Ensham Resources Pty Ltd

Groundwater Dependent Ecosystem Management and Monitoring Plan

Ensham Mine

July 2025

Question today
Imagine tomorrow
Create for the future

Groundwater Dependent Ecosystem Management and Monitoring Plan
Ensham Mine

Ensham Resources Pty Ltd

WSP
Level 12, 900 Ann Street
Fortitude Valley QLD 4006
GPO Box 2907
Brisbane QLD 4001

Tel: +61 7 3854 6200
Fax: +61 7 3854 6500
wsp.com

Rev	Date	Details
A	02/05/2024	Draft for client review and comment
B	30/05/2024	Final
C	28/07/2025	Response to DCCEEW

	Name	Date	Signature
Prepared by:	Larissa Boundy	28/07/2025	
Reviewed by:	Rob Harrison	28/07/2025	
Approved by:	Rob Harrison	28/07/2025	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

This document may contain confidential and legally privileged information, neither of which are intended to be waived, and must be used only for its intended purpose. Any unauthorised copying, dissemination or use in any form or by any means other than by the addressee, is strictly prohibited. If you have received this document in error or by any means other than as authorised addressee, please notify us immediately and we will arrange for its return to us.

Table of contents

1 Introduction 1
1.1 Background 1
1.2 Study purpose 1
1.3 Areas of investigation 2
1.4 Study limitations 2
1.5 Declaration of accuracy 4
1.6 Conditions of approval 4
2 Environmental context 13
2.1 Climate 13
2.2 Geology 14
2.3 Hydrogeological setting 14
2.4 Receiving waters 14
2.5 Connectivity 15
2.6 Land use 15
2.7 Groundwater dependent ecosystems 15
3 Desktop findings 16
3.1 Literature review 16
3.2 Groundwater Monitoring and Management Plan Report (SLR, 2024) 19
3.3 Zone 1: Groundwater Impact Assessment (SLR, 2022a) and Zones 2 and 3: Groundwater Impact Assessment (SLR, 2022b) 24
3.4 Flora Technical Report (AECOM, 2020) 31
3.5 Summary 34
4 Mitigation and management 36
4.1 Groundwater trigger levels 36
4.2 Data management and reporting 36
5 Conclusion 37

CONTENTS (Continued)

6 Limitations 38

6.1 Permitted purpose 38

6.2 Qualifications and assumptions 38

6.3 Use and reliance 38

6.4 Disclaimer 39

Bibliography 40

List of tables

Table 1.1 Conditions of approval reference table 5

Table 3.1 Groundwater monitoring bores 16

Table 3.2 Electrical Conductivity summary statistics (SLR, 2022a and SLR, 2022b) 27

Table 3.3 Regional ecosystems field verified as occurring within the Project Footprint 31

List of figures

Figure 1.1 Study area 3

Figure 2.1 Annual precipitation (1992–2024) divided between wet and dry season records from the Emerald Airport weather station (BoM, 2024) 13

Figure 3.1 Mapped GDE's 18

Figure 3.2 Hydrograph for Twin (bore 5), the upstream basal alluvium bore (SLR, 2024) 19

Figure 3.3 Hydrograph of western, upstream Nogoa River alluvial bores (SLR, 2024) 20

Figure 3.4 Hydrograph of eastern alluvial bores (SLR, 2024) 21

Figure 3.5 Conceptual cross section through Nogoa River alluvium and Quaternary sediments (SLR, 2024) 23

Figure 3.6 Hydrographs for upstream bores (SLR, 2022a) 24

Figure 3.7 Hydrograph of bores near/in Zone 1 and 2 (SLR, 2022a) 25

Figure 3.8 Hydrograph of the EC bores (SLR, 2022a) 26

Figure 3.9 Conceptual cross section through the Nogoa River and quaternary sediments (SLR, 2022a and SLR, 2022b) 27

Figure 3.10 Location of impacts to Nogoa River alluvium 29

Figure 3.11 Recovery curve of EC11, an alluvial bore in Zone 1 (SLR, 2022a) 30

Figure 3.12 Field verified vegetation communities 32

List of appendices

Appendix A Ensham Groundwater Monitoring – Groundwater Monitoring and Management Plan Report (SLR, 2024)

Appendix B Ensham Life of Mine Extension Project – Zone 1: Groundwater Impact Assessment (SLR, 2022a)

Appendix C Ensham Life of Mine Extension Project – Zones 2 and 3: Groundwater Impact Assessment (SLR, 2022b)

Appendix D Ensham Life of Mine Extension Project: Flora Technical Report (AECOM, 2020)

1 Introduction

1.1 Background

Ensham Resources Pty Ltd (Ensham), has engaged suitably qualified ecologists to prepare this Groundwater Dependent Ecosystem Monitoring and Management Plan (GDEMMP) for Ensham Mine. The Ensham Mine is an open-cut and underground coal mine located approximately 35 kilometres east of Emerald, and it is proposed to extend underground operations into zones 1, 2 and 3 (Figure 1.1), which is the subject of an Environmental Authority Amendment application. The preparation of a GDEMMP and terrestrial Groundwater Dependent Ecosystem (GDE) monitoring methodology is in response to Condition 5 of the EPBC Approval (2020/8669) for the Ensham Life of Mine Extension (the Project).

Condition 5 of the EPBC Approval (2020/8669) outlines the following requirements for the GDEMMP and development and implementation of a potential terrestrial GDE monitoring program:

> *Condition 5:*
>
> *The outcome of implementing the GDEMMP must be that all GDEs potentially impacted by the Action are identified and any impacts are avoided, mitigated or residual impacts are offset in accordance with the Environmental Offsets Policy. The GDEMMP must be consistent with the Environmental Management Plan Guidelines and include the following to the satisfaction of the Minister:*
>
> *a) the details and results of a GDE field assessment of the project area.*
>
> *b) if any riparian vegetation or Brigalow on alluvial plains within the project area is found to not be groundwater dependent, the evidence used to draw this conclusion.*
>
> *c) if any riparian vegetation or Brigalow on alluvial plains is determined likely to be groundwater dependent, a description and map/s to clearly define the location and boundaries of GDEs and where they include habitat for protected matters.*
>
> *d) if any riparian vegetation or Brigalow on alluvial plains is determined likely to be groundwater dependent, the proposed methodology and timing for the monitoring and detection of any impacts to GDEs as a result of the Action, including collecting baseline data and specifying associated:*
>
> > *i) trigger values that, if reached, the approval holder commits to investigate the cause of and take effective corrective actions to bring values below the trigger, and*
> >
> > *ii) limits that, if exceeded, the approval holder commits to provide environmental offsets to compensate for likely residual impacts to GDEs as a result of the Action in accordance with condition 9.*
>
> *e) details of the investigations and corrective actions that will be taken if trigger values are reached.*

1.2 Study purpose

The purpose of the GDEMMP is to:

- identify field verified regional ecosystems that may be potential GDEs dependant on the subsurface presence of groundwater (subsurface GDEs), within the modelled areas of potential groundwater drawdown associated with mining operations
- evaluate the potential groundwater drawdown impacts to threatened ecological communities (TECs) (e.g. Brigalow) listed as Matters of National Environmental Significance (MNES) under the EPBC Act, which may be potential GDEs.

1.3 Areas of investigation

The primary area of interest for assessment was 2,737 ha of land within three zones into which underground operations expansion is proposed, or has commenced:

- Zone 1 (proposed)
  - Lot A AP7202
  - Lot 2 CP911010
  - Lot 8 TT345
  - Lot 7 TT309
  - Lot 6 TT309
- Zone 2 (approved and commenced)
  - Lot 31 CP864573
  - Lot 32 RP908643
- Zone 3 (approved, not yet commenced)
  - Lot 30 CP864574
  - Lot 33 RP864576.

The areas of investigation and assessment discussed within this report for the Project, include:

- *Mine Expansion Area*– the extent of the expansion (zone 1, 2 and 3).
- *Study Area* – the extent of the Mine Expansion Area and additional areas within the Ensham mining leases where flora and hydrological surveys have been conducted.
- *Locality* – the extent of 20 km radius of the Study Area.

The areas of investigation are illustrated in Figure 1.1.

1.4 Study limitations

The GDE study and assessment presented herein has involved a desktop assessment only, which has relied on publicly available information and data and reports prepared by various consultancies for Ensham. It assumes these sources of information contain correct and scientifically robust analytical information and data, to enable the assessment of potential impacts upon GDEs, which may or may not result from modelled groundwater drawdown.

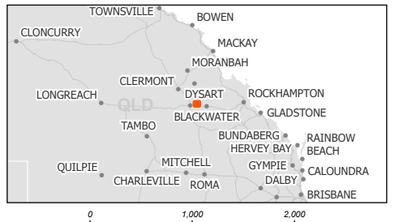
This study has also evaluated the influence of water releases from Fairbairn Dam for the purpose of crop irrigation that occurs on agricultural land associated with an alluvial floodplain, which is immediately adjacent to mining operations, and how the irrigated water recharges the shallow alluvial aquifer within the Quaternary aged alluvium.

PS206966
Ensham GDEMMP

Figure 1.1
Study Area

Legend

- Watercourse
- Roads
- Mine Expansion Area
- Mining Lease
- Land Parcels



0 1,000 2,000
Meters

Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3

1:60,000 Date: 18/04/2024

Data sources: DELWP, Geoscience Australia
World Imagery: Earthstar Geographics

© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it was supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCSI Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.

1.5 Declaration of accuracy

In making this declaration, I am aware that section 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed	
Full name	Larissa Boundy
Organisation	WSP
Date	28/07/2025

1.6 Conditions of approval

The conditions of approval and location of supporting information is presented in Table 1.1.

Table 1.1 Conditions of approval reference table

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
5	The outcome of implementing the GDEMMP must be that all GDEs potentially impacted by the Action are identified and any impacts are avoided, mitigated or residual impacts are offset in accordance with the Environmental Offsets Policy. The GDEMMP must be consistent with the Environmental Management Plan Guidelines.	Overall	The GDEMMP has demonstrated that GDEs are not present, as per the determinations and key findings of *Groundwater Monitoring and Management Plan Report* (SLR 2024), *Groundwater Impact Assessment* (SLR 2022a and 2022b) and *Flora Technical Report* (AECOM, 2020), as technical appendices to this report.
		2.3	Refer Section 2.3 that explains how the Quaternary aged alluvium is disconnected from the Rangal Coal Measures, and how the alluvium is disconnected from the Nogoa River, as per the *Groundwater Monitoring and Management Plan Report* and Groundwater Impact Assessments. Explains the alluvial aquifer is highly saline, has low water levels and is not continuously saturated (as indicated by periodically dry bores). These conditions are not suitable for GDEs (see Section 2.7 regarding reliance on groundwater and Section 3.5 salinity tolerances of species).
		2.4	Refer Section 2.4 that explains that the Nogoa River is anthropogenically managed for stock watering and agricultural purposes.
		2.7	Refer Section 2.7 that identifies aquatic and terrestrial GDEs (low confidence) are mapped in the Mine Expansion Area, and these are defined as dependant on subsurface presence of groundwater or subsurface expression of groundwater from shallow aquifers (respectively). GDEs rely on groundwater to function, and alterations in groundwater result in noticeable changes such as stunted or absent growth and dieback, and lack of recruitment.

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
		3.2.1	Refer Section 3.2.1 explaining that the alluvium groundwater level is 13.8 m below ground surface level. No groundwater drawdown has occurred since mining commenced, as per the findings of the *Groundwater Monitoring and Management Plan Report*. The western bores are generally reflective of cumulative rainfall departure (CRD rainfall trends), eastern bores are not. The levels in the eastern bores remain stable during prolonged dry periods, which is likely due to anthropogenic management of Nogoa River demonstrating evidence of the hydraulic disconnect between the Nogoa River alluvium and the Rangal Coal Measures.
		3.2.2	Refer Section 3.2.2 explaining that no drawdown of groundwater has been observed in the alluvium, since commencement and advancement of mining operations, as per the findings of the *Groundwater Monitoring and Management Plan Report*.
		3.2.3	Refer Section 3.2.3 that describes how the groundwater is highly saline and appears to be influenced by irrigation upstream, as per the findings of the *Groundwater Monitoring and Management Plan Report*. These conditions are not suitable for GDEs (see Section 3.5 regarding salinity tolerances of flora species recorded on site.
		3.2.4	Refer Section 3.2.4 that explains how the alluvium is not connected to the Nogoa River due to silts and clays, only connected during periods of intense irrigation or when basal clay is absent, as per *Groundwater Monitoring and Management Plan Report* findings. The difference in groundwater levels and salinity provide additional evidence.

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
		3.3.1	Refer Section 3.3.1 that highlights how the agricultural practices are altering the groundwater level, by increasing water level during periods of prolonged dryness, and higher groundwater levels further away from the Nogoa River, as per the *Groundwater Monitoring and Management Plan Report*. There has been no evidence of groundwater drawdown from mining, as per the *Groundwater Monitoring and Management Plan Report*. Periodically dry monitoring bores indicate the alluvium is not consistently saturated and there may be disconnected zones with stagnant lenses, as per the Groundwater Impact Assessment. If there is any connectivity between the alluvium and the riverbed it is extremely limited, further supported by water quality parameters; after dry periods the water refilling bores was saline whilst Nogoa River was fresh. Bores further away from the Nogoa River have higher groundwater levels, as per the Groundwater Impact Assessment. These conditions are not suitable for GDEs (see Section 2.7 regarding GDE reliance on consistent groundwater and Section 3.5 regarding salinity tolerances of species).
		3.3.2	Refer Section 3.3.2 describes how the groundwater is highly saline and appears to be influenced by irrigation upstream, as per the Groundwater Impact Assessment. These conditions are not suitable for GDEs (see Section 3.5 regarding salinity tolerances of species).
		3.3.3	Aquatic and terrestrial GDE seeps denote ecosystems dependent on surface water closely linked with groundwater (see Section 2.7). There is evidence that there is no connectivity between the alluvium and the Nogoa River, as per the Groundwater Impact Assessment, and therefore, there are no GDEs present.

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
		3.3.4	Refer Section 3.3.4 that specifies that there is no evidential predicted reduction in baseflow in the Nogoa River resulting from mine expansion (i.e. no change from current operations) , as per the Groundwater Impact Assessment. The difference in alluvial extraction due to drawdown between the null model and the Project is 0.7 ML/day, as per the Groundwater Impact Assessment, which is negligible. The Nogoa River alluvium is expected to recover fully post-mining. Therefore, even if there were GDEs present (although it has been proven there are not), there would not be any impacts resulting from the Project.
		3.3.5	Refer Section 3.3.5 outlining that impacts resulting from the Project are negligible and would not impact any Ges even if they were present (although it has been determined there are not).
		3.4.1	Refer Section 3.4.1 that discusses how the field surveys identified five regional ecosystems (vegetation communities) are present within the Mine Expansion Area, as per the Flora Technical Report.
		3.4.3	Refer Section 3.4.3 discussing that three regional ecosystems were field verified within the Mine Expansion Area, which are state mapped as low-confidence GDEs, as per the Flora Technical Report. — *Acacia harpophylla* has a shallow, lateral root system that is extremely likely to be dependent on groundwater — *Eucalyptus coolabah* exhibited signs of water stress, indicating community is not accessing permanent water. — *Eucalyptus camaldulensis* is not tolerant of long-term drought or salinity and was in good condition, likely accessing water from the Nogoa River. The alluvium is not suitable for GDEs as it is not permanently saturated and highly saline, as per the Flora Technical Report.

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
		3.5	Refer Section 3.5 and the Flora Technical Report that confirm there are no aquatic or terrestrial GDEs within the Mine Expansion Area. The Nogoa River and the alluvium are not connected. The alluvium is highly saline and is not permanently saturated, as per the Groundwater Monitoring and Management Plan Report and Groundwater Impact Assessments. Aquatic and terrestrial GDE seeps denote ecosystems that depend on surface water closely linked with groundwater. There are no known GDEs within a 10 km radius, only low-confidence derived GDEs. Aquatic GDEs require groundwater present at the surface, and as the groundwater level is, on average, 13.8 m below ground level, this is not possible, as per the Groundwater Impact Assessment. The dominant species of the field verified regional ecosystems present within the Mine Expansion Area, either do not have a root depth that could potentially reach the groundwater 13.8 m below ground level or have a salinity tolerance far lower than the salinity level of the groundwater. Vegetation communities would access the fresh water from the Nogoa River and show signs of ill health, and likely dieback, if there was interaction with the highly saline groundwater within the alluvium. Even if there were GDEs present, changes are negligible. There is no predicted reduction of baseflow in the Nogoa River, and reduction in loss from the alluvium into the lower strata is temporary and negligible, as per the Groundwater Impact Assessment.
5a	GDEMMP must include the details and results of a GDE field assessment of the project area	3.4	Refer Section 3.4 that details the results of the GDE field assessment (also presented in Appendix D).

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
5b	If any riparian vegetation or Brigalow on alluvial plains within the project area is found to not be groundwater dependent, the evidence used to draw this conclusion	3.4	Refer to Section 3.4.1 that discusses the field verified vegetation, and Section 3.4.3.1 that discusses the field verified vegetation, which is present within the mapped low-confidence GDEs, and Section 3.4.3.3 which outlines evidence that field verified vegetation is not accessing groundwater, primarily due to exhibiting signs of water stress, as per the findings of the Flora Technical Report. Also refer to Section 3.5 which provides evidence that field verified vegetation would be negatively impacted if it were accessing groundwater due to salinity tolerances.
5c	If any riparian vegetation or Brigalow on alluvial plains is determined likely to be groundwater dependent, a description and map/s to clearly define the location and boundaries of GDEs and where they include habitat for protected matters	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.
5d	If any riparian vegetation or Brigalow on alluvial plains is determined likely to be groundwater dependent, the proposed methodology and timing for the monitoring and detection of any impacts to GDEs as a result of the Action, including collecting baseline data and specifying associated: **i** trigger values that, if reached, the approval holder commits to investigate the cause of and take effective corrective actions to bring values below the trigger, and **ii** limits that, if exceeded, the approval holder commits to provide environmental offsets to compensate for likely residual impacts to GDEs as a result of the Action in accordance with condition 9.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.
5e	Details of the investigations and corrective actions that will be taken if trigger values are reached.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
6	If, at any time during the period for which the approval has effect, the approval holder detects that any trigger value specified in the approved GDEMMP has been reached or any limit specified in the approved GDEMMP exceeded, the approval holder must notify the department in writing within 10 business days of the detection.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.
7	Within 14 business days of detecting the reaching or exceeding of a trigger value or limit that must be notified under condition 6, the approval holder must commence an investigation to determine if the reaching of a trigger value or exceedance of a limit is a result of the Action.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.
8	The approval holder must, within 60 business days of a detection that must be notified under condition 6, complete and submit to the department a report of the investigation required under condition 7. Unless evidence can be provided, to the Minister's satisfaction, that the reaching of a trigger value is not attributable to the Action, the approval holder must implement the corrective actions in accordance with the commitments made in the approved GDEMMP to halt and prevent further harm to protected matters.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.

Cond.	Condition requirement	Plan reference	Demonstration of how the plan addresses condition requirements and commitments made in the plan to address condition requirements
9	If a limit specified in the approved GDEMMP is exceeded the approval holder must, within 12 months from the detection of the exceedance, submit an Offset Management Plan to address residual harm to protected matters to the department for the Minister's written approval. The Offset Management Plan must be consistent with the Environmental Management Plan Guidelines and the Environmental Offsets Policy and contain the information and commitments specified in Attachment 4. The approval holder must implement the approved Offset Management Plan from when it is approved by the Minister in writing until the expiry date of this approval.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.
10	If an Offset Management Plan is required under condition 9 and an Offset Management Plan has not been approved by the Minister in writing within 4 months of its first submission to the department and the Minister notifies the approval holder that the Offset Management Plan is not suitable for approval, the Minister may, at least two months after so notifying the approval holder, approve a version of the Offset Management Plan prepared or revised by the department. The approval holder must implement the Offset Management Plan as approved by the Minister in writing.	n/a	Not applicable. The Groundwater Monitoring and Management Plan Report, Groundwater Impact Assessment, the Flora Technical Report and the WSP assessment, have all determined that GDEs are not present.

2 Environmental context

2.1 Climate

Ensham is in the Central Highlands region of Queensland in the Brigalow Belt bioregion, which is characterised by hot summers and mild winters. Meteorological data is available from the Emerald airport station (35264; BoM, 2024) from 1992 to 2024, which is approximately 35 km southwest of Ensham.

The Emerald region typically experiences short, intense rainfall events that occur primarily from November to April (the wet season), with comparatively less precipitation during the dry season (May to October) (BoM, 2024; refer Figure 2.1). Mean annual rainfall between 1992 and 2024 was 558 mm, average dry season rainfall was 159 mm and average wet season rainfall was 380 mm.

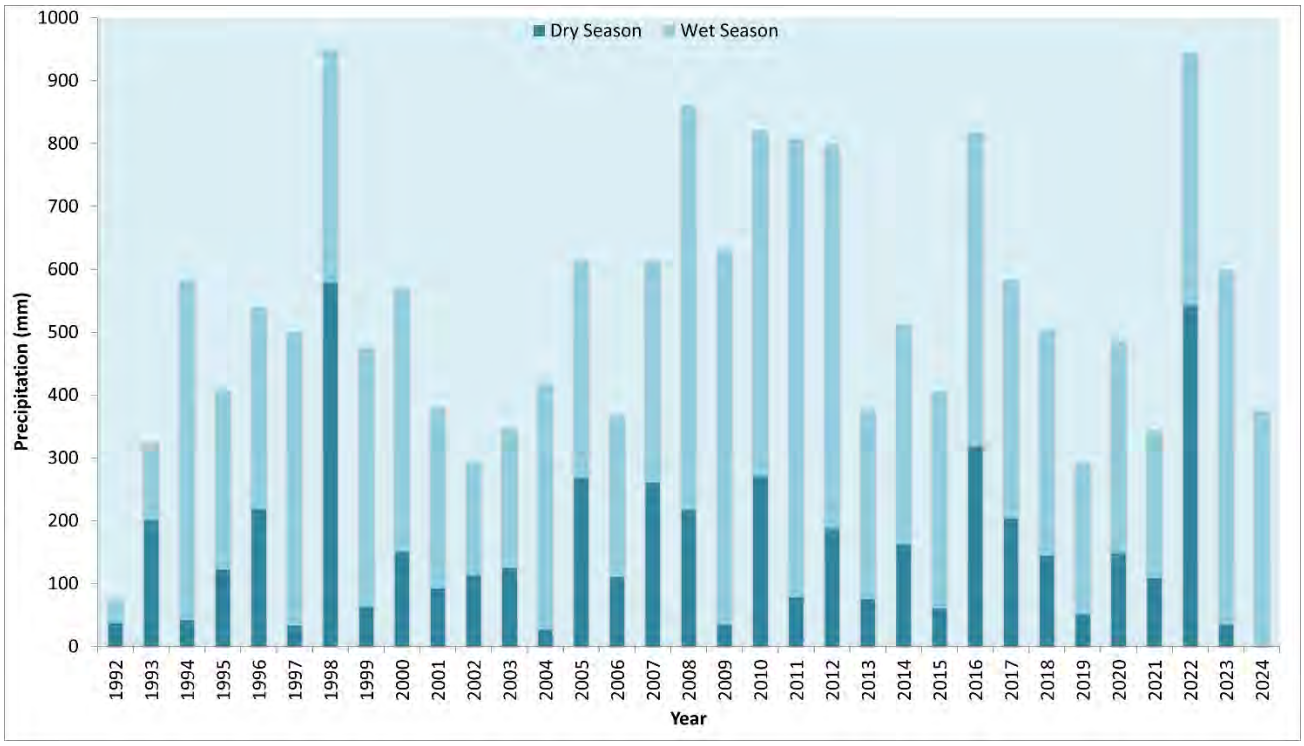


Figure 2.1 Annual precipitation (1992–2024) divided between wet and dry season records from the Emerald Airport weather station (BoM, 2024)

2.2 Geology

Geology features of the Study Area are described using the current Queensland Government online mapping resource (Queensland Globe, 2024).

The general landscape of Ensham is approximately 150 m above sea level (ASL) and characterised by gently undulating plains with some rocky hills with elevations up to 250 m. There are four separate surface geologies:

- The predominant surface geology in the Study Area is an alluvial flood plain with stratified units from the Quaternary, including clay, silt, sand and gravel.
- To the north of zone 1 and 2 there is stratified sedimentary rocks from the Eocene, with deeply weathered claystone, siltstone, sandstone, gravel, lignite, oil shale and interbedded basalt.
- There is a small section in the north-east corner of zone 2 with stratified ferricrete from the Tertiary which is characterised by duricrusted paleosols at the top of deep weathering profiles.
- In the centre of zone 1 and 2 there is a section of arenite-mudrock from the early/middle Triassic containing sandstones, mudstone and conglomerate.

2.3 Hydrogeological setting

There are two groundwater bearing units within the Study Area, the Quaternary aged alluvium, and the Permian aged Rangal Coal Measures, which are separated by a low permeability unit, the Rewan Group (SLR, 2024).

The Quaternary aged alluvium groundwater aquifer level is shallow (on average 13.8 m below ground level) and is comprised of sequences of less permeable clay, silt, and sand, underlain by more permeable sand and gravel (SLR, 2022a). It is likely the less permeable layers isolate the alluvium from the Nogoa River. The shallow alluvial aquifer is highly saline and unsuitable for stock watering and irrigation, which also indicates the aquifer is not connected to the Nogoa River, which has freshwater (discussed further in Section 3.2 and 3.3). The shallow alluvial aquifer has low water levels and may not be continuously saturated and rather form lenses of highly saline, stagnant water, as indicated by periodically dry bores.

2.4 Receiving waters

Watercourse features of the Study Area are described using the current Queensland Government online mapping resource (Queensland Globe, 2024).

The Nogoa River is a stream order 8 major watercourse that transects the Study Area, flowing from west to east, and continues south-east for approximately 20 km before its confluence with the Comet River to form the Mackenzie River. The Nogoa River briefly splits into two river channels within the Study Area before re-converging again into the one. The main channel flows the southern route. There are several ephemeral watercourses, including Mosquito Creek, stream order 4, which originates beyond the north-western boundary of zone 1 and flows into the Nogoa River in zone 1, and several small unnamed watercourses that drain to Mosquito Creek and the Nogoa River.

The Nogoa River is naturally ephemeral yet is anthropogenically managed for consistent low flow through releases from Fairbairn Dam, located ~60 km from the Study Area, for stock watering and agricultural crop irrigation.

2.5 Connectivity

Connectivity has been assessed using the Biodiversity Planning Assessment using Queensland Government online mapping resource (Queensland Spatial, 2024).

The Project Footprint contains 537.9 ha of state significant habitat and 164.8 ha of regionally significant habitat, which are predominantly along watercourses and represented by remnant vegetation. The watercourses and fringing vegetation provide habitat and a functional riparian wildlife corridor for the movement and dispersal of aquatic and terrestrial fauna species. It provides a safe refuge for and maintains genetic flow and diversity, which is particularly important for threatened fauna species. The waterway and transient fauna also enable the dispersal of flora seeds and pollen. The state and regionally significant habitats are connected to large tracts of state significant habitat that continues northward of the Project footprint.

2.6 Land use

Land use of the locality is described using the current Queensland Government online mapping resource (Queensland Globe, 2024).

The majority of the Study Area and the locality has been historically cleared for grazing and agricultural crop production, which has been occurring prior to the mine development and continues to currently occur.

2.7 Groundwater dependent ecosystems

Groundwater dependant ecosystems are defined as aquatic and terrestrial ecosystems reliant on groundwater for some, or all of their water requirements to survive, which can be influenced by variations in groundwater level and groundwater water quality. Groundwater dependant ecosystems are classified into three broad types (DESI, 2013):

1. Aquatic/surface expression GDEs: aquatic ecosystems dependent on the subsurface presence of groundwater.
2. Terrestrial GDEs: terrestrial ecosystems dependent on the subsurface expression of groundwater from shallow aquifers.
3. Subterranean GDEs: aquatic ecosystems within deeper aquifer and cave ecosystems.

Aquatic and terrestrial GDE's (low confidence) have been mapped within the Mine Expansion Area (Queensland Spatial, 2024).

Groundwater dependant ecosystems rely on groundwater presence to sustain their functionality and composition (Foster et al. 2005 and Murray et al. 2003). Alterations in groundwater levels can induce noticeable changes in GDEs, as evidenced through observable shifts in vegetation. These alterations include stunted or absent growth and dieback due to limited availability of water for transpiration and limit the effective recruitment of seedlings from adult trees.

Predicting the impacts of groundwater drawdown on vegetation communities is difficult as the critical groundwater depth threshold is unknown, as too the depth of roots of flora species that can be groundwater dependant (e.g. *Eucalyptus camaldulensis* and *E. tereticornis*). Ecological responses may exhibit either linear patterns, wherein a tree's health deteriorates proportionally with changes in groundwater depth, or threshold responses, where tree health remains relatively stable until groundwater depth plunges below the critical threshold (Kath et al., 2014).

The response to drawdown is likely contingent upon tree size, with younger trees possessing shallow roots exhibiting distinct requirements, thresholds, and responses compared to larger trees (Kath et al., 2014). Smaller trees typically have less interactions with groundwater and may not exhibit discernible responses to dewatering.

In regions characterised by highly intermittent watercourse flows, groundwater serves a vital water source for groundwater dependent species and vegetation. Consequently, the structure of riparian vegetation communities along ephemeral watercourses may be attributed to, or at least partly dependent upon, groundwater for long-term survival and persistence.

3 Desktop findings

3.1 Literature review

The following reports have been prepared for Ensham to support approval applications in relation to the Project and have been reviewed as part of the desktop assessment:

- Ensham Groundwater Monitoring – Groundwater Monitoring and Management Plan Report (SLR, 2024) (Appendix A)
- Ensham Life of Mine Extension Project – Zone 1: Groundwater Impact Assessment (SLR, 2022a) (Appendix B)
- Ensham Life of Mine Extension Project – Zones 2 and 3: Groundwater Impact Assessment (SLR, 2022b) (Appendix C)
- Ensham Life of Mine Extension Project: Flora Technical Report (AECOM, 2020) (Appendix D).

3.1.1 Groundwater monitoring network

A progressive groundwater monitoring network has been progressively installed at Ensham since the 1990's. The bore network comprises a comprehensive network located within Ensham and adjacent agricultural land, and they include alluvial, inactive, private landholder (agriculture), regional and residual void monitoring bores.

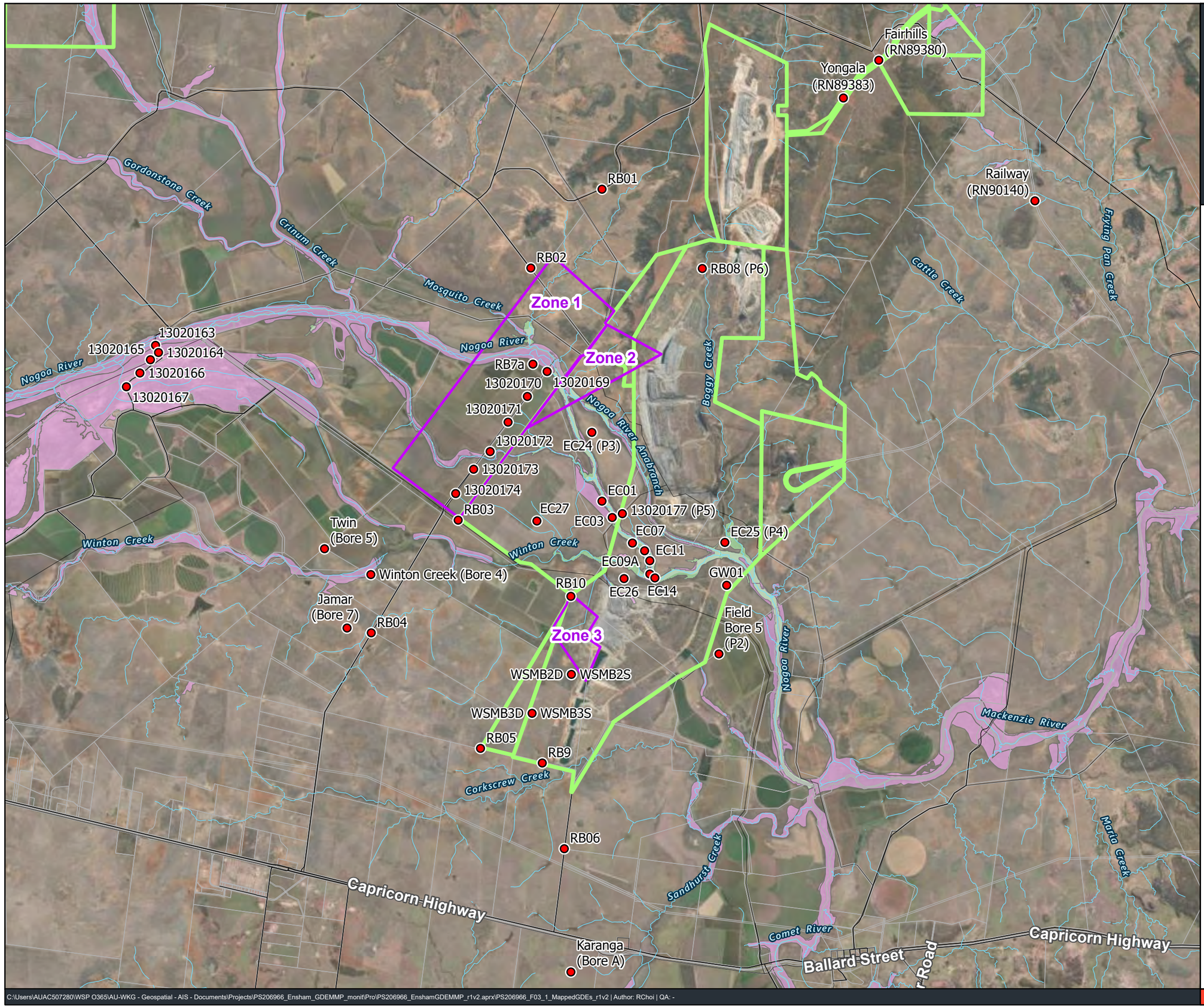
As the potential GDE's occur above the Quaternary aged alluvium (land zone 3, see Section 3.4.1) associated with the Nogoa River floodplain, only the Nogoa River Alluvium bores have been interrogated by the GDE assessments (Table 3.1 and Figure 3.1).

Table 3.1 Groundwater monitoring bores

Bore name	Longitude	Latitude	Aquifer
13020163*	148.3304	-23.4328	Not specified, likely alluvium
13020164*	148.3313	-23.4348	Not specified, likely alluvium
13020165*	148.3288	-23.4369	Not specified, likely alluvium
13020166	148.3268	-23.4406	Alluvium
13020167*	148.3216	-23.4446	Not specified, likely alluvium
13020169	148.4517	-23.4391	Alluvium
13020170*	148.4446	-23.4462	Not specified, likely alluvium
13020171*	148.4388	-23.4536	Not specified, likely alluvium
13020172*	148.4334	-23.4619	Not specified, likely alluvium
13020173	148.4295	-23.467	Alluvium
13020174*	148.4229	-23.4739	Not specified, likely alluvium
13020177 (P5)	148.4752	-23.4791	Alluvium
EC01	148.4689	-23.4756	Alluvium
EC03	148.4721	-23.4802	Alluvium
EC07	148.4784	-23.4874	Alluvium
EC09A	148.4822	-23.4896	Alluvium

Bore name	Longitude	Latitude	Aquifer
EC11	148.4838	-23.4924	Alluvium
EC13	148.4839	-23.4961	Alluvium
EC14	148.4854	-23.4972	Alluvium
EC24 (P3)	148.4656	-23.4562	Alluvium
EC25 (P4)	148.5068	-23.487	Alluvium
EC26	148.476	-23.4975	Alluvium
EC27	148.449	-23.4815	Alluvium
Fairhills (RN89380)	148.5524	-23.3501	Burngrove formation
Field Bore 5 (P2)	148.5053	-23.5185	Alluvium
GW01	148.5075	-23.4991	Alluvium
Jamar (Bore 7)	148.3911	-23.5123	Rewan group
Karanga (Bore A)	148.4609	-23.609	Coal measures (not specified)
Railway (RN90140)	148.6008	-23.3894	Fair hill formation
RB01	148.468	-23.3874	Rangal coal measures coal (a2c)
RB02	148.4464	-23.4099	Rangal coal measures coal
RB03	148.4249	-23.4814	Rangal coal measures coal (a2c)
RB04	148.3985	-23.5136	Rangal coal measures coal (a21)
RB05	148.4324	-23.546	Rangal coal measures coal (a21)
RB06	148.4585	-23.5741	Rangal coal measures coal (a2c)
RB08 (P6)	148.499	-23.4095	Coal seam (not specified)
RB10	148.4597	-23.5027	Coal seam (not specified)
RB7a	148.4473	-23.4371	Alluvium
RB9	148.4514	-23.5499	Coal seam (not specified)
Twin (Bore 5)	148.3839	-23.4899	Basal alluvium
Winton Creek (Bore 4)	148.3982	-23.4971	Rewan group
WSMB2D	148.4601	-23.5248	Rangal coal measures (coal seam)
WSMB2S	148.4601	-23.5248	Rangal coal measures overburden
WSMB3D	148.4481	-23.5359	Rangal coal measures (coal seam)
WSMB3S	148.4481	-23.5359	Rangal coal measures overburden
Yongala (RN89383)	148.5417	-23.3609	Burngrove formation

* indicates DNRM bores that were monitored before the mines influence that are not sampled by Ensham, and many of which no longer exist.

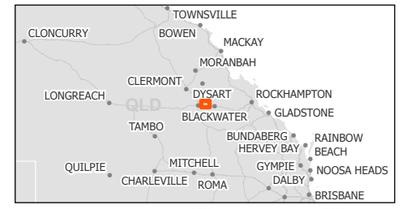


PS206966
Ensham GDEMMP

Figure 3.1
Mapped GDE's

Legend

- Bores
- Watercourse
- Roads
- Project Footprint
- Mining Lease
- Land Parcels
- Derived Surfacre GDE - low confidence
- Derived Terrestrial GDE - low confidence



Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3

1:115,000 Date: 14/04/2025

Data sources: DELWP, Geoscience Australia
World Imagery: Earthstar Geographics

© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it was supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCSI Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.

3.2 Groundwater Monitoring and Management Plan Report (SLR, 2024)

The Groundwater Monitoring and Management Plan (GMMP) was prepared to satisfy groundwater management conditions I14 and I15 from Environmental Authority (EA) EPML00732813 for Ensham Mine. A conceptual hydrological model described within the report represents the current understanding of the groundwater environment at Ensham Mine.

3.2.1 Groundwater levels

The GMMP separates the Nogoa River alluvium bores into two categories:

- Western bores: 13020166, 13020169, 13020173, RB7a, and basal alluvium Twin (Bore 5). These are in the western section and are the most upstream monitoring points in the groundwater monitoring network. Water levels here range between 155 and 146 m AHD (Australian Height Datum).
- Eastern bores: EC01, EC03, EC07, EC09a, EC11, EC13, EC14, GW01, GW01, EC24, EC25, and Field 5. These are in the eastern section of the groundwater monitoring network, which is primarily within the central area of mining operations. Water levels here range between 145 and 136 m AHD.

On average, the alluvium groundwater level is 13.8 m below ground surface level.

Cumulative rainfall departure (CRD) reflects rainfall trends and is a parameter used to assess the nature of groundwater level changes. Positive gradients indicate wetter than normal climatic conditions, and conversely, negative gradients indicate drier than normal climatic conditions.

3.2.1.1 Western bores

One of the western groundwater monitoring bores, the Twin bore site, is approximately 7 km west of the mine and has the highest groundwater levels of the alluvial aquifer. Between 2006 and 2018 groundwater levels increased, regardless of climatic trends (Figure 3.2), which is theorised to be due to agricultural irrigation recharging the shallow alluvial aquifer. Since 2018 groundwater levels have been in line with general climatic trends and are trending towards baseline conditions, which may reflect a reduction of recharge related to decreased irrigation, more so than climatic rainfall variables.

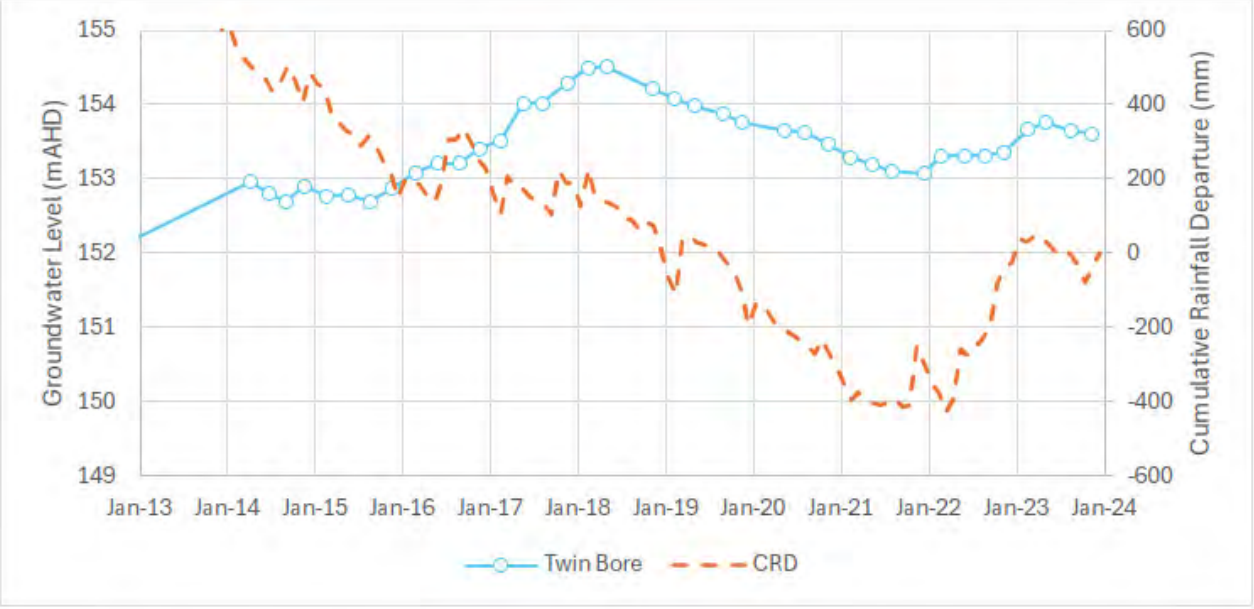


Figure 3.2 Hydrograph for Twin (bore 5), the upstream basal alluvium bore (SLR, 2024)

Water level for the other western bores largely reflect climatic trends (Figure 3.3). The groundwater level at these bores has been relatively stable, with a strong correlation between groundwater levels and CRD, as demonstrated through increasing water levels in response to wetter than average climatic conditions over the 2022/2023 cusp, and subsequent decline as the wetter weather decreased.

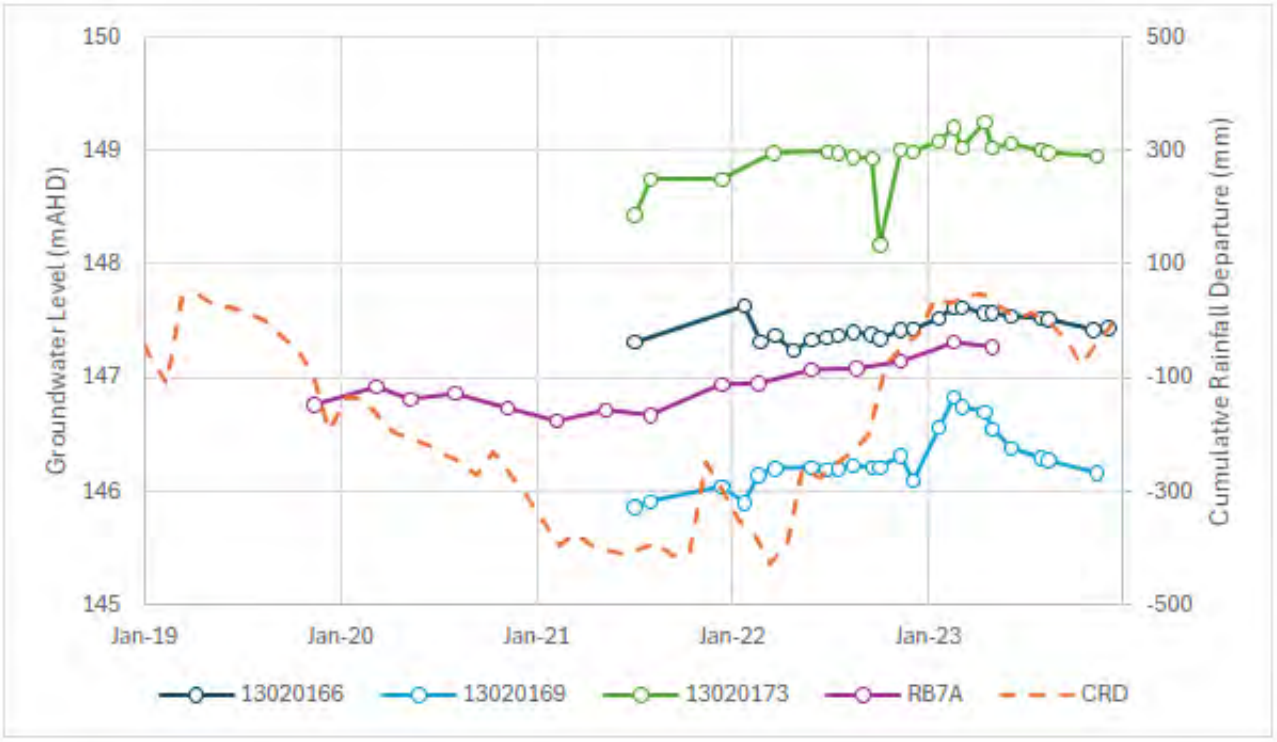


Figure 3.3 Hydrograph of western, upstream Nogoa River alluvial bores (SLR, 2024)

3.2.1.2 Eastern bores

In the eastern section of the alluvial monitoring network, the eastern monitoring bores are situated downstream and at lower elevations within the catchment area. These alluvial bores include the EC monitoring bore series, as well as the GW01 and Field 5 bore. The EC monitoring bore series is positioned near the Nogoa River and its anabranch, typically where the Rangal Coal measures sub-crops into the overlying alluvium. Meanwhile, the GW01 and Field 5 bores are situated further downstream, to the east of the sub-crop and current mining operations.

Hydrographs depicted in Figure 3.4 illustrate the water levels recorded in the eastern monitoring bores. Similar to the western boreholes, these downstream bores exhibit some sensitivity to climatic variations, with trends in CRD closely correlated with groundwater levels prior to 2011. However, most boreholes have remained relatively stable despite prolonged periods of drier-than-average conditions.

The potential impact of mining activities, if any, may have been obscured by a significant rainfall event at the onset of 2011, causing a sharp increase in water levels across the alluvium monitoring bore network. Subsequent monitoring efforts have revealed no discernible influence of mining extraction since then. Although water levels initially returned to near baseline levels following the flooding event, they continued to remain elevated despite the prevailing drier climatic conditions from 2014 to 2019. The persistent groundwater level during a prolonged dry period can likely be attributed to crop irrigation associated with agricultural land use.

The rising water levels within the EC monitoring bore series have been attributed to upstream irrigation, particularly in proximity to EC01 and EC03, with bores closest to the irrigation area experiencing the most substantial increase in water level over time. Monitoring bores farther from this recharge area demonstrate a greater response to climatic influences, particularly evident during the significant rainfall events of early 2022.

The lack of groundwater level decline amidst generally drier climatic conditions, coupled with the commencement and advancement of mining operations, indicates hydraulic disconnect or impediment between the Nogoa River alluvium and the Rangal Coal Measures. Notably, no groundwater level drawdown attributable to mining activities has been observed in the alluvium. Instead, it is evident that increases to groundwater levels, which are inconsistent with CRD and prevailing climatic conditions (rainfall) and modelled groundwater drawdown from mining operations, can be attributed to crop irrigation practices recharging the shallow alluvial aquifer.

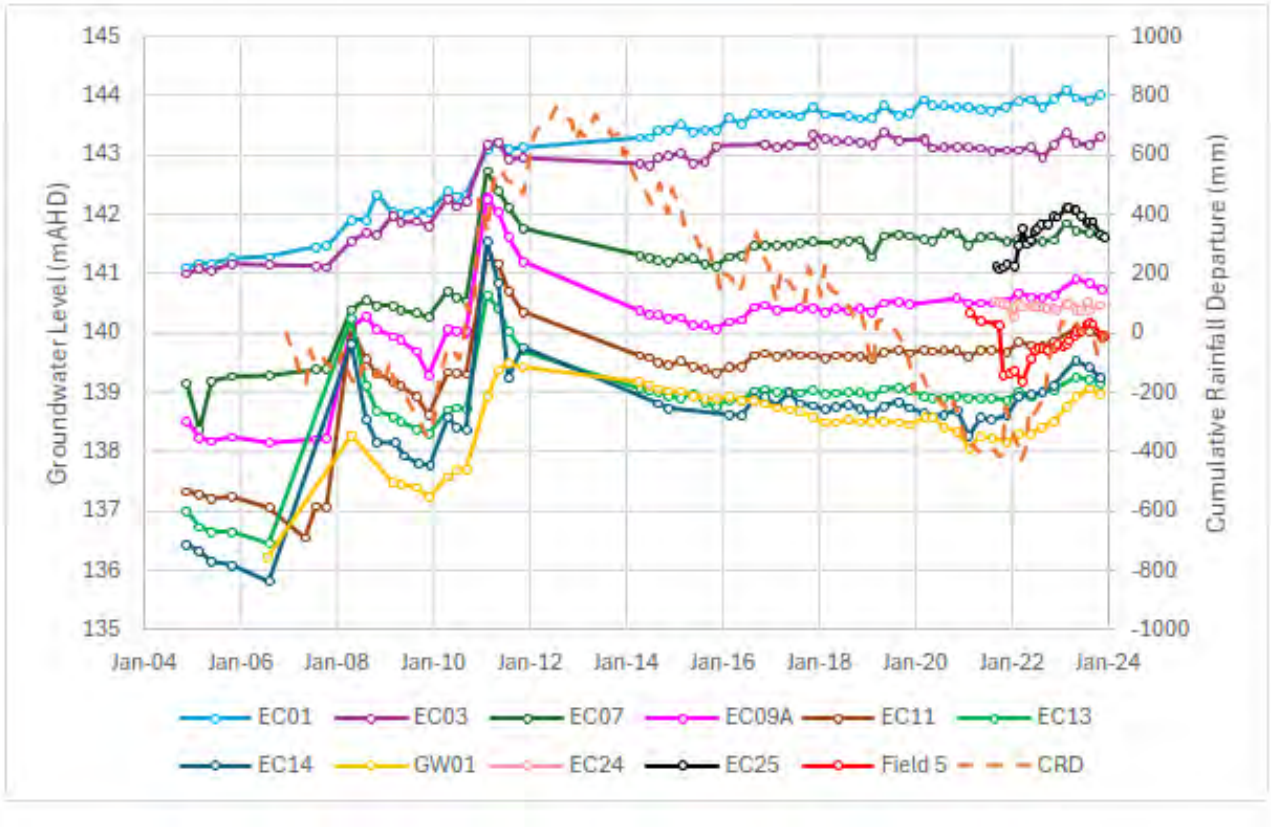


Figure 3.4 Hydrograph of eastern alluvial bores (SLR, 2024)

3.2.2 *Drawdown mapping*

No drawdown of groundwater has been observed in the alluvium.

3.2.3 *Groundwater quality*

The groundwater quality of the shallow alluvial aquifer is moderately to highly saline, with neutral to moderately alkaline pH and sodium-chloride water. The high rainfall and flooding events during 2011 resulted in increased salinity in the alluvial aquifer system due to the flushing of precipitated salts, which is now declining to baseline levels for most monitoring bores. However, at monitoring bore 13020166 there is a trend of increasing electrical conductivity, and as this is upstream of Ensham it can most likely be attributed to influences associated with agricultural crop irrigation.

Monitoring bores 13020169, GW01 and EC07 exhibit an upward trending pH, which is correlated with decreasing EC trends at these locations, likely due to calcite precipitation. These chemical trends are not considered related to mining operations as they are located upstream of mining and are likely to be due to both natural processes and influences beyond the Study Area.

Additional interaction with agricultural activities (irrigation) is evidenced by the substantial influx of high bicarbonate and low pH recharge originating from agricultural runoff and infiltration into the shallow alluvial aquifer, both within and outside the monitoring area.

3.2.4 Aquifer connection

The Nogoa River is partially isolated from the shallow alluvial aquifer, due to shallow silts and clays which divide the surface water areas from the basal gravel layers that comprise the lower areas of the groundwater aquifer. Groundwater and surface water interactions may only occur during periods of intense irrigation, when the basal clay is absent, or the basal sands are exposed within the river. This is further supported by the differences in salinity and groundwater level observations, which specifically demonstrate no correlation between groundwater level and distance to the Nogoa River.

Figure 3.5 illustrates a conceptual cross section of the alluvium and underlying rock mass.

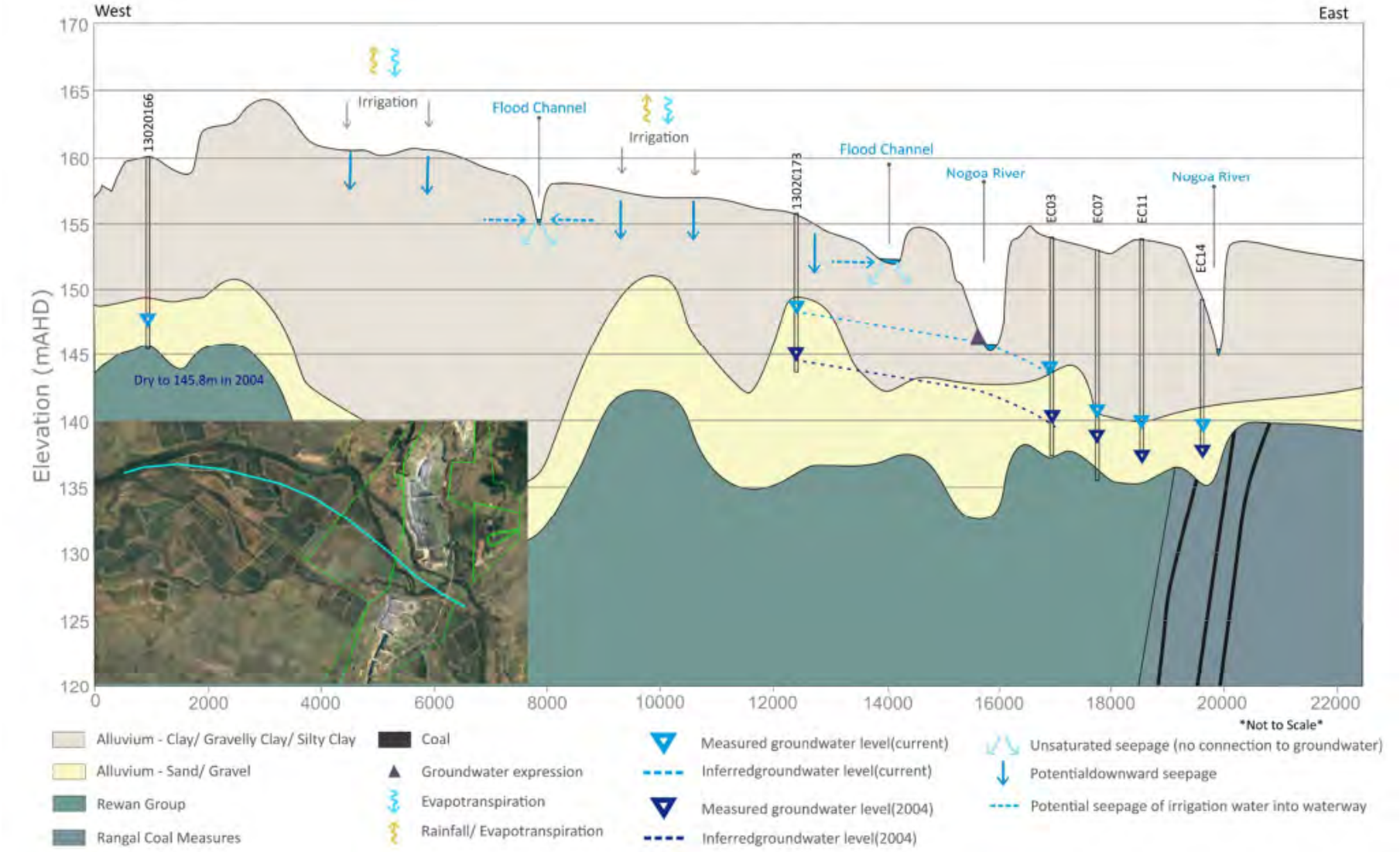


Figure 3.5 Conceptual cross section through Nogoa River alluvium and Quaternary sediments (SLR, 2024)

3.3 Zone 1: Groundwater Impact Assessment (SLR, 2022a) and Zones 2 and 3: Groundwater Impact Assessment (SLR, 2022b)

These two reports are essentially the same, as assessment of Zone 1 and Zone 2 utilise the same groundwater monitoring bores and were developed to assess potential impacts upon groundwater associated with the mine development (potential groundwater drawdown) and are thus combined herein.

3.3.1 Groundwater levels, flow, recharge and discharge

This section discussed the hydrogeological unit pertinent to the Project, describing groundwater hydrology (including groundwater occurrence, hydraulic gradients, recharge, and discharge), hydraulic characteristics, groundwater quality, and groundwater utilization and administration.

3.3.1.1 Upstream bores

This assessment incorporated analysis of monitoring bores upstream of the Study Area (13020163, 13020164, 13020165, 13020166 and 130201670), operated by the Queensland Government. These bores were deemed to represent the natural interaction of the Nogoa River floodplain's alluvial aquifer and the Nogoa River, particularly prior to 2000 when there was an absence of agricultural and mining activities in the area.

The upstream bores exhibited a general disconnect to three flood events that happened prior to 2000, and the bore closest to the river, 13020163, remained dry for that period (Figure 3.6). The bore second closest to the river, 13020164 has only exhibited a response to flooding once, to the major flood in 2008 where the water level rose by approximately one metre. Monitoring for many bores ceased in 2008, with one more round occurring in 2018. During this period the water level at all bores had increased two metres, except for 13020164 which increased by four metres. These increases are likely due to agricultural irrigation commencing and continuing.

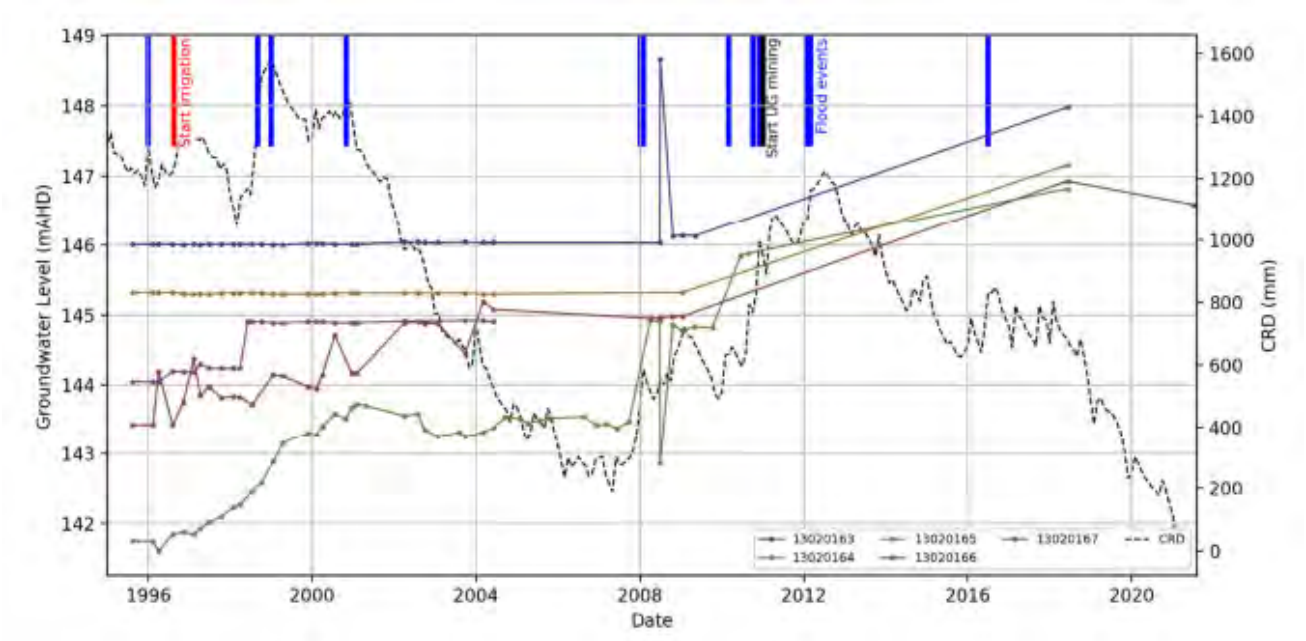


Figure 3.6 Hydrographs for upstream bores (SLR, 2022a)

3.3.1.2 Zone 1 and 2 bores

These bores include 13020169, 13020170, 13020171, 13020172, 13020173, 13020174 and RB7a.

The monitoring bore closest to the river, 13020169, did not exhibit a response to periods of high rainfall, in 1996, 1998 and 1999 (Figure 3.7). There was a minor response observed from the 2008 flood event, with water level rising by approximately 0.5 m. However, this response aligns with the overall upward trend witnessed across all monitoring boreholes.

This trend commenced around 2000, coinciding with a period of severe drought and an absence of flood events, as indicated by rainfall monitoring data. Since 1996, water levels in these bores have risen by approximately five to six meters, exceeding those recorded in upstream boreholes by up to four meters. Groundwater measurements taken from 2021 onwards in accessible monitoring bores indicate a sustained and continually upward trend. With no other identified sources that could have influenced groundwater during this period, it was concluded that irrigation activities were responsible for the increased water levels in the shallow alluvial aquifer associated with the Nogoa River's alluvium deposits.

An additional observation is that groundwater levels tend to be higher farther away from the Nogoa River, suggesting a gradient towards the river. Typically, if the river were the primary source of groundwater, groundwater levels would be expected to be higher closer to the river.

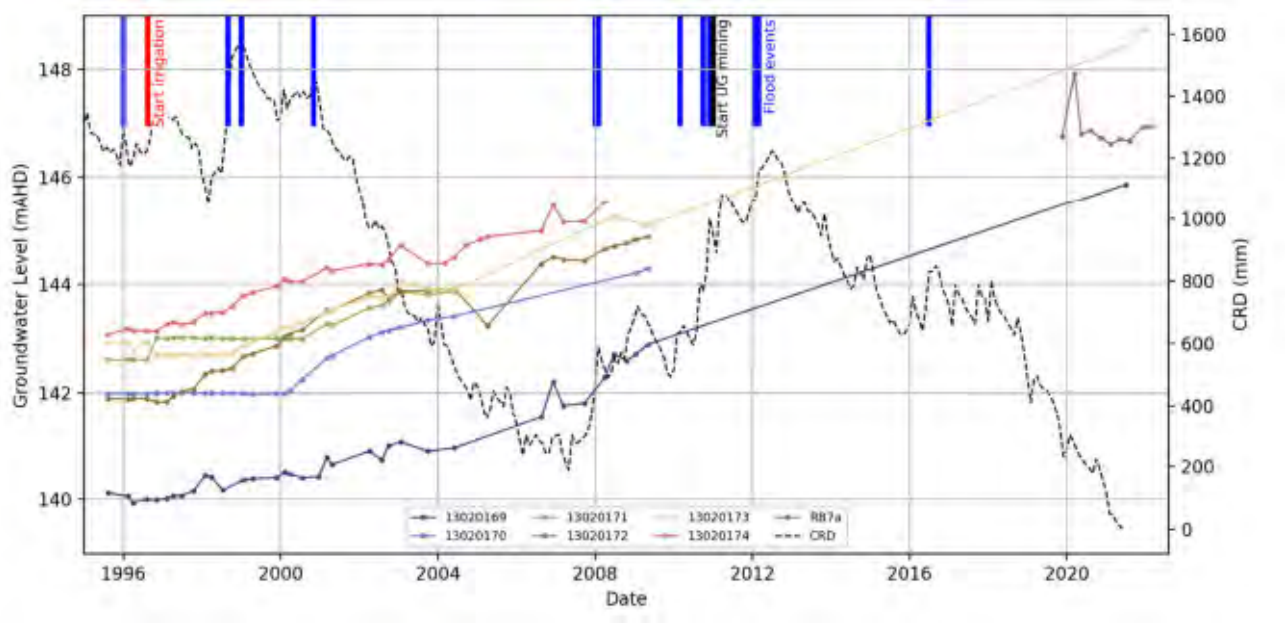


Figure 3.7 Hydrograph of bores near/in Zone 1 and 2 (SLR, 2022a)

3.3.1.3 EC monitoring bore series

The EC monitoring bore series (EC01, EC03, EC07, EC09A, EC11, EC13 and EC14) is situated within the Nogoa River alluvium, near or within the sub-crop of the Rangal Coal measures. Unlike the bores discussed above, the EC monitoring bore series exhibit a distinct response to flooding and climate conditions (Figure 3.8). Specifically, bores EC07 to EC14 respond to flooding in the Nogoa River and/or rainfall, as evidenced by the CRD data. Over time, water levels in these bores show a decreasing trend, which contrasts with the constantly increasing trend observed in bores EC01 and EC03. Bores EC01 and EC03, which are closest to the irrigation area, do not display a decrease in water levels over time. It has been interpreted that the upstream rise in alluvial groundwater levels has moved towards EC01 and EC03, indicating that agricultural irrigation influences the groundwater levels within the shallow alluvial aquifer, via recharging the aquifer with water releases from Fairbairn Dam.

No EC monitoring bores showed a response to the commencement of underground mining, whereby groundwater drawdown from mining could be evidenced.

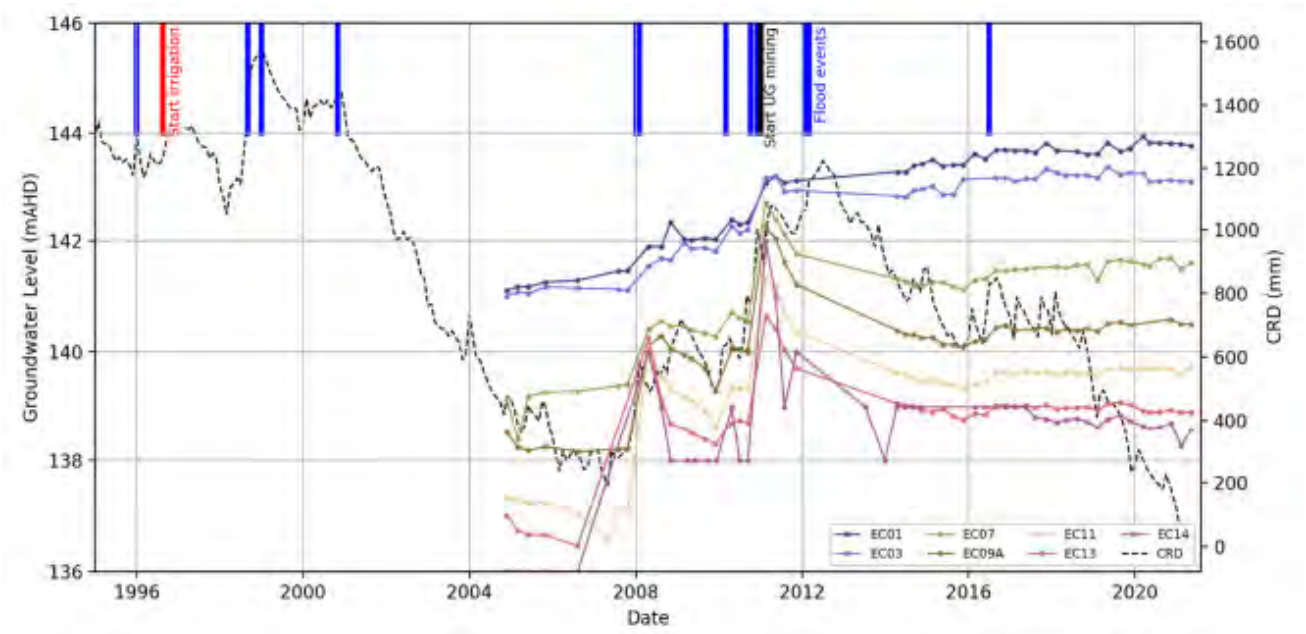


Figure 3.8 Hydrograph of the EC bores (SLR, 2022a)

3.3.1.4 Groundwater flow

There is limited hydraulic connection between the coal seam groundwater and the shallow alluvial aquifer associated with the Nogoa River's alluvium, with the Rewan Group acting as a flow barrier.

Groundwater movement within the alluvial deposits conforms to the topographical slopes, generally flowing from the northwest to the southeast across the Study Area. The flow direction of groundwater within the alluvium mirrors the course of the Nogoa River, trending from northwest to southeast. The shallow alluvial aquifer may not be consistently saturated and the contours offer the most accurate representation. However, there is a possibility of disconnected zones and stagnant lenses within the groundwater system, as indicated by dry monitoring bores.

3.3.1.5 Interaction with surface water

The saturated water level of the alluvium is approximately 140 m AHD, and the riverbed is approximately 147 m AHD. The groundwater level of the alluvium is, on average, 13.8 m below ground level. There have been numerous investigations, which have conceptualised the groundwater interaction with surface water. All investigations have concluded there is limited, and potentially no, interaction between the two water features (groundwater and surface water) (Figure 3.9).

There are silts and clays at the upper part of the alluvium with poor permeability and the groundwater occurrence in the alluvium is highly variable, with some bores documented as being repeatedly dry. If the alluvium was connected to the river, the water quality parameters should be expected to be similar. However, when the alluvial monitoring bores started to refill after extended dry periods, the water was saline whilst the Nogoa River is fresh.

Additionally, the bores further away from Nogoa River tend to have higher groundwater levels, which is contradictory of what would be expected if there was hydraulic connectivity, whereby groundwater levels would be higher closer to the river and the river would naturally lose stream. It is conceptualised, the alluvium during the wet season is recharged primarily through irrigation, with limited amounts of downward seepage from rainfall.

The most likely explanation for the steady long-term increase in groundwater levels is agricultural irrigation of water releases from Fairbairn Dam upstream of Zone 1. In July 2019 it was clearly determined that groundwater was flowing into the river and again was most likely due to irrigation upstream of the Study Area increasing the standing water level of the alluvium.

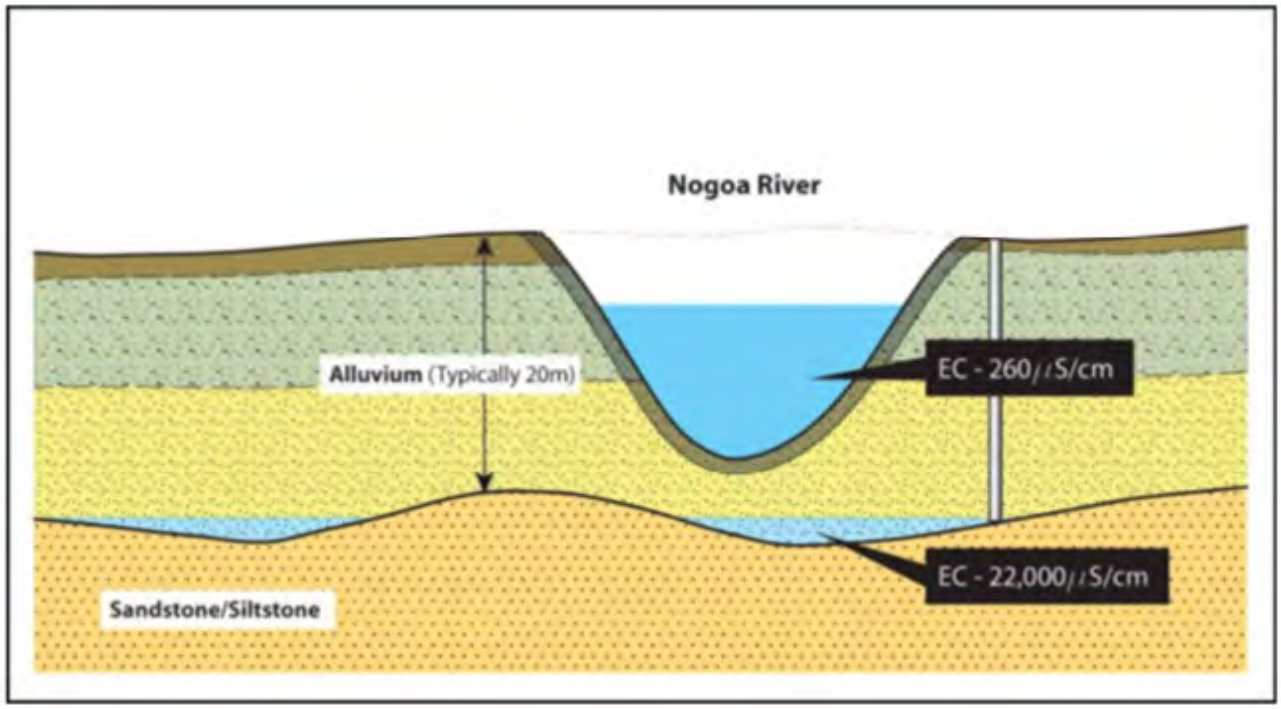


Figure 3.9 Conceptual cross section through the Nogoa River and quaternary sediments (SLR, 2022a and SLR, 2022b)

3.3.2 Groundwater water quality

Electrical conductivity (EC) is a measurement of salinity levels in water, and the water within the alluvium is highly saline, as demonstrated by over 350 monitoring observations (Table 3.2). Historical data indicates that high electrical conductivity (EC) in the alluvium is natural, as EC was high prior to the commencement of mining (late 1990s and early 2000s). It is likely that the alluvium is highly saline due to slow infiltration recharge from rainfall and evapotranspiration, and the evidential lack of influx from the Nogoa River.

Table 3.2 Electrical Conductivity summary statistics (SLR, 2022a and SLR, 2022b)

Parameter	Number of observations	20th percentile (µS/cm)	Median (µS/cm)	80th percentile (µS/cm)
Field EC	353	3,208	11,590	20,040
EC Lab	668	2,124	6,150	19,360

After a main recharge event in late 2010 the EC at bores had begun to increase, with varying times of onset. At the furthest upstream bore from the mine (where EC data is available, EC07), salinity began increasing in 2013, and at EC13, which is downstream of the mine, EC began increasing around 2016. The trend of increase beginning upstream then downstream indicates the increase is not mining related.

The 80th percentile value for EC for EC01, EC03, EC05, EC07, EC09A, EC11 and EC13 is above the 80th percentile of water quality objectives for electrical conductivity for the region (15,495 µS/cm), which indicate groundwater from the alluvium at these bores is not suitable for aquatic ecosystems. Groundwater quality parameters support the conclusion that the Nogoa River is separated from the alluvium, as demonstrated through high salinity within the alluvium in contrast to the freshwater in the river.

3.3.3 Groundwater dependent ecosystems

The ecological survey (AECOM, 2020) identified three Regional Ecosystems within the terrestrial GDE mapping, though there was a lack of wetland flora indicator species, evidence of water stress and high availability of preferential freshwater surface flows, which confirmed it is unlikely these communities rely on groundwater to persist.

Within a 10 km radius of the Survey Area, there are no identified aquatic GDE seeps with known or high confidence, nor are there any subterranean GDE seeps. The primary channel of the Nogoa River and its anabranches are categorised as low confidence aquatic GDE seeps. Aquatic and terrestrial GDE seeps denote ecosystems dependent on surface water closely linked with groundwater. As detailed previously, there is documented evidence that there is no hydraulic connectivity between the alluvium and the Nogoa River.

There are no potential GDE's mapped in Zone 3.

3.3.4 Groundwater modelling predictions

The groundwater model primarily presents its predictions as incremental impacts, meaning it compares the results of three cases, a Null run (no mining post January 2022), current underground operations (ending mining in 2028) and modelling of the proposed mine expansion (ending mining in 2037).

The model is likely an overestimation, as the model does not account for active management measures to reduce inflows after mining has passed through an area, thus predicting larger drawdown, resulting in a conservative impact assessment.

Lower inflows are expected when mining remains in an area for a longer period of time and can be higher when going into new areas, as no previous dewatering has occurred. Mine dewatering, both directly and indirectly through induced flow, leads to a reduction in water levels in the surrounding groundwater units.

The scope of the area impacted by modelled mine dewatering, resulting in decreased water levels, is contingent upon the hydraulic characteristics of the aquifers / aquitards. In a confined aquifer, this area is termed the zone of depressurisation, whereas in an unconfined aquifer, it is referred to as the zone of drawdown within the water table. The most significant depressurisation and drawdown of groundwater levels occur at the coal-face of the mine workings, gradually diminishing with distance from the mine.

Predictive groundwater modelling demonstrates the rate of inflow for the proposed mine expansion is similar to existing operations, and the incremental alluvial flux is negligible, with no evidential predicted reduction in baseflow in the Nogoa River.

There is a predicted maximum incremental groundwater drawdown of 1 m in the target coal seams associated with the Project at end of mining, which is expected to extend up to 15 km west. The drawdown resulting from mine dewatering is not causing wide-spread drawdown in the alluvium, as there is limited hydraulic connection between the alluvium groundwater and the Rangal Coal measures.

The model shows a downward trend of recharge in the alluvium south-west of the Mine Expansion Area (Figure 3.10) from 2030, due to reduction in loss from the alluvium into the lower strata, with a maximum decrease of 0.5 ML/day in 2036 before recovery commences. The long-term average alluvial extraction, calculated using annual climate inputs, is approximately 0.9 ML/day for the Project. In contrast, the null model (where there is no change) indicates a slightly lower extraction rate of around 0.8 ML/day, resulting in a difference of 0.1 ML/day between the two, which is considered negligible and of no tangible significance to the groundwater aquifer.

The Nogoa River alluvium is predicted to fully recover post-mining.

PS206966
Ensham GDEMMP

Figure 3.10
Location of Impacts to Nogoa River Alluvium

Fairhills (RN89380)
Yongala (RN89383)
Railway (RN90140)
RB01
RB02
RB08 (P6)
Zone 1
Zone 2
Zone 3
13020163
13020164
13020165
13020166
13020167
RB7a
13020169
13020170
13020171
13020172
13020173
13020174
EC24 (P3)
EC01
13020177 (P5)
EC03
EC07
EC09A
EC11
EC14
EC25 (P4)
GW01
EC26
EC27
RB03
Twin (Bore 5)
Winton Creek (Bore 4)
Jamar (Bore 7)
RB04
RB10
WSMB2D
WSMB2S
WSMB3D
WSMB3S
RB05
RB9
RB06
Field Bore 5 (P2)
Karanga (Bore A)
Gordonstone Creek
Crinum Creek
Mosquito Creek
Nogoa River
Nogoa River Anabranch
Boggy Creek
Cattle Creek
Frying Pan Creek
Winton Creek
Corkscrew Creek
Sandhurst Creek
Comet River
Mackenzie River
Maria Creek
Capricorn Highway
Ballard Street
Comet River Road

Legend
- Bores
- Watercourse
- Roads
- Maximum Incremental drawdown
- Project Footprint
- Mining Lease
- Land Parcels
- Derived Surfacre GDE - low confidence
- Derived Terrestrial GDE - low confidence

TOWNSVILLE, CLONCURRY, BOWEN, MACKAY, MORANBAH, CLERMONT, LONGREACH, QLD, DYSART, ROCKHAMPTON, BLACKWATER, GLADSTONE, TAMBO, BUNDABERG, HERVEY BAY, RAINBOW BEACH, QUILPIE, MITCHELL, GYMPIE, NOOSA HEADS, CHARLEVILLE, ROMA, DALBY, BRISBANE

0 2,500 5,000
Meters

Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3

1:115,000 Date: 14/04/2025

Data sources: DELWP, Geoscience Australia
World Imagery: Earthstar Geographics

© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it was supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCSI Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.

3.3.5 *Potential impacts*

The 0.5 m contour of the Project's incremental maximum drawdown intersects parts of the low confidence aquatic and terrestrial GDEs outside of the Mine Development Area yet being within the mining lease (south-west of Zone 2, see Figure 3.1).

Due to the conservative approach in drawdown calculations, the model predicts an incremental drawdown curve. However, upon reviewing hydrographs within the drawdown contour, it becomes evident the groundwater system will not experience additional drawdown due to the Project. For instance, in the hydrograph example for EC11 in Figure 3.11, the maximum incremental drawdown (the maximum difference between the light blue and dark blue lines) is around 1 m, as predicted to occur in 2070 (noting that mining is proposed to conclude in 2037 and that drawdown continues post-works).

In terms of the three scenarios (graphical lines for Null run, Existing operations, and Project), water level predictions remain consistent up to 2038. Subsequently, the water level for the Null run indicates a faster recovery, resulting in a difference between water levels resembling drawdown, although in real terms, the water levels are gradually increasing. Groundwater availability in the alluvium increases across all scenarios, indicating no actual additional drawdown forecasted from mining, and all scenarios ultimately recover to the same final levels. Thus, impacts on any potential low confidence GDE's are negligible as the drawdowns in the shallow alluvial aquifer are a typical delay in groundwater recovery and not a reduction in water levels.

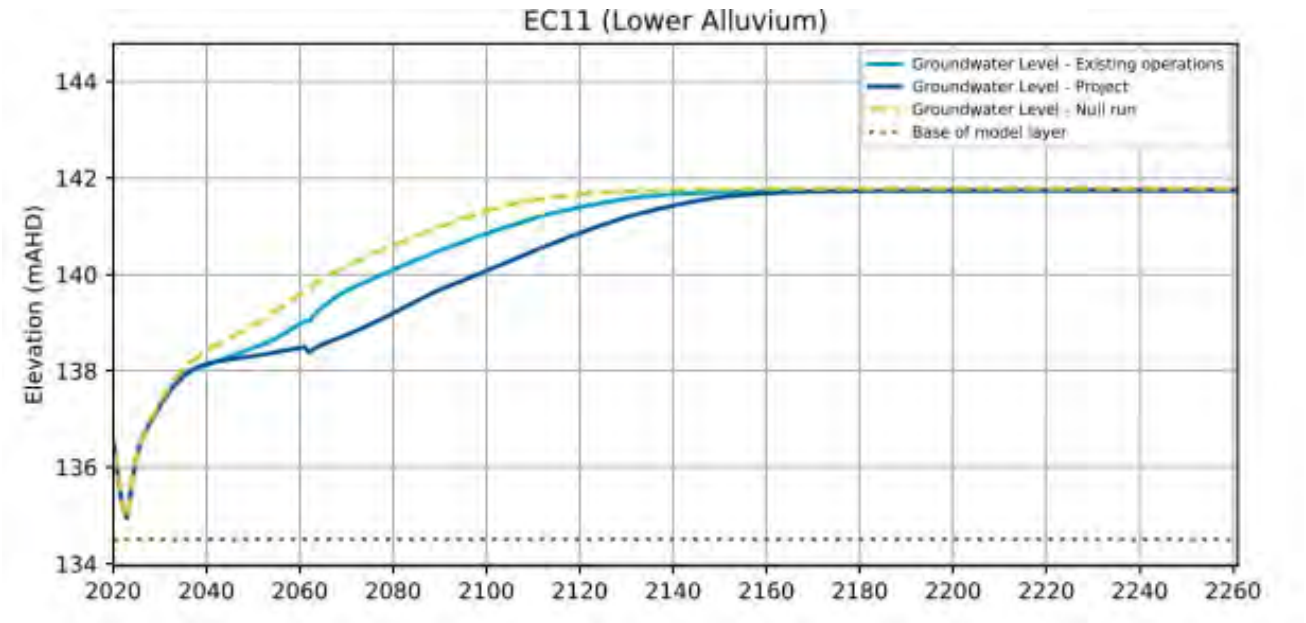


Figure 3.11 Recovery curve of EC11, an alluvial bore in Zone 1 (SLR, 2022a)

3.4 Flora Technical Report (AECOM, 2020)

Three seasonal flora surveys were conducted in zones 1, 2 and 3 in May 2019, October 2019 and January 2020. The surveys consisted of field verification (ground truthing) the presence and extent of regulated vegetation (regional ecosystems), EPBC Act listed threatened ecological communities (TEC's), GDE's and threatened flora habitat.

3.4.1 Regulated vegetation (regional ecosystems)

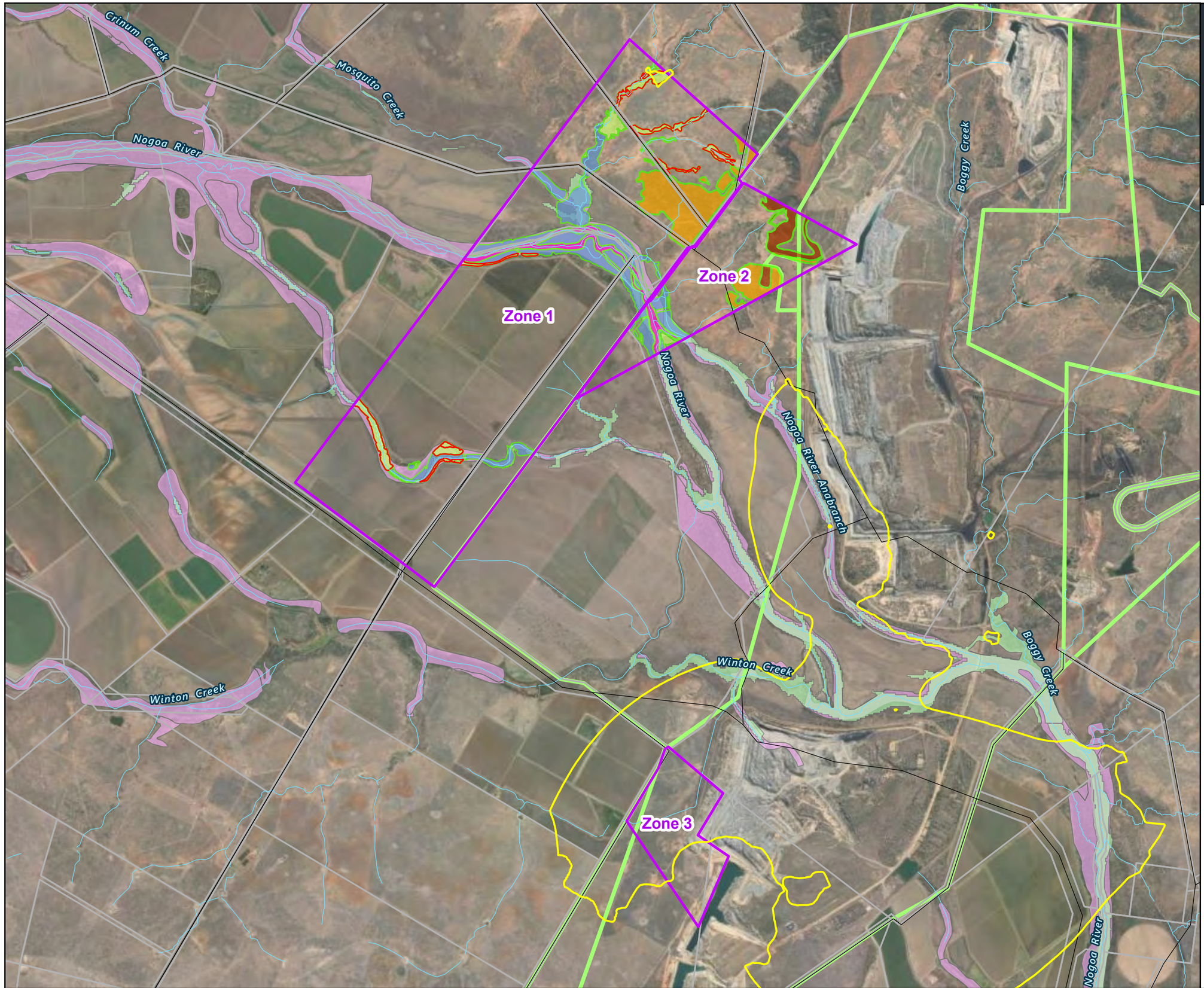
Five regional ecosystems have been field verified as occupying 450.2 ha within the Mine Expansion Area (Table 3.3 and Figure 3.12). The remaining 1,774.6 ha is non-remnant woodland and pastures, agricultural land, mine rehabilitation and regrowth vegetation. The vegetation outside of the Mine Expansion Area, though within the Ensham mining lease, was not field verified as part of the AECOM survey and report.

Table 3.3 Regional ecosystems field verified as occurring within the Project Footprint

RE	Regional ecosystem description	VM Act status	Area (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	63.7
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	169.4
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern	52.3
11.7.1	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust	Least concern	127.7
11.7.2	Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	Least concern	37.1
Total regulated vegetation			450.2
Non-remnant			1,774.6
Total Project area			**2,224.8**

3.4.2 Threatened ecological communities

The Brigalow (*Acacia harpophylla*) dominant and co-dominant TEC (Brigalow TEC) has been field verified as occurring within the Mine Expansion Area. The Brigalow TEC is analogous with RE 11.3.1, although the listing advice requires the vegetation meets key diagnostic criteria and condition thresholds to be considered the TEC. The primary criteria and thresholds are that the patch is 0.5 ha or larger, and exotic perennial vegetation does not exceed 50% of the patch. Within the Mine Expansion Area, 72% of RE 11.3.1 met the Brigalow TEC key diagnostics.



PS206966
Ensham GDEMMP

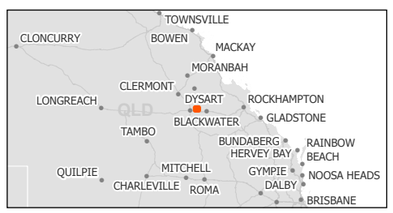
Figure 3.12
Field Verified Vegetation Communities

Legend

- Watercourse
- Roads
- Maximum Incremental drawdown
- Project Footprint
- Mining Lease
- Land Parcels
- Derived Surfacre GDE - low confidence
- Derived Terrestrial GDE - low confidence
- Brigalow TEC

Regional ecosystems - RE

- 11.3.1
- 11.3.25
- 11.3.3
- 11.7.1
- 11.7.2



0 1,000 2,000
Meters

Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3

1:55,000 Date: 14/04/2025

Data sources: DELWP, Geoscience Australia
World Imagery: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

© WSP Australia Pty Ltd ("WSP") Copyright in the drawings, information and data recorded ("the information") is the property of WSP. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that which it was supplied by WSP. WSP makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information. NCSI Certified Quality System to ISO 9001. © APPROVED FOR AND ON BEHALF OF WSP Australia Pty Ltd.

3.4.3 Groundwater dependent ecosystems

3.4.3.1 Vegetation with potential to be terrestrial GDEs

The field verified regional ecosystems (RE) that occur within the Mine Expansion Area, which have been state mapped as low-confidence derived GDEs, include:

- RE 11.3.1: *Acacia harpophylla* open forest on alluvial plains
- RE 11.3.3: *Eucalyptus coolabah* woodland on alluvial plains, and
- RE 11.3.25: *E. camaldulensis* woodland fringing drainage lines.

The *Acacia harpophylla* (Brigalow) forest is located along an unnamed watercourse within zone 1 and in small linear strips along the Nogoa River. It is comprised of remnant and high-value regrowth with a canopy range from 6 m to 7 m, with some emergent *Acacia harpophylla* (Brigalow) and *Eucalyptus coolabah* (Coolabah) reaching up to 14 m. *Terminalia oblongata* (Yellowwood) and *Lysiphyllum carronii* (Red bauhinia) are common in the canopy. Due to extensive historical clearing in the surrounding areas this community was in poor/moderate condition.

The remnant *Eucalyptus coolabah* (Coolabah) woodland is located along the Nogoa River, Mosquito Creek and a southern unnamed tributary. The canopy reaches 21 m and is generally mid-dense, though during the post-dry season surveys the condition of the canopy foliage was reduced, indicating water stress.

The remnant *Eucalyptus camaldulensis* (River red gum) woodland within the potential GDE mapping is located along the Nogoa River, fringing stream banks adjacent to where the channel typically held water during the surveys. The canopy reaches 22 m and *Casuarina cunninghamiana* (River she-oak) and *Eucalyptus coolabah* (Coolabah) are common. The community had good growth and coverage and was determined to be in good condition.

3.4.3.2 Wetland indicator species

Seven wetland indicator species were recorded, which can indicate, though does not confirm, groundwater dependence, including:

- *Casuarina cunninghamiana* (River she-oak)
- *Marsilea hirsuta* (Nardoo)
- *Eucalyptus camaldulensis* (River red gum)
- *Melaleuca trichostachya* (Flax-leaf paperbark)
- *Ischaemum australe* (Large bluegrass)
- *Duma florulenta* (Lignum), and
- *Eremophila bignoniiflora* (Dogwood).

Most of the wetland indicator species occurred within RE 11.3.25, with *Eucalyptus camaldulensis* (River red gum) the most common species. *Duma florulenta* (Lignum) and *Marsilea hirsuta* (Nardoo) were recorded within RE 11.3.3, and no wetland indicator species were recorded within RE 11.3.1.

3.4.3.3 Likelihood of GDE's within the Mine Development Area

Acacia harpophylla (Brigalow) has a shallow horizontal root system concentrated in the upper soil profile, enabling the species to draw resources from a substantial, shallow area around the plant, and is thus highly unlikely to be dependent on access to groundwater for long-term survival.

Eucalyptus coolabah (Coolabah) exhibited signs of water stress during the surveys that occurred post-dry season, indicating that the community is not accessing permanent groundwater. Additionally, the alluvium groundwater has a higher saline content and thin, discontinuous saturation zones, which limit the use and reliance of flora upon any potential GDE present.

The *Eucalyptus camaldulensis* (River red gum) woodlands were dominated by wetland indicator species and were in good condition. *Eucalyptus camaldulensis* (River red gum) is a common species along Australian watercourses that can develop vertical roots to depths greater than 10 m and is not tolerant of long-term drought or salinity. Whilst *Eucalyptus camaldulensis* (River red gum) has the ability to access and utilise groundwater, the alluvium groundwater within the Study Area is not suitable due to the high salinity content and thin, discontinuous saturation zones. It is likely the health of the community is attributed to the Nogoa River which has permanent water due to water releases from Fairbairn Dam for irrigation, which reduces the need and reliance upon permanent groundwater.

It should be noted the only the regional ecosystems within the Mine Expansion Area were field verified by AECOM, and the area of drawdown that intersects derived GDE's is outside of the Mine Expansion Area, although within the mining lease (Figure 3.12). The state mapping indicates that the regional ecosystems within the potential drawdown area are the same, though would need to be field verified if monitoring is undertaken, to confirm regional ecosystem presence and extent.

3.5 Summary

The combination of groundwater data and flora surveys determine that there are no aquatic or terrestrial GDE's within the Study Area and Mine Development Area.

There is evidence that the shallow alluvial aquifer within the Nogoa River alluvium is not connected to the Nogoa River, via highly differential saline levels and a groundwater gradient that is higher further away from the river, instead of lower gradient. This separation is due to shallow silts and clays which divide the surface water areas from the basal gravel layers that comprise the lower areas of the aquifer. The Nogoa River is a freshwater river that has permanent flow, which is anthropogenically controlled via releases from Fairbairn Dam.

The shallow alluvial aquifer within the Nogoa River alluvium has low groundwater levels that are not continuously saturated and rather form lenses of highly saline, stagnant water, as indicated by periodically dry groundwater monitoring bores. When the bores recharge following periods of being dry, the water was saline, which could be attributed to a combination of naturally saline groundwater and possibly recharge from irrigation. If the shallow alluvial aquifer and river were connected, it would be expected the bores would not dry whilst there was flow in the river and water chemistry would be similar; thus, there is no recharge of the alluvium from the river.

The hydraulic disconnect results in no dilution of the highly saline water within the shallow alluvial aquifer, which is so saline that it is unsuitable for stock watering and irrigation. Seven bores are above the 80th percentile of water quality objectives for electrical conductivity for the region (15,495 µS/cm). These bores (EC01, EC03, EC07, EC05, EC09A, EC11 and EC13) are either within 200 m of the incremental maximum drawdown of the alluvium or within it. Aquatic and terrestrial GDE seeps denote ecosystems that depend on surface water closely linked with groundwater. As detailed, there is evidence that there is no hydraulic connectivity between the shallow alluvial aquifer and Nogoa River.

There is evidence that irrigation above the Study Area is increasing the water level of the shallow alluvial aquifer and altered chemistry. There has been a substantial influx of high bicarbonate and low pH recharge originating from agricultural runoff and infiltration of irrigated water. Monitoring bores closest to the irrigation area have been steadily increasing, regardless of climatic conditions. There is potential for increasing, highly saline groundwater to have negative impacts on the flora communities, if it gets closer to the ground surface and encroaches on root zones, and on the aquatic community, if it starts to seep into the Nogoa River.

There are no known GDE's within a 10 km radius, only low-confidence derived GDE's. Aquatic GDE's require groundwater present at the surface, and as the groundwater level is, on average, 13.8 m below ground level, this is not possible. The flora present within the Mine Expansion Area are does not indicate any reliance on subsurface groundwater (terrestrial GDE's), regardless of whether that groundwater is suitable.

Acacia harpophylla (Brigalow; dominant species of RE 11.3.1 and Brigalow TEC), which has a shallow, lateral root system that is concentrated in the upper soil profile and is a shallow-rooted species (Johnson et al, 2016). Brigalow's shallow rooting habitat is evident through the tendency of mature trees to fall because of disturbance to the upper soil profile, which exposes the lateral root system with little evidence of deeper sinking roots. It is therefore unlikely this vegetation community is reliant on the groundwater, which is on average 13.8 m below ground level, discontinuous and highly saline.

Eucalyptus coolabah (Coolabah; dominant species of RE 11.3.3) is a species that can utilise groundwater and is tolerant of slightly saline sites (2,000-4,000 µS/cm; Government of Western Australia, 2023). However, surrounding and within the areas mapped as derived GDE's, which also intersect the incremental maximum drawdown of the shallow alluvial aquifer, the salinity of the groundwater exceeds 15,495 µS/cm. Additionally, during the flora surveys conducted post-dry season, there was signs of water stress among the *Eucalyptus coolabah* canopy, further indicating this vegetation community is not interacting with the groundwater present in the alluvium.

Eucalyptus camaldulensis (River red gum; dominant species of RE 11.3.25) is a species that can utilise groundwater and is tolerant of moderately saline sites (4,000–8,000 µS/cm; Government of Western Australia, 2023). However, surrounding and within the areas mapped as derived GDE's, which also intersect the incremental maximum groundwater drawdown of the alluvium, the salinity of the groundwater exceeds 15,495 µS/cm.

In summary, it is therefore likely the vegetation communities along the Nogoa River would access the high availability of preferred, permanent freshwater surface flows from the river and regulated water releases from Fairbairn Dam and would show signs of poor health, and likely senesce, if there was interaction with the highly saline groundwater within the alluvium.

Regardless, if there were GDE's present, the groundwater model for the mine expansion determined that the inflow and incremental alluvial flux predicted changes, are negligible and there is no predicted reduction of baseflow in the Nogoa River. The predicted reduction in loss from the alluvium into the lower strata reaches an incremental maximum drawdown of 0.5 m, which is temporary and was determined to be a negligible reduction. Additionally, the alluvium is separated from the Rangal Coal Measures groundwater unit, and thus drawdown in the coal seam aquifer would also not affect any present GDE's.

4 Mitigation and management

Ensham's existing EA requires monitoring of groundwater, as summarised below. There are no GDE's present, therefore additional mitigation or management is not required, and no further actions are proposed.

4.1 Groundwater trigger levels

Drawdown trigger levels have been established within the GMMP (SLR, 2024) to provide an early warning of potential impacts. If a drawdown trigger level is exceeded, Ensham will conduct an investigation into the potential for environmental harm. If the investigation indicates potential for environmental harm, a suitably qualified person will develop an action plan to mitigate the potential harm.

4.2 Data management and reporting

4.2.1 Groundwater level (SLR, 2022a and SLR, 2022b)

In accordance with the current EA the following will apply:

- The groundwater monitoring at all bores will be conducted on a quarterly basis or as defined in the EA.
- Data will be stored within the existing consolidated groundwater database.
- Quality assurance and quality control procedures, such as field sampling procedures and the use of NATA accredited laboratories, will continue to be in place to assess the accuracy of data entered into the database.

In accordance with the current EA, findings from the quarterly monitoring events will continue to be documented:

- The quarterly review will include identification of any groundwater quality trigger exceedances.
- Where a trigger exceedance is identified, the regulator will be notified within 28 days and an investigation into the potential for environmental harm will be completed. The groundwater database and factual quarterly documentation will be available for provision to the regulator upon request.
- Each year an annual review of groundwater level and water quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

5 Conclusion

There is no indication there are aquatic or terrestrial GDE's within the Study Area. It has been demonstrated there is no hydrological connectivity between the Nogoa River, Nogoa River alluvium and the coal seam groundwater. The Nogoa River alluvium is not consistently saturated and rather forms lenses of stagnant, highly saline water.

The vegetation along the Nogoa River is slightly to moderately tolerant of saline water. However, the salinity within the groundwater in the area of drawdown impact significantly exceeds the known tolerant range of dominant species. It is likely that the vegetation is accessing the permanent, freshwater of the Nogoa River, more so than water from the shallow alluvial aquifer and would show signs of poor health if the vegetation was interacting with the highly saline groundwater.

Regardless, if there were GDE's present within the Study Area, the modelled 0.5 m incremental maximum drawdown of the shallow alluvial aquifer is temporary and determined to be a negligible impact.

Ensham currently monitors groundwater as per the existing EA requirements, and as there are no GDE's present additional mitigation or management is not required.

6 Limitations

This Report has been prepared by WSP on behalf of Ensham and in accordance with WSP's proposal and agreement with Ensham.

Even though attention has been paid to desktop and field-based identification of project risks, this Report is not able to comprehensively account for unknown risks not captured by this Report.

6.1 Permitted purpose

This report has been prepared by WSP on behalf of Ensham for the purpose described in the contractual agreement and no responsibility is accepted by WSP for the use of the Report in whole or in part, for any other purpose (Permitted Purpose).

6.2 Qualifications and assumptions

The services undertaken by WSP in preparing this Report were limited to those specifically detailed in the Report and are subject to the scope, qualifications, assumptions and limitations set out in the Report or otherwise communicated to Ensham.

Except as otherwise stated in the Report and to the extent that statements, opinions, facts, conclusion and/or recommendations in the Report are based in whole or in part on information provided by Ensham and other parties identified in the Report, the management recommendations are based on assumptions by WSP of the reliability, adequacy, accuracy and completeness of available information and guidelines and have not been verified. WSP accepts no responsibility for the information used.

WSP has prepared the Report without regard to any special interest of any person other than Ensham when undertaking the services described in the contractual agreement or in preparing the Report.

6.3 Use and reliance

This Report should be read in its entirety and must not be copied, distributed or referred to in part only. The Report must not be reproduced without the written approval of WSP. WSP will not be responsible for interpretations or conclusions drawn by the reader. This Report (or sections of it) should not be used as part of a specification for a project or for incorporation into any other document without the prior agreement of WSP.

WSP is not (and will not be) obliged to provide an update of this Report to include any event, circumstance, revised information or any matter coming to WSP's attention after the date of this Report. Data reported and Conclusions drawn are based solely on information made available to WSP at the time of preparing the Report. The passage of time; unexpected variations in ground conditions; manifestations of latent conditions; or the impact of future events (including (without limitation) changes in policy, legislation, guidelines, scientific knowledge; and changes in interpretation of policy by statutory authorities); may require further investigation or subsequent re-evaluation of the recommendations.

This Report can only be relied upon for the Permitted Purpose and may not be relied upon for any other purpose. The Report does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise. It is the responsibility of Ensham to accept (if Ensham so chooses) any recommendations contained within the Report and implement them in an appropriate, suitable and timely manner.

In the absence of express written consent of WSP, no responsibility is accepted by WSP for the use of the Report in whole or in part by any party other than Ensham for any purpose whatsoever. Without the express written consent of WSP, any use which a third party makes of this Report or any reliance on (or decisions to be made) based on this Report is at the sole risk of those third parties without recourse to WSP. Third parties should make their own enquiries and obtain independent advice in relation to any matter dealt with or recommendations expressed in the Report.

6.4 Disclaimer

No warranty, undertaking or guarantee whether expressed or implied, is made with respect to the data reported or the recommendations provided. To the fullest extent permitted at law, WSP, its related bodies corporate and its officers, employees and agents assumes no responsibility and will not be liable to any third party for, or in relation to any losses, damages or expenses (including any indirect, consequential or punitive losses or damages or any amounts for loss of profit, loss of revenue, loss of opportunity to earn profit, loss of production, loss of contract, increased operational costs, loss of business opportunity, site depredation costs, business interruption or economic loss) of any kind whatsoever, suffered on incurred by a third party.

Bibliography

AECOM, 2020 '*Ensham Life of Mine Extension Project: Flora Technical Report*'. Prepared August 2020, Job No.: 60603371.

Coaldrake, J.E., 1967. "*Depth of ploughing in relation to depth of suckering and soil type in the control of root suckers of brigalow (Acacia harpophylla)*". Australian Journal of Experimental Agriculture 7, 523-527.

Bureau of Meteorology (BoM), 2024. '*Climate Data Online*'. Retrieved from http://www.bom.gov.au/climate/data/.

Commonwealth of Australia, 2013. '*Vegetation Assessment Guide'*. Retrieved from http://www.nrm.gov.au/system/files/resources/600d1b92-c1ca-436e-8f83-23e7f15ca892/files/vegetation-assesment-guide.pdf.

Department of Environment, Science and Innovation (DESI), 2013, '*Groundwater dependent ecosystem – system types*'. Retrieved from https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/groundwater-dependent/systems/.

Dillon, P., Kumar, A., Kookana, R., Leijs, R., Reed, D., Parsons, S., & Ingleton, G., 2009. '*Managed aquifer recharge - Risks to groundwater dependent ecosystems - A review'*. Water for a Healthy Country Flagship Report to Land & Water Australia, 2009.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J., 2015. '*BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2*'. Queensland Herbarium, Department of Science, Information Technology and Innovation.

Foster, S., Koundouri, P., Tuinhof, A., Kemper, K., Nanni, M., & Gardufio, H., 2005. '*Groundwater dependent ecosystems: The challenge of balanced assessment and adequate conservation'*. Washington, USA: The World Bank.

Government of Western Australia, 2023. '*Salinity tolerance of plants for agriculture and revegetation in Western Australia*'. Retrieved from https://www.agric.wa.gov.au/soil-salinity/salinity-tolerance-plants-agriculture-and-revegetation-western-australia.

Johnson, R., McDonald, W., Fensham, R., McAlpine, C., & Lawes, M., 2016. '*Changes over 46 years in plant community structure in a cleared brigalow (Acacia harpophylla) forest'*. Austral Ecology, 41(6), 644-656.

Kath J., Reardon-Smith K., Le Brocque A.F., Dyer F.J., Dafny E., Fritz L., Batterham M., 2014. '*Groundwater decline and tree change in floodplain landscapes: Identifying non-linear threshold responses in canopy condition'*. *Global Ecology and Conservation* 2: 148-160.

Munakata, K., Nonaka, T., Ogaya, N., & Kanamori, M., 2010. '*Practical application for estimating the crown density of conifers using LiDAR data*'. In Proceedings of the International Society for Photogrammetry and Remote Sensing Technical Commission VIII Symposium, Kyoto, Japan.

Murray, B.R., Zeppel, M.J.B., Hose, G.C., & Eamus, D., 2003. '*Groundwater-dependent ecosystems in Australia: It's more than just water for rivers'*. EBSCO Publishing.

Neldner, V. J., Niehus R.E., Wilson B.A., McDonald W.J.F., Ford A.J., and Accad A., 2019. '*The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 4.0*'. Queensland Herbarium, Department of Environment and Science.

Queensland Globe, 2024. '*Queensland Globe*'. Retrieved from https://qldglobe.information.qld.gov.au/.

QSpatial, 2024. '*QSpatial*'. Retrieved from https://www.business.qld.gov.au/running-business/support-assistance/mapping-data-imagery/data/qspatial.

SLR, 2022a, '*Ensham Life of Mine Extension Project – Zone 1: Groundwater Impact Assessment'* Prepared October 2022, SLR Project No.: 620.30872.00400-R01.

SLR, 2022b, '*Ensham Life of Mine Extension Project – Zones 2 and 3: Groundwater Impact Assessment'*. Prepared March 2022, SLR Project No.: 620.30686.00400-R01.

SLR, 2024, '*Ensham Groundwater Monitoring – Groundwater Monitoring and Management Plan Report*'. Prepared February 2024, SLR Project No.: 620.040784.00001.

Appendix A

Ensham Groundwater Monitoring – Groundwater Monitoring and Management Plan Report (SLR, 2024)

Ensham Groundwater Monitoring

Groundwater Monitoring and Management Plan Report

Ensham Resources Pty Ltd

Duckponds Road, Emerald

Prepared by:

SLR Consulting Australia

Level 16, 175 Eagle Street, Brisbane QLD 4000,
Australia

SLR Project No.: 620.040784.00001

Client Reference No.: AU.08993

27 February 2024

Revision: 2.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	22 February 2024	Gabrielle Killalea	Daniel Ashton	Ines Epari
2.0	27 February 2024	Gabrielle Killalea	Daniel Ashton	Ines Epari
	Click to enter a date.			
	Click to enter a date.			
	Click to enter a date.			

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Ensham Resources Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Table of Contents

Basis of Report ..... **i**
1.0 Introduction **1**
1.1 Environmental Authority Conditions 1
1.2 Project Background 2
2.0 Conceptual Hydrogeological Model **5**
2.1 Climate 5
2.2 Local Geology 8
2.3 Hydrogeological Units 8
3.0 Monitoring Data **11**
3.1 Groundwater Bore Network 11
3.2 Groundwater Levels 18
3.2.1 Nogoa River Alluvium 18
3.2.2 Rewan Group 21
3.2.3 Rangal Coal Measures 22
3.2.4 Drawdown Mapping 25
3.3 Groundwater Quality 28
3.3.1 Aquifer Characterisation 28
3.3.2 Trend Analysis 29
4.0 Summary of Completed Investigations **35**
5.0 Aquifer Connection Investigation **37**
5.1 Conceptualisation Summary 37
5.2 Relevant Additional Data 39
6.0 Groundwater Monitoring and Management Plan Review **42**
7.0 Conclusions **44**
7.1 Water Quality and Level Trends 44
7.2 Aquifer Connection Investigation 44
7.3 Conceptual Model Revision 44
7.4 Assessment of GMMP 44
8.0 Recommendations **45**
9.0 References **46**

Tables in Text

Table 1-1 EPML0032813 conditions relating to the Groundwater Monitoring and Management Plan Report 1

Table 2-1 Average monthly and annual rainfall comparison between SILO and on-site data 5
Table 2-2 Hydrostratigraphy of Ensham Mine Area 8
Table 3-1 Groundwater Monitoring Locations and Frequency 15
Table 3-2 Rangal Coal Measures Drawdown Data 26
Table 3-3 Trending Analytes for Bores at Ensham Mine 31
Table 4-1 Summary of Completed Investigations 36
Table 6-1 Condition I9 requirements and section of GMMP where these are addressed ... 42

Figures in Text

Figure 1-1 Project Location 3
Figure 1-2 Project Overview 4
Figure 2-1 Average monthly rainfall and evapotranspiration 6
Figure 2-2 Average monthly rainfall compared with actual monthly rainfall in 2023 6
Figure 2-3 Long term Monthly Rainfall and Cumulative Rainfall Departure from mean monthly rainfall at SILO data point Lat: -23.45 and Long: 148.5. 7
Figure 2-4 Long-term annual rainfall statistics (January 1900 - January 2024) 7
Figure 2-5 Surface Geology and Project Groundwater Bores 10
Figure 3-1 Ensham Mine Groundwater Monitoring Network 13
Figure 3-2 Monitoring Bores and Predicted Maximum Cumulative Drawdown 14
Figure 3-3 Hydrograph for Basal Alluvium Bore (Twin Bore) 19
Figure 3-4 Hydrographs for Upstream Nogoa River Alluvium Bores 20
Figure 3-5 Hydrographs for Downstream Nogoa River Alluvium Bores 21
Figure 3-6 Hydrograph for Winton Creek Bore 21
Figure 3-7 Hydrograph for Jamar Bore 22
Figure 3-8 Coal Seams (excluding RB10) Hydrographs 23
Figure 3-9 Rangal Coal Measures Hydrograph 24
Figure 3-10 Regional Bores (Coal Seams) Hydrograph 25
Figure 3-11 Measured water level drawdown contours 27
Figure 3-12 Durov Plot of Alluvium Water Quality Sampling at Ensham Mine 28
Figure 3-13 Durov Plot of Rangal Coal Measures Water Quality Sampling at Ensham Mine 29
Figure 3-14 Time series of molybdenum analysis at EC01, EC03, EC07 and EC27 34
Figure 5-1 Conceptual Cross Section Through Nogoa River Alluvium and Quaternary Sediments (modified after SLR, 2022c) 38
Figure 5-2 Alluvium Piper Plot 40
Figure 5-3 Rangal Coal Measures Piper Plot 41

Appendices

Appendix A Groundwater Quality Time Series Plots

1.0 Introduction

This report has been prepared to address groundwater management conditions I14 and I15 from Environmental Authority (EA) EPML00732813 dated 5 September 2022, applying to coal extraction and associated waste material storage at Ensham Mine near Emerald, Queensland.

The objective of this report is to evaluate the Groundwater Monitoring and Management Plan (GMMP) according to EA conditions and provide recommendations for changes to the GMMP should there be any deficiencies identified. As this is the inaugural report (herein referred to as the GMMP Report as per the EA) on the status of the GMMP, the scope of this data review includes all monitoring available. The intent is to establish trends and groundwater influences at the outset of this reporting, allowing subsequent reporting to build off this work by focusing on the two-year reporting period.

1.1 Environmental Authority Conditions

Specific requirements for the GMMP Report, are provided in condition I14 and I15 of the Ensham Mine EA. These are listed in **Table 1-1**, and links are provided to sections within this document where they have been addressed.

Table 1-1 EPML0032813 conditions relating to the Groundwater Monitoring and Management Plan Report

Condition	Section of Report
Condition I14: Groundwater Management and Monitoring Program Report. The environmental authority holder must:	
a) Complete a Groundwater Management and Monitoring Program Report every two years which outlines how the program meets the requirements specified in condition **I9**;	**Section 6.0**
b) Submit the Groundwater Management and Monitoring Program Report to the administering authority via WaTERS by 1 March of 2024, and subsequently every second year thereafter; and	Completed via this report
c) Submit all groundwater monitoring data from January to December of the previous calendar year to the administering authority via WaTERS by 1 March of each calendar year.	Completed separate to this report
Condition I15: The Groundwater Management and Monitoring Program Report required by condition I14 must include:	
a) The standing water level of all groundwater bores within *Table I1 – Quarterly groundwater monitoring requirements and location*;	**Section 3.2**
b) An assessment of long-term water quality and water level trends at all groundwater bores in *Table I1 – Quarterly groundwater monitoring requirements and location*;	**Section 3.2** **Section 3.3**
c) Maps showing the actual water level drawdown contours caused by the take of associated water for each groundwater aquifer;	**Section 3.2.4**
d) Details of any review undertaken of the numerical groundwater model and conceptual model;	**Section 2.0** **Section 7.3**
e) An assessment of any differences between the groundwater level impact predicted and the actual impacts for corresponding periods in the most current numerical groundwater model;	**Section 3.2.4**

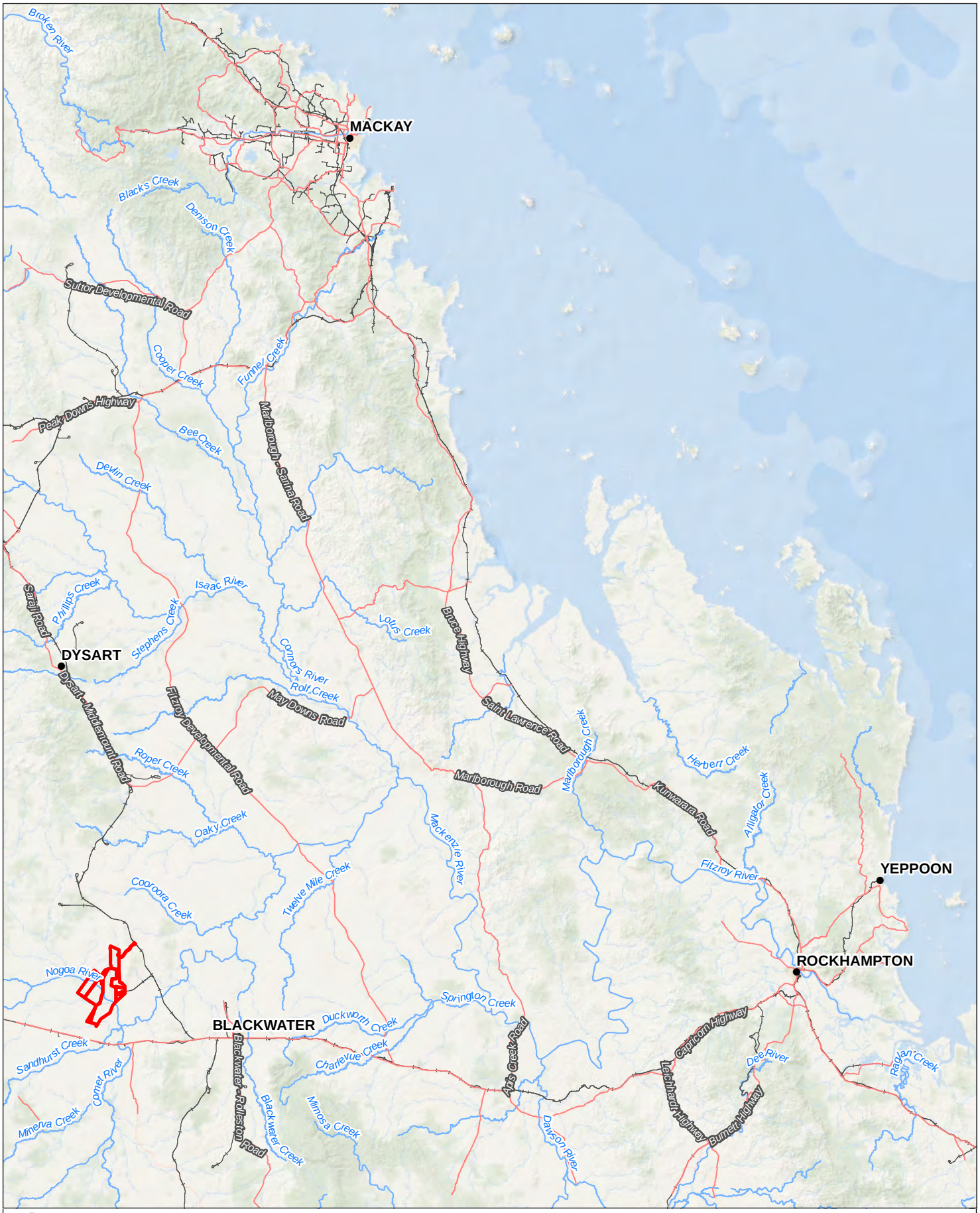
Condition	Section of Report
f) Details of any bores which are predicted by the most current numerical groundwater model to be located within the depressurisation zone; and	**Section 3.1**
g) An investigation into any interconnection and direction of flow between the alluvial aquifer and the Permian coal measures, including any recharge.	**Section 5.0**

1.2 Project Background

Ensham is located in Central Queensland, approximately 35 km east of Emerald and 50 km north-west of Blackwater. Regional locality is presented in **Figure 1-1**. This site covers an along-strike length of over 20 km, including open cut and underground workings that straddle the north and south banks of the Nogoa River. Project Area includes seven approved Mining Leases (ML) (ML 7459, ML 7460, ML 70326, ML 70049, ML 70365, ML 70366, and ML 70367) operated by Ensham, and one ML currently going through approval process (ML 700061) (**Figure 1-2**).

Mining activities target the Aries and Castor seams of the Rangal Coal Measures, which are Permian aged coal seams dipping to the west. The full geological context for the area is outlined in **Section 2.2** Open pit operations commenced in 1993, and underground operations commenced in 2011. Previous mined areas, and future planned mining, is indicated in **Figure 1-2**, showing progression of underground mining to the west. Open cut mining void to the south of Nogoa River are used for surface water storage.

The primary environmentally relevant activities carried out on site, with respect to groundwater, are mine void extraction and spoil waste storage. Excavation of mine voids and dewatering activities to keep underground workings operating form groundwater sinks and have the potential to lower (draw down) water levels in the regional system. This constitutes approved mining impacts. Material excavated during the process of mining the open pit void has been deposited adjacent to the mine void in areas referred to as spoil dumps. Progressive rehabilitation activities are carried out to address these risks and the Groundwater Monitoring and Management Plan outlines the management of these potential groundwater impacts.



0 25 50 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:1,500,000 at A4
Project Number:	620.040784.00001
Date:	22-Feb-2024
Drawn by:	RB

LEGEND

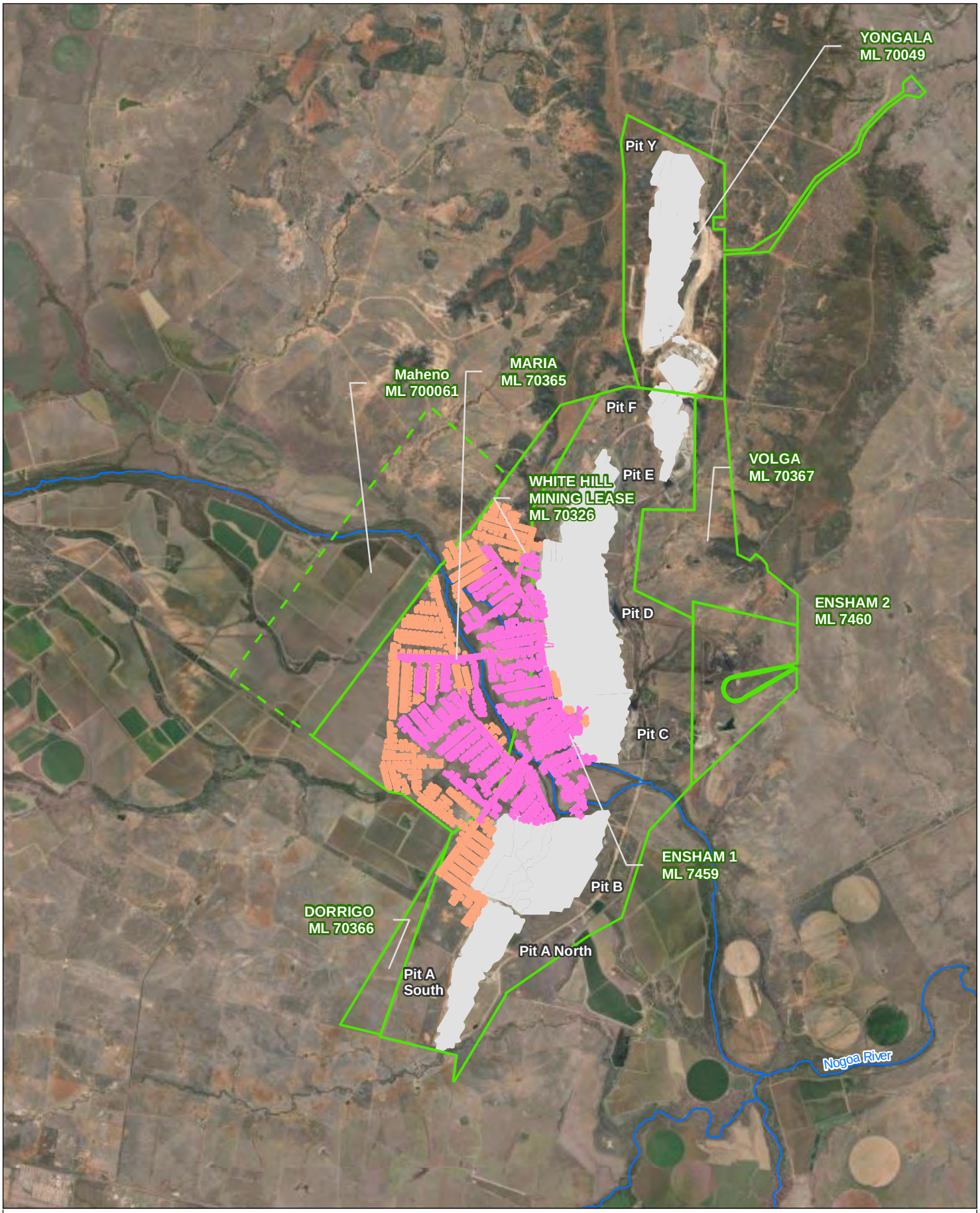
- State Controlled Road
- Railway
- Major Watercourse
- Ensham Project Location

ENSHAM GROUNDWATER MONITORING AND MANAGEMENT PLAN REPORT

PROJECT LOCATION

FIGURE 1-1

\\au.slr.local\corporate\Projects-SLR\620-BNE\620.040784.00001Ensham 2024 GMMP Report\06 SLR Data\01 CADGIS\GIS\620040784_F01-01_Project Location.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.040784.00001
Date:	27-Feb-2024
Drawn by:	RB

LEGEND

- Watercourse
- Zone 1
- Mine Lease
- Open Cut

Current Mining

- Asmined
- Design

ENSHAM GROUNDWATER MONITORING AND MANAGEMENT PLAN REPORT

PROJECT OVERVIEW

SLR

FIGURE 1-2

\\au.slr.local\corporate\Projects-SLR\620-BNE\620.040784.00001Ensham 2024 GMMP Report\06 SLR Data\01 CADGIS\GIS\620040784_F01-02_Project Overview.mxd

2.0 Conceptual Hydrogeological Model

This section discusses the elements of the hydrogeological system relevant to Ensham Mine, describing climatological influences, groundwater hydrology (groundwater occurrence, recharge, and discharge), hydraulic properties, groundwater quality and groundwater use and management. This summary conceptualisation represents the current understanding of groundwater environment at Ensham Mine, derived through the evaluation of the site EIS (SLR, 2021), Groundwater Impact Assessment (SLR, 2022a), Groundwater Monitoring Management Program (SLR, 2023), and assessment of monitoring data up to December 2023. CHM presented here is reviewed in **Section 7.3** in accordance with EA conditions.

2.1 Climate

Ensham Mine lies in the Central Highlands region of Queensland, displaying a sub-humid, sub-tropical climate, with distinct wet and dry seasons. Long-term rainfall, evaporation and temperature data sourced through the Scientific Information for Land Owners (SILO) database (Jeffrey et al, 2001) as a patch point data set for the closest location (Lat: -23.45S / Long: 148.5E).

In addition to this publicly available data, Ensham have been operating a site meteorological station since 2007. A comparison between the SILO derived climatic data and the on-site rainfall station is shown in **Table 2-1**. Note that due to the shorter time frame for the available site data, the long-term analysis was carried for the SILO data set.

Table 2-1 Average monthly and annual rainfall comparison between SILO and on-site data

Dataset	Monthly Rainfall (mm)												Annual Rainfall (mm)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
SILO	90.2	78.4	54.7	31.2	32.0	22.8	22.8	16.5	21.1	40.2	55.0	85.9	**550.9**
On-site	99.9	78.2	77.7	31.1	21.8	25.0	31.0	15.1	27.9	47.9	62.1	98.2	**616.1**

Evapotranspiration data was not available for the on-site weather station and was taken from SILO dataset. For the SILO dataset (January 1970 to January 2024), the long-term average annual evapotranspiration, as calculated using the FAO 56 method (Allen et al, 1998), was 2,081 mm/year and the long-term average annual rainfall was 550.9 mm/year.

Average monthly rainfall and evaporation for the area is presented on **Figure 2-1**, showing the seasonality. For each month, evaporation is approximately two to three times greater than the average monthly rainfall. Evapotranspiration primarily takes place where close to ground surface, either from direct radiation or where root zones access phreatic surface. Within the area, the highest rates of potential evapotranspiration are along creek and river lines, in particular the Nogoa River, where the alluvial water table is closer to ground surface, and deeper rooting vegetation exists.

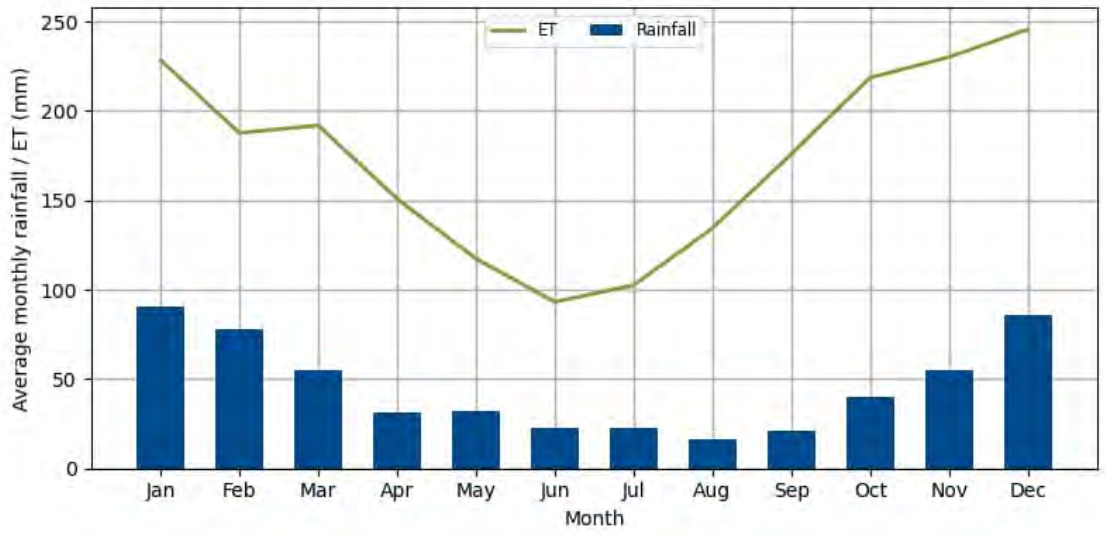


Figure 2-1 Average monthly rainfall and evapotranspiration

The average monthly rainfall, in comparison with the actual monthly rainfall recorded in 2023, is presented in **Figure 2-2**. The year 2023 shows above average rainfall during January, March, July, November, and December with rainfall in May approximately equal to the respective long-term average. In all other months in 2023, conditions were drier than average.

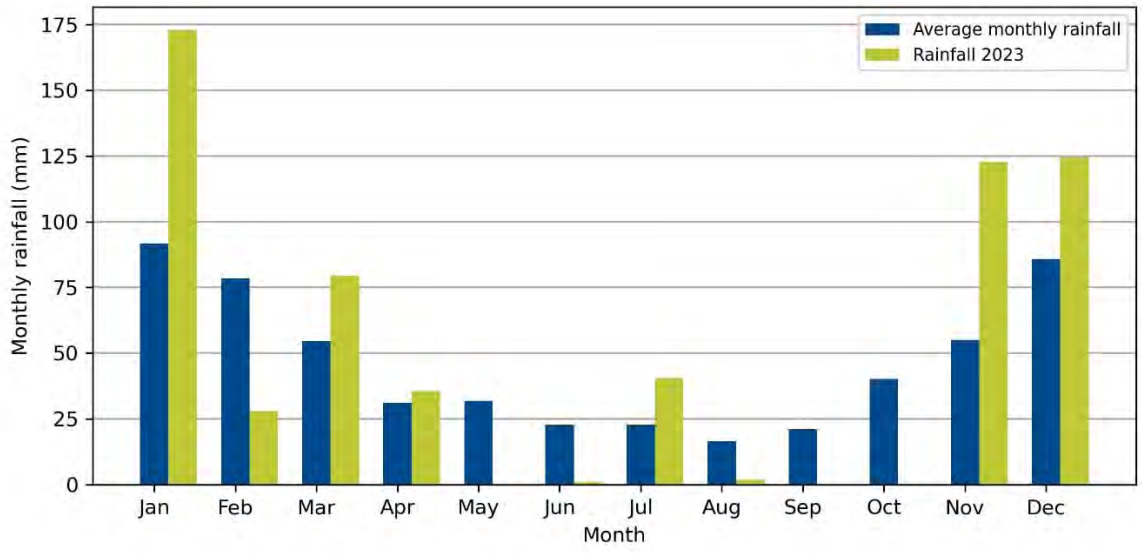


Figure 2-2 Average monthly rainfall compared with actual monthly rainfall in 2023

Rainfall trends for the area since 1970 are indicated by analysis of the Cumulative Rainfall Departure (CRD) trend for monthly rainfall data (**Figure 2-3**). Positive gradients on this curve (rising limbs) confirm wetter climatic conditions than normal, while negative gradients (falling limbs) indicate dry conditions. Average rainfall conditions are inferred during periods of stable residual mass. **Figure 2-3** shows that, over the past 25 years, the wettest period occurred 2010-2011. The driest periods were 2001-2007. As shown by the declining trend in the CRD, recently between 2021 and 2023 Ensham Mine experienced wetter than average

conditions before drier than average conditions prevailed between mid-2023 and the present.

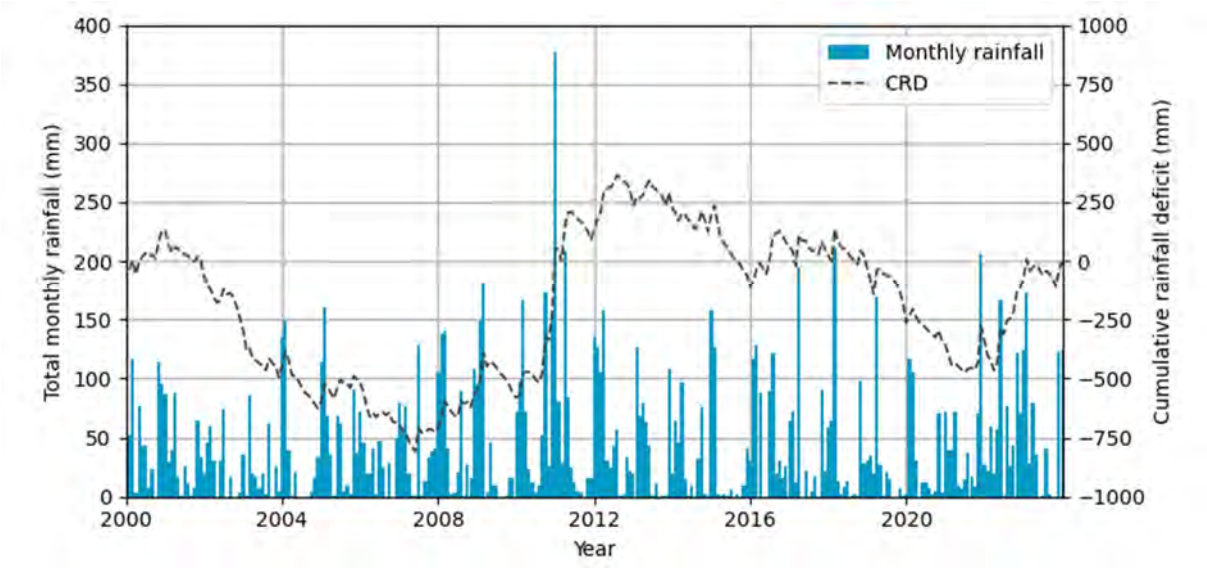


Figure 2-3 Long term Monthly Rainfall and Cumulative Rainfall Departure from mean monthly rainfall at SILO data point Lat: -23.45 and Long: 148.5.

The long-term annual rainfall for the selected data point over the last 50 years, together with the 20th and 80th percentiles and average, is presented in **Figure 2-4**. Years above the 80th percentile line are considered wet years (shown in dark blue) and years below the 20th percentile line are considered dry years (shown in light green). In this figure, dry years are the years with less rain than the 20th percentile and wet year are years with more rain than the 80th percentile. A long-term mean annual rainfall of 542 mm, a 20th percentile of 343 mm/year and an 80th percentile of 677 mm/year are observed. The year 2023 was considered an average rainfall year, with annual rainfall falling just above the long-term average.

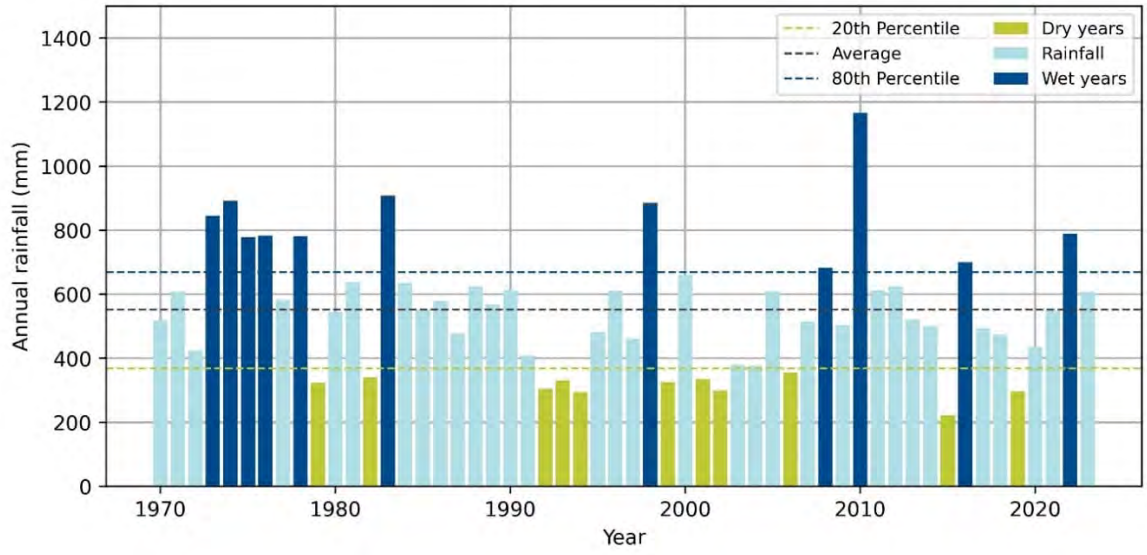


Figure 2-4 Long-term annual rainfall statistics (January 1900 - January 2024)

2.2 Local Geology

Ensham Mine is located in the western part of the Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin stretches from Townsville to south of the Queensland-New South Wales border in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap. The Rewan Formation is recognised as the basal aquitard of the GAB (Habermehl, 1980). In the study area, the Rewan Group is present at subcrop, which means no other GAB aquifers are present locally. The Clematis Sandstone which forms the basal aquifer of the GAB is not present, the closest intake area being located 50 km south-east of the study area.

Table 2-2 provides a summary of the stratigraphy across the site. The stratigraphic sequence comprises unconsolidated Quaternary aged sediments unconformably overlying consolidated Permian and Triassic aged sequences. The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular. The coal deposits mined at Ensham Mine are found within the Rangal Coal Measures, which is the uppermost Permian unit. The surface geology of the study area is dominated by the Nogoa River alluvium to the south and the Tertiary Sediment to the south and the north.

2.3 Hydrogeological Units

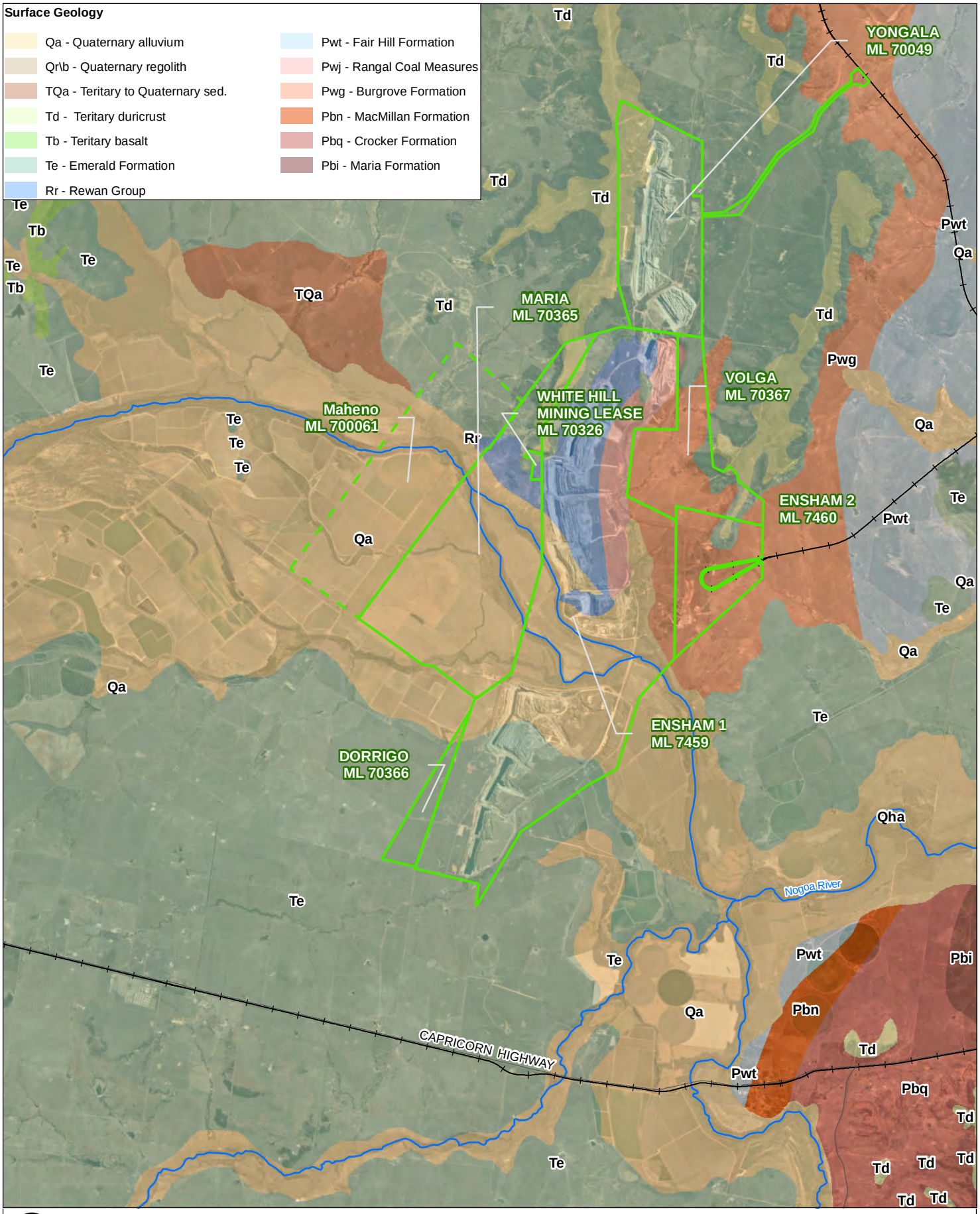
There are two primary groundwater bearing units within the local stratigraphy; the Quaternary aged alluvium, and the Permian aged Rangal Coal Measures. These two key units are separated by a low permeability aquitard, the Rewan Group, as listed in **Table 2-2**. Tertiary material forms a cover over most of the surficial deposits that are outside of the immediate vicinity of surface water features. This unit is not considered to be a significant hydrostratigraphic unit as intrusive investigations have found inconsistent saturation and poor connection throughout the unit.

Table 2-2 Hydrostratigraphy of Ensham Mine Area

Age	Unit	Max Thickness[1] (m)	Description	Groundwater unit type
Quaternary	-	25	Alluvium – silt, clay, sand, and gravel	Unconfined Aquifer
Tertiary	Basalt	ND	Tertiary volcanics (basalt) mapped as being present over 10 km west of the site	Semi confined aquifer
	Undifferentiated Tertiary Sediments	50	Fluviatile and lacustrine claystone and siltstone, quartzose sandstone, pebbly sandstone, gravel, lignite, oil shale, interbedded basalt; all deeply weathered in outcrop	Unconfined aquifer
Triassic	Rewan Group	200	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate (at base); deposited in a fluvial-lacustrine environment	Aquitard

Age	Unit	Max Thickness[1] (m)	Description	Groundwater unit type
Permian	Rangal Coal Measures	125	Interburden/Overburden: Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, and tuff.	Aquitard
			Coal Seams: these include the Aries, Castor, Pollux, and Orion seams. The main economic seams at Ensham are the Aries 2 and Castor seams. Deeper seams include the Pollux and Orion seams. They express as 0.5-6m thick beds of highly cleated coal.	Confined Aquifer

1: Approximate maximum thickness based on available exploration holes and/or relevant literature
ND: not defined, not enough data available



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.12225
Date:	22-Feb-2024
Drawn by:	RB

LEGEND

- Rail
- Road
- Watercourse
- Zone 1
- Mine Lease

ENSHAM GROUNDWATER MONITORING AND MANAGEMENT PLAN REPORT

SURFACE GEOLOGY

FIGURE 2-5

\\au.slr.local\corporate\Projects-SLR\620-BNE\620.040784.00001Ensham 2024 GMMP Report\06 SLR Data\01 CADGIS\GIS\620040784_F02-05_Surface Geology.mxd

3.0 Monitoring Data

3.1 Groundwater Bore Network

The existing groundwater monitoring program is presented in Table I1 of the site EA and is reproduced in **Table 3-1**, together with bores that are not part of the EA but are monitored for operational or investigative purposes. The locations of the bores listed in **Table 3-1** are presented in **Figure 3-1**. The groundwater monitoring network and program includes groundwater levels and quality monitoring at the locations and frequencies defined in **Table 3-1** which also shows the formation that will be monitored.

The below table includes a classification of whether a bore lies within the predicted depressurisation zone for the relevant aquifer, these are shown graphically on **Figure 3-2**. Based on the most recent groundwater level modelling (SLR, 2022b), most bores are within the potential Rangal Coal Measures depressurisation envelope (**Figure 3-2**). Predicted drawdown propagation into the overlying alluvial aquifer is significantly less than the coal measures in magnitude and extent, which is explored in **Section 5.0**.

This modelling includes necessarily conservative assumptions to mitigate the potential for un-modelled impacts to groundwater, and predicted depressurisation modelled in the alluvial aquifer is not considered a to be a likely occurrence based on water level observations since underground mining commenced in 2011. No drawdown of alluvial groundwater levels has been observed to date (**Section 3.2.4**).

Regional landholder bores were the only locations that were not within the predicted cumulative impact radius:

- Karanga: located approximately 10 km south of the UG mining area, this bore is logged to be screened in the Rangal Coal Measures, however interpretation is that the distance south insulates this location from drawdown propagation.
- Yongala: 10 km northeast of underground mining in the Burngrove Formation. This bore is in a geological unit that is offset from the target mining area and is therefore not expected to display hydrogeological influence from the mining activities at Ensham Mine.
- Fairhill: approximately 11.5 km northeast of underground mining area, this bore is also screened in the Burngrove formation and, similar to the Yongala bore, groundwater take at mining areas is not expected to have affect this hydrogeological unit.
- Railway: located approximately 13 km east northeast of the underground mining area and screened in the Fairhill formation. This unit is also offset from the target mining horizons and is not expected to display influence of mining operations.
- Conmurra: 11.5 km east southeast of the mining area ands screened within the Fairhill Formation. As with Railway bore, no drawdown propagation into this unit expected.

Quarterly groundwater monitoring is carried out at these properties, and this is assessed to establish whether there has been mining influence detected. Periodic assessment has concluded that changes in, landholder groundwater utilisation, climatic trends, and local recharge factors such as intensity of irrigation have been primary drivers of groundwater level and chemistry trends.

Previous investigations (SLR, 2023) have identified some trending chemistry data at RB9, RB10 and EC24 and it was recommended that these bores be re-developed to confirm that

the groundwater chemistry observed at these sites is stabilized with local environment following potential influence during bore installation.

Groundwater level monitoring in the mine monitoring network is considered to be sufficient for detecting water level or water quality influence on the environment around mining and waste storage activities on site.

0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.12225
Date:	22-Feb-2024
Drawn by:	RB

LEGEND

Groundwater Monitoring Bore

- Alluvial Monitoring Bore
- Inactive Monitoring Bore
- Private Landholder Bore
- Regional Monitoring Bore
- Residual Void Bore

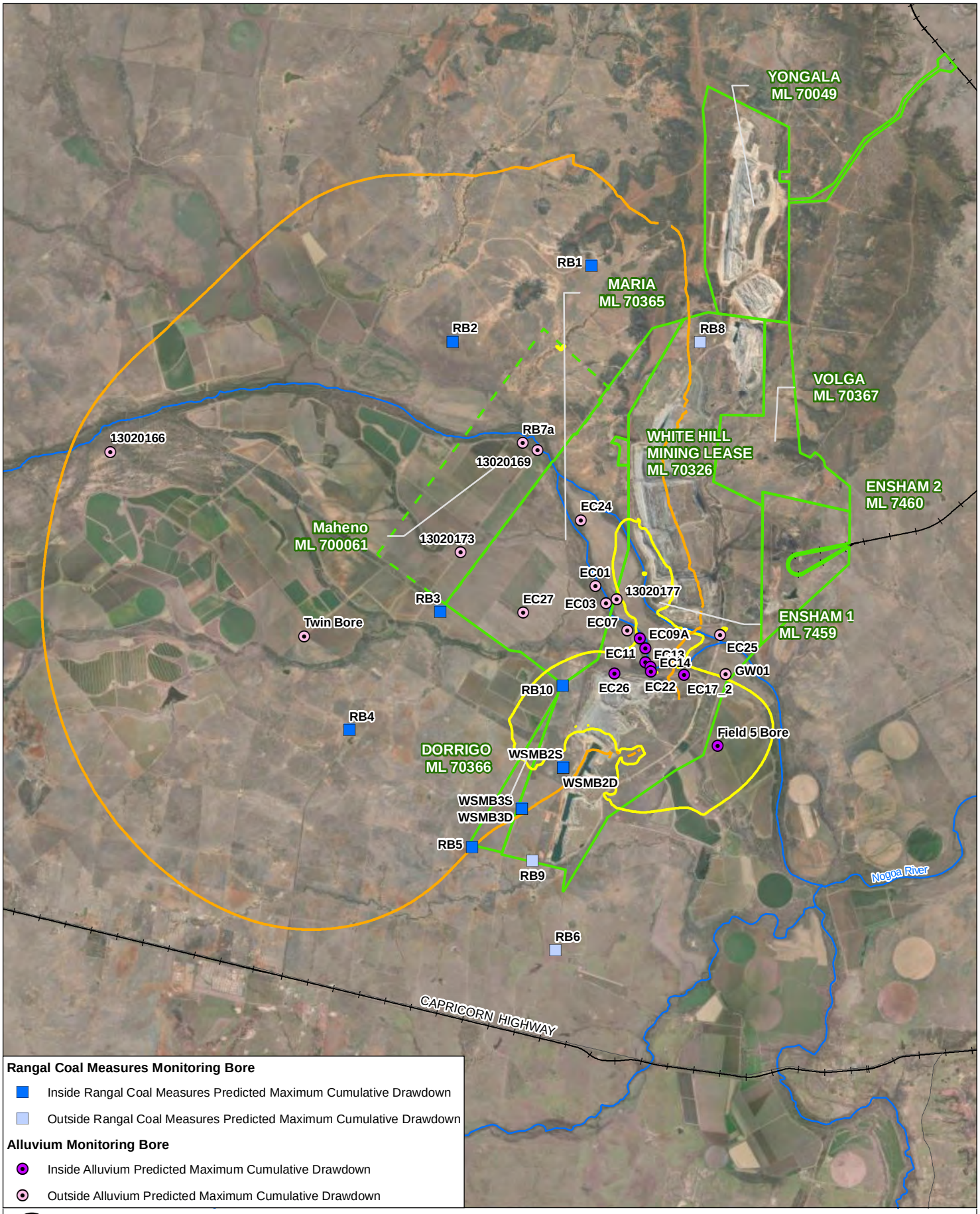
- Rail
- Road
- Watercourse
- Zone 1
- Mine Lease

ENSHAM GROUNDWATER MONITORING AND MANAGEMENT PLAN REPORT

GROUNDWATER MONITORING NETWORK

FIGURE 3-1

\\au.slr.local\corporate\Projects-SLR\620-BNE\620.040784.00001Ensham 2024 GMMP Report\06 SLR Data\01 CADGIS\GIS\620040784_F03-01_Groundwater Monitoring Network.mxd



Rangal Coal Measures Monitoring Bore

- Inside Rangal Coal Measures Predicted Maximum Cumulative Drawdown
- Outside Rangal Coal Measures Predicted Maximum Cumulative Drawdown

Alluvium Monitoring Bore

- Inside Alluvium Predicted Maximum Cumulative Drawdown
- Outside Alluvium Predicted Maximum Cumulative Drawdown

0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.040784.00001
Date:	22-Feb-2024
Drawn by:	RB

LEGEND

- Road
- Rail
- Watercourse
- Zone 1
- Mine Lease
- Nogoa River Alluvium Predicted Maximum Cumulative Drawdown (1m)
- Rangal Coal Measures Predicted Maximum Cumulative Drawdown (5m)

SLR

ENSHAM GROUNDWATER MONITORING AND MANAGEMENT PLAN REPORT

GROUNDWATER MONITORING AND PREDICTED DRAWDOWN EXTENT

FIGURE 3-2

\\au.slr.local\corporate\Projects-SLR\620-BNE\620.040784.00001Ensham 2024 GMMP Report\06 SLR Data\01 CADGIS\GIS\620040784_F03-02 Groundwater Monitoring and Predicted Drawdown Extent.mxd

Table 3-1 Groundwater Monitoring Locations and Frequency

Bore ID	EA location	Easting GDA2020, Z55	Northing GDA2020, Z55	TOC elevation (mAHD)	Groundwater Level and Quality Monitoring Frequency	Screened Interval (mbGL)	Formation Monitored	Within Predicted Impacts Zone for Relevant Aquifer
EC01	Nogoa River Alluvium	650018.7206	7403060.43	154.3	Quarterly	14-17	Alluvium	No
EC03	Nogoa River Alluvium	650338.7246	7402548.436	153.2	Quarterly	12.3-15.3	Alluvium	No
EC07	Nogoa River Alluvium	650973.7191	7401747.432	153.9	Quarterly	12.6-15.6	Alluvium	No
EC09A	Nogoa River Alluvium	651354.7173	7401505.432	153.5	Quarterly	15.1-18.1	Alluvium	Yes
EC11	Nogoa River Alluvium	651517.729	7401193.437	152.7	Quarterly	14.3-17.3	Alluvium	Yes
EC13	Nogoa River Alluvium	651517.721	7400777.433	152	Quarterly	12.2-15.2	Alluvium	Yes
EC14	Nogoa River Alluvium	651676.7252	7400654.428	146.1	Quarterly	8.7-11.7	Alluvium	Yes
GW01	Nogoa River Alluvium	653926.8858	7400423.867	153	Quarterly	To 19.8	Alluvium	Yes
RB7a	Nogoa River Alluvium	647853.5889	7407354.491	157.08	Quarterly	9-15	Alluvium	No
13020166	Nogoa River Alluvium	635531.3831	7407076.773	161.87	Quarterly	15.2-17	Alluvium	No
13020169	Nogoa River Alluvium	648298.962	7407123.449	156.22	Quarterly	14-15.8	Alluvium	No
13020173	Nogoa River Alluvium	645994.6942	7404061.441	155.43	Quarterly	9.2-11.20	Alluvium	No
WSMB2S	Residual void bore	649062.7195	7397630.405	173	Quarterly	43-49	Rangal Coal Measures (Overburden)	Yes

Bore ID	EA location	Easting GDA2020, Z55	Northing GDA2020, Z55	TOC elevation (mAHD)	Groundwater Level and Quality Monitoring Frequency	Screened Interval (mbGL)	Formation Monitored	Within Predicted Impacts Zone for Relevant Aquifer
WSMB2D	Residual void bore	649059.718	7397631.441	173	Quarterly	97-107	Rangal Coal Measures (Coal Seam)	Yes
WSMB3S	Residual void bore	647826.7212	7396414.432	174	Quarterly	6-21	Rangal Coal Measures (Overburden)	Yes
WSMB3D	Residual void bore	647826.7212	7396411.433	174	Quarterly	60 – 72	Rangal Coal Measures (Coal Seam)	Yes
Field 5 Bore	Residual void bore	653684.6907	7398272.681	151.22	Quarterly	Unknown	Alluvium	Yes
EC24	Residual void bore	649701.5688	7405215.604	156.62	Quarterly	13-16	Alluvium	No
EC25	Residual void bore	653870.36	7401767.639	150.817	Quarterly	12.5-15.5	Alluvium	No
EC26	Residual void bore	650709.9111	7400633.792	153.449	Quarterly	10-13	Alluvium	Yes
13020177	Residual void bore	650656.914	7402668.581	154.37	Quarterly	14.9-15.9	Alluvium	No
RB8	Residual void bore	653163.0786	7410350.525	187.212	Quarterly	104.5-107.5	Coal seam	No
RB9	Residual void bore	648145.7775	7394854.485	163.694	Quarterly	96-99	Coal seam	No
RB10	Residual void bore	649043.3571	7400077.246	157.19	Quarterly	149-153	Coal seam	Yes
RB1*	Regional bores (Ensham mine)	650016.9098	7412834.779	187.73	Quarterly	95.5-97.0	Rangal Coal Measures Coal (A2C)	Yes
RB2*	Regional bores (Ensham mine)	7410365.679	7410365.679	160.6	Quarterly	149-153	Rangal Coal Measures Coal	Yes
RB3*	Regional bores (Ensham mine)	645508.5133	7402465.191	156.49	Quarterly	137.5-143.5	Rangal Coal Measures Coal (A2C)	Yes

Bore ID	EA location	Easting GDA2020, Z55	Northing GDA2020, Z55	TOC elevation (mAHD)	Groundwater Level and Quality Monitoring Frequency	Screened Interval (mbGL)	Formation Monitored	Within Predicted Impacts Zone for Relevant Aquifer
RB4*	Regional bores (Ensham mine)	642783.3871	7398932.789	175.89	Quarterly	205.25-208.25	Rangal Coal Measures Coal (A21)	Yes
RB5*	Regional bores (Ensham mine)	646451.4097	7395428.036	173.35	Quarterly	237.1-240.1	Rangal Coal Measures Coal (A21)	Yes
RB6*	Regional bores (Ensham mine)	648835.1788	7392168.63	177.06	Quarterly	227.3-230.3	Rangal Coal Measures Coal (A2C)	No
Karanga (Bore A)	Regional bores (Private Property)	642025.7281	7388305.439	172.97	Quarterly	54-60	Coal Measures (not specified)	No
Winton Creek (Bore 4)	Regional bores (Private Property)	657586.7268	7400759.432	157.31	Quarterly	To 60	Rewan Group	No
Twin (Bore 5)	Regional bores (Private Property)	658696.7206	7401568.434	158.39	Quarterly	To 18	Basal Alluvium	No
Jamar (Bore 7)	Regional bores (Private Property)	663591.7298	7399085.428	183.43	Quarterly	To 90	Rewan Group	No
Yongala (RN89383)	Regional bores (Private Property)	647976.743	7415694.432	266	Quarterly	65 – 71	Burngrove Formation	No
Fairhills (RN89380)	Regional bores (Private Property)	658696.7206	7416878.428	265	Quarterly	42 – 54	Burngrove Formation	No
Railway (RN90140)	Regional bores (Private Property)	663591.7298	7412471.432	181	Quarterly	18 – 61	Fair Hill Formation	No
EC27	Additional (not in EA)	647976.743	7402436.55	154.414	NA	12.5-15.5	Alluvium	No

3.2 Groundwater Levels

Condition I15 requires discussion of the GMMP water level monitoring data, including depiction of standing water level, assessment of long-term trends, mapping of water level drawdown, and assessment of the differences between groundwater level impact and model predictions. This section addresses these aspects through presentation and discussion of hydrographs and groundwater level contours.

3.2.1 Nogoa River Alluvium

For ease of presentation and discussion, the bores screened in Nogoa River Alluvium have been separated into:

- Western Bores: Located in the western area of the groundwater monitoring network, most upstream of the monitoring positions. These include Twin Bore, 13020166, 13020169, 13020173, and RB7a. Water levels in these bores range between 155 and 146 mAHD
- Eastern Bores: Primarily located in the central area of the mining operations, these bores are relatively east of the groundwater monitoring network. Locations include EC01, EC03, EC07, EC09a, EC11, EC13, EC14, GW01, EC24, EC25, and Field 5 Bore. Water levels in these bores range between 145 and 136 mAHD.

3.2.1.1 Western Alluvium Bores

The highest groundwater levels observed in the alluvial aquifer are seen at the Twin Bores site, approximately 7 kilometres (km) west of the underground mine. Monitoring is undertaken at one of the two bores at this location, installed approximately 18 metres (m) deep, reflecting basal alluvium (see **Figure 3-3**). Historical data shows an increase in groundwater levels for Twin Bores from 2006 to 2018. Since May 2018, groundwater levels at the Twin Bores have reverted to remain in line with general climatic trends. This change may reflect reduced irrigation water recharge in the immediate area, which has in turn resulted in groundwater levels being susceptible to climatic influences. Due to the likelihood of irrigation being a recharge mechanism for the Twin Bores prior to 2018, reduction in recharge has likely resulted in the Twin Bores groundwater level trending towards baseline conditions.

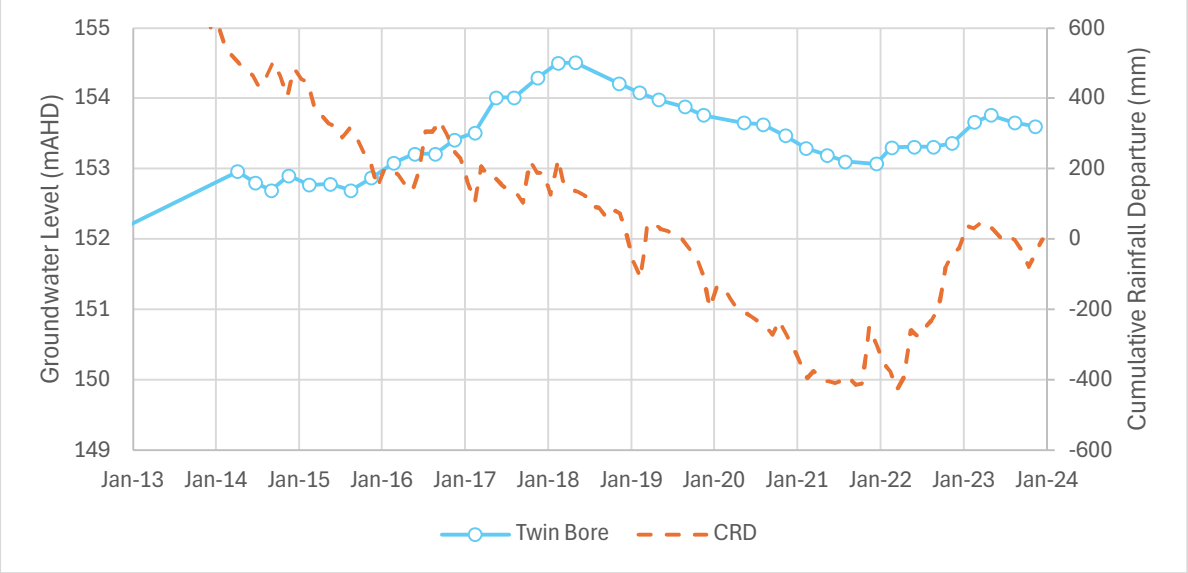


Figure 3-3 Hydrograph for Basal Alluvium Bore (Twin Bore)

Water level data for alluvium bores upstream of Ensham Mine are shown on **Figure 3-4**. The upstream alluvium bores are deemed to reflect the natural interaction between the Nogoa River alluvium and the Nogoa River; with climatic influence being the primary control on water level trends and changes.

Besides Twin Bore, monitoring in the upstream area of the alluvium monitoring network is over a shorter time scale. These have been relatively stable, with minimal fluctuation on a monthly to quarterly scale. Limited data across 2021-2023 shows a relatively strong correlation between water levels and CRD. All bores had rising water levels in response to wetter than average climate conditions towards the end of 2022 and into 2023. Recently, water levels have been trending back to baseline conditions following high rainfall events experienced at the beginning of 2023.

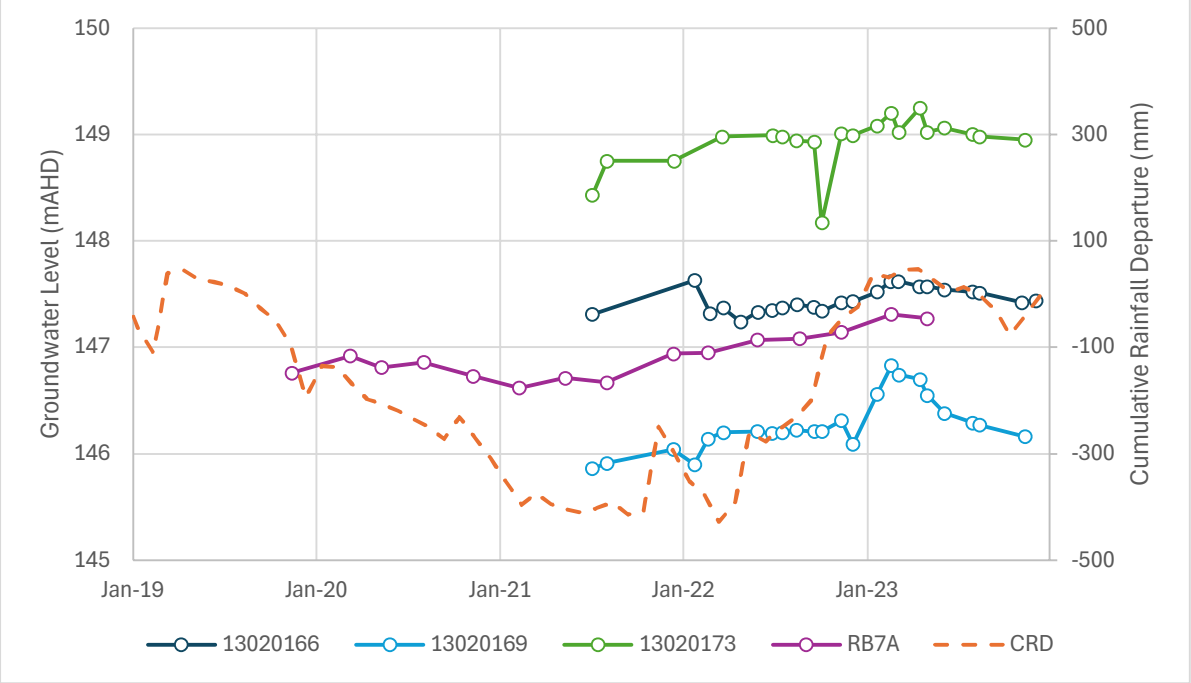


Figure 3-4 Hydrographs for Upstream Nogoa River Alluvium Bores

3.2.1.2 Eastern Alluvium Bores

Bores in the eastern area of the alluvial monitoring network are in the downstream and lower elevations of the catchment. These alluvium bores consist of the EC bore series, GW01 and Field 5 Bore. The EC bore series are located adjacent to the Nogoa River and its anabranch, near or in the area where the Rangal Coal measures sub-crops into the overlying alluvium. GW01 and Field 5 are located downstream, east of the sub-crop and current mine workings.

Figure 3-5 shows the hydrographs for the eastern Alluvium Bores. Similar to the western bores, these downstream bores appear to be somewhat responsive to climatic influence, with trends in CRD correlating well with groundwater levels prior to 2011, however most bores have remained relatively stable despite long periods of drier than average conditions.

Potential influence, if present, of mining commencement may have been obscured (see "Start UG Mining" line in **Figure 3-5**) by a high rainfall event at the beginning of 2011, with the observed sharp increase in water levels reflecting widespread inundation of alluvium monitoring bores. However, subsequent monitoring has demonstrated no clear influence of mine extraction since this time. Water levels reset to near baseline levels following this flooding event but continued to remain elevated despite drier than average climatic conditions prevailing across 2014 to 2019. Increasing water levels within the EC bores have been attributed to upstream irrigation (closest to EC1 and EC3), with bores closest to the irrigation area showing the greatest increase in water level over time. Bores furthest away from this recharge area showing greater response to climatic influences (EC14, EC25, GW01 and Field 5), especially in reference to the large rainfall events of early 2022 (see **Figure 3-5**) .

A lack of decline in groundwater levels with generally drier climatic conditions and despite commencement and advance of mining supports the interpretation of hydraulic disconnect or impediment between the Nogoa River Alluvium and the Rangal Coal Measures. No groundwater level drawdown due to mining activities has been observed in the alluvium.

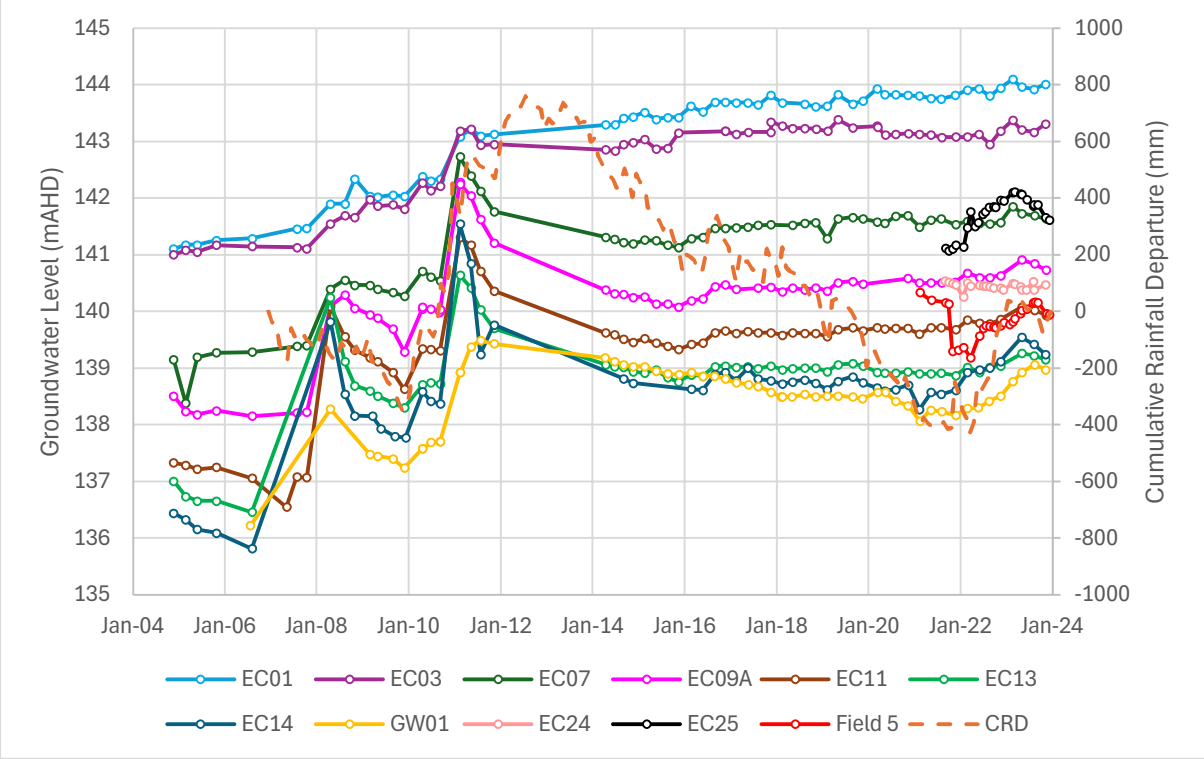


Figure 3-5 Hydrographs for Downstream Nogoa River Alluvium Bores

3.2.2 Rewan Group

Groundwater level trends within the Rewan Group at Winton Creek Bore (**Figure 3-6**) and Jamar Bore (**Figure 3-7**) are presented below. The hydrograph shows groundwater elevations within the Rewan Group at Winton Creek bore are relatively stable, at around 137 mAHD, while levels within Jamar Bore are highly variable between 108 mAHD and 126 mAHD. Routine monitoring and reporting at Ensham mine indicate that the variability relates to private bore usage with localised drawdown and slow recovery of groundwater levels within the low permeability Rewan Group.

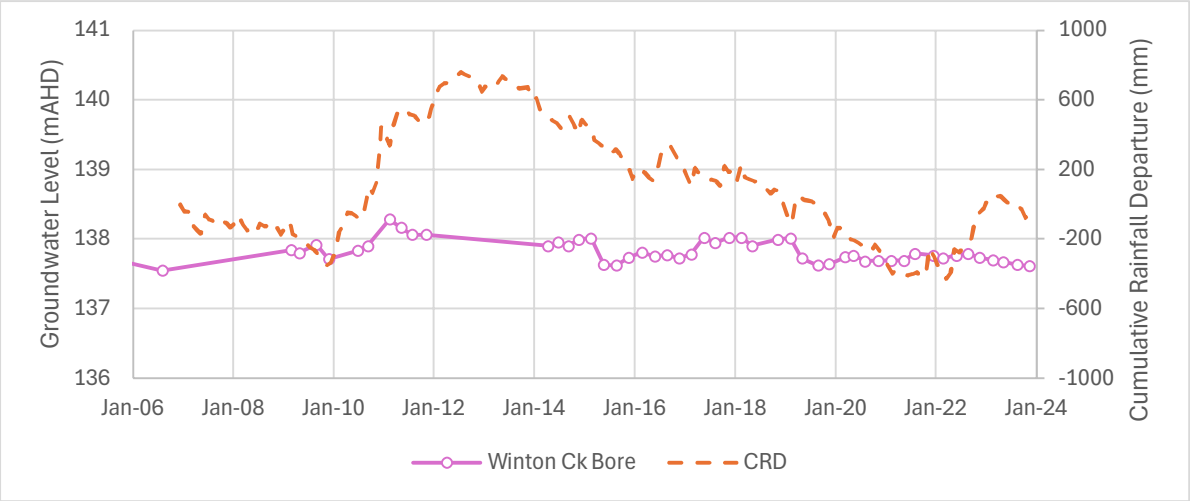


Figure 3-6 Hydrograph for Winton Creek Bore

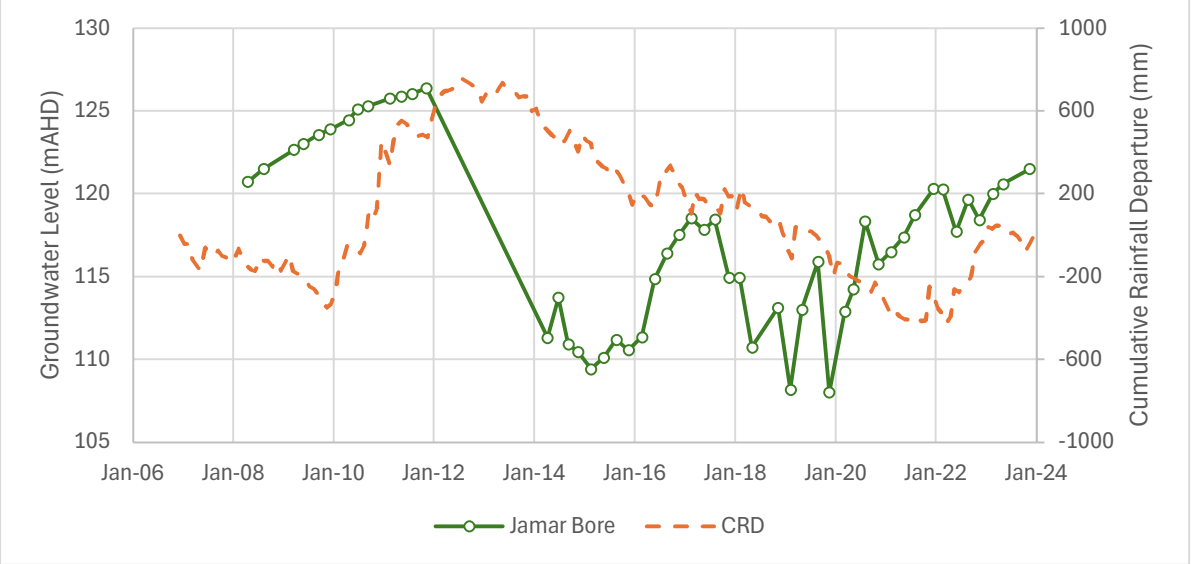


Figure 3-7 Hydrograph for Jamar Bore

3.2.3 Rangal Coal Measures

Fifteen bores are screened within the Permian Coal Measures, with the hydrographs for these bores grouped as follows:

- Local Coal Seam Bores: RB8, RB9, WSMB2D and WSMB3D
- Rangal Overburden: Karanga Bore, WSMB2S and WSMB2D
- Regional Coal Seam Bores: RB1, RB2, RB3, RB4, RB5 and RB6

3.2.3.1 Local Coal Seams

These bores are screened in coal seams closest to open pit and underground mine voids. Hydrographs are presented in **Figure 3-8**. They display three main influences on water level:

- General adherence to climatic trend;
- Some evidence of depressurisation at WSMB2D; and
- Water level rise likely attributable to water storage in open pit void.

RB8 is the northernmost of these bores, sited on the north of Pit E. With a short monitoring record, the baseline conditions for the water level in this area are unclear, however it is likely that the groundwater level has reached relative stability with the influence of adjacent mine void, resulting in the lowest groundwater levels of these bores. Outcropping into the mining void, any surface water captured in residual void is able to directly recharge the coal measures, and this is understood to have increased the climatic sensitivity of this unit, seen in the recent response to high rainfall in 2022.

Bores RB9, WSMB2D and WSMB3D are south of the Nogoa River and adjacent to the residual open pit mining voids; with Bore WSMB2D within 400 m of Pit A North (Ramp 22) and Bore WSMB3D located within approximately 1 km west of Pit A (Ramp 20 and Ramp 21).

Screened in the coal seam; WSMB2D is the only bore to show potential response to mining operations, with declining water level despite relatively wet conditions 2010 to 2012. The 12 m water level decline between 2009 and 2020 is very likely to reflect depressurisation in

combination with relatively drier conditions. In 2020, the water levels in Ramp 22 rose by 6 m as those pits were used to store water previously stored in Pit B. The coal seam bore WSMB2D mimics this increase very closely, demonstrating that the Permian strata is in connection with the residual void at Ramp 22.

Unlike WSMB2D, bore WSMB3D has shown a generally increasing trend since monitoring began in 2009. Initial groundwater level rise may be attributed to the residual mine void acting to equalise groundwater levels in the various Rangal Coal Measures horizons, and through allowing direct rainfall recharge. Further step change in water level occurs in 2020, where water levels were seen to rise over 2 m in response to Ramps 21 and 22 being used to store water that was previously stored in Pit B.

RB9, located south of bores WSMB2D and WSMB3D, was relatively recently installed and displays a more muted response to stressors than the other monitoring locations. Groundwater levels at this location have remained relatively stable, with groundwater level rise likely attributed to relatively wet climatic conditions throughout 2022.

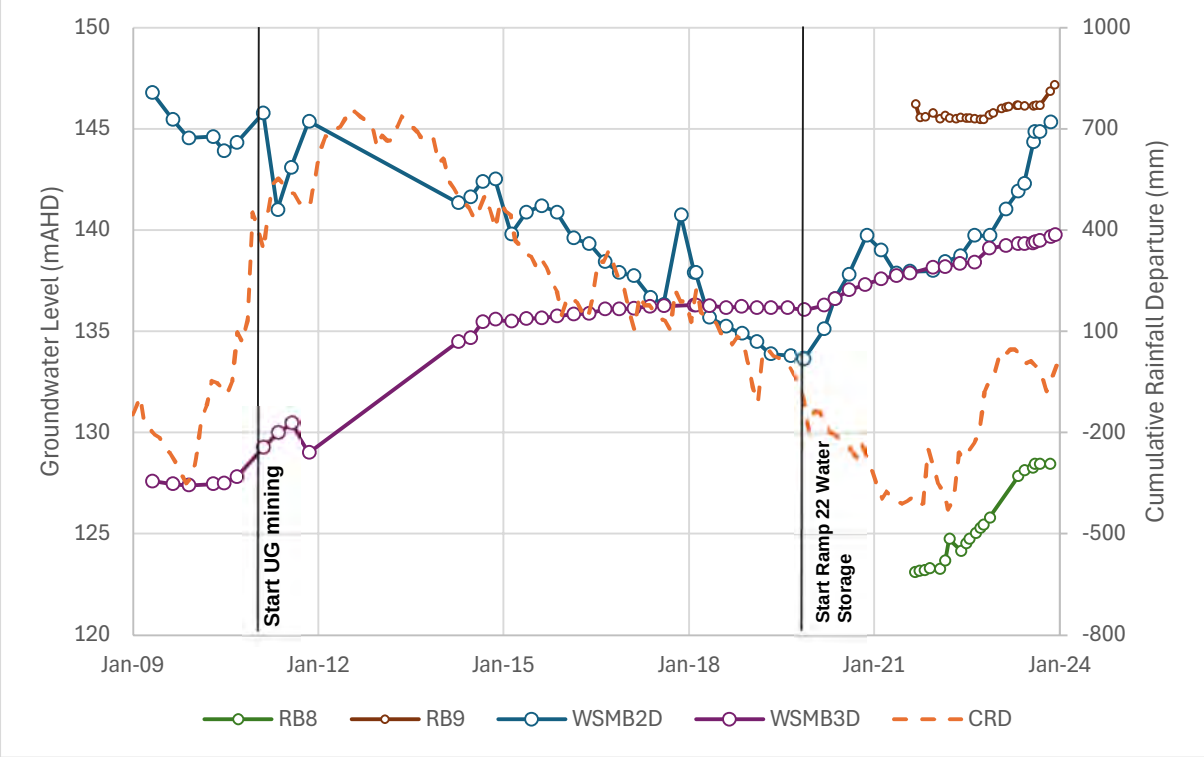


Figure 3-8 Coal Seams (excluding RB10) Hydrographs

3.2.3.2 Rangal Overburden

Bores WSMB2S, WSMB3S and Karanga are all interpreted to be screened within the siltstone and sandstone coal measures overburden, with hydrographs for these bores presented in **Figure 3-9**.

Similar to WSMB2D, bores WSMB2S and WSMB3S also show depressurisation as a result of mining void, though they are subdued with respect to the coal seams bores, a likely reflection of lower hydraulic conductivity. Water storage increase commencing at the beginning of 2020 in Ramp 22 also resulted in increasing water level trends within these two bores, however, similarly subdued to the coal seams bores. Shallow water levels for WSMB3S have been attributed to its screen depth (6-21m); targeting the uppermost coal measures overburden. A deeper screen depth of 43-49m for WSMB2S has meant that

influences such as depressurisation and pit water storage are more pronounced in **Figure 3-9**.

Outside of a 5m outlier encountered in May 2023, groundwater levels for Karanga Bore have remained within an expected range, following a decreasing trend since late 2013. Is likely related to changes in the usage of this bore, as it is currently being pumped, and this is understood to have a much greater impact on the local aquifer conditions than any potential mining impact propagation. Pumping volume generally fluctuates in response to availability of surface water. Monitoring at RB6 shows upwards trend and this being in between Karanga Bore and the mining areas, indicates that groundwater response at Karanga is separated from mining influence.

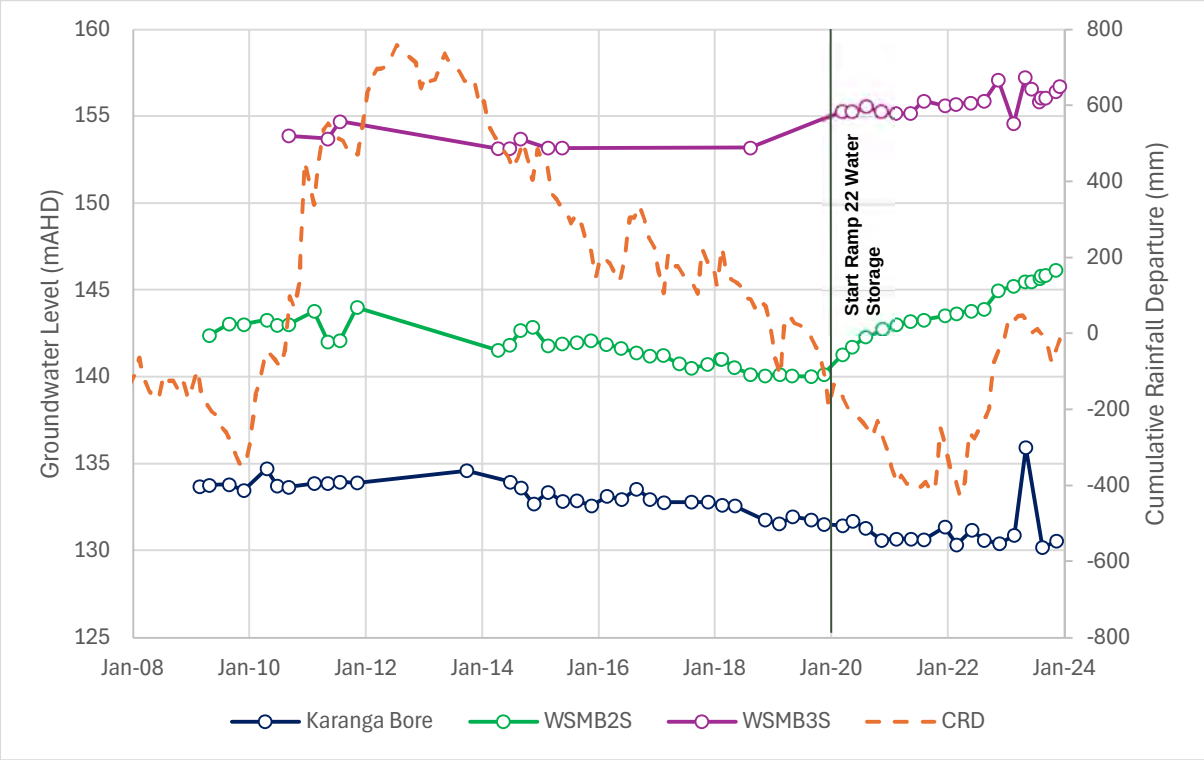


Figure 3-9 Rangal Coal Measures Hydrograph

3.2.3.3 Regional Coal Seam Bores

Bores RB1 to RB6 are all screened within the Rangal Coal seams at extended distances from Ensham Mine. Hydrographs for these regional scale bores are presented in **Figure 3-10**. The majority of these bores follow decreasing trends since their instalment in 2015. Most pronounced of these is RB3 which lies in the core part of predicted depressurisation and is closest to underground mining area.

Bores RB5 and RB6 are exceptions to this decreasing trend. RB5 shows a step-change in response to when water storage in Ramps 21 and 22 was significantly increased. RB6 is located approximately 2.6 km directly south of Pit A South and historically stable, likely due to the distance from groundwater level stressors (recharge/discharge areas). It is interpreted that the coal measures in this area are in equilibrium with open pit mining void. Mild increasing trend is in contrast to the climatic trend up to 2022, and therefore is likely to be a subtle response to water level storage in open pit mining void.

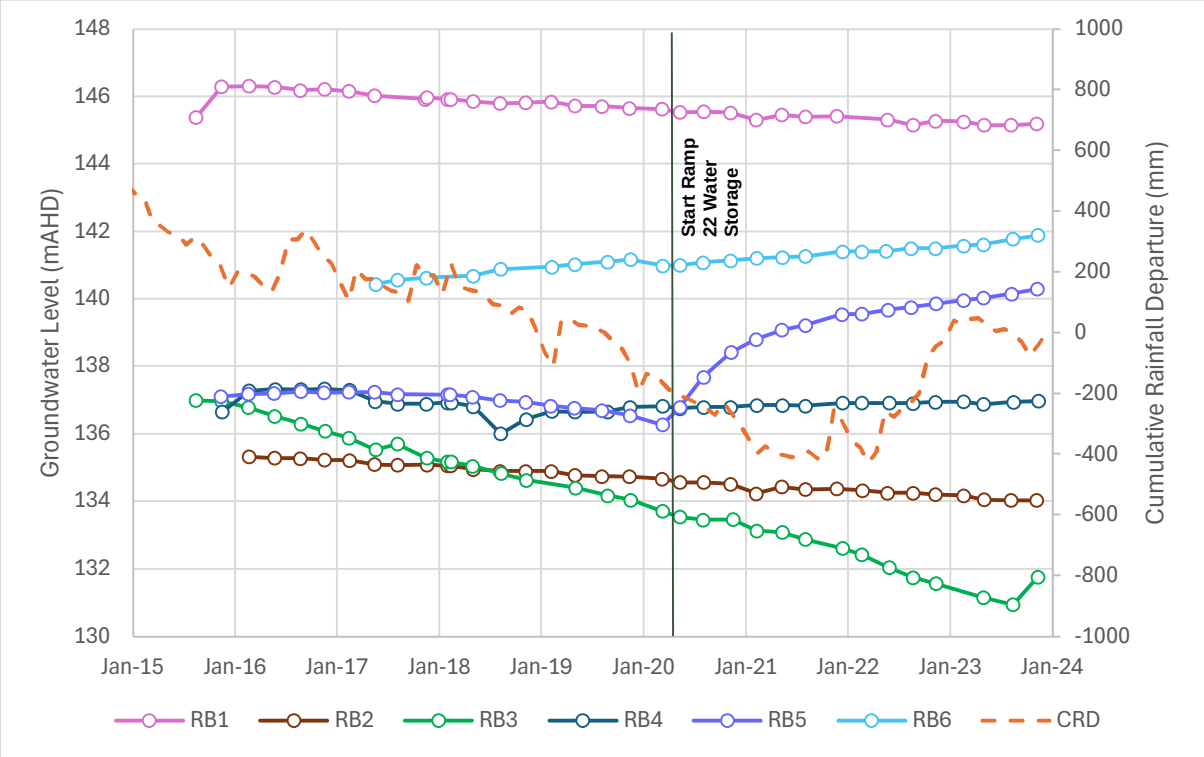


Figure 3-10 Regional Bores (Coal Seams) Hydrograph

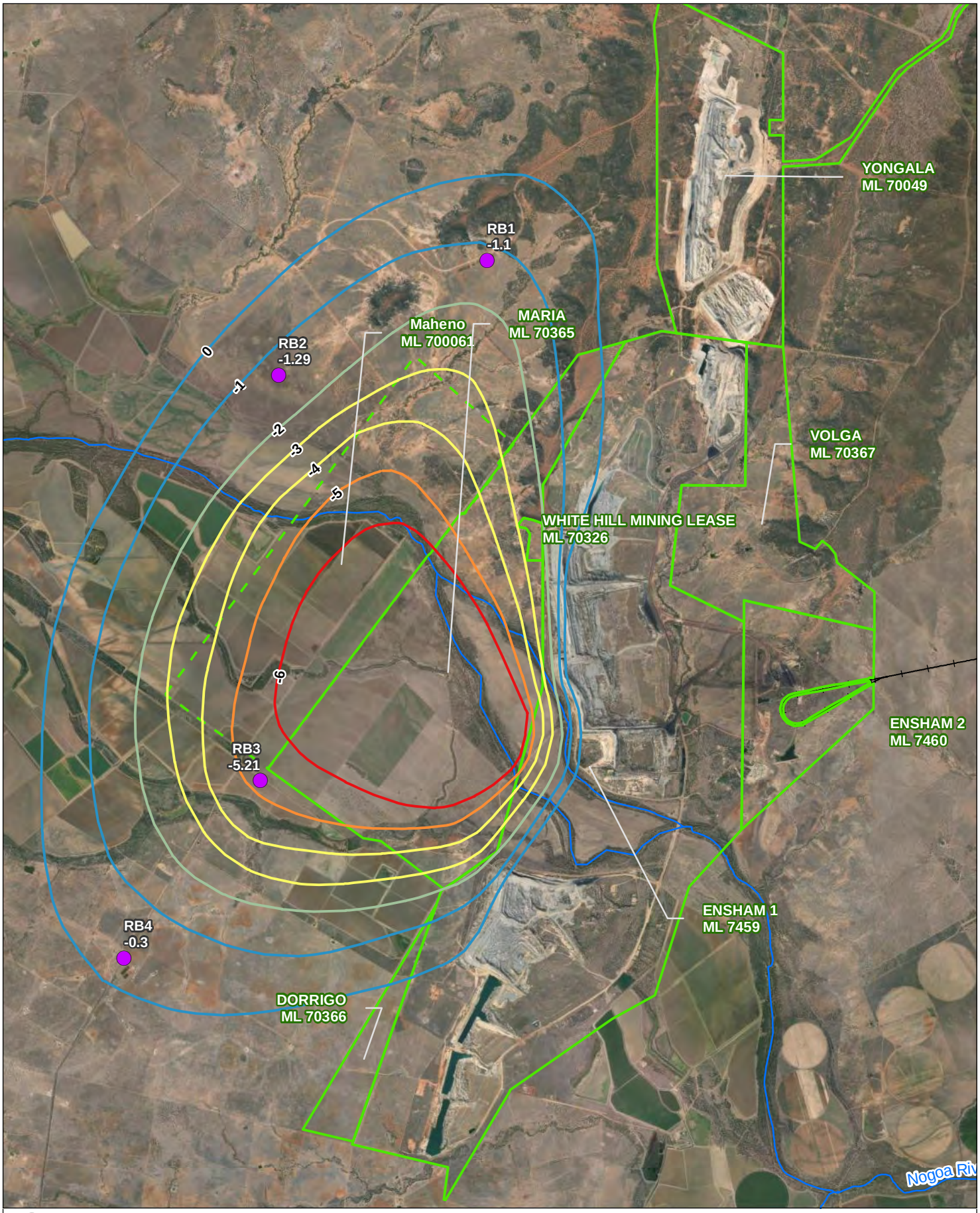
3.2.4 Drawdown Mapping

Comparison of measured drawdown with the modelled predictions of water level change in response to groundwater take is presented in **Table 3-2**. These locations are screened in the Rangal Coal Measures which is the target for mining activities at Ensham Mine and the primary horizon which was modelled to be depressurised through water extraction. No groundwater level drawdown has been observed in the Alluvium. As per the water level observations below, actual drawdown observed has been below the predicted drawdown for the corresponding stress period in the model. Water level modelling for impact prediction is necessarily conservative to avoid underprediction of potential impacts, hence the discrepancy between observed and modelled values. Drawdown was not observed at RB5 and RB6 where increase in water level was observed between 2015 and 2023, matching water level predictions in the model.

In accordance with condition I15, a contour plot of actual water level drawdown is presented in **Figure 3-11**. These contours display the primary active underground mine void, where active dewatering is depressurizing the coal measures. Drawdown propagation extent is broadly in line with predicted depressurization, though the magnitude is lower than predictions.

Table 3-2 Rangal Coal Measures Drawdown Data

Bore ID	Initial Observation Date	Initial Observation (mAHD)	Recent Observation Date	Recent Observation (mAHD)	Actual Water Level Change (m)	Modelled Water Level Change (m)
RB1	19-11-2015	146.28	07-11-2023	145.18	-1.1	-6.0
RB2	24-02-2016	135.33	07-11-2023	134.04	-1.3	-22.0
RB3	18-11-2015	136.97	13-11-2023	131.76	-5.2	-31.5
RB4	26-02-2016	137.27	13-11-2023	136.97	-0.3	-4.2
RB5	16-11-2015	137.1	09-11-2023	140.29	3.2	0.8
RB6	23-05-2017	140.435	13-11-2023	141.88	1.4	1.3



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.040784.00001
Date:	22-Feb-2024
Drawn by:	AS

LEGEND

- Measured Drawdown (m)
- Rail
- Watercourses
- Zone 1
- Mine Lease

Interpreted Drawdown Contour (m)

- -6
- -6 - -5
- -4 - -3
- -3 - -2
- -1 - 0

ENSHAM GROUNDWATER MONITORING AND MANAGEMENT PLAN REPORT

MEASURED WATER LEVEL DRAWDOWN CONTOURS

FIGURE 3-11

\\au.slr.local\corporate\Projects-SLR\620-BNE\620.040784.00001Ensham 2024 GMMP Report\06 SLR Data\01 CADGIS\GIS\620040784_F04-08 Measured Water Level Drawdown Contours.mxd

3.3 Groundwater Quality

Water quality observations are presented here for general characterisation and evaluation of the conceptual model, and trend analysis is carried out to satisfy EA conditions. Discussion of aquifer connection builds on this water quality analysis in **Section 5.0**.

3.3.1 Aquifer Characterisation

Figure 3-12 and **Figure 3-13** show Durov plots for the alluvial and Permian groundwater bores. Durov plots are used to show major ion chemistry (water type) together with the physiochemical parameters EC and pH. It allows characterisation of the primary dissolved material and the approximate quantity (salinity).

Monitoring data displays significant variability in groundwater quality between hydrostratigraphic units, and between individual bores within individual hydrostratigraphic units (particularly within the Alluvium) (**Figure 3-12**). The water quality across Ensham Mine is generally moderately saline, with neutral to moderately alkaline pH and sodium-chloride (Na-Cl) water type. Alluvium water quality falls in two primary chemistries, highly saline Na-Cl dominated (eg. EC07, EC13), and Na-HCO3 dominated fresher water quality. Rangal Coal Measures bores are clustered between 6,000 and 12,000 micro-Siemens per centimetre (µS/cm) (**Figure 3-13**).

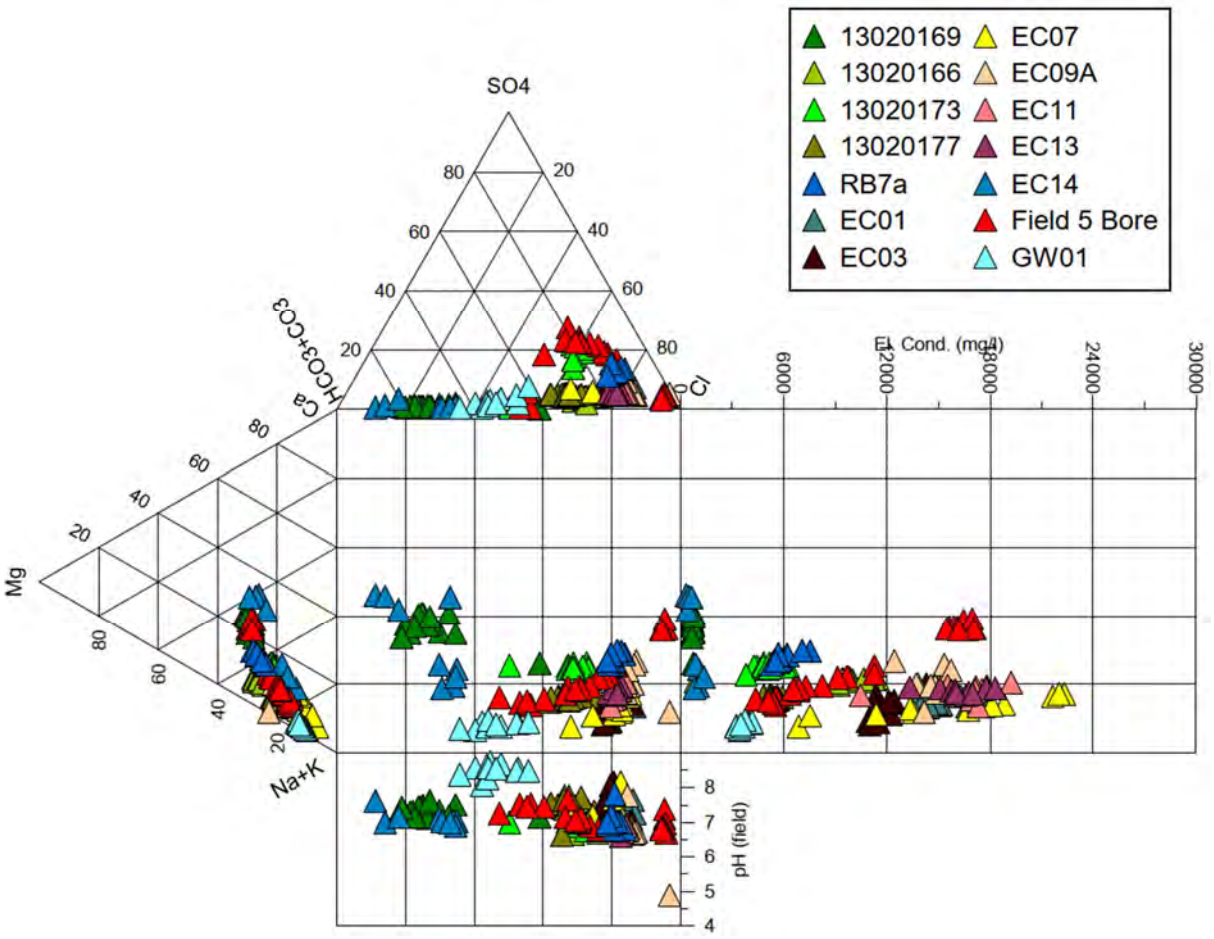


Figure 3-12 Durov Plot of Alluvium Water Quality Sampling at Ensham Mine

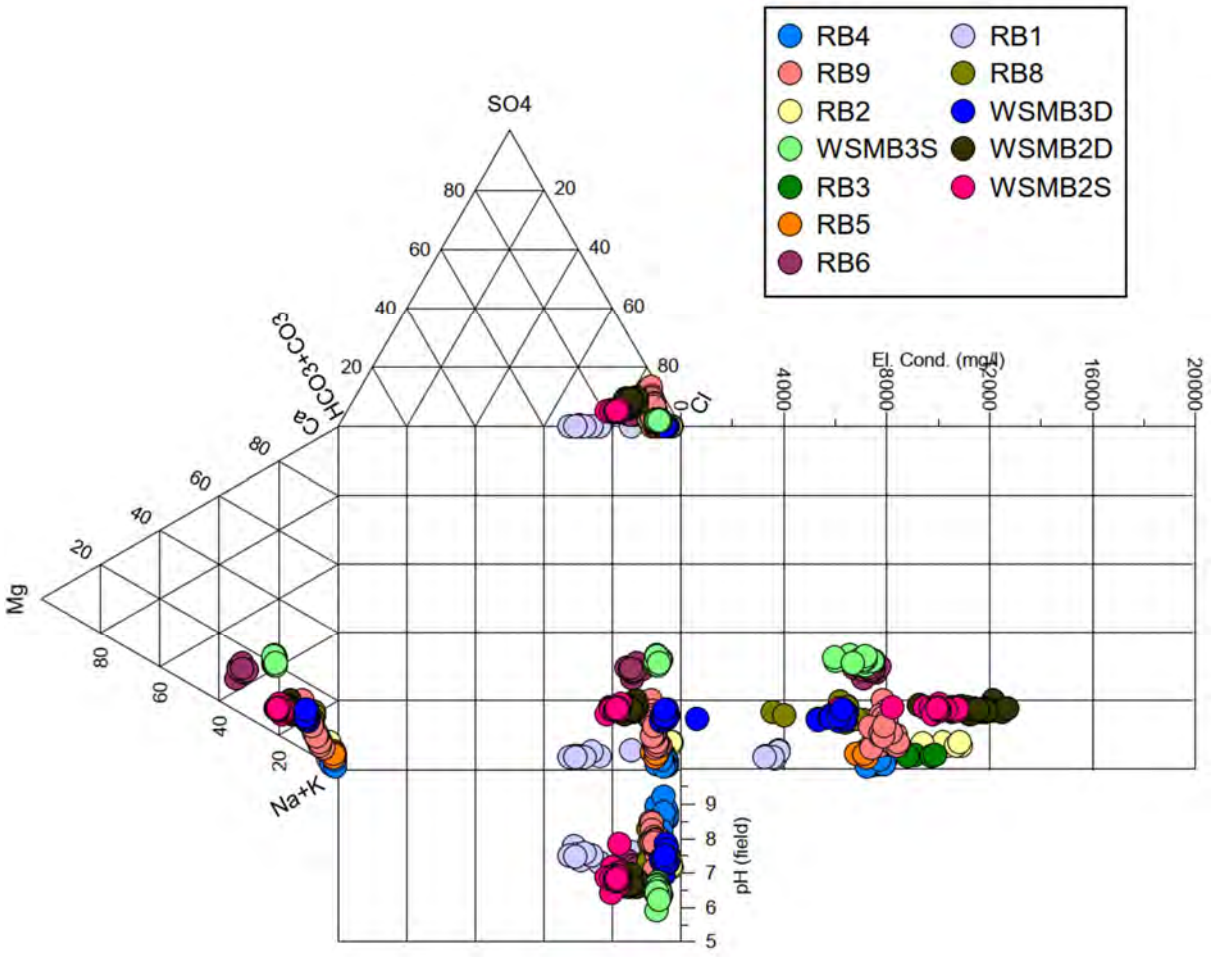


Figure 3-13 Durov Plot of Rangal Coal Measures Water Quality Sampling at Ensham Mine

3.3.2 Trend Analysis

This section relates to the requirement for the GMMP report to evaluate water quality trends for all groundwater bores within Table I1 of the EA, as outlined in condition I15. Analytes being assessed are those included in Table I2 of the EA.

In accordance with the GMMP, monitoring data used for this review includes raw data from the Ensham environmental monitoring database. Data input was subject to the following quality assurance processes:

- Laboratory and field duplicate sampling;
- Data review to detect and correct inconsistencies with analysis units;
- Non-detect data: In accordance with DES (2021), all values below the limit of reporting (LOR) were converted to one half of the limit of reporting for that specific parameter for the trend analysis;
- Outliers: A statistical outlier is defined as a value originating from a different statistical population than the rest of the sample. Outliers are likely the result of sampling or

measuring error and are a common occurrence in groundwater data. Tukey's method (1977) was used to screen outliers ranging above and below 1.5 times the interquartile range. Statistical and trend analysis was performed on the raw data (i.e., including outliers); and

- Removal of early time data in cases of a large time gap in the monitoring record (i.e., prior to 2019) if groundwater quality was not considered to be representative of current conditions relevant to the current Ensham operation and EA.

The non-seasonal Mann-Kendall statistical trend test was used to detect potential trends in the dataset, with the results provided in **Table 3-3** below.

The Mann-Kendal test is used as a first pass check if a dataset contains a statistically significant trend that warrants further analysis to assess if a real trend exists, and therefore the data may be inappropriate to use as a true indication of trends. Interpretation of Mann-Kendall results relies on the p-value and the Kendall rank correlation coefficient, tau. A p-value less than 0.05 means that there is statistically significant trend in the data. Despite having a low p-value, statistically significant trends may be the result of historical trends, or fluctuations in concentration that effectively skew datasets. In order to verify whether these trends were true and current, time series plots were generated for each trending analyte to visually confirm whether or not the trend was accurate. Only trends that were deemed true following a visual check have been tabulated in **Table 3-3**. Discussion of these increasing trends has been split based on parameter group, with time series plots of all the analytes presented in **Appendix A**.

These trends are assessed for all EA analytes, including major cations and anions. It is noted that major cations and anions are interpretation only analytes, unlikely to reflect a potential risk to environment, but the analysis below aims to establish what mechanisms might be relevant to the GMMP and updates to conceptualisation understanding.

Table 3-3 Trending Analytes for Bores at Ensham Mine

Bore ID	Aluminium	Arsenic	Bicarbonate	C10 – C40 Fraction	Calcium	Carbonate	Chloride	Field EC	Field pH	Iron	Magnesium	Molybdenum	Potassium	Selenium	Sodium	Sulfate
13020166	No Trend	No Trend	No Trend	No Trend	Trend – Increasing	No Trend	Trend – Increasing	Trend – Increasing	No Trend	No Trend	Trend – Increasing	No Trend	No Trend	No Trend	Trend – Increasing	Trend – Increasing
13020169	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Increasing	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend
13020173	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend
13020177	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing
EC01	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing
EC03	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing
EC07	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	Trend – Increasing	Trend – Decreasing	Trend – Decreasing	Trend – Increasing	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing
EC09A	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing
EC11	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend
EC13	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend
EC14	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing
EC25	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend
EC27	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend
Fairhills Bore	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
Field 5 Bore	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Increasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing
GW01	No Trend	No Trend	Trend – Increasing	No Trend	Trend – Decreasing	Trend – Increasing	Trend – Decreasing	Trend – Decreasing	Trend – Increasing	No Trend	Trend – Decreasing	No Trend	Trend – Increasing	No Trend	Trend – Decreasing	Trend – Decreasing
Jamar Bore	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
Karanga Bore	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing
Railway Bore	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
RB1	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing
RB2	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	Trend – Increasing	No Trend	No Trend	No Trend	No Trend	No Trend
RB3	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Increasing	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing
RB4	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Increasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Increasing	No Trend	No Trend	Trend – Decreasing
RB5	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Increasing	No Trend
RB6	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Increasing
RB7a	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
RB8	No Trend	No Trend	Trend – Increasing	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend
RB9	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing
Twin Bore	No Trend	No Trend	Trend – Increasing	No Trend	Trend – Decreasing	Trend – Increasing	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Increasing	No Trend	No Trend	Trend – Decreasing
Winton Creek Bore	No Trend	No Trend	Trend – Increasing	No Trend	Trend – Increasing	No Trend	Trend – Increasing	Trend – Increasing	Trend – Decreasing	No Trend	Trend – Increasing	No Trend	No Trend	No Trend	Trend – Increasing	Trend – Increasing
WSMB2D	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing
WSMB2S	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
WSMB3D	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing	Trend – Decreasing	Trend – Decreasing	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend
WSMB3S	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	No Trend	Trend – Decreasing	Trend – Decreasing
Yongala Bore	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Trend – Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend

3.3.2.1 Electrical Conductivity and pH

Key observations from trend analysis are outlined for the physiochemical parameters EC and pH:

- Historical high rainfall and flooding events (2011) flushed precipitated salts into the alluvial system. These elevated salinity values are now declining to baseline levels, resulting in decreasing EC, major cation and major anion trends for many bores.
- Increasing trends are observed at 13020166 and Winton Creek Bore which are in the west of the monitoring network, upstream of the mining operations area, and may reflect salinity increasing factors such as agricultural influence outside of monitoring network to the west.
- 13020169, Field Bore 5, GW01, and EC07 display an increasing trend in pH. The aquifers around Ensham are silicate rich and carbonate poor, based on lithological understanding, thus rock-water interaction in the aquifer is unlikely to be related to these chemistry changes. Increasing pH trends are generally matched with decreasing EC trends at all of these locations (including 13020169, when considering a sub-set of the data since 2022). The geochemical mechanism for this relationship is likely to be calcite precipitation (Appello and Postma,1993), where calcite and bicarbonate are removed from the aqueous solution and deposited in either the formation or within the bore construction.
- RB4 pH change discussed in detail during exceedance investigations carried out in 2021, 2022, and 2023. See **Section 4.0**.

These chemistry trends are not considered to be related to mining activity, as they are:

- Located distally from mining operation area in the case of 13020166, Winton Creek Bore and RB4, and are likely to be observing groundwater influences from outside of the monitoring network, based on comparisons with other local bores.
- GW01 and Field Bore 5 are in shallow areas where surface water input has a direct influence on groundwater chemistry and may be driving the calcite precipitation. This is a natural process and not anthropogenic.

3.3.2.2 Major Anions and Cations

The following dot points examine the key trend analysis outcomes presented in **Table 3-3**:

- Increasing trends for major cations and anions at 13020166 and Winton Creek Bore are driven by increasing salinity and total dissolved solids content. This is understood to be caused by flushing of salts into the western (upstream) areas of the aquifer.
- Similarly, decreasing salinity trends at most locations, driven by historical saline plume flushing through system, and relatively wetter conditions through 2022 flushing fresher water through the system, result in declining trends for most parameters.
- Increases in cation concentrations including magnesium at RB2 and RB3, sodium at RB5, potassium at RB4 and Twin Bore are likely to be due to very small variations in cation exchange within the water chemistry that is entirely dominated by sodium chloride. Magnitude of concentration change for these bores is between 0.5% an 0.1% of TDS.
- Increasing carbonate concentration at RB4 and Twin Bore is linked to increases in carbonate content, subsequent pH increase and change in the speciation of the alkalinity.

- RB6 increasing trend in sulfate values are likely to be a reflection of water flowing from other areas of the aquifer into this zone, potentially due to head flux from surface water storages. The observed change is a very mild increase, from 140 to 160 mg/L, and could therefore also be due to slight changes in flow regimes for this area of the aquifer. With sulfate concentrations at these levels there is no risk to environment. No significant changes in water type are observed, as sulfate is a very minor constituent compared with Na-Cl. This trend should be re-examined in the subsequent GMMP Report with respect to potential environmental receptors, If it does not stabilise in the meantime.

In summary, the key mechanisms driving trends in major anions and cations include:

- Periodic saline flushing from drainage area into and out of the aquifers; and
- Input of high bicarbonate and low pH recharge, from agricultural runoff infiltration, and from outside of monitoring area.

These processes are anthropogenic in the relationship with agriculture activities, but are unlikely to be associated with mining activities at Ensham Mine and there are no risks of potential environmental harm from operations identified at this stage.

3.3.2.3 Trending Metals

A trend of increasing molybdenum was observed at EC07, with levels increasing from 0.001 mg/L to 0.011 mg/L. This is well below the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) toxicant limit of 0.034 mg/L.

Figure 3-14 shows a time series of molybdenum concentration at three alluvial monitoring locations, EC01, EC03, EC07 and EC27. Increasing trend at EC07 is likely a result of slow advection of molybdenum concentration from upstream in the alluvium, with higher molybdenum levels observed at EC01 and EC03. EC03 especially shows a breakthrough curve in molybdenum concentrations that suggest a transient source for this molybdenum, potentially short term saturation of alluvium sourced from granitic or volcanic areas. It may also represent flushing through the system of unknown sources in the upstream areas of the aquifer. EC27 displays molybdenum values of 0.009 and 0.008 mg/L for two available sample in 2021 and 2023. There is no clear trend from these isolated samples, however this location displays similar values, well below the trigger level.

The increasing molybdenum trend at EC07 is considered unlikely to be caused by mining activity, based on the reference analysis from upstream groundwater monitoring. Additionally, these values are well below the trigger level defined based on water quality objectives and environmental values. Subsequent GMMP reporting should revisit this issue in two years to assess if linear trend has continued.

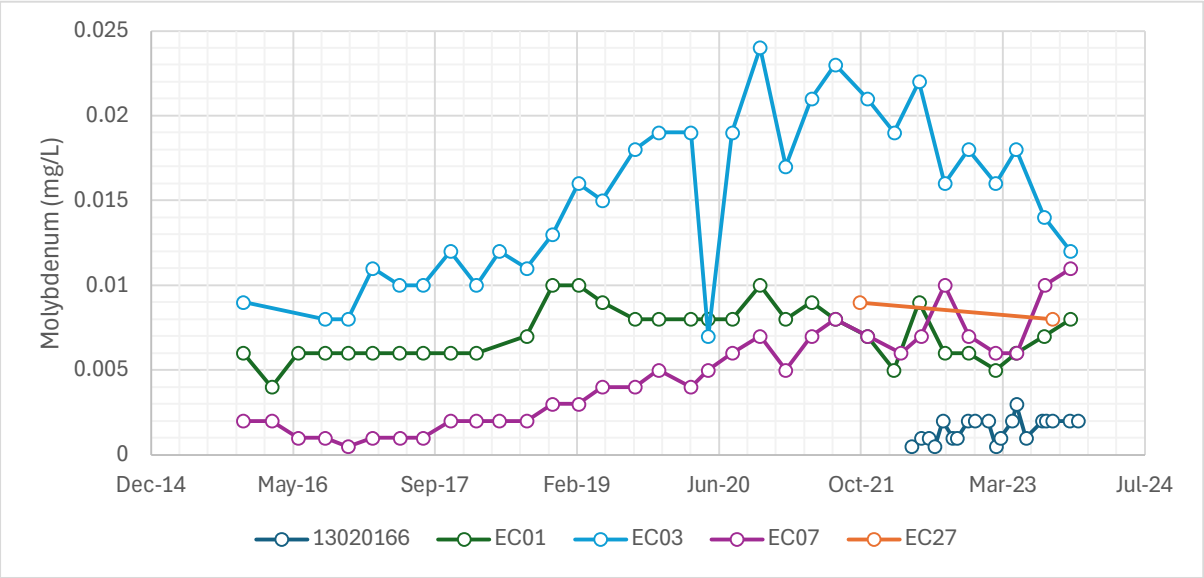


Figure 3-14 Time series of molybdenum analysis at EC01, EC03, EC07 and EC27

4.0 Summary of Completed Investigations

Groundwater quality sampling is undertaken on a quarterly (3-monthly) basis, with the analysis suite of this sampling relevant to potential contaminants related to environmentally relevant activities on site.

As per condition I4, the environmental authority holder must notify the administering any monitoring result that shows an exceedance of any limit for any quality characteristic specified in Table I2 – Groundwater quality limits. The EA defines an exceedance as an occasion when a limit for any quality characteristic specified in Table I2 – Groundwater quality limits is exceeded on any three consecutive sampling occasions.

Should these exceedances be identified, Ensham must commence an investigation to determine if the exceedance is a result of:

a) the mining activities including rehabilitation activities;

b) seasonal / natural variation;

c) neighbouring land use resulting in groundwater impacts;

d) any other potential cause of exceedance; or

e) an investigation is only required if the mining affected drawdown fluctuations reported in Condition I3 are outside of modelled values;

f) any combination of (a) to (d) the above.

Investigations that have resulted from this process are limited to three bores and two analytes:

- EC01 – Sulfate
- GW01 – pH
- RB4 – pH

A summary of these investigations, including their causes, recommendations and outcomes are presented in **Table 4-1**.

- Increasing sulfate at RB4 – Likely to reflect irrigation contribution to shallow groundwater from nearby agricultural areas.
- Increasing pH at GW01 – Increased bicarbonate has led to pH increase, calcite dissolution and ion exchange processes; likely a reflection of irrigation waters entering the groundwater system.
- Increasing pH at RB4 – Increased bicarbonate content through the introduction of high pH water from the south (which extends beyond the range of the monitoring area) is driving chemistry change; likely a reflection of groundwater flow regime change.

Investigations have concluded that trends relating to these analytes are unlikely to be connected to mining activities; with chemistry change likely related to changes in the groundwater flow regime and sources of recharge.

Recently, in response to these investigation outcomes, reassessment of these trigger levels was performed and presented within the updated GMMP (SLR, 2023).

Table 4-1 Summary of Completed Investigations

Location	Aquifer	Analyte	Date	Exceed. Value	Date Investigation Completed	Trigger Level	Cause	Recommendations	Outcomes
EC01	*Alluvium*	Sulfate	10/11/2020	658	10/06/2021	650 mg/L	Increasing sulfate levels likely to reflect irrigation contribution to shallow groundwater from nearby agricultural areas.	· Consider revision of trigger values in line with 95th percentile of appropriately defined recent chemistry data; and · Include nutrient analysis suite in all groundwater sampling at alluvial monitoring locations.	Quality assurance of the chemistry data suggests that these analyses are not likely to be the result of data collection errors. No consecutive exceedances of sulfate have occurred at EC01 since 2021.
			8/02/2021	666					
			10/05/2021	685					
			8/02/2021	666	19/10/2021		Increasing sulfate levels likely to reflect irrigation contribution to shallow groundwater from nearby agricultural areas.	· Consider revision of trigger values in line with 95th percentile of appropriately defined recent chemistry data; and · Include nutrient analysis suite in all groundwater sampling monitoring locations.	
			10/05/2021	685					
			2/08/2021	692					
GW01	*Alluvium*	pH	23/05/2022	8.66	17/02/2023	8.5	Increased bicarbonate the groundwater at GW01 has led to pH increase. This is caused by calcite dissolution and ion exchange processes. Such mechanisms are often a reflection of irrigation waters entering a groundwater system.	· Ongoing monitoring of pH, and close scrutiny of field physiochemical parameters. · Revisit investigation should increasing pH trend intensify	A new site-specific trigger for GW01 pH (7-9) was proposed within the 2023 GMMP update based on investigations determining natural water chemistry variation.
			16/08/2022	8.61					
			15/11/2022	8.73					
RB04	*Rangal Coal Measures*	pH	13/05/2021	8.59	4/03/2022	8.5	Exceedances are considered to be due to natural processes (calcite dissolution) within the formation that may be related to minor changes of the groundwater flow regime	· Ongoing monitoring of pH, and scrutiny of field physiochemical parameters. · Revisit investigation should increasing pH trend intensify	An inspection carried out in February 2022 indicated the surficial casing is in good condition and surface seal degradation is unlikely linked to pH change. A new site-specific trigger for RB4 pH (7-9) was proposed within the 2023 GMMP update based on investigations determining natural water chemistry variation.
			4/08/2021	8.75					
			14/12/2021	8.66					
			31/05/2022	8.62	17/02/2023		Exceedances are considered to be due to natural processes (calcite dissolution) within the formation that may be related to minor changes of the groundwater flow regime	· Ongoing monitoring of pH, and scrutiny of field physiochemical parameters. · Engage with the regulator to amend the trigger limit at this bore location to be site-specific	
			23/08/2022	8.74					
			12/11/2022	8.86					
			20/02/2023	9.22	13/11/2023		Chemistry change is likely to be driven by new water introduced into this area of the aquifer from the south.	· Engage with the regulator regarding observed processes and groundwater changes induced by surrounding water uses, with objective to agreeing on site-specific amendments to the trigger limit at this bore, following the DES, 2021 guidelines.	
			2/05/2023	8.75					
			16/08/2023	8.94					
			2/05/2023	8.75	21/12/2023				
			16/08/2023	8.94					
			13/11/2023	9.07					

5.0 Aquifer Connection Investigation

This section relates to the requirement for the GMMP report to investigate any interconnection, recharge, and direction of flow between the alluvial aquifer and the Permian Coal Measures, as outlined in condition I15.

5.1 Conceptualisation Summary

Previous conceptualisation work regarding the degree of connection between the river, alluvium and underlying hydrogeological units, has been carried out by AGE (2006), and SLR (2021, 2022a). The key elements established in these studies and referenced in the GMMP include:

- Lithological observations of the base of Nogoa River have identified lenses of aquitard material (clays) dividing the surface water areas from basal gravel layers that comprise the lower areas of this aquifer feature. The shallow silts and clays are anticipated to be partially isolating the Nogoa River, limiting discharge from the river into the basal sands and gravels. Discharges from groundwater to surface water may occur where intensive irrigation elevates local groundwater level, and these clays are absent or where the basal sands are exposed within the river (SLR, 2022c). The dominant disconnection between the surface water and the alluvium along much of the surface water reach is further supported by differences in salinity (SLR, 2022a) and groundwater level observations which show that there is no correlation between groundwater level and distance to river (SLR, 2021). A conceptual cross section of the alluvium and underlying consolidated rock mass presented in **Figure 5-1** shows these elements graphically.
- Drilling and monitoring within the alluvium show there are areas of inconsistent saturation that inhibit this regional flow direction on a local scale.
- Discharge out of the alluvium occurs via:
    - Evapotranspiration;
    - Flow laterally to the east out of Ensham Mine area;
    - Flow laterally where water table transected by Nogoa River as evidenced by springs;
    - Seepage at northern wall of Pit B and
    - Leakage to underlying Rangal Coal Measures locally where they sub-crop and are not inhibited by weathering profile unconformity.
- Recharge to the Rangal Coal Measures is understood to occur locally where they sub-crop into the overlying alluvium (in the area of EC14 and EC22) and where the coal measures outcrop into residual mine void (**Figure 5-1**). Recharge through vertical infiltration through Rewan Formation is not likely to be a significant contribution due to the low hydraulic conductivity of this unit (SLR, 2022a, 2022c)
- In the Ensham Mine area, discharge from Rangal Coal Measures is primarily through flow to underground mine void and dewatering system.

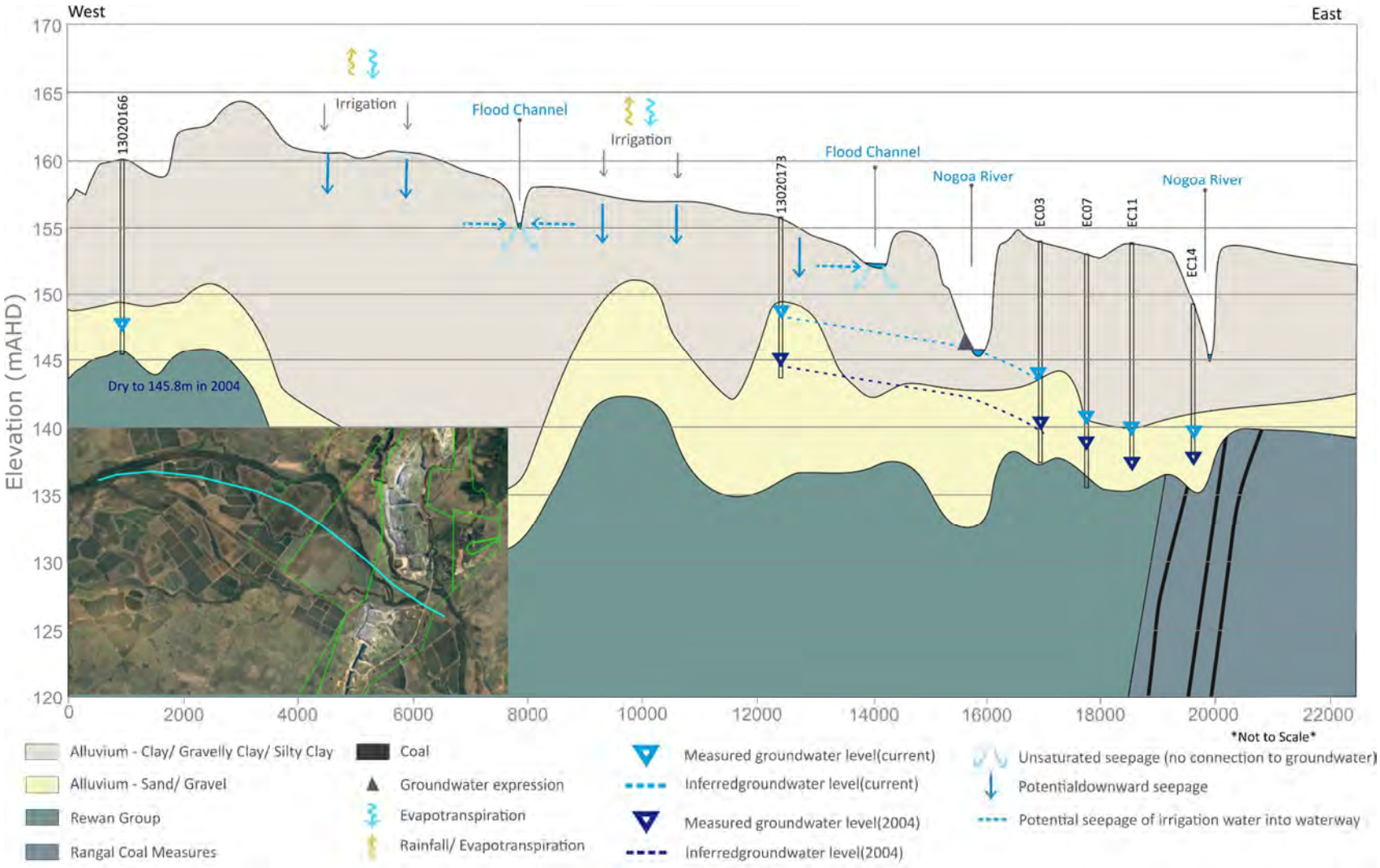


Figure 5-1 Conceptual Cross Section Through Nogoa River Alluvium and Quaternary Sediments (modified after SLR, 2022c)

5.2 Relevant Additional Data

The groundwater conceptual model of the connection between hydrogeological units has been most recently established in the GMMP completed Q4 2023, however all relevant groundwater data is included in the below review to establish if continuing mechanisms support the previous conceptualisation. The key aspects of this, as outlined above, are:

- Connection between the alluvium and the Rangal Coal Measures localised at the sub crop;
- Other areas, infiltration from overlying unconsolidated aquifer limited by low conductivity Rewan Group and other vertical impediments; and
- Low groundwater level in coal measures eliminates potential for discharge to alluvium.

Major ion analysis for water quality dataset is examined to establish the degree of similarity in water-type dominance and dissimilarities in end-member concentrations between aquifers. Most alluvium bores are of sodium-chloride (Na-Cl) water-type dominance; however, several bores show increasing trends in magnesium and bicarbonate concentrations over time (**Figure 5-2**). Trends towards these end members likely reflect mixing in response to varying recharge sources in the natural environment. Similar to alluvium, bores screened within the deeper Rangal Coal Measures are of strong sodium-chloride (Na-Cl) water-type dominance, with significant development of the chloride end member, which is indicative of the units significant groundwater evolution (**Figure 5-3**).

In previous conceptualisation works, both rainfall and irrigation (from nearby agricultural sites) have been identified as significant recharge contributors to the alluvium aquifer. Surface water from MP7 has been plotted with alluvium groundwater samples in **Figure 5-2** to highlight potential geochemical indicators for connection between the Nogoa River and alluvium aquifer. As can be seen, the Nogoa River surface water samples share the same geochemical signature as bores 13020169 and EC14; with Field 5 Bore and GW01 trending towards this signature as well. As both 13020169 and EC14 are located in close proximity to Nogoa River, similar geochemical signatures may reflect limited interconnection between the river and the alluvium, through limited leakage and observed discharge. As for trends towards this signature for bores GW01 and Field 5 Bore; they are unlikely to reflect an interconnection between the river surface water and alluvium aquifer, and more likely to reflect increased use of irrigation water (which is sourced from the Nogoa River) instead. Field 5 Bore is located in the middle of irrigated cotton paddocks within metres of ditch drains, and GW01 is similarly close to irrigated areas.

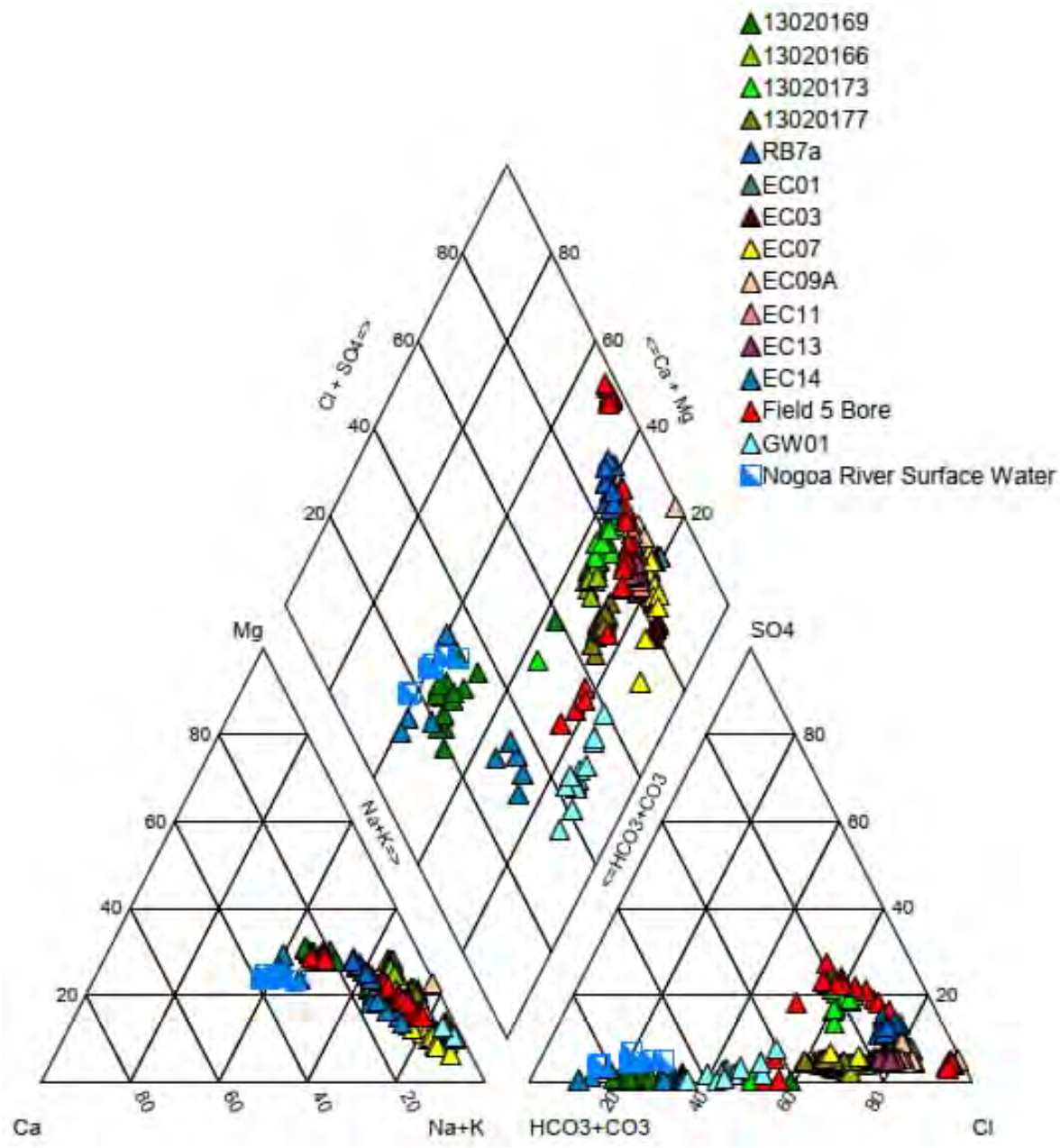


Figure 5-2 Alluvium Piper Plot

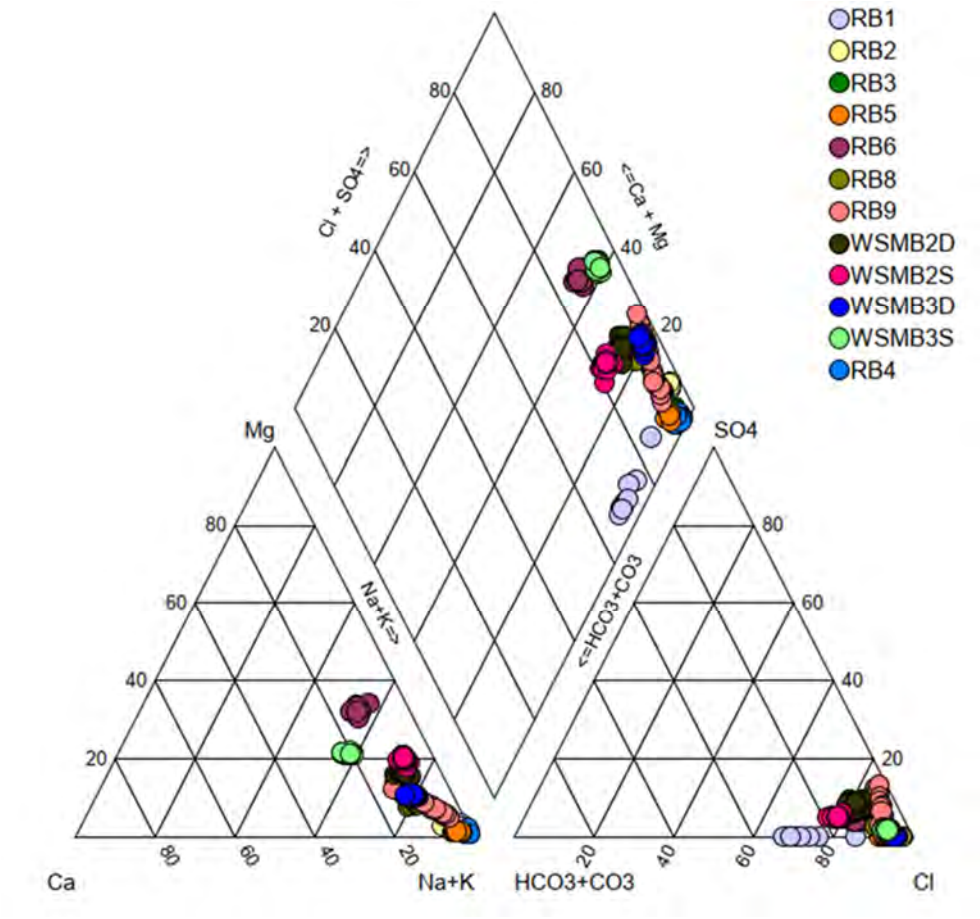


Figure 5-3 Rangal Coal Measures Piper Plot

Disconnection between the overlying alluvium and underlying coal measures is observed through water chemistry zonation that expresses as variability between monitoring datasets (as seen in **Figure 5-2** and **Figure 5-3)**. Lack of any strong trends towards the bicarbonate end member within the Rangal Coal Measures dataset indicates that very limited recharge is expected to occur via the alluvial aquifer. This limited leakage reflects low vertical hydraulic conductivity between the Quaternary and Permian aged aquifers; which has been previously conceptualised and attributed to the geology of the Rewan Formation. Consisting of interbedded siltstone and mudstone horizons, this unit has been conceptualised as a flow barrier between the overlying alluvium and underlying Rangal Coal Measures, where present.

The disconnection between the alluvium and Permian strata can be further demonstrated by comparing the groundwater levels; with no correlation observed between trends seen in the alluvium and trends seen in the deeper Rangal Coal Measures. For example, increasing trends within a majority of the alluvium monitoring bores as a result of irrigation from agricultural activities is not mimicked within the deeper Rangal Coal Measures bores. The majority of Permian monitoring bores are seen to be following a decreasing trend with time (likely reflecting depressurisation as a result of mining activities). That this is not observed in the alluvium aquifer indicates the effectiveness of vertical hydraulic disconnectors.

In summary, the recently collected monitoring data supports the previous conceptualisation of disconnection between the Nogoa River Alluvium and Rangal Coal Measures. No groundwater level drawdown has been observed in the Alluvium.

6.0 Groundwater Monitoring and Management Plan Review

This section relates to the requirement for the GMMP report to evaluate the GMMP (SLR, 2023) to assess its suitability and evaluate the program against the EA mandated objectives of the GMMP which are outlined in condition I9. **Table 6-1** presents these requirements and includes a reference to the section of the GMMP document where they are addressed.

Table 6-1 Condition I9 requirements and section of GMMP where these are addressed

Condition	Section of GMMP	Assessment
Condition I9: The Groundwater Management and Monitoring Program must be developed and implemented at all times mining activities, including rehabilitation, are being carried out to meet the following requirements:		
a) Identified all potential sources of contamination to groundwater from mining activities and rehabilitated areas	**Section 1.1** **Section 3.0** **Section 4.0**	Monitoring network sufficient, based on understanding of environmentally relevant activities on site and groundwater conceptualisation.
b) Provides a hydrogeological conceptual groundwater model that details the interactions and direction of flow between the Permian coal measures, the Triassic Rewan Group, the Quaternary alluvial aquifer and the Nogoa River system including its tributaries within a 5 km radius of the residual voids	**Section 2.0**	Conceptual model discussed in the GMMP and assessment as part of the monitoring data evaluation and aquifer connection investigation does not propose significant changes. GMMP conceptualisation is adequate.
c) identifies all environmental values (including the Nogoa River) that must be protected;	**Section 3.0**	Detailed discussion of GDEs including stygofauna included. No update required on GDE understanding.
d) details groundwater levels in all identified aquifers present across and adjacent to the site to confirm existing groundwater flow paths	**Section 2.0**	Sufficient data on groundwater levels in all aquifers. Discussed in **Section 3.0**.
e) estimates the groundwater inflow to any rehabilitated landforms and surface water ingress to groundwater from flooding events in the form of a groundwater model;	**Section 2.0**	Groundwater inflow data discussed in the GMMP document. No rehabilitation relevant to inflow calculations based on current site activities.
f) details a water balance model	**Section 2.0**	Water balance model included with model and up to date based on current understanding
g) ensures all potential adverse groundwater impacts due to mining and rehabilitation activities are identified, monitored, and mitigated	**Section 5.0**	Site activities and potential impacts assessed appropriately
h) ensures groundwater and stygofauna monitoring and data analysis is undertaken to:	**Section 3.2** **Section 5.0** **Section 6.2**	Stygofauna assessment, including potential harm vectors included in plan. Ongoing bi-annual monitoring

Condition	Section of GMMP	Assessment
(i) detect any impacts to groundwater levels due to mining and rehabilitation activities; (ii) detect any impacts to groundwater quality due to mining and rehabilitation activities; (iii) determine compliance with condition I1; (iv) determine trends in groundwater quality; and (v) detect any impacts to stygofauna communities due to mining and rehabilitation activities consistent with Table I3 – Stygofauna monitoring locations and frequency;		being carried out, though no new data was collected since the GMMP was updated.
i) provides an appropriate quality assurance and quality control program	**Section 5.0** **Section 6.1.1**	Detailed quality assurance/quality control program is described.
j) documents groundwater management and monitoring methodologies undertaken for the duration of all mining activities and rehabilitation activities; and	**Section 5.0** **Section 6.2** **Section 8.0**	Groundwater monitoring details adequately described and followed.
k) includes a review process to identify improvements to the program that includes addressing any comments provided by the administering authority.	**Section 5.0**	Review process outlined in GMMP and followed in this document.

7.0 Conclusions

7.1 Water Quality and Level Trends

Analysis of trends in the water level and water quality data have yielded the following conclusions:

- Wet conditions in 2022 have been significant influence on the groundwater system, with groundwater level rises and recharge introducing some water chemistry changes in the shallow monitoring locations.
- Intensive agricultural activities are having effect on the groundwater chemistry, with increased bicarbonate concentrations and decreased pH at some locations.
- Water storage in southern residual mining void increasing groundwater levels to the south. Beyond the groundwater level rise, there is no evidence of groundwater chemistry impact.
- Depressurisation due to underground mining observed at RB1, RB2, and RB3. The magnitude of drawdown is below the modelled prediction for the equivalent time period, indicative of the conservative assumptions used in modelling process.
- No depressurisation has been observed in Nogoa River Alluvium monitoring bores.

7.2 Aquifer Connection Investigation

Review of the conceptualisation of inter-aquifer connection between the Nogoa River Alluvium and the Rangal Coal Measures suggests that the recent groundwater monitoring data supports previous conclusions. There is likely to be recharge from the alluvium to the coal measures where they sub-crop at the base of the alluvium; however, disconnections in water level, differences in water chemistry, and lack of observed drawdown following excavation of mine void supports the conclusion that these recharge areas are spatially limited and the hydraulic barriers of Rewan Formation and weathering zone unconformities and effective at disconnecting these units.

7.3 Conceptual Model Revision

The analysis carried out as part of this assessment has not found any evidence or mechanisms that are not currently part of the conceptualisation for site. Previous reported groundwater processes are relevant and do not require revision at this time.

7.4 Assessment of GMMP

Cross-check of the GMMP against the required content has concluded that all aspects of the GMMP are appropriate. Actions to be completed in GMMP recommendations have not been actioned at this stage, due to the recency of the drafting. These are repeated in the below section; however, these are considered continuous improvement initiatives and the GMMP remains effective at managing the risks of environmental harm in its current form.

8.0 Recommendations

The following were the key recommendations made in the GMMP that relate to its effectiveness to detect potential environmental harm:

- Re-development should be completed at RB9, RB10 and EC24 to confirm that the groundwater chemistry observed at these sites is stabilized with local environment following potential influence during bore installation.
- RB10 and EC24 should not be included trigger until at least 4 samples have been collected following re-development process. At this point a review should be conducted to assess their suitability as groundwater quality trigger locations.
- Trending pH data has led to exceedances of existing trigger levels for GW01 and RB04. Investigations have concluded that pH rise at RB4 is unlikely to be connected to mining activities; with chemistry change likely driven by new water introduced into this area from the south (SLR, 2023), and GW01 pH trend related to increased agricultural activities to the south of the bore (SLR, 2022a). As the trigger limits proposed in the EA are not effective at highlighting potential mine influence, it is proposed that limit of 7 to 9 pH be adopted for RB4, with ongoing review. This review should include close quality assurance of field monitoring data to confirm reliability of sampling data collection, in consideration of potential pH sensor calibration issues.
- Though no water level trigger values are proposed for these locations, it is recommended that EC24 and EC26 are maintained in the monitoring program to detect short-term contribution of potentially mine affected water throughout mining and rehabilitation activities.

9.0 References

Allen, R.G., Pereira, L.S., Raes, D. and Smith M. 1998. *Crop evapotranspiration - Guidelines for computing crop water requirements*. FAO Irrigation and drainage Paper 56. Food and Agriculture Organization of the United Nations, p.300

ANZG 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Appelo, C.A.J., & Postma, D., 2005*. Geochemistry, Groundwater and Pollution* (2nd ed.). CRC Press.

Australasian Groundwater and Environmental (AGE) Consultants 2006, *Report on Ensham Central Project – EIA*, Groundwater Impact Assessment, Project No. G1258, Appendix C of EIS, February 2006.

Department of Environment and Science (DES). 2018. Monitoring and Sampling Manual Environmental Protection (Water) Policy 2009. Brisbane, QLD: Department of Environment and Science Government.

Department of Science (DES), 2021, Using monitoring data to assess groundwater quality and potential environmental impacts, Version 2, Brisbane, Australia: Queensland Government.

Habermehl MA, 1980, *The Great Artesian Basin, Australia.* BMR Journal of Geology & Geophys. 5, 9-38.

Jeffrey, S.J., Carter, J.O., Moodie, K.B. and Beswick, A.R. 2001. *Using spatial interpolation to construct a comprehensive archive of Australian climate data*, Environmental Modelling and Software, Vol 16/4, pp 309-330. DOI: 10.1016/S1364-8152(01)00008-1.

SLR Consulting (SLR), 2020, *Ensham Life of Mine Extension Project Groundwater Impact Assessment*, Prepared for: AECOM Australia Pty Ltd on behalf of Ensham. Ref: 665.ENS02.10000-R01-02, May 2020.

SLR Consulting (SLR), 2021, *Ensham Life of Mine Extension Project Groundwater Impact Assessment -Amendment*, Prepared for: Ensham Resources Pty Ltd. Ref: 665.ENS02.10202-R04-v1.0, August 2021.

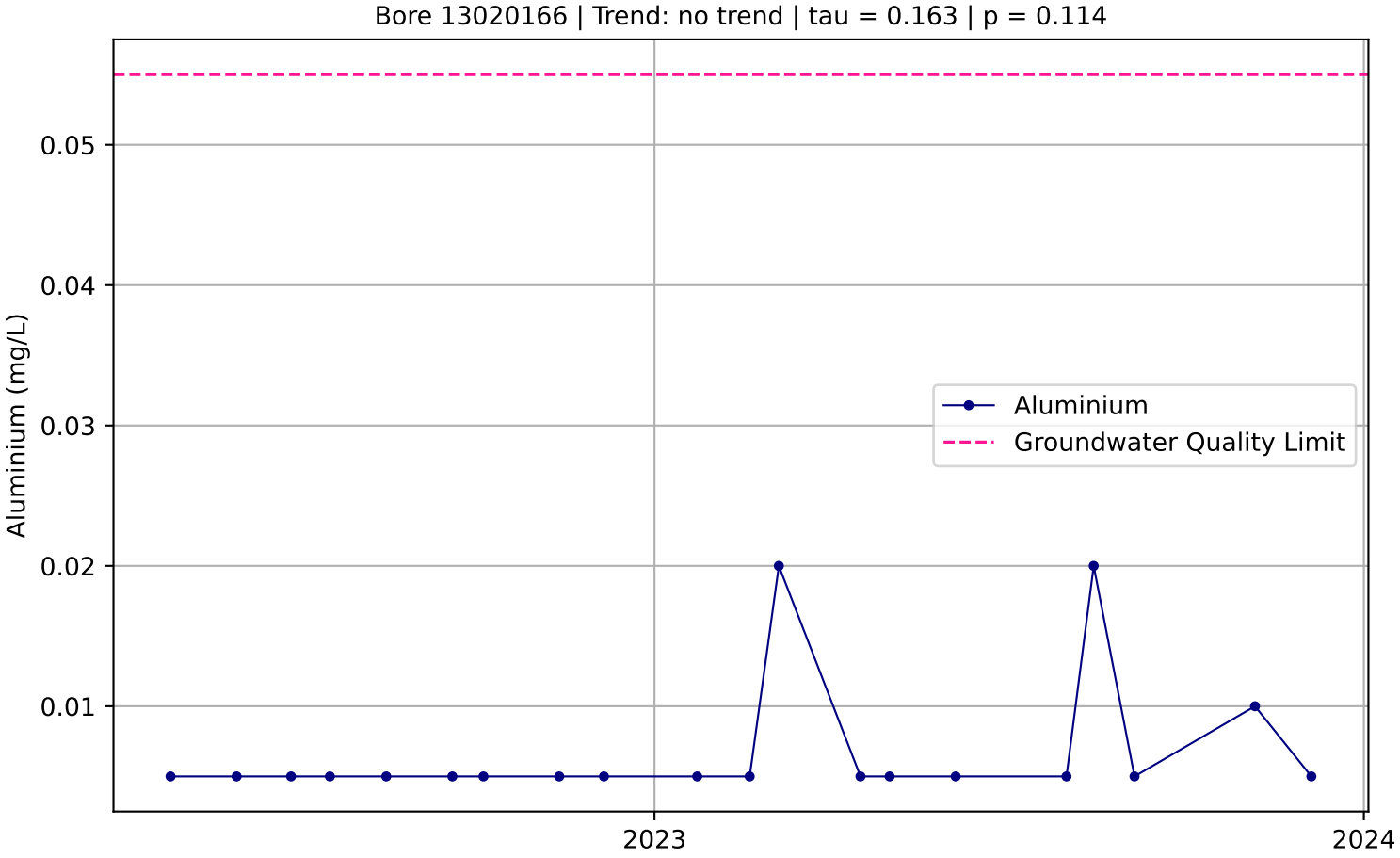
SLR Consulting (SLR), 2022a, Ensham Life of Mine Extension Project – ZONES 2 AND 3-Groundwater Impact Assessment, Prepared for: Ensham Resources Pty Ltd. March 2022.

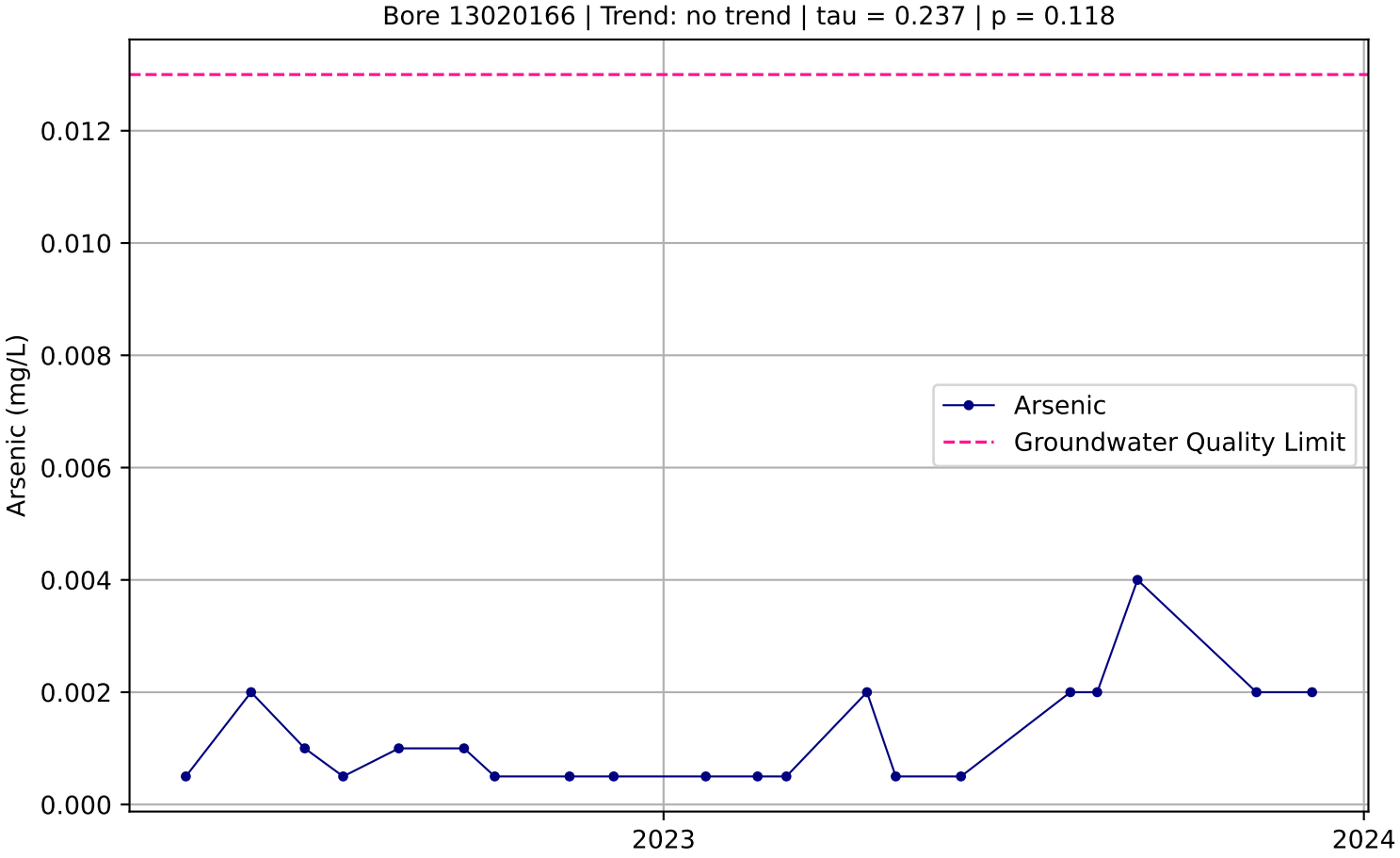
SLR Consulting (SLR), 2022b, *Ensham Life of Mine Extension Project – Zone 1 Water Balance*. Prepared for Ensham Resources Pty Ltd. October 2022.

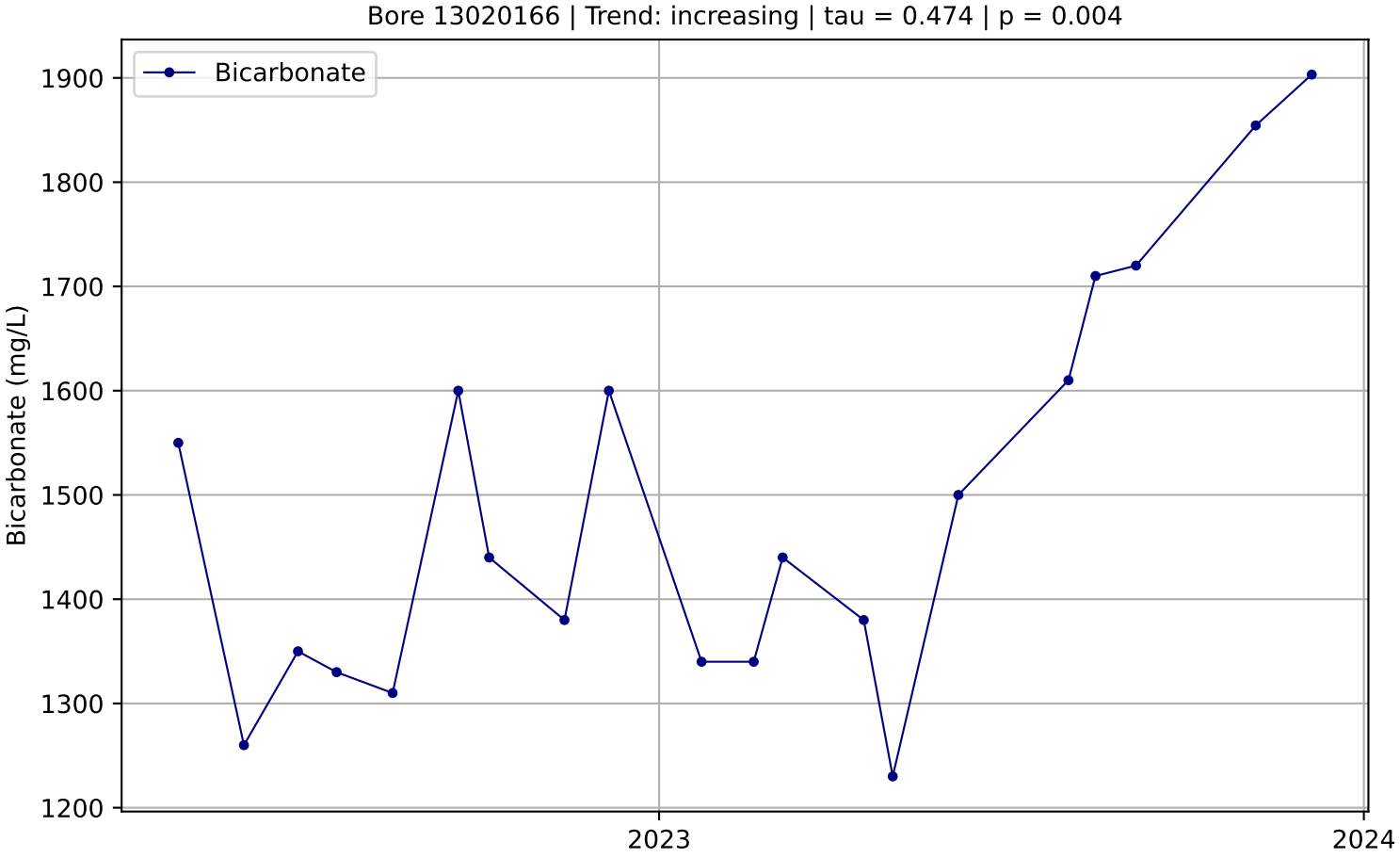
SLR Consulting (SLR), 2022c, Ensham Life of Mine Extension Project – ZONES 2 AND 3-Groundwater Assessment – Response to DES RFI 5, Prepared for: Ensham Resources Pty Ltd. June 2022.

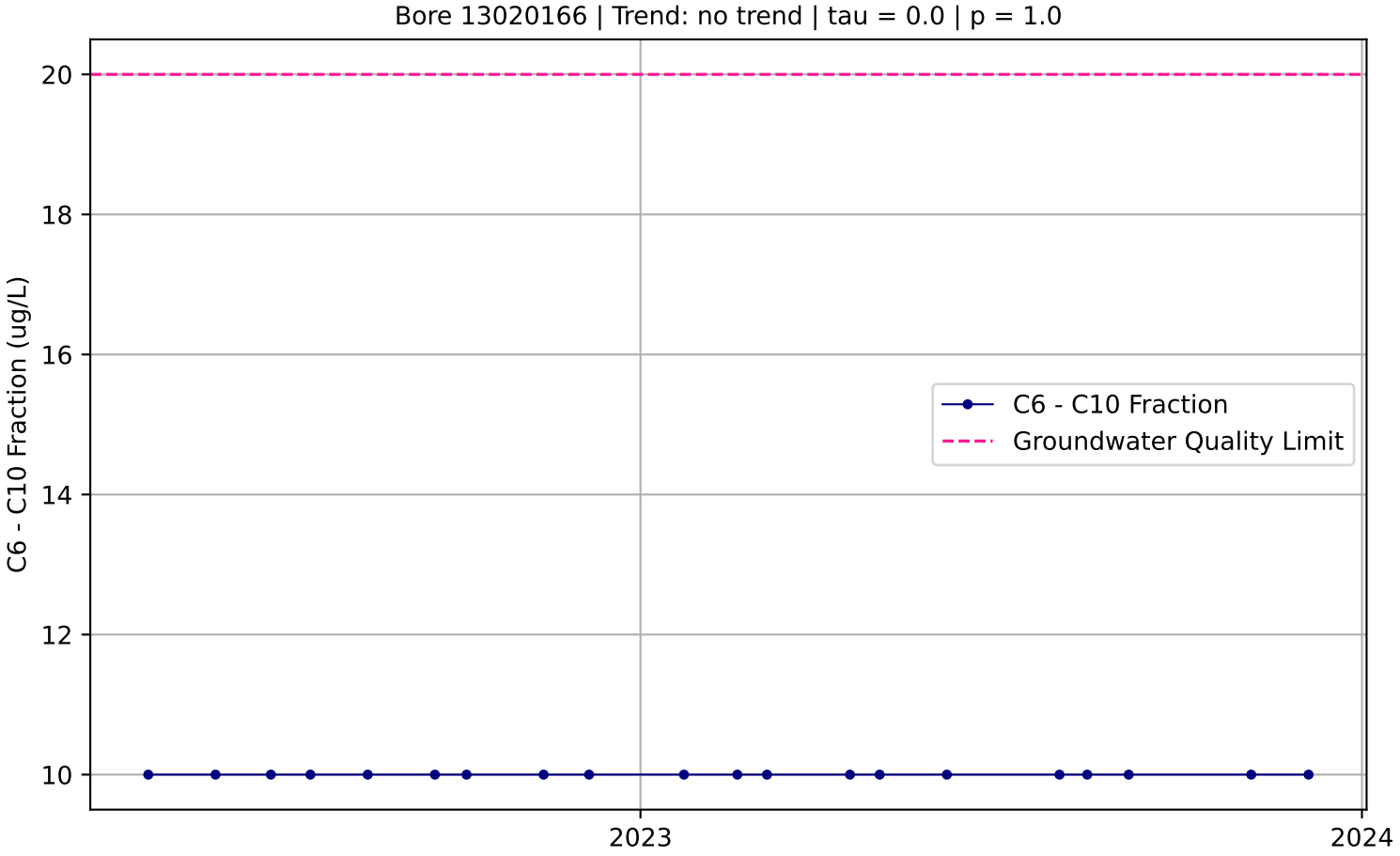
SLR Consulting (SLR), 2023, *Ensham Groundwater Monitoring Management Plan Update* - Prepared for: Ensham Resources Pty Ltd. Ref: 620.040310.00001-R01-v2.0, December 2023.

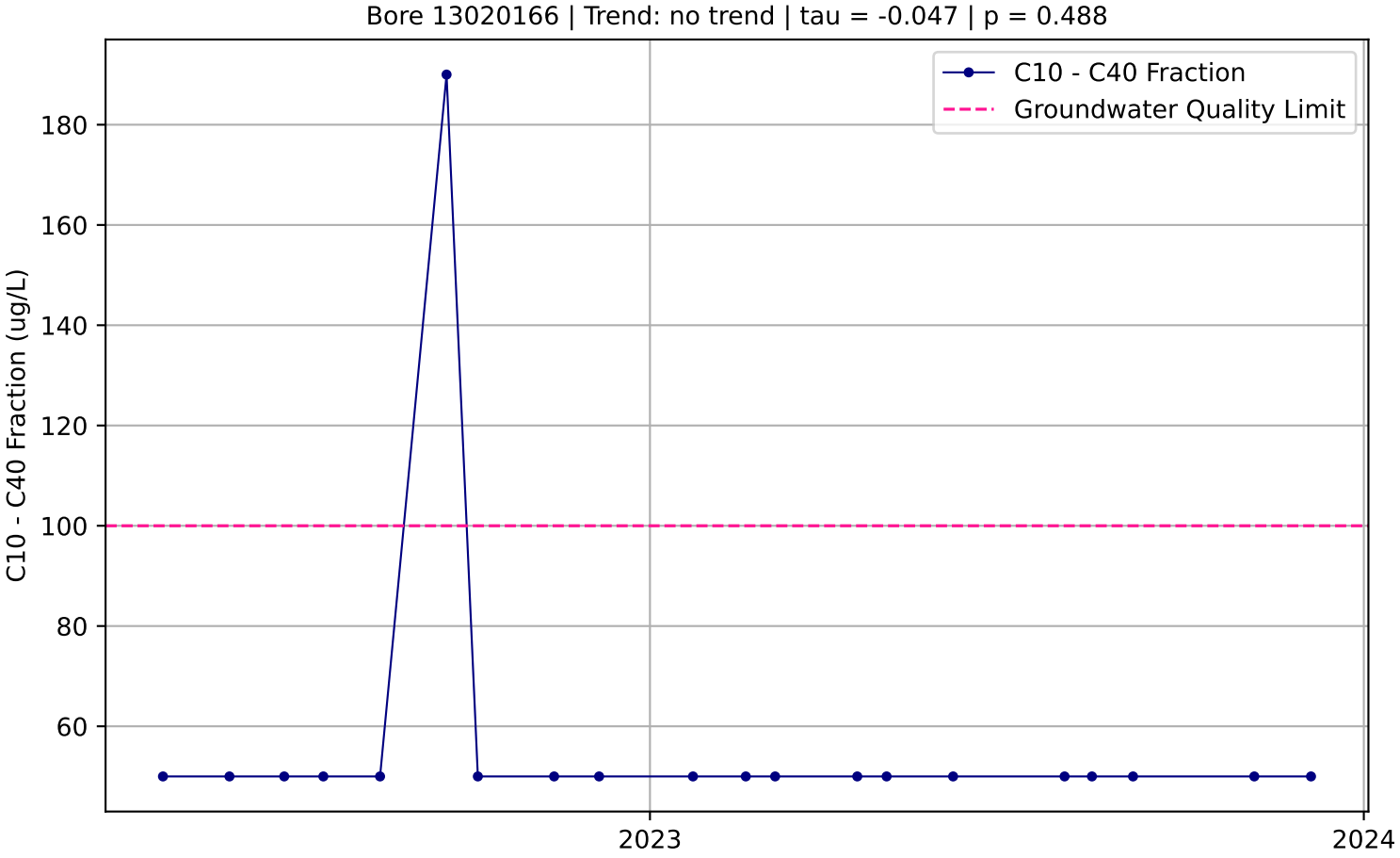
Appendix A Groundwater Quality Time Series Plots

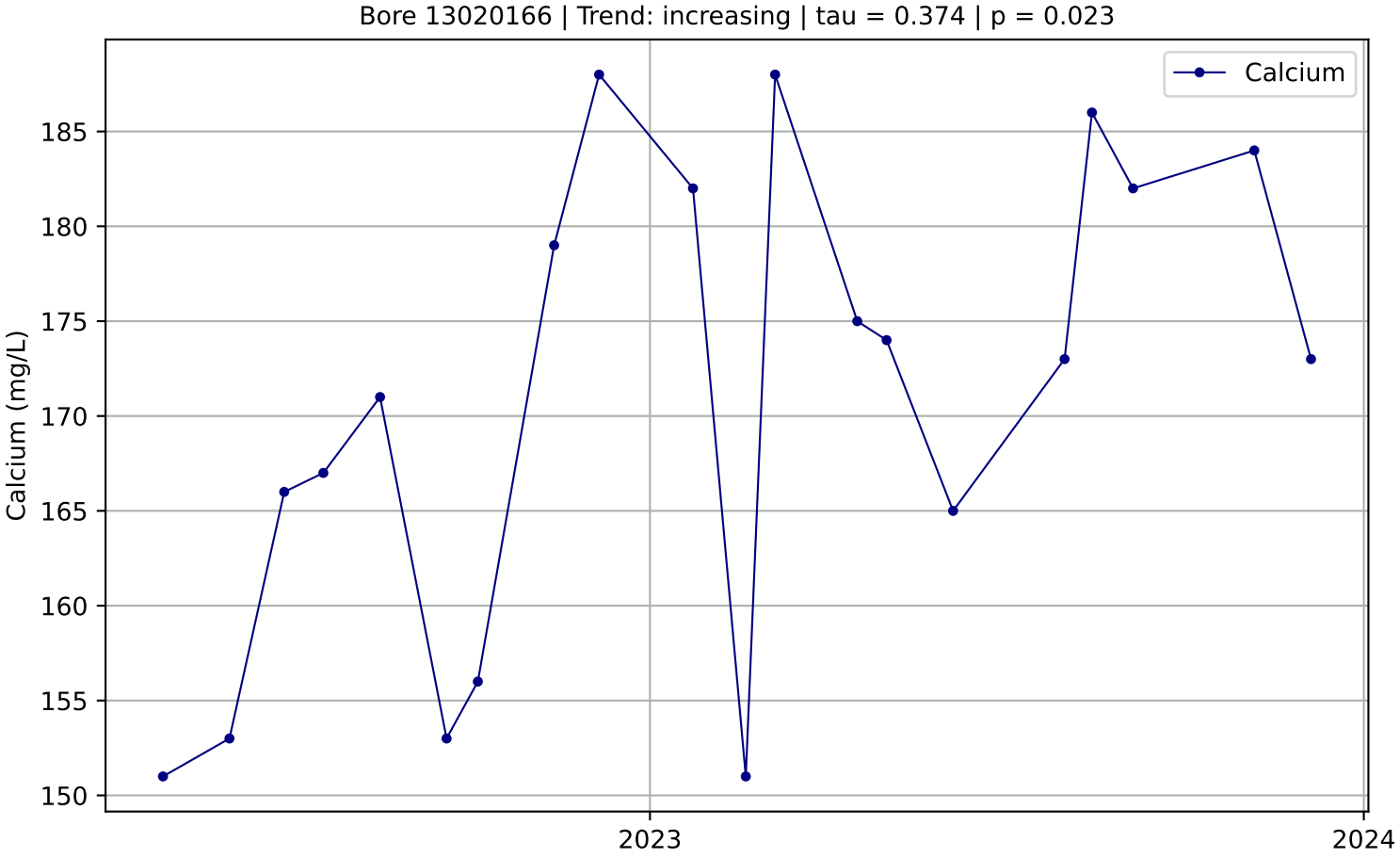

Bore 13020166 | Trend: no trend | tau = 0.163 | p = 0.114
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2023
2024
Aluminium
Groundwater Quality Limit

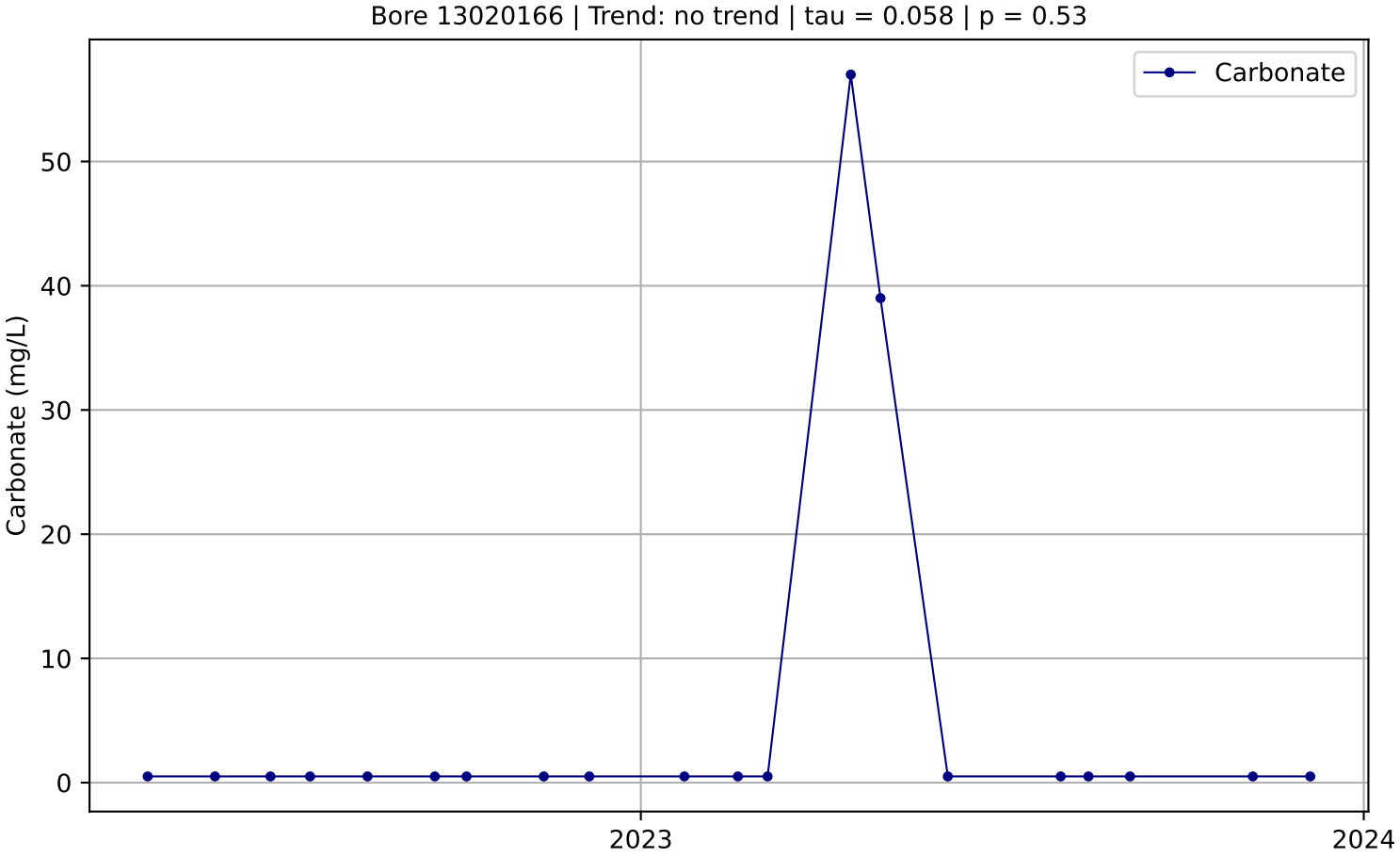

Bore 13020166 | Trend: no trend | tau = 0.237 | p = 0.118
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2023
2024
Arsenic
Groundwater Quality Limit

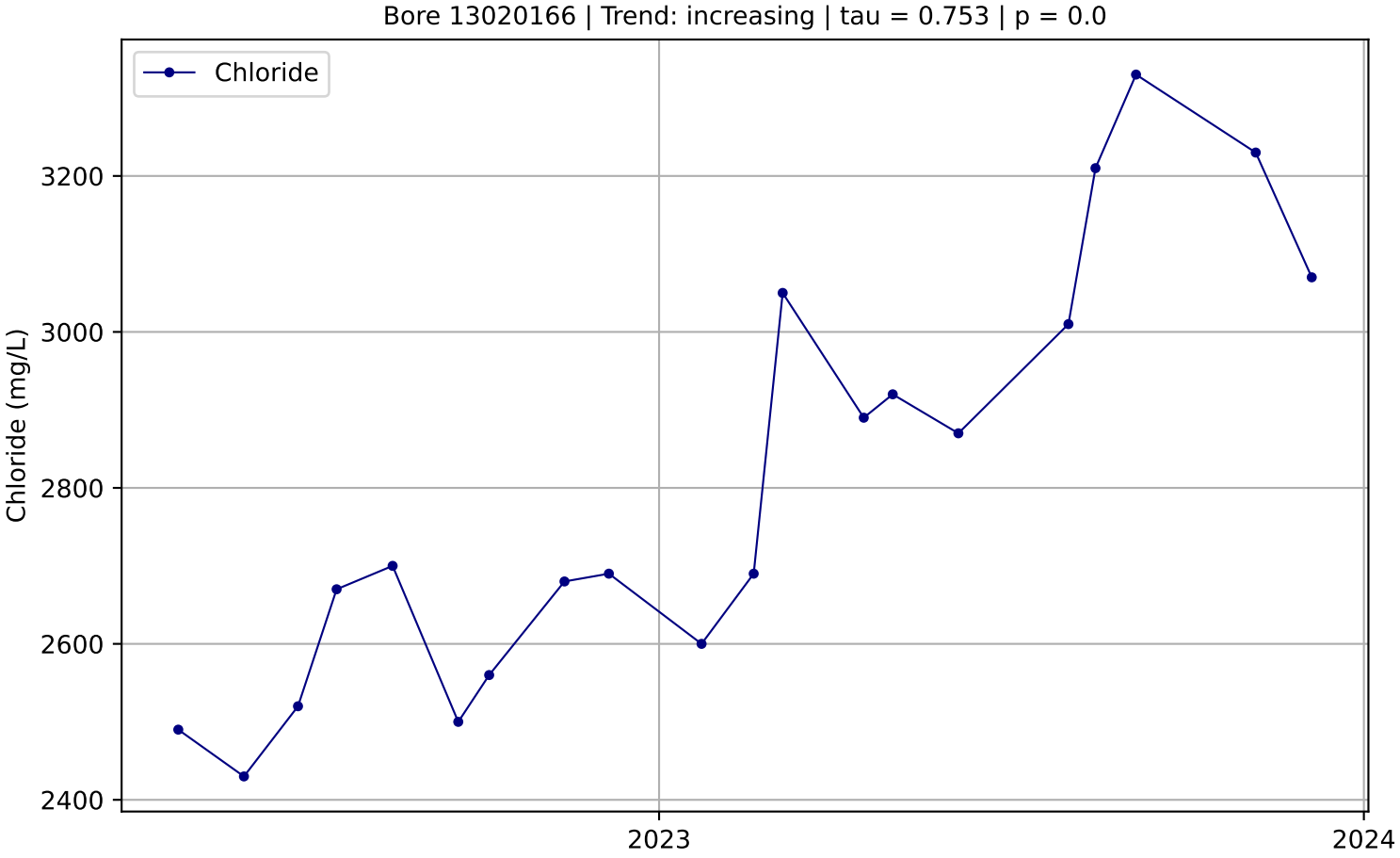

Bore 13020166 | Trend: increasing | tau = 0.474 | p = 0.004
Bicarbonate
Bicarbonate (mg/L)
1900
1800
1700
1600
1500
1400
1300
1200
2023
2024

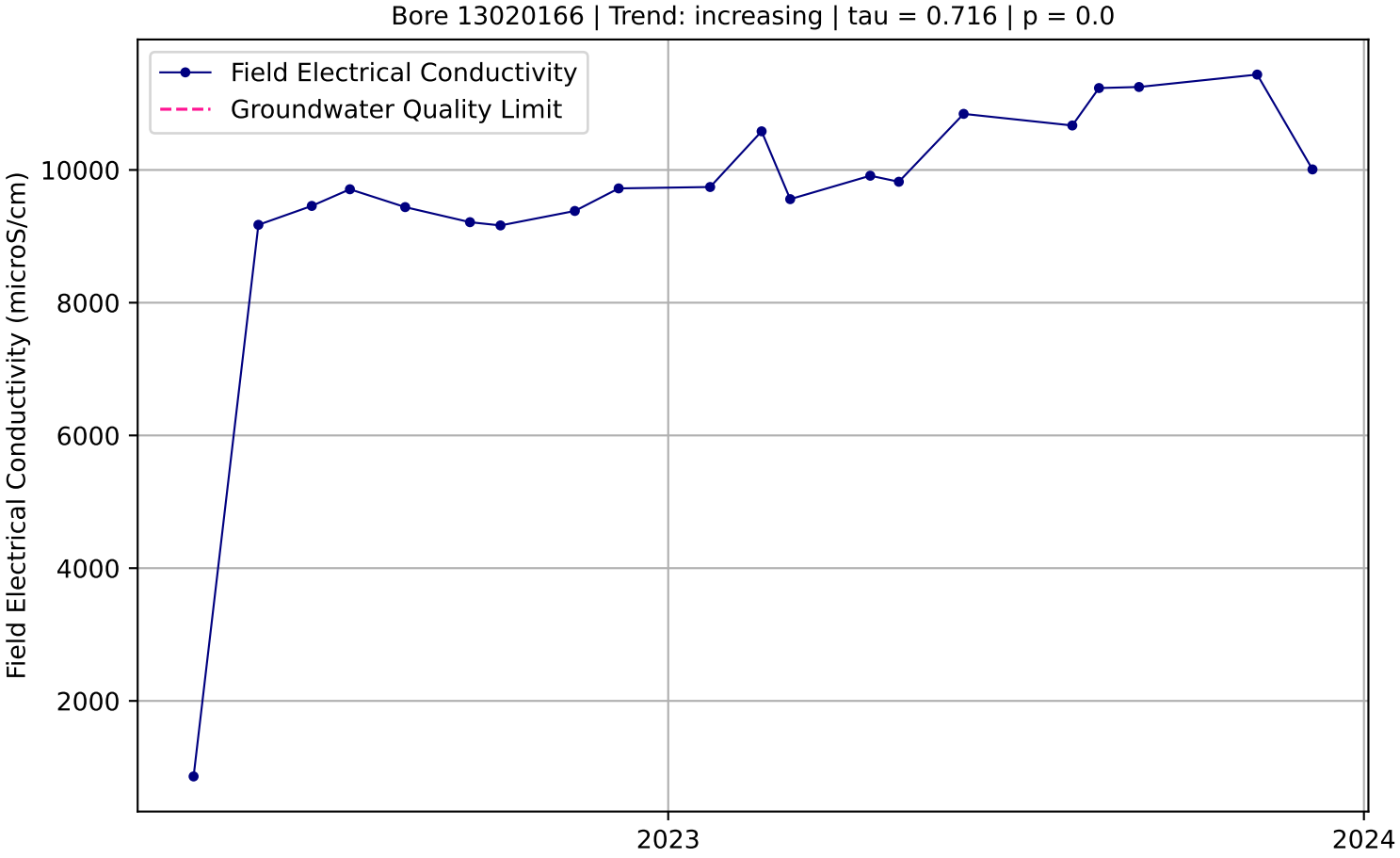

Bore 13020166 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

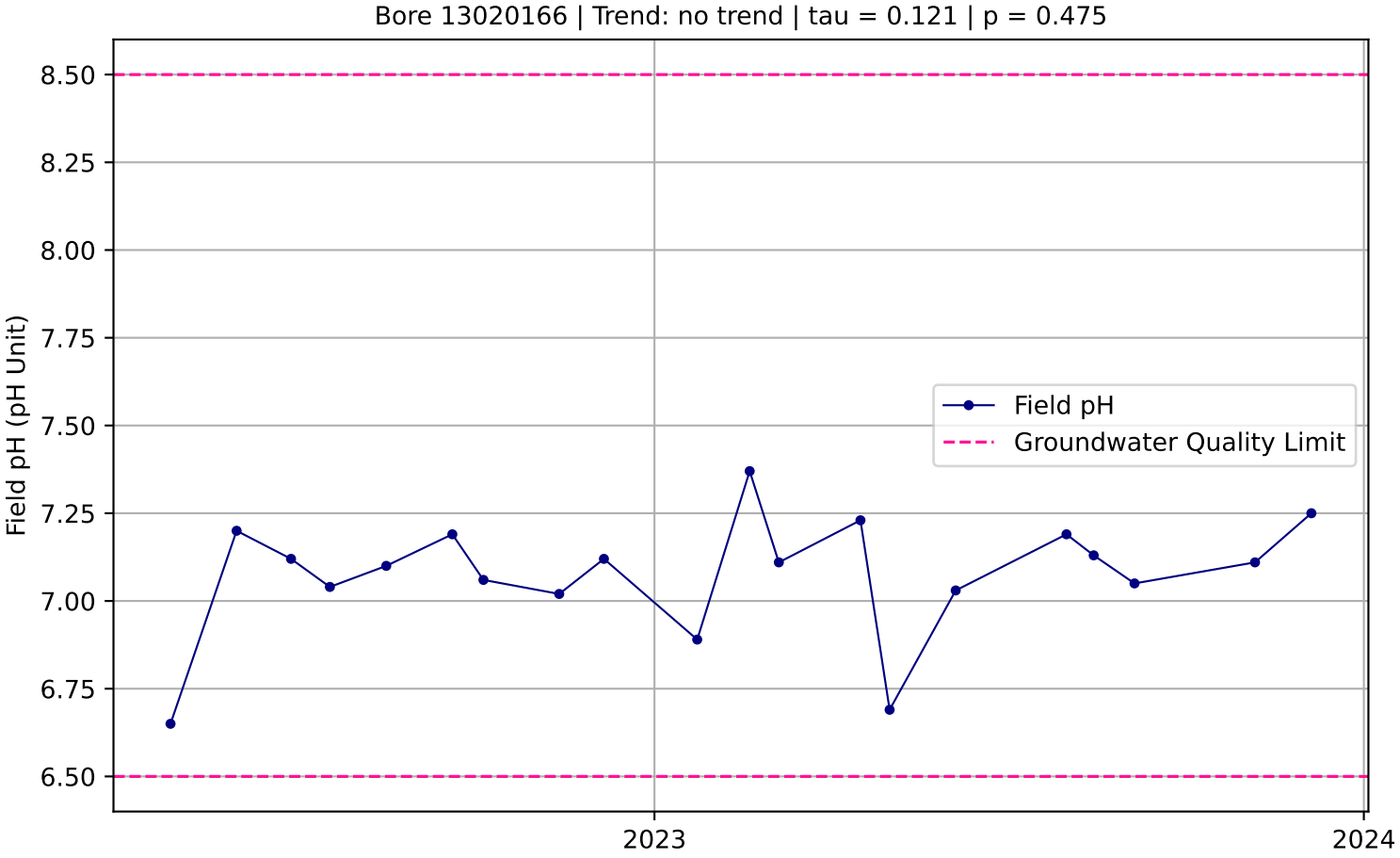

Bore 13020166 | Trend: no trend | tau = -0.047 | p = 0.488
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
180
160
140
120
100
80
60
2023
2024

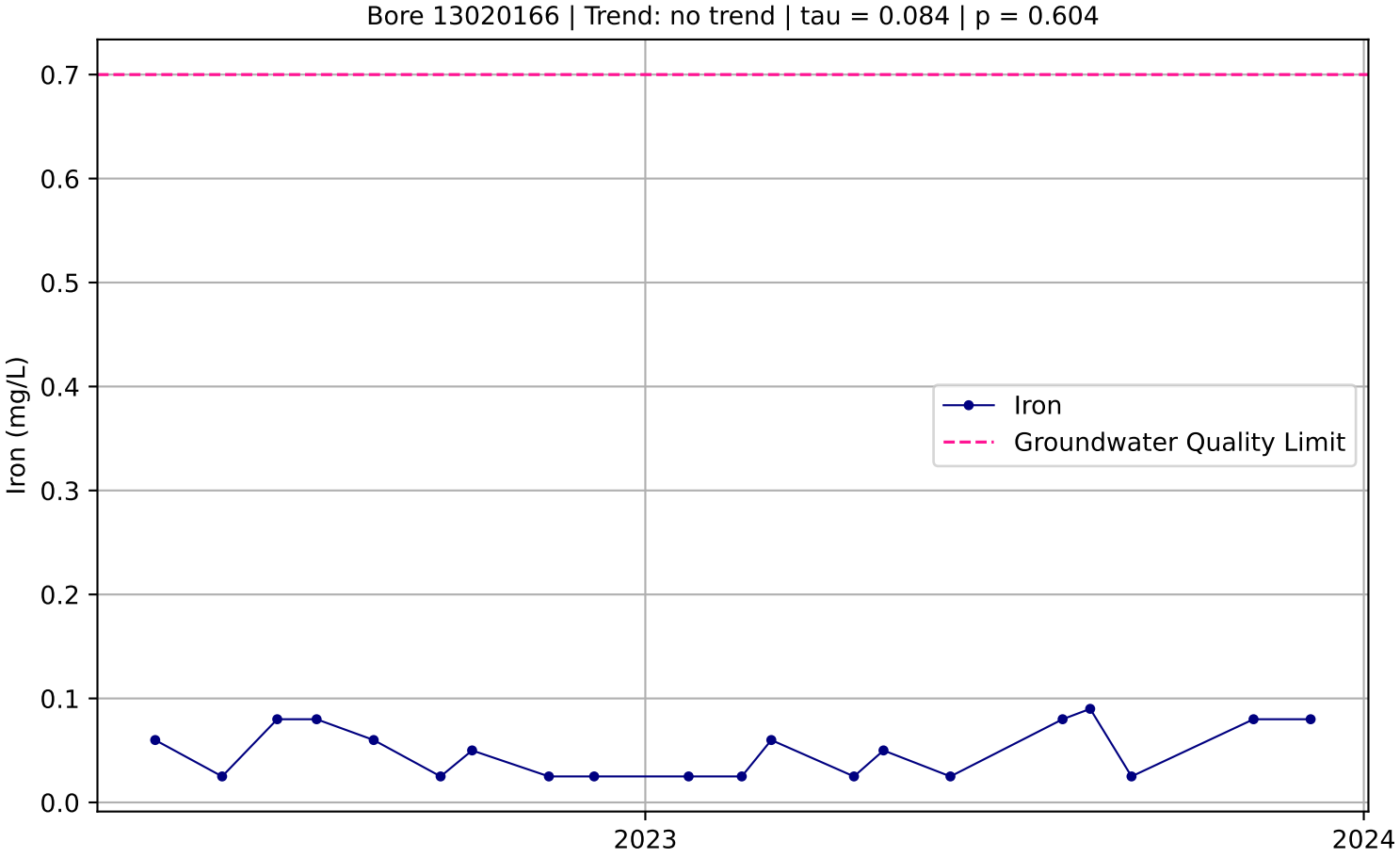

Bore 13020166 | Trend: increasing | tau = 0.374 | p = 0.023
Calcium
Calcium (mg/L)
185
180
175
170
165
160
155
150
2023
2024

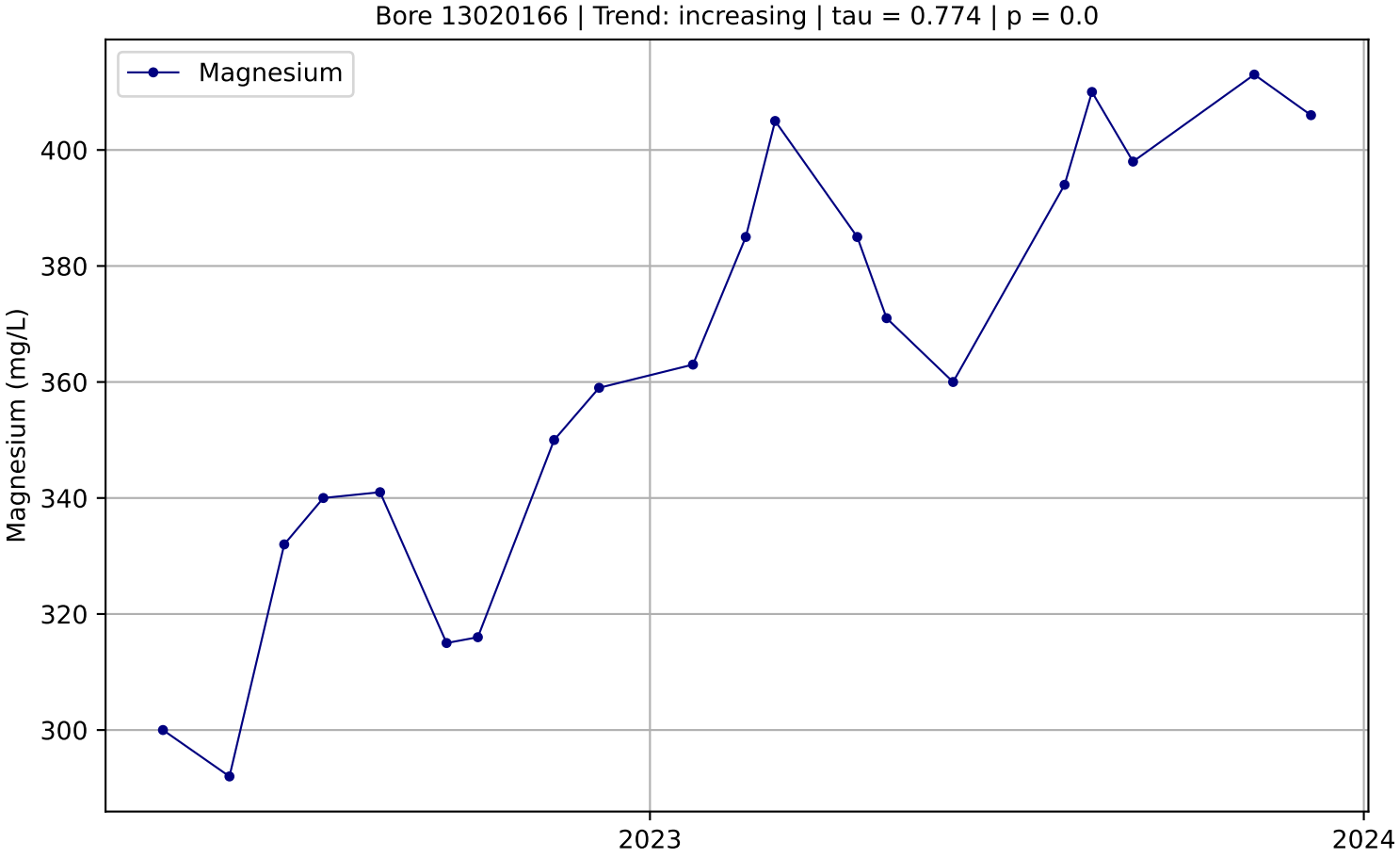

Bore 13020166 | Trend: no trend | tau = 0.058 | p = 0.53
Carbonate
Carbonate (mg/L)
0
10
20
30
40
50
2023
2024

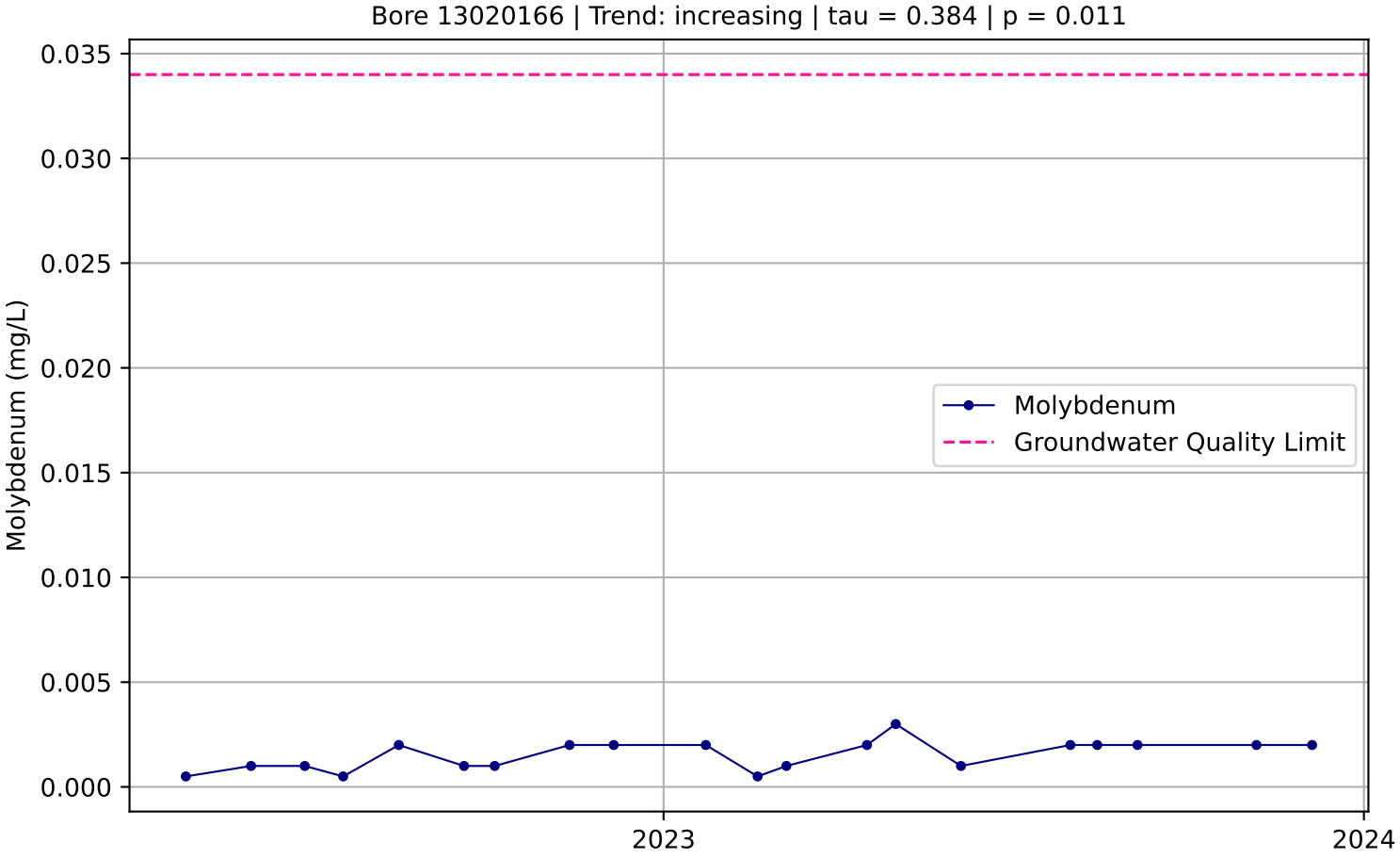

Bore 13020166 | Trend: increasing | tau = 0.753 | p = 0.0
Chloride
Chloride (mg/L)
3200
3000
2800
2600
2400
2023
2024


Bore 13020166 | Trend: increasing | tau = 0.716 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
10000
8000
6000
4000
2000
2023
2024

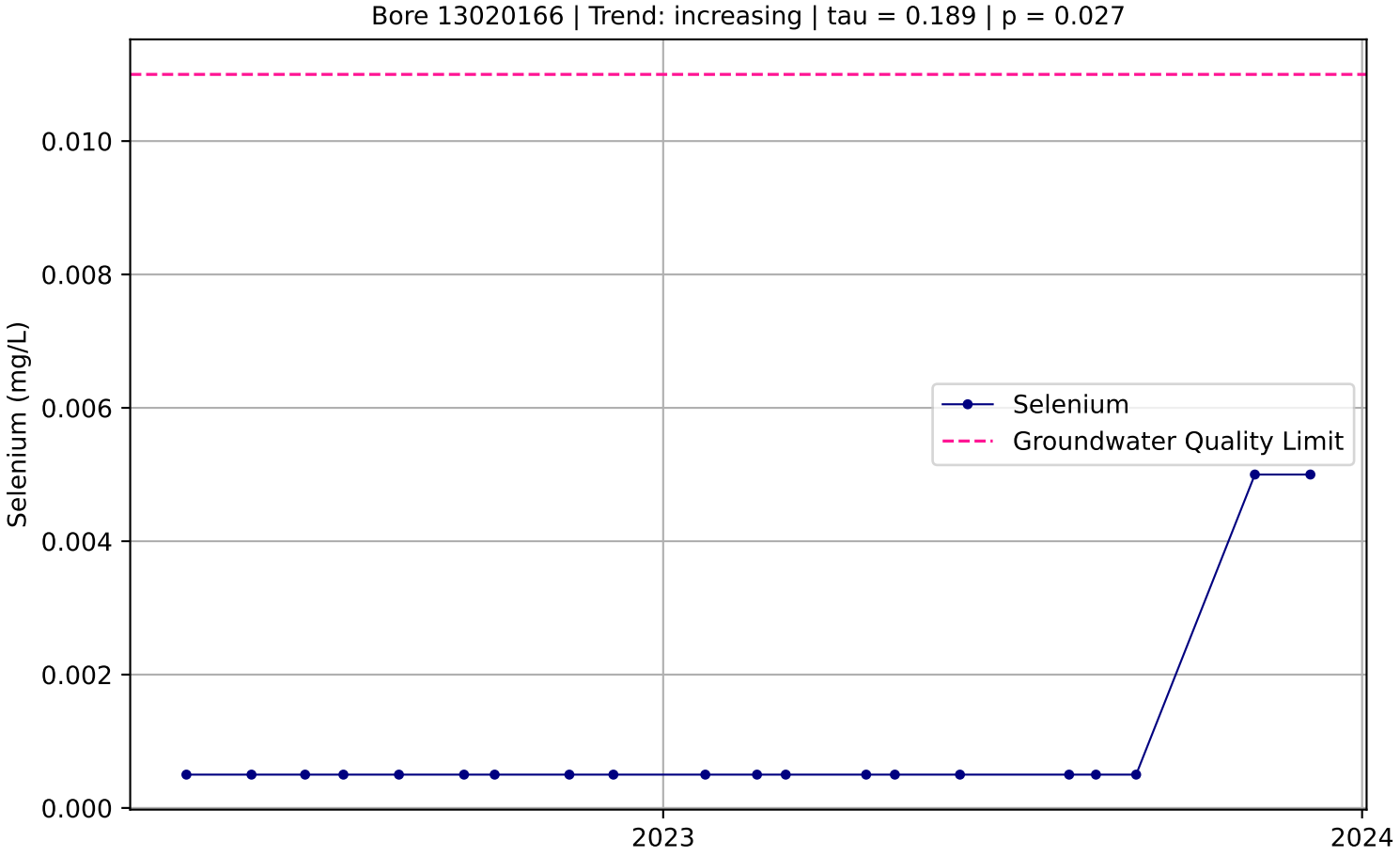

Bore 13020166 | Trend: no trend | tau = 0.121 | p = 0.475
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2023
2024
Field pH
Groundwater Quality Limit

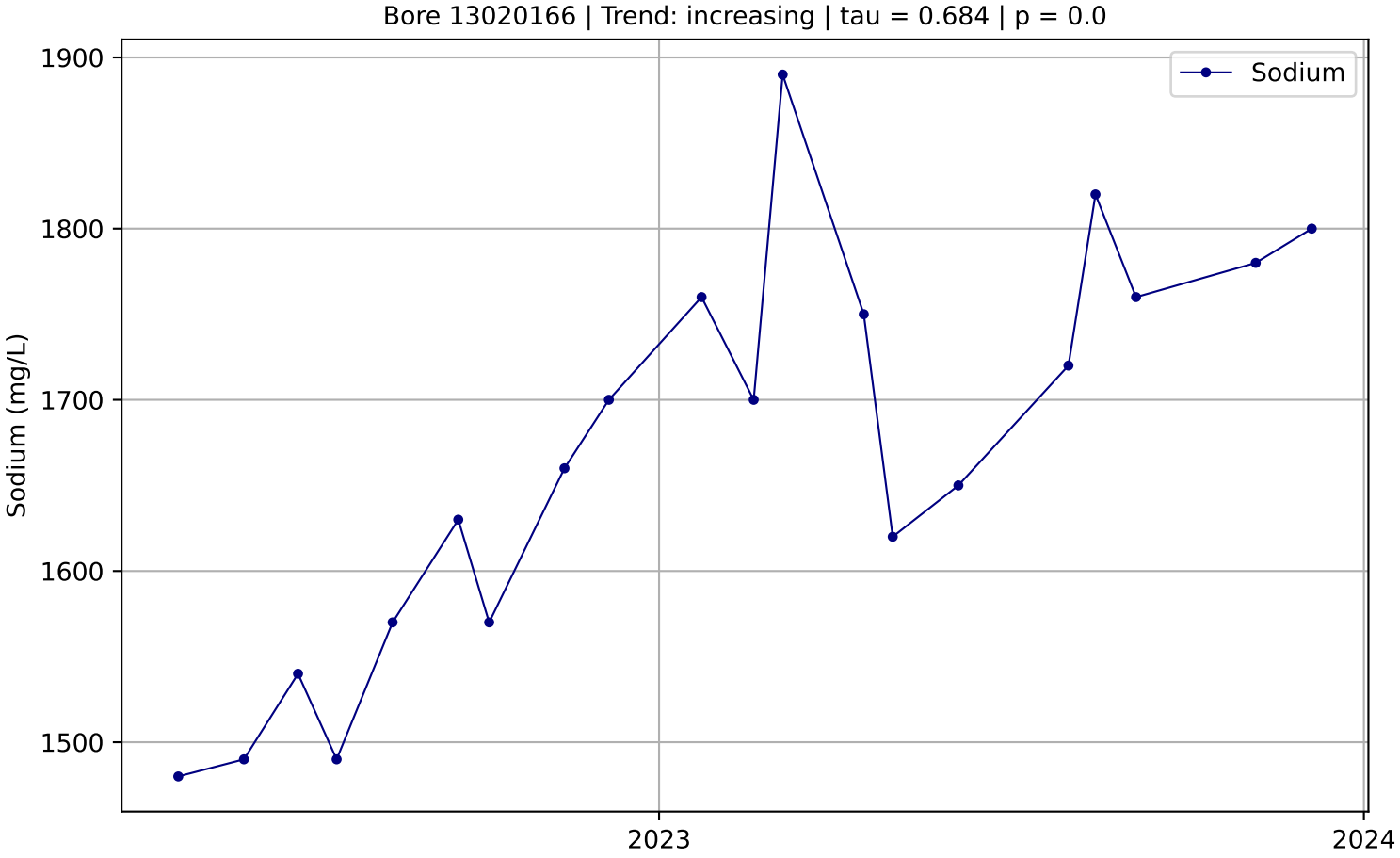

Bore 13020166 | Trend: no trend | tau = 0.084 | p = 0.604
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2023
2024
Iron
Groundwater Quality Limit

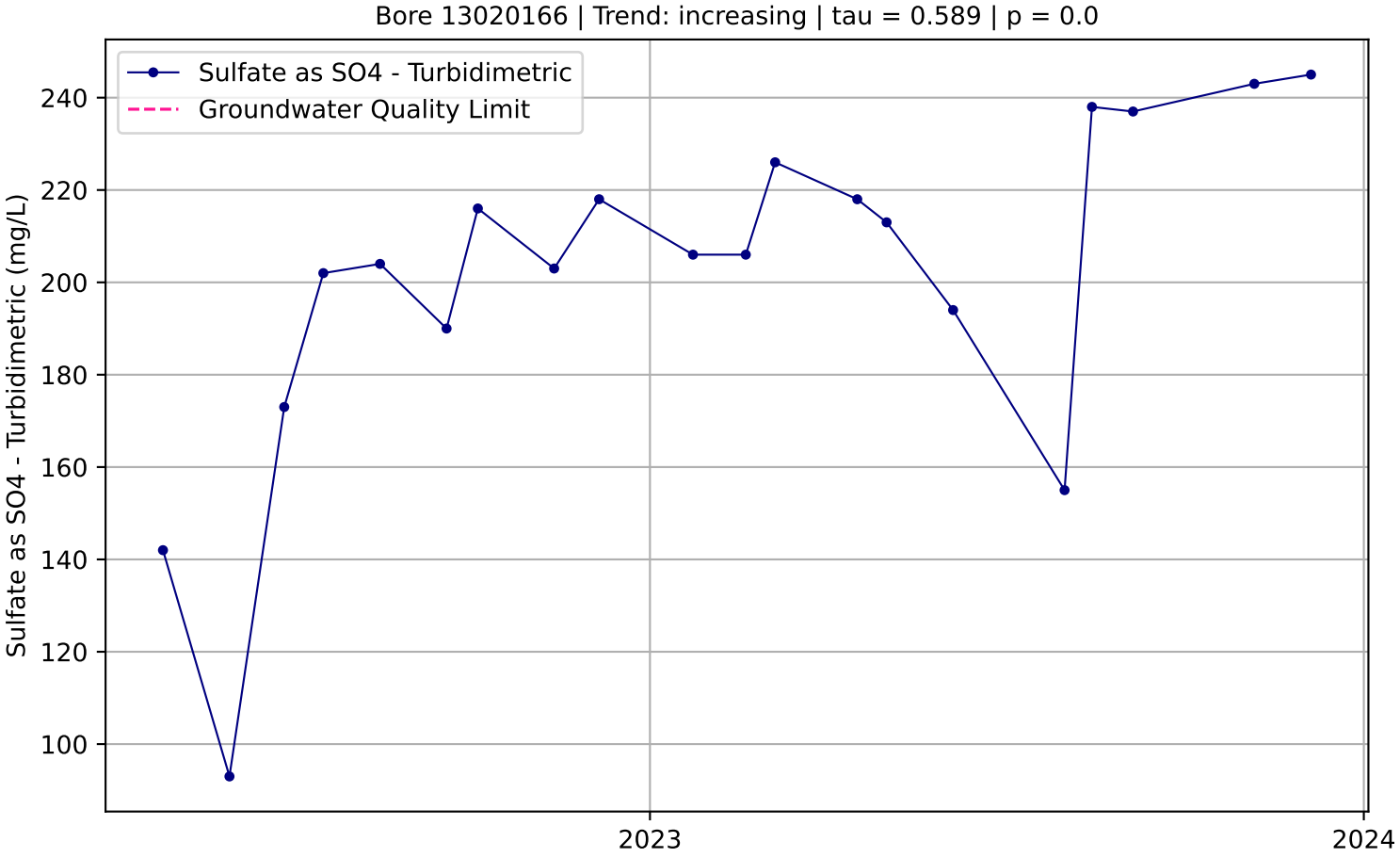

Bore 13020166 | Trend: increasing | tau = 0.774 | p = 0.0
Magnesium
Magnesium (mg/L)
400
380
360
340
320
300
2023
2024

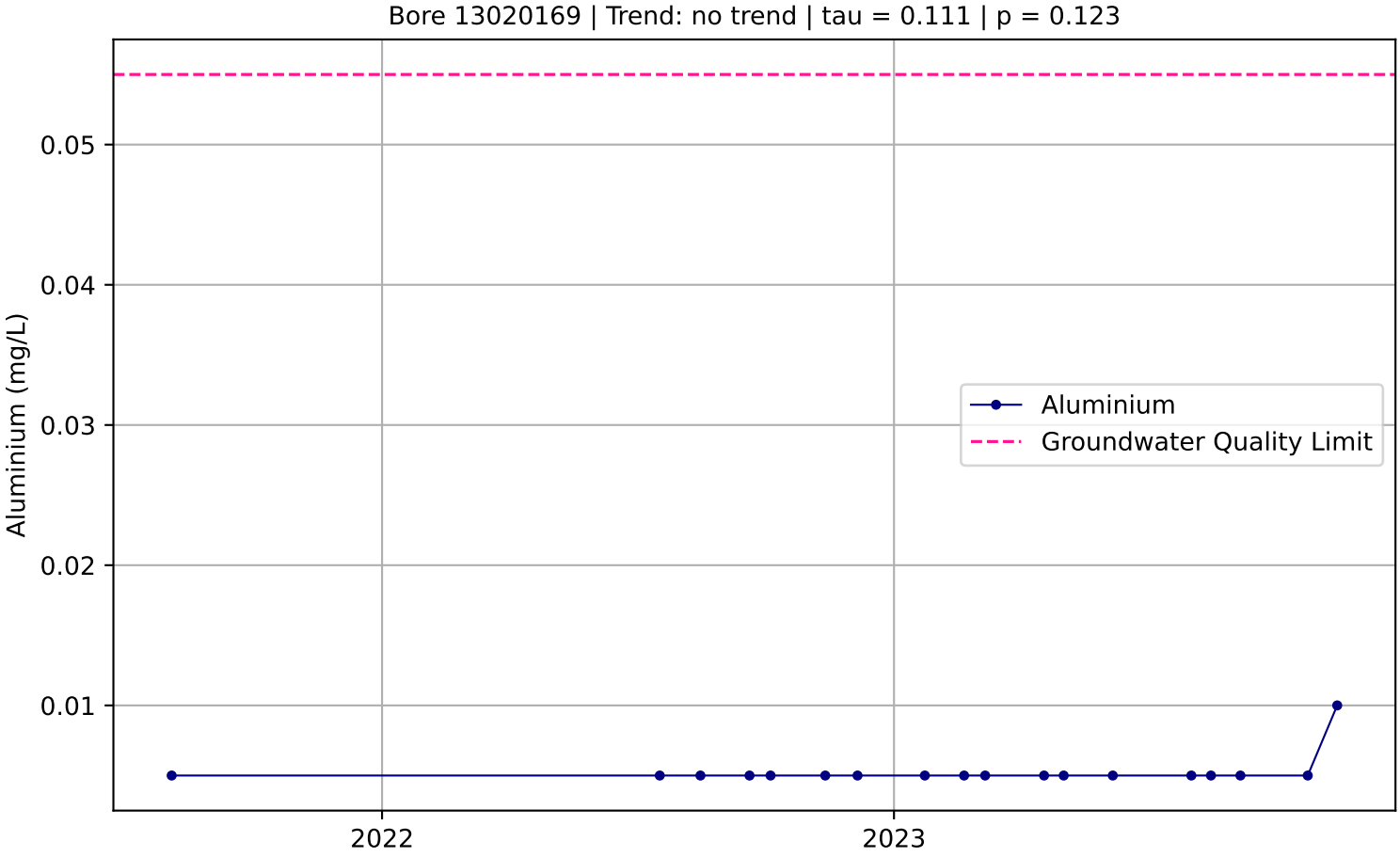

Bore 13020166 | Trend: increasing | tau = 0.384 | p = 0.011
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2023
2024
Molybdenum
Groundwater Quality Limit

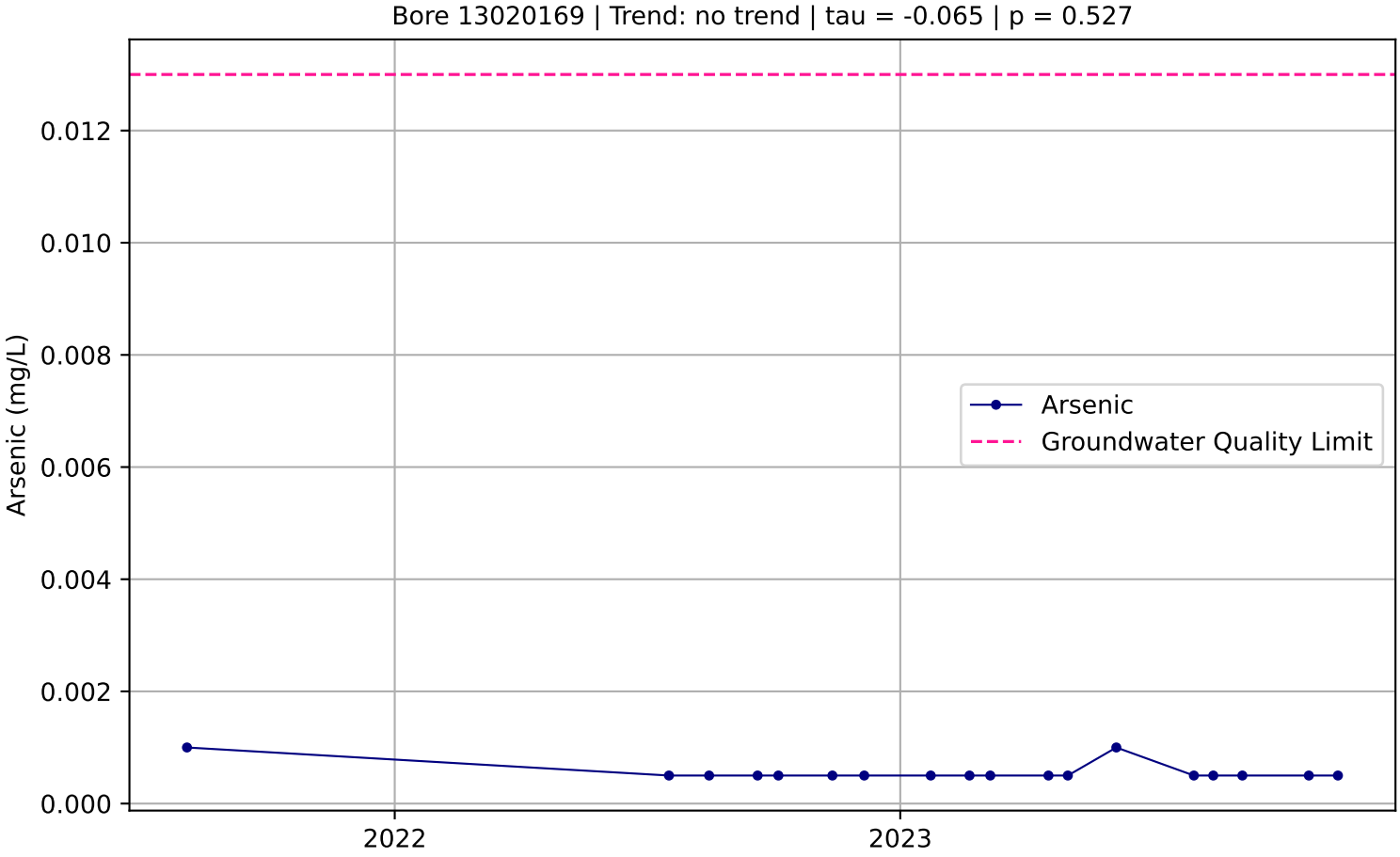
Bore 13020166 | Trend: no trend | tau = -0.084 | p = 0.609
Potassium
Potassium (mg/L)
10
9
8
7
6
5
2023
2024

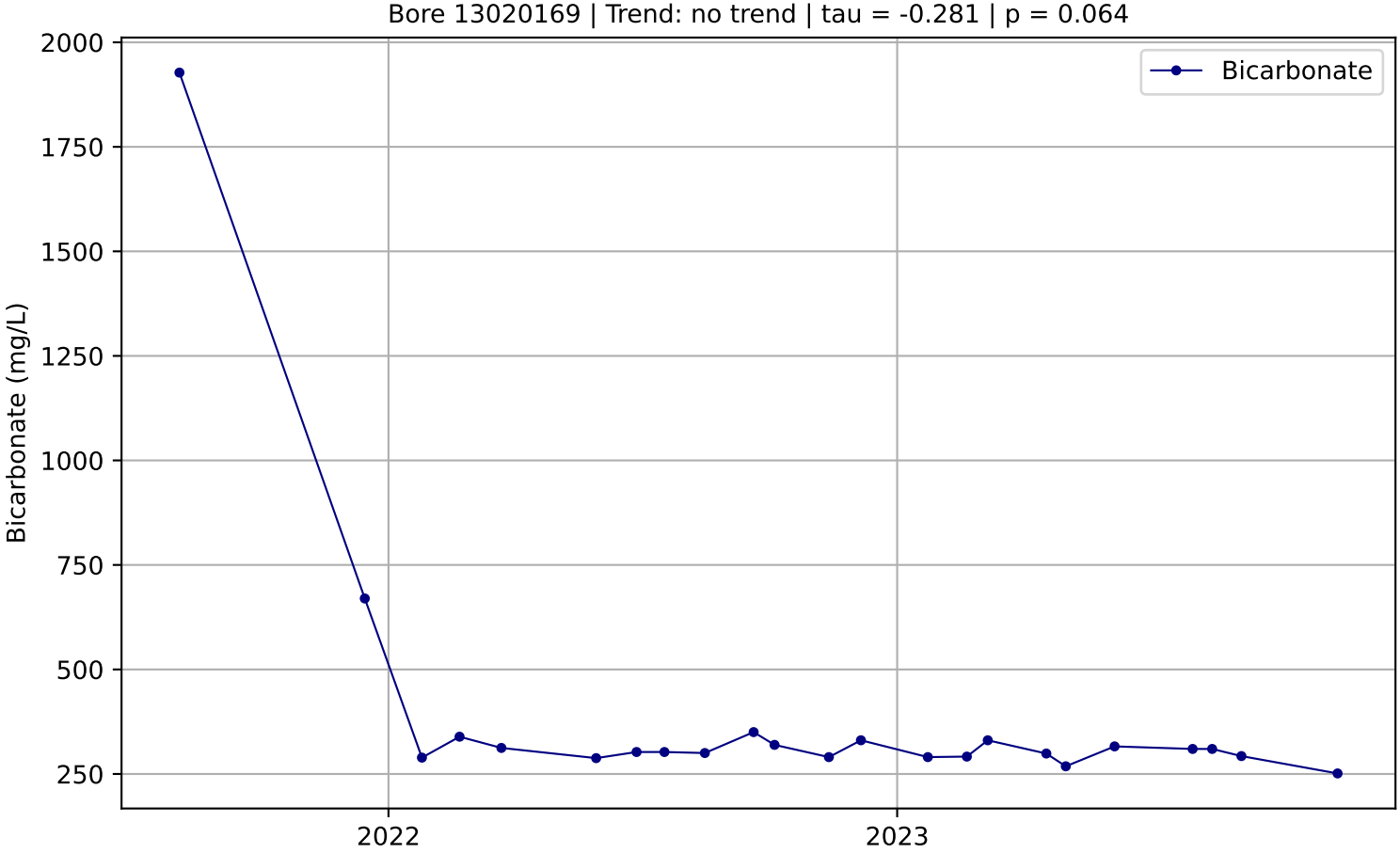

Bore 13020166 | Trend: increasing | tau = 0.189 | p = 0.027
Selenium (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
2023
2024
Selenium
Groundwater Quality Limit

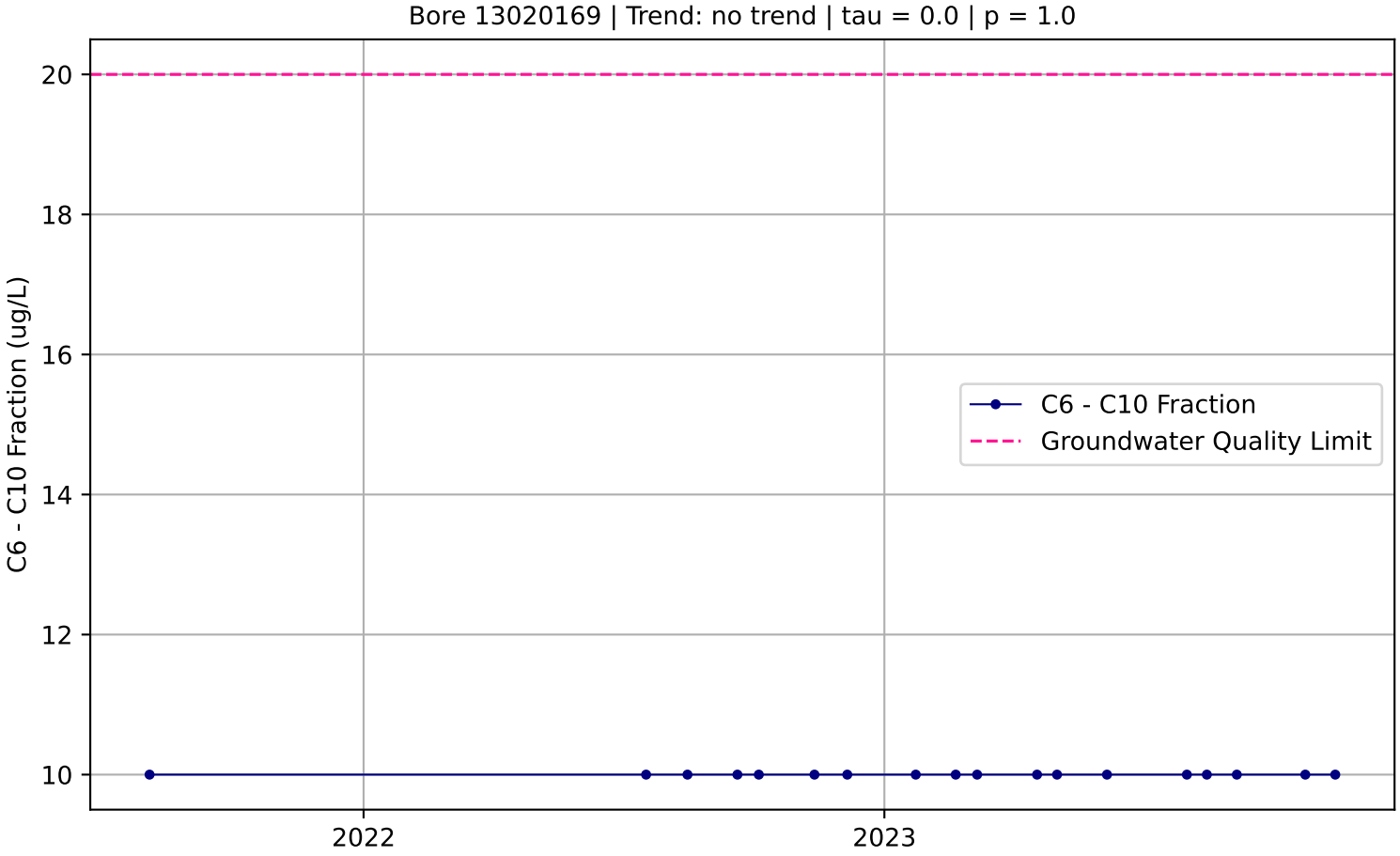

Bore 13020166 | Trend: increasing | tau = 0.684 | p = 0.0
Sodium
Sodium (mg/L)
1900
1800
1700
1600
1500
2023
2024

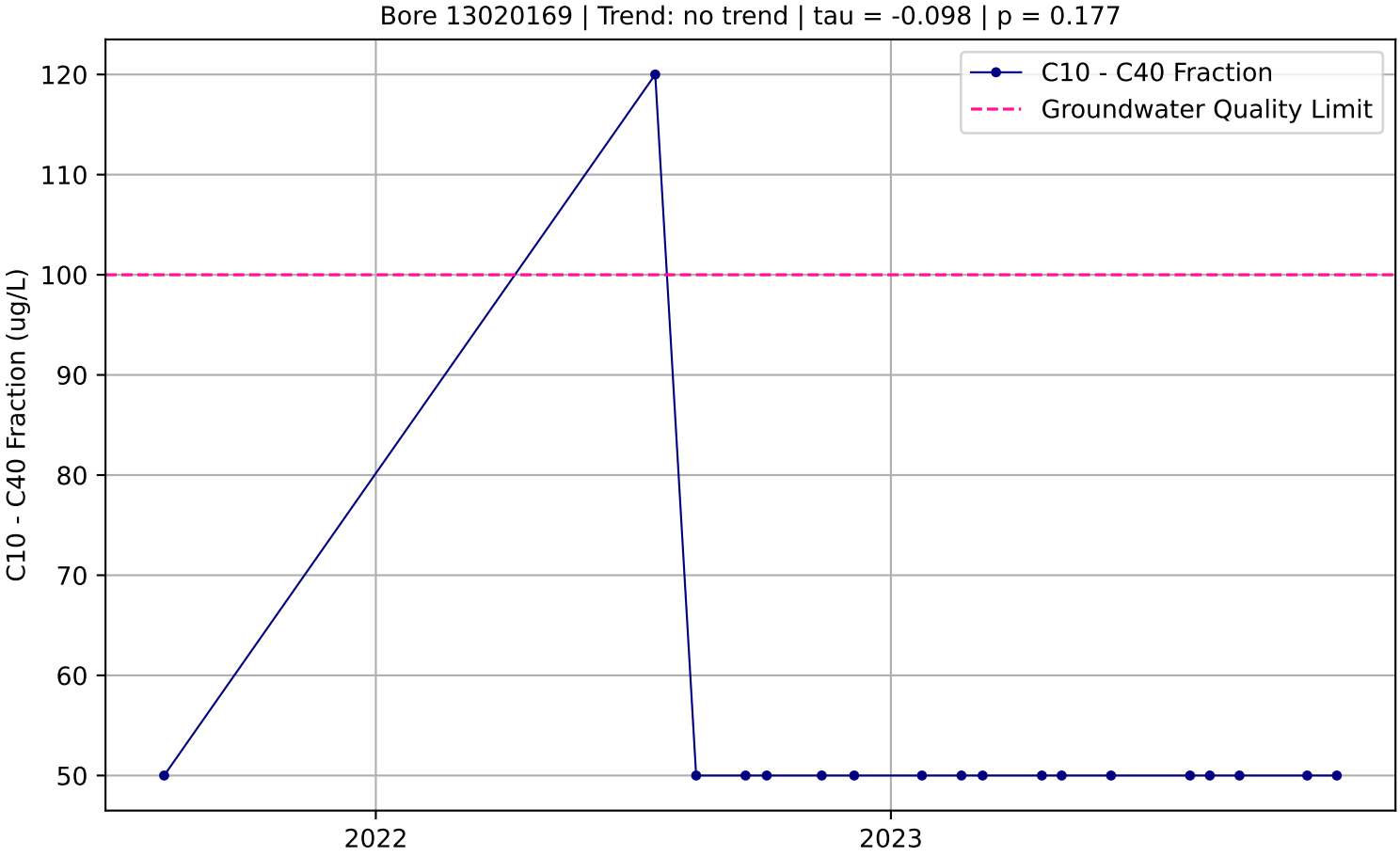

Bore 13020166 | Trend: increasing | tau = 0.589 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
240
220
200
180
160
140
120
100
2023
2024

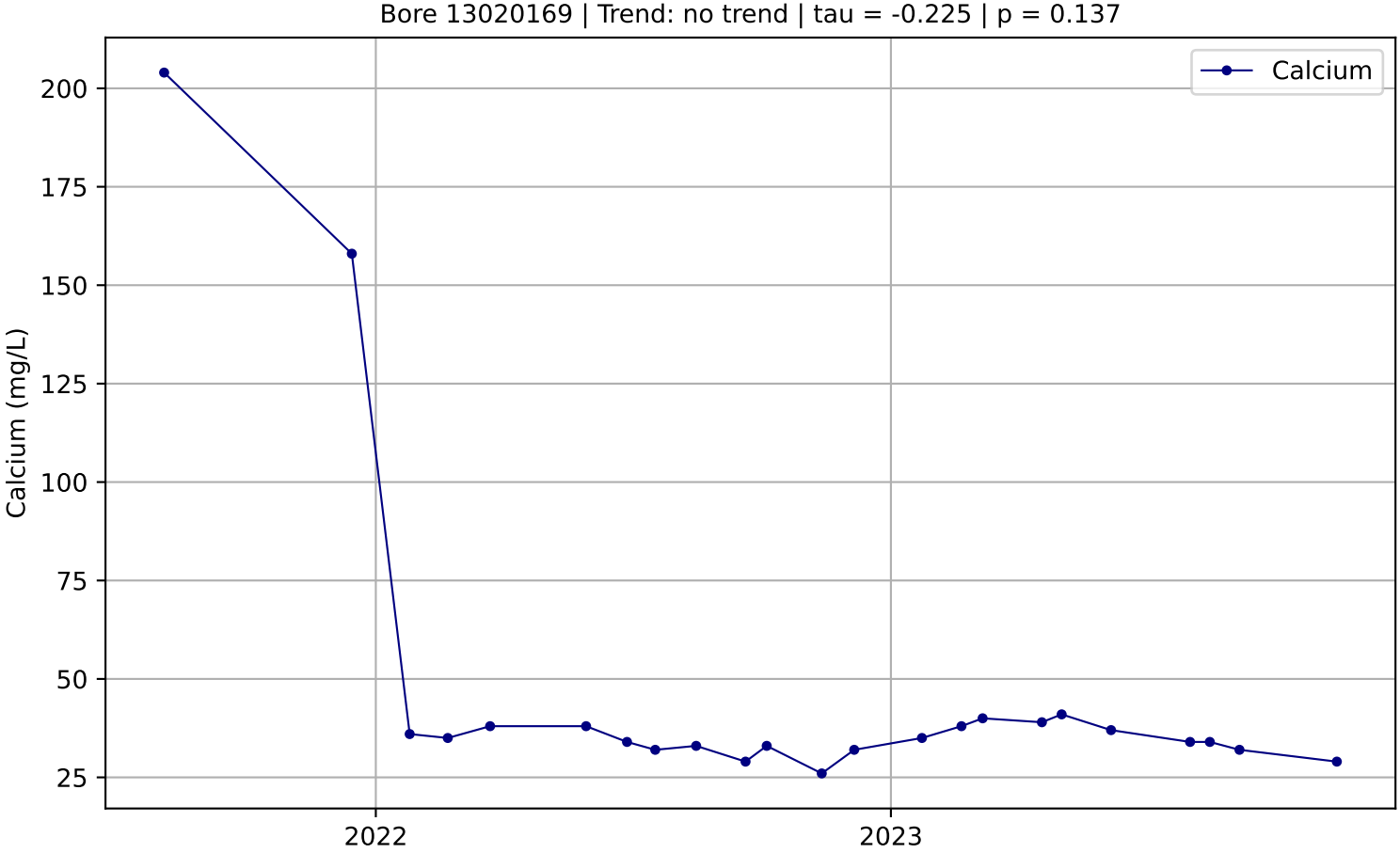

Bore 13020169 | Trend: no trend | tau = 0.111 | p = 0.123
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2022
2023
Aluminium
Groundwater Quality Limit

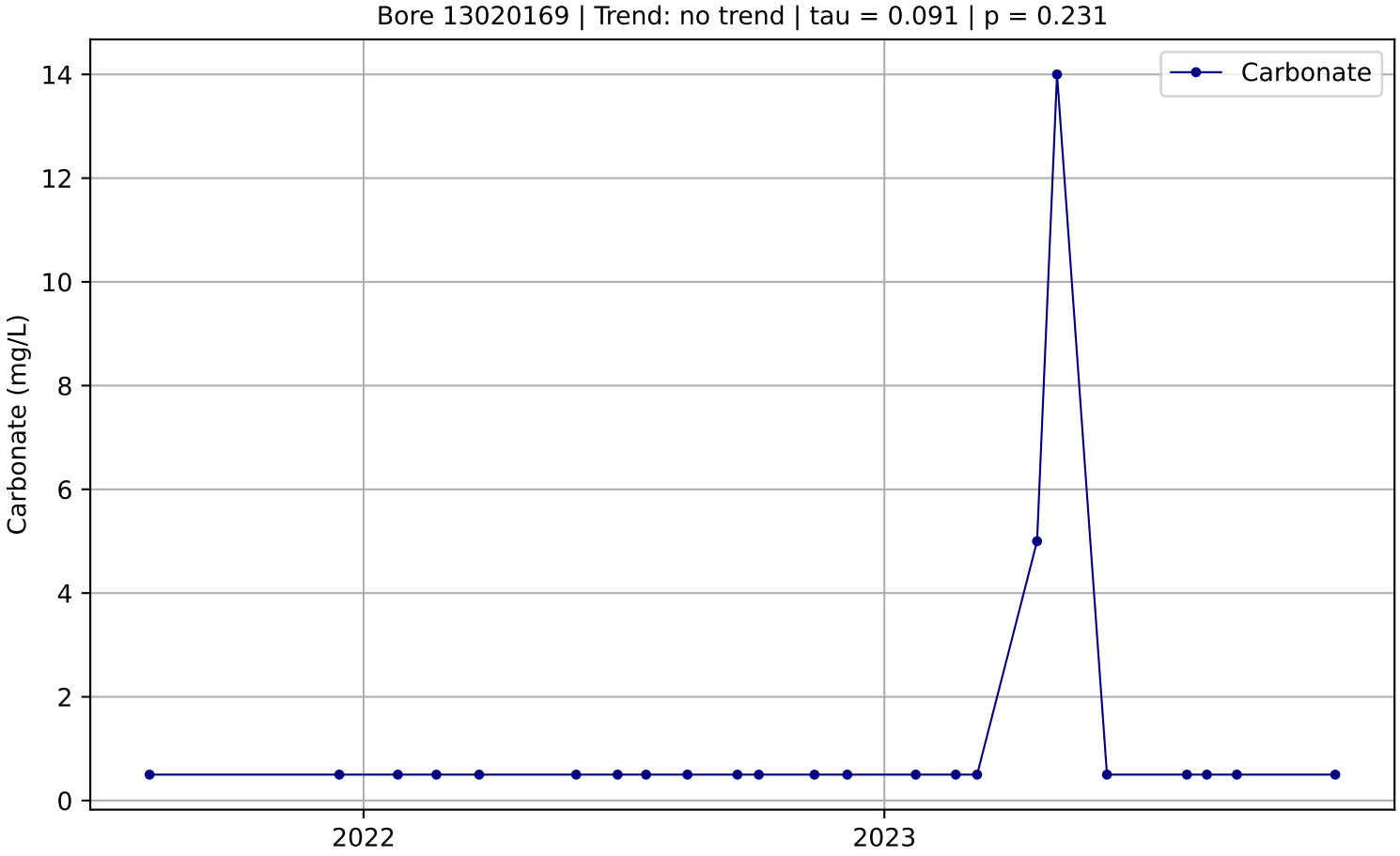

Bore 13020169 | Trend: no trend | tau = -0.065 | p = 0.527
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2022
2023
Arsenic
Groundwater Quality Limit

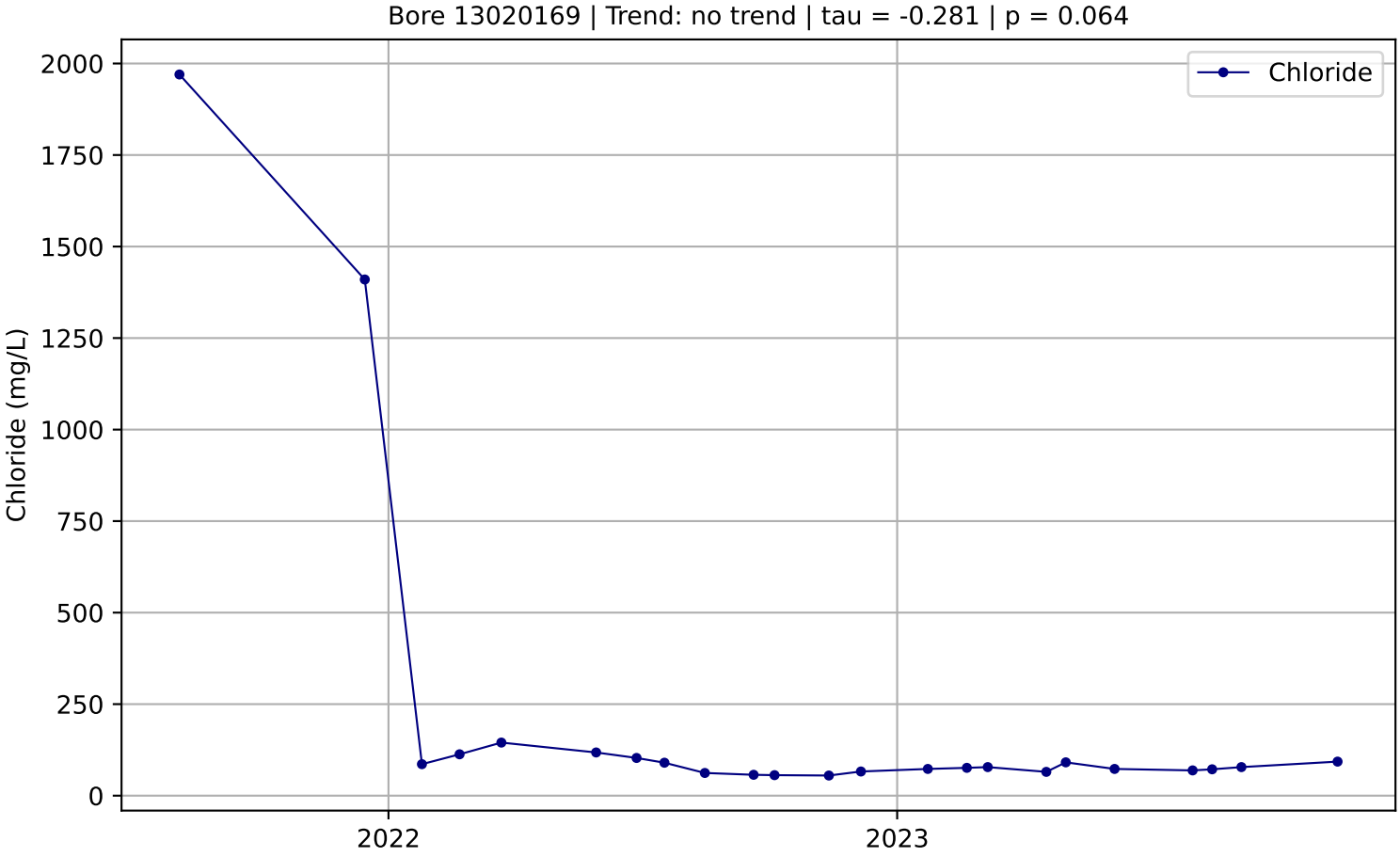

Bore 13020169 | Trend: no trend | tau = -0.281 | p = 0.064
Bicarbonate
Bicarbonate (mg/L)
2000
1750
1500
1250
1000
750
500
250
2022
2023

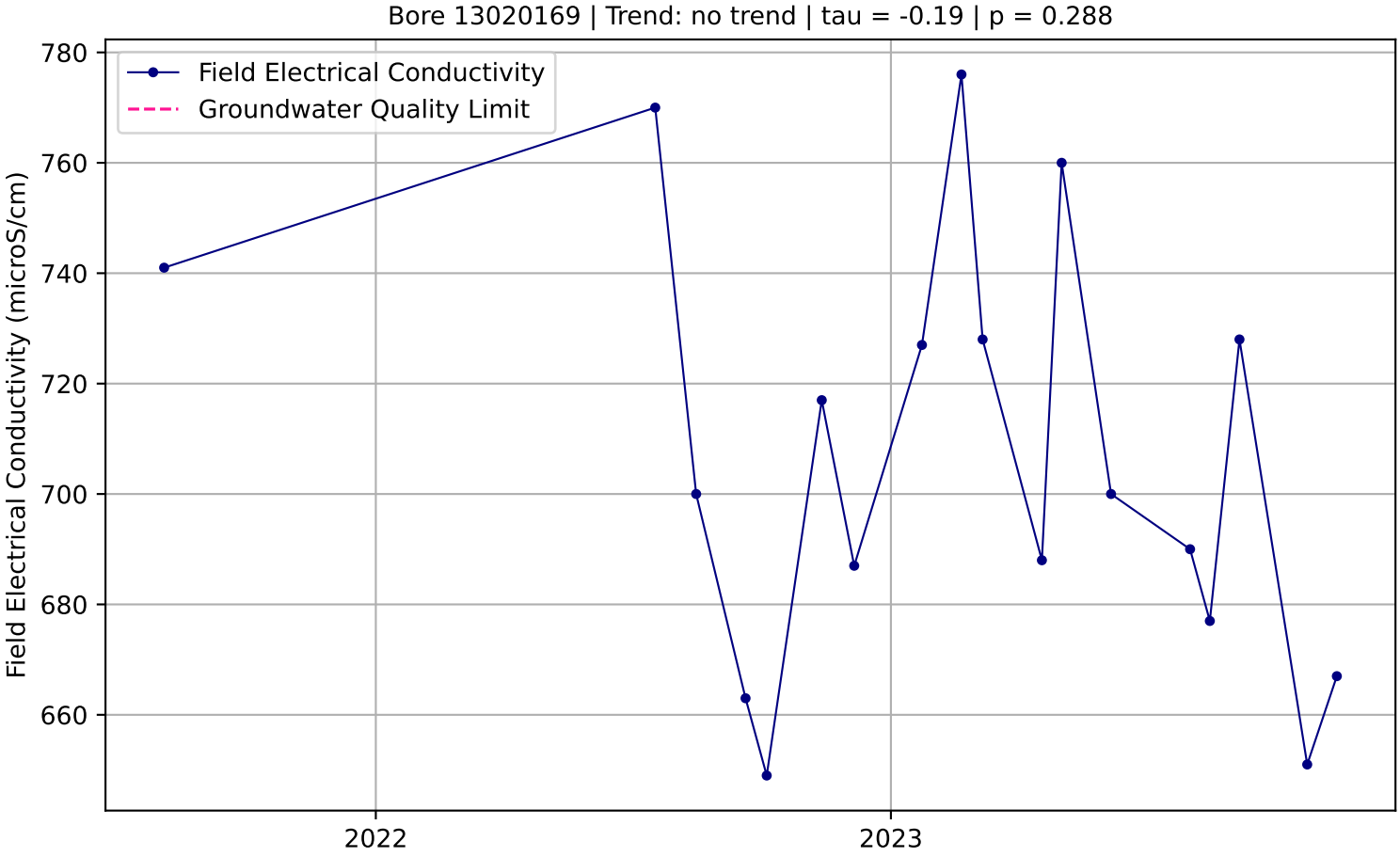

Bore 13020169 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2022
2023
C6 - C10 Fraction
Groundwater Quality Limit

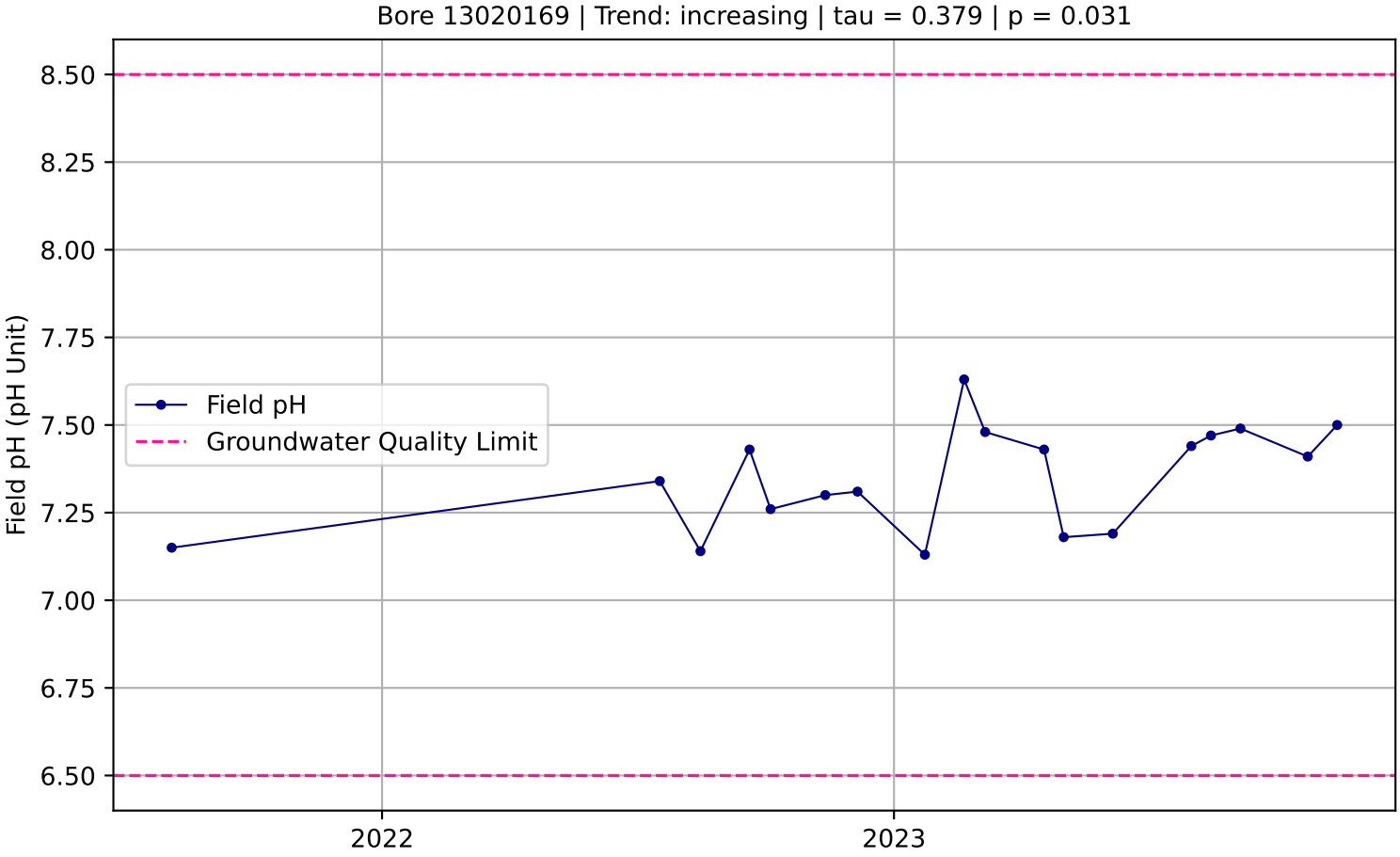

Bore 13020169 | Trend: no trend | tau = -0.098 | p = 0.177
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
120
110
100
90
80
70
60
50
2022
2023

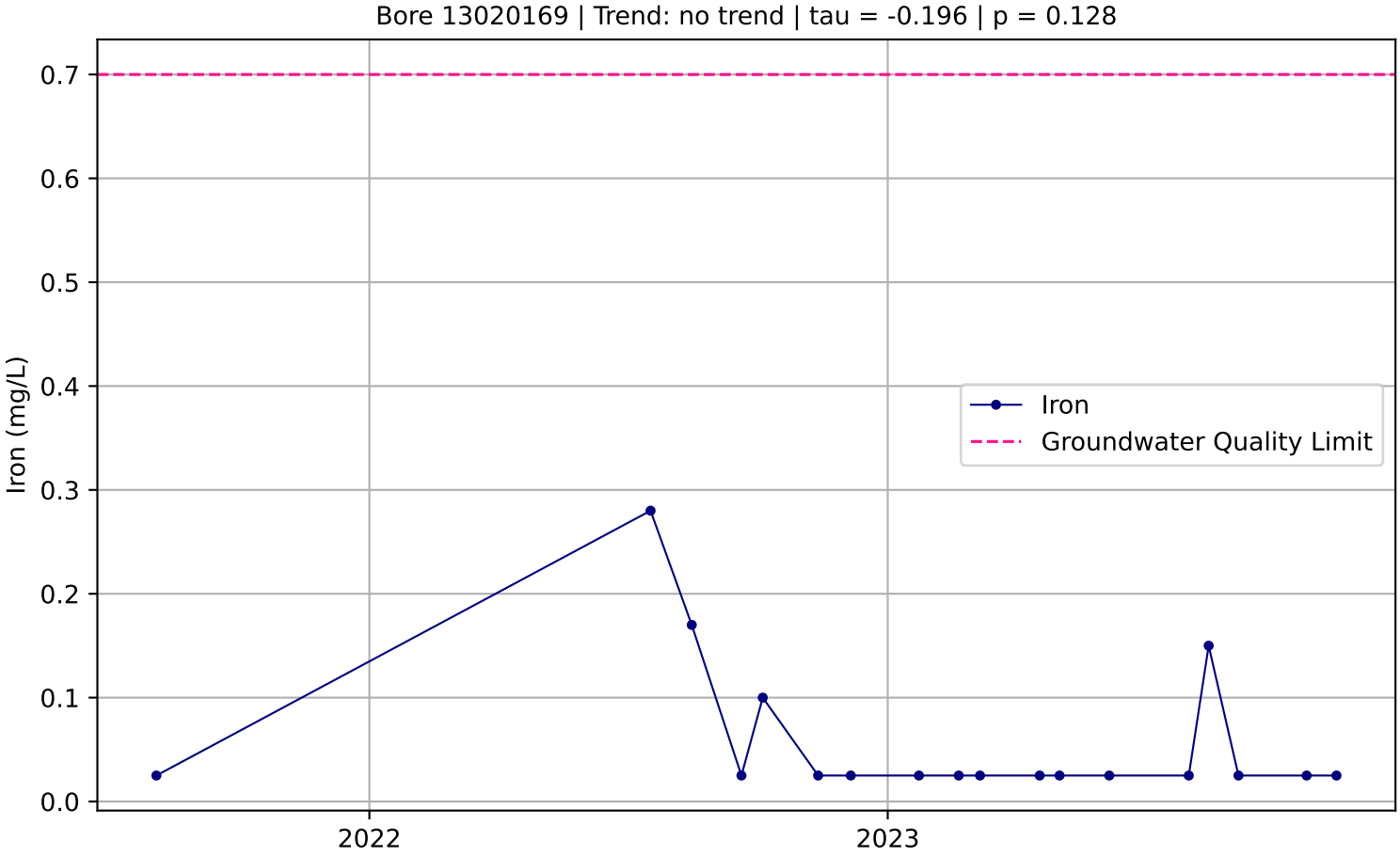

Bore 13020169 | Trend: no trend | tau = -0.225 | p = 0.137
Calcium
Calcium (mg/L)
200
175
150
125
100
75
50
25
2022
2023

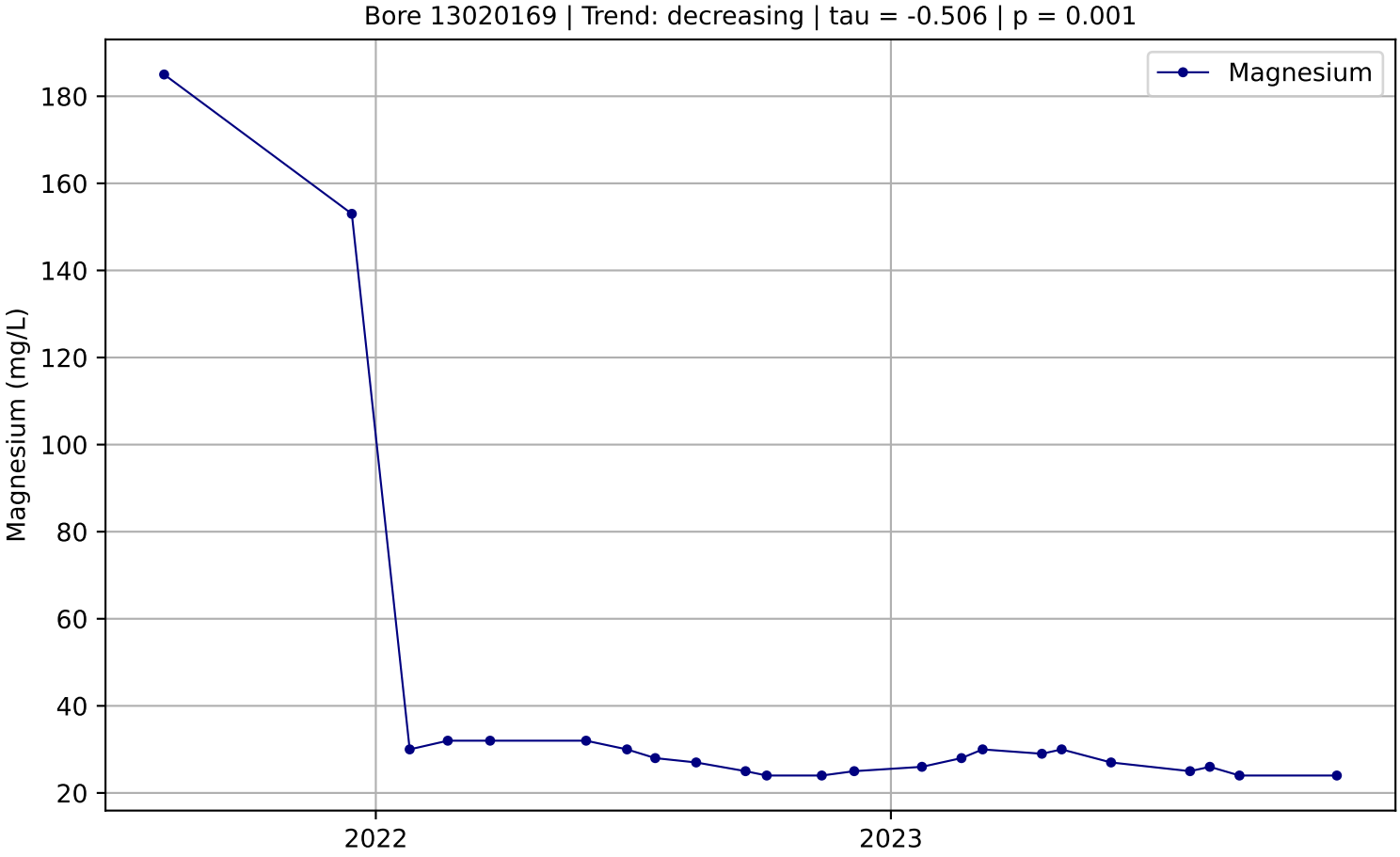

Bore 13020169 | Trend: no trend | tau = 0.091 | p = 0.231
Carbonate
Carbonate (mg/L)
0
2
4
6
8
10
12
14
2022
2023

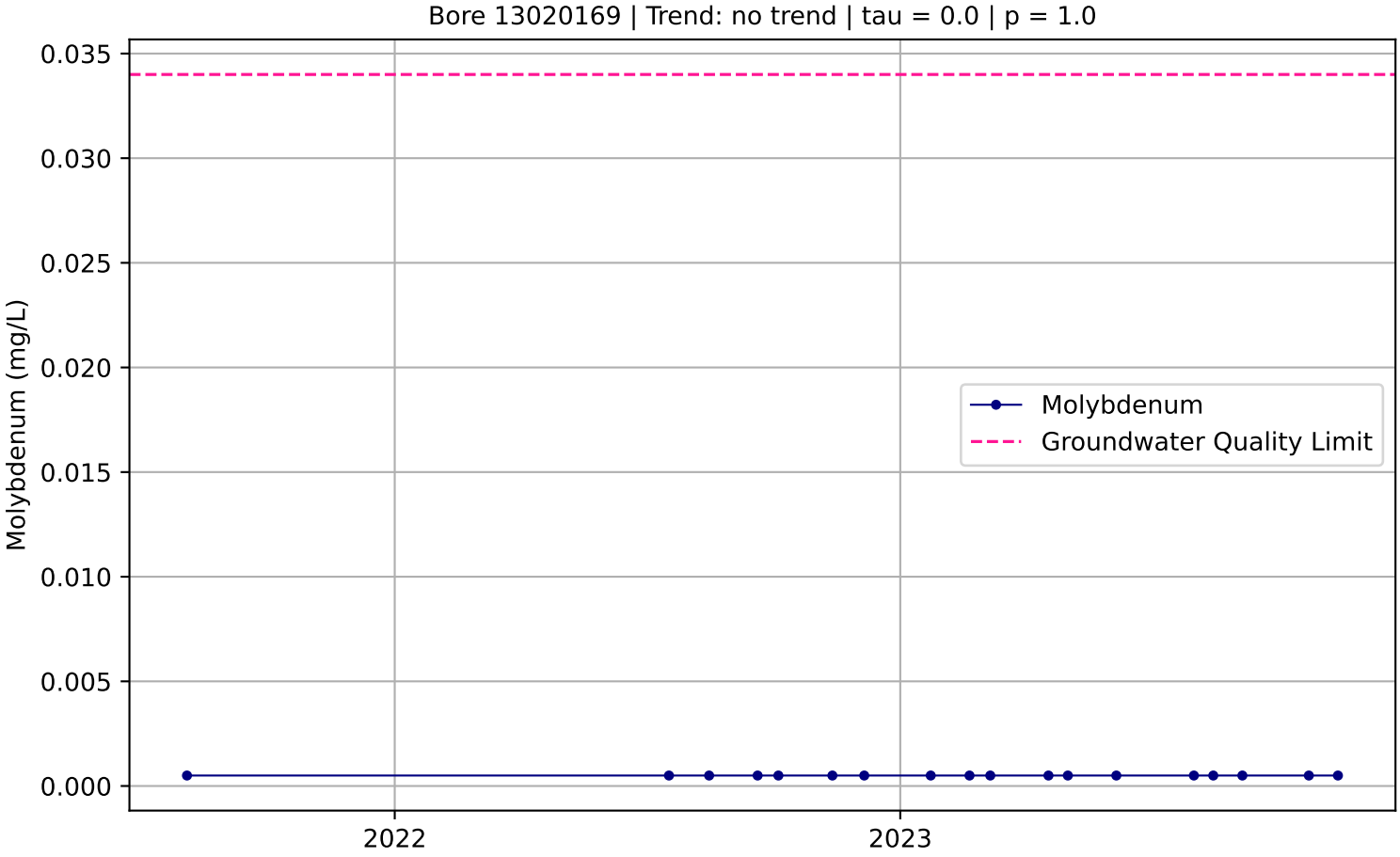

Bore 13020169 | Trend: no trend | tau = -0.281 | p = 0.064
Chloride
Chloride (mg/L)
2000
1750
1500
1250
1000
750
500
250
0
2022
2023

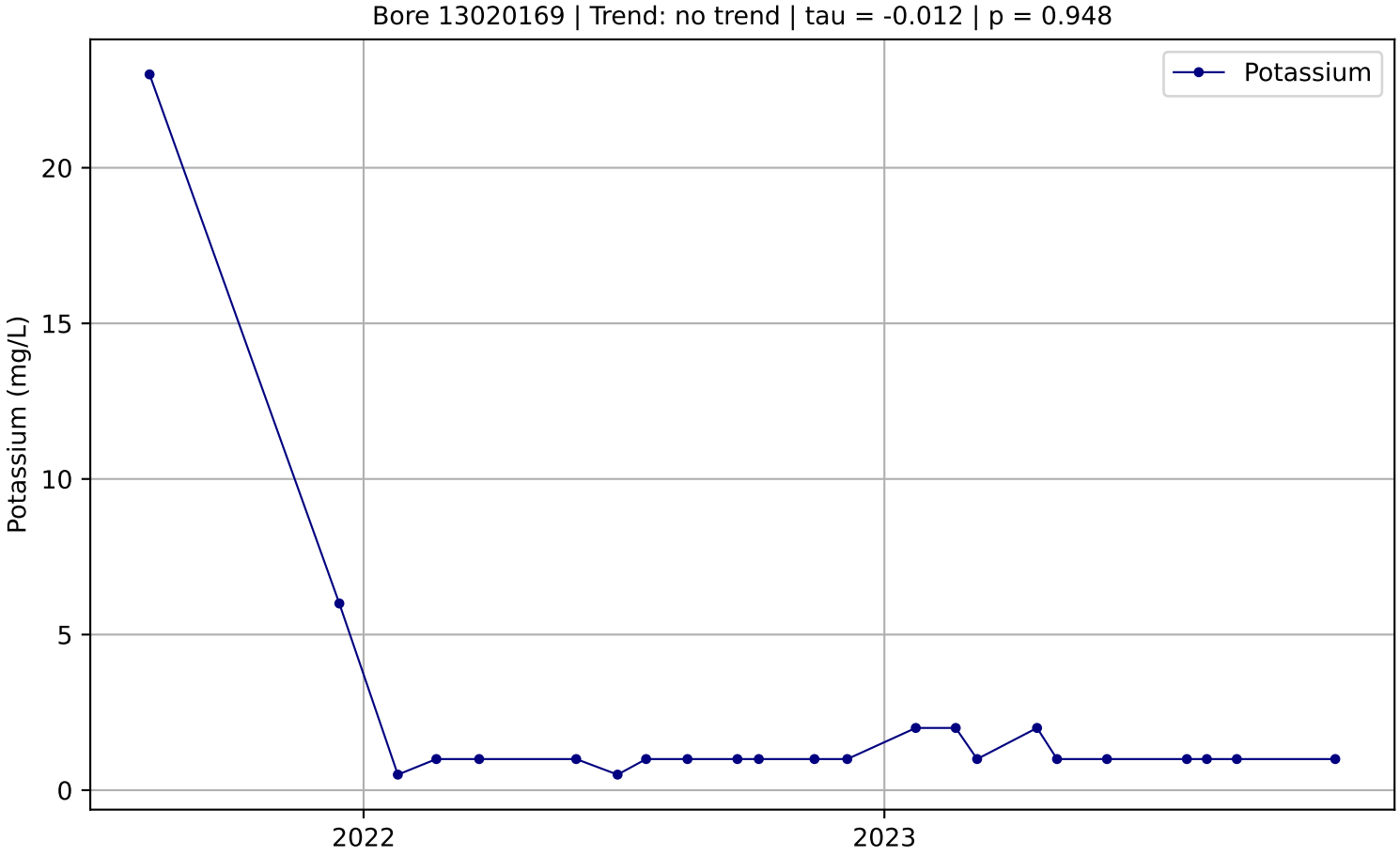

Bore 13020169 | Trend: no trend | tau = -0.19 | p = 0.288
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
780
760
740
720
700
680
660
2022
2023

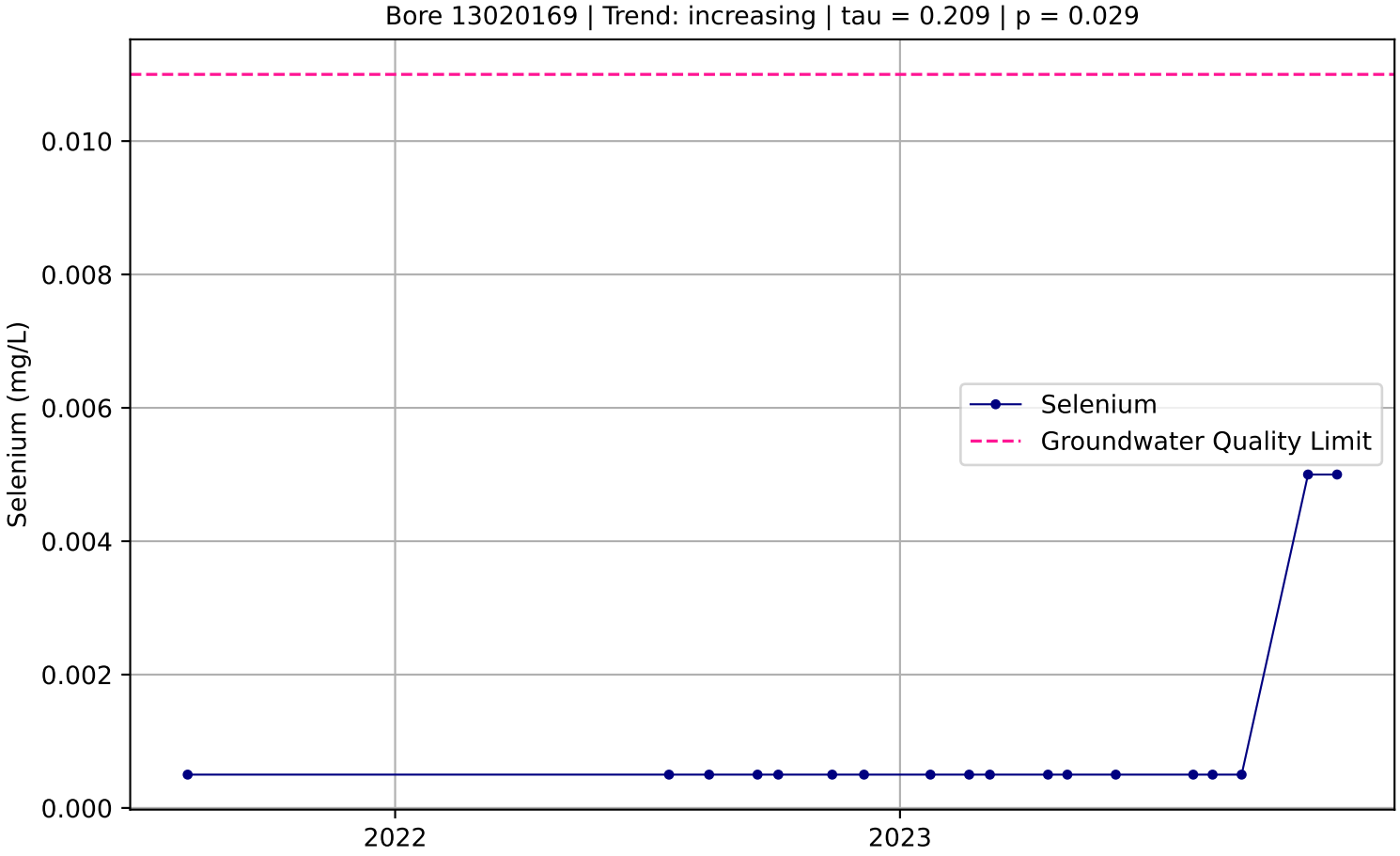

Bore 13020169 | Trend: increasing | tau = 0.379 | p = 0.031
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2022
2023
Field pH
Groundwater Quality Limit

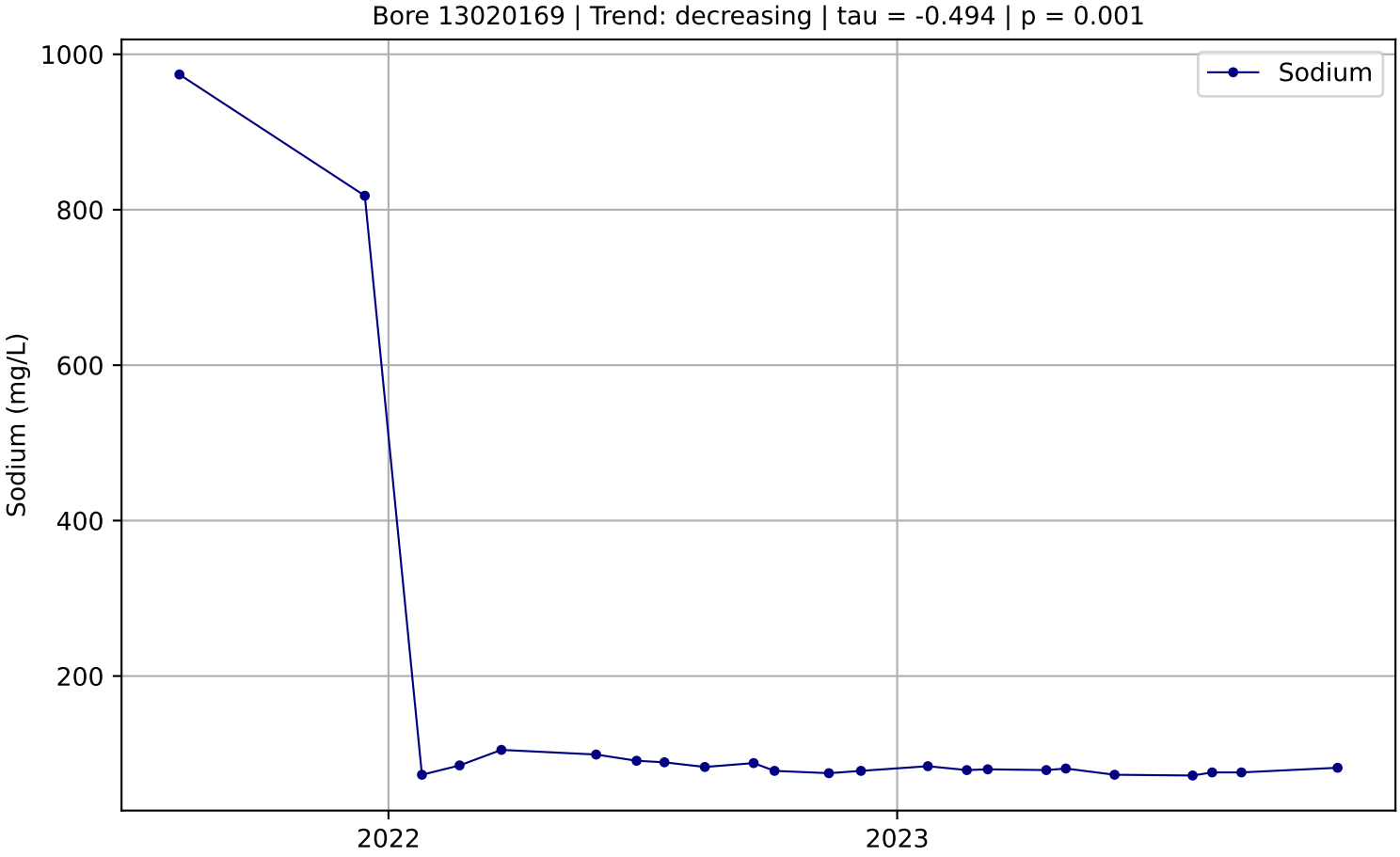

Bore 13020169 | Trend: no trend | tau = -0.196 | p = 0.128
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2022
2023
Iron
Groundwater Quality Limit

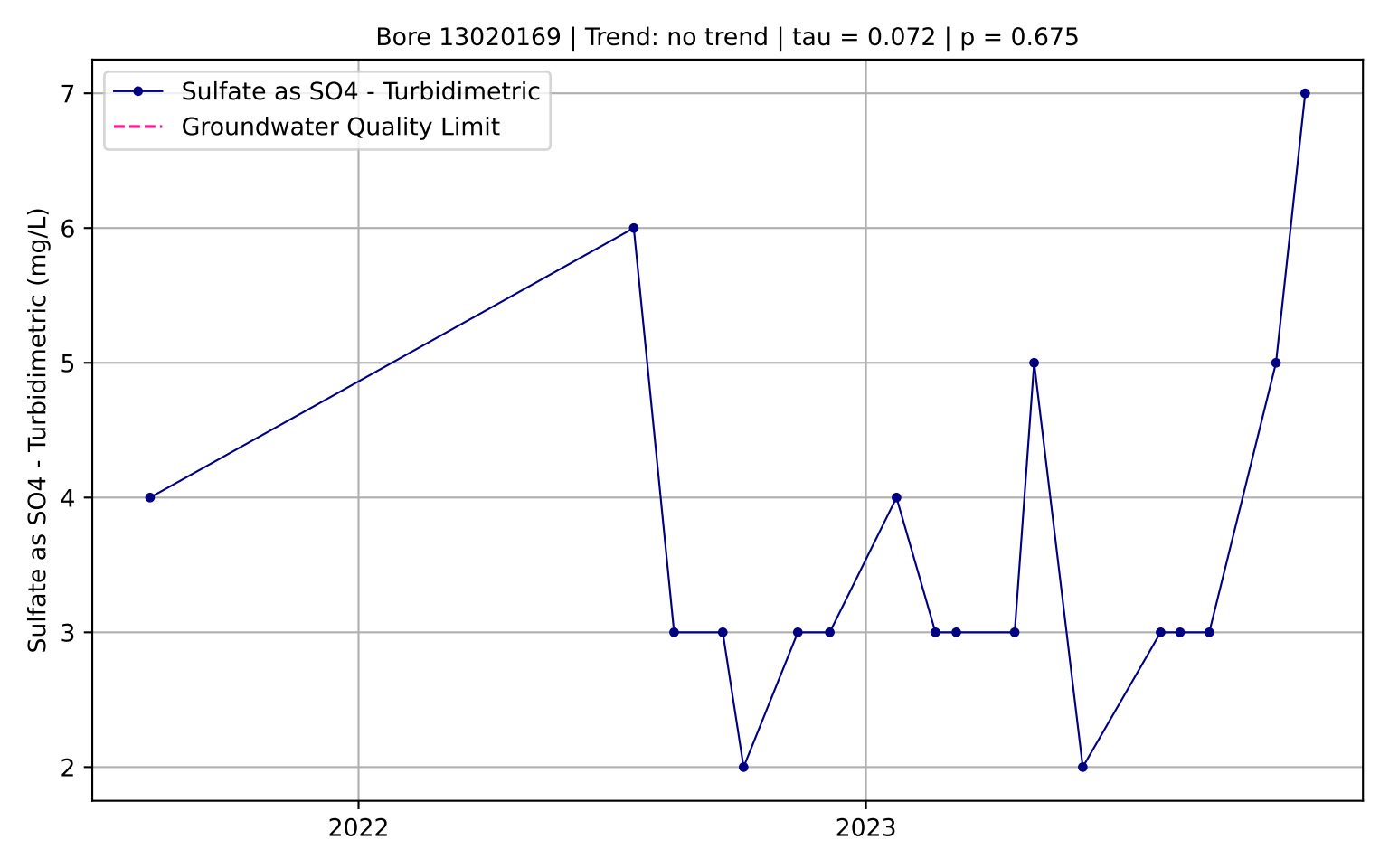

Bore 13020169 | Trend: decreasing | tau = -0.506 | p = 0.001
Magnesium
Magnesium (mg/L)
180
160
140
120
100
80
60
40
20
2022
2023

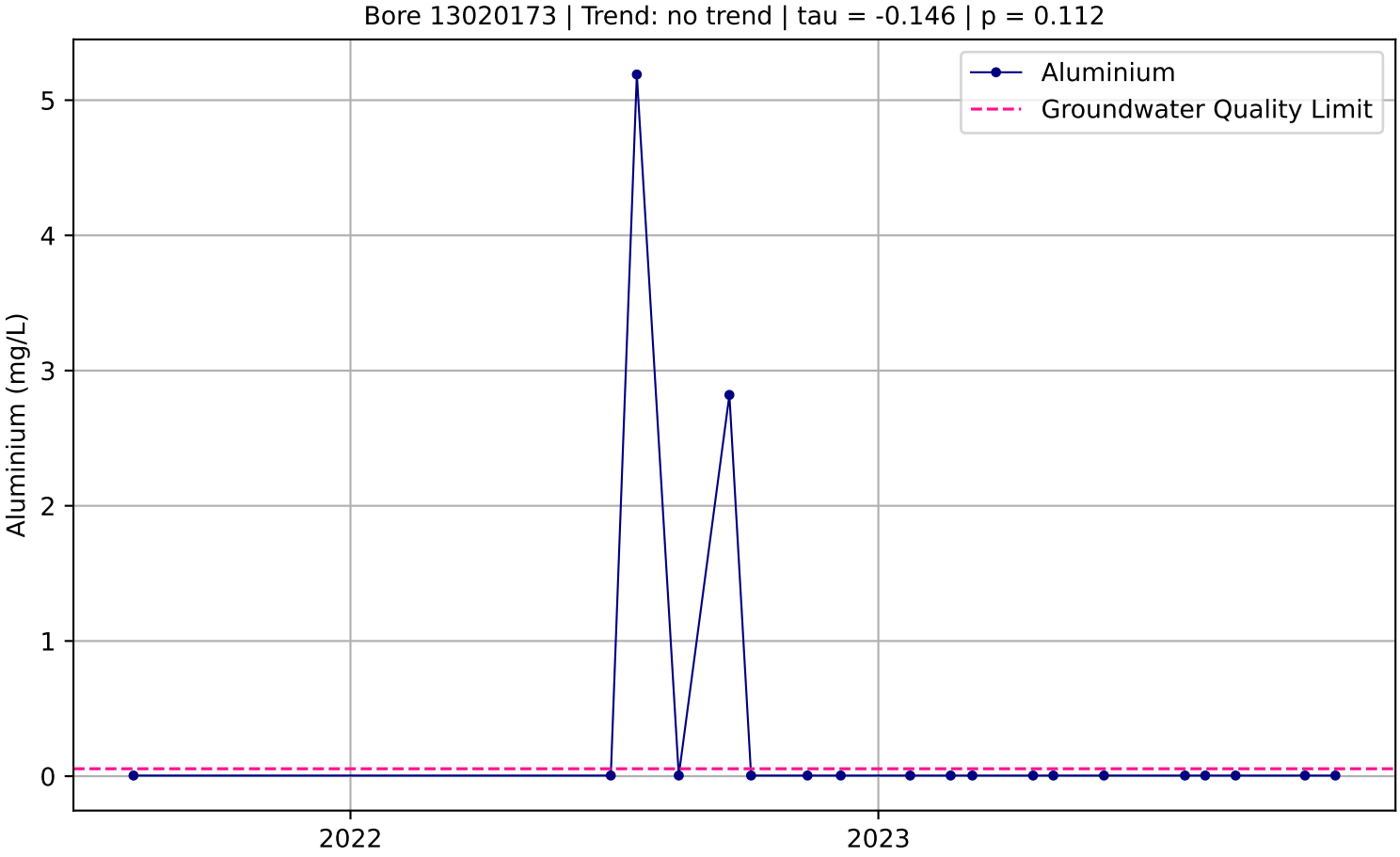

Bore 13020169 | Trend: no trend | tau = 0.0 | p = 1.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2022
2023
Molybdenum
Groundwater Quality Limit

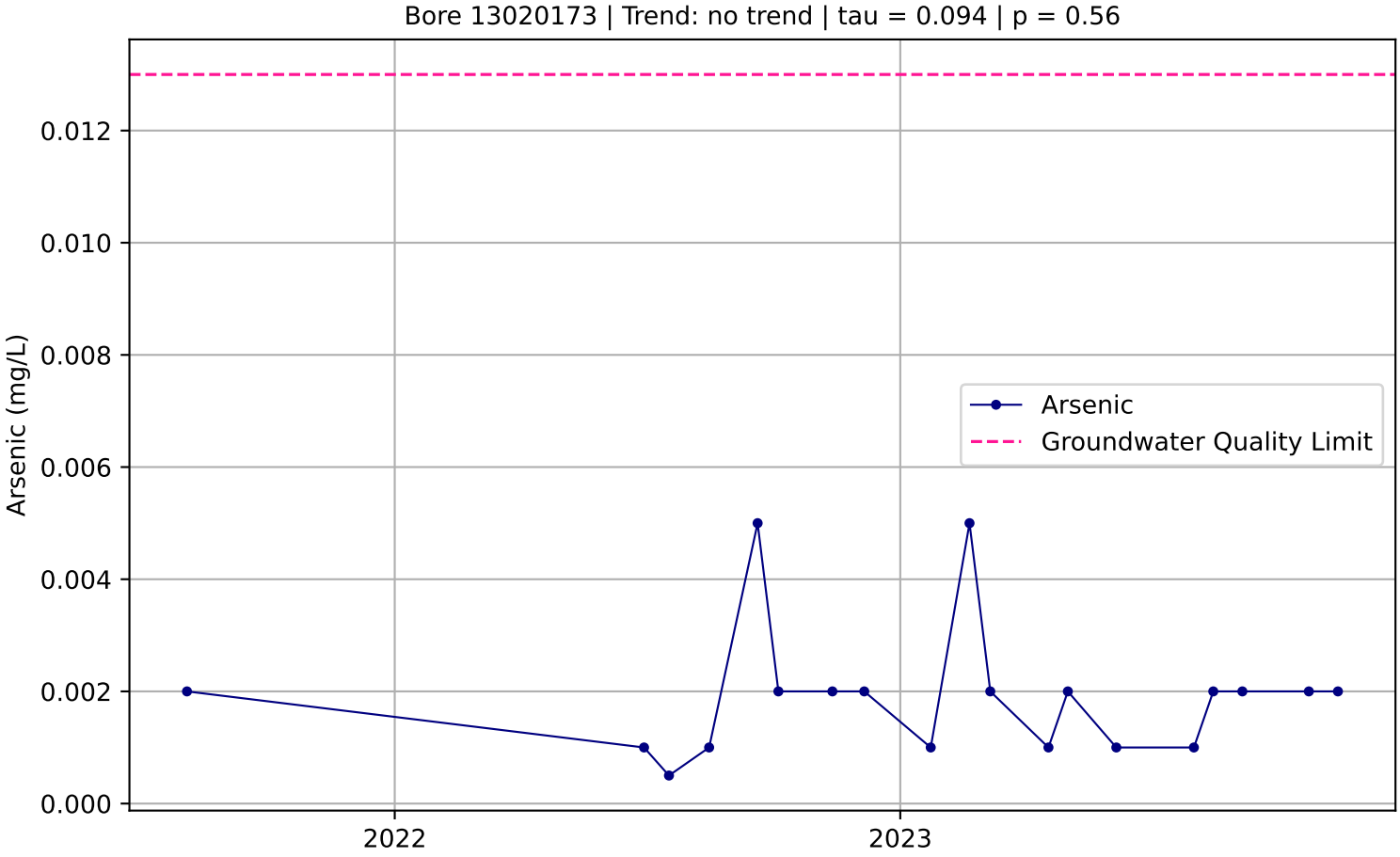

Bore 13020169 | Trend: no trend | tau = -0.012 | p = 0.948
Potassium
Potassium (mg/L)
0
5
10
15
20
2022
2023

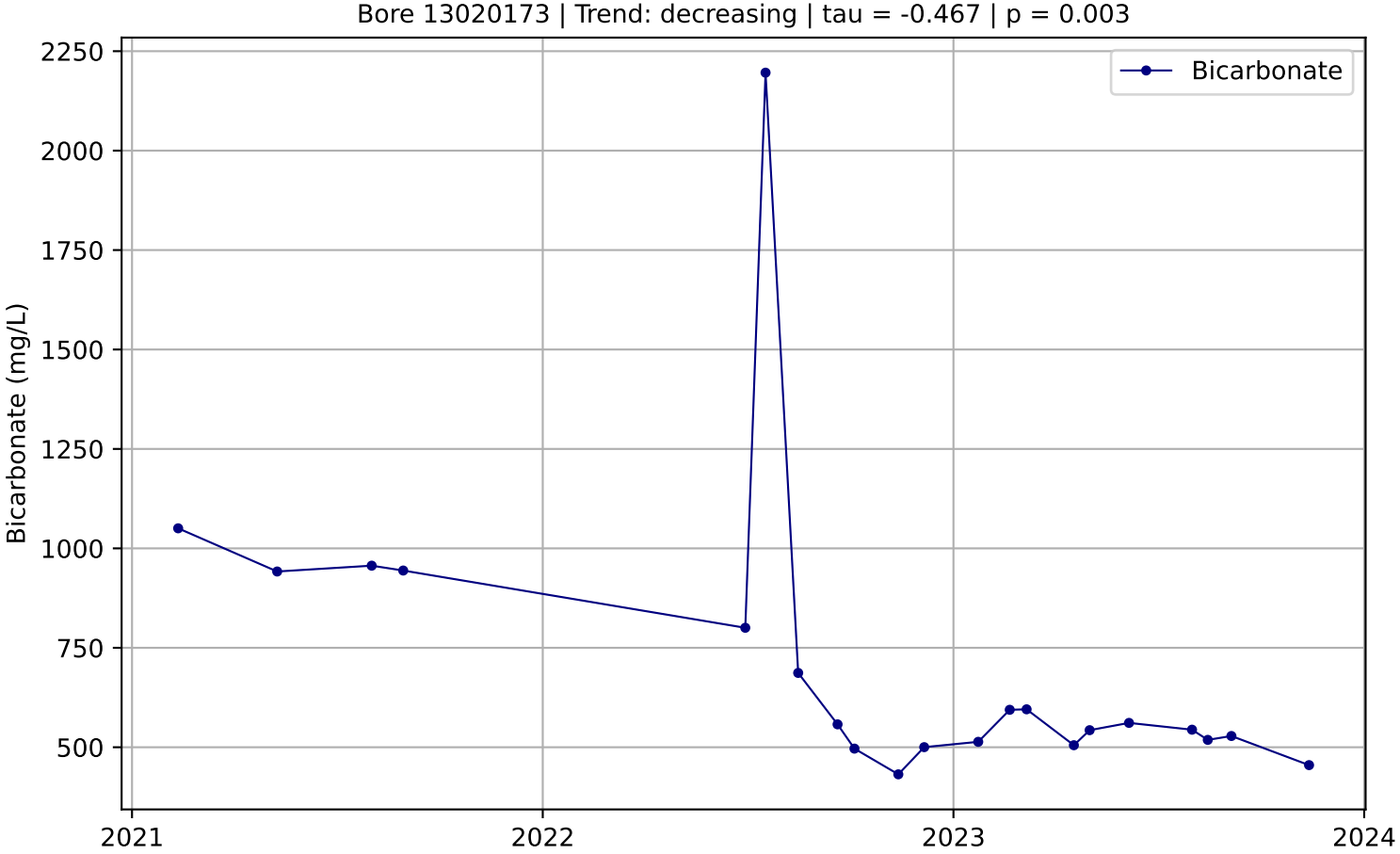

Bore 13020169 | Trend: increasing | tau = 0.209 | p = 0.029
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2022
2023
Selenium
Groundwater Quality Limit

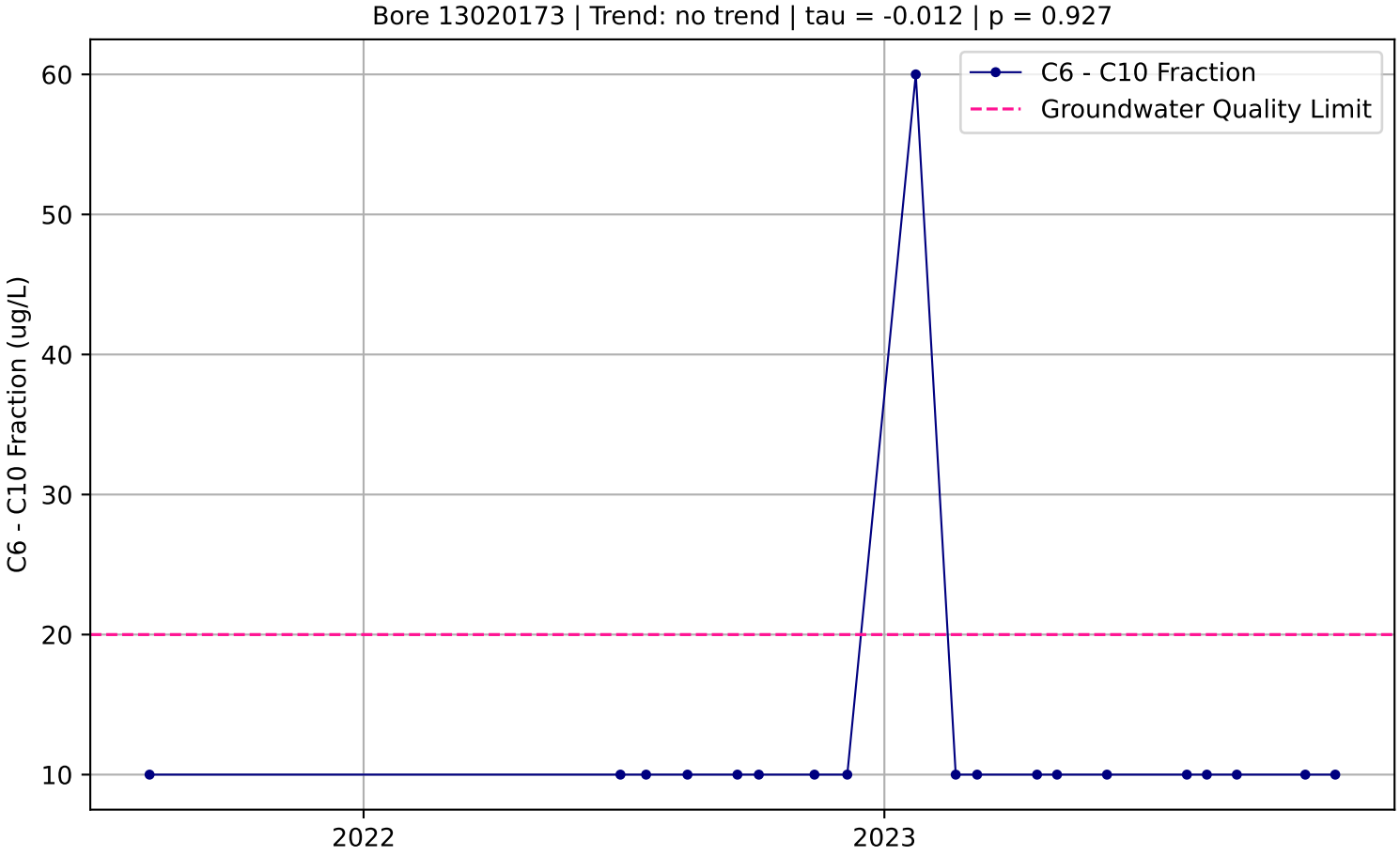

Bore 13020169 | Trend: decreasing | tau = -0.494 | p = 0.001
Sodium
Sodium (mg/L)
1000
800
600
400
200
2022
2023

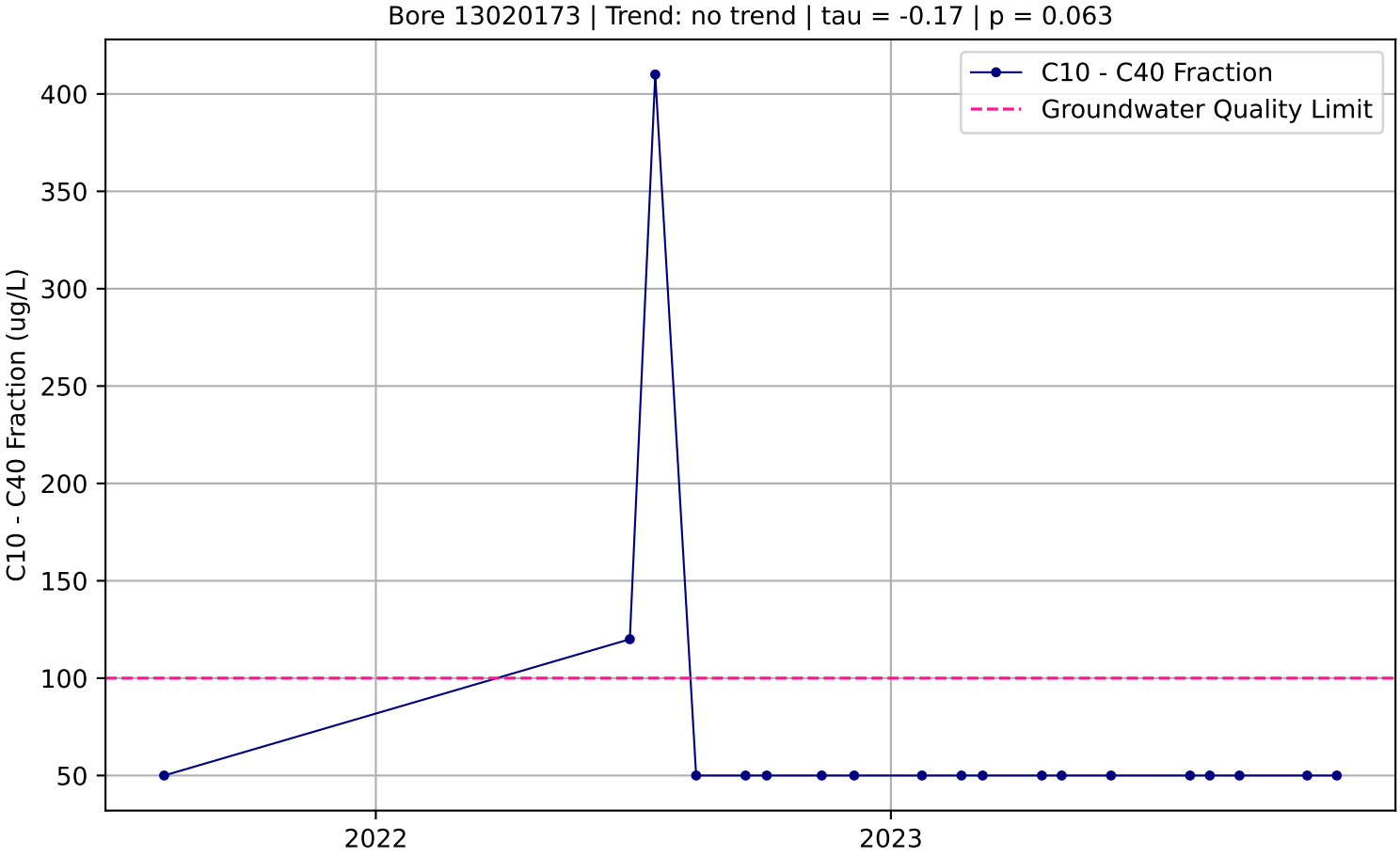

Bore 13020169 | Trend: no trend | tau = 0.072 | p = 0.675
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
7
6
5
4
3
2
2022
2023

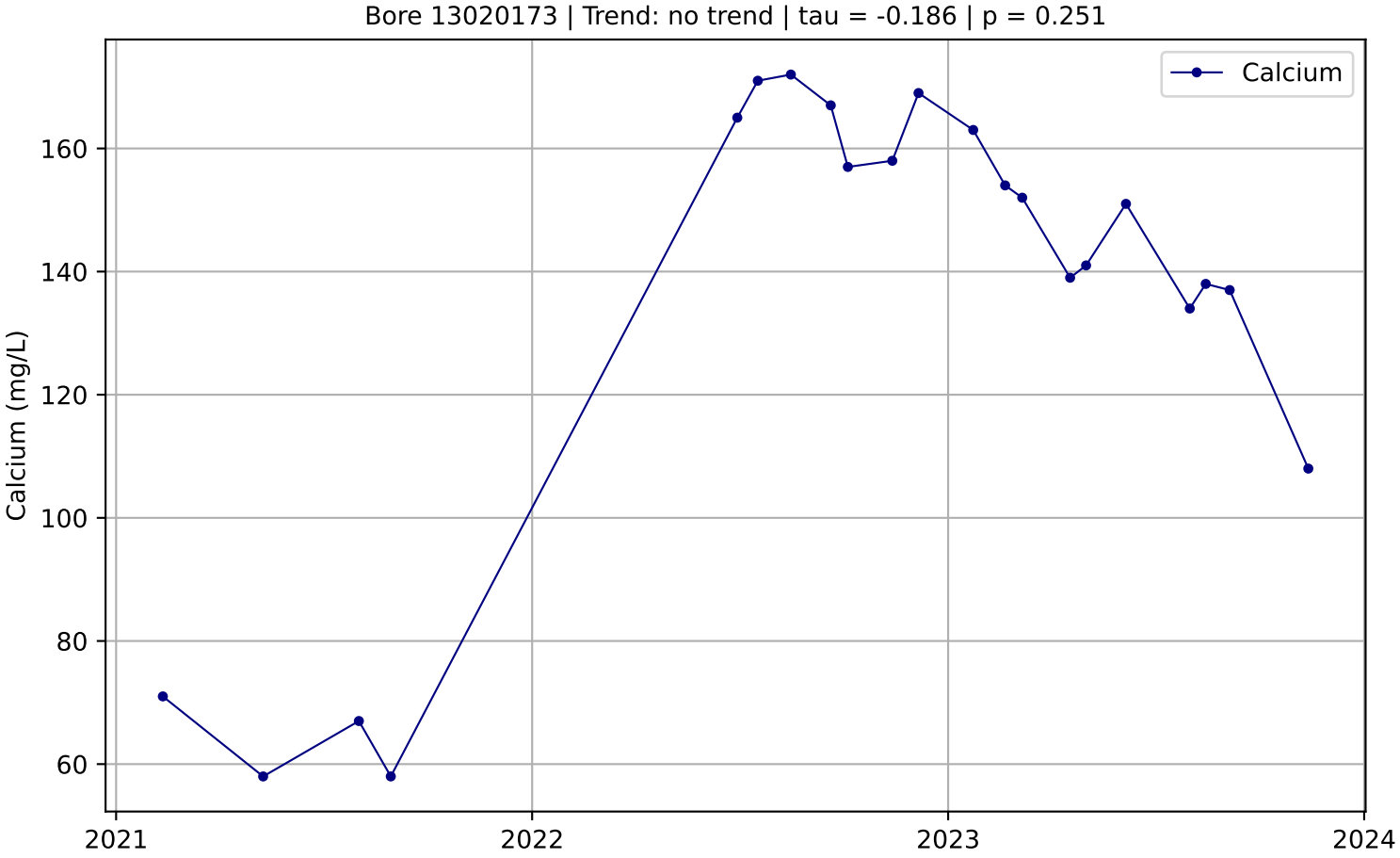

Bore 13020173 | Trend: no trend | tau = -0.146 | p = 0.112
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0
1
2
3
4
5
2022
2023

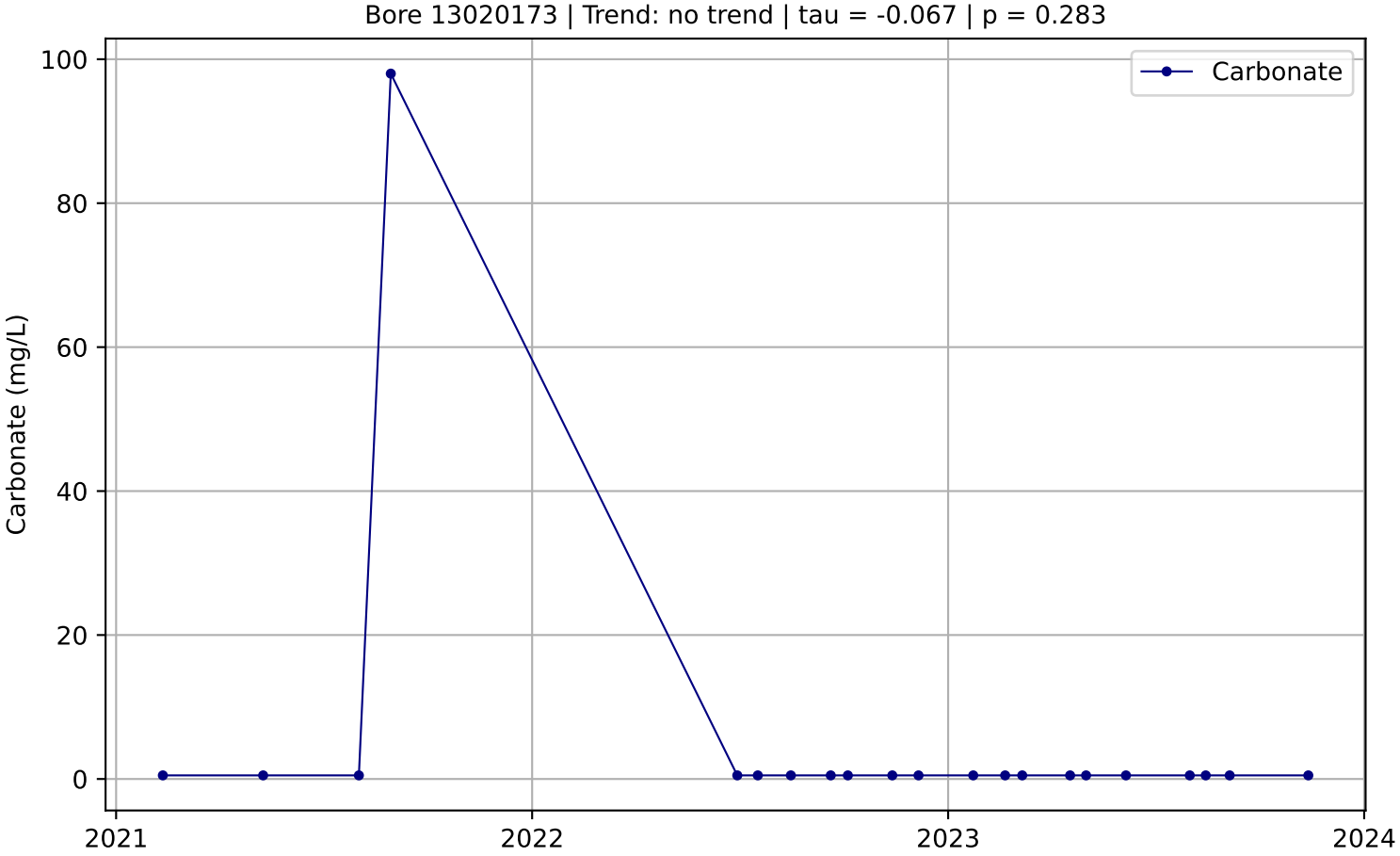

Bore 13020173 | Trend: no trend | tau = 0.094 | p = 0.56
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2022
2023
Arsenic
Groundwater Quality Limit


Bore 13020173 | Trend: decreasing | tau = -0.467 | p = 0.003
Bicarbonate
Bicarbonate (mg/L)
2250
2000
1750
1500
1250
1000
750
500
2021
2022
2023
2024

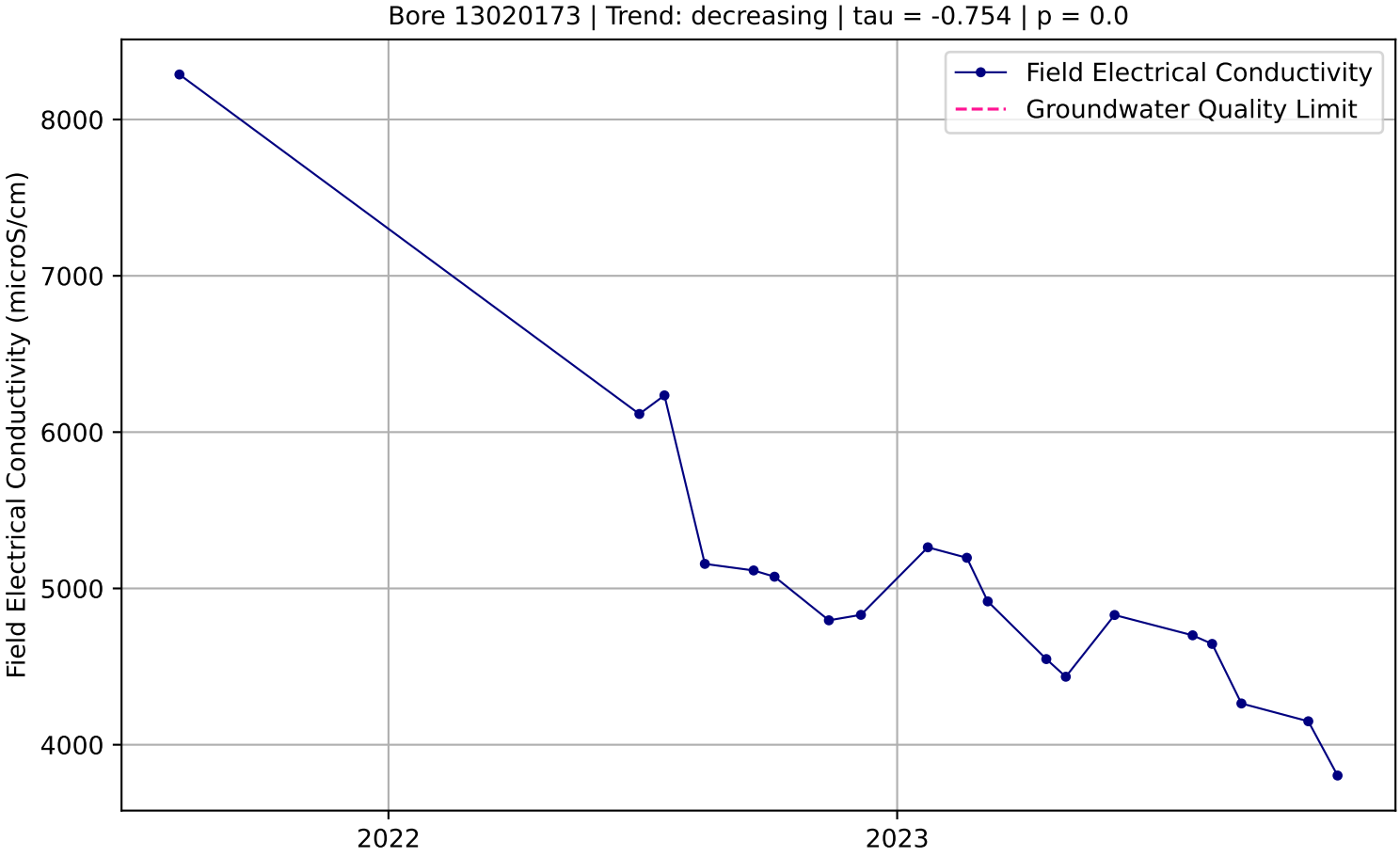

Bore 13020173 | Trend: no trend | tau = -0.012 | p = 0.927
C6 - C10 Fraction
Groundwater Quality Limit
C6 - C10 Fraction (ug/L)
60
50
40
30
20
10
2022
2023

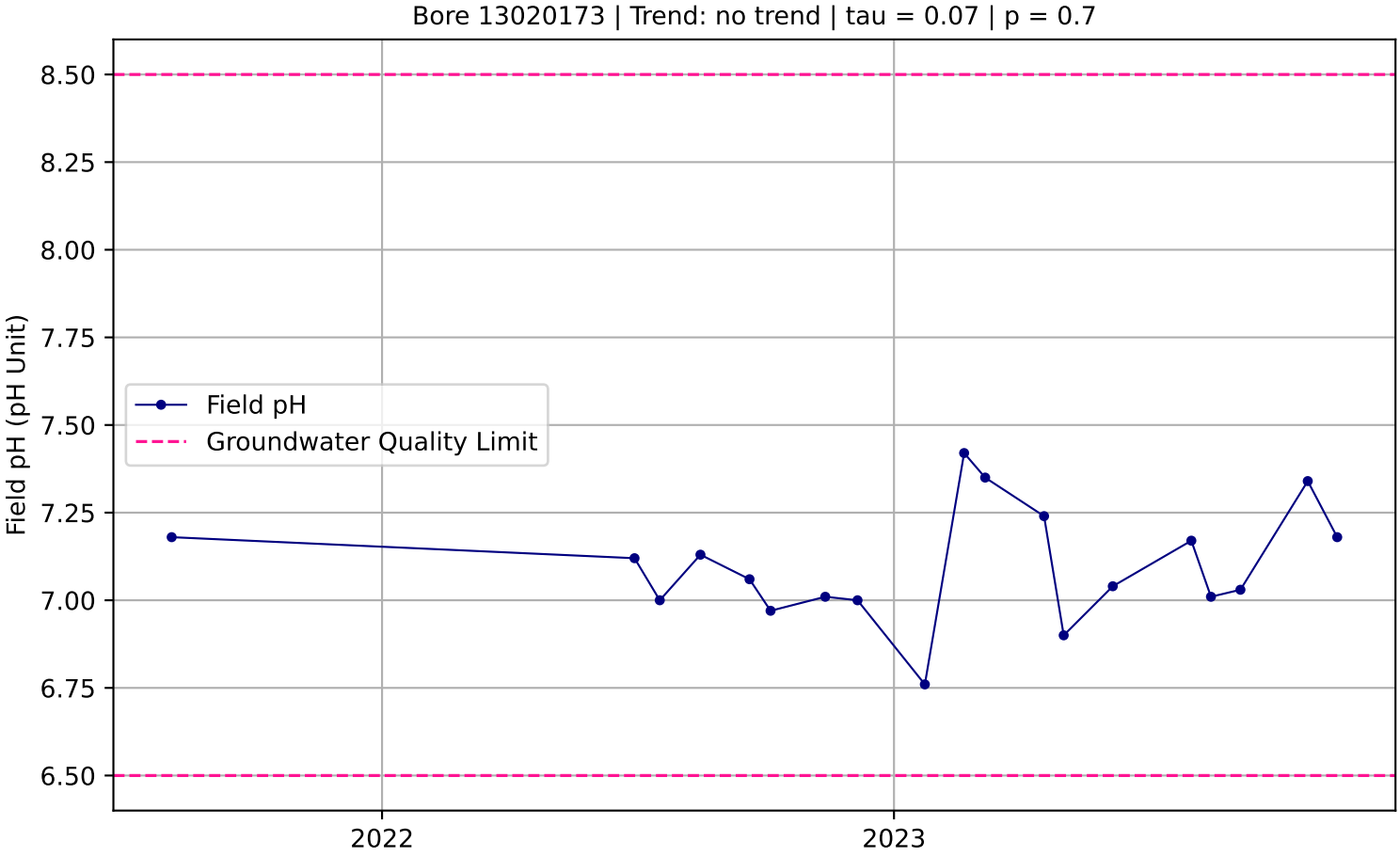

Bore 13020173 | Trend: no trend | tau = -0.17 | p = 0.063
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
400
350
300
250
200
150
100
50
2022
2023

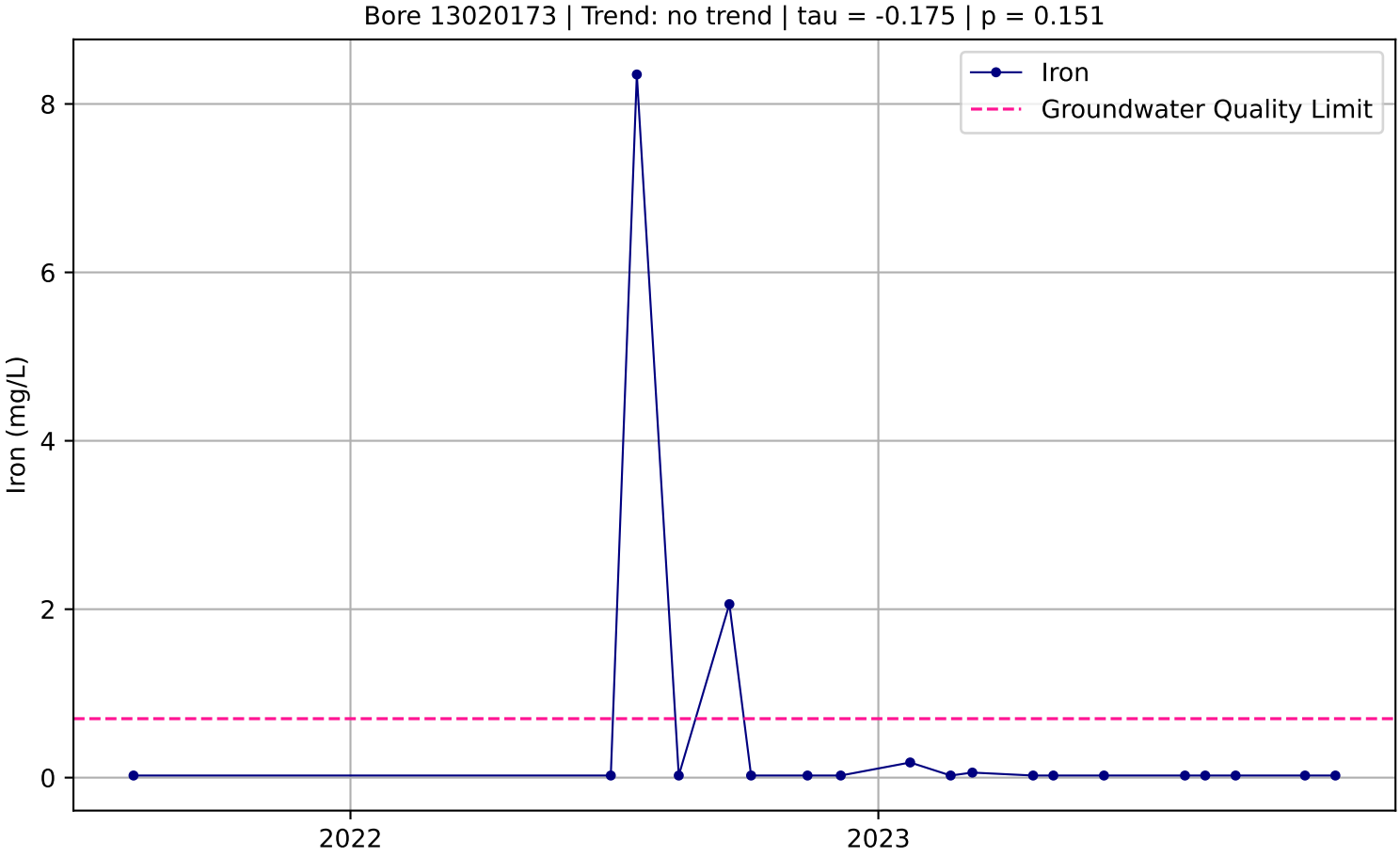

Bore 13020173 | Trend: no trend | tau = -0.186 | p = 0.251
Calcium
Calcium (mg/L)
160
140
120
100
80
60
2021
2022
2023
2024

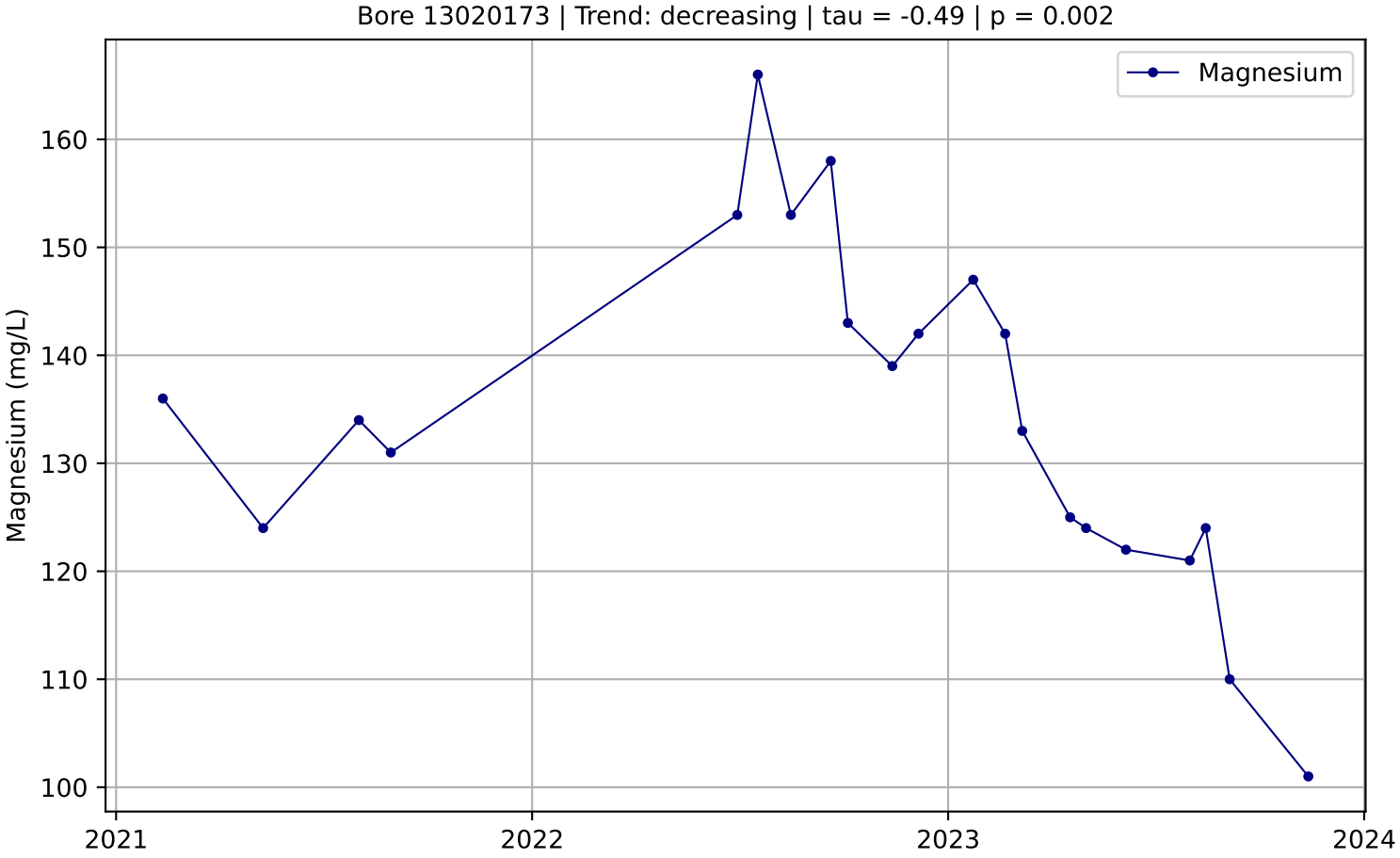

Bore 13020173 | Trend: no trend | tau = -0.067 | p = 0.283
Carbonate
Carbonate (mg/L)
100
80
60
40
20
0
2021
2022
2023
2024

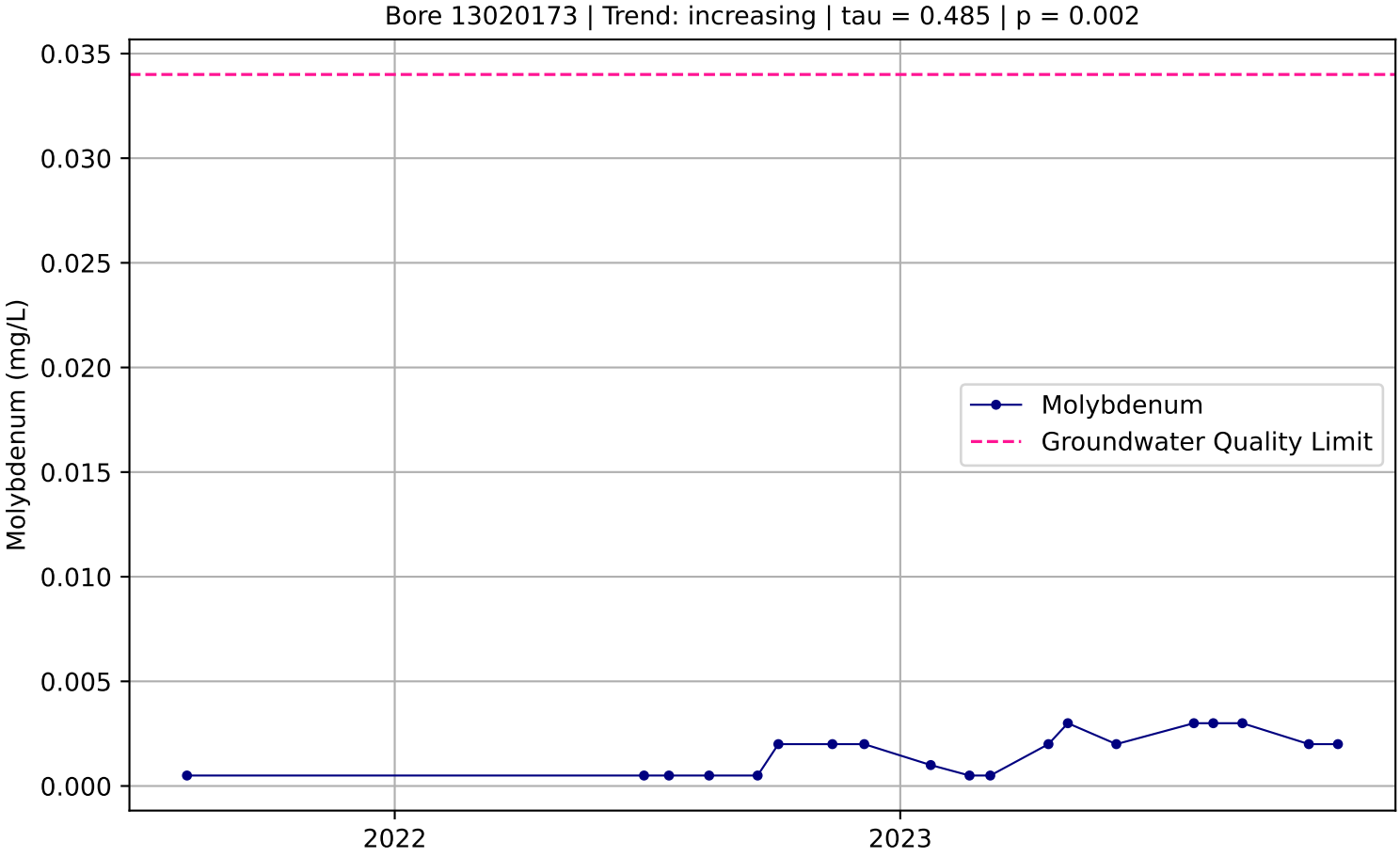
Bore 13020173 | Trend: decreasing | tau = -0.548 | p = 0.001
Chloride
Chloride (mg/L)
1600
1500
1400
1300
1200
1100
1000
2021
2022
2023
2024

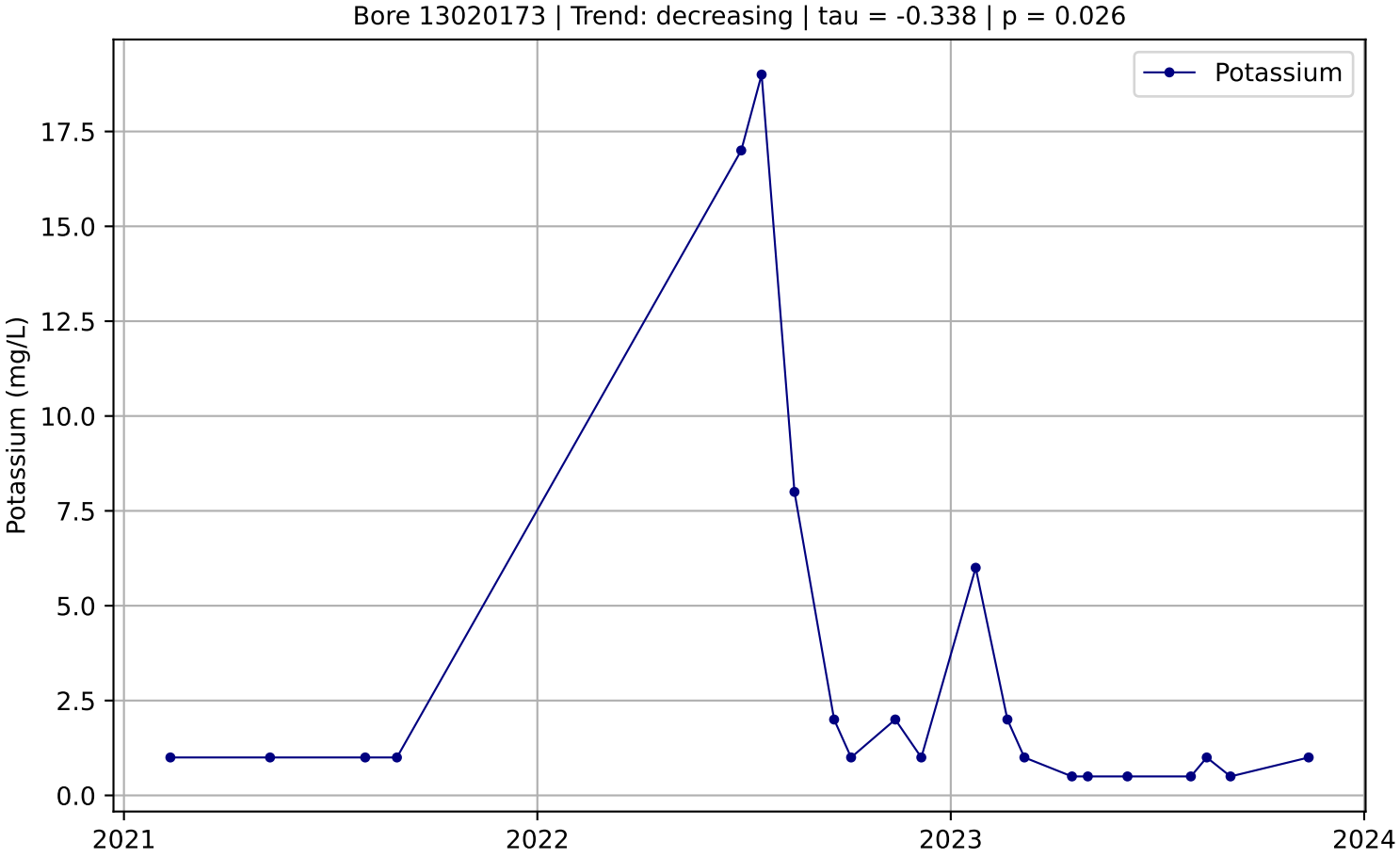

Bore 13020173 | Trend: decreasing | tau = -0.754 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
8000
7000
6000
5000
4000
2022
2023

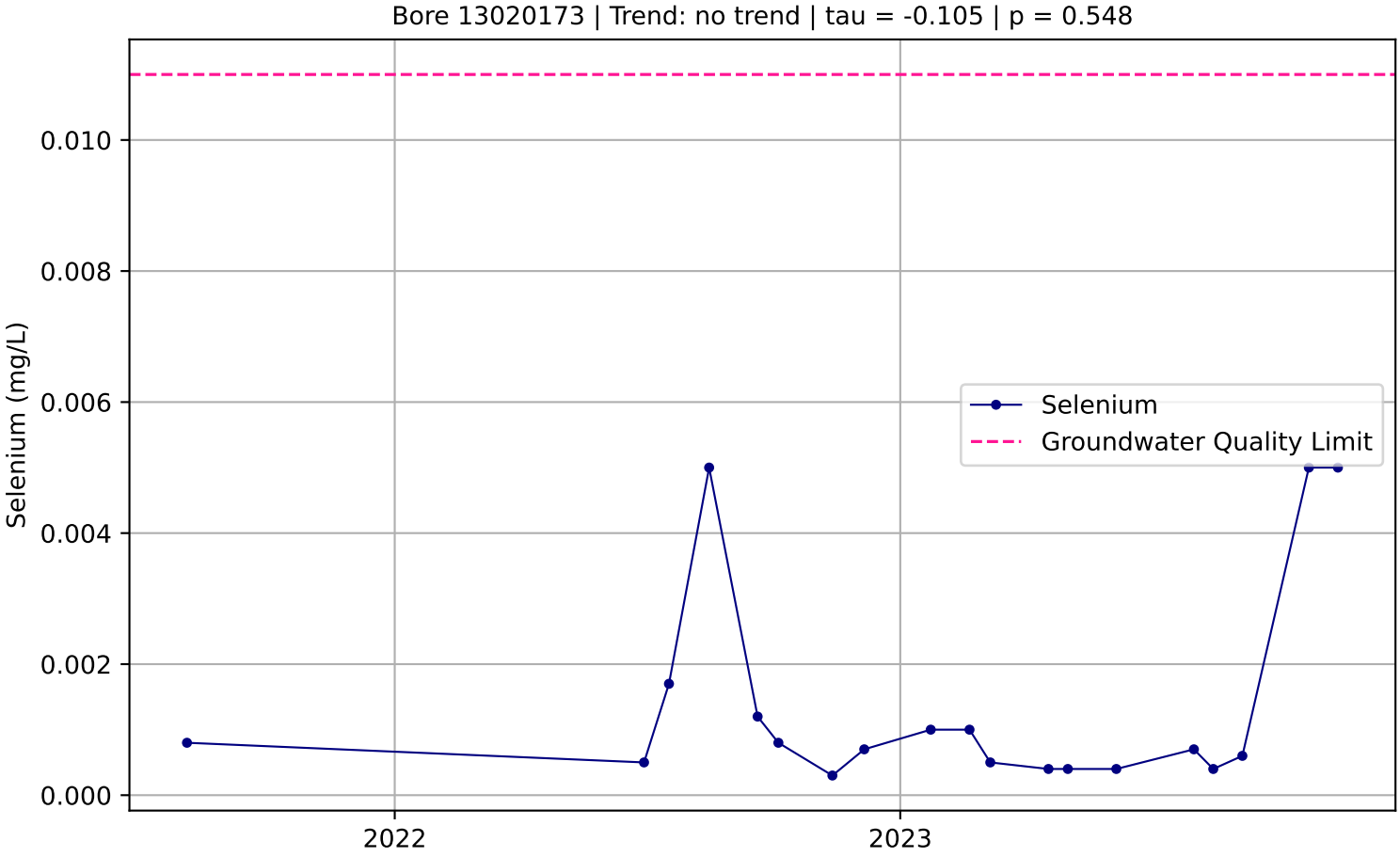

Bore 13020173 | Trend: no trend | tau = 0.07 | p = 0.7
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2022
2023
Field pH
Groundwater Quality Limit

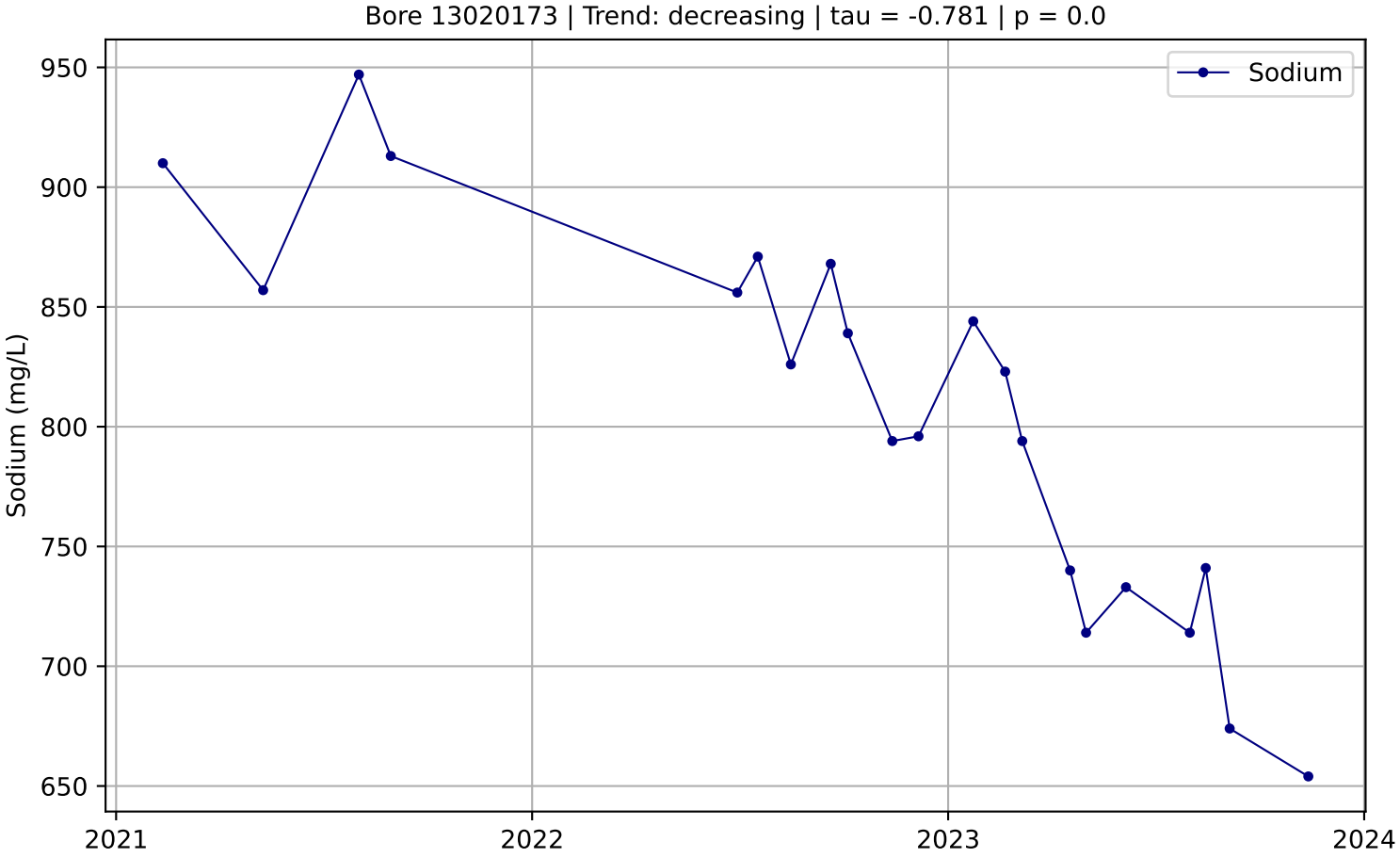

Bore 13020173 | Trend: no trend | tau = -0.175 | p = 0.151
Iron
Groundwater Quality Limit
Iron (mg/L)
0
2
4
6
8
2022
2023

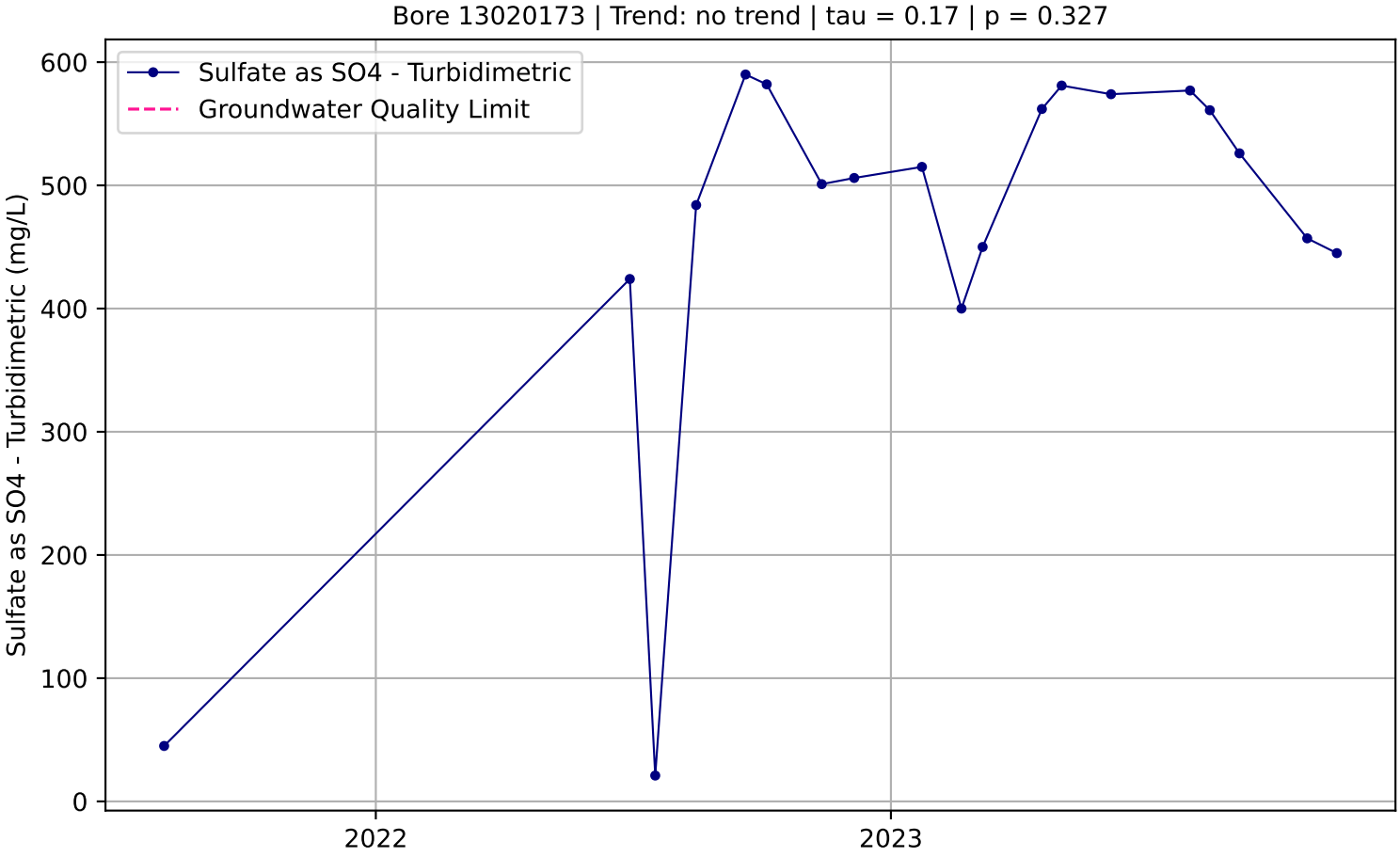

Bore 13020173 | Trend: decreasing | tau = -0.49 | p = 0.002
Magnesium
Magnesium (mg/L)
160
150
140
130
120
110
100
2021
2022
2023
2024

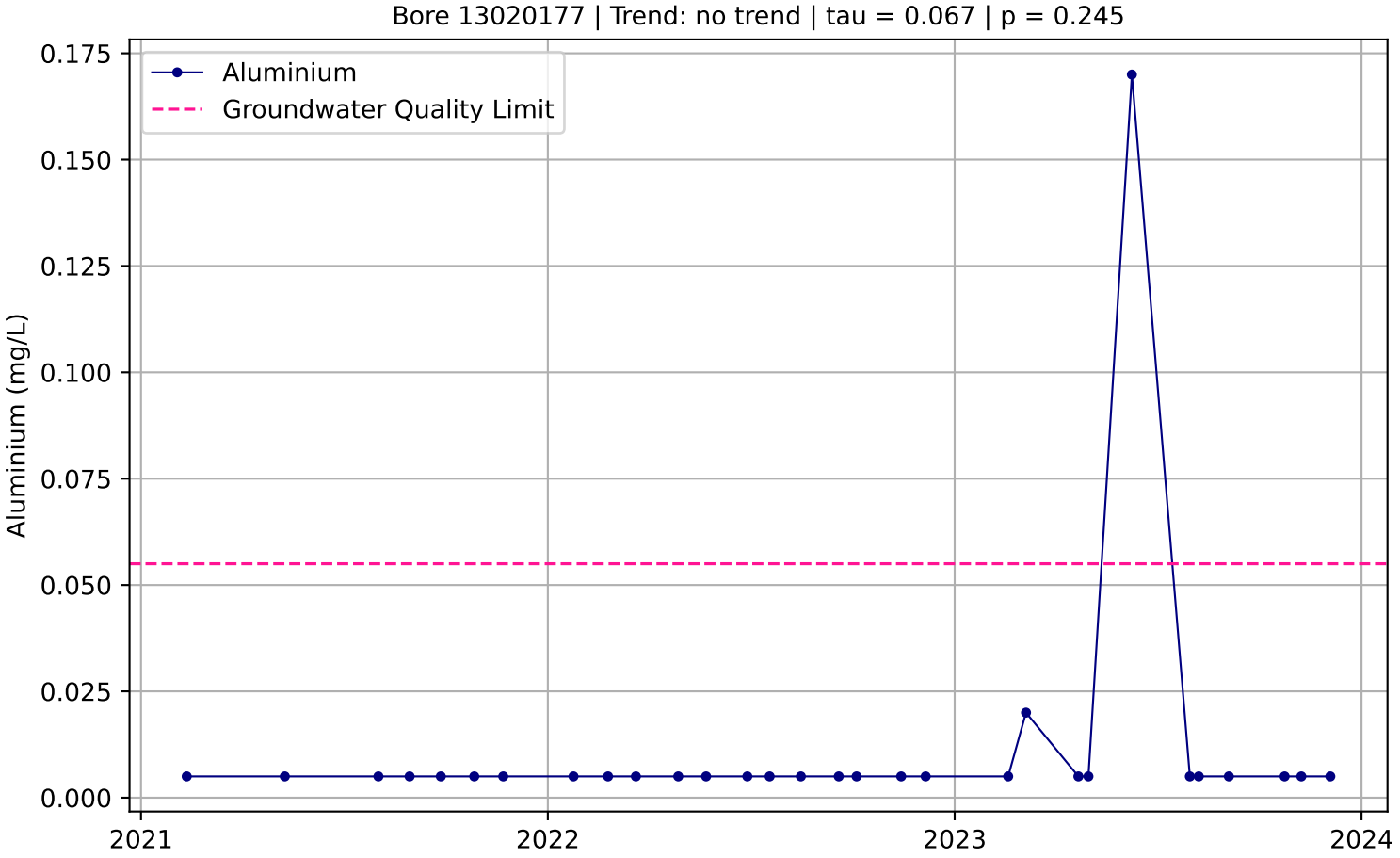

Bore 13020173 | Trend: increasing | tau = 0.485 | p = 0.002
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2022
2023
Molybdenum
Groundwater Quality Limit

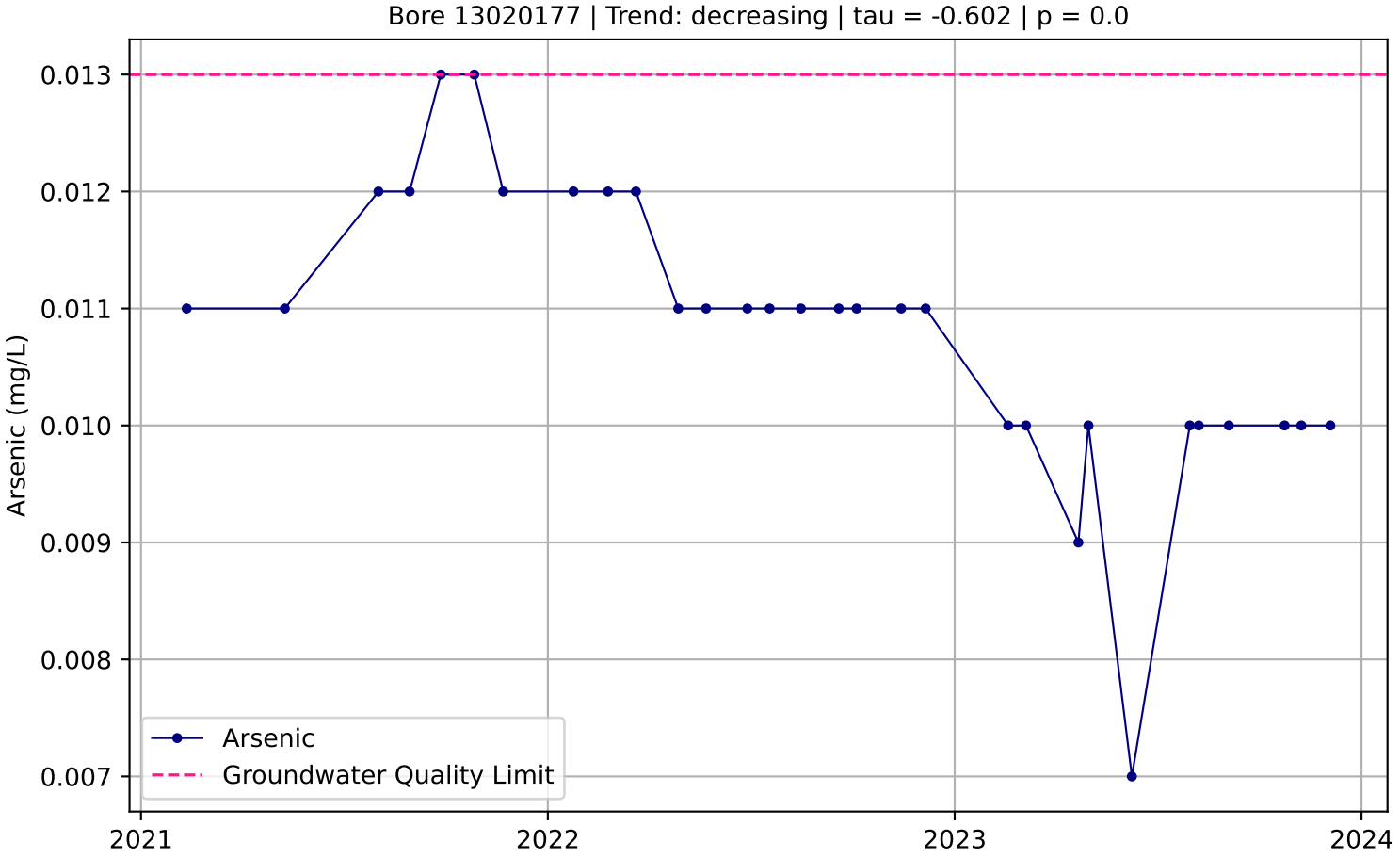

Bore 13020173 | Trend: decreasing | tau = -0.338 | p = 0.026
Potassium
Potassium (mg/L)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
2021
2022
2023
2024

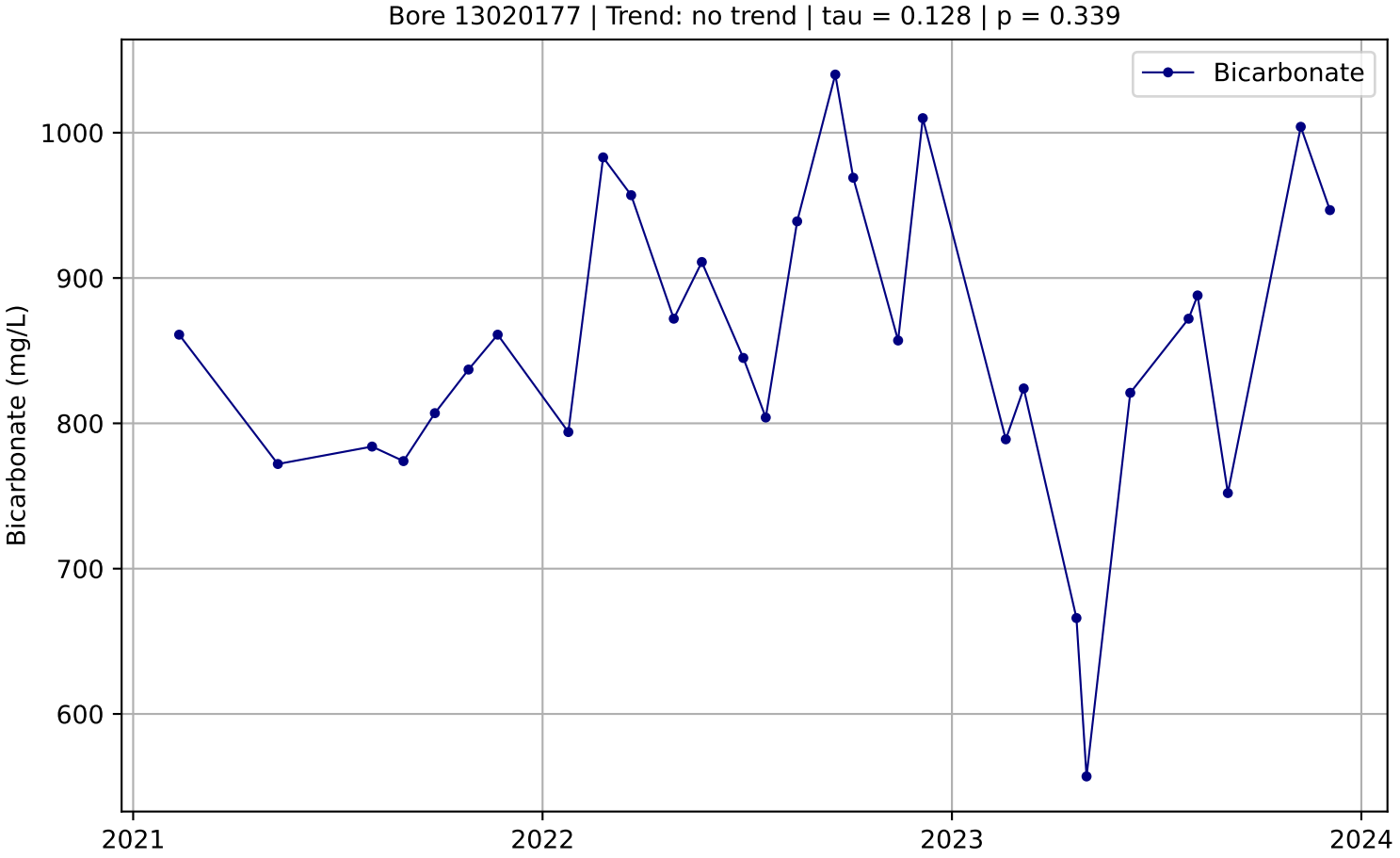

Bore 13020173 | Trend: no trend | tau = -0.105 | p = 0.548
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2022
2023
Selenium
Groundwater Quality Limit

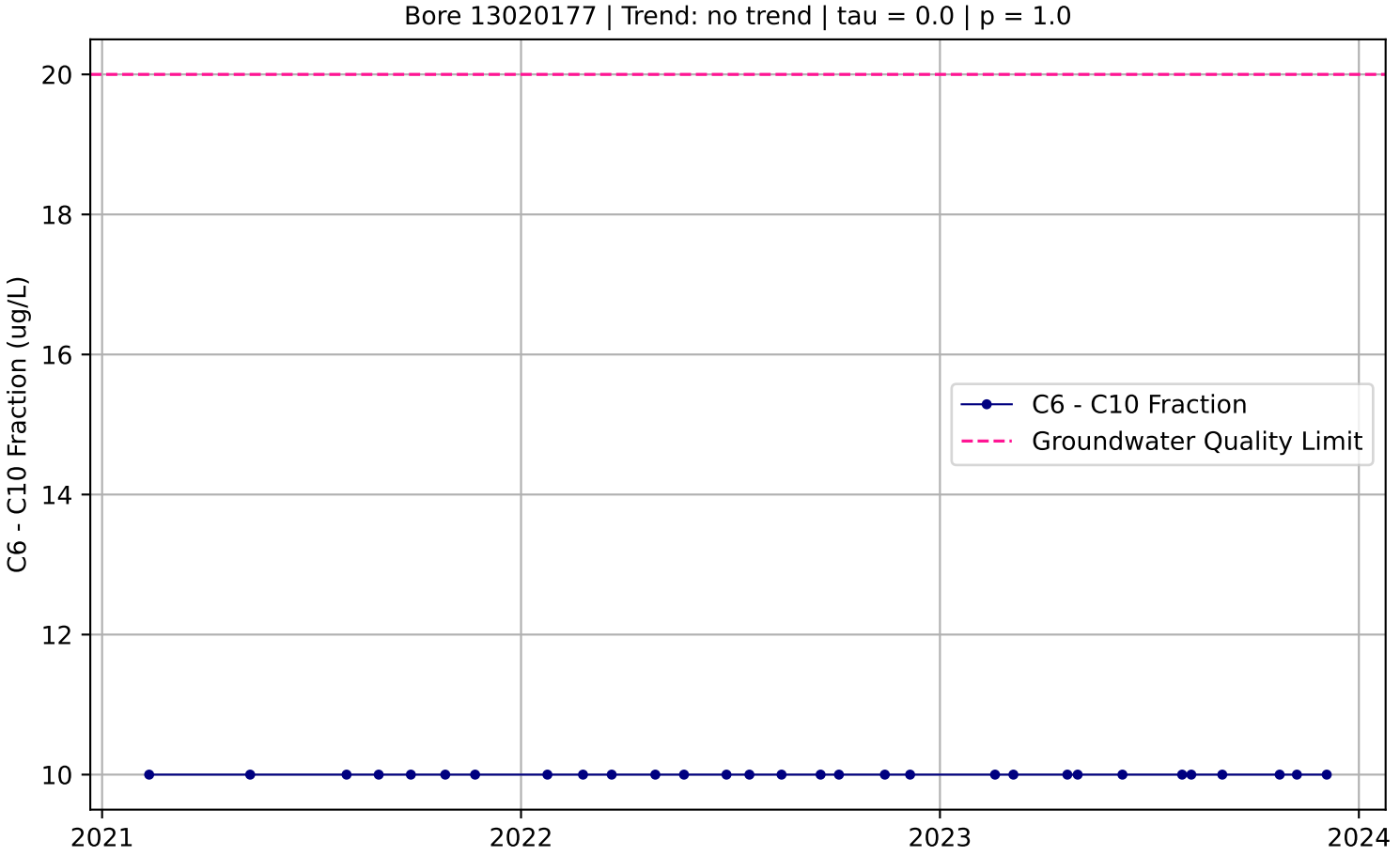

Bore 13020173 | Trend: decreasing | tau = -0.781 | p = 0.0
Sodium
Sodium (mg/L)
950
900
850
800
750
700
650
2021
2022
2023
2024

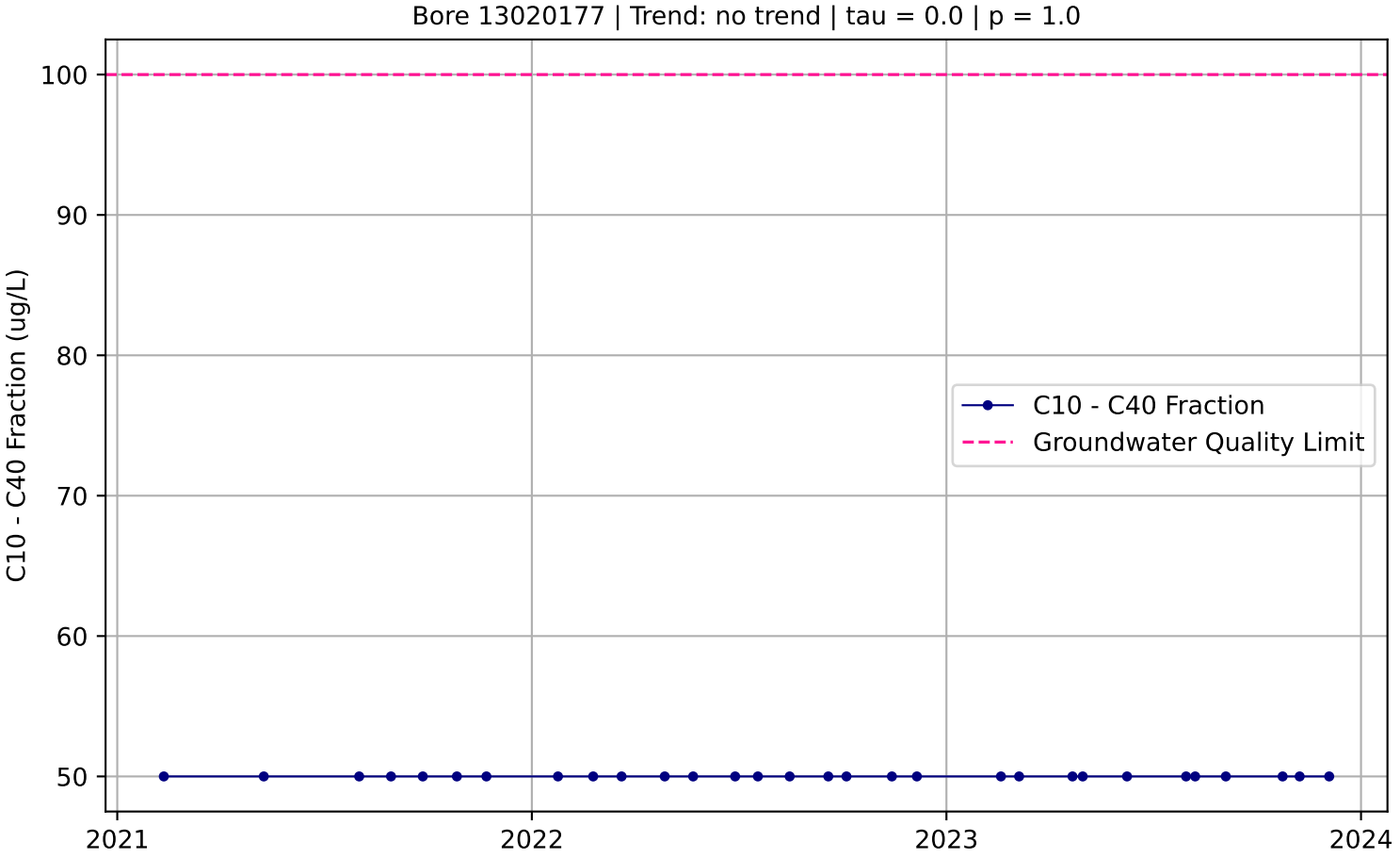

Bore 13020173 | Trend: no trend | tau = 0.17 | p = 0.327
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
0
100
200
300
400
500
600
2022
2023

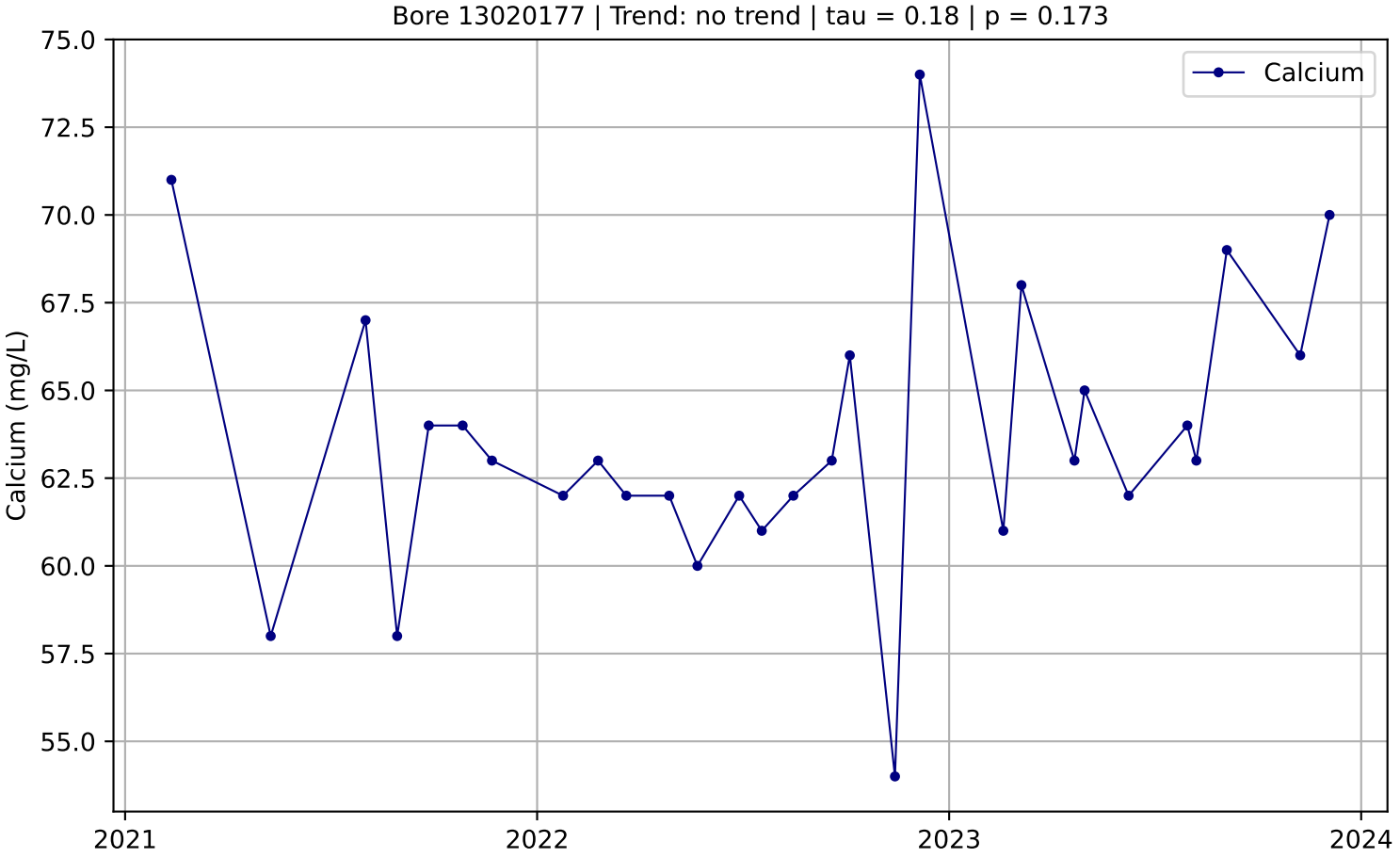

Bore 13020177 | Trend: no trend | tau = 0.067 | p = 0.245
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
2021
2022
2023
2024

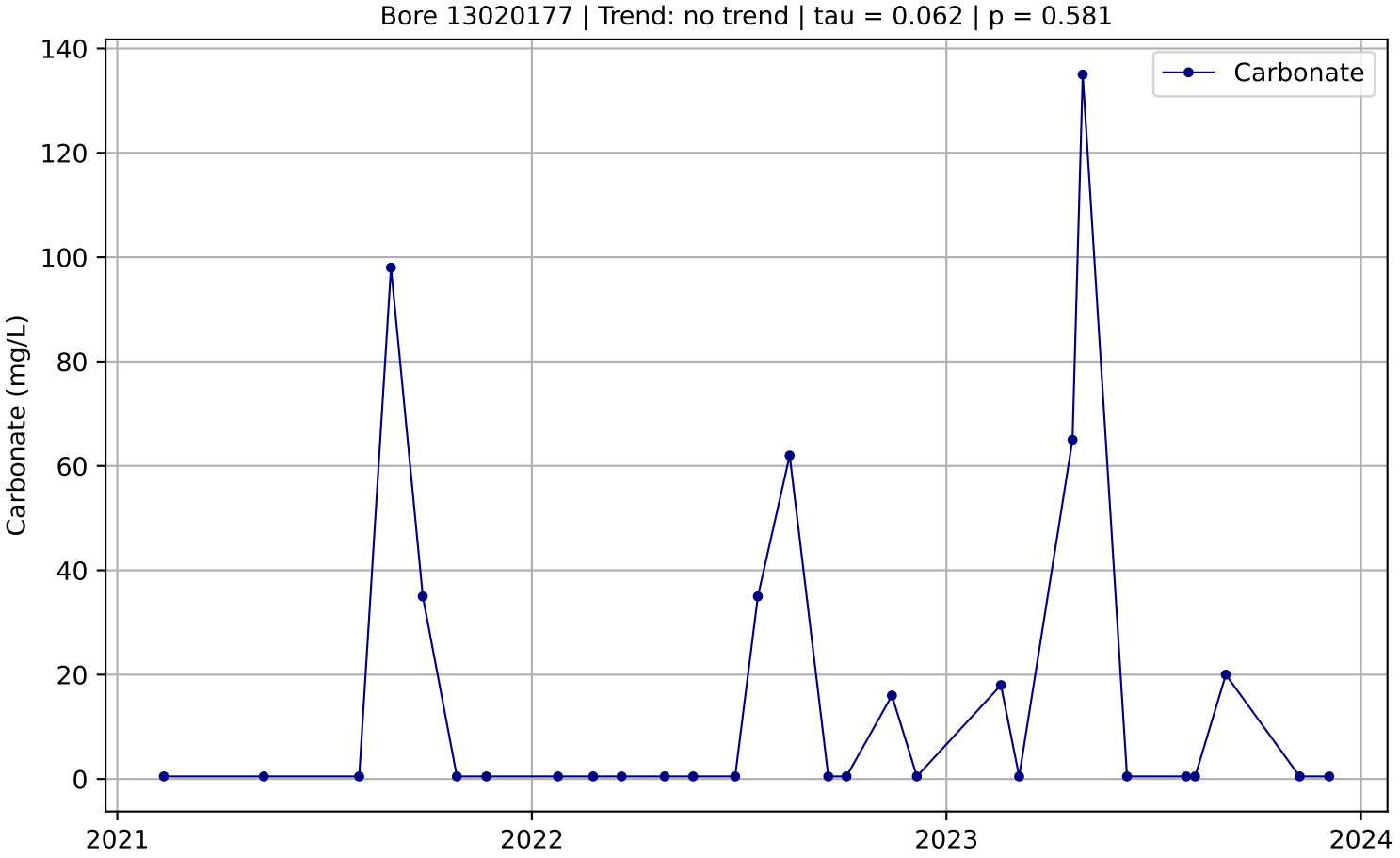

Bore 13020177 | Trend: decreasing | tau = -0.602 | p = 0.0
Arsenic (mg/L)
0.013
0.012
0.011
0.010
0.009
0.008
0.007
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

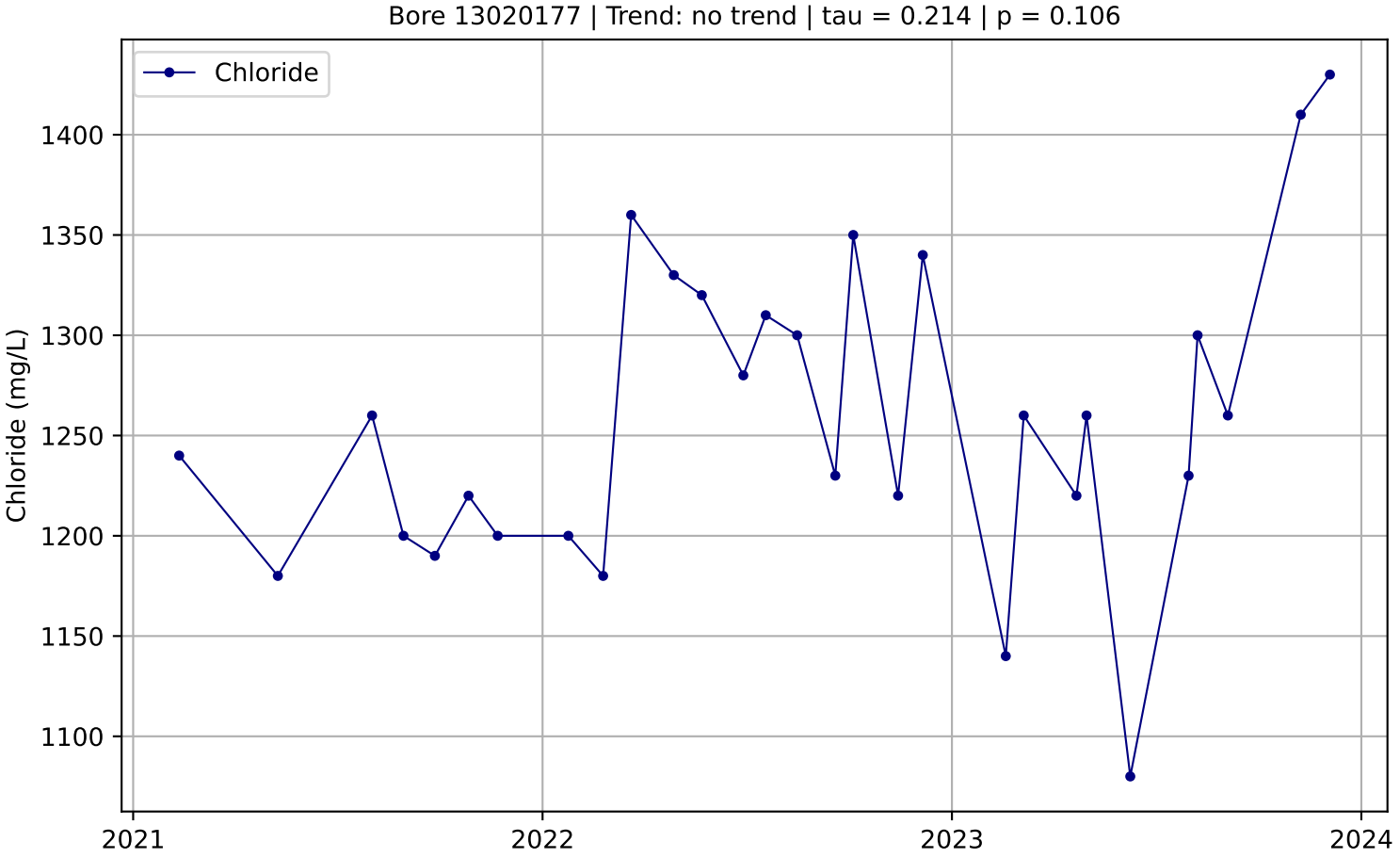

Bore 13020177 | Trend: no trend | tau = 0.128 | p = 0.339
Bicarbonate
Bicarbonate (mg/L)
1000
900
800
700
600
2021
2022
2023
2024

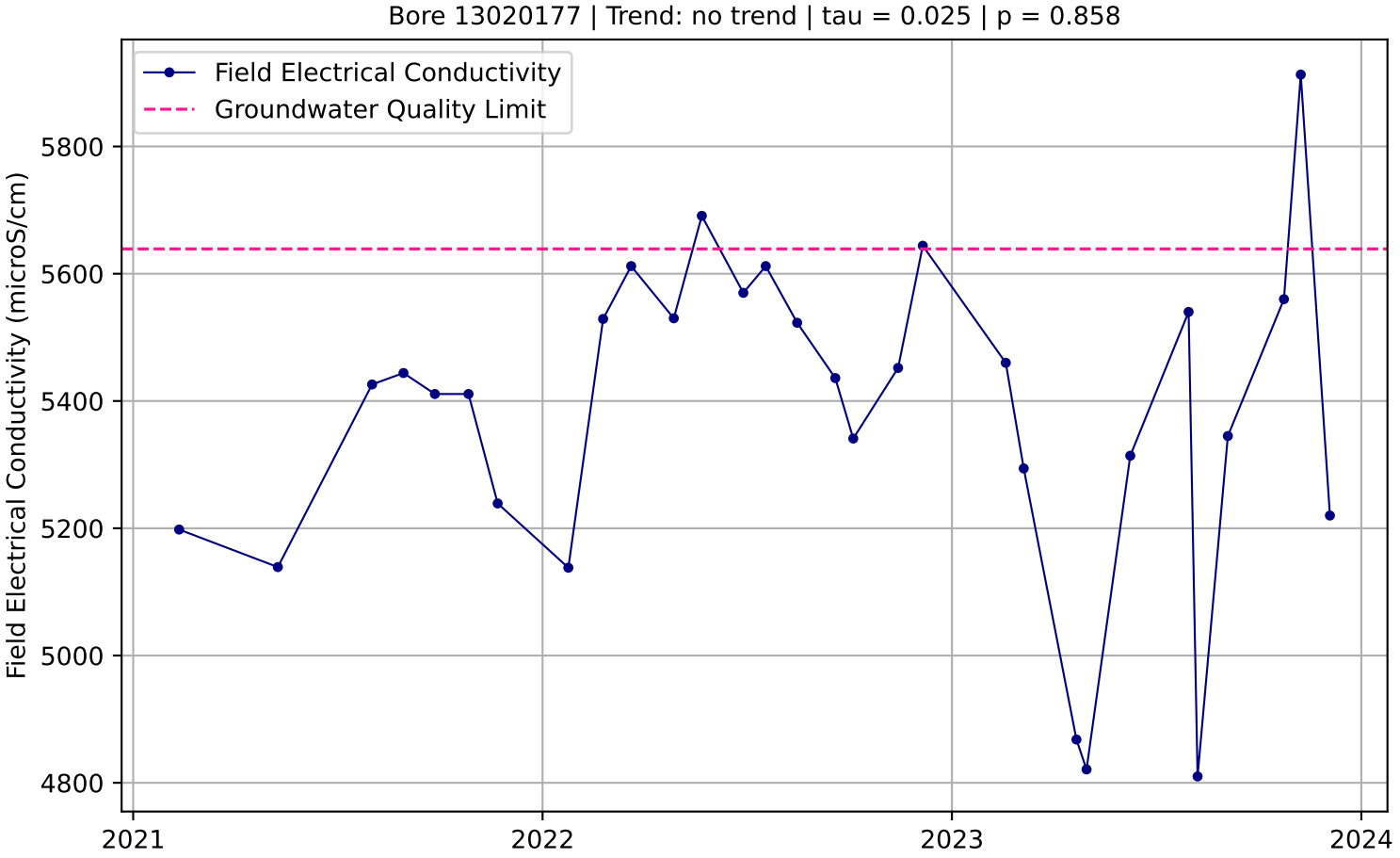

Bore 13020177 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

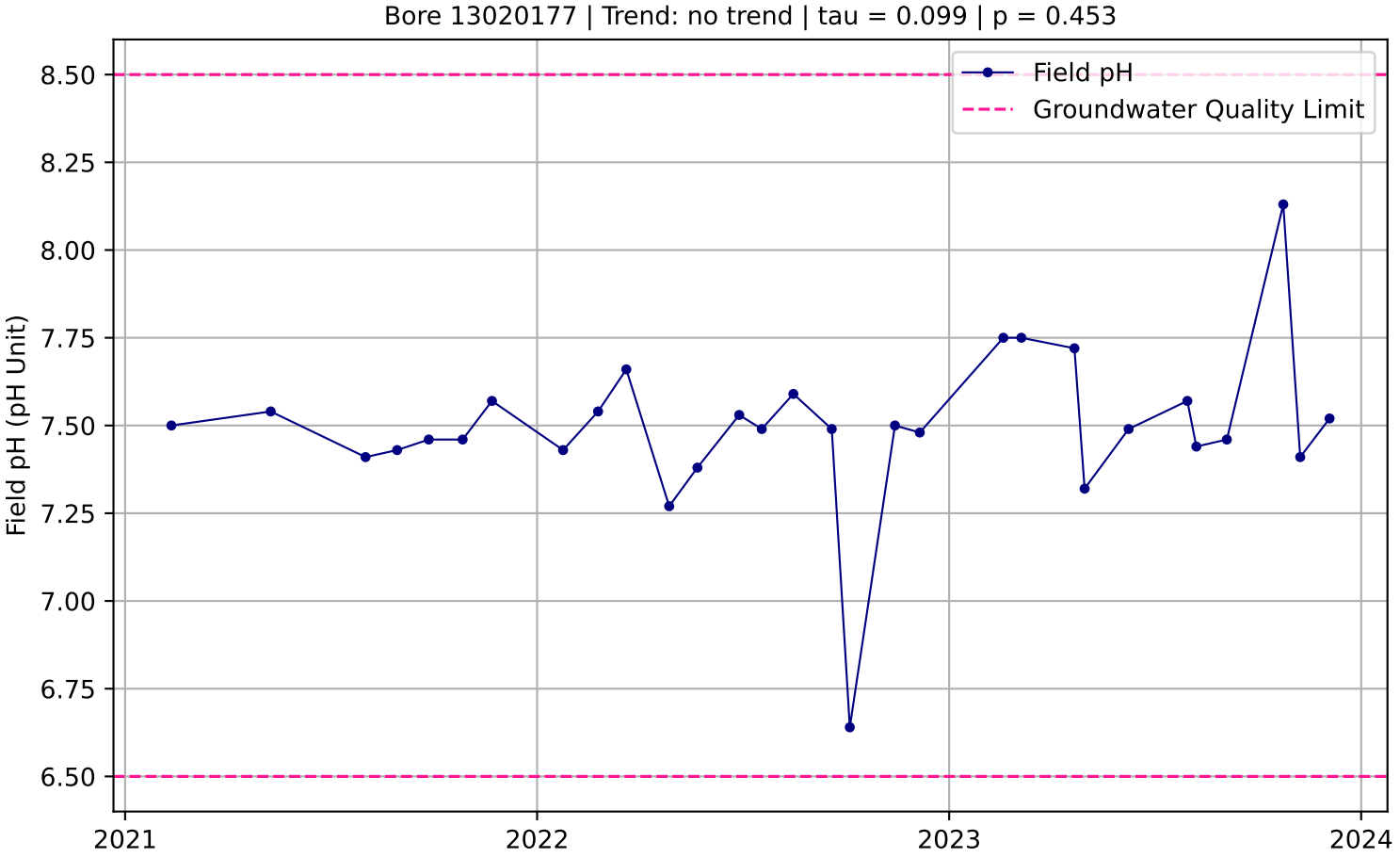

Bore 13020177 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

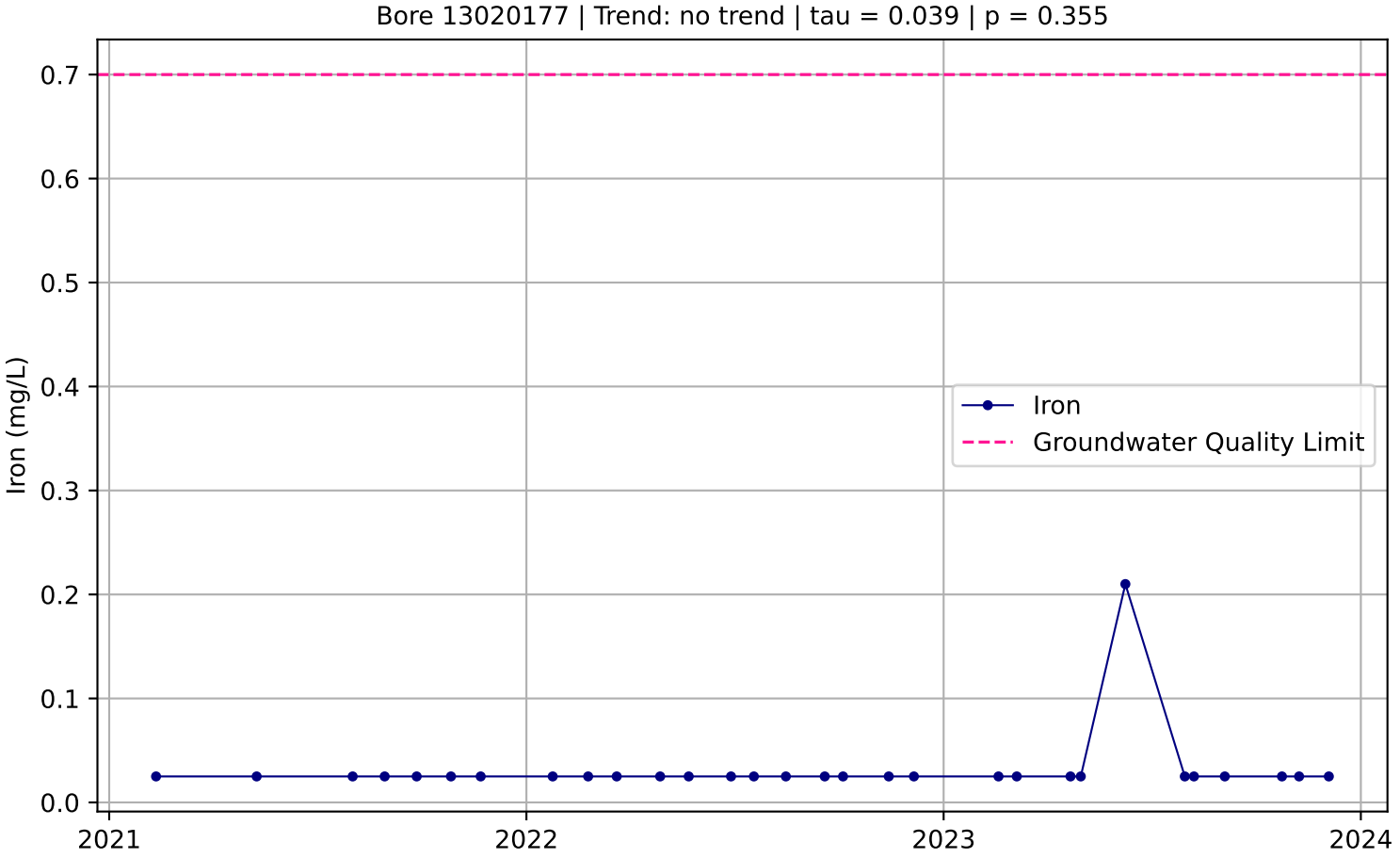

Bore 13020177 | Trend: no trend | tau = 0.18 | p = 0.173
Calcium
Calcium (mg/L)
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
2021
2022
2023
2024

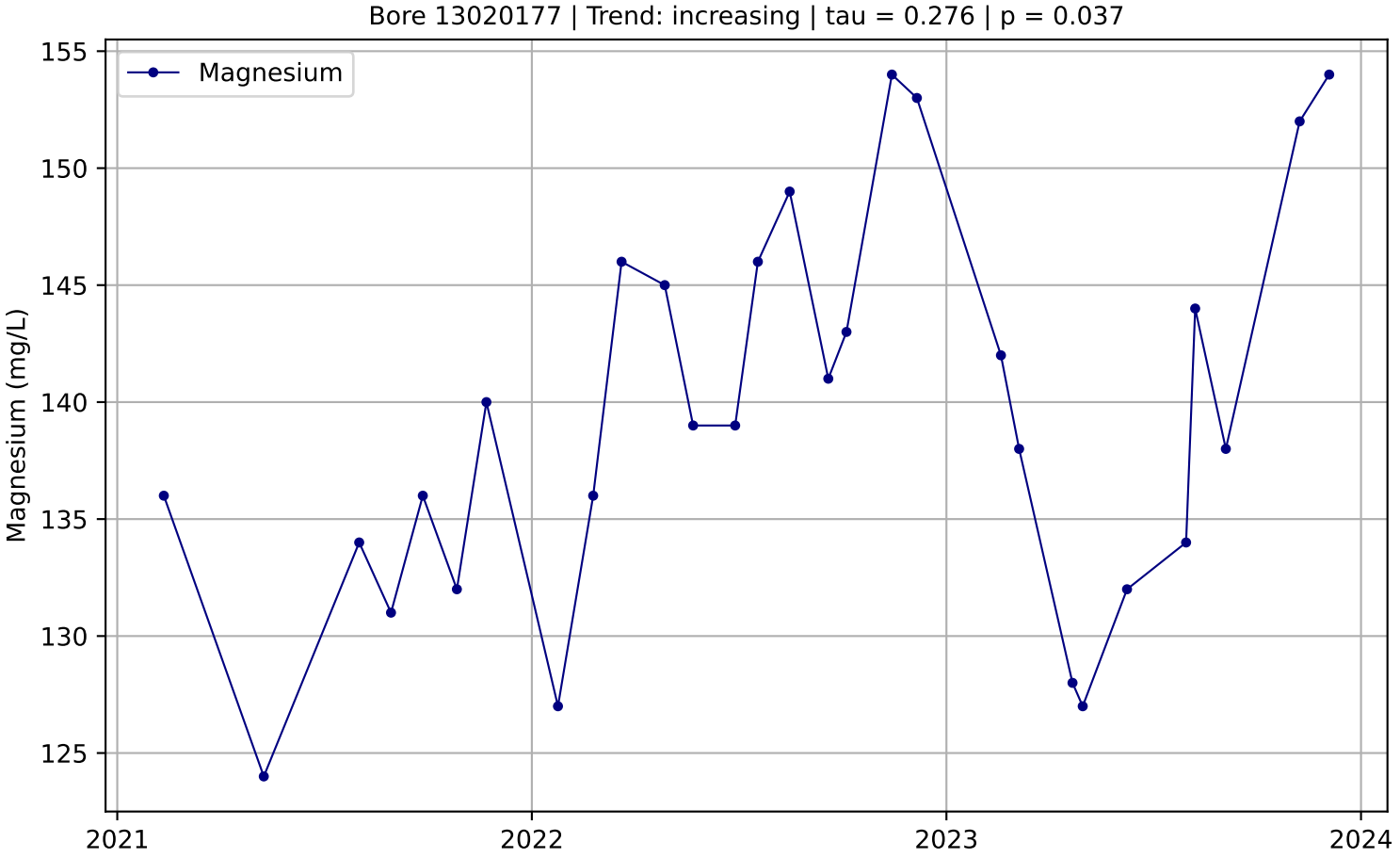

Bore 13020177 | Trend: no trend | tau = 0.062 | p = 0.581
Carbonate
Carbonate (mg/L)
140
120
100
80
60
40
20
0
2021
2022
2023
2024

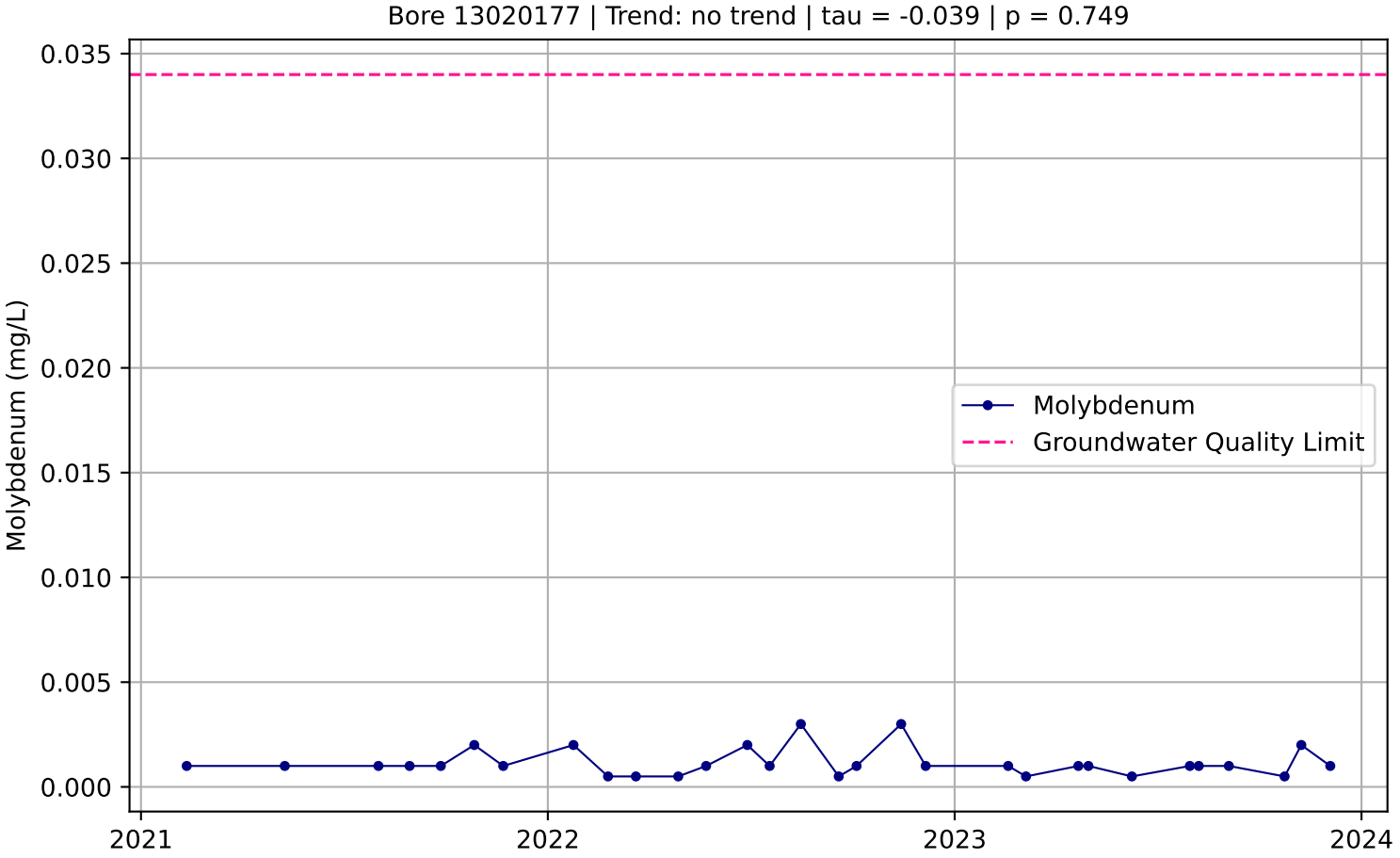

Bore 13020177 | Trend: no trend | tau = 0.214 | p = 0.106
Chloride
Chloride (mg/L)
1400
1350
1300
1250
1200
1150
1100
2021
2022
2023
2024

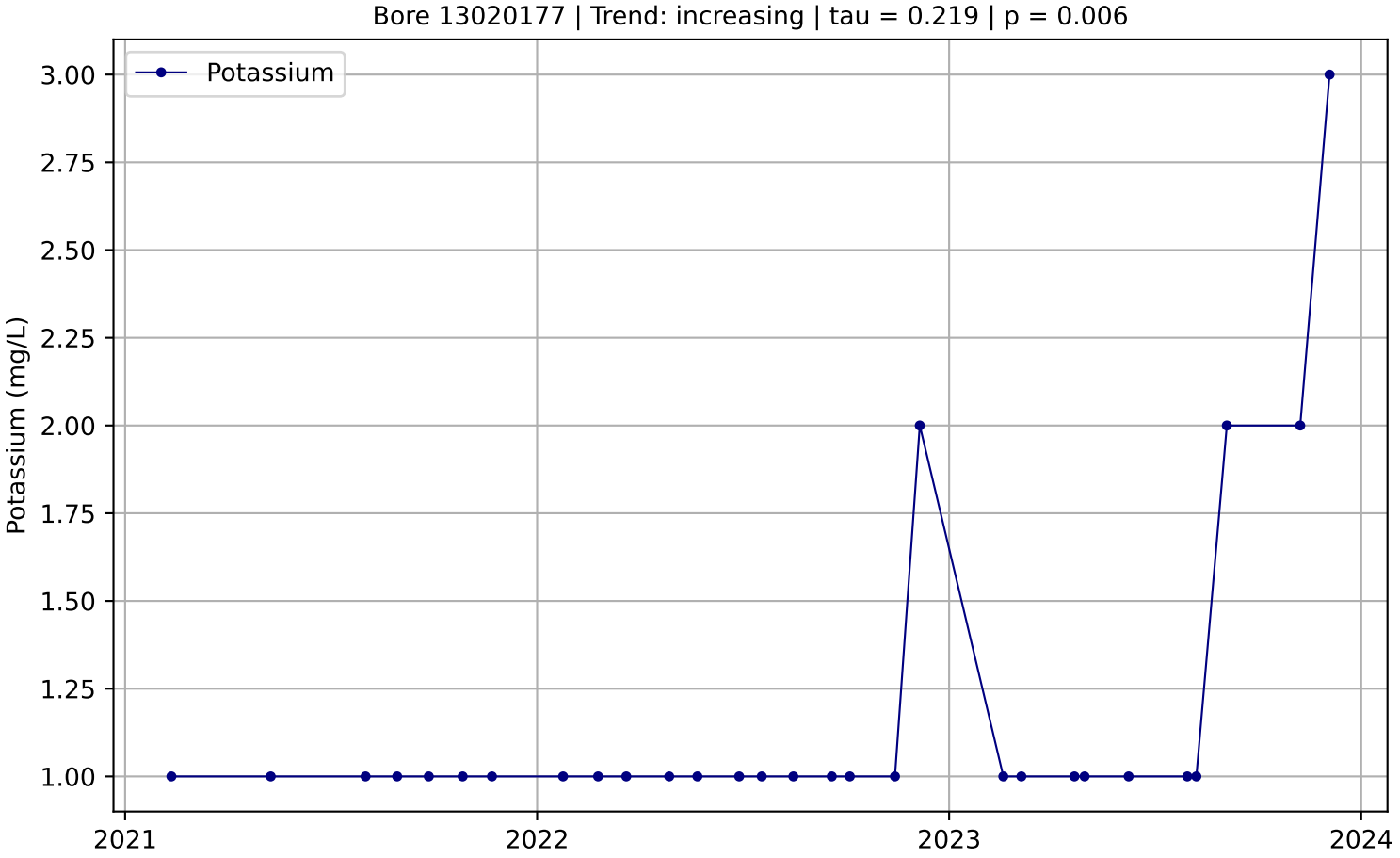

Bore 13020177 | Trend: no trend | tau = 0.025 | p = 0.858
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
5800
5600
5400
5200
5000
4800
2021
2022
2023
2024

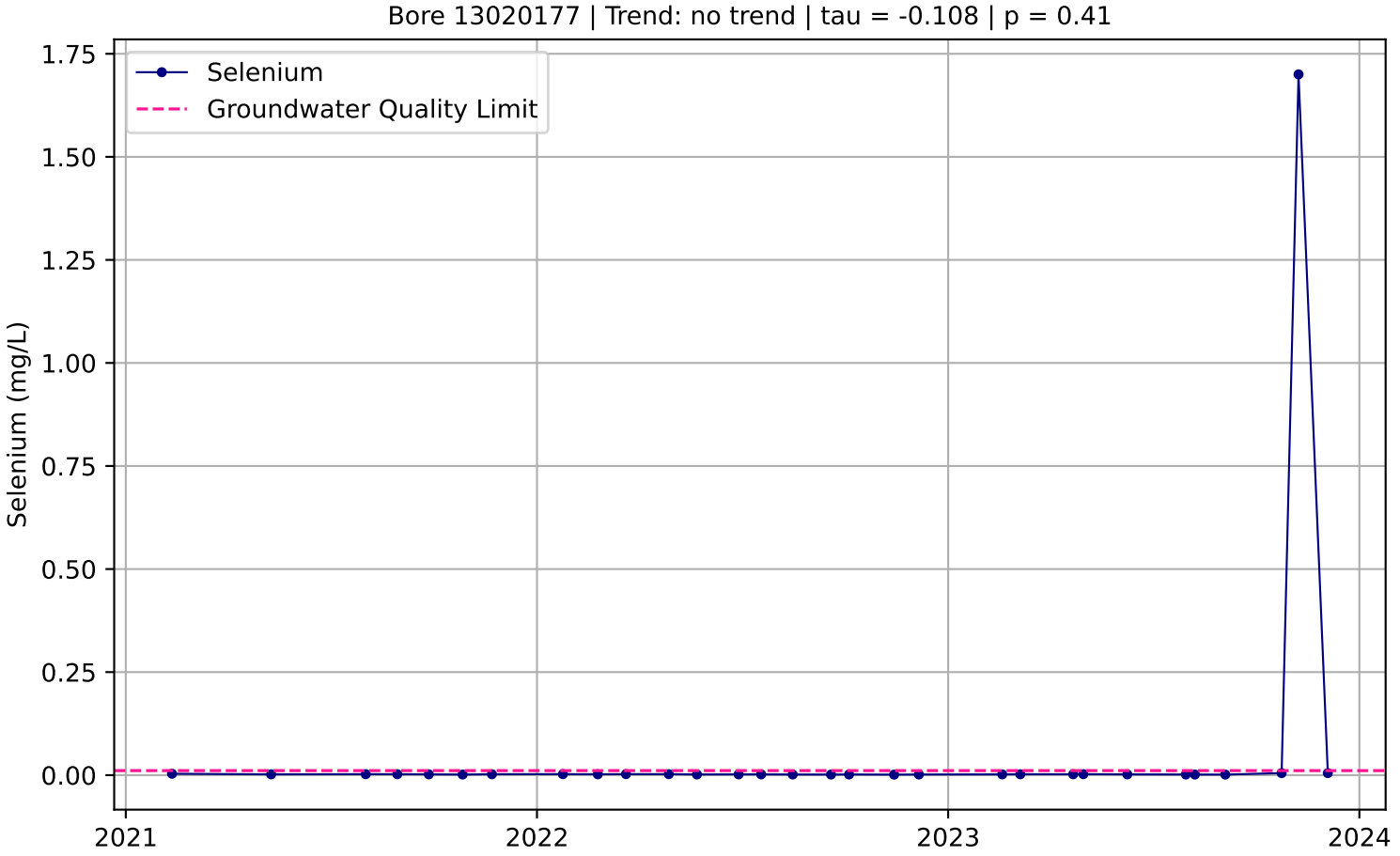

Bore 13020177 | Trend: no trend | tau = 0.099 | p = 0.453
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2021
2022
2023
2024

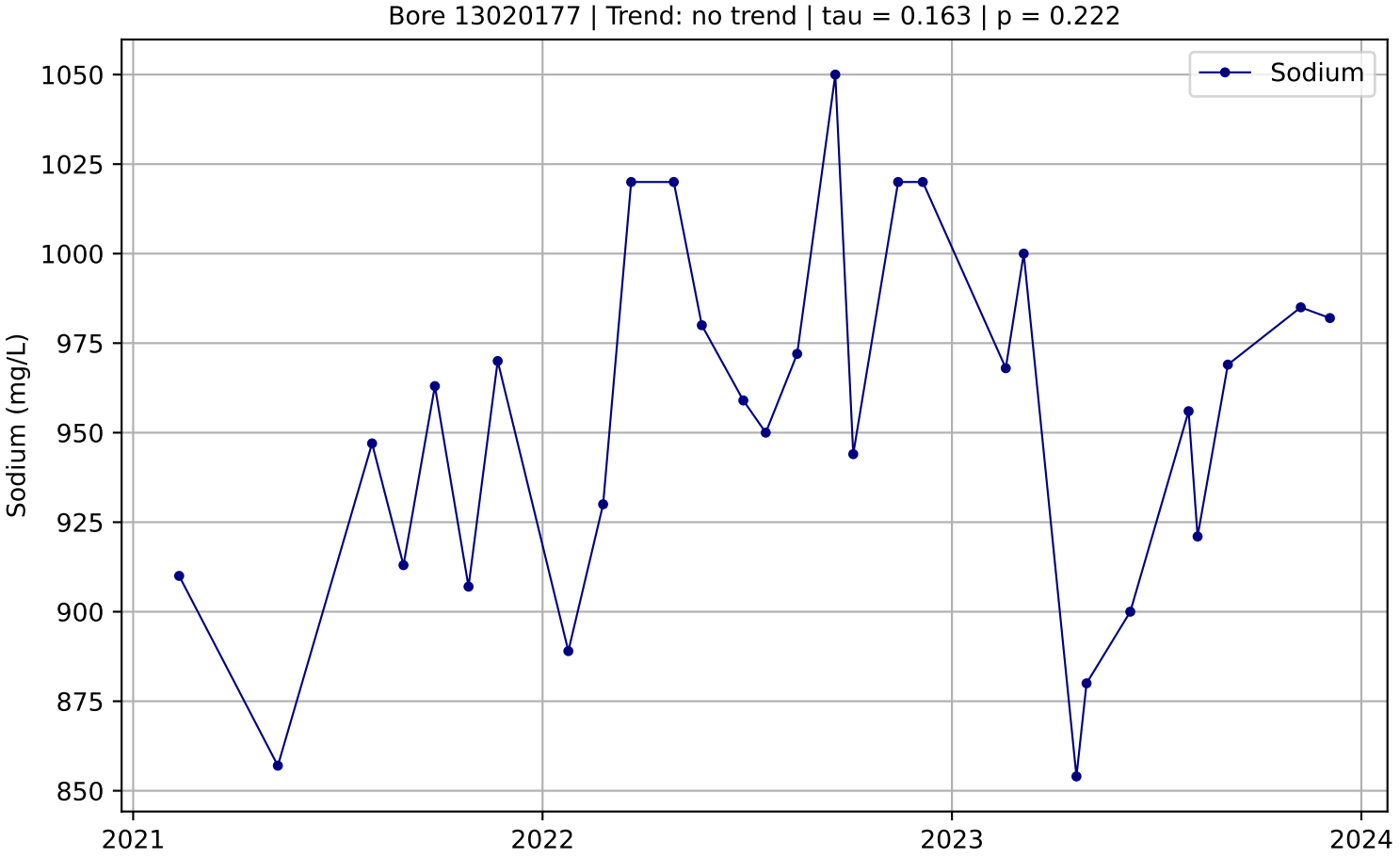

Bore 13020177 | Trend: no trend | tau = 0.039 | p = 0.355
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2021
2022
2023
2024
Iron
Groundwater Quality Limit

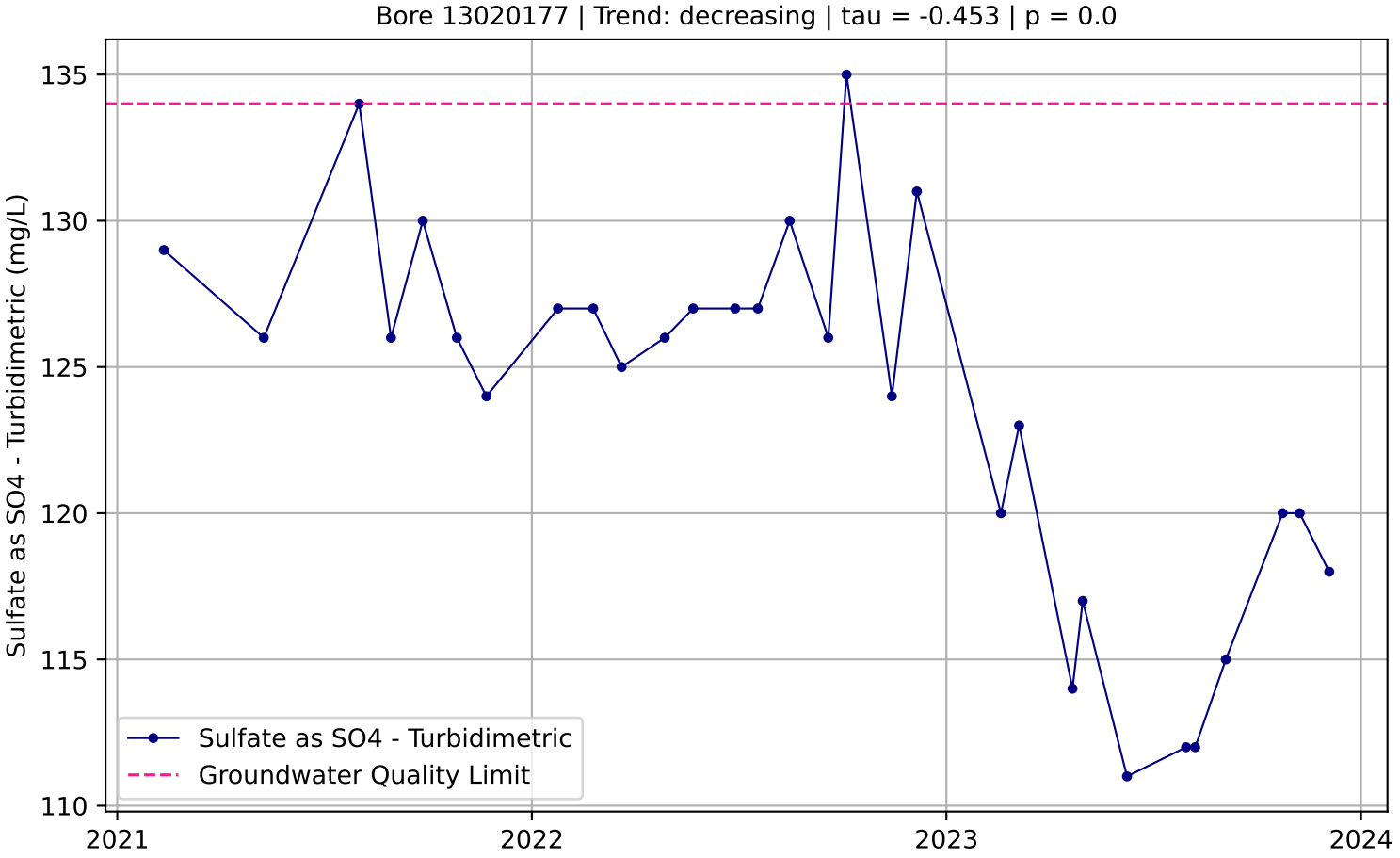

Bore 13020177 | Trend: increasing | tau = 0.276 | p = 0.037
Magnesium
Magnesium (mg/L)
155
150
145
140
135
130
125
2021
2022
2023
2024

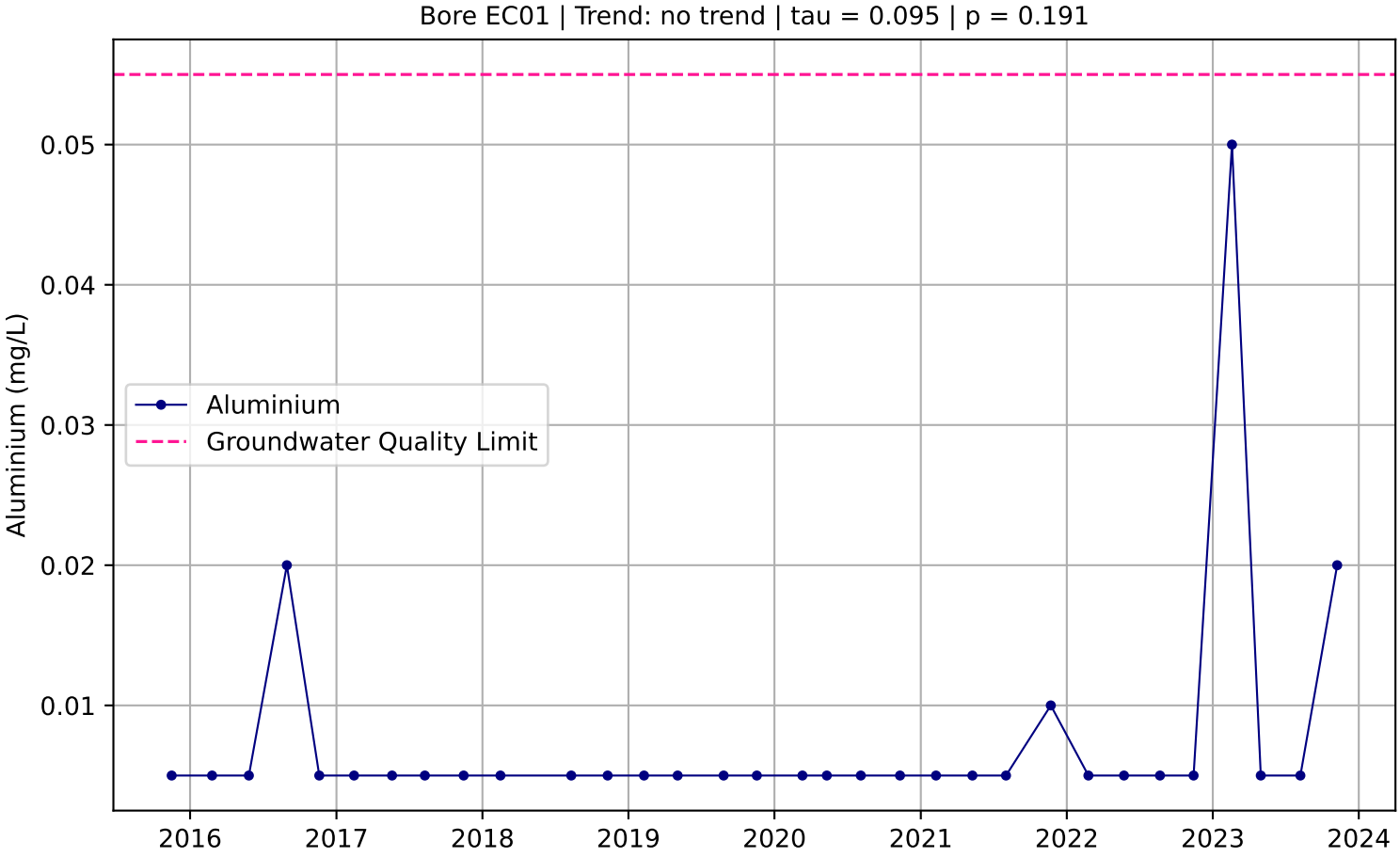

Bore 13020177 | Trend: no trend | tau = -0.039 | p = 0.749
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

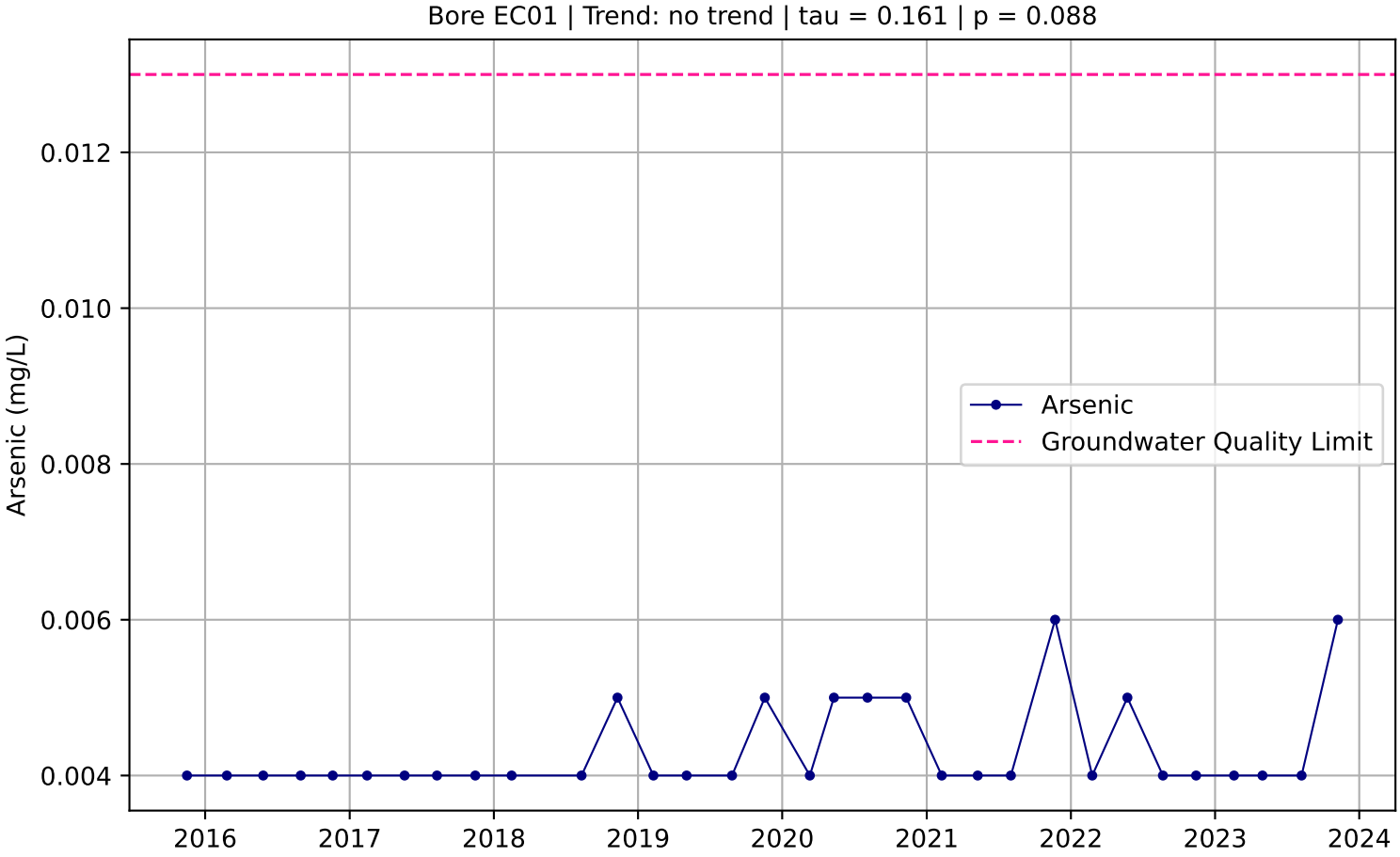

Bore 13020177 | Trend: increasing | tau = 0.219 | p = 0.006
Potassium
Potassium (mg/L)
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
2021
2022
2023
2024

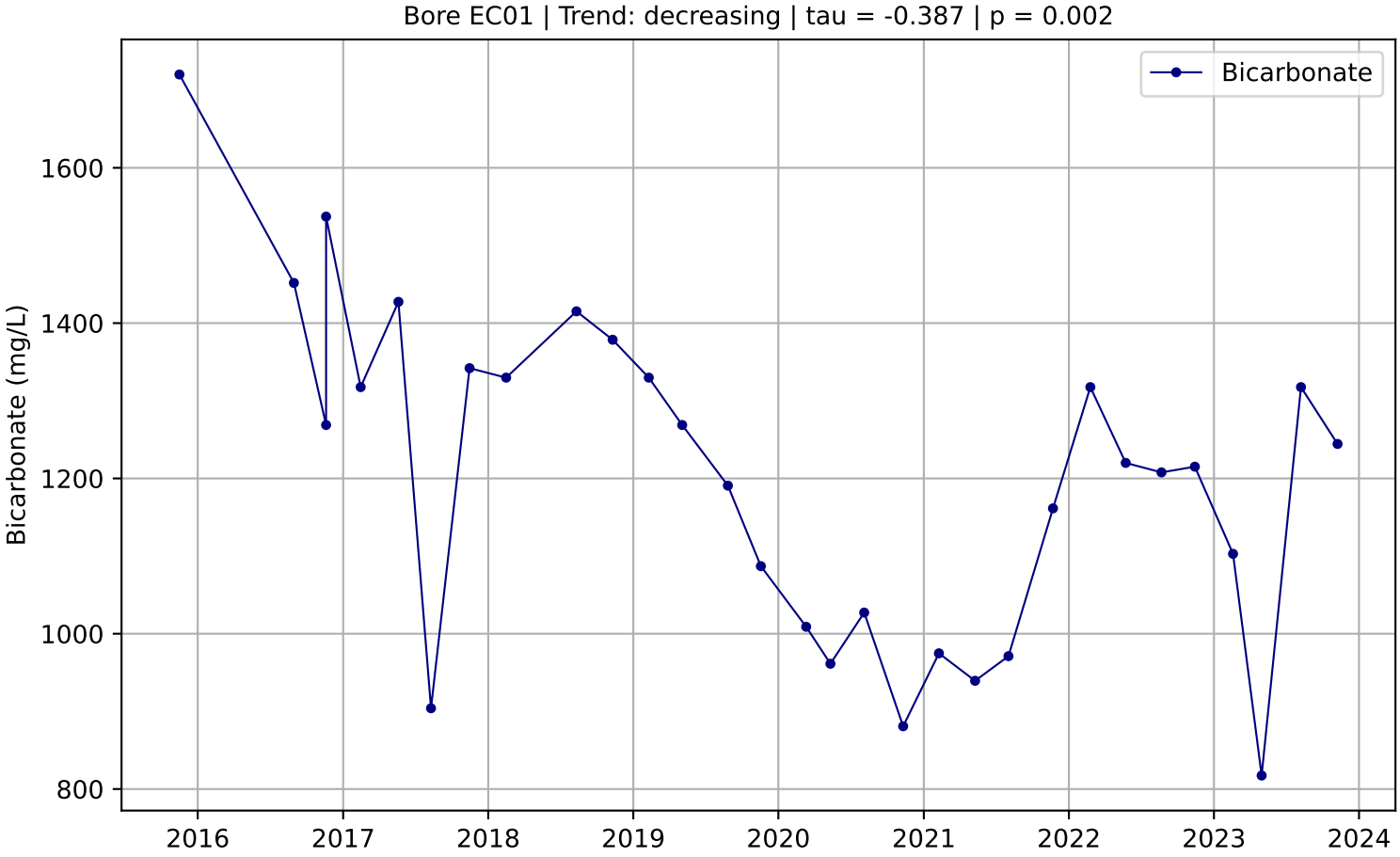

Bore 13020177 | Trend: no trend | tau = -0.108 | p = 0.41
Selenium
Groundwater Quality Limit
Selenium (mg/L)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2021
2022
2023
2024

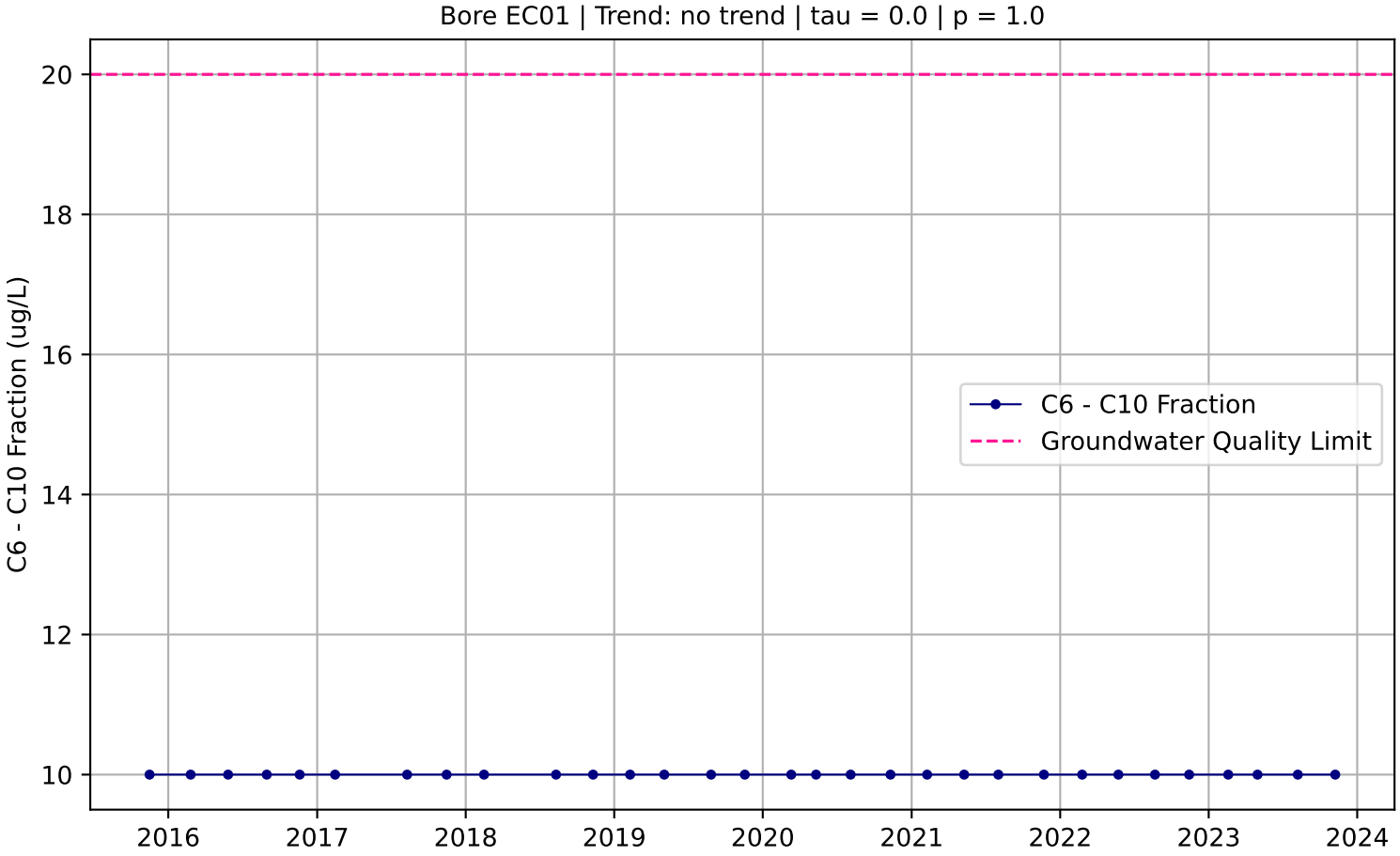

Bore 13020177 | Trend: no trend | tau = 0.163 | p = 0.222
Sodium
Sodium (mg/L)
1050
1025
1000
975
950
925
900
875
850
2021
2022
2023
2024

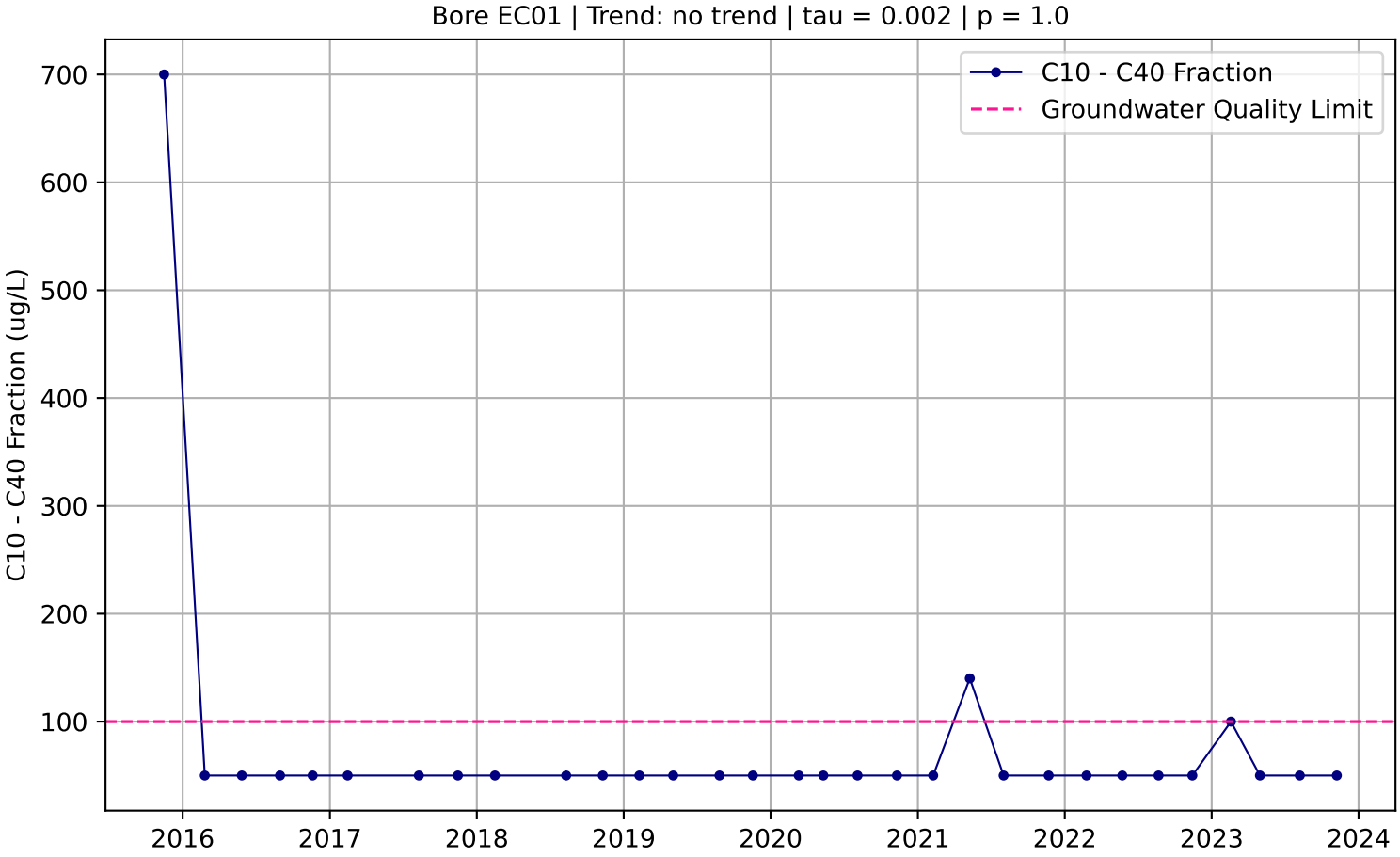

Bore 13020177 | Trend: decreasing | tau = -0.453 | p = 0.0
Sulfate as SO4 - Turbidimetric (mg/L)
135
130
125
120
115
110
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

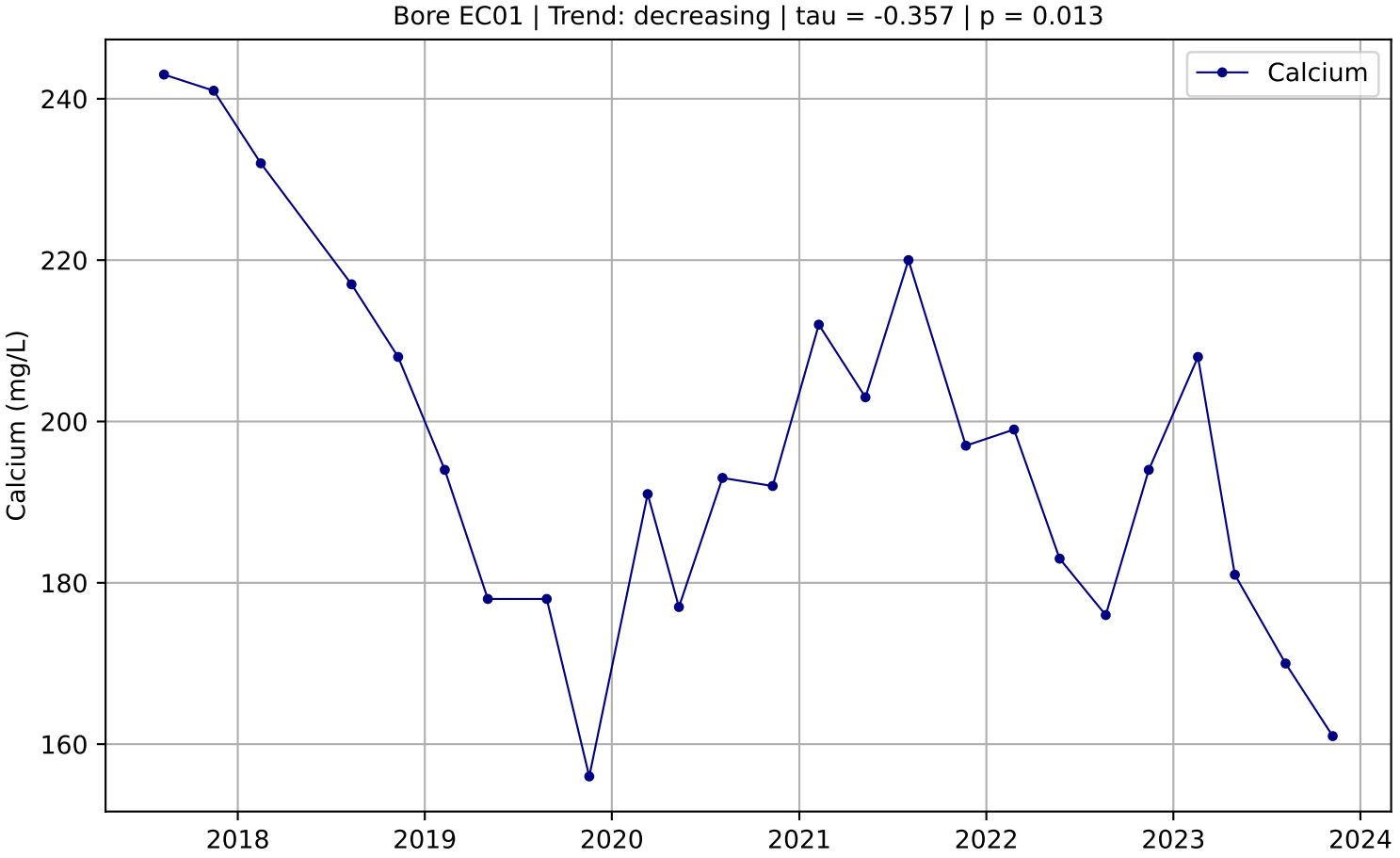

Bore EC01 | Trend: no trend | tau = 0.095 | p = 0.191
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
Aluminium
Groundwater Quality Limit
2016
2017
2018
2019
2020
2021
2022
2023
2024

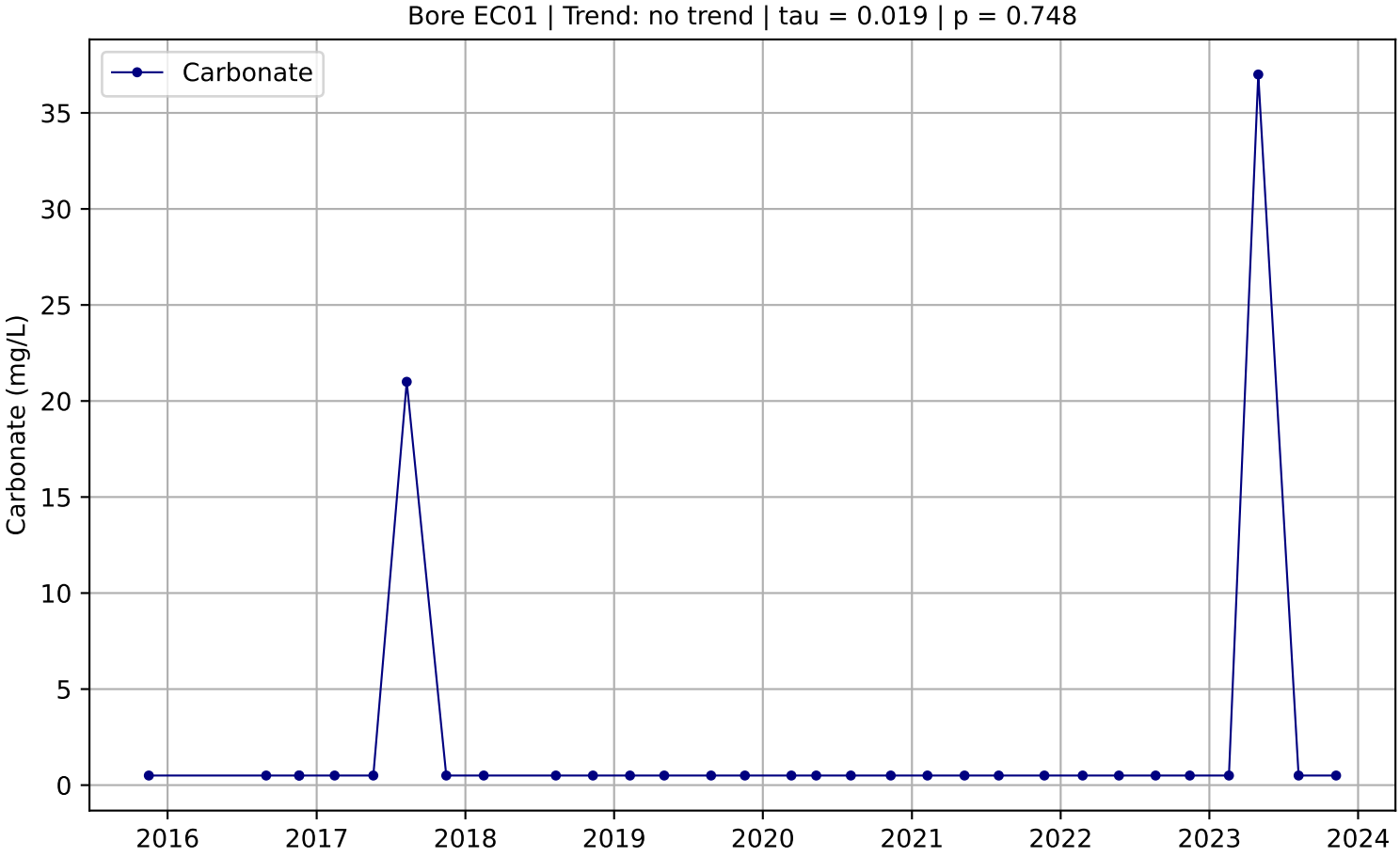

Bore EC01 | Trend: no trend | tau = 0.161 | p = 0.088
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

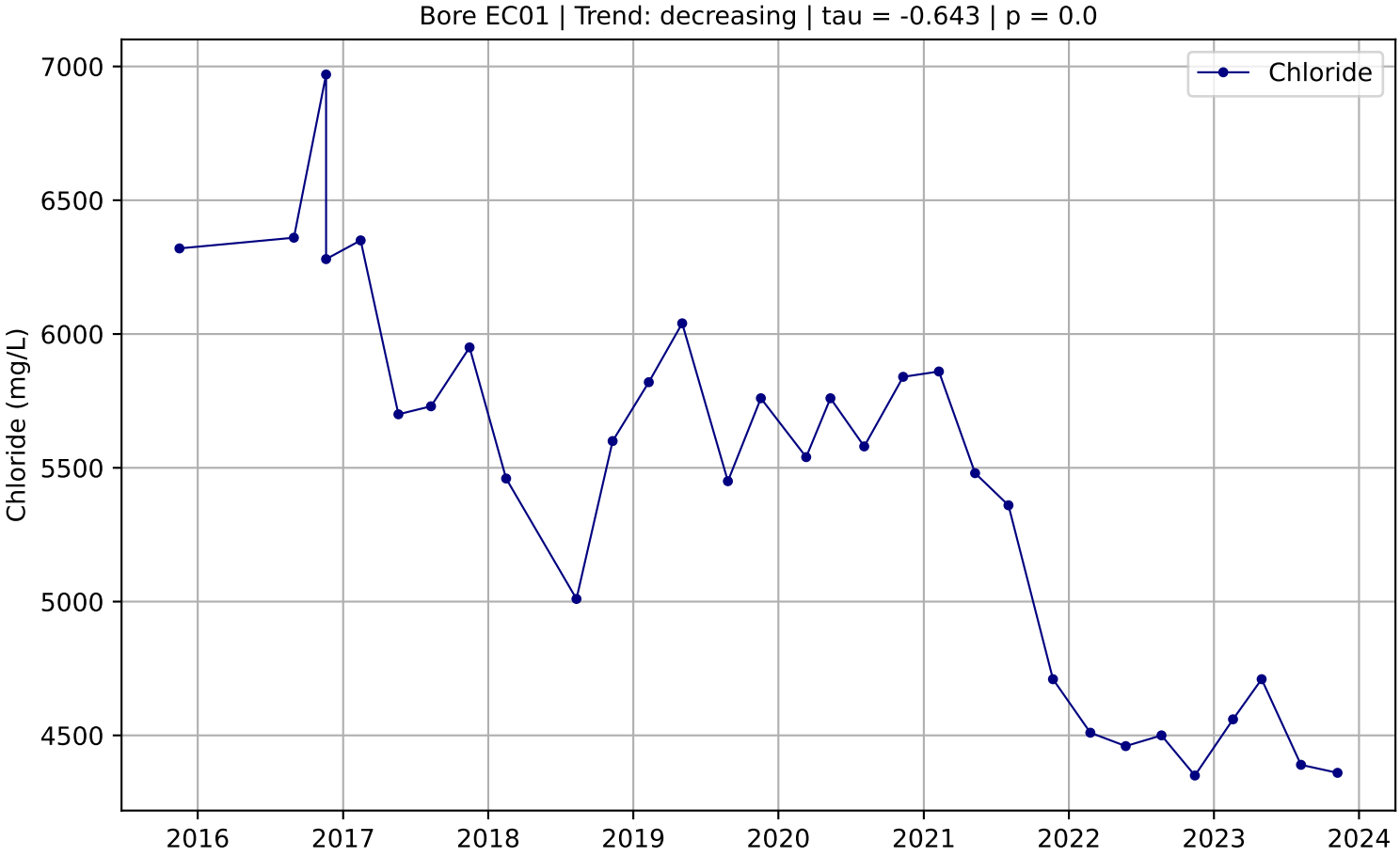

Bore EC01 | Trend: decreasing | tau = -0.387 | p = 0.002
Bicarbonate
Bicarbonate (mg/L)
1600
1400
1200
1000
800
2016
2017
2018
2019
2020
2021
2022
2023
2024

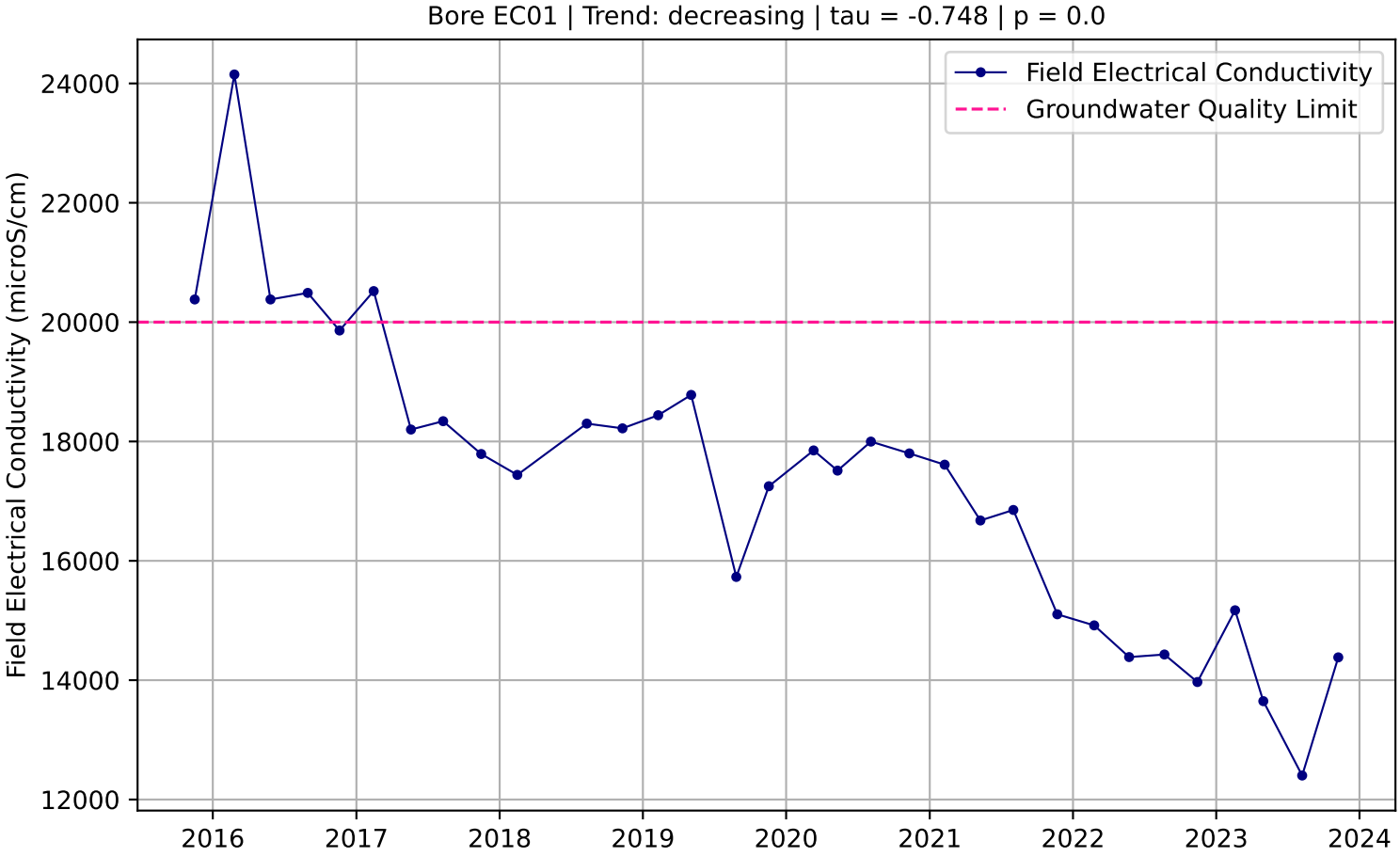

Bore EC01 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

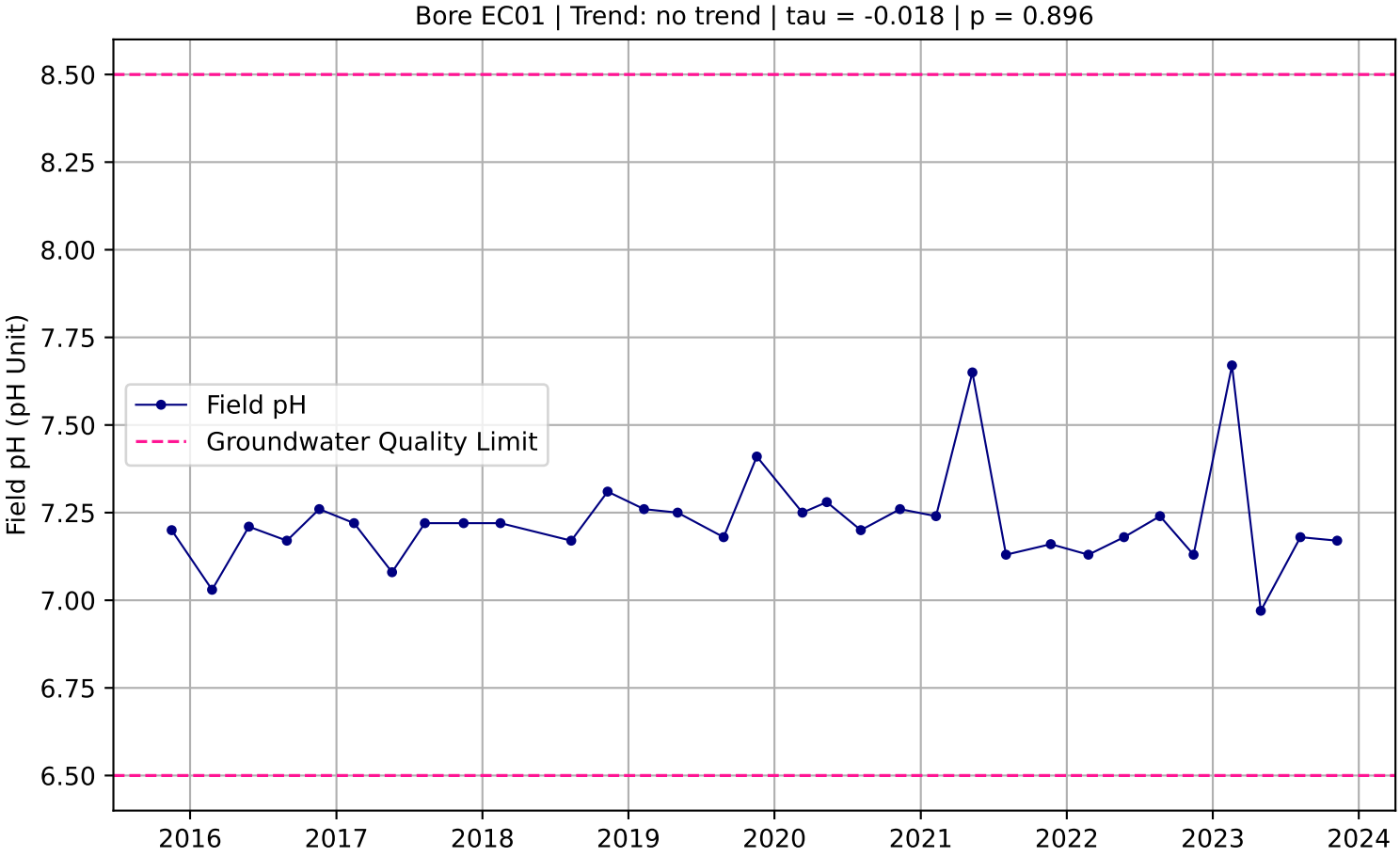

Bore EC01 | Trend: no trend | tau = 0.002 | p = 1.0
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
700
600
500
400
300
200
100
2016
2017
2018
2019
2020
2021
2022
2023
2024

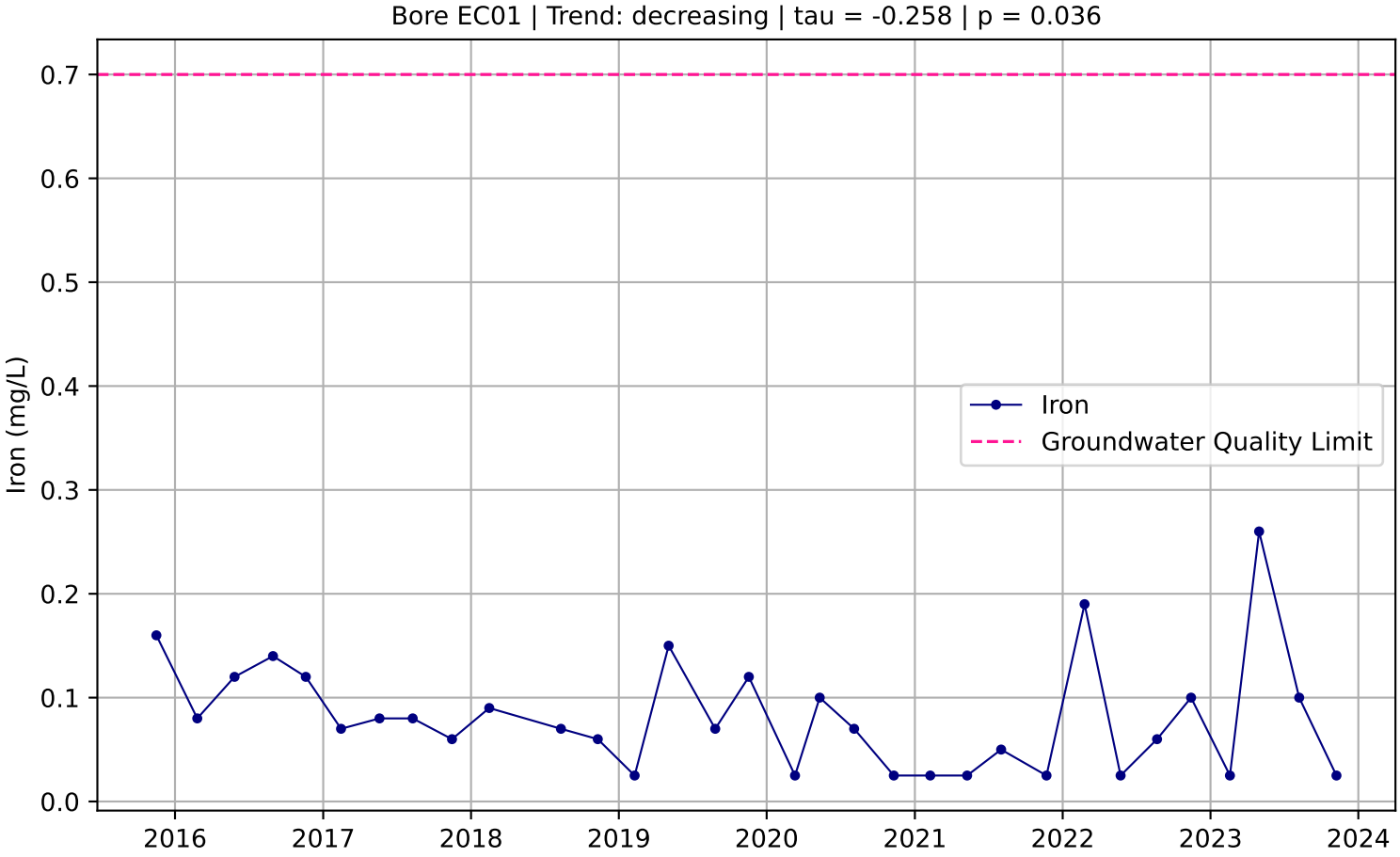

Bore EC01 | Trend: decreasing | tau = -0.357 | p = 0.013
Calcium
Calcium (mg/L)
240
220
200
180
160
2018
2019
2020
2021
2022
2023
2024

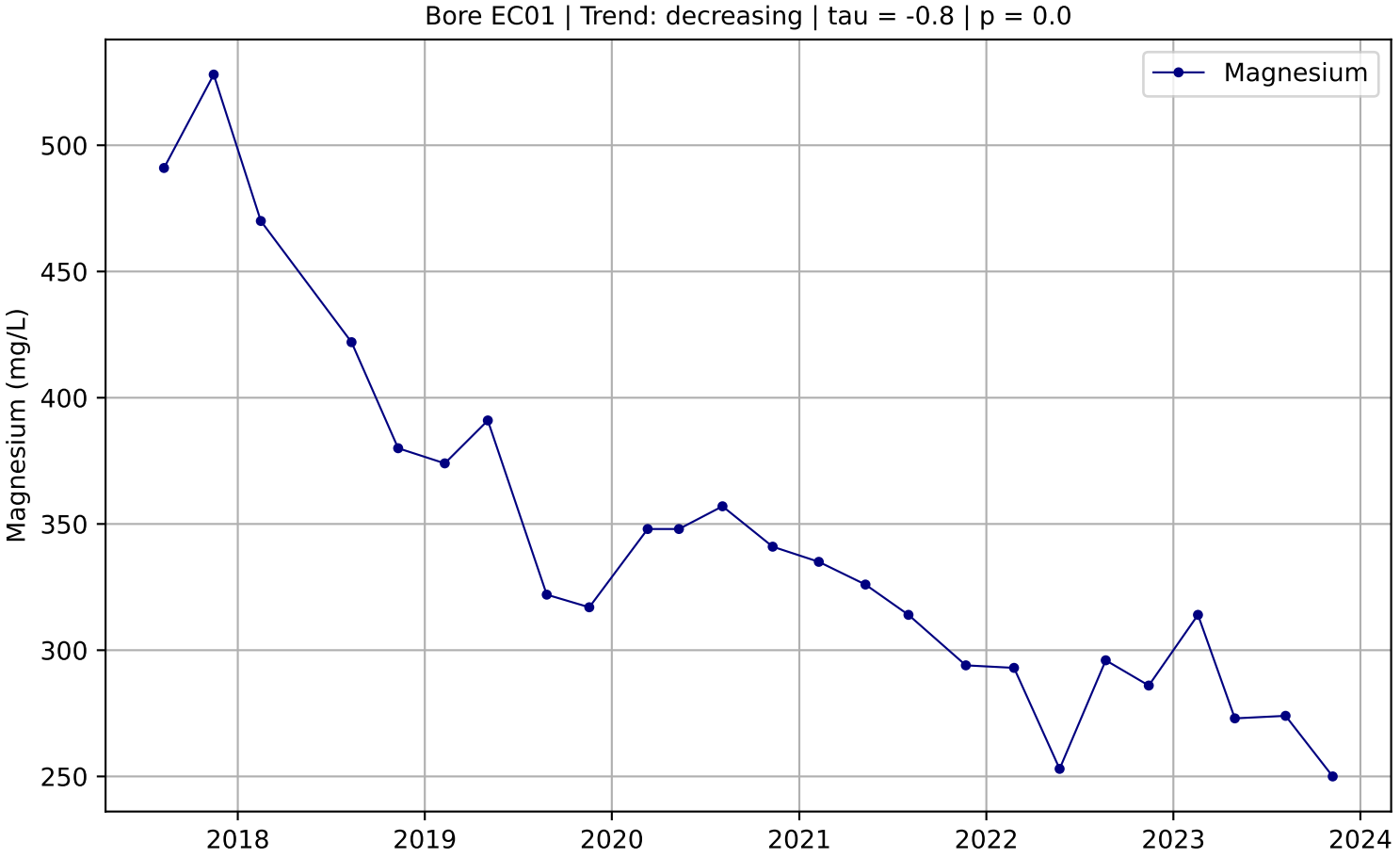

Bore EC01 | Trend: no trend | tau = 0.019 | p = 0.748
Carbonate
Carbonate (mg/L)
0
5
10
15
20
25
30
35
2016
2017
2018
2019
2020
2021
2022
2023
2024

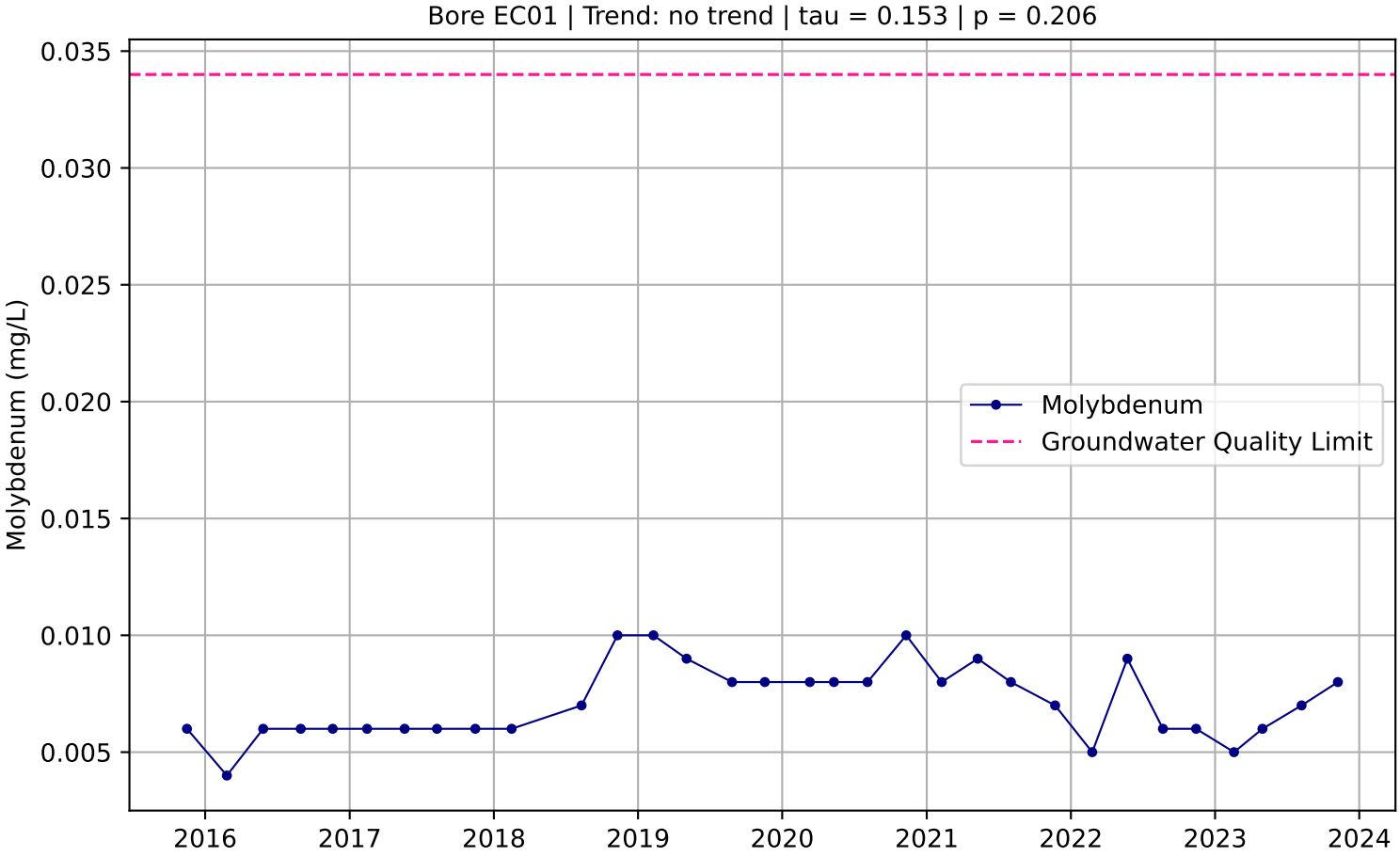

Bore EC01 | Trend: decreasing | tau = -0.643 | p = 0.0
Chloride
Chloride (mg/L)
7000
6500
6000
5500
5000
4500
2016
2017
2018
2019
2020
2021
2022
2023
2024

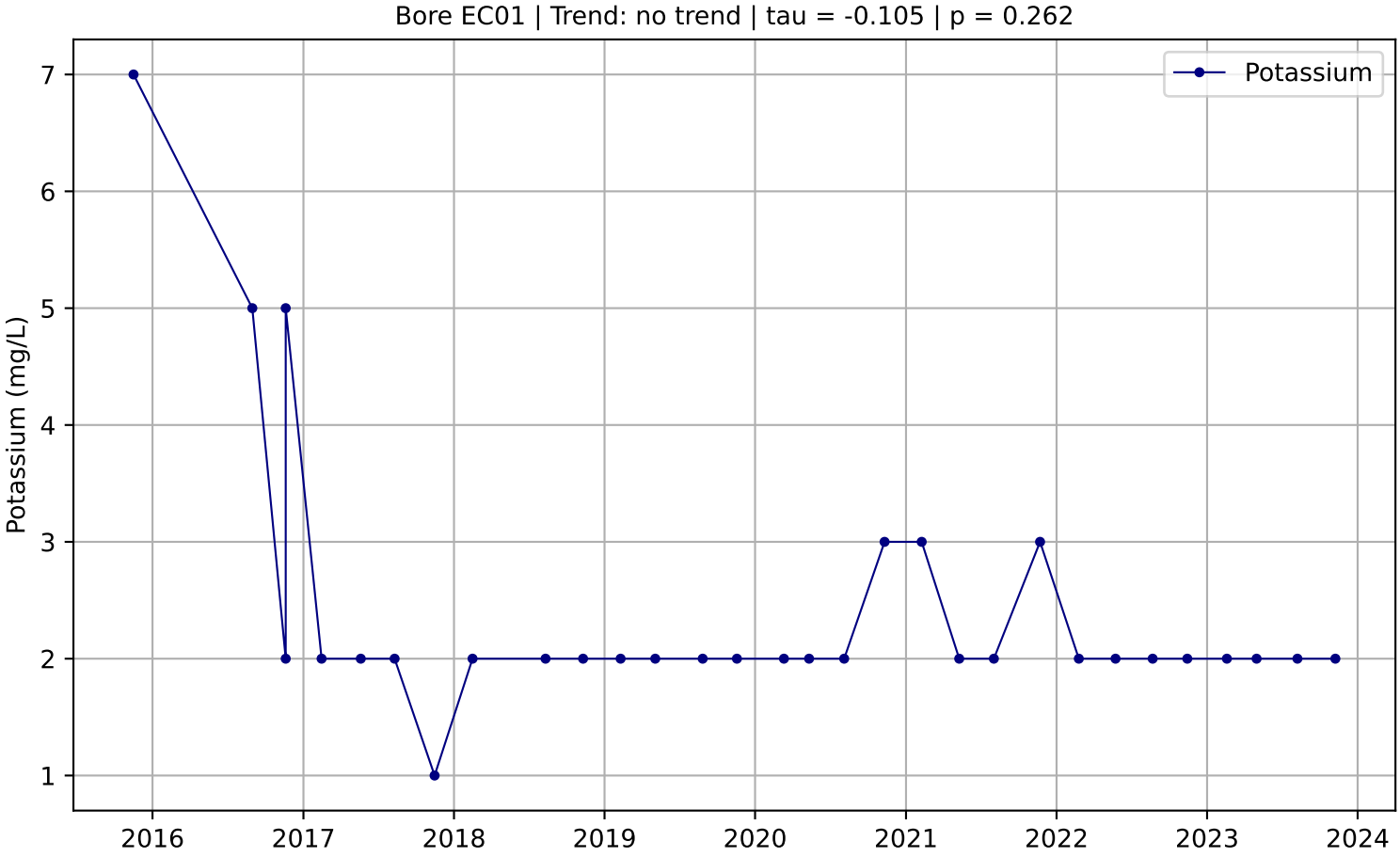

Bore EC01 | Trend: decreasing | tau = -0.748 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
24000
22000
20000
18000
16000
14000
12000
2016
2017
2018
2019
2020
2021
2022
2023
2024

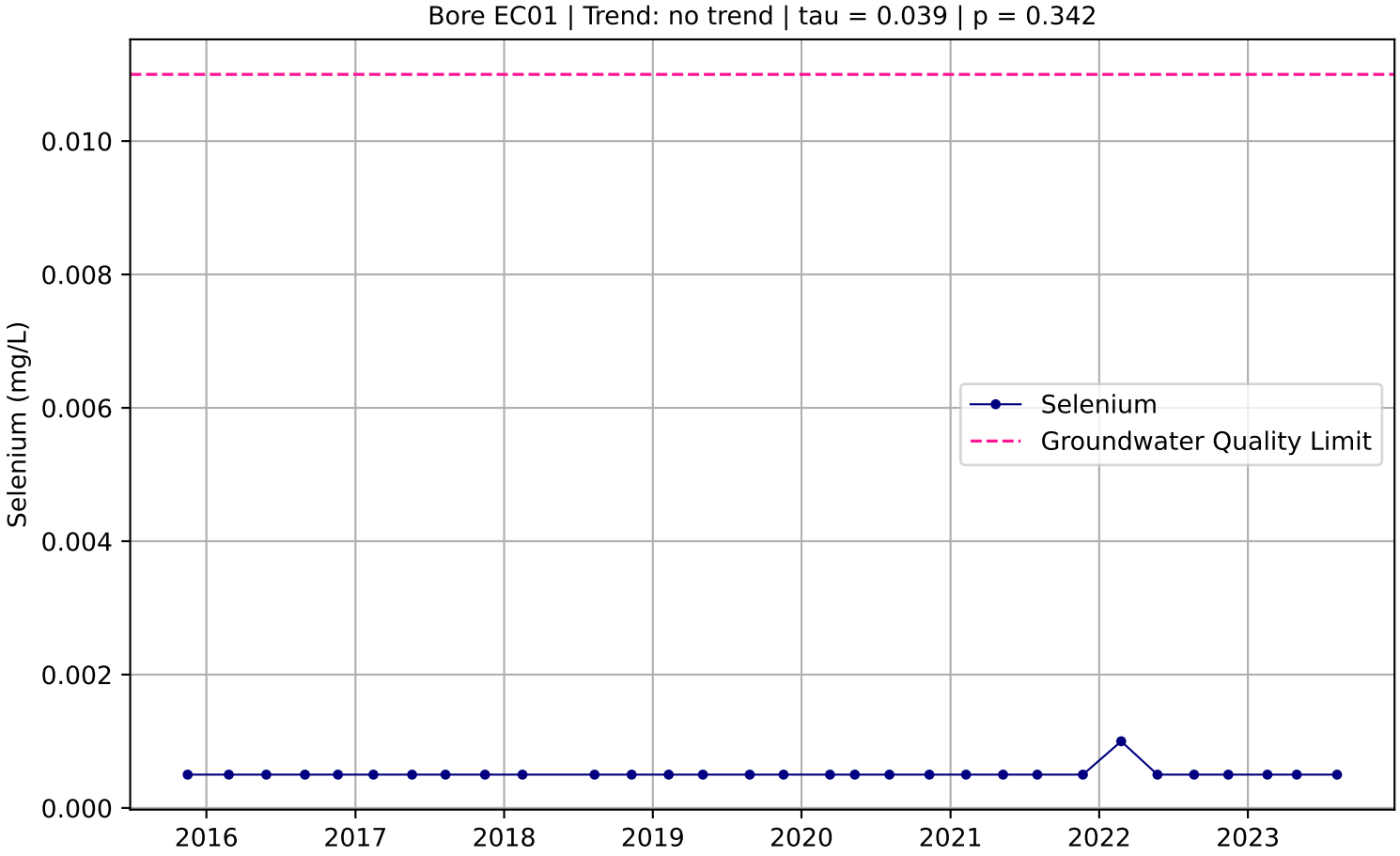

Bore EC01 | Trend: no trend | tau = -0.018 | p = 0.896
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

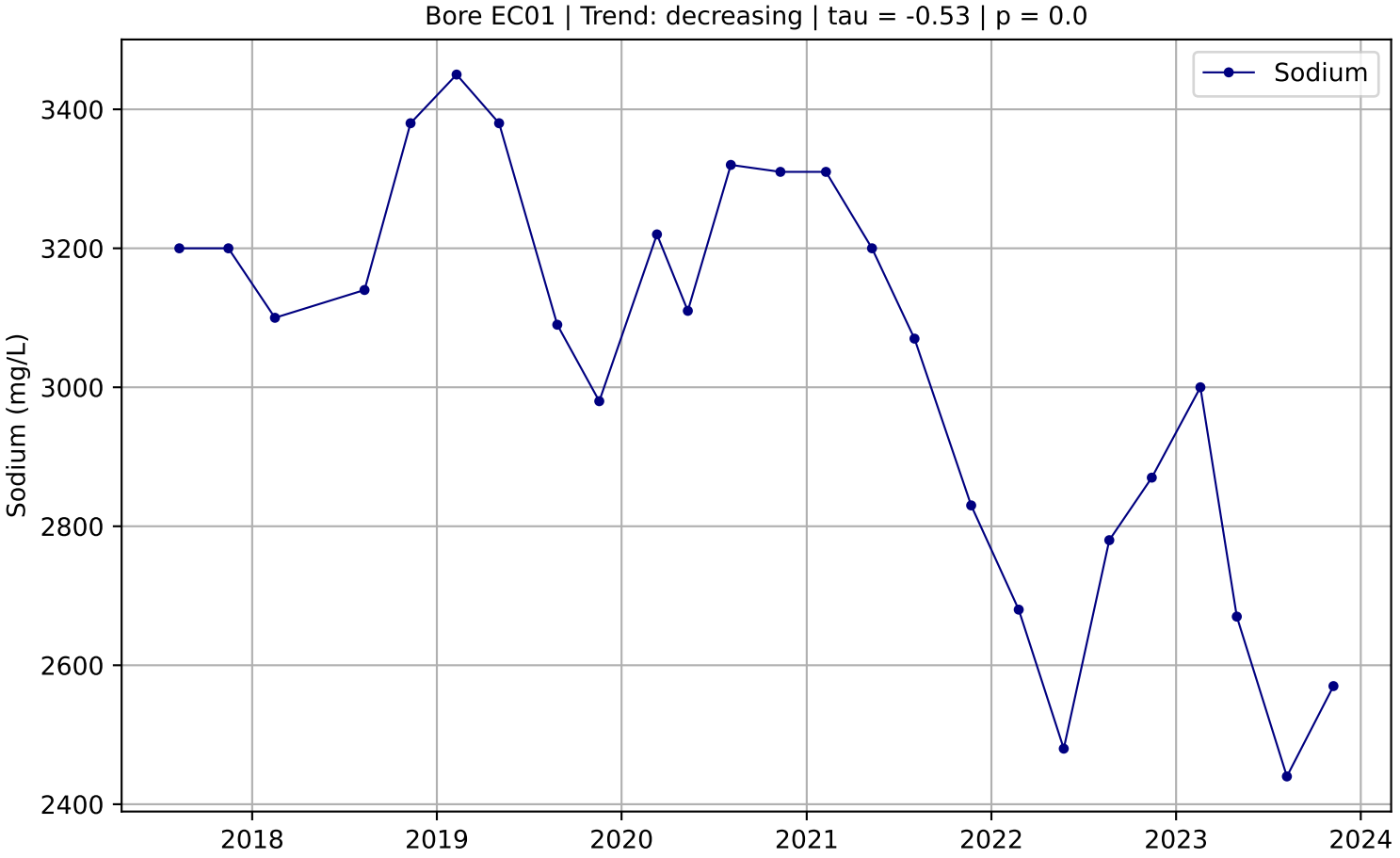

Bore EC01 | Trend: decreasing | tau = -0.258 | p = 0.036
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2016
2017
2018
2019
2020
2021
2022
2023
2024
Iron
Groundwater Quality Limit

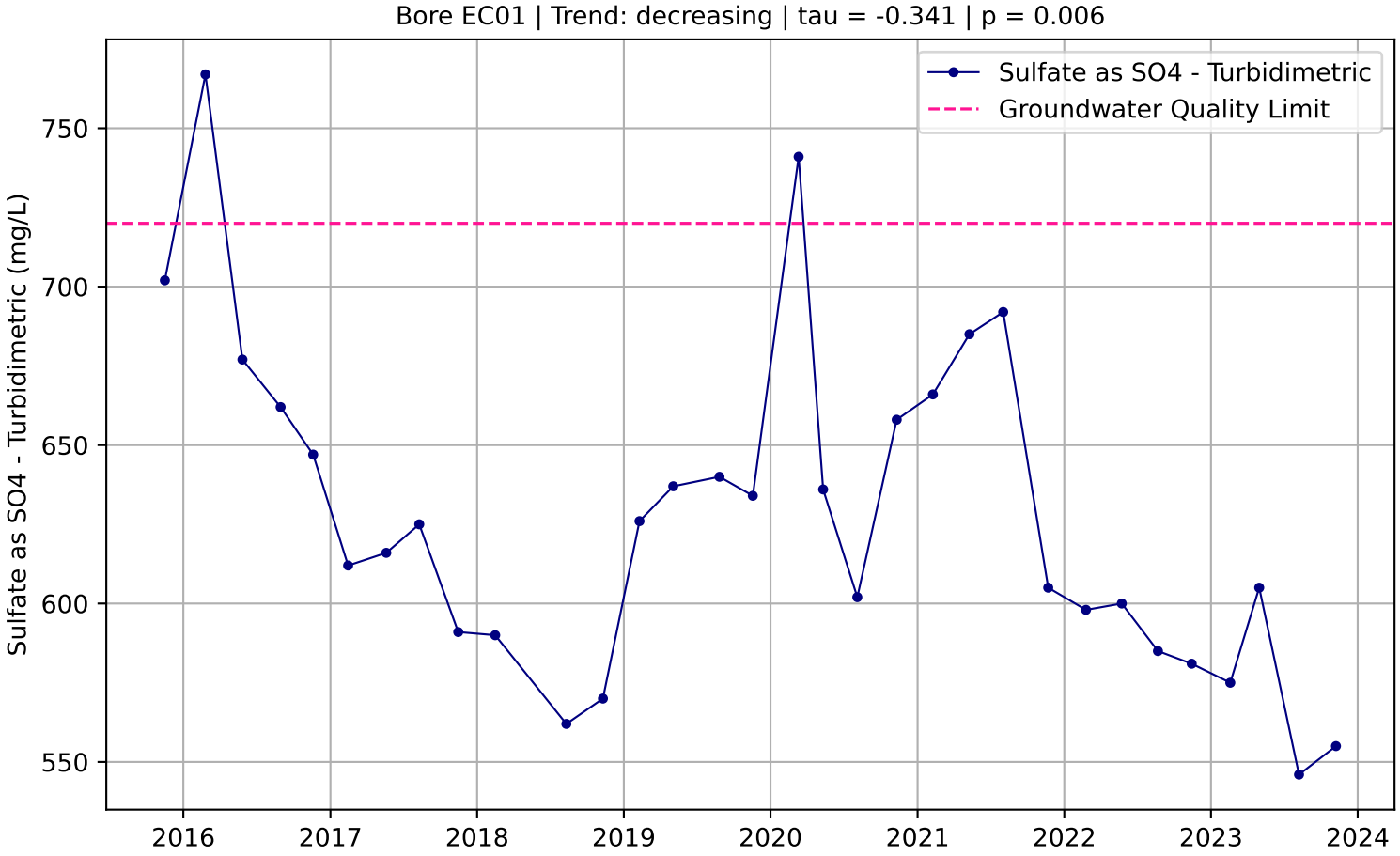

Bore EC01 | Trend: decreasing | tau = -0.8 | p = 0.0
Magnesium
Magnesium (mg/L)
500
450
400
350
300
250
2018
2019
2020
2021
2022
2023
2024

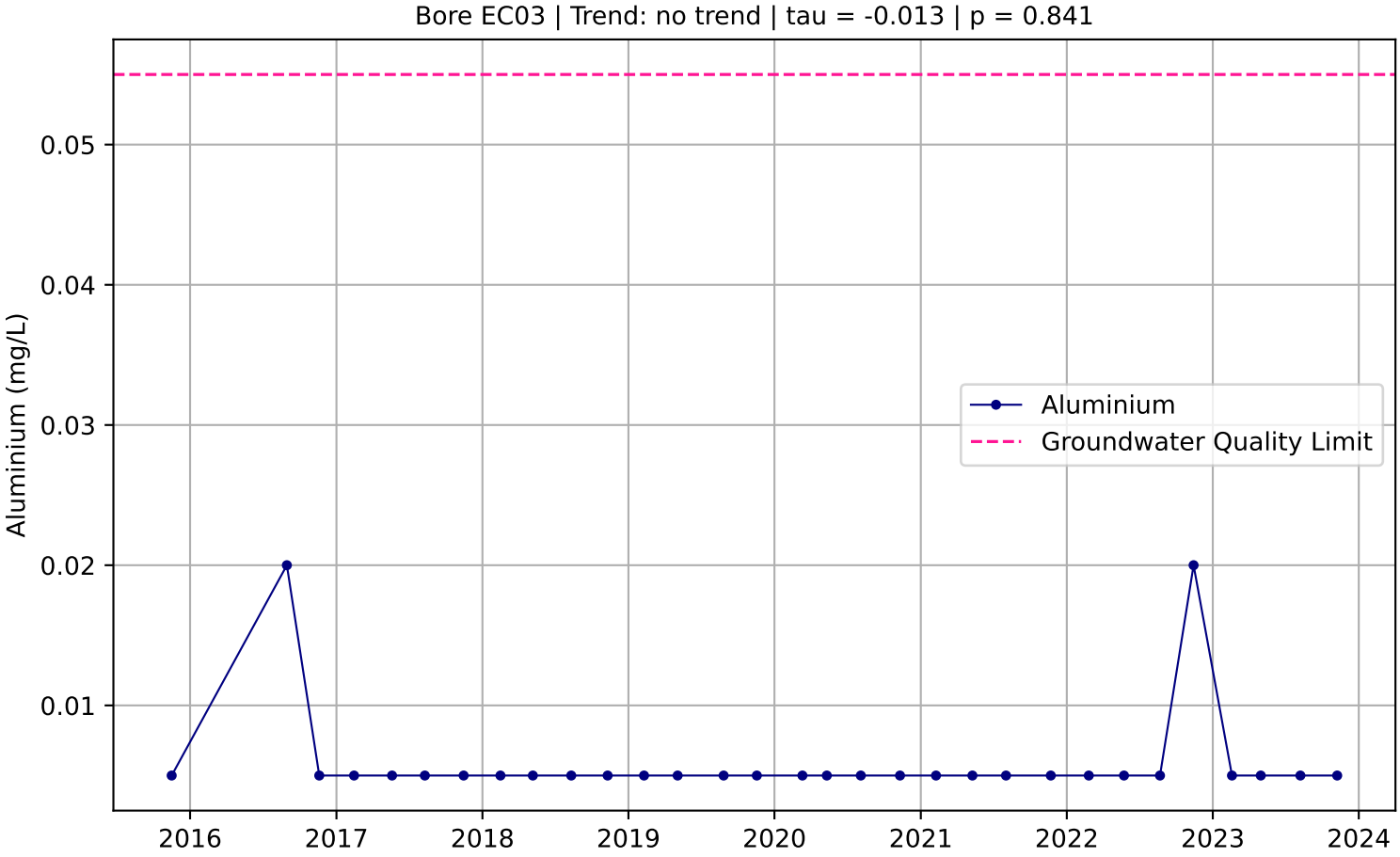

Bore EC01 | Trend: no trend | tau = 0.153 | p = 0.206
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

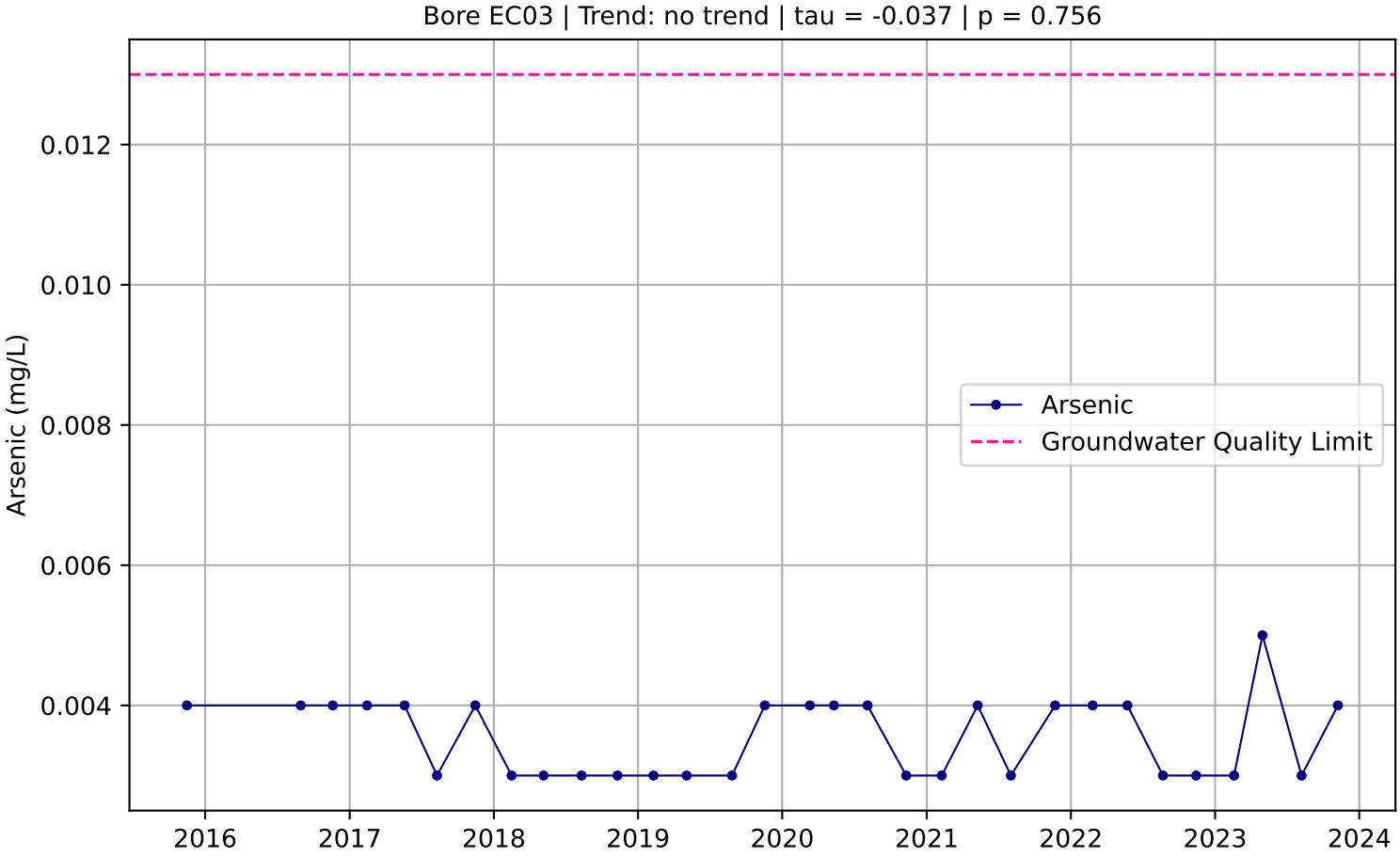

Bore EC01 | Trend: no trend | tau = -0.105 | p = 0.262
Potassium
Potassium (mg/L)
7
6
5
4
3
2
1
2016
2017
2018
2019
2020
2021
2022
2023
2024

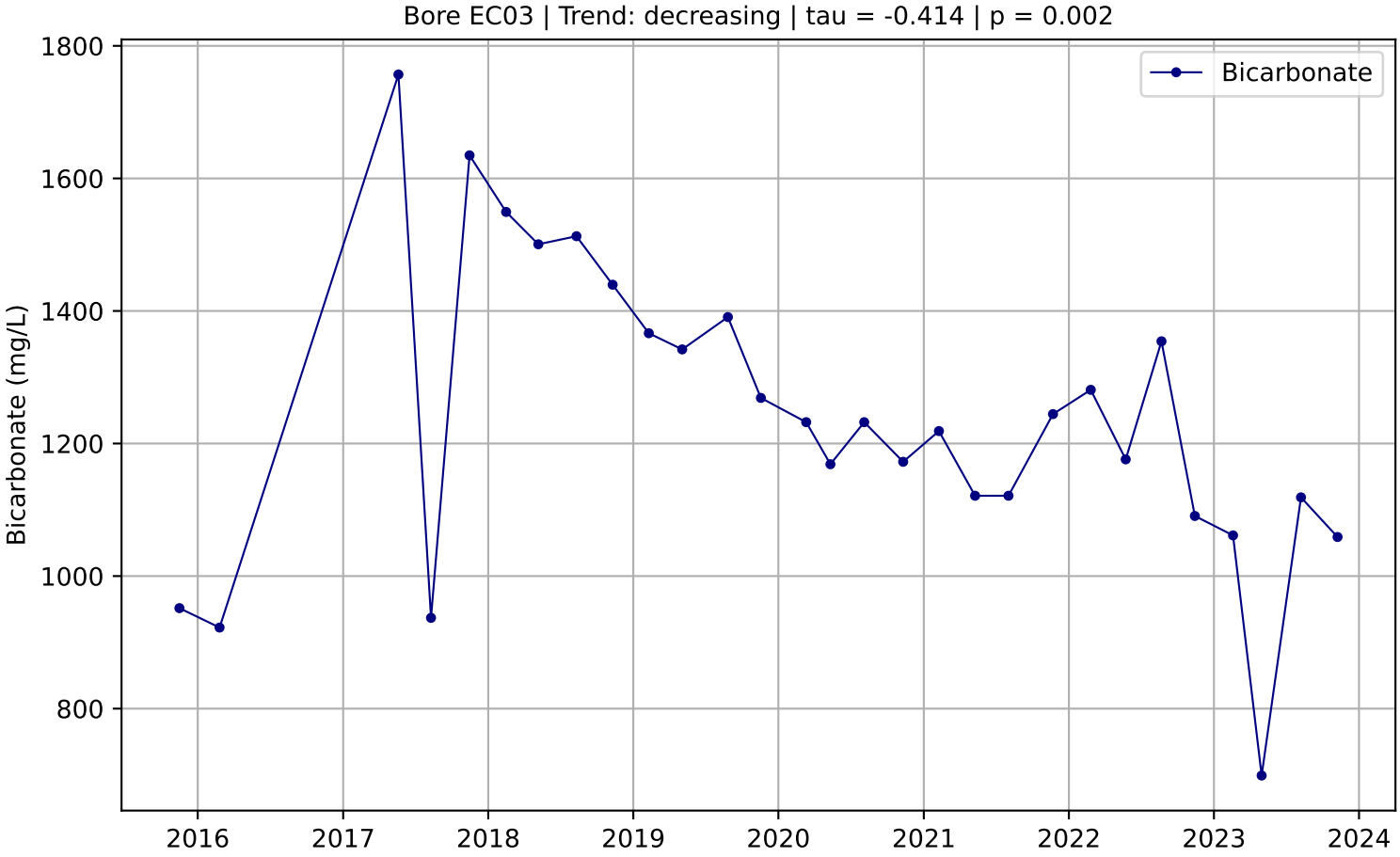

Bore EC01 | Trend: no trend | tau = 0.039 | p = 0.342
Selenium (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
2016
2017
2018
2019
2020
2021
2022
2023
Selenium
Groundwater Quality Limit

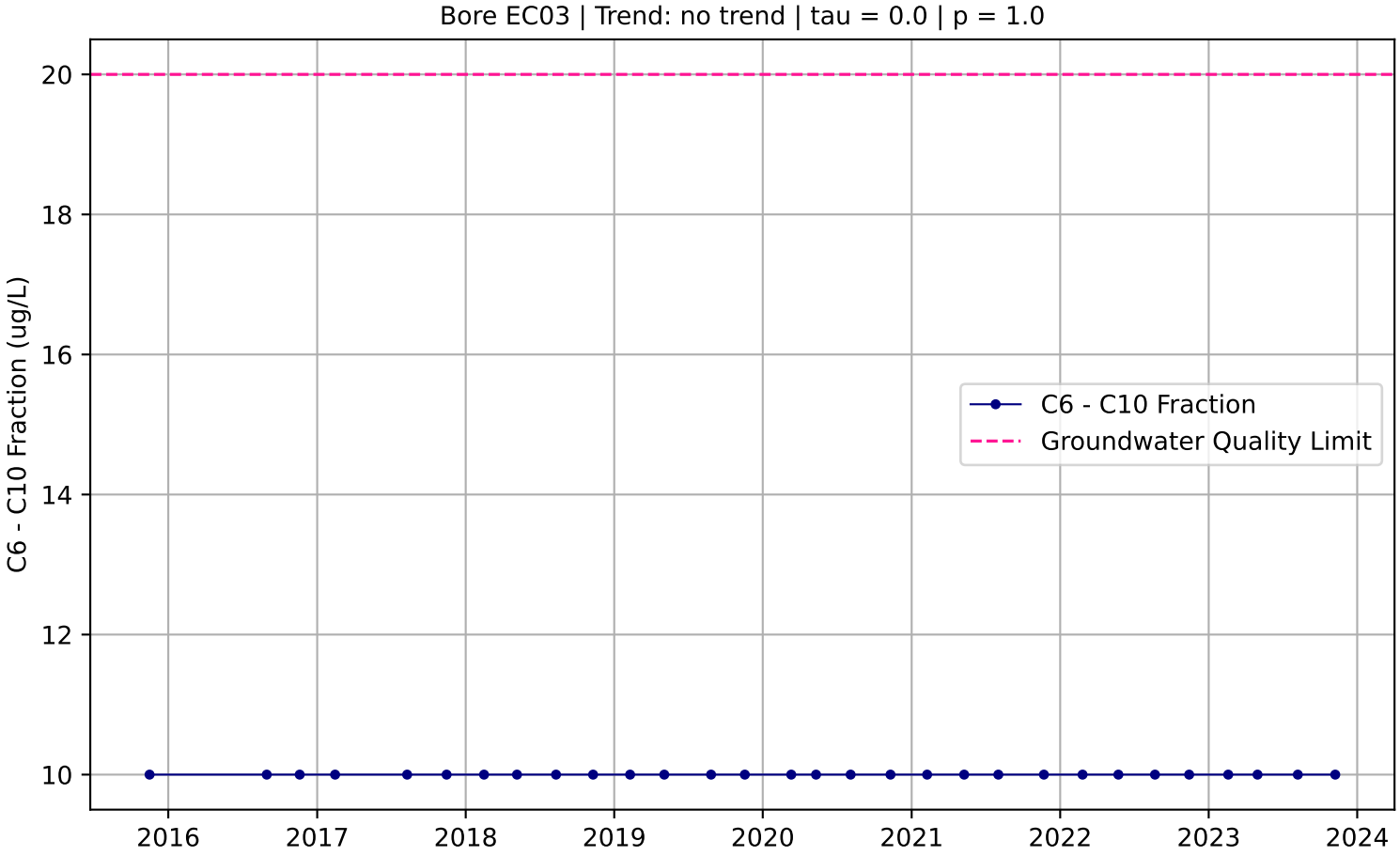

Bore EC01 | Trend: decreasing | tau = -0.53 | p = 0.0
Sodium
Sodium (mg/L)
3400
3200
3000
2800
2600
2400
2018
2019
2020
2021
2022
2023
2024

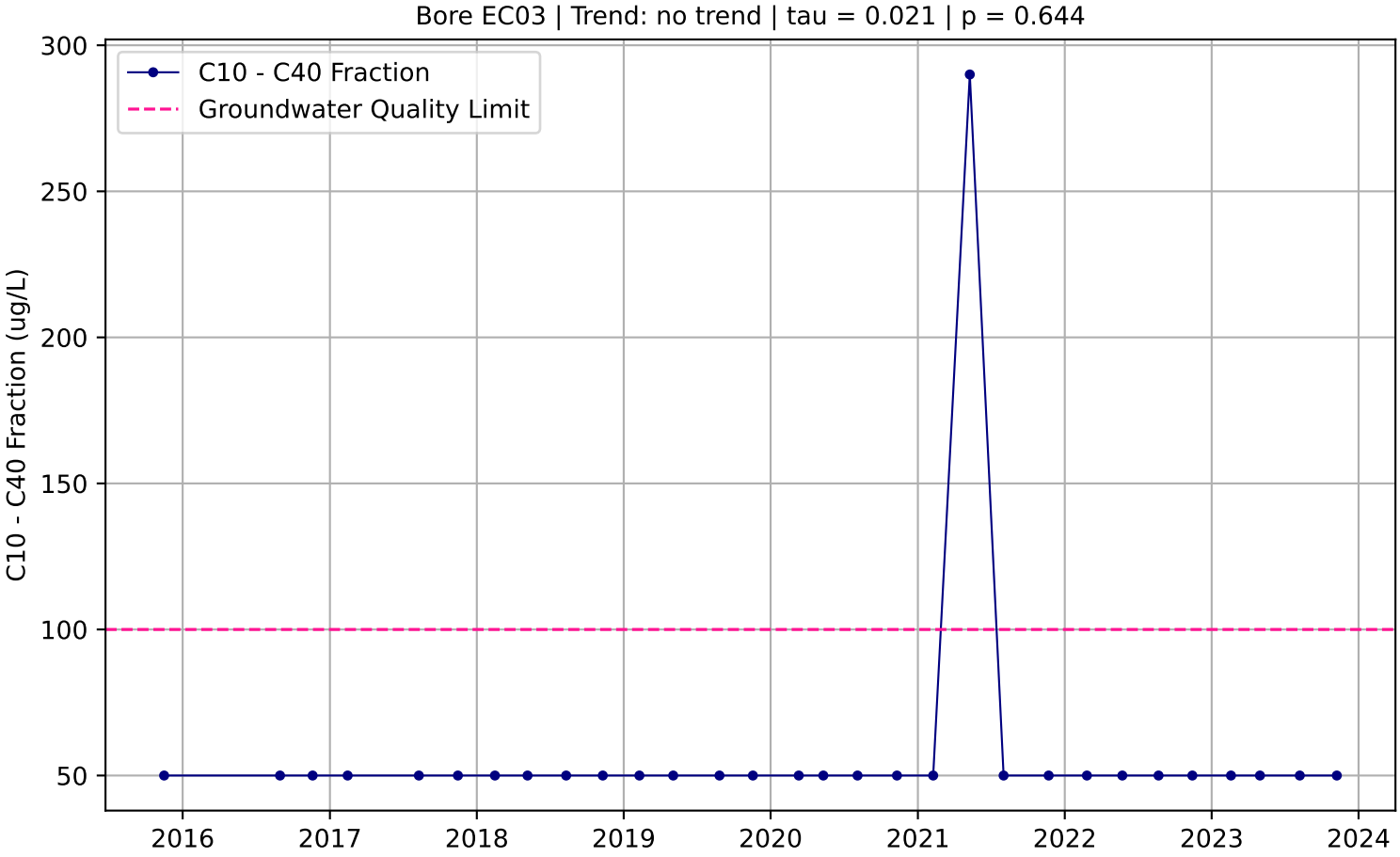

Bore EC01 | Trend: decreasing | tau = -0.341 | p = 0.006
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
750
700
650
600
550
2016
2017
2018
2019
2020
2021
2022
2023
2024

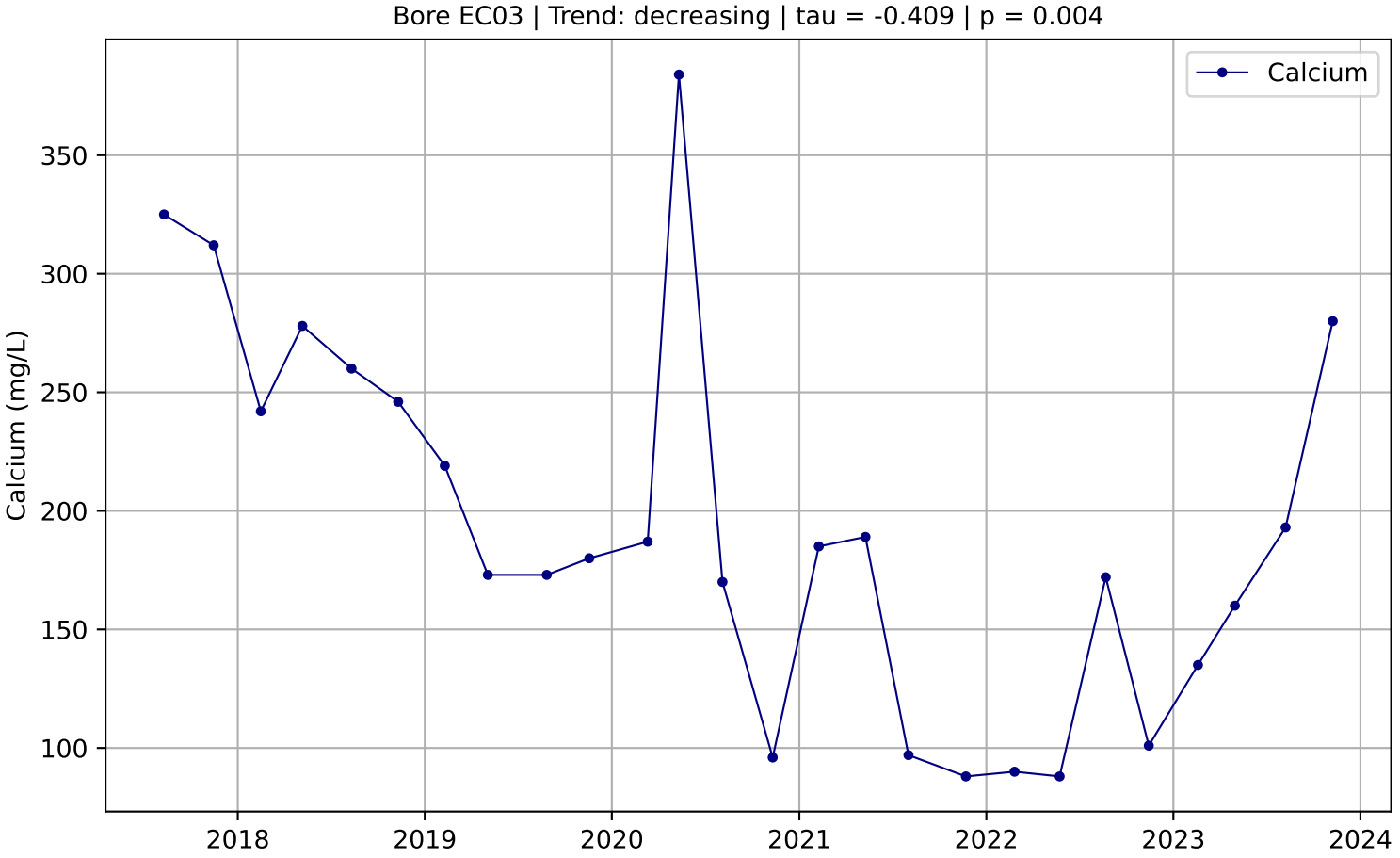

Bore EC03 | Trend: no trend | tau = -0.013 | p = 0.841
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

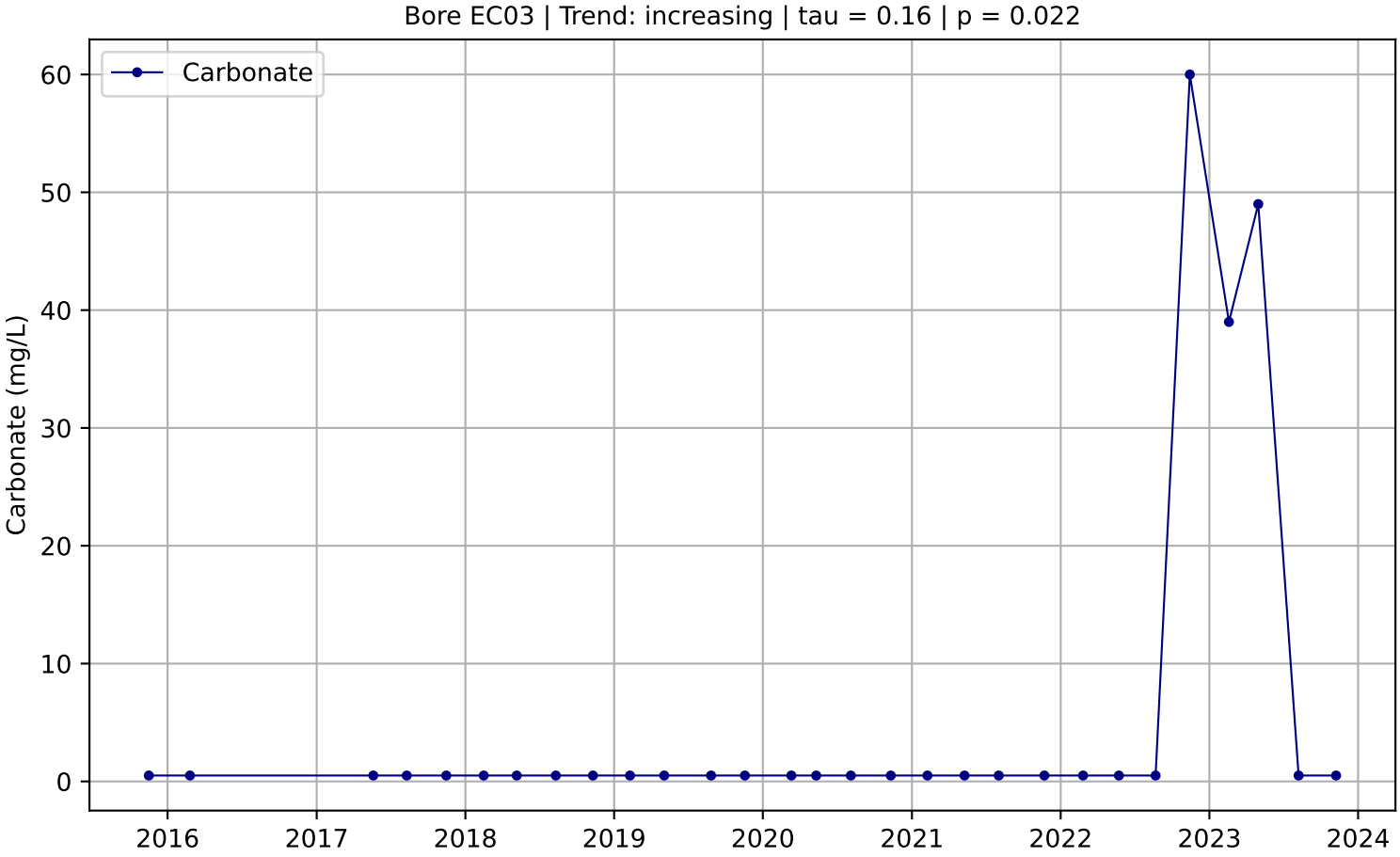

Bore EC03 | Trend: no trend | tau = -0.037 | p = 0.756
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

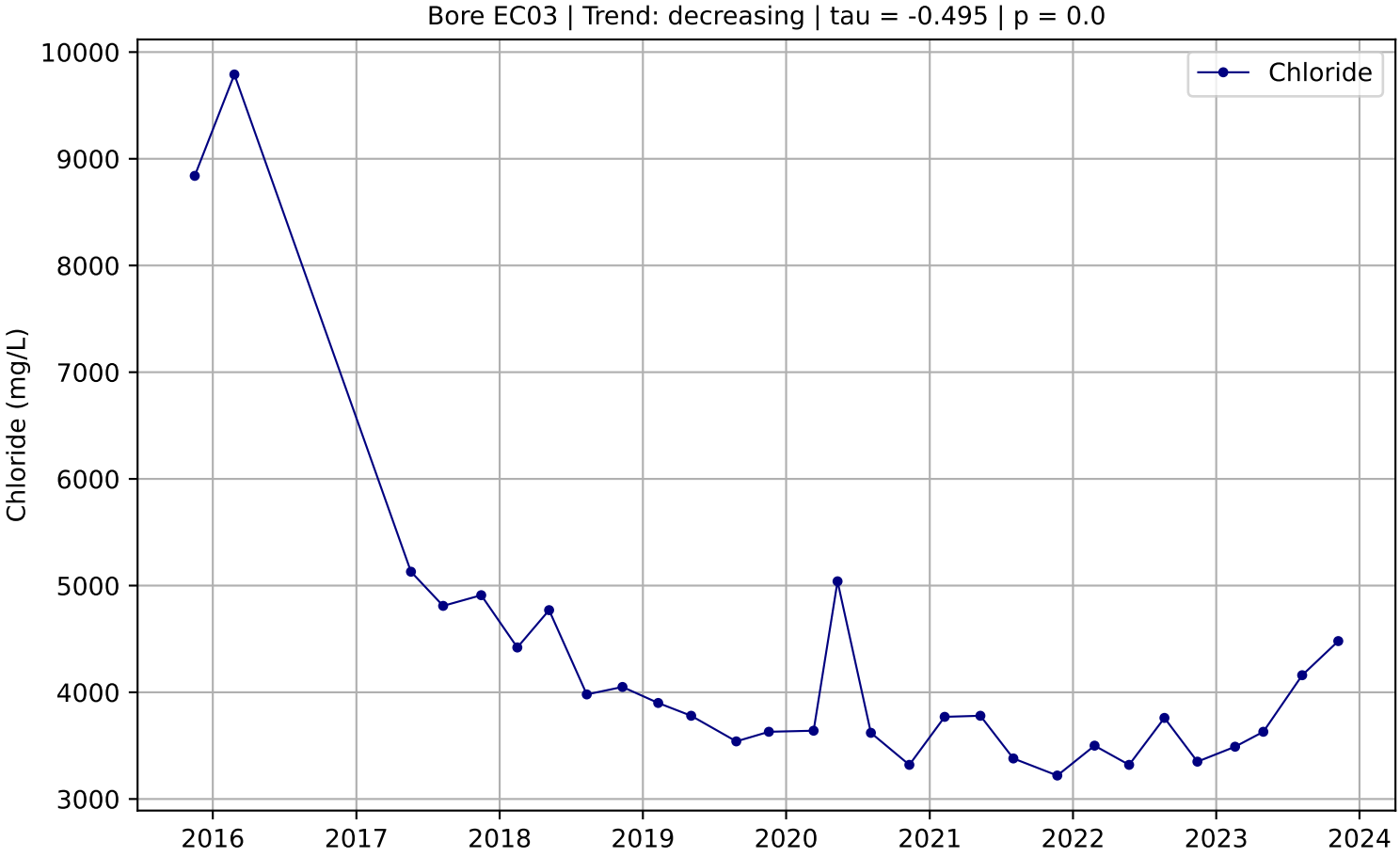

Bore EC03 | Trend: decreasing | tau = -0.414 | p = 0.002
Bicarbonate
Bicarbonate (mg/L)
1800
1600
1400
1200
1000
800
2016
2017
2018
2019
2020
2021
2022
2023
2024

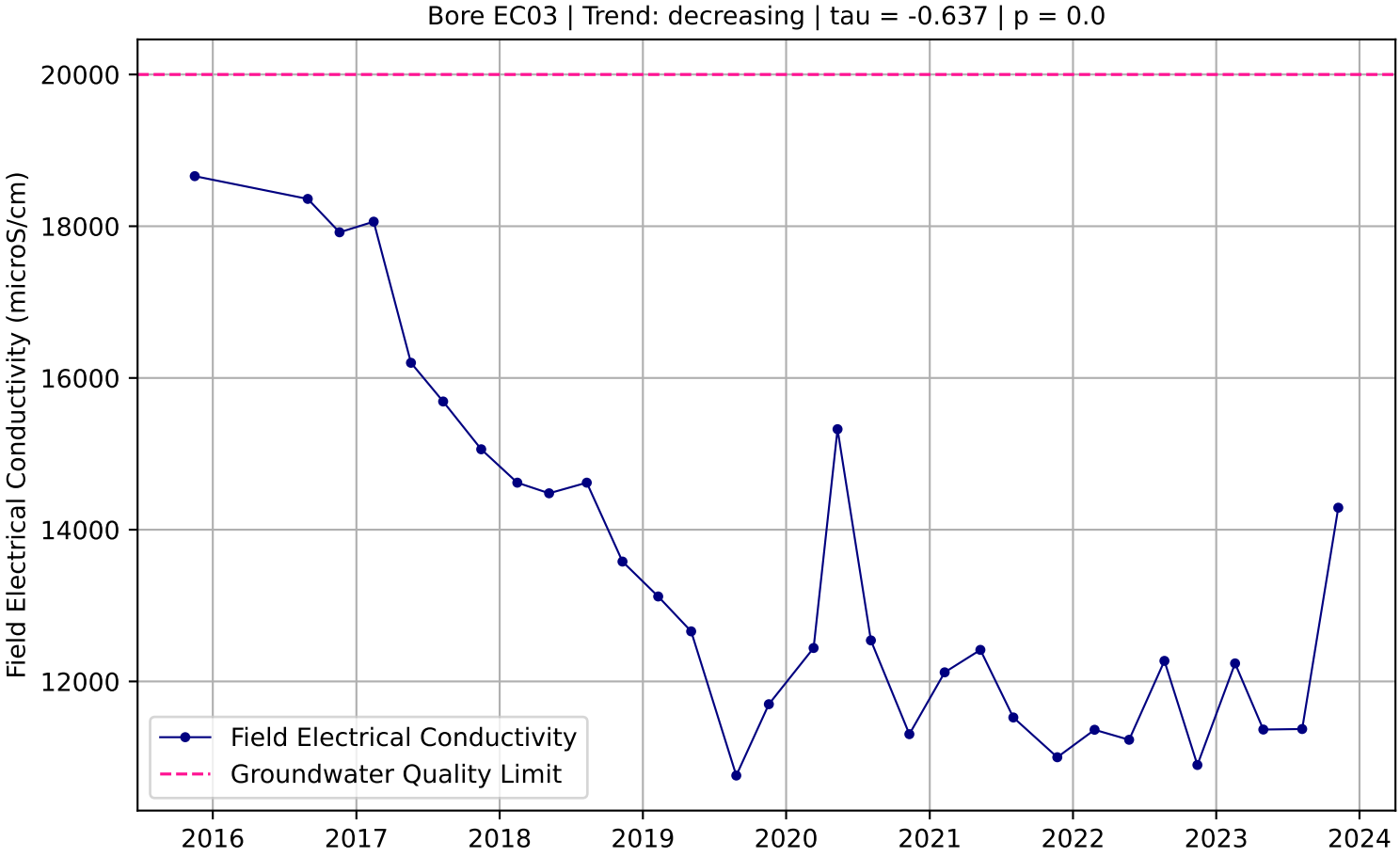

Bore EC03 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

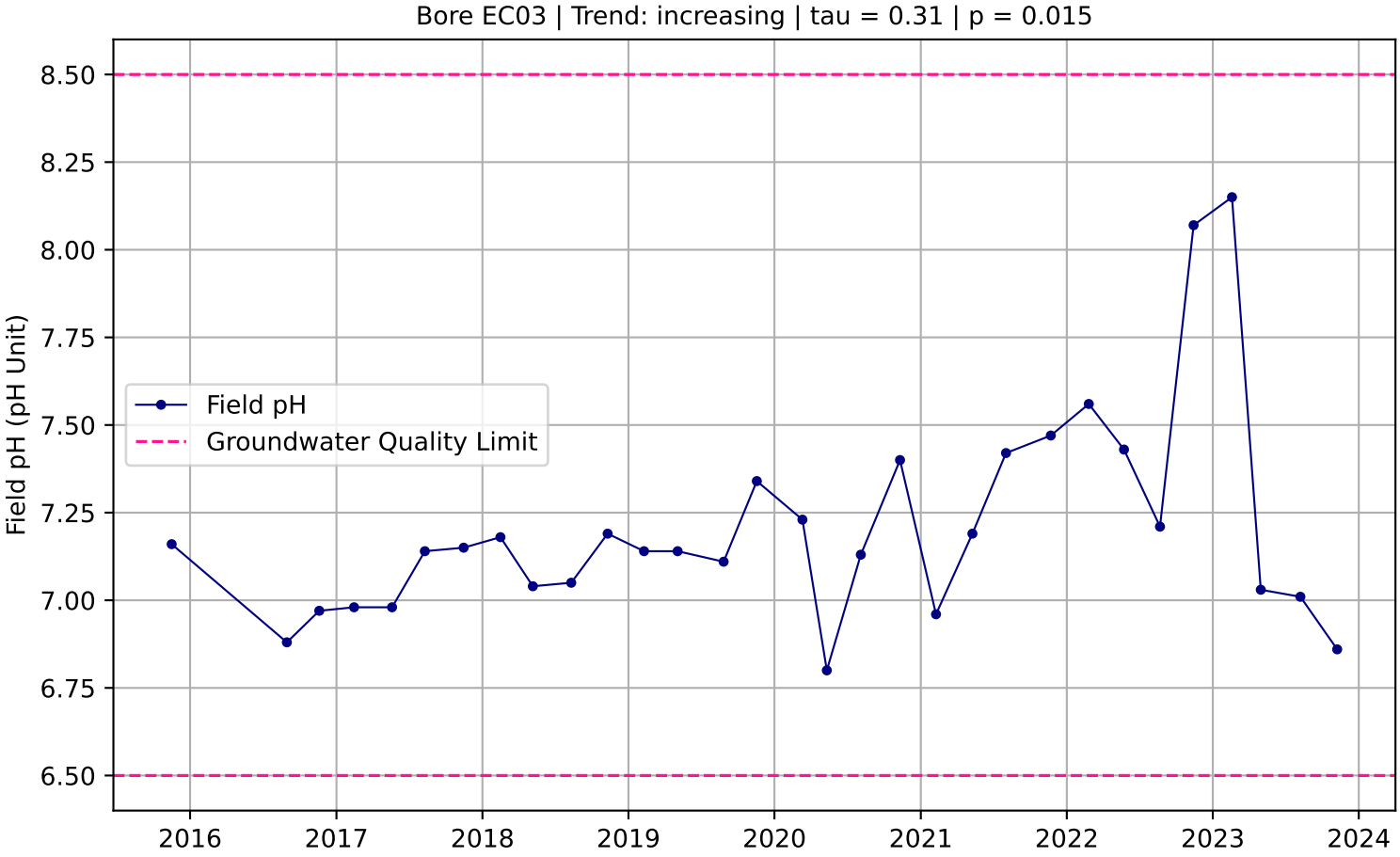

Bore EC03 | Trend: no trend | tau = 0.021 | p = 0.644
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
300
250
200
150
100
50
2016
2017
2018
2019
2020
2021
2022
2023
2024

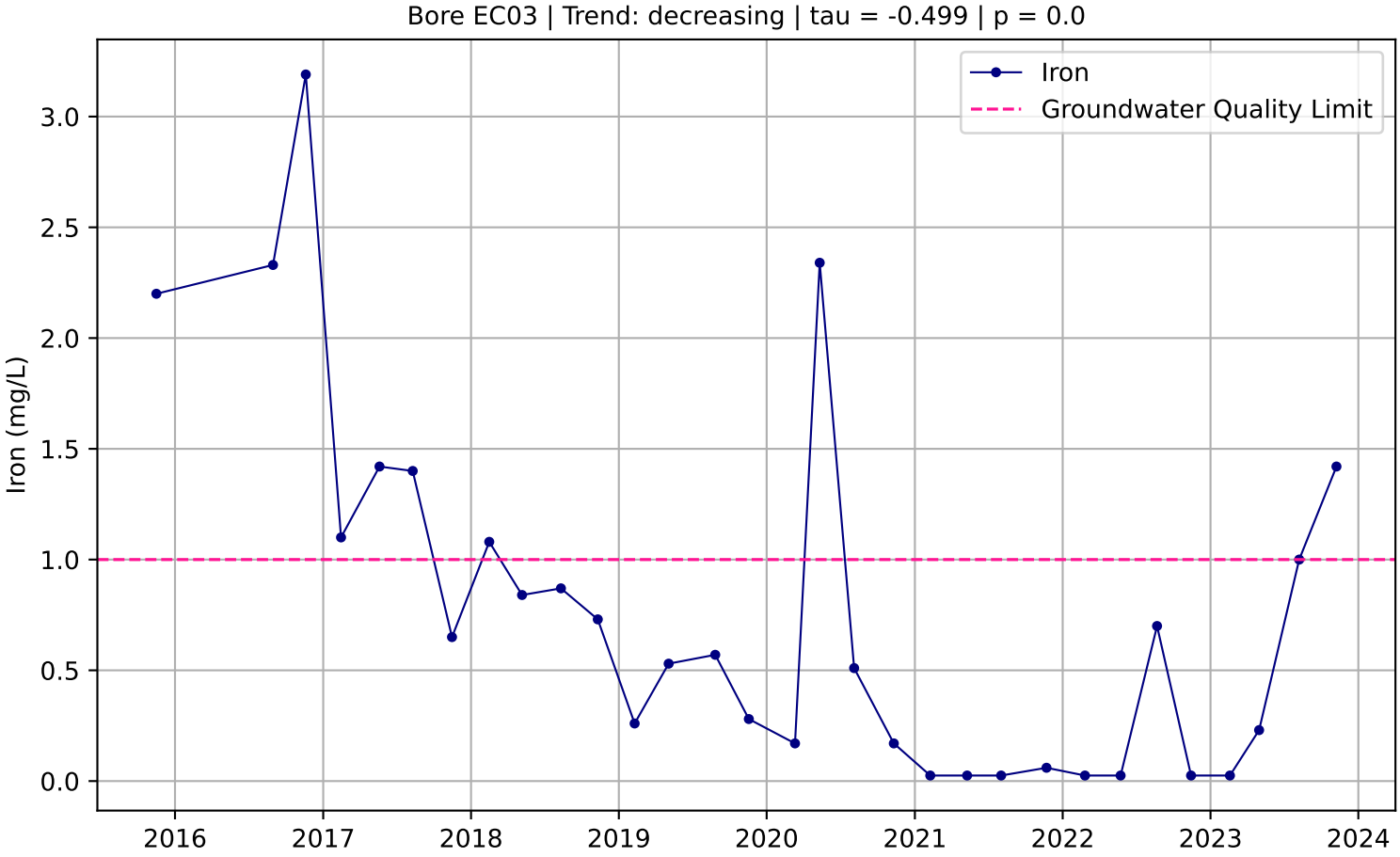

Bore EC03 | Trend: decreasing | tau = -0.409 | p = 0.004
Calcium
Calcium (mg/L)
350
300
250
200
150
100
2018
2019
2020
2021
2022
2023
2024

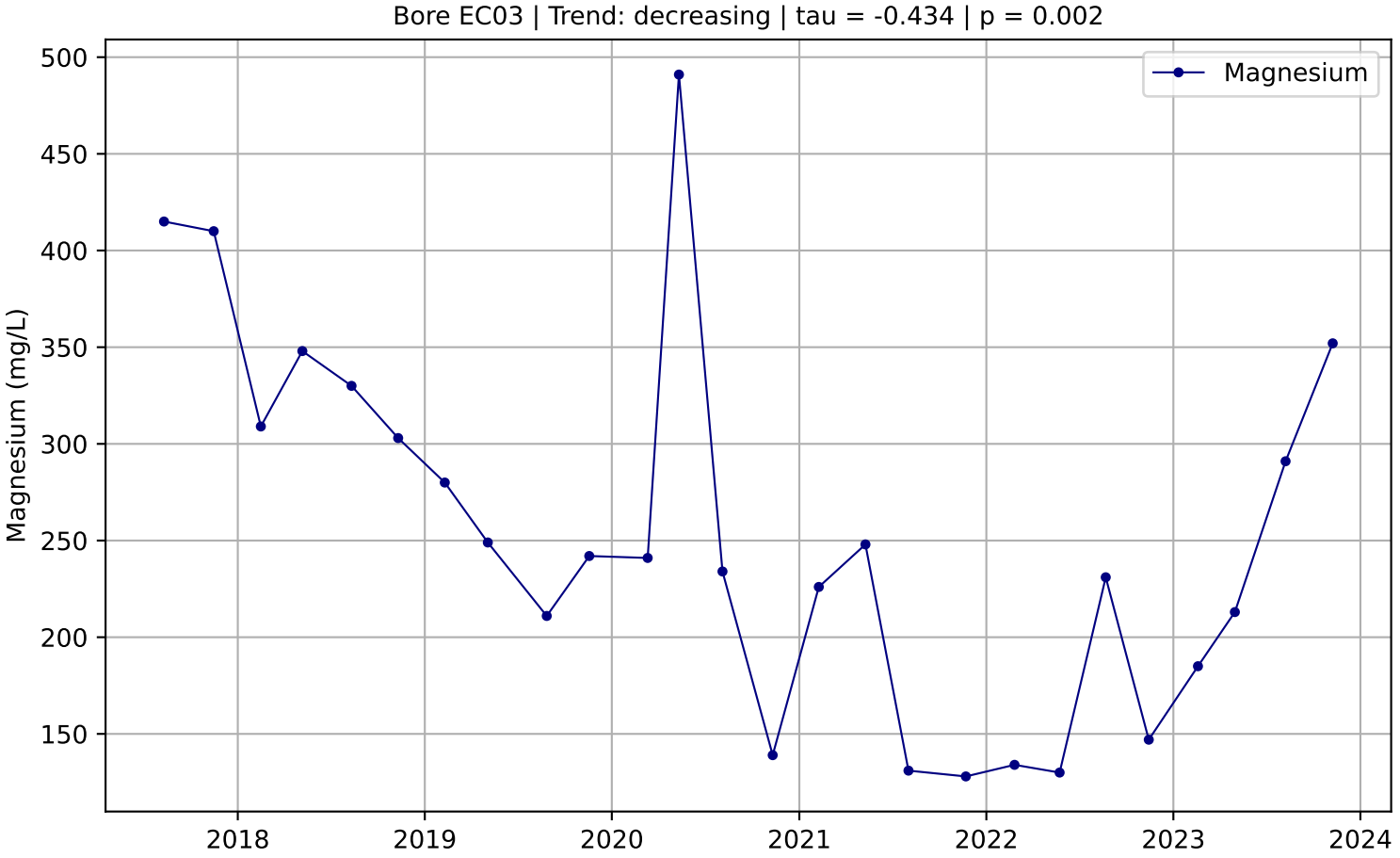

Bore EC03 | Trend: increasing | tau = 0.16 | p = 0.022
Carbonate
Carbonate (mg/L)
0
10
20
30
40
50
60
2016
2017
2018
2019
2020
2021
2022
2023
2024

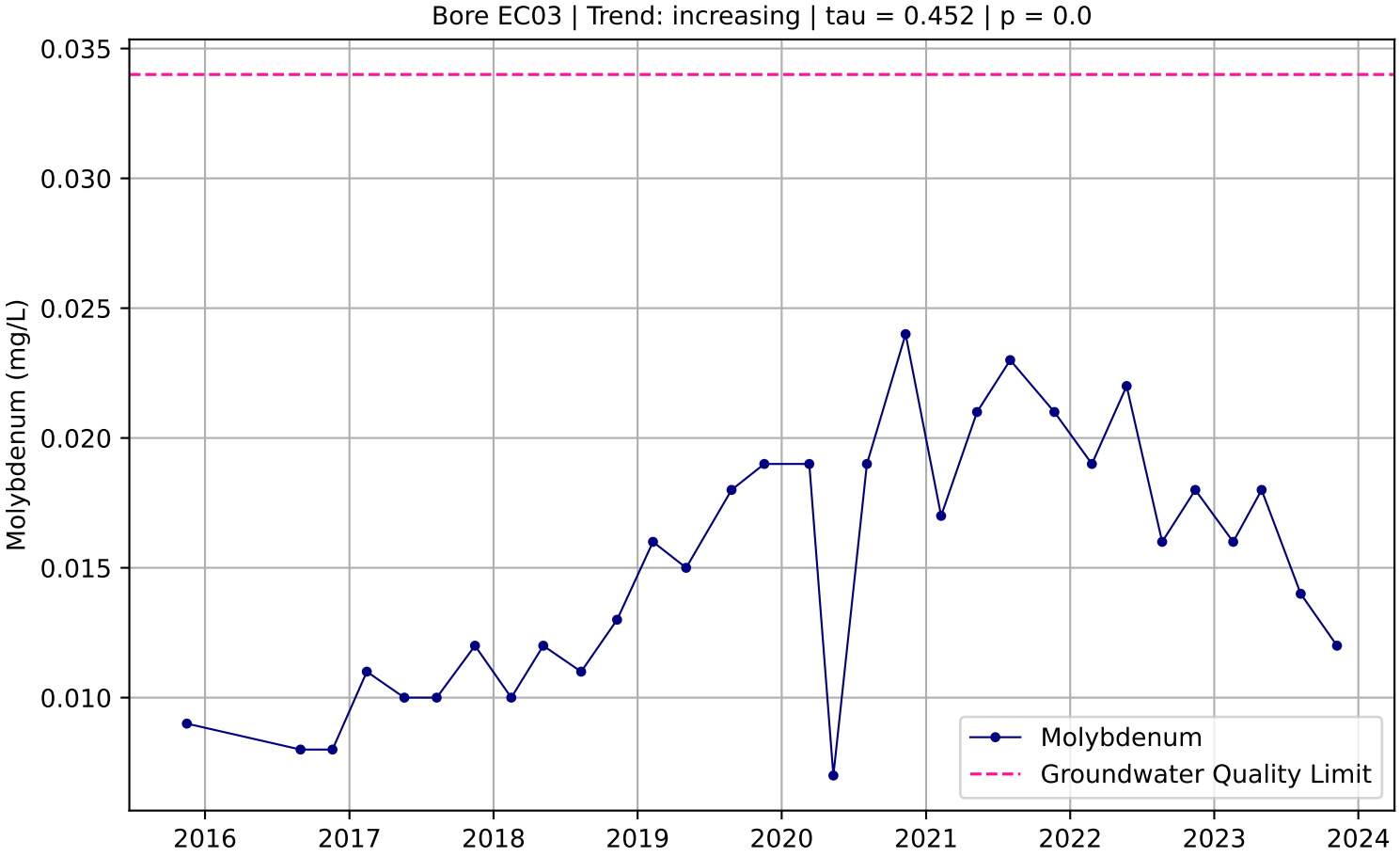

Bore EC03 | Trend: decreasing | tau = -0.495 | p = 0.0
Chloride
Chloride (mg/L)
10000
9000
8000
7000
6000
5000
4000
3000
2016
2017
2018
2019
2020
2021
2022
2023
2024

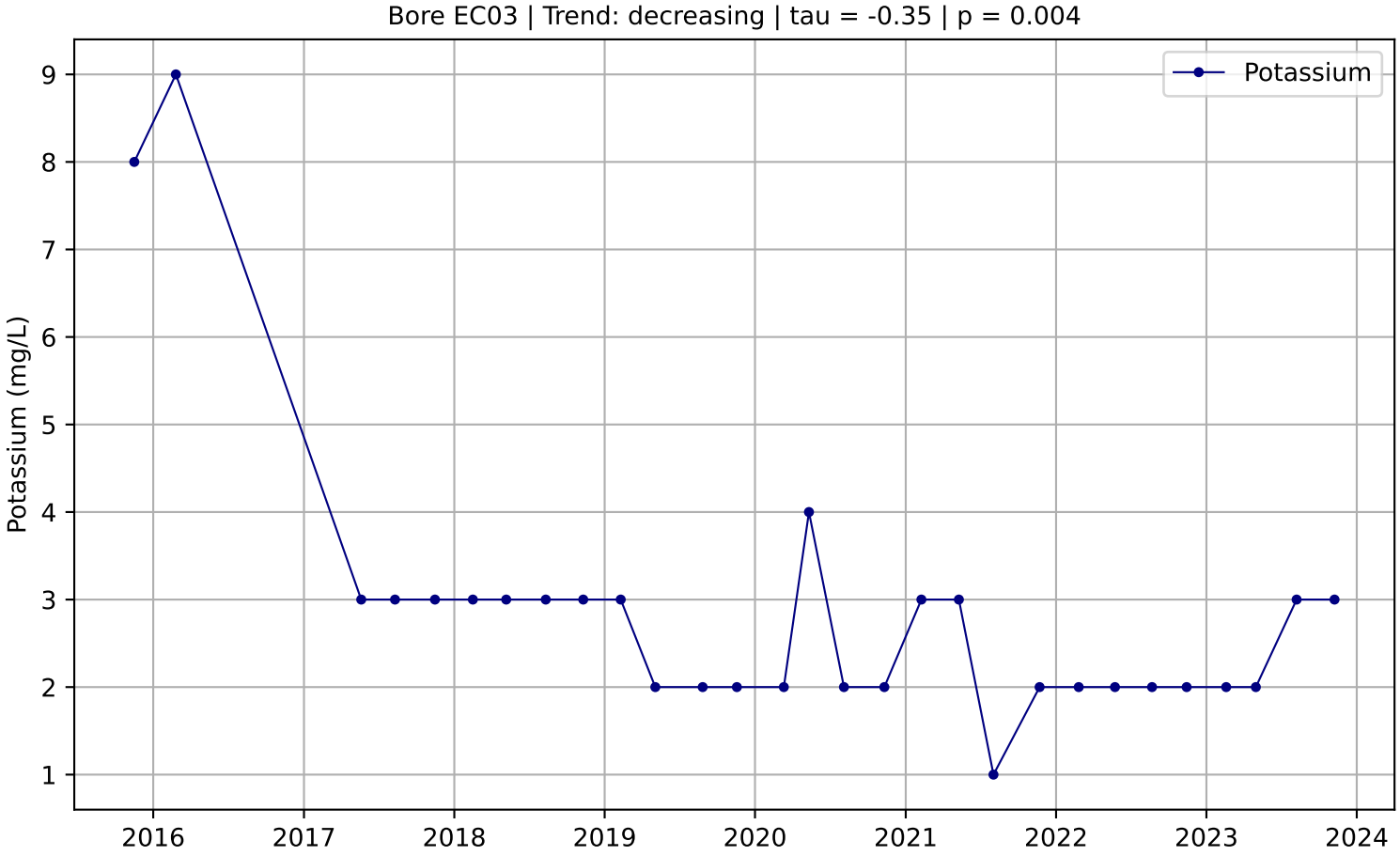

Bore EC03 | Trend: decreasing | tau = -0.637 | p = 0.0
Field Electrical Conductivity (microS/cm)
20000
18000
16000
14000
12000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

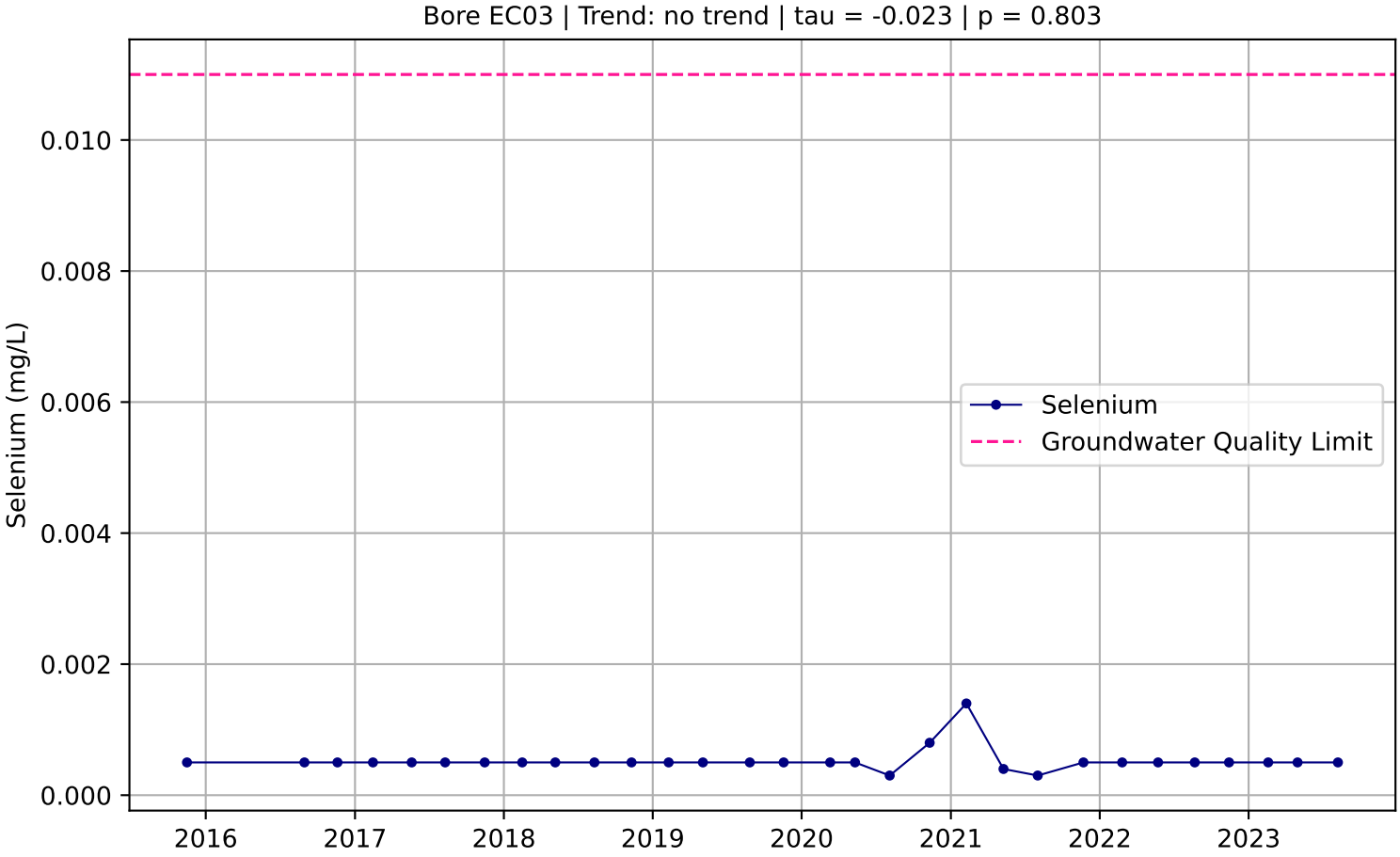

Bore EC03 | Trend: increasing | tau = 0.31 | p = 0.015
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

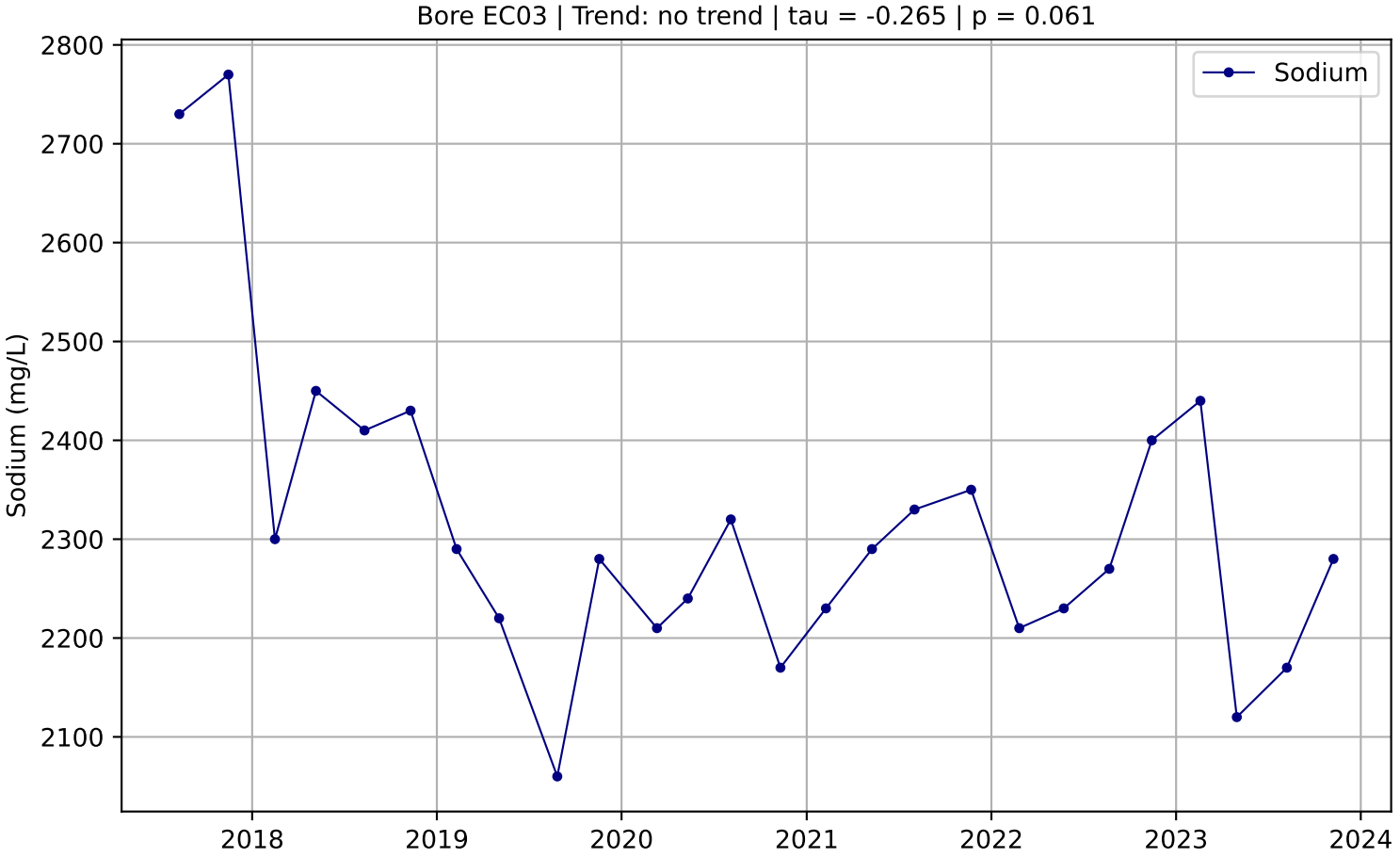

Bore EC03 | Trend: decreasing | tau = -0.499 | p = 0.0
Iron
Groundwater Quality Limit
Iron (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

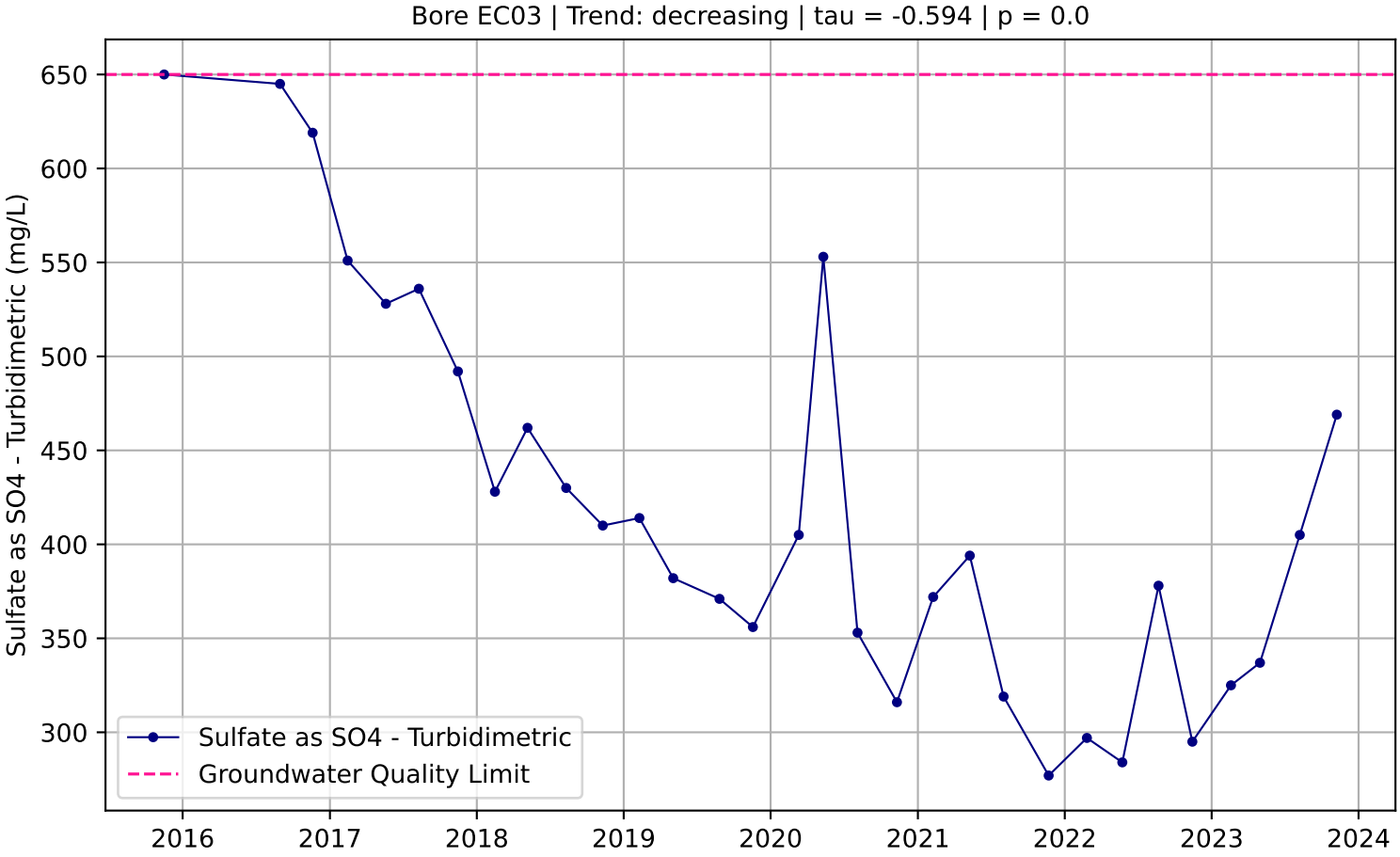

Bore EC03 | Trend: decreasing | tau = -0.434 | p = 0.002
Magnesium
Magnesium (mg/L)
500
450
400
350
300
250
200
150
2018
2019
2020
2021
2022
2023
2024

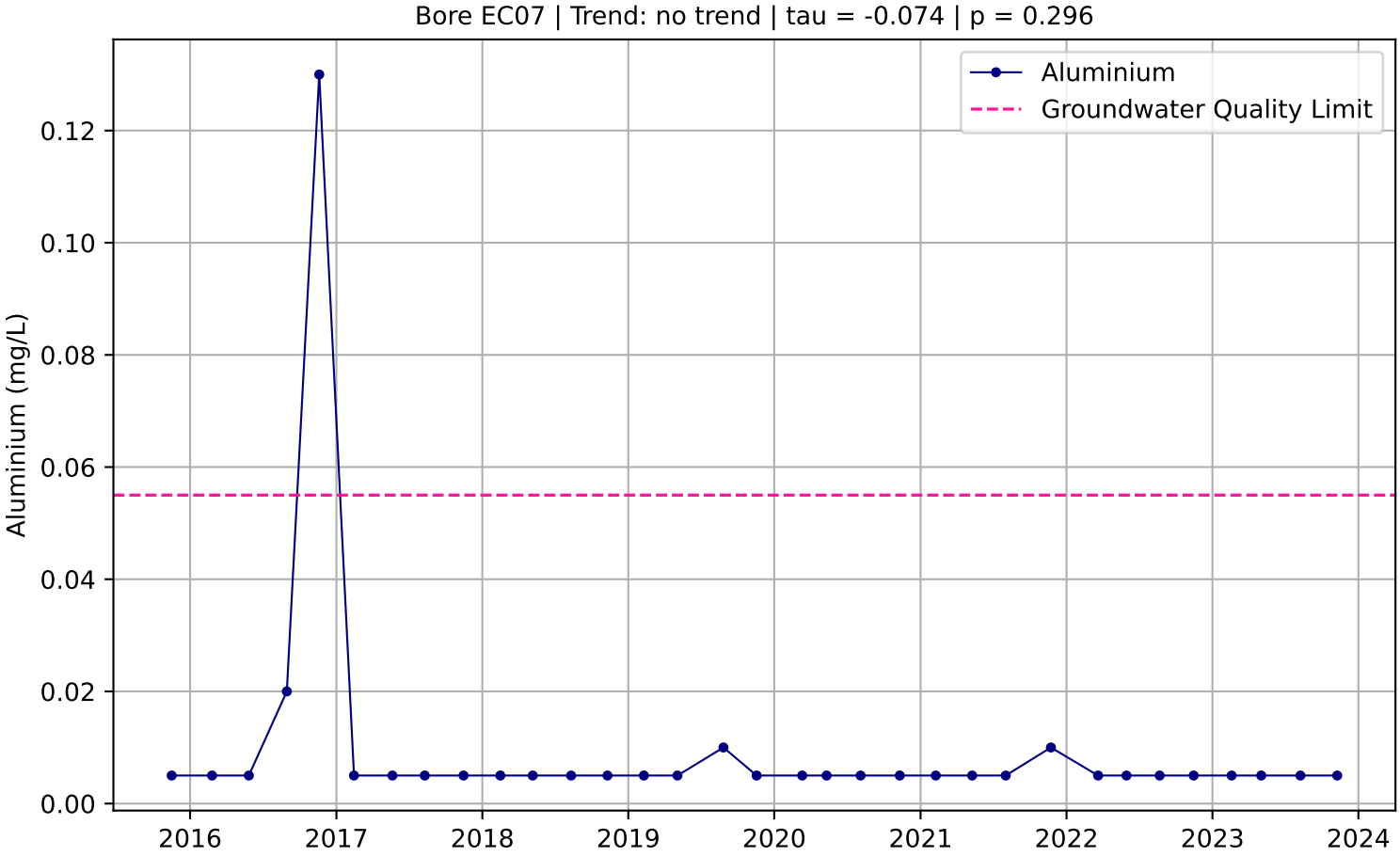

Bore EC03 | Trend: increasing | tau = 0.452 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

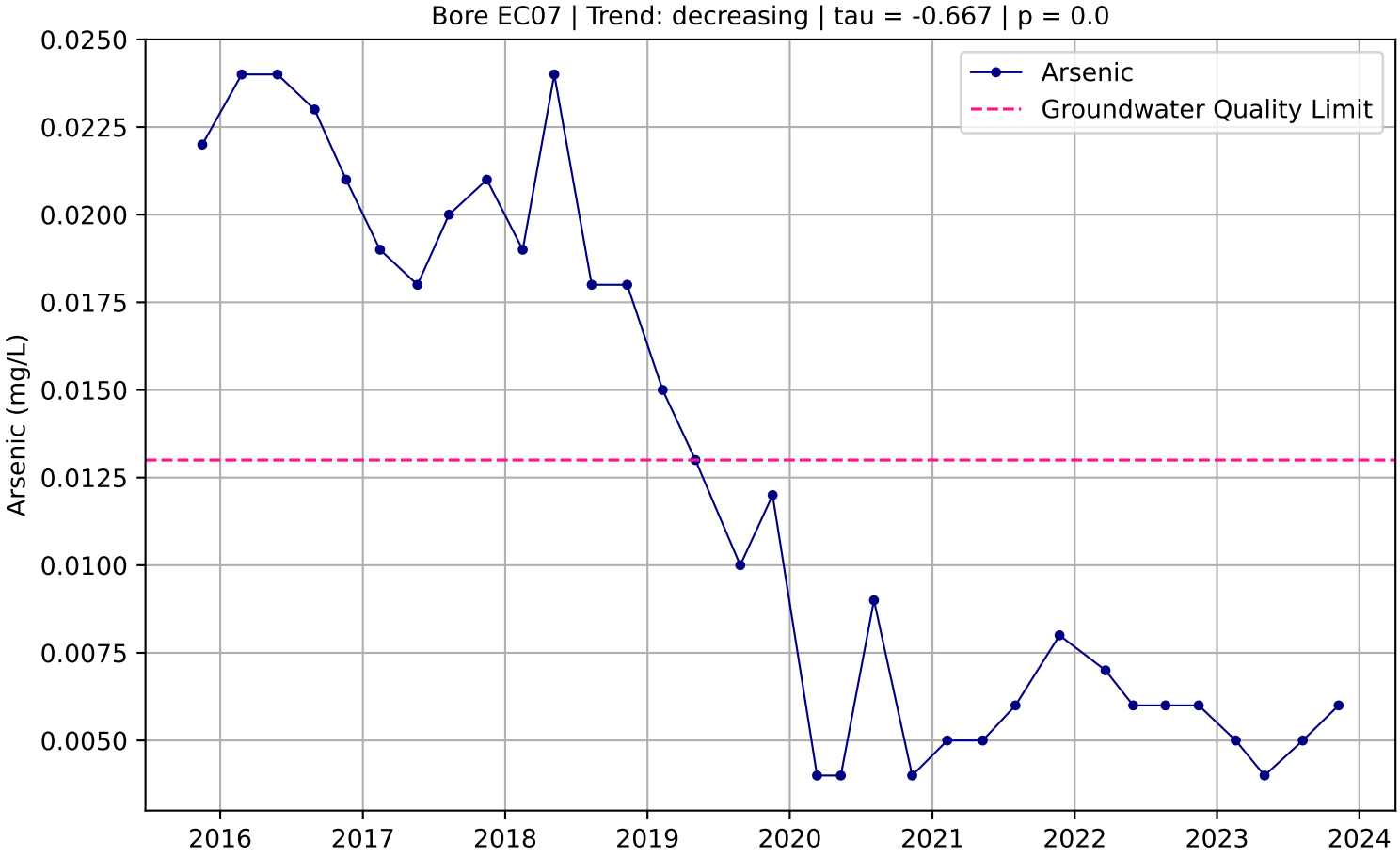

Bore EC03 | Trend: decreasing | tau = -0.35 | p = 0.004
Potassium
Potassium (mg/L)
9
8
7
6
5
4
3
2
1
2016
2017
2018
2019
2020
2021
2022
2023
2024

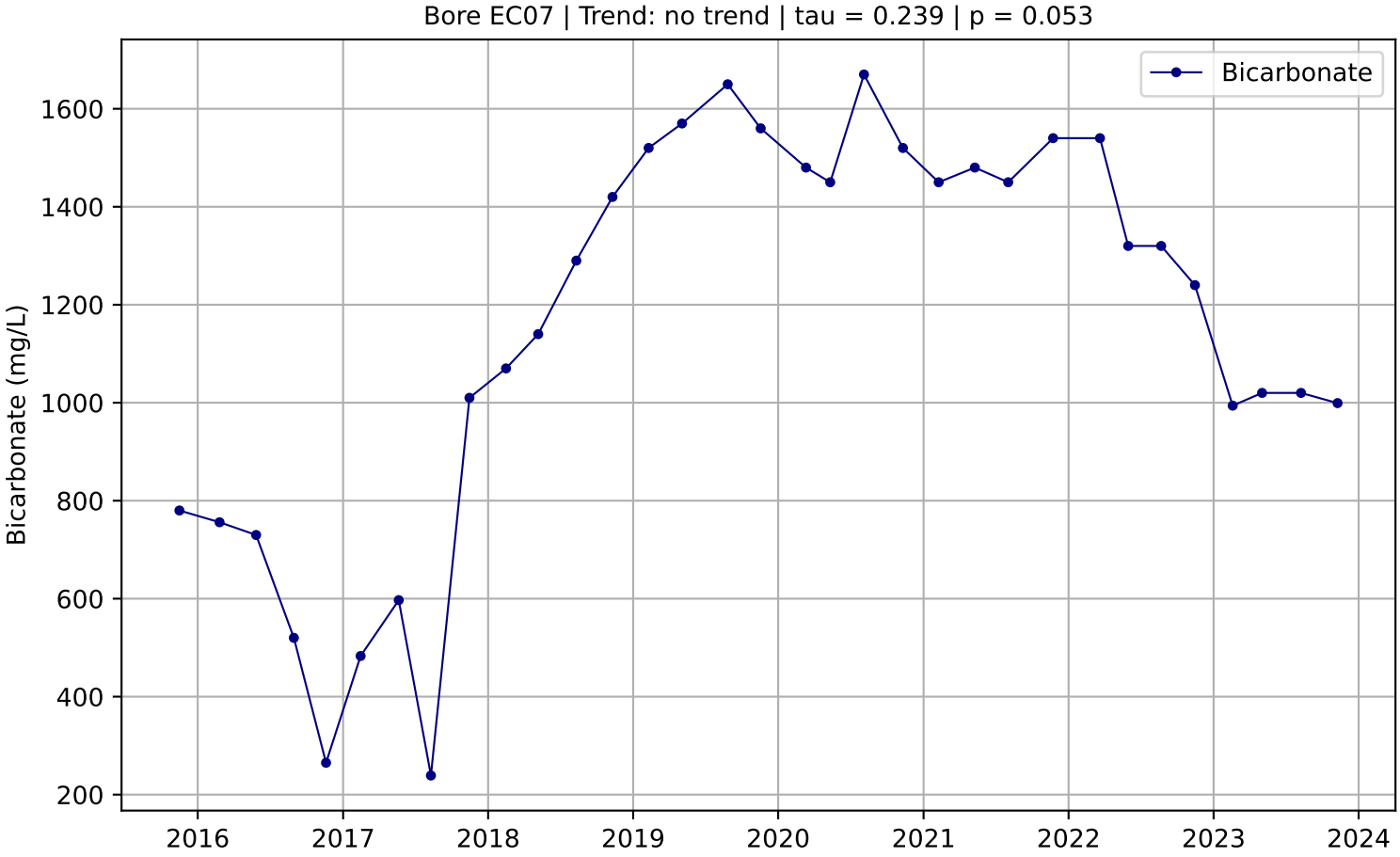

Bore EC03 | Trend: no trend | tau = -0.023 | p = 0.803
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
2022
2023
Selenium
Groundwater Quality Limit

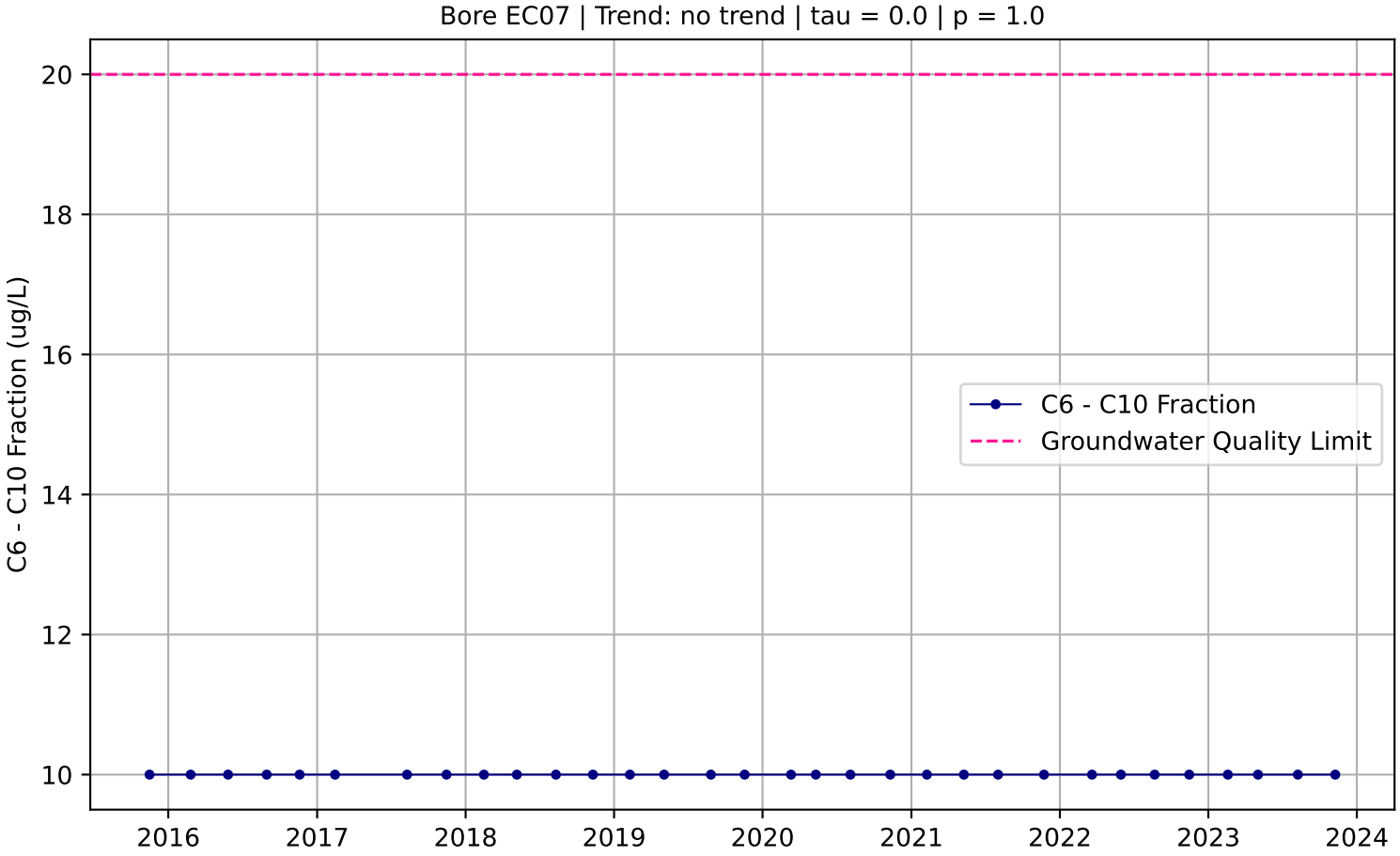

Bore EC03 | Trend: no trend | tau = -0.265 | p = 0.061
Sodium
Sodium (mg/L)
2800
2700
2600
2500
2400
2300
2200
2100
2018
2019
2020
2021
2022
2023
2024

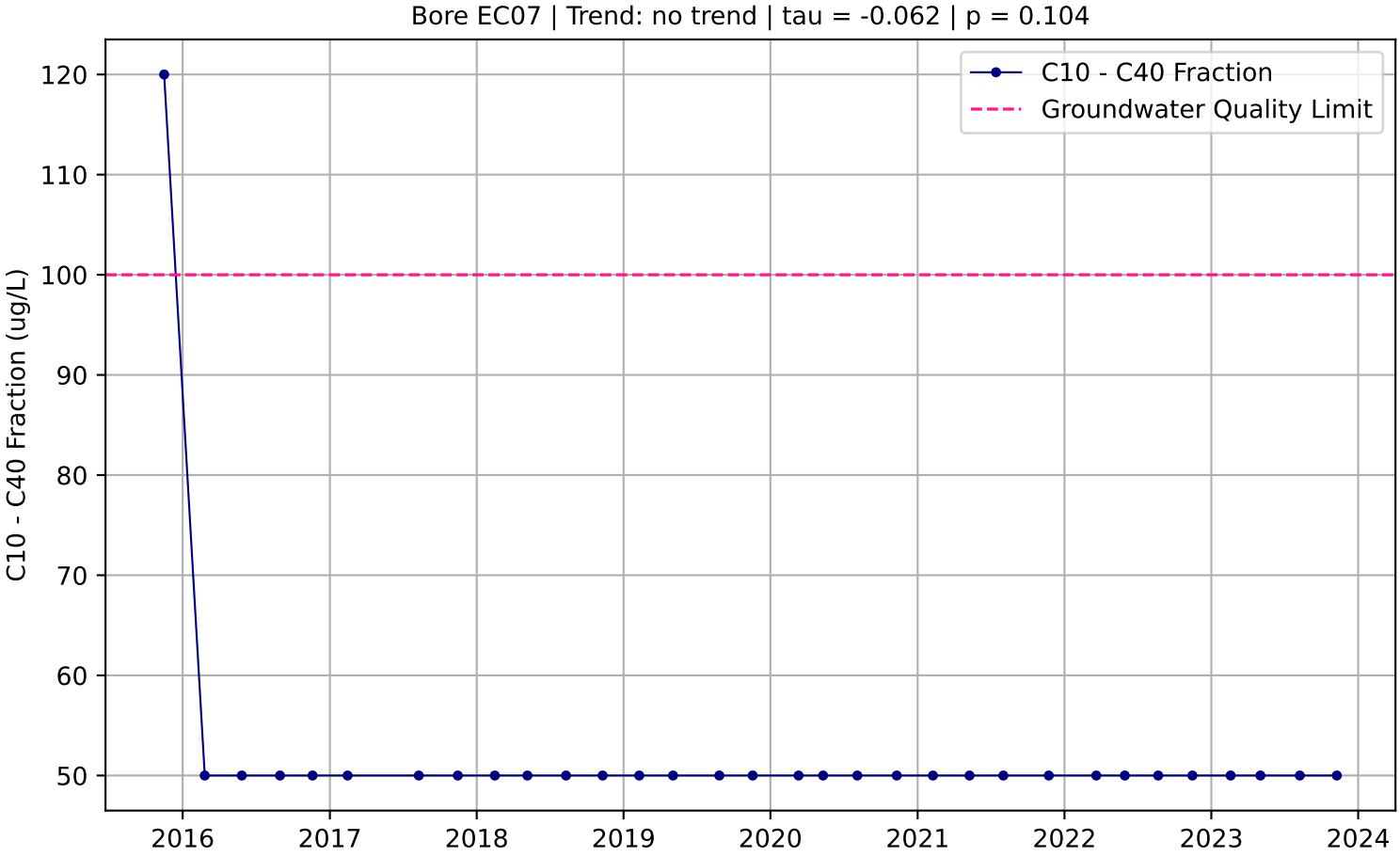

Bore EC03 | Trend: decreasing | tau = -0.594 | p = 0.0
Sulfate as SO4 - Turbidimetric (mg/L)
650
600
550
500
450
400
350
300
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

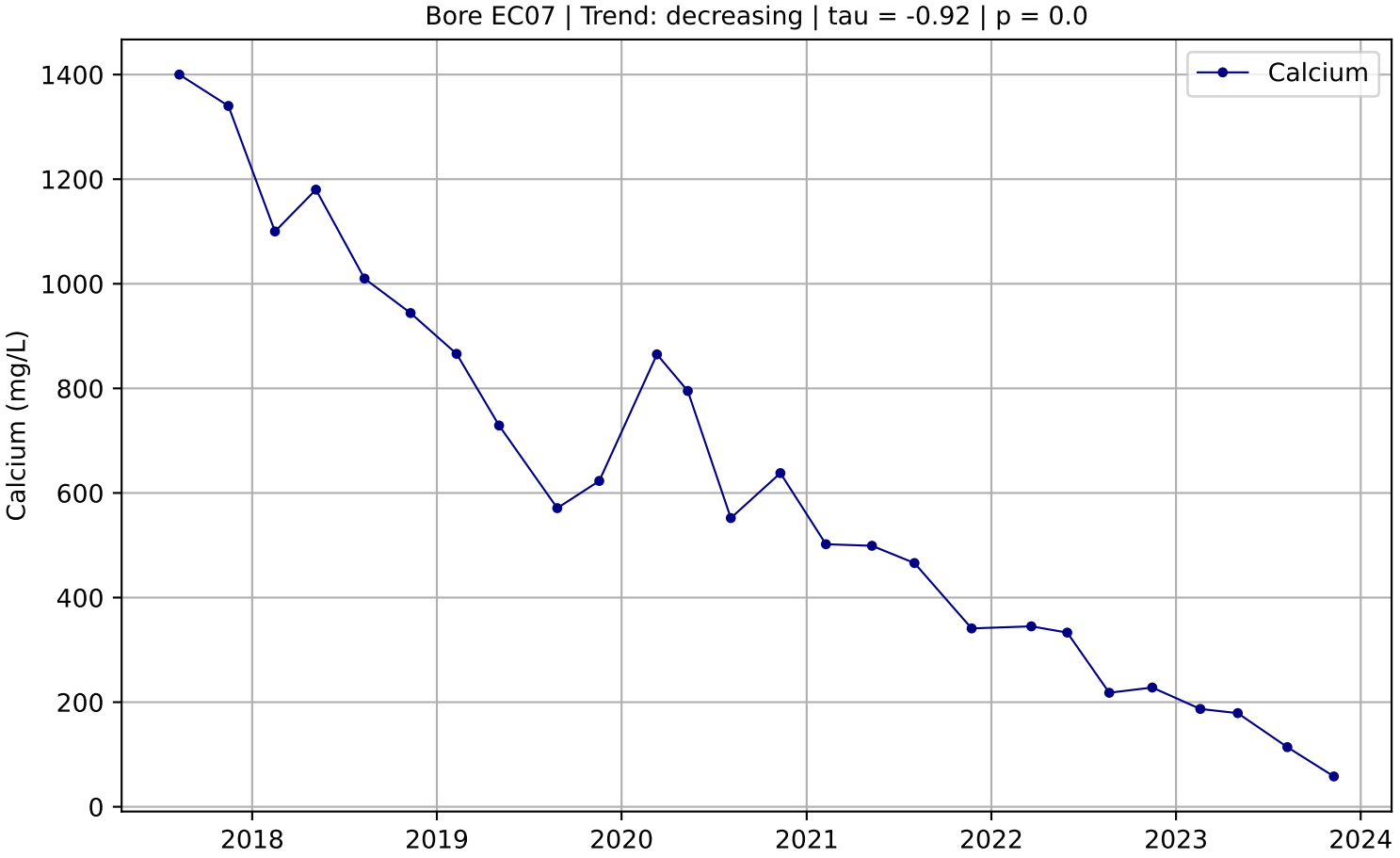

Bore EC07 | Trend: no trend | tau = -0.074 | p = 0.296
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
2016
2017
2018
2019
2020
2021
2022
2023
2024

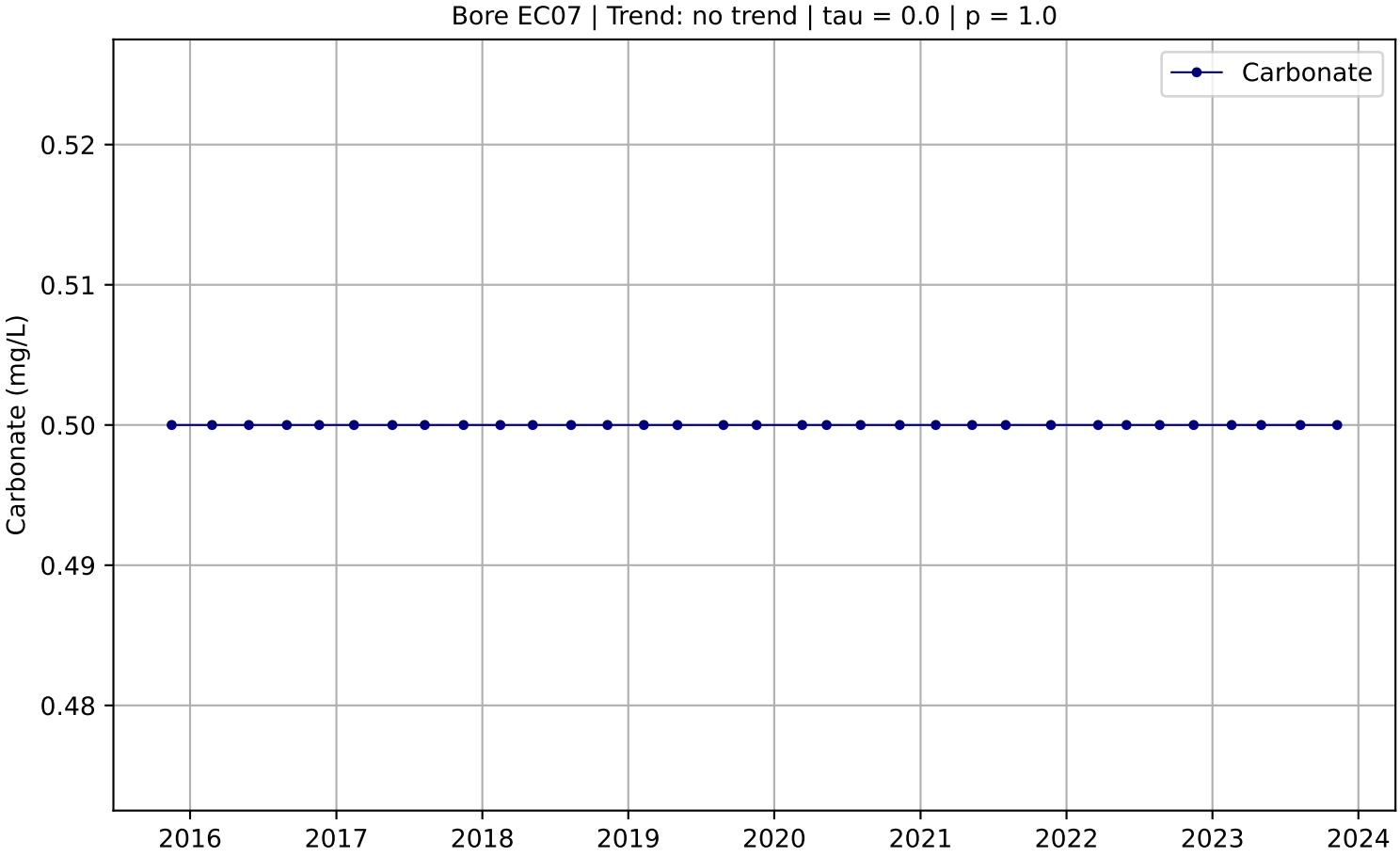

Bore EC07 | Trend: decreasing | tau = -0.667 | p = 0.0
Arsenic
Groundwater Quality Limit
Arsenic (mg/L)
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
2016
2017
2018
2019
2020
2021
2022
2023
2024

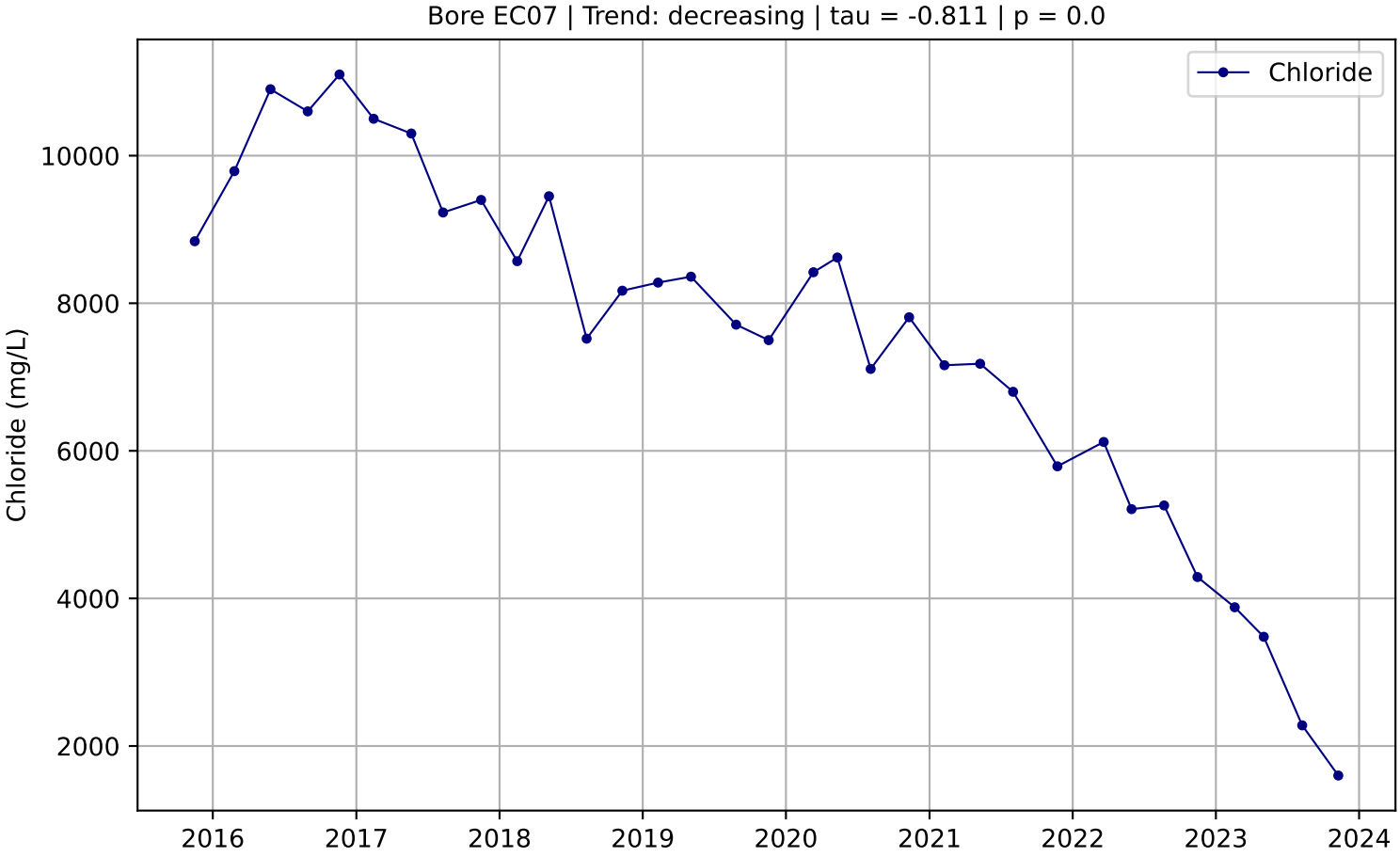

Bore EC07 | Trend: no trend | tau = 0.239 | p = 0.053
Bicarbonate
Bicarbonate (mg/L)
200
400
600
800
1000
1200
1400
1600
2016
2017
2018
2019
2020
2021
2022
2023
2024

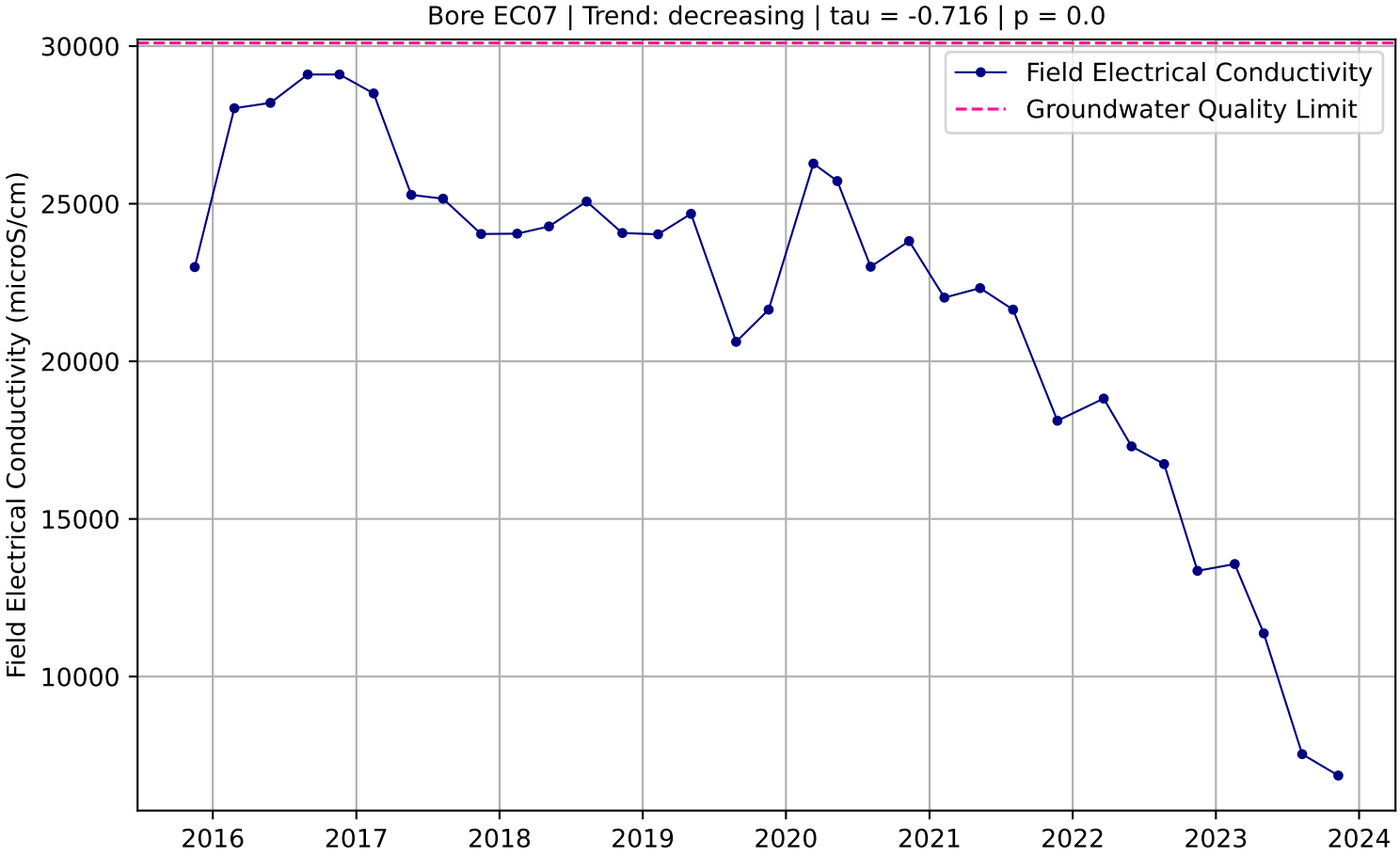

Bore EC07 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

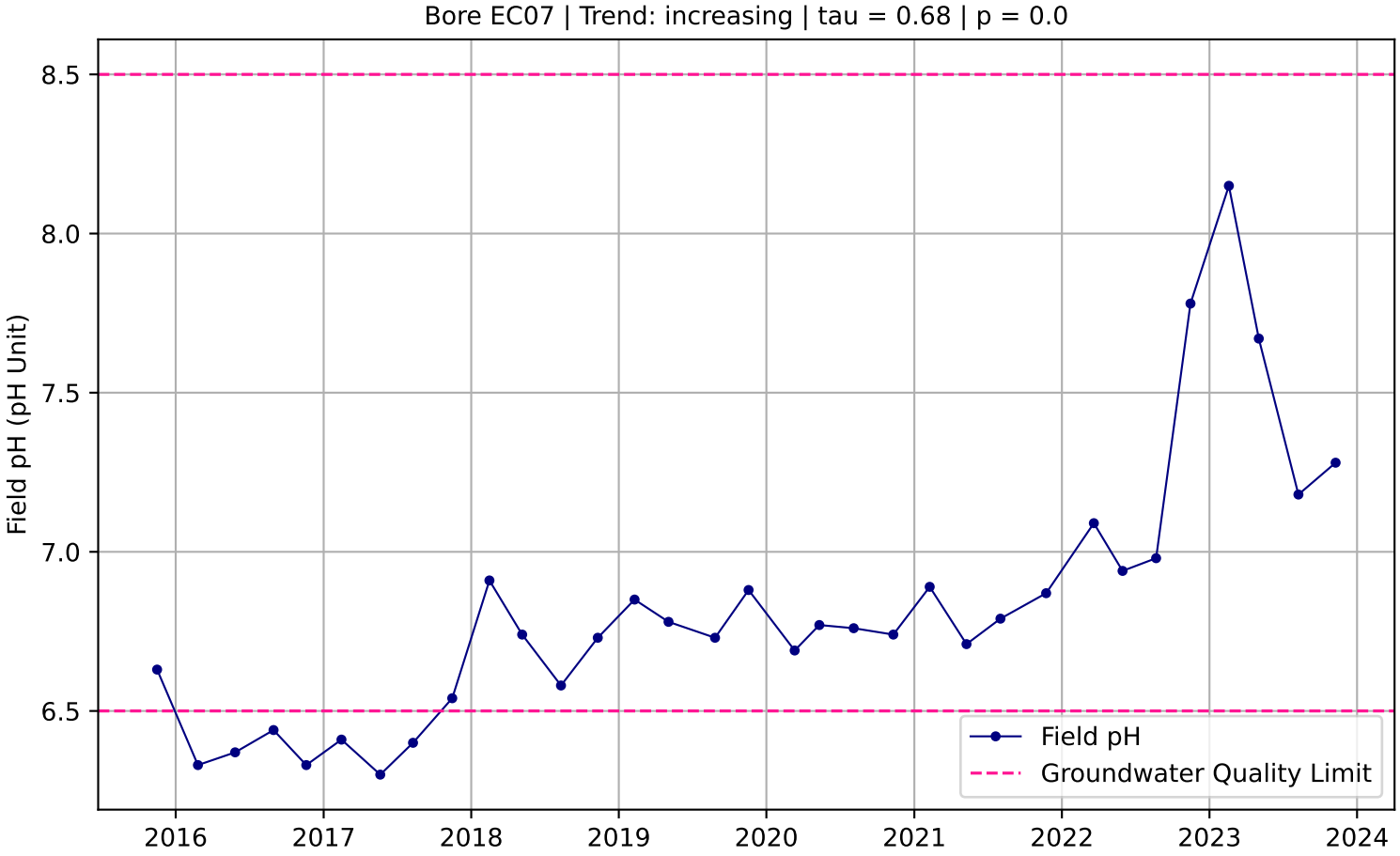

Bore EC07 | Trend: no trend | tau = -0.062 | p = 0.104
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
120
110
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024

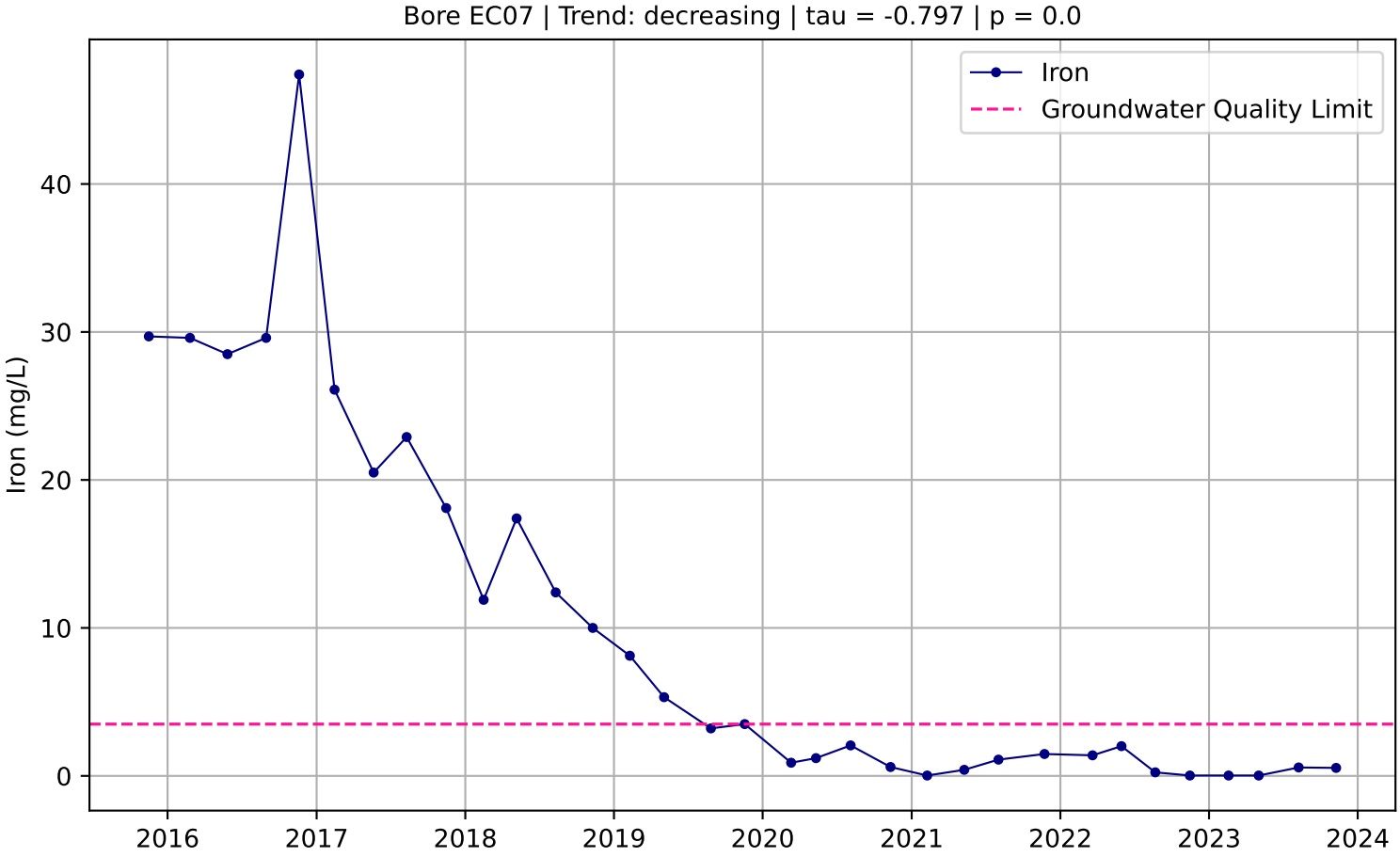

Bore EC07 | Trend: decreasing | tau = -0.92 | p = 0.0
Calcium
Calcium (mg/L)
0
200
400
600
800
1000
1200
1400
2018
2019
2020
2021
2022
2023
2024

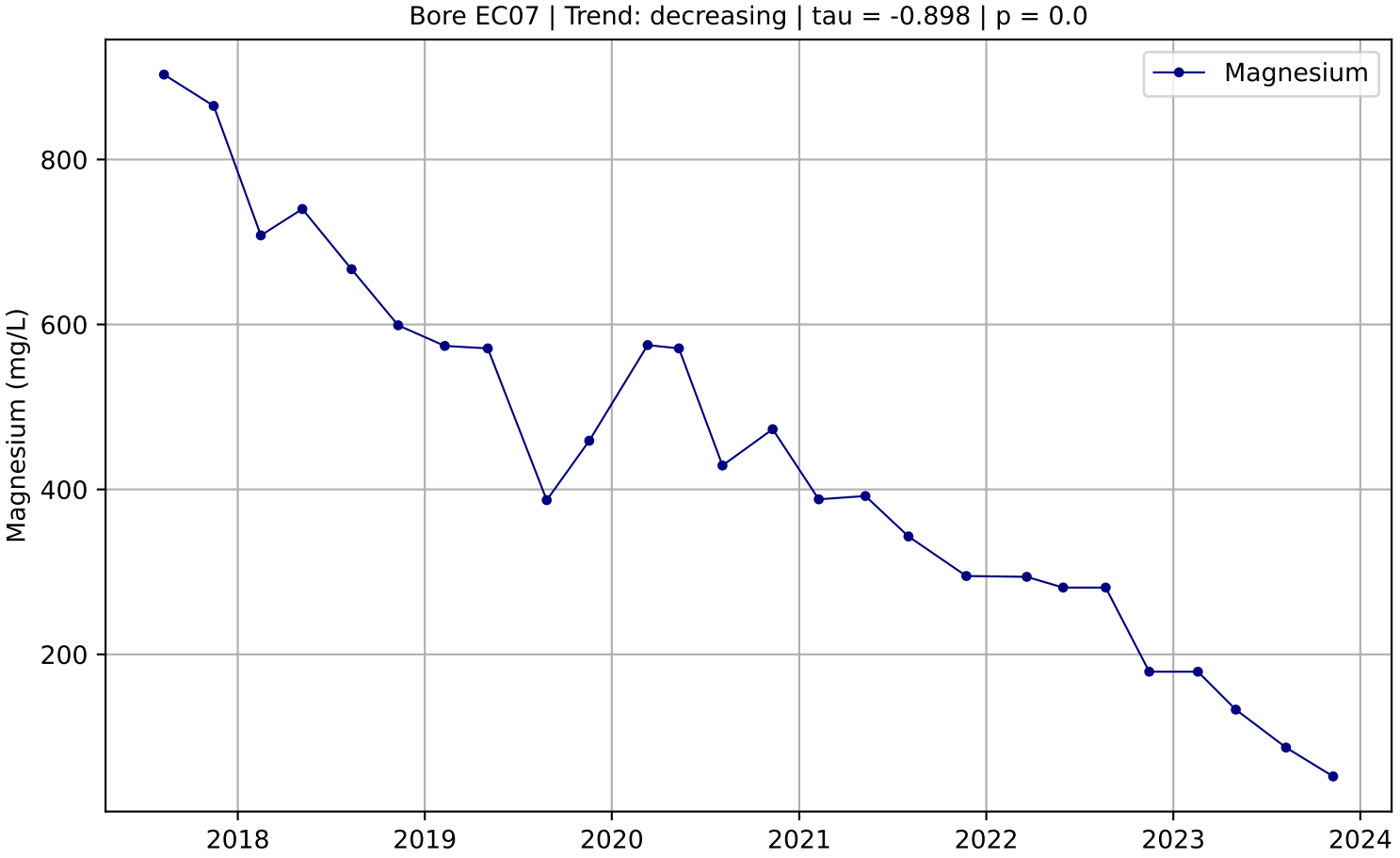

Bore EC07 | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

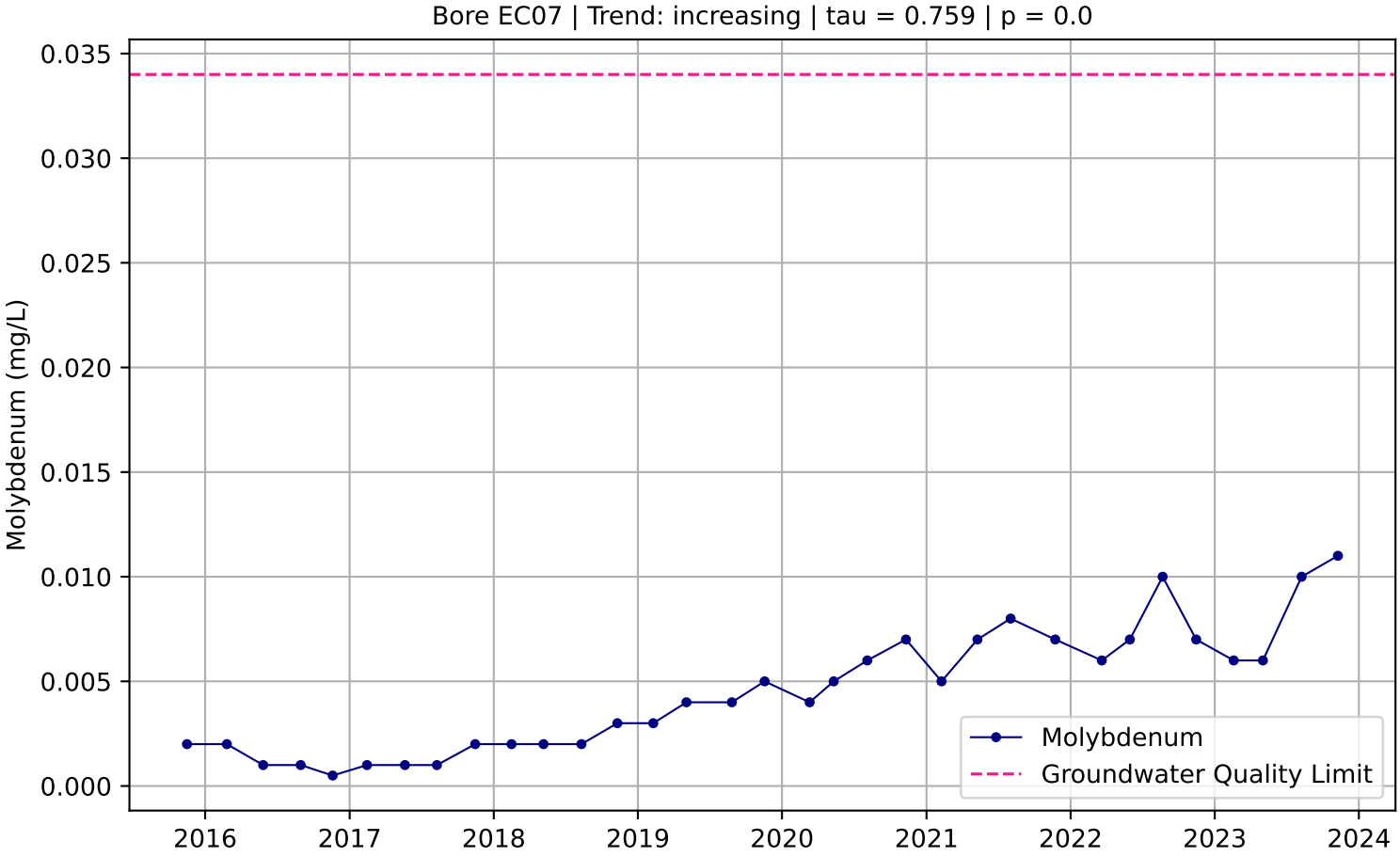

Bore EC07 | Trend: decreasing | tau = -0.811 | p = 0.0
Chloride
Chloride (mg/L)
10000
8000
6000
4000
2000
2016
2017
2018
2019
2020
2021
2022
2023
2024

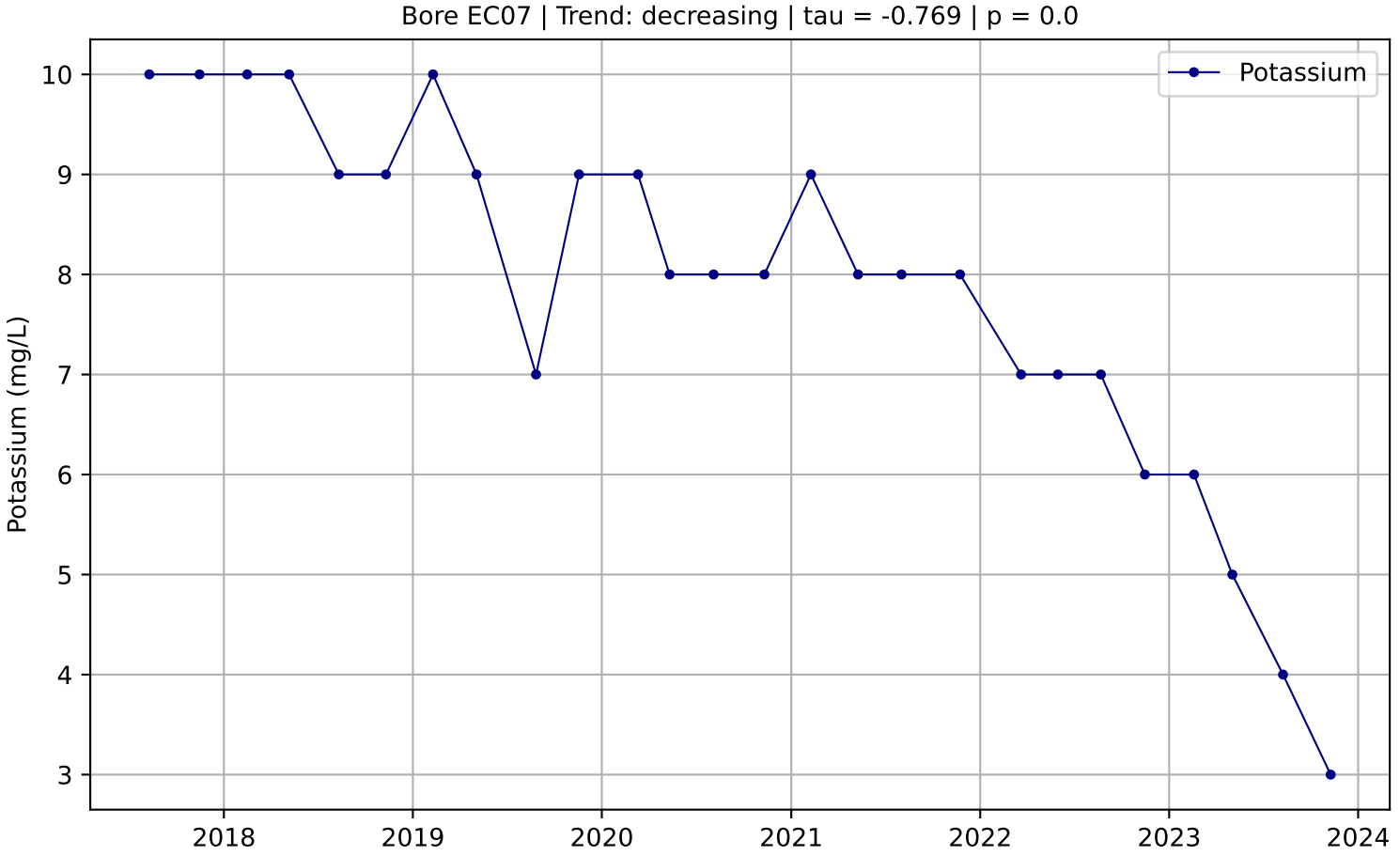

Bore EC07 | Trend: decreasing | tau = -0.716 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
30000
25000
20000
15000
10000
2016
2017
2018
2019
2020
2021
2022
2023
2024

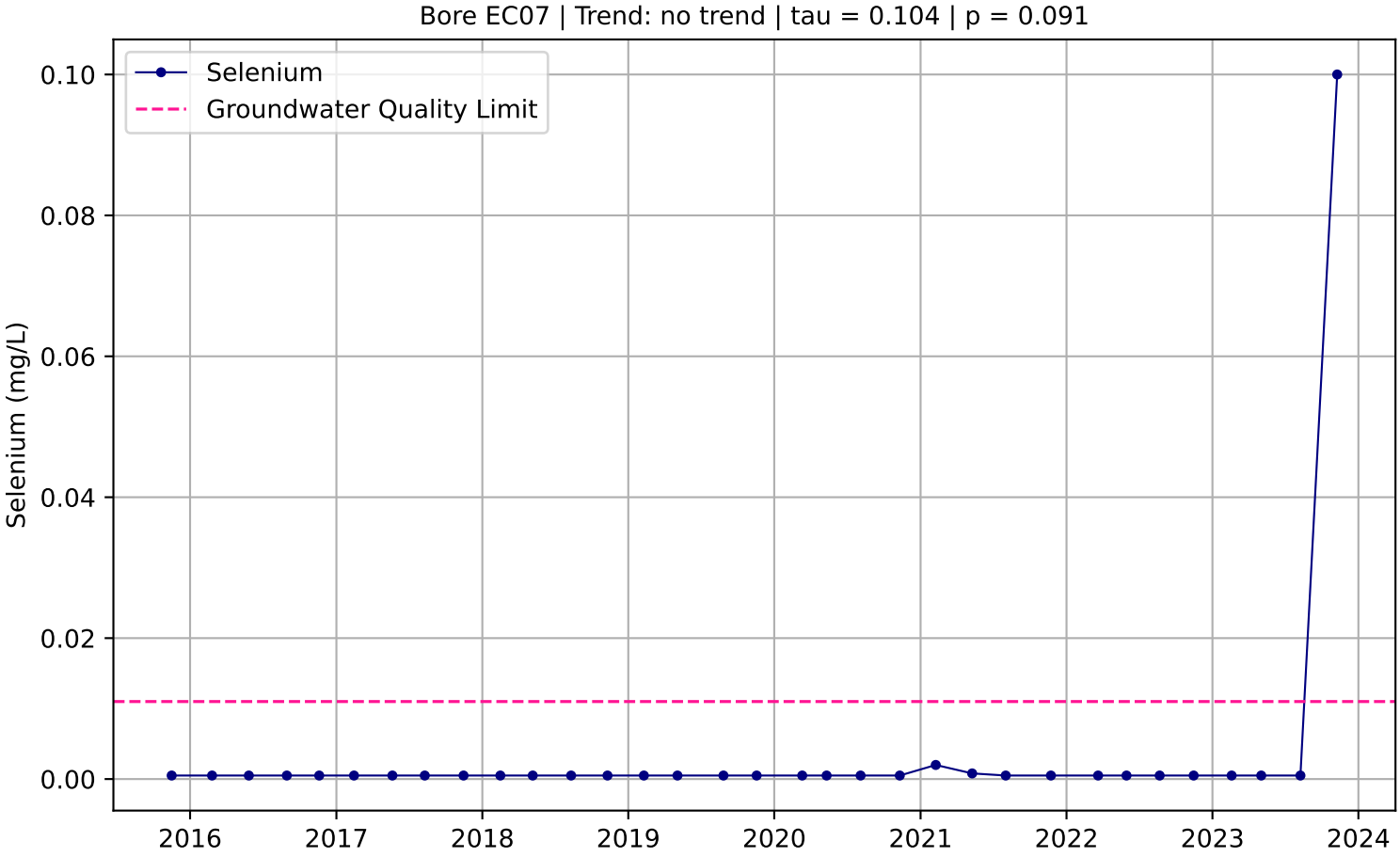

Bore EC07 | Trend: increasing | tau = 0.68 | p = 0.0
Field pH (pH Unit)
8.5
8.0
7.5
7.0
6.5
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

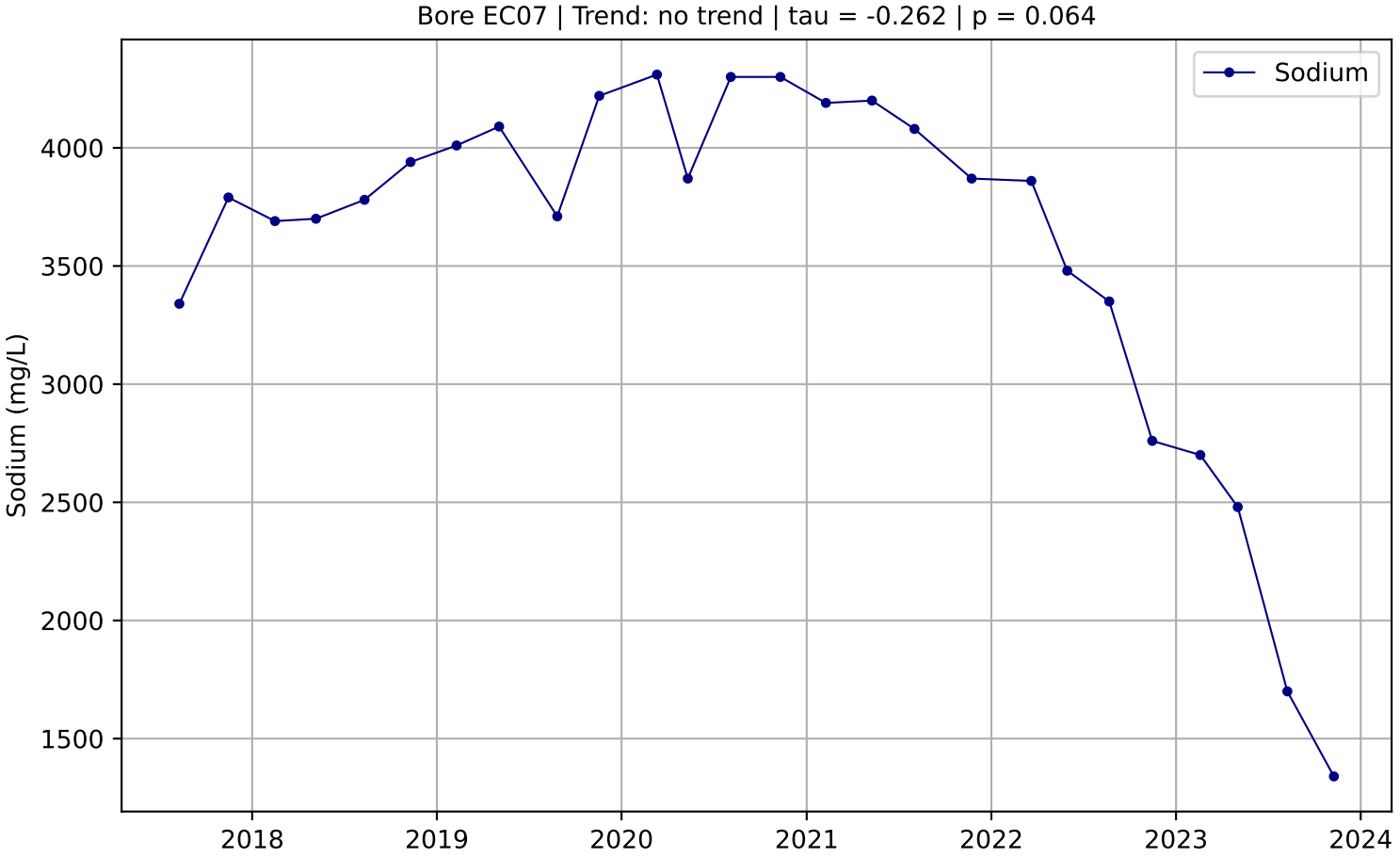

Bore EC07 | Trend: decreasing | tau = -0.797 | p = 0.0
Iron
Groundwater Quality Limit
Iron (mg/L)
0
10
20
30
40
2016
2017
2018
2019
2020
2021
2022
2023
2024

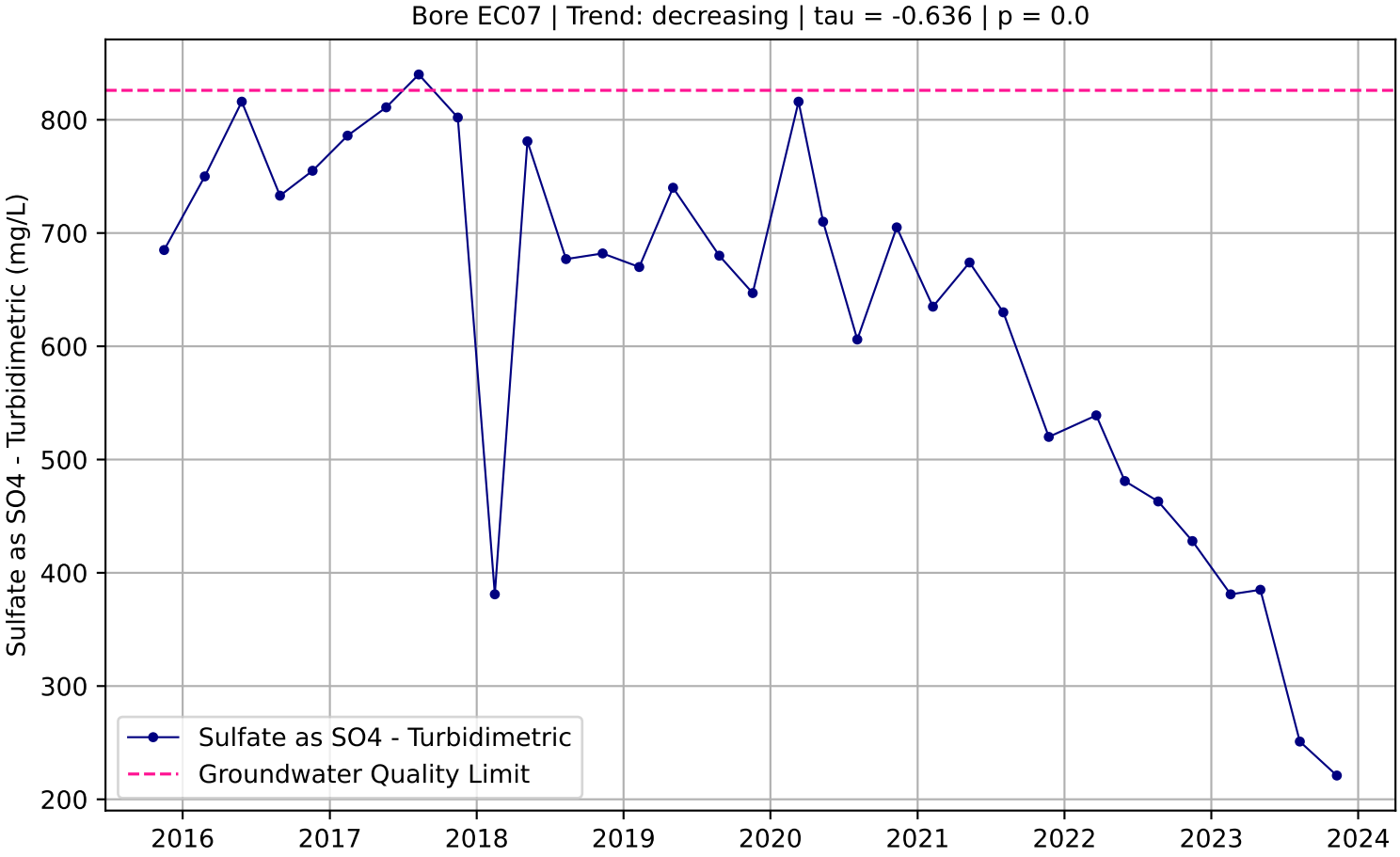

Bore EC07 | Trend: decreasing | tau = -0.898 | p = 0.0
Magnesium
Magnesium (mg/L)
800
600
400
200
2018
2019
2020
2021
2022
2023
2024

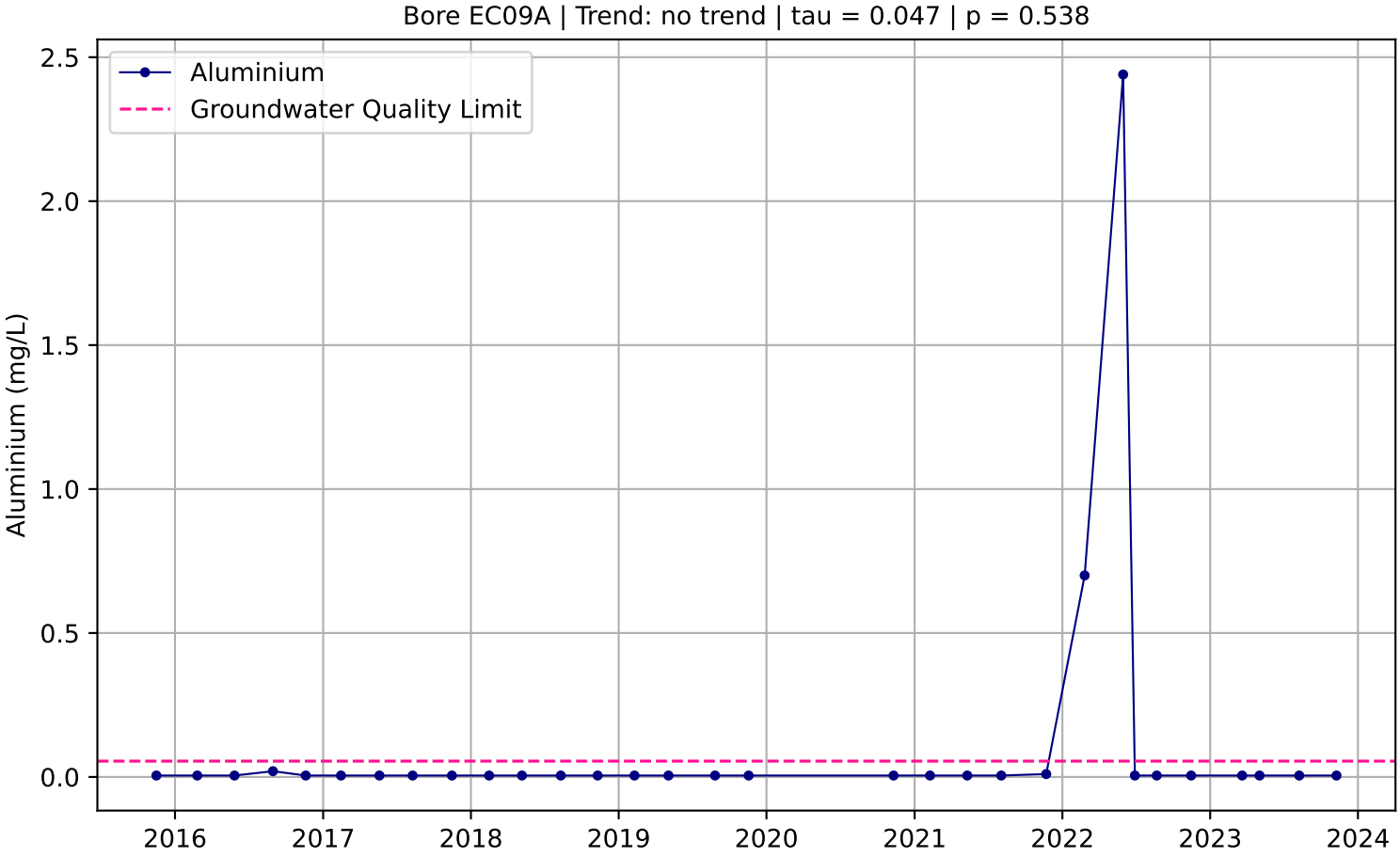

Bore EC07 | Trend: increasing | tau = 0.759 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

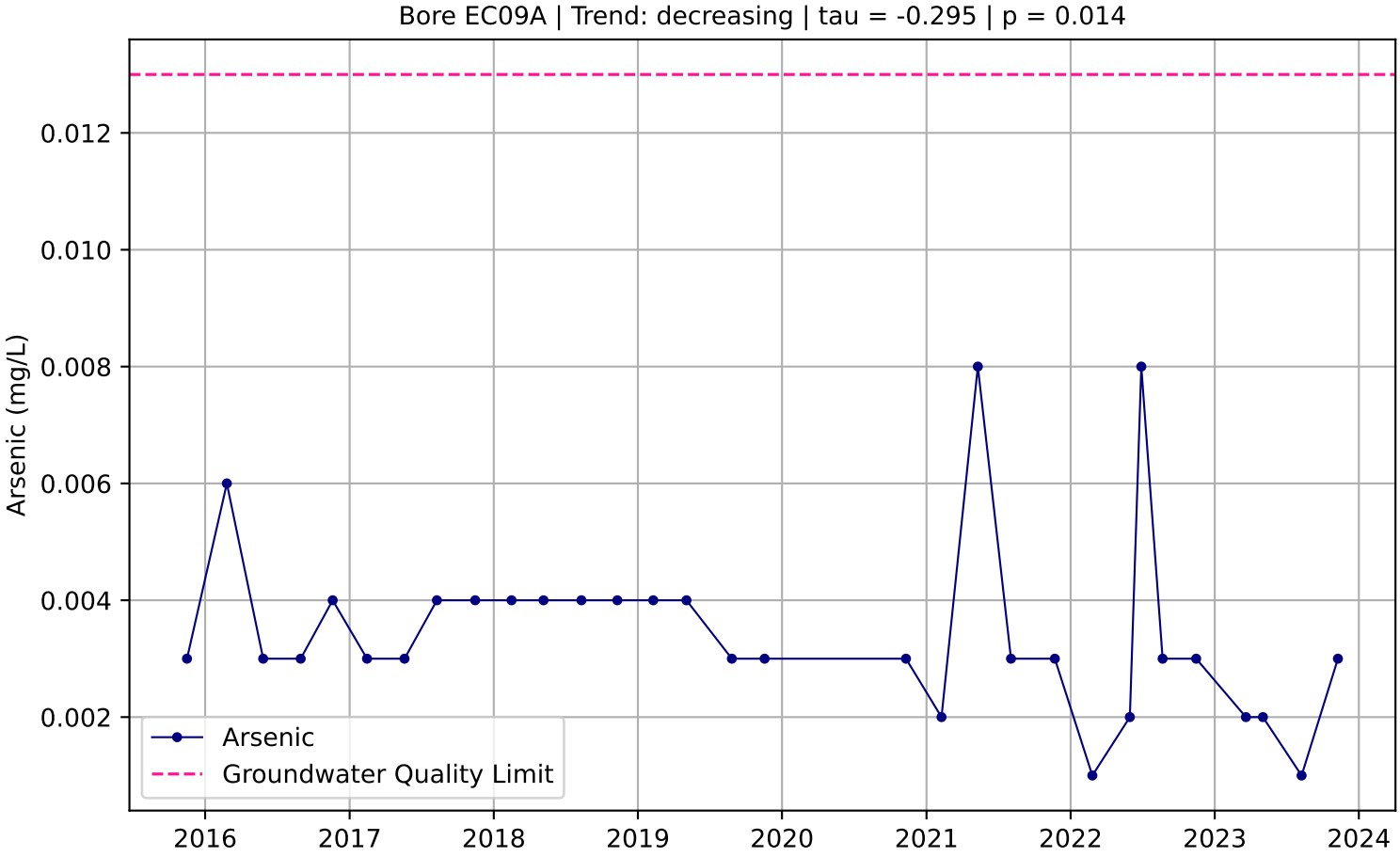

Bore EC07 | Trend: decreasing | tau = -0.769 | p = 0.0
Potassium
Potassium (mg/L)
10
9
8
7
6
5
4
3
2018
2019
2020
2021
2022
2023
2024

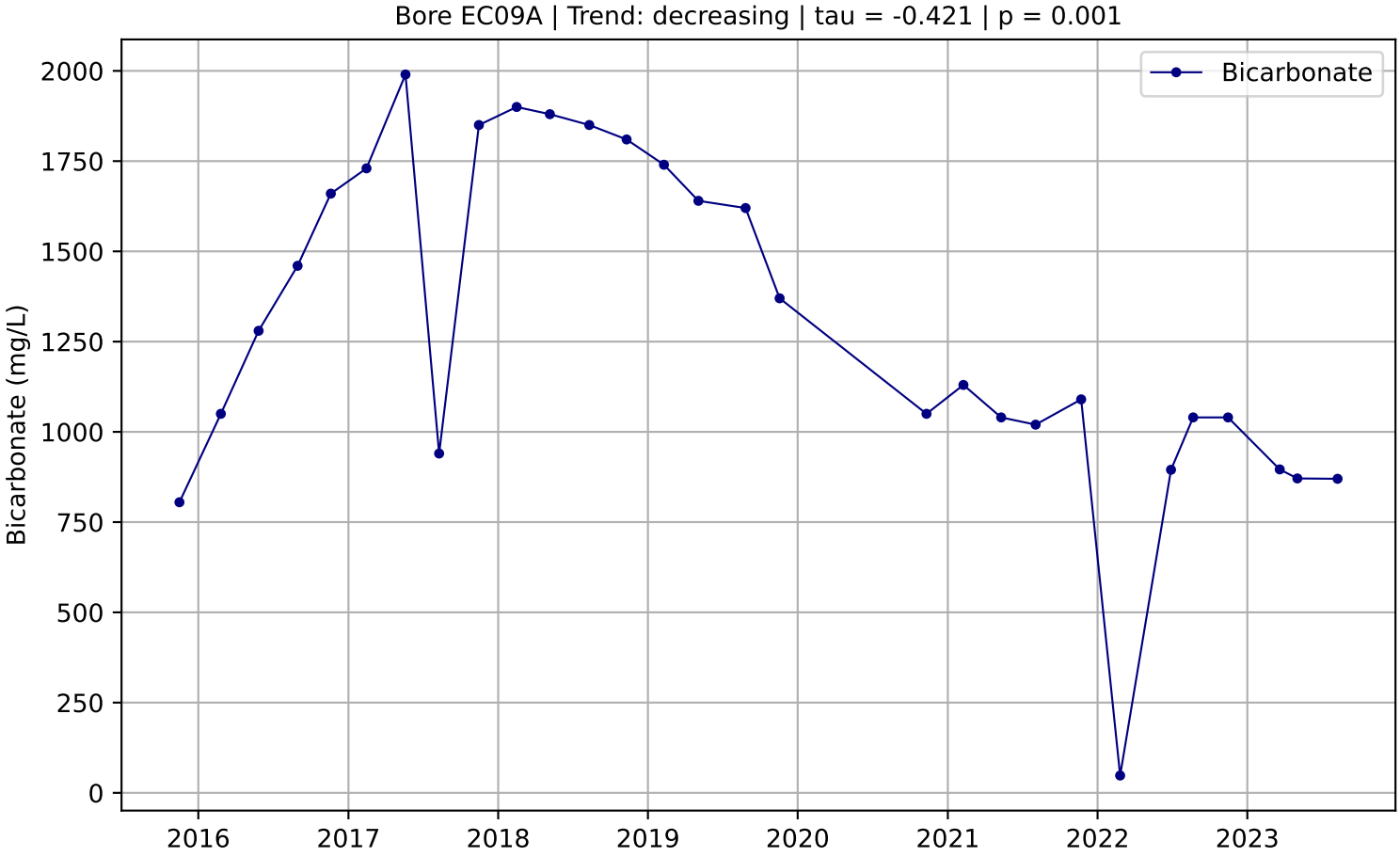

Bore EC07 | Trend: no trend | tau = 0.104 | p = 0.091
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

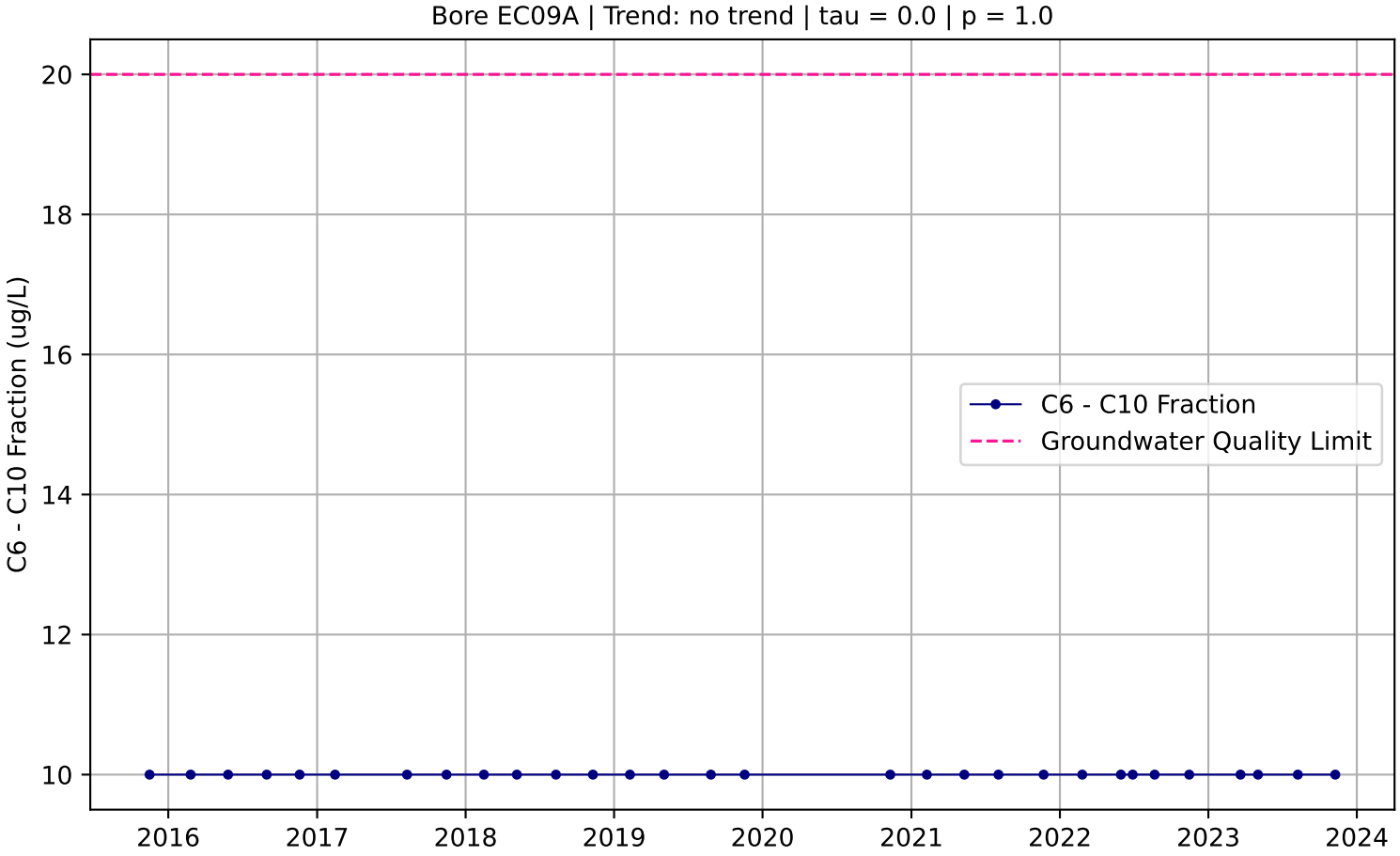

Bore EC07 | Trend: no trend | tau = -0.262 | p = 0.064
Sodium
Sodium (mg/L)
4000
3500
3000
2500
2000
1500
2018
2019
2020
2021
2022
2023
2024

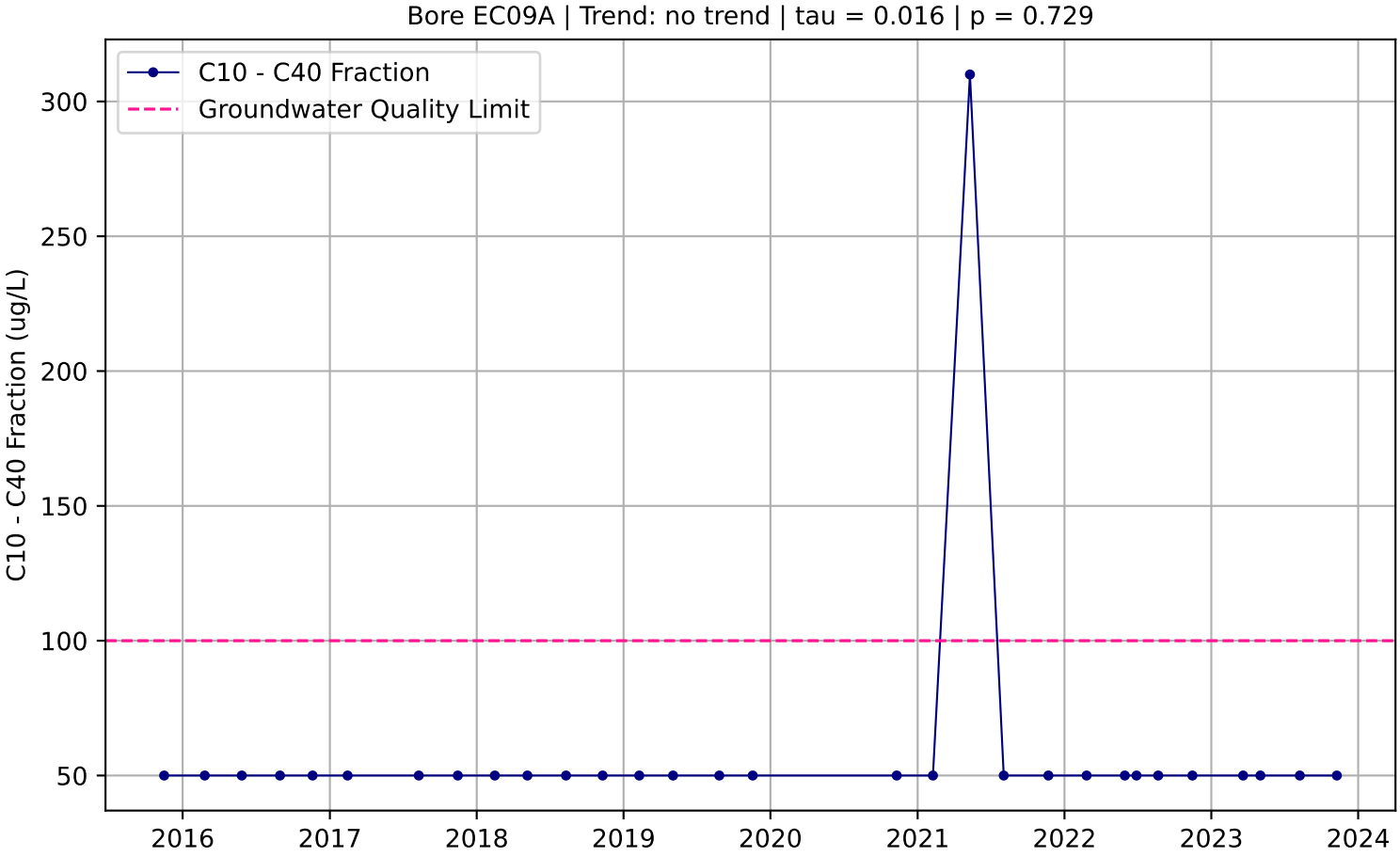

Bore EC07 | Trend: decreasing | tau = -0.636 | p = 0.0
Sulfate as SO4 - Turbidimetric (mg/L)
800
700
600
500
400
300
200
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

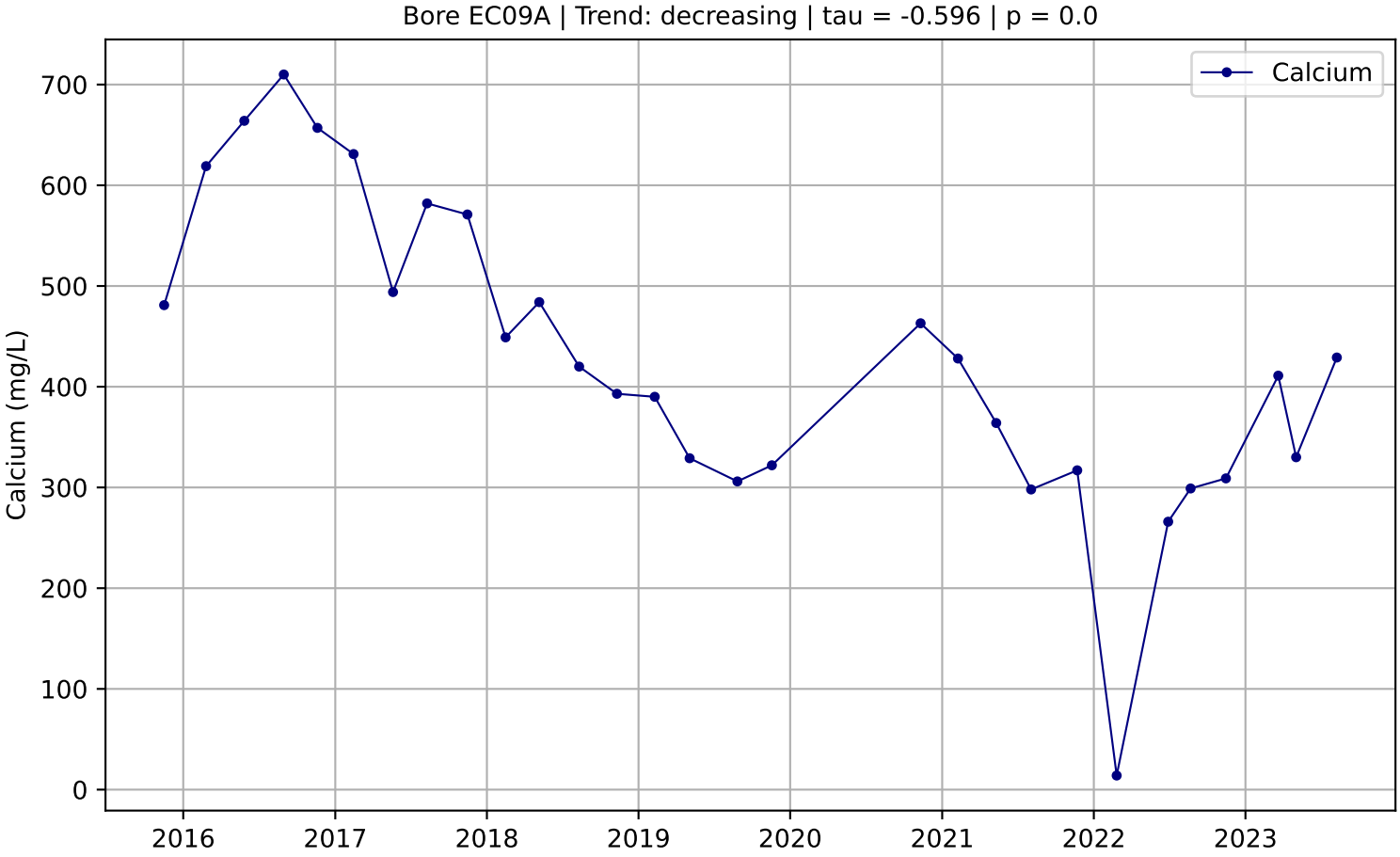

Bore EC09A | Trend: no trend | tau = 0.047 | p = 0.538
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

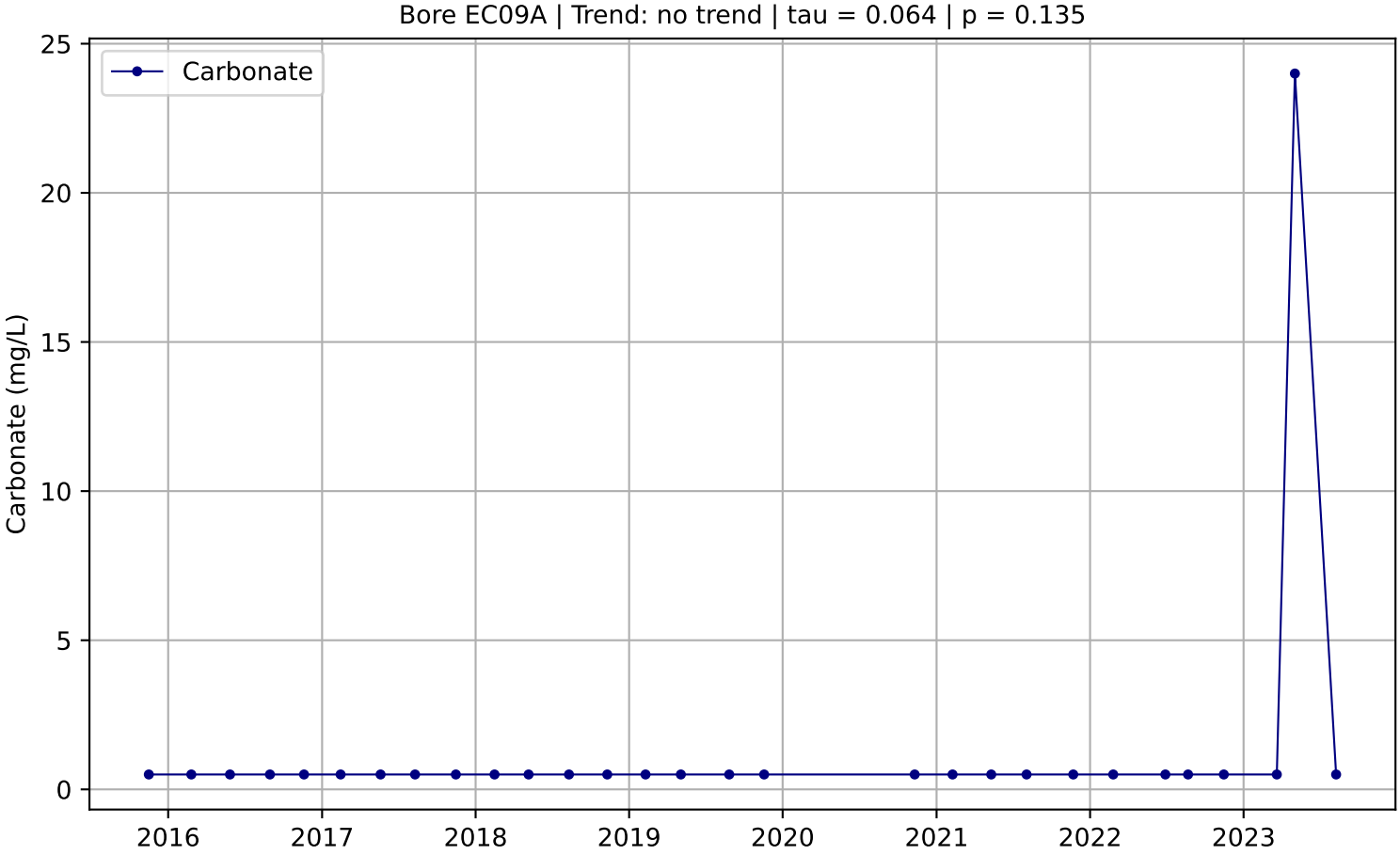

Bore EC09A | Trend: decreasing | tau = -0.295 | p = 0.014
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

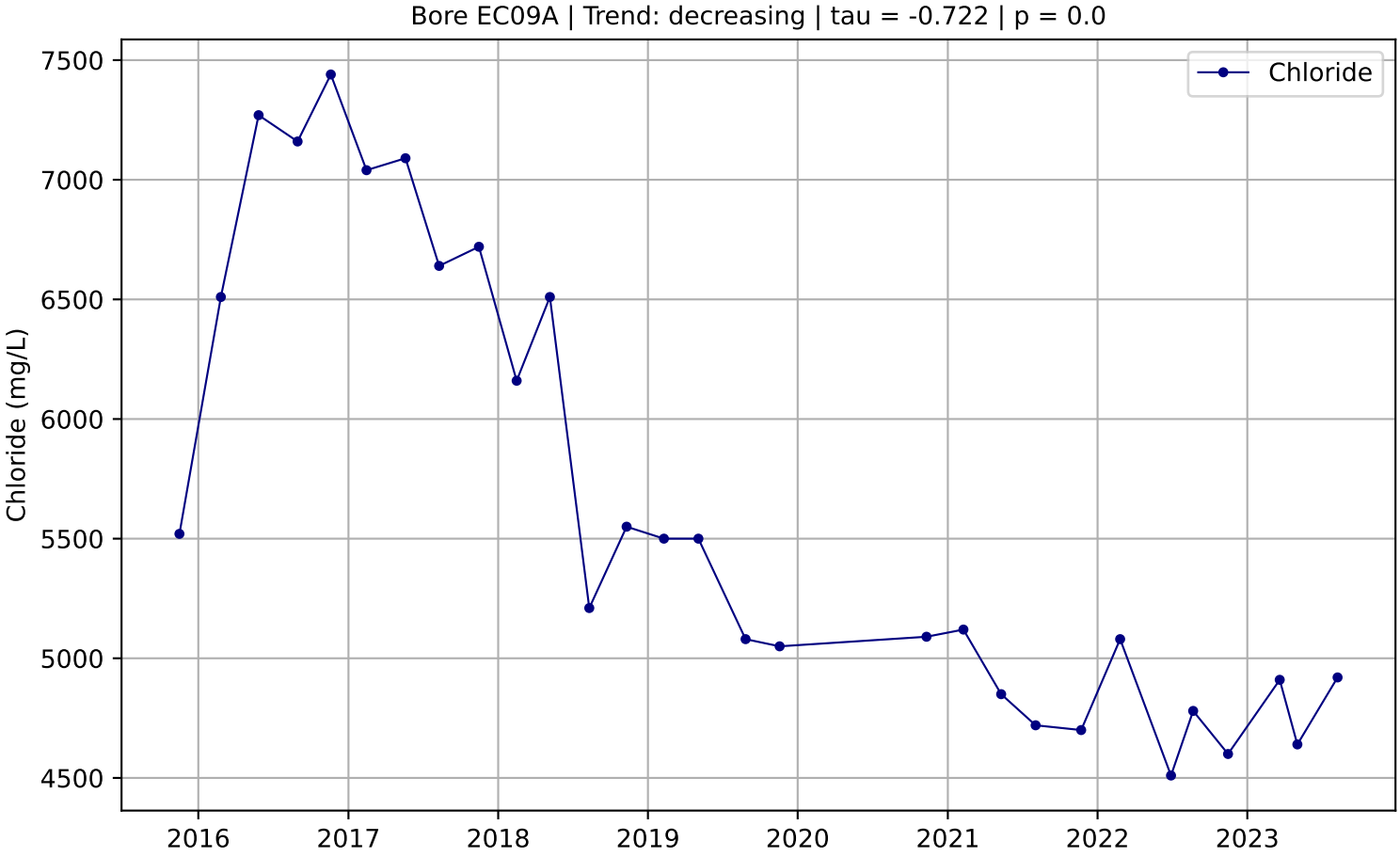

Bore EC09A | Trend: decreasing | tau = -0.421 | p = 0.001
Bicarbonate
Bicarbonate (mg/L)
2000
1750
1500
1250
1000
750
500
250
0
2016
2017
2018
2019
2020
2021
2022
2023

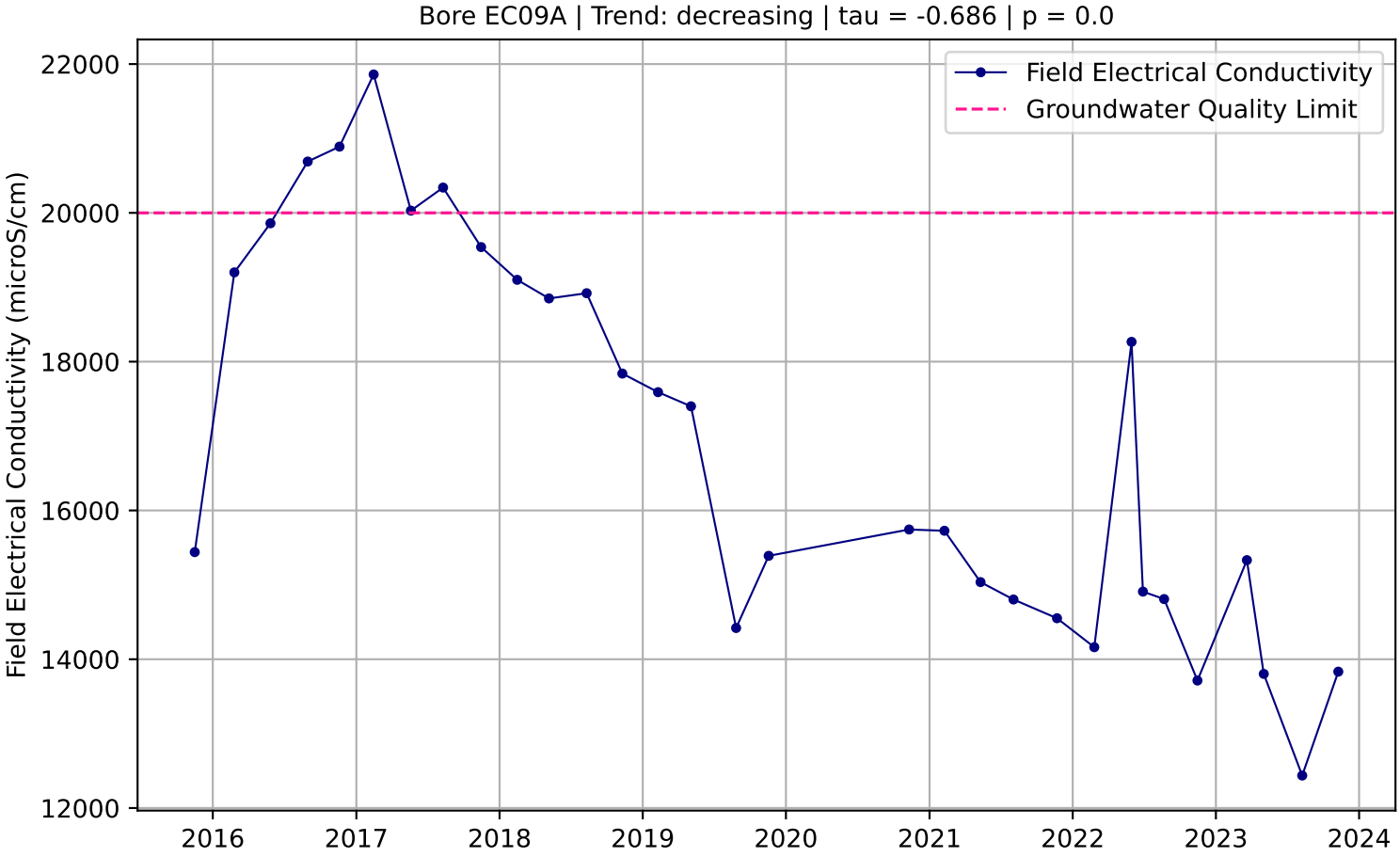

Bore EC09A | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

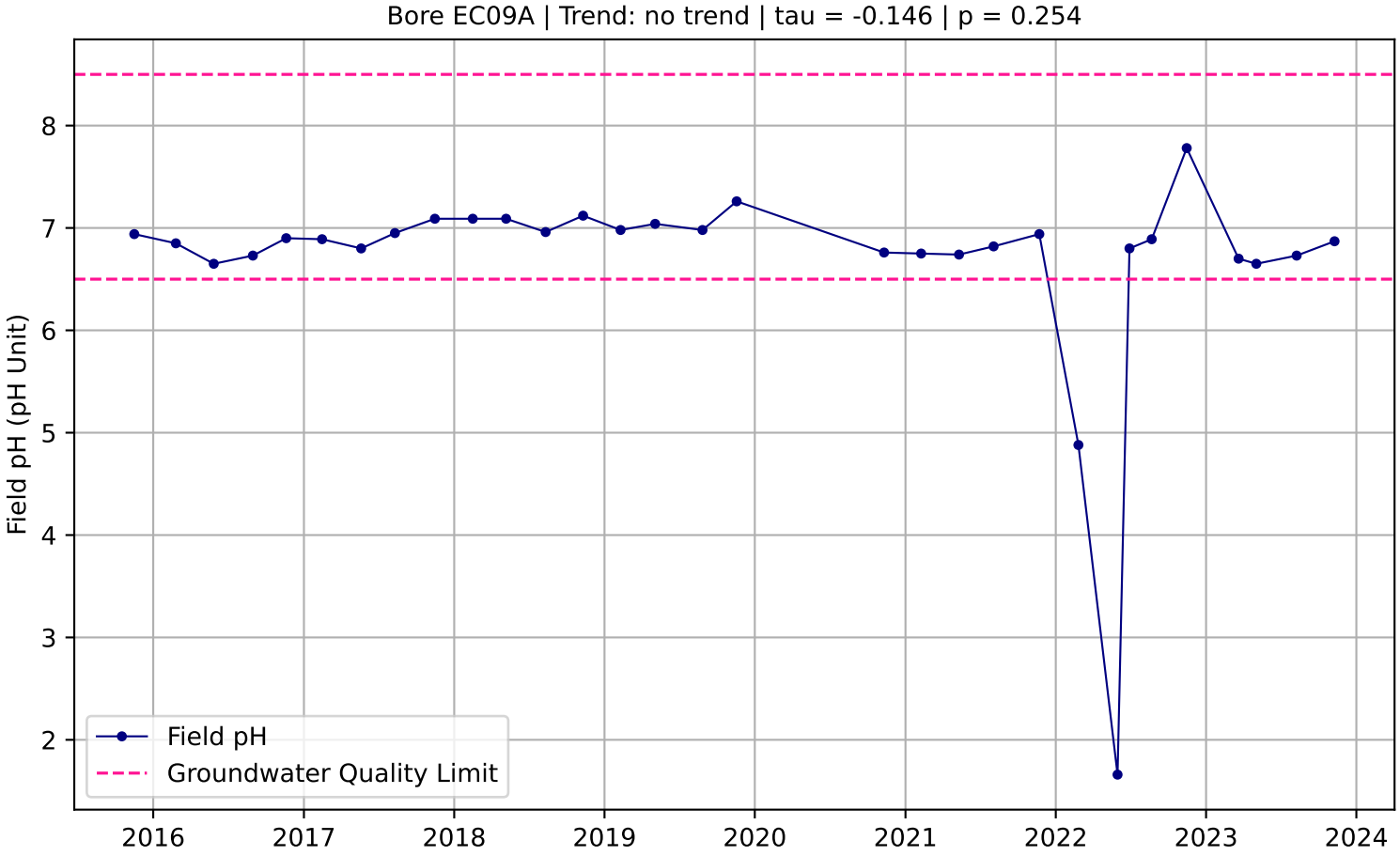

Bore EC09A | Trend: no trend | tau = 0.016 | p = 0.729
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
300
250
200
150
100
50
2016
2017
2018
2019
2020
2021
2022
2023
2024

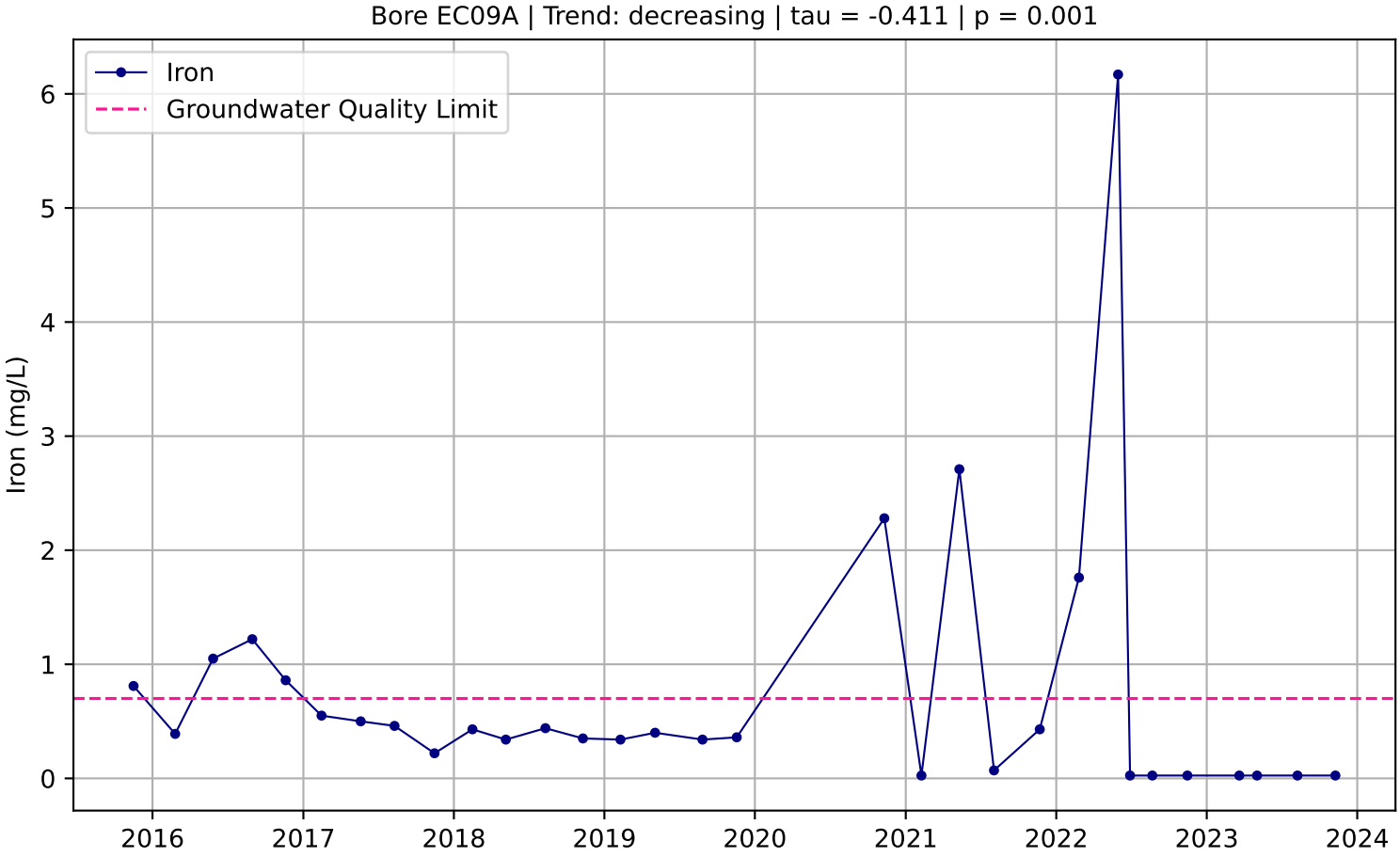

Bore EC09A | Trend: decreasing | tau = -0.596 | p = 0.0
Calcium
Calcium (mg/L)
0
100
200
300
400
500
600
700
2016
2017
2018
2019
2020
2021
2022
2023

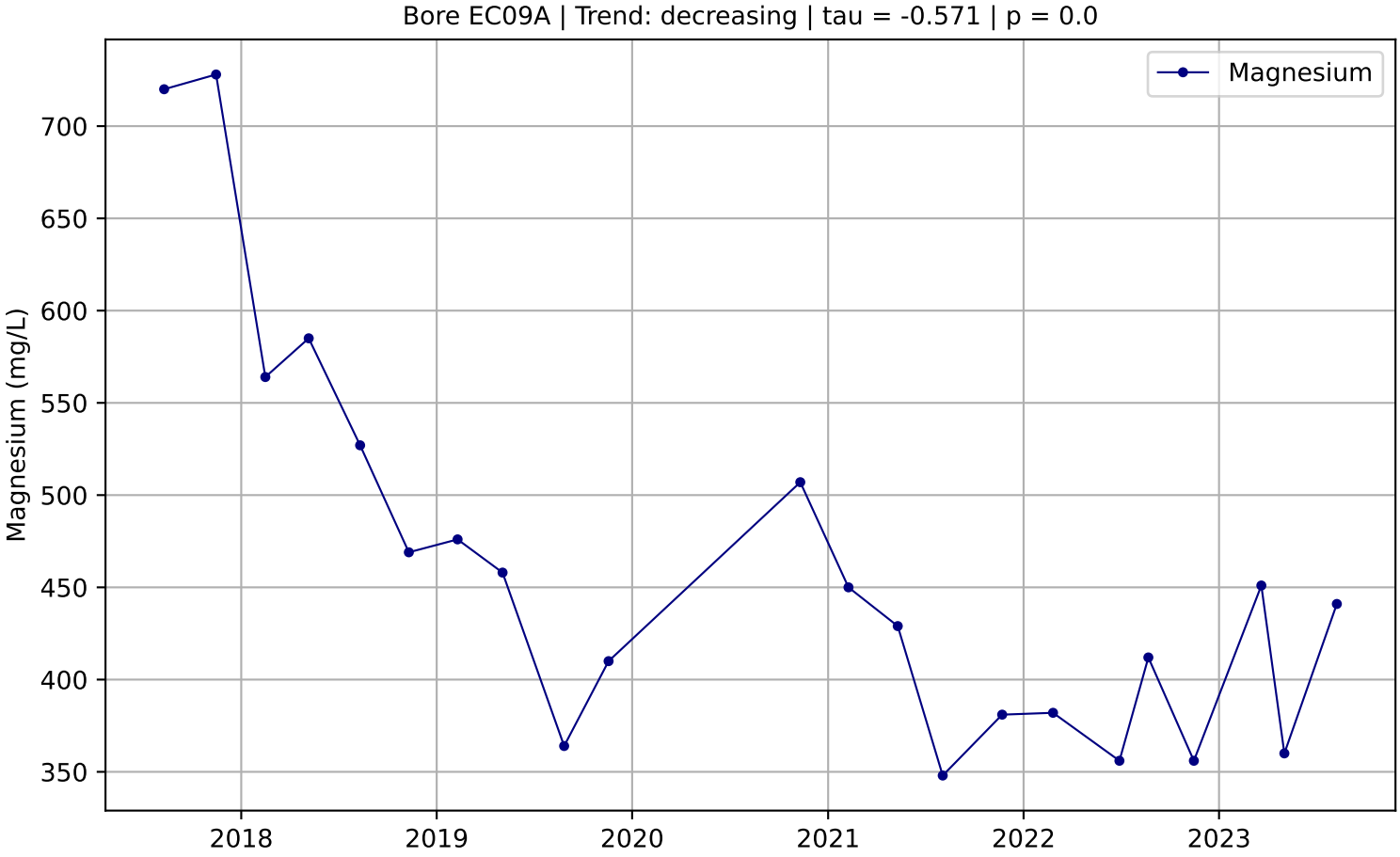

Bore EC09A | Trend: no trend | tau = 0.064 | p = 0.135
Carbonate
Carbonate (mg/L)
25
20
15
10
5
0
2016
2017
2018
2019
2020
2021
2022
2023

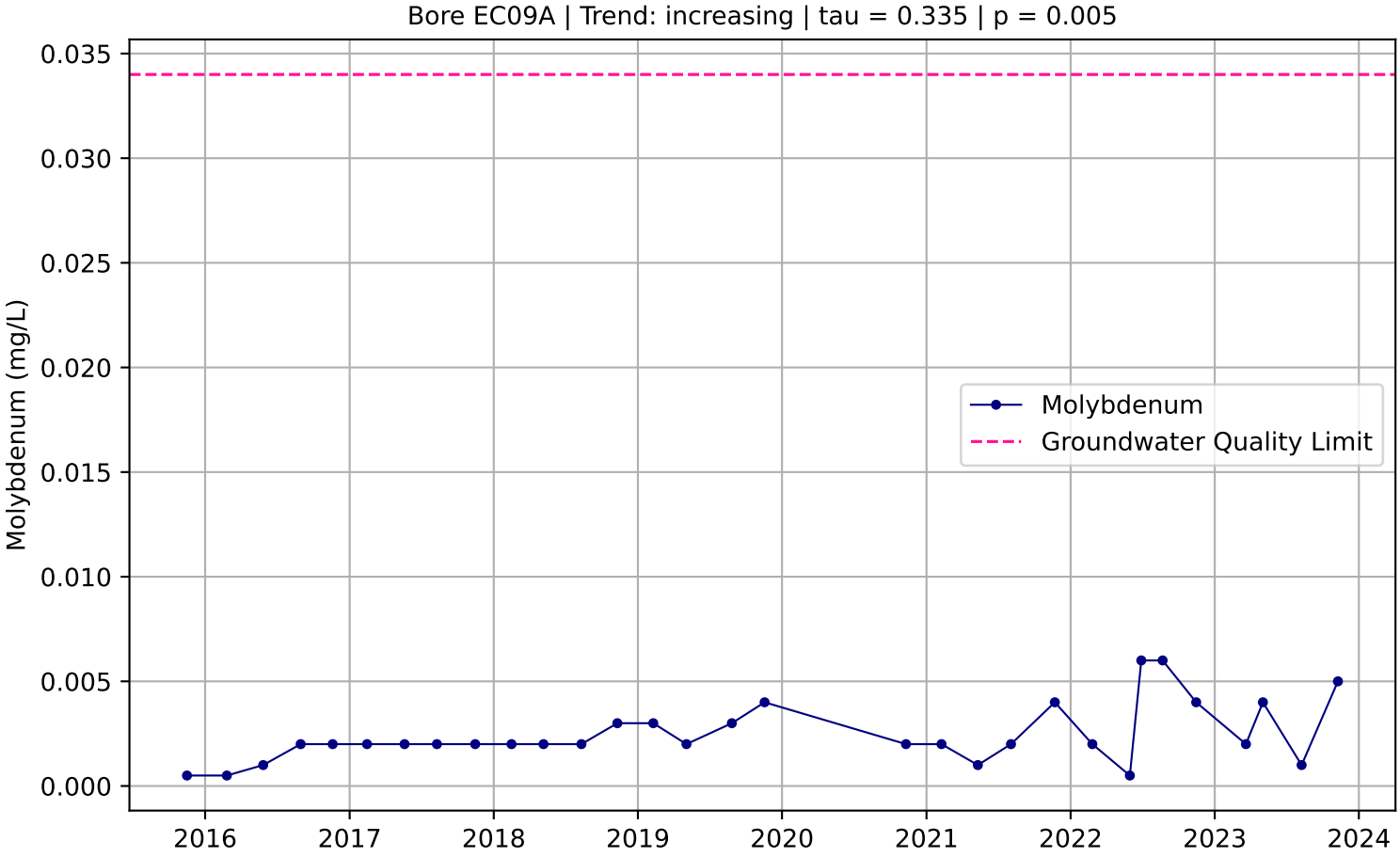

Bore EC09A | Trend: decreasing | tau = -0.722 | p = 0.0
Chloride
Chloride (mg/L)
7500
7000
6500
6000
5500
5000
4500
2016
2017
2018
2019
2020
2021
2022
2023

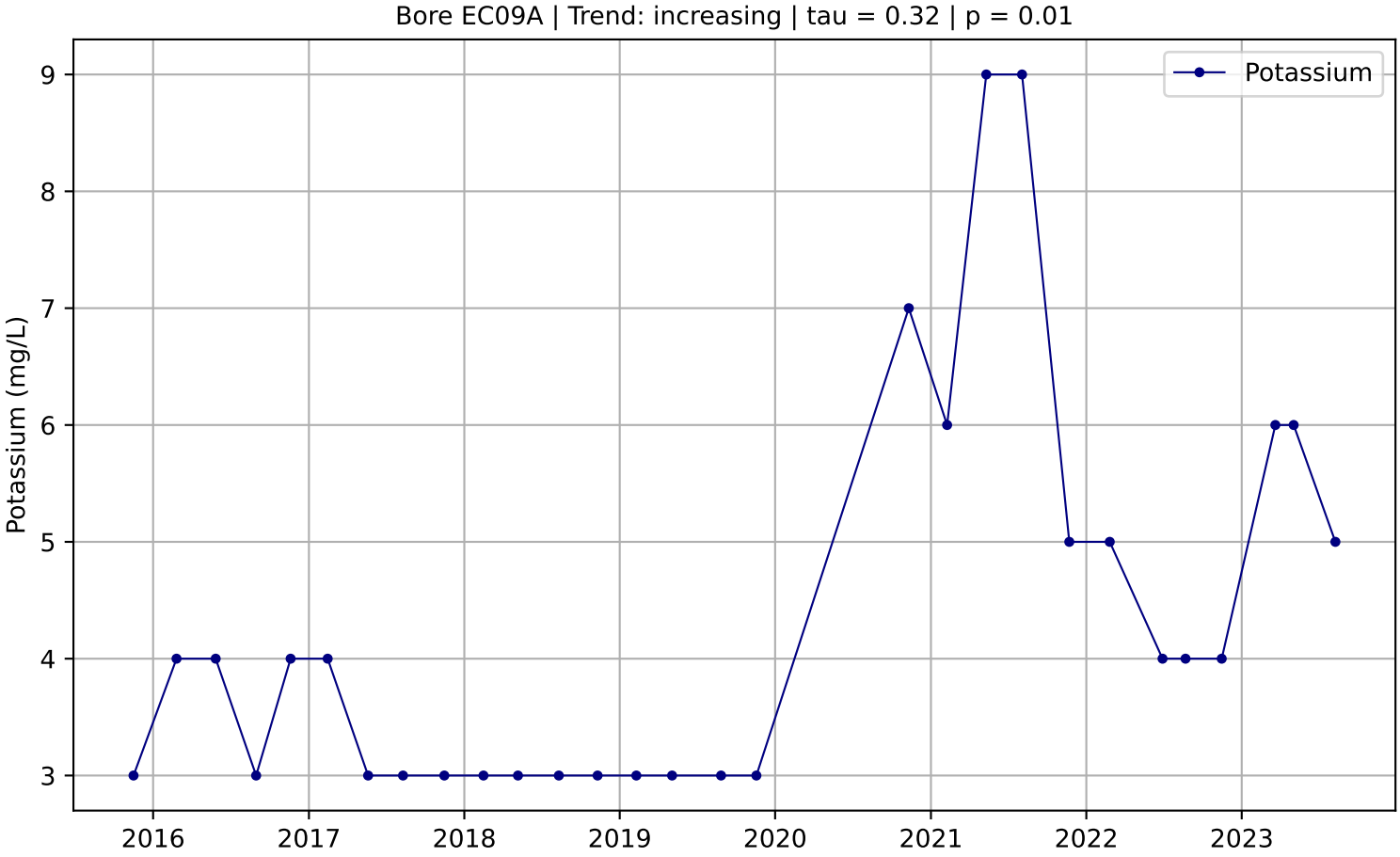

Bore EC09A | Trend: decreasing | tau = -0.686 | p = 0.0
Field Electrical Conductivity (microS/cm)
22000
20000
18000
16000
14000
12000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

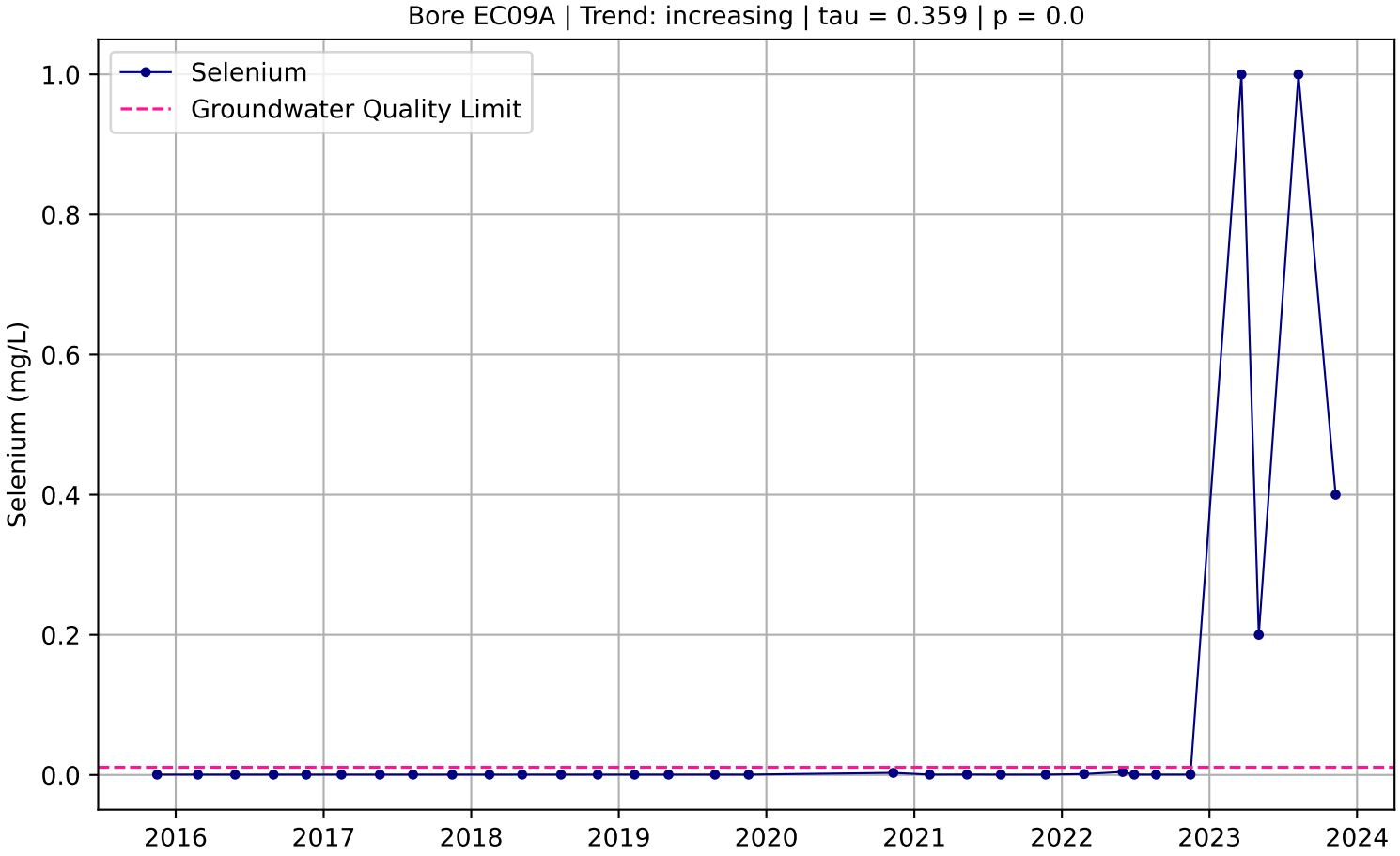

Bore EC09A | Trend: no trend | tau = -0.146 | p = 0.254
Field pH (pH Unit)
8
7
6
5
4
3
2
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

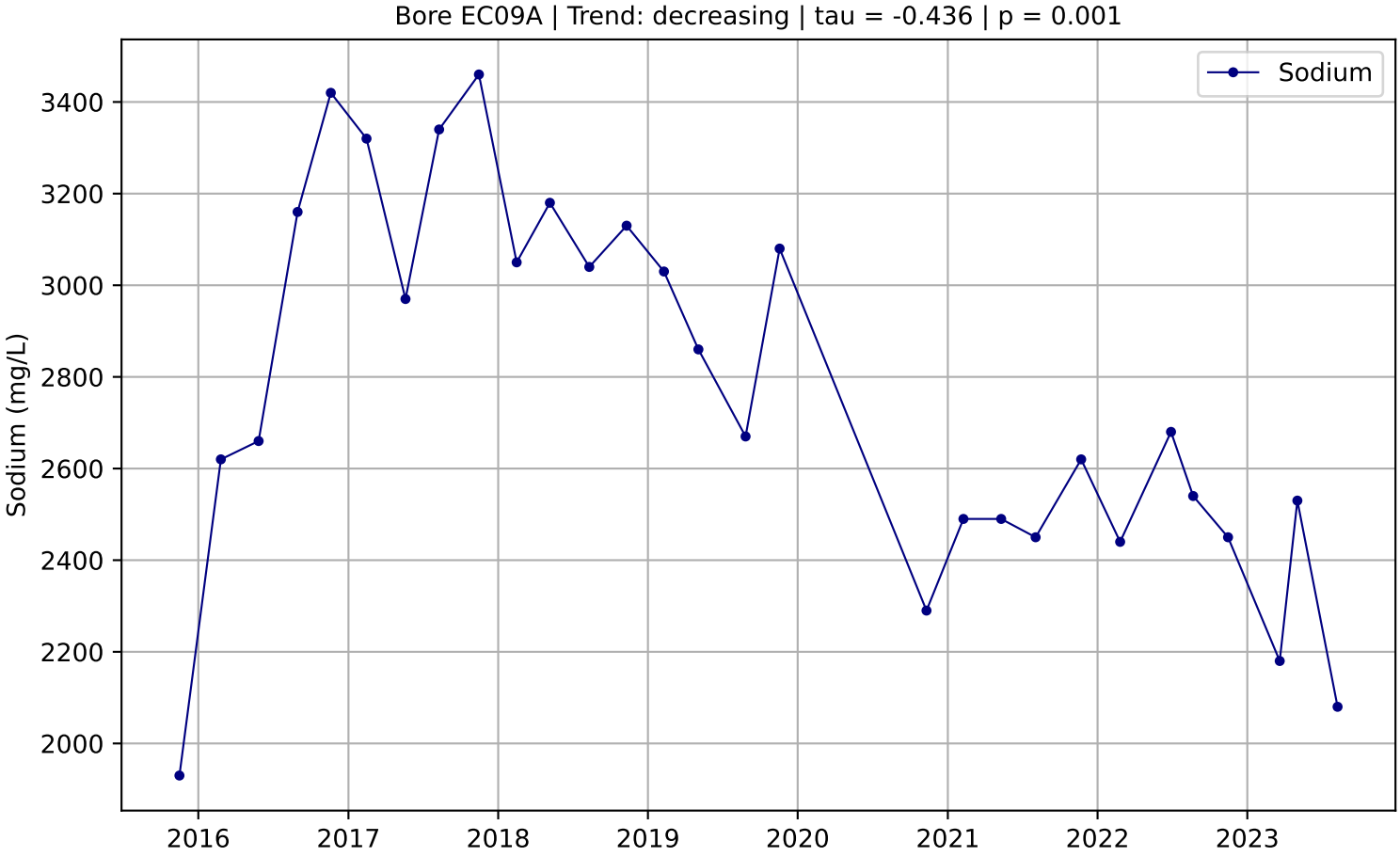

Bore EC09A | Trend: decreasing | tau = -0.411 | p = 0.001
Iron
Groundwater Quality Limit
Iron (mg/L)
0
1
2
3
4
5
6
2016
2017
2018
2019
2020
2021
2022
2023
2024

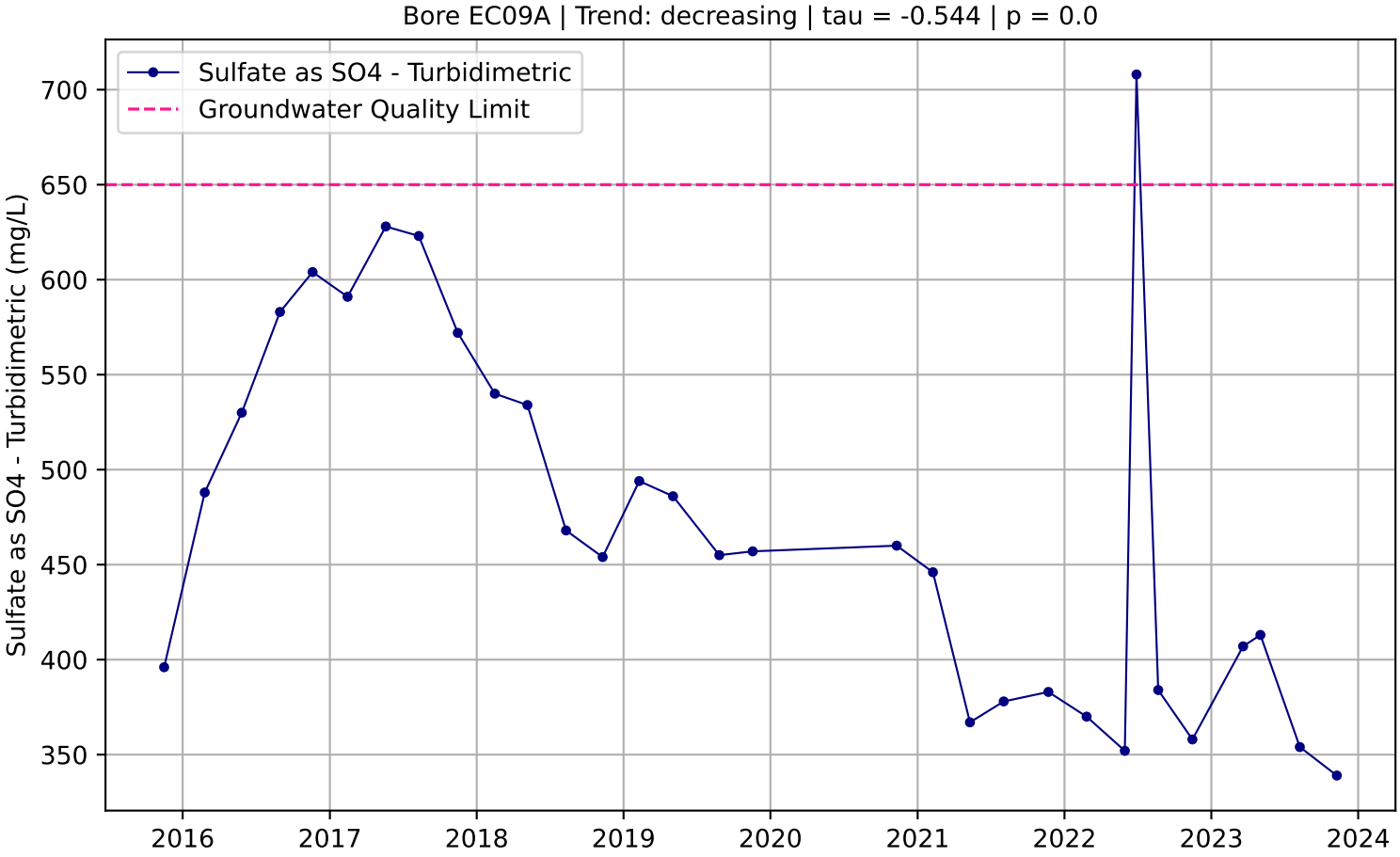

Bore EC09A | Trend: decreasing | tau = -0.571 | p = 0.0
Magnesium
Magnesium (mg/L)
700
650
600
550
500
450
400
350
2018
2019
2020
2021
2022
2023

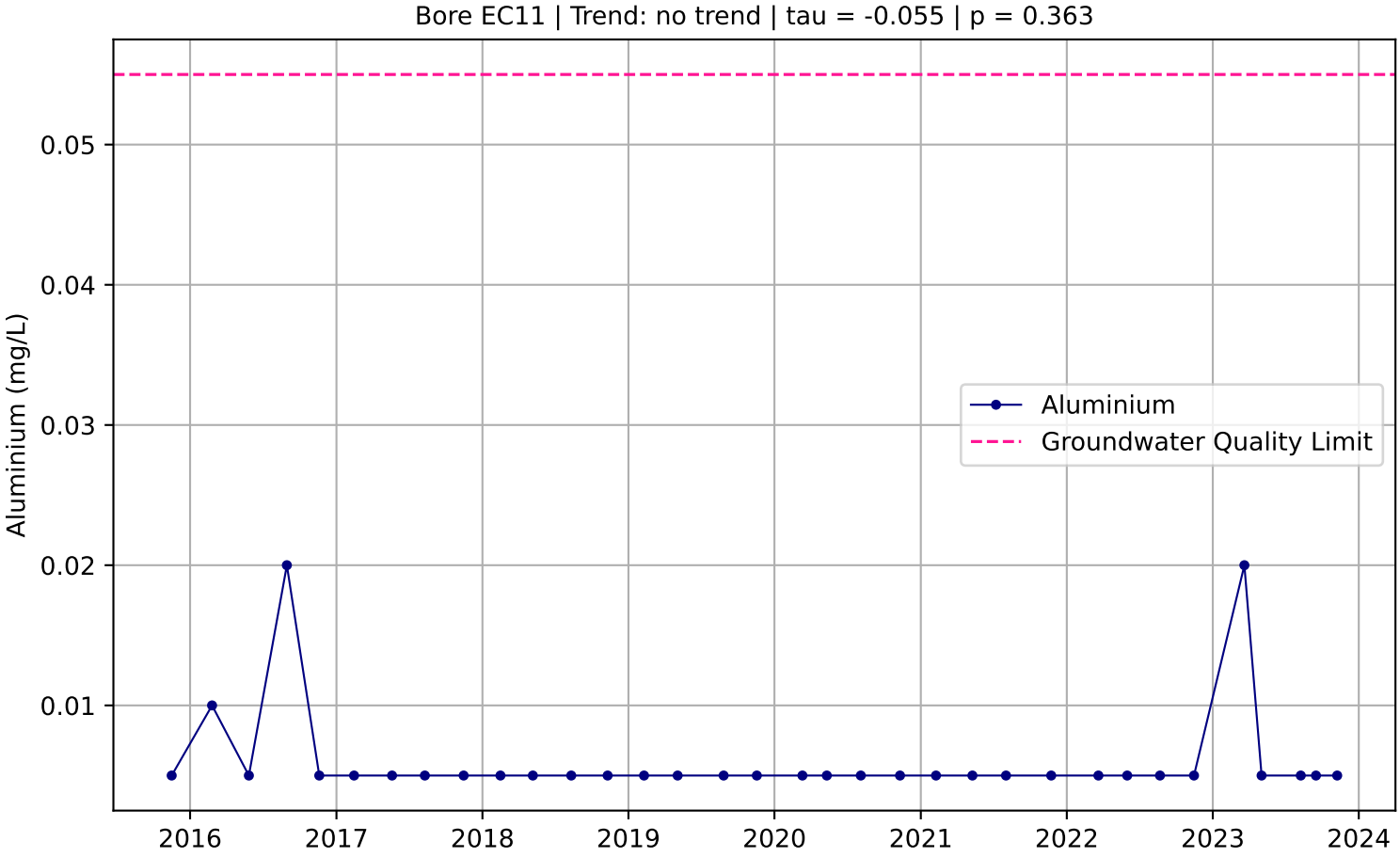

Bore EC09A | Trend: increasing | tau = 0.335 | p = 0.005
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

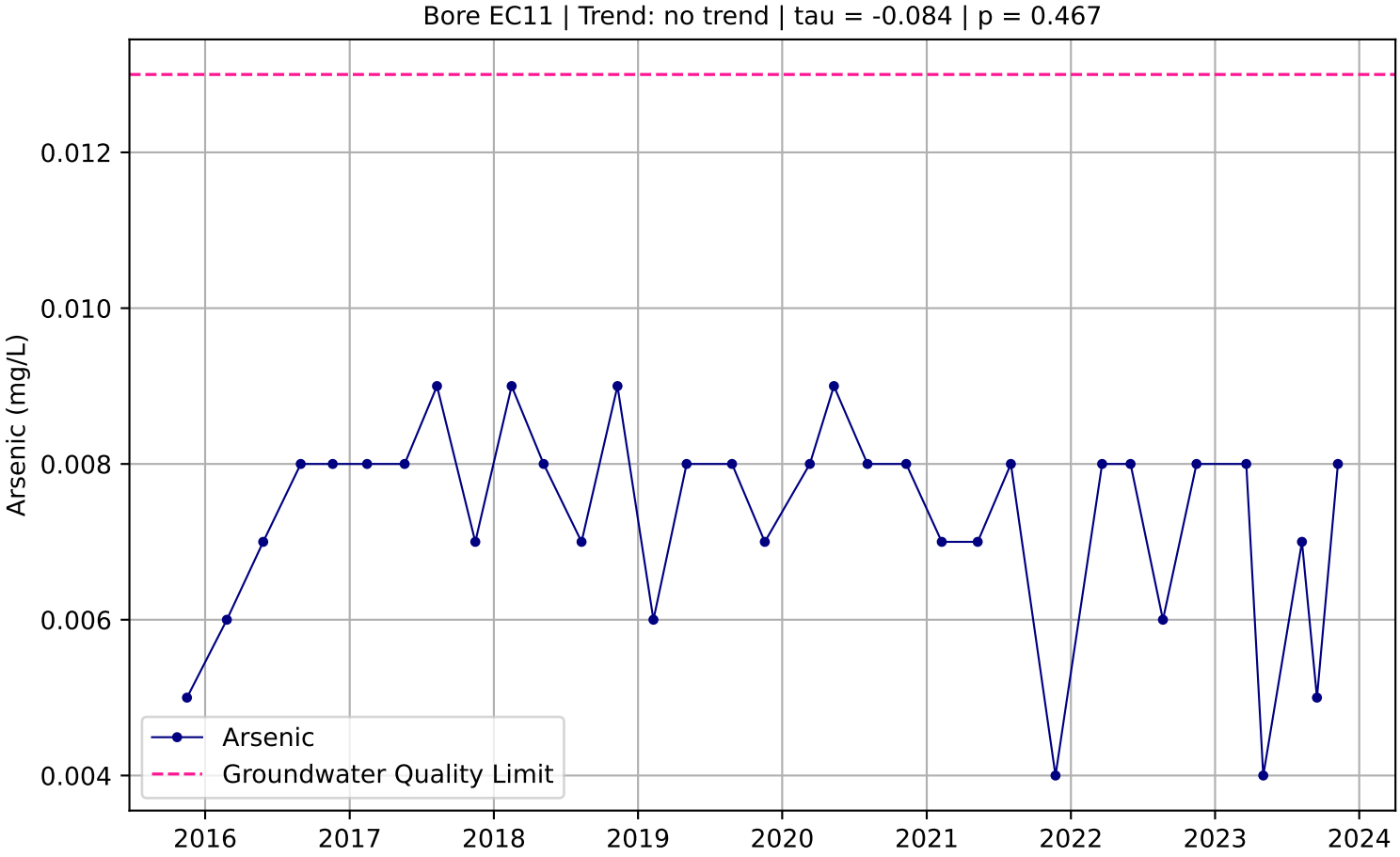

Bore EC09A | Trend: increasing | tau = 0.32 | p = 0.01
Potassium
Potassium (mg/L)
9
8
7
6
5
4
3
2016
2017
2018
2019
2020
2021
2022
2023

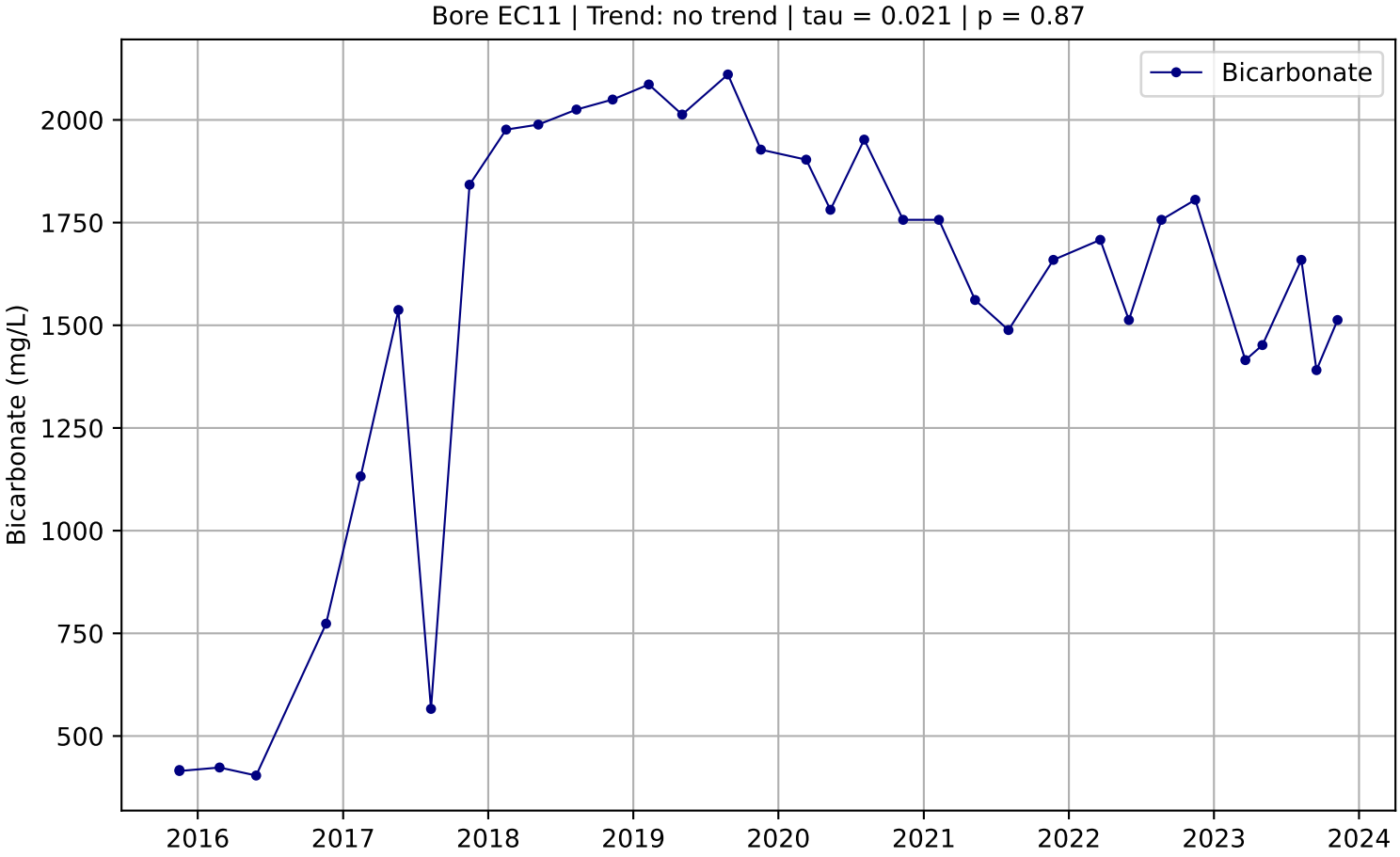

Bore EC09A | Trend: increasing | tau = 0.359 | p = 0.0
Selenium
Groundwater Quality Limit
Selenium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

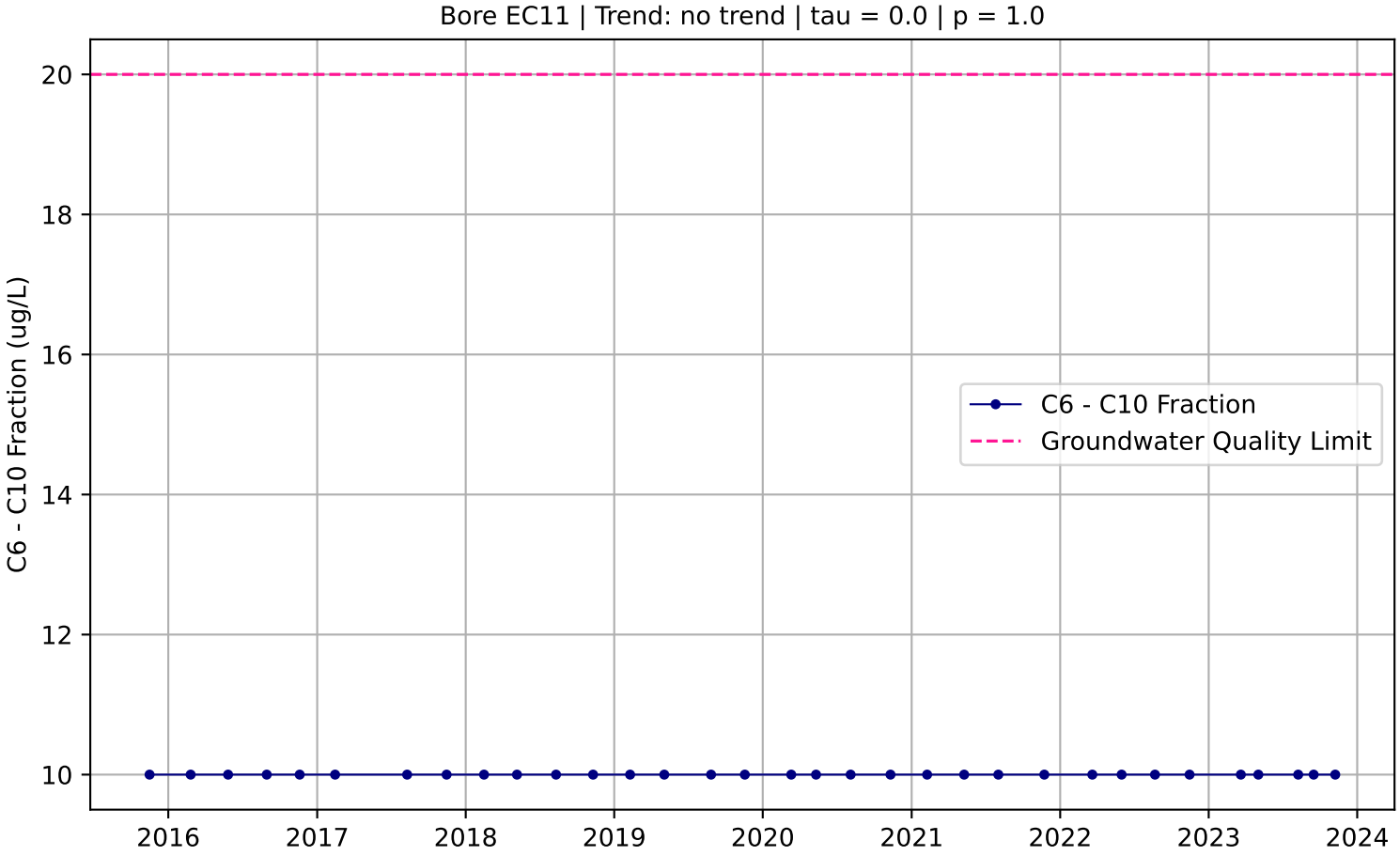

Bore EC09A | Trend: decreasing | tau = -0.436 | p = 0.001
Sodium
Sodium (mg/L)
3400
3200
3000
2800
2600
2400
2200
2000
2016
2017
2018
2019
2020
2021
2022
2023

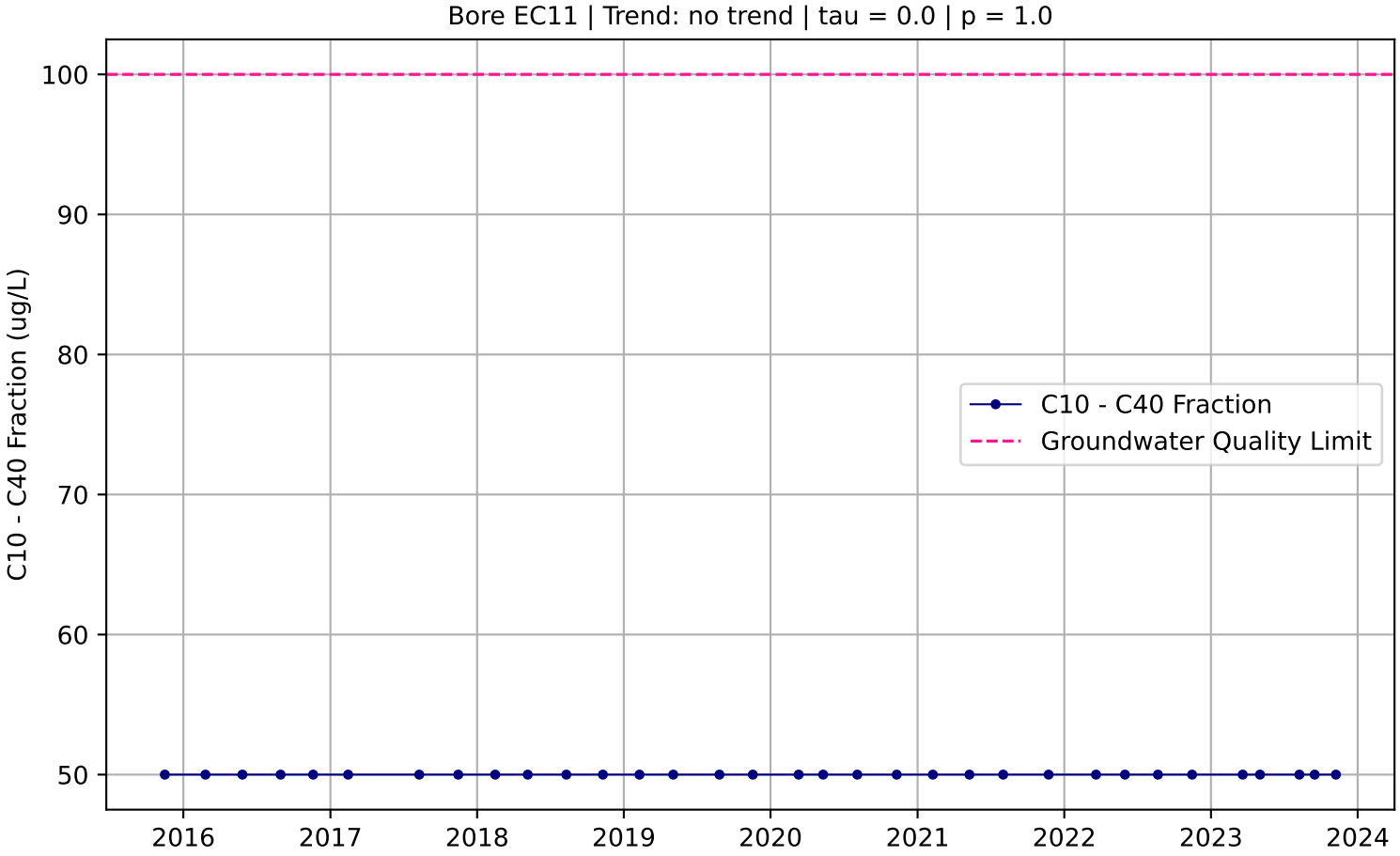

Bore EC09A | Trend: decreasing | tau = -0.544 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
700
650
600
550
500
450
400
350
2016
2017
2018
2019
2020
2021
2022
2023
2024

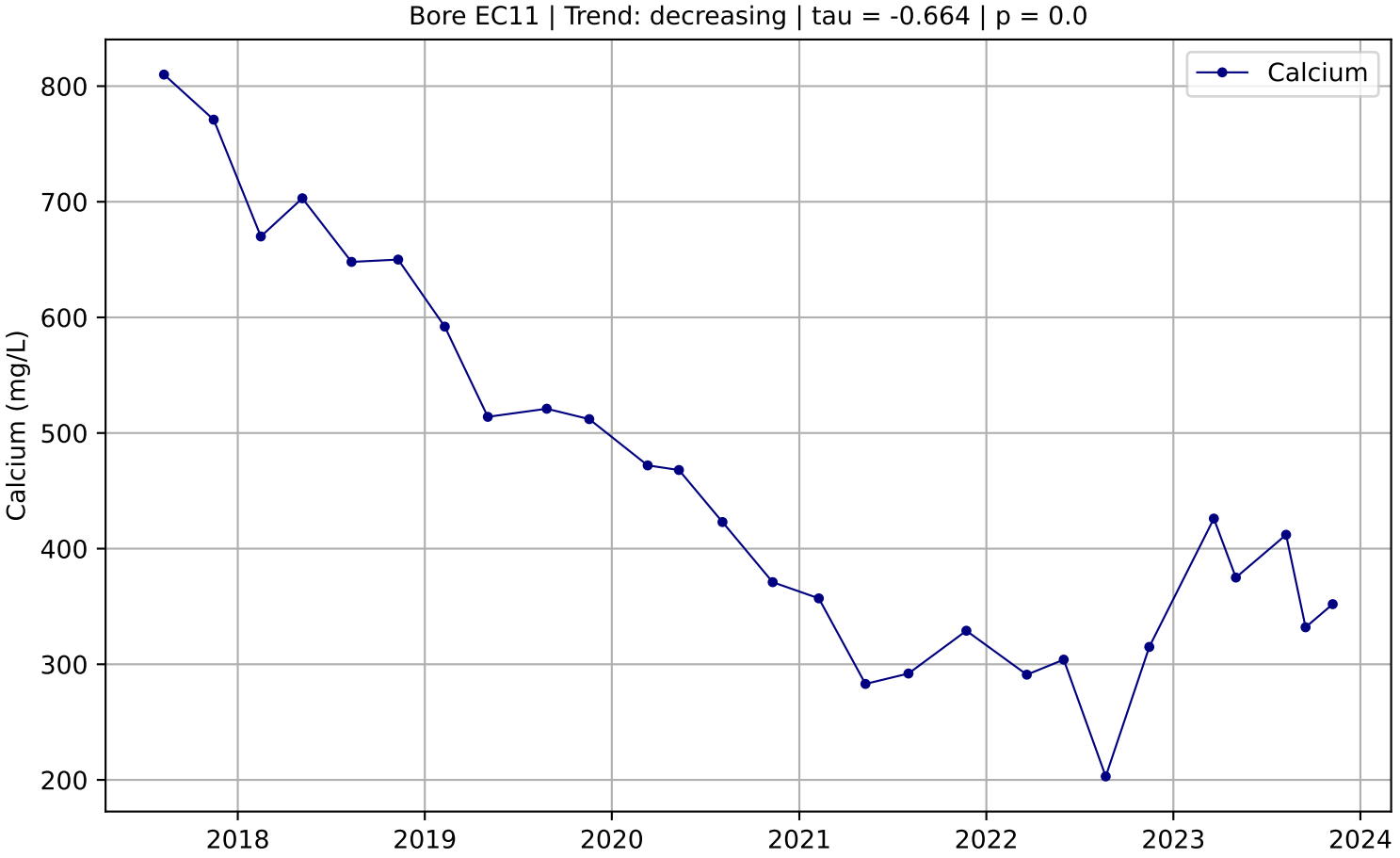

Bore EC11 | Trend: no trend | tau = -0.055 | p = 0.363
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

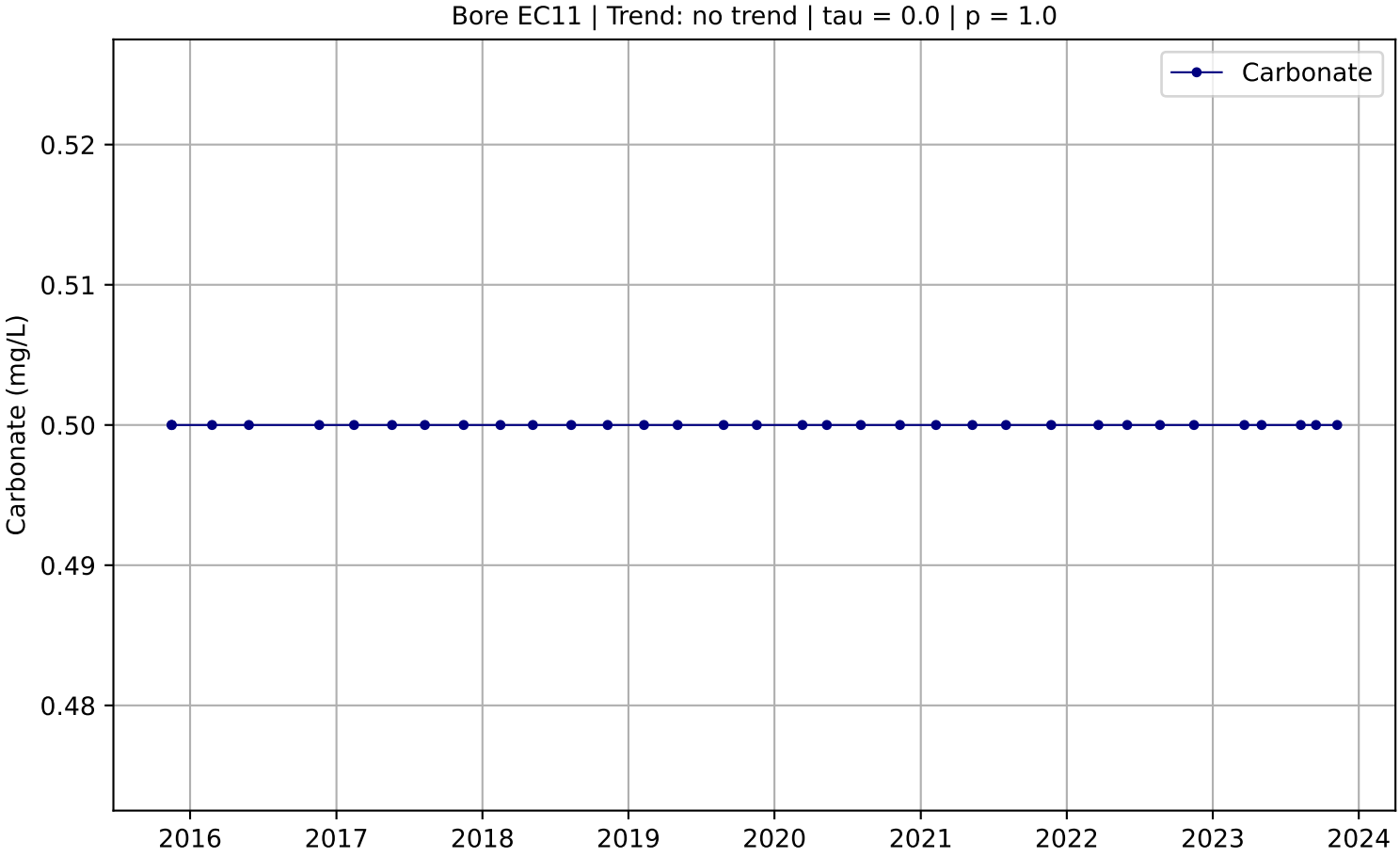

Bore EC11 | Trend: no trend | tau = -0.084 | p = 0.467
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

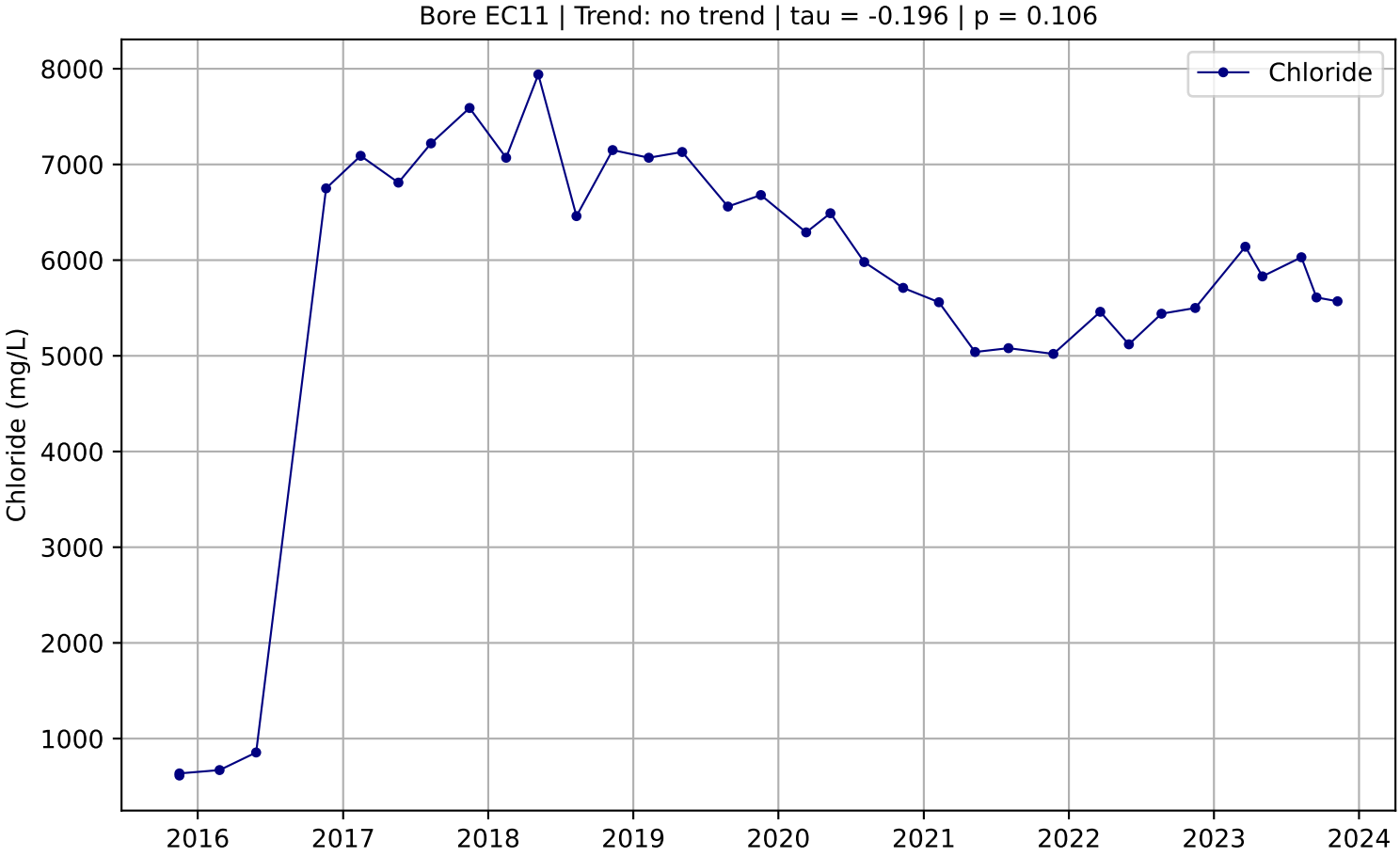

Bore EC11 | Trend: no trend | tau = 0.021 | p = 0.87
Bicarbonate
Bicarbonate (mg/L)
2000
1750
1500
1250
1000
750
500
2016
2017
2018
2019
2020
2021
2022
2023
2024

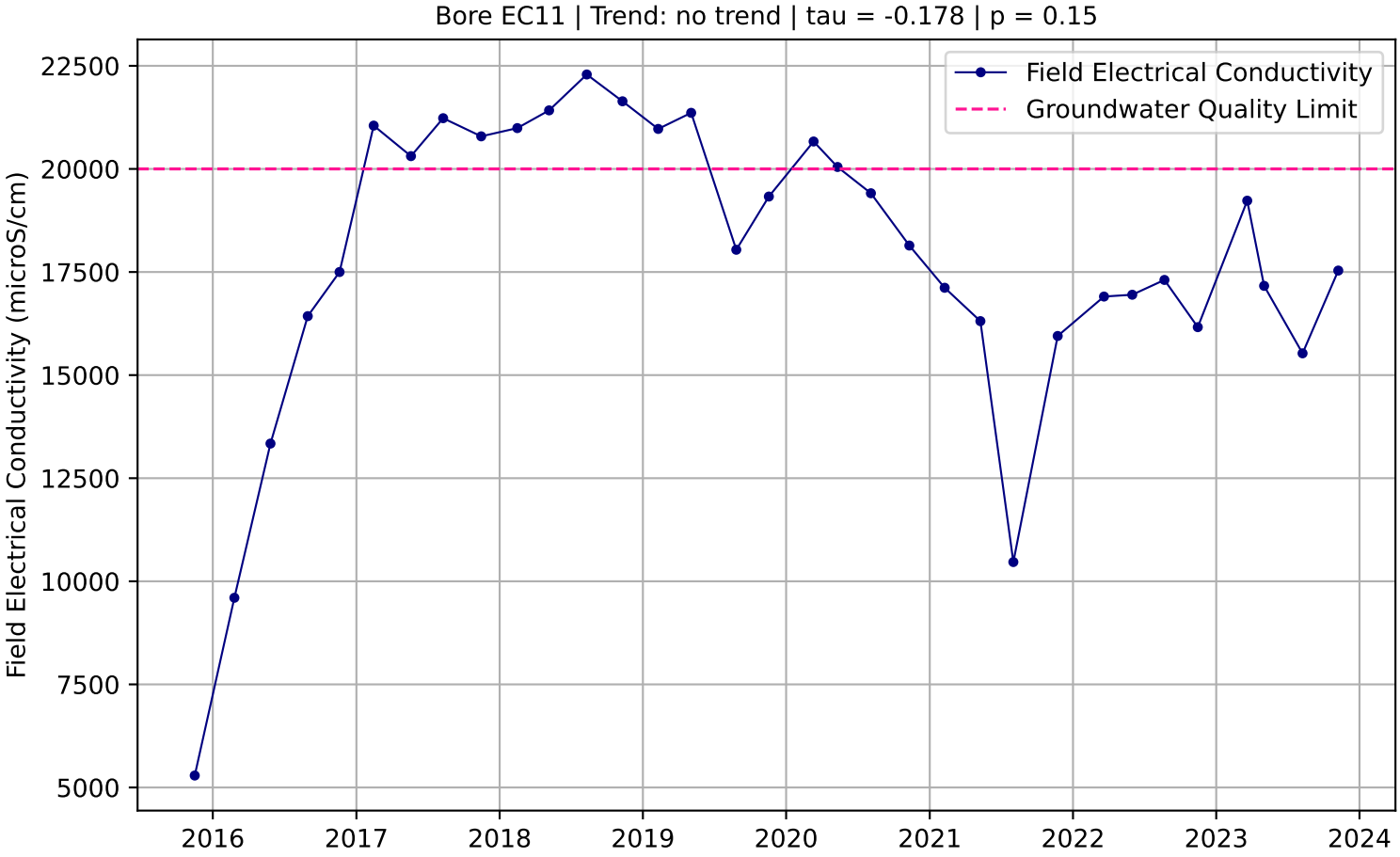

Bore EC11 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

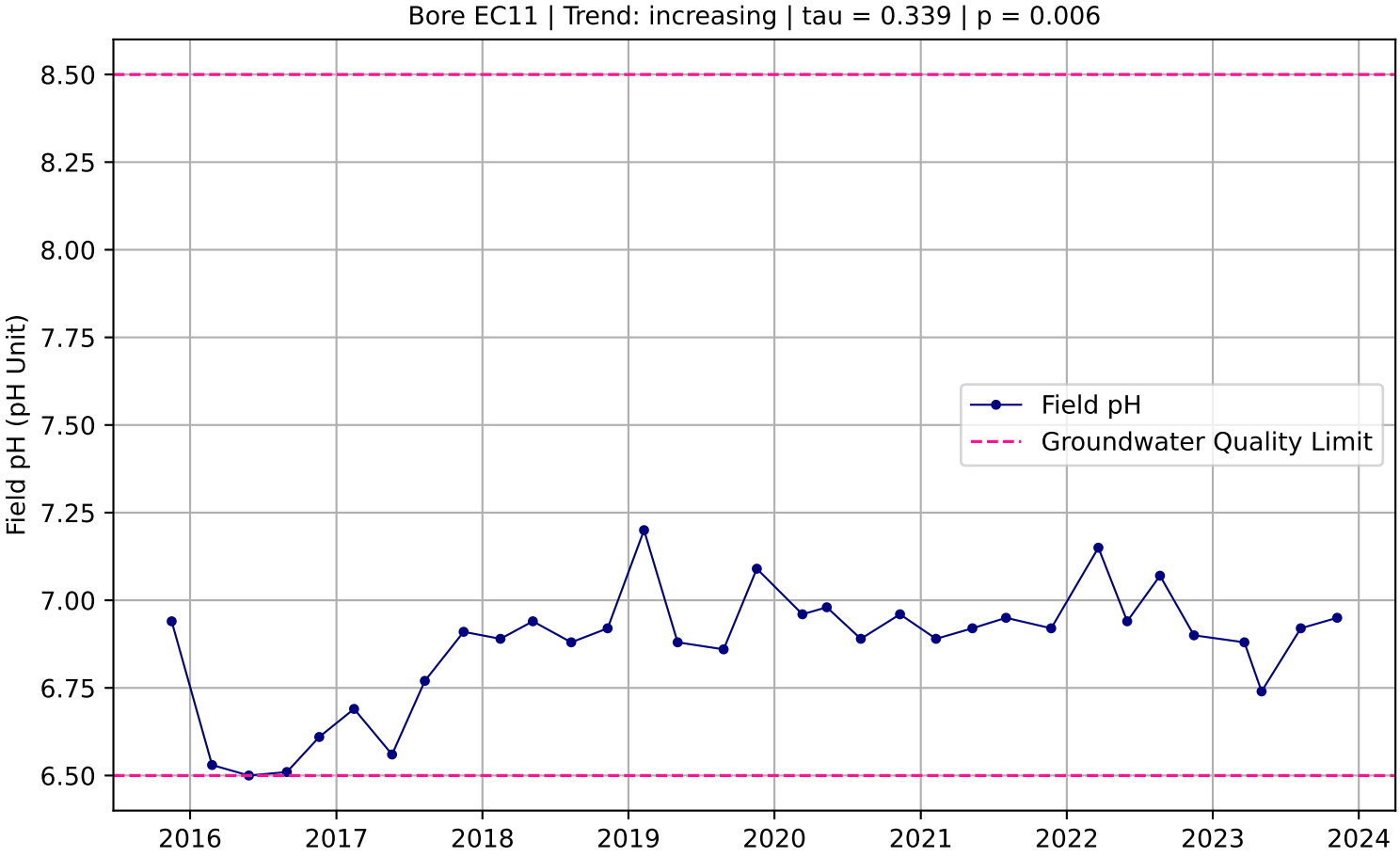

Bore EC11 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

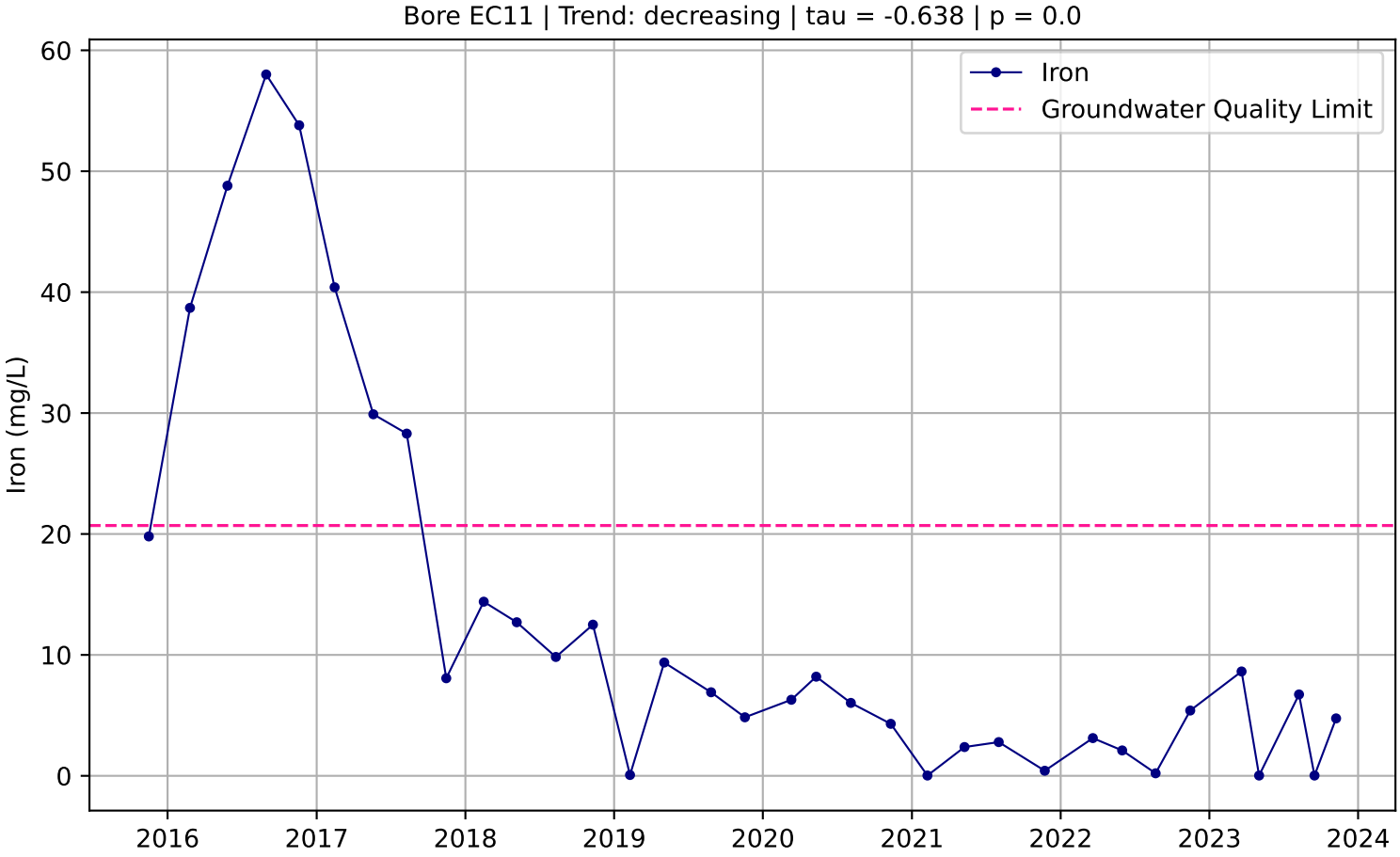

Bore EC11 | Trend: decreasing | tau = -0.664 | p = 0.0
Calcium
Calcium (mg/L)
800
700
600
500
400
300
200
2018
2019
2020
2021
2022
2023
2024

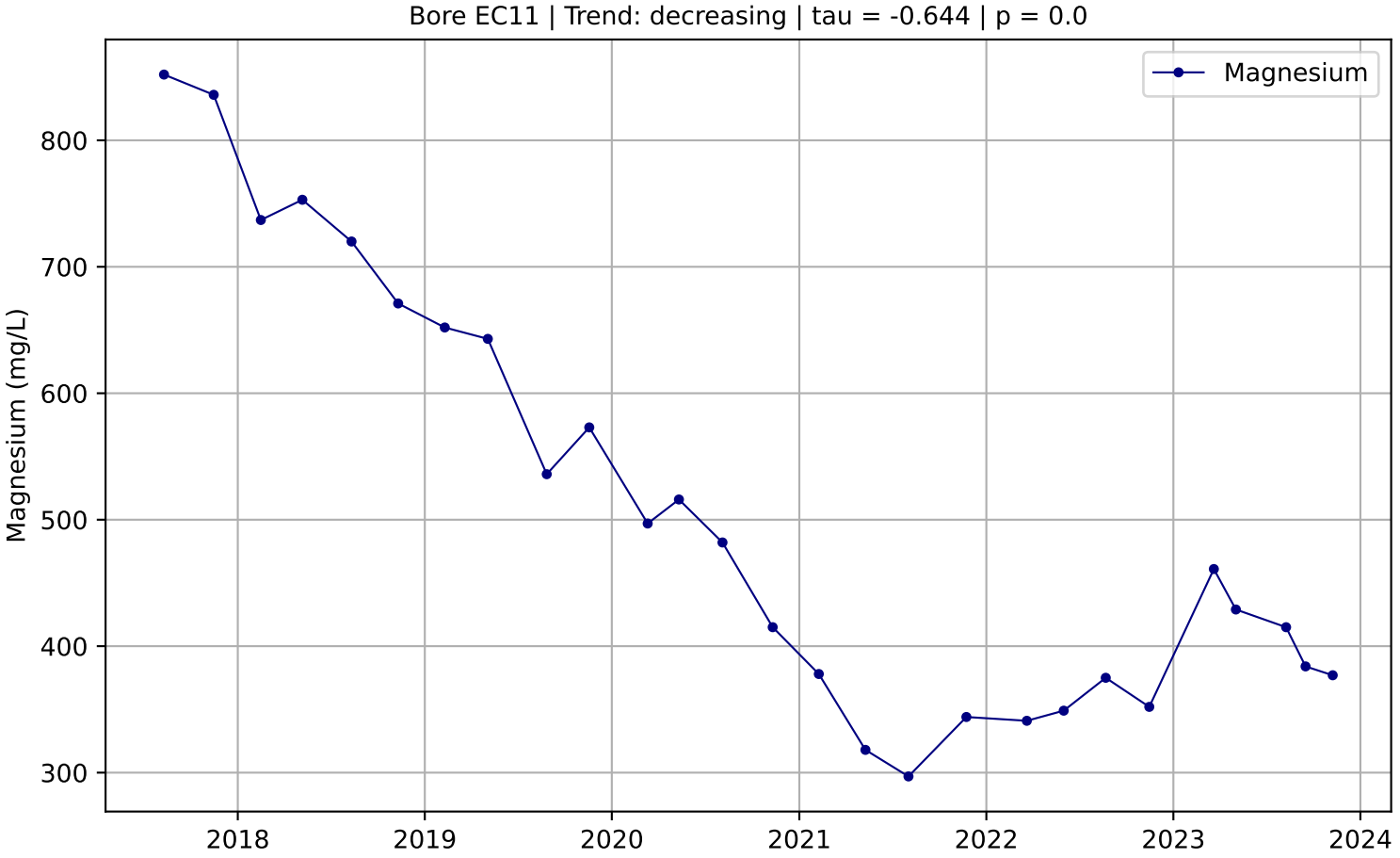

Bore EC11 | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

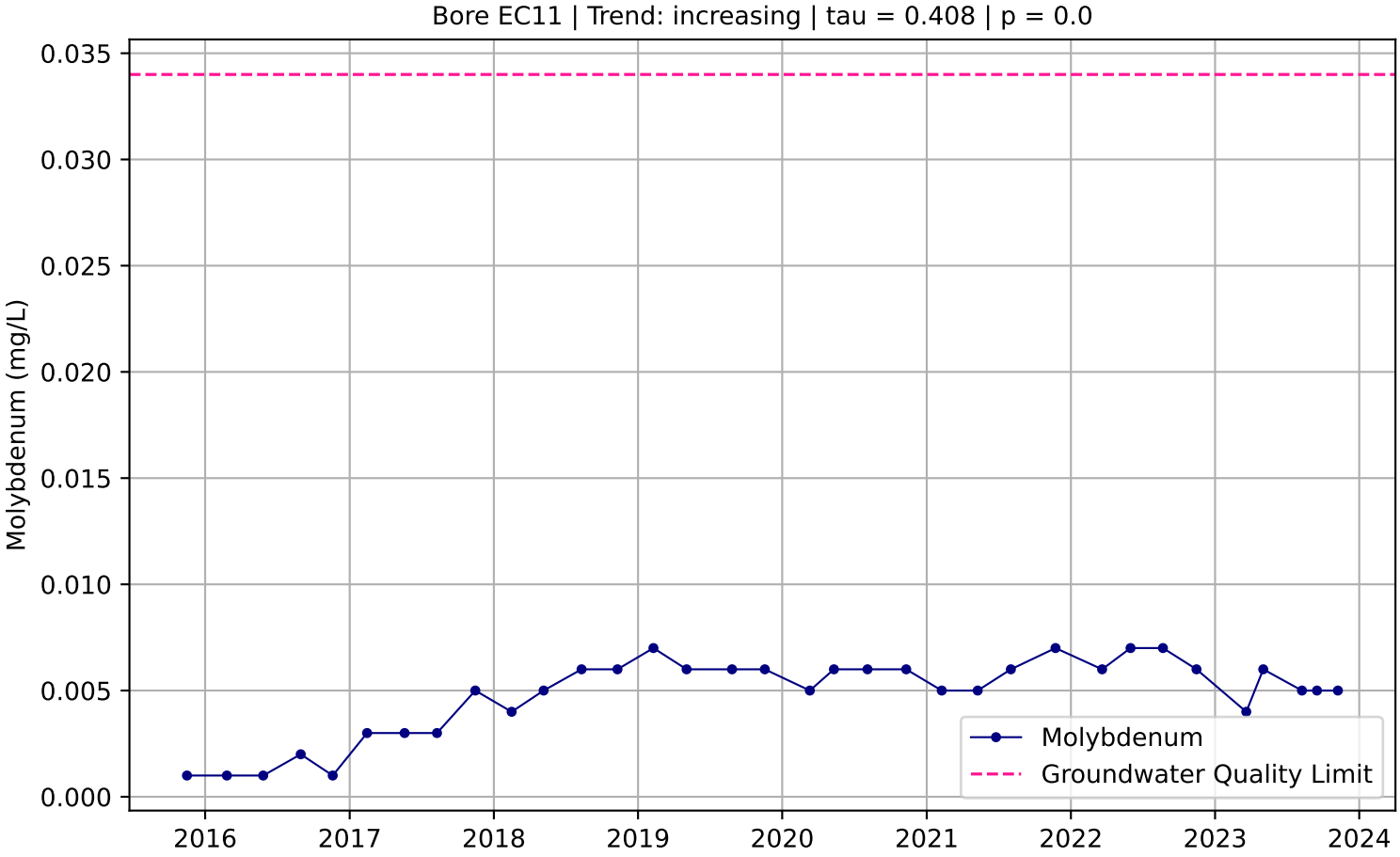

Bore EC11 | Trend: no trend | tau = -0.196 | p = 0.106
Chloride
Chloride (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
2016
2017
2018
2019
2020
2021
2022
2023
2024

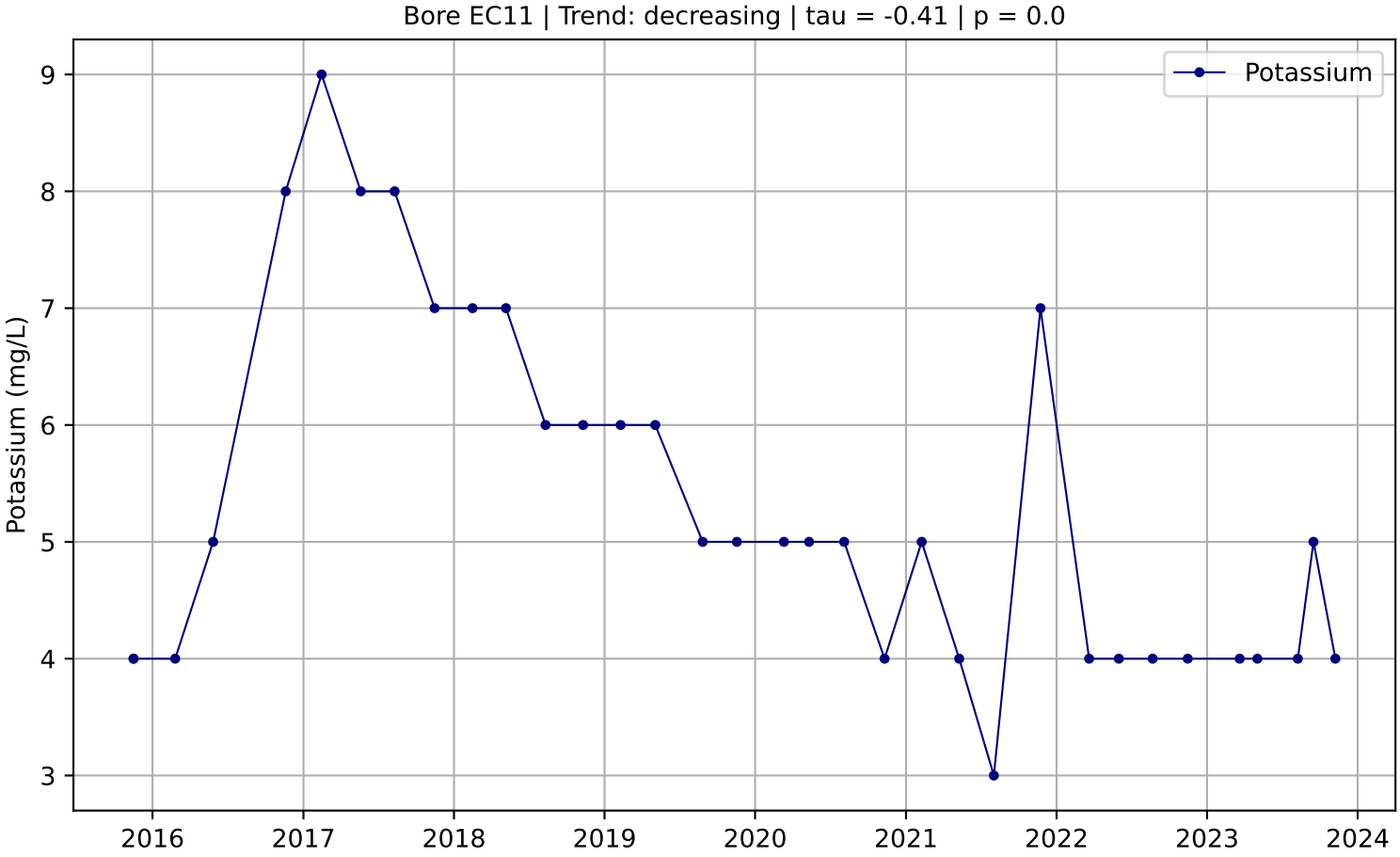

Bore EC11 | Trend: no trend | tau = -0.178 | p = 0.15
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
22500
20000
17500
15000
12500
10000
7500
5000
2016
2017
2018
2019
2020
2021
2022
2023
2024

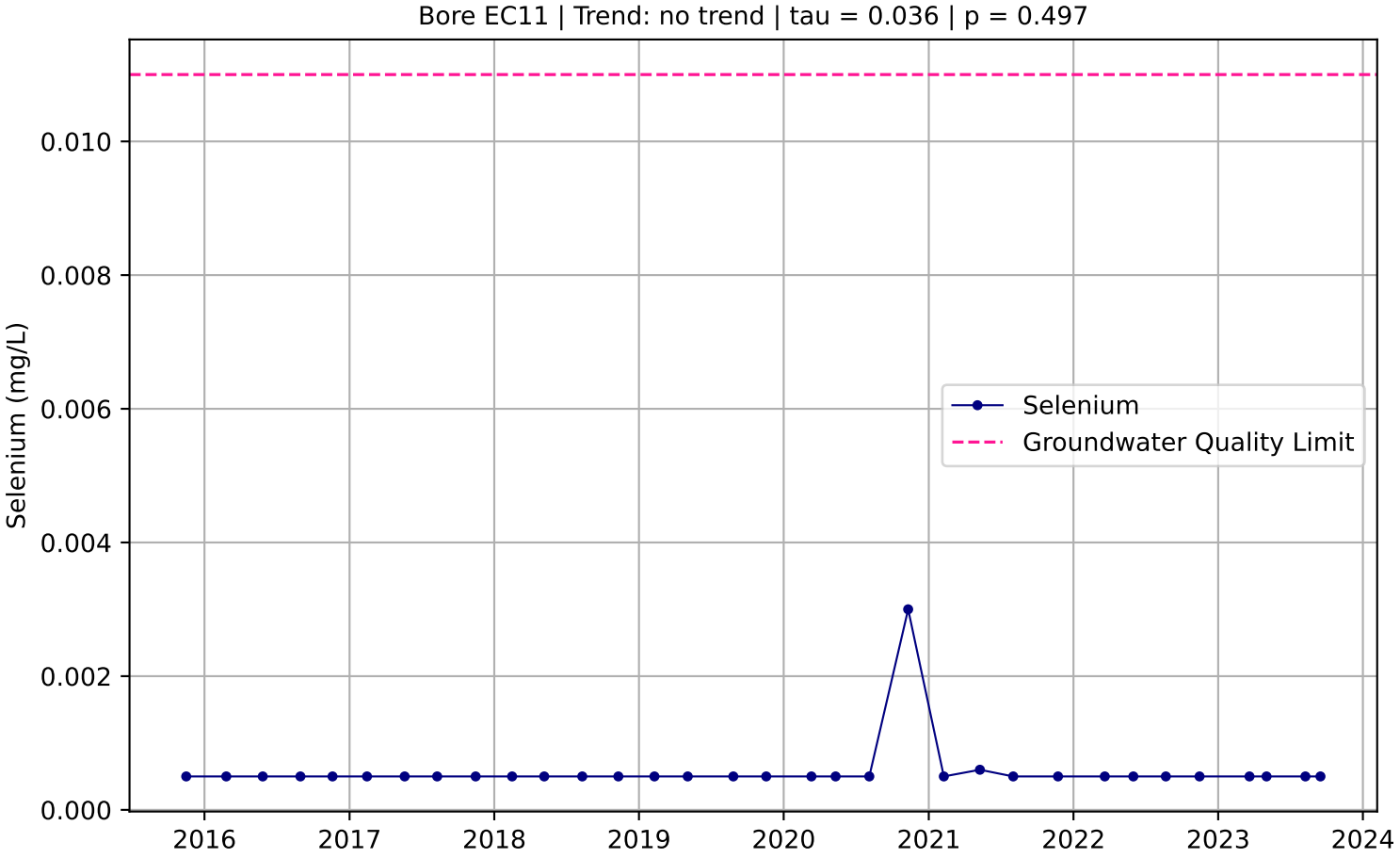

Bore EC11 | Trend: increasing | tau = 0.339 | p = 0.006
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

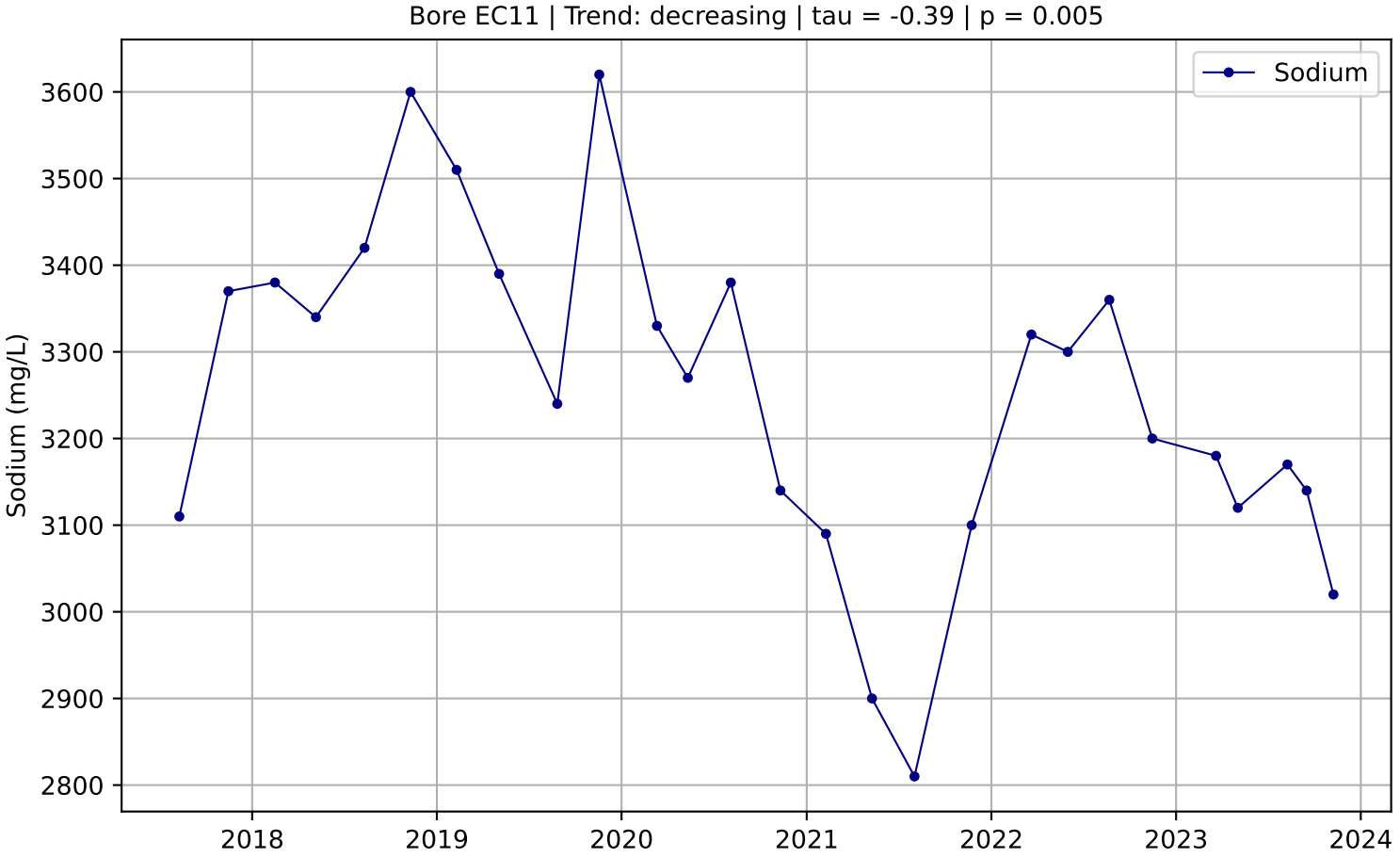

Bore EC11 | Trend: decreasing | tau = -0.638 | p = 0.0
Iron
Groundwater Quality Limit
Iron (mg/L)
60
50
40
30
20
10
0
2016
2017
2018
2019
2020
2021
2022
2023
2024

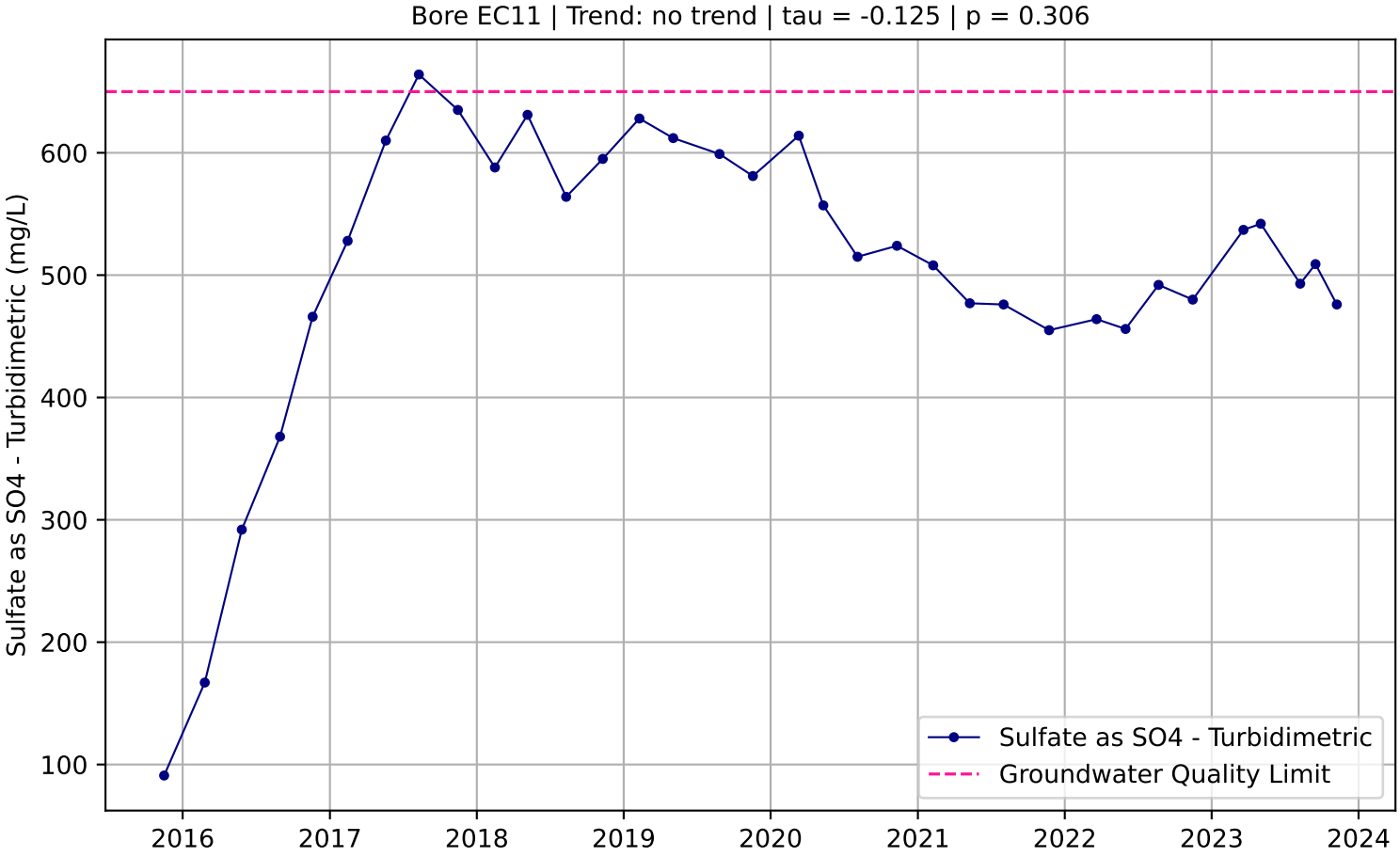

Bore EC11 | Trend: decreasing | tau = -0.644 | p = 0.0
Magnesium
Magnesium (mg/L)
800
700
600
500
400
300
2018
2019
2020
2021
2022
2023
2024

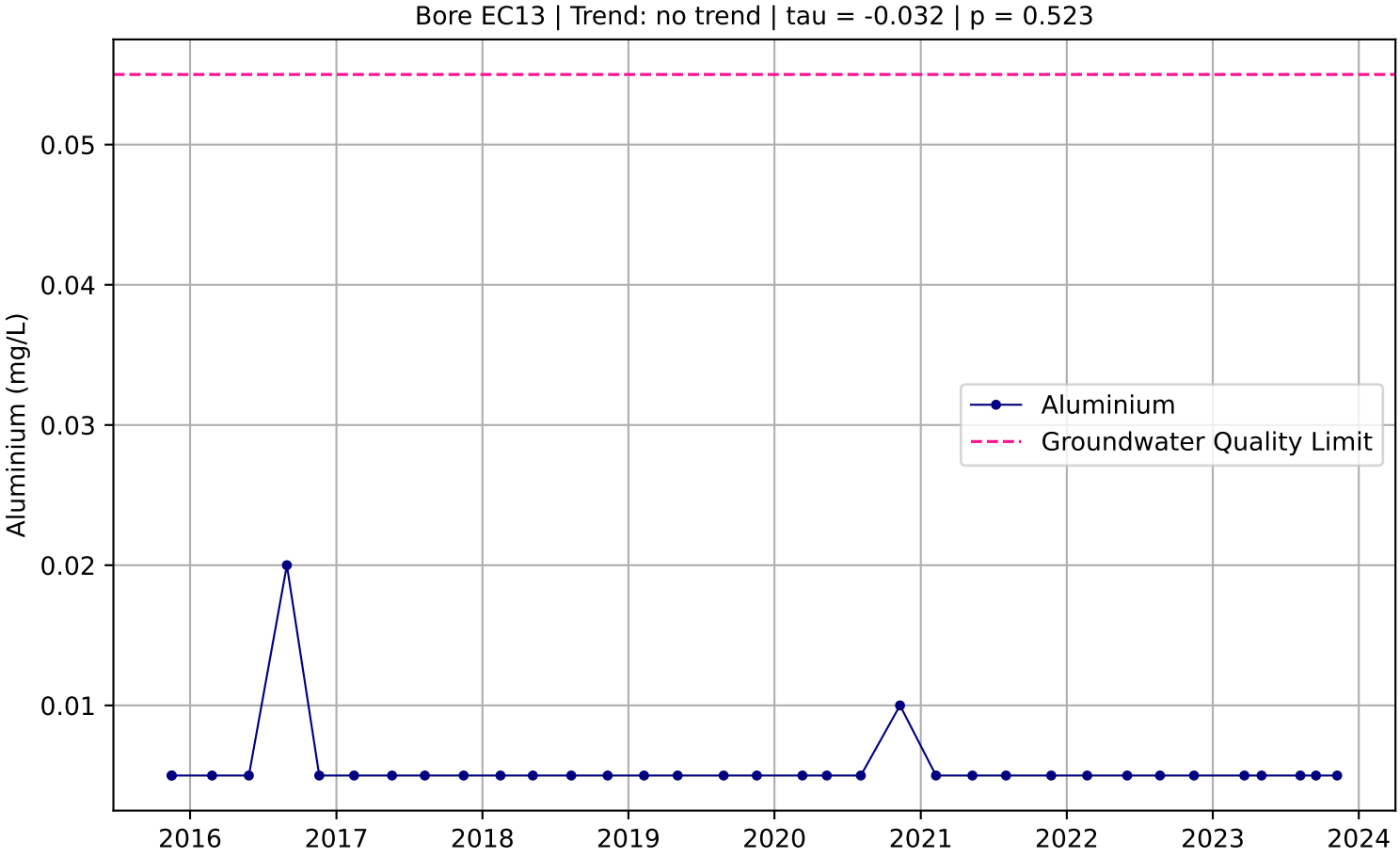

Bore EC11 | Trend: increasing | tau = 0.408 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

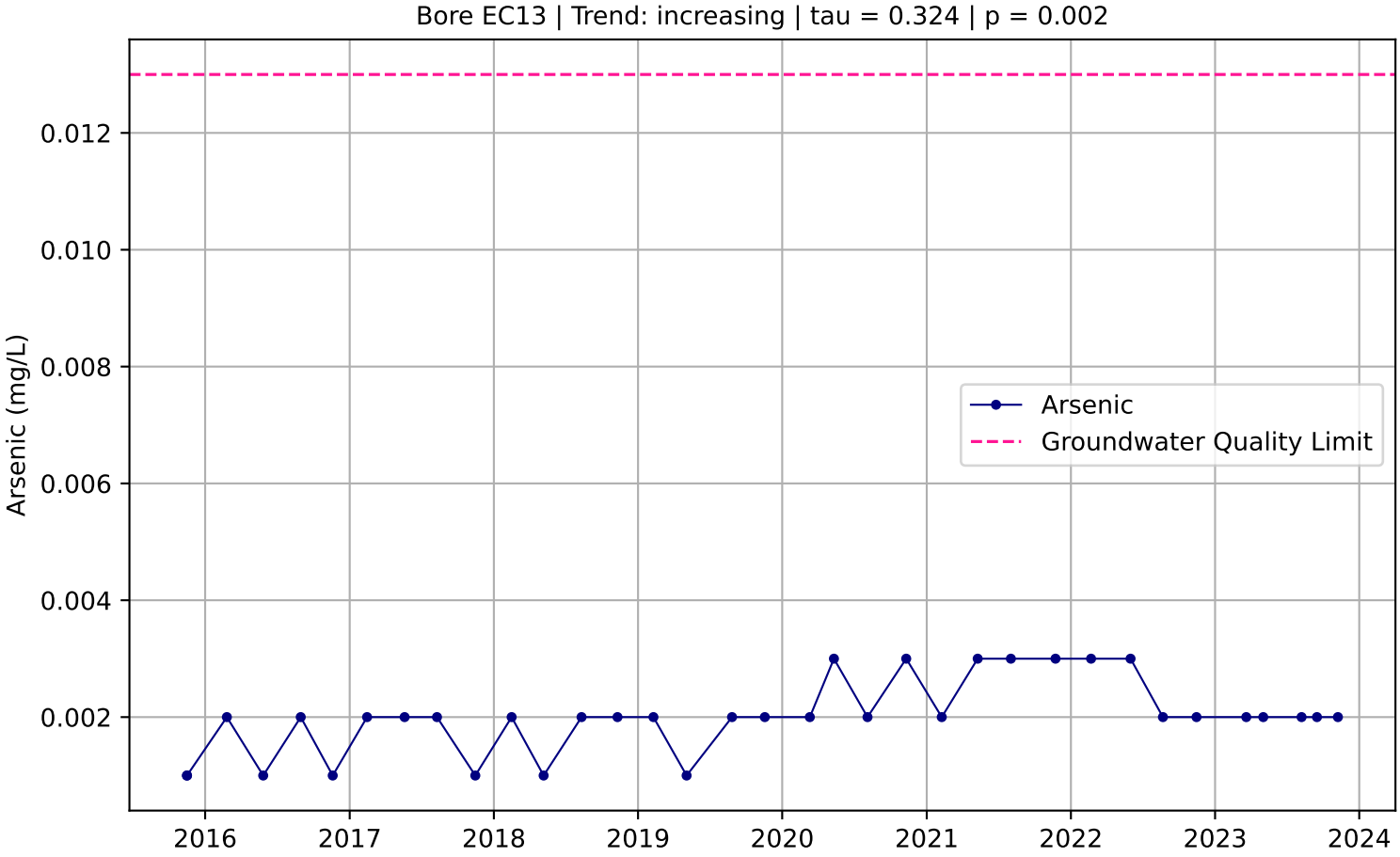

Bore EC11 | Trend: decreasing | tau = -0.41 | p = 0.0
Potassium
Potassium (mg/L)
9
8
7
6
5
4
3
2016
2017
2018
2019
2020
2021
2022
2023
2024

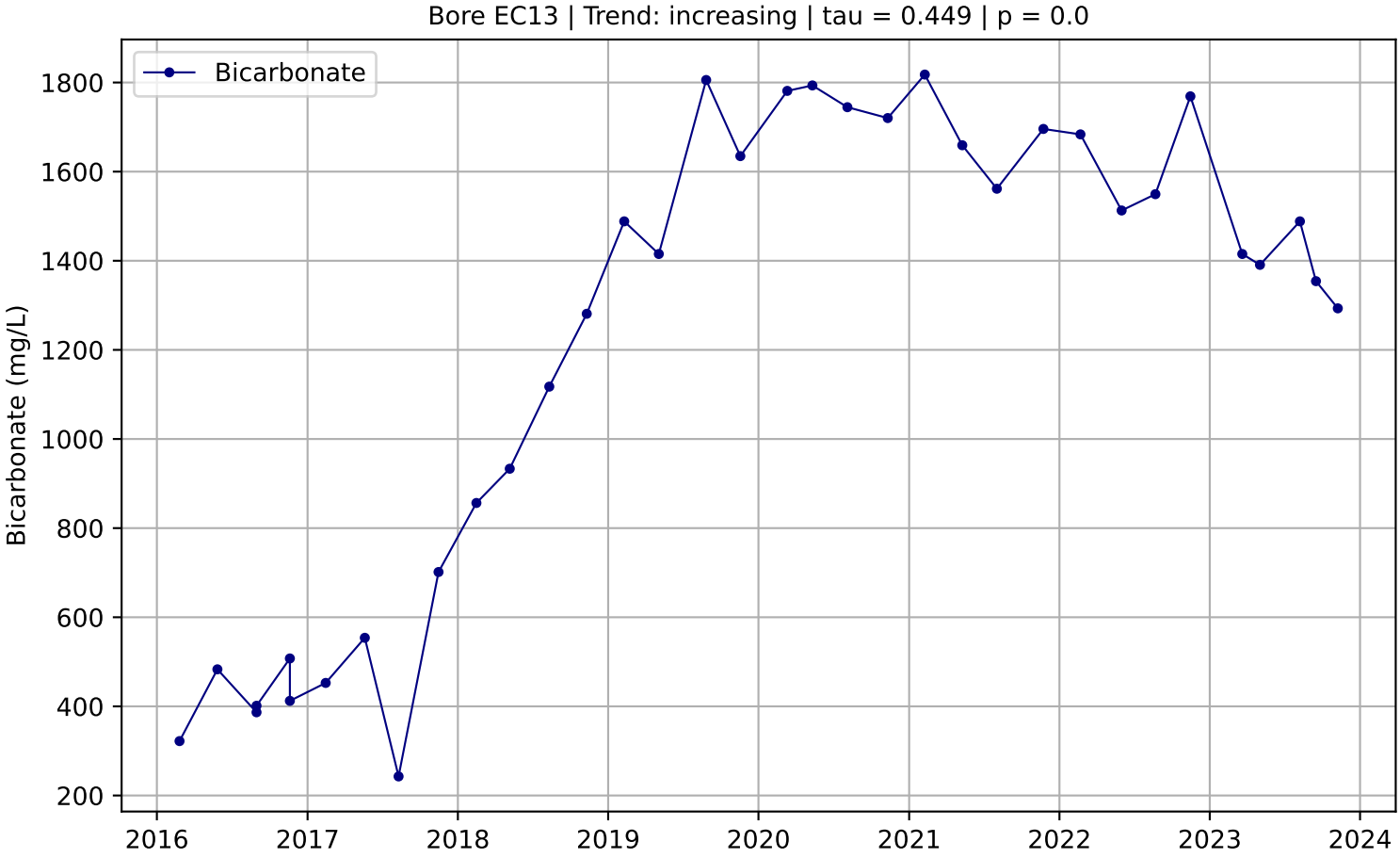

Bore EC11 | Trend: no trend | tau = 0.036 | p = 0.497
Selenium (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
2016
2017
2018
2019
2020
2021
2022
2023
2024
Selenium
Groundwater Quality Limit

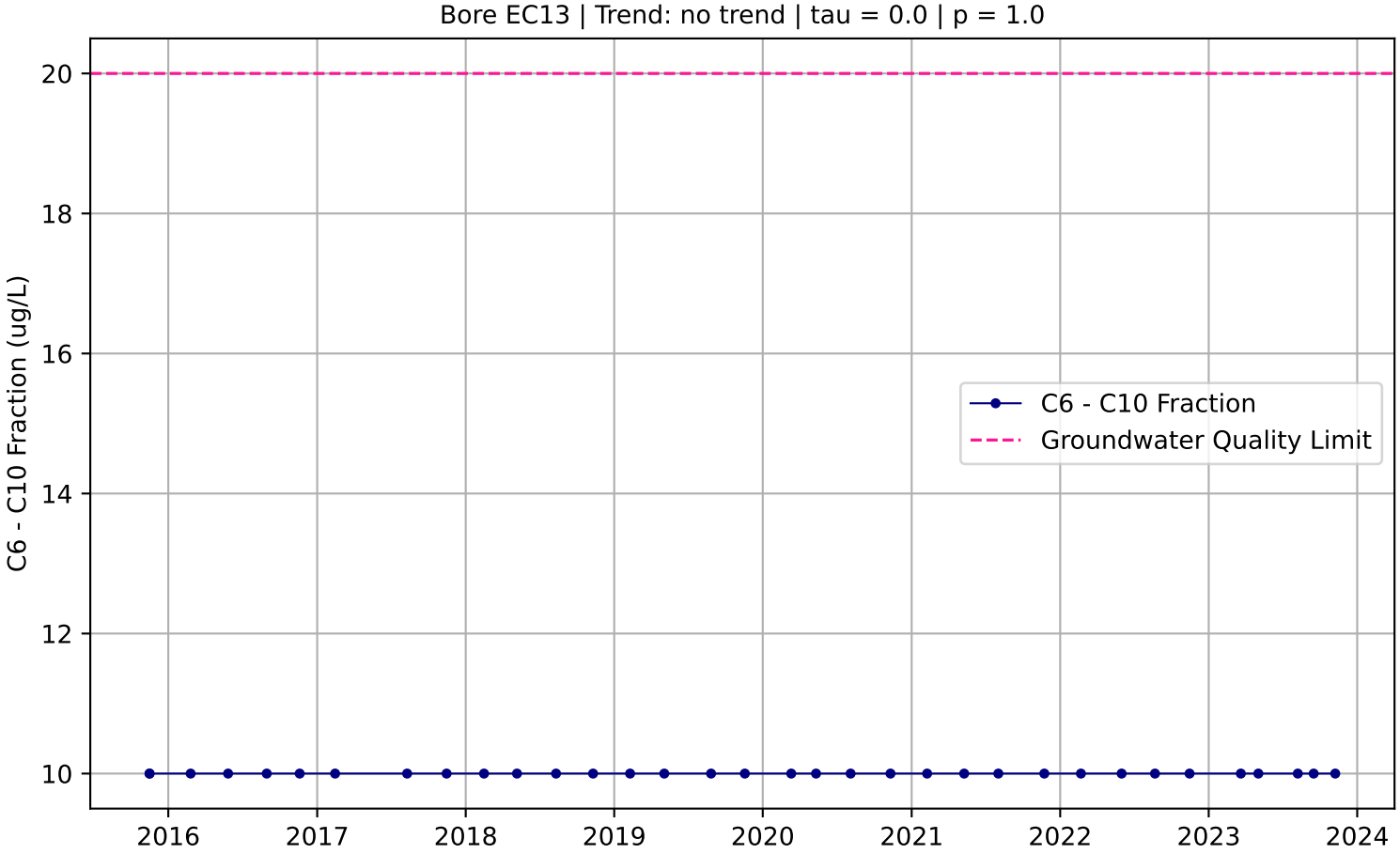

Bore EC11 | Trend: decreasing | tau = -0.39 | p = 0.005
Sodium
Sodium (mg/L)
3600
3500
3400
3300
3200
3100
3000
2900
2800
2018
2019
2020
2021
2022
2023
2024

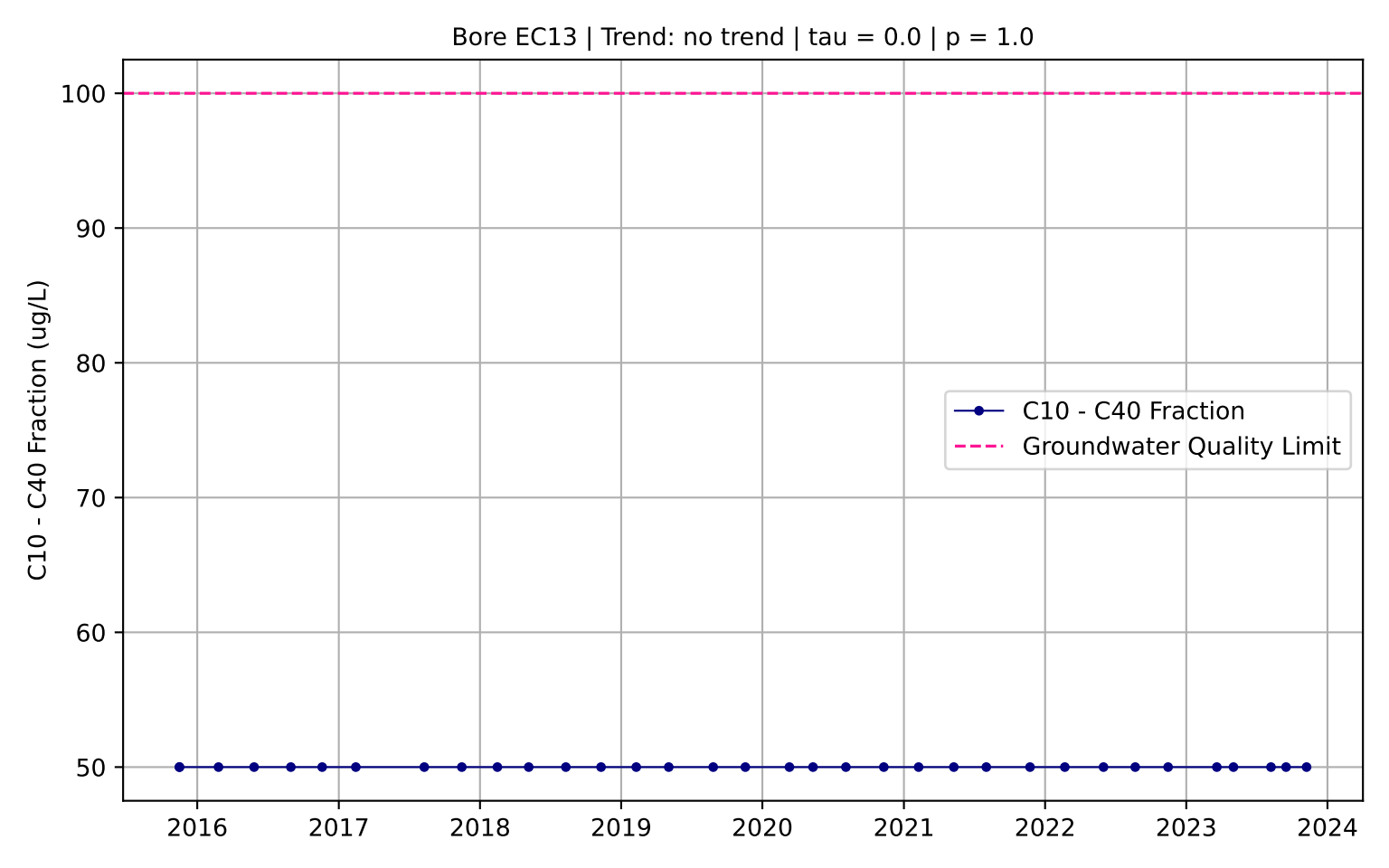

Bore EC11 | Trend: no trend | tau = -0.125 | p = 0.306
Sulfate as SO4 - Turbidimetric (mg/L)
100
200
300
400
500
600
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

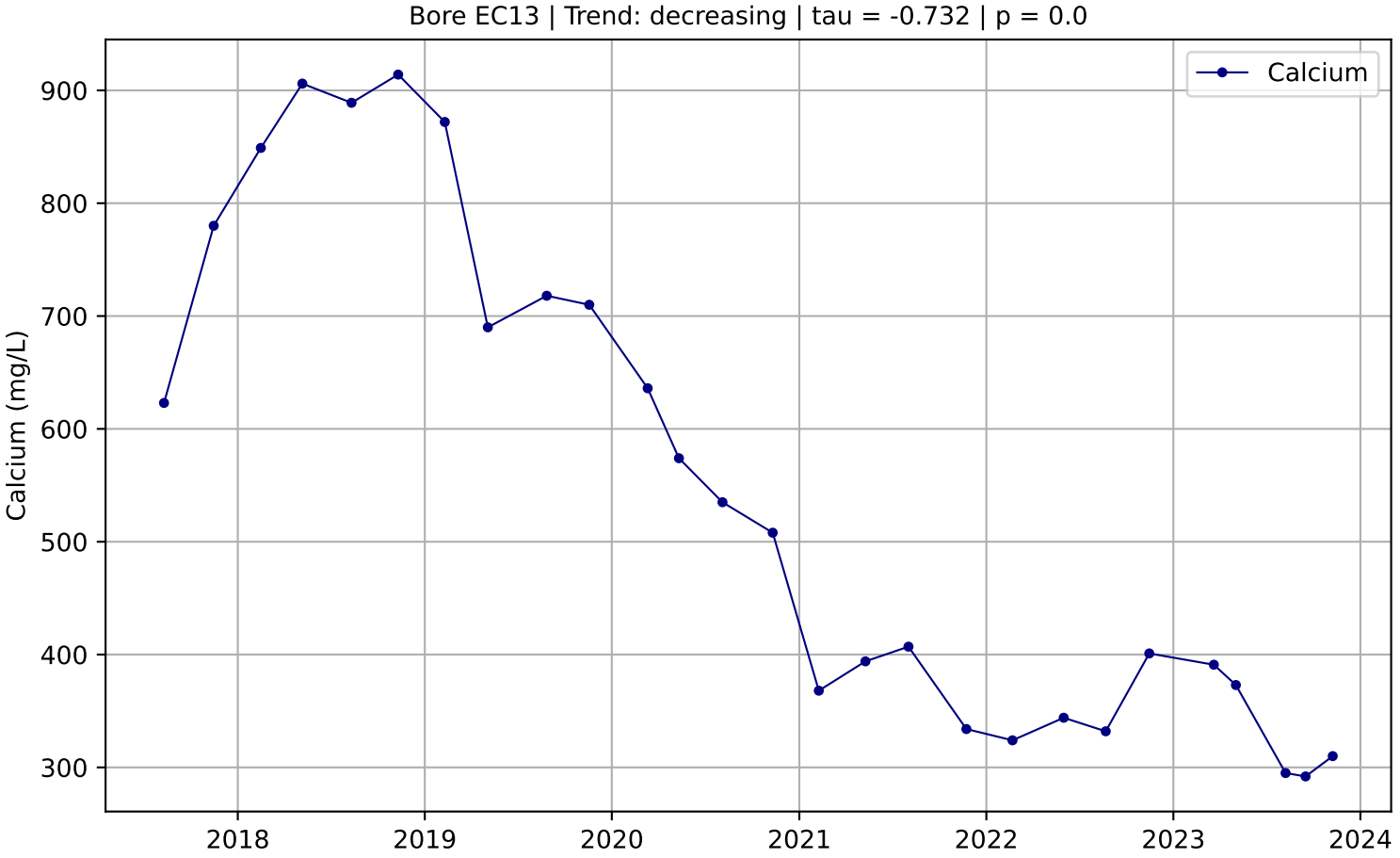

Bore EC13 | Trend: no trend | tau = -0.032 | p = 0.523
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

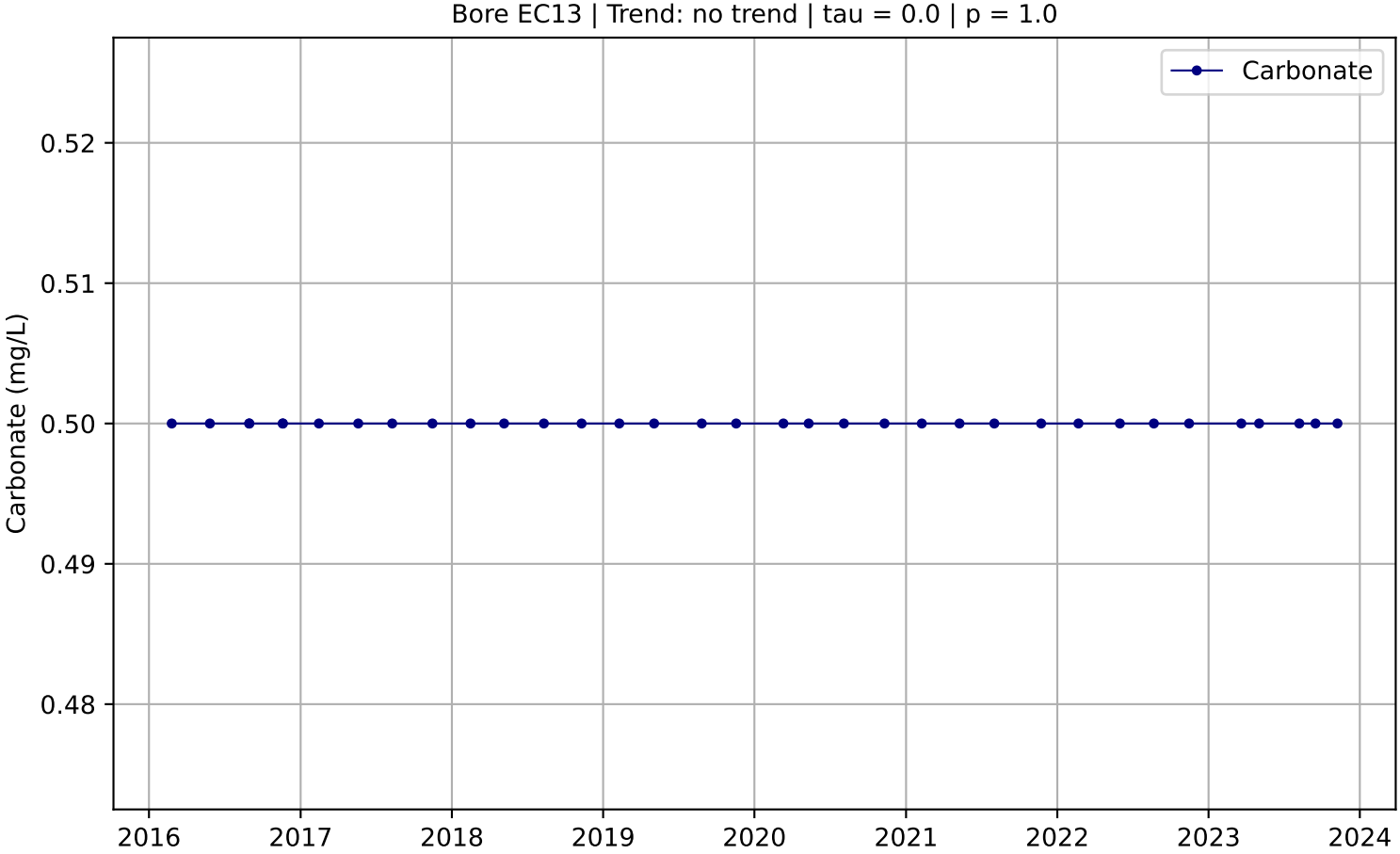

Bore EC13 | Trend: increasing | tau = 0.324 | p = 0.002
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

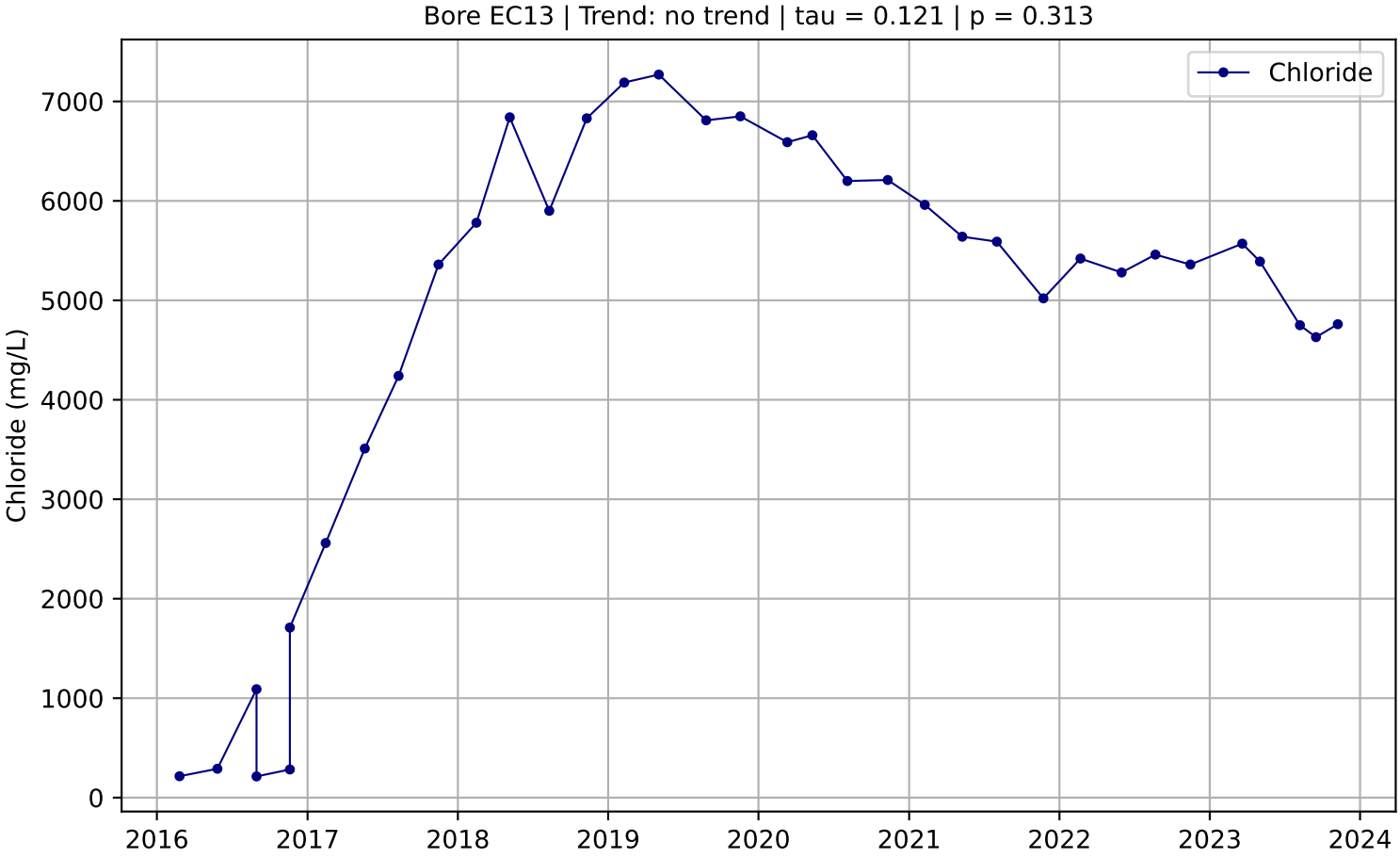

Bore EC13 | Trend: increasing | tau = 0.449 | p = 0.0
Bicarbonate
Bicarbonate (mg/L)
200
400
600
800
1000
1200
1400
1600
1800
2016
2017
2018
2019
2020
2021
2022
2023
2024

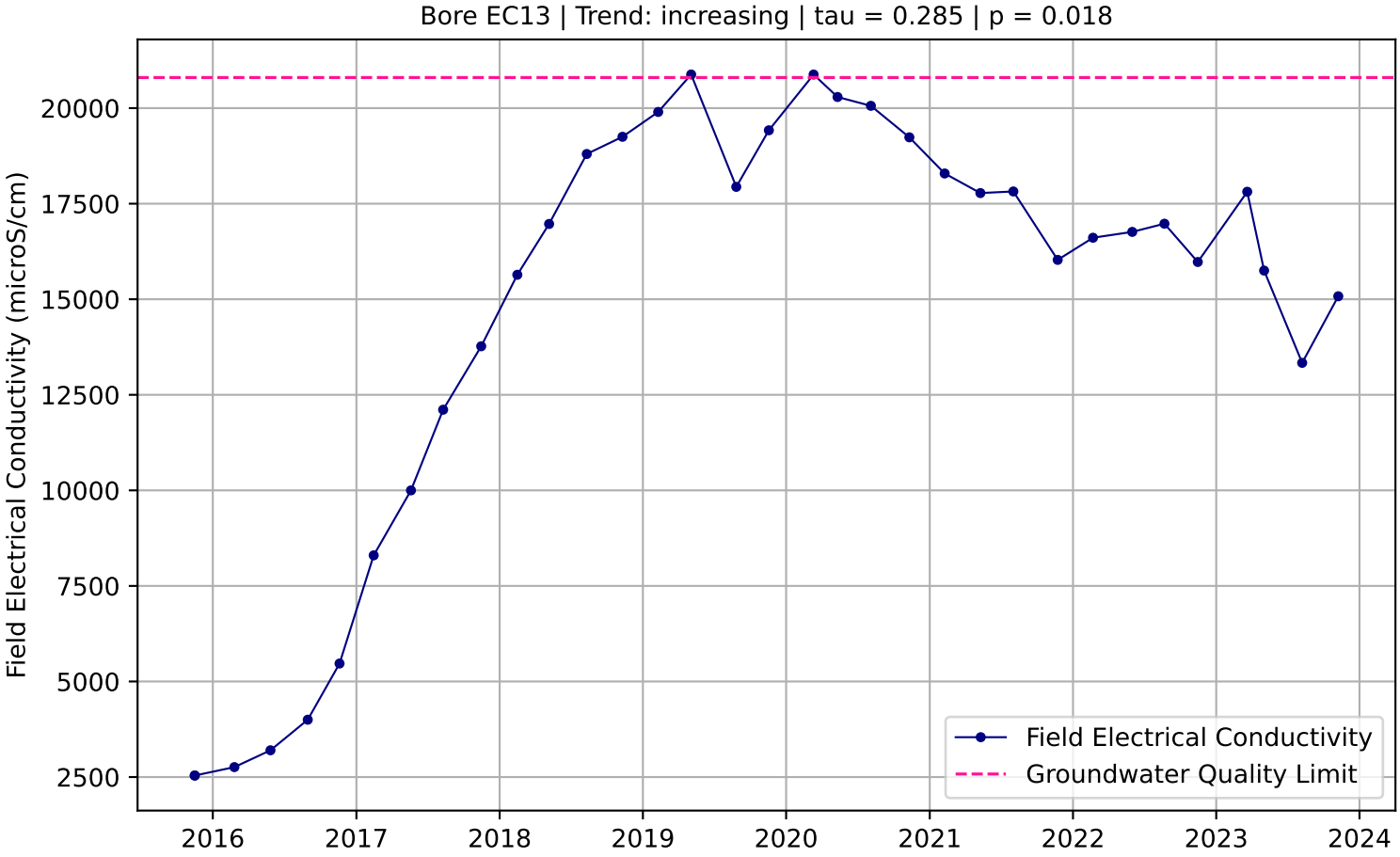

Bore EC13 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

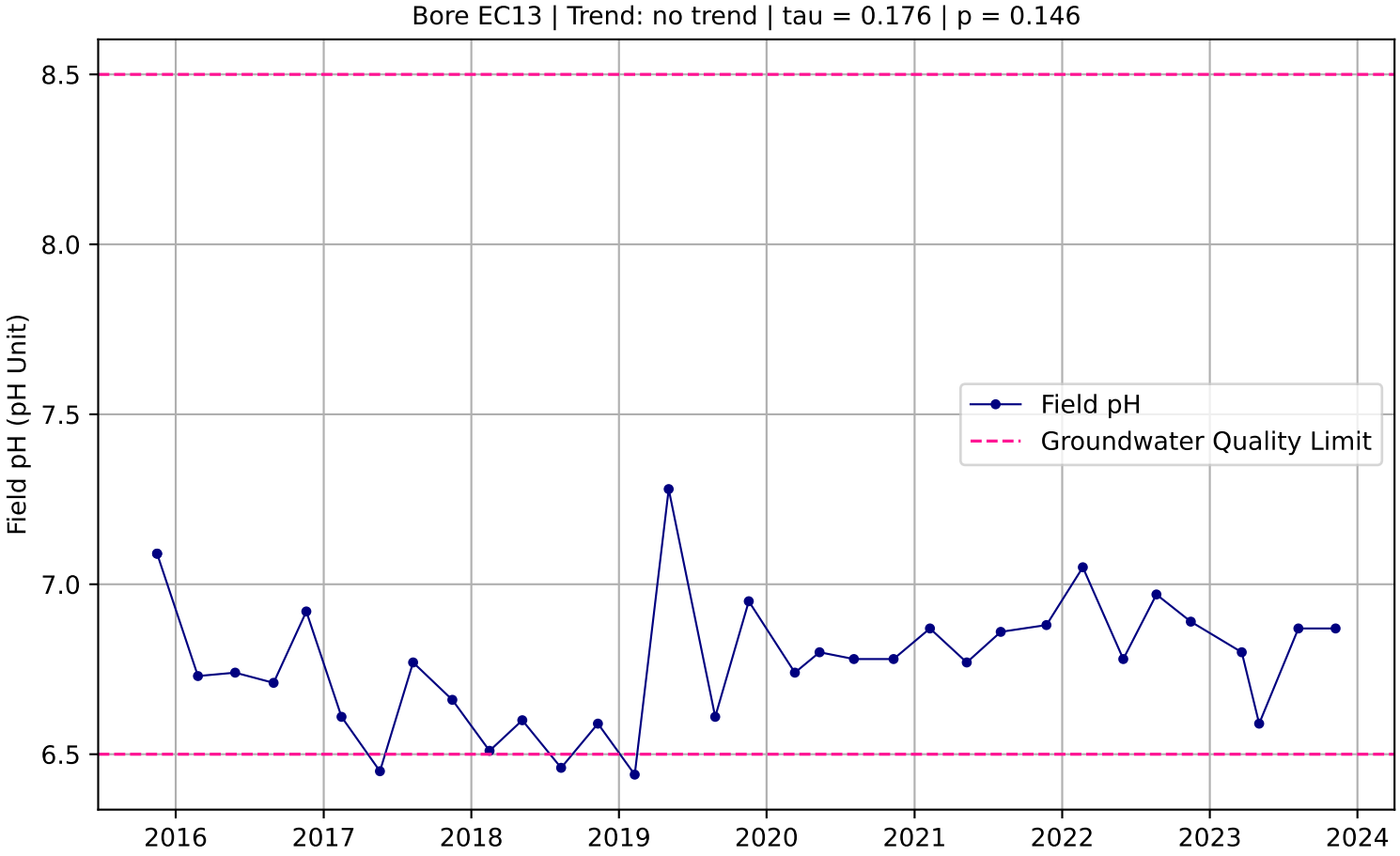

Bore EC13 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

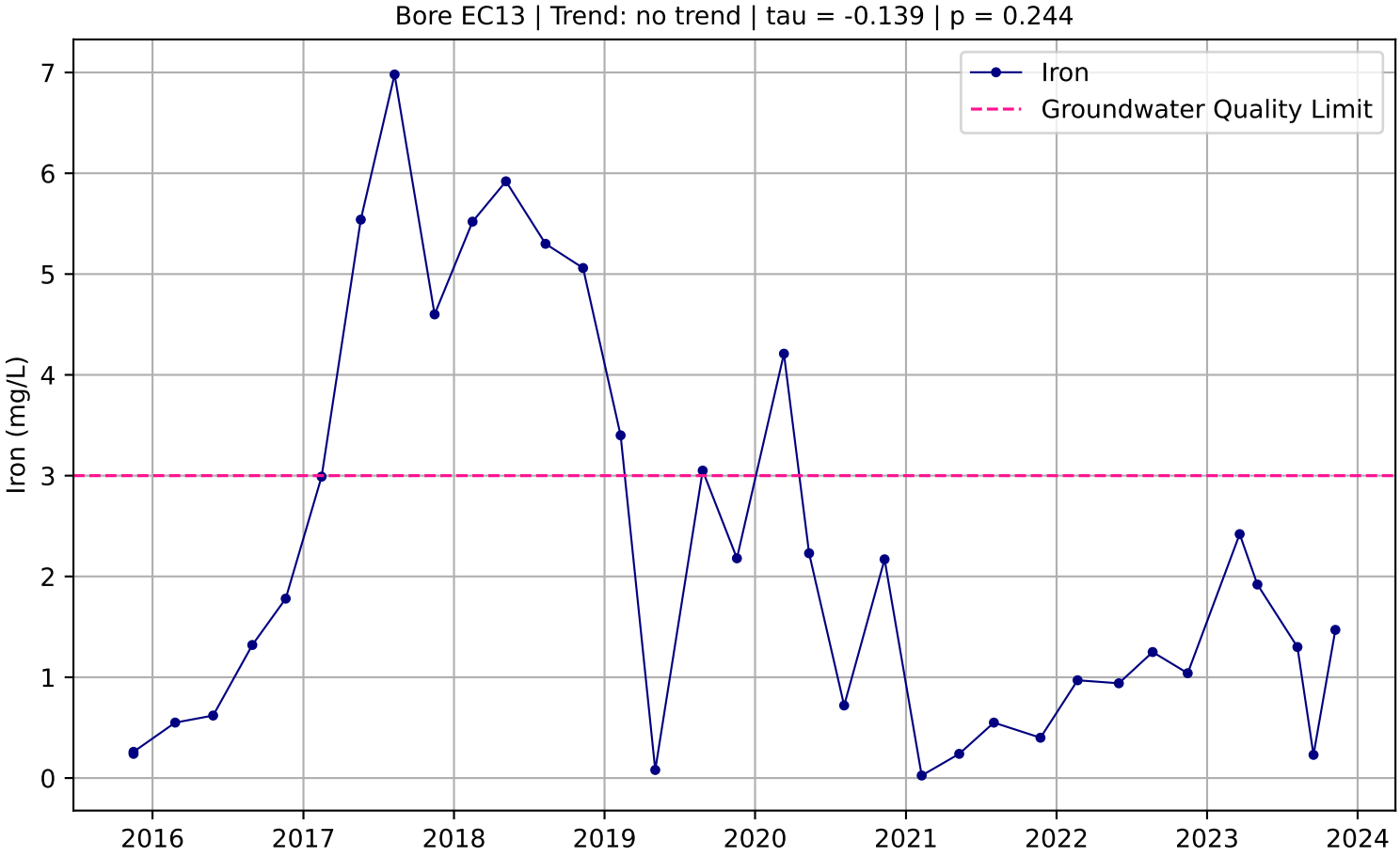

Bore EC13 | Trend: decreasing | tau = -0.732 | p = 0.0
Calcium
Calcium (mg/L)
900
800
700
600
500
400
300
2018
2019
2020
2021
2022
2023
2024

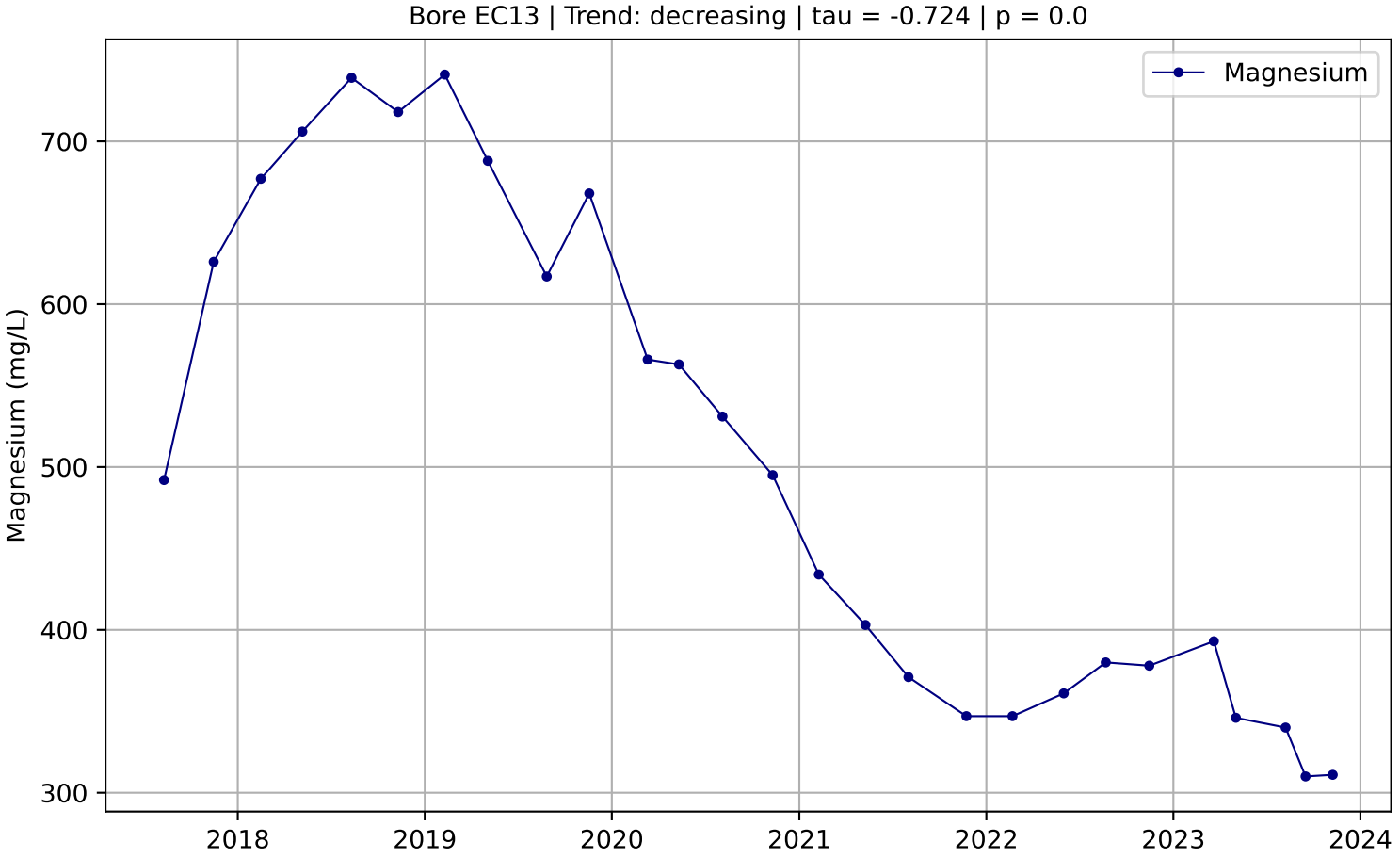

Bore EC13 | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

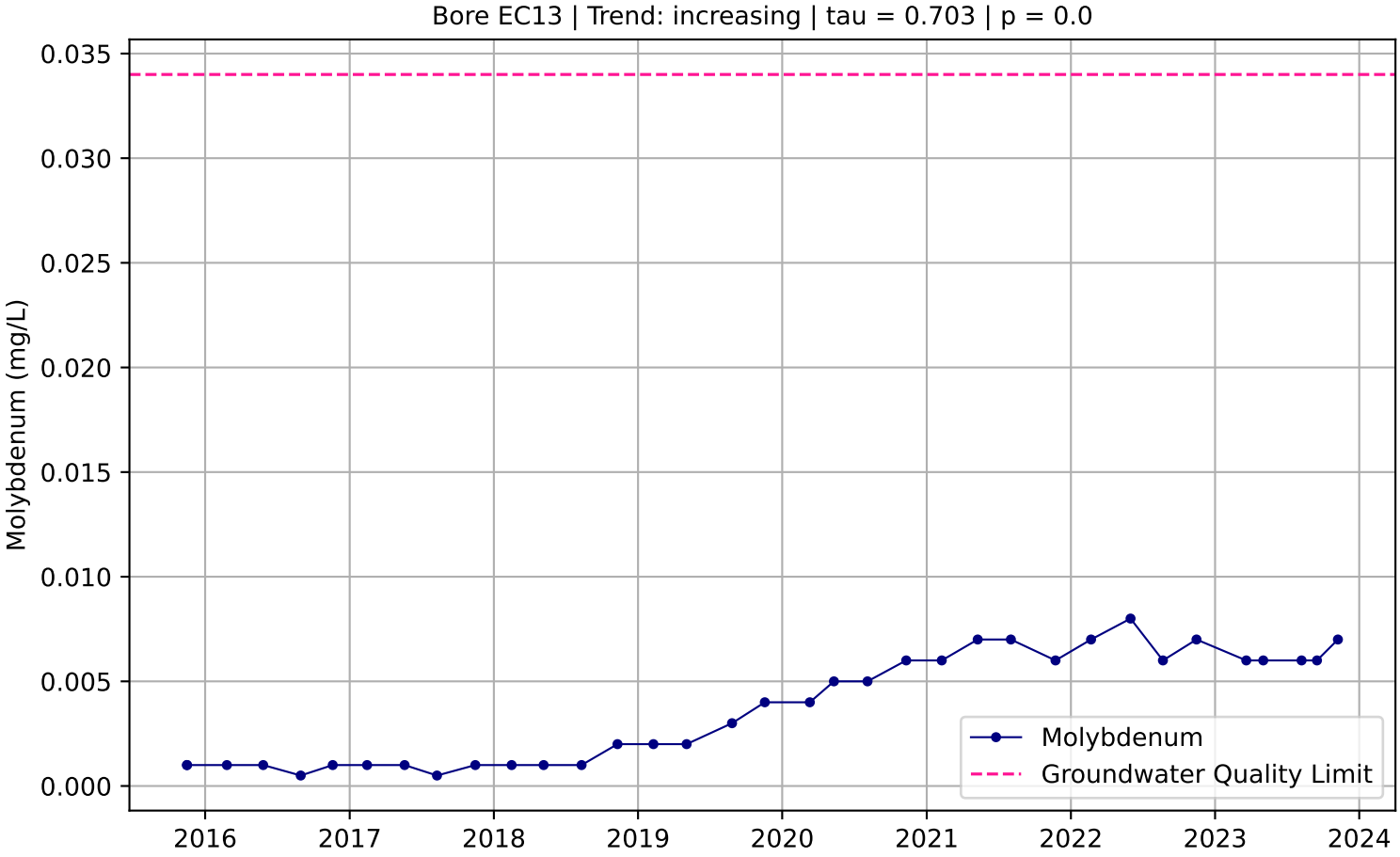

Bore EC13 | Trend: no trend | tau = 0.121 | p = 0.313
Chloride
Chloride (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
2016
2017
2018
2019
2020
2021
2022
2023
2024

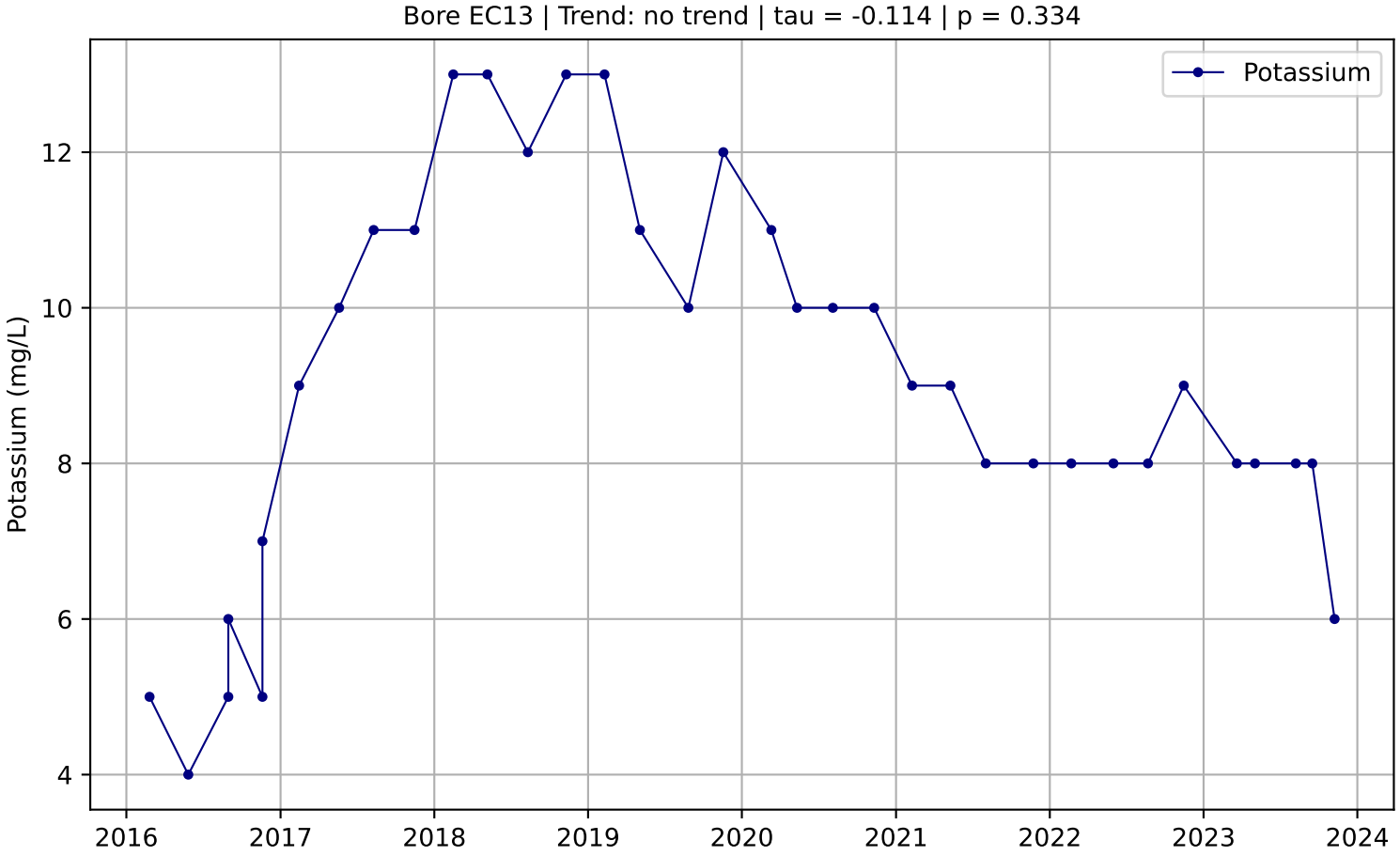

Bore EC13 | Trend: increasing | tau = 0.285 | p = 0.018
Field Electrical Conductivity (microS/cm)
20000
17500
15000
12500
10000
7500
5000
2500
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

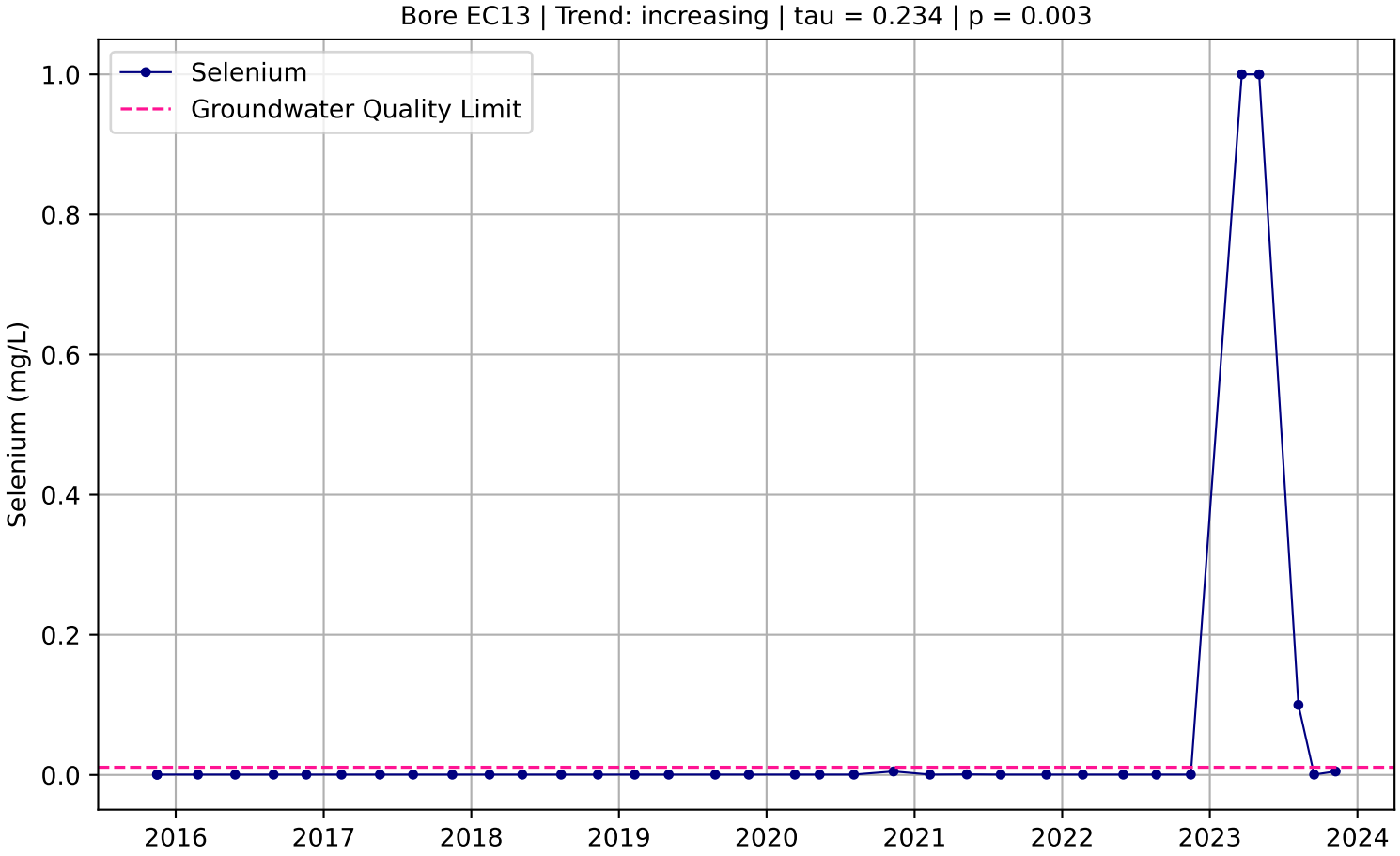

Bore EC13 | Trend: no trend | tau = 0.176 | p = 0.146
Field pH (pH Unit)
8.5
8.0
7.5
7.0
6.5
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

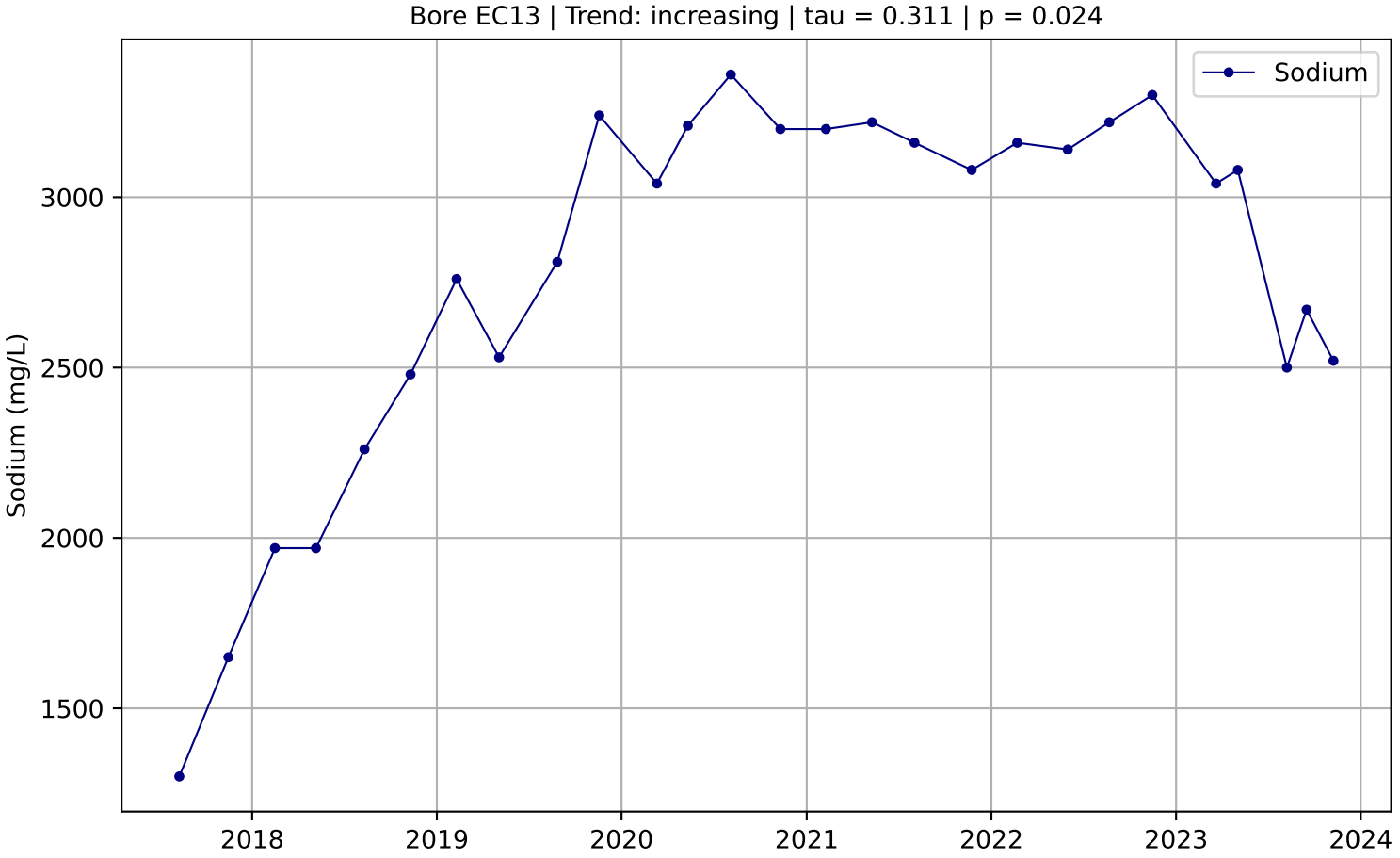

Bore EC13 | Trend: no trend | tau = -0.139 | p = 0.244
Iron
Groundwater Quality Limit
Iron (mg/L)
0
1
2
3
4
5
6
7
2016
2017
2018
2019
2020
2021
2022
2023
2024

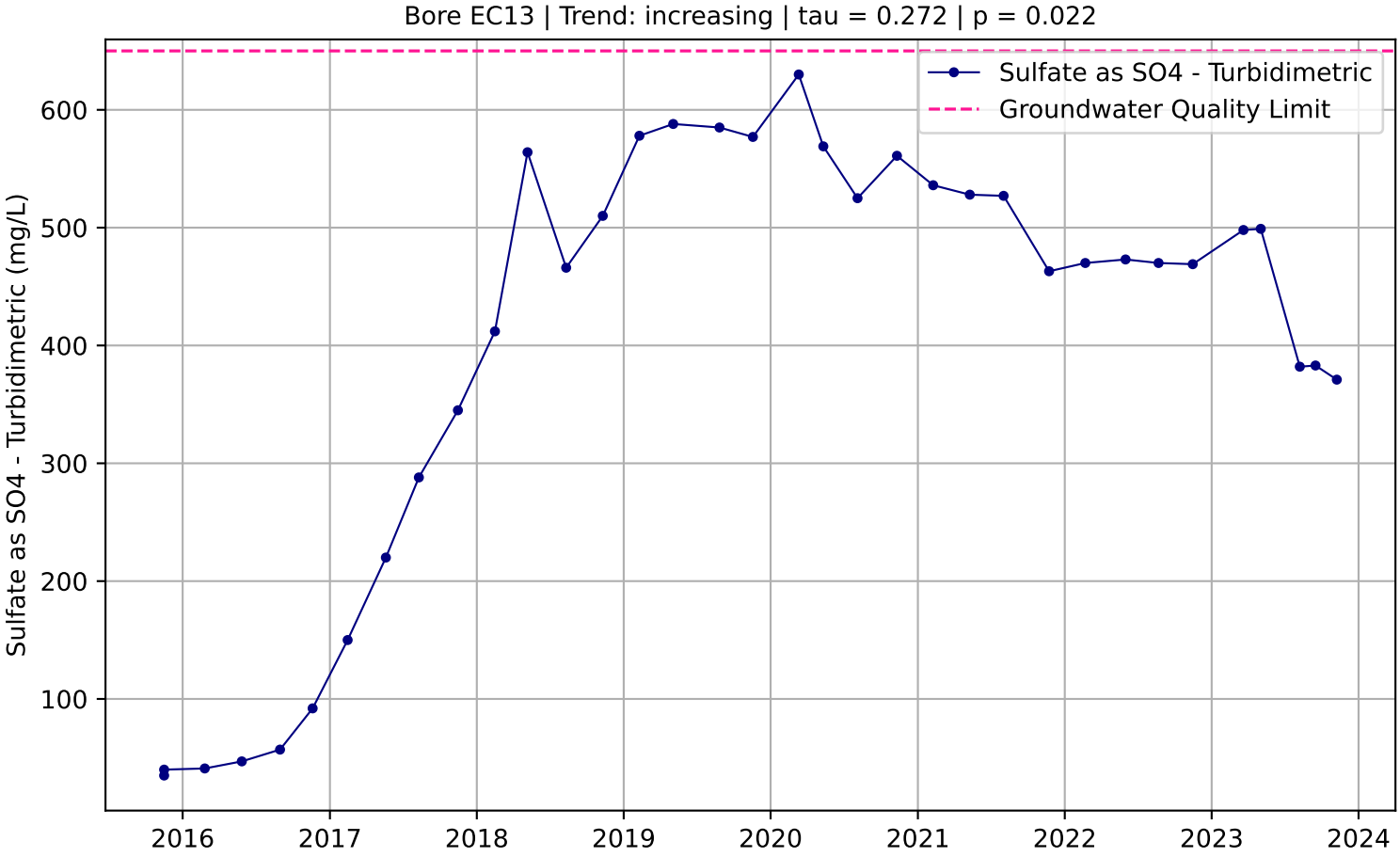

Bore EC13 | Trend: decreasing | tau = -0.724 | p = 0.0
Magnesium
Magnesium (mg/L)
700
600
500
400
300
2018
2019
2020
2021
2022
2023
2024

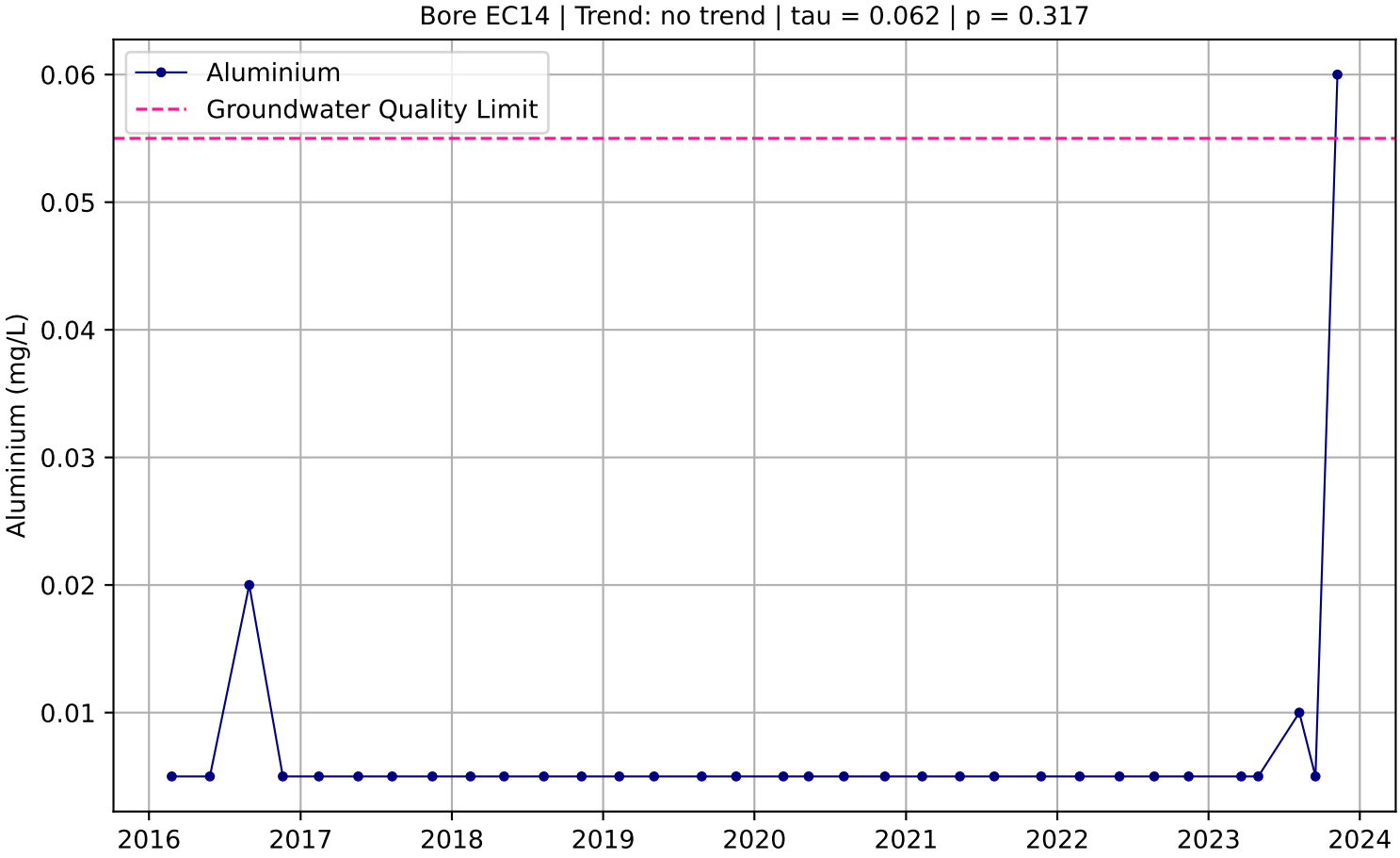

Bore EC13 | Trend: increasing | tau = 0.703 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

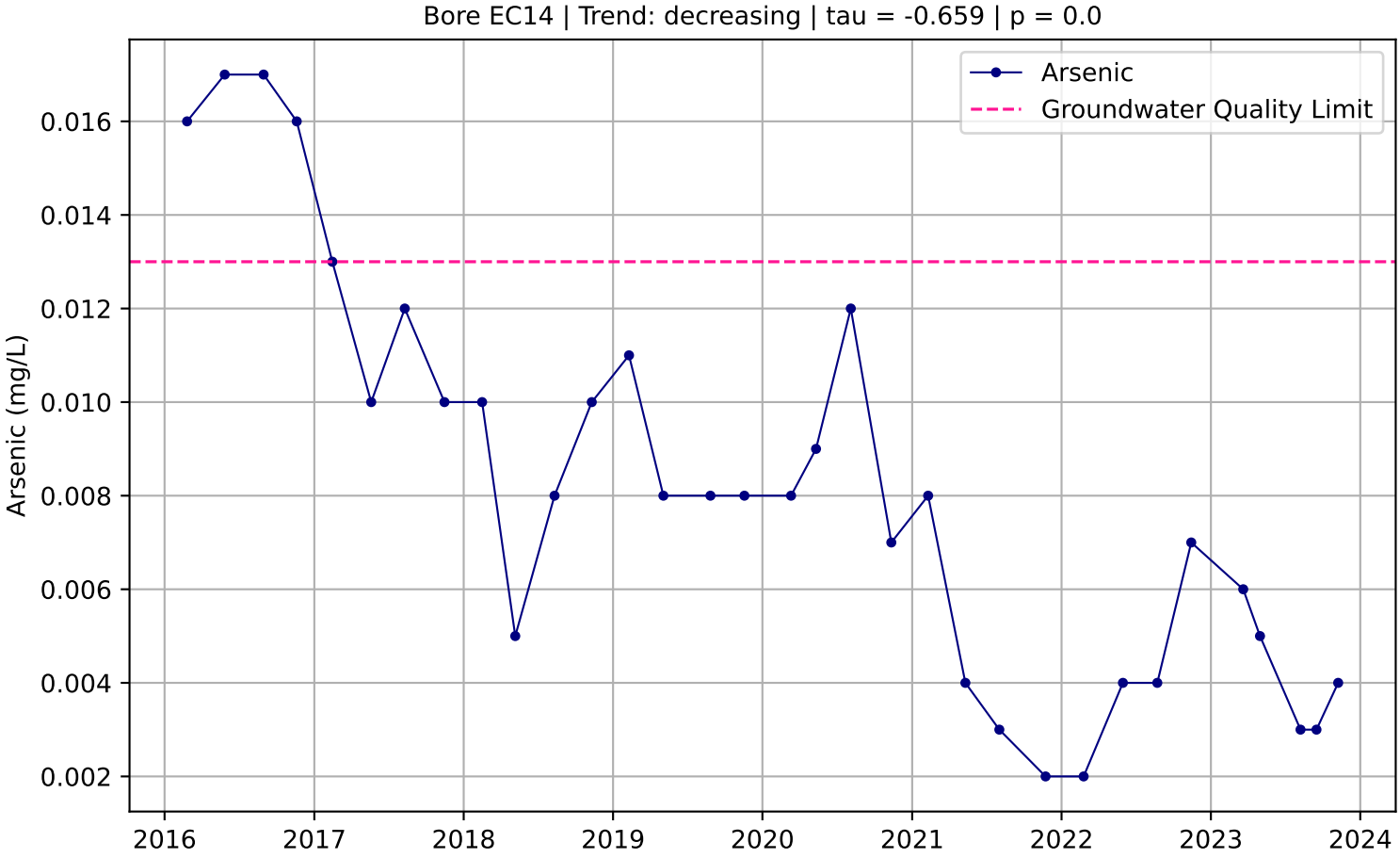

Bore EC13 | Trend: no trend | tau = -0.114 | p = 0.334
Potassium
Potassium (mg/L)
12
10
8
6
4
2016
2017
2018
2019
2020
2021
2022
2023
2024

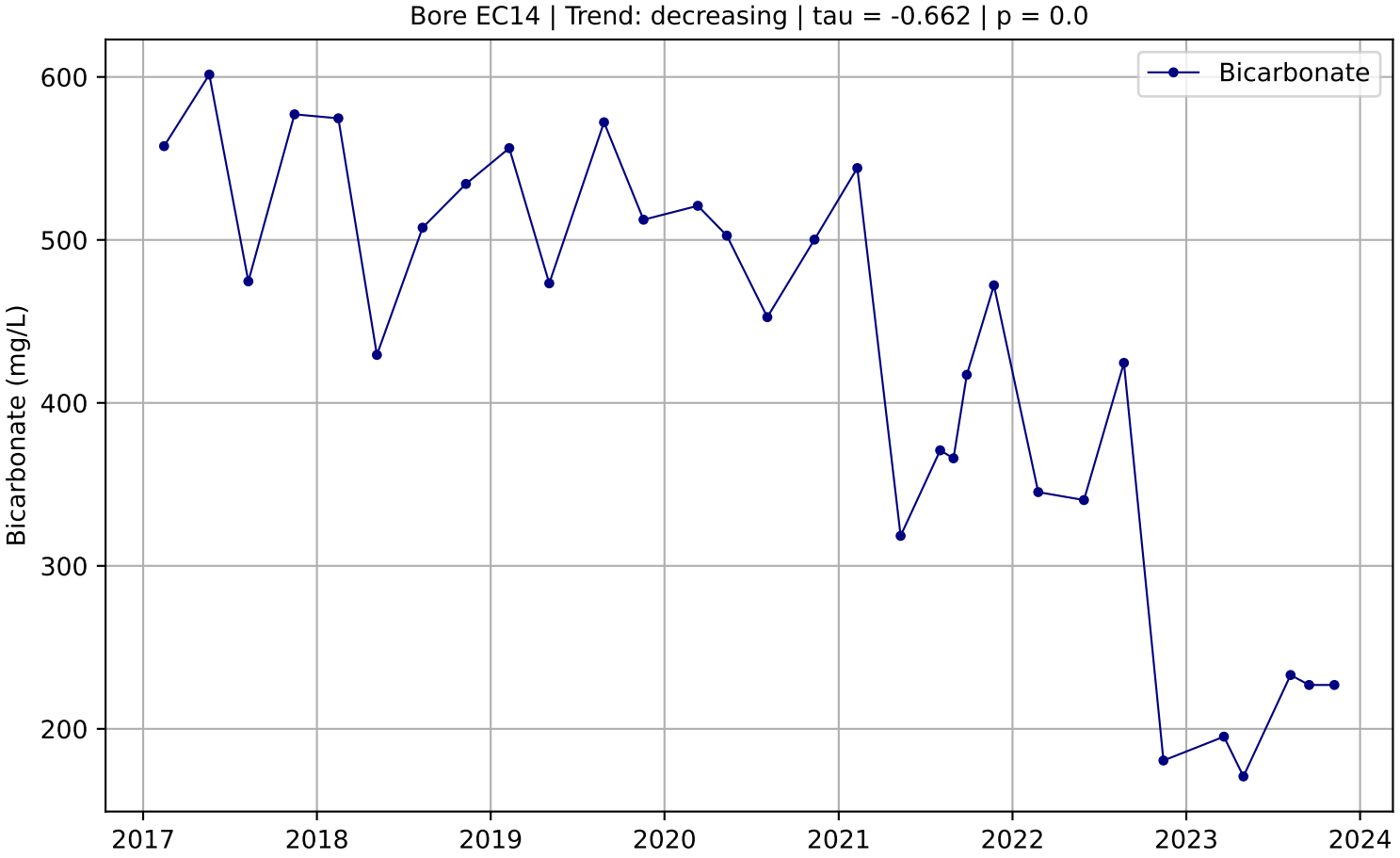

Bore EC13 | Trend: increasing | tau = 0.234 | p = 0.003
Selenium
Groundwater Quality Limit
Selenium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

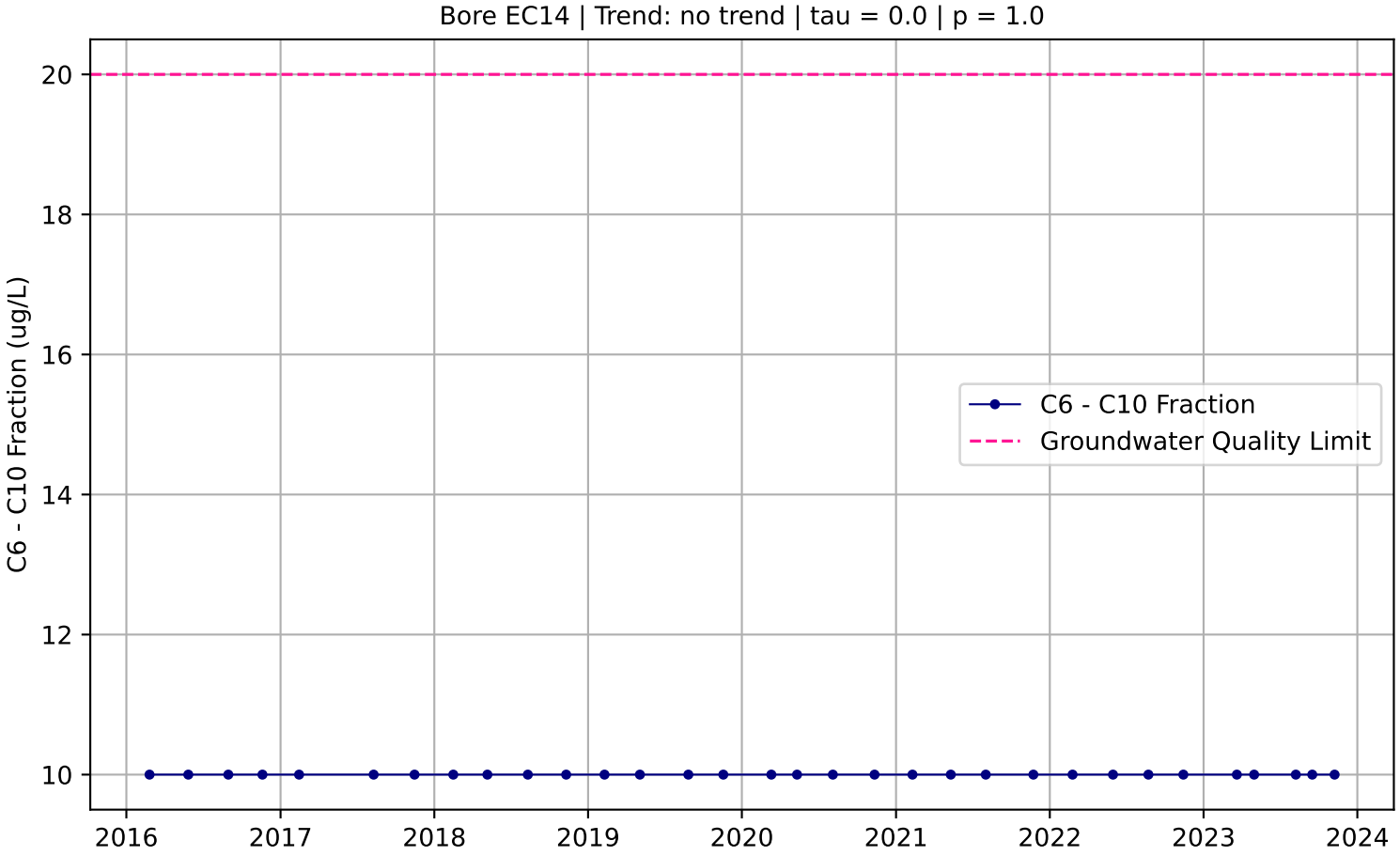

Bore EC13 | Trend: increasing | tau = 0.311 | p = 0.024
Sodium
Sodium (mg/L)
3000
2500
2000
1500
2018
2019
2020
2021
2022
2023
2024

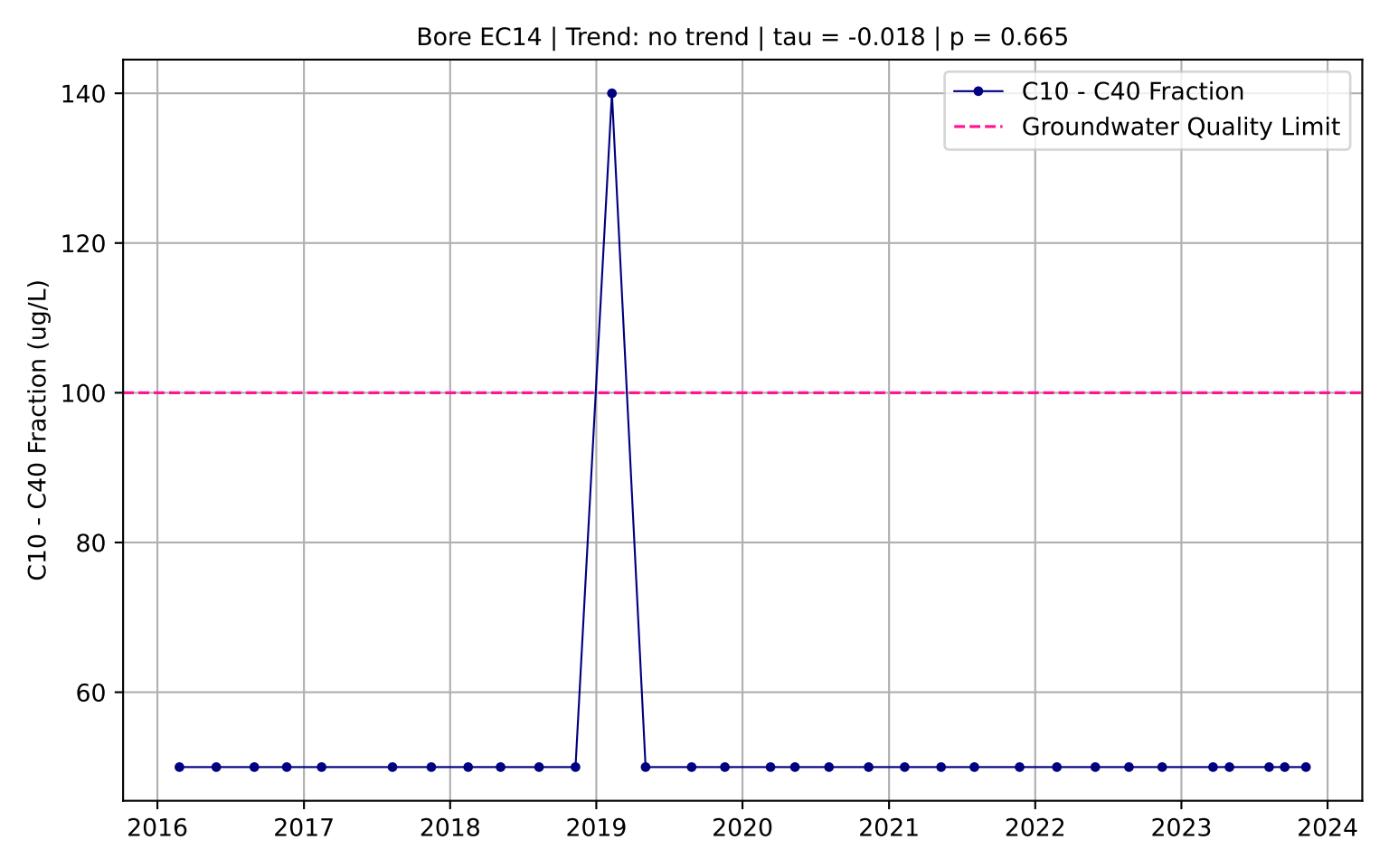

Bore EC13 | Trend: increasing | tau = 0.272 | p = 0.022
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
100
200
300
400
500
600
2016
2017
2018
2019
2020
2021
2022
2023
2024

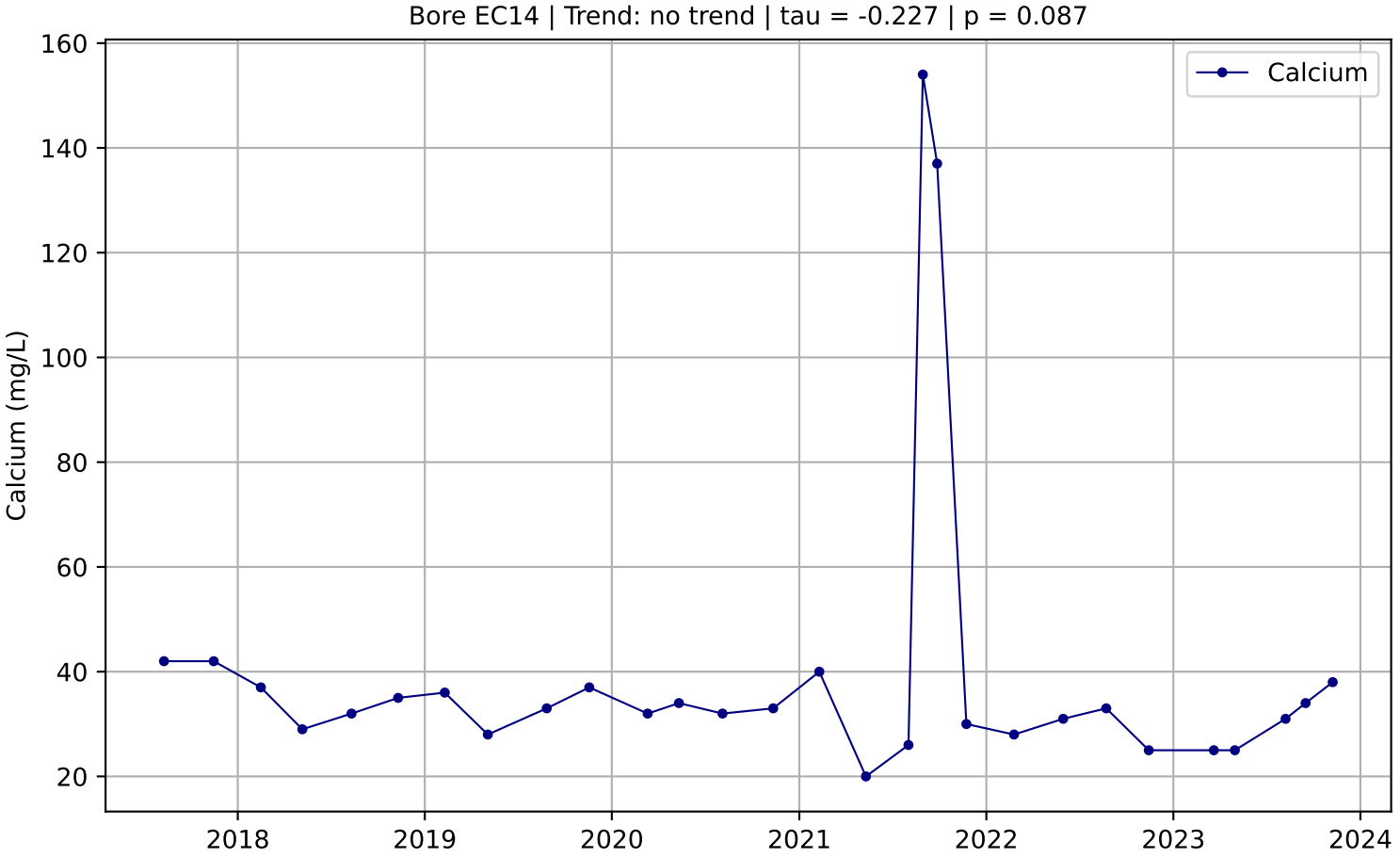

Bore EC14 | Trend: no trend | tau = 0.062 | p = 0.317
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024

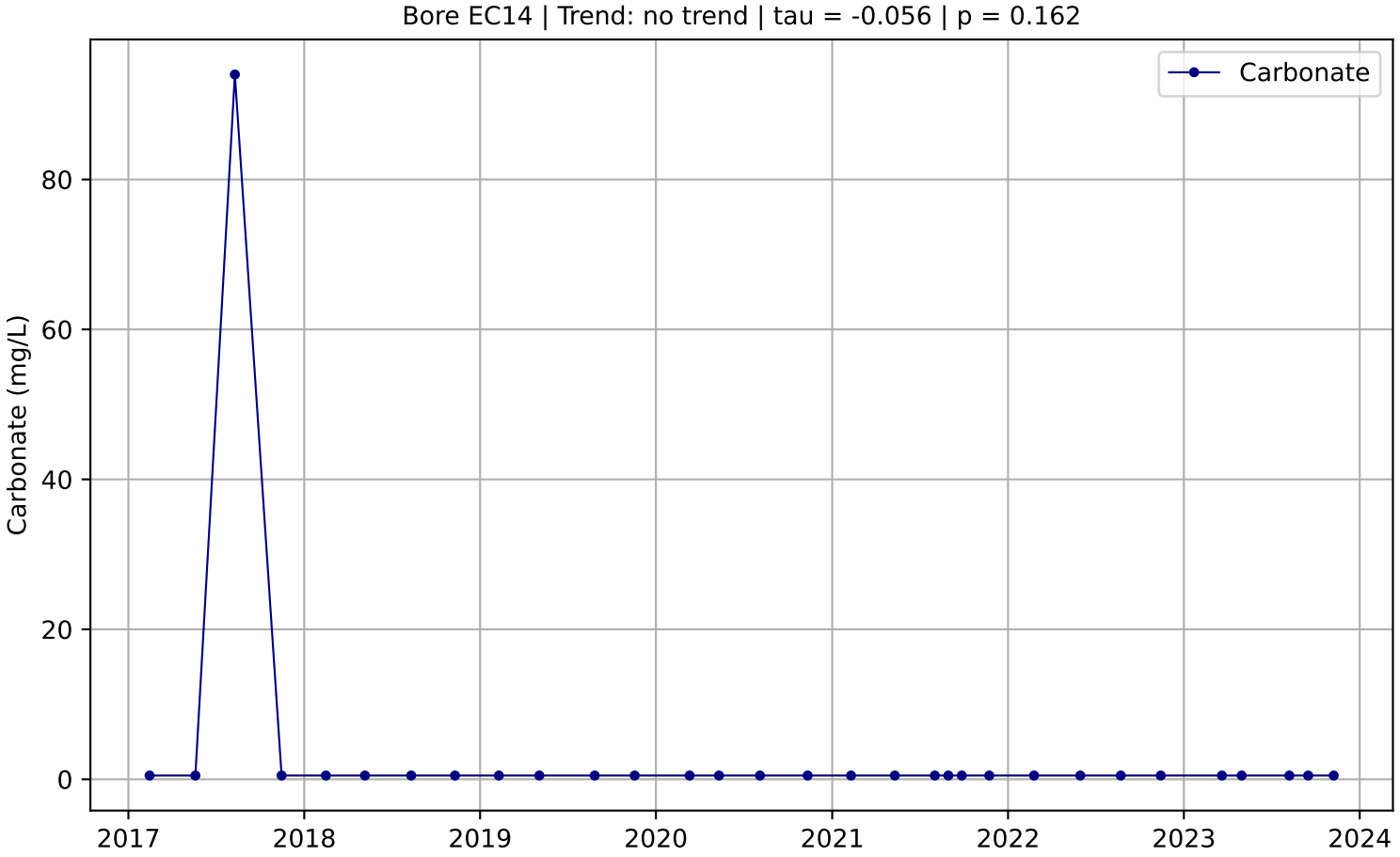

Bore EC14 | Trend: decreasing | tau = -0.659 | p = 0.0
Arsenic
Groundwater Quality Limit
Arsenic (mg/L)
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
2016
2017
2018
2019
2020
2021
2022
2023
2024

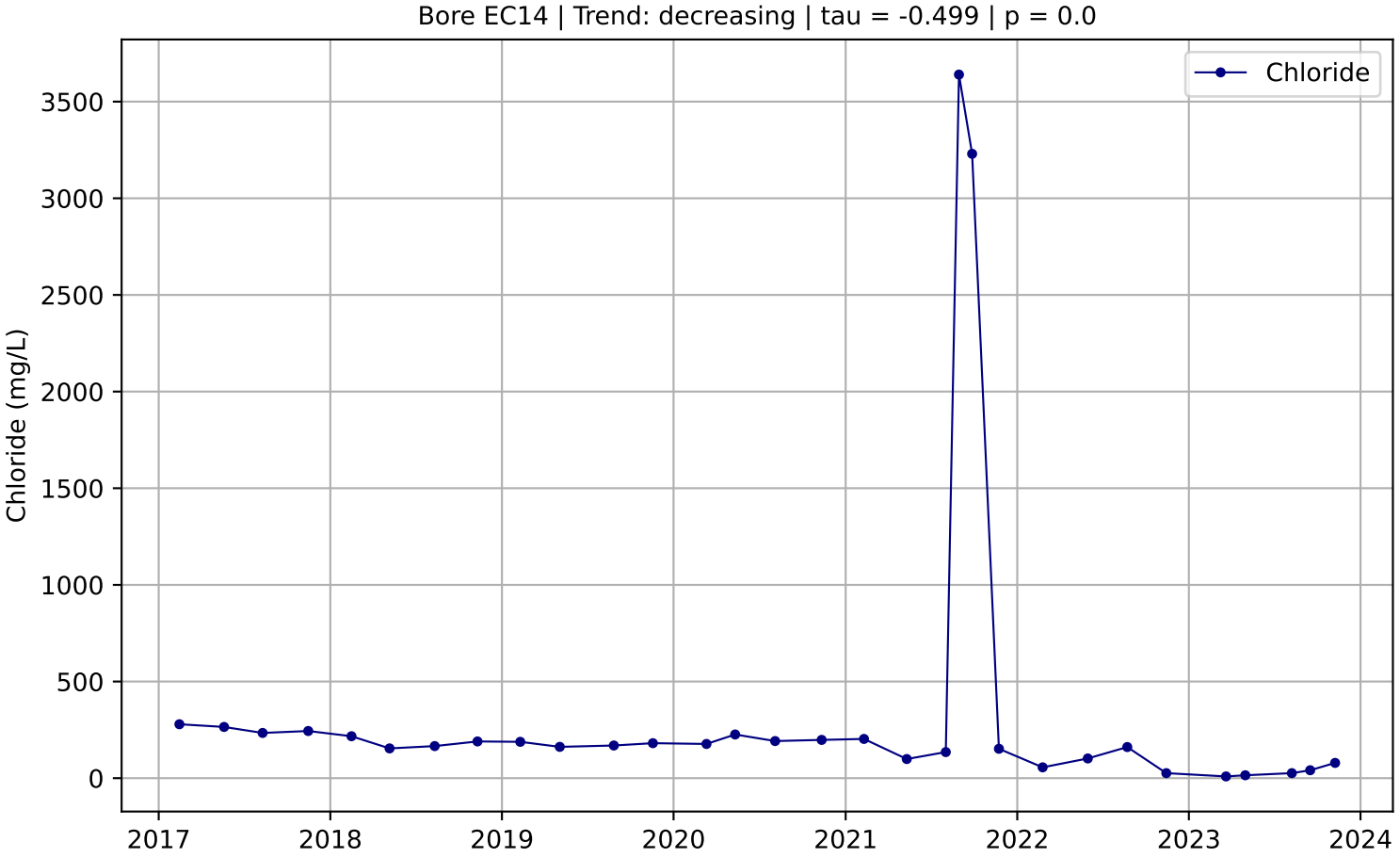

Bore EC14 | Trend: decreasing | tau = -0.662 | p = 0.0
Bicarbonate
Bicarbonate (mg/L)
600
500
400
300
200
2017
2018
2019
2020
2021
2022
2023
2024

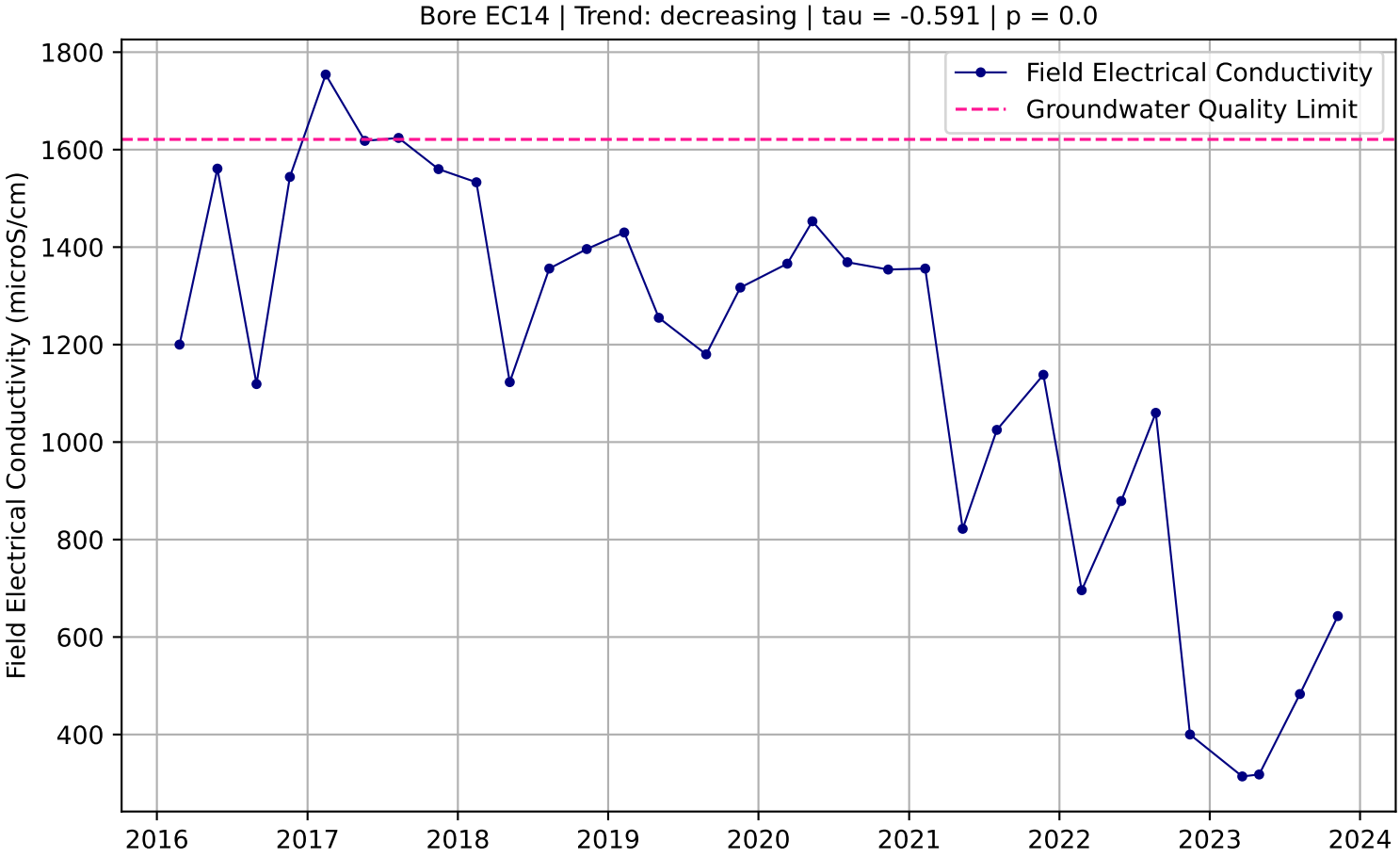

Bore EC14 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

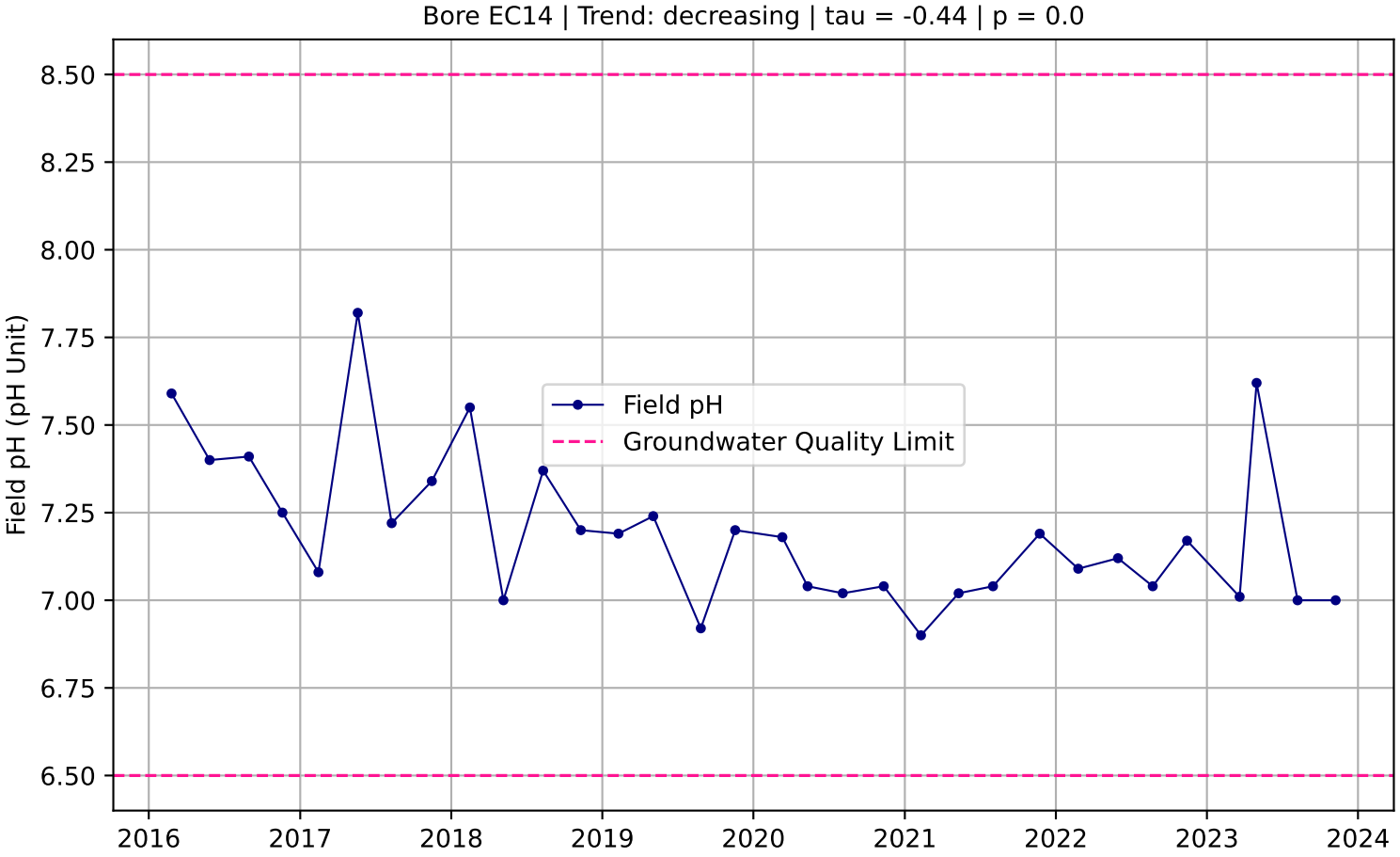

Bore EC14 | Trend: no trend | tau = -0.018 | p = 0.665
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
140
120
100
80
60
2016
2017
2018
2019
2020
2021
2022
2023
2024

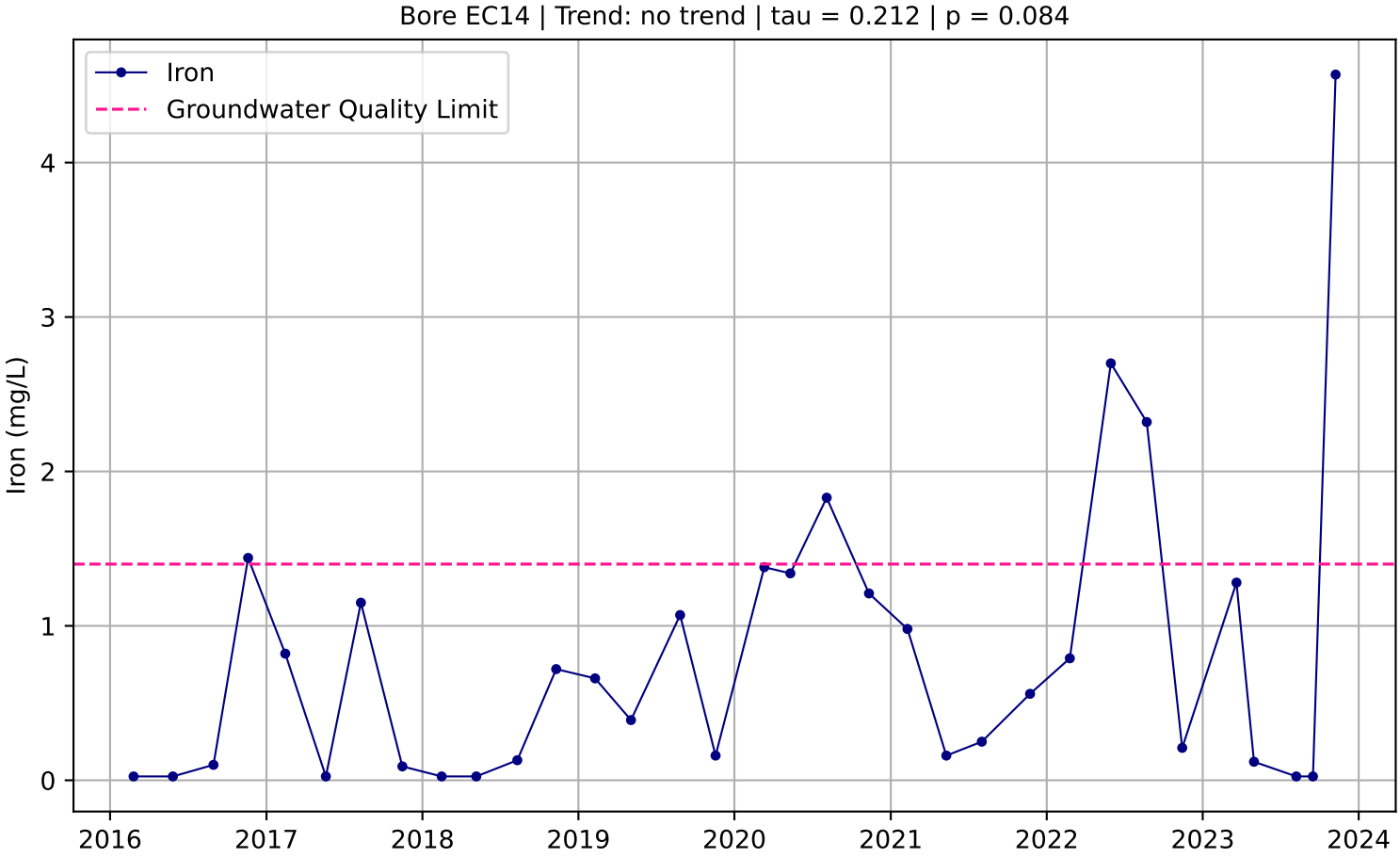

Bore EC14 | Trend: no trend | tau = -0.227 | p = 0.087
Calcium
Calcium (mg/L)
160
140
120
100
80
60
40
20
2018
2019
2020
2021
2022
2023
2024

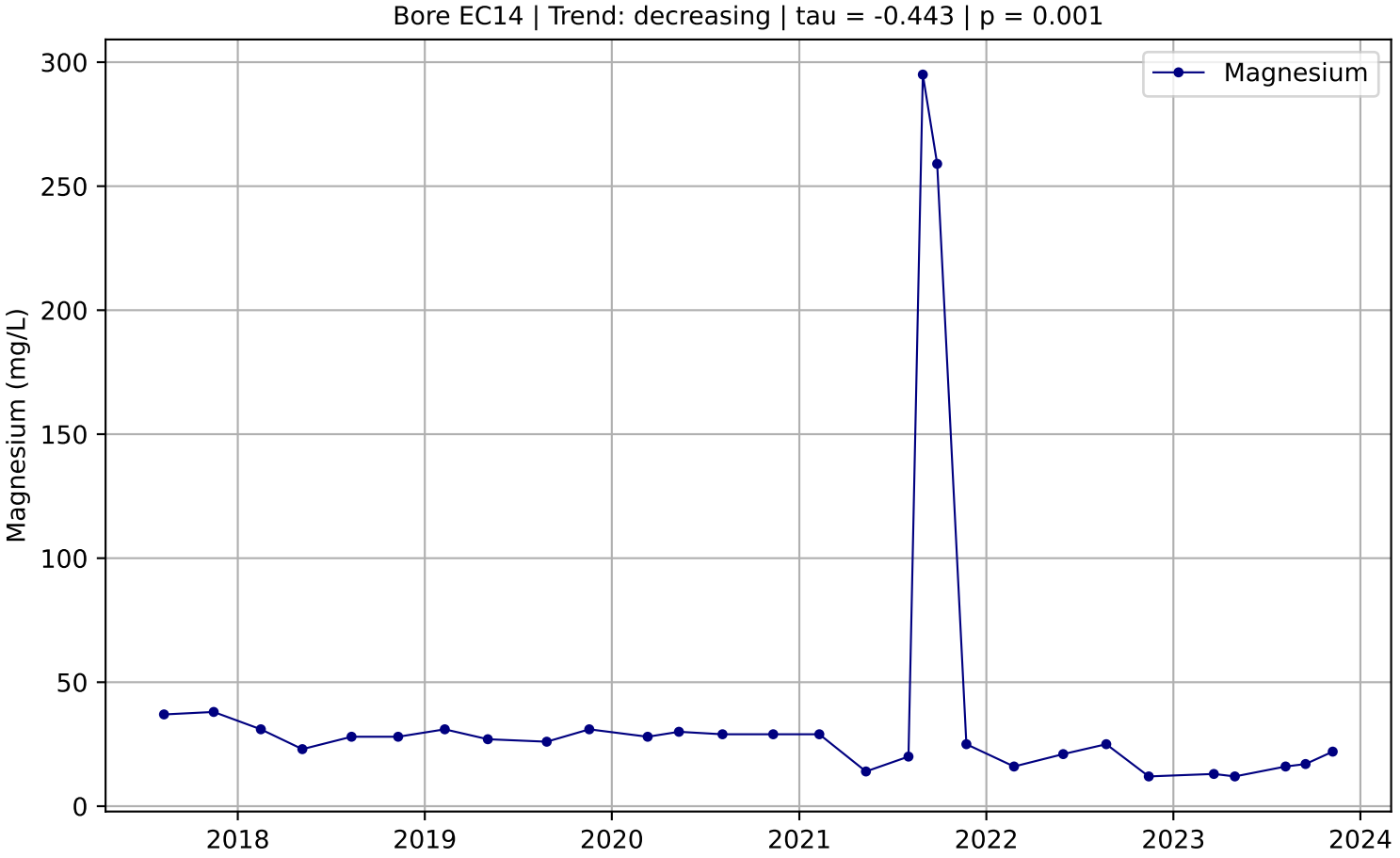

Bore EC14 | Trend: no trend | tau = -0.056 | p = 0.162
Carbonate
Carbonate (mg/L)
0
20
40
60
80
2017
2018
2019
2020
2021
2022
2023
2024

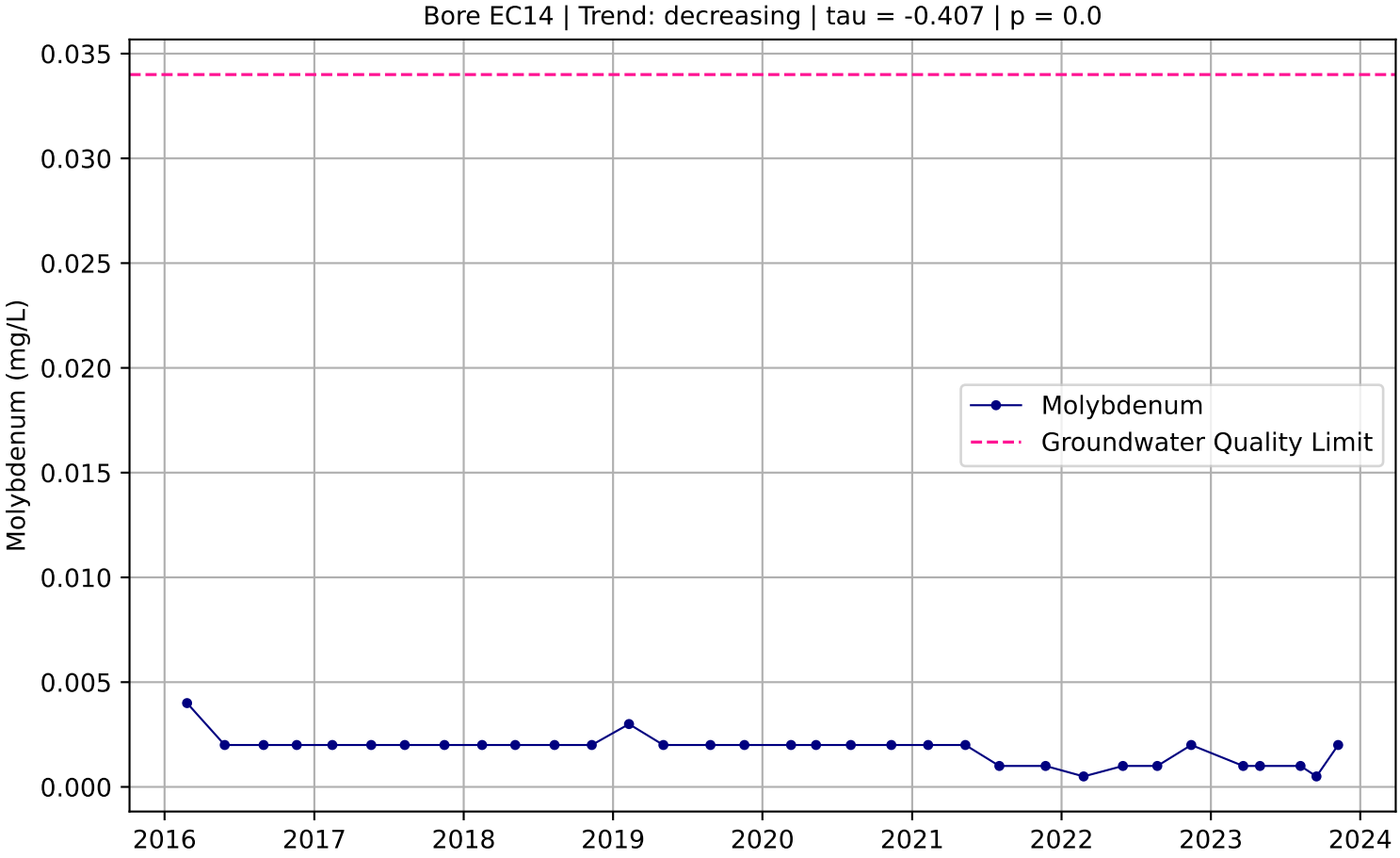

Bore EC14 | Trend: decreasing | tau = -0.499 | p = 0.0
Chloride
Chloride (mg/L)
3500
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020
2021
2022
2023
2024

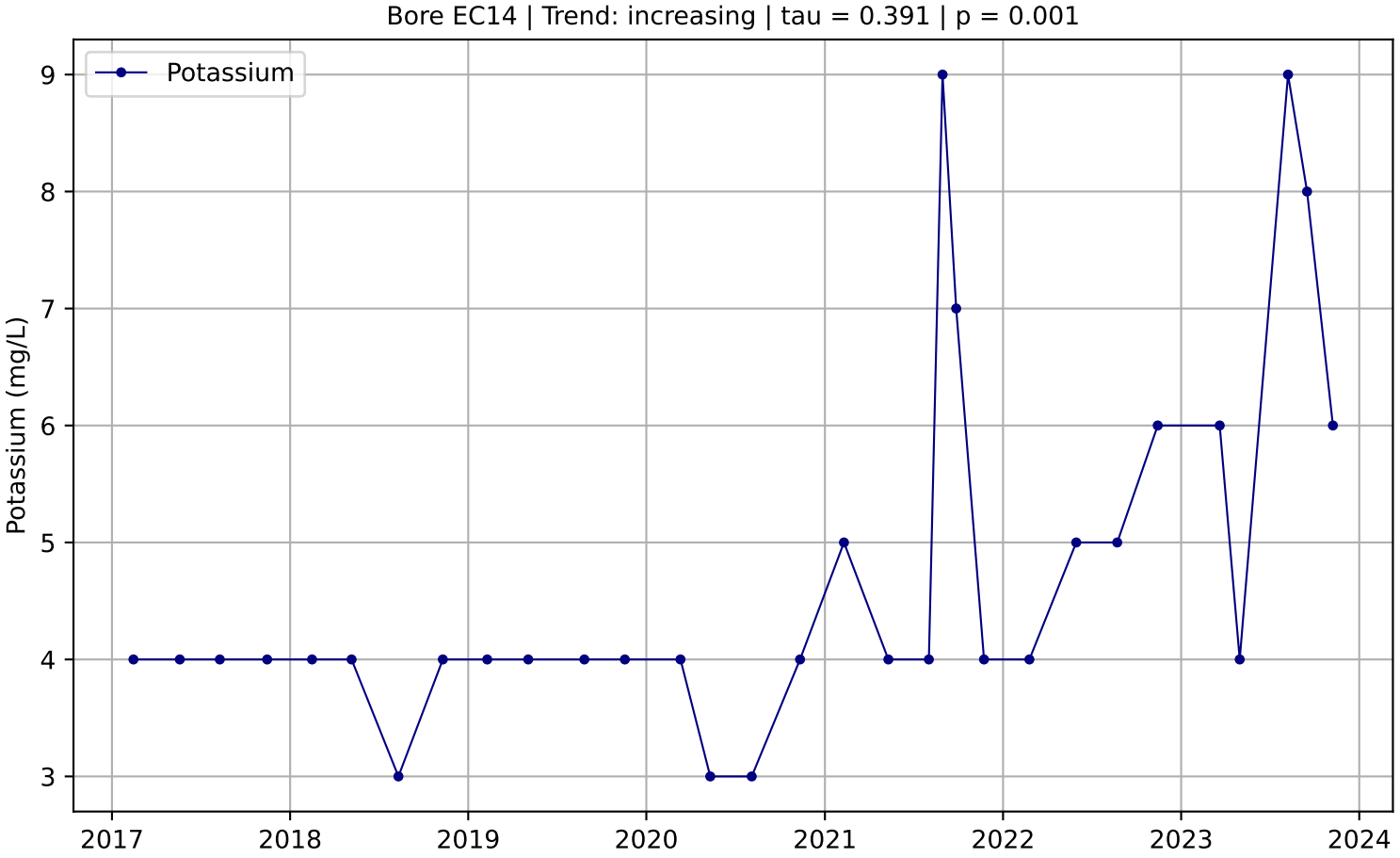

Bore EC14 | Trend: decreasing | tau = -0.591 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
1800
1600
1400
1200
1000
800
600
400
2016
2017
2018
2019
2020
2021
2022
2023
2024

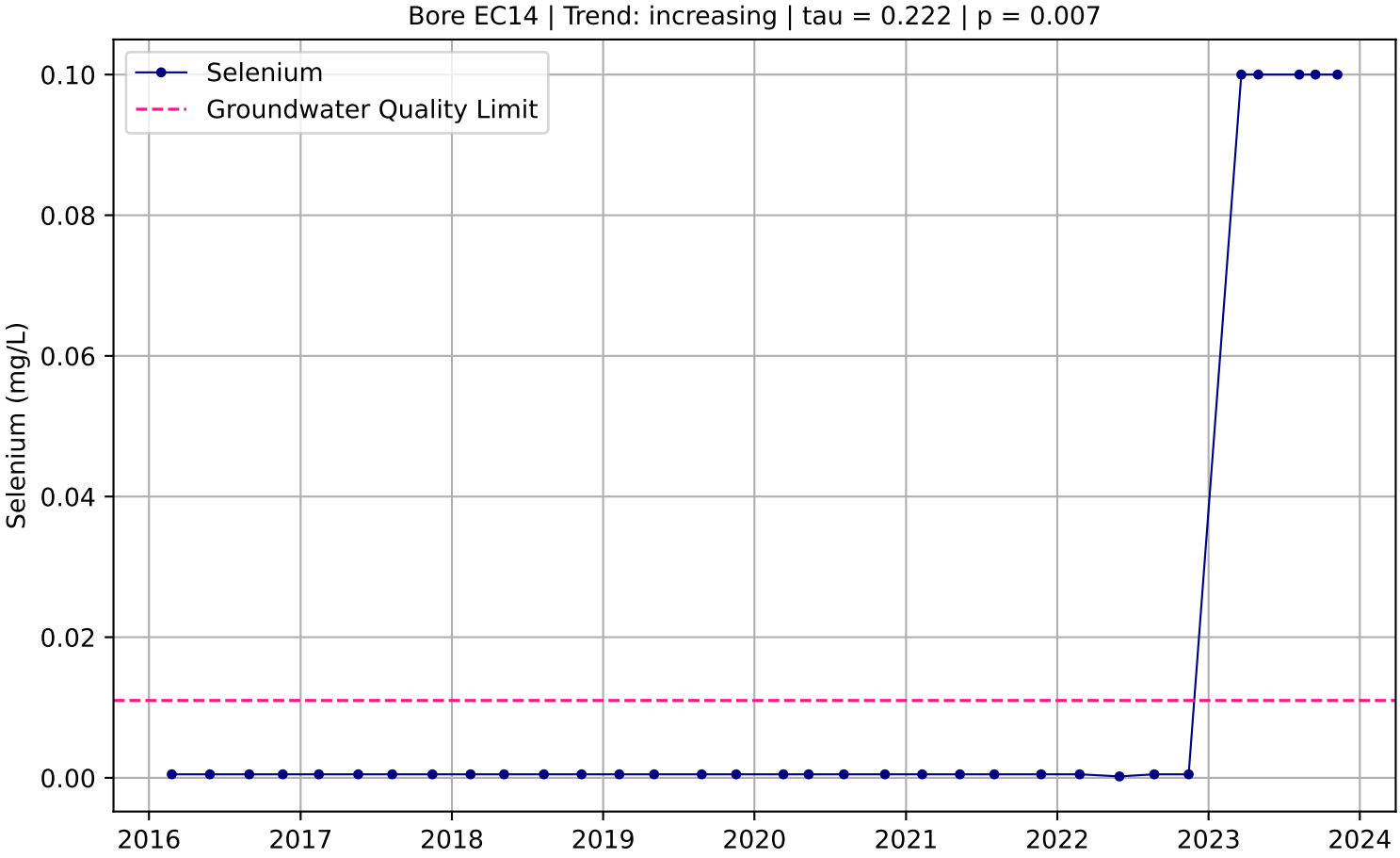

Bore EC14 | Trend: decreasing | tau = -0.44 | p = 0.0
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

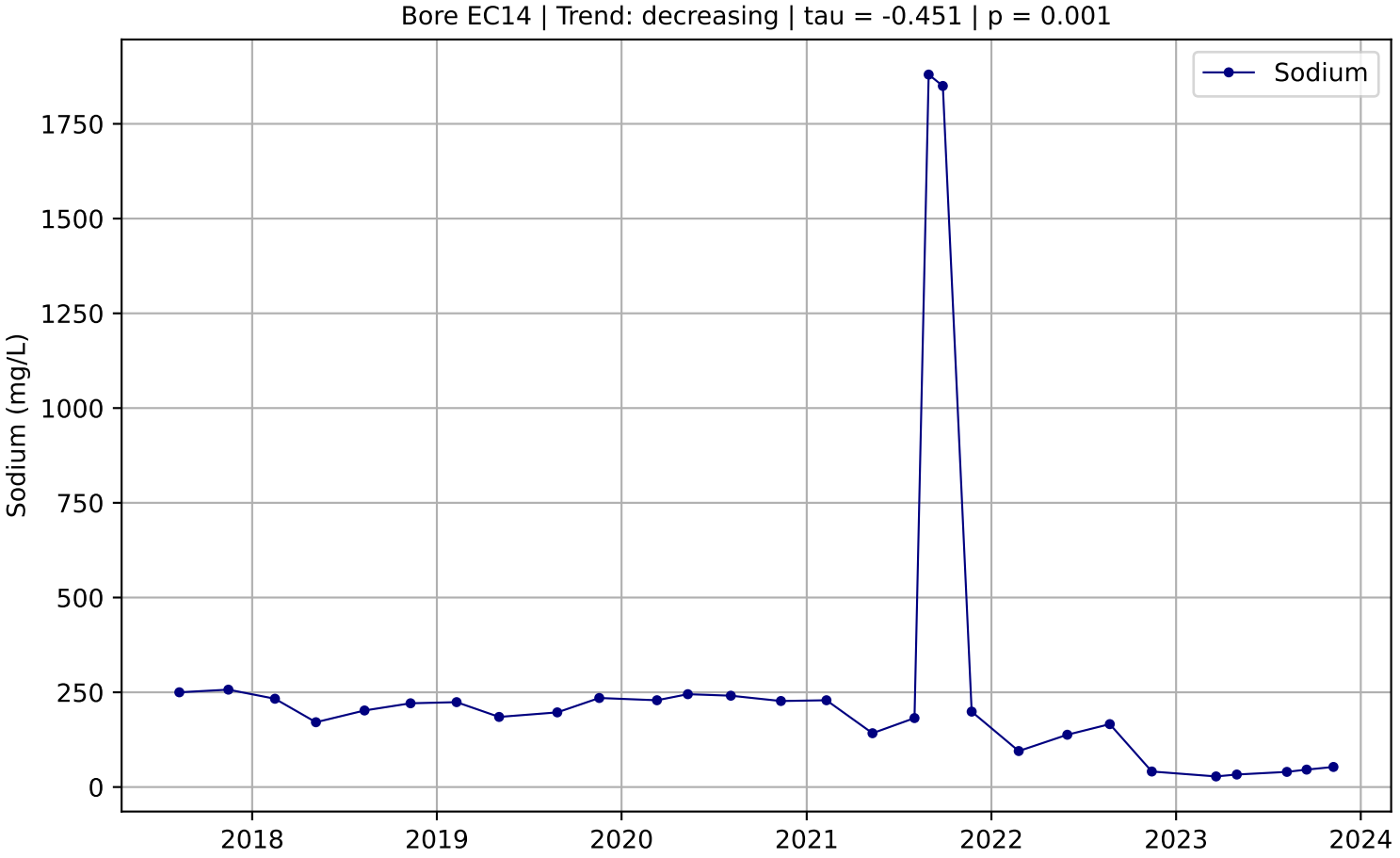

Bore EC14 | Trend: no trend | tau = 0.212 | p = 0.084
Iron
Groundwater Quality Limit
Iron (mg/L)
0
1
2
3
4
2016
2017
2018
2019
2020
2021
2022
2023
2024

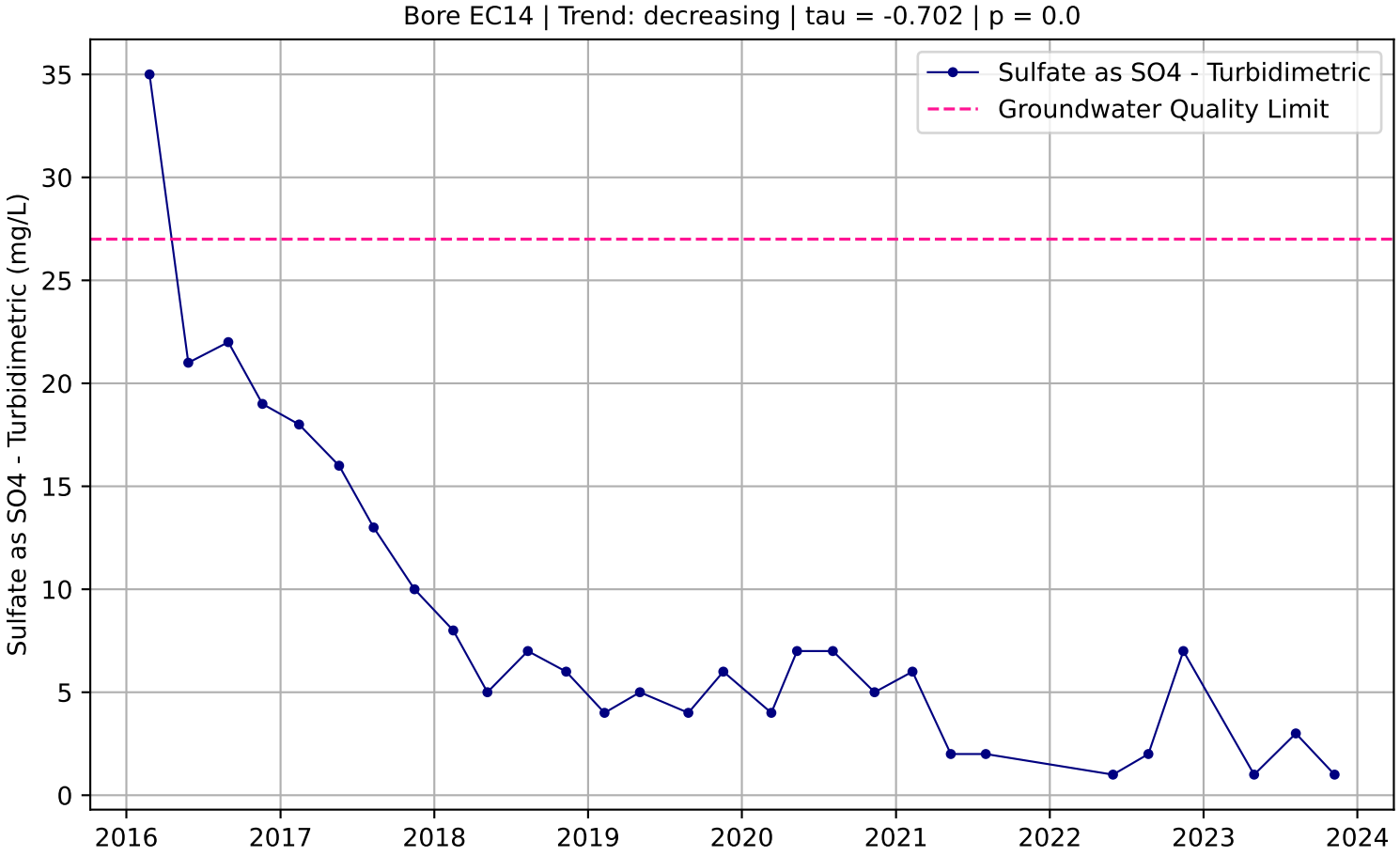

Bore EC14 | Trend: decreasing | tau = -0.443 | p = 0.001
Magnesium
Magnesium (mg/L)
300
250
200
150
100
50
0
2018
2019
2020
2021
2022
2023
2024

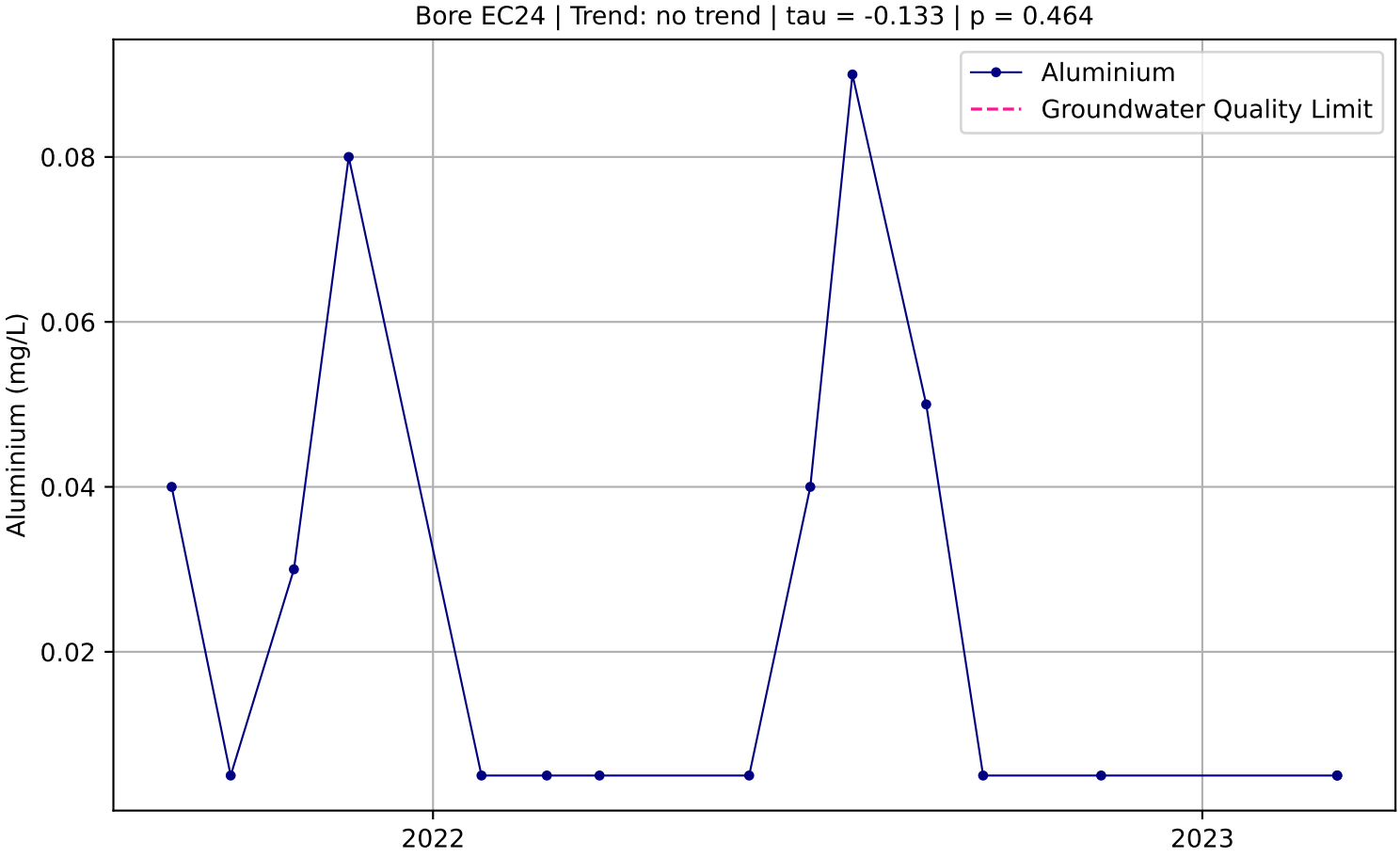

Bore EC14 | Trend: decreasing | tau = -0.407 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

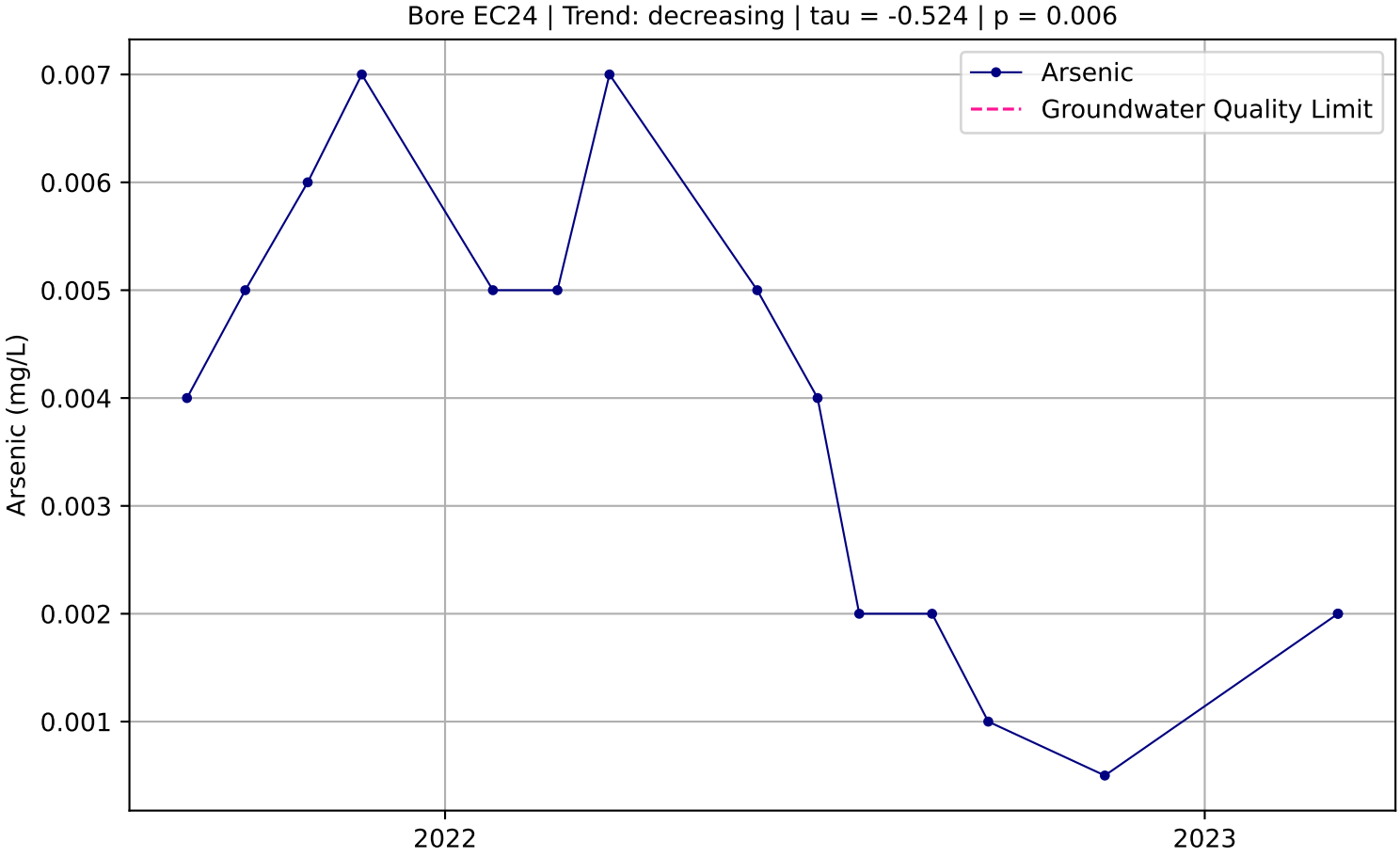

Bore EC14 | Trend: increasing | tau = 0.391 | p = 0.001
Potassium
Potassium (mg/L)
9
8
7
6
5
4
3
2017
2018
2019
2020
2021
2022
2023
2024

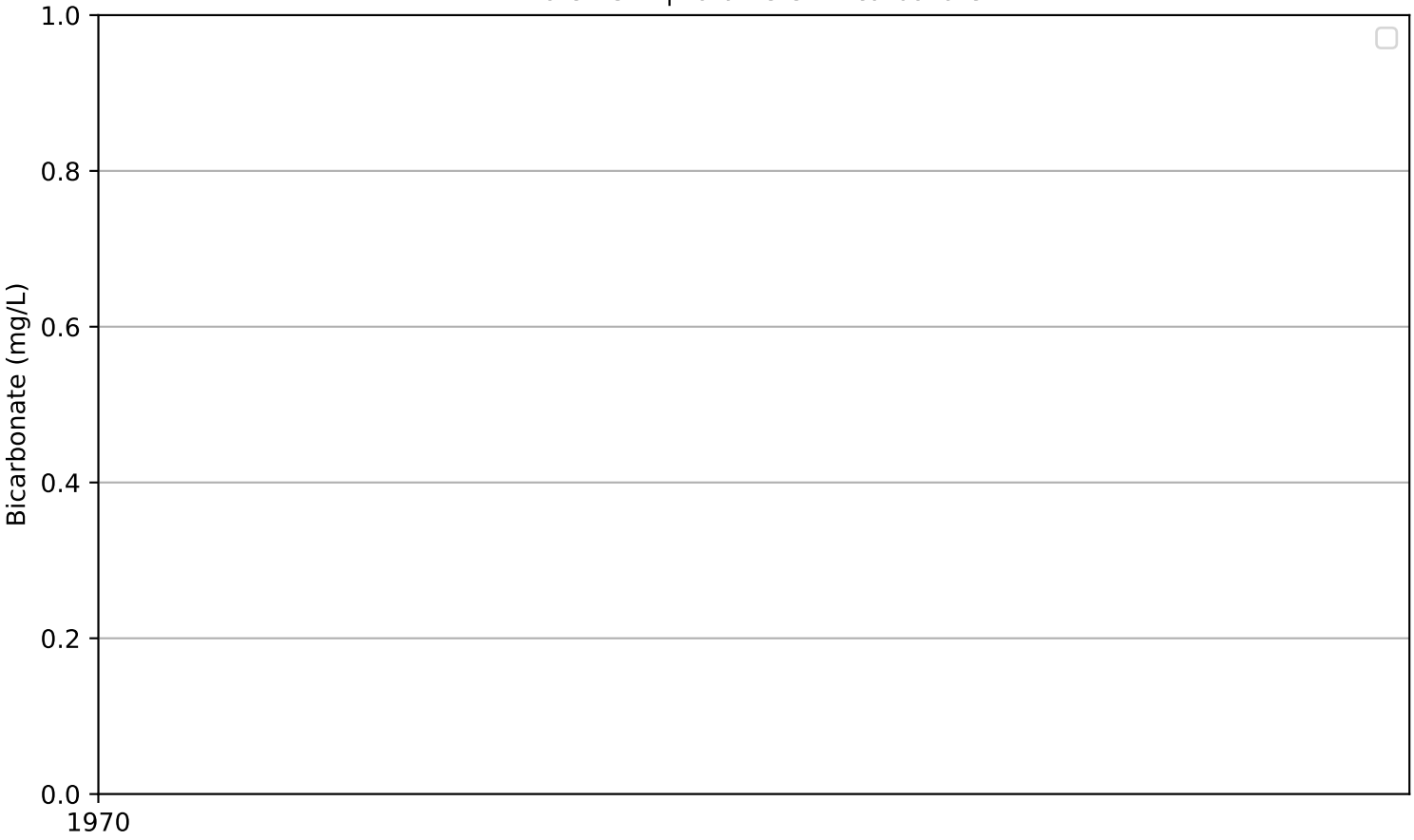

Bore EC14 | Trend: increasing | tau = 0.222 | p = 0.007
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

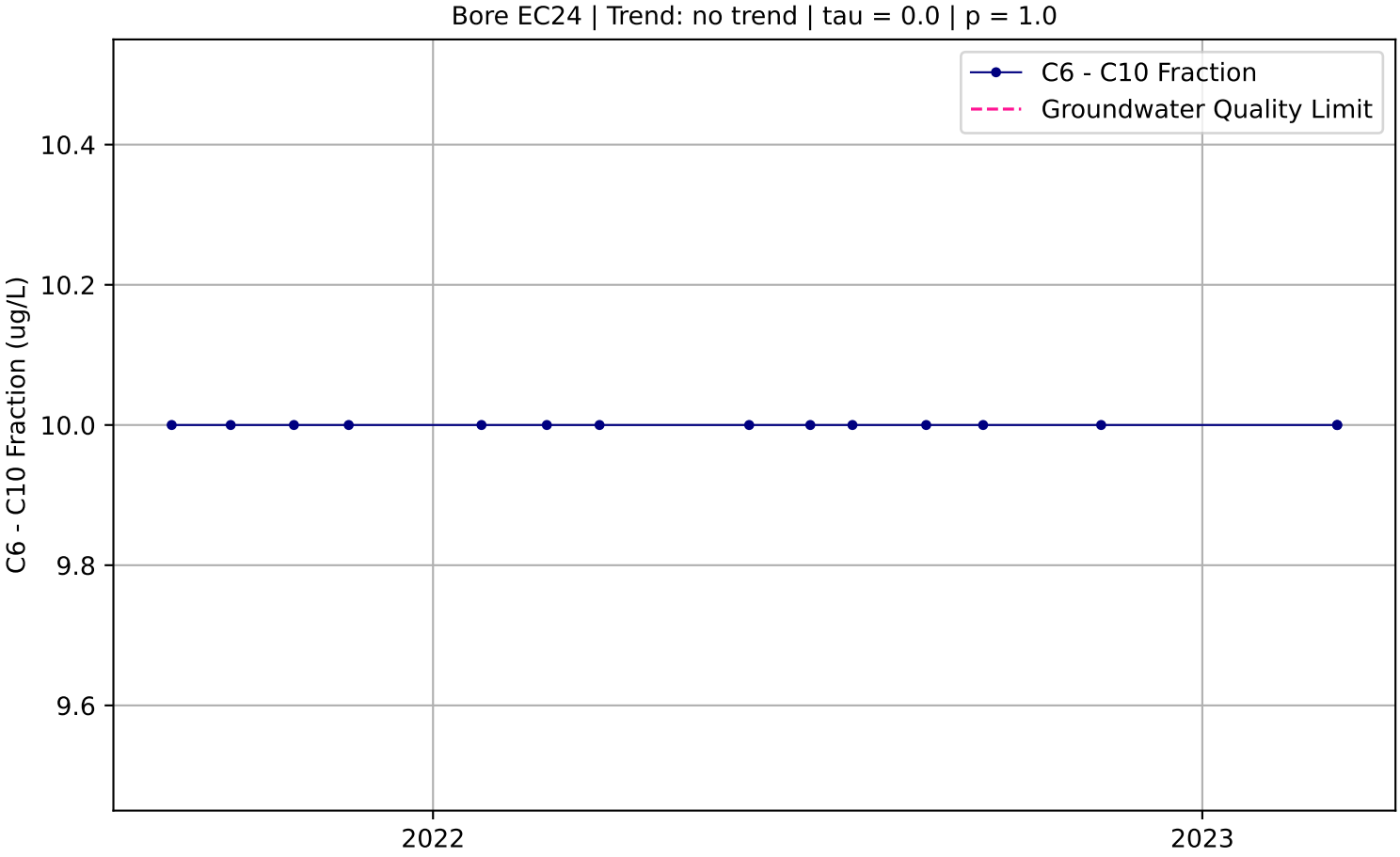

Bore EC14 | Trend: decreasing | tau = -0.451 | p = 0.001
Sodium
Sodium (mg/L)
1750
1500
1250
1000
750
500
250
0
2018
2019
2020
2021
2022
2023
2024

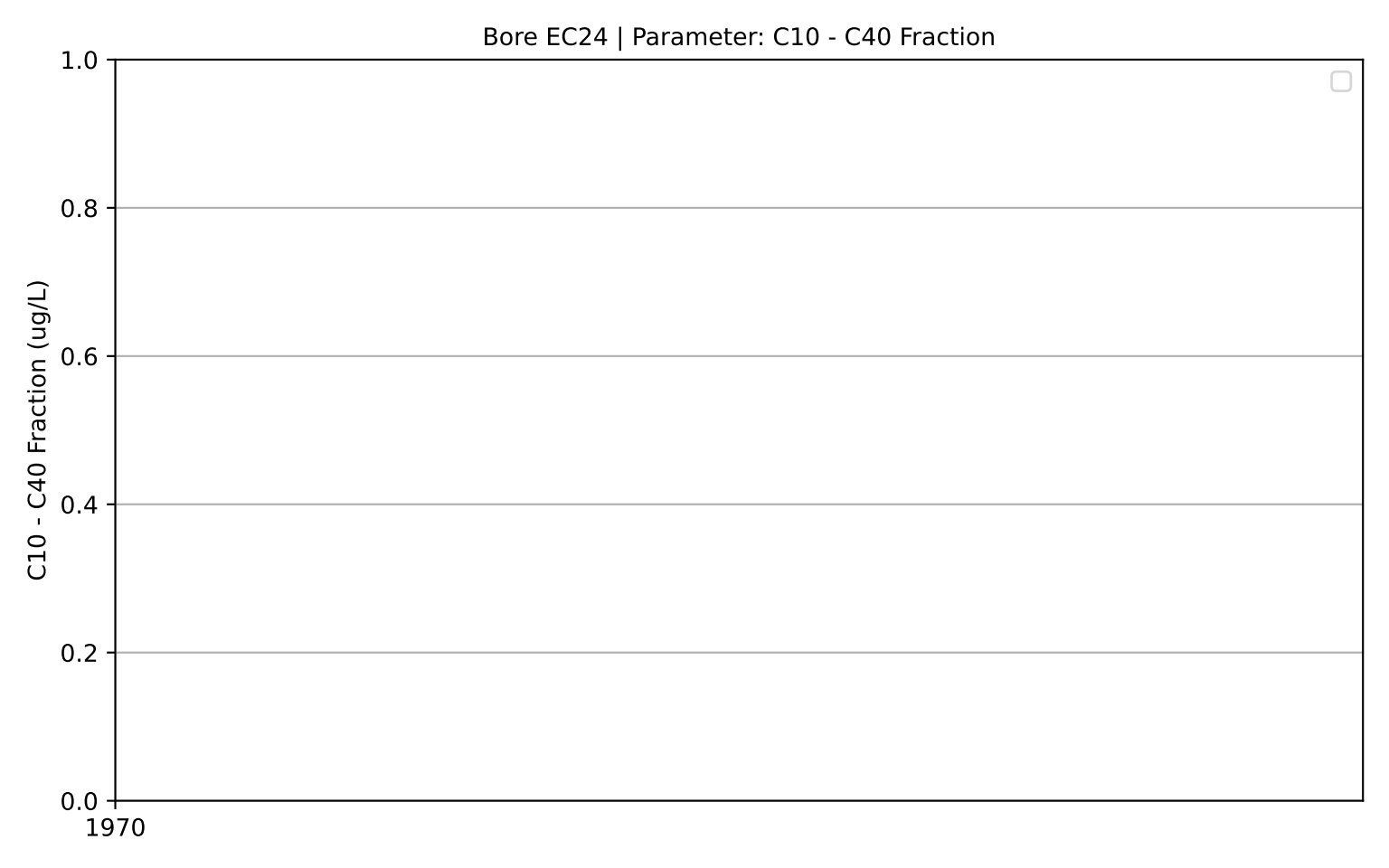

Bore EC14 | Trend: decreasing | tau = -0.702 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
0
5
10
15
20
25
30
35
2016
2017
2018
2019
2020
2021
2022
2023
2024

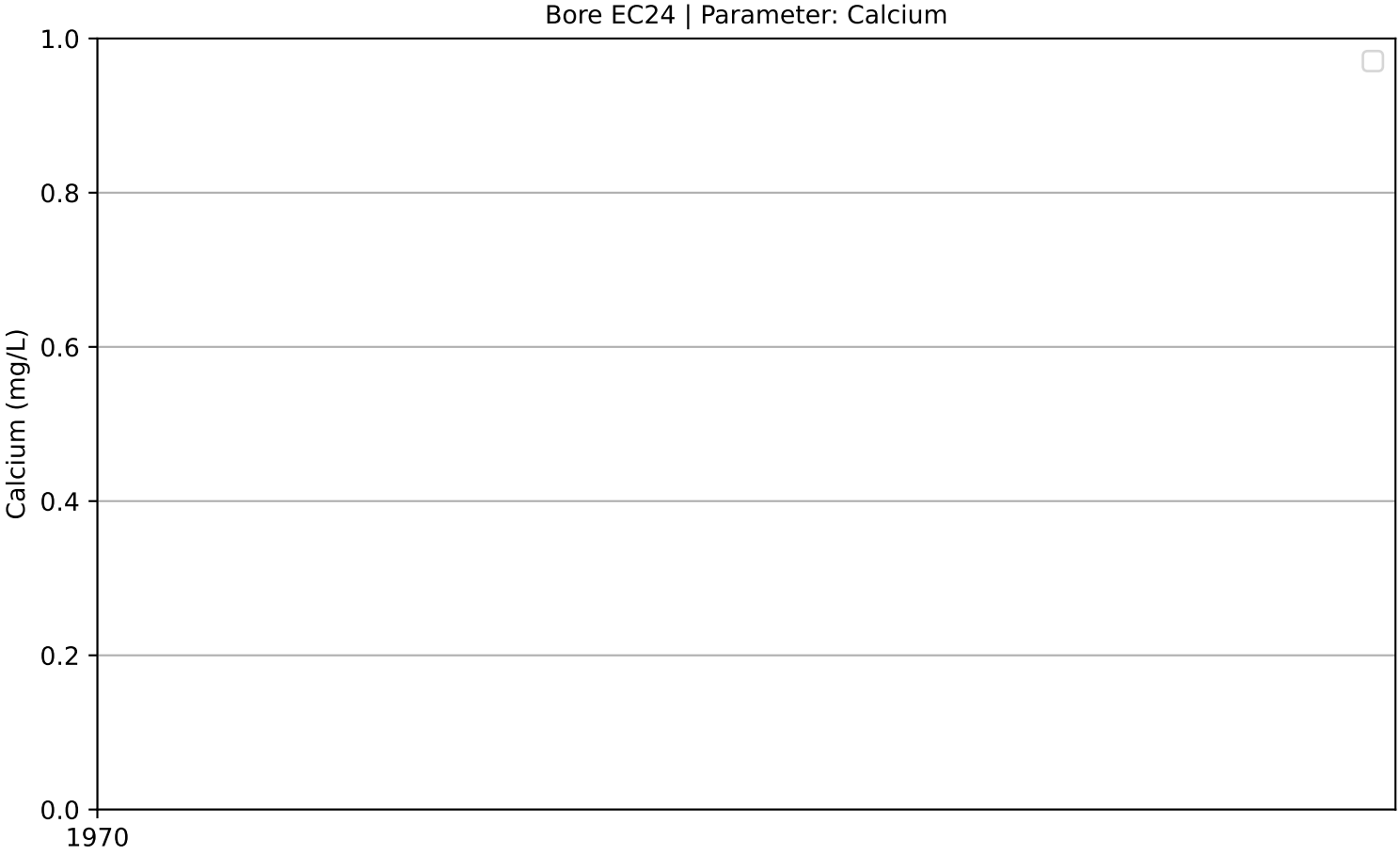

Bore EC24 | Trend: no trend | tau = -0.133 | p = 0.464
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.08
0.06
0.04
0.02
2022
2023

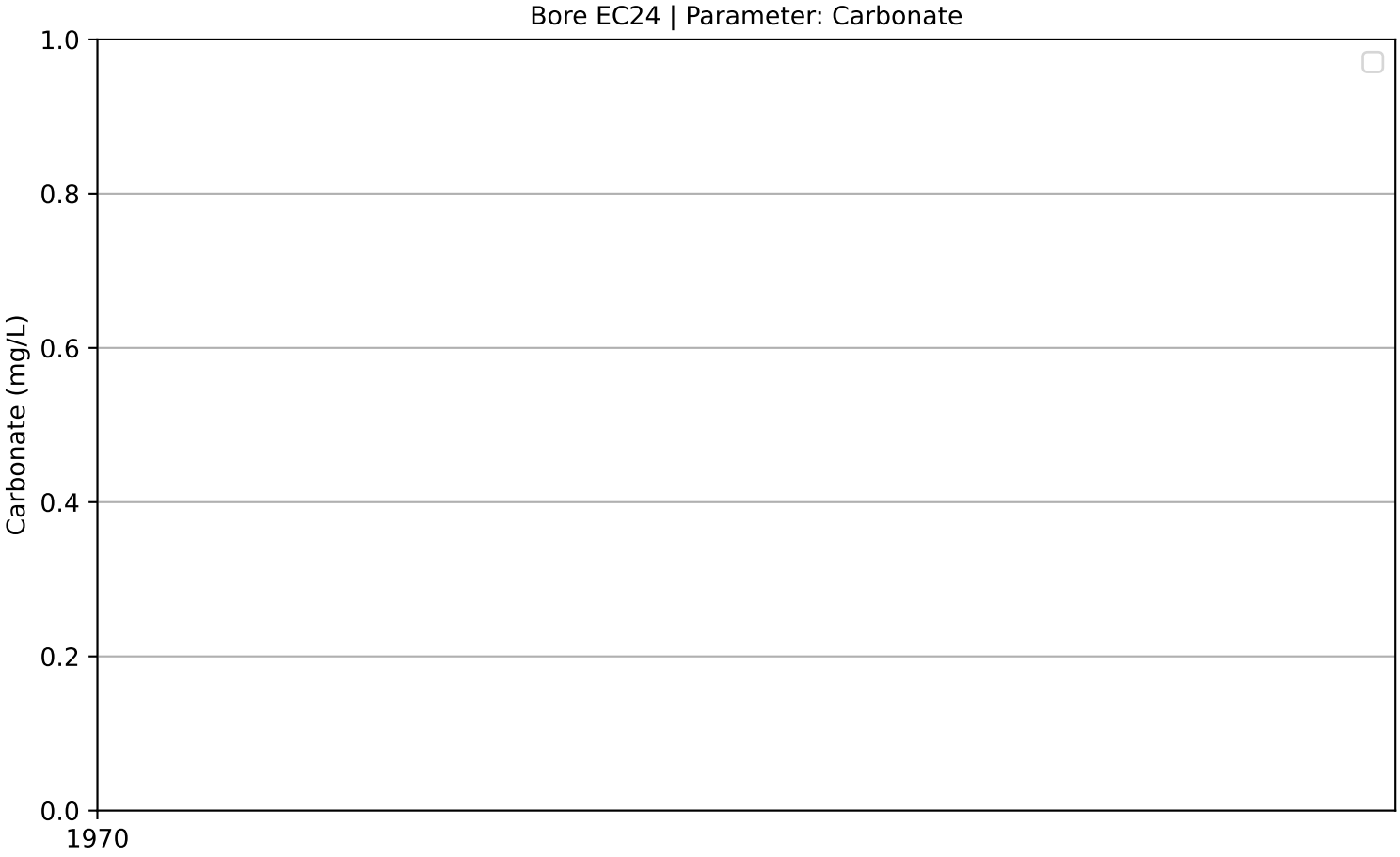

Bore EC24 | Trend: decreasing | tau = -0.524 | p = 0.006
Arsenic
Groundwater Quality Limit
Arsenic (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
2022
2023

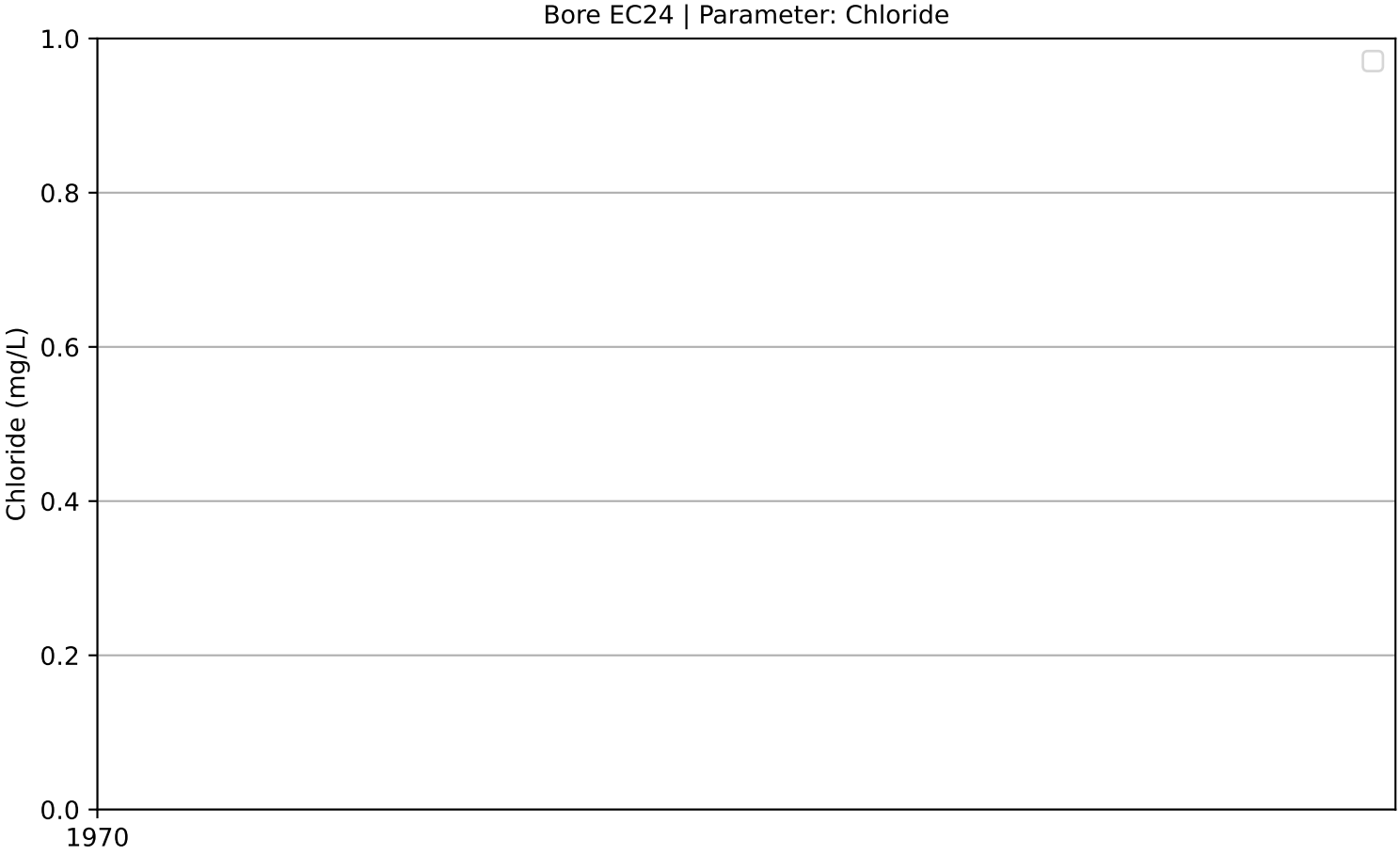

Bore EC24 | Parameter: Bicarbonate
Bicarbonate (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

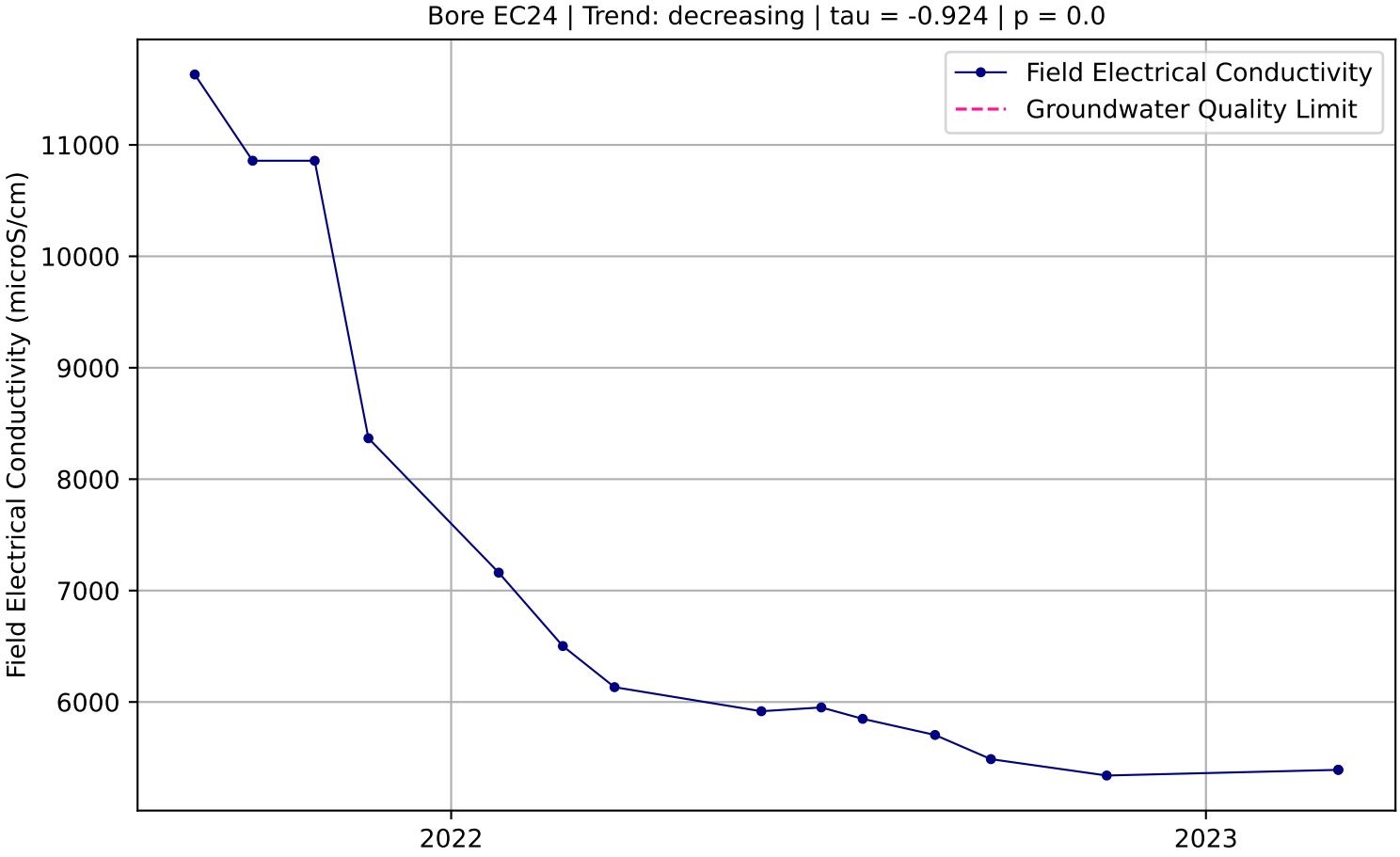

Bore EC24 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction
Groundwater Quality Limit
C6 - C10 Fraction (ug/L)
10.4
10.2
10.0
9.8
9.6
2022
2023

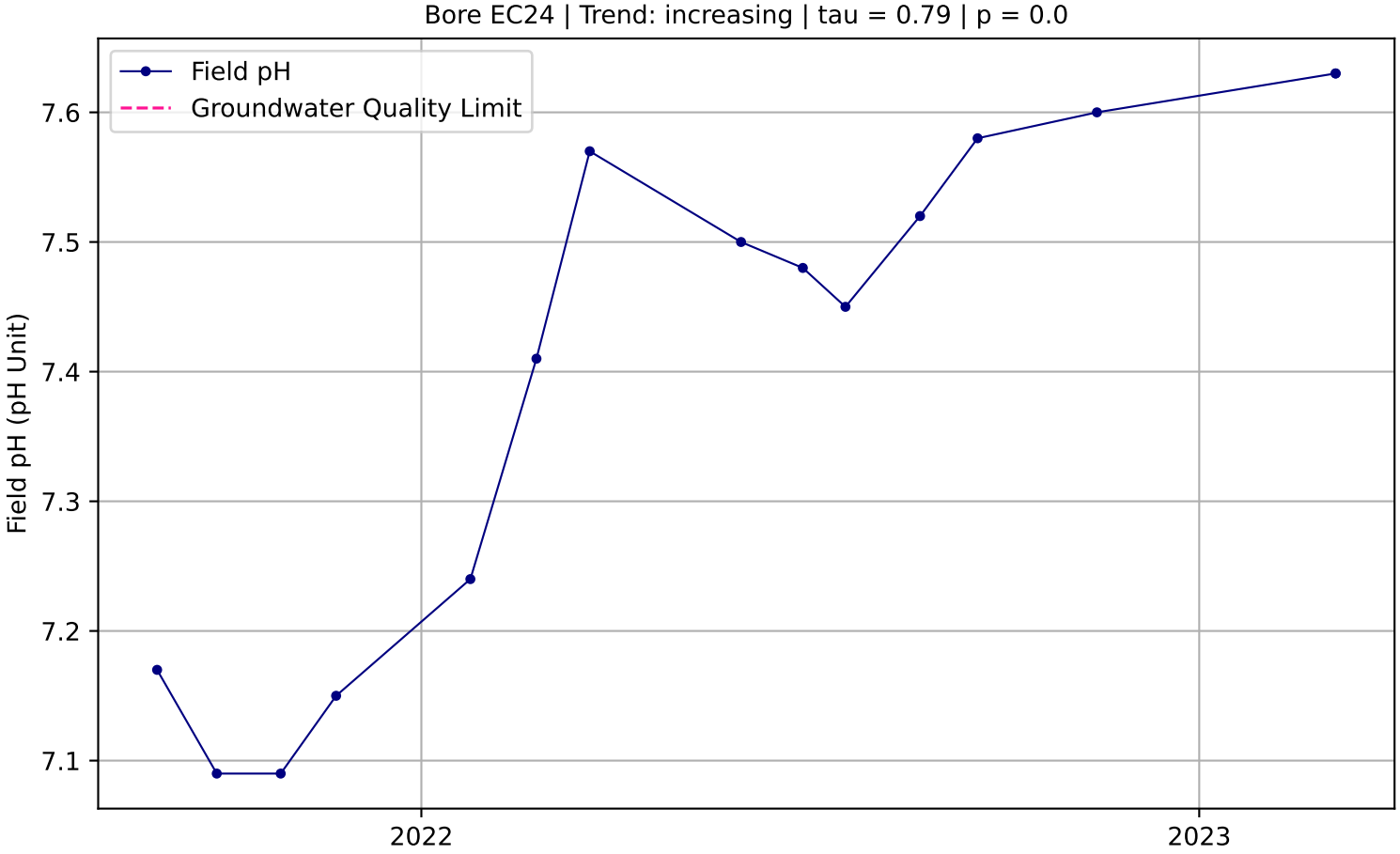

Bore EC24 | Parameter: C10 - C40 Fraction
C10 - C40 Fraction (ug/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

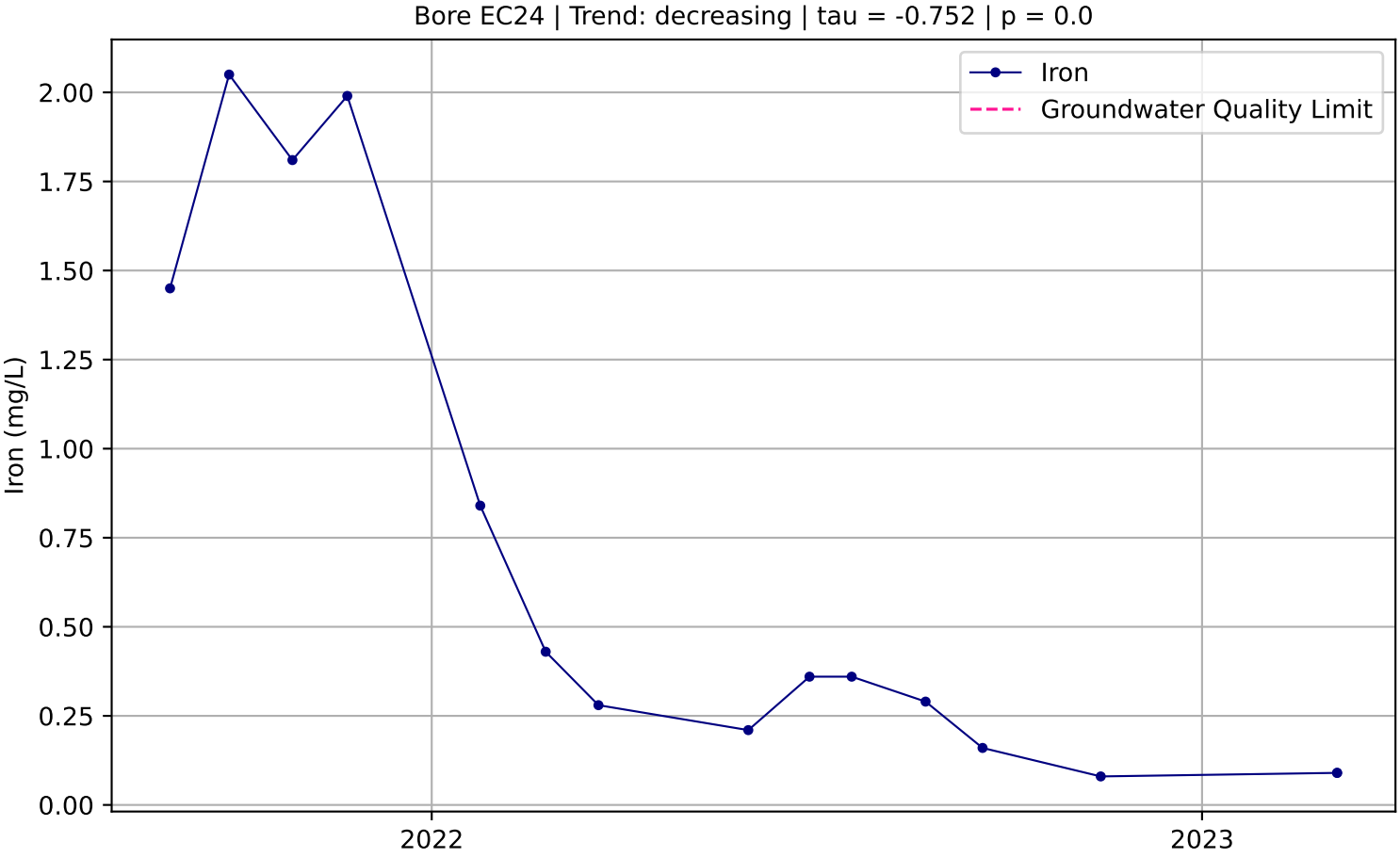

Bore EC24 | Parameter: Calcium
Calcium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

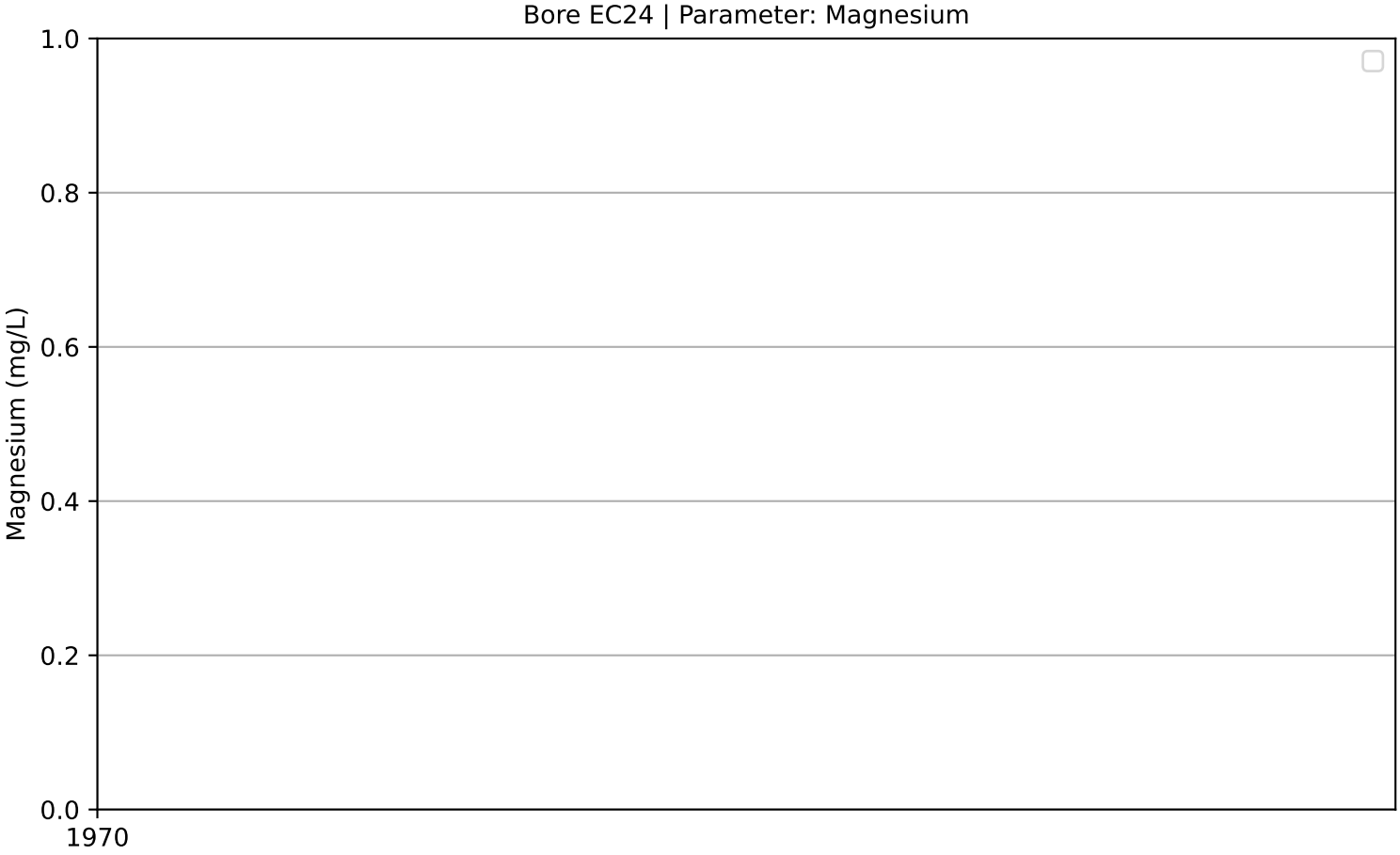

Bore EC24 | Parameter: Carbonate
Carbonate (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

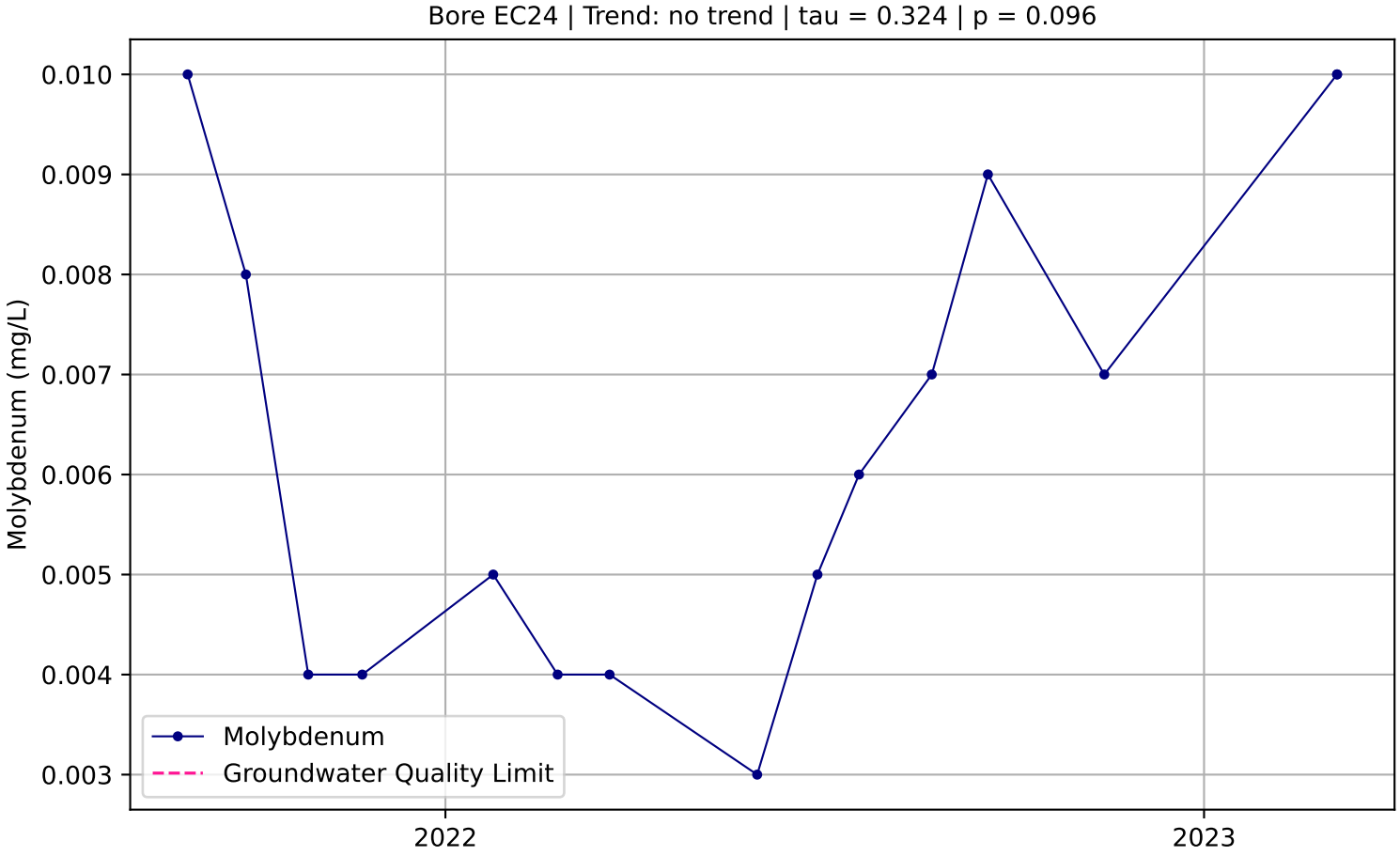

Bore EC24 | Parameter: Chloride
Chloride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

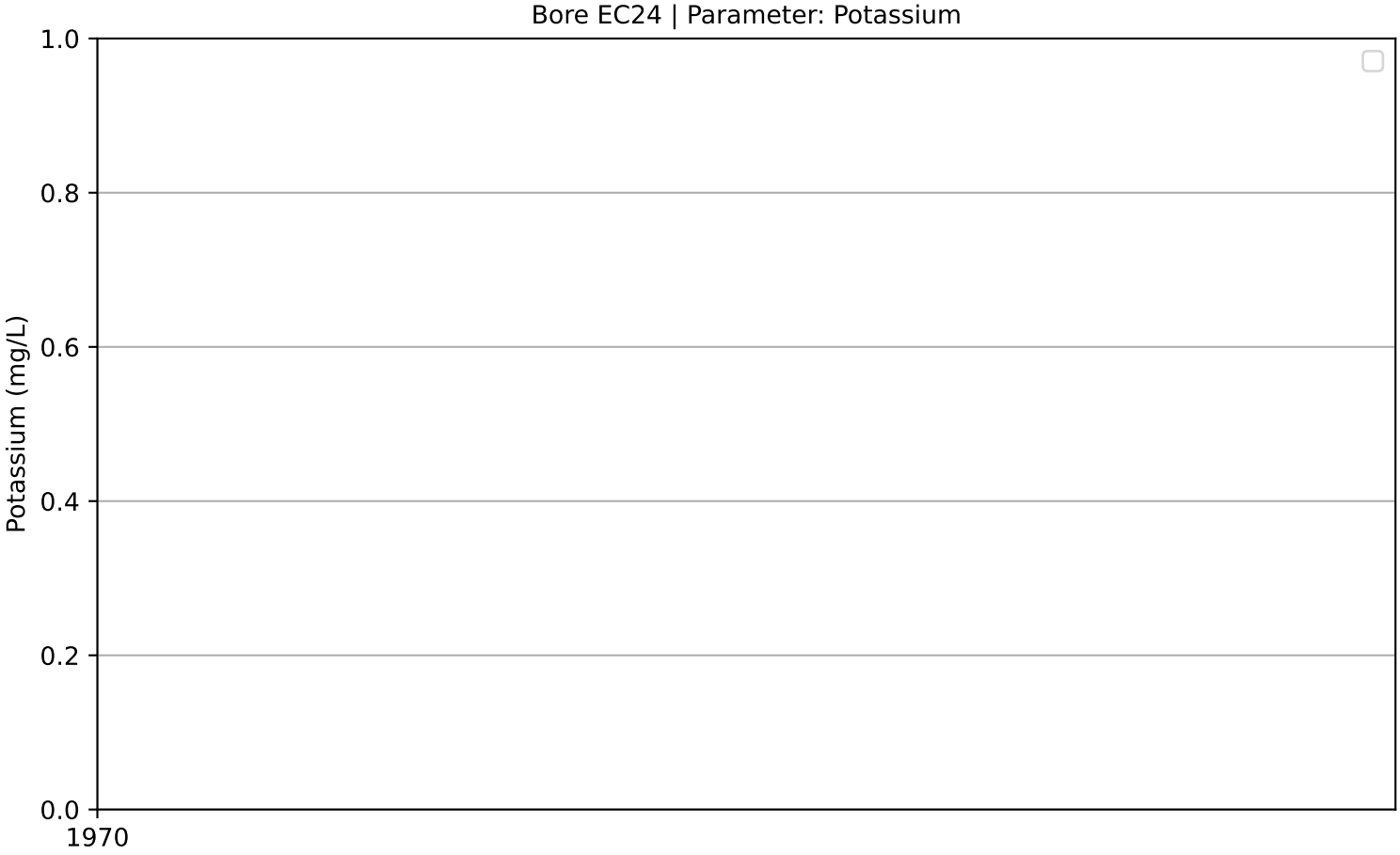

Bore EC24 | Trend: decreasing | tau = -0.924 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
11000
10000
9000
8000
7000
6000
2022
2023

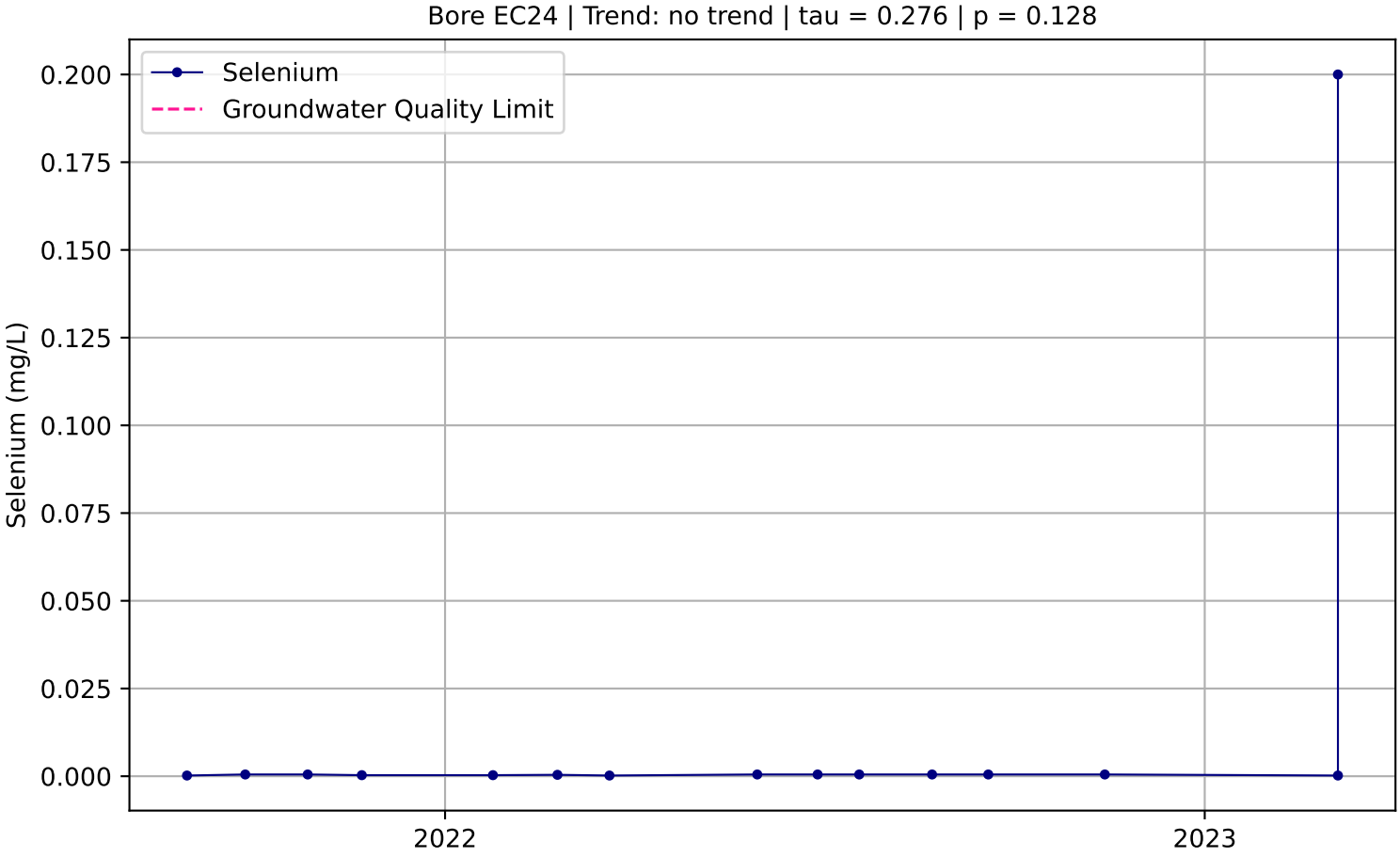

Bore EC24 | Trend: increasing | tau = 0.79 | p = 0.0
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
7.6
7.5
7.4
7.3
7.2
7.1
2022
2023

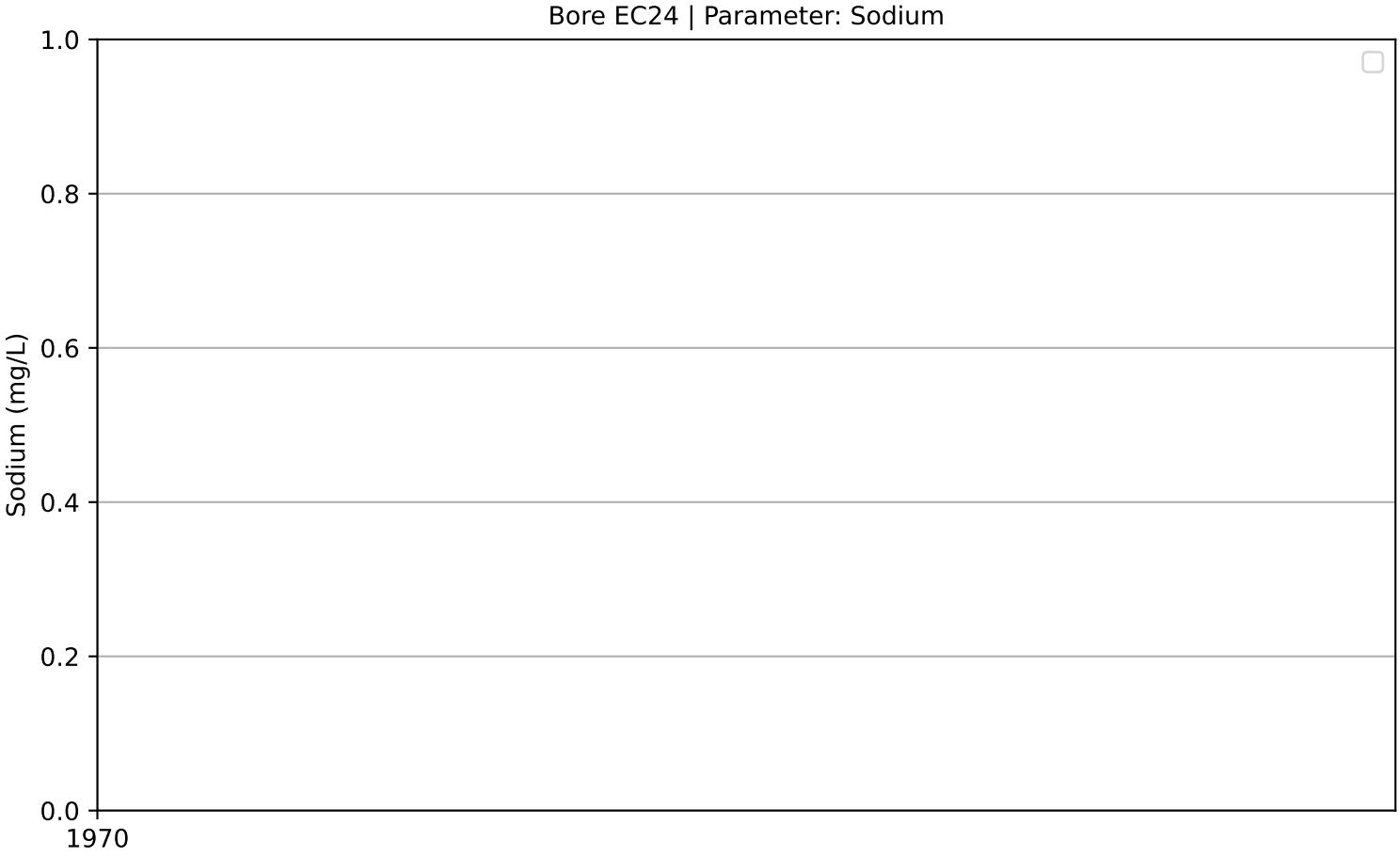

Bore EC24 | Trend: decreasing | tau = -0.752 | p = 0.0
Iron
Groundwater Quality Limit
Iron (mg/L)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2022
2023

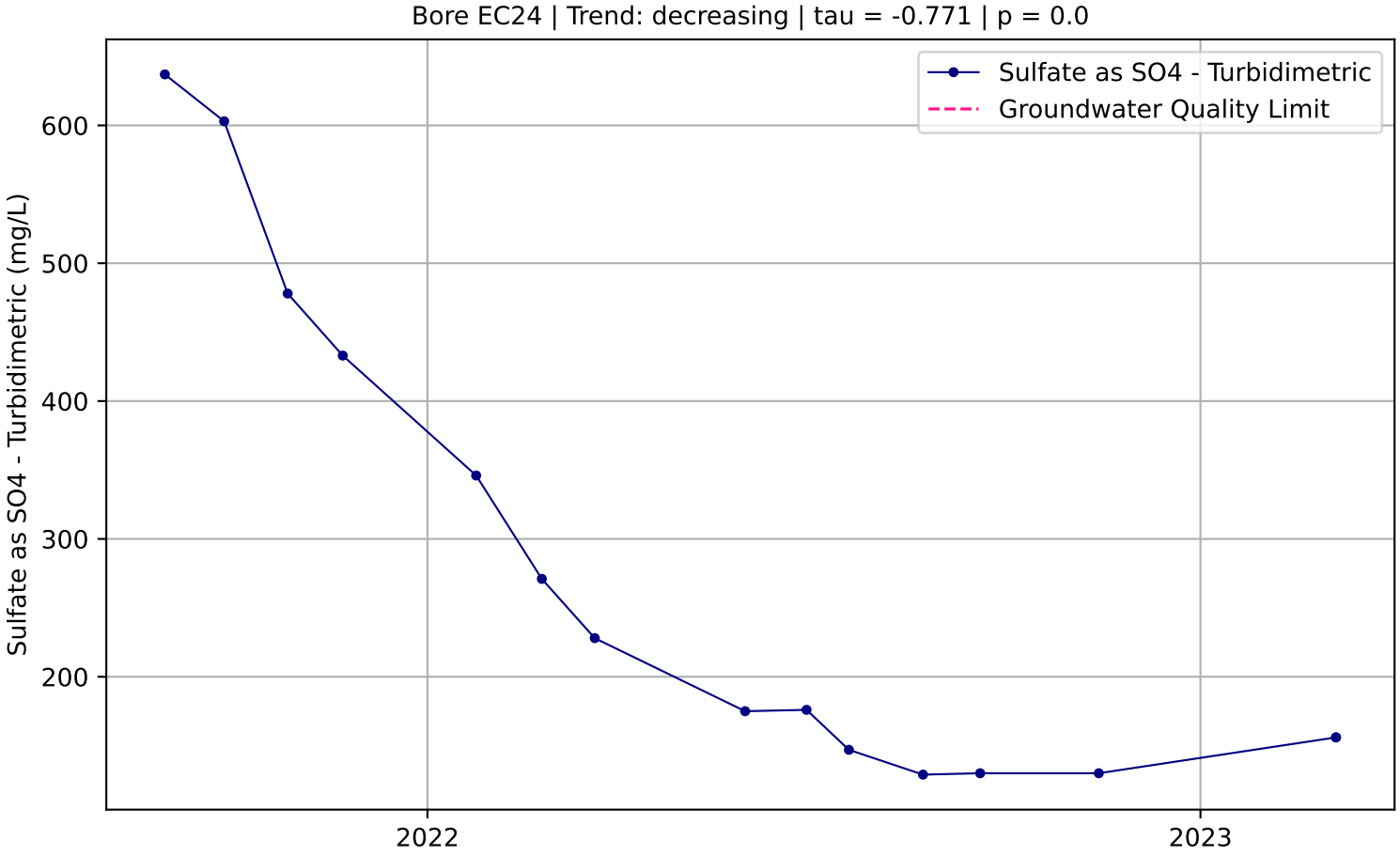

Bore EC24 | Parameter: Magnesium
Magnesium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

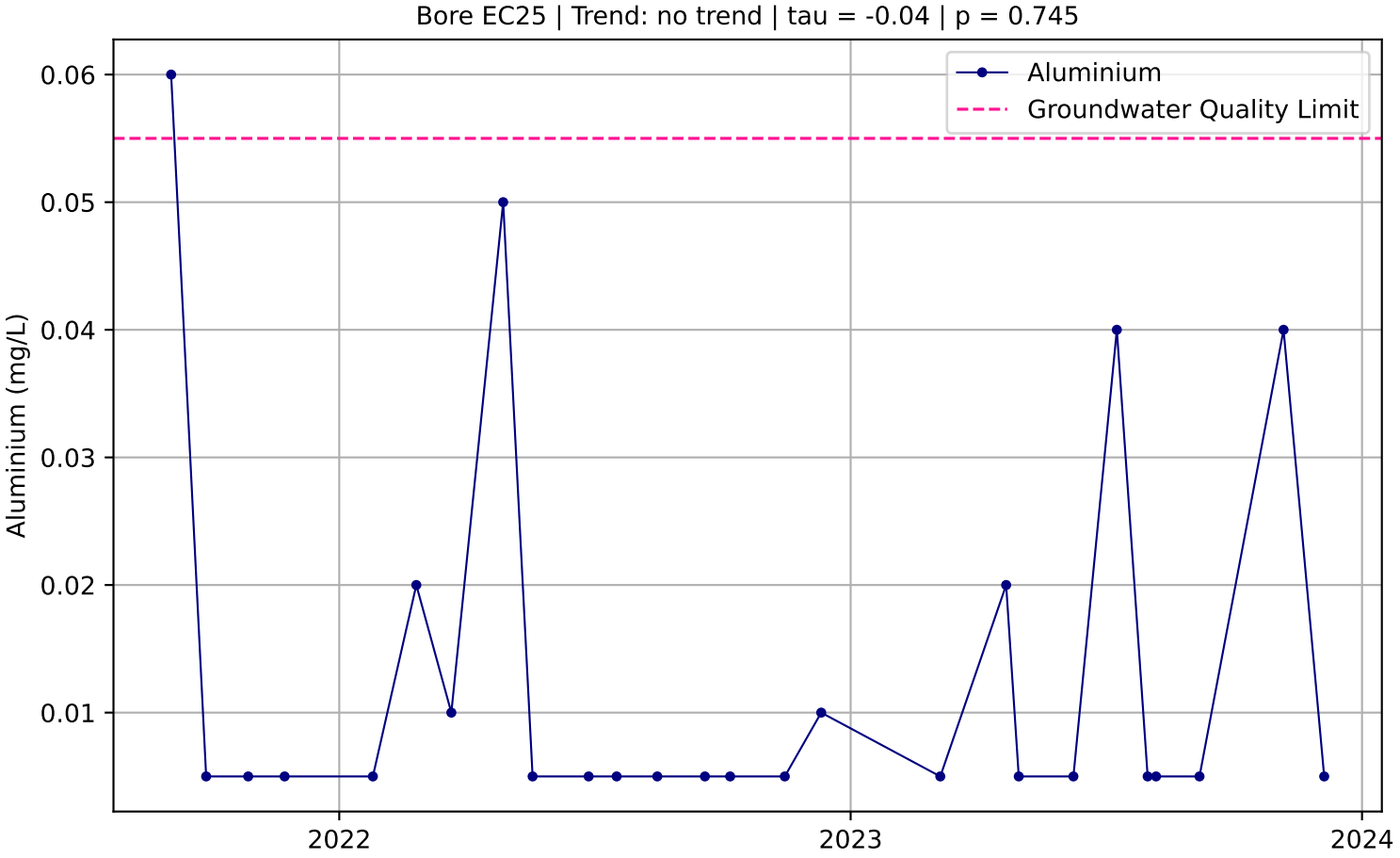

Bore EC24 | Trend: no trend | tau = 0.324 | p = 0.096
Molybdenum (mg/L)
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
2022
2023
Molybdenum
Groundwater Quality Limit

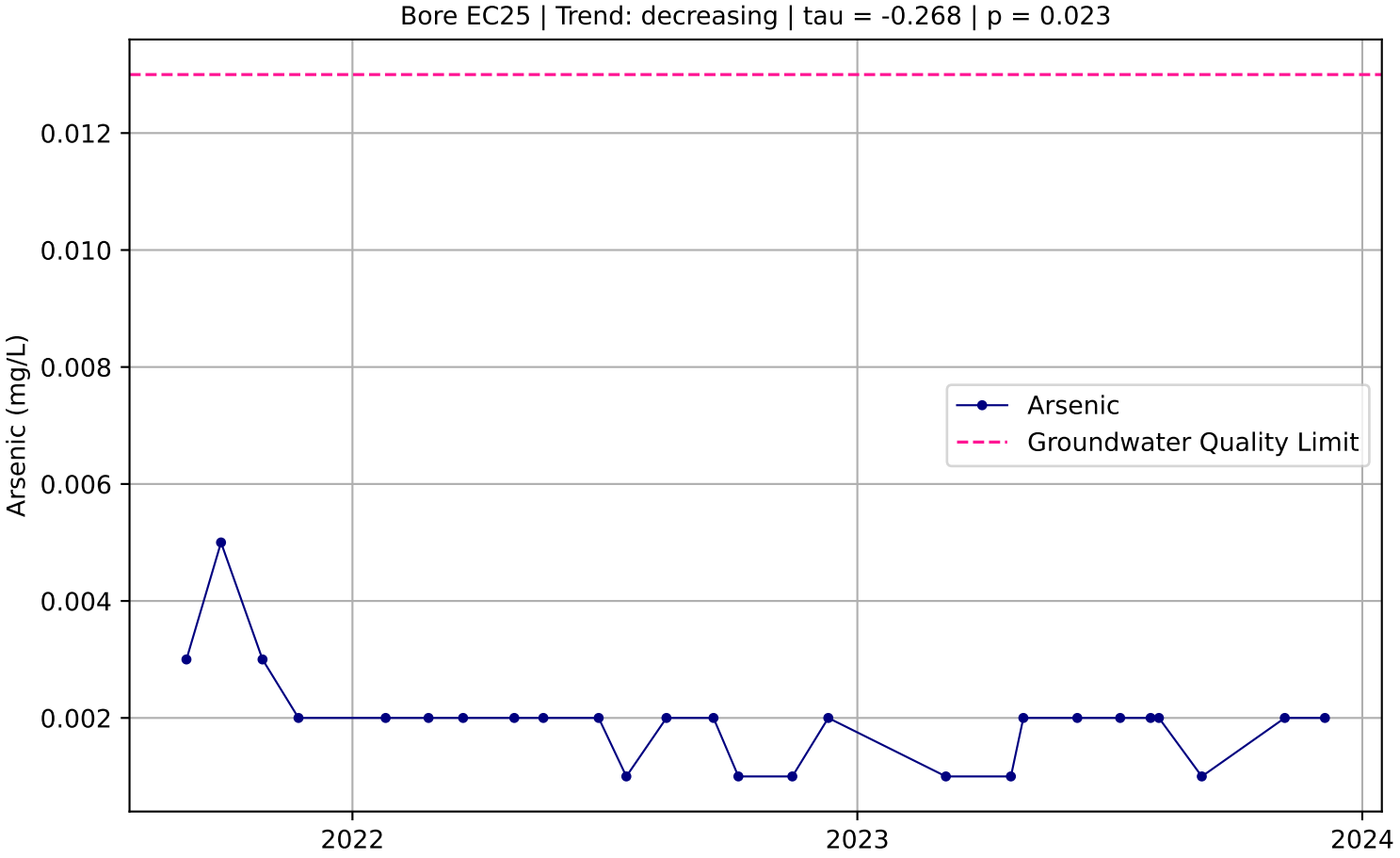

Bore EC24 | Parameter: Potassium
Potassium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

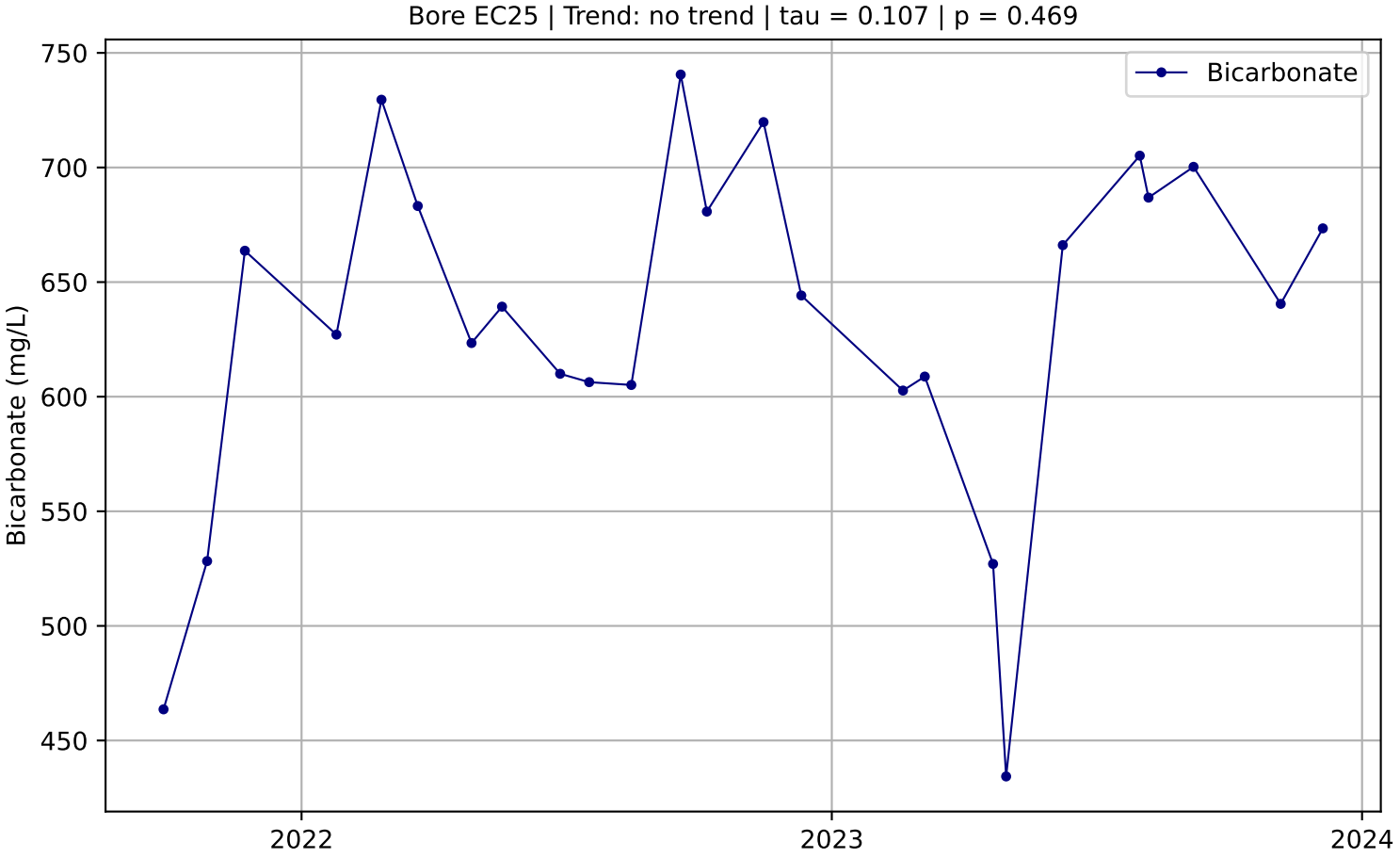

Bore EC24 | Trend: no trend | tau = 0.276 | p = 0.128
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
2022
2023

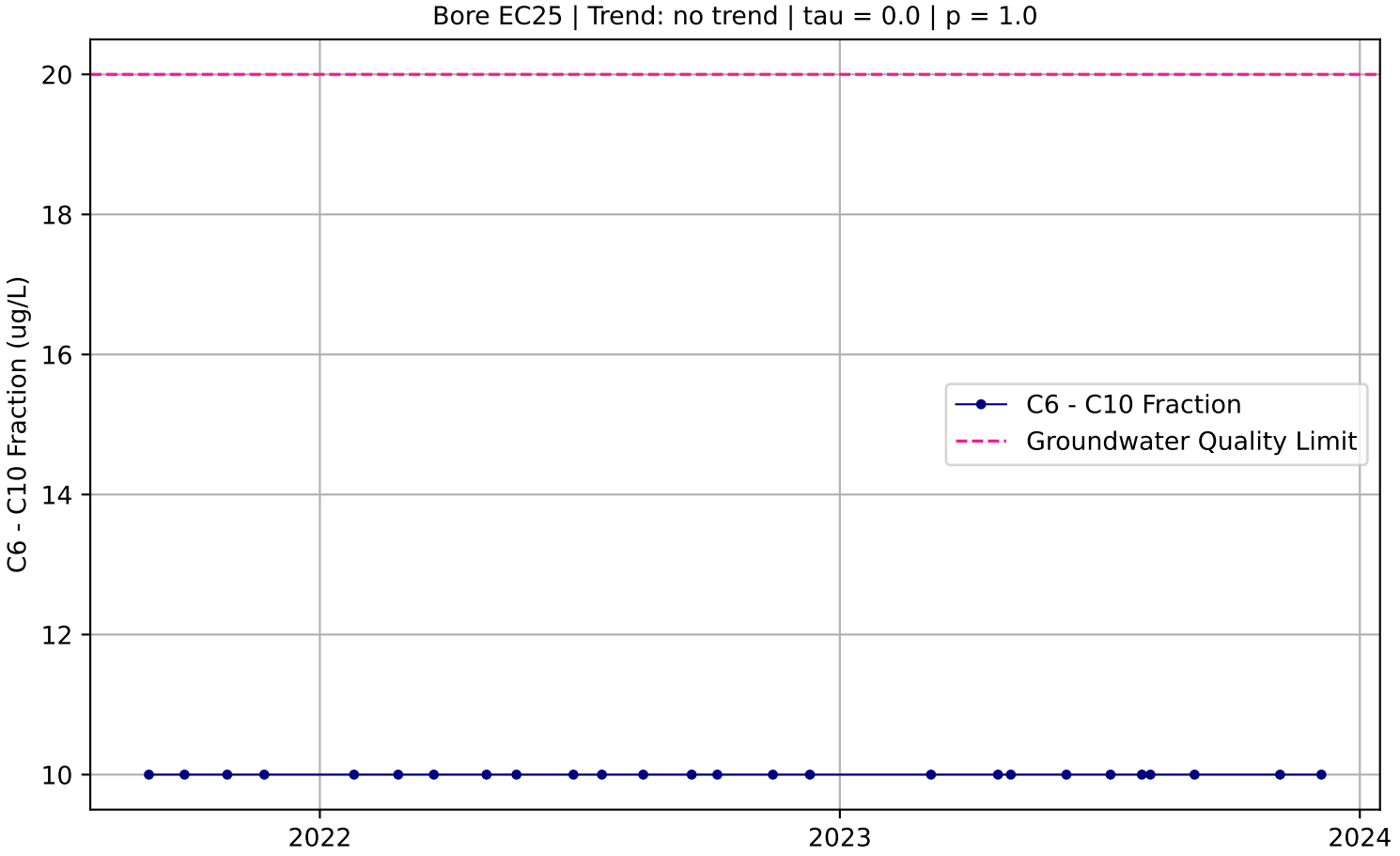

Bore EC24 | Parameter: Sodium
Sodium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

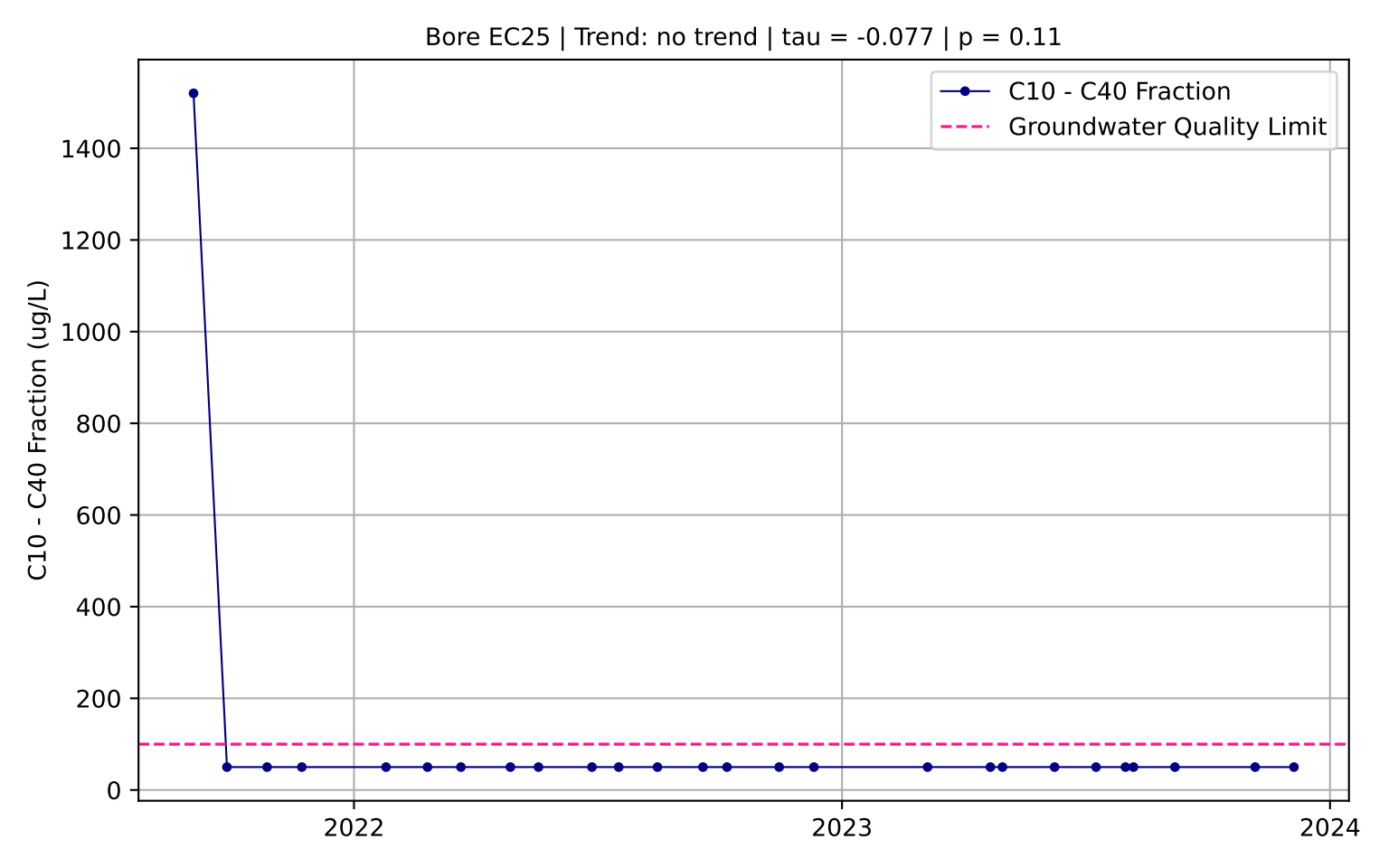

Bore EC24 | Trend: decreasing | tau = -0.771 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
600
500
400
300
200
2022
2023

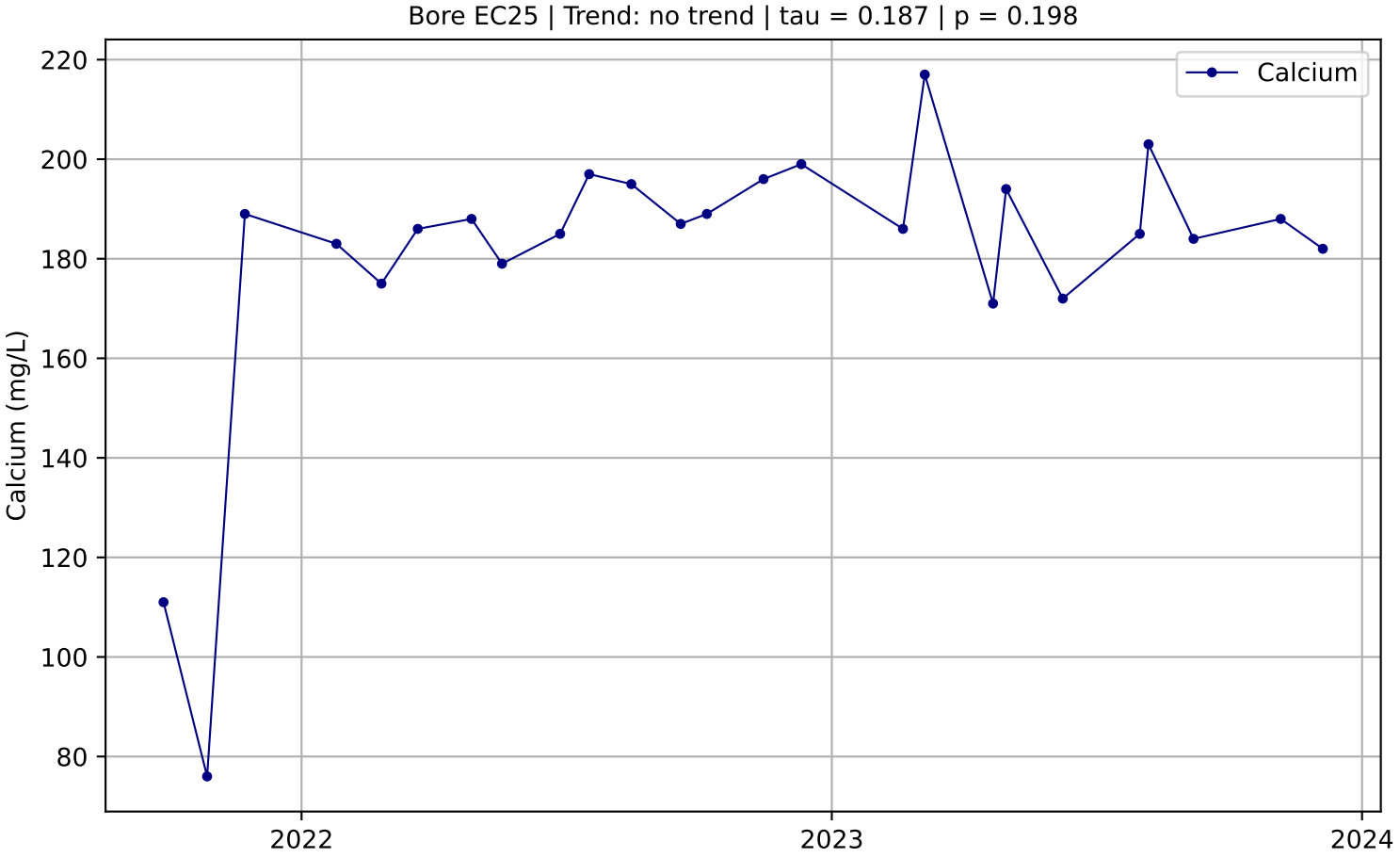

Bore EC25 | Trend: no trend | tau = -0.04 | p = 0.745
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
2022
2023
2024

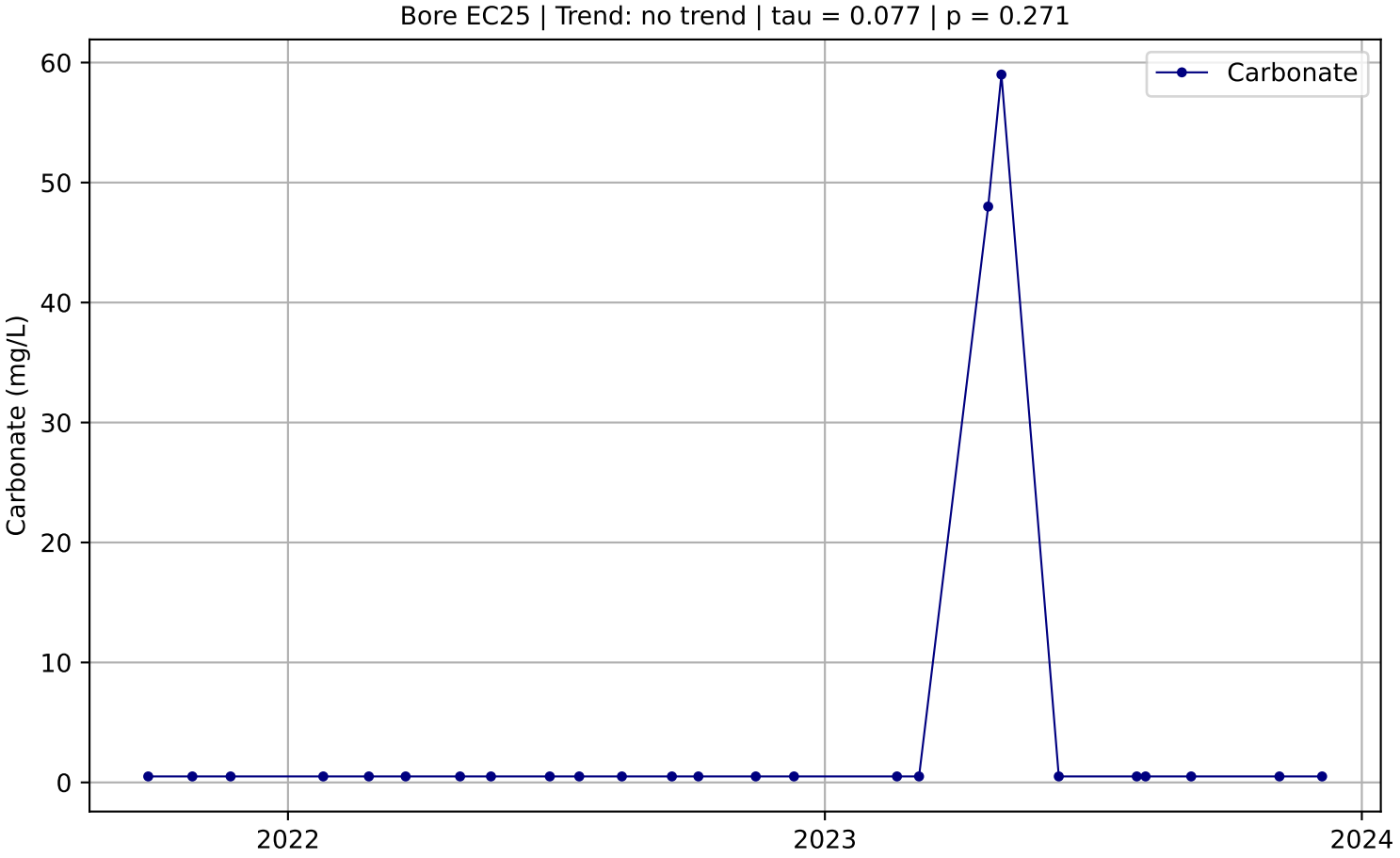

Bore EC25 | Trend: decreasing | tau = -0.268 | p = 0.023
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
2022
2023
2024
Arsenic
Groundwater Quality Limit

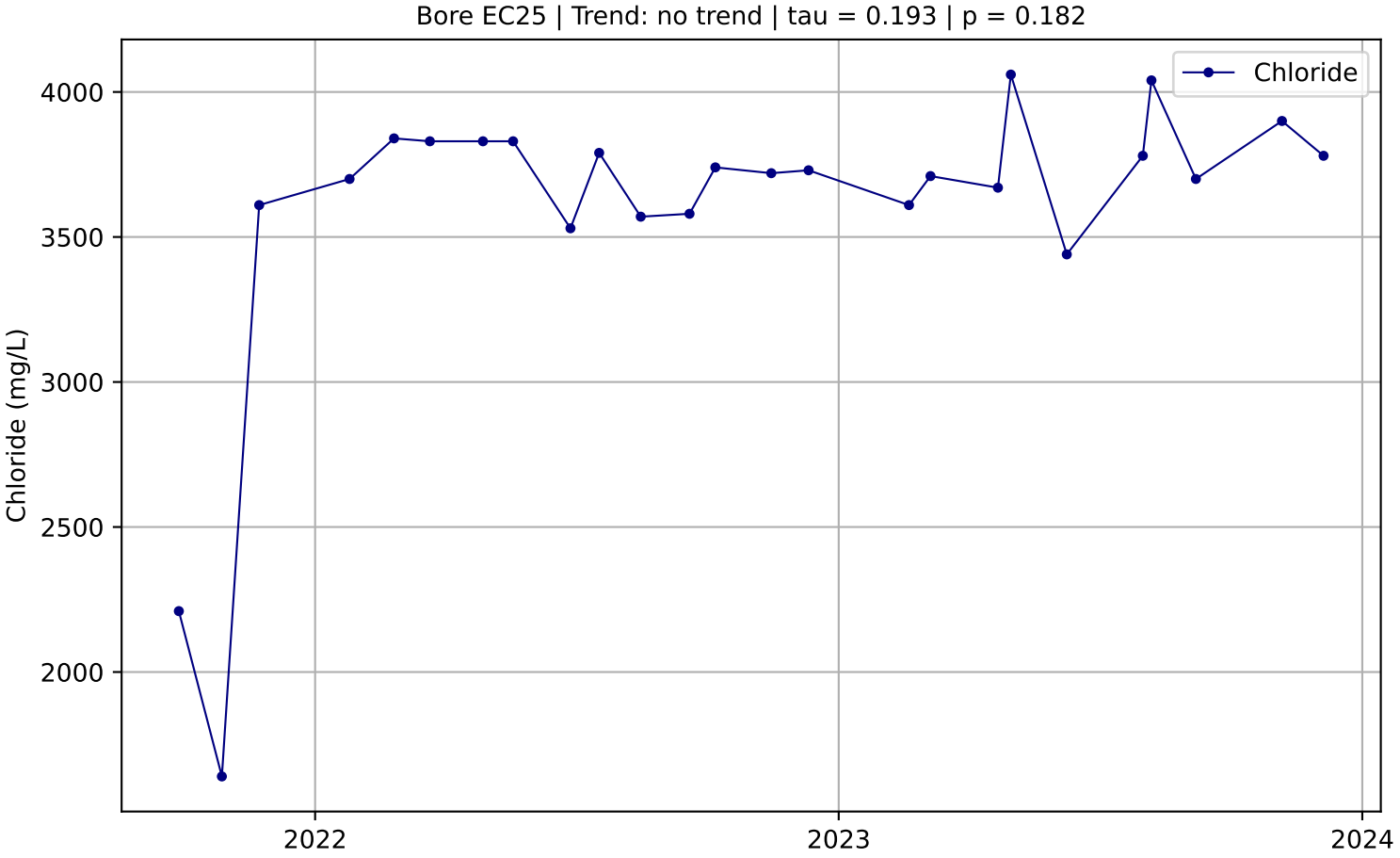

Bore EC25 | Trend: no trend | tau = 0.107 | p = 0.469
Bicarbonate
Bicarbonate (mg/L)
750
700
650
600
550
500
450
2022
2023
2024

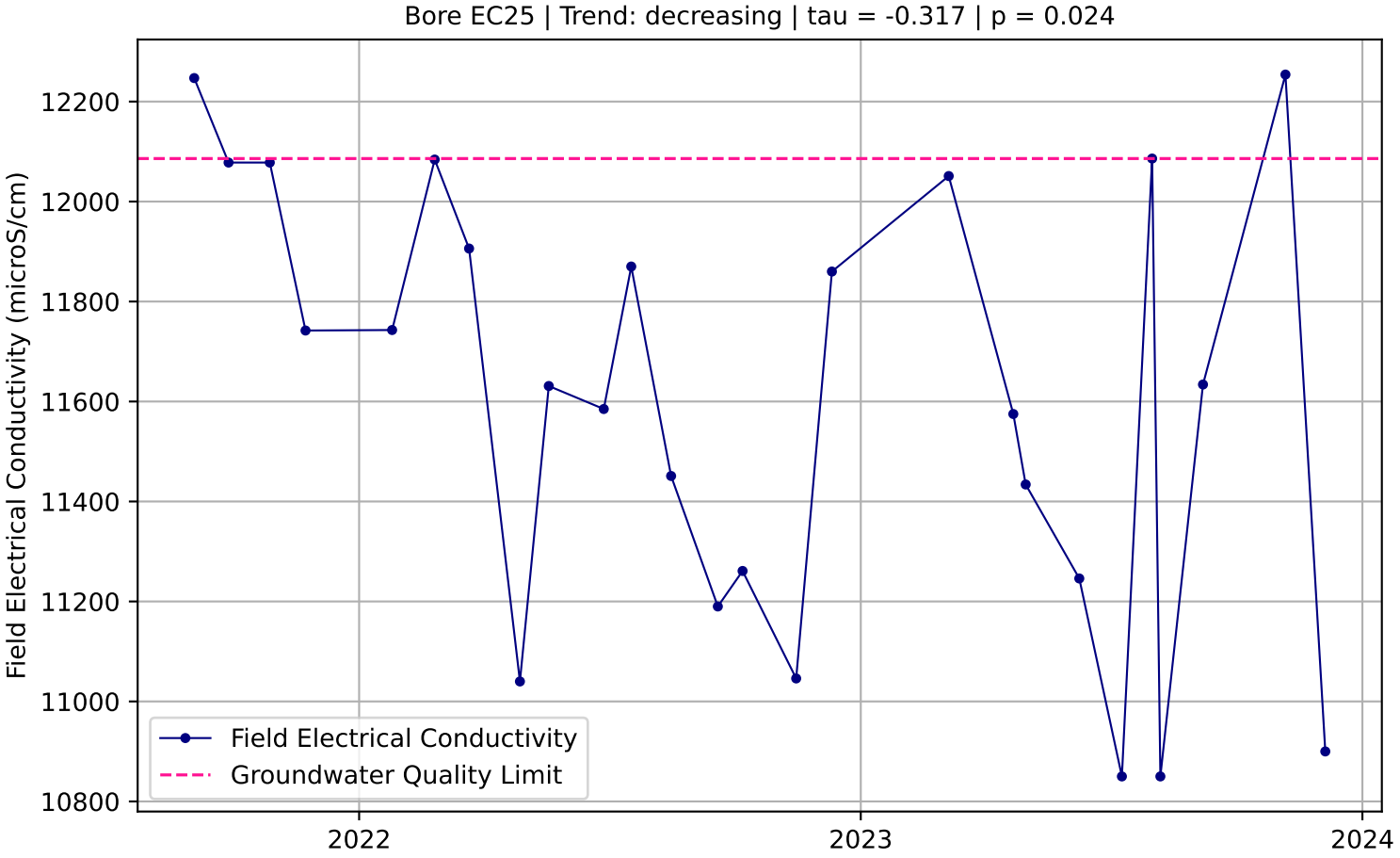

Bore EC25 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

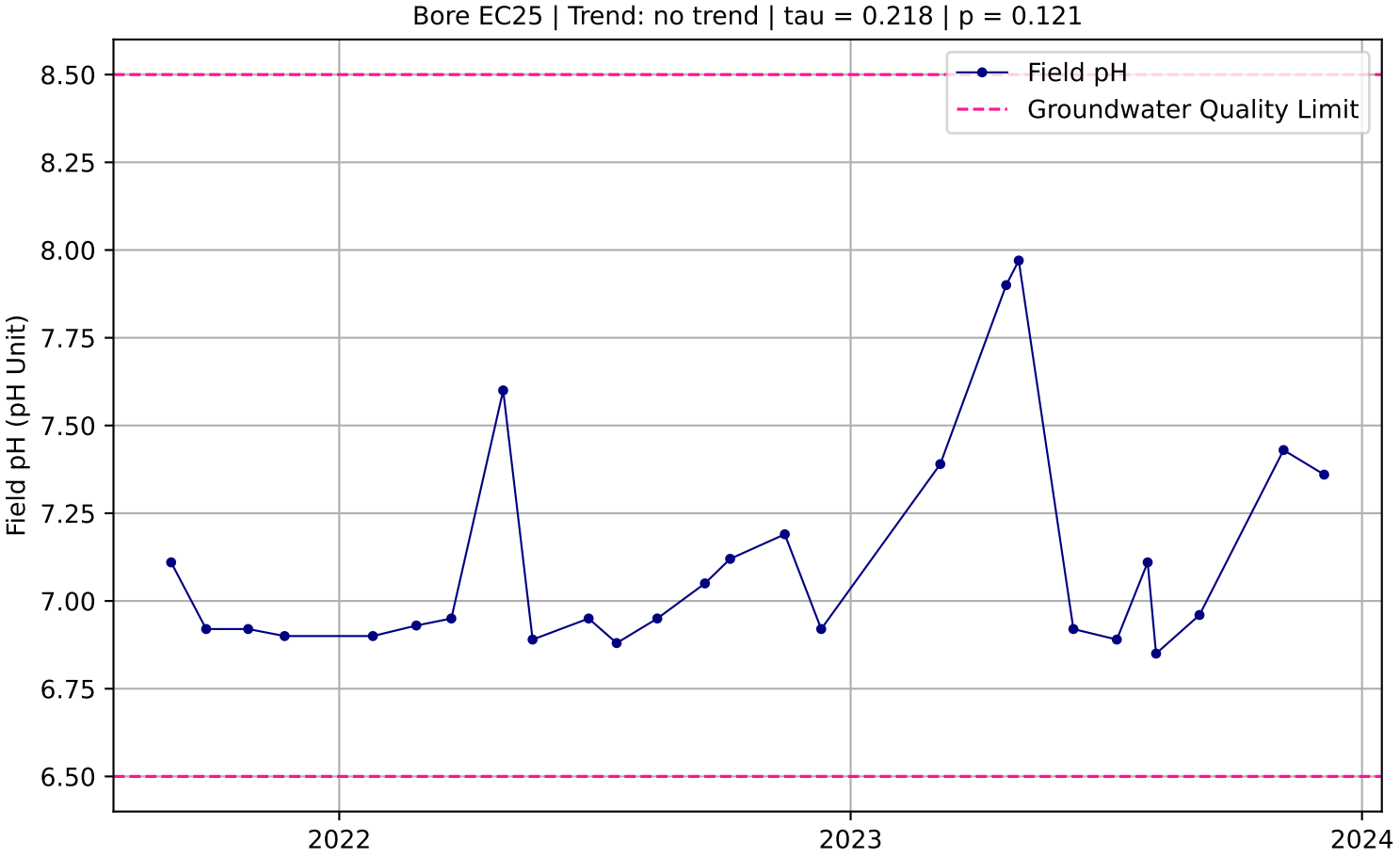

Bore EC25 | Trend: no trend | tau = -0.077 | p = 0.11
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
0
200
400
600
800
1000
1200
1400
2022
2023
2024

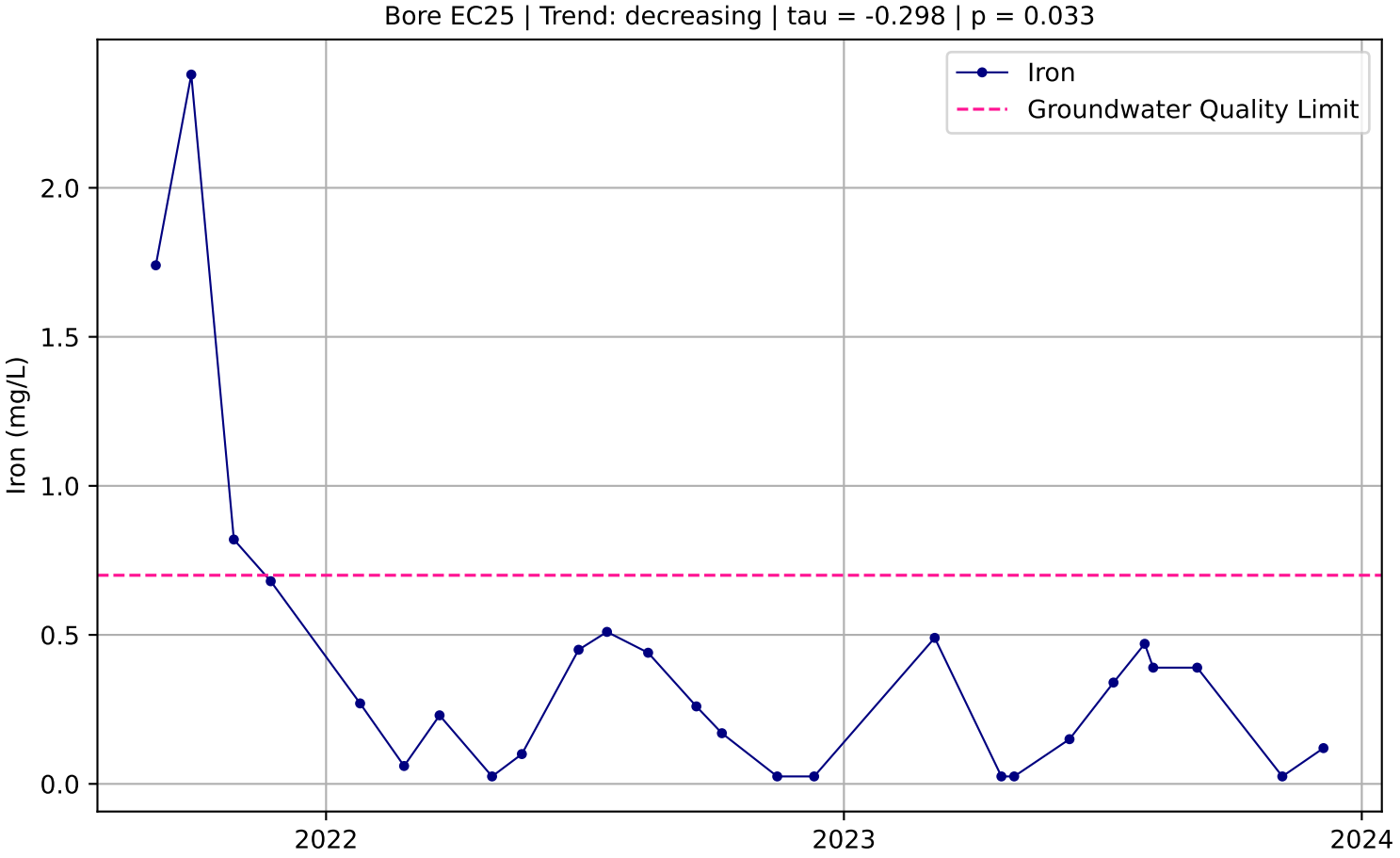

Bore EC25 | Trend: no trend | tau = 0.187 | p = 0.198
Calcium
Calcium (mg/L)
220
200
180
160
140
120
100
80
2022
2023
2024

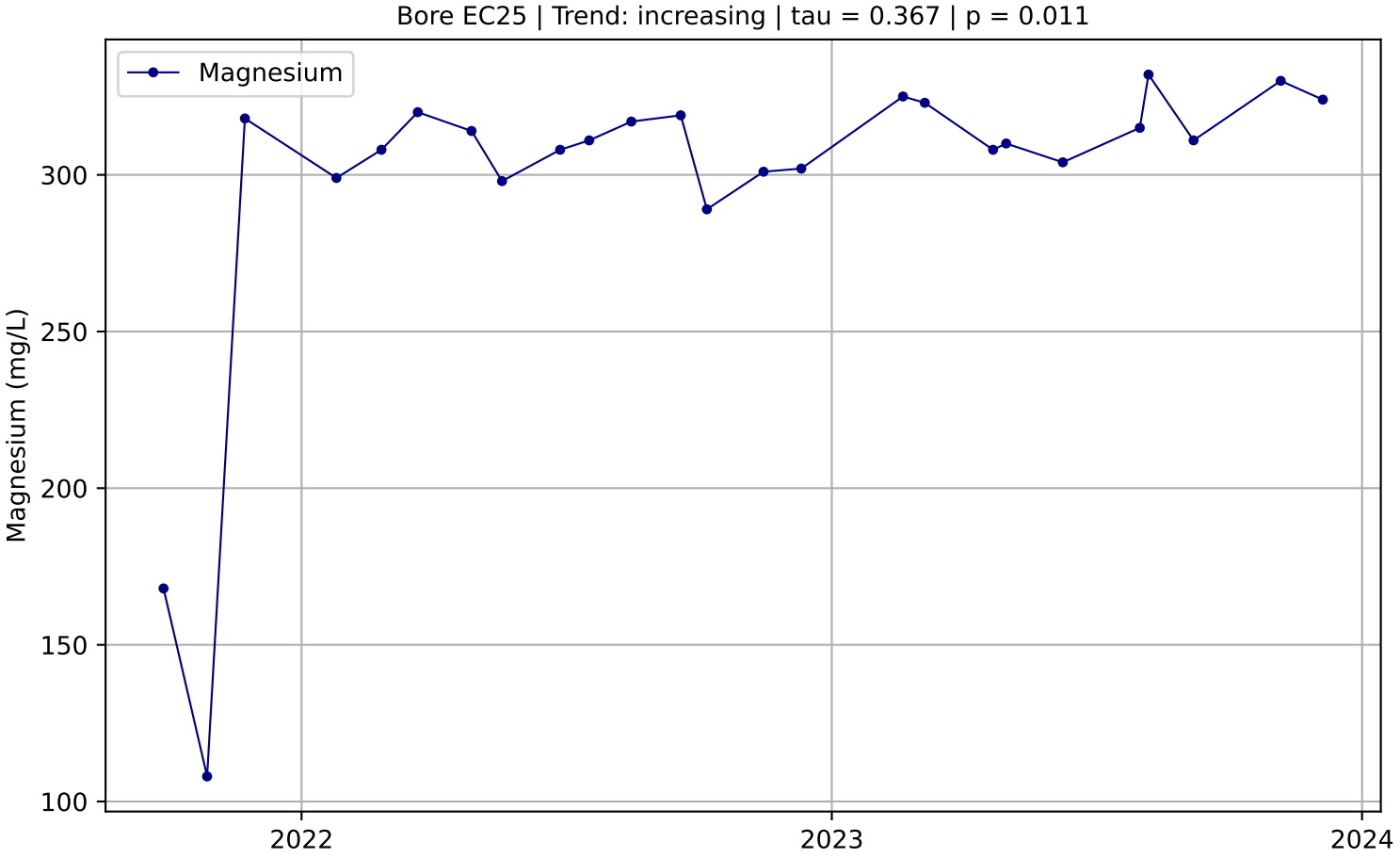

Bore EC25 | Trend: no trend | tau = 0.077 | p = 0.271
Carbonate
Carbonate (mg/L)
60
50
40
30
20
10
0
2022
2023
2024

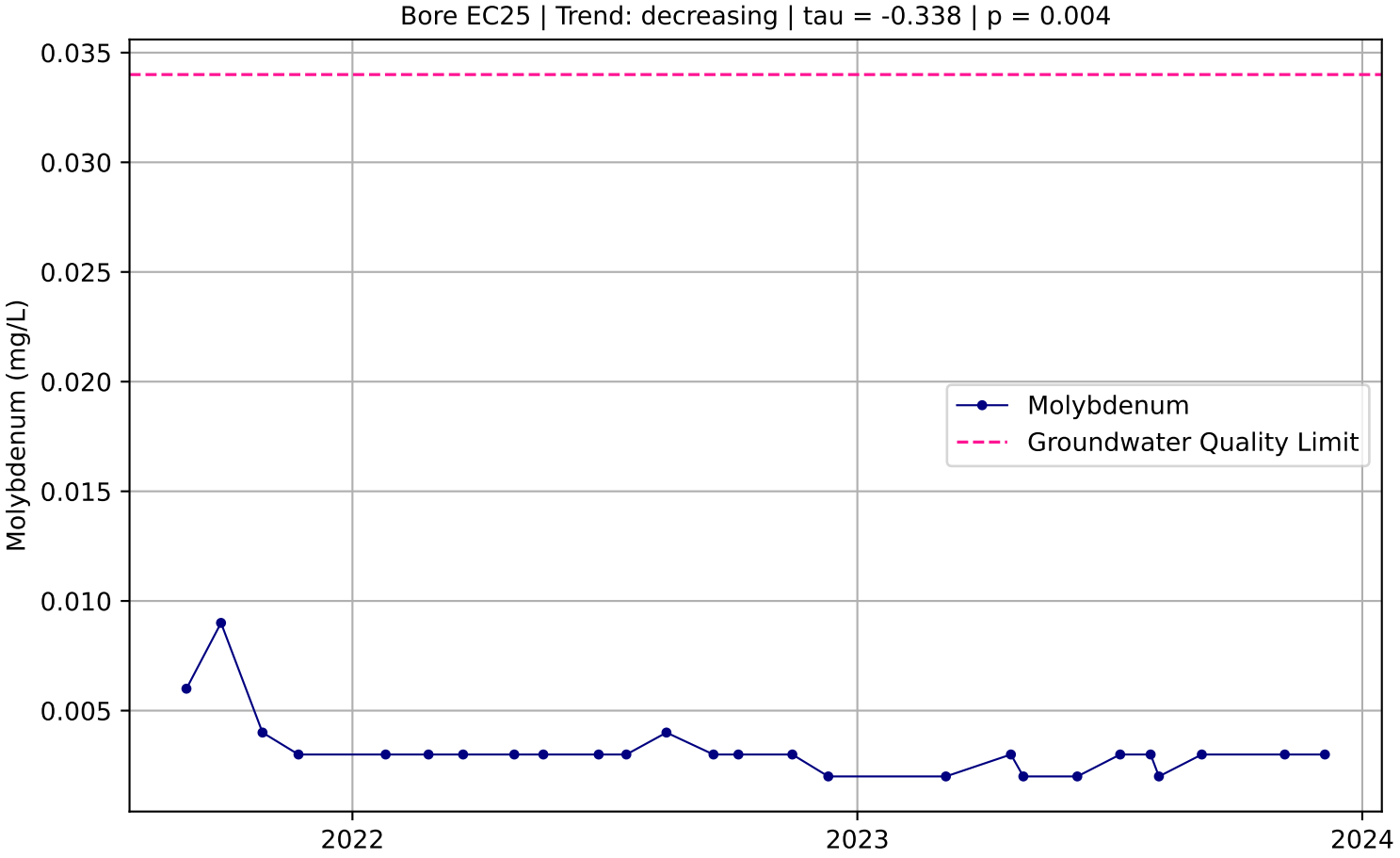

Bore EC25 | Trend: no trend | tau = 0.193 | p = 0.182
Chloride
Chloride (mg/L)
4000
3500
3000
2500
2000
2022
2023
2024

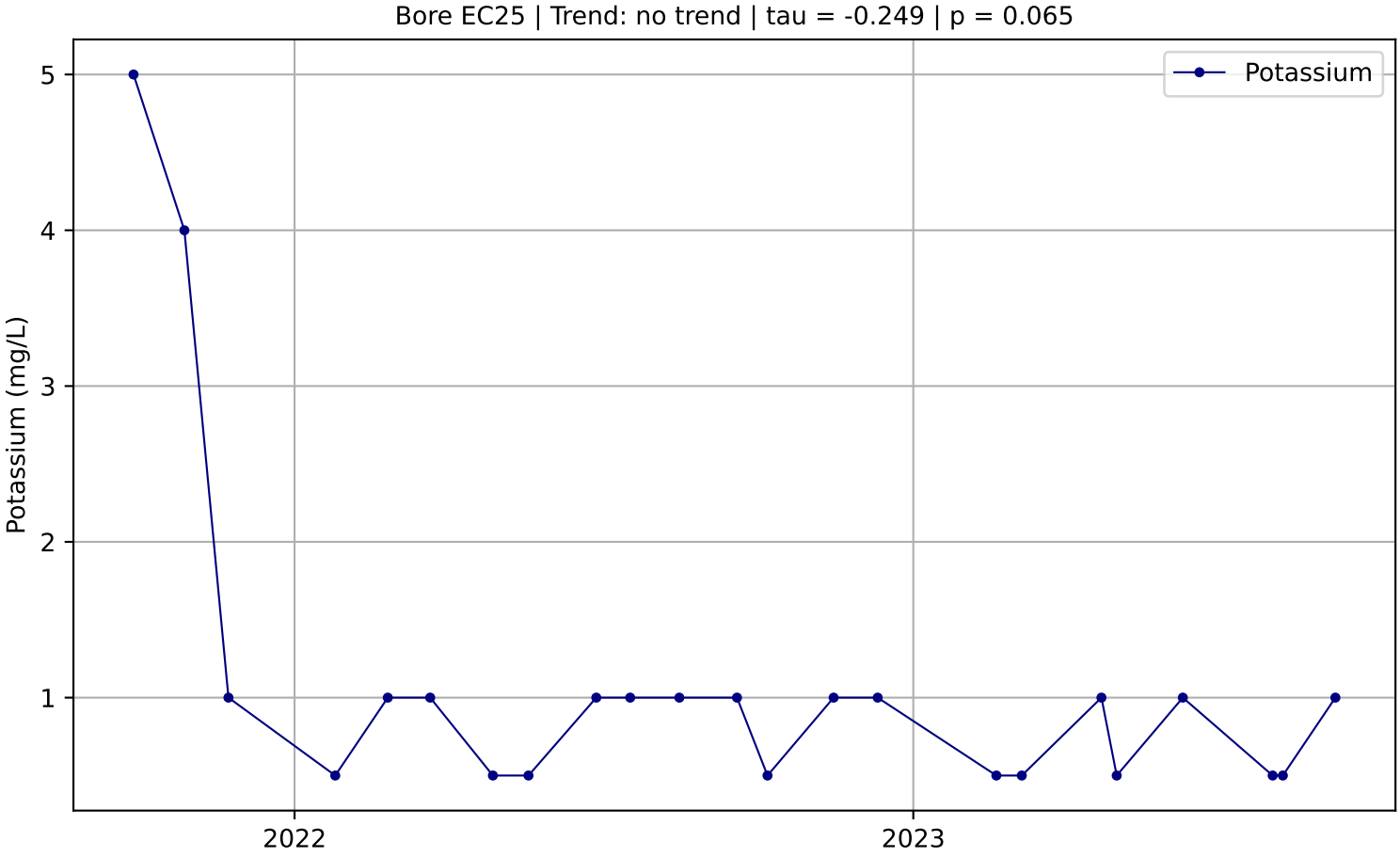

Bore EC25 | Trend: decreasing | tau = -0.317 | p = 0.024
Field Electrical Conductivity (microS/cm)
12200
12000
11800
11600
11400
11200
11000
10800
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

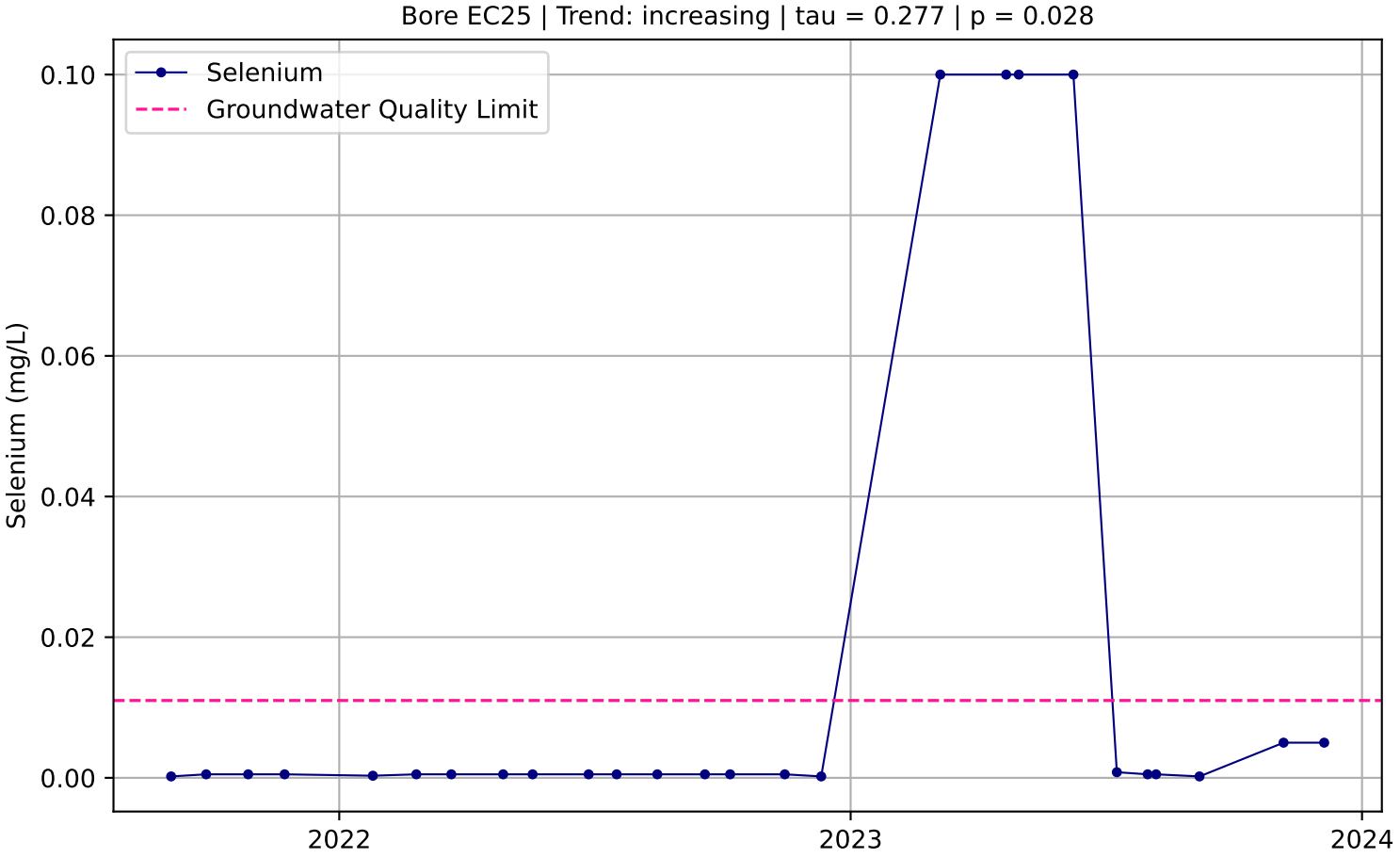

Bore EC25 | Trend: no trend | tau = 0.218 | p = 0.121
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2022
2023
2024

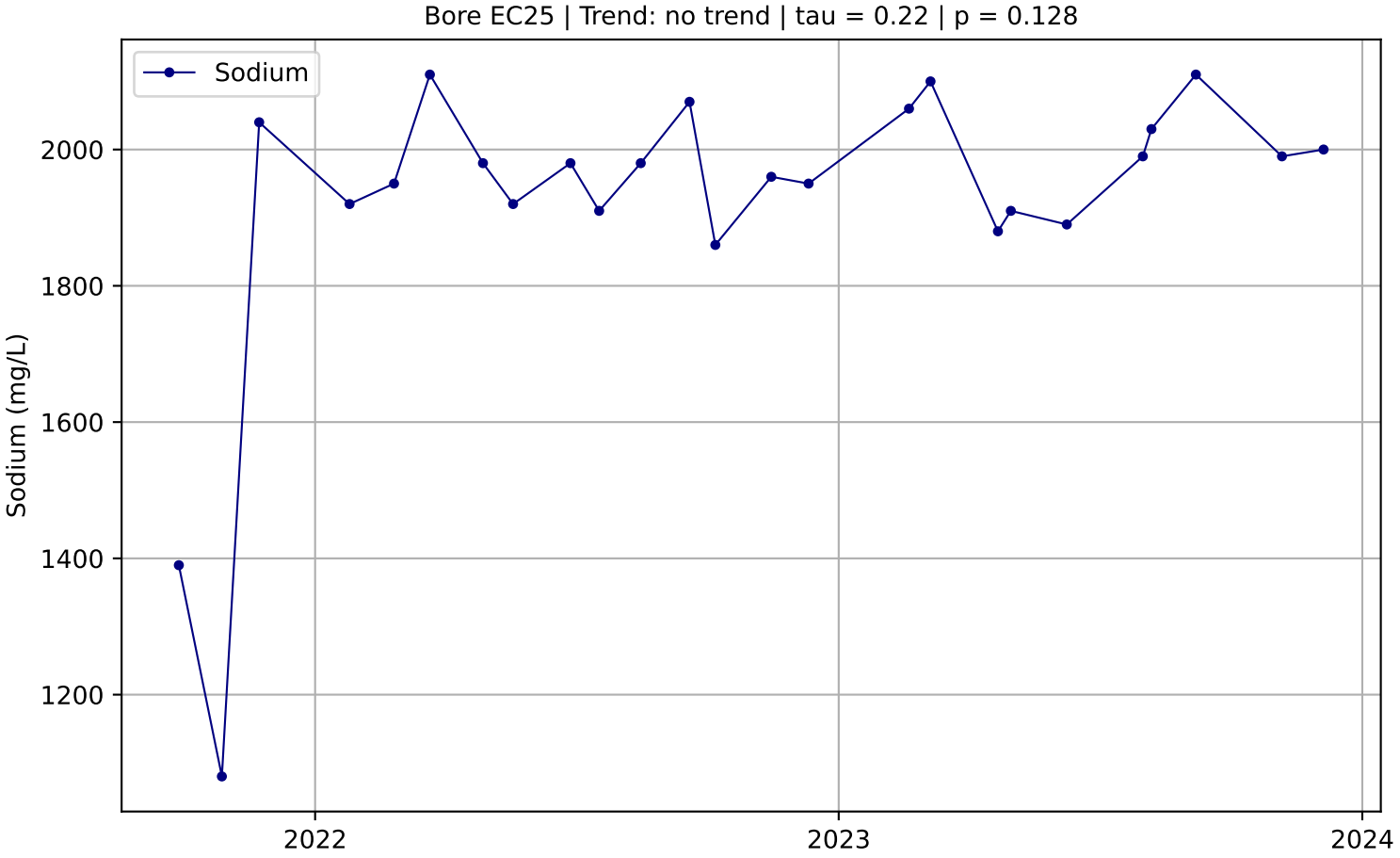

Bore EC25 | Trend: decreasing | tau = -0.298 | p = 0.033
Iron
Groundwater Quality Limit
Iron (mg/L)
2.0
1.5
1.0
0.5
0.0
2022
2023
2024

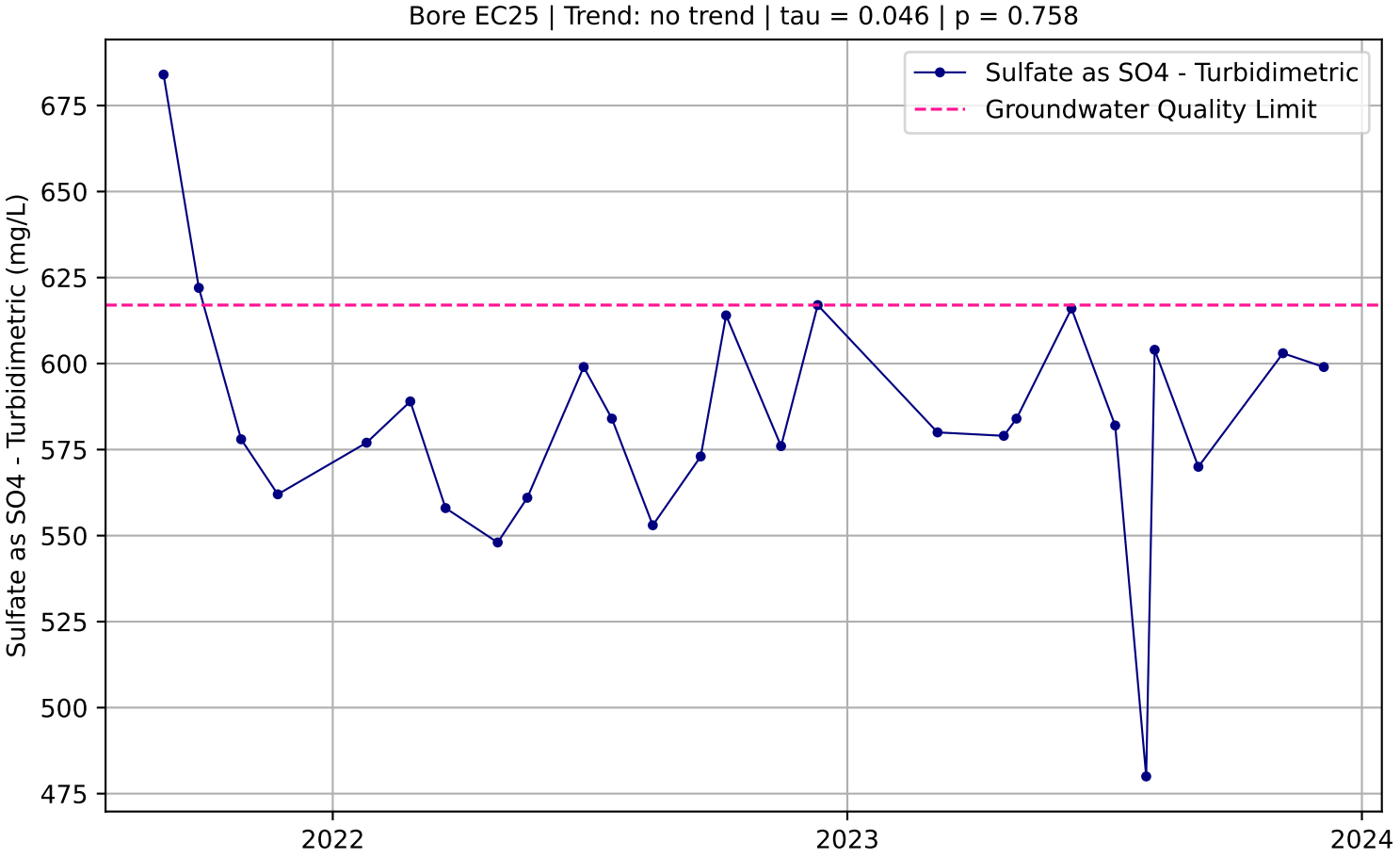

Bore EC25 | Trend: increasing | tau = 0.367 | p = 0.011
Magnesium
Magnesium (mg/L)
100
150
200
250
300
2022
2023
2024

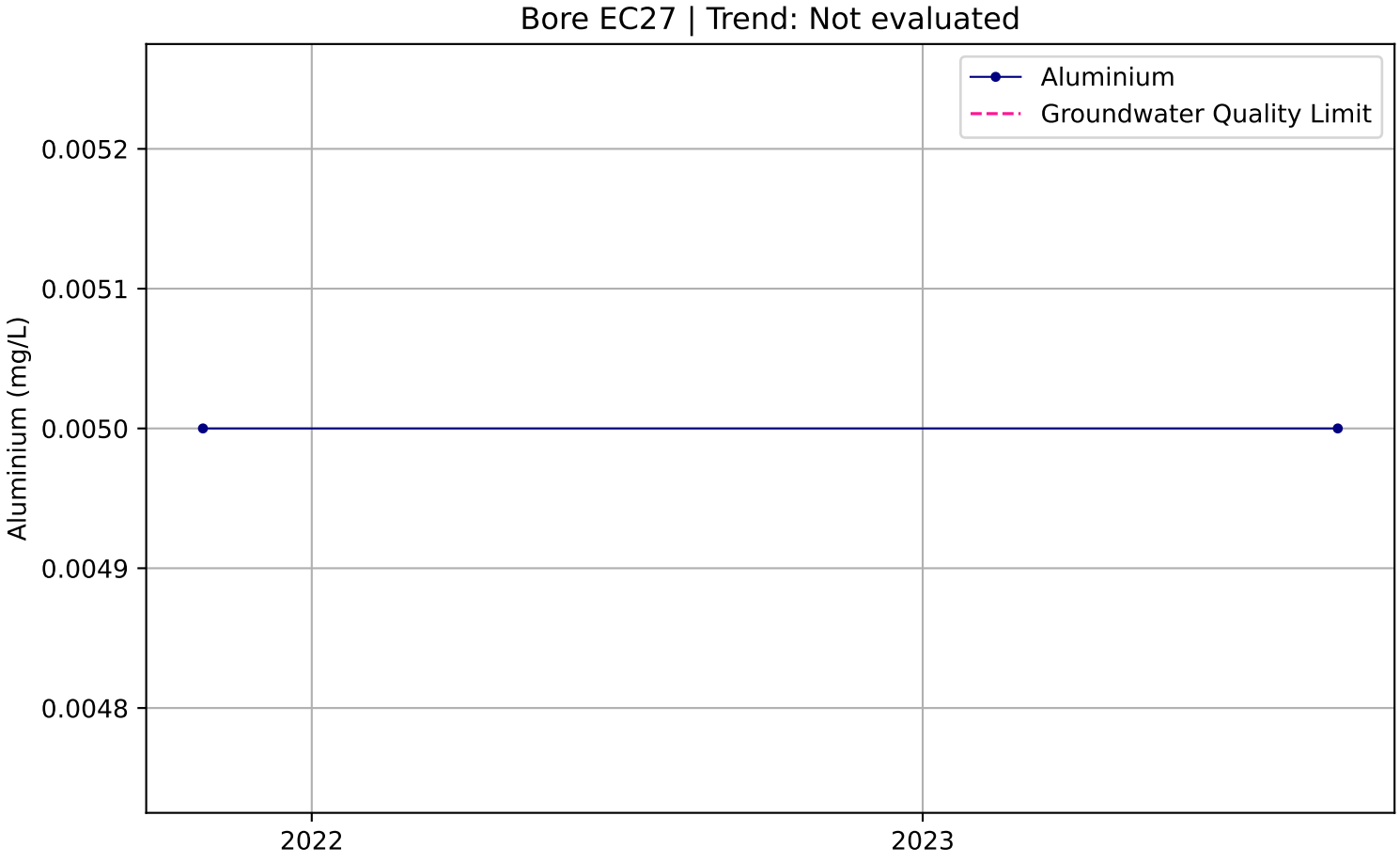

Bore EC25 | Trend: decreasing | tau = -0.338 | p = 0.004
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
2022
2023
2024
Molybdenum
Groundwater Quality Limit

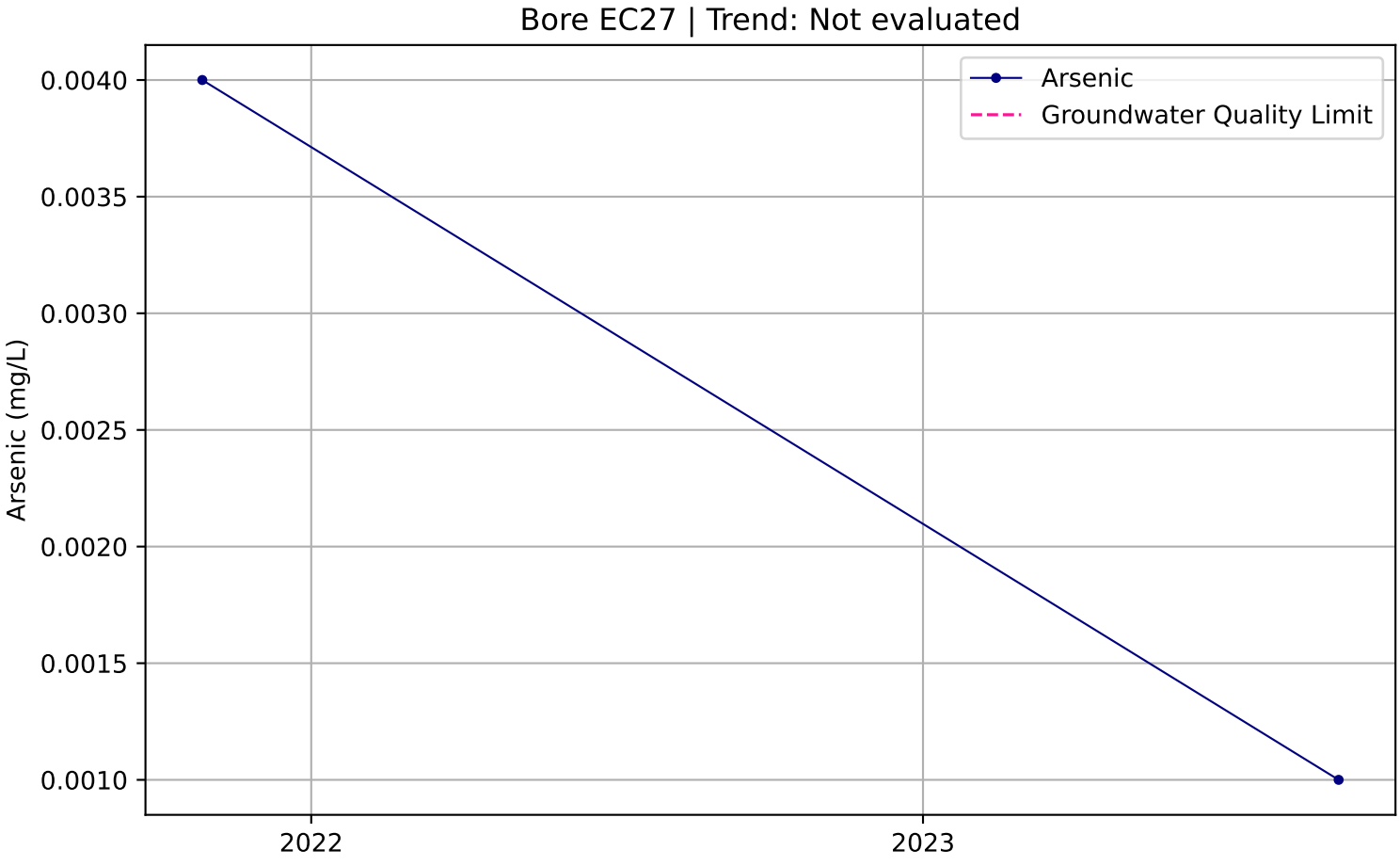

Bore EC25 | Trend: no trend | tau = -0.249 | p = 0.065
Potassium
Potassium (mg/L)
5
4
3
2
1
2022
2023

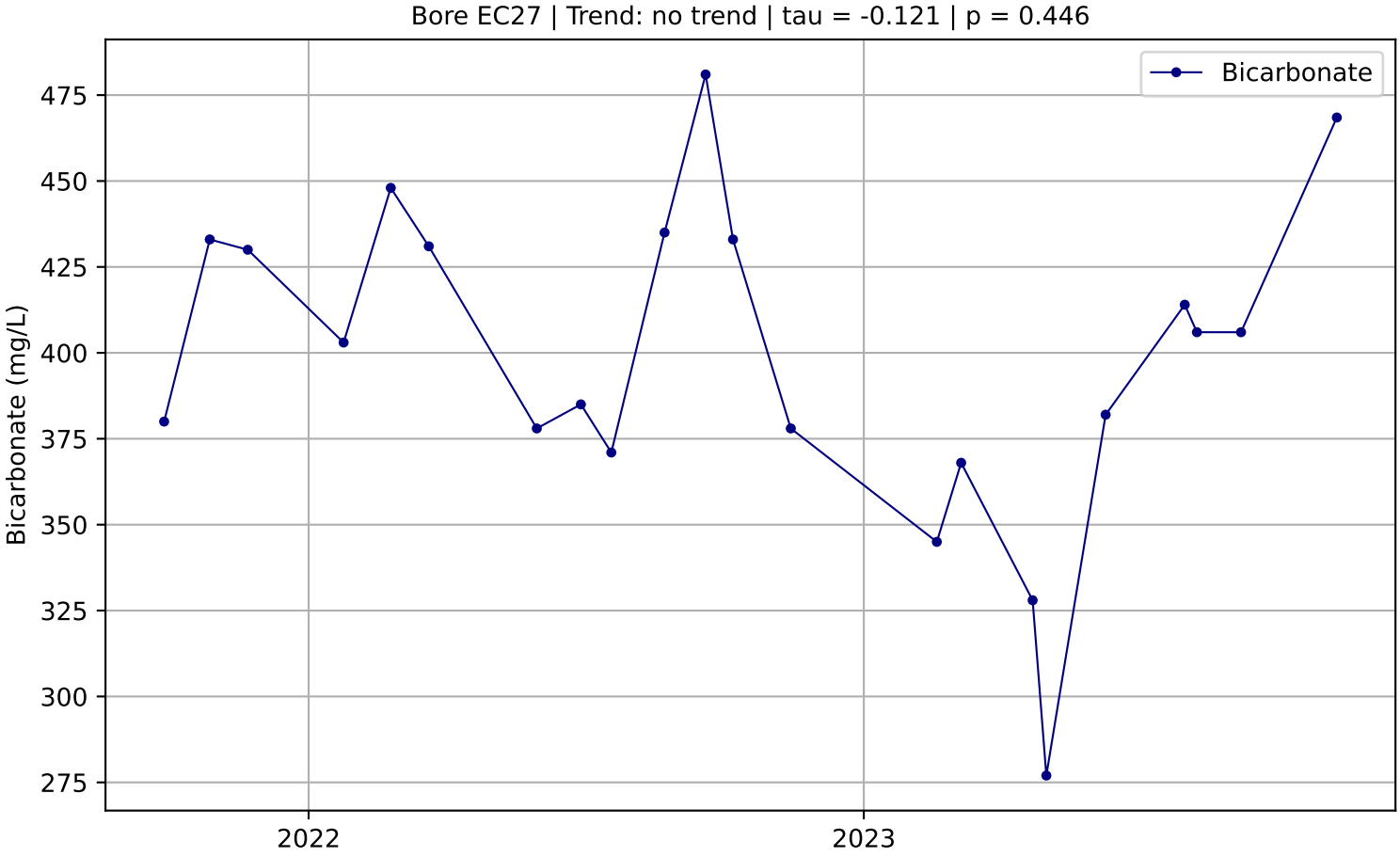

Bore EC25 | Trend: increasing | tau = 0.277 | p = 0.028
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2022
2023
2024

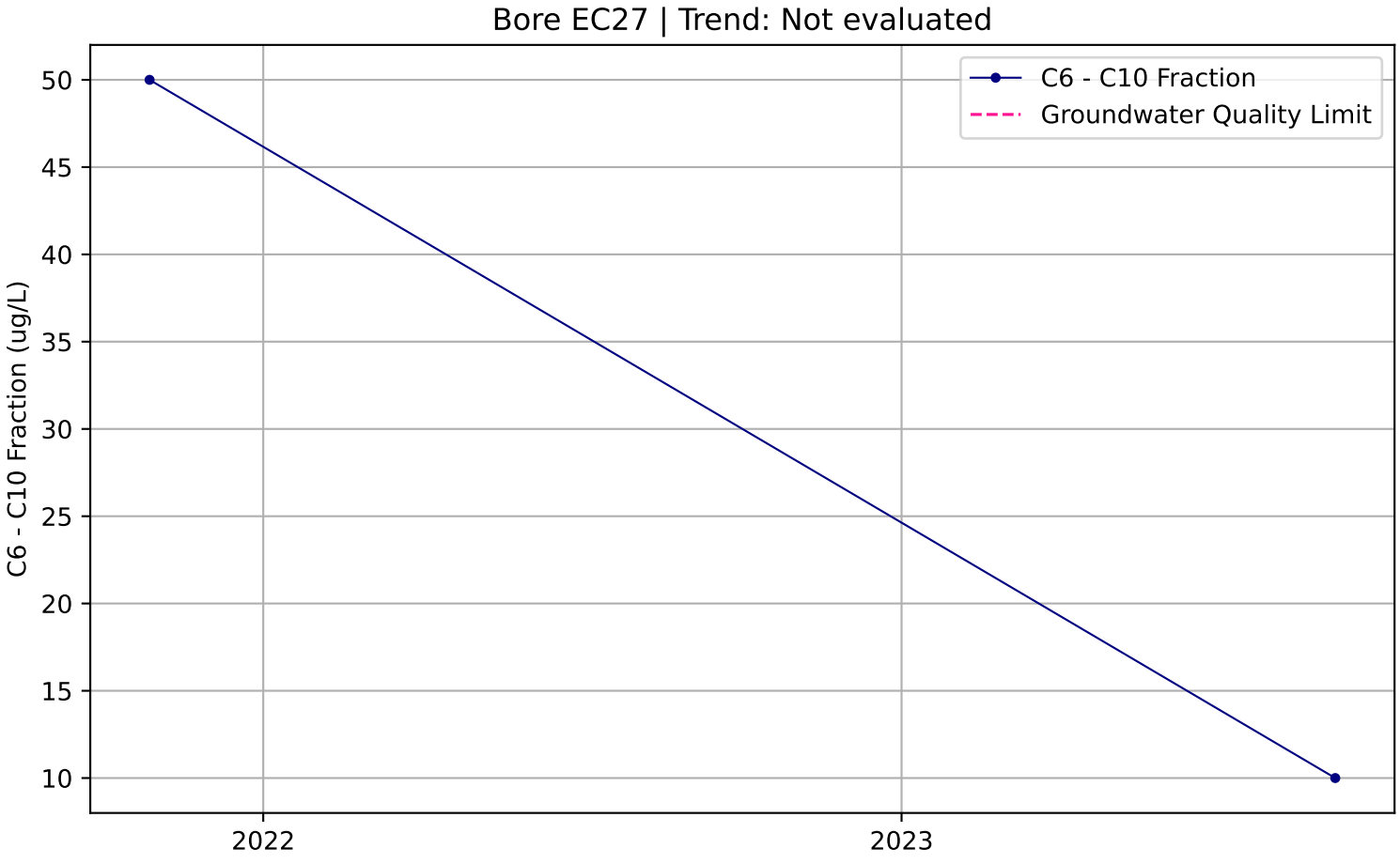

Bore EC25 | Trend: no trend | tau = 0.22 | p = 0.128
Sodium
Sodium (mg/L)
2000
1800
1600
1400
1200
2022
2023
2024

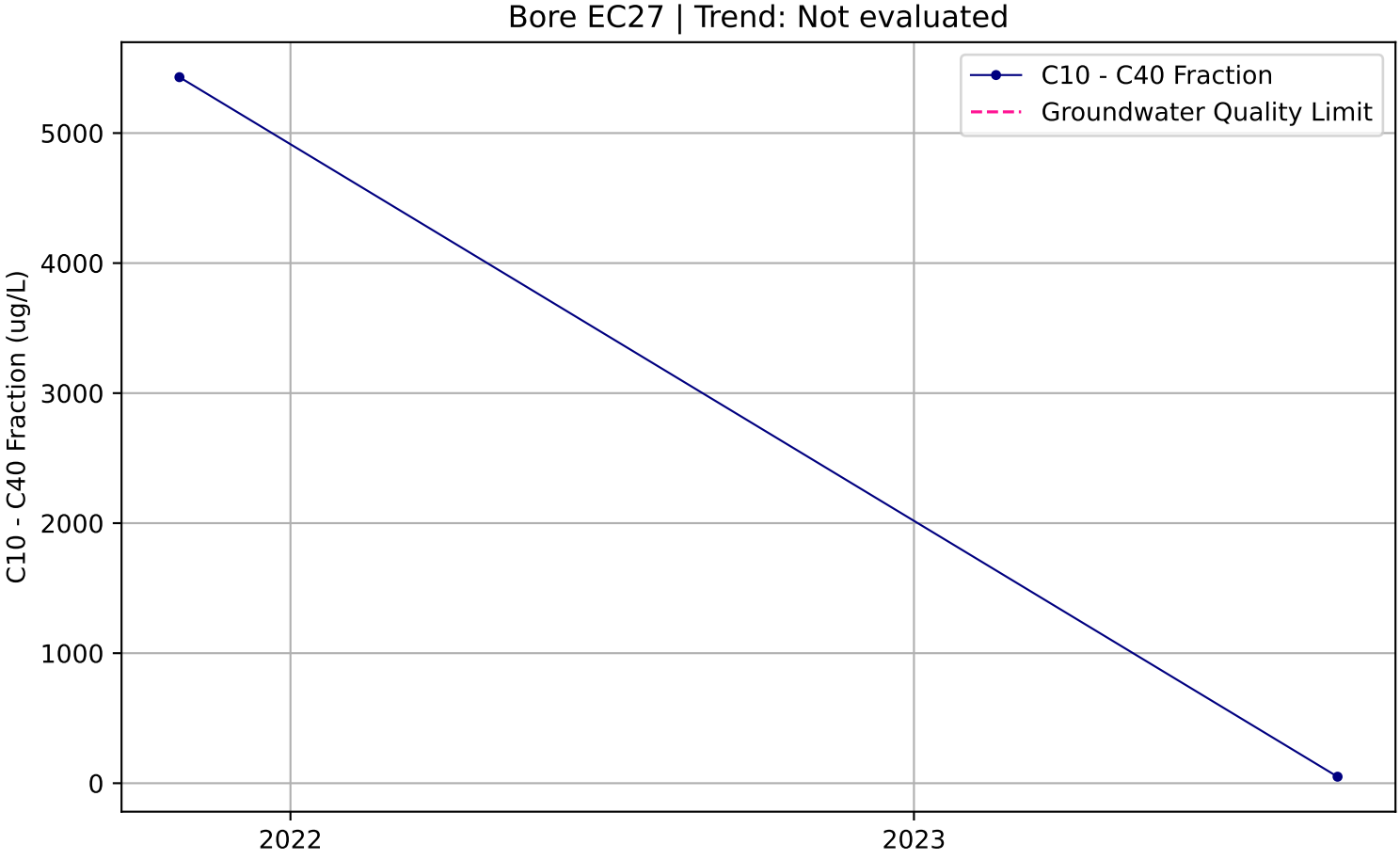

Bore EC25 | Trend: no trend | tau = 0.046 | p = 0.758
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
675
650
625
600
575
550
525
500
475
2022
2023
2024

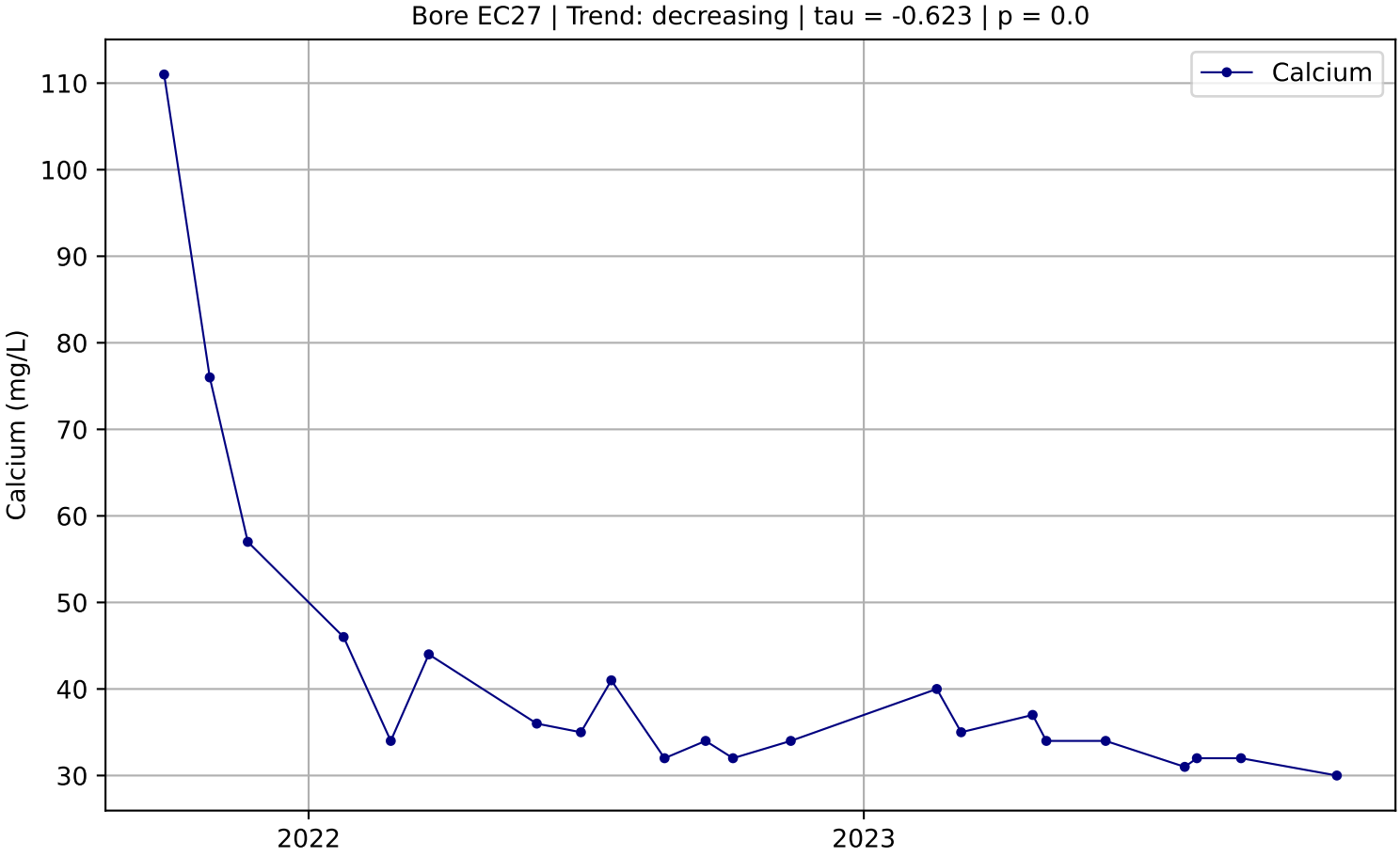

Bore EC27 | Trend: Not evaluated
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.0052
0.0051
0.0050
0.0049
0.0048
2022
2023

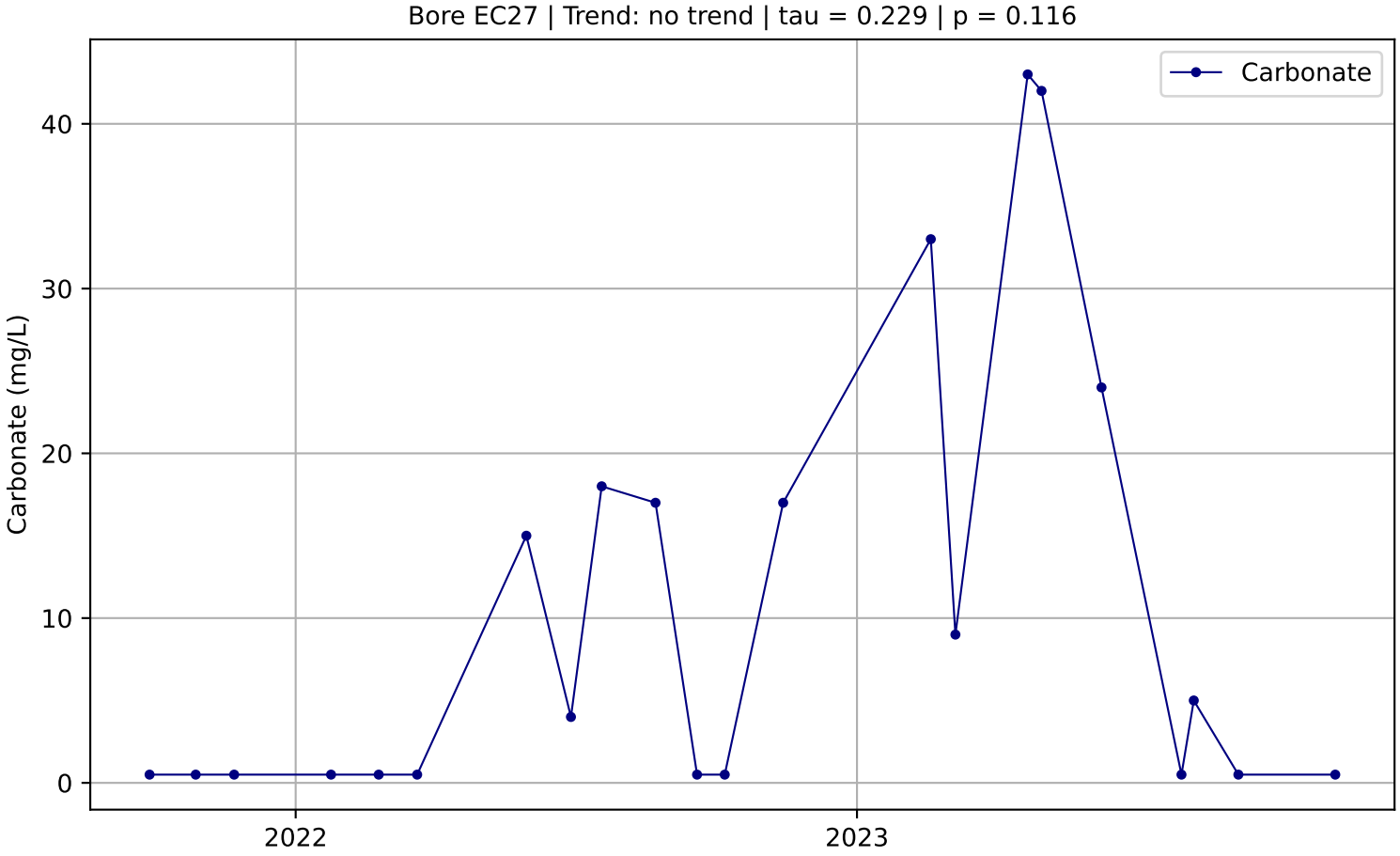

Bore EC27 | Trend: Not evaluated
Arsenic
Groundwater Quality Limit
Arsenic (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
2022
2023

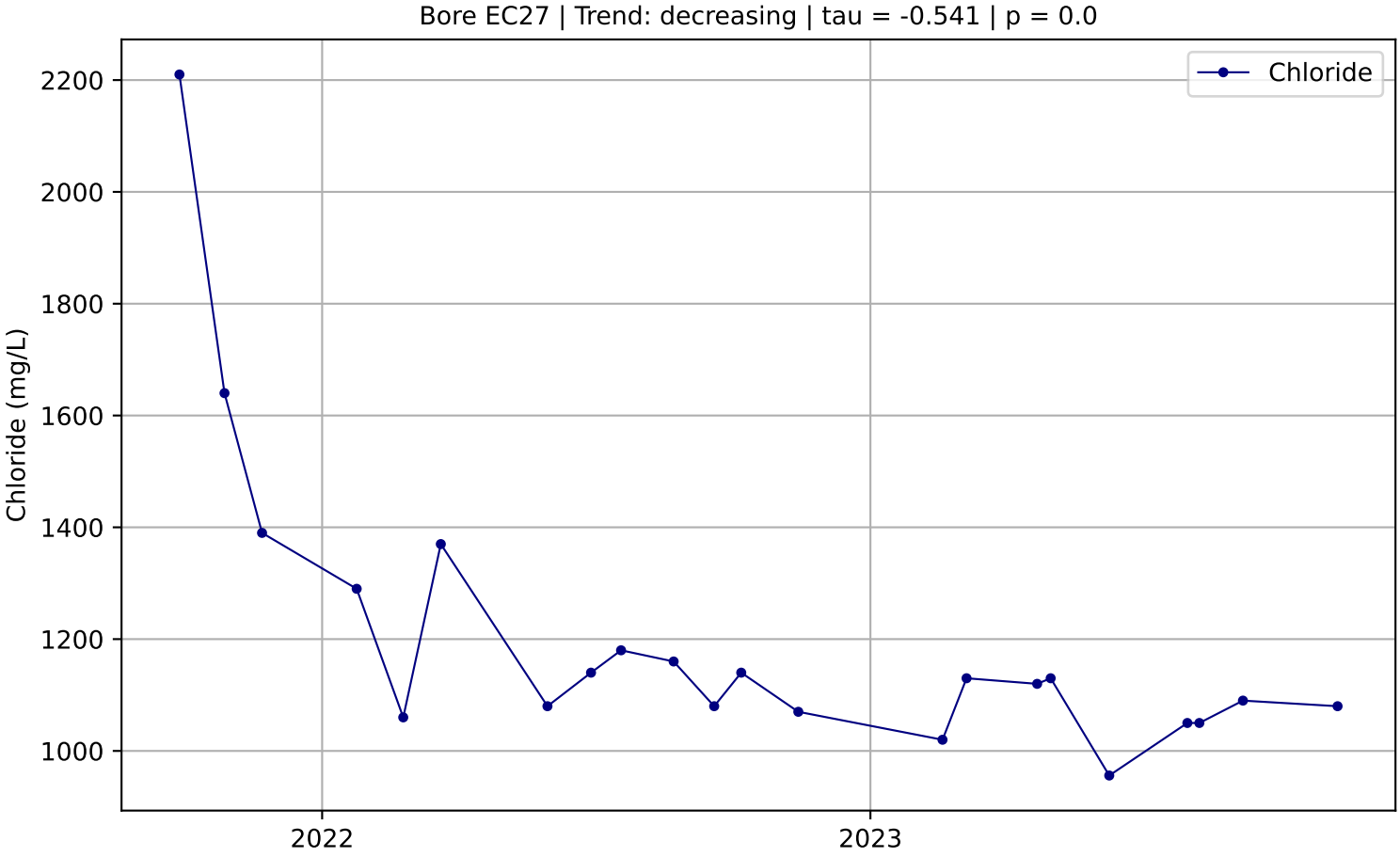

Bore EC27 | Trend: no trend | tau = -0.121 | p = 0.446
Bicarbonate
Bicarbonate (mg/L)
475
450
425
400
375
350
325
300
275
2022
2023

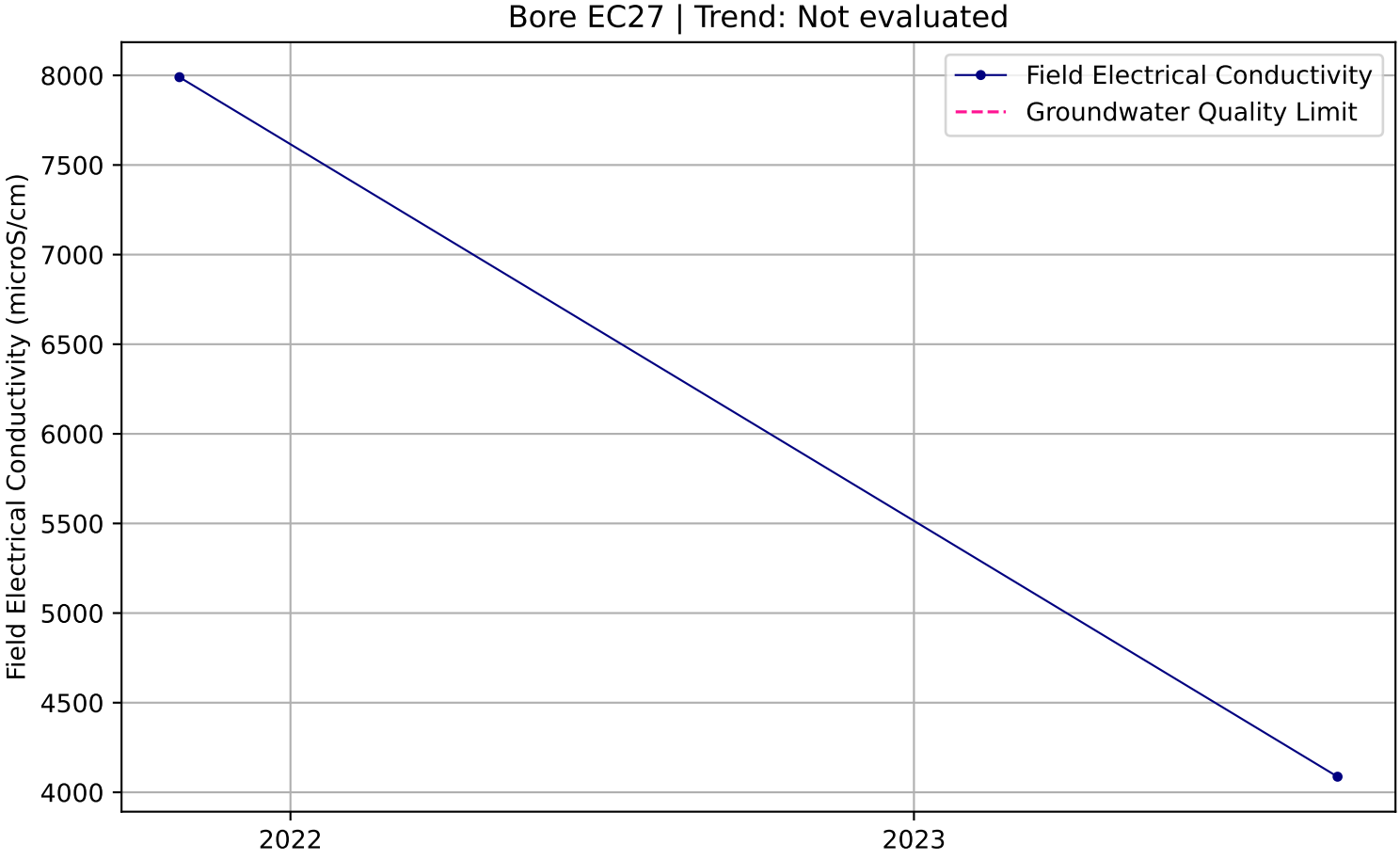

Bore EC27 | Trend: Not evaluated
C6 - C10 Fraction
Groundwater Quality Limit
C6 - C10 Fraction (ug/L)
50
45
40
35
30
25
20
15
10
2022
2023

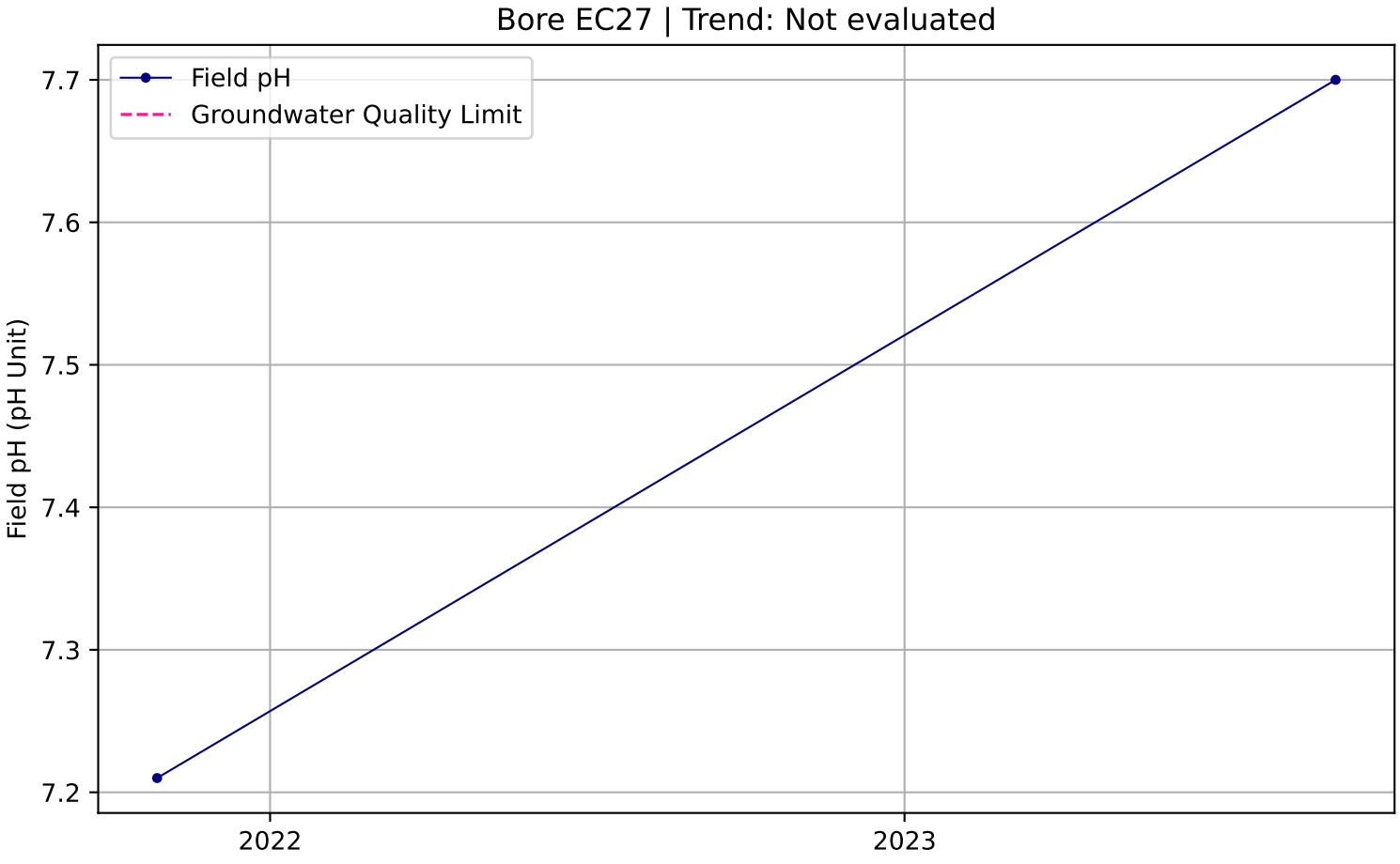

Bore EC27 | Trend: Not evaluated
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
5000
4000
3000
2000
1000
0
2022
2023

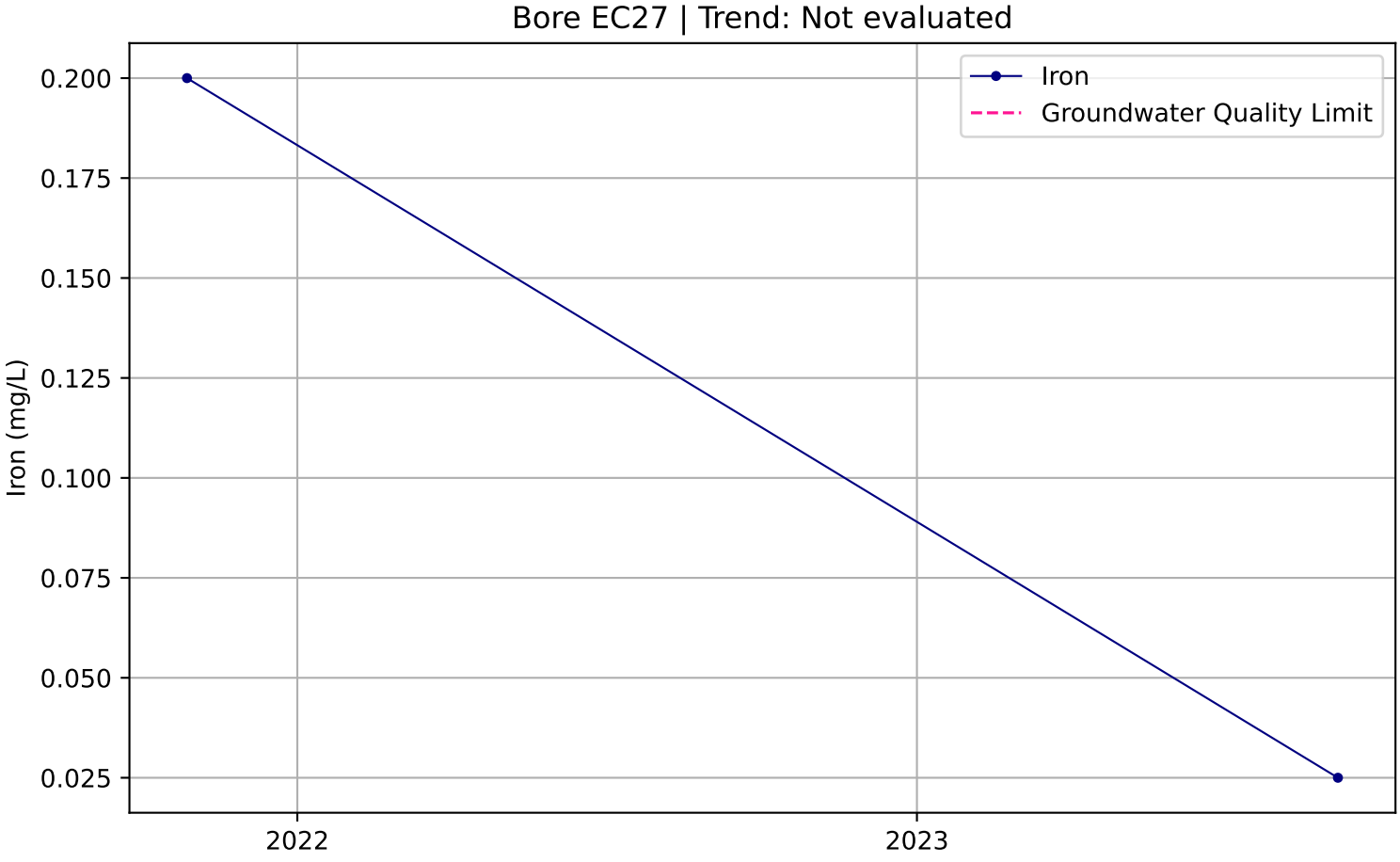

Bore EC27 | Trend: decreasing | tau = -0.623 | p = 0.0
Calcium
Calcium (mg/L)
110
100
90
80
70
60
50
40
30
2022
2023

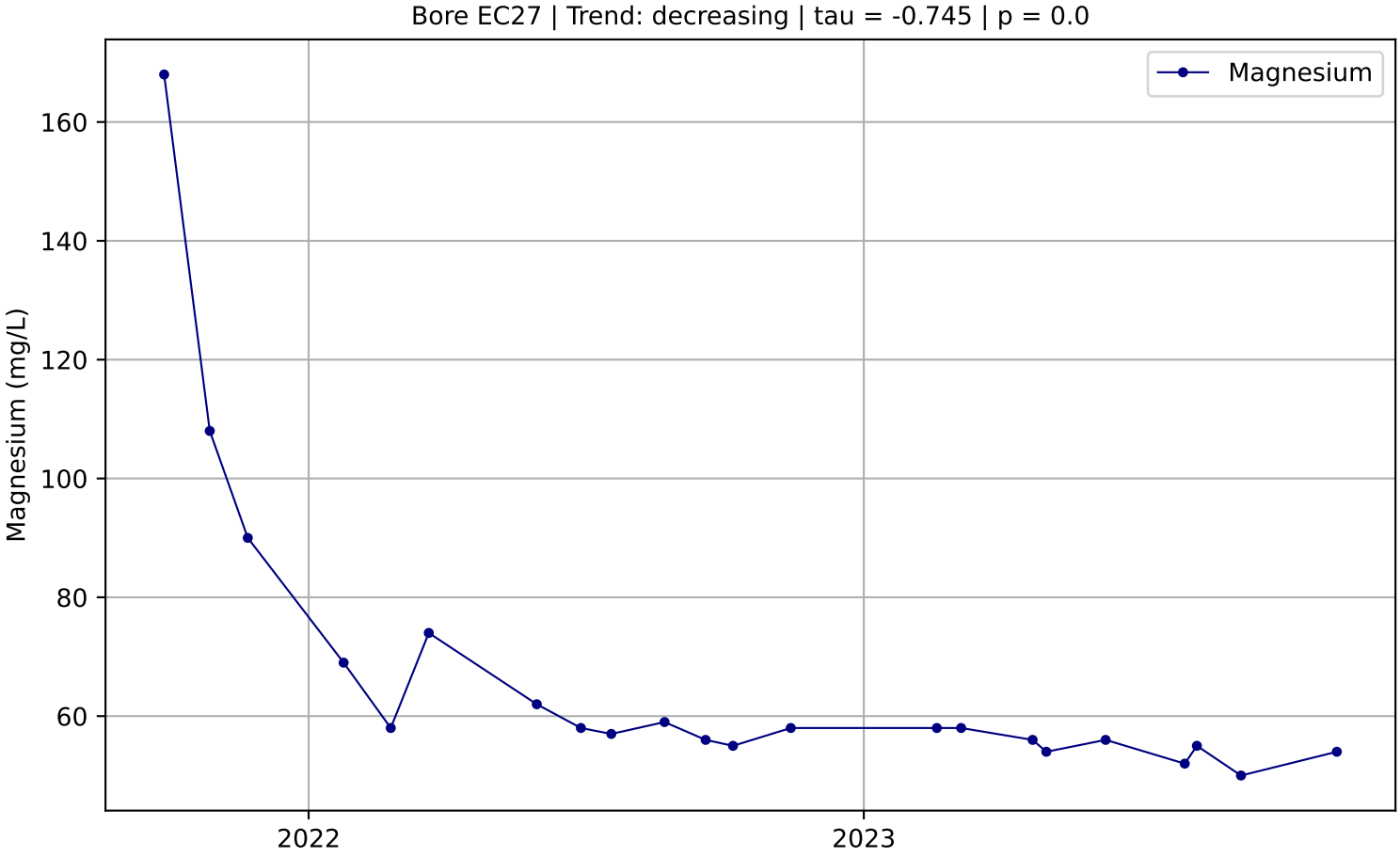

Bore EC27 | Trend: no trend | tau = 0.229 | p = 0.116
Carbonate
Carbonate (mg/L)
0
10
20
30
40
2022
2023

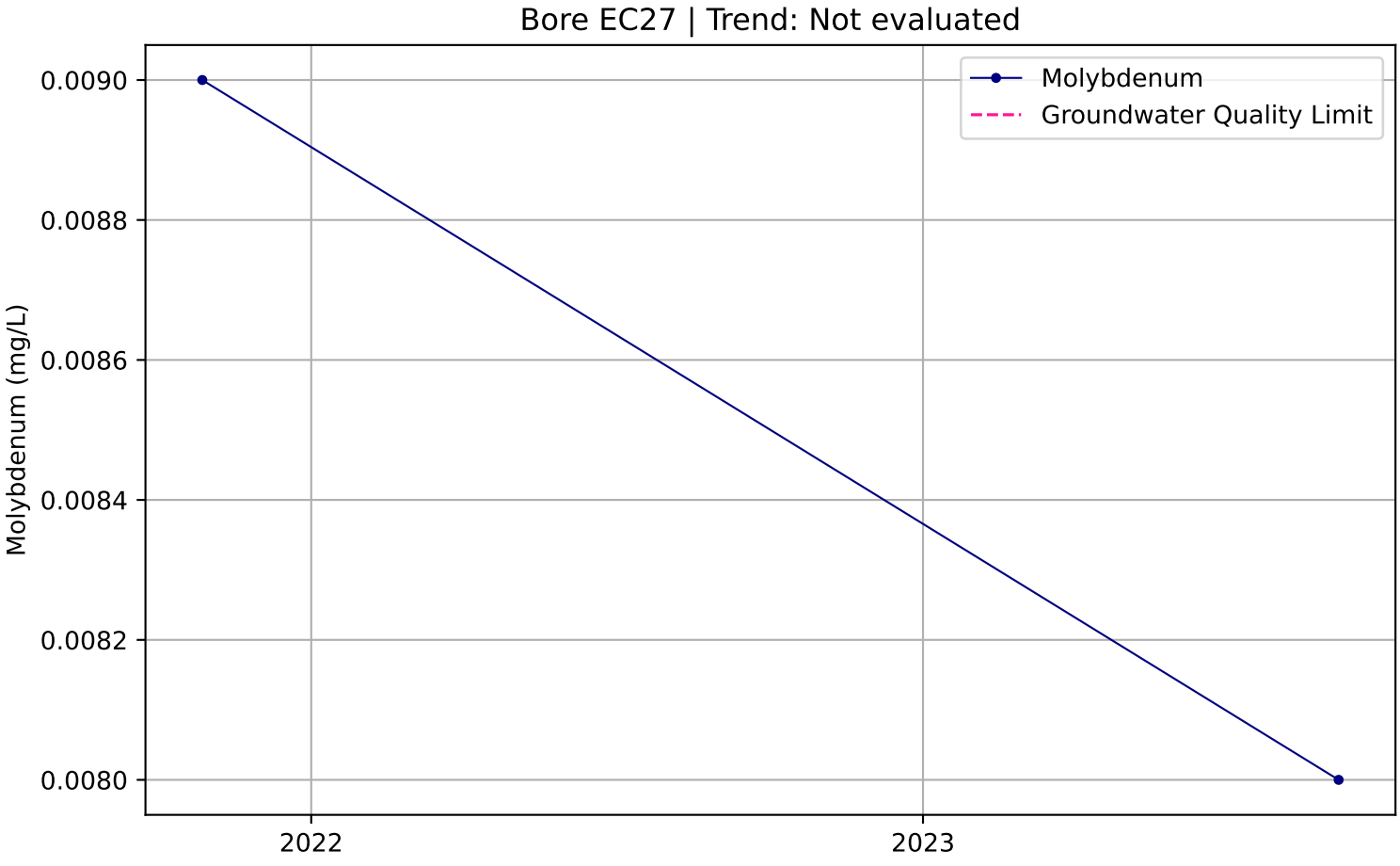

Bore EC27 | Trend: decreasing | tau = -0.541 | p = 0.0
Chloride
Chloride (mg/L)
2200
2000
1800
1600
1400
1200
1000
2022
2023

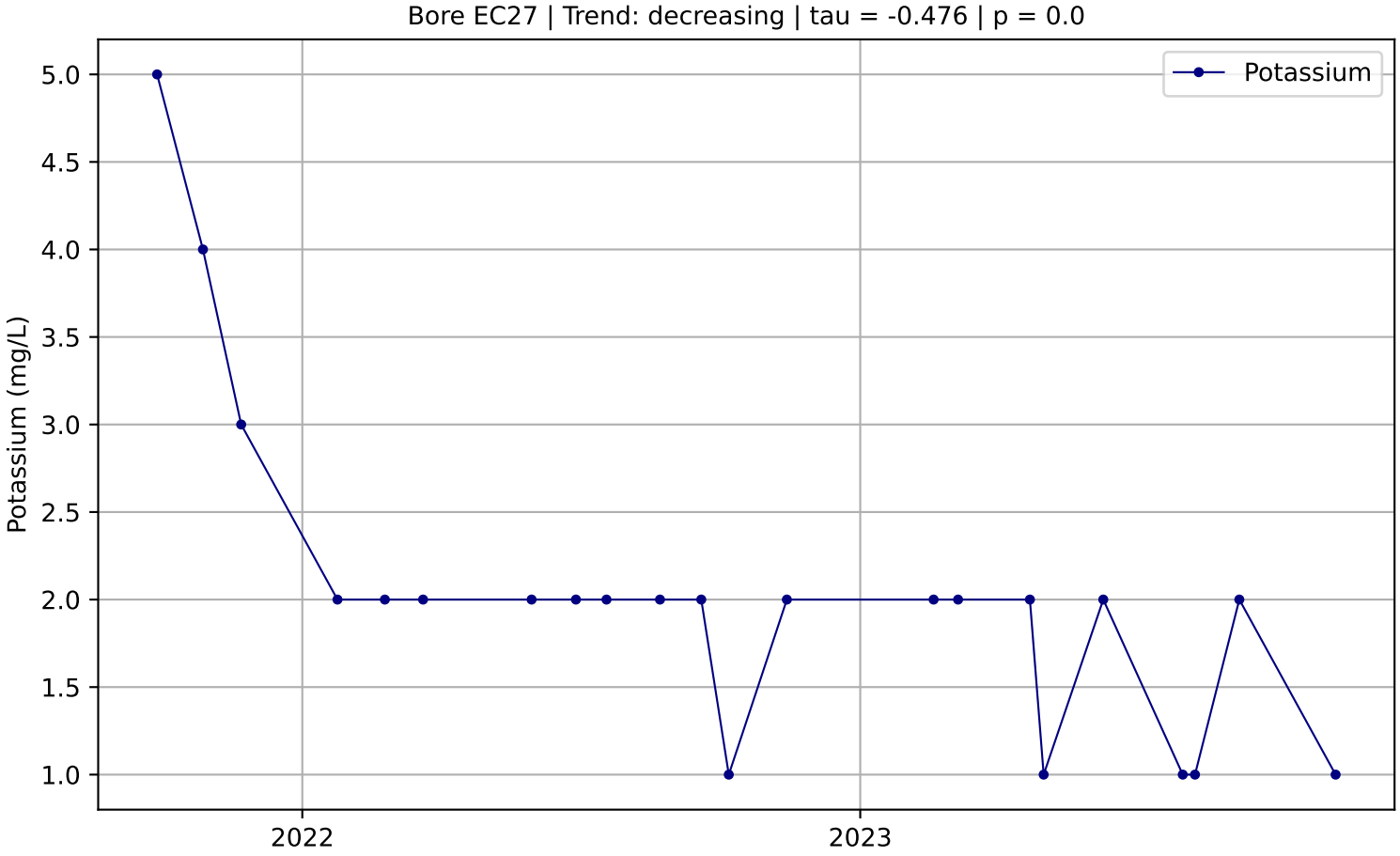

Bore EC27 | Trend: Not evaluated
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
8000
7500
7000
6500
6000
5500
5000
4500
4000
2022
2023

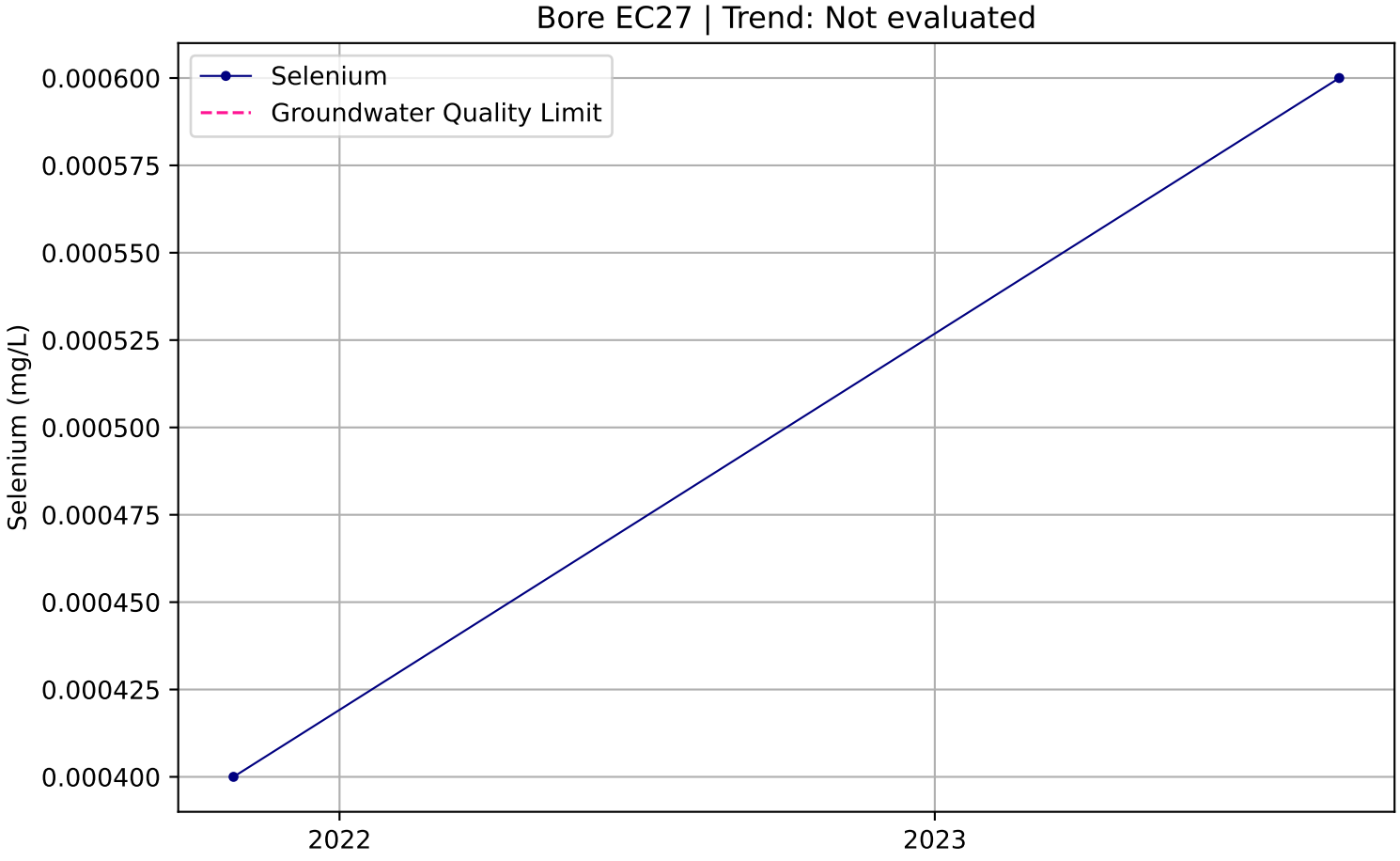

Bore EC27 | Trend: Not evaluated
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
7.7
7.6
7.5
7.4
7.3
7.2
2022
2023

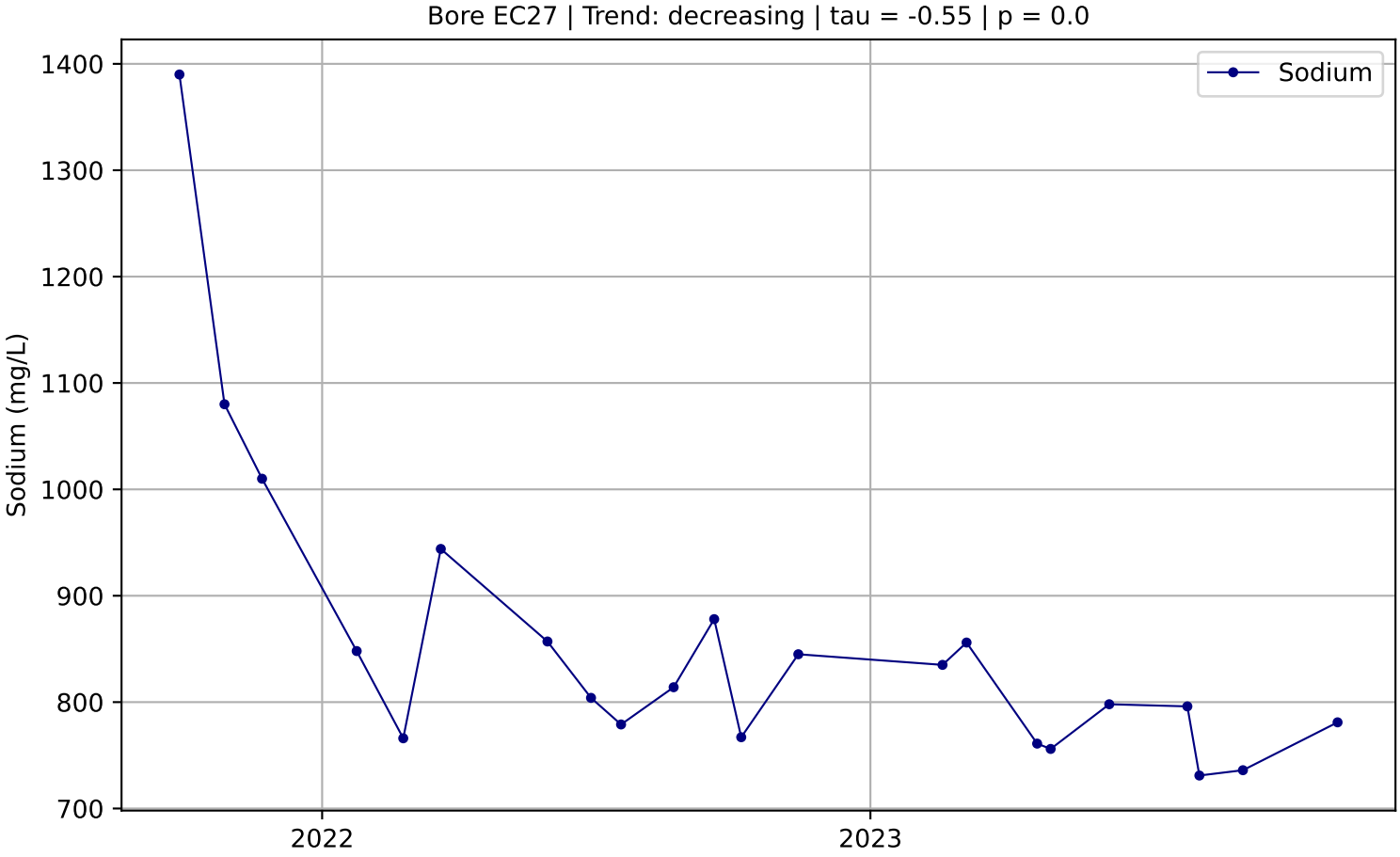

Bore EC27 | Trend: Not evaluated
Iron
Groundwater Quality Limit
Iron (mg/L)
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
2022
2023

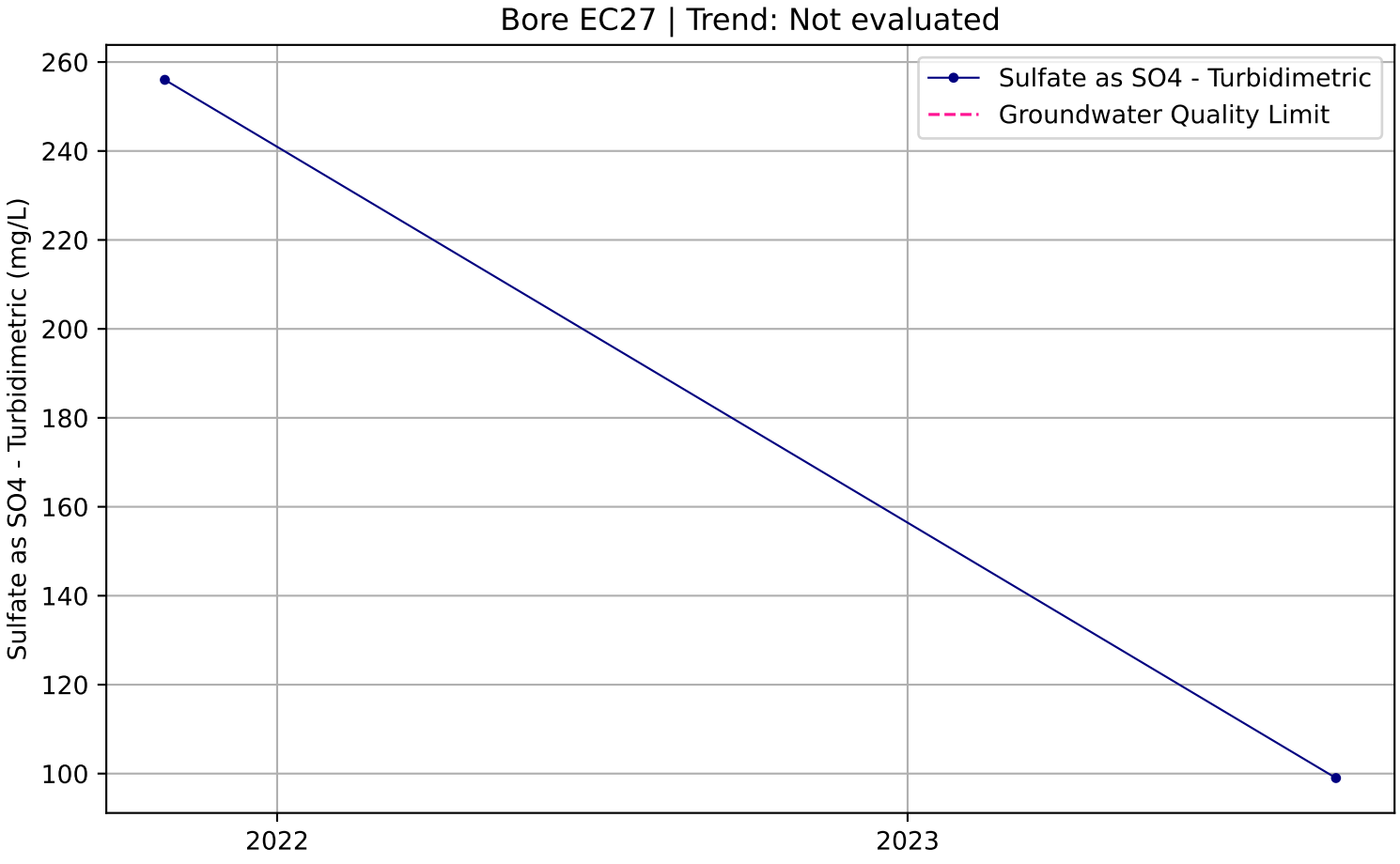

Bore EC27 | Trend: decreasing | tau = -0.745 | p = 0.0
Magnesium
Magnesium (mg/L)
160
140
120
100
80
60
2022
2023

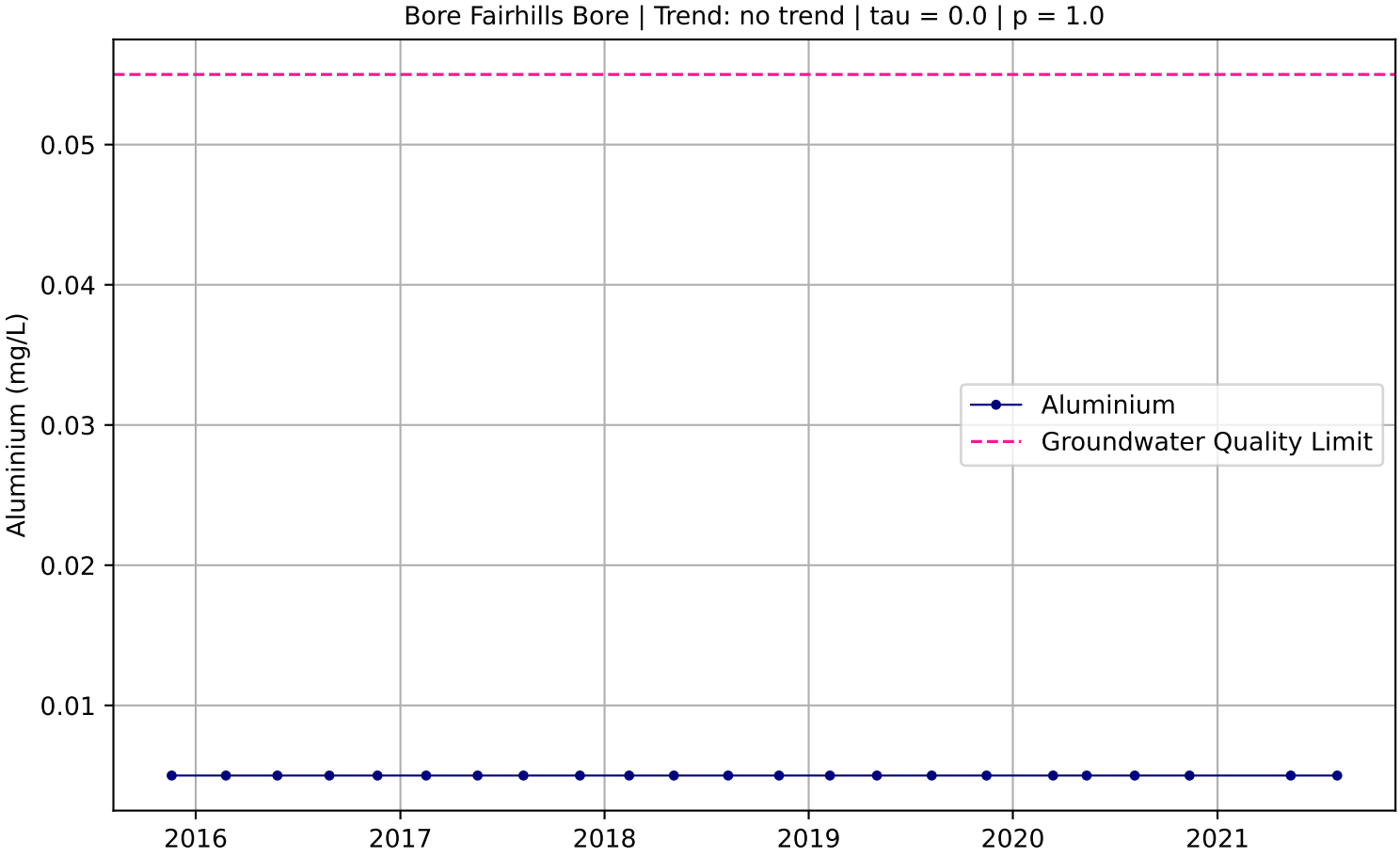

Bore EC27 | Trend: Not evaluated
Molybdenum
Groundwater Quality Limit
Molybdenum (mg/L)
0.0090
0.0088
0.0086
0.0084
0.0082
0.0080
2022
2023

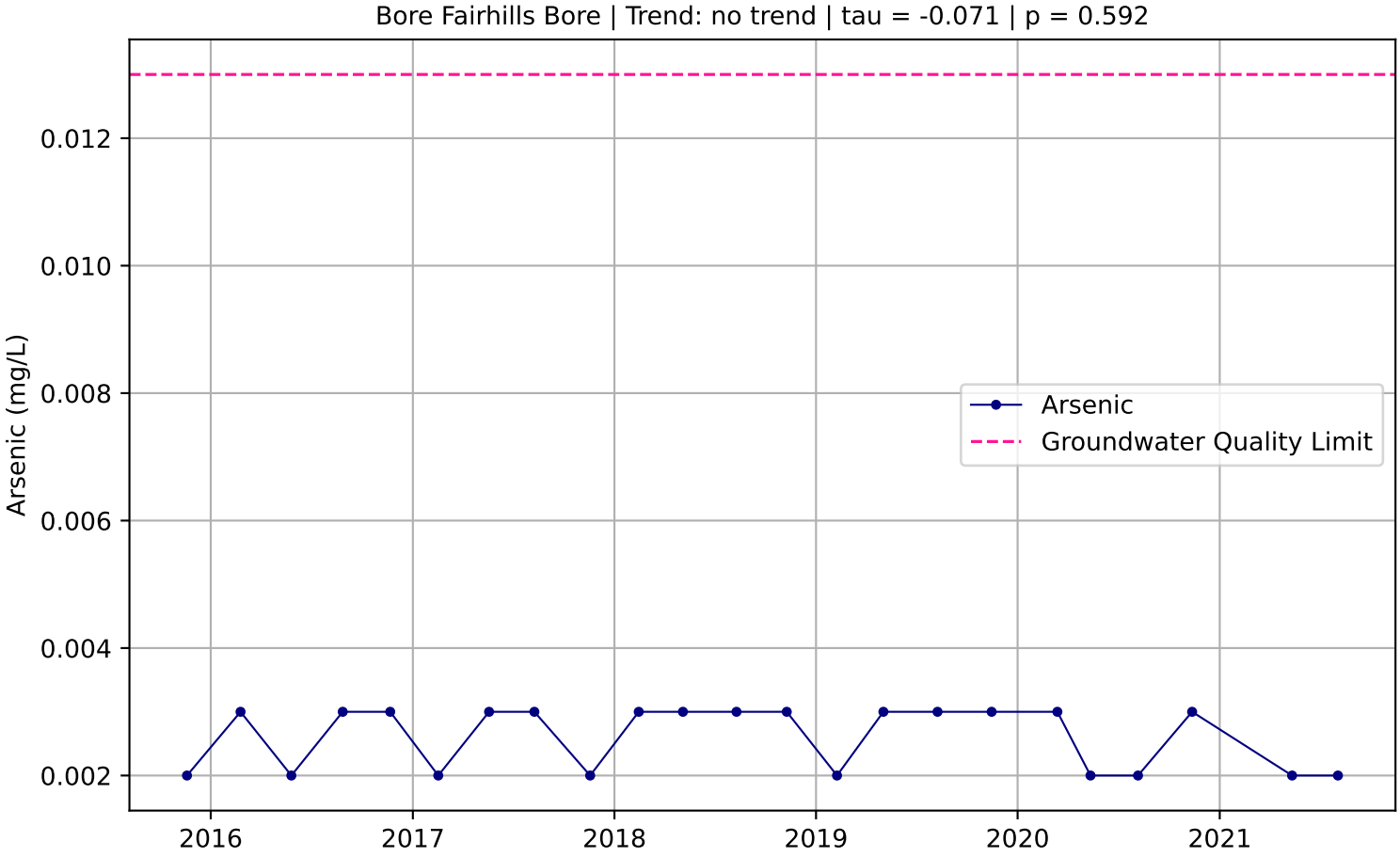

Bore EC27 | Trend: decreasing | tau = -0.476 | p = 0.0
Potassium
Potassium (mg/L)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
2022
2023

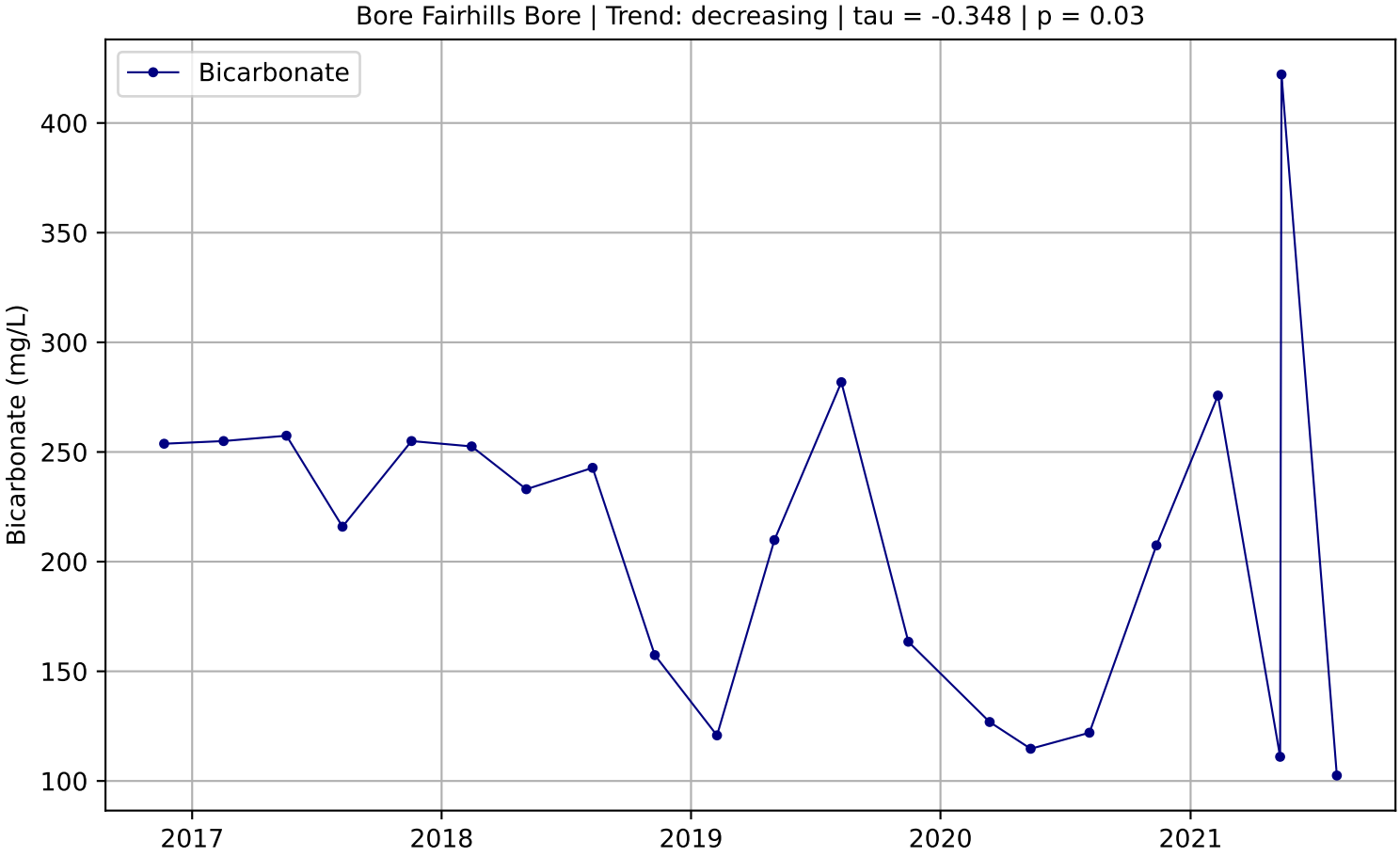

Bore EC27 | Trend: Not evaluated
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.000600
0.000575
0.000550
0.000525
0.000500
0.000475
0.000450
0.000425
0.000400
2022
2023

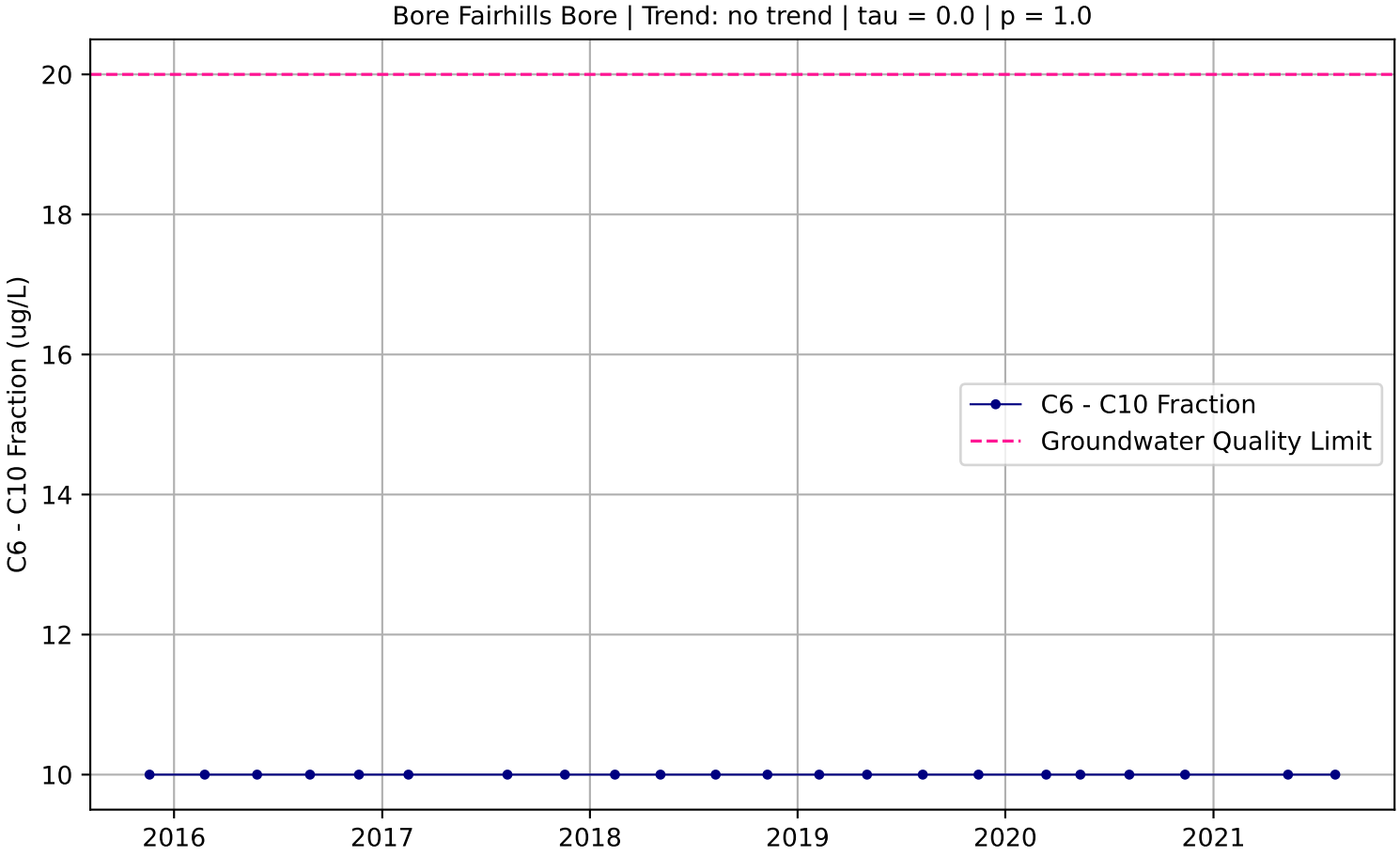

Bore EC27 | Trend: decreasing | tau = -0.55 | p = 0.0
Sodium
Sodium (mg/L)
1400
1300
1200
1100
1000
900
800
700
2022
2023

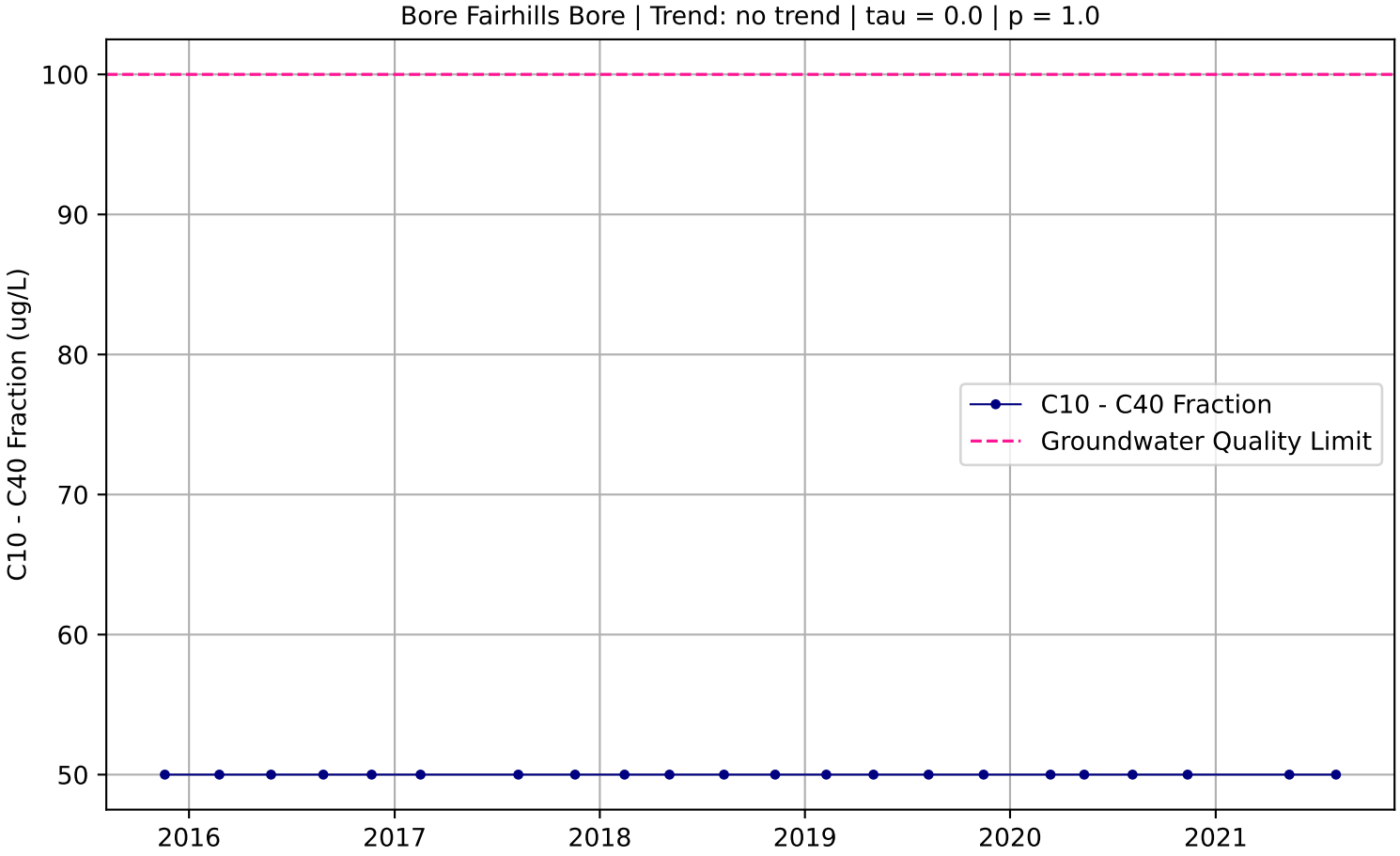

Bore EC27 | Trend: Not evaluated
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
260
240
220
200
180
160
140
120
100
2022
2023

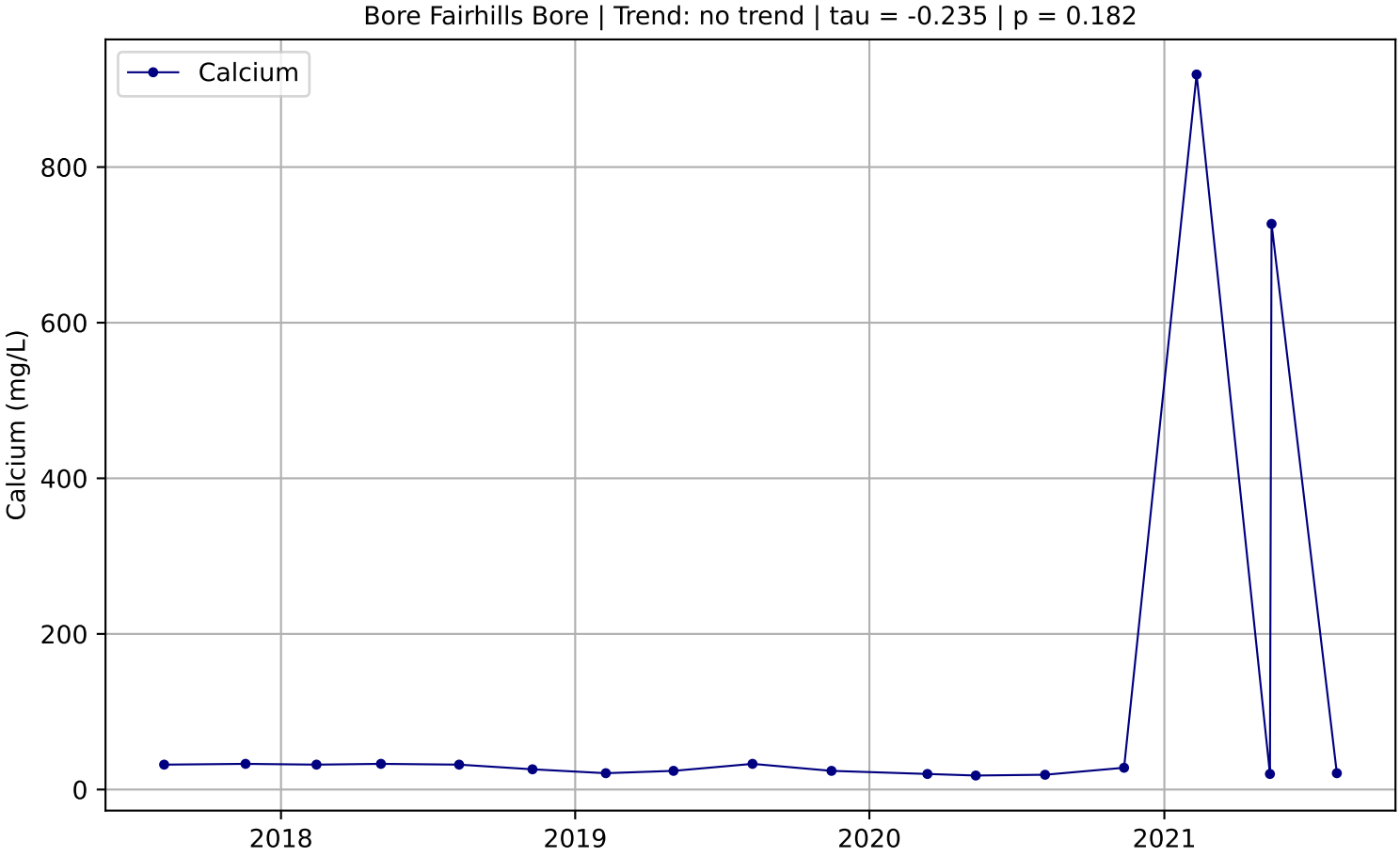

Bore Fairhills Bore | Trend: no trend | tau = 0.0 | p = 1.0
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
Aluminium
Groundwater Quality Limit

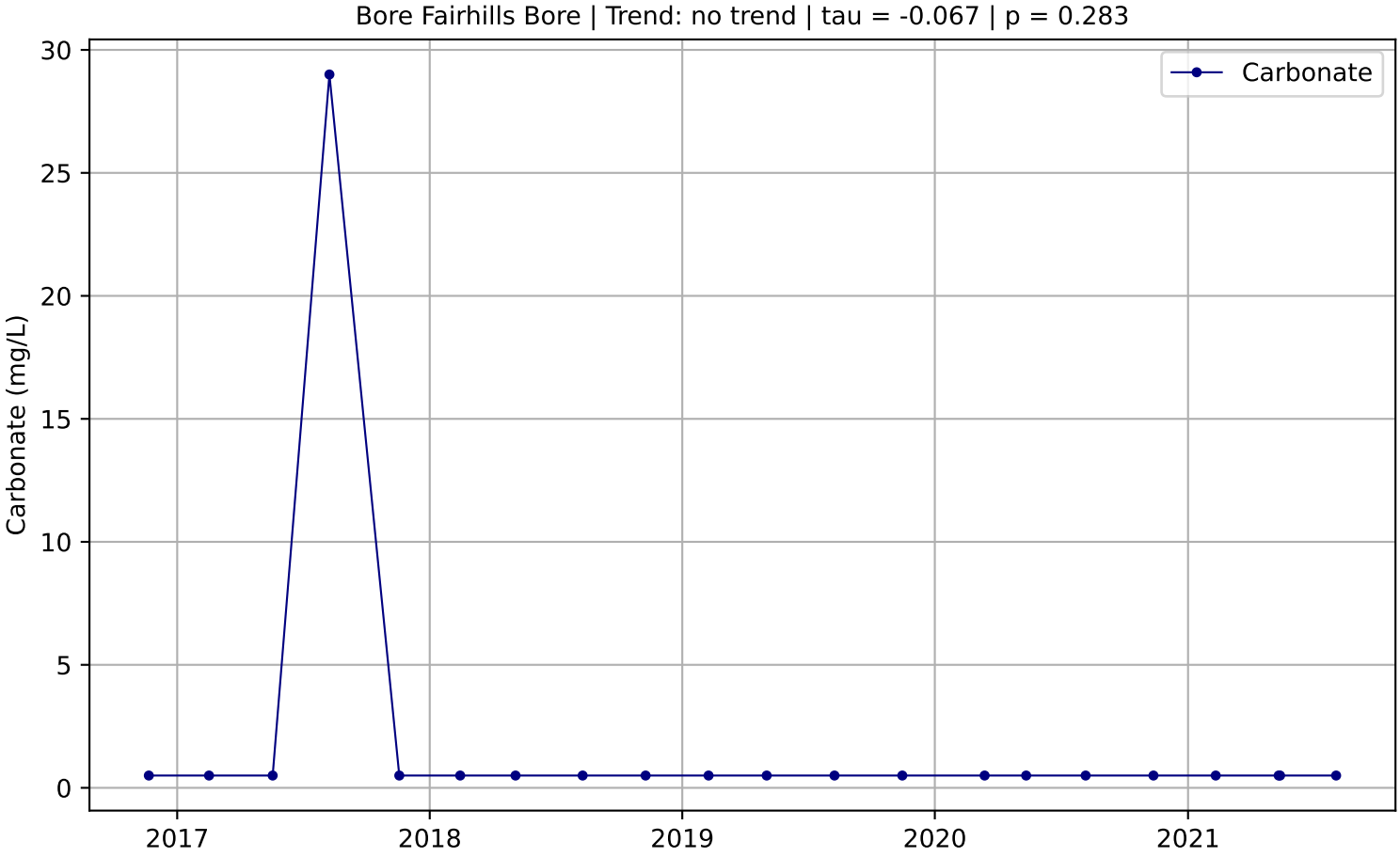

Bore Fairhills Bore | Trend: no trend | tau = -0.071 | p = 0.592
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

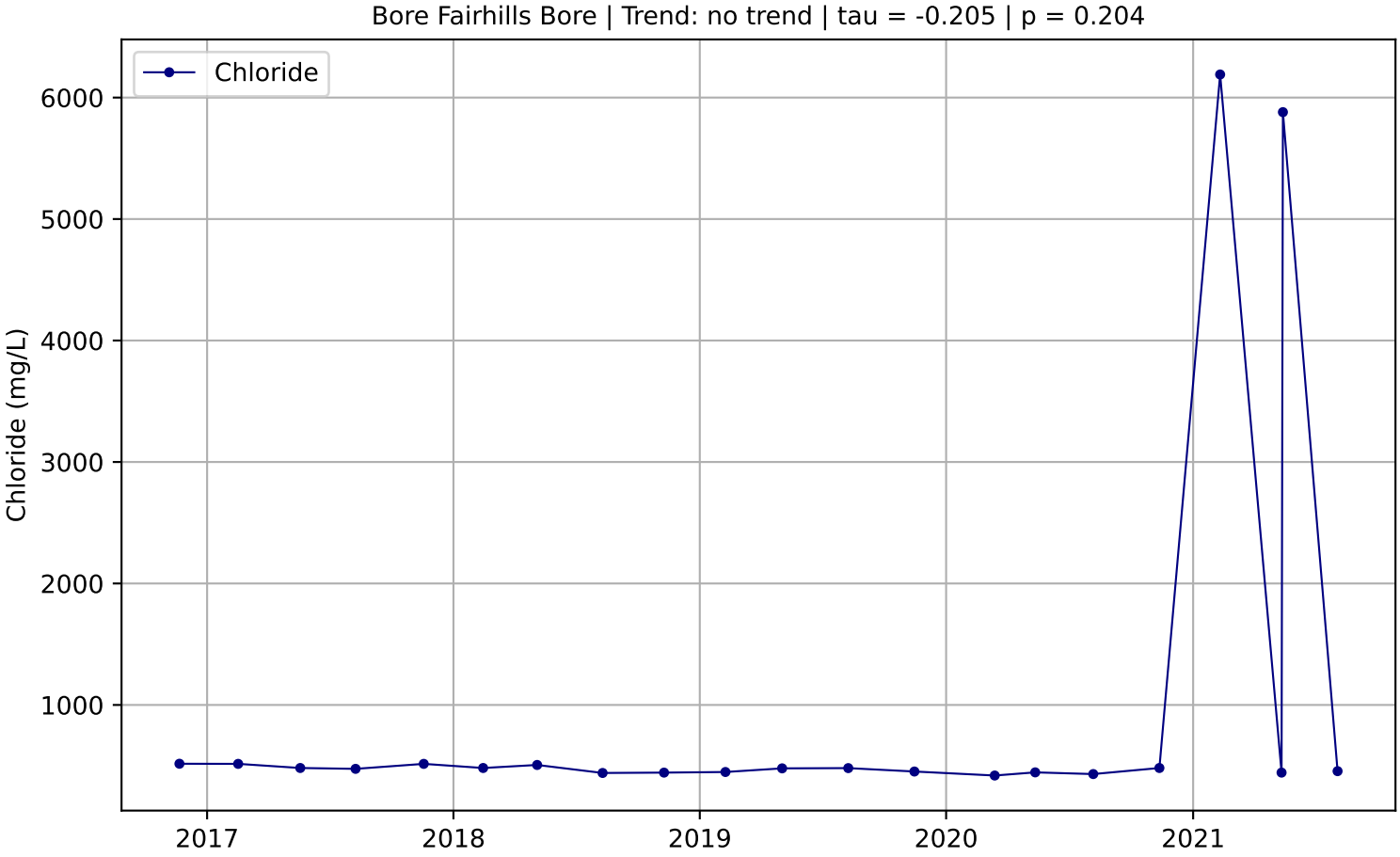

Bore Fairhills Bore | Trend: decreasing | tau = -0.348 | p = 0.03
Bicarbonate
Bicarbonate (mg/L)
400
350
300
250
200
150
100
2017
2018
2019
2020
2021

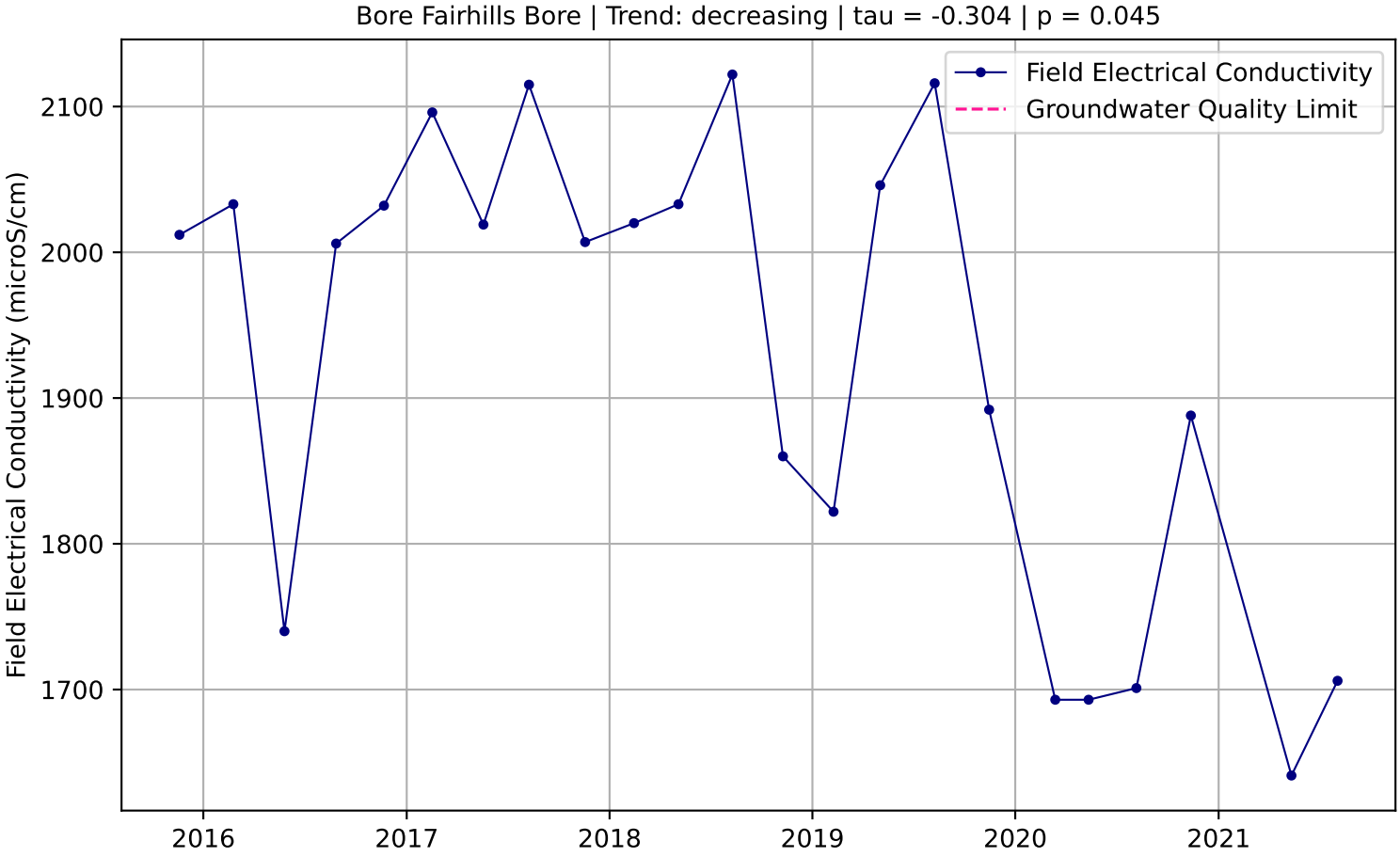

Bore Fairhills Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

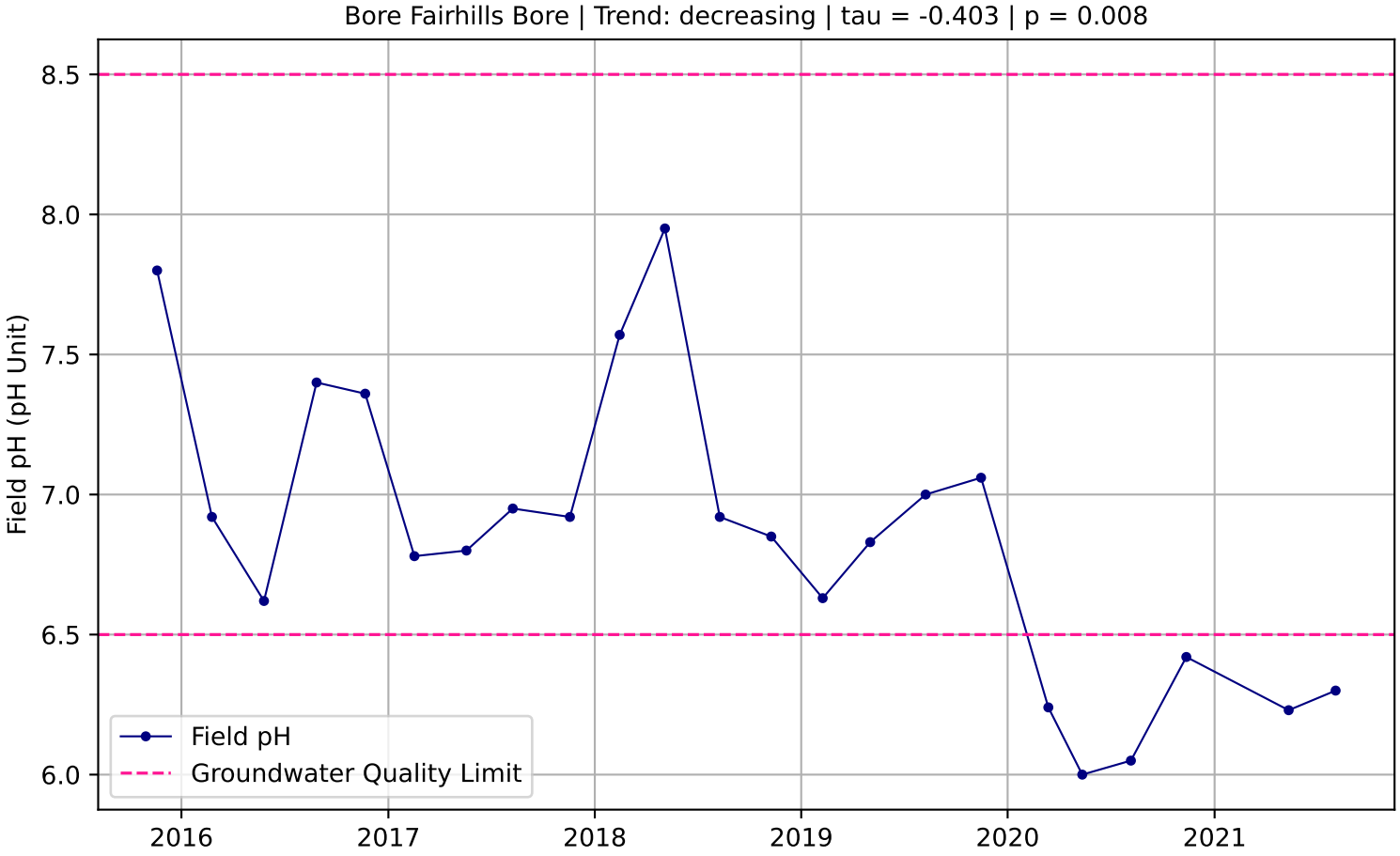

Bore Fairhills Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

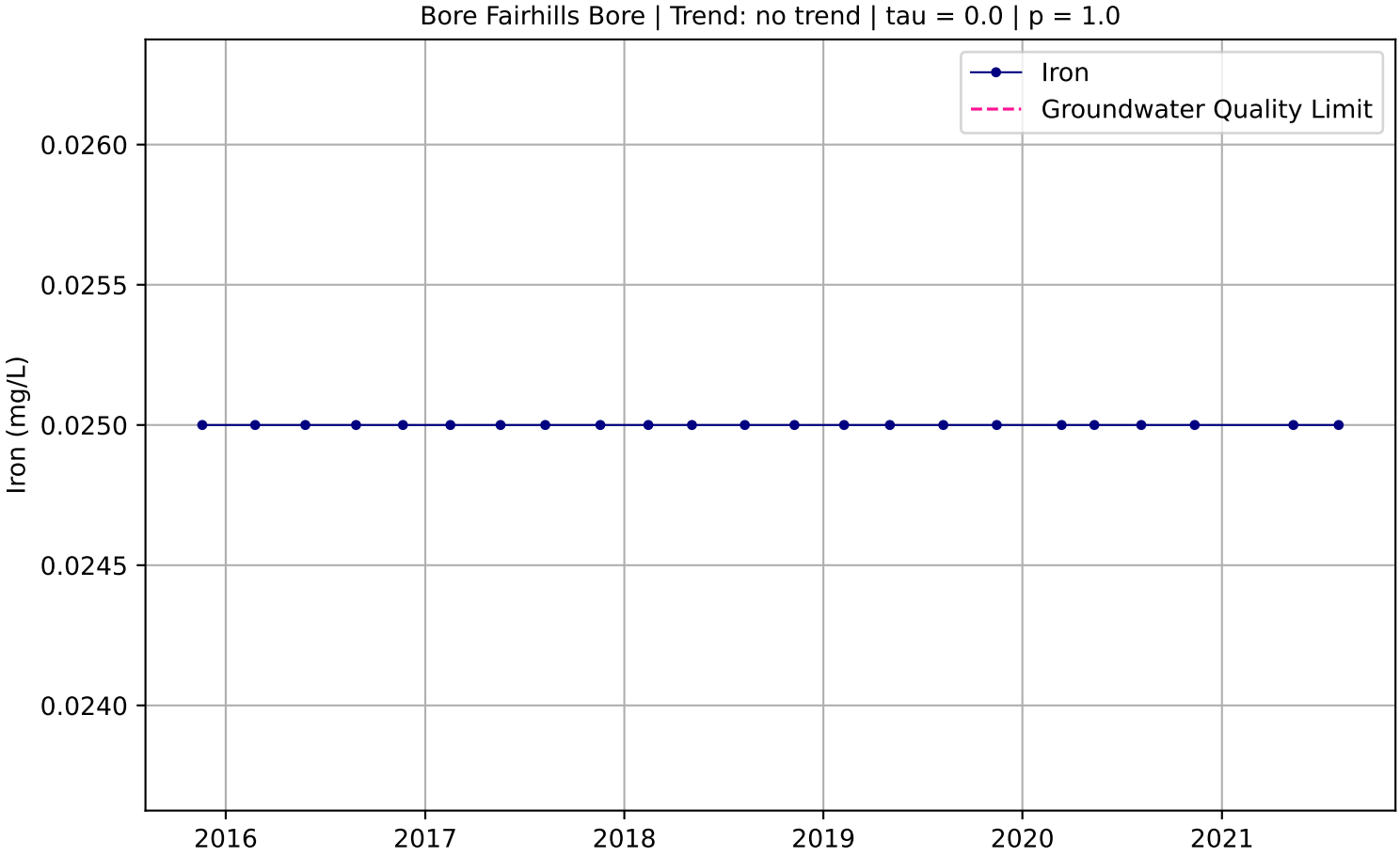

Bore Fairhills Bore | Trend: no trend | tau = -0.235 | p = 0.182
Calcium
Calcium (mg/L)
0
200
400
600
800
2018
2019
2020
2021

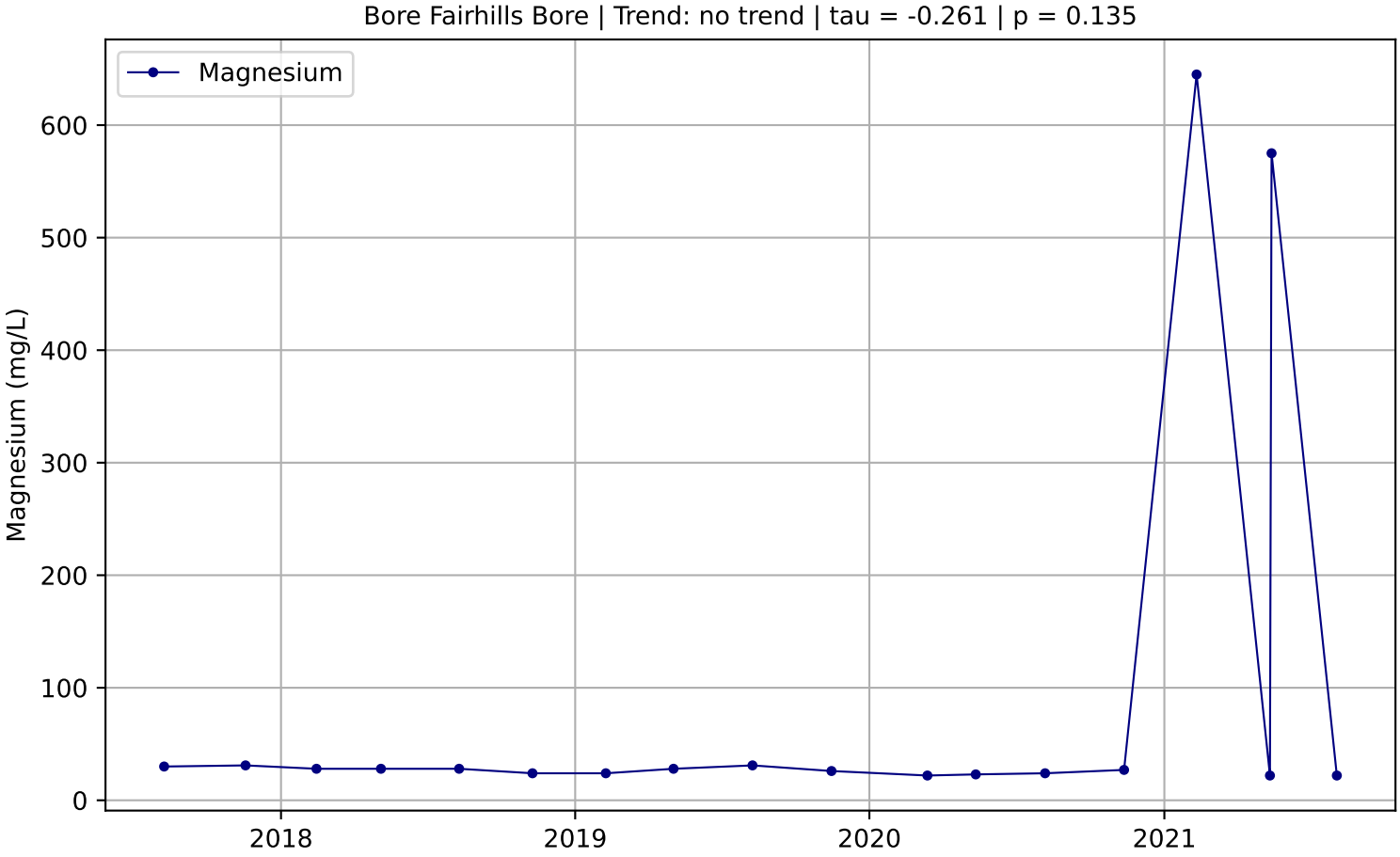

Bore Fairhills Bore | Trend: no trend | tau = -0.067 | p = 0.283
Carbonate
Carbonate (mg/L)
30
25
20
15
10
5
0
2017
2018
2019
2020
2021

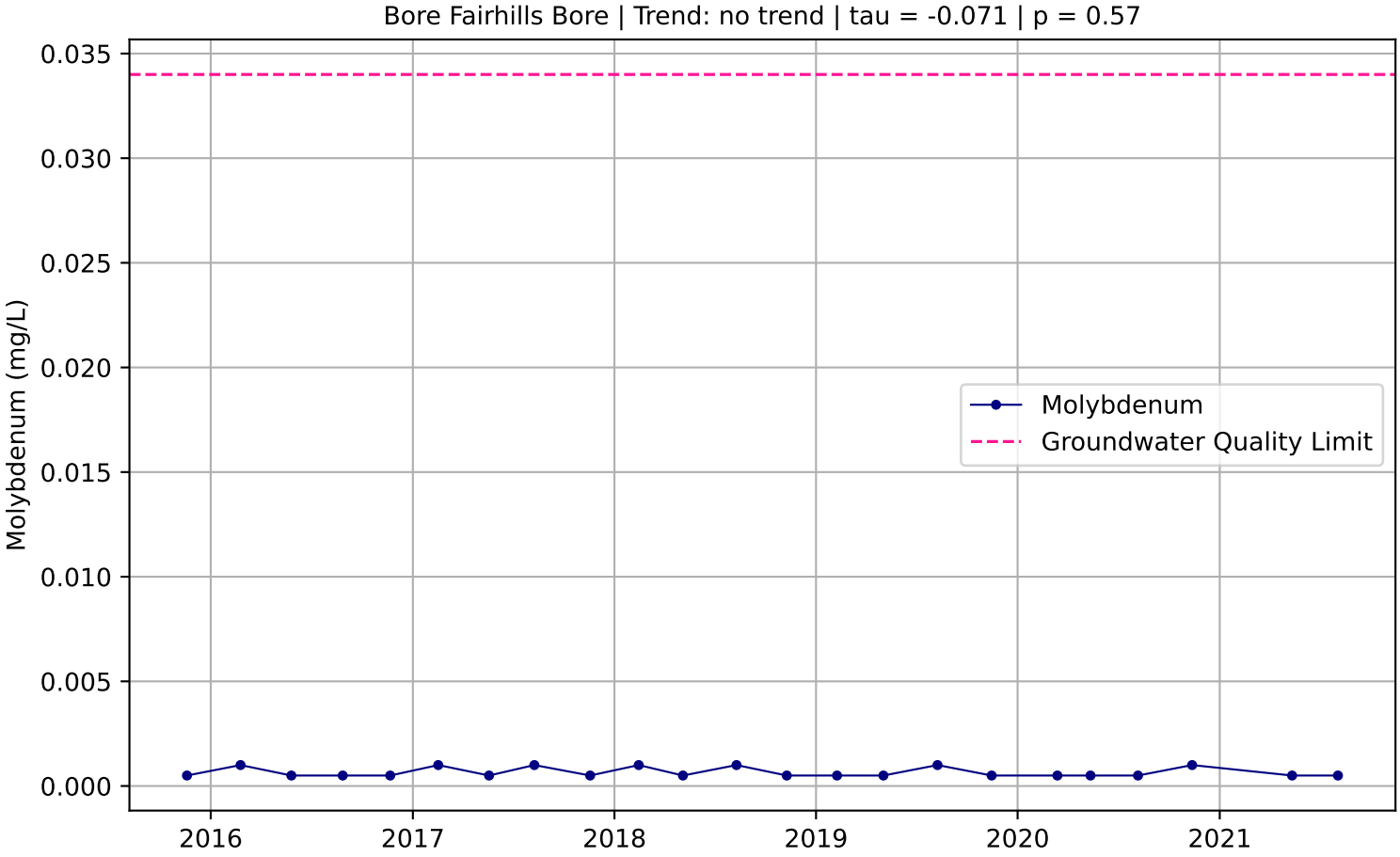

Bore Fairhills Bore | Trend: no trend | tau = -0.205 | p = 0.204
Chloride
Chloride (mg/L)
6000
5000
4000
3000
2000
1000
2017
2018
2019
2020
2021

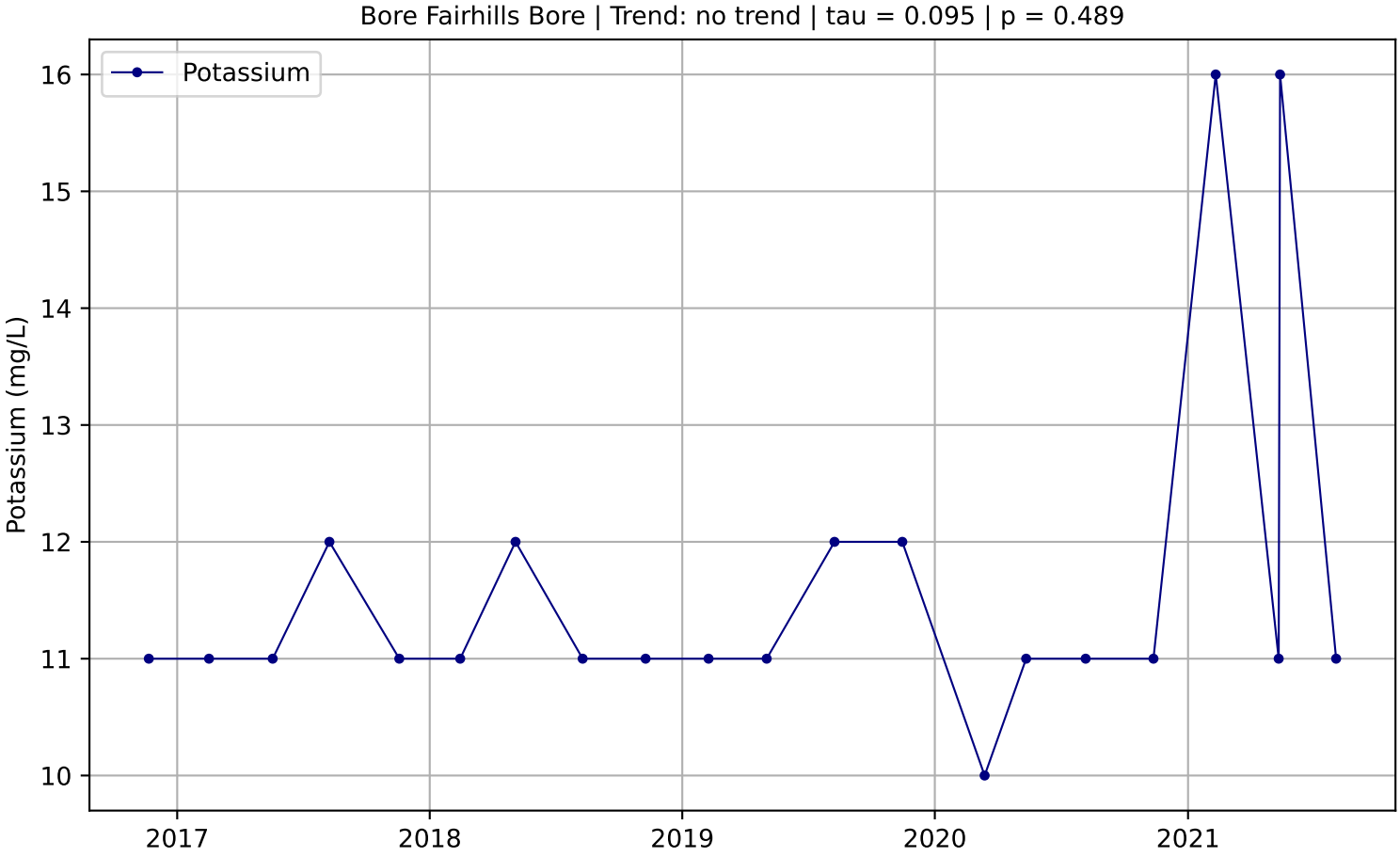

Bore Fairhills Bore | Trend: decreasing | tau = -0.304 | p = 0.045
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
2100
2000
1900
1800
1700
2016
2017
2018
2019
2020
2021

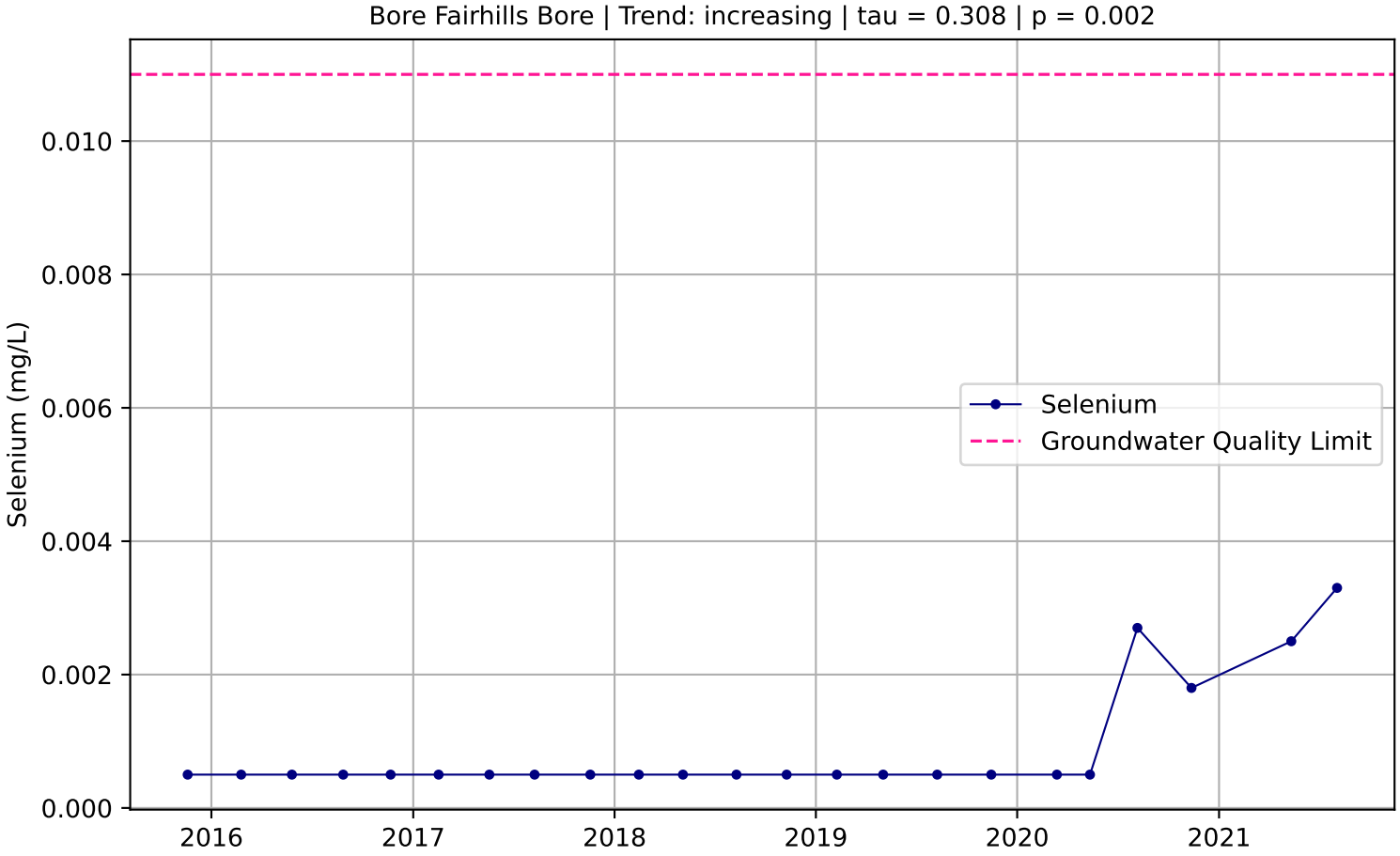

Bore Fairhills Bore | Trend: decreasing | tau = -0.403 | p = 0.008
Field pH (pH Unit)
8.5
8.0
7.5
7.0
6.5
6.0
2016
2017
2018
2019
2020
2021
Field pH
Groundwater Quality Limit

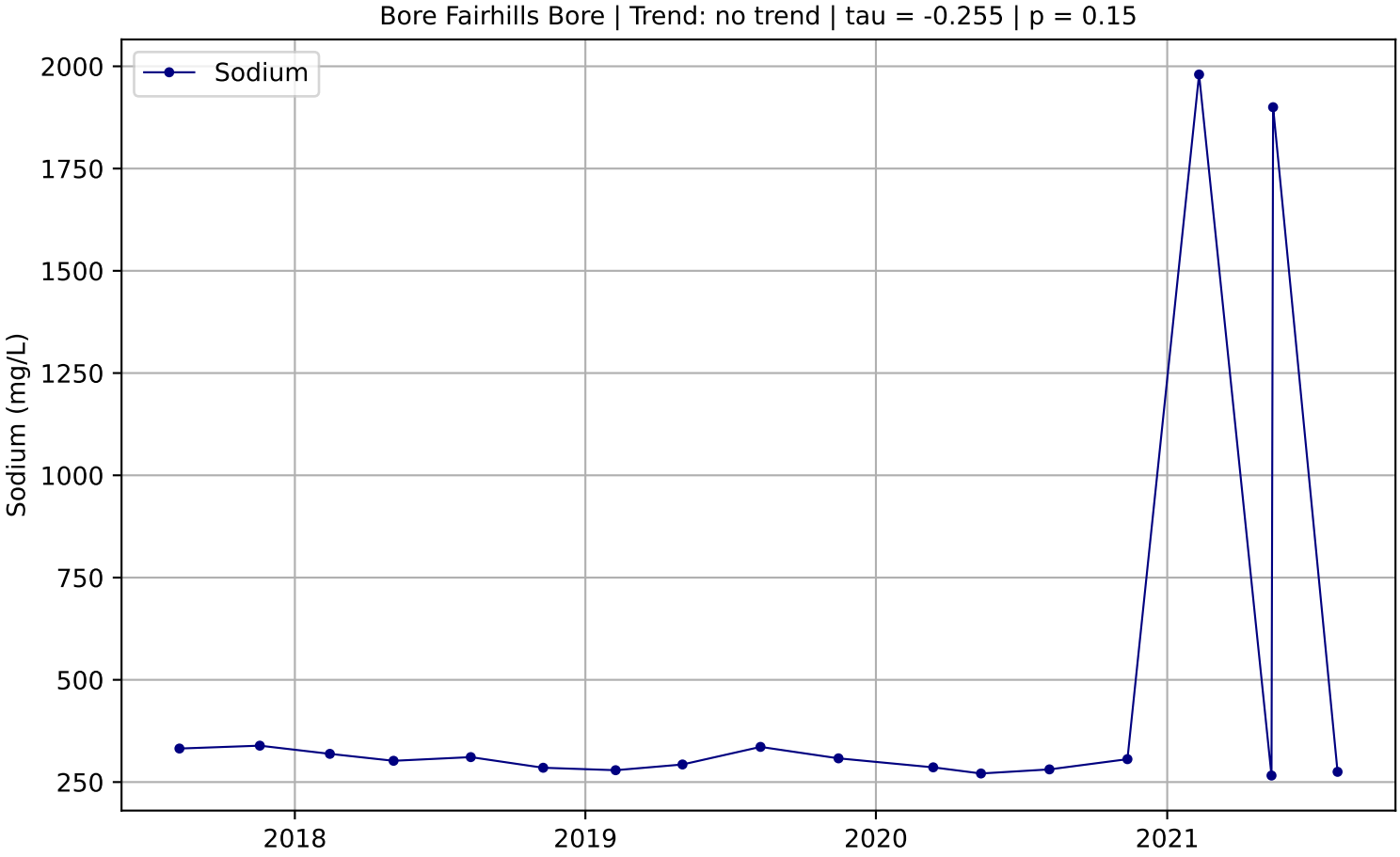

Bore Fairhills Bore | Trend: no trend | tau = 0.0 | p = 1.0
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0260
0.0255
0.0250
0.0245
0.0240
2016
2017
2018
2019
2020
2021

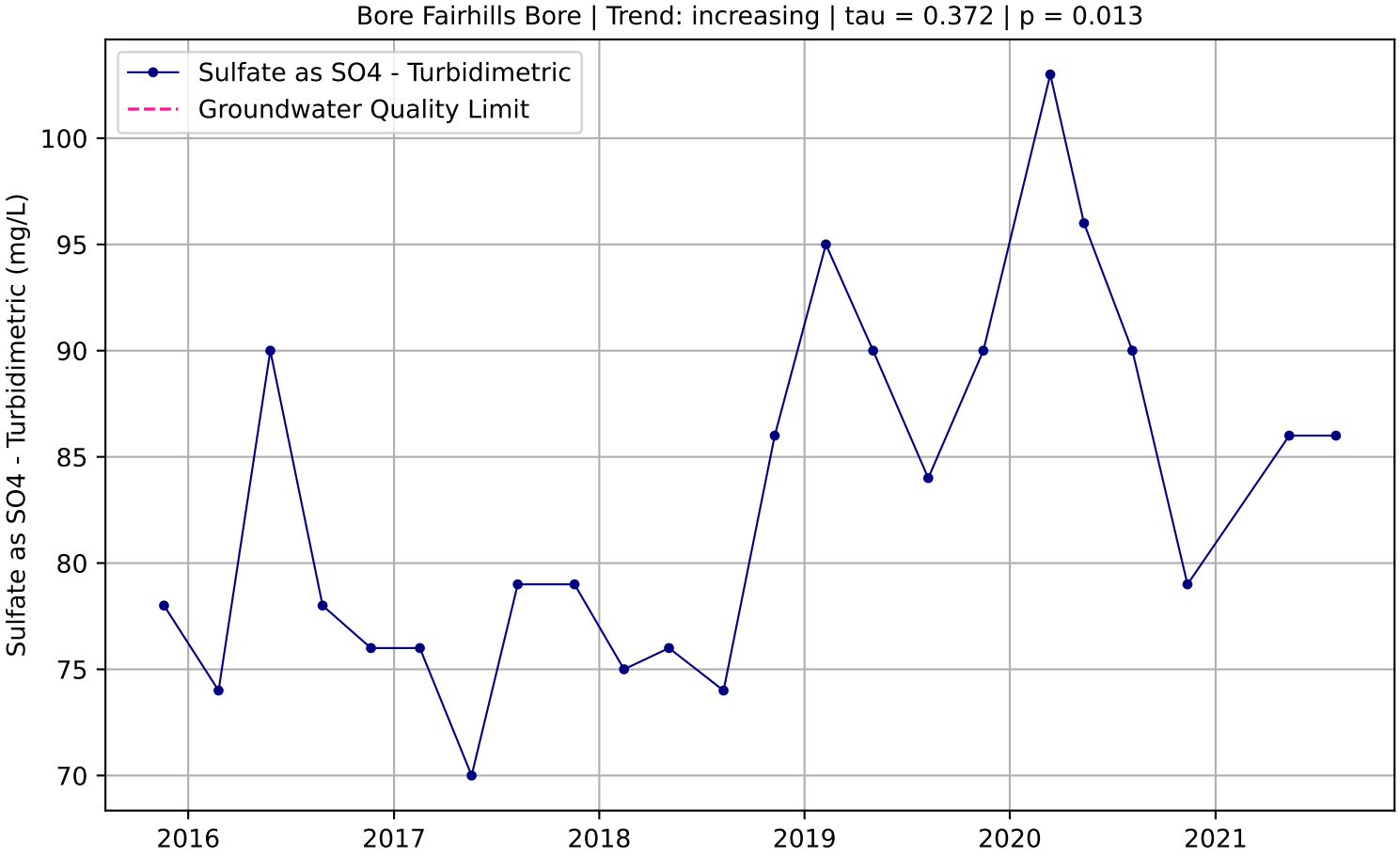

Bore Fairhills Bore | Trend: no trend | tau = -0.261 | p = 0.135
Magnesium
Magnesium (mg/L)
0
100
200
300
400
500
600
2018
2019
2020
2021

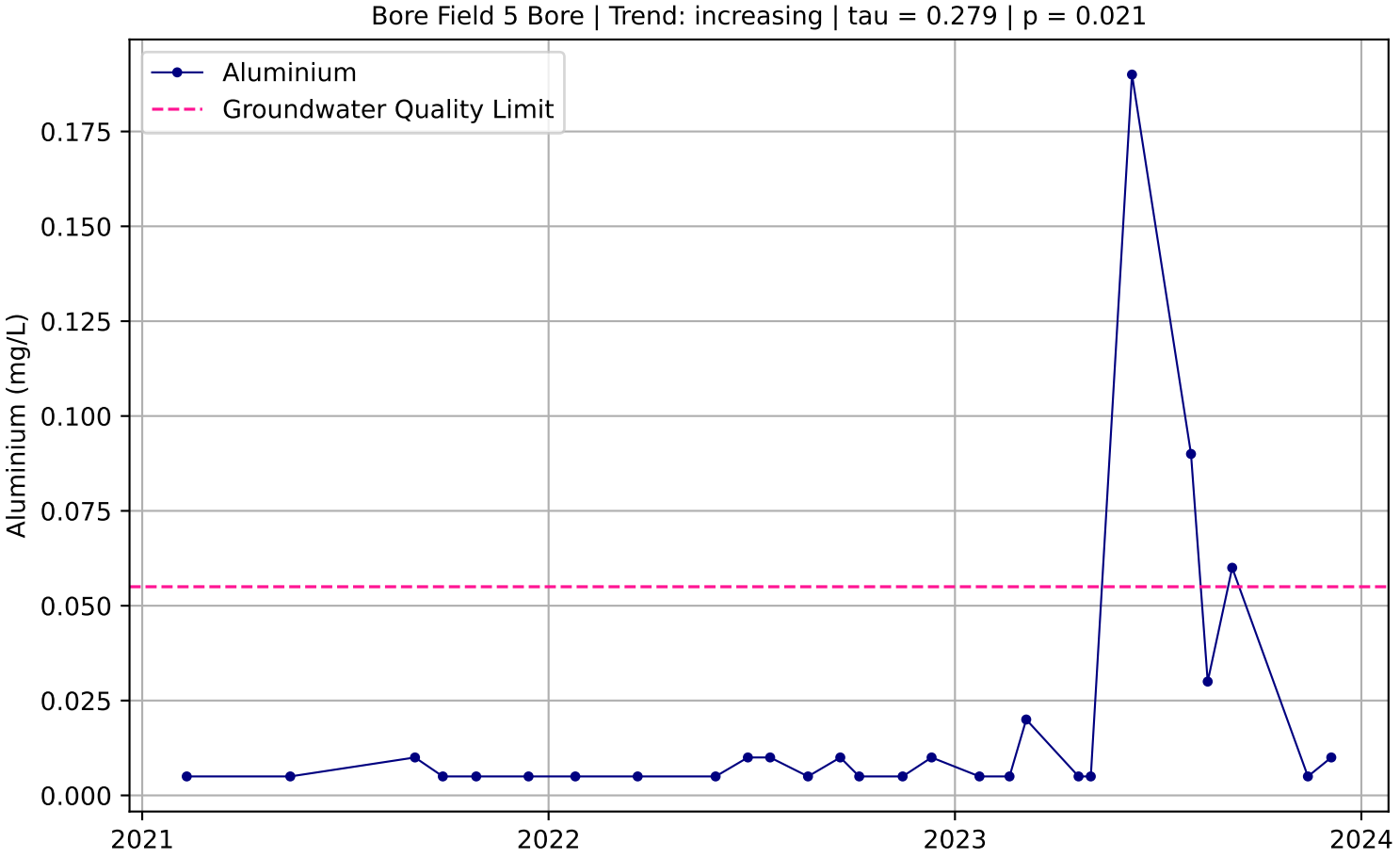

Bore Fairhills Bore | Trend: no trend | tau = -0.071 | p = 0.57
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit

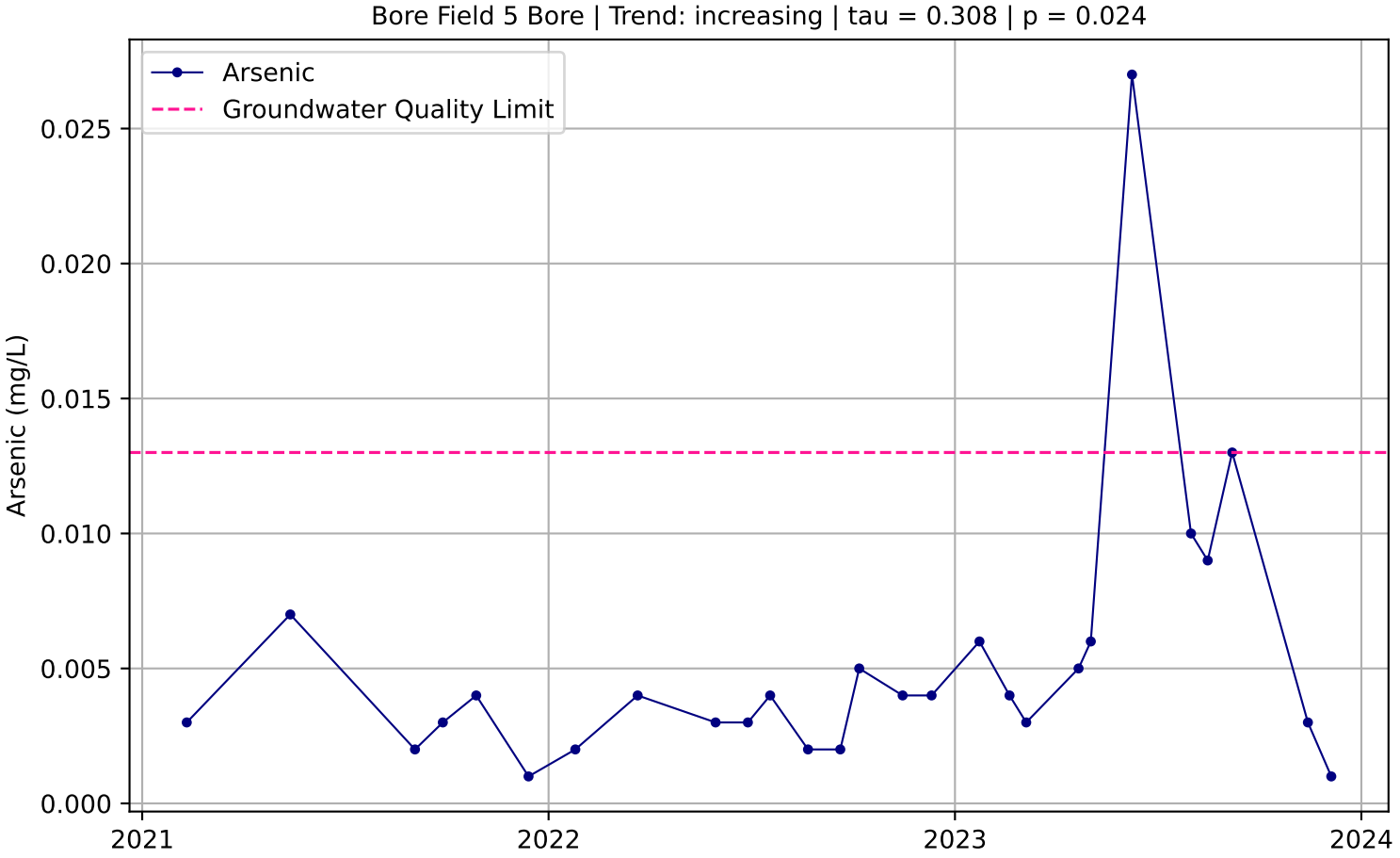

Bore Fairhills Bore | Trend: no trend | tau = 0.095 | p = 0.489
Potassium
Potassium (mg/L)
16
15
14
13
12
11
10
2017
2018
2019
2020
2021

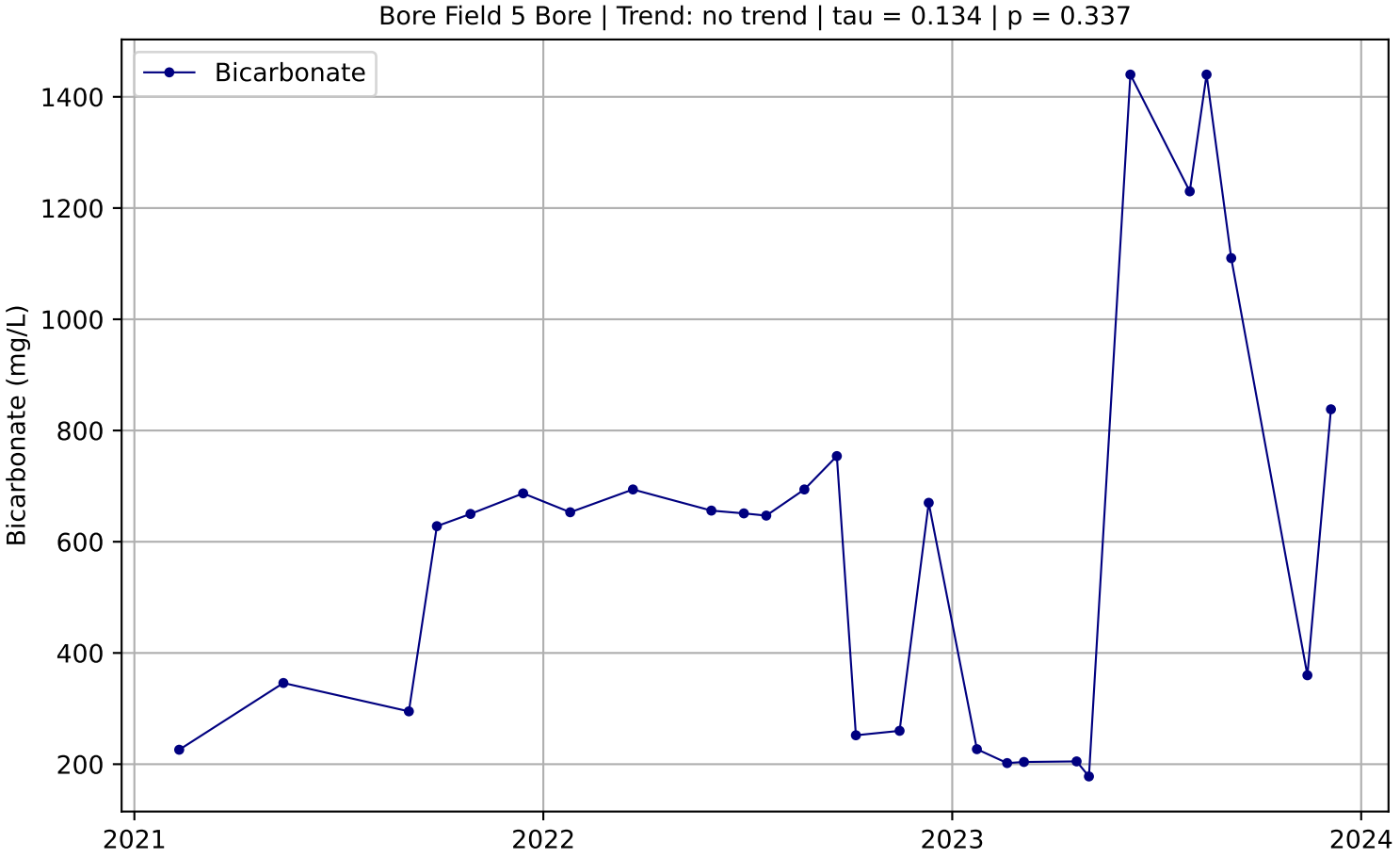

Bore Fairhills Bore | Trend: increasing | tau = 0.308 | p = 0.002
Selenium (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit

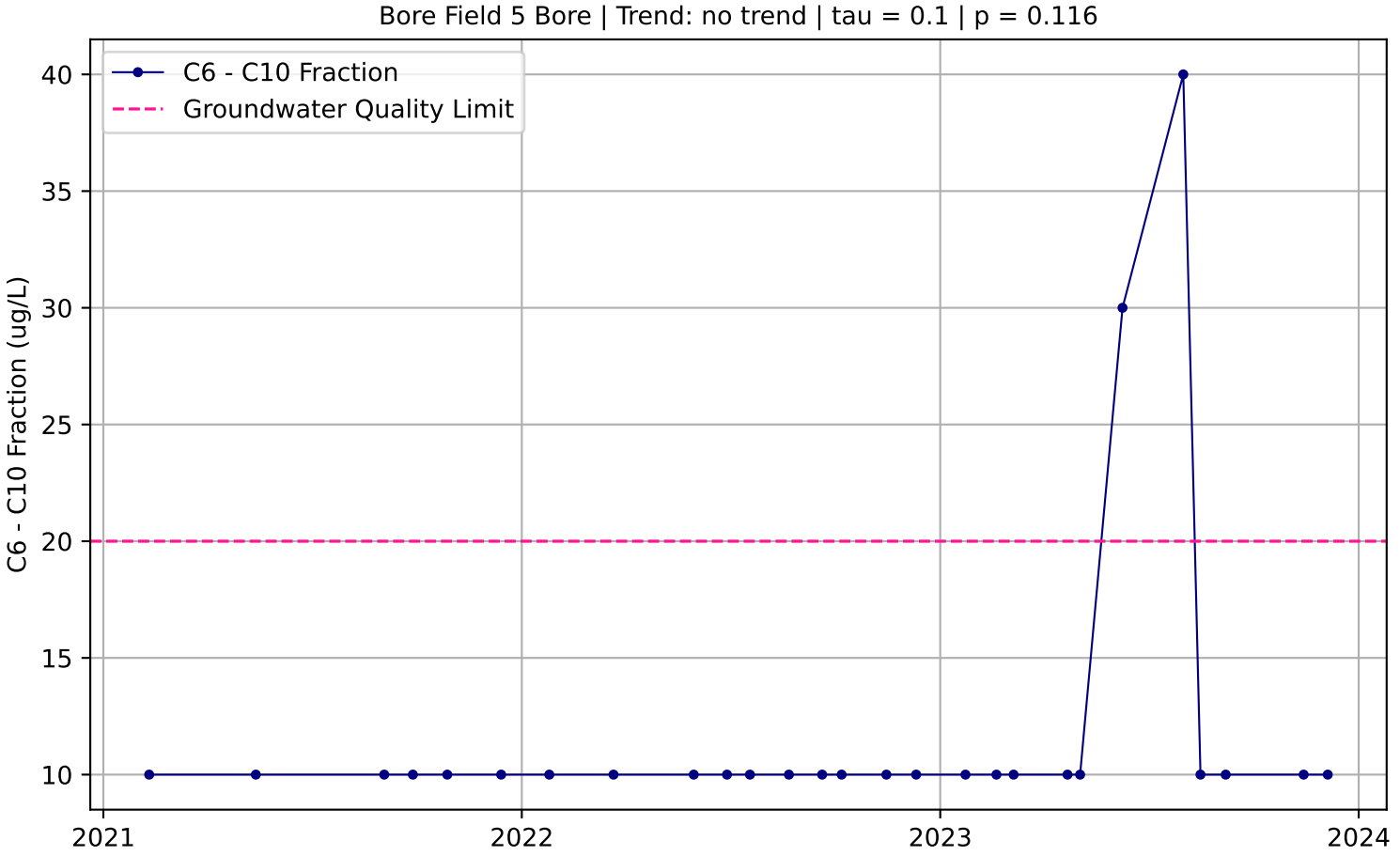

Bore Fairhills Bore | Trend: no trend | tau = -0.255 | p = 0.15
Sodium
Sodium (mg/L)
2000
1750
1500
1250
1000
750
500
250
2018
2019
2020
2021

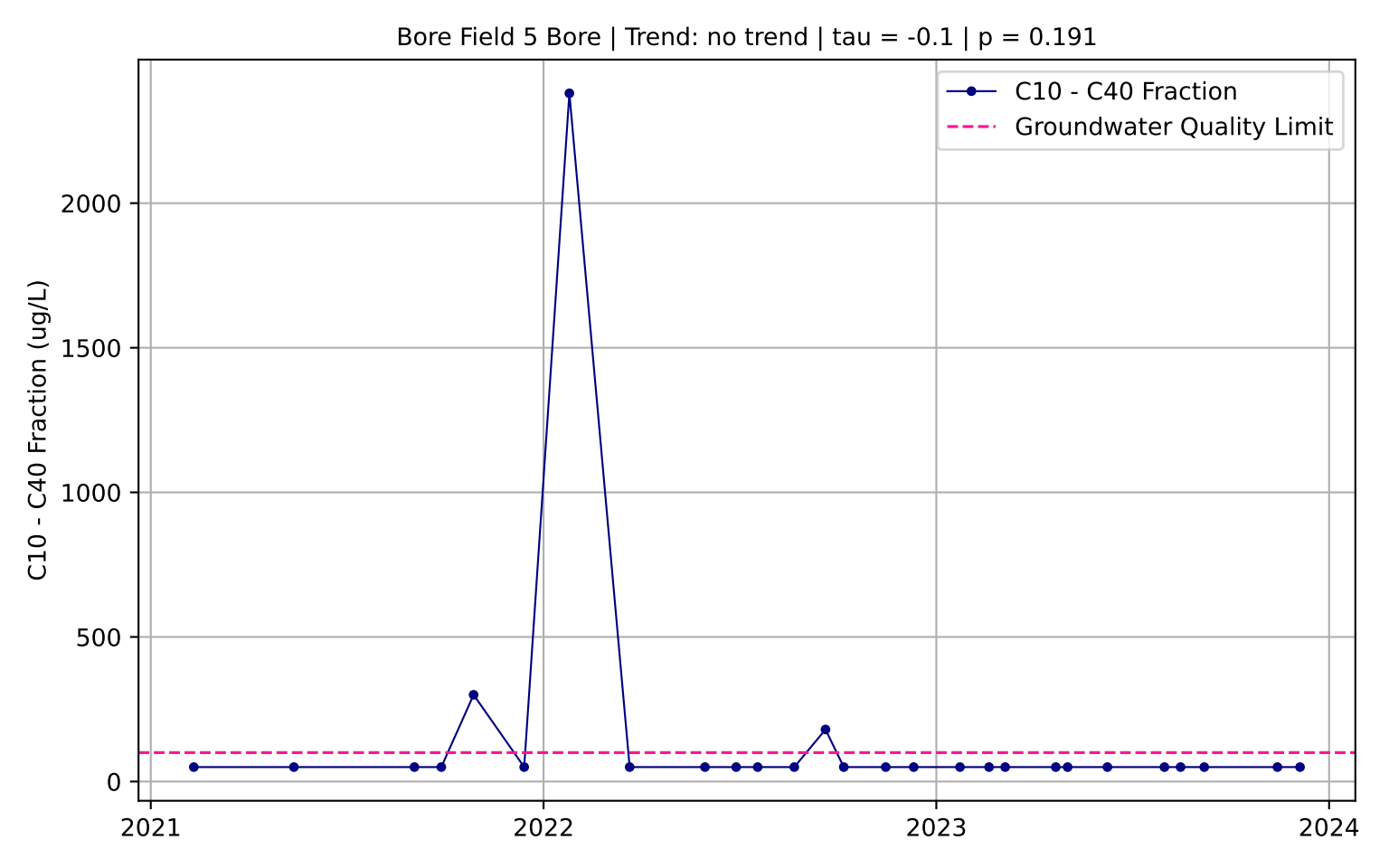

Bore Fairhills Bore | Trend: increasing | tau = 0.372 | p = 0.013
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
100
95
90
85
80
75
70
2016
2017
2018
2019
2020
2021

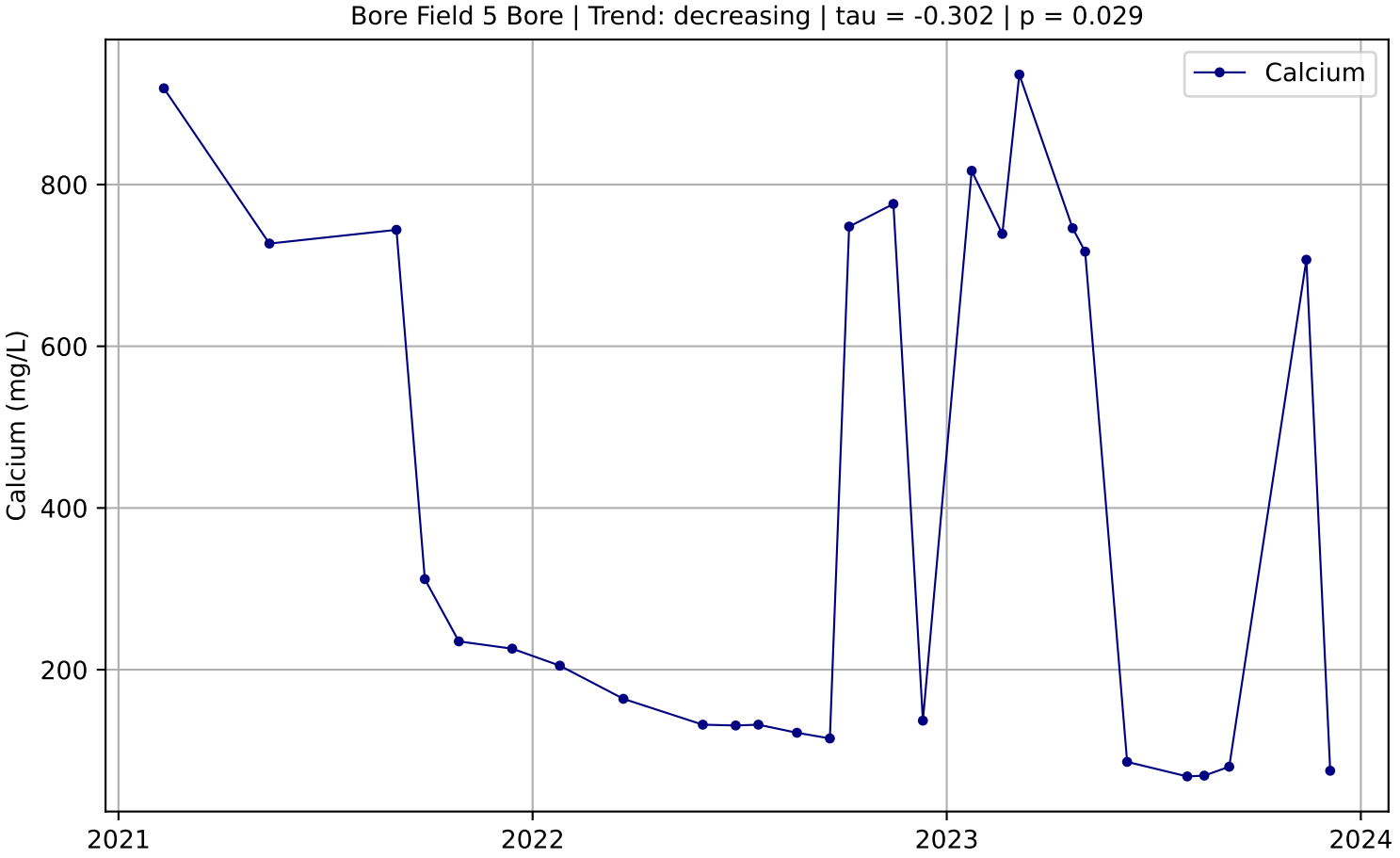

Bore Field 5 Bore | Trend: increasing | tau = 0.279 | p = 0.021
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
2021
2022
2023
2024

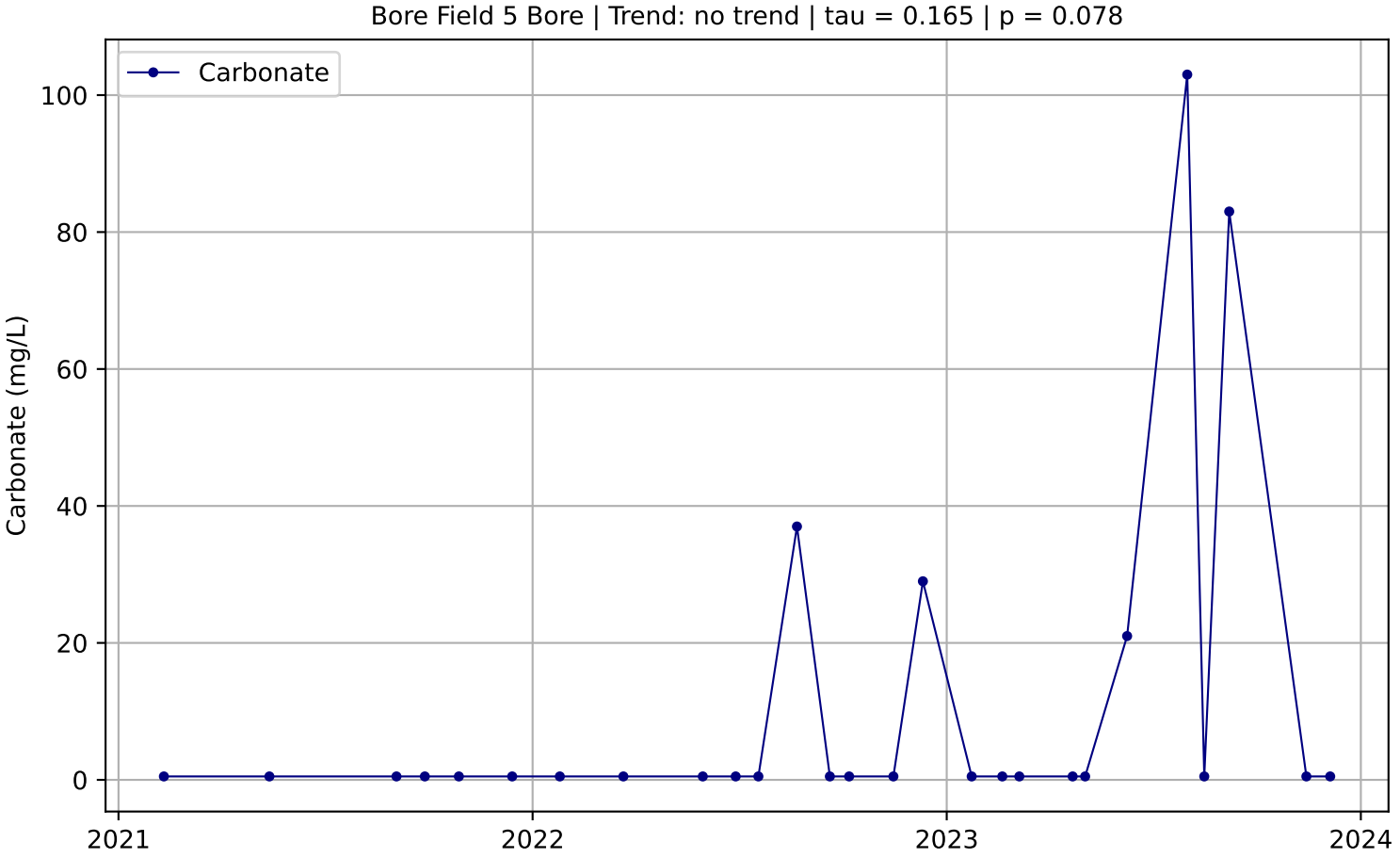

Bore Field 5 Bore | Trend: increasing | tau = 0.308 | p = 0.024
Arsenic
Groundwater Quality Limit
Arsenic (mg/L)
0.000
0.005
0.010
0.015
0.020
0.025
2021
2022
2023
2024

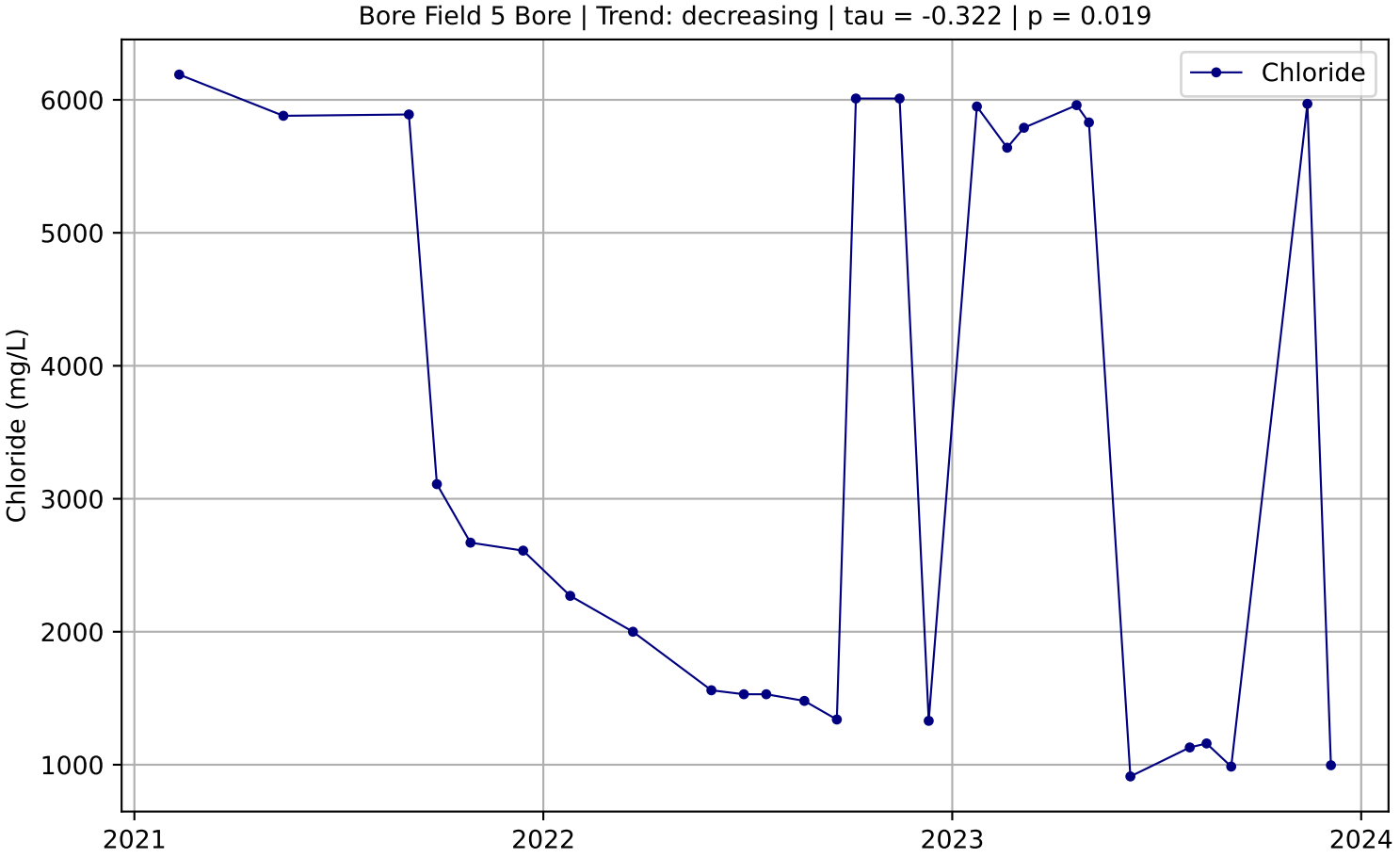

Bore Field 5 Bore | Trend: no trend | tau = 0.134 | p = 0.337
Bicarbonate
Bicarbonate (mg/L)
1400
1200
1000
800
600
400
200
2021
2022
2023
2024

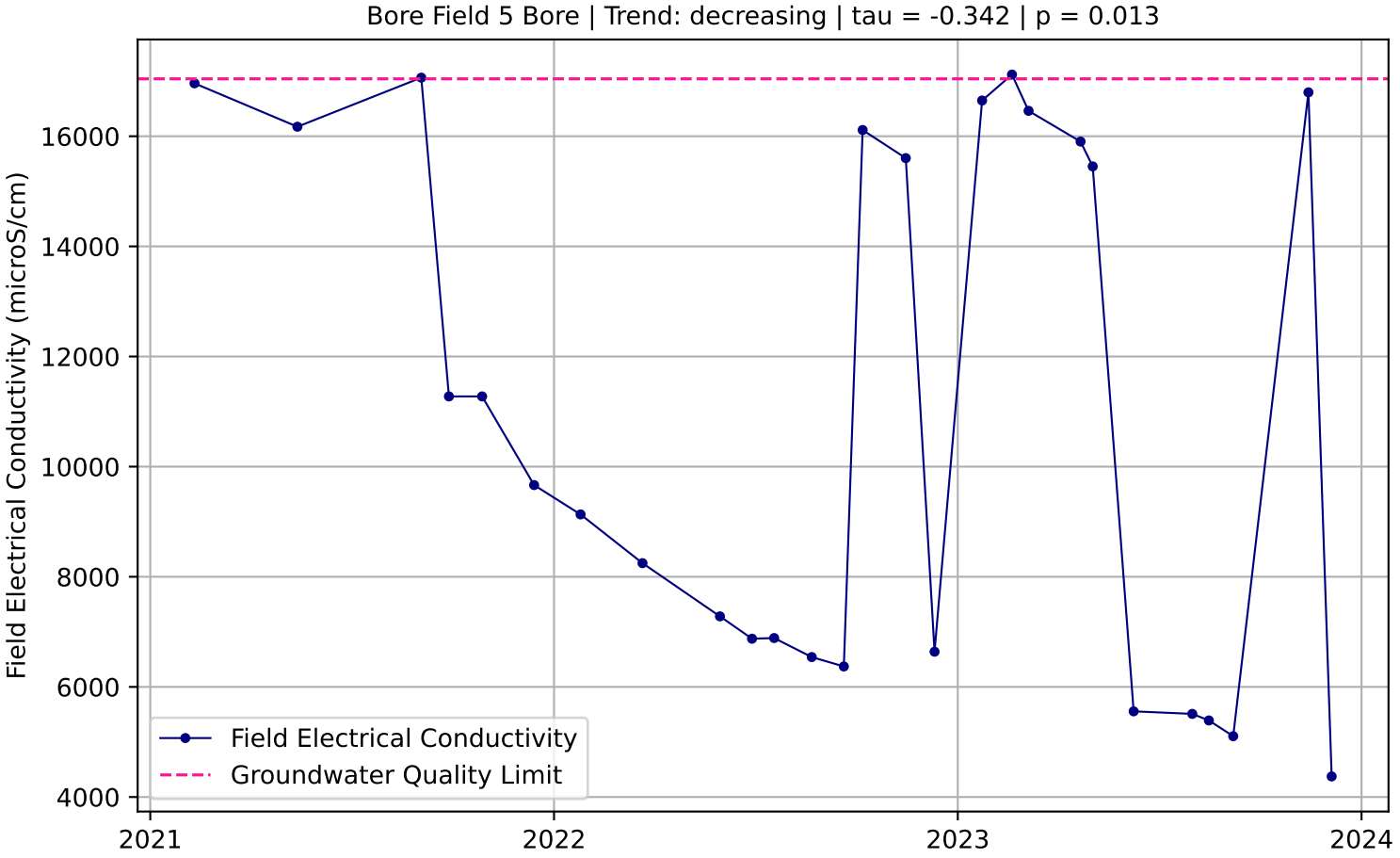

Bore Field 5 Bore | Trend: no trend | tau = 0.1 | p = 0.116
C6 - C10 Fraction
Groundwater Quality Limit
C6 - C10 Fraction (ug/L)
40
35
30
25
20
15
10
2021
2022
2023
2024

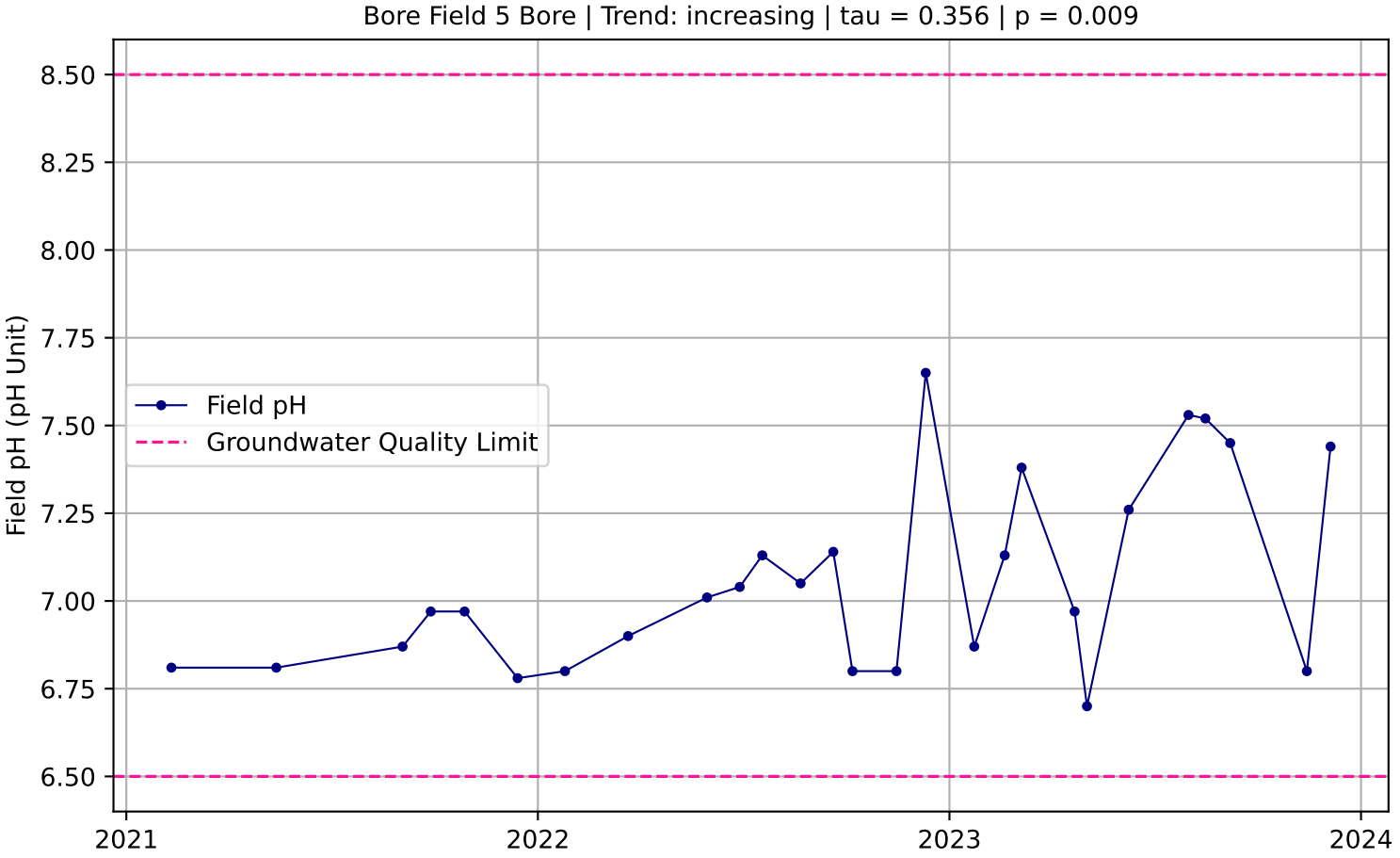

Bore Field 5 Bore | Trend: no trend | tau = -0.1 | p = 0.191
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
0
500
1000
1500
2000
2021
2022
2023
2024

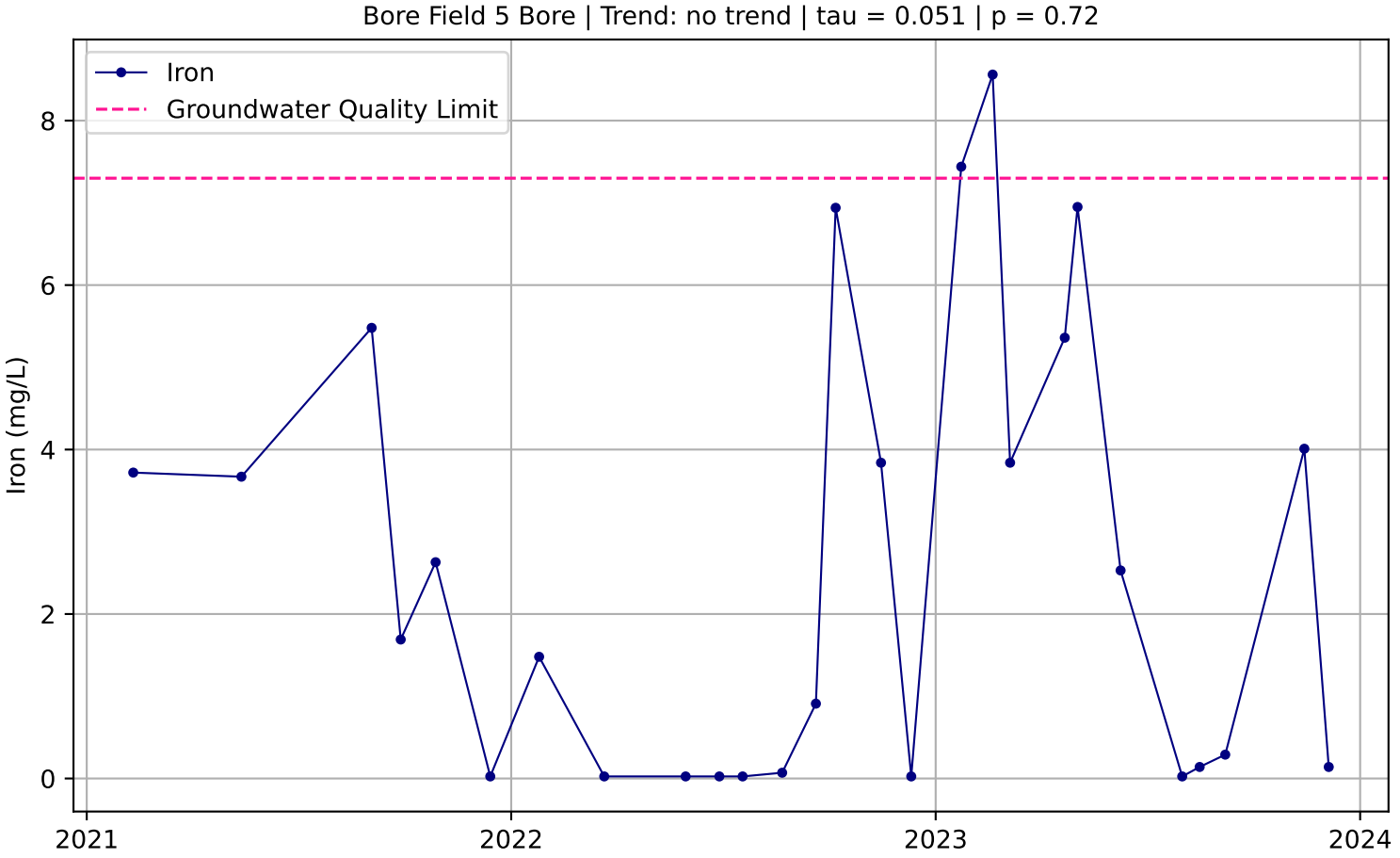

Bore Field 5 Bore | Trend: decreasing | tau = -0.302 | p = 0.029
Calcium
Calcium (mg/L)
800
600
400
200
2021
2022
2023
2024

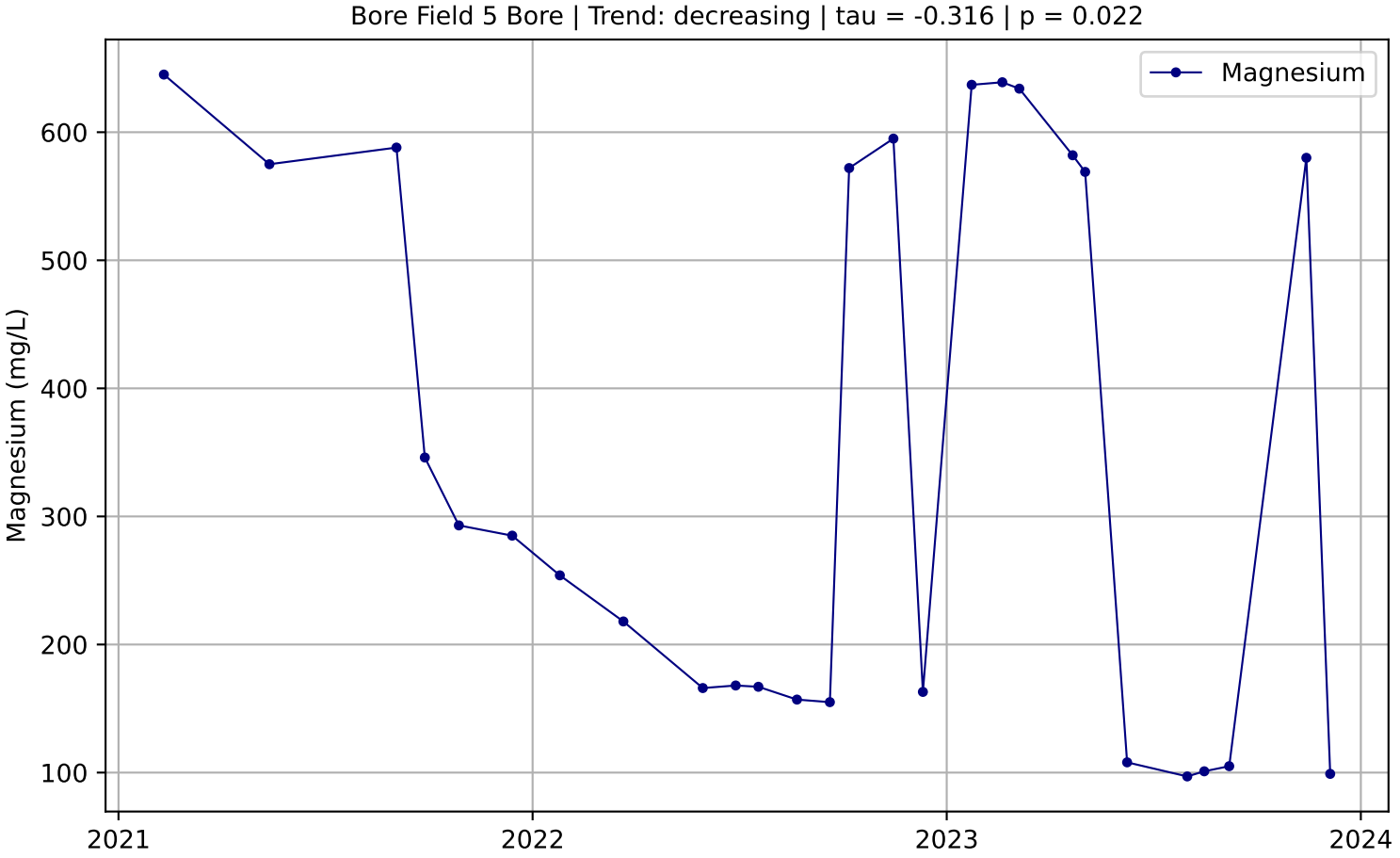

Bore Field 5 Bore | Trend: no trend | tau = 0.165 | p = 0.078
Carbonate
Carbonate (mg/L)
0
20
40
60
80
100
2021
2022
2023
2024

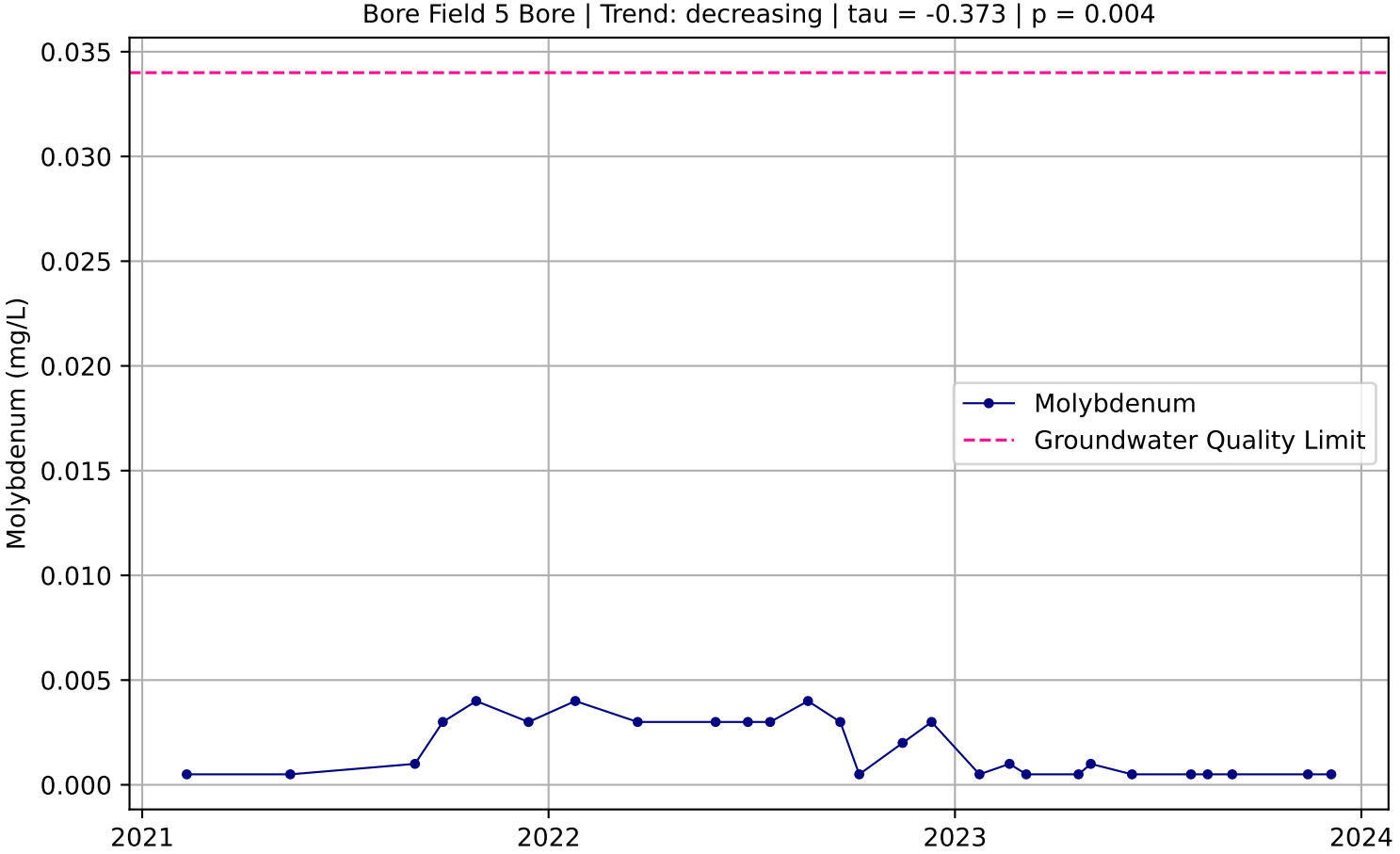

Bore Field 5 Bore | Trend: decreasing | tau = -0.322 | p = 0.019
Chloride
Chloride (mg/L)
6000
5000
4000
3000
2000
1000
2021
2022
2023
2024

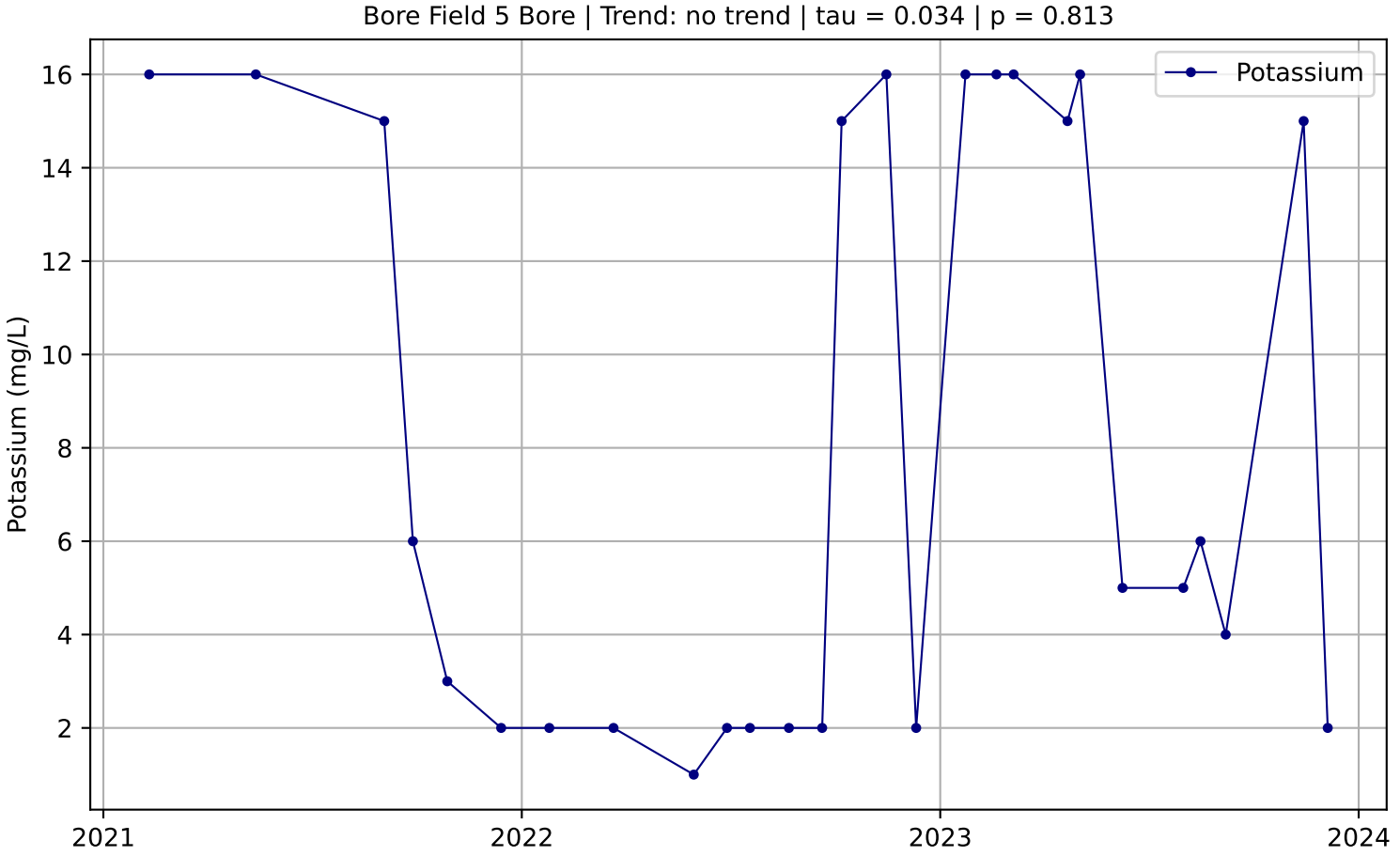

Bore Field 5 Bore | Trend: decreasing | tau = -0.342 | p = 0.013
Field Electrical Conductivity (microS/cm)
16000
14000
12000
10000
8000
6000
4000
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

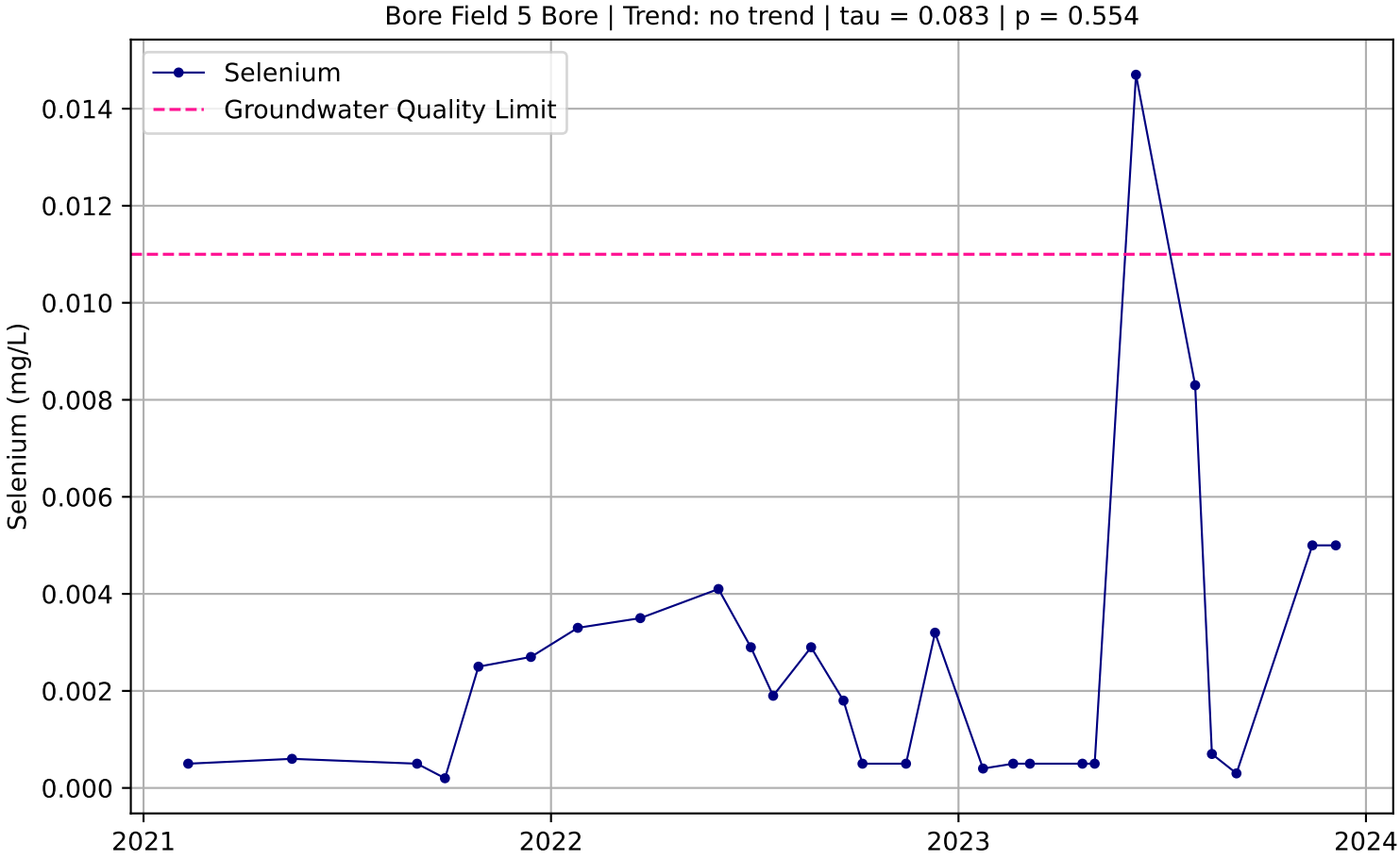

Bore Field 5 Bore | Trend: increasing | tau = 0.356 | p = 0.009
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

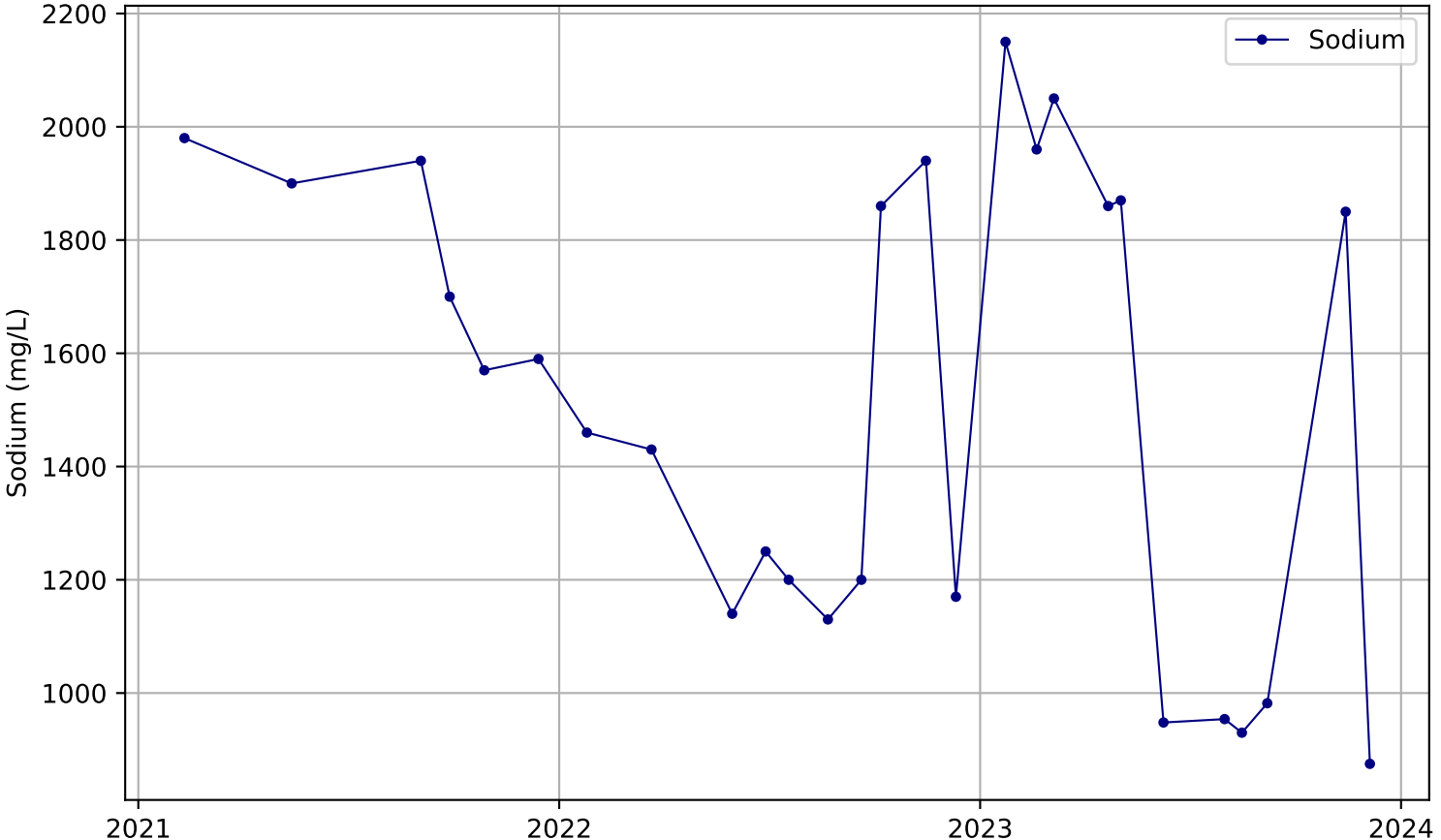

Bore Field 5 Bore | Trend: no trend | tau = 0.051 | p = 0.72
Iron
Groundwater Quality Limit
Iron (mg/L)
0
2
4
6
8
2021
2022
2023
2024

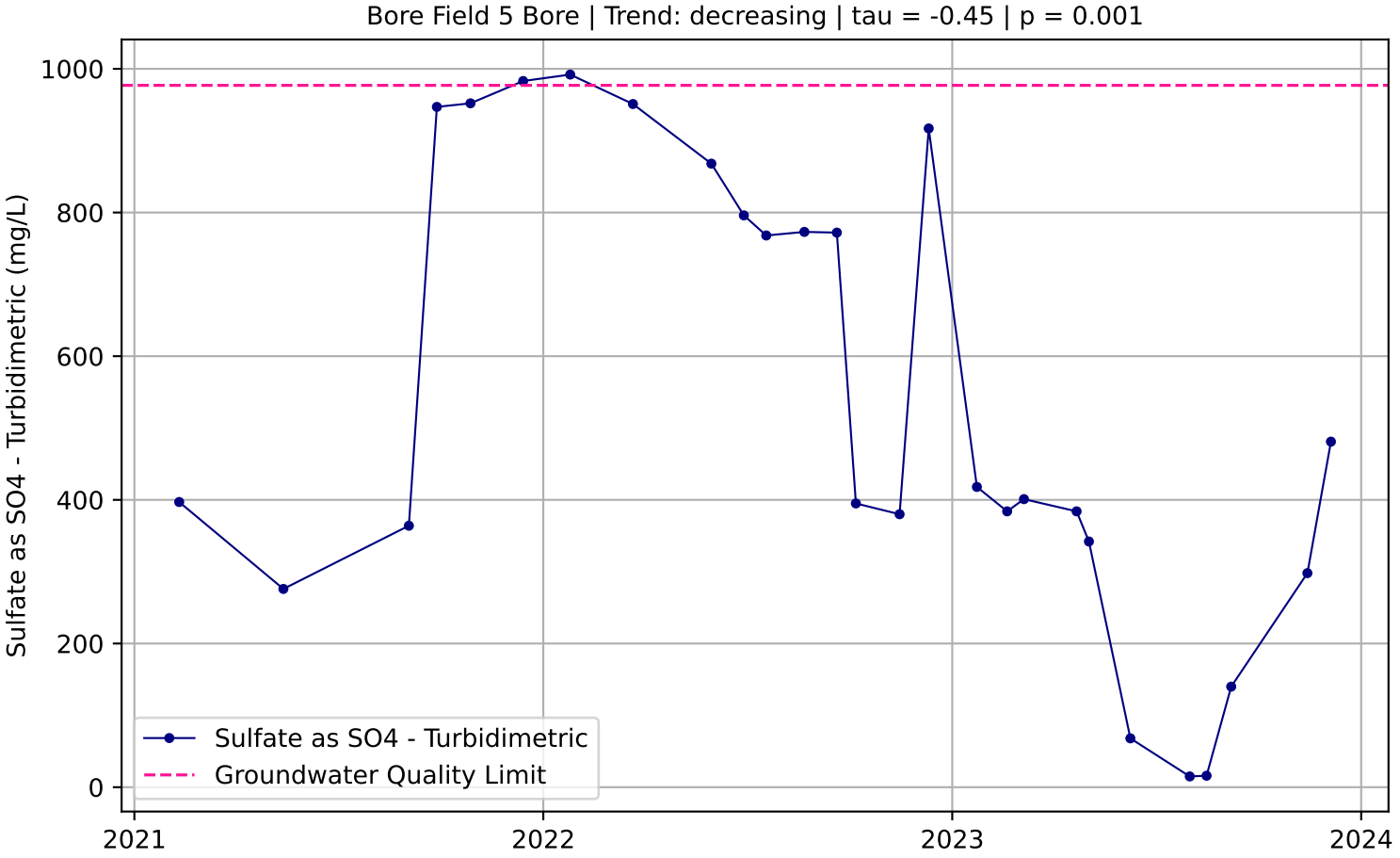

Bore Field 5 Bore | Trend: decreasing | tau = -0.316 | p = 0.022
Magnesium
Magnesium (mg/L)
600
500
400
300
200
100
2021
2022
2023
2024

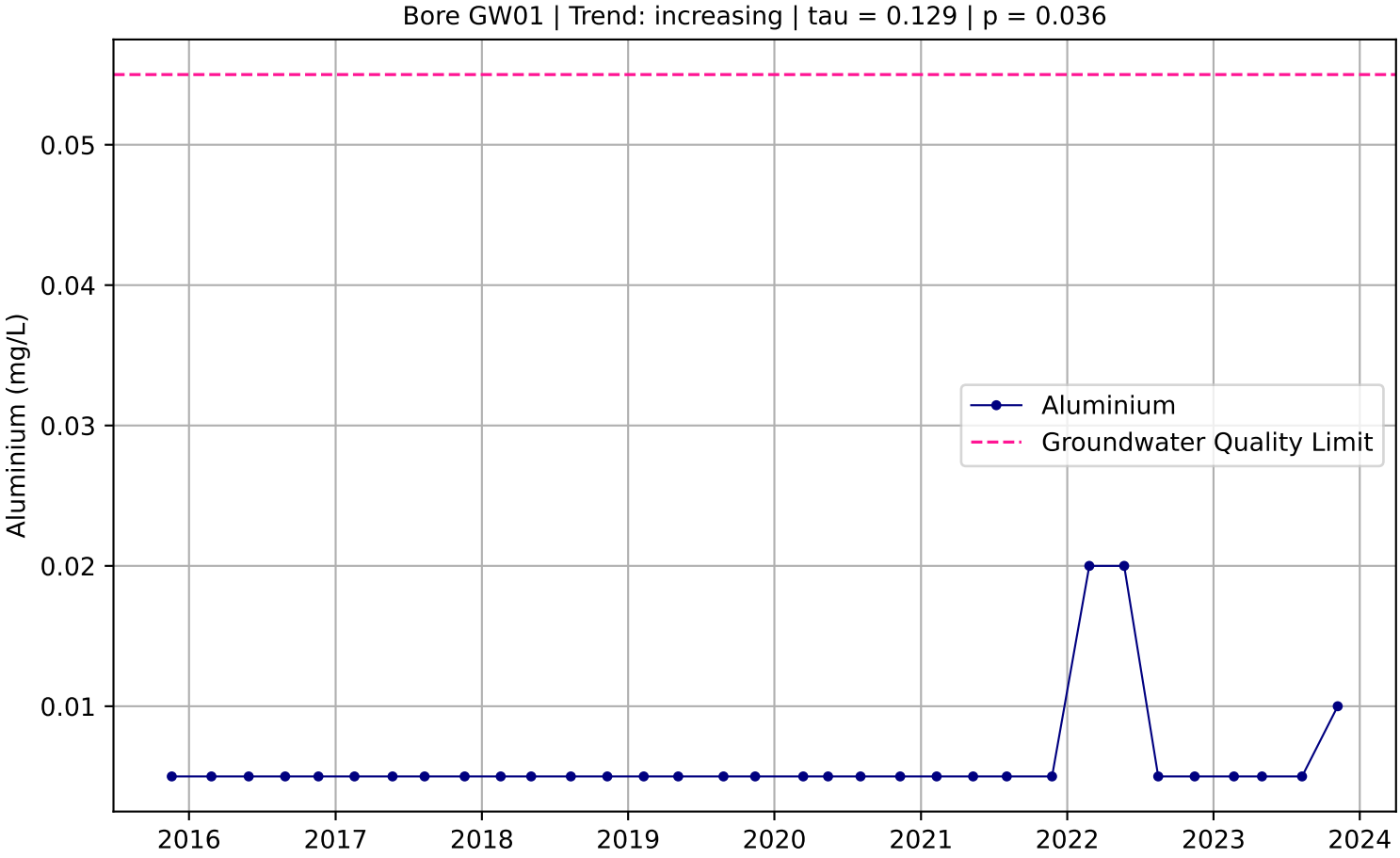

Bore Field 5 Bore | Trend: decreasing | tau = -0.373 | p = 0.004
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

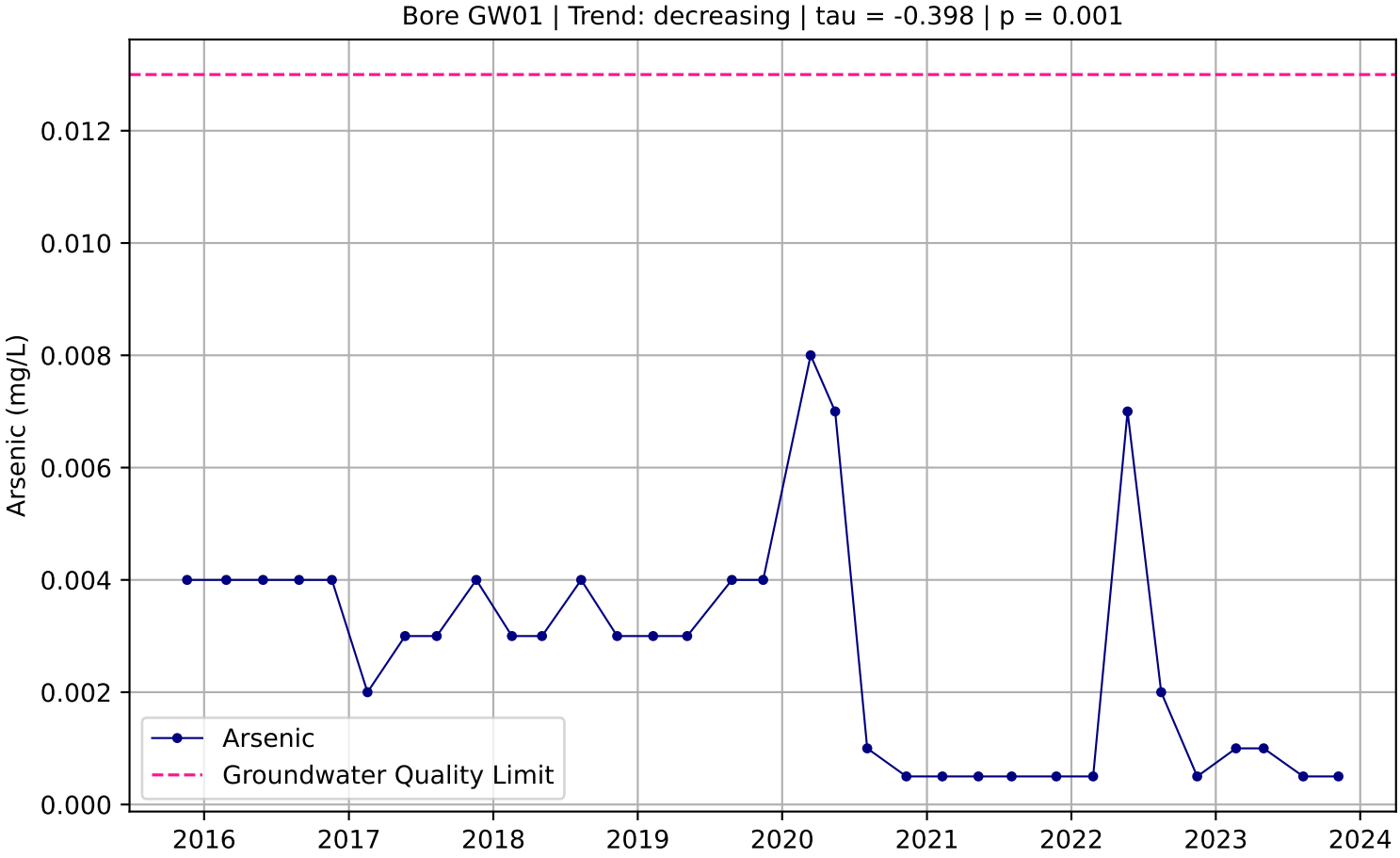

Bore Field 5 Bore | Trend: no trend | tau = 0.034 | p = 0.813
Potassium
Potassium (mg/L)
16
14
12
10
8
6
4
2
2021
2022
2023
2024

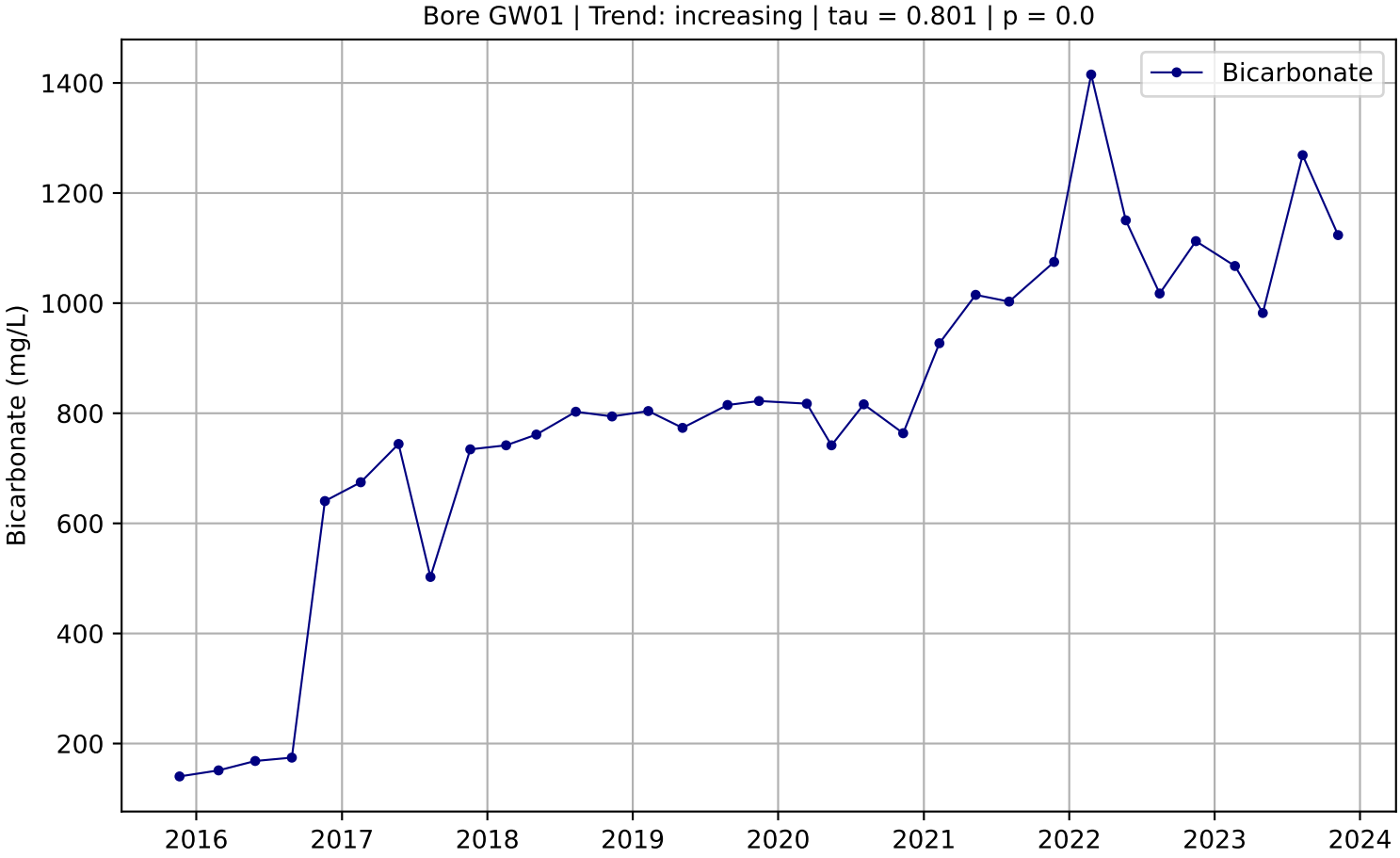

Bore Field 5 Bore | Trend: no trend | tau = 0.083 | p = 0.554
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2021
2022
2023
2024

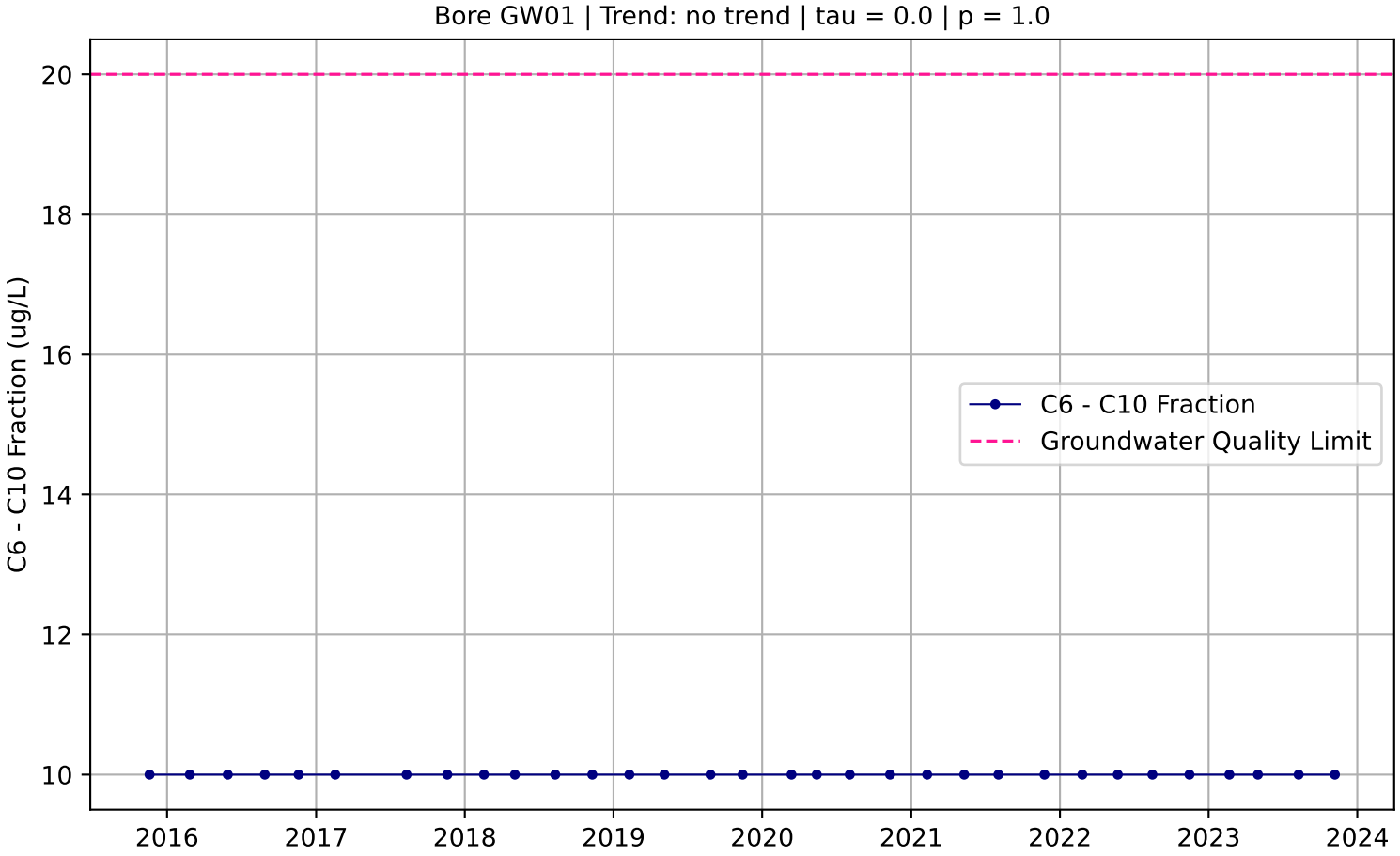

Bore Field 5 Bore | Trend: decreasing | tau = -0.302 | p = 0.028
Sodium
Sodium (mg/L)
2200
2000
1800
1600
1400
1200
1000
2021
2022
2023
2024

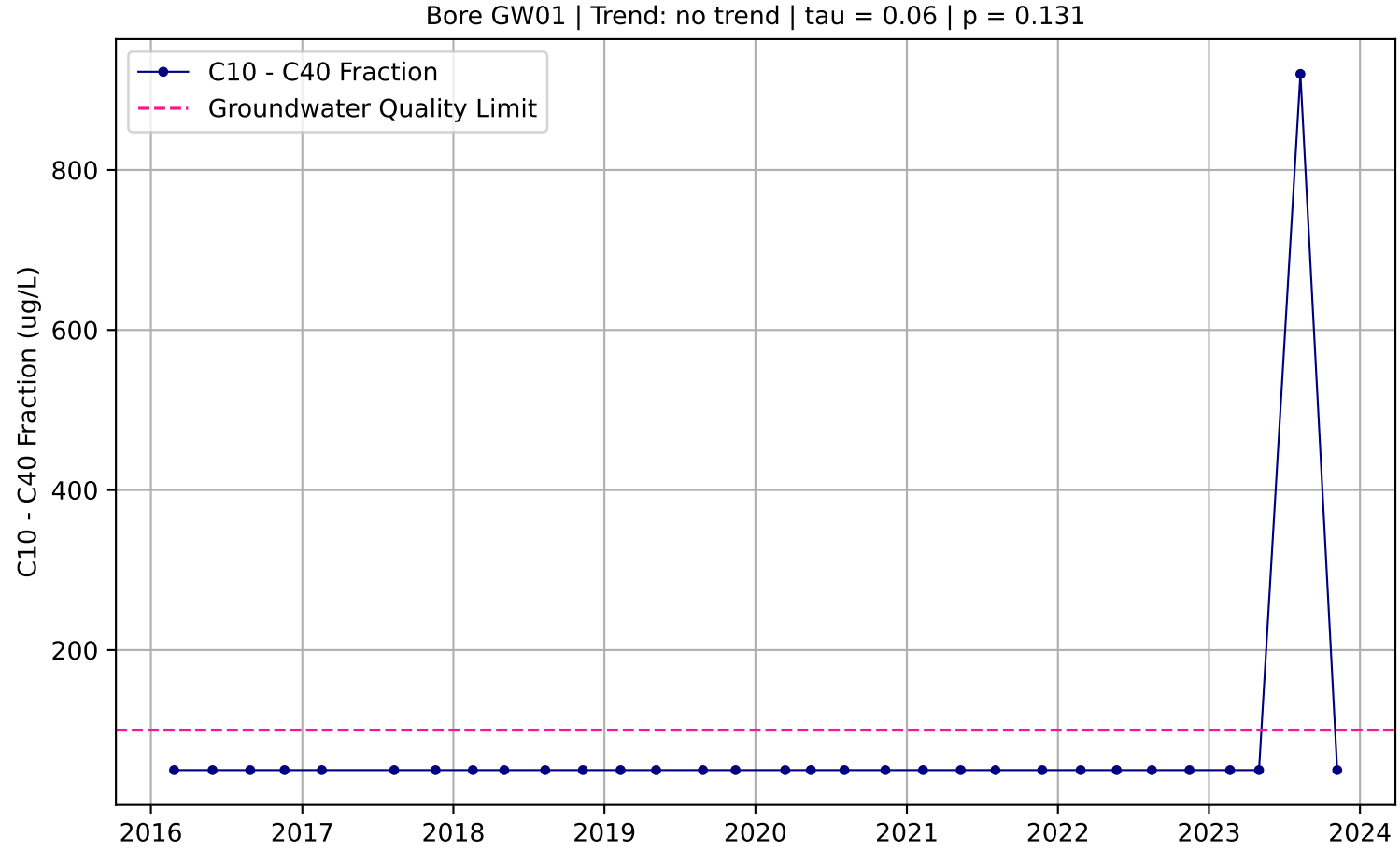

Bore Field 5 Bore | Trend: decreasing | tau = -0.45 | p = 0.001
Sulfate as SO4 - Turbidimetric (mg/L)
1000
800
600
400
200
0
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

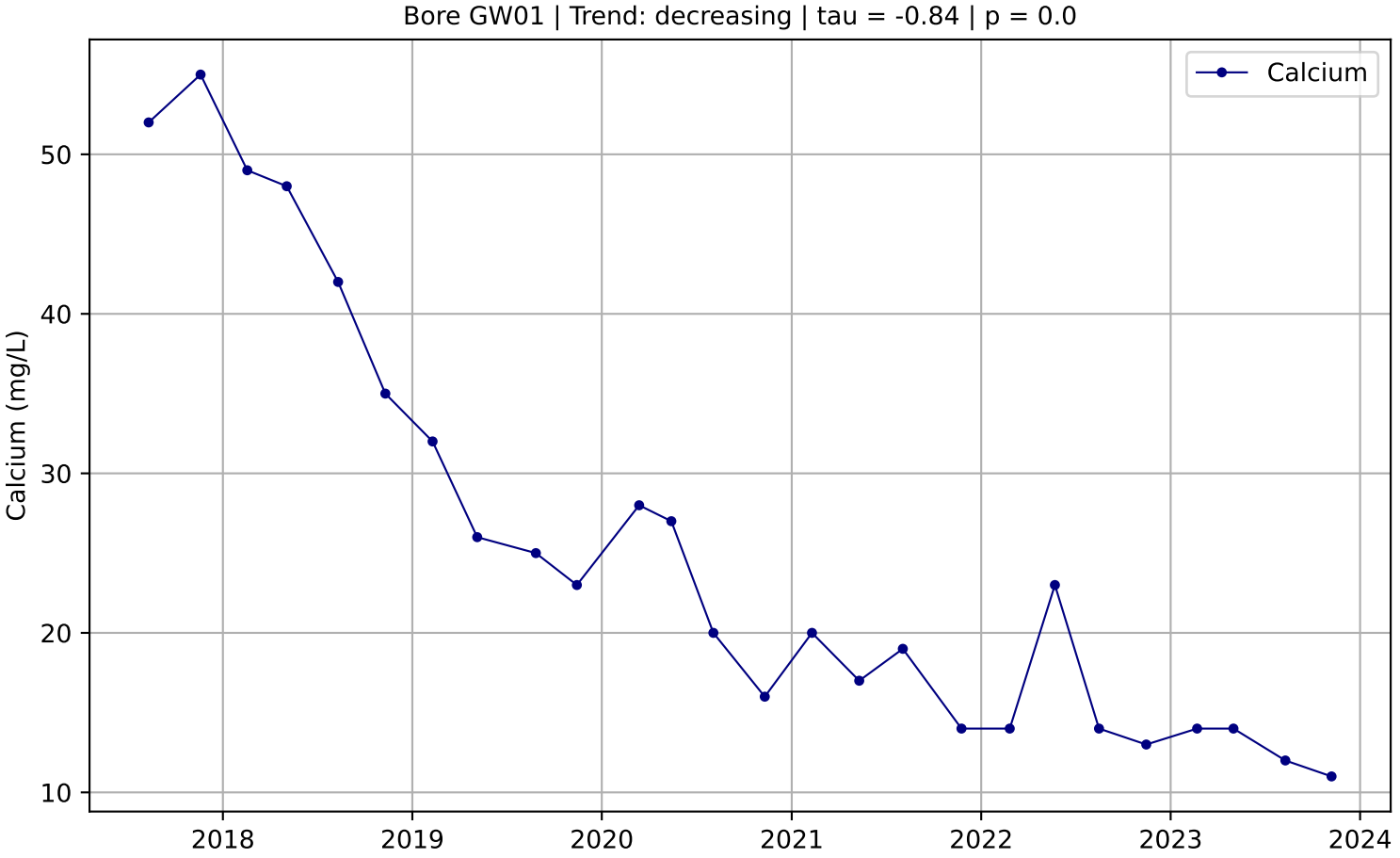

Bore GW01 | Trend: increasing | tau = 0.129 | p = 0.036
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

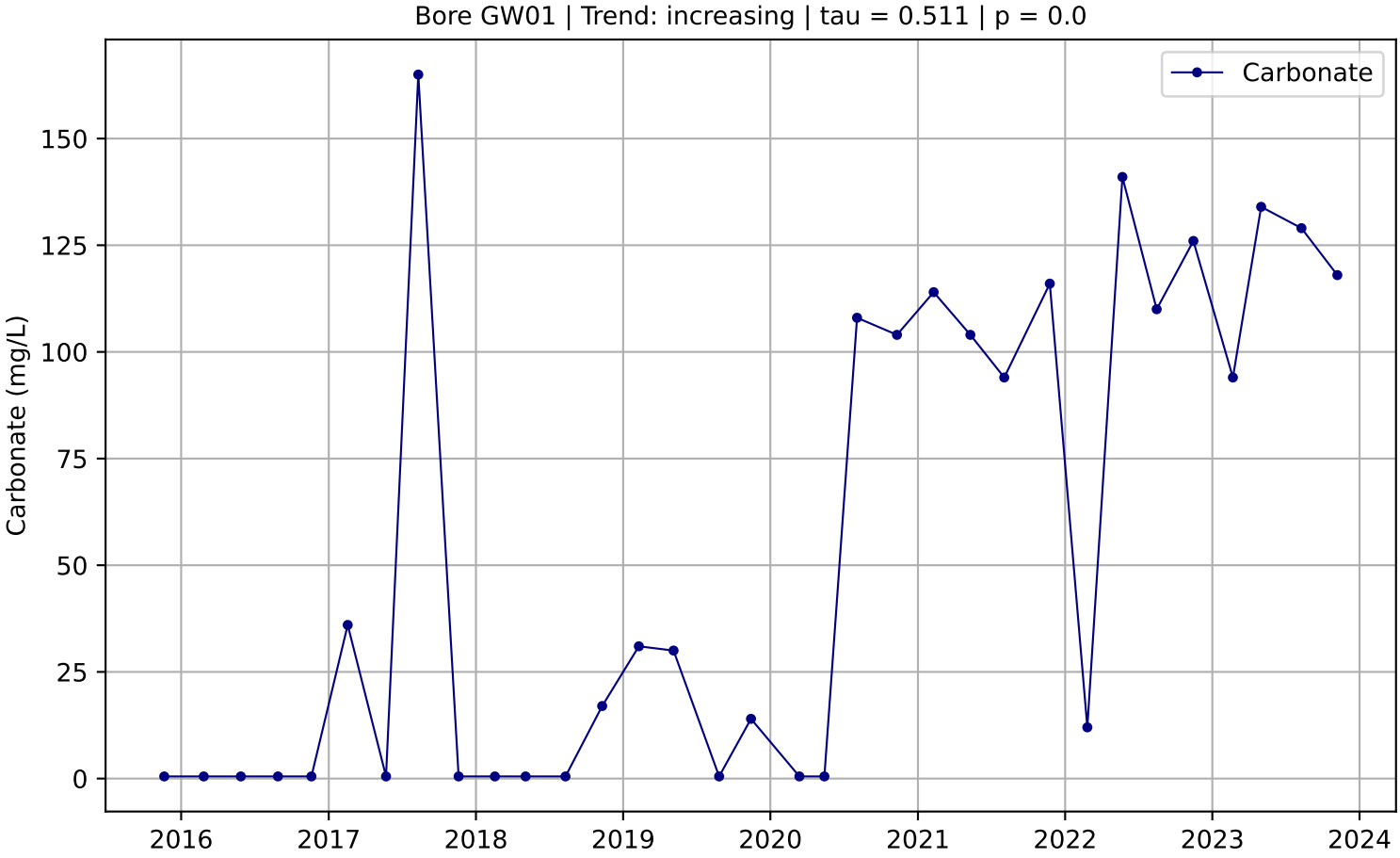

Bore GW01 | Trend: decreasing | tau = -0.398 | p = 0.001
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

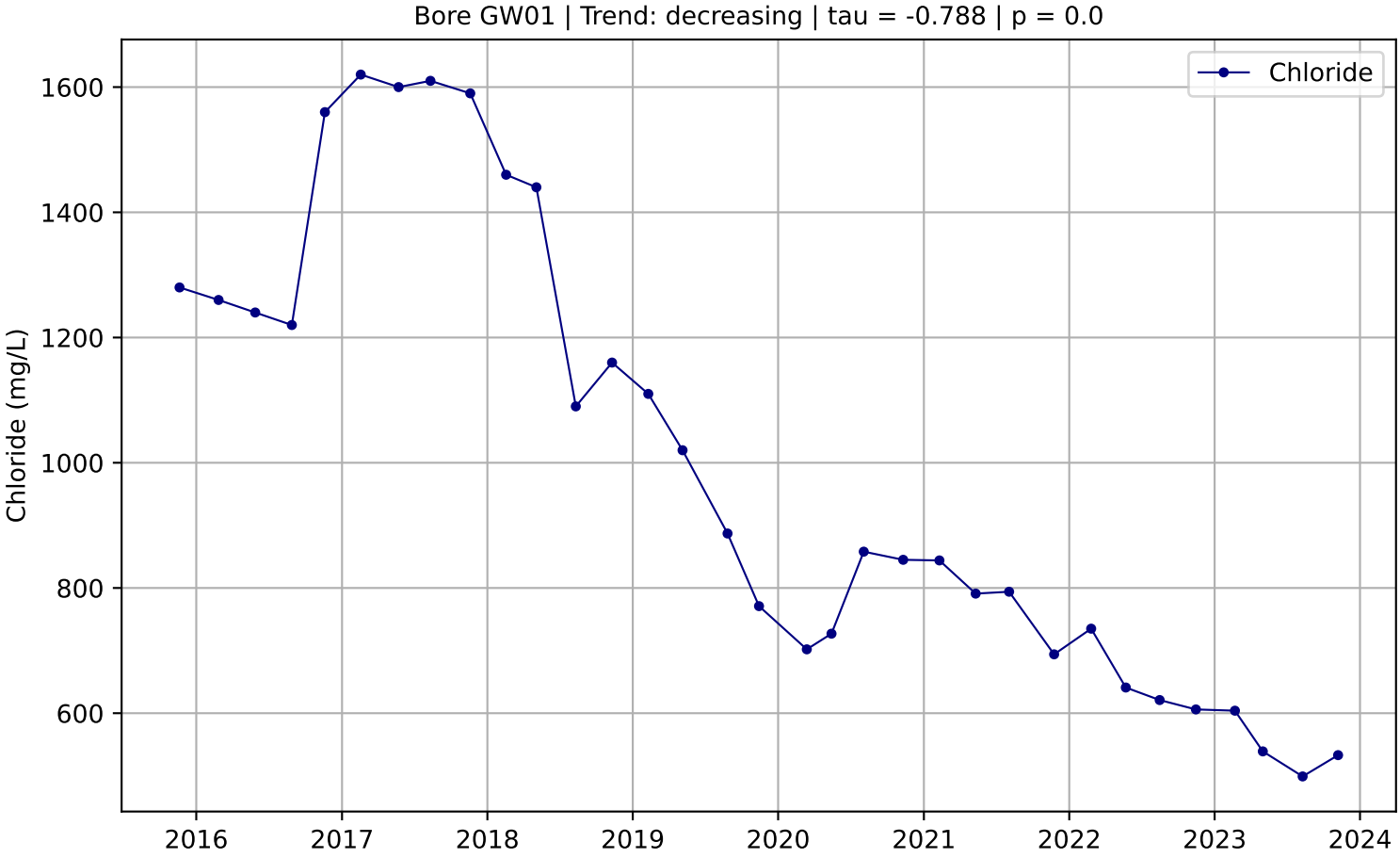

Bore GW01 | Trend: increasing | tau = 0.801 | p = 0.0
Bicarbonate
Bicarbonate (mg/L)
1400
1200
1000
800
600
400
200
2016
2017
2018
2019
2020
2021
2022
2023
2024

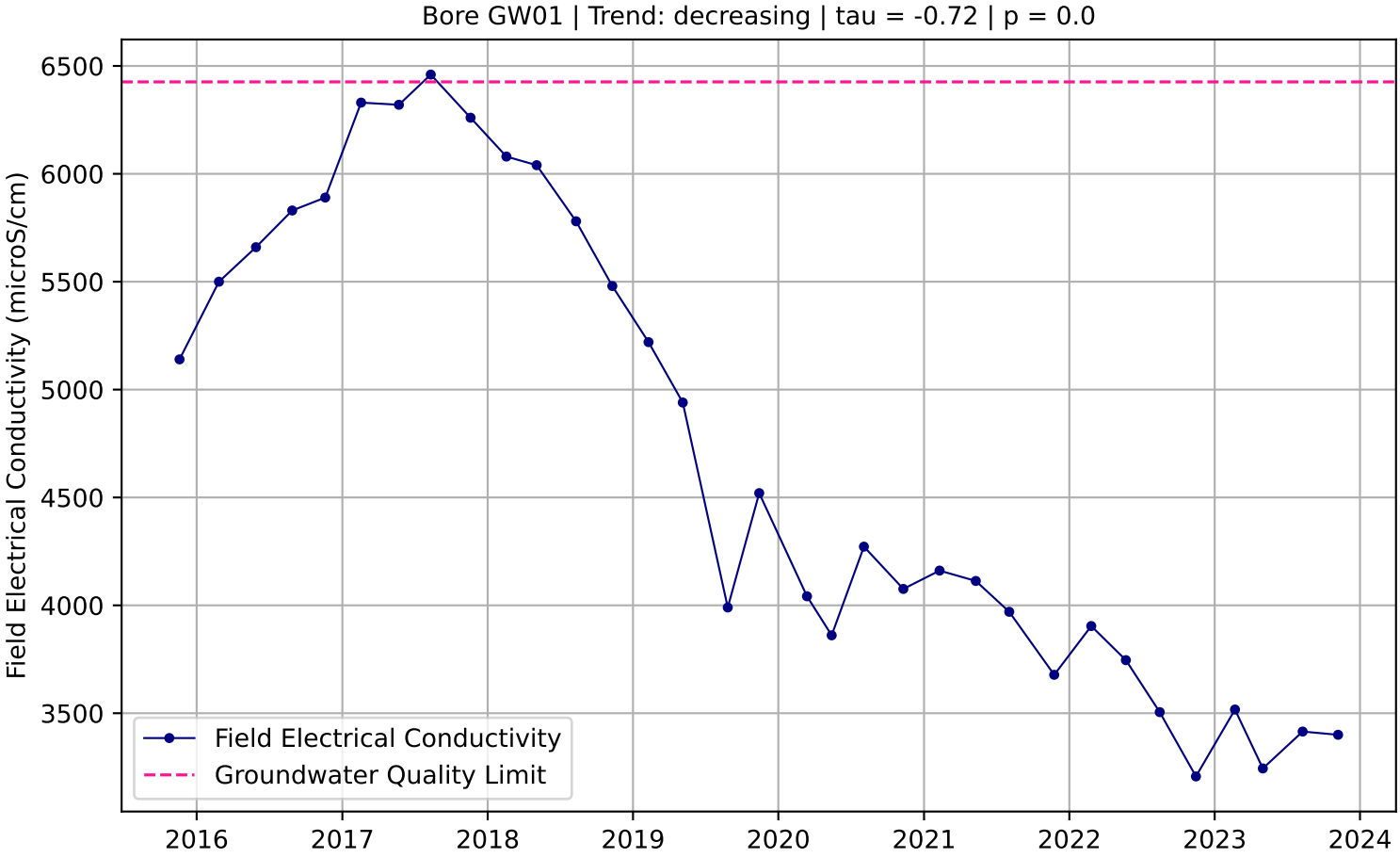

Bore GW01 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

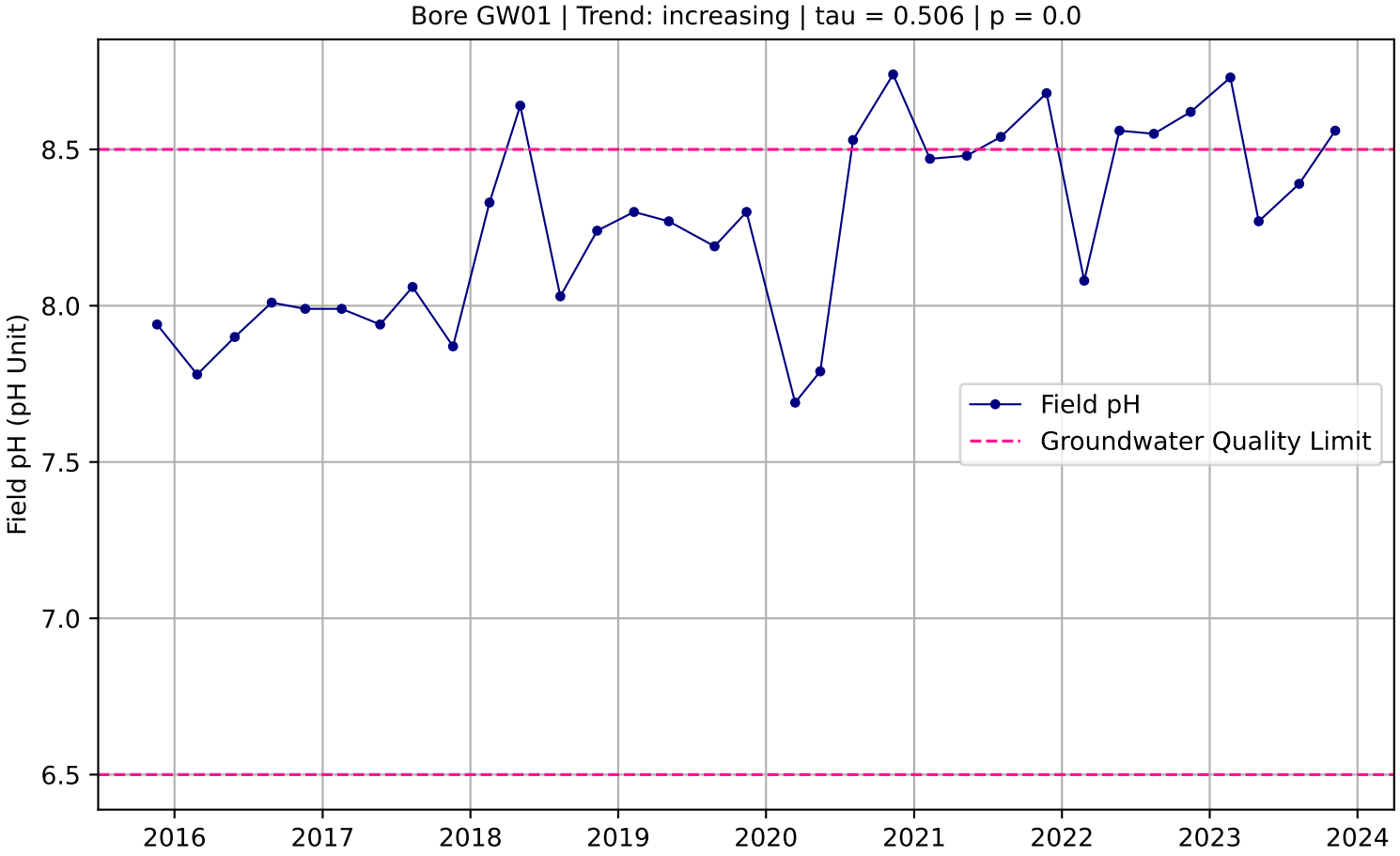

Bore GW01 | Trend: no trend | tau = 0.06 | p = 0.131
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
800
600
400
200
2016
2017
2018
2019
2020
2021
2022
2023
2024

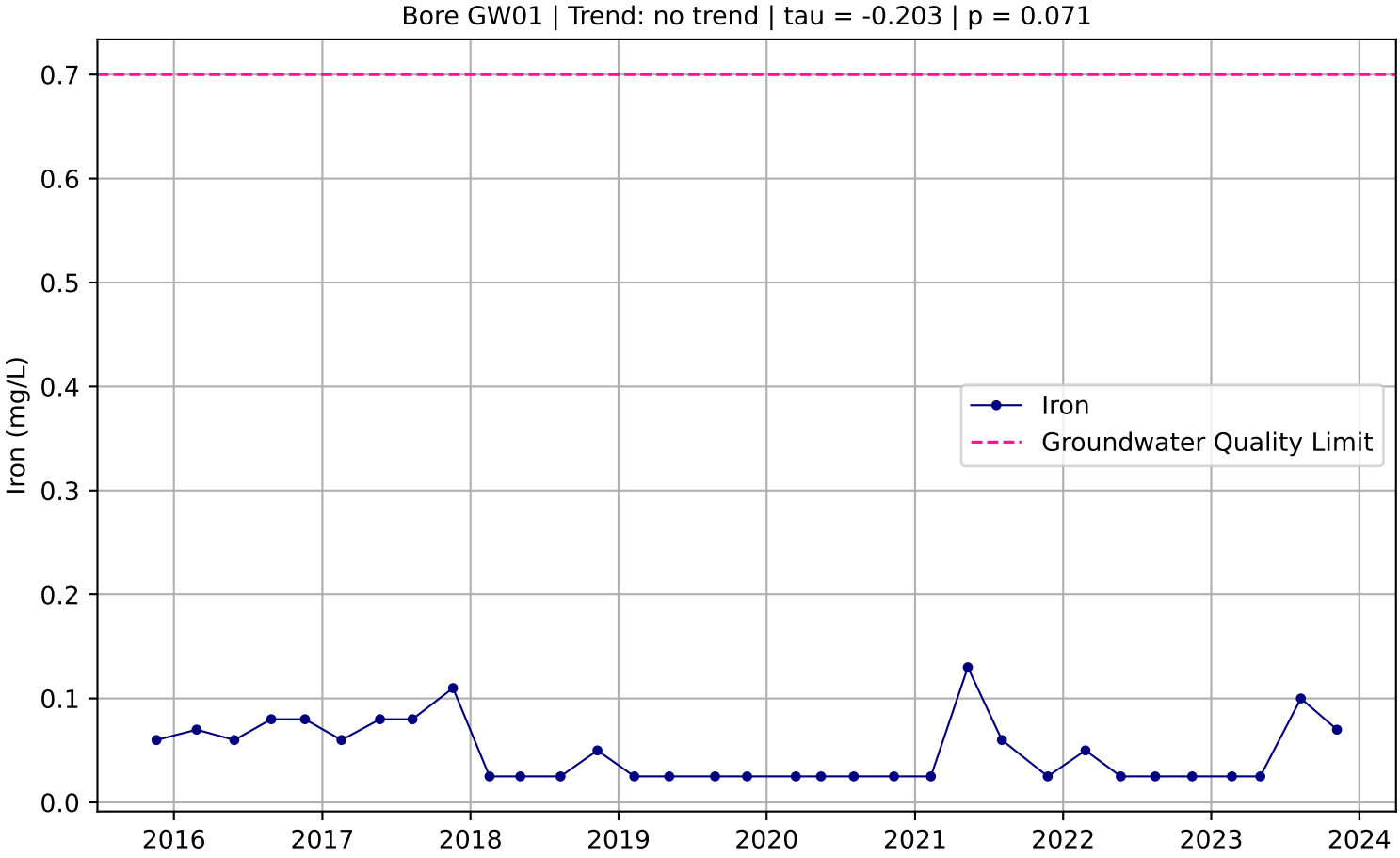

Bore GW01 | Trend: decreasing | tau = -0.84 | p = 0.0
Calcium
Calcium (mg/L)
50
40
30
20
10
2018
2019
2020
2021
2022
2023
2024

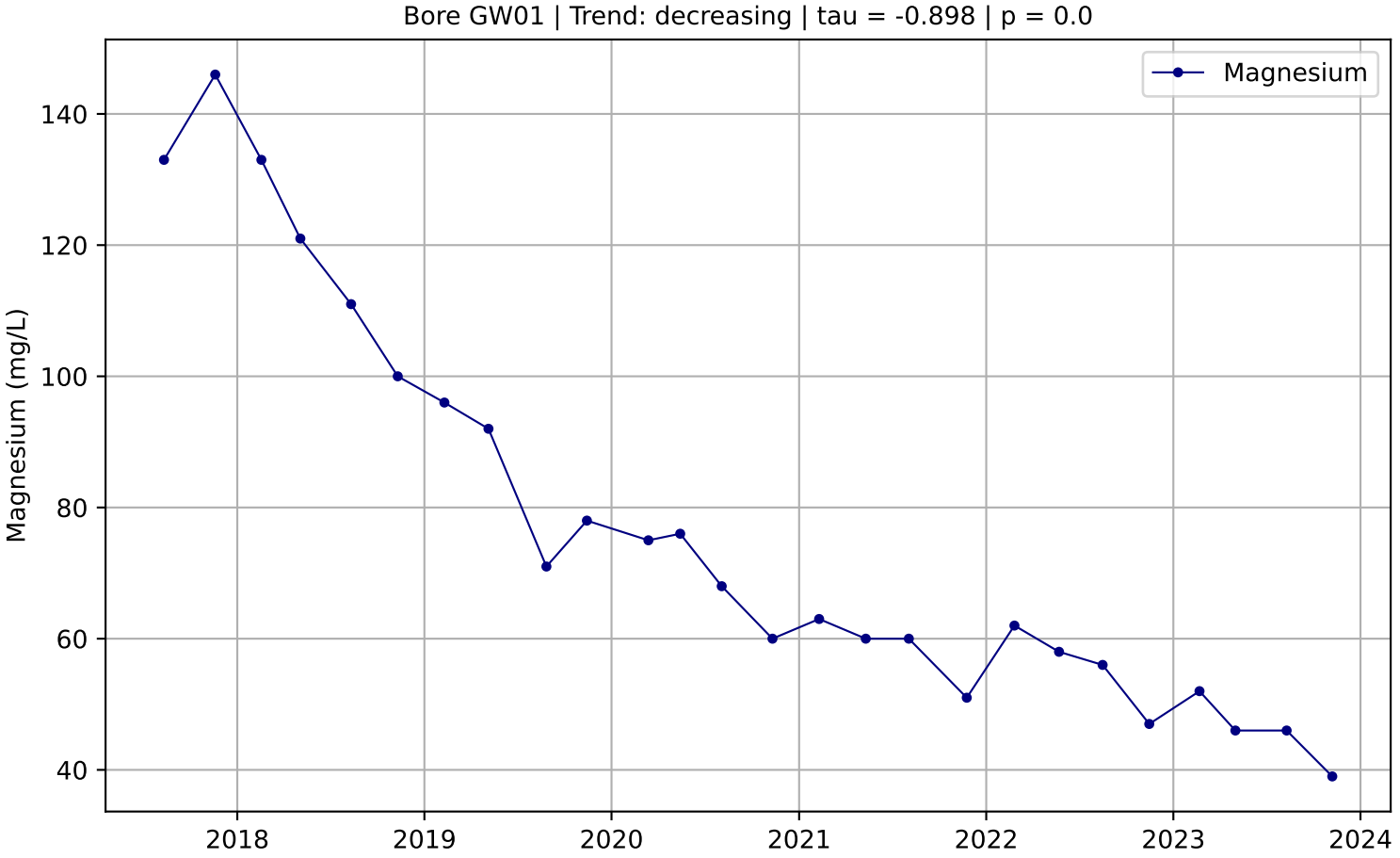

Bore GW01 | Trend: increasing | tau = 0.511 | p = 0.0
Carbonate
Carbonate (mg/L)
150
125
100
75
50
25
0
2016
2017
2018
2019
2020
2021
2022
2023
2024

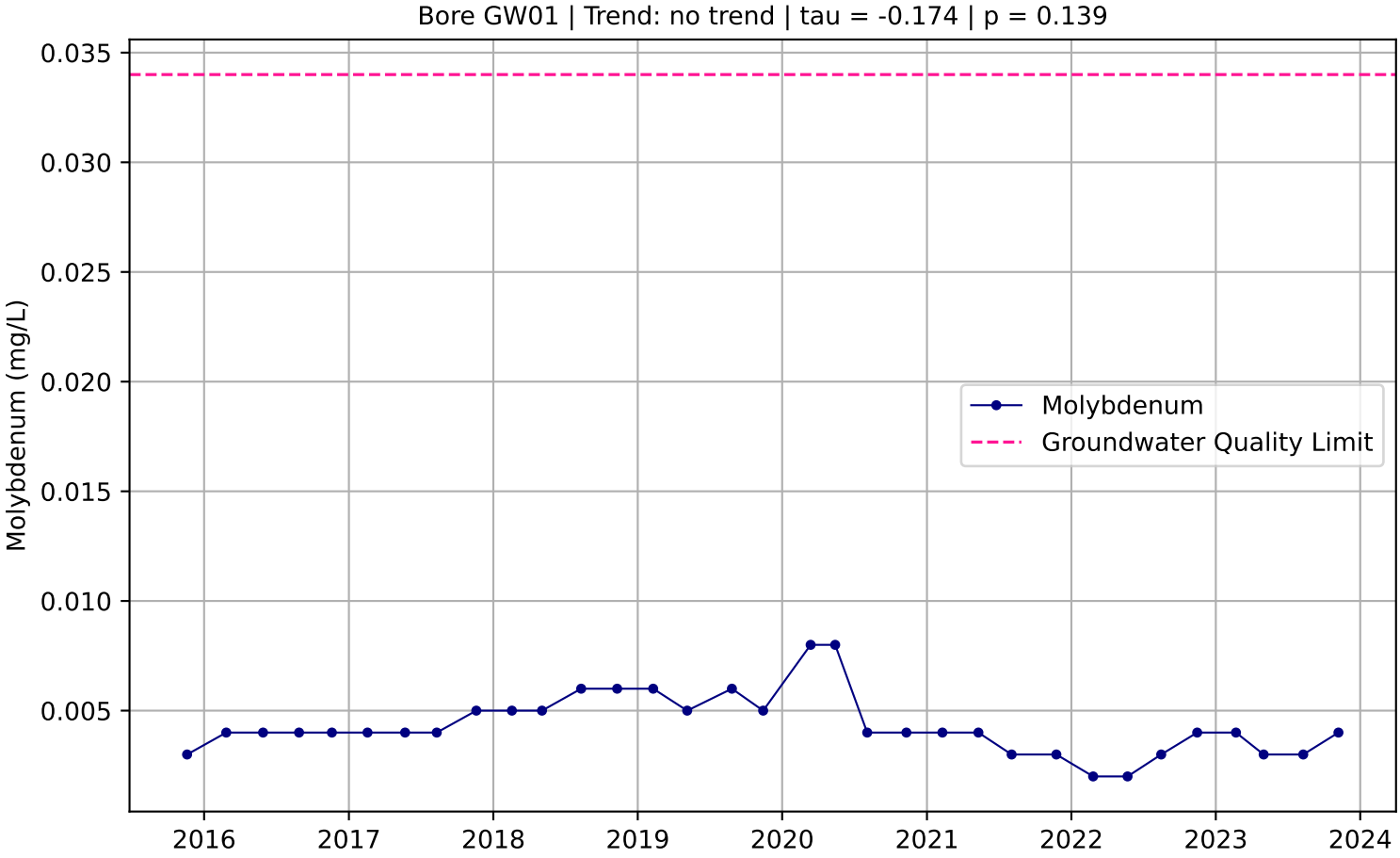

Bore GW01 | Trend: decreasing | tau = -0.788 | p = 0.0
Chloride
Chloride (mg/L)
1600
1400
1200
1000
800
600
2016
2017
2018
2019
2020
2021
2022
2023
2024

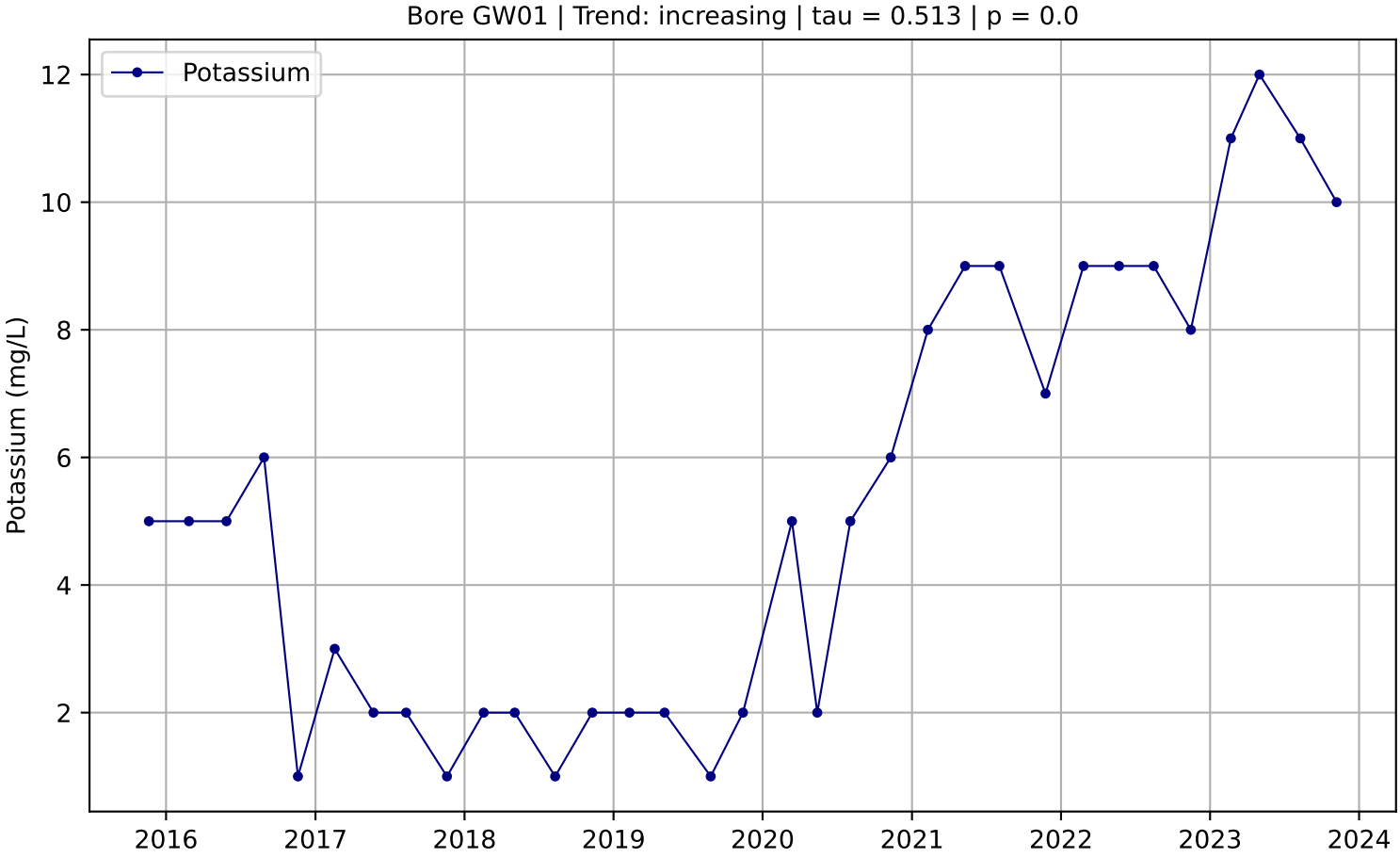

Bore GW01 | Trend: decreasing | tau = -0.72 | p = 0.0
Field Electrical Conductivity (microS/cm)
6500
6000
5500
5000
4500
4000
3500
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

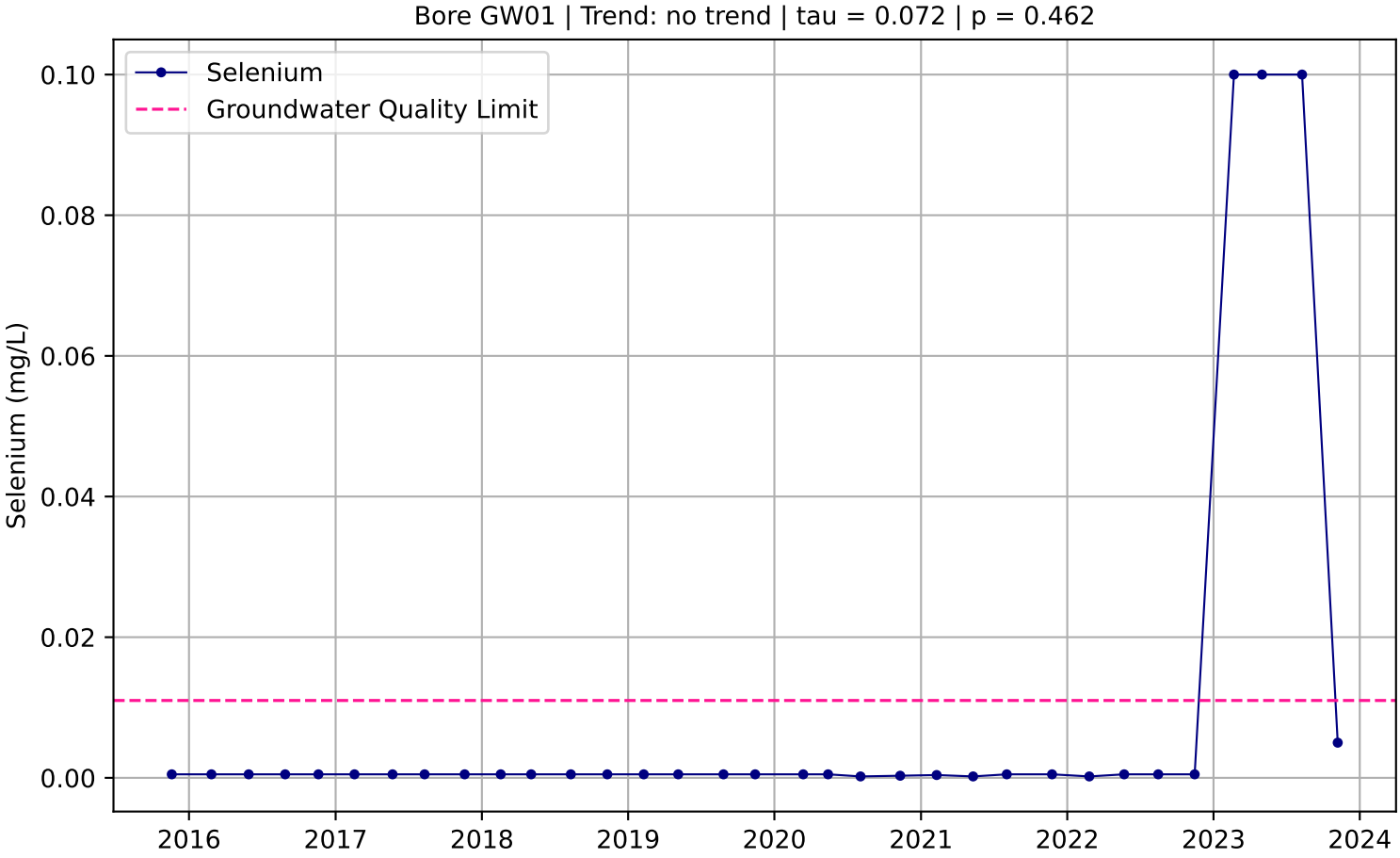

Bore GW01 | Trend: increasing | tau = 0.506 | p = 0.0
Field pH (pH Unit)
8.5
8.0
7.5
7.0
6.5
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

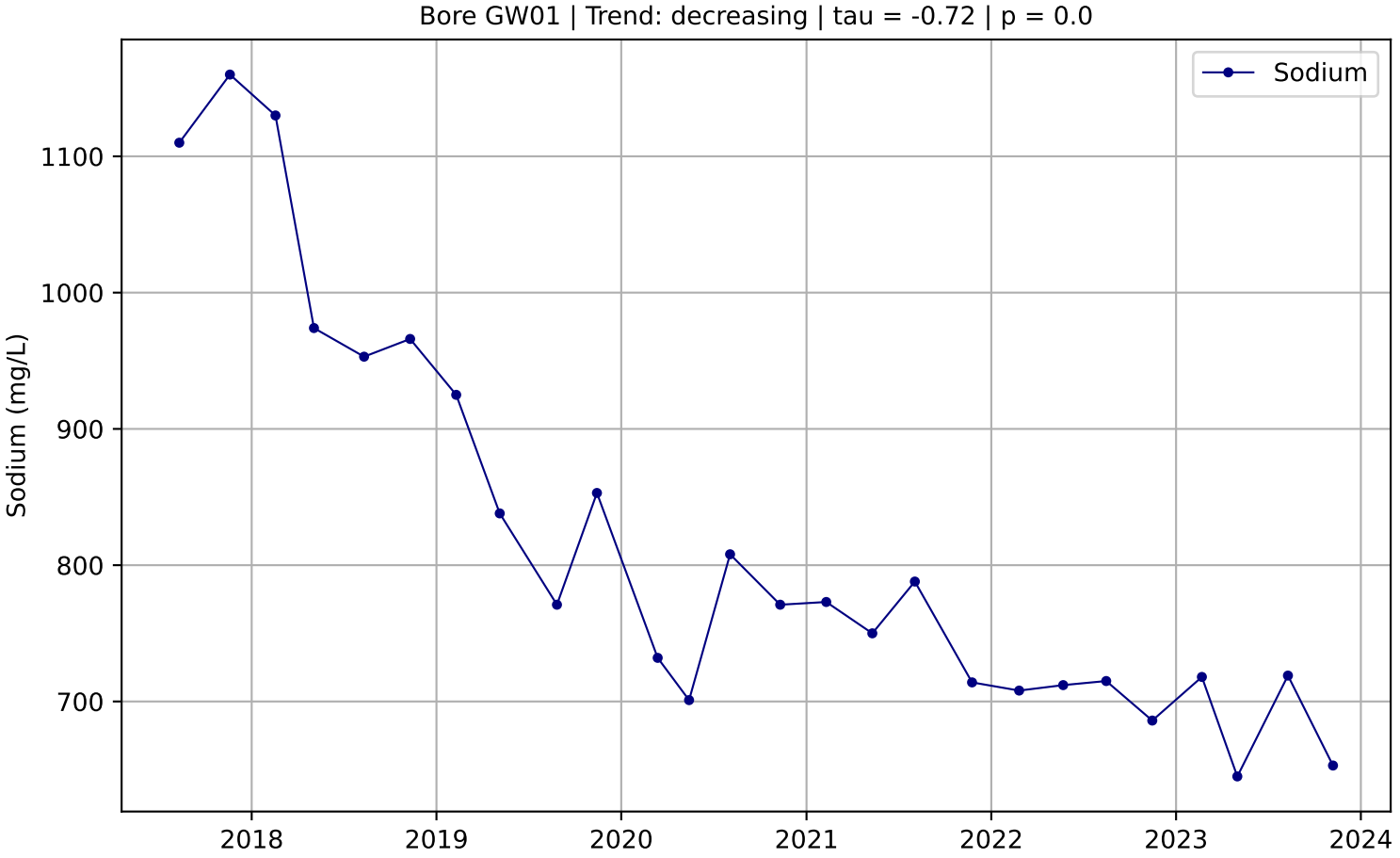

Bore GW01 | Trend: no trend | tau = -0.203 | p = 0.071
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2016
2017
2018
2019
2020
2021
2022
2023
2024
Iron
Groundwater Quality Limit

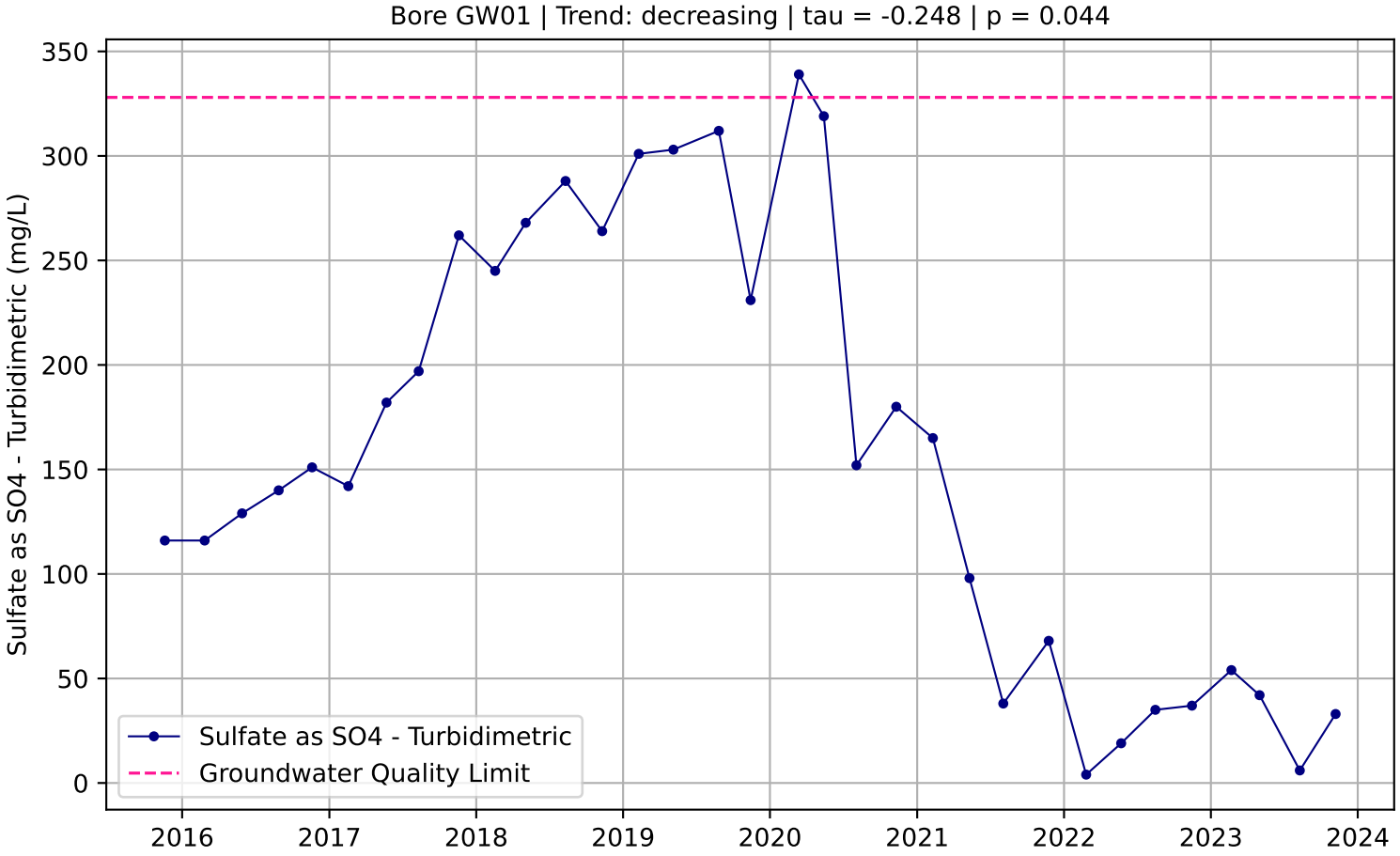

Bore GW01 | Trend: decreasing | tau = -0.898 | p = 0.0
Magnesium
Magnesium (mg/L)
140
120
100
80
60
40
2018
2019
2020
2021
2022
2023
2024

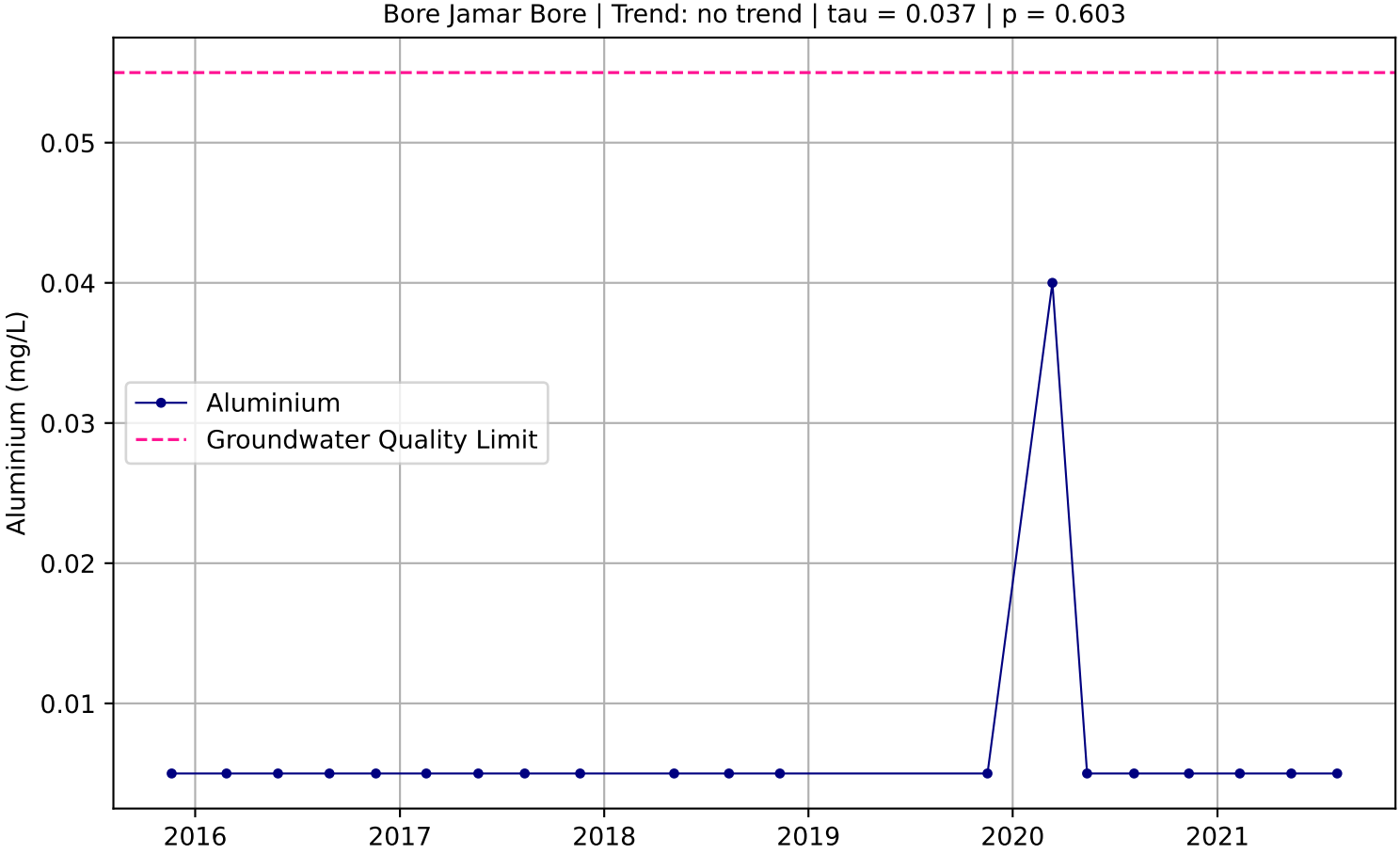

Bore GW01 | Trend: no trend | tau = -0.174 | p = 0.139
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

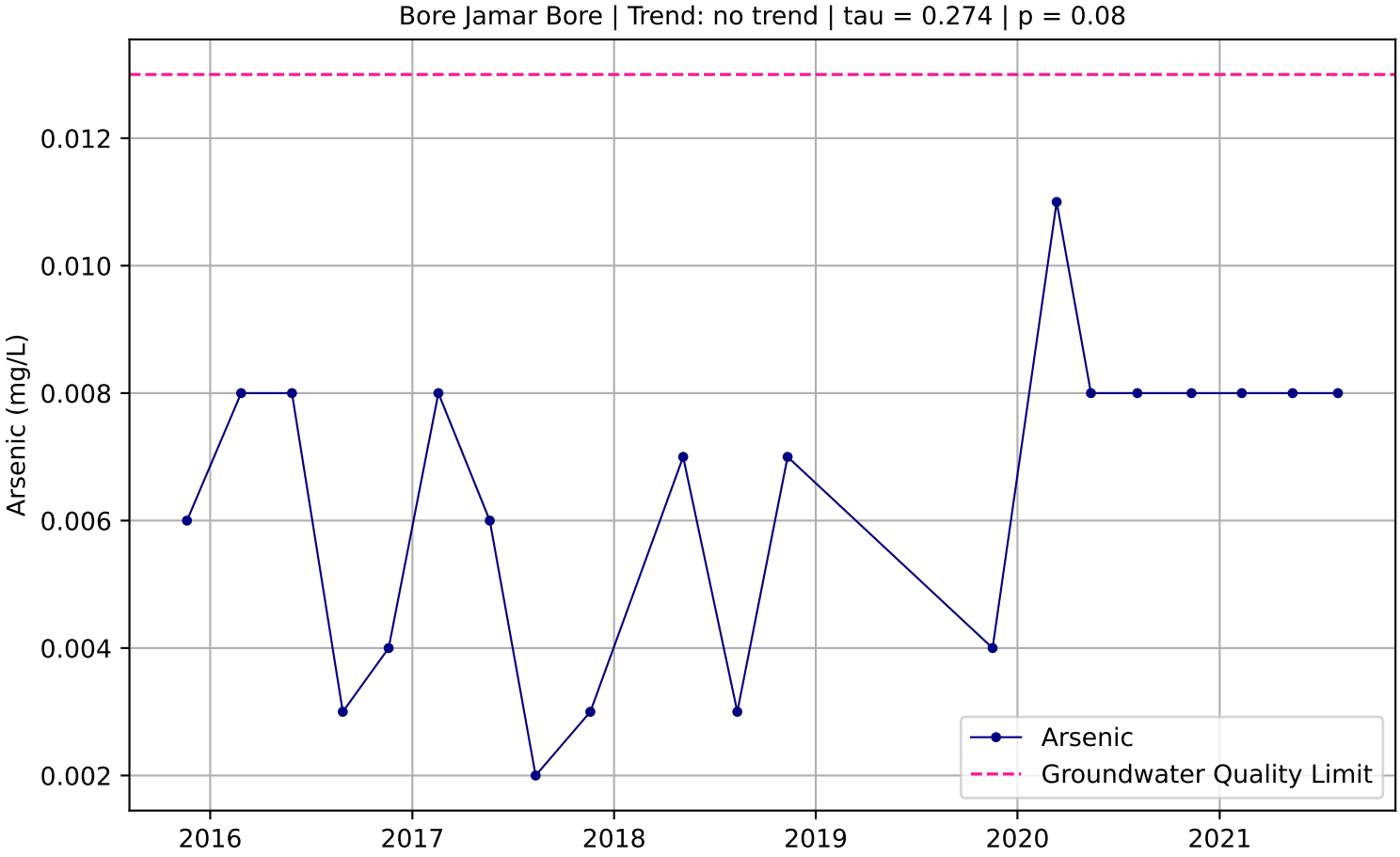

Bore GW01 | Trend: increasing | tau = 0.513 | p = 0.0
Potassium
Potassium (mg/L)
12
10
8
6
4
2
2016
2017
2018
2019
2020
2021
2022
2023
2024

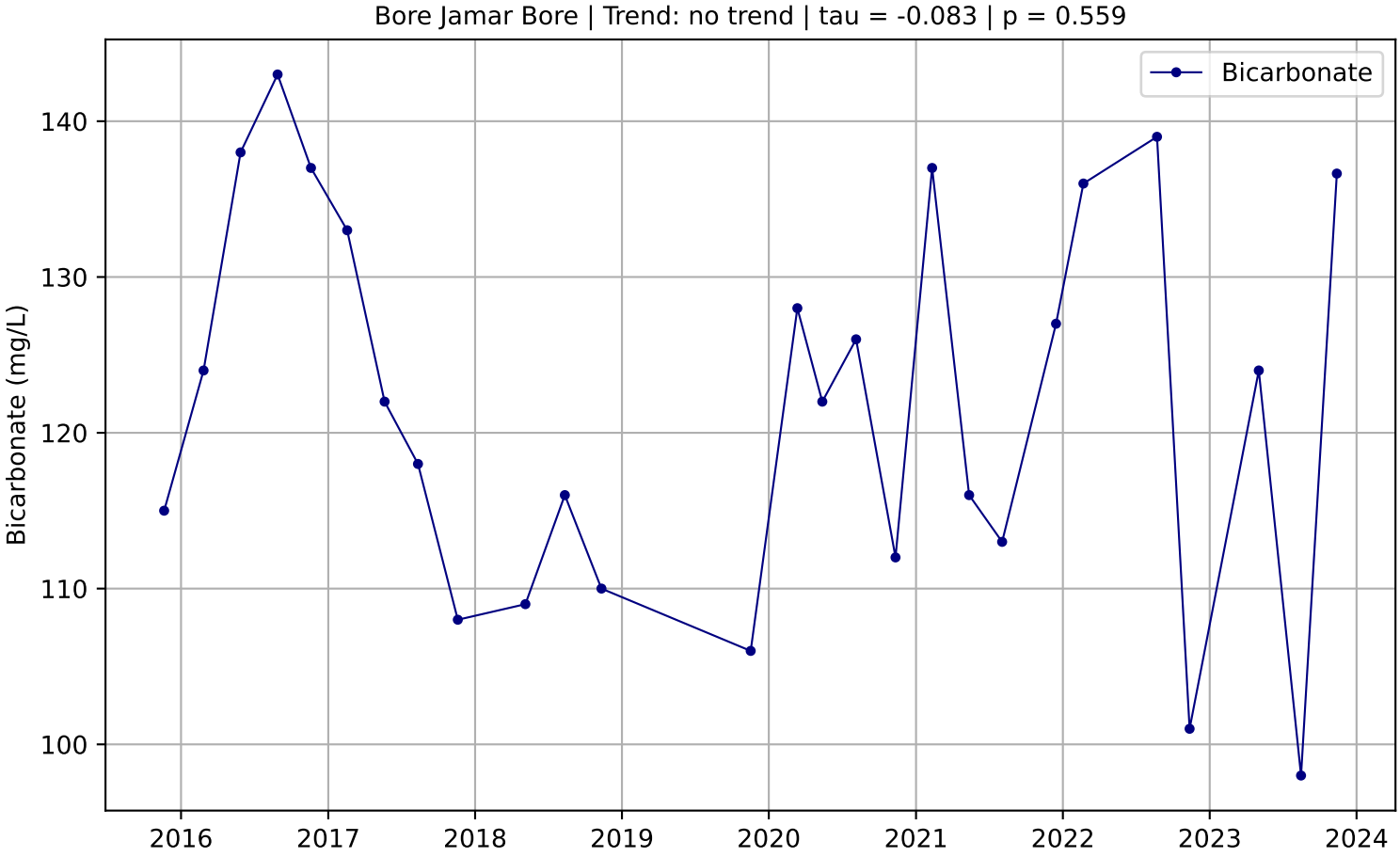

Bore GW01 | Trend: no trend | tau = 0.072 | p = 0.462
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

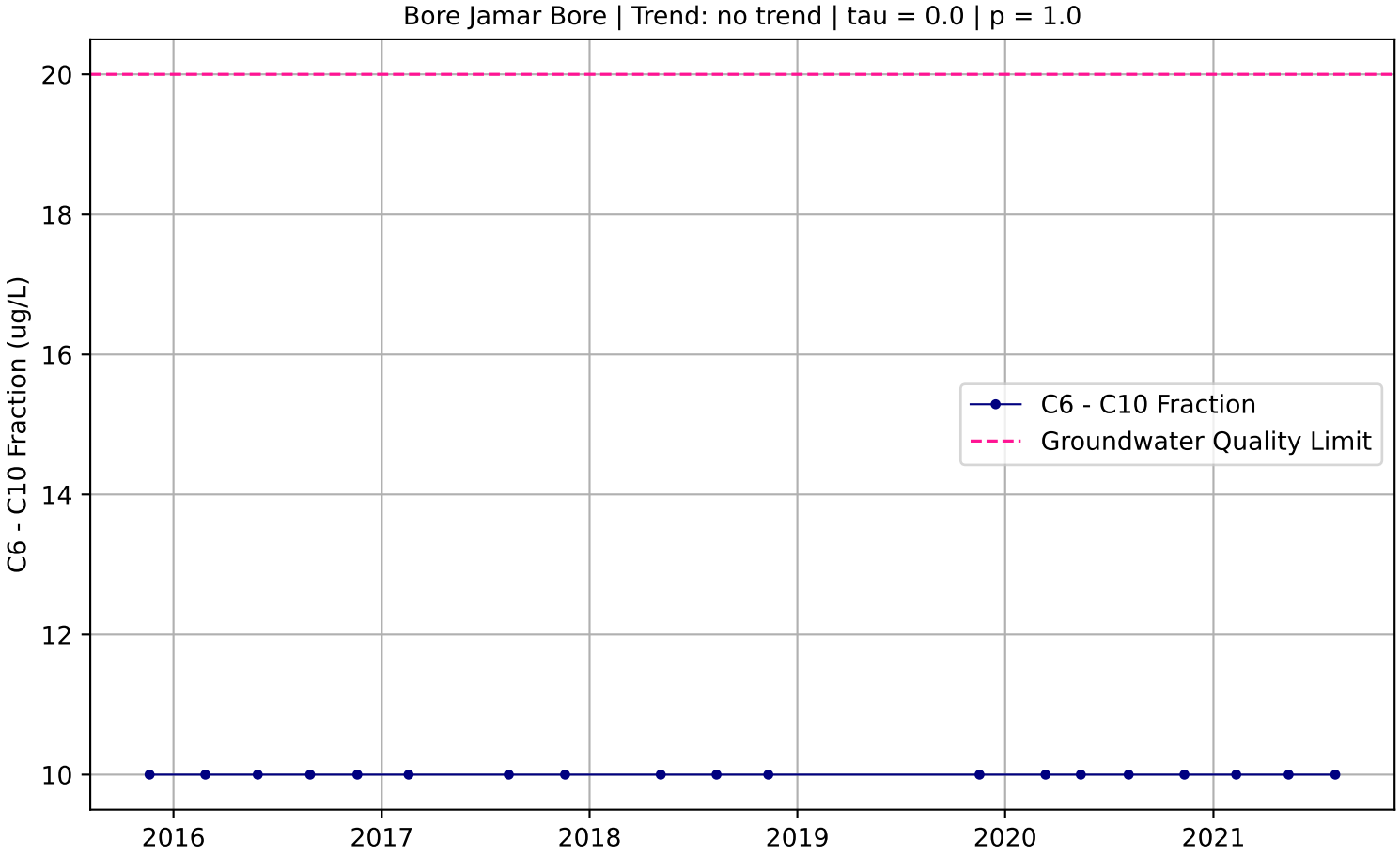

Bore GW01 | Trend: decreasing | tau = -0.72 | p = 0.0
Sodium
Sodium (mg/L)
1100
1000
900
800
700
2018
2019
2020
2021
2022
2023
2024

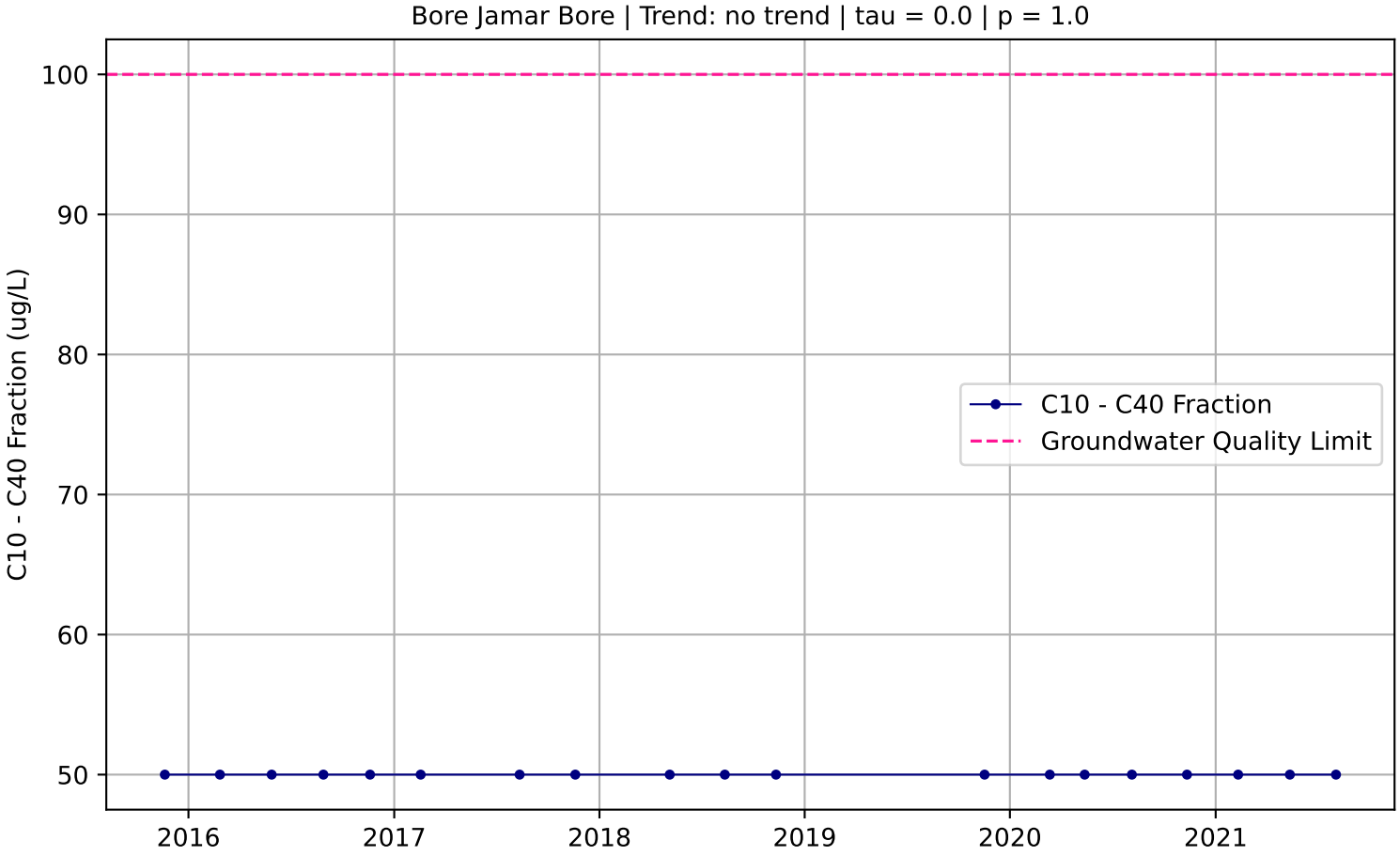

Bore GW01 | Trend: decreasing | tau = -0.248 | p = 0.044
Sulfate as SO4 - Turbidimetric (mg/L)
350
300
250
200
150
100
50
0
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

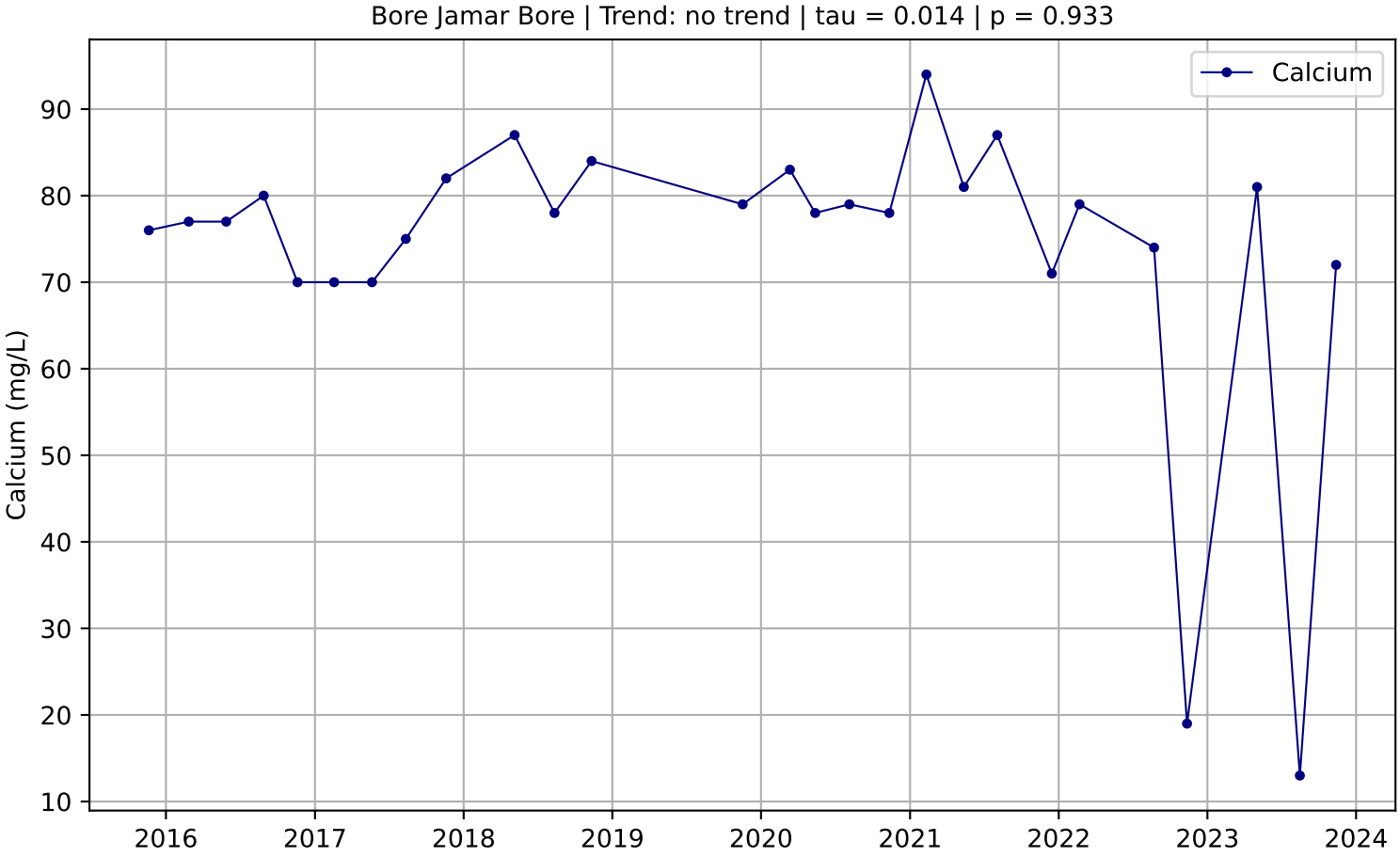

Bore Jamar Bore | Trend: no trend | tau = 0.037 | p = 0.603
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
Aluminium
Groundwater Quality Limit
2016
2017
2018
2019
2020
2021

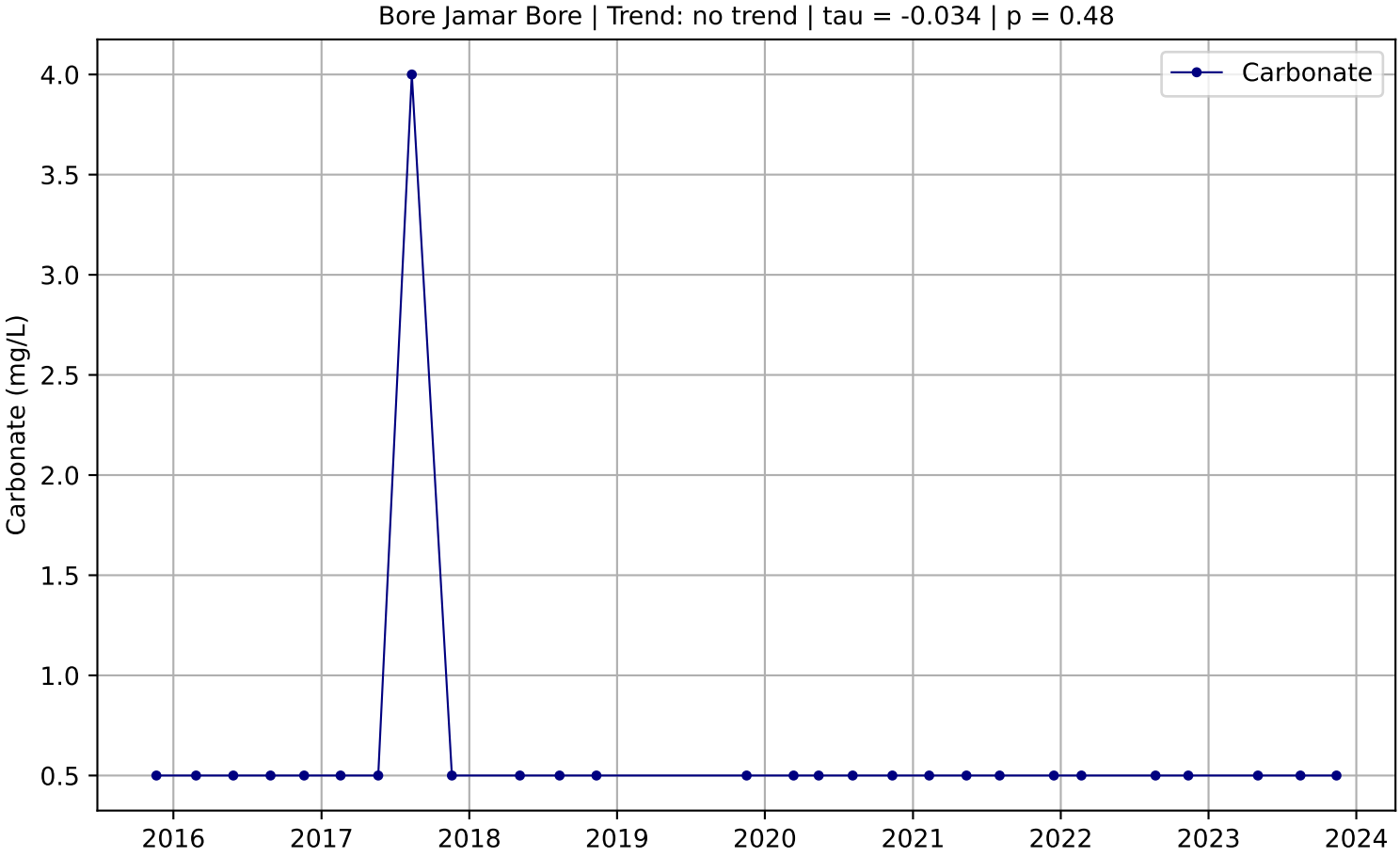

Bore Jamar Bore | Trend: no trend | tau = 0.274 | p = 0.08
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

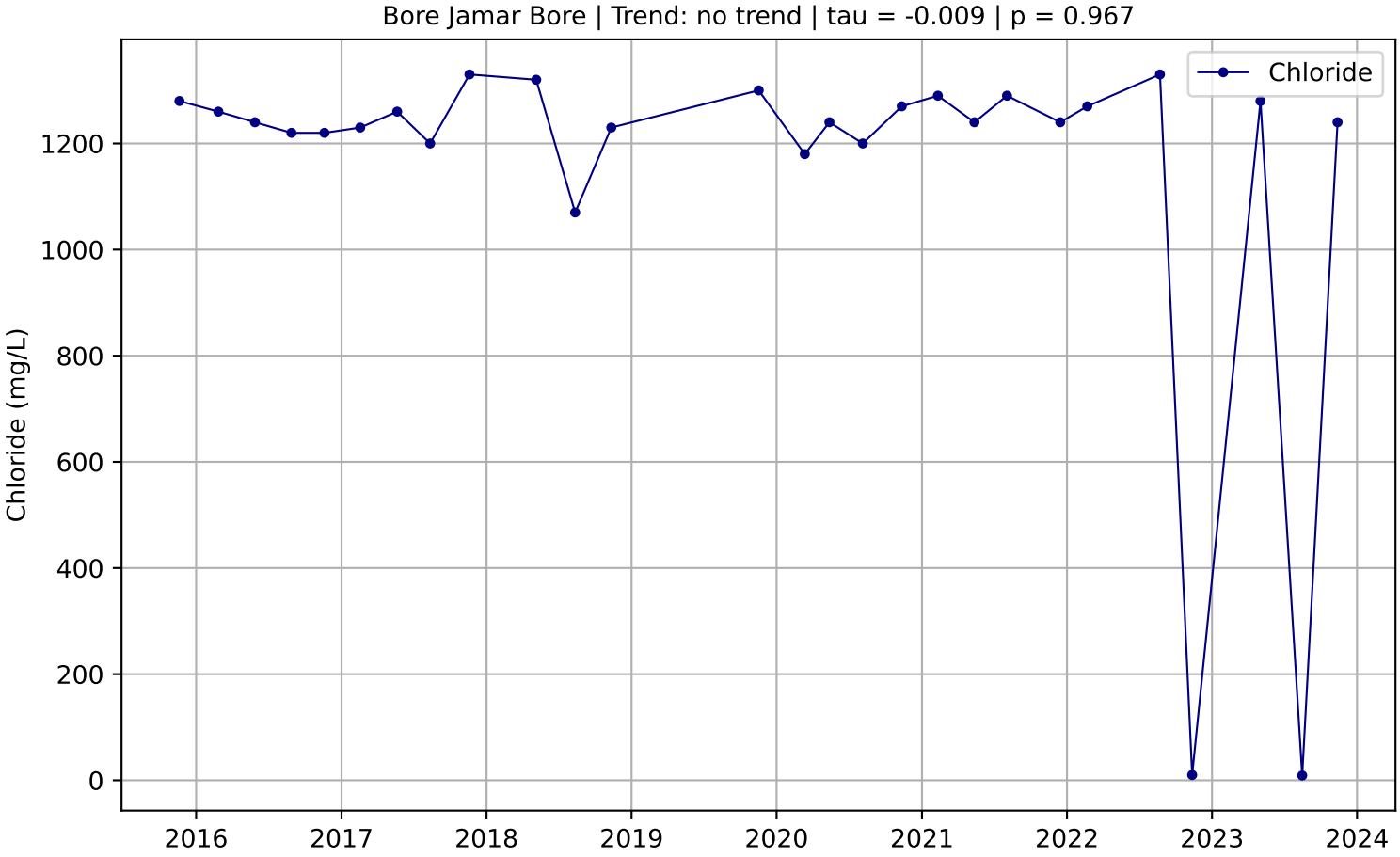

Bore Jamar Bore | Trend: no trend | tau = -0.083 | p = 0.559
Bicarbonate
Bicarbonate (mg/L)
140
130
120
110
100
2016
2017
2018
2019
2020
2021
2022
2023
2024

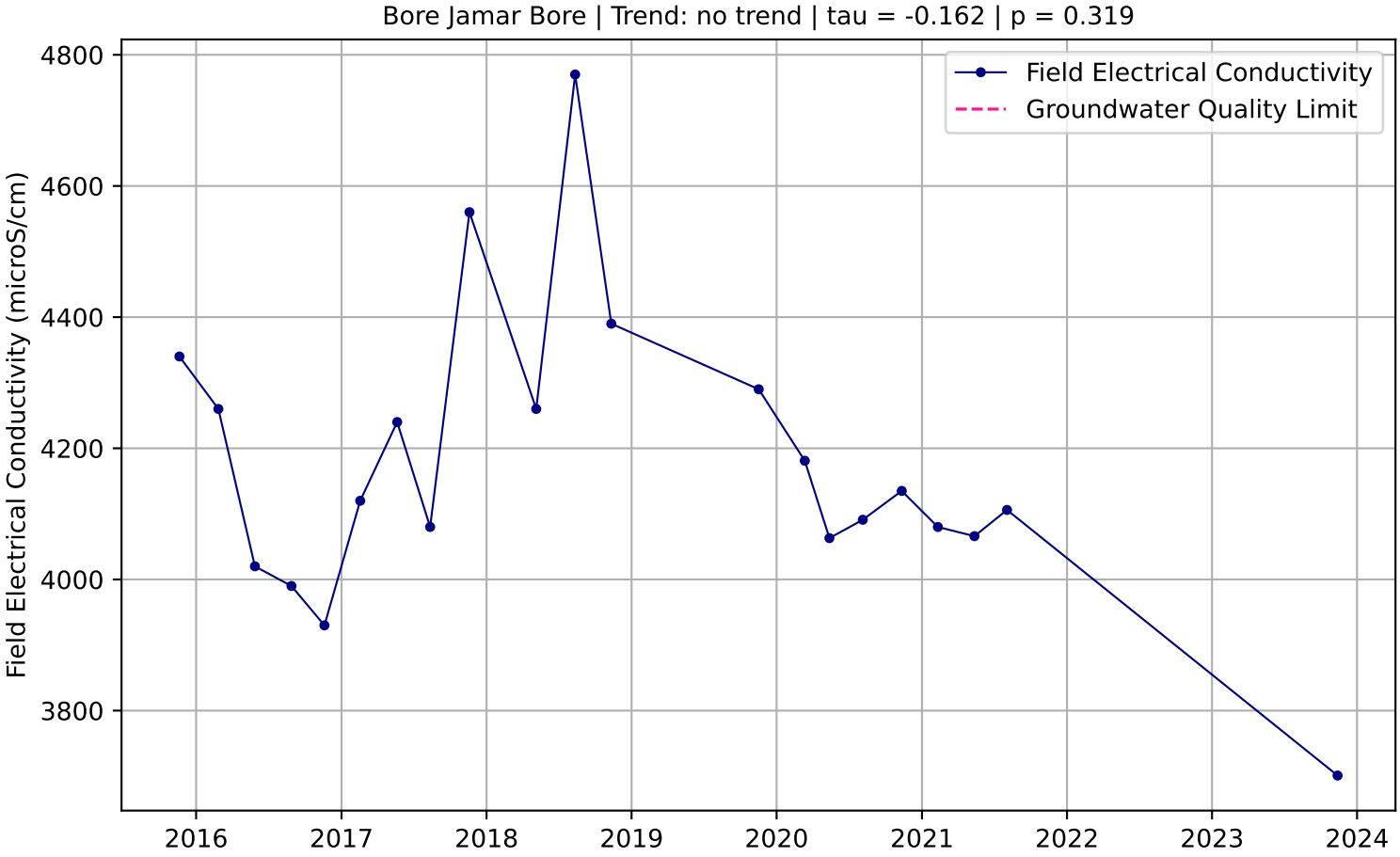

Bore Jamar Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

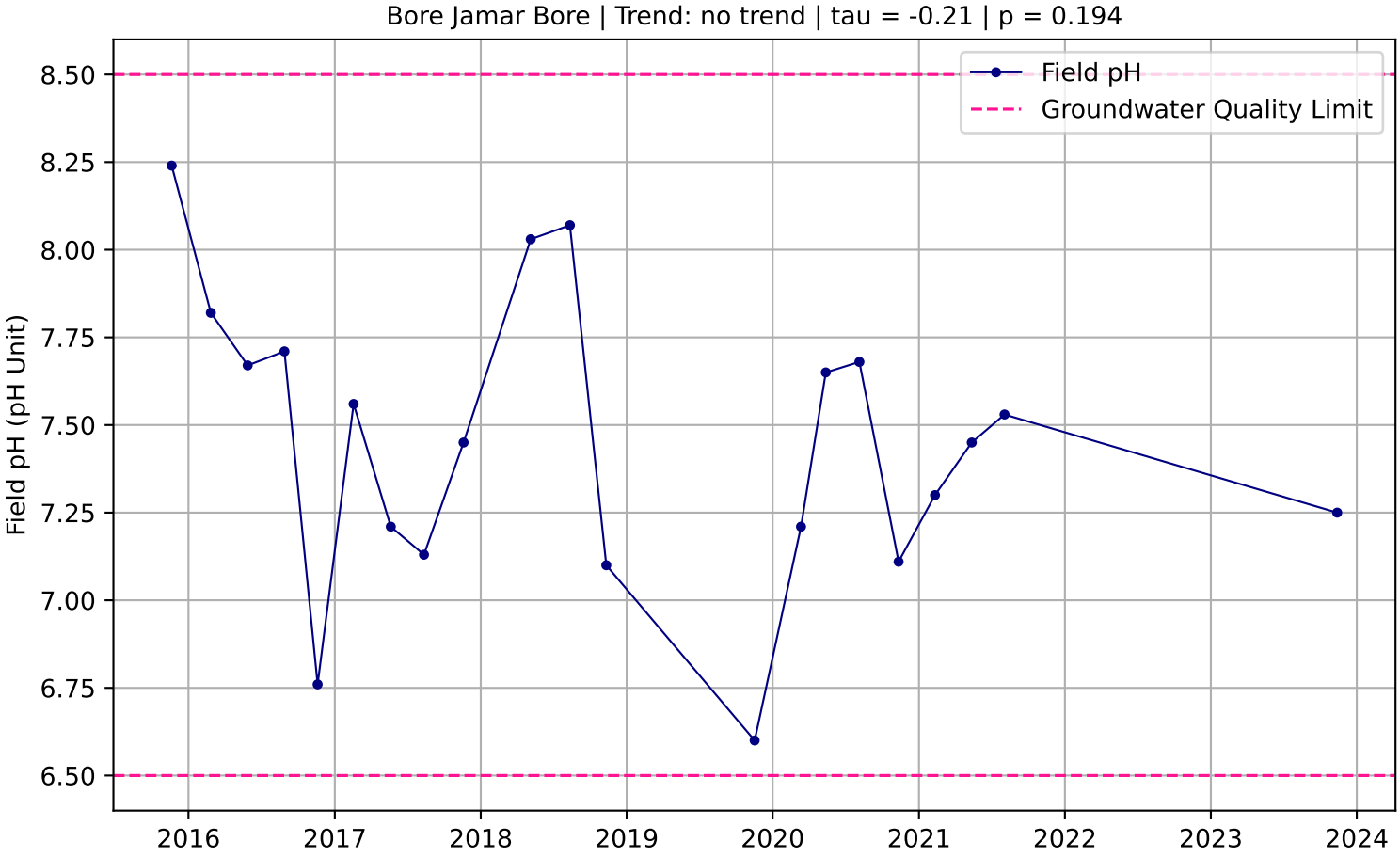

Bore Jamar Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

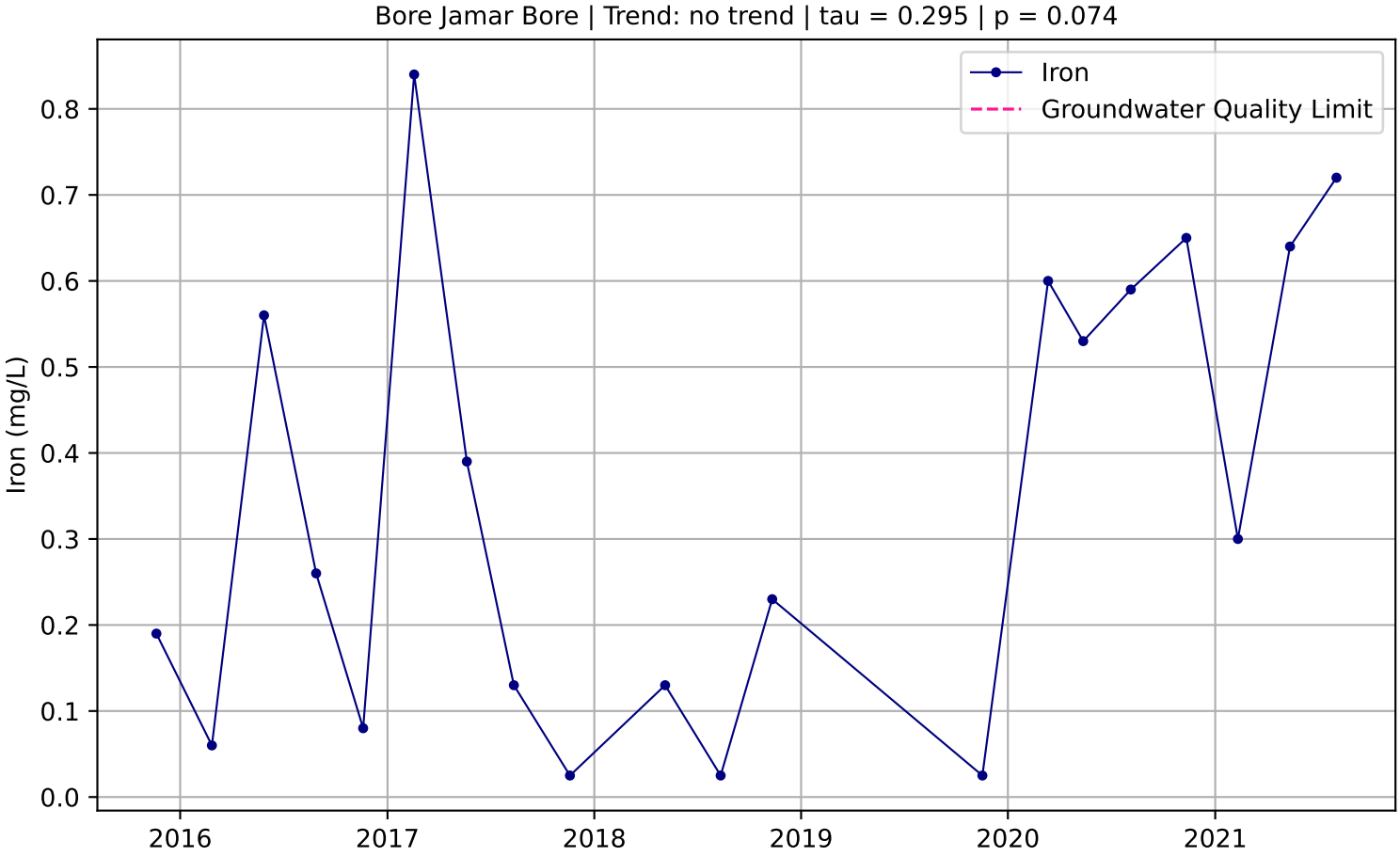

Bore Jamar Bore | Trend: no trend | tau = 0.014 | p = 0.933
Calcium
Calcium (mg/L)
90
80
70
60
50
40
30
20
10
2016
2017
2018
2019
2020
2021
2022
2023
2024

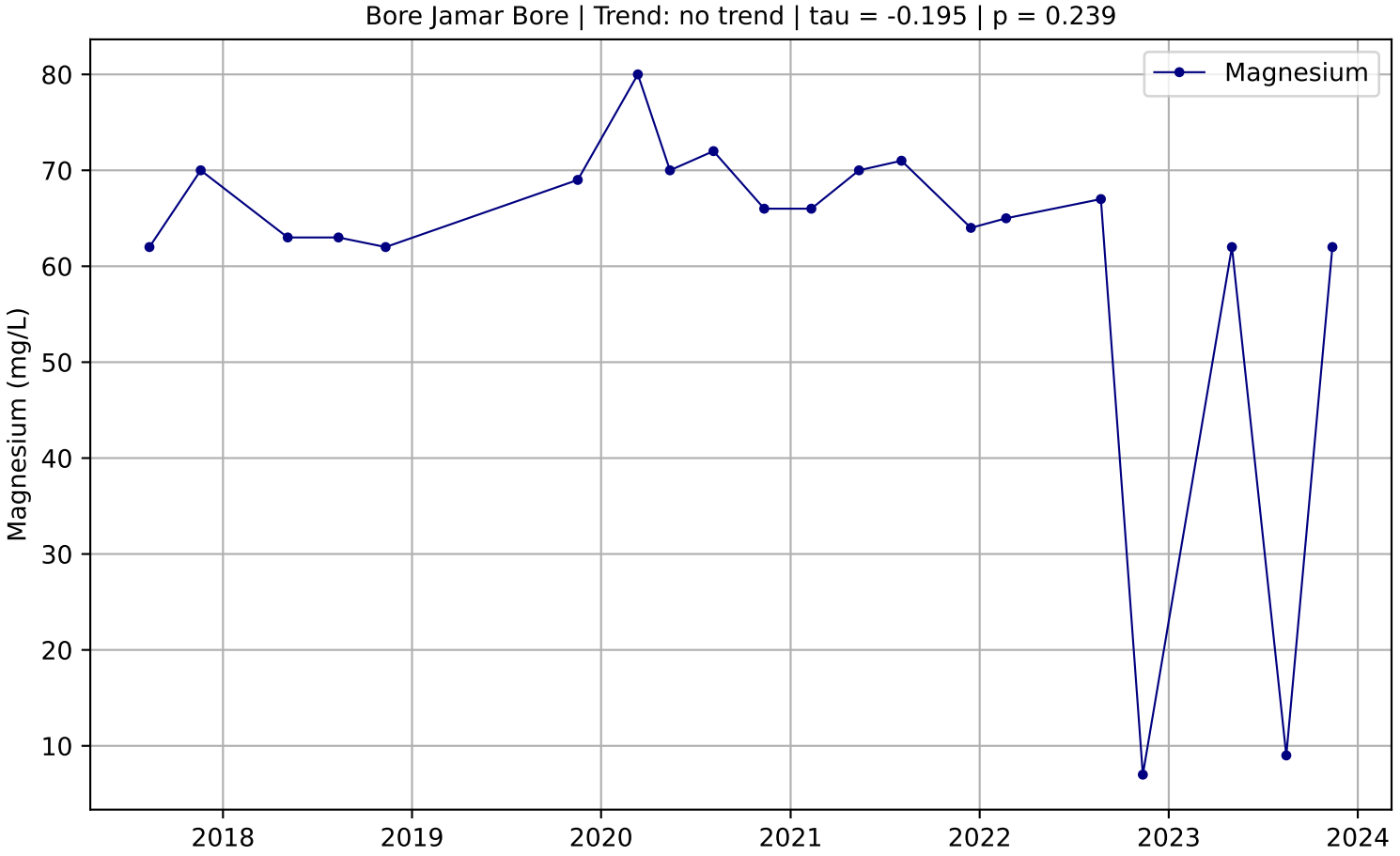

Bore Jamar Bore | Trend: no trend | tau = -0.034 | p = 0.48
Carbonate
Carbonate (mg/L)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
2016
2017
2018
2019
2020
2021
2022
2023
2024

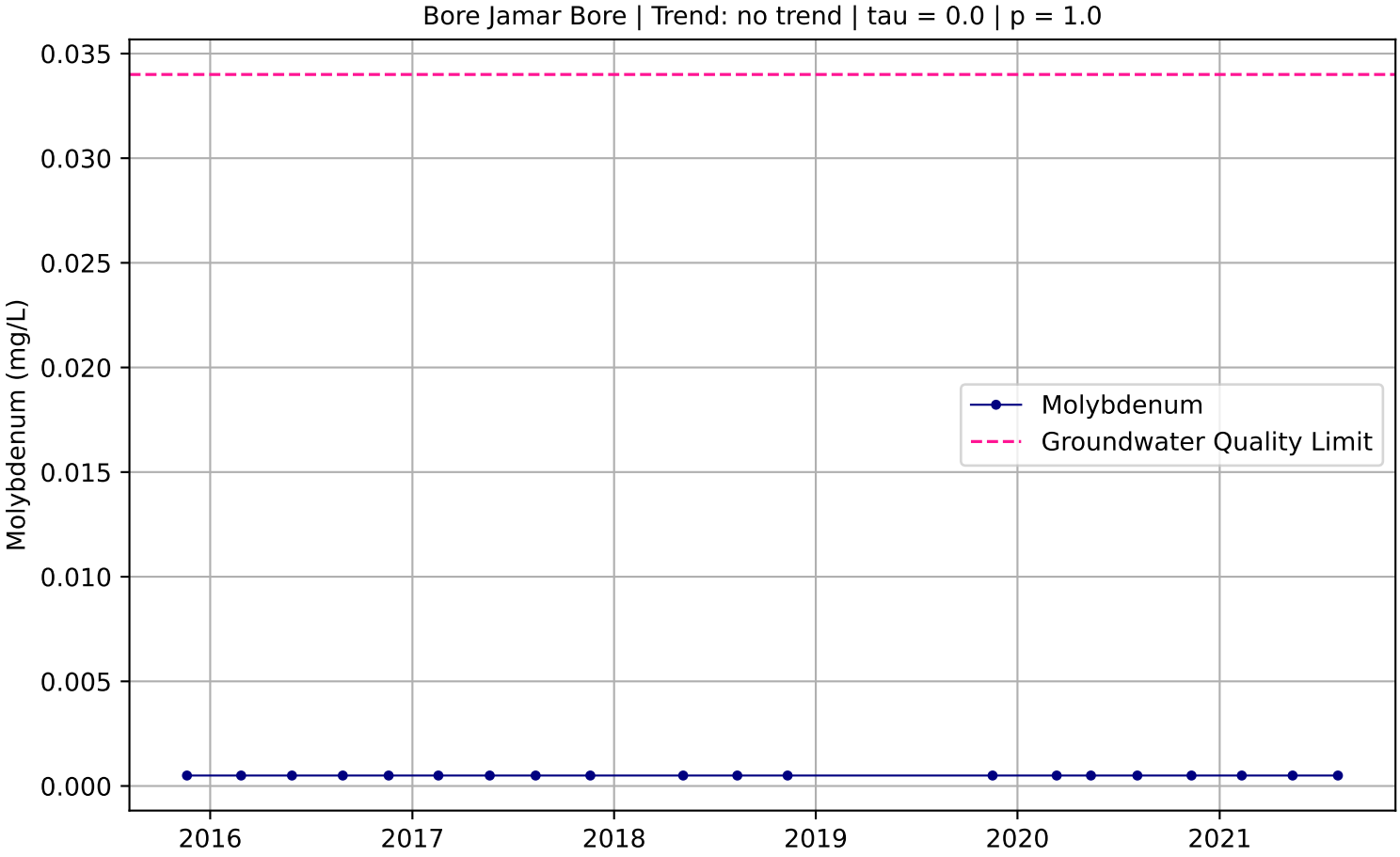

Bore Jamar Bore | Trend: no trend | tau = -0.009 | p = 0.967
Chloride
Chloride (mg/L)
0
200
400
600
800
1000
1200
2016
2017
2018
2019
2020
2021
2022
2023
2024

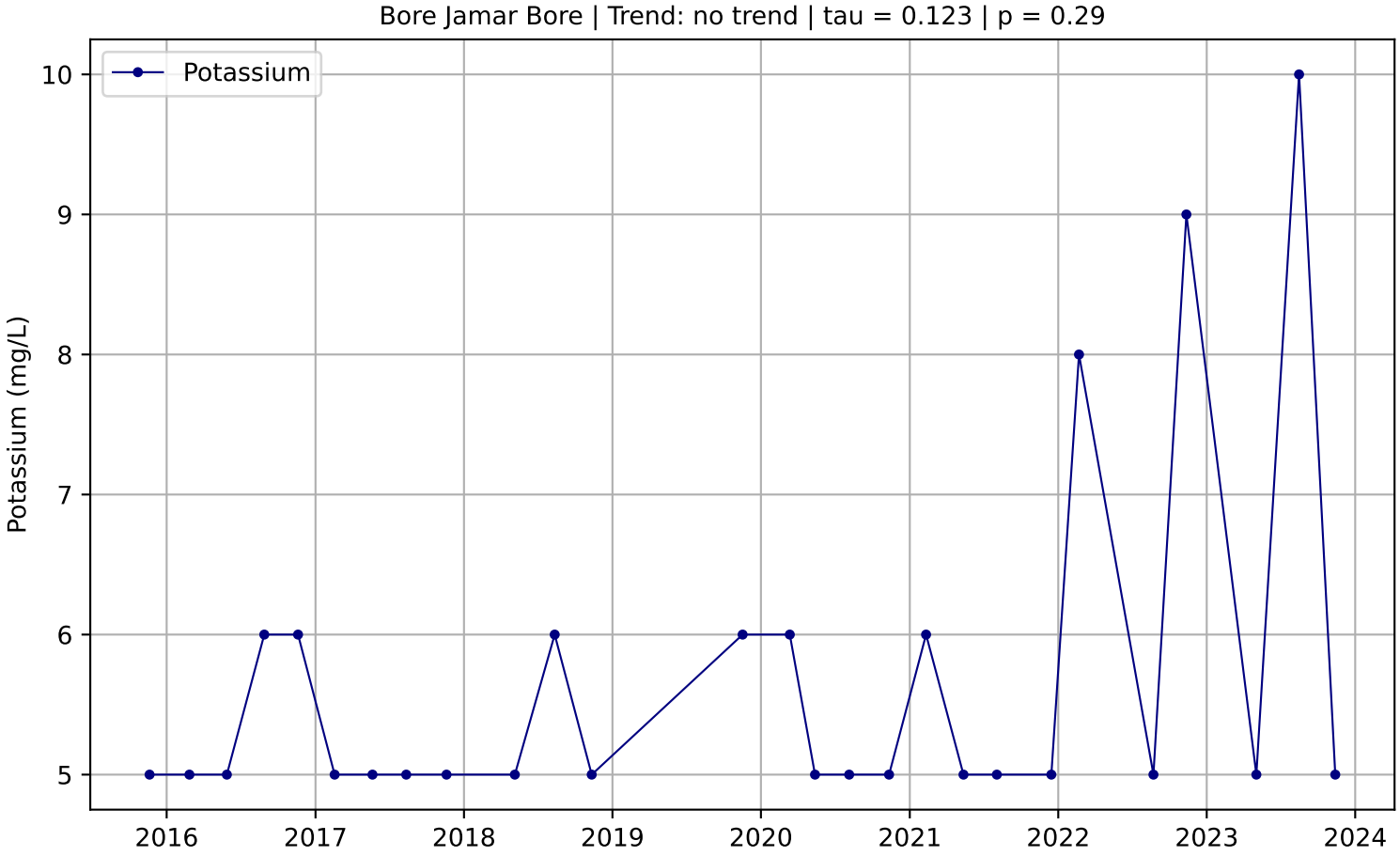

Bore Jamar Bore | Trend: no trend | tau = -0.162 | p = 0.319
Field Electrical Conductivity (microS/cm)
4800
4600
4400
4200
4000
3800
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

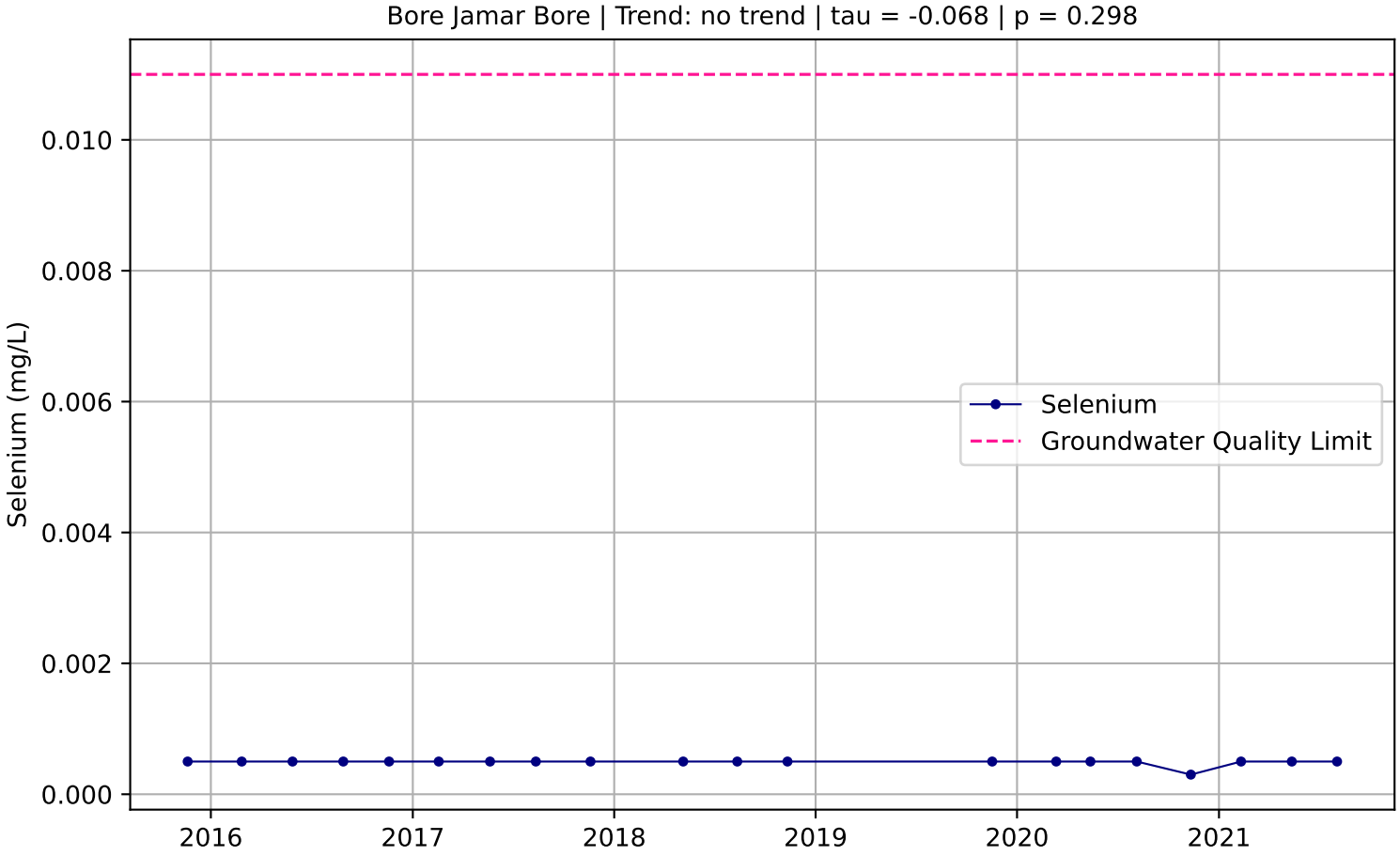

Bore Jamar Bore | Trend: no trend | tau = -0.21 | p = 0.194
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024

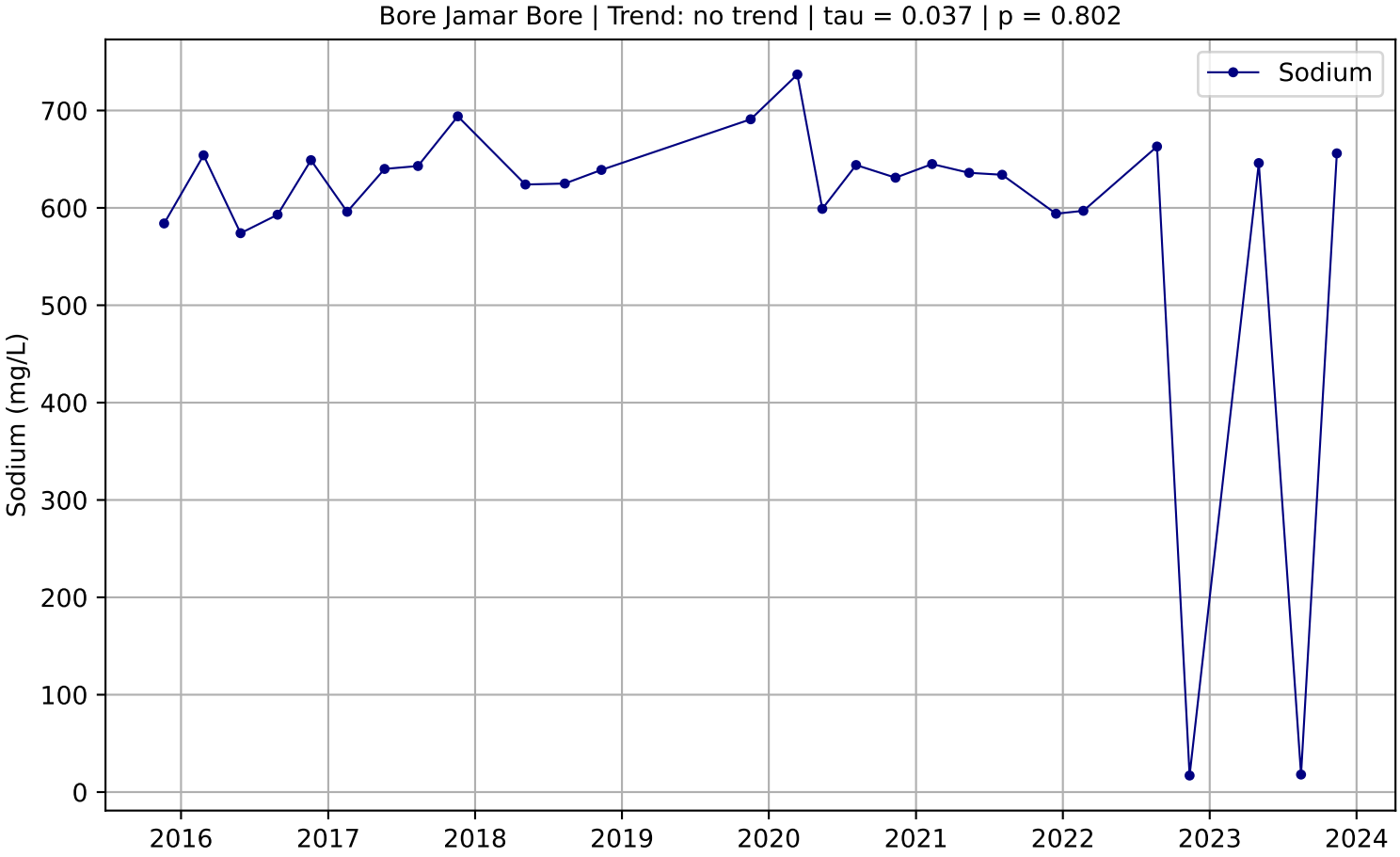

Bore Jamar Bore | Trend: no trend | tau = 0.295 | p = 0.074
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
2016
2017
2018
2019
2020
2021

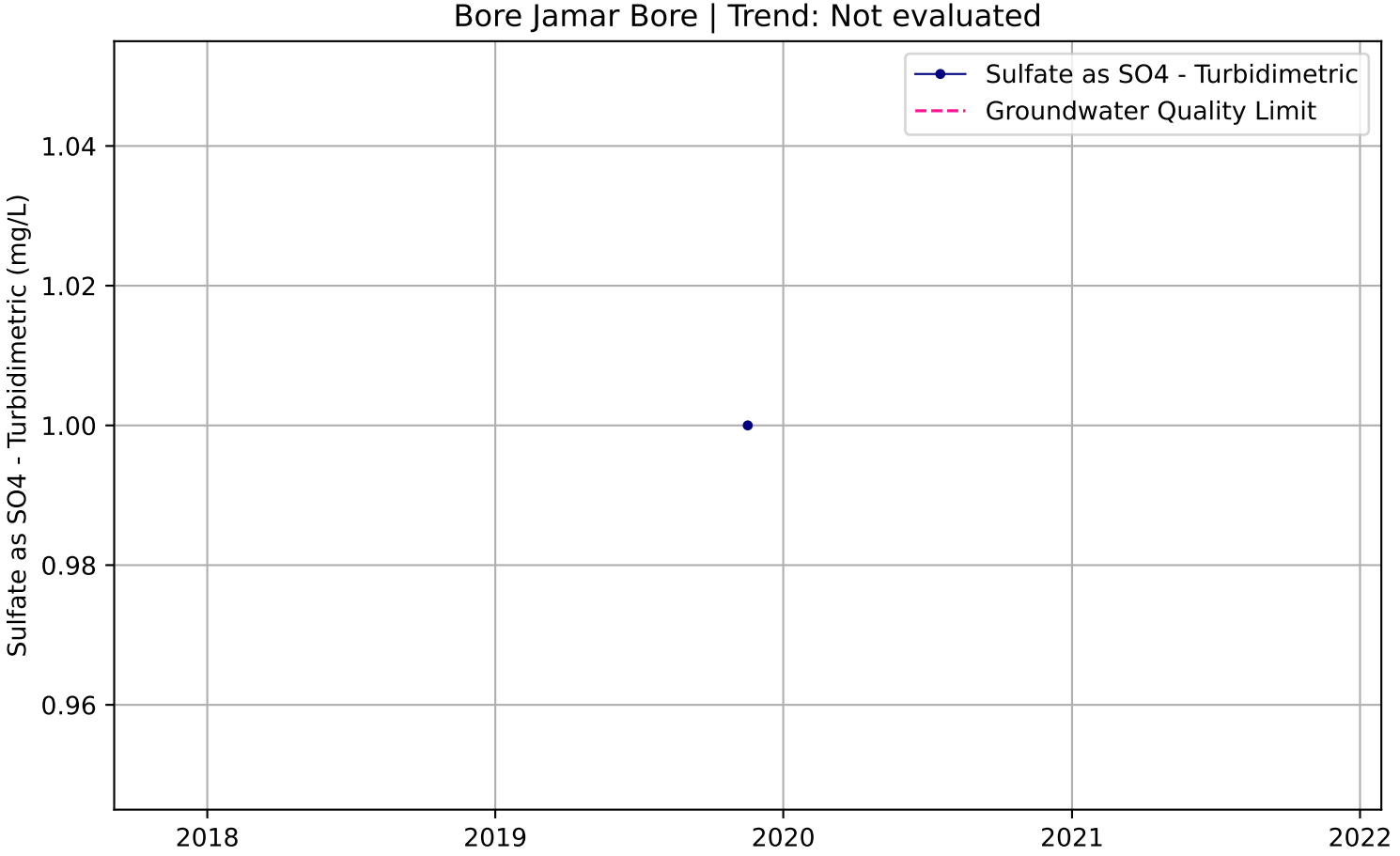

Bore Jamar Bore | Trend: no trend | tau = -0.195 | p = 0.239
Magnesium
Magnesium (mg/L)
80
70
60
50
40
30
20
10
2018
2019
2020
2021
2022
2023
2024

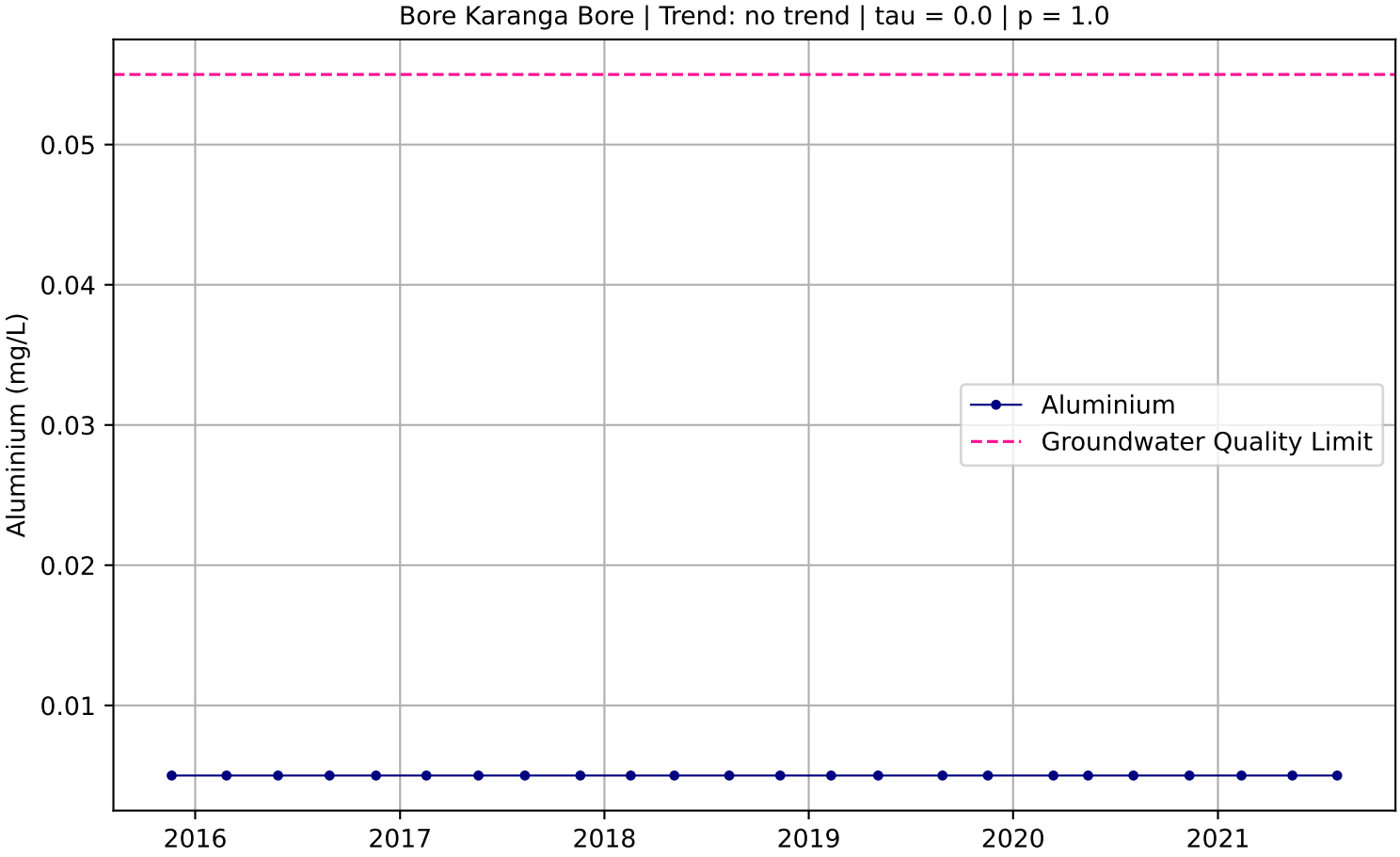

Bore Jamar Bore | Trend: no trend | tau = 0.0 | p = 1.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit

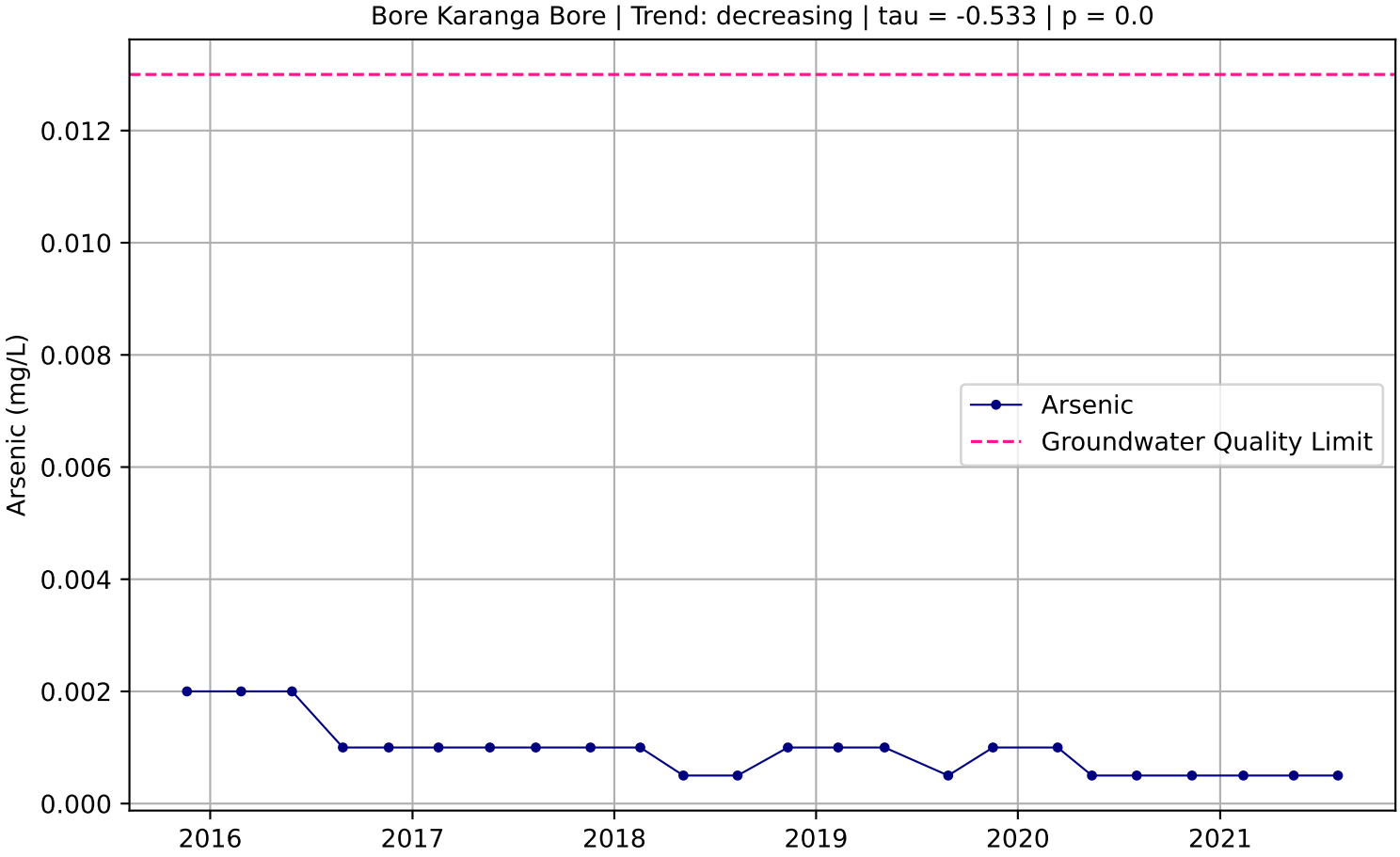

Bore Jamar Bore | Trend: no trend | tau = 0.123 | p = 0.29
Potassium
Potassium (mg/L)
10
9
8
7
6
5
2016
2017
2018
2019
2020
2021
2022
2023
2024

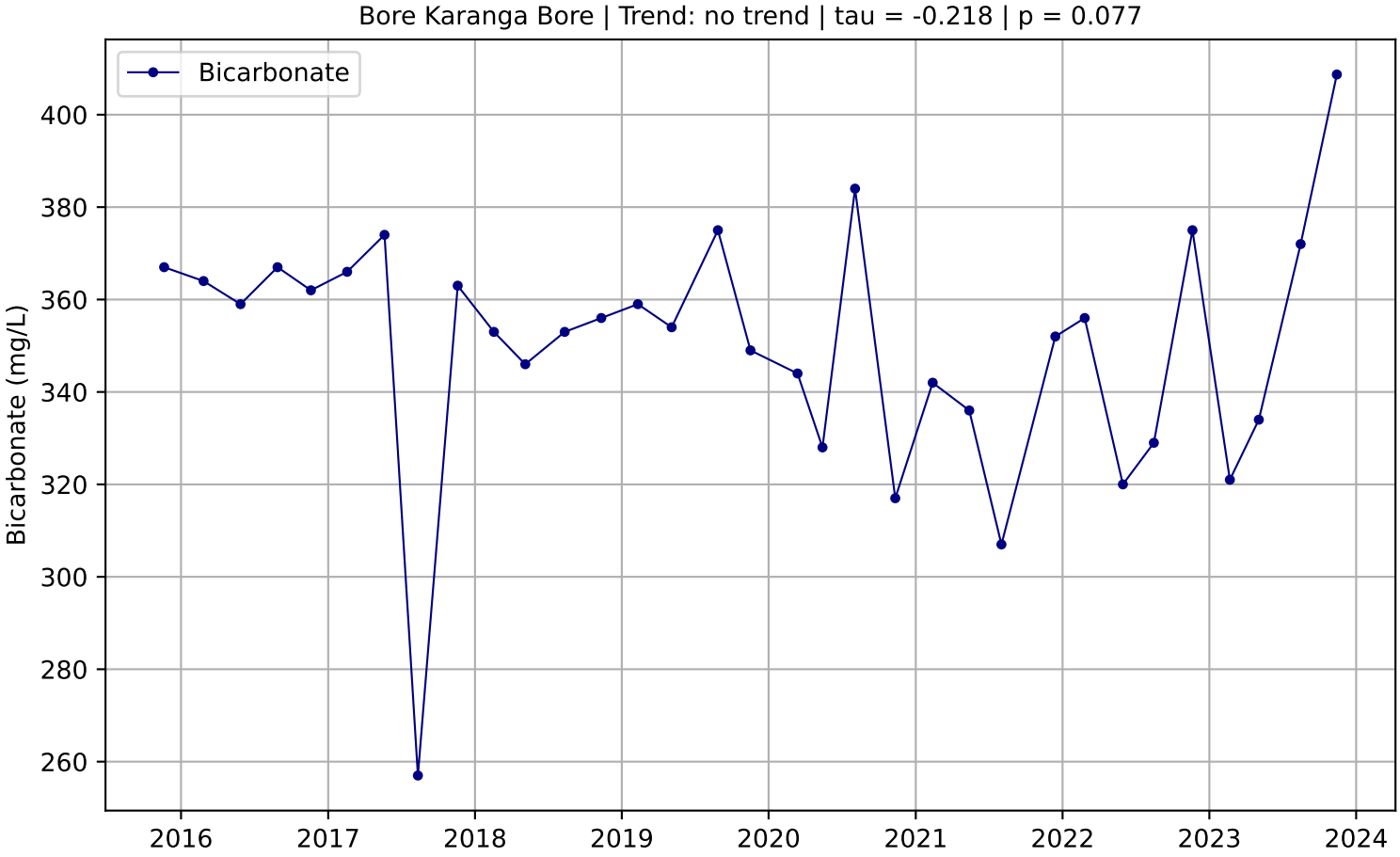

Bore Jamar Bore | Trend: no trend | tau = -0.068 | p = 0.298
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit

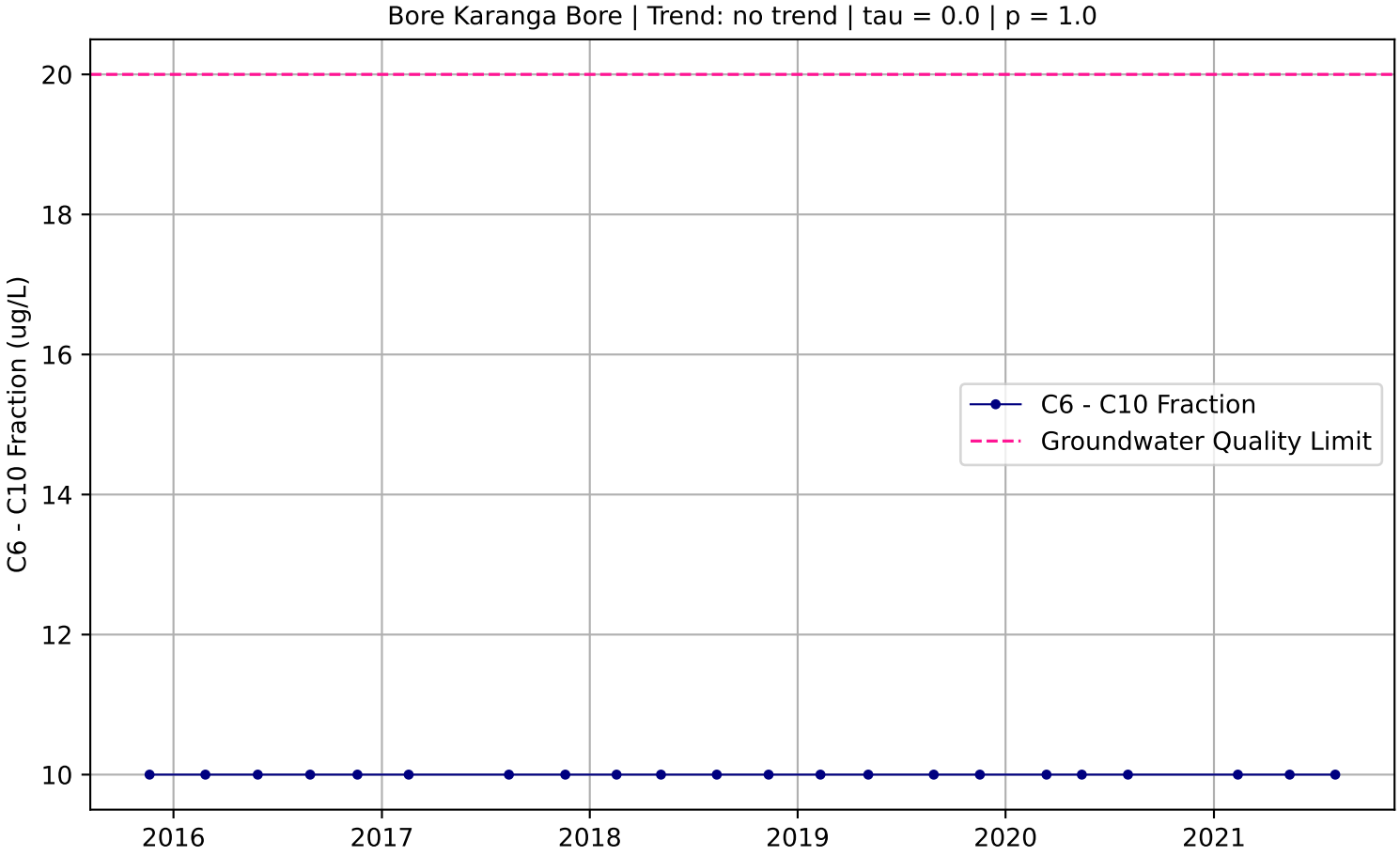

Bore Jamar Bore | Trend: no trend | tau = 0.037 | p = 0.802
Sodium
Sodium (mg/L)
0
100
200
300
400
500
600
700
2016
2017
2018
2019
2020
2021
2022
2023
2024

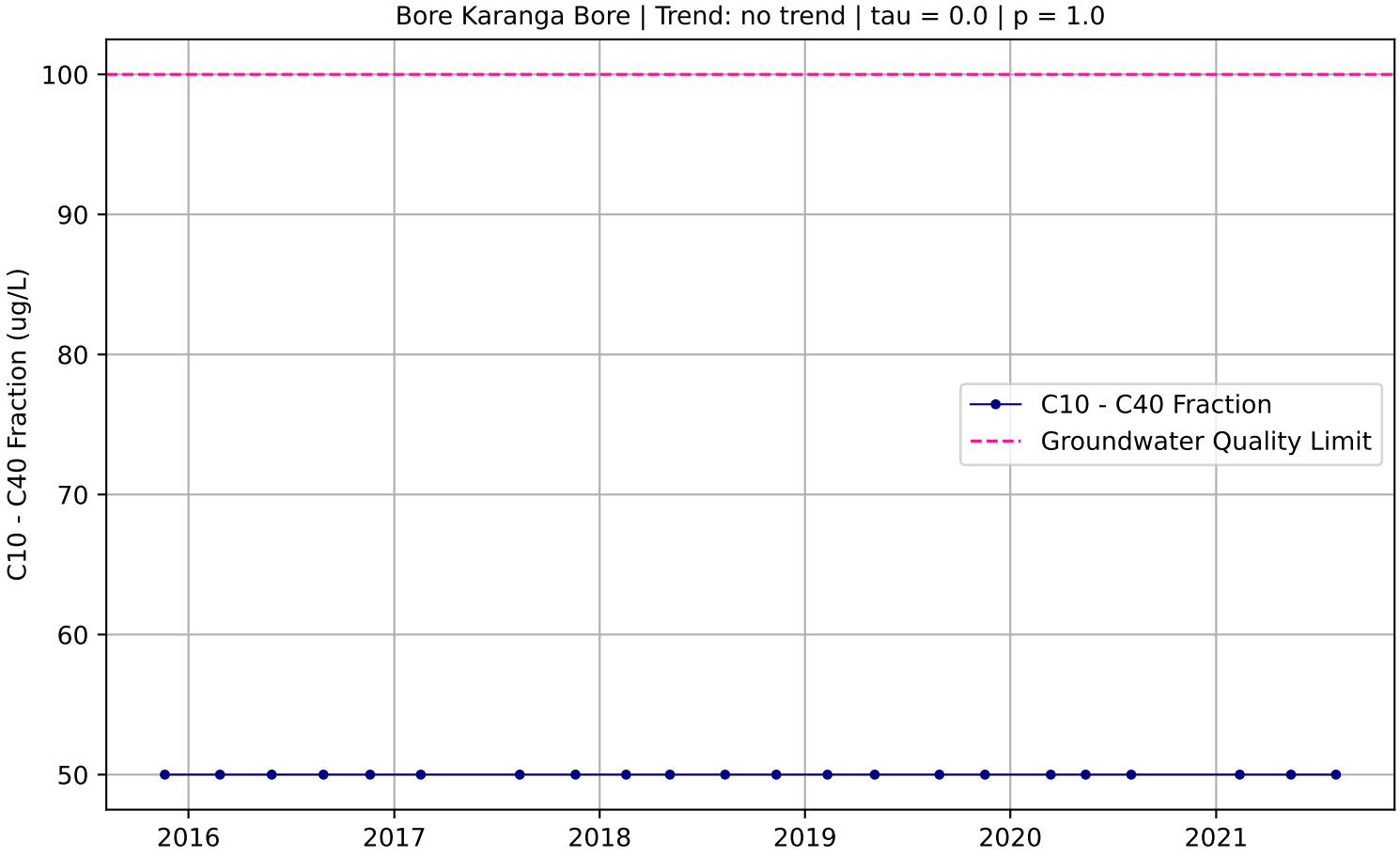

Bore Jamar Bore | Trend: Not evaluated
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
1.04
1.02
1.00
0.98
0.96
2018
2019
2020
2021
2022

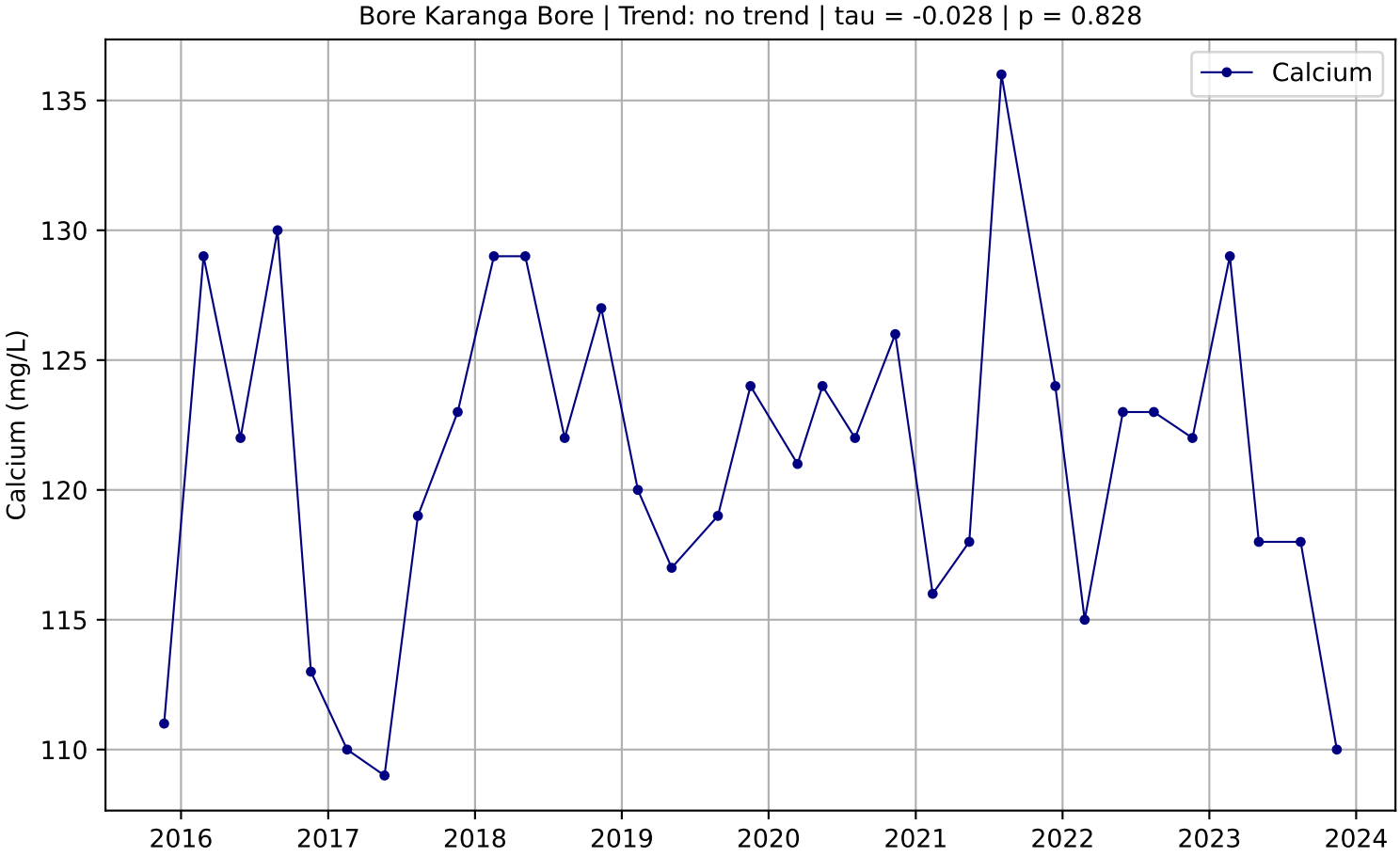

Bore Karanga Bore | Trend: no trend | tau = 0.0 | p = 1.0
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
Aluminium
Groundwater Quality Limit

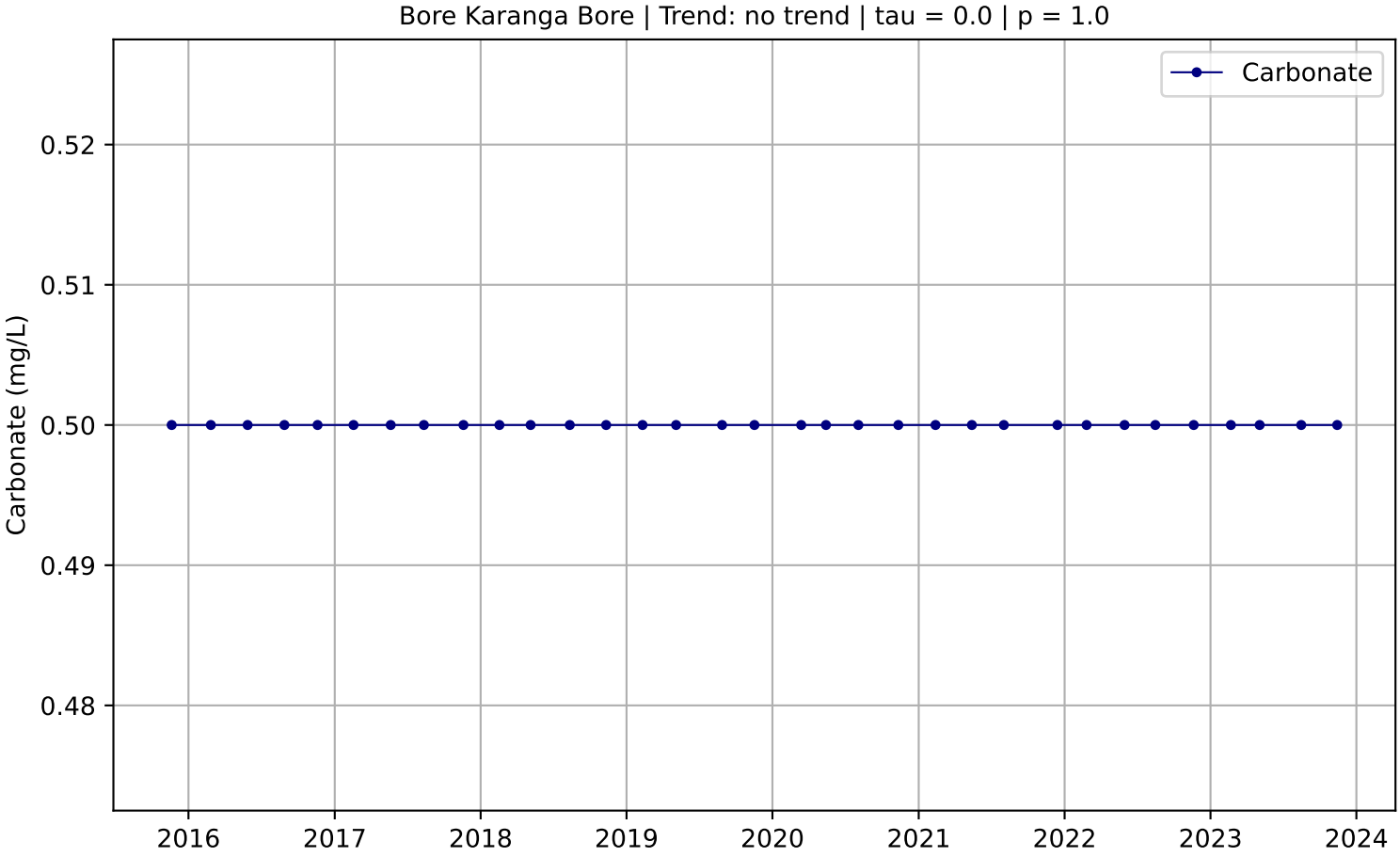

Bore Karanga Bore | Trend: decreasing | tau = -0.533 | p = 0.0
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

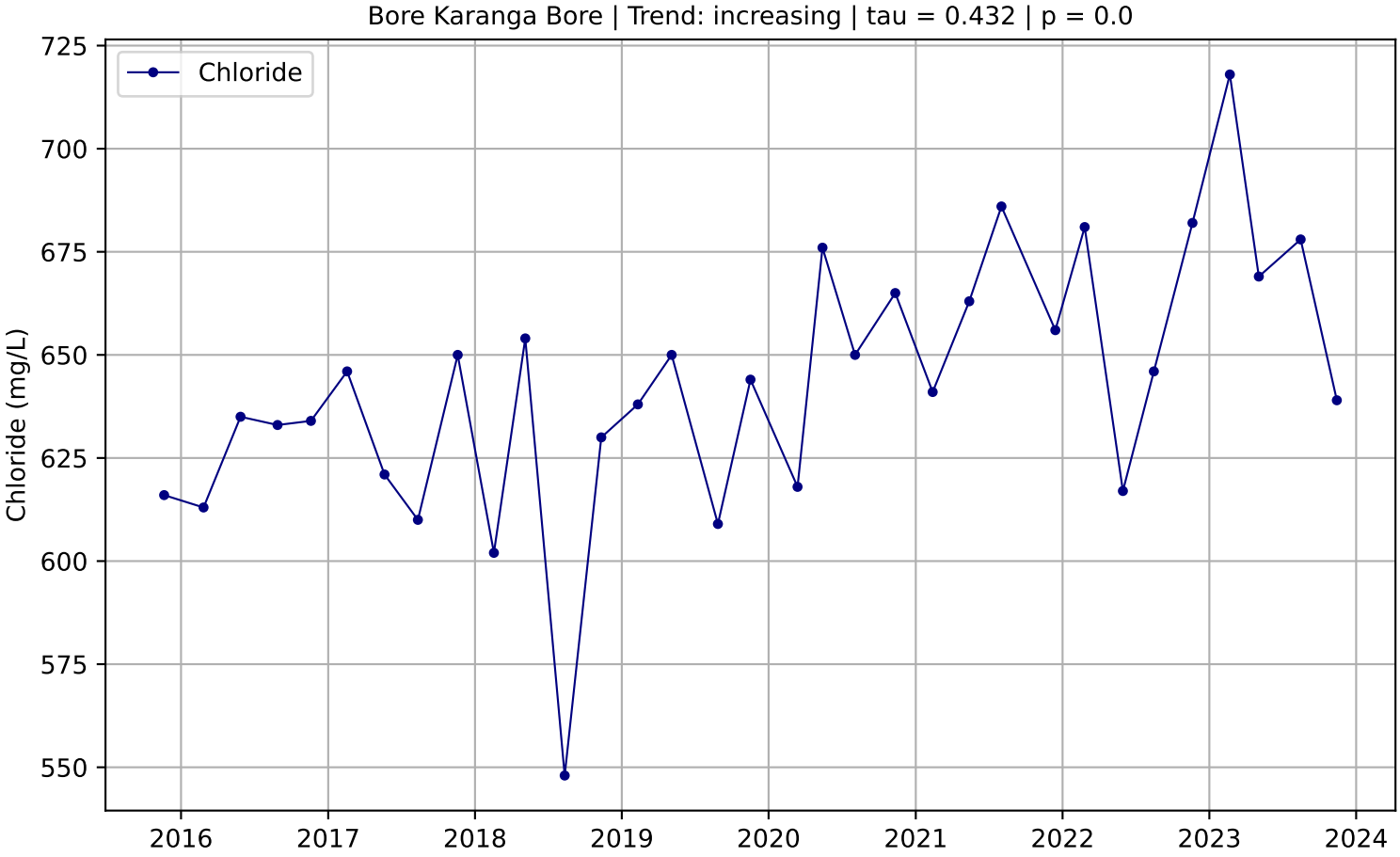

Bore Karanga Bore | Trend: no trend | tau = -0.218 | p = 0.077
Bicarbonate
Bicarbonate (mg/L)
400
380
360
340
320
300
280
260
2016
2017
2018
2019
2020
2021
2022
2023
2024

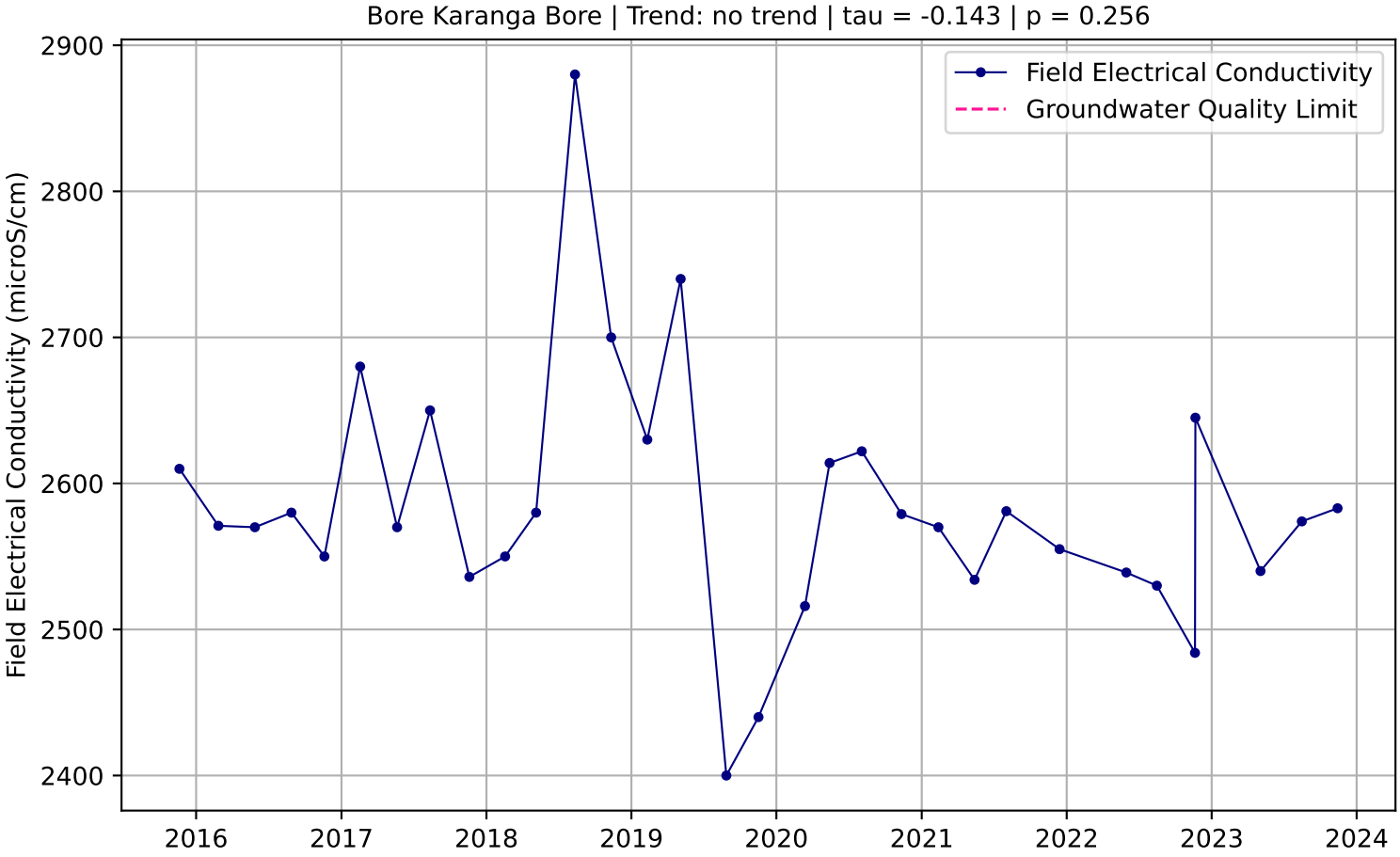

Bore Karanga Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

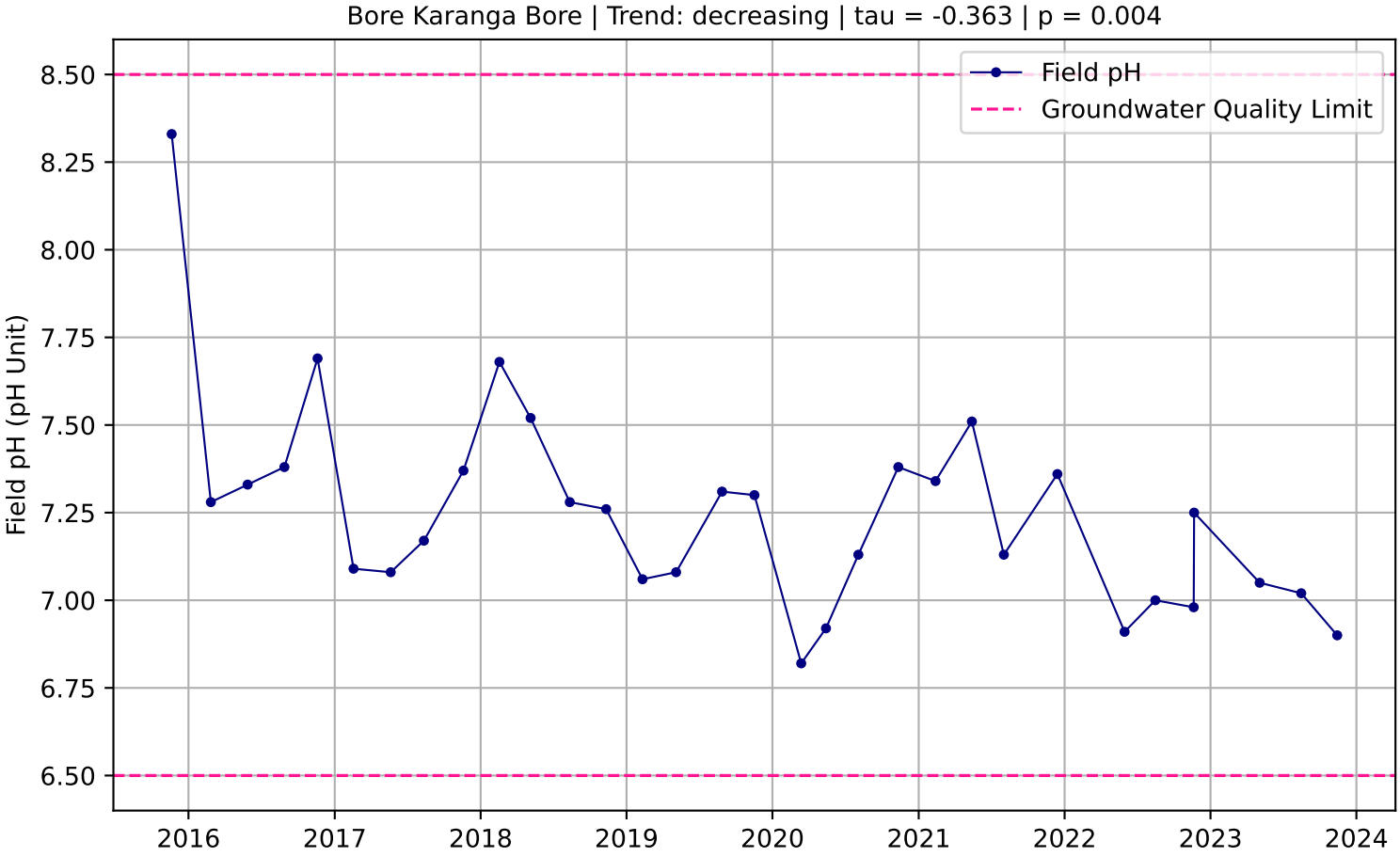

Bore Karanga Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

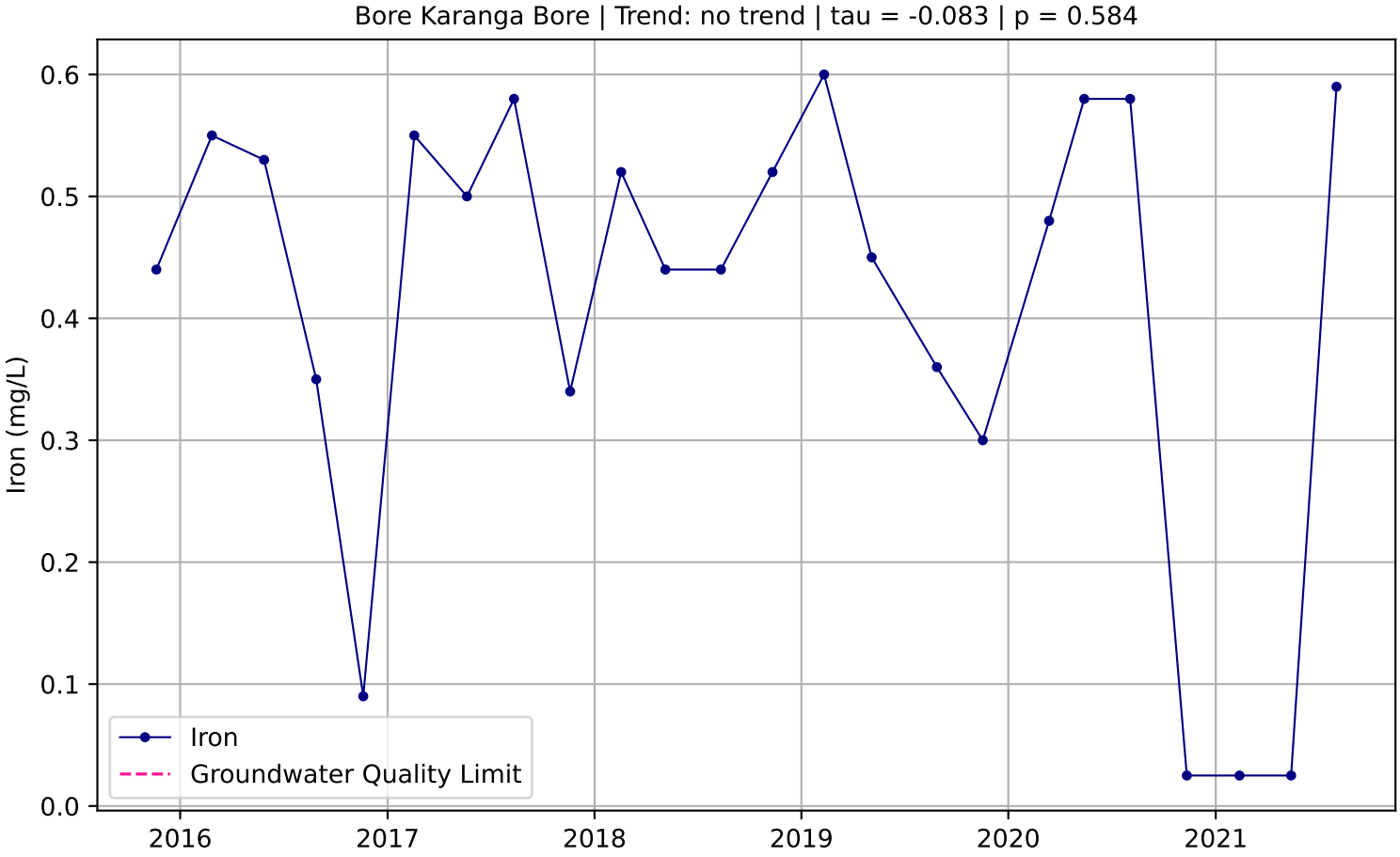

Bore Karanga Bore | Trend: no trend | tau = -0.028 | p = 0.828
Calcium
Calcium (mg/L)
135
130
125
120
115
110
2016
2017
2018
2019
2020
2021
2022
2023
2024

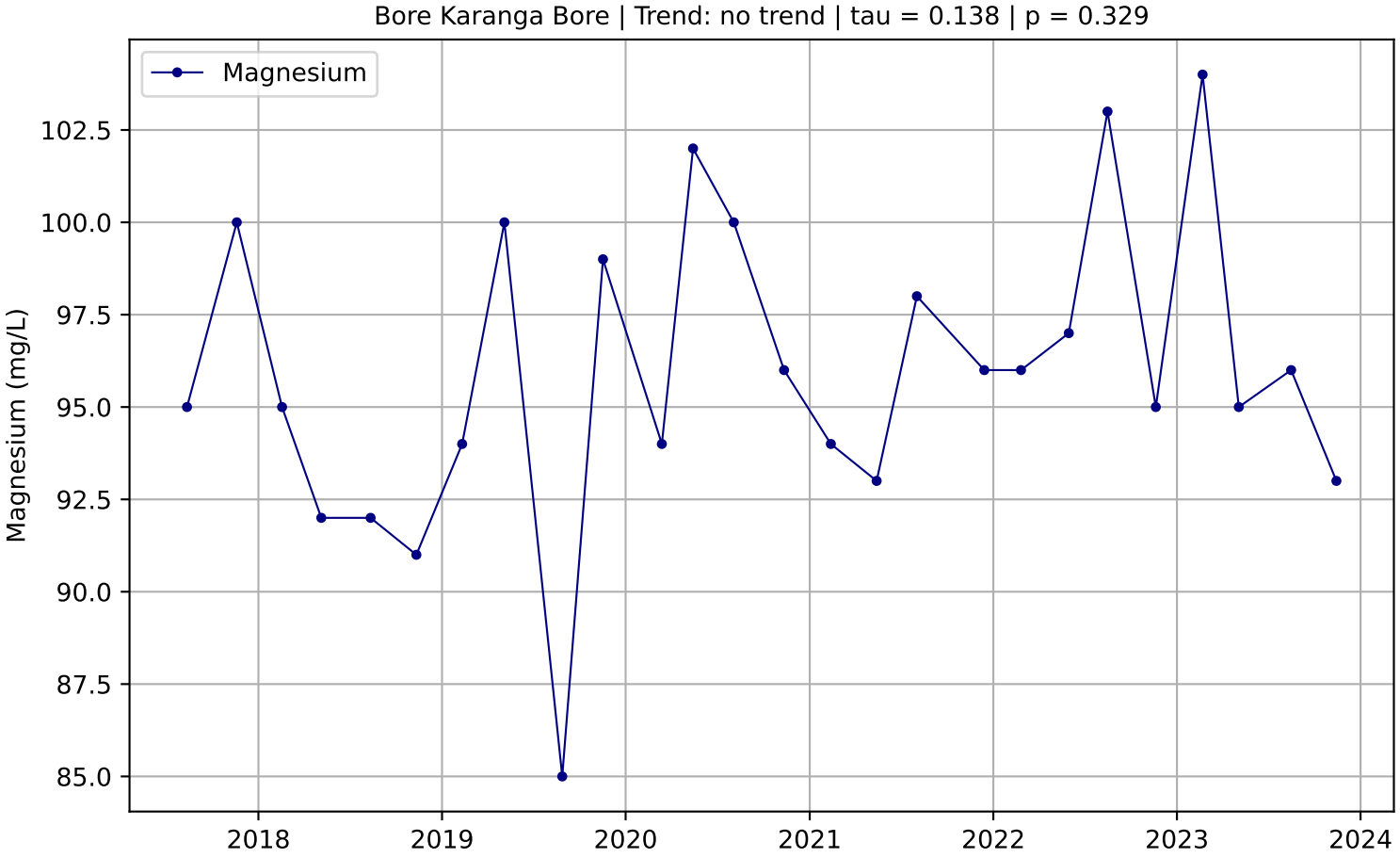

Bore Karanga Bore | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

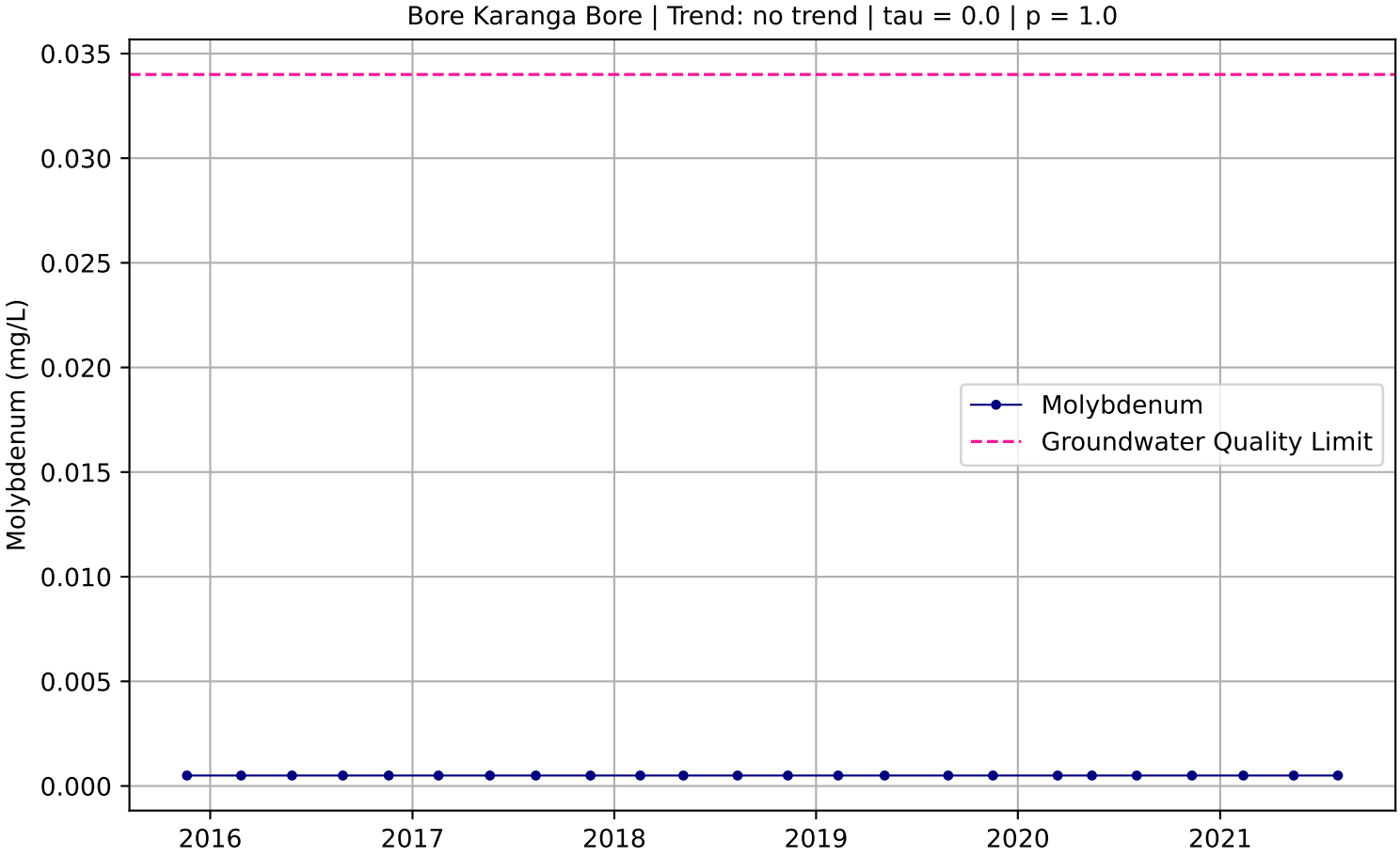

Bore Karanga Bore | Trend: increasing | tau = 0.432 | p = 0.0
Chloride
Chloride (mg/L)
725
700
675
650
625
600
575
550
2016
2017
2018
2019
2020
2021
2022
2023
2024

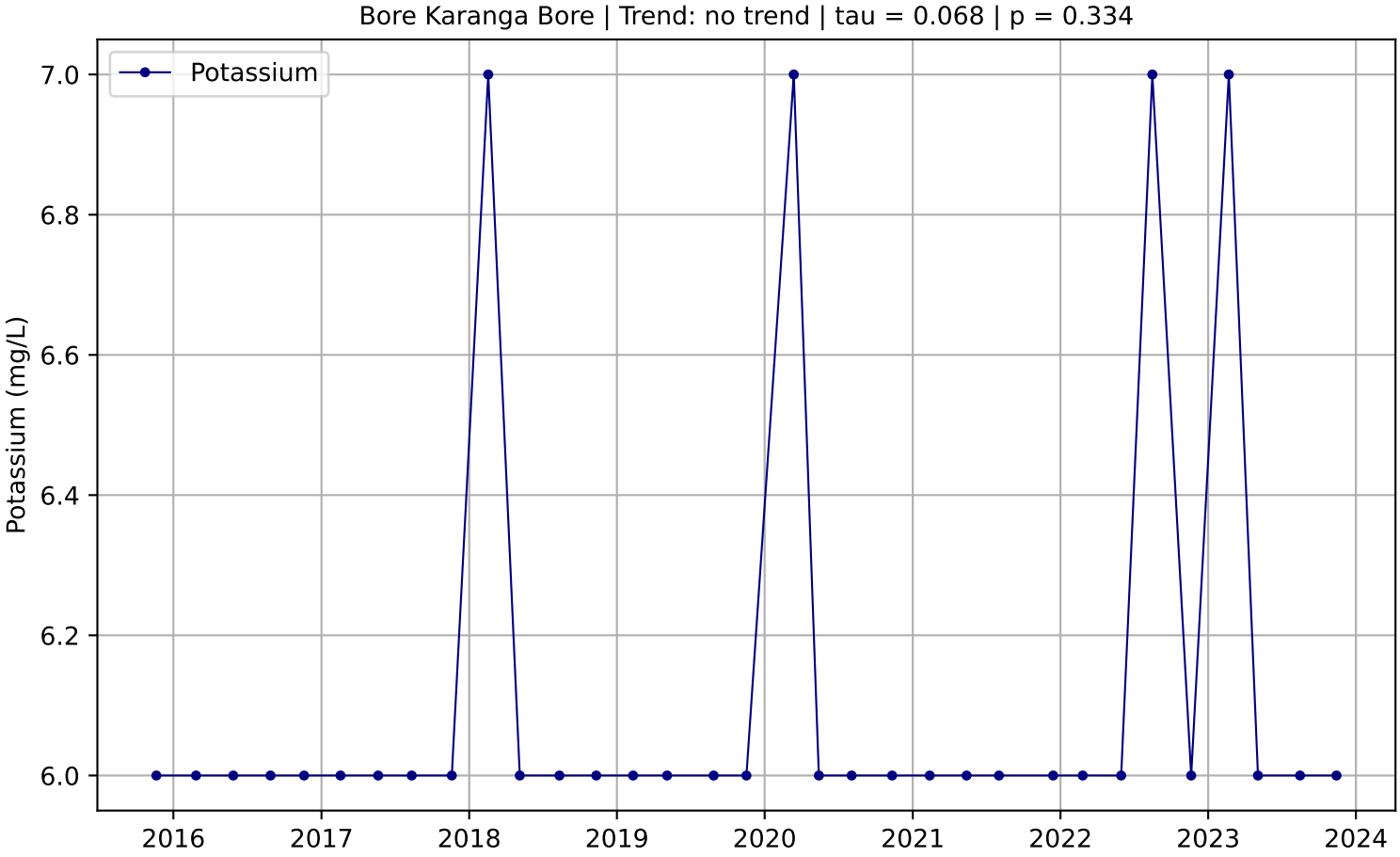

Bore Karanga Bore | Trend: no trend | tau = -0.143 | p = 0.256
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
2900
2800
2700
2600
2500
2400
2016
2017
2018
2019
2020
2021
2022
2023
2024

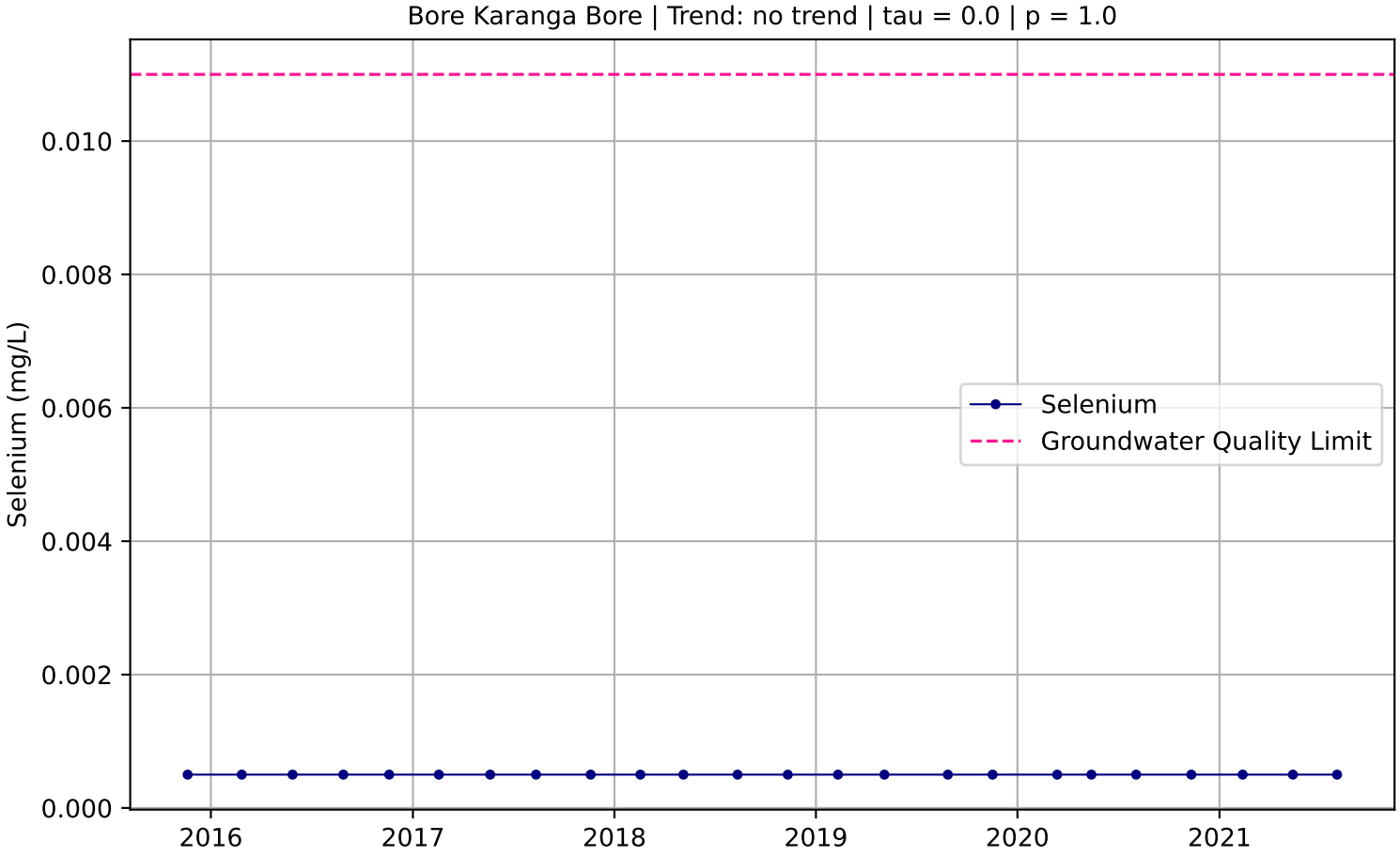

Bore Karanga Bore | Trend: decreasing | tau = -0.363 | p = 0.004
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024

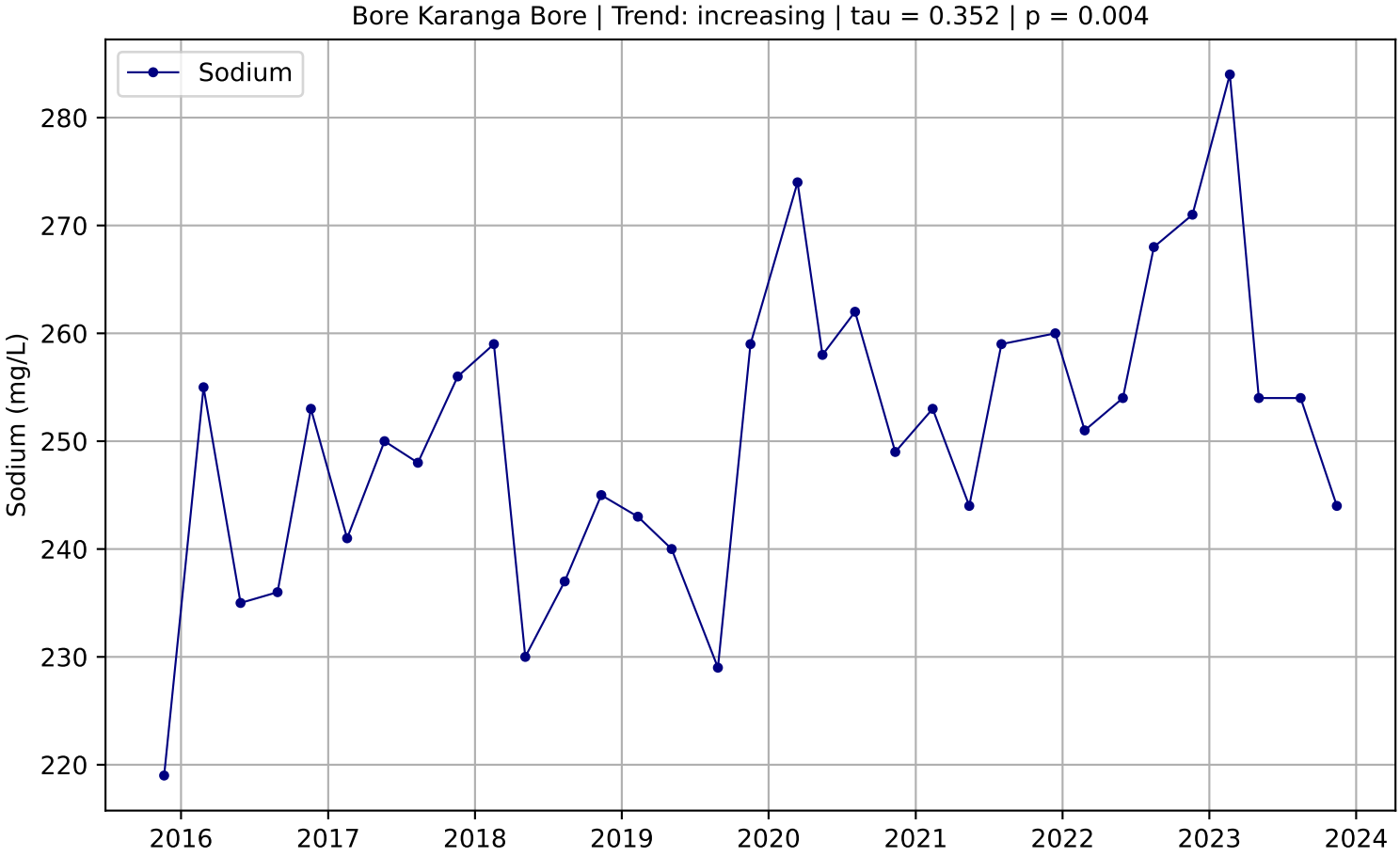

Bore Karanga Bore | Trend: no trend | tau = -0.083 | p = 0.584
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
2016
2017
2018
2019
2020
2021
Iron
Groundwater Quality Limit

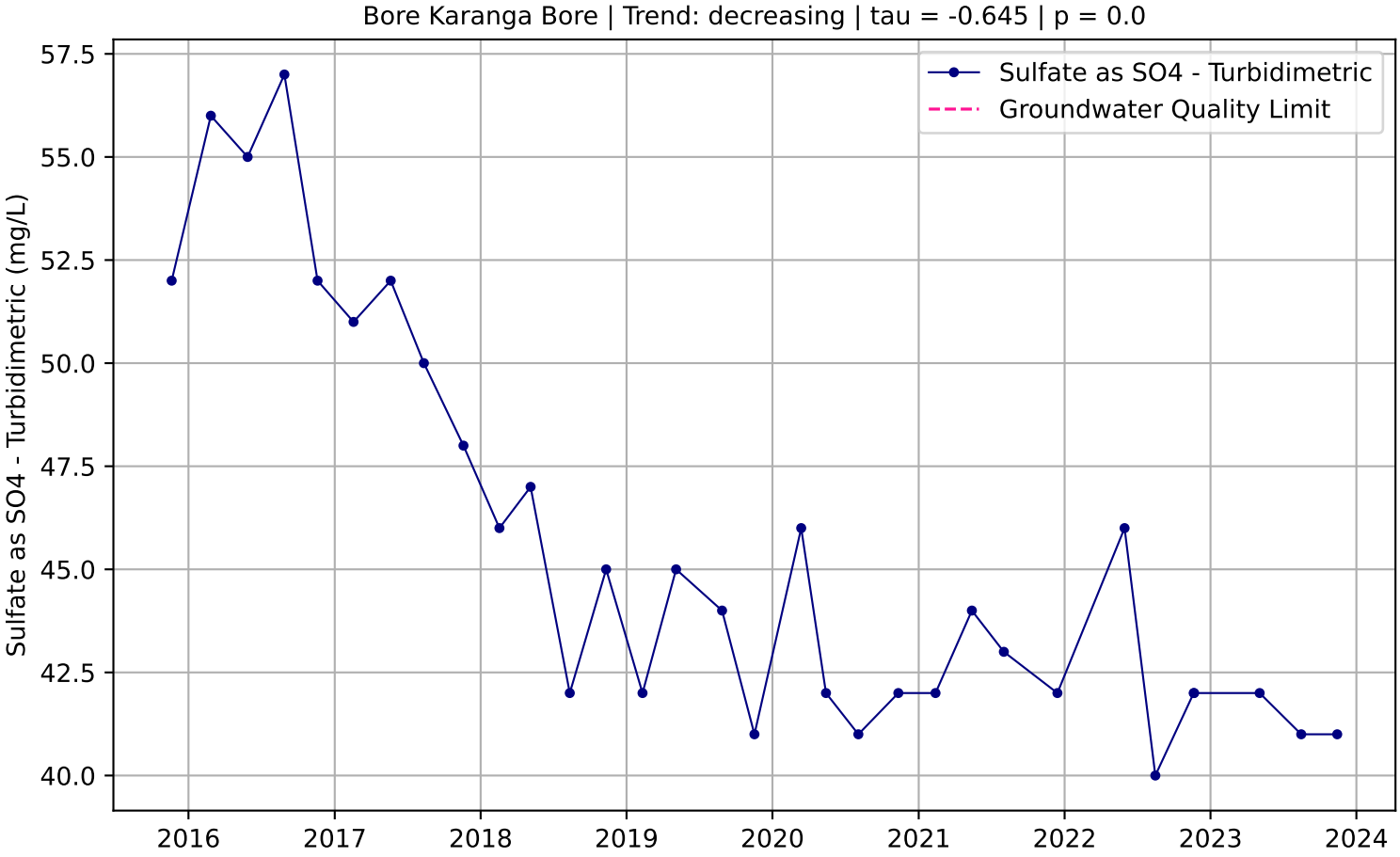

Bore Karanga Bore | Trend: no trend | tau = 0.138 | p = 0.329
Magnesium
Magnesium (mg/L)
102.5
100.0
97.5
95.0
92.5
90.0
87.5
85.0
2018
2019
2020
2021
2022
2023
2024

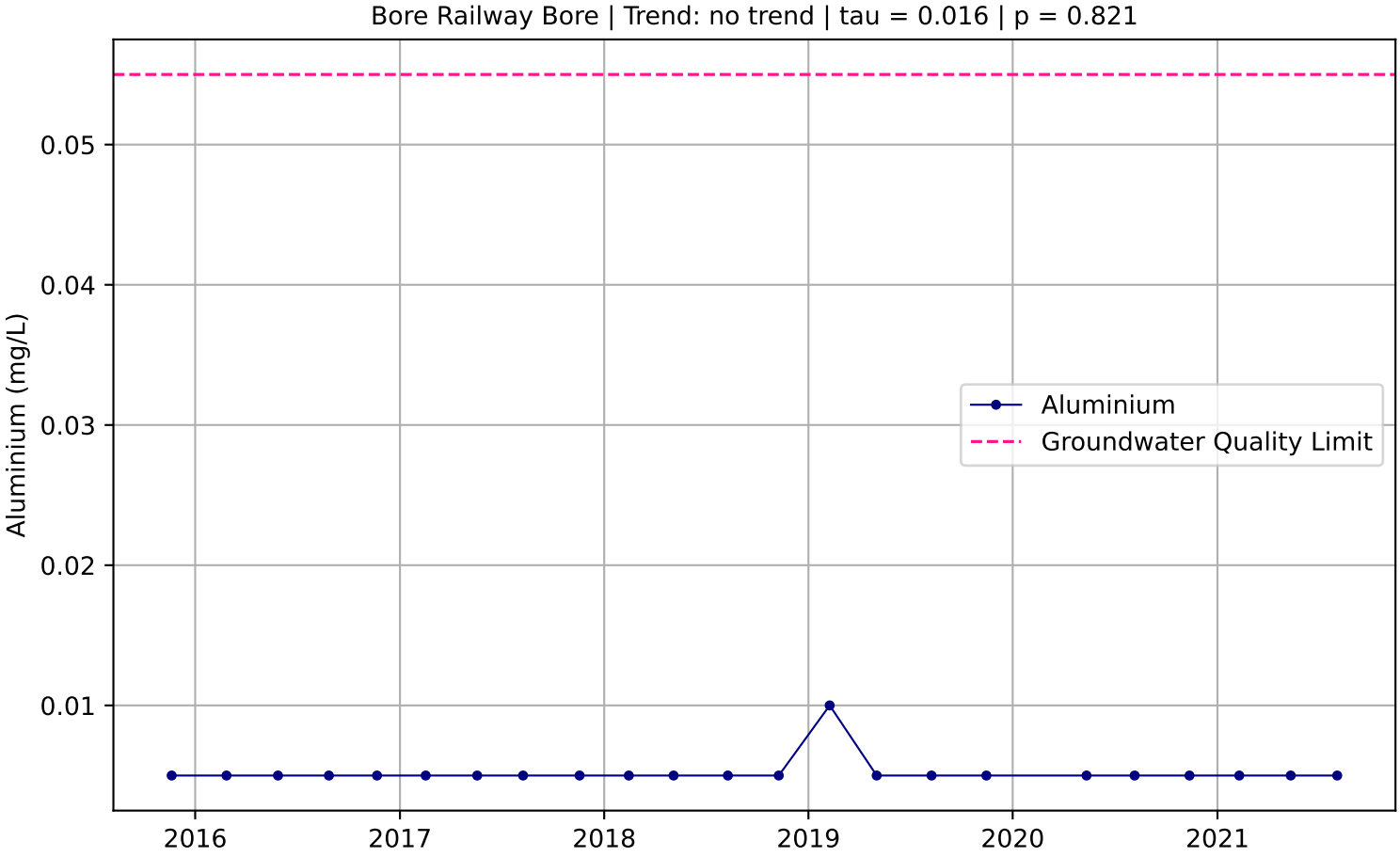

Bore Karanga Bore | Trend: no trend | tau = 0.0 | p = 1.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit

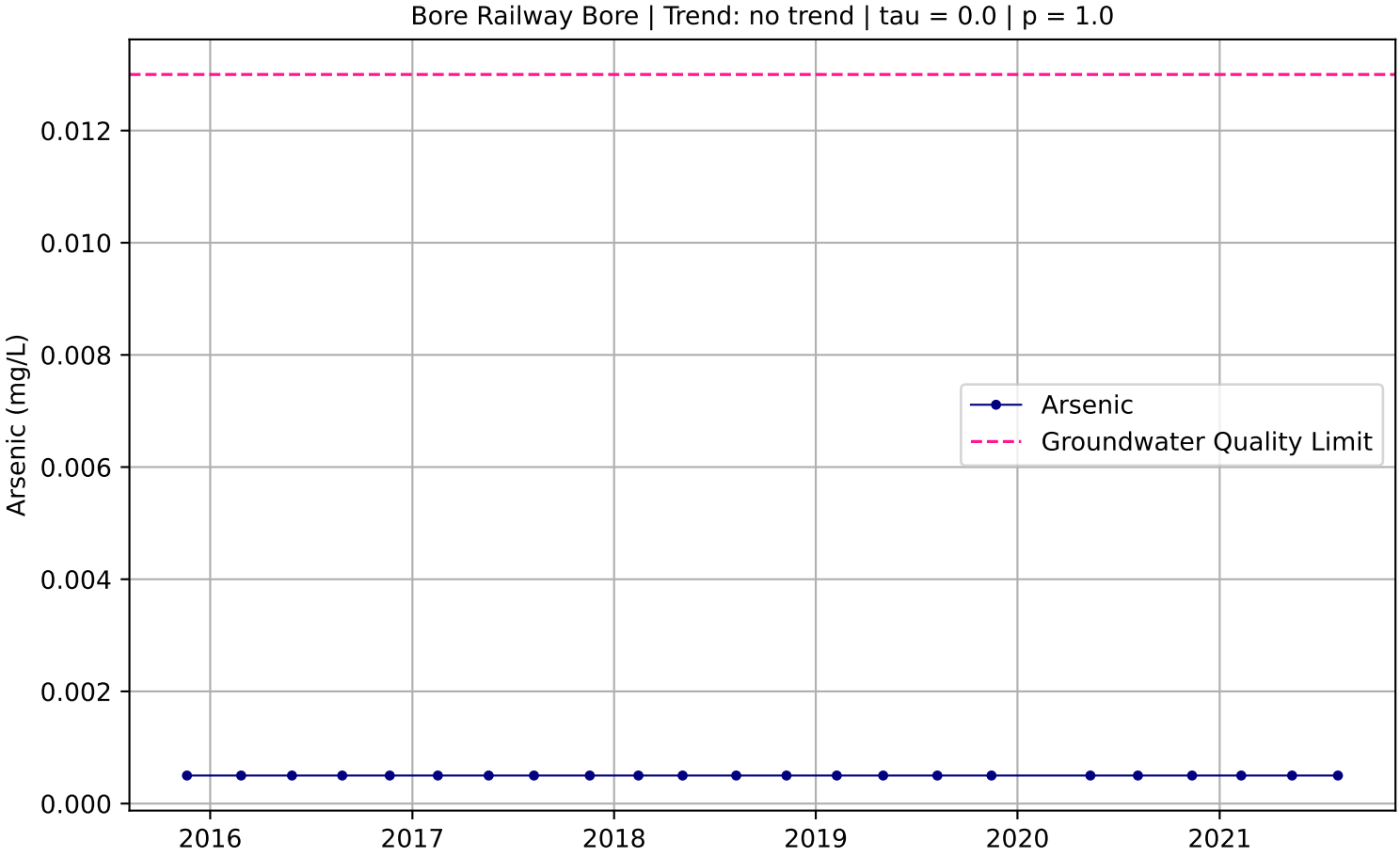

Bore Karanga Bore | Trend: no trend | tau = 0.068 | p = 0.334
Potassium
Potassium (mg/L)
7.0
6.8
6.6
6.4
6.2
6.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

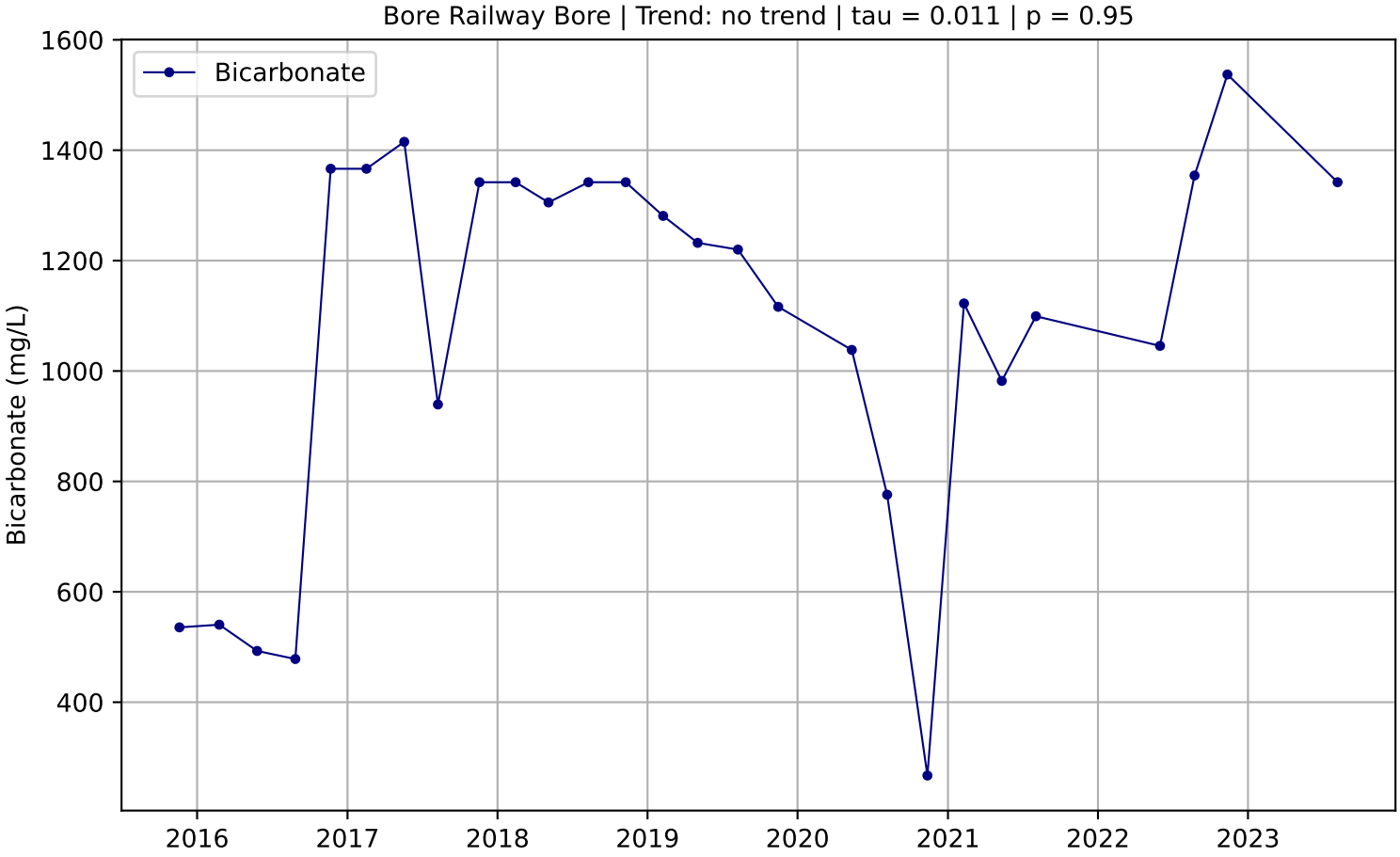

Bore Karanga Bore | Trend: no trend | tau = 0.0 | p = 1.0
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit

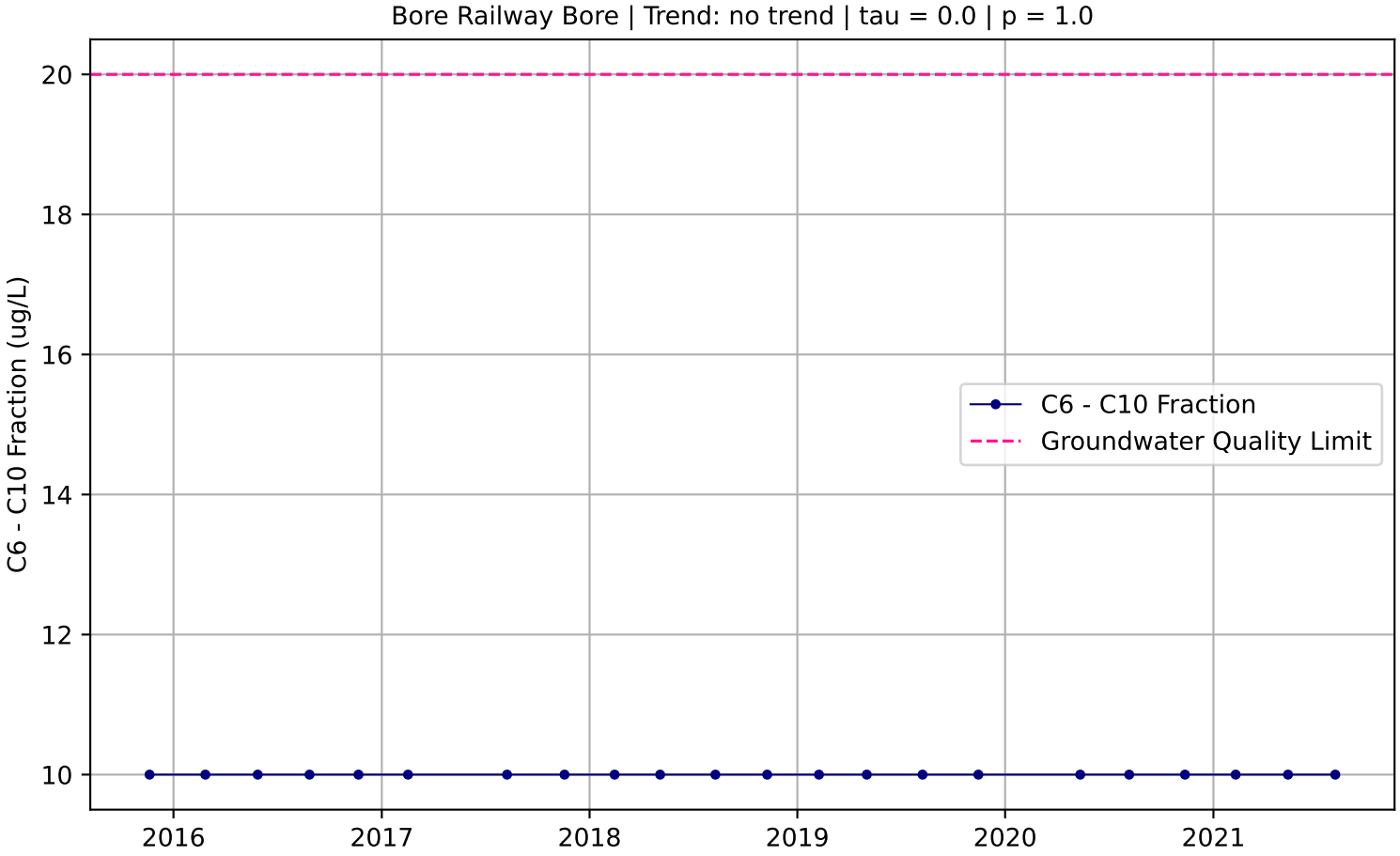

Bore Karanga Bore | Trend: increasing | tau = 0.352 | p = 0.004
Sodium
Sodium (mg/L)
280
270
260
250
240
230
220
2016
2017
2018
2019
2020
2021
2022
2023
2024

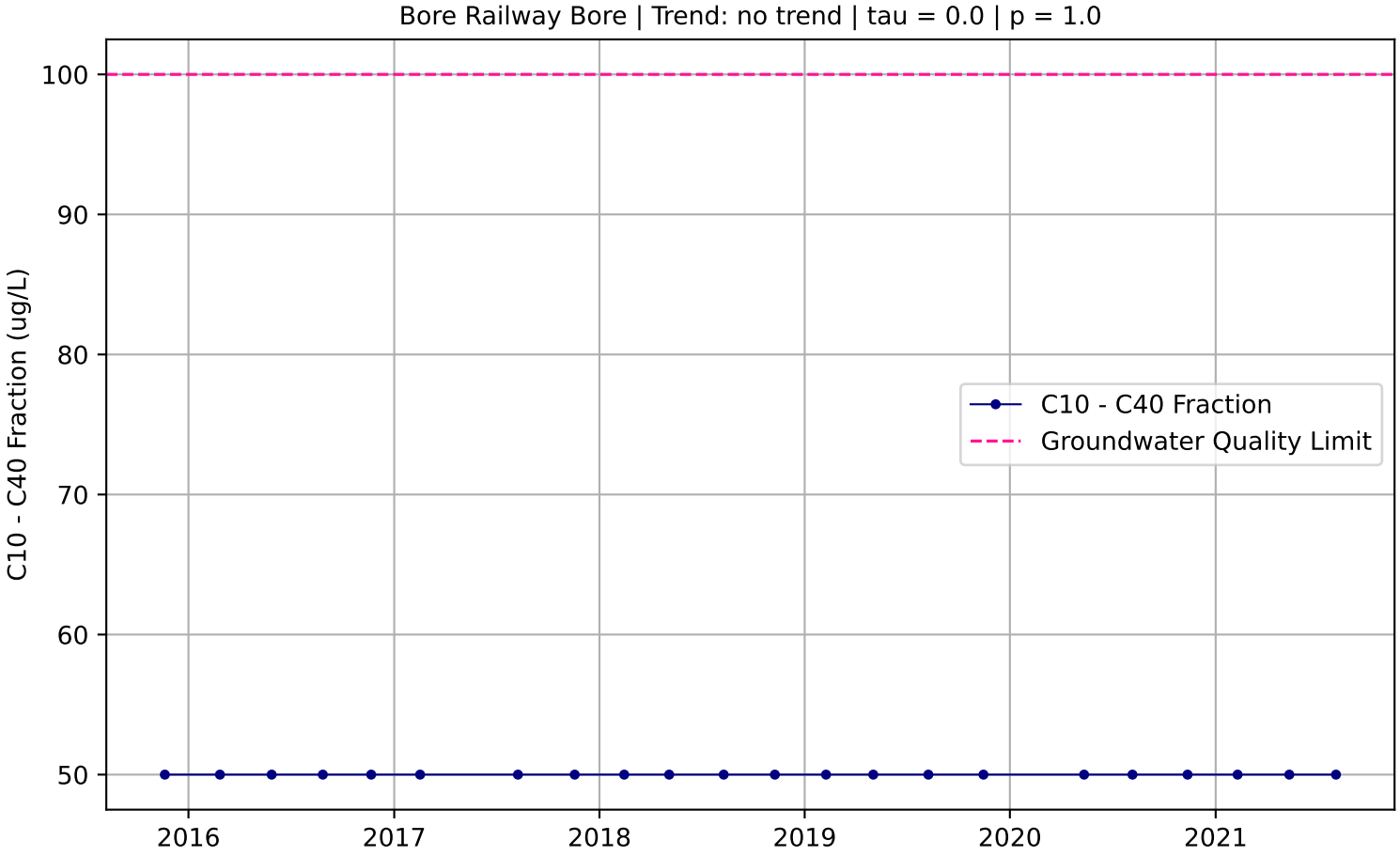

Bore Karanga Bore | Trend: decreasing | tau = -0.645 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

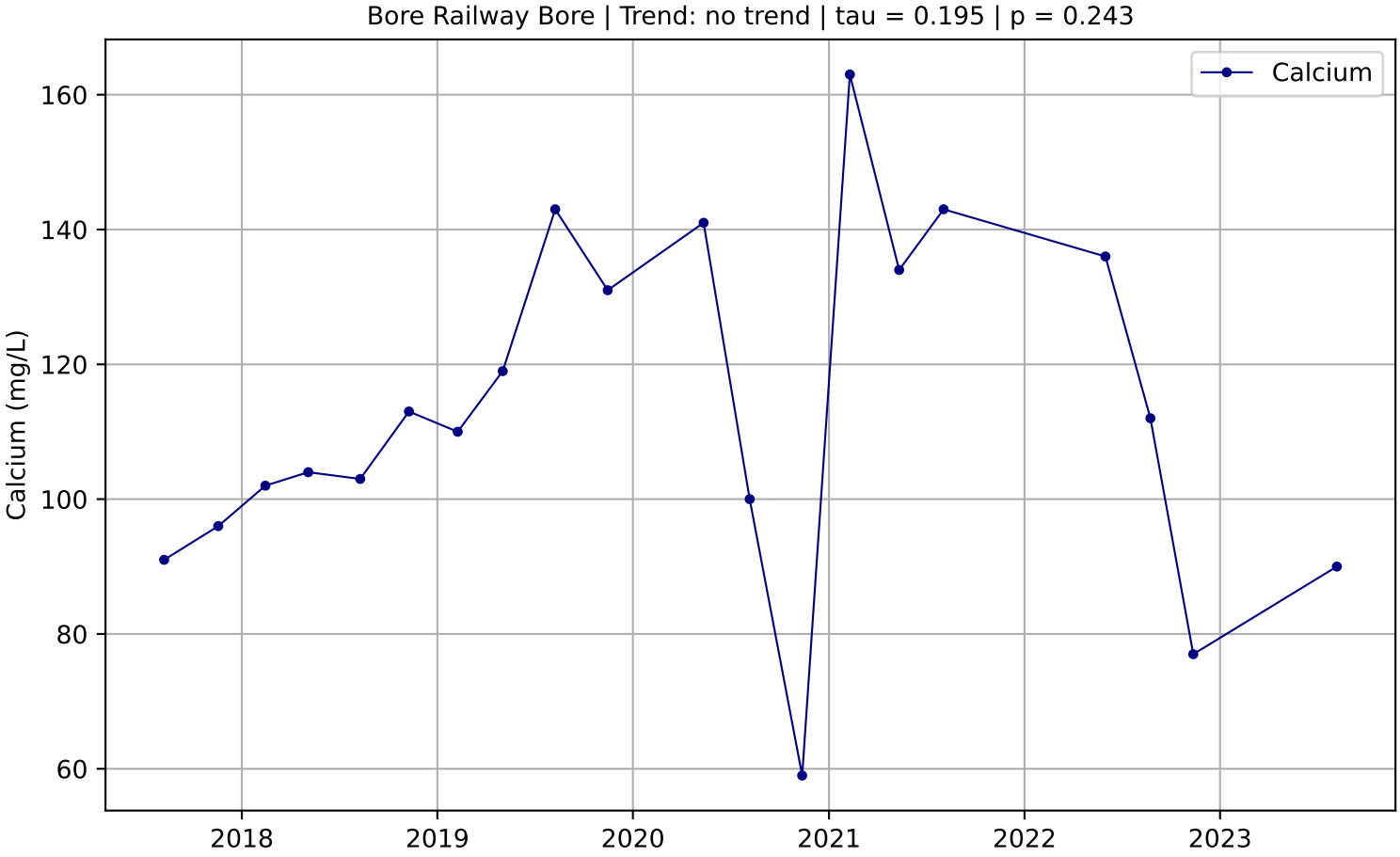

Bore Railway Bore | Trend: no trend | tau = 0.016 | p = 0.821
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
Aluminium
Groundwater Quality Limit

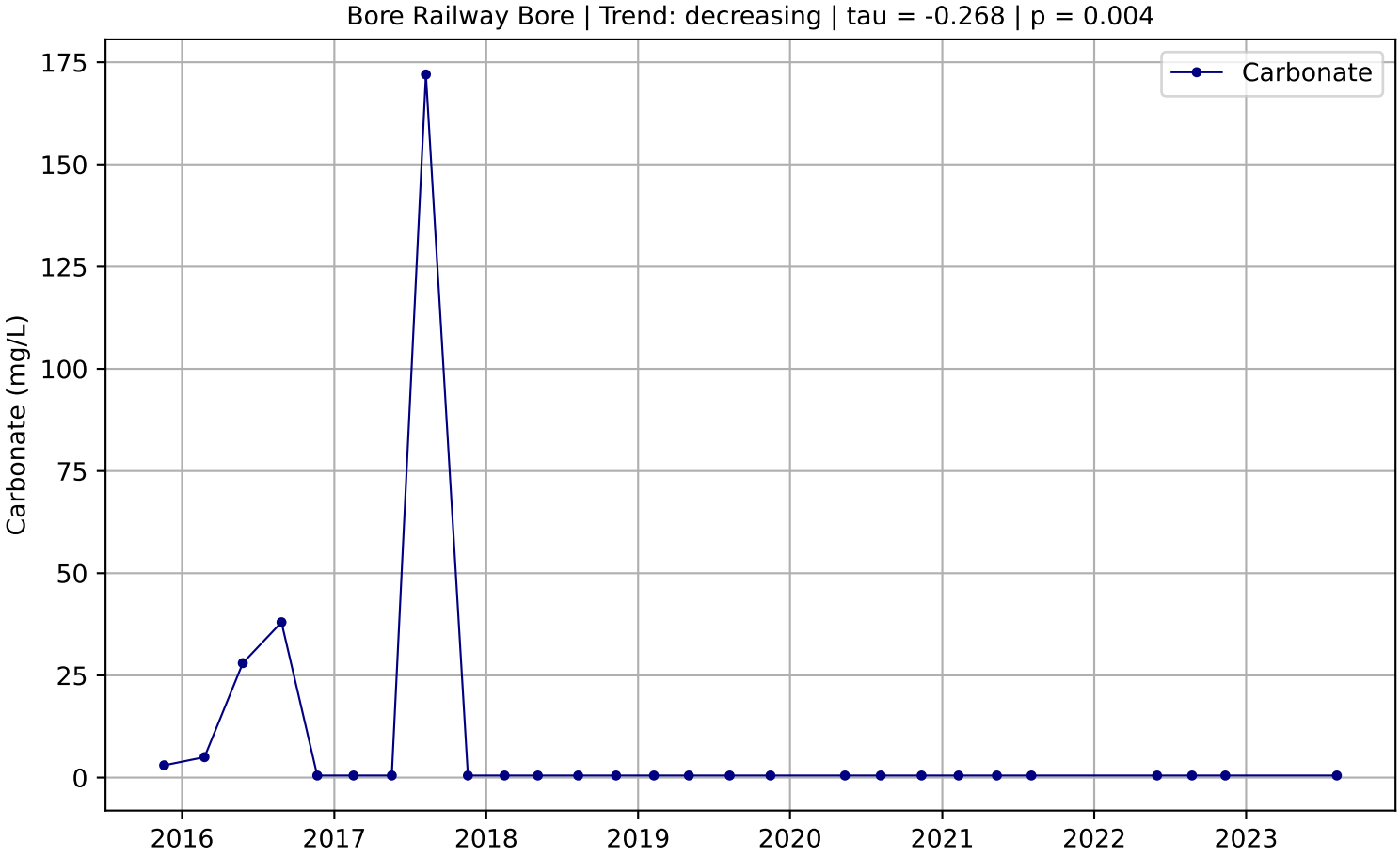

Bore Railway Bore | Trend: no trend | tau = 0.0 | p = 1.0
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

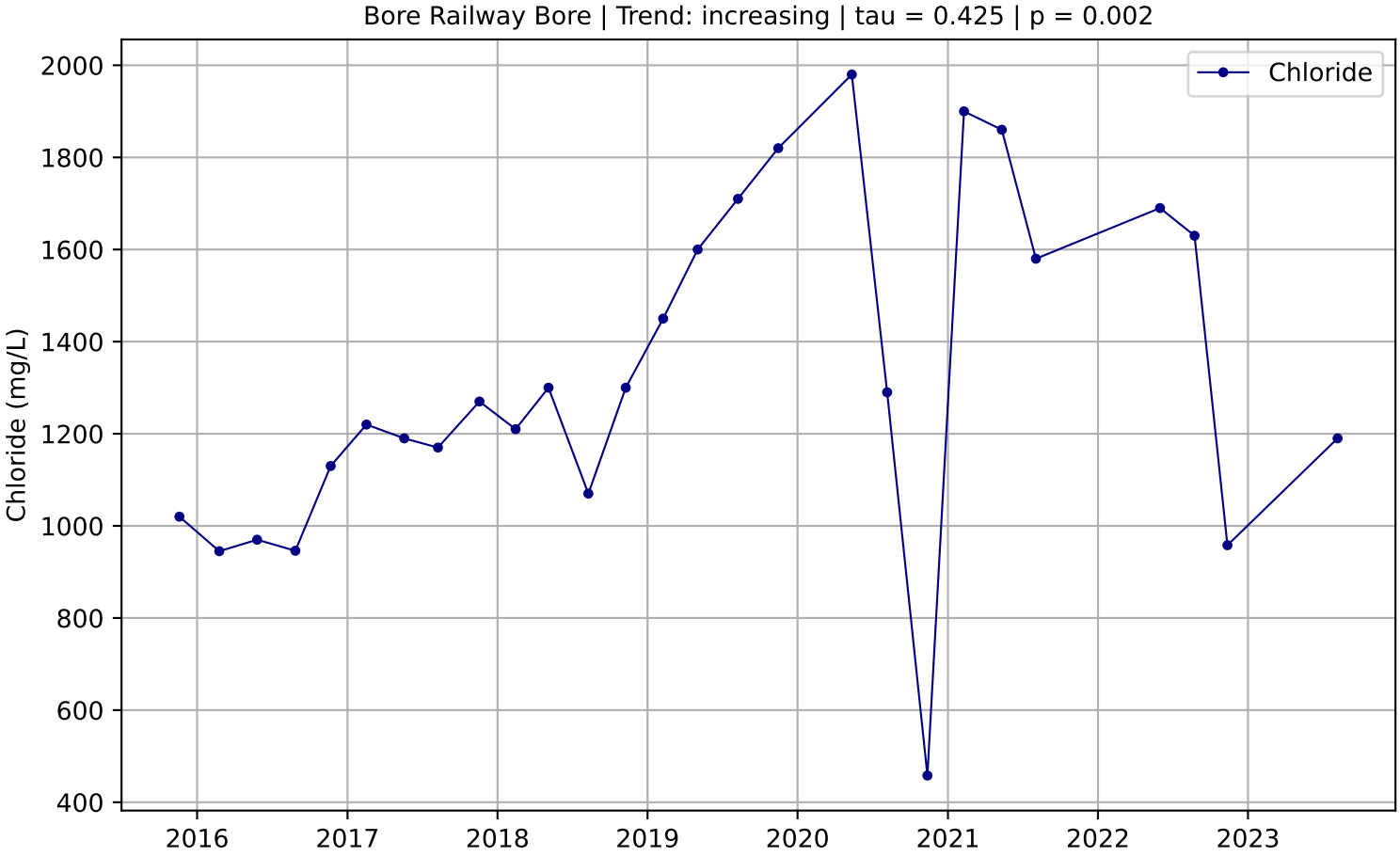

Bore Railway Bore | Trend: no trend | tau = 0.011 | p = 0.95
Bicarbonate
Bicarbonate (mg/L)
1600
1400
1200
1000
800
600
400
2016
2017
2018
2019
2020
2021
2022
2023

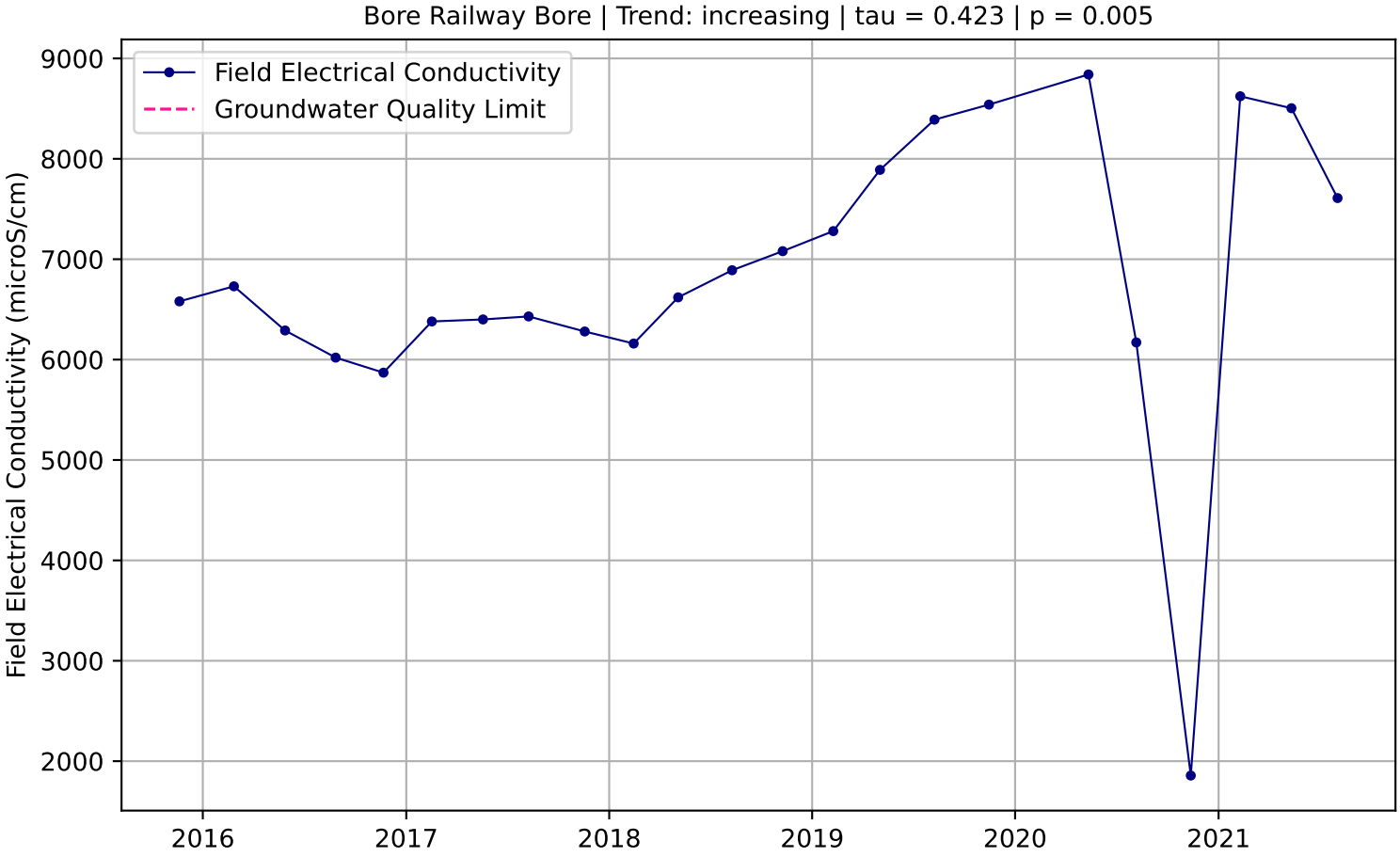

Bore Railway Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

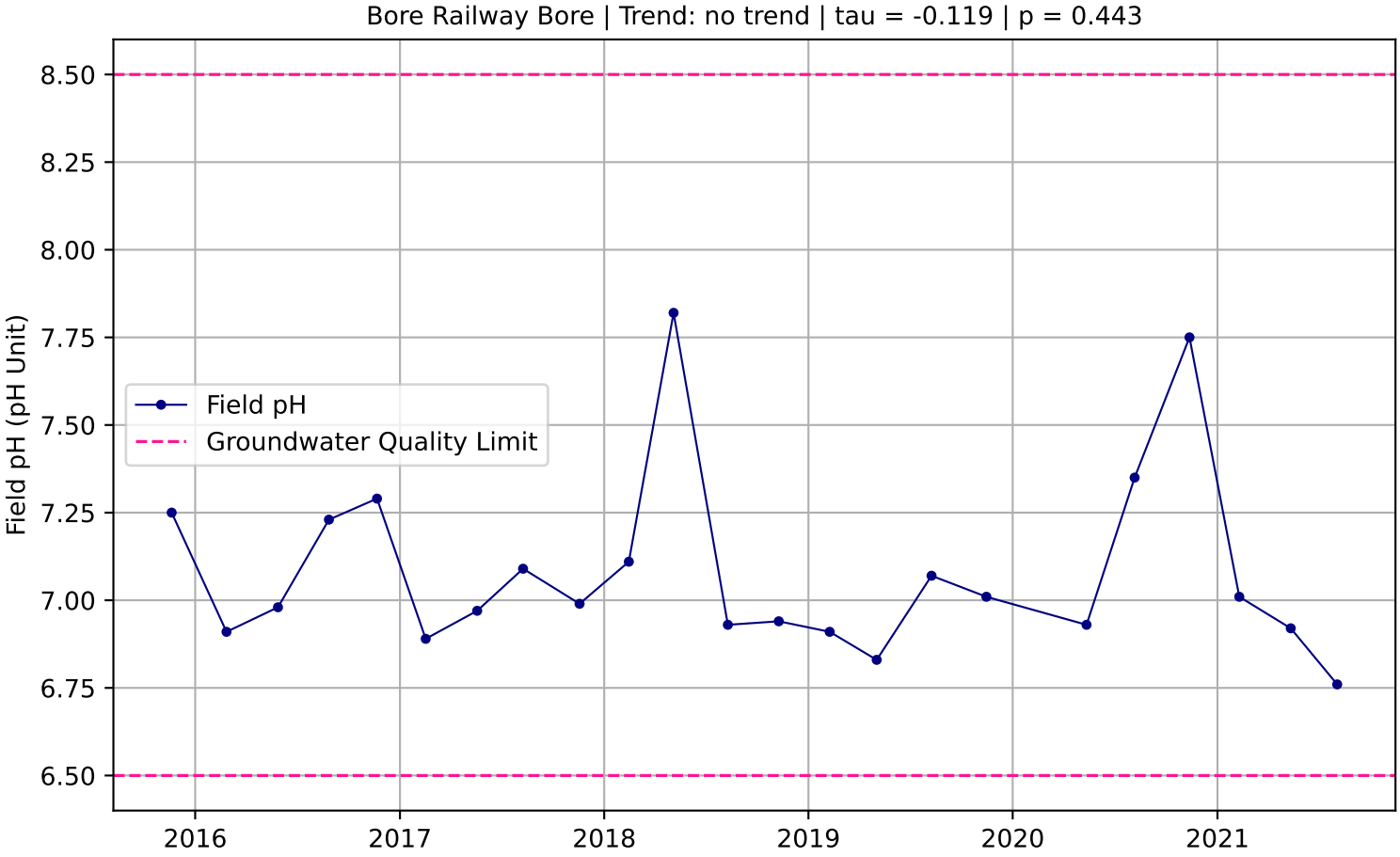

Bore Railway Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

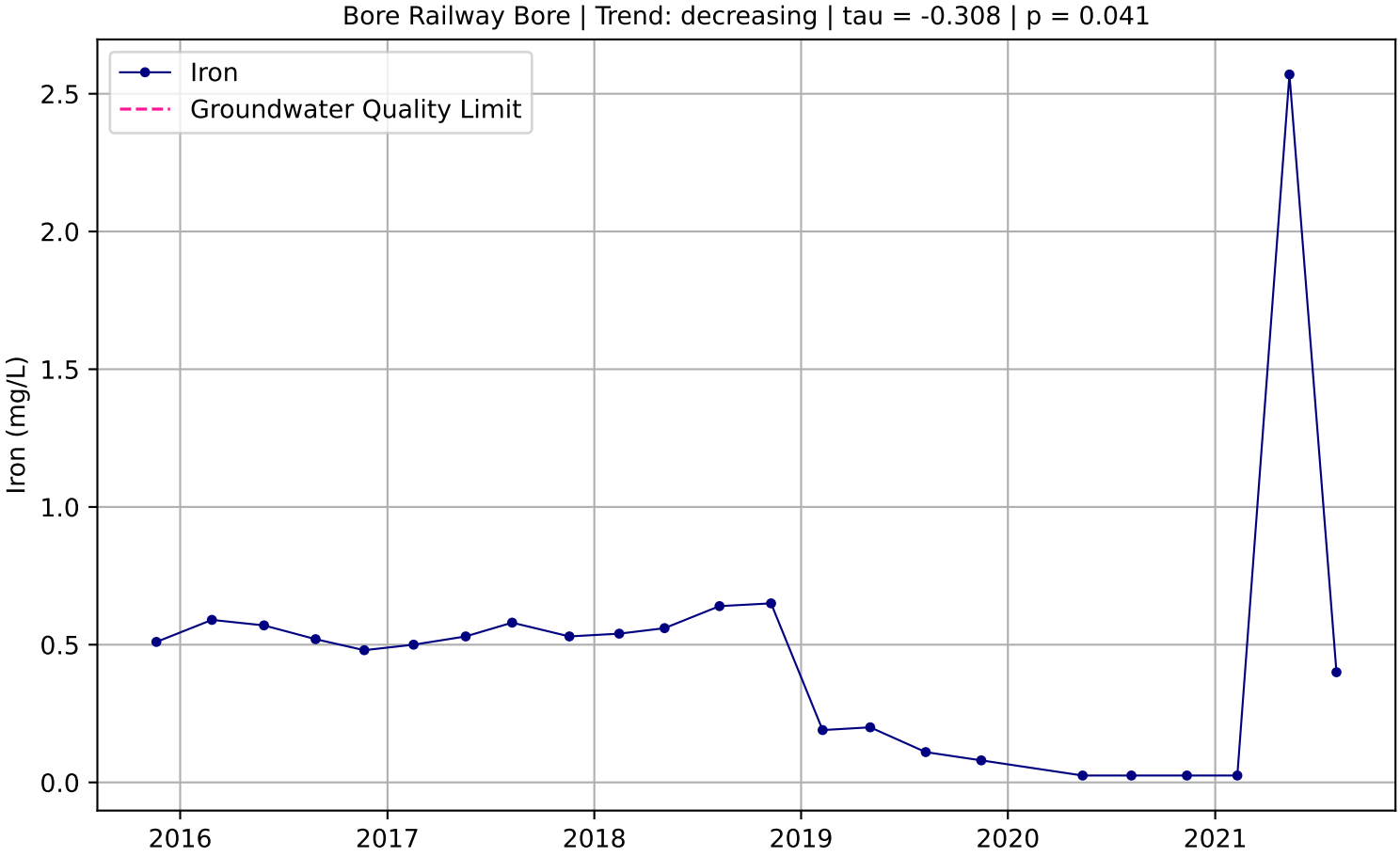

Bore Railway Bore | Trend: no trend | tau = 0.195 | p = 0.243
Calcium
Calcium (mg/L)
160
140
120
100
80
60
2018
2019
2020
2021
2022
2023

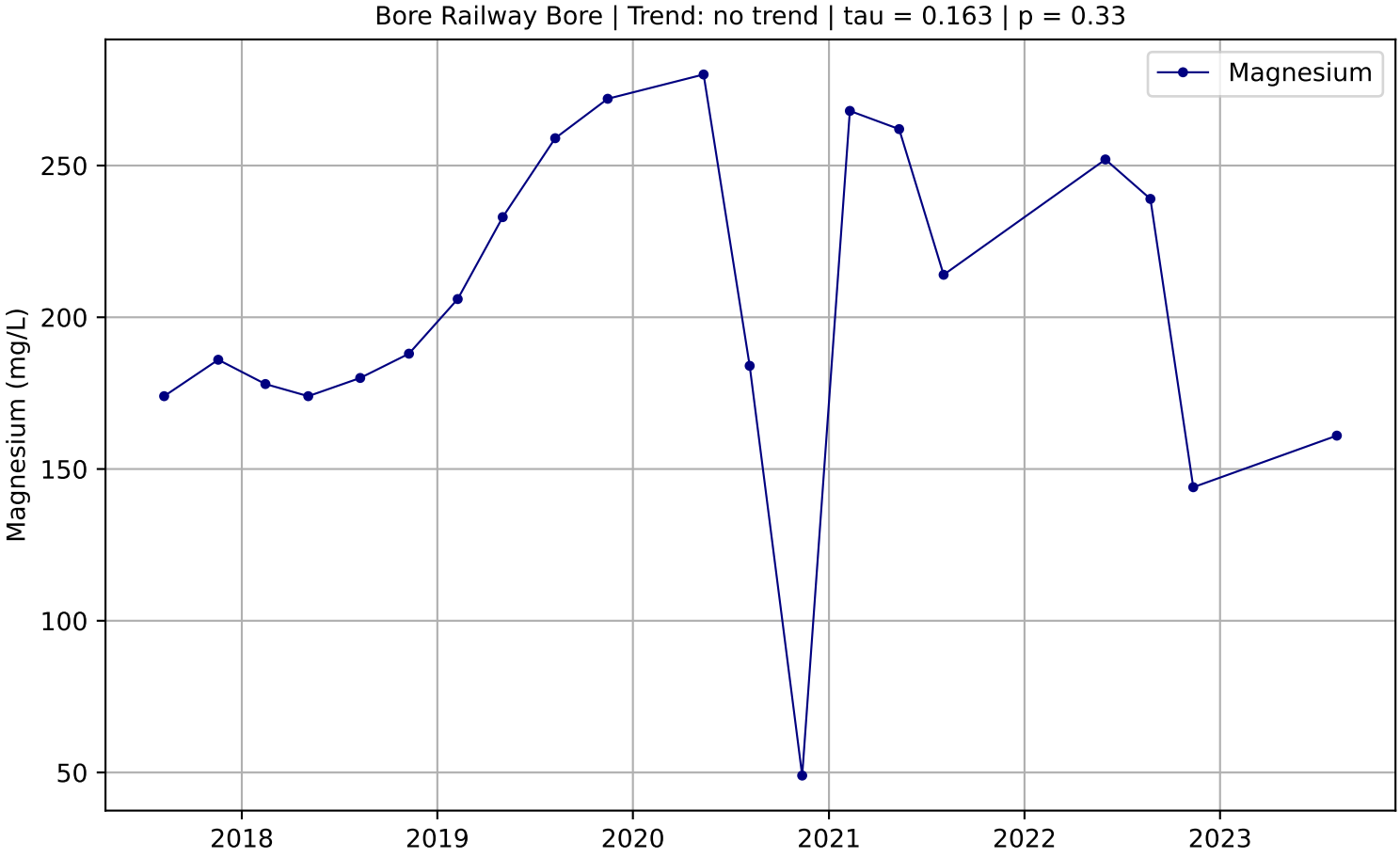

Bore Railway Bore | Trend: decreasing | tau = -0.268 | p = 0.004
Carbonate
Carbonate (mg/L)
175
150
125
100
75
50
25
0
2016
2017
2018
2019
2020
2021
2022
2023

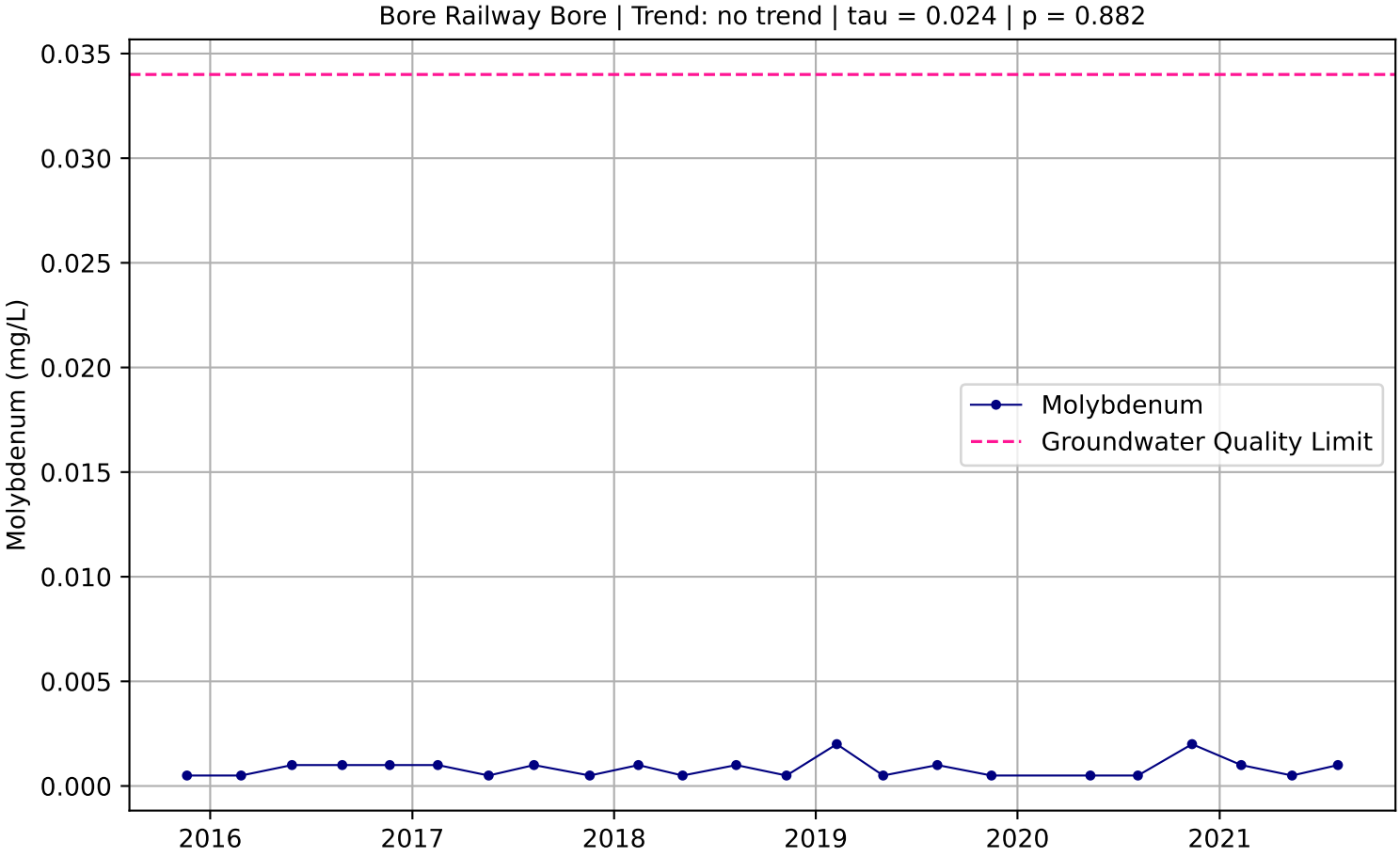

Bore Railway Bore | Trend: increasing | tau = 0.425 | p = 0.002
Chloride
Chloride (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
2016
2017
2018
2019
2020
2021
2022
2023

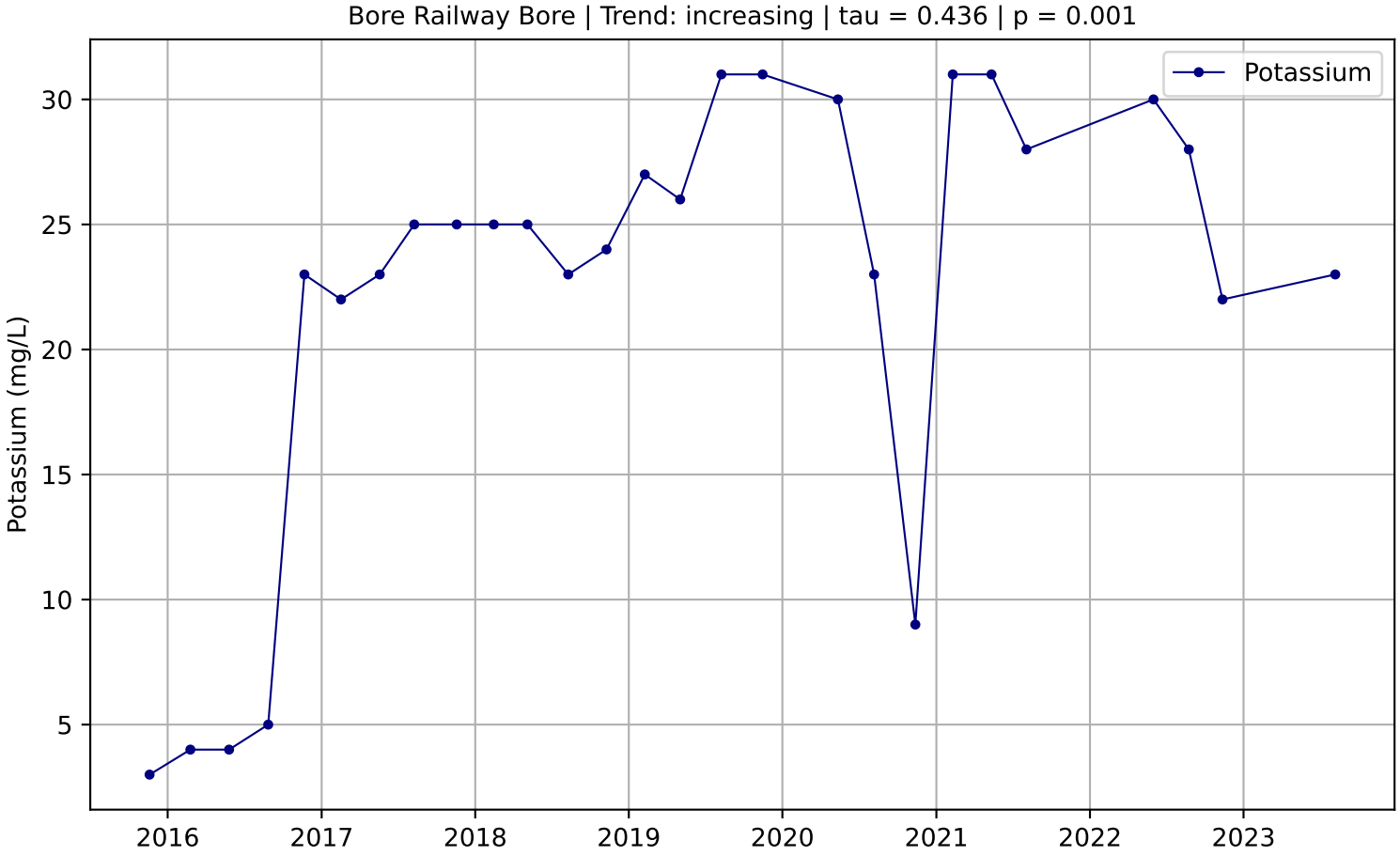

Bore Railway Bore | Trend: increasing | tau = 0.423 | p = 0.005
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
9000
8000
7000
6000
5000
4000
3000
2000
2016
2017
2018
2019
2020
2021

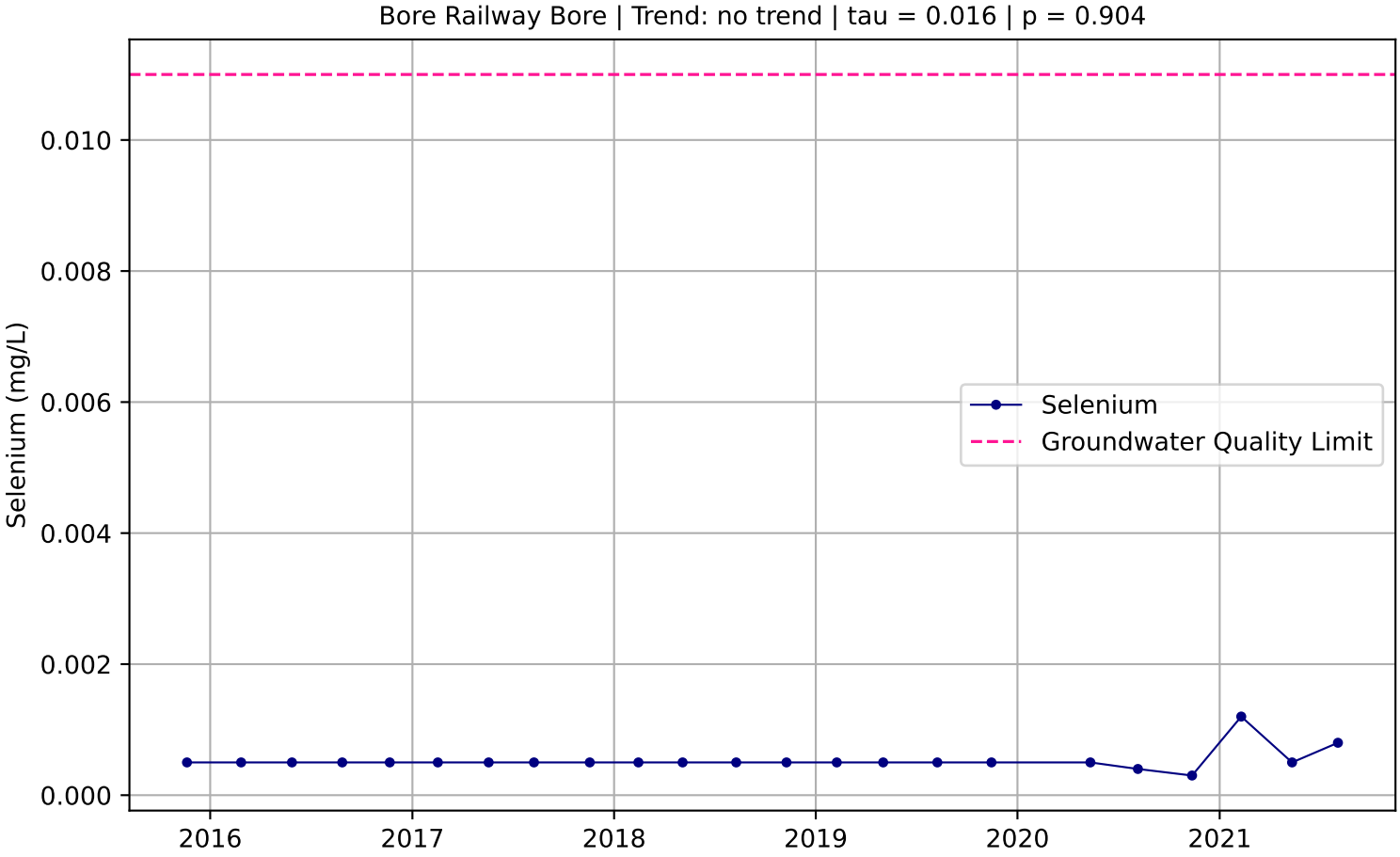

Bore Railway Bore | Trend: no trend | tau = -0.119 | p = 0.443
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
Field pH
Groundwater Quality Limit

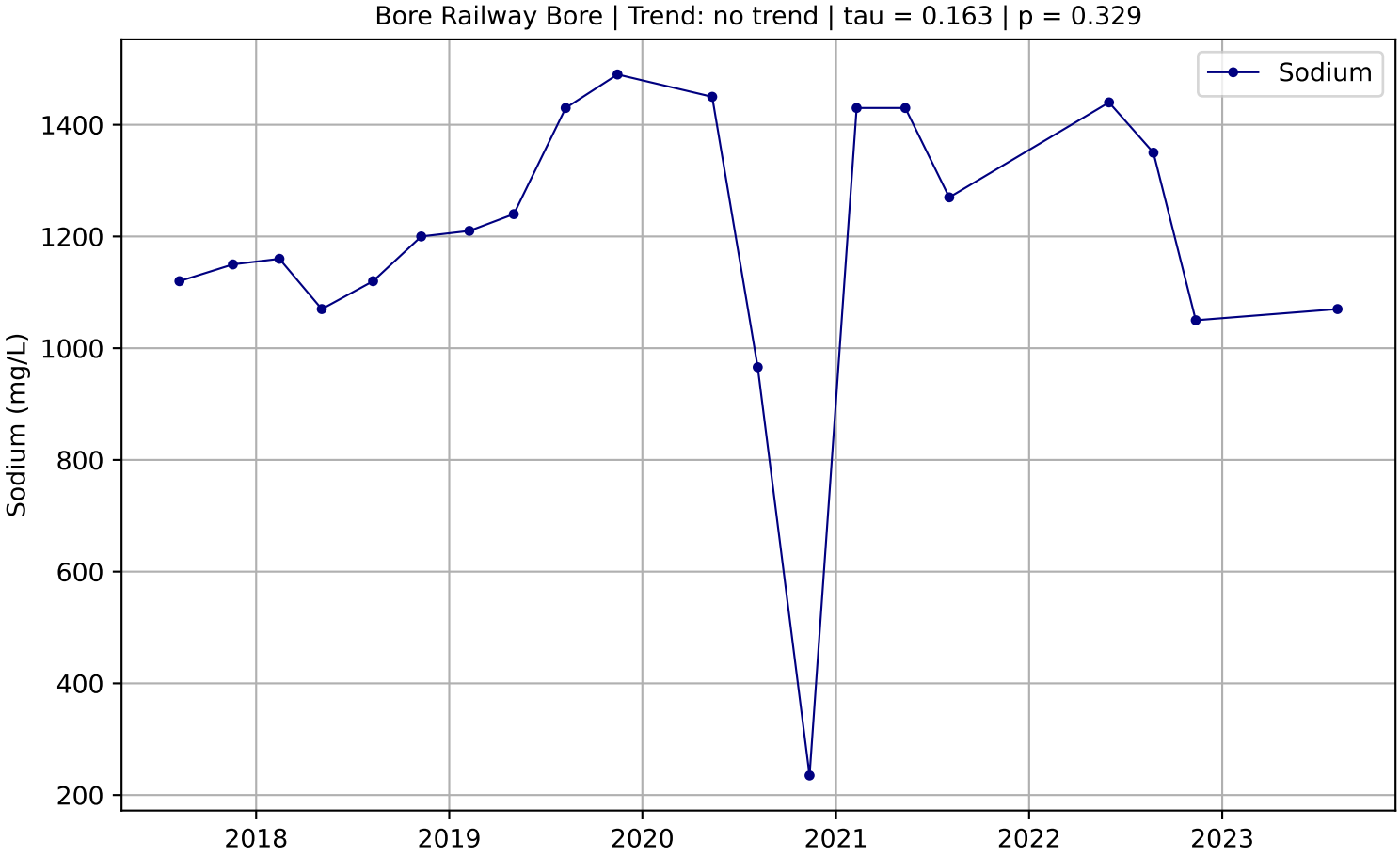

Bore Railway Bore | Trend: decreasing | tau = -0.308 | p = 0.041
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
2016
2017
2018
2019
2020
2021

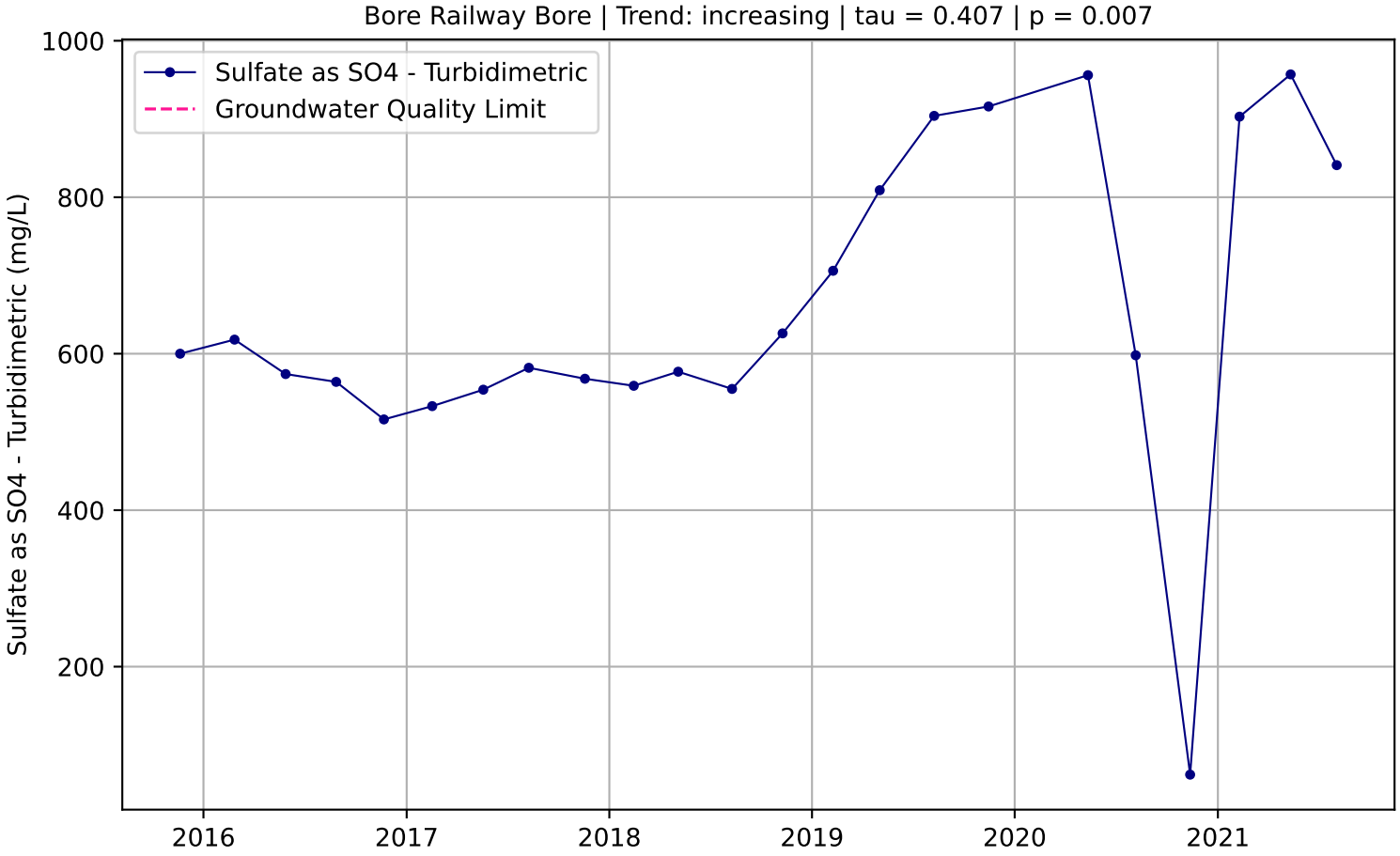

Bore Railway Bore | Trend: no trend | tau = 0.163 | p = 0.33
Magnesium
Magnesium (mg/L)
250
200
150
100
50
2018
2019
2020
2021
2022
2023

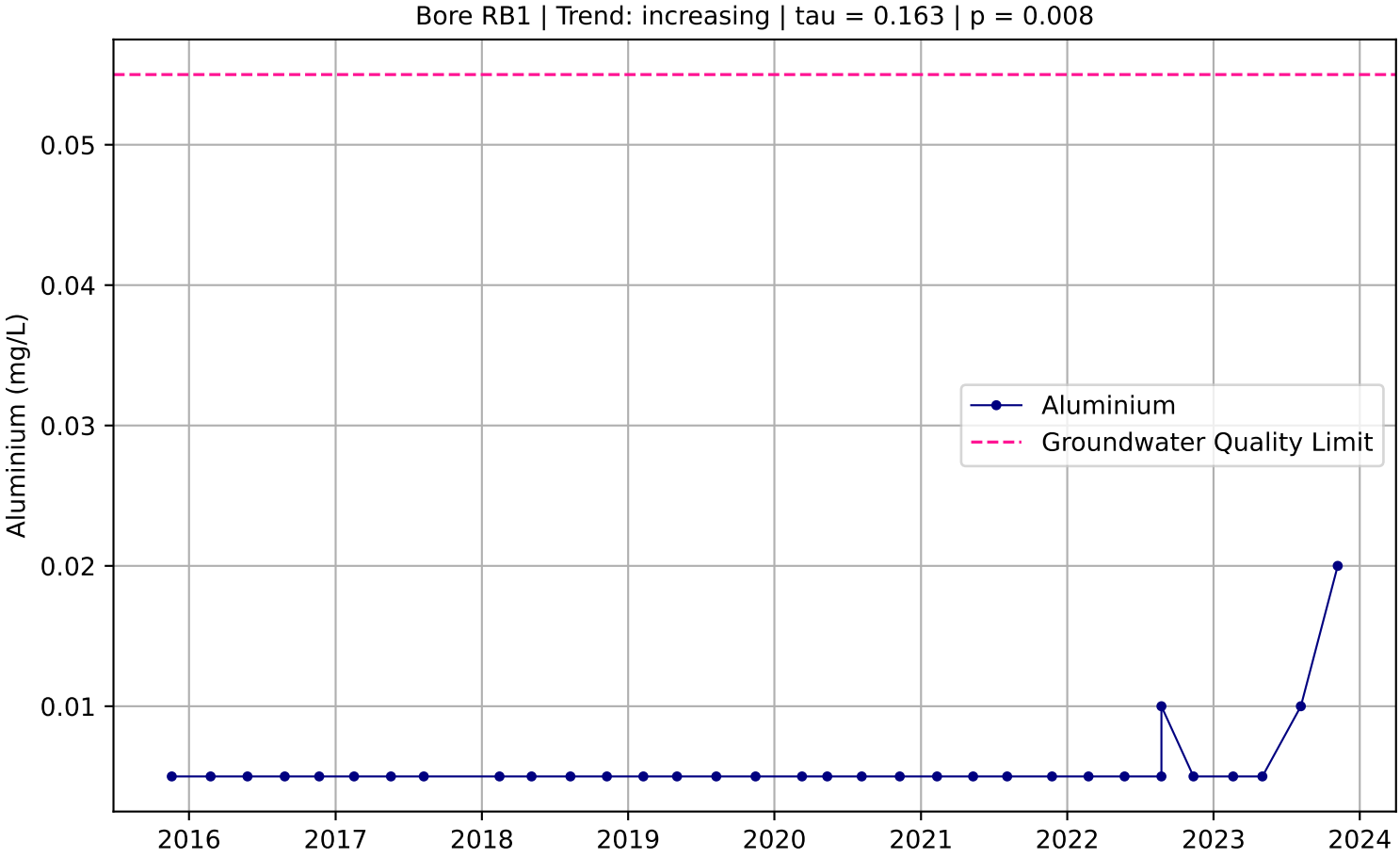

Bore Railway Bore | Trend: no trend | tau = 0.024 | p = 0.882
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit

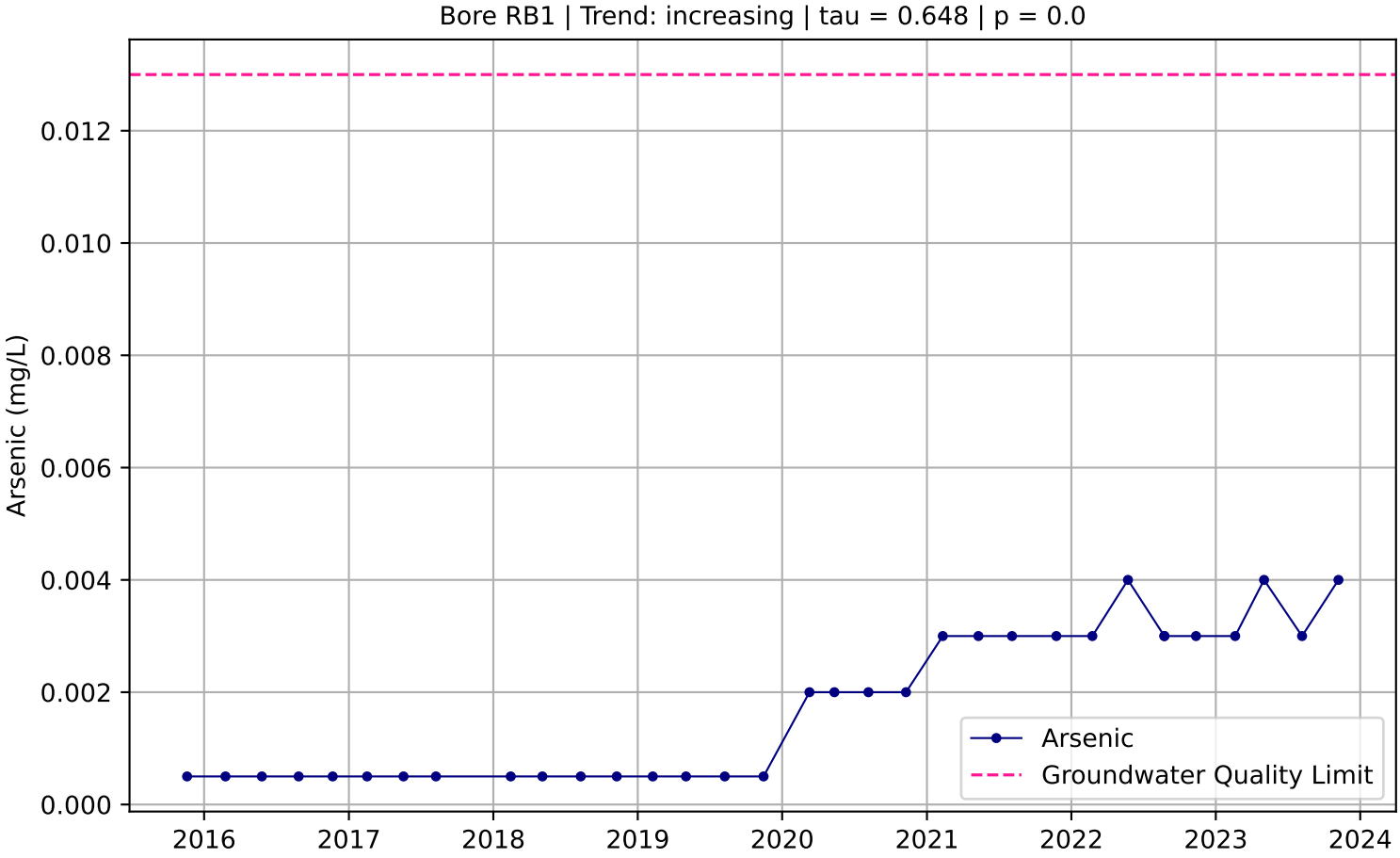

Bore Railway Bore | Trend: increasing | tau = 0.436 | p = 0.001
Potassium
Potassium (mg/L)
30
25
20
15
10
5
2016
2017
2018
2019
2020
2021
2022
2023

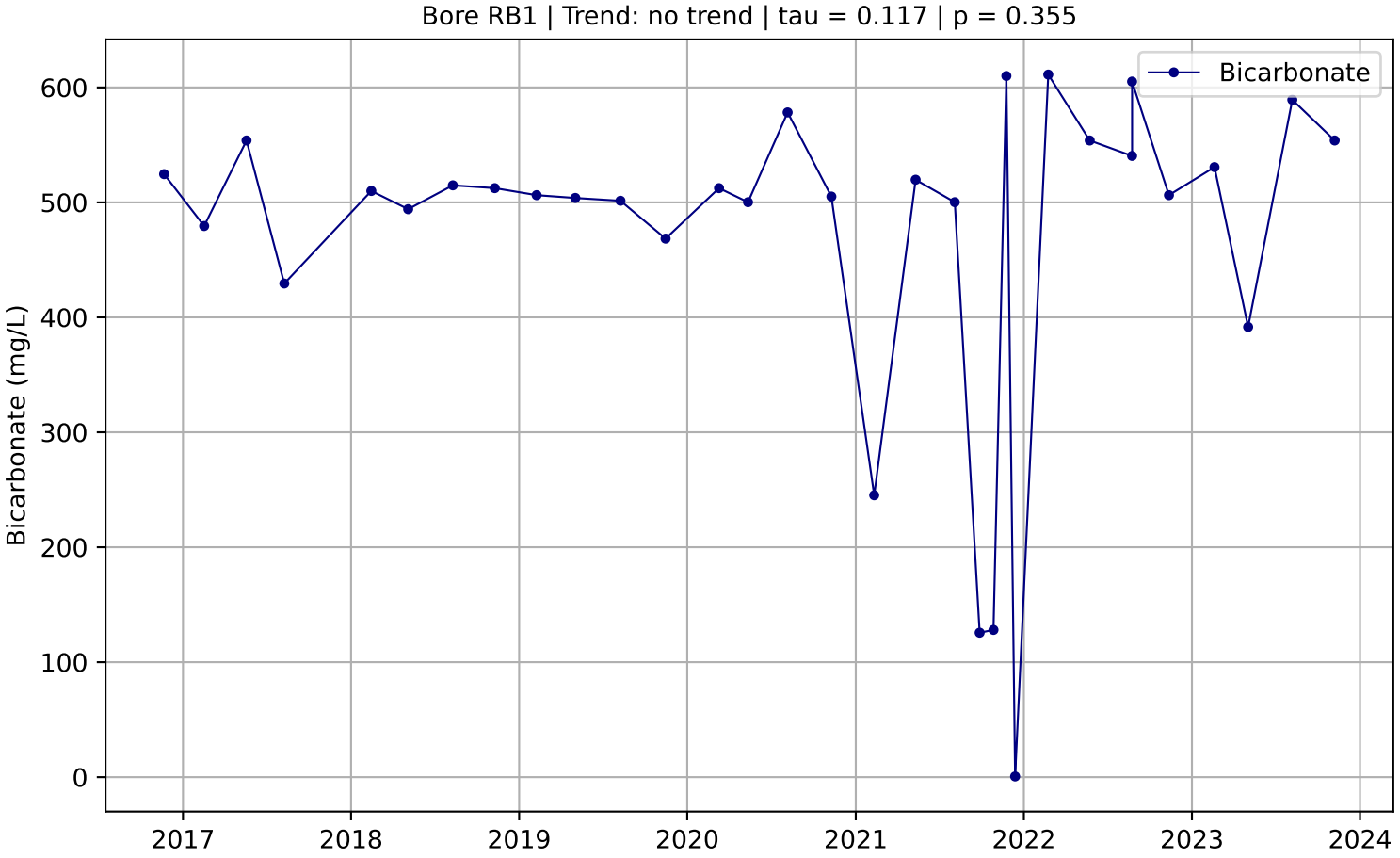

Bore Railway Bore | Trend: no trend | tau = 0.016 | p = 0.904
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit

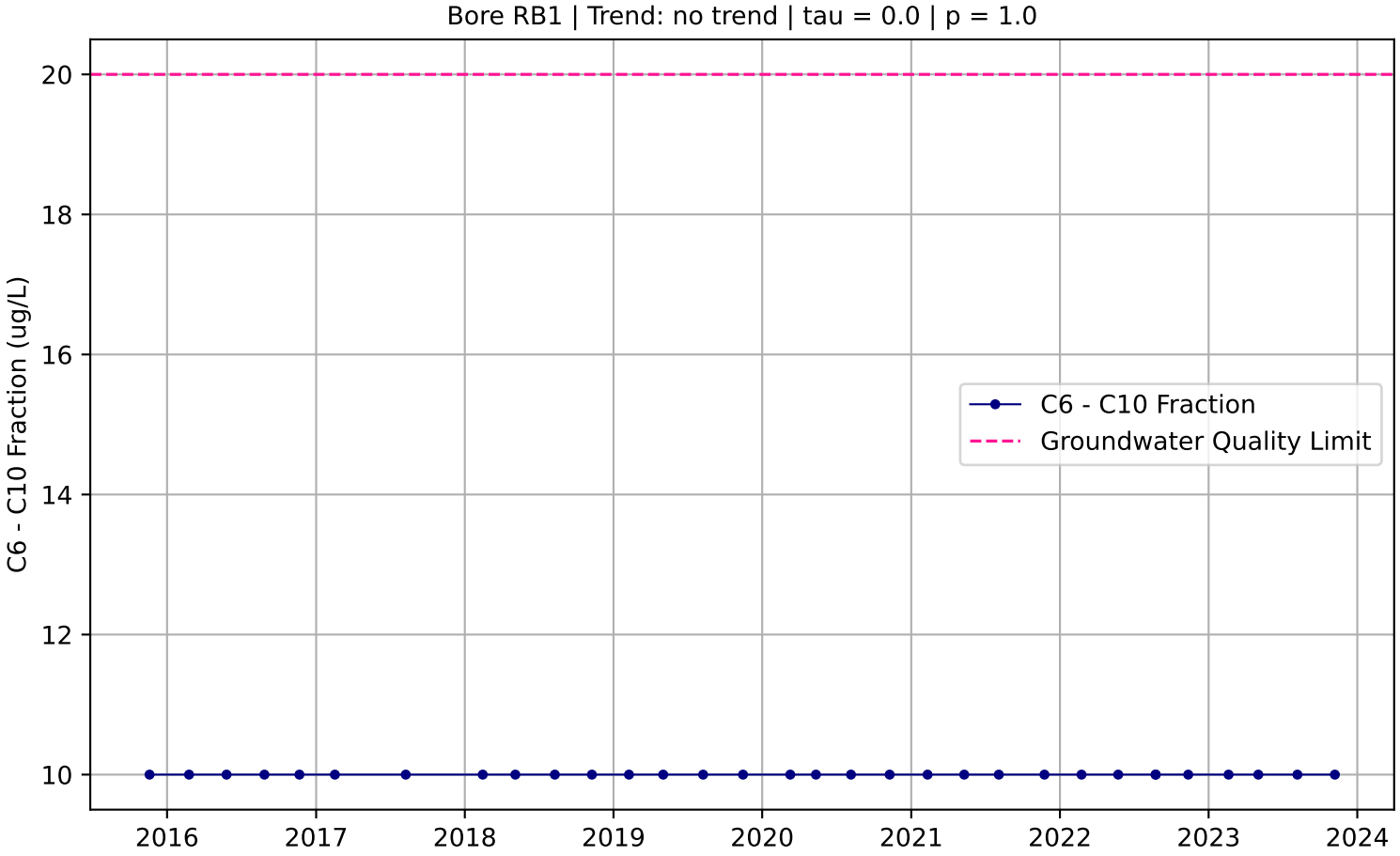

Bore Railway Bore | Trend: no trend | tau = 0.163 | p = 0.329
Sodium
Sodium (mg/L)
1400
1200
1000
800
600
400
200
2018
2019
2020
2021
2022
2023

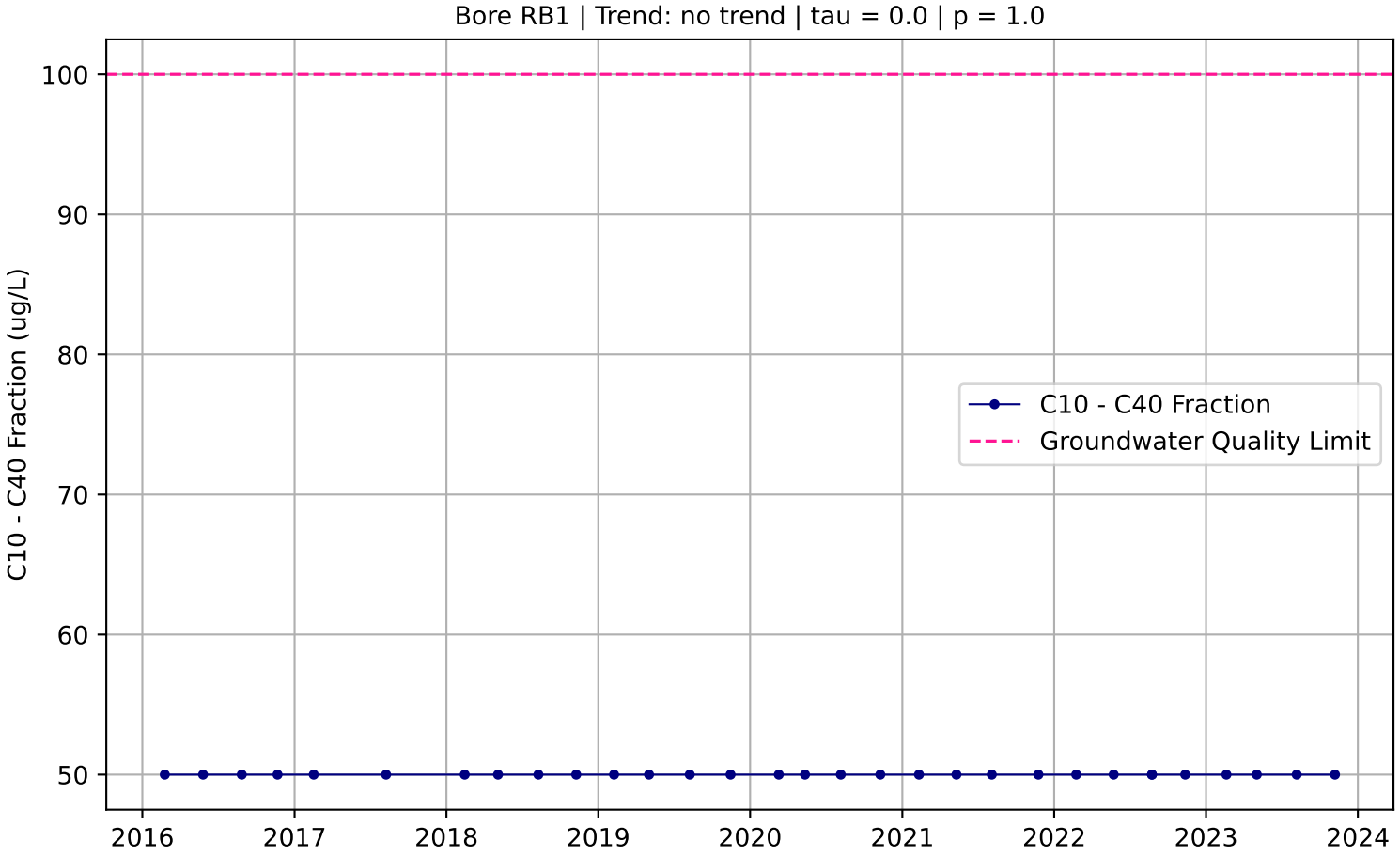

Bore Railway Bore | Trend: increasing | tau = 0.407 | p = 0.007
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
1000
800
600
400
200
2016
2017
2018
2019
2020
2021

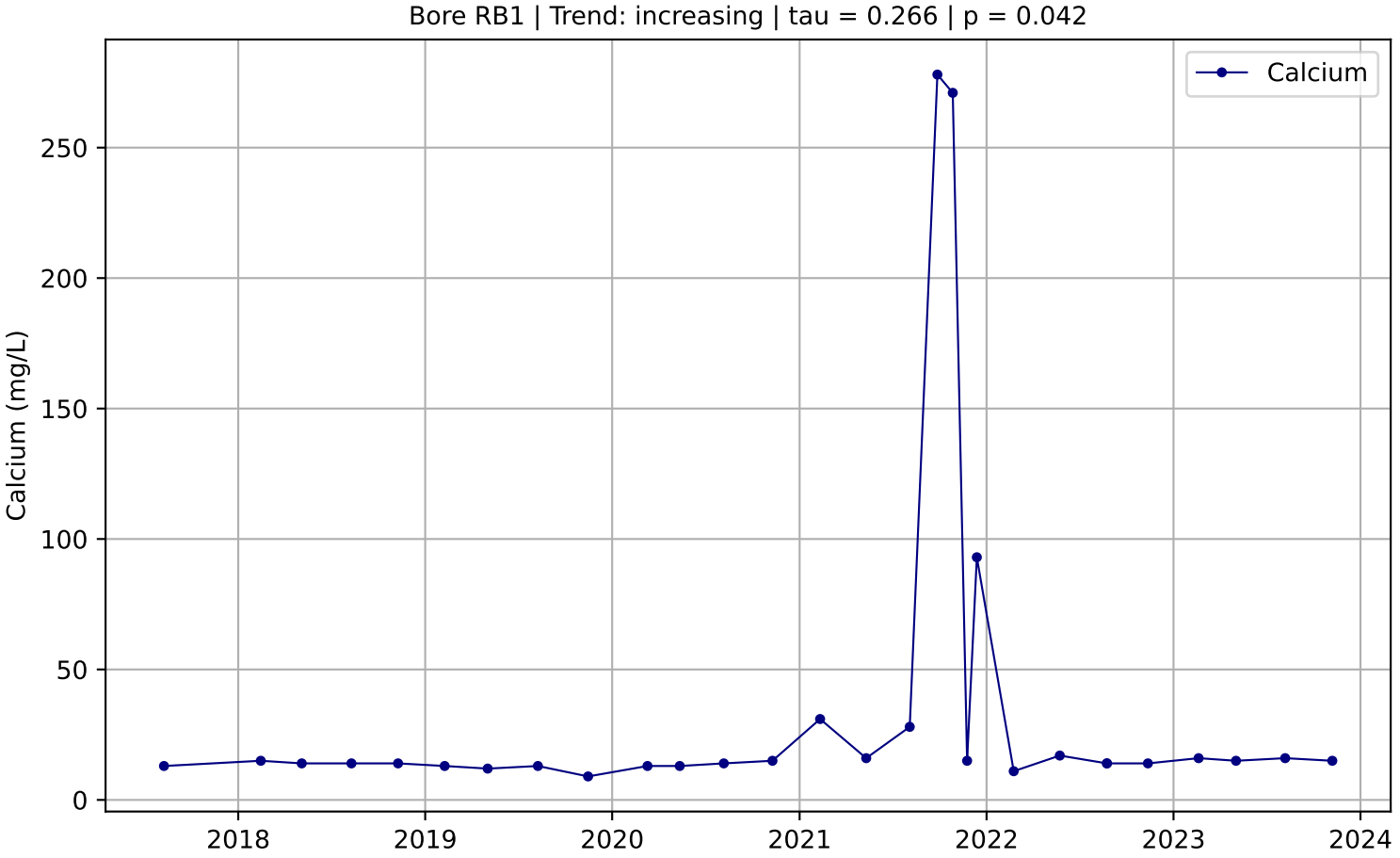

Bore RB1 | Trend: increasing | tau = 0.163 | p = 0.008
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

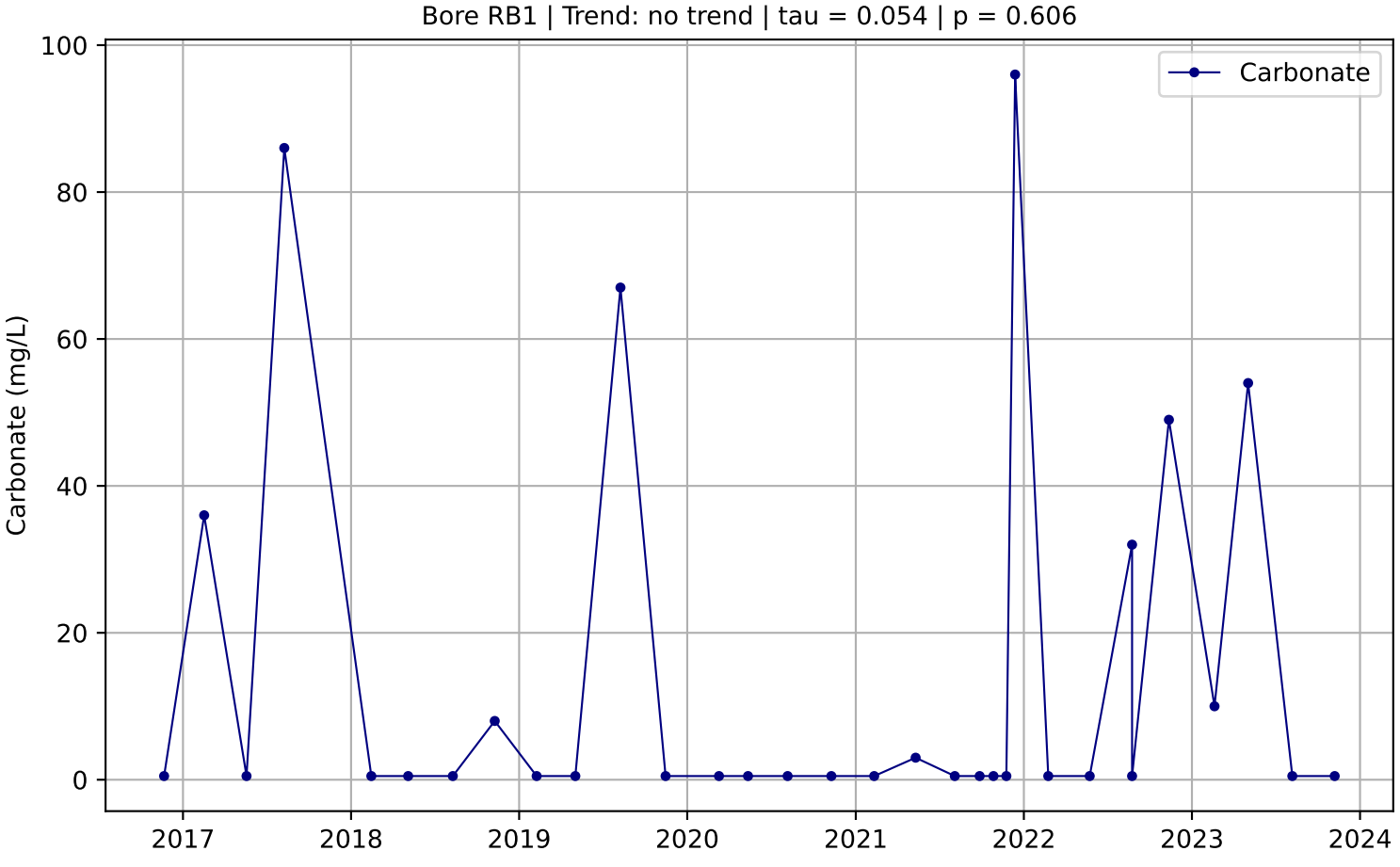

Bore RB1 | Trend: increasing | tau = 0.648 | p = 0.0
Arsenic (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

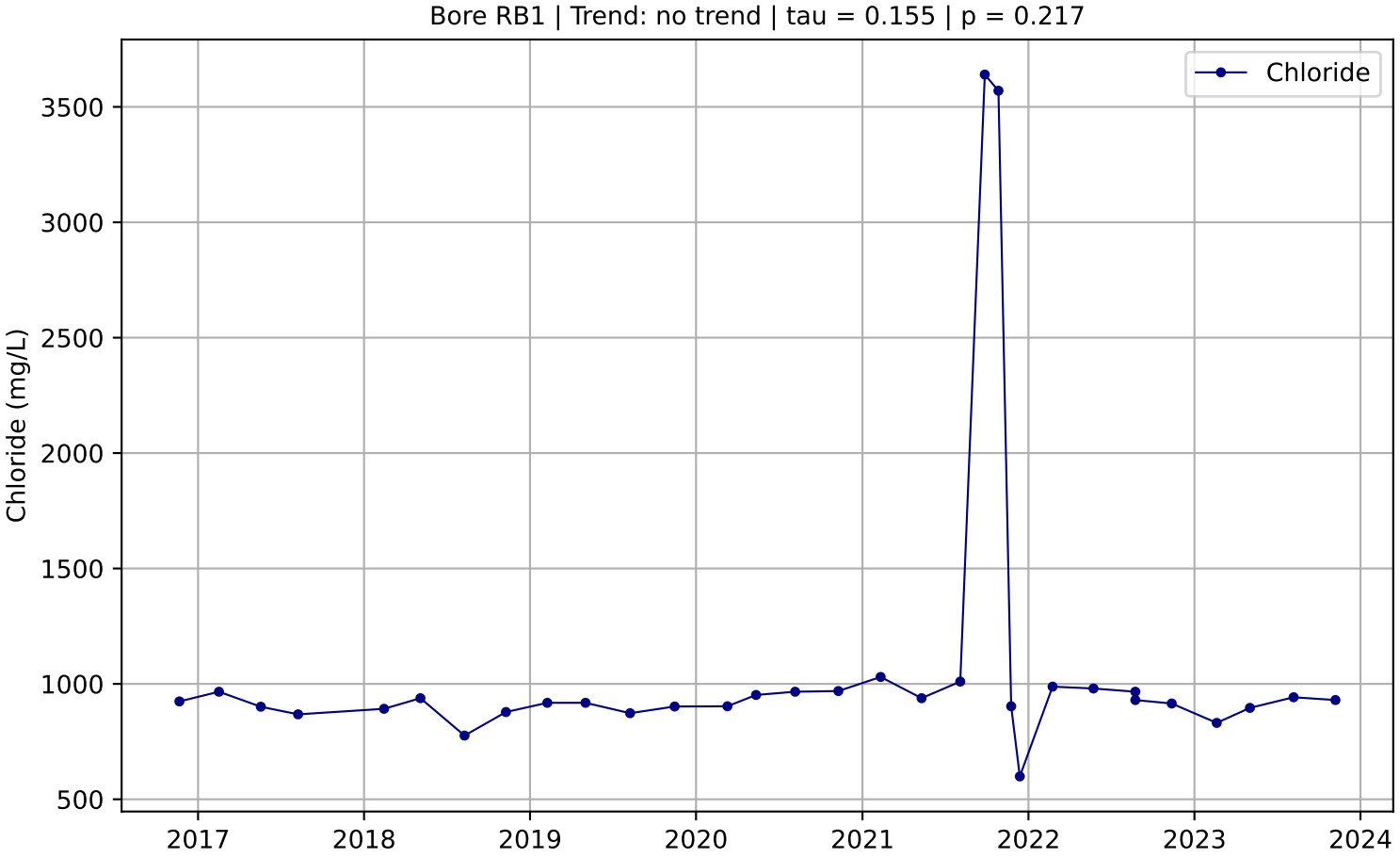

Bore RB1 | Trend: no trend | tau = 0.117 | p = 0.355
Bicarbonate
Bicarbonate (mg/L)
600
500
400
300
200
100
0
2017
2018
2019
2020
2021
2022
2023
2024

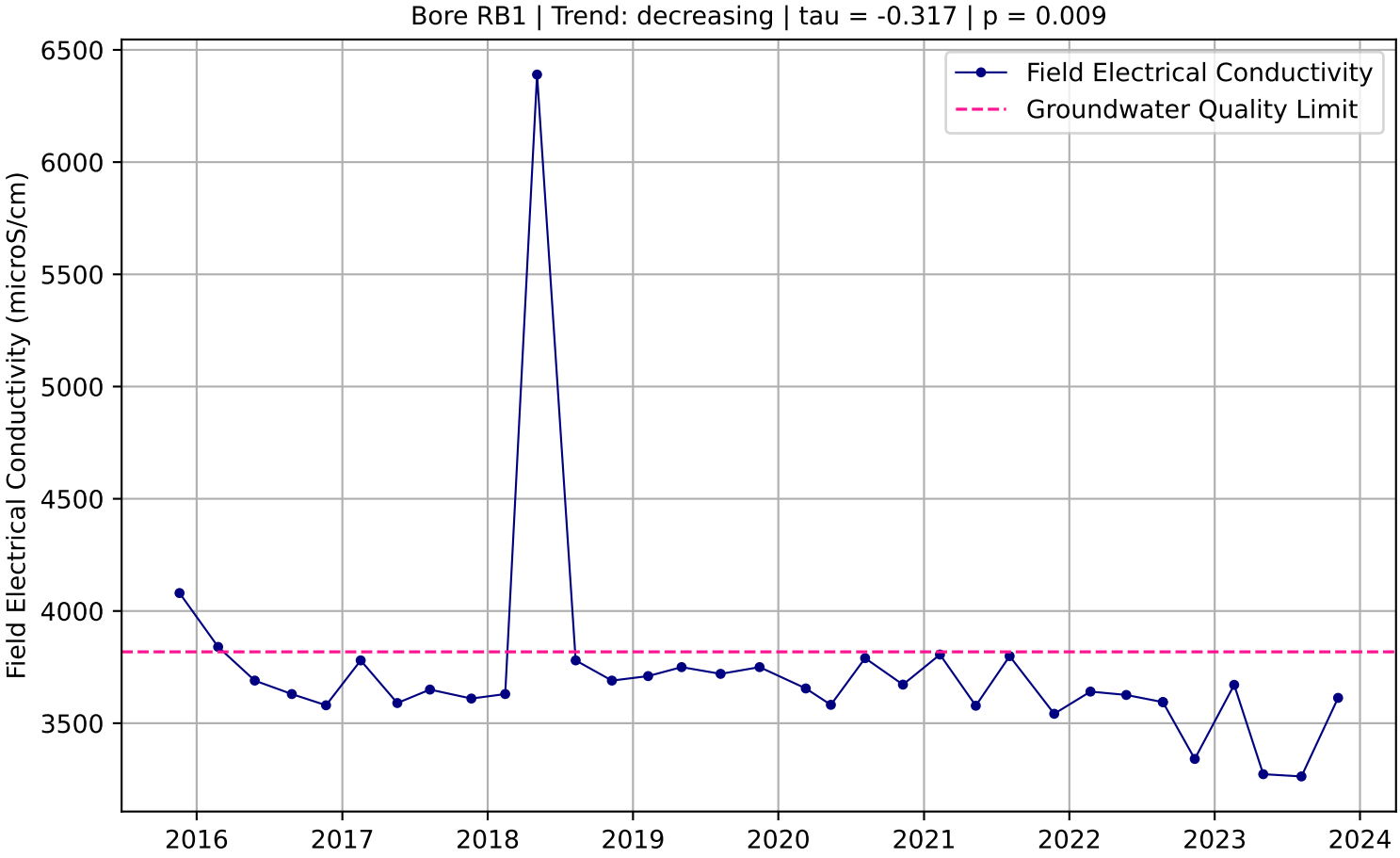

Bore RB1 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

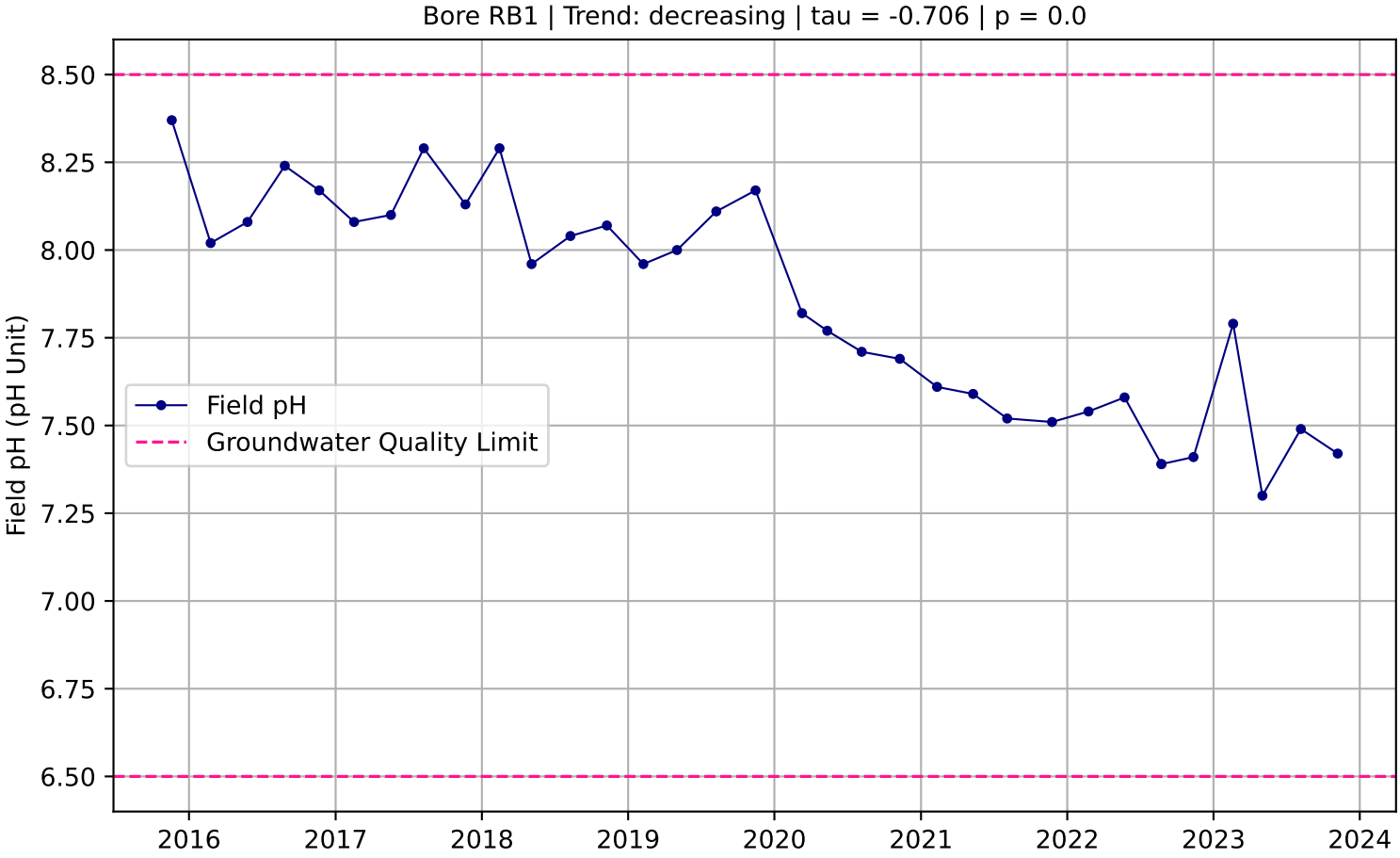

Bore RB1 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

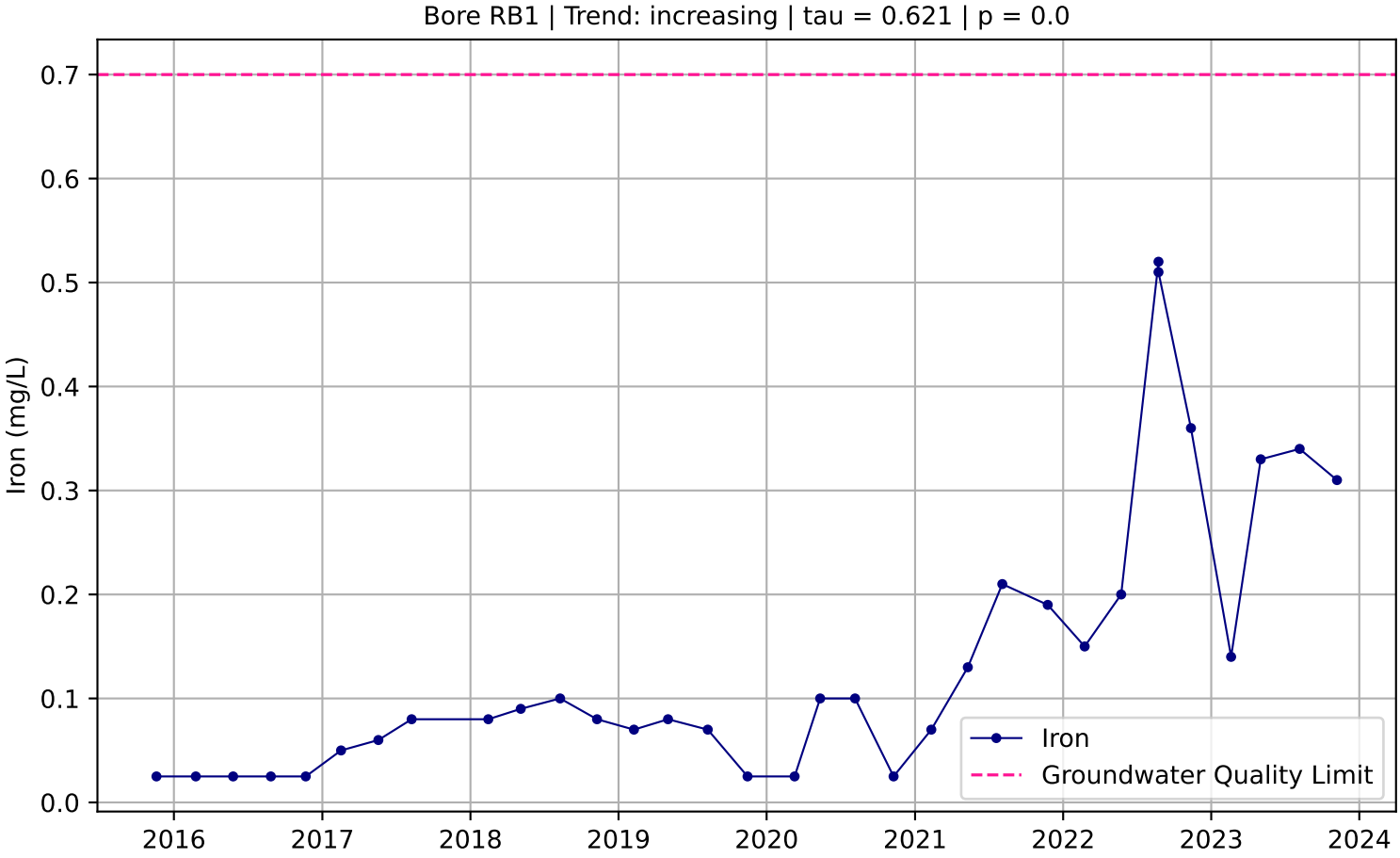

Bore RB1 | Trend: increasing | tau = 0.266 | p = 0.042
Calcium
Calcium (mg/L)
0
50
100
150
200
250
2018
2019
2020
2021
2022
2023
2024

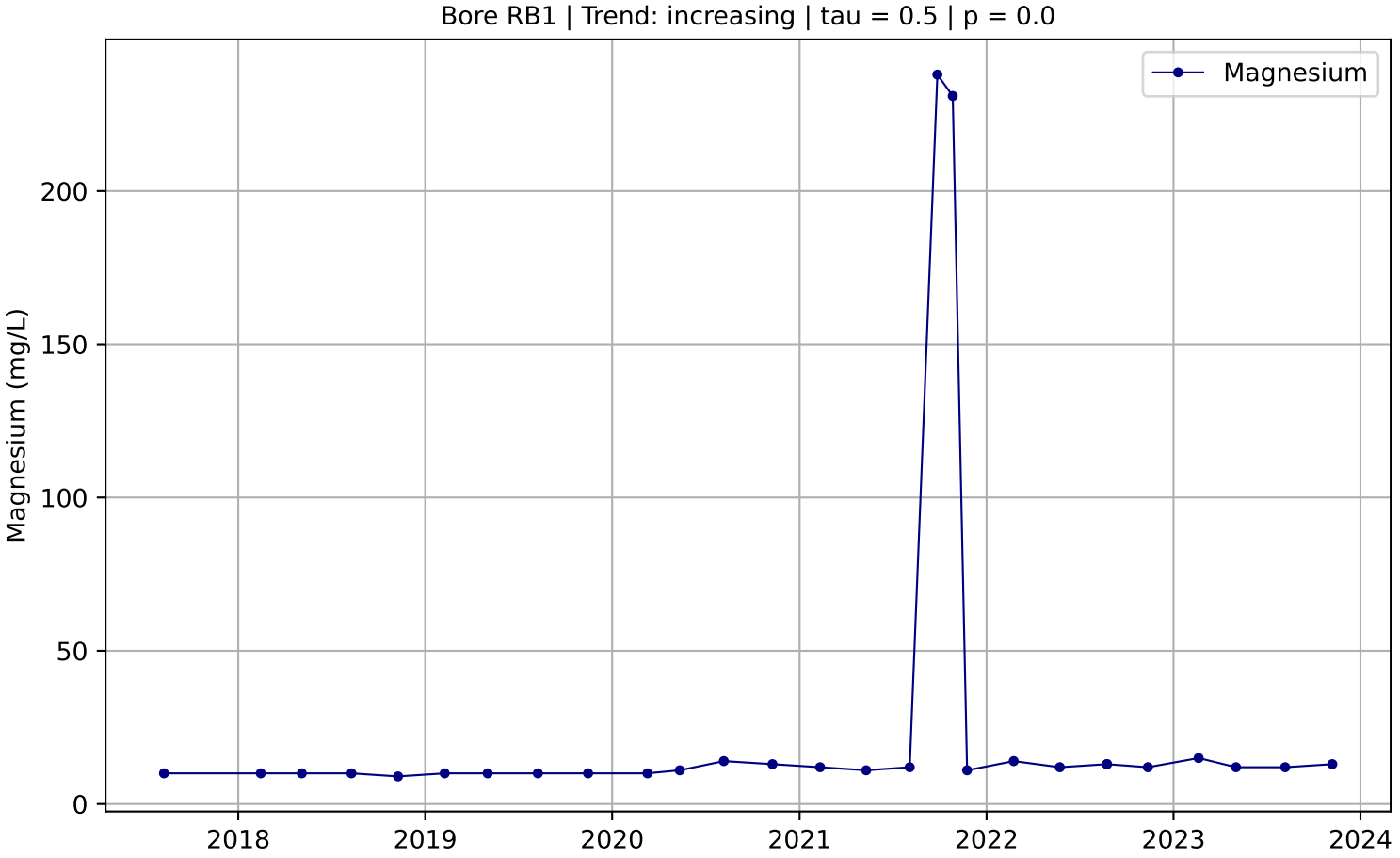

Bore RB1 | Trend: no trend | tau = 0.054 | p = 0.606
Carbonate
Carbonate (mg/L)
0
20
40
60
80
100
2017
2018
2019
2020
2021
2022
2023
2024

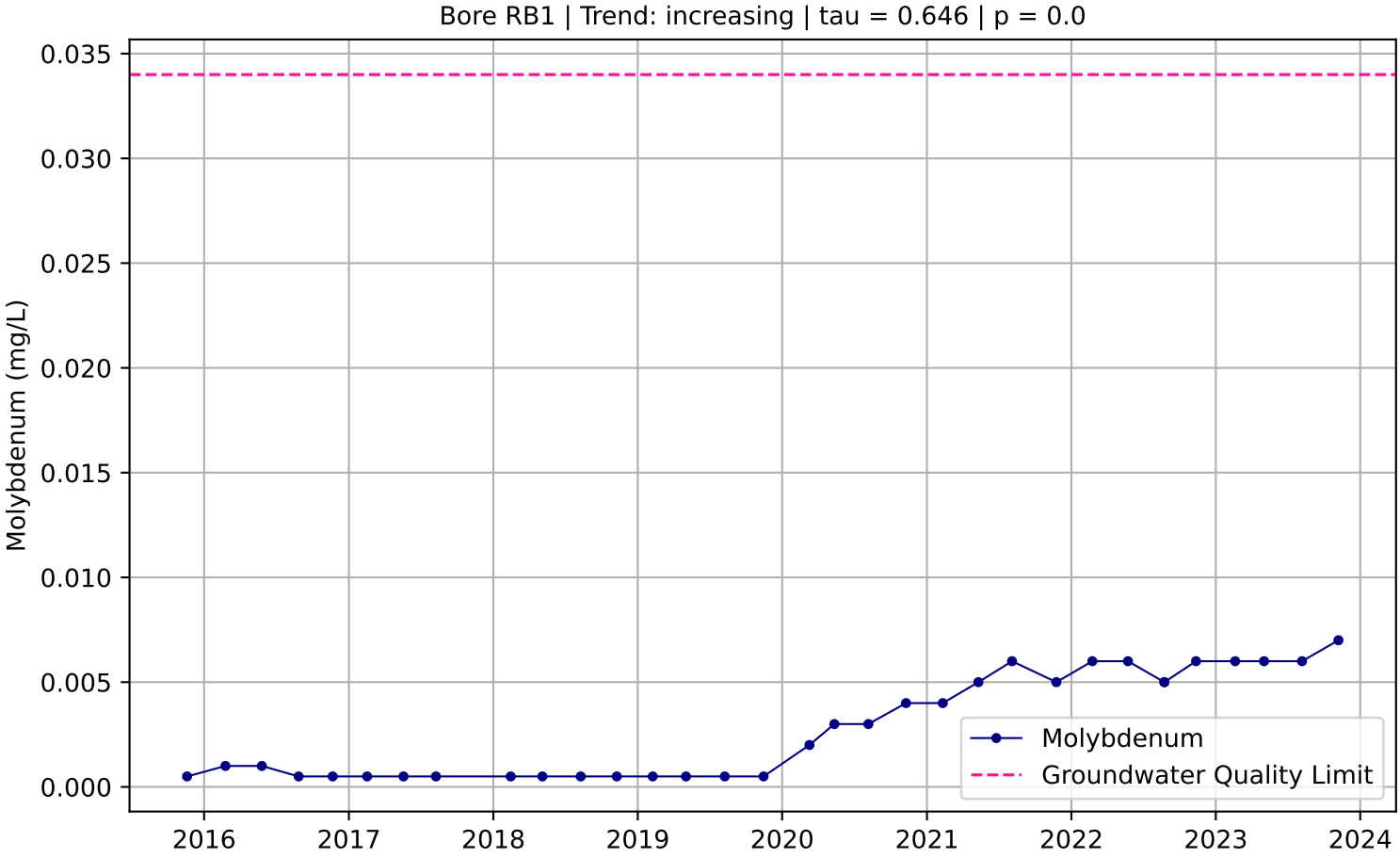

Bore RB1 | Trend: no trend | tau = 0.155 | p = 0.217
Chloride
Chloride (mg/L)
3500
3000
2500
2000
1500
1000
500
2017
2018
2019
2020
2021
2022
2023
2024

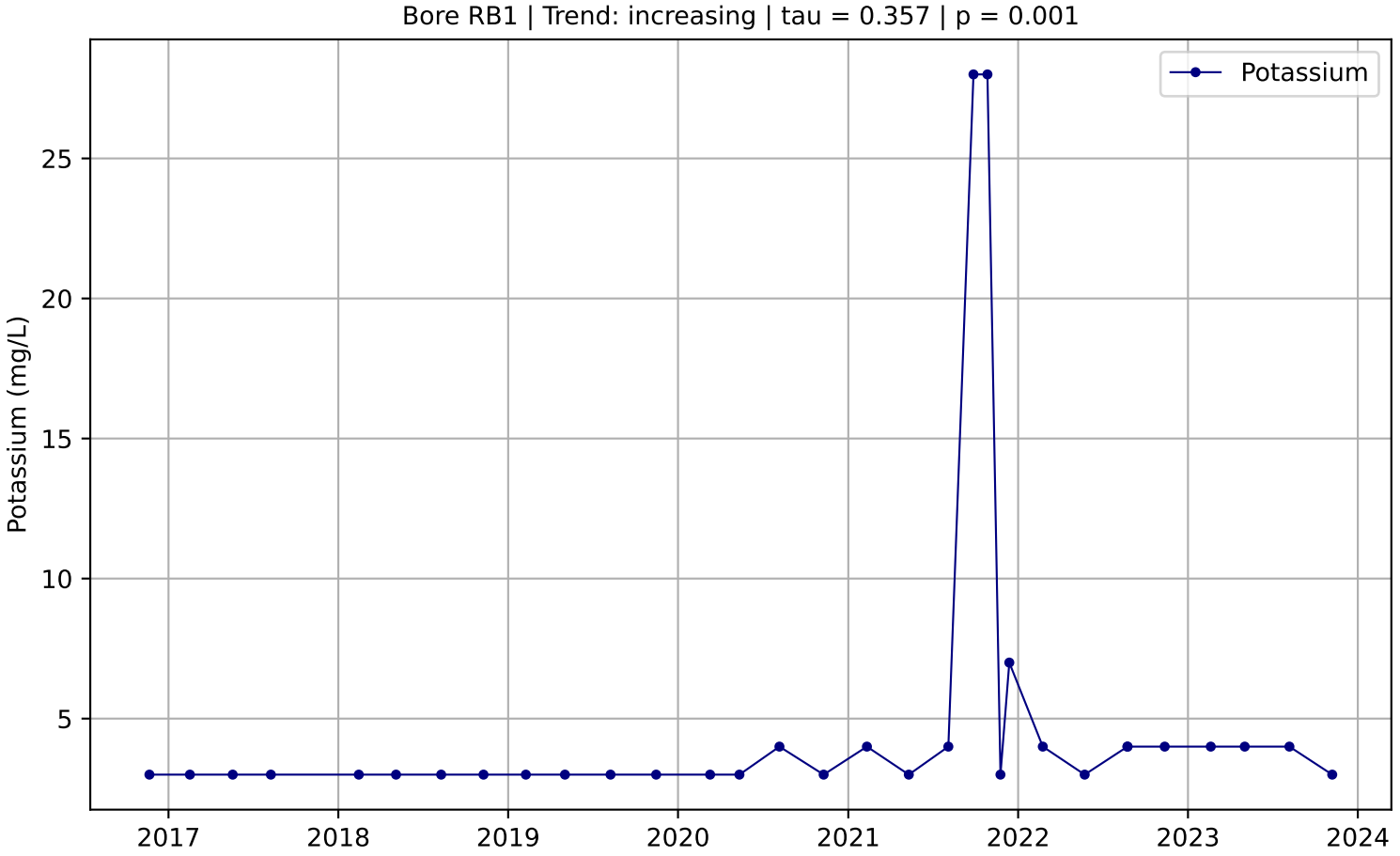

Bore RB1 | Trend: decreasing | tau = -0.317 | p = 0.009
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
6500
6000
5500
5000
4500
4000
3500
2016
2017
2018
2019
2020
2021
2022
2023
2024

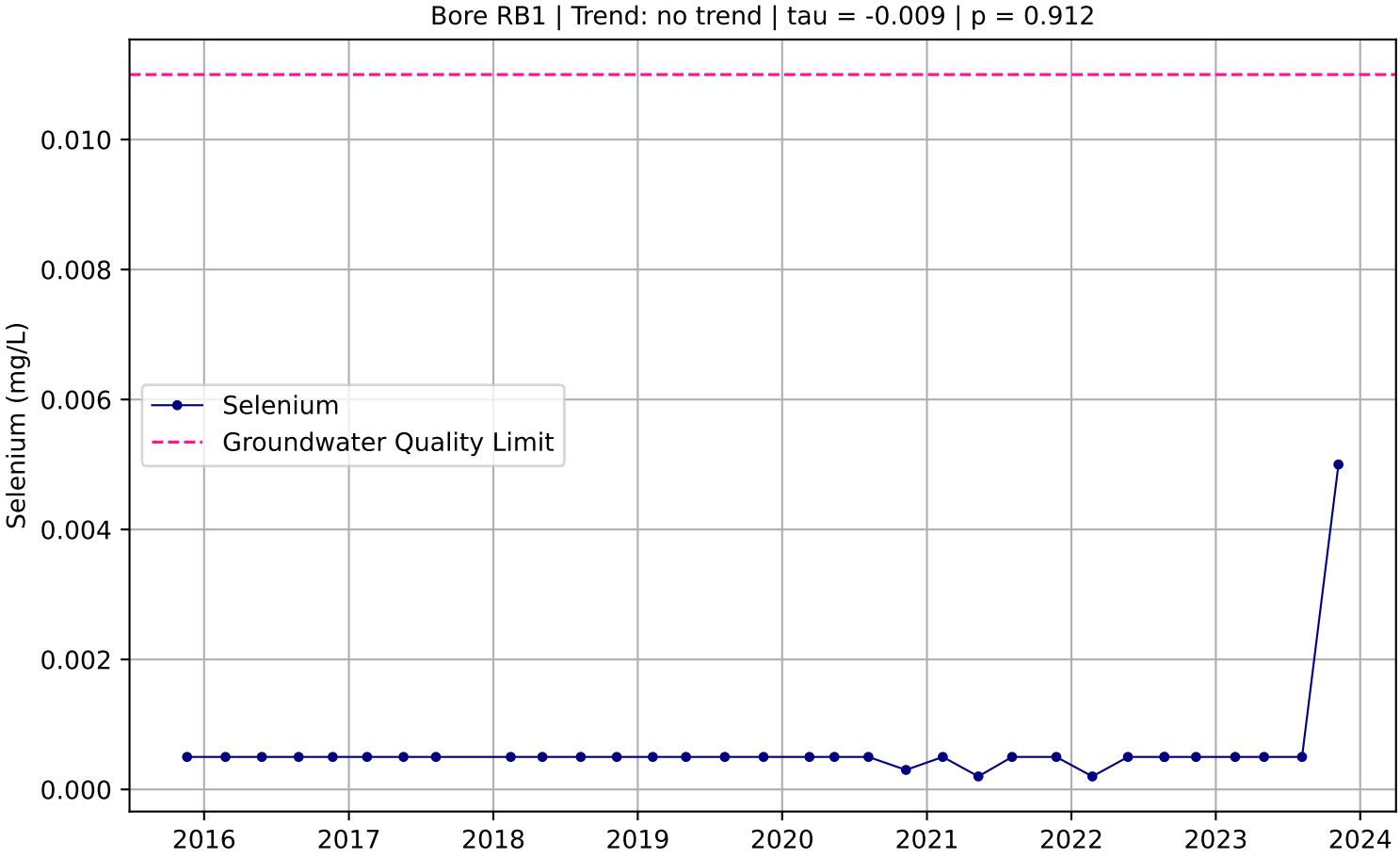

Bore RB1 | Trend: decreasing | tau = -0.706 | p = 0.0
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

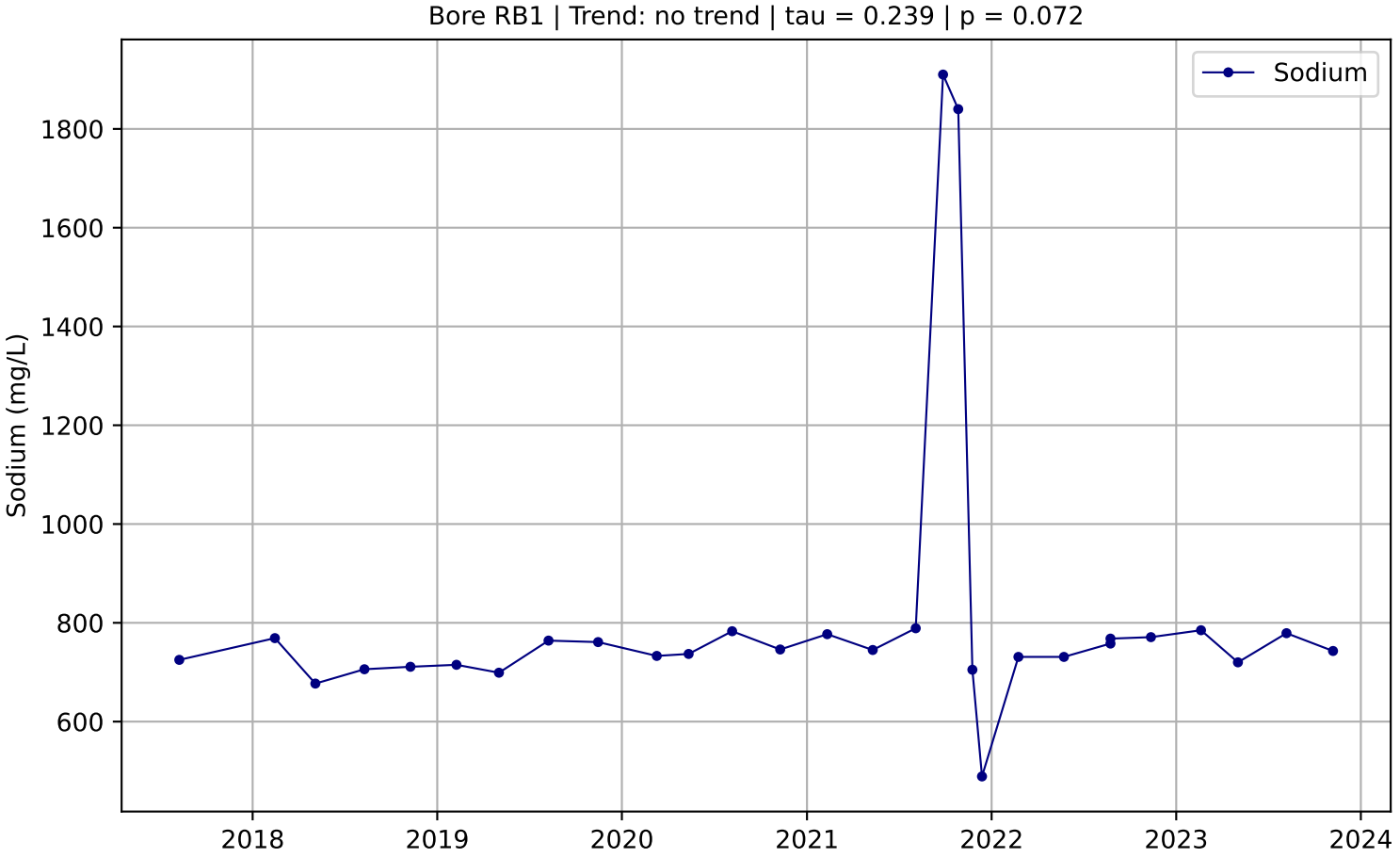

Bore RB1 | Trend: increasing | tau = 0.621 | p = 0.0
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2016
2017
2018
2019
2020
2021
2022
2023
2024
Iron
Groundwater Quality Limit

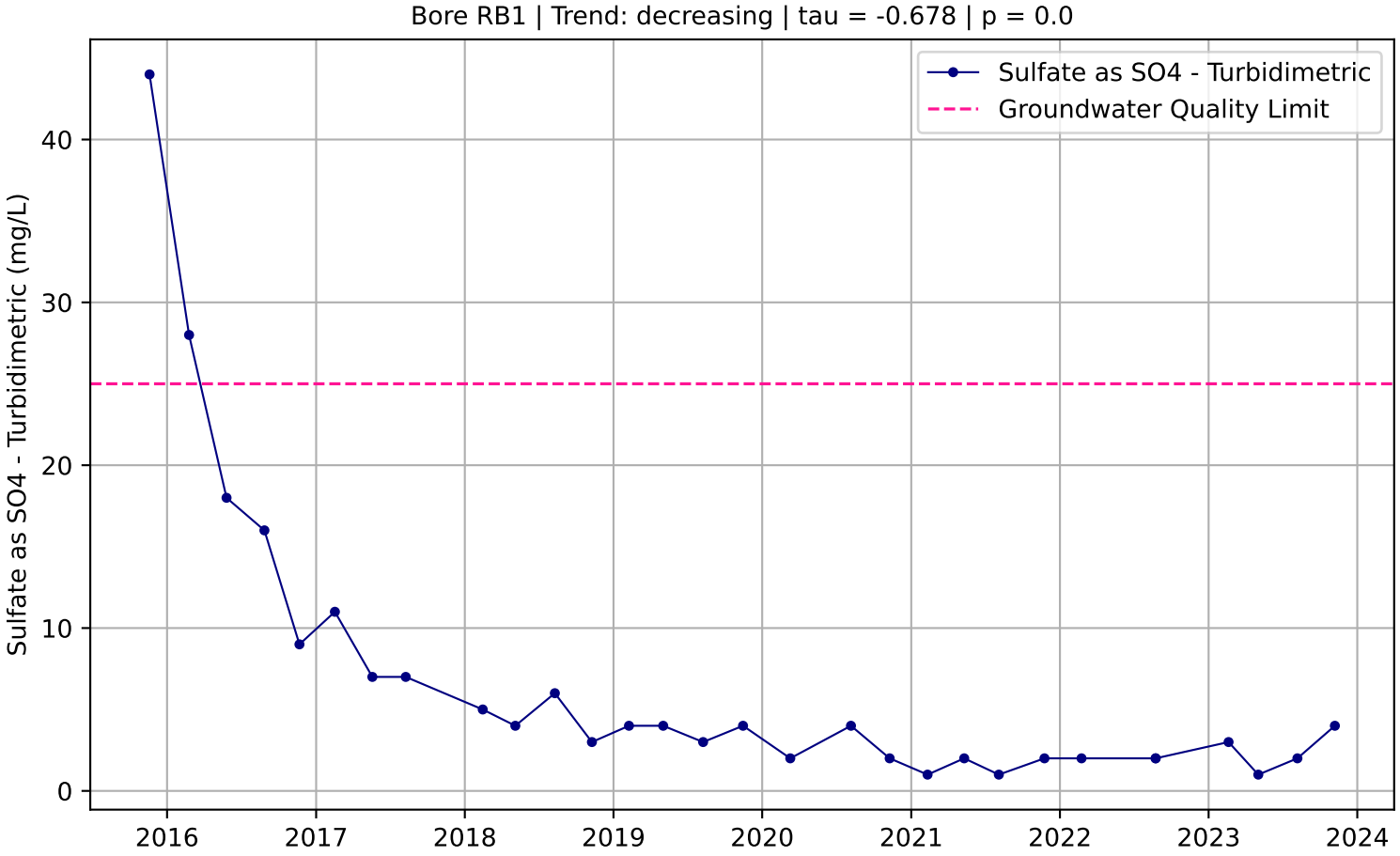

Bore RB1 | Trend: increasing | tau = 0.5 | p = 0.0
Magnesium
Magnesium (mg/L)
0
50
100
150
200
2018
2019
2020
2021
2022
2023
2024

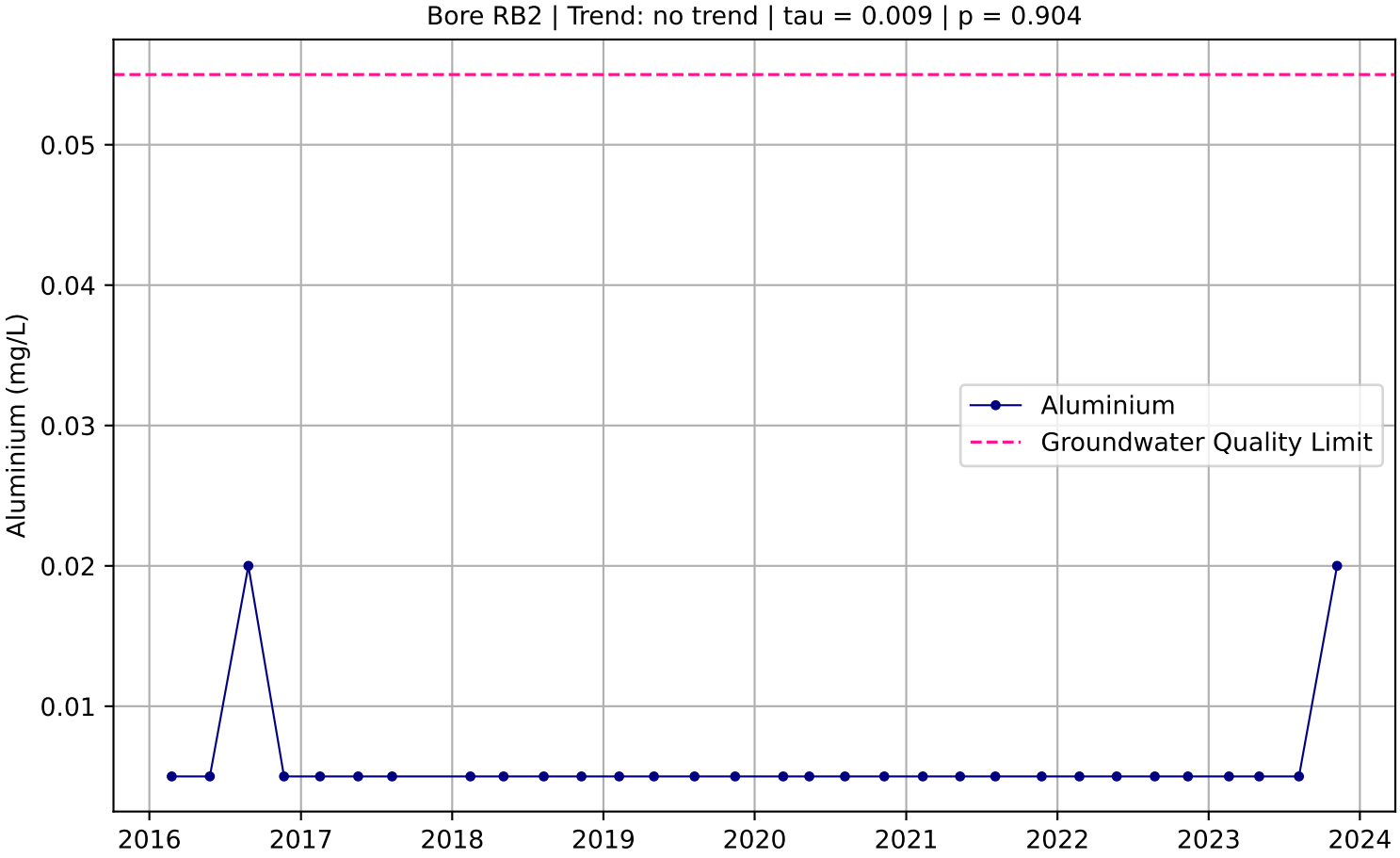

Bore RB1 | Trend: increasing | tau = 0.646 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

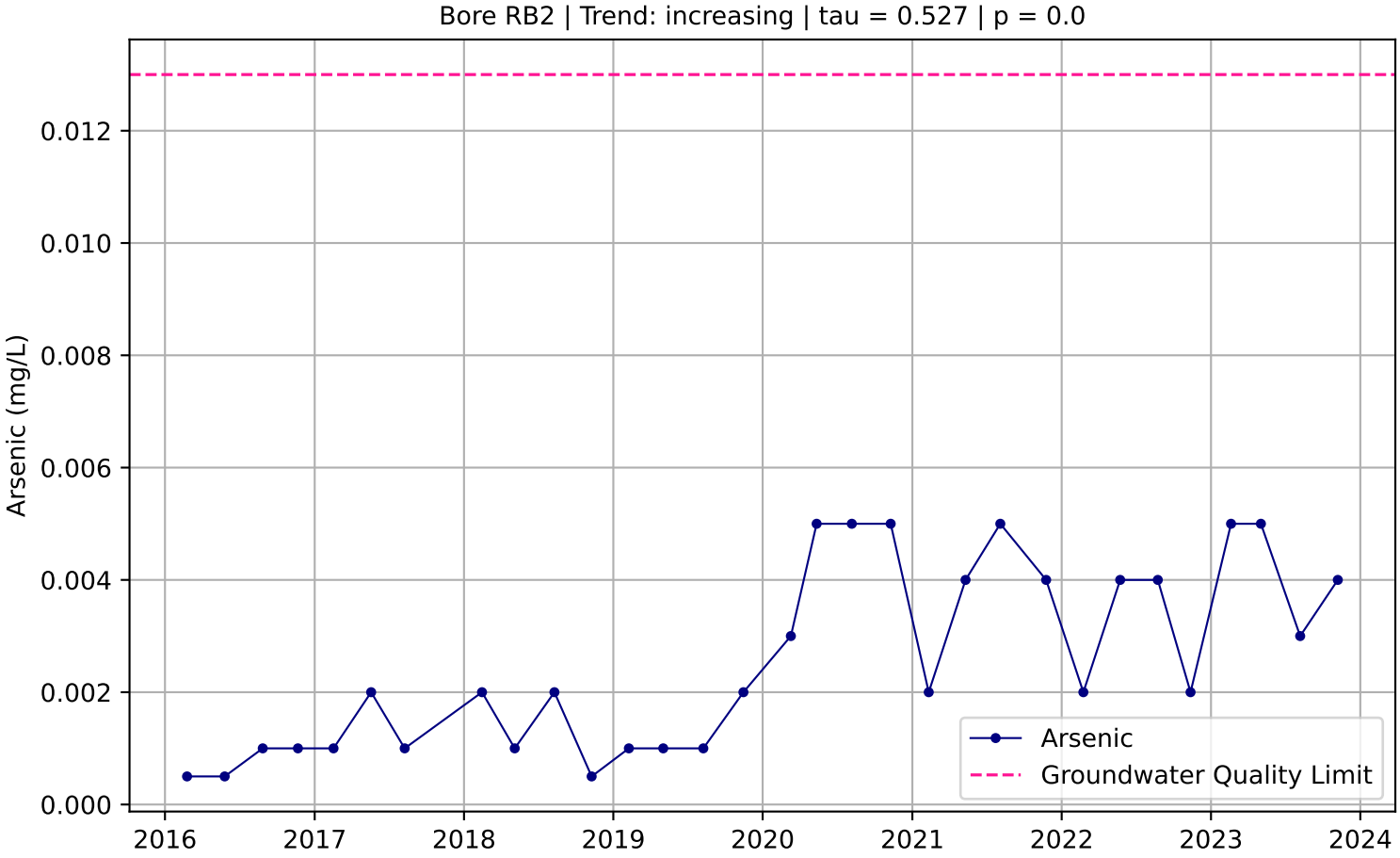

Bore RB1 | Trend: increasing | tau = 0.357 | p = 0.001
Potassium
Potassium (mg/L)
25
20
15
10
5
2017
2018
2019
2020
2021
2022
2023
2024

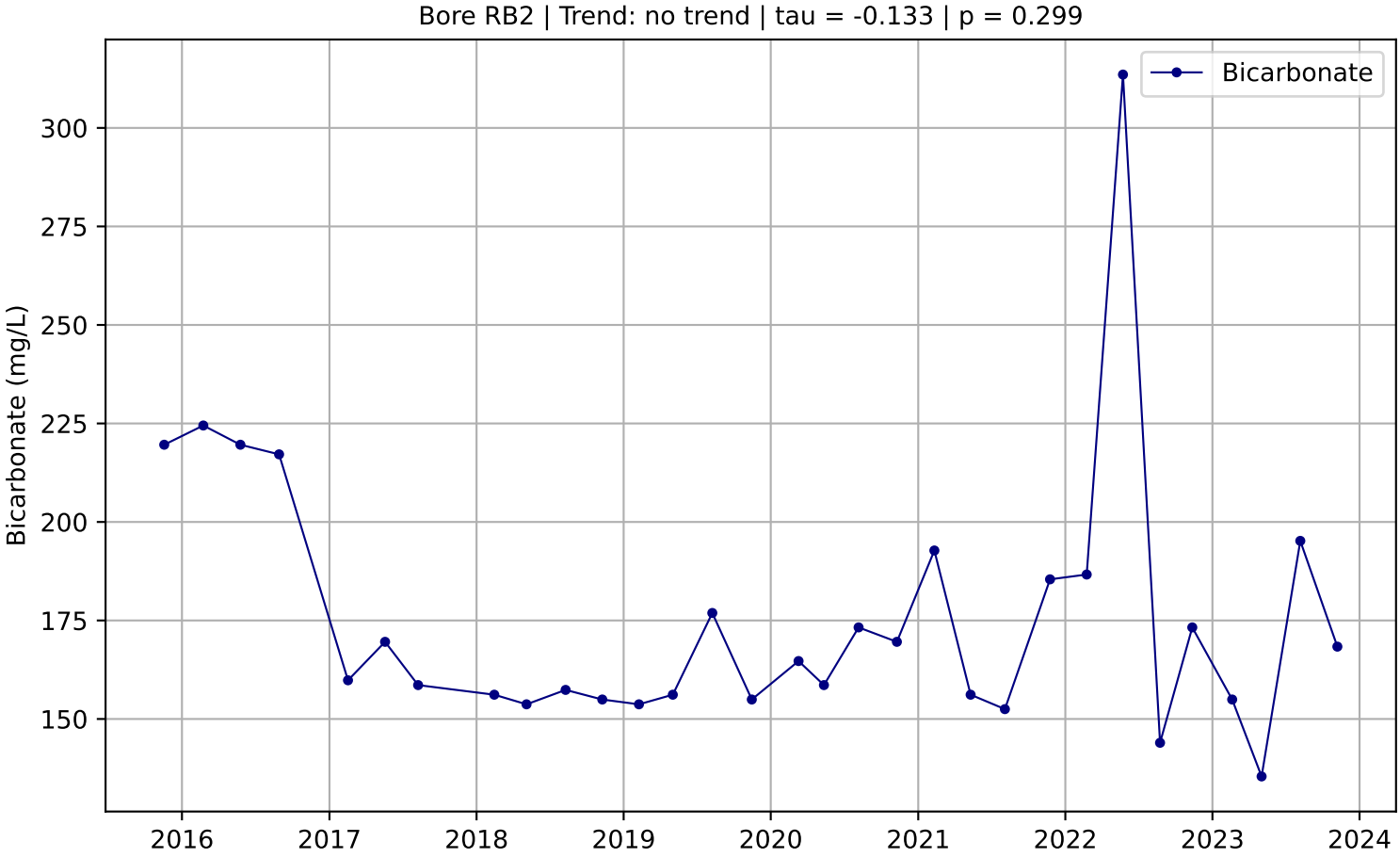

Bore RB1 | Trend: no trend | tau = -0.009 | p = 0.912
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
Selenium
Groundwater Quality Limit
2016
2017
2018
2019
2020
2021
2022
2023
2024

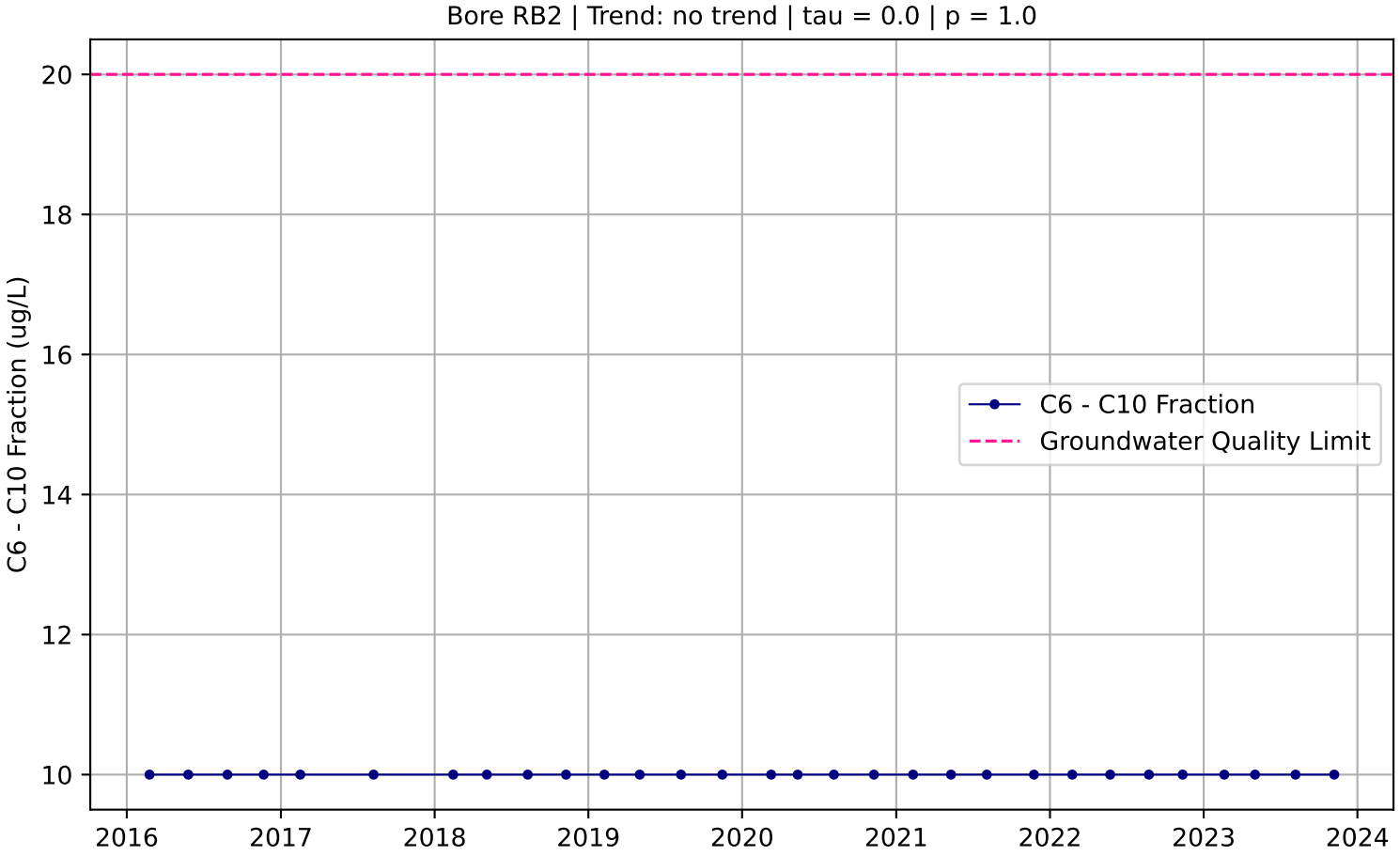

Bore RB1 | Trend: no trend | tau = 0.239 | p = 0.072
Sodium
Sodium (mg/L)
1800
1600
1400
1200
1000
800
600
2018
2019
2020
2021
2022
2023
2024

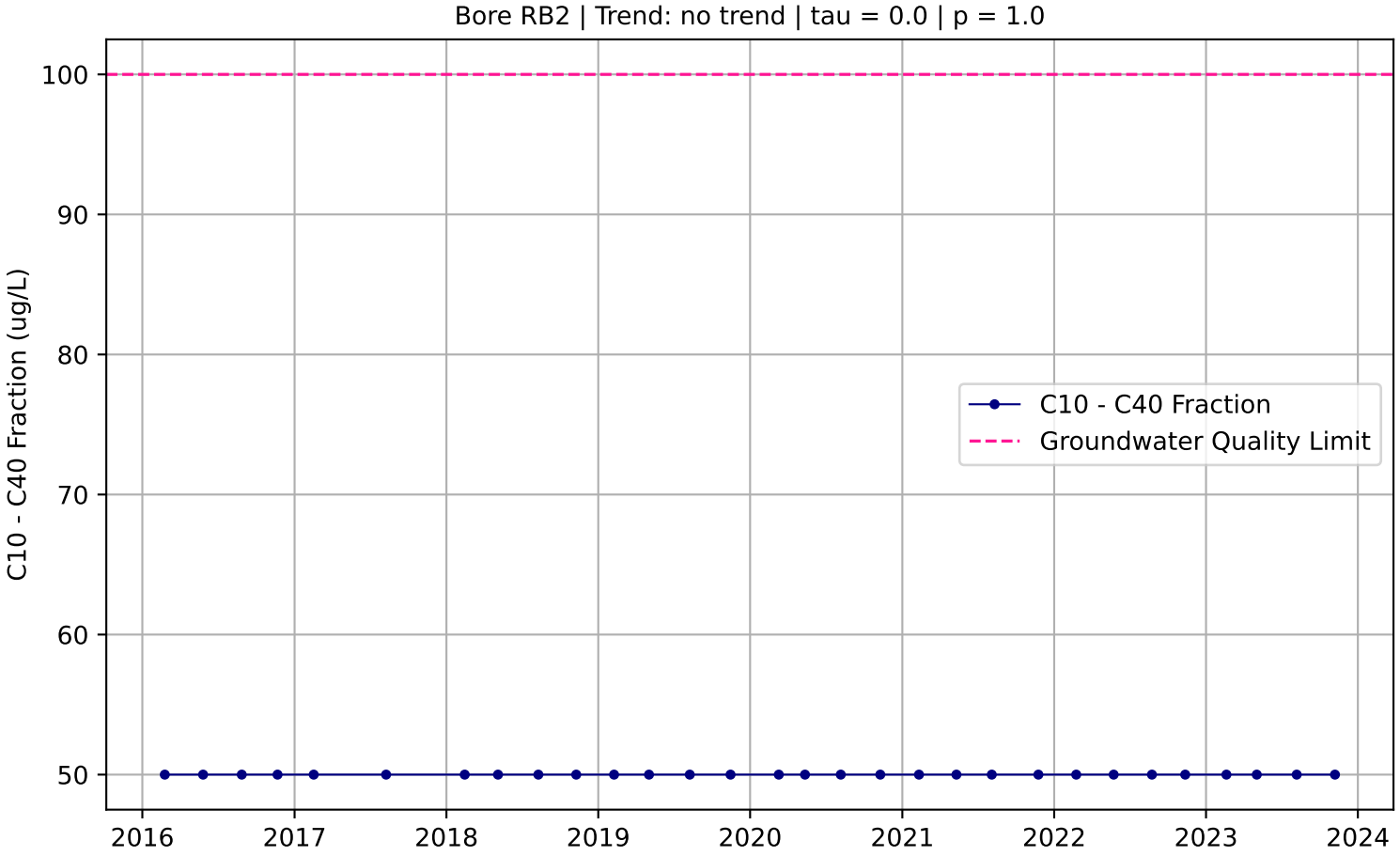

Bore RB1 | Trend: decreasing | tau = -0.678 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
0
10
20
30
40
2016
2017
2018
2019
2020
2021
2022
2023
2024

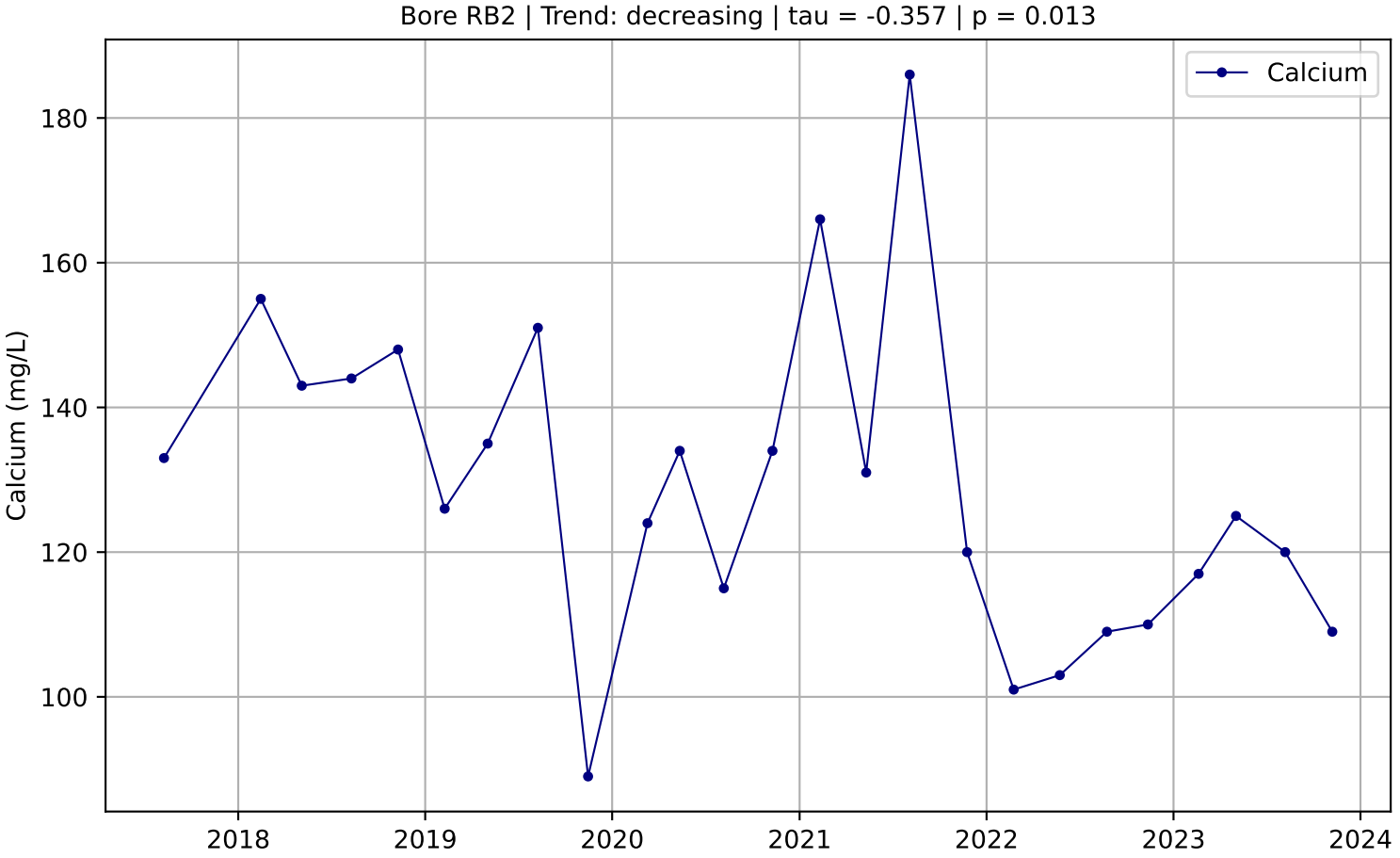

Bore RB2 | Trend: no trend | tau = 0.009 | p = 0.904
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

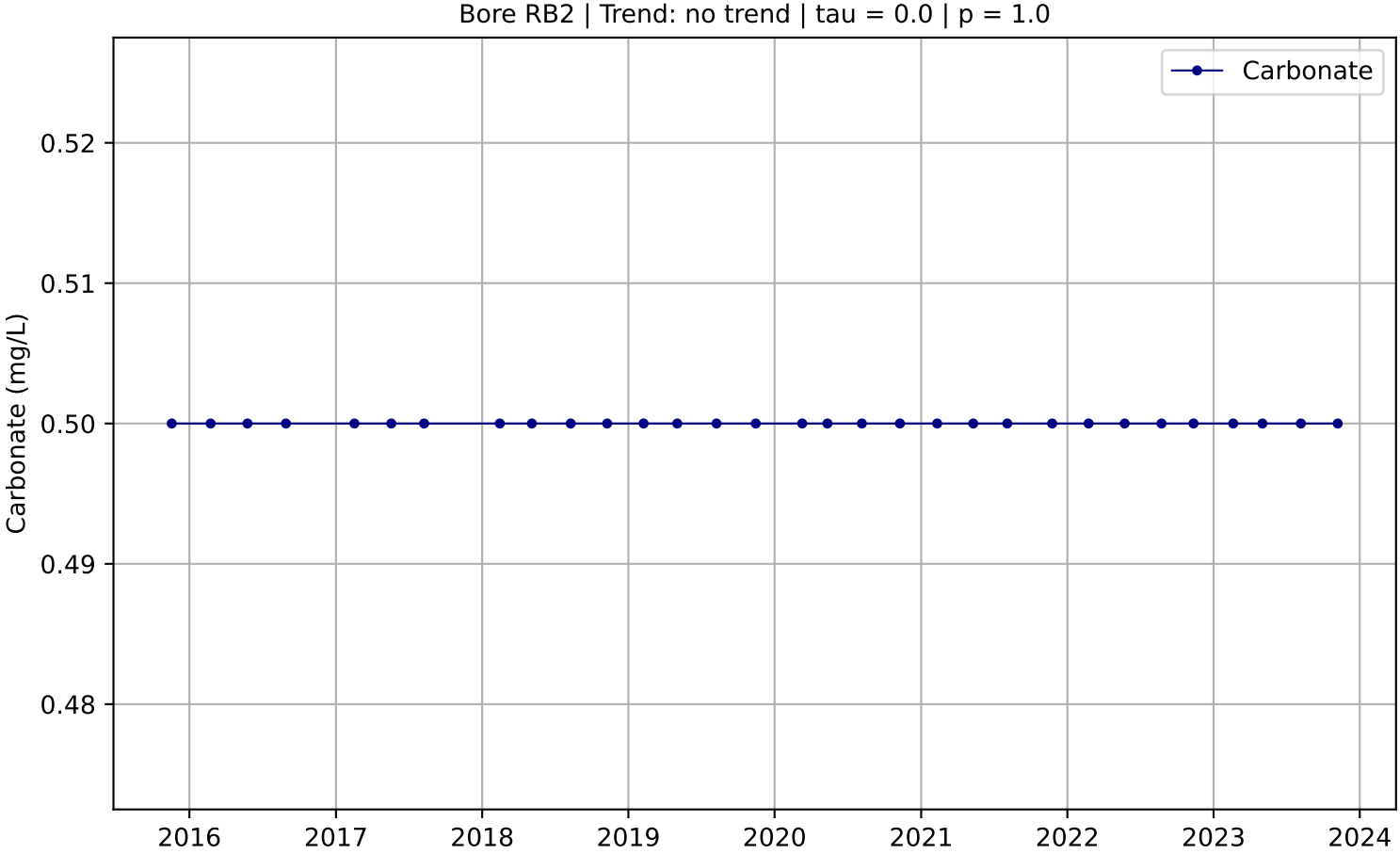

Bore RB2 | Trend: increasing | tau = 0.527 | p = 0.0
Arsenic (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

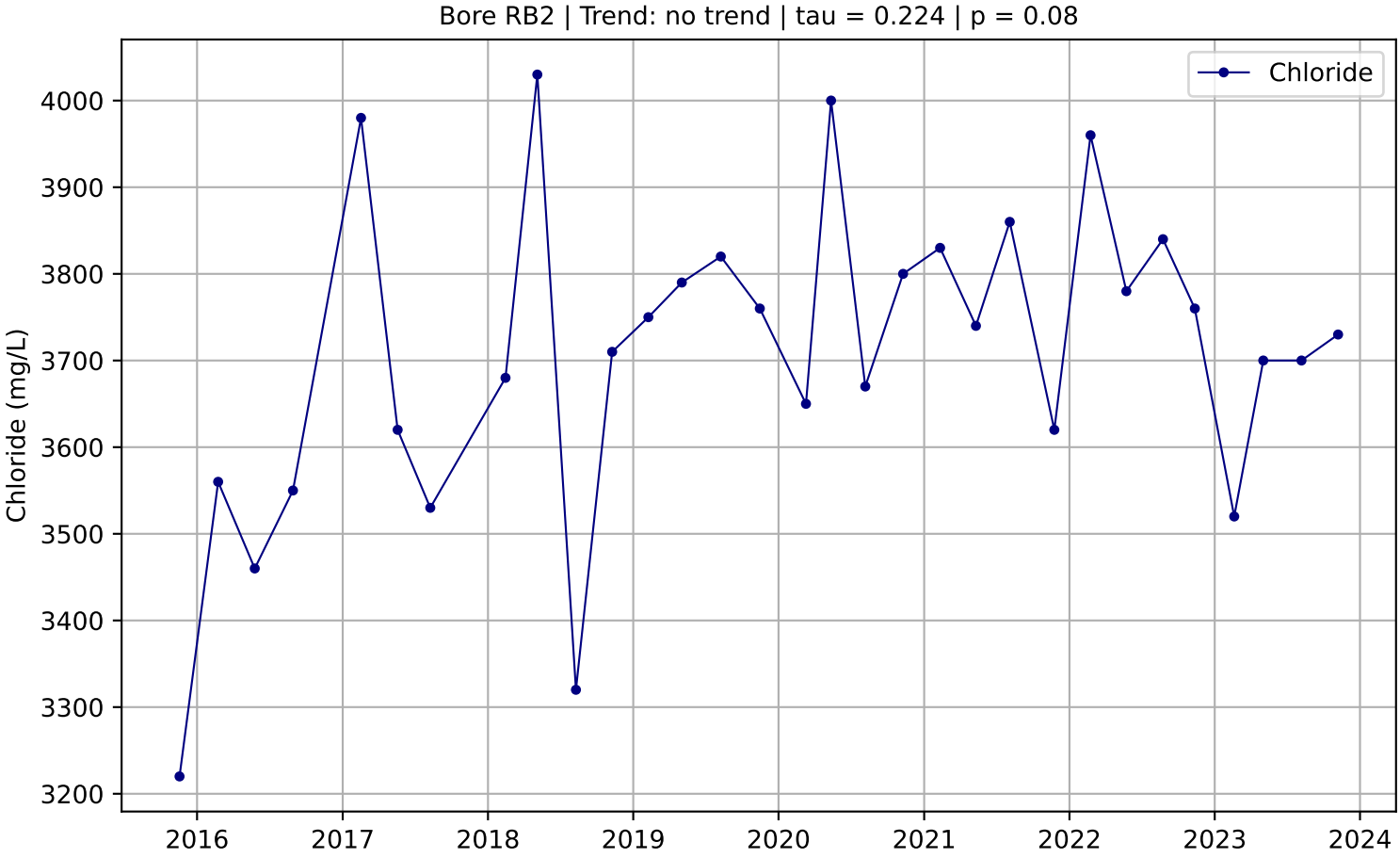

Bore RB2 | Trend: no trend | tau = -0.133 | p = 0.299
Bicarbonate
Bicarbonate (mg/L)
300
275
250
225
200
175
150
2016
2017
2018
2019
2020
2021
2022
2023
2024

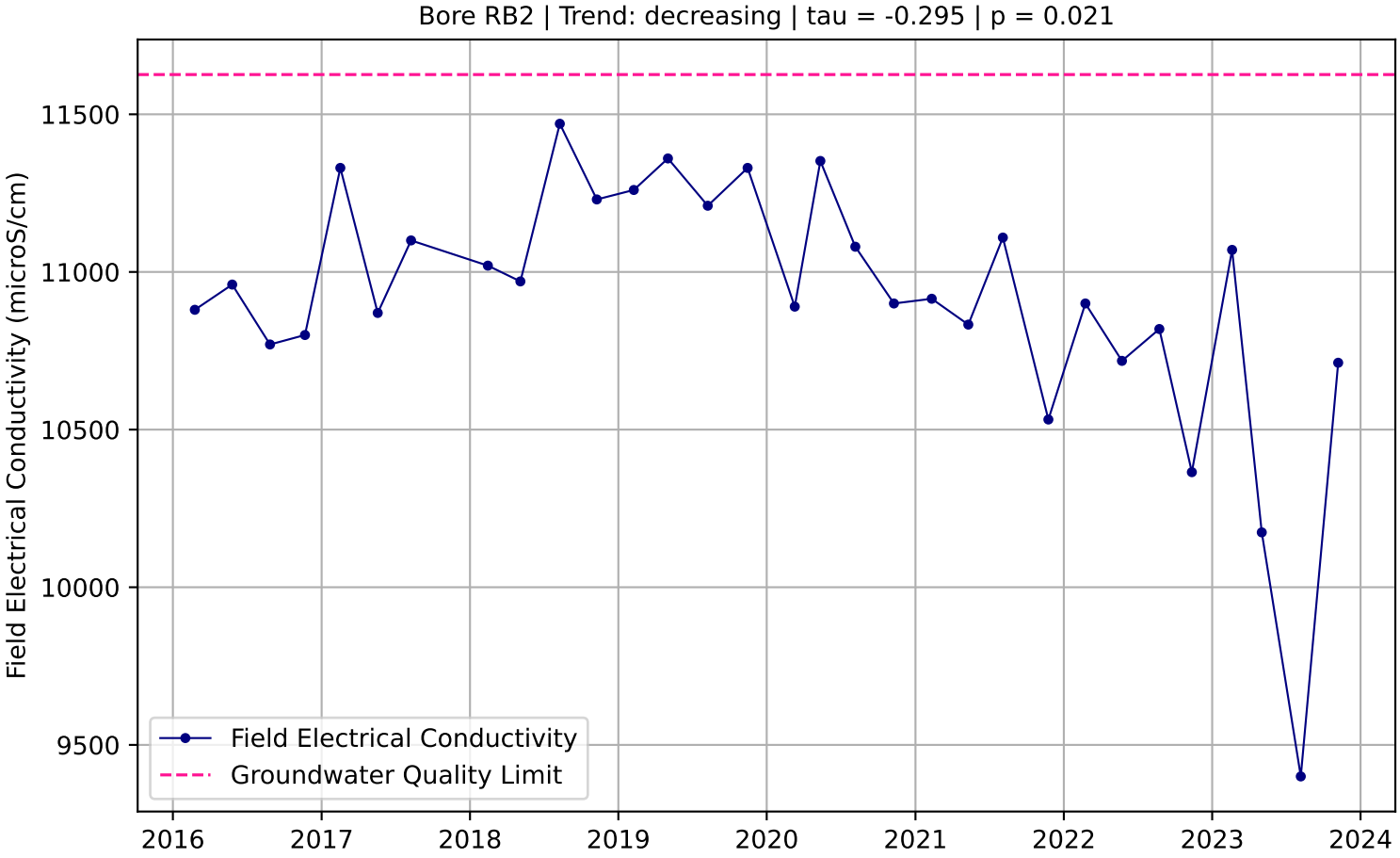

Bore RB2 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

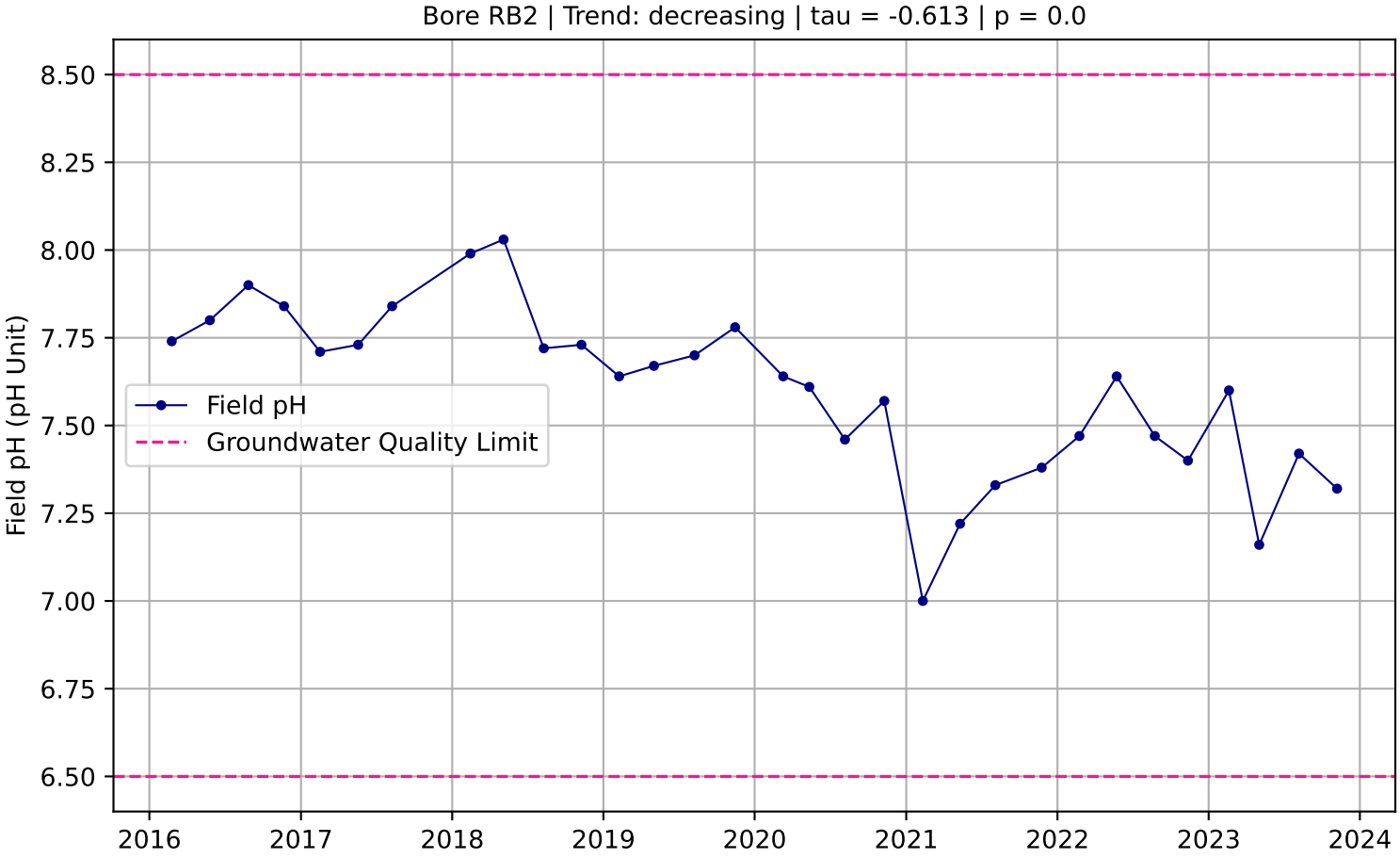

Bore RB2 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

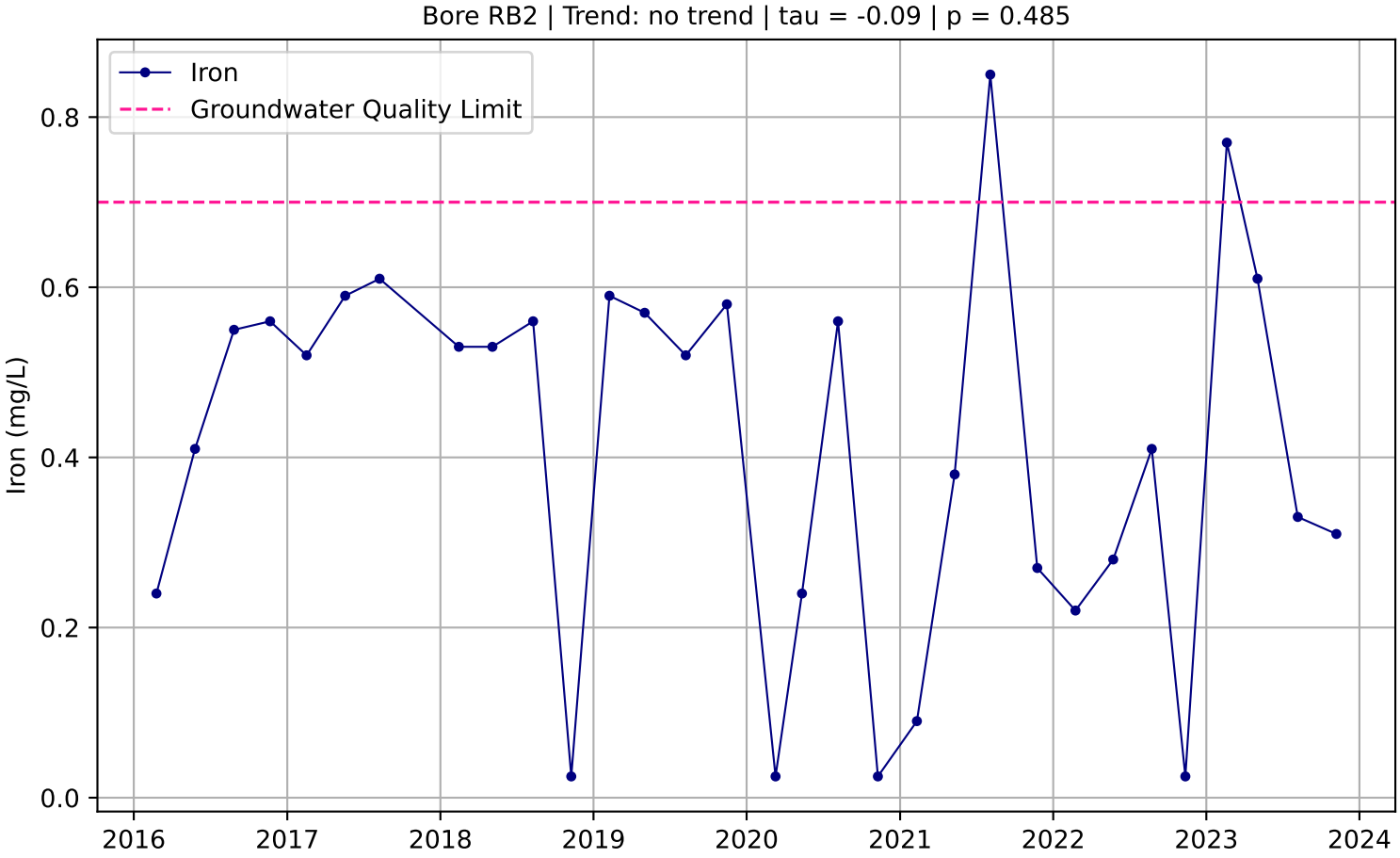

Bore RB2 | Trend: decreasing | tau = -0.357 | p = 0.013
Calcium
Calcium (mg/L)
180
160
140
120
100
2018
2019
2020
2021
2022
2023
2024

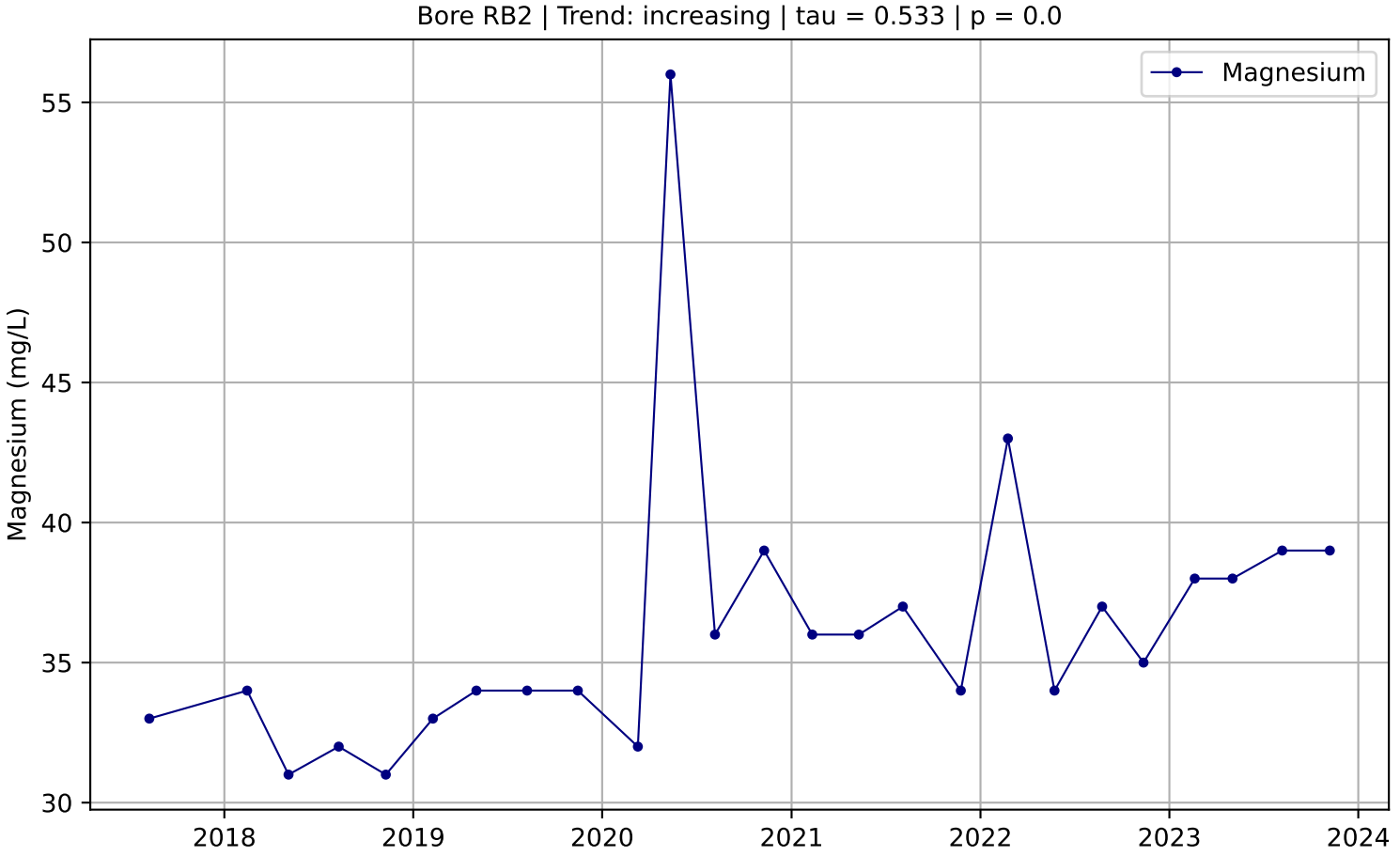

Bore RB2 | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

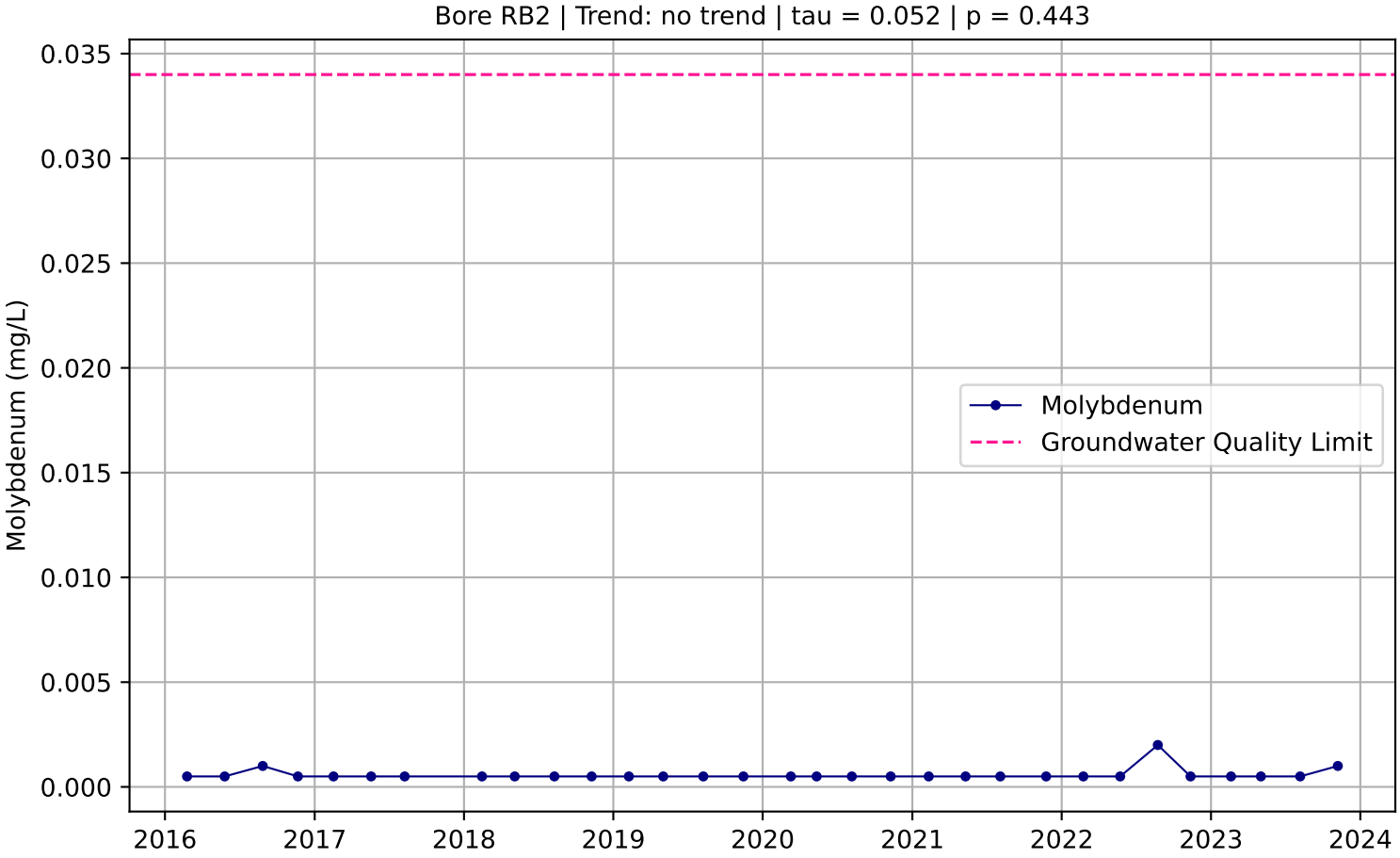

Bore RB2 | Trend: no trend | tau = 0.224 | p = 0.08
Chloride
Chloride (mg/L)
4000
3900
3800
3700
3600
3500
3400
3300
3200
2016
2017
2018
2019
2020
2021
2022
2023
2024

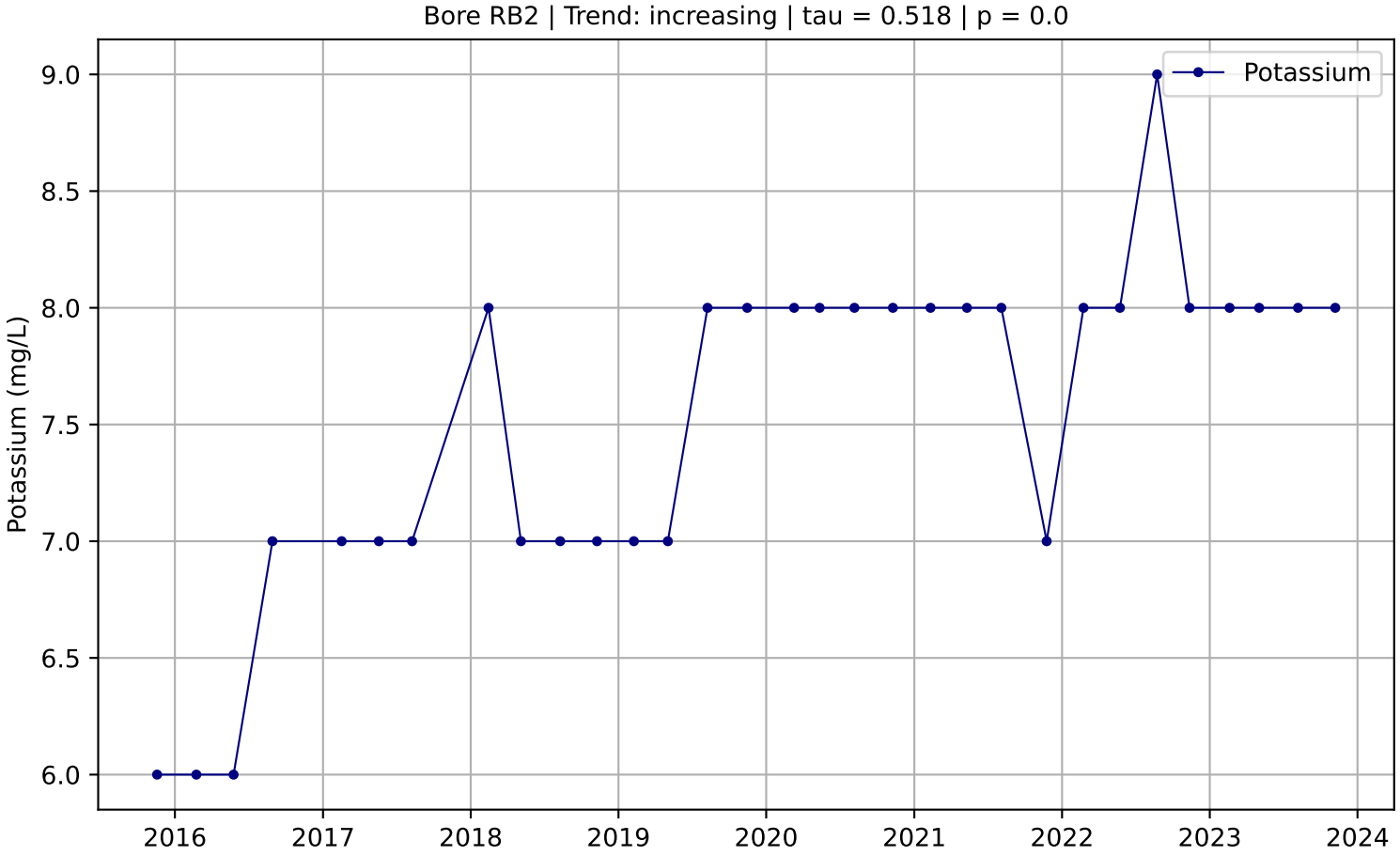

Bore RB2 | Trend: decreasing | tau = -0.295 | p = 0.021
Field Electrical Conductivity (microS/cm)
11500
11000
10500
10000
9500
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

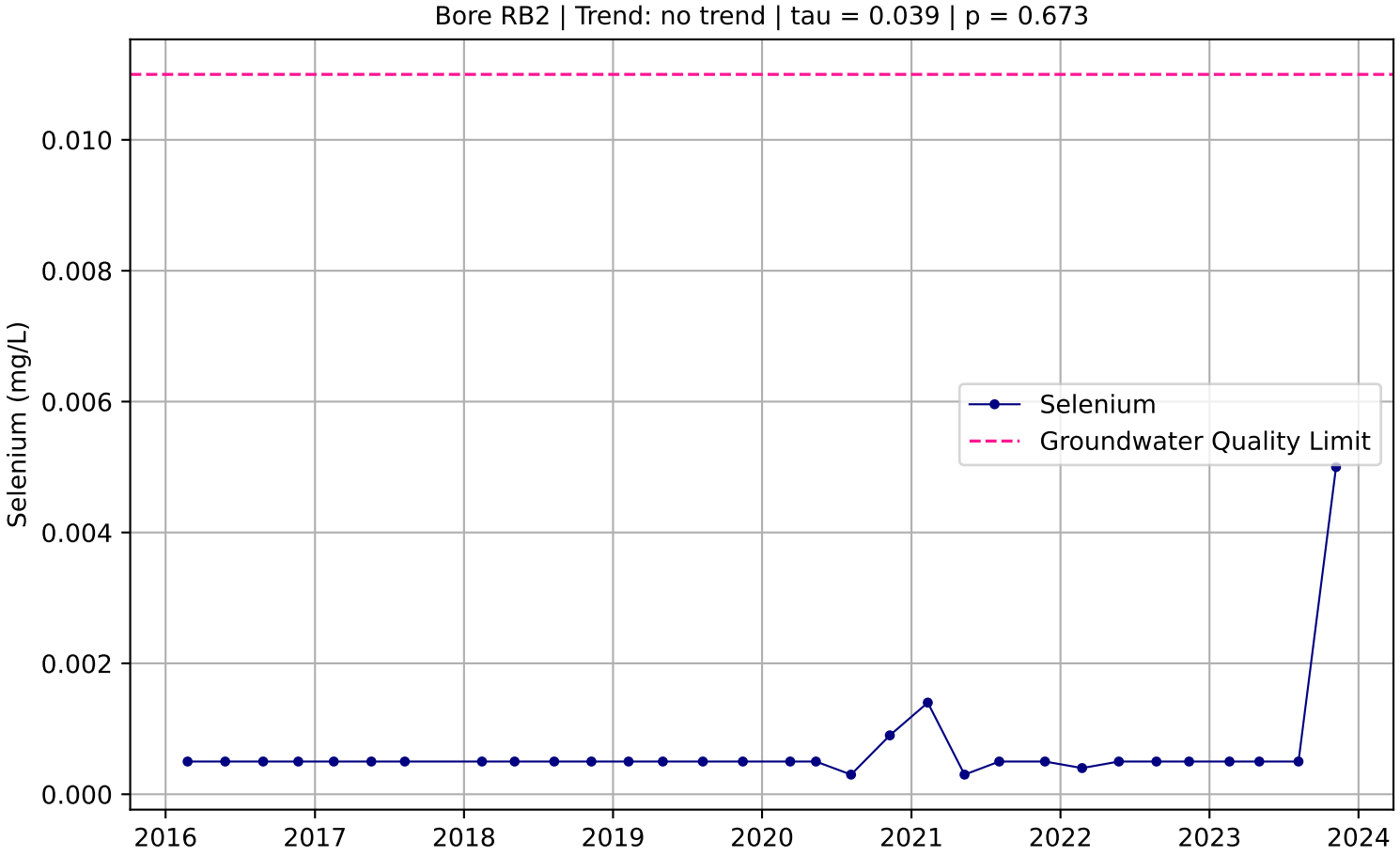

Bore RB2 | Trend: decreasing | tau = -0.613 | p = 0.0
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

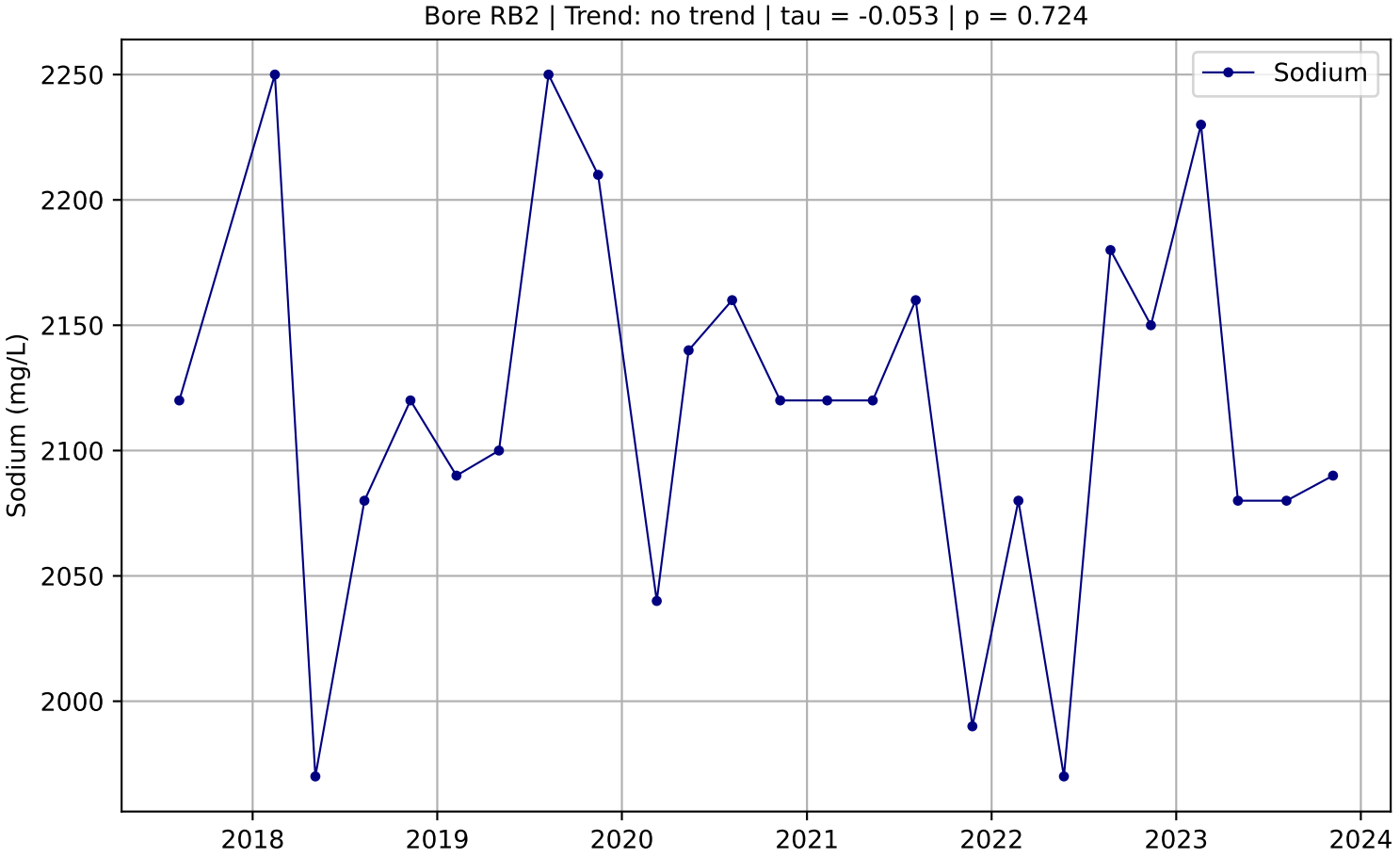

Bore RB2 | Trend: no trend | tau = -0.09 | p = 0.485
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.2
0.4
0.6
0.8
2016
2017
2018
2019
2020
2021
2022
2023
2024

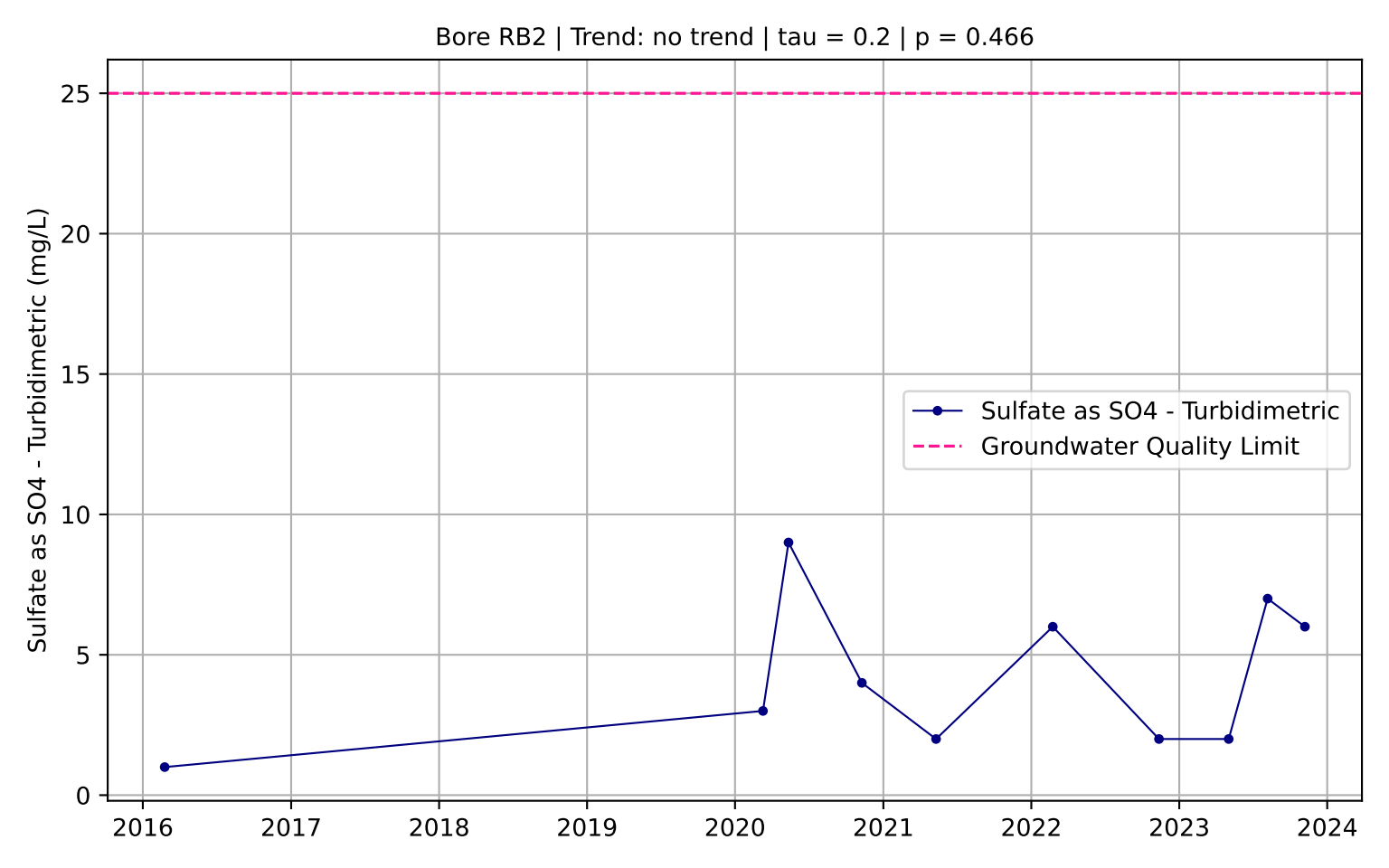

Bore RB2 | Trend: increasing | tau = 0.533 | p = 0.0
Magnesium
Magnesium (mg/L)
55
50
45
40
35
30
2018
2019
2020
2021
2022
2023
2024

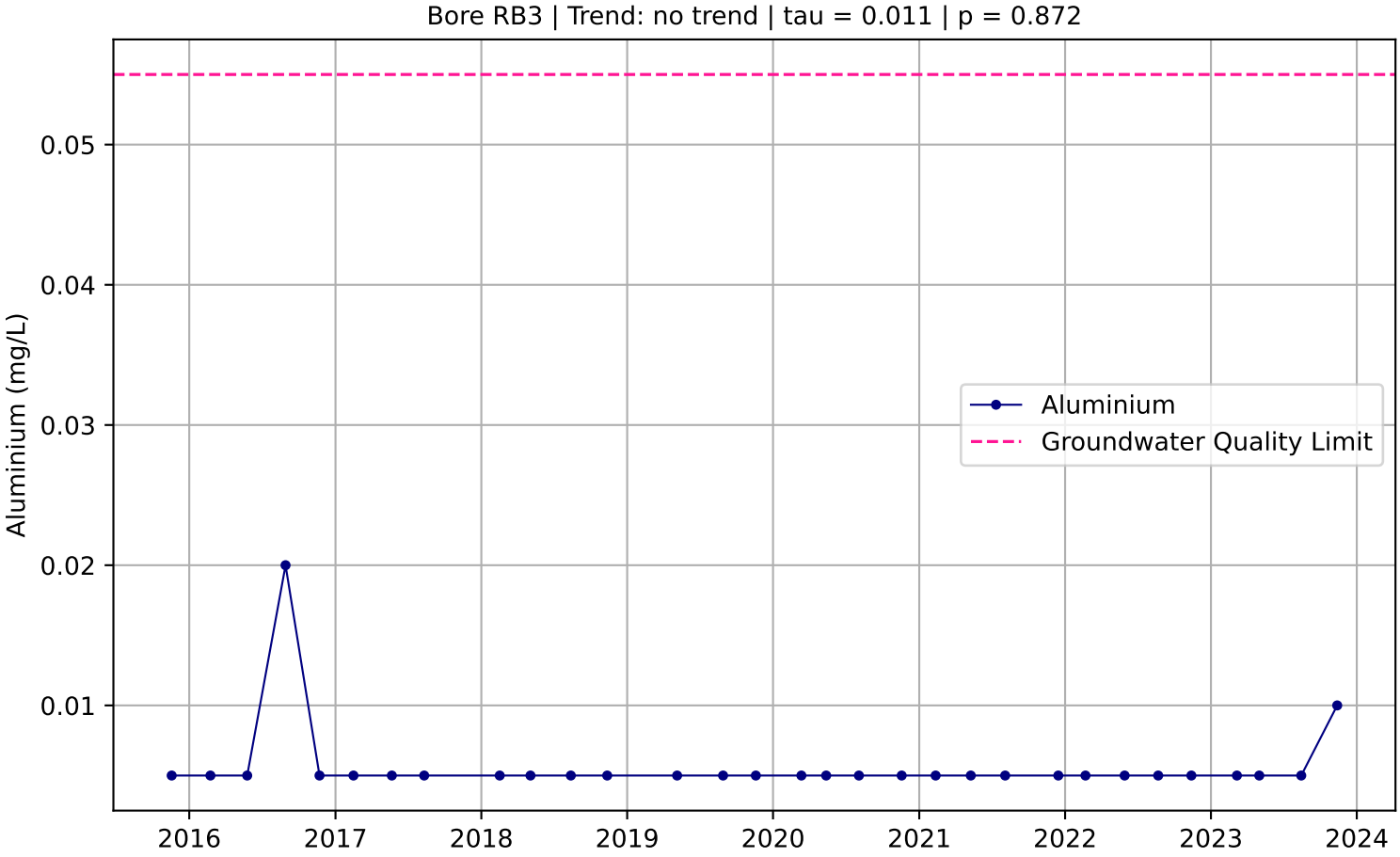

Bore RB2 | Trend: no trend | tau = 0.052 | p = 0.443
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

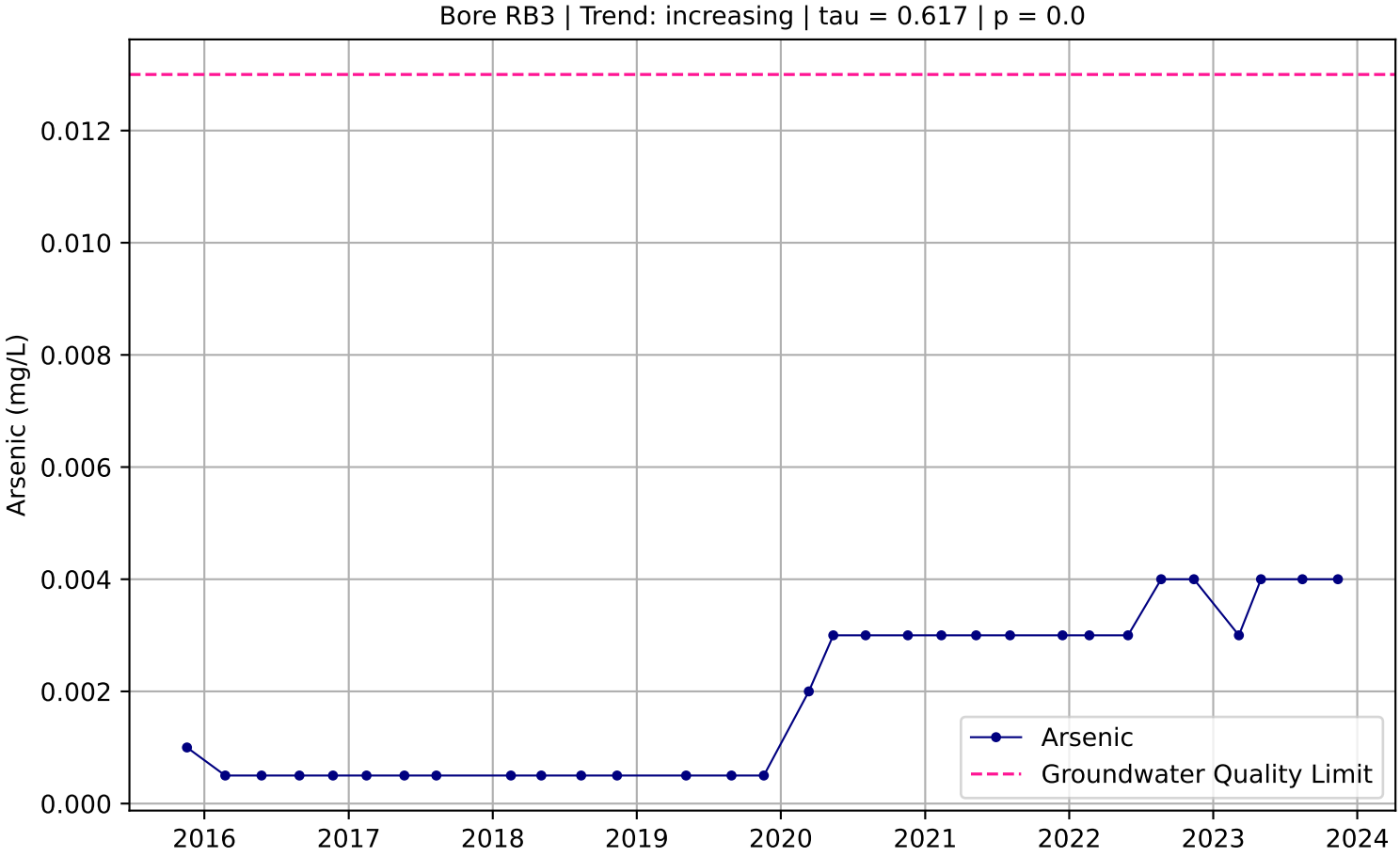

Bore RB2 | Trend: increasing | tau = 0.518 | p = 0.0
Potassium
Potassium (mg/L)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

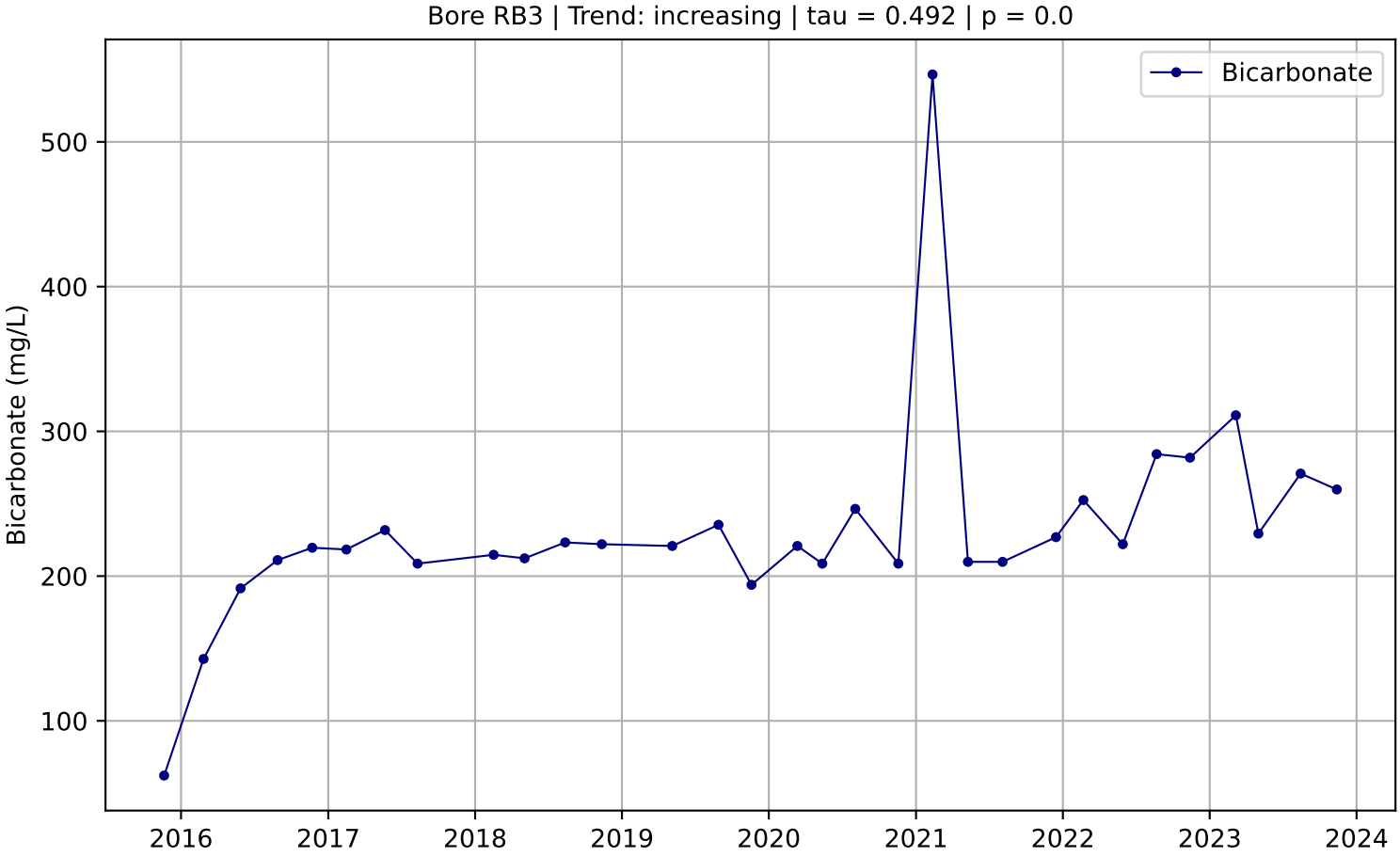

Bore RB2 | Trend: no trend | tau = 0.039 | p = 0.673
Selenium (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
2016
2017
2018
2019
2020
2021
2022
2023
2024
Selenium
Groundwater Quality Limit

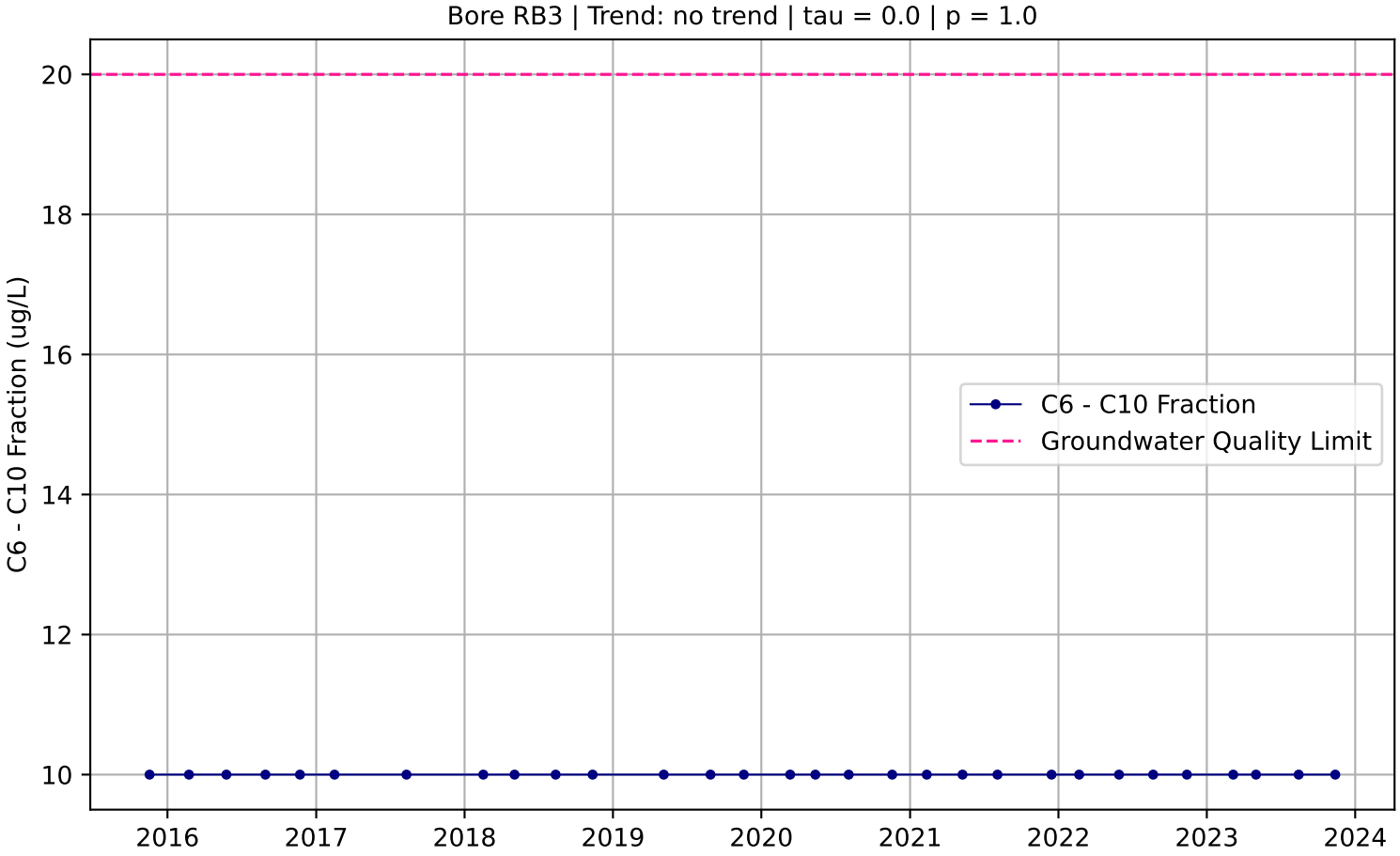

Bore RB2 | Trend: no trend | tau = -0.053 | p = 0.724
Sodium
Sodium (mg/L)
2250
2200
2150
2100
2050
2000
2018
2019
2020
2021
2022
2023
2024

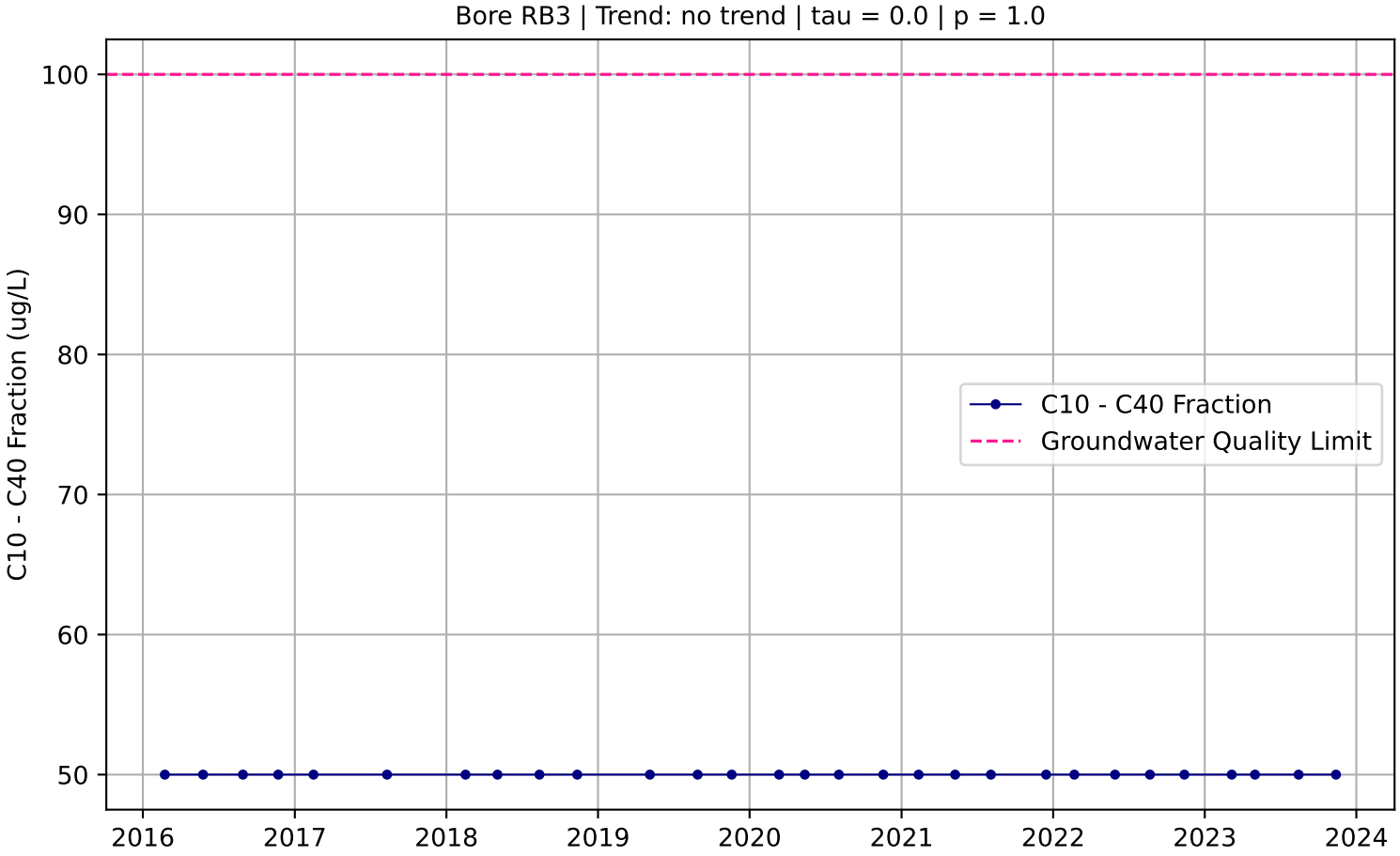

Bore RB2 | Trend: no trend | tau = 0.2 | p = 0.466
Sulfate as SO4 - Turbidimetric (mg/L)
0
5
10
15
20
25
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

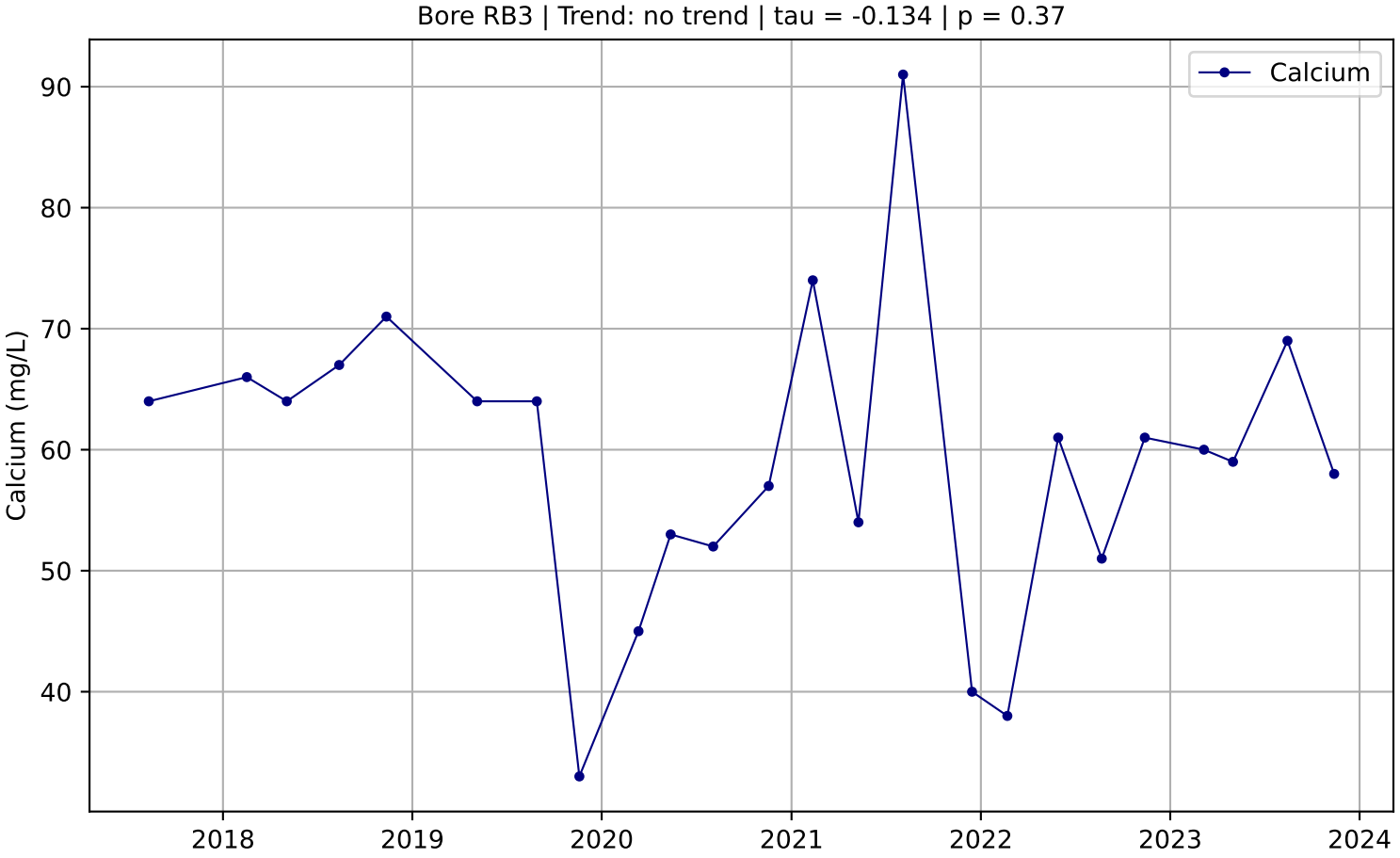

Bore RB3 | Trend: no trend | tau = 0.011 | p = 0.872
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

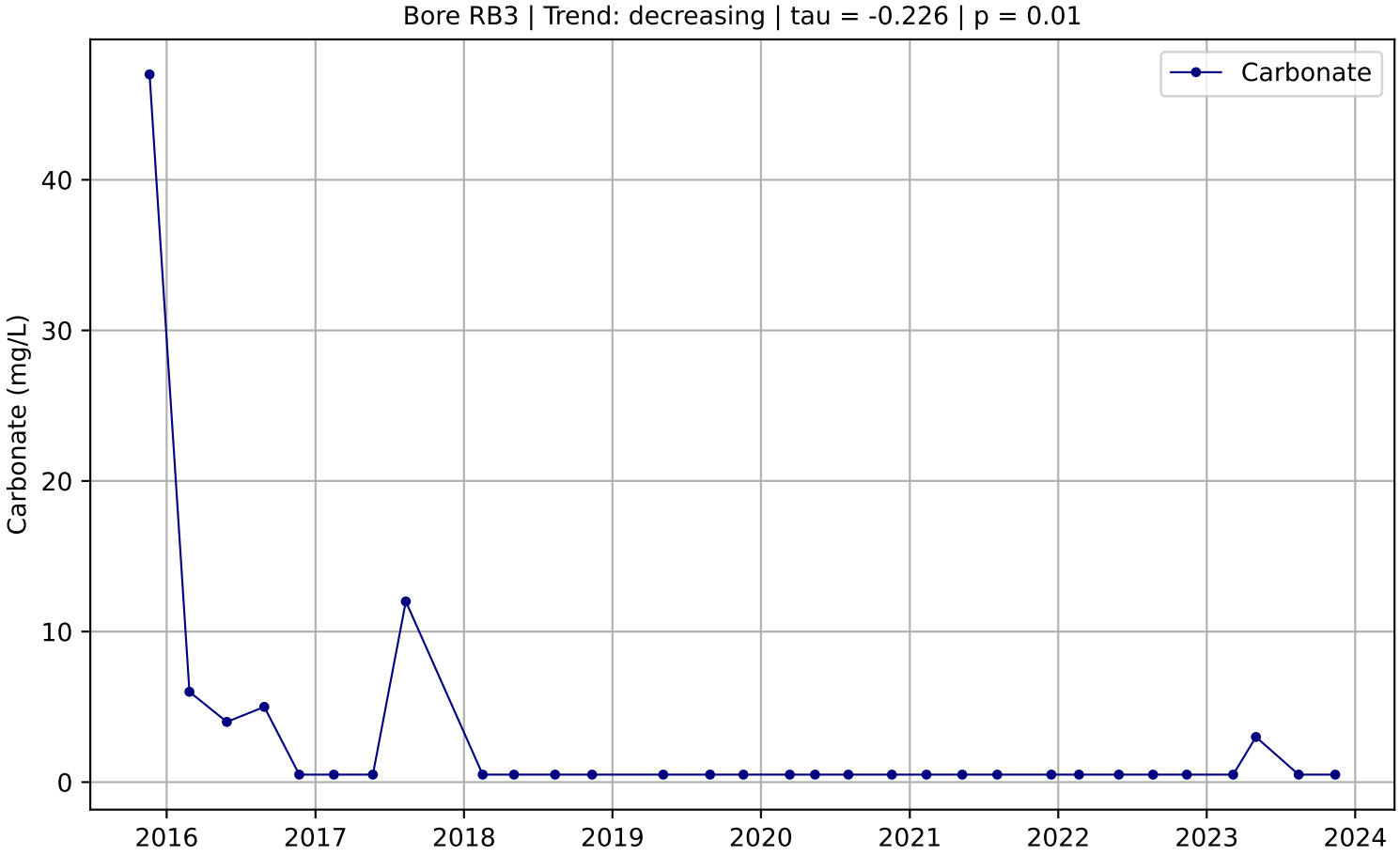

Bore RB3 | Trend: increasing | tau = 0.617 | p = 0.0
Arsenic (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

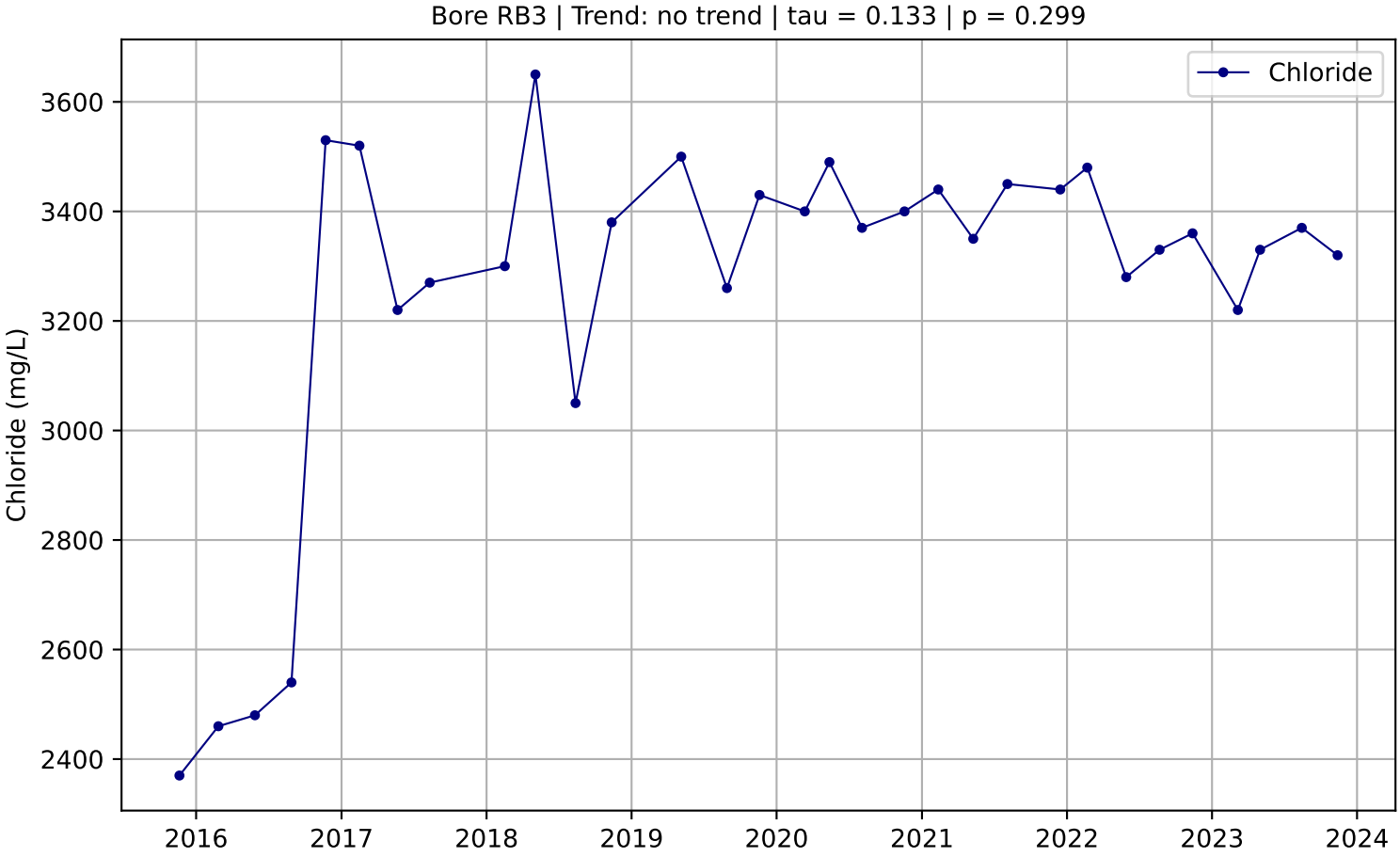

Bore RB3 | Trend: increasing | tau = 0.492 | p = 0.0
Bicarbonate
Bicarbonate (mg/L)
100
200
300
400
500
2016
2017
2018
2019
2020
2021
2022
2023
2024

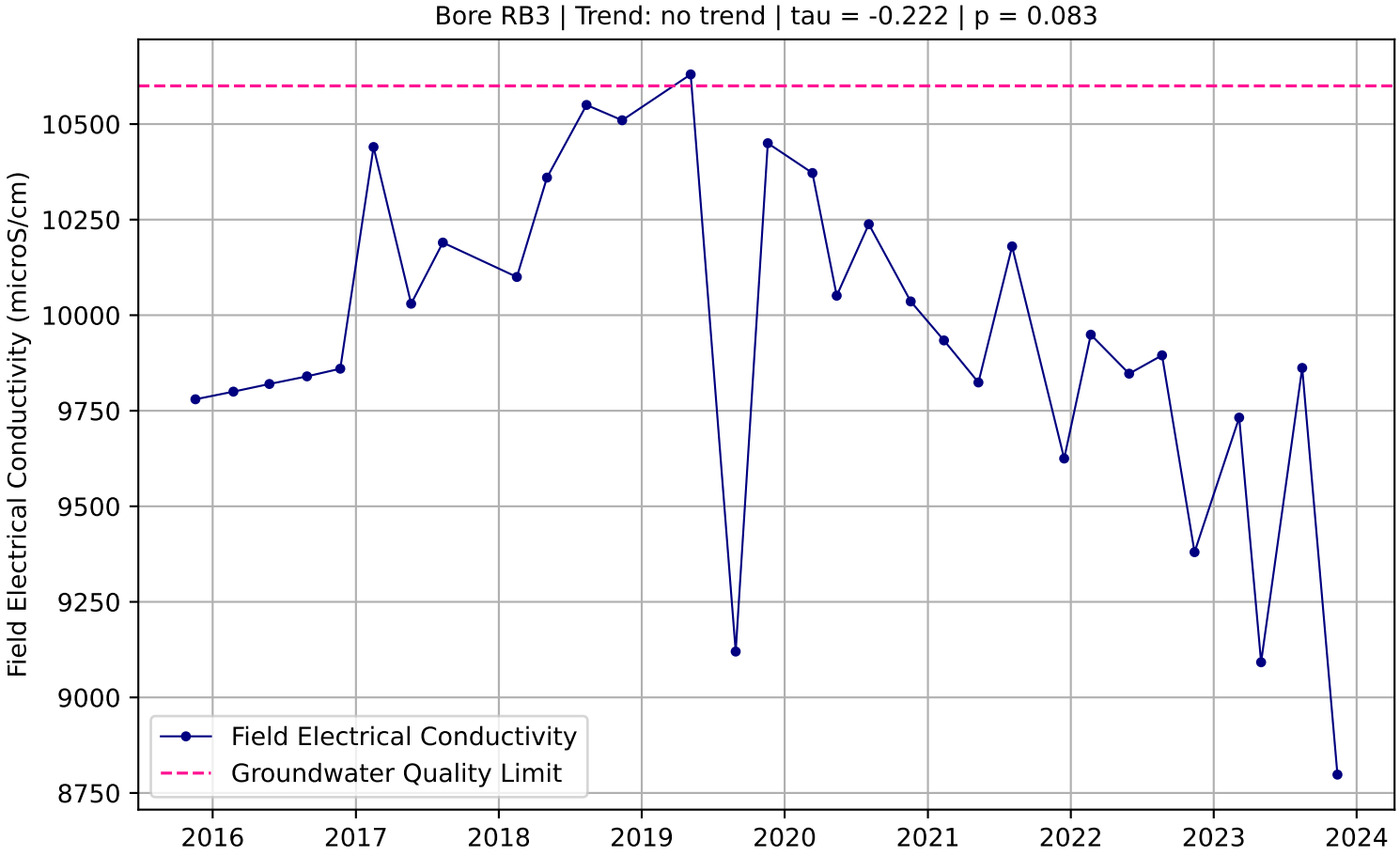

Bore RB3 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

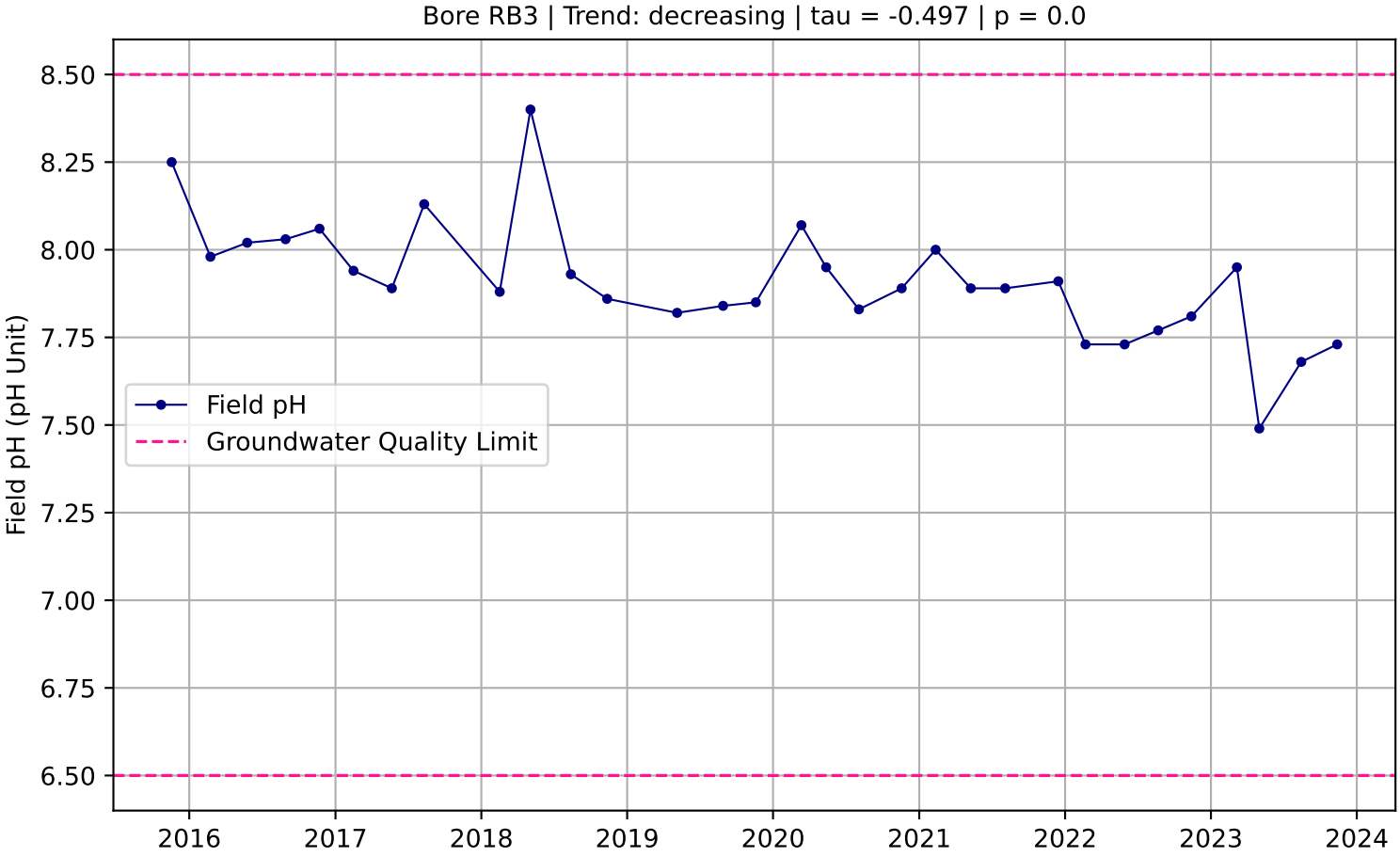

Bore RB3 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

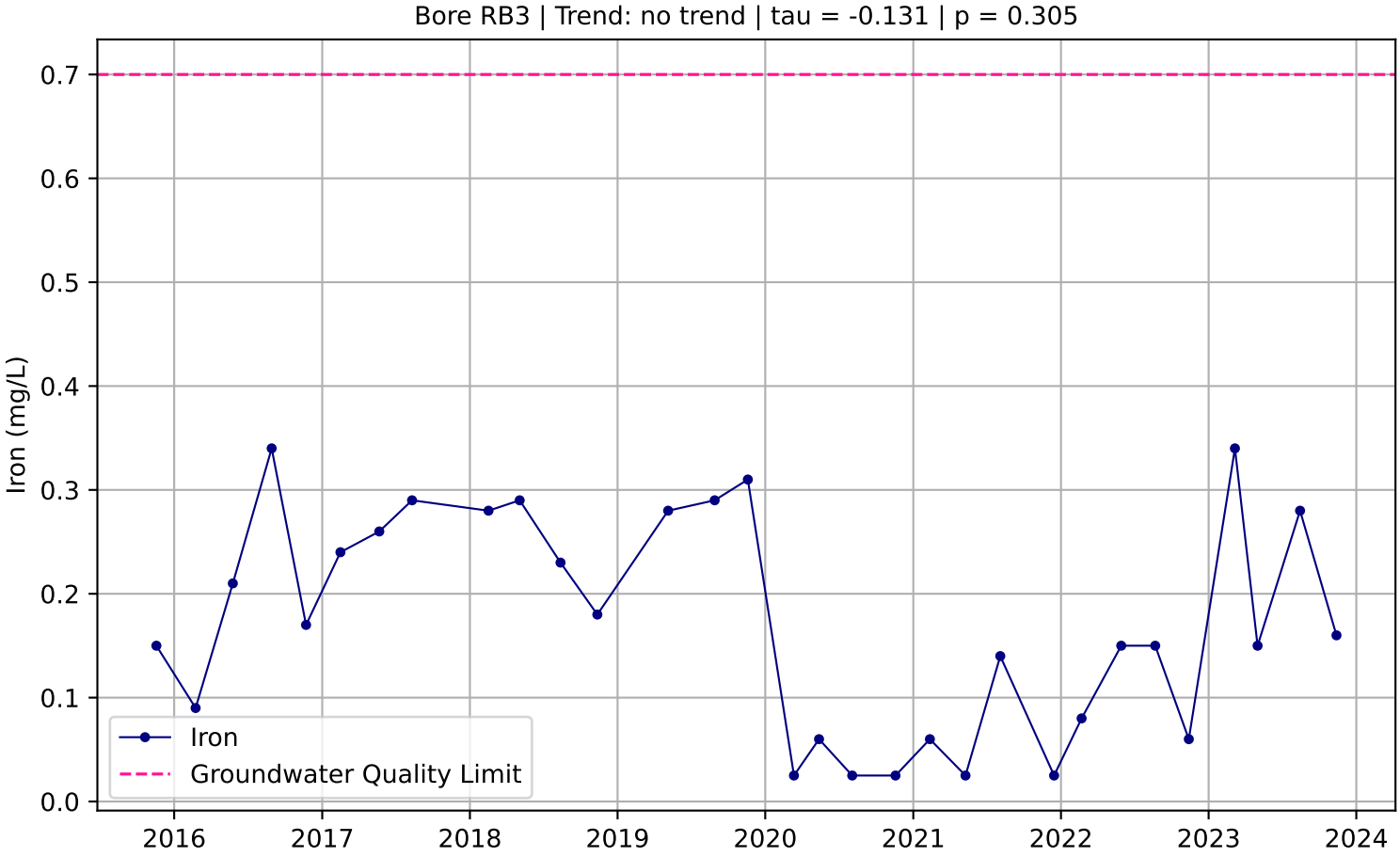

Bore RB3 | Trend: no trend | tau = -0.134 | p = 0.37
Calcium
Calcium (mg/L)
90
80
70
60
50
40
2018
2019
2020
2021
2022
2023
2024

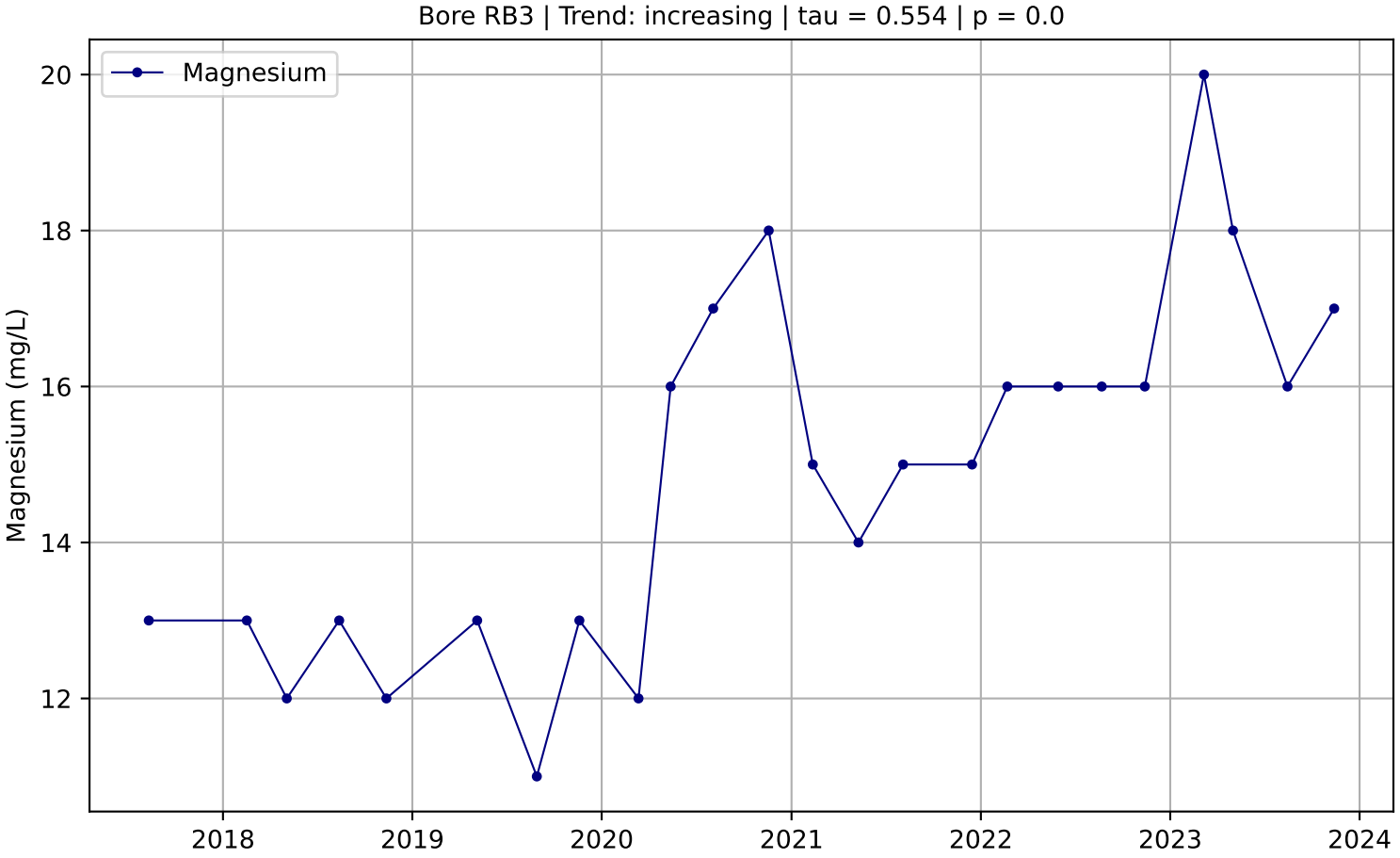

Bore RB3 | Trend: decreasing | tau = -0.226 | p = 0.01
Carbonate
Carbonate (mg/L)
0
10
20
30
40
2016
2017
2018
2019
2020
2021
2022
2023
2024

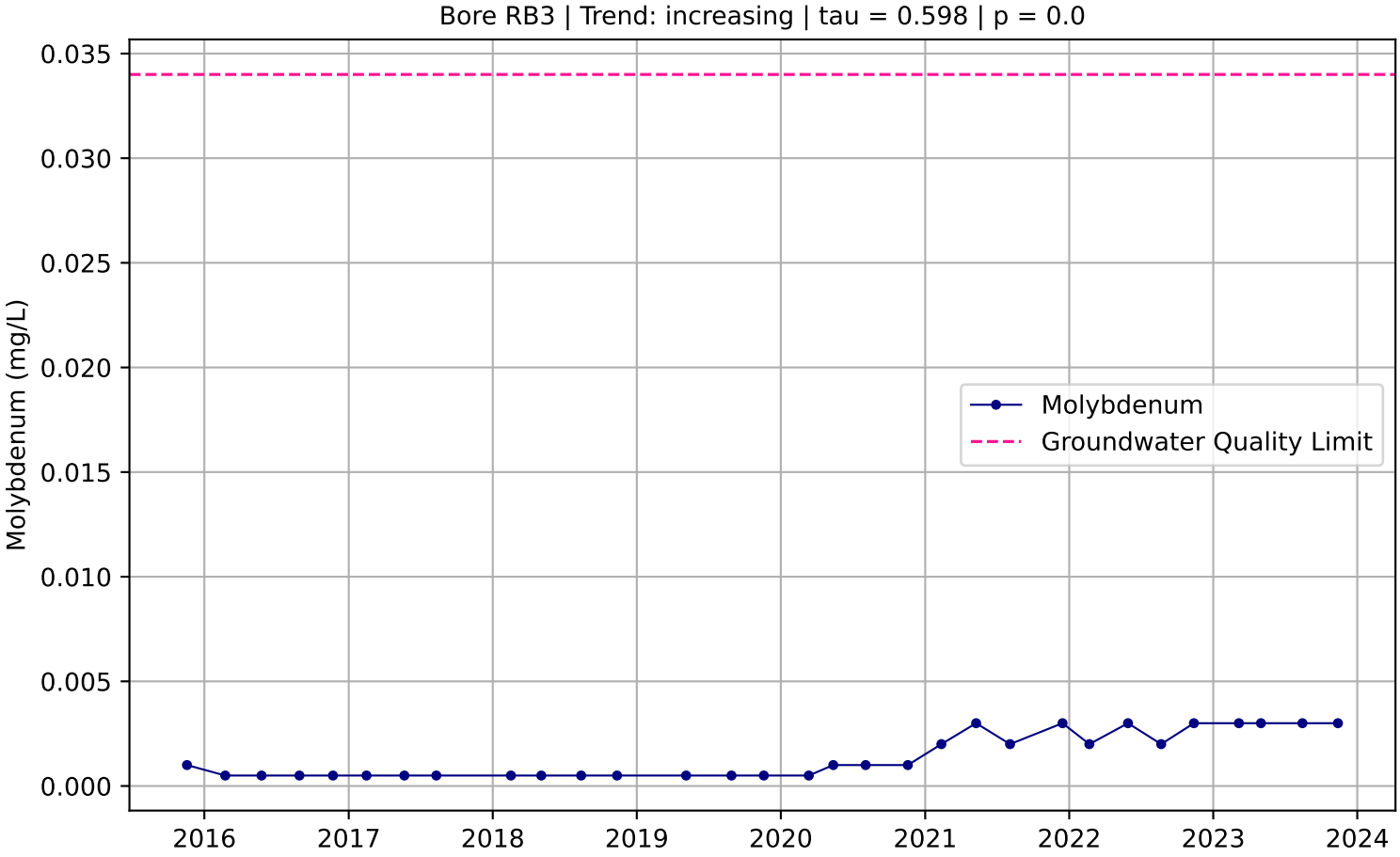

Bore RB3 | Trend: no trend | tau = 0.133 | p = 0.299
Chloride
Chloride (mg/L)
2400
2600
2800
3000
3200
3400
3600
2016
2017
2018
2019
2020
2021
2022
2023
2024

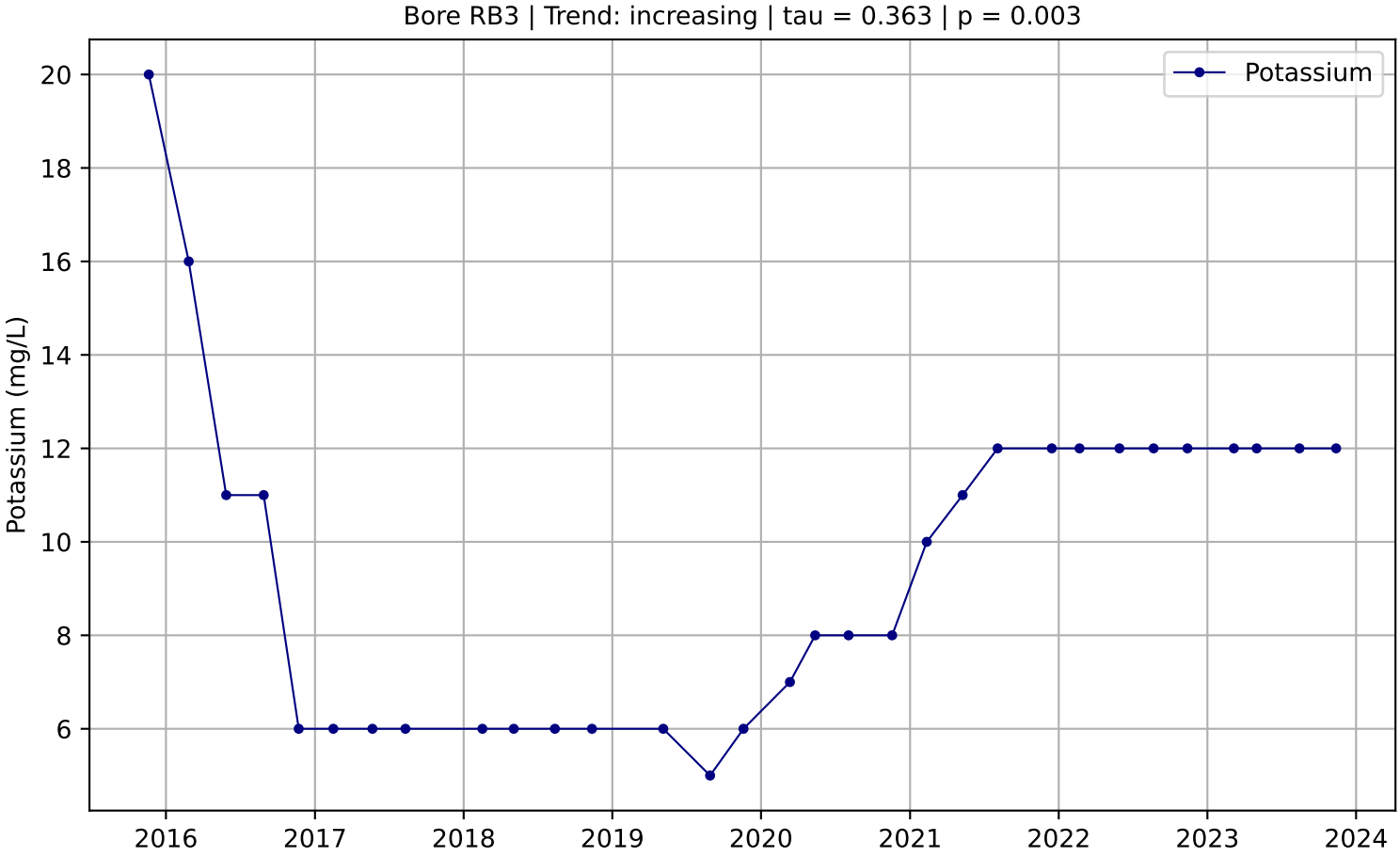

Bore RB3 | Trend: no trend | tau = -0.222 | p = 0.083
Field Electrical Conductivity (microS/cm)
10500
10250
10000
9750
9500
9250
9000
8750
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

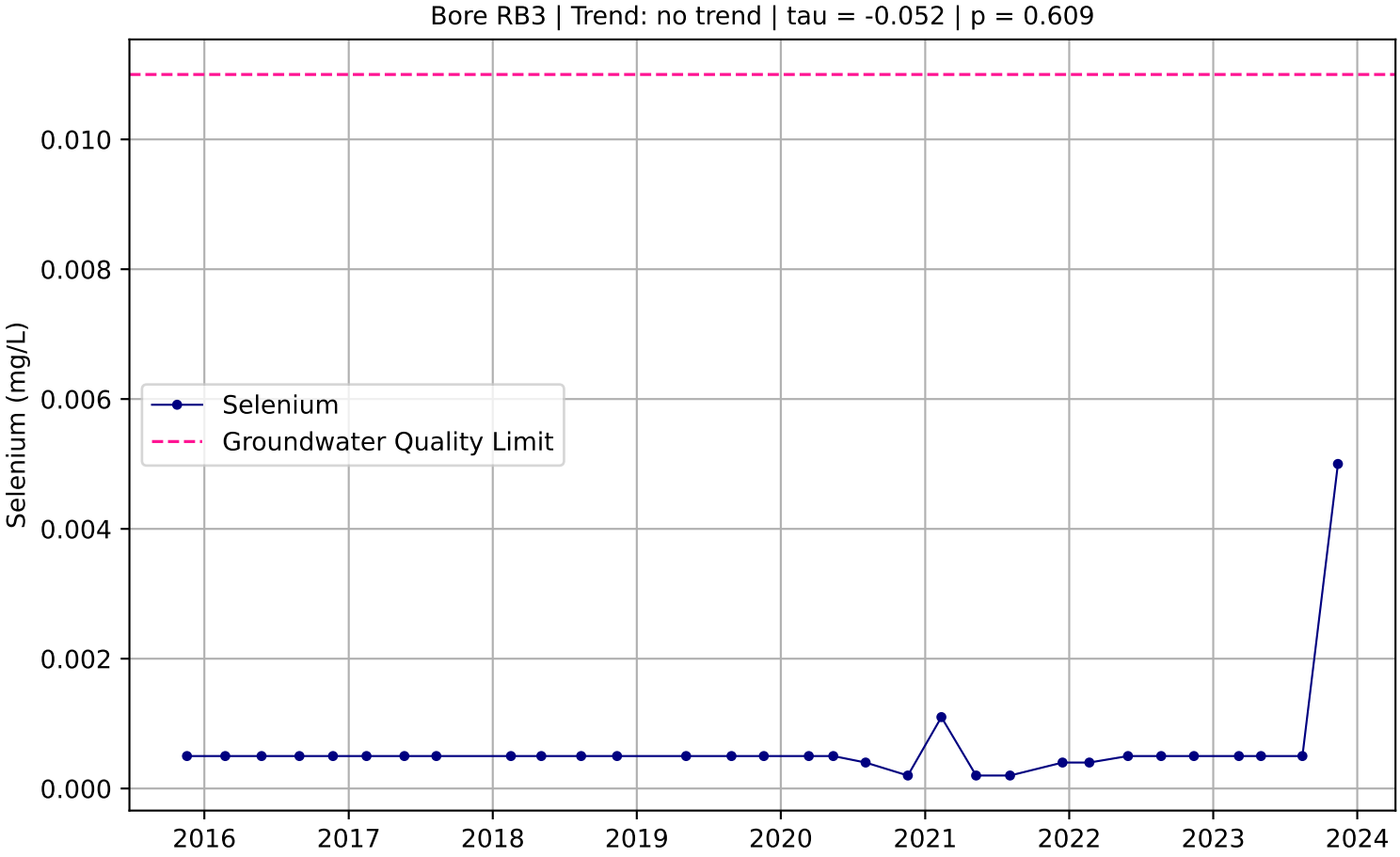

Bore RB3 | Trend: decreasing | tau = -0.497 | p = 0.0
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

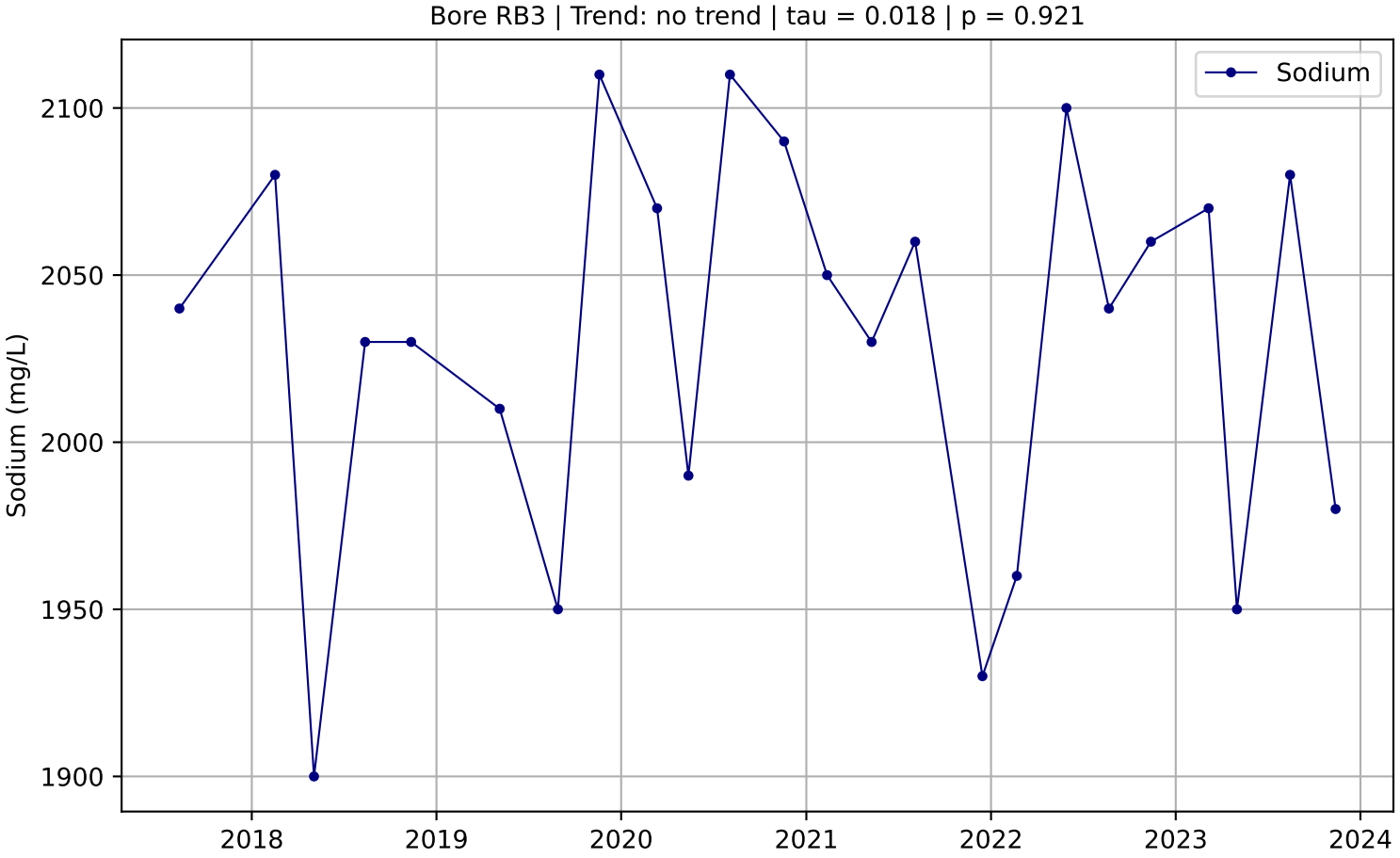

Bore RB3 | Trend: no trend | tau = -0.131 | p = 0.305
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2016
2017
2018
2019
2020
2021
2022
2023
2024
Iron
Groundwater Quality Limit

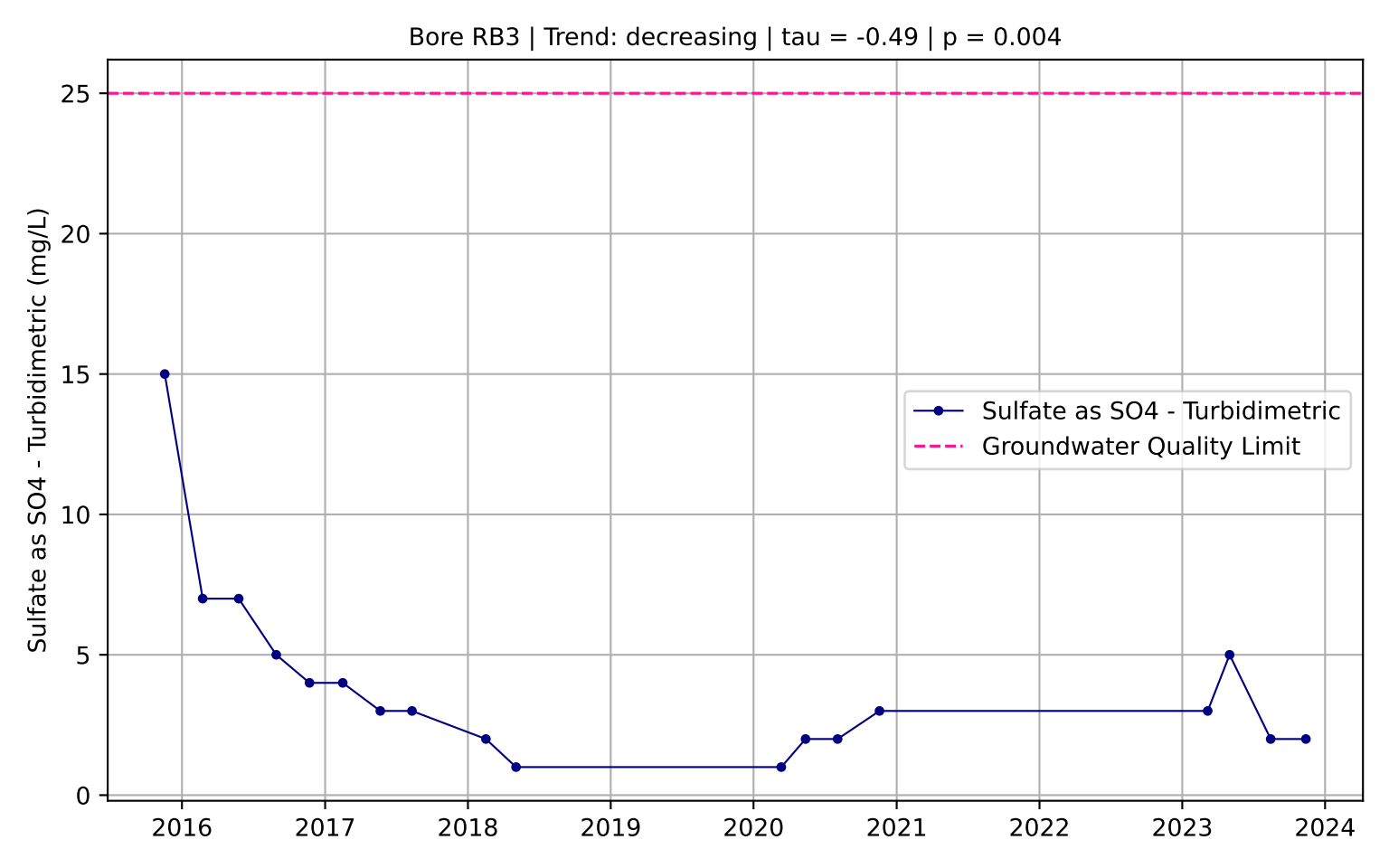

Bore RB3 | Trend: increasing | tau = 0.554 | p = 0.0
Magnesium
Magnesium (mg/L)
20
18
16
14
12
2018
2019
2020
2021
2022
2023
2024

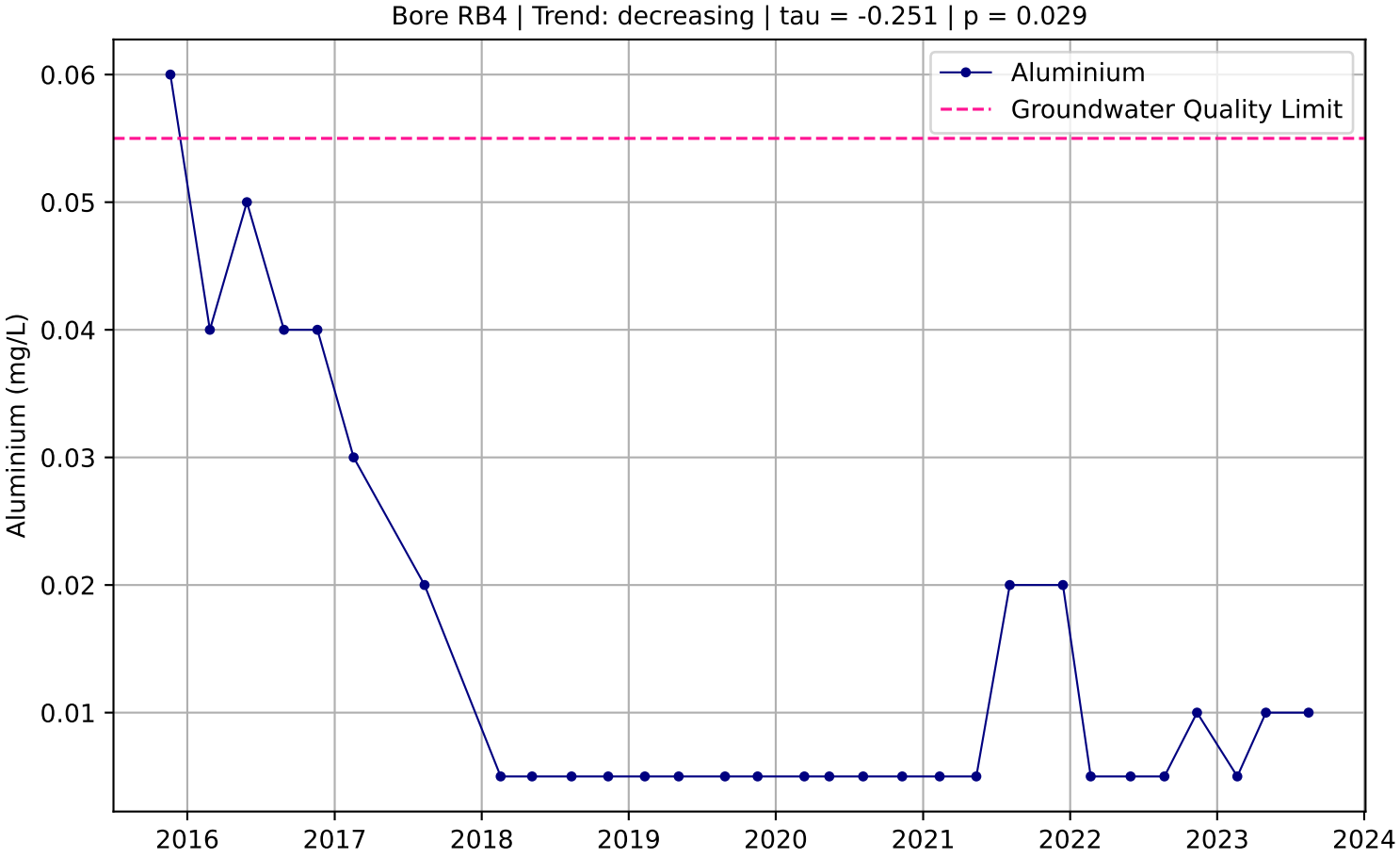

Bore RB3 | Trend: increasing | tau = 0.598 | p = 0.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

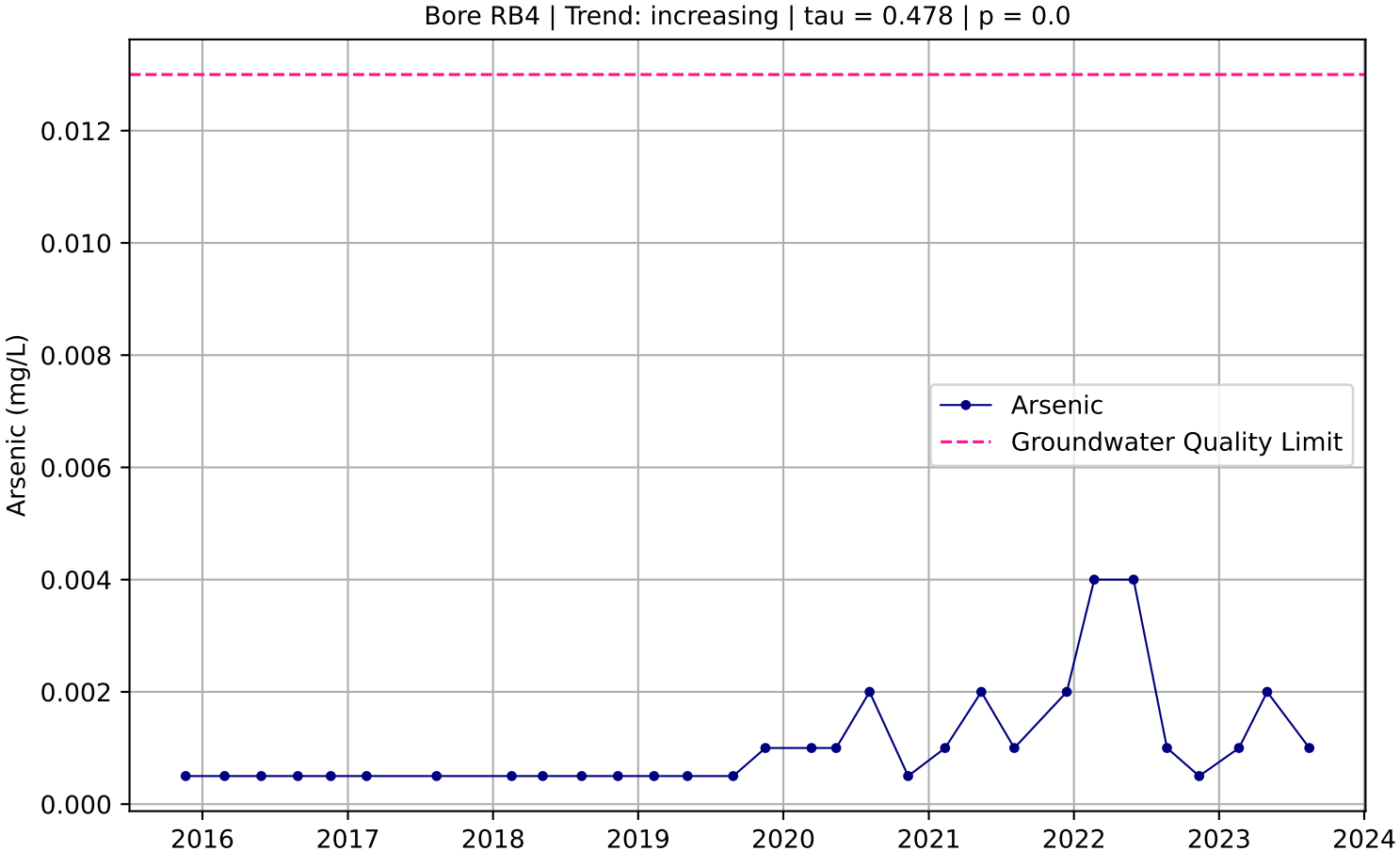

Bore RB3 | Trend: increasing | tau = 0.363 | p = 0.003
Potassium
Potassium (mg/L)
20
18
16
14
12
10
8
6
2016
2017
2018
2019
2020
2021
2022
2023
2024

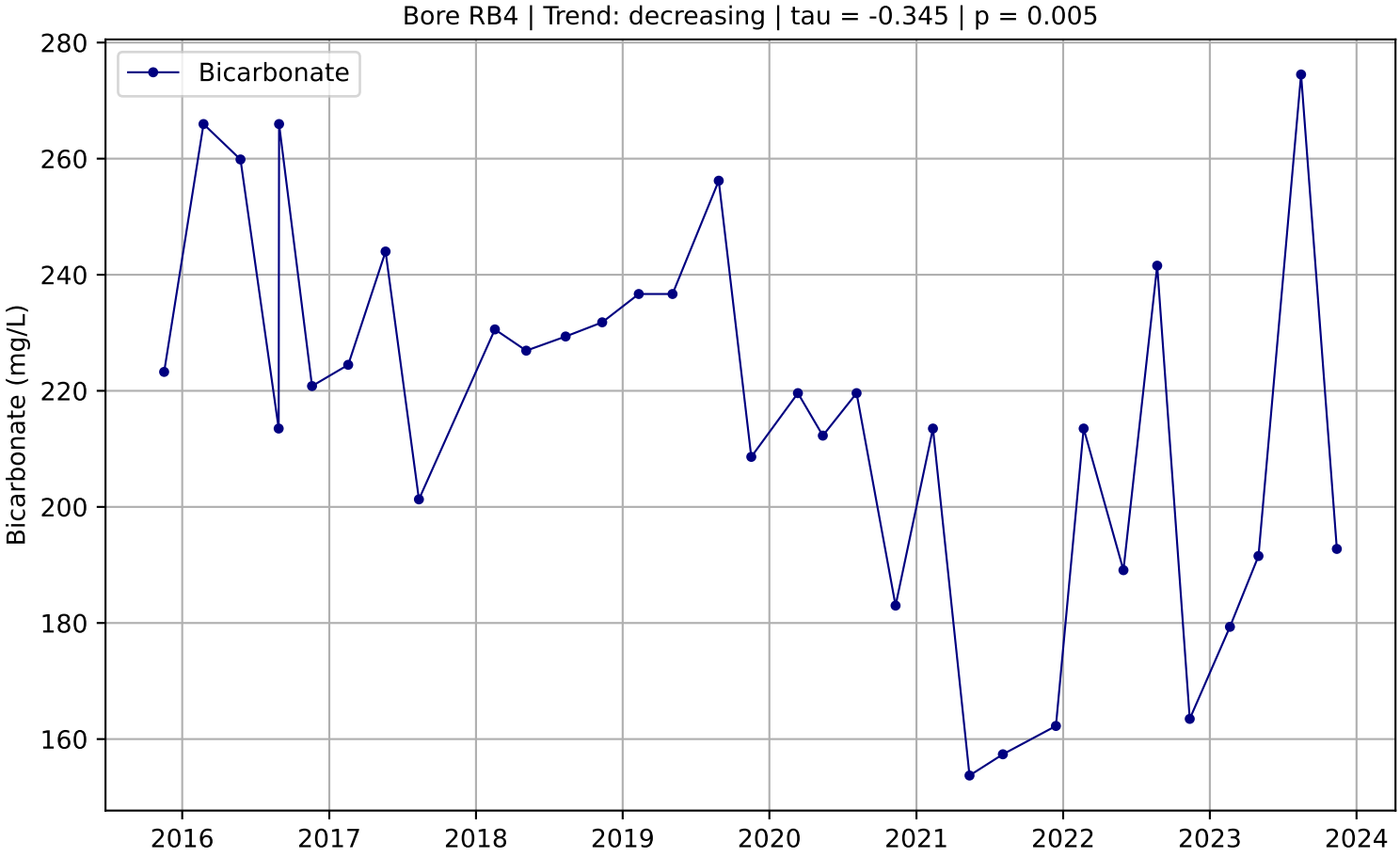

Bore RB3 | Trend: no trend | tau = -0.052 | p = 0.609
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
Selenium
Groundwater Quality Limit
2016
2017
2018
2019
2020
2021
2022
2023
2024

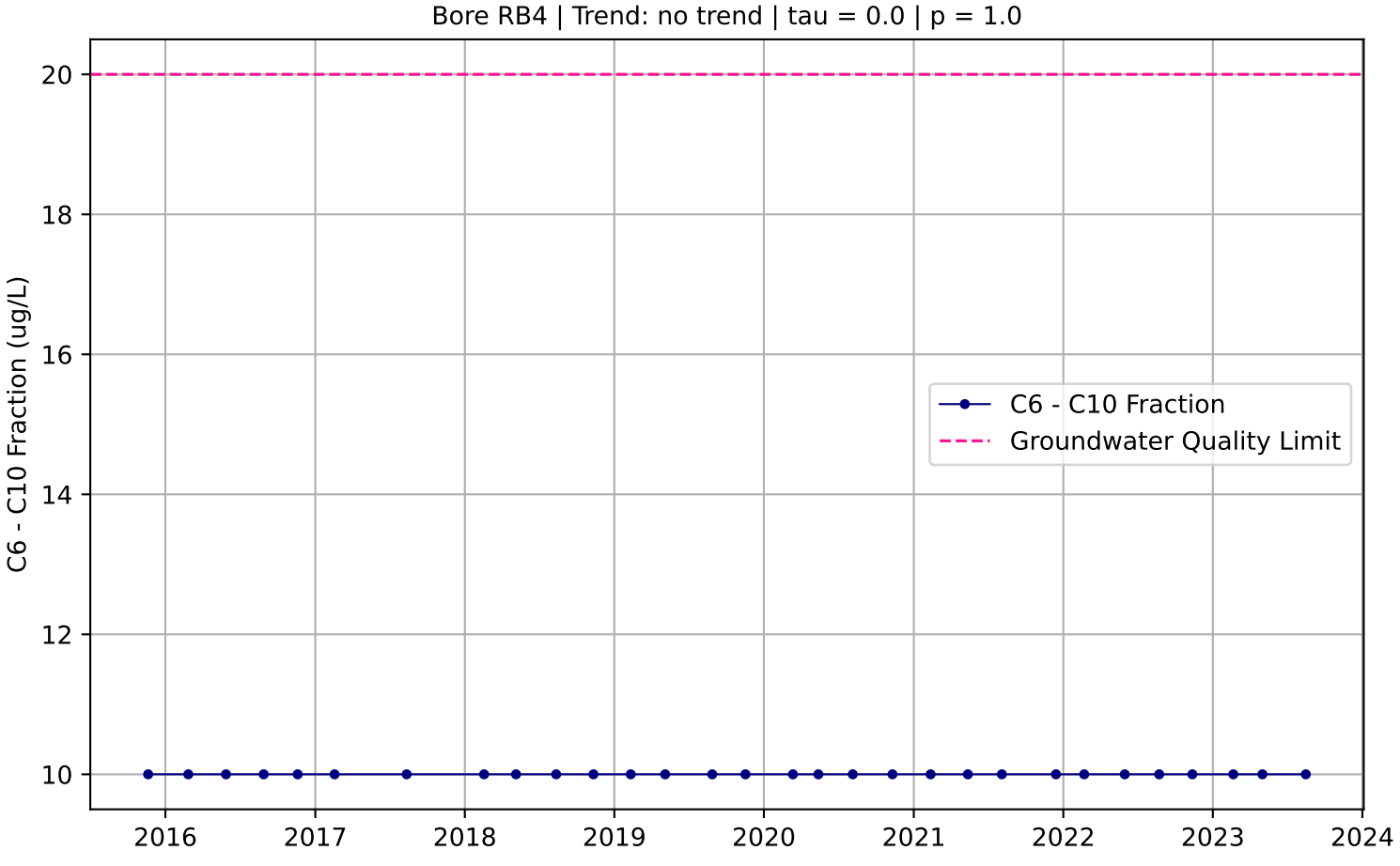

Bore RB3 | Trend: no trend | tau = 0.018 | p = 0.921
Sodium
Sodium (mg/L)
2100
2050
2000
1950
1900
2018
2019
2020
2021
2022
2023
2024

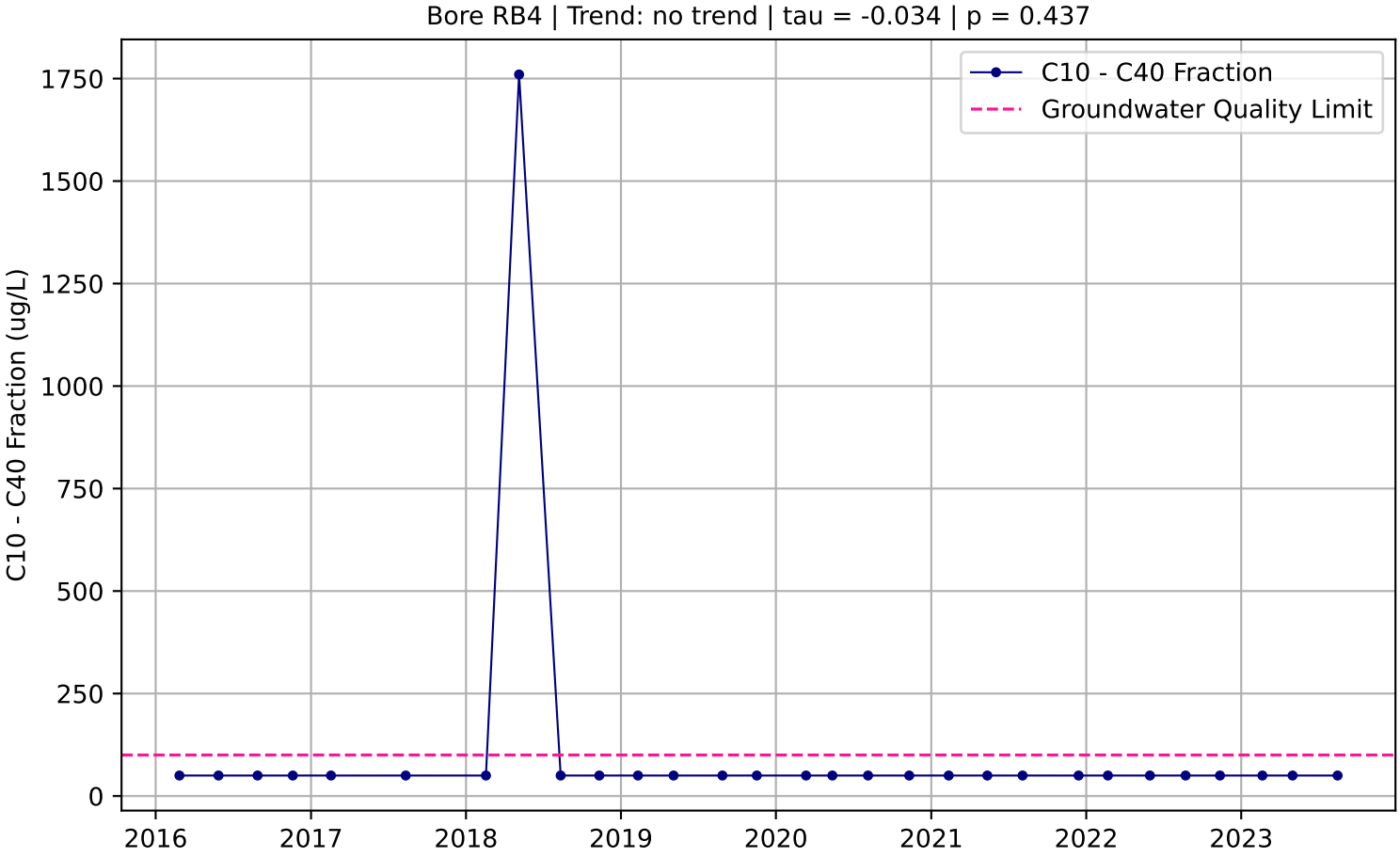

Bore RB3 | Trend: decreasing | tau = -0.49 | p = 0.004
Sulfate as SO4 - Turbidimetric (mg/L)
0
5
10
15
20
25
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

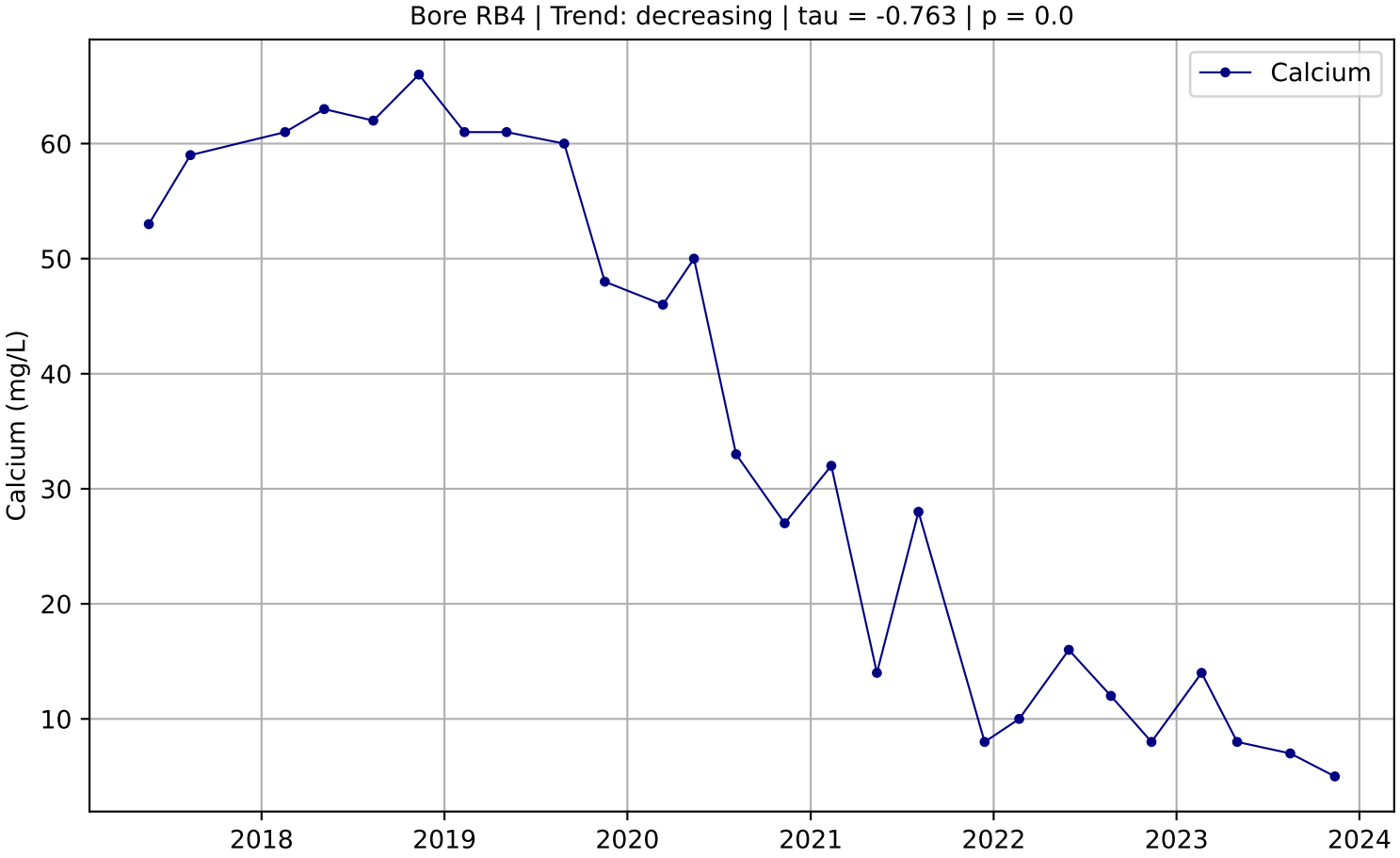

Bore RB4 | Trend: decreasing | tau = -0.251 | p = 0.029
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.06
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024

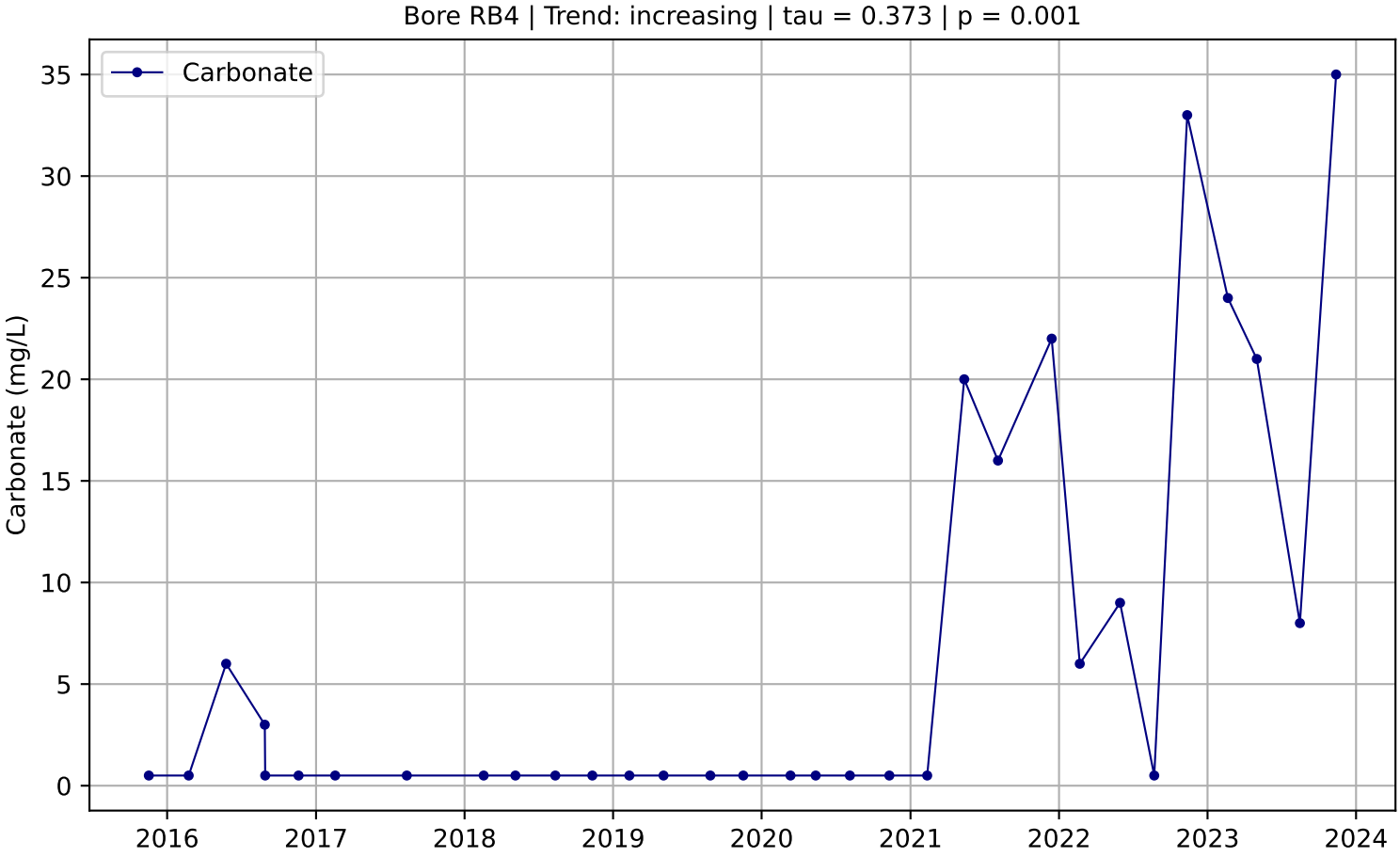

Bore RB4 | Trend: increasing | tau = 0.478 | p = 0.0
Arsenic (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

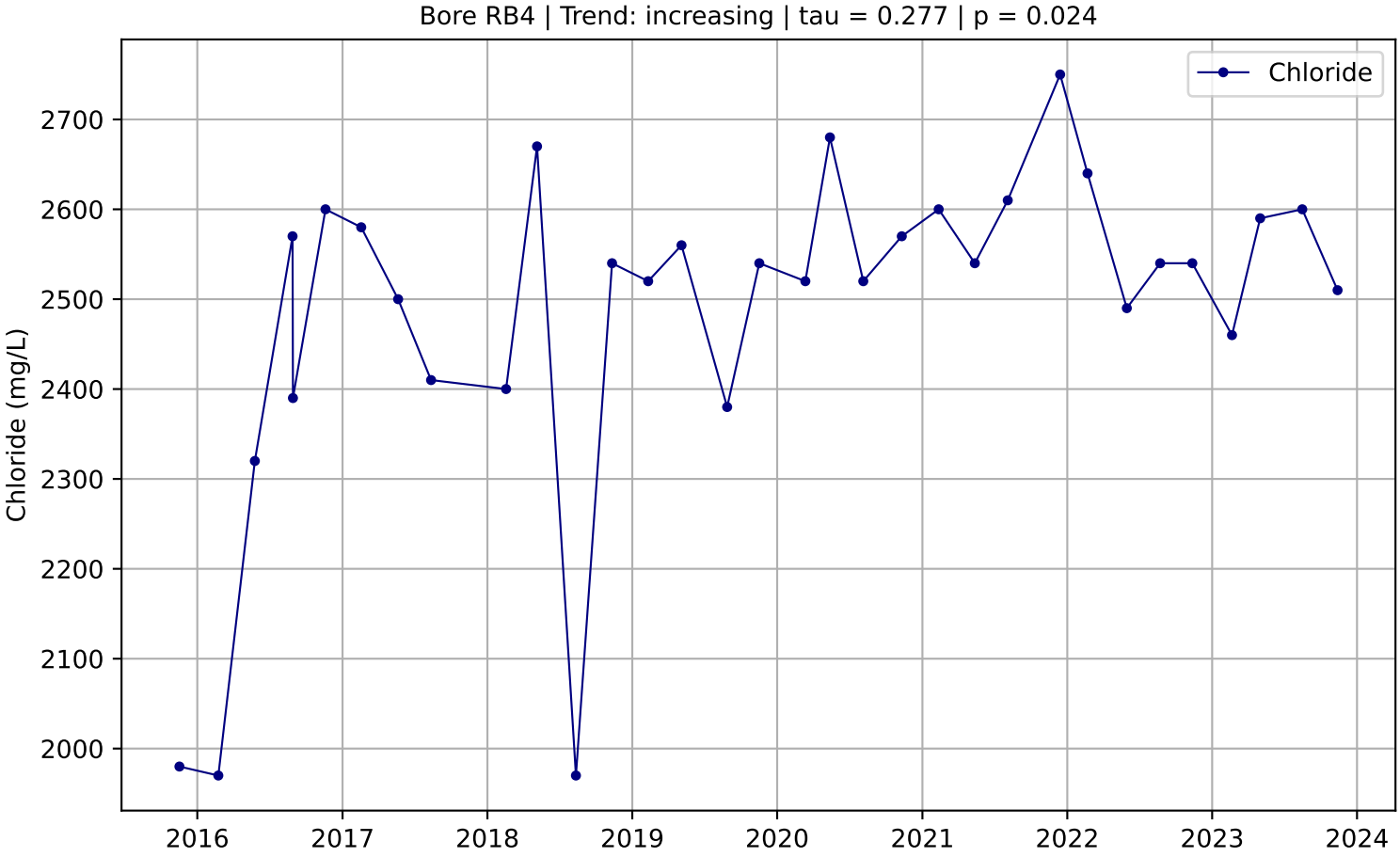

Bore RB4 | Trend: decreasing | tau = -0.345 | p = 0.005
Bicarbonate
Bicarbonate (mg/L)
280
260
240
220
200
180
160
2016
2017
2018
2019
2020
2021
2022
2023
2024

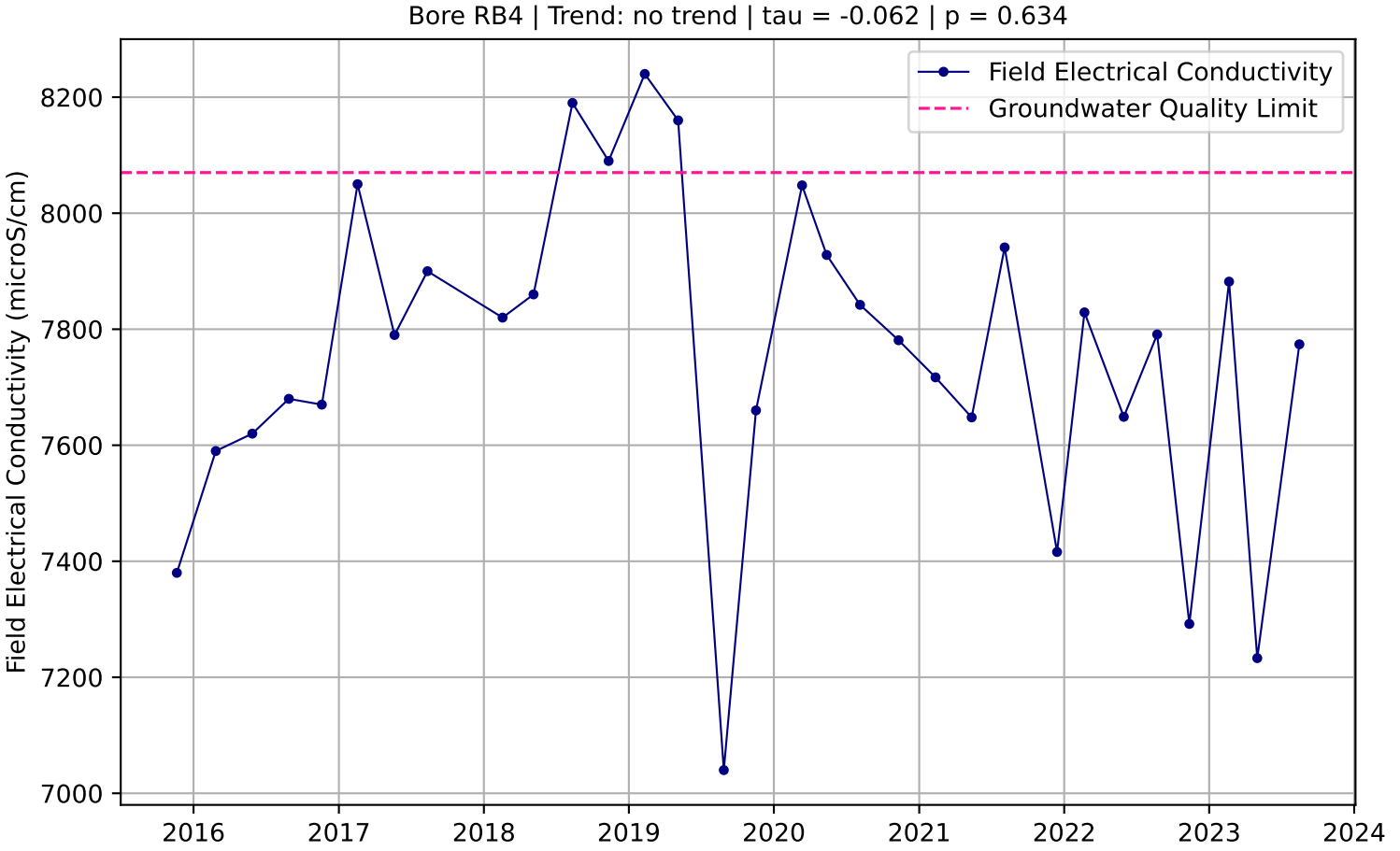

Bore RB4 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

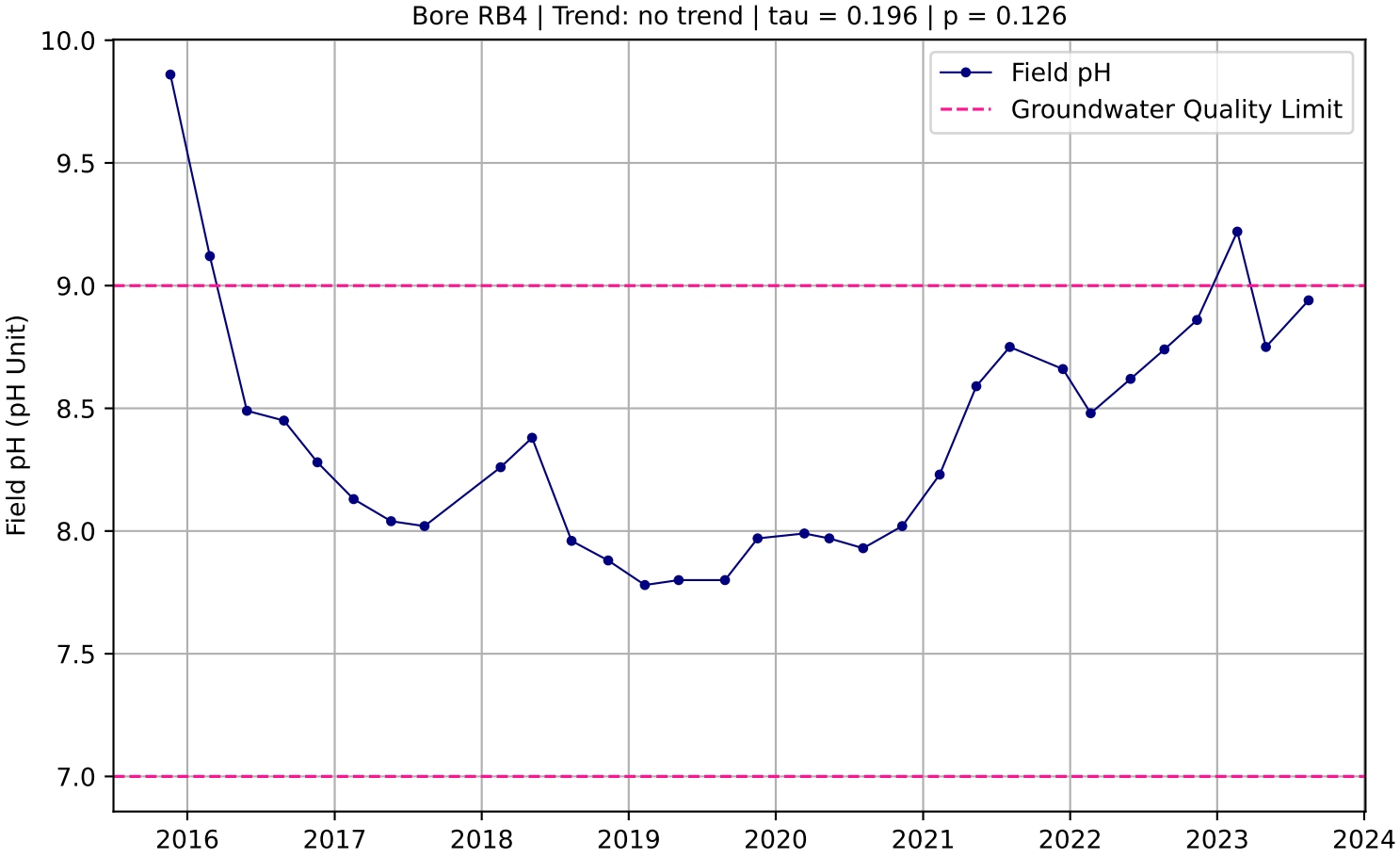

Bore RB4 | Trend: no trend | tau = -0.034 | p = 0.437
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
1750
1500
1250
1000
750
500
250
0
2016
2017
2018
2019
2020
2021
2022
2023

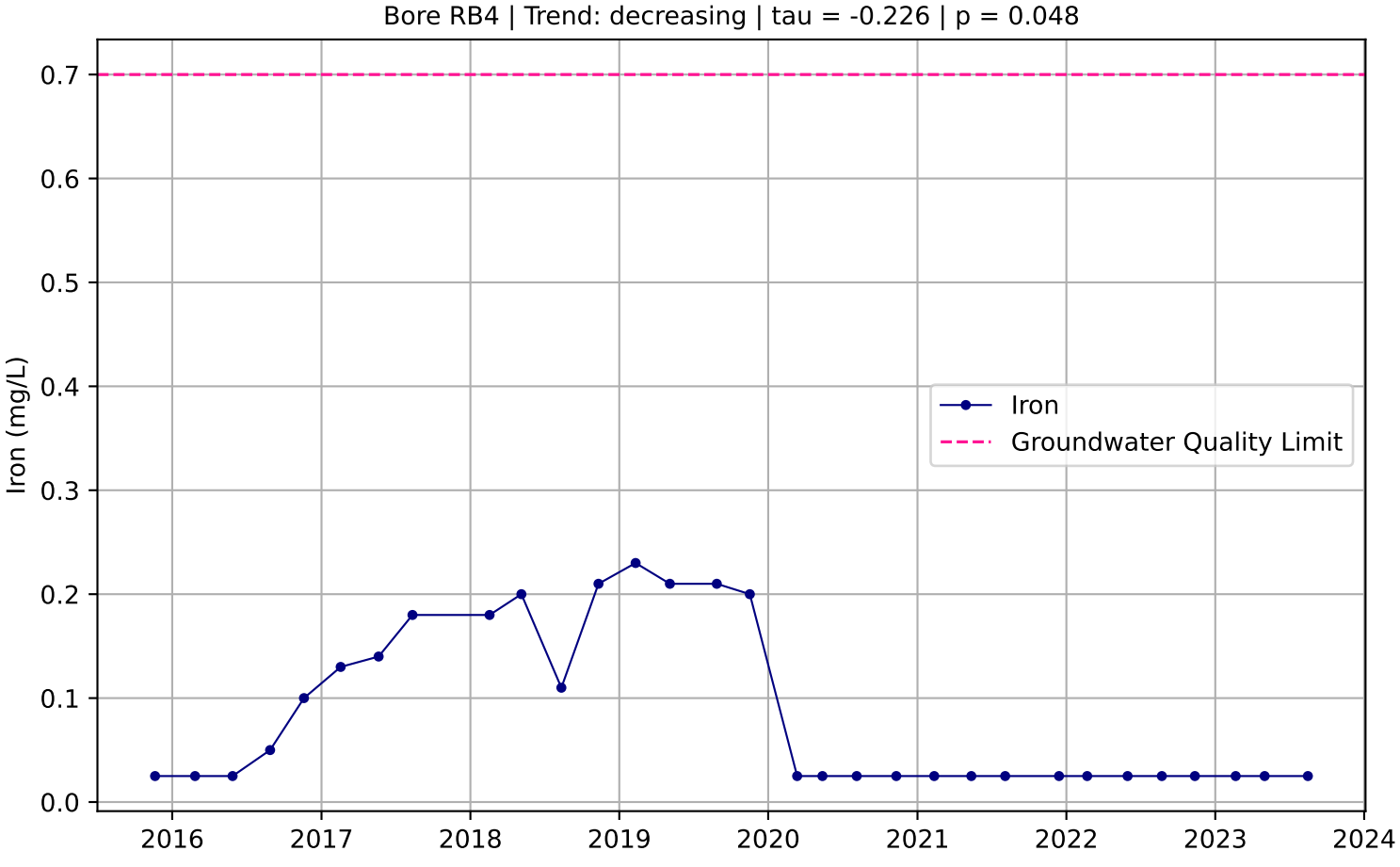

Bore RB4 | Trend: decreasing | tau = -0.763 | p = 0.0
Calcium
Calcium (mg/L)
60
50
40
30
20
10
2018
2019
2020
2021
2022
2023
2024

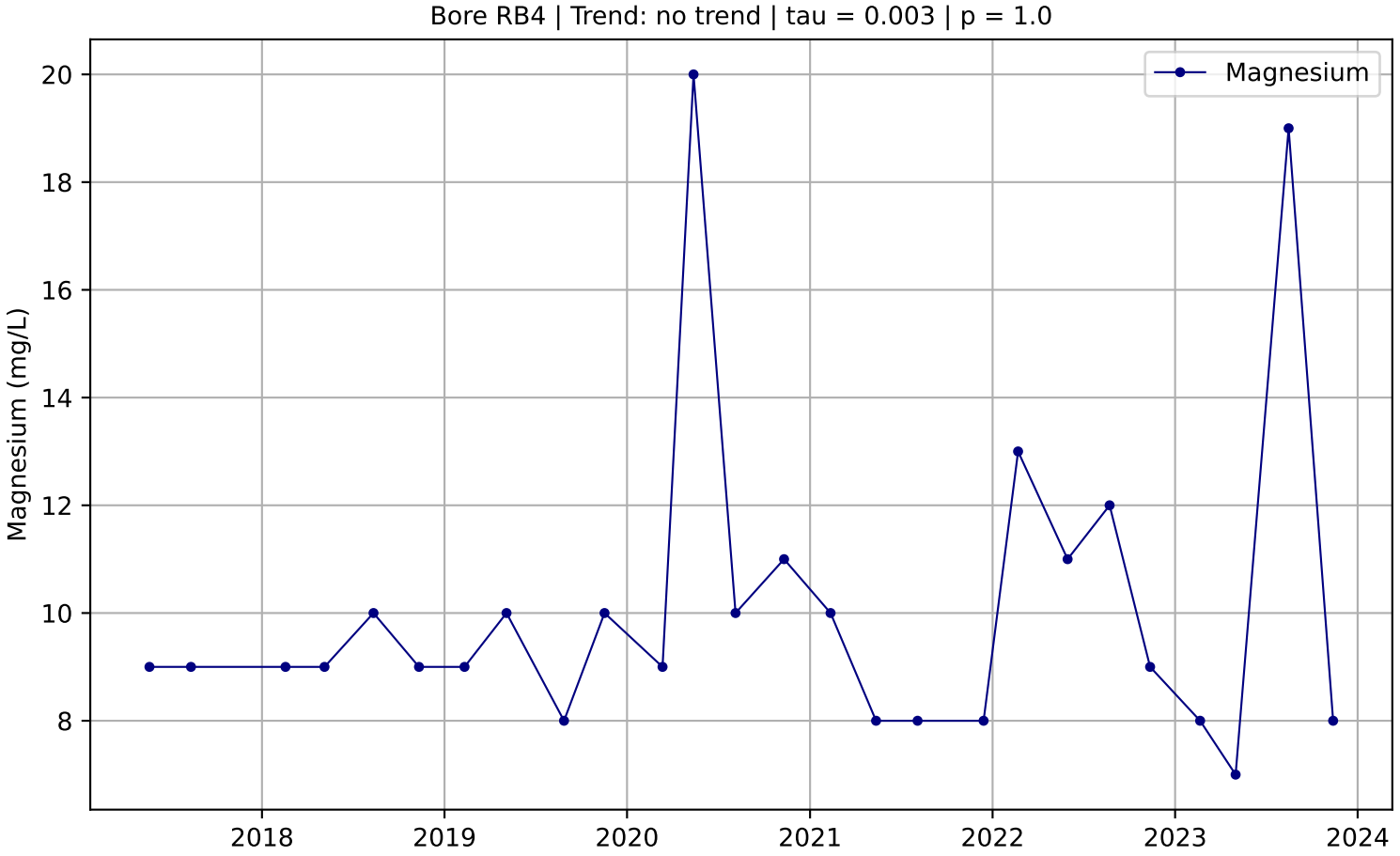

Bore RB4 | Trend: increasing | tau = 0.373 | p = 0.001
Carbonate
Carbonate (mg/L)
0
5
10
15
20
25
30
35
2016
2017
2018
2019
2020
2021
2022
2023
2024

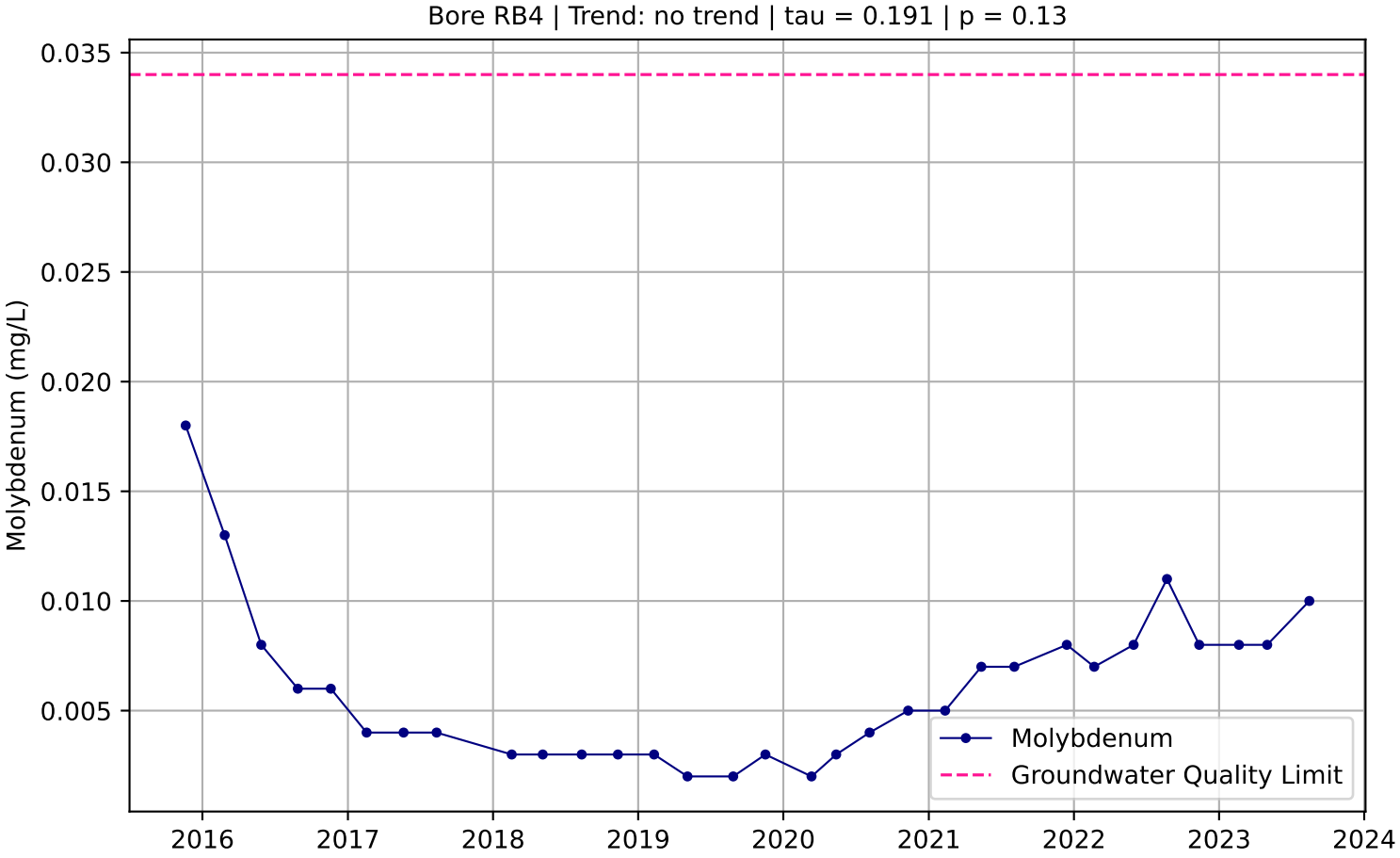

Bore RB4 | Trend: increasing | tau = 0.277 | p = 0.024
Chloride
Chloride (mg/L)
2700
2600
2500
2400
2300
2200
2100
2000
2016
2017
2018
2019
2020
2021
2022
2023
2024

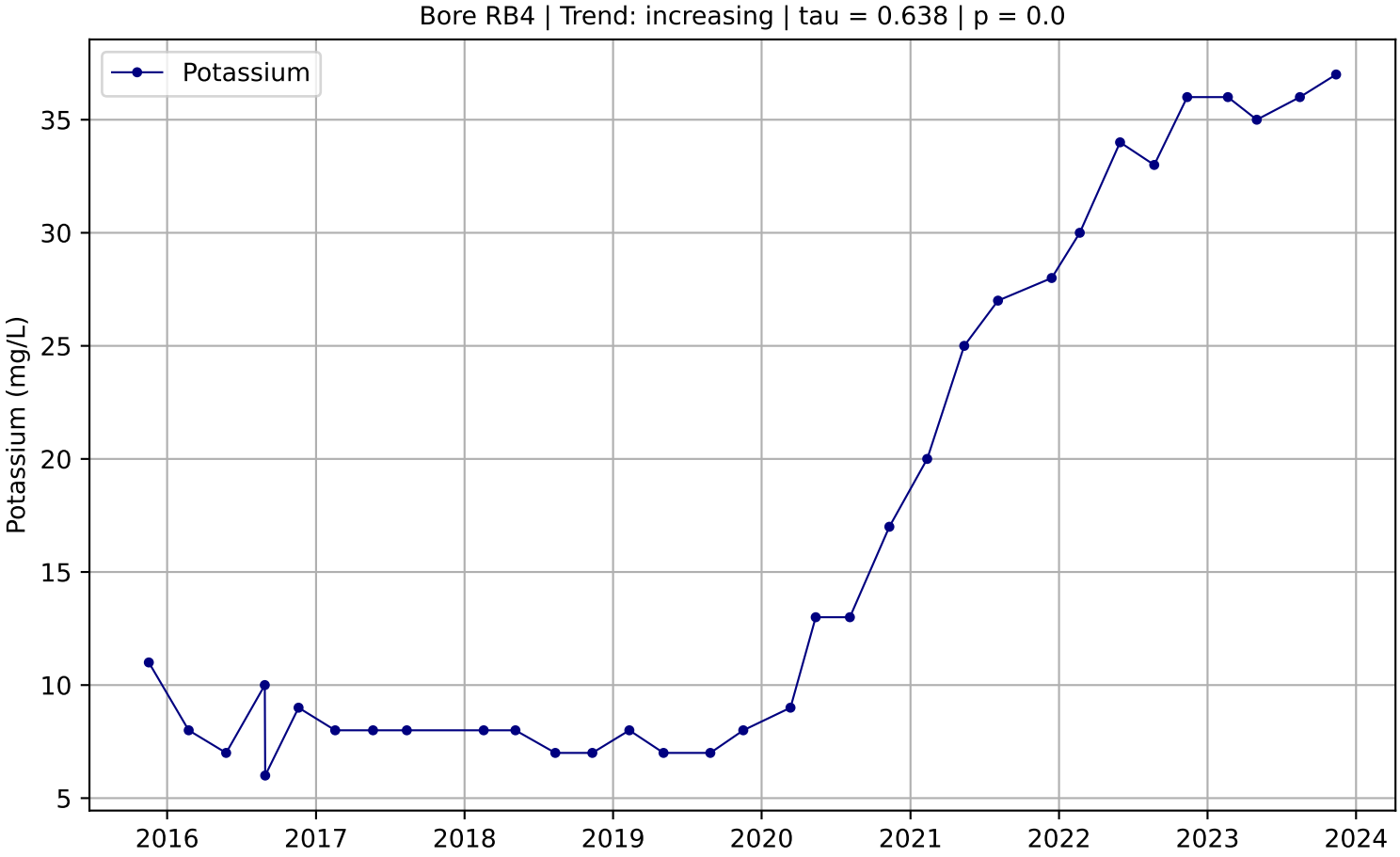

Bore RB4 | Trend: no trend | tau = -0.062 | p = 0.634
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
8200
8000
7800
7600
7400
7200
7000
2016
2017
2018
2019
2020
2021
2022
2023
2024

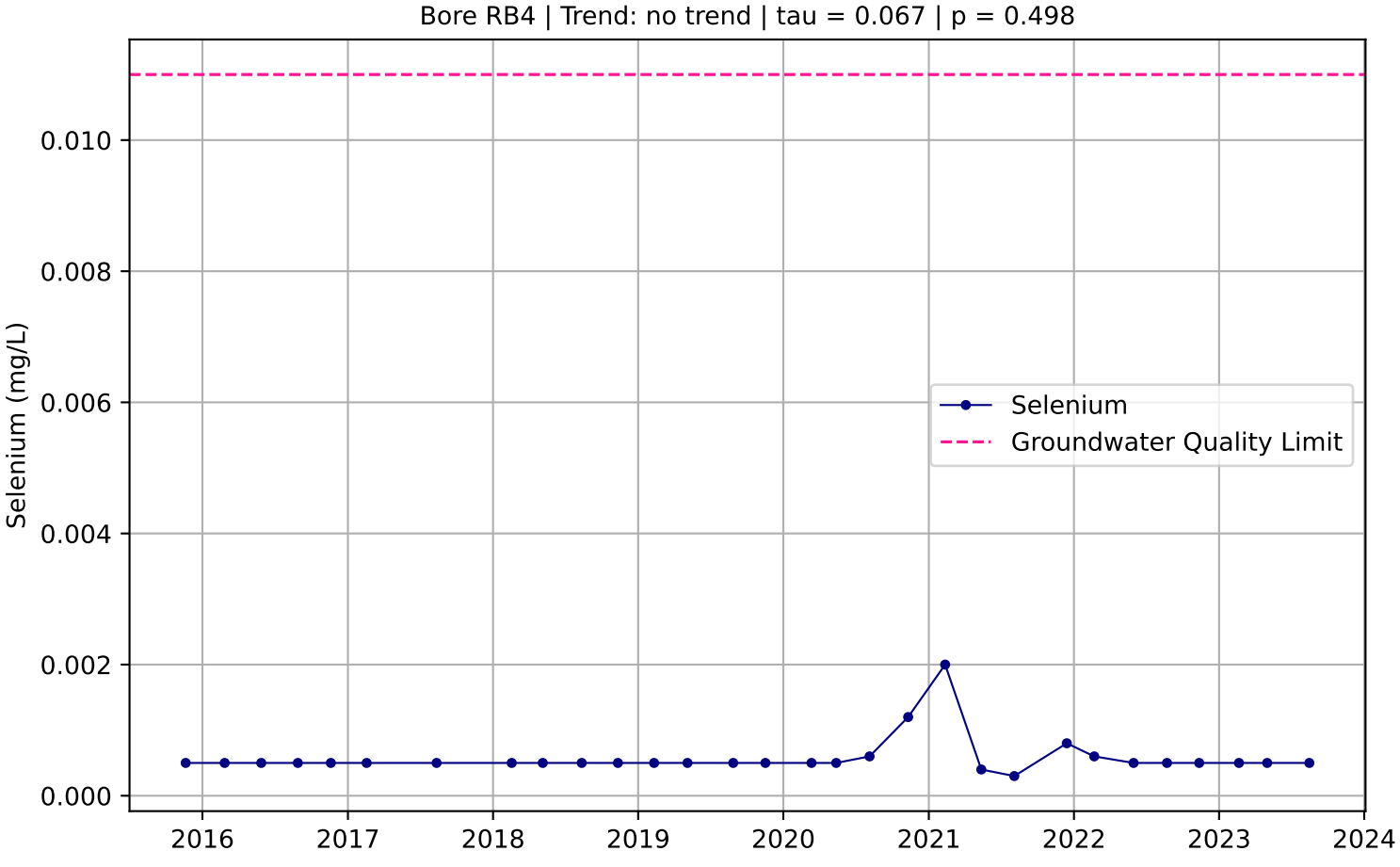

Bore RB4 | Trend: no trend | tau = 0.196 | p = 0.126
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

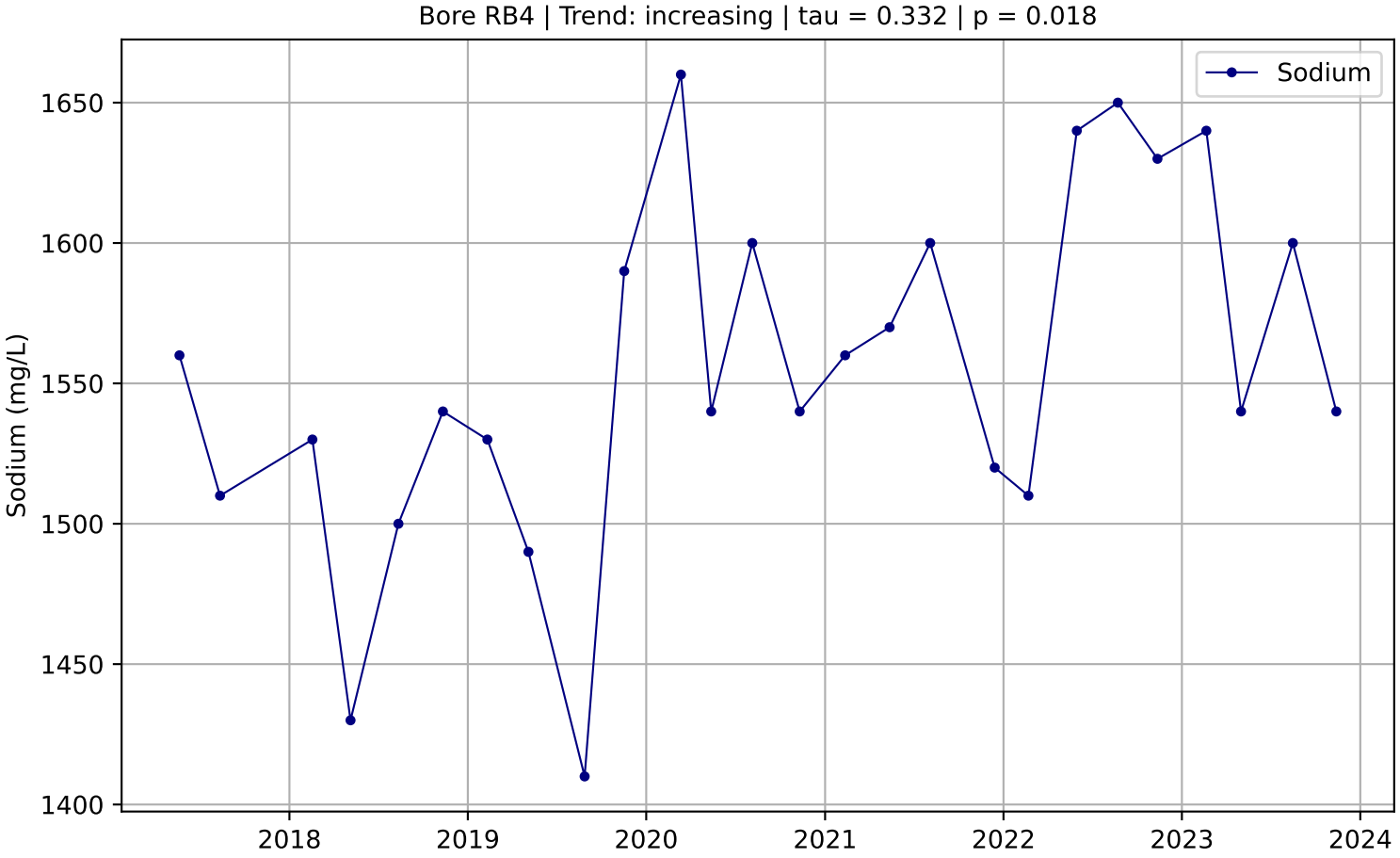

Bore RB4 | Trend: decreasing | tau = -0.226 | p = 0.048
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2016
2017
2018
2019
2020
2021
2022
2023
2024
Iron
Groundwater Quality Limit

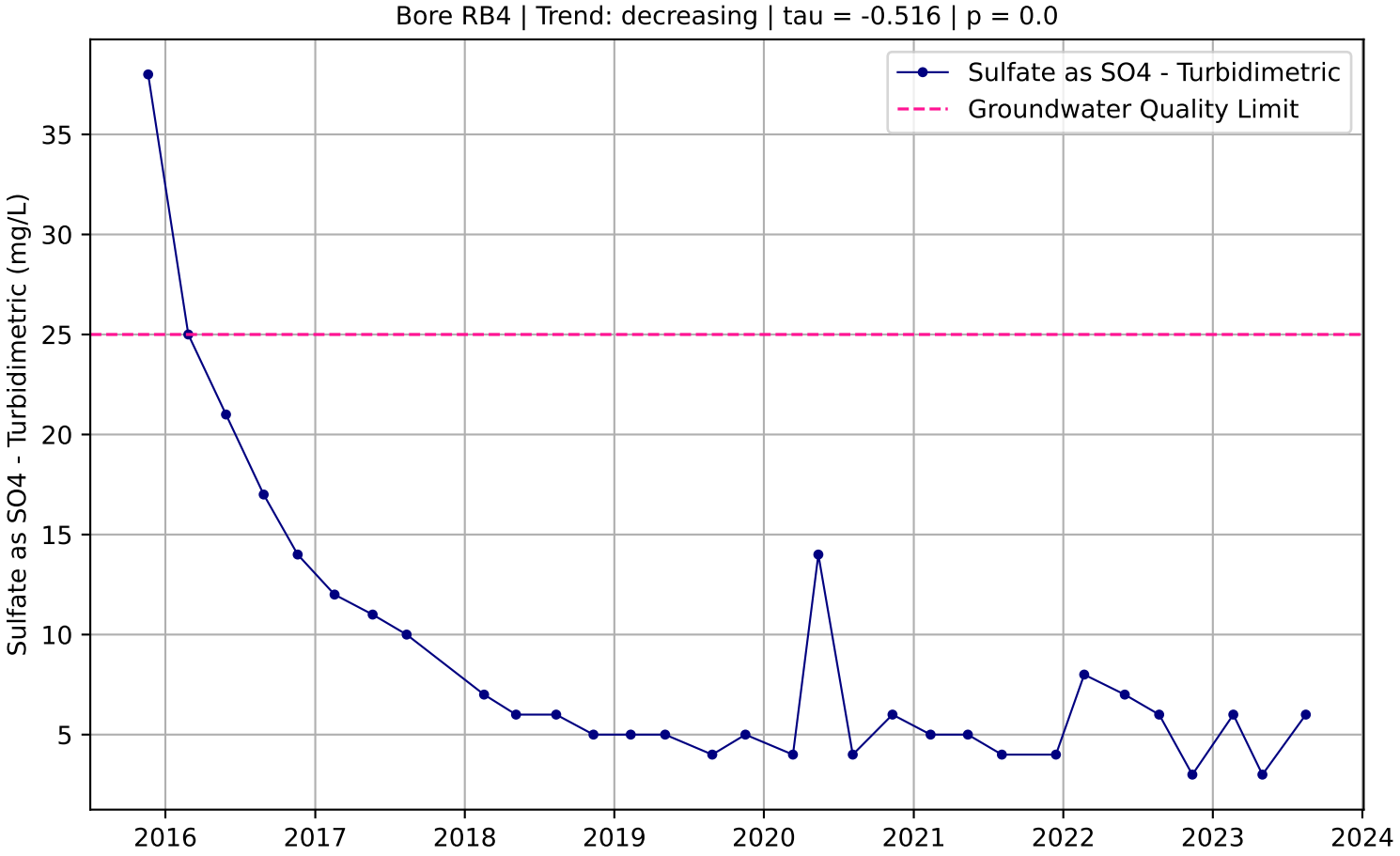

Bore RB4 | Trend: no trend | tau = 0.003 | p = 1.0
Magnesium
Magnesium (mg/L)
20
18
16
14
12
10
8
2018
2019
2020
2021
2022
2023
2024

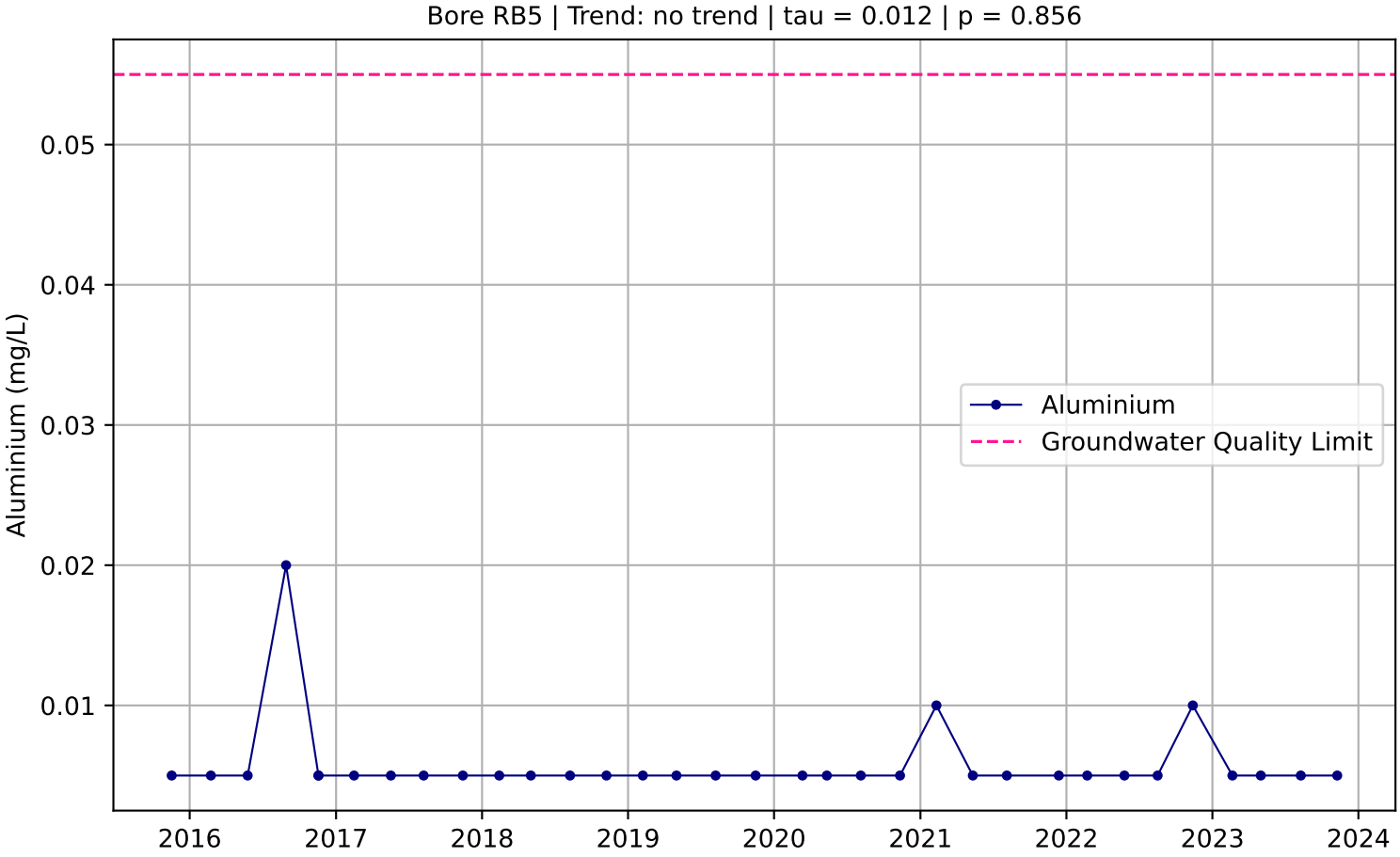

Bore RB4 | Trend: no trend | tau = 0.191 | p = 0.13
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

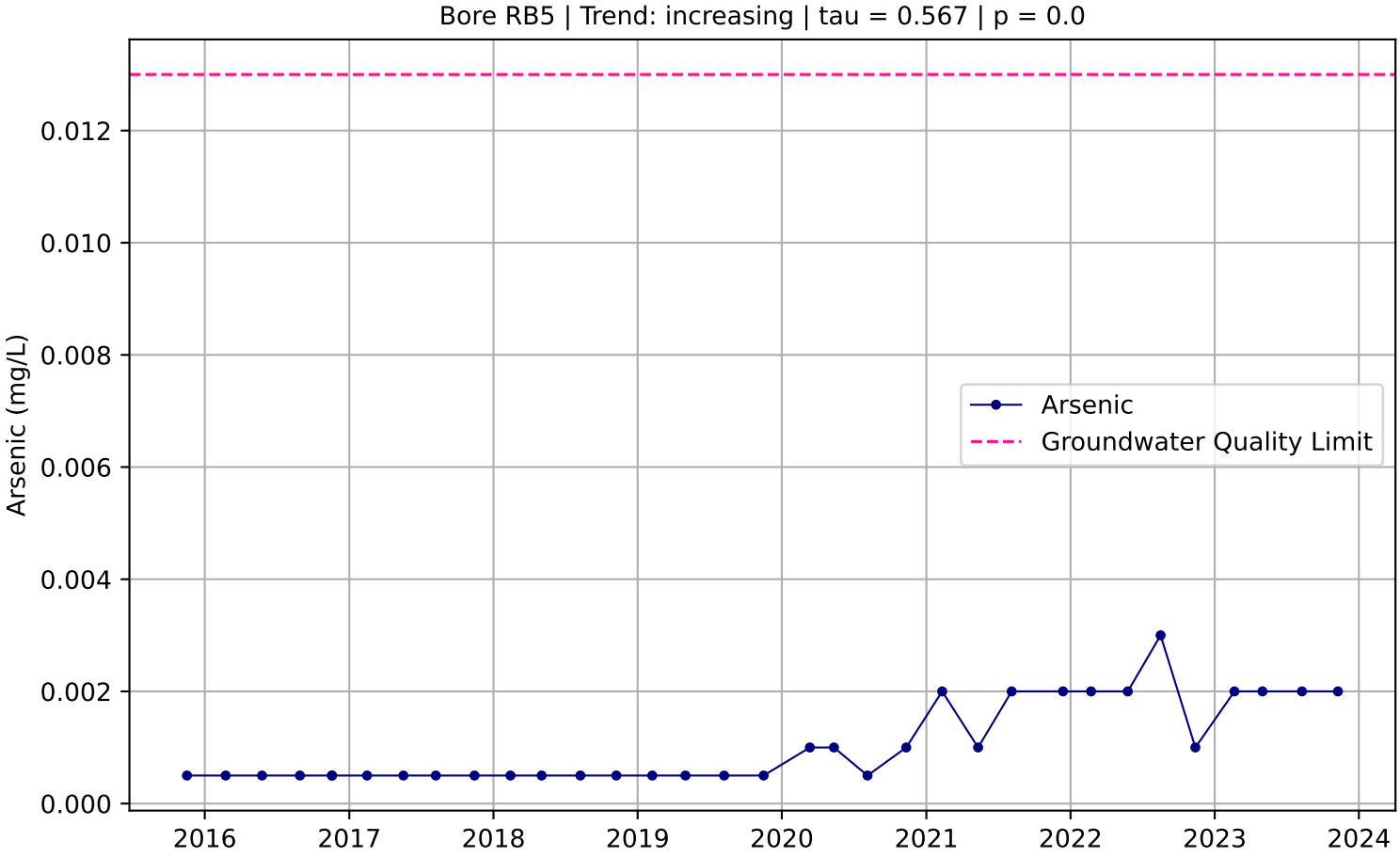

Bore RB4 | Trend: increasing | tau = 0.638 | p = 0.0
Potassium
Potassium (mg/L)
5
10
15
20
25
30
35
2016
2017
2018
2019
2020
2021
2022
2023
2024

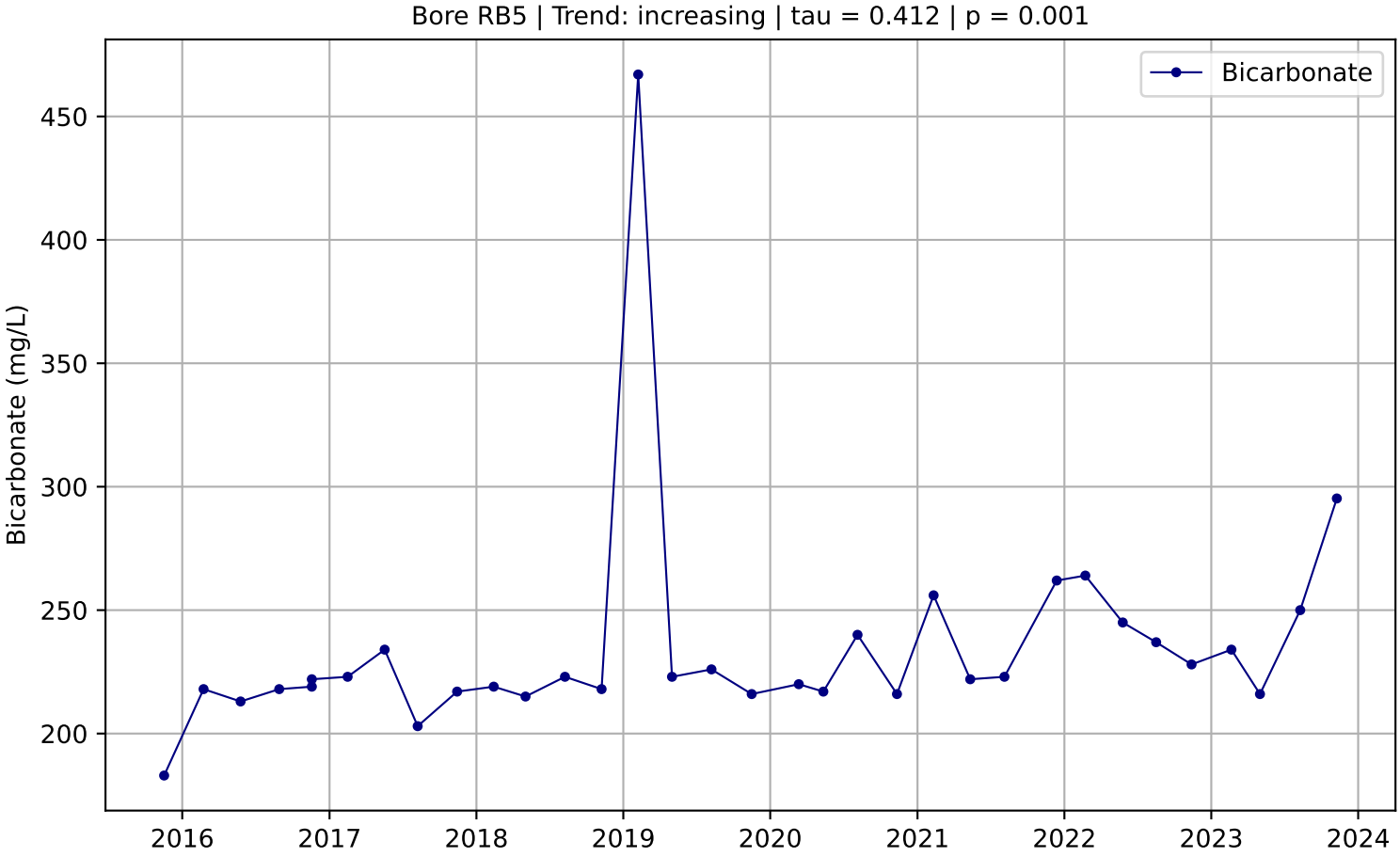

Bore RB4 | Trend: no trend | tau = 0.067 | p = 0.498
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Selenium
Groundwater Quality Limit

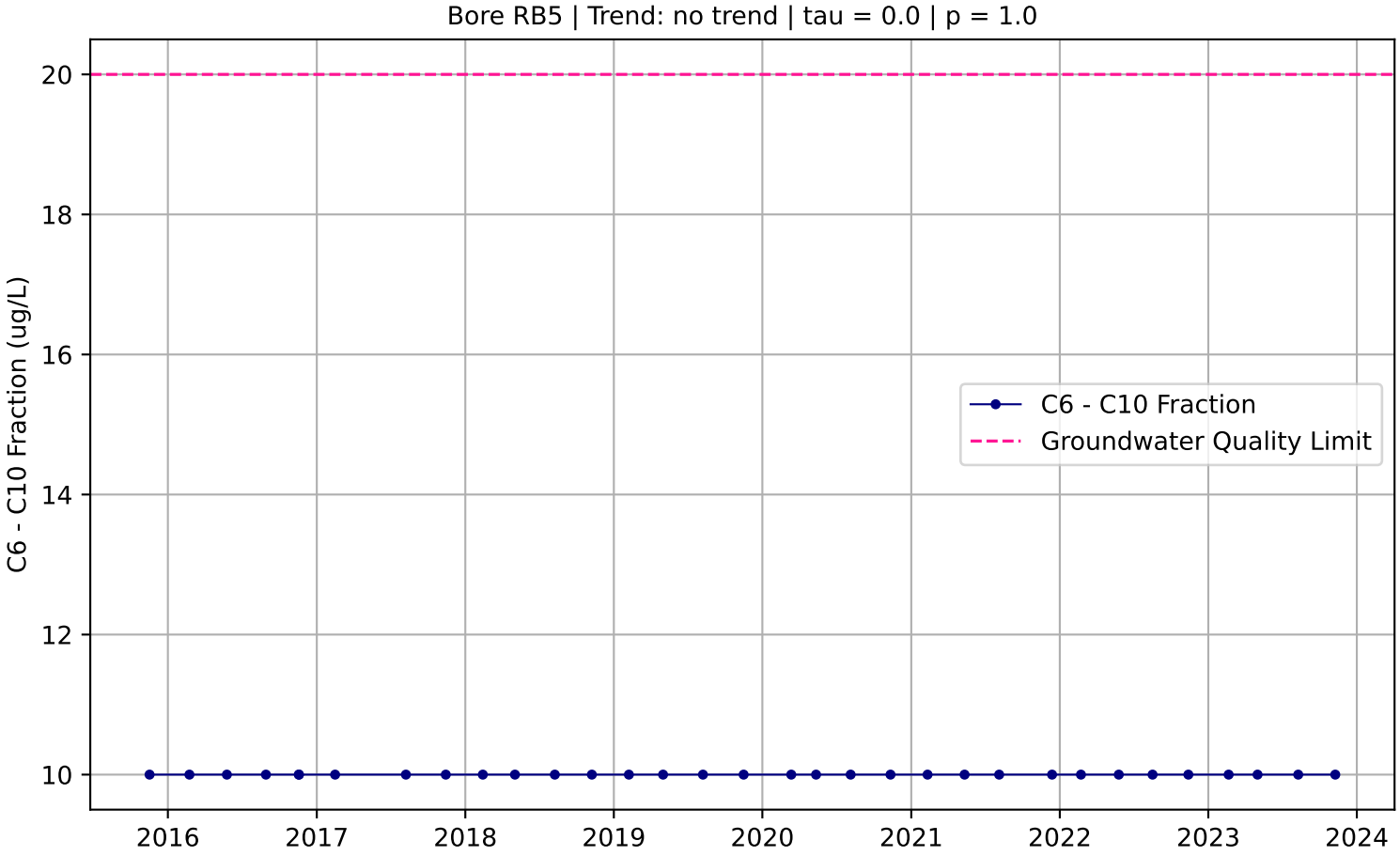

Bore RB4 | Trend: increasing | tau = 0.332 | p = 0.018
Sodium
Sodium (mg/L)
1650
1600
1550
1500
1450
1400
2018
2019
2020
2021
2022
2023
2024

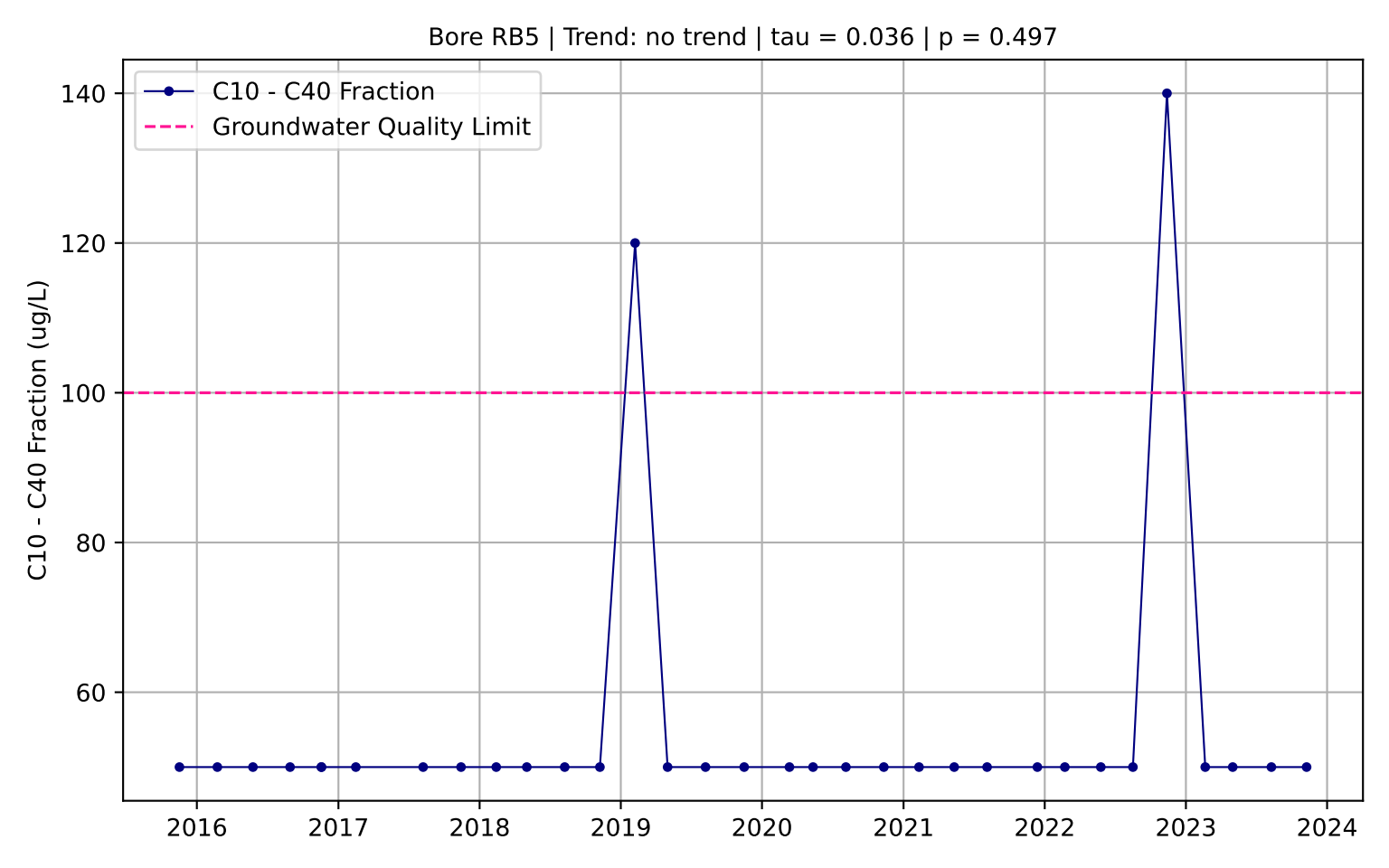

Bore RB4 | Trend: decreasing | tau = -0.516 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
35
30
25
20
15
10
5
2016
2017
2018
2019
2020
2021
2022
2023
2024

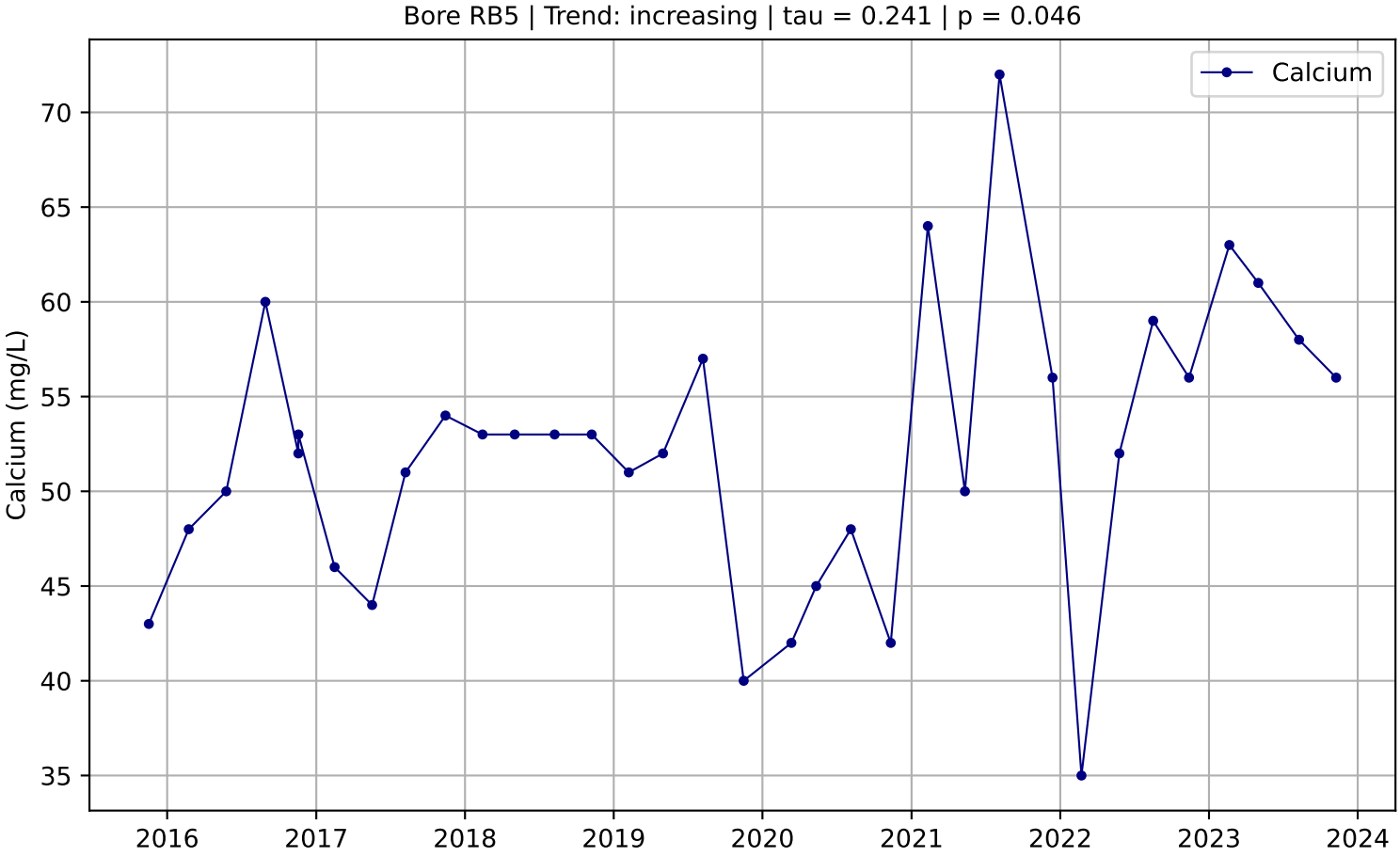

Bore RB5 | Trend: no trend | tau = 0.012 | p = 0.856
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

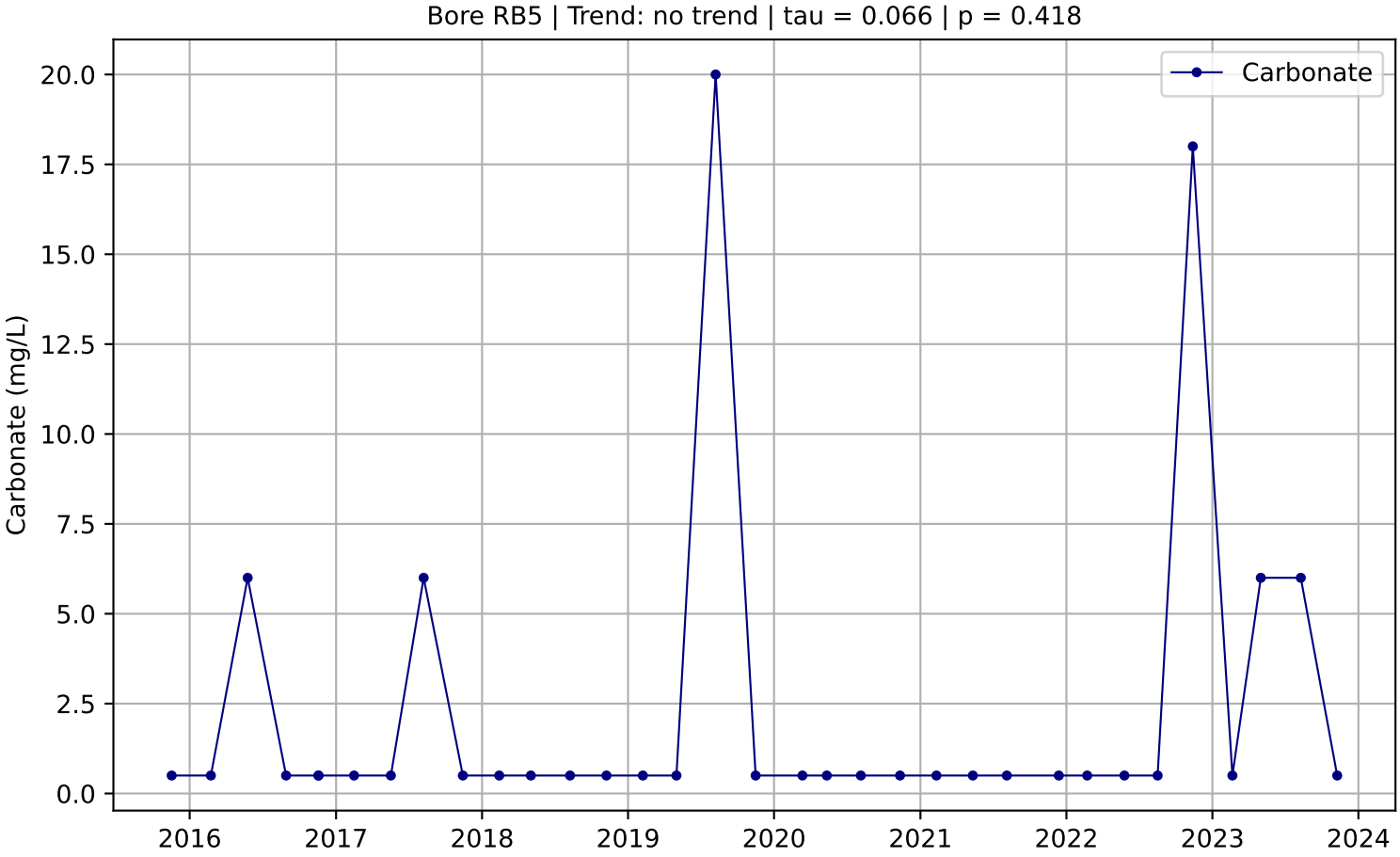

Bore RB5 | Trend: increasing | tau = 0.567 | p = 0.0
Arsenic (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

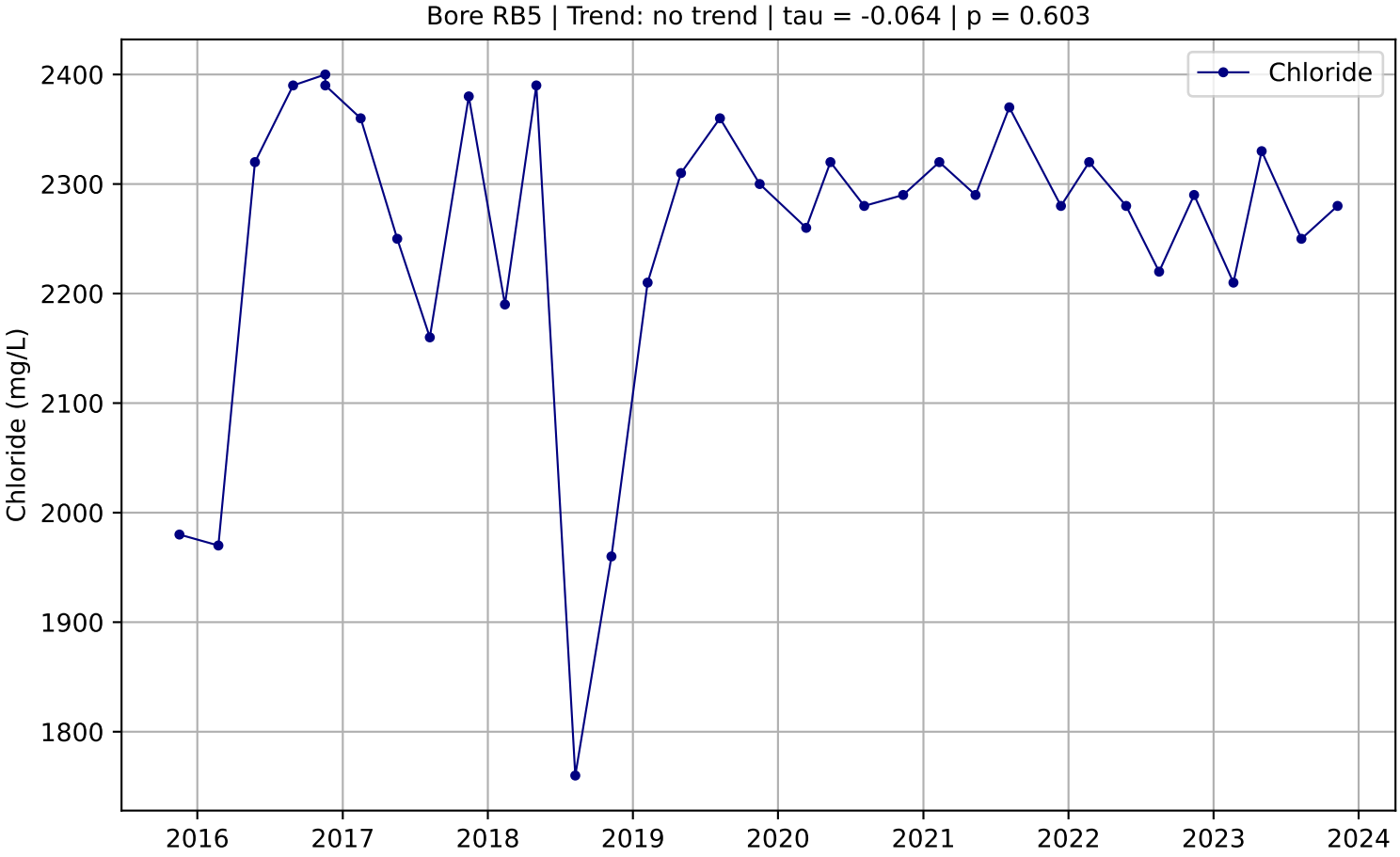

Bore RB5 | Trend: increasing | tau = 0.412 | p = 0.001
Bicarbonate
Bicarbonate (mg/L)
450
400
350
300
250
200
2016
2017
2018
2019
2020
2021
2022
2023
2024

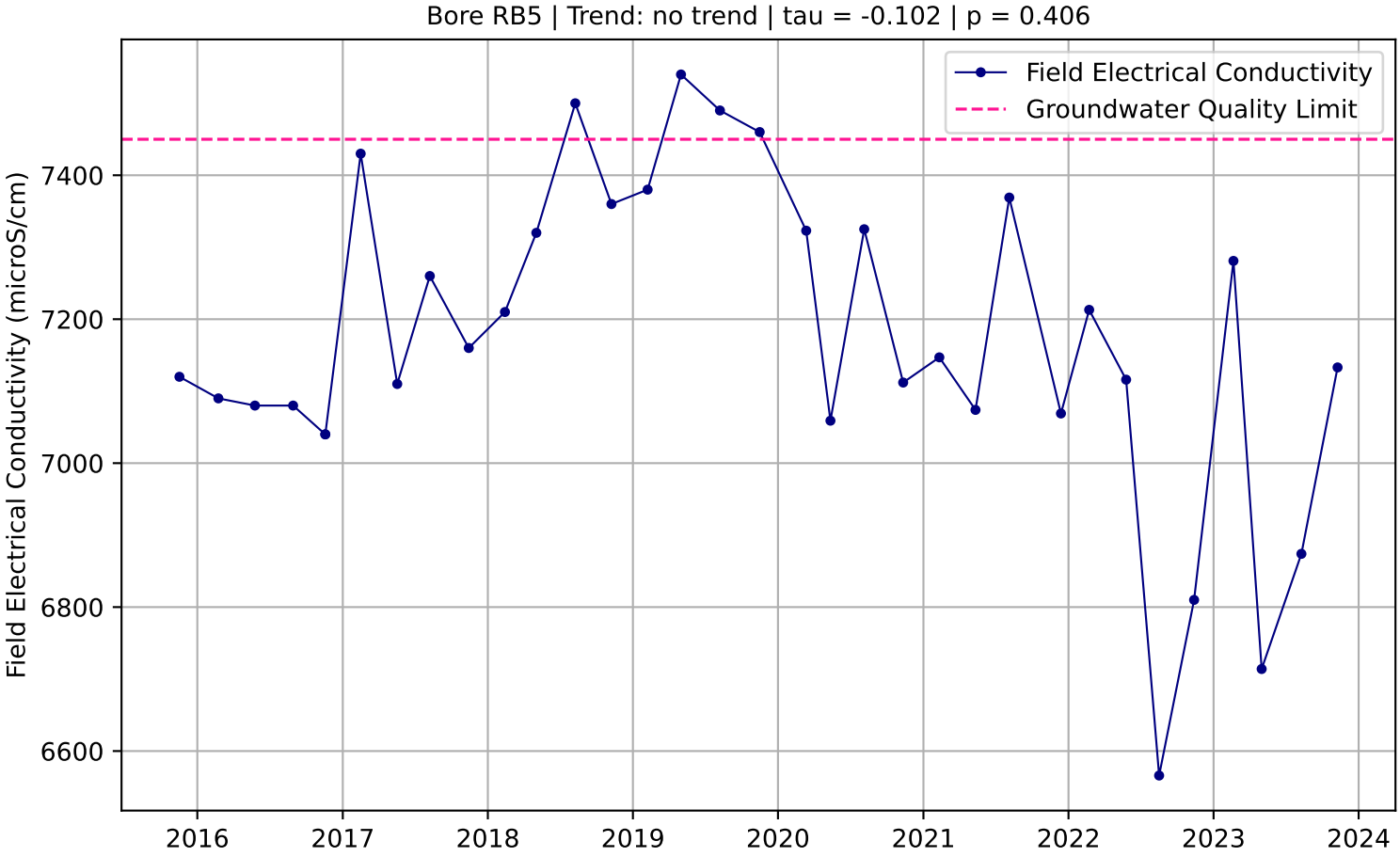

Bore RB5 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

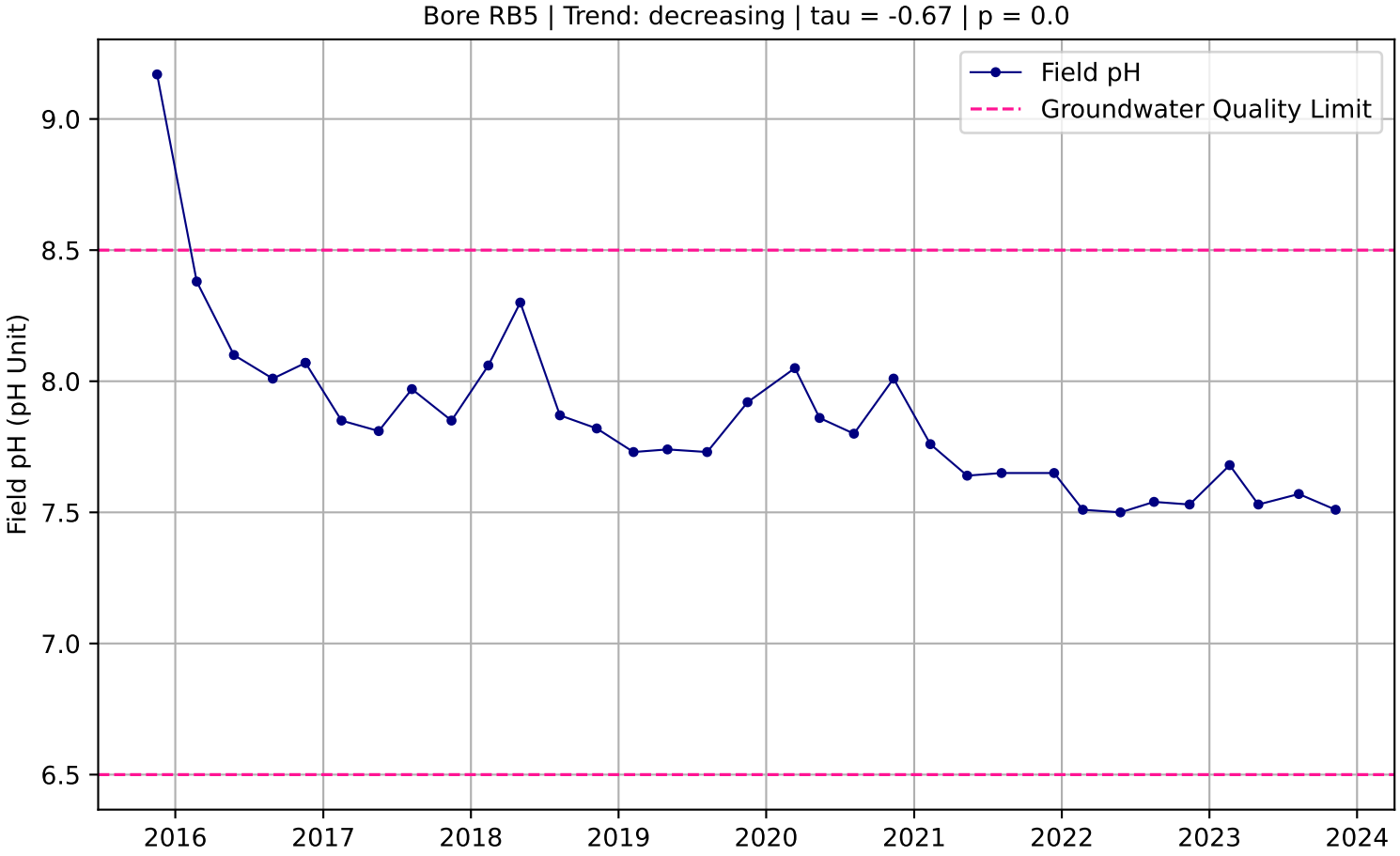

Bore RB5 | Trend: no trend | tau = 0.036 | p = 0.497
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
140
120
100
80
60
2016
2017
2018
2019
2020
2021
2022
2023
2024

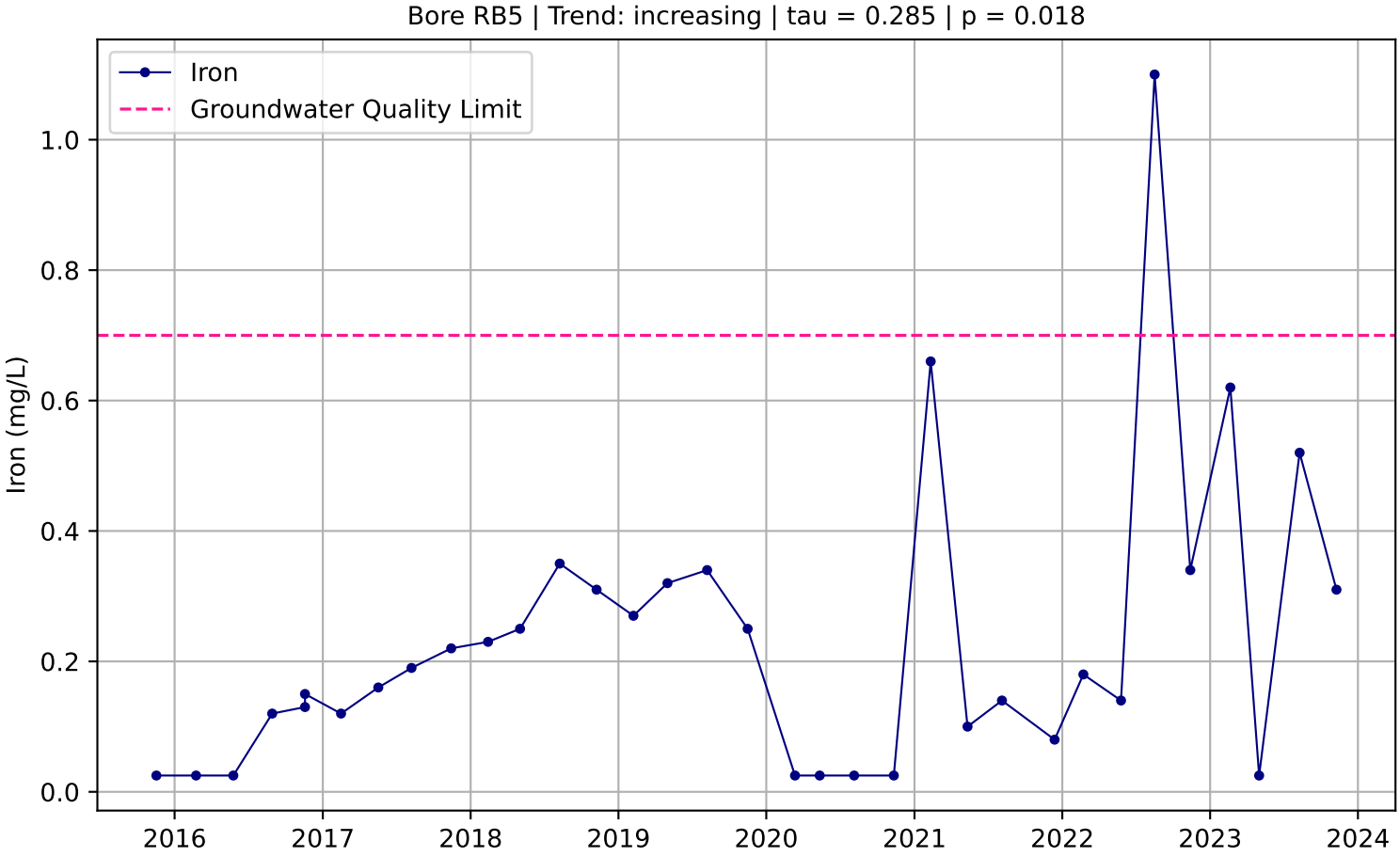

Bore RB5 | Trend: increasing | tau = 0.241 | p = 0.046
Calcium
Calcium (mg/L)
70
65
60
55
50
45
40
35
2016
2017
2018
2019
2020
2021
2022
2023
2024

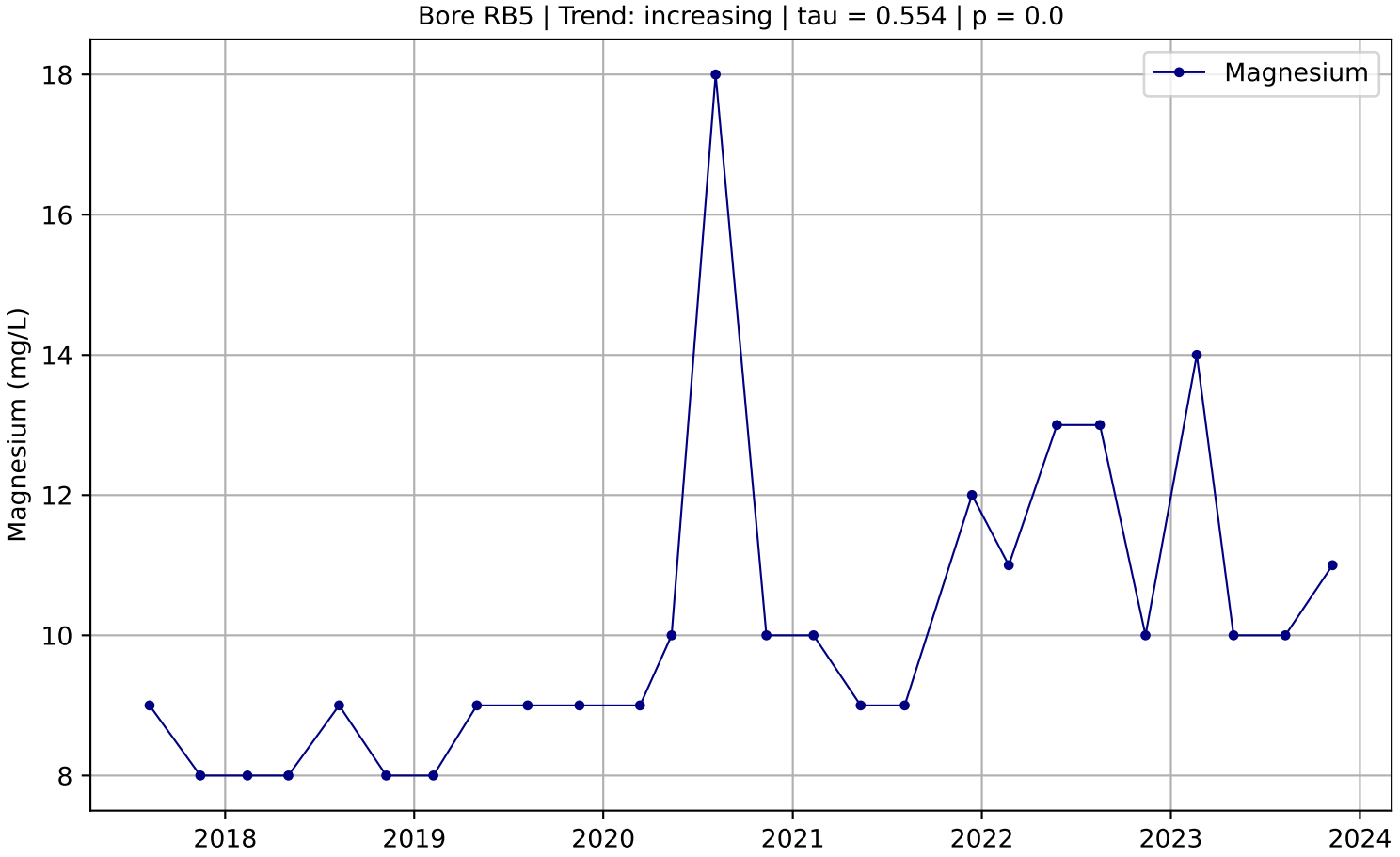

Bore RB5 | Trend: no trend | tau = 0.066 | p = 0.418
Carbonate
Carbonate (mg/L)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

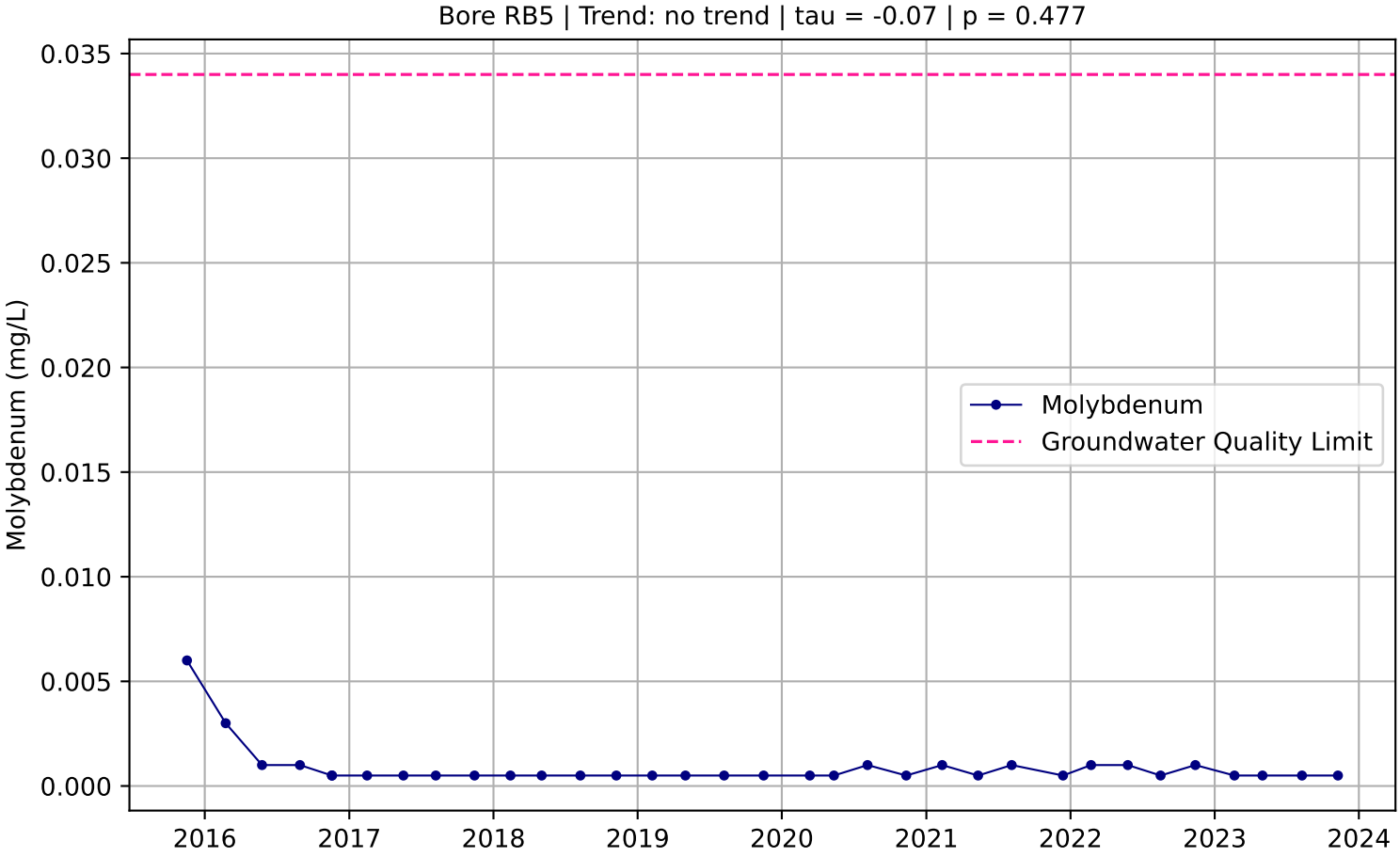

Bore RB5 | Trend: no trend | tau = -0.064 | p = 0.603
Chloride
Chloride (mg/L)
2400
2300
2200
2100
2000
1900
1800
2016
2017
2018
2019
2020
2021
2022
2023
2024

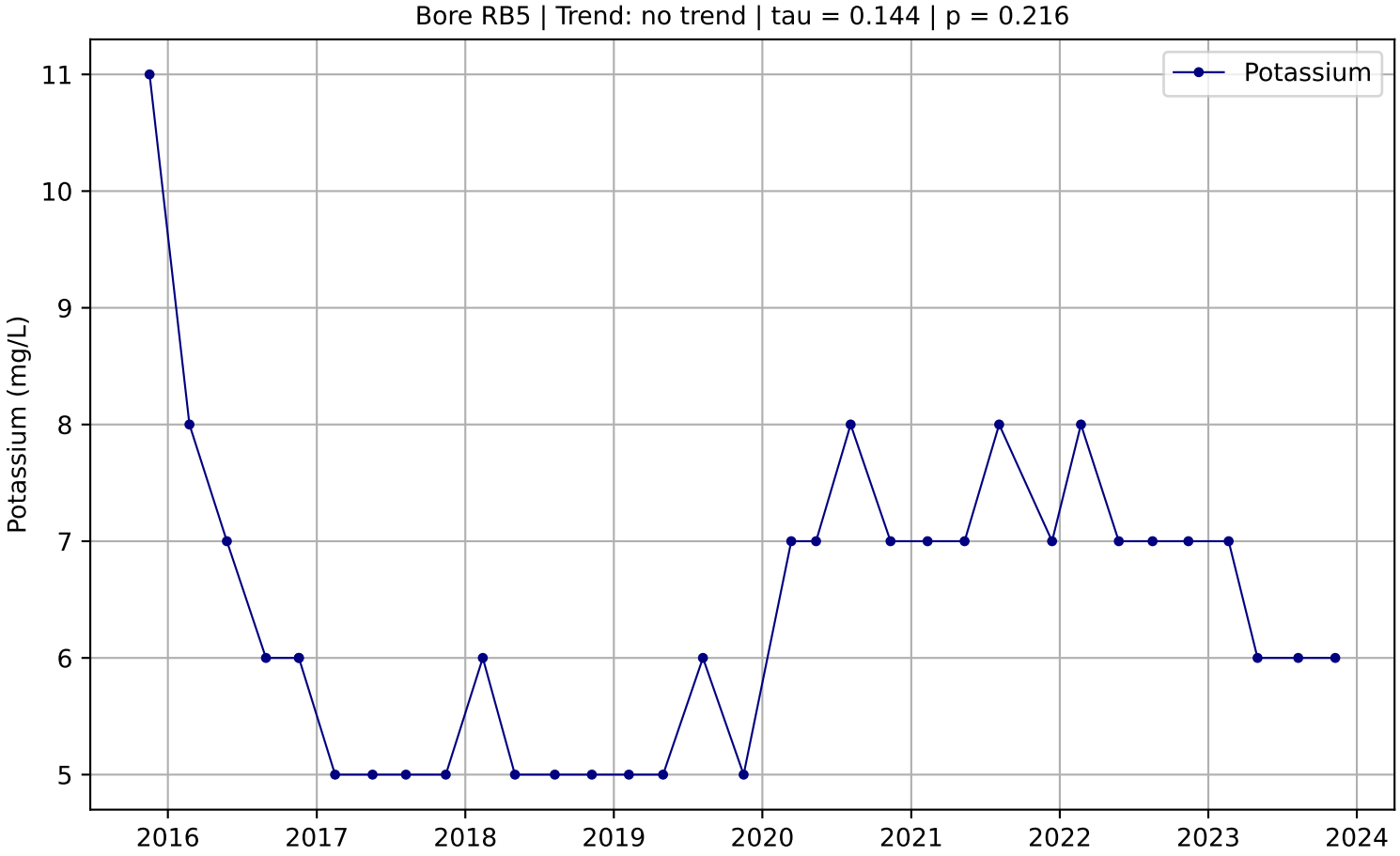

Bore RB5 | Trend: no trend | tau = -0.102 | p = 0.406
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
7400
7200
7000
6800
6600
2016
2017
2018
2019
2020
2021
2022
2023
2024

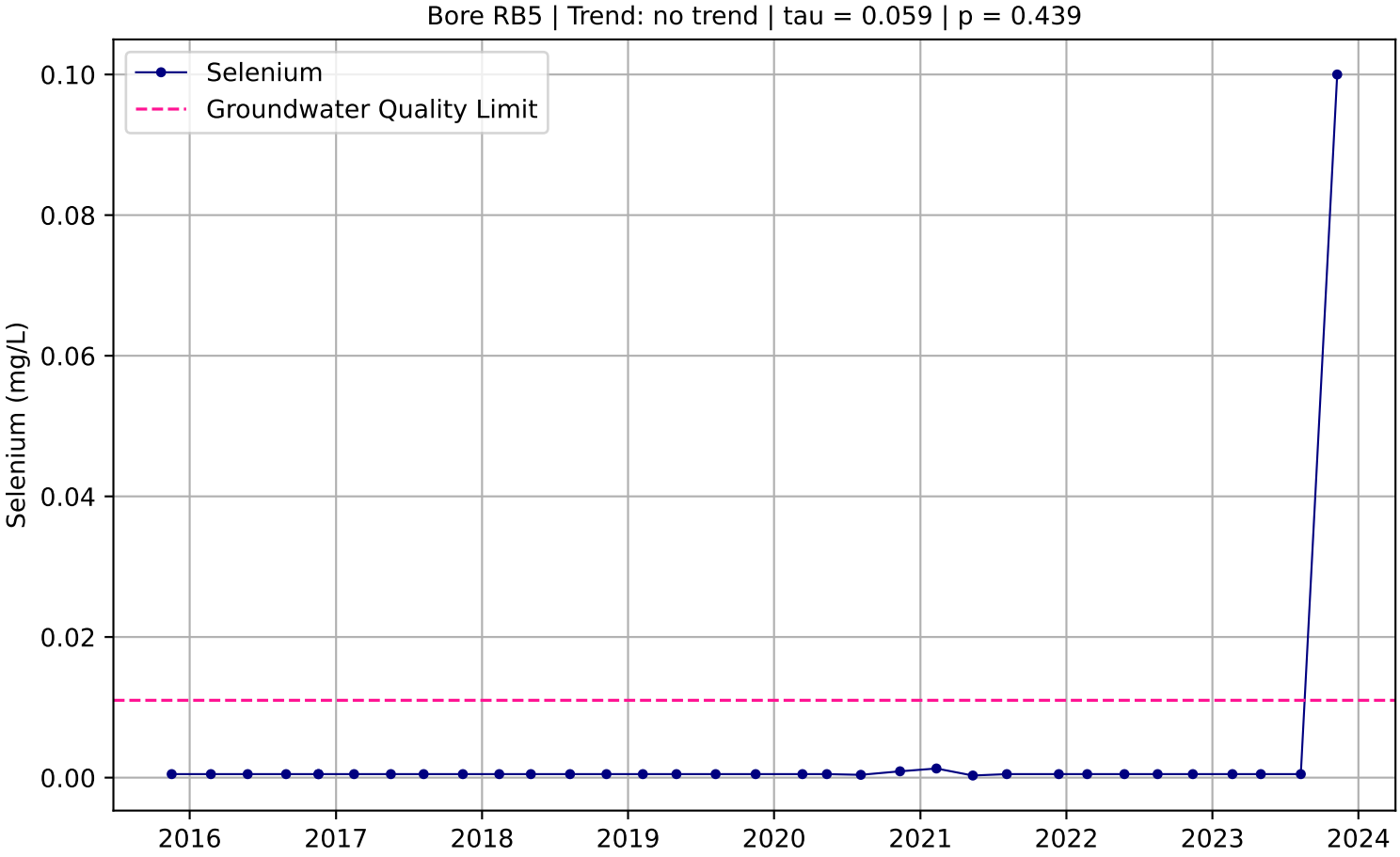

Bore RB5 | Trend: decreasing | tau = -0.67 | p = 0.0
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
2016
2017
2018
2019
2020
2021
2022
2023
2024

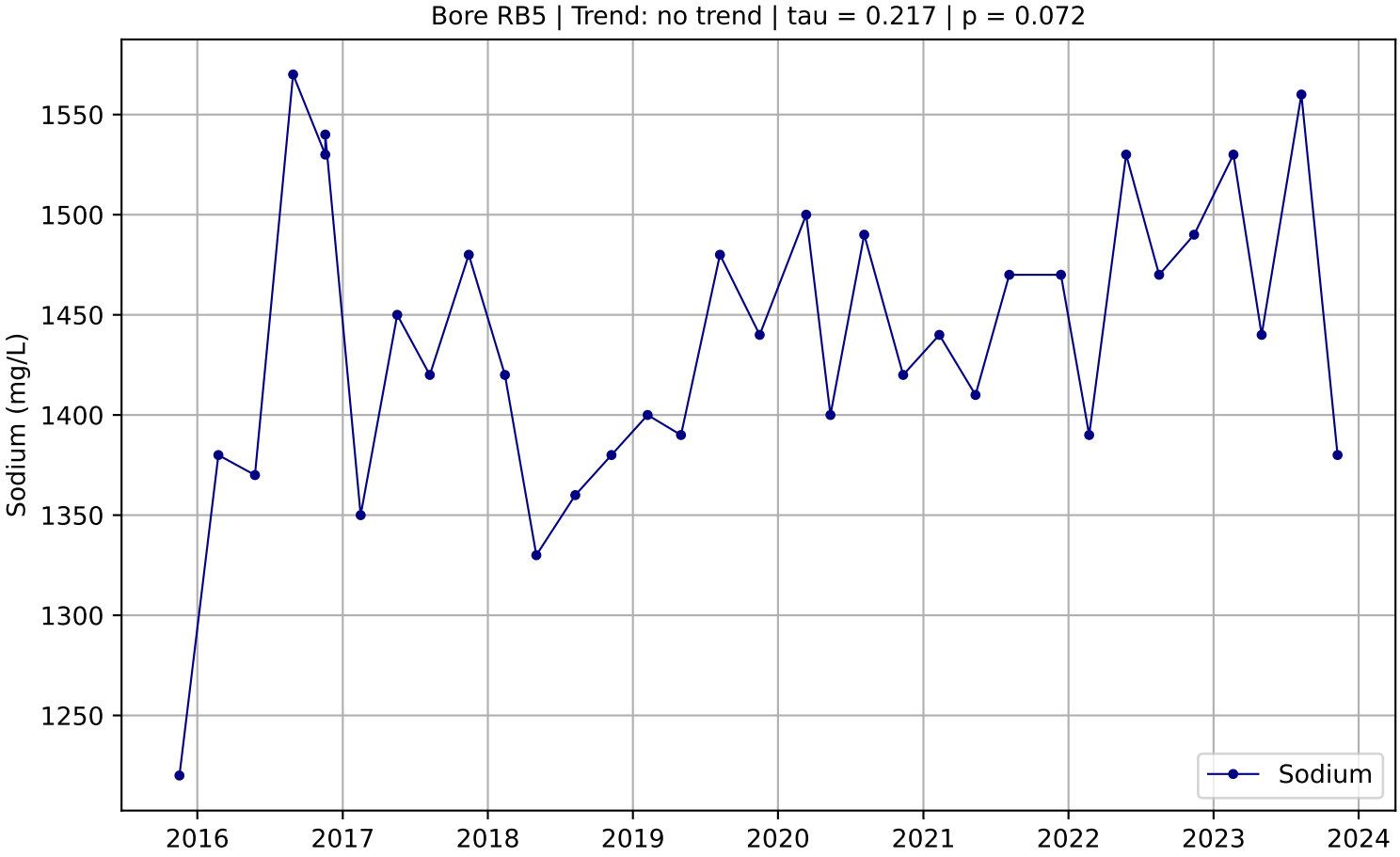

Bore RB5 | Trend: increasing | tau = 0.285 | p = 0.018
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

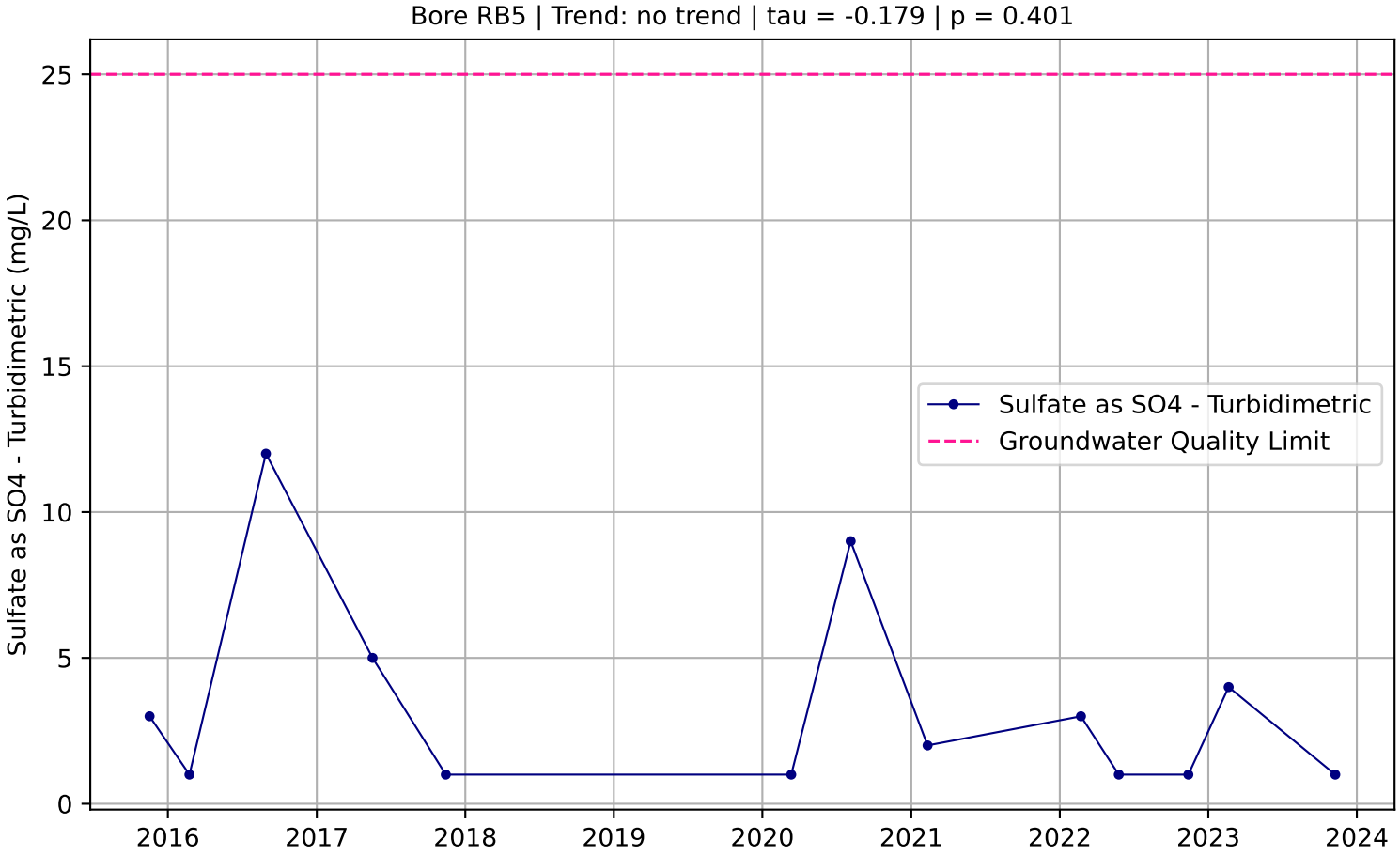

Bore RB5 | Trend: increasing | tau = 0.554 | p = 0.0
Magnesium
Magnesium (mg/L)
18
16
14
12
10
8
2018
2019
2020
2021
2022
2023
2024

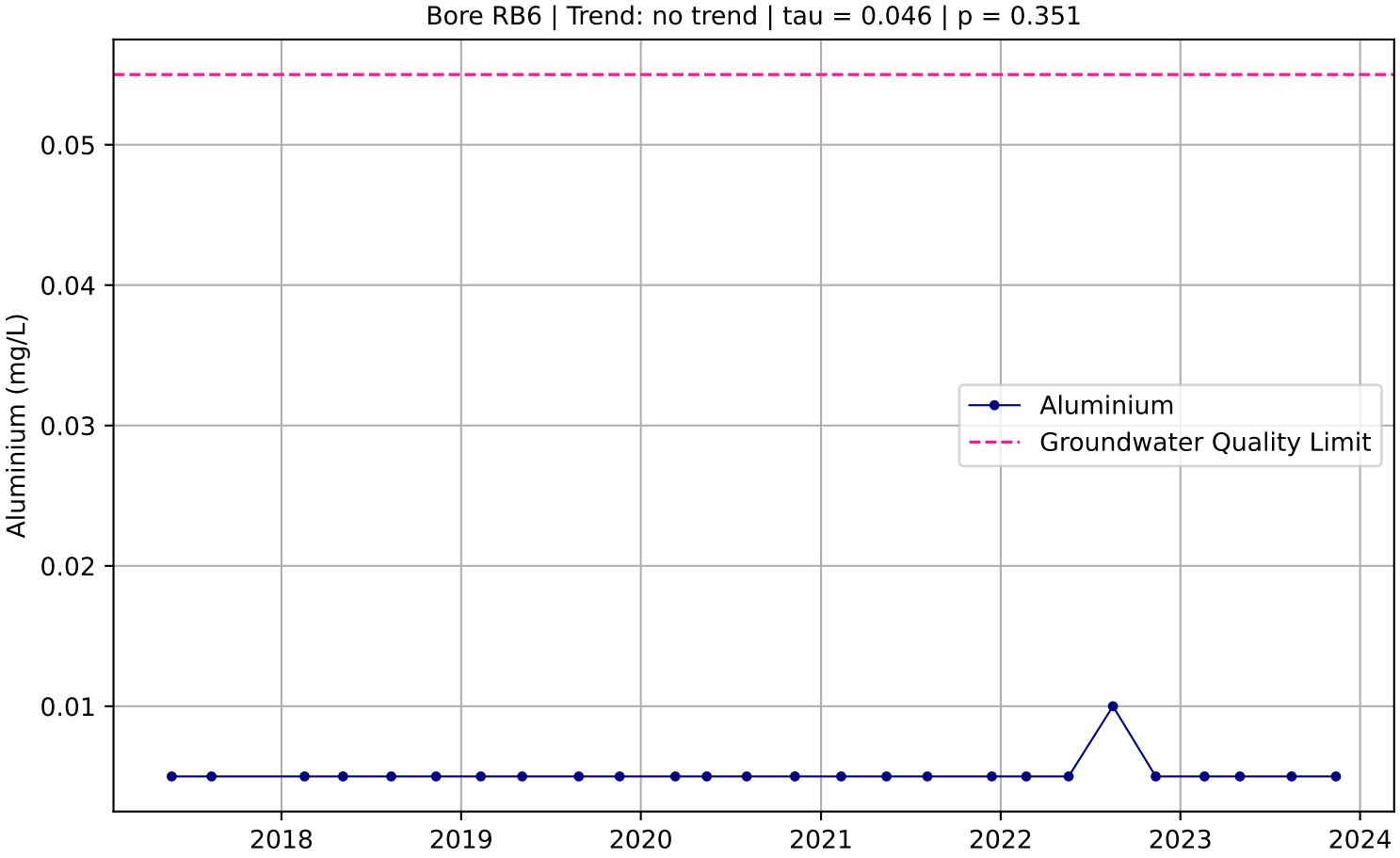

Bore RB5 | Trend: no trend | tau = -0.07 | p = 0.477
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

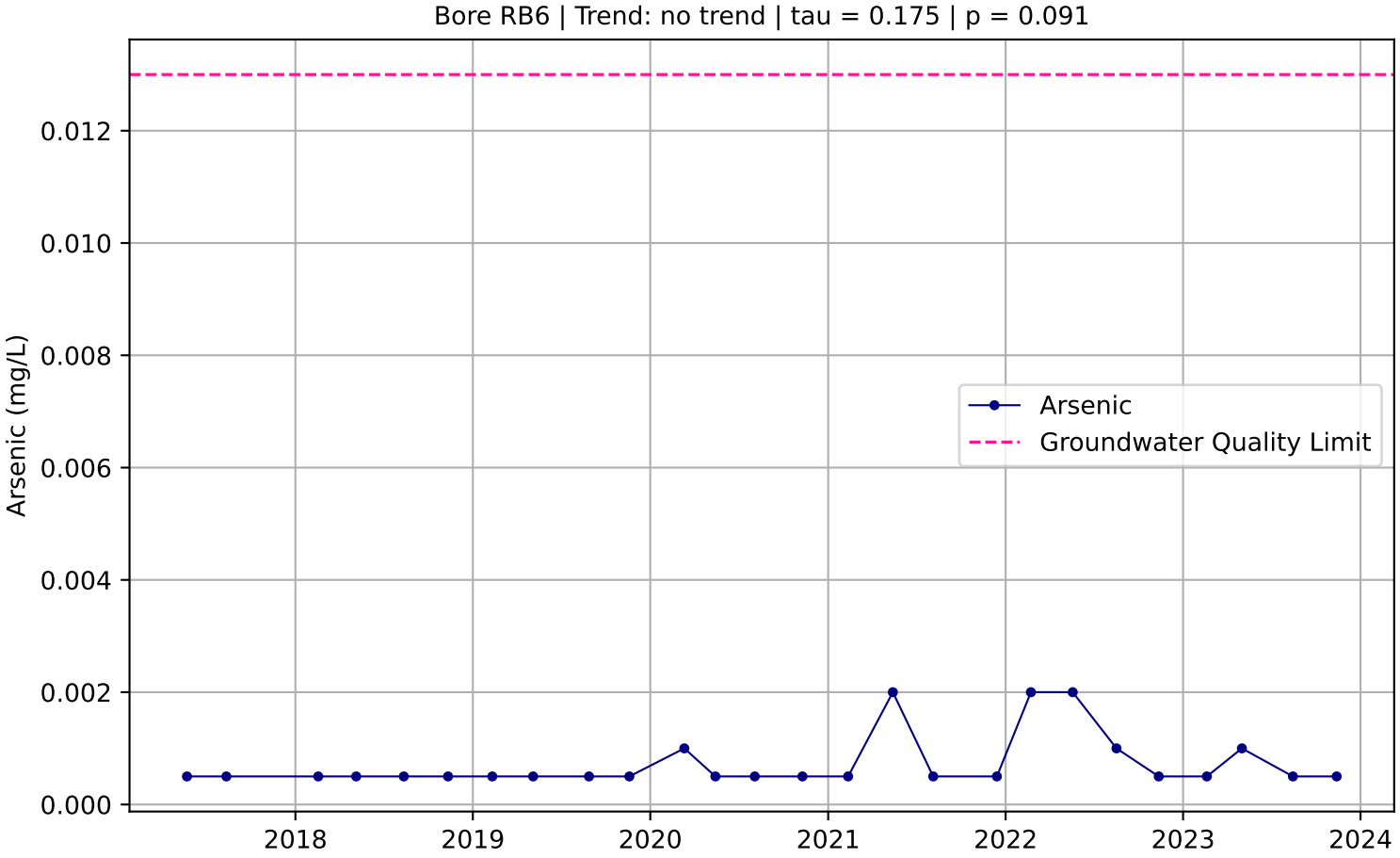

Bore RB5 | Trend: no trend | tau = 0.144 | p = 0.216
Potassium
Potassium (mg/L)
11
10
9
8
7
6
5
2016
2017
2018
2019
2020
2021
2022
2023
2024

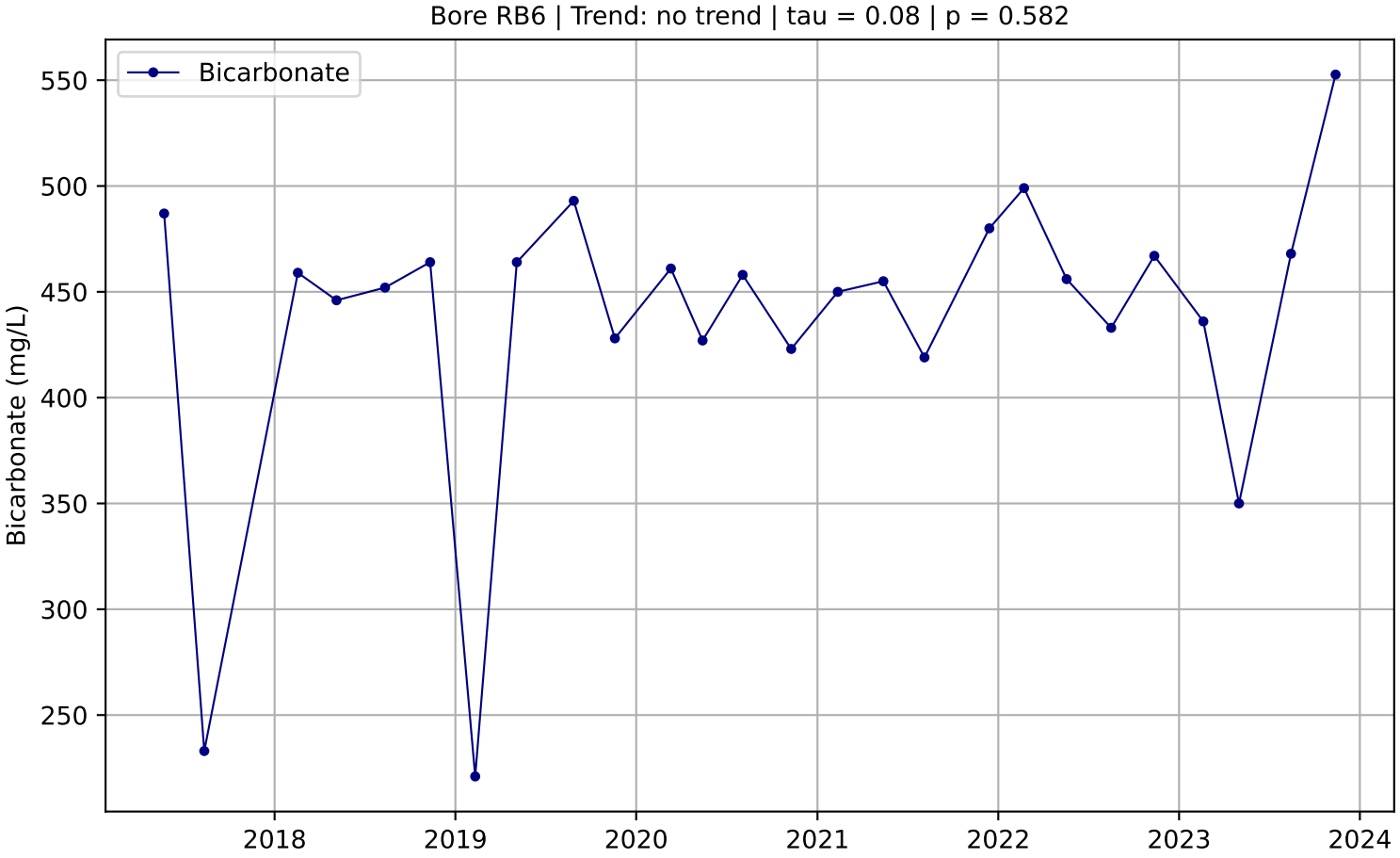

Bore RB5 | Trend: no trend | tau = 0.059 | p = 0.439
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

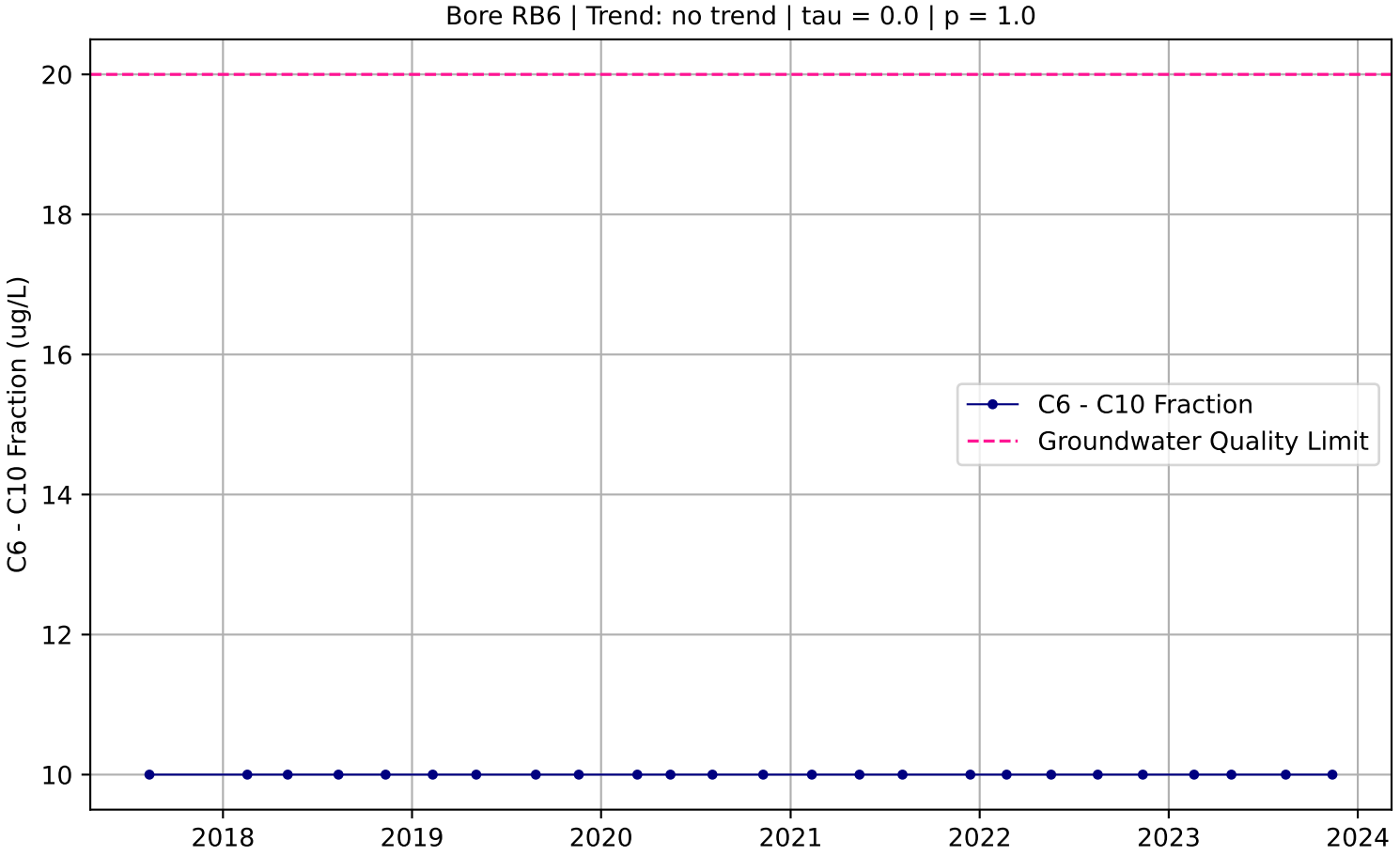

Bore RB5 | Trend: no trend | tau = 0.217 | p = 0.072
Sodium (mg/L)
1550
1500
1450
1400
1350
1300
1250
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sodium

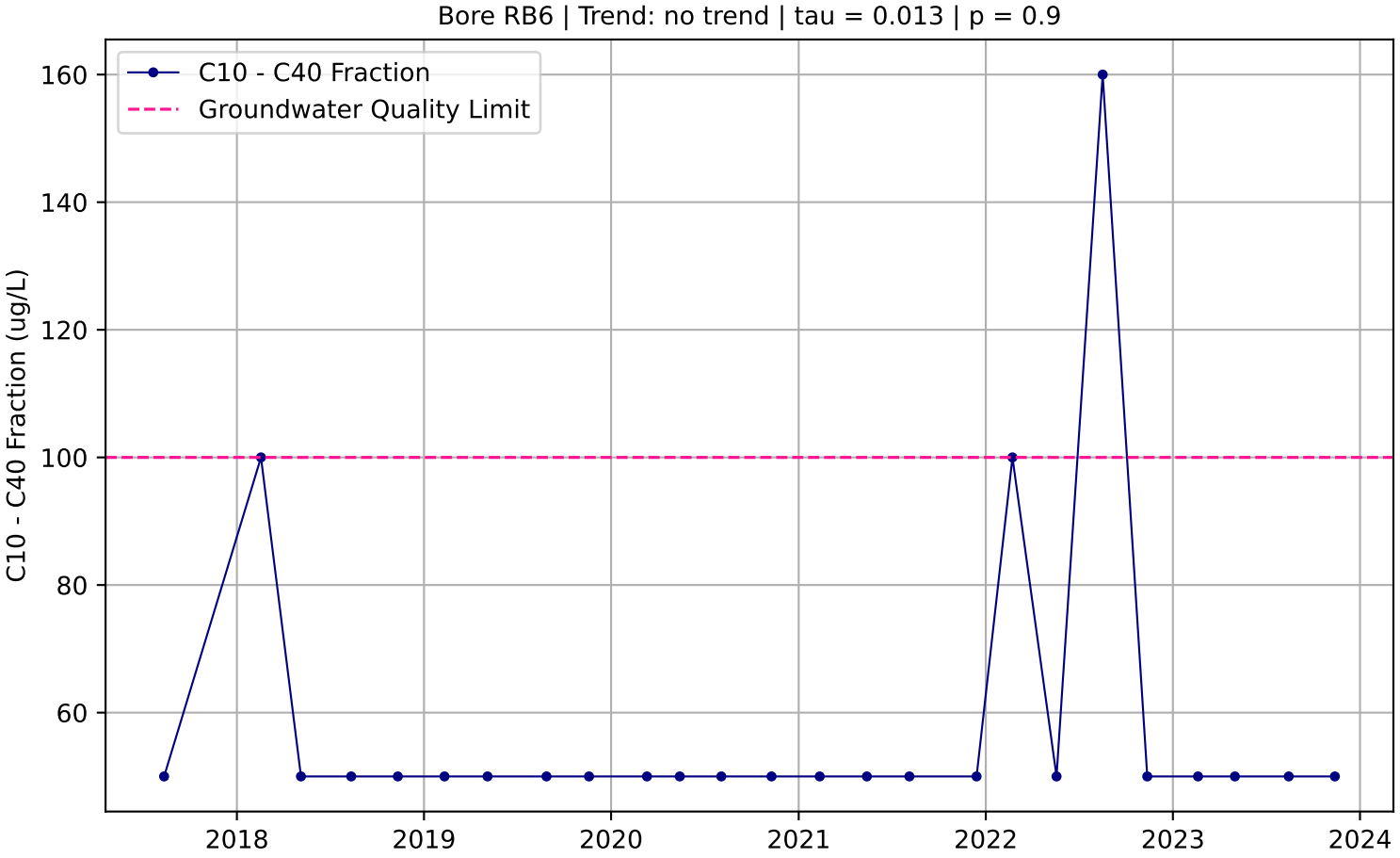

Bore RB5 | Trend: no trend | tau = -0.179 | p = 0.401
Sulfate as SO4 - Turbidimetric (mg/L)
0
5
10
15
20
25
2016
2017
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

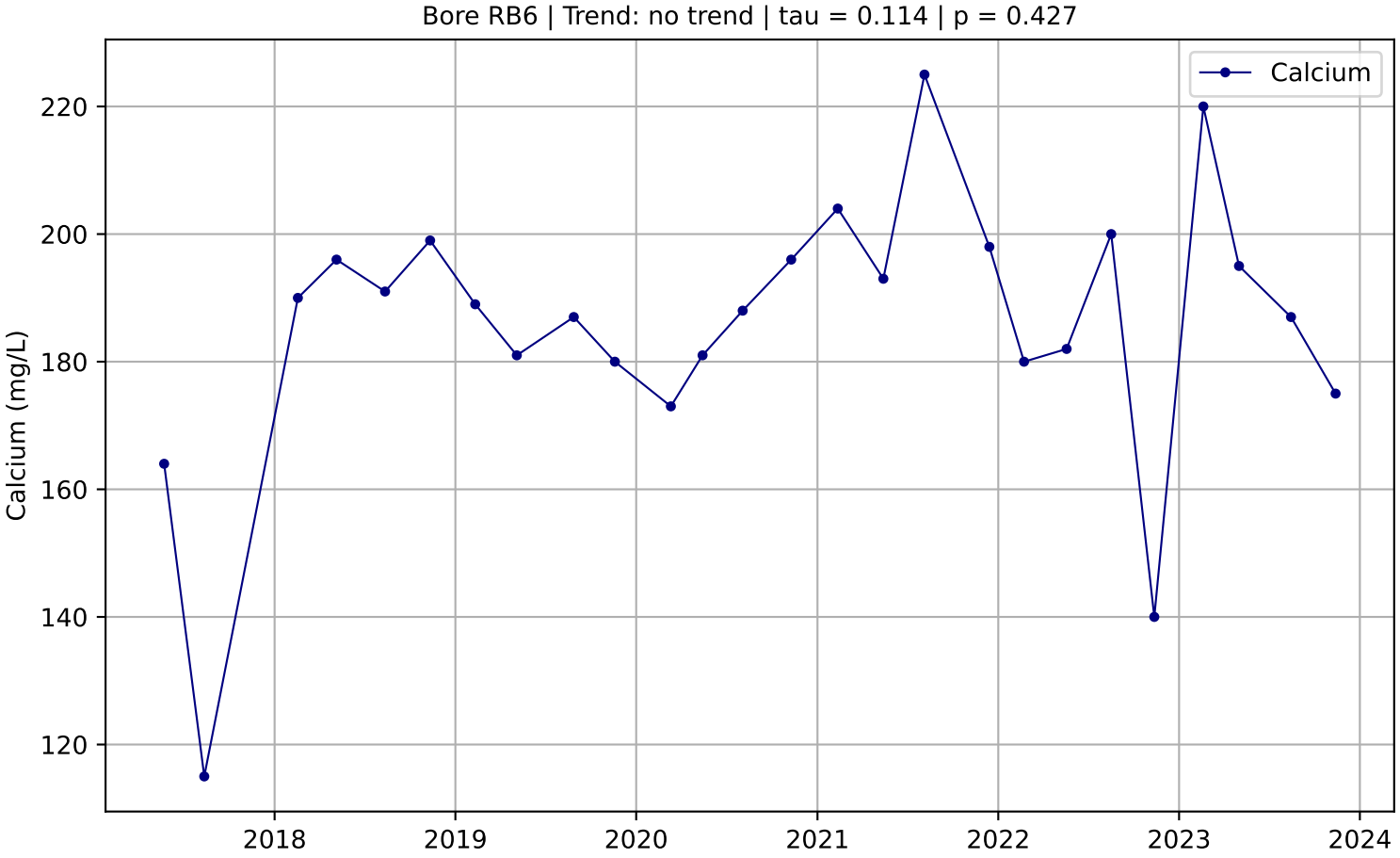

Bore RB6 | Trend: no trend | tau = 0.046 | p = 0.351
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

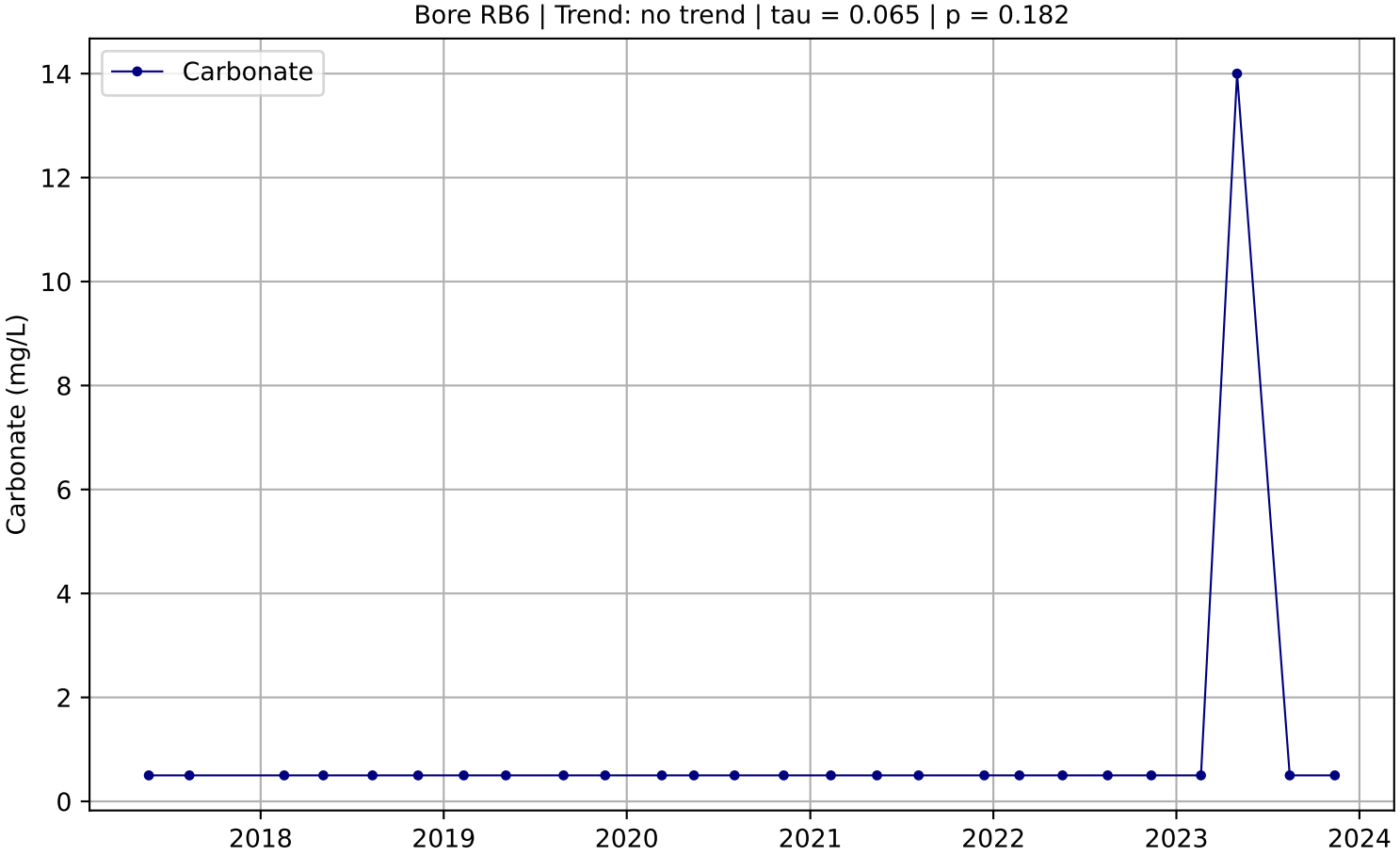

Bore RB6 | Trend: no trend | tau = 0.175 | p = 0.091
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

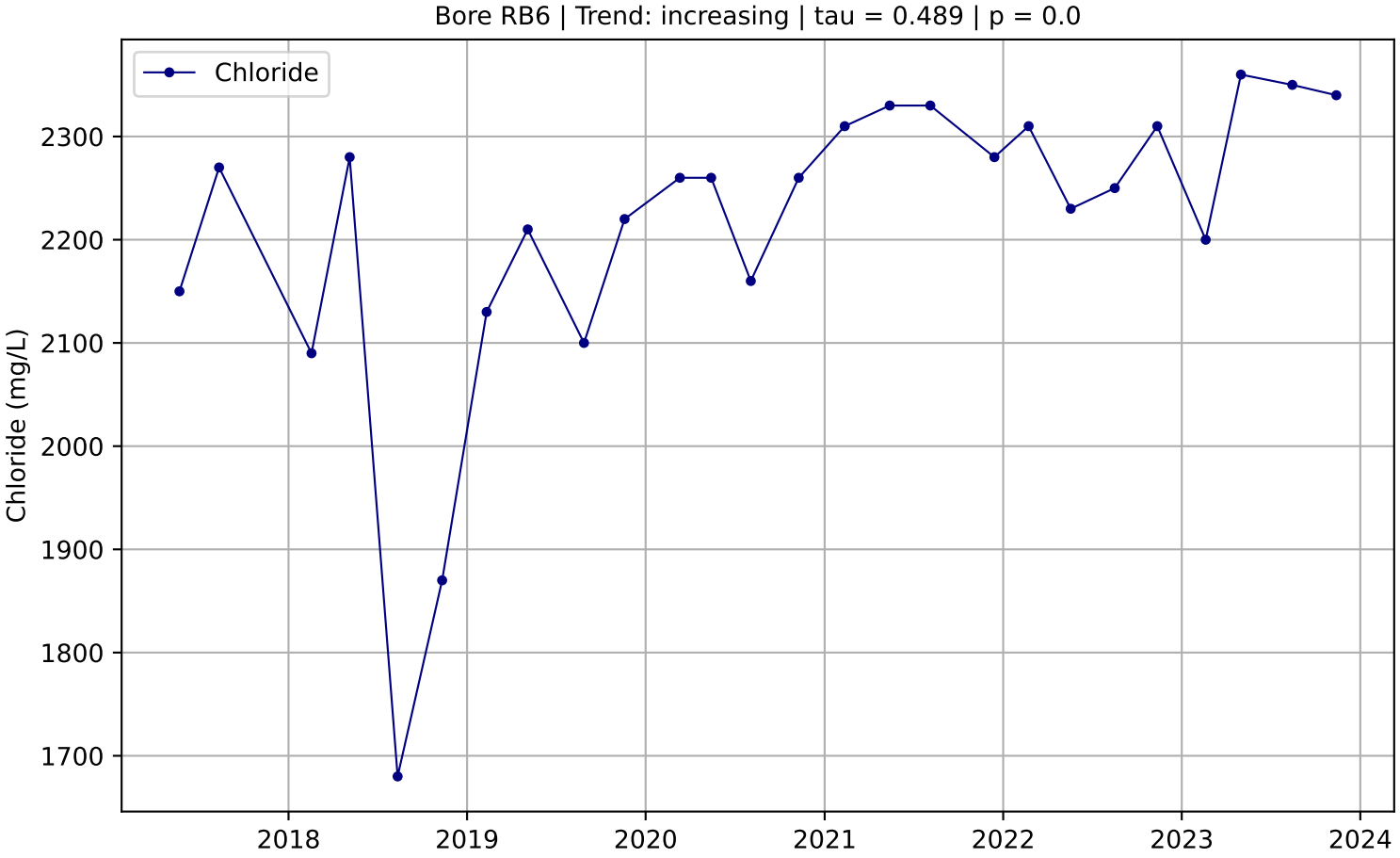

Bore RB6 | Trend: no trend | tau = 0.08 | p = 0.582
Bicarbonate
Bicarbonate (mg/L)
550
500
450
400
350
300
250
2018
2019
2020
2021
2022
2023
2024

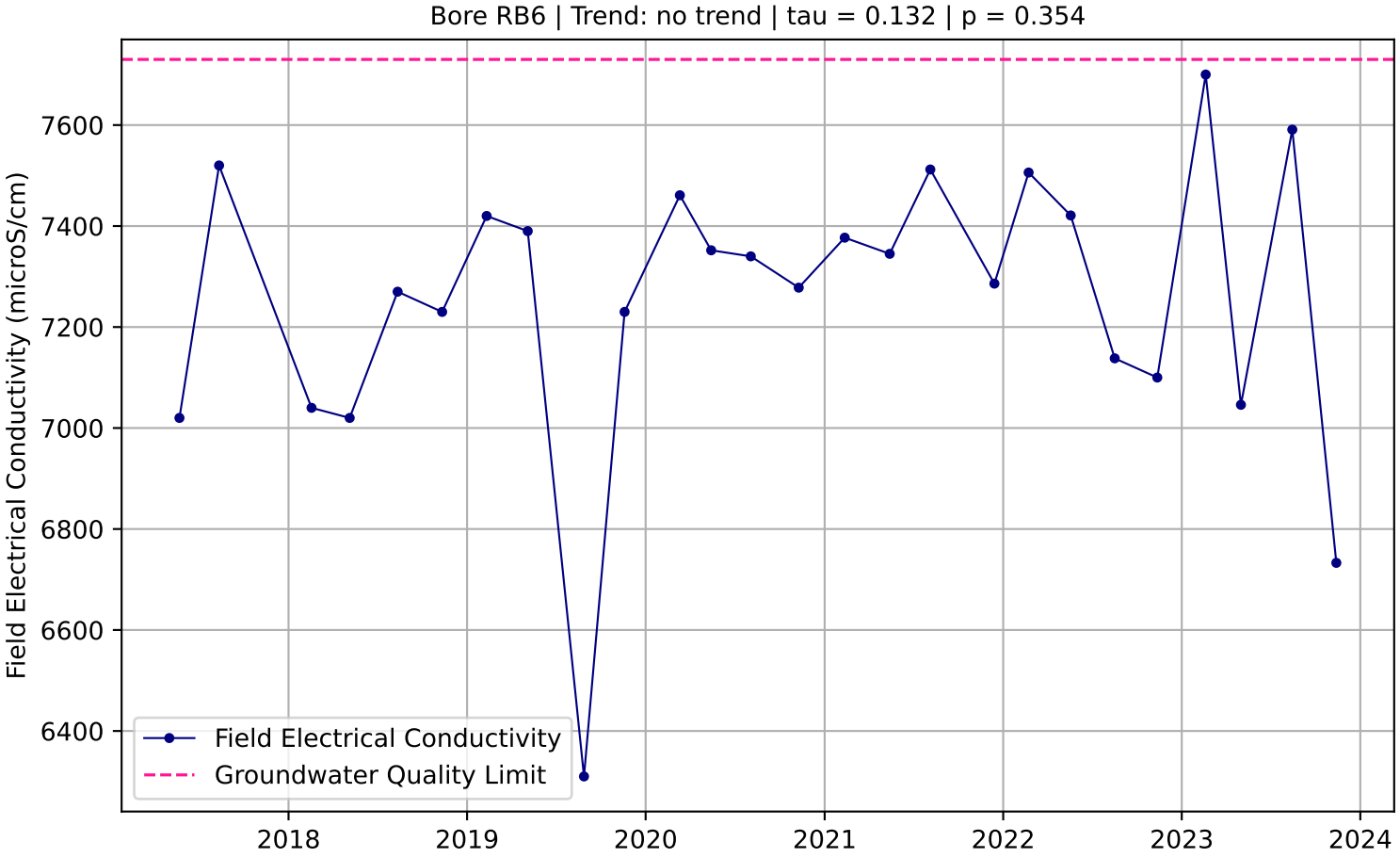

Bore RB6 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

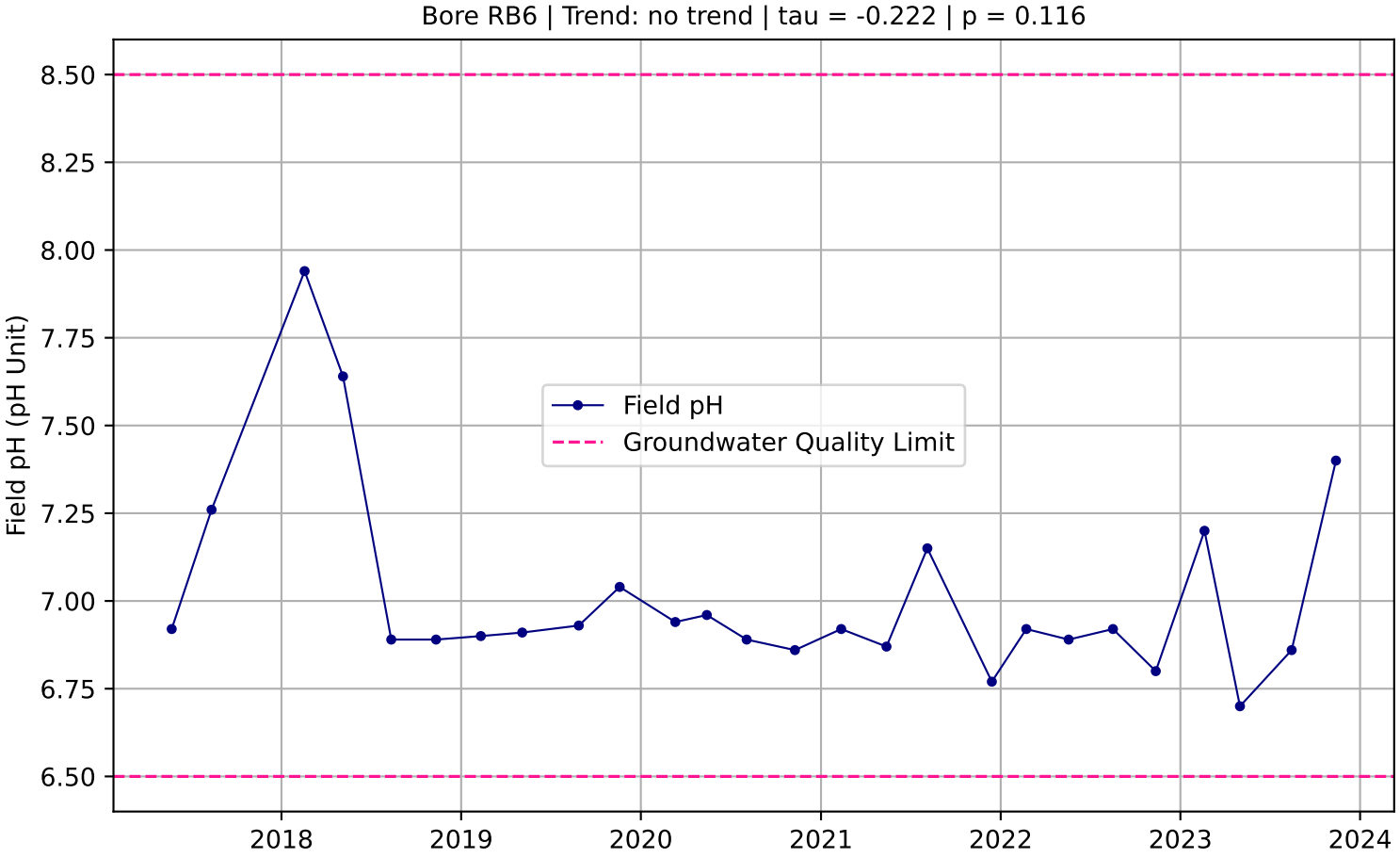

Bore RB6 | Trend: no trend | tau = 0.013 | p = 0.9
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
160
140
120
100
80
60
2018
2019
2020
2021
2022
2023
2024

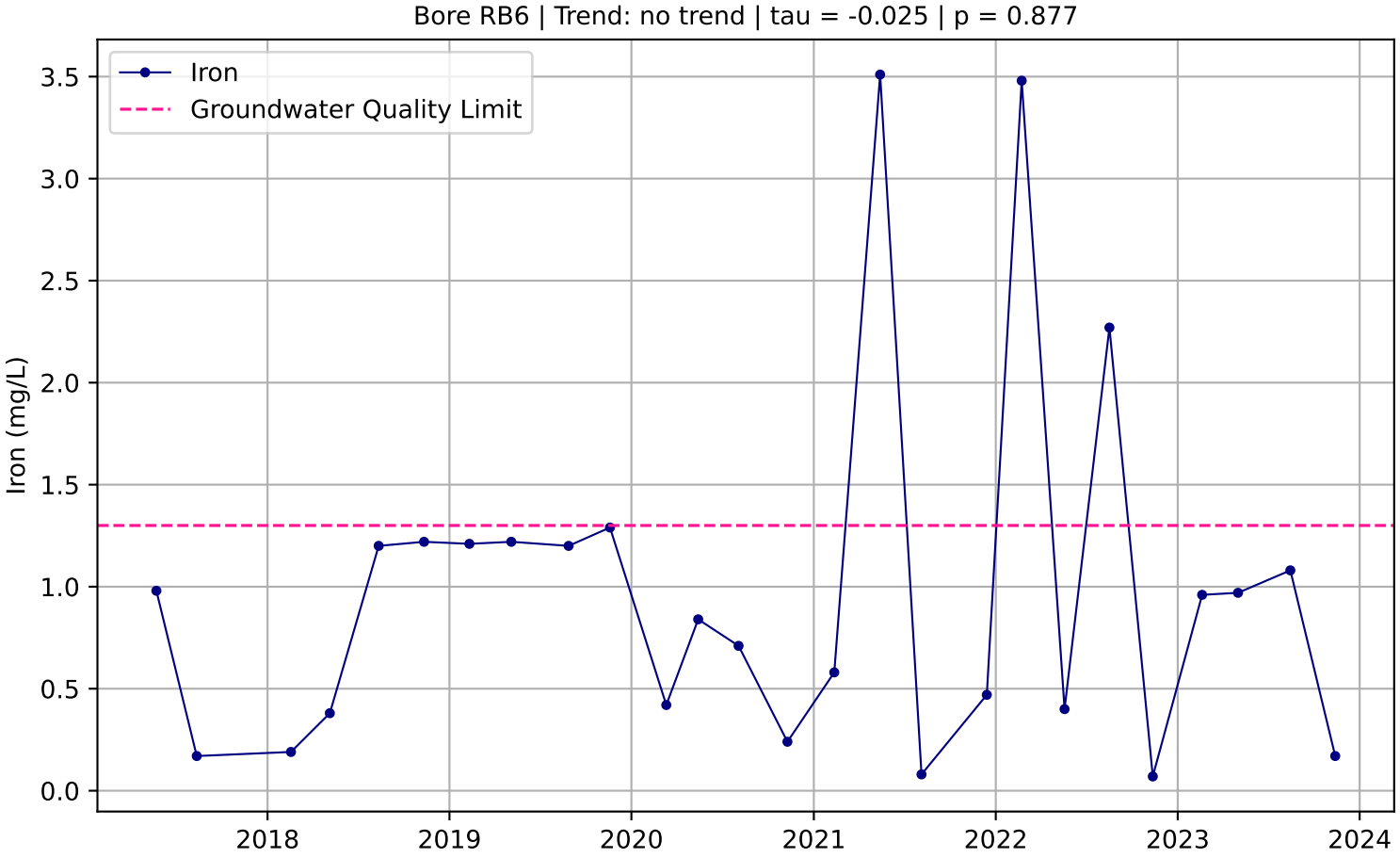

Bore RB6 | Trend: no trend | tau = 0.114 | p = 0.427
Calcium
Calcium (mg/L)
220
200
180
160
140
120
2018
2019
2020
2021
2022
2023
2024

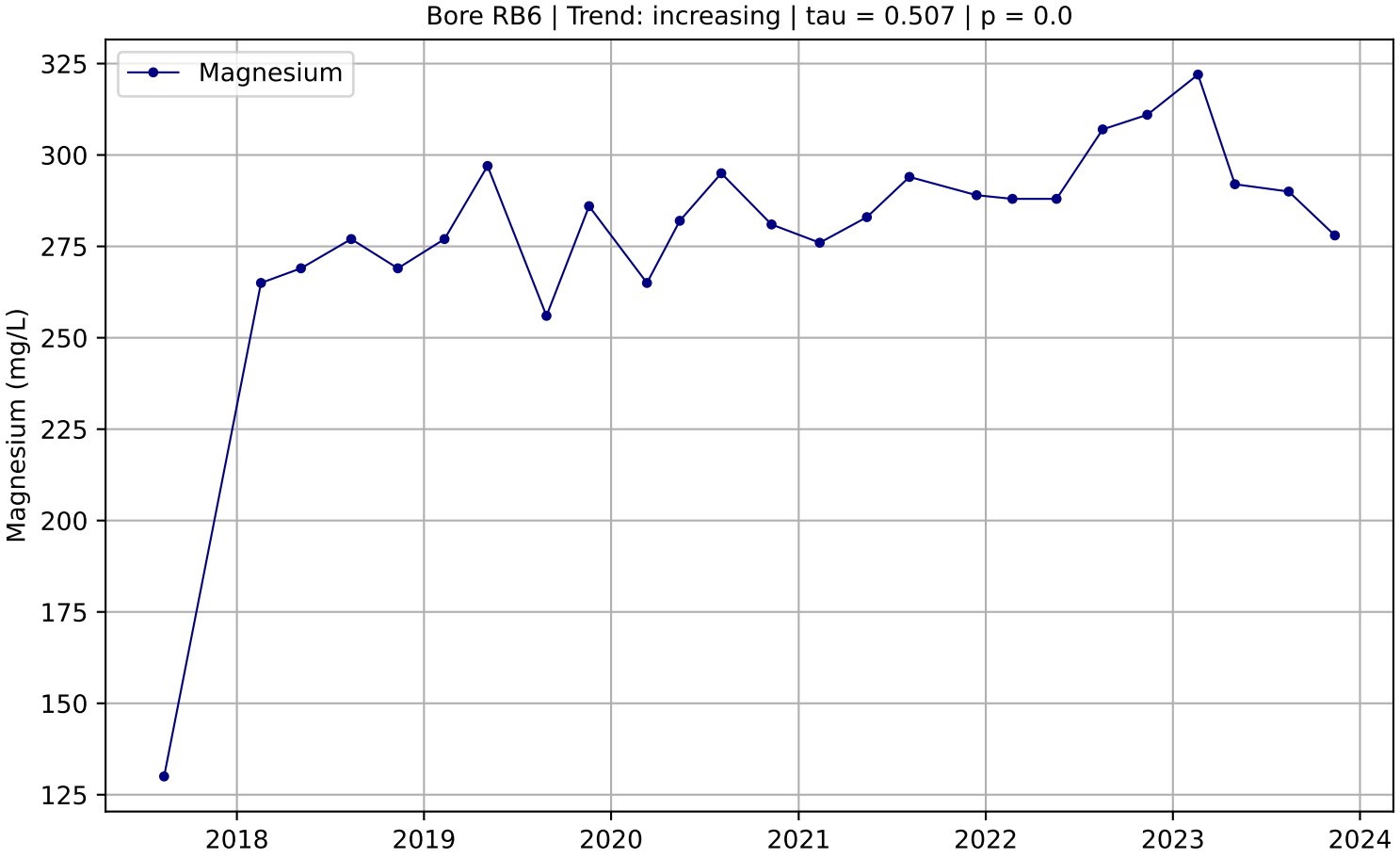

Bore RB6 | Trend: no trend | tau = 0.065 | p = 0.182
Carbonate
Carbonate (mg/L)
0
2
4
6
8
10
12
14
2018
2019
2020
2021
2022
2023
2024

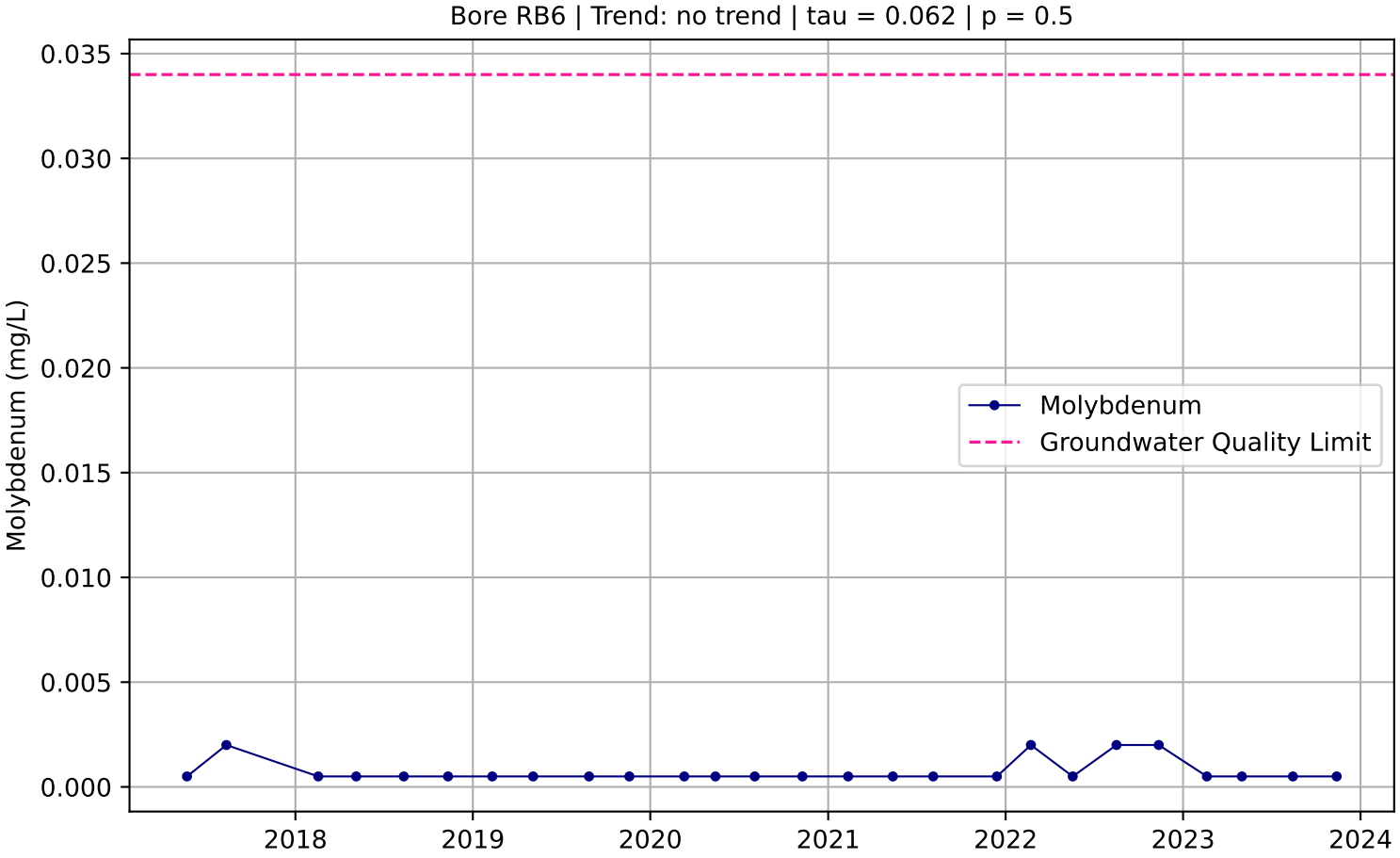

Bore RB6 | Trend: increasing | tau = 0.489 | p = 0.0
Chloride
Chloride (mg/L)
2300
2200
2100
2000
1900
1800
1700
2018
2019
2020
2021
2022
2023
2024

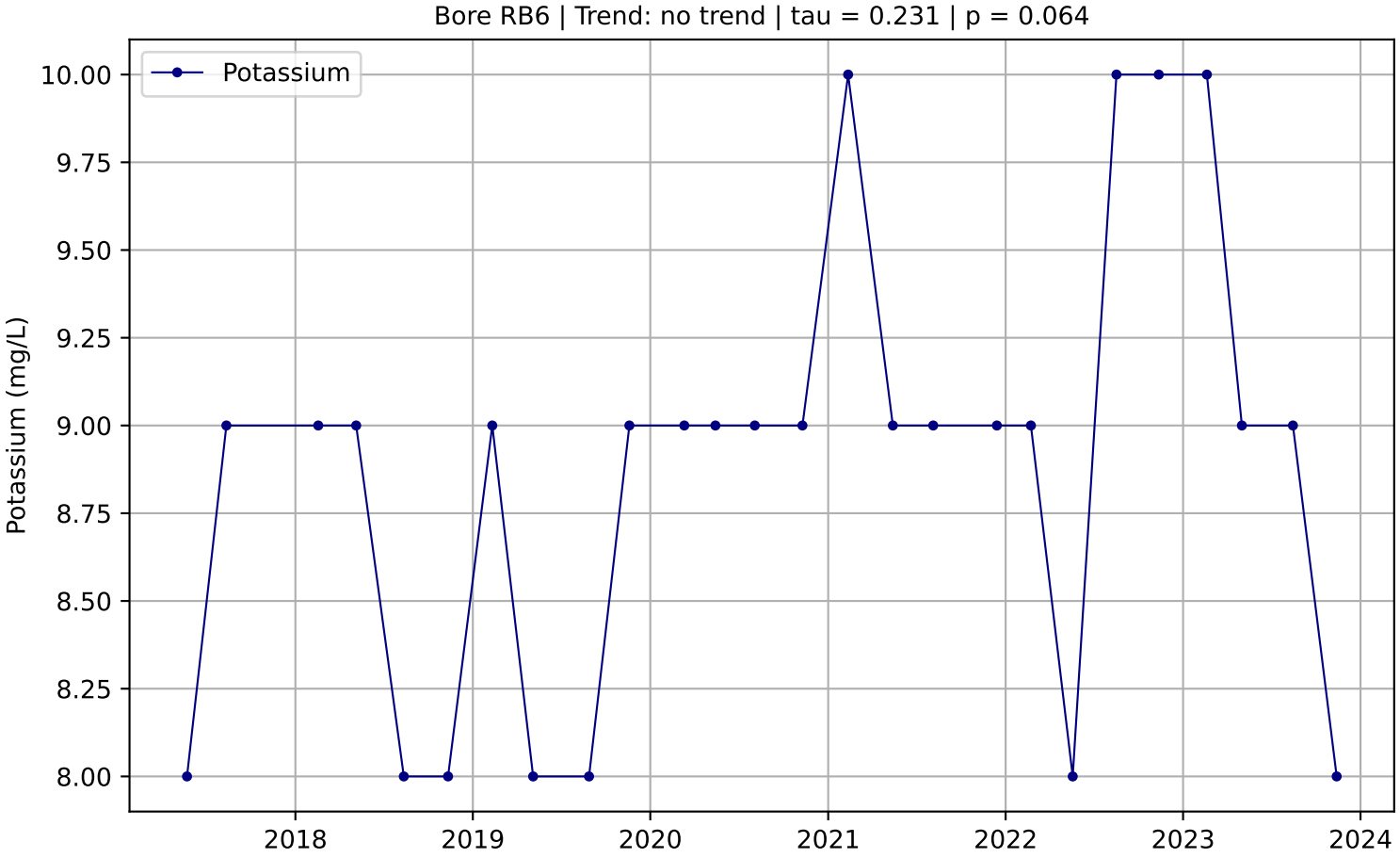

Bore RB6 | Trend: no trend | tau = 0.132 | p = 0.354
Field Electrical Conductivity (microS/cm)
7600
7400
7200
7000
6800
6600
6400
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

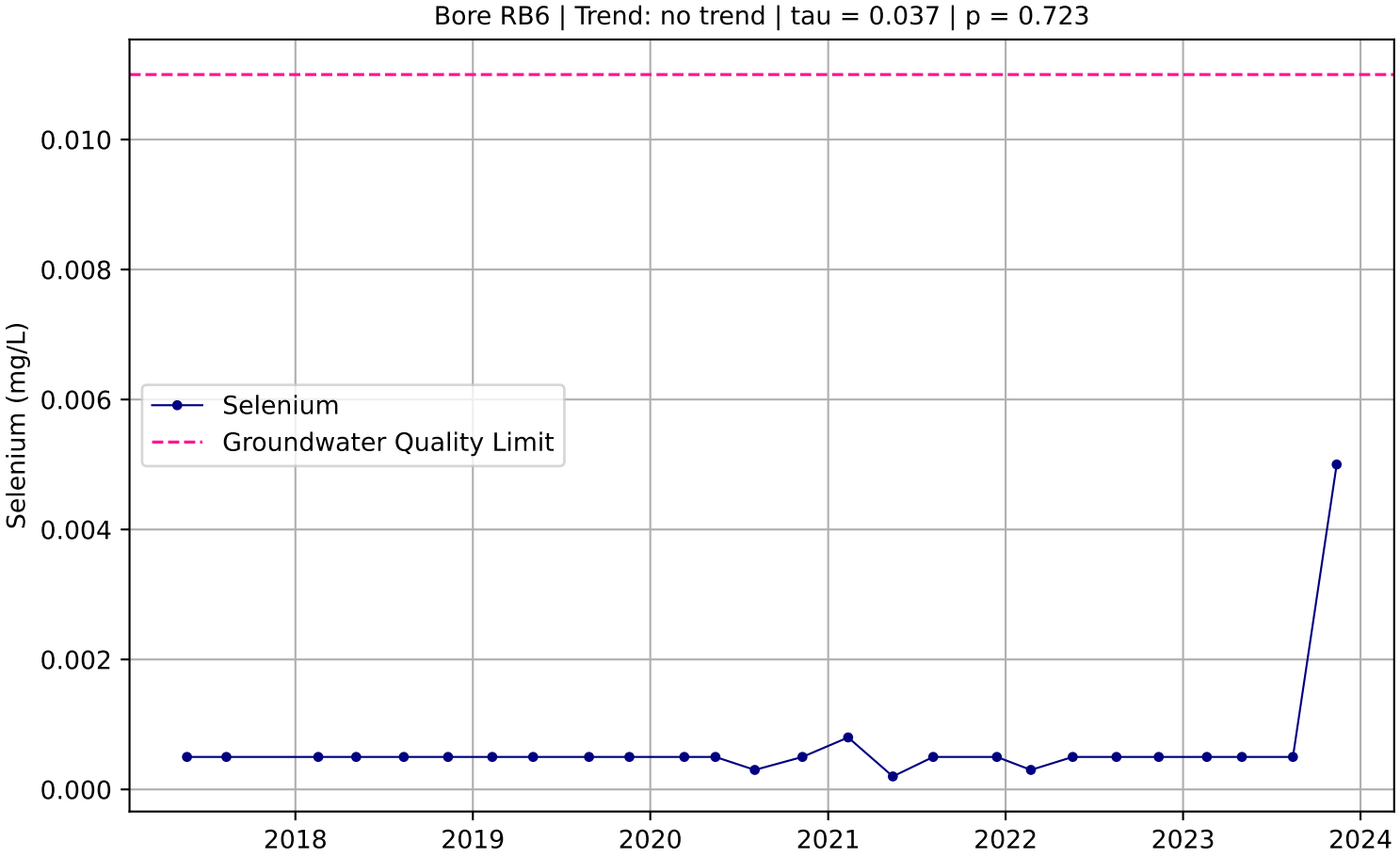

Bore RB6 | Trend: no trend | tau = -0.222 | p = 0.116
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

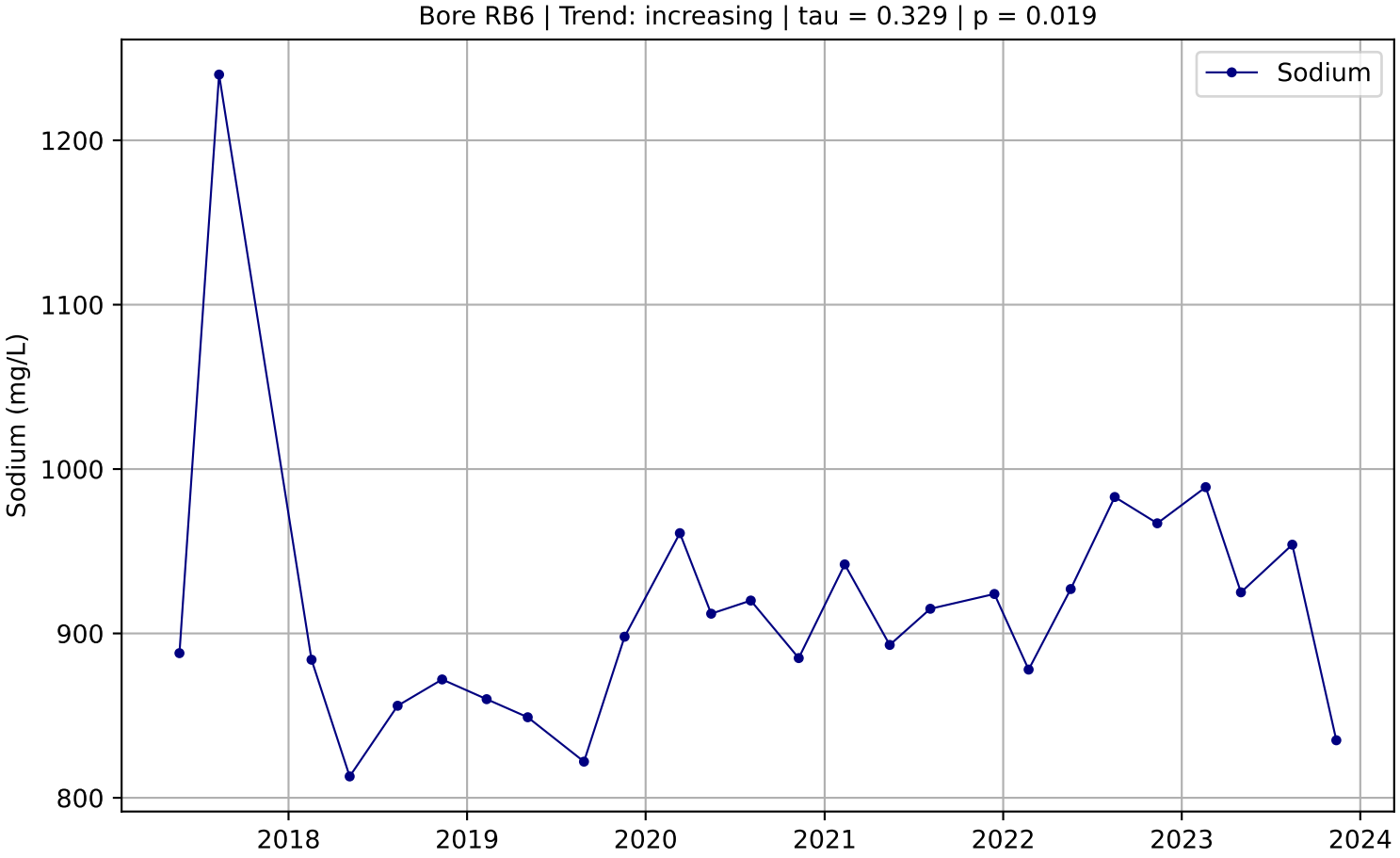

Bore RB6 | Trend: no trend | tau = -0.025 | p = 0.877
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
2018
2019
2020
2021
2022
2023
2024

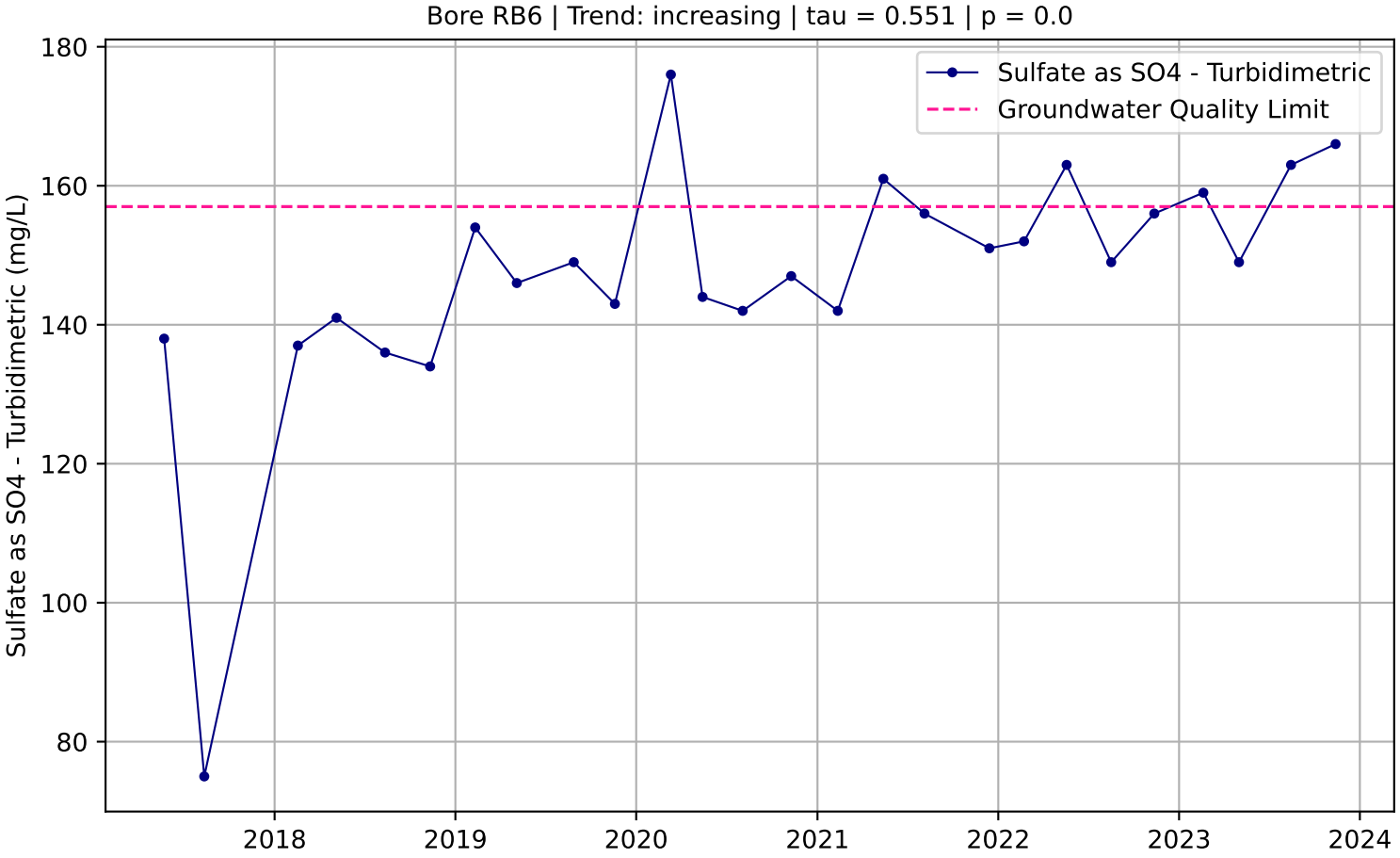

Bore RB6 | Trend: increasing | tau = 0.507 | p = 0.0
Magnesium
Magnesium (mg/L)
325
300
275
250
225
200
175
150
125
2018
2019
2020
2021
2022
2023
2024

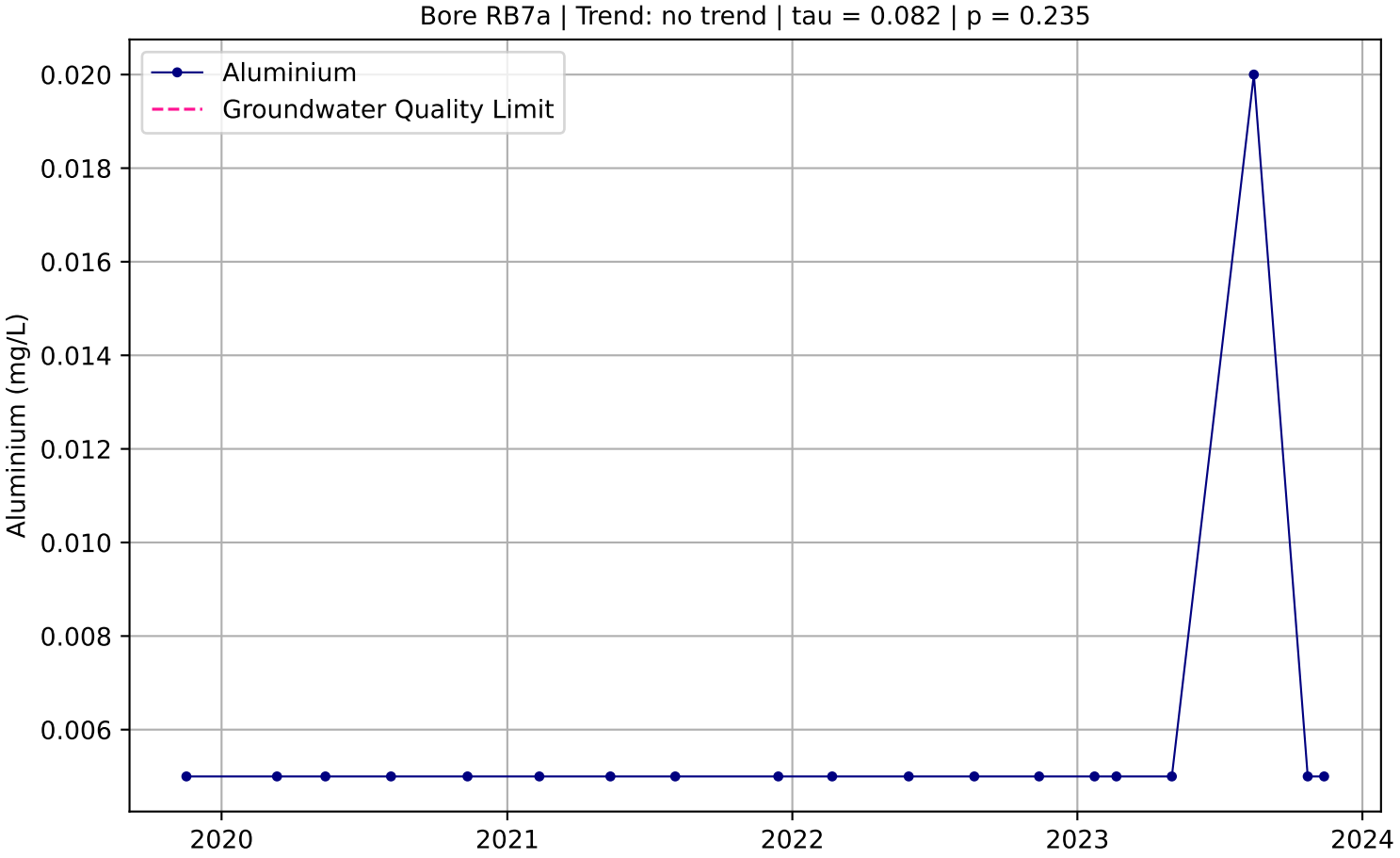

Bore RB6 | Trend: no trend | tau = 0.062 | p = 0.5
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

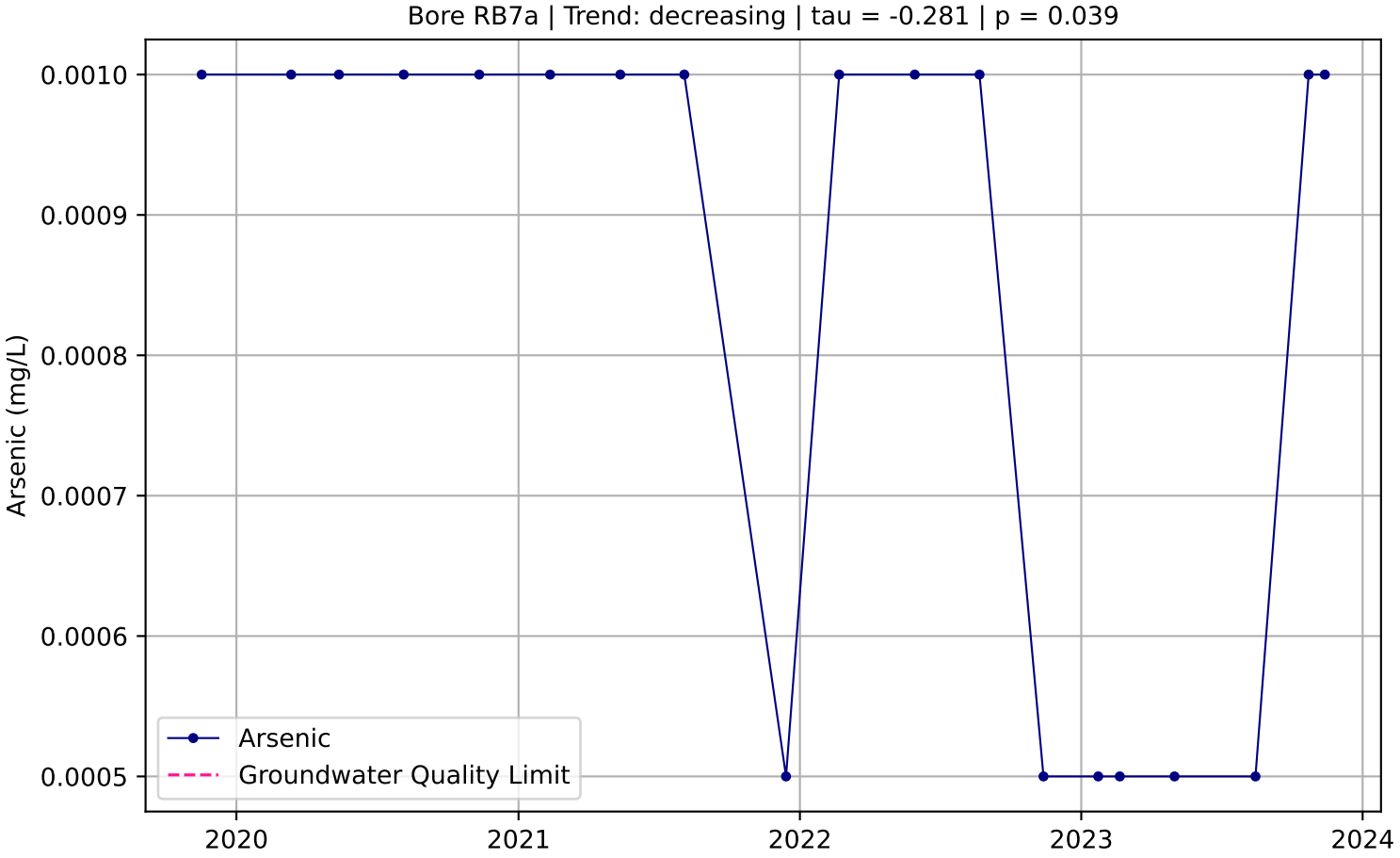

Bore RB6 | Trend: no trend | tau = 0.231 | p = 0.064
Potassium
Potassium (mg/L)
10.00
9.75
9.50
9.25
9.00
8.75
8.50
8.25
8.00
2018
2019
2020
2021
2022
2023
2024

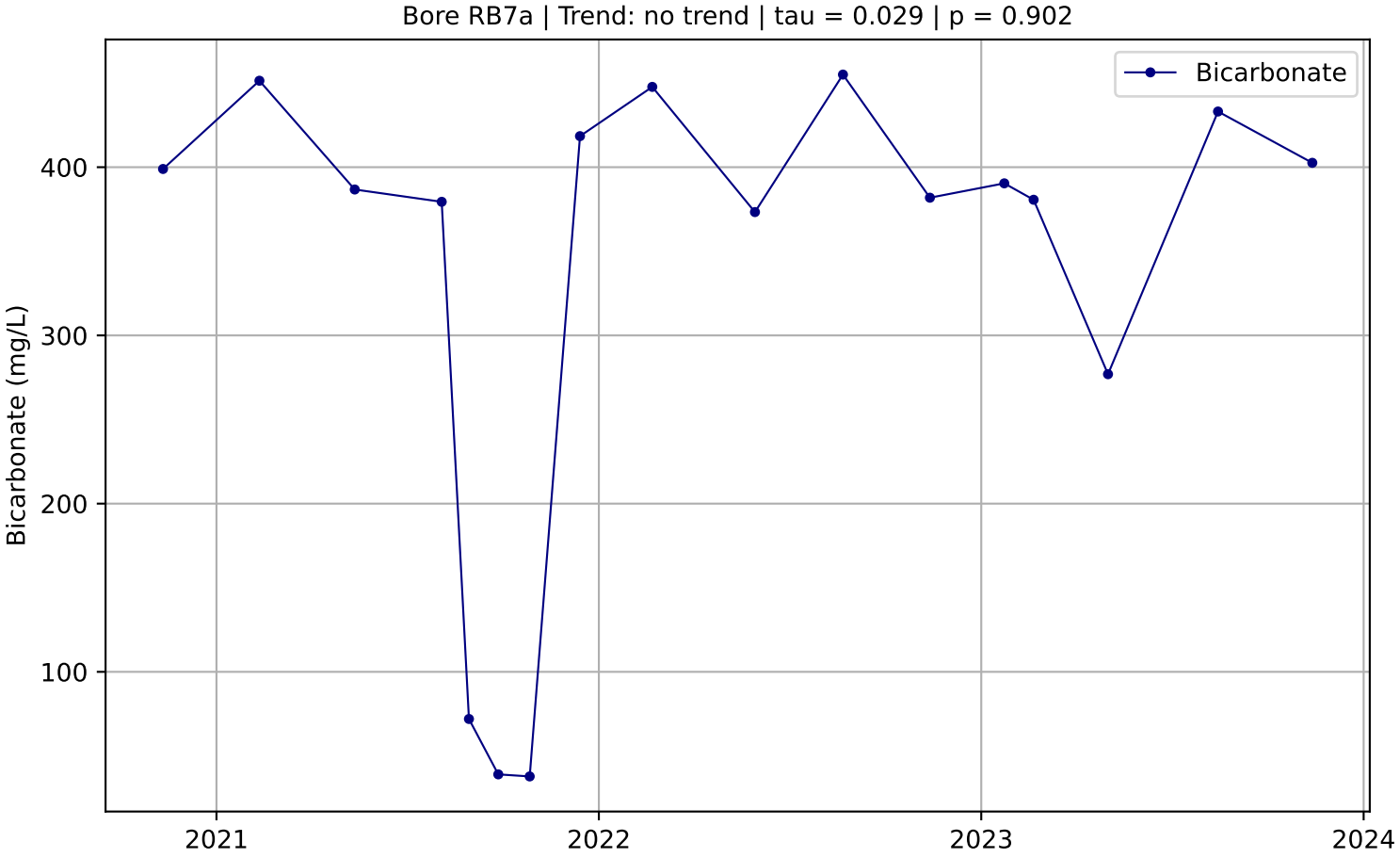

Bore RB6 | Trend: no trend | tau = 0.037 | p = 0.723
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
Selenium
Groundwater Quality Limit
2018
2019
2020
2021
2022
2023
2024

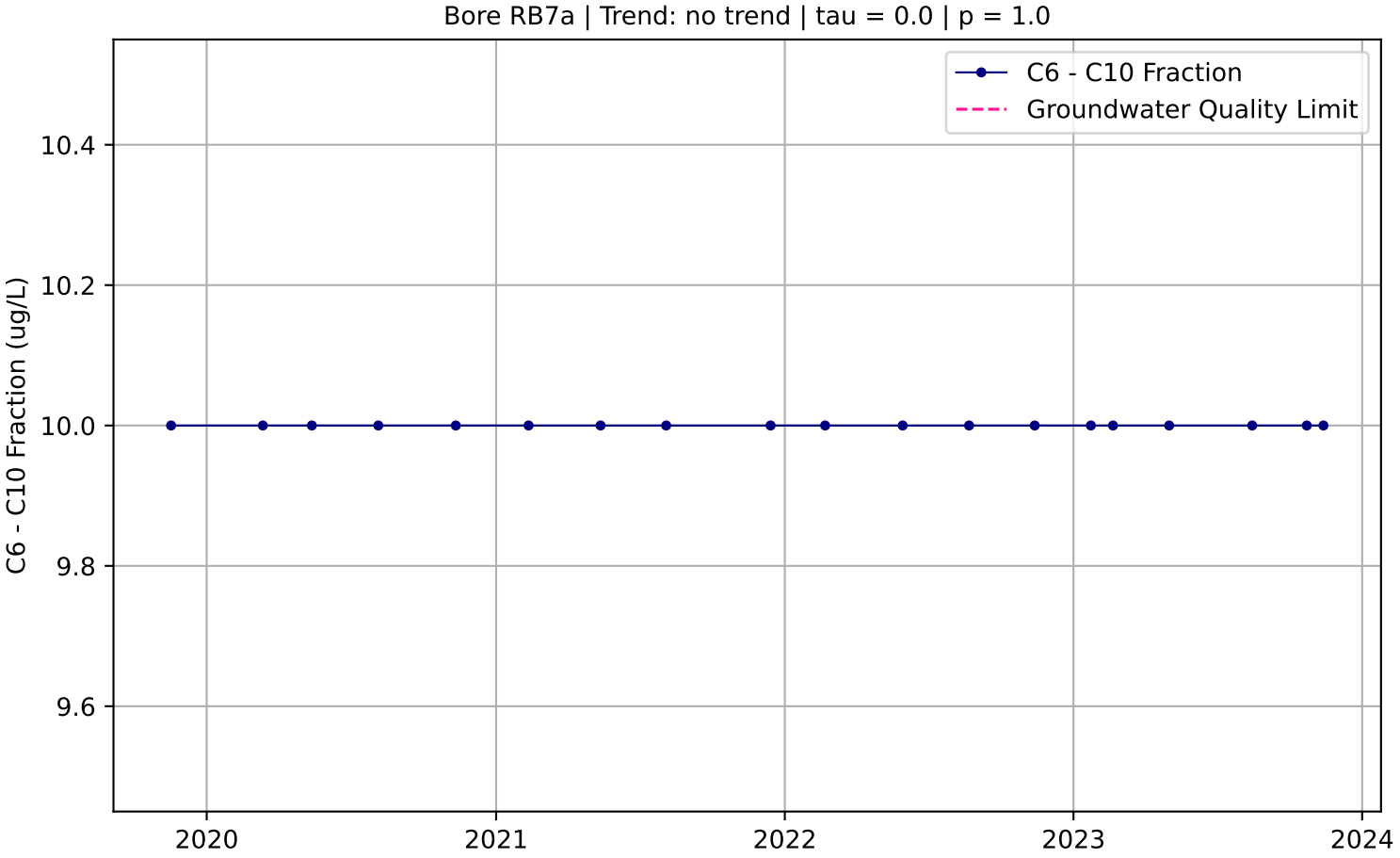

Bore RB6 | Trend: increasing | tau = 0.329 | p = 0.019
Sodium
Sodium (mg/L)
1200
1100
1000
900
800
2018
2019
2020
2021
2022
2023
2024

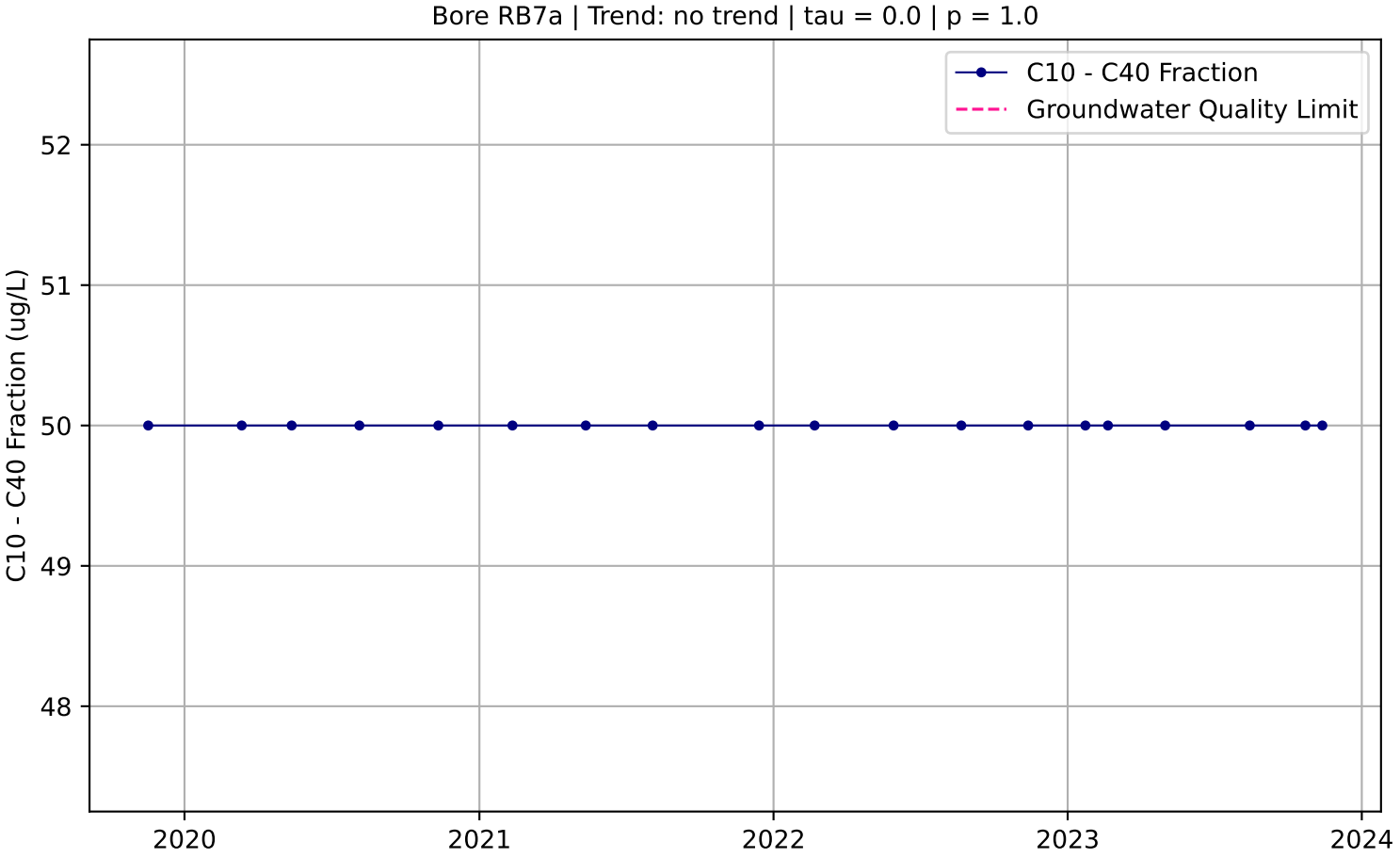

Bore RB6 | Trend: increasing | tau = 0.551 | p = 0.0
Sulfate as SO4 - Turbidimetric (mg/L)
180
160
140
120
100
80
2018
2019
2020
2021
2022
2023
2024
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

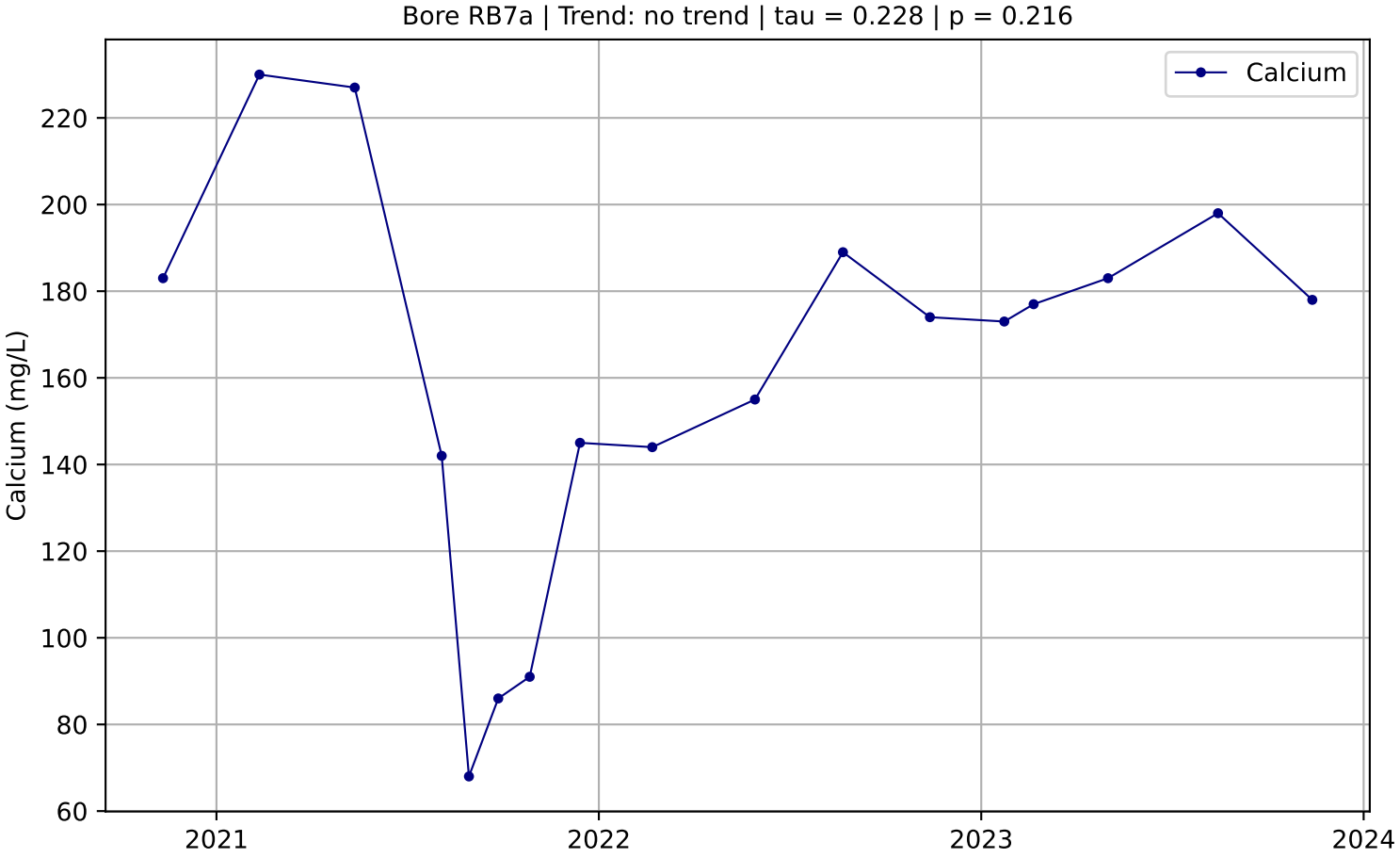

Bore RB7a | Trend: no trend | tau = 0.082 | p = 0.235
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
2020
2021
2022
2023
2024

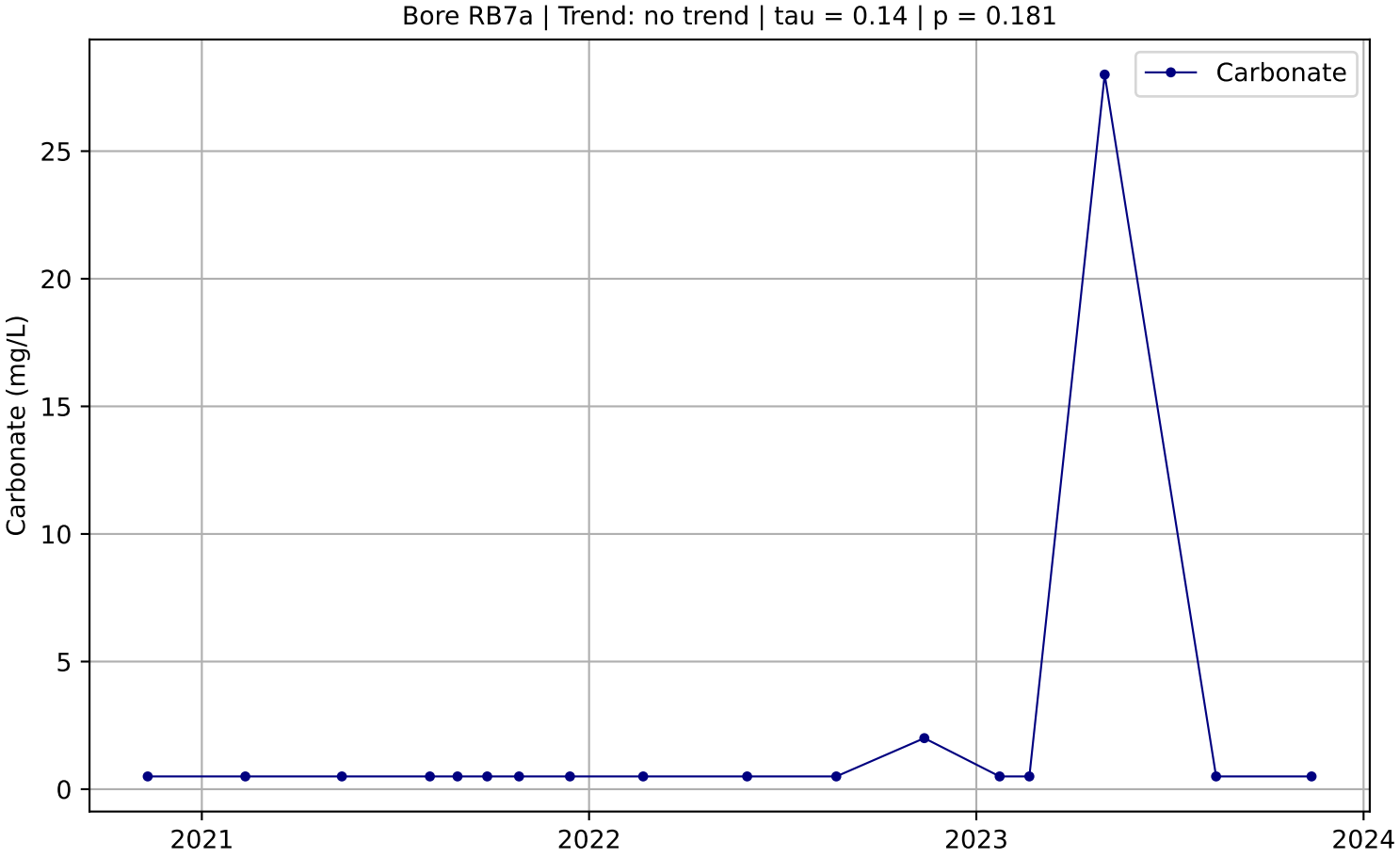

Bore RB7a | Trend: decreasing | tau = -0.281 | p = 0.039
Arsenic (mg/L)
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

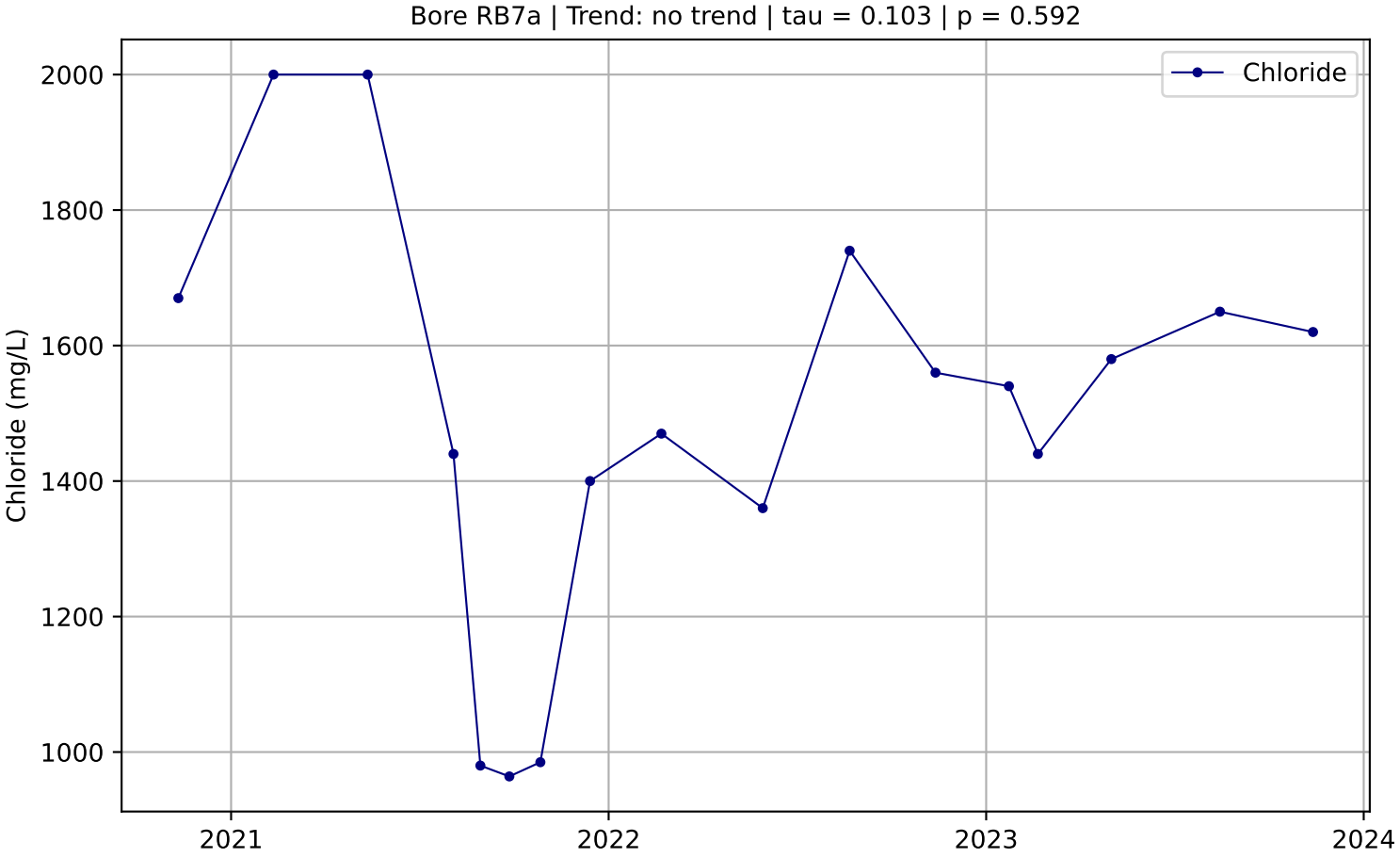

Bore RB7a | Trend: no trend | tau = 0.029 | p = 0.902
Bicarbonate
Bicarbonate (mg/L)
400
300
200
100
2021
2022
2023
2024

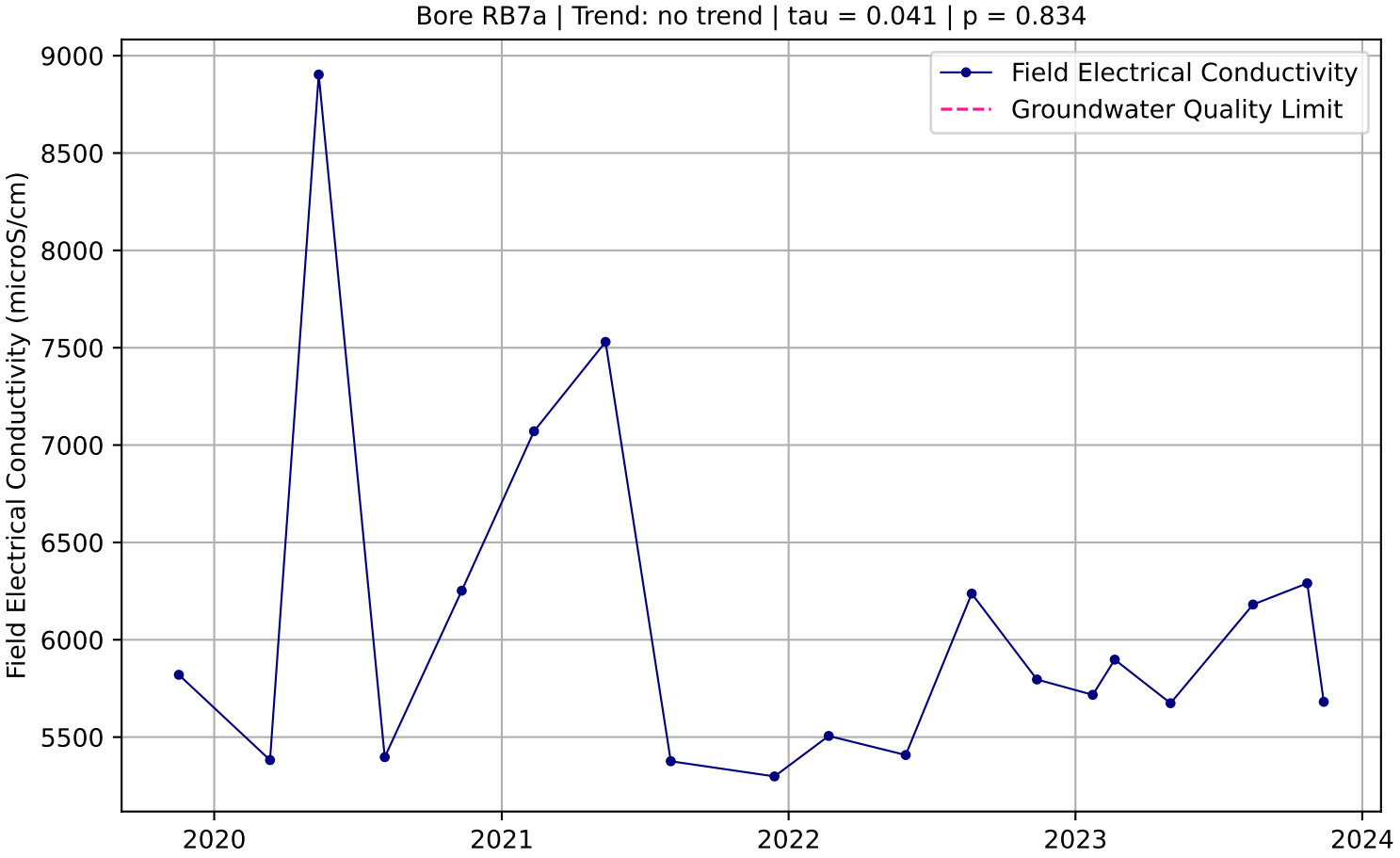

Bore RB7a | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction
Groundwater Quality Limit
C6 - C10 Fraction (ug/L)
10.4
10.2
10.0
9.8
9.6
2020
2021
2022
2023
2024

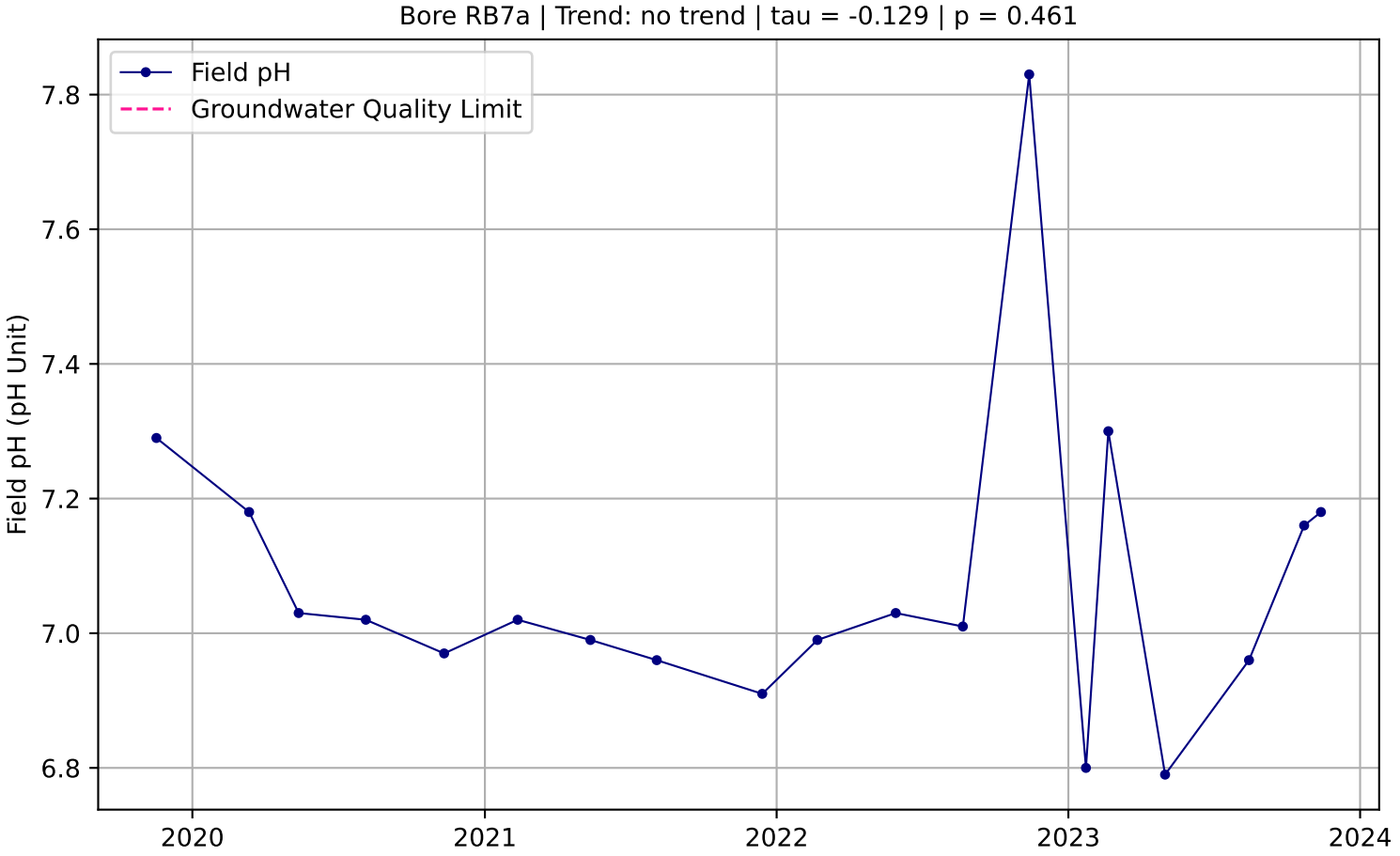

Bore RB7a | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
52
51
50
49
48
2020
2021
2022
2023
2024

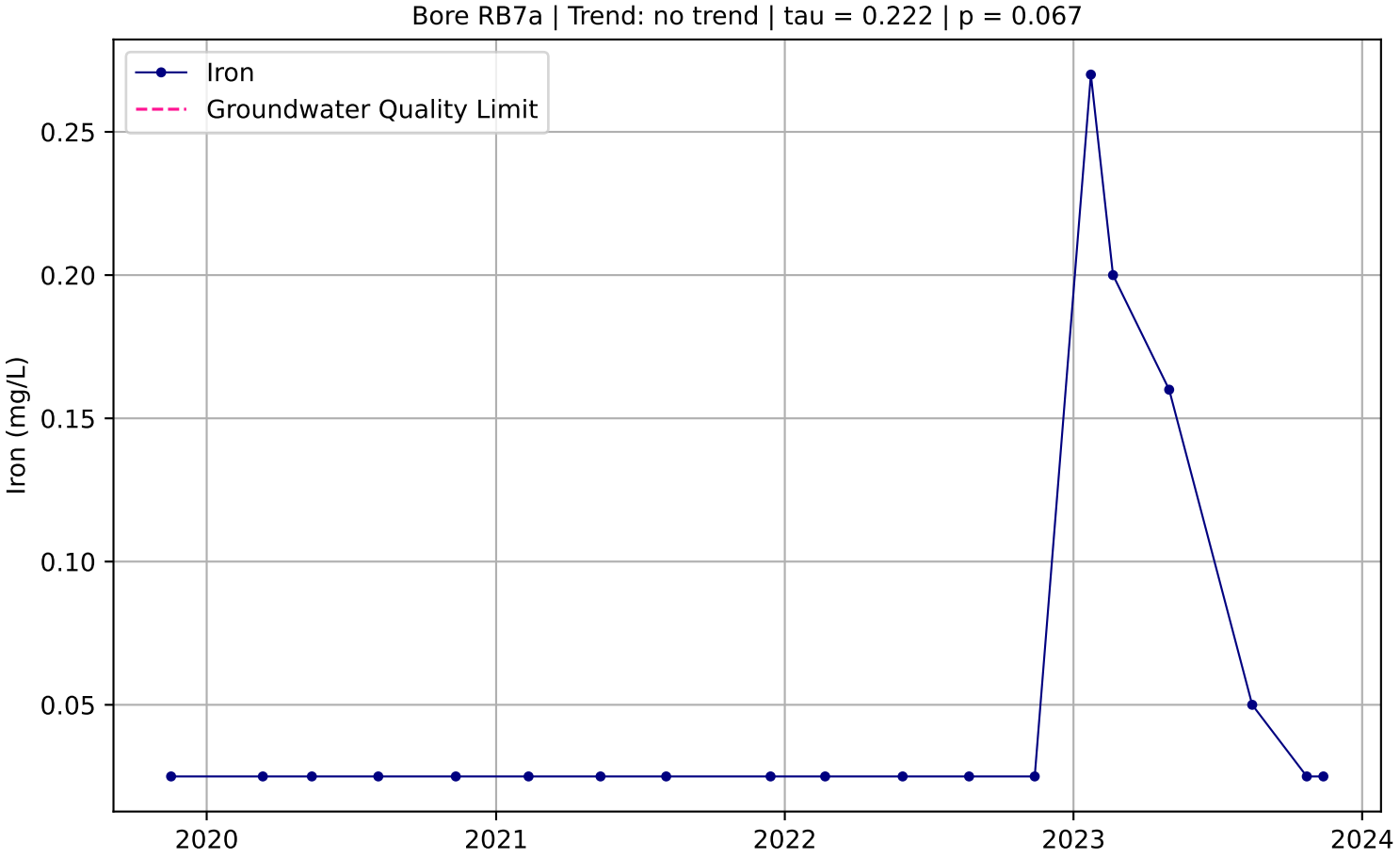

Bore RB7a | Trend: no trend | tau = 0.228 | p = 0.216
Calcium
Calcium (mg/L)
220
200
180
160
140
120
100
80
60
2021
2022
2023
2024

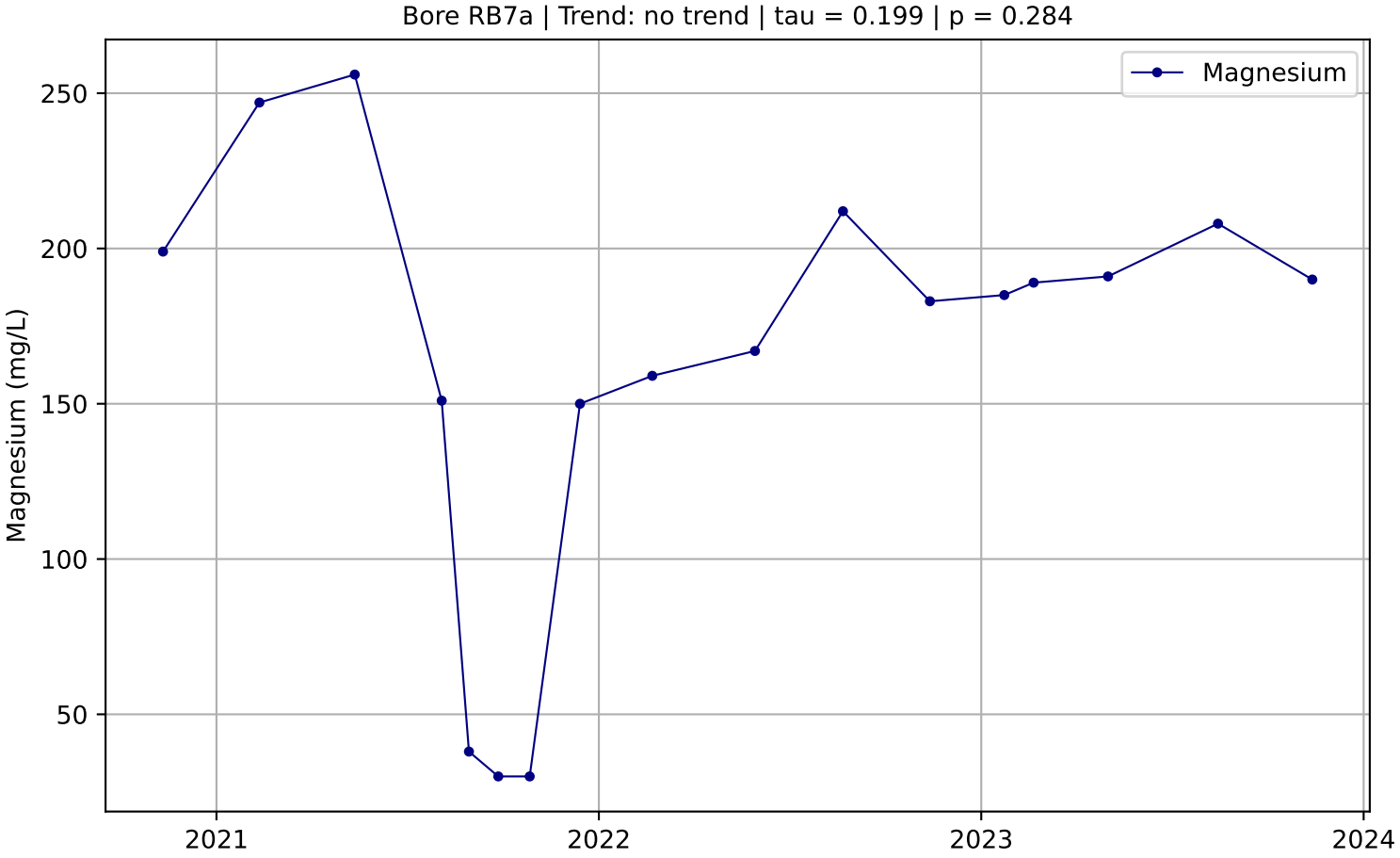

Bore RB7a | Trend: no trend | tau = 0.14 | p = 0.181
Carbonate
Carbonate (mg/L)
0
5
10
15
20
25
2021
2022
2023
2024

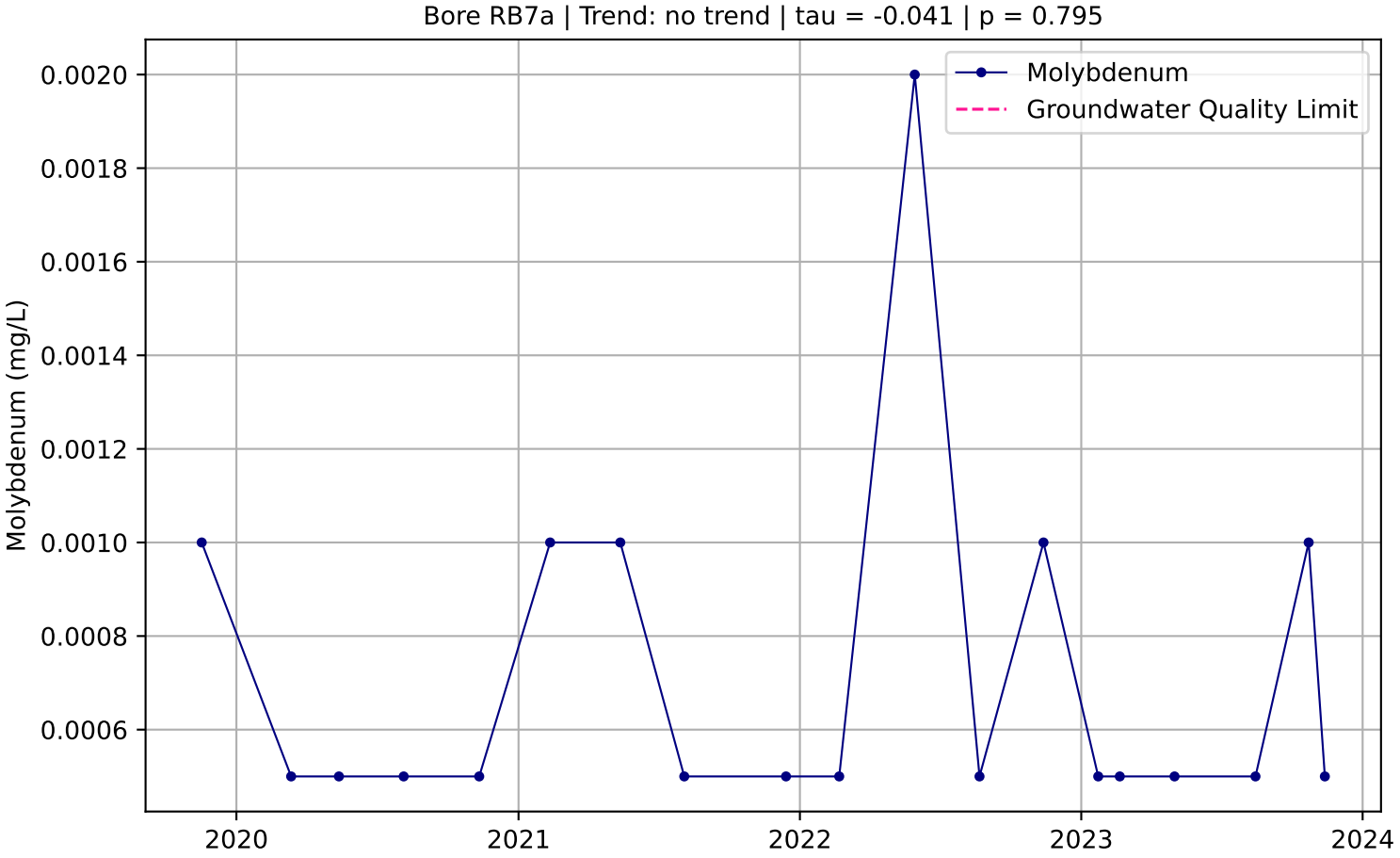

Bore RB7a | Trend: no trend | tau = 0.103 | p = 0.592
Chloride
Chloride (mg/L)
2000
1800
1600
1400
1200
1000
2021
2022
2023
2024

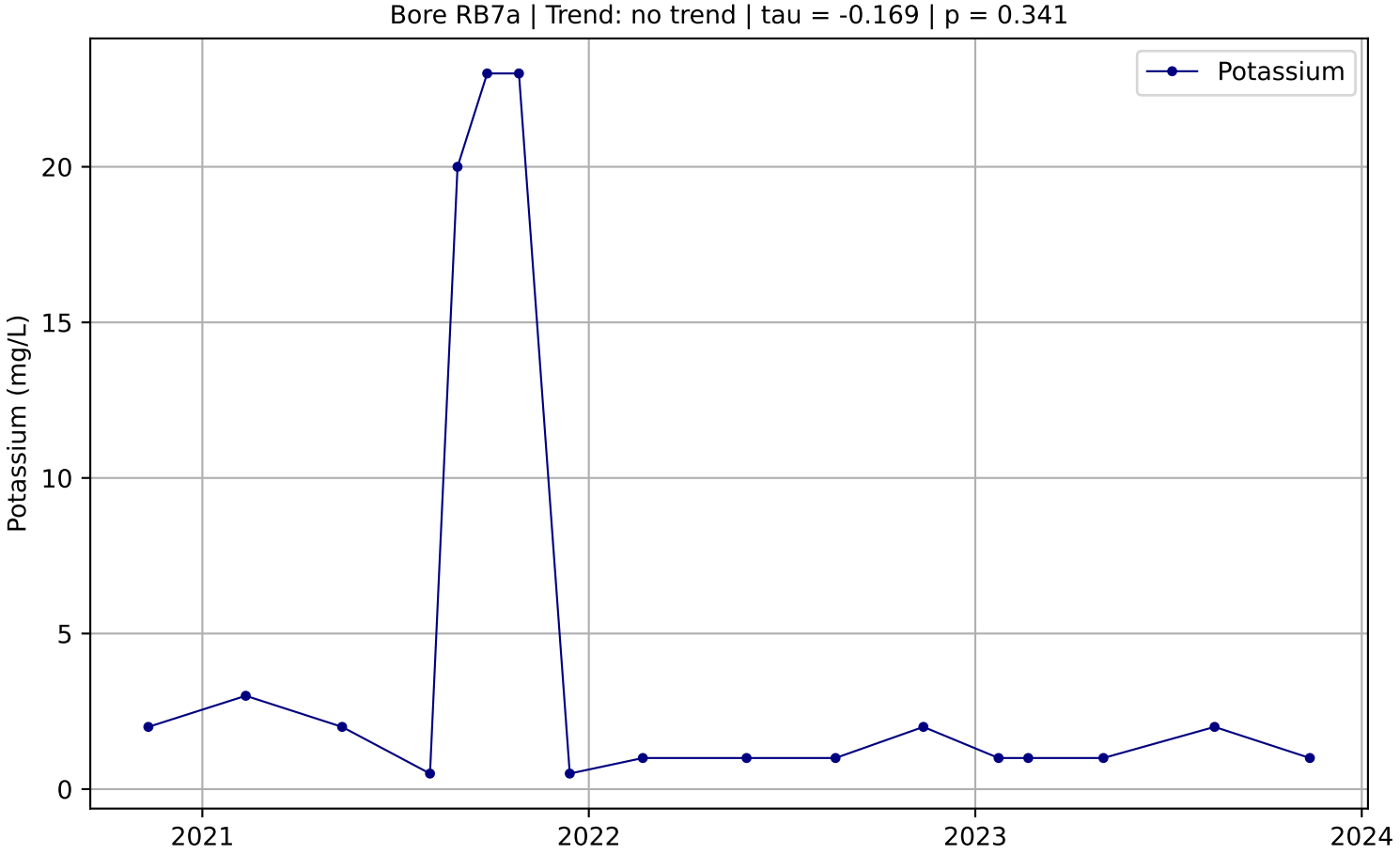

Bore RB7a | Trend: no trend | tau = 0.041 | p = 0.834
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
9000
8500
8000
7500
7000
6500
6000
5500
2020
2021
2022
2023
2024

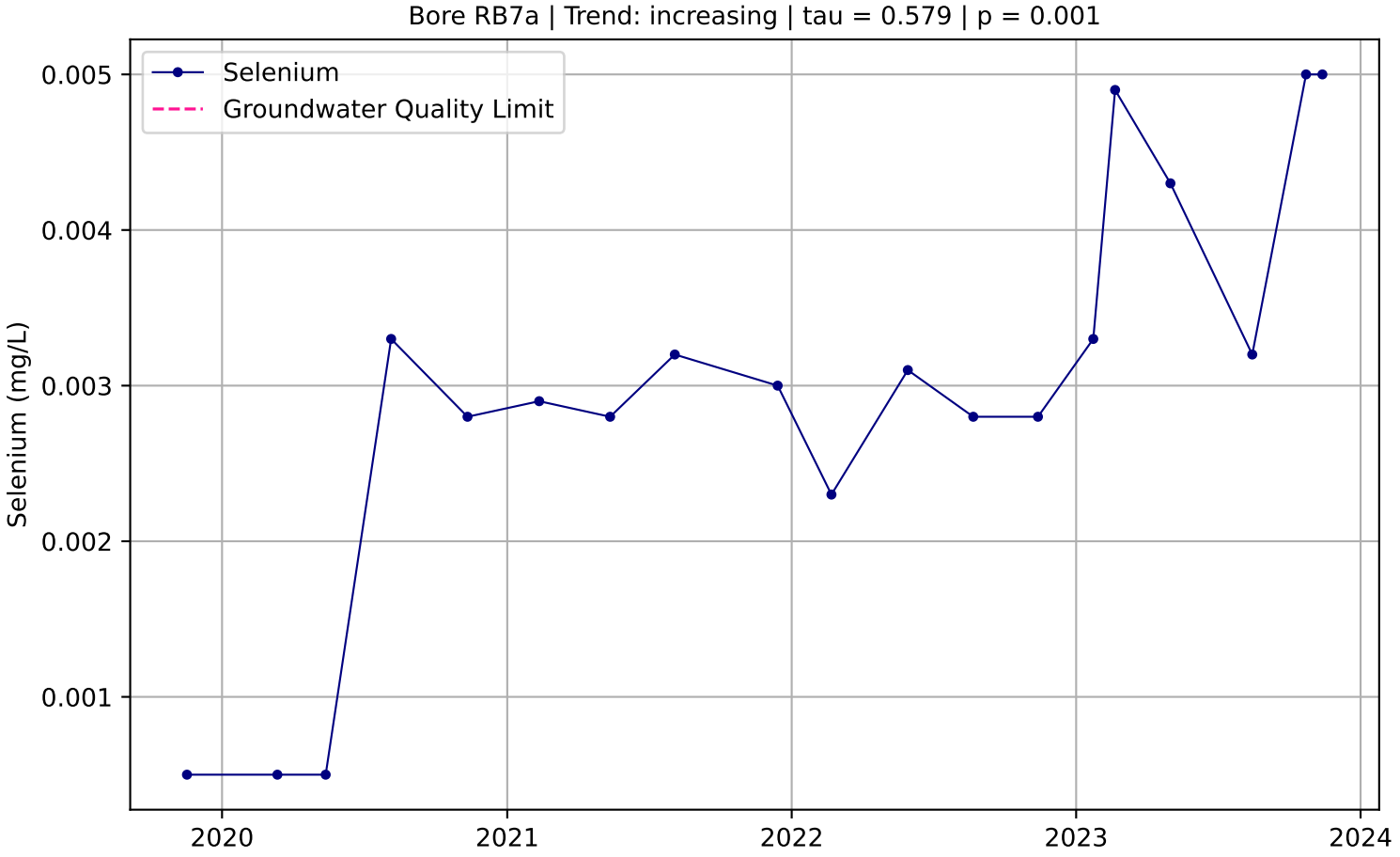

Bore RB7a | Trend: no trend | tau = -0.129 | p = 0.461
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
7.8
7.6
7.4
7.2
7.0
6.8
2020
2021
2022
2023
2024

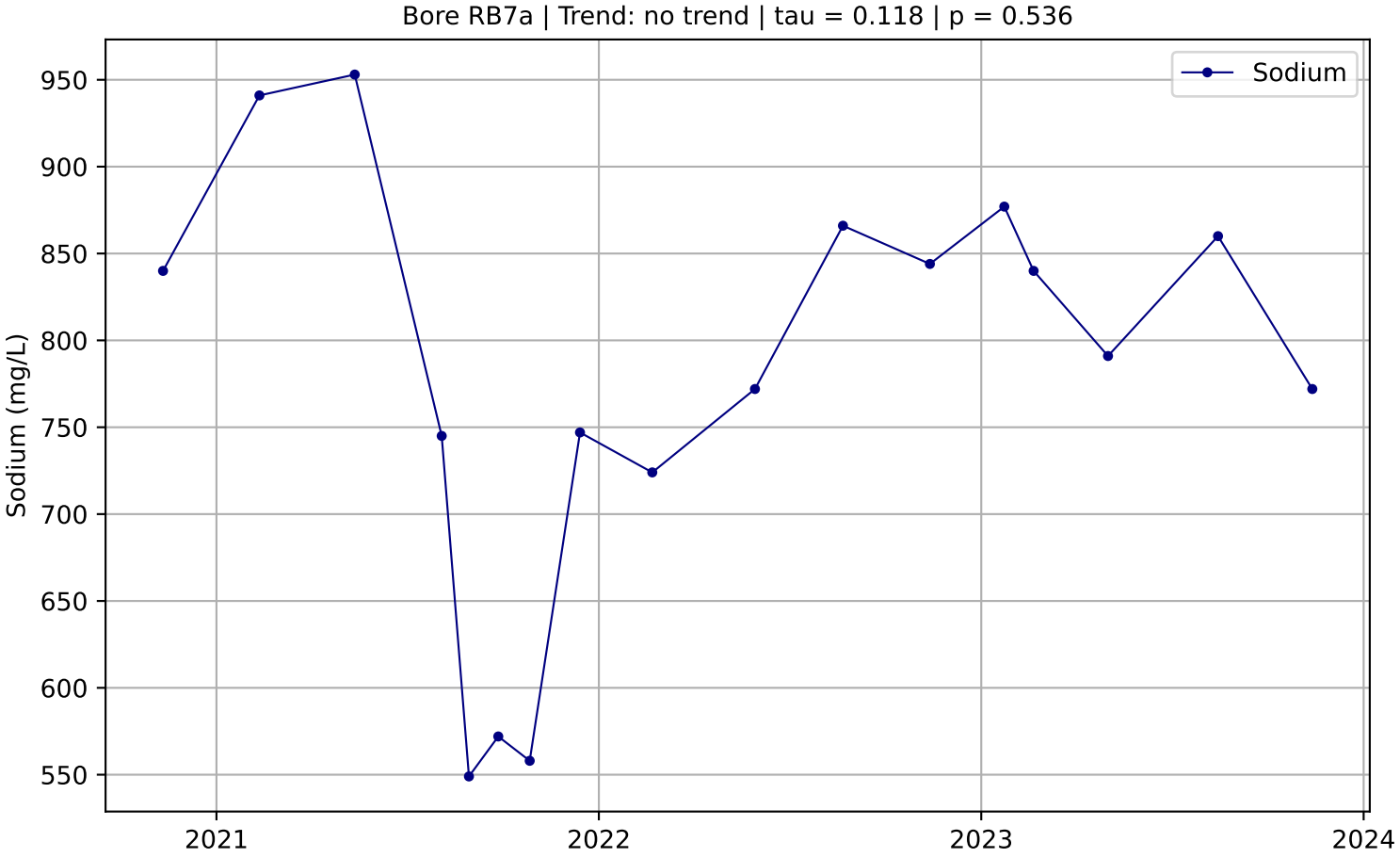

Bore RB7a | Trend: no trend | tau = 0.222 | p = 0.067
Iron
Groundwater Quality Limit
Iron (mg/L)
0.25
0.20
0.15
0.10
0.05
2020
2021
2022
2023
2024

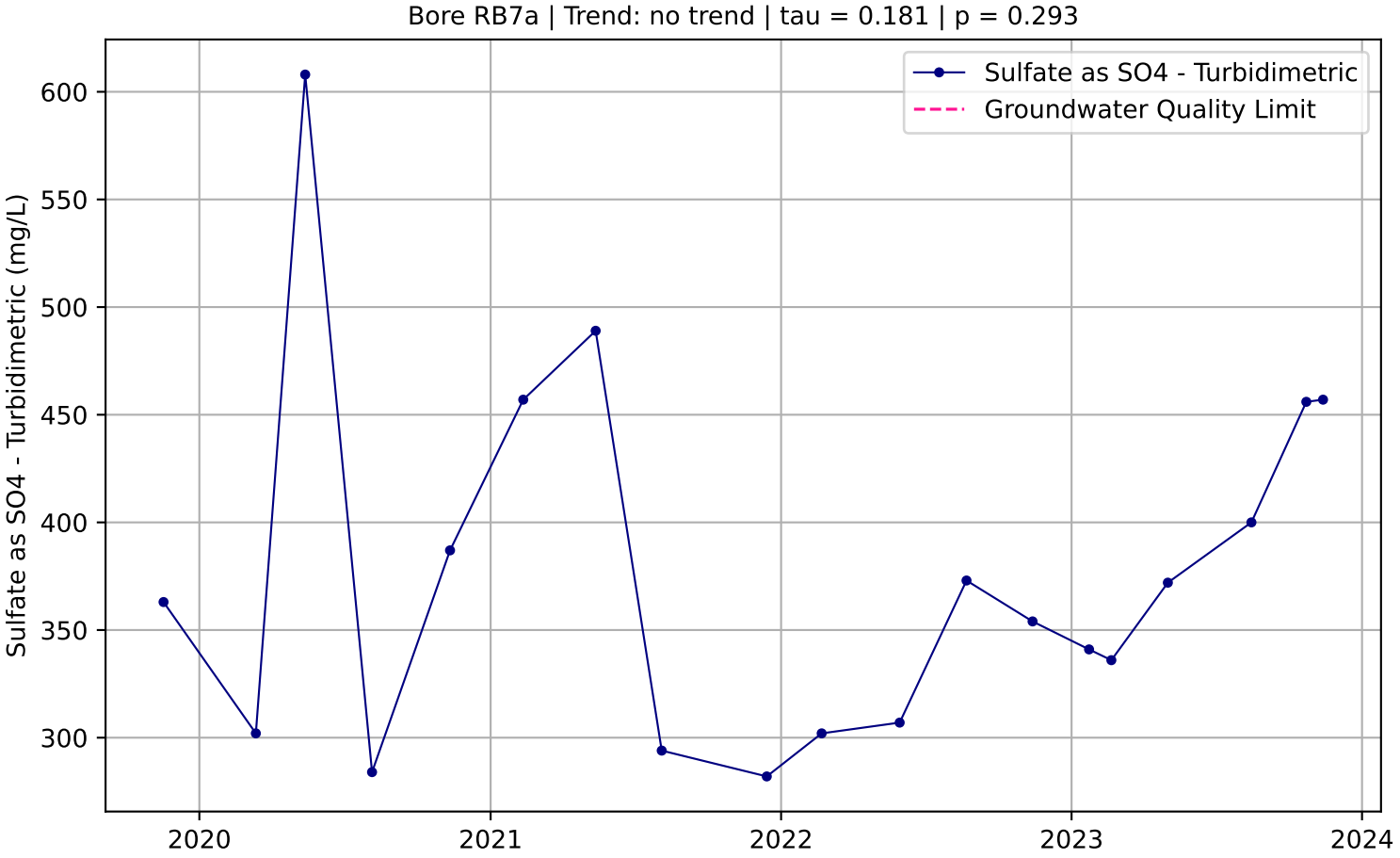

Bore RB7a | Trend: no trend | tau = 0.199 | p = 0.284
Magnesium
Magnesium (mg/L)
250
200
150
100
50
2021
2022
2023
2024

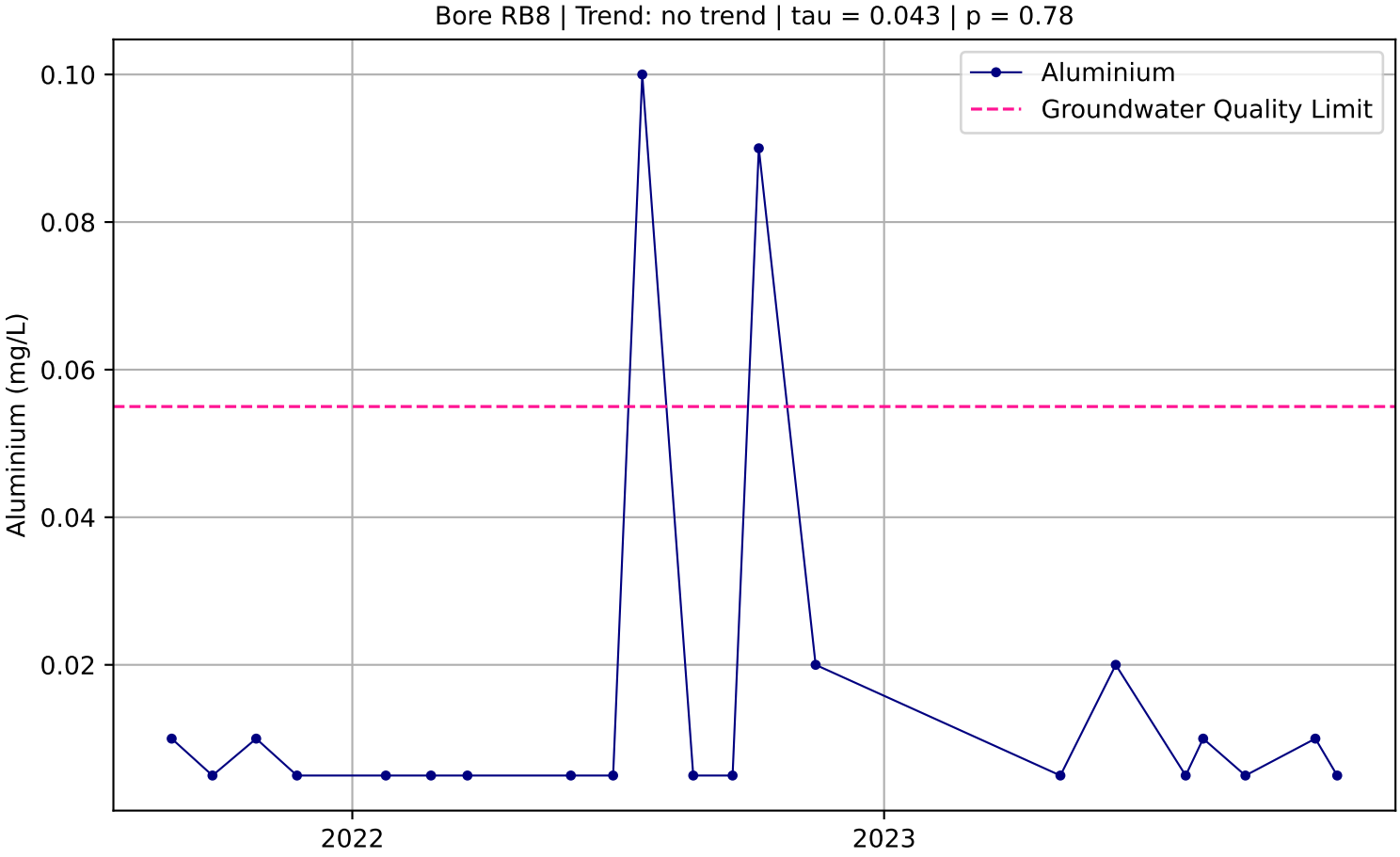

Bore RB7a | Trend: no trend | tau = -0.041 | p = 0.795
Molybdenum
Groundwater Quality Limit
Molybdenum (mg/L)
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
2020
2021
2022
2023
2024

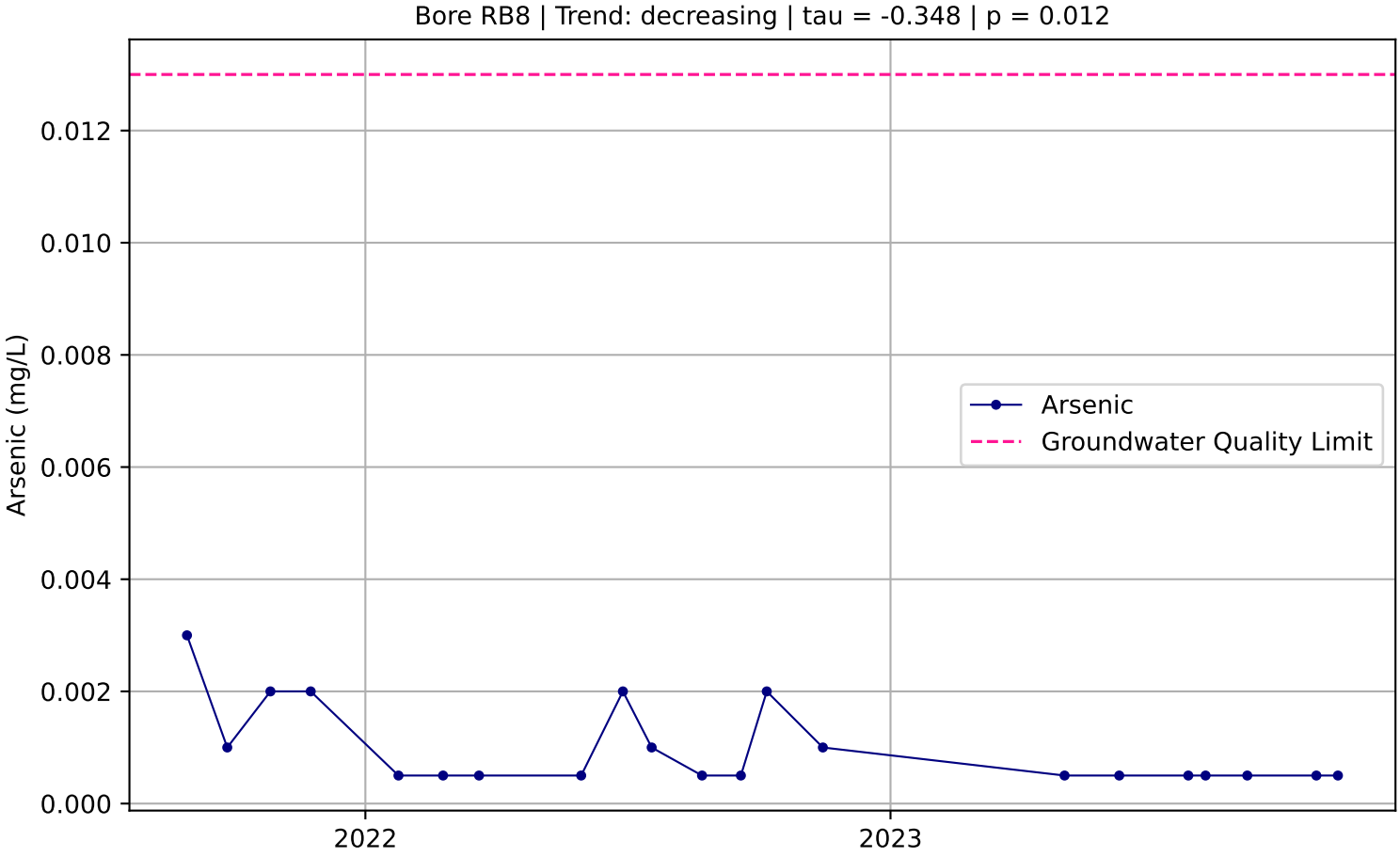

Bore RB7a | Trend: no trend | tau = -0.169 | p = 0.341
Potassium
Potassium (mg/L)
0
5
10
15
20
2021
2022
2023
2024

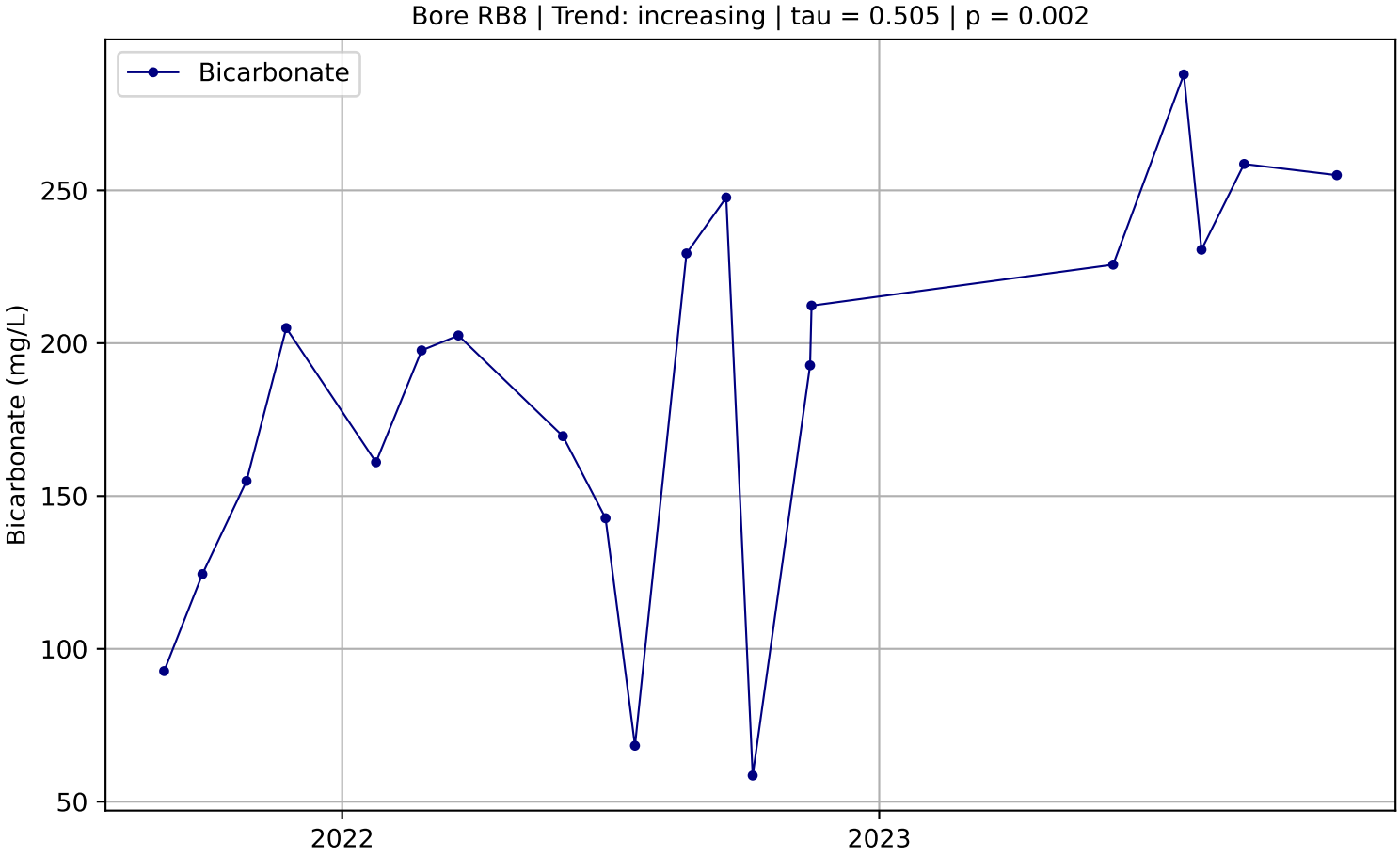

Bore RB7a | Trend: increasing | tau = 0.579 | p = 0.001
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.005
0.004
0.003
0.002
0.001
2020
2021
2022
2023
2024

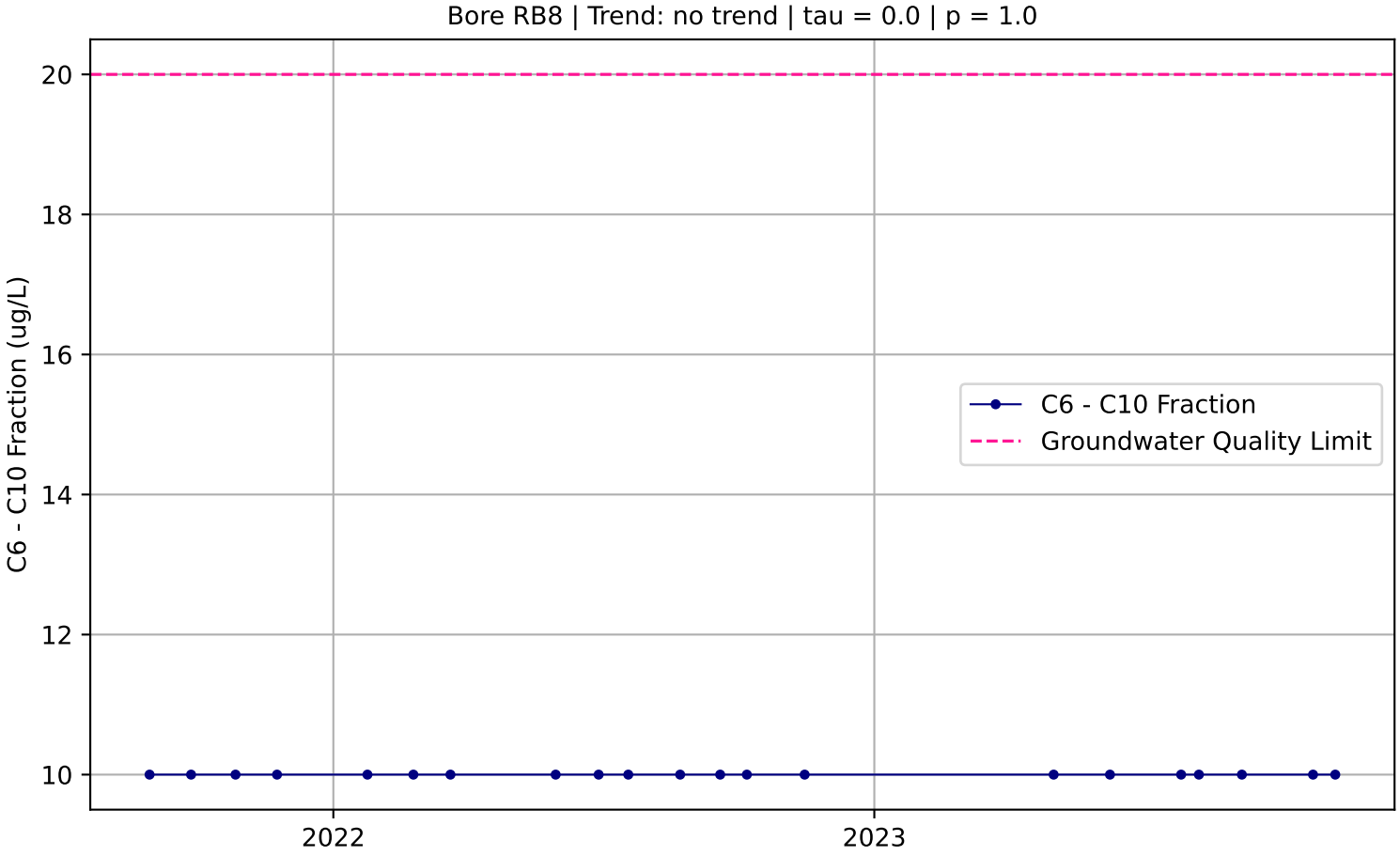

Bore RB7a | Trend: no trend | tau = 0.118 | p = 0.536
Sodium
Sodium (mg/L)
950
900
850
800
750
700
650
600
550
2021
2022
2023
2024

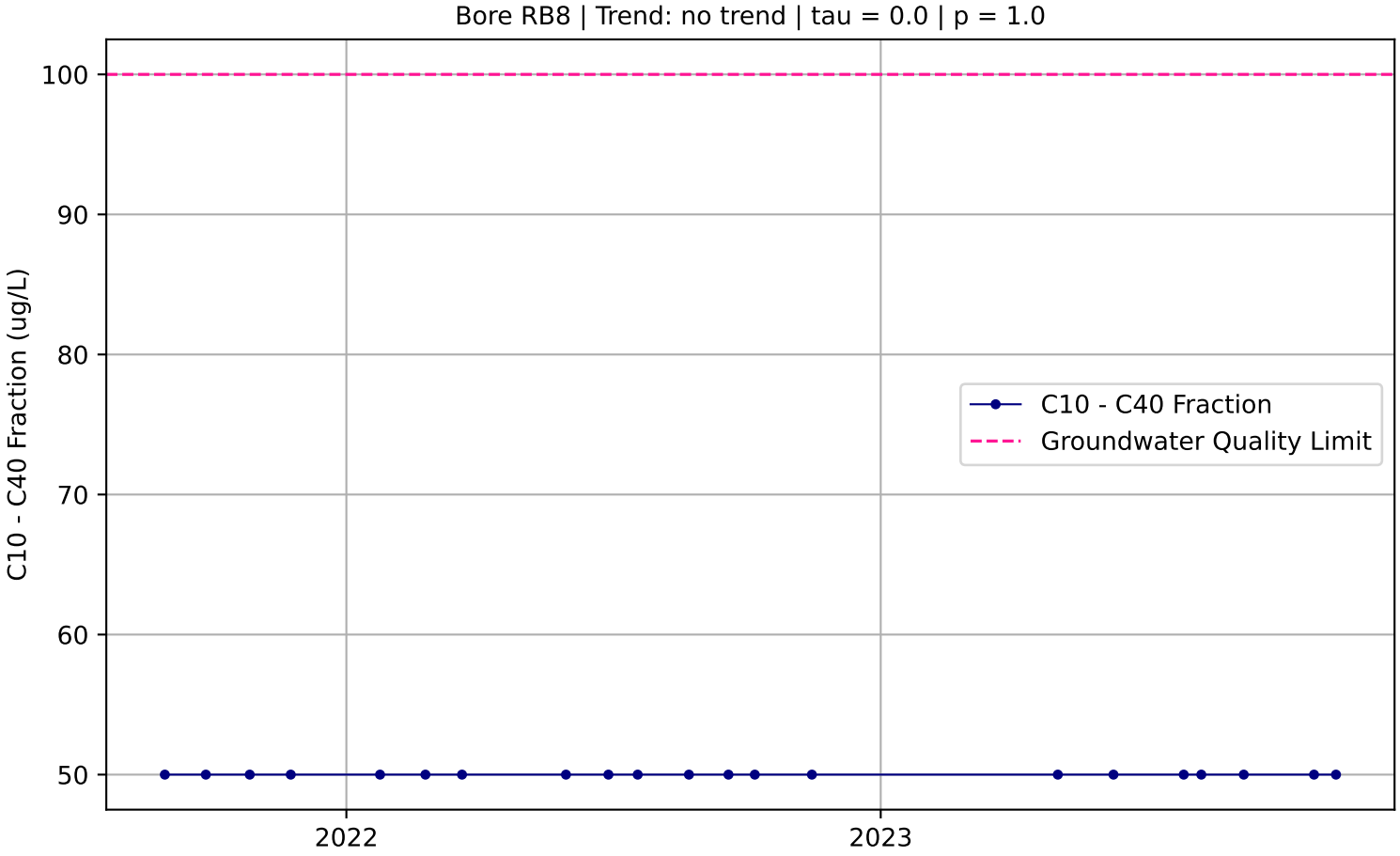

Bore RB7a | Trend: no trend | tau = 0.181 | p = 0.293
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
600
550
500
450
400
350
300
2020
2021
2022
2023
2024

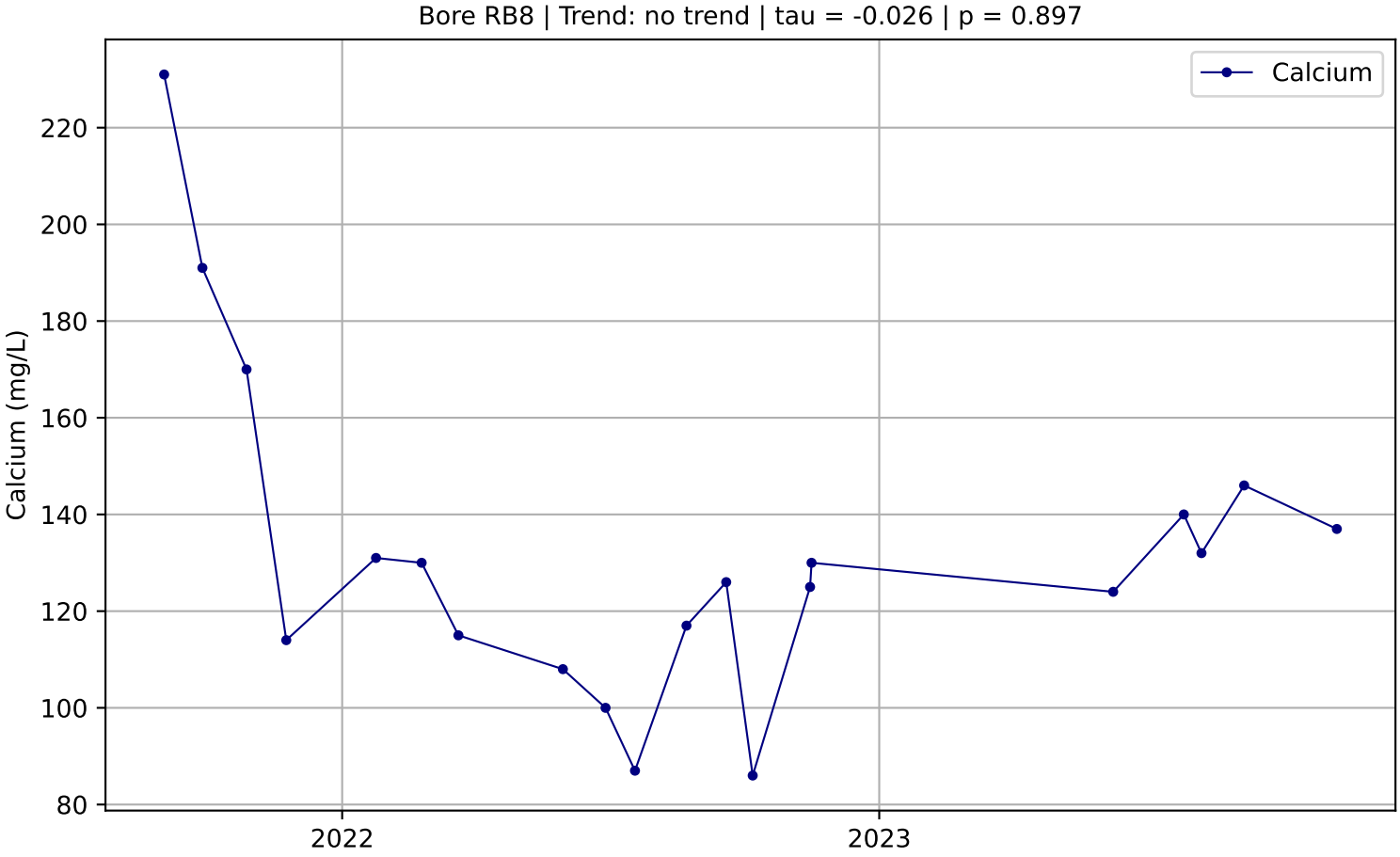

Bore RB8 | Trend: no trend | tau = 0.043 | p = 0.78
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.10
0.08
0.06
0.04
0.02
2022
2023

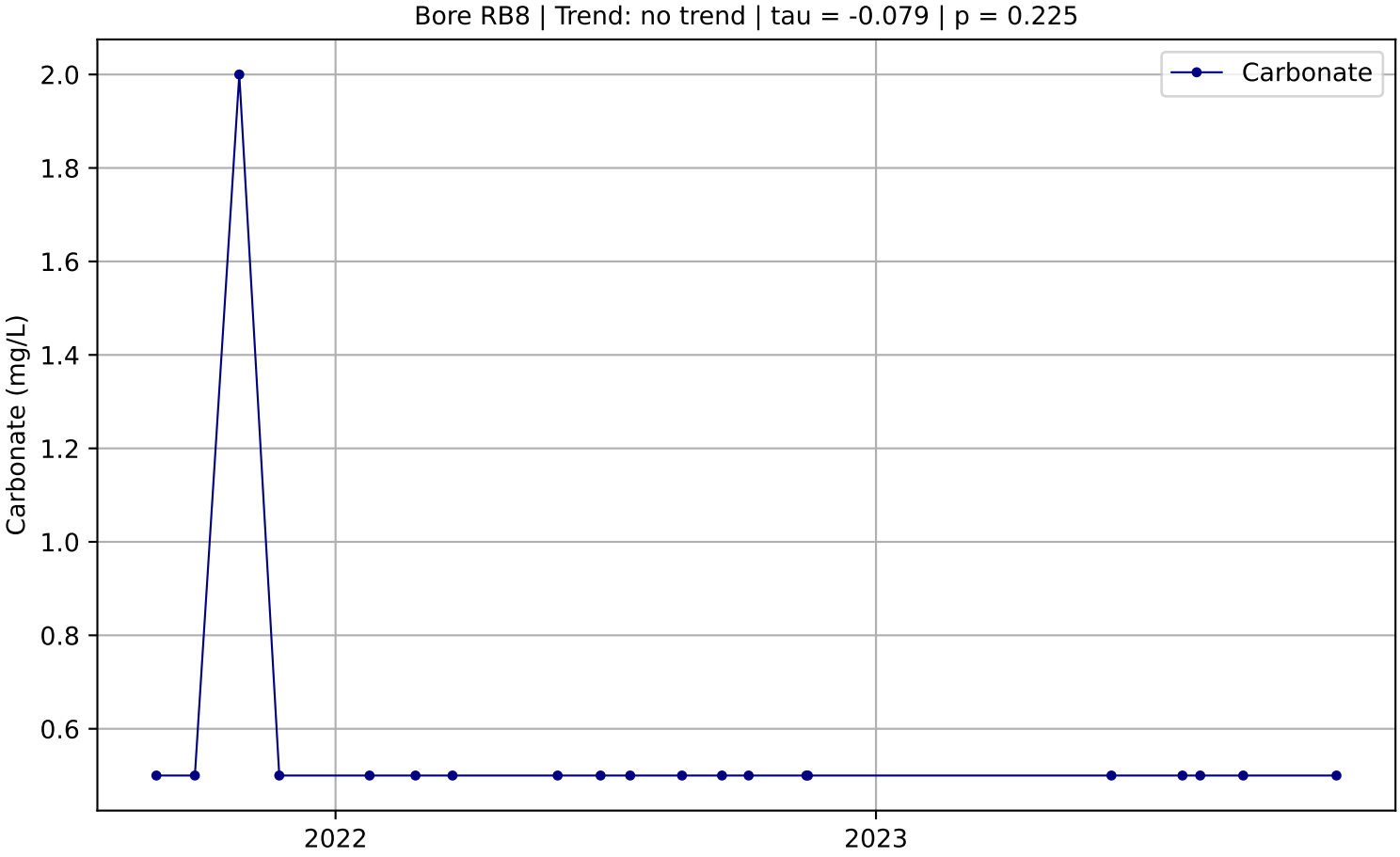

Bore RB8 | Trend: decreasing | tau = -0.348 | p = 0.012
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2022
2023
Arsenic
Groundwater Quality Limit

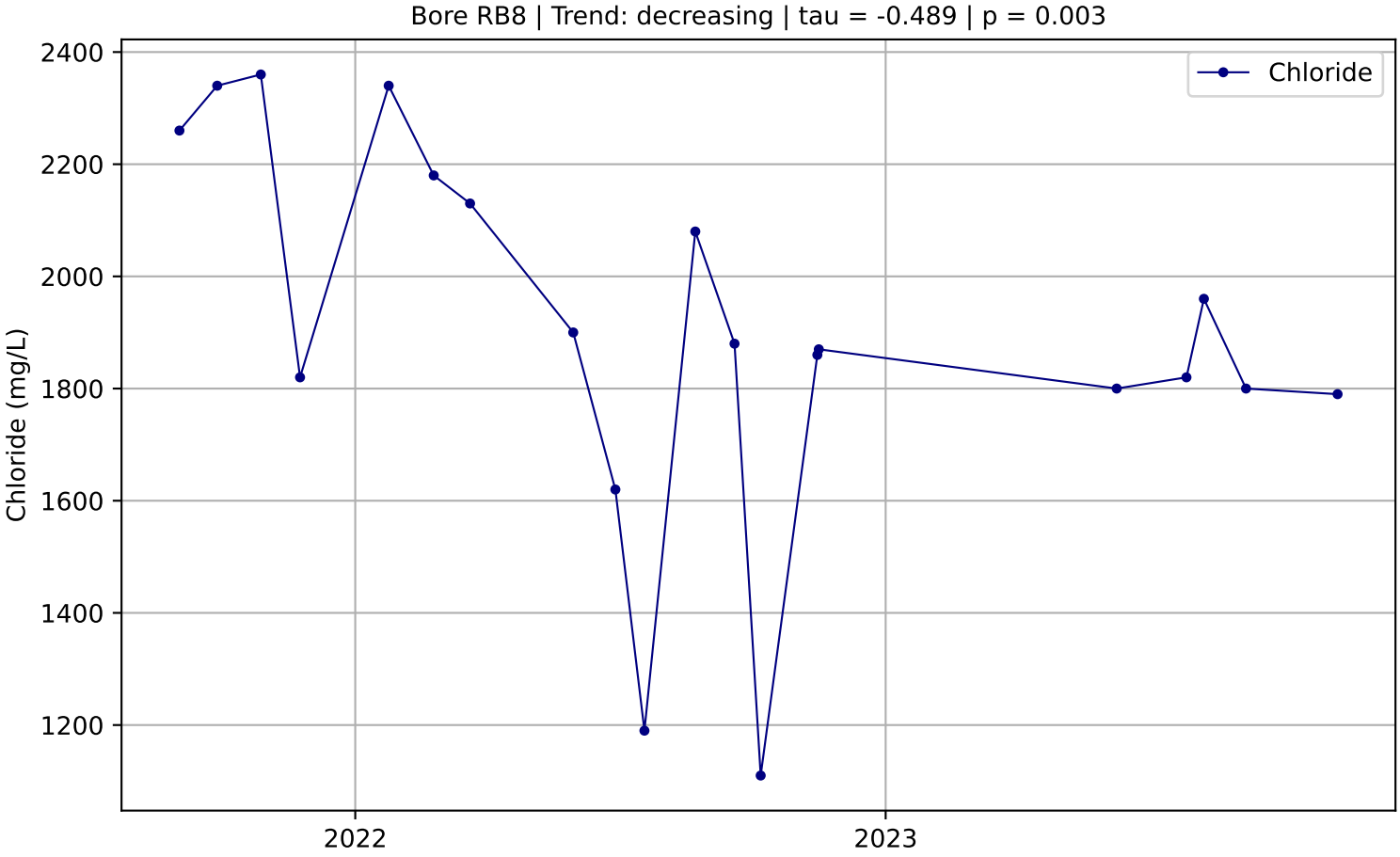

Bore RB8 | Trend: increasing | tau = 0.505 | p = 0.002
Bicarbonate
Bicarbonate (mg/L)
250
200
150
100
50
2022
2023

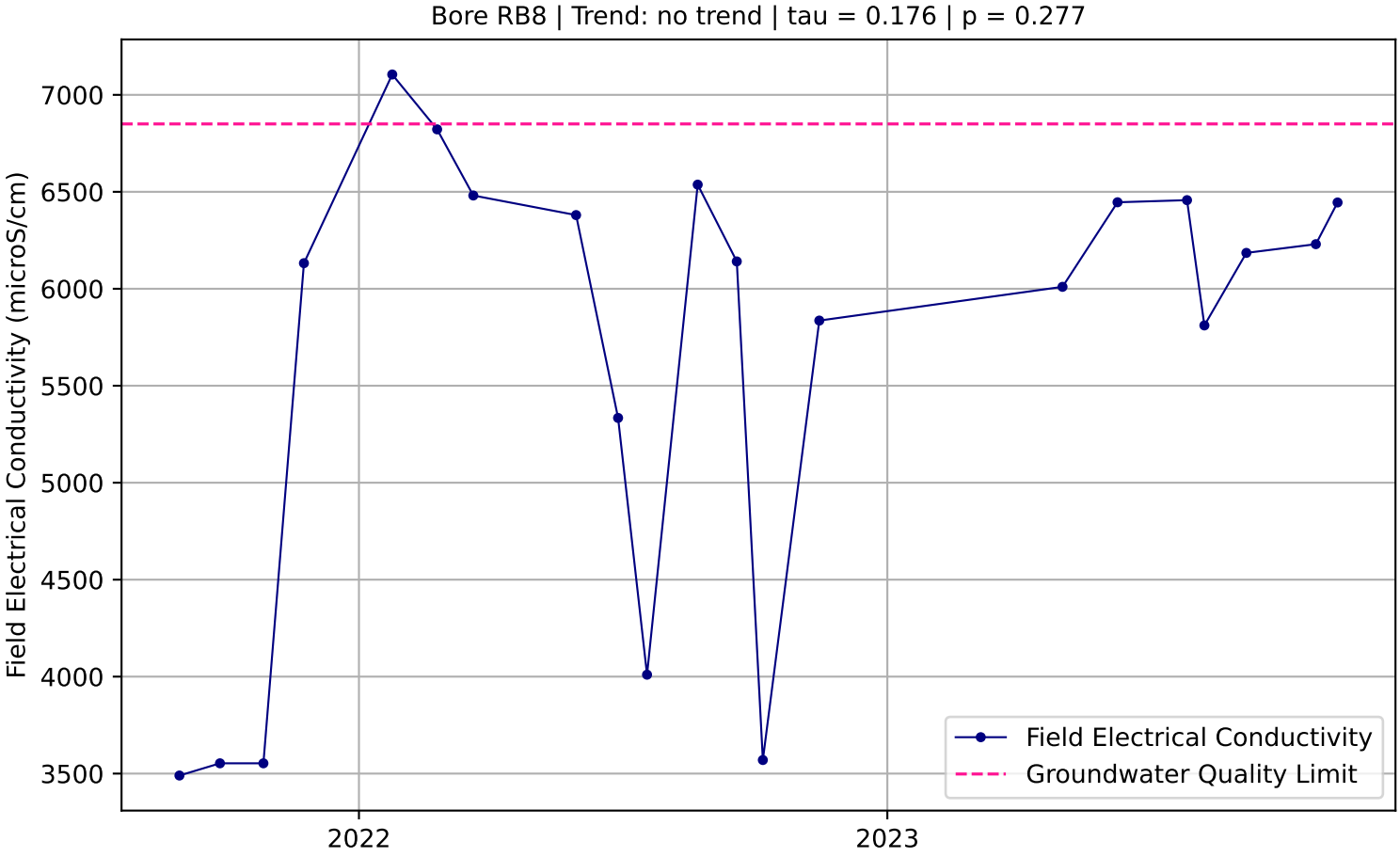

Bore RB8 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2022
2023
C6 - C10 Fraction
Groundwater Quality Limit

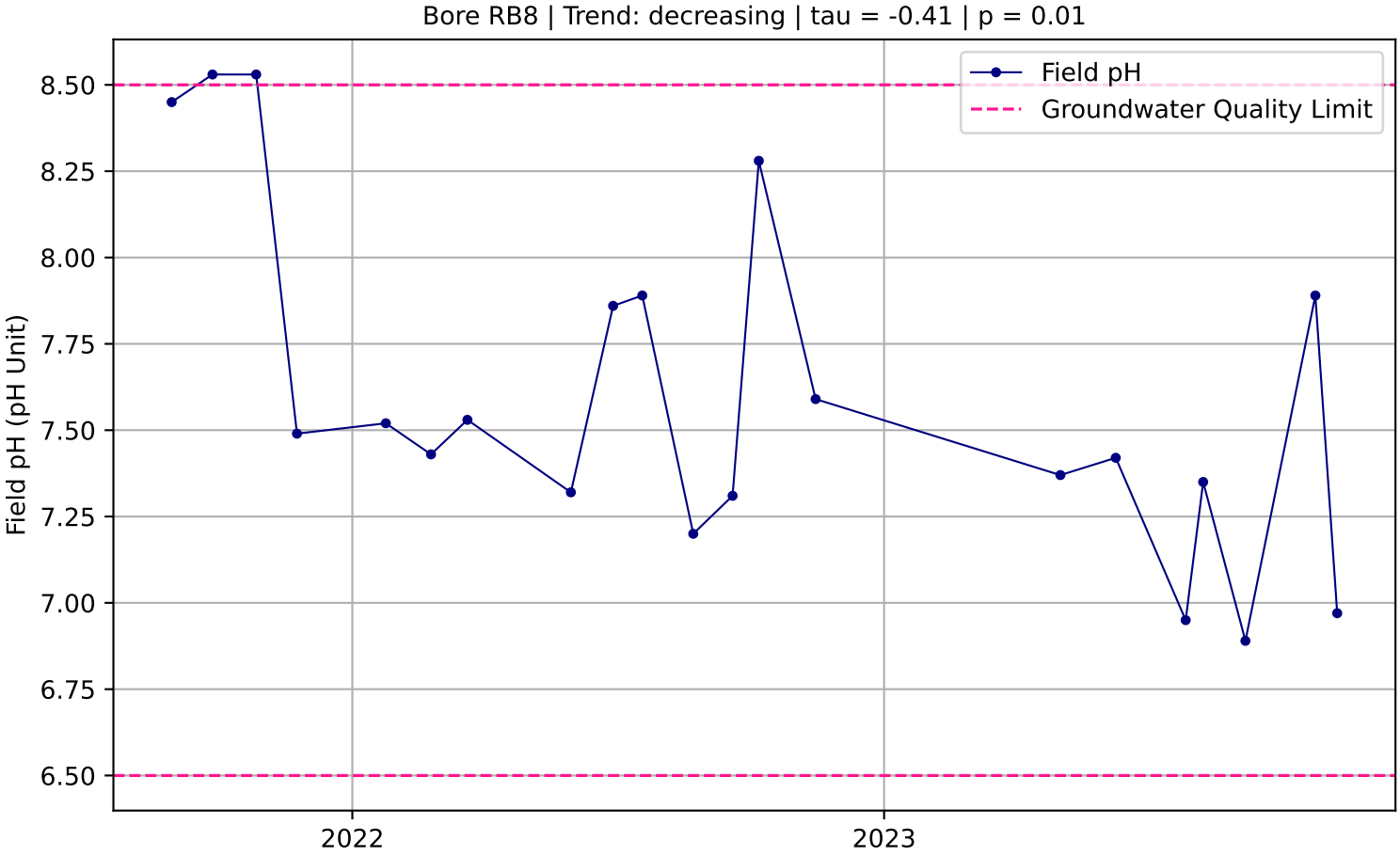

Bore RB8 | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2022
2023
C10 - C40 Fraction
Groundwater Quality Limit

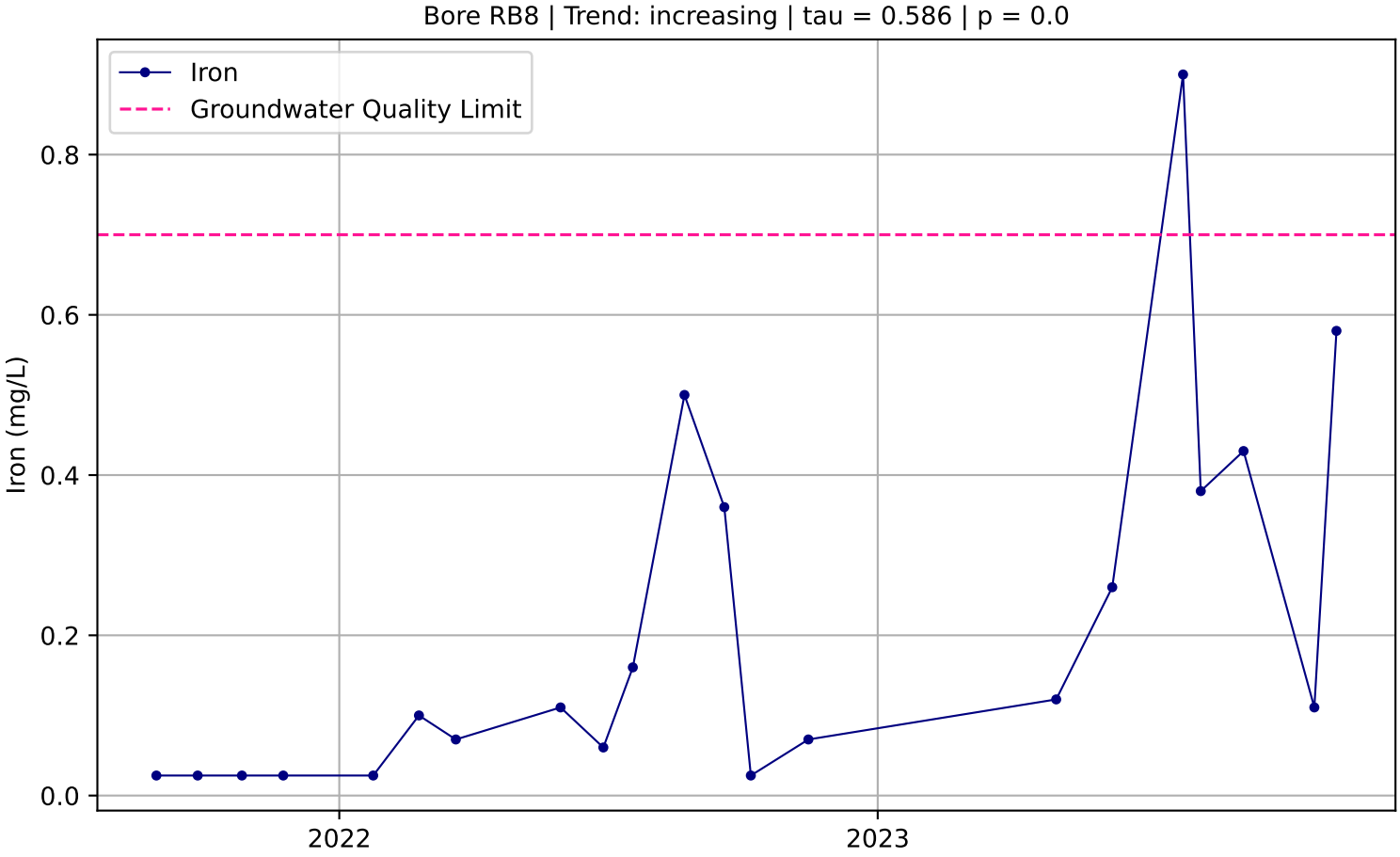

Bore RB8 | Trend: no trend | tau = -0.026 | p = 0.897
Calcium
Calcium (mg/L)
220
200
180
160
140
120
100
80
2022
2023

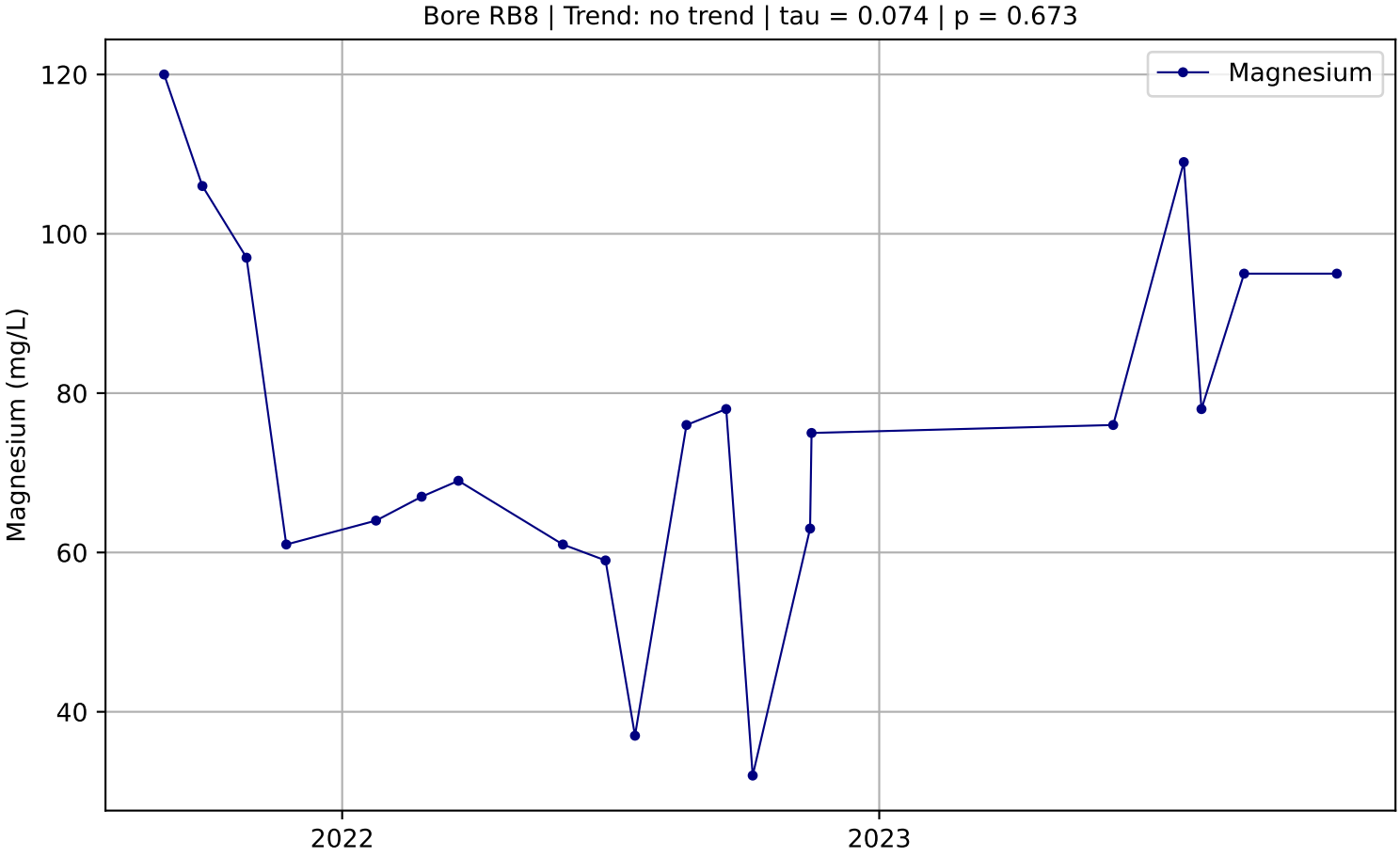

Bore RB8 | Trend: no trend | tau = -0.079 | p = 0.225
Carbonate
Carbonate (mg/L)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
2022
2023

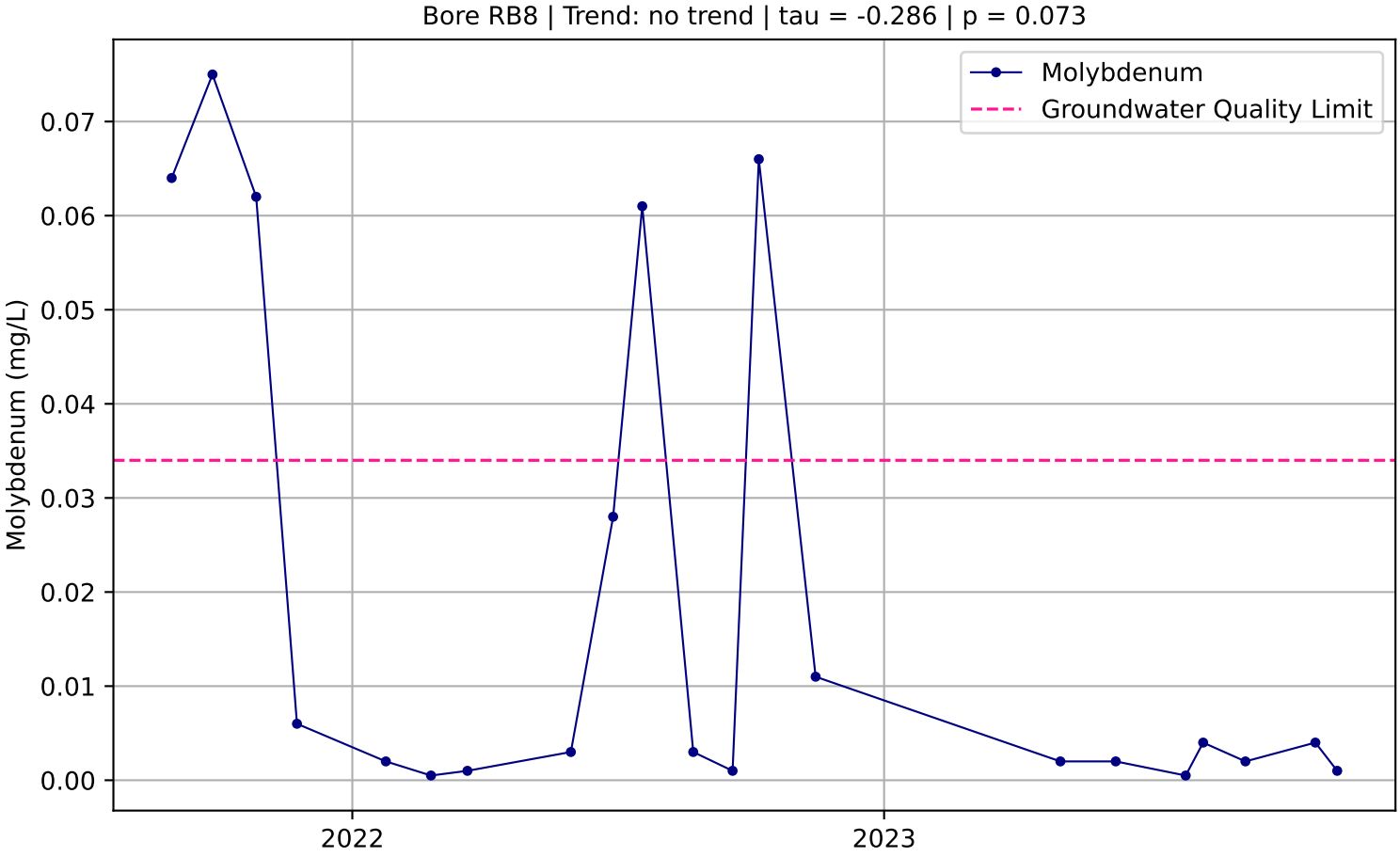

Bore RB8 | Trend: decreasing | tau = -0.489 | p = 0.003
Chloride
Chloride (mg/L)
2400
2200
2000
1800
1600
1400
1200
2022
2023

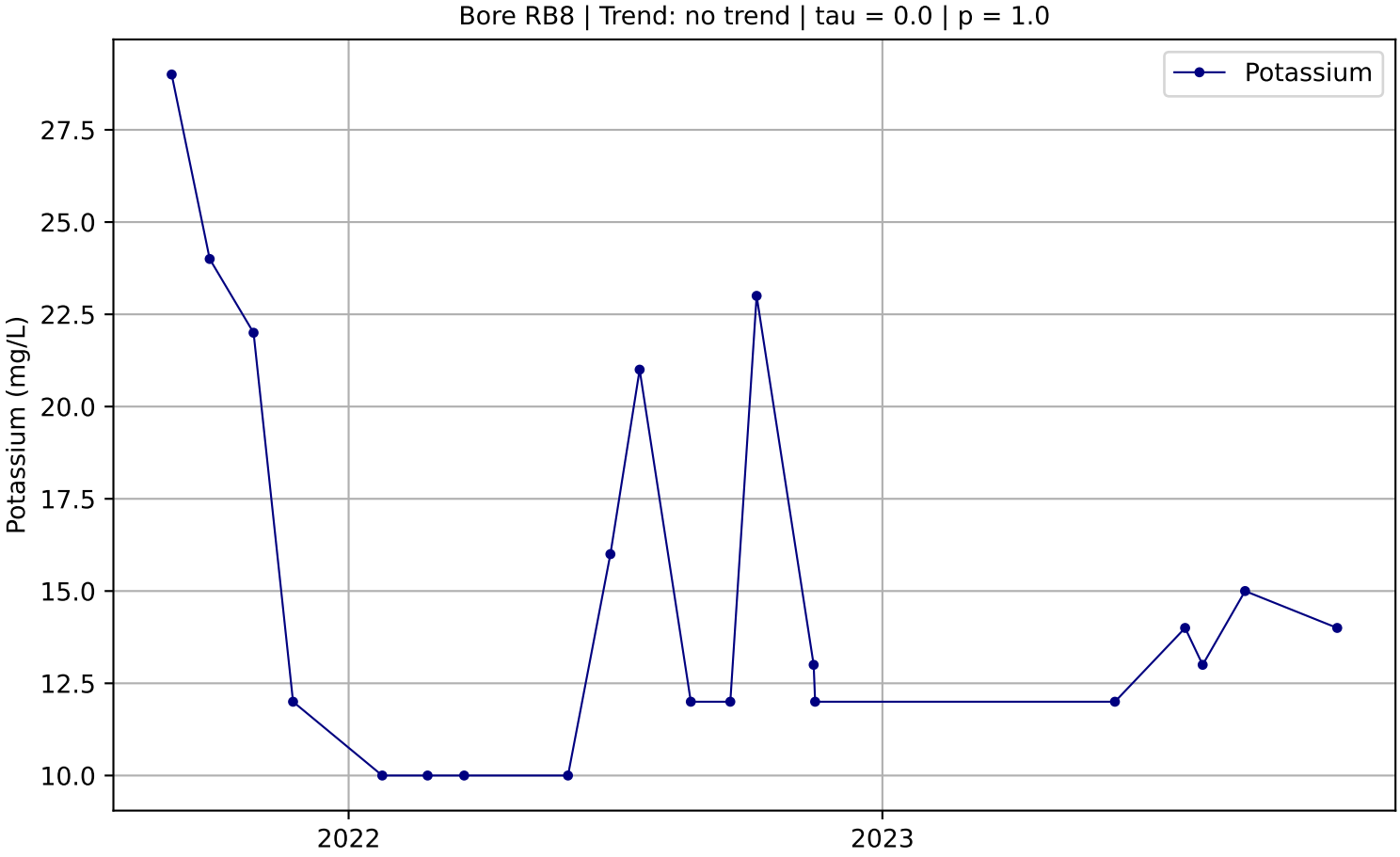

Bore RB8 | Trend: no trend | tau = 0.176 | p = 0.277
Field Electrical Conductivity (microS/cm)
7000
6500
6000
5500
5000
4500
4000
3500
2022
2023
Field Electrical Conductivity
Groundwater Quality Limit

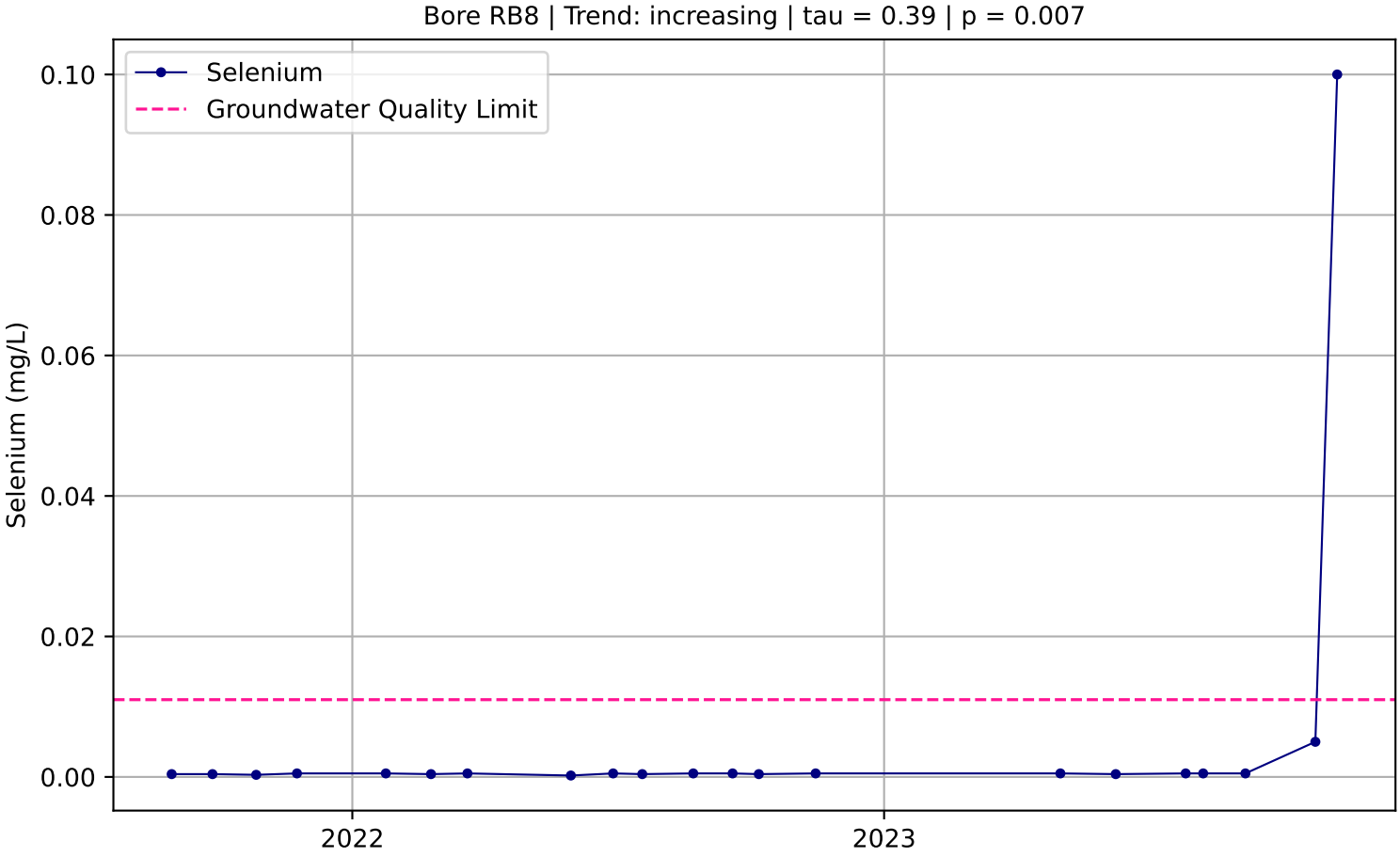

Bore RB8 | Trend: decreasing | tau = -0.41 | p = 0.01
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2022
2023

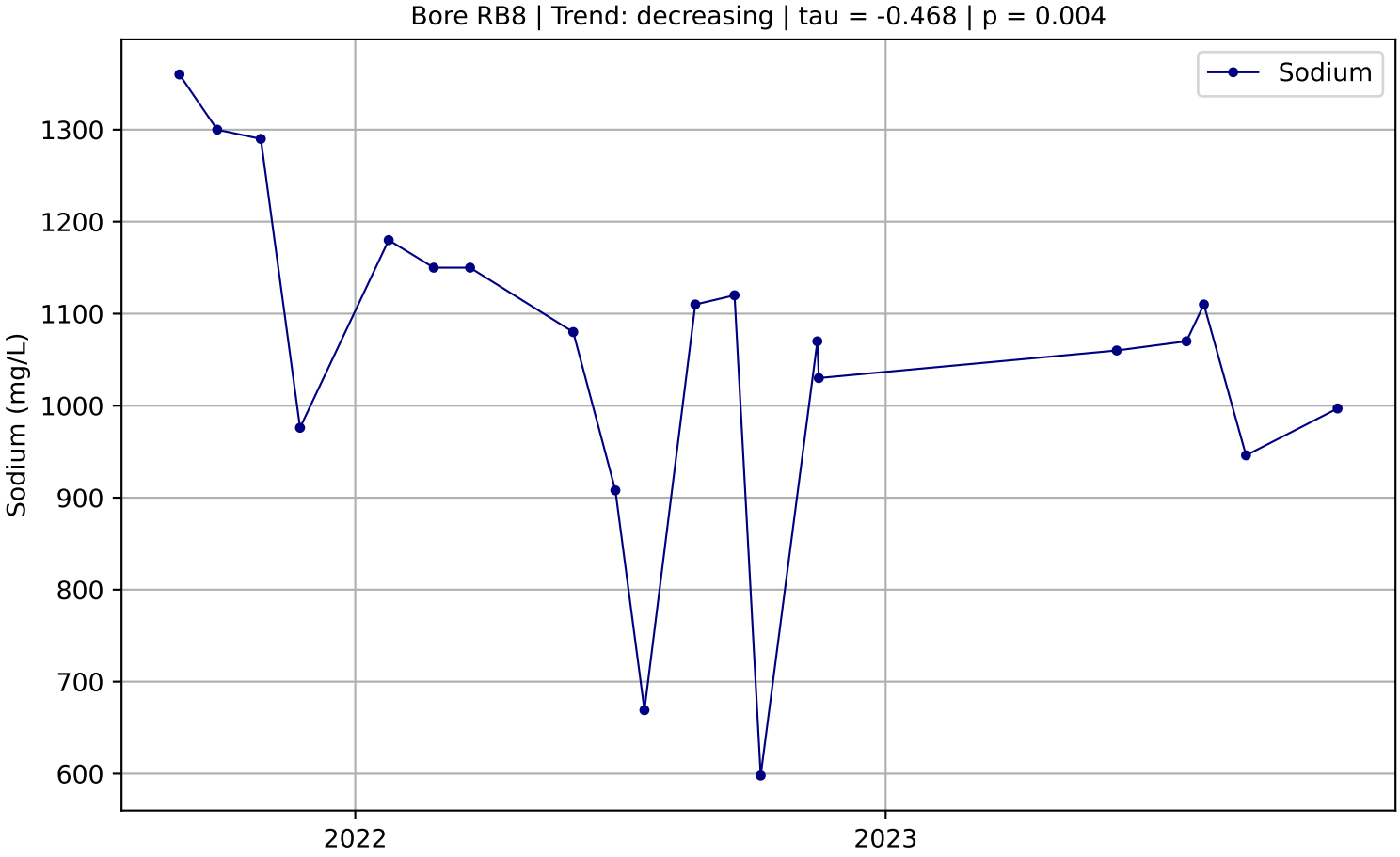

Bore RB8 | Trend: increasing | tau = 0.586 | p = 0.0
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.2
0.4
0.6
0.8
2022
2023

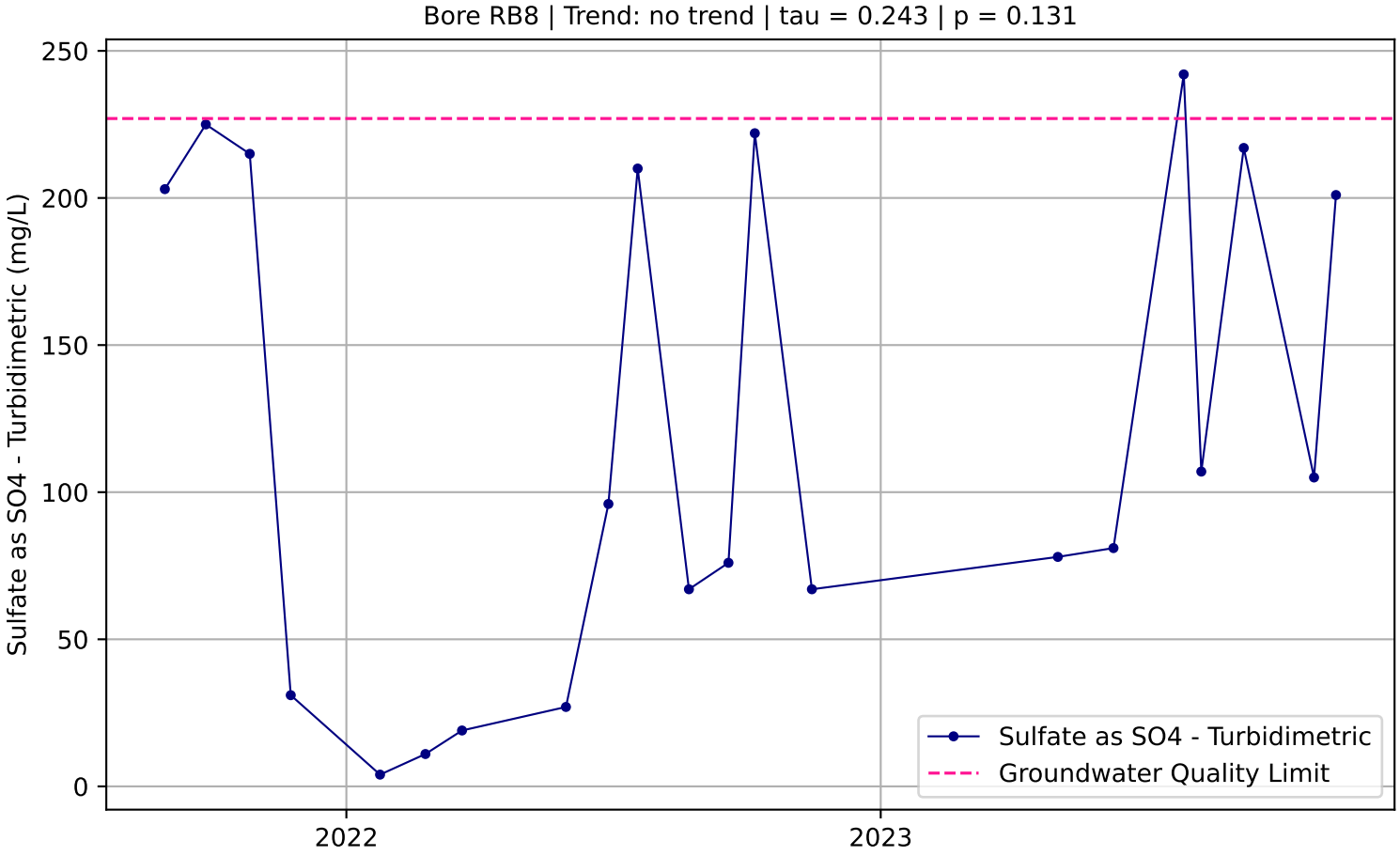

Bore RB8 | Trend: no trend | tau = 0.074 | p = 0.673
Magnesium
Magnesium (mg/L)
120
100
80
60
40
2022
2023

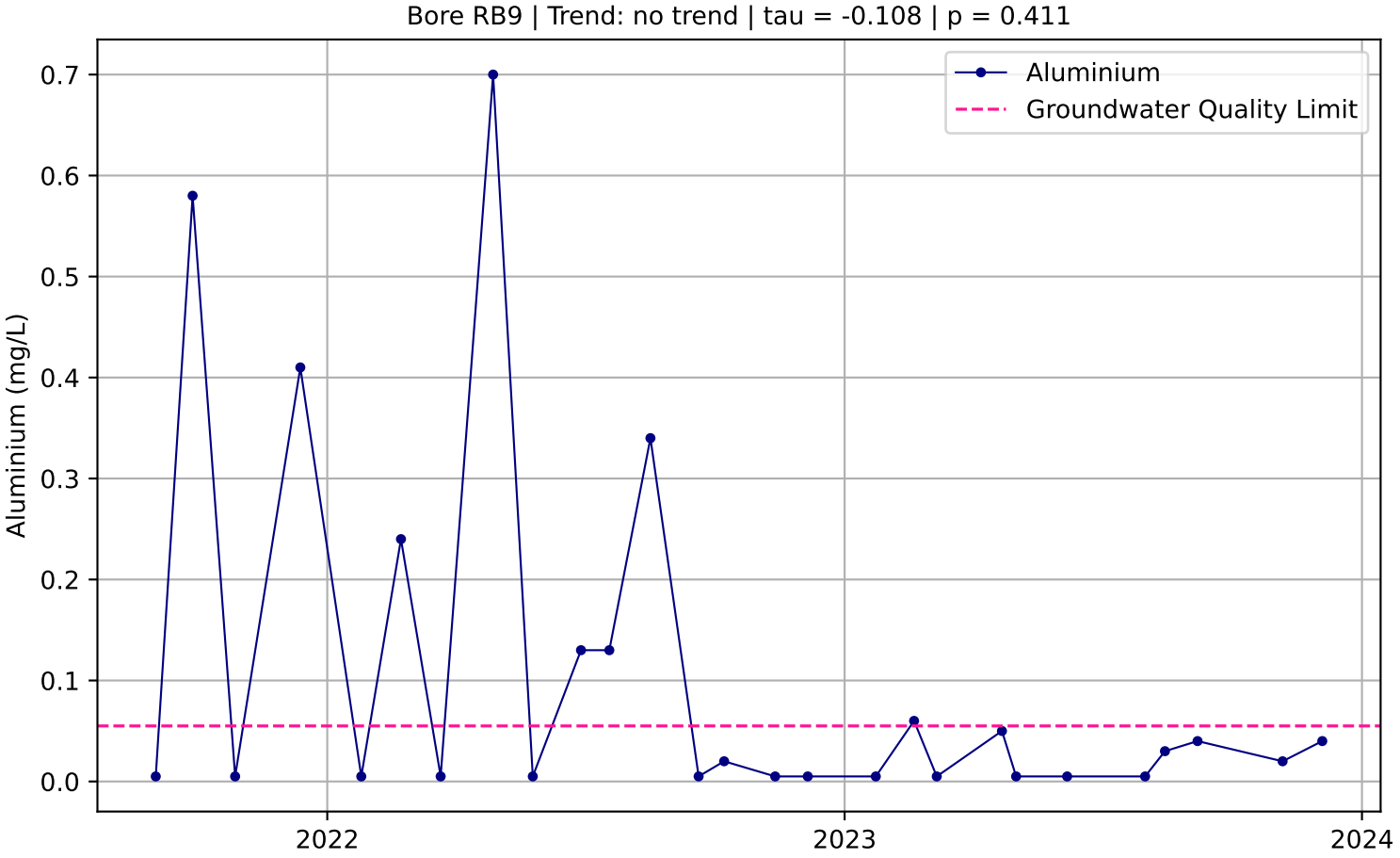

Bore RB8 | Trend: no trend | tau = -0.286 | p = 0.073
Molybdenum
Groundwater Quality Limit
Molybdenum (mg/L)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
2022
2023

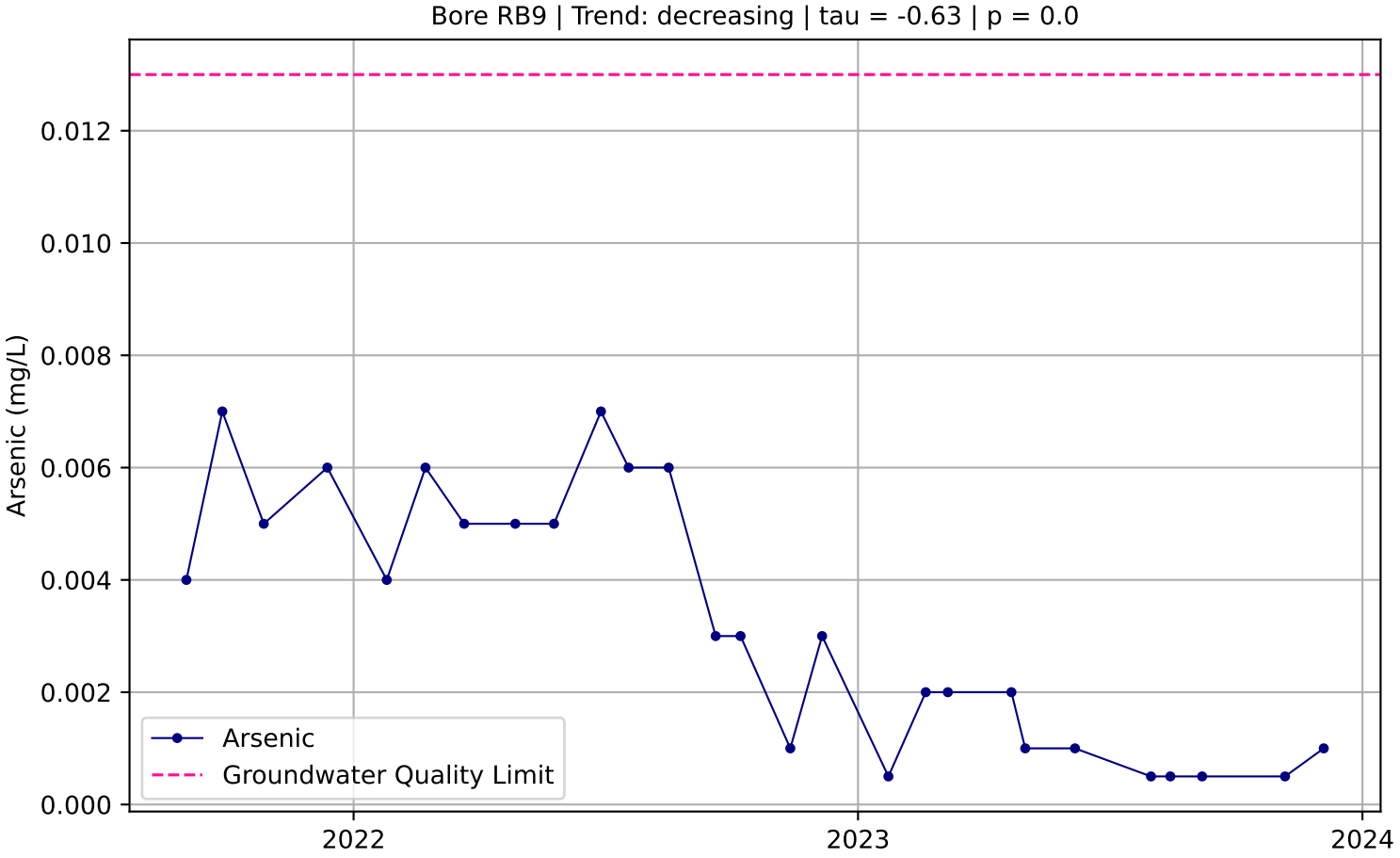

Bore RB8 | Trend: no trend | tau = 0.0 | p = 1.0
Potassium
Potassium (mg/L)
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
2022
2023

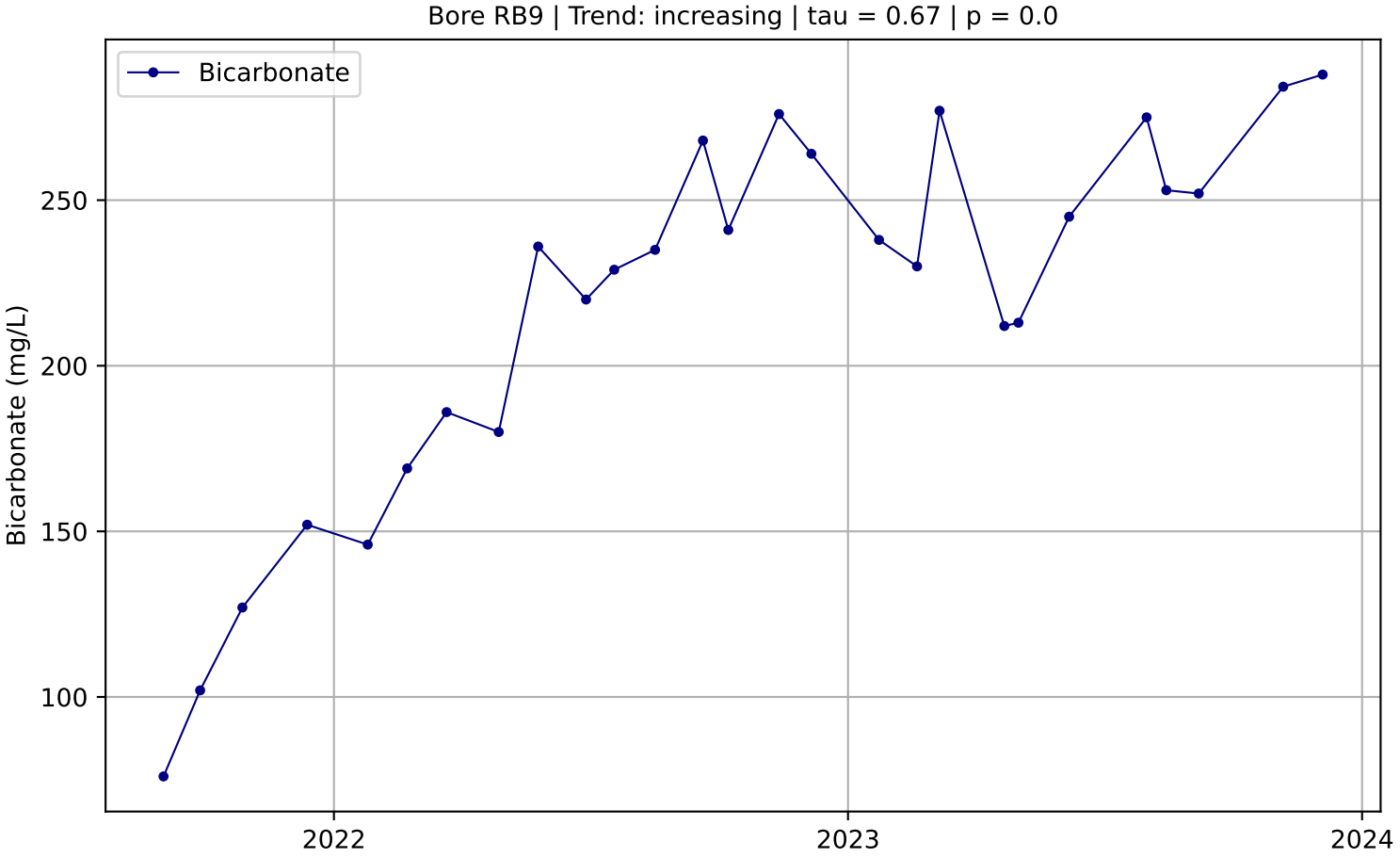

Bore RB8 | Trend: increasing | tau = 0.39 | p = 0.007
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2022
2023

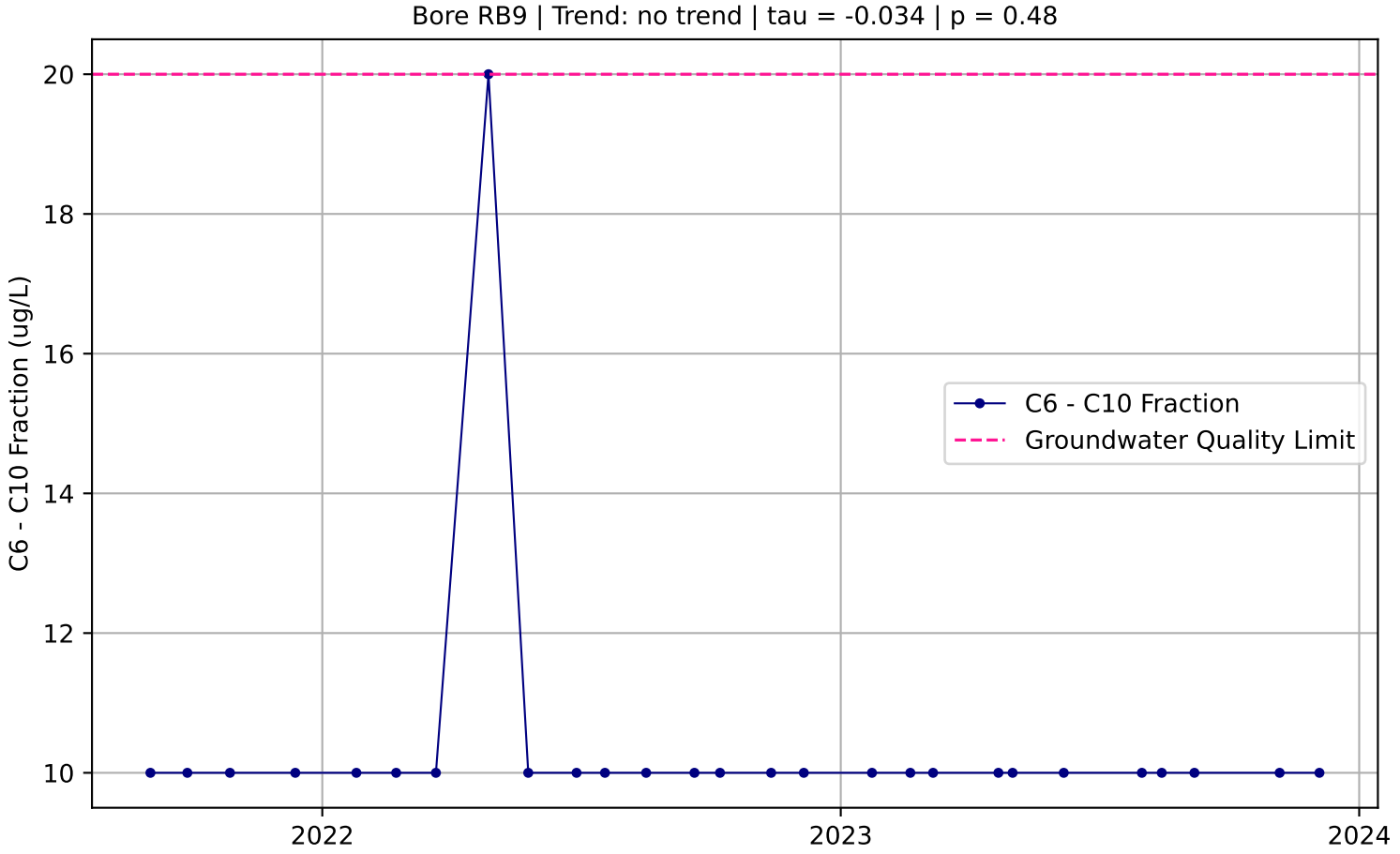

Bore RB8 | Trend: decreasing | tau = -0.468 | p = 0.004
Sodium
Sodium (mg/L)
1300
1200
1100
1000
900
800
700
600
2022
2023

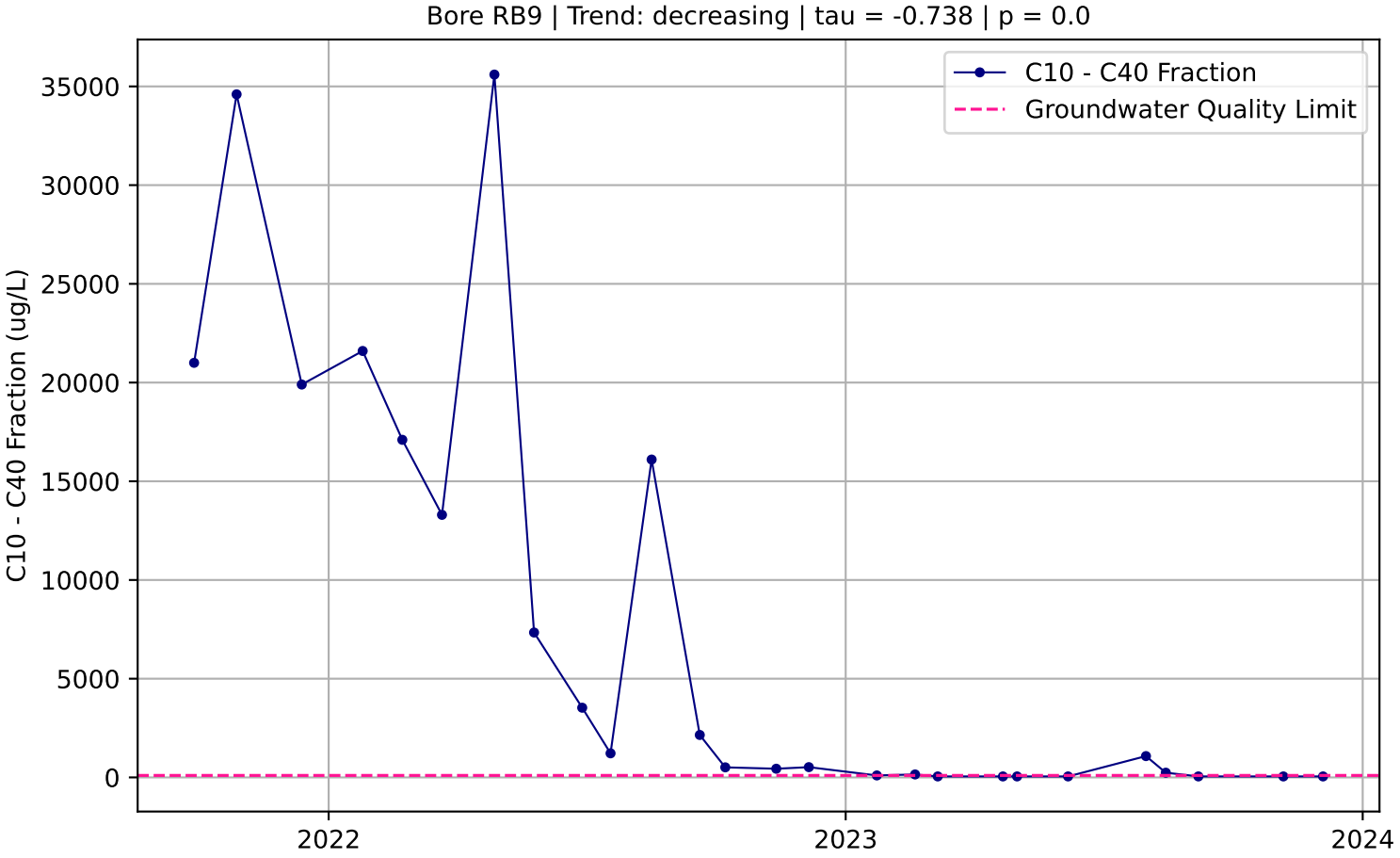

Bore RB8 | Trend: no trend | tau = 0.243 | p = 0.131
Sulfate as SO4 - Turbidimetric (mg/L)
250
200
150
100
50
0
2022
2023
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit

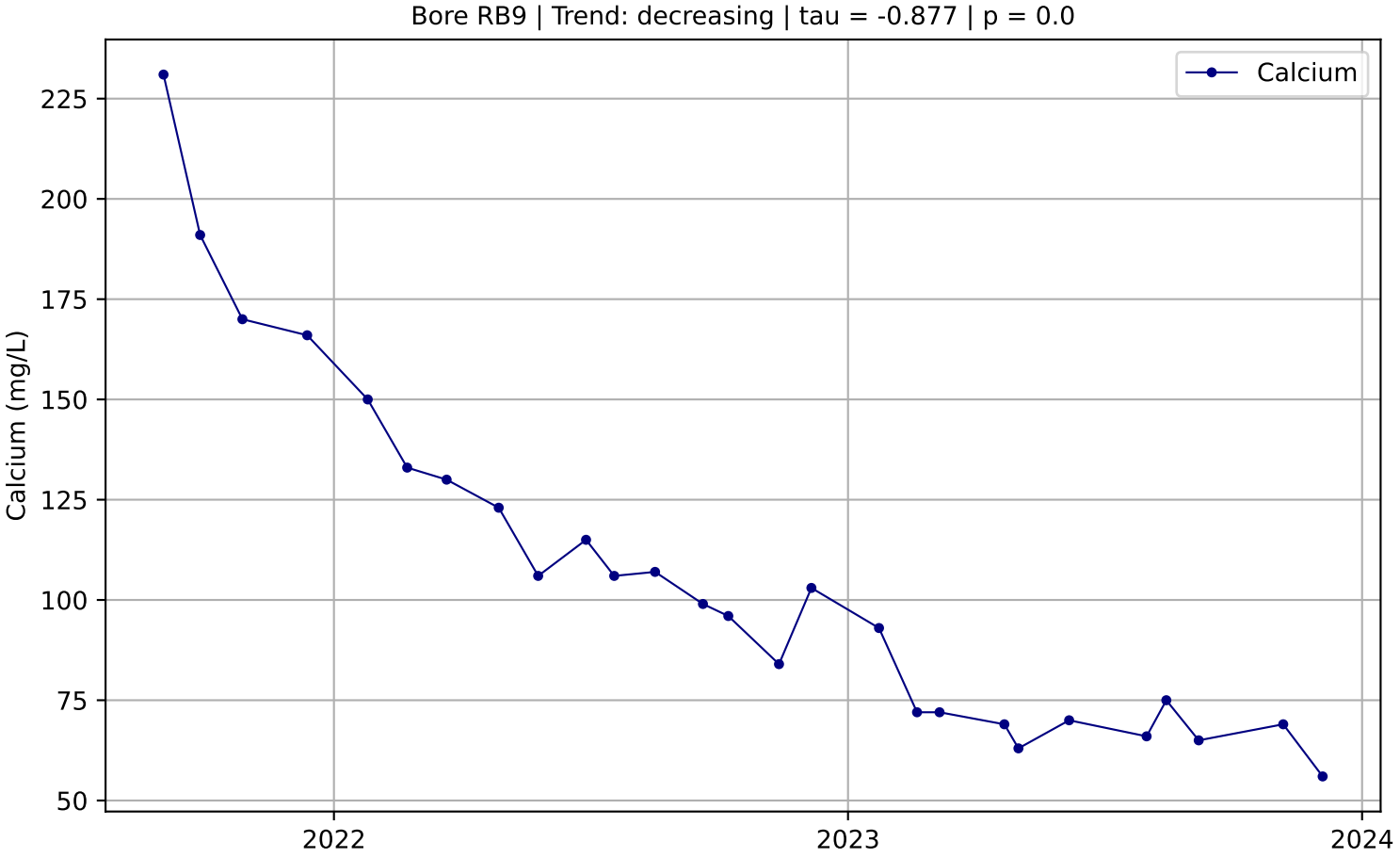

Bore RB9 | Trend: no trend | tau = -0.108 | p = 0.411
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2022
2023
2024

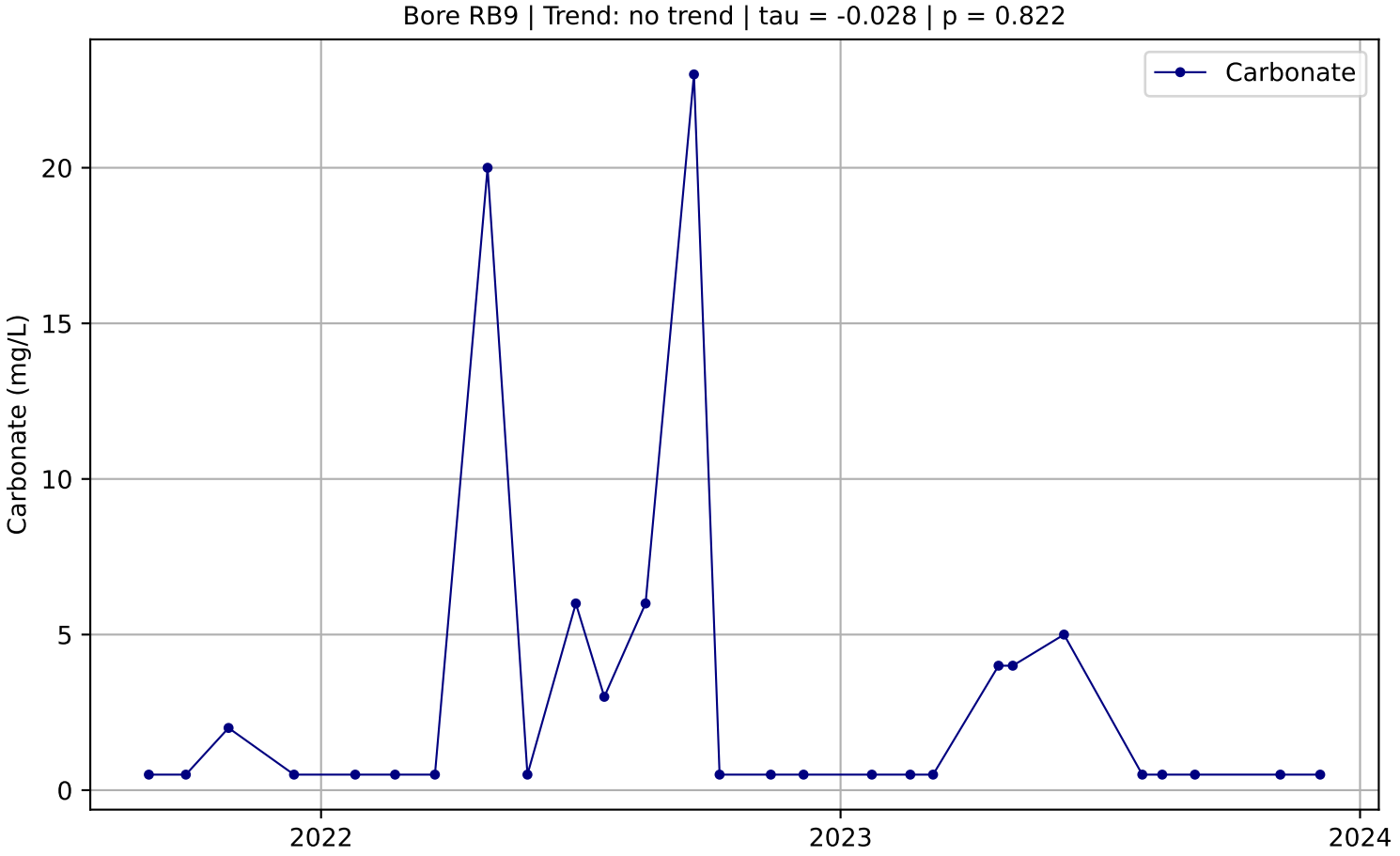

Bore RB9 | Trend: decreasing | tau = -0.63 | p = 0.0
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2022
2023
2024
Arsenic
Groundwater Quality Limit

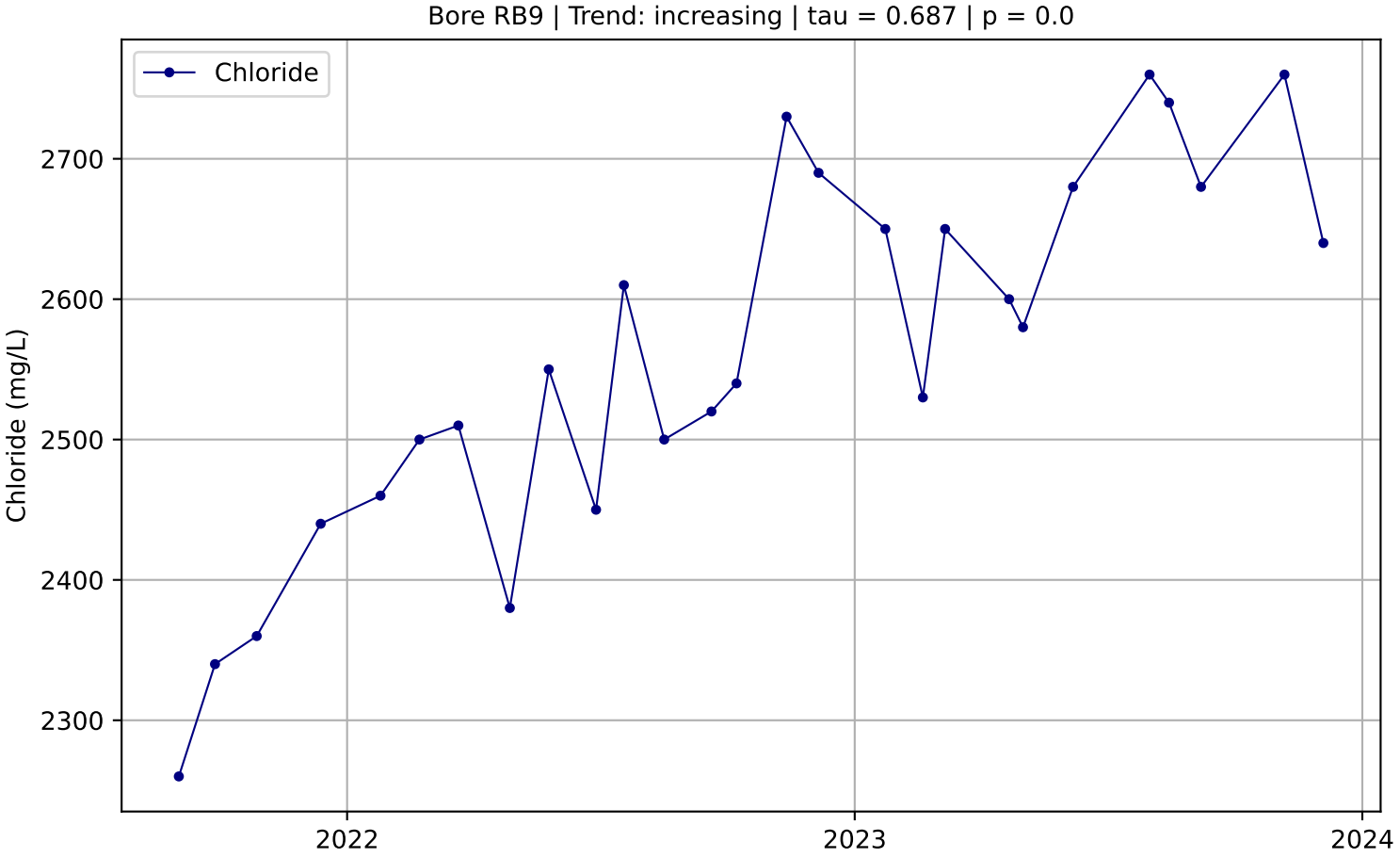

Bore RB9 | Trend: increasing | tau = 0.67 | p = 0.0
Bicarbonate
Bicarbonate (mg/L)
250
200
150
100
2022
2023
2024

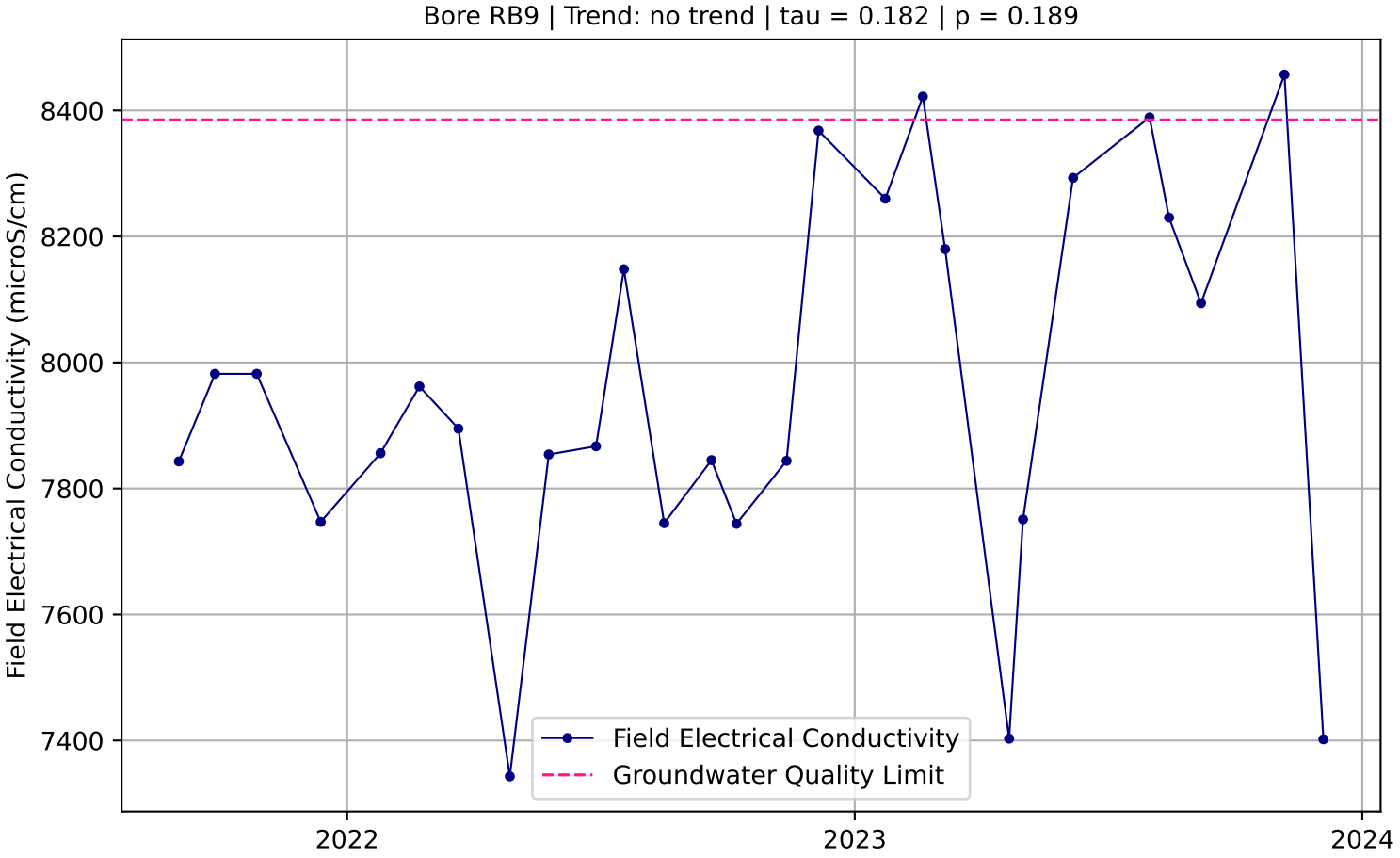

Bore RB9 | Trend: no trend | tau = -0.034 | p = 0.48
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

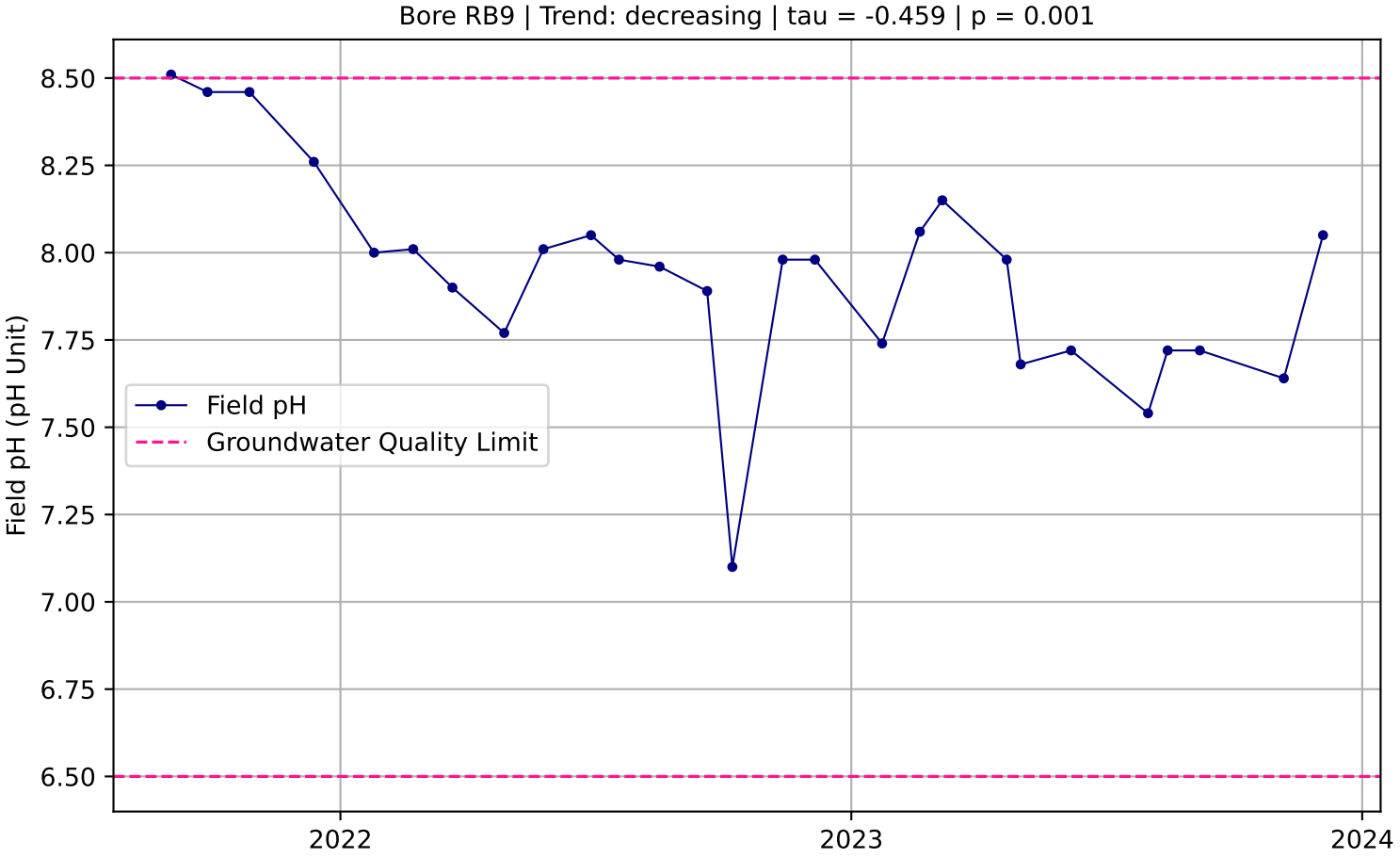

Bore RB9 | Trend: decreasing | tau = -0.738 | p = 0.0
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
35000
30000
25000
20000
15000
10000
5000
0
2022
2023
2024

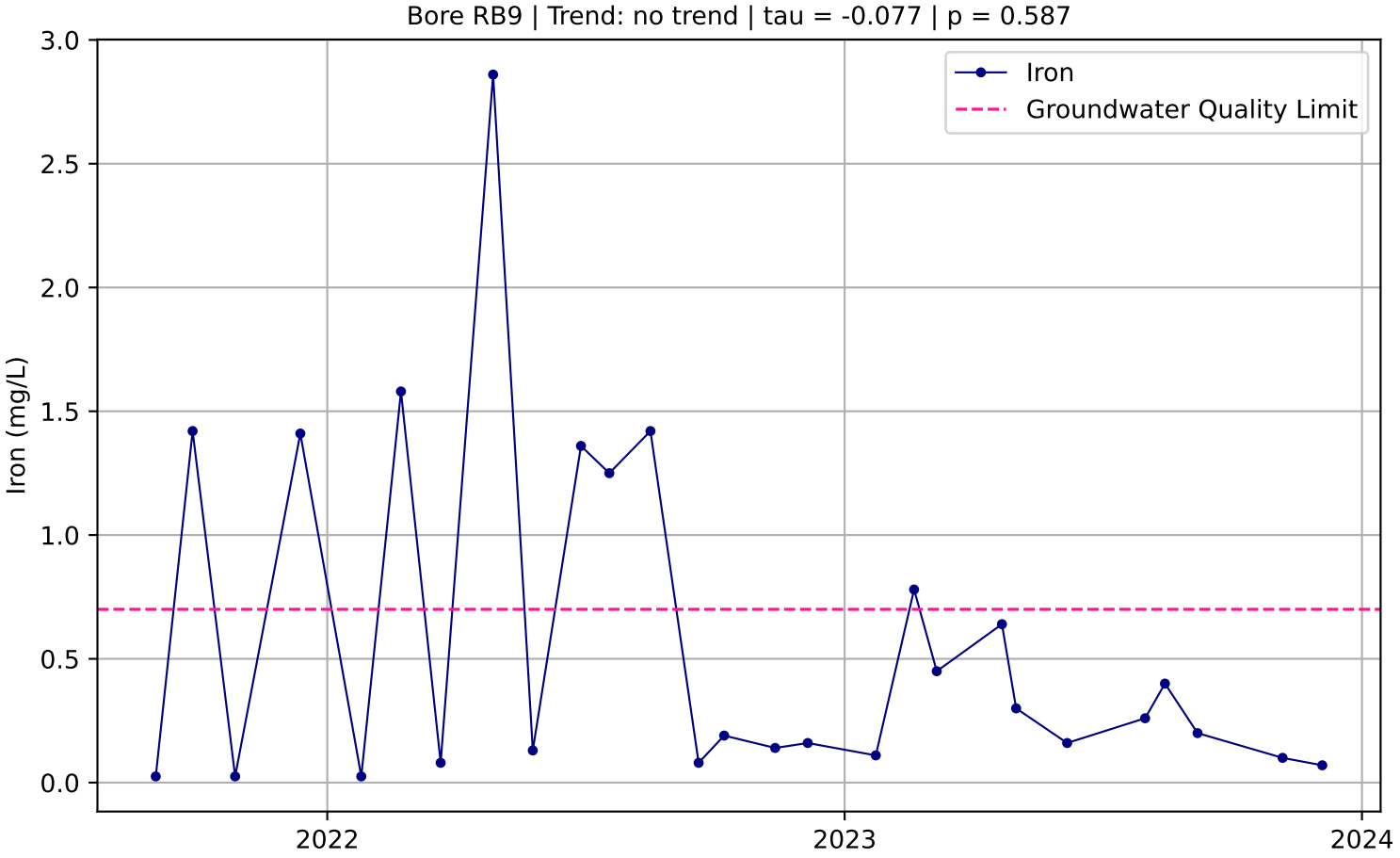

Bore RB9 | Trend: decreasing | tau = -0.877 | p = 0.0
Calcium
Calcium (mg/L)
225
200
175
150
125
100
75
50
2022
2023
2024

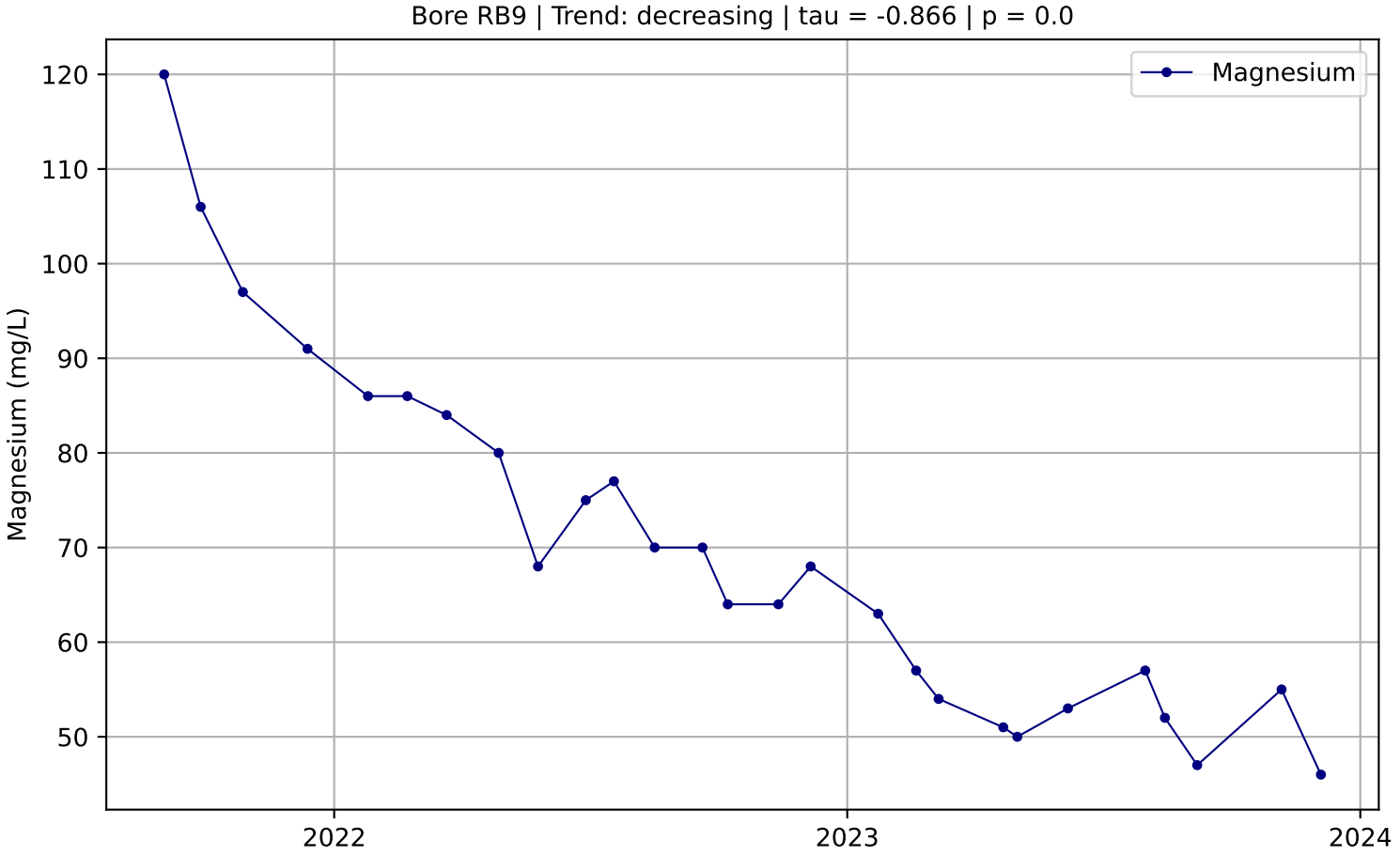

Bore RB9 | Trend: no trend | tau = -0.028 | p = 0.822
Carbonate
Carbonate (mg/L)
0
5
10
15
20
2022
2023
2024

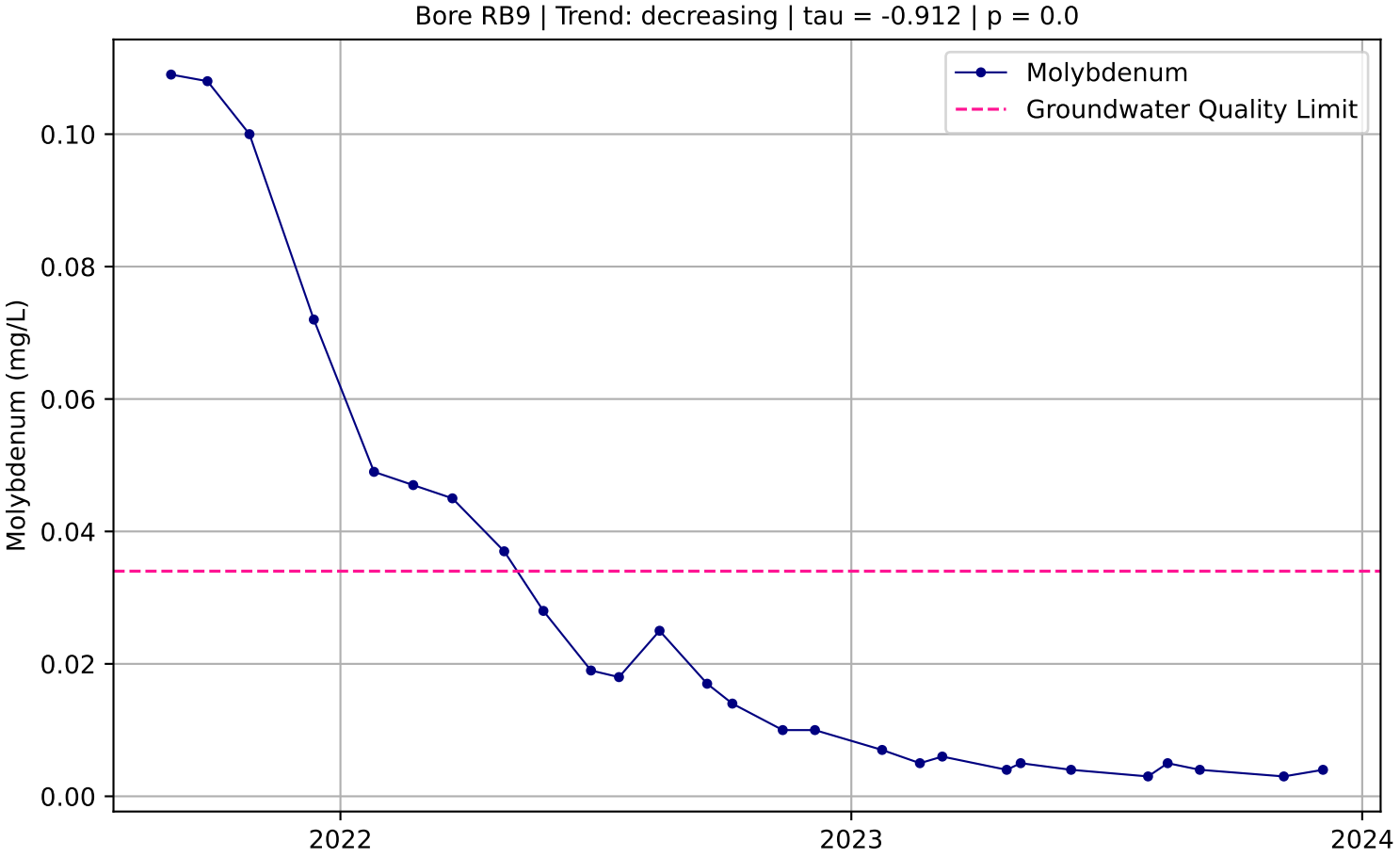

Bore RB9 | Trend: increasing | tau = 0.687 | p = 0.0
Chloride
Chloride (mg/L)
2700
2600
2500
2400
2300
2022
2023
2024

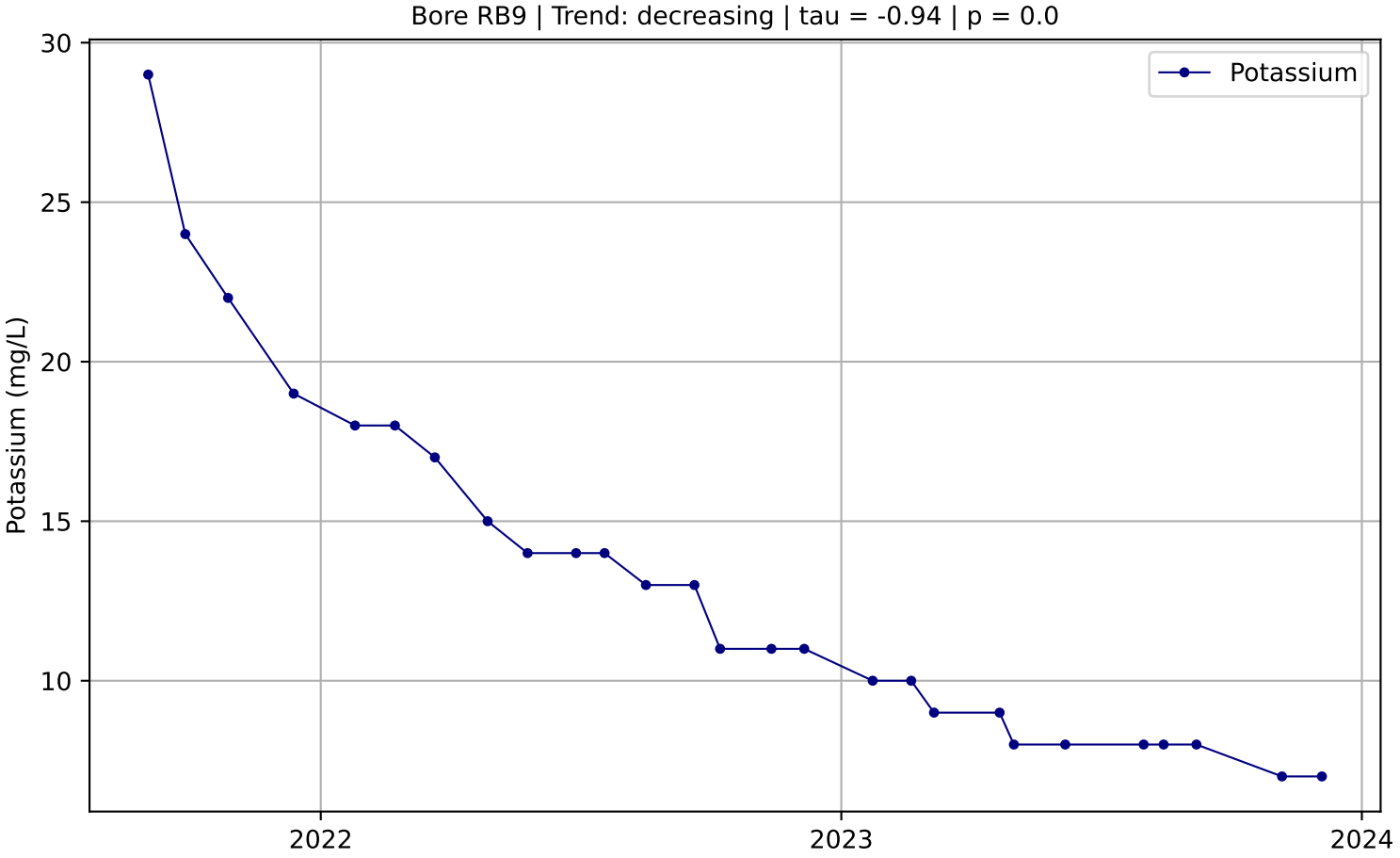

Bore RB9 | Trend: no trend | tau = 0.182 | p = 0.189
Field Electrical Conductivity (microS/cm)
8400
8200
8000
7800
7600
7400
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

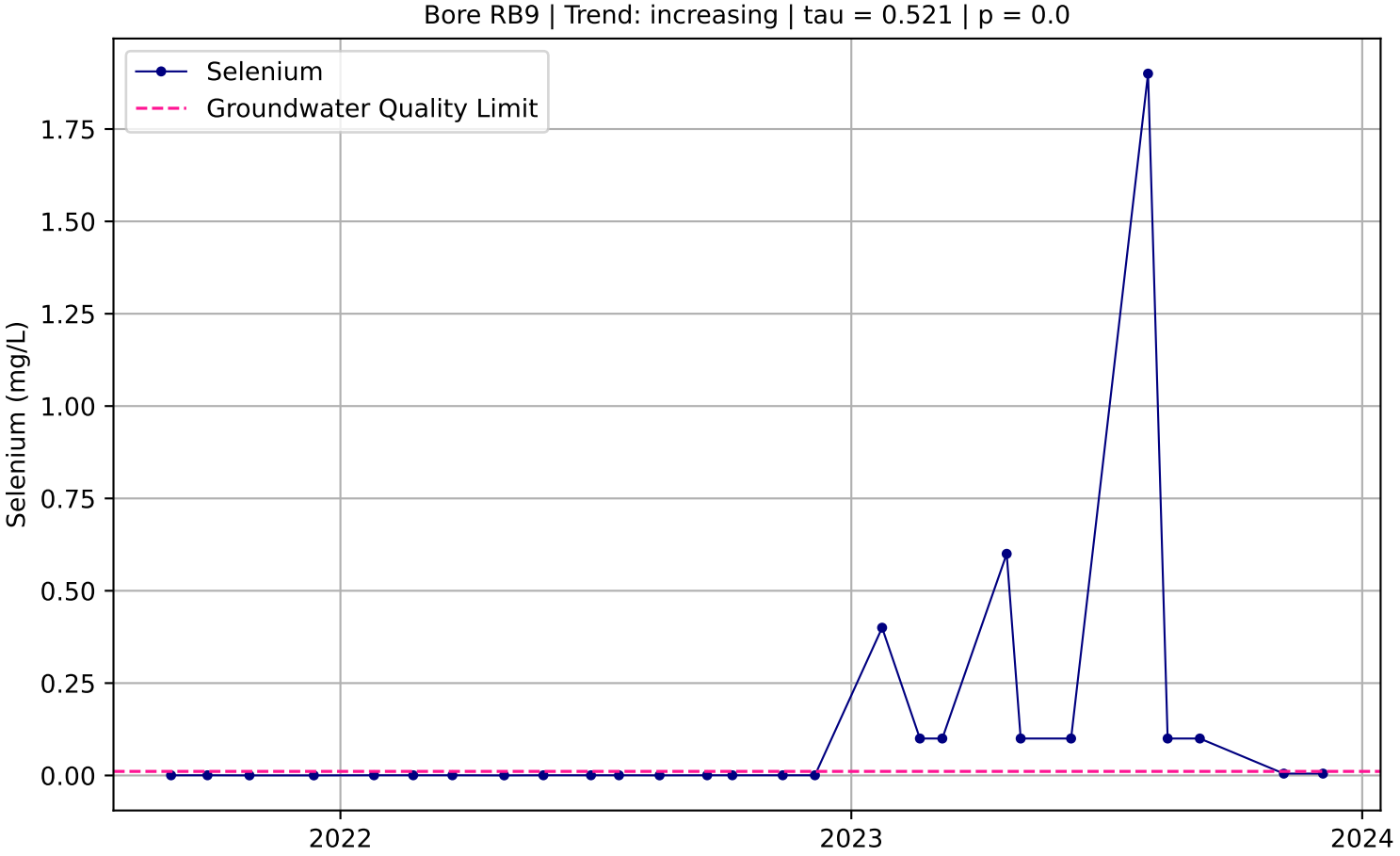

Bore RB9 | Trend: decreasing | tau = -0.459 | p = 0.001
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2022
2023
2024
Field pH
Groundwater Quality Limit

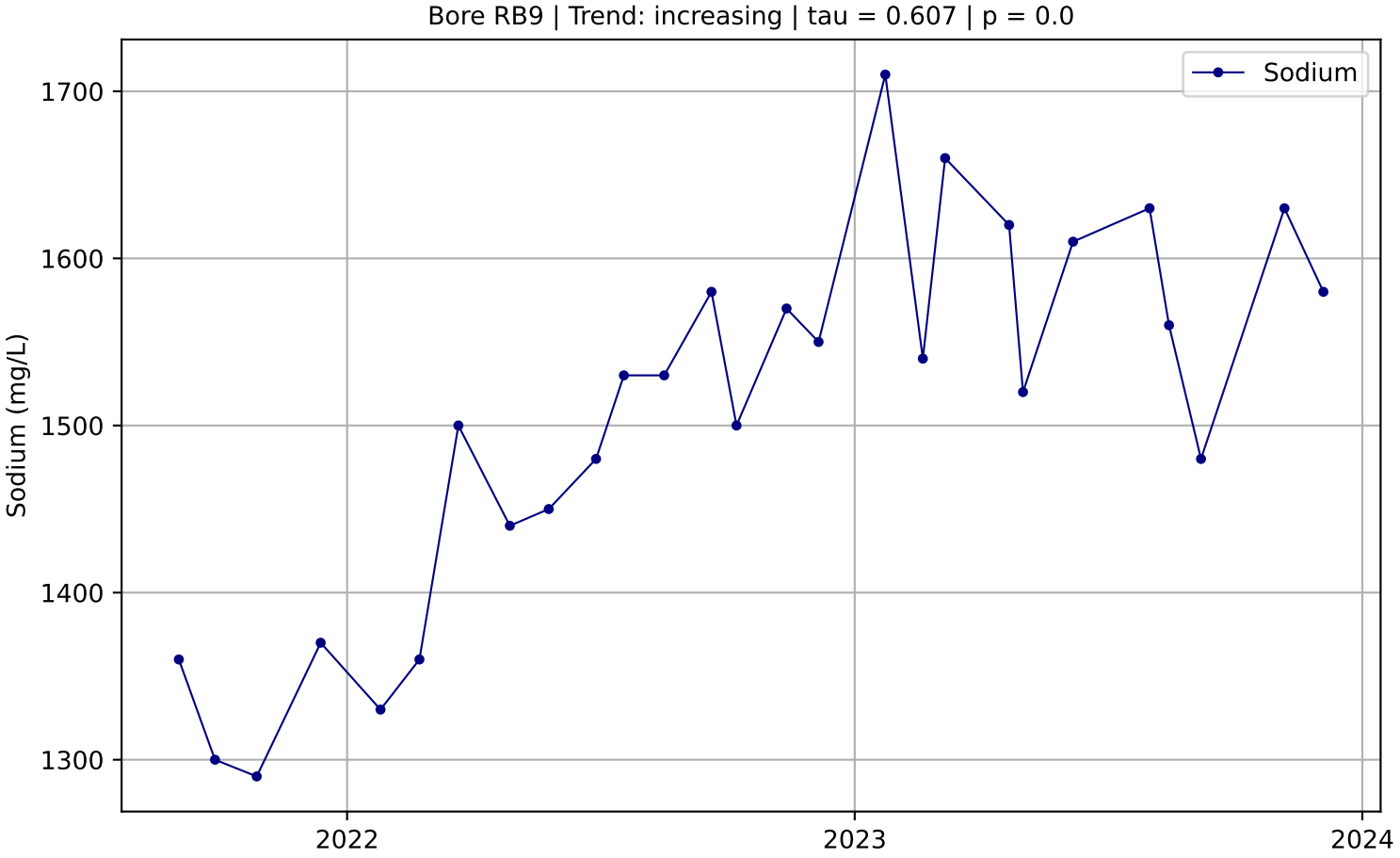

Bore RB9 | Trend: no trend | tau = -0.077 | p = 0.587
Iron
Groundwater Quality Limit
Iron (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2022
2023
2024

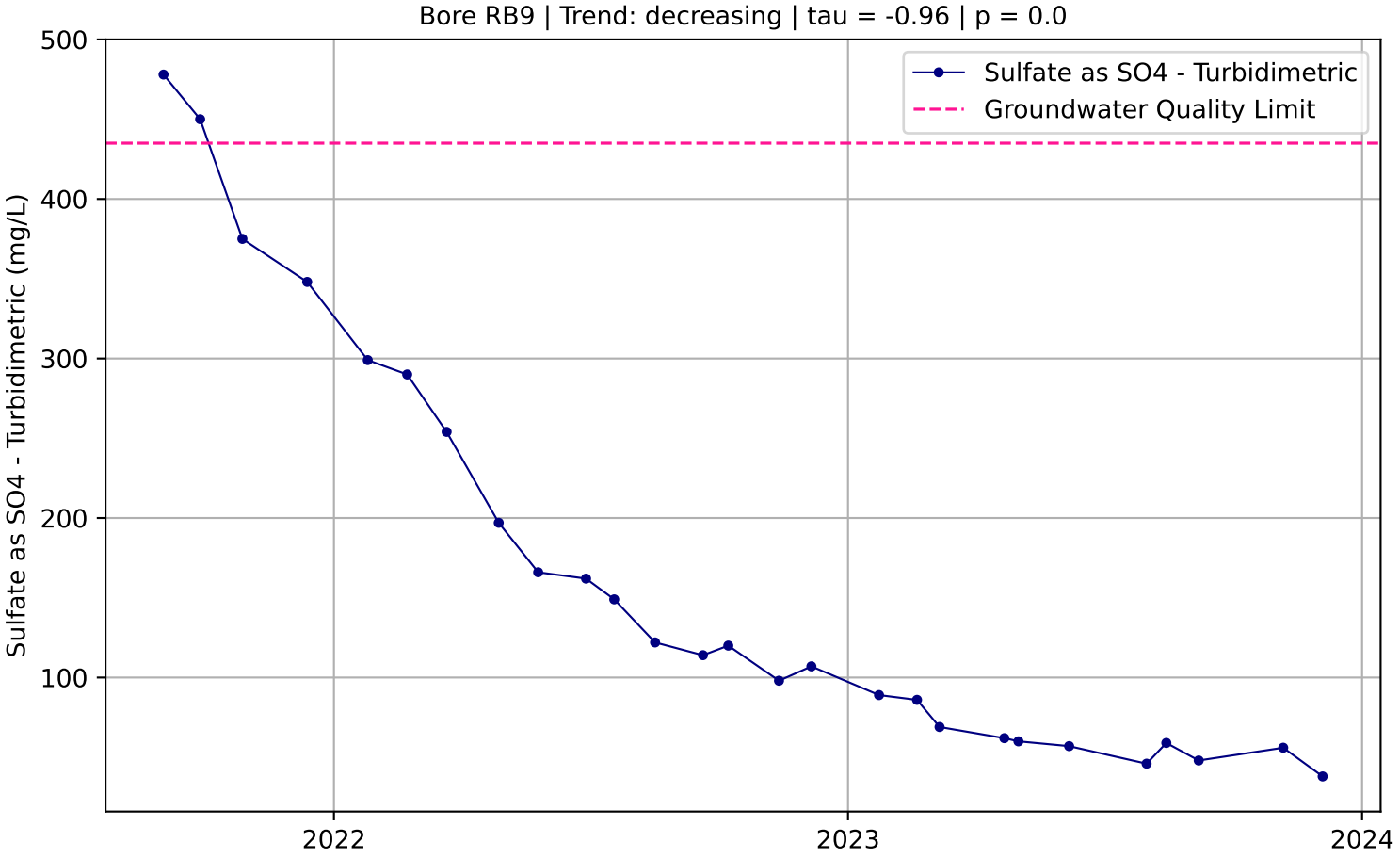

Bore RB9 | Trend: decreasing | tau = -0.866 | p = 0.0
Magnesium
Magnesium (mg/L)
120
110
100
90
80
70
60
50
2022
2023
2024

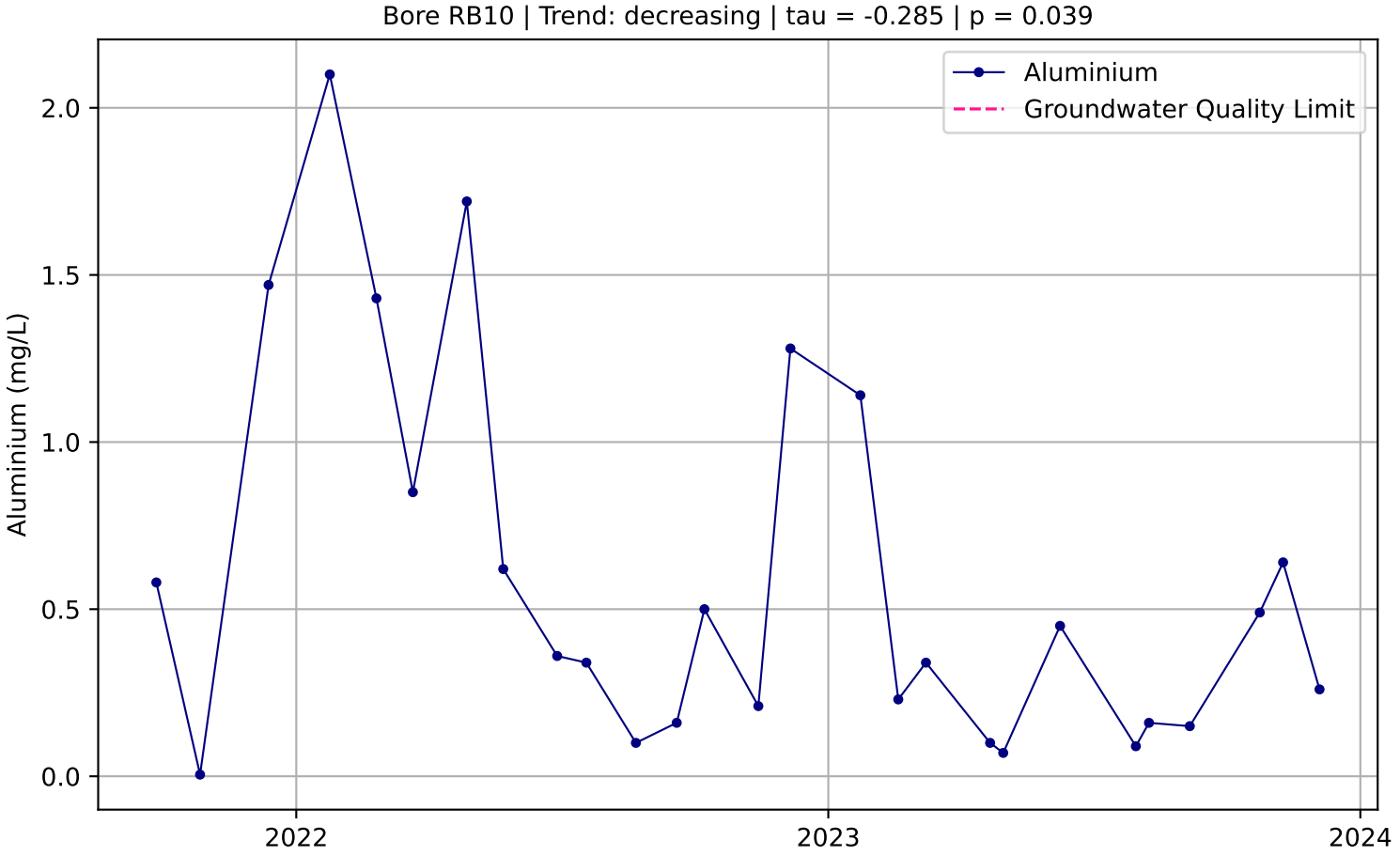

Bore RB9 | Trend: decreasing | tau = -0.912 | p = 0.0
Molybdenum
Groundwater Quality Limit
Molybdenum (mg/L)
0.00
0.02
0.04
0.06
0.08
0.10
2022
2023
2024

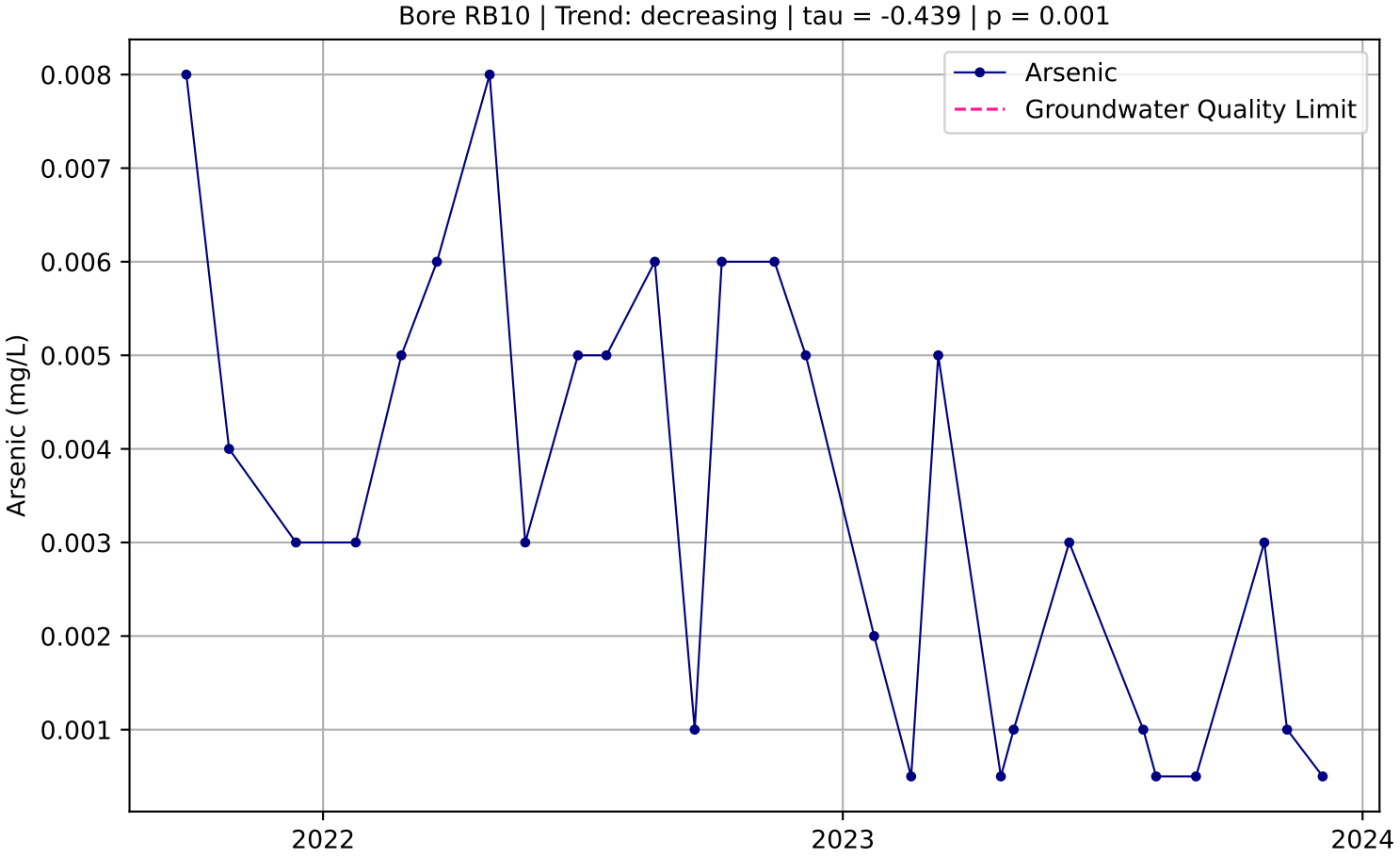

Bore RB9 | Trend: decreasing | tau = -0.94 | p = 0.0
Potassium
Potassium (mg/L)
30
25
20
15
10
2022
2023
2024


Bore RB9 | Trend: increasing | tau = 0.521 | p = 0.0
Selenium
Groundwater Quality Limit
Selenium (mg/L)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2022
2023
2024

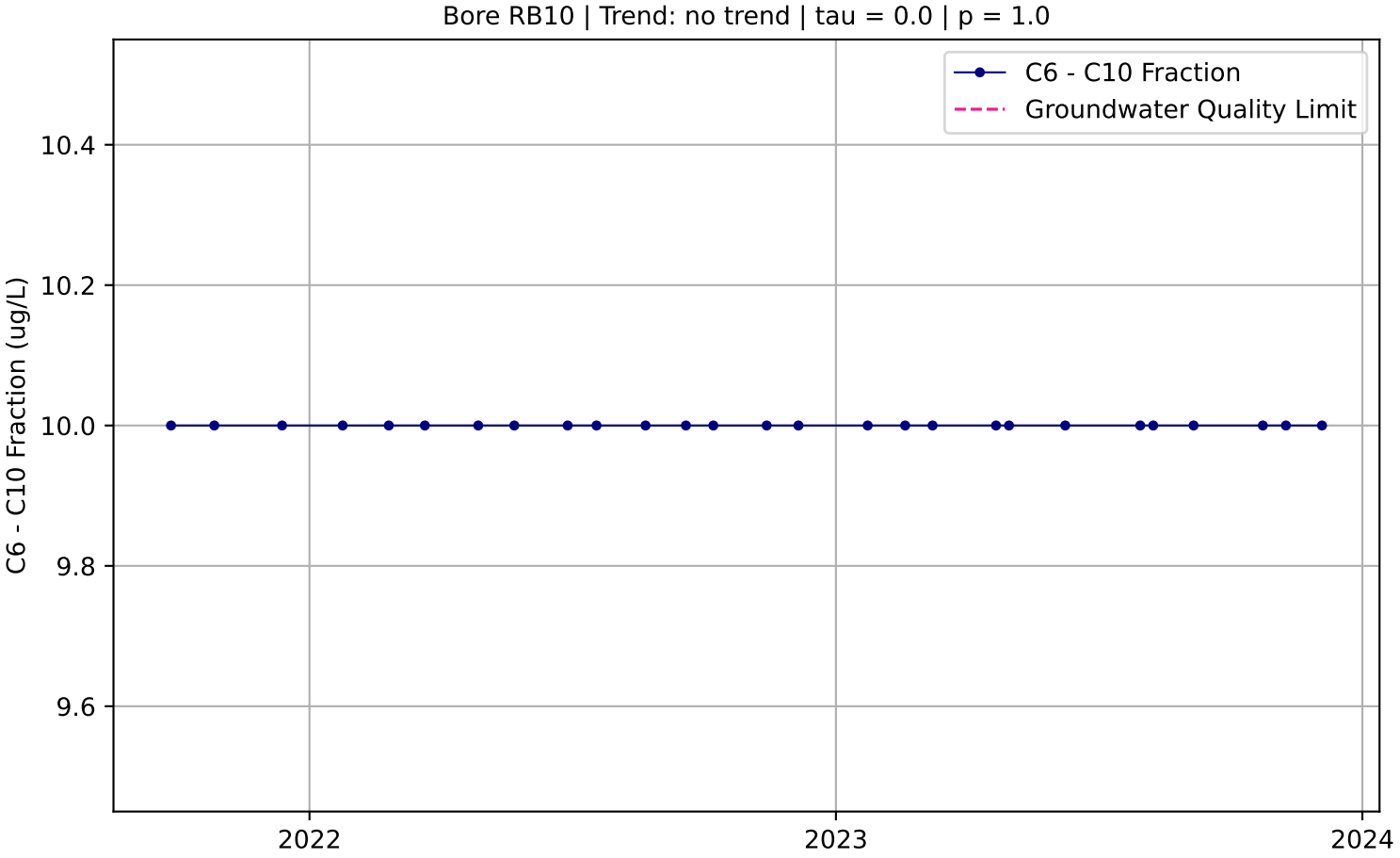

Bore RB9 | Trend: increasing | tau = 0.607 | p = 0.0
Sodium
Sodium (mg/L)
1700
1600
1500
1400
1300
2022
2023
2024

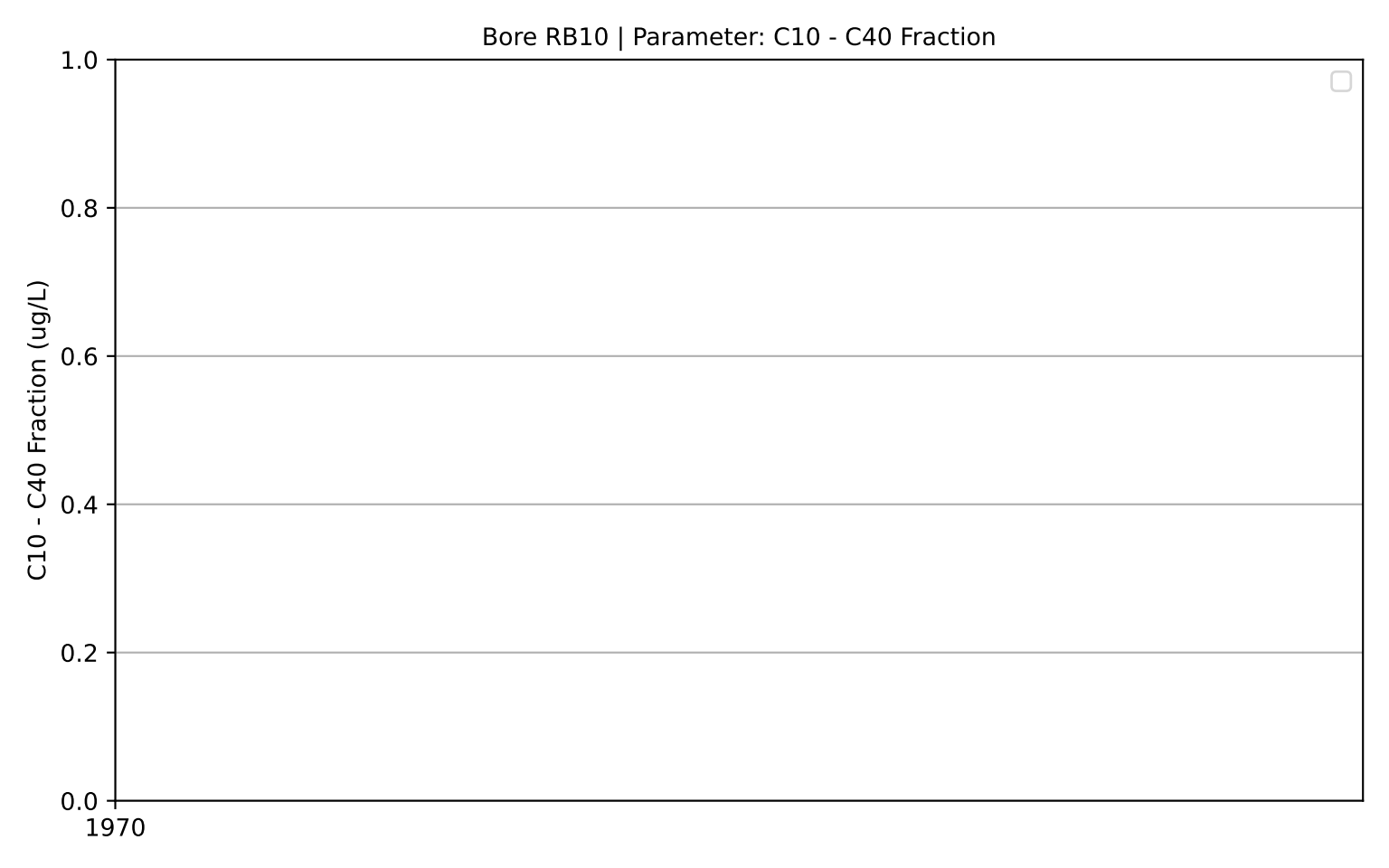

Bore RB9 | Trend: decreasing | tau = -0.96 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
500
400
300
200
100
2022
2023
2024

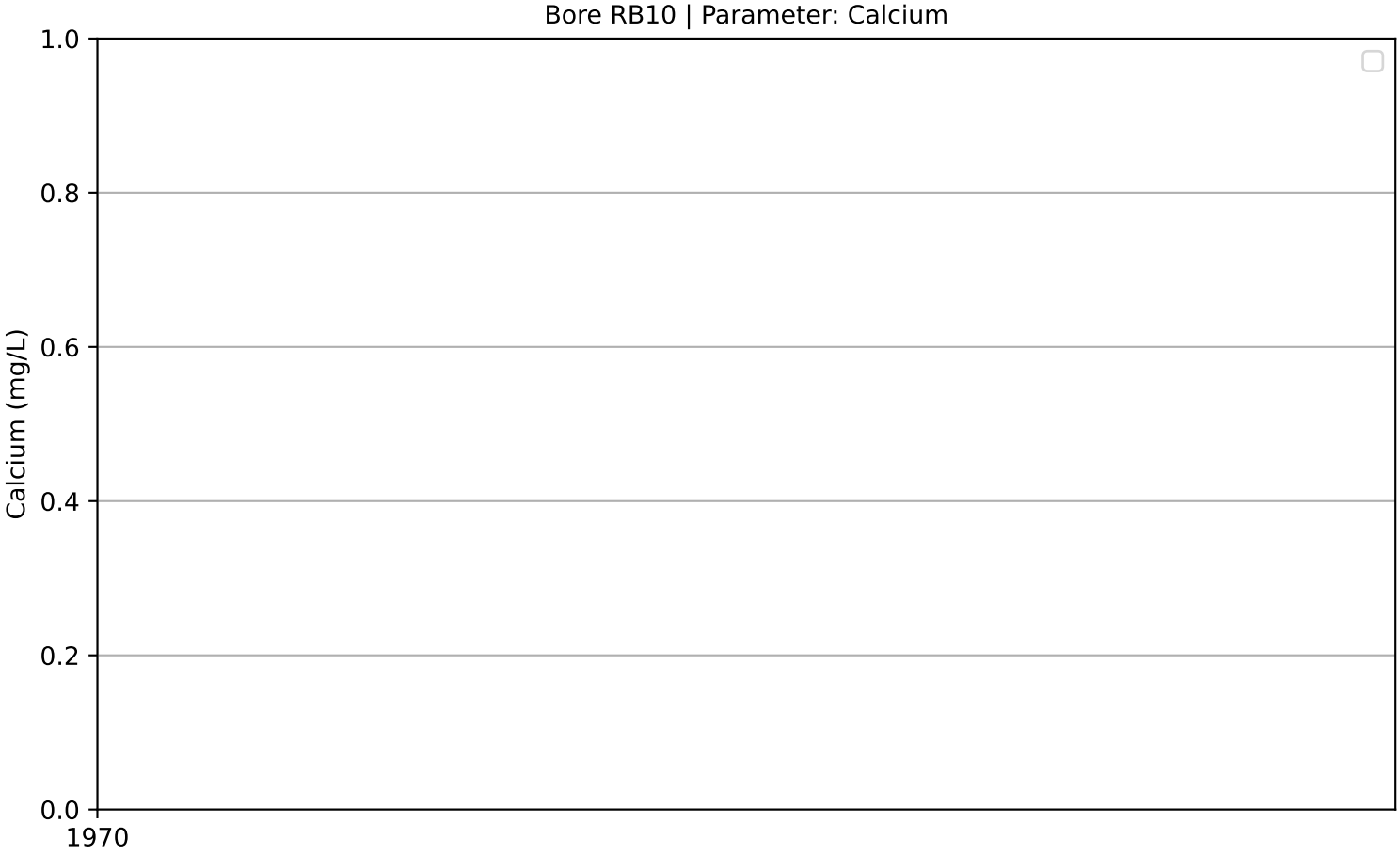

Bore RB10 | Trend: decreasing | tau = -0.285 | p = 0.039
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
2.0
1.5
1.0
0.5
0.0
2022
2023
2024

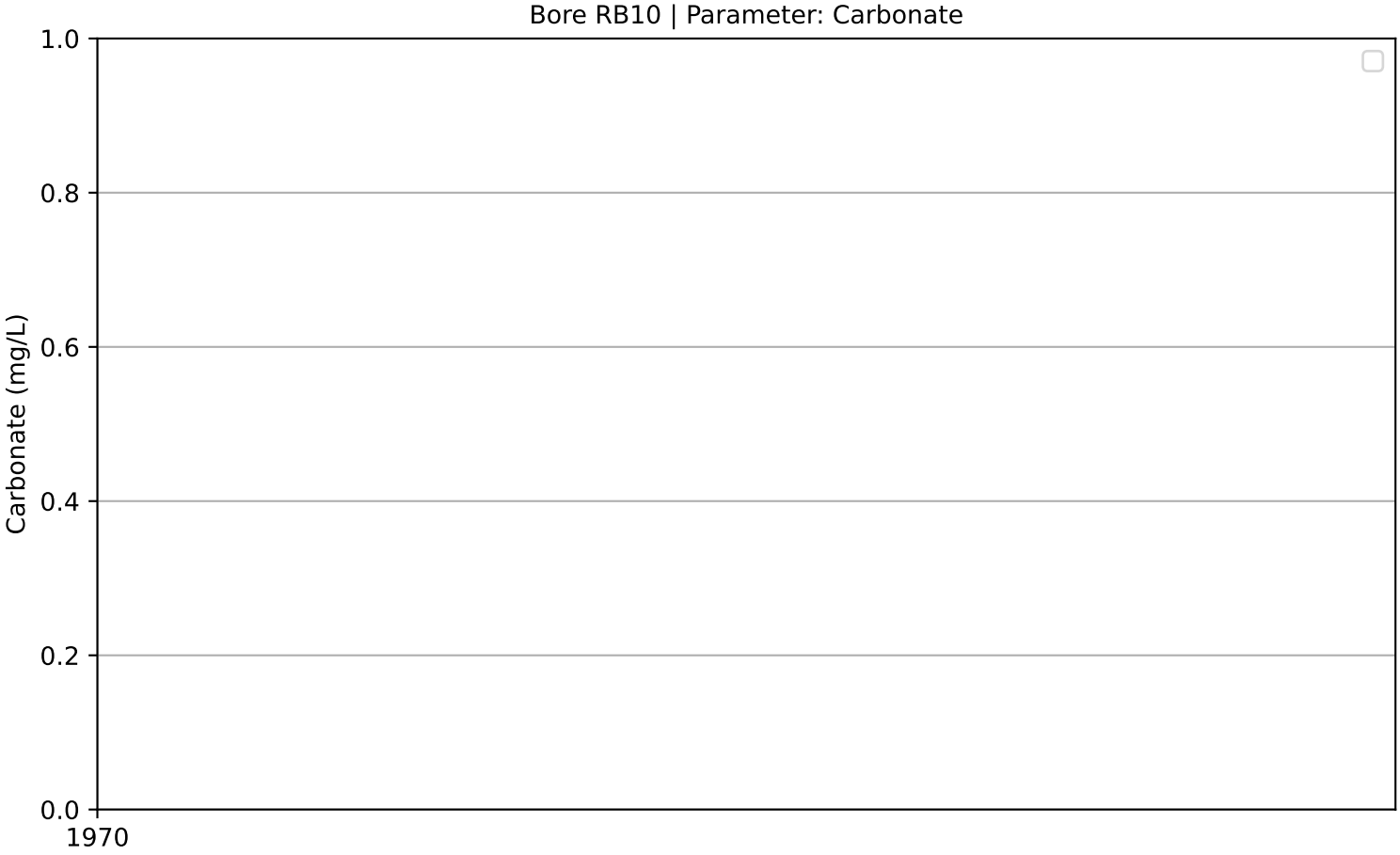

Bore RB10 | Trend: decreasing | tau = -0.439 | p = 0.001
Arsenic
Groundwater Quality Limit
Arsenic (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
2022
2023
2024

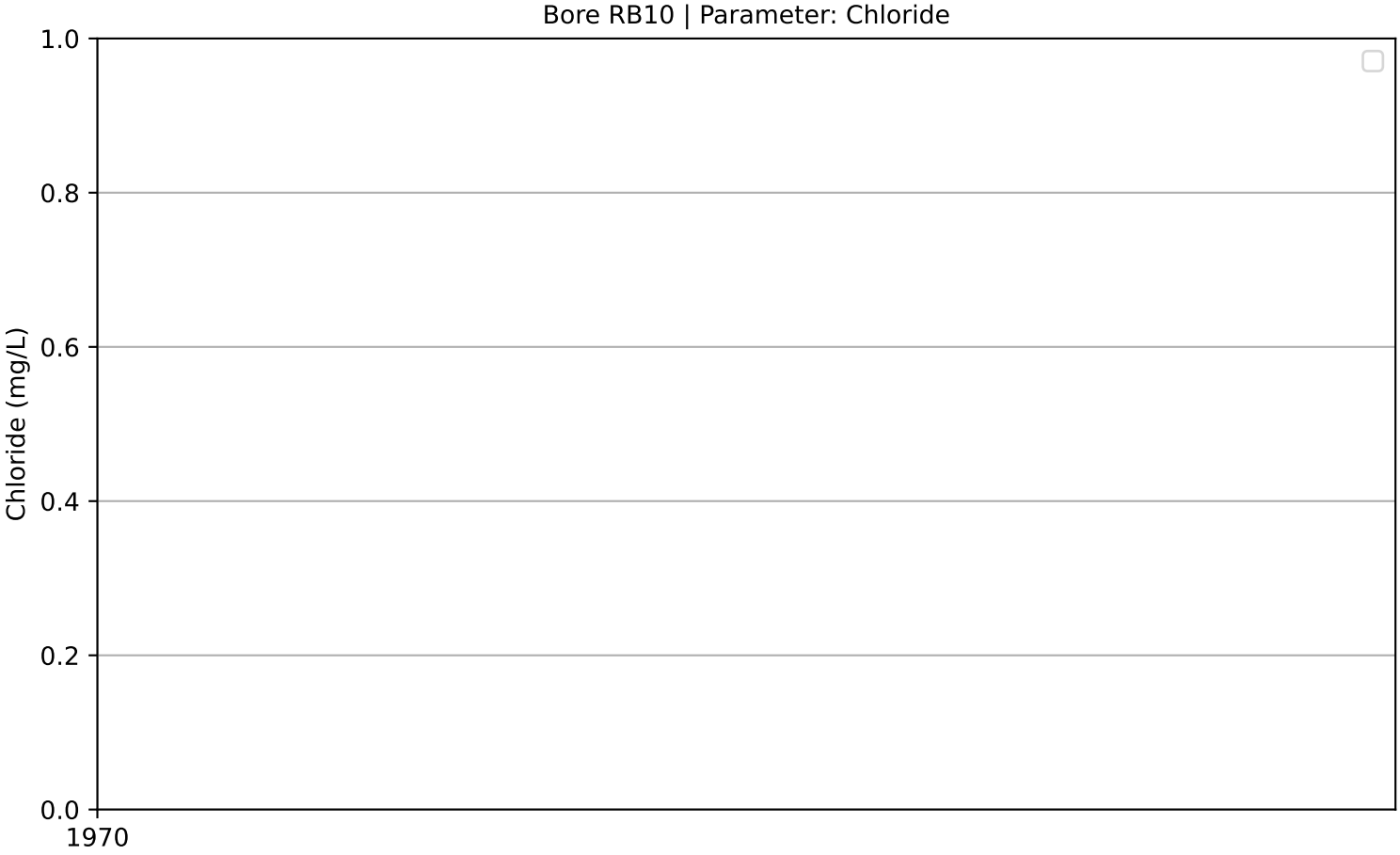
Bore RB10 | Parameter: Bicarbonate
Bicarbonate (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

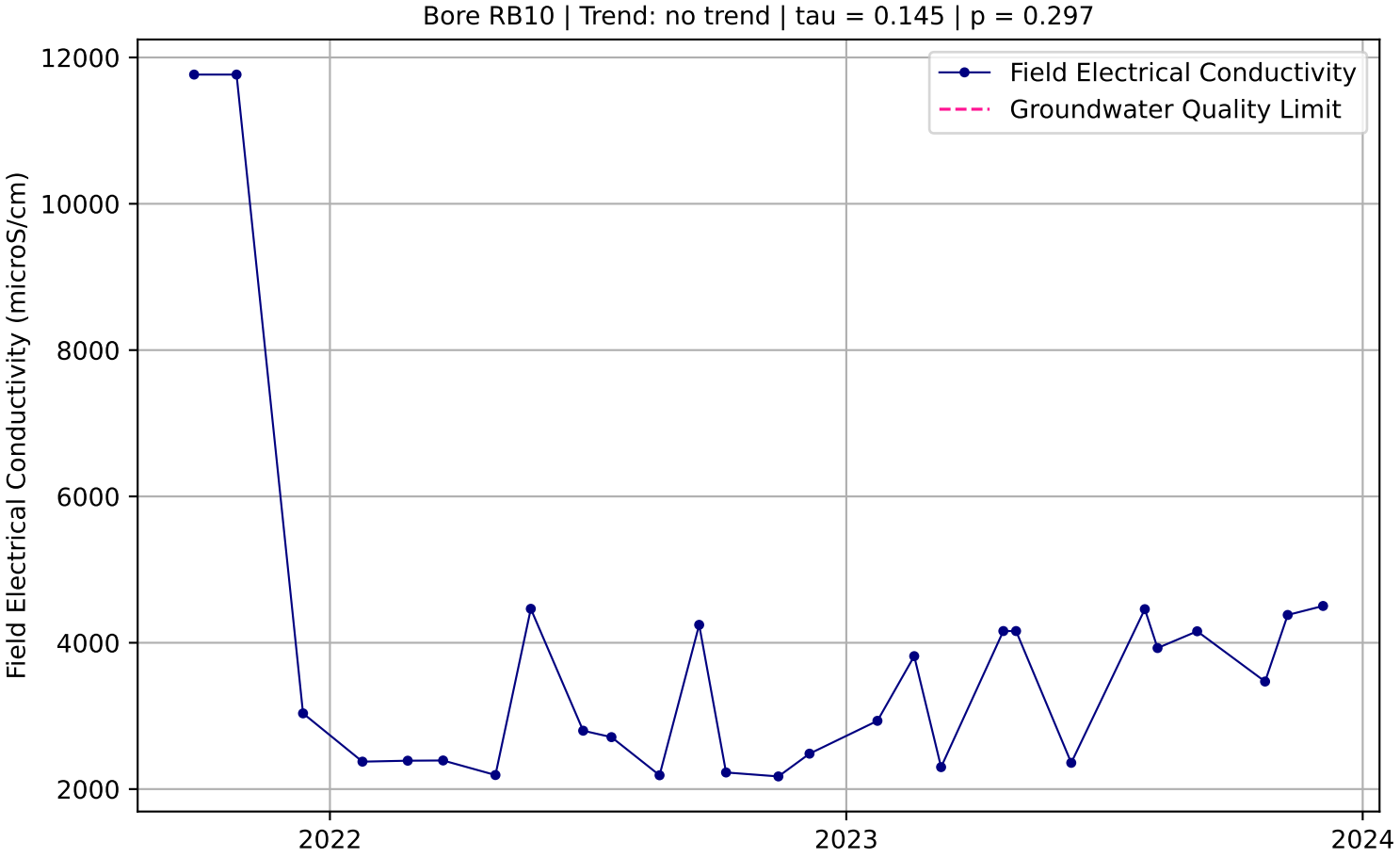

Bore RB10 | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction
Groundwater Quality Limit
C6 - C10 Fraction (ug/L)
10.4
10.2
10.0
9.8
9.6
2022
2023
2024

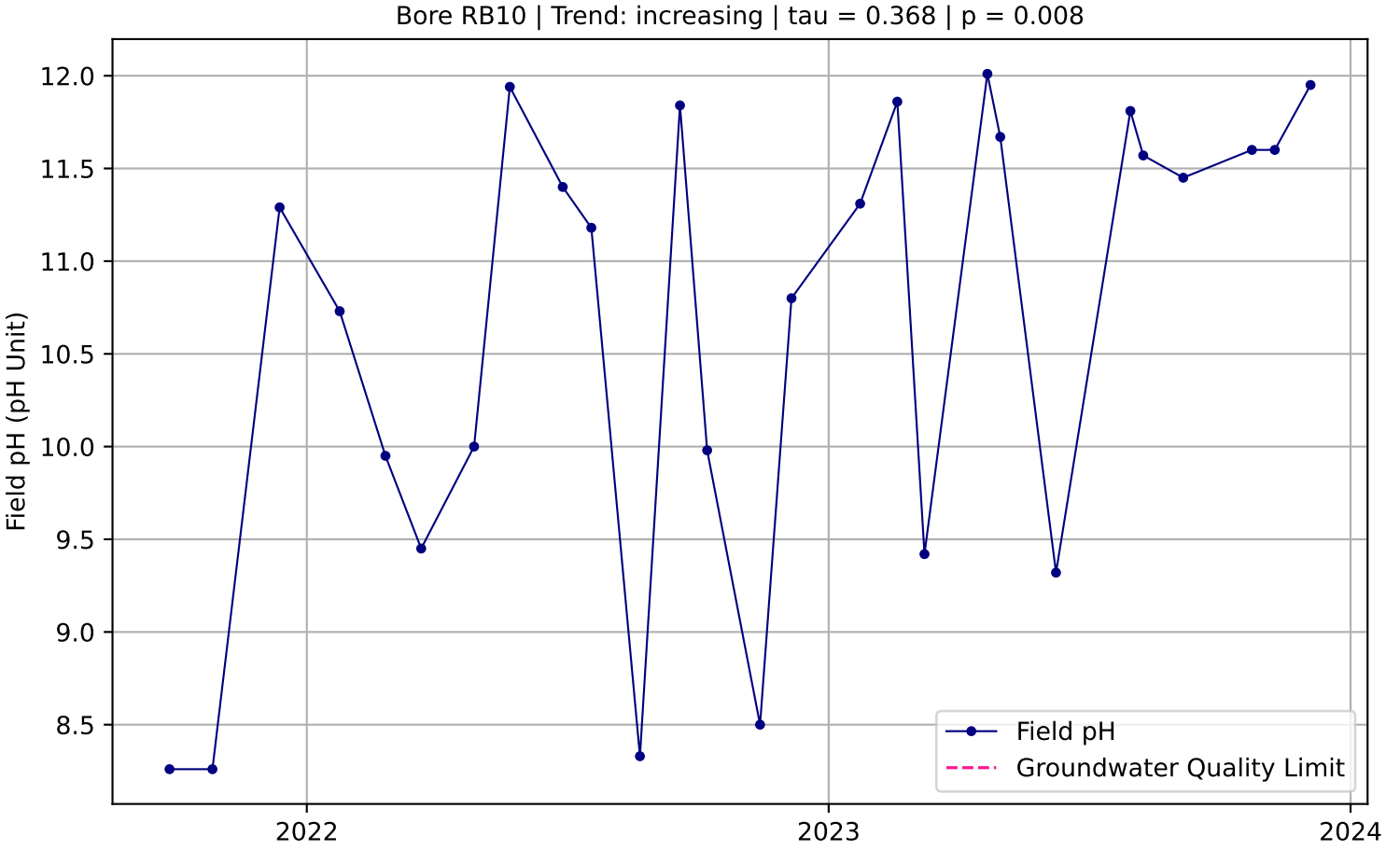

Bore RB10 | Parameter: C10 - C40 Fraction
C10 - C40 Fraction (ug/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

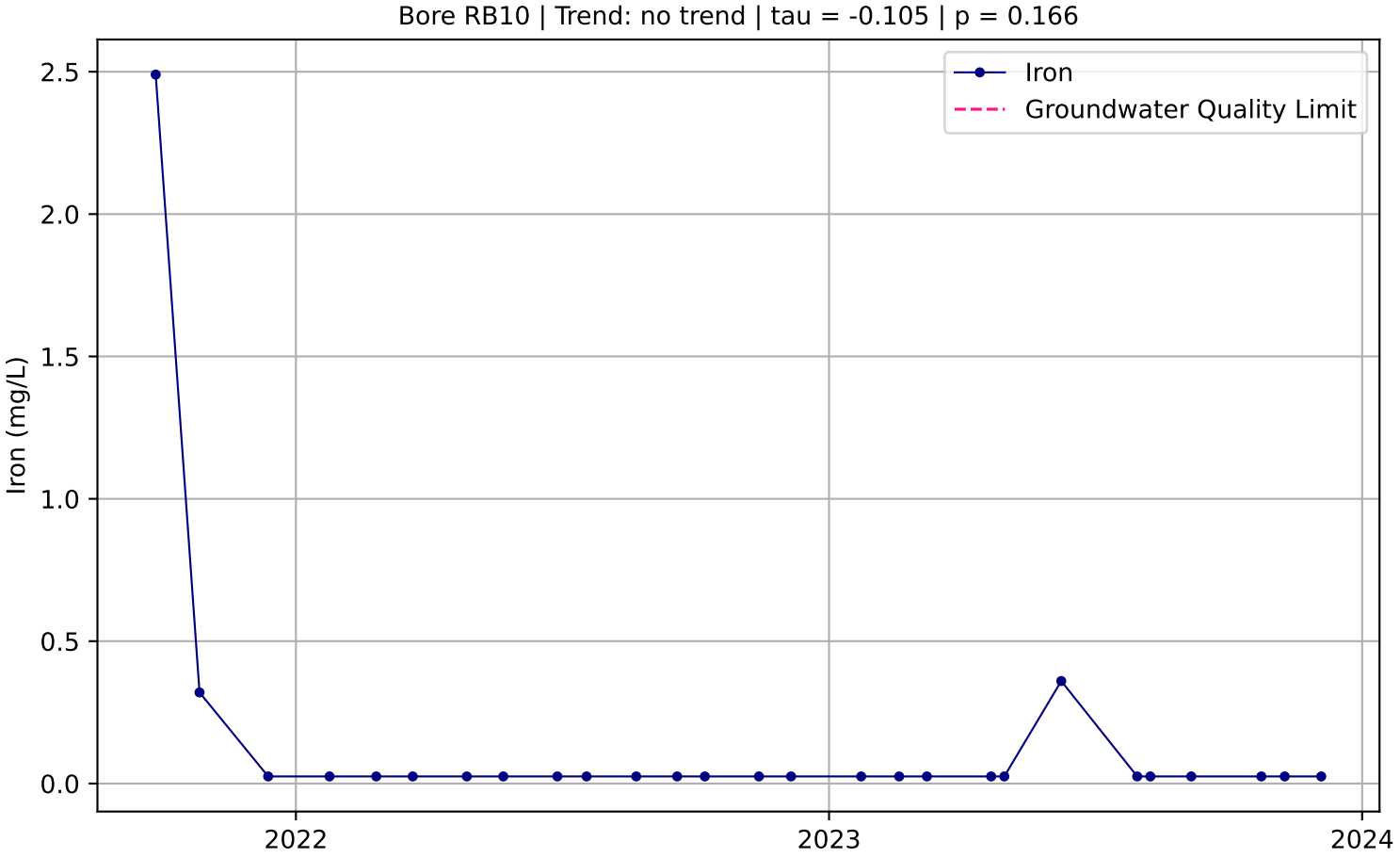

Bore RB10 | Parameter: Calcium
Calcium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

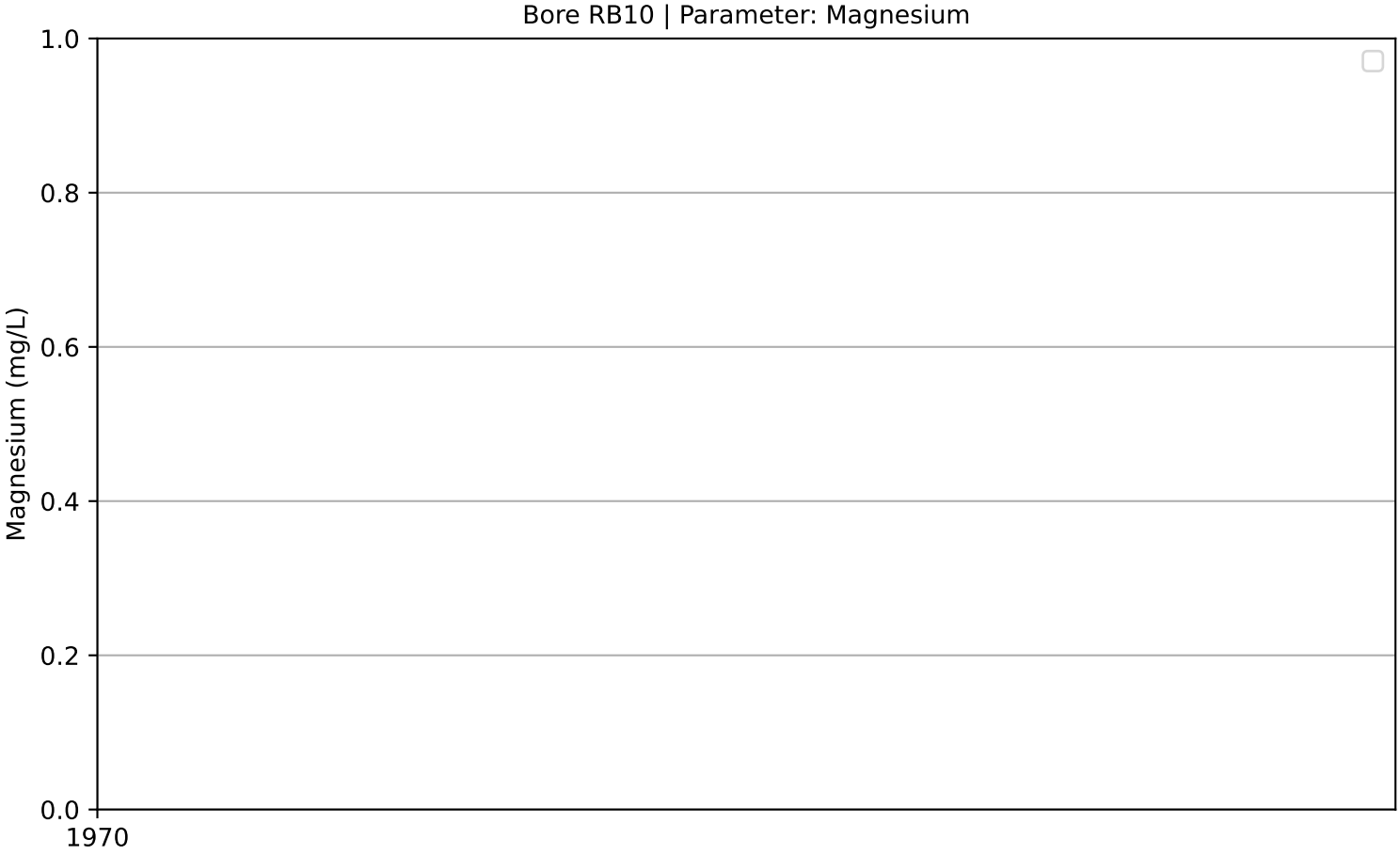

Bore RB10 | Parameter: Carbonate
Carbonate (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

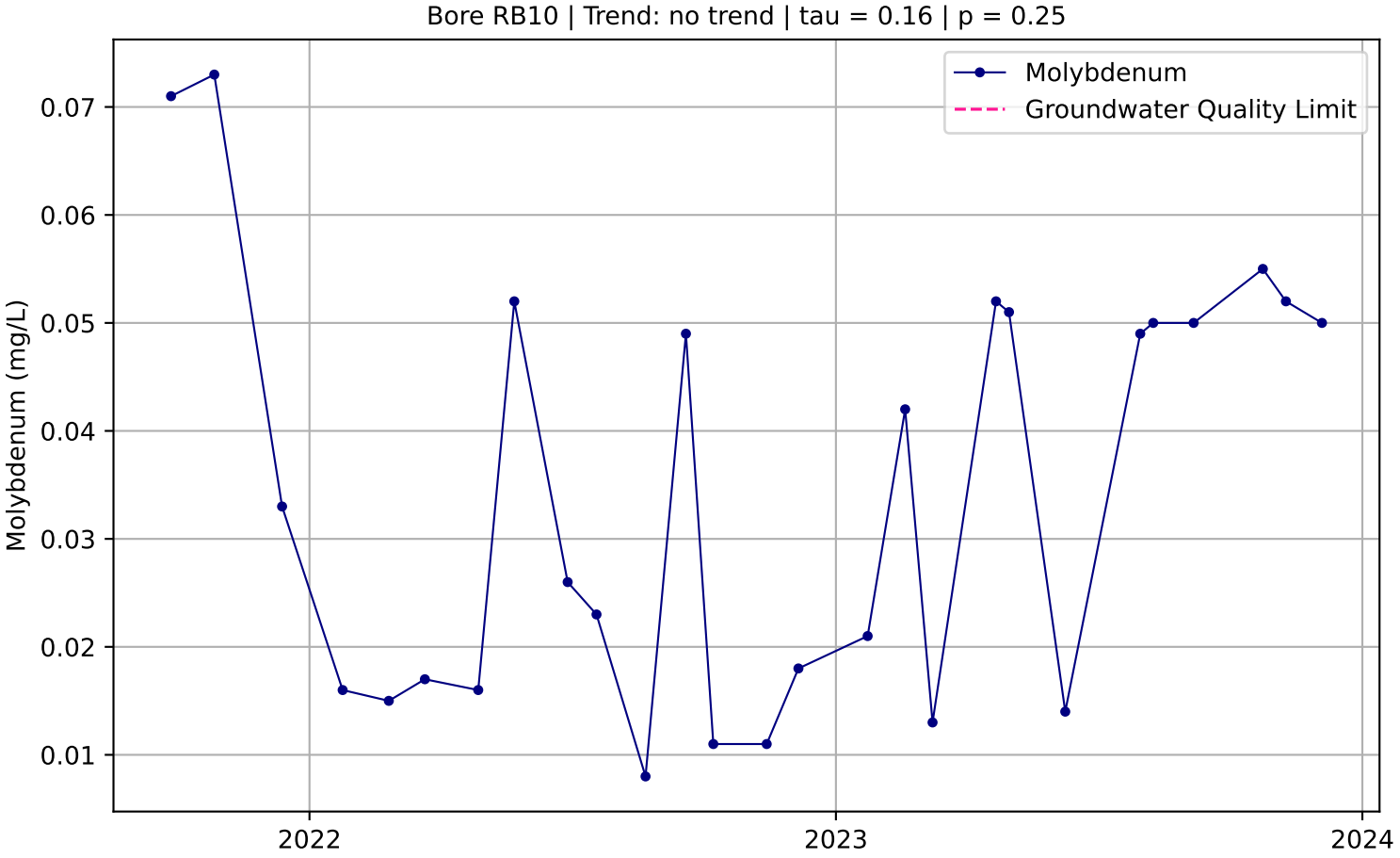

Bore RB10 | Parameter: Chloride
Chloride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

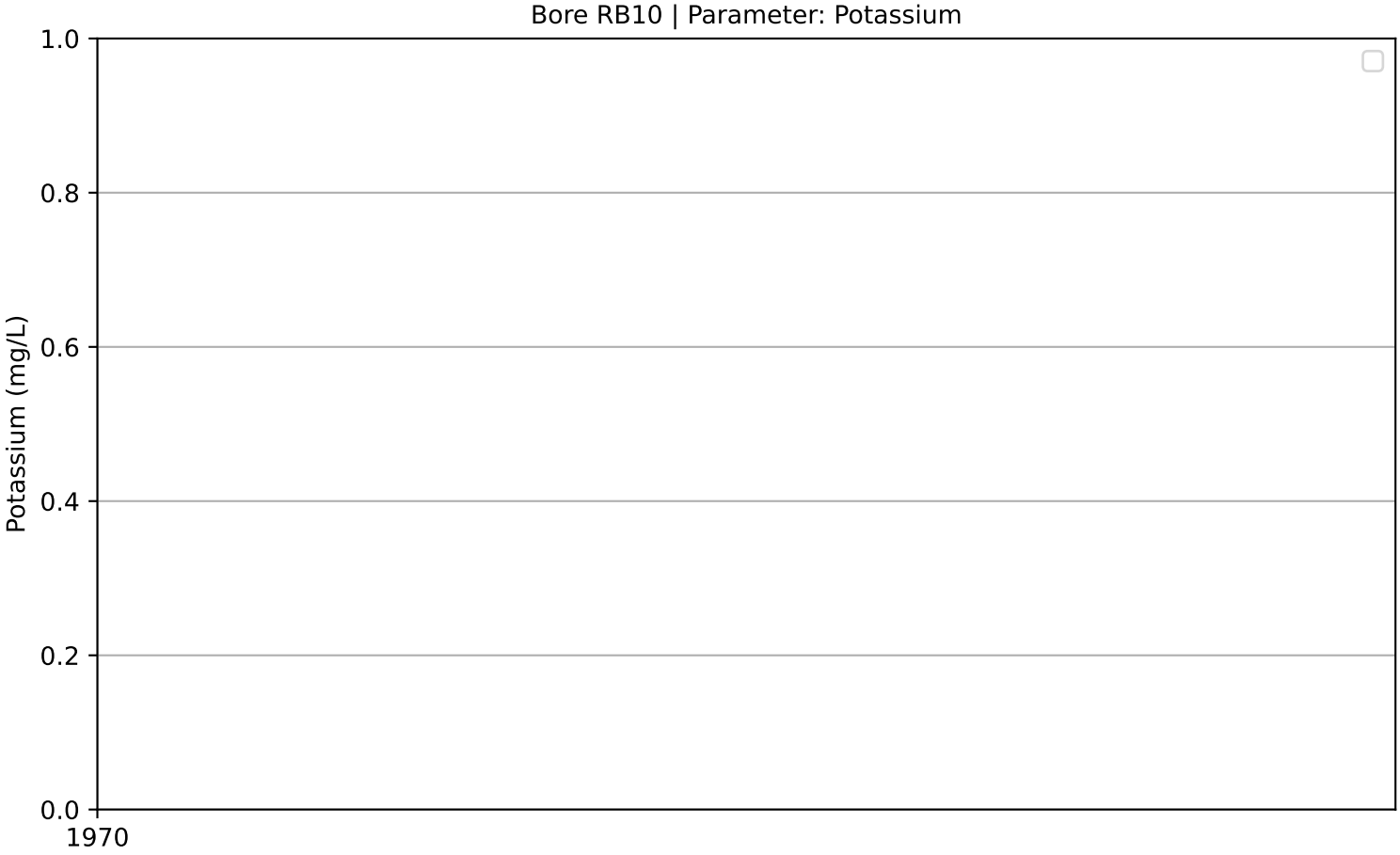

Bore RB10 | Trend: no trend | tau = 0.145 | p = 0.297
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
12000
10000
8000
6000
4000
2000
2022
2023
2024

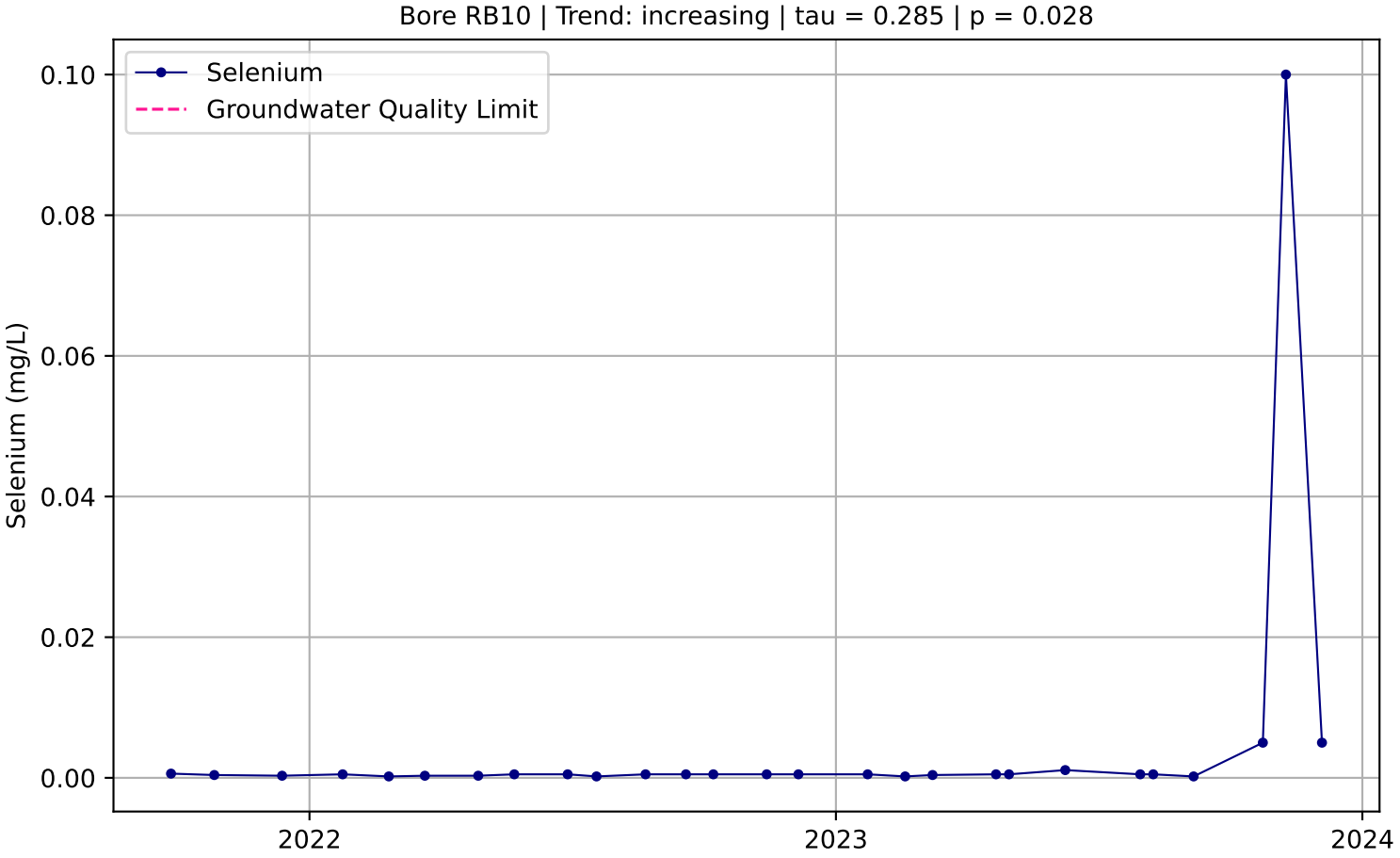

Bore RB10 | Trend: increasing | tau = 0.368 | p = 0.008
Field pH (pH Unit)
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
2022
2023
2024
Field pH
Groundwater Quality Limit


Bore RB10 | Trend: no trend | tau = -0.105 | p = 0.166
Iron
Groundwater Quality Limit
Iron (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
2022
2023
2024

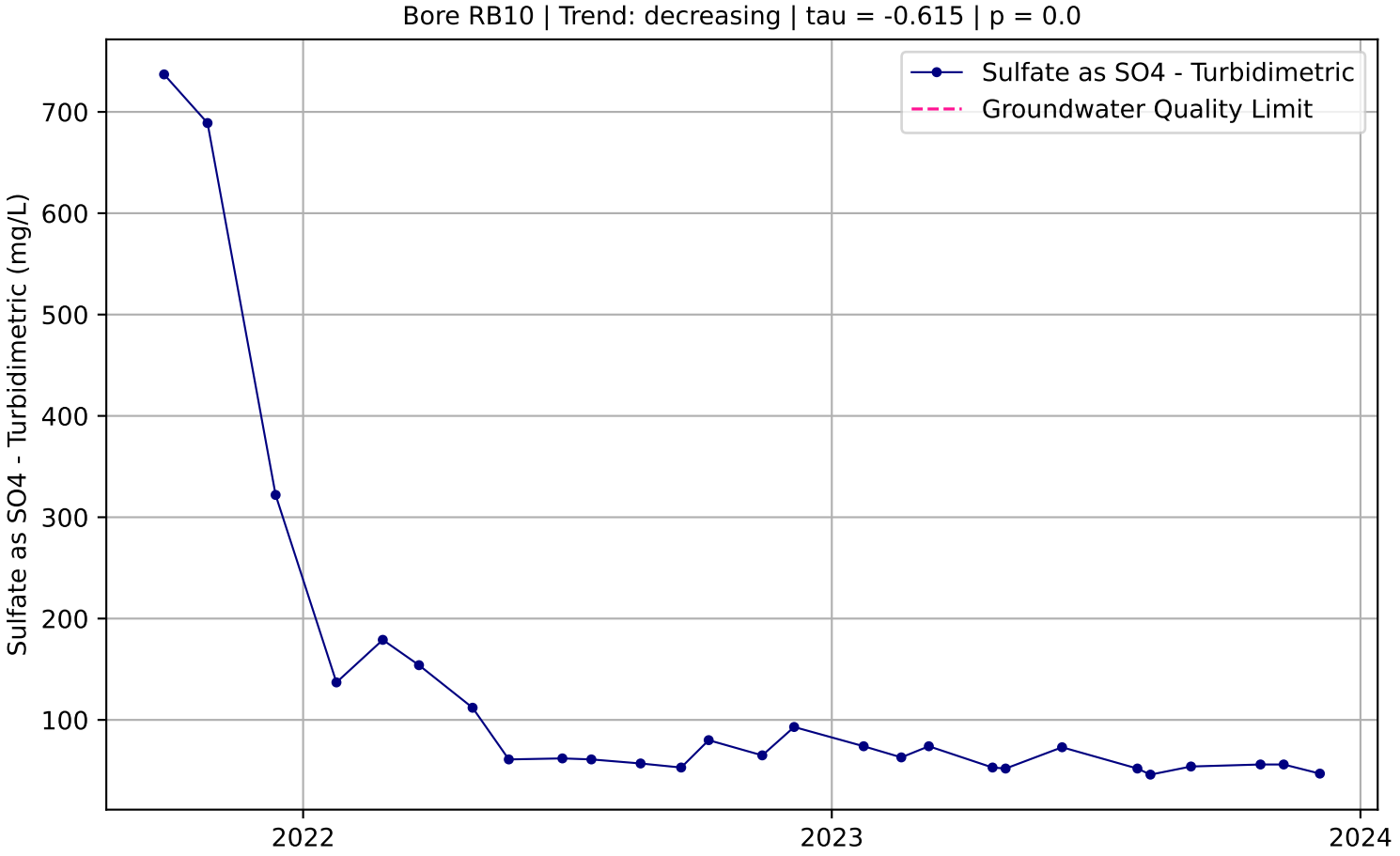

Bore RB10 | Parameter: Magnesium
Magnesium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

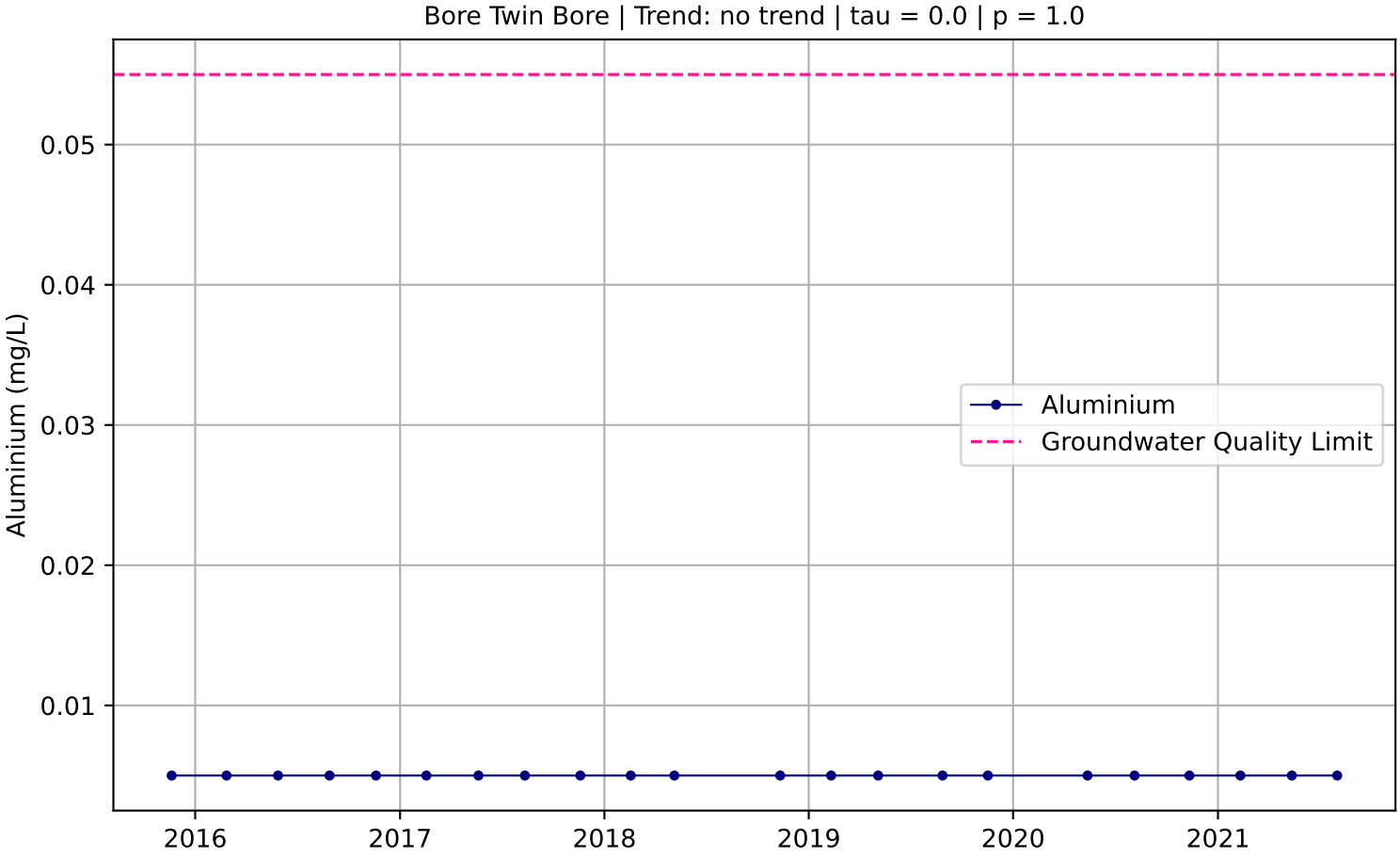

Bore RB10 | Trend: no trend | tau = 0.16 | p = 0.25
Molybdenum
Groundwater Quality Limit
Molybdenum (mg/L)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
2022
2023
2024

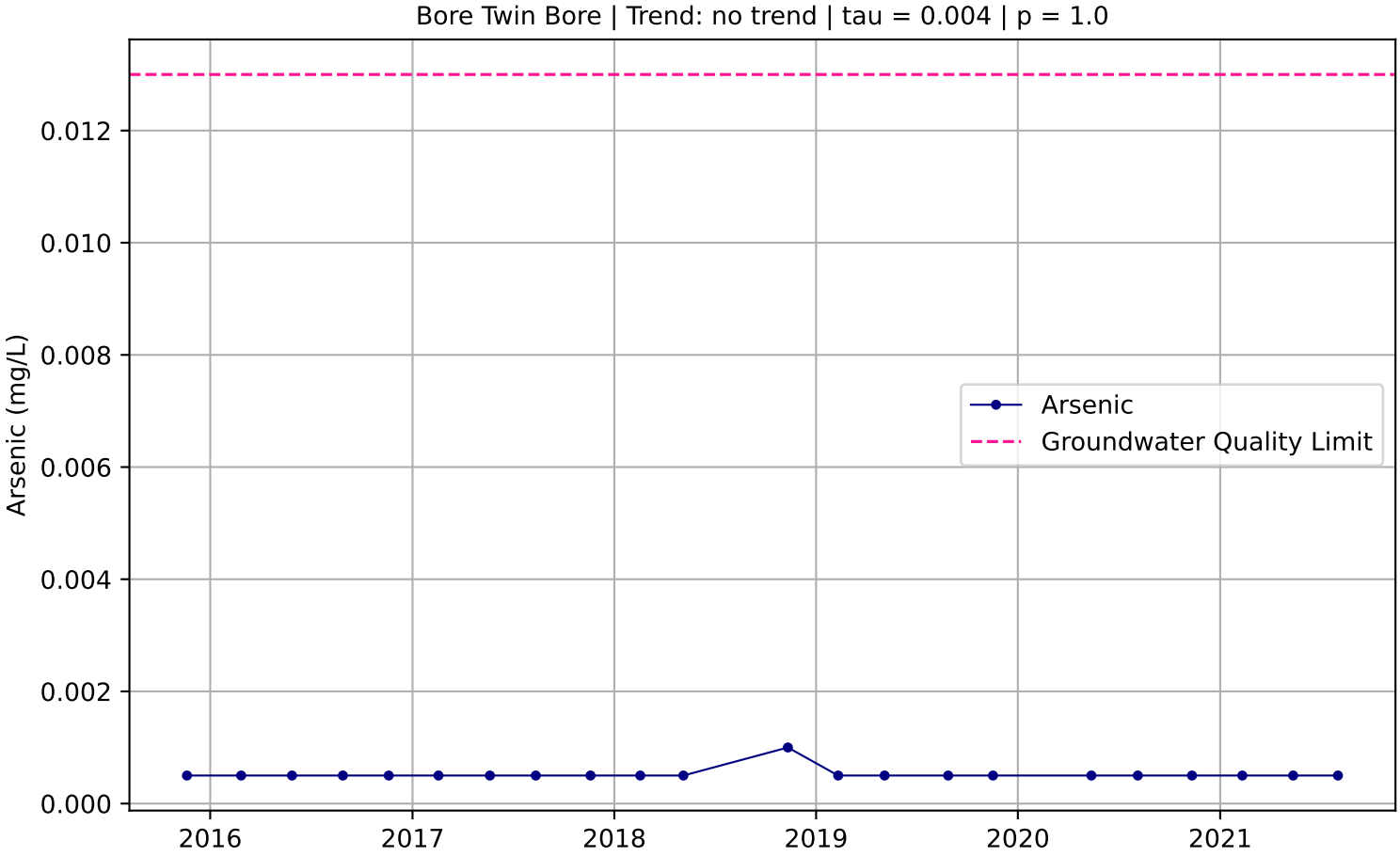

Bore RB10 | Parameter: Potassium
Potassium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

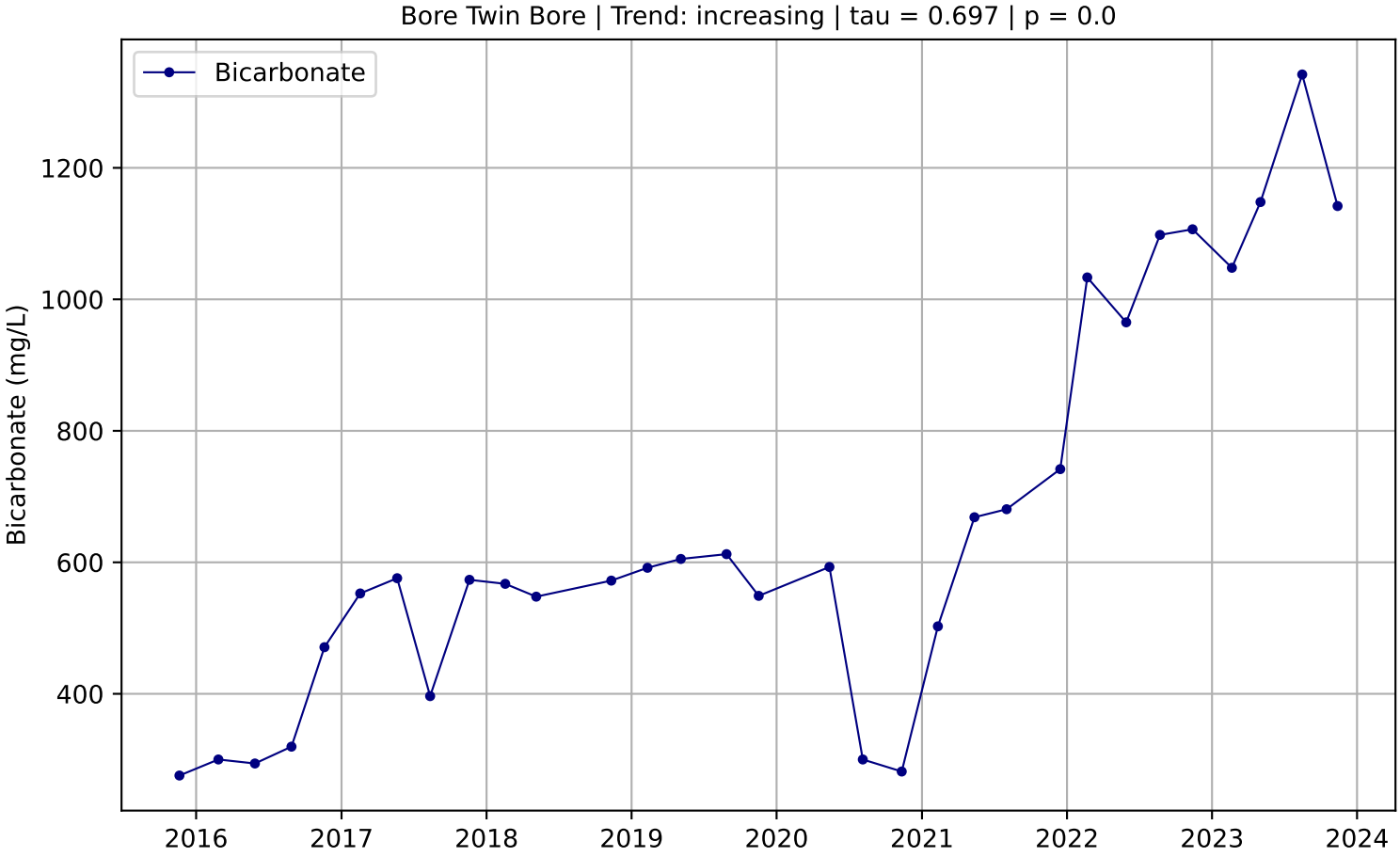

Bore RB10 | Trend: increasing | tau = 0.285 | p = 0.028
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2022
2023
2024

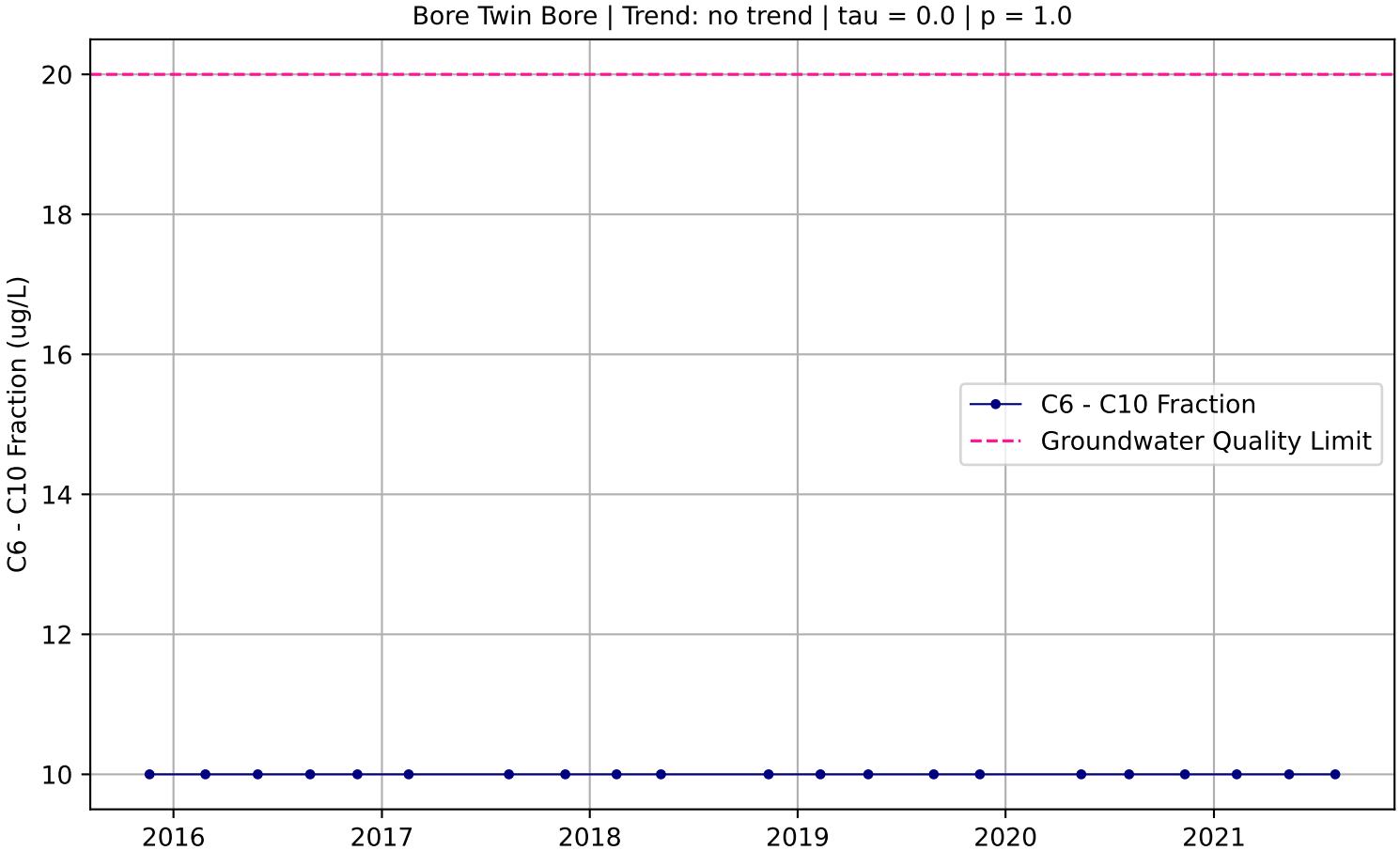
Bore RB10 | Parameter: Sodium
Sodium (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970

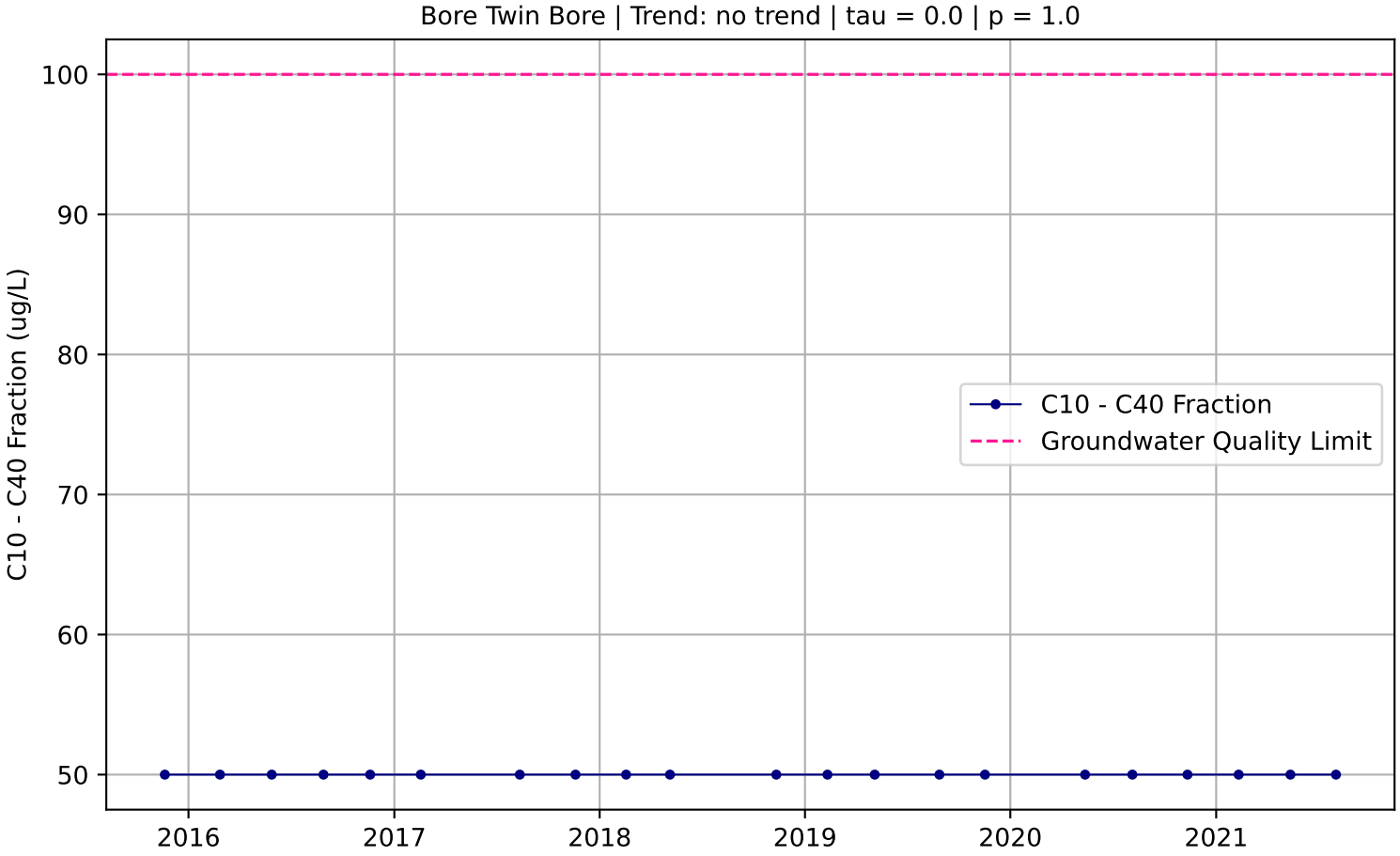

Bore RB10 | Trend: decreasing | tau = -0.615 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
700
600
500
400
300
200
100
2022
2023
2024

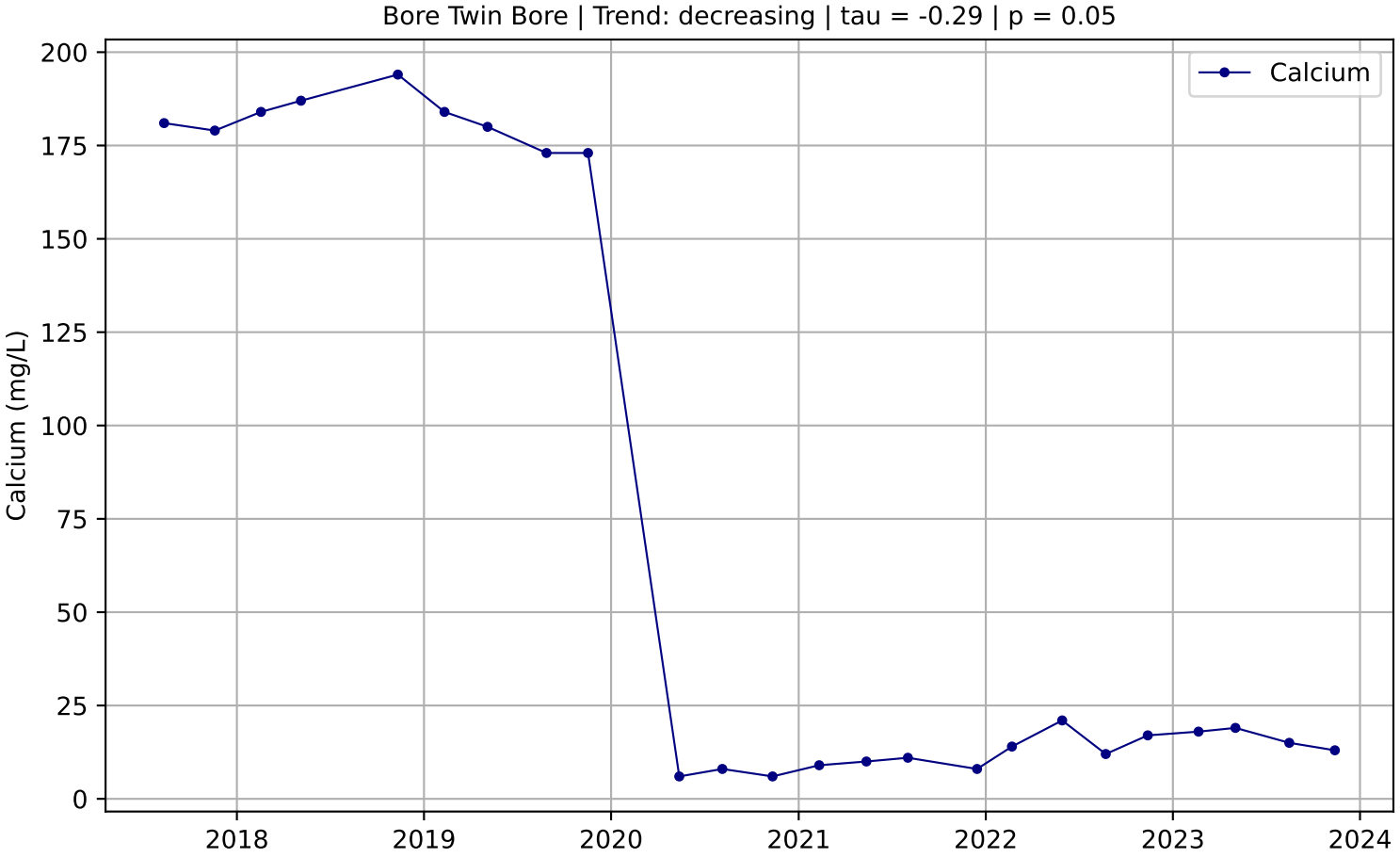

Bore Twin Bore | Trend: no trend | tau = 0.0 | p = 1.0
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
Aluminium
Groundwater Quality Limit

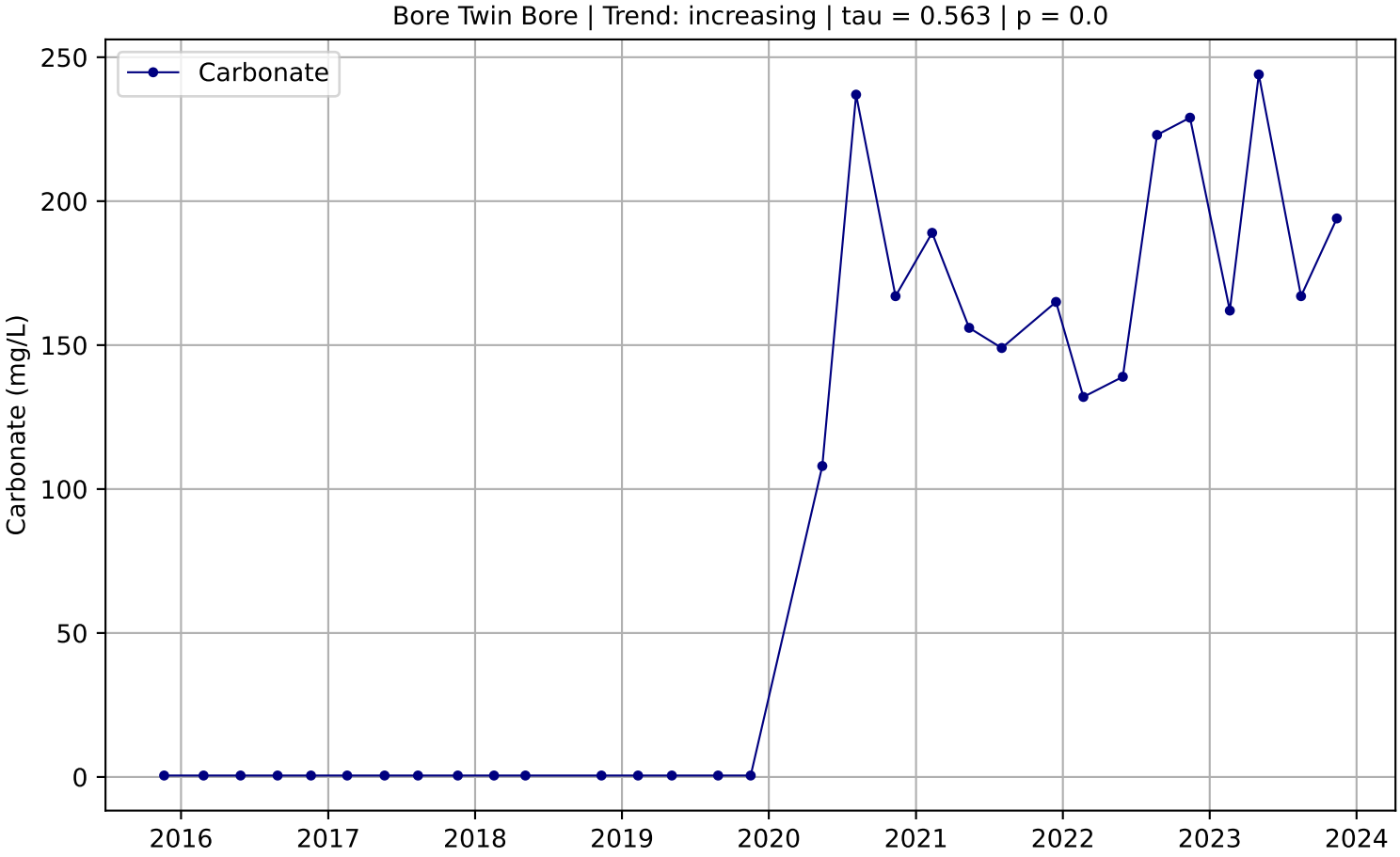

Bore Twin Bore | Trend: no trend | tau = 0.004 | p = 1.0
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

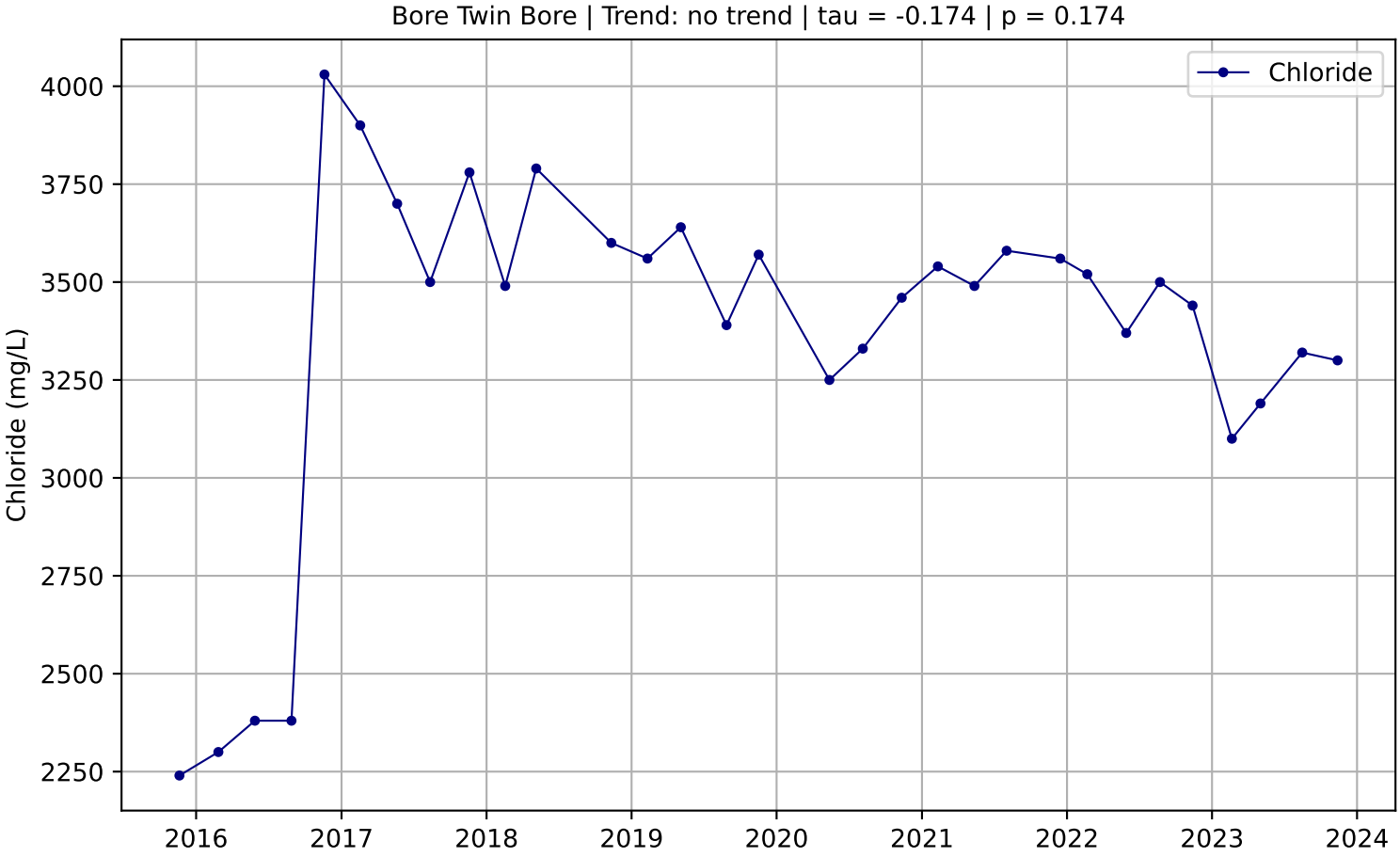

Bore Twin Bore | Trend: increasing | tau = 0.697 | p = 0.0
Bicarbonate
Bicarbonate (mg/L)
1200
1000
800
600
400
2016
2017
2018
2019
2020
2021
2022
2023
2024

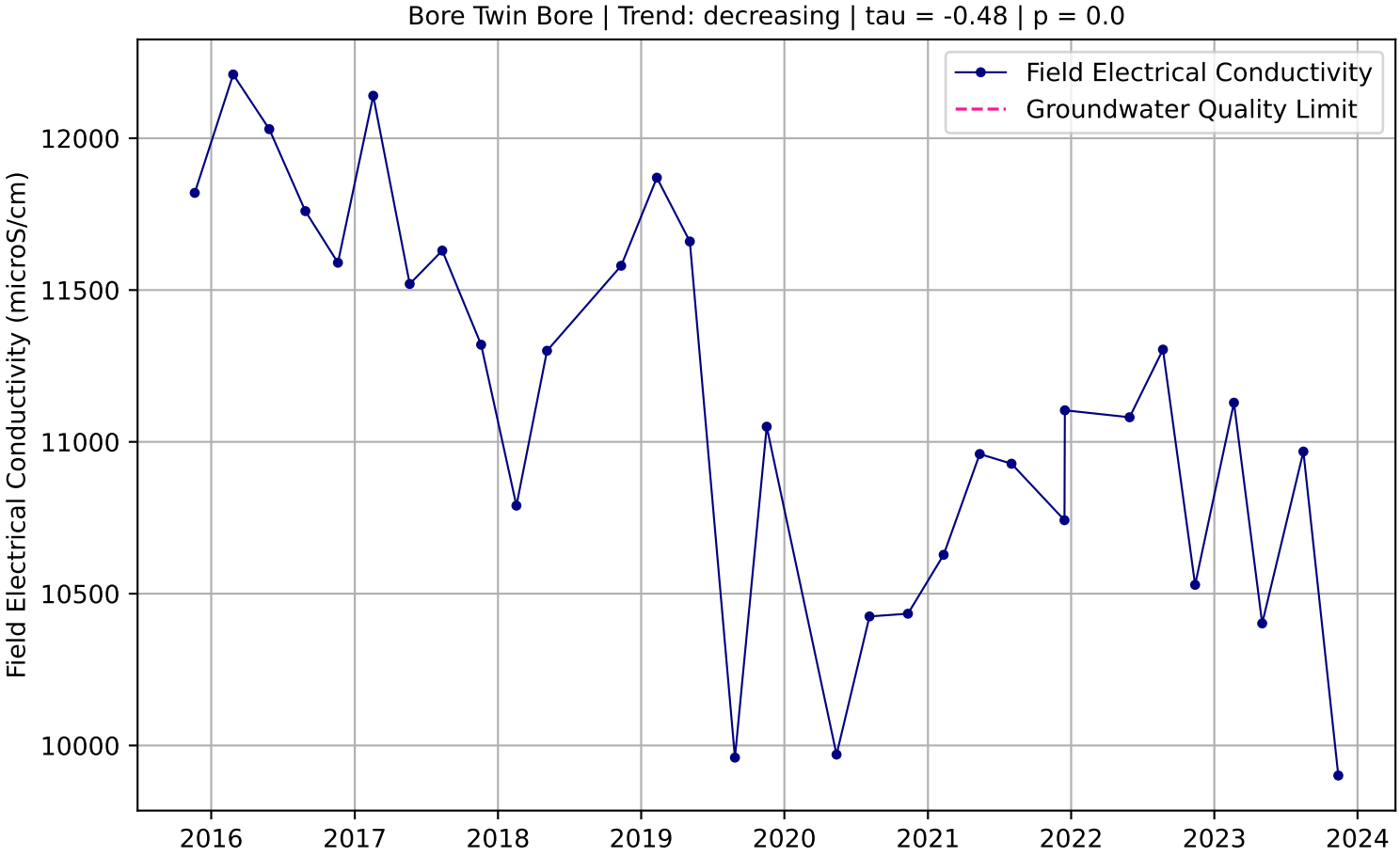

Bore Twin Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

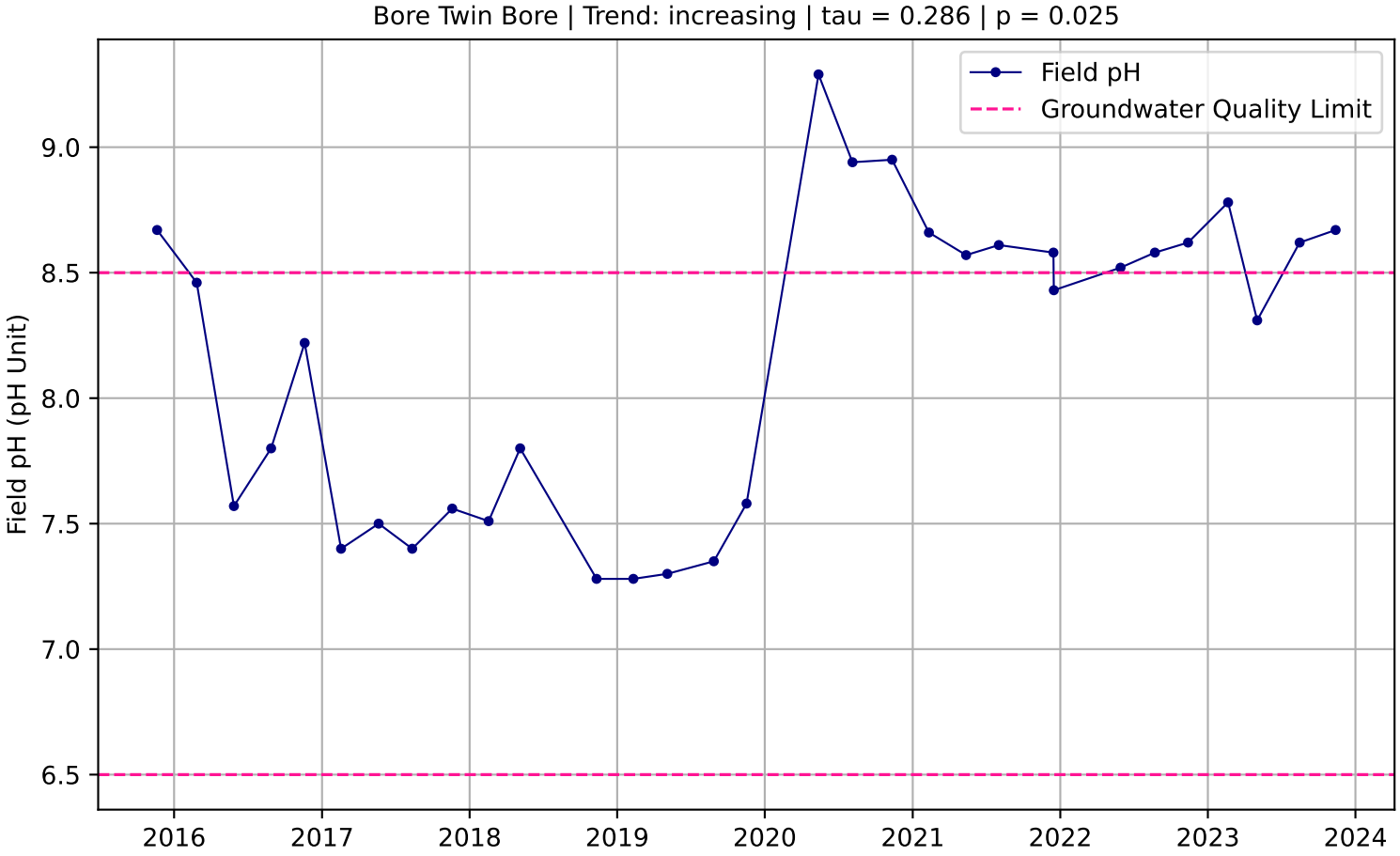

Bore Twin Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

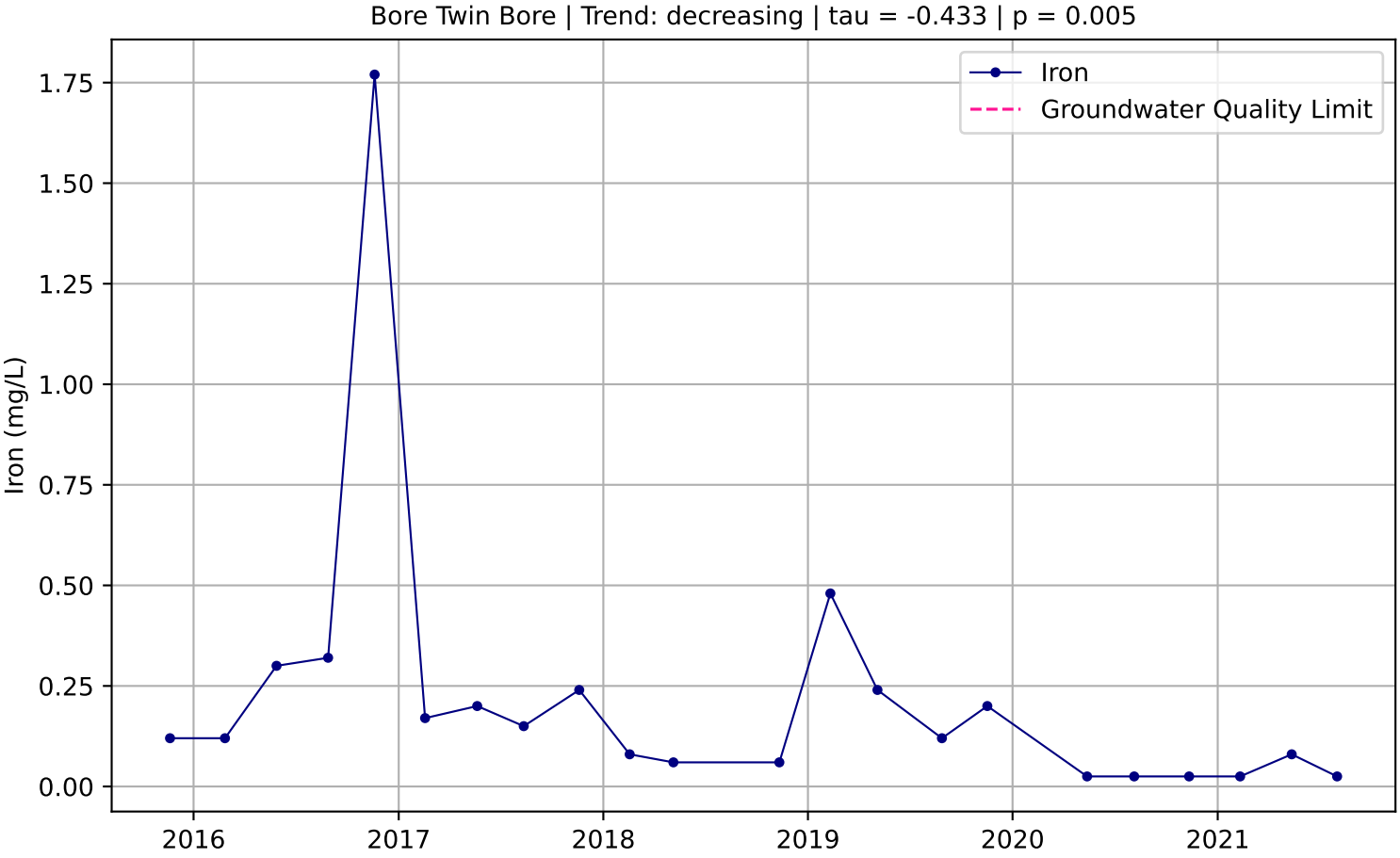

Bore Twin Bore | Trend: decreasing | tau = -0.29 | p = 0.05
Calcium
Calcium (mg/L)
200
175
150
125
100
75
50
25
0
2018
2019
2020
2021
2022
2023
2024

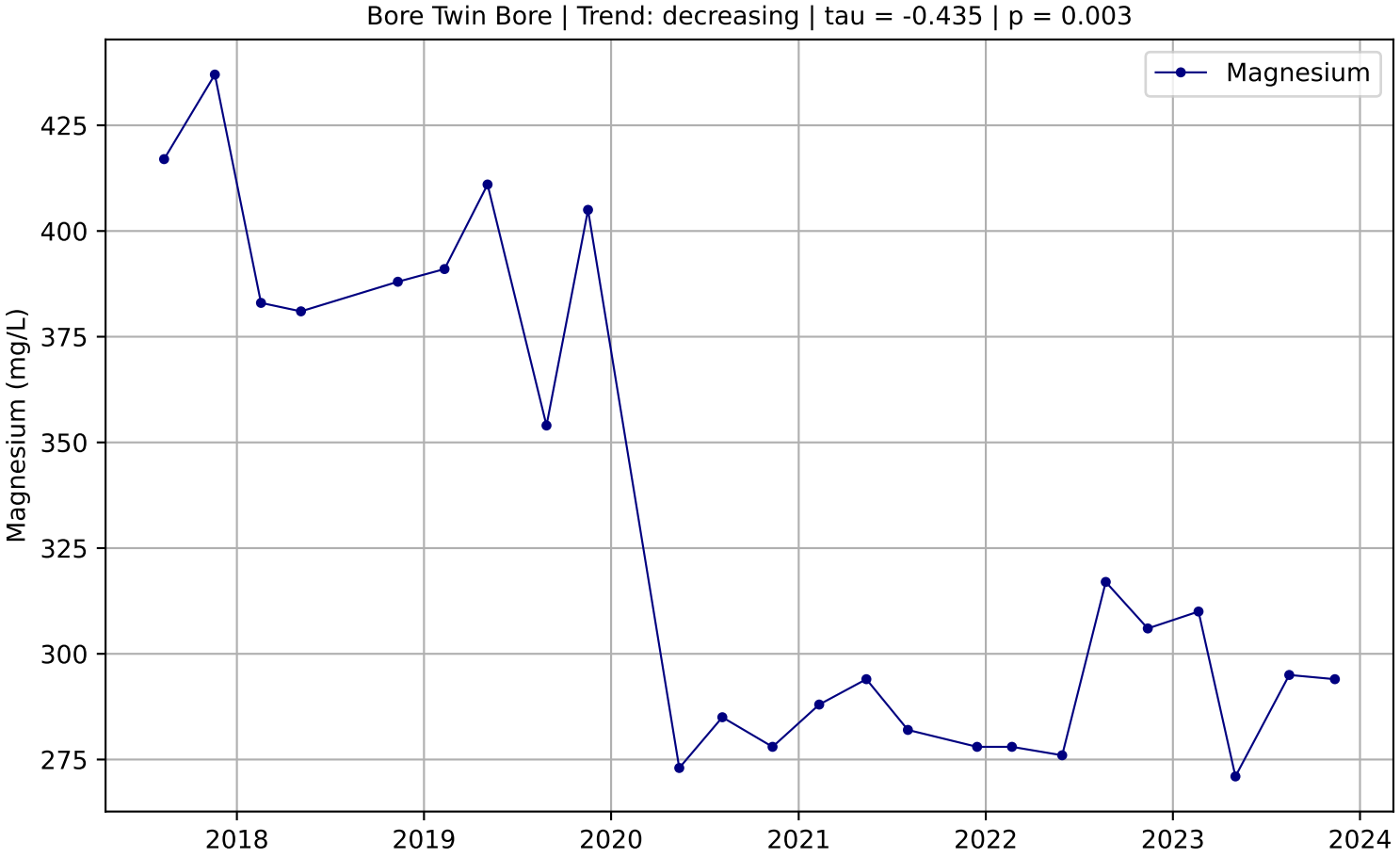

Bore Twin Bore | Trend: increasing | tau = 0.563 | p = 0.0
Carbonate
Carbonate (mg/L)
250
200
150
100
50
0
2016
2017
2018
2019
2020
2021
2022
2023
2024

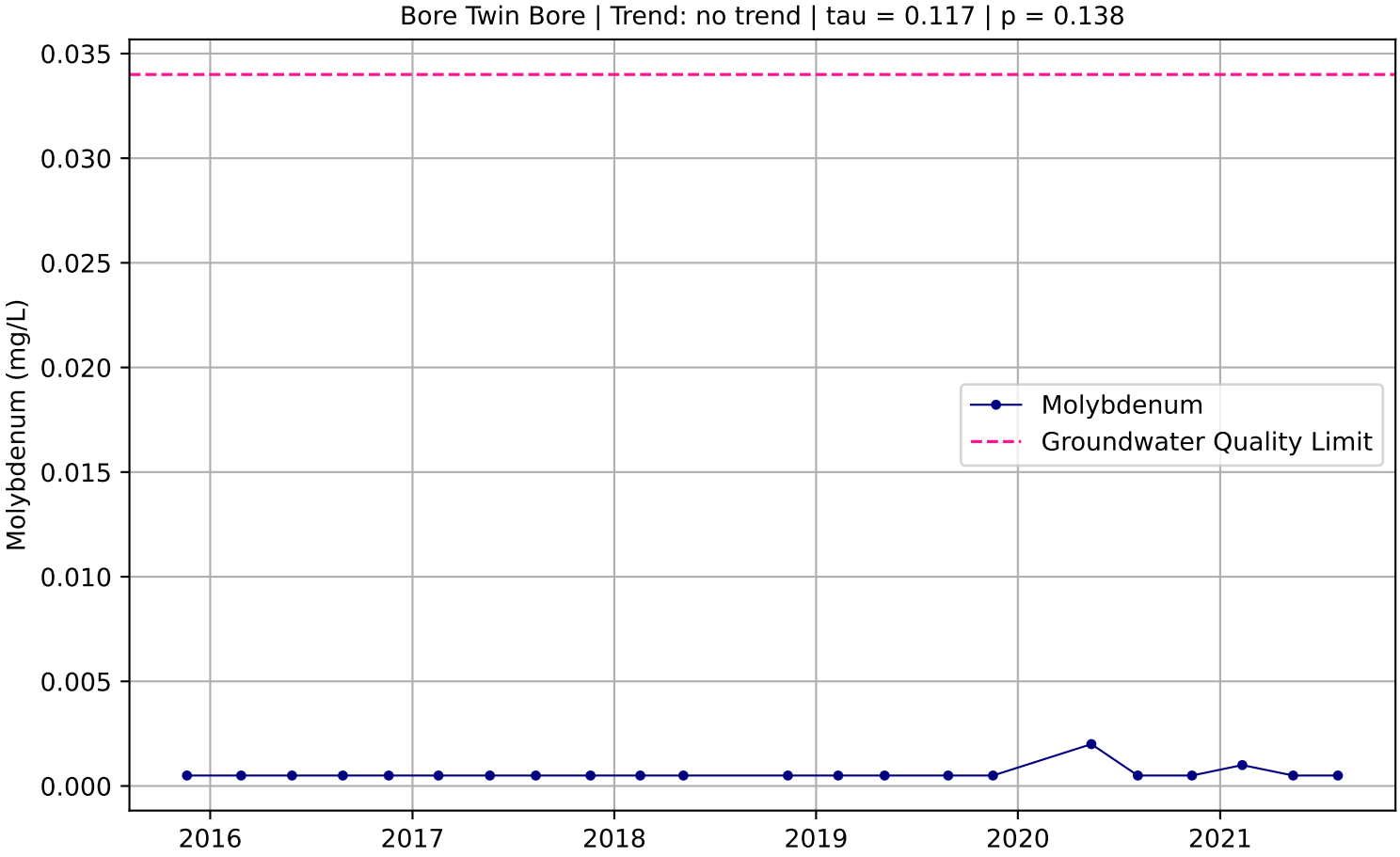

Bore Twin Bore | Trend: no trend | tau = -0.174 | p = 0.174
Chloride
Chloride (mg/L)
4000
3750
3500
3250
3000
2750
2500
2250
2016
2017
2018
2019
2020
2021
2022
2023
2024

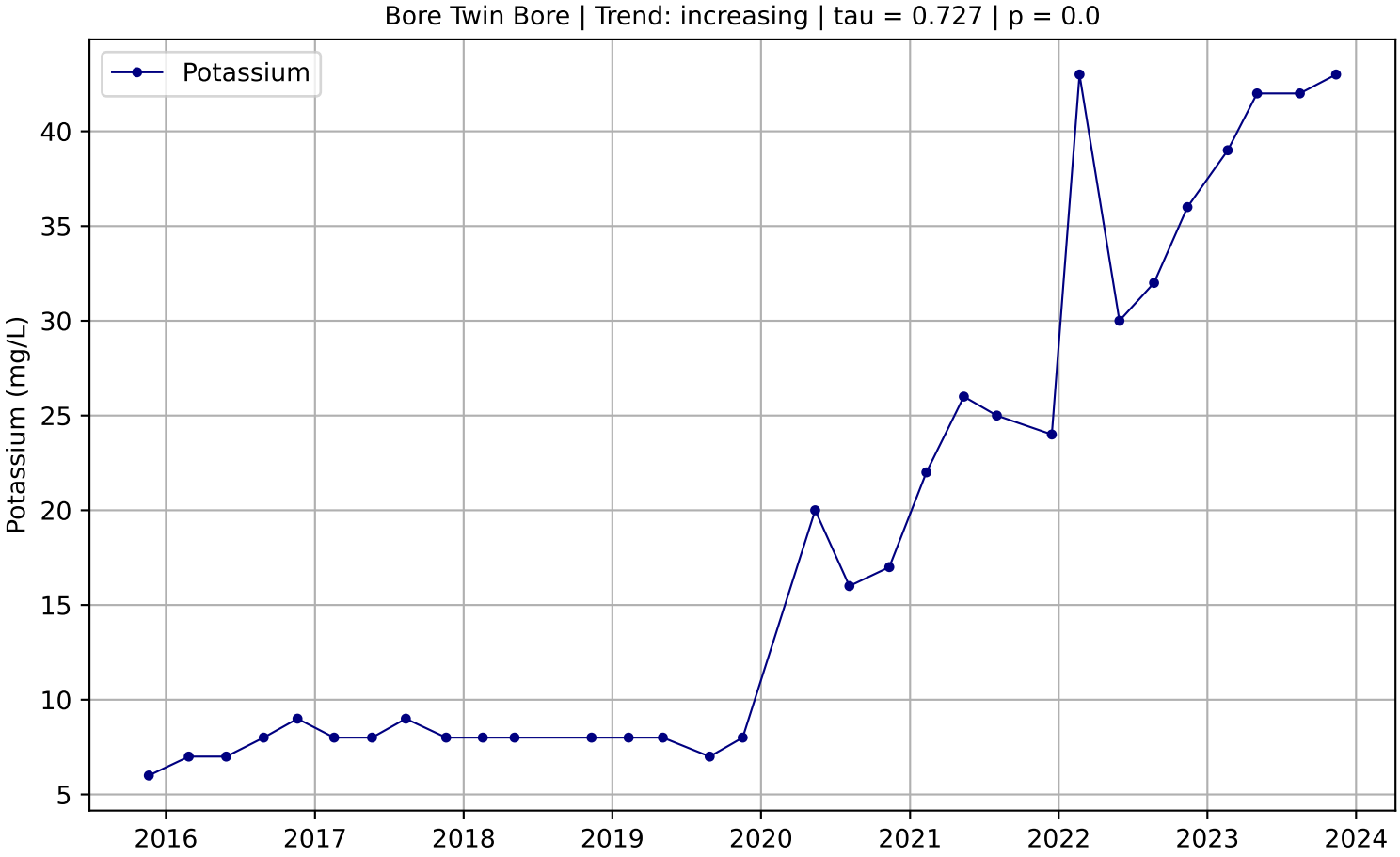

Bore Twin Bore | Trend: decreasing | tau = -0.48 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
12000
11500
11000
10500
10000
2016
2017
2018
2019
2020
2021
2022
2023
2024

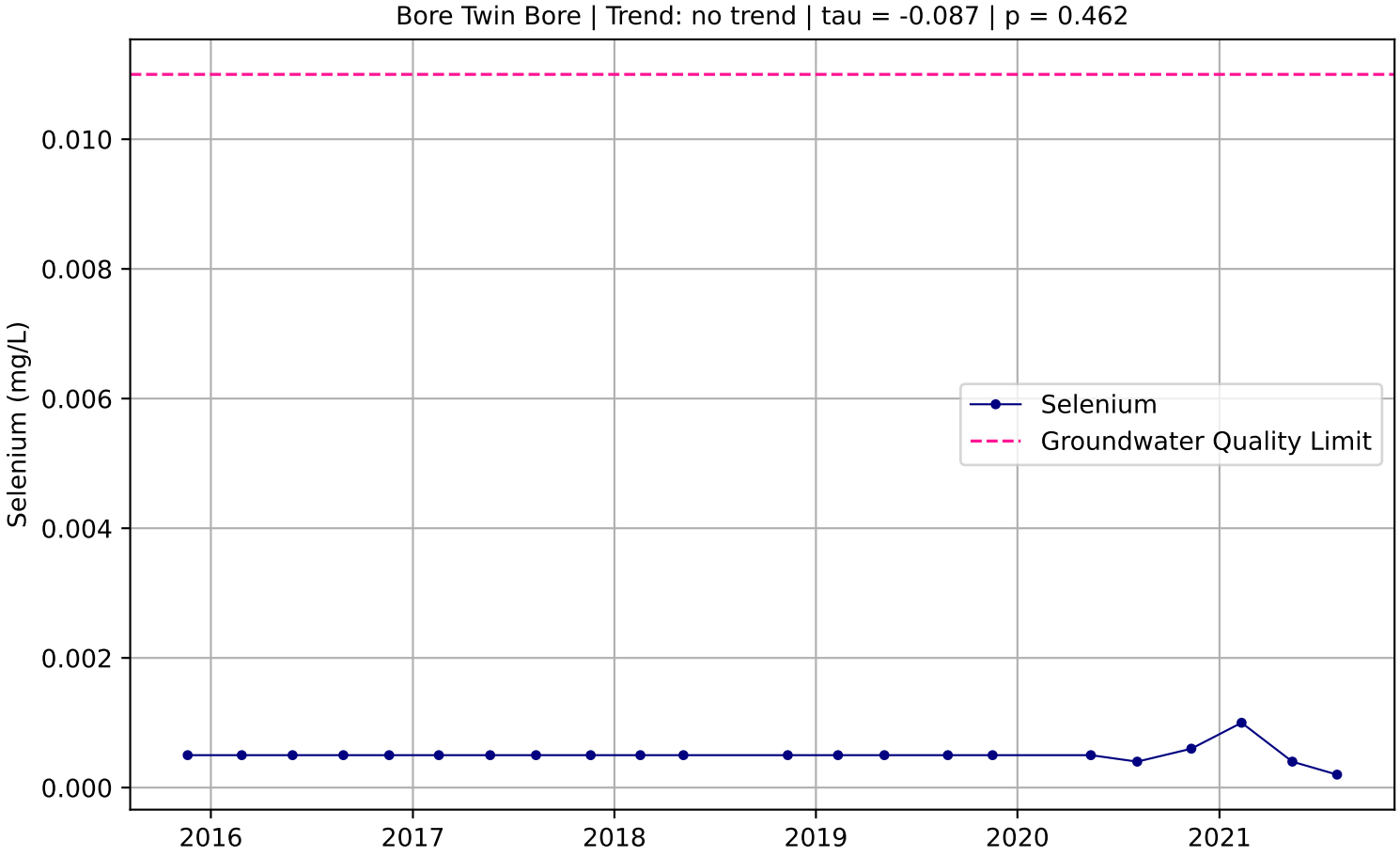

Bore Twin Bore | Trend: increasing | tau = 0.286 | p = 0.025
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
2016
2017
2018
2019
2020
2021
2022
2023
2024

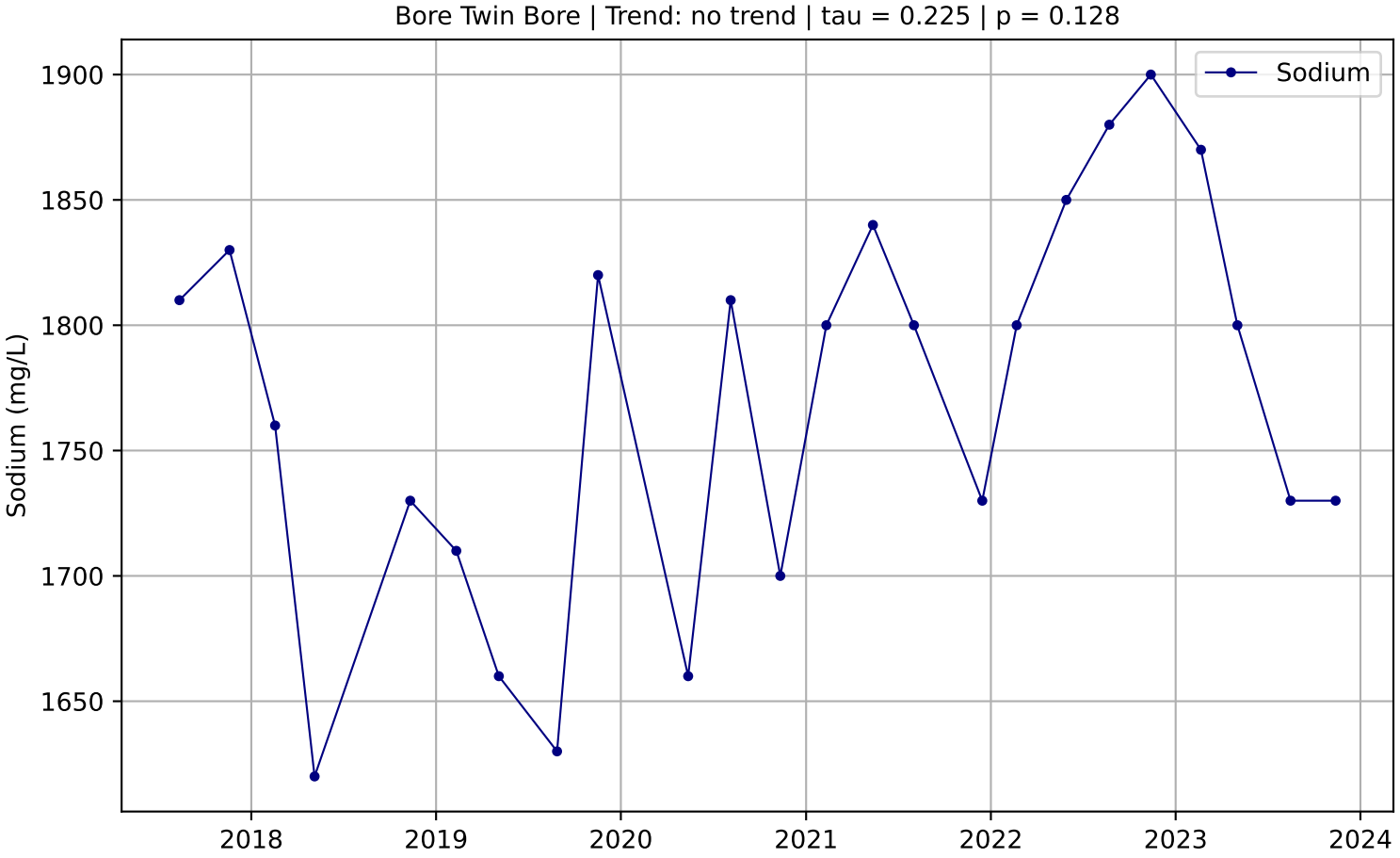

Bore Twin Bore | Trend: decreasing | tau = -0.433 | p = 0.005
Iron
Groundwater Quality Limit
Iron (mg/L)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2016
2017
2018
2019
2020
2021

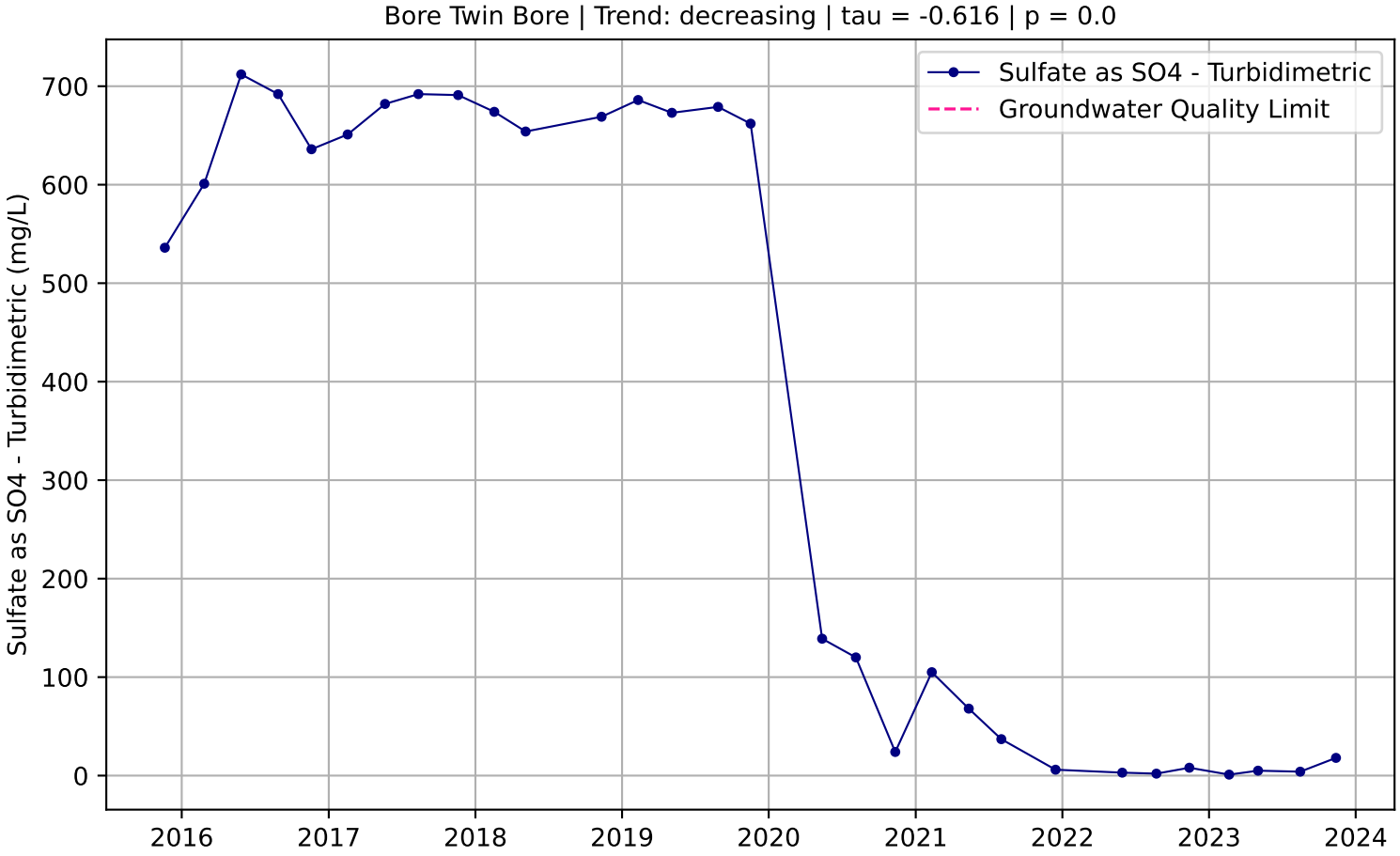

Bore Twin Bore | Trend: decreasing | tau = -0.435 | p = 0.003
Magnesium
Magnesium (mg/L)
425
400
375
350
325
300
275
2018
2019
2020
2021
2022
2023
2024

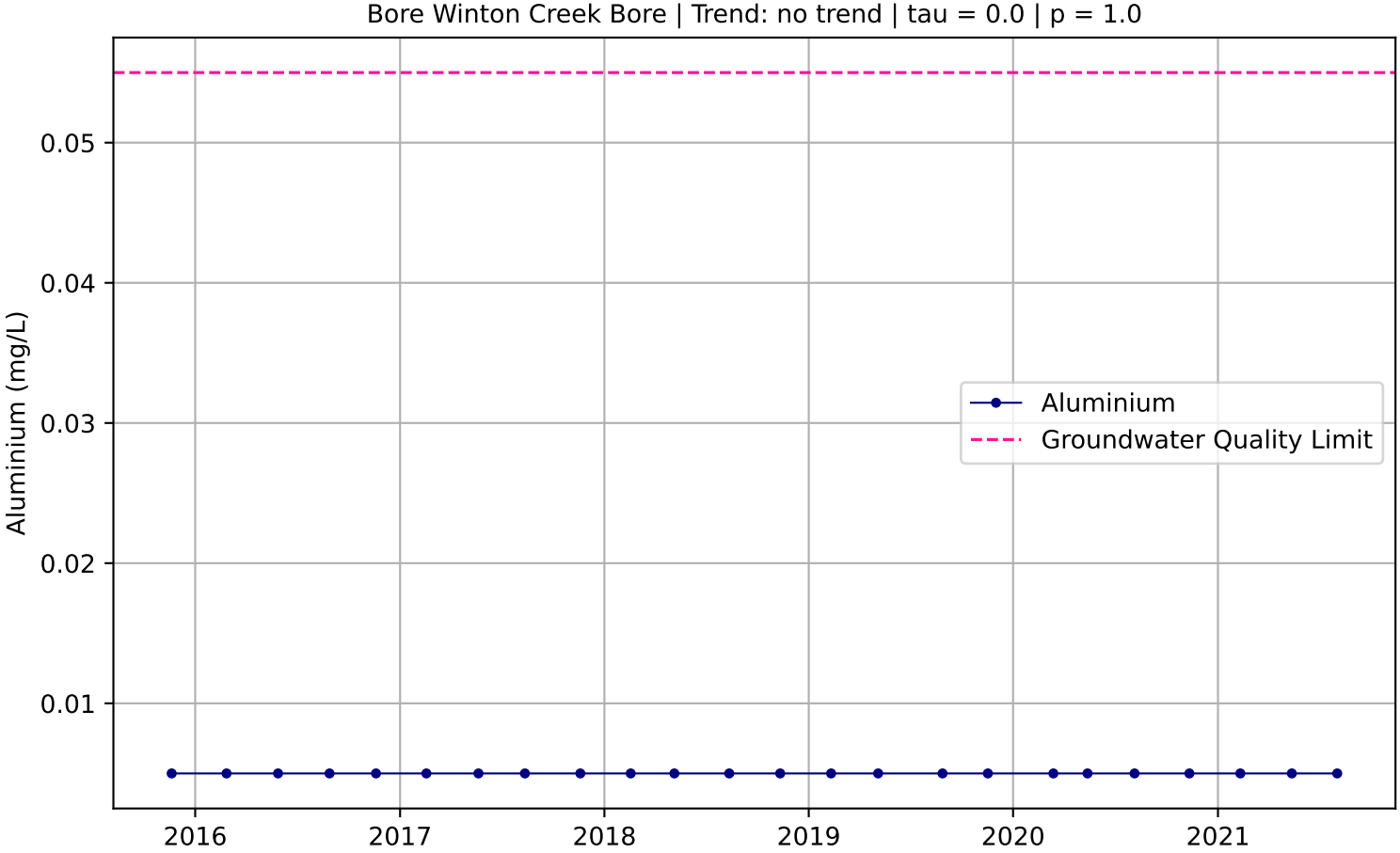

Bore Twin Bore | Trend: no trend | tau = 0.117 | p = 0.138
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit

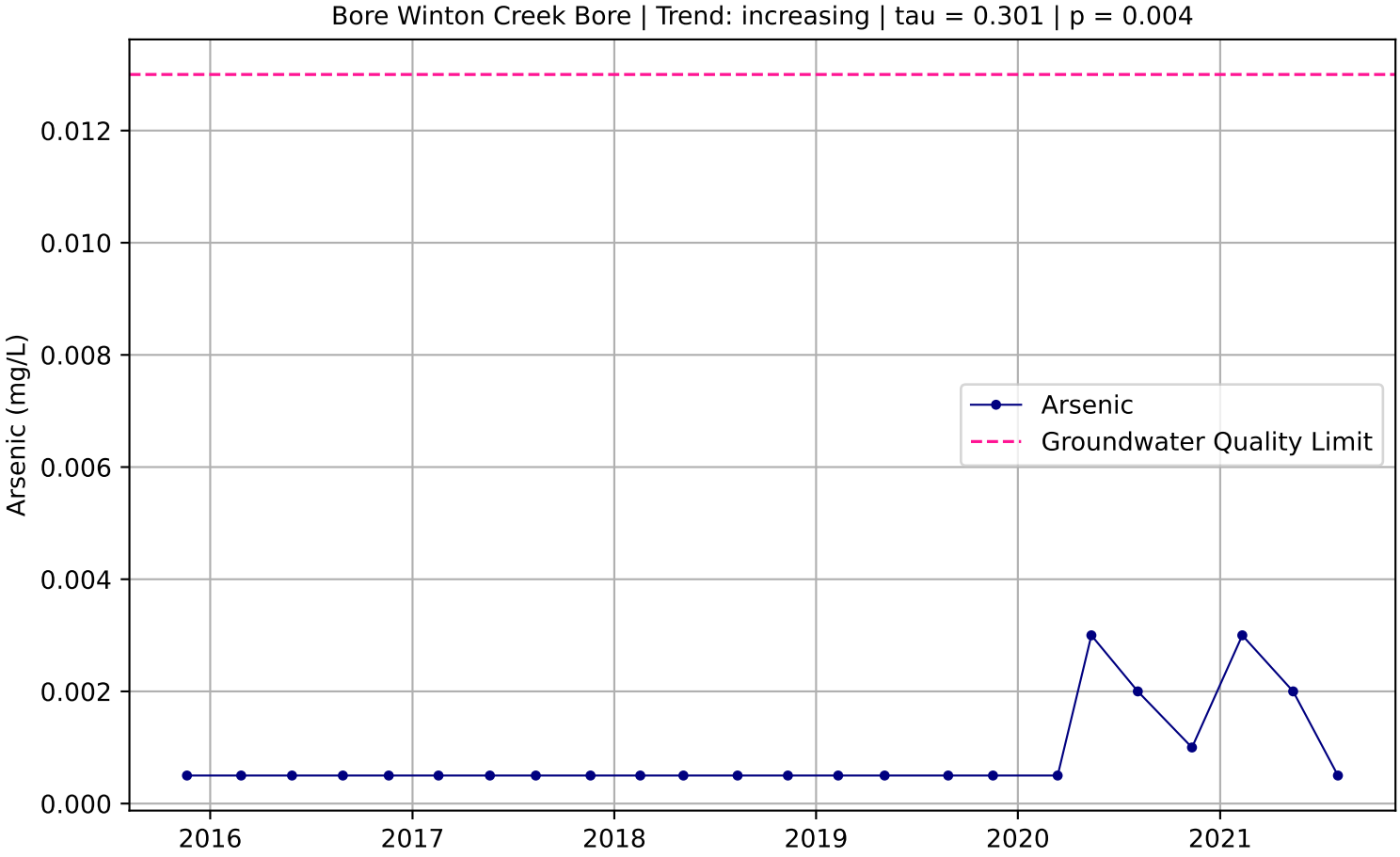

Bore Twin Bore | Trend: increasing | tau = 0.727 | p = 0.0
Potassium
Potassium (mg/L)
40
35
30
25
20
15
10
5
2016
2017
2018
2019
2020
2021
2022
2023
2024

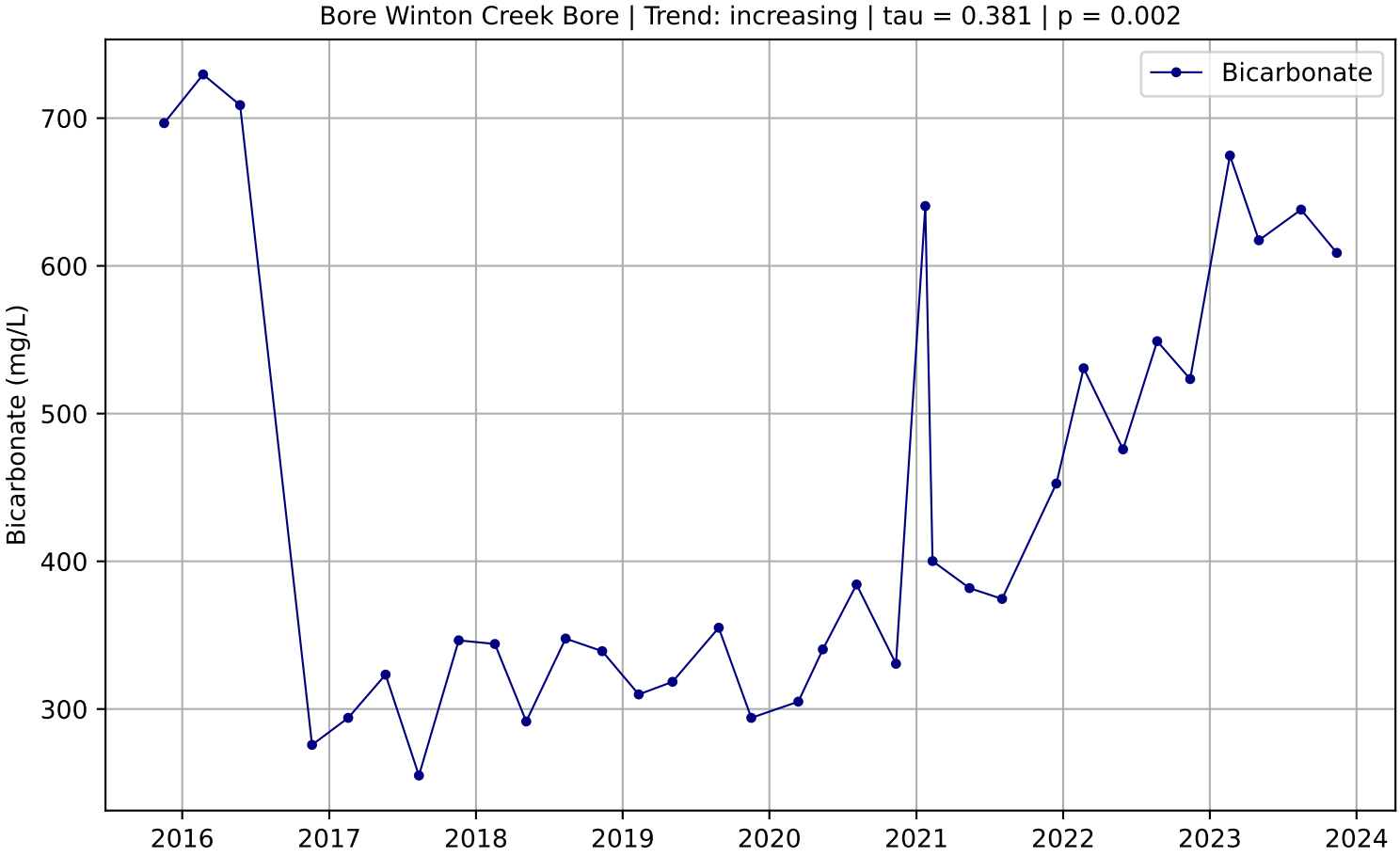

Bore Twin Bore | Trend: no trend | tau = -0.087 | p = 0.462
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit

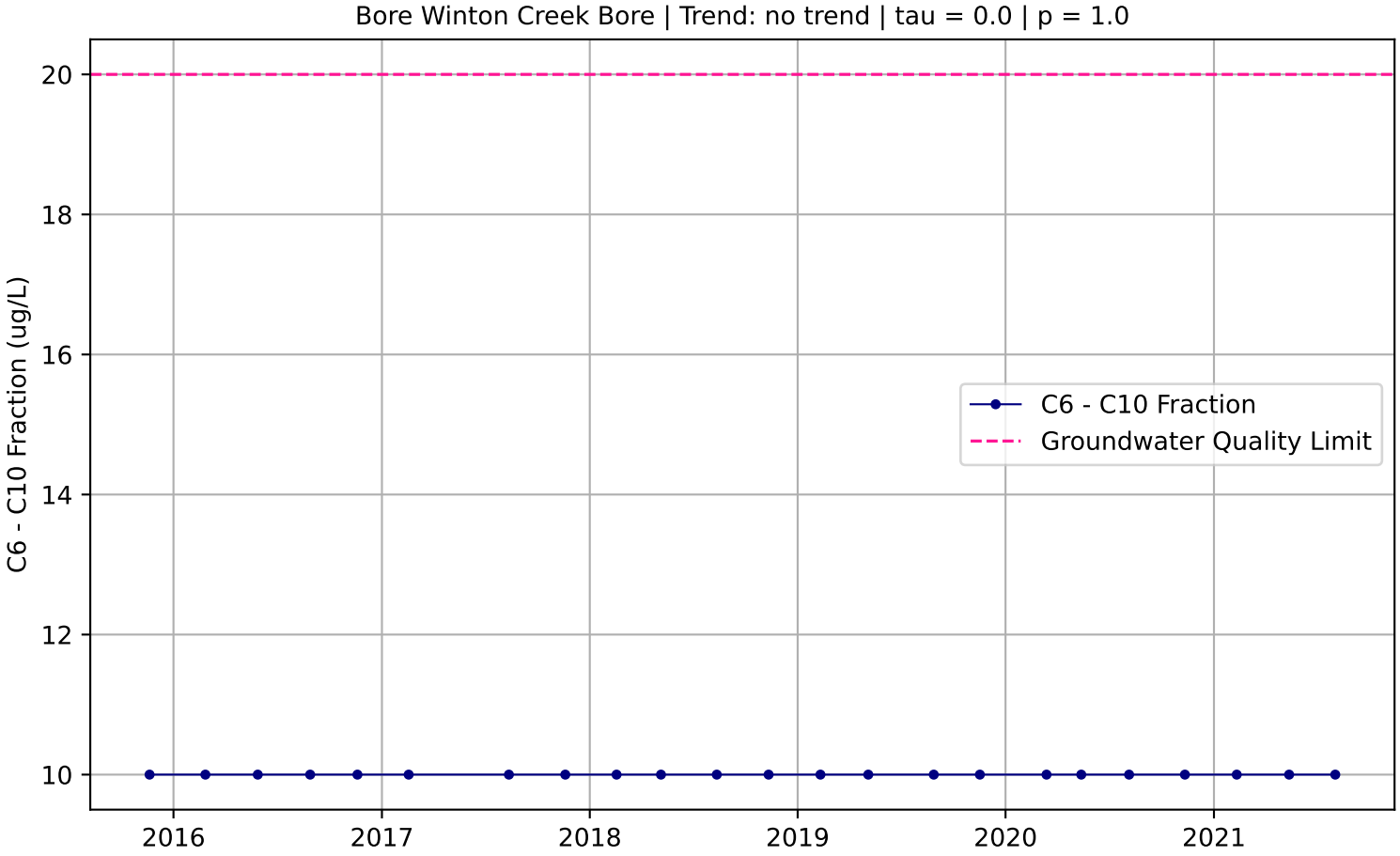

Bore Twin Bore | Trend: no trend | tau = 0.225 | p = 0.128
Sodium
Sodium (mg/L)
1900
1850
1800
1750
1700
1650
2018
2019
2020
2021
2022
2023
2024

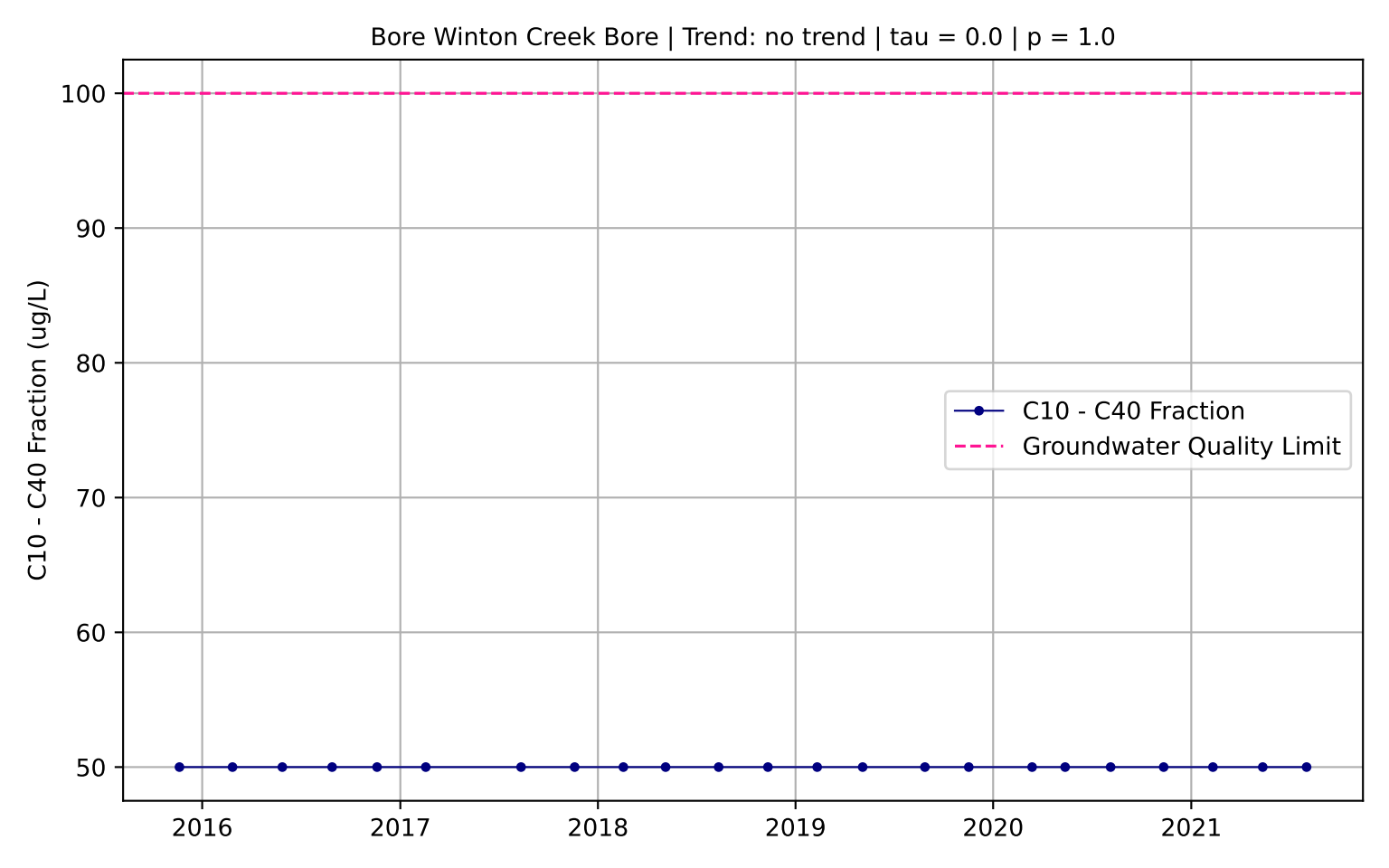

Bore Twin Bore | Trend: decreasing | tau = -0.616 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
0
100
200
300
400
500
600
700
2016
2017
2018
2019
2020
2021
2022
2023
2024

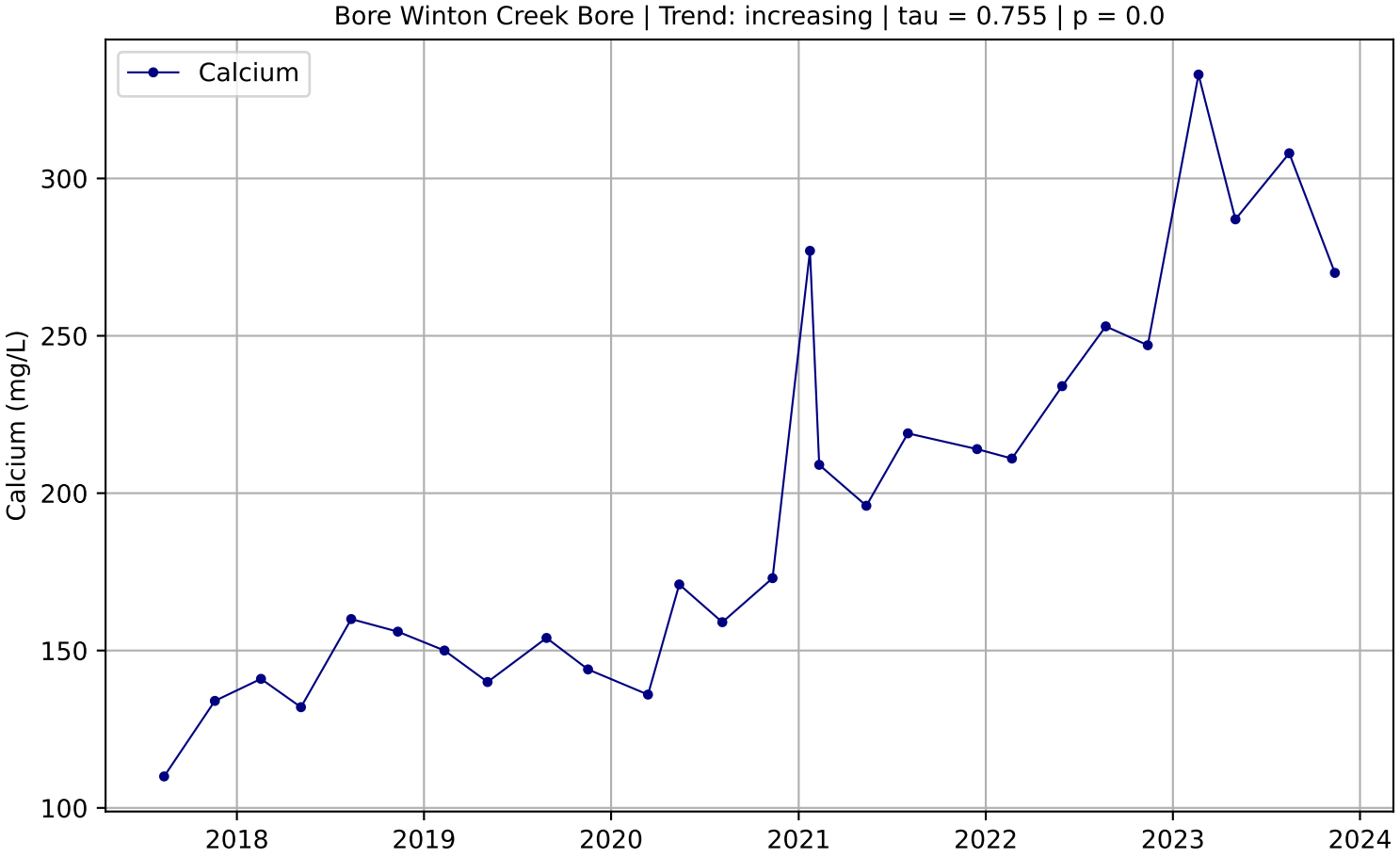

Bore Winton Creek Bore | Trend: no trend | tau = 0.0 | p = 1.0
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
Aluminium
Groundwater Quality Limit

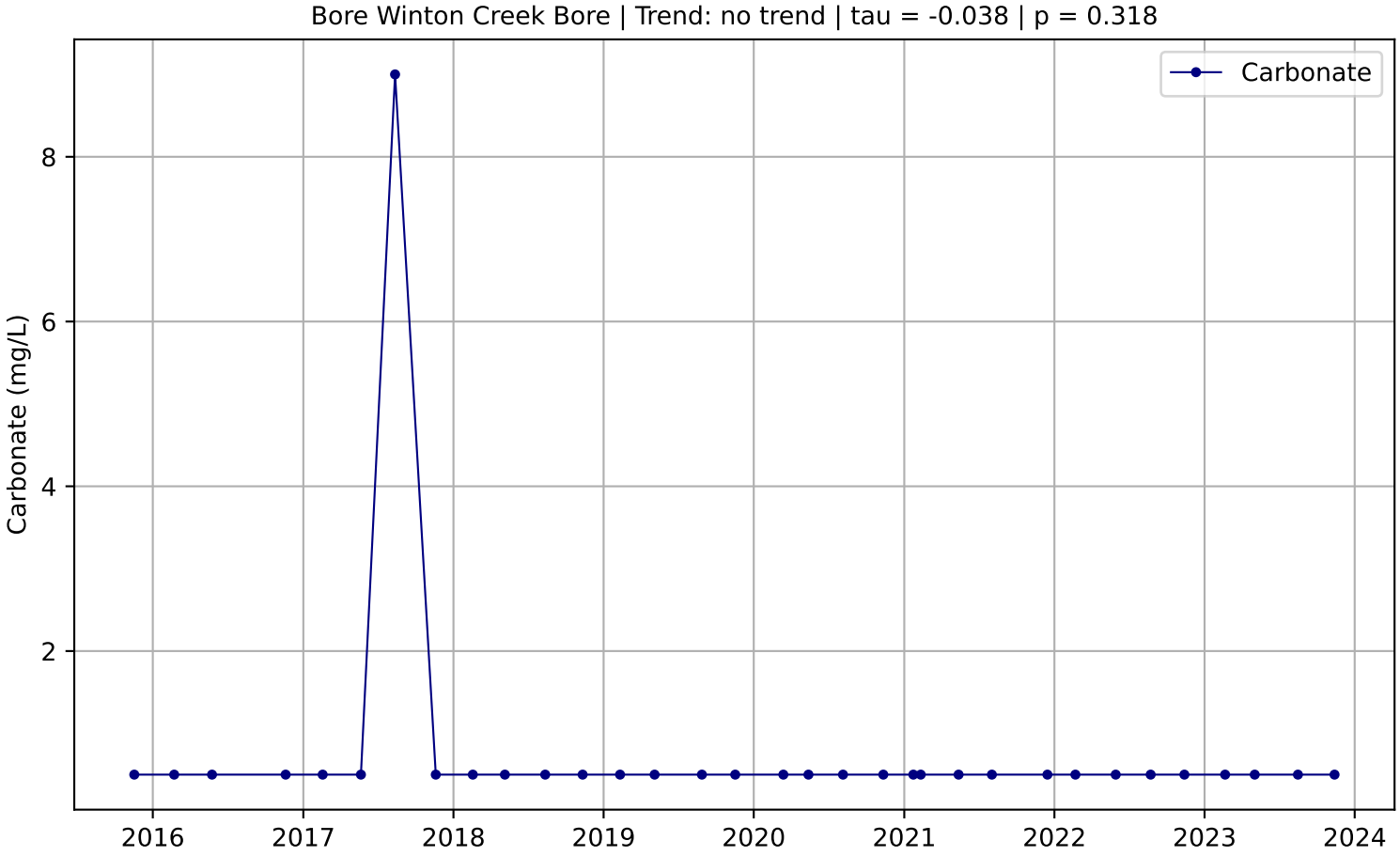

Bore Winton Creek Bore | Trend: increasing | tau = 0.301 | p = 0.004
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

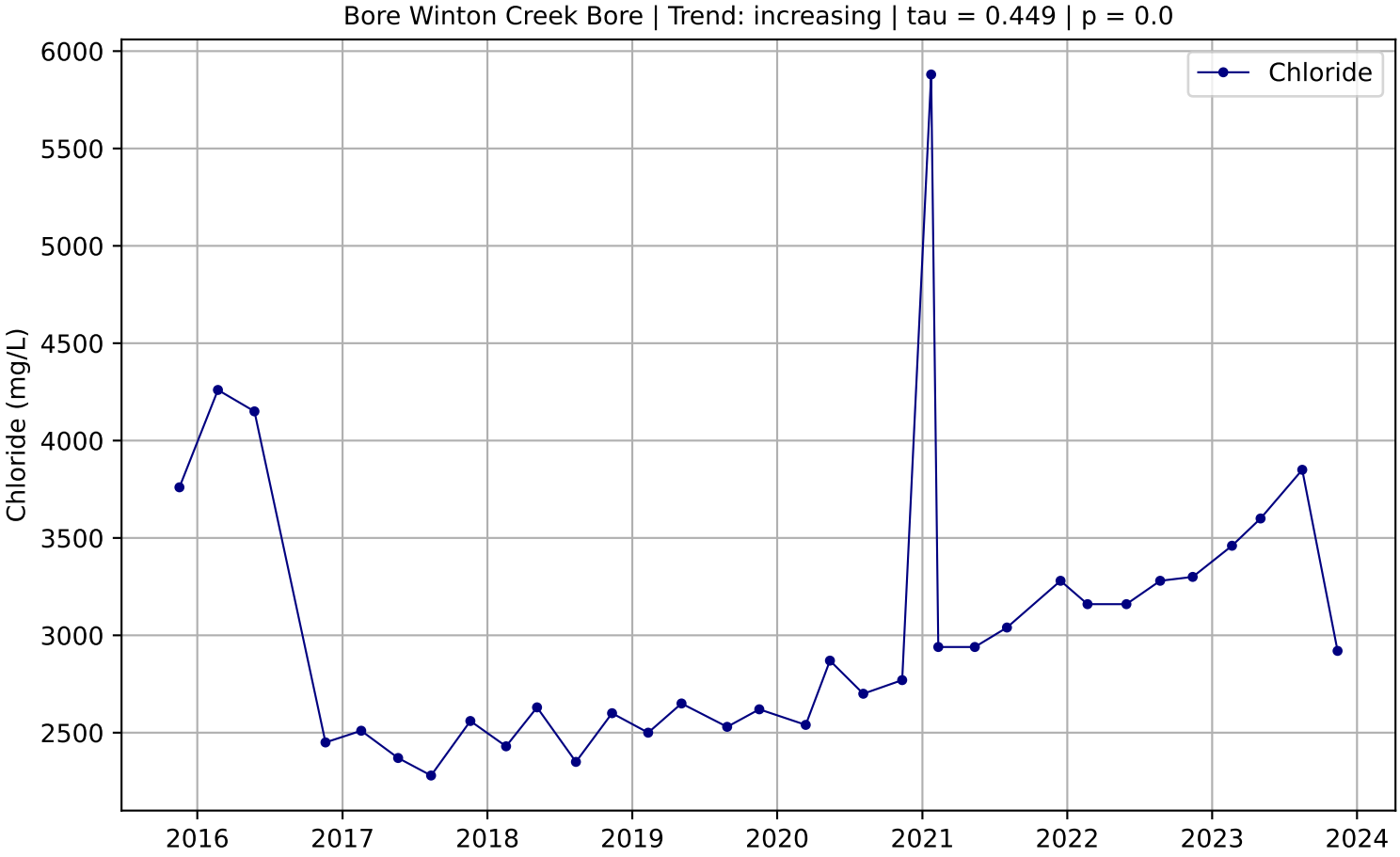

Bore Winton Creek Bore | Trend: increasing | tau = 0.381 | p = 0.002
Bicarbonate
Bicarbonate (mg/L)
700
600
500
400
300
2016
2017
2018
2019
2020
2021
2022
2023
2024

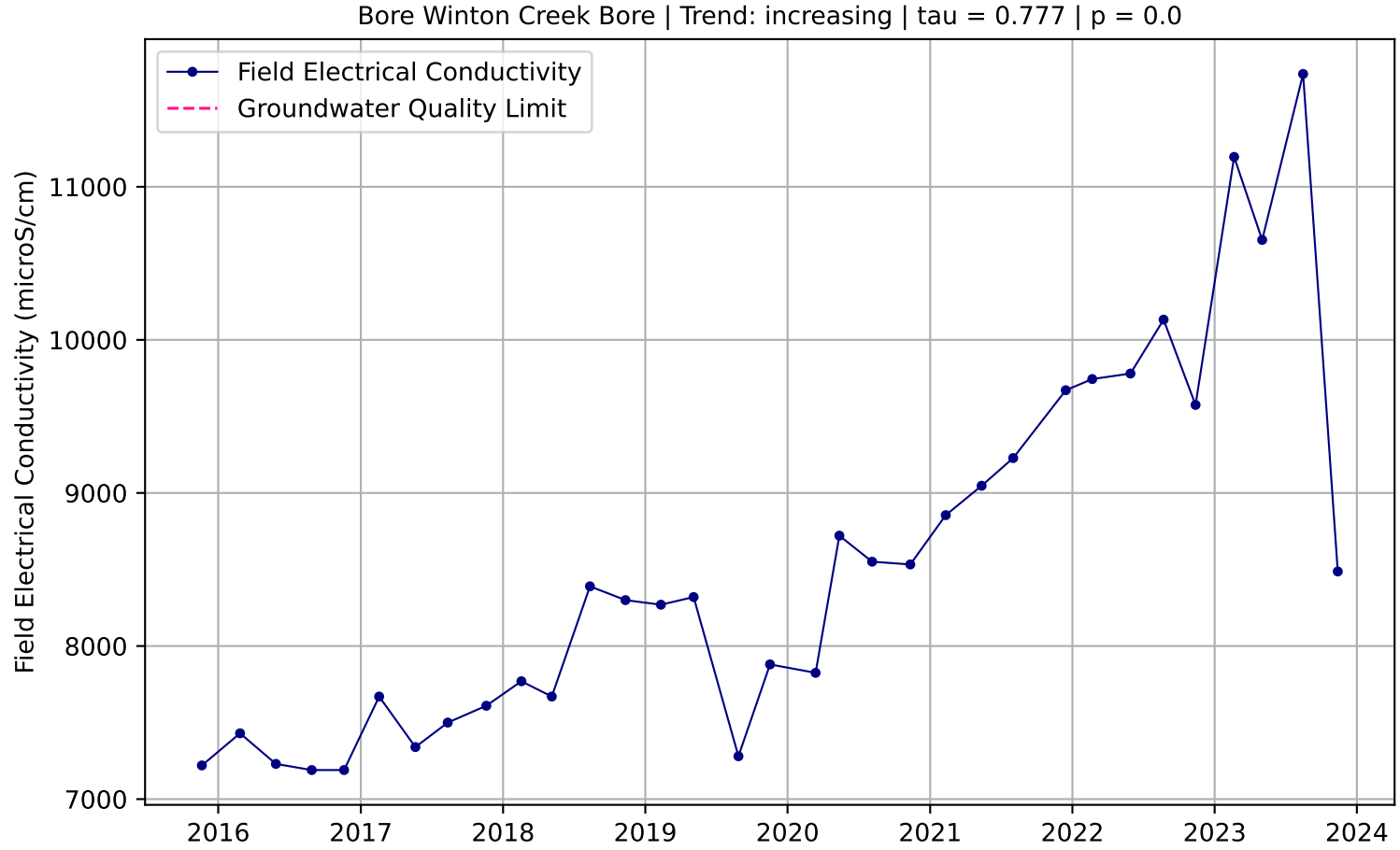

Bore Winton Creek Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

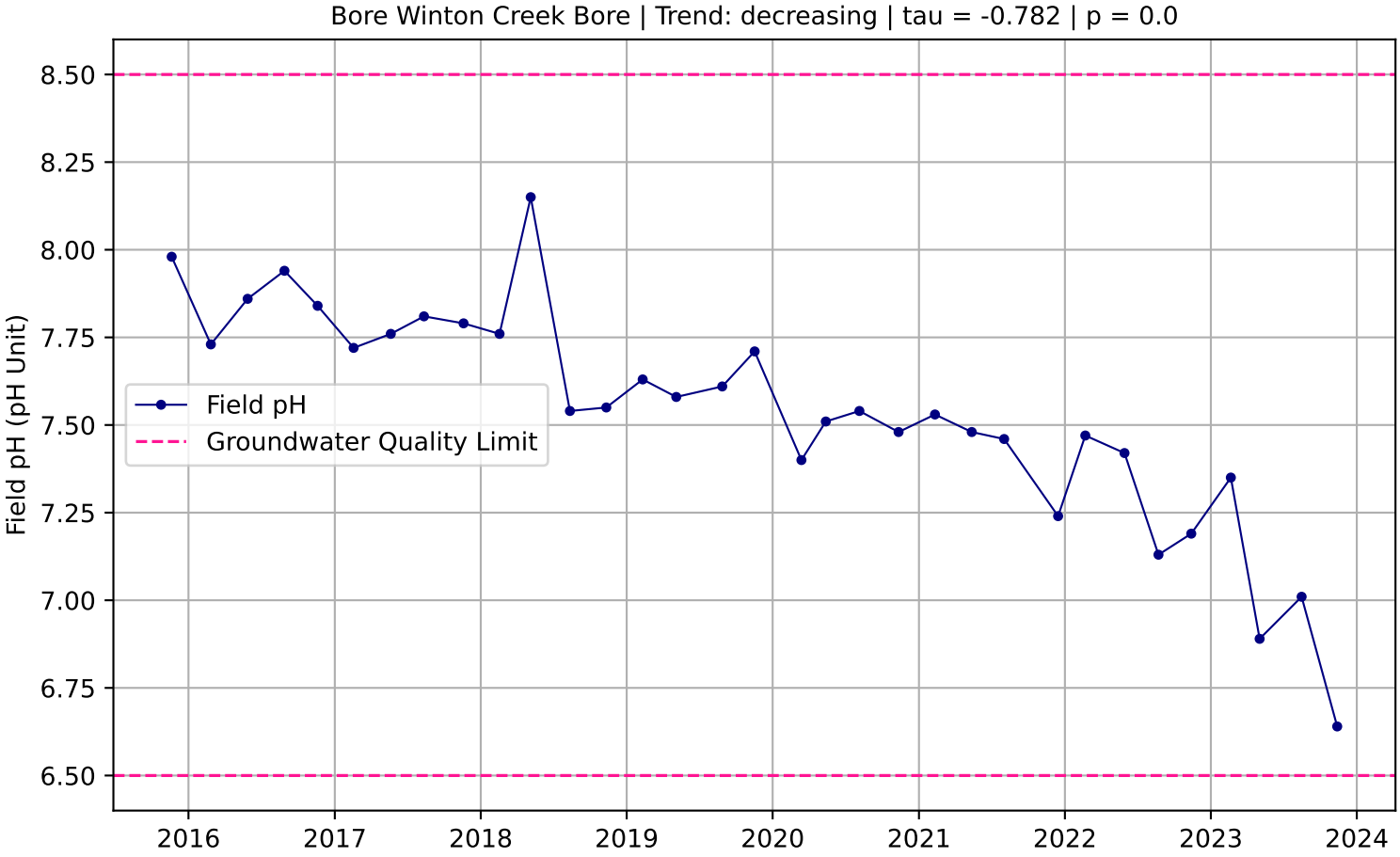

Bore Winton Creek Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

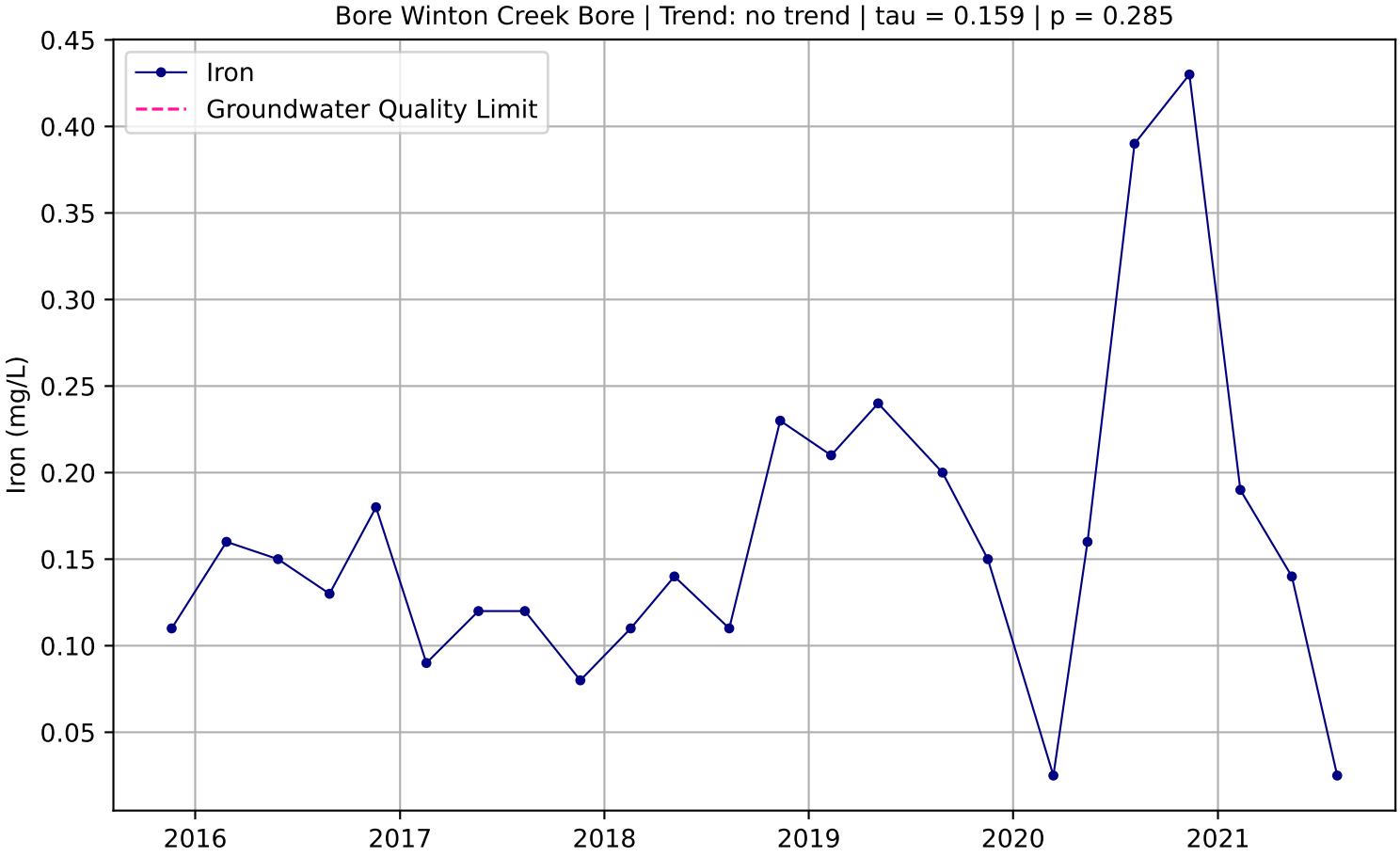

Bore Winton Creek Bore | Trend: increasing | tau = 0.755 | p = 0.0
Calcium
Calcium (mg/L)
100
150
200
250
300
2018
2019
2020
2021
2022
2023
2024

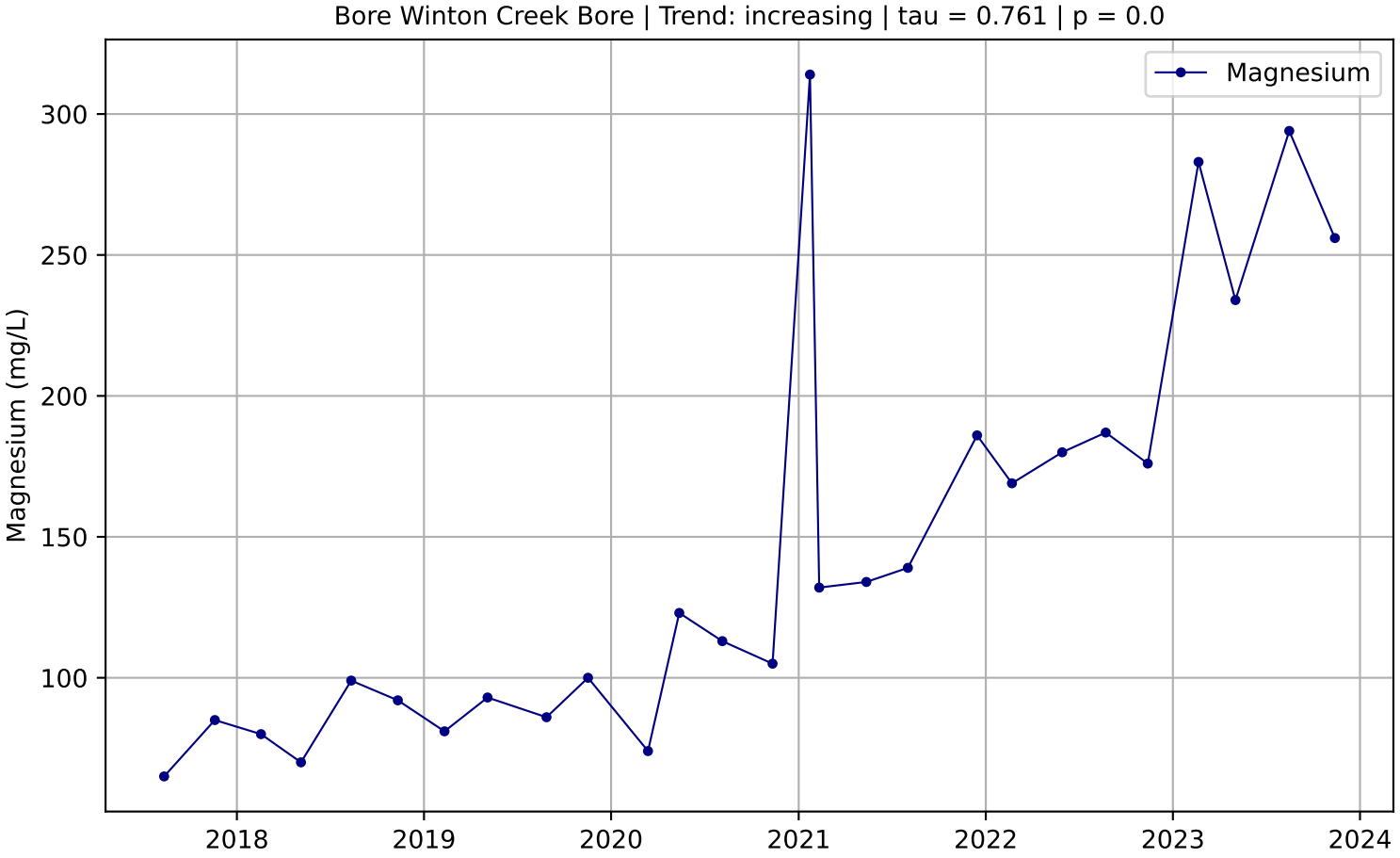

Bore Winton Creek Bore | Trend: no trend | tau = -0.038 | p = 0.318
Carbonate
Carbonate (mg/L)
8
6
4
2
2016
2017
2018
2019
2020
2021
2022
2023
2024

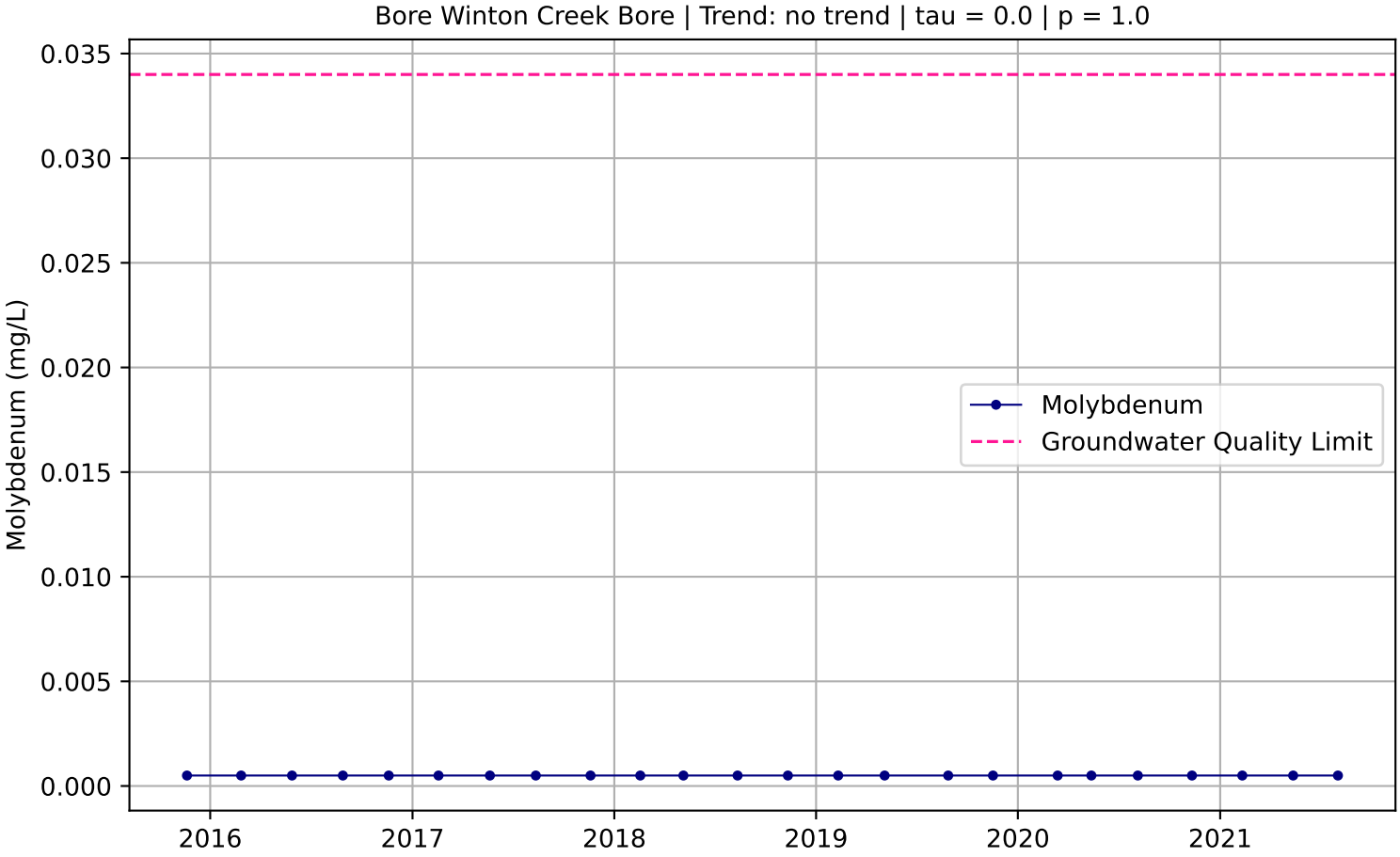

Bore Winton Creek Bore | Trend: increasing | tau = 0.449 | p = 0.0
Chloride
Chloride (mg/L)
6000
5500
5000
4500
4000
3500
3000
2500
2016
2017
2018
2019
2020
2021
2022
2023
2024

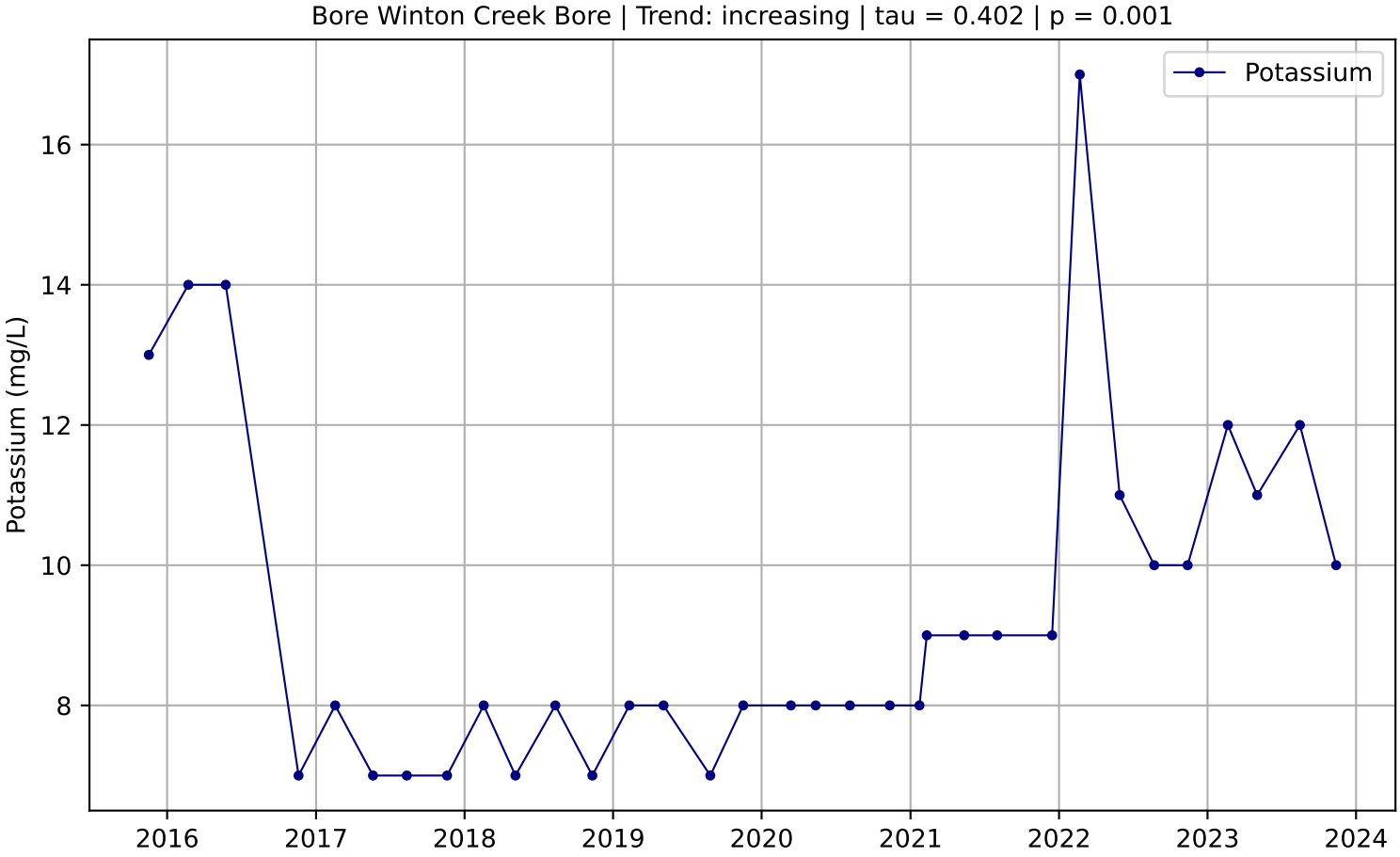

Bore Winton Creek Bore | Trend: increasing | tau = 0.777 | p = 0.0
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
11000
10000
9000
8000
7000
2016
2017
2018
2019
2020
2021
2022
2023
2024

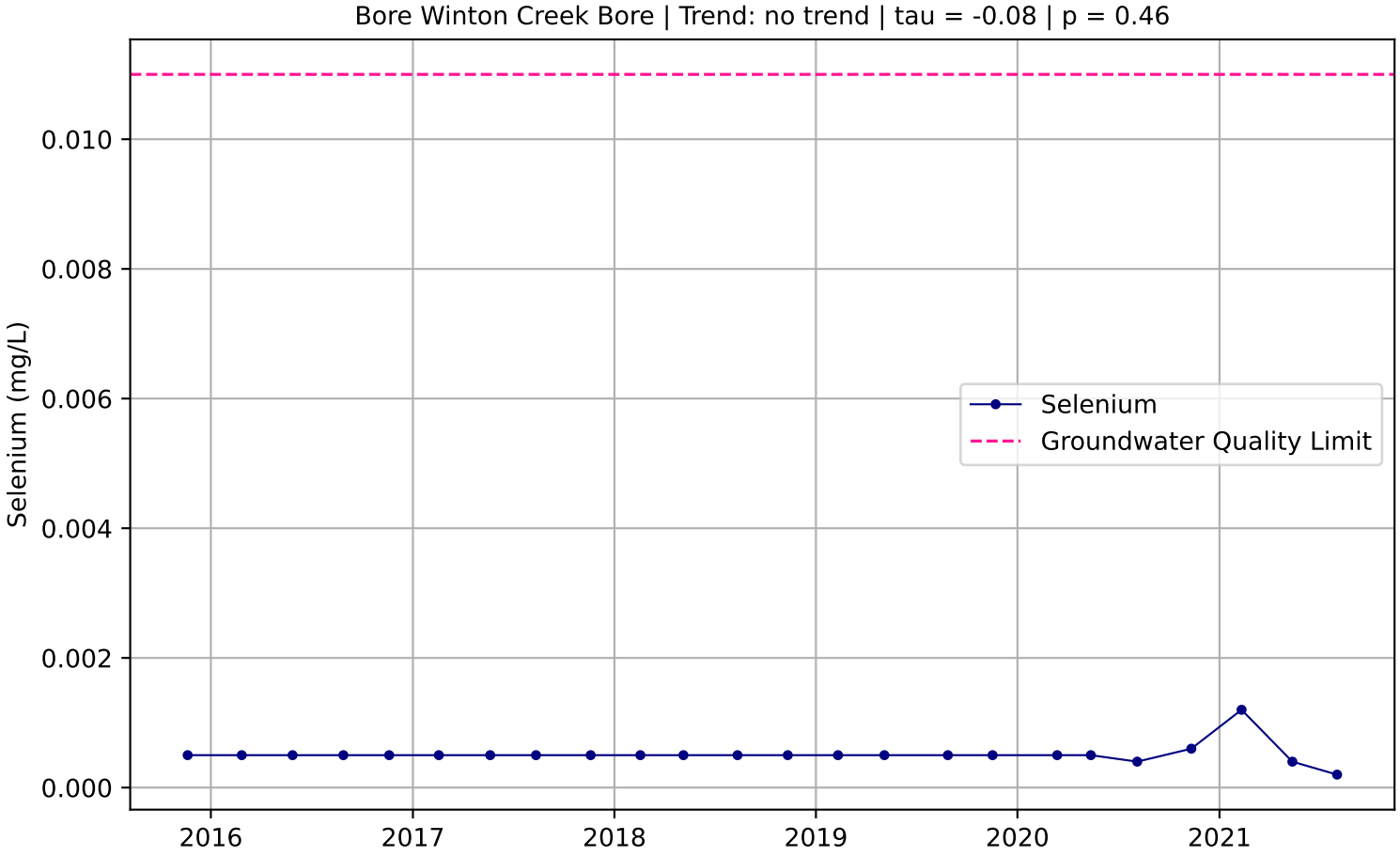

Bore Winton Creek Bore | Trend: decreasing | tau = -0.782 | p = 0.0
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

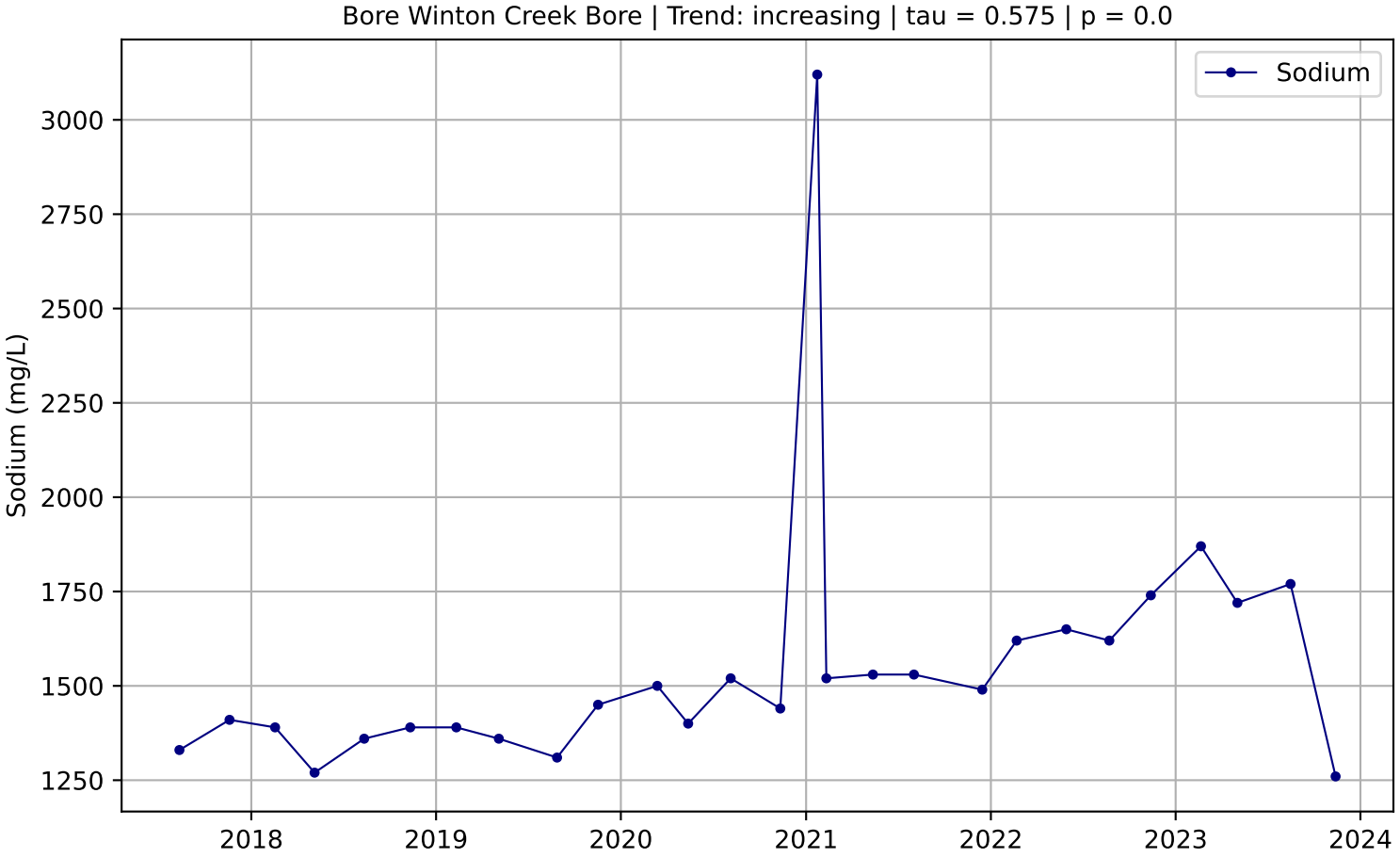

Bore Winton Creek Bore | Trend: no trend | tau = 0.159 | p = 0.285
Iron
Groundwater Quality Limit
Iron (mg/L)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
2016
2017
2018
2019
2020
2021

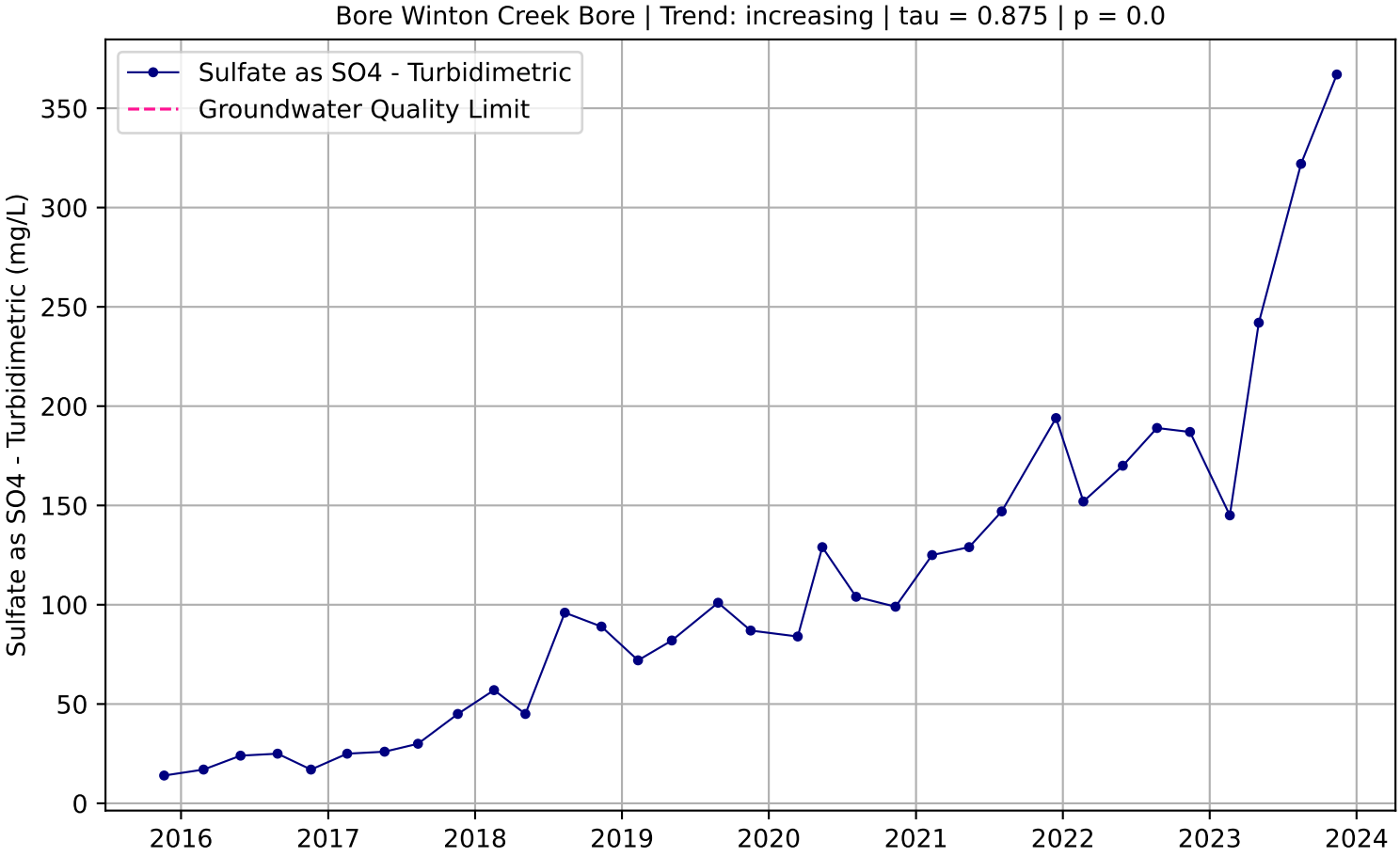

Bore Winton Creek Bore | Trend: increasing | tau = 0.761 | p = 0.0
Magnesium
Magnesium (mg/L)
300
250
200
150
100
2018
2019
2020
2021
2022
2023
2024

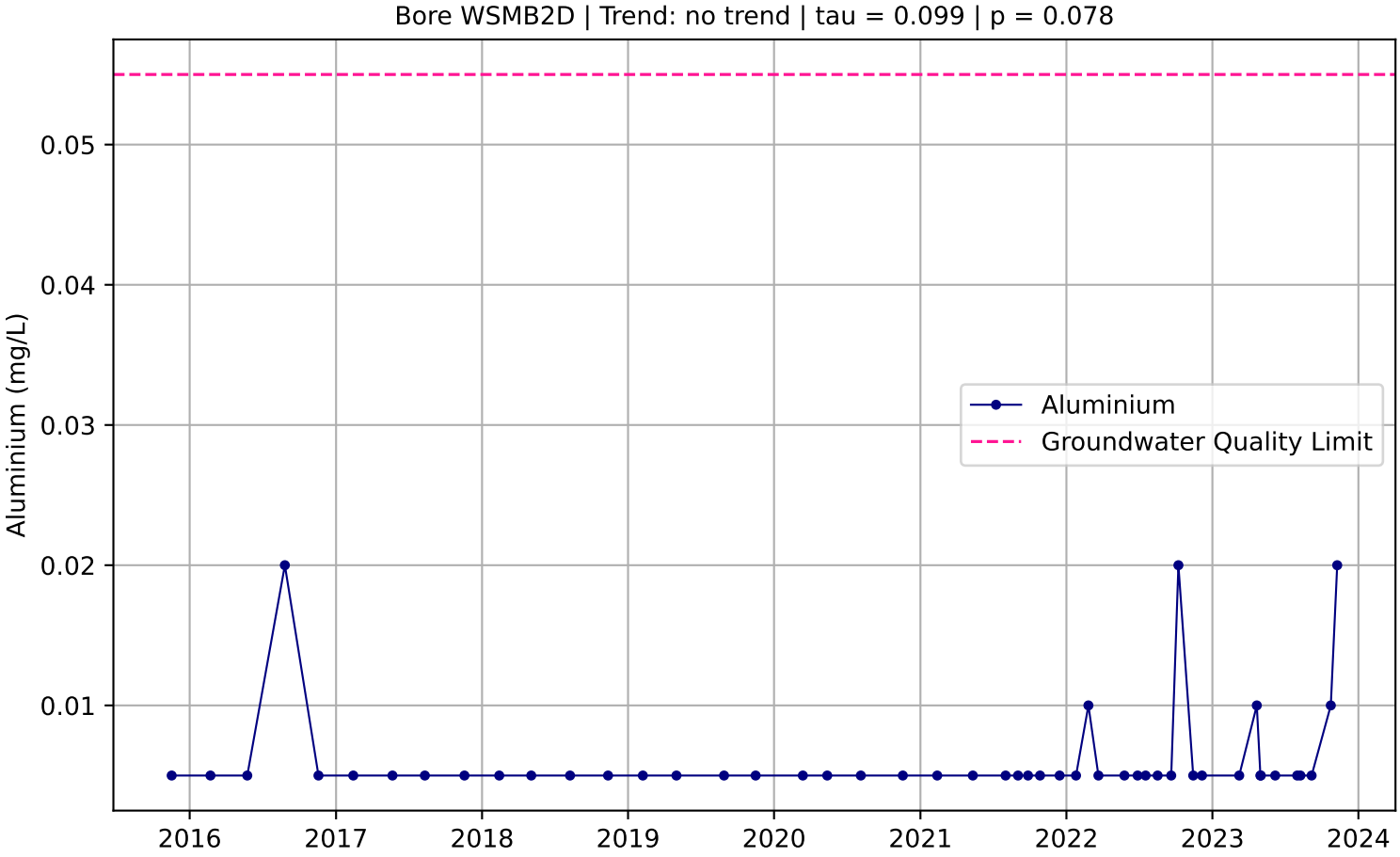

Bore Winton Creek Bore | Trend: no trend | tau = 0.0 | p = 1.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit

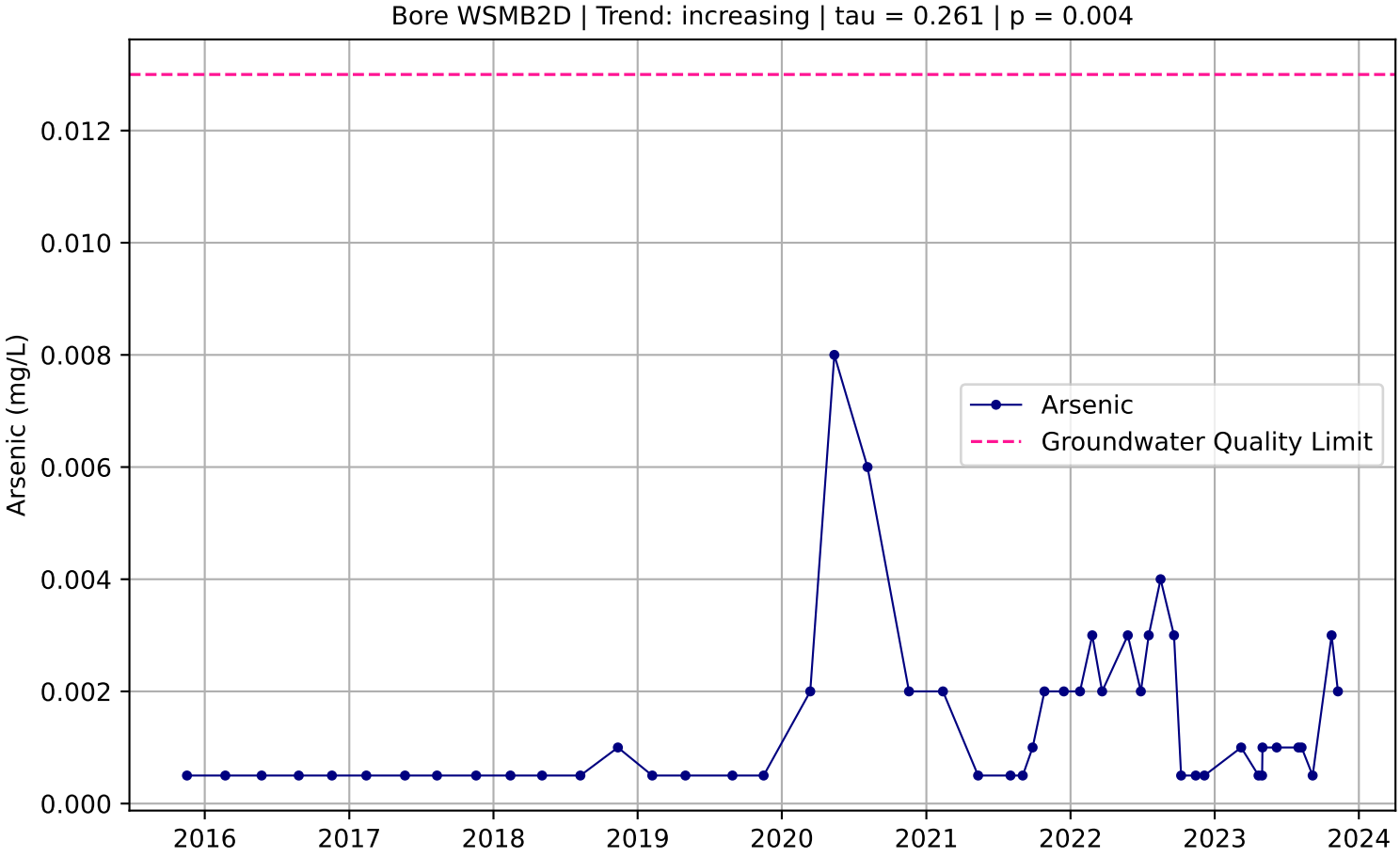

Bore Winton Creek Bore | Trend: increasing | tau = 0.402 | p = 0.001
Potassium
Potassium (mg/L)
16
14
12
10
8
2016
2017
2018
2019
2020
2021
2022
2023
2024

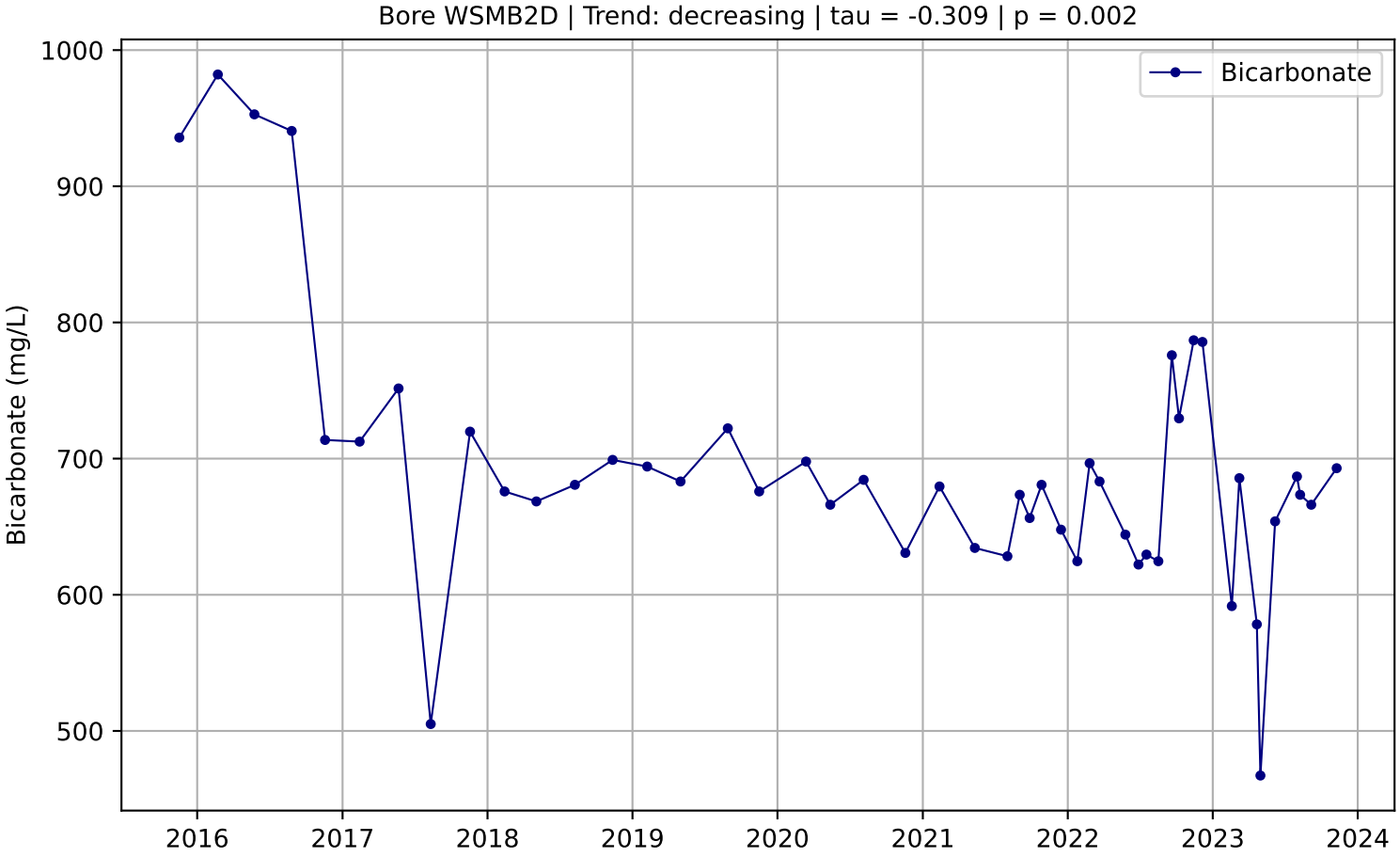

Bore Winton Creek Bore | Trend: no trend | tau = -0.08 | p = 0.46
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit

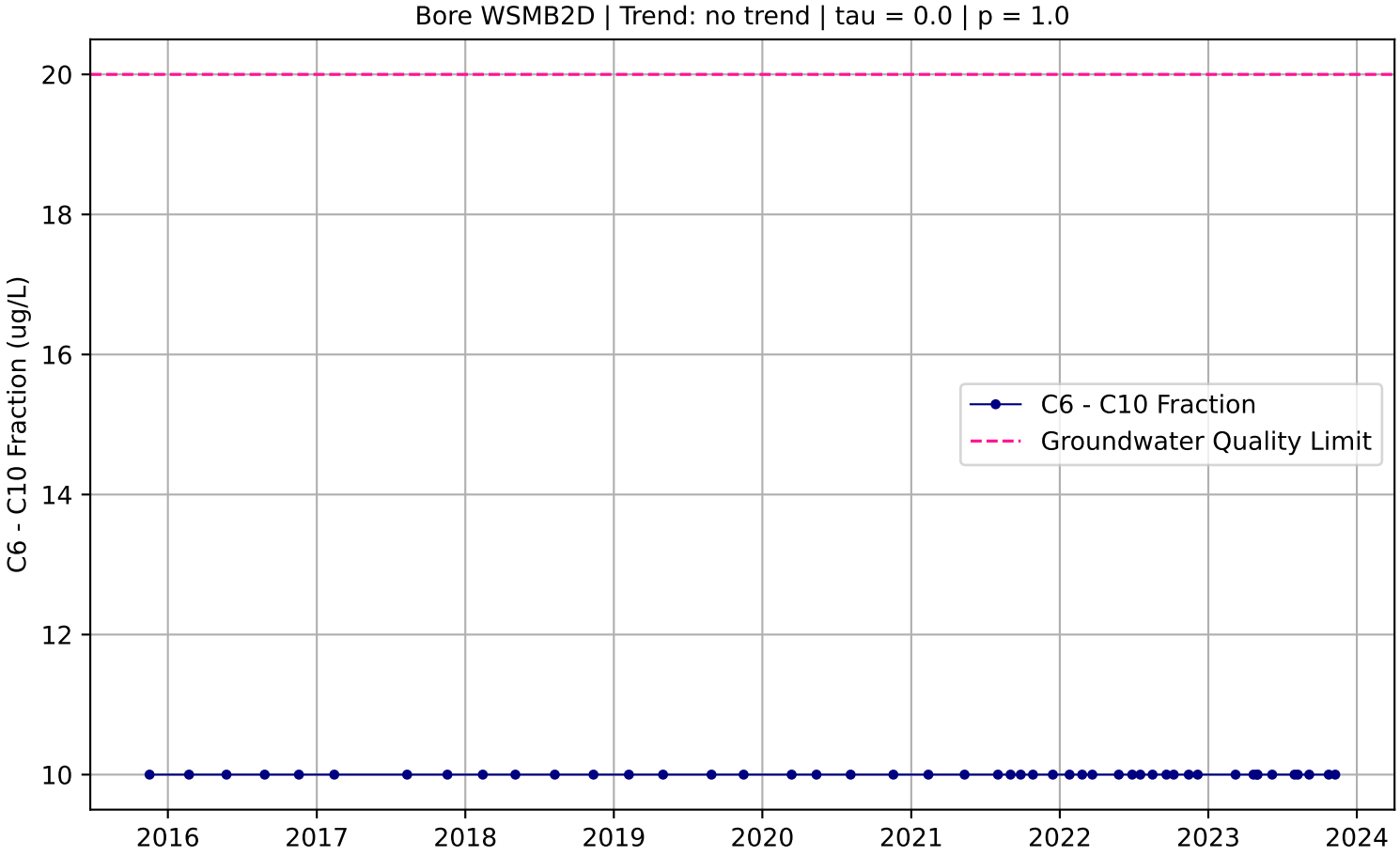

Bore Winton Creek Bore | Trend: increasing | tau = 0.575 | p = 0.0
Sodium
Sodium (mg/L)
3000
2750
2500
2250
2000
1750
1500
1250
2018
2019
2020
2021
2022
2023
2024

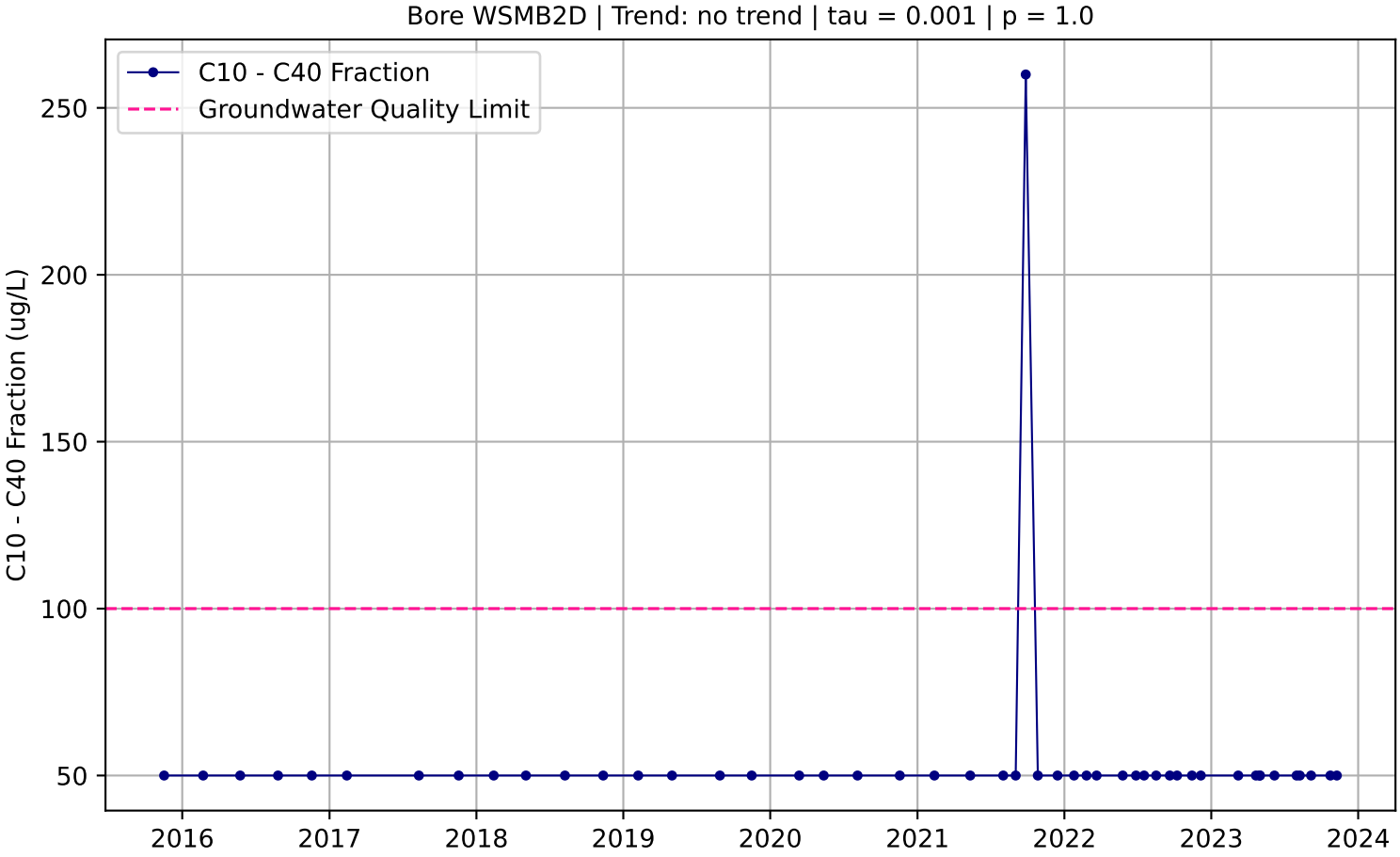

Bore Winton Creek Bore | Trend: increasing | tau = 0.875 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
0
50
100
150
200
250
300
350
2016
2017
2018
2019
2020
2021
2022
2023
2024

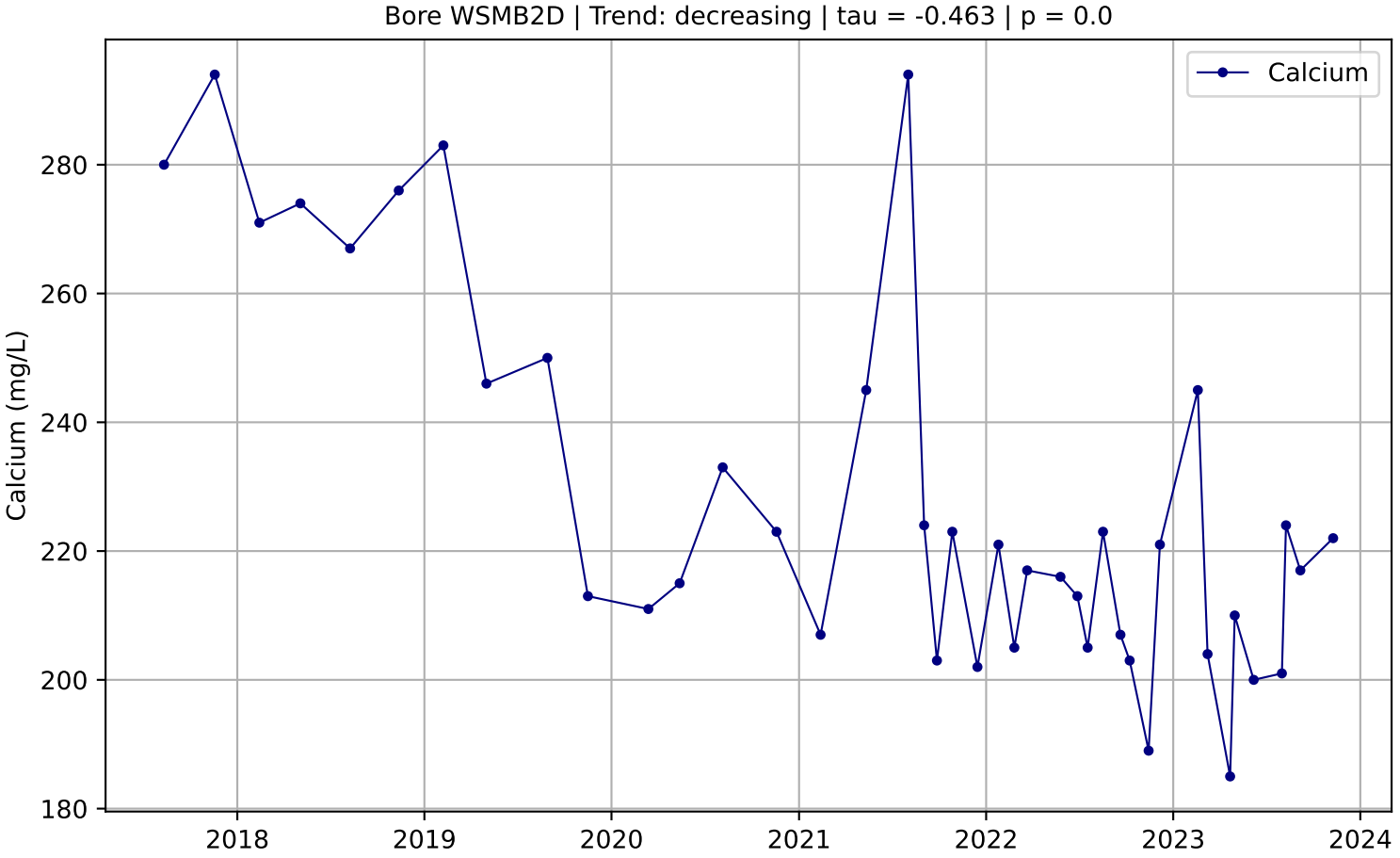

Bore WSMB2D | Trend: no trend | tau = 0.099 | p = 0.078
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

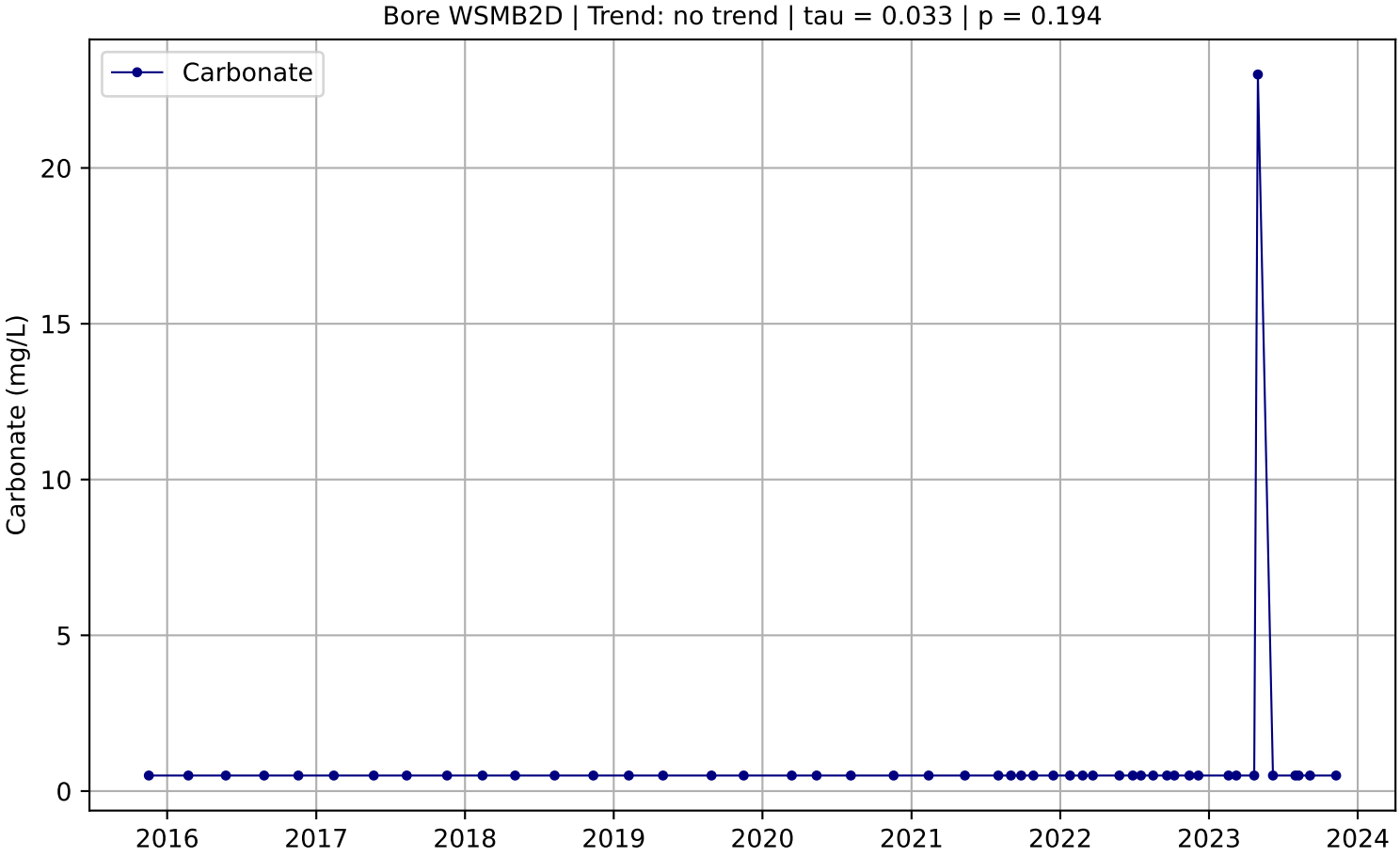

Bore WSMB2D | Trend: increasing | tau = 0.261 | p = 0.004
Arsenic (mg/L)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

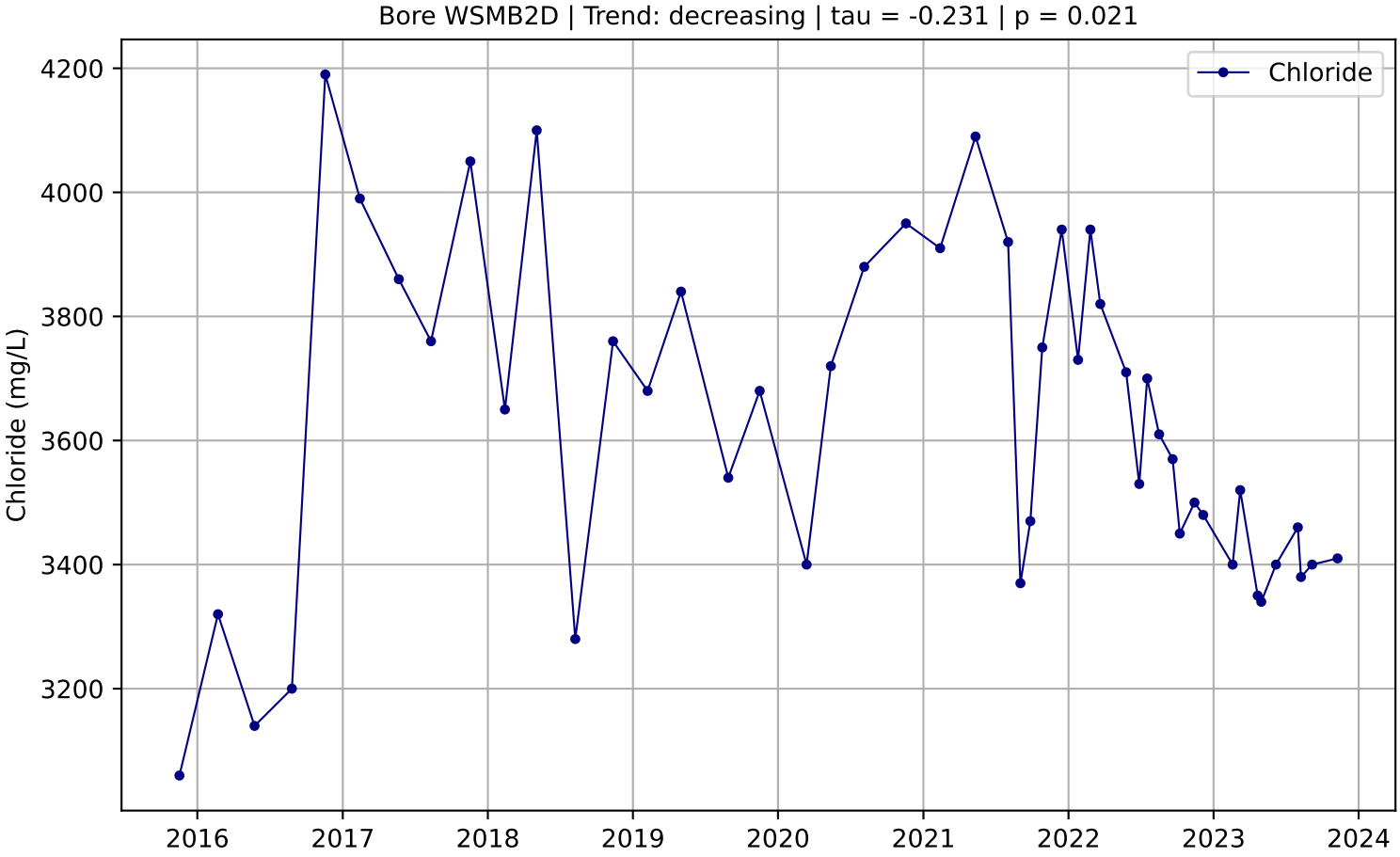

Bore WSMB2D | Trend: decreasing | tau = -0.309 | p = 0.002
Bicarbonate
Bicarbonate (mg/L)
1000
900
800
700
600
500
2016
2017
2018
2019
2020
2021
2022
2023
2024

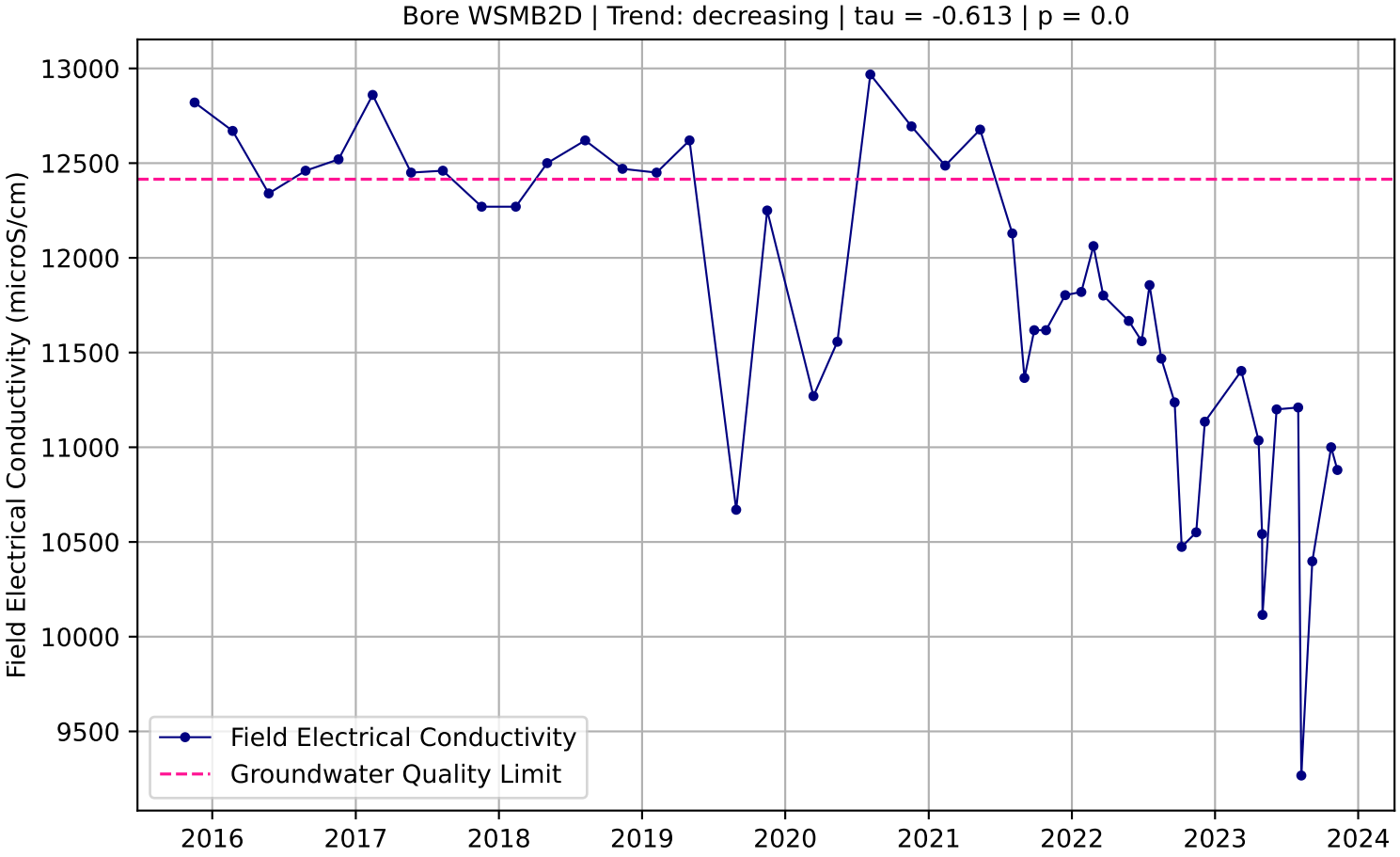

Bore WSMB2D | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

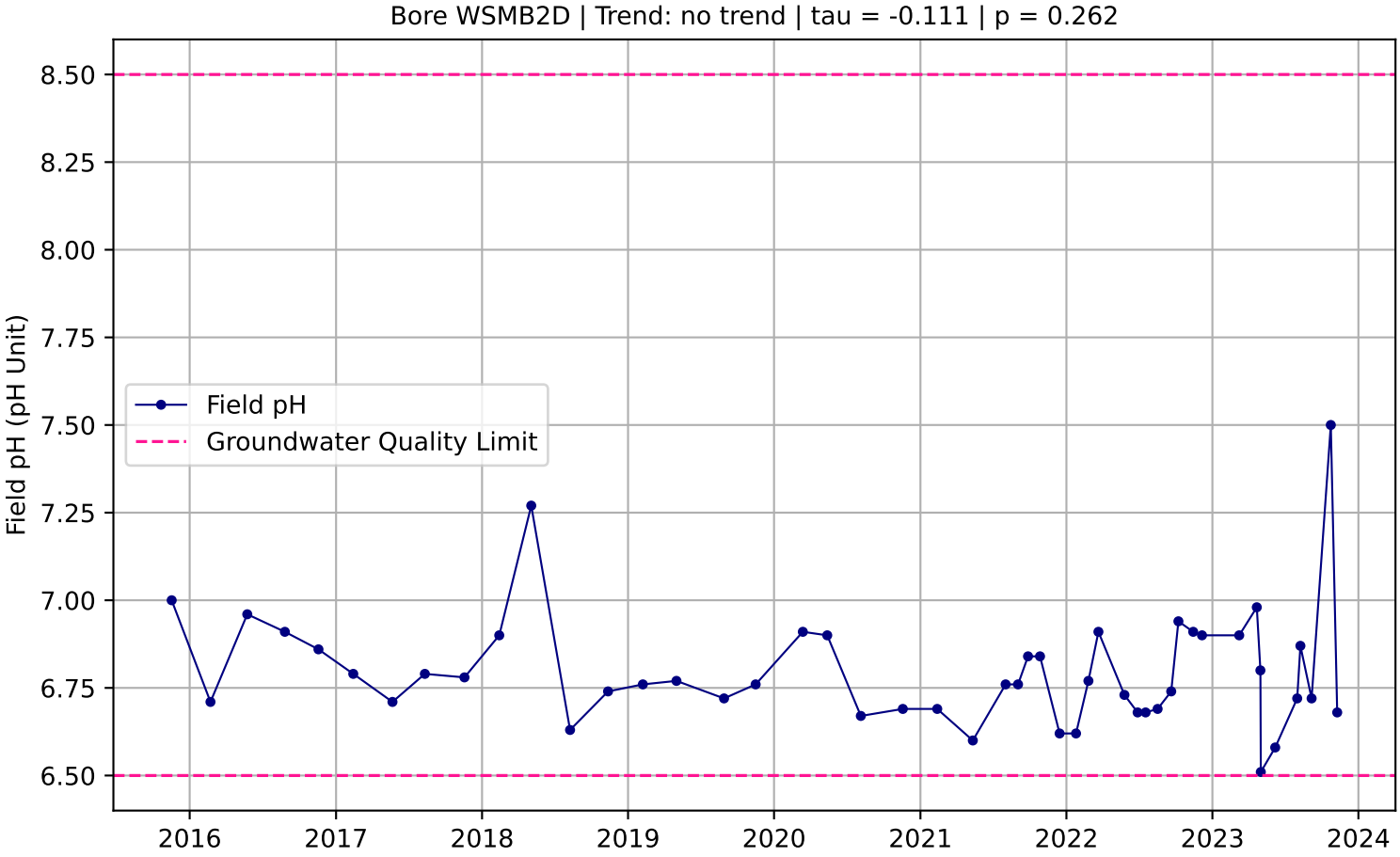

Bore WSMB2D | Trend: no trend | tau = 0.001 | p = 1.0
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
250
200
150
100
50
2016
2017
2018
2019
2020
2021
2022
2023
2024

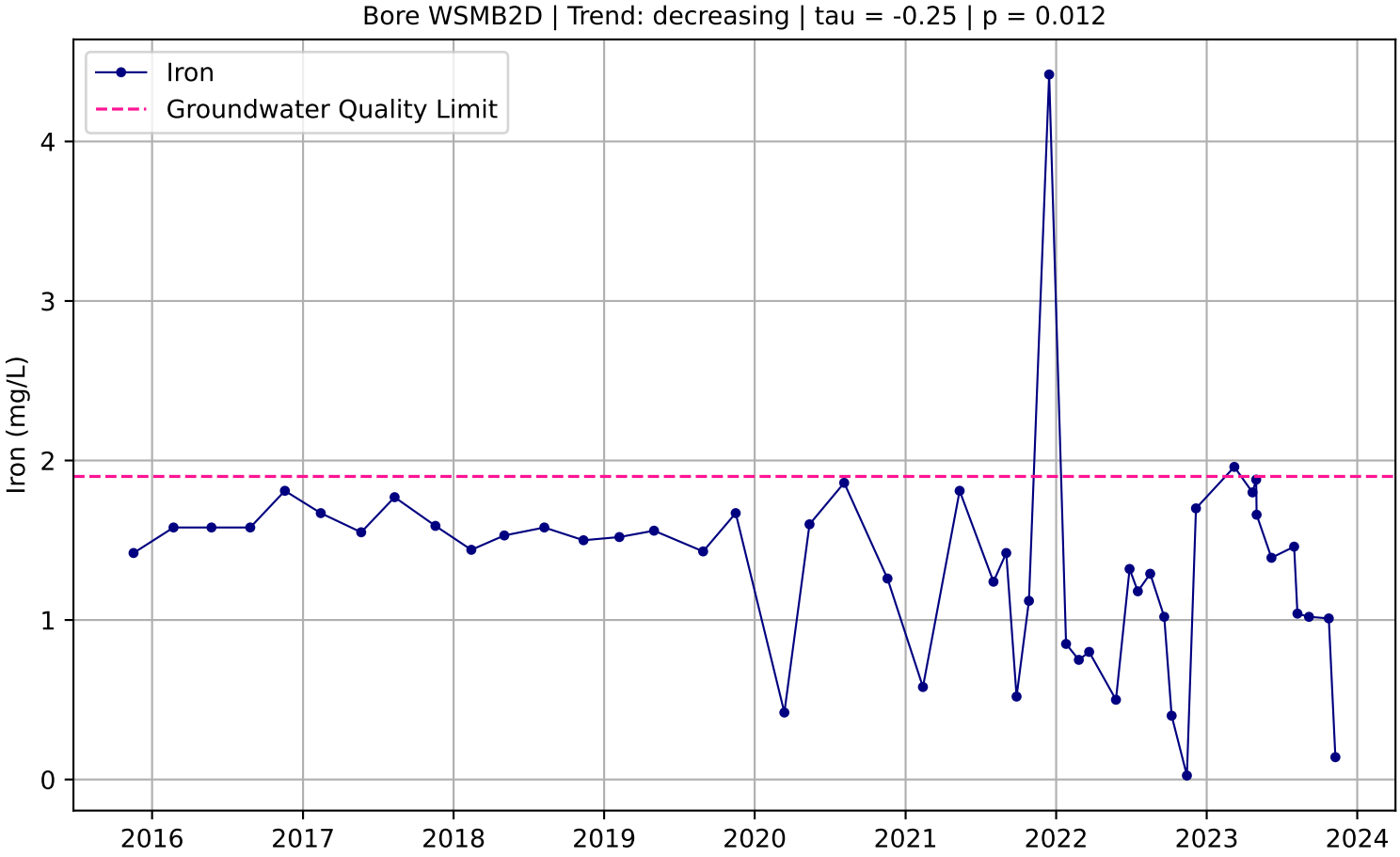

Bore WSMB2D | Trend: decreasing | tau = -0.463 | p = 0.0
Calcium
Calcium (mg/L)
280
260
240
220
200
180
2018
2019
2020
2021
2022
2023
2024

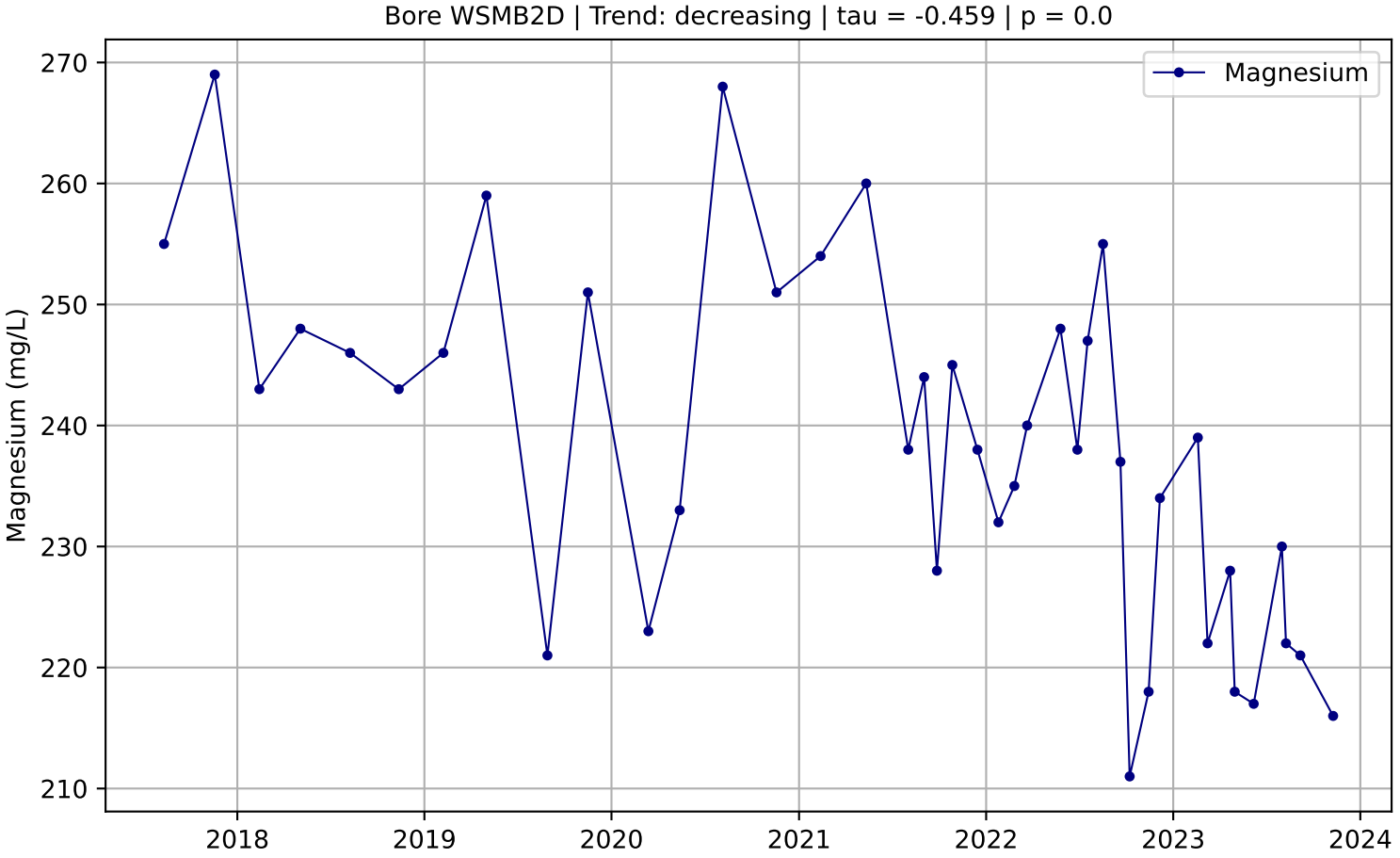

Bore WSMB2D | Trend: no trend | tau = 0.033 | p = 0.194
Carbonate
Carbonate (mg/L)
0
5
10
15
20
2016
2017
2018
2019
2020
2021
2022
2023
2024

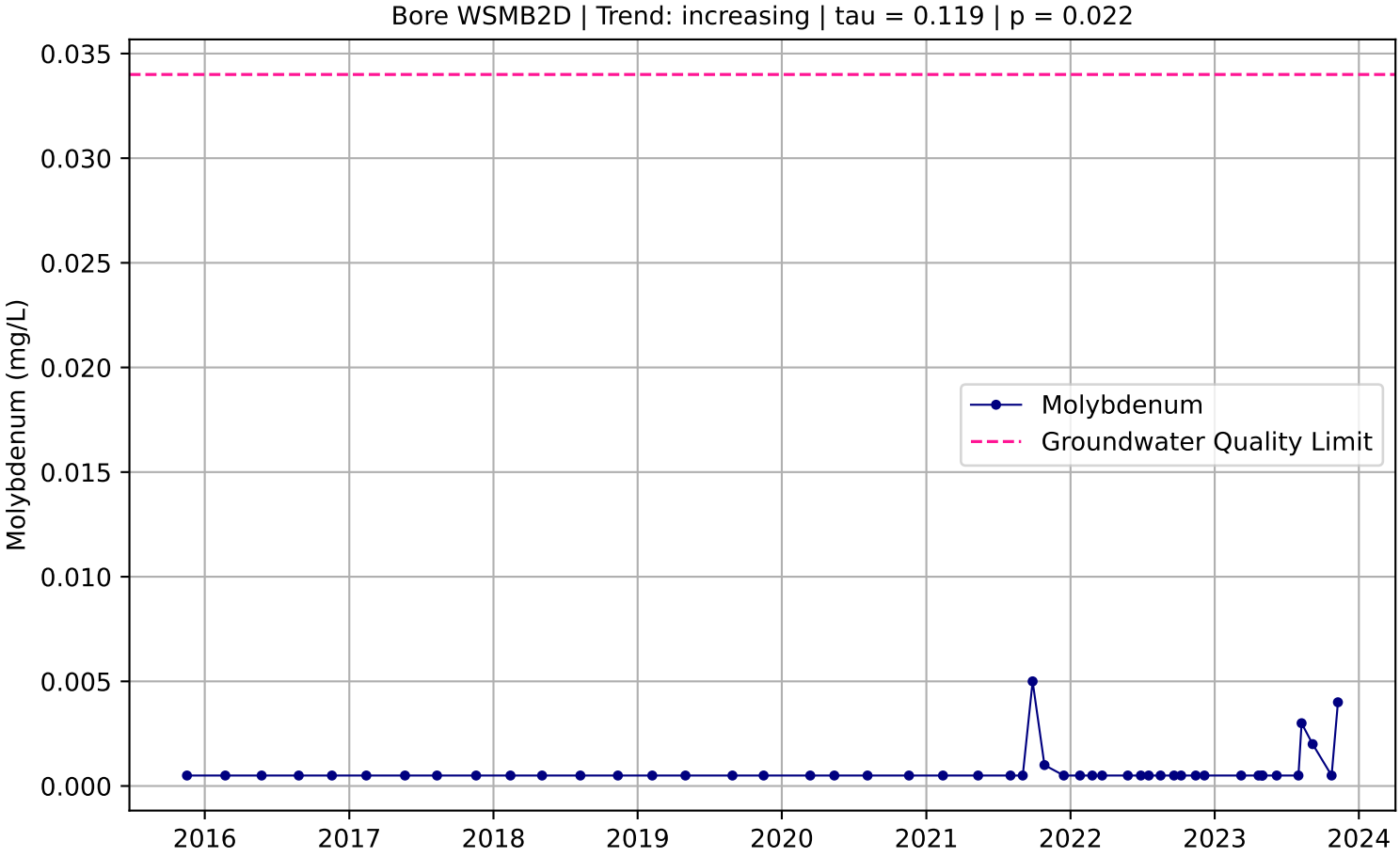

Bore WSMB2D | Trend: decreasing | tau = -0.231 | p = 0.021
Chloride
Chloride (mg/L)
4200
4000
3800
3600
3400
3200
2016
2017
2018
2019
2020
2021
2022
2023
2024

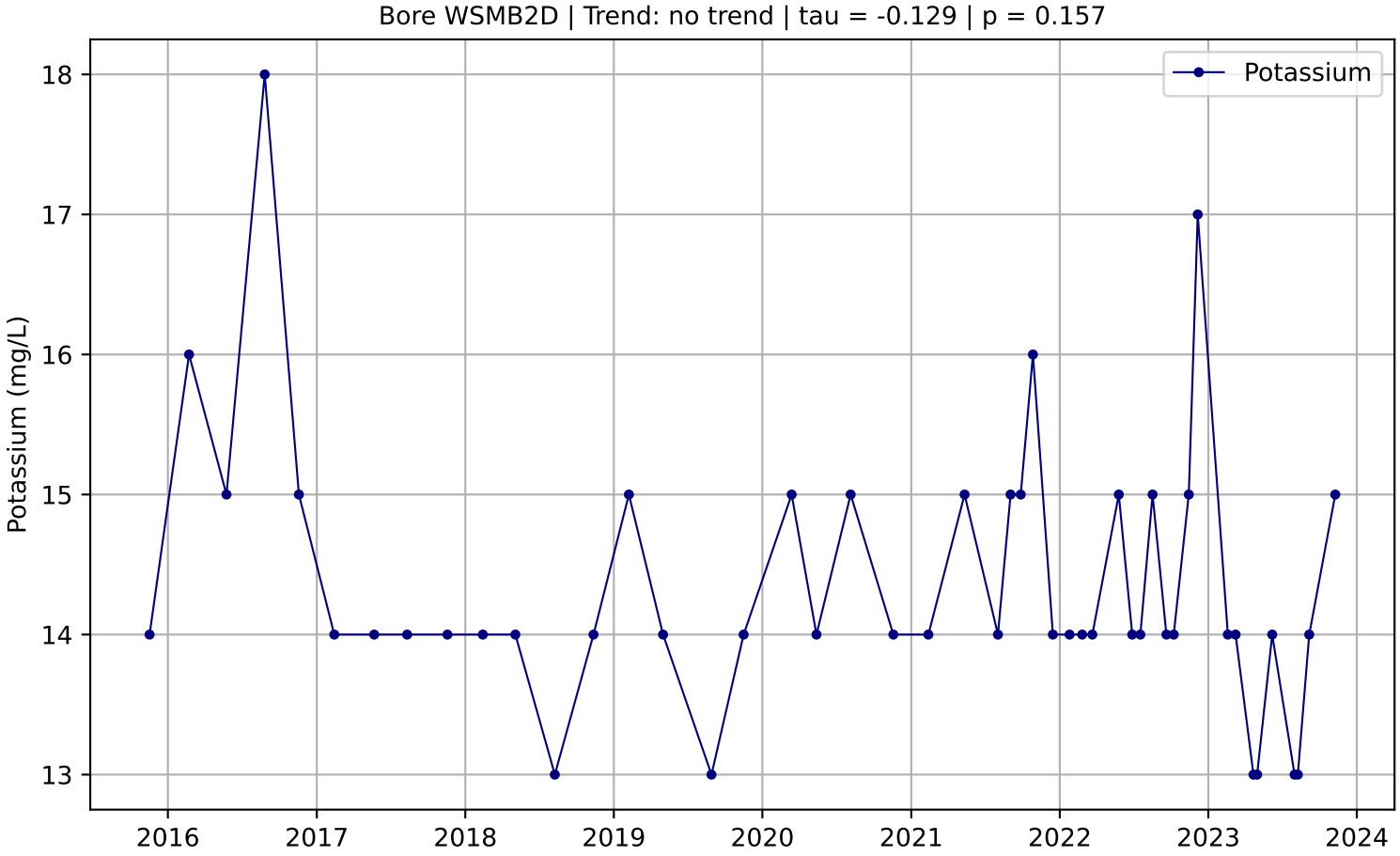

Bore WSMB2D | Trend: decreasing | tau = -0.613 | p = 0.0
Field Electrical Conductivity (microS/cm)
13000
12500
12000
11500
11000
10500
10000
9500
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

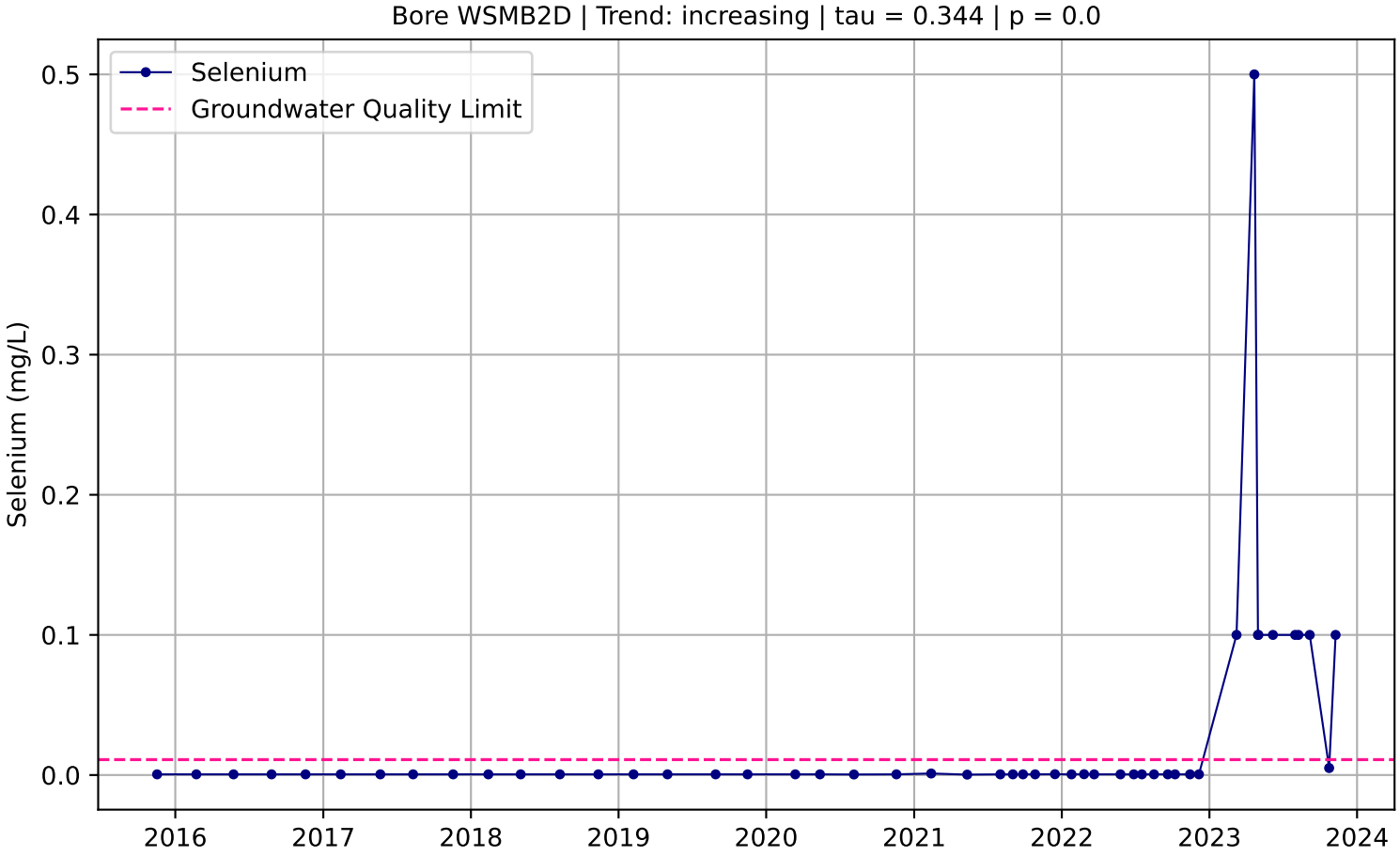

Bore WSMB2D | Trend: no trend | tau = -0.111 | p = 0.262
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

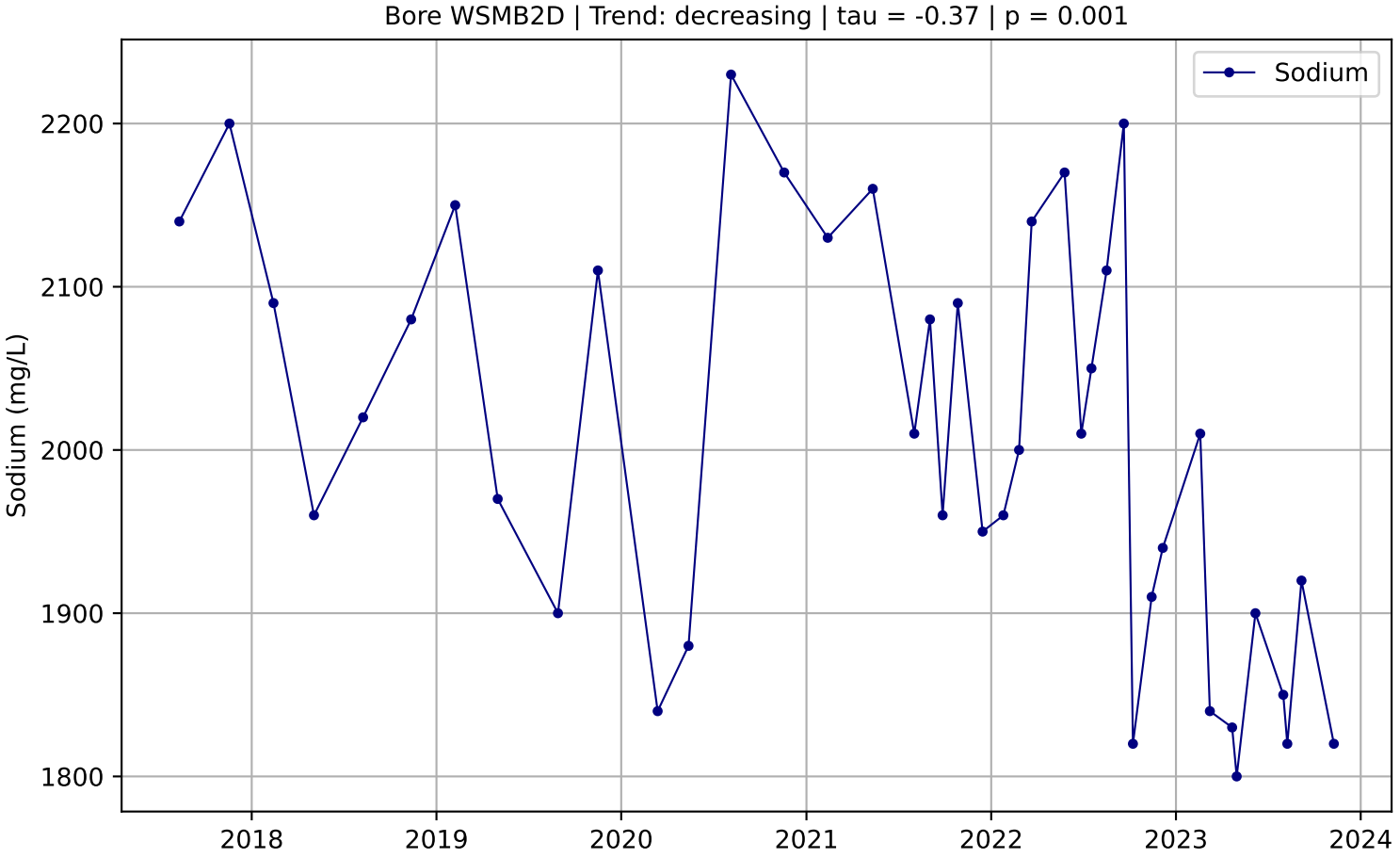

Bore WSMB2D | Trend: decreasing | tau = -0.25 | p = 0.012
Iron
Groundwater Quality Limit
Iron (mg/L)
0
1
2
3
4
2016
2017
2018
2019
2020
2021
2022
2023
2024

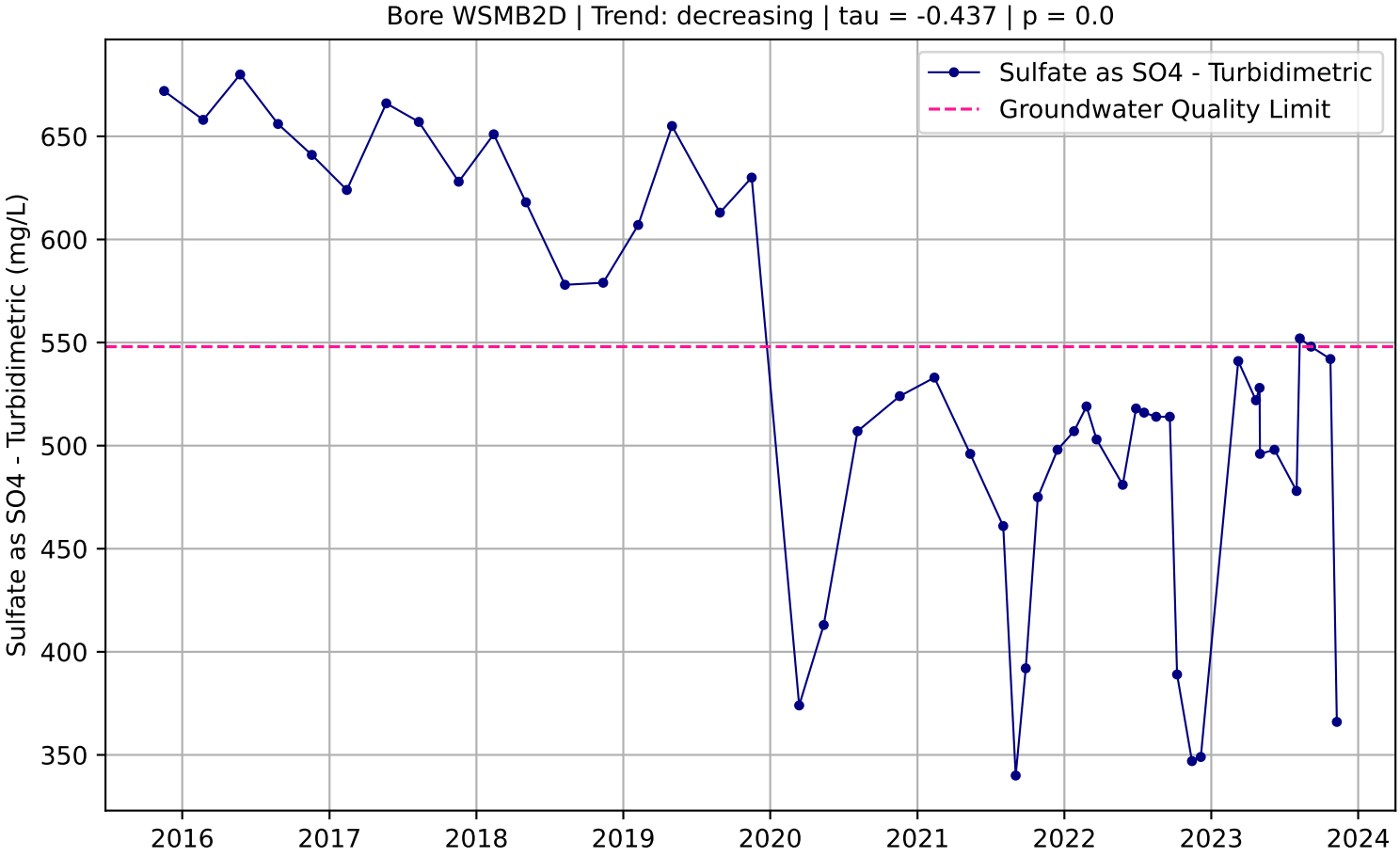

Bore WSMB2D | Trend: decreasing | tau = -0.459 | p = 0.0
Magnesium
Magnesium (mg/L)
270
260
250
240
230
220
210
2018
2019
2020
2021
2022
2023
2024

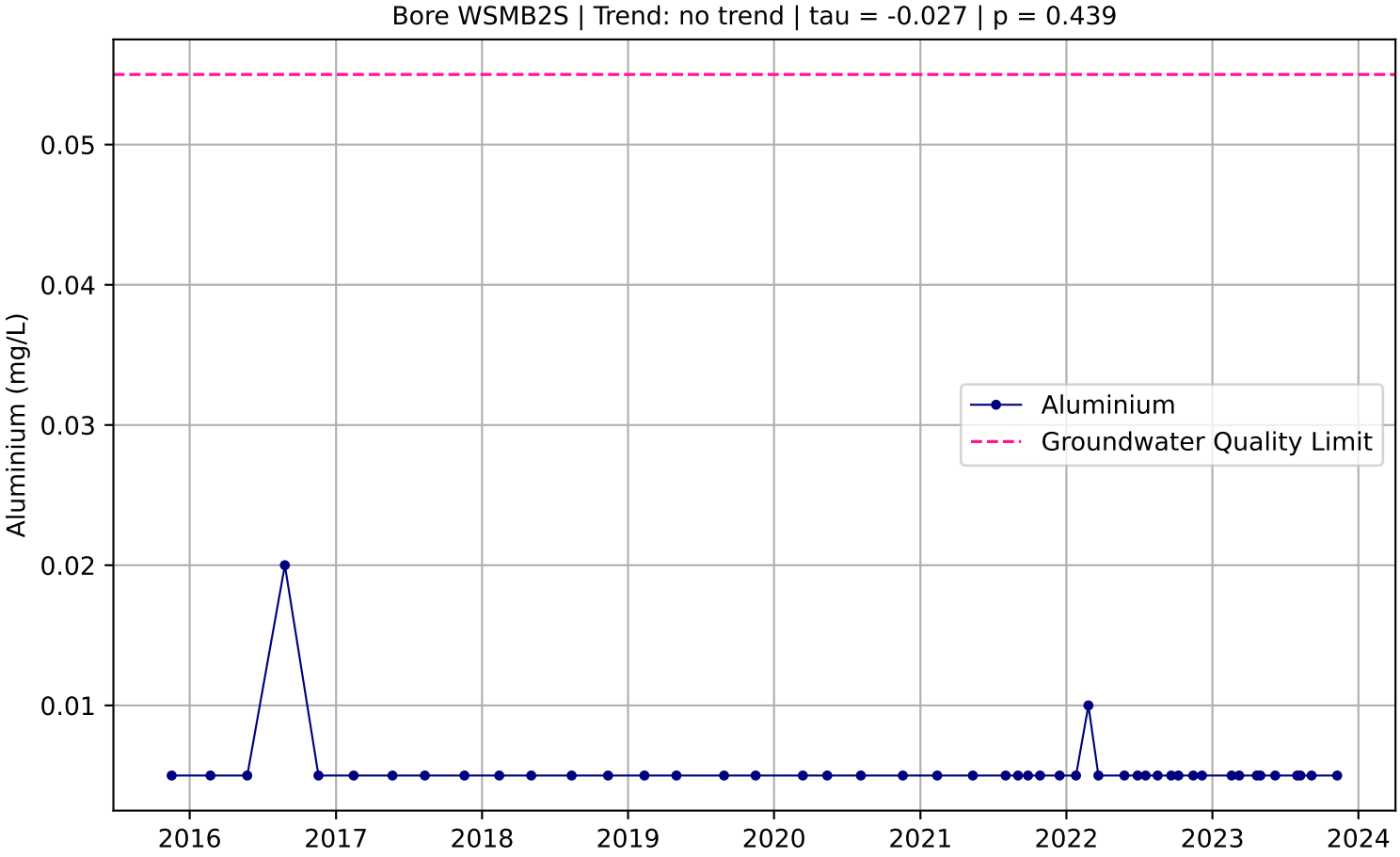

Bore WSMB2D | Trend: increasing | tau = 0.119 | p = 0.022
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

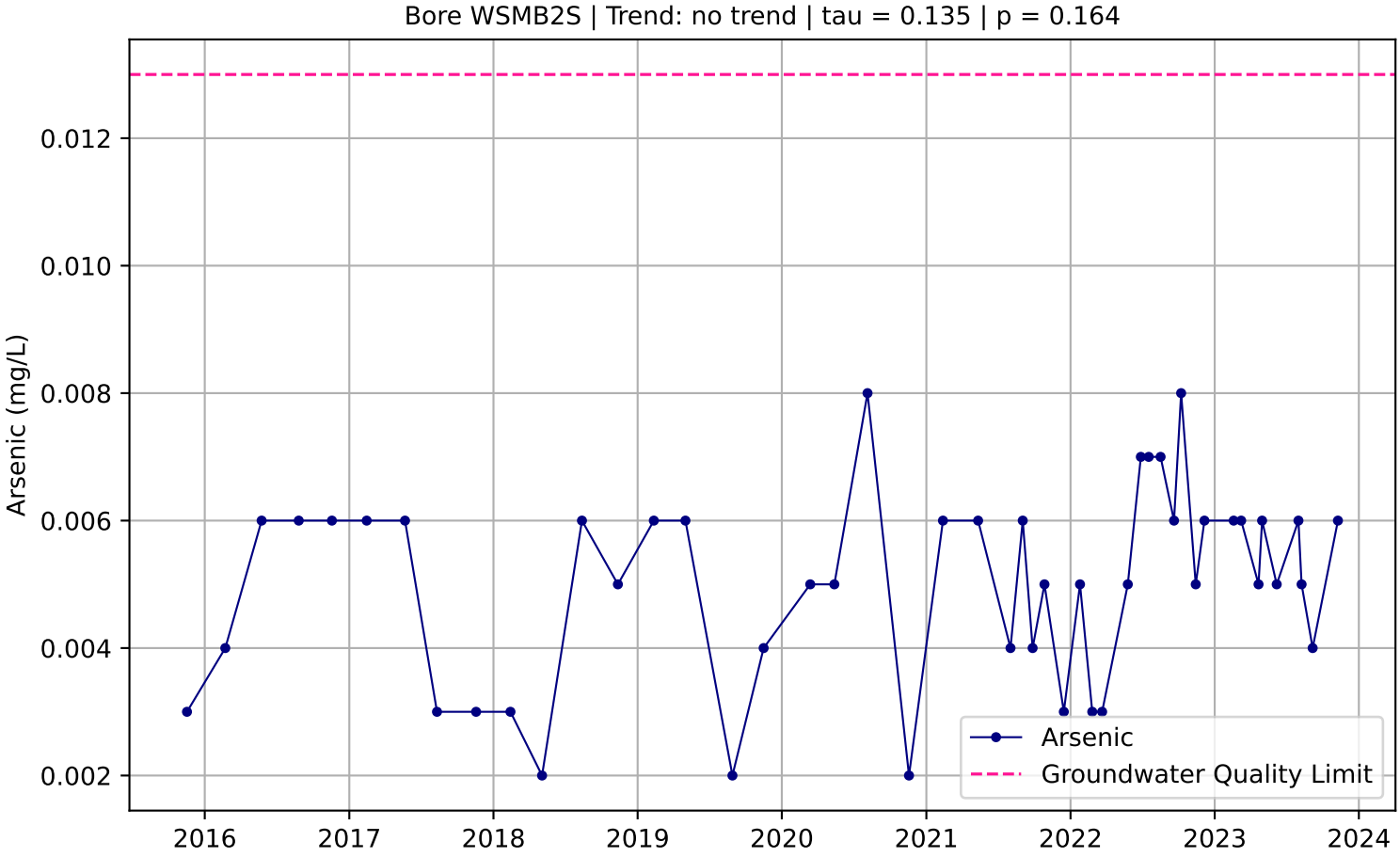

Bore WSMB2D | Trend: no trend | tau = -0.129 | p = 0.157
Potassium
Potassium (mg/L)
18
17
16
15
14
13
2016
2017
2018
2019
2020
2021
2022
2023
2024

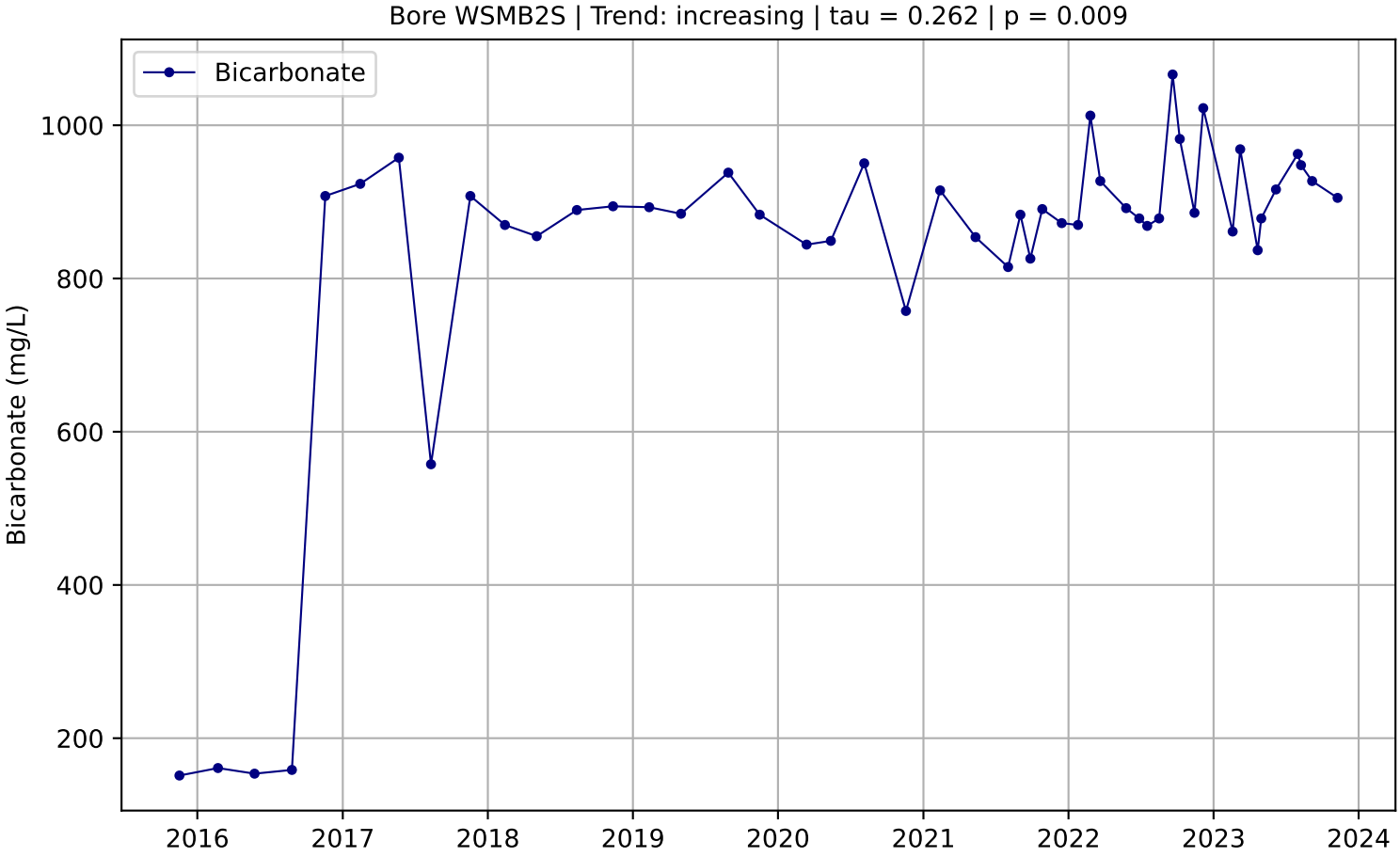

Bore WSMB2D | Trend: increasing | tau = 0.344 | p = 0.0
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
2016
2017
2018
2019
2020
2021
2022
2023
2024

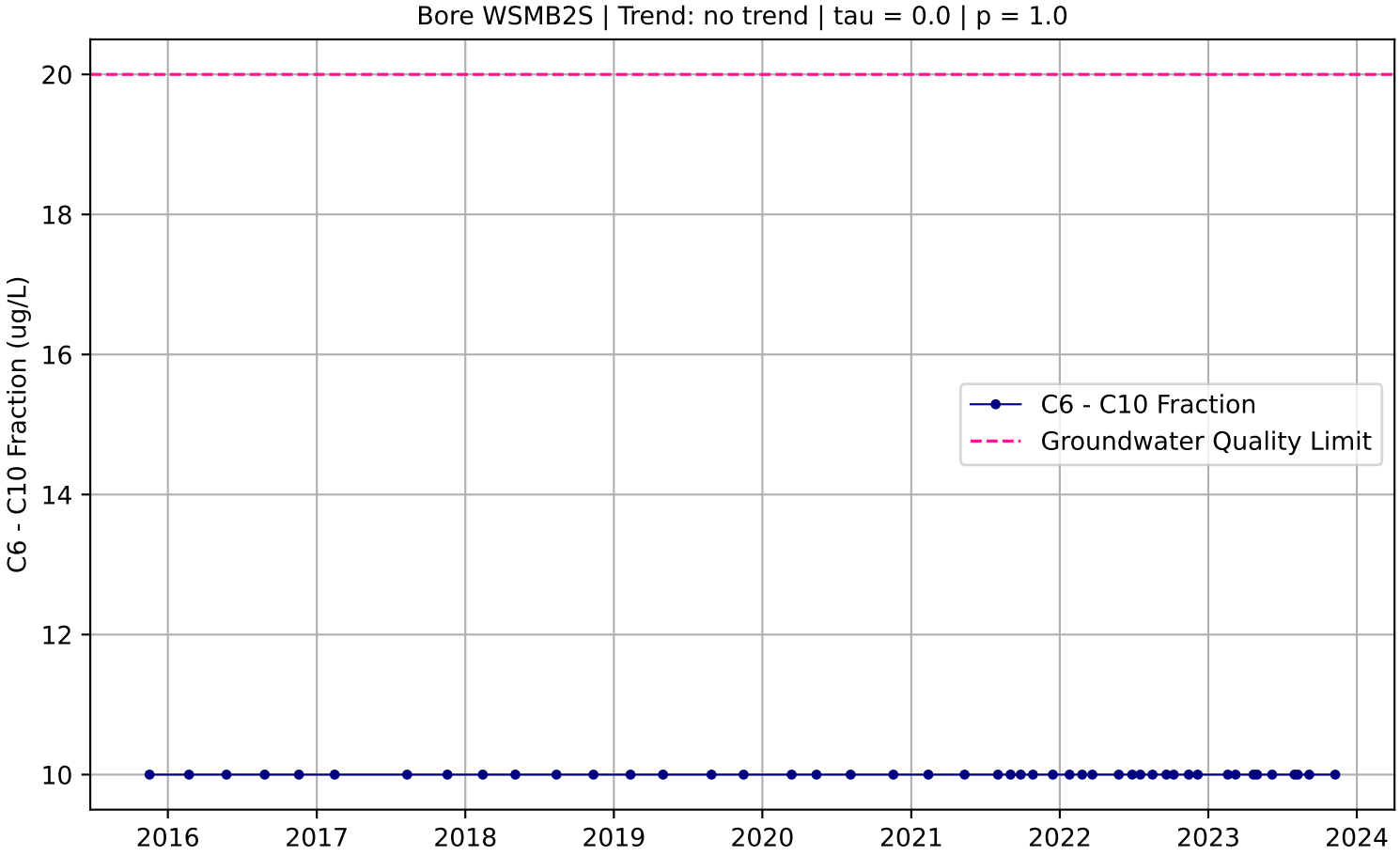

Bore WSMB2D | Trend: decreasing | tau = -0.37 | p = 0.001
Sodium
Sodium (mg/L)
2200
2100
2000
1900
1800
2018
2019
2020
2021
2022
2023
2024

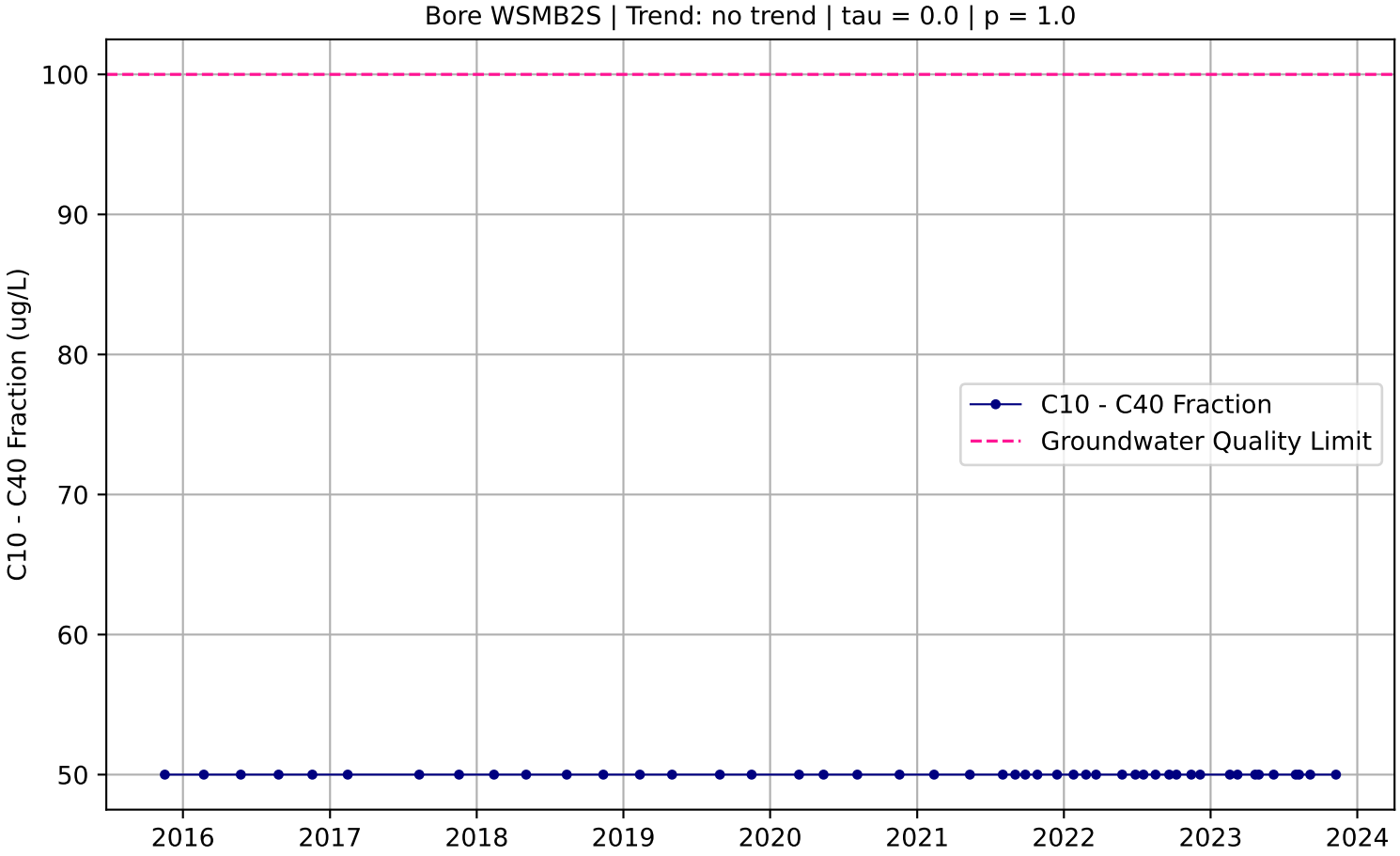

Bore WSMB2D | Trend: decreasing | tau = -0.437 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
650
600
550
500
450
400
350
2016
2017
2018
2019
2020
2021
2022
2023
2024

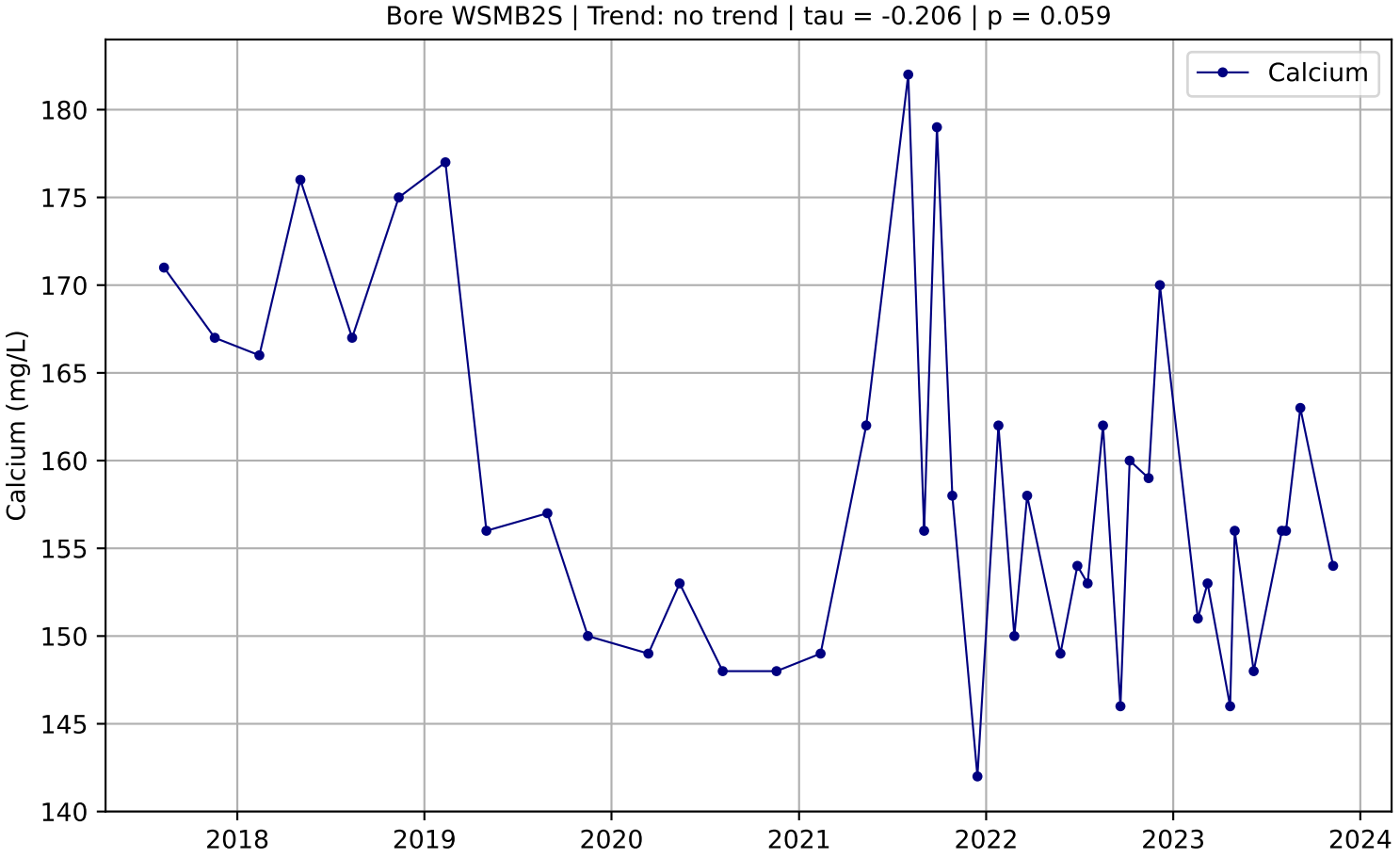

Bore WSMB2S | Trend: no trend | tau = -0.027 | p = 0.439
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
2022
2023
2024
Aluminium
Groundwater Quality Limit

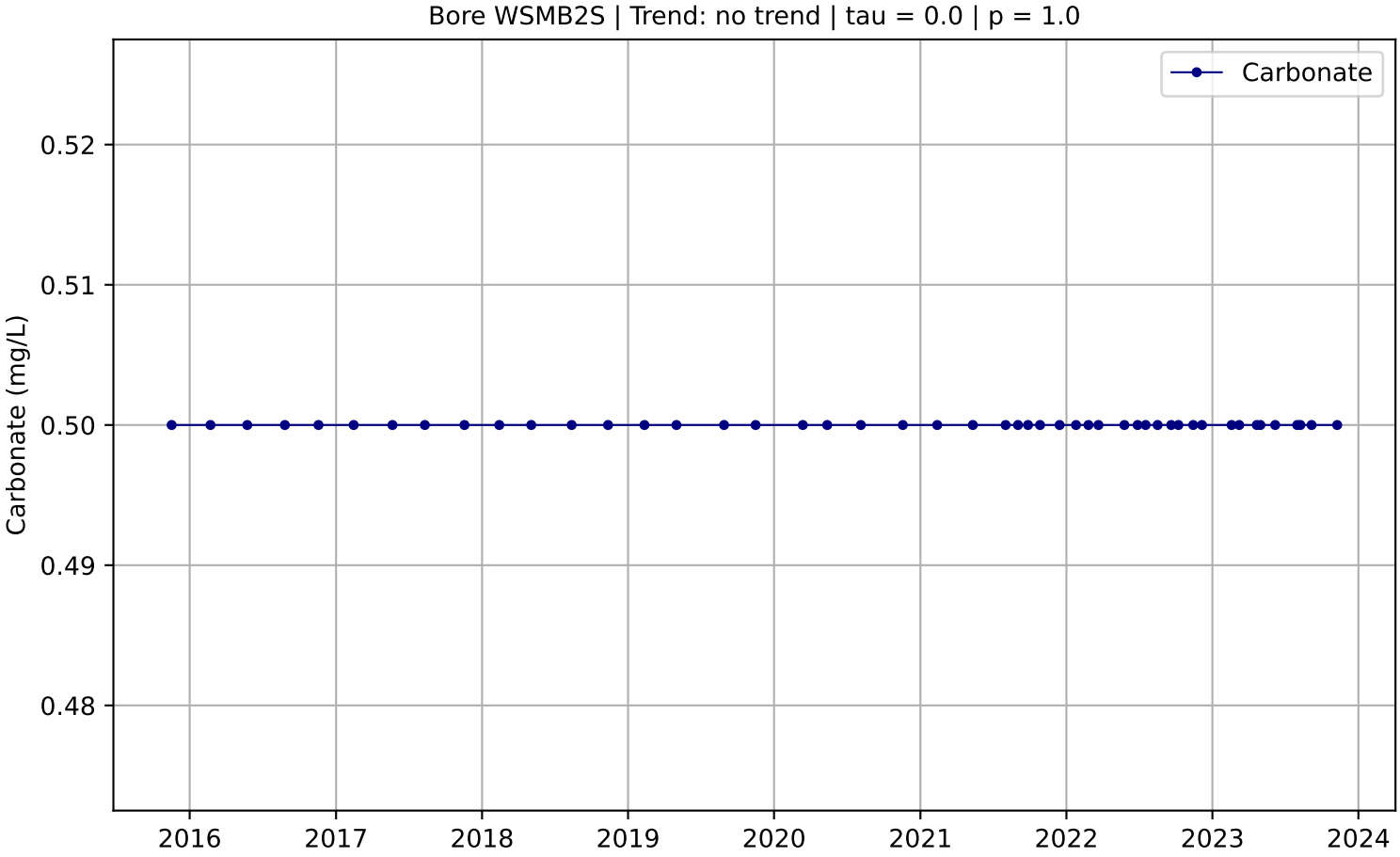

Bore WSMB2S | Trend: no trend | tau = 0.135 | p = 0.164
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

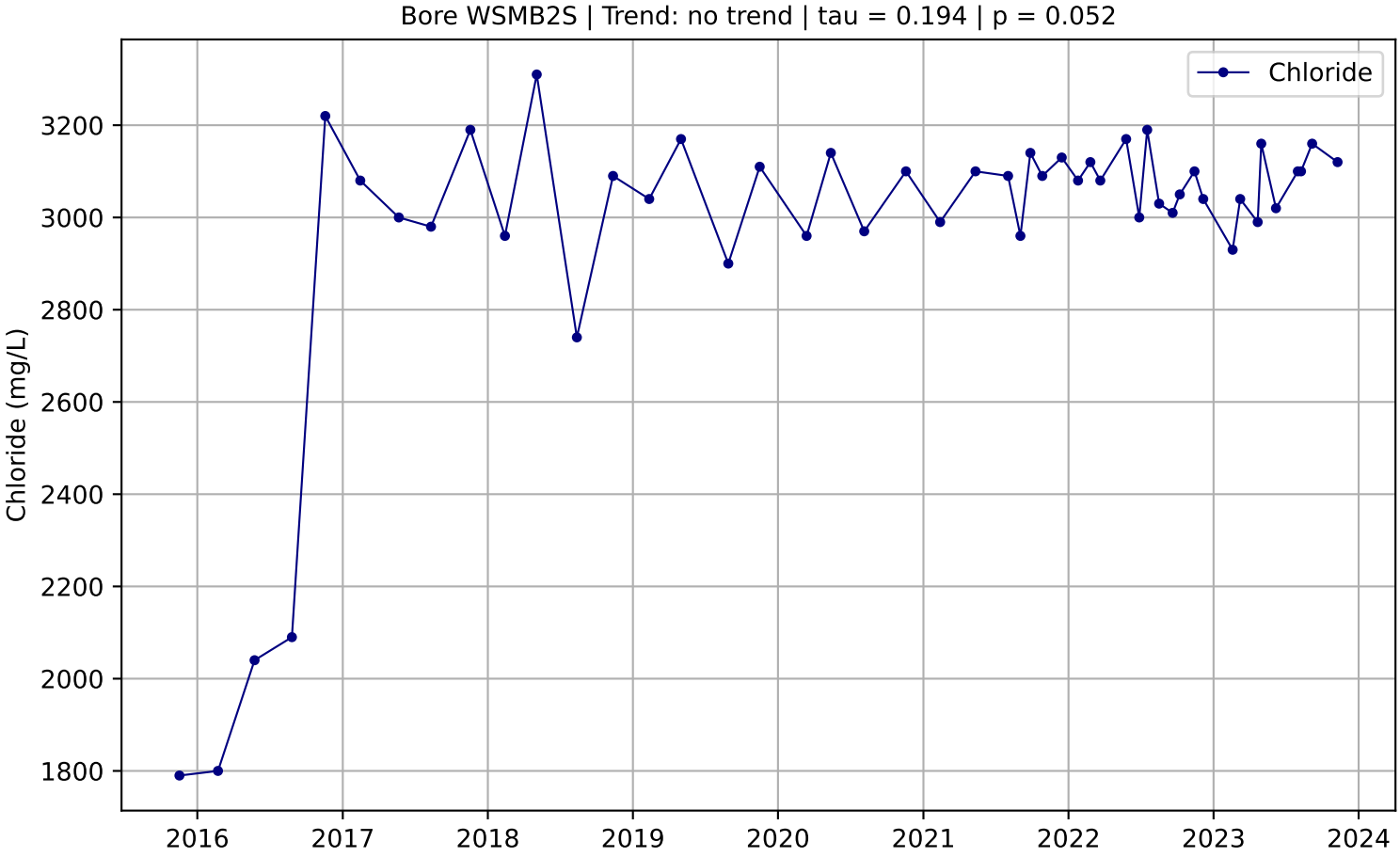

Bore WSMB2S | Trend: increasing | tau = 0.262 | p = 0.009
Bicarbonate
Bicarbonate (mg/L)
200
400
600
800
1000
2016
2017
2018
2019
2020
2021
2022
2023
2024

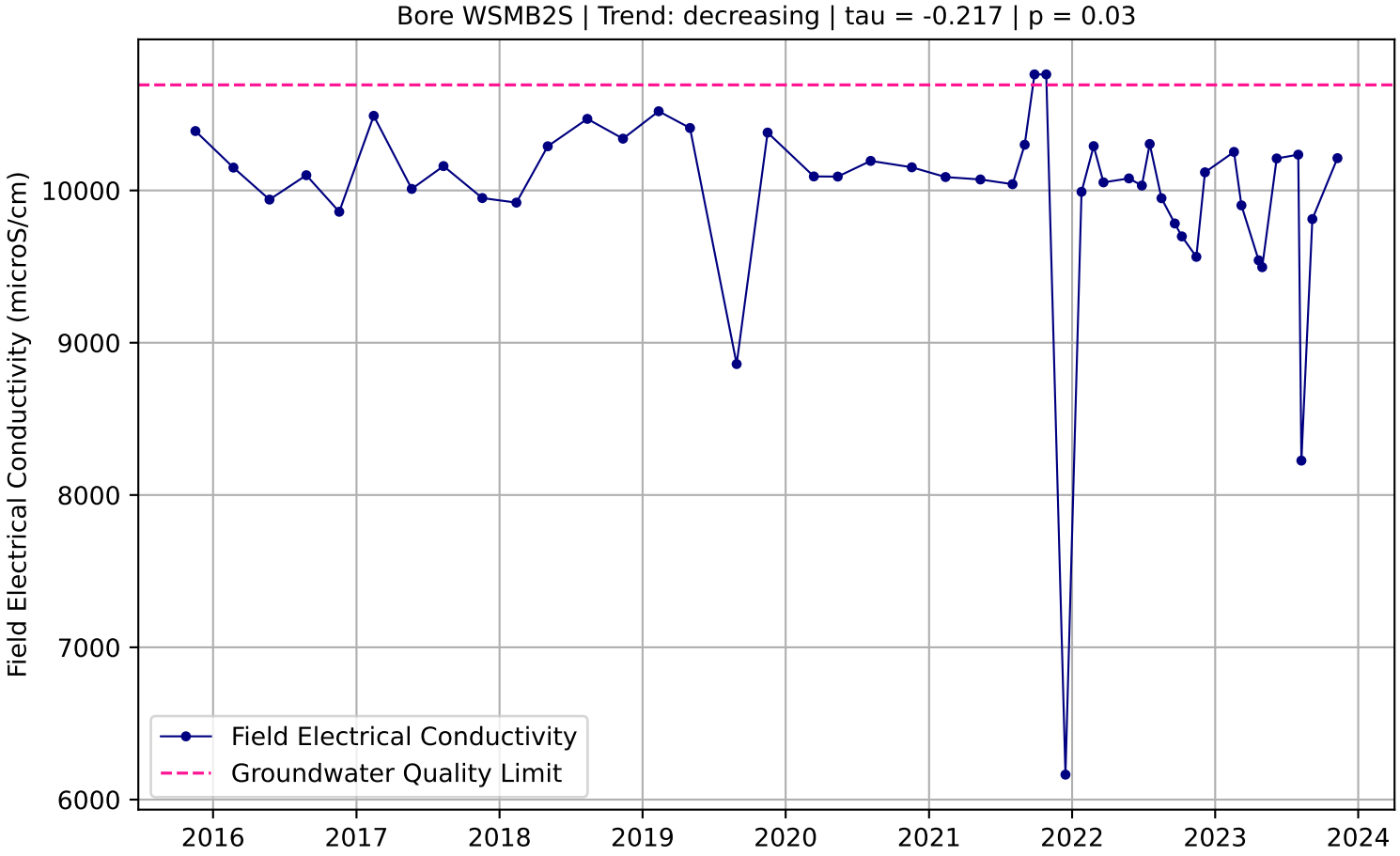

Bore WSMB2S | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

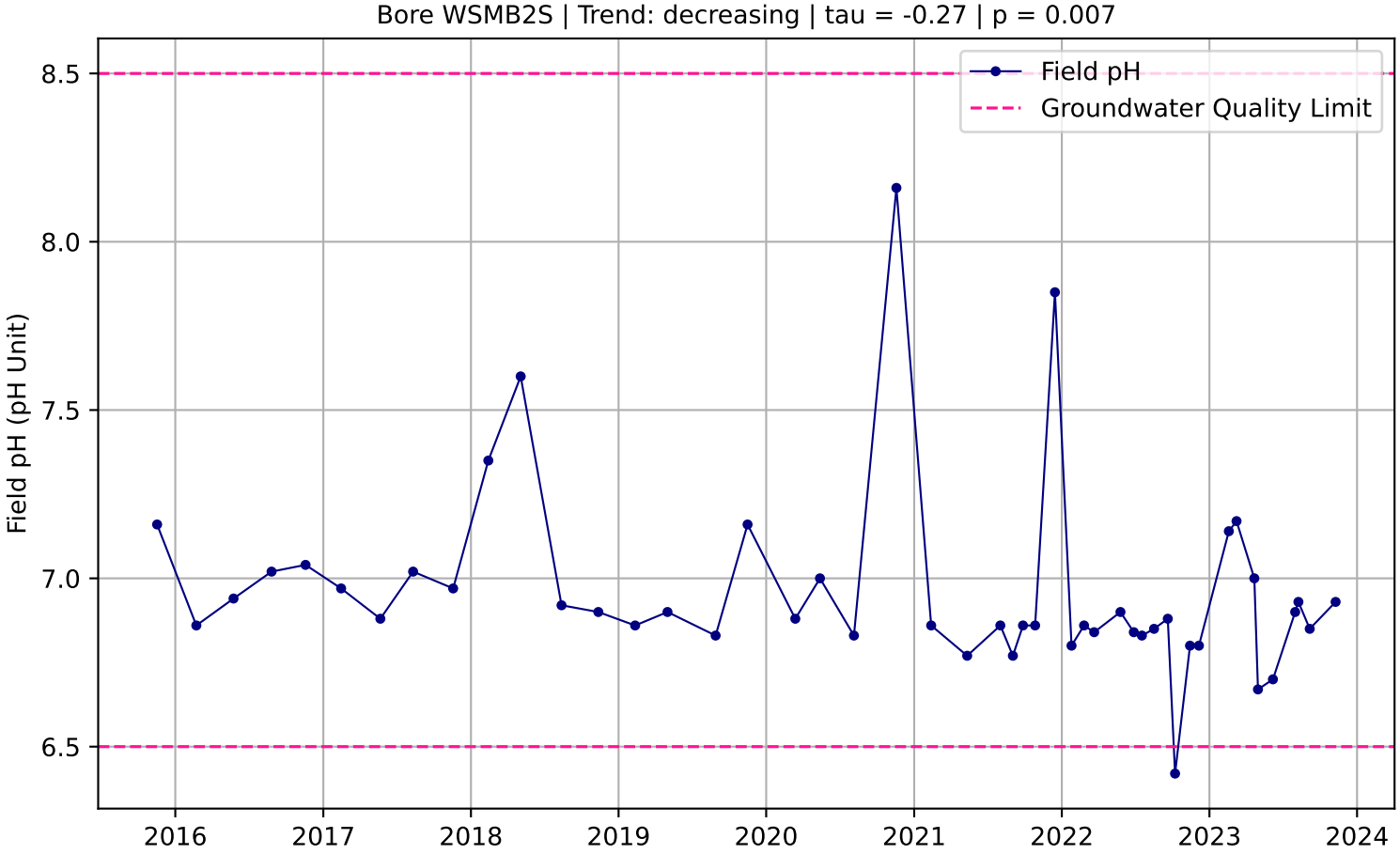

Bore WSMB2S | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

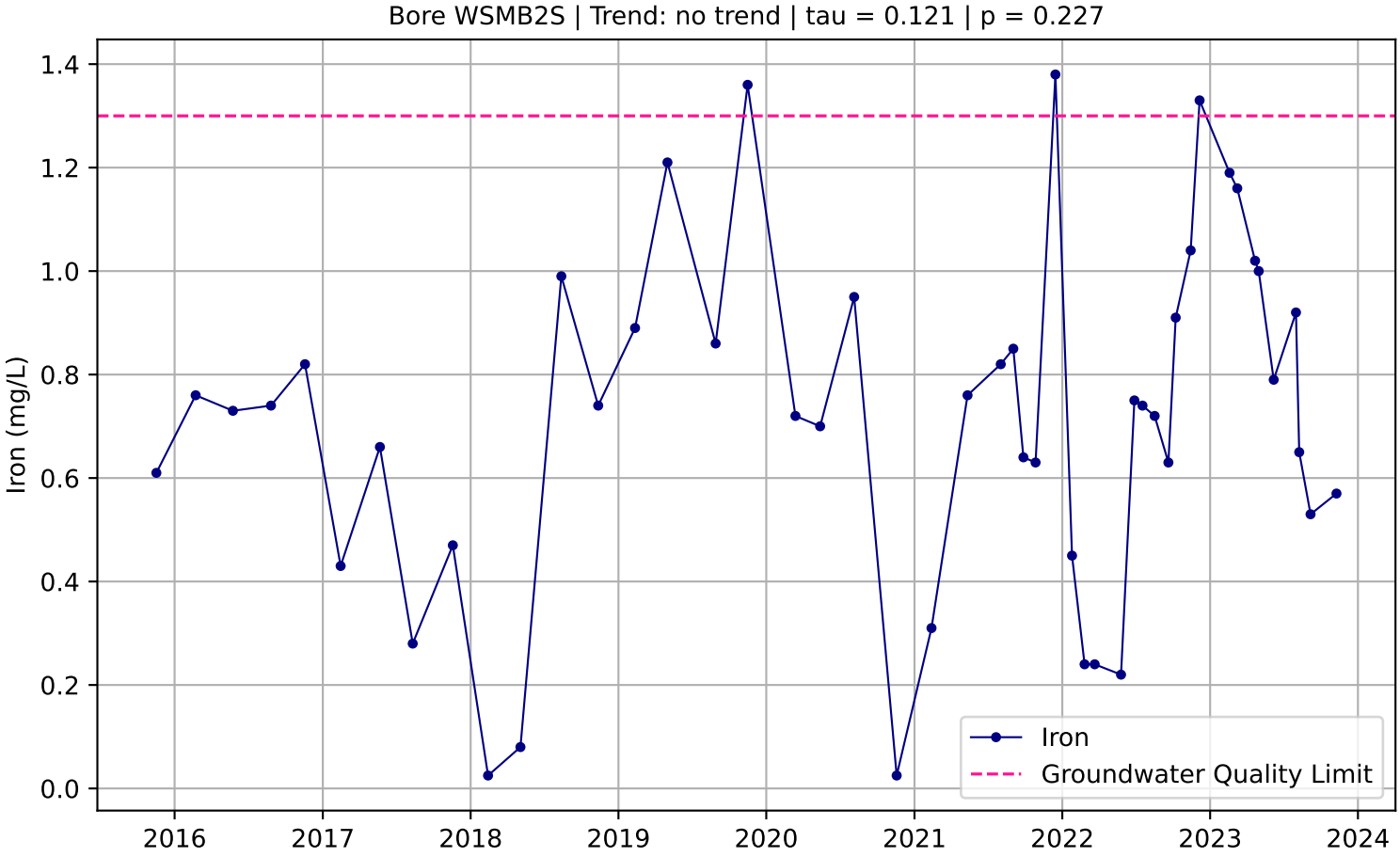

Bore WSMB2S | Trend: no trend | tau = -0.206 | p = 0.059
Calcium
Calcium (mg/L)
180
175
170
165
160
155
150
145
140
2018
2019
2020
2021
2022
2023
2024

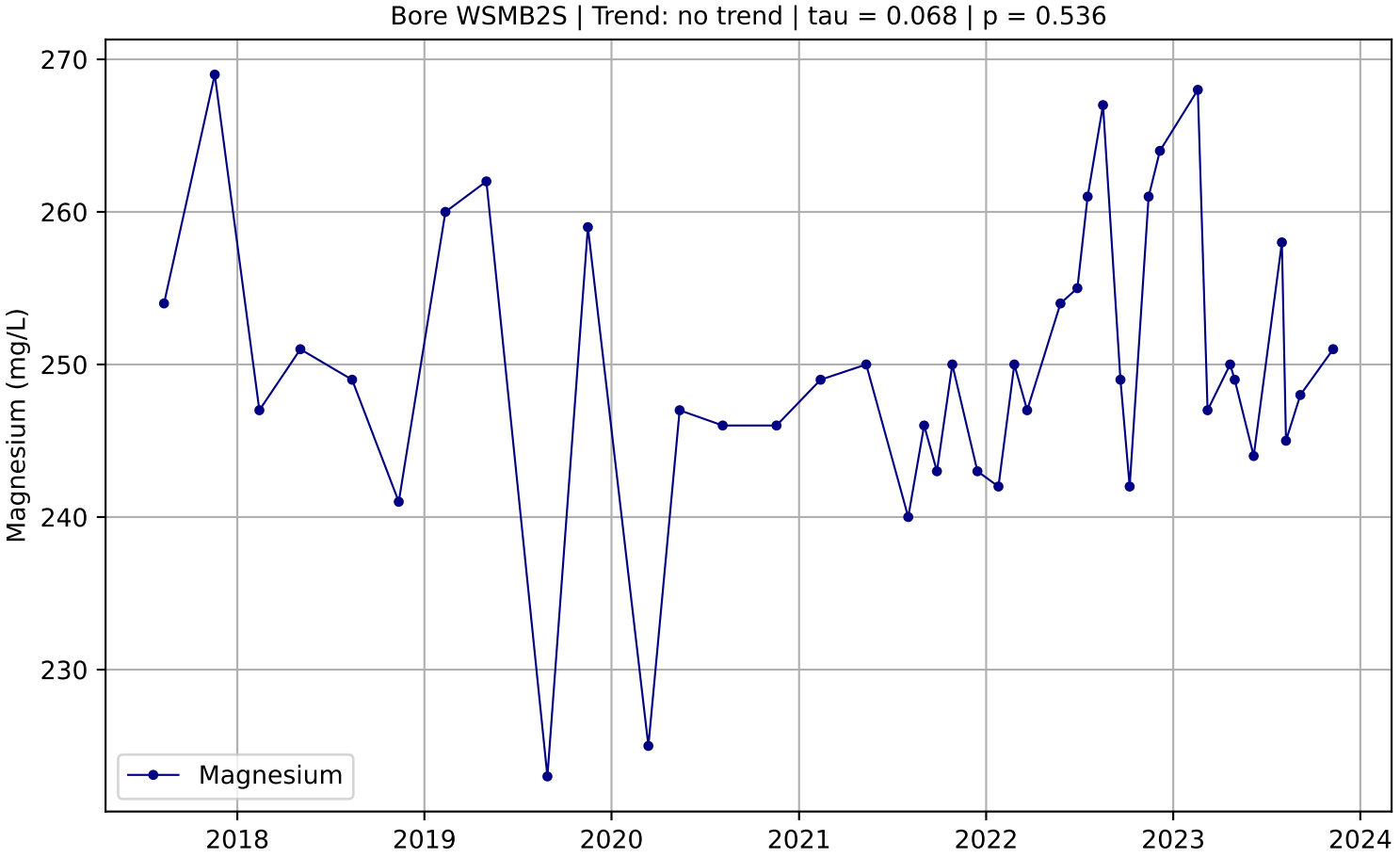

Bore WSMB2S | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

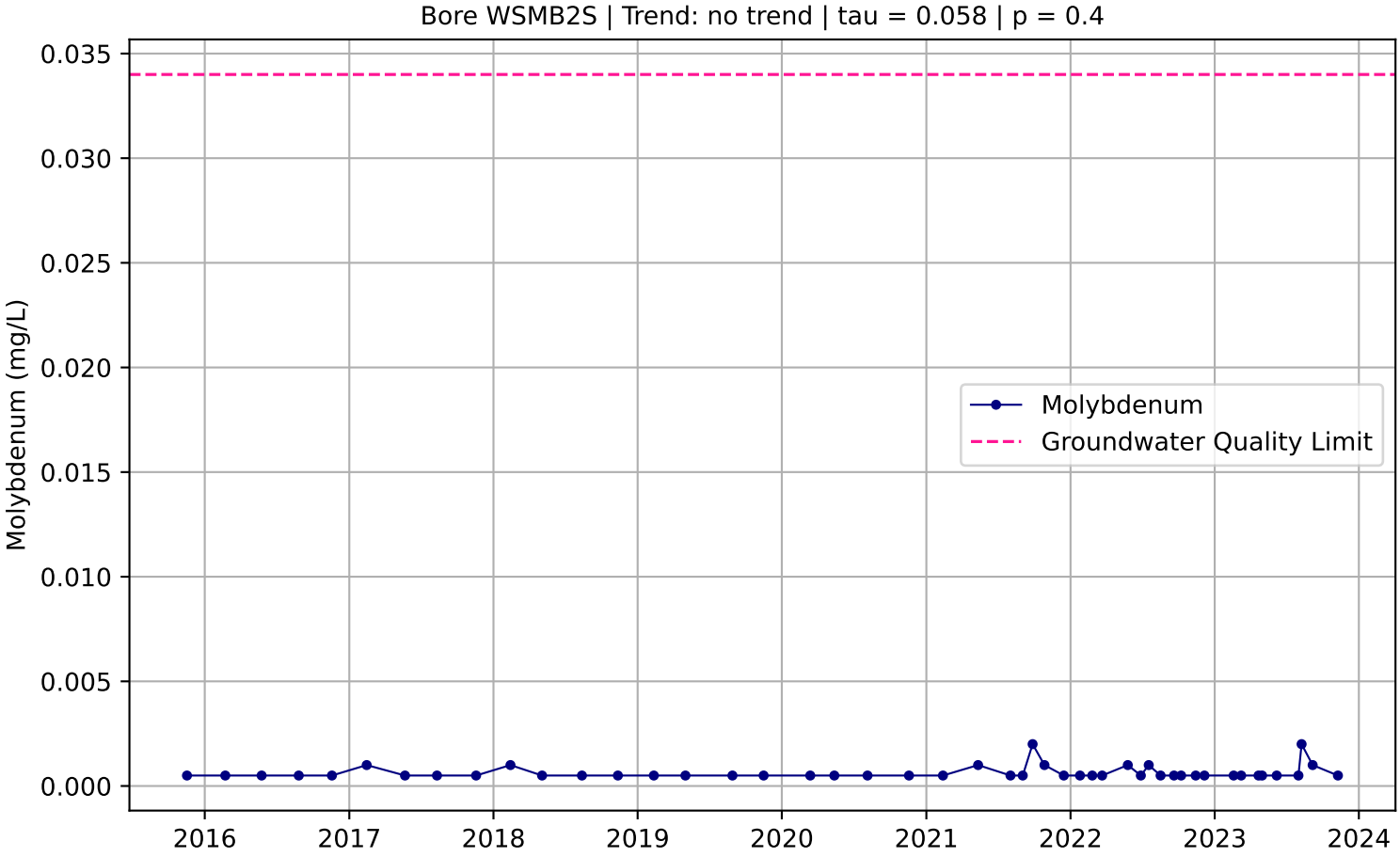

Bore WSMB2S | Trend: no trend | tau = 0.194 | p = 0.052
Chloride
Chloride (mg/L)
1800
2000
2200
2400
2600
2800
3000
3200
2016
2017
2018
2019
2020
2021
2022
2023
2024

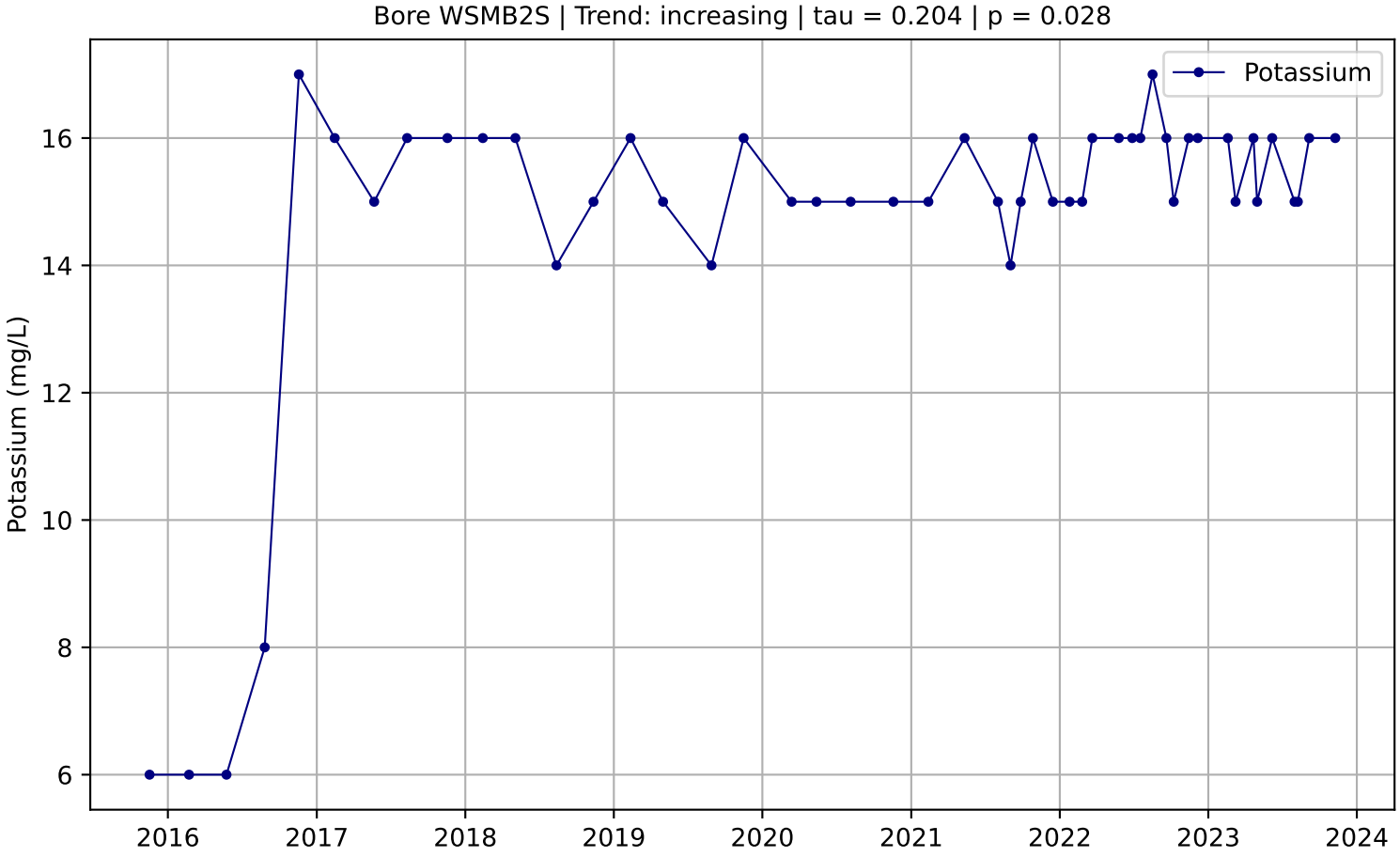

Bore WSMB2S | Trend: decreasing | tau = -0.217 | p = 0.03
Field Electrical Conductivity (microS/cm)
10000
9000
8000
7000
6000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

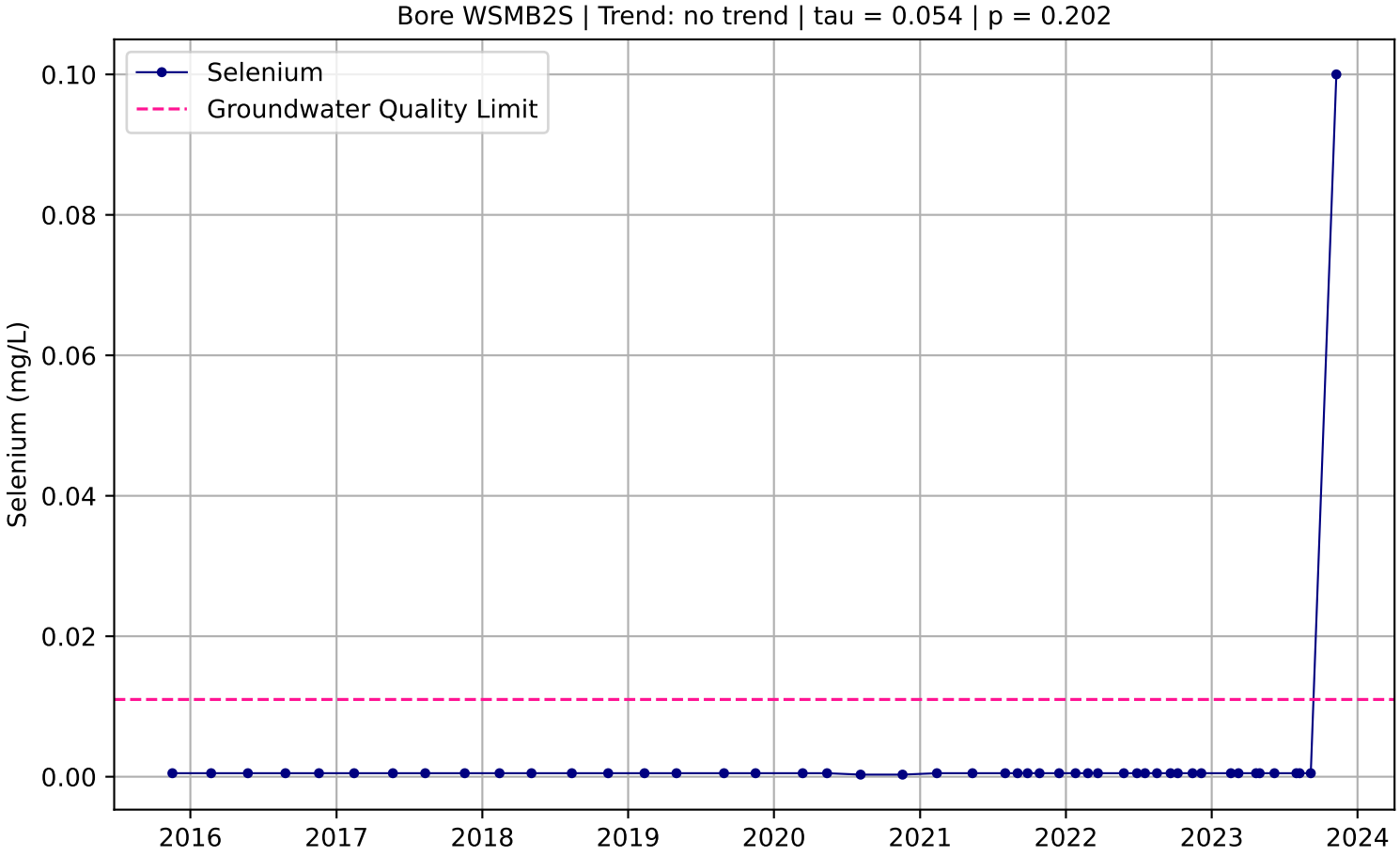

Bore WSMB2S | Trend: decreasing | tau = -0.27 | p = 0.007
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.5
8.0
7.5
7.0
6.5
2016
2017
2018
2019
2020
2021
2022
2023
2024

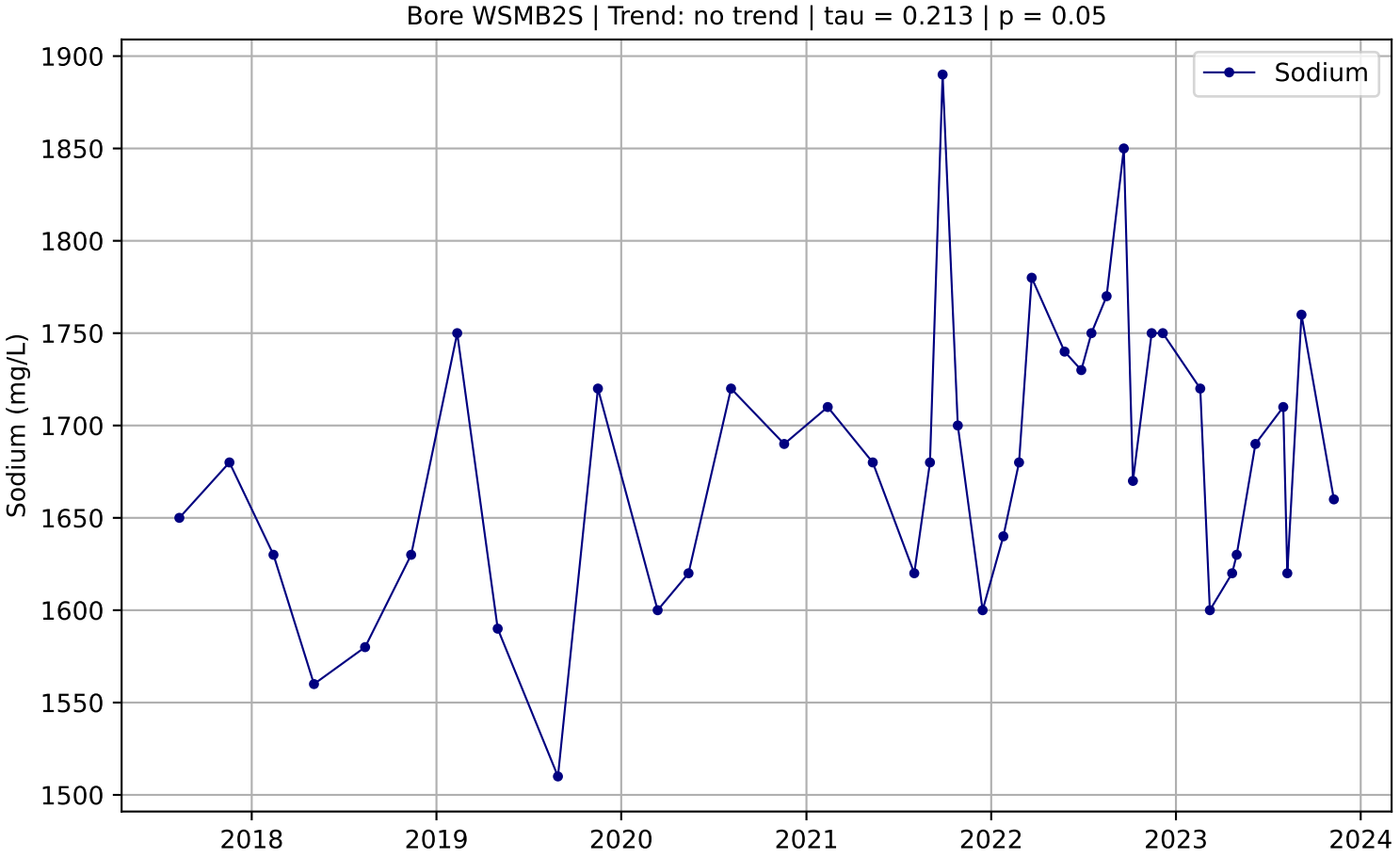

Bore WSMB2S | Trend: no trend | tau = 0.121 | p = 0.227
Iron (mg/L)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2016
2017
2018
2019
2020
2021
2022
2023
2024
Iron
Groundwater Quality Limit

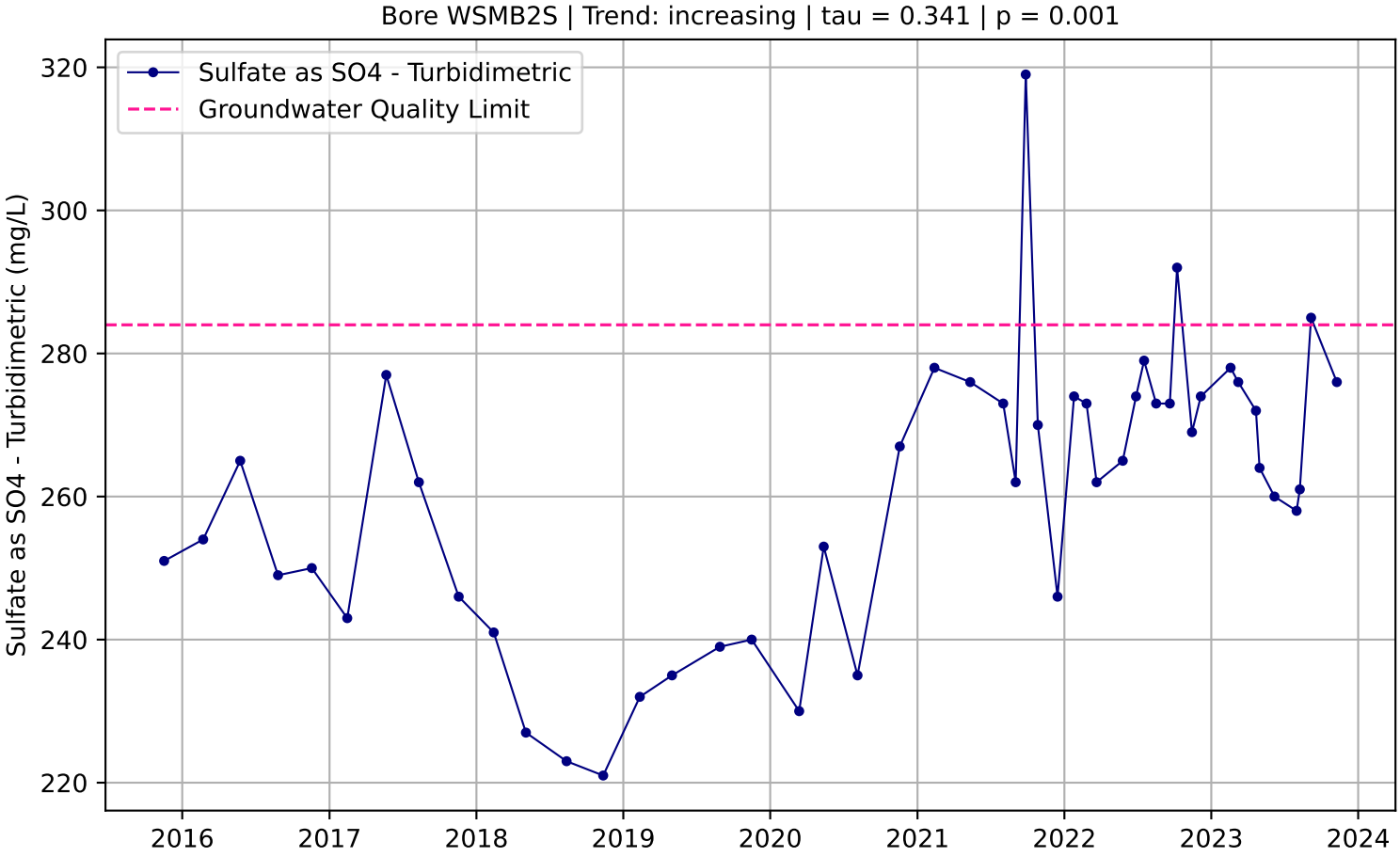

Bore WSMB2S | Trend: no trend | tau = 0.068 | p = 0.536
Magnesium (mg/L)
270
260
250
240
230
2018
2019
2020
2021
2022
2023
2024
Magnesium

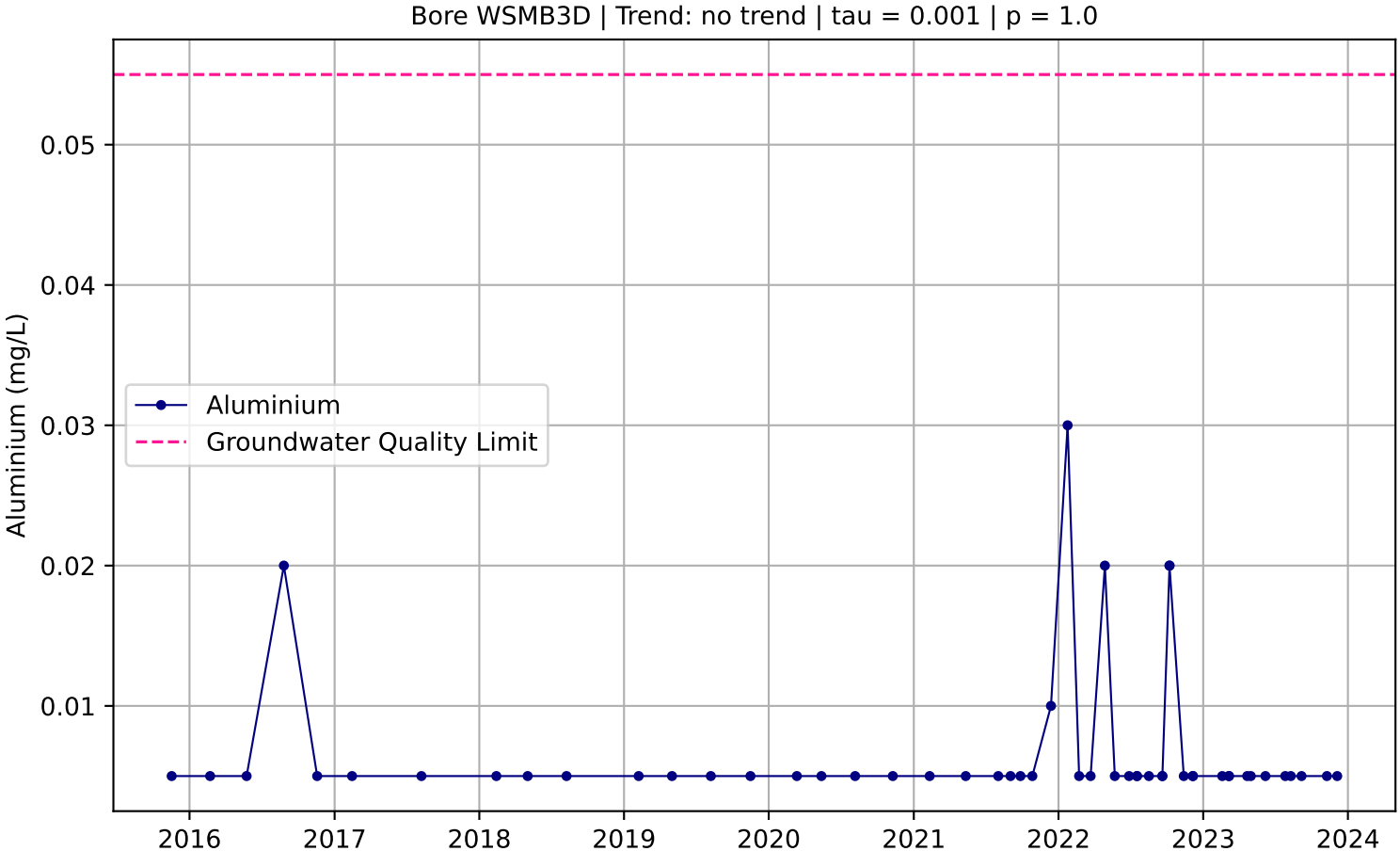

Bore WSMB2S | Trend: no trend | tau = 0.058 | p = 0.4
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

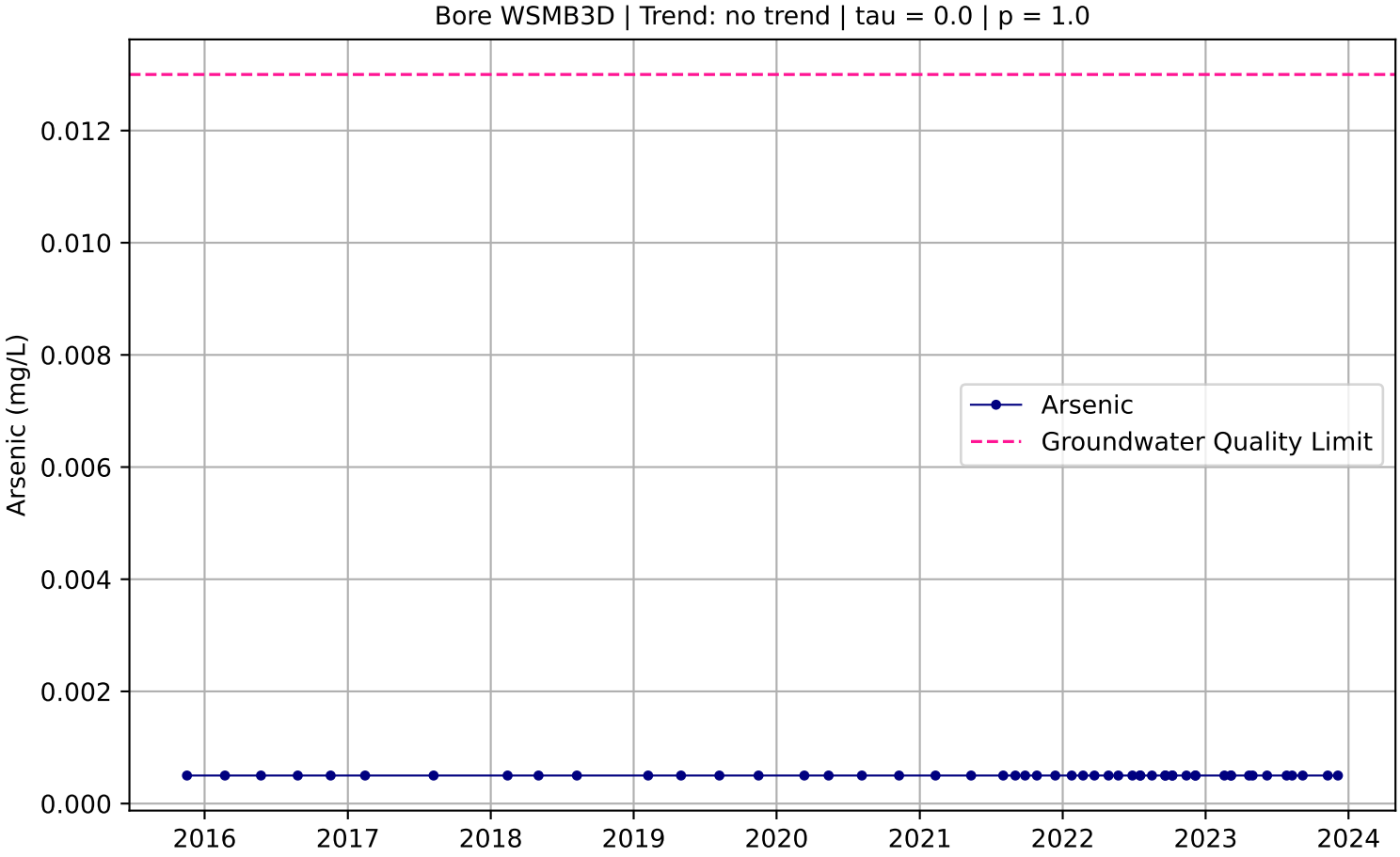

Bore WSMB2S | Trend: increasing | tau = 0.204 | p = 0.028
Potassium
Potassium (mg/L)
6
8
10
12
14
16
2016
2017
2018
2019
2020
2021
2022
2023
2024

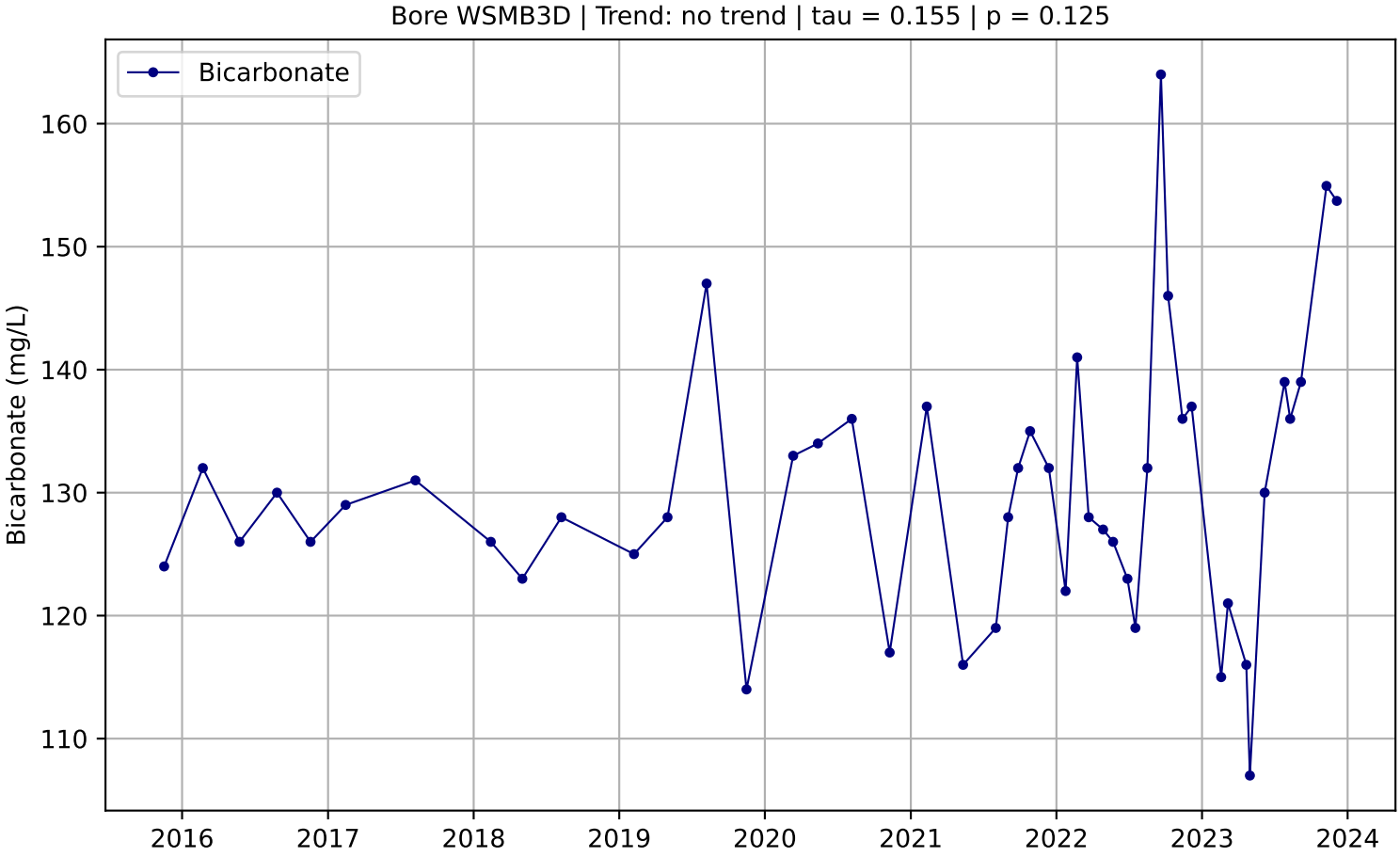

Bore WSMB2S | Trend: no trend | tau = 0.054 | p = 0.202
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

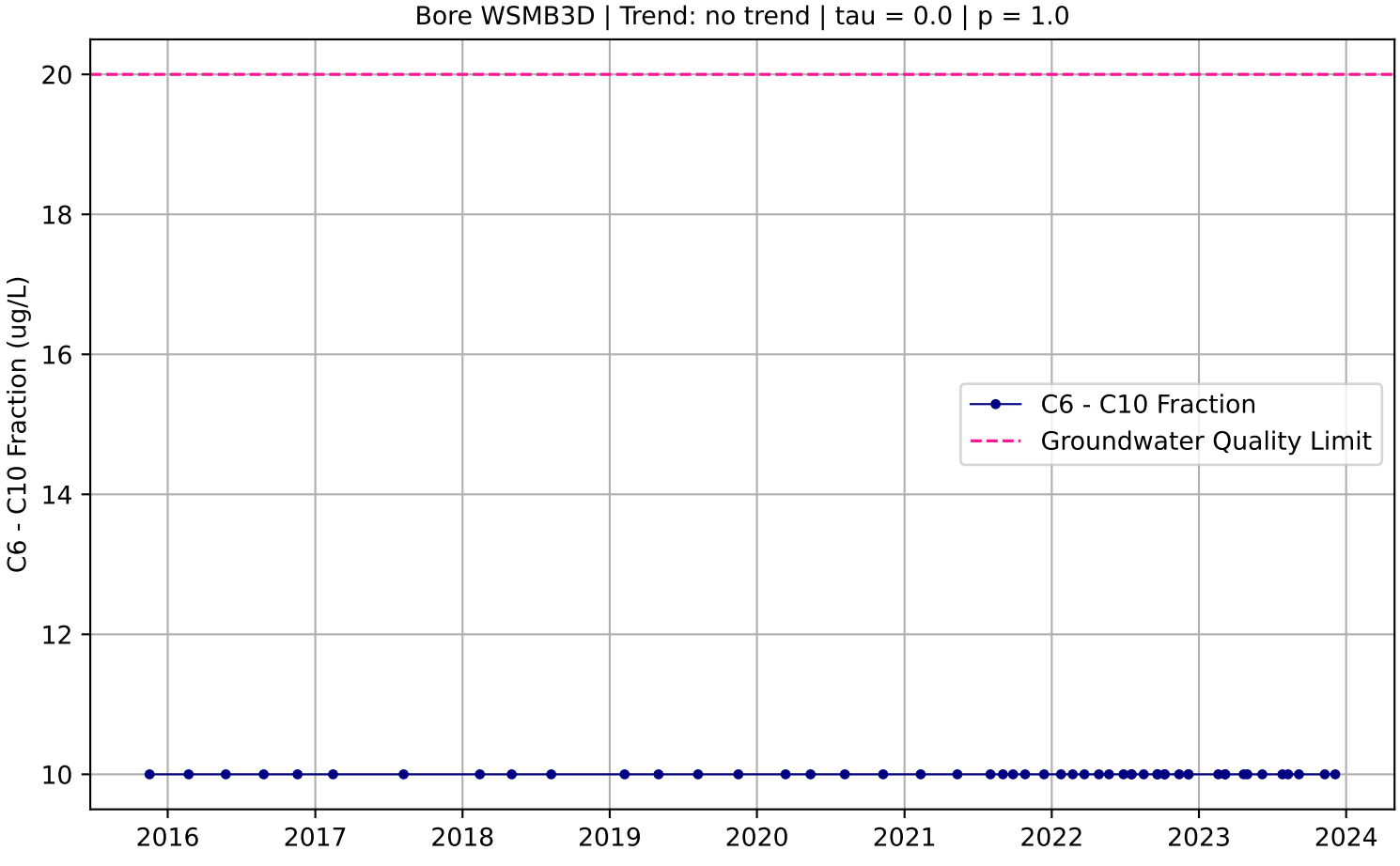

Bore WSMB2S | Trend: no trend | tau = 0.213 | p = 0.05
Sodium
Sodium (mg/L)
1900
1850
1800
1750
1700
1650
1600
1550
1500
2018
2019
2020
2021
2022
2023
2024

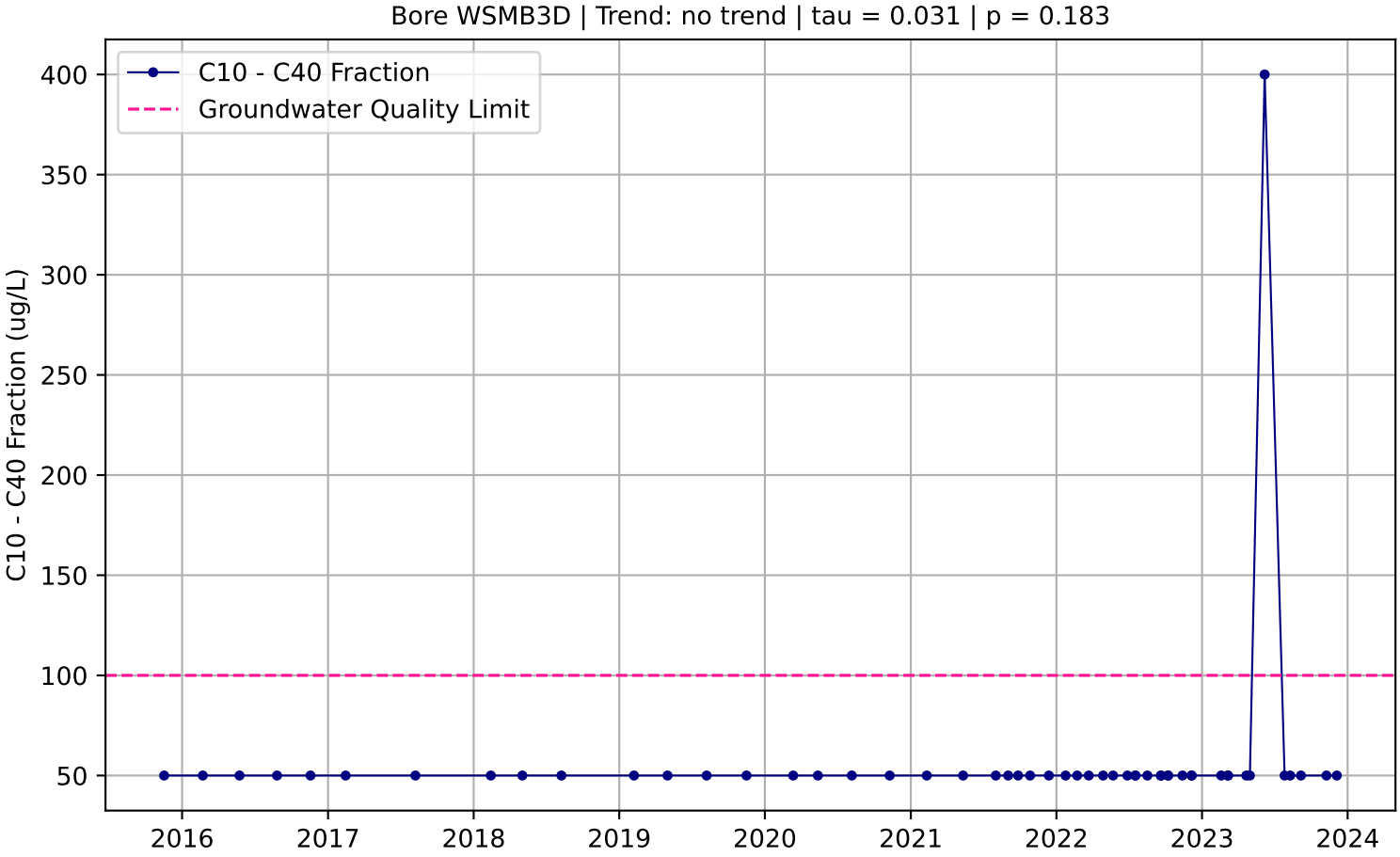

Bore WSMB2S | Trend: increasing | tau = 0.341 | p = 0.001
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
320
300
280
260
240
220
2016
2017
2018
2019
2020
2021
2022
2023
2024

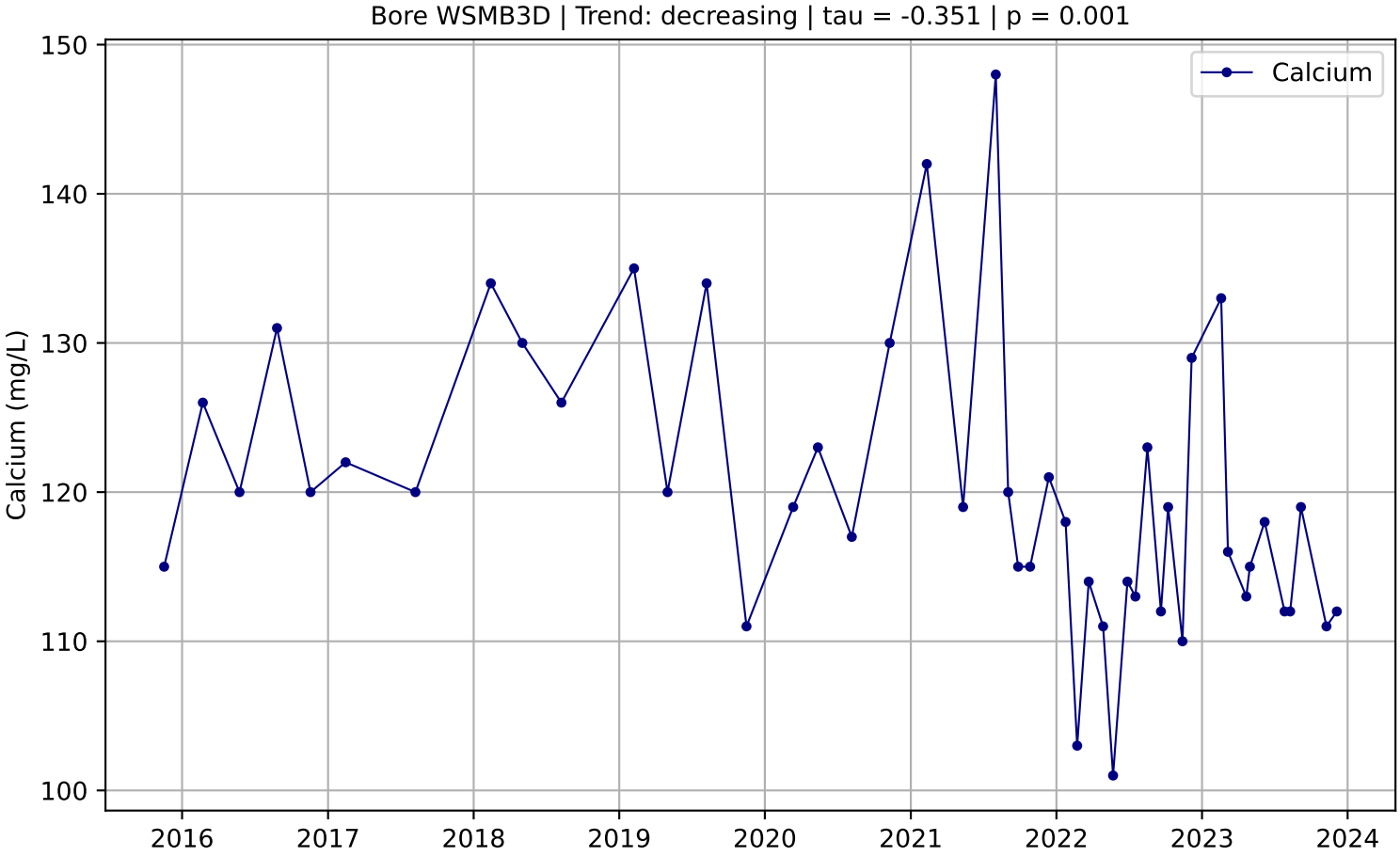

Bore WSMB3D | Trend: no trend | tau = 0.001 | p = 1.0
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
Aluminium
Groundwater Quality Limit
2016
2017
2018
2019
2020
2021
2022
2023
2024


Bore WSMB3D | Trend: no trend | tau = 0.0 | p = 1.0
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

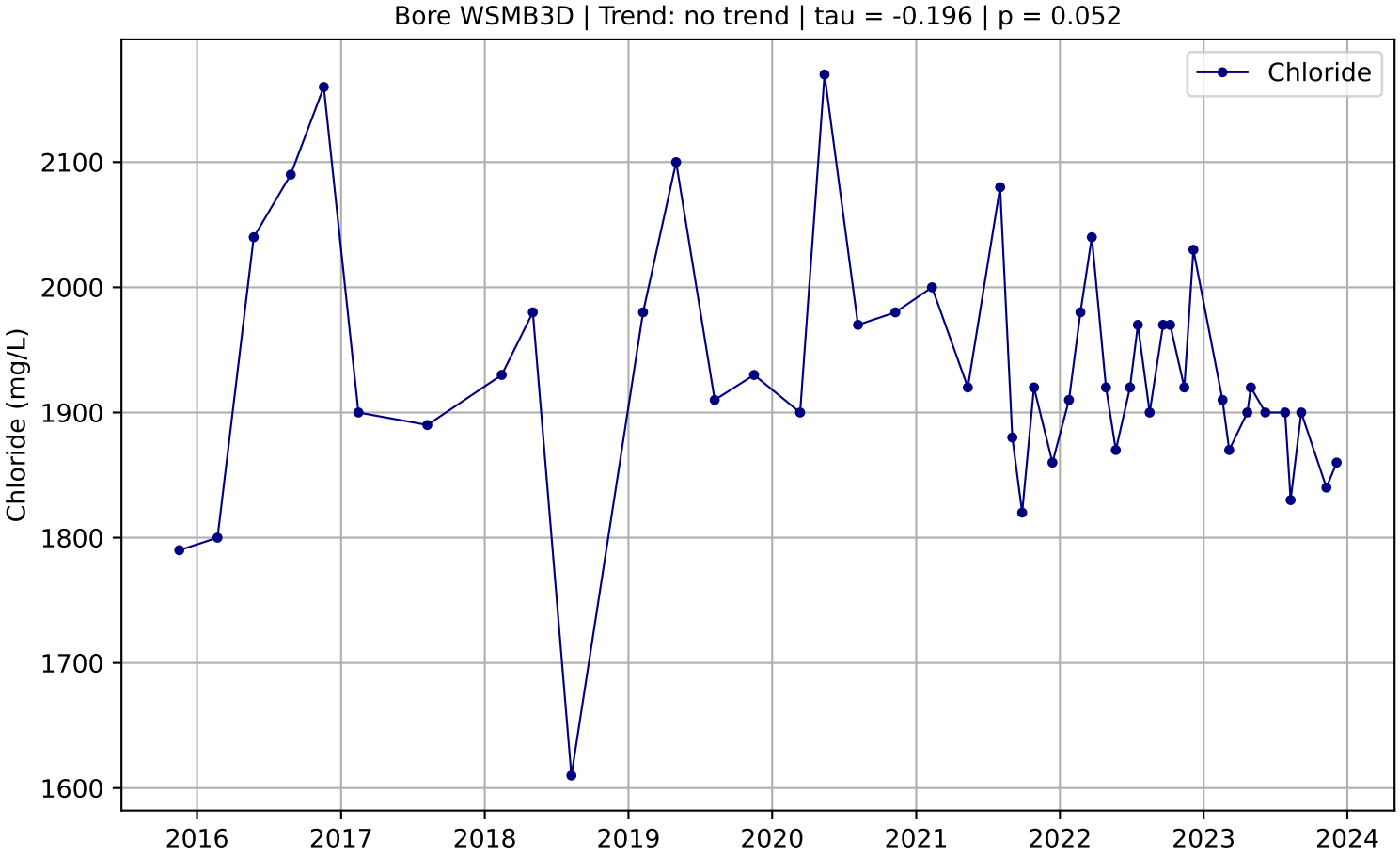

Bore WSMB3D | Trend: no trend | tau = 0.155 | p = 0.125
Bicarbonate
Bicarbonate (mg/L)
160
150
140
130
120
110
2016
2017
2018
2019
2020
2021
2022
2023
2024

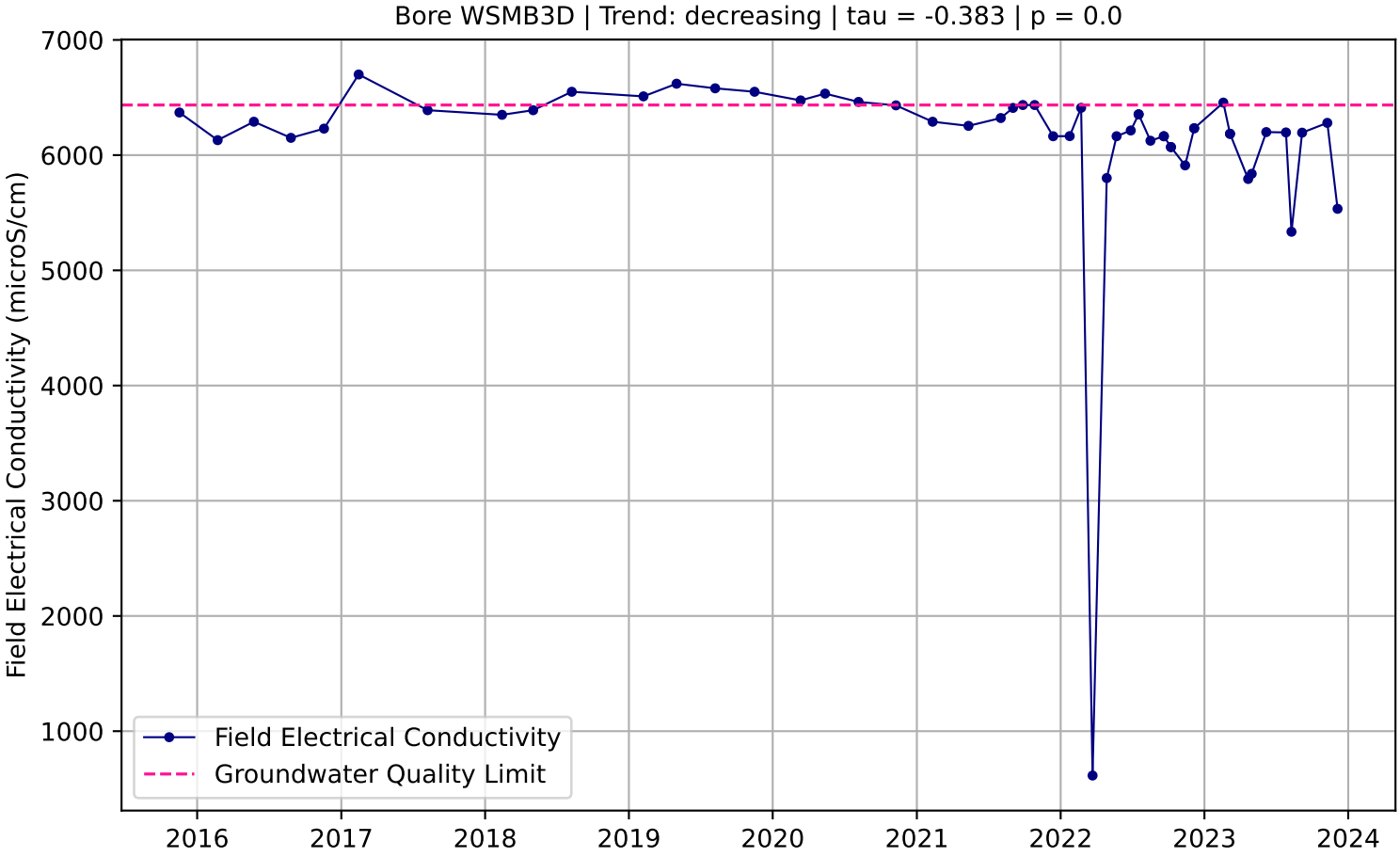

Bore WSMB3D | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

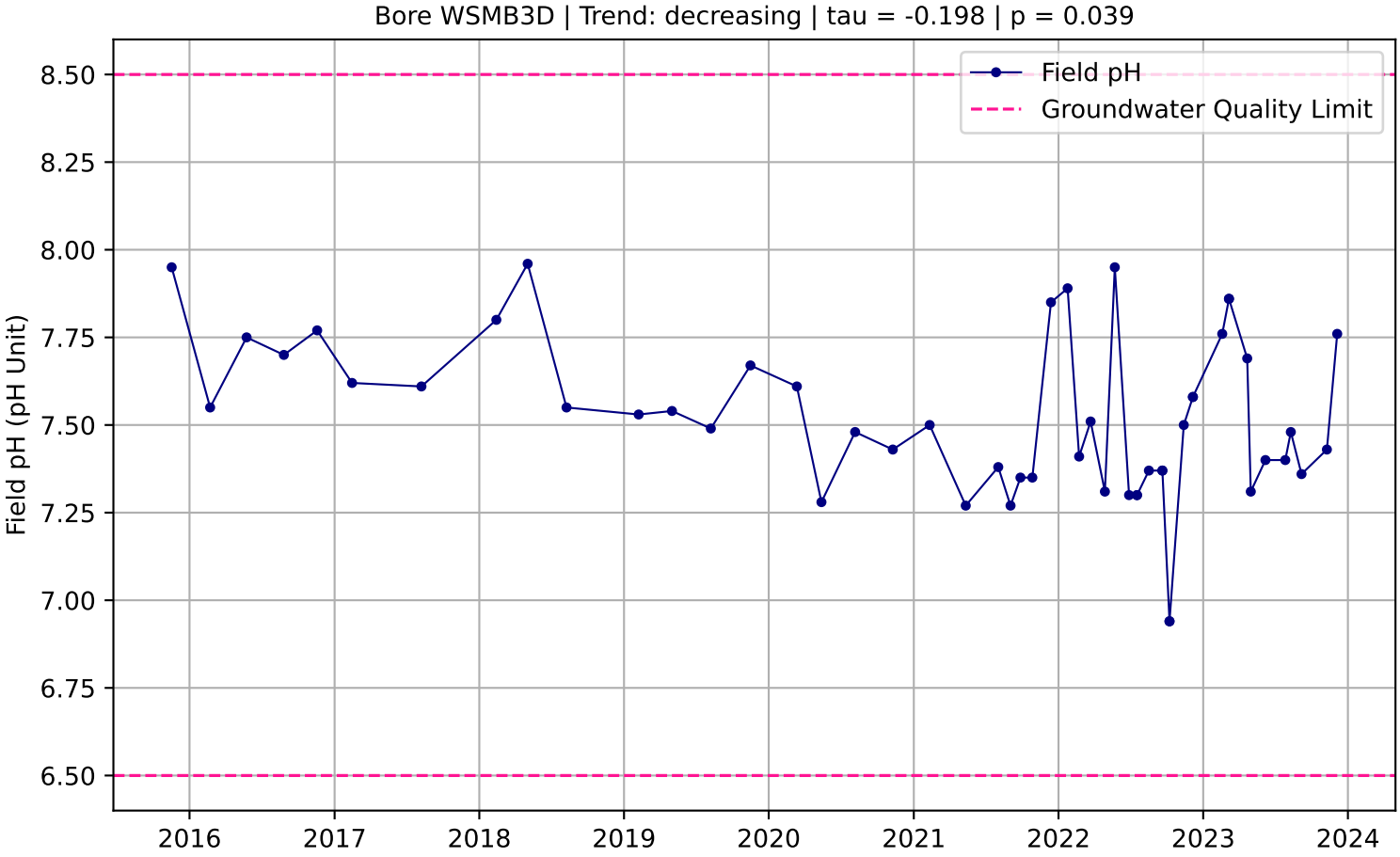

Bore WSMB3D | Trend: no trend | tau = 0.031 | p = 0.183
C10 - C40 Fraction
Groundwater Quality Limit
C10 - C40 Fraction (ug/L)
400
350
300
250
200
150
100
50
2016
2017
2018
2019
2020
2021
2022
2023
2024

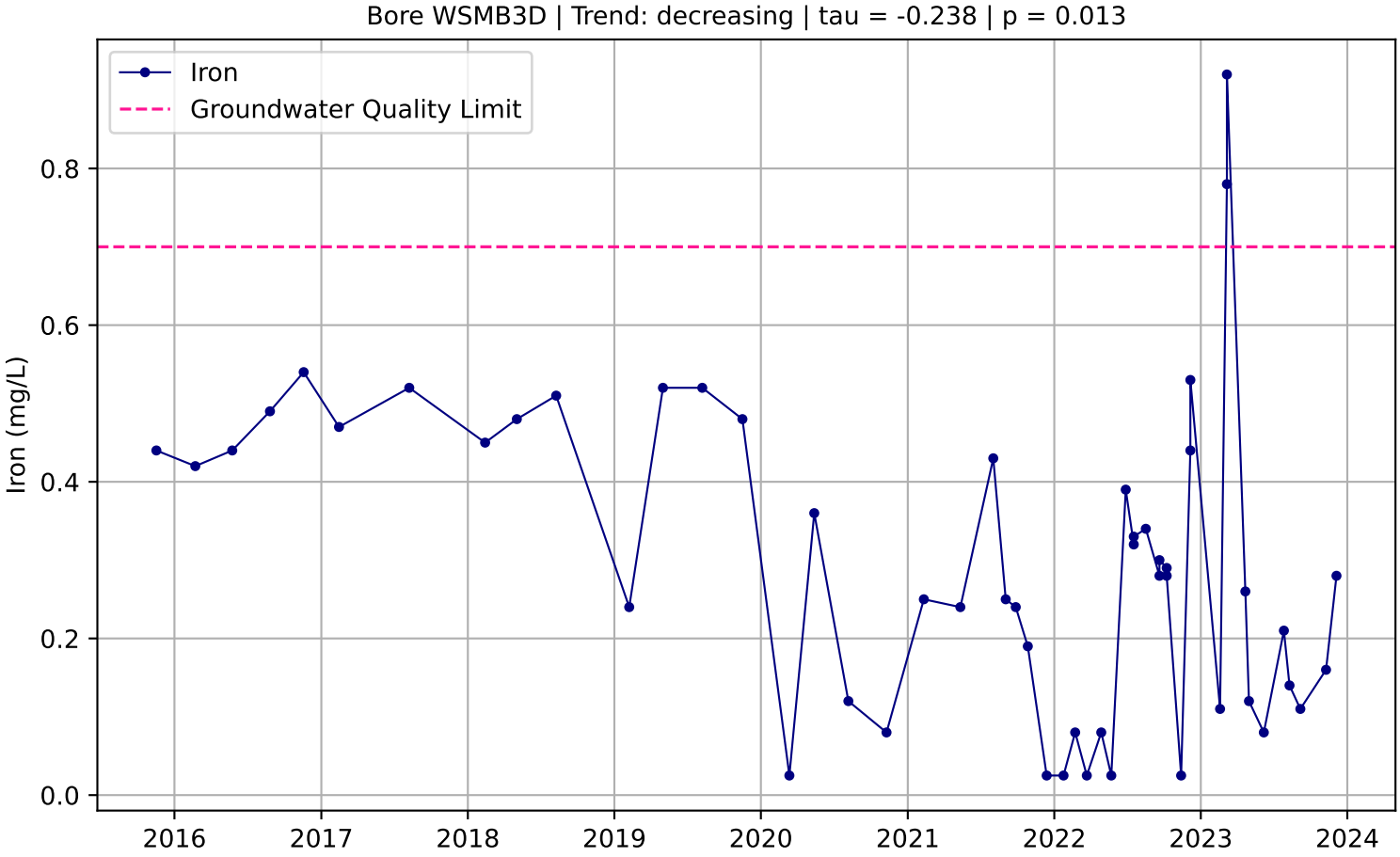

Bore WSMB3D | Trend: decreasing | tau = -0.351 | p = 0.001
Calcium
Calcium (mg/L)
150
140
130
120
110
100
2016
2017
2018
2019
2020
2021
2022
2023
2024

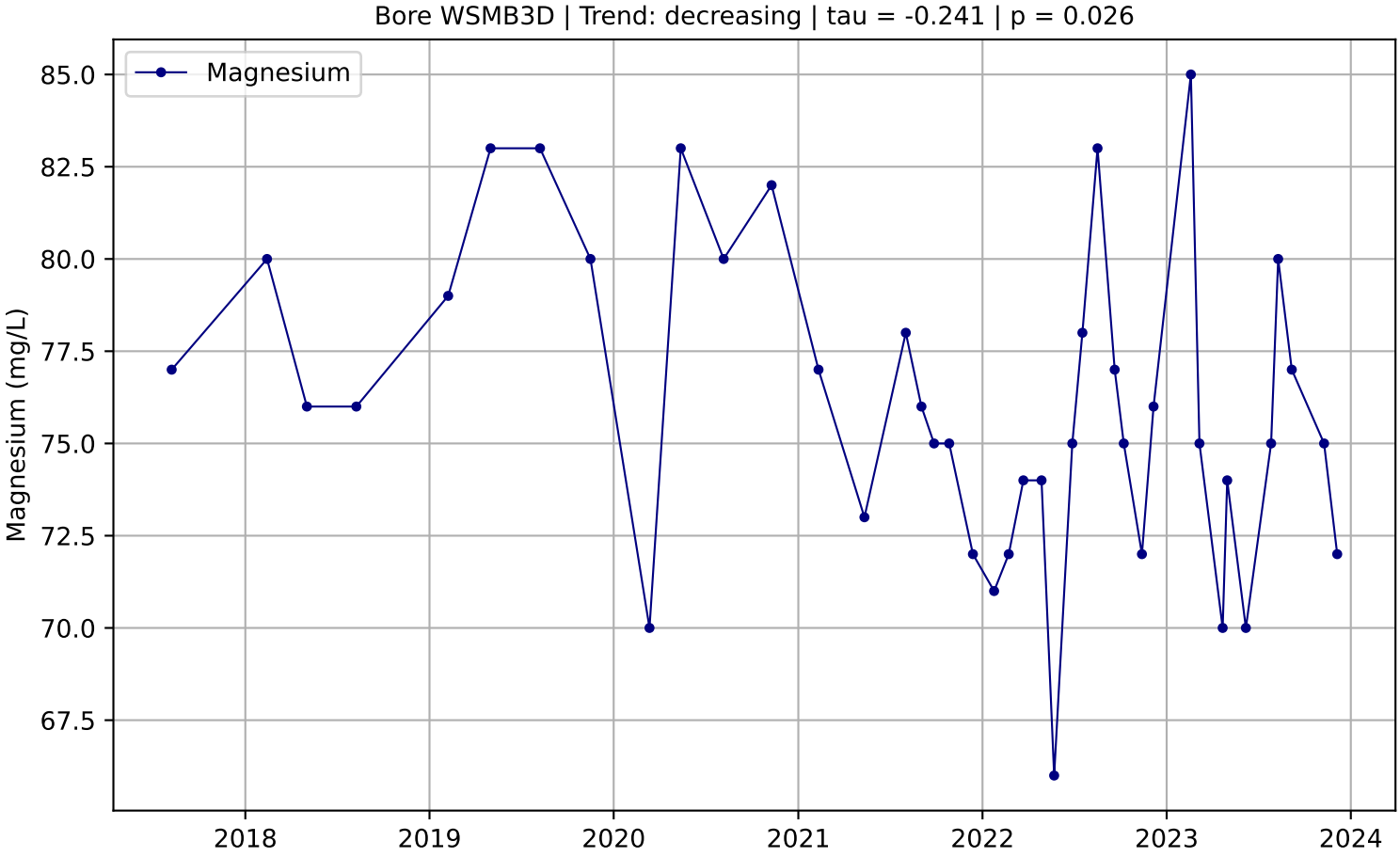
Bore WSMB3D | Trend: Not evaluated
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48

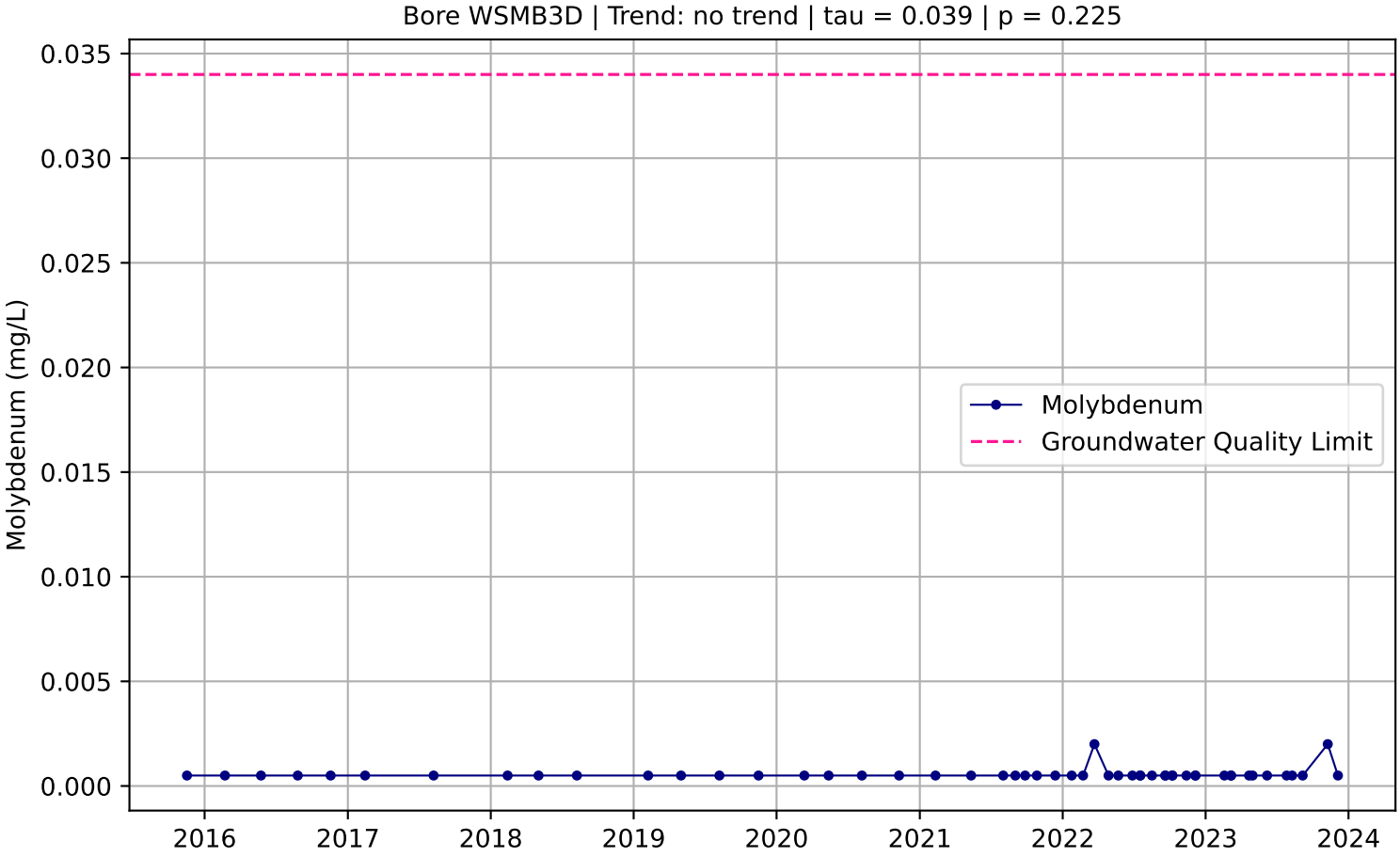

Bore WSMB3D | Trend: no trend | tau = -0.196 | p = 0.052
Chloride
Chloride (mg/L)
2100
2000
1900
1800
1700
1600
2016
2017
2018
2019
2020
2021
2022
2023
2024

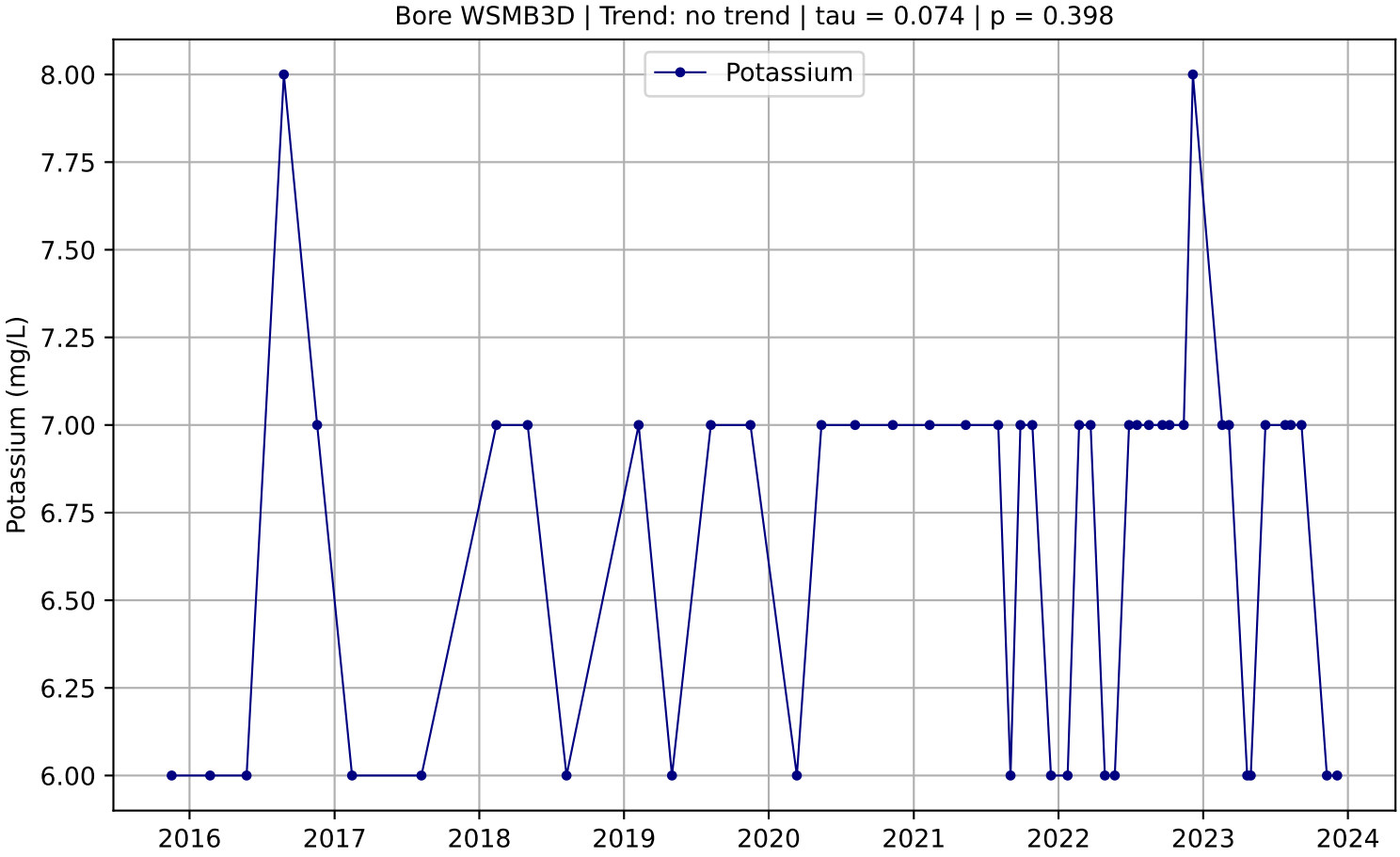

Bore WSMB3D | Trend: decreasing | tau = -0.383 | p = 0.0
Field Electrical Conductivity (microS/cm)
7000
6000
5000
4000
3000
2000
1000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

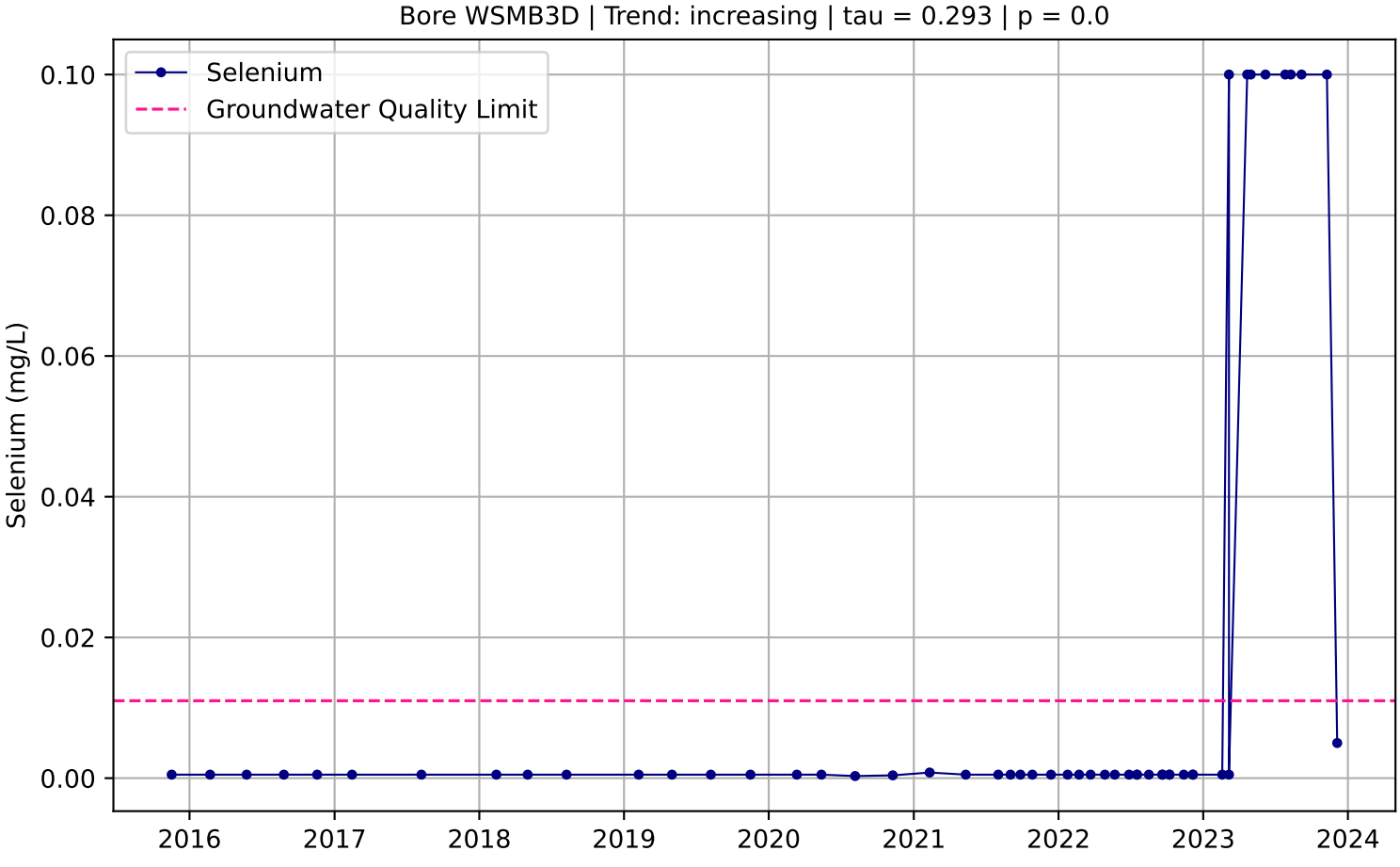

Bore WSMB3D | Trend: decreasing | tau = -0.198 | p = 0.039
Field pH
Groundwater Quality Limit
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
2024

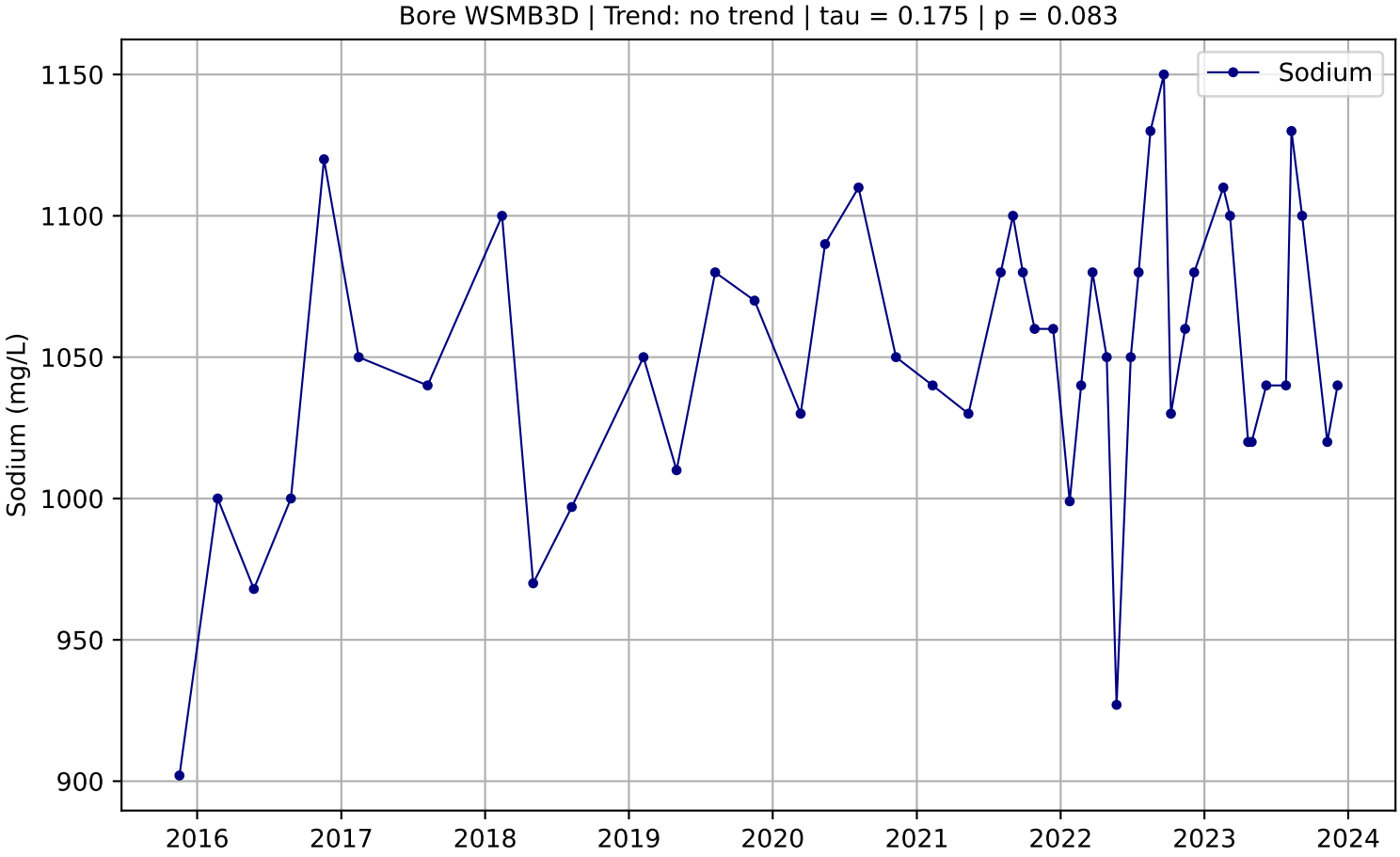

Bore WSMB3D | Trend: decreasing | tau = -0.238 | p = 0.013
Iron
Groundwater Quality Limit
Iron (mg/L)
0.0
0.2
0.4
0.6
0.8
2016
2017
2018
2019
2020
2021
2022
2023
2024

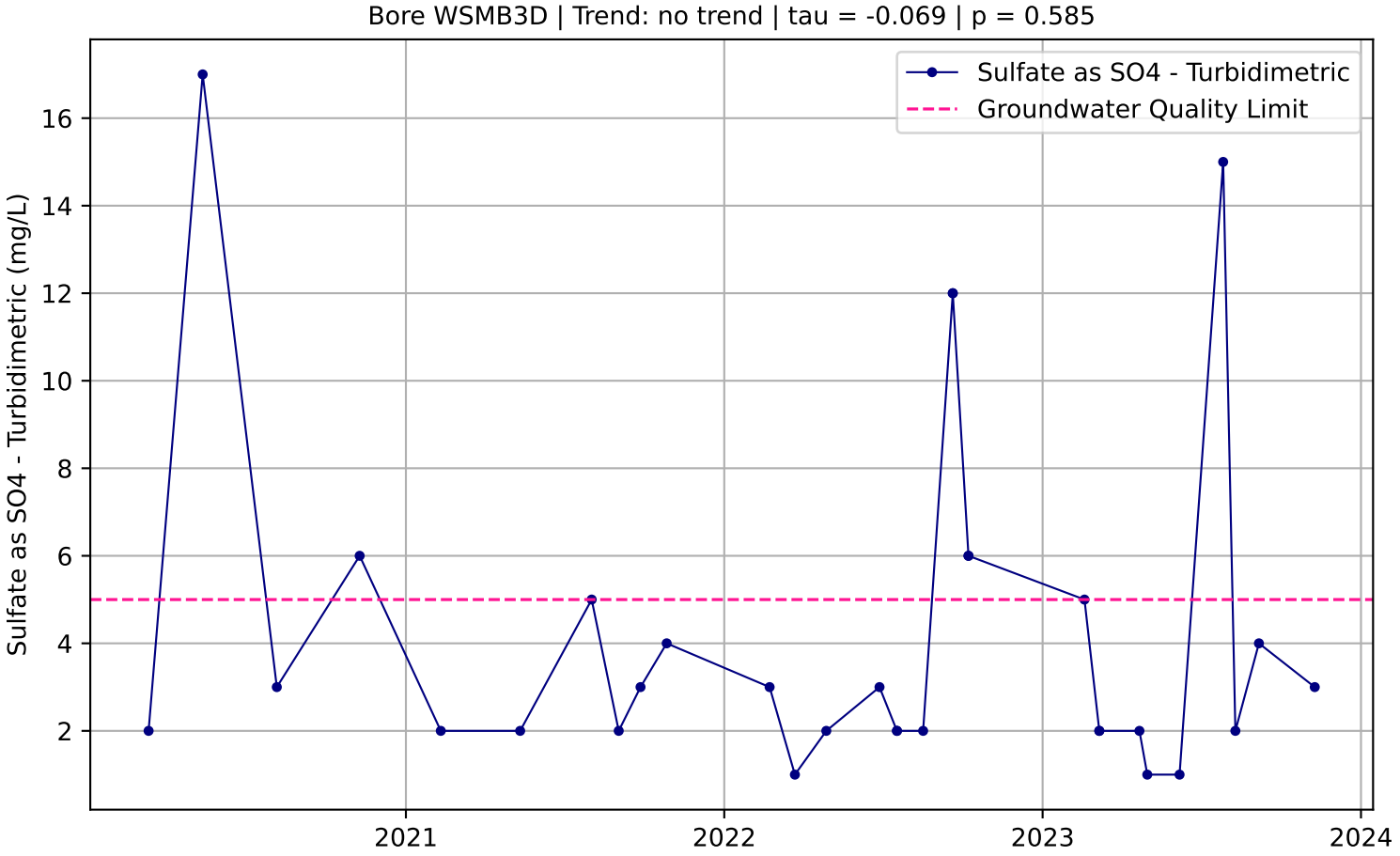

Bore WSMB3D | Trend: decreasing | tau = -0.241 | p = 0.026
Magnesium
Magnesium (mg/L)
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
2018
2019
2020
2021
2022
2023
2024

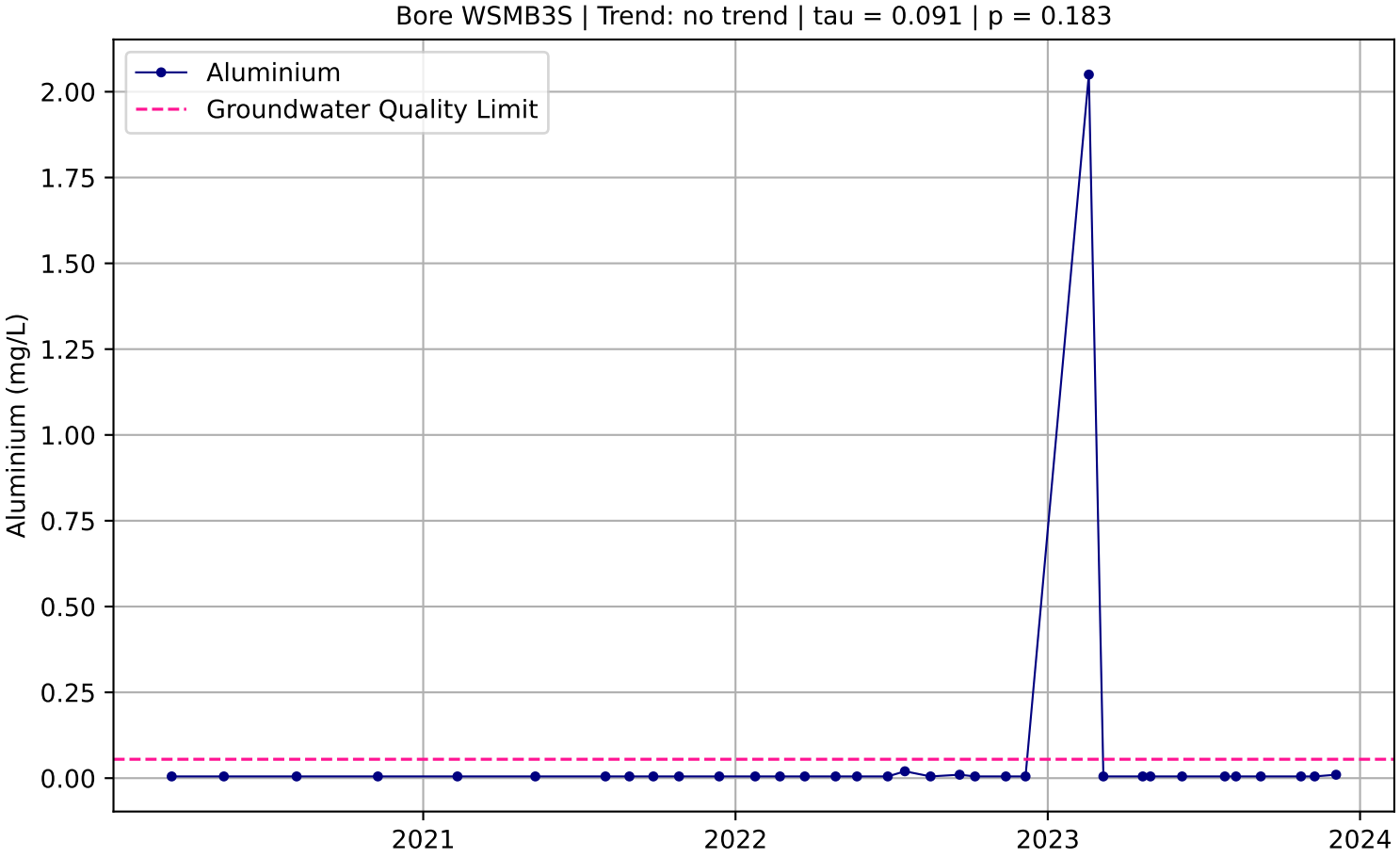

Bore WSMB3D | Trend: no trend | tau = 0.039 | p = 0.225
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

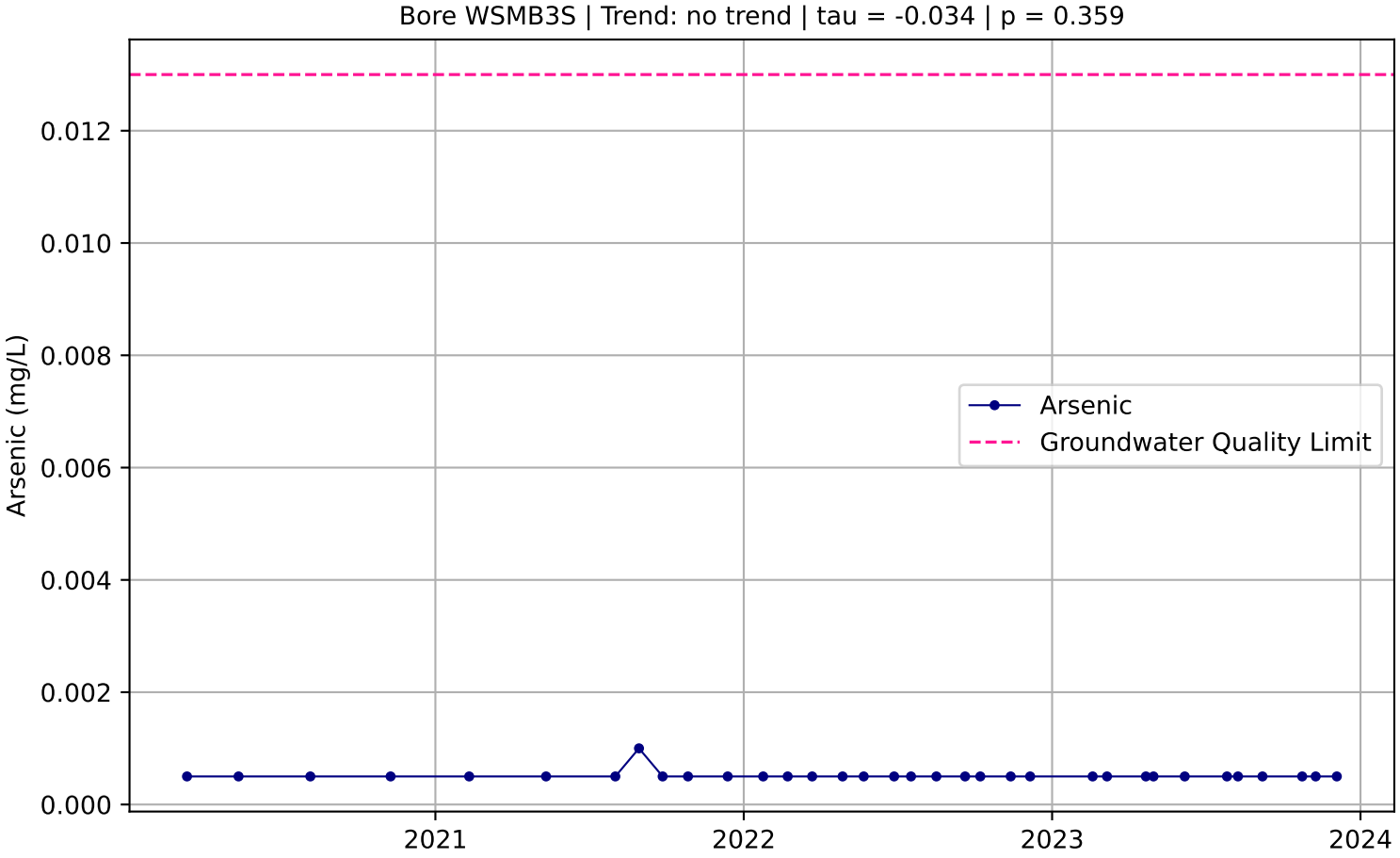

Bore WSMB3D | Trend: no trend | tau = 0.074 | p = 0.398
Potassium
Potassium (mg/L)
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

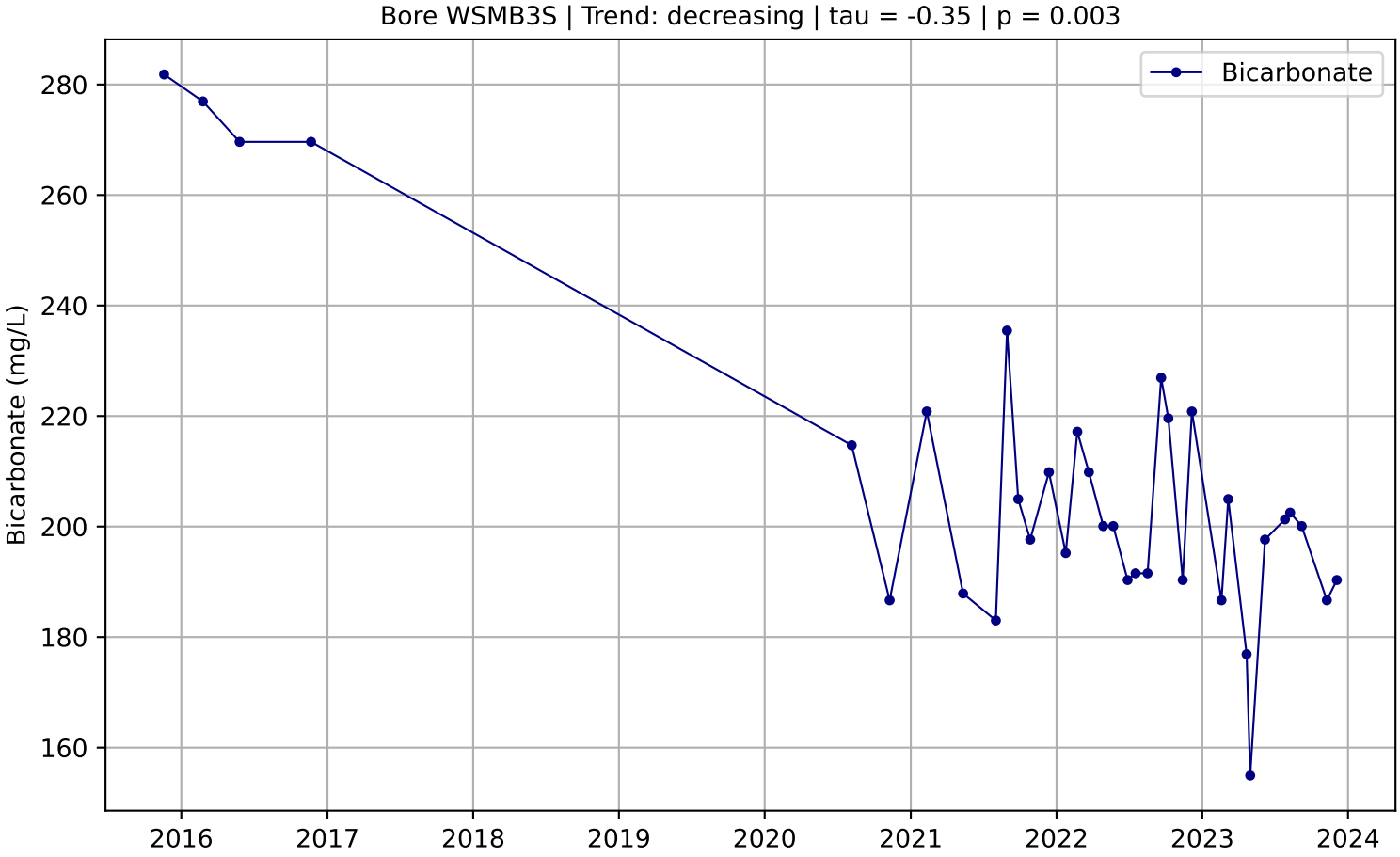

Bore WSMB3D | Trend: increasing | tau = 0.293 | p = 0.0
Selenium
Groundwater Quality Limit
Selenium (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
2016
2017
2018
2019
2020
2021
2022
2023
2024

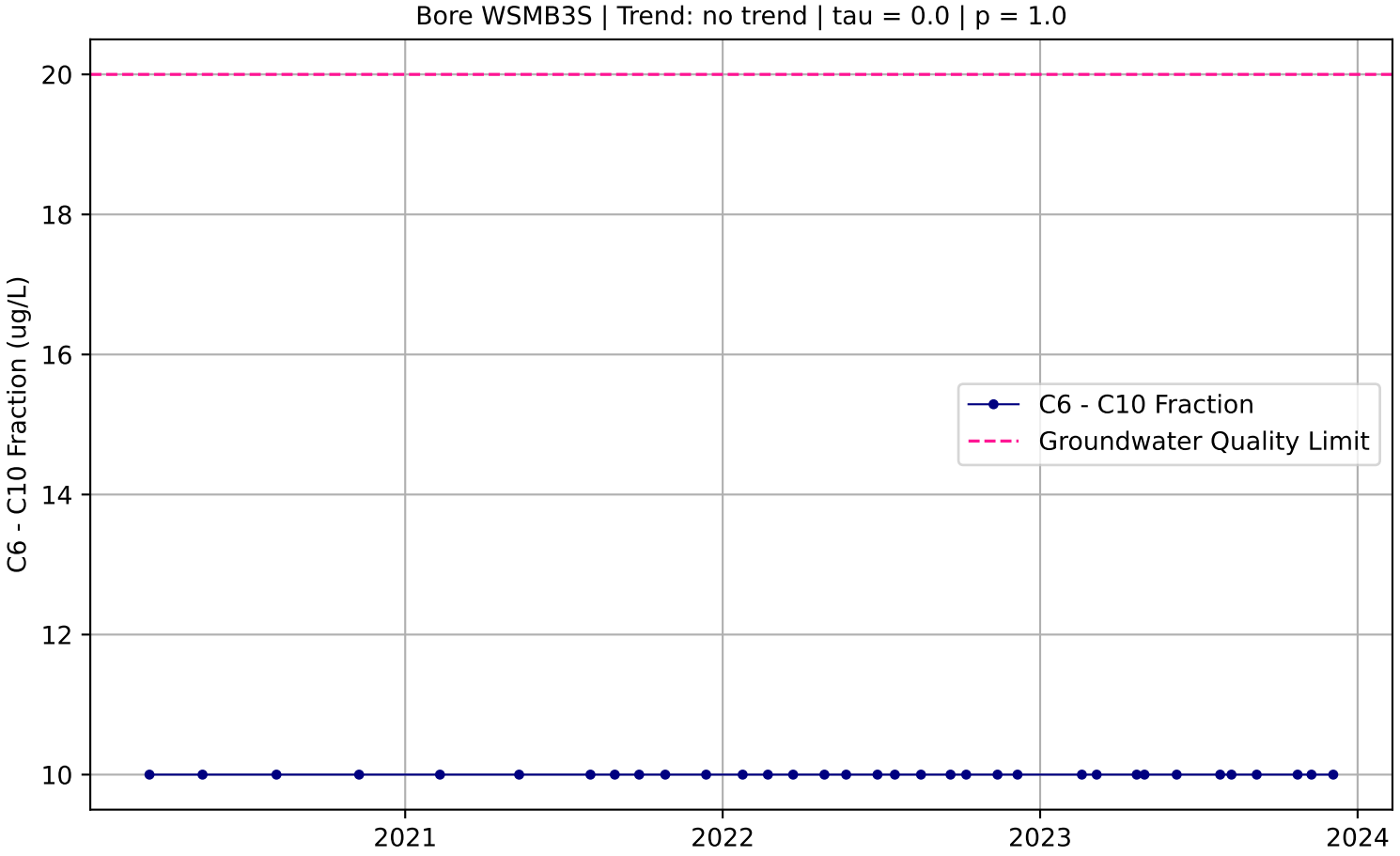

Bore WSMB3D | Trend: no trend | tau = 0.175 | p = 0.083
Sodium
Sodium (mg/L)
1150
1100
1050
1000
950
900
2016
2017
2018
2019
2020
2021
2022
2023
2024

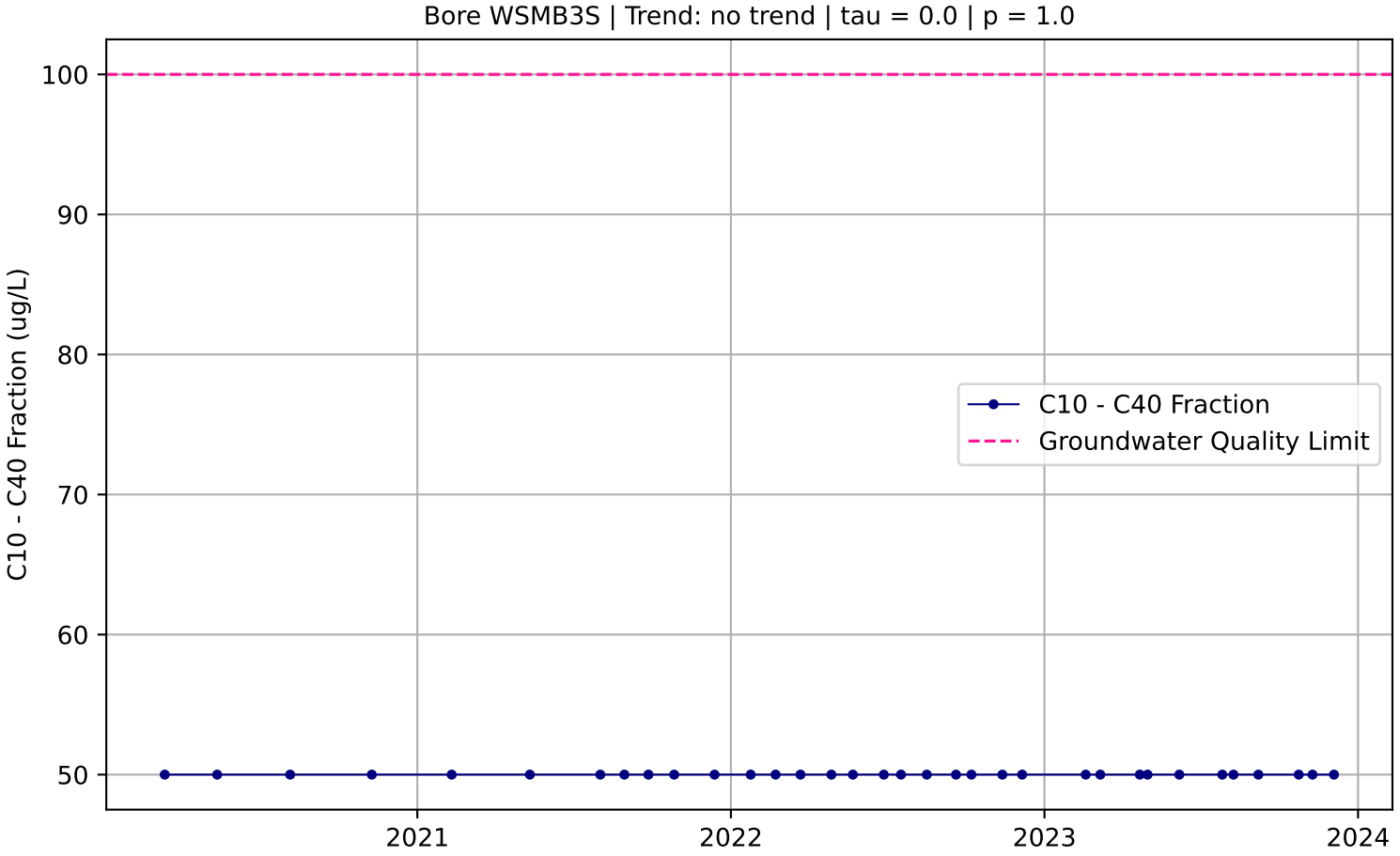

Bore WSMB3D | Trend: no trend | tau = -0.069 | p = 0.585
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
2
4
6
8
10
12
14
16
2021
2022
2023
2024

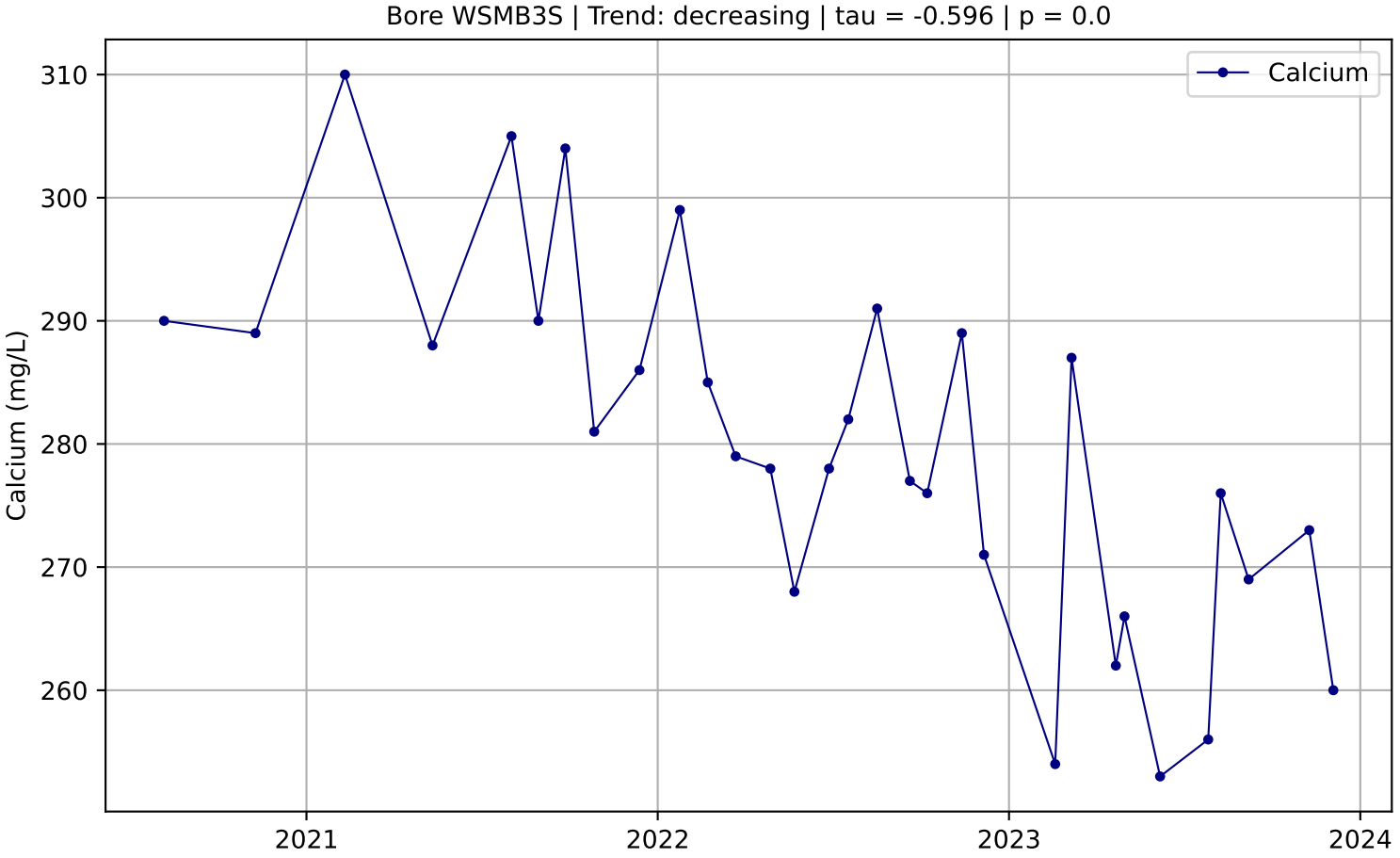

Bore WSMB3S | Trend: no trend | tau = 0.091 | p = 0.183
Aluminium
Groundwater Quality Limit
Aluminium (mg/L)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2021
2022
2023
2024

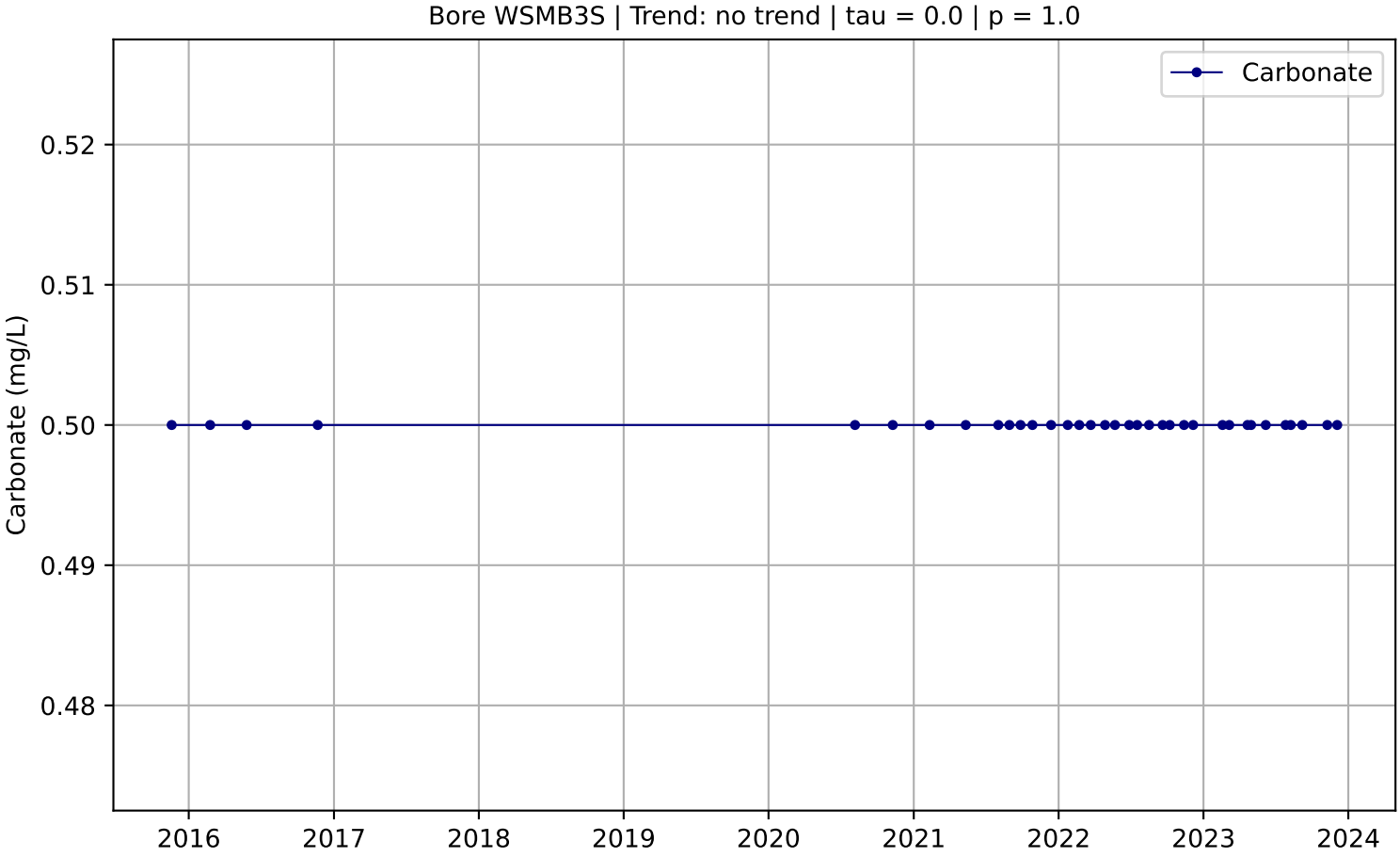

Bore WSMB3S | Trend: no trend | tau = -0.034 | p = 0.359
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2021
2022
2023
2024
Arsenic
Groundwater Quality Limit

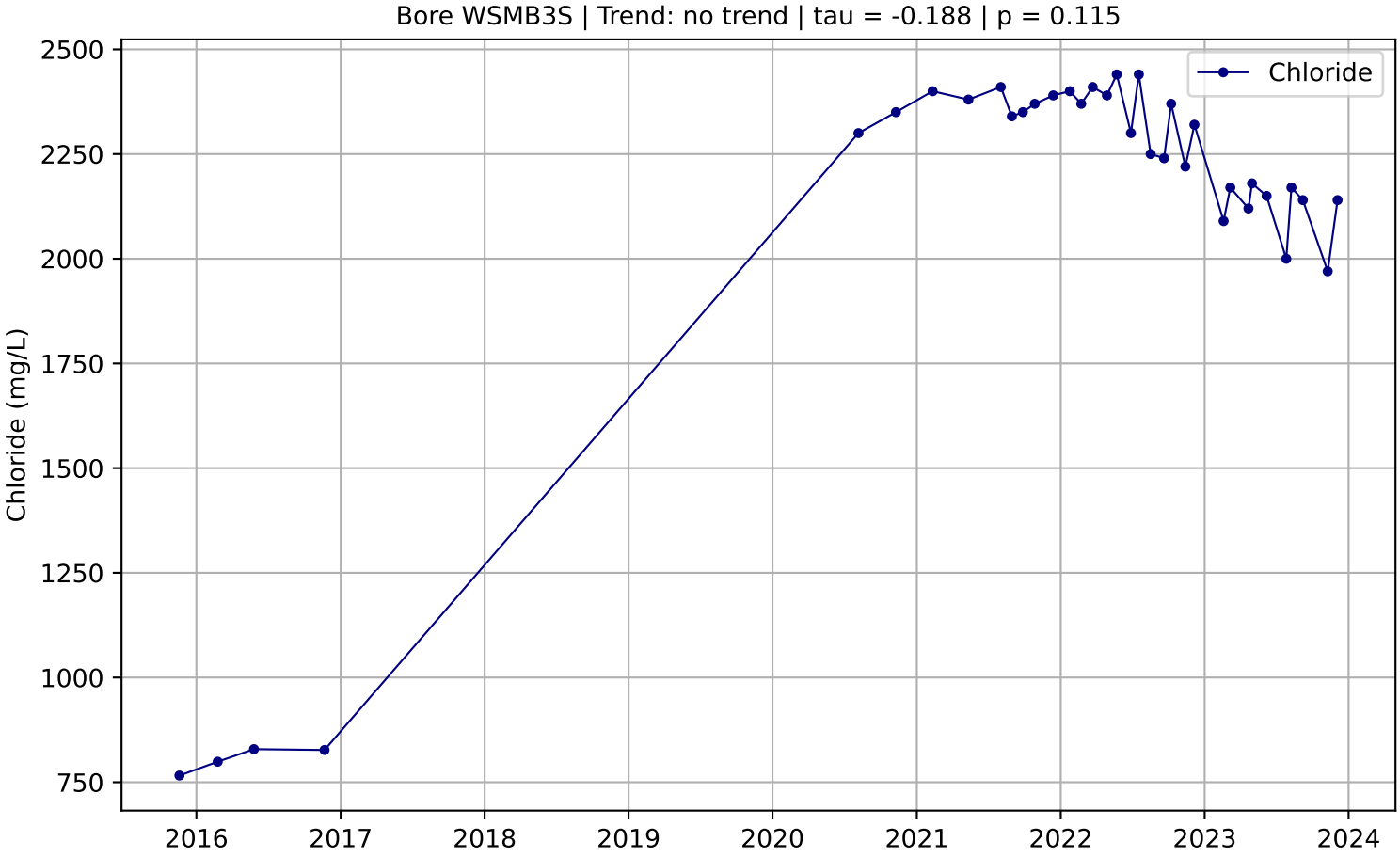

Bore WSMB3S | Trend: decreasing | tau = -0.35 | p = 0.003
Bicarbonate
Bicarbonate (mg/L)
280
260
240
220
200
180
160
2016
2017
2018
2019
2020
2021
2022
2023
2024

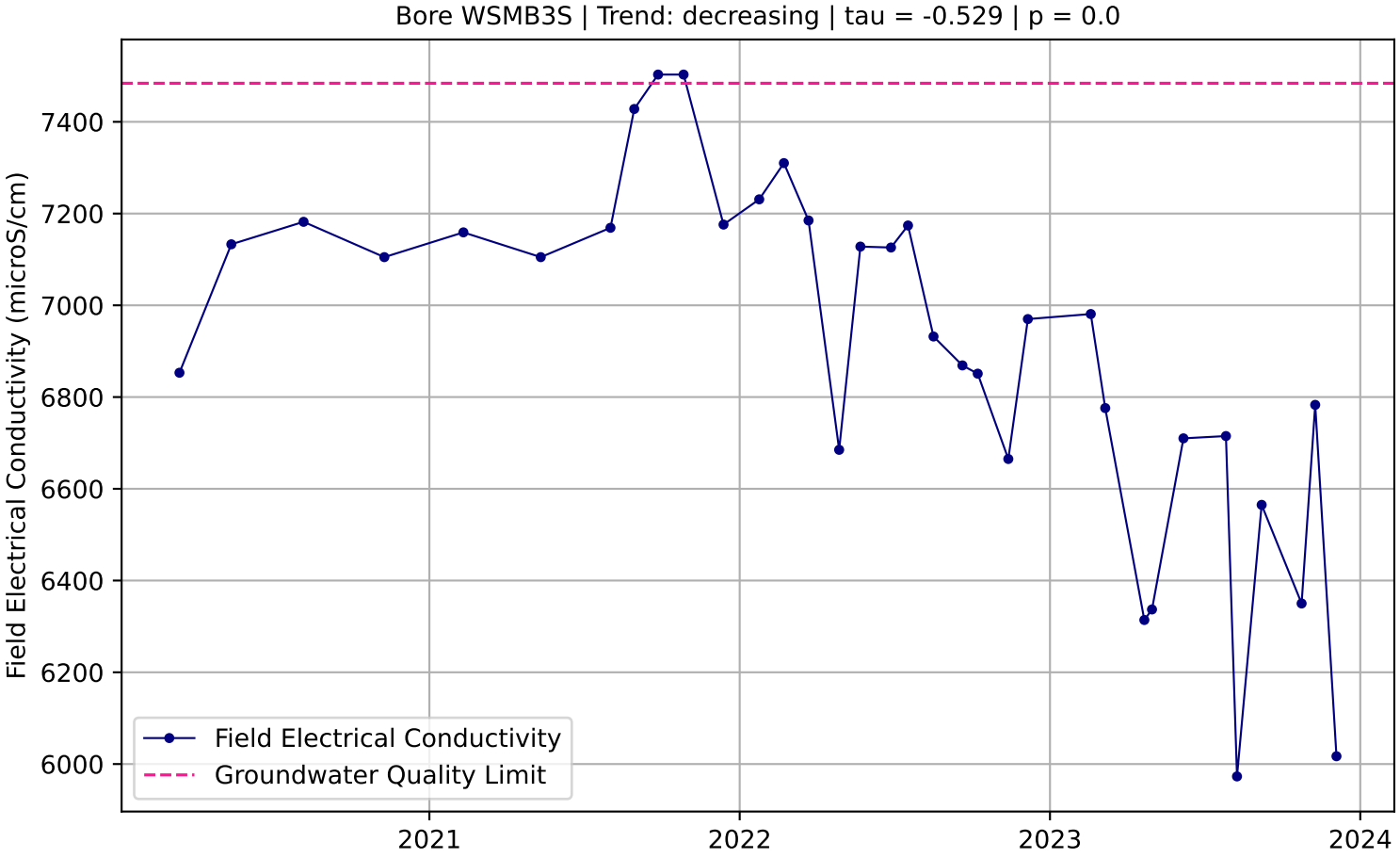

Bore WSMB3S | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2021
2022
2023
2024
C6 - C10 Fraction
Groundwater Quality Limit

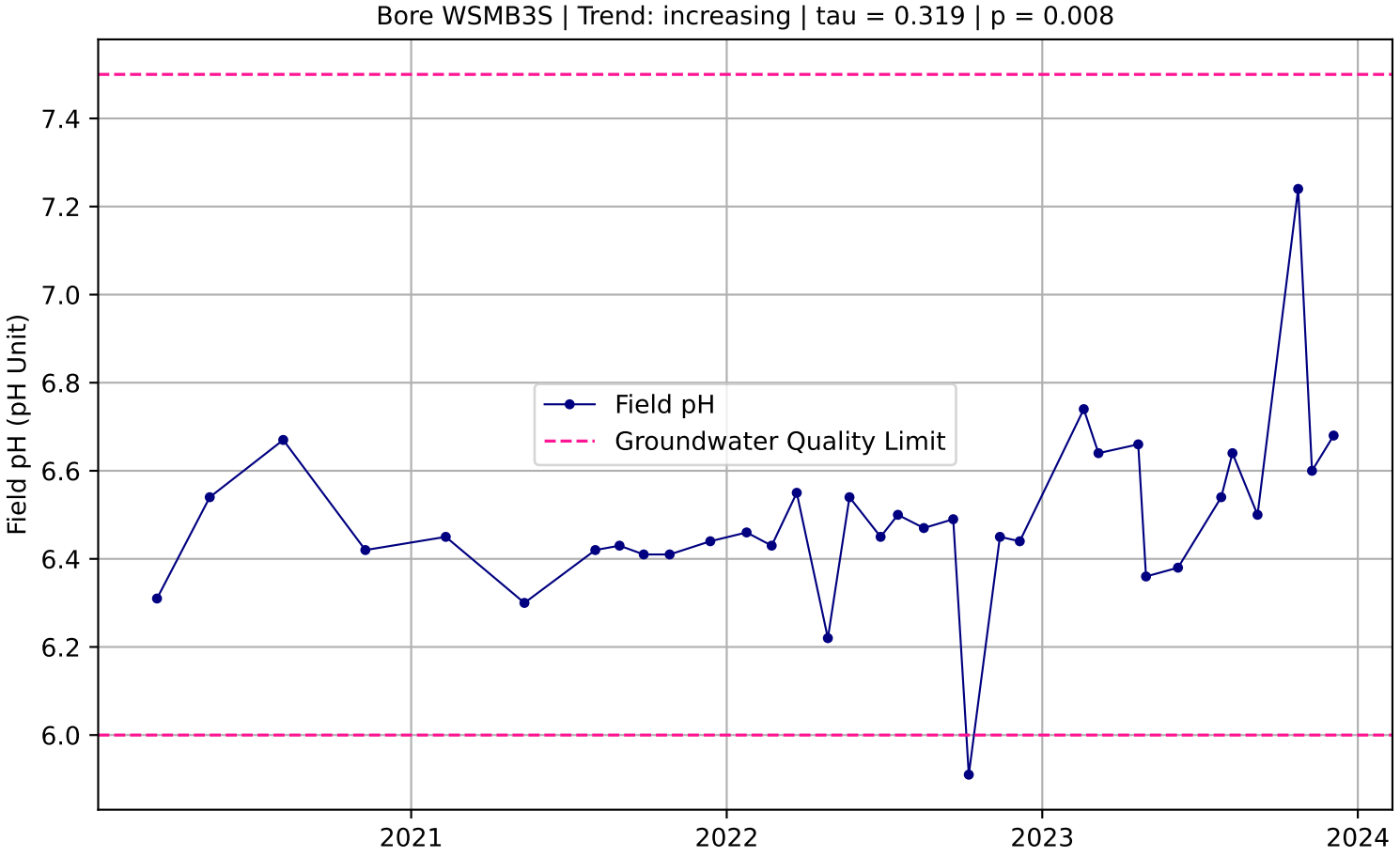

Bore WSMB3S | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2021
2022
2023
2024
C10 - C40 Fraction
Groundwater Quality Limit

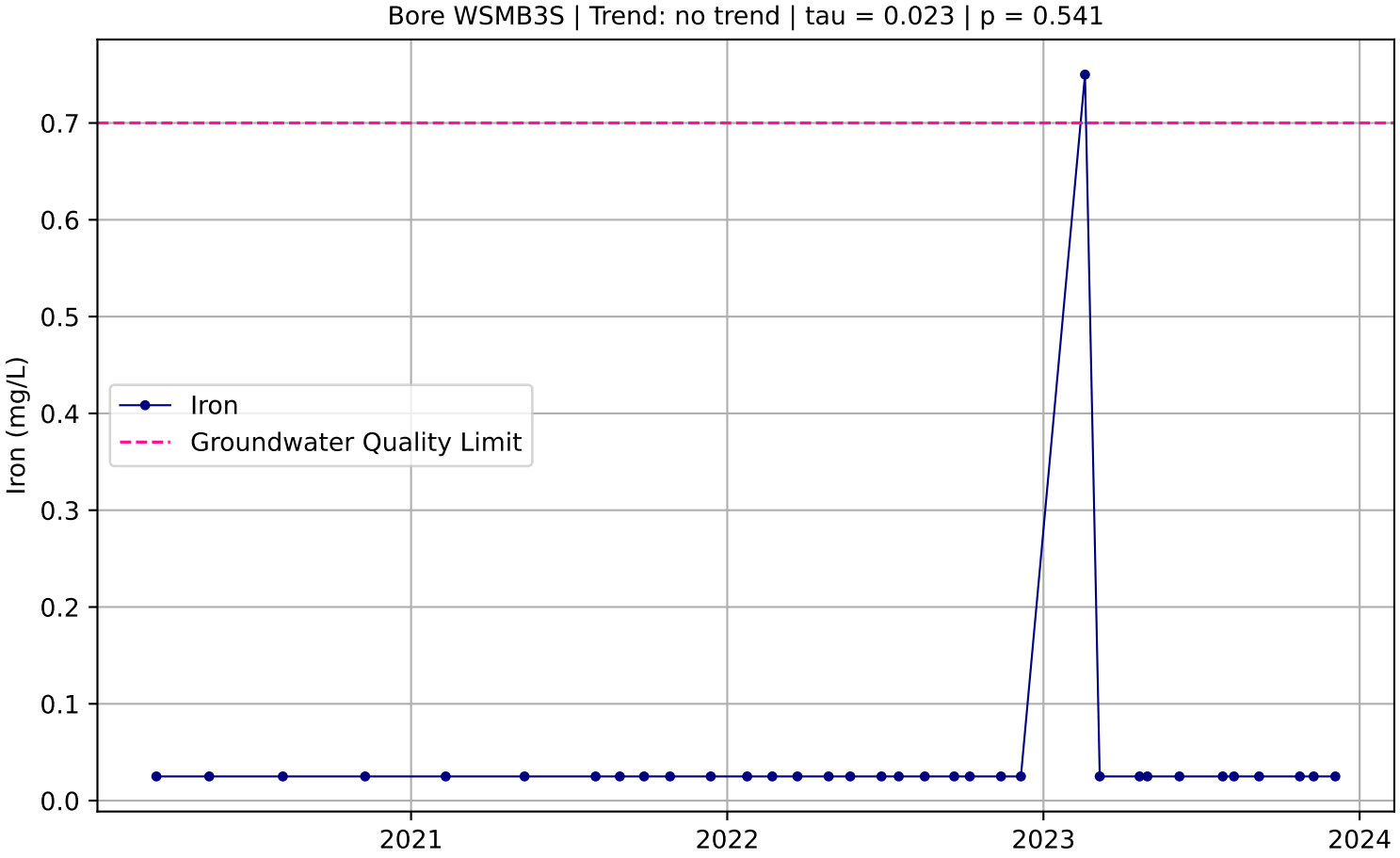

Bore WSMB3S | Trend: decreasing | tau = -0.596 | p = 0.0
Calcium
Calcium (mg/L)
310
300
290
280
270
260
2021
2022
2023
2024

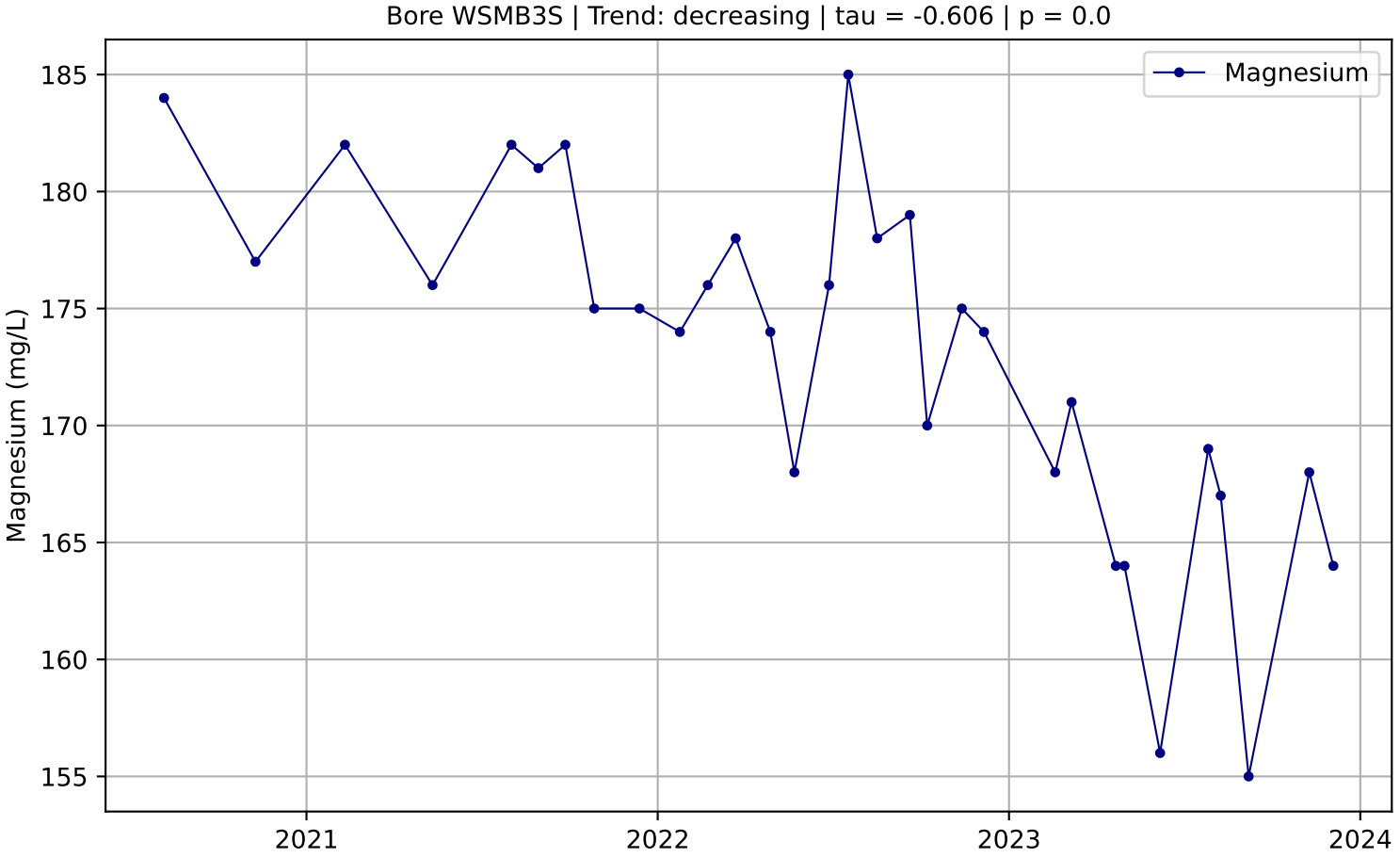

Bore WSMB3S | Trend: no trend | tau = 0.0 | p = 1.0
Carbonate
Carbonate (mg/L)
0.52
0.51
0.50
0.49
0.48
2016
2017
2018
2019
2020
2021
2022
2023
2024

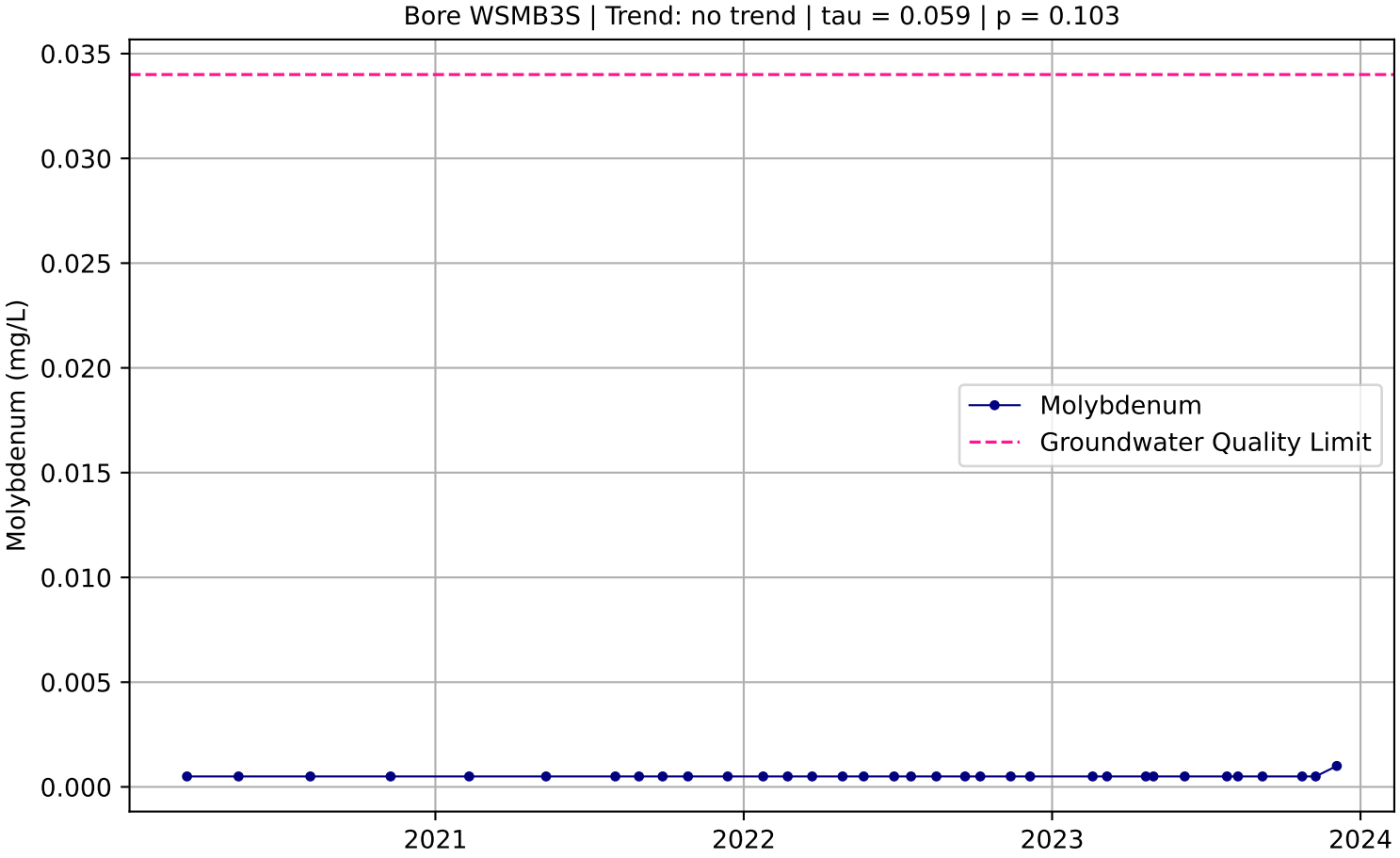

Bore WSMB3S | Trend: no trend | tau = -0.188 | p = 0.115
Chloride
Chloride (mg/L)
2500
2250
2000
1750
1500
1250
1000
750
2016
2017
2018
2019
2020
2021
2022
2023
2024

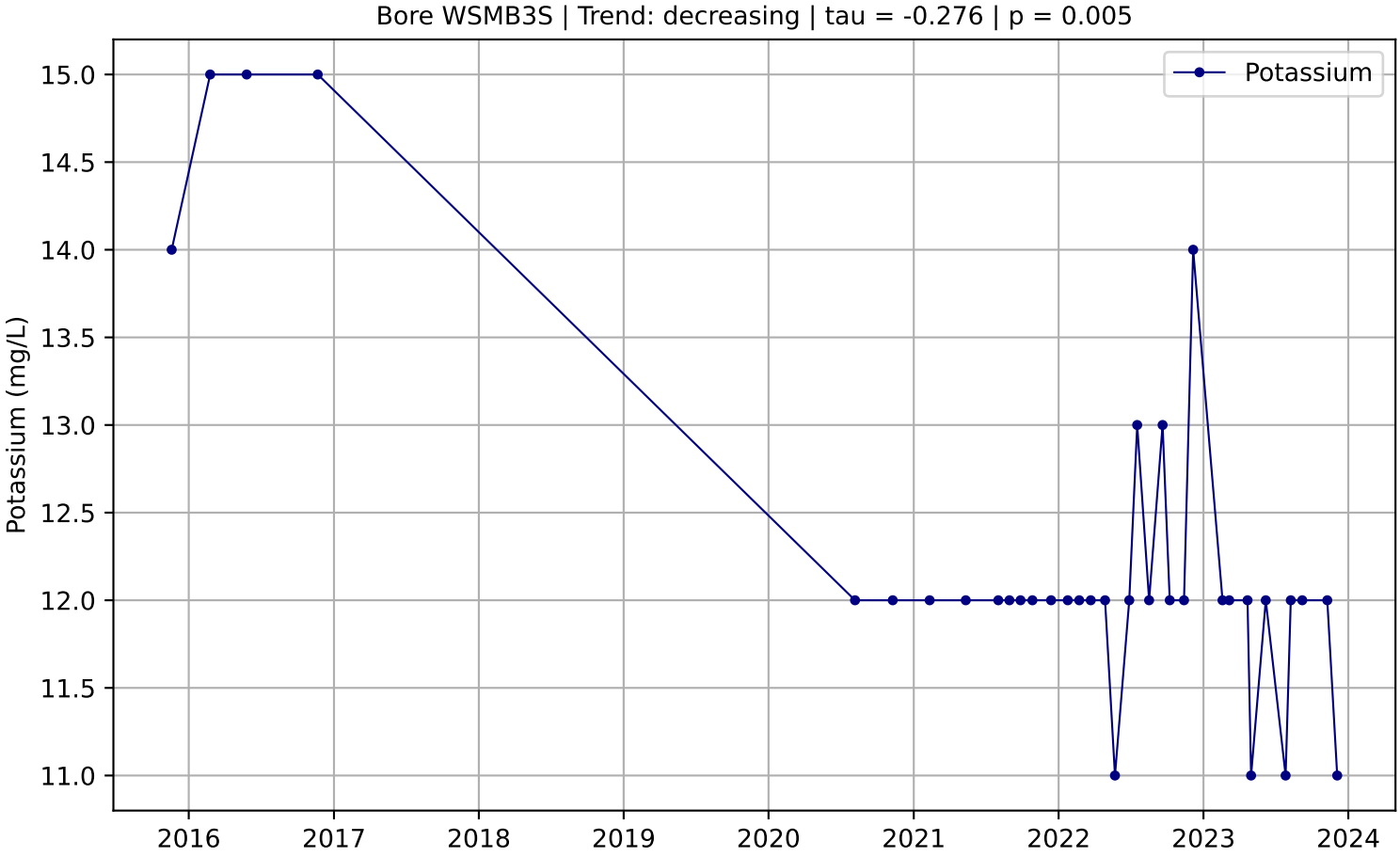

Bore WSMB3S | Trend: decreasing | tau = -0.529 | p = 0.0
Field Electrical Conductivity (microS/cm)
7400
7200
7000
6800
6600
6400
6200
6000
2021
2022
2023
2024
Field Electrical Conductivity
Groundwater Quality Limit

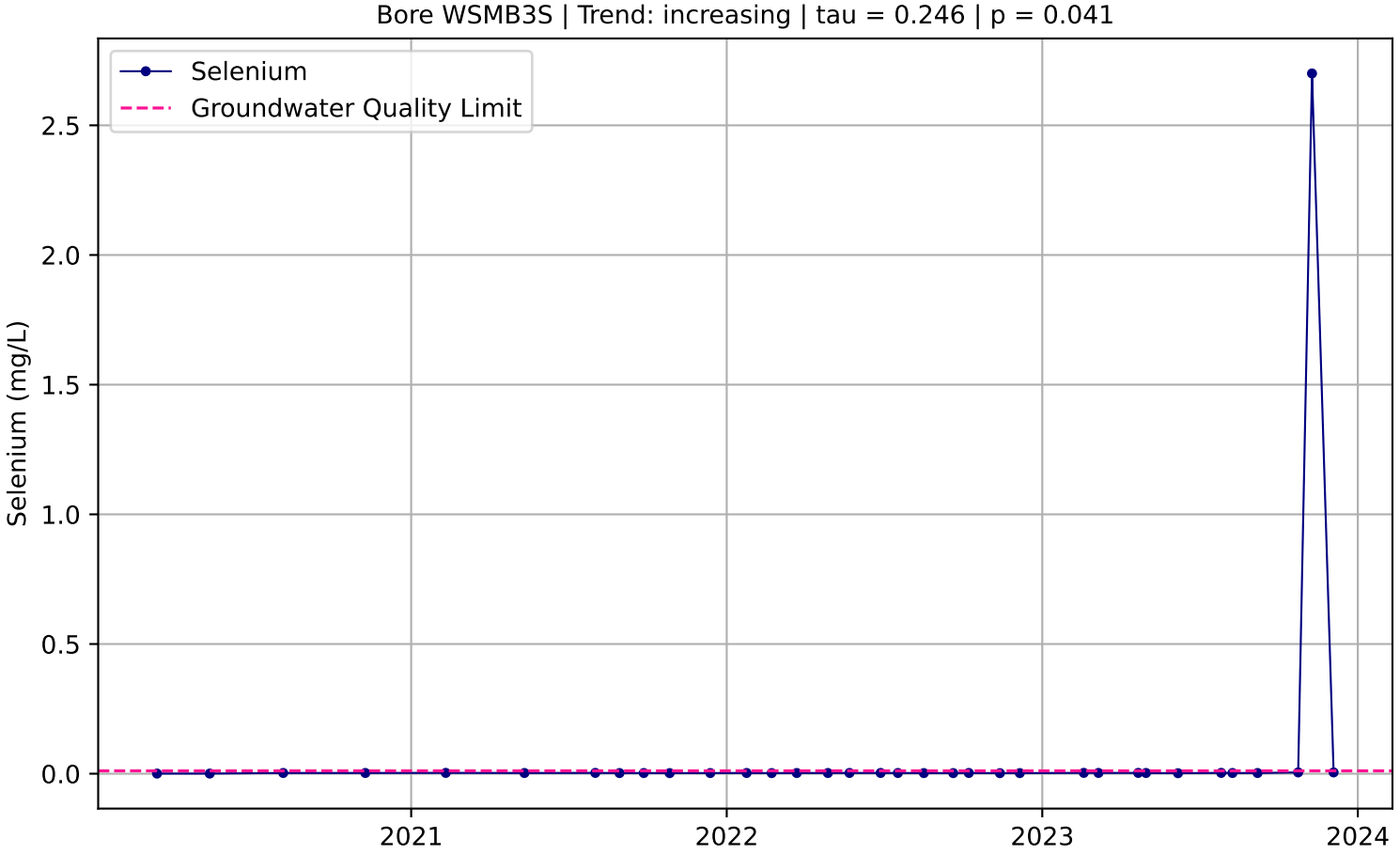

Bore WSMB3S | Trend: increasing | tau = 0.319 | p = 0.008
Field pH (pH Unit)
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
2021
2022
2023
2024
Field pH
Groundwater Quality Limit

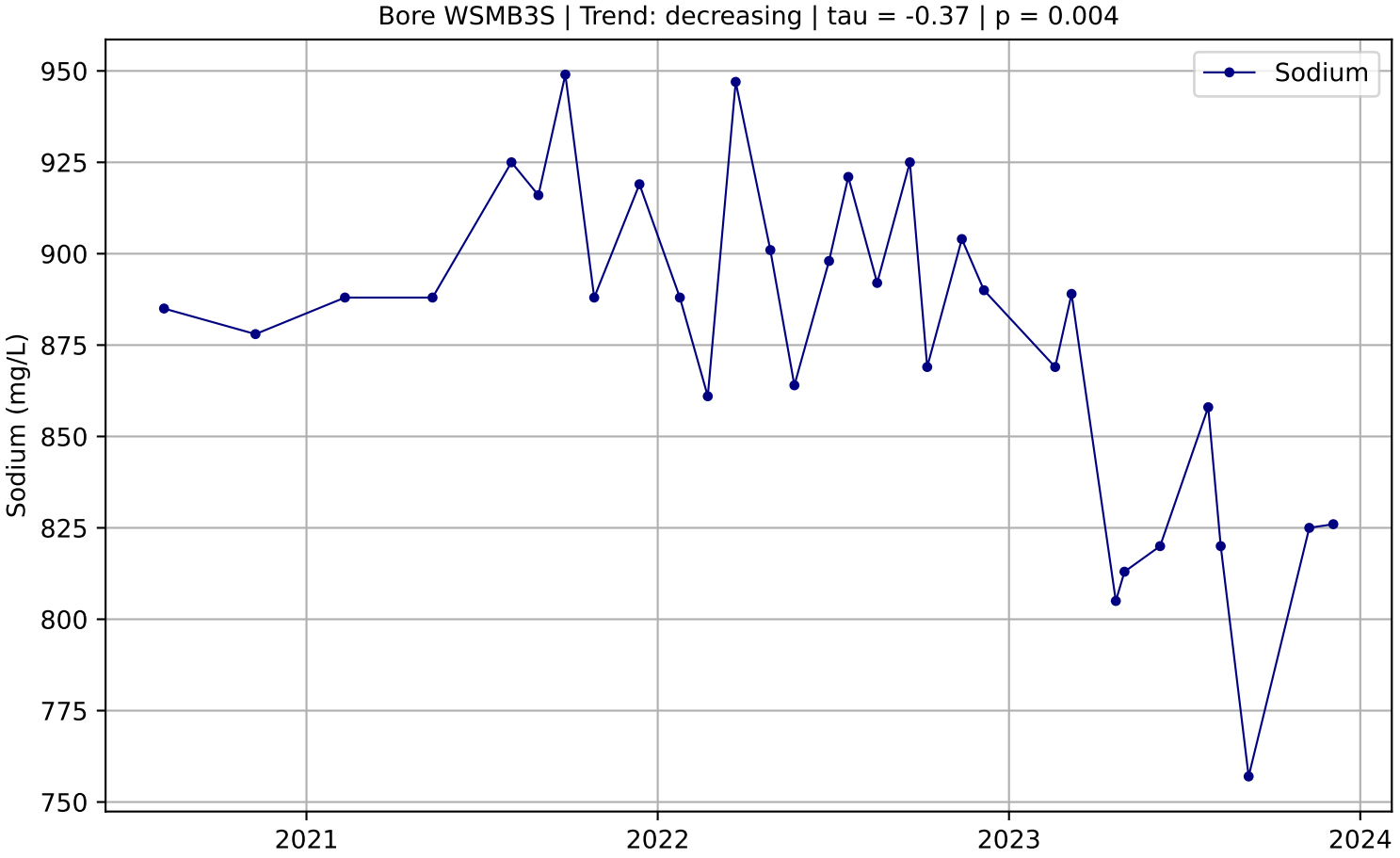

Bore WSMB3S | Trend: no trend | tau = 0.023 | p = 0.541
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
2021
2022
2023
2024
Iron
Groundwater Quality Limit

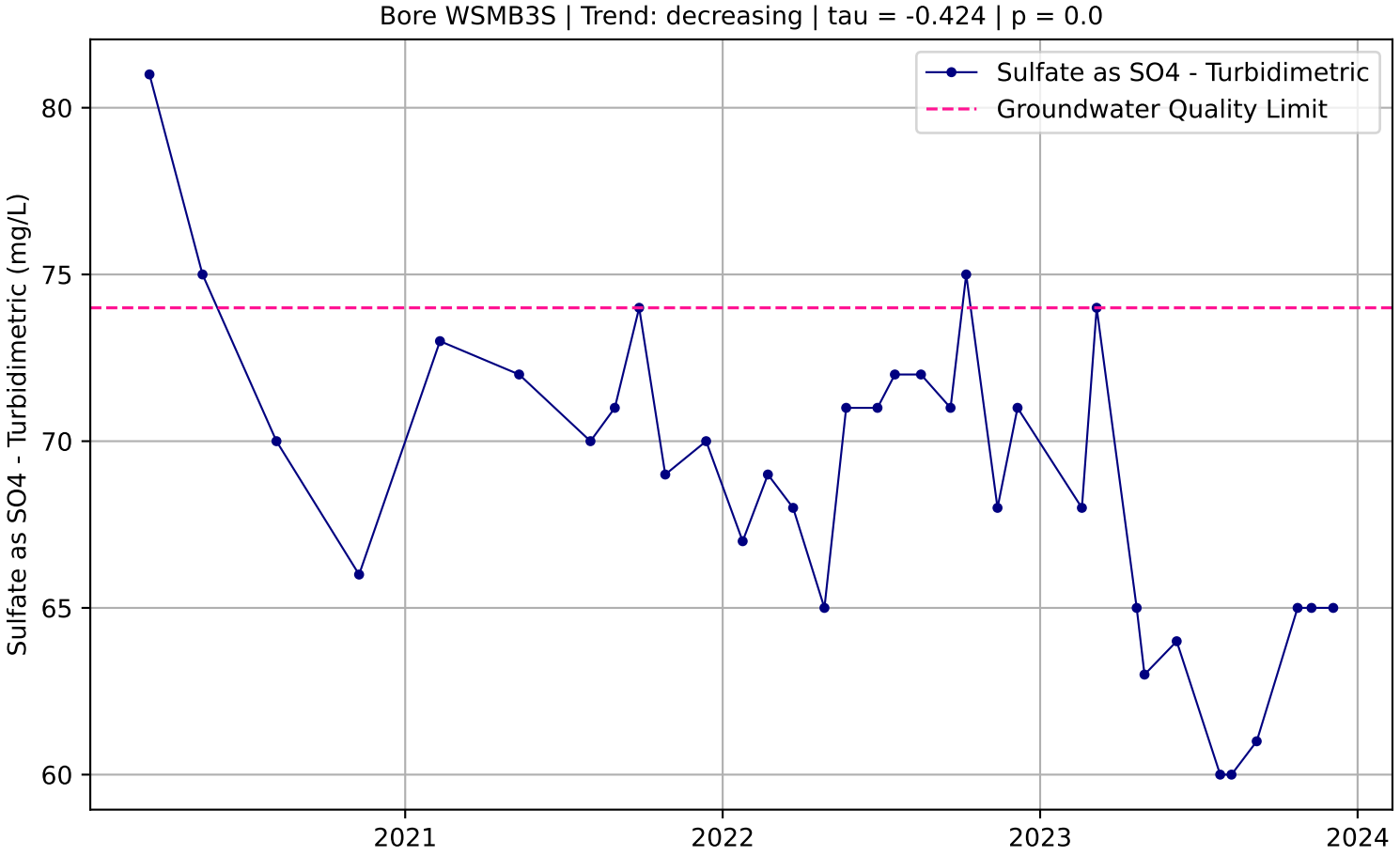

Bore WSMB3S | Trend: decreasing | tau = -0.606 | p = 0.0
Magnesium
Magnesium (mg/L)
185
180
175
170
165
160
155
2021
2022
2023
2024

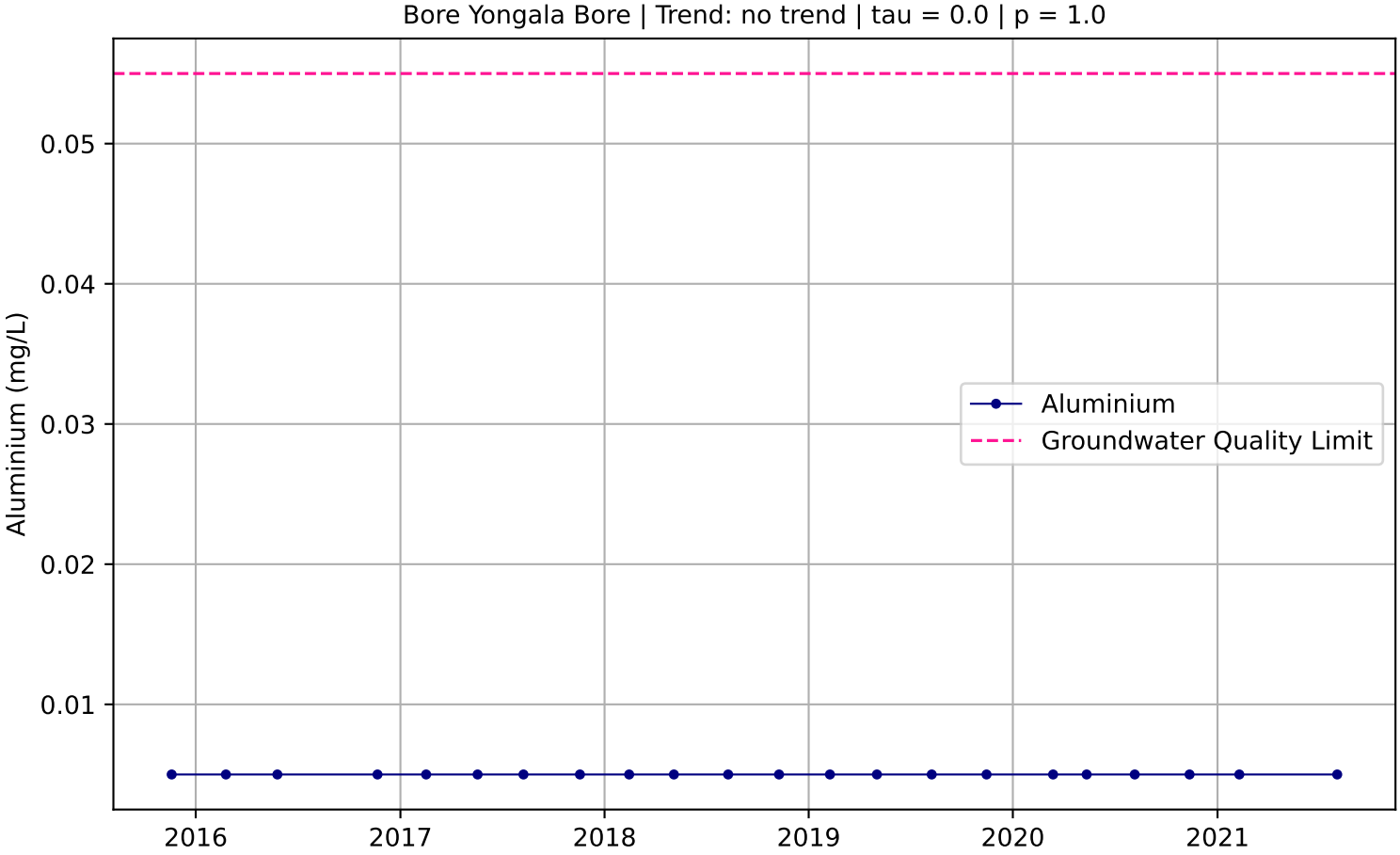

Bore WSMB3S | Trend: no trend | tau = 0.059 | p = 0.103
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2021
2022
2023
2024
Molybdenum
Groundwater Quality Limit

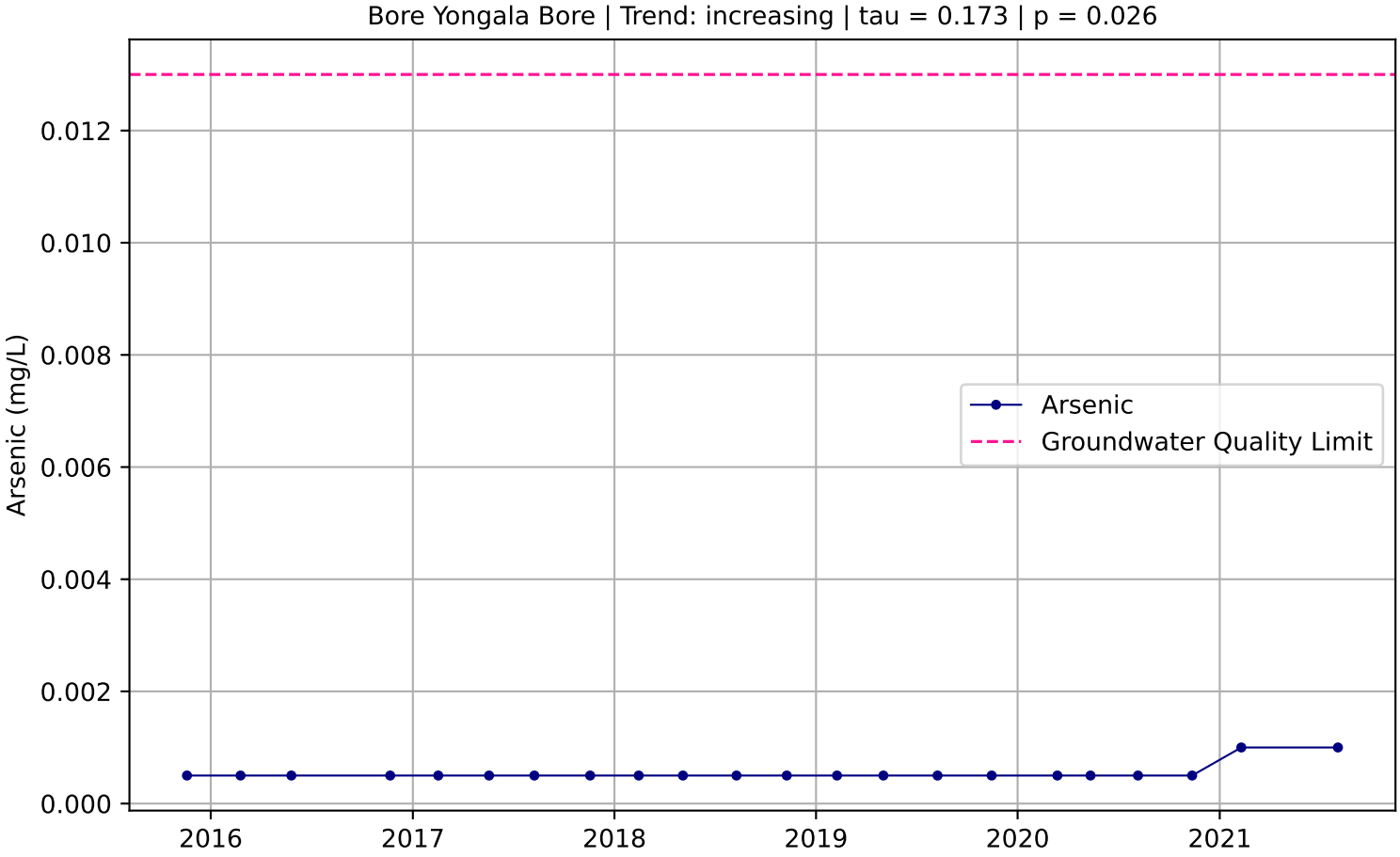

Bore WSMB3S | Trend: decreasing | tau = -0.276 | p = 0.005
Potassium
Potassium (mg/L)
15.0
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
2016
2017
2018
2019
2020
2021
2022
2023
2024

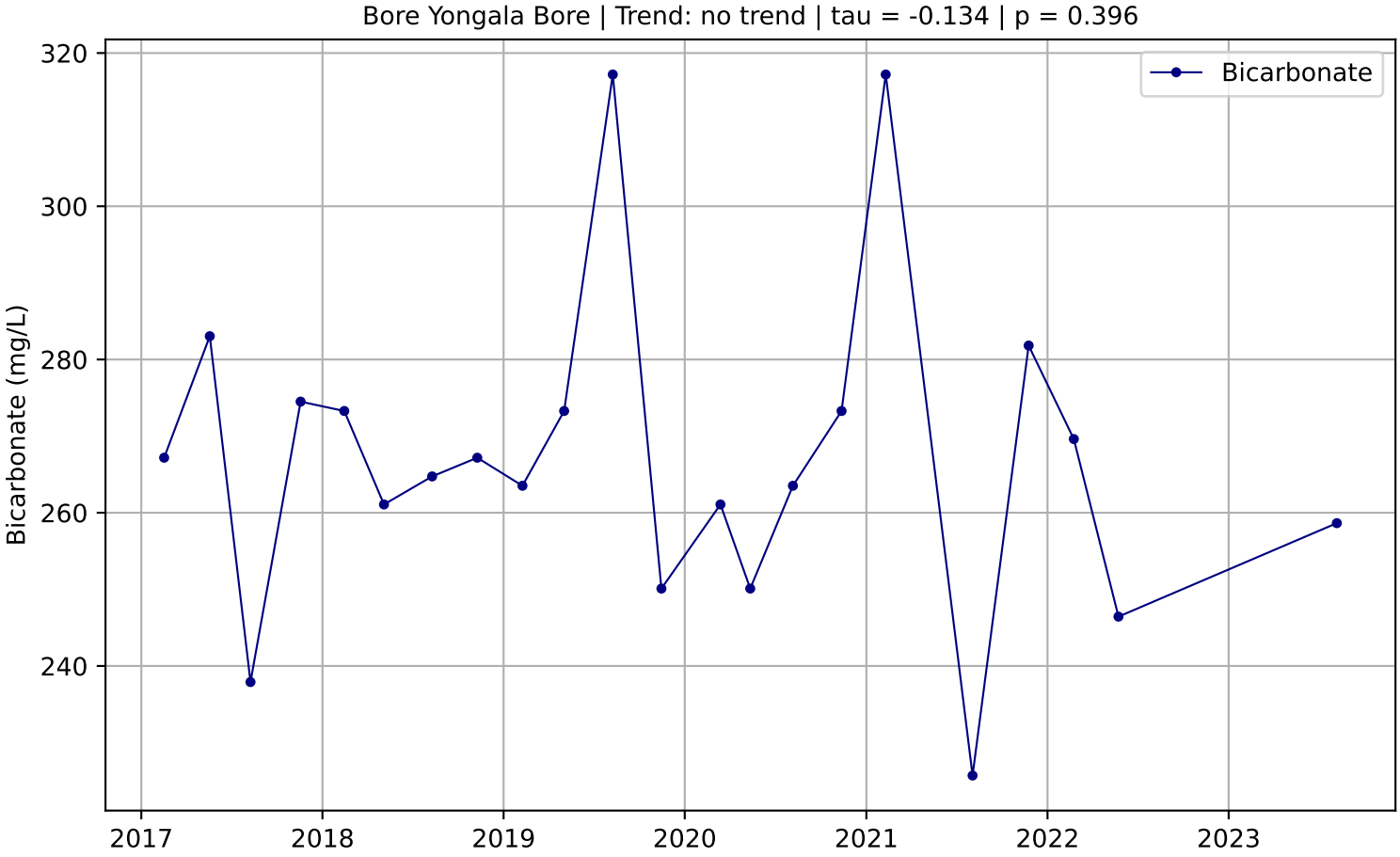

Bore WSMB3S | Trend: increasing | tau = 0.246 | p = 0.041
Selenium
Groundwater Quality Limit
Selenium (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
2021
2022
2023
2024

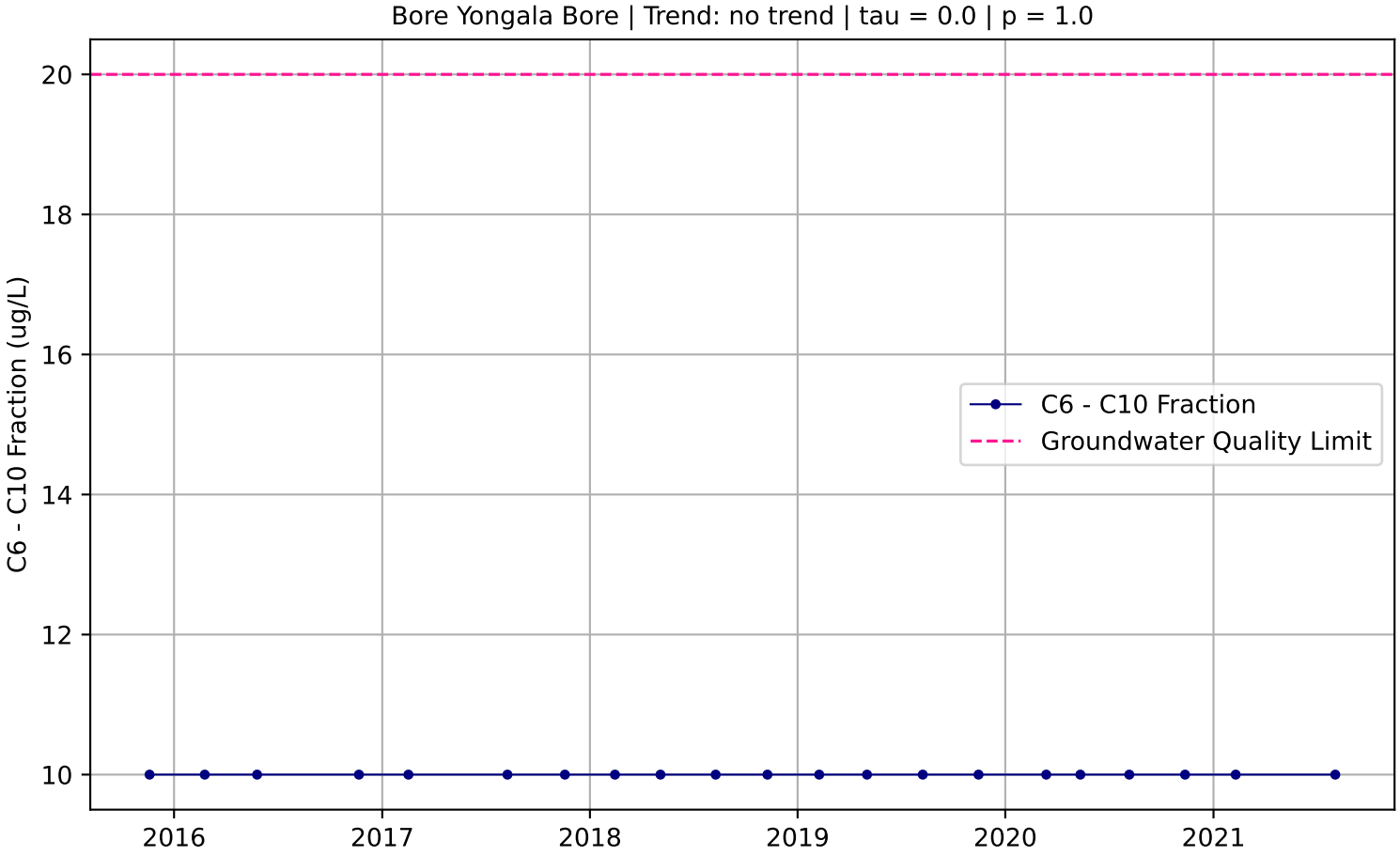

Bore WSMB3S | Trend: decreasing | tau = -0.37 | p = 0.004
Sodium
Sodium (mg/L)
950
925
900
875
850
825
800
775
750
2021
2022
2023
2024

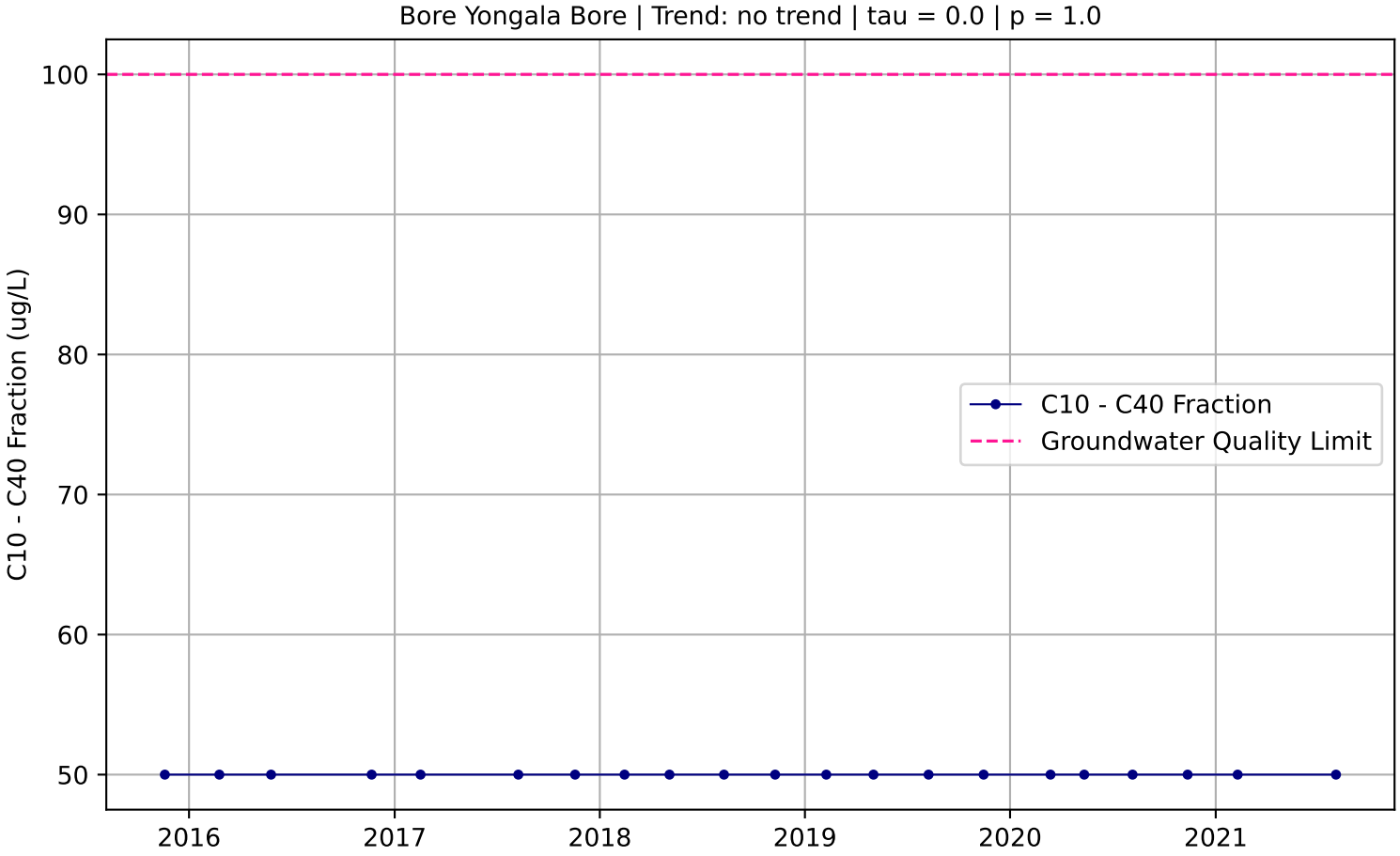

Bore WSMB3S | Trend: decreasing | tau = -0.424 | p = 0.0
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
80
75
70
65
60
2021
2022
2023
2024

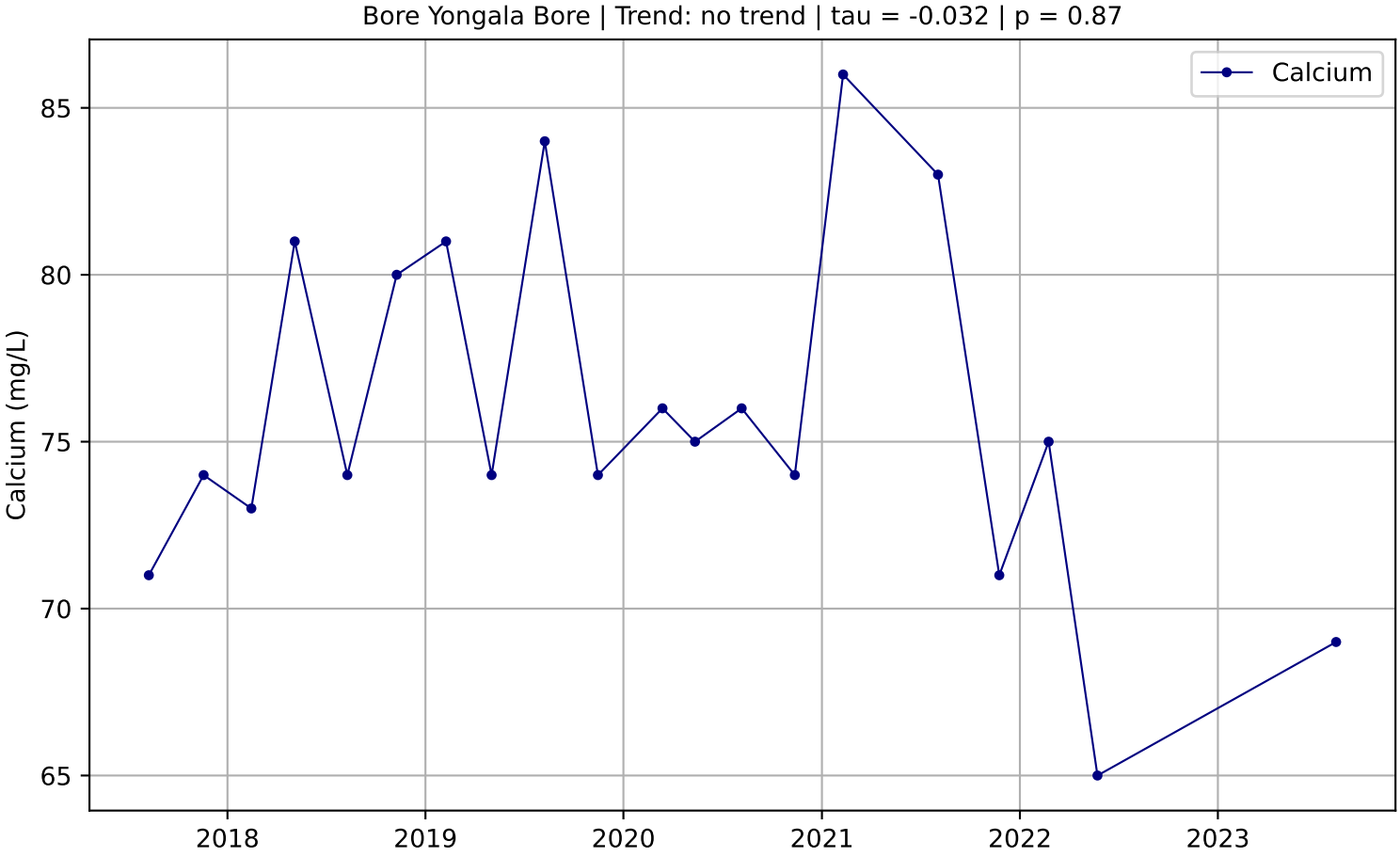

Bore Yongala Bore | Trend: no trend | tau = 0.0 | p = 1.0
Aluminium (mg/L)
0.05
0.04
0.03
0.02
0.01
2016
2017
2018
2019
2020
2021
Aluminium
Groundwater Quality Limit

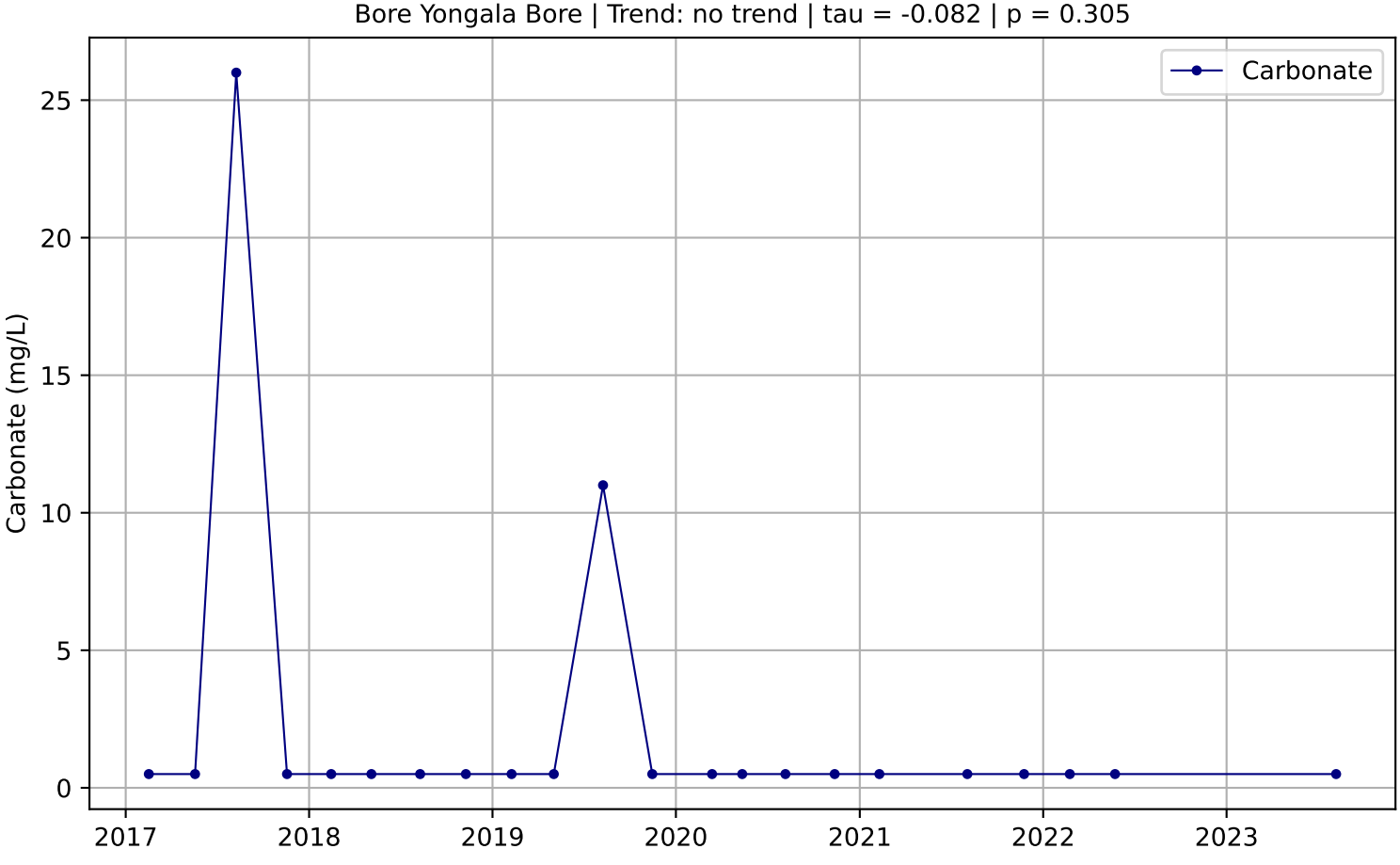

Bore Yongala Bore | Trend: increasing | tau = 0.173 | p = 0.026
Arsenic (mg/L)
0.012
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Arsenic
Groundwater Quality Limit

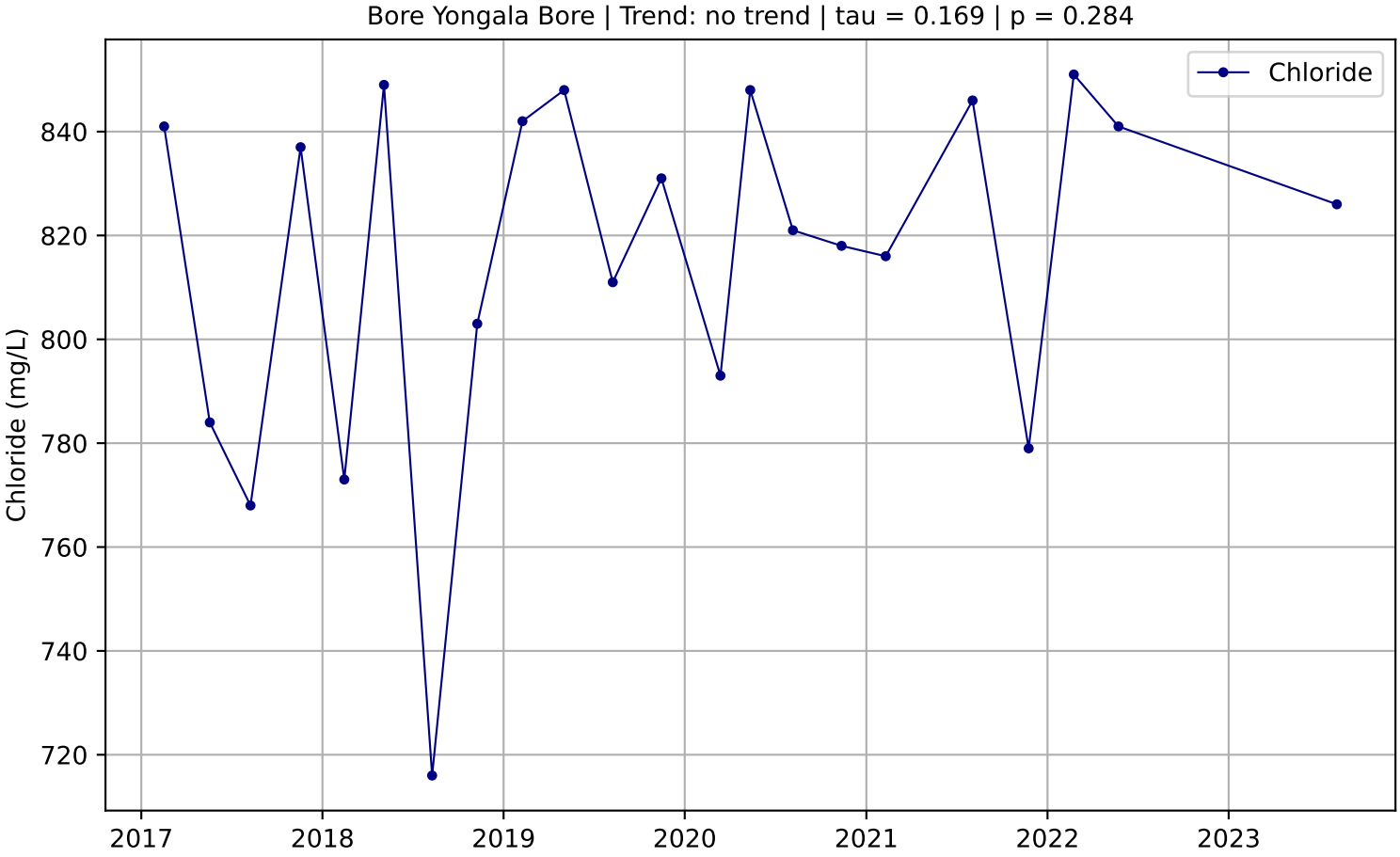

Bore Yongala Bore | Trend: no trend | tau = -0.134 | p = 0.396
Bicarbonate
Bicarbonate (mg/L)
320
300
280
260
240
2017
2018
2019
2020
2021
2022
2023

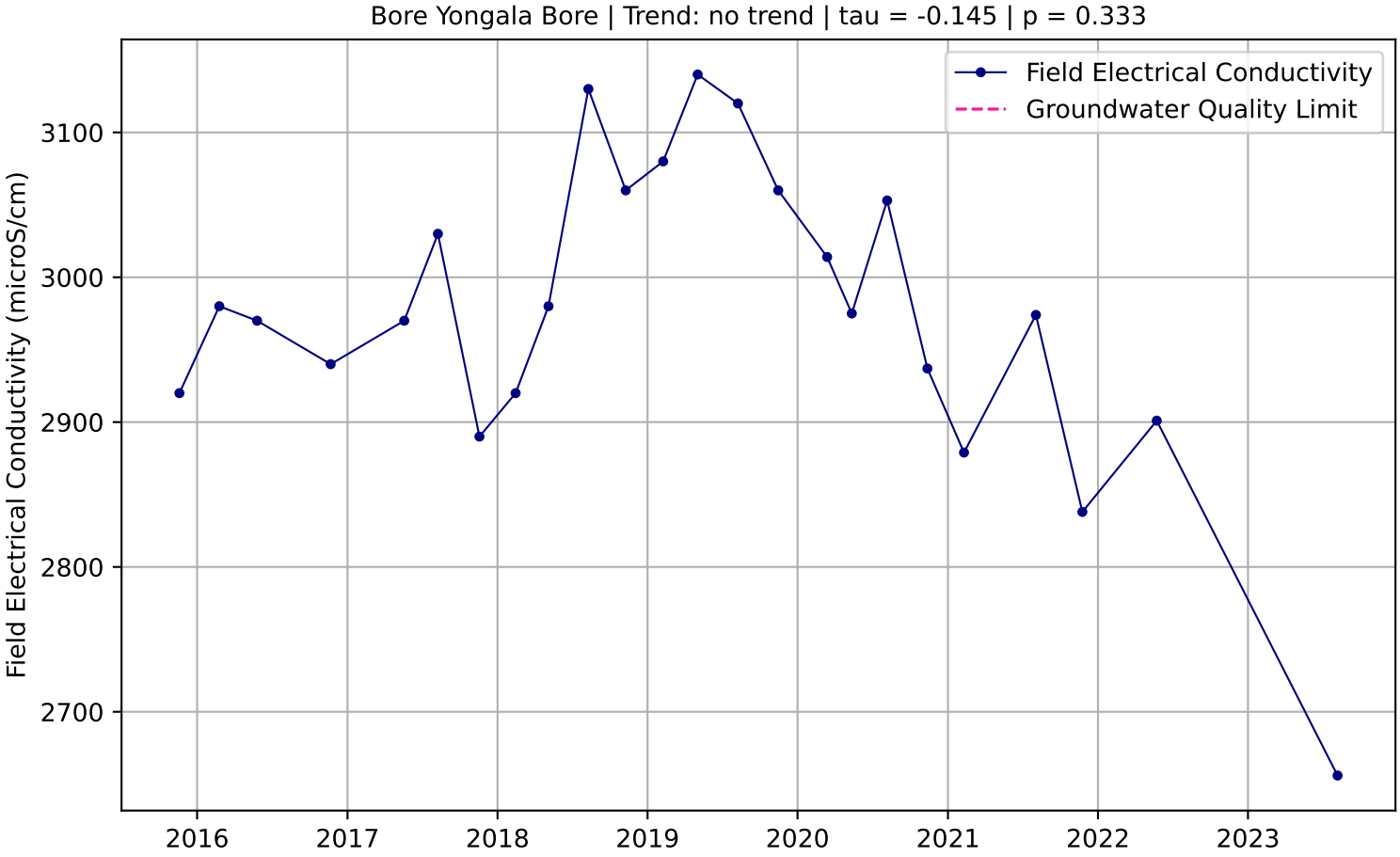

Bore Yongala Bore | Trend: no trend | tau = 0.0 | p = 1.0
C6 - C10 Fraction (ug/L)
20
18
16
14
12
10
2016
2017
2018
2019
2020
2021
C6 - C10 Fraction
Groundwater Quality Limit

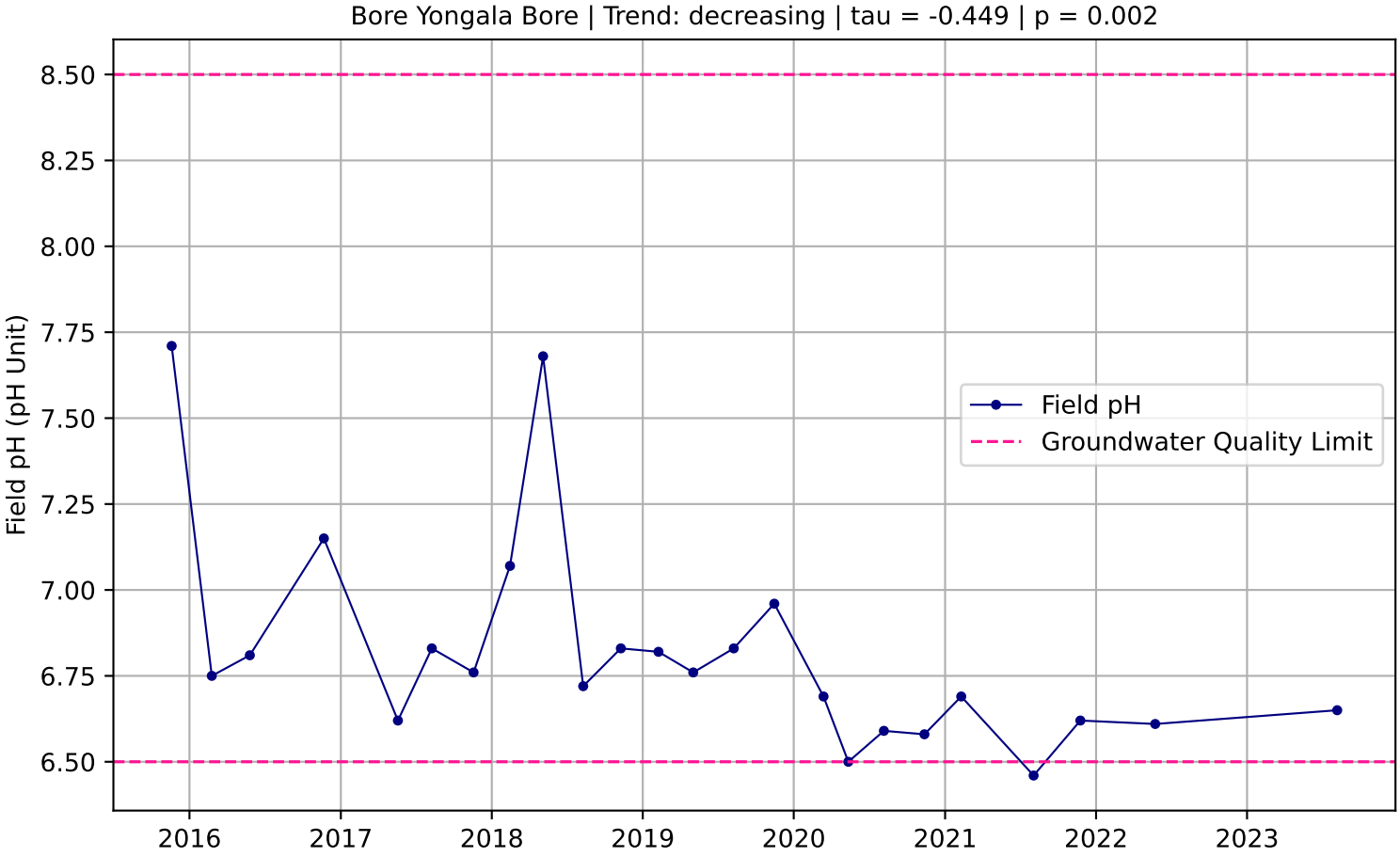

Bore Yongala Bore | Trend: no trend | tau = 0.0 | p = 1.0
C10 - C40 Fraction (ug/L)
100
90
80
70
60
50
2016
2017
2018
2019
2020
2021
C10 - C40 Fraction
Groundwater Quality Limit

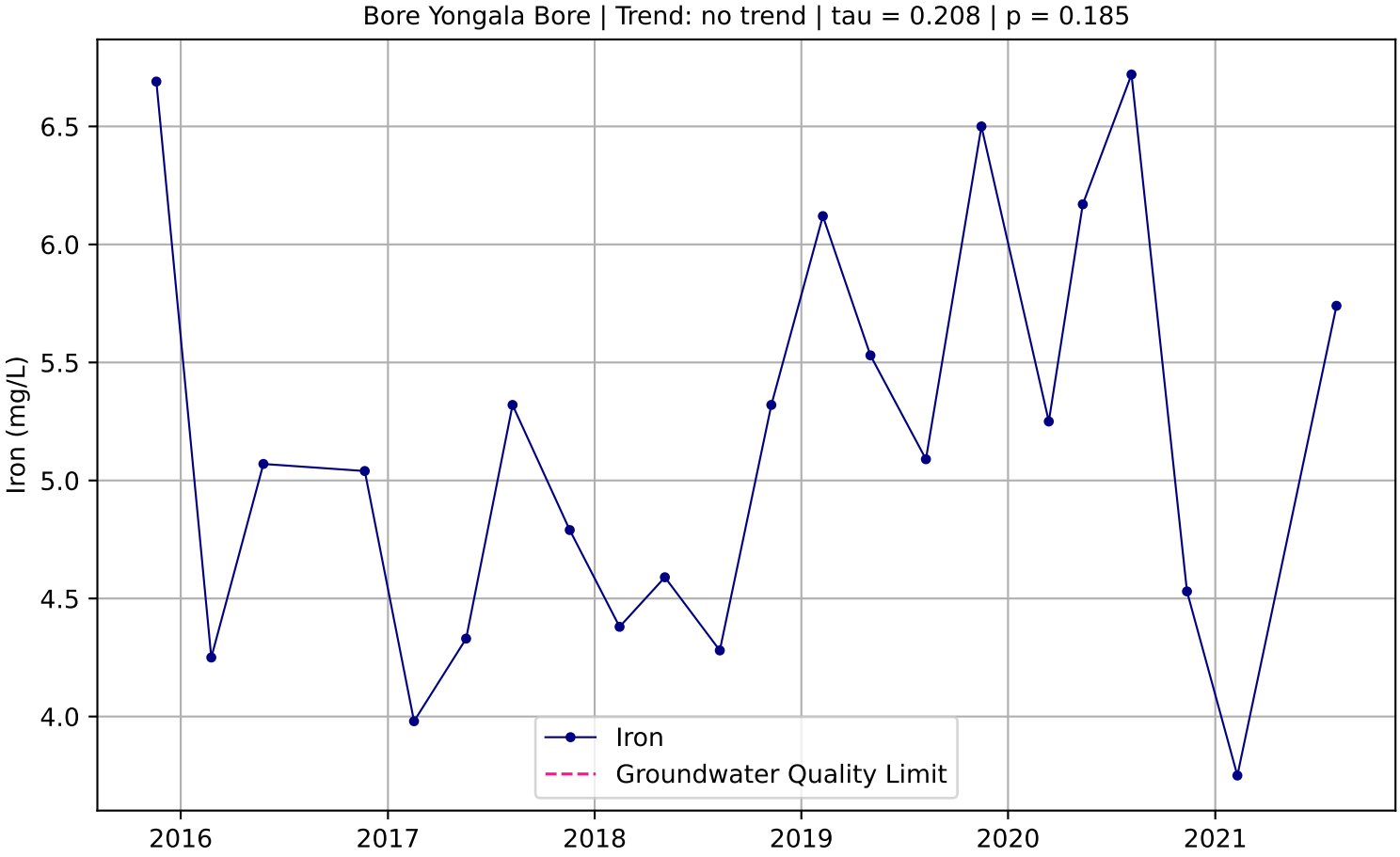

Bore Yongala Bore | Trend: no trend | tau = -0.032 | p = 0.87
Calcium
Calcium (mg/L)
85
80
75
70
65
2018
2019
2020
2021
2022
2023

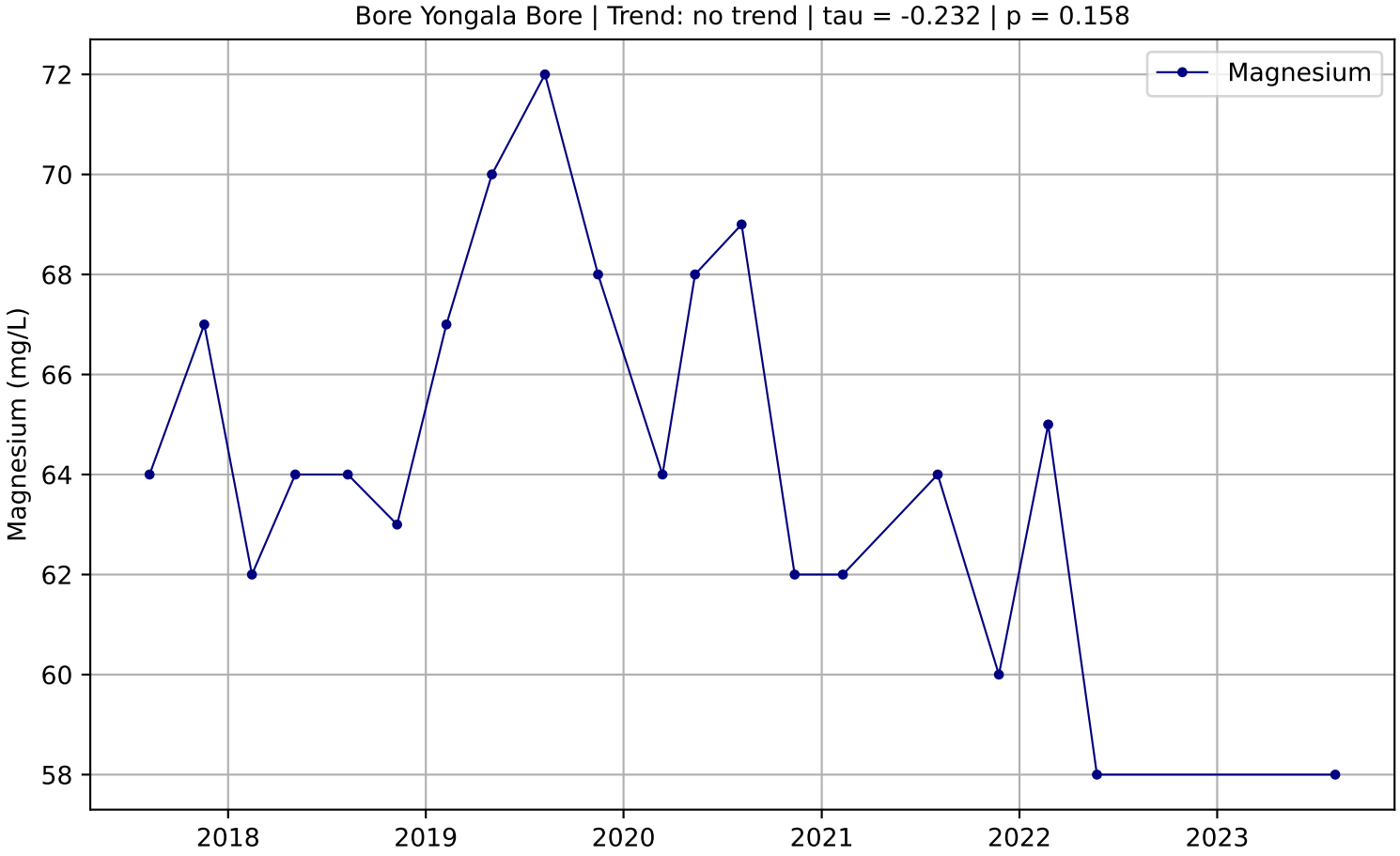

Bore Yongala Bore | Trend: no trend | tau = -0.082 | p = 0.305
Carbonate
Carbonate (mg/L)
0
5
10
15
20
25
2017
2018
2019
2020
2021
2022
2023

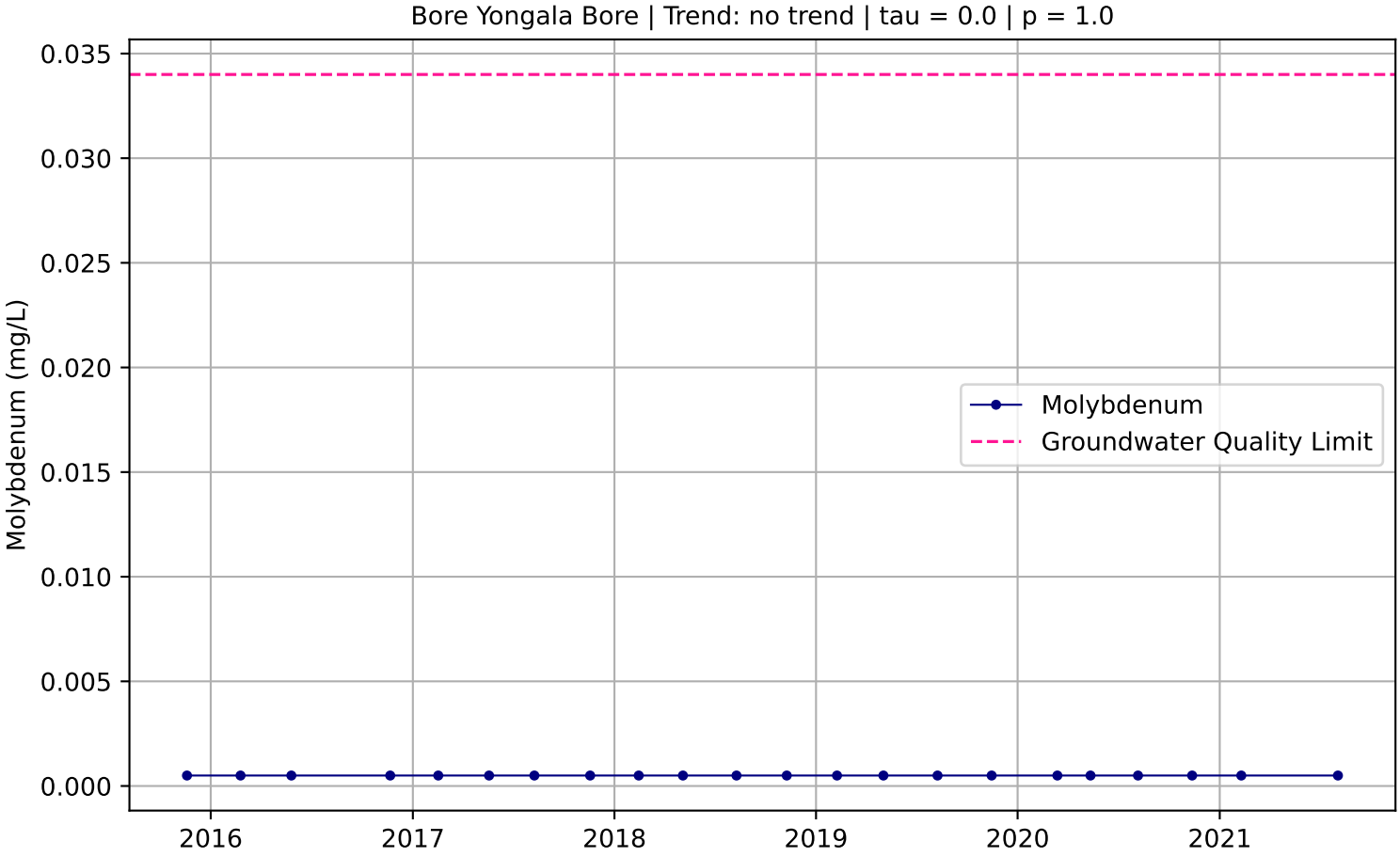

Bore Yongala Bore | Trend: no trend | tau = 0.169 | p = 0.284
Chloride
Chloride (mg/L)
840
820
800
780
760
740
720
2017
2018
2019
2020
2021
2022
2023

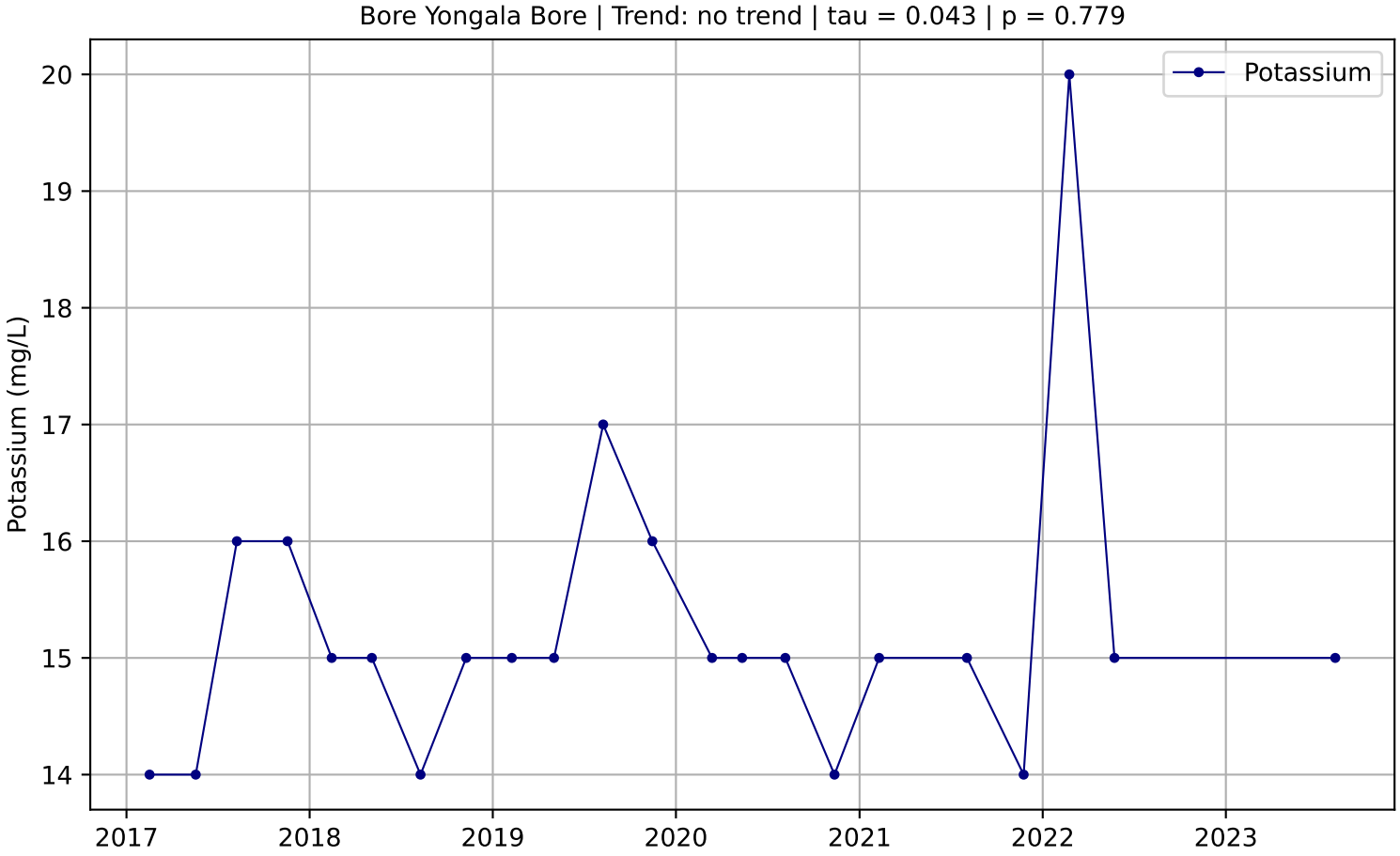

Bore Yongala Bore | Trend: no trend | tau = -0.145 | p = 0.333
Field Electrical Conductivity
Groundwater Quality Limit
Field Electrical Conductivity (microS/cm)
3100
3000
2900
2800
2700
2016
2017
2018
2019
2020
2021
2022
2023

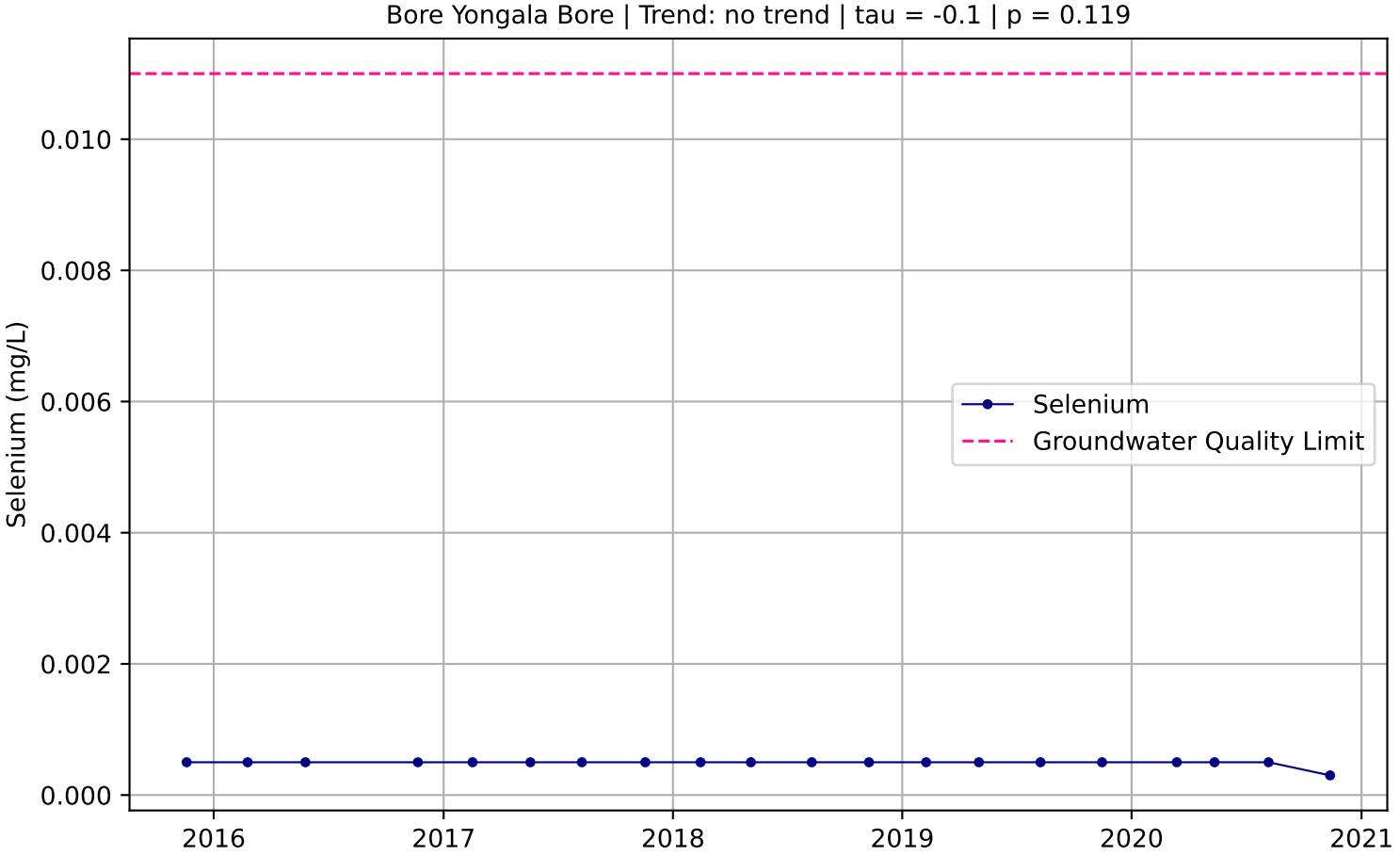

Bore Yongala Bore | Trend: decreasing | tau = -0.449 | p = 0.002
Field pH (pH Unit)
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
2016
2017
2018
2019
2020
2021
2022
2023
Field pH
Groundwater Quality Limit

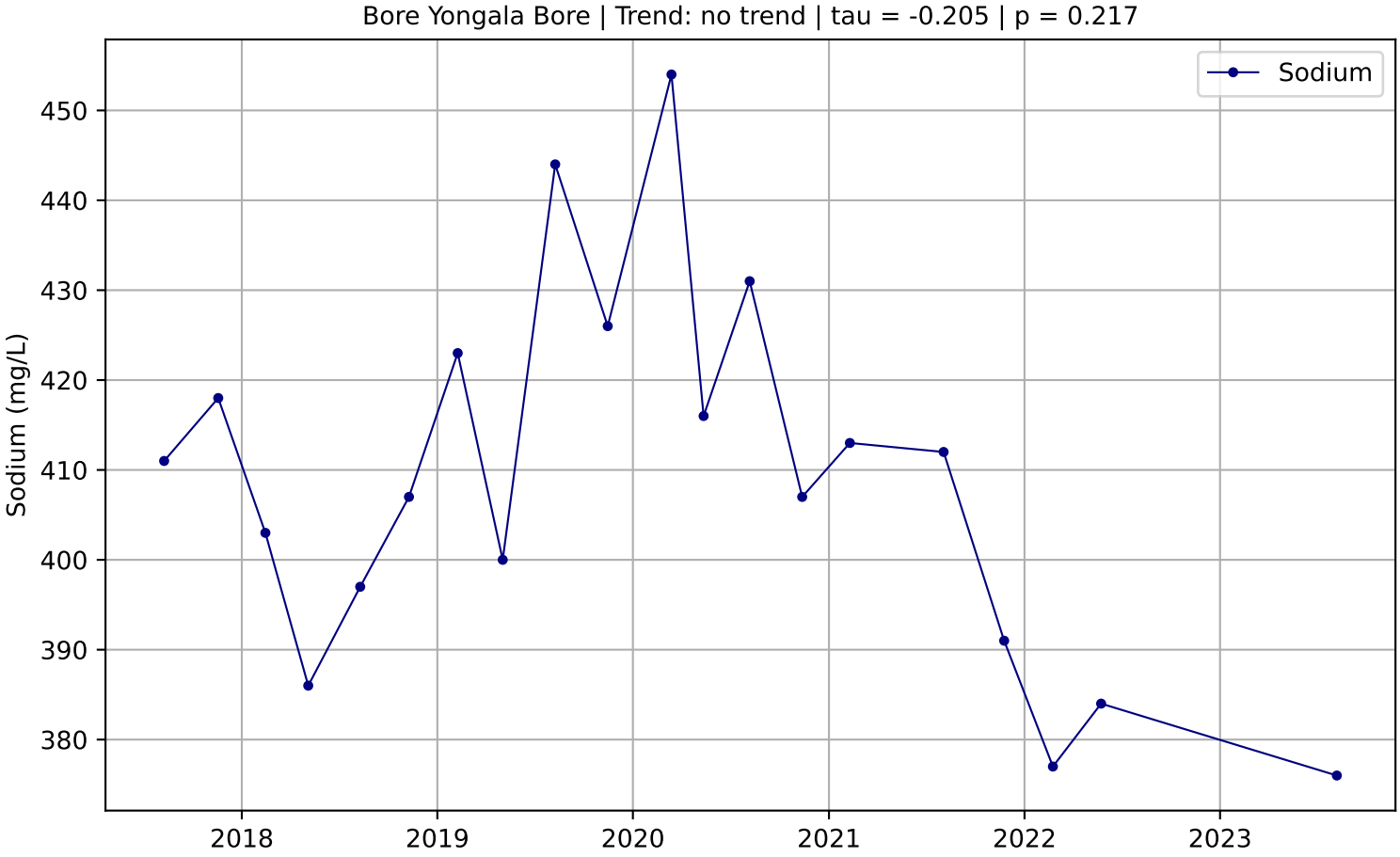

Bore Yongala Bore | Trend: no trend | tau = 0.208 | p = 0.185
Iron (mg/L)
6.5
6.0
5.5
5.0
4.5
4.0
2016
2017
2018
2019
2020
2021
Iron
Groundwater Quality Limit

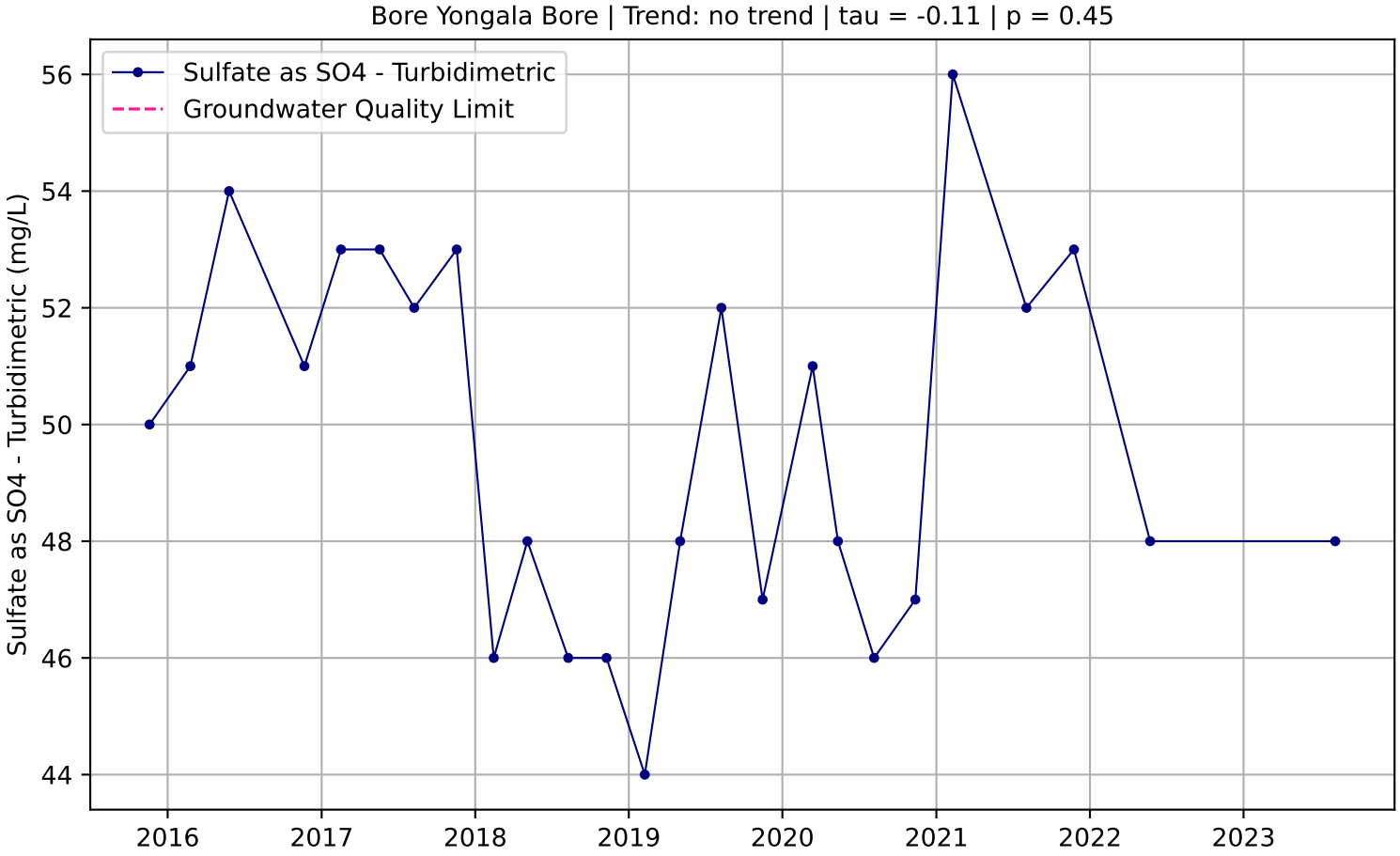

Bore Yongala Bore | Trend: no trend | tau = -0.232 | p = 0.158
Magnesium
Magnesium (mg/L)
72
70
68
66
64
62
60
58
2018
2019
2020
2021
2022
2023

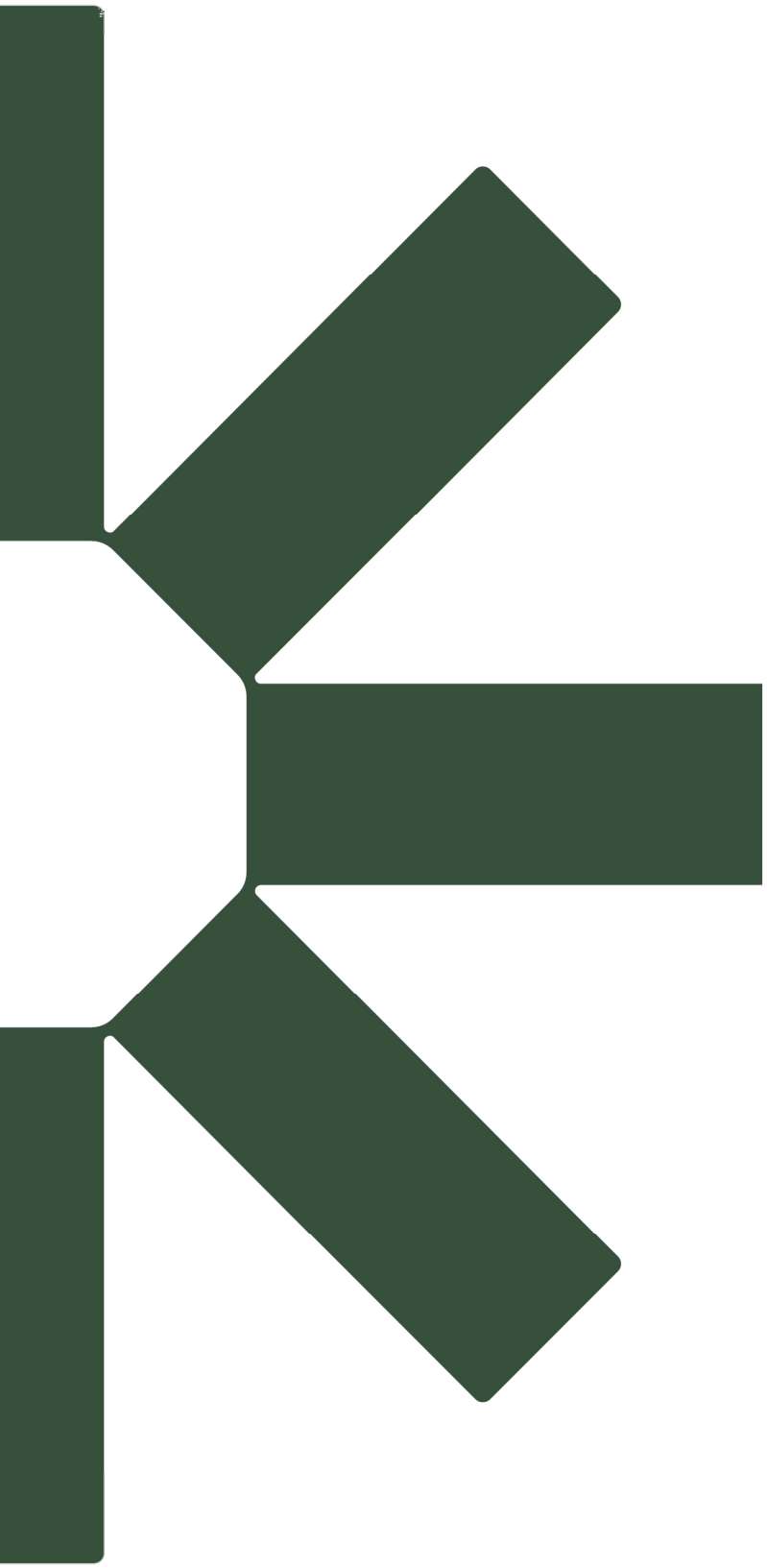

Bore Yongala Bore | Trend: no trend | tau = 0.0 | p = 1.0
Molybdenum (mg/L)
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2016
2017
2018
2019
2020
2021
Molybdenum
Groundwater Quality Limit


Bore Yongala Bore | Trend: no trend | tau = 0.043 | p = 0.779
Potassium
Potassium (mg/L)
20
19
18
17
16
15
14
2017
2018
2019
2020
2021
2022
2023


Bore Yongala Bore | Trend: no trend | tau = -0.1 | p = 0.119
Selenium (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
2016
2017
2018
2019
2020
2021
Selenium
Groundwater Quality Limit


Bore Yongala Bore | Trend: no trend | tau = -0.205 | p = 0.217
Sodium
Sodium (mg/L)
450
440
430
420
410
400
390
380
2018
2019
2020
2021
2022
2023


Bore Yongala Bore | Trend: no trend | tau = -0.11 | p = 0.45
Sulfate as SO4 - Turbidimetric
Groundwater Quality Limit
Sulfate as SO4 - Turbidimetric (mg/L)
56
54
52
50
48
46
44
2016
2017
2018
2019
2020
2021
2022
2023



Making Sustainability Happen

Appendix B

Ensham Life of Mine Extension Project – Zone 1: Groundwater Impact Assessment (SLR, 2022a)

ENSHAM LIFE OF MINE EXTENSION PROJECT - ZONE 1

Groundwater Impact Assessment

Prepared for:

Ensham Resources Pty Ltd
Level 9/175 Eagle Street,
Brisbane QLD 4000

SLR Ref: 620.30872.00400-R01
Version No: Rev 1.0
October 2022

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 16, 175 Eagle Street
Brisbane QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004)
T: +61 7 3858 4800
E: brisbane@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Ensham Resources Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30872.00400-R01-Rev 1.0	11 October 2022	G Holmes	I Epari	I Epari

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) was engaged by Ensham Resources Pty Ltd (Ensham) to assess the potential impacts on the groundwater environment from the proposed Ensham Life of Mine Extension Project – Zone 1 (the Project), which is the subject of an Environmental Authority (EA) Amendment application. The scope of this groundwater impact assessment covers the underground mining operations proposed for the Project. The methodology adopted for the 2021 EIS has also been adopted for this groundwater assessment.

The impacts were assessed in two ways:

1. Project Incremental impacts (change from existing mining operations to the Project); and

2. Project Net impacts (change from a hypothetical scenario without any underground mining to the Project).

Ensham mine is an existing open-cut and underground bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald in Queensland. The Project will increase the life of the existing underground operations by extending the underground bord and pillar mine into an area identified as Zone 1.

Approval of the Project will allow Ensham Mine to continue to produce at current planned coal production rate of approximately 4.5 million tonnes per annum (Mtpa) of product coal and would extend the Ensham Life of Mine (LOM) by up to eight years to 2037. The extension of the underground operation will utilise existing infrastructure and therefore no surface construction or surface disturbance for the operation will be required.

Hydrogeological setting and sensitive receptors

The hydrogeological setting of the Study area (which is defined in this report as the groundwater model extent) comprises of two groundwater bearing units, the Quaternary aged alluvium and the Permian aged Rangal Coal Measures. These two key units are separated by a low permeability unit, the Rewan Group.

The Quaternary aged alluvium comprises shallow sequences of clay, silty sand and sand, underlain by basal sands and gravel. The groundwater in the alluvium is highly saline, which makes it unsuitable for uses such as stock watering and irrigation. The alluvium is not well connected with the Nogoa River: data analysis demonstrates that alluvial groundwater is saline whereas water from the river is fresh. In addition, some bores installed in the alluvium close to the Nogoa River are sporadically dry. If the alluvium was connected to the river, these bores would not be expected to dry out. In July 2019, a site investigation showed that groundwater was flowing into the river, the driver for this flow was assessed to be resulting from upstream irrigation that is potentially causing elevated alluvium groundwater levels in the area and not from mining activities.

The Rangal Coal Measures comprise economic coal seams interbedded with low permeability siltstone, sandstone and shale. The coal seams contain groundwater which is generally saline and is not suitable for stock water supply or irrigation.

A desktop search for sensitive receptors was undertaken to identify the relevant receptors which could be impacted by the Project. A previous baseline assessment identified 19 landholder bores within a 15 km radius from the Project (AGE, 2017). For the groundwater dependent ecosystems, a desktop search radius of 10 km radius from the Project was selected. This desktop review identified a wetland, and potential terrestrial and aquatic GDE's, which have been mapped as low confidence. This means that there is a low confidence that these ecosystems have some degree of groundwater dependence. A stygofauna field assessment (Appendix O of the EA Amendment application) found four alluvial groundwater monitoring bores with Stygofauna present. No active springs were identified within the 10 km radius of the Project, with the closest active spring located 58 km away.

Numerical groundwater model

A previous groundwater model (SLR, 2022) was used as a basis for the Project groundwater impact assessment. This previous model was peer reviewed (SMI, 2022) and approved by the Department of Science (DES) in July 2022. The model was amended to include the proposed mine plan (i.e. inclusive of Zone 1) to assess the impacts of the Project on the groundwater environment.

Groundwater modelling predictions

Predictive groundwater modelling showed that the rate of inflow for the Project remains similar to existing operations (i.e., 2 to 14 ML/day for the Project).

Modelling also showed that the incremental alluvial flux (alluvial water seeping into lower formations) is limited to less than 0.1 ML/day, which is considered negligible. The groundwater model predicts no reduction in baseflow in the Nogoa River over the life of the Project, and so no further assessment on indirect surface water takes (such as increased leakage from the river to groundwater) is required.

The predicted Project maximum incremental groundwater drawdown of 1 m in the target coal seams at end of mining in 2037 is expected to extend up to 15 km to the west. Groundwater modelling showed that the drawdown introduced by mine dewatering in the target coal seams is not causing wide-spread drawdown in the shallow alluvium. As conceptualised and supported by over 18 years of collected data, there is limited hydraulic connection between the two units, with the Rewan Group acting as a flow barrier.

The post-mining equilibrium groundwater level was calculated over a timeframe of 220 years. Groundwater levels the shallow aquifer, specifically the Nogoa River Alluvium, is predicted to fully recover. Some permanent reduction for the water levels in the target coal seams is predicted. Further, the groundwater recovery modelling for Zone 1 showed that the open-cut pits will remain as long-term sinks consistent with Environmental Authority (EA) condition I16.

In accordance with the IESC guideline, model uncertainty was assessed by an extensive sensitivity analysis. Sensitivity analysis evaluates the effects of model parameters on model results and provides information on the degree to which the adopted values for the various parameters in the model influence predictions. Eleven selected model parameters were assessed, and the changes in the predictions, both from a water balance and drawdown perspective, were evaluated. The model results were sensitive to variations in some parameters, but these variations produce model results which are not consistent with measured site observations. As such, the sensitivity to these parameter values within the model was not considered further.

Based on the outcomes of the sensitivity analysis it was concluded that the calibrated groundwater model parameters are fit for purpose to assess the impacts on the sensitive receptors.

Groundwater impacts

Overall, the findings of the groundwater impact assessment are consistent with previous assessments, most notably the 2021 EIS and the recently approved EA Amendment Application (July 2022). Potential impacts from the Project can be inferred from the results produced by the Project Incremental scenario:

- The maximum drawdown contour intersects part of a surface expression GDE where the coal measures sub-crop the alluvium. The maximum drawdown also intersects parts of a low confidence surface expression GDE and parts of low confidence terrestrial GDEs in the northwest of the Project. However, these potential impacts on identified potential GDEs are considered to be negligible, due to the conservative methodology of the drawdown calculations. The drawdowns in the shallow layer are in fact a delay in recovery, and not a further reduction in water levels. As such, the proposed GDE monitoring is deemed suitable. The maximum drawdown does not intersect the wetland identified and as such the Project will have no impact on this wetland.
- The maximum drawdown does not intersect any active springs, and as such the Project will have no impact on springs.
- Modelling results indicated that none of the four bores that were identified to have Stygofauna present are predicted to be impacted by the Project.
- No impacts on groundwater quality are predicted
- Gordon Geotechniques (2022) assessed the subsidence risk of the Project, with low levels of subsidence and associated strains and tilts predicted, and no surface cracking anticipated within Zone 1.

Management and mitigation of impacts

A comprehensive groundwater monitoring program is in place for the existing approved operations at the Ensham mine. The monitoring network is considered fit for purpose to detect any groundwater level or quality changes resulting from the Project, with the proposed addition of one additional monitoring bore to the west of Zone 1 in the target coal seam to confirm the predicted drawdowns to west of the Project. The addition of this bore is listed in Chapter 18 (Commitments) of the EA Amendment Application as a commitment for the Project.

No changes to the current EA conditions are proposed other than the inclusion as noted in the above commitment to add an additional monitoring bore.

CONTENTS

1 INTRODUCTION 12
1.1 Overview 12
1.2 Project background 12
1.3 Previous studies 16
1.4 Proposed mining operations 16
1.5 Study objectives 16
2 LEGISLATIVE REQUIREMENTS AND RELEVANT GUIDELINES 17
2.1 Environment Protection and Biodiversity Conservation Act 1999 17
2.2 Water Act 2000 17
2.3 Environmental Protection Act 1994 17
2.3.1 Current Environmental Authority 20
3 SITE SETTING 21
3.1 Climate 21
3.2 Topography and drainage 24
3.3 Land use 26
3.3.1 Agriculture 26
3.3.2 Mining adjacent to the Project 29
3.3.2.1 Gregory Crinum and Kestrel 29
3.3.2.2 Wilton 30
3.3.2.3 Fairhill 30
3.3.3 Petroleum 31
4 GEOLOGY 32
4.1 Quaternary alluvium 36
4.2 Tertiary age sediments 36
4.3 Triassic age Rewan Group 36
4.4 Permian Rangal Coal Measures 36
4.5 Structural geology 37
5 HYDROGEOLOGY 38
5.1 Current groundwater monitoring 38
5.2 Hydraulic properties 41
5.2.1 Hydrogeological units 41
5.2.2 Faults 43
5.3 Groundwater levels, flow, recharge and discharge 45
5.3.1 Quaternary sediments (alluvium) 45
5.3.1.1 Water levels 45

CONTENTS

5.3.1.2 Groundwater flow 49
5.3.1.3 Interaction with surface water 51
5.3.2 Rewan Group 56
5.3.3 Permian Coal Measures 57
5.3.3.1 Water levels 58
5.3.3.2 Interaction with open-cut mine pits 62
5.4 Groundwater quality 63
5.4.1 Physiochemical parameters 63
5.4.1.1 Alluvium 65
5.4.1.2 Rewan Group 69
5.4.1.3 Rangal Coal Measures 72
5.4.2 Metals and metalloids 75
5.5 Groundwater use and management 76
5.5.1 Groundwater dependent ecosystems 76
5.5.2 Stygofauna 77
5.5.3 Springs 77
5.5.4 Wetlands 78
5.5.5 Irrigation, farm supply / use and stock water (private bores) 80
5.6 Conceptual groundwater model 82
6 GROUNDWATER MODEL 85
6.1 Model objectives 85
6.2 Software 85
6.3 Model history and peer reviews 85
6.4 Model setup 86
6.4.1 Model grid and layers 86
6.4.2 Model properties 87
6.4.3 Boundary conditions 88
6.4.3.1 No flow boundary 89
6.4.3.2 General head boundary 89
6.4.3.3 Recharge and evaporation 89
6.4.3.4 Open-cut mining 91
6.4.3.5 Underground workings 91
6.4.3.6 Rivers 92
6.4.3.7 Other stresses 92
6.4.4 Temporal discretisation 92
6.4.5 Validation 93
6.4.5.1 Groundwater levels 93
6.4.5.2 Validated underground mine inflows 97
6.5 Model predictions 98
6.5.1 Groundwater model water balance 98
6.5.2 Predicted groundwater interception 99

CONTENTS

6.5.3 Predicted drawdown ... 100
6.5.3.1 Project Incremental maximum drawdown ... 101
6.5.3.2 Project Net drawdown ... 104
6.5.4 Incidental water impact ... 107
6.5.4.1 Influence on alluvium ... 107
6.5.4.2 Influence on baseflow ... 107
6.5.5 Post mining equilibrium ... 108
6.6 Sensitivity analysis ... 113
6.6.1 Scenario selection ... 113
6.6.2 Results ... 114
6.6.2.1 Drawdowns ... 114
6.6.2.2 Water fluxes ... 117
6.7 Model confidence ... 119
6.8 Model limitations ... 121
7 POTENTIAL IMPACTS ... 125
7.1 Assessment framework ... 125
7.2 Water licensing ... 125
7.3 Potential impact on aquatic and terrestrial ecosystems ... 126
7.4 Potential impact on private bores ... 129
7.5 Impact on groundwater quality ... 131
7.6 Climate change scenarios ... 131
7.6.1 Future climate scenarios and their impact on the alluvium ... 132
7.6.2 Future climate scenarios and their impact on the coal seams ... 133
7.7 Other potential impacts ... 134
8 MANAGEMENT AND MITIGATION ... 135
8.1 Mine affected water ... 135
8.2 Subsidence ... 135
8.3 Groundwater users ... 136
8.4 Groundwater monitoring program ... 136
8.4.1 Impact assessment criteria ... 138
8.4.1.1 Water Level trigger levels ... 138
8.4.1.2 Water quality trigger levels ... 138
8.4.2 Data management and reporting ... 139
9 CONCLUSIONS ... 140
10 COMMITMENT ... 141
11 REFERENCES ... 142

CONTENTS

DOCUMENT REFERENCES

TABLES

Table 1 Requirement for site-specific and amendment applications – underground water rights 18
Table 2 Priority agricultural land use in the Central Queensland regional plan area 27
Table 3 Proposed and current mining operations within 50 km from the Project 29
Table 4 Predicted drawdown at private bores from the Wilton Coal Project 30
Table 5 Exploration permits across the Study area 31
Table 6 Summary of stratigraphy in the Study area 33
Table 7 Monitoring network 38
Table 8 Summary of adopted hydraulic properties from other Bowen Basin studies 41
Table 9 Groundwater seep field observation 53
Table 10 Causes for alluvium groundwater level increase 56
Table 11 Summary statistics of pH observations 64
Table 12 Summary statistics of EC observations 65
Table 13 Existent private groundwater bores 80
Table 14 Model Version History and Peer Review 85
Table 15 Stratigraphy – model layer summary 87
Table 16 Simulated aquifer properties 87
Table 17 Adopted properties relative to field data ranges 88
Table 18 Recharge values 89
Table 19 Model and stress periods 93
Table 20 Model run selections 98
Table 21 Average simulated water balance during the prediction period (2022 to 2038) 99
Table 22 Sensitivity analysis – overview of scenarios 113
Table 23 Sensitivity analysis – changes to mining inflow and stream flow losses 117
Table 24 Groundwater model classification 120
Table 25 Groundwater model and data limitations 122
Table 26 Impact assessment framework for each environmental value 125
Table 27 Predicted Project incremental maximum drawdown at private bores due to the Project 129
Table 28 Predicted Project Net maximum drawdown at private bores due to the Project 130
Table 29 Change in rainfall for different climate scenarios (2090) 132
Table 30 Qualitative assessment of other potential impacts 134
Table 31 Release points and source water conditions (Table C1 of EPML00732813) 135
Table 32 Proposed additional groundwater monitoring bore 136
Table 33 Interim trigger levels for the new bores (EC, pH, Sulfate) 138
Table 34 Interim trigger levels for the new bore (remaining parameters) 138

FIGURES

Figure 1 Project location and surrounding mine tenements 13
Figure 2 Underground mine plan (Approved and the Project) 14
Figure 3 Project mine tenements, pit shell boundaries and underground mining areas 15

CONTENTS

Figure 4 Long-term annual rainfall statistics (1900-2021) 21
Figure 5 Average monthly rainfall and evaporation at Emerald Post office (1900-2021) 22
Figure 6 Monthly rainfall and CRD 23
Figure 7 Monthly rainfall at Ensham mine and Emerald Post office (2007-2021) 23
Figure 8 Topography and drainage 25
Figure 9 Maximum monthly level for the Nogoa River plotted against CRD 26
Figure 10 Priority Agricultural Areas and Strategic Cropping Land in the vicinity of the Project 28
Figure 11 Surface geology 34
Figure 12 Solid geology 35
Figure 13 Coal seam stratigraphy of the Rangal Coal Measures 37
Figure 14 Location of EA monitoring and other mine monitoring bores 40
Figure 15 Local faults 44
Figure 16 Nogoa River alluvium with surface water and alluvial groundwater monitoring locations 46
Figure 17 Hydrographs for upstream bores 47
Figure 18 Hydrographs for bores in Zone 1 48
Figure 19 Hydrographs for bores near or in the sub-crop area 49
Figure 20 Groundwater contours in the alluvium (2021) 50
Figure 21 Conceptual cross section through the Nogoa River and quaternary sediments (Source: AGE 2006) 51
Figure 22 Water level comparison at Nogoa River (Duckponds) and EC03 53
Figure 23 Piper Diagram comparing water quality 54
Figure 24 EC in the Nogoa River (upstream to downstream) 55
Figure 25 Hydrographs for Rewan bores compared with RB04 (Coal measures) 57
Figure 26 Hydrographs for Permian bores (Northern Area) 58
Figure 27 Hydrographs for Permian Bores (Central Area) 59
Figure 28 Hydrographs for Permian bores (Southern Area) 60
Figure 29 Groundwater contours in the Rangal Coal Measures (2021) 61
Figure 30 Hydrographs for bores WSMB2D, WSMB2S, and surface water levels at Ramp 22 62
Figure 31 Hydrographs for bores WSMB3S, WSMB3D, RB5, RB6, RB9 with surface water level at Ramp 20 and 21 63
Figure 32 Piper plot alluvium 65
Figure 33 Lab EC – alluvium 66
Figure 34 Field EC – alluvium 67
Figure 35 Electrical conductivity (Lab) – EC04, EC06, EC16, EC17 and EC19 68
Figure 36 Field pH – alluvium 69
Figure 37 Piper plot – Rewan Group 70
Figure 38 Field EC – Rewan Group 71
Figure 39 Electrical conductivity (Lab) – Rewan Group 71
Figure 40 Field pH – Rewan Group 72
Figure 41 Piper Plot – Rangal Coal Measures 73
Figure 42 Field EC – Rangal Coal Measures 74
Figure 43 Field pH – Rangal Coal Measures 74

CONTENTS

Figure 44 Number of bores with 80th percentile above ANZECC guidelines for aquatic ecosystem protection (95%) in the main hydrogeological units 75
Figure 45 Groundwater Dependent Ecosystems and Private bores 79
Figure 46 Conceptual groundwater model (location of cross section shown on Figure 12) 83
Figure 47 Cross section along the alluvium and sub-crop (location of cross section shown on Figure 16) 84
Figure 48 Model grid, boundary conditions and mine plan 90
Figure 49 Observed vs computed target water levels 94
Figure 50 Calibration hydrographs (alluvium) 95
Figure 51 Calibration hydrographs (Coal seam) 95
Figure 52 Maps of average residuals (difference between observed and modelled water levels) 96
Figure 53 Observed versus modelled underground mine inflows 97
Figure 54 Predicted underground mine inflow 100
Figure 55 Illustration of drawdown calculations 101
Figure 56 Project Incremental maximum drawdown in the unconsolidated (L2) 102
Figure 57 Project Incremental maximum drawdown in the Aries and Castor seam (L8) 103
Figure 58 Project Net maximum drawdown in the Unconsolidated (L2) 105
Figure 59 Project Net maximum drawdown in the Aries and Castor seam (L8) 106
Figure 60 Flux from the Alluvium into underlying strata 107
Figure 61 Stream flow in the Nogoa River 108
Figure 62 Recovery times series for two selected bores 109
Figure 63 Equilibrium groundwater level (2260) in the unconsolidated (L2) 110
Figure 64 Equilibrium groundwater level (2260) in the Aries and Castor seam (L8) 111
Figure 65 Equilibrium groundwater table (2260) 112
Figure 66 Sensitivity analysis for groundwater drawdown in the Aries and Castor Coal Seam (L8) 116
Figure 67 Underground mine inflow (sensitivity analysis) 118
Figure 68 Nogoa River net stream flow (sensitivity analysis) 119
Figure 69 Recovery curve for an alluvial bore 126
Figure 70 Project incremental maximum drawdown in the alluvium and GDEs 128
Figure 71 Long-term recovery hydrograph for alluvial bore EC25 133
Figure 72 Long-term recovery hydrograph for bore RB4 134
Figure 73 Proposed groundwater monitoring network 137

APPENDICES

Appendix A Layer extents and thickness
Appendix B Summary statistic of EA water quality parameters
Appendix C Water quality compared to regional and national guidelines - Boxplots
Appendix D Water Quality Parameters - Time Series
Appendix E Calibration Hydrographs
Appendix F Hydraulic properties zones
Appendix G Prediction Hydrographs

1 Introduction

1.1 Overview

SLR Consulting Australia Pty Ltd (SLR) was engaged by Ensham Resources Pty Ltd (Ensham) to assess the potential impacts on groundwater environmental values of the proposed Ensham Life of Mine Extension Project – Zone 1 (the Project), which is the subject of an Environmental Authority (EA) Amendment application.

The scope of this assessment is to:

- Describe the existing hydrogeological environment of the Project and surrounds.
- Assess the potential impacts of the proposed extension of underground mining on the groundwater related environment.
- Propose measures to manage and/or mitigate any impacts to groundwater environmental values.

For this assessment, the Study area is the extent of the groundwater model domain (Figure 1), which includes the Project and surrounds. The scope of this groundwater impact assessment is limited to the underground mining operations proposed within Zone 1 (Figure 2).

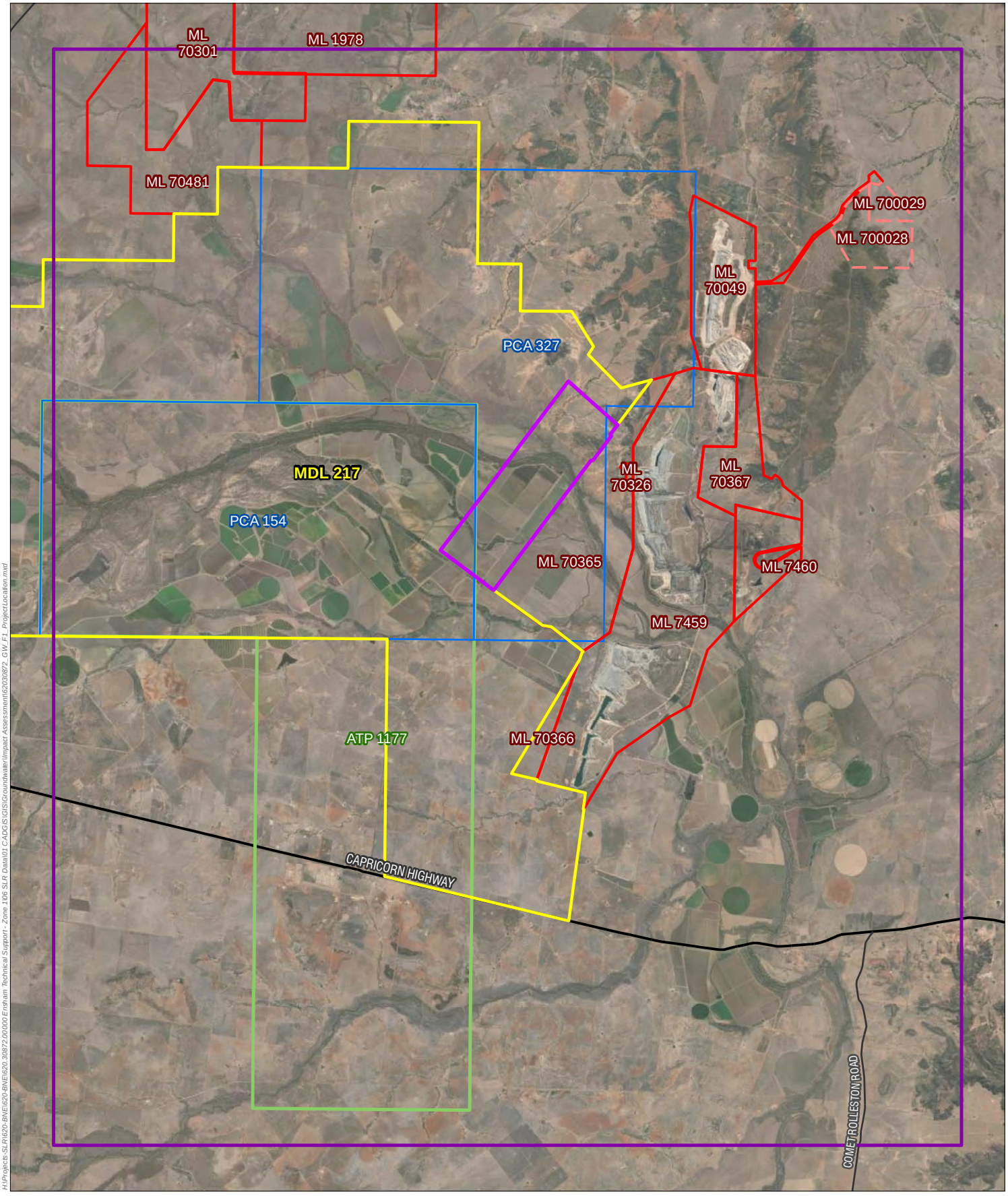
1.2 Project background

Ensham mine is an existing open-cut and underground bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald in Queensland. The approved bord and pillar operations exist within Mining Lease (ML) 7459, ML 70326 and ML 70365 (Figure 1) and to extract a portion of the various combined Aries/Castor seam plies. Current approved underground operations commenced in 2011. Existing approved underground operations within the currently approved MLs are referred to as the “existing operations” in this report. It is noted that Zones 2 and 3, which have been recently approved by the Department of Environment and Science (DES) in July 2022 for underground mining, forms part of the existing approved mining operations as shown in Figure 2.

Ensham mine currently produces up to 4.5 million tonnes per annum (Mtpa) of coal for both the open-cut and underground mine operations. The open-cut operation (Figure 3) is currently undergoing closure with dragline and blasting operations now ceased, and truck fleet movements considerably reduced. The open-cut mine operations and its rehabilitation have been separately approved and does not form part of the Project.

It is proposed to increase the life of the existing underground operations by extending the underground bord and pillar mine into an area identified as Zone 1 as shown in Figure 2). The target coal seam dips in a westerly direction and lies approximately 120 to 210 metres (m) beneath the Nogoa River floodplain surface.

The existing approved underground workings are accessed through three portals located in Pits C and D, which will be retained to allow for access to the underground mine portals. These pits will then be rehabilitated towards the end of the authorised open cut rehabilitation program and do not form part of the scope of this Project.



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F1_ProjectLocation.mxd

0 5 km

GROUNDWATER IMPACT ASSESSMENT

Project location and surrounding mine tenements

Figure 1

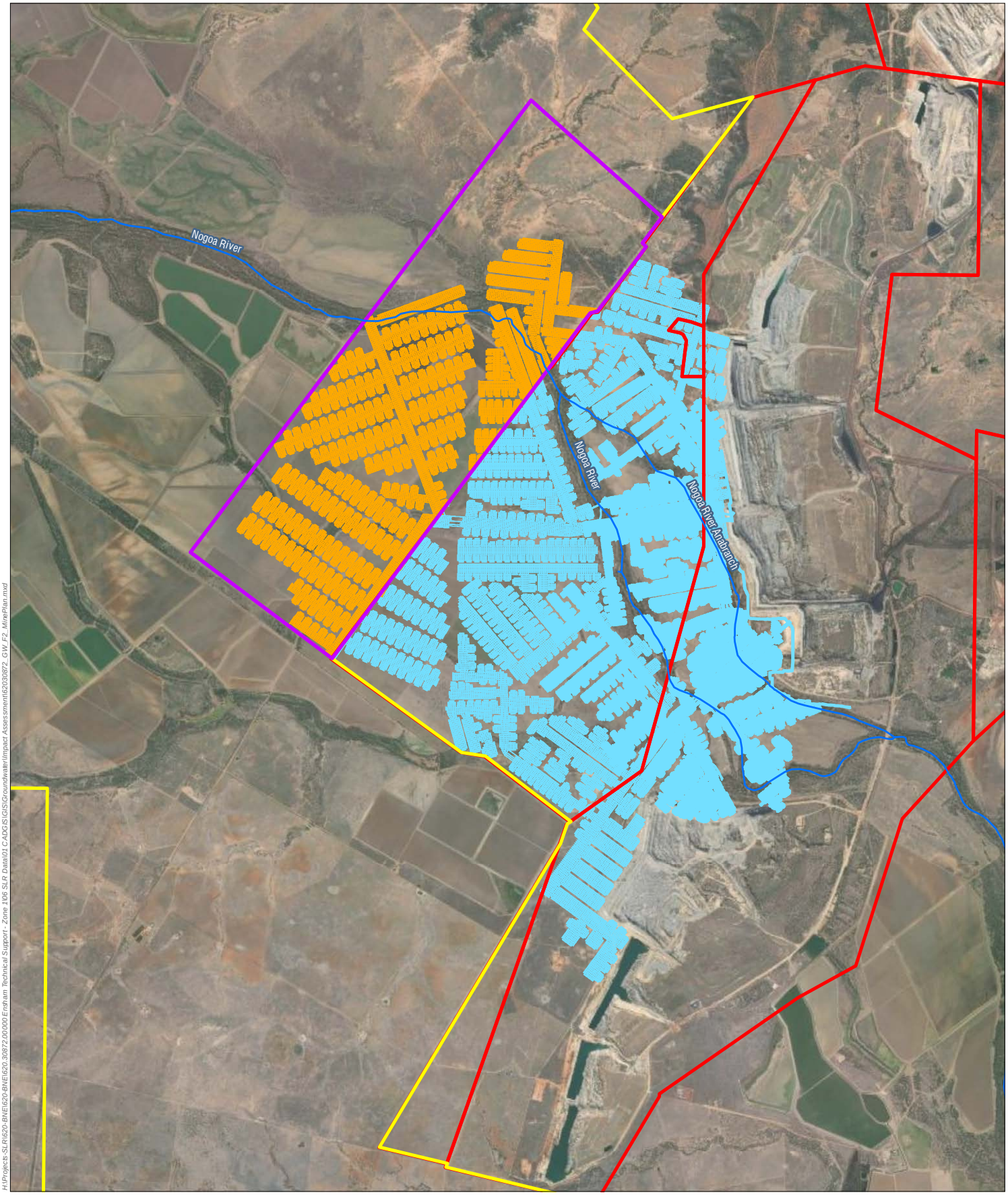
Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Highway
- Major Road
- Zone 1
- Study Area (Groundwater model domain)
- Mineral Development Licence (MDL) 217
- Mining Lease (Granted)
- Mining Lease (Application not related to the Project)
- Potential Commerical Area
- Exploration Permit for Petroleum

SLR



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F2_MinePlan.mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Underground mine plan (Approved and the Project)

Figure 2

Projection: GDA 1994 MGA Zone 55
Scale: 1:75,000

Project No.:	620.30686
Date:	11-Aug-2022
Drawn by:	SLR Consulting
Sheet Size:	A4

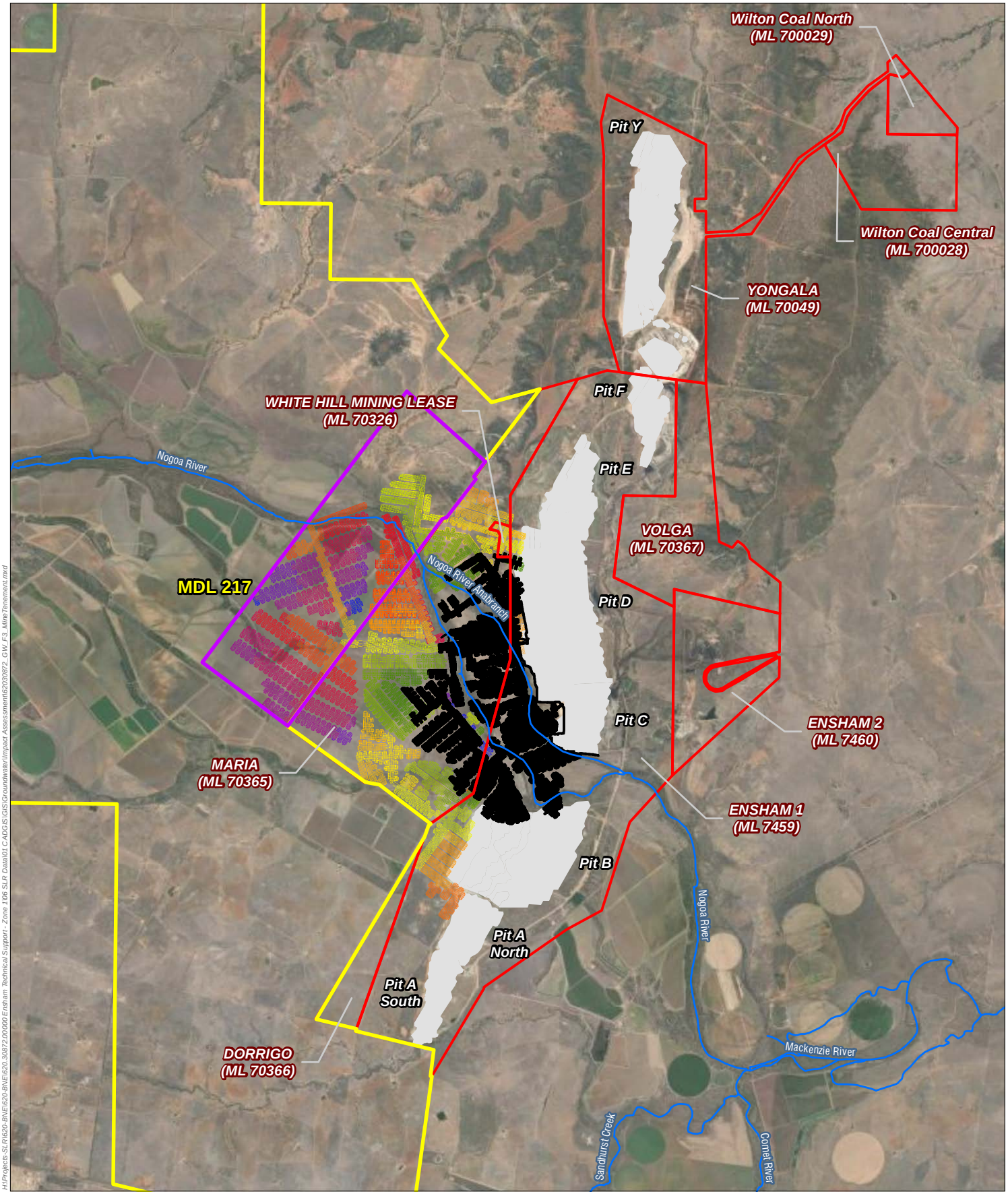
Legend

- Watercourse
- Zone 1
- Mineral Development Licence (MDL) 217
- Mining Lease (Granted)

Underground Mining

- Approved
- Project

SLR



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 1\06 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F3_MineTenement.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30872
Date:	19-Jul-2022
Drawn by:	PM
Sheet Size:	A4

SLR

GROUNDWATER IMPACT ASSESSMENT

Project mine tenements pit shell boundaries and underground mining areas

Figure 3

Legend

- Watercourse
- Zone 1
- Mineral Development Licence (MDL) 217
- Mining Lease
- Open Cut

Underground Mining

- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
- 2030
- 2031
- 2032
- 2033
- 2034
- 2035
- 2036
- 2037
- Mined Out UG

1.3 Previous studies

The Life of Mine Extension Project Environmental Impact Statement (EIS) was submitted in March 2021. The EIS assessed impacts on diverse environmental receptors from extension Zones 1, 2 and 3. The EIS was on public display and an amended EIS (AEIS) was subsequently prepared to address submissions. The AEIS was submitted to DES in August 2021and an EIS assessment report was issued in November 2021.The recommendations from the EIS assessment report in relation to groundwater have been considered for this assessment.

The groundwater assessment prepared for the EIS was peer reviewed by the Sustainable Minerals Institute, University of Queensland, and was also reviewed by the Independent Expert Scientific Committee (IESC) and the Commonwealth Department of Agriculture, Water and the Environment (now the Department of Climate Change, Energy, the Environment and Water (DCCEEW)). The methodology adopted for the EIS has also been adopted for this groundwater assessment.

The study presented herein assesses potential effects as a result of Zone 1.

1.4 Proposed mining operations

The Project is an extension of the approved underground operations and will utilise existing surface infrastructure and processes. The Project will continue to produce at a current run of mine (ROM) production rate of up to approximately 4.5 Mtpa. This will extend the Ensham Life of Mine (LOM) by eight years, to 2037. The Project is currently anticipated to be accessed from ML 70365 in approximately 2024.

The Project will continue to operate using the same bord and pillar mining method currently being used for the existing underground mining operations. The mine design has been completed with a factor of safety of 1.6 for bord and pillar workings beneath the Nogoa River floodplain, and 2.11 beneath the Nogoa River for mining and to connect the bord and pillar mining areas as discussed in the Subsidence Report located in Appendix B of the Environmental Authority Amendment application.

The current dedicated dewatering system (which pumps mine affected water from the underground to surface infrastructure) will be extended underground for the Project.

1.5 Study objectives

This study assessed the potential impacts of bord and pillar mining, including the depressurisation of groundwater (i.e., the dewatering of the coal seam during mining).

This groundwater assessment was undertaken in accordance with the Queensland government requirements under Chapter 3 of the Water Act 2000 (Qld) (Water Act). To achieve the requirements of these regulatory requirements, the groundwater assessment comprised two parts:

(i) A description of the existing hydrogeological environment.

(ii) An assessment of the potential impacts of mining on the groundwater related environment.

2 Legislative Requirements and Relevant Guidelines

This section summarises the relevant groundwater legislation and policy relevant to the Project, inclusive of the following:

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).
- Queensland Water Act 2000 (Water Act).
  - Water Resource (Fitzroy Basin) Plan 2011.
  - Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016.
- Queensland Environmental Protection Act 1994 (EP Act).
  - Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water).

2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by DCCEEW and is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES).

This assessment was carried out under State legislation. Commonwealth considerations were included in the Life of Mine Extension Project EIS (refer to Section 1.3) and have been considered in this assessment.

2.2 Water Act 2000

The Water Act 2000, supported by the subordinate Water Regulation 2016, is the primary legislation regulating water resources in Queensland. The purpose of the Water Act is to advance sustainable management and efficient use of water resources by establishing a system for the planning, allocation, and use of water. The Water Act is enacted under a framework of catchment specific Water Plans (WPs).

Water resources within the Study area are captured under the Water Plan (Fitzroy Basin) 2011 (DEHP, 2011). This WP covers the surface water (zone WQ1303) associated with lower Nogoa River and groundwaters (zone WQ1310 – Fitzroy Basin groundwaters). Further, the Study area is covered by the Highlands Groundwater Management Area under the Water Plan (Fitzroy Basin) 2011.

As part of the Project, Ensham proposes to exercise underground water rights during the period in which resource activities will be carried out in Zone 1 and an Underground Water Impact Report (UWIR) has been prepared (located in Appendix J of the Environmental Authority Amendment application).

2.3 Environmental Protection Act 1994

Minimum reporting requirements for groundwater impact assessments are outlined within the Environmental Protection Act 1994 (Qld) (EP Act) guideline requirements for site-specific and amendment applications – underground water rights. A summary of the guideline requirements and where they have been addressed within this report are provided in Table 1.

Table 1 Requirement for site-specific and amendment applications – underground water rights

Part	Detail	Section in report
Part A	A statement that the applicant proposes to exercise underground water rights	Section 2.2
Part B	A description of the area/s in which underground water rights are proposed to be exercised	Sections 4 and 5
Part C	A description of the aquifer/s affected or likely to be affected	Section 5
	Aquifer type (confined, unconfined, fractured etc)	Section 5
	Geology/ stratigraphy for each aquifer	Section 4
	Depth to and thickness of the aquifers	Section 4 and Appendix A
	Physical integrity of the aquifer, fluvial processes and morphology	Section 4
	Depth to water level and seasonal changes in levels	Section 5.3
	Hydrogeological cross sections	Section 5.6
	Maps (spatial extent)	Extent of the units in Appendix A and Appendix F
Part D	An analysis of the movement of underground water to and from the aquifer	Sections 5.3
	Inputs (i.e. recharge) and outputs (i.e. baseflow and abstraction)	Section 5.3
	Underground water elevations (i.e. mapped groundwater flow directions)	Figure 20 and Figure 29
	Connectivity between aquifers and hydraulic properties	Sections 5.2 and 5.3
	Preferential flow pathways (i.e. faults)	Section 5.2.2
	Springs	Section 5.5.2
Part E	A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights	Section 7
	Predictions should: • Be made for the life of the resource project and for post resource tenure closure • Be made about the timing, spatial extent and magnitude of maximum water level declines in affected aquifers • Be made about the timing and magnitude of groundwater level equilibrium in affected aquifers.	Section 7 and Appendix G

Part	Detail	Section in report
	Produce potentiometric contour maps showing maximum predicted water level decline for each affected aquifer.	Section 6.5.3
	Modelling methodology, including: • Model type (e.g. numerical or analytical) • Modelling platform • Model inputs • Model boundary conditions • Model assumptions and limitations • Sensitivity analysis and calibration results.	Section 6
Part F	The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights	Section 6.5.2
	Details on the methodology used for measuring extraction volumes and developing the extraction schedule	Section 6.4.3
Part G	Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights	Section 7.5
	Identify the quality of the groundwater prior to the resource activity commencing	Section 5.4
	Explain the variation of chemical concentrations as a result of chemical reactions over the life of the Project due to the exercise of underground water rights (i.e. changes in salinity and concentration of dissolved gas)	Section 7.5
	Estimate extent and likelihood of groundwater quality impacts, with justification based on potential sources of contamination	Section 7.5
Part H	Identifying and describing environmental values: • Information on the environmental values that will, or may, be affected by the exercise of underground water rights • Describe and define environmental value of aquifers, presenting available raw data used. Document groundwater use, including details on operating bores within the areas predicted to be affected by the exercise of underground water rights	Section 5.5
	Nature and extent of the impacts on the environmental values (risk assessment): • The magnitude, relative size or actual extent of any impact in relation to the environmental value being affected • The vulnerability or resilience of the environmental value (severity and duration) • Uncertainty of impacts and any assumptions.	Section 7.3 and 7.4
	Surface subsidence impacts	Section 8.2

Part	Detail	Section in report
Part I	Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater Strategies for avoiding, mitigating and managing the predicted impacts on both environmental values and predicted changes in groundwater quality should include: • Objectives which define the outcomes that are intended to be achieved (i.e., avoiding, mitigating and managing the predicted impacts) and a description of unavoidable impacts to environmental values • Measures (specific methods/procedures/tools) to be implemented to demonstrate how the objectives will be achieved • Indicators relevant to protection of the EVs (i.e., indicators are the values that are to be measured to gauge whether the objectives are being achieved and are used to are to be used in auditing the performance of measures) • A program for monitoring the indicators • A reporting program which includes triggers for the review of the strategies, and identifies additional data, assessment, analysis and reporting requirements	Section 8

2.3.1 Current Environmental Authority

The current EA, EPML00732813, for the existing approved mine includes mining activities on the following mining leases: ML 7459, ML 7460, ML 70326, ML 70049, ML 70365, ML 70366, and ML 70367 (Figure 1).

The EA conditions relevant to groundwater are listed in Schedule I, conditions I1 to I17 and Tables I1 and I2. These conditions detail monitoring and reporting requirements pertinent to groundwater level and quality. Quarterly groundwater monitoring is required to be carried out for all bores included in Table I1 of the EA (refer to Table 7 for a list of EA bores) and for all parameters included in Table I2of the EA. The monitoring network comprises site-based and regional observation bores, among which are included private landholder bores local to the mining area. The current groundwater monitoring network is presented in more detail in Section 5.1.

3 Site setting

3.1 Climate

The Central Highlands region has a sub-humid, sub-tropical climate, with distinct wet and dry seasons. Long-term rainfall, evaporation and temperature data sourced from Emerald Post Office (Bureau of Meteorology (BoM) station 035027) shows a long-term mean annual rainfall of 600 mm, a 20th percentile of 445 mm/year and an 80th percentile of 736 mm/year (Figure 4). In this figure, dry years are the years with less rain than the 20th percentile and wet year are years with more rain than the 80th percentile.

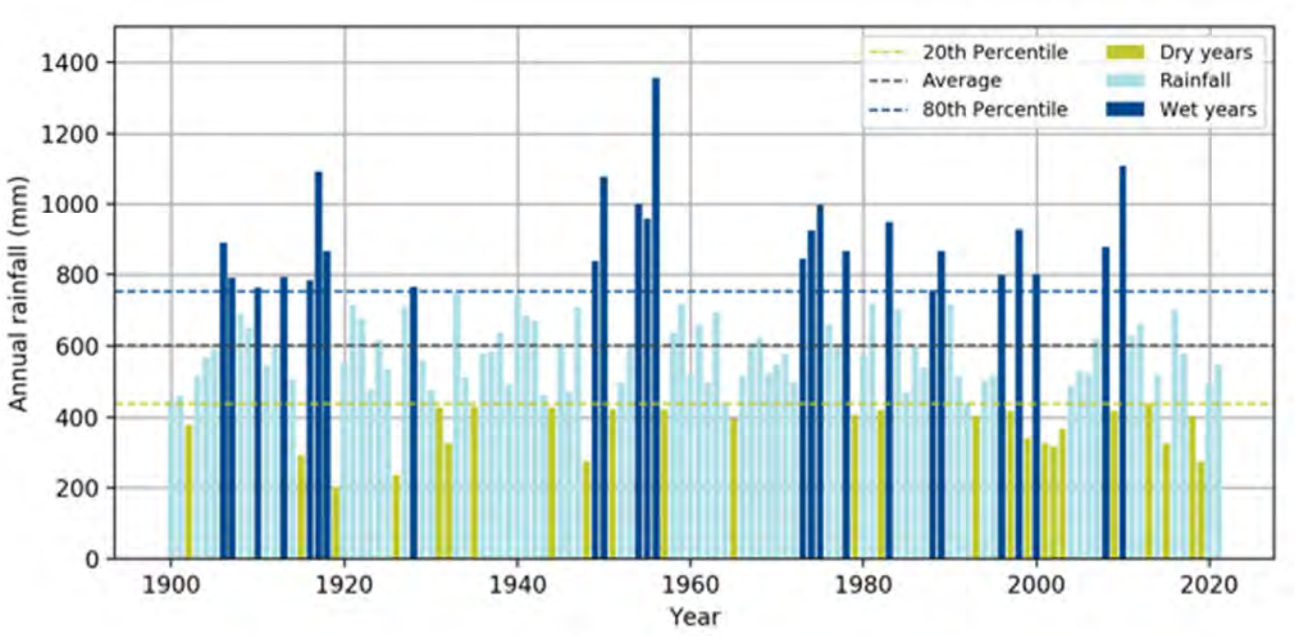


Figure 4 Long-term annual rainfall statistics (1900-2021)

The Scientific Information for Land Owners (SILO) data (Jeffrey, 2001) for rainfall and pan evaporation at this station (patched with surrounding stations after station closure in 1991) is presented on Figure 5. For each month, evaporation is approximately two to three times greater than the average monthly rainfall (Figure 5). Evapotranspiration takes place where water table is close to ground surface and / or within root zone depths (typically 1-2 m away from creek lines). Within the Study area, the highest rates of potential evapotranspiration are along creek and river lines, in particular the Nogoa River, Winton Creek and Boggy Creek, where the water table is closer to ground surface, and deeper rooting vegetation exists.

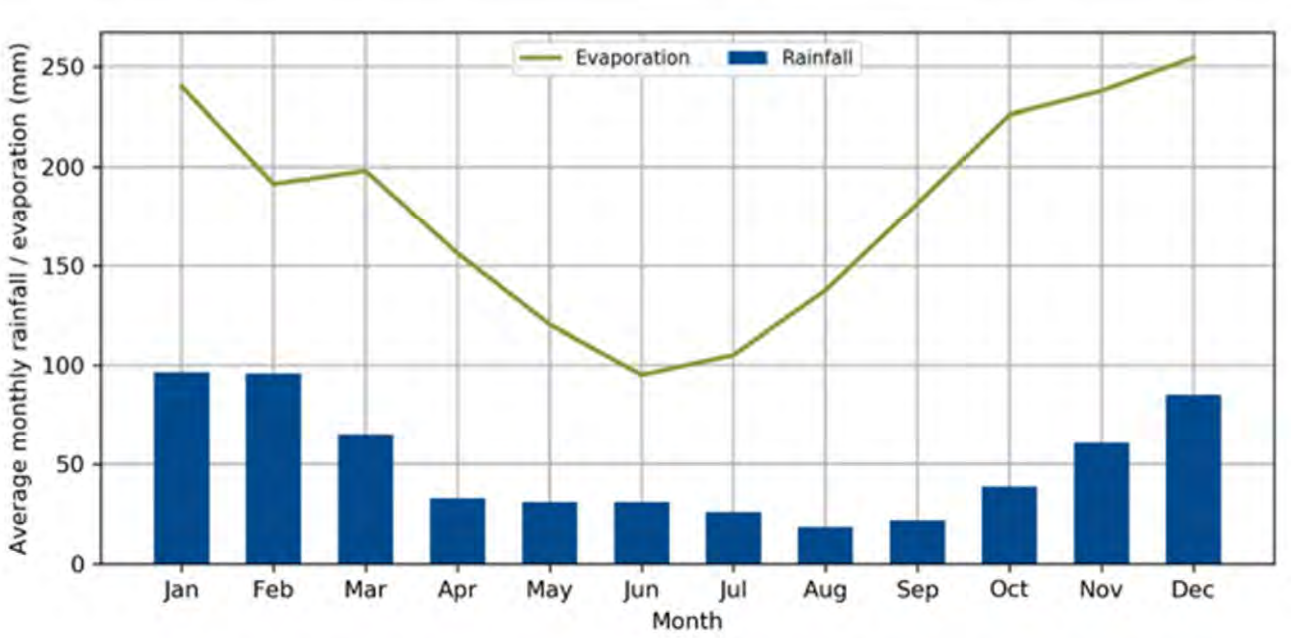


Figure 5 Average monthly rainfall and evaporation at Emerald Post office (1900-2021)

The monthly rainfall total and cumulative rainfall departure (CRD) are presented on Figure 6. The CRD has been calculated for the following location and time frame:

- Location: latitude -23.55/ longitude 148.15 (closest to Emerald Post Office).
- 1/1/1900 to 30/09/2021.

The CRD in Figure 6 is presented between 1995 – 2022.

The CRD is used in the discussion of the observed groundwater levels as a means to characterise climatic conditions (e.g., dry and wet climatic conditions). The early 2000s showed prolonged drier than average conditions (decreasing slope in CRD), followed by a period of wetter conditions (2008-2012, increasing slope in CRD). Since then, the CRD shows a decreasing trend, however not as steep as in the early 2000s.

Site data are also available from 2007 onward. A comparison between monthly rainfall recorded at Ensham mine and monthly rainfall sourced from SILO for Emerald Post office is presented on Figure 7. The data are reasonably consistent between the two data sets, with some local events being captured at one of the two sites only e.g. January 2008 (Emerald Post office higher than site) and December 2010 (site rainfall higher than Emerald Post office). The highest monthly rainfall recorded at the site are, in a decreasing order, December 2010, March 2019, February 2010, March 2011 and January 2012.

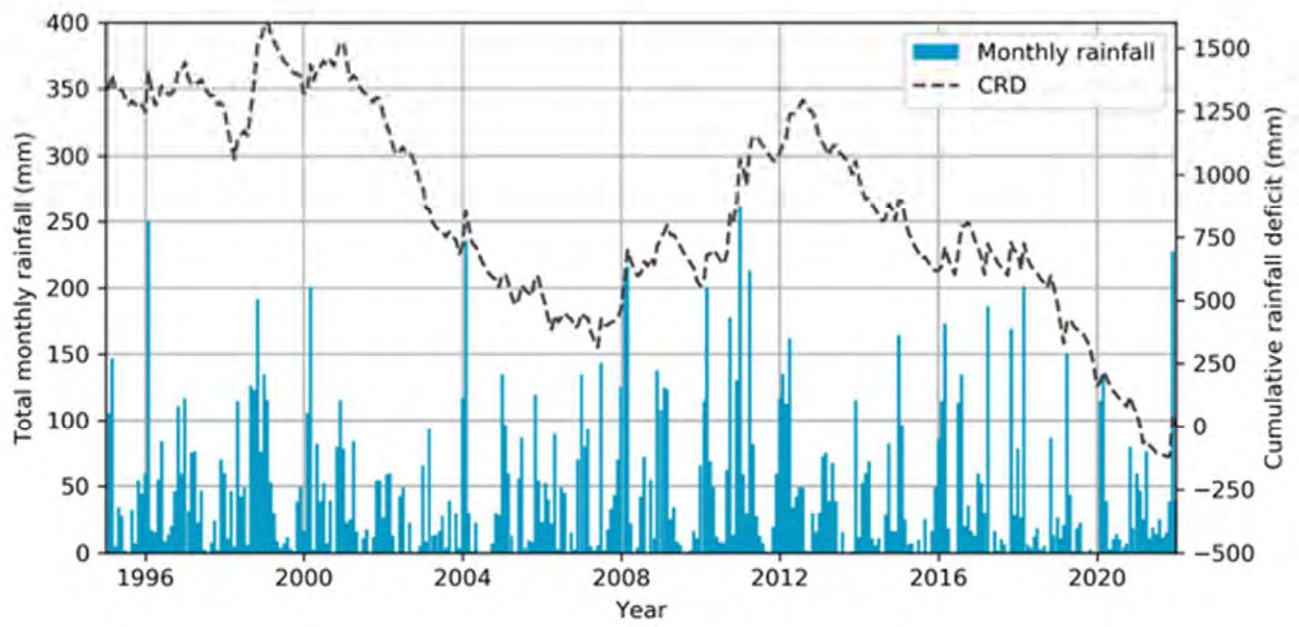


Figure 6 Monthly rainfall and CRD

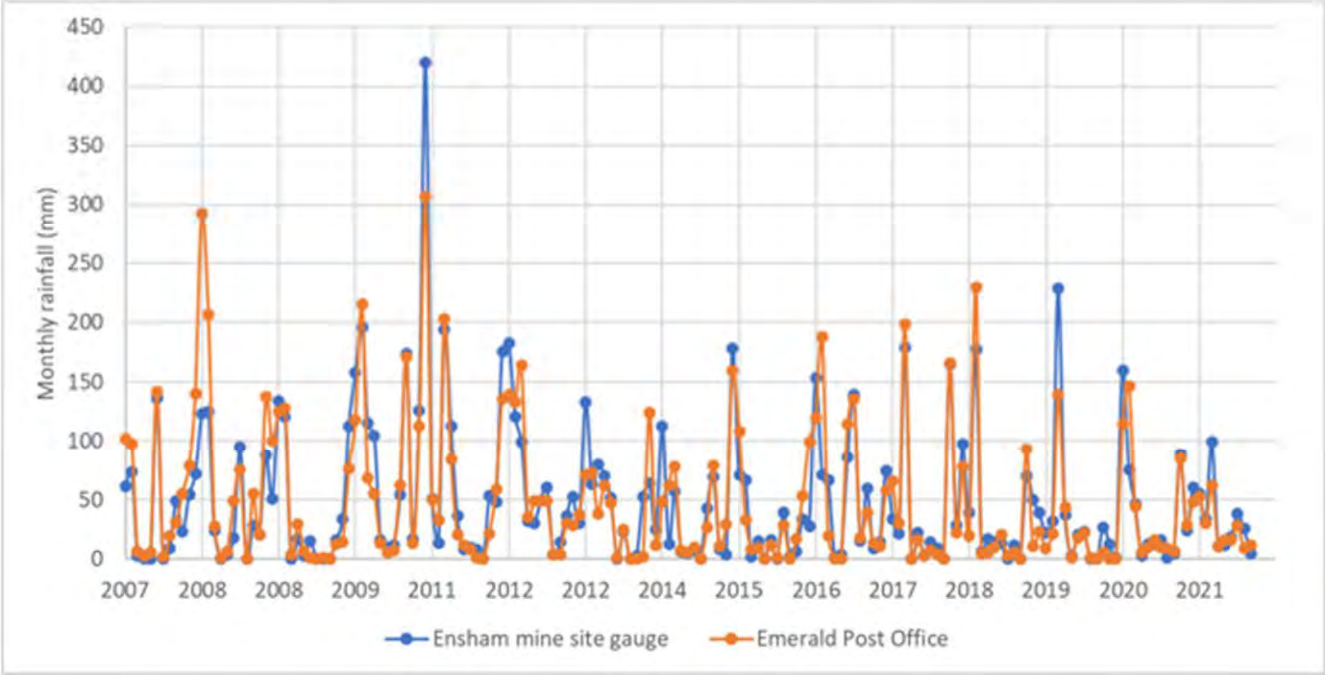


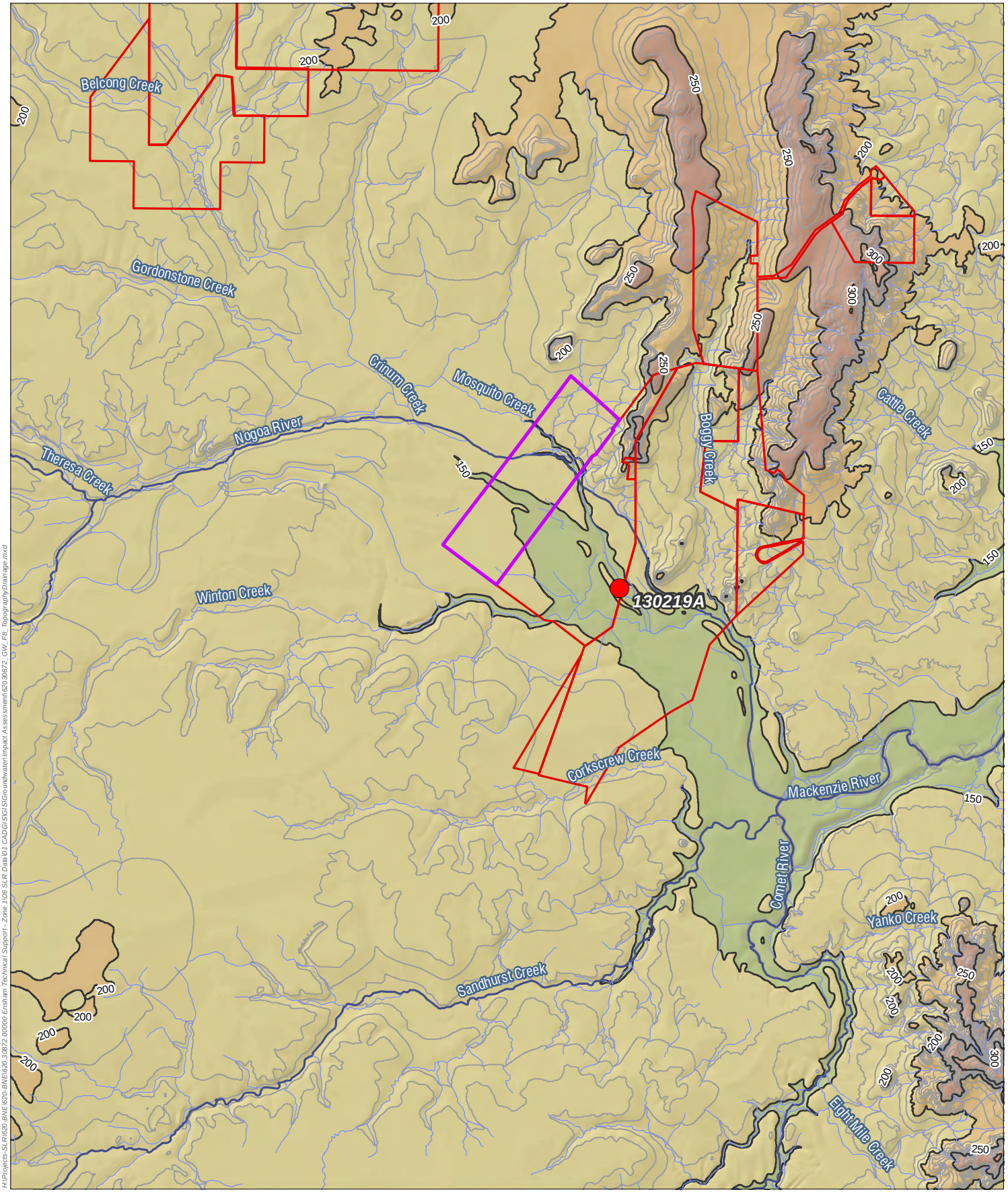
Figure 7 Monthly rainfall at Ensham mine and Emerald Post office (2007-2021)

3.2 Topography and drainage

The terrain in the Study area is generally low-lying, and the few hills within the area are capped by duricrusts. The main drainage of the area is via the Nogoa River, which flows in an easterly and south-easterly direction through the Ensham mining leases before joining the Mackenzie River near the town of Comet. In the Study area, the elevation of the Nogoa River banks average 150 mAHD, with river water used for irrigation and stock water supply, and flows maintained by releases from Fairbairn Dam, located south of Emerald. The low-lying area includes floodplains and riparian zones along the Nogoa River and an anabranch, which runs to the north of the Nogoa River (Figure 8).

Stream flow data for the Nogoa River is collected daily by the Department of Regional Development, Manufacturing and Water at the Nogoa River stream station 130219A (Duck Ponds). Figure 9 shows the monthly mean of maximum river level recorded at Duck Ponds compared against the CRD, which is based on rainfall measured on site. As shown on Figure 9, between 2009 and 2012 the Study area experienced above average rainfall and stream levels, followed by a gradual decline in rainfall to below average conditions between 2014 and 2016. Above average rainfall events between 2016 and 2018 were driving peak flows associated with events of 1:10 annual exceedance probability and these correspond to multiple stream level peaks. Low maximum stream levels since the beginning of 2018 have been the result of relatively low rainfall conditions and regulation of releases from Fairbairn Dam.

Bureau of Meteorology (BoM), 2021 classifies flood levels for station 130219A as minor, moderate and major for water level at respectively 9 m, 10 m, and 11 m above the riverbed. According to this classification, in January 2008 and December 2010 there were two major flood events, and in January 2012 there was a moderate flood event. The latest flood event in October 2021 was minor (Figure 9).



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106\ SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F8_TopographyDrainage.mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Topography and drainage

Figure 8

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	02-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- DNRME Gauge Station #130219A (Nogoa River at Duck Ponds)
- Major Watercourse
- Minor Watercourse
- Topographic Contour (50m)
- Topographic Contour (10m)
- Zone 1
- Mining Lease

Elevation (m)

- < 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 350
- 350 - 500
- > 500

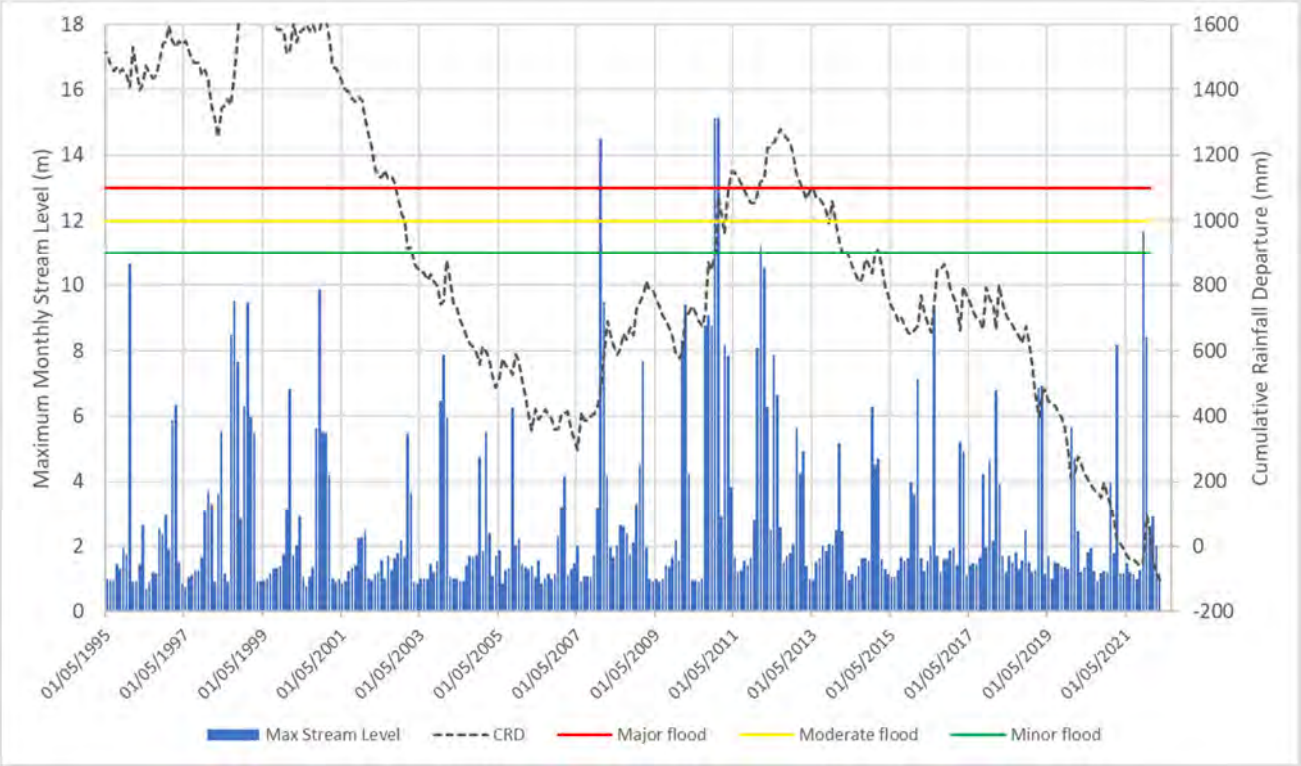


Figure 9 Maximum monthly level for the Nogoa River plotted against CRD

3.3 Land use

Land use in the greater surrounds of the Study area is predominately agricultural and mining. In addition, there are coal seam gas (CSG) developments proposed in the area (Figure 1). These land uses are discussed in the sections below.

3.3.1 Agriculture

Agricultural activities include dry land cropping, cattle grazing and cropping (mainly irrigated cotton growing). In the vicinity of the Project, two areas of regional interest from the Regional Planning Interests Act 2014 (Qld) area applicable:

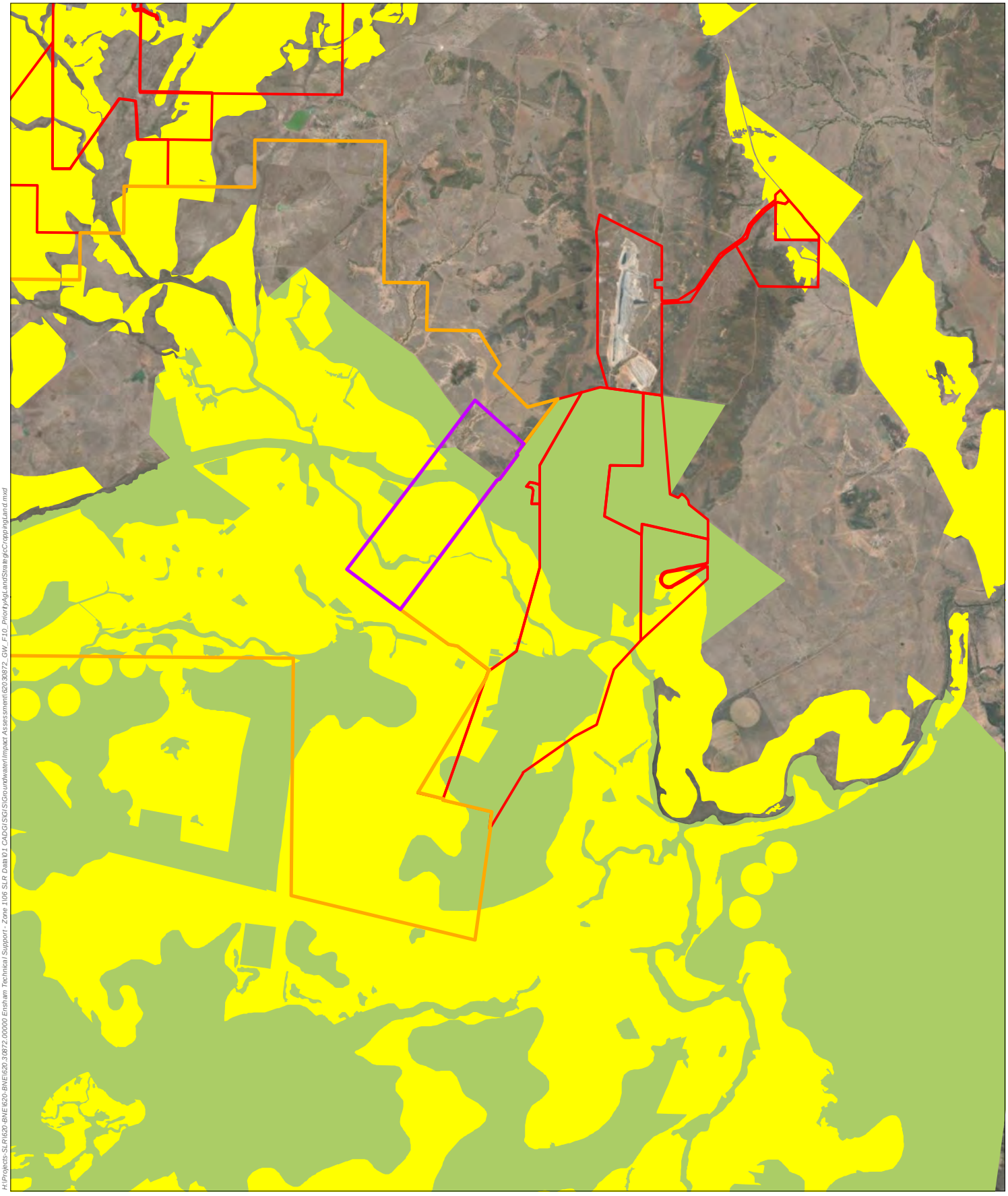
- Priority agricultural areas (PAAs).
- Strategic cropping areas (SCAs).

A PAA is an area of regionally significant agricultural production in which at least one area must be used for priority agricultural land use (PALU). PALUs applicable to the area are summarised in Table 2. PAAs and SCAs located in the Study area are mapped on Figure 10.

Table 2 Priority agricultural land use in the Central Queensland regional plan area

3 Production from dryland agriculture and plantations	4. Production from irrigated agriculture and plantations	5. Intensive uses
3.3.0 Cropping 3.4.0 Perennial horticulture 3.5.0 Seasonal horticulture	4.1.0 Irrigated plantation forestry 4.2.0 Grazing irrigated modified pastures 4.3.0 Irrigated cropping 4.4.0 Irrigated perennial horticulture 4.5.0 Irrigated seasonal horticulture 4.6.0 Irrigated land in transition	5.1.0 Intensive horticulture

In addition to the PAA, the Study area is located within the SCA Western Cropping zone. SCAs are land that is deemed highly suitable for cropping because of a combination of the soil, climate and landscape features (DILPG, 2014). Note that this assessment only lists the land uses as a general reference but does not consider any impacts on the PAA or SCA. These are covered in the Land Quality Report (Appendix A of the Environmental Authority Amendment application).



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106\SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F10_PriorityAgLandStrategicCroppingLand.mxd

0 5 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	02-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Zone 1
- Mineral Development Licence (MDL) 217
- Mining Lease
- Strategic Cropping Land
- Priority Agricultural Land

GROUNDWATER IMPACT ASSESSMENT

Priority Agricultural Areas and Strategic Cropping Land in the vicinity of the project

Figure 10

3.3.2 Mining adjacent to the Project

The Project is located in an existing mining precinct with several coal mines operating nearby. Table 3 lists operating and proposed mines in a radius of 50 km from Ensham mine. Mine operations located within 30 km from the site are detailed in Section 3.3.2.1 to Section 3.3.2.3. All these mines target different coal seams than those targeted by the Project. As such, cumulative impacts are not expected due to the interbedded low permeability layers (aquitards) separating the coal seams (refer to Section 4.4).

The mines located further than 30 km from Ensham mine are also listed in Table 3. Of the six mines further than 30 km away, five are targeting the Rangal Coal Measures (same Coal Measures as the Project), however, the distance means it unlikely that cumulative impacts will occur. The groundwater model therefore did not include any other mining operations.

Table 3 Proposed and current mining operations within 50 km from the Project

Mine	Status	Type of mining operation	Planned Start	Planned End	Distance from Project (km)	Target Coal	Surface water Catchment
Wilton	Proposed	Open-cut	2019	TBD	15	Fairhill Coal Measures	Upper Mackenzie
Kestrel	Operating	Underground	1992	2032	20	German Creek Coal Measures	Nogoa
Gregory Crinum	Operating	Open-cut and underground	1979	TBD	25	German Creek Coal Measures	Nogoa
Fairhill	Proposed	Open-cut	2019	TBD	25	Fairhill Coal Measures	Upper Mackenzie
Oaky Creek	Operating	Open-cut and underground	1982	2033	35	German Creek Coal Measures	Upper Mackenzie
Curragh	Operating	Open-cut	1983	2025	40	Rangal Coal Measures	Upper Mackenzie
Jellinbah	Operating	Open-cut	1989	TBD	45	Rangal Coal Measures	Upper Mackenzie
Blackwater	Operating	Open-cut	1967	2040	40	Rangal Coal Measures	Upper Mackenzie
Yarrabee	Operating	Open-cut	1982	TBD	40	Rangal Coal Measures	Upper Mackenzie
Grasstree	Operating	Underground	2002	2047	45	German Creek Coal Measures	Upper Mackenzie
Foxleigh	Operating	Open-cut	1999	2028	50	Rangal Coal Measures	Upper Mackenzie

3.3.2.1 Gregory Crinum and Kestrel

The Gregory Crinum and Kestrel mines are located 25 km and 20 km north-west of the Project, respectively. Both operations target the German Creek Coal Measures that underlie the Rangal Coal Measures targeted at Ensham mine.

Sojitz recently acquired the Gregory Crinum Mine (GCM), previously owned and operated by BHP Mitsubishi Alliance (BMA). Gregory open-cut mining operations commenced in 1979 while the Crinum underground mining operation started in 1997. The mine ceased production and was placed on care and maintenance by BMA in November 2015. Sojitz resumed operations in October 2019.

The Kestrel Mine, owned by Kestrel Coal Resources and Mitsui Investments, is an underground coal mine which currently produces 7-8 Mtpa of predominantly hard coking and some thermal coal and more than 5 Mtpa of product. Mine life is currently estimated at 35 years with 2017 reserves of 146 Mt and resources of 241 Mt (QRC, 2019).

Both GCM and Kestrel share the same numerical groundwater flow model. According to the 2015 model update by AGE, 2015, the maximum extent of drawdown in all hydrogeological units was predicted to be less than 15 km from the two mines. Therefore, as the mines are located over 20 km from the Project and are mining the Coal Seams in the German Creek Coal measures, there is limited potential for cumulative impacts.

3.3.2.2 Wilton

The Wilton Coal Project (WCP) is a proposed open-cut coal mine located 15 km north-east of the Project. WCP aims to excavate the high ash coal of the Burngrove Formation (Burngrove Seam), which will be trucked to established mining facilities at GCM for processing. Approximately 1.65 Mtpa of export quality thermal and coking coal products is expected to be produced from the WCP.

An analytical model developed by Northern Resources Consultant (NRC, 2018) predicted that some private bores intersecting the Burngrove Formation could be impacted by the WCP (Table 4).

Table 4 Predicted drawdown at private bores from the Wilton Coal Project

Registered RN (ID)	Bore name	Easting (mMGA)	Northing (mMGA)	Bore depth (m)	Use	Geology	Predicted drawdown from WCP (m)
89383	Yongala	657586	7415693	74	Stock	Burngrove Formation	1.9
89382	-	657253	7415184	74	Stock	Burngrove Formation	1.4
89384	-	657691	7416083	78	Stock	Burngrove Formation	2.6

The WCP targets the Burngrove Formation, which underlies the Rangal Coal Measures targeted at the Ensham mine. Due to the structural geology, discussed further in Section 4, the Rangal Coal Measures are absent at the WCP. Therefore, there is limited potential for cumulative impacts between the WCP and the Project.

3.3.2.3 Fairhill

The Fairhill Coal Project (FHCP) is located 25 km north-east of the Project. The FHCP tenement covers a total exploration area of approximately 3,045 ha. The FHCP is a proposed open-cut mine, aiming to produce a maximum of 1.7 Mtpa of primarily coking coal extracted from coal seams of the Fairhill Formation, which underlies the Burngrove Formation.

Mining operations proposed at the FHCP site are scheduled to last for seven years and will include the development of a shallow greenfield open-cut mine targeting coal from the Fairhill 1 and 2 coal seams. The operation will be by cut and fill method, with the mine excavation progressing from east to west. The pit will reach a minimum elevation of 130 mAHD, leaving a final void 20 m to 30 m deep.

A 2D numerical groundwater flow model was developed by SLR for the FHCP (SLR, 2019). The model predicts a drawdown radius of 4.5 km from the open-cut mine pit. The groundwater assessment findings for FHCP and the geology of the site indicates there is no potential for cumulative impacts between the FHCP and the Project.

3.3.3 Petroleum

Exploration permits of varying types were identified within the Study area. Table 5 identifies the allocation type, permit number, holder of these existing permits and if the permit intersects Zone 1. The location of those permits is also shown on Figure 1.

The target coal seams for ATP 806 and associated PCA 237 (previously PCA 170) are the Rangal Coal Measures, the same as targeted by the Project (Golder, 2017). The exact location of the potential CSG extraction wells is unknown.

For ATP 1177 associated PCA 154, two well completion and abandonment reports were identified on GeoResGlobe (GeoResGlobe, 2020). These reports showed that two exploration wells were drilled into the Bandanna Formation (an equivalent for the Rangal Coal Measures), where they ended. As these coal measures are the shallowest of the Blackwater Group, it is interpreted that the potential future CSG wells would target the same coal seams as the Project.

Table 5 Exploration permits across the Study area

Allocation type	Permit Number	Purpose	Expiry date	Holder	Intersects Zone 1
Potential Commercial Area – Petroleum	PCA 327	Petroleum	Currently lodged, not approved yet.	Ome Resources Australia Pty Ltd (75%) and CNOOC Coal Seam Gas Company Pty Ltd (25%)	Yes
Authority to Prospect	ATP 1177	Petroleum	30 November 2025	Denison Gas (Queensland) Pty Ltd	Yes
Potential Commercial Area – Petroleum	PCA 154	Petroleum	25 June 2029	Denison Gas (Queensland) Pty Ltd	Yes

4 Geology

The Project is located in the geological western Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin is the largest productive coal basin in the country. It stretches from Townsville to south of the Queensland-New South Wales border, in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap. The Rewan Formation is recognised as the base aquitard of the GAB (Habermehl, 1980 and 1998). An aquitard is defined as a geologic formation or stratum that lies adjacent to an aquifer and that allows only a small amount of liquid to pass. In the Study area, the Rewan Group is present at subcrop.

The stratigraphic sequence across the Study area comprises unconsolidated Quaternary aged sediments unconformably overlying consolidated Permian and Triassic aged sequences (Figure 11). The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular. The coal deposits mined at Ensham mine are found within the Rangal Coal Measures, which is the uppermost Permian unit (Figure 12).

The surface geology of the Study area is dominated by the Nogoa River alluvium to the south and the Tertiary Sediment to the south and the north (Figure 11).

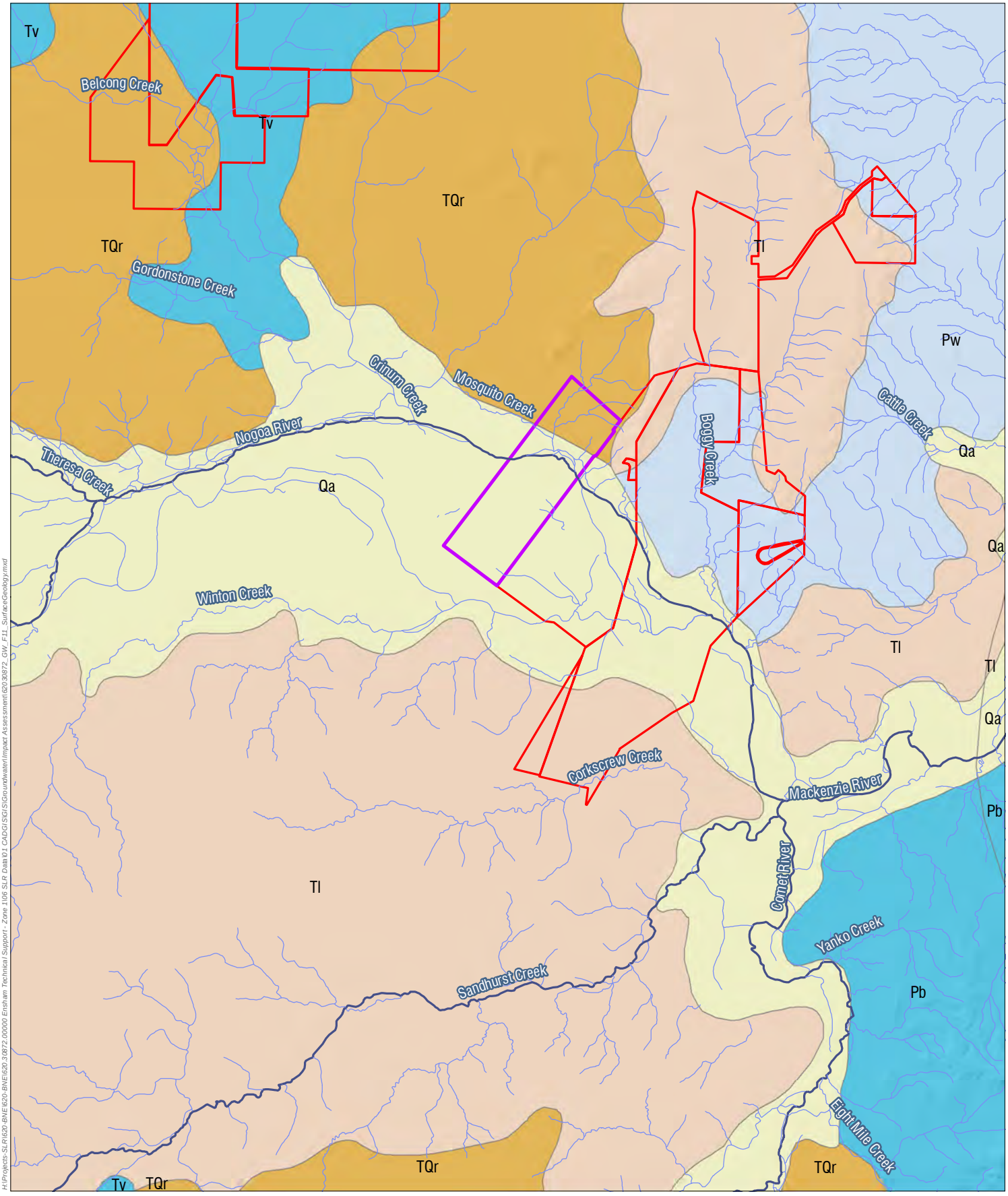
Table 6 provides a summary of the stratigraphy encountered in the Study area. Discussion on each of the main stratigraphic units relevant to the Project is included in Section 4.1 and Section 4.4, and details on the structural geology provided in Section 4.5. Appendix A presents the interpolated extent and thickness of all formations as well as the elevation of the base of each layer for the greater Ensham mine area.

Table 6 Summary of stratigraphy in the Study area

Age	Unit	Max Thickness[1] (m)	Description
Quaternary	-	25	Alluvium – silt, clay, sand and gravel
Tertiary	-	ND	Duricrusted palaeosols at the top of deep weathering profiles, including ferricrete and silcrete; duricrusted old land surfaces
	Emerald Formation	50	Fluviatile and lacustrine claystone and siltstone, quartzose sandstone, pebbly sandstone, gravel, lignite, oil shale, interbedded basalt; all deeply weathered in outcrop
	Basalt	ND	Tertiary volcanics (basalt) mapped as being present over 10 km west of the site
Triassic	Rewan Group	200	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base); deposited in a fluvial-lacustrine environment
Permian	Rangal Coal Measures	125	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion seams. The main economic seams at Ensham are the Aries 2 and Castor seams. Deeper seams include the Pollux and Orion seams.
	Burngrove Formation	200	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones – coal seams include the Virgo and Leo seams
	Fair Hill Formation	150	Lithic and feldspathic labile sandstone, siltstone, mudstone and conglomerate
	Macmillan Formation	100	Lithic and feldspathic sublabile mudstone, siltstone and sandstone

[1] Approximate maximum thickness based on available exploration holes and/or relevant literature

ND: not defined, not enough data available



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 10\6 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F11_SurfaceGeology.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	02-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Major Watercourse
- Minor Watercourse
- Zone 1
- Mining Lease

Surface Geology

Quaternary
- Quaternary alluvium (Qa)

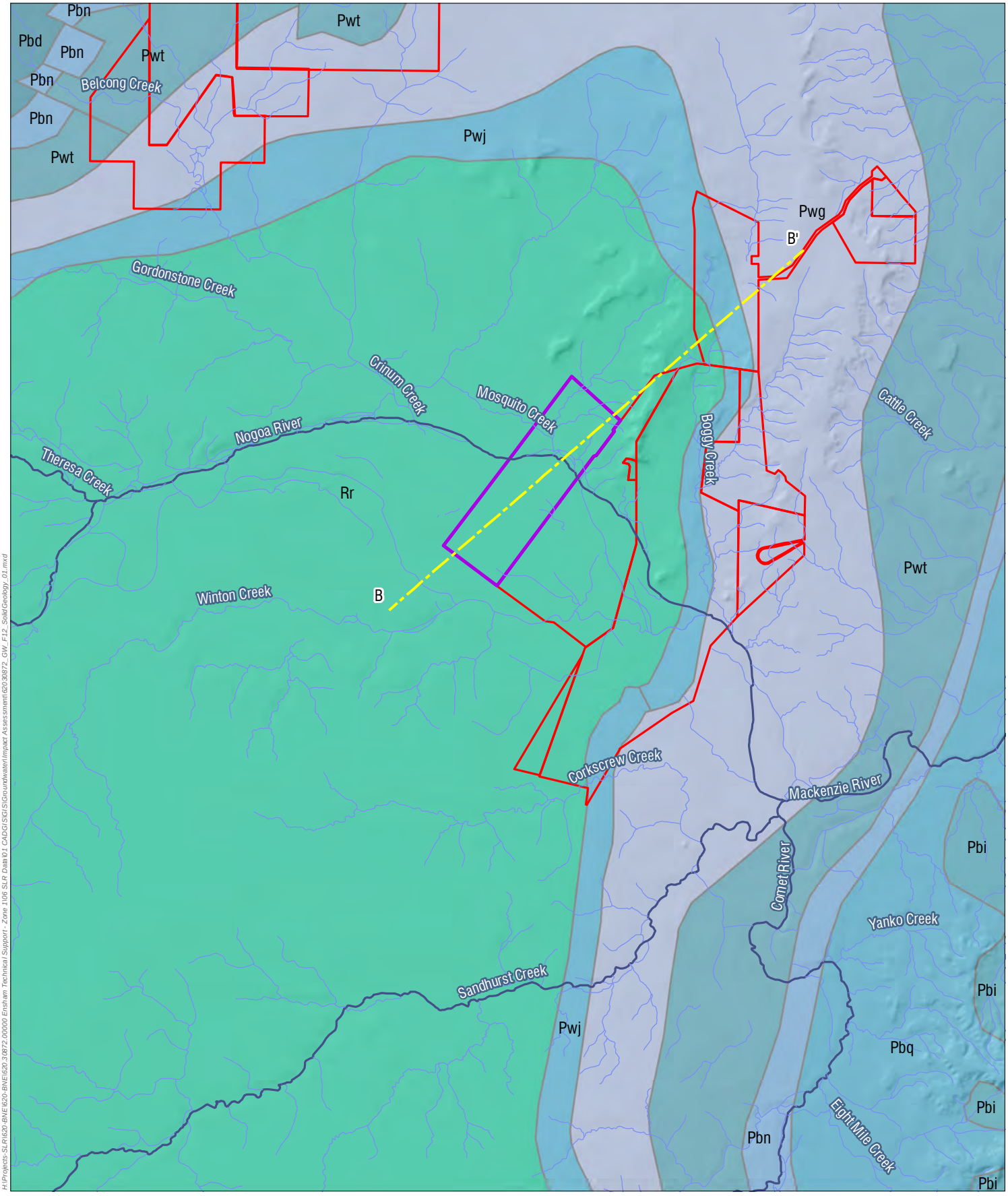
Tertiary
- Paleocene-Oligocene sediments (Tl)
- TQr-QLD (TQr)

Permian
- Blackwater Group (Pw)
- Back Creek Group (Pb)

GROUNDWATER IMPACT ASSESSMENT

Surface Geology

Figure 11



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106\SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F12_SolidGeology_01.mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Solid Geology

Figure 12

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

SLR

Legend

- Cross section
- Major Watercourse
- Minor Watercourse
- Zone 1
- Mine Lease

Solid Geology

- Burngrove Formation (Pwg)
- Crocker Formation (Pbq)
- Fair Hill Formation,Fort Cooper Coal Measures (Pwt)
- German Creek Formation (Pbd)
- Ingelara Formation,Maria Formation (Pbi)
- MacMillan Formation (Pbn)
- Rangal Coal Measures (Pwj)
- Rewan Group (Rr)

4.1 Quaternary alluvium

The Quaternary age alluvial sediments unconformably overlie the Triassic age Rewan Group and Permian age coal measures. A weathering surface is evident at the unconformable contact.

Within the Nogoa River floodplain, the alluvial sequence comprises silt and clay underlain by a basal unit of sand and gravel. The alluvium is itself overlain by a deep clay-rich black soil, which tends to be highly absorbent during rainfall events. The alluvial sequence varies in thickness, with a maximum observed depth of 25 m.

4.2 Tertiary age sediments

Tertiary formations include the duricrusted paleosols on top of deep weathering profiles (labelled as “Tertiary QLD” in the state geology database, accessed via QLD Globe) and the Emerald Formation. The Emerald Formation primarily consists of fluviatile and lacustrine claystone, siltstone, sandstone and mudstone, all deeply weathered in outcrop. Tertiary age volcanics (basalt) are mapped as being present over 10 km west from the site (Hydrosimulations, 2020).

4.3 Triassic age Rewan Group

The Rewan Group overlies the Permian coal measures and occurs as in-fill material, thickening to the west with the dip of the coal measures and thin to the east where the coal measures occur at outcrop (Figure 47). Where present, the Rewan Group has a distinct greenish tint in colour (non-marine deposits containing glauconite) and is composed of siltstone and mudstone, with interbeds of lithic and volcanic sandstones.

Based on exploration holes and groundwater bore holes, the Rewan Group is not expected to be more than 200 m thick in Study area. Across the Project it is between 50 m and 150 m thick. The Rewan Group forms an aquitard between the coal and the alluvium.

4.4 Permian Rangal Coal Measures

The Rangal Coal Measures consist of interbedded sandstone, siltstone, mudstone, and coal with tuff (towards the base) and have a thickness of up to 100 m in the Study area. The coal seams outcrop / subcrop over a strike length of about 80 km in north-south direction at the Ensham mine to the east of the Project. To the north, the outcrop / subcrop changes direction and is showing east to west. The shape of the outcrop / subcrop can be seen on Figure 12. It forms part of the syncline basin plunging to the south-west.

The coal seams targeted at Ensham mine include the Aries A1 Seam, Aries 2-Castor Seam (A2C) which has combined average thickness of 4.3 m, and the Castor Seam Lower Split (C22) which is between 0.2 m and 0.4 m thick. The seams are separated by a mudstone parting that varies between 0.1 m and 0.4 m in thickness. The Pollux Seam is a banded seam and is only mined within the Yongala (Y Pit) where it is close to the C22 Seam (AGE, 2006).

The targeted seams for the Project are the thickest Aries and Castor Seams (A2C1, A2C, A3C, A22C and A22C1) and Castor Seam (where the Aries seams thin out). A schematic representation of the coal seam stratigraphy across the area studied by Gordon Geotechniques, 2016 is presented on Figure 13.

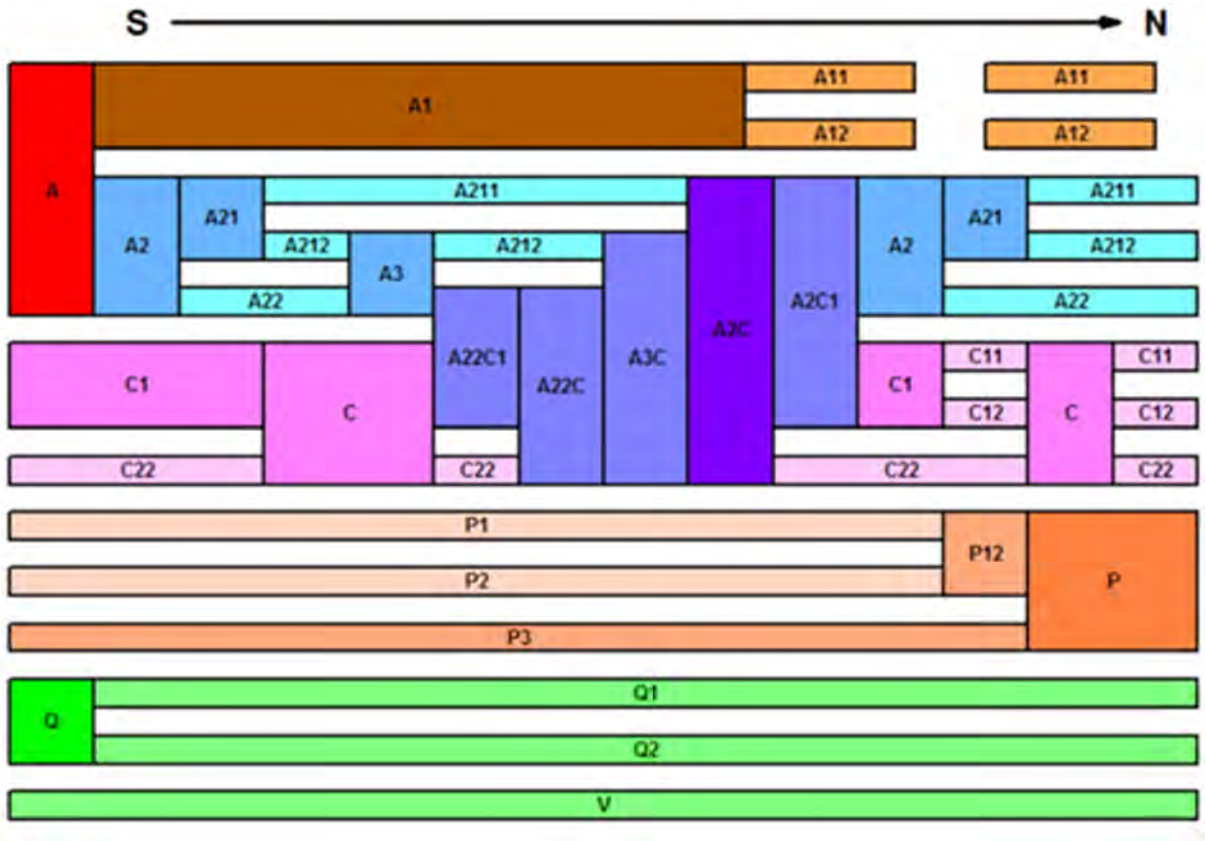


Figure 13 Coal seam stratigraphy of the Rangal Coal Measures

4.5 Structural geology

The structural geology of the Bowen Basin includes major north-west to south-east trending faults, like the Jellinbah Fault and Yarrabee Fault located over 40 km east of the Project. However, no regional-scale faults have been mapped within the Study area.

The Permian age lithostratigraphy at Ensham mine outcrops on the eastern side of a syncline structure that is plunging to the south-west (Figure 12). The Permian and Triassic sediments, intersected within the Ensham open-cut, dip in a westerly direction at generally less than five degrees towards the synclinal axis.

There is limited mapped information available with regards to faults in the region. AGE (2006) reported that, where present, faulting is generally normal, trending east to west, to south-east to north-west, with throws of less than 10 m, although occasional low angle thrust faulting has been noted. The local faults (AGE, 2017) are presented on Figure 15 in Section 5.2.2.

5 Hydrogeology

The principal groundwater bearing strata in the Study area are associated with the Permian coal seams and the Quaternary alluvium. The siltstones and sandstones that make up the majority of the overburden are considered aquitards.

This section discusses each of the hydrogeological units relevant to the Project, describing groundwater hydrology (groundwater occurrence, hydraulic gradients, recharge and discharge), hydraulic properties, groundwater quality and groundwater use and management. The existing conceptual model (SLR, 2020 and SLR, 2021) for the Study area was refined with the most recent groundwater monitoring dataset.

5.1 Current groundwater monitoring

The existing mining activity at Ensham mine is operating under EA permit EPML00732813, which specifies a groundwater monitoring program. This groundwater monitoring program is presented in Table I1 of the current EA) and reproduced in Table 7, together with bores that are not part of the EA but are monitored for operational or investigative purposes. The locations of the bores listed in Table 7 are presented in Figure 14.

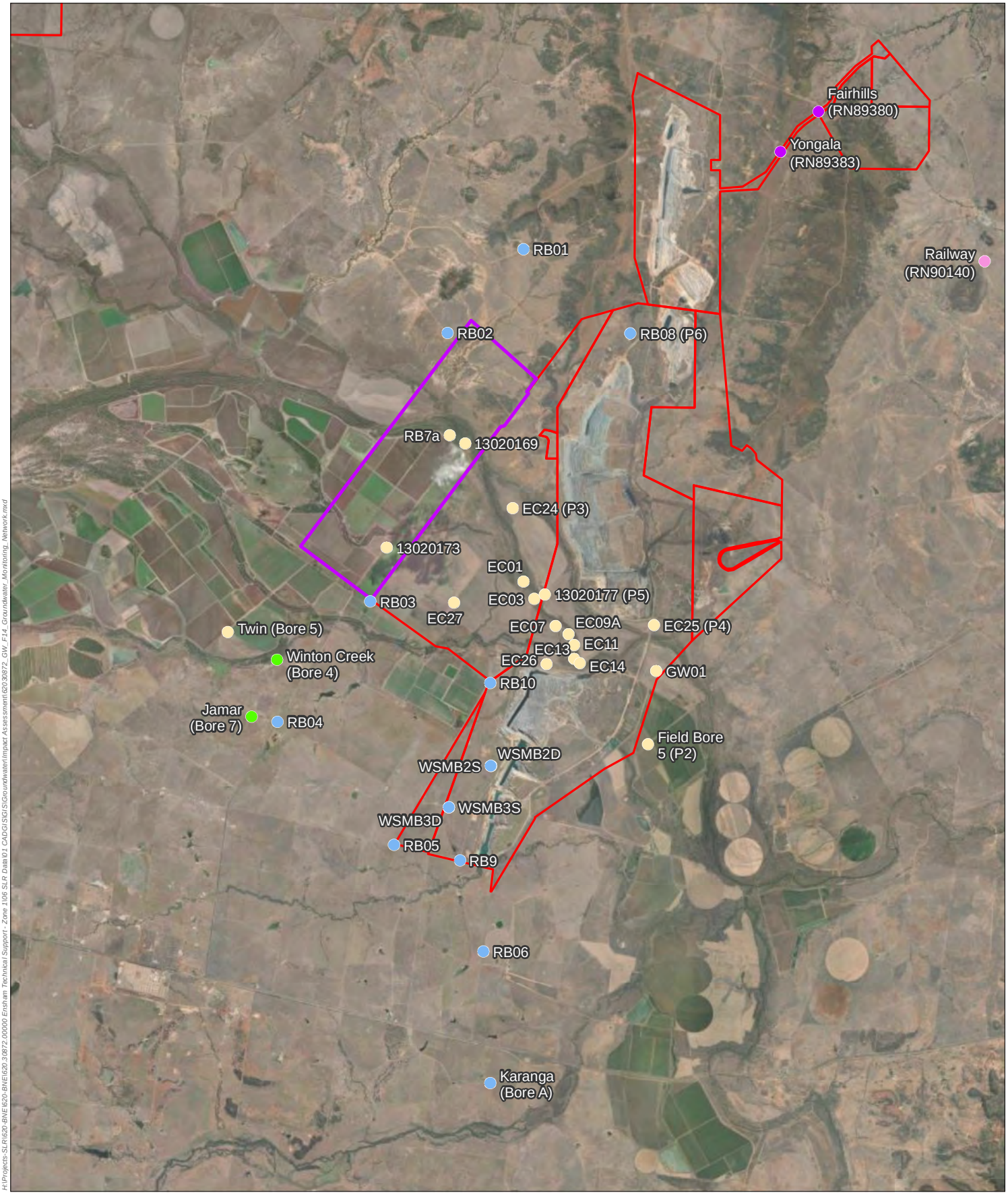
Groundwater monitoring is currently being completed at Ensham Mine as per the groundwater monitoring program, however it should be noted that the groundwater monitoring data presented in this report is presented up to September 2021. This presentation of data is to align with data used within the groundwater modelling used for the impact assessment as outlined in Section 6.

Table 7 Monitoring network

EA location	Monitoring Point	Easting GDA2020, Z55	Northing GDA2020, Z55	TOC elevation (mAHD)	Screen Interval (mBGL)	Aquifer
Nogoa River Alluvium	EC01	650018.7206	7403060.43	154.3	14-17	Alluvium
Nogoa River Alluvium	EC03	650338.7246	7402548.436	153.2	12.3-15.3	Alluvium
Nogoa River Alluvium	EC07	650973.7191	7401747.432	153.9	12.6-15.6	Alluvium
Nogoa River Alluvium	EC09A	651354.7173	7401505.432	153.5	15.1-18.1	Alluvium
Nogoa River Alluvium	EC11	651517.729	7401193.437	152.7	14.3-17.3	Alluvium
Nogoa River Alluvium	EC13	651517.721	7400777.433	152	12.2-15.2	Alluvium
Nogoa River Alluvium	EC14	651676.7252	7400654.428	146.1	8.7-11.7	Alluvium
Nogoa River Alluvium	GW01	653926.8858	7400423.867	153	To 19.8	Alluvium
Nogoa River Alluvium	RB7a	647853.5889	7407354.491	157.08	9-15	Alluvium
Nogoa River Alluvium	13020166	635531.3831	7407076.773	161.87	15.2-17	Alluvium
Nogoa River Alluvium	13020169	648298.962	7407123.449	156.22	14-15.8	Alluvium
Nogoa River Alluvium	13020173	645994.6942	7404061.441	155.43	9.2-11.20	Alluvium
Residual void bore	WSMB2S	649062.7195	7397630.405	173	43-49	Rangal Coal Measures (Overburden)
Residual void bore	WSMB2D	649059.718	7397631.441	173	97-107	Rangal Coal Measures (Coal Seam)

EA location	Monitoring Point	Easting GDA2020, Z55	Northing GDA2020, Z55	TOC elevation (mAHD)	Screen Interval (mBGL)	Aquifer
Residual void bore	WSMB3S	647826.7212	7396414.432	174	6-21	Rangal Coal Measures (Overburden)
Residual void bore	WSMB3D	647826.7212	7396411.433	174	60 – 72	Rangal Coal Measures (Coal Seam)
Residual void bore	Field 5 Bore	653684.6907	7398272.681	151.22	Unknown	Alluvium
Residual void bore	EC24	649701.5688	7405215.604	156.62	13-16	Alluvium
Residual void bore	EC25	653870.36	7401767.639	150.817	12.5-15.5	Alluvium
Residual void bore	EC26	650709.9111	7400633.792	153.449	10-13	Alluvium
Residual void bore	13020177	650656.914	7402668.581	154.37	14.9-15.9	Alluvium
Residual void bore	RB8	653163.0786	7410350.525	187.212	104.5-107.5	Coal seam
Residual void bore	RB9	648145.7775	7394854.485	163.694	96-99	Coal seam
Residual void bore	RB10	649043.3571	7400077.246	157.19	149-153	Coal seam
Regional bores (Ensham mine)	RB01	650016.9098	7412834.779	187.73	95.5-97.0	Rangal Coal Measures Coal (A2C)
Regional bores (Ensham mine)	RB02	7410365.679	7410365.679	160.6	149-153	Rangal Coal Measures Coal
Regional bores (Ensham mine)	RB03	645508.5133	7402465.191	156.49	137.5-143.5	Rangal Coal Measures Coal (A2C)
Regional bores (Ensham mine)	RB04	642783.3871	7398932.789	175.89	205.25-208.25	Rangal Coal Measures Coal (A21)
Regional bores (Ensham mine)	RB05	646451.4097	7395428.036	173.35	237.1-240.1	Rangal Coal Measures Coal (A21)
Regional bores (Ensham mine)	RB06	648835.1788	7392168.63	177.06	227.3-230.3	Rangal Coal Measures Coal (A2C)
Regional bores (Private Property)	Karanga (Bore A)	642025.7281	7388305.439	172.97	54-60	Coal Measures (not specified)
Regional bores (Private Property)	Winton Creek (Bore 4)	657586.7268	7400759.432	157.31	To 60	Rewan Group
Regional bores (Private Property)	Twin (Bore 5)	658696.7206	7401568.434	158.39	To 18	Basal Alluvium
Regional bores (Private Property)	Jamar (Bore 7)	663591.7298	7399085.428	183.43	To 90	Rewan Group
Regional bores (Private Property)	Yongala (RN89383)	647976.743	7415694.432	266	65 – 71	Burngrove Formation
Regional bores (Private Property)	Fairhills (RN89380)	658696.7206	7416878.428	265	42 – 54	Burngrove Formation
Regional bores (Private Property)	Railway (RN90140)	663591.7298	7412471.432	181	18 – 61	Fair Hill Formation
Additional (not in EA)	EC27	647976.743	7402436.55	154.414	12.5-15.5	Alluvium

mBGL – metres below ground level



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F14_Groundwater_Monitoring_Network.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:150,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Zone 1
- Mining Lease

Monitoring Network by Aquifer

- Alluvium
- Rewan Group
- Rangal Coal Measures
- Burngrove Formation
- Fair Hill Formation

GROUNDWATER IMPACT ASSESSMENT

Groundwater Monitoring Network

Figure 14

5.2 Hydraulic properties

5.2.1 Hydrogeological units

Reported hydraulic and storage properties of key formations in the broader Bowen Basin have been gathered from various sources and summarised in Table 8. Not unexpectedly, there is a very wide range of values in each formation. Table 8 lists the horizontal hydraulic conductivity (Kh), the vertical hydraulic conductivity (Kv), the specific yield (Sy) and the specific storage (Ss).

Coffey (2014) compiled packer testing data from mines in the northern Bowen Basin and found that although there was a degree of variability in the dataset due to irregular fracturing, there is a general trend of reducing hydraulic conductivity with depth. This is likely due to increasing overburden pressure resulting in a reduction in fracture aperture with depth. Hydraulic conductivity of the coal seams is typically three times higher than that of the interburden.

A historic study by AQC-Pacific Pty Ltd,1986 found that the horizontal hydraulic conductivity of the Castor Seam ranged between 0.3 m/day and 5.9 m/day. A study was also conducted by Sigra in 2013 at Ensham mine, involving packer testing of two exploration holes that intersect the Rangal Coal Measures at Ensham mine, C4878 and C4879. The results indicate that hydraulic conductivity within the A22 and A2C seam can range between 0.07 m/day and 0.2 m/day at depths greater than 88.5 m below surface.

Table 8 Summary of adopted hydraulic properties from other Bowen Basin studies

Age	Formation	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	Source
Quaternary	Alluvium	1.00E+00 to 4.00E+01	1.00E-01 to 2.50E+01	5.00E-02 to 1.80E-01	5.00E-04	2
		1.00E+02	1.00E+01	2.50E-01	1.00E-03	1
		7.00E-01 to 1.50E+00				3
		1.00E+01	1.00E+00	2.00E-01	1.00E-04	7
		8.80E-02 to 3.80E-01				5
		1.00E+01	1.00E+00	1.00E-01	1.00E-05	10
			3.80E-01 to 8.40E+00			12
		1.50E+00	3.80E-01	1.20E-01	8.60E-06	14
		1.00E+00				15
		7.00E-03 to 4.20E+00				16
		2.00E-02	4.00E-03			15

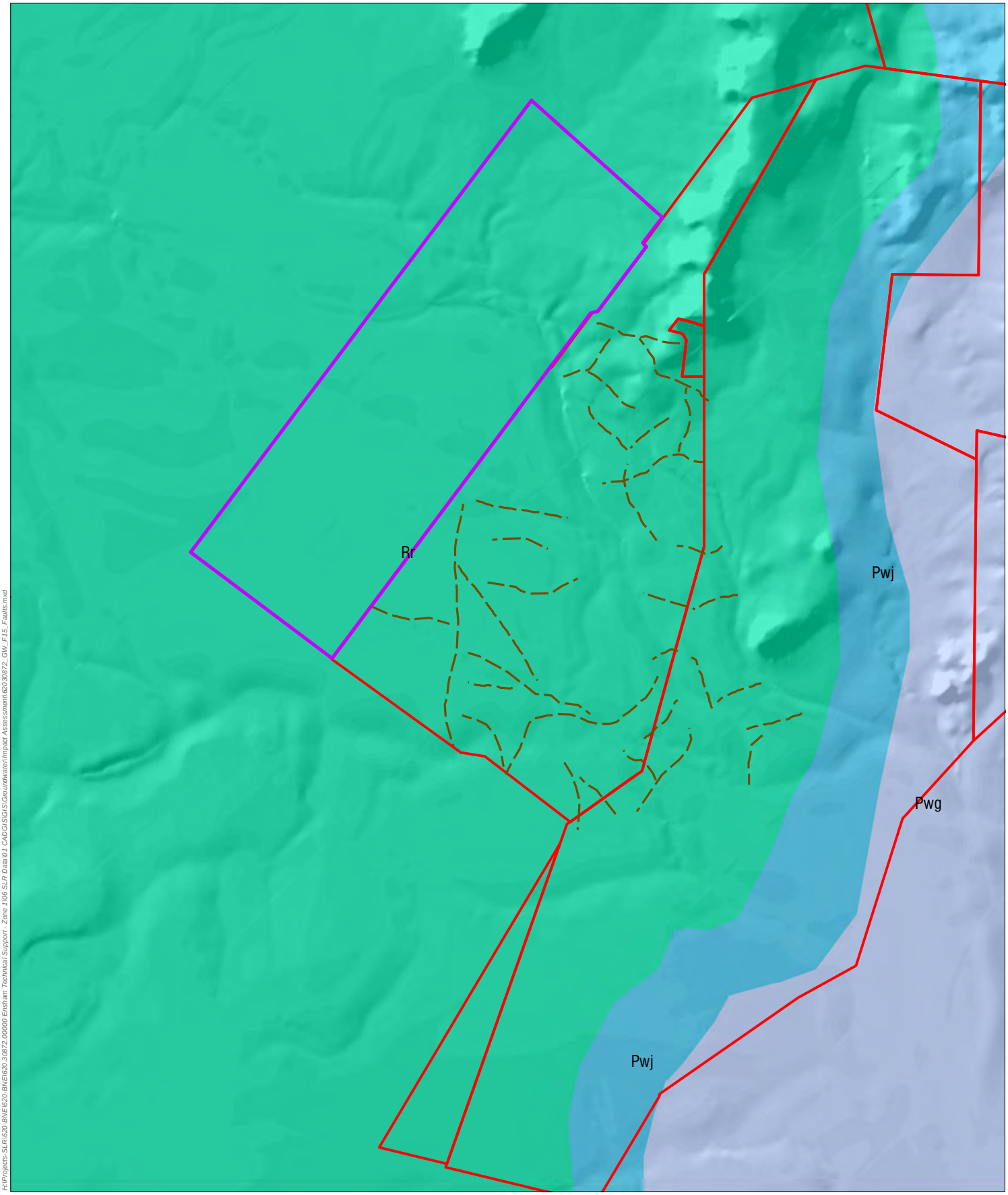
Age	Formation	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	Source
Tertiary	Basalt	1.00E-01 to 1.00E+01	5.00E-03 to 1.00E+00	5.00E-02 to 2.00E-01	5.00E-07 to 5.00E-05	2
		6.10E-03 to 6.20E-01				13
		1.10E-01				16
		5.00E-01	1.00E-01			15
	Undifferentiated Tertiary Sediments	4.30E-01				13
		5.00E-01	1.30E-01	5.00E-02	8.60E-06	14
		1.00E-02	2.00E-03			15
Triassic	Rewan Group	1.00E-05 to 1.00E-04	1.00E-06 to 1.00E-04	5.00E-03	1.00E-06	1
		1.00E-01		5.00E-02	5.00E-06	6
		1.00E-04	1.00E-05	1.00E-02	1.00E-05	10
		3.60E-04	7.40E-06			11
		1.30E-05 to 2.70E-03	5.80E-09	3.00E-05		12
			2.20E-08			13
		5.00E-04 to 5.00E-02	1.00E-07 to 1.00E-04	1.00E-01 to 2.50E-01	5.00E-06 to 5.00E-04	2
		2.00E-03	5.00E-04			14
		1.00E-03	2.00E-04	3.00E-02	8.60E-06	15
		9.00E-04	5.40E-05			9
Permian	Rangal Coal Measures – coal seams	2.80E-03 to 4.70E-02				4
		1.00E-05 to 5.00E-02	5.00E-04 to 5.00E-03	0.01 to 0.12	5.0E-6 to 5.0E-4	2
		1.00E-02	2.50E-03	5.00E-02	8.60E-06	14
		2.00E-05 to 2.30E+00	2.00E-06 to 1.00E-01			15
						3
		1.00E-06 to 1.00E+00	1.00E-06 to 1.00E+00	1.00E-02	1.00E-06	1
		1.10E-01 to 9.00E-01		8.00E-02	4.00E-04	7
		5.00E+00		5.00E-02	5.00E-06	6
		5.00E-02	5.00E-03	1.00E-02	1.00E-05	10
		9.00E-04	1.80E-05			9
	Rangal Coal Measures – Interburden	1.00E-04	7.00E-08	5.00E-02	1.00E-05	2
		1.20E-01	3.00E-02	3.00E-02	8.60E-06	14

Age	Formation	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	Source
		2.00E-05 to 2.00E-02	2.00E-05 to 2.00E-03			15
		1.00E-01		5.00E-02	5.00E-06	6
		1.00E-03	1.00E-05	1.00E-02	1.00E-05	10
1: AGE (2006); 2: Ausenco-Norwest (2012); 3: JBT (2012); 4: Parsons Brinckerhoff (2011); 5: URS (2009); 6: BHP Billiton Mitsubishi Alliance (2009); 7: Matrix Plus (2010); 9: AGE (2013); 10: CDM Smith (2013); 11: GHD (2013); 12: OGIA (2016); 13: Coffey (2014); 14: JBT(2016); 15: KCB (2016); 16: AGE (2015						

5.2.2 Faults

Faults can increase permeability within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane (Jourde et al., 2002). Coffey (2014) developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin. The study found that strata perpendicular to the fault plane recorded a hydraulic conductivity one to three orders of magnitude lower than the regional host rock, and the damage zone (parallel to the fault plain) approximately one order of magnitude higher. However hydraulic conductivity within the damage zone is also dependent on timing, with hydrothermal alternation and mineralisation filing the fractured pore space over time (Paul et al., 2009; Uysal et al., 2000).

The Project targets Permian aged coal seams within the Bowen Basin, where faulting has been inactive for over 140 million years (Clark et al., 2011). No regional-scale faulting has been mapped, according to basement geology mapping (refer to Section 4.5). However, site observations indicate that there is local faulting in the currently approved MLs (Figure 15). These faults (AGE, 2017) have been included in the groundwater model (refer to Section 6.4.2) as low permeability zones.



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106\SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F15_Faults.mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Local faults

Figure 15

Projection: GDA 1994 MGA Zone 55
Scale: 1:75,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Faults
- Zone 1
- Mining Leases

Solid Geology

- Rewan Group (Rr)
- Rangal Coal Measures (Pwj)
- Burngrove Formation (Pwg)

SLR
www.slrconsulting.com

5.3 Groundwater levels, flow, recharge and discharge

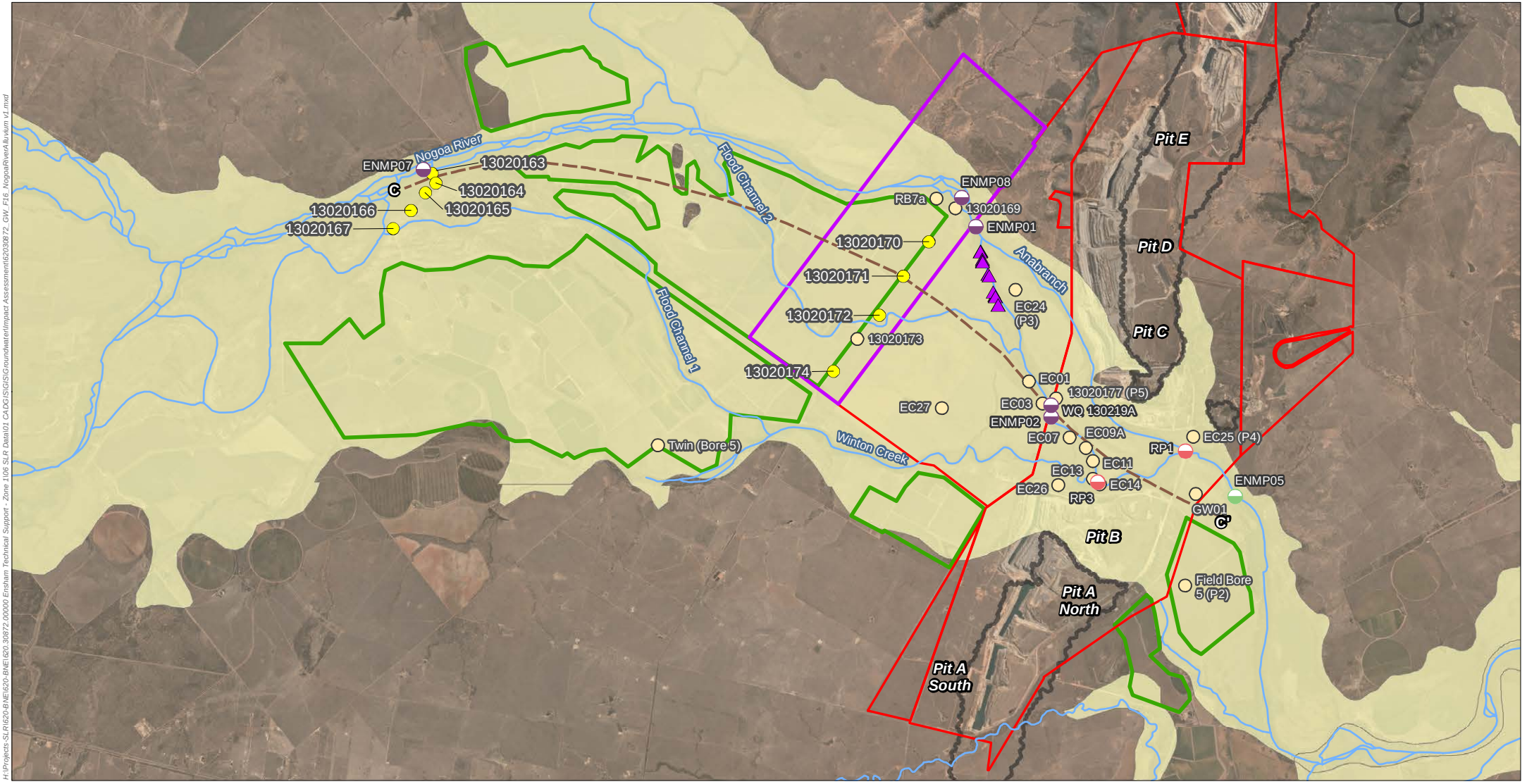
5.3.1 Quaternary sediments (alluvium)

5.3.1.1 Water levels

Figure 16 shows the location several alluvial bores discussed in this section, the surface water features, irrigation extent, alluvial extent, mining leases and Rangal Coal measures sub-crop.

The Nogoa River is conceptualised as having a limited connectivity to the alluvial groundwaters. To understand the dynamics of the groundwater interactions with the Nogoa River, three sets of plots have been prepared for the following bores:

- Department of Resources bores RN13020163-13020167, located upstream of much of the irrigation area, close to the Nogoa River. An extensive levee system separates the irrigated paddocks from the monitoring bores (Figure 17).
- Department of Resources bores RN13020169-13020174, located immediately downstream of irrigation area, 13020169 located closest to the Nogoa River, 13020174 located furthest from river, all bores upstream of current Ensham mine. All bores are located less than 100m from irrigated paddocks (Figure 18).
- EC-Bores series, located closer to the Ensham mine, encompassing the sub-crop of the Rangal Coal measures (Figure 19).



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30686
Date:	19-Jul-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Nogoa River Groundwater Seeps
- Alluvial Bore (Historical)
- Alluvium Monitoring Bore (Ensham Mine Network)
- Cross Section

Surface Water Monitoring

- Downstream
- Mine Area (release)
- Upstream

- Watercourse
- Alluvium
- Coal Outcrop/subcrop

- Irrigation Area
- Zone 1
- Mining Lease

GROUNDWATER IMPACT ASSESSMENT

Nogoa River Alluvium

Figure 16

H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 1\06 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F16_NogoaRiverAlluvium v1.mxd

Upstream Bores

Water level data for bores RN1320163 to RN 1320166 were accessed via the Queensland Groundwater Database, (Department of Regional Development, Manufacturing and Water), as shown on Figure 17. The bores upstream of the irrigation and mine are deemed to reflect the natural interaction between the Nogoa River alluvium and the Nogoa River. Particularly the time before 2000 is considered reflective of natural conditions, as no other anthropogenic impacts to the area were apparent at that time.

The Nogoa River was subject to three flood events (January 1996: moderate, September 1998 and January 1999: minor, also refer to Figure 9). The bore closest to the river, RN13020163, was dry during that period and shows no response to the increased water level in the river. Bore RN13020164, second closest to the river, does not show any response to the moderate flood even in January 1996, although it did show a response (of approximately one metre as seen in Figure 17) following the major flood event in January 2008. Overall, groundwater levels in RN13020164 show a continual rise in water level between 1997 and 2008. All other bores stayed dry up to 2008 and then showed increasing water level (although only evidenced by one round of observation in 2018).

Monitoring ceased for bores RN1320163 to RN 1320166 in 2008, with another round of water level observations occurring in 2018. In 2018, all the bores showed an increased water level compared to the levels observed at the start of monitoring in 1995. The increase was approximately two metres for all bores except RN13020164, in which there was a four metre increase. RN13020166 was recorded as being dry between 1995 and 2018 but since commencing monitoring in 2021 has had sufficient water to sample despite having approximately 2 metres of silt in the bottom of the bore. The water level in RN13020166 is at least 2.5 metres higher than the level during the 1990s / 2000s. Section 5.3.1.3 further discusses how the Nogoa River interacts with the alluvium.

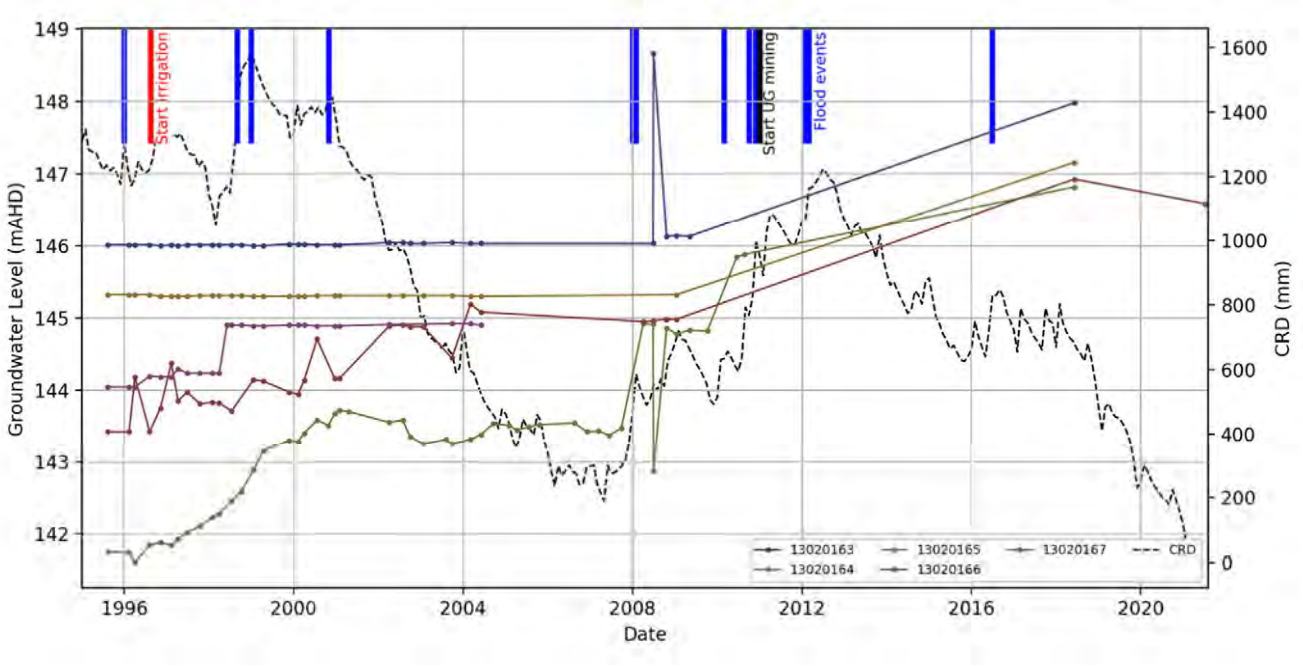


Figure 17 Hydrographs for upstream bores

Bores near in Zone 1

Similar to the upstream bores, the bores RN13020169 to RN13020174 (Queensland Groundwater Database, Department of Regional Development, Manufacturing and Water) were installed in 1995 and were mostly found dry at that time. The bore closest to the river, RN13020169 did not show any response to the 1996 moderate flooding event, nor to the rainfall and floods in September 1998 to January 1999 (Figure 18).

Some minor response is visible from the flood event in January 2008, with an increase of water level of approximately 0.5 m. However, this response is in line with the general upward trend observed in all of the monitored bores. The upward trend started around 2000, when rainfall monitoring indicates a severe drought period and a period with no flood events. No other sources were identified that could have had an impact on the groundwater during that time, so it was concluded that the irrigation had caused the increase in water levels in the alluvium. Since 1996, the water levels in these bores have increased by approximately 5-6 m, which is 3 m more than recorded in the upstream bores. Groundwater measurements taken since 2021 in bores that monitoring access was available, show a steady to continuing upward trend.

From anecdotal evidence ((pers. comm., Environmental Superintendent, Ensham mine, 2020), the intensive irrigation within and west of Zone 1 (Figure 16) was established in the late 1980's. For Figures 17, 18 and 19, the starting date for irrigation was assumed to be 1996, as it was thought to have intensified during that time. This coincides with the groundwater level increases observed in some of the alluvial bores in this area as discussed above. Furthermore, the groundwater levels were observed to be rising after 2000 when the climate signal (CRD) indicates drought conditions. This is interpreted that during all climatic conditions some recharge to the groundwater from intensive irrigation might occur. During wet conditions, this recharge is a combination of irrigation and rainfall. This is discussed further in Section 5.3.1.3.

It is also notable that the groundwater levels are generally higher further away from the Nogoa River, which indicates a gradient towards the river. If the river was the main source of groundwater, the groundwater levels would be expected to be higher near the river..

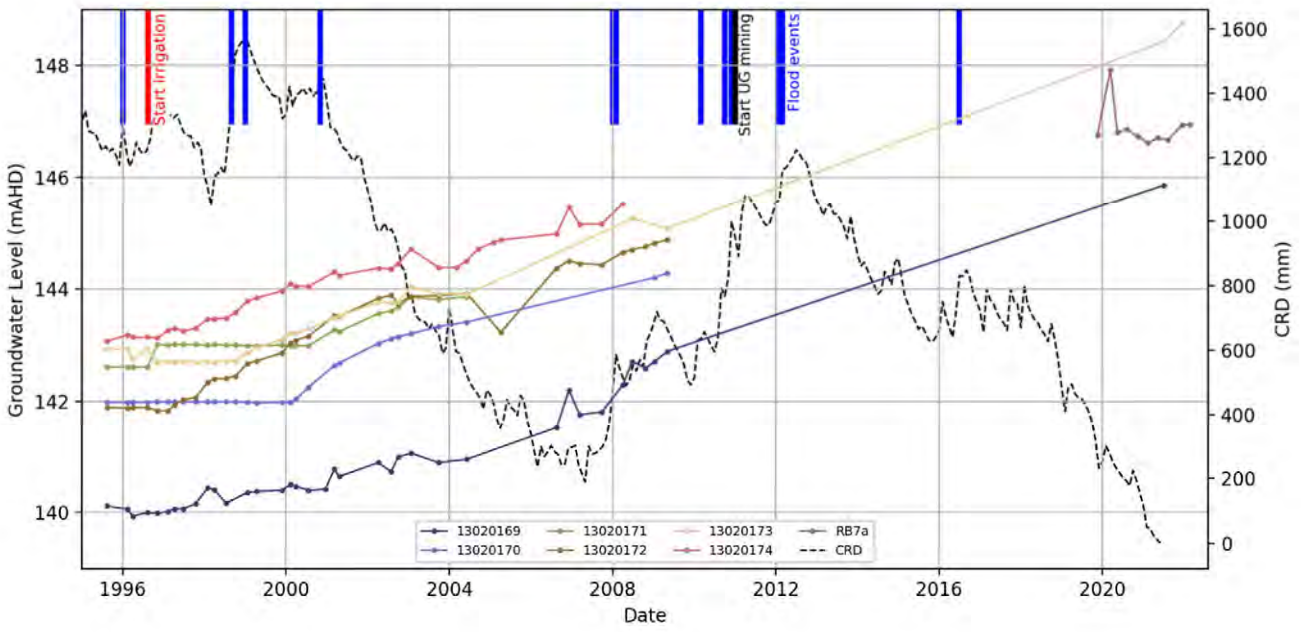


Figure 18 Hydrographs for bores in Zone 1

EC bores (sub-crop)

The EC bores series are located in the Nogoa River alluvium near or in the sub-crop of the Rangal Coal measures. For easier comparison, Figure 19 shows the same timeframe as Figure 17 and Figure 18, however the EC monitoring bores were not installed until 2004. The EC bores show a different response to flooding/climate than the bores discussed above. Specifically, EC07 to EC14 respond to the flooding in the Nogoa River and/or rainfall (as indicated by the CRD). The water levels in these bores decrease over time, which was not observed in bores EC01 and EC03, which display a constantly increasing trend. The bores closest to the irrigation area, EC01 and EC03, show no decrease of water levels over time. It has been interpreted that the upstream increase in alluvial water levels has moved towards EC01 and EC03. EC03 is further discussed in Section 5.3.1.3 in relation to surface water/groundwater interactions.

Figure 19 also displays the start of underground mining, which started in late 2011. None of the EC bores showed a response to the underground mining, which occurred below the alluvium in that area.

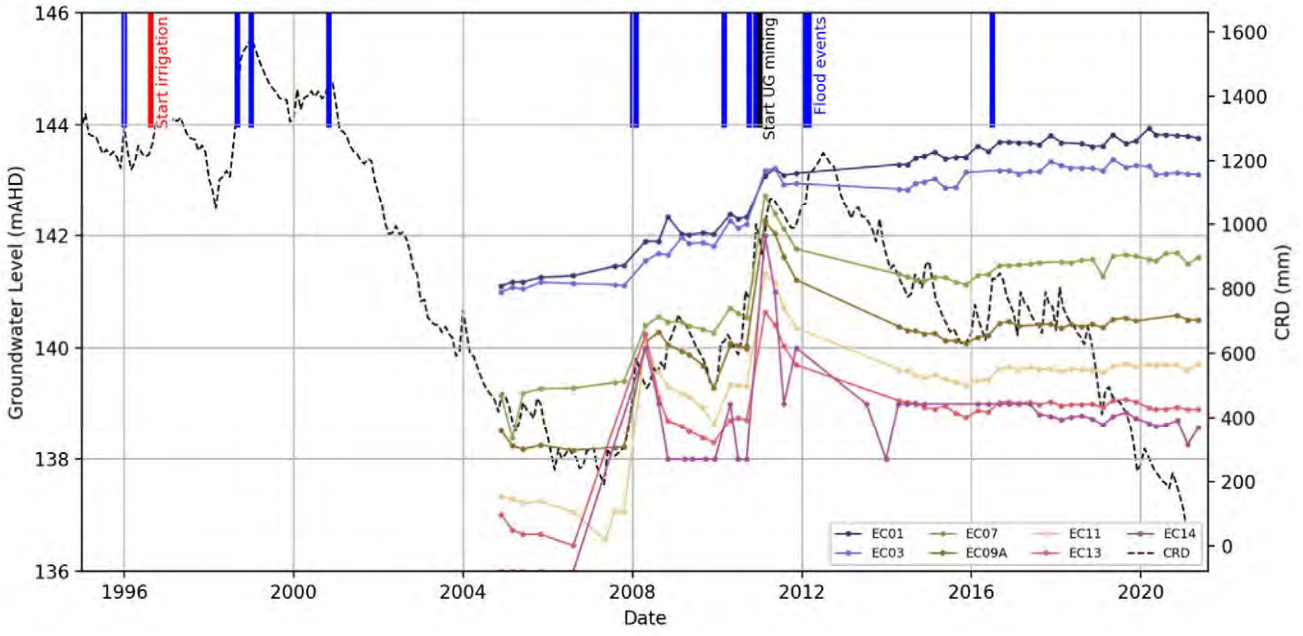
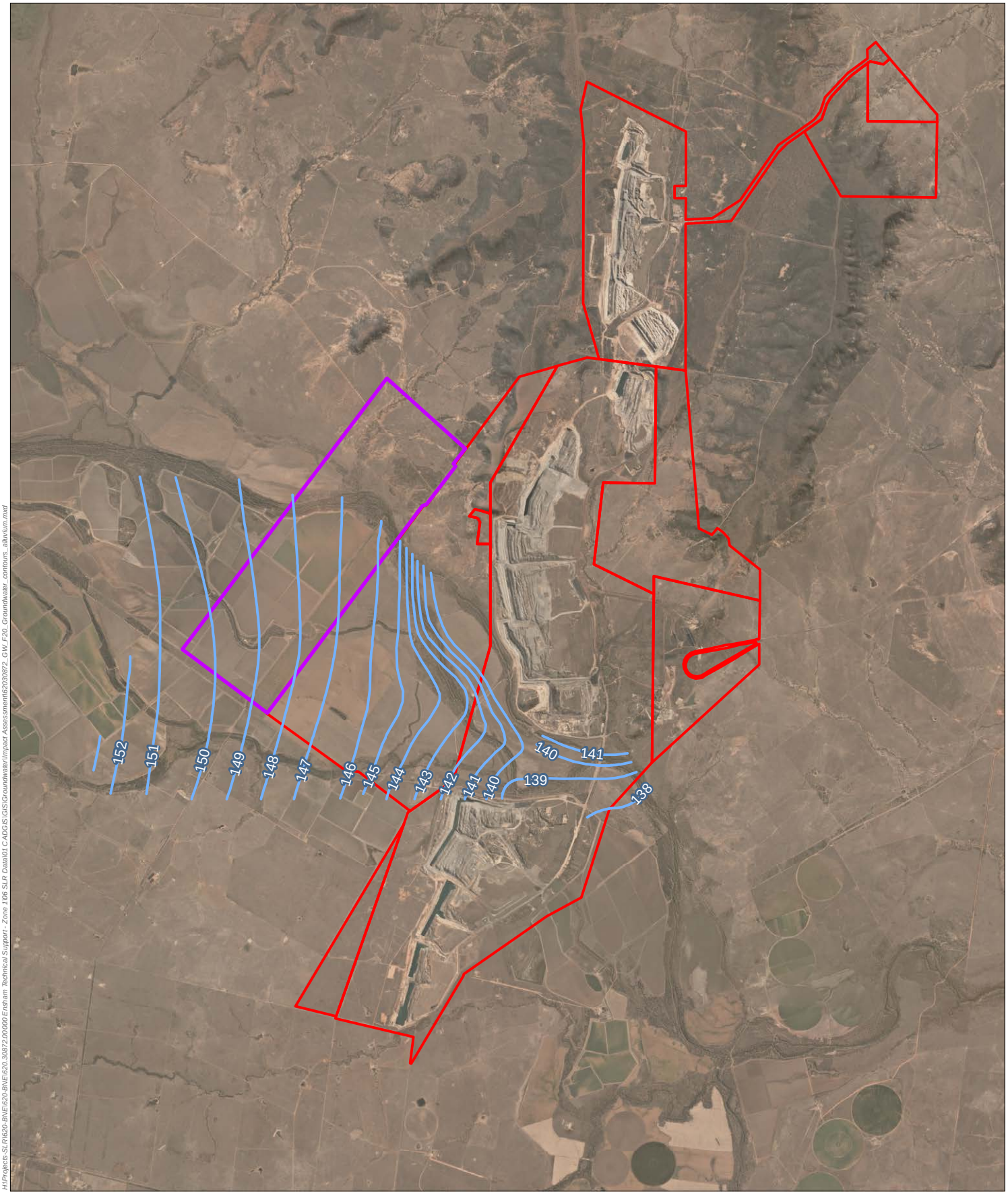


Figure 19 Hydrographs for bores near or in the sub-crop area

5.3.1.2 Groundwater flow

Groundwater flow in the alluvium follows topographical gradients, which is from north-west to south-east in the vicinity of the Project. To visualise the groundwater contours, the water level data from the alluvial bores in August 2021 was interpolated using the kriging method. The resulting contours are presented on Figure 20. The groundwater flow direction in the alluvium is from north-west to south-east and follows the Nogoa River flow direction. The interpolated contours are the best approximation, however, as noted earlier, the alluvium might not be saturated continuously and the alluvial groundwater might not be connected, but rather forms stagnant lenses with unsaturated regions (indicated by dry bores), as reflected in Section 5.4.1.1.



H:\Projects-SLR\620-BNE\620.30872\00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F20_Groundwater_contours_alluvium.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Groundwater Contour in the Alluvium (2021, mAHD)
- Zone 1
- Mining Lease

GROUNDWATER IMPACT ASSESSMENT

Groundwater contours in the alluvium (2021)

Figure 20

5.3.1.3 Interaction with surface water

Figure 21 shows a conceptual cross section of the alluvium around the Nogoa River (AGE, 2006). The upper part of the alluvium comprises silts and clay that may limit recharge. The silts and clays are underlain by a more permeable layer of sands and gravels (referred to as basal gravel or basal alluvium). The shallow silts and clays are anticipated to be partially isolating the Nogoa River, limiting leakage from the river into the basal sands and gravels. It is possible that leakage may occur where these clays are absent or where the basal sands are exposed within the river. However, there is no data confirming or rejecting this hypothesis.

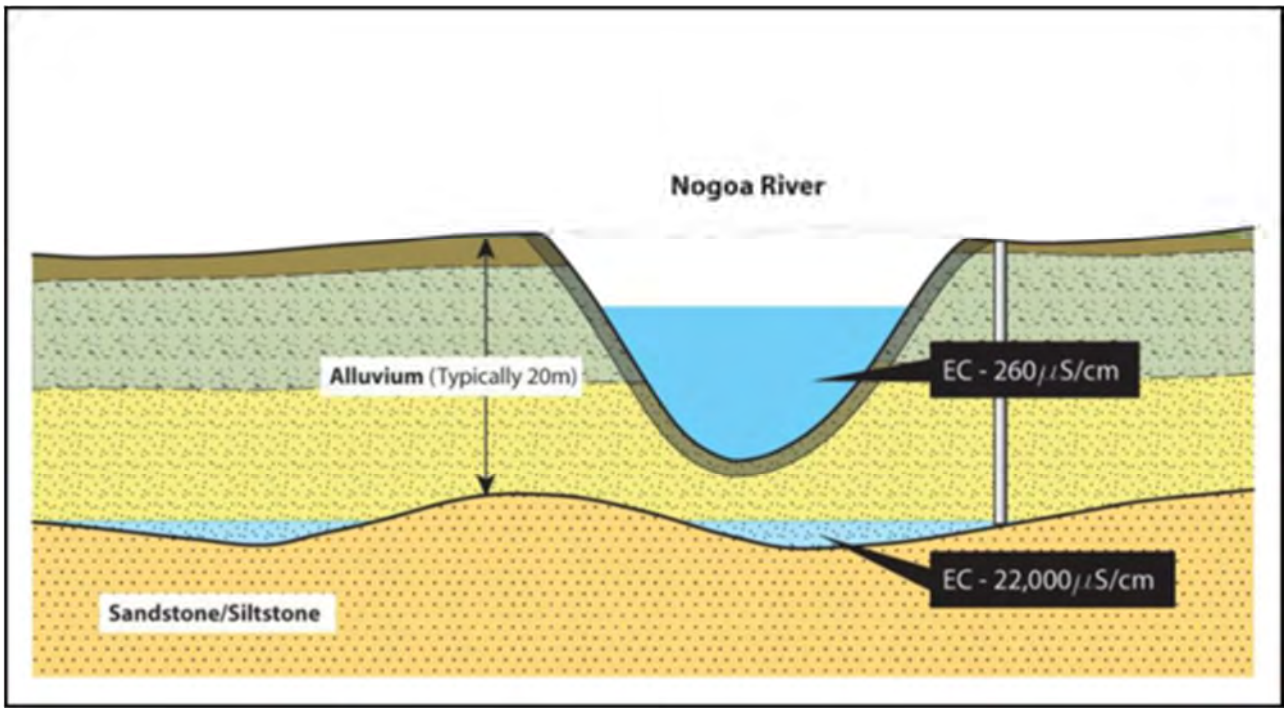


Figure 21 Conceptual cross section through the Nogoa River and quaternary sediments (Source: AGE 2006)

Numerous investigations have been undertaken in the Study area which have provided information to support the conceptualisation of groundwater interaction with surface water including:

- An investigation in the Study area in 2004 (AGE, 2006) found that groundwater occurrence in the alluvium was highly variable, with saturated zones of poor-quality water found in deeper sections of an otherwise largely unsaturated formation. As part of the investigation, 23 shallow bores were drilled in the alluvium, of which nine were dry at the time of drilling. Water levels in the remaining bores ranged from 7.2 metres below ground level (mBGL) to 17.9 mBGL, with an average of 13.8 mBGL. Some bores of the EC series that were found to be repeatedly dry have been removed from the regular monitoring program.
- Known historical data and the conceptual hydrogeological model of the Study area (AGE, 2006, SLR, 2021) was supported by the field data from the alluvium bores (Figure 17, Figure 18). If the Nogoa River was well connected and a major source for groundwater, the groundwater quality in the alluvium would be expected to be similar to the Nogoa River water quality. However, in 1995, the groundwater bores in the alluvium were dry and once they started to increase in water level, the water quality was saline, in comparison to the Nogoa River water which is fresh as reflected in the EC values (Figure 21).

- Further, as stated in Section 5.3.1.1, the groundwater levels are generally higher further away from the Nogoa River (Figure 47), which indicates a gradient towards the river. If the river was the main source of groundwater, the groundwater levels would be expected to be higher near the river. Furthermore, the river would naturally be a losing stream, with limited recharge due to the fact that the shallow alluvium is of low permeability and the water would have to go through a few metres of clay material to reach the lower sandy aquifers.

With regards to the steady long-term increase groundwater levels in the alluvium, as discussed in Section 5.3.1.1, the most likely cause is irrigation at, and upstream, of Zone 1. This is further supported as ground water levels were measured to be steadily rising between 2002 and 2008, when:

- No minor, moderate or major floods had occurred in the Nogoa River.
- The CRD indicates prolonged drought conditions during this time.

A site inspection along the Nogoa River on 24 July 2019 identified several locations where groundwater was flowing into the Nogoa River (referred to as groundwater seeps in this document), one of which has been formally documented in Table 9. Another site reconnaissance undertaken on 22 July 2020 identified several more seeps, which were recorded using a GPS, with the locations shown in Figure 16 (pers. comm., Environmental Superintendent, Ensham mine, 2020).

Table 9 lists the coordinates, a photograph, water quality parameters and water type assessment for the field observation undertaken in July 2019. The water type is a Sodium-Chloride (Na-Cl) water type, similar to the alluvium groundwater water type. The sulphate/chloride ratio is 0.16 milli-equivalents (meq), which indicates that the groundwater seep is unlikely to be related to mine affected water, given the mine related water type as discussed in Section 5.4.1.3 and shown in Figure 41. This point is further outlined in Table 10.

The groundwater seeps are not considered natural springs but assessed to be caused by upstream irrigation that is potentially causing elevated groundwater levels in the area upstream of EC01, resulting in discharges into the Nogoa River. The groundwater levels at EC01 and EC03 have been identified as being impacted by irrigation (refer to Section 5.3.1.1), with groundwater levels staying high whilst climatic conditions were dry and other alluvial bores showed a decline (Figure 19). In addition, Figure 22 shows that historically the groundwater levels at EC03 were below the river level. In 2009 this trend was reversed, with the water levels now above the river level, which is consistent with the newly formed groundwater seeps.

Table 9 Groundwater seep field observation

Parameter	Value
Easting (GDA94, Z55)	649216.196
Northing (GDA94, Z55)	7405074.399
Photograph	
EC (field)	7,762 µS/cm
Sodium	1,110 mg/L
Chloride	1,980 mg/L
Sulphate	436 mg/L
Water type	Na-Mg-Cl type water - similar water type to alluvium

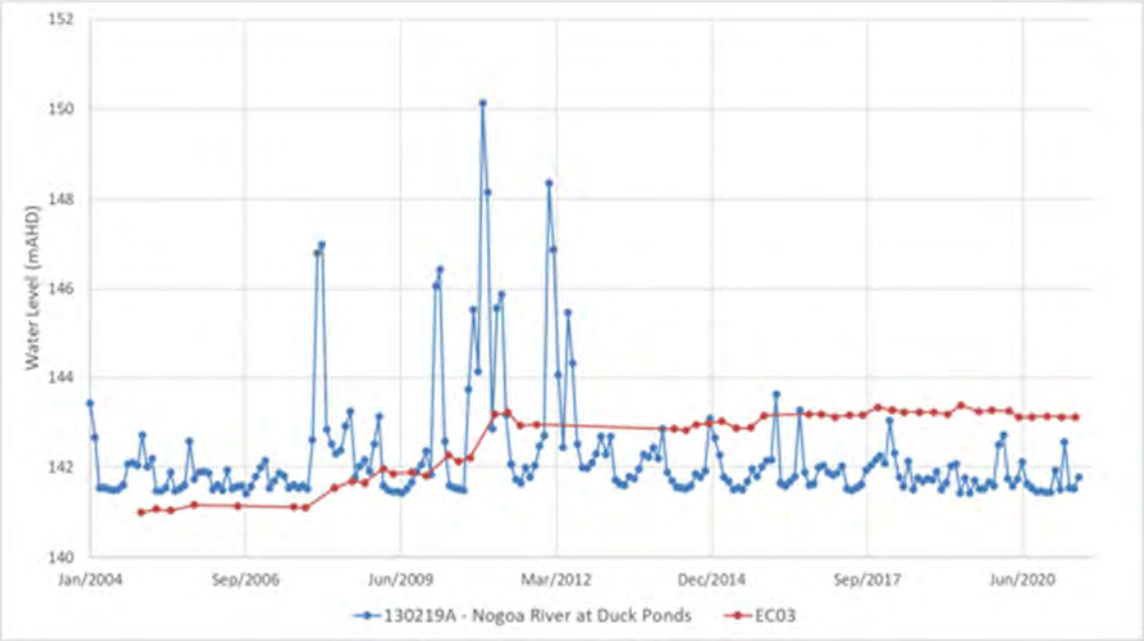


Figure 22 Water level comparison at Nogoa River (Duckponds) and EC03

Figure 23 shows the Piper plot for groundwater from relevant Ensham alluvial bores, the groundwater seeps, and the following surface water locations (ENMP07 Bridge Flats, ENMP01, ENMP02 Duckponds, refer to Figure 16 for the locations). From the plot it can be concluded that:

- The seeps are groundwater fed, as the quality of the groundwater seeps matches the alluvial groundwater cluster. This confirms that the increase in alluvial groundwater levels has caused the seeps to form.
- One of the groundwater seeps shows a water quality similar to the surface water quality, which could be due to sampling methodology at the seep sampling location. It was difficult to ensure that no surface water flowed into the sampling container when sampling the groundwater seep. This hypothesis is supported by the fact that the sample has much lower EC.
- The surface water readings show a wide range of water types. This can be due to the different contributions to the river water:
  - Flow from Fairbairn Dam, fresh water (likely during high flow conditions)
  - Flow from upstream creeks, such as Theresa creek (when flowing). This can include mine affected water from upstream mines (Kestrel, Gregory Crinum)
  - Groundwater seeps as indicated by the surface water point plotting close to the groundwater cluster (likely during low flow conditions).

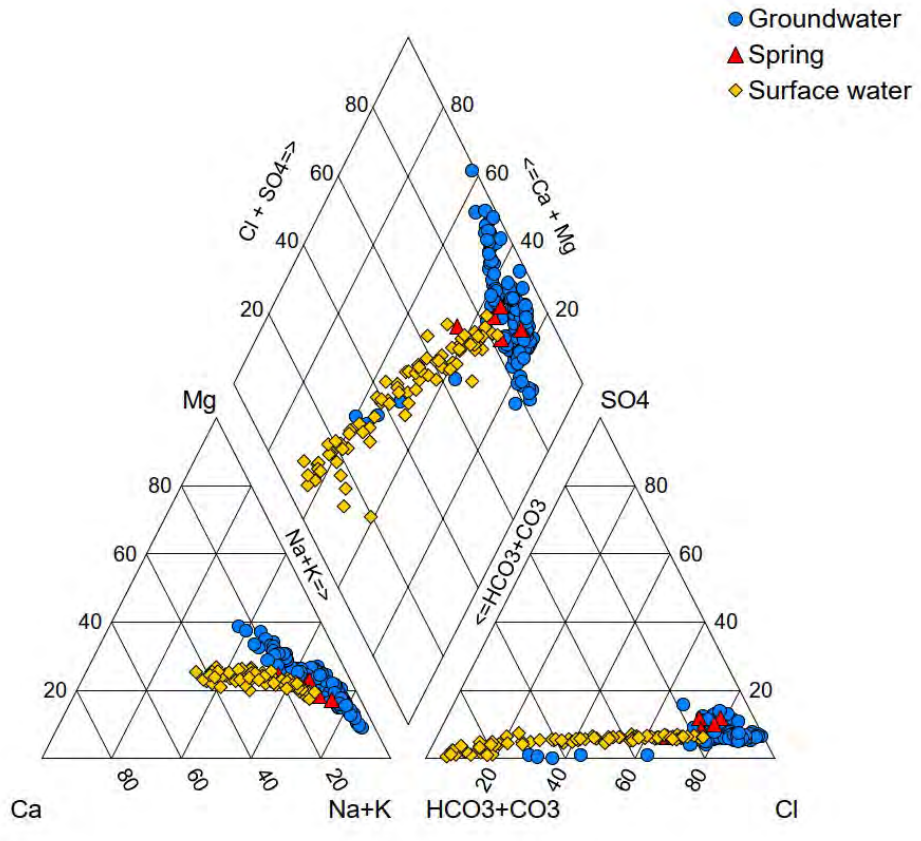


Figure 23 Piper Diagram comparing water quality

The salinity of the groundwater seeps ranged from 6,520 µS/cm to 8,520 µS/cm, with one seep recording 1,560 µS/cm (likely representing a sample mixed with river water).

Figure 24 displays the monthly mine monitoring for EC in Nogoa River at several points, as well as the flow on the monitoring day from station 130219A (Duckponds). This figure highlights that the EC is increasing between ENMP7, ENMP08 and Duckponds for all monitoring events, most prominently in September 2021, November 2021 and February 2022. Flow data from Duckponds shows that the largest increases in EC between ENMP08 and Duckpond occur in times of low flow.

This would fit into the groundwater conceptualisation whereby the increase alluvial groundwater levels create seeps into Nogoa River between ENMP1 and Duckponds. As the amount of groundwater seeping into the river is limited, the increase of EC would only be observed during low flow conditions, when the seeps would contribute a larger percentage of the mixed water between upstream river flow and groundwater seeps.

Based on the February 2022 data (Figure 24) it would require a rate of 5 ML/day of groundwater from the groundwater seeps with an EC of 7,000 µS/cm to seep into Nogoa River between ENMP01 and Duckponds (a length of approximately 1.5 km) to increase the EC between those two points from 500 µS/cm to 1,200 µS/cm at a river flow rate of 50 ML/day. This would mean the rate of groundwater seepage equates to approximately 2.5 litres per minute, which is consistent with the observations in the field (pers. comm. Environmental Superintendent, Ensham mine, 2020).

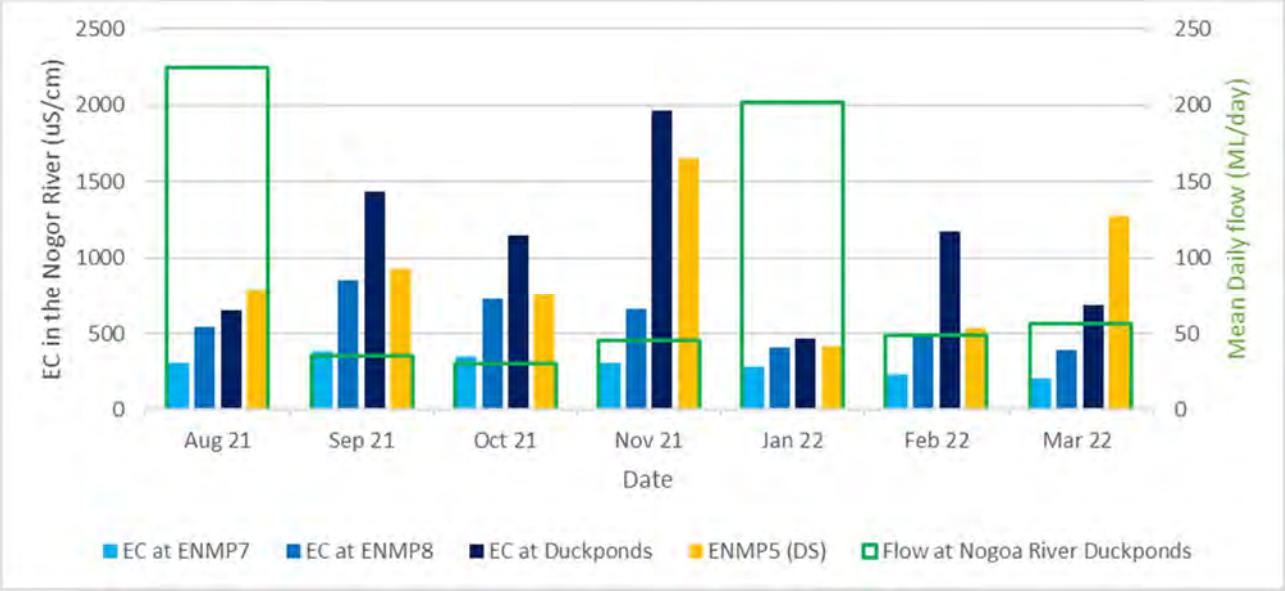


Figure 24 EC in the Nogoa River (upstream to downstream).

Table 10 summarises the potential activities and assesses the likelihood for those activities to be the cause for the groundwater seeps.

Table 10 Causes for alluvium groundwater level increase

Activity	Cause for groundwater level increase	Reason
Mine water releases at RP1	No	The releases occur downstream from the bores in questions. No pathway for the releases to increase the groundwater levels.
Underground mining	No	Underground mining was predicted to have no impact to a minor drawdown impact on the alluvium. No pathway for UG mining to increase the groundwater levels.
Mine water infrastructure	No	The mine water storages are 3km downstream from the bores in questions and exist at a water level well below the groundwater level. No pathway exists for the mine water infrastructure to increase the groundwater levels. No mine water pipelines are located upstream of Duckponds.
Irrigation	Likely	The groundwater bores downstream of the irrigation were dry before the irrigation started. An increase over 6m has been observed, which likely extends towards the Nogoa River forming the groundwater seeps.

5.3.2 Rewan Group

The Rewan Group comprises low permeability siltstones, mudstones and lithic sandstones and is recognised to be a regional scale aquitard. Private landholder bores Jamar Bore and Winton Creek Bore have limited bore construction details available and are screened in the Rewan Group which is inferred from the bore log of the nearby bore RB04.

Groundwater level trends within the Rewan Group at Jamar bore and Winton Creek bore compared to groundwater level trends within the Aries Seam (RB04) are presented on Figure 25. The hydrograph shows groundwater elevations within the Rewan Group at Winton Creek bore are relatively stable, at around 137 mAHD, while levels within Jamar Bore are highly variable between 108 mAHD and 126 mAHD. Routine monitoring and reporting at Ensham mine indicates that the variability relates to private bore usage with localised drawdown and slow recovery of groundwater levels within the low permeability Rewan Group. In contrast, groundwater levels within the Aries Seam of the Rangal Coal Measures (RB04) records stable to slightly declining groundwater levels between 136 mAHD and 137 mAHD.

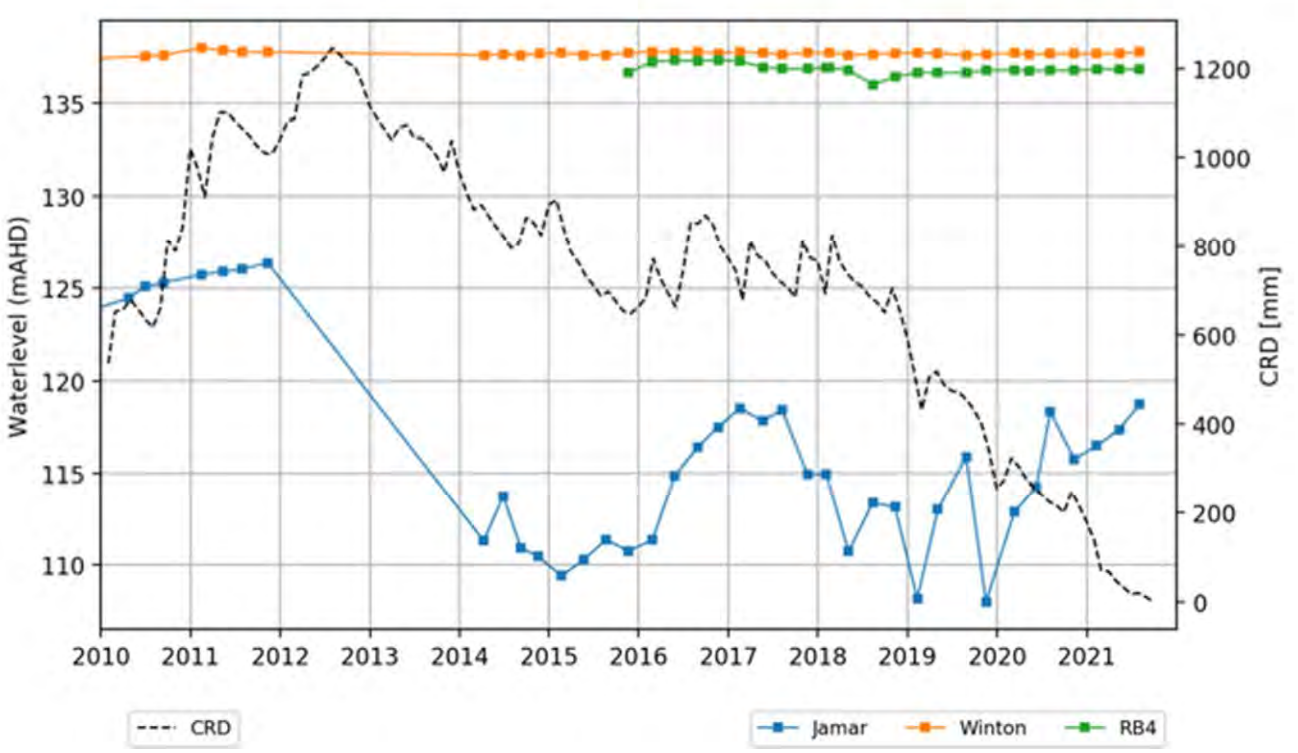


Figure 25 Hydrographs for Rewan bores compared with RB04 (Coal measures)

5.3.3 Permian Coal Measures

The most permeable lithological units at Ensham mine are the coal seams within the Rangal Coal Measures. The coal seams form aquifers that generally exhibit low transmissivities and are confined by overlying and underlying shales and mudstones (AGE, 2017). Groundwater storage and movement largely occurs within the coal seams, along cleats and occasionally within minor fault zones that intercept the seams. The other lithologies present in the overburden and interburden sequence are considered to form aquitards.

The Permian strata can be categorised into the following hydrogeological units:

- Very low to low permeability sediments that comprise the majority of the Permian age interburden and overburden within the coal measures.
- Low to moderately permeable coal seams, of varying degrees of competency (and therefore fracturing).

Recharge to the Permian Coal Measures occurs at the eastern edge of Ensham mine, where the Permian Coal Measures outcrop. Recharge would occur from direct rainfall on the ground surface, infiltrating into the underlying formations through the thin soil cover, weathered profile, as well as through the spoil at site. The coal measures also subcrop in localised zones beneath alluvium associated with the Nogoa River, where the unit may be recharged by downward seepage where there is an absence of clay and silt layers.

Limited recharge may also occur via downward leakage from the Triassic age Rewan Group and Tertiary sediments, as well as from areas of site surface water storage (i.e., in-pit water storages from open-cut mining at Ensham mine). The coal seams are connected with the open-cut mine voids (which are the mined-out areas of the outcropping coal seams), refer to Section 5.3.3.2 for a detailed discussion of the interaction between the Rangal Coal Measures and the open-cut mine voids.

Discharge from the Permian Coal Measures is occurring from bore abstraction and mine dewatering and regional flow.

5.3.3.1 Water levels

Fifteen bores tap the Permian Coal Measures, with the hydrographs for these bores grouped by approximate locations as follows:

- Northern Area: RB1, RB2, RB8.
- Central Area: WSMB2S, WSMB2D, RB3, RB4, RB10.
- Southern Area: Karanga Bore, RB5, RB6, RB9, WSMB3 S and WSMB3D.

Northern Area

Groundwater in the Rangal Coal Measures flows primarily towards the Ensham underground mine area (as a result of mine dewatering and depressurisation). Groundwater level trends within the Rangal Coal Measures west of Ensham mine (RB1, RB2 and RB8) are presented on Figure 26. Groundwater level trends for RB1 and RB2 are slightly declining, with groundwater elevations ranging between 122 mAHD (RB8) to 145 mAHD (RB1). The bore RB8 was installed in August 2021 and has only two observations. This bore is closest to the mine and shows the lowest water levels, confirming the gradient towards the mining area.

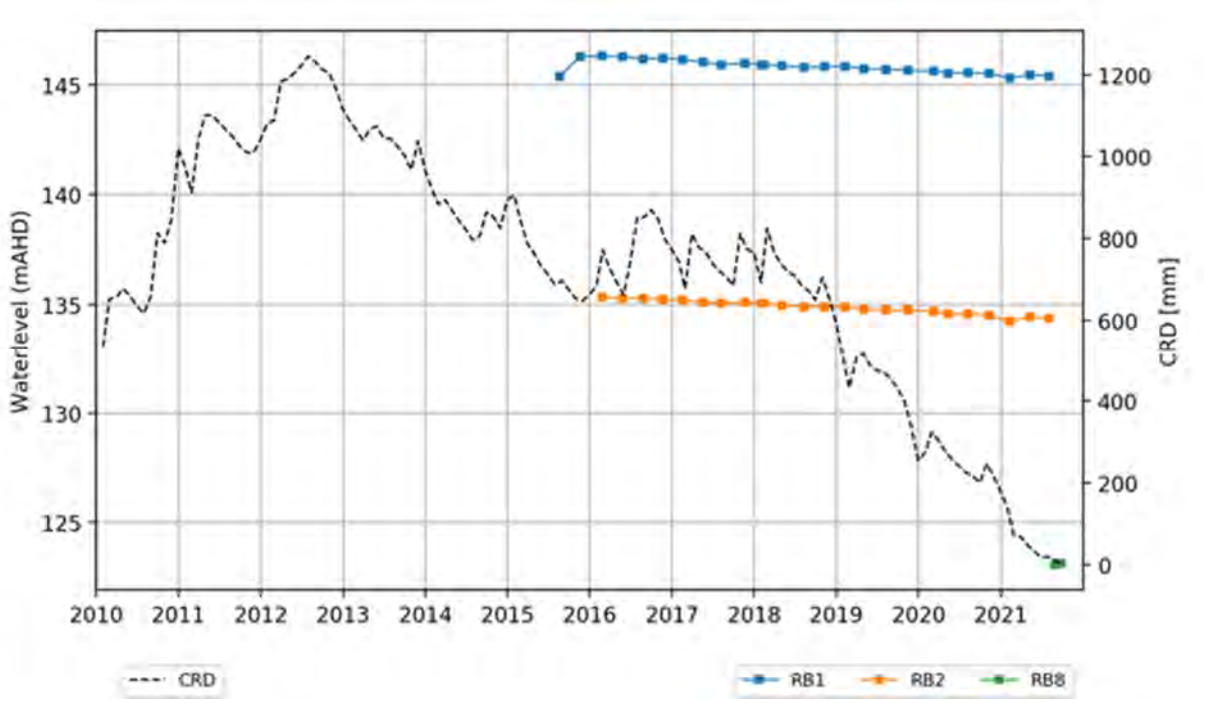


Figure 26 Hydrographs for Permian bores (Northern Area)

Central Area

Bore RB03 is located within 3 km of active underground mining and records a general decline in groundwater levels of around 4 m from 2016 to 2021. This trend is in line with predicted depressurisation of the Permian coal seams with existing operations (HydroSimulations, 2020). It is anticipated that the influence of the underground workings will transmit readily through the coal seams; however, vertical impediments (such as the Rewan Group and the Permian aquitards above and between the coal seams) would restrict the dewatering of bounding lithologies.

The water levels in the RB04 area are generally considered depressed relative to what is anticipated under natural conditions, lending weight to the prevalence of an abstraction signal in this area. The RB04 borehole has a comparatively low groundwater level of 136 mAHD (40 m unsaturated zone thickness). RB10 was only installed in August 2021 and showed similar water levels as RB3.

Nested bore WSMB2S (shallow) and WSMB2D (deep) show that the depressurisation in the deeper bore is not impacting the shallow bore. The shallow bore follows the surface water level of near-by water storage pit Ramp 22 (refer to Section 5.3.3.2).

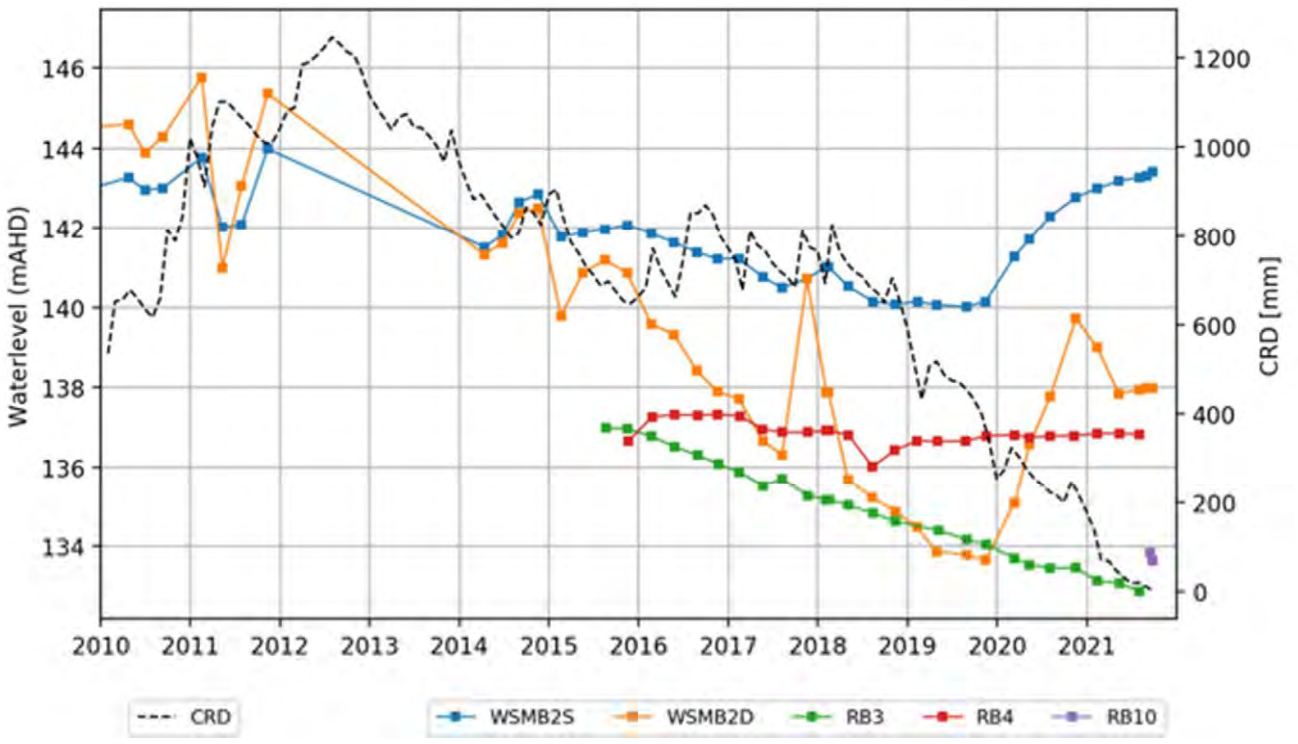


Figure 27 Hydrographs for Permian Bores (Central Area)

Southern Area

Bore RB06 and Private landholder Karanga Bore intersect the shallow Rangal Coal Measures 2.5 km and 6.5 km south of the Ensham mine open-cut, respectively. Groundwater level trends for the bores are presented on Figure 28. Karanga Bore, which is located further from the existing mine also shows influence from localised private bore usage. RB06 shows a slight increasing trend over the observation period of around 1 m, when the CRD indicates drier than normal climatic conditions. In Figure 28, the hydrographs for WSMB3S and WSMB3D have been plotted to compare with the trend in RB06. The water level in WSMB3D (monitoring the coal seam downdip of Pit A) is below the water level of RB06, whereas the water level in WSMB3S (monitoring the overburden downdip of Pit A) is higher than in RB06. There is potential for the water level in RB06 being influenced by the water level in Pit A, however, the limited number of data points is insufficient to assess trends at this time.

RB9 was installed in August 2021 and shows similar water levels around 5m higher than RB6. Once more data is available, the trend at this bore can be further assessed.

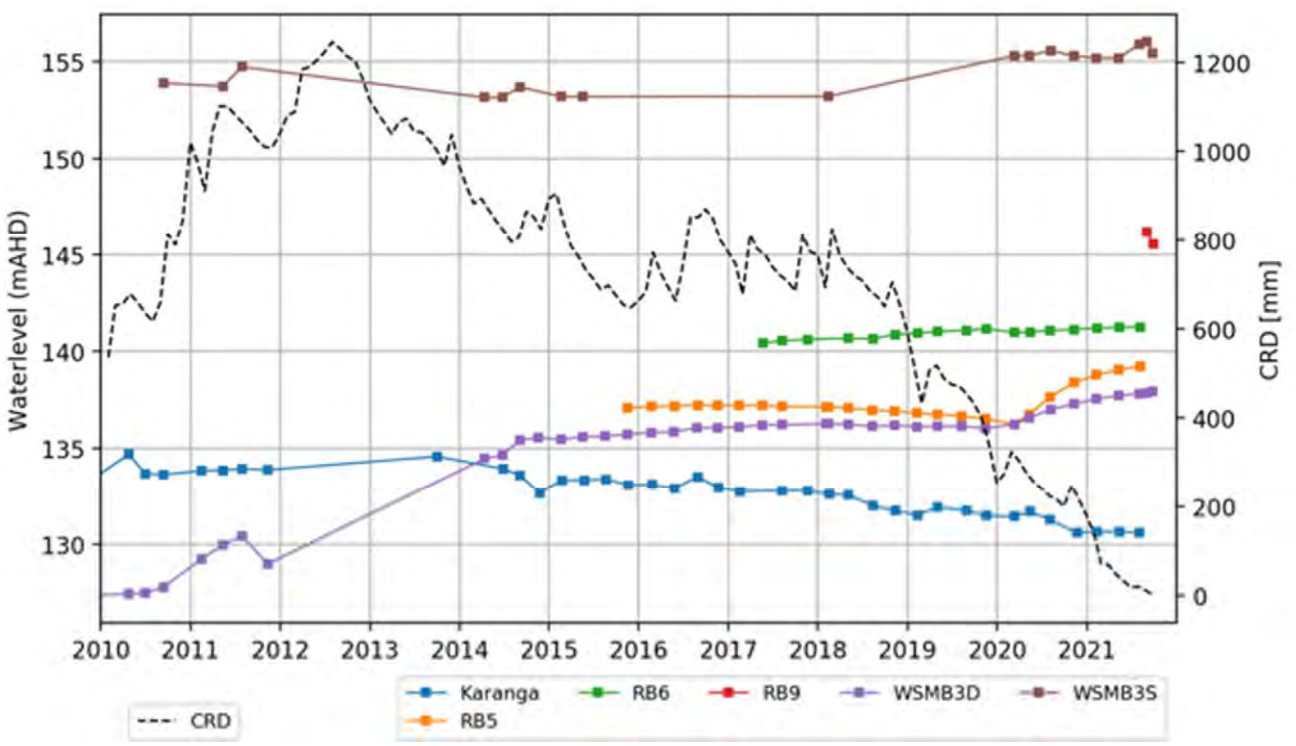
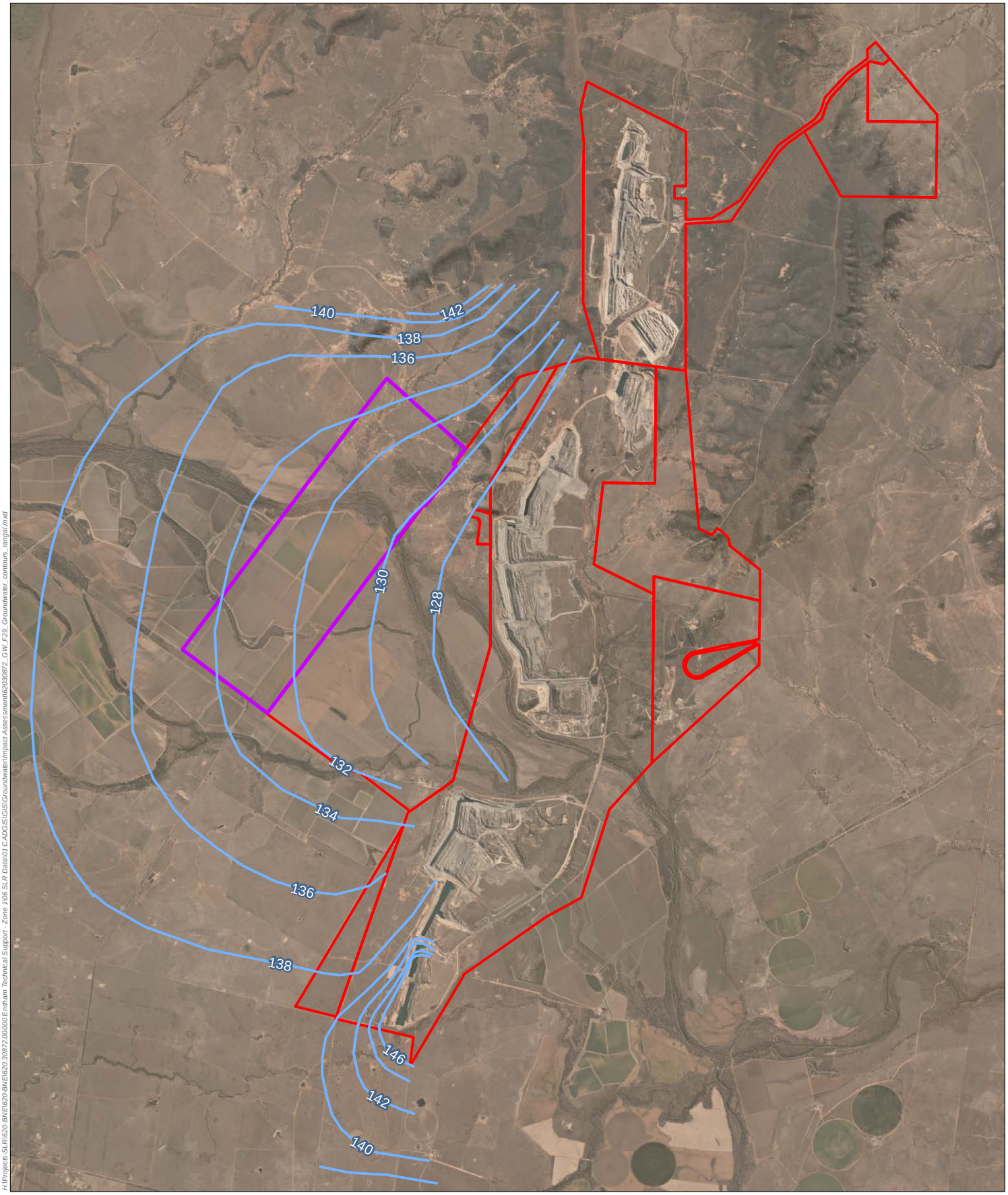


Figure 28 Hydrographs for Permian bores (Southern Area)

Figure 29 shows the groundwater level contour in the Rangal Coal Measures for September 2021. The groundwater flows from west to east towards the mine. In the south, the water storage in Pit A seems to cause higher groundwater levels and a flow away from the mine.



H:\Projects-SLR\620-BNE\620.30872\00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F29_Groundwater_contours_rangal.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

GROUNDWATER IMPACT ASSESSMENT

Groundwater contours in the Rangal Coal Measures (2021)

Figure 29

Legend

- Groundwater Contour in the Rangal Coal Measures (2021, mAHD)
- Zone 1
- Mining Lease

5.3.3.2 Interaction with open-cut mine pits

Groundwater level trends are also influenced by water storage within Ensham open-cut pits, in addition to depressurisation from existing underground mining. Groundwater level trends for bores within the shallow Permian coal measures within 2 km west of Pit A and Pit B are shown on Figure 30 and Figure 31, along with trends for the deeper bore RB05 located over 2 km west of the open-cut pits. The WSMB series are installed in "Coal Measures Overburden" [S] or "Coal Seams" [D].

Bores WSMB2S and WSMB2D are within 400 m of Pit B (Ramp 22) and overlying the existing operations mining area. Figure 31 shows WSMB2 recorded a generally upward gradient with higher groundwater elevations within the deeper bore until around 2013, after which time a downward gradient is visible. This coincides with progression of Pit B towards the bore. The deeper bore shows a more pronounced response to mining activities than the shallow one. In general, this also indicates low vertical hydraulic connectivity within the Rangal Coal Measures. In 2020, the water levels in Ramp 22 rose by 6 m as those pits were used to store water previously stored in Pit C. The deep bore mimics this increase very closely, meaning that the Permian strata is in connection with Ramp 22. The shallow bore also responds to the increase, however somewhat more subdued (increase of 4 m).

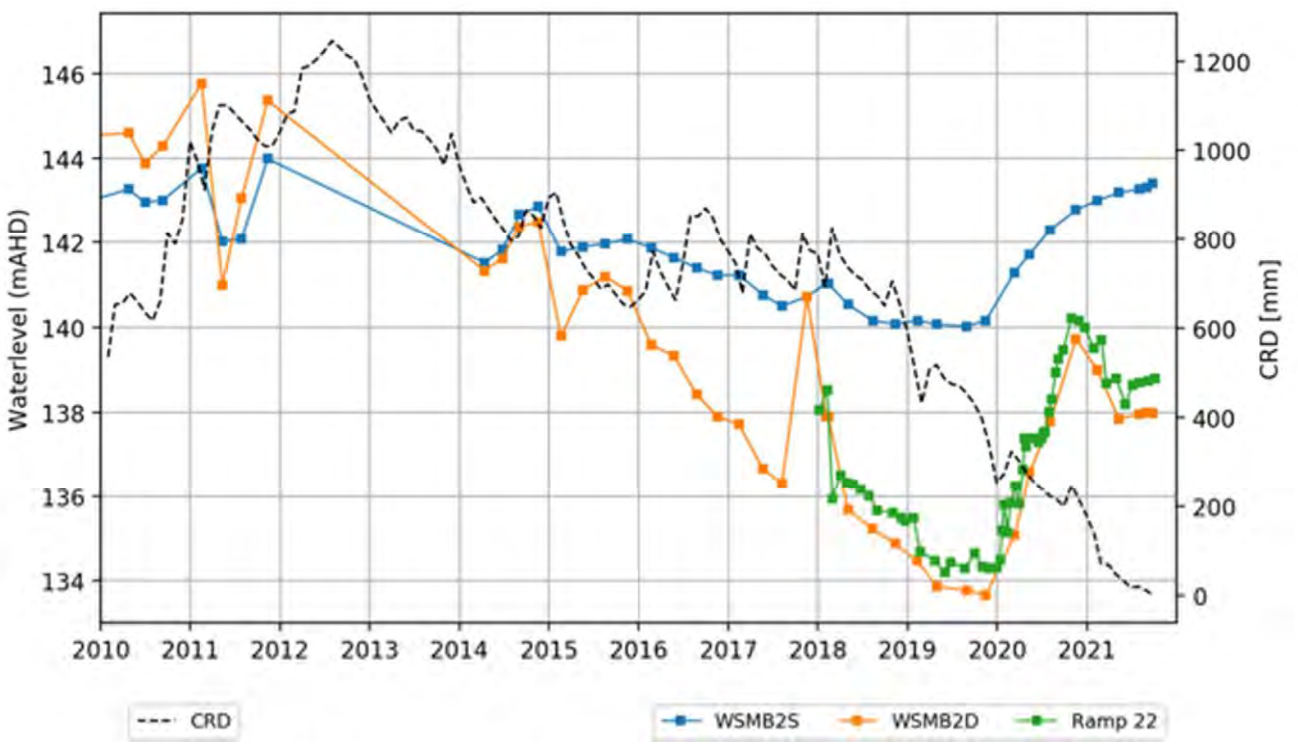


Figure 30 Hydrographs for bores WSMB2D, WSMB2S, and surface water levels at Ramp 22

WSMB3S and WSMB3D intersect Permian overburden and are located approximately 1 km west of Pit A (Ramp 20 and Ramp 21). Bore WSMB3S has been screened to 21 m depth and has been recorded as dry since mid-2015. Groundwater levels within WSMB3D have gradually risen since 2009, which coincides with cessation of mining at Pit A and commencement of water storage within the pit. In 2020, the water levels in Ramps 21 and 22 rose by 10 m as those pits were used to store water previously stored in Pit C. Water levels in RB5 and WSMB3B respond to this increase in surface water with an increase of 2-3 m.

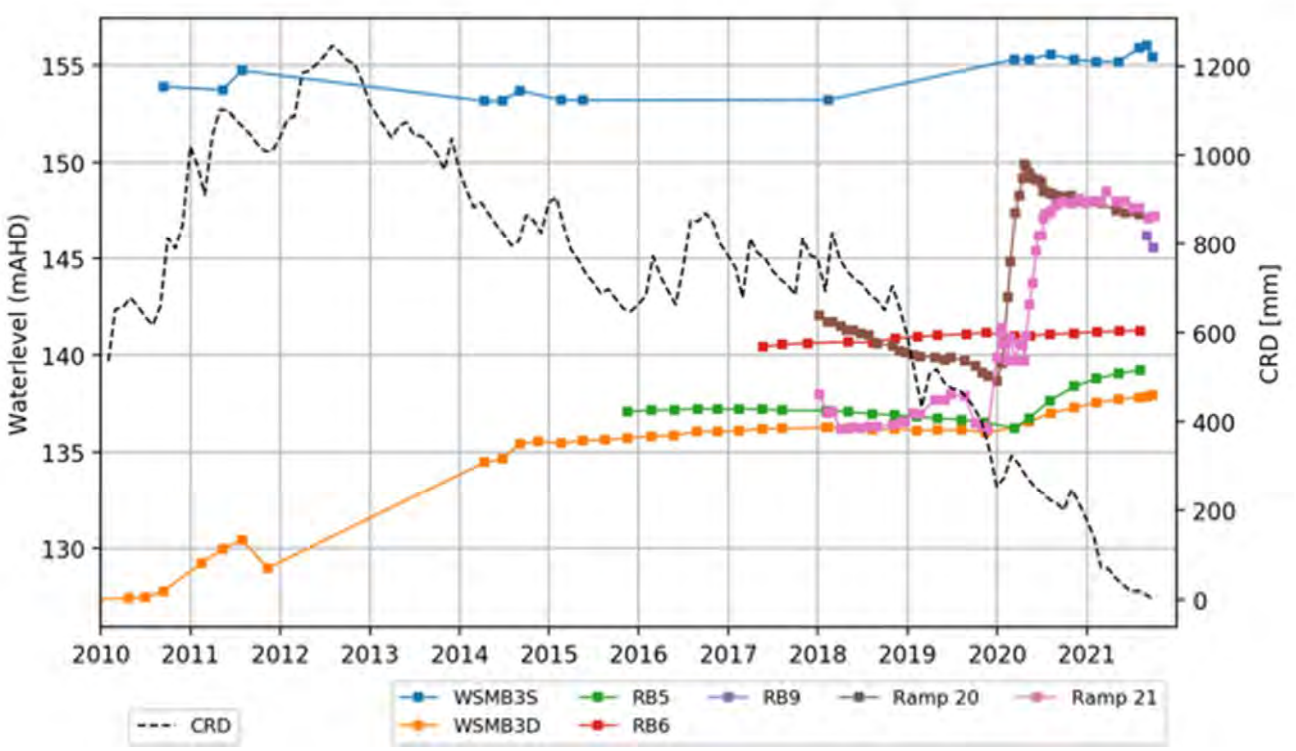


Figure 31 Hydrographs for bores WSMB3S, WSMB3D, RB5, RB6, RB9 with surface water level at Ramp 20 and 21

5.4 Groundwater quality

Recent groundwater quality data are available for 21 bores with parameters as outlined within the current EA for the Ensham mine (refer to Section 5.1). In addition, historical data are available for 65 bores across the mine site and its surroundings. In this section, only the bores for which the bearing strata is known are discussed. Summary statistics for all EA parameters and bores with a sufficiently long data set are presented in Appendix B.

Physiochemical parameters and metals are discussed for each groundwater unit in Section 5.4.1 and Section 5.4.2. The water quality results are compared as box-and-whisker plots against water quality triggers for relevant environmental values, as discussed in Section 5.5. These comparisons are shown in Appendix C. Time series of all groundwater parameter at all bores is provided in Appendix D.

5.4.1 Physiochemical parameters

Physiochemical parameters include:

- Major ions, i.e. calcium (Ca), sodium (Na), magnesium (Mg), potassium (K), sulphate (SO_4), chloride (Cl), bicarbonate (HCO_3).
- Electrical Conductivity (EC).
- Total Dissolved Solids (TDS).
- pH.

Major ions allow comparison of water types (ionic dominance) between bores. According to DES (2021), major anions and cations analysis enables characterisation of the groundwater regardless of the activity. The water type can also be used in correlation with other physiochemical parameters, precipitation records and groundwater level measurements to inform groundwater flow and hydrological processes.

Table 11 lists the 20th percentile, median and 80th percentile of the pH (field and laboratory) for the alluvium, the Rewan Group and the Rangal Coal Measures. The field pH is considered the more accurate measurement, as pH has a short holding time for laboratory analysis. However, the laboratory pH is listed here because the field pH was not measured until 2013. The waters are all neutral to slightly alkaline, with median field pH values of 7.1 for the alluvium, 7.6 for the Rewan Group and 7.7 for the Rangal Coal measures.

Table 11 Summary statistics of pH observations

Geological unit	Parameter	Number of observations	20th percentile	Median	80th percentile
Alluvium	Field pH	338	6.8	7.1	7.4
	pH Lab	667	7.1	7.5	7.9
Rewan	Field pH	62	7.4	7.6	7.8
	pH Lab	79	7.7	7.9	8.1
Coal Measures	Field pH	239	7.0	7.7	8.0
	pH Lab	242	7.5	7.9	8.2

EC and TDS both are both a measure of salinity levels in water. EC is generally recommended as a measure of salinity as it can be easily measured on site without requiring laboratory analysis. EC measured in the field is generally recommended over laboratory analysis due the potential for change in salt composition that can occur with temperature change during the sample transport and storage prior to analysis.

EC measured in the field is available for EA bores only, from 2014 onward. Where no EC field data are available, EC laboratory data is discussed instead.

Table 12 lists the 20th percentile, median and 80th percentile of the EC (field and laboratory) for the alluvium, the Rewan Group and the Rangal Coal Measures. The median EC in the alluvium is around double the median EC in the Rewan Group and the Rangal Coal Measures. This indicates generally poor water quality that may not be suitable for all users (this will be further discussed in Section 5.5).

Historical water quality records from DRNME bores showed high EC values in the alluvium before underground mining started, which indicates that these EC values are occurring naturally. The EC observations in the late 1990s and early 2000s ranged from 710 µS/cm in Bore RN13020175 to 38,900 µS/cm in Bore RN13020173.

Table 12 Summary statistics of EC observations

Geological unit	Parameter	Number of observations	20th percentile (µS/cm)	Median (µS/cm)	80th percentile (µS/cm)
Alluvium	Field EC	353	3,208	11,590	20,040
	EC Lab	668	2,124	6,150	19,360
Rewan Group	Field EC	62	4,069	5,825	7,750
	EC Lab	79	3,946	6,290	7,744
Rangal Coal Measures	Field EC	239	3,702	7,360	10,933
	EC Lab	242	3,454	7,105	10,780

Discussion on the physiochemical properties for each groundwater bearing unit is presented in Section 5.4.1.1 to Section 5.4.1.3.

5.4.1.1 Alluvium

Major ions analysis reveals that most alluvium bores are of sodium-chloride (Na-Cl) water type dominance (Figure 32). As described in Section 5.3.1, most of the alluvium is hydraulically isolated from the Nogoa River, resulting in brackish to highly saline conditions. Slow infiltration recharge and evapotranspiration are likely to be the dominant processes resulting in salinisation of the alluvium.

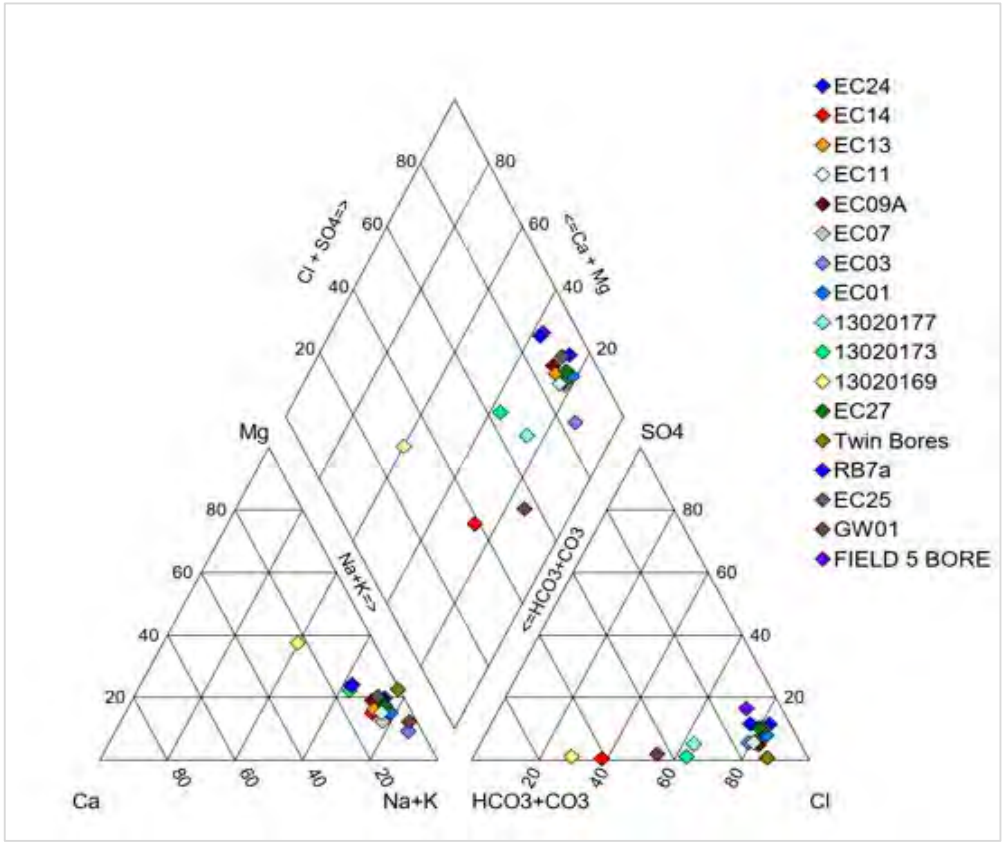


Figure 32 Piper plot alluvium

Alluvium bores show a wide range in salinity with recorded values from about 1,000 µS/cm to 30,000 µS/cm.

The data suggests that most alluvium bores are responsive to rainfall events indicating that rainfall infiltration is likely the main recharge process. The EC in bores EC07, EC09A, EC11 and EC13 is responsive to rainfall changes, with various delay of response (Figure 33 and Figure 34). These bores had a higher EC before the main recharge event in late 2010 (shown with an increasing CRD), and then decreased during the inflow of fresher water (blending).

The bores have since displayed an increase in EC with different timing in onset, with EC07 (most upstream from the mine) starting in 2013 and EC13 (downstream from the mine) starting around 2016. The reason for this increase is unclear. The corresponding increase from upstream to downstream along the Nogoa River would indicate that the increase is not mining related. If it was a mining related effect, the EC increase would be expected to start in the bores closest to the mine (EC11 and EC13). At this stage, it is plausible that the continued drier conditions since the last major recharge event could be leading to the increase in EC.

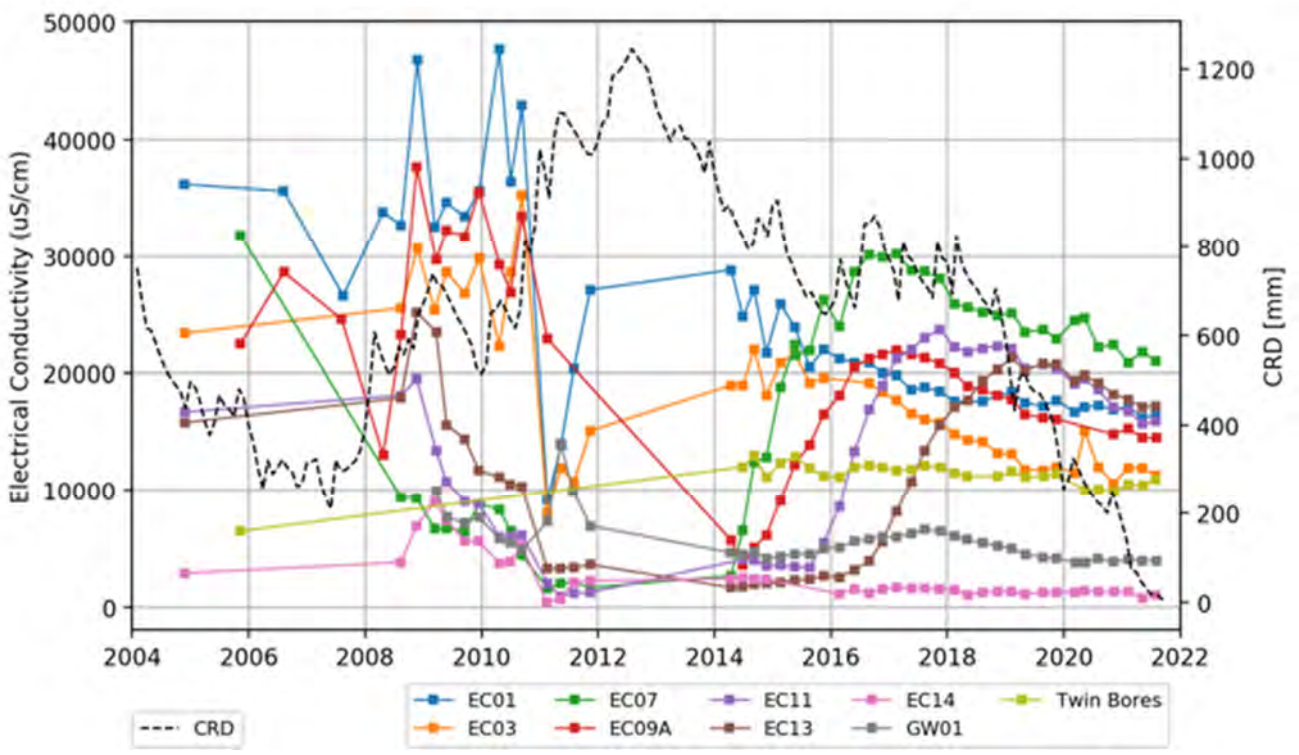


Figure 33 Lab EC – alluvium

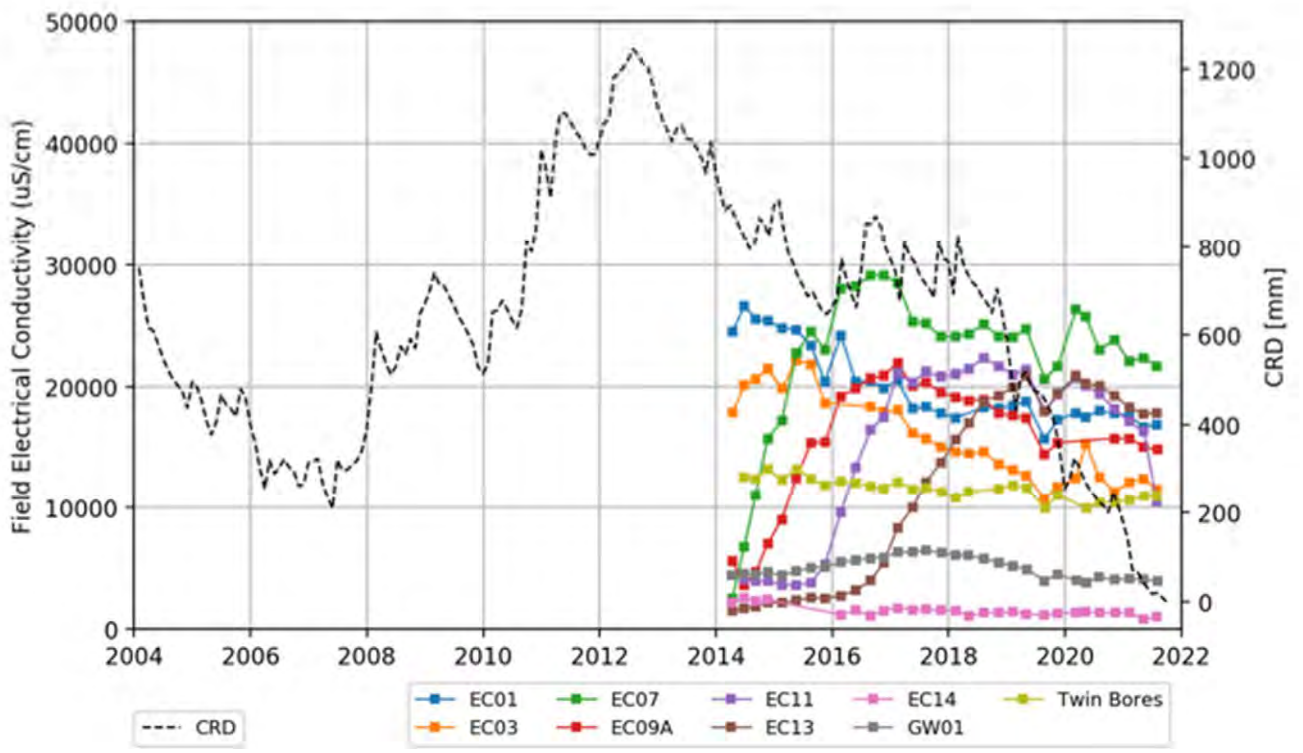


Figure 34 Field EC – alluvium

Figure 35 shows bores EC04, EC06, EC14, EC16, EC17 and EC19, for which the latest observations available were in 2014). EC16, EC17 and EC19 show ECs below 2000 µS/cm. The salinity at EC17 increased to over 6000 µS/cm in 2014, whereas the other two bores remained at similar levels. The reason for this increase is unknown. EC04 and EC06 show higher salinities of around 3,000-5,000 µS/cm. In general, all these bores show much lower salinity than the bores further upstream (Figure 34), which recorded salinities of up to 30,000 µS/cm.

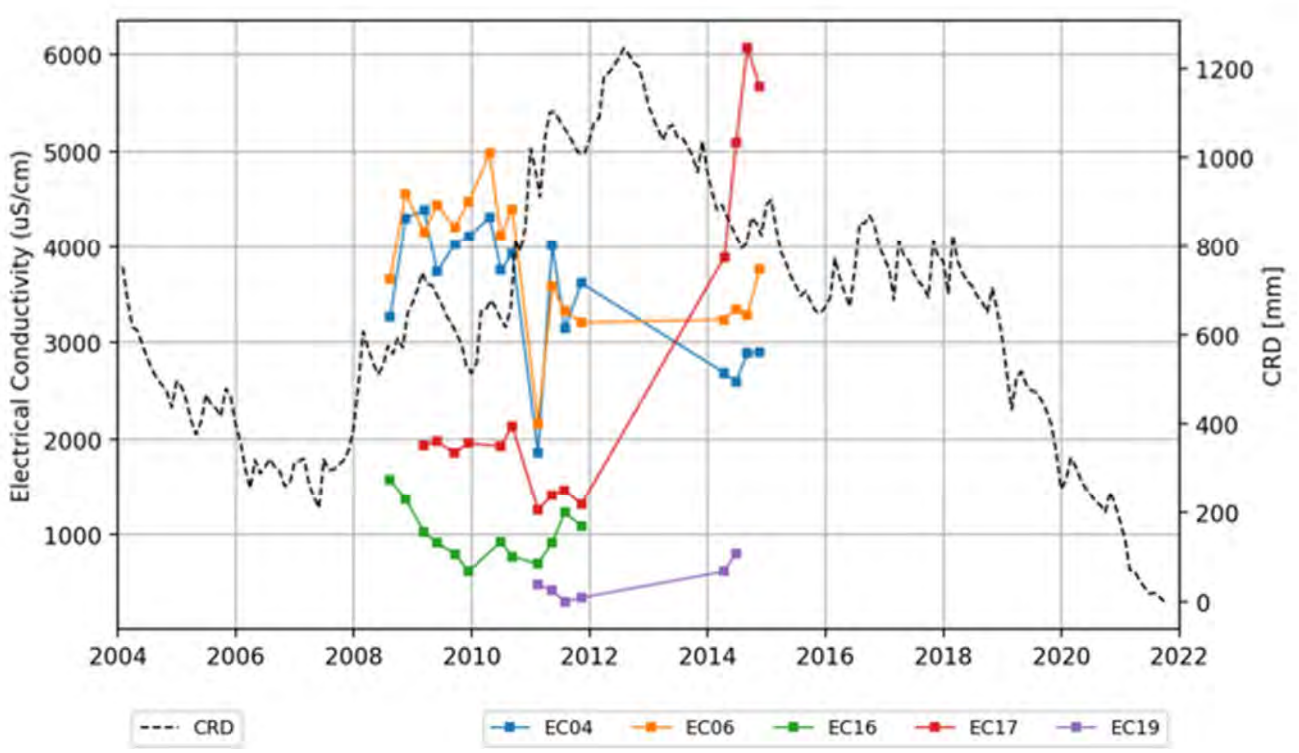


Figure 35 Electrical conductivity (Lab) – EC04, EC06, EC16, EC17 and EC19

Regional water quality objectives (WQO) for aquatic ecosystem protection are available for EC (DEHP, 2011). The 80th percentile value of EC for several alluvium bores (EC01, EC03, EC05, EC07, EC09A, EC11 and EC13) is above the regional WQO (Appendix C), indicating that groundwater from the alluvium at these bores is not suitable for aquatic ecosystems sensitive to highly saline conditions, with only tolerant taxa such as crustaceans (i.e. copepods and syncarids) likely to occur in groundwater with high electrical conductivity.

Variations in pH are generally small with the regional bore (Twin Bore) showing a higher degree of variability (Figure 36). Most measurements are between 6.5 and 8.5, which is within the lower Nogoa River WQOs for aquatic ecosystem protection (DEHP, 2011). Bore GW01 is slightly basic and has exceeded the upper WQO four times in the past ten years. The pH observations at Twin Bores increased in early 2020 to above 8.5 and have remained there since.

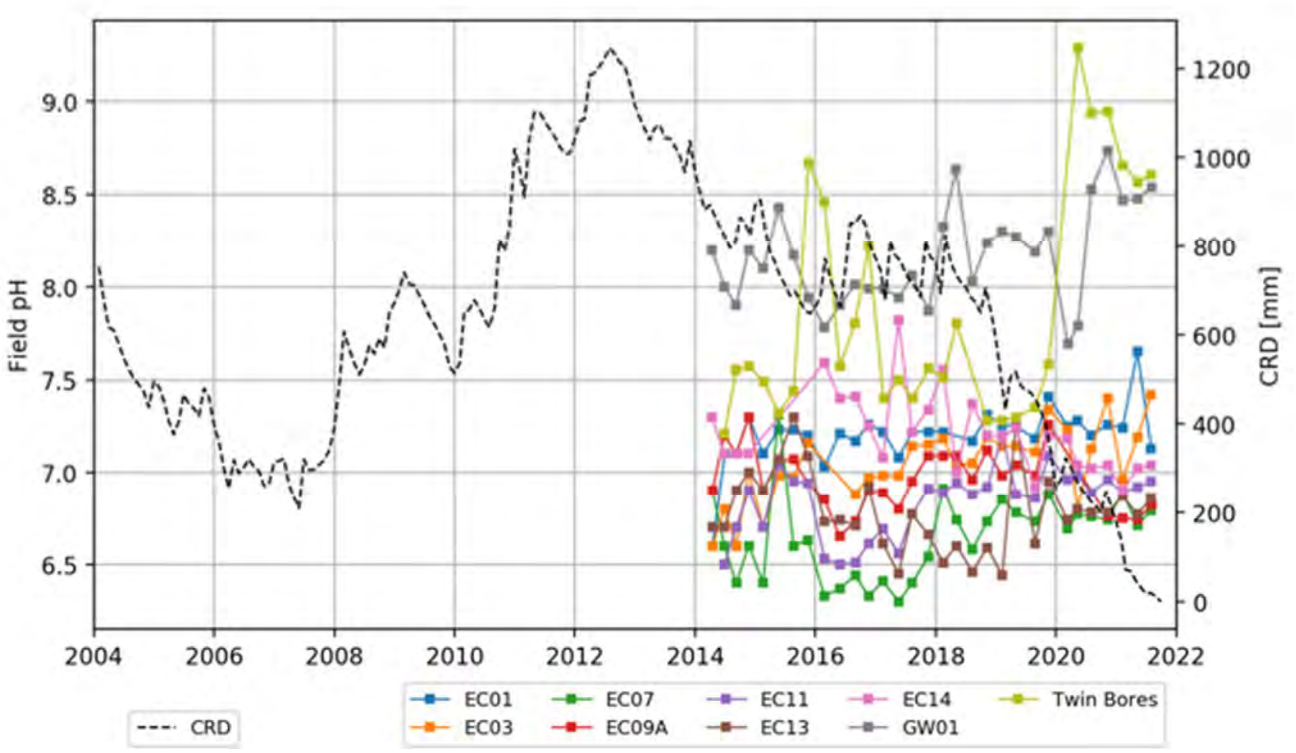


Figure 36 Field pH – alluvium

5.4.1.2 Rewan Group

Bores screened in the Rewan Group (Winton Creek Bore and Jamar Bore) are all Na-Cl dominant (Figure 37).

Laboratory EC available from 2004 at Winton Creek Bore and Jamar Bore show that these bores are likely to respond to very high intensity rainfall events and associated major flooding (refer to Figure 9), with EC level decreasing for a short period of time following such events (Figure 38). Jamar Bore shows consistent EC observations around 4,000 µS/cm. The EC at Winton Creek Bore displays an increasing trend since 2014 and in 2020 has exceeded the previous maximum of approximately 8,300 µS/cm, with EC now observed at 9,000 µS/cm. The water levels at this bore show little variation (Figure 25) that could explain this increase.

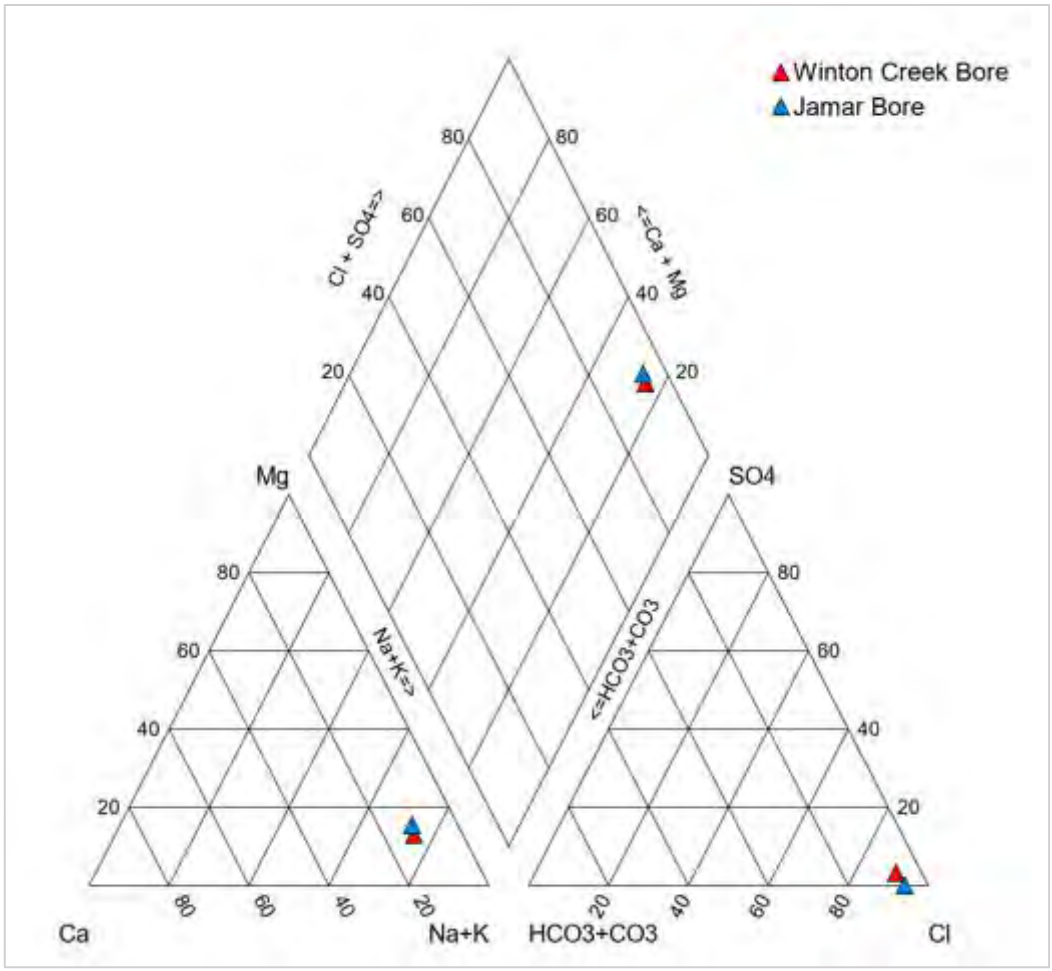


Figure 37 Piper plot – Rewan Group

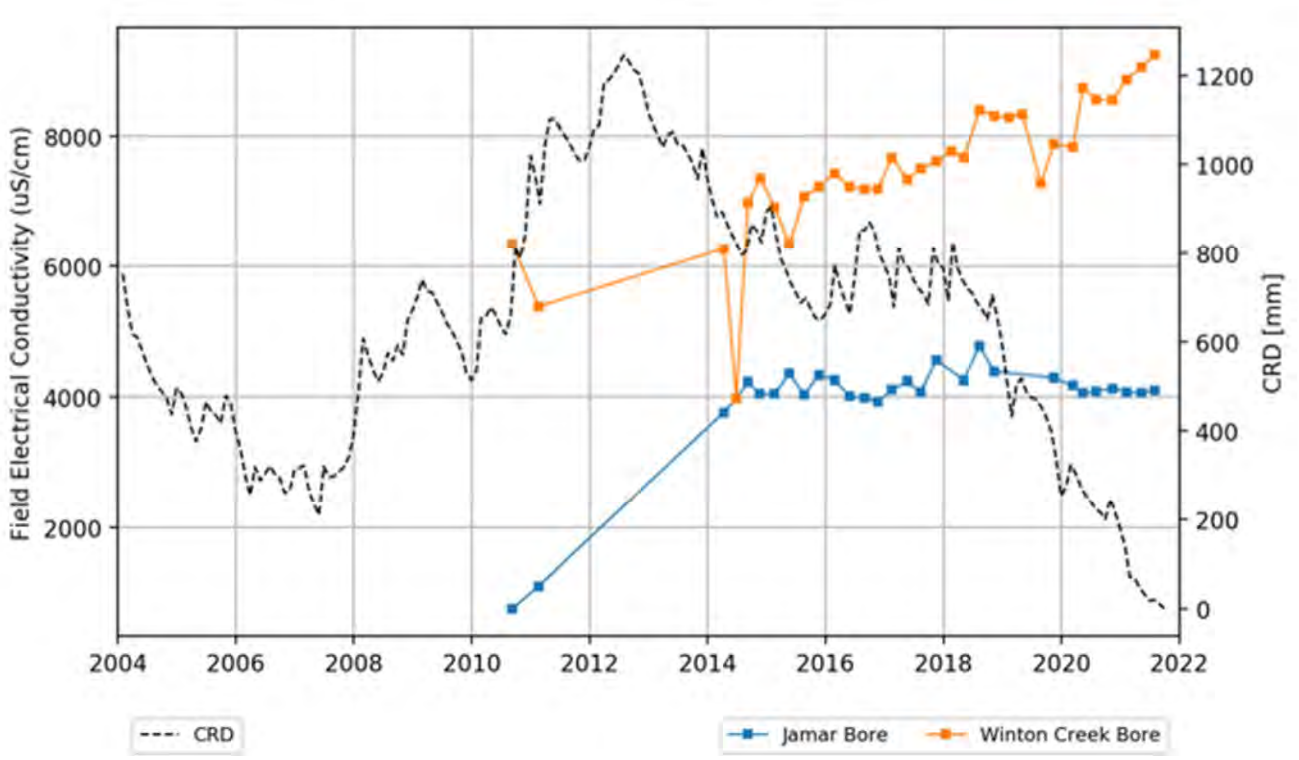


Figure 38 Field EC – Rewan Group

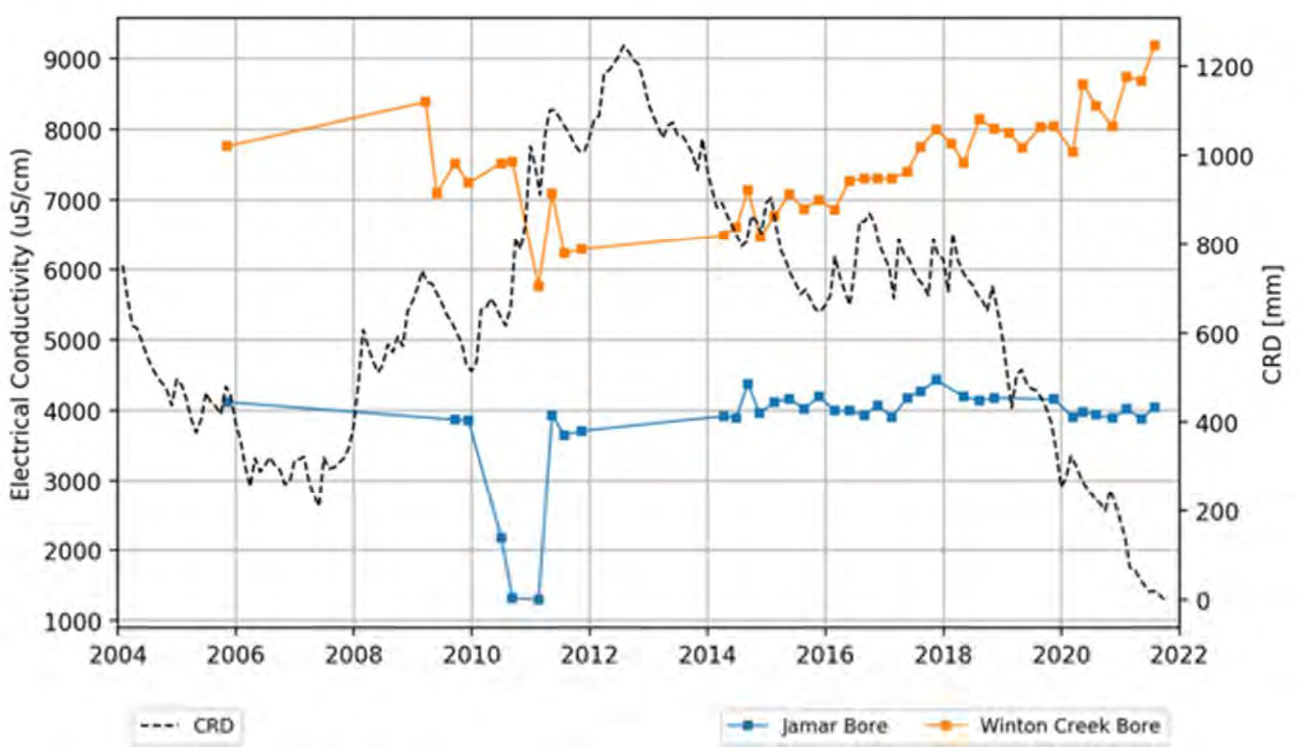


Figure 39 Electrical conductivity (Lab) – Rewan Group

The pH at both Rewan Group bores shows high variability, however, remain between 6.5 and 8.5 (Figure 40) at all times, which is within the lower Nogoa River WQOs for aquatic ecosystem protection (Appendix C).

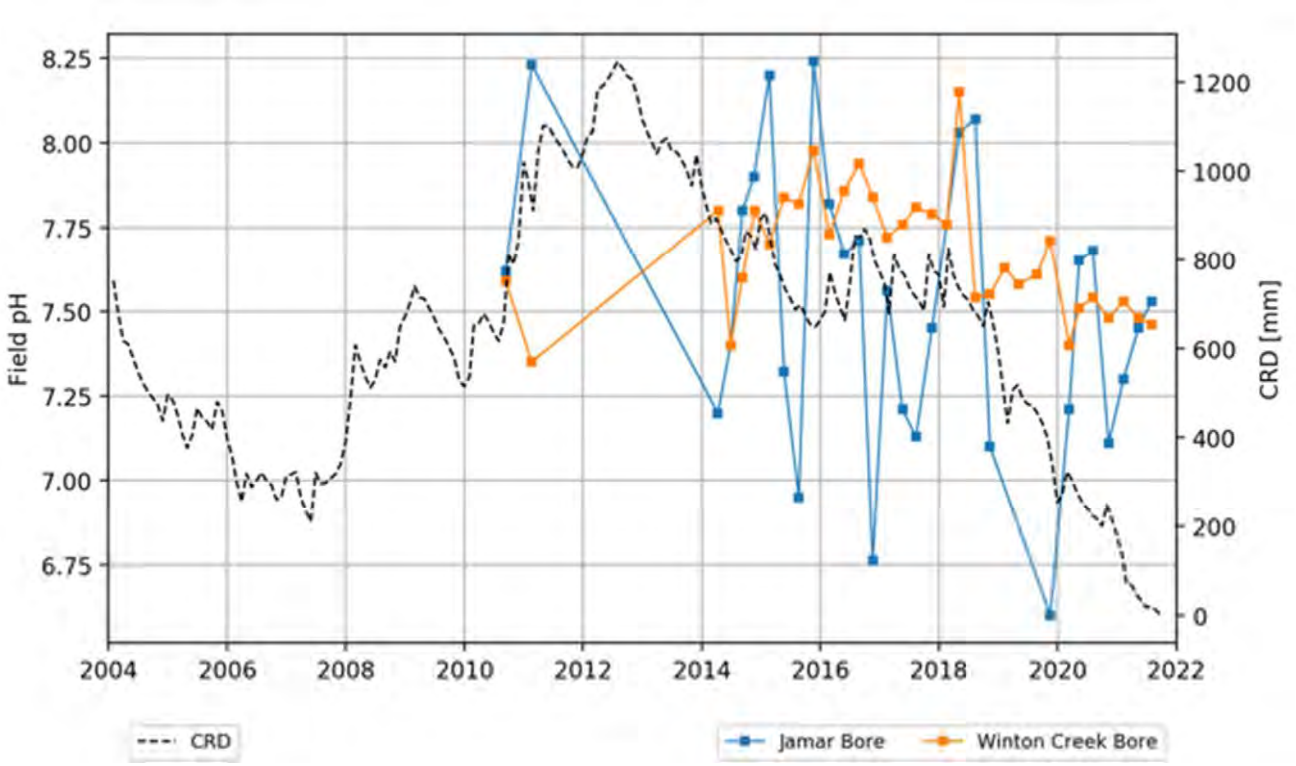


Figure 40 Field pH – Rewan Group

5.4.1.3 Rangal Coal Measures

The water in all the bores monitoring the Rangal Coal Measures are Na-Cl dominant with the exception of Karanga Bore (private bore to the south of the open-cut pits), which is Mg-Cl dominant (Figure 41.

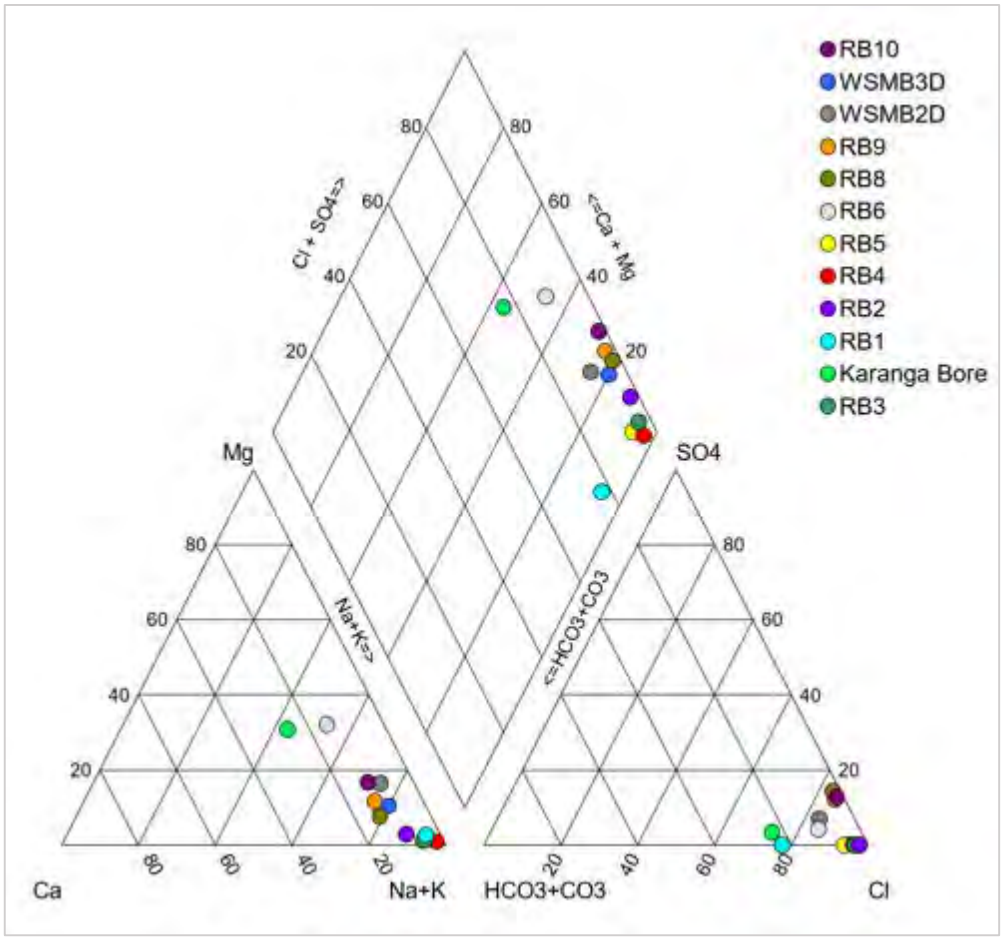


Figure 41 Piper Plot – Rangal Coal Measures

Bores screened within the deeper Rangal Coal Measures generally record relatively stable trends in EC, similar to relatively stable to slightly declining trends in groundwater levels. This highlights the relatively low response to rainfall recharge. An outlier can be seen in Figure 42 for RB01 (field EC), which is likely attributed to a measurement or transcription error.

The 80th percentile value for EC in monitoring bores WSMB2D, RB02, RB03 and RB04 is above the regional WQO for EC (Appendix C), which means these water quality objectives are not applicable and site specific triggers are suitable, as outlined in EA EPML00732813.

The pH variations are between 6.3 and 9.8 (Figure 43), however, all bore have 80th percentiles within the lower Nogoa River Evs for aquatic ecosystem protection (Appendix C). Alkaline pH values at RB04 and RB05 for two sampling events following bore construction are likely due to poor development of the bore initially. RB04 has started to display an upwards trend in pH since mid-2020.

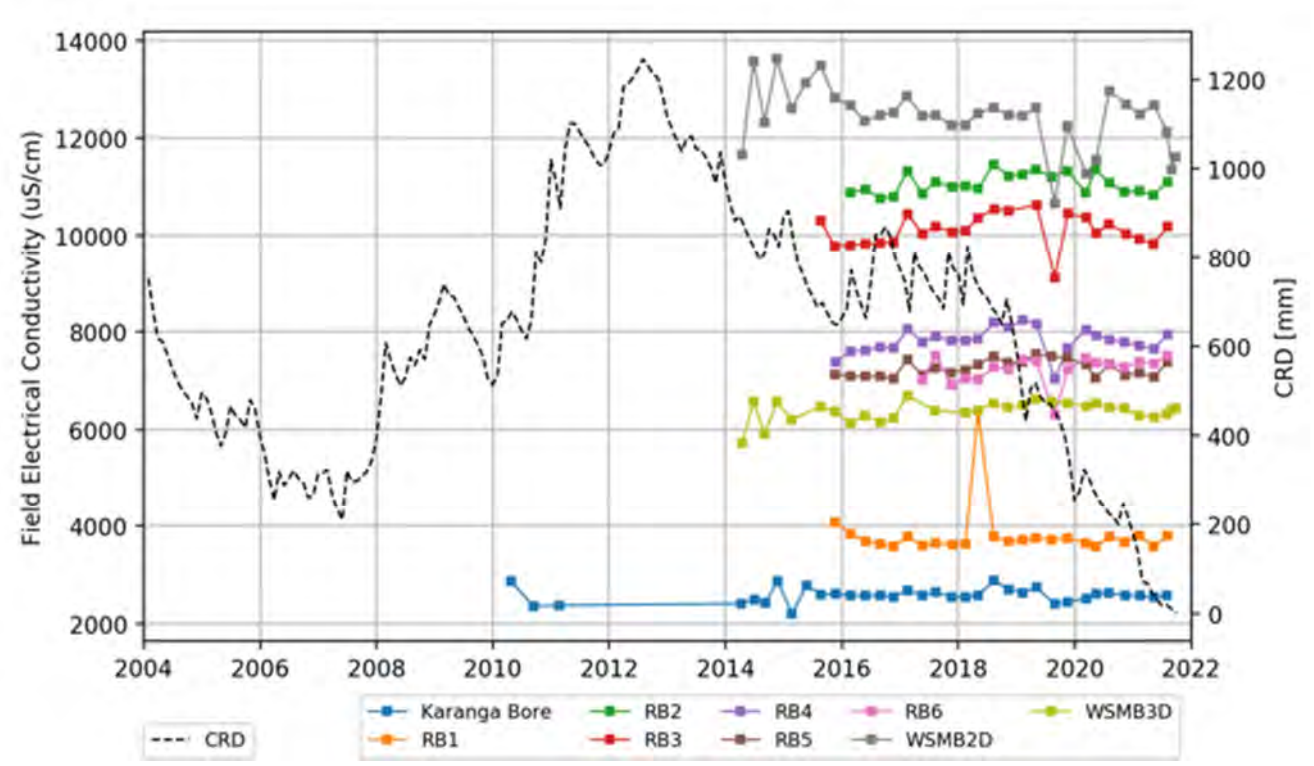


Figure 42 Field EC – Rangal Coal Measures

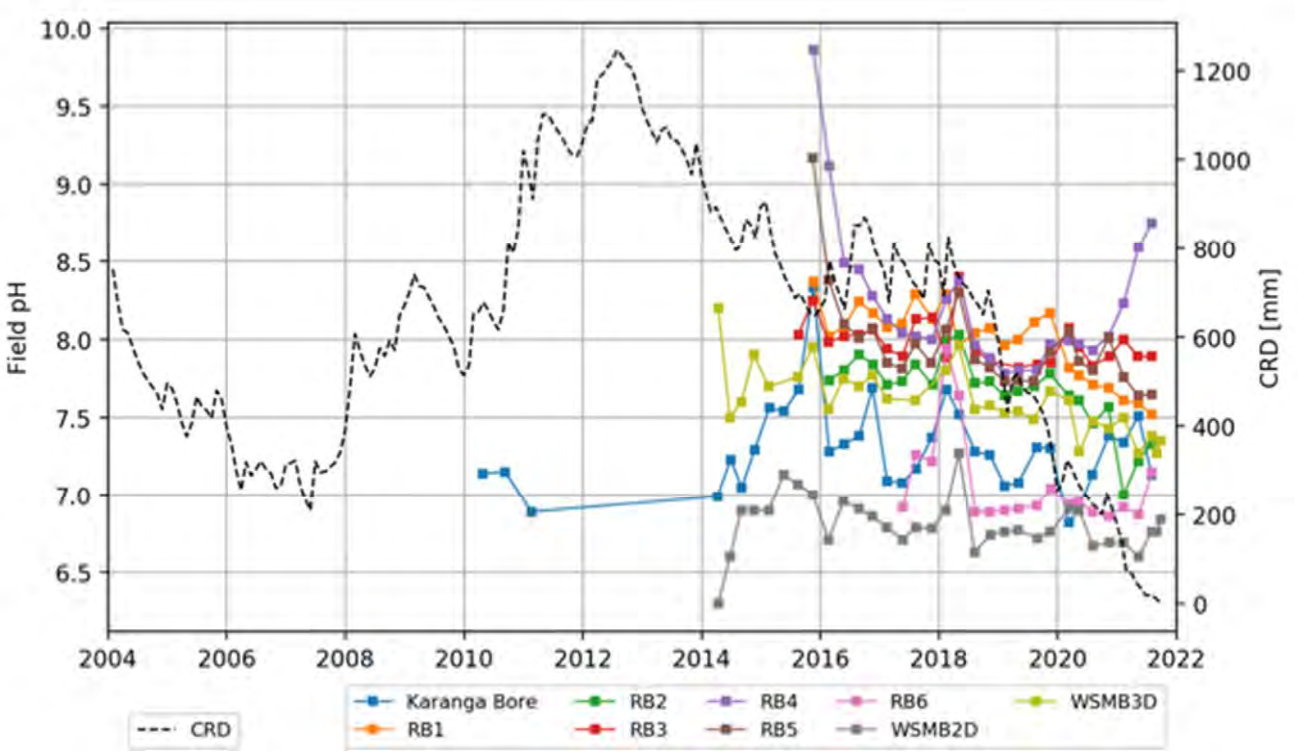


Figure 43 Field pH – Rangal Coal Measures

5.4.2 Metals and metalloids

Metal and metalloids identified as potential stressors in the current EA include iron, arsenic, aluminium, molybdenum and selenium. Metal and metalloids stressors are identified based on their abundance in the geological formations that are disturbed during mining and their potential for leaching.

For the purposes of this statistical analysis and visualisation, values reported as below the laboratory Limit of Reporting (LOR) in the dataset have been assigned a value equal to half of the LOR, consistent with the relevant DES (2021) Guideline. Data provided by Ensham before 2014 has been assigned a value equal to the LOR.

Figure 44 shows the number of bores with five or more data points that have 80th percentile values for the five selected metals (iron, arsenic, aluminium, molybdenum and selenium) above the ANZECC guideline for Aquatic Ecosystems (fresh water). Figure 44 shows that selenium, iron and molybdenum have the highest number of bores with an 80th percentile value above the guideline. In the alluvium, several bores have an 80th percentile value above the guideline for these metals, and a few for the Rangal Coal Measures and other formations. A few bores in the alluvium also have an 80th percentile value above the guideline for aluminium and arsenic. Appendix B shows the summary statistics for all EA parameters and bores with a sufficiently long data set, while Appendix C shows the box-and-whisker plots of all bores, plotted with the local WQO and relevant guidelines.

Individual time series and trend for these bores, in addition with pH, EC and sulphate variations do not indicate that the water quality in these bores is likely impacted by mining activities. Time series for each bore and parameters are provided in Appendix D.

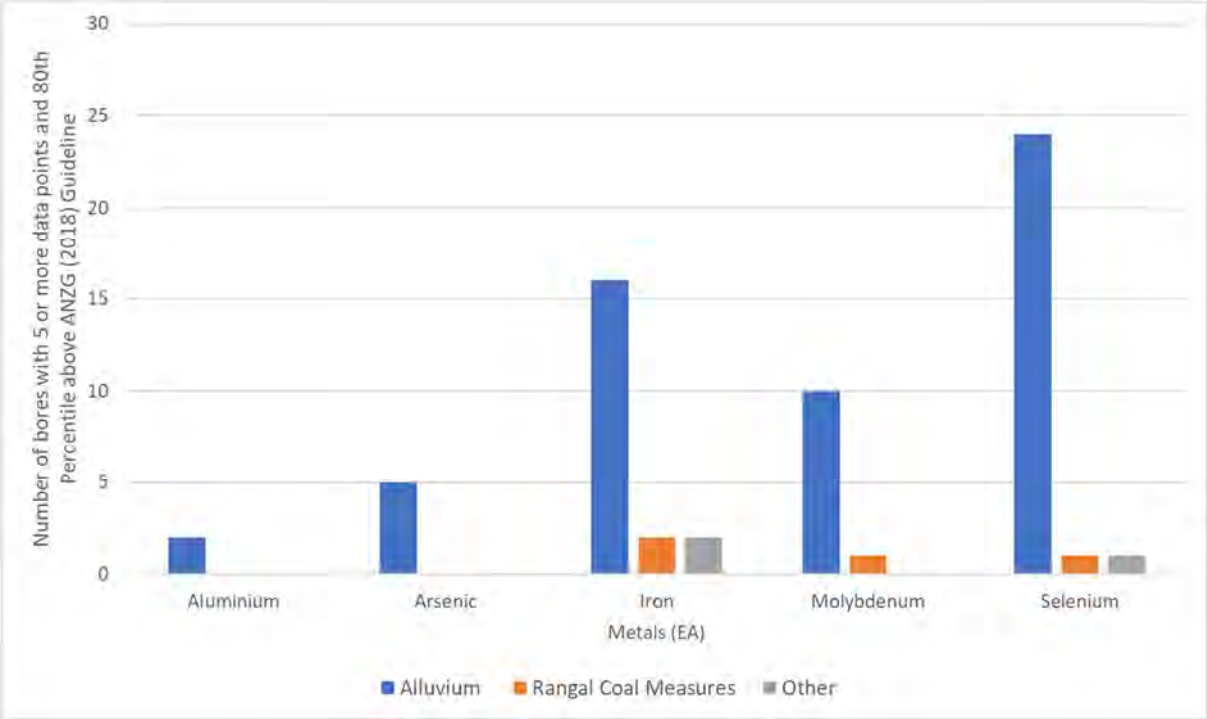


Figure 44 Number of bores with 80th percentile above ANZECC guidelines for aquatic ecosystem protection (95%) in the main hydrogeological units

5.5 Groundwater use and management

The Study area is covered by the Highlands Groundwater Management Area under the Fitzroy Water plan and is located in the lower Nogoa Groundwaters of the Fitzroy Groundwater plan (DEHP, 2011). Environmental values (EV) pertinent to the Project are listed in DEHP (2011) as:

- Aquatic ecosystems.
- Irrigation.
- Farm supply/use.
- Stock water.
- Primary recreation.
- Drinking water.
- Cultural and spiritual values.

Primary recreation environmental values apply to water reservoirs and connected waterbodies. The lack of connectivity between groundwater and surface water within the Study area means that the primary recreation EV is not relevant to groundwater for the Project.

As presented in Section 5.4, the groundwater quality in the Study area is not suitable for drinking. Most bores are brackish to highly saline. A bore census undertaken in September 2014 and reported in AGE (2017) revealed no bores were used for drinking water within a 10 km radius from Zone 1. Of the nine private bores identified as being in use, seven were reported to be used for stock water and two bores are in use for irrigation / stock and domestic.

Although groundwater in the Study area is listed to have cultural and spiritual values (DEHP, 2011), considering the brackish nature of the groundwater, the depth to groundwater (10 m or more), and the availability of freshwater in the nearby Nogoa River, it is unlikely that groundwater in the area will hold significant cultural or spiritual values.

As detailed in HydroSimulations, 2020, the EVs pertinent to groundwater in the vicinity of the Ensham mine are:

- Ecosystems.
- Irrigation.
- Farm supply / use and stock water supply.

A detailed assessment of each of the EV's is outlined in Section 5.5.1 to 5.5.5.

5.5.1 Groundwater dependent ecosystems

Ecosystems (aquatic and terrestrial) that are dependent on groundwater, or that may be affected by change in groundwater quality and levels, are referred to as GDEs. GDE mapping is available from DES (DES, 2022) The dataset contains shapefile data which can be grouped into the three categories of GDEs:

- Aquatic GDEs (and surface seeps).
- Terrestrial GDEs.
- Subterranean GDEs (including stygofauna).

The dataset contains information on both known and potential GDE areas. Known GDEs refers to areas that have been verified through field studies while potential GDEs refer to areas that have been mapped at a large scale primarily through analysis of GIS data. The dataset was queried to assess the presence of GDEs within a 10km buffer of the Project. The search showed the following GDEs which are shown on Figure 45:

- Terrestrial GDEs – Potential, derived with low confidence (along the Nogoa River, Winton Creek and at the confluence of Nogoa River, Mackenzie River and Comet River). This means that there is a low confidence that these ecosystems have some degree of groundwater dependence.
- Aquatic GDEs – Potential, derived with low confidence (along the Nogoa River and Winton Creek). Again, this means that there is a low confidence that these ecosystems have some degree of groundwater dependence.

Terrestrial GDEs are ecosystems that are dependent on the sub-surface presence of groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. A desktop assessment and field surveys were undertaken in 2019 and 2020 (AECOM, 2020). Field verified Regional Ecosystem mapping identified four vegetation communities within the terrestrial GDE mapping. Field observations including the lack of wetland flora indicator species, and evidence of water stress or high availability of preferential freshwater surface flows, confirmed the low likelihood of these communities to utilise and rely on groundwater.

There are no known or high confidence surface GDE seeps and no subterranean GDE seeps within 10 km of the Project, with the main channel of the Nogoa River and its anabranches instead mapped as low confidence surface GDE seeps (as located in Appendix N - Aquatic Ecology of the EA Amendment application). Aquatic and surface GDE seeps refers to ecosystems reliant on surface water hydraulically connected with groundwater. As discussed in Section 5.3.1, there is little potential for surface expression GDEs around the Project.

5.5.2 Stygofauna

A comprehensive stygofauna assessment was undertaken for Zones 2 and 3 (as located in Appendix O of the EA Amendment Application). The results of this study are transferrable to Zone 1. Of the 26 groundwater monitoring bores sampled, stygofauna were found in only four of the bores, all in the alluvium. These bores are EC11, EC13, EC14 and RN13020177. The stygofauna assessment found that the environmental value of the stygofauna community within 10 km of the Project was:

- Moderate in the alluvium.
- Low for the Rewan group and Rangal Coal Measures groundwater systems.

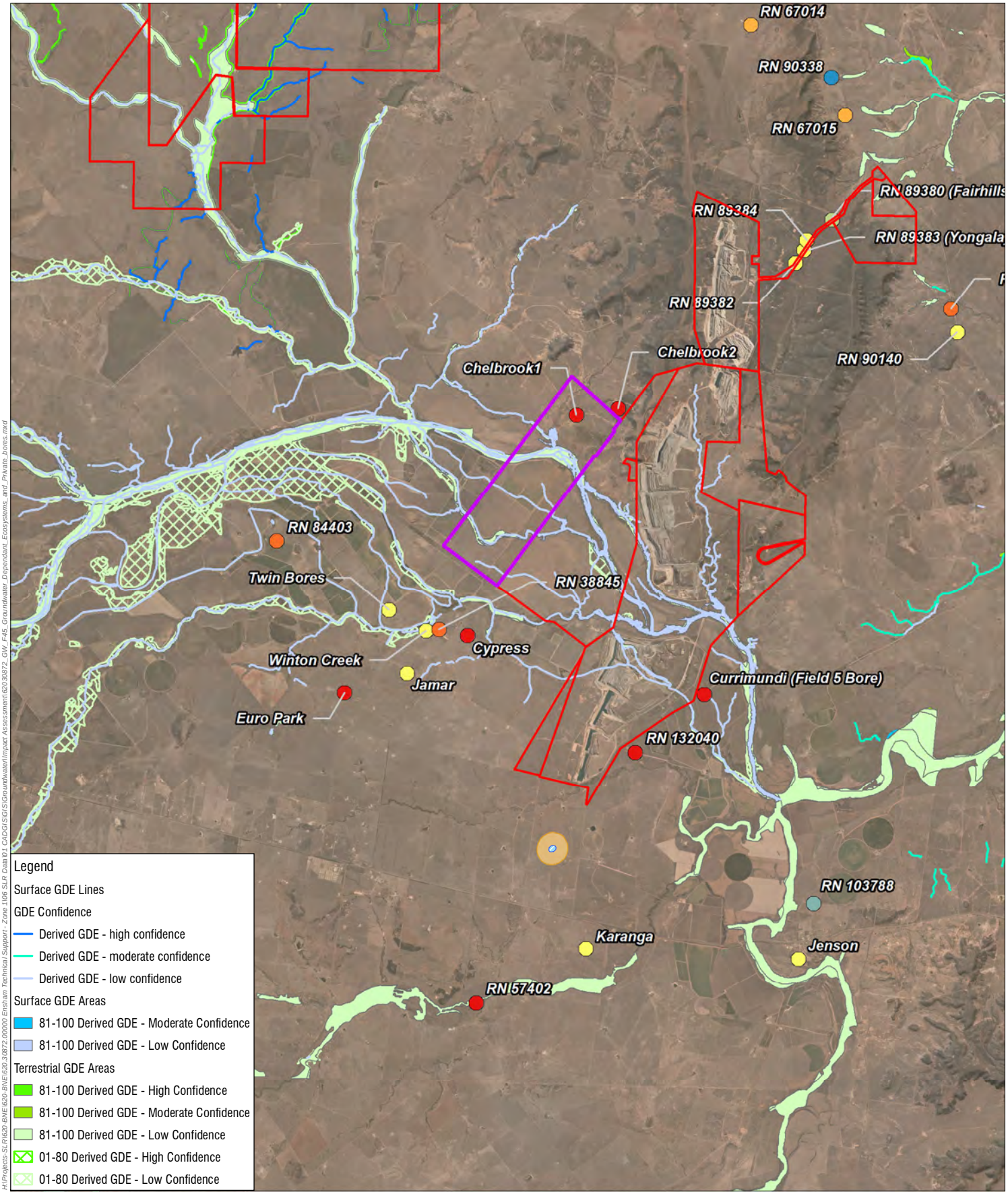
The stygofauna environmental values within the alluvial aquifer in the Study area will be managed via a groundwater level, water quality and stygofauna monitoring program that targets bores where stygofauna were recorded. Condition I9 and I10 of the EA stipulate that the existing Groundwater Monitoring and Management Plan is to be updated by 30th November 2023 to include stygofauna monitoring and data analysis to detect any impacts to stygofauna communities due to mining activities.

5.5.3 Springs

A search for springs was conducted using the Springs – Active – Queensland dataset downloaded from Qspatial (DES, 2018). The search showed that there were no active springs within a 10 km buffer of Zone 1 and that the closest active spring is approximately 58 km southeast of the Project.

5.5.4 Wetlands

A search for wetlands was conducted using the Wetland protection area – GBR high ecological significance wetland (DES, 2020). The search showed a wetland of high significance located approximately 10 km south of Zone 1 (Figure 45). The wetland is surrounded by agriculturally used land, as indicated by farm dams and irrigation pivots in the area. The wetland has not been confirmed by a site visit. The dataset classifies the wetland as a Palustrine wetland, which are primarily vegetated non-channel environments of less than 8 hectares.



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106\SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F45_Groundwater_Dependant_Ecosystems_and_Private_bores.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

SLR

Legend

- Wetland
- Wetland Protection Area
- Zone 1
- Mining Lease
- Farm Supply (Potable)
- Irrigation, Stock, and Domestic
- Stock and Domestic
- Stock
- Unlikely used (very saline)
- Unknown
- Not in use

GROUNDWATER IMPACT ASSESSMENT

Groundwater Dependant Ecosystems and Private bores

Figure 45

5.5.5 Irrigation, farm supply / use and stock water (private bores)

Several private bores extract groundwater adjacent to the mine lease boundary for irrigation, farm supply or stock water. AGE, 2017 reported on a bore census conducted in September 2014 coupled with a database search for registered bores on the groundwater database (GWDB), hosted by the Department of Regional Development, Manufacturing and Water.

For this report, an additional database search was conducted and a summary of identified existing bores within a 15 km radius from the proposed lease is provided in Table 13. Overall, groundwater usage is limited in the district, given access to better quality water provided from the Fairbairn Dam.

The distribution of private bores, categorised according to use, is shown on Figure 45

Table 13 Existent private groundwater bores

Registered RN (ID)	Bore name	Easting (mMGA)	Northing (mMGA)	Geology	Bore depth (m)	Use
103788	Conmurra	657954	7390072	Fair Hill Formation	66	Irrigation (stock and domestic)
132040	Currimundi	650966	7395998	Burngrove Formation	-	Not in use
57402	Kensington	644749	7386154	Tertiary undifferentiated	-	Not in use
84403	-	636913	7404293	Alluvium	-	Unknown
89380	Fair Hills	658696	7416877	Burngrove Formation	77	Stock
89383	Yongala	657586	7415693	Burngrove Formation	74	Stock
89382	-	657253	7415184	Burngrove Formation	74	Not in use
89384	-	657691	7416083	Burngrove Formation	78	Not is use
90140	Railway	663591	7412470	Fair Hill Formation	61	Stock
-	Chelbrook1	648661	7409238	Tertiary undifferentiated	24	Not in use
-	Chelbrook2	650303	7409481	Rangal Coal Measures	>100	Not in use
-	Currimundi (Field 5 bore)	653687	7398270	Alluvium	29	Not in use
-	Cypress	644408	7400570	Rangal Coal Measures	>160	Not in use
-	Euro Park	639581	7398327	Rewan Group	74	Not in use
-	Jamar	642025	7399084	Rewan Group	90	Stock

Registered RN (ID)	Bore name	Easting (mMGA)	Northing (mMGA)	Geology	Bore depth (m)	Use
-	Jenson	657364	7387906	MacMillan Formation	41	Stock
-	Karanga	649043	7388304	Rangal Coal Measures	~50	Stock
-	Twin Bores	641319	7401567	Basal alluvium	18	Stock
-	Winton Creek	642771	7400758	Rewan Group	60	Stock

5.6 Conceptual groundwater model

A conceptual cross section for the Study area centred on the Ensham mine is shown in Figure 46. The location of the groundwater specific cross section (B-B') is shown on Figure 12.

The conceptual regional cross section includes the Nogoa River, the agricultural area within the flood plain, and the Yongala pit. The Project targets the Aries and Castor seams at depth of 80 m to 210 m below surface. The Rewan Group, a regional aquifer of 100-200 m observed thickness at the Project, separates the Nogoa River flood plain and alluvium from the proposed underground working. Recharge to the Permian Coal Measures occurs where the formations outcrop. The dewatering from mining results in a lowering of the groundwater levels in the Rangal Coal measures, consequently groundwater flows towards the mine in this formation.

A shallow cross section across the subcrop is presented in Figure 47. The location of cross section is shown on Figure 16 as C-C'. This cross section is based on the groundwater model layers (Section 6.4.1), with some refinement around the monitoring bores in order to demonstrate how the subcrop is included in the groundwater model. Note that due to the location of the cross section, the Nogoa River (Main channel) is crossed twice.

During the winter dry season, the ephemeral Winton Creek and Flood channel 2 are conceptualised as being dry. The ecology assessment (as located in Appendix N of the Environmental Authority Amendment application) observed standing pools of water in Flood channel 2 after a prolonged time with no substantial rainfall. It is not clear if this is stagnant water from the previous rain event or if some of the irrigation water is seeping into the drainage line (through the topsoil). This is marked on the cross section as potential shallow seepage from irrigation.

The groundwater is conceptualised as not receiving a substantial amount of natural recharge during the dry season. The water levels in the alluvium are low and groundwater can form discontinued lenses of stagnant water that has high salinity. The Nogoa River is disconnected from the groundwater. The saturated water level in the alluvium is approximately 140 mAHD, and the river stage is approximately 147 m AHD (estimated based on the Digital Elevation Model (DEM), depth of riverbed and average water level in the river). If any seepage would occur, this would be disconnected unsaturated flow, which would be limited based on the surrounding clays.

During the wet season, the groundwater is conceptualised as receiving the main recharge by irrigation and limited amounts of recharge through downward seepage from rainfall. The water levels in the wet season are higher than in the dry season and the EC is observed to decrease when groundwater levels increase.

The Rangal Coal measures subcrop below the alluvium in the area between Pit C and Pit B (Figure 16). The cross-section (C-C') crosses the Nogoa River and it is apparent that the river is not in direct connection with the coal measures, but rather separated by the shallow clay and deeper sand layer of the alluvium. The bores that are located along, at, or near the sub-crop are EC07, EC11 and EC14. The cross section shows the latest water levels at those bores, which show that they are below the Nogoa River water levels.

The cross section further illustrates the inferred groundwater level between 13020171 and EC03 at two points in time (2004 and 2021), which shows how the rise of the groundwater levels upstream of EC03 may potentially cause the observed groundwater seeps.

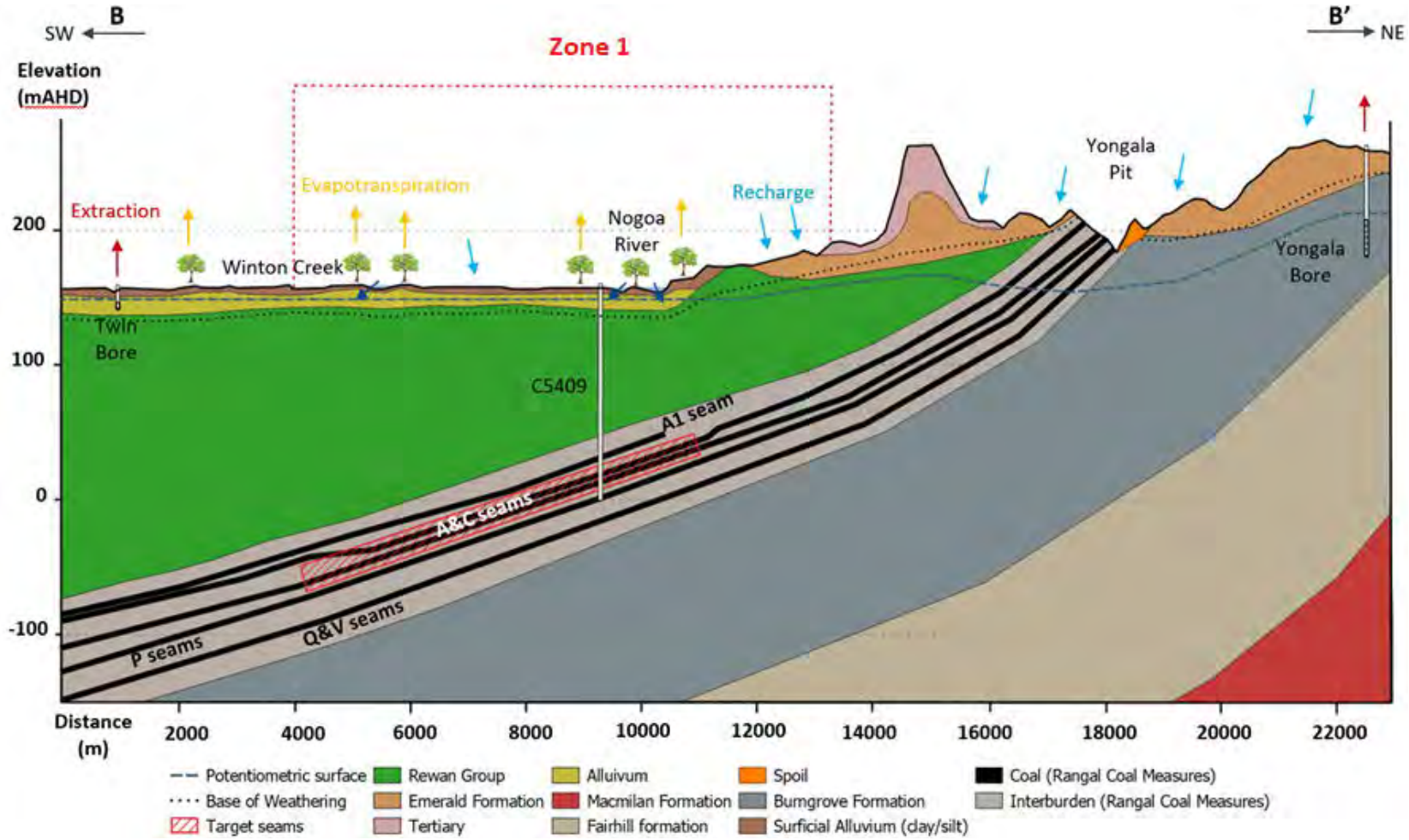


Figure 46 Conceptual groundwater model (location of cross section shown on Figure 12)

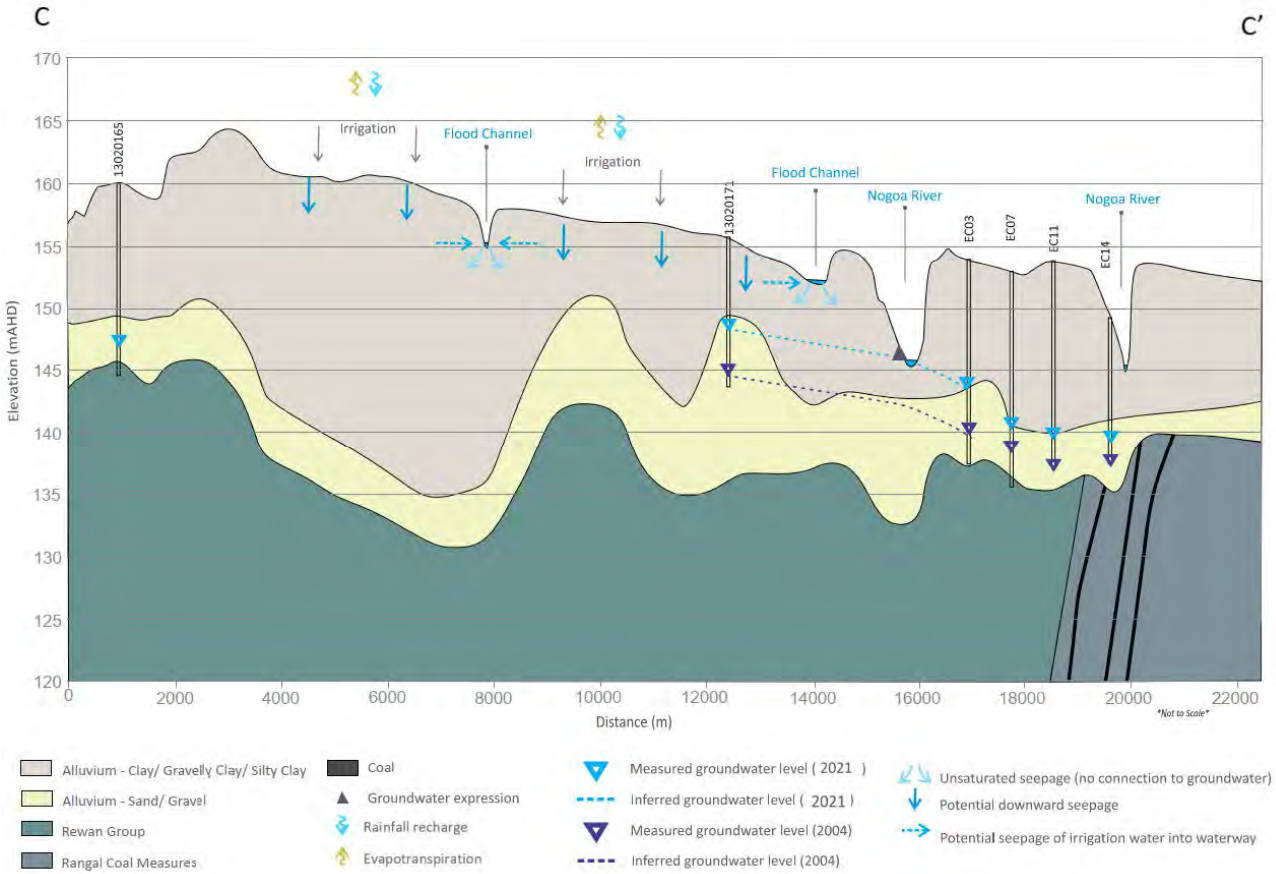


Figure 47 Cross section along the alluvium and sub-crop (location of cross section shown on Figure 16)

6 Groundwater model

6.1 Model objectives

Numerical modelling was undertaken to assess the impact of the Project on the groundwater regime. The objectives of the predictive modelling were to:

- Estimate the groundwater inflow to the mine workings as a function of mine position and timing.
- Simulate and predict the extent and area of influence of dewatering and the level and rate of drawdown at specific locations (bores identified in Section 5.5.5 and the EA monitoring bores for ongoing model validation).
- Identify areas where groundwater impact mitigation / control measures may be necessary.

6.2 Software

The groundwater model was originally constructed and calibrated in 2016 by AGE, 2017, using MODFLOW-USG software, version 1.2.4 (Panday et al., 2013) coupled with mesh generation software AlgoMesh developed by HydroAlgorithmics Pty Ltd (Merrick and Merrick, 2015). Functionality of the MODFLOW-USG package has been employed to represent discontinuous lithology, time-variant hydraulic properties and improved model stability under desaturated conditions.

6.3 Model history and peer reviews

The groundwater model used within this assessment has undergone numerous developments and peer reviews since it was originally constructed and calibrated in 2017 as outlined in Table 14.

Table 14 Model Version History and Peer Review

Model Developer	Year	Project	Peer Reviewer
AGE	2017	Underground Extension	Not known
Hydrosimulations	2020	Residual Void Project	DHI
SLR	2020	Environmental Impact Assessment Zone 1, 2 and 3	SMI, IESC
SLR	2022	Zone 2 and 3 EA amendment	SMI
SLR	2022	Zone 1 EA amendment (Current Project)	SMI

6.4 Model setup

A groundwater flow model is a computer-based three-dimensional mathematical representation of a groundwater system using the laws of physics. A model is generally developed for all or part of a groundwater system. The modelled area is referred to as the model domain, which exists in three dimensions. It is divided into a number of building blocks to represent key features of the groundwater flow system including the elevation of the ground surface and each geological formation present within the area.

The groundwater model presented in this report was constructed with a number of layers that represent the hydrogeological units (Section 6.4.1), based on the data collected and described in Section 5. The model layers were assigned representative aquifer parameters (Section 6.4.2), initial conditions (i.e. the water level at the start of the modelling period) and boundary conditions (Section 6.4.3). These conditions were adopted from previous model iterations (SLR, 2022).

The model was used to calculate the response of this conceptualised groundwater system to the following boundary conditions:

- No flow and general head boundary (Section 6.4.3.1 and 6.4.3.2).
- The climatic inputs and outputs, specifically the rainfall recharge and evapotranspiration (Section 6.4.3.3).
- Interactions of the groundwater system with open-cut mining operations (Section 6.4.3.4).
- Interactions of the groundwater system with the underground operations (Section 6.4.3.5).
- Interaction with natural surface water bodies (Section 6.4.3.6).

The model is not only discretised in space, but also in time. The time steps used in this model are described in Section 6.4.4.

6.4.1 Model grid and layers

Figure 48 shows the model domain and the model grid (a voronoi polygon mesh), which, with 12 layers, is consistent with previous model iterations.

All model iterations, including the model presented in this report (SLR 2022 model), utilise the pinching capability of MODFLOW-USG. This capability allows the reduction of overall cell count when a layer is not present at a location (for example coal outcrops). In this model, the maximum number of cells is 770,190 compared to 952,236 cells in an equivalent layered model. This represents a saving for model runtime of about 20 percent.

The stratigraphic units that are represented by each model layer are summarised in Table 15. The alluvium and the Rewan Group are both discretised with two model layers. The alluvium is subdivided because two distinct layers are observed (Section 5.3.1.3), while the Rewan Group was subdivided to provide better vertical resolution. Further, the division into two layers allows for assigning different aquifer parameters to represent the change in geology. The Rangal Coal Measures are split into seven layers, accounting for three coal seams and the overburden, interburden and underburden.

Table 15 Stratigraphy – model layer summary

Model layer	Geological age	Stratigraphic unit	
1	Quaternary	Low permeability alluvium and regolith	
2		Alluvium (basal gravel) and regolith	
3	Triassic	Rewan Group – fine grained sandstone and siltstone	
4			
5	Permian	Rangal Coal Measures	Sandstone, siltstone and shale
6			Aries 1 seam
7			Sandstone, siltstone and shale
8			Aries 2 seam and Castor seam
9			Sandstone, siltstone and shale
10			Pollux seam
11			Sandstone, siltstone and shale
12		Burngrove Formation	Sandstone, siltstone, shale and coal

6.4.2 Model properties

Summaries of the model layer calibrated properties from Hydrosimulation, 2020 and adopted in this model are presented in Table 16. A comparison between adopted hydraulic conductivities and field data is presented in Table 17. Appendix F, Figure F1-1 to Figure F1-12 show the hydrostratigraphic zones for each layer.

Table 16 Simulated aquifer properties

Model layer	Lithology	Horizontal hydraulic conductivity Kh (m/day)		Vertical hydraulic conductivity Kv (m/day)		Specific yield Sy (-)	Specific storage Ss (m)
		From (lower value)	To (upper value)	From (lower value)	To (upper value)		
1	Surficial alluvium (clay / silt)	1.00E-03	1.00E-03	5.00E-05	5.00E-05	7.50E-03	1.00E-06
1,2	Regolith	2.80E-01	2.80E-01	7.00E-03	7.00E-03	7.50E-03	1.00E-06
1,2	Permian subcrop	3.00E-02	3.00E-02	1.20E-04	1.20E-04	1.50E-02	1.00E-06
2	Basal alluvium (sand / gravel)	1.00E+01	1.00E+01	5.00E-01	5.00E-01	1.50E-01	5.00E-06
3	Rewan Group	4.20E-02	4.20E-02	2.10E-04	2.10E-04	7.50E-03	1.70E-06
4	Rewan Group	1.20E-04	1.20E-04	6.00E-07	6.00E-07	7.50E-03	1.50E-06
5	Sandstone / siltstone / shale	2.00E-04	2.00E-01	4.55E-06	4.55E-03	3.75E-02	1.00E-07
6	Aries 1 Seam	1.00E-02	1.00E+01	2.78E-04	2.78E-01	7.50E-03	1.00E-07
7	Sandstone / siltstone / shale	4.00E-04	2.00E-01	3.57E-06	3.57E-03	1.38E-03	5.00E-07
8	Aries 2 and Castor Seam	5.00E-03	5.00E-01	2.50E-04	2.50E-01	7.50E-03	5.00E-07
9	Sandstone / siltstone / shale	1.00E-04	1.00E-01	5.00E-06	5.00E-03	7.80E-04	5.00E-07
10	Pollux Seam	5.00E-03	5.00E+00	2.78E-04	2.78E-01	7.50E-03	5.00E-07

Model layer	Lithology	Horizontal hydraulic conductivity Kh (m/day)		Vertical hydraulic conductivity Kv (m/day)		Specific yield Sy (-)	Specific storage Ss (m)
		From (lower value)	To (upper value)	From (lower value)	To (upper value)		
11	Sandstone / siltstone / shale	1.00E-04	1.00E-01	4.17E-06	4.17E-03	7.73E-04	5.00E-07
12	Burngrove Formation	1.00E-05	1.00E-04	8.60E-06	8.60E-06	1.00E-03	5.00E-06
-	Spoil	1.00E+00	1.00E+00	1.00E-01	1.00E-01	4.00E-02	1.00E-03
-	Void	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+00	1.00E-04
-	Bord and Pillar zone	1.00E+02	1.00E+02	1.00E+02	1.00E+02	5.00E-01	1.00E-04
-	Faults	1.00E-05	1.00E-04	1.00E-06	1.00E-05	1.00E-02	1.00E-05

Table 17 Adopted properties relative to field data ranges

Model layer	Lithology	Validated horizontal hydraulic conductivity kh (m/day)		Field data horizontal hydraulic conductivity kh (m/day)	
		From (lower value)	To (upper value)	From (lower value)	To (upper value)
1	Surficial alluvium (clay / silt)	1.00E-03	1.00E-03	9.00E-04	1.00E-03
1,2	Regolith	2.80E-01	2.80E-01	4.30E-01	4.30E-01
1,2	Permian subcrop	3.00E-02	3.00E-02	-	-
2	Basal alluvium (sand / gravel)	1.00E+01	1.00E+01	9.00E-02	1.00E+02
3	Rewan Group	4.20E-02	4.20E-02	-	-
4	Rewan Group	1.20E-04	1.20E-04	-	-
5	Sandstone / siltstone / shale	2.00E-04	2.00E-01	4.00E-03	4.00E-03
6	Aries 1 Seam	1.00E-02	1.00E+01	9.00E-03	5.90E+00
7	Sandstone / siltstone / shale	4.00E-04	2.00E-01	1.80E-02	1.19E+00
8	Aries 2 and Castor Seam	5.00E-03	5.00E-01	9.00E-03	5.90E+00
9	Sandstone / siltstone / shale	1.00E-04	1.00E-01	1.80E-02	1.19E+00
10	Pollux Seam	5.00E-03	5.00E+00	9.00E-03	5.90E+00
11	Sandstone / siltstone / shale	1.00E-04	1.00E-01	1.80E-02	1.19E+00
12	Burngrove Formation	1.00E-04	1.00E-04	-	-
-	Spoil	1.00E+00	1.00E+00	-	-

6.4.3 Boundary conditions

The model boundary conditions that were applied are consistent with the previous model iterations (SLR, 2022). Figure 48 shows the General head boundary (GHB) to the southwest and south of the model, the mining related drain boundaries and the surface water related River and Streamflow boundaries. They are described in more detail below.

6.4.3.1 No flow boundary

No-flow boundary conditions were applied for the north-west to eastern boundary, which means that no groundwater flow occurs across these boundaries. These boundaries were chosen by earlier model iterations and were kept consistent in this model.

6.4.3.2 General head boundary

General head boundaries represent regional inflow or outflow. The GHBs were chosen by earlier model iterations (Section 6.3) and were kept consistent in this model. The GHB is applied to the south and southwest of the model domain for all model layers. The GHB heads range is from 140 to 150 mAHD (no change over time).

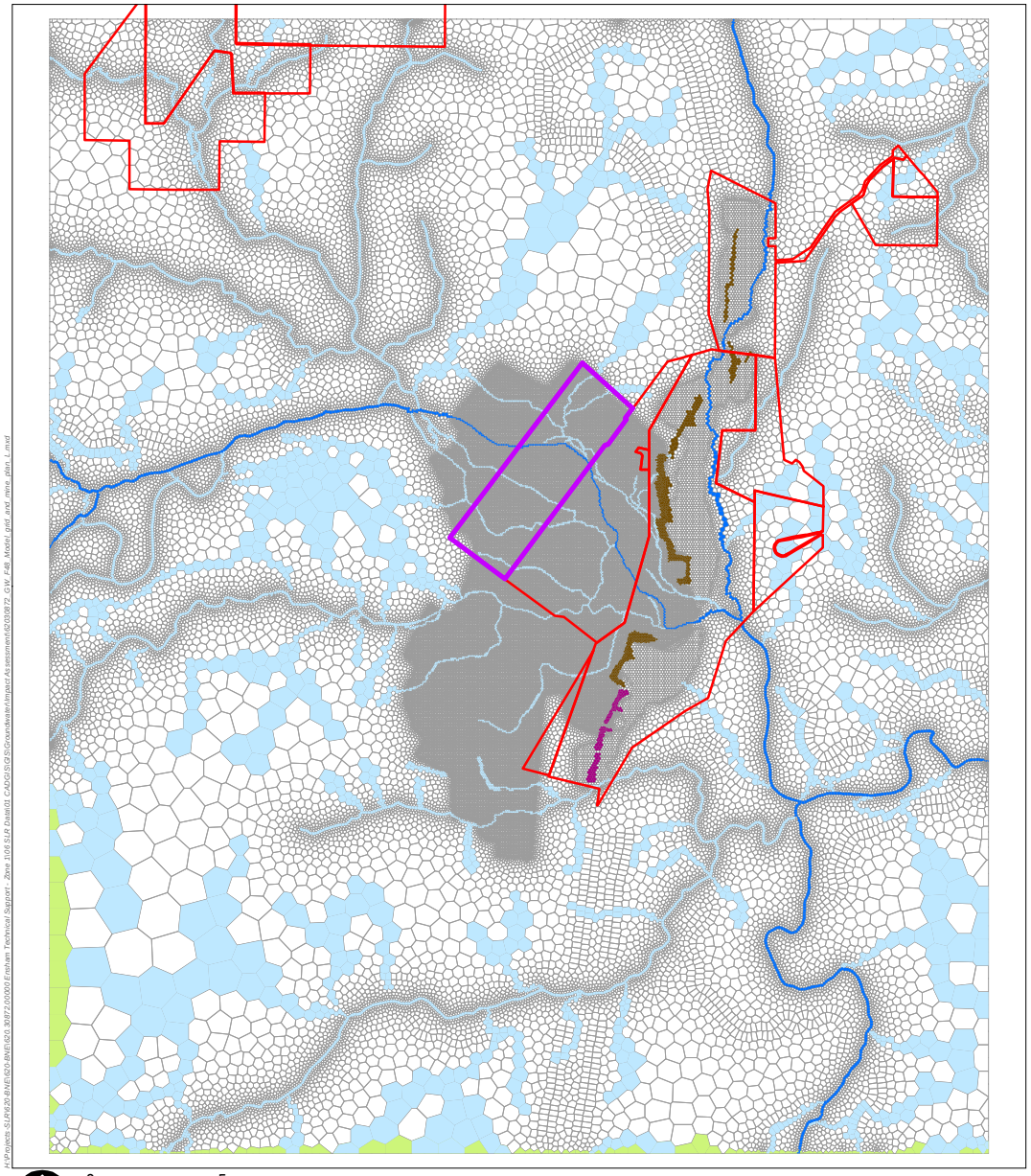
6.4.3.3 Recharge and evaporation

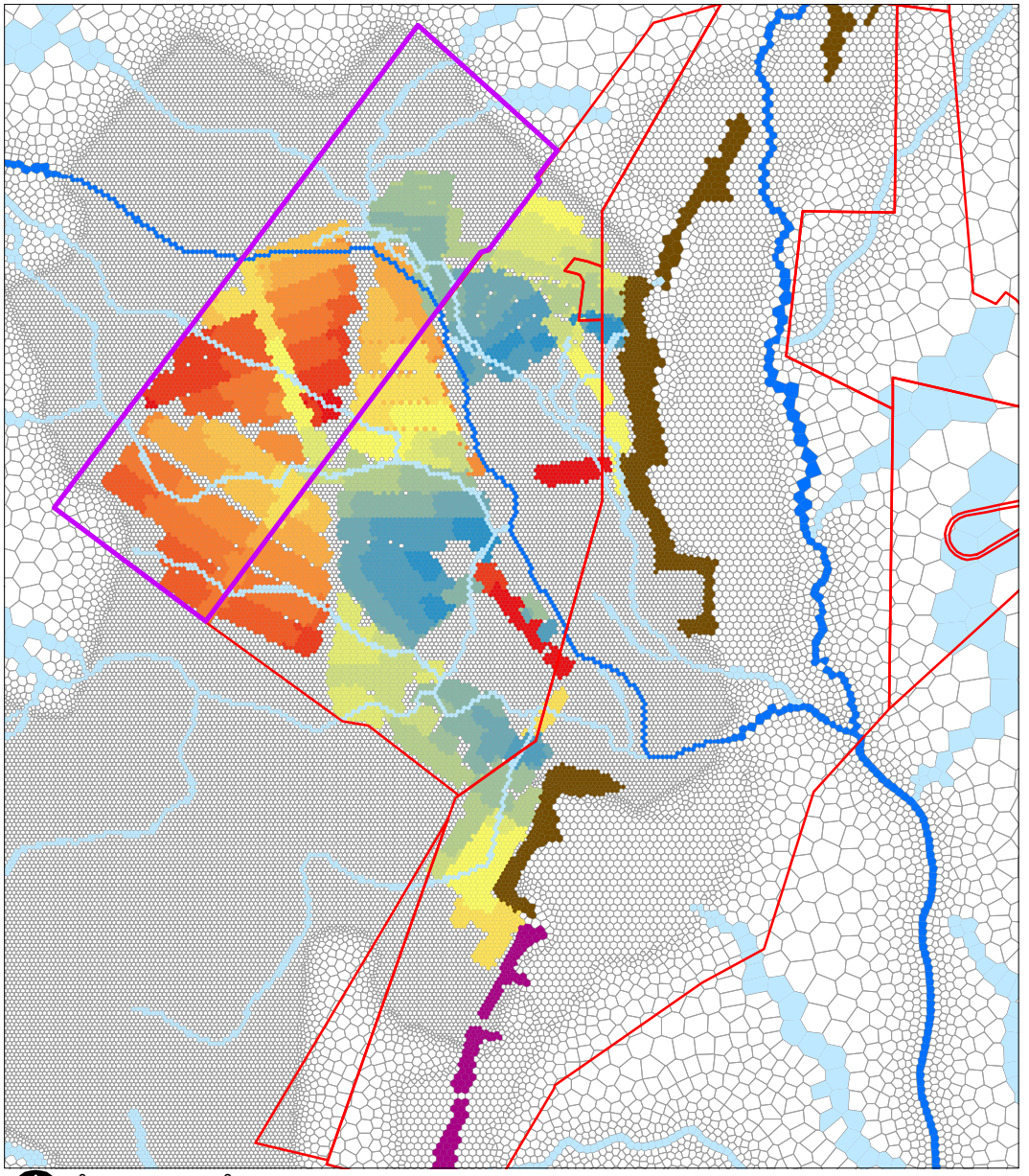
Recharge from rainfall was assigned to the top model layer as a percentage of the rainfall. The calibrated values from HydroSimulations, 2020 are presented in Table 18 and were adopted in this model. Appendix F, Figure F2-1 presents the zones for the groundwater recharge.

Table 18 Recharge values

Zone	Diffuse recharge rate	
	mm / yr	Percent of annual rainfall (%)
Surficial alluvium	5.18	0.8
Regolith	0.032	0.005
Permian subcrop	0.032	0.005
Spoil	53.1	8.2
Open-cut mine void	647.5	100

The evapotranspiration rates are 1,030 mm/year for the general areas and 1,650 mm/year for the open water bodies of the voids, which equates to 50% and 80% of the long-term pan evaporation observations of 2,062 mm/year. The rates are applied at the surface at the reported values and decrease linearly over depth to zero at the so-called extinction depth of 2 m BGL. This means that the evapotranspiration processes are most prevalent at the surface and expected to reach down to 2 m below ground surface, representing the root zone.





0 5 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:275,000

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:100,000

Project No.:620.30872
Date: 03-Jun-2022
Drawn by: NT
Sheet Size: A4

SLR

Legend

- Stream Cell (STR)
- River Cell (RIV)
- Open Cut Drain Cell (DRN)
- Constant Head Boundary (CHB)
- General Head Boundary (GHB)
- Zone 1
- Model Grid
- Mining Lease

Underground Mining Year

2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037

GROUNDWATER IMPACT ASSESSMENT
Model grid, boundary conditions and mine plan

Figure 48

6.4.3.4 Open-cut mining

The open-cut mine is currently undergoing closure with dragline, and, drill and blast operations having ceased, and truck fleet movements now much reduced; operations (excluding rehabilitation) are expected to cease this year (2022). The open-cut pits will continue to be rehabilitated or used as water storages. Pit C and D will remain dewatered to allow access to the portals for the underground mine which includes the Project.

The open-cut mine and associated spoils are simulated within the model through the use of MODFLOW drain cells and the time variant materials (TVM) process. A drain cell in a groundwater model has two properties assigned to it, a water level (to which the model attempts to drain this cell) and a conductance (a parameter that defines how much resistance the surrounding groundwater shows against the drain). Figure 48 shows the modelled mine progression. The drain cell conductance was selected as 100 m^2 / day, consistent with previous model iterations.

After open-cut mine operations cease, pits will continue to be rehabilitated using spoil. The spoil creates a porous medium through which water can flow. This water is treated as groundwater and is included in the model through implementation of the TVM package. Similar to an aquifer, the waste material is assigned hydraulic properties (a conductivity of 1 m/day and storage properties, a specific yield of 0.04). Water stored in waste material impacts on rate of void water rebound and pit water level predictions. Having the material in place also reduces the evaporation volume compared to an open water surface setting. It is thus critical to include these flows in the groundwater model.

6.4.3.5 Underground workings

The model is constructed to simulate the gradually developing underground workings. The mine plan for the calibration model (which covers the time frame between 1995 and 2021) has not been changed since the previous model (SLR, 2022). However, for the future predictions (2022 onwards), the underground mine plan for the existing approved operations and the Project model have been updated accordingly.

The underground mining is modelled using drain cells. The model then calculates the inflow into the drain cell based on these two parameters described above. First, it compares the groundwater level to the drain level. If the groundwater is above this level, the drain cell will remove water until the groundwater and the drain cell head are at the same level, using the drain cell conductance as a factor. If the groundwater level is below the drain cell head, no water is removed from the groundwater. The heads in the drain cells in the model range from -73.85 mAHD in the west to 106.82 mAHD in the east for the underground workings, accounting for the dip in the westerly direction. The drain cell conductance was selected as 100 m^2 / day in accordance with previous model iterations (Section 6.3).

The underground mining is represented by two model packages.

- Firstly, as described above, when mining moves into a model cell, the model uses drain cells to reproduce the dewatering of the area. The drains are active for two years. This approach is consistent with the previous model iterations (Section 6.3). Therefore, the model provides ingress predictions up to December 2038, i.e., two (2) full calendar years of active drains (2037 and 2038).
- Secondly, once the active mining moves out of the model cell, an underground void is left behind. This void is represented by changing the material properties of the area, using the TVM. The horizontal and vertical K was increased to 100 m/day. The specific yield for the underground workings after coal removal was set to 0.5 (i.e., 50% of coal left in place and 50% of void space created). This is conservative as Ensham advises that an average of 37% of coal left in place in practice.

6.4.3.6 Rivers

Groundwater interaction with surface drainage was modelled using the stream routing (STR) package for major rivers and creeks and using the river (RIV) package for minor drainage lines. Both boundary conditions have a surface water head assigned to them (steady state or transient). The surface water level in each cell that has a STR or RIV component is compared to the groundwater level in the respective cell:

- If the groundwater level is higher than the surface water level, the model will calculate the discharge of groundwater into the surface water based on the stream or riverbed conductance (a variable describing the permeability of a stream or riverbed).
- If the surface water level is higher than the groundwater level, the model will calculate the infiltration of surface water into the groundwater based on the riverbed conductance (STR package only).
- If the surface water and groundwater are in equilibrium, no flow is calculated.

Stream cells were set up to use the dynamic stage functionality of the STR package. This represents a basic flow volume – stage relationship. During the flood periods in particular, stream stages are elevated and there is an increase of water recharged into the groundwater system. The riverbed conductance values used were consistent with the previous model, in the 200-300 m^2/day range. The low hydraulic conductivity in the upper alluvial layer limits the water flux between river and alluvium in line with the conceptual model.

River cells have moderate conductance values ranging from 5 to 20 m^2 / day and are set up so that they act as drain cells (gaining water, but never losing water) (AGE, 2017).

6.4.3.7 Other stresses

In the model, groundwater recharge by irrigation is not explicitly represented because it is considered minor.

6.4.4 Temporal discretisation

For this assessment, the groundwater model's temporal discretisation includes:

- Validation runs from 1995 to 2021 including historical open-cut and underground mining (Model 1).
- Predictive runs to assess three scenarios:
  - the existing operations (Model 2a): with active drain cells from January 2022 to December 2029 (plus one more year of active drains), as approved under current EA. The model covers the time period from 2030 to 2262 to capture short term recovery (quarterly stress periods to model the initial recovery response) and long-term recovery (annual stress periods to model the long-term recovery response).
  - The Project (Model 2b): with active drain cells from January 2022 to December 2037 (plus one more year of active drains), as proposed for the Project. The model covers the time period from 2039 to 2262 to capture short term recovery (quarterly stress periods to model the initial recovery response) and long-term recovery (annual stress periods to model the long-term recovery response).
  - The Null run (Model 2c): no underground mining from January 2022 onwards, as a hypothetical "no future underground mining" scenario. The model covers the time period 2022 to 2262 to capture short term recovery (quarterly stress periods to model the initial recovery response) and long-term recovery (annual stress periods to model the long-term recovery response).

The set-up of the temporal discretisation is presented in Table 19.

Table 19 Model and stress periods

Model	Stress period number	Stress period Length	Time frame covered	Comments
1 Validation model	1 – 2	5 years	1/9/1995-31/8/2005	
	3 – 55	3 months	1/9/2005-31/8/2018	
	56	4 months	1/9/2021-31/12/2018	Adjustment to calendar quarters
	57 – 68	3 months	1/1/2019- 31/12/2021	Additional validation period
2a Existing operations	69 – 104	3 months	1/1/2022-31/12/2030	Active dewatering[1]
	105 – 224	3 months	1/1/2031-31/12/2060	Short term recovery
	225 – 425	1 year	1/1/2061-31/12/2261	Long term recovery
2b Project	69 – 136	3 months	1/1/2022-31/12/2038	Active dewatering[1]
	137 – 224	3 months	1/1/2039-31/12/2060	Short term recovery
	225 – 425	1 year	1/1/2061-31/12/2261	Long term recovery
2c Null run	68 – 96	3 months	1/1/2022-31/12/2028	Active dewatering[2]
	96 – 224	3 months	1/1/2029-31/12/2060	Short term recovery
	225 – 425	1 year	1/1/2061-31/12/2261	Long term recovery

Notes: [1] Model dewatering with two years of active drains as per model conceptualisation (i.e., mine year plus one additional year), [2] open-cut pits only, portals Pit C and D.

6.4.5 Validation

6.4.5.1 Groundwater levels

As the groundwater model was last calibrated in 2018 (HydroSimulations, 2020), the calibrated parameters of that peer-reviewed calibrated model were applied, and the model was then evaluated against the updated water level observations collected since the last calibration. The Australian groundwater modelling guidelines recommend a scaled root mean square (SRMS) error less than 10 per cent (Barnett et al., 2012).

Overall, the root mean square (RMS) error for the transient model was 7.85 m and the Scaled SRMS error was 5.0 per cent. This is within acceptable limits recommended by Barnett et al.,2012. Further discussion on the results of the groundwater level validation process is outlined below.

The comparison between the observed water levels and the water levels simulated for the validation period (01/09/2005 to 31/12/2021) is presented on Figure 49.In addition to those observed versus modelled water levels, the figure shows three types of lines:

- Line of equality: This line represents the ideal modelling outcome, i.e., the line that represents the case where observed water levels are matched exactly by the model.
- The 95% confidence interval of equality line: The goal for model calibration is to have the 95% confidence interval lines fall either side of the equality line. In this instance, both lines are above the line of equality, which means that there is a slight bias in the modelled water levels.

- The 95% interval lines: the interval between those two lines represents the area where 95% of the total number of data points are expected to occur. In this instance, only 80% of the points (9,669 of 12,036 observations) fall within the line, showing some room for improvement for the calibrations.

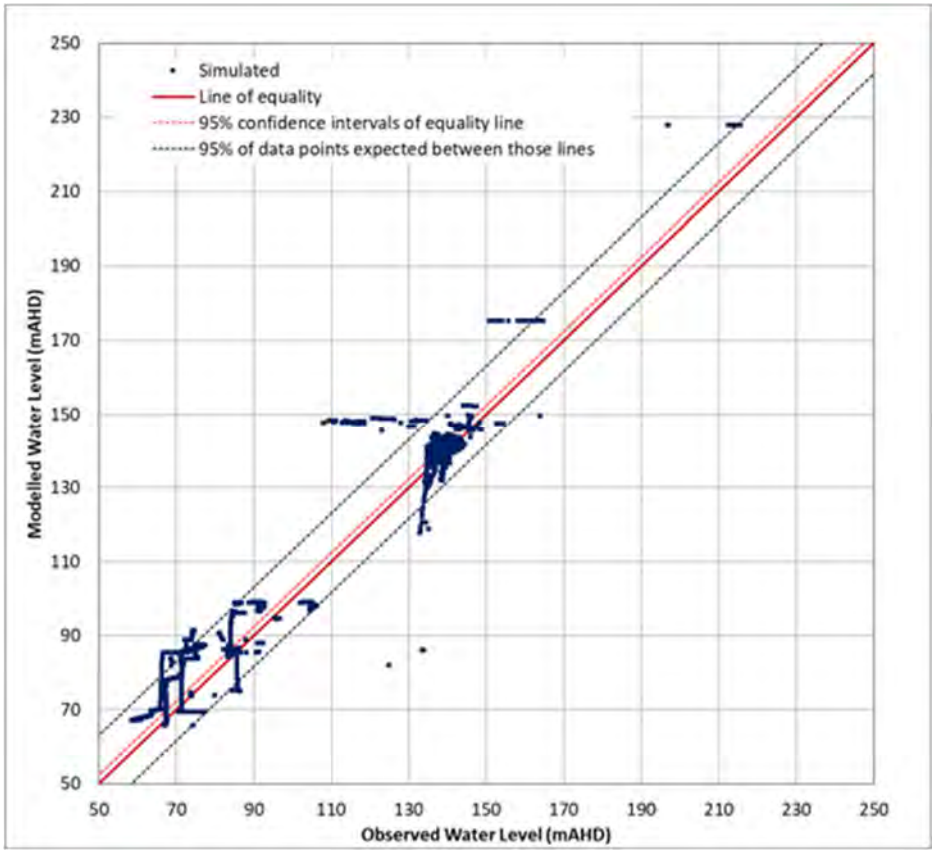


Figure 49 Observed vs computed target water levels

A full set of calibration hydrographs is presented in Appendix E. The hydrographs are consistent with the hydrographs presented in Hydrosimulations, 2020; SLR, 2020 and SLR, 2022.

Figure 50 presents four selected calibration hydrographs for bores screened within the alluvium. Generally, the model reproduces water levels well within the alluvium, especially during the 2008 – 2014 period. In the period 1995-2008, the model is not reproducing the observations as well, with the model generally overestimating the water levels. This may be due to the initial conditions (sparse data available) and/or stress period length (5 yearly). As discussed in Section 5.3.1, EC01 is likely showing a response to irrigation which is not explicitly reproduced in the model (as stated in Section 6.4.3.7).

After 2014, the model generally underestimates water levels in the alluvium. However, the decreasing trend that is simulated from 2014 stabilises in 2018 and water levels show a slow increase in 2019, in accordance with observed values. In general, the model reproduces observed streamflow response and flood events in the alluvium bores quite well.

The RB series of bores (Regional Bores, refer to Table 7) are installed in coal seams at depths between 100 and 240 mBGL. Figure 51 presents two selected RB bores. There is some mining effect observed at RB03, with the modelled rate of drawdown larger than observed. The model generally overestimates the heads at these bores by 0.5 to 7.0 m. RB5 shows the connection to the open-cut pits, with the water levels recovering in line with the observed pit water level (also refer to Section 5.3.3.2).

At each monitoring location, the average difference between the observed and the modelled water levels is calculated, and the result is the average residual. Figure 52 shows the spatial distribution of the average residuals over the model domain.

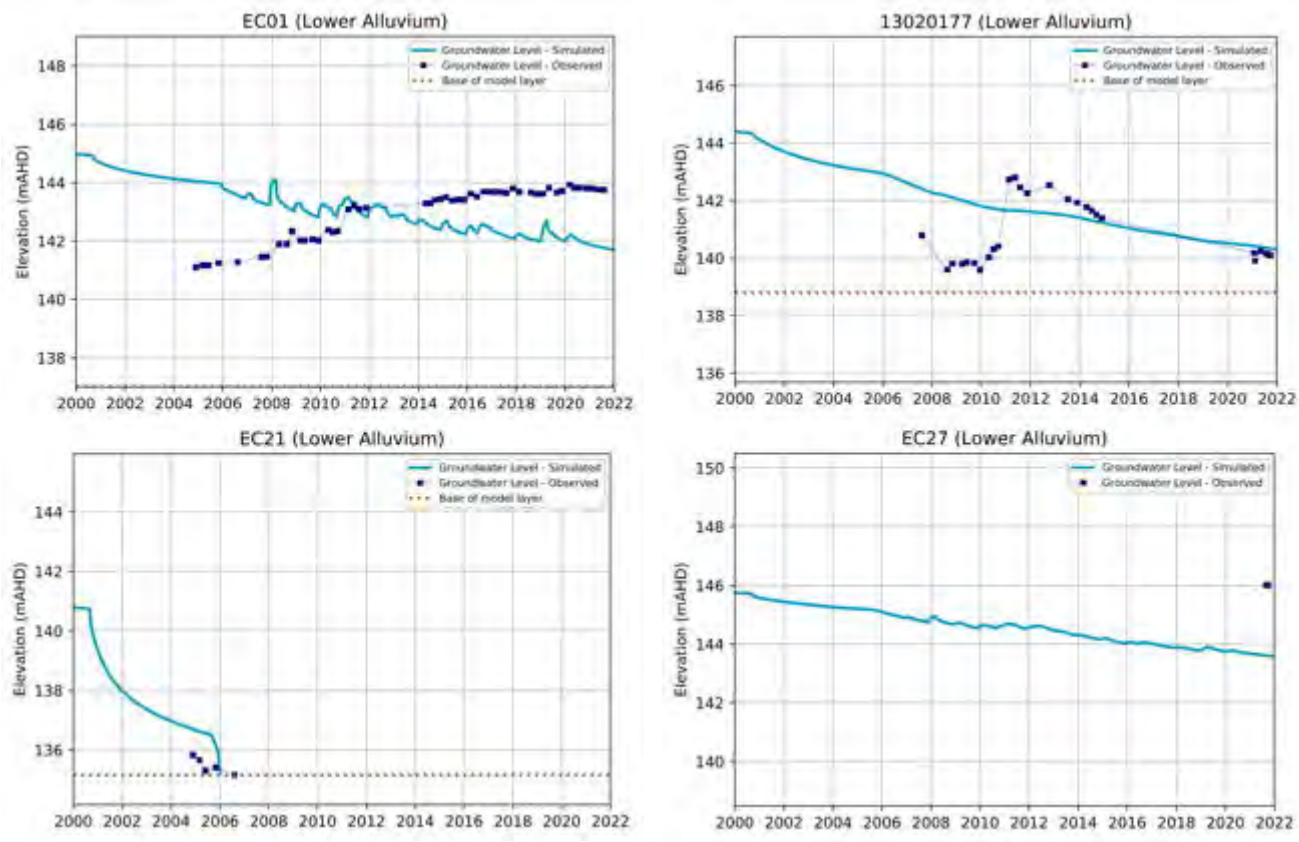


Figure 50 Calibration hydrographs (alluvium)

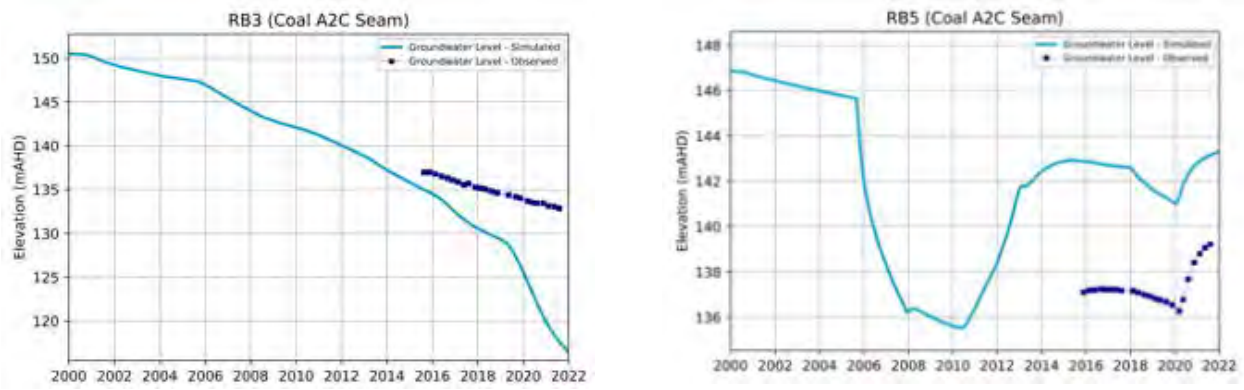
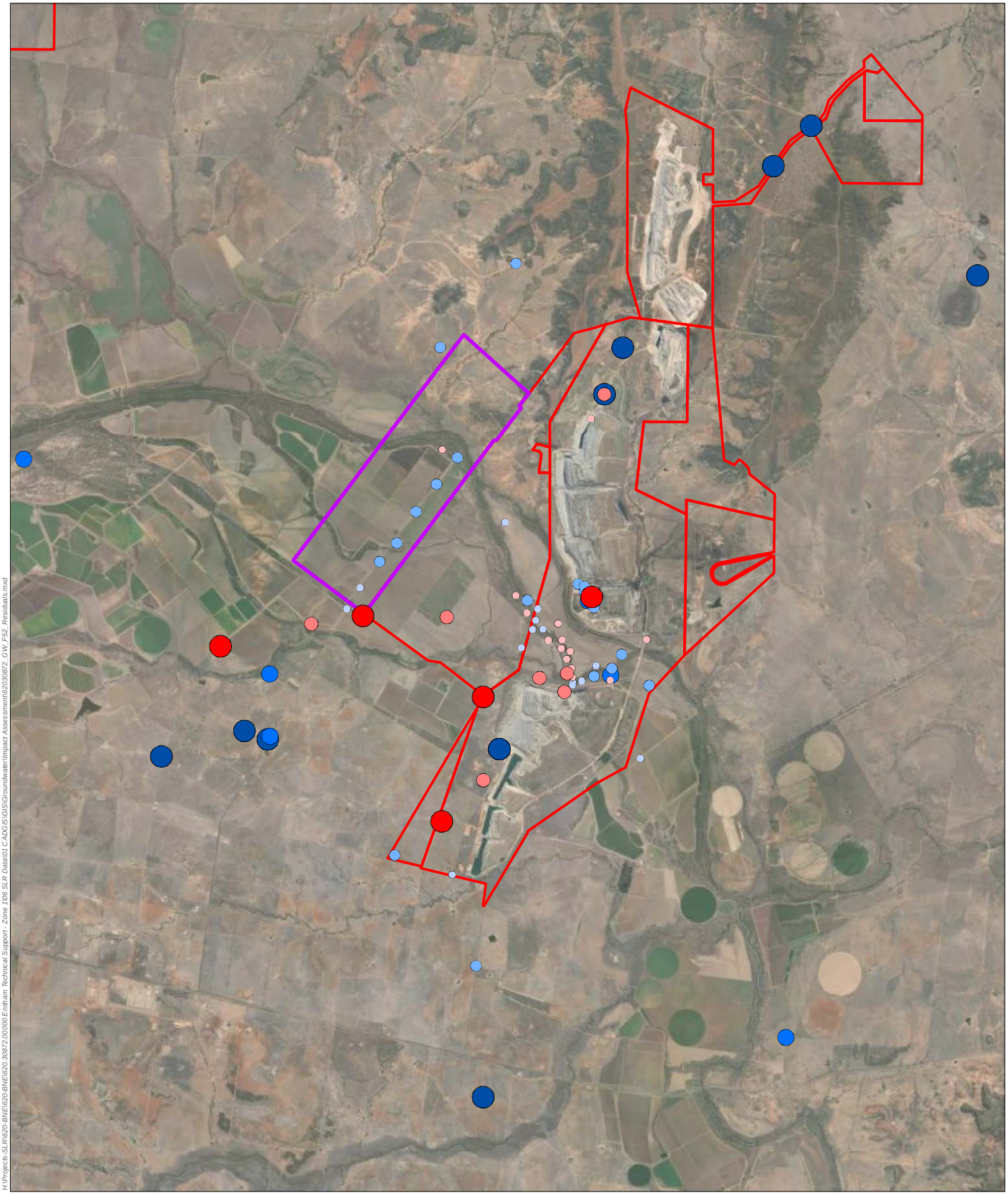


Figure 51 Calibration hydrographs (Coal seam)



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:150,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Zone 1
- Mining Lease

Residuals (m)

- -50 - -5
- -5 - -2
- -2 - 0
- 0 - 2
- 2 - 5
- 5 - 10
- 10 - 40

GROUNDWATER IMPACT ASSESSMENT

Map of Average Residuals (Difference Between Observed and Modelled Water Levels)

Figure 52

6.4.5.2 Validated underground mine inflows

The model simulated average inflows of 3 – 5.5 ML/day into the underground mine during the calibration period (Figure 53). Observed site inflows ranged from 0 to 5 ML / day between January 2015 and September 2021. Note that the observed "underground inflow" is not reflecting the actual groundwater inflow but represents the difference of water pumped into the underground and water pumped out of the underground. This is relevant for the practice described in the next paragraph.

It should be noted that there are two time periods (late 2017-2019 and 2021) in which the model is considerably overestimating inflows. This overestimation is due to the process where Ensham has pumped excess groundwater water into abandoned panels, where suitable, rather than sealing the panels and pumping them full of inert gas to manage gas levels. This process will be ongoing again where suitable to do so. This process will assist with groundwater recovery in the future as the groundwater will be stored in the underground rather than pumped to the surface water management system. Due to the intermittent nature of this arrangement, this process cannot be reflected in the groundwater model and explains the variation in modelled versus observed inflows.

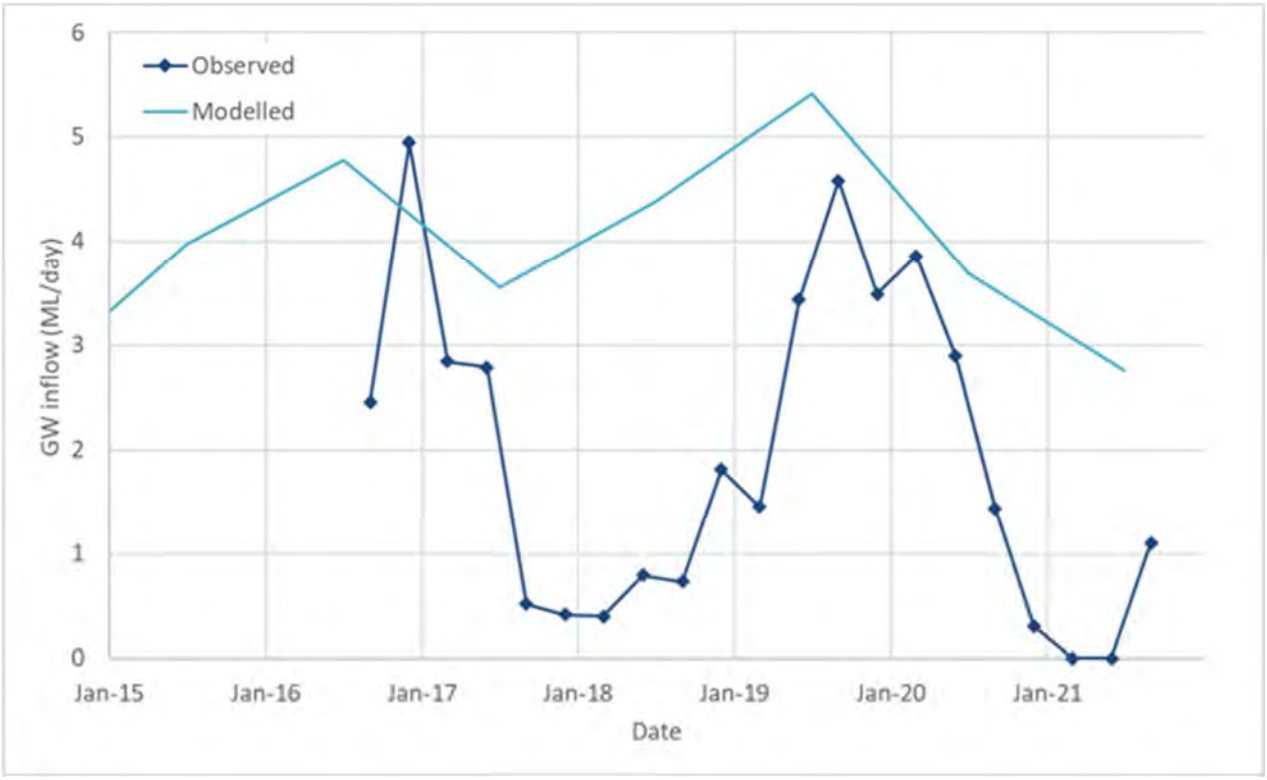


Figure 53 Observed versus modelled underground mine inflows

6.5 Model predictions

The predictive model was run for three cases, as listed in Table 20. As stated in Section 6.4.4, there are three model runs, a Null run, the existing operations, and the Project. These three runs were used to assess:

- Project Net impacts: represented by the difference in results predicted for the Null run and results predicted for the Project.
- Project Incremental impacts: represented by the difference in results predicted for the existing approved operations and results predicted for the Project.

Table 20 Model run selections

Run name	Properties	Rationale
Null run	• No underground mining after January 2022)	The Null run was used to assess the Project Net impact from the underground mining (Null run – Project). Because the underground mining at Ensham is a historical fact, the "No future mining" scenario start was set to January 2022 to coincide with the start of the predictive model.
Existing approved operations	• Future underground mining as approved (2030[1])	The existing operations model was used to assess the Project incremental impacts between existing operations and Project, i.e. the impact of the extension only.
Project	• Further future underground mining as proposed (2038[1])	This run was used in both the Project Net impact assessment and Project incremental impact assessment. The Project run includes approved mining until December 2029 and the proposed extension to December 2037.

Notes: 1 the underground mine plan was provided on an annual time scale. Last year of mining for the existing operations is 2029, drains stay active for 2 years (2029 and 2030). For the Project, the last year of mining is 2037, and the drains stay active for two years (2037 and 2038)

6.5.1 Groundwater model water balance

The groundwater model water balance for the Null Run, existing operations and the Project are presented in Table 21, as an average over the time period between 2022 and 2038.

The climatic components are comparable, with the evapotranspiration (ET) showing a negligible variation for the Null run. The flows from and to rivers (RIV package) and streams (STR package) are near identical for both for all three runs. This indicates stream flows are not changing because of the proposed mining extension.

The constant head boundary shows slightly different results for the Null Run, existing operations and the Project. However, these differences are not significant when the constant head fluxes are set into context with the climatic components, which are an order of magnitude larger.

The difference in the drains (i.e., mining) outflow rates is due to the longer timeframe of the Project. Averaged over the assessment period, the Project is predicted to increase mining inflow on average by 0.31 ML /day. The temporal mining inflows are discussed in Section 6.5.2.

Table 21 Average simulated water balance during the prediction period (2022 to 2038)

Component	Null run		Existing approved underground operations		Project	
	Inflow (ML / d)	Outflow (ML / d)	Inflow (ML / d)	Outflow (ML / d)	Inflow (ML / d)	Outflow (ML / d)
Recharge (RCH)	7.31	0	7.31	0	7.31	0
ET (from GW) (EVT)	0	14.41	0	14.39	0	14.39
RIV	0	0.09	0	0.09	0	0.09
STR	13.83	0.42	13.83	0.41	13.83	0.41
Regional GW Flow (GHB)	0.12	0.45	0.12	0.45	0.12	0.45
Constant Head (CHD)	2.13	1.41	2.15	1.4	2.15	1.4
Mine inflows (DRN)	0	0.77 (portals) 0 (UG)	0	0.75 (portals) 6.33 (UG)	0	0.76 (portals) 6.51 (UG)
Storage	5.39	11.23	10.93	10.31	11.25	10.63
Total (ML / day)	28.78	28.78	34.34	34.34	34.65	34.65
Mass Balance	0		0		0	

Notes: UG = underground, portals -= Pit C and D and access to underground

6.5.2 Predicted groundwater interception

The daily predicted inflow rates into the underground operations are shown on Figure 54 (left) for the existing operations and the Project. Figure 54 (right) shows the Project incremental inflows (difference between existing operations and Project) into the underground.

The Project inflows are the Project Net inflows (Project compared to Null run, which has no underground mining in the predictive period). As shown on Figure 54, both the existing operations and the Project show inflows of 2-14 ML/day for the period between 2021 and 2030. Lower inflows can be expected when mining remains in an area for a longer time. When going into new areas, the inflows can increase, as no previous dewatering was active there. The inflows for the existing operations then cease (end of mining December 2030, drains active until December 2031). The Project (mining up to December 2038) shows further inflow until the model drains are inactive (December 2039). These inflow estimates are likely an overestimation because the model does not account for active management measures to reduce inflows after mining has passed through an area. For the context of the impact assessment, an overestimation of inflow will result in a larger drawdown and hence a conservative impact assessment.

The inflows are a combination of the losses from coal removal (water in pore space) and active pumping within the underground workings. The model does not quantify the losses from the coal removal. This means that the actual requirement for pumping will be lower than this total estimate.

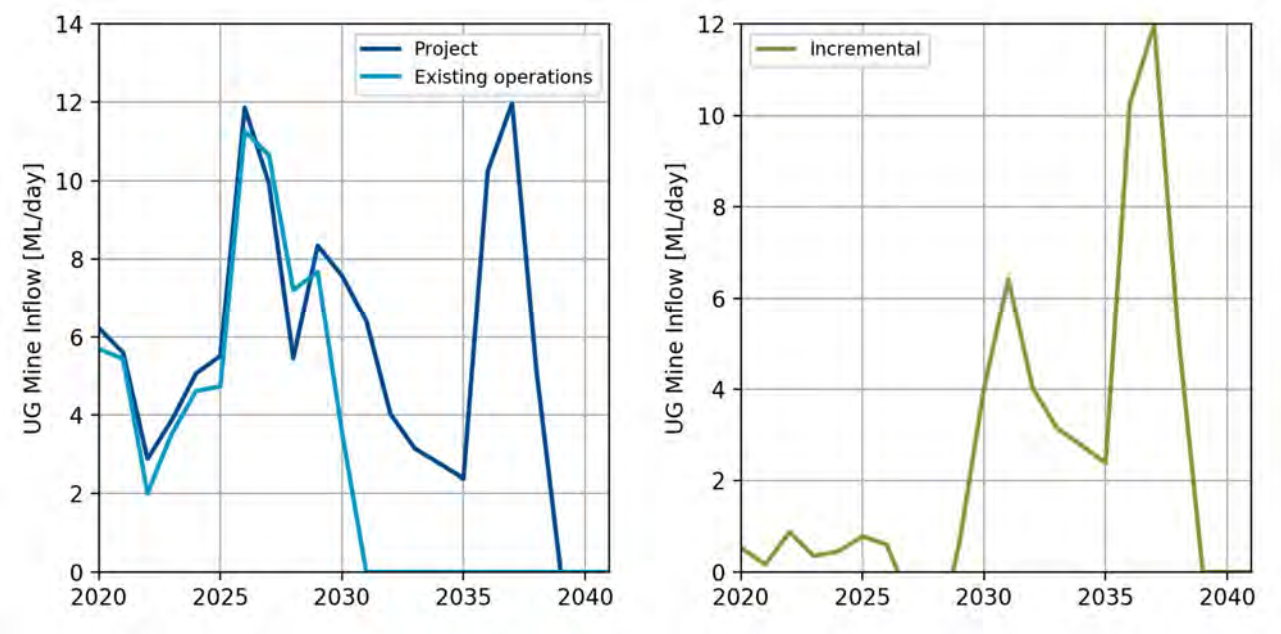


Figure 54 Predicted underground mine inflow

6.5.3 Predicted drawdown

The process of mine dewatering directly and indirectly (induced flow) reduces water levels in surrounding groundwater units. The extent of the zone affected by the mine dewatering (resulting in decreased water levels) is dependent on the hydraulic properties of the aquifers / aquitards and is referred to as the zone of depressurisation in a confined aquifer and zone of drawdown within the (unconfined aquifer) water table. Depressurisation and drawdown of groundwater levels are greatest at the mine working coal-face and reduces with distance from the mine.

The Project incremental maximum drawdown over the entire model timeframe was calculated as follows:

- At each model cell and at each timestep, the water level (or pressure) for the existing operations and the Project are exported.
- These two levels are then compared.
- Starting at the first timestep, this difference is stored as the maximum drawdown and the next timestep will be evaluated.
- If the difference is larger than in the previous time step, the new difference will become the maximum drawdown at that model cell.

It is worth noting that the resulting map of maximum drawdowns is not a snapshot of one particular point in time, because the maximum difference in water level will not occur at the same point in time for all locations. This is illustrated in Figure 55, where the Project incremental and Project Net maximum drawdowns are occurring at different times due to the water level recovery in the existing operations.

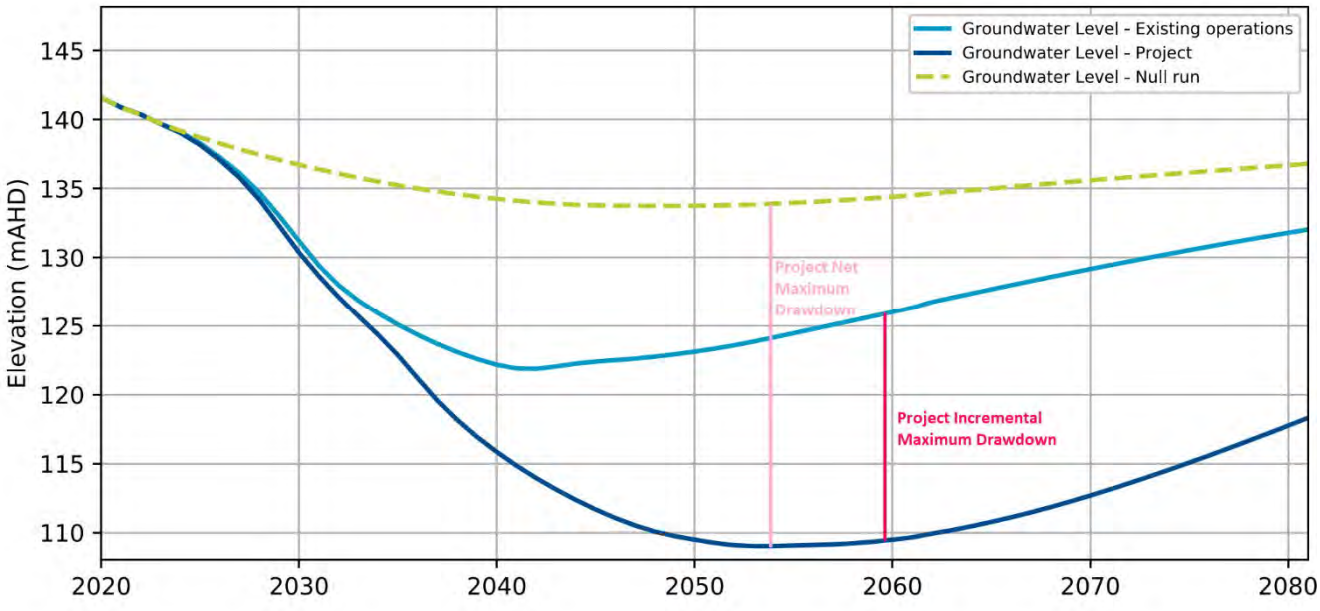


Figure 55 Illustration of drawdown calculations

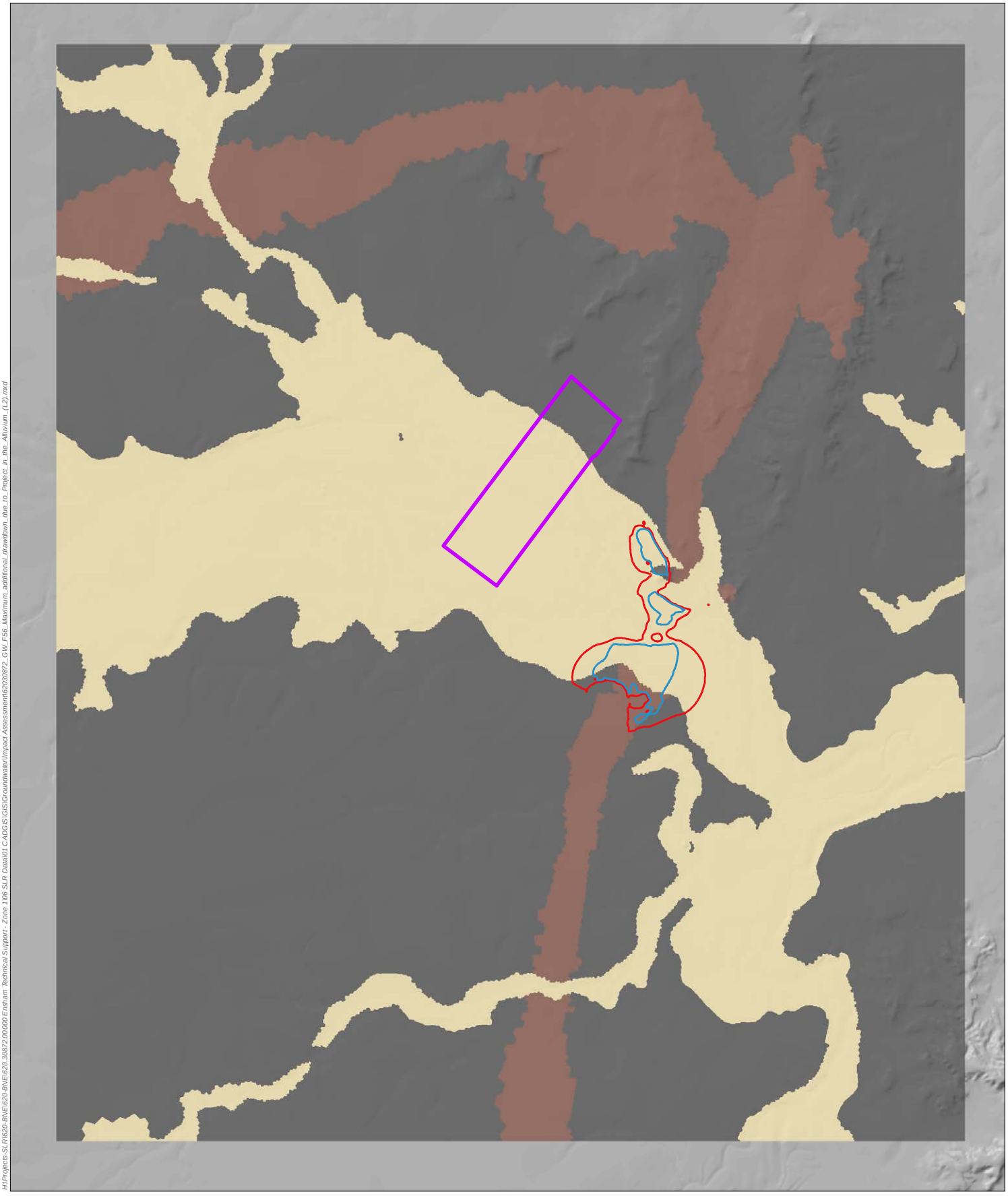
6.5.3.1 Project Incremental maximum drawdown

The Project incremental maximum drawdown for the unconsolidated (L2) and target coal seam (L8) are shown on Figure 56 and Figure 57, respectively.

Figure 56 shows the Project incremental maximum drawdown due to the Project within Layer 2 (L2), where the unit is predicted to be saturated. As shown on Figure 56, the predicted drawdown in the alluvium is most significant within the open-cut pits, extending out from these in predominantly in the east and west directions.

Figure 57 shows the Project incremental maximum drawdown due to the Project within the mined Aries 2 and Castor Seams (A2C, Layer 8 (L8)). As shown on Figure 57 the maximum groundwater level drawdown within the A2C seams is predicted to extend up to 15 km to the west (1 m drawdown contour) of the Project. Groundwater level drawdown within the A2C seams is limited to where the coal seam is present (outcrop to the east).

Based on the comparison of drawdown in alluvium (Figure 56) and the drawdown in the target coal seam (Figure 57), it is apparent that the drawdown introduced by mine dewatering in the coal seams is not causing wide-spread drawdown in the shallow alluvium. As conceptualised and supported by observation data there is limited hydraulic connection between the two units (alluvium and coal seams), and thus the Rewan Group was assessed as acting as a flow barrier.



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308872_GW_F56_Maximum_additional_drawdown_due_to_Project_in_the_Alluvium_(L2).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

Zone 1

Drawdown (m)

1

2

L2 K Zones

Alluvium

Regolith

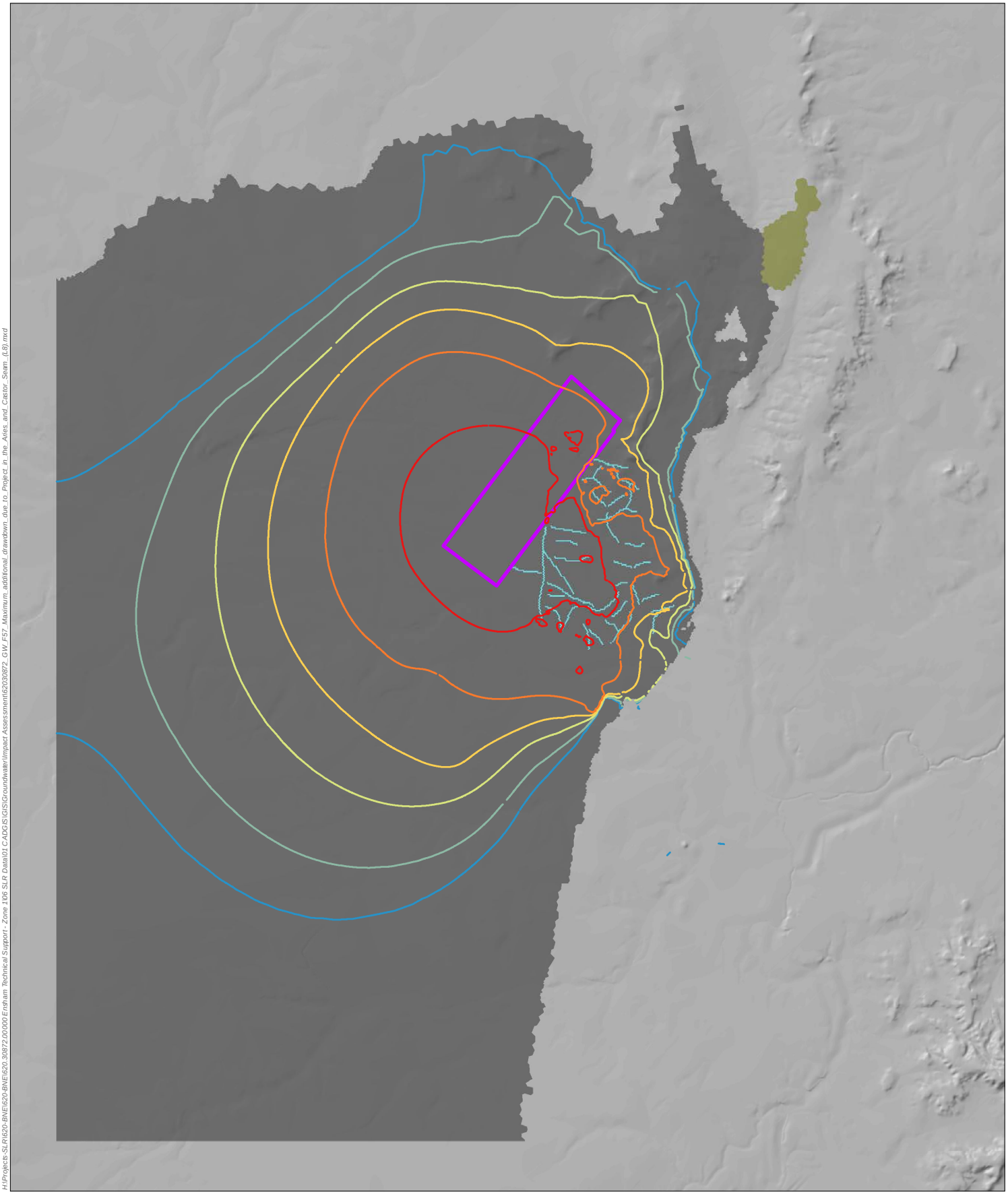
Shallow CM

GROUNDWATER IMPACT ASSESSMENT

Project Incremental maximum drawdown in the unconsolidated (L2)

Figure 56

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CADGIS\GIS\Groundwater\Impact Assessment\620308872_GW_F57_Maximum_additional_drawdown_due_to_Project_in_the_Aries_and_Castor_Seam_(L8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

SLR
www.slrconsulting.com

Legend

Zone 1

Drawdown (m)
- 1
- 2
- 5
- 10
- 20
- 50

L8 K Zones
- Aries 2 and Castor
- Basement
- Fault

GROUNDWATER IMPACT ASSESSMENT

Project Incremental maximum drawdown in the Aries and Castor seam (L8)

Figure 57

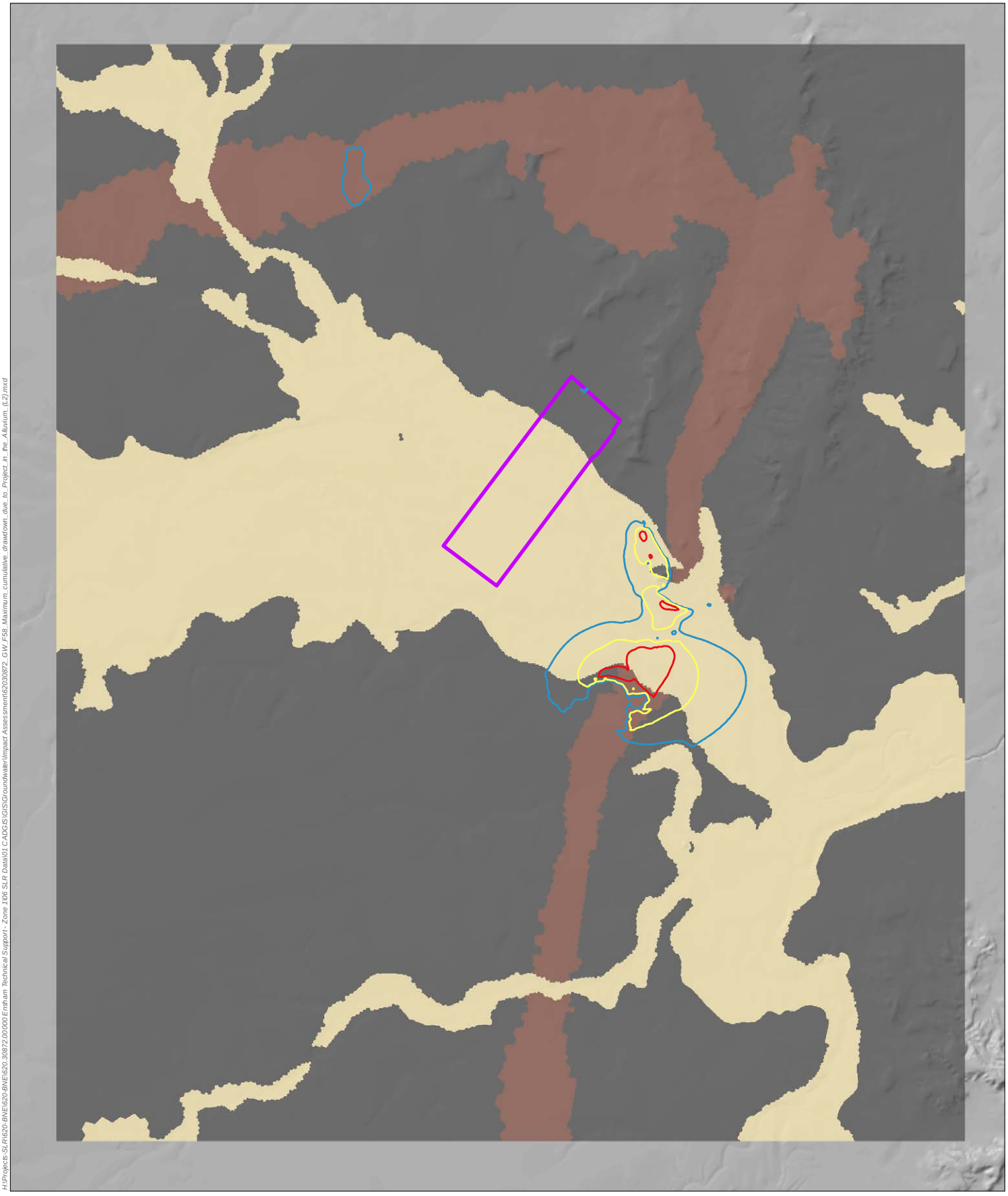
6.5.3.2 Project Net drawdown

The Project Net maximum drawdown was assessed based on the difference between the existing operation plus the Project, and the hypothetical scenario without any underground mining after the end of 2021.

Figure 58 shows the Project Net maximum drawdown due to the Project within layer 2 (L2), where the unit is predicted to be saturated. The drawdown is most substantial within the open-cut pits, extending out to a radius of about 3 km in both the east and west directions. The Project Net maximum drawdown is similar to the Project incremental maximum drawdown, but more significant in magnitude and extent. This is related to the increased duration of mining for the Project, causing a difference in recovery timing. The Null run will begin recovering from 2021 onwards, and the modelled water levels for the Project starting to recover in 2038 (drain cells are active for two years in the model).

The Project Net maximum drawdown in the target Aries 2 and Castor seams is shown in Figure 59. The Project Net 5 m drawdown curve is extending approximately 10 km from the Project to the west. An impact to this formation is expected, as it needs to be depressurised for safe working conditions underground.

Based on the comparison of the Project Net maximum drawdown in Layer 2 (Figure 58) and the Project Net maximum drawdown in the target coal seam (Figure 59), it is apparent that the drawdown introduced by mine dewatering in the coal seams is not causing wide-spread drawdown in the shallow alluvium. As conceptualised and supported by observation data there is limited hydraulic connection between the two units, with the Rewan Group acting as a flow barrier.



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

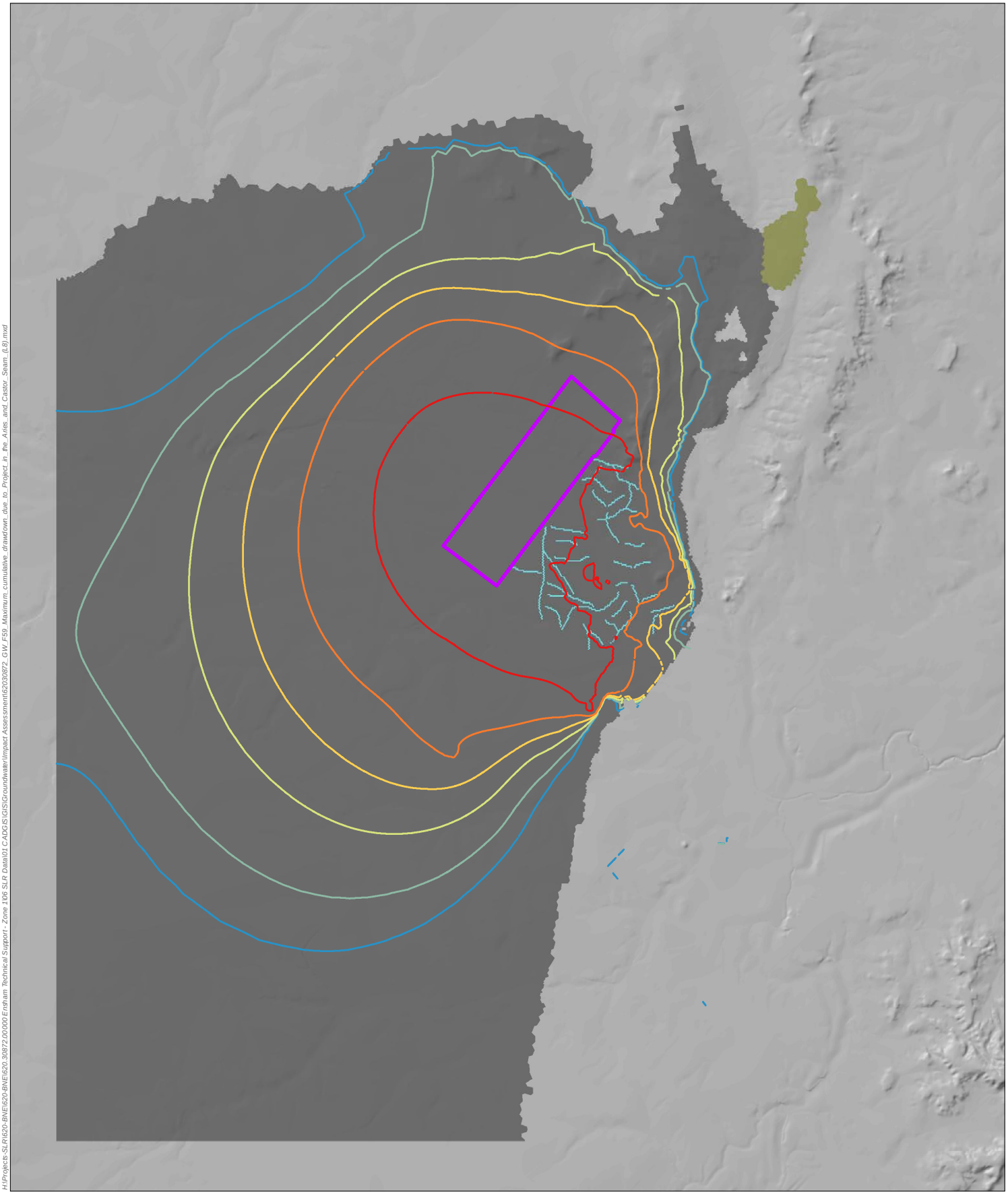
SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Project Net maximum drawdown in the unconsolidated (L2)

Figure 58

H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F58_Maximum_cumulative_drawdown_due_to_Project_in_the_Alluvium_(L2).mxd



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Project Net maximum drawdown in the Aries and Castor seam (L8)

Figure 59

H:\Projects-SLR\620-BNE\620.30872.00000 Eridham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308872_GW_F59_Maximum_cumulative_drawdown_due_to_Project_in_the_Aries_and_Castor_Seam_(L8).mxd

6.5.4 Incidental water impact

6.5.4.1 Influence on alluvium

Figure 60 (left) shows the flux from the alluvium into the underlying formations ("Alluvial Take") for the Null run, the existing operations and the Project. The null run and existing operations are nearly identical, excluding a minor deviation from 2028 to 2030 where the existing operations closely follow the Project. The Project shows a decrease in flux when compared with the other two runs, meaning a reduction in loss from the Alluvium into lower strata (reduced recharge). This is further illustrated in Figure 60 (right), which shows that the Project causes a decrease in Alluvial take (approximately 0.5 ML/day in 2036).

The long-term average alluvial take based on annual climatic inputs for the proposed and approved runs is about 0.9 ML/day, and the null model run is around 0.8 ML/day (a difference of 0.1 ML/day).

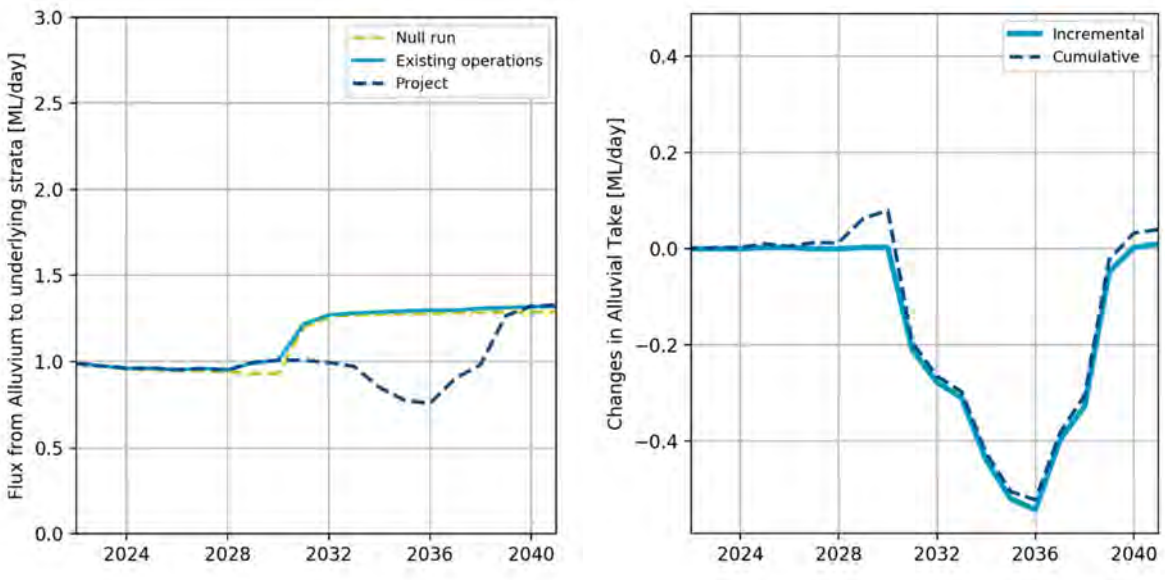


Figure 60 Flux from the Alluvium into underlying strata

6.5.4.2 Influence on baseflow

The model predicts a net baseflow for the Nogoa River to the groundwater system of 3.5 to 4.5 ML/day over the model domain, as shown in Figure 61 (left). The net baseflow is the net flow between the River and the shallow unconsolidated formations. The model predicts no measurable reduction in baseflow in the Nogoa River between the Null run, existing operations, and the Project up until 2035. After this point, the existing operations and the Project have a continually decreasing streamflow, with a reduction of approximately 0.25 ML/day in 2050. This is further illustrated in Figure 61 (right), which shows the Project incremental maximum and Project Net maximum changes in base flow of the Nogoa River. These changes are negligible compared to the predicted net fluxes of 3.5-4.5 ML/day from the Nogoa River to the groundwater system. To put this into context, the mean daily discharge of the Nogoa River at Duck Ponds is 1,690 ML/day.

The long-term net baseflow based on annual climatic inputs is approximately 2.1, 2.3 and 2.4 ML/day (recovery model 2060-2260) for the null, approved and proposed model runs respectively.

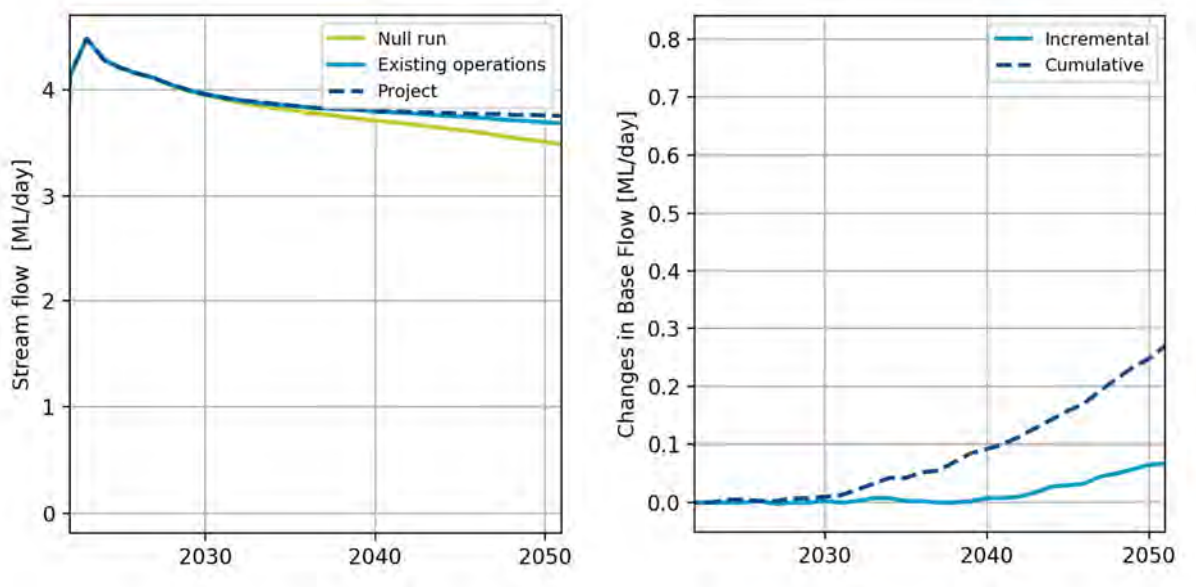


Figure 61 Stream flow in the Nogoa River

6.5.5 Post mining equilibrium

As shown in Table 19, each predictive run model was run from 2040 to 2060 in quarterly stress periods and then from 2060 to 2262 in annual stress periods to simulate long-term recovery with annual averaged climatic inputs. Figure 62 shows the water levels for the Null run, the existing operations, and the Project for alluvium near Ensham mine at EC03, and for the Permian coal measures to the south-west of the Project extent at RB04. Appendix G shows the prediction hydrographs for all relevant bores.

The post-mining long-term groundwater levels at alluvial bore EC03 (Figure 62, top) are predicted to increase by approximately 1.5 m over 200 years with minor differences between cases. However, it will take up to forty years longer for the Project to recover when compared with the null case.

The bore RB04 (refer to Figure 62, bottom) is located within the target coal seams (Aries 2 and Castor). The results show that the drawdown predicted at this bore is greatest for the Project, compared with that predicted for current operations and that predicted by the Null run. In the long-term, the groundwater levels at RB4 for all three scenarios recover to the similar levels.

The impact of climate change on the predictions and recovery is discussed in Section 7.6.

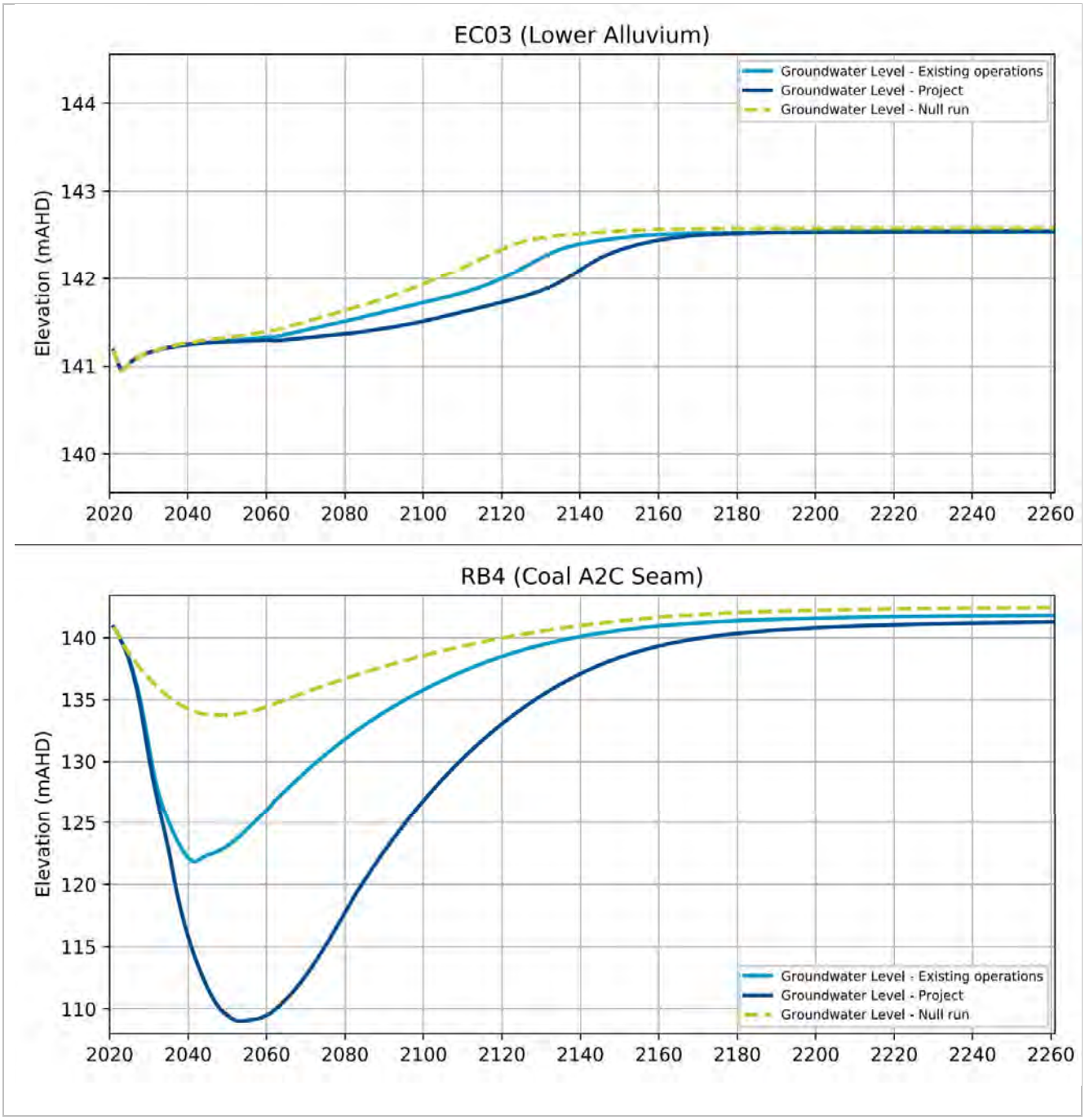
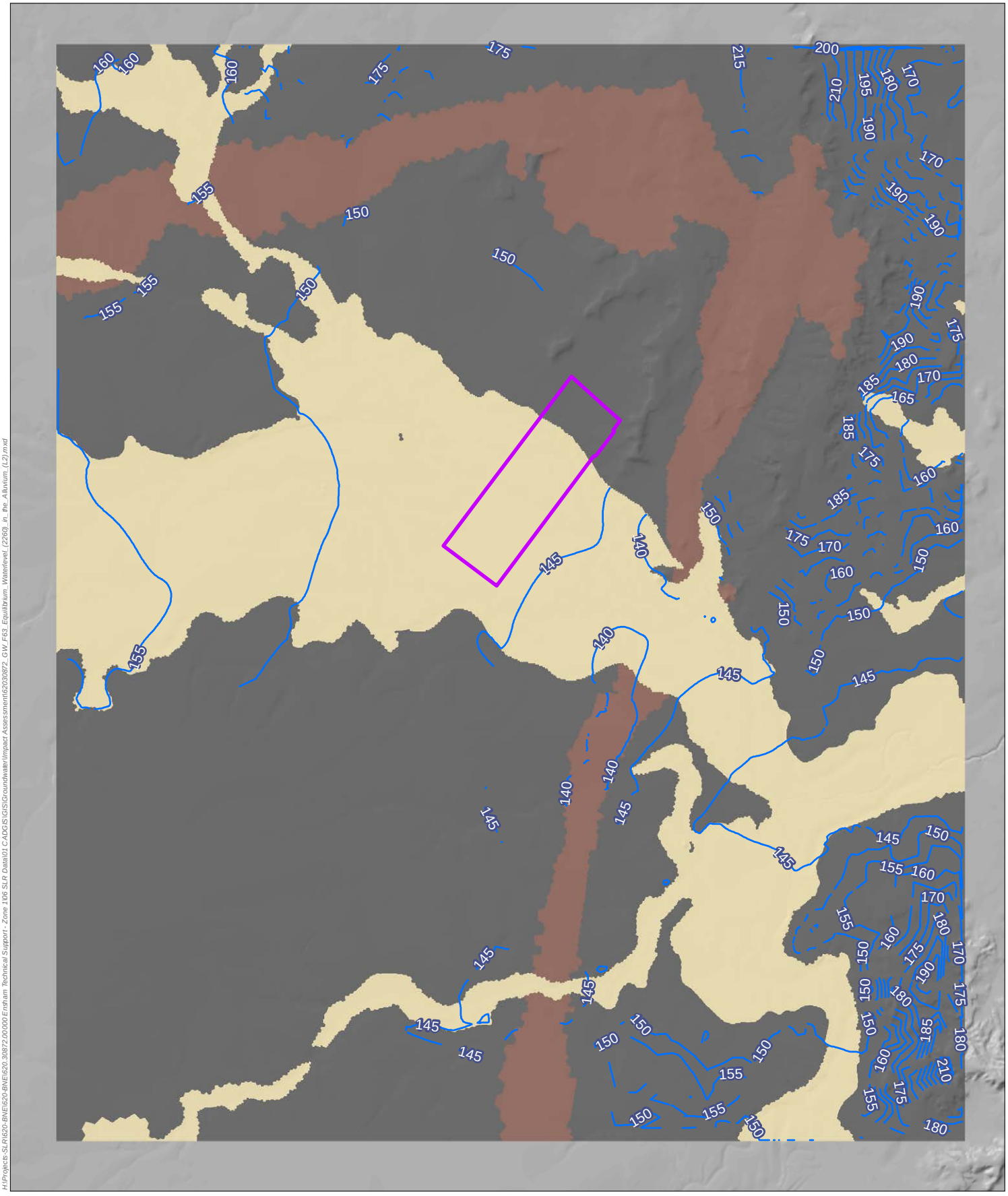


Figure 62 Recovery times series for two selected bores

Figure 63 and Figure 64 show the post mining equilibrium water levels in the alluvium and regolith (model layer 2) and the Aries 2 and Castor coal seams (model layer 8), respectively. The alluvial water levels show the same general flow direction as the Nogoa River (west to east).

As expected, the water level contours in the coal seams (in 2260) show a lower water level in the area where the underground mining was occurring. The water levels are around 5 m lower than in the surrounds, with the largest remaining drawdown remaining around Zone 1. The groundwater recovery modelling showed that the open-cut pits are long-term sinks, as indicated by the recovered water table contours (Figure 65).



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F63_Equilibrium_Waterlevel_(2260)_in_the_Alluvium_(L2).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.3872
Date:	10-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

Zone 1

Potentiometric Surface (mAHD)

L2 K Zones

Alluvium

Regolith

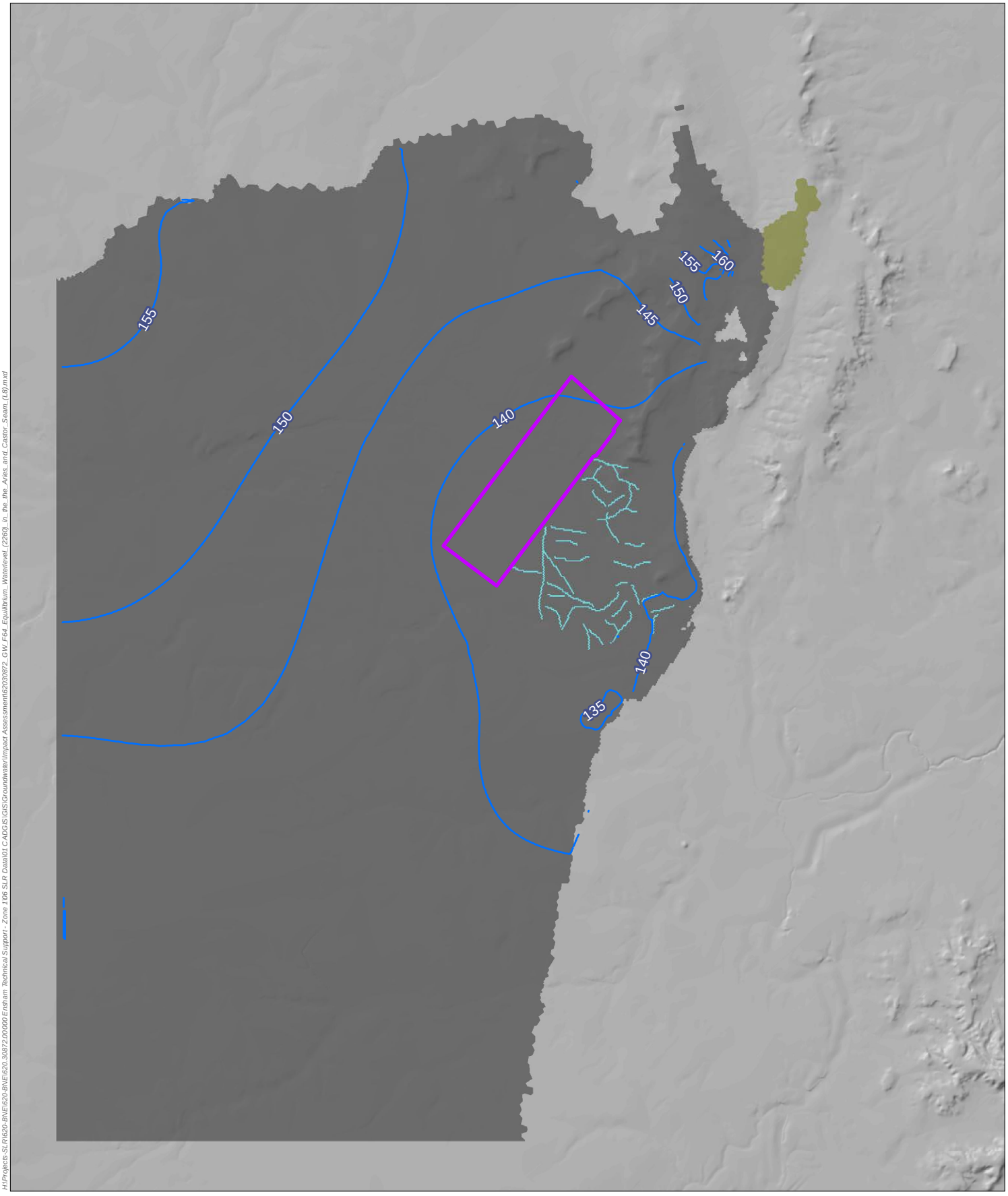
Shallow CM

GROUNDWATER IMPACT ASSESSMENT

Equilibrium groundwater level (2260) in the unconsolidated (L2)

Figure 63

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Eridham Technical Support - Zone 106 SLR Data\01 CADGIS\GIS\Groundwater\Impact Assessment\620308872_GW_F64_Equilibrium_Waterlevel_(2260)_in_the_the_Aries_and_Castor_Seam_(L8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	10-Jun-2022
Drawn by:	NT
Sheet Size:	A4

GROUNDWATER IMPACT ASSESSMENT

Equilibrium groundwater level (2260) in the Aries and Castor seam (L8)

Figure 64

Legend

Zone 1

Potentiometric Surface (mAHD)

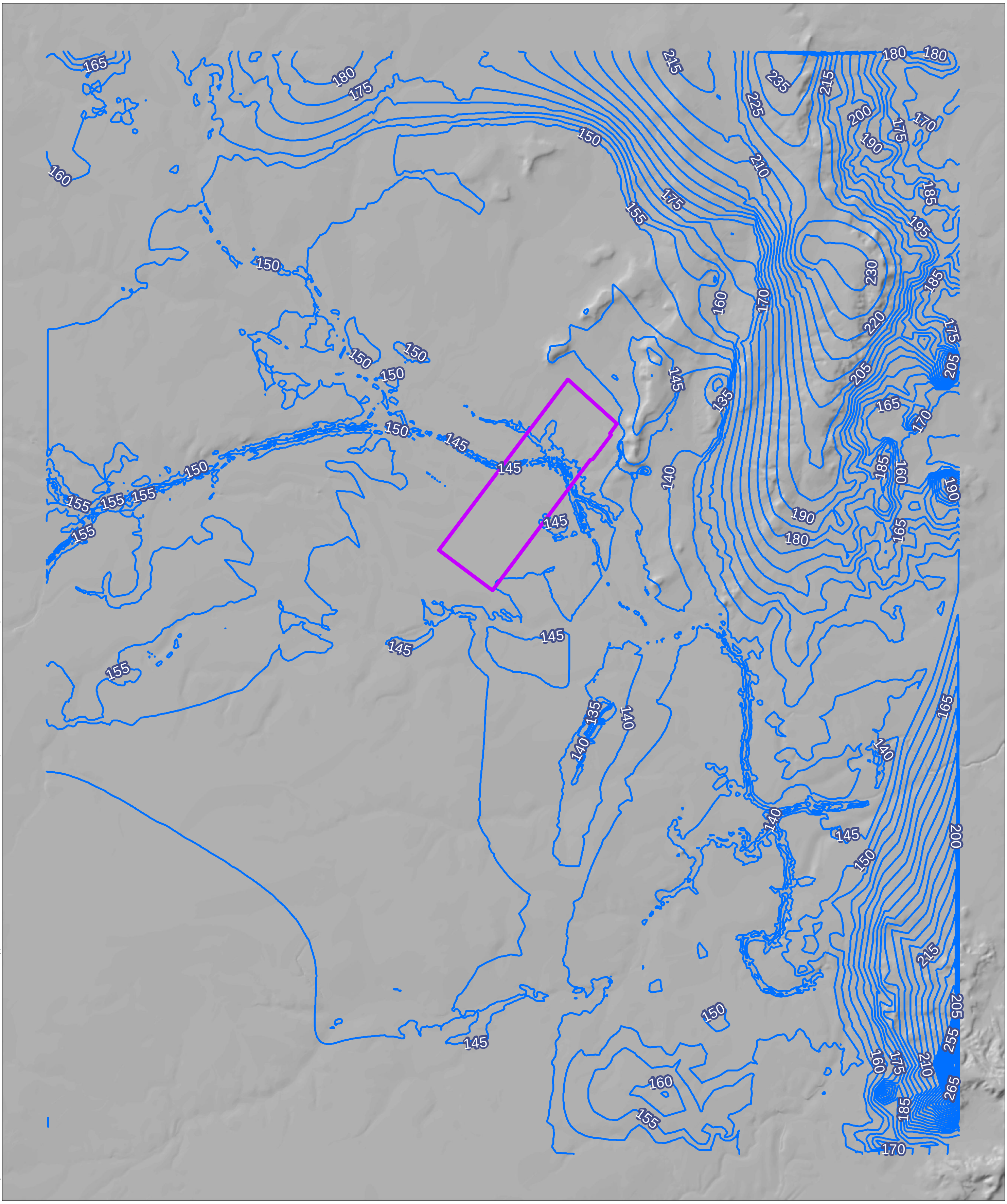
L8 K Zones

Aries 2 and Castor

Basement

Fault

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 1\06 SLR Data\01 CADGIS\GIS\Groundwater\Impact Assessment\62030872_GW_F65_Equilibrium_Groundwater_Table.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	10-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend
- Water Table Contour (mAHD)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Equilibrium groundwater table (2260)

Figure 65

SLR
www.slrconsulting.com

6.6 Sensitivity analysis

The uncertainty of model predictions was assessed with a deterministic approach to sensitivity analysis. Sensitivity analysis evaluates the effects of model parameters on model results and provides information on the degree to which the adopted values for the various parameters in the model influence predictions. It can provide an indication of the uncertainty in the results and guide future data collection to reduce this uncertainty.

6.6.1 Scenario selection

Parameter sensitivity on the predictive period (model run 2b, simulating the Project) was explored through additional model simulations where model parameters were varied. These parameters and model inputs were considered because they could potentially impact the model predictions. The eleven analysed parameters are listed in Table 22 together with the magnitude of change imposed on each parameter. The upper and lower bounds have been chosen as a wide range (refer to Table 8). A total of 20 runs were performed (labelled S2 – S21 in Table 22) in addition to the base case (described in Section 6.4). The results should not be viewed as absolute; this analysis is performed to assess relative changes and identify parameters that might need further investigation.

Table 22 Sensitivity analysis – overview of scenarios

Parameter	Scenario number and lower bound	Base case (S1)	Scenario number and upper bound
Stream conductance	S2 Factor 10 lower	1-1000 m²/day (depending on cell size)	S3 Factor 10 higher
Alluvium horizontal hydraulic conductivity	S4 Factor 10 lower	L1: 0.001 m/day L2: 10 m/day	S5 Factor 10 higher
Alluvium vertical hydraulic conductivity	S6 Factor 10 lower	L1: 5.60E-05 m/day L2: 0.5m/day	S7 Factor 10 higher
Coal (L8) horizontal hydraulic conductivity	S8 Factor 10 lower	0.004 - 1.250 m/day	S9 Factor 10 higher
Coal (L8) vertical hydraulic conductivity	S10 Factor 10 lower	2.53E-04 - 0.186 m/day	S11 Factor 10 higher
Coal (L8) specific yield	S12 0.01	0.04	S13 0.07
UG workings specific yield	S14 0.4	0.5	S15 0.6
Recharge	S16 20% decrease	Surficial alluvium: 5.18 mm/yr Regolith: 0.64 mm/yr Permian subcrop: 0.64 mm/yr Spoil: 53.1 mm/yr Open-cut void: 647.5 mm/yr	S17 20% increase
Rewan (L3 and L4) vertical hydraulic conductivity	Not calculated	Layer 3: 4.20E-02m/day Layer 4: 1.20E-04m/day	S18 Factor 10 higher

Parameter	Scenario number and lower bound	Base case (S1)	Scenario number and upper bound
Rewan (L3 and L4) horizontal hydraulic conductivity	Not calculated	Layer 3: 2.10E-04 m/day Layer 4: 6.00E-07 m/day	S19 Factor 10 higher
General Head Boundary	S20 -10 m	140-150 mAHD	S21 +10 m

The predictive sensitivity analysis was based on the calibrated parameter set (base case). In each run, one parameter was changed by an order of magnitude (or by a relevant percentage) in each run. The results for all 21 runs are presented in Section 6.6.2 and the most sensitive parameters are discussed in Section 6.6.2.
By changing only one parameter at a time, it is assumed that the calibrated data set would still be matched adequately, and the predictions could still be considered a potential outcome.

There was no run where several parameters were changed. If several parameters were changed in one run, the model calibration would not be valid for this parameter set, and as such, the prediction would not be meaningful. Further, the change of multiple parameters into a worst-case direction may stress the boundaries of physically possible values and result in a failure for the groundwater model to run, because of numerical instabilities.

6.6.2 Results

This section discusses the results of the sensitivity analysis. The changes in predicted drawdown in the coal seam (model layer 8), inflow into the mine during mining and the loss from the Nogoa River were assessed. In summary, the predictions were most sensitive to the horizonal hydraulic conductivity of the coal seams. This means that uncertainties in the hydraulic conductivity of the coal seams leads to uncertainty about the absolute value of the predicted impact (drawdown or mine inflow). However, since the impacts are on the coal seams and therefore do not affect water users and GDEs in the shallower formations, certainty about absolute value of impact is not essential to assess impacts from the Project on these types of receptors.

6.6.2.1 Drawdowns

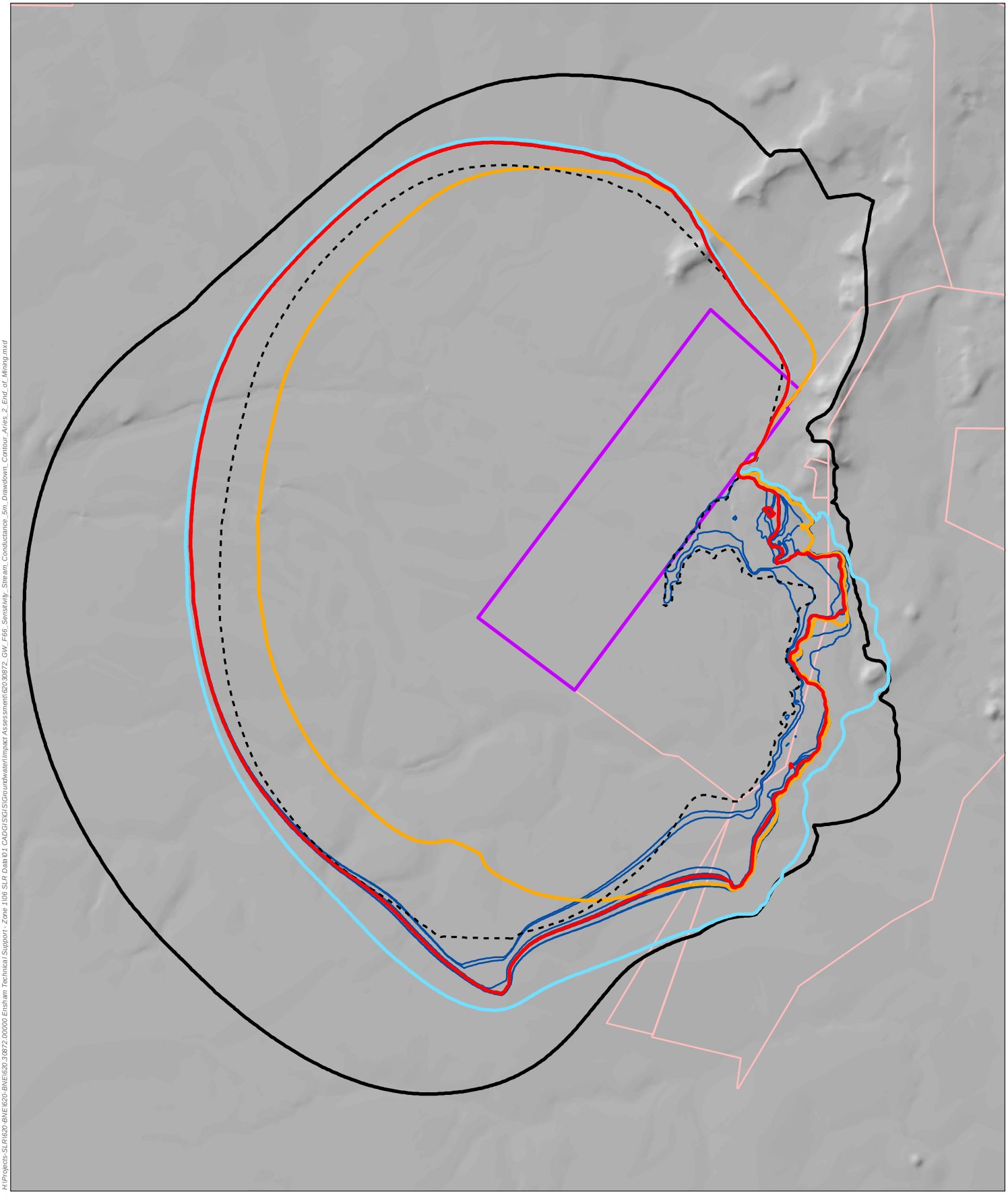
Figure 66 presents the Project incremental 5m drawdown contours at the end of mining (2030) for the base case compared to all 20 scenarios. The base case Project incremental 5 m drawdown curve is shown together with the Project incremental 5 m drawdown contour for each of the parameter permutation scenarios. The sensitivity was assessed for L8 (A2C seam) only, as the alluvium is predicted to have little or no drawdown due to the Project.

In general, most scenarios show the same extent of the 5 m drawdown curve to the north, west and south. To the east towards the outcrops, some changes are apparent. These are minor and likely attributed to the difference in recovery. Note that most scenarios are not visible in Figure 66 because the drawdown line of most scenarios is identical to that obtained for the base case. This means that for most scenarios, parameter value selection does not impact on the prediction of drawdown.

Scenario 8 and scenario 9 (horizontal hydraulic conductivity in the Coal L8), however, show a change in the extent of the 5 m drawdown curve. A reduced horizontal hydraulic conductivity results in a reduction of the 5 m drawdown curve by approximately 1 km in north-westerly (along strike) direction, whereas an increased horizontal hydraulic conductivity results in an extension of the 5 m drawdown curve by 1.3 km in westerly (down dip) direction.

In Scenario 18, a greater vertical conductivity was assigned to the Rewan Group, which resulted in the model predicting an increased leakage from the Rewan Group and thus predicting a reduction of the drawdown in the coal seams.

In summary, the extent of the drawdown curve to the west (down dip) is not sensitive to any parameter changes except the coal horizontal hydraulic conductivity.



H:\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106\SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620.30872_GW_F66_Sensitivity_Stream_Conductance_5m_Drawdown_Contour_Aries_2_End_of_Mining.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:110,000

Project No.:	620.30872
Date:	10-Jun-2022
Drawn by:	NT
Sheet Size:	A4

www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Sensitivity analysis for groundwater drawdown in the Aries and Castor Coal Seam (L8)

FIGURE 66

Legend

- Zone 1
- Mining Lease

5m incremental drawdown curves

- Base Case
- Scenario 5
- Scenario 8
- Scenario 9
- Scenario 18
- All Other Scenarios

6.6.2.2 Water fluxes

Table 23 lists the percent change for the underground mine inflow predictions for all 20 sensitivity scenarios compared to the base case, averaged over the mining period 2022 to 2038. Note that for the sensitivity analysis, the numbers reported are for the Project only.

The underground mine inflow estimates are most sensitive to the coal horizontal hydraulic conductivity (a factor 10 increase results in inflows that are 178 per cent greater) and to a lesser degree to the alluvial horizontal hydraulic conductivity (+34 per cent) and the specific yield of the coal seam (+38%). These scenarios are highlighted in the table, all other parameters are not sensitive for the stream flow predictions (less than 20 percent change). The mine inflow rates over time are presented on Figure 67.

Table 23 lists the percent change for the Nogoa River net stream flows for all 20 sensitivity scenarios compared to the base case, averaged over the mining the period 2022 to 2038. An increase in alluvial horizonal hydraulic conductivity increases the net stream flow by 86 per cent, increase in the stream conductance results in an increase by 34%. A decrease in stream conductance and alluvial horizontal hydraulic conductivity results in a decrease of 80 per cent and 41 per cent, respectively. These scenarios are highlighted in the table - all other parameters are not predicted to be sensitive for the stream flow predictions (less than 20 percent change). The base flow changes over time are presented on Figure 68.

Both the underground mine inflows and the Nogoa River net flow are not sensitive to an increased vertical hydraulic conductivity of the Rewan Group.

The extent of the drawdown curves in the target coal seams at end of mining is not sensitive to the west (except for coal seam hydraulic conductivity). The drawdown curves show higher variability towards the outcrop, where the coal seams interact with other formations and the open-cut pits. This aligns with the sensitivity to the flows, because at those locations, the water level drawdown will be influenced by availability of water from the pits, and the streams.

Table 23 Sensitivity analysis – changes to mining inflow and stream flow losses

Scenario #	Description	Change of model parameter value	UG mine inflows % change	Nogoa River net stream flows % change
1	Base case	(none)	NA	NA
2	Stream conductance (lower)	÷ 10	-7%	-80%
3	Stream conductance (higher)	* 10	5%	34%
4	Alluvium Kh (lower)	÷ 10	-8%	-41%
5	Alluvium Kh (higher)	* 10	34%	86%
6	Alluvium Kv (lower)	÷ 10	-2%	-8%
7	Alluvium Kv (higher)	* 10	-1%	13%
8	Coal L8 Kh (lower)	÷ 10	-6%	-5%
9	Coal L8 Kh (higher)	* 10	178%	14%
10	Coal L8 Kv (lower)	÷ 10	-1%	-2%
11	Coal L8 Kv (higher)	* 10	0%	-2%
12	Coal L8 Sy (lower)	- 0.03	3%	0%

Scenario #	Description	Change of model parameter value	UG mine inflows % change	Nogoa River net stream flows % change
13	Coal L8 Sy (higher)	+ 0.03	38%	0%
14	UG workings Sy (lower)	- 0.1	11%	-2%
15	UG workings Sy (higher)	+ 0.1	-8%	-2%
16	Recharge (lower)	* 0.8	-1%	-1%
17	Recharge (higher)	*1.2	0%	-3%
18	Rewan Kv L3/L4 (higher)	* 10	4%	4%
19	Rewan Kh L3/L4 (higher)	* 10	3%	4%
20	GHB (lower)	-10m	0%	-2%
21	GHB (upper)	+10m	0%	-2%

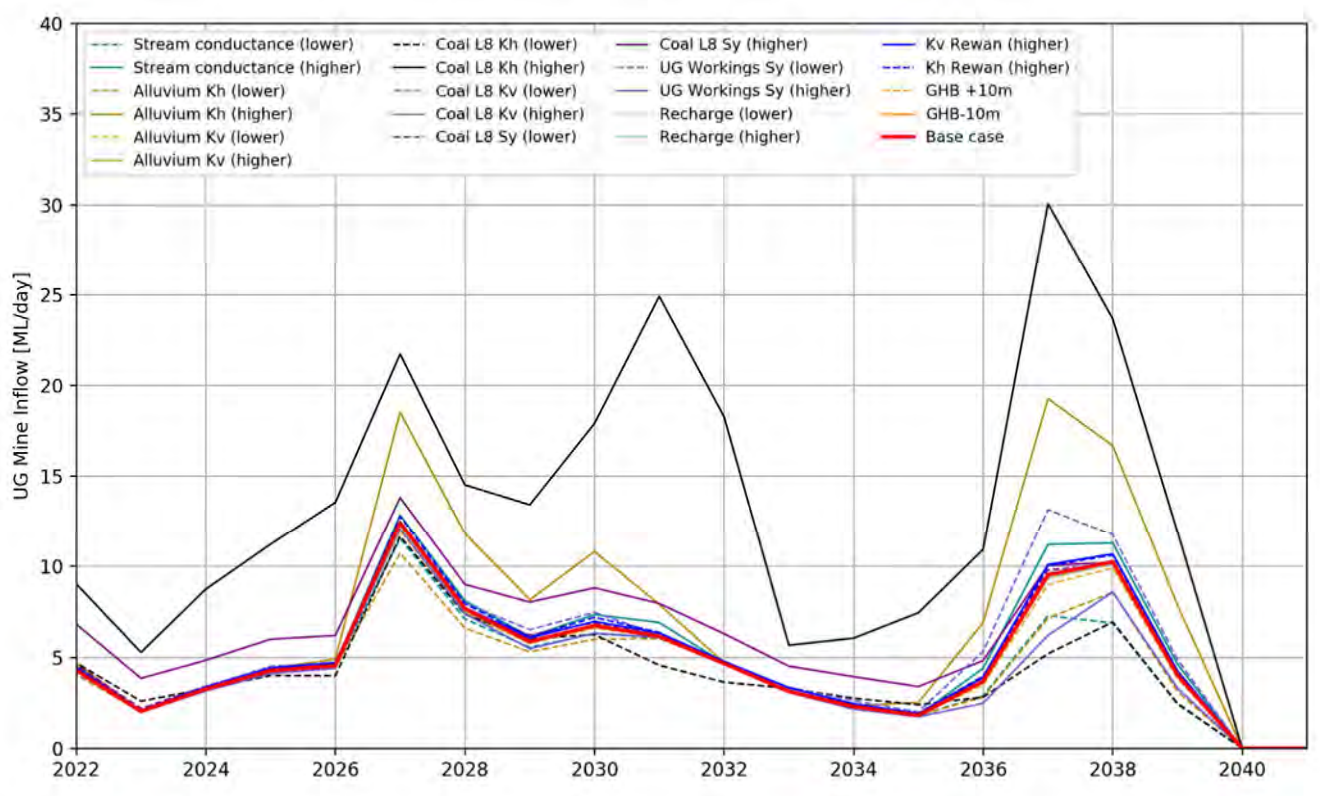


Figure 67 Underground mine inflow (sensitivity analysis)

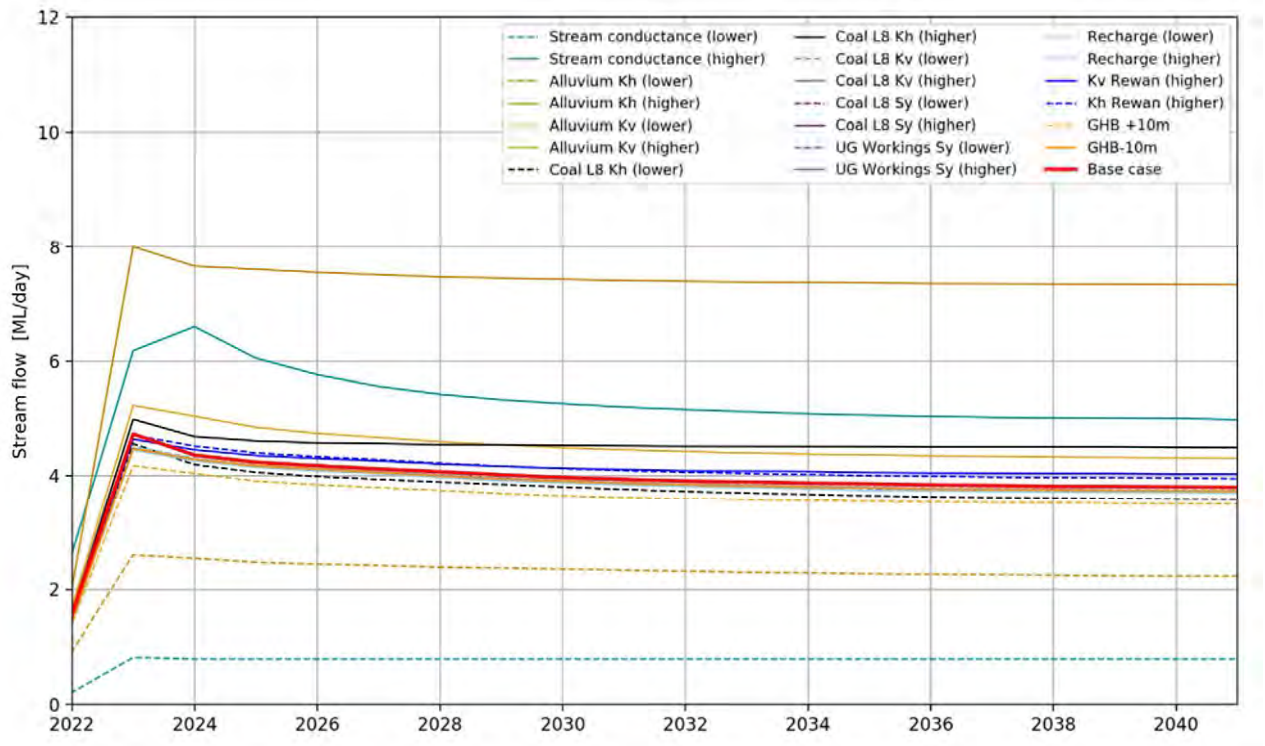


Figure 68 Nogoa River net stream flow (sensitivity analysis)

6.7 Model confidence

Groundwater modelling has been conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) and the Murray Darling Basin Commission Groundwater Flow Modelling Guideline (Middlemis et al., 2000). As these are mostly generic guides, there are no specific guidelines on special applications, such as coal mine modelling or mine closure.

Under the earlier MDBC modelling guideline (Middlemis et al., 2000), the model is best categorised as an Impact Assessment Model of medium complexity. That earlier guide (Middlemis et al., 2000) describes this model type as follows:

"Impact Assessment model – a moderate complexity model, requiring more data and a better understanding of the groundwater system dynamics, and suitable for predicting the impacts of proposed developments or management policies."

The 2012 guide has replaced the model complexity classification of the previous guideline by a "model confidence level", (Class 1, Class 2 or Class 3 in order of increasing confidence) typically depending on:

- Available data (and the accuracy of that data) for the conceptualisation, design and construction phases of a model.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

Table 24 (based on Table 2.1, Barnett et al., 2012) summarises the classification criteria and shows a scoring system allowing model classification. Based on Table 24, the groundwater model developed for this groundwater assessment may be classified as a mixture of Class 2 (about 40 per cent) and Class 3 (about 60 per cent).

Table 24 Groundwater model classification

Class	Data		Calibration		Prediction		Indicators		TOTAL
1	Not much		Not Possible		Timeframe>> calibration		Timeframe>10x		1
	Sparse		Large error statistics		Long stress periods		Stresses>5x		
	No metered usage	✓	Inadequate data spread		Transient prediction but steady state calibration		Mass balance>1% (or single 5%)		
	Remote climate data		Targets incompatible with model purpose		Bad verification		Properties<>Field		
							Bad discretisation		
							No review		
2	Some	✓	Partial performance	✓	Timeframe> calibration	✓	Timeframe=3-10x	✓	10
	Poor coverage		Long-term trends wrong		Long stress periods		Stresses=2-5x	✓	
	Some usage info	✓	Short time record	✓	New stresses not in calibration	✓	Mass balance<1%		
	Baseflow estimates		Weak seasonal replication		Poor verification	✓	Some properties<> Field measurements		
			No use of targets compatible with model purpose				Some key coarse discretisation		
							Reviewed by hydrogeologist	✓	

Class	Data		Calibration		Prediction		Indicators		TOTAL
3	Lots		Good performance stats		Timeframe~ calibration		Timeframe<3x		12
	Good aquifer geometry	✓	Long-term trends replicated	✓	Similar stress periods	✓	Stresses<2x		
	Good usage info		Seasonal fluctuations represented well	✓	Similar stresses to those in calibration	✓	Mass balance<0.5%	✓	
	Local climate info		Present day data targets	✓	Steady state prediction consistent with steady state calibration		Properties~ Field measurements	✓	
	K measurement	✓	Head and flux targets		Good verification		Some key coarse discretisation	✓	
	Hi -res Digital Elevation Model (DEM)	✓					Reviewed by modeller	✓	

6.8 Model limitations

The IESC Uncertainty analysis – Guidance for groundwater modelling within a risk management framework (Middlemis and Peeters, 2018) also identifies four key sources of scientific uncertainty affecting groundwater model simulations:

- Structural / conceptual.
- Parameterisation.
- Measurement error.
- Scenario uncertainties.

These four sources of scientific uncertainty have been qualitatively assessed and are presented in Table 25. Overall, it is considered that the groundwater model is fit for the purpose for addressing the objectives of the Project as outlined in Section 6.1.

The groundwater model was used to assess the impacts of underground mining in this complex setting. The complexity is based on the history of mining (both open-cut and underground mining), complex geology, interactions between aquifers, interactions between groundwater and surface water, changes in material properties over time and so forth. Due to the aforementioned complexity, some of the modelling results might not be easily attributed to certain inputs, processes or settings. The presented potential impacts need to be accepted based on the model set-up, parametrisation and choice of result display.

Table 25 Groundwater model and data limitations

Type	Part	Status	Comment
Structural / conceptual geology / structure	Grid	Fit for purpose	Model has unstructured Voronoi grid that includes detailed cell refinement around site and along drainage features.
	Layer 1 to Layer 2	Fit for purpose	Top of Layer 1 based on LiDAR data at site and DEM outside of site. Alluvium thickness based on site drill data where available.
	Layer 3 to Layer 4	Fit for purpose	Top of Rewan Group based on bottom of alluvium Bottom of Rewan Group based on top of Rangal Coal Measures from a mine geological model.
	Layer 4 to Layer 11	Fit for purpose	The structure of Layers 4 to 11 is based on previous peer reviewed model iterations. Rangal Coal Measures at site were based on detailed geological model, which captures minor fault displacements in coal measures in the approved area. The layer divisions were based on hydrostratigraphic horizons available within geological models and extrapolated beyond the limit of these using available data where applicable.
	Geological structure	Fit for purpose with future improvements	The structure of the geology is based on previous peer reviewed model iterations. Those models were based on site and regional geological mapping to understand the outcrop extents, strike and dip of the Permian Coal Measures. There is limited fault mapping in the area, which was used in the model (Figure 15 and Appendix F, Figures F-5 to F-12). Understanding of faults can potentially be further improved with analysing data from the ongoing collection of site geological information. Potential connectivity between the coal seam and the shallow formations was tested during sensitivity analysis. The vertical hydraulic conductivity of the Rewan Formation was increased by a factor of 10 to simulate how faulting or fractures could impact the model predictions.
Parameterisation	Hydraulic conductivity	Fit for purpose	Field testing of hydraulic conductivity (horizontal and vertical) has been conducted at the site and surrounds for the coal seams and the alluvium. Values for the other hydrostratigraphic units were taken from the literature (Table 8). Model parameters calibrated in line with field data ranges and in consideration of model parameters used in the region. Scenario analysis was run to test hydraulic properties by varying them by an order of magnitude within the alluvium, the Rewan Group and the Rangal Coal Measures in order to understand the influence this had on the model predictions.

Type	Part	Status	Comment
	Storage properties	Fit for purpose	Limited site data available for the storage properties, but values matched to align with parameters used at surrounding mines and consistent with current literature (i.e., Rau et al 2018).
	Recharge	Fit for purpose	Recharge parameters were zoned based on surface geology / land use and calibrated in the steady state calibration. Recharge in the transient calibration was represented based on actual quarterly rainfall to capture seasonal variability.
	Mine inflows	Future improvements	The approach how adopted to simulate mine inflows was kept consistent with previous models (drain cells active for two years when mining commences at a location). This is a conservative approach and may lead to overestimation of the mine inflows.
Measurement Error	Observation Data quality	Fit for purpose with future improvements	As part of the conceptualisation the quality of data was reviewed, including review of groundwater level and quality trends to verify target lithology. The quality of the observation data for water levels is fit for purpose. There is a need for more accurate collection of groundwater dewatering data from underground.
	Spatial spread	Fit for purpose	Observation targets are available for most model layers across the model domain.
	Temporal spread	Fit for purpose with future improvements	Groundwater levels have been recorded on a quarterly basis across the network. Groundwater level readings for bores within the existing mine have historical data from around 2005 to 2021, capturing responses to rainfall events and mining in the region over the calibration period. Ongoing monitoring of the bores will be conducted, which will be incorporated into future iterations of the groundwater model. The model changes from quarterly to annual time steps in 2060. For some bores, this change is visible in the hydrographs. This can be improved for future model iterations.
Scenario uncertainties future stresses/ conditions	Calibration	Fit for purpose	Previous transient calibration from December 2005 to September 2021 with quarterly stress periods. The calibration data set (water levels) is well suited in the vicinity of the mine. The bores of the RB-series (observing the target coal seam) have shown a clear mining impact.
	Predictive	Fit for purpose	Predictive model January 2022 to December 2038 (16 years) with quarterly stress periods. Model predictive time frame is the same duration as transient calibration. Temporal discretisation varies to calibration, in order to align with mine plan design timing.

Type	Part	Status	Comment
	Recovery	Fit for purpose	Recovery model was run in quarterly time steps between 2039 and 2060 and then in annual time steps between 2060 and 2262. The total recovery period is 232 years, and the hydrographs are flattening out for all bores, which indicates long-term equilibrium has been captured.
	Sensitivity	Fit for purpose with future improvements	Eleven key parameters were selected and changed by permutation to assess the predictive uncertainty for the drawdown, the Project inflows and the stream flow losses.

7 Potential Impacts

7.1 Assessment framework

The potential impacts of the Project on the groundwater resources are assessed both in term of change in groundwater levels and groundwater quality, in accordance with the requirements listed in Table 1. Note that the impacts presented are Project incremental maximum impacts, i.e., the additional impact of the Project compared to the existing approved underground operations.

Each EV (as detailed in Section 5.5) may be impacted differently by changes in groundwater levels and groundwater quality. The basis for assessing impact for each groundwater EV is presented in Table 26.

Table 26 Impact assessment framework for each environmental value

EVs pertinent to Ensham	Potential impact 1 – groundwater drawdown	Impact assessment 1	Potential impact 2 – Groundwater quality degradation	Impact assessment 2
Aquatic and terrestrial ecosystem	A decrease of the groundwater table may reduce the ability for some vegetation to access groundwater. It may also affect baseflow in connected waterways as well as habitat for stygofauna.	Drawdown (m) in the alluvium, at a wetland and mapped GDE area	Changes in groundwater quality may affect the health of groundwater dependant ecosystems	Predicted change in quality, area affected and potential impact on GDE.
Irrigation; farm supply / use; stock water	A decrease of the groundwater table may reduce bore yield or degrade groundwater quality (e.g., increase EC).	Drawdown (m) in all affected private bores	Change in groundwater quality may reduce potential use of groundwater depending on groundwater usage	Predicted change in quality, private bores affected and potential impact for each bore based on usage.

7.2 Water licensing

As outlined in Section 2.2, the Project is located within the Water Plan (Fitzroy Basin), which covers surface water resources only. The groundwater model predicts no reduction in baseflow in the Nogoa River over the life of the existing mine from the existing operations or for the Project, and so no further assessment on indirect surface water takes (such as increased leakage from the river to groundwater) is required.

Groundwater is regulated in the Highlands Groundwater Management Area under the Water Plan (Fitzroy Basin) 2011. The associated water take (groundwater inflows into the pit area) does not require a water entitlement under the Water Plan.

Chapter 3 of the Water Act, which regulates the take of underground water, will apply to proposed project activities. An Underground Water Impact Report (UWIR) was prepared for the take of associated water (Appendix J of the Environmental Authority Amendment application). Any non-associated take of underground water for mining activities would require a water entitlement. However, Ensham does not use any groundwater for non-associated activities.

7.3 Potential impact on aquatic and terrestrial ecosystems

The potential impact on aquatic and terrestrial ecosystems was assessed by reviewing the potential alluvial drawdown in the vicinity of the aquatic and terrestrial ecosystems. Figure 70 shows the aquatic and terrestrial ecosystems identified in Section 5.5.1 and Section 5.5.4 with the 0.5 m contour of the Project incremental maximum drawdown in the unconsolidated material (model layer 2).

This Project incremental maximum drawdown contour intersects part of a surface expression GDE (which was assessed as “low confidence”, Section 5.5.1) where the coal measures sub-crop the alluvium. The Project incremental maximum drawdown also intersects parts of a low confidence surface expression GDE and parts of a low confidence terrestrial GDEs in the northwest of the Project. Due to the conservative methodology of the drawdown calculations (Section_ 6.5.3), the model predicts an incremental drawdown curve. However, when reviewing the hydrographs within the drawdown contour (Figure 69), it becomes apparent that the groundwater system will not experience an additional drawdown due to the Project. In the example hydrograph for EC11 in Figure 69, the maximum incremental drawdown (the maximum difference between the light blue and the dark blue line) is around 1m, experienced in 2070.

For the three scenarios Null run, Existing operations and the Project, the water level predictions are the same up to 2038. After this, the water level for the Null run shows a faster recovery. This leads to a difference between the water levels that is akin to a drawdown, when in reality, the water levels are increasing. However, the availability of groundwater in the alluvium increases for all the scenarios, which means that there is no actual additional drawdown predicted. Furthermore, all scenarios recover to the same final level.

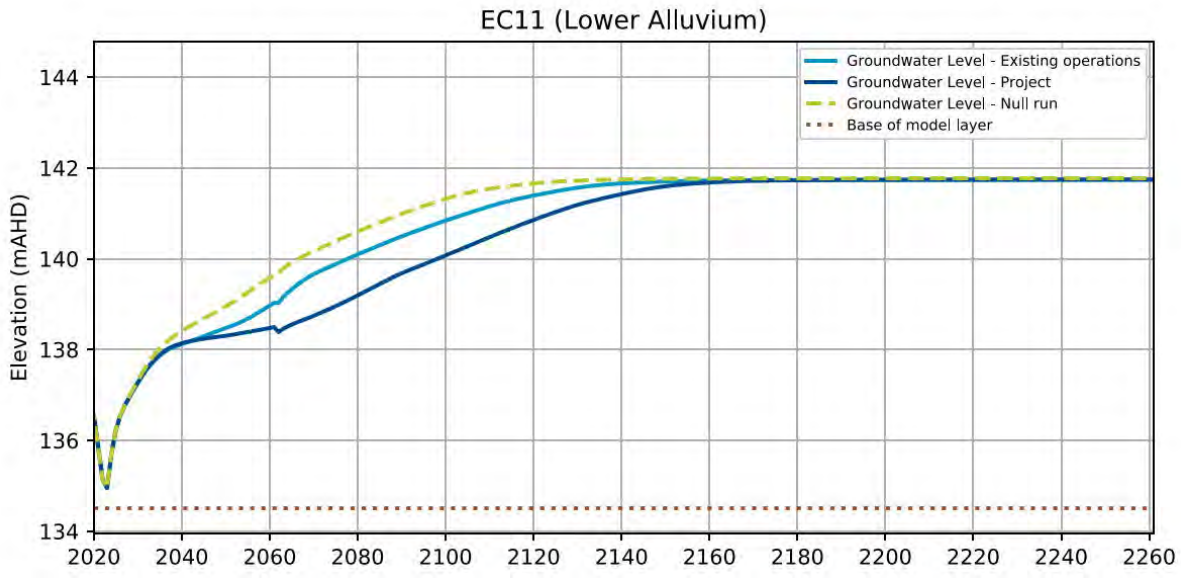
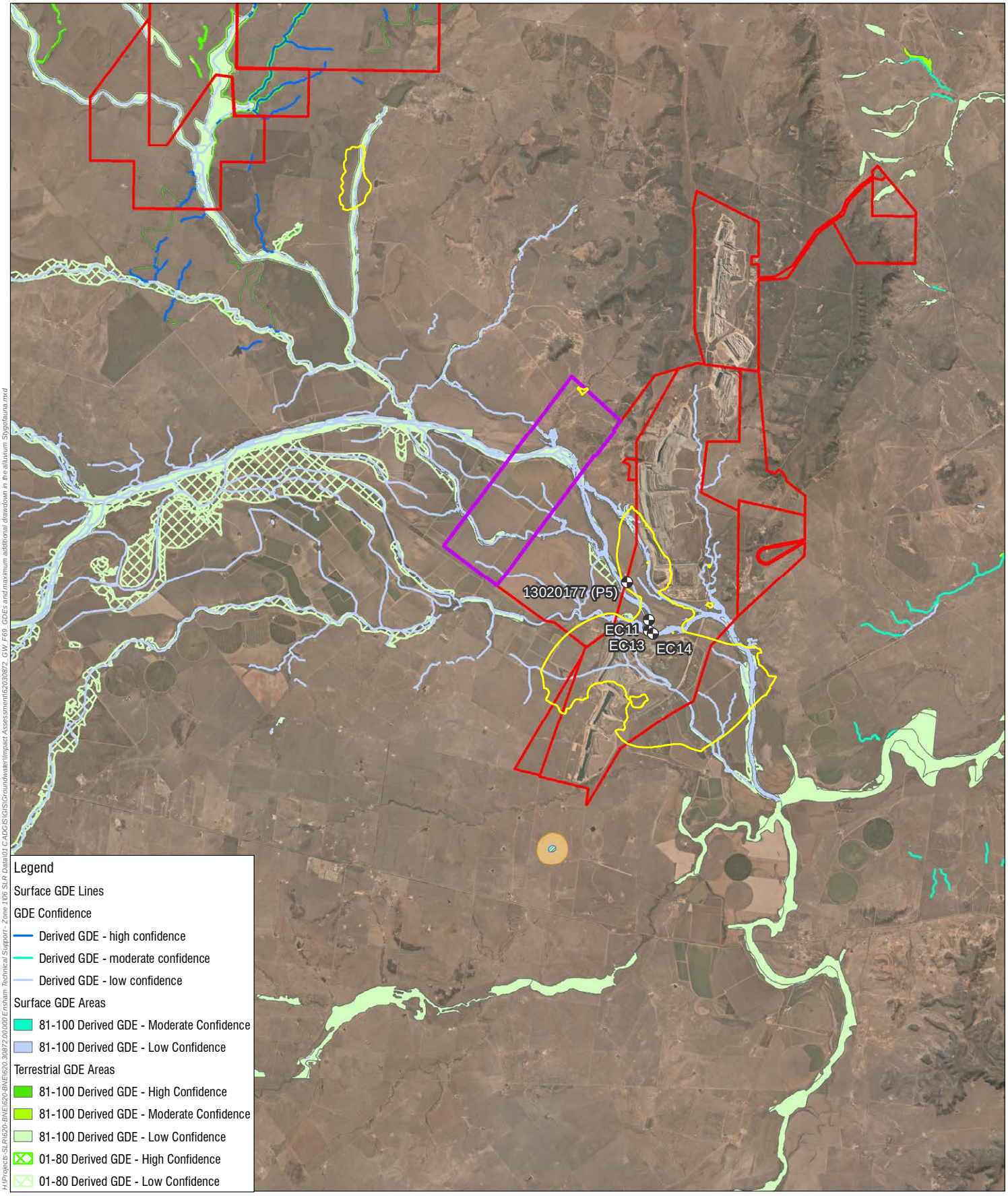


Figure 69 Recovery curve for an alluvial bore

The Project incremental maximum drawdown does not intersect the wetland identified in Section 5.5.4, and as such the Project will have no impact on this wetland. In addition, the Project incremental maximum drawdown does not intersect any active springs, so the Project will have no impact on springs.

Further, Figure 69 shows the four bores that were identified to have Stygofauna present. None of the bores are predicted to be impacted by the Project, with no Project incremental maximum drawdown identified compared to the current groundwater levels. Due to the conservative methodology used to calculate the Project incremental maximum drawdown (Section 6.5.3) the Project maximum incremental drawdown (of up to 0.5 m) contour shown in Figure 70 represents a delay in recovery, as explained above with the example hydrograph of EC11, which is one of the bores with Stygofauna present. The predictive hydrographs for the other three bores are presented in Appendix G. As discussed above, the alluvial water levels are predicted to recover for all three scenarios and hence no drawdown impact is expected for the Stygofauna.



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2 GW F69 GDEs and maximum additional drawdown in the alluvium Stygofauna.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30872
Date:	03-Jun-2022
Drawn by:	NT
Sheet Size:	A4

SLR
www.slrconsulting.com

Legend

- Groundwater Bore - Stygofauna detected
- Wetland
- Wetland Protection Area
- Zone 1
- Mining Lease

Drawdown (m)
- 0.5

GROUNDWATER IMPACT ASSESSMENT

Project Incremental maximum drawdown in the unconsolidated and GDE's

Figure 70

7.4 Potential impact on private bores

The potential Project incremental maximum and Project Net maximum impact on each private bore (irrigation, farm supply/use and stock water) identified in Section 5.5.5 is presented in Table 27 and Table 28 respectively. Some bores are not in use, or, screened within units that have not been identified / logged. For these bores, the impacts cannot readily be assessed.

The bores with the largest Project incremental drawdown impact are Jamar Bore (0.12 m) and Winton Creek Bore (0.10 m), both taking water from the Rewan Group. The Project Net drawdowns for those bores are 0.19 m and 0.15 m, respectively. These drawdowns are all considered negligible.

These bores were previously attributed to model layer 4 (lower Rewan) (HydroSimulations, 2020). The re-assessment of the bore log for RB04 and the reported depths of Jamar and Winton Creek bores in comparison with the model geometry concluded that these bores are screened in model layer 3 (Upper Rewan). The impacts were assessed for model Layer 3 (Table 27 and Table 28).

Table 27 Predicted Project incremental maximum drawdown at private bores due to the Project

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum incremental DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
103788	Conmurra	66	Irrigation (stock & domestic)	Regolith	140	0	2073	0
132040	Currimundi	-	Not in use	Unknown	Unknown	NC	NC	NC
57402	Kensington	-	Not in use	Unknown	Unknown	NC	NC	NC
84403	-	-	Unknown	Unknown	Unknown	NC	NC	NC
89380	Fair Hills	77	Stock & domestic	Burngrove	196-214	0	2225	0
89383	Yongala	74	Stock	Burngrove	213	0	2257	0
89382		74	Stock	Unknown	213	NC	NC	NC
89384		78	Stock	Unknown	213	NC	NC	NC
90140	Railway	61	Stock	Regolith	130 - 160	0	NA	0
-	Chelbrook1	24	Not in use	Unknown	Unknown	NC	NC	NC
-	Chelbrook2	>100	Not in use	Unknown	Unknown	NC	NC	NC
-	Currimundi (Field 5 Bore)	29	Not in use	Unknown	Unknown	NC	NC	NC
-	Cypress	>160	Not in use	Unknown	Unknown	NC	NC	NC
-	Euro Park	74	Not in use	Rewan (upper)	Unknown	0.09	2117	0.03
-	Jamar	90	Stock	Rewan (upper)	108 - 126	0.12	2097	0.03
-	Jenson	41	Stock	Unknown	Unknown	NC	NC	NC
-	Karanga	~50	Stock	Burngrove	133	0.03	2116	0.02
-	Twin Bore	18	Stock	Alluvium	153	0.03	2080	0

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum incremental DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
-	Winton Creek	60	Stock	Rewan (upper)	138	0.10	2076	0.01
67014		80	Unlikely used (very saline)	Unknown	164.3 (1983)	NC	NC	NC
90338		30	Farm supply (potable)	Unknown	Unknown	NC	NC	NC
67015		44	Unlikely used (very saline)	Unknown	Unknown	NC	NC	NC
38845		70	Unknown	Unknown	Unknown	NC	NC	NC
90337		31	Unknown	Unknown	Unknown	NC	NC	NC

NC: not calculated: bore not in use or geology not known (if geology is unknown, it is unknown in which model layer the bore would be and hence not results can be extracted), DD: drawdown (base case). NA: if drawdowns is zero, no year can be extracted, as this is valid during the entire model run.

Table 28 Predicted Project Net maximum drawdown at private bores due to the Project

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum Project Net DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
103788	Conmurra	66	Irrigation (stock & domestic)	Regolith	140	0	2066	0
132040	Currimundi	-	Not in use	Unknown	Unknown	NC	NC	NC
57402	Kensington	-	Not in use	Unknown	Unknown	NC	NC	NC
84403	-	-	Unknown	Unknown	Unknown	NC	NC	NC
89380	Fair Hills	77	Stock & domestic	Burngrove	196-214	0	2256	0
89383	Yongala	74	Stock	Burngrove	213	0	2260	0
89382		74	Stock	Unknown	213	NC	NC	NC
89384		78	Stock	Unknown	213	NC	NC	NC
90140	Railway	61	Stock	Regolith	130 - 160	0	NA	0
-	Chelbrook1	24	Not in use	Unknown	Unknown	NC	NC	NC
-	Chelbrook2	>100	Not in use	Unknown	Unknown	NC	NC	NC
-	Currimundi (Field 5 Bore)	29	Not in use	Unknown	Unknown	NC	NC	NC
-	Cypress	>160	Not in use	Unknown	Unknown	NC	NC	NC
-	Euro Park	74	Not in use	Rewan (upper)	Unknown	0.14	2118	0.06
-	Jamar	90	Stock	Rewan (upper)	108 - 126	0.19	2097	0.05
-	Jenson	41	Stock	Unknown	Unknown	NC	NC	NC
-	Karanga	~50	Stock	Burngrove	133	0.05	2159	0.03

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum Project Net DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
-	Twin Bore	18	Stock	Alluvium	153	0.05	2129	0.01
-	Winton Creek	60	Stock	Rewan (upper)	138	0.15	2073	0.03
67014		80	Unlikely used (very saline)	Unknown	164.3 (1983)	NC	NC	NC
90338		30	Farm supply (potable)	Unknown	Unknown	NC	NC	NC
67015		44	Unlikely used (very saline)	Unknown	Unknown	NC	NC	NC
38845		70	Unknown	Unknown	Unknown	NC	NC	NC
90337		31	Unknown	Unknown	Unknown	NC	NC	NC

NC: not calculated: bore not in use or geology not known (if geology is unknown, it is unknown in which model layer the bore would be located and hence no results can be extracted), DD: drawdown (base case). NA: if drawdown is zero, no year can be extracted, as this is valid during the entire model run.

7.5 Impact on groundwater quality

The Project does not include any new infrastructure, construction phase or spoil emplacements, which could potentially impact the groundwater quality. The Project is exclusively a continuation of underground bord and pillar mining, leaving the excavated underground voids in the coal body to recharge naturally over time post mining. The inflowing water will have the same quality as the water previously stored in the coal seam.

As discussed in Section 5.4.1.1, the alluvial groundwater shows a great range in salinity with recorded values ranging from about 1,000 µS / cm to 50,000 µS / cm. Based on the groundwater modelling, the alluvium is predicted to have minor Project incremental drawdowns (Section 6.5.3), consequently the groundwater quality is not predicted to change due to the Project.

Current recharge and discharge mechanisms (recharge through large rain or flood events and discharge through evapotranspiration) will have a greater impact on the groundwater quality in the alluvium (reduction of EC in wet periods by dilution and increase of EC during droughts) than mining.

7.6 Climate change scenarios

The Climate Future Tool (CCIA, 2022) was interrogated for the cluster East Coast North, which is the relevant sub-cluster for the Ensham mine. The general rainfall projection for this cluster was summarised as:

“Natural climate variability is projected to remain the major driver of rainfall changes in the next few decades. Models show a range of results, with little change or decrease being more common particularly in winter and spring. Impact assessment in this region should consider the risk of both a drier and wetter climate.”

In the Climate Futures Tool, the functionality “Explore projections” was used to quantify the predicted change in annual rainfall. There are four Representative Concentration Pathways (RCPs), which represent different greenhouse gas concentration scenarios. These are:

- RCP8.5 - a future with little curbing of emissions, with a CO_2 concentration continuing to rapidly rise, reaching 940 ppm by 2100.
- RCP6.0 – lower emissions, achieved by application of some mitigation strategies and technologies. CO_2 concentration rising less rapidly (than RCP8.5), but still reaching 660 ppm by 2100 and total radiative forcing stabilising shortly after 2100.
- RCP4.5 - CO_2 concentrations are slightly above those of RCP6.0 until after mid-century, but emissions peak earlier (around 2040), and the CO_2 concentration reaches 540 ppm by 2100.
- RCP2.6 - the most ambitious mitigation scenario, with emissions peaking early in the century (around 2020), then rapidly declining. The CO_2 concentration reaches 440 ppm by 2040 then slowly declines to 420 ppm by 2100) (CSIRO and BOM, 2020).

In the projections explorer, each RCP can be assessed at different points in time (up to 2090). For the long-term recovery, the projections' change in annual rainfall was assessed for the year 2090. The results are presented in Table 29. The percentage value for each RCP indicates the percentage of models which had the corresponding outcome of percent change in rainfall. For example, in 2090 for RCP 2.6, 28% (8 of 29) models predicted a reduction in rainfall of more than 15%. For RCP 8.5 37% (26 of 70) models predicted a reduction in rainfall of more than 15%.

Table 29 Change in rainfall for different climate scenarios (2090)

% Annual Rainfall Comparison	RCP 2.6 (n=29)	RCP 4.5 (n=68)	RCP 6.0 (n=22)	RCP 8.5 (n=70)
>15% (much wetter)	-	-	9%	6%
5 to 15% (wetter)	14%	15%	23%	13%
-5 to 5 (little change)	34%	29%	27%	21%
-15 to -5 (drier)	24%	40%	23%	23%
> -15% (much drier)	28%	16%	18%	37%

Notes: n refers to the number of models in each of the RCP categories

7.6.1 Future climate scenarios and their impact on the alluvium

The impact of the climate change scenarios and their impact on the alluvium is illustrated in Figure 71, with the example hydrograph for EC25. The figure shows the calculated hydrographs for this bore for the Existing Operations scenario and the Project, both for the average climate, the 20% more recharge scenario and the 20% less recharge scenario. Based on Table 29, the climate is more likely to get drier over time with climate change.

The figure shows the following:

- The estimated water level variation under average quarterly recharge and river stages into the groundwater model (2020-2060) is approximately 1 m. This represents the natural variability of the alluvial groundwater levels.
- The difference between the Project and Existing Operations represents the mining impact. The Existing Operation scenarios results in slightly higher alluvial water levels in the long-term. The mining impact is approximately 5 cm.

- The difference between the Project, Project, Recharge -20% and Project, Recharge +20% represents the climate change impact. The estimate of the climate change impact on the alluvium is a decrease of groundwater levels by approximately 5 cm.

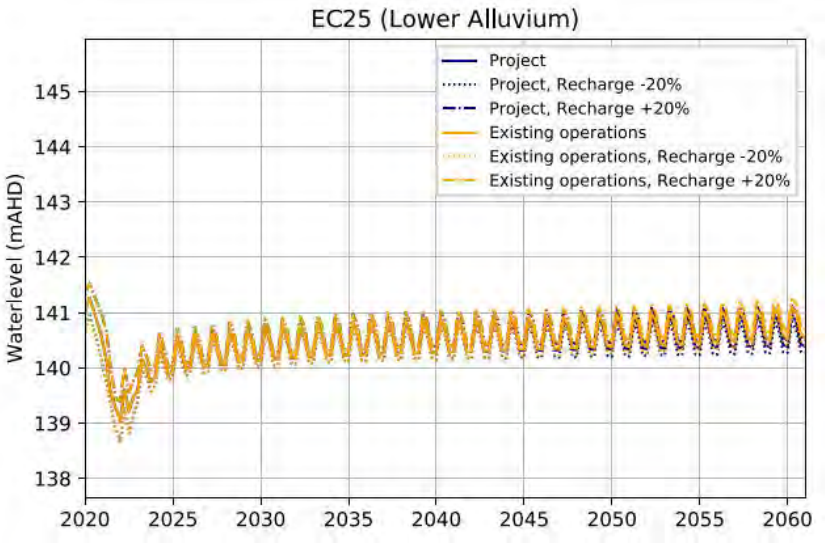


Figure 71 Long-term recovery hydrograph for alluvial bore EC25

In summary, the predicted long-term groundwater level changes at bore EC25 result in a decrease of approximately 5 cm for the climate change (20% decrease in rainfall recharge) and an increase of approximately 5 cm for the mining impact, which is considered an effect from the different drawdown and recovery curves compared to the existing operations. These changes are likely to be masked by the natural variability, which was shown to be 1 m for an average quarterly input of climate data into the groundwater model.

7.6.2 Future climate scenarios and their impact on the coal seams

The impact of the climate change scenarios and their impact on the coal seam is illustrated in Figure 72, with the example hydrograph for RB4. The figure shows the calculated hydrographs for this bore for the Existing operations scenario and the Project, both for the average climate, the 20% more recharge scenario and the 20% less recharge scenario.

The impact from climate change on the water levels in the coal seam is minor (range of centimetres). Due to depressurisation of the coal seam, the mining impact is larger (approximately 5m). This shows that the predictions for the water level drawdowns are not sensitive to climate change.

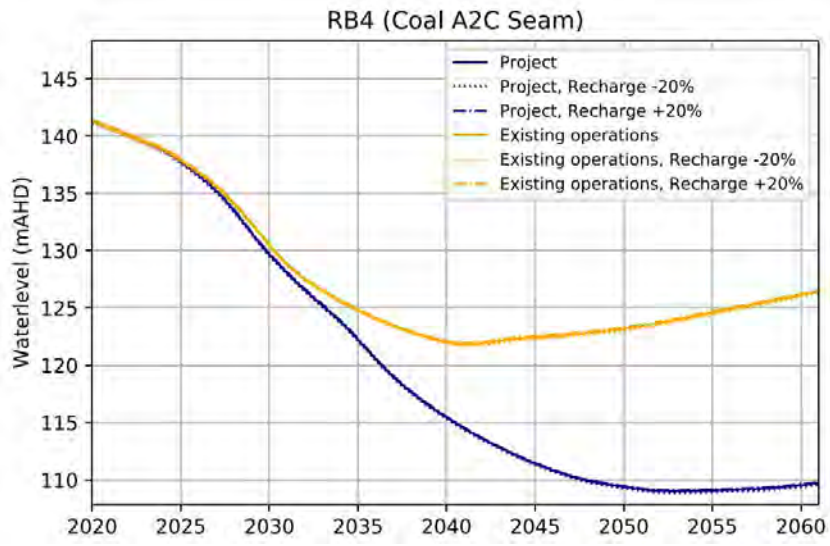


Figure 72 Long-term recovery hydrograph for bore RB4

7.7 Other potential impacts

This section covers other potential impacts on the groundwater resources from the Project. These potential impacts have been qualitatively assessed and are presented in Table 30.

Table 30 Qualitative assessment of other potential impacts

Potential Impact	Qualitative assessment
Contamination from underground machinery, fuel storage, workshops, waste storage	The extension of the underground coal mine will not have any additional impacts compared to the existing operations. The same methods of underground mining will continue to be used. The only difference to the existing operations in this context is the duration of mining (between 2022 and 2029 for the existing operations, versus between 2024 and 2037 for the Project).
Incidental mine gas	The measured seam gas content in the current ML 7459 and ML 70365 areas is generally low. The current operational procedures will be utilised for incidental mine gas management. The current ventilation system and flaring equipment will be utilised to manage incidental gas for the underground mining in the Zone 1. There is no likely impact on landholder bores. Should any of the landholder bores become gassy, the Groundwater Management Plan (GWMP) would be amended to include gas sampling at these bores.
Flood mitigation measures	There are no additional surface water infrastructure required as existing infrastructure will be utilised, hence there are no additional impacts on the groundwater.
Any ventilation shafts	No additional ventilation shafts are required, hence no additional impact on the groundwater is expected.

8 Management and mitigation

8.1 Mine affected water

Mine-affected water will be managed using the existing mine water management system (Water Balance Report - Appendix F of the Environmental Authority Amendment application). No new water related infrastructure will therefore be required. The existing water management system is regulated through the Environmental Authority EPML00732813.

The current EA defines conditions for the release of mine affected water including release points, sources, release limits and receiving water. The source of water associated with the Project will be Ramp 22, Ramp 24 Fill Point Dam and Ramp 3 / 4 Drain (Table 31).

Table 31 Release points and source water conditions (Table C1 of EPML00732813)

Release point	Easting (GDA94)	Northing (GDA 94)	Mine affected water source and location	Monitoring point	Receiving waters description
RP1	653731	7401335	Ramp 24 Fill Point Dam, Ramp 3 / 4 Drain, Pits A, B, C, D, E, F and Y.	End of pipe	Nogoa River
RP3	651680	740068	Ramp 24 Fill Point Dam, Ramp 3 / 4 Drain, Pits A, B, C, D, E, F and Y.	End of pipe	Nogoa River

8.2 Subsidence

Gordon Geotechniques (2022) assessed the subsidence risk for the Project and the study has been peer reviewed by Mine Advice (see Subsidence Peer review Letter in Appendix C-1 of the Environmental Authority Amendment application). The assessment of the stability of the coal pillars in Zone 1 has been carried out using the industry accepted University of New South Wales Pillar Design Procedure. There is a high degree of confidence in these subsidence predictions due to the amount of information from the existing bord and pillar mining at Ensham with similar mining heights, depth of cover and mining methodology. This assessment has confirmed the long-term stability of the proposed mine layout.

Due to the nature of the bord and pillar mining method, subsidence related to the Project is predicted to be typically less than 40 mm; RTK-GPS monitoring at Ensham (which has an accuracy of +/-5mm) indicates subsidence levels of less than 10 mm above existing mined underground panels and confirms the maximum subsidence prediction for the Project. To provide context, Commonwealth of Australia, 2014 and 2015, states that seasonal variation in surface levels can be as high as 50 mm as a result of changes in moisture content.

Due to the low levels of subsidence and associated strains and tilts, no surface cracking is anticipated within the Zone 1. The expected low levels of subsidence are also unlikely to result in the formation of significant depressions in the surface topography where ponding of the surface drainage may occur. This is consistent with experience at the existing Ensham mine operations where no surface cracking or ponding has been observed above the operating bord and pillar mine areas.

8.3 Groundwater users

As reported in Section 7.4, there are two private bores (Jamar Bore and Winton Creek Bore, both in the Rewan Group) that are predicted to experience a Project incremental drawdown of 0.12 and 0.10 m. Section 362 of the Water Act defines groundwater level thresholds (when groundwater levels are predicted to decrease by more than 2 m in the alluvium and by more than 5 m in the consolidated hydrostratigraphic units) to determine if management/mitigation measures are required. If triggered, these thresholds require mitigations to be undertaken to ensure the bore owner has access to a similar quantity and quality of water for the bores authorised purpose.

As the modelled drawdowns are all below the thresholds defined in Section 362 of the Water Act, no additional mitigation measures would be required to be put in place.

8.4 Groundwater monitoring program

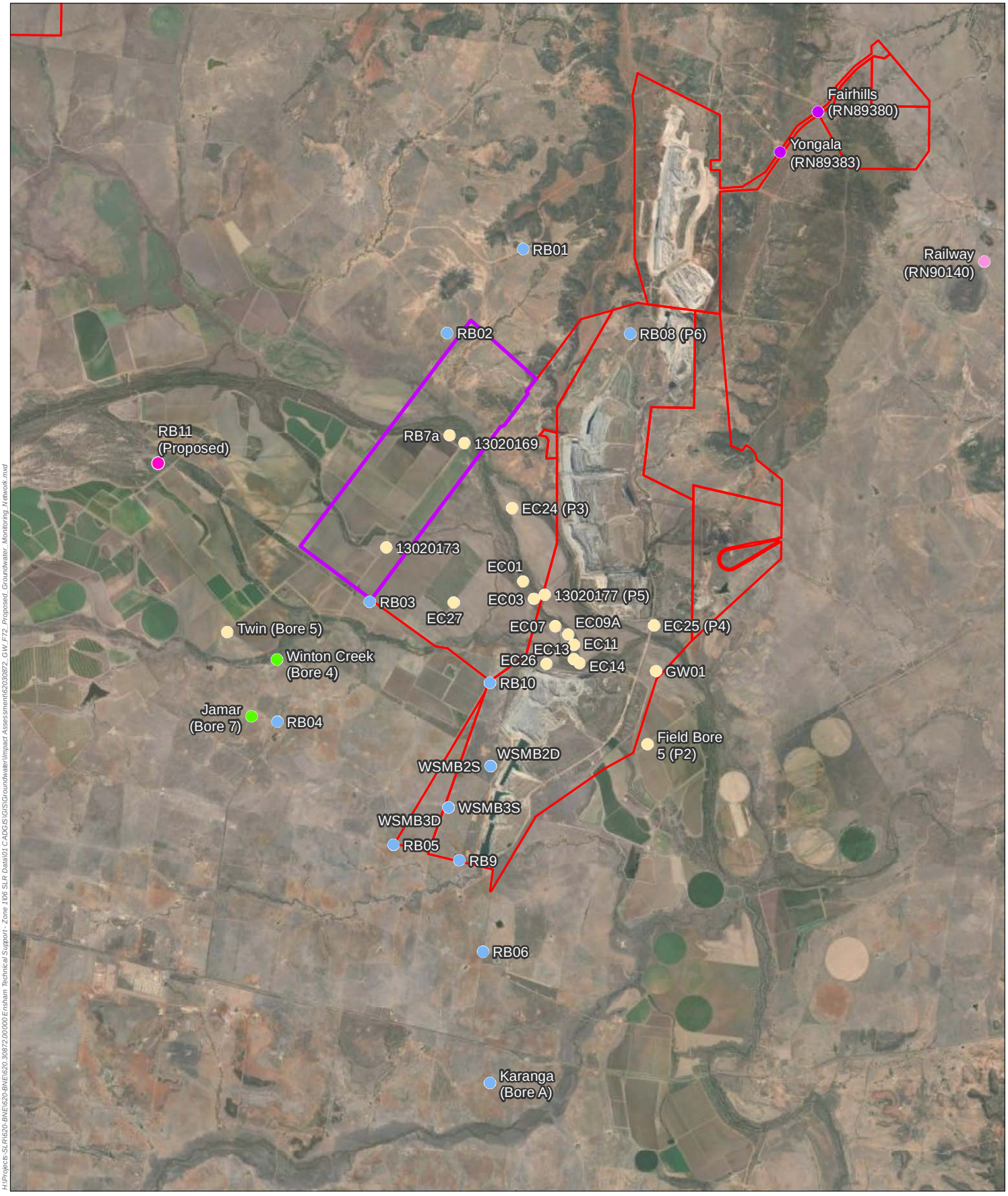
The groundwater monitoring bore network as per EA EPML00732813 is extensive and allows for the compilation of groundwater monitoring data from the Quaternary (alluvium), Triassic age sediments, Rewan Group and Rangal Coal Measures for the currently approved operations at Ensham. This network is presented in Section 5.1 (Table 7) and is deemed suitable to assess the impacts of the additional years of mining for the Project (up to 2037), with the one addition.

It is proposed to include one additional monitoring bore to the west of Zone 1, as shown in Figure 73 with details listed in Table 32. The proposed bore is designed to monitor the predicted extent of the drawdown in the coal seam to the west of Zone 1, to confirm modelling predictions.

Table 32 Proposed additional groundwater monitoring bore

Location	Monitoring point	Easting (GDA20 z55)	Northing (GDA20 z55)	Depth (m bgl)	Aquifer
West of Project	RB11	639285*	740654*	approximately 300	Rangal Coal Measures (Coal)

Note: * final coordinates to be determined based on access and final drill location.



H:\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Impact Assessment\620308?2_GW_F?2_Proposed_Groundwater_Monitoring_Network.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:150,000

Project No.:	620.30872
Date:	10-Jun-2022
Drawn by:	NT
Sheet Size:	A4

Legend

- Proposed Groundwater Mornitorng Bore
- Zone 1
- Mining Lease

Monitoring Network by Aquifer

- Alluvium
- Rewan Group
- Rangal Coal Measures
- Burngrove Formation
- Fair Hill Formation

GROUNDWATER IMPACT ASSESSMENT

Proposed Groundwater Monitoring Network

Figure 73

8.4.1 Impact assessment criteria

Groundwater trigger levels for the proposed bore will be developed in line with the Department of Science, Information Technology and Innovation guideline on "Using monitoring data to assess groundwater quality and potential environmental impacts" (DES, 2021). The trigger levels will be established once at least 8 samples, obtained over 24 months, have been collected from the new bore. In line with the current EA, the site-specific triggers will be established for RB11.

8.4.1.1 Water Level trigger levels

The proposed bore is located in the Rangal Coal measures within the 5 m drawdown contour (Figure 57). It is proposed to collect a baseline data set (8 samples over 24 months) before deriving a water level trigger.

8.4.1.2 Water quality trigger levels

Table 33 lists the proposed interim trigger values for the new bore for EC, pH and sulfate. Table 34 lists the interim trigger values for the remaining parameters that are also applied in the current EA, which reflect the ANZG, 2018 guideline values for 95% species protection. These interim trigger values are valid until a data set of at least 8 samples have been collected (DES, 2021).

The trigger values in Table 33 are assigned according to the water chemistry in zone 43 deep (WQ1310), with the 80th percentile applied as a trigger.

Once a baseline data set is available, the data will be assessed against the WQO. If the 80th percentile of a bore exceeds the WQO, reflective of pre-mining conditions, a bore specific trigger will be derived for that bore. Otherwise, the interim trigger values can remain in place as a final trigger.

Table 33 Interim trigger levels for the new bores (EC, pH, Sulfate)

	EC (µS/cm)	pH	Sulfate (mg/L)
RB 11 (proposed) Zone 43 deep	7,720	6.5-8.5	362

Table 34 Interim trigger levels for the new bore (remaining parameters)

Iron mg/l	Arsenic mg/l	Aluminium mg/l	Molybdenum mg/l	Selenium mg/l	*TRH C6 – C10 (µg/L)	*TRH C10-C40 (µg/L)
Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum
0.7	0.013	0.055	0.034	0.005	≤20	≤100

8.4.2 Data management and reporting

In accordance with the current EA the following will apply:

- The groundwater monitoring at all bores will be conducted on a quarterly basis or as defined in the EA.
- Data will be stored within the existing consolidated groundwater database.
- Quality assurance and quality control procedures, such as field sampling procedures and the use of NATA accredited laboratories, will continue to be in place to assess the accuracy of data entered into the database.

In accordance with the current EA, findings from the quarterly monitoring events will continue to be documented:

- The quarterly review will include identification of any groundwater quality trigger exceedances.
- Where a trigger exceedance is identified, the regulator will be notified within 28 days and an investigation into the potential for environmental harm will be completed. The groundwater database and factual quarterly documentation will be available for provision to the regulator upon request.
- Each year an annual review of groundwater level and quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

9 Conclusions

The key conclusions of this groundwater assessment are:

- The findings of this groundwater impact assessment are consistent with previous assessments, most notably the 2021 EIS. The EIS had undergone peer review by the Sustainable Minerals Institute at the University of Queensland and Queensland State and Commonwealth (DCCEEW and IESC) reviews.
- The Project modelling has a predicted underground mine inflow of between 2 and 14 ML / day, with an average inflow of 6.5 ML / day. Daily inflow rates are calculated to be similar to those from existing approved operations. These inflows are considered a conservative overestimate because the model does not account for underground groundwater storage measures (to manage gas levels) which in turn reduces surface water storage volumes after mining has passed through an area.
- The predicted Project incremental maximum groundwater level drawdown within the alluvium is 2 m. However, the drawdown in the alluvium is very localised, specifically east of the open-cut voids and is related to the increased duration of mining for the Project, causing a difference in recovery timing.
- The modelling showed (and is supported by observational data) that the drawdown introduced by mine dewatering in the coal seams is not causing wide-spread drawdown in the shallow layer, meaning that there is limited hydraulic connection between the two units, as conceptualised with the Rewan Group acting as a barrier of flow.
- The Project incremental maximum drawdown of 0.5 m in the alluvium intersects part of a surface expression GDE (which was assessed as “low confidence”) where the coal measures sub-crop the alluvium. The Project incremental maximum drawdown also intersects parts of a low confidence surface expression GDE and parts of a low confidence terrestrial GDEs in the northwest of the Project. However, impacts on identified potential GDEs are considered to be negligible due the conservative methodology of the drawdown calculations. The drawdowns in the shallow layer are in fact a delay in recovery, and not a further reduction in water levels. As such, the proposed GDE monitoring is deemed suitable.
- The stygofauna environmental values within the alluvial aquifer in the Study area will be managed via a groundwater level, water quality and stygofauna monitoring program that targets bores where stygofauna were recorded.
- The Project incremental groundwater level drawdown within the Rangal Coal Measures (coal seam) is predicted to extend up to 15 km to the west of the Project, where a drawdown of 1 m is expected.
- No private landholder bores are predicted to have a Project incremental drawdown in groundwater levels greater than 0.2 m. The largest predicted Project incremental drawdowns in landholder bores are all less than 0.12 cm.
- Modelling also showed that the incremental alluvial flux (alluvial water seeping into lower formations) is limited to less than 0.1 ML/day. This is not considered material.
- The predicted change in baseflow of the Nogoa River due to the Project is not considered material, both for the Project incremental and Project Net assessments.
- There is no predicted leakage from the coal measures into the alluvium for the Project.
- There are no impacts on groundwater quality predicted as a result of the Project.
- Post mining, the groundwater levels are predicted to recover slowly based on 200-year recovery simulations. Some permanent reduction in water levels is predicted in the target coal seams.

- The groundwater recovery modelling showed that the open-cut pits will continue to remain long-term sinks, as indicated by the recovered water table contours.
- Based upon this groundwater assessment, no changes to the current EA conditions are proposed. A commitment to include an additional bore is shown below.

10 Commitment

It is proposed that the existing Ensham Mine monitoring bore network be expanded to include one additional groundwater monitoring bore in the Rangal Coal measures as discussed in Section 8.4 of this report.

11 References

AQC-Pacific Pty Ltd 1986, Geology and Coal Resources of the Ensham Open Cut Area, A to P 426C, reported in AGE 2006¸ Ensham Alluvial Project Phase 1 Hydrogeological Assessment, Project G1229, prepared for Hansen Consulting, August 2004.

AECOM, 2020, Ensham Life of Mine Extension Project - Flora Technical Report, prepared for Ensham Resources Pty Ltd, 12 August 2020

Ausenco-Norwest 2012, Groundwater Model, Northern Bowen Basin Regional Model Impact Predictions, Queensland, Australia, Prepared for Arrow Energy Pty Ltd.

Australasian Groundwater and Environmental (AGE) Consultants 2006, Report on Ensham Central Project – EIA, Groundwater Impact Assessment, Project No. G1258, Appendix C of EIS, February 2006.

AGE (Australasian Groundwater and Environmental Consultants) 2013, Minyango Project Groundwater, Proj G1562, Report for Hansen Bailey, April 2013.

AGE (Australasian Groundwater and Environmental Consultants) 2015, Gregory Crinum Kestrel Groundwater Model Update, Prepared for BHP Billiton Mitsubishi Alliance. March 2015.

AGE (Australasian Groundwater and Environmental Consultants) 2017, Ensham Underground Groundwater Model, Report prepared for Ensham Resources Pty Ltd. February 2017.

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Barnett, B, Townley, LR, Post, V, Evans, RE, Hunt, RJ, Peeters, L, Richardson, S, Werner, AD, Knapton, A & Boronkay, A, 2012. Australian Groundwater Modelling Guidelines. Waterlines Report 82, National Water Commission, Canberra.

BHP Billiton Mitsubishi Alliance, 2009. Daunia Coal Mine Project - Environmental Impact Statement', Appendix H Technical Report: Groundwater Modelling Assessment of Impact of Daunia Coal Mine on Regional Groundwater Aquifers.

Bureau of Meteorology (BOM), 2021. Latest River Heights for Nogoa R at Duckponds, http://www.bom.gov.au/fwo/IDQ65392/IDQ65392.535097.plt.shtml#notes , accessed 8 November 2021

CCIA, 2022, https://www.climatechangeinaustralia.gov.au/en/projections-tools/climate-futures-tool/projections/, website accessed, March 2022.

CDM Smith, 2013, Springsure Creek Coal Mine Project: EIS Chapter 9 – Groundwater, Report for Springsure Creek Coal Pty Ltd.

Clark, D, McPherson, A & Collins, C 2011, Australia's seismogenic neotectonic record, Geoscience Australia record 2011/11.

Coffey, 2014, Appendix E - Supplementary Groundwater Assessment, Arrow Energy Bowen Gas Project. Supplementary Report to the EIS, 17 April 2014.

Commonwealth of Australia, 2014, Subsidence from coal mining activities, background review, prepared by Sinclair Knight Merz Pty Ltd for the Department of the Environment, Commonwealth of Australia, Canberra.

Commonwealth of Australia, 2015, Management and monitoring of subsidence induced by longwall coal mining activity, prepared by Jacobs Group (Australia) for the Department of the Environment, Commonwealth of Australia, Canberra.

DEHP (Department of Environment and Heritage Protection), 2011. Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin. Environmental Protection (Water) Policy 2009. September 2011.

DES (Department of Environment and Science), 2022, Springs – Active – Queensland. Accessed 24 November 2021, available at http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Springs - Active - Queensland%22

DES (Department of Environment and Science), 2020, Wetland protection area - GBR high ecological significance wetland. Accessed 29 November 2021, available at http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Wetland protection area - GBR high ecological significance wetland%22

Department of Science (DES), 2021, Using monitoring data to assess groundwater quality and potential environmental impacts, Version 2, Brisbane, Australia: Queensland Government.

Department of Infrastructure, Local Government and Planning (DILGP), 2014, State Planning Policy (SPP).

FRC, 2022a, Ensham Life of Mine Extension – Zone 2 and 3 Aquatic Ecology Assessment, Prepared for: Ensham Resources Pty Ltd, Ref 211010, Draft Report, 19 January 2022

GeoResGLobe, 2020, GeoResGlobe - A new and improved mapping application, visited 07 April 2020, < https://georesglobe.information.qld.gov.au/>.

GHD, 2013, Carmichael Coal Mine and Rail Project SEIS - Mine Hydrogeology Report Addendum. Report 41/26422/452475, October 2013.

Golder Associates, 2017, Human Health and Ecological Chemical Assessment – Hydraulic stimulation chemical assessment QGC Surat and Bowen Basin operation. Report 127635006-004-R-Rev4-05300, 29 June 2017

Gordon Geotechniques, 2016, Geotechnical review of the mine plan extension into MDL217, Report prepared for Ensham Resources Pty Ltd, September 2016.

Gordon Geotechniques, 2022, Subsidence Report for the Ensham Life of Mine Extension - Zone 1, Prepared for Ensham Resources Pty Ltd, June 2022

Habermehl MA, 1980, The Great Artesian Basin, Australia. BMR Journal of Geology & Geophys. 5, 9-38.

Habermehl MA, 1998, Hydrogeology and hydrochemistry of the Great Artesian Basin, Australia. AGSO (Geoscience Australia) Canberra, ACT

HydroSimulations, 2020, Ensham Resources Residual Void Project - Groundwater Assessment Stage 3, Prepared for Ensham Resources Pty Ltd, Rev R, April 2020.

JBT Consulting, 2012, Report on Groundwater Seepage Studies and Operational Monitoring Review: Baralaba North Project, Report for CCL, December 2012.

JBT Consulting, 2016, Lake Vermont Northern Extension Groundwater Impact Assessment, Prepared for AARC on Behalf of Bowen Basin Coal Pty Ltd.

Jeffrey, SJ, Carter, JO, Moodie, KB and Beswick, AR (2001), Using spatial interpolation to construct a comprehensive archive of Australian climate data, Environmental Modelling and Software, Vol 16/4, pp 309-330. DOI: 10.1016/S1364-8152(01)00008-1.

Jourde, H, Flodin, EA, Aydin, A, Durlofsky, LJ, & Wen, XH, 2002, Computing permeability of fault zones in eolian sandstone from outcrop measurements, AAPG Bulletin, v. 86, no. 7, p. 1187–1200

KCB, 2016. Isaac Plains East Project Groundwater Modelling Report. Prepared for Hansen Bailey, EAR Groundwater Report Appendix IV.

Matrix Plus, 2010. Groundwater Impact Assessment for Millennium Expansion Project EIS.

Merrick, DP & Merrick, NP, 2015, AlgoMesh: A New Software Tool for Building Unstructured Grid Models, MODFLOW and More 2015 Proceedings, Colorado School of Mines, Integrated Groundwater Modeling Center, May 31 – June 3, 2015, 321-325.

Middlemis, 2000, Murray-Darling Basin Commission Groundwater Flow Modelling Guideline, November 2000

Middlemis H and Peeters LJM (2018) Uncertainty analysis—Guidance for groundwater modelling within a risk management framework. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

Northern Resource Consultants (NRC), 2018. Wilton Coal Project, Response to information Request – Groundwater. Prepared for Wilton Coking Coal Pty ltd. February 2019.

Office of Groundwater Impact Assessment 2016, Groundwater modelling report for the Surat Cumulative Management Area. State of Queensland, September 2019.

Panday, S, Langevin, CD, Niswonger, RG, Ibaraki, Motomu, & Hughes, JD, 2013, MODFLOW– USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p. < https://pubs.usgs.gov/tm/06/a45>

Parsons Brinckerhoff, 2011, Middlemount Coal Project Stage 2 Environmental Impact Statement - Chapter 10 Groundwater, Prepared for Middlemount Coal.

Paul PK, Zoback MD & Hennings PH, 2009, Fluid Flow in a Fractured Reservoir Using a Geomechanically Constrained Fault-Zone-Damage Model for Reservoir Simulation, SPE Reservoir Evaluation & Engineering, Volume 12, Number 4, p. 562-575.

Rau et al, 2018, Quantifying Compressible Groundwater Storage by Combining Cross-Hole Seismic Surveys and Head Response to Atmospheric Tides, Journal of Geophysical Research:Earth Surface,123, 1910–1930.https://doi.org/10.1029/

SLR Consulting (SLR), 2019, Fairhill Coal Project, Underground Water Impact Report, Prepared for Fairhill Coking Coal Pty Ltd, May 2019.

SLR Consulting (SLR), 2020, Ensham Life of Mine Extension Project Groundwater Impact Assessment, Prepared for: AECOM Australia Pty Ltd on behalf of Ensham. Ref: 665.ENS02.10000-R01-02, May 2020.

SLR Consulting (SLR), 2021, Ensham Life of Mine Extension Project Groundwater Impact Assessment - Amendment, Prepared for: Ensham Resources Pty Ltd. Ref: 665.ENS02.10202-R04-v1.0, August 2021.

SLR Consulting (SLR), 2022, Ensham Life of Mine Extension Project – ZONES 2 AND 3- Groundwater Impact Assessment, Prepared for: Ensham Resources Pty Ltd. March 2022.

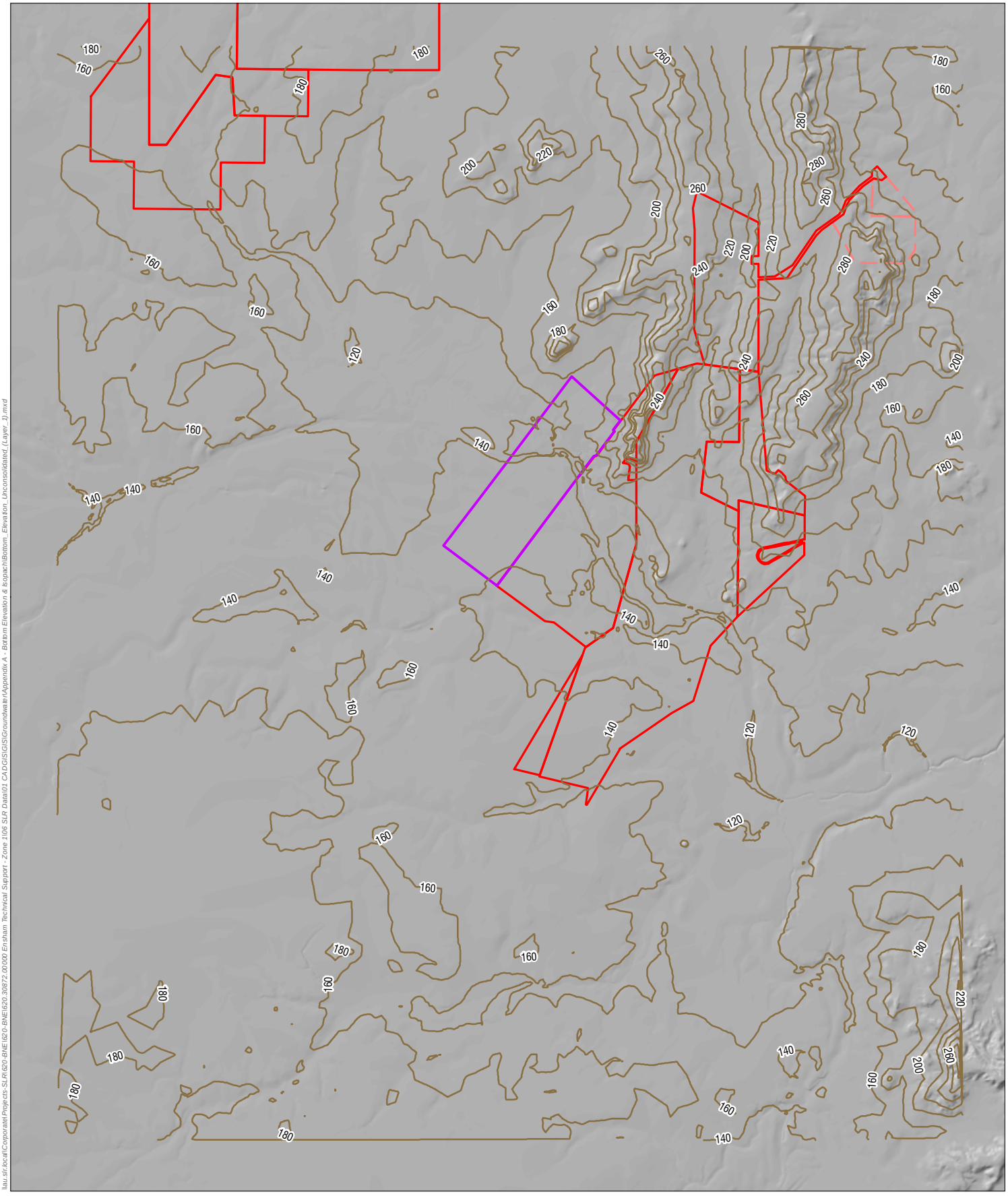
SMI, 2022. Ensham Life of Mine Extension Project (Zones 2 and 3)– Peer Review of Groundwater Impact Assessment, 10 March 2022

URS, 2009. Caval Ridge Groundwater Impact Assessment. Prepared for BM Alliance Coal Operations Pty Ltd.

Uysal, T, Golding, S & Glikson, M, 2000, Thermal and Fluid Flow History in the Bowen Basin, Bowen Basin Symposium 2000.

APPENDIX A

Aquifer depths and thicknesses



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

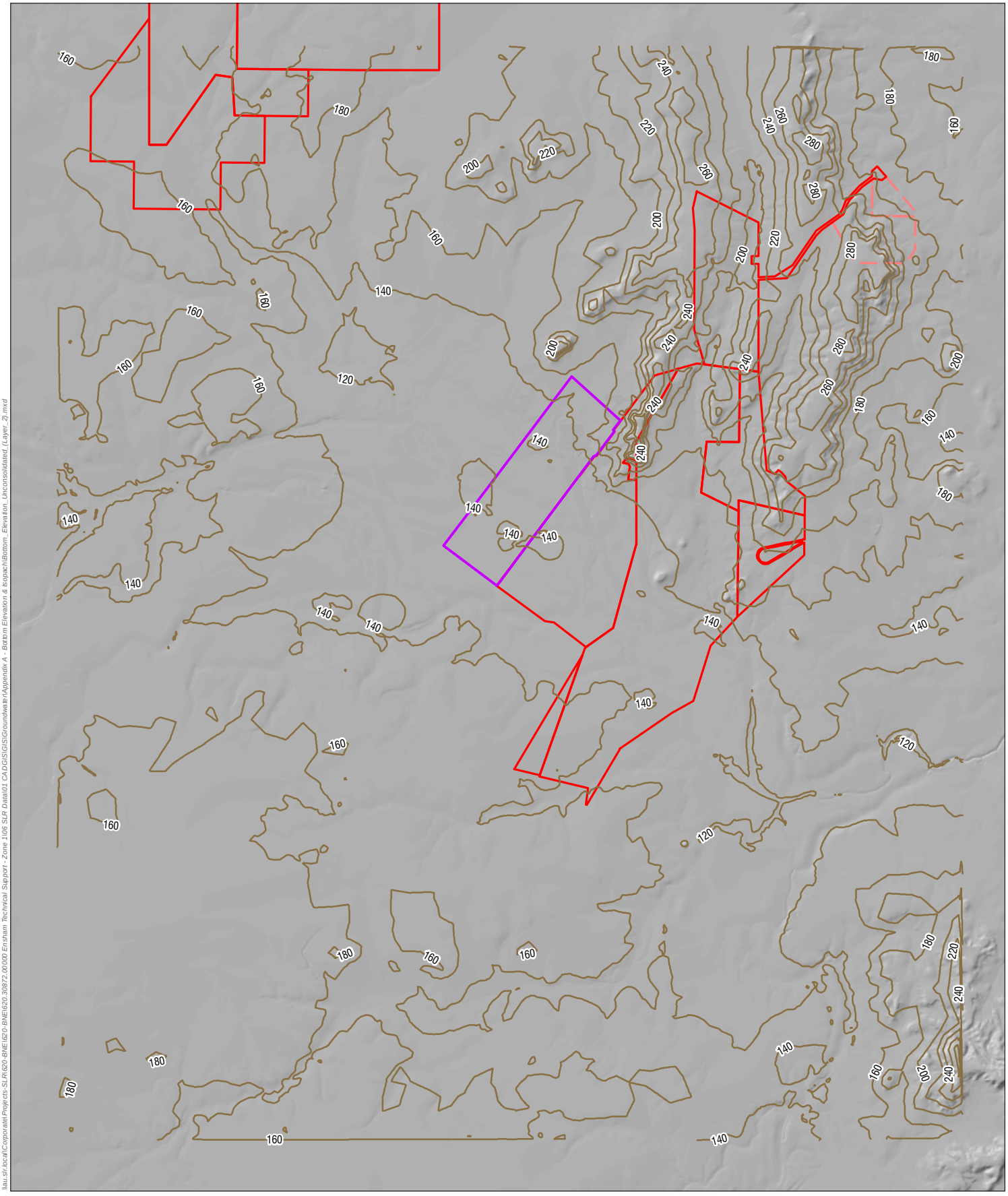
GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Unconsolidated (Layer 1)

A1-1

SLR
www.slrconsulting.com

\\au.sli-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Unconsolidated_(Layer_1).mxd



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Unconsolidated_(Layer_2).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

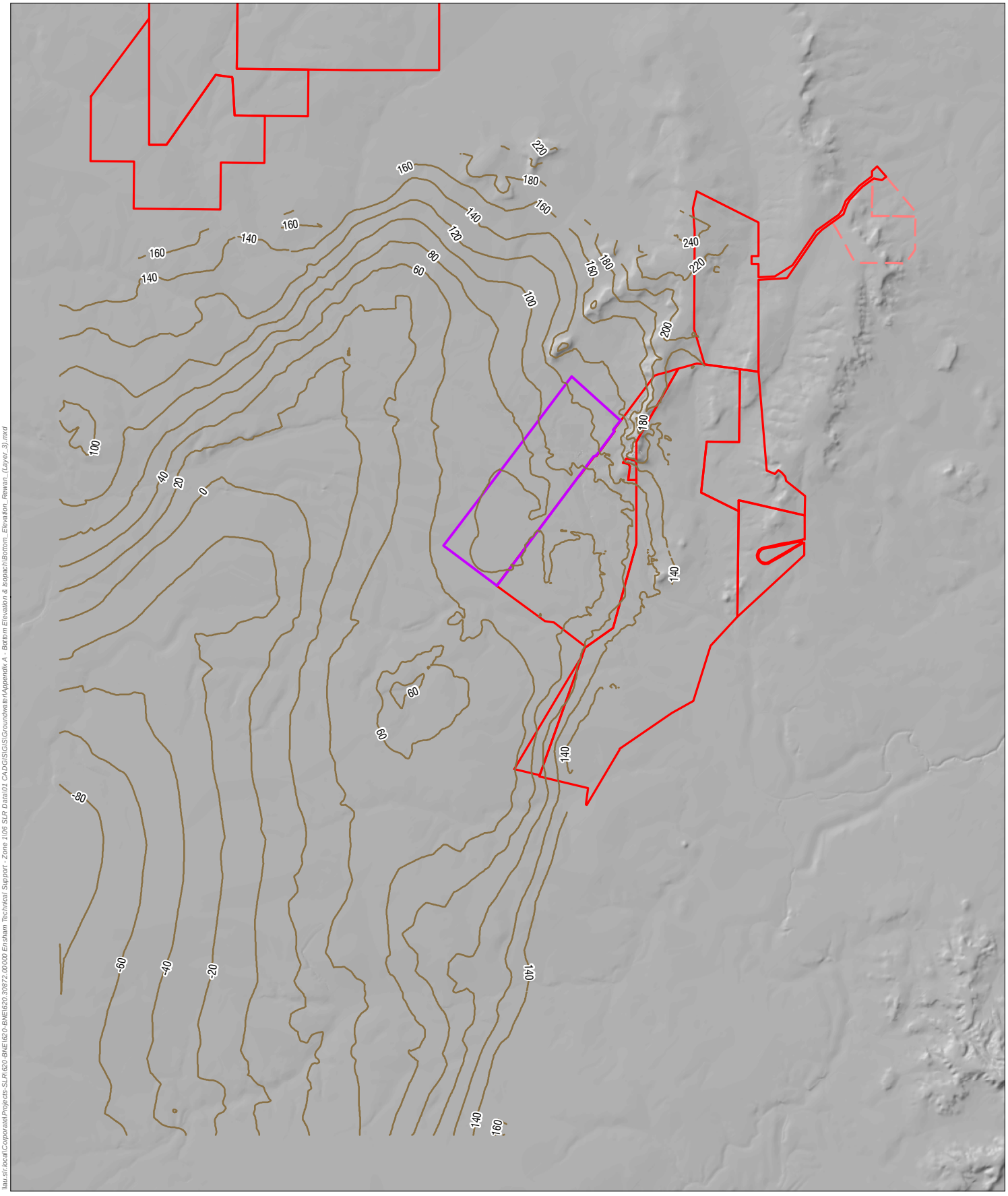
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1
- Elevation Contours (mAHD)

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Unconsolidated (Layer 2)

A1-2

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Rewan_(Layer_3).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

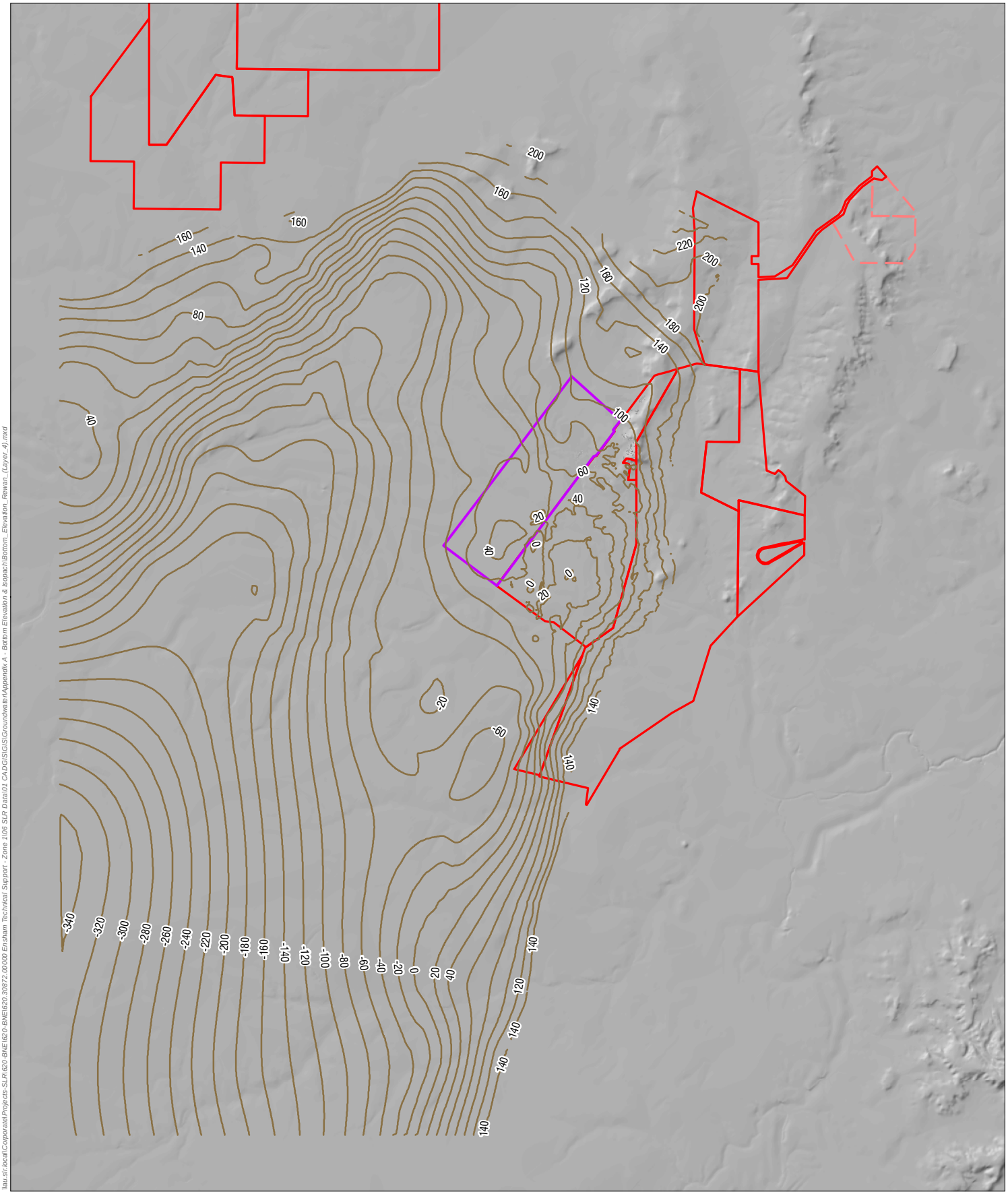
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Rewan (Layer 3)

A1-3

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Rewan_(Layer_4).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

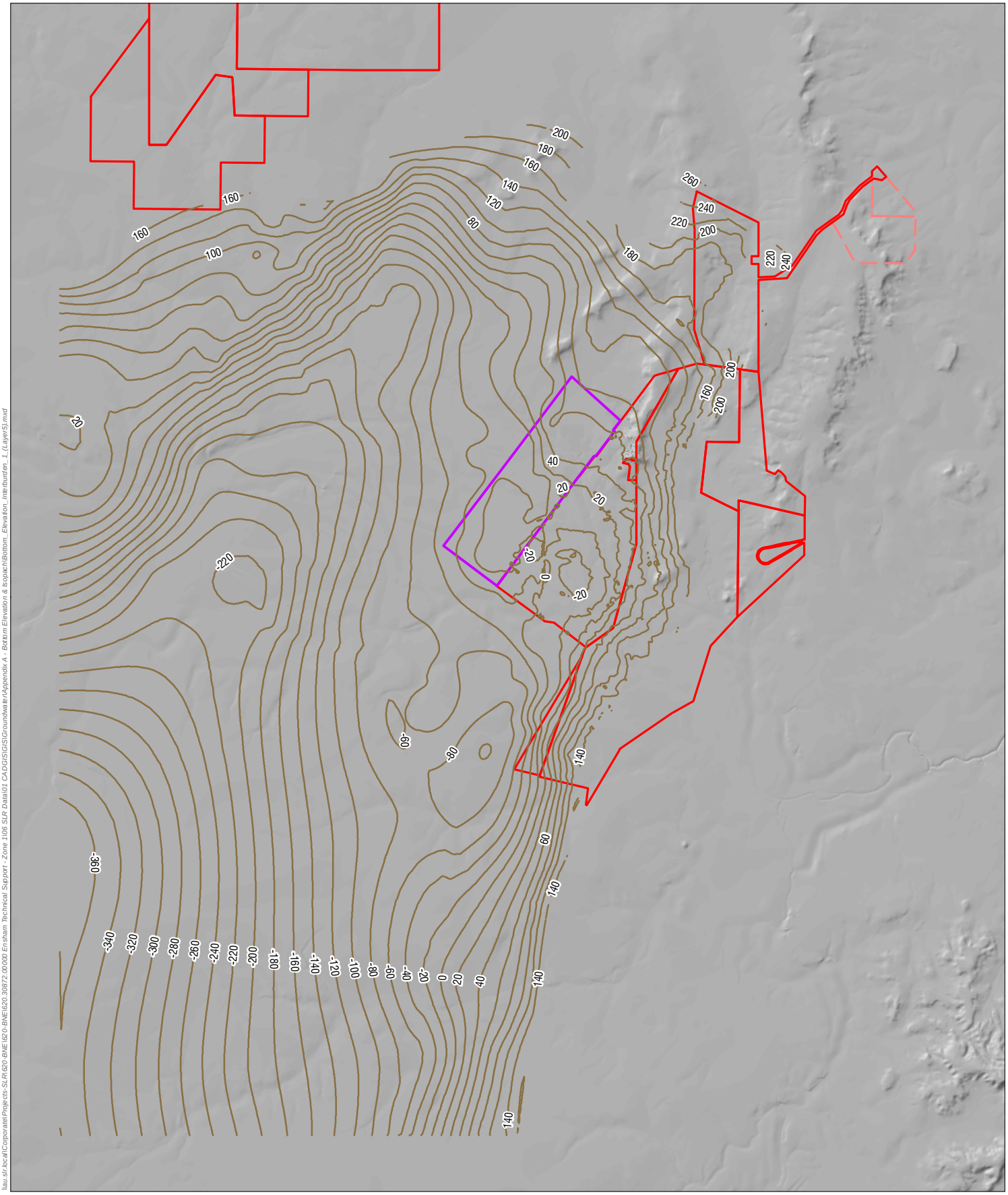
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Rewan (Layer 4)

A1-4

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Interburden_1_(Layer5).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

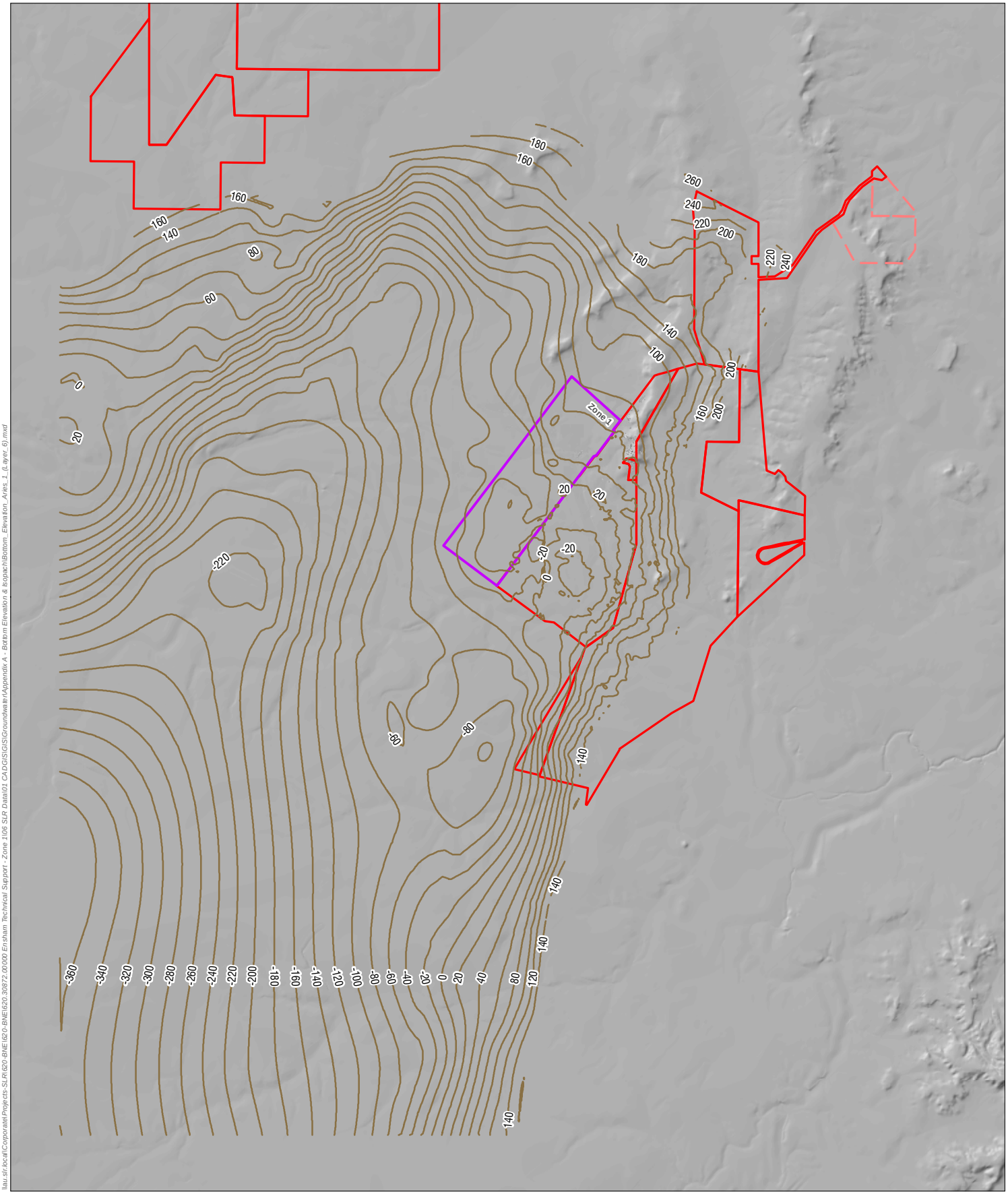
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1
- Elevation Contours (mAHD)

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 1 (Layer5)

A1-5

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Aries_1_(Layer_6).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

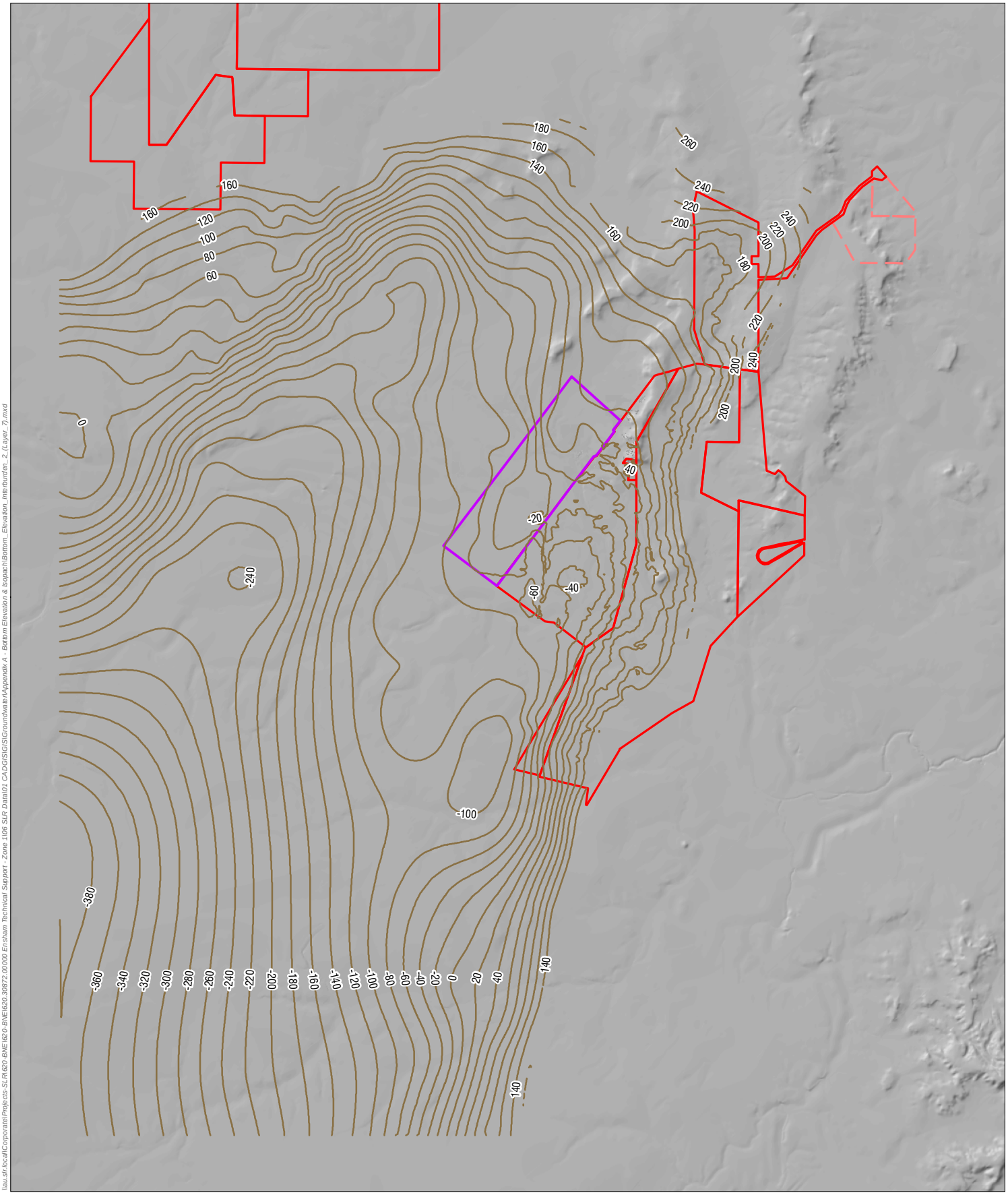
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Aries 1 (Layer 6)

A1-6

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Interburden_2_(Layer_7).mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 2 (Layer 7)

A1-7

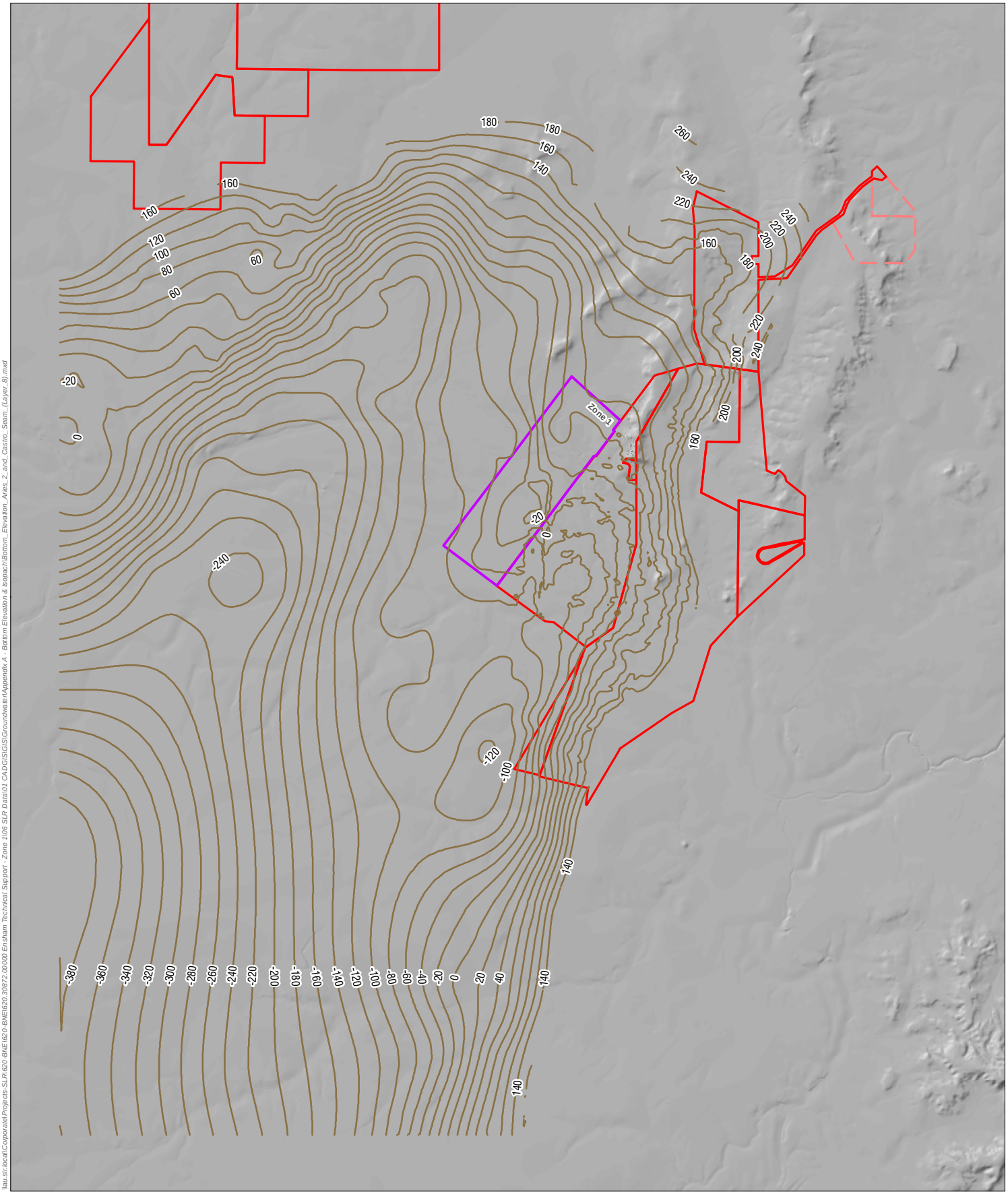
Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Aries_2_and_Castro_Seam_(Layer_8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

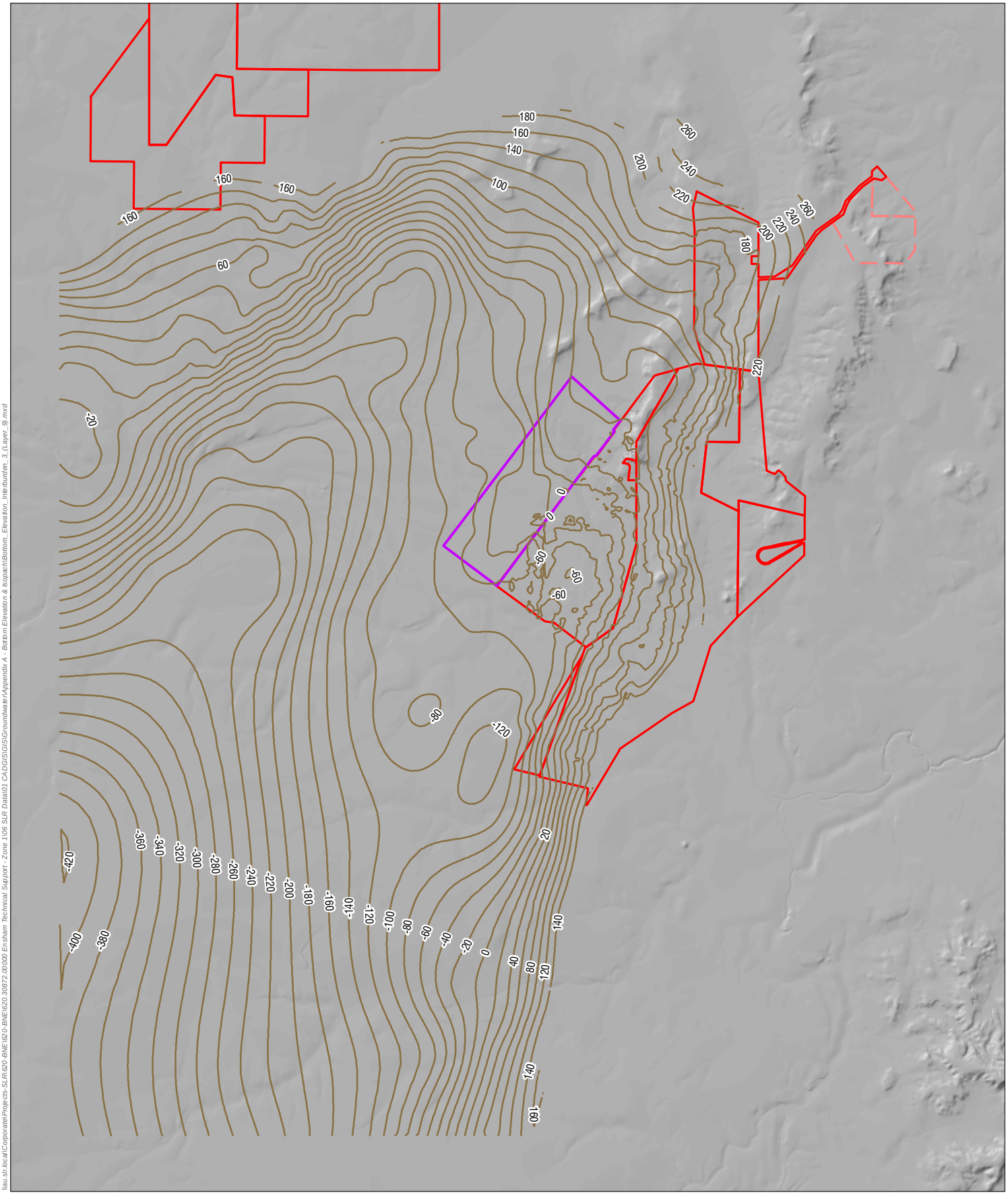
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Aries 2 and Castro Seam (Layer 8)

A1-8

SLR
www.slrconsulting.com



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

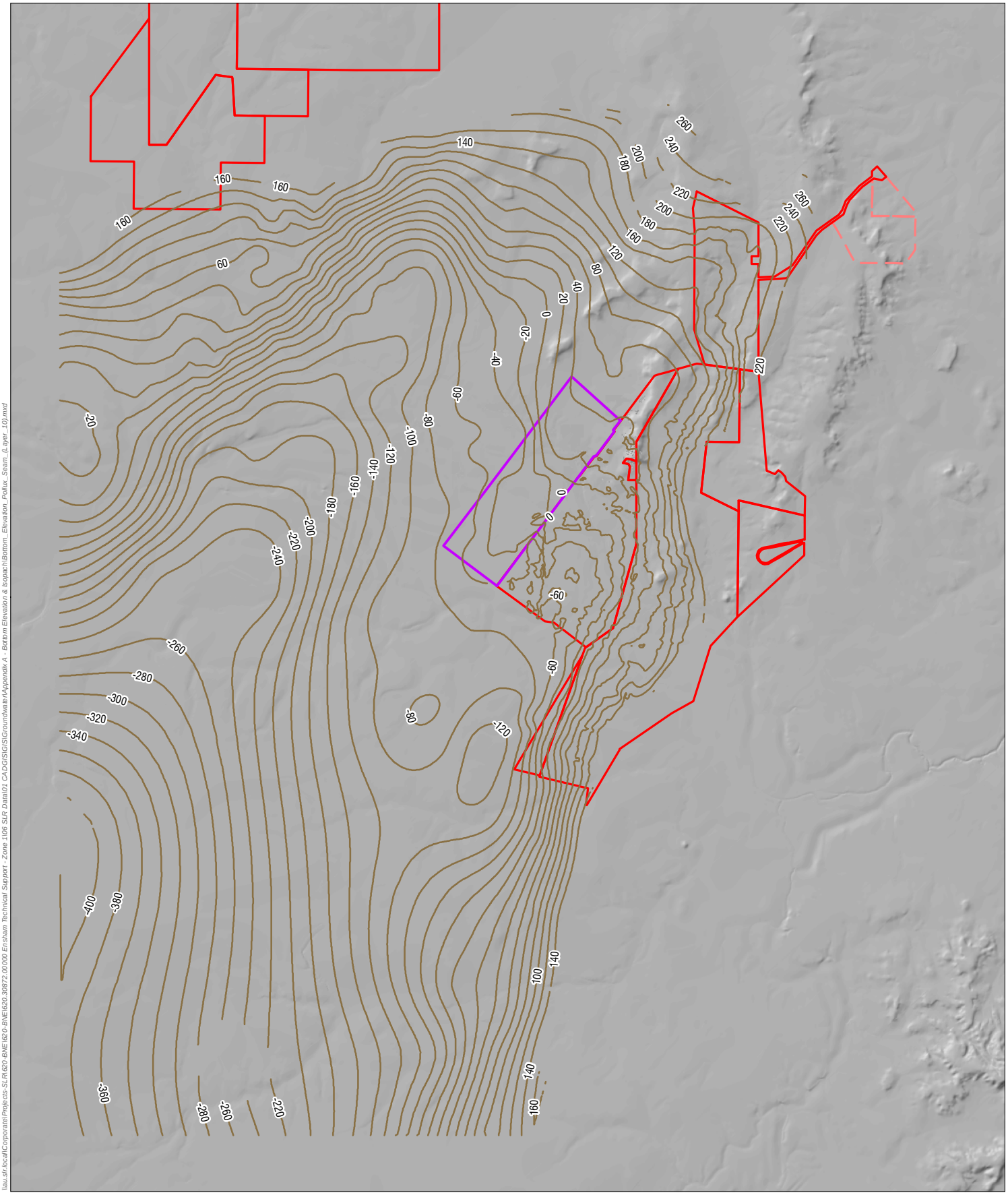
GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 3 (Layer 9)

A1-9

SLR
www.slrconsulting.com

\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Interburden_3_(Layer_9).mxd



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Pollux_Seam_(Layer_10).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

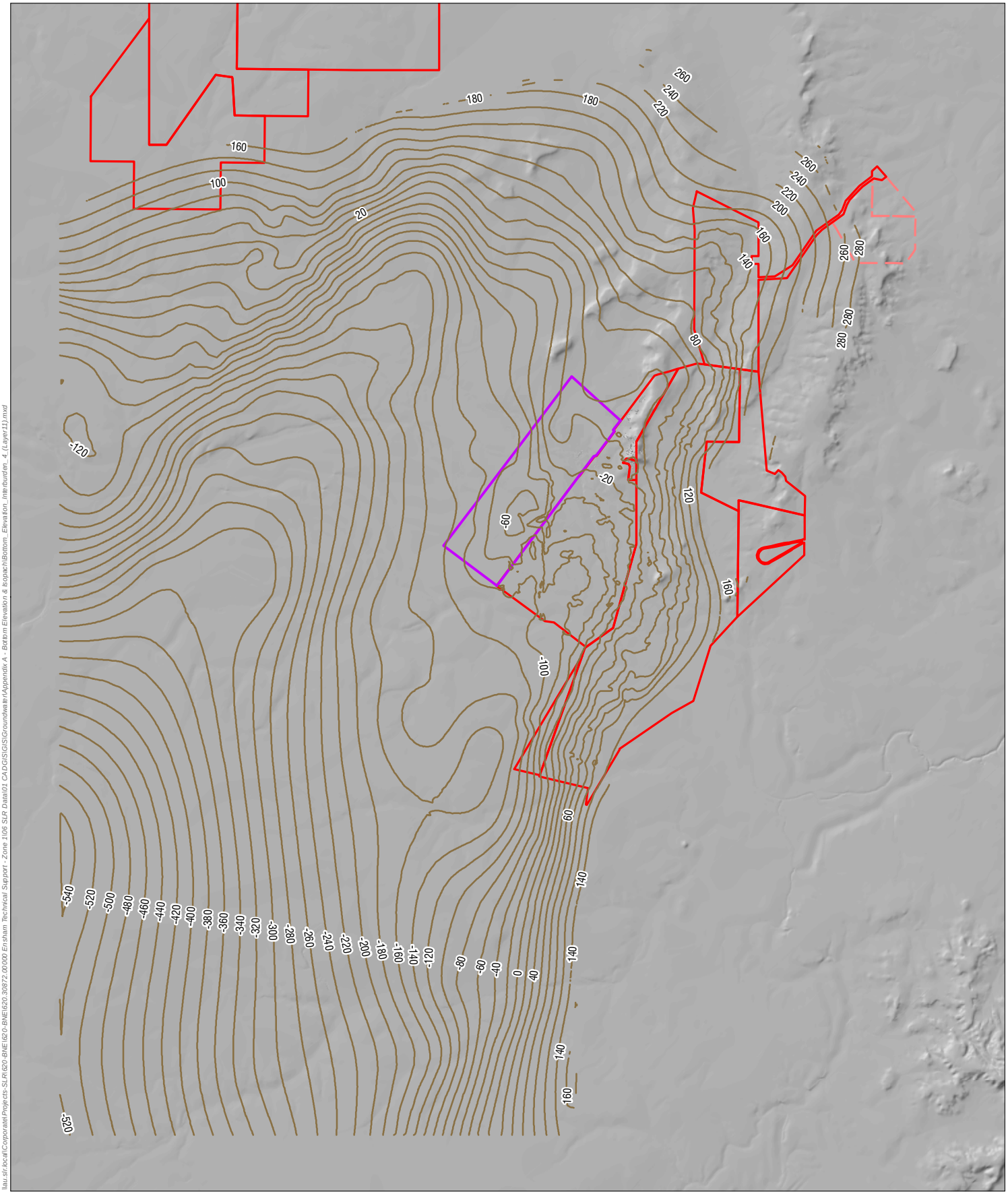
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Pollux Seam (Layer 10)

A1-10

SLR
www.slrconsulting.com



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Interburden_4_(Layer11).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

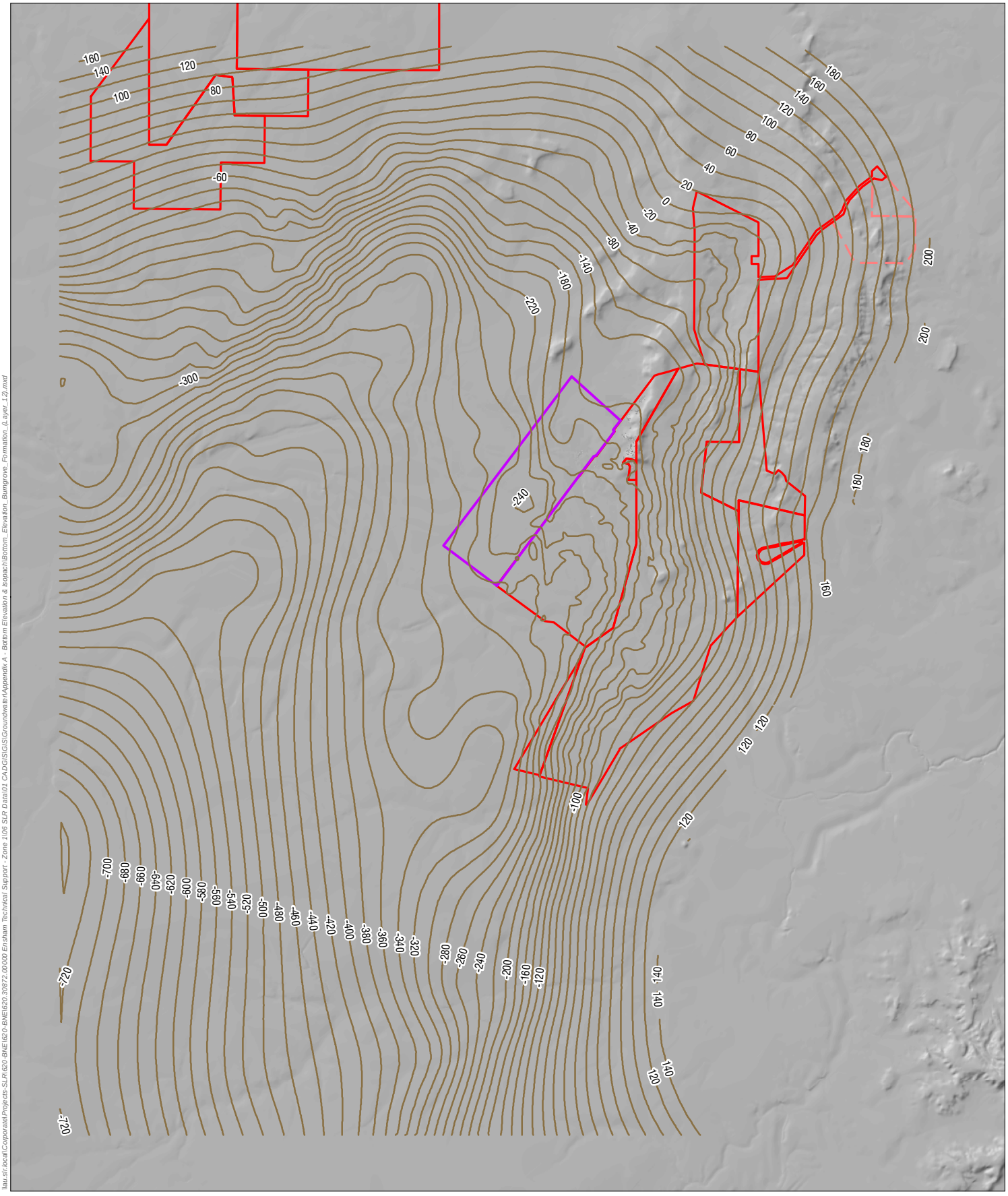
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 4 (Layer11)

A1-11

SLR
www.slrconsulting.com



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1
- Elevation Contours (mAHD)

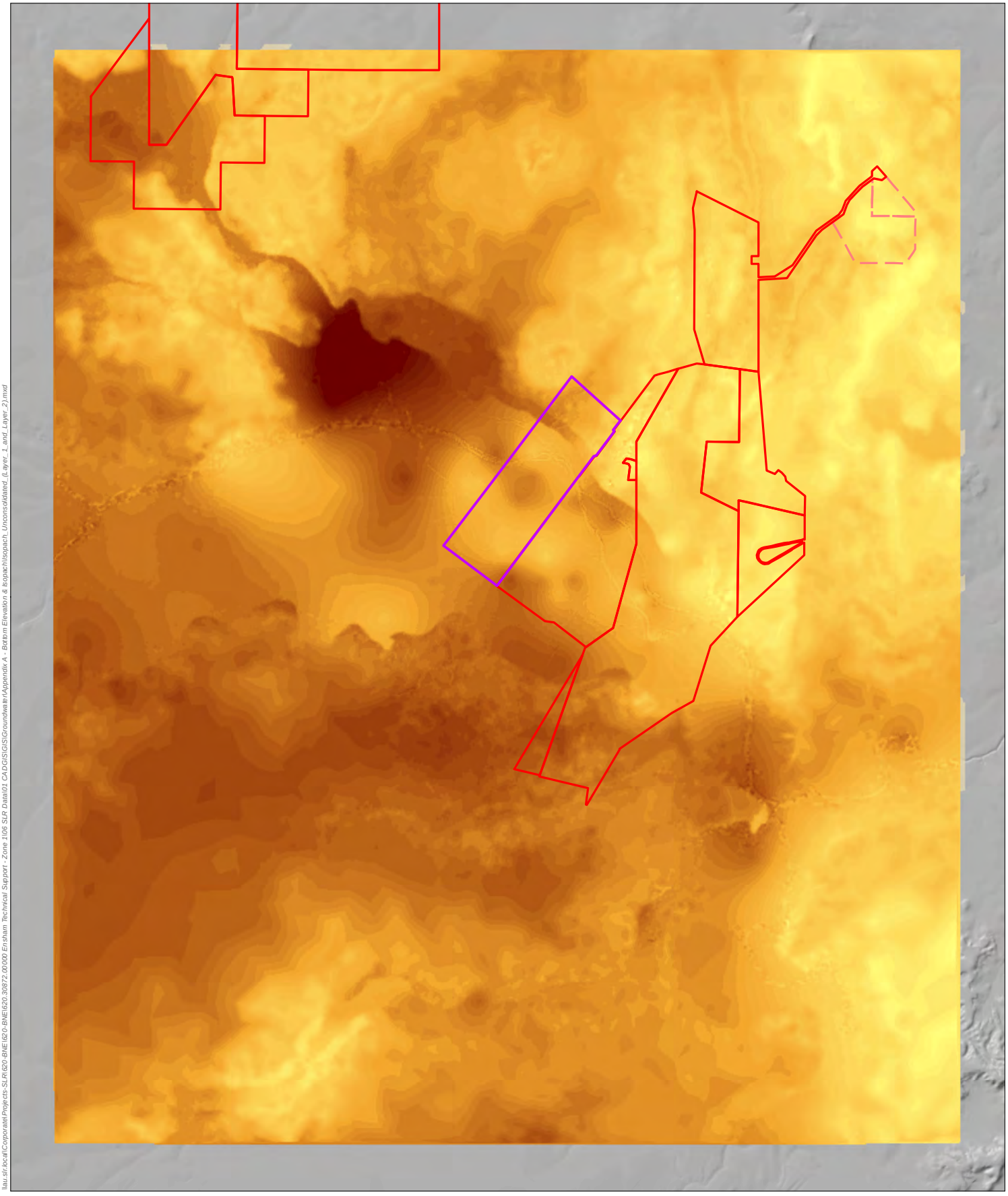
GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Burngrove Formation (Layer 12)

A1-12

SLR
www.slrconsulting.com

\\au.sl\-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Bottom_Elevation_Burngrove_Formation_(Layer_12).mxd



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value

High : 46

Low : 1

Modelled Alluvial Extents

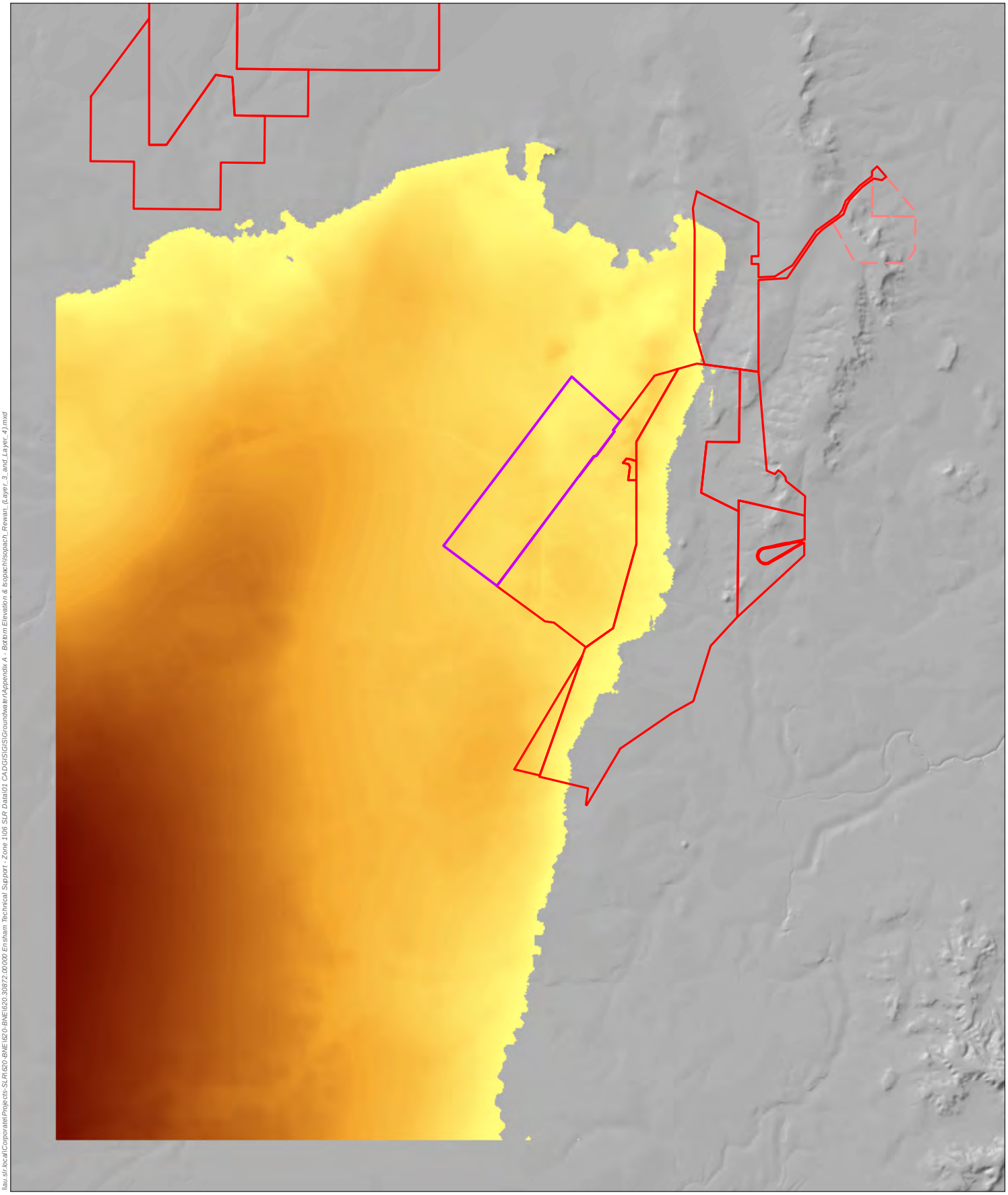
GROUNDWATER IMPACT ASSESSMENT

Isopach - Unconsolidated (Layer 1 and Layer 2)

A2-1

SLR
www.slrconsulting.com

\\au.slr.local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Unconsolidated_(Layer_1_and_Layer_2).mxd



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value

High : 518

Low : 0

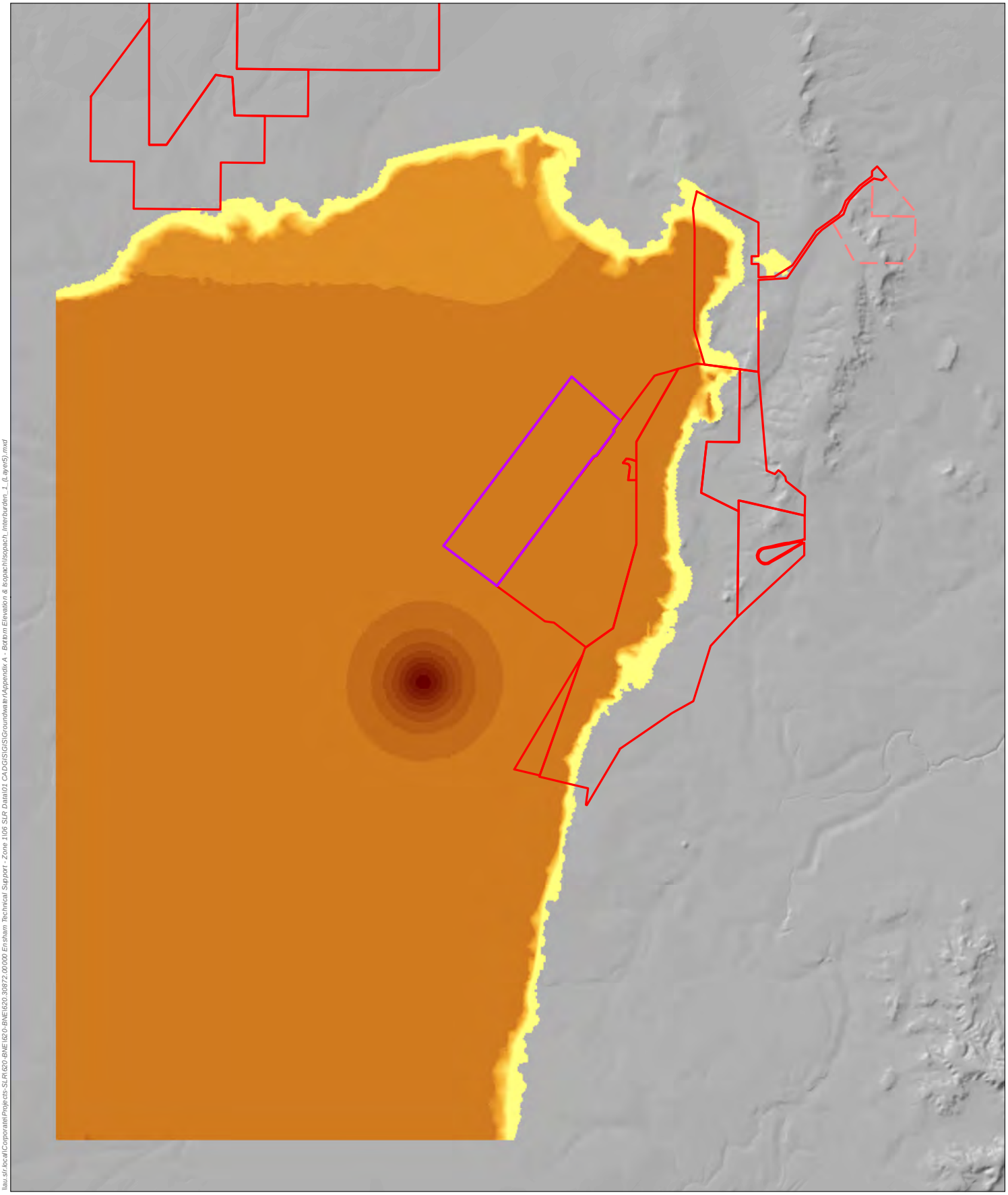
SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Rewan (Layer 3 and Layer 4)

A2-2

\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Rewan_(Layer_3_and_Layer_4).mxd



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Interburden_1_(Layer5).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

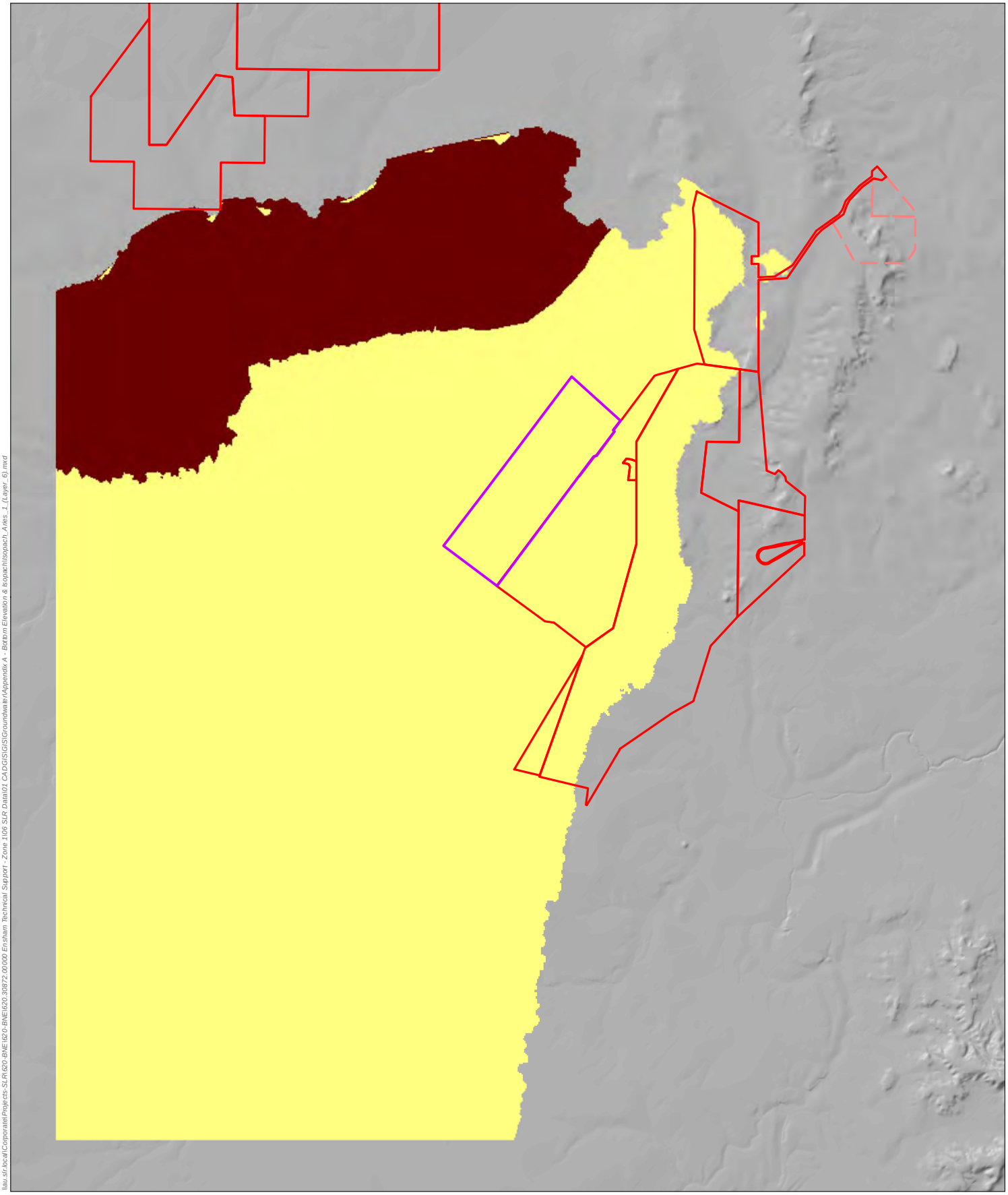
Value
High : 37
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 1 (Layer5)

A2-3



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Aries_1 (Layer_6).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value

High : 1

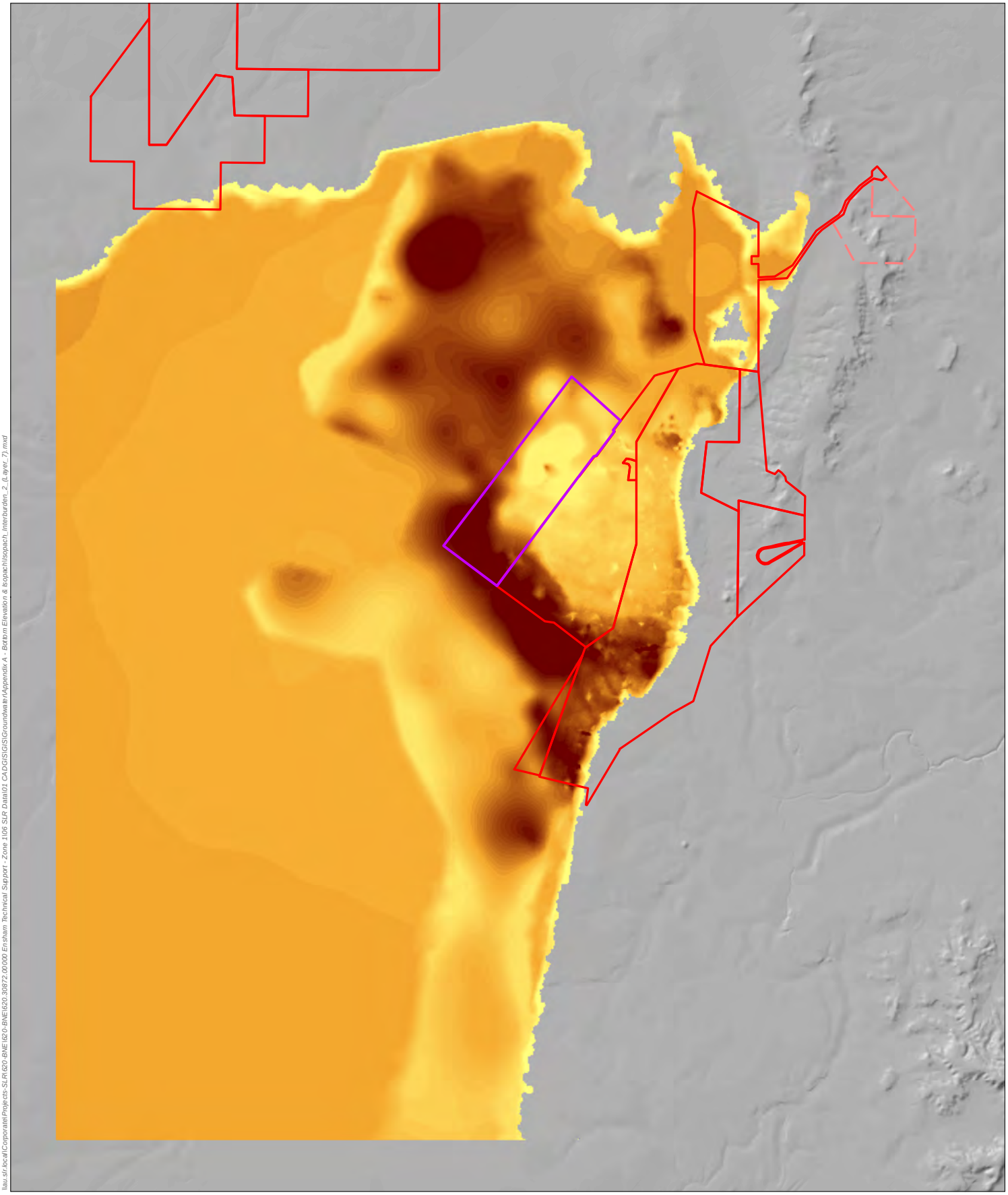
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Aries 1 (Layer 6)

A2-4



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value
High : 48
Low : 0

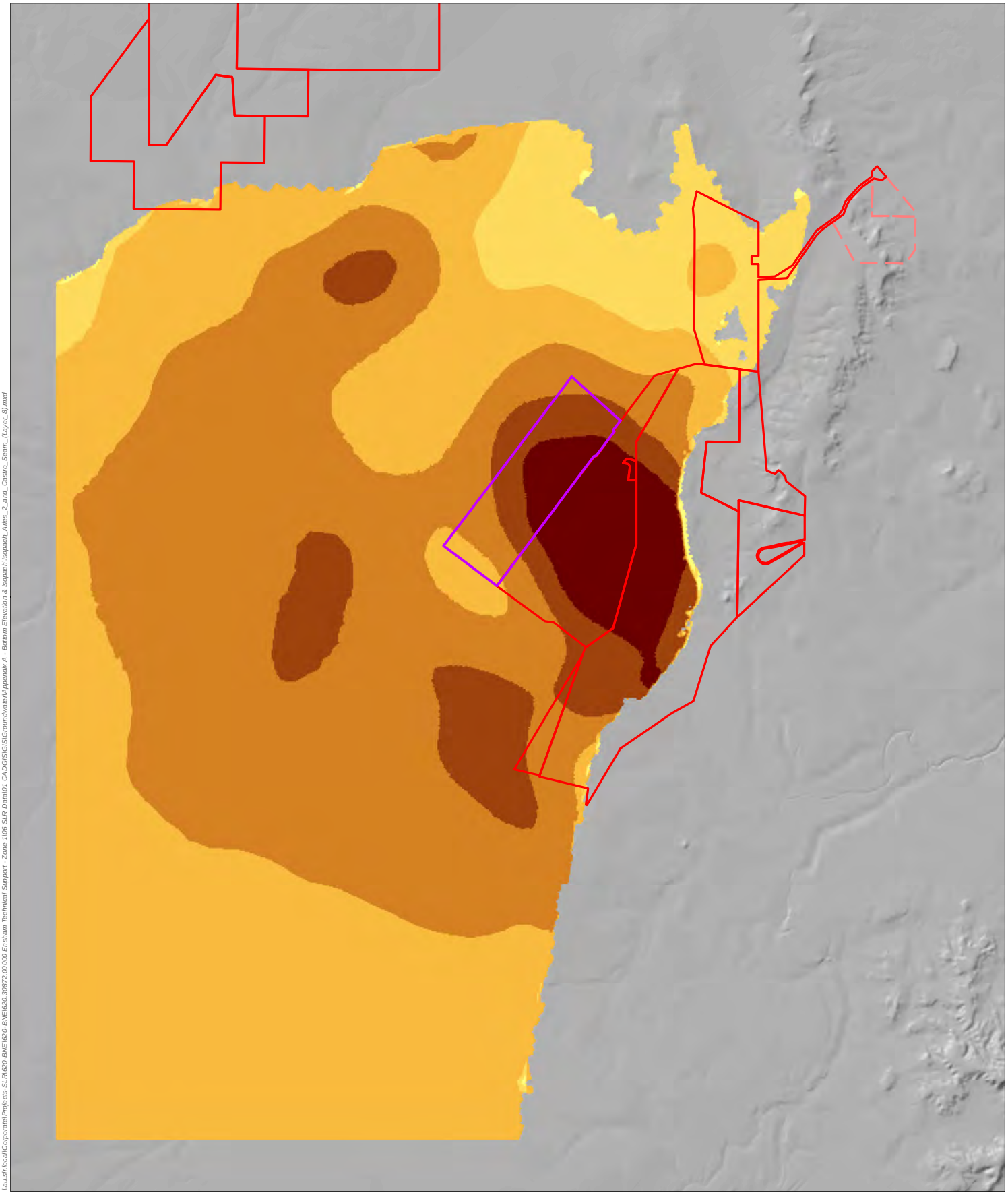
GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 2 (Layer 7)

A2-5

SLR
www.slrconsulting.com

\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Interburden_2_(Layer_7).mxd



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Aries_2 and_Castro_Seam_(Layer_8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value

High : 5

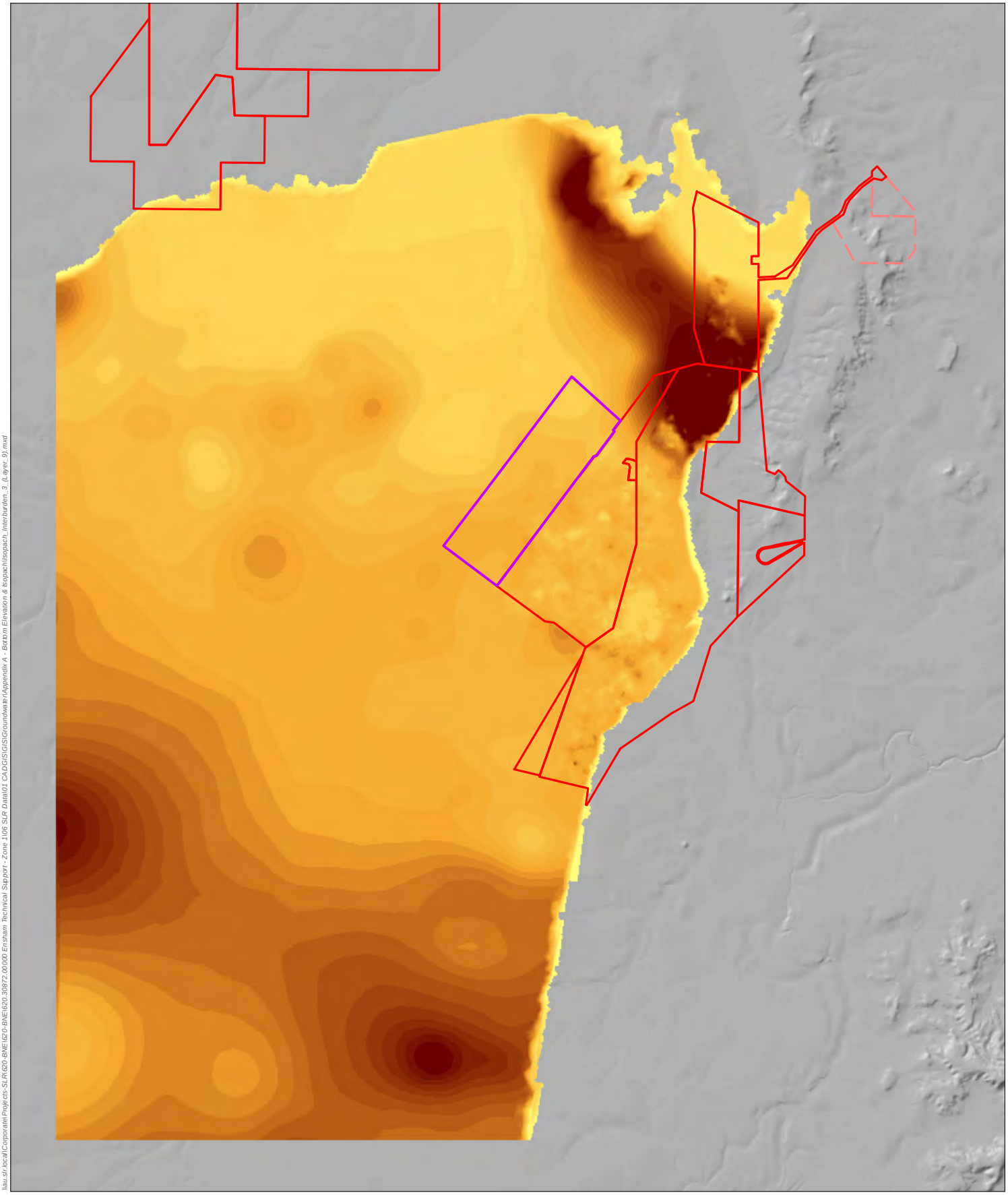
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Aries 2 and Castro Seam (Layer 8)

A2-6



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value

High : 32

Low : 0

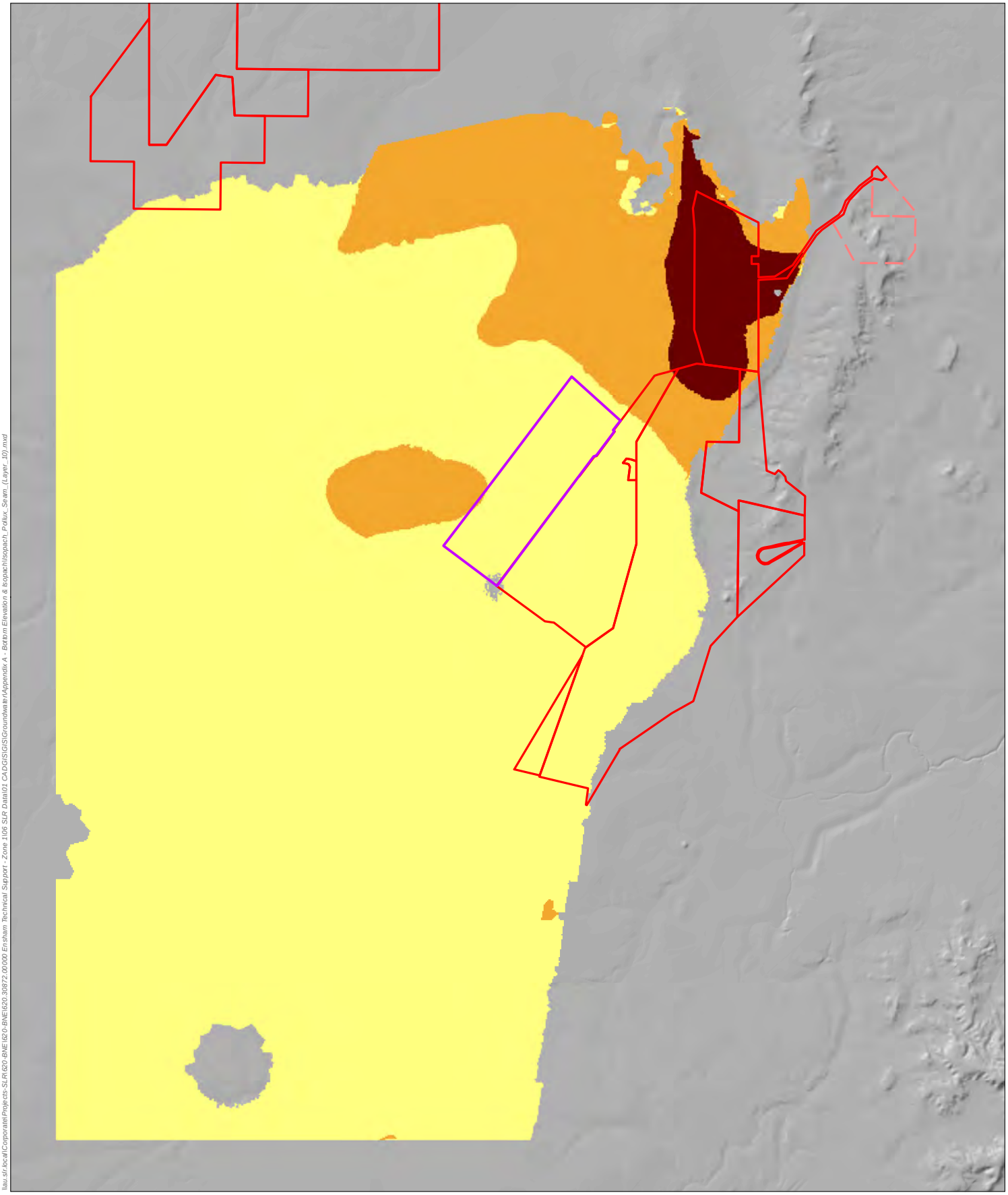
GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 3 (Layer 9)

A2-7

SLR
www.slrconsulting.com

\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Interburden_3_(Layer_9).mxd



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value
High : 2
Low : 0

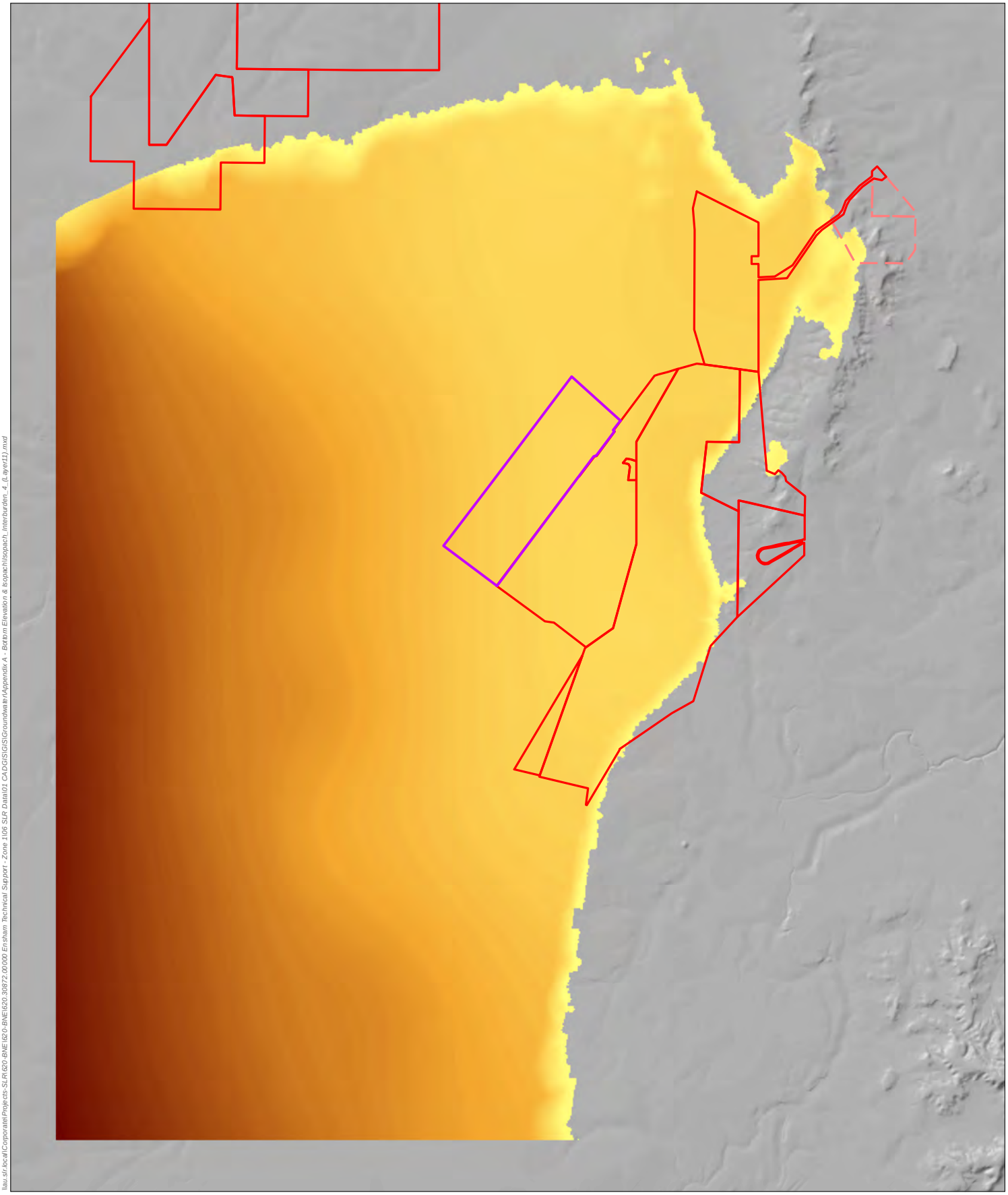
SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Pollux Seam (Layer 10)

A2-8

\\au.sl\-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Pollux_Seam_(Layer_10).mxd



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value
High : 132
Low : 0

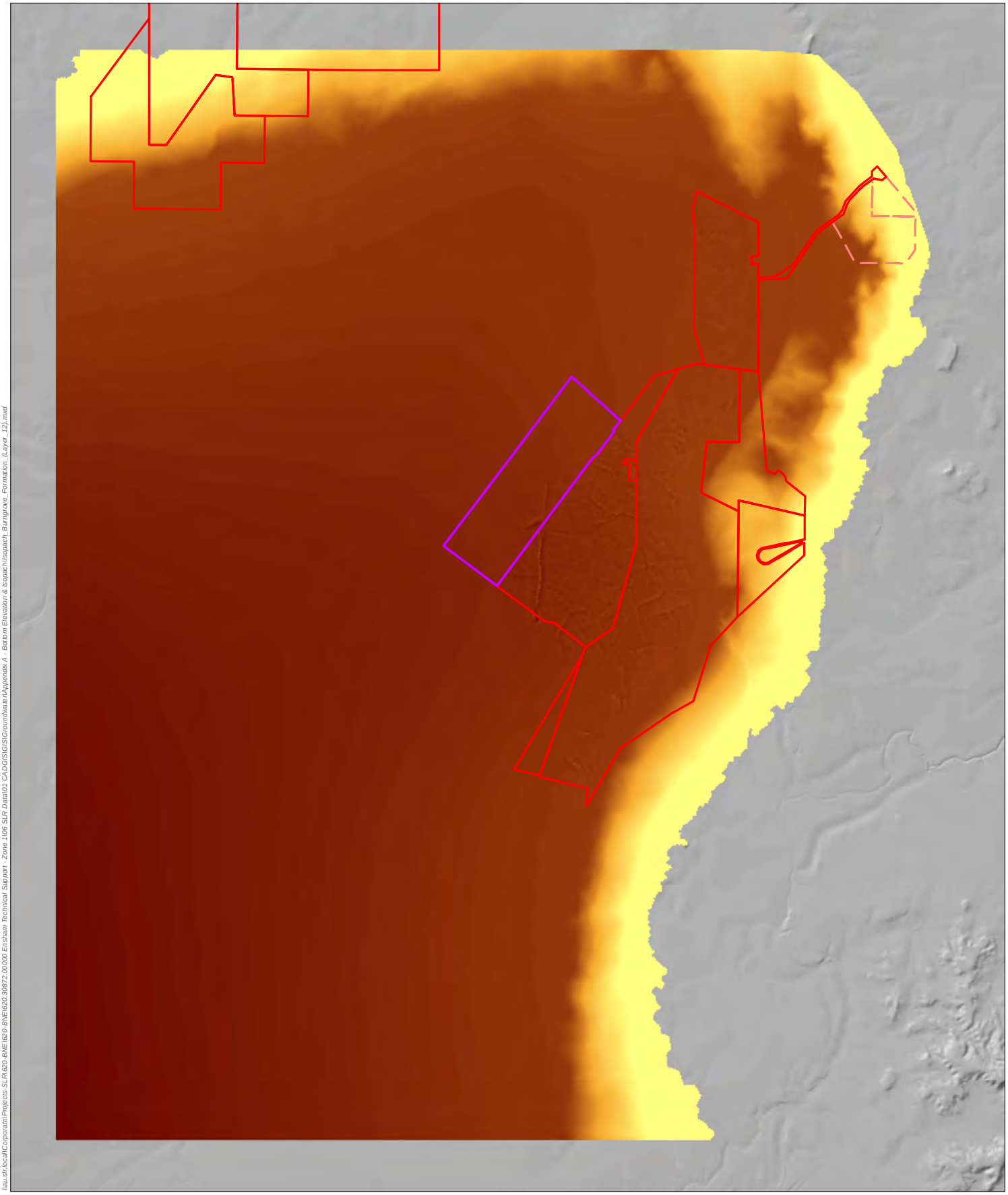
GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 4 (Layer11)

A2-9

SLR
www.slrconsulting.com

\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Interburden_4_(Layer11).mxd



\\au.sl-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix A - Bottom Elevation & Isopach\Isopach_Burngrove_Formation_(Layer_12).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

Value

High : 197

Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Burngrove Formation (Layer 12)

A2-10

APPENDIX B

Summary statistic of EA water quality parameters

Bore	Aquifer	Statistic	pH (field)	EC (field)	pH (Lab)	EC (Lab)	TDS	Ca	Na	K	Cl	Mg	SO4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Al (diss)	Al (total)	Sb (diss)	Sb (total)	As (diss)	As (total)	B (diss)	B (total)	Fe (diss)	Fe (total)	Mn (diss)	Mn (total)	Hg (diss)	Hg (total)	Mo (diss)	Mo (total)	Se (diss)	Se (total)	Ag (diss)	Ag (total)	TPH C10_C40	TPH C6_C10
		unit	-	µS/cm	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Guideline	WQO Zone 43 (Shallow) 80th percentile		8.2	15495	8.2	15495	-	-	-	-	-	-	387	0.91	-	-	-	-	-	-	-	-	-	-	-	0.115	0.115	3.755	3.755	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 80th percentile		8.4	7720	8.4	7720	-	-	-	-	-	-	362	0.31	-	-	-	-	-	-	-	-	-	-	-	0.856	0.856	0.054	0.054	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Shallow) 20th percentile		7.09	-	7.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 20th percentile		7.7	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ANZG (2018)		8.5	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	0.055	0.055	0.009	0.009	0.013	0.013	-	-	0.7	0.7	-	-	-	-	0.0034	0.0034	0.005	0.005	-	-	-	-
	ANZG (2018) lower		6.5	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DES (2013)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
13020172	Alluvium	count	NC	5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	mini	NC	10200	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	max	NC	32000	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	median	NC	13540	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	20th	NC	12456	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	80th	NC	22000	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020177	Alluvium	count	9	12	24	24	5	24	24	24	24	24	24	8	24	24	16	16	5	11	7	15	12	NC	NC	23	12	13	7	8	7	16	12	11	12	8	7	9	8
13020177	Alluvium	mini	7.4	2900	6.31	2400	3120	27	429	0.5	447.1	52	62.2	0.72	0.5	327	327	0.005	0.42	0.0005	0.0005	0.001	0.01	NC	NC	0.01	0.14	0.01	0.014	0.00005	0.00005	0.0005	0.001	0.005	0.005	0.0005	0.0005	50	10
13020177	Alluvium	max	7.8	5444	8.56	5540	3460	71	963	2	1260	136	477	0.91	98	1145.8	872	0.02	1.49	0.001	0.001	0.027	0.029	NC	NC	5.66	3.32	0.073	0.05	0.0001	0.0002	0.002	0.002	0.01	0.01	0.001	0.001	50	10
13020177	Alluvium	median	7.5	4980	8.005	4550	3330	45	782	1	1085	91	126	0.8	1	604.5	618.5	0.005	0.85	0.001	0.0005	0.012	0.0115	NC	NC	0.05	0.82	0.016	0.021	0.000075	0.00005	0.001	0.001	0.01	0.005	0.00075	0.0005	50	10
13020177	Alluvium	20th	7.422	3718	7.74	3308	3168	36.16	603.48	1	645.12	72.66	101.44	0.8	0.5	499.6	449	0.005	0.484	0.0005	0.0005	0.01	0.01	NC	NC	0.025	0.224	0.0138	0.02	0.00005	5E-05	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
13020177	Alluvium	80th	7.74	5368.4	8.232	5146	3380	58.4	888.6	1.12	1194	123.4	136	0.866	10.04	793.2	784	0.01	1.434	0.001	0.001	0.0172	0.0194	NC	NC	0.114	1.466	0.032	0.0274	0.0001	0.0001	0.001	0.002	0.01	0.009	0.001	0.001	50	10
EC01	Alluvium	count	30	30	47	47	16	47	47	46	47	47	47	16	46	47	37	37	16	33	29	34	31	18	17	45	33	37	28	30	29	35	31	33	33	29	29	29	29
EC01	Alluvium	mini	6.60	15730	6.39	9130	10500	156	1450	1	2850	231	292	0.3	0.15	303	418	0.005	0.1	0.0005	0.0005	0.002	0.0025	0.025	0.025	0.01	0.2	0.164	0.18	0.00005	0.00005	0.003	0.003	0.005	0.005	0.0005	0.0005	50	10
EC01	Alluvium	max	7.65	26570	8.33	47700	12200	1270	7700	13	15300	1610	1320	0.6	21	1750	1750	0.5	4.58	0.005	0.0025	0.05	0.013	0.16	0.18	3.5	30.6	6.25	1.36	0.0001	0.0001	0.01	0.012	1	0.025	0.0025	0.0025	700	10
EC01	Alluvium	median	7.22	18390	7.59	20900	11300	243	3830	2	6970	506	702	0.55	0.5	971	904	0.005	1.23	0.0005	0.0005	0.004	0.005	0.125	0.13	0.11	2.45	0.337	0.341	0.00005	0.00005	0.006	0.007	0.005	0.005	0.0005	0.0005	50	10
EC01	Alluvium	20th	7.12	17591	7.21	17340	11000	204	3200	2	5620	349.8	617.8	0.5	0.5	782.4	782.4	0.005	0.6	0.0005	0.0005	0.004	0.004	0.08	0.102	0.05	1.224	0.2246	0.2474	0.00005	0.00005	0.005	0.006	0.005	0.005	0.0005	0.0005	50	10
EC01	Alluvium	80th	7.26	24218	7.89	33248	11800	515.2	5852	5	12160	1084	1198	0.6	1	1266	1090	0.01	2.57	0.001	0.0005	0.005	0.005	0.15	0.158	0.45	4.254	1	0.4496	0.00005	0.00005	0.008	0.01	0.01	0.005	0.001	0.0005	50	10
EC02	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	8	5	NC	NC	17	6	11	5	8	7	9	5	11	7	8	7	NC	NC
EC02	Alluvium	mini	NC	NC	6.88	3850	NC	49	682	1	935	82	114	NC	0.5	476	476	0.005	NC	0.0005	0.0005	0.004	0.005	NC	NC	0.025	0.24	0.002	0.023	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC02	Alluvium	max	NC	NC	8.22	12900	NC	113	2063	9	3150	256	291	NC	10	1310	953	0.23	NC	0.001	0.001	0.012	0.011	NC	NC	4.13	3.21	0.07	0.097	0.0001	0.0002	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC02	Alluvium	median	NC	NC	7.39	8530	NC	87	1510	2	2210	187	200	NC	1	870	702	0.01	NC	0.001	0.0005	0.009	0.009	NC	NC	0.05	1.08	0.036	0.07	0.000075	0.00005	0.002	0.002	0.01	0.005	0.00075	0.0005	NC	NC
EC02	Alluvium	20th	NC	NC	7.322	5646	NC	69.6	968.4	2	1400	145.6	137.4	NC	0.6	618.2	520	0.005	NC	0.0005	0.0005	0.005	0.0058	NC	NC	0.03	0.59	0.013	0.0246	0.00005	5E-05	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC02	Alluvium	80th	NC	NC	7.886	9556	NC	95.8	1624	3	2618	209.4	248	NC	1	912	890	0.01	NC	0.001	0.001	0.0116	0.011	NC	NC	0.206	1.92	0.049	0.0786	0.0001	0.0001	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC03	Alluvium	count	29	29	43	43	17	43	43	43	43	43	43	17	43	43	36	36	17	32	28	33	30	17	16	43	32	36	28	29	28	34	30	32	32	28	28	28	27
EC03	Alluvium	mini	6.60	10760	6.27	8090	6890	96	1040	1	2550	131	218	0.1	0.035	129	249	0.005	0.52	0.0005	0.0005	0.003	0.002	0.05	0.025	0.025	1.39	1.27	1.3	0.00005	0.00005	0.001	0.001	0.0003	0.005	0.0005	0.0005	50	10
EC03	Alluvium	max	7.42	22120	8.27	35300	10500	1180	3640	21	11000	1400	1150	0.8	10	1440	1440	0.35	32	0.001	0.001	0.014	0.009	0.22	0.24	13.8	43.2	23.7	14	0.0001	0.0001	0.024	0.028	0.08	0.02	0.003	0.004	290	10
EC03	Alluvium	median	7.05	15060	7.49	16600	7800	413	2730	5	5130	513	551	0.6	0.5	958	1004.5	0.005	4.45	0.0005	0.0005	0.004	0.005	0.18	0.18	1.4	10.9	5.18	3.235	0.00005	0.00005	0.01	0.0105	0.005	0.005	0.0005	0.0005	50	10
EC03	Alluvium	20th	6.93	12431	6.99	11900	7614	201	2234	3	3692	248.4	376	0.5	0.5	691	768	0.005	3.112	0.0005	0.0005	0.003	0.004	0.15	0.14	0.372	5.3	1.81	1.706	0.00005	0.00005	0.0026	0.0048	0.005	0.005	0.0005	0.0005	50	10
EC03	Alluvium	80th	7.18	19128	7.68	22960	9556	855.2	3098	12.6	7884	989.6	823.4	0.7	1	1214	1240	0.01	9.282	0.0009	0.0005	0.004	0.007	0.2	0.21	4.76	21.16	11	7.962	0.00005	0.00005	0.0174	0.0204	0.009	0.005	0.0005	0.0005	50	10
EC04	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	9	6	NC	NC	16	6	13	6	8	7	11	7	11	7	8	7	NC	NC
EC04	Alluvium	mini	NC	NC	6.92	1860	NC	87	216	1	311	70	39	NC	0.416	419	419	0.005	NC	0.0005	0.0005	0.001	0.001	NC	NC	0.06	0.94	0.061	0.066	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC04	Alluvium	max	NC	NC	7.78	4390	NC	210	594	9	1030	187	118	NC	10	1130	936	0.01	NC	0.001	0.001	0.004	0.005	NC	NC	2.58	2.68	1.05	0.25	0.0001	0.0001	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC04	Alluvium	median	NC	NC	7.48	3740	NC	177	408	2	684	142	92	NC	1	600	548	0.01	NC	0.001	0.0005	0.003	0.0035	NC	NC	0.47	1.32	0.207	0.171	0.000075	0.00005	0.001	0.001	0.01	0.005	0.00075	0.0005	NC	NC
EC04	Alluvium	20th	NC	NC	7.192	2892	NC	112.8	380.4	1	616	90.6	60.2	NC	0.5	512.8	509	0.005	NC	0.0005	0.0005	0.0016	0.002	NC	NC	0.21	1.11	0.1398	0.109	0.00005	5E-05	0.0005	0.0006	0.005	0.005	0.0005	0.0005	NC	NC
EC04	Alluvium	80th	NC	NC	7.586	4094	NC	194.2	529.6	3	861.4	152	110	NC	1	931.2	791	0.01	NC	0.001	0.001	0.004	0.004	NC	NC	1.4	1.54	0.3416	0.226	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC05	Alluvium	count	NC	NC	18	18	NC	18	18	18	18	18	18	NC	18	18	11	11	NC	11	7	10	6	NC	NC	17	6	15	7	8	7	10	6	11	7	8	7	NC	NC
EC05	Alluvium	mini	NC	NC	7.21	1240	NC	12	220	1	212	12	40	NC	0.5	178	178	0.005	NC	0.0005	0.0005	0.001	0.0025	NC	NC	0.01	1	0.044	0.094	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	NC	NC
EC05	Alluvium	max	NC	NC	7.89	32800	NC	781	5560	17	11400	1270	1140	NC	10	2090	2090	0.25	NC	0.005	0.005	0.025	0.025	NC	NC	2.05	9.06	1.11	1	0.0001	0.0001	0.008	0.008	0.05	0.05	0.005	0.005	NC	NC
EC05	Alluvium	median	NC	NC	7.54	23650	NC	501.5	3685	8.5	8175	771	799	NC	1	647	708	0.01	NC	0.001	0.001	0.004	0.0065	NC	NC	0.125	2.28	0.411	0.559	0.000075	0.00005	0.0035	0.005	0.01	0.01	0.001	0.001	NC	NC
EC05	Alluvium	20th	NC	NC	7.38	3128	NC	38	526.8	3.4	665.4	39.2	88.2	NC	0.6924	241.4	245	0.01	NC	0.001	0.0006	0.0022	0.004	NC	NC	0.05	1	0.1164	0.274	0.00005	5E-05	0.0024	0.0025	0.01	0.006	0.0007	0.0006	NC	NC
EC05	Alluvium	80th	NC	NC	7.76	28780	NC	688	4800	14.4	10100	906.8	898.4	NC	1	1238.4	1890	0.025	NC	0.001	0.0022	0.0062	0.008	NC	NC	0.43	5.69	0.9248	0.6998	0.0001	0.0001	0.0054	0.005	0.02	0.024	0.0019	0.0022	NC	NC
EC06	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	9	6	NC	NC	17	7	14	7	8	7	10	6	11	7	8	7	NC	NC
EC06	Alluvium	mini	NC	NC	6.6	2160	NC	140	191	5	332	90	39	NC	0.123	243	558	0.005	NC	0.0005	0.0005	0.004	0.009	NC	NC	0.05	11	1.63	1.54	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC06	Alluvium	max	NC	NC	7.53	4980	NC	329	530	22	1400	274	111	NC	10	1286	720	0.01	NC	0.001	0.001	0.015	0.021	NC	NC	6.83	26	12	7.33	0.0001	0.0001	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC06	Alluvium	median	NC	NC	7.16	3770	NC	235	320	9	856	166	72	NC	1	692	636	0.01	NC	0.001	0.0005	0.008	0.0125	NC	NC	2.53	19.9	4.615	4.86	0.000075	0.00005	0.001	0.0015	0.01	0.005	0.001	0.0005	NC	NC
EC06	Alluvium	20th	NC	NC	6.896	3298	NC	199.2	304	7	752.8	142	51	NC	0.5	619.6	618	0.005	NC	0.0005	0.0005	0.0052	0.01	NC	NC	0.844	15.2	2.182	4.034	0.00005	5E-05	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC06	Alluvium	80th	NC	NC	7.336	4432	NC	292.8	401.8	12.8	1078	203.4	87.2	NC	1	758.4	704	0.01	NC	0.001	0.001	0.0102	0.016	NC	NC	4.56	22.4	6.186	6.04	0.0001	0.0001	0.0012	0.002	0.01	0.01	0.001	0.001	NC	NC
EC07	Alluvium	count	32	32	46	46	17	46	46	46	46	46	46	17	46	46	39	39	17	35	31	37	34	19	18	46	35	39	31	32	31	39	34	35	35	31	31	31	30
EC07	Alluvium	mini	6.30	2540	6.25	1620	13600	37	224	2	351	28	22	0.05	0.072	162	162	0.005	0.91	0.0005	0.0005	0.0005	0.006	0.025	0.025	0.025	3.9	0.36	0.545	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
EC07	Alluvium	max	7.31	29100	7.97	31800	18600	1620	5270	24	13000	1400	1170	0.4	10	1670	1670	0.13	46.5	0.001	0.0025	0.024	0.047	0.06	0.08	47.8	78.7	16.8	18.7	0.0001	0.0001	0.008	0.008	1	0.025	0.001	0.003	120	280
EC07	Alluvium	median	6.70	24035	7.17	22050	15900	683.5	3160	8	7510	571	657	0.3	0.5	590.5	730	0.005	3.85	0.0005	0.0005	0.015	0.0205	0.025	0.025	5.415	22	6.92	8.56	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	50	10
EC07	Alluvium	20th	6.40	21640	7.00	6670	14440	171	1080	5	2060	162	178	0.2	0.5	265	255	0.005	2.516	0.0005	0.0005	0.0066	0.013	0.025	0.025	0.89	7.4	2.038	4.99	5E-05	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC07	Alluvium	80th	6.84	25631	7.47	25900	16560	1160	4010	10	9230	875	754	0.38	1	1450	1462	0.01	6.788	0.0006	0.0005	0.0208	0.026	0.025	0.025	28.5	49.46	11.04	12.8	0.00005	0.00005	0.004	0.005	0.01	0.005	0.0005	0.0005	50	10
EC08	Alluvium	count	NC	NC	10	10	NC	10	10	10	10	10	10	NC	10	10	7	7	NC	7	NC	6	NC	NC	NC	10	NC	10	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC08	Alluvium	mini	NC	NC	6.77	311	NC	28	20	3	9	12	1	NC	0.201	152	152	0.01	NC	0.001	NC	0.004	NC	NC	NC	0.06	NC	1.2	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	max	NC	NC	7.36	1990	NC	124	277	11	440	62	8	NC	10	587	514	0.14	NC	0.001	NC	0.006	NC	NC	NC	11.4	NC	4.85	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	median	NC	NC	7.15	1020	NC	44.5	130	5.5	67	30	2	NC	1	393.5	380	0.01	NC	0.001	NC	0.005	NC	NC	NC	2.8	NC	1.87	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	20th	NC	NC	6.968	830.8	NC	32.8	97	3.8	39.4	19.8	2	NC	1	276.2	228.8	0.01	NC	0.001	NC	0.004	NC	NC	NC	1.002	NC	1.446	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	80th	NC	NC	7.256	1298	NC	56	161.6	6.4	175.4	44.4	7	NC	1	513.2	504.6	0.09	NC	0.001	NC	0.005	NC	NC	NC	4.726	NC	3.16	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC09	Alluvium	count	NC	NC	15	15	NC	15	15	15	15	15	15	NC	15	15	10	10	NC	10	6	9	5	NC	NC	14	6	11	5	7	6	9	5	10	6	7	6	NC	NC
EC09	Alluvium	mini	NC	NC	6.68	1550	NC	27	295	0.5	316	25	37	NC	0.328	326	340	0.005	NC	0.0005	0.0005	0.002	0.003	NC	NC	0.025	0.76	0.018	0.062	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC09	Alluvium	max	NC	NC	8.17	30900	NC	1160	4390	11	12100	1200	1050	NC	10	672	647	0.01	NC	0.001	0.001	0.005	0.005	NC	NC	12.5	20.7	0.747	0.212	0.0001	0.0002	0.004	0.002	0.01	0.01	0.001	0.001	NC	NC
EC09	Alluvium	median	NC	NC	7.45	11200	NC	252	1220	5	3040	311	204	NC	1	395	379.5	0.01	NC	0.001	0.00075	0.003	0.004	NC	NC	0.485	9.525	0.122	0.113	0.0001	0.000075	0.002	0.001	0.01	0.0075	0.001	0.00075	NC	NC
EC09	Alluvium	20th	NC	NC	7.03	3208	NC	103.6	436.2	1.8	726	71.6	50.4	NC	0.5	351.8	351.8	0.005	NC	0.0005	0.0005	0.002	0.003	NC	NC	0.05	3.72	0.045	0.0756	5E-05	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC09	Alluvium	80th	NC	NC	7.69	28580	NC	802.8	3706	8.4	8980	860.8	790.6	NC	1	612	573.6	0.01	NC	0.001	0.001	0.004	0.005	NC	NC	2.164	13.6	0.471	0.1528	0.0001	0.0001	0.0034	0.002	0.01	0.01	0.001	0.001	NC	NC
EC09A	Alluvium	count	28	28	42	42	14	42	42	41	42	42	42	14	41	42	32	32	14	28	24	30	27	16	15	41	28	31	23	25	24	31	27	28	28	24	24	27	26
EC09A	Alluvium	mini	6.65	3650	6.41	3590	9420	75	645	1	922	3	113	0.05	0.066	140	368	0.005	0.33	0.0005	0.0005	0.001	0.003	0.025	0.025	0.025	0.95	0.056	0.063	0.00005	0.00005	0.0005	0.0005	0.003	0.005	0.0005	0.0005	50	10
EC09A	Alluvium	max	7.3	21860	8.18	37650	13800	1100	5040	17	12200	1240	1080	0.7	10	1990	1990	0.03	4.17	0.001	0.001	0.008	0.011	0.09	0.1	21	10.1	3.23	0.373	0.0001	0.00005	0.004	0.004	0.02	0.005	0.002	0.002	310	10
EC09A	Alluvium	median	6.955	16572	7.46	19450	11150	489	3045	4	6510	585.5	512	0.6	0.5	897.5	1050	0.005	0.73	0.0005	0.0005	0.004	0.004	0.06	0.07	0.7	1.595	0.254	0.23	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	50	10
EC09A	Alluvium	20th	6.808	13244	7.104	14500	9812	336	2138	3	4890	374.8	369.2	0.4	0.5	522.6	502.6	0.005	0.51	0.0005	0.0005	0.003	0.003	0.025	0.045	0.34	1.204	0.182	0.1898	0.00005	0.00005	0.001	0.0006	0.005	0.005	0.0005	0.0005	50	10
EC09A	Alluvium	80th	7.09	19732	7.698	26440	12580	849.6	4042	9	9636	971.2	804.4	0.6	1	1656	1738	0.005	1.672	0.0005	0.0005	0.0042	0.004	0.07	0.072	2.71	3.428	0.434	0.3338	0.00005	0.00005	0.002	0.003	0.005	0.005	0.0005	0.0005	50	10
EC10	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	9	6	NC	NC	17	7	13	6	8	7	11	7	11	7	8	7	NC	NC
EC10	Alluvium	mini	NC	NC	6.81	725	NC	12	115	0.5	88	16	12	NC	0.141	197	197	0.005	NC	0.0005	0.0005	0.002	0.003	NC	NC	0.025	3	0.031	0.098	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC10	Alluvium	max	NC	NC	8.02	6635	NC	150	740	7	1235	170	111	NC	10	471	453	0.09	NC	0.001	0.001	0.005	0.009	NC	NC	0.86	26.9	0.501	0.37	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC10	Alluvium	median	NC	NC	7.64	2170	NC	58	298	1	478	78	47	NC	1	360	391	0.01	NC	0.001	0.0005	0.004	0.0045	NC	NC	0.05	9.21	0.14	0.223	0.000075	0.00005	0.001	0.0005	0.01	0.005	0.00075	0.0005	NC	NC
EC10	Alluvium	20th	NC	NC	7.30	1858	NC	43.6	261.6	1	422.8	54.4	40.2	NC	0.5	305.2	305	0.005	NC	0.0005	0.0005	0.003	0.004	NC	NC	0.03	6.612	0.1114	0.142	0.00005	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC10	Alluvium	80th	NC	NC	7.85	3428	NC	90.8	397.4	2	689.6	111.4	94.6	NC	1	422.4	423	0.03	NC	0.001	0.001	0.004	0.006	NC	NC	0.276	15.766	0.2736	0.285	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC11	Alluvium	count	30	30	44	44	17	44	44	44	44	44	44	17	44	44	37	37	17	33	29	35	32	19	18	44	33	36	29	30	29	36	31	33	33	29	29	29	28
EC11	Alluvium	mini	6.5	3640	6.52	903	10200	20	128	2	156	17	13	0.05	0.063	144	170	0.005	0.02	0.0005	0.0005	0.0005	0.003	0.025	0.025	0.01	4.28	0.368	0.542	0.00005	0.00005	0.001	0.001	0.003	0.005	0.0005	0.0005	50	10
EC11	Alluvium	max	7.2	22290	7.88	23700	15400	823	3620	16	7940	852	664	0.5	10	1730	1730	0.04	11.3	0.001	0.001	0.009	0.018	0.07	0.09	58	59	13	12.4	0.0001	0.0001	0.007	0.008	1	0.01	0.001	0.002	50	10
EC11	Alluvium	median	6.89	18091	7.335	16300	13300	394.5	2108	6	5020	396.5	409	0.4	0.5	486	634	0.005	1.42	0.0005	0.0005	0.007	0.008	0.025	0.025	9.82	17.5	3.645	3.82	0.00005	0.00005	0.003	0.005	0.005	0.005	0.0005	0.0005	50	10
EC11	Alluvium	20th	6.674	5056	6.968	4046	11300	158	502.6	4	1096	130.4	81.4	0.3	0.5	326.2	323.4	0.005	0.128	0.0005	0.0005	0.004	0.005	0.025	0.025	2.796	8.282	2.46	2.676	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC11	Alluvium	80th	6.952	21002	7.618	20900	14400	648.8	3334	8	6774	690.6	590.8	0.5	1	1568	1596	0.01	4.594	0.0008	0.0005	0.008	0.01	0.05	0.06	19.68	37	6.84	7.452	0.00005	0.00005	0.006	0.007	0.01	0.005	0.0005	0.0005	50	10
EC12	Alluvium	count	NC	NC	22	22	NC	22	22	20	22	22	22	NC	20	22	11	11	NC	11	7	9	6	NC	NC	21	7	15	6	8	7	11	6	11	7	8	7	NC	NC
EC12	Alluvium	mini	NC	NC	5.75	1110	NC	28	164	1	159	28	24	NC	0.037	132	249	0.005	NC	0.0005	0.0005	0.003	0.017	NC	NC	0.05	1.37	0.278	0.354	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC12	Alluvium	max	NC	NC	7.95	12300	NC	800	1400	12	5630	1000	300	NC	10	526	476	0.01	NC	0.001	0.001	0.017	0.022	NC	NC	28	6.77	5.78	0.544	0.0001	0.0001	0.001	0.001	0.02	0.01	0.001	0.001	NC	NC
EC12	Alluvium	median	NC	NC	7.17	4900	NC	187.5	505.5	6.5	1245	162	102	NC	1	347.5	392	0.01	NC	0.001	0.0005	0.015	0.0195	NC	NC	0.65	2.55	1.44	0.438	0.000075	0.00005	0.001	0.001	0.01	0.005	0.00075	0.0005	NC	NC
EC12	Alluvium	20th	NC	NC	6.62	1764	NC	46	267.6	2	369.8	56	42.2	NC	0.5	266.2	265	0.005	NC	0.0005	0.0005	0.011	0.018	NC	NC	0.25	1.982	0.3898	0.379	0.00005	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC12	Alluvium	80th	NC	NC	7.69	7428	NC	376.8	620.2	10	2162	335.6	146.4	NC	1	411.8	422	0.01	NC	0.001	0.001	0.016	0.022	NC	NC	8.95	4.776	3.87	0.478	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC13	Alluvium	count	31	31	45	45	17	45	45	45	45	45	45	17	45	45	38	38	17	34	30	35	33	19	18	44	34	37	30	31	30	37	32	34	34	30	30	30	29
EC13	Alluvium	mini	6.44	1527	6.32	1670	8710	63	241	4	406	47	5	0.2	0.042	119	199	0.005	0.03	0.0005	0.0005	0.001	0.001	0.025	0.025	0.025	0.83	1.61	1.83	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
EC13	Alluvium	max	7.3	20880	8.09	25200	13800	914	3360	21	7270	741	630	0.5	10	1490	1490	0.02	15.2	0.001	0.002	0.003	0.011	0.08	0.08	8.79	34.5	27.6	29.8	0.0001	0.0001	0.007	0.008	1	0.01	0.001	0.009	50	10
EC13	Alluvium	median	6.77	13770	7.29	13400	12500	415	1650	10	4800	405	345	0.4	0.5	517	484.5	0.005	0.97	0.0005	0.0005	0.002	0.002	0.025	0.025	1.225	4.02	6.28	10.115	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC13	Alluvium	20th	6.61	2540	6.886	3056	11120	102	330	4.8	797.4	79.2	45.8	0.3	0.5	332.6	331.8	0.005	0.364	0.0005	0.0005	0.001	0.002	0.025	0.025	0.444	2.528	2.488	2.76	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10

APPENDIX B

Water quality summary table

Bore	Aquifer	Statistic	pH (field)	EC (field)	pH (Lab)	EC (Lab)	TDS	Ca	Na	K	Cl	Mg	SO4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Al (diss)	Al (total)	Sb (diss)	Sb (total)	As (diss)	As (total)	B (diss)	B (total)	Fe (diss)	Fe (total)	Mn (diss)	Mn (total)	Hg (diss)	Hg (total)	Mo (diss)	Mo (total)	Se (diss)	Se (total)	Ag (diss)	Ag (total)	TPH C10_C40	TPH C6_C10
		unit	-	µS/cm	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Guideline	WQO Zone 43 (Shallow) 80th percentile		8.2	15495	8.2	15495	-	-	-	-	-	-	387	0.91	-	-	-	-	-	-	-	-	-	-	-	0.115	0.115	3.755	3.755	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 80th percentile		8.4	7720	8.4	7720	-	-	-	-	-	-	362	0.31	-	-	-	-	-	-	-	-	-	-	-	0.856	0.856	0.054	0.054	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Shallow) 20th percentile		7.09	-	7.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 20th percentile		7.7	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ANZG (2018)		8.5	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	0.055	0.055	0.009	0.009	0.013	0.013	-	-	0.7	0.7	-	-	-	-	0.0034	0.0034	0.005	0.005	-	-	-	-
	ANZG (2018) lower		6.5	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DES (2013)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
EC13	Alluvium	80th	6.92	19250	7.65	19400	13180	723.2	2834.4	13	6518	607.4	540.2	0.4	1	1232	1316	0.01	3.322	0.0007	0.0005	0.002	0.003	0.054	0.06	4.366	9.05	19.18	22.62	0.00005	0.00005	0.0038	0.004	0.01	0.005	0.0005	0.001	50	10
EC14	Alluvium	count	27	27	41	41	17	41	41	41	41	41	41	17	41	41	34	34	16	30	26	32	29	19	18	41	30	34	26	27	26	33	29	31	30	27	26	26	25
EC14	Alluvium	mini	6.90	822	6.49	419	512	20	28	3	27	14	2	0.4	0.05	128	128	0.005	3.07	0.0005	0.0005	0.003	0.002	0.025	0.025	0.02	1.14	0.26	0.47	0.00005	0.00005	0.001	0.0005	0.005	0.005	0.0005	0.0005	50	10
EC14	Alluvium	max	7.82	2576	8.78	9000	1040	558	887	24	2950	400	172	0.6	94	608	497	0.47	54.7	0.001	0.001	0.017	0.04	0.07	0.16	9.87	106	9.45	1.62	0.0001	0.0002	0.004	0.007	0.1	0.01	0.001	0.001	140	10
EC14	Alluvium	median	7.19	1396	7.48	1550	845	42	242	5	244	37	18	0.5	0.5	416	414.5	0.005	15.1	0.0005	0.0005	0.0095	0.012	0.025	0.05	0.88	21	0.471	0.7175	0.00005	0.00005	0.002	0.001	0.005	0.005	0.0005	0.0005	50	10
EC14	Alluvium	20th	7.04	1211	7.17	1250	755.2	33	197	4	177	28	6	0.5	0.5	322	320	0.005	5.24	0.0005	0.0005	0.008	0.011	0.025	0.025	0.1	9.59	0.4056	0.57	5E-05	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC14	Alluvium	80th	7.36	1623	7.77	3720	907	135	380	7	956	138	62	0.6	1	469	462.8	0.01	33	0.001	0.0005	0.012	0.018	0.054	0.06	1.83	41.32	1.068	1.07	0.00005	0.00005	0.002	0.002	0.01	0.005	0.0005	0.0005	50	10
EC15	Alluvium	count	NC	NC	10	10	NC	11	11	11	11	11	10	NC	11	10	6	7	NC	7	NC	6	NC	NC	NC	11	NC	8	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC15	Alluvium	mini	NC	NC	7.01	426	NC	22	29	1	10	10	4	NC	1	153	164	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.05	NC	0.04	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	max	NC	NC	7.84	3870	NC	242	222	4	1110	207	67	NC	1	435	323	0.14	NC	0.001	NC	0.001	NC	NC	NC	2.32	NC	0.452	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	median	NC	NC	7.32	886	NC	41	68	2	102	32	14	NC	1	290.5	253.5	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.05	NC	0.1905	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	20th	NC	NC	7.128	666.2	NC	37	41	1	26	26	5	NC	1	186.4	192	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.05	NC	0.121	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	80th	NC	NC	7.524	1600	NC	91	105	4	286	73	28.2	NC	1	349.6	316	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.24	NC	0.316	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	count	NC	NC	12	12	NC	13	13	13	13	13	12	NC	13	12	6	7	NC	7	NC	6	NC	NC	NC	13	NC	10	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC16	Alluvium	mini	NC	NC	7.03	621	NC	2	140	1	60	3	2	NC	0.671	214	214	0.01	NC	0.001	NC	0.008	NC	NC	NC	0.04	NC	0.008	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	max	NC	NC	8.00	1578	NC	32	350	7	239	26	22	NC	10	666	401	0.53	NC	0.001	NC	0.029	NC	NC	NC	10.3	NC	0.207	NC	NC	NC	0.005	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	median	NC	NC	7.33	920	NC	5	186	1	90	7	6	NC	1	279	233.5	0.01	NC	0.001	NC	0.0145	NC	NC	NC	0.05	NC	0.0145	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	20th	NC	NC	7.14	778	NC	3	155.6	1	67	6	4	NC	1	223.6	216	0.01	NC	0.001	NC	0.013	NC	NC	NC	0.05	NC	0.012	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	80th	NC	NC	7.77	1202	NC	7.6	247	1	138	9.6	9	NC	1	388.8	309	0.37	NC	0.001	NC	0.02	NC	NC	NC	0.832	NC	0.089	NC	NC	NC	0.004	NC	0.01	NC	NC	NC	NC	NC
EC17	Alluvium	count	NC	NC	14	14	NC	15	15	15	15	15	14	NC	15	14	10	11	NC	11	7	9	6	NC	NC	15	7	12	7	8	7	10	6	11	7	8	7	NC	NC
EC17	Alluvium	mini	NC	NC	6.62	1260	NC	54	148	3	131	36	36	NC	0.5	300	300	0.005	NC	0.0005	0.0005	0.007	0.015	NC	NC	0.025	5	0.585	0.625	0.00005	0.00005	0.003	0.003	0.005	0.005	0.0005	0.0005	NC	NC
EC17	Alluvium	max	NC	NC	7.87	6070	NC	328	735	6	1800	250	297	NC	1	605	605	0.01	NC	0.001	0.001	0.042	0.033	NC	NC	6.81	16.1	2.08	2.23	0.0001	0.0001	0.004	0.004	0.01	0.01	0.001	0.001	NC	NC
EC17	Alluvium	median	NC	NC	7.14	1950	NC	102	224	5	320	64	106.5	NC	1	370	386.5	0.01	NC	0.001	0.0005	0.017	0.018	NC	NC	3	7.5	1.25	1.67	0.0001	0.00005	0.003	0.003	0.01	0.005	0.00075	0.0005	NC	NC
EC17	Alluvium	20th	NC	NC	6.774	1446	NC	71.8	157	4	185.2	48.6	52.2	NC	0.5	341.6	347.2	0.005	NC	0.0005	0.0005	0.014	0.017	NC	NC	0.622	6.14	0.6154	0.8058	0.00005	5E-05	0.003	0.003	0.005	0.005	0.0005	0.0005	NC	NC
EC17	Alluvium	80th	NC	NC	7.494	4370	NC	234.8	415.6	5.2	1214	169	187.6	NC	1	428.6	465.6	0.01	NC	0.001	0.001	0.0282	0.029	NC	NC	4.568	10.826	1.92	2.096	0.0001	0.0001	0.004	0.004	0.01	0.01	0.001	0.001	NC	NC
EC19	Alluvium	count	NC	NC	6	6	NC	6	6	6	6	6	6	NC	6	6	6	6	NC	6	5	6	5	NC	NC	6	5	6	5	6	5	6	5	6	5	6	5	NC	NC
EC19	Alluvium	mini	NC	NC	7.34	307	NC	9	31	0.5	15	14	4	NC	0.5	132	132	0.005	NC	0.0005	0.0005	0.001	0.002	NC	NC	0.025	0.18	0.009	0.031	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC19	Alluvium	max	NC	NC	7.72	802	NC	21	98	1	88	30	12	NC	1	246	246	0.1	NC	0.004	0.003	0.042	0.044	NC	NC	0.05	1.49	0.061	0.073	0.0001	0.0001	0.003	0.003	0.01	0.01	0.001	0.01	NC	NC
EC19	Alluvium	median	NC	NC	7.56	454	NC	14.5	42.5	1	20	22	7	NC	1	176.5	176.5	0.01	NC	0.001	0.001	0.002	0.002	NC	NC	0.05	1.19	0.0175	0.051	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC19	Alluvium	20th	NC	NC	7.46	348	NC	11	35	0.5	19	14	5	NC	0.5	136	136	0.005	NC	0.001	0.0009	0.001	0.002	NC	NC	0.025	0.876	0.009	0.0318	0.00005	0.00005	0.001	0.0009	0.005	0.005	0.0005	0.0005	NC	NC
EC19	Alluvium	80th	NC	NC	7.69	620	NC	18	89	1	61	26	9	NC	1	245	245	0.03	NC	0.001	0.0014	0.003	0.0112	NC	NC	0.05	1.346	0.025	0.0626	0.0001	1E-04	0.001	0.0014	0.01	0.01	0.001	0.0028	NC	NC
EC22	Alluvium	count	5	5	19	19	NC	19	19	19	19	19	19	NC	19	19	12	12	NC	12	8	9	7	NC	NC	18	8	15	8	9	8	11	7	11	8	9	8	5	NC
EC22	Alluvium	mini	7.1	2420	6.81	2380	NC	67	262	2	490	60	22	NC	0.135	207	342	0.005	NC	0.0005	0.0005	0.006	0.007	NC	NC	0.01	14.1	0.17	0.453	0.00005	0.00005	0.001	0.0005	0.005	0.005	0.0005	0.0005	50	NC
EC22	Alluvium	max	7.47	2750	8	5910	NC	271	776	11	2070	287	1962	NC	10	566	560	0.88	NC	0.001	0.001	0.01	0.047	NC	NC	2.11	34.4	1.4	1	0.0001	0.0002	0.002	0.002	0.01	0.01	0.001	0.001	50	NC
EC22	Alluvium	median	7.2	2607	7.55	2730	NC	99	375	5	647	87	75	NC	1	462	458	0.01	NC	0.001	0.0005	0.008	0.025	NC	NC	0.11	25.55	0.368	0.529	0.00005	0.00005	0.001	0.001	0.01	0.005	0.0005	0.0005	50	NC
EC22	Alluvium	20th	7.18	2444	7.018	2554	NC	76.6	332.2	3.6	574.6	75.4	52	NC	0.5	369.6	372	0.005	NC	0.0005	0.0005	0.0066	0.0112	NC	NC	0.05	18.16	0.324	0.4808	0.00005	0.00005	0.001	0.0006	0.005	0.005	0.0005	0.0005	50	NC
EC22	Alluvium	80th	7.254	2646	7.844	4285	NC	165.4	439.2	5.4	944.6	164	112.6	NC	1	517.4	517.6	0.018	NC	0.001	0.001	0.0088	0.0288	NC	NC	0.852	34.12	0.7336	0.6392	0.0001	0.0001	0.002	0.001	0.01	0.01	0.001	0.001	50	NC
EC23	Alluvium	count	NC	NC	12	13	NC	13	13	13	13	13	12	NC	13	12	6	7	NC	7	NC	6	NC	NC	NC	13	NC	10	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC23	Alluvium	mini	NC	NC	6.83	954	NC	21	134	1	100	23	24	NC	1	239	239	0.01	NC	0.001	NC	0.002	NC	NC	NC	0.01	NC	0.078	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	max	NC	NC	8.00	7910	NC	369	799	6	2230	384	155	NC	1	881	449	0.02	NC	0.001	NC	0.003	NC	NC	NC	0.9	NC	0.497	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	median	NC	NC	7.24	2500	NC	82	322	4	585	92	51	NC	1	479	340.5	0.01	NC	0.001	NC	0.002	NC	NC	NC	0.08	NC	0.2475	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	20th	NC	NC	7.06	2016	NC	62	241.6	2	396	57.4	29	NC	1	321	265	0.01	NC	0.001	NC	0.002	NC	NC	NC	0.05	NC	0.1464	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	80th	NC	NC	7.73	4280	NC	172.2	553.6	4.6	1136	179.2	75.2	NC	1	583.4	398	0.01	NC	0.001	NC	0.003	NC	NC	NC	0.588	NC	0.4038	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
FIELD 5 BORE	Alluvium	count	NC	NC	5	5	NC	5	5	5	5	5	5	NC	5	5	5	5	NC	NC	NC	5	5	NC	NC	5	5	NC	NC	NC	NC	5	5	NC	5	NC	NC	5	5
FIELD 5 BORE	Alluvium	mini	NC	NC	7.32	10900	NC	312	1700	6	3110	346	276	NC	0.5	226	226	0.005	NC	NC	NC	0.002	0.002	NC	NC	0.025	1.91	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	max	NC	NC	8.16	20200	NC	919	2120	41	6300	755	947	NC	0.5	923	923	0.01	NC	NC	NC	0.007	0.016	NC	NC	5.48	20.2	NC	NC	NC	NC	0.003	0.003	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	median	NC	NC	7.68	16600	NC	727	1940	16	5890	588	397	NC	0.5	346	346	0.005	NC	NC	NC	0.003	0.005	NC	NC	3.67	5.7	NC	NC	NC	NC	0.001	0.002	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	20th	NC	NC	7.488	15060	NC	625.6	1860	13.2	5326	529.2	346.4	NC	0.5	281.2	281.2	0.005	NC	NC	NC	0.0028	0.0028	NC	NC	1.357	4.55	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	80th	NC	NC	7.84	17320	NC	779	2008	21	6212	667	611	NC	0.5	687	687	0.006	NC	NC	NC	0.0062	0.0096	NC	NC	4.072	9.296	NC	NC	NC	NC	0.0022	0.0022	NC	0.005	NC	NC	50	10
GW01	Alluvium	count	31	31	42	42	17	42	42	42	42	42	42	17	42	42	38	38	12	34	30	35	33	19	18	42	34	33	29	31	30	37	32	34	34	31	30	29	29
GW01	Alluvium	mini	7.69	3861	7.29	3780	2460	16	701	0.5	702	60	38	0.4	0.5	412	525	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.1	0.11	0.025	0.13	0.006	0.059	0.00005	0.00005	0.001	0.0005	0.0002	0.005	0.0005	0.0005	50	10
GW01	Alluvium	max	8.74	6460	8.81	14000	4290	137	1890	9	3740	406	339	0.8	165	1670	1460	0.01	22.4	0.001	0.001	0.008	0.009	0.21	0.42	0.98	26	1.03	0.338	0.0001	0.0001	0.008	0.008	0.01	0.01	0.001	0.001	50	10
GW01	Alluvium	median	8.17	4940	8.27	5150	2760	31.5	970	2	1125	94	150.5	0.6	15.5	672	682.5	0.005	0.045	0.0005	0.0005	0.003	0.003	0.15	0.16	0.06	0.47	0.084	0.097	0.00005	0.00005	0.004	0.005	0.005	0.005	0.0005	0.0005	50	10
GW01	Alluvium	20th	7.94	4161	8.06	4184	2580	25.2	791.8	1	879	70.2	110.4	0.42	0.5	608	604.4	0.005	0.022	0.0005	0.0005	0.0018	0.002	0.126	0.124	0.025	0.21	0.0712	0.076	0.00005	0.00005	0.003	0.0032	0.005	0.005	0.0005	0.0005	50	10
GW01	Alluvium	80th	8.43	5890	8.47	6574	3696	48.8	1160	4.8	1584	136.2	258.6	0.6	60	1018	927.4	0.005	0.08	0.0007	0.0005	0.004	0.004	0.178	0.18	0.154	1.256	0.118	0.129	0.00005	0.00005	0.005	0.006	0.007	0.005	0.0005	0.0005	50	10
GW02	Alluvium	count	NC	NC	16	16	NC	16	16	16	16	16	16	NC	16	16	11	11	NC	11	7	10	7	NC	NC	16	7	13	7	8	7	11	7	11	7	8	7	NC	NC
GW02	Alluvium	mini	NC	NC	6.79	303	NC	19	27	2	19	10	2	NC	0.11	112	112	0.005	NC	0.0005	0.0005	0.0005	0.0005	NC	NC	0.025	1.89	0.178	0.355	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
GW02	Alluvium	max	NC	NC	7.94	5300	NC	49	94	7	1100	25	150	NC	10	602	211	0.06	NC	0.001	0.001	0.003	0.004	NC	NC	1.4	19.4	1.2	0.472	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
GW02	Alluvium	median	NC	NC	7.365	517.5	NC	34	44.5	3	63.5	19.5	4	NC	1	186	134	0.01	NC	0.001	0.0005	0.0015	0.002	NC	NC	0.77	3.81	0.331	0.381	0.0001	0.00005	0.001	0.0005	0.01	0.005	0.00075	0.0005	NC	NC
GW02	Alluvium	20th	NC	NC	7.23	389	NC	23	29	2	38	12	2	NC	0.5	129	129	0.005	NC	0.0005	0.0005	0.0005	0.0006	NC	NC	0.05	2.292	0.2622	0.3726	0.00005	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
GW02	Alluvium	80th	NC	NC	7.68	687	NC	43	54	4	96	23	9	NC	1	197	196	0.01	NC	0.001	0.001	0.002	0.002	NC	NC	1.18	8.096	0.4622	0.3972	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
RB7a	Alluvium	count	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7	NC	NC	8	8	NC	NC	8	5	NC	NC	NC	NC	8	8	5	8	NC	NC	8	8
RB7a	Alluvium	mini	6.96	5376	7.42	5000	3250	140	745	0.5	1310	145	284	0.4	0.5	311	311	0.005	0.02	NC	NC	0.001	0.0005	NC	NC	0.025	0.07	NC	NC	NC	NC	0.0005	0.0005	0.0028	0.005	NC	NC	50	10
RB7a	Alluvium	max	7.29	8903	7.95	8840	5750	283	1100	7	2740	330	608	0.4	0.5	396	396	0.005	0.21	NC	NC	0.001	0.003	NC	NC	0.025	0.25	NC	NC	NC	NC	0.001	0.002	0.005	0.005	NC	NC	50	10
RB7a	Alluvium	median	7.02	6036	7.60	5930	3855	175.5	835.5	2	1630	197	375	0.4	0.5	333	333	0.005	0.04	NC	NC	0.001	0.001	NC	NC	0.025	0.08	NC	NC	NC	NC	0.0005	0.0005	0.005	0.005	NC	NC	50	10
RB7a	Alluvium	20th	6.98	5388	7.50	5242	3410	142.4	762.8	1	1410	155	297.2	0.4	0.5	321	321	0.005	0.024	NC	NC	0.001	0.0007	NC	NC	0.025	0.07	NC	NC	NC	NC	0.0005	0.0005	0.0032	0.005	NC	NC	50	10
RB7a	Alluvium	80th	7.12	7346	7.80	7106	4620	228.8	948.2	3.6	2000	252.4	476.2	0.4	0.5	366	366	0.005	0.098	NC	NC	0.001	0.0016	NC	NC	0.025	0.202	NC	NC	NC	NC	0.001	0.001	0.005	0.005	NC	NC	50	10
Twin Bores	Alluvium	count	28	28	29	29	15	29	29	29	29	29	29	15	29	29	28	28	12	24	24	28	28	17	17	29	28	25	24	24	24	28	28	25	28	24	24	27	26
Twin Bores	Alluvium	mini	7.21	9960	7.6	6470	6420	6	1040	7	1750	197	24	0.05	0.5	188	214	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.28	0.34	0.025	0.25	0.159	0.17	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
Twin Bores	Alluvium	max	9.29	13230	8.99	13000	7860	206	2100	26	4350	486	807	0.2	237	558	707	0.005	0.13	0.0005	0.0005	0.001	0.001	0.56	0.64	1.77	5.45	0.948	0.9	0.00005	0.00005	0.002	0.002	0.005	0.005	0.001	0.0005	50	10
Twin Bores	Alluvium	median	7.565	11610	8.05	11400	7280	166	1770	9	3700	391	673	0.2	0.5	449	452	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.48	0.53	0.12	1.325	0.337	0.352	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Twin Bores	Alluvium	20th	7.37	10845.2	7.702	10740	6720	14.6	1684	8	3490	291.6	279.4	0.05	0.5	375.6	409.4	0.005	0.032	0.0005	0.0005	0.0005	0.0005	0.46	0.484	0.04	0.636	0.2534	0.2624	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Twin Bores	Alluvium	80th	8.594	12258	8.548	12000	7492	181.4	1852	14.2	4030	437	696	0.2	58.8	477.2	491.6	0.005	0.07	0.0005	0.0005	0.0005	0.0005	0.528	0.55	0.248	2.306	0.4358	0.4758	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Weir Bore (2)	Alluvium	count	NC	NC	10	10	NC	10	10	10	10	10	10	NC	10	10	5	5	NC	5	NC	5	NC	NC	NC	10	NC	6	NC	NC	NC	5	NC	5	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	mini	NC	NC	6.70	1330	NC	7	275	1	118	10	1	NC	1	34	417	0.01	NC	0.001	NC	0.004	NC	NC	NC	0.05	NC	0.001	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	max	NC	NC	8.46	2550	NC	29	466	11	753	43	78	NC	50	641	615	0.02	NC	0.001	NC	0.006	NC	NC	NC	1.04	NC	0.342	NC	NC	NC	0.004	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	median	NC	NC	8.06	1815	NC	16.5	368	1	206.5	20.5	43.5	NC	1	548	529	0.01	NC	0.001	NC	0.005	NC	NC	NC	0.05	NC	0.0595	NC	NC	NC	0.003	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	20th	NC	NC	7.87	1566	NC	8.8	304.8	1	170.8	11	23	NC	1	417.8	417.8	0.01	NC	0.001	NC	0.004	NC	NC	NC	0.05	NC	0.032	NC	NC	NC	0.0028	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	80th	NC	NC	8.18	2386	NC	20.8	430	1.2	424.6	27.6	52.8	NC	40	615	615	0.02	NC	0.001	NC	0.006	NC	NC	NC	0.398	NC	0.102	NC	NC	NC	0.004	NC	0.01	NC	NC	NC	NC	NC
Fairhill Bore	Burngrove	count	29	29	28	28	16	28	28	28	28	28	28	16	28	28	28	28	7	25	25	28	28	19	18	28	14	25	25	25	25	28	28	26	28	25	25	27	26
Fairhill Bore	Burngrove	mini	6	1641	6.59	1590	1030	18	266	10	419	22	70	0.1	0.5	84	84	0.005	0.01	0.0005	0.0005	0.0005	0.001	0.38	0.45	0.025	0.06	0.002	0.002	0.00005	0.00005	0.0005	0.0005	0.0018	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	max	8.54	3130	8.58	2070	1340	34	382	14	516	31	103	0.2	29	231	231	0.02	0.02	0.0005	0.0005	0.003	0.003	0.61	0.6	3.7	7.08	0.21	0.228	0.00005	0.0001	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	median	6.92	2006	7.105	1830	1150	27.5	305	11	479	27.5	80.5	0.2	0.5	174.5	181.5	0.005	0.02	0.0005	0.0005	0.003	0.003	0.51	0.55	0.025	0.315	0.016	0.023	0.00005	0.00005	0.0005	0.00075	0.005	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	20th	6.432	1747.8	6.882	1690	1070	21.4	276.6	11	446.2	24	76	0.2	0.5	105.6	105.6	0.005	0.01	0.0005	0.0005	0.002	0.002	0.484	0.5	0.025	0.082	0.0066	0.008	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	80th	7.404	2066	7.728	2012	1290	32	332.6	12	498.6	28.6	90	0.2	0.5	209	209	0.005	0.02	0.0005	0.0005	0.003	0.003	0.544	0.57	0.025	0.628	0.043	0.0532	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	count	26	26	27	27	16	27	27	27	27	27	27	16	27	27	27	27	13	24	24	27	27	18	17	27	25	23	23	24	24	27	27	25	27	24	24	26	25
Yongala Bore	Burngrove	mini	6.46	2820	6.91	2700	1790	65	357	13	716	54	44	0.2	0.5	185	185	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.51	0.55	0.025	1.97	0.002	0.023	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	max	8.54	3140	8.53	3160	2050	86	460	17	849	72	62	0.3	30	272	303	0.005	0.2	0.0005	0.0005	0.001	0.004	0.72	0.74	6.72	10.9	0.339	0.374	0.00005	0.00005	0.0005	0.0005	0.1	0.005	0.0005	0.001	50	10
Yongala Bore	Burngrove	median	6.83	2978	7.26	2900	1895	74	410	15	816	63	51	0.2	0.5	221	221	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.62	0.66	5.04	6.56	0.266	0.287	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	20th	6.69	2920	7.06	2832	1850	71.2	397.4	14	775.2	61.2	47	0.2	0.5	211.6	214	0.005	0.014	0.0005	0.0005	0.0005	0.0005	0.6	0.632	4.256	5.536	0.24	0.2546	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	80th	7.11	3060	7.74	2944	1920	79.2	422.6	16	840.2	67	53	0.2	0.5	230.8	230.8	0.005	0.098	0.0005	0.0005	0.0005	0.001	0.65	0.696	5.698	7.94	0.2828	0.2972	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	count	27	27	27	27	16	27	27	27	27	27	27	16	27	27	27	27	5	23	23	27	27	18	17	27	26	23	23	23	23	27	26	24	27	23	23	26	25
Railway Bore	Fairhill	mini	6.76	1857	7.23	1770	1150	59	235	9	458	49	62	0.4	0.5	219	219	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.52	0.52	0.025	0.11	0.009	0.008	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	max	7.82	8840	8.69	8650	5620	163	1490	32	1980	280	957	0.6	172	1160	1270	0.01	0.07	0.0005	0.0005	0.004	0.0005	0.84	0.84	2.57	3.74	0.033	0.177	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	median	7.01	6600	7.63	6370	4520	101	1150	25	1280	180	598	0.4	0.5	1100	1100	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.74	0.76	0.52	0.58	0.011	0.011	0.00005	0.00005	0.0005	0.00075	0.005	0.005	0.0005	0.0005	50	10

APPENDIX B

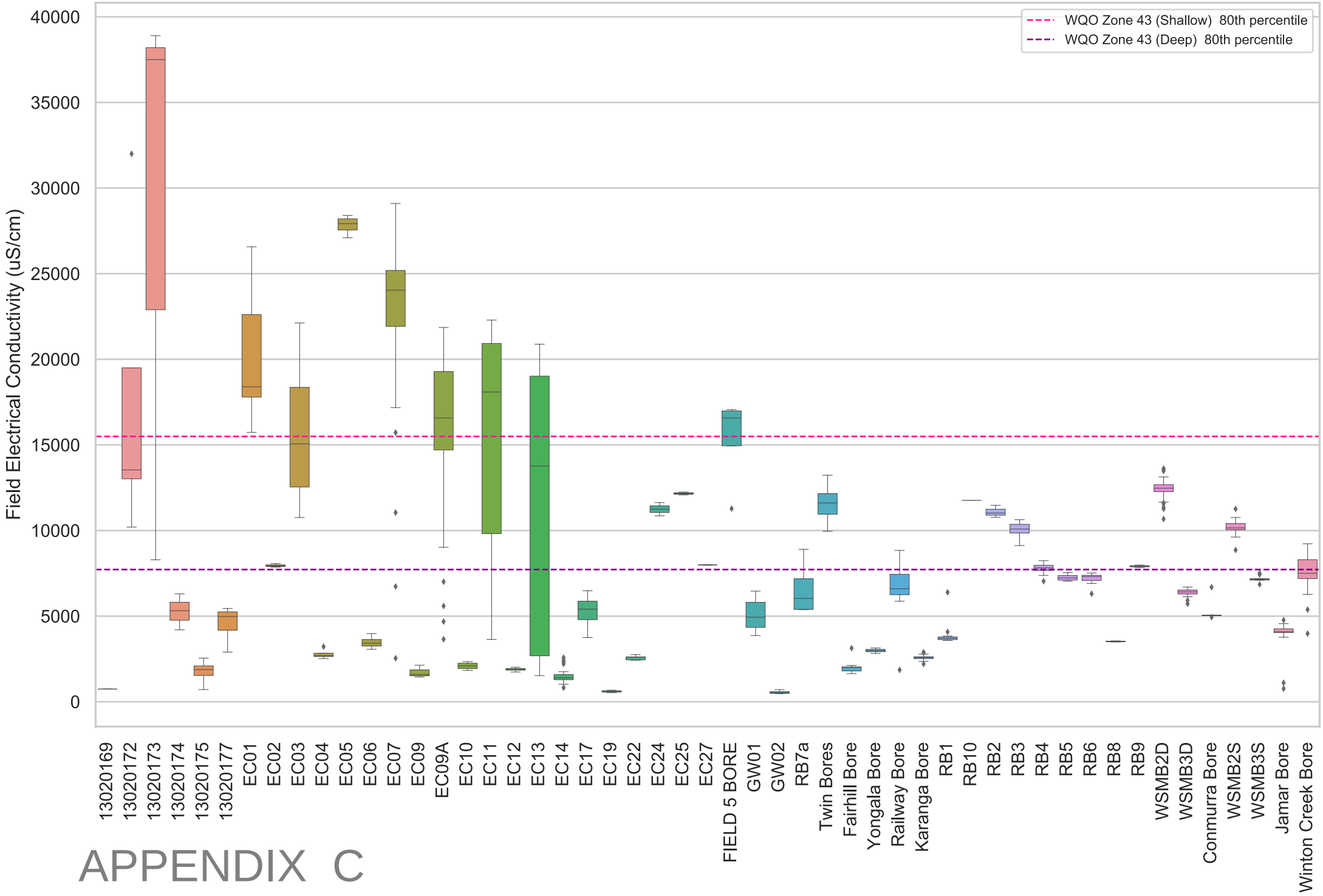
Water quality summary table

Bore	Aquifer	Statistic	pH (field)	EC (field)	pH (Lab)	EC (Lab)	TDS	Ca	Na	K	Cl	Mg	SO4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Al (diss)	Al (total)	Sb (diss)	Sb (total)	As (diss)	As (total)	B (diss)	B (total)	Fe (diss)	Fe (total)	Mn (diss)	Mn (total)	Hg (diss)	Hg (total)	Mo (diss)	Mo (total)	Se (diss)	Se (total)	Ag (diss)	Ag (total)	TPH C10_C40	TPH C6_C10
		unit	-	µS/cm	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Guideline	WQO Zone 43 (Shallow) 80th percentile		8.2	15495	8.2	15495	-	-	-	-	-	-	387	0.91	-	-	-	-	-	-	-	-	-	-	-	0.115	0.115	3.755	3.755	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 80th percentile		8.4	7720	8.4	7720	-	-	-	-	-	-	362	0.31	-	-	-	-	-	-	-	-	-	-	-	0.856	0.856	0.054	0.054	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Shallow) 20th percentile		7.09	-	7.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 20th percentile		7.7	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ANZG (2018)		8.5	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	0.055	0.055	0.009	0.009	0.013	0.013	-	-	0.7	0.7	-	-	-	-	0.0034	0.0034	0.005	0.005	-	-	-	-
	ANZG (2018) lower		6.5	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DES (2013)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
Railway Bore	Fairhill	20th	6.912	6180.8	7.386	5968	4120	91	1030	23	1174	164.6	555.8	0.4	0.5	903.8	916	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.694	0.732	0.126	0.29	0.01	0.0104	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	80th	7.246	7833.8	8.002	7426	5340	128.6	1264	29.6	1596	229.2	834.6	0.5	0.5	1120	1120	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.78	0.834	0.58	0.67	0.012	0.0158	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	count	34	34	42	42	16	43	43	43	42	43	42	16	42	42	37	37	NC	34	30	37	33	19	18	43	33	35	30	31	30	37	33	35	33	31	30	28	27
Karanga Bore	Rangal Coal Measures	mini	6.82	2204	6.96	2400	1570	53	130	6	336	84	41	0.05	0.5	144	201	0.005	NC	0.0005	0.0005	0.0005	0.0005	0.18	0.18	0.025	0.05	0.001	0.055	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	max	8.33	2880	8.40	3320	1680	210	380	34	870	157	302	0.1	20	398	397	0.01	NC	0.001	0.001	0.004	0.002	0.27	0.27	1.55	0.7	0.334	0.276	0.0001	0.0001	0.009	0.011	0.1	0.01	0.001	0.001	50	10
Karanga Bore	Rangal Coal Measures	median	7.28	2575	7.61	2510	1615	125	249	6	633.5	98	54.5	0.05	0.5	359	358	0.005	NC	0.0005	0.0005	0.001	0.001	0.22	0.24	0.48	0.61	0.198	0.201	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	20th	7.08	2473	7.41	2450	1590	118	233.2	6	609.2	92	44.2	0.05	0.5	336	336	0.005	NC	0.0005	0.0005	0.0005	0.0005	0.21	0.224	0.108	0.564	0.1838	0.1914	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	80th	7.51	2662	7.88	2768	1640	149.2	259	7.6	657	114.2	187.6	0.05	1	369.4	367	0.005	NC	0.0007	0.0005	0.002	0.001	0.24	0.256	0.59	0.652	0.2154	0.2154	0.00005	0.00005	0.0005	0.0005	0.01	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	count	24	24	23	23	16	23	23	23	23	23	22	16	23	23	23	23	14	19	19	23	23	18	17	23	23	19	19	19	19	23	23	20	23	19	19	21	22
RB1	Rangal Coal Measures	mini	7.52	3578	7.67	3350	2180	9	677	3	776	9	1	0.2	0.5	201	201	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.28	0.34	0.025	0.12	0.009	0.011	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	max	8.37	6390	8.85	4040	2450	31	789	5	1030	14	44	0.6	86	474	478	0.005	0.81	0.0005	0.0005	0.003	0.004	0.46	0.48	0.21	14.4	0.137	0.832	0.00005	0.00005	0.006	0.006	0.1	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	median	8.055	3700	8.21	3520	2270	14	737	3	938	10	4	0.4	0.5	414	428	0.005	0.105	0.0005	0.0005	0.0005	0.0005	0.39	0.42	0.07	0.36	0.014	0.02	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	20th	7.746	3622	8.154	3458	2240	13	712.6	3	895.6	10	2.2	0.4	0.5	397.4	411.2	0.005	0.026	0.0005	0.0005	0.0005	0.0005	0.38	0.4	0.025	0.144	0.011	0.014	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	80th	8.17	3793.6	8.426	3686	2330	16	762.8	4	967.8	12	10.6	0.5	20	428.4	440.4	0.005	0.482	0.0005	0.0005	0.002	0.002	0.426	0.458	0.096	0.796	0.0472	0.0626	0.00005	0.00005	0.003	0.004	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	count	23	23	22	22	16	22	22	22	22	22	5	16	22	22	22	22	11	18	18	22	22	18	17	22	22	18	18	18	18	22	22	19	22	18	18	21	21
RB2	Rangal Coal Measures	mini	7.00	10770	7.20	10200	6630	89	1970	7	3320	30	1	0.2	0.5	125	125	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.28	0.32	0.025	0.38	0.054	0.056	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	max	8.03	11470	8.24	11700	7600	186	2250	10	4030	56	9	0.3	0.5	158	158	0.02	0.52	0.0005	0.0005	0.005	0.006	0.42	0.45	0.85	1.18	0.181	0.196	0.00005	0.00005	0.001	0.002	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	median	7.71	11020	7.83	10850	7020	135.5	2120	8	3795	33	3	0.3	0.5	130.5	130.5	0.005	0.06	0.0005	0.0005	0.0015	0.002	0.375	0.41	0.53	0.685	0.089	0.094	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	20th	7.59	10884	7.70	10700	6820	124.4	2080	7	3672	31.2	1.8	0.3	0.5	127.2	127.2	0.005	0.02	0.0005	0.0005	0.001	0.001	0.36	0.372	0.24	0.526	0.062	0.0624	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	80th	7.82	11302	8.03	11000	7150	150.4	2160	8	3950	36	5	0.3	0.5	138.2	138.2	0.005	0.09	0.0005	0.0005	0.0038	0.0038	0.406	0.42	0.578	0.758	0.1154	0.1226	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	count	24	24	23	23	15	23	23	23	23	23	15	15	23	23	23	23	10	19	19	23	23	17	16	23	23	19	19	19	19	23	23	20	22	19	19	21	22
RB3	Rangal Coal Measures	mini	7.82	9120	7.91	9310	6140	33	1720	5	3050	11	1	0.2	0.5	159	159	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.4	0.38	0.025	0.11	0.025	0.029	0.00005	0.00005	0.0005	0.0005	0.0002	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	max	8.4	10630	8.41	10600	6890	91	2190	12	3650	18	19	0.6	12	448	448	0.02	0.15	0.0005	0.0005	0.003	0.004	0.53	0.54	0.34	0.66	0.104	0.122	0.00005	0.00005	0.003	0.004	0.005	0.005	0.002	0.0005	50	10
RB3	Rangal Coal Measures	median	7.945	10085	8.05	9920	6450	64	2030	6	3400	13	3	0.2	0.5	180	180	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.47	0.49	0.18	0.35	0.036	0.041	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	20th	7.872	9833.6	7.948	9706	6278	53.4	1944	6	3264	12.4	2	0.2	0.5	171.4	172	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.44	0.46	0.039	0.3	0.0284	0.0316	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	80th	8.064	10399.2	8.16	10000	6500	68.8	2076	8	3512	15	7	0.2	0.5	183.6	183.6	0.005	0.108	0.0005	0.0005	0.003	0.002	0.49	0.52	0.286	0.464	0.05	0.0522	0.00005	0.00005	0.001	0.002	0.005	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	count	24	24	23	23	17	23	24	24	23	23	24	16	22	23	22	22	16	18	18	22	22	18	17	23	23	19	19	18	18	23	23	19	22	18	18	21	22
RB4	Rangal Coal Measures	mini	7.78	7040	7.79	7100	4800	14	1320	7	1970	6	4	0.4	0.5	51	98	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.42	0.41	0.025	0.09	0.001	0.007	0.00005	0.00005	0.002	0.003	0.0006	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	max	9.86	8240	9.23	8070	5240	66	1660	27	2680	20	38	0.5	47	210	210	0.06	0.78	0.0005	0.0005	0.002	0.002	0.53	0.56	0.23	1.18	0.037	0.071	0.00005	0.00005	0.018	0.019	0.005	0.005	0.0005	0.0005	1760	10
RB4	Rangal Coal Measures	median	8.03	7820	8.08	7640	4980	53	1535	8.5	2540	9	6	0.4	0.5	180	179	0.005	0.06	0.0005	0.0005	0.0005	0.0005	0.46	0.49	0.1	0.26	0.013	0.017	0.00005	0.00005	0.004	0.005	0.005	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	20th	7.95	7655	8.02	7488	4888	32.4	1472	8	2430	8	5	0.4	0.5	152.8	152.4	0.005	0.05	0.0005	0.0005	0.0005	0.0005	0.434	0.47	0.025	0.194	0.0078	0.0112	0.00005	0.00005	0.003	0.003	0.005	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	80th	8.47	8049	8.33	7734	5064	61	1564	16.4	2592	10	14	0.4	4.8	189.6	188.8	0.038	0.33	0.0005	0.0005	0.001	0.001	0.486	0.52	0.2	0.47	0.0144	0.0204	0.00005	0.00005	0.0066	0.007	0.005	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	count	24	24	24	24	17	24	24	24	24	24	8	17	24	24	24	24	17	20	20	24	24	19	18	24	24	20	20	20	20	24	24	21	24	19	20	23	23
RB5	Rangal Coal Measures	mini	7.64	7040	7.47	6800	4420	40	1220	5	1760	8	1	0.05	0.5	183	183	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.36	0.38	0.025	0.17	0.015	0.027	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	max	9.17	7540	8.5	7430	4830	72	1570	11	2400	18	12	0.4	20	467	467	0.02	0.38	0.0005	0.0005	0.002	0.002	0.52	0.52	0.66	1.43	0.067	0.079	0.00005	0.00005	0.006	0.006	0.005	0.005	0.0005	0.0005	120	10
RB5	Rangal Coal Measures	median	7.865	7235	8.05	7070	4570	51	1420	6	2295	9	2.5	0.3	0.5	219	219.5	0.005	0.07	0.0005	0.0005	0.0005	0.0005	0.44	0.47	0.155	0.43	0.03	0.0355	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	20th	7.752	7086	7.928	6976	4462	44.6	1376	5	2178	8	1	0.3	0.5	216	216.6	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.42	0.444	0.025	0.37	0.0262	0.0308	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	80th	8.064	7400	8.274	7162	4702	53.4	1480	7	2364	9.4	7.4	0.4	0.5	224.2	227.4	0.005	0.148	0.0005	0.0005	0.001	0.001	0.488	0.49	0.286	0.67	0.0412	0.0482	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	count	18	18	17	17	16	17	17	17	17	17	17	16	17	17	17	17	16	13	13	17	17	13	12	17	17	13	13	13	13	17	17	14	17	13	13	16	16
RB6	Rangal Coal Measures	mini	6.86	6310	7.23	6890	4480	115	813	8	1680	130	75	0.05	0.5	221	221	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.26	0.24	0.08	0.81	0.047	0.088	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	max	7.94	7520	8.21	7730	5020	225	1240	10	2330	297	176	0.4	0.5	493	493	0.005	17.4	0.0005	0.0005	0.002	0.009	0.46	0.44	3.51	62.9	0.108	1.28	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	100	10
RB6	Rangal Coal Measures	median	6.93	7309	7.45	7110	4625	189	888	9	2220	277	143	0.05	0.5	452	452	0.005	2.52	0.0005	0.0005	0.0005	0.002	0.33	0.37	0.84	7.45	0.071	0.217	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	20th	6.89	7028	7.33	6972	4520	180.2	856.8	8	2106	265	137.2	0.05	0.5	423.8	423.8	0.005	0.75	0.0005	0.0005	0.0005	0.0005	0.314	0.332	0.268	2.756	0.0674	0.1056	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	80th	7.19	7408	7.86	7266	4720	196	919	9	2278	285.4	153	0.1	0.5	463.4	463.4	0.005	9.42	0.0005	0.0005	0.0005	0.003	0.34	0.388	1.218	17.68	0.0784	0.3948	0.00005	0.00005	0.0005	0.001	0.005	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	count	33	33	32	32	18	32	32	32	32	32	32	18	32	32	32	32	15	27	27	32	32	19	18	32	32	27	27	27	27	32	32	28	31	26	27	31	30
WSMB2D	Rangal Coal Measures	mini	6.3	10670	7.02	10600	6890	203	1840	13	3280	221	340	0.05	0.5	414	414	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.34	0.38	0.025	0.46	0.081	0.079	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	max	7.27	13620	8.2	13800	8970	310	2370	18	4270	288	740	0.2	0.5	616	616	0.02	0.16	0.0005	0.0005	0.008	0.007	0.62	0.63	1.86	3.44	0.175	0.183	0.00005	0.00005	0.005	0.005	0.005	0.005	0.0005	0.0005	420	10
WSMB2D	Rangal Coal Measures	median	6.78	12470	7.535	12250	7830	258	2105	14	3920	251	626	0.1	0.5	569.5	569.5	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.52	0.56	1.535	1.675	0.093	0.1	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	20th	6.698	12177.4	7.246	11800	7486	230.6	1970	14	3680	237.2	498.2	0.1	0.5	548.8	548.8	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.496	0.52	1.244	1.46	0.0902	0.0944	5E-05	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	80th	6.906	12769.6	7.816	12600	8000	279.2	2188	15	4150	265.6	664.4	0.1	0.5	589.2	589.2	0.005	0.068	0.0005	0.0005	0.0009	0.001	0.548	0.586	1.616	1.772	0.1008	0.1114	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	count	30	30	30	30	17	30	30	30	30	30	11	17	30	30	30	30	13	24	24	30	30	16	15	30	30	24	24	24	24	30	30	25	30	23	24	30	29
WSMB3D	Rangal Coal Measures	mini	7.27	5720	7.21	5890	3890	107	871	5	1610	61	2	0.2	0.5	114	114	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.25	0.28	0.025	0.19	0.089	0.09	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	max	8.20	6700	8.28	6740	4380	148	1180	8	2180	83	17	0.2	0.5	147	147	0.02	0.09	0.0005	0.0005	0.0005	0.001	0.38	0.39	0.54	0.6	0.227	0.26	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	360	10
WSMB3D	Rangal Coal Measures	median	7.59	6421	7.88	6245	4050	120	1040	7	1925	76.5	3	0.2	0.5	127	127	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.335	0.35	0.34	0.505	0.098	0.103	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	20th	7.47	6249	7.71	6036	3962	118.6	983.6	6	1816	74	2	0.2	0.5	122.8	122.8	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.3	0.334	0.176	0.308	0.093	0.098	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	80th	7.76	6550	8.02	6360	4124	131.6	1082	7	2082	80	5	0.2	0.5	132.2	132.2	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.35	0.36	0.482	0.59	0.1028	0.109	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	count	5	5	5	5	NC	5	5	5	5	5	5	NC	5	5	5	5	NC	5	5	5	5	NC	NC	5	5	5	5	5	5	5	NC	5	5	5	5	5	5
Conmurra Bore	Regolith	mini	7.1	4940	7.61	4350	NC	76	605	9	1020	152	91	NC	0.5	648	648	0.005	NC	0.0005	0.0005	0.0005	0.001	NC	NC	0.025	0.54	0.014	0.03	0.00005	0.00005	0.0005	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	max	7.34	6690	7.88	5620	NC	112	745	13	1260	219	167	NC	0.5	734	734	0.005	NC	0.0005	0.0005	0.003	0.01	NC	NC	0.025	11	0.069	0.757	0.00005	0.00005	0.003	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	median	7.22	5050	7.67	4840	NC	90	728	11	1200	161	118	NC	0.5	666	666	0.005	NC	0.0005	0.0005	0.002	0.004	NC	NC	0.025	2.73	0.033	0.076	0.00005	0.00005	0.002	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	20th	7.18	5012	7.642	4622	NC	85.6	610.6	10.6	1116	152	107.8	NC	0.5	662.4	662.4	0.005	NC	0.0005	0.0005	0.0009	0.0018	NC	NC	0.025	1.932	0.0164	0.046	0.00005	0.00005	0.0009	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	80th	7.308	5378	7.856	5036	NC	102.4	733	12.2	1228	203.8	151	NC	0.5	731.6	731.6	0.005	NC	0.0005	0.0005	0.0022	0.0068	NC	NC	0.025	6.248	0.0522	0.2162	5E-05	5E-05	0.0022	NC	0.005	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	count	33	33	32	32	18	32	32	32	32	32	32	18	32	32	32	32	18	27	27	32	32	19	18	32	32	27	27	27	27	32	32	28	31	26	27	31	30
WSMB2S	Regolith	mini	6.77	8860	7.20	9430	6130	146	1470	14	2740	223	214	0.05	0.5	457	457	0.005	0.06	0.0005	0.0005	0.002	0.002	0.24	0.43	0.025	0.77	0.095	0.137	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	max	8.30	11260	8.33	10400	6760	183	1890	29	3330	279	319	0.05	17	954	972	0.02	19.2	0.0005	0.0005	0.008	0.022	0.54	0.56	1.36	31	0.436	0.524	0.00005	0.0001	0.002	0.003	0.005	0.005	0.002	0.0005	710	10
WSMB2S	Regolith	median	6.97	10152	7.70	9995	6485	167	1655	15.5	3125	249.5	248	0.05	0.5	744	744	0.005	0.96	0.0005	0.0005	0.004	0.008	0.46	0.495	0.68	7.34	0.152	0.241	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	20th	6.86	10018	7.44	9772	6344	153	1592	15	2984	241	232.6	0.05	0.5	700.2	700.2	0.005	0.218	0.0005	0.0005	0.003	0.005	0.432	0.468	0.142	1.794	0.1282	0.187	5E-05	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	80th	7.20	10470	7.93	10300	6644	175	1720	16	3260	259.8	266.8	0.05	0.5	778.4	778.4	0.005	7.924	0.0005	0.0005	0.006	0.012	0.484	0.522	0.844	14.44	0.1786	0.3026	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3S	Regolith	count	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	NC	NC	9	9	NC	NC	9	9	NC	NC	NC	NC	9	9	NC	9	NC	NC	9	9
WSMB3S	Regolith	mini	6.3	6853	6.81	6440	4190	280	854	12	2270	169	66	0.4	0.5	150	150	0.005	0.29	NC	NC	0.0005	0.0005	NC	NC	0.025	0.49	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	max	6.67	7503	8.01	7250	4710	310	949	12	2410	184	81	0.4	0.5	193	193	0.005	25.5	NC	NC	0.001	0.003	NC	NC	0.025	46.6	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	median	6.42	7159	7.39	7010	4560	290	888	12	2350	181	72	0.4	0.5	161	161	0.005	5.21	NC	NC	0.0005	0.0005	NC	NC	0.025	10.2	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	20th	6.37	7105	7.004	6718	4366	286.4	874.8	12	2324	176.6	70	0.4	0.5	153.6	153.6	0.005	1.548	NC	NC	0.0005	0.0005	NC	NC	0.025	2.664	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	80th	6.486	7280.4	7.66	7120	4628	304.4	919.6	12	2400	182	74.4	0.4	0.5	178	178	0.005	14.52	NC	NC	0.0005	0.0024	NC	NC	0.025	27.5	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
Jamar Bore	Rewan	count	29	29	36	36	13	36	36	36	36	36	10	13	36	36	33	33	NC	29	26	33	30	15	14	36	28	30	26	27	26	33	30	30	30	27	26	26	26
Jamar Bore	Rewan	mini	6.60	764	6.95	1300	2520	30	112	5	200	47	1	0.05	0.5	105	105	0.005	NC	0.0005	0.0005	0.001	0.002	0.26	0.3	0.025	0.05	0.103	0.198	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
Jamar Bore	Rewan	max	8.24	4770	8.32	4430	2880	94	770	15	1400	80	3	0.2	4	397	397	0.04	NC	0.001	0.001	0.041	0.042	0.36	0.37	6.75	4.49	0.515	0.357	0.0001	0.0001	0.002	0.001	0.1	0.01	0.001	0.001	50	10
Jamar Bore	Rewan	median	7.53	4091	7.88	3990	2630	77.5	635	5.5	1225	64	1	0.1	0.5	122.5	122	0.005	NC	0.0005	0.0005	0.007	0.007	0.31	0.33	0.175	0.39	0.2545	0.2625	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Jamar Bore	Rewan	20th	7.17	4008	7.70	3880	2548	70	596	5	1140	61	1	0.1	0.5	112	111.4	0.005	NC	0.0005	0.0005	0.003	0.004	0.288	0.316	0.05	0.2	0.2108	0.23	5E-05	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Jamar Bore	Rewan	80th	7.85	4272	8.02	4170	2726	82	655	6	1290	69	1	0.1	1	137	135.4	0.008	NC	0.0007	0.0005	0.008	0.008	0.326	0.36	0.6	0.72	0.3068	0.282	0.00005	0.00005	0.0005	0.0005	0.01	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	count	33	33	42	42	17	42	42	42	42	42	42	17	42	42	37	37	16	33	30	37	34	19	18	42	34	34	30	31	30	37	34	34	34	31	30	30	30
Winton Creek Bore	Rewan	mini	7.35	3980	7.56	5760	4890	72	1060	5	1610	43	1	0.2	0.5	193	193	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.39	0.37	0.025	0.12	0.142	0.16	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	max	8.15	9228	8.35	9180	5970	219	1530	12	3040	139	147	0.4	9	381	381	0.01	0.18	0.001	0.001	0.003	0.003	0.5	0.54	0.53	1.66	0.322	0.331	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	110	10
Winton Creek Bore	Rewan	median	7.7	7500	7.86	7520	5220	109	1345	8	2405	66.5	34.5	0.3	0.5	249	254	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.45	0.475	0.125	0.355	0.191	0.2015	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	20th	7.518	7010	7.734	6896	5046	97.2	1226	7	2130	54	17	0.3	0.5	226	226	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.416	0.45	0.03	0.21	0.1672	0.184	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	80th	7.816	8362	8.09	8038	5570	153.2	1428	9	2616	92.8	88.6	0.3	1	284	284.8	0.005	0.06	0.0005	0.0005	0.001	0.001	0.464	0.5	0.2	0.884	0.2448	0.261	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10

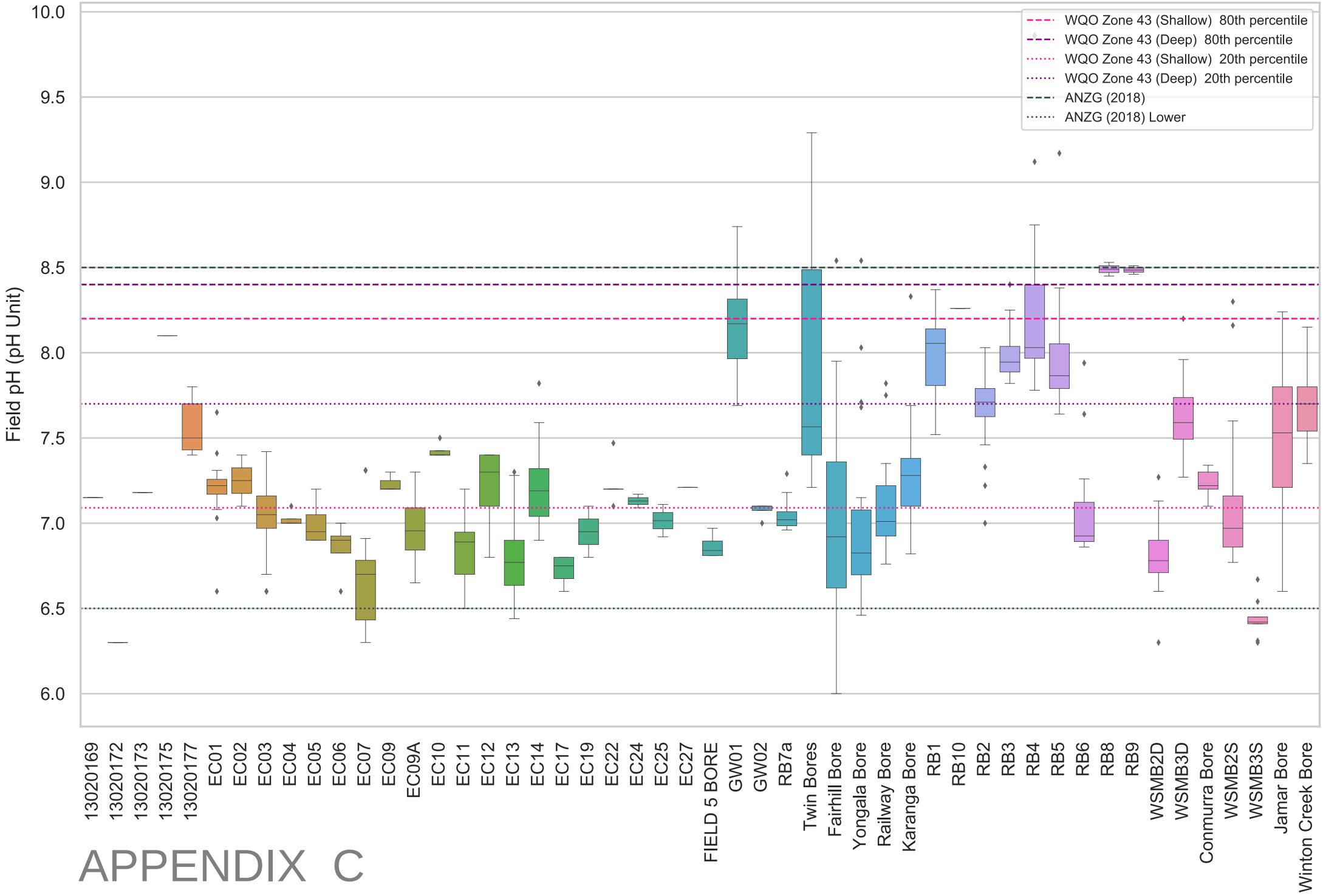
NC = Not Calculated (less than 4 data points)

APPENDIX C

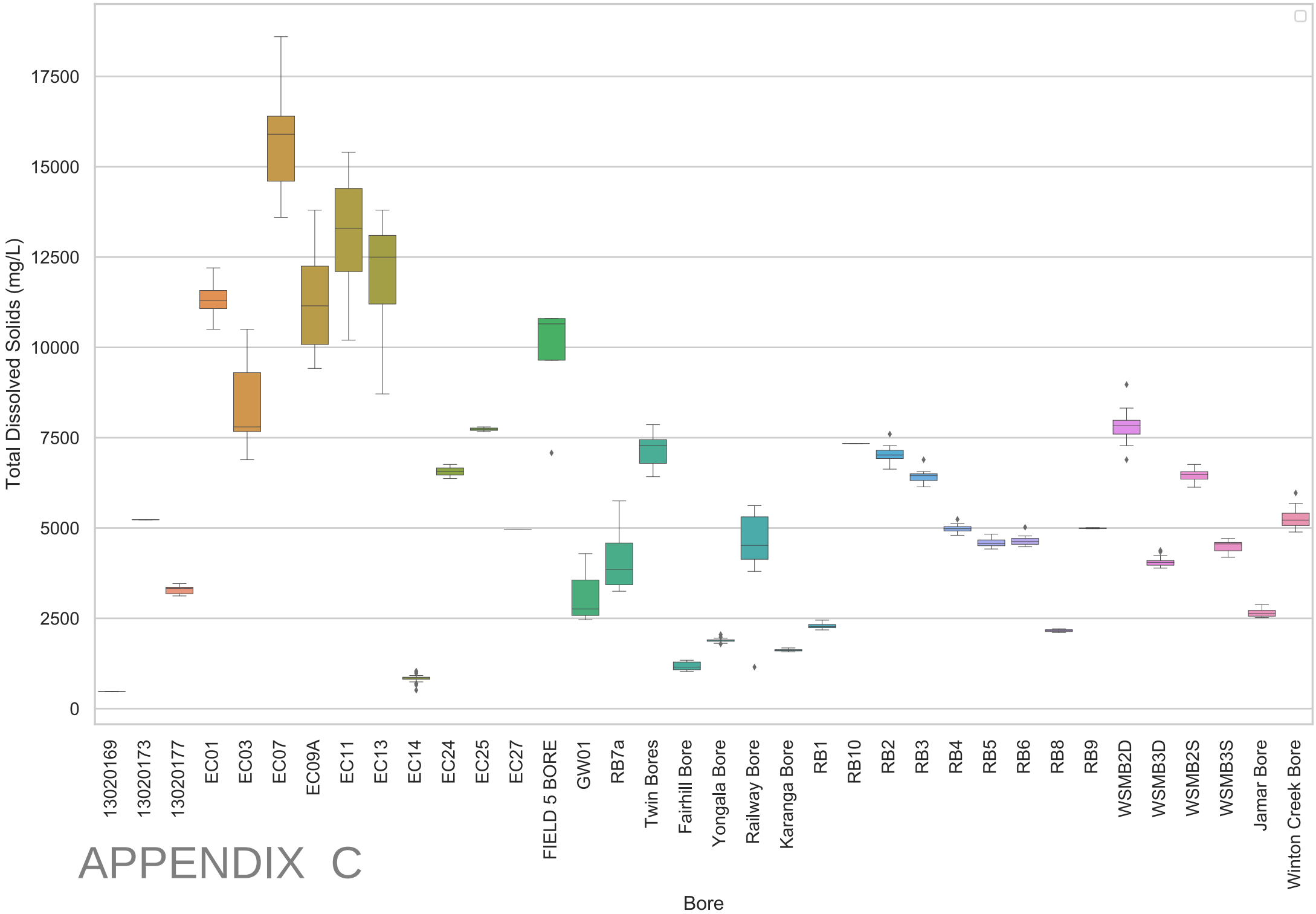
Water quality compared to regional and national guidelines - boxplots


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Field Electrical Conductivity (uS/cm)
40000
35000
30000
25000
20000
15000
10000
5000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

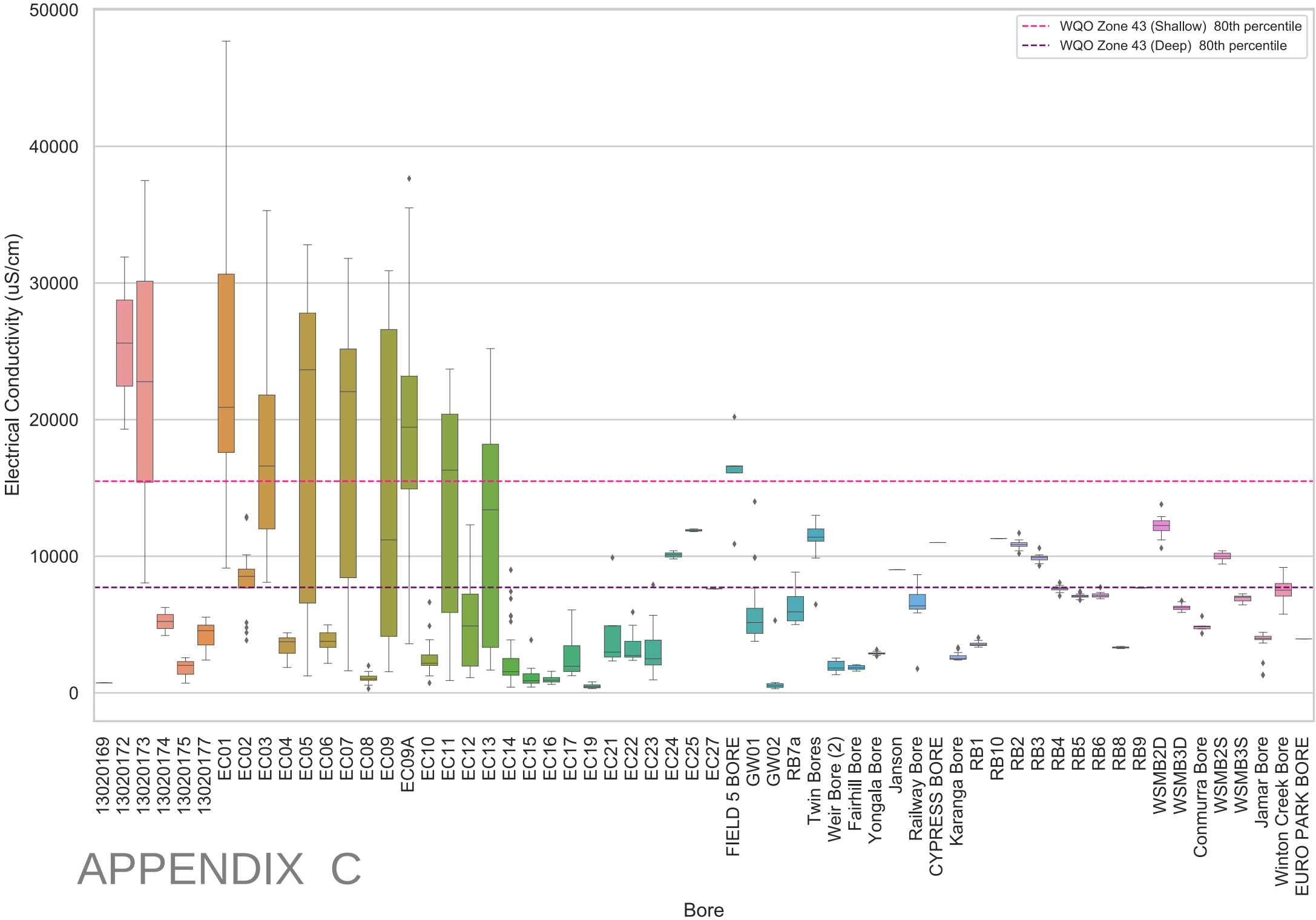
APPENDIX C


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
WQO Zone 43 (Shallow) 20th percentile
WQO Zone 43 (Deep) 20th percentile
ANZG (2018)
ANZG (2018) Lower
Field pH (pH Unit)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
13020169
13020172
13020173
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

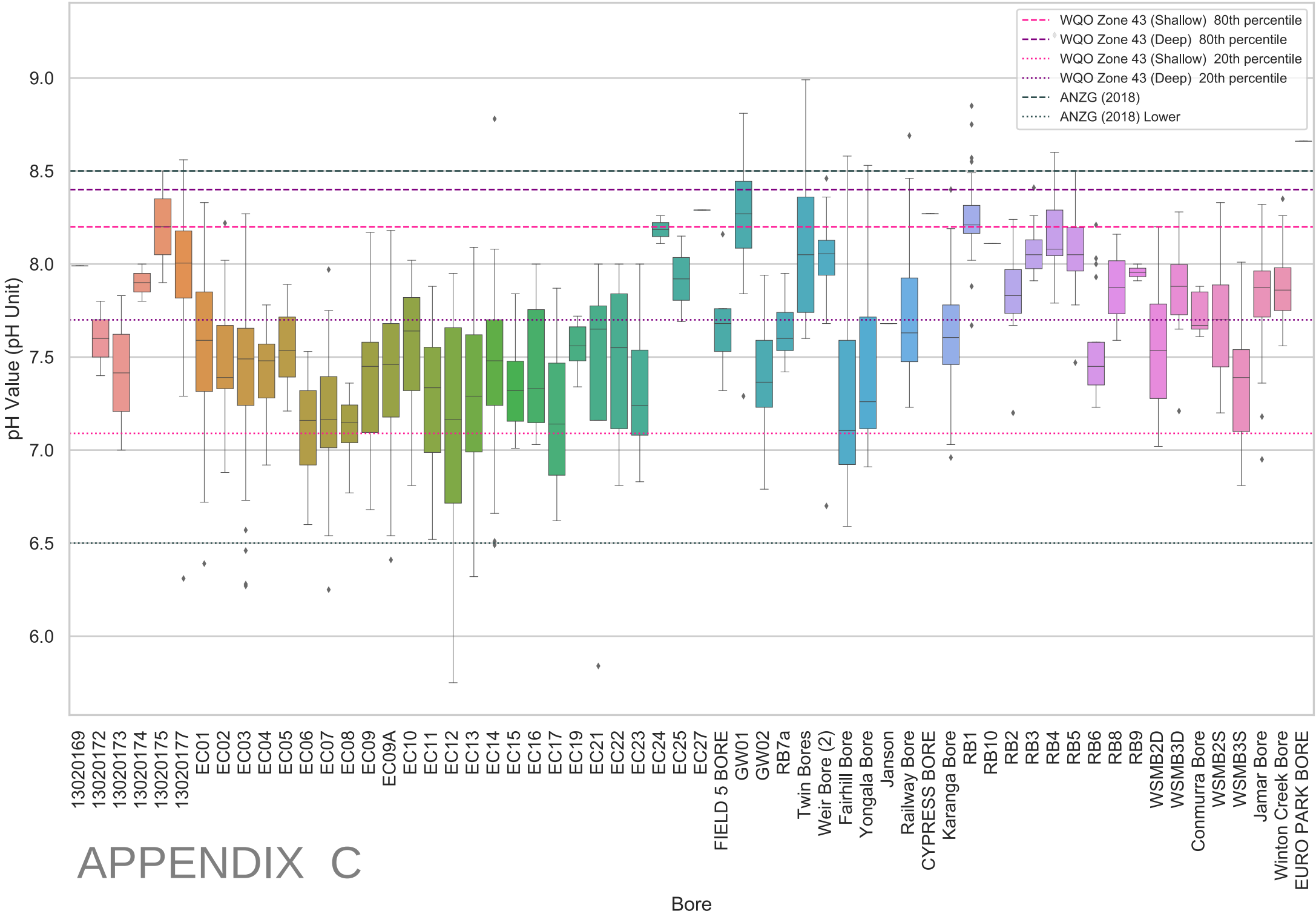
APPENDIX C


Total Dissolved Solids (mg/L)
0
2500
5000
7500
10000
12500
15000
17500
13020169
13020173
13020177
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
EC24
EC25
EC27
FIELD 5 BORE
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

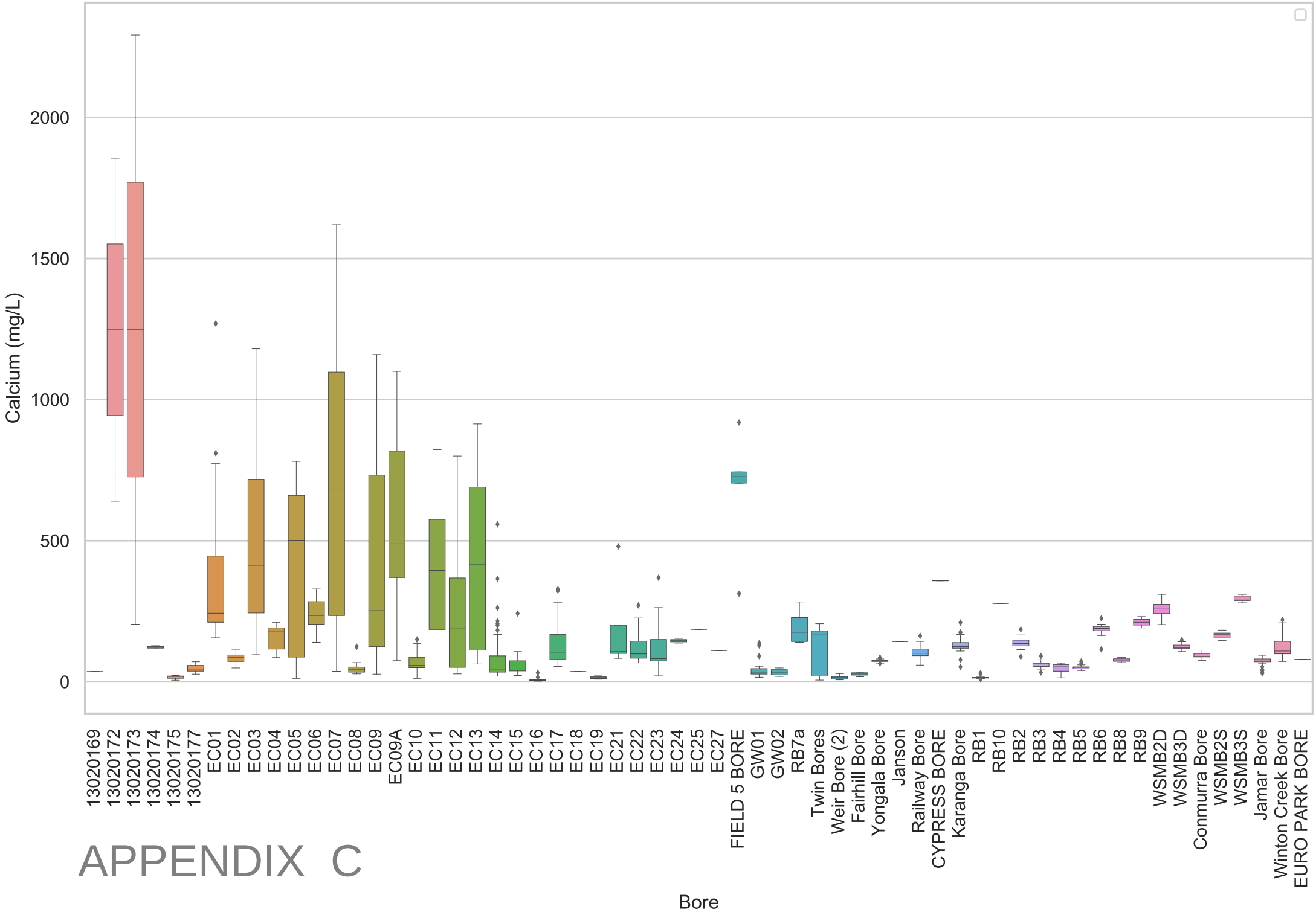
APPENDIX C


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Electrical Conductivity (uS/cm)
50000
40000
30000
20000
10000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

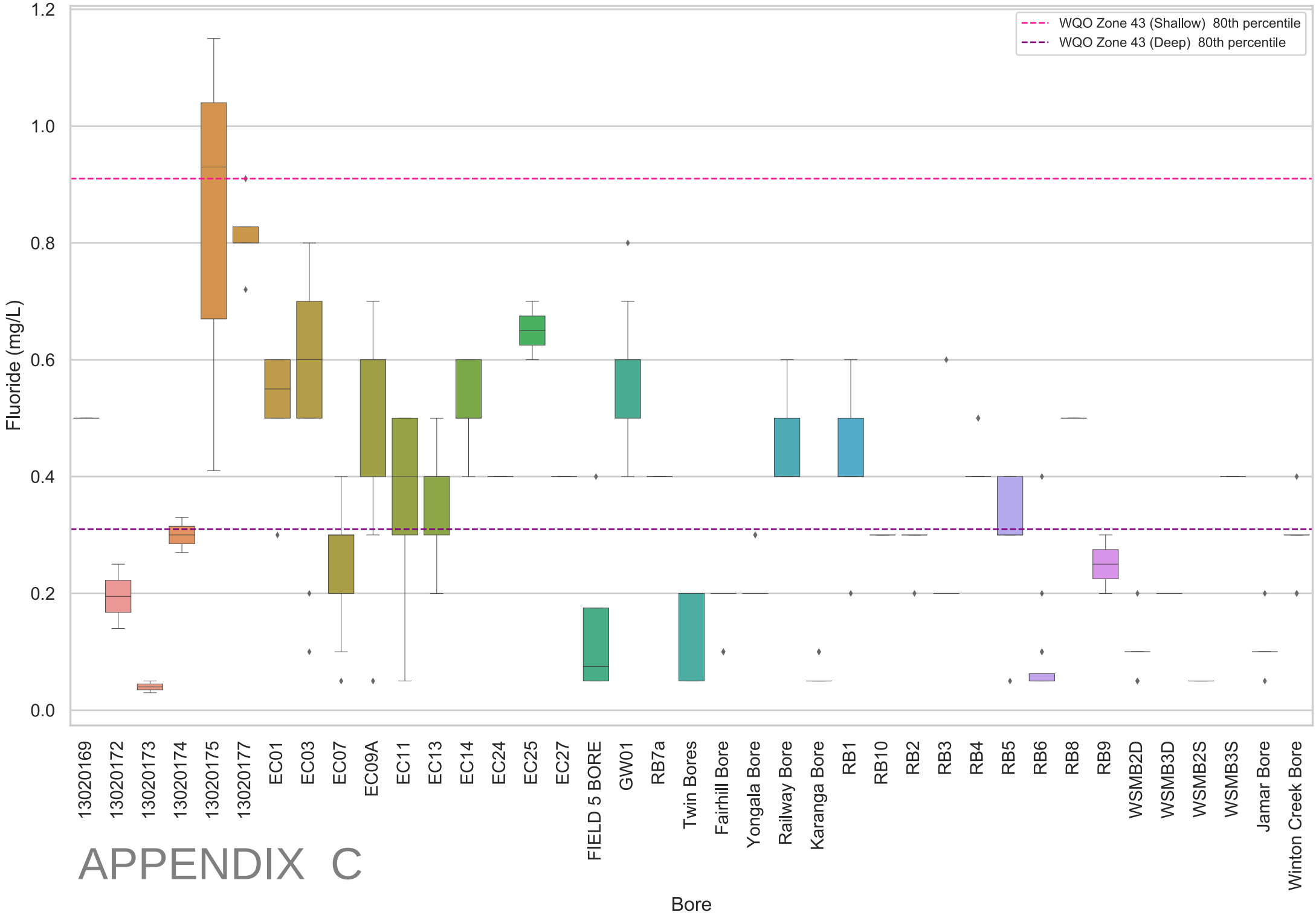
APPENDIX C


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
WQO Zone 43 (Shallow) 20th percentile
WQO Zone 43 (Deep) 20th percentile
ANZG (2018)
ANZG (2018) Lower
pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

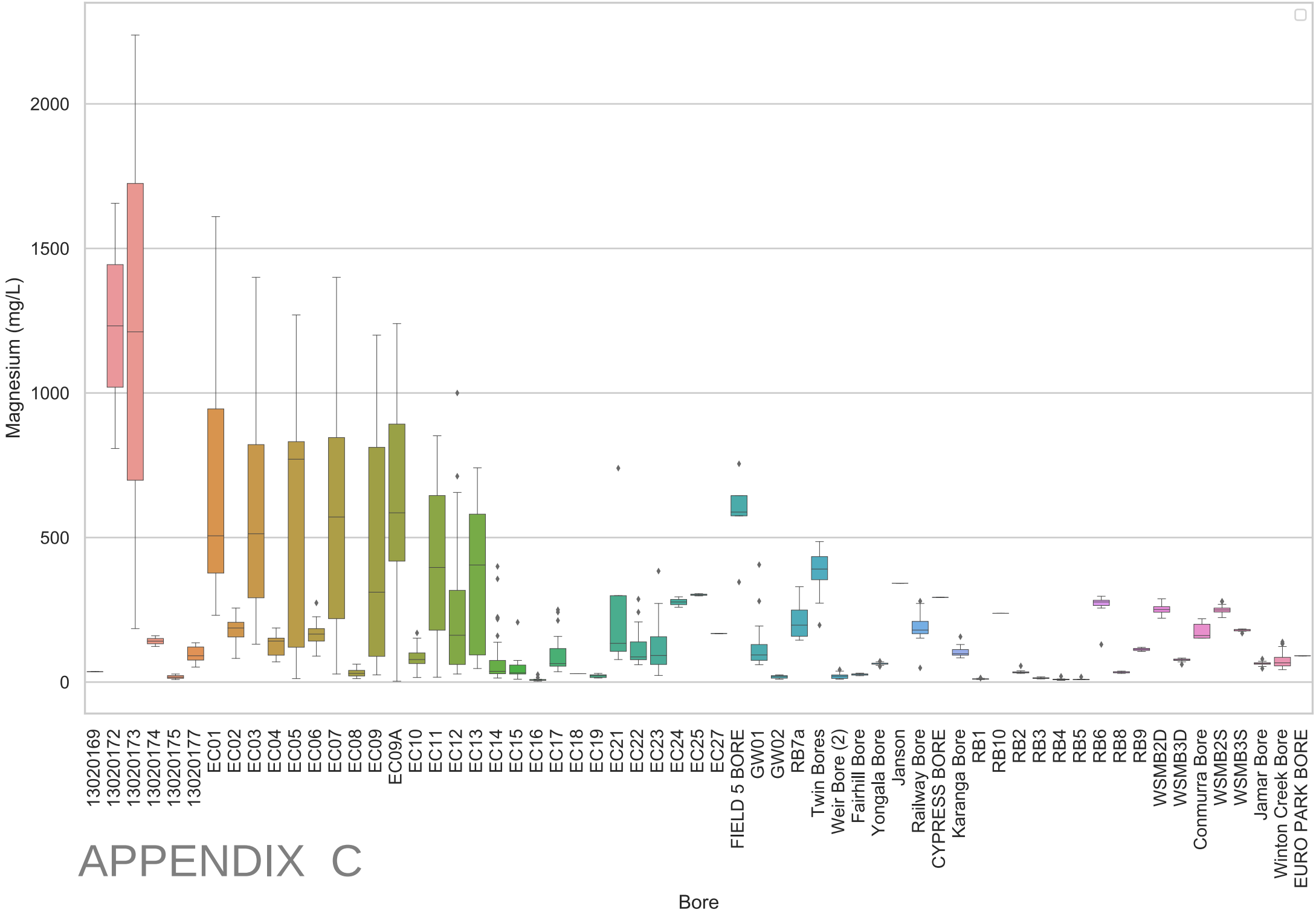
APPENDIX C


Calcium (mg/L)
2000
1500
1000
500
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

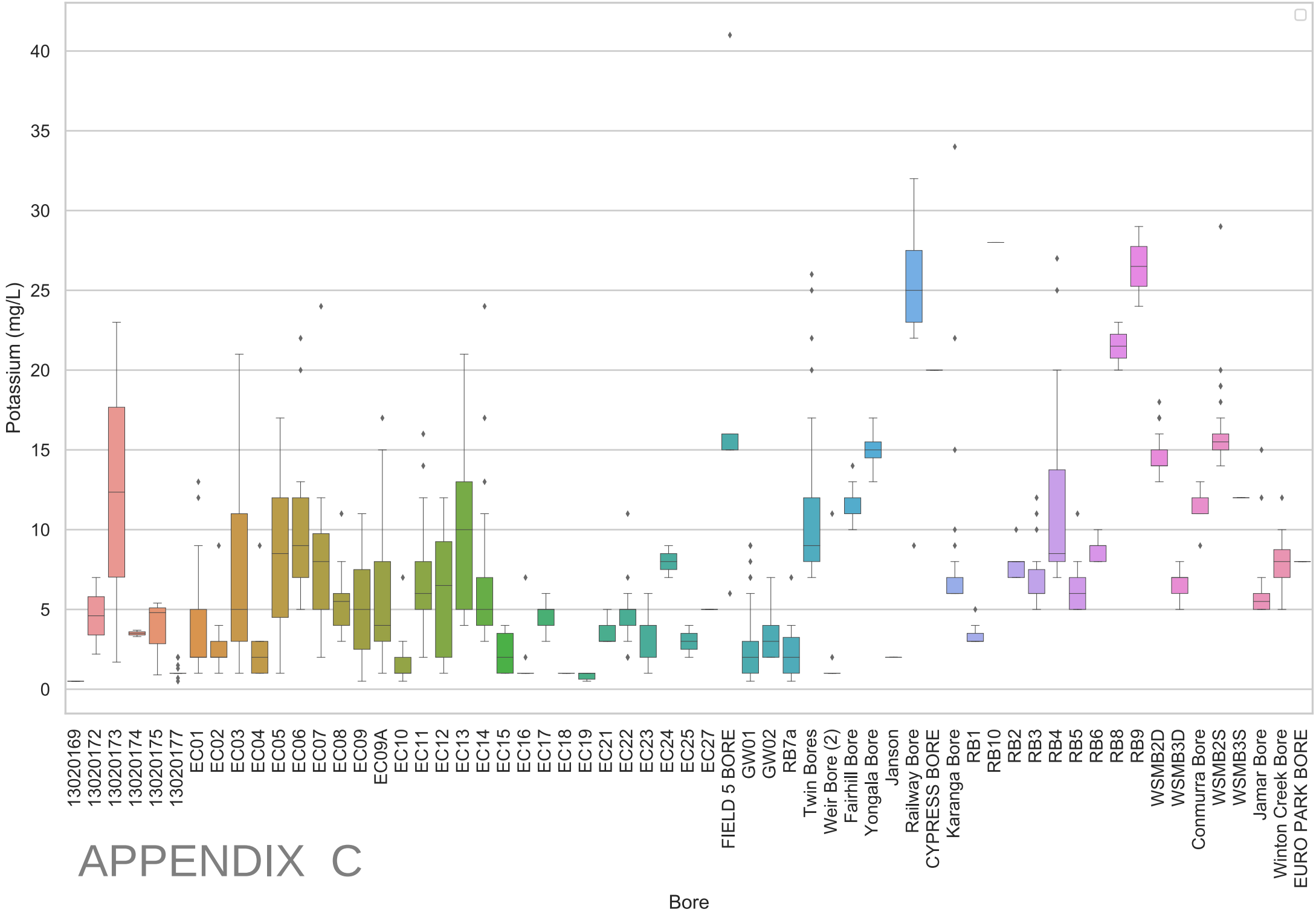
APPENDIX C


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Fluoride (mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
EC24
EC25
EC27
FIELD 5 BORE
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

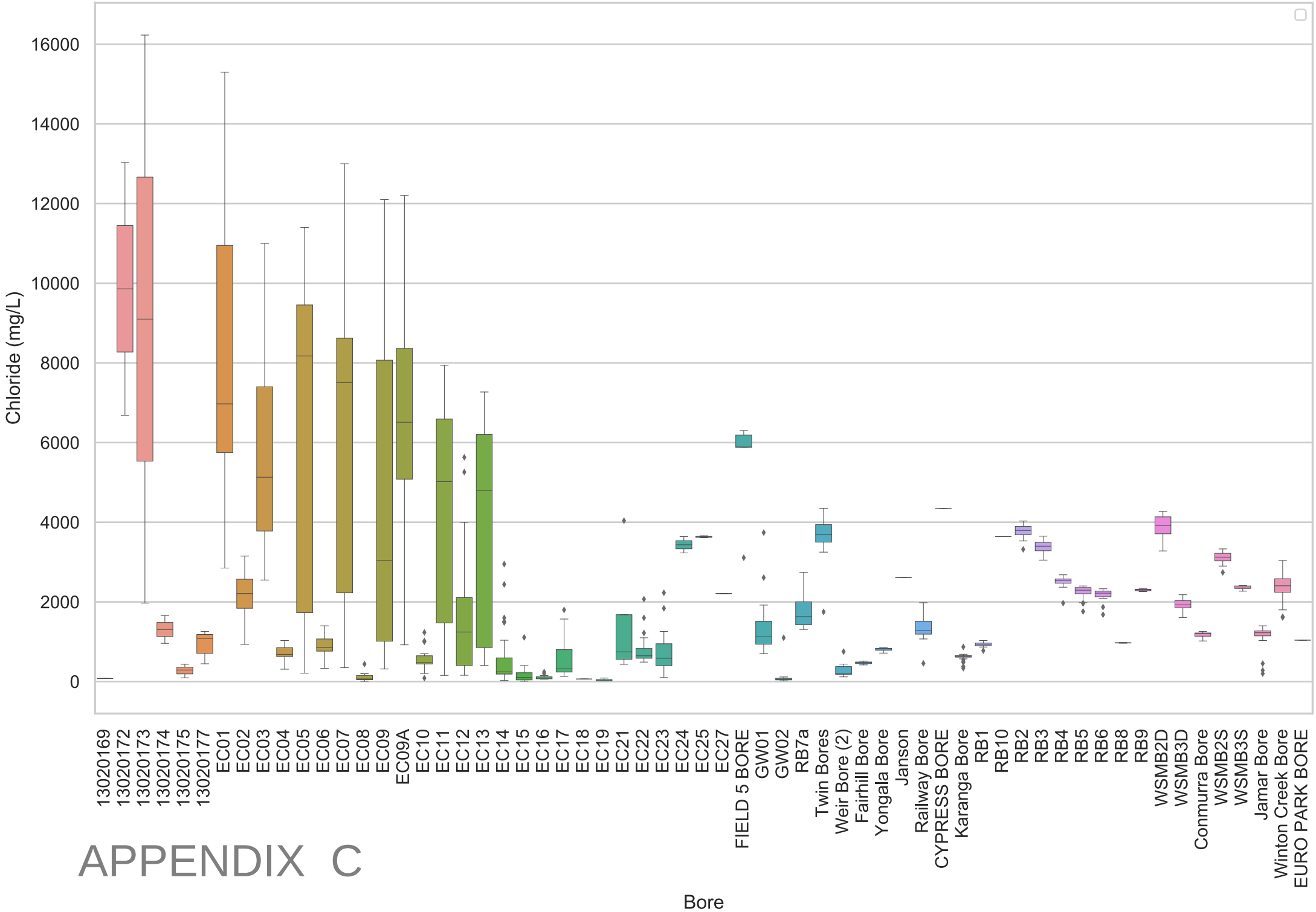
APPENDIX C


Magnesium (mg/L)
2000
1500
1000
500
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

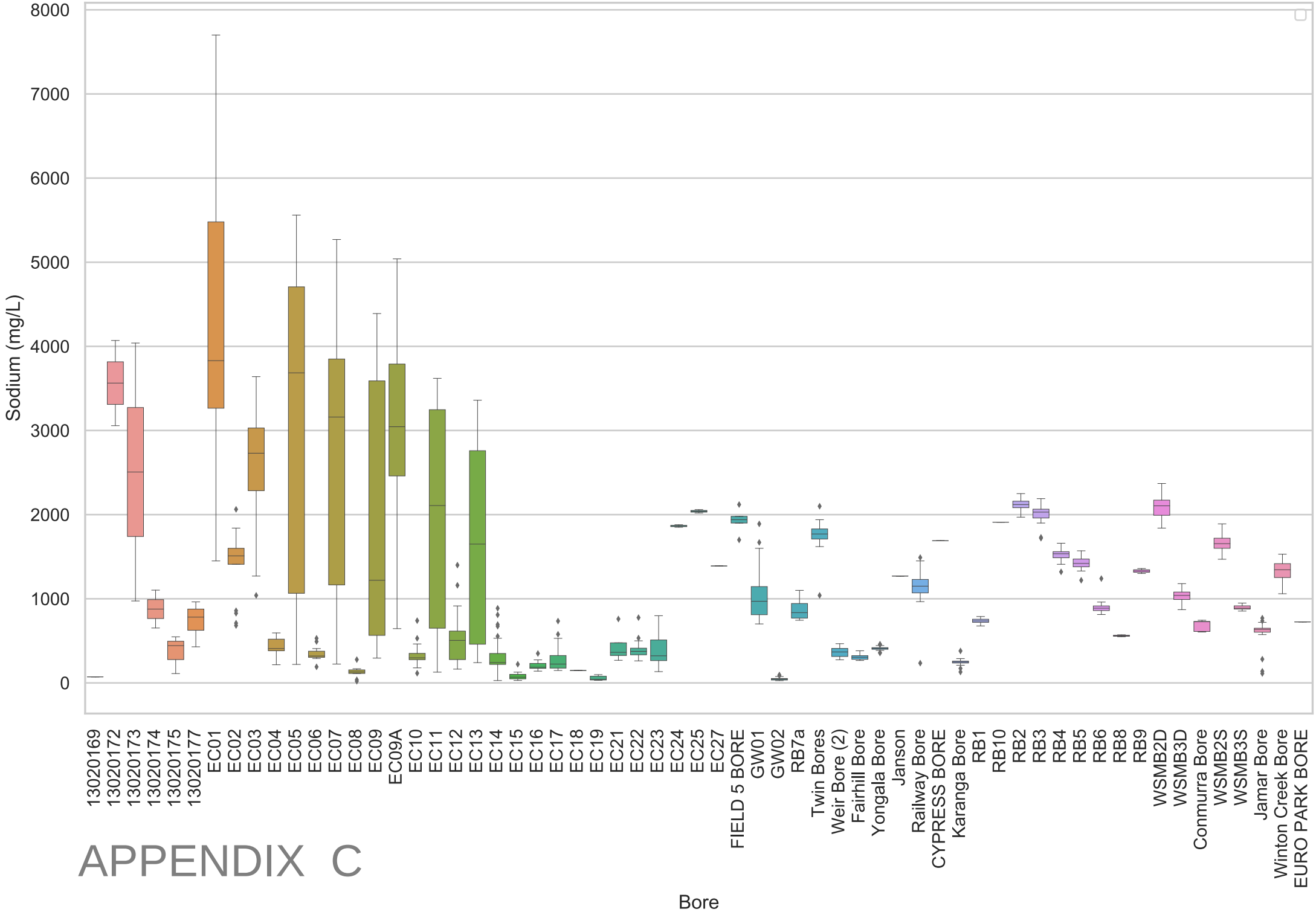
APPENDIX C


Potassium (mg/L)
0
5
10
15
20
25
30
35
40
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

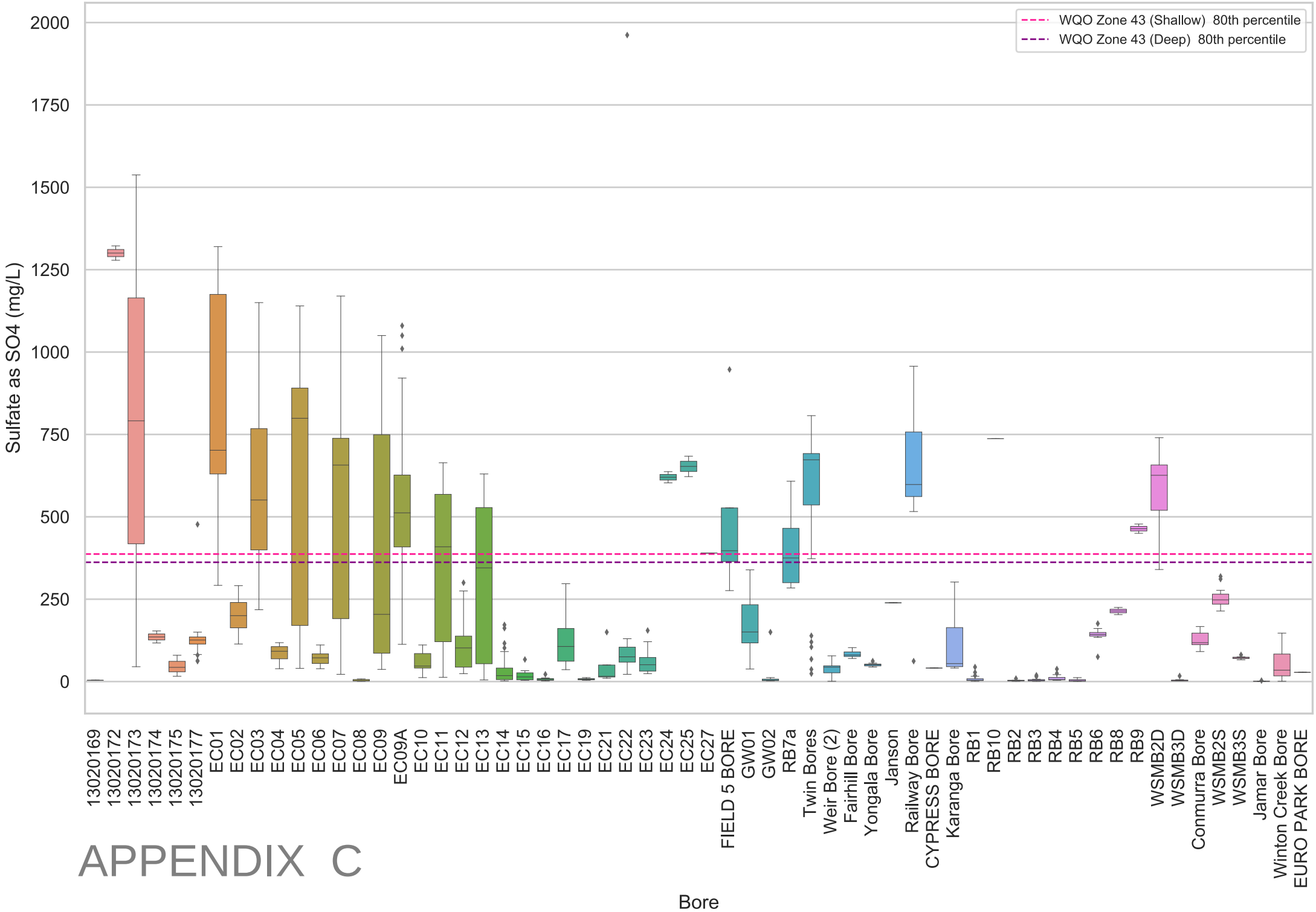
APPENDIX C


Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

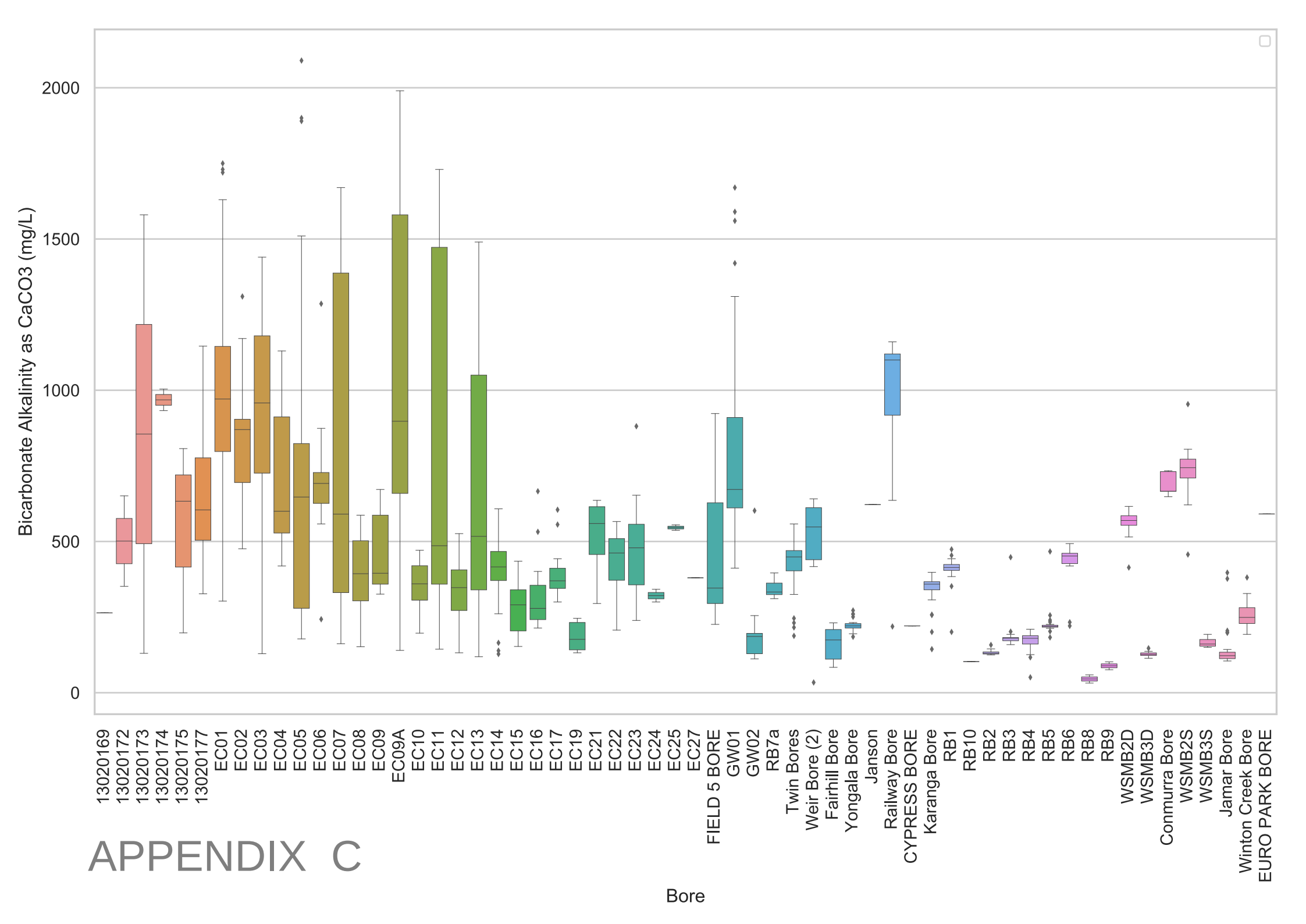
APPENDIX C


8000
7000
6000
5000
4000
3000
2000
1000
0
Sodium (mg/L)
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

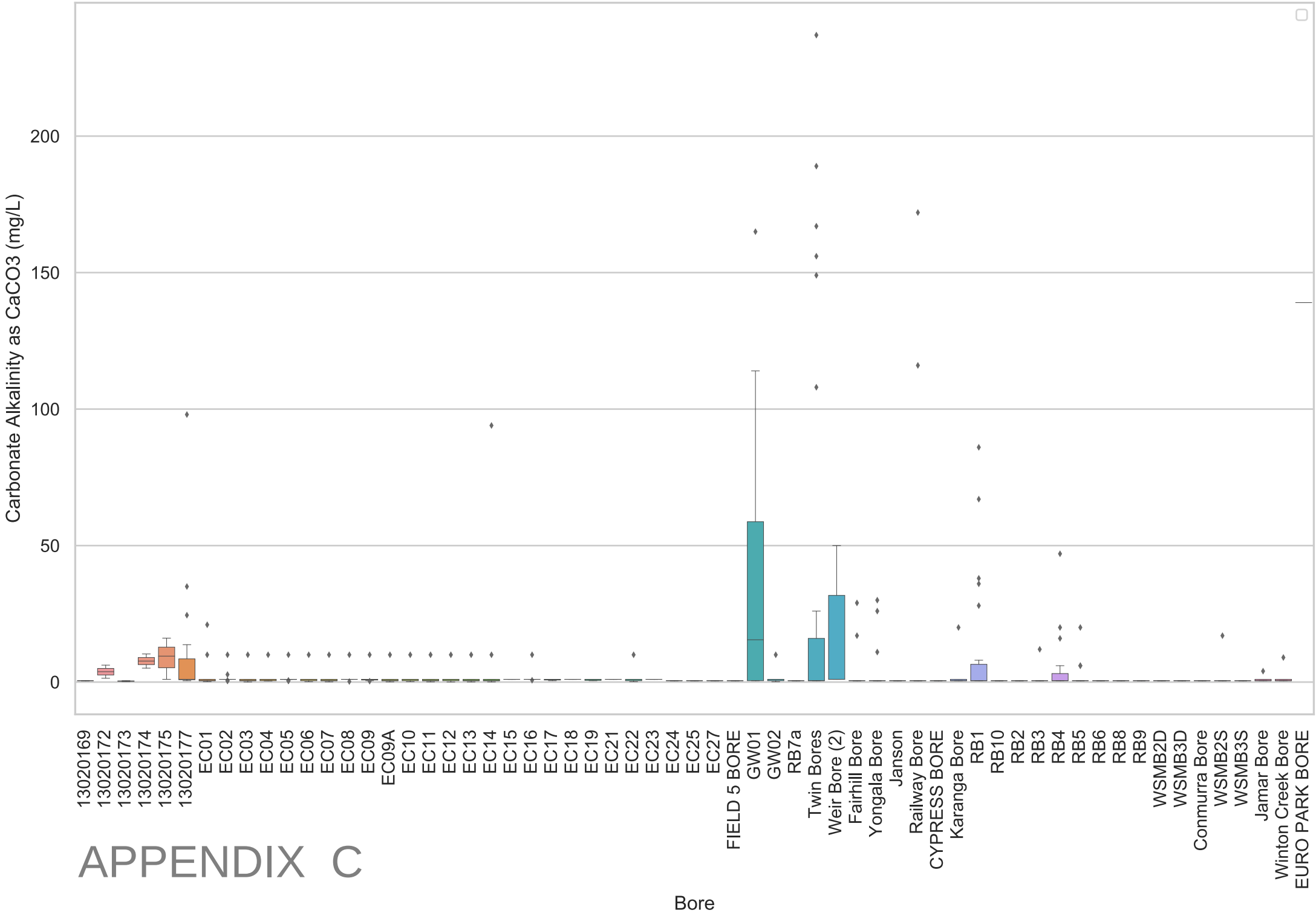
APPENDIX C


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Sulfate as SO4 (mg/L)
2000
1750
1500
1250
1000
750
500
250
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

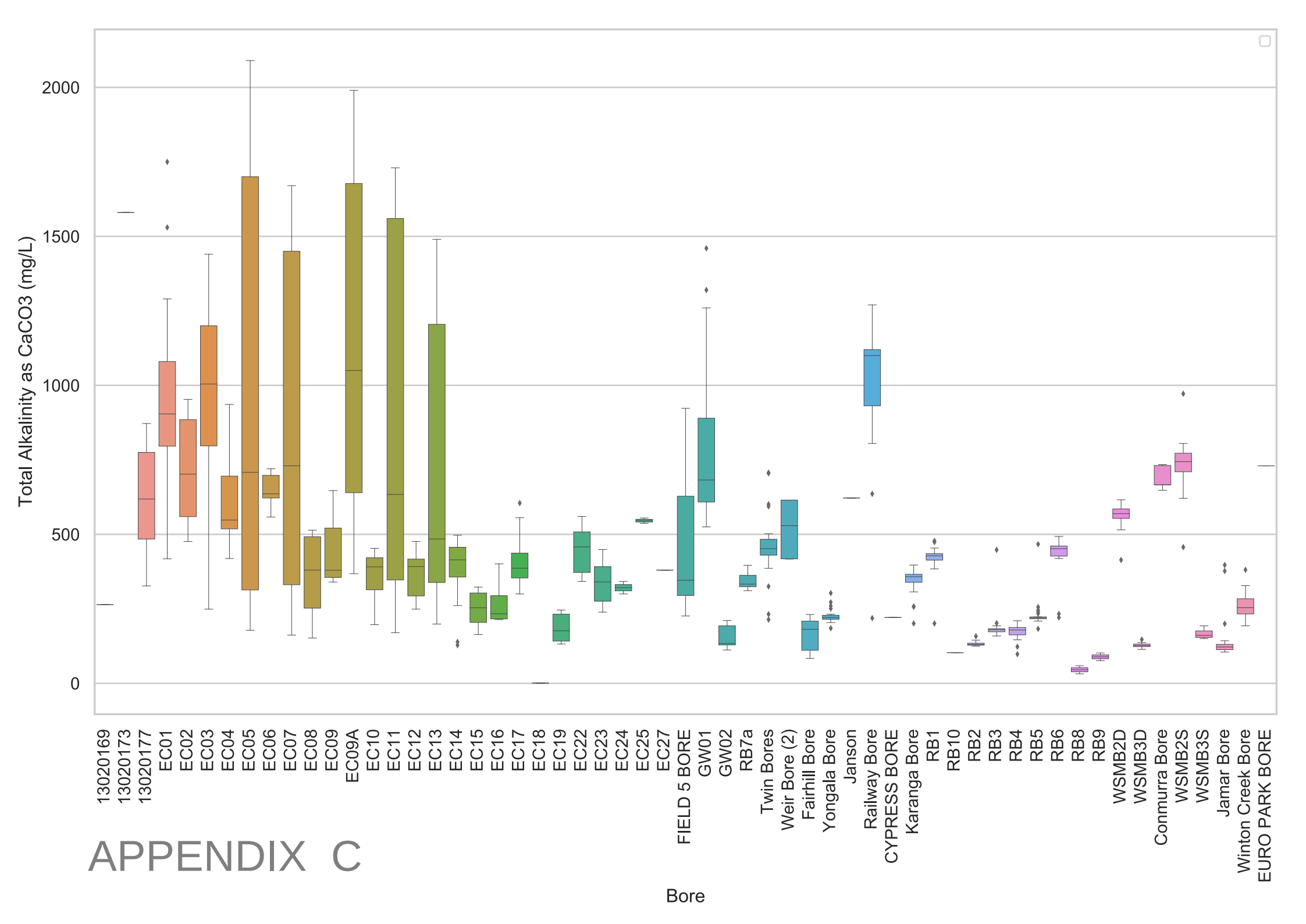
APPENDIX C


Bicarbonate Alkalinity as CaCO3 (mg/L)
2000
1500
1000
500
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

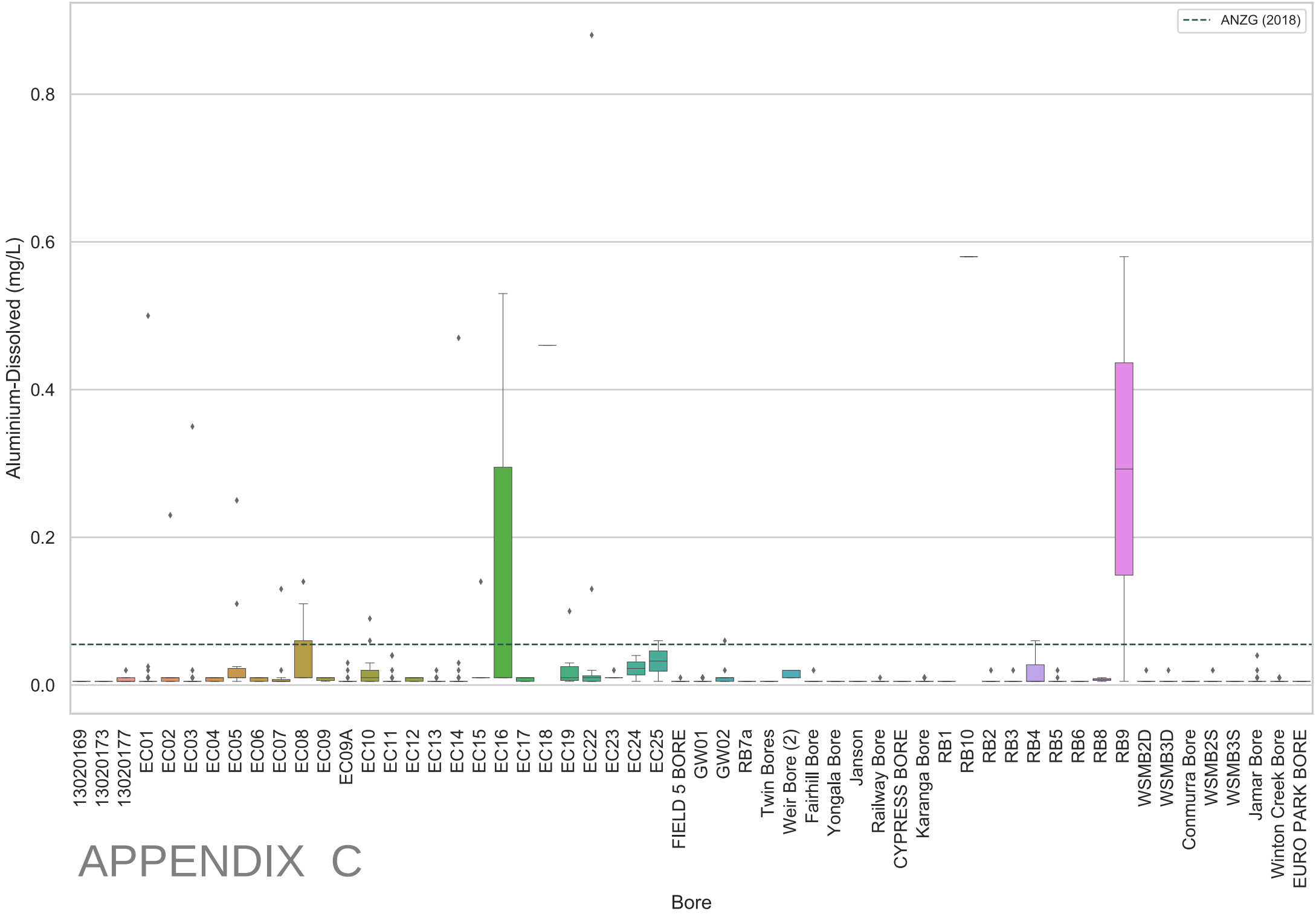
APPENDIX C


Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

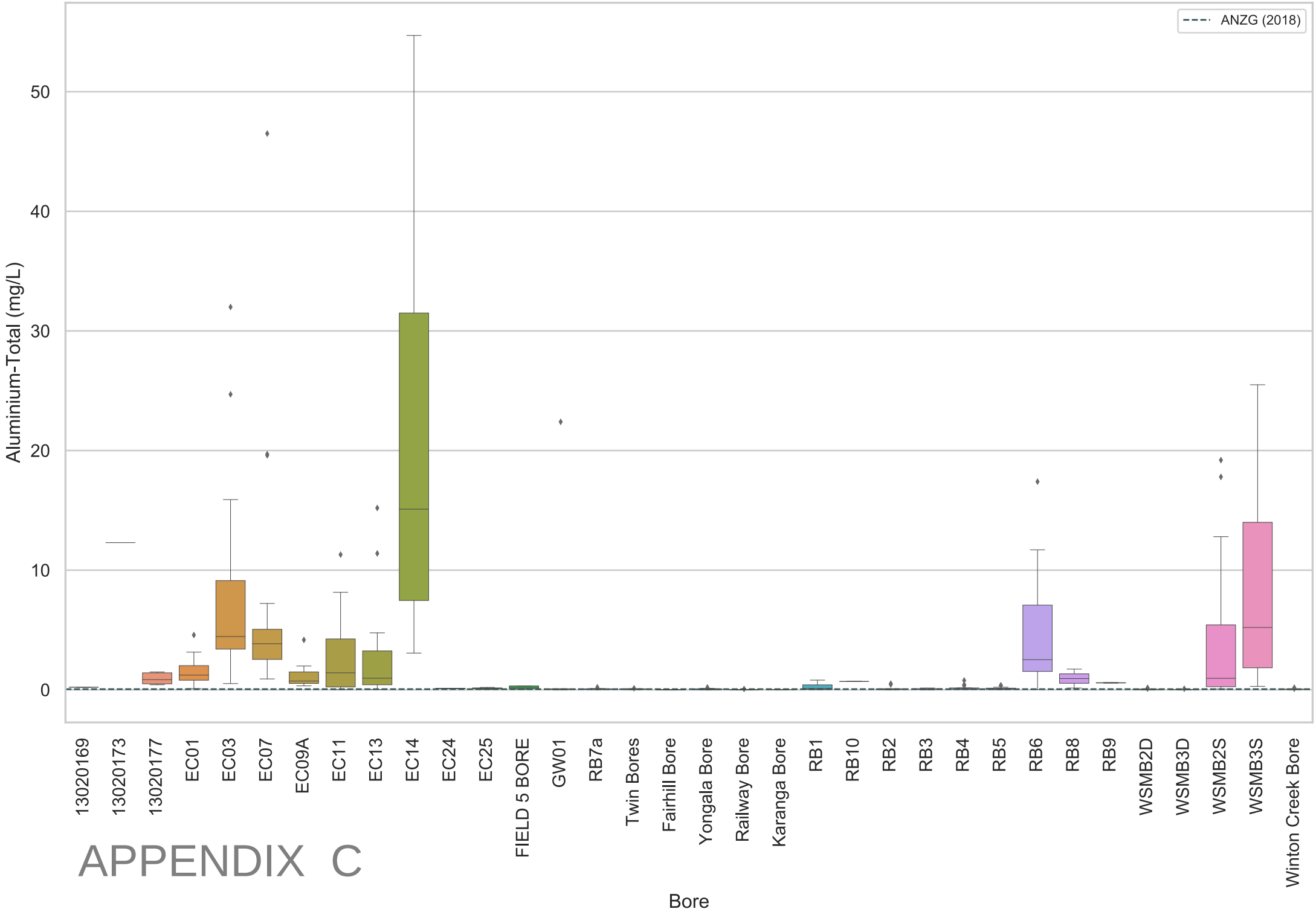
APPENDIX C


Total Alkalinity as CaCO3 (mg/L)
2000
1500
1000
500
0
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

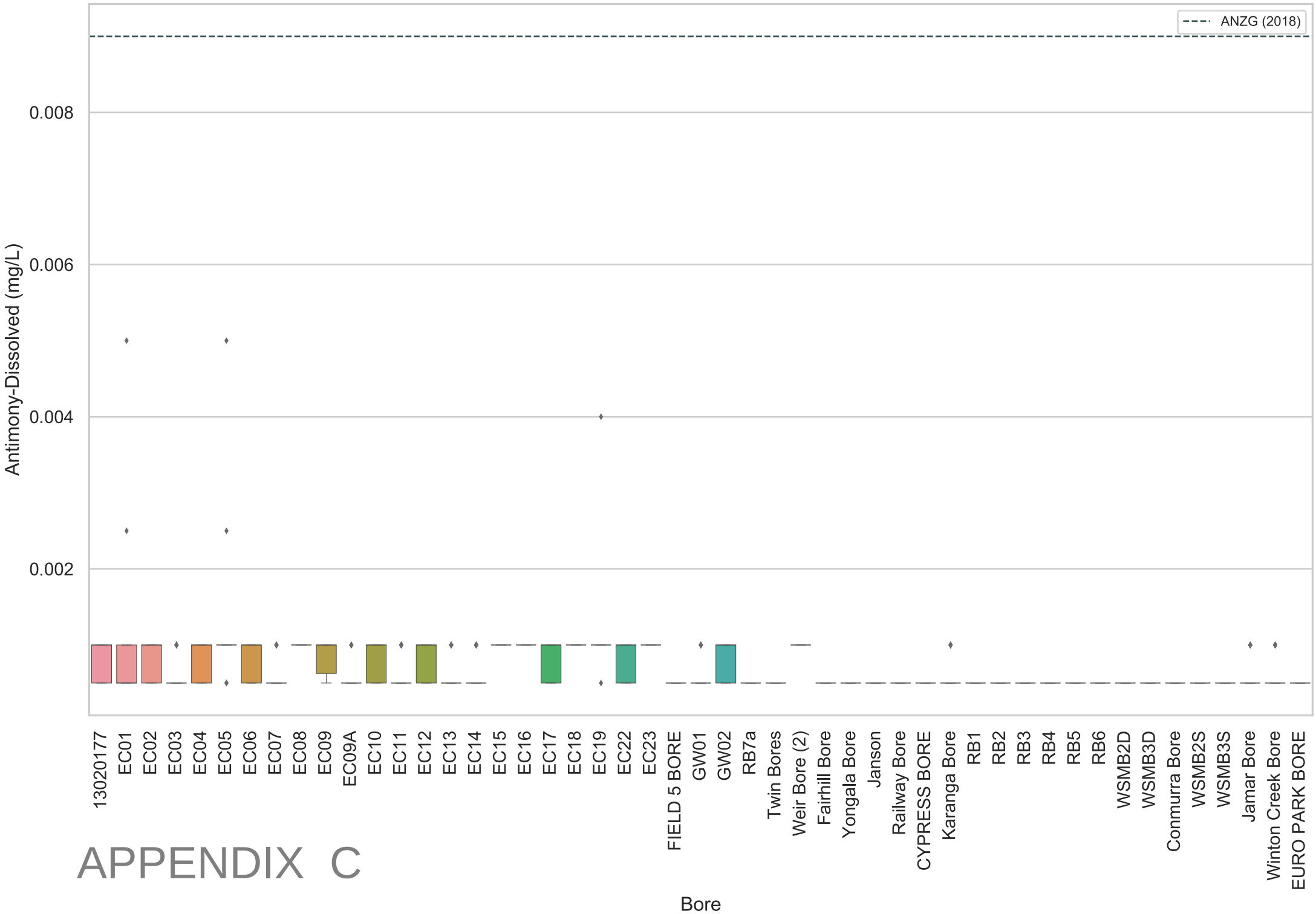
APPENDIX C


ANZG (2018)
Aluminium-Dissolved (mg/L)
0.0
0.2
0.4
0.6
0.8
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

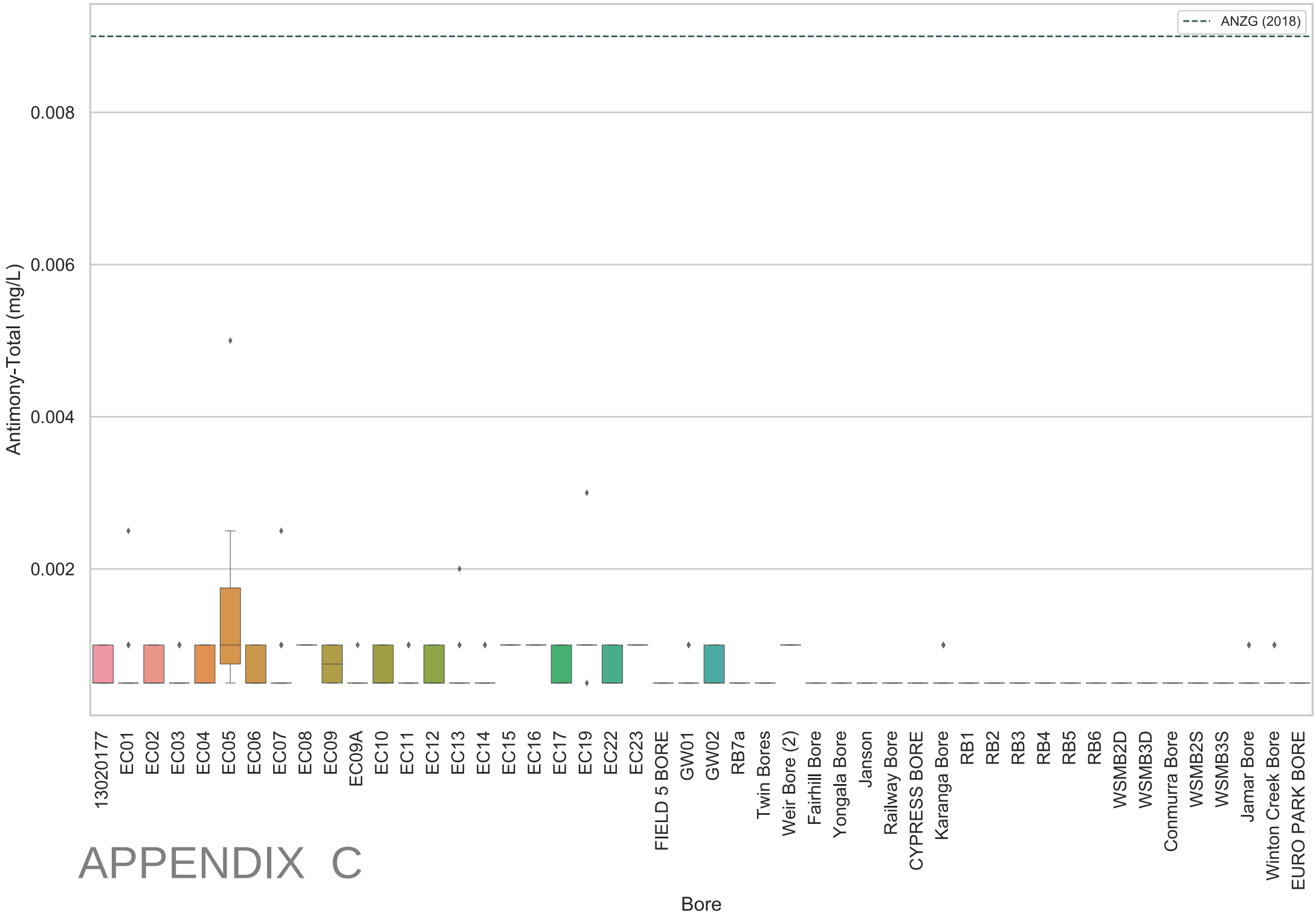
APPENDIX C


ANZG (2018)
Aluminium-Total (mg/L)
0
10
20
30
40
50
13020169
13020173
13020177
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
EC24
EC25
FIELD 5 BORE
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Winton Creek Bore
Bore

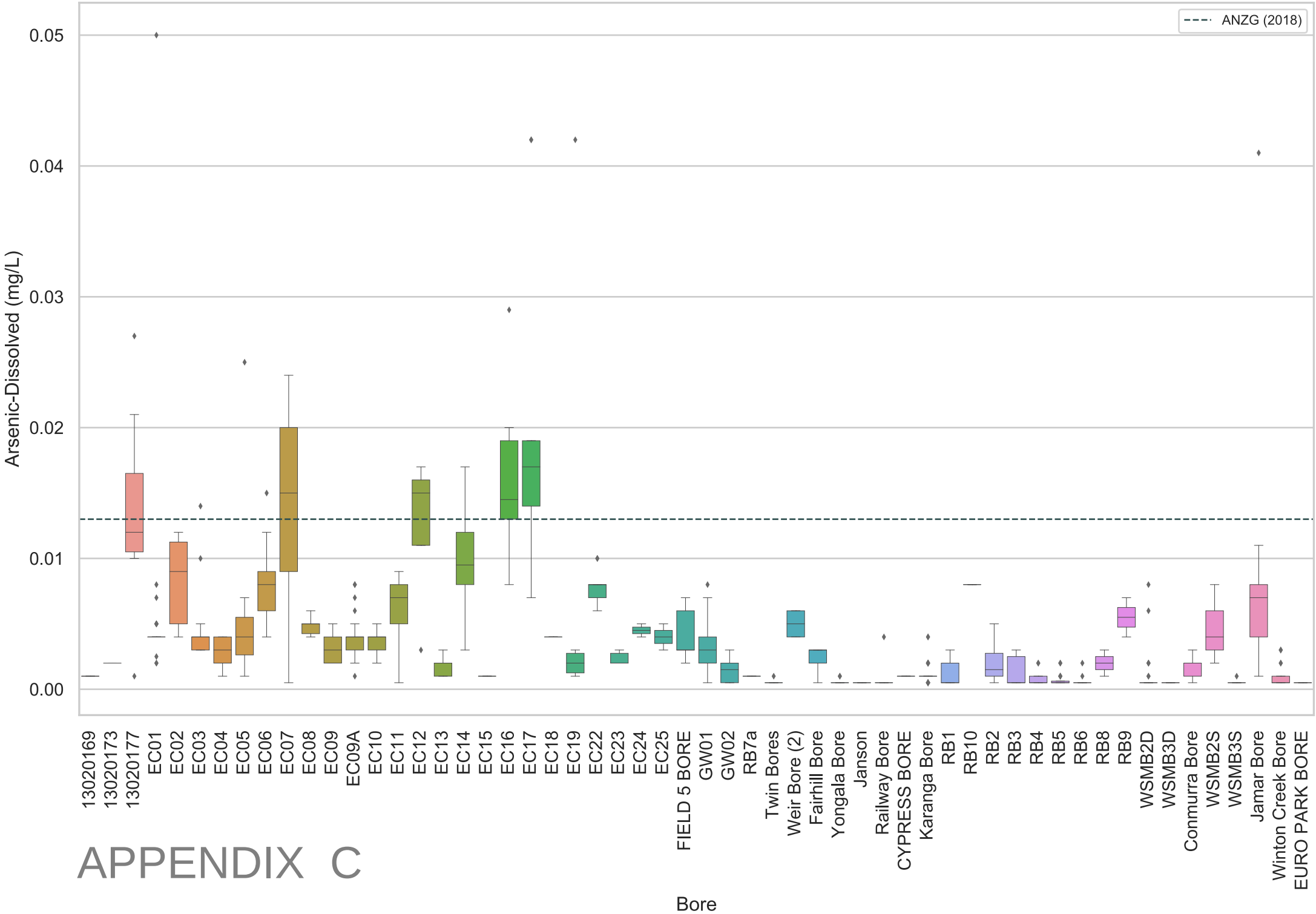
APPENDIX C


ANZG (2018)
Antimony-Dissolved (mg/L)
0.008
0.006
0.004
0.002
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

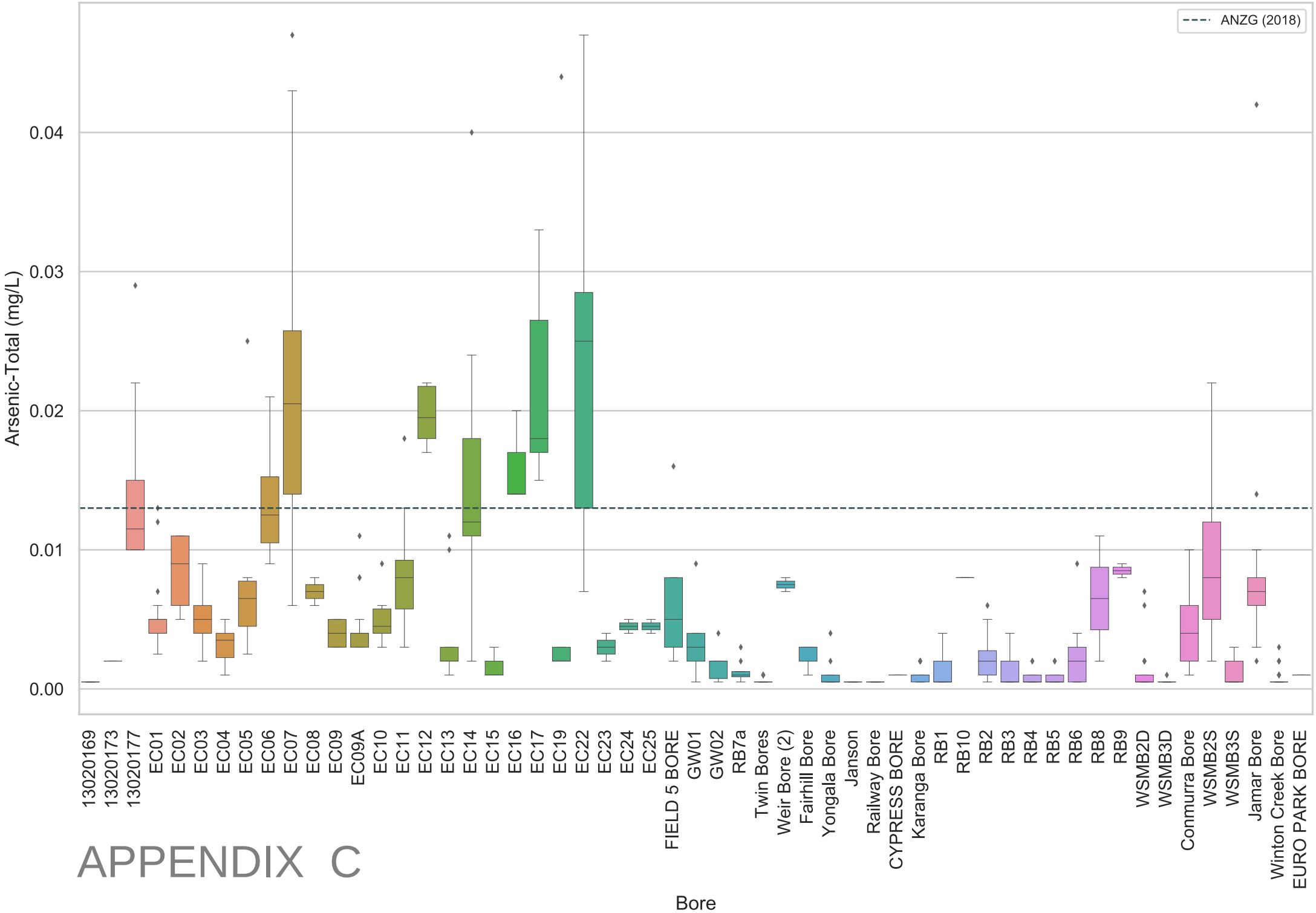
APPENDIX C


ANZG (2018)
Antimony-Total (mg/L)
0.008
0.006
0.004
0.002
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

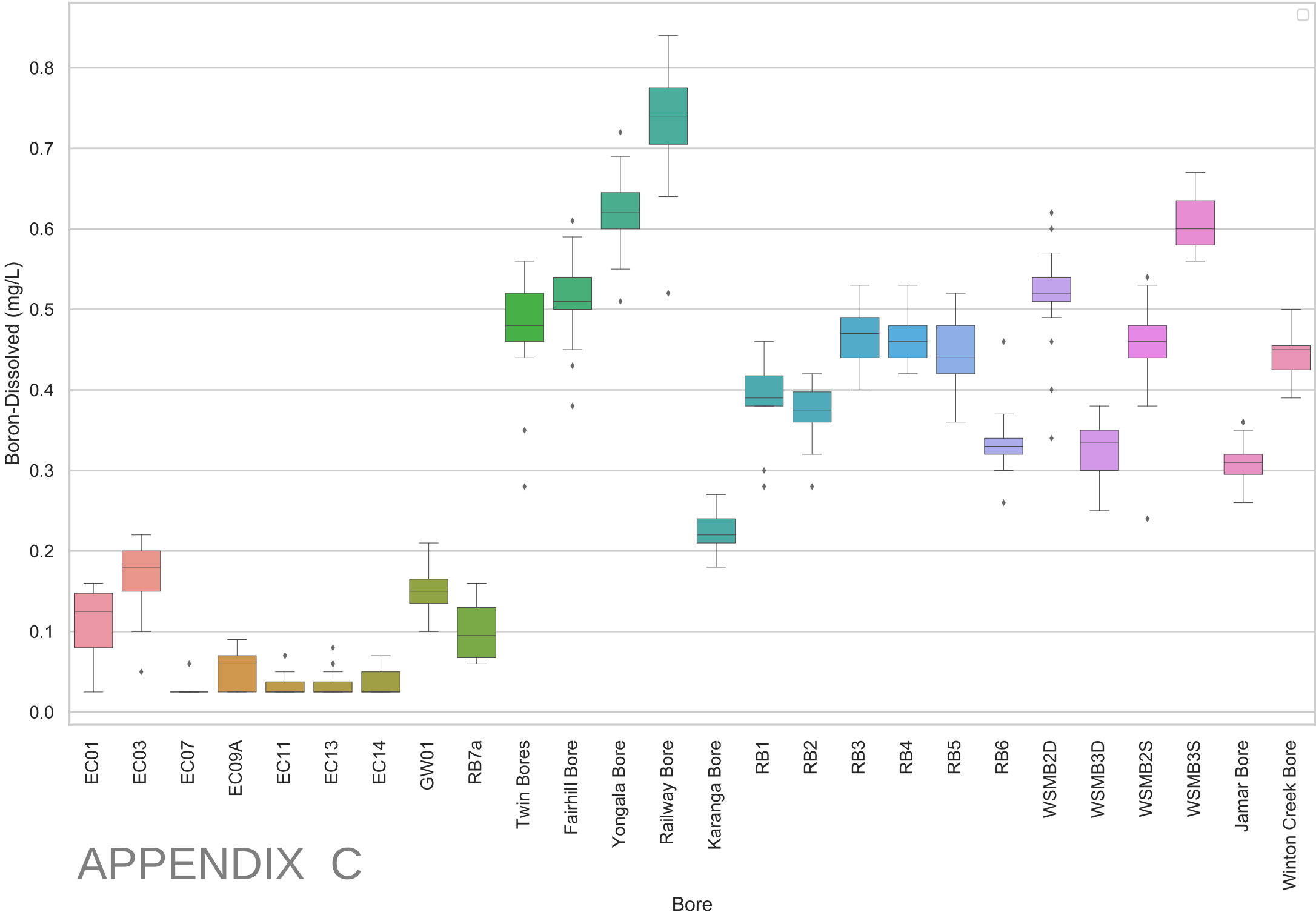
APPENDIX C


ANZG (2018)
Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

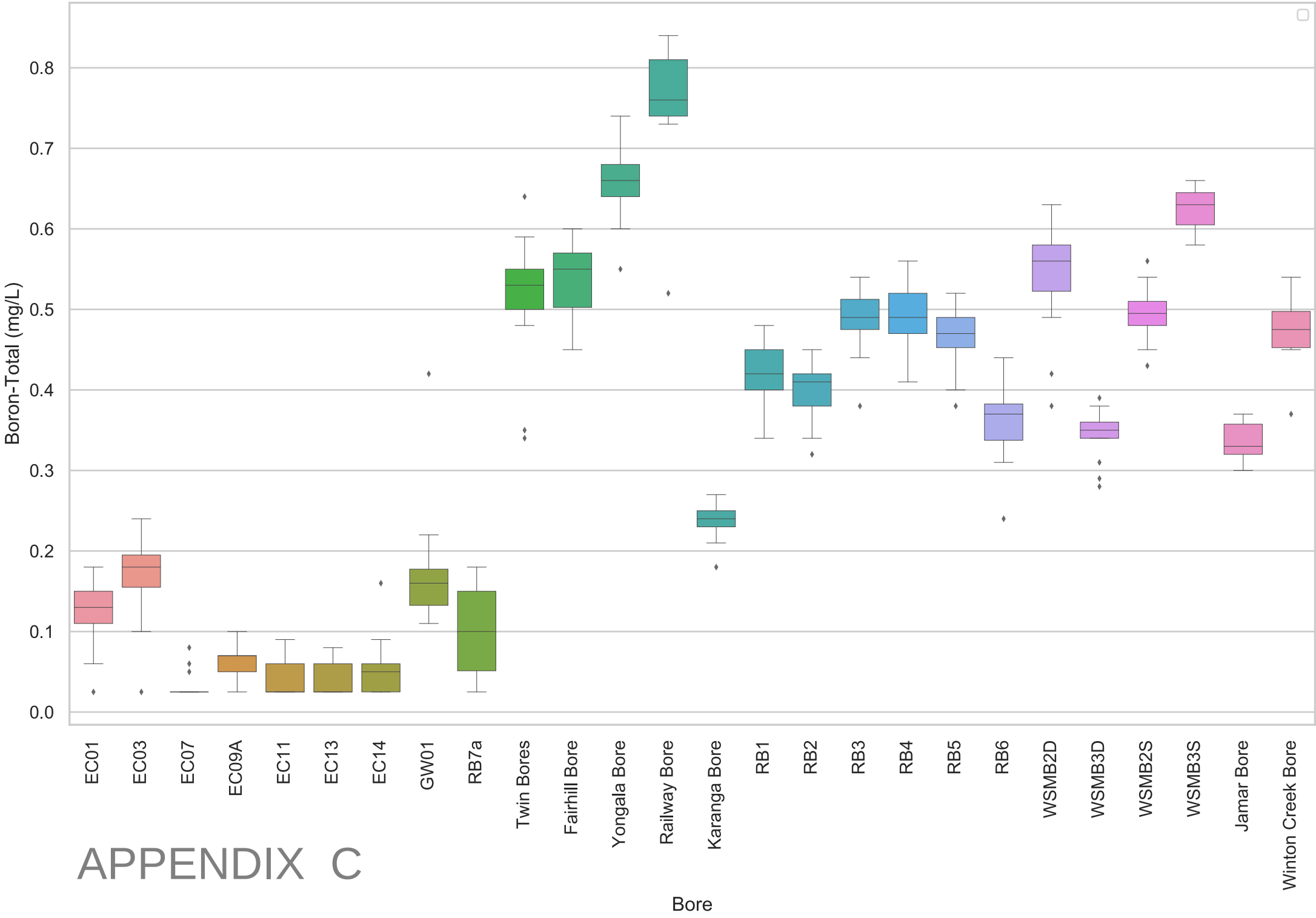
APPENDIX C


ANZG (2018)
Arsenic-Total (mg/L)
0.00
0.01
0.02
0.03
0.04
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

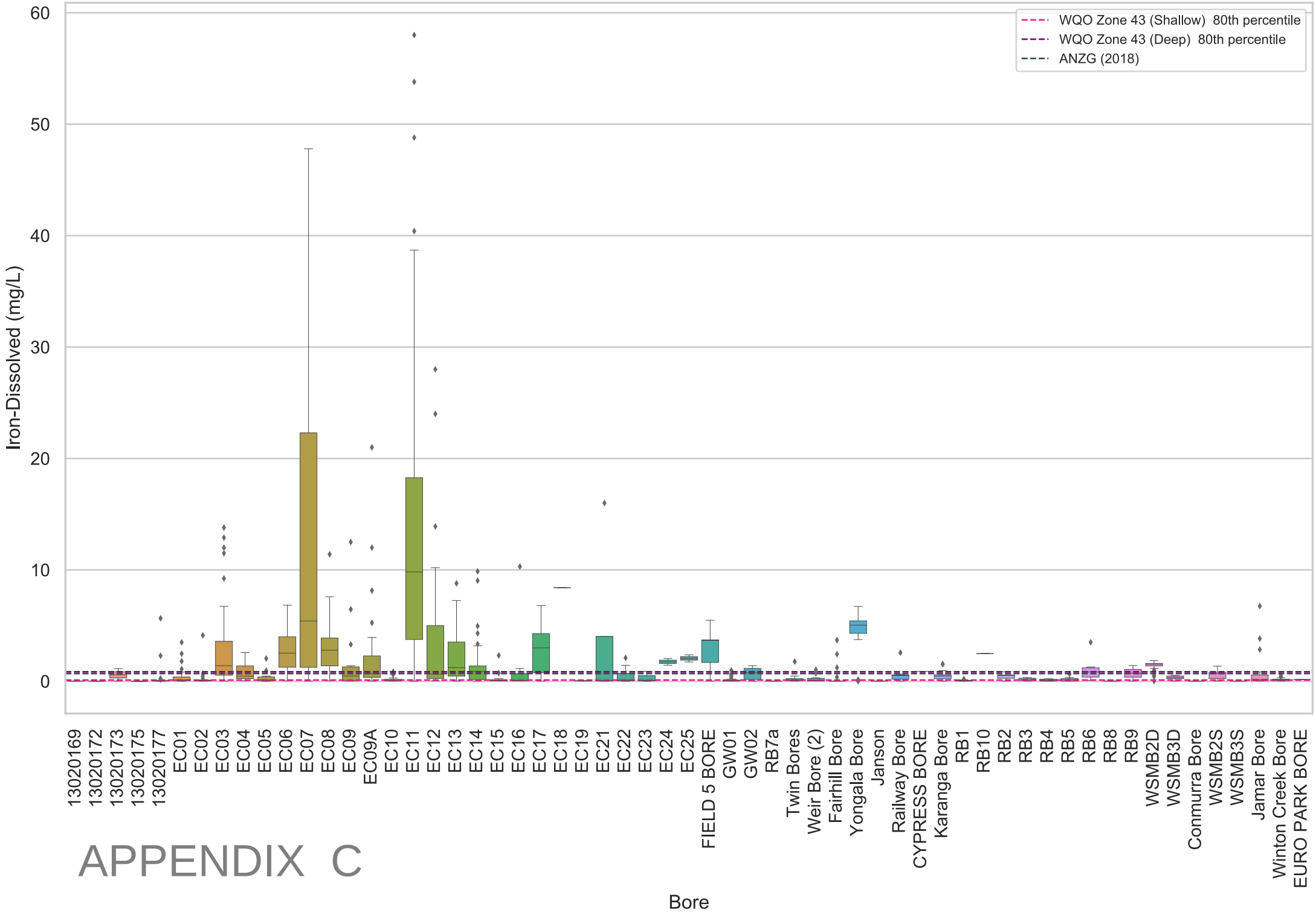
APPENDIX C


Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

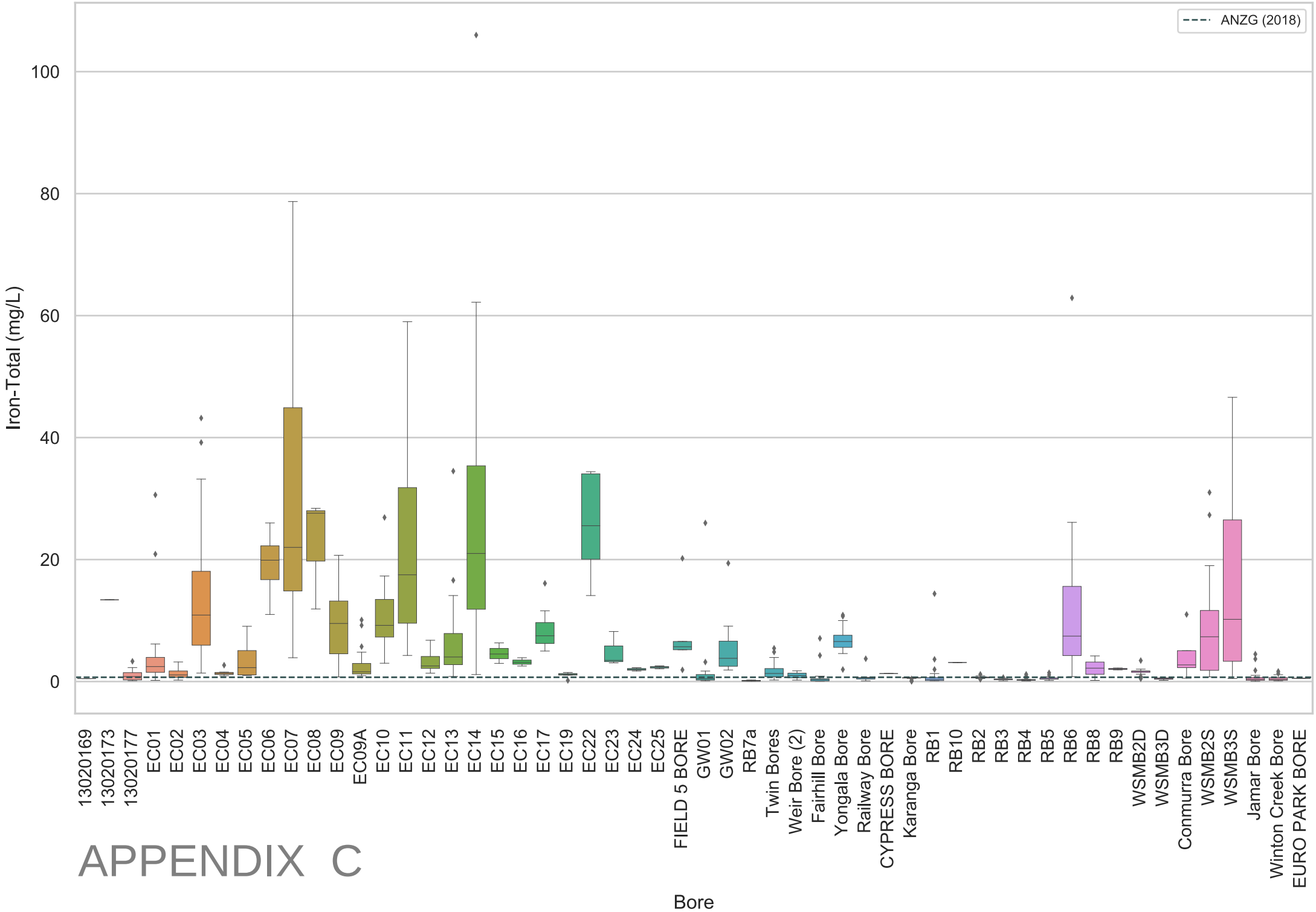
APPENDIX C


Boron-Total (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

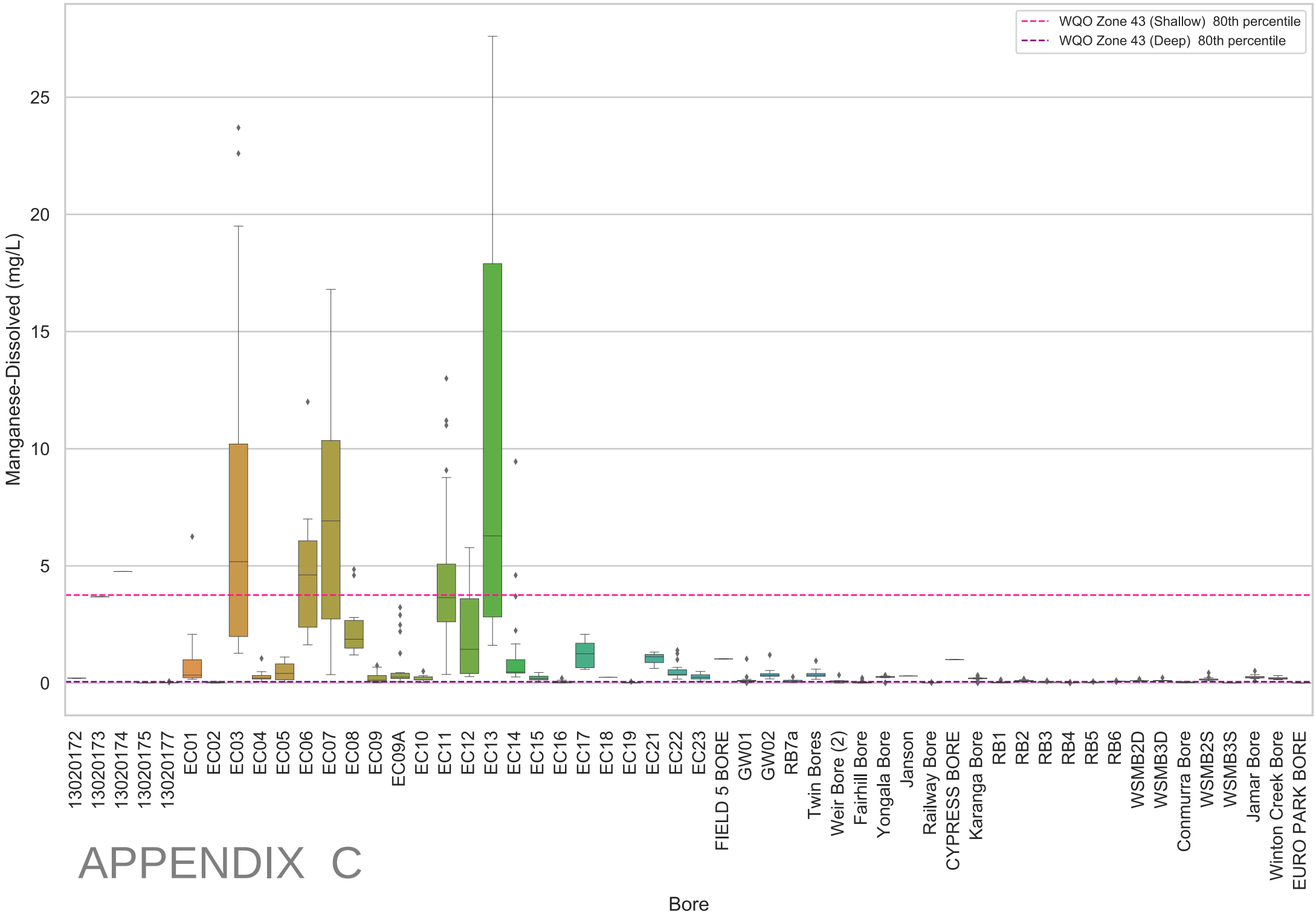
APPENDIX C


WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
ANZG (2018)
Iron-Dissolved (mg/L)
60
50
40
30
20
10
0
13020169
13020172
13020173
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

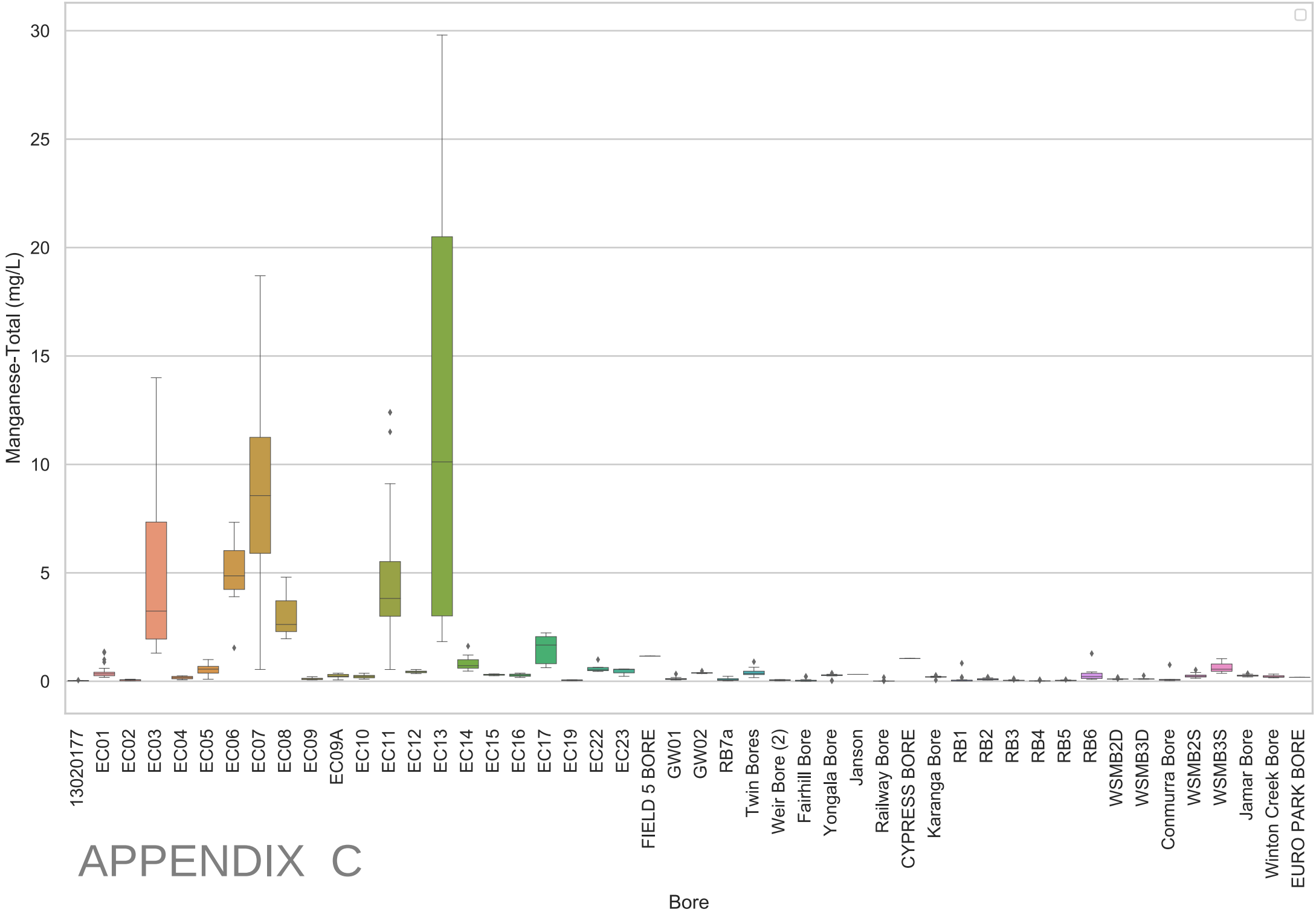
APPENDIX C


ANZG (2018)
Iron-Total (mg/L)
0
20
40
60
80
100
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

APPENDIX C

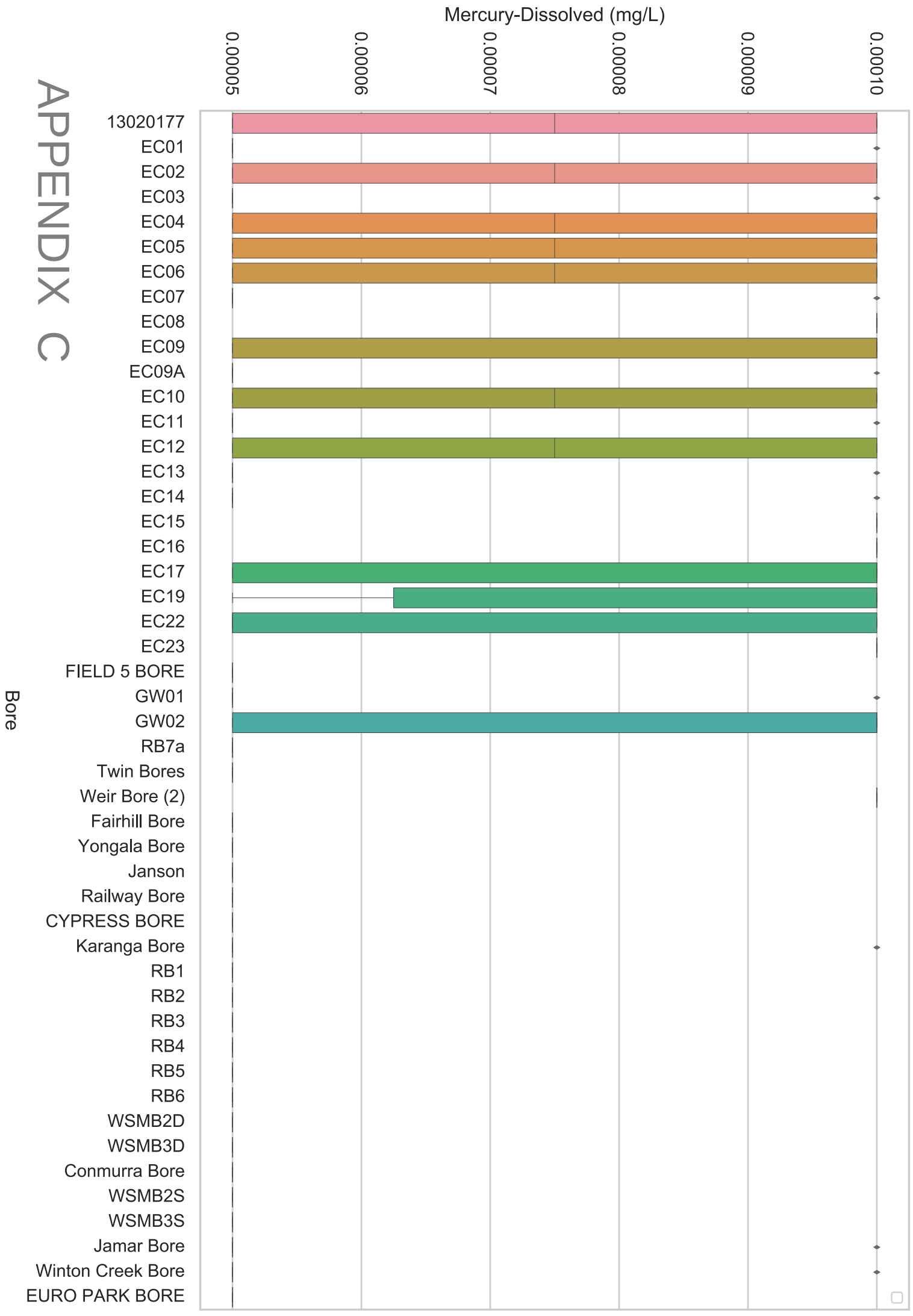

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Manganese-Dissolved (mg/L)
0
5
10
15
20
25
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

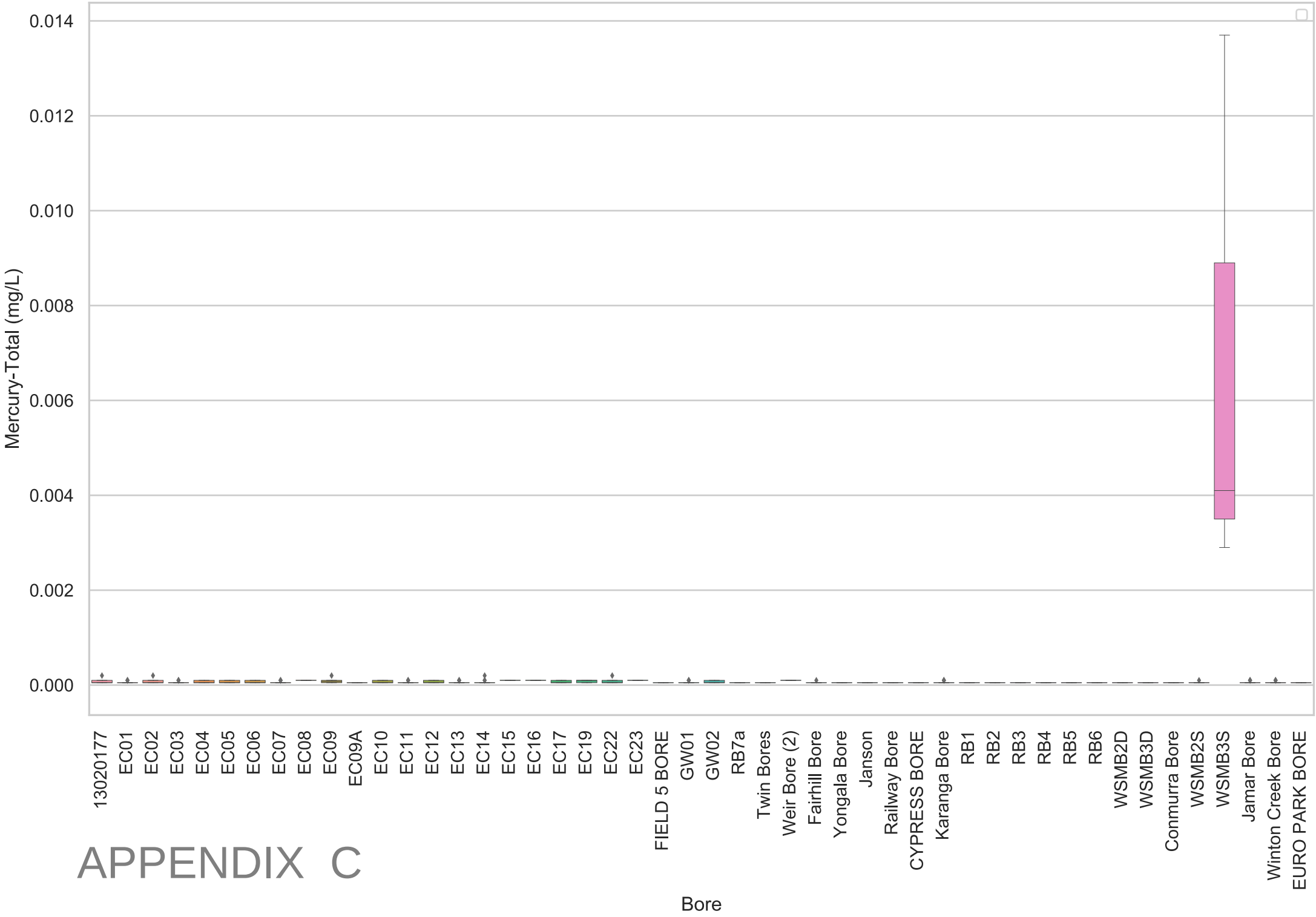
APPENDIX C


Manganese-Total (mg/L)
30
25
20
15
10
5
0
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

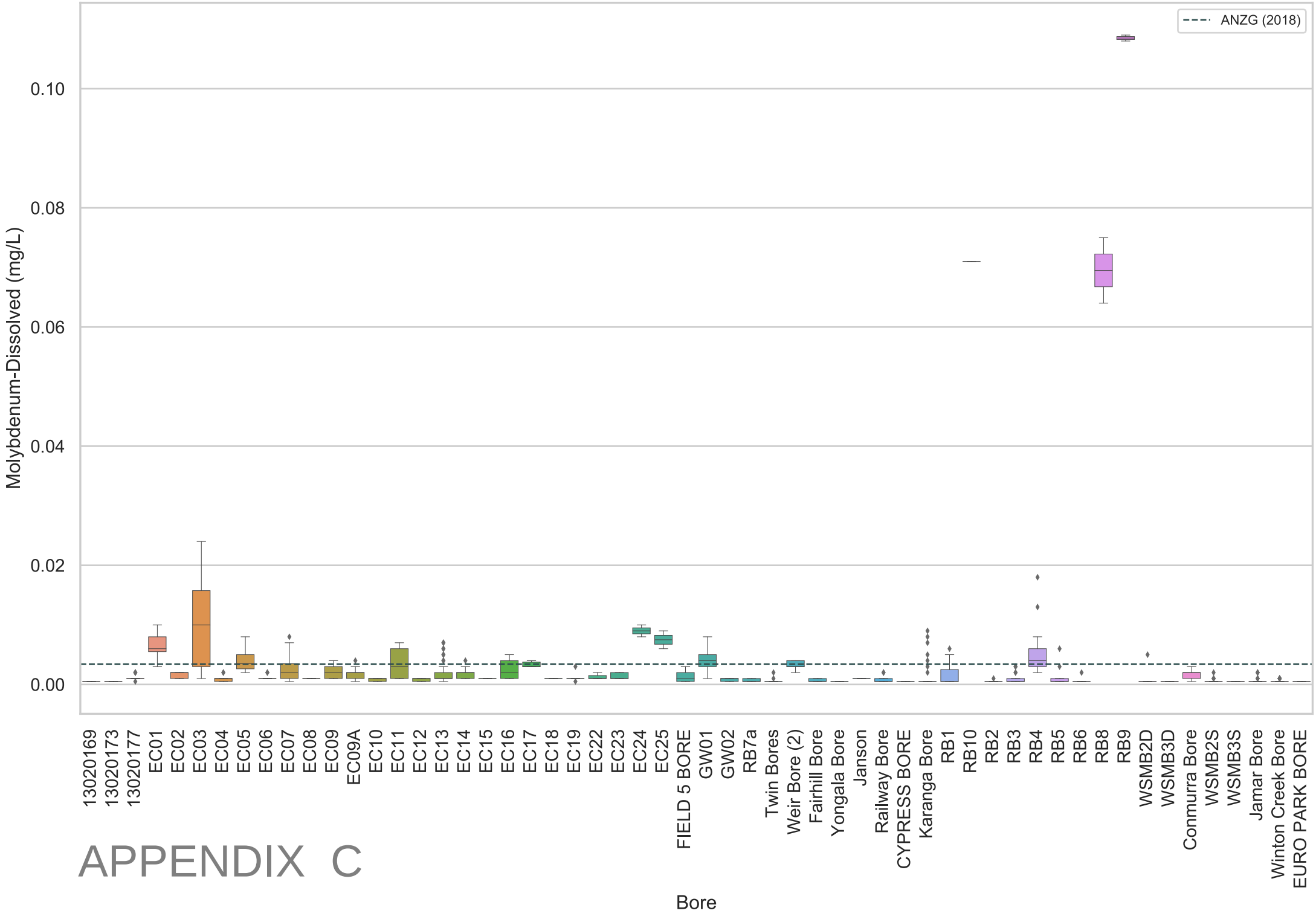
APPENDIX C

APPENDIX C

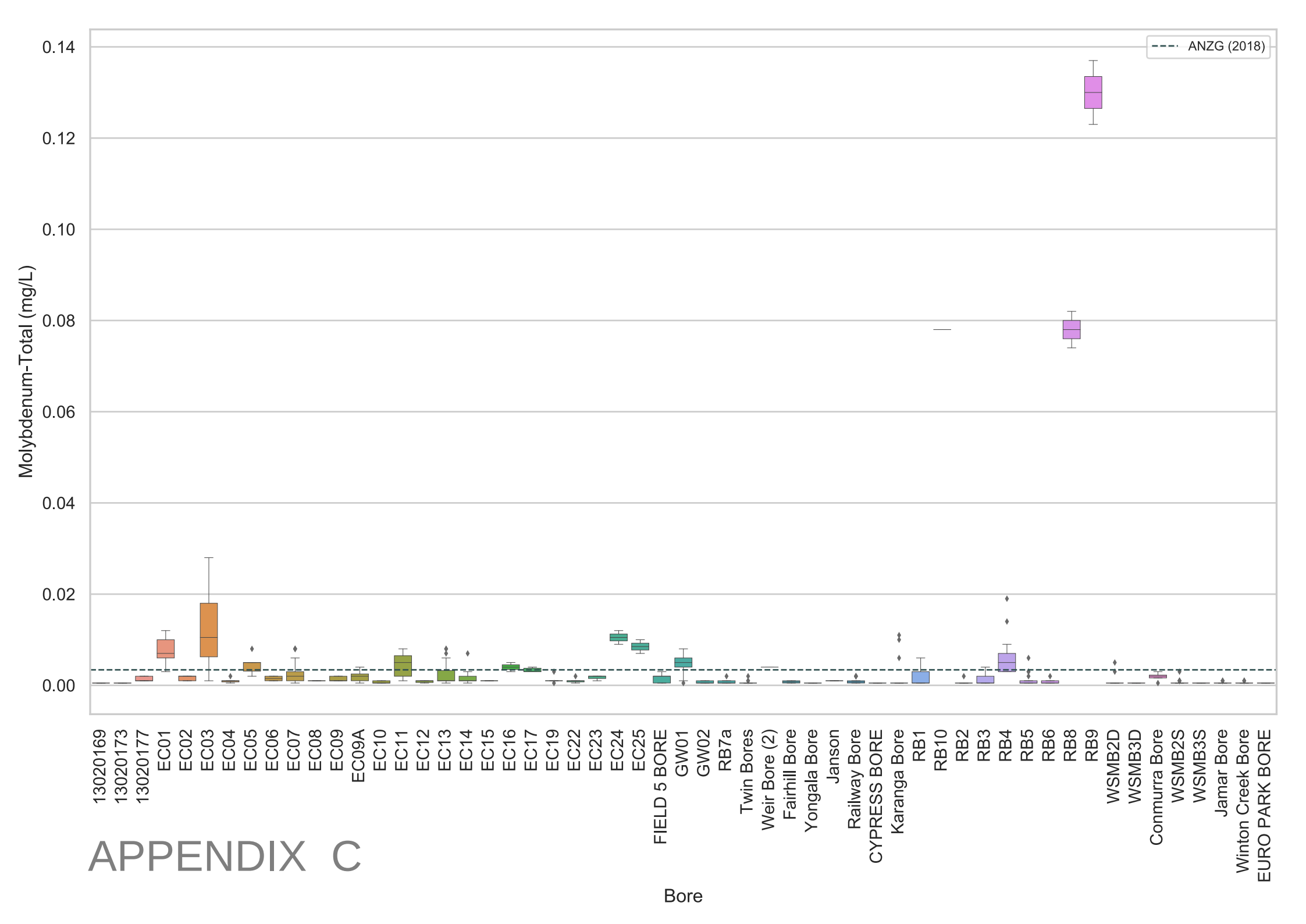

Mercury-Dissolved (mg/L)
0.00005
0.00006
0.00007
0.00008
0.00009
0.00010
Bore
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE


Mercury-Total (mg/L)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

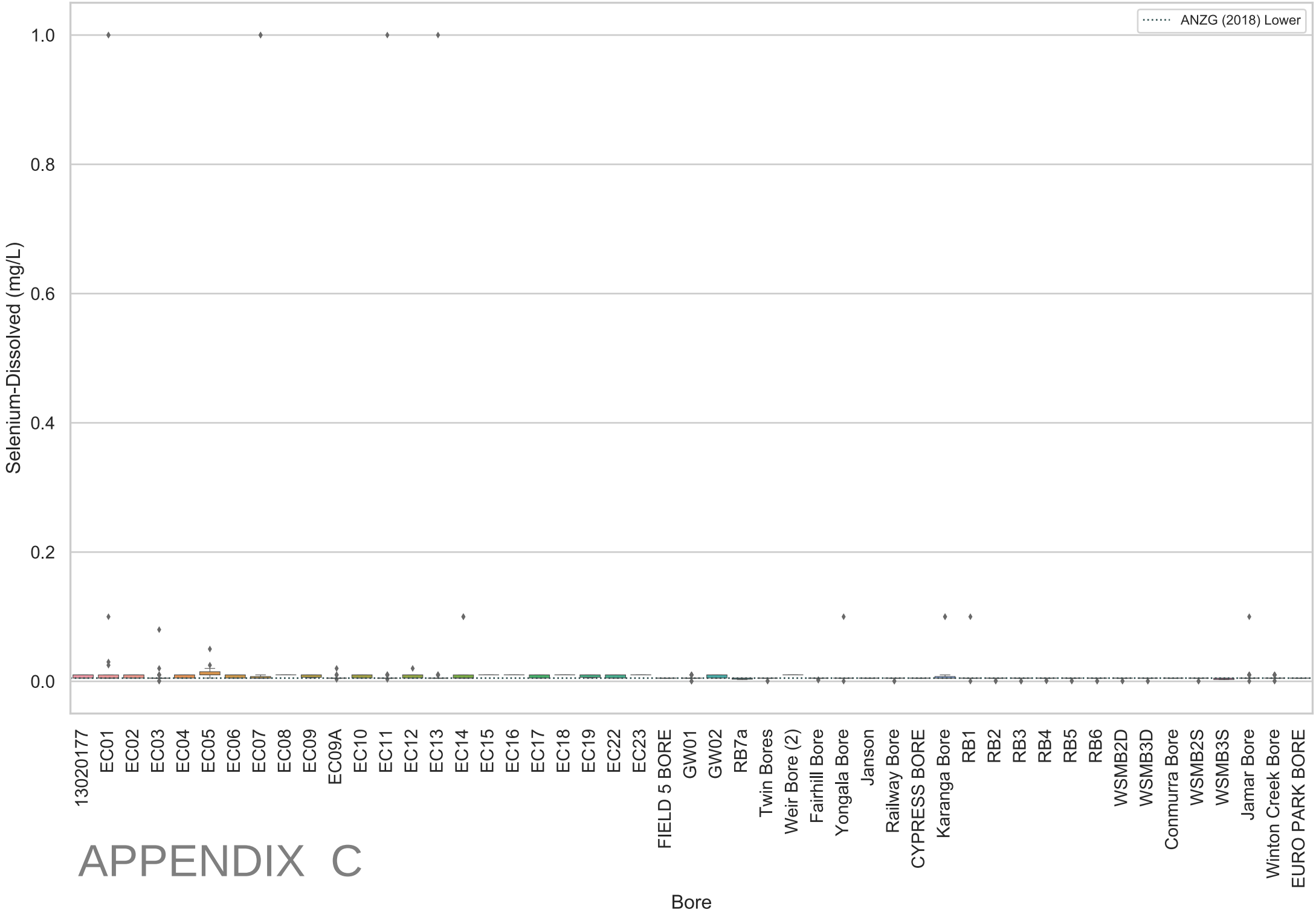
APPENDIX C


ANZG (2018)
Molybdenum-Dissolved (mg/L)
0.00
0.02
0.04
0.06
0.08
0.10
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

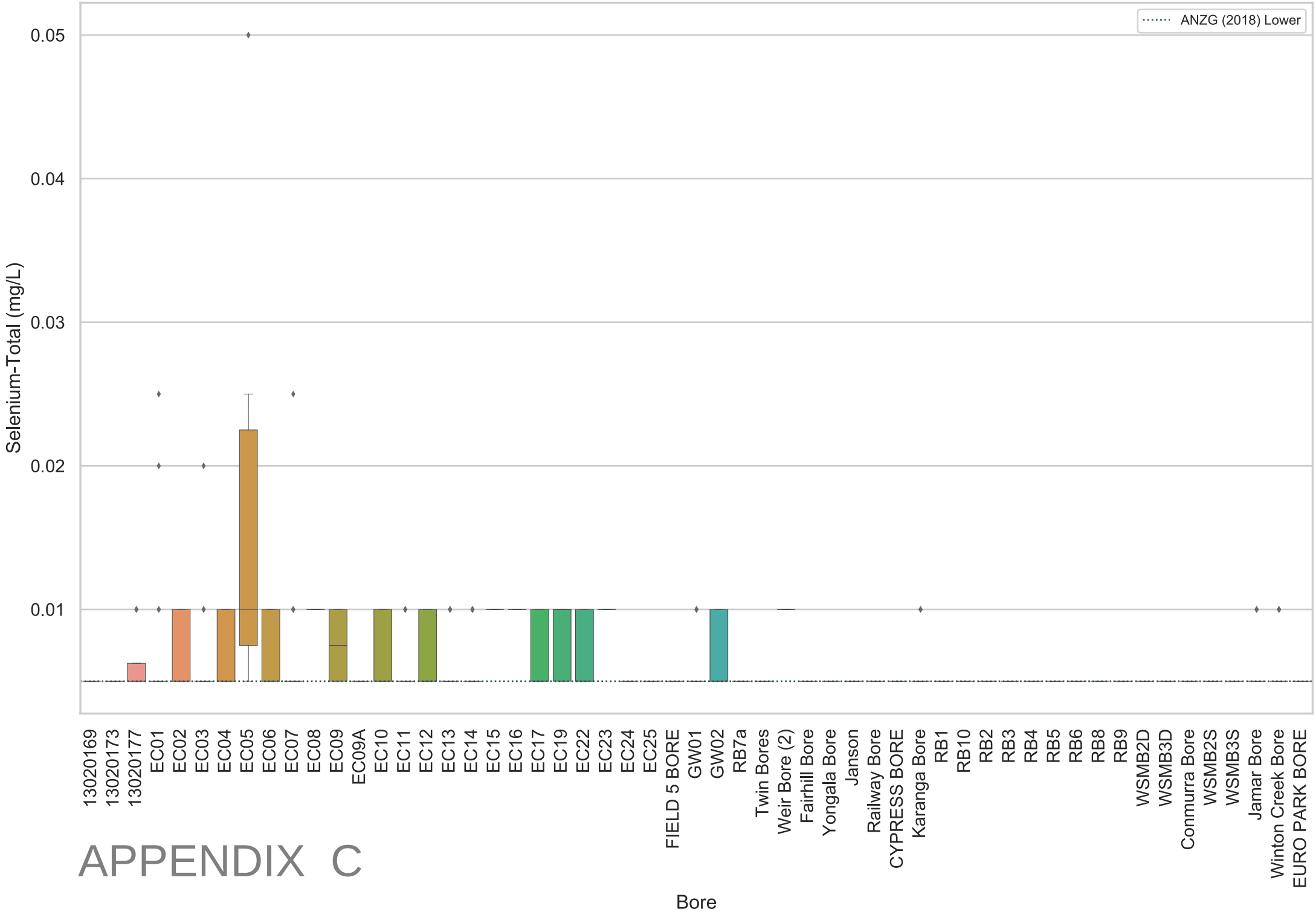
APPENDIX C


ANZG (2018)
Molybdenum-Total (mg/L)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

APPENDIX C


ANZG (2018) Lower
Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

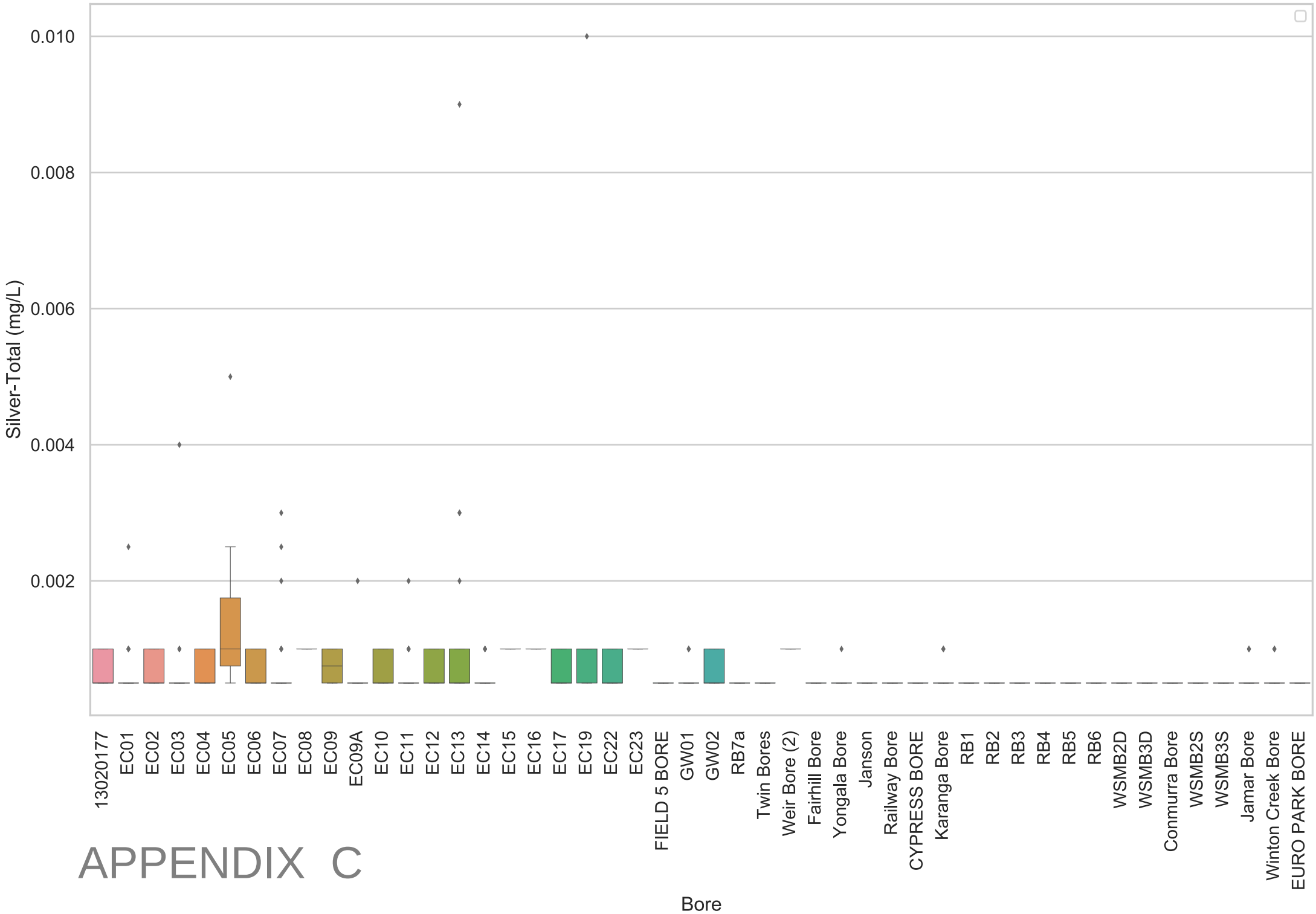
APPENDIX C


ANZG (2018) Lower
0.05
0.04
0.03
0.02
0.01
Selenium-Total (mg/L)
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

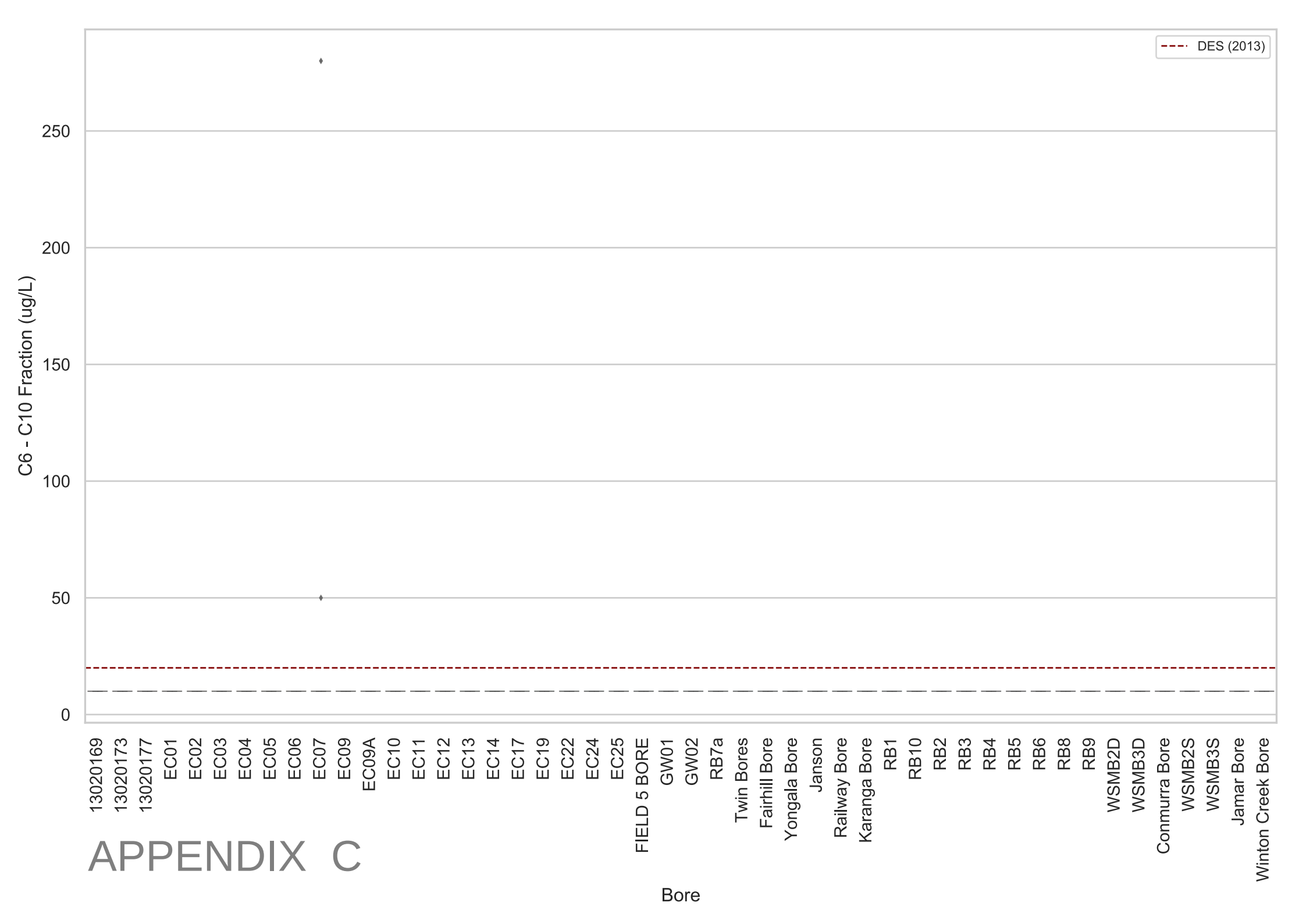
APPENDIX C

0.005
0.004
0.003
0.002
0.001
Silver-Dissolved (mg/L)
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

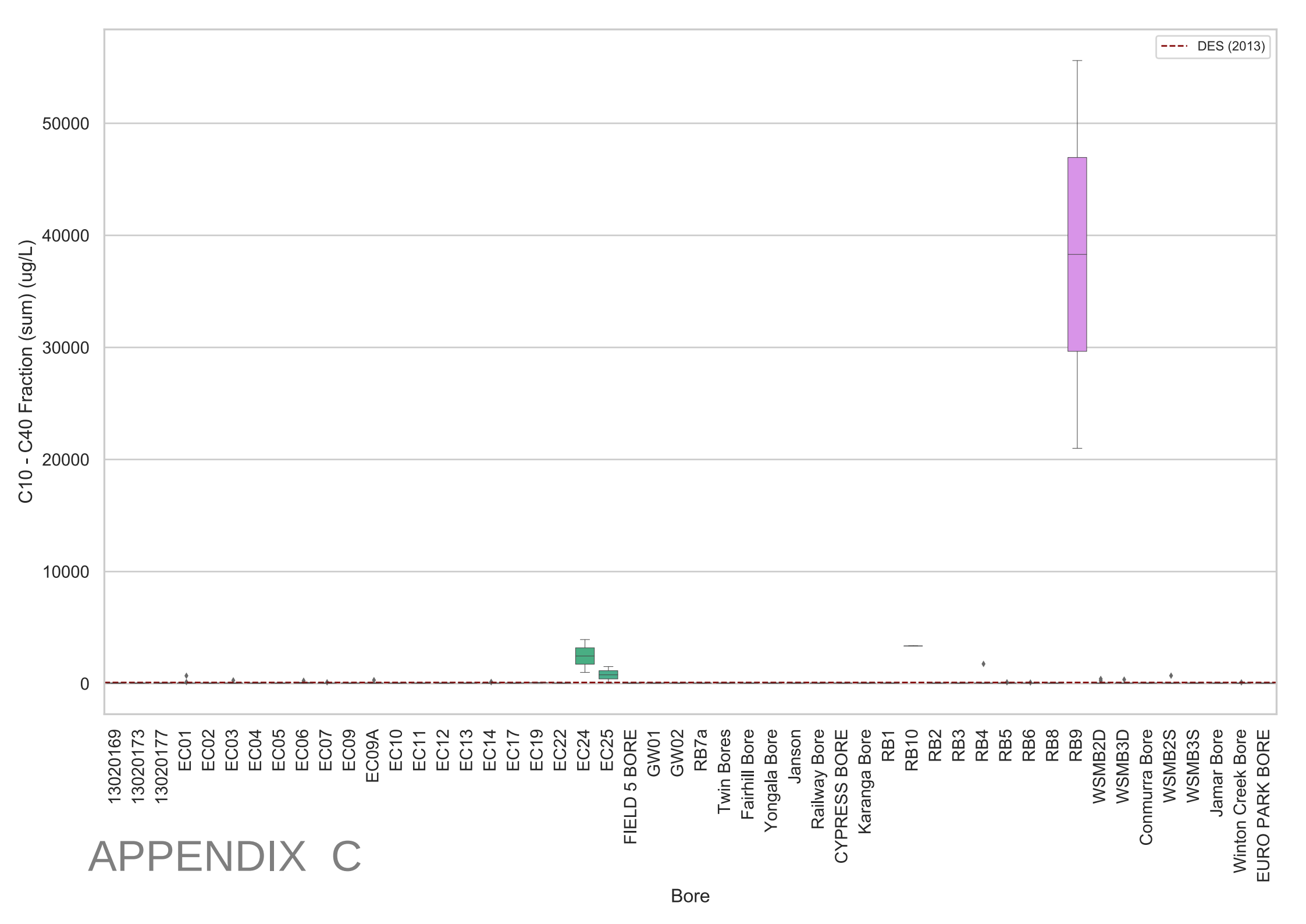
APPENDIX C


Silver-Total (mg/L)
0.010
0.008
0.006
0.004
0.002
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

APPENDIX C


DES (2013)
C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Janson
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

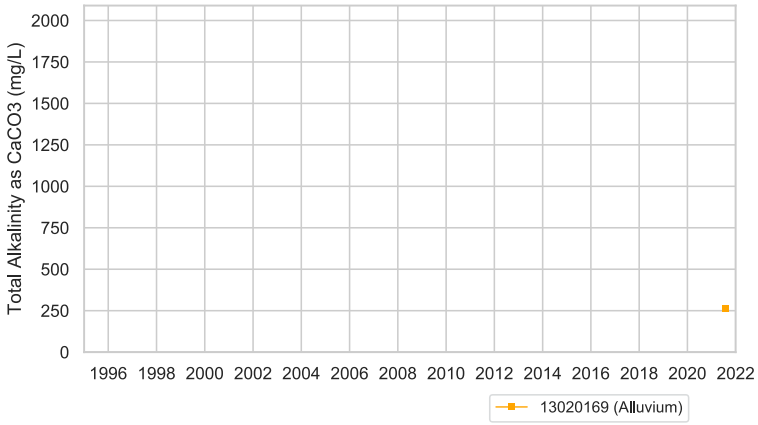
APPENDIX C

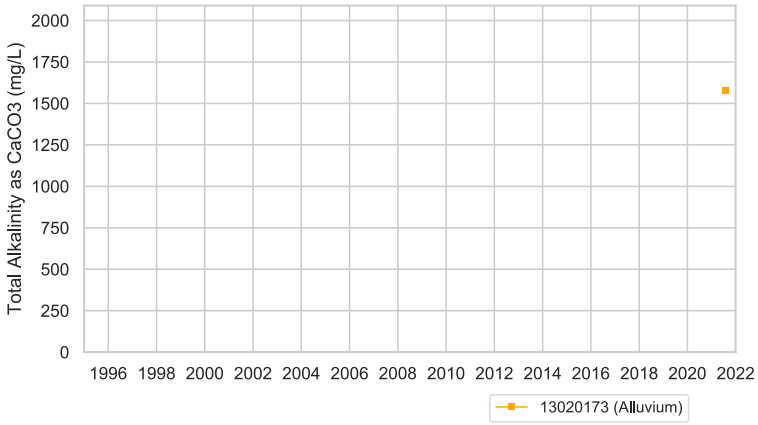

DES (2013)
C10 - C40 Fraction (sum) (ug/L)
50000
40000
30000
20000
10000
0
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

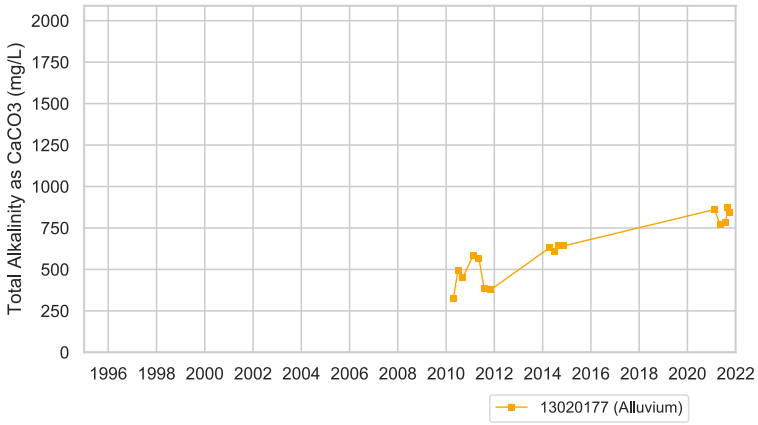
APPENDIX C

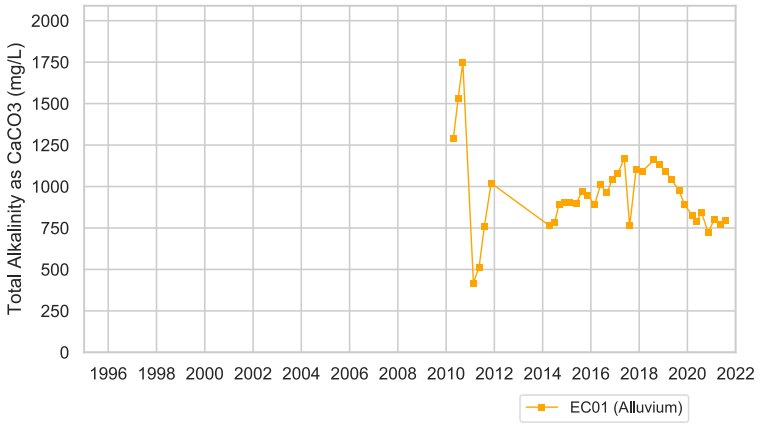
APPENDIX D

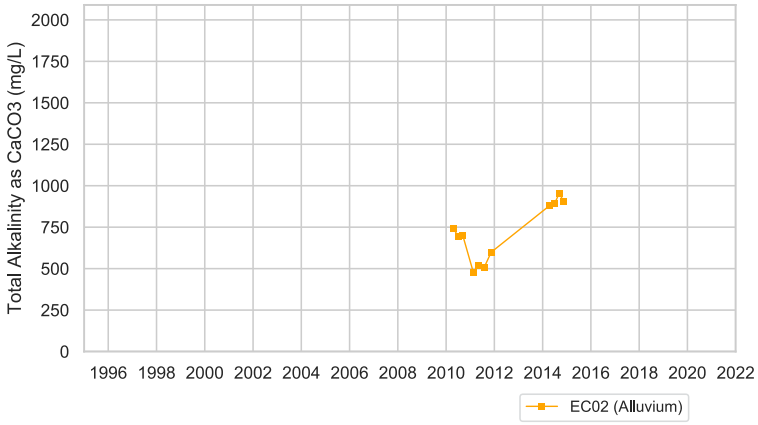
Water quality parameters – time series

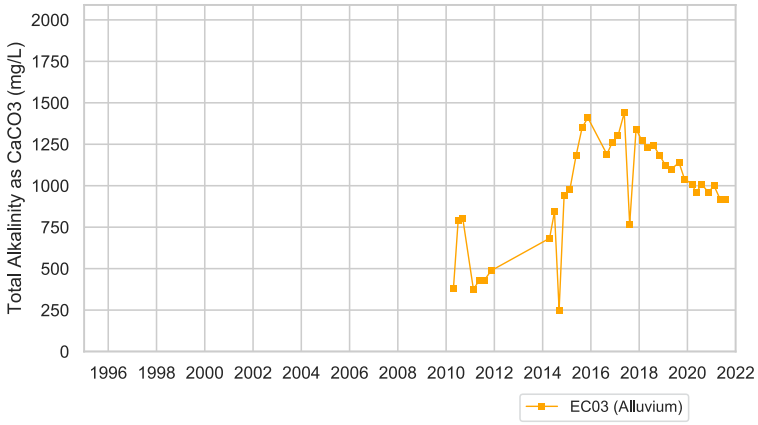

Total Alkalinity as CaCO3 (mg/L)
13020169 (Alluvium)

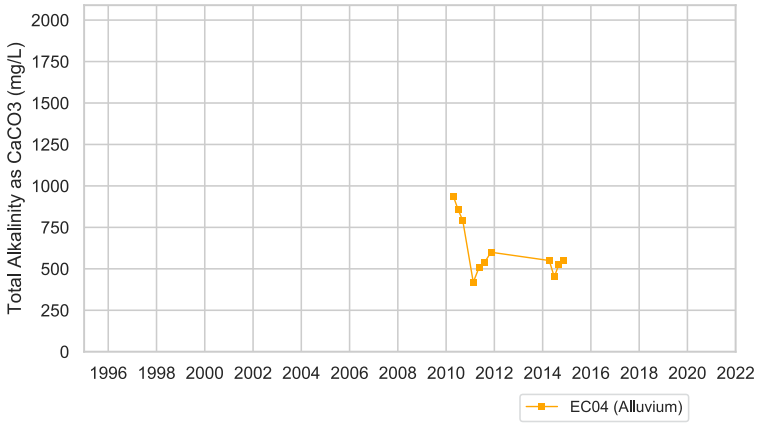

Total Alkalinity as CaCO3 (mg/L)
13020173 (Alluvium)

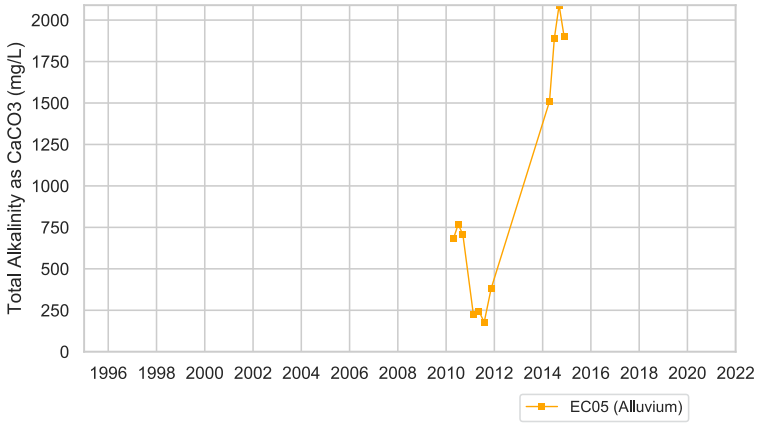

Total Alkalinity as CaCO3 (mg/L)
13020177 (Alluvium)

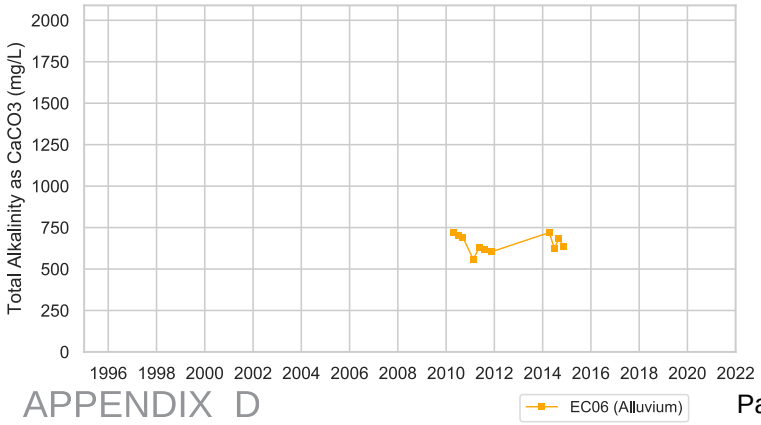

Total Alkalinity as CaCO3 (mg/L)
EC01 (Alluvium)

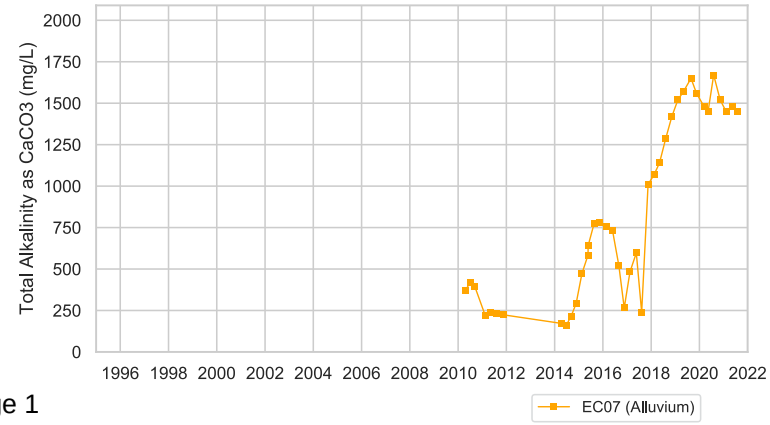

Total Alkalinity as CaCO3 (mg/L)
EC02 (Alluvium)

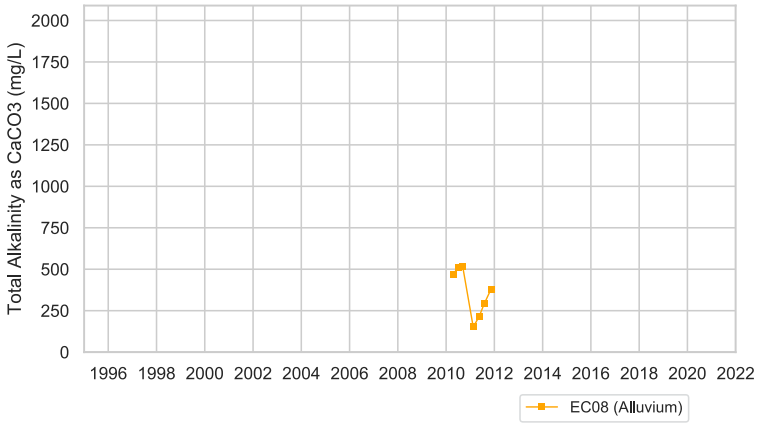

Total Alkalinity as CaCO3 (mg/L)
EC03 (Alluvium)

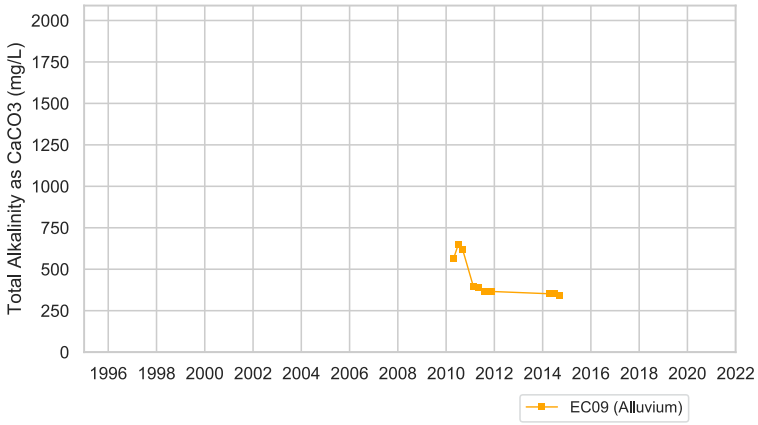

Total Alkalinity as CaCO3 (mg/L)
EC04 (Alluvium)

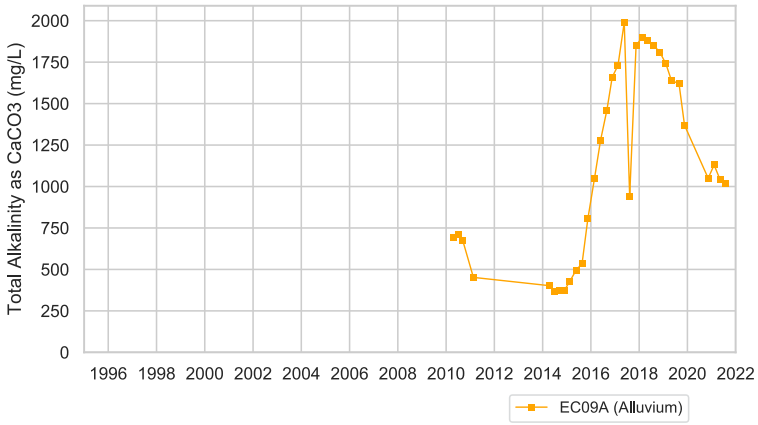

Total Alkalinity as CaCO3 (mg/L)
EC05 (Alluvium)

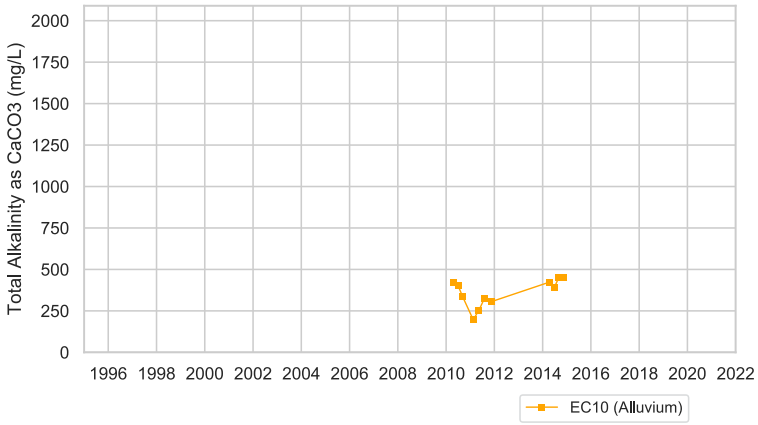

Total Alkalinity as CaCO3 (mg/L)
EC06 (Alluvium)

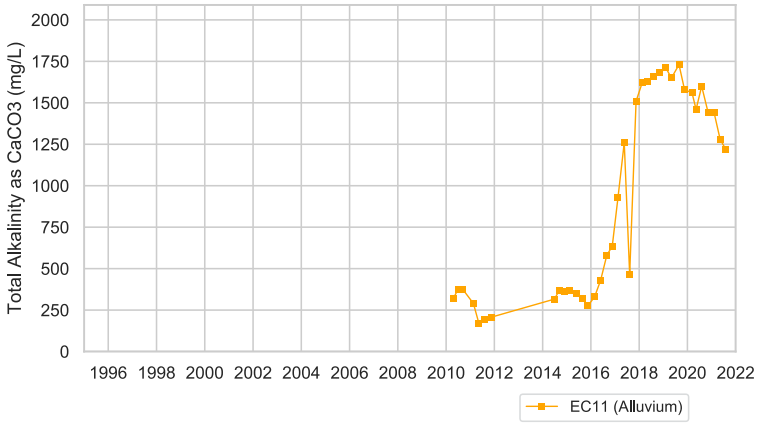

Total Alkalinity as CaCO3 (mg/L)
EC07 (Alluvium)

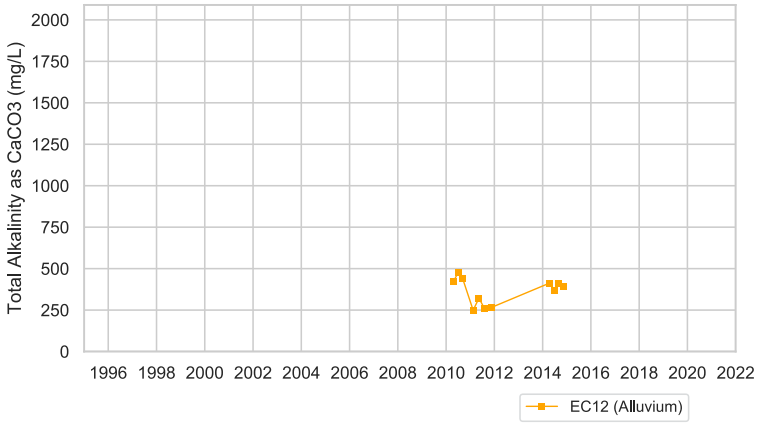

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

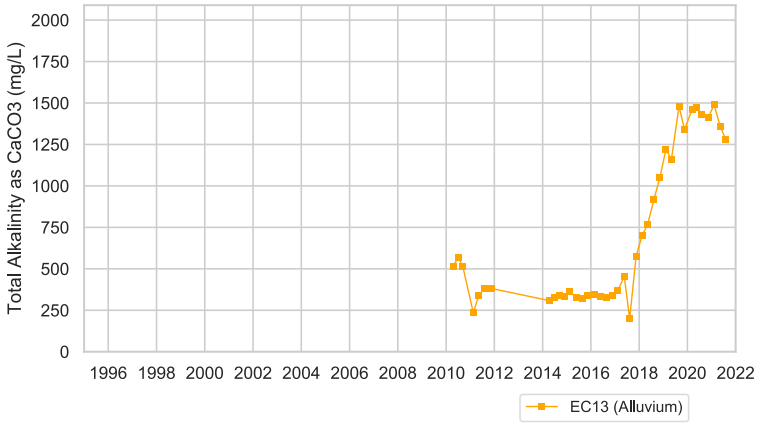

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

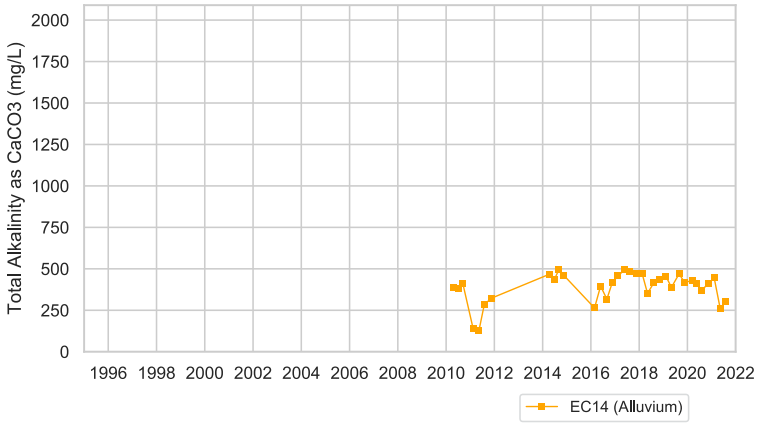

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

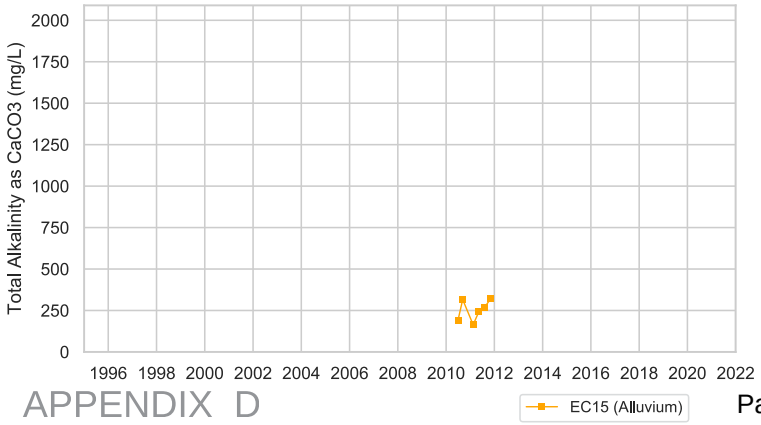

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

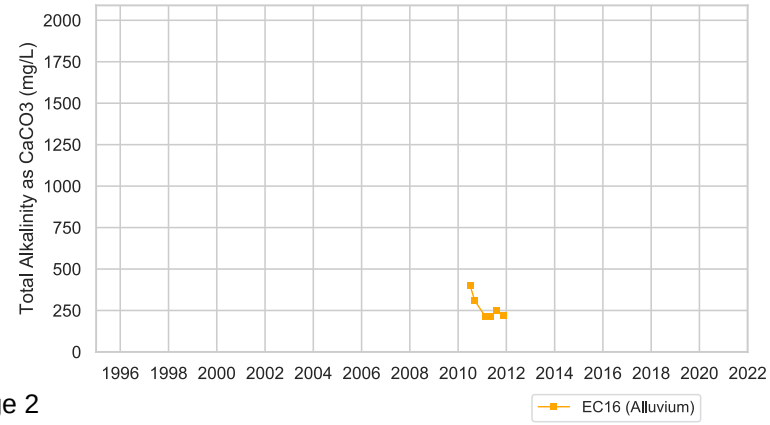

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

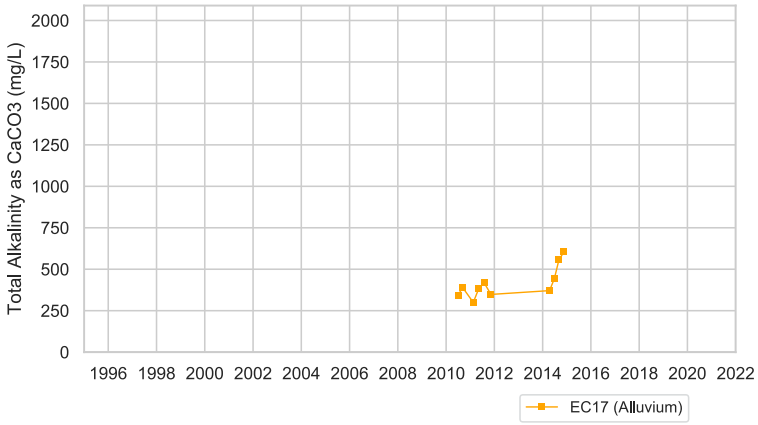

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

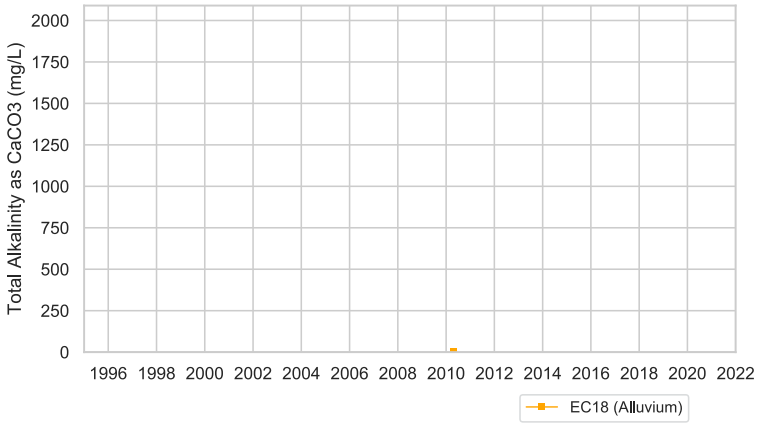

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

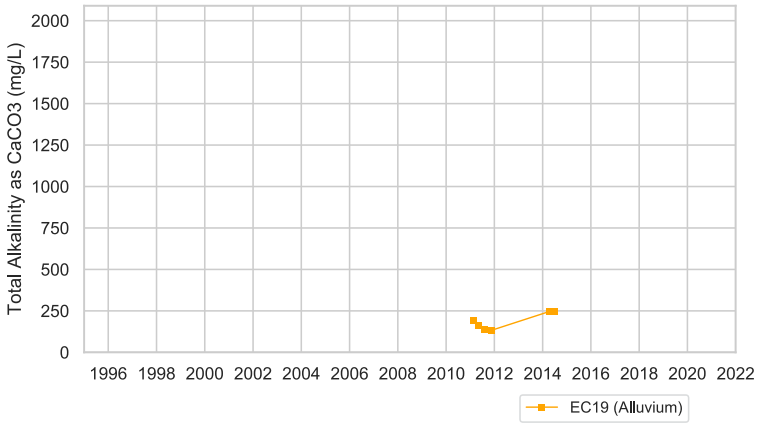

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

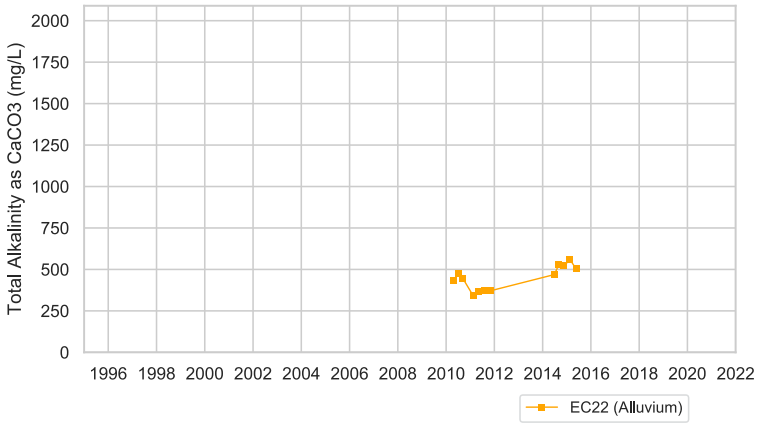

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

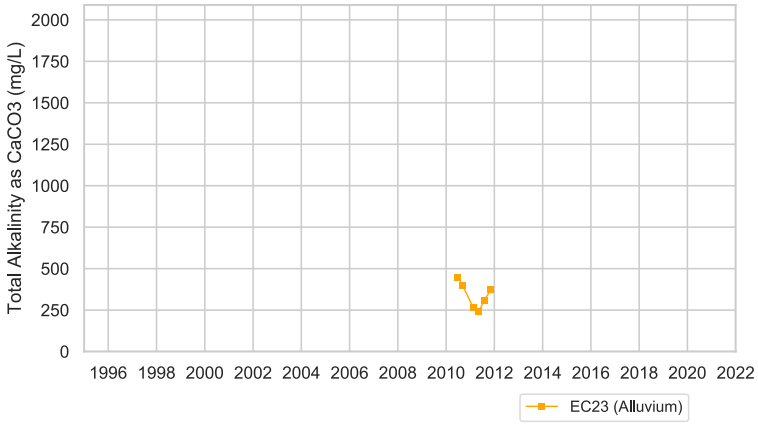

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

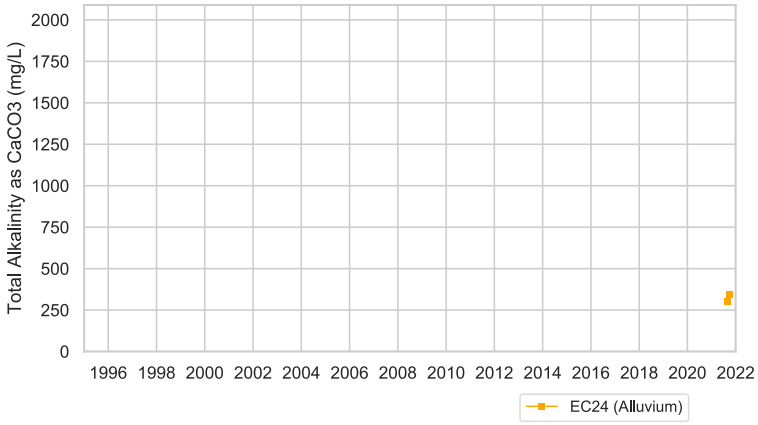

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

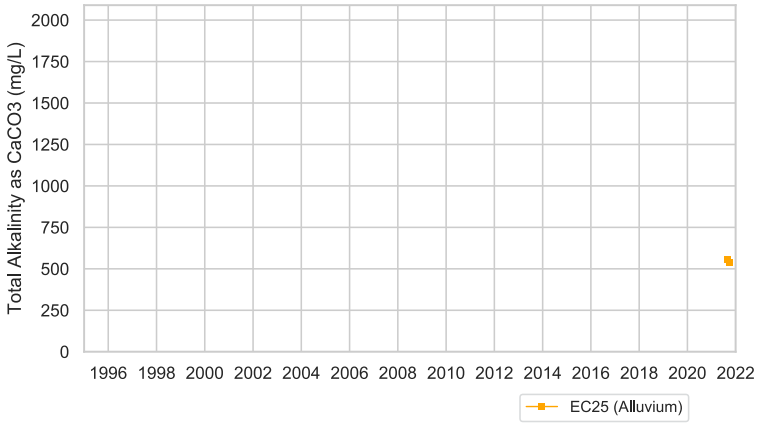

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

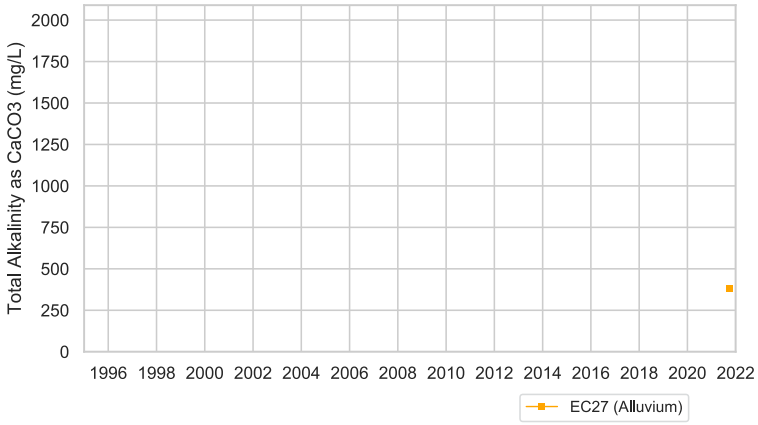

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

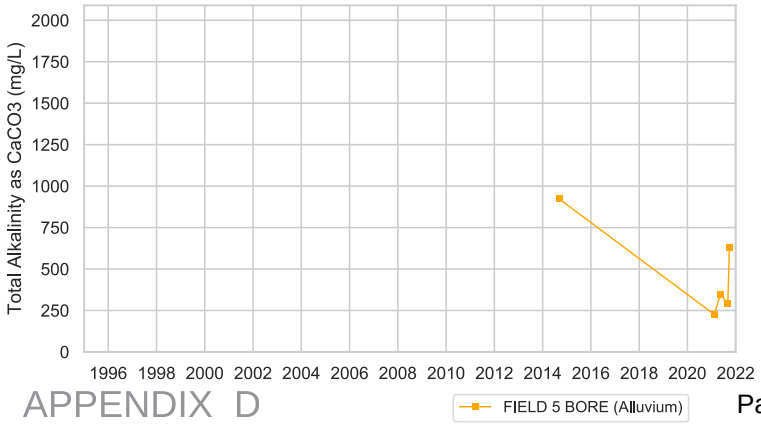

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

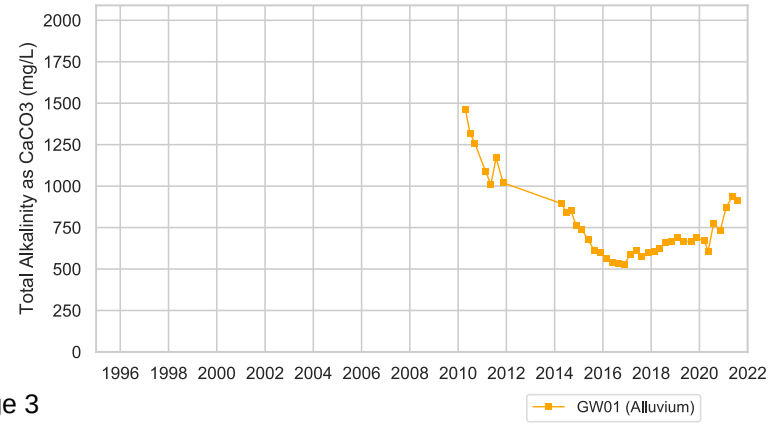

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

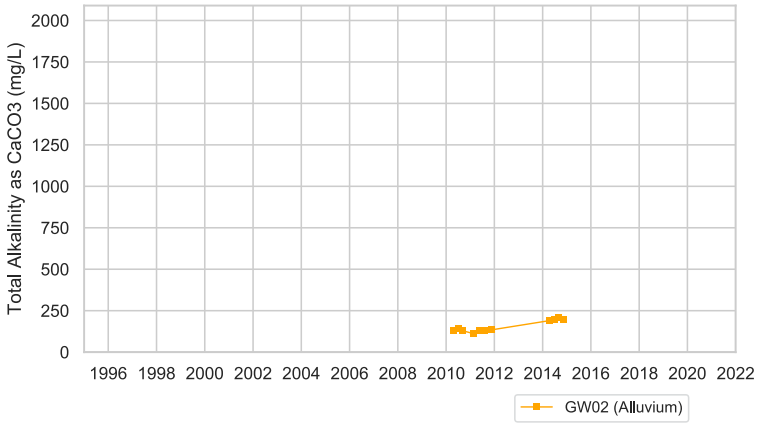

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

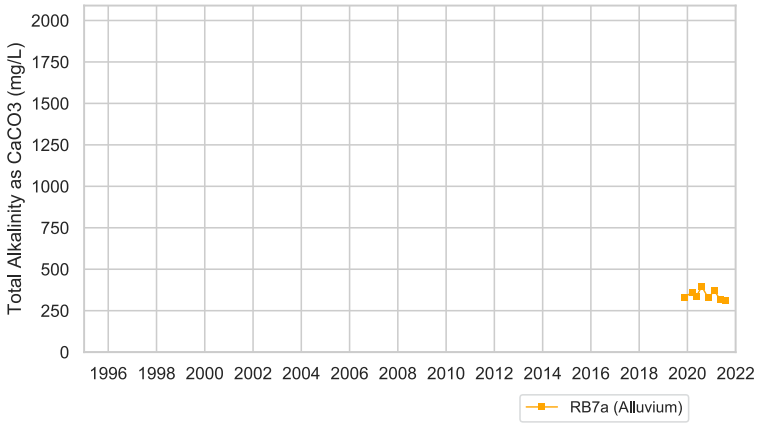

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

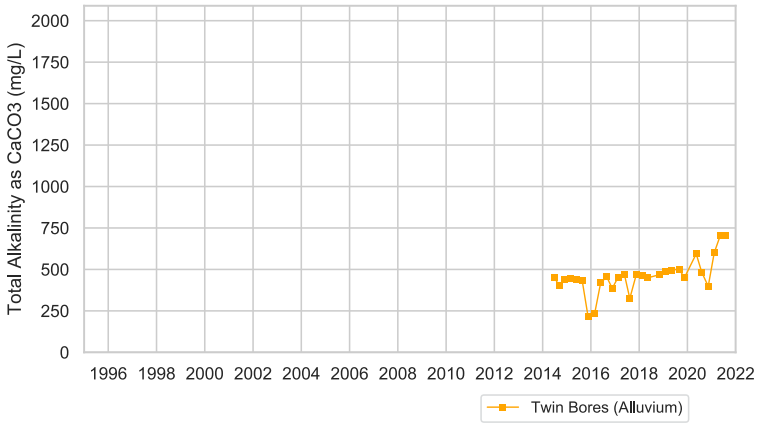

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

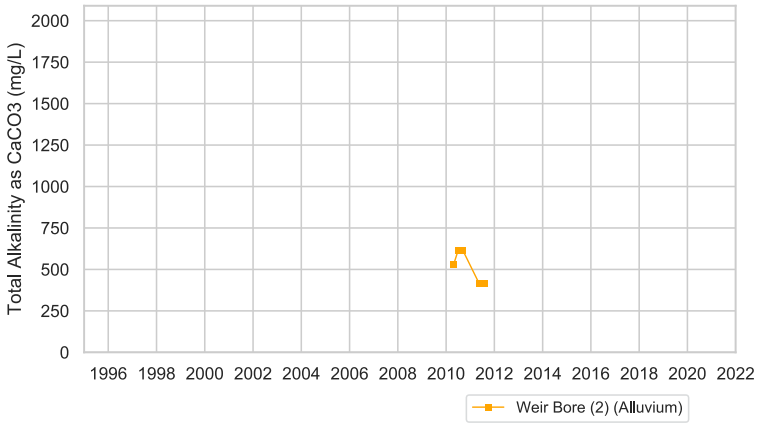

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

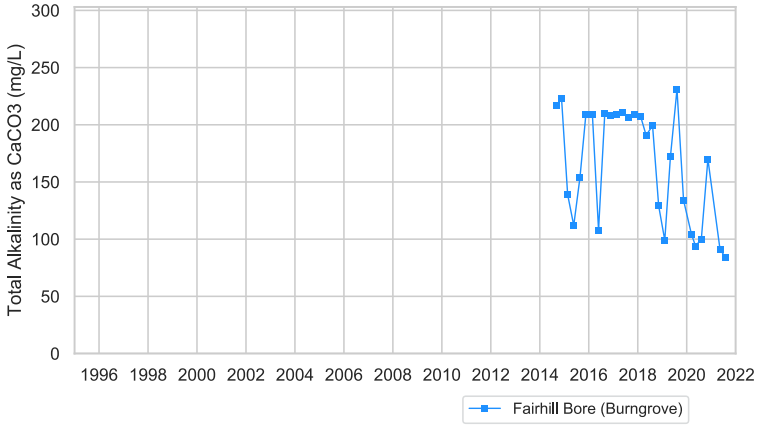

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

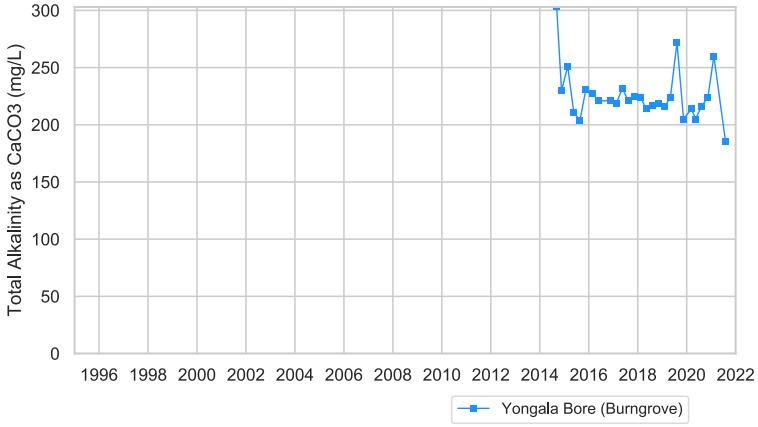

Total Alkalinity as CaCO3 (mg/L)
GW02 (Alluvium)

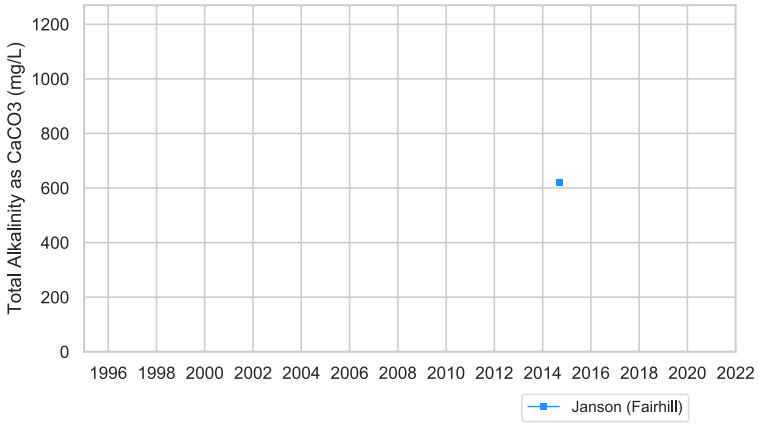

Total Alkalinity as CaCO3 (mg/L)
RB7a (Alluvium)

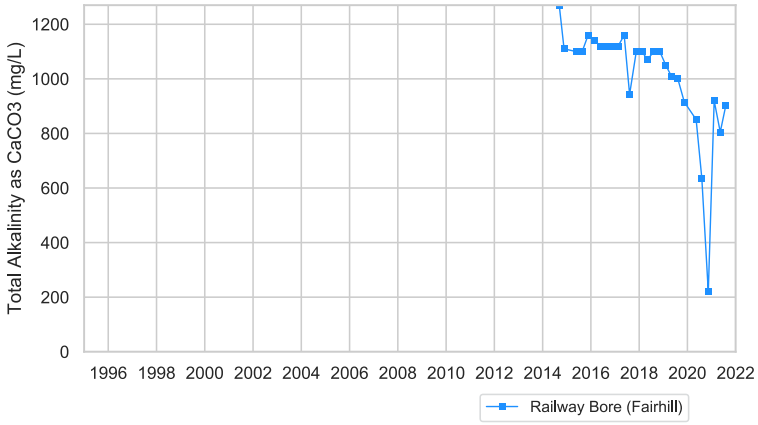

Total Alkalinity as CaCO3 (mg/L)
Twin Bores (Alluvium)


Total Alkalinity as CaCO3 (mg/L)
Weir Bore (2) (Alluvium)

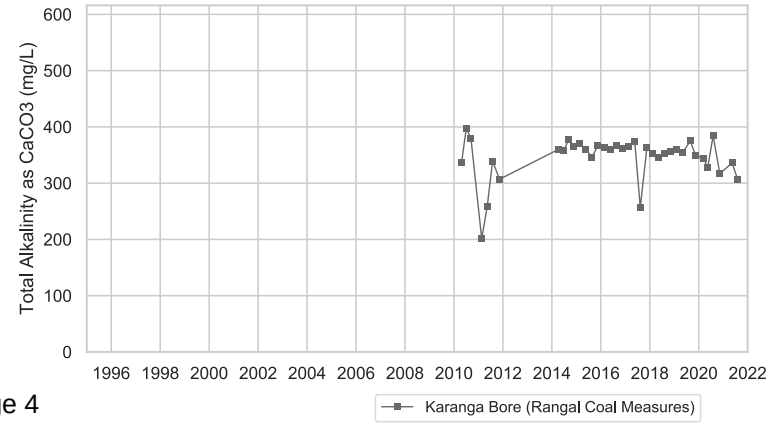

Total Alkalinity as CaCO3 (mg/L)
Fairhill Bore (Burngrove)

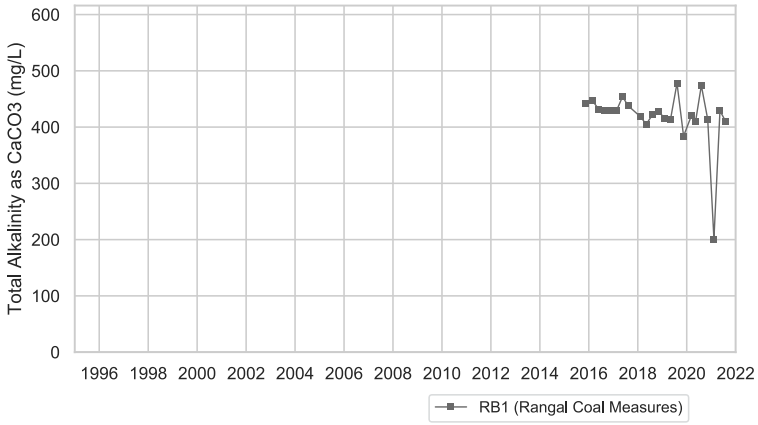

Total Alkalinity as CaCO3 (mg/L)
Yongala Bore (Burngrove)

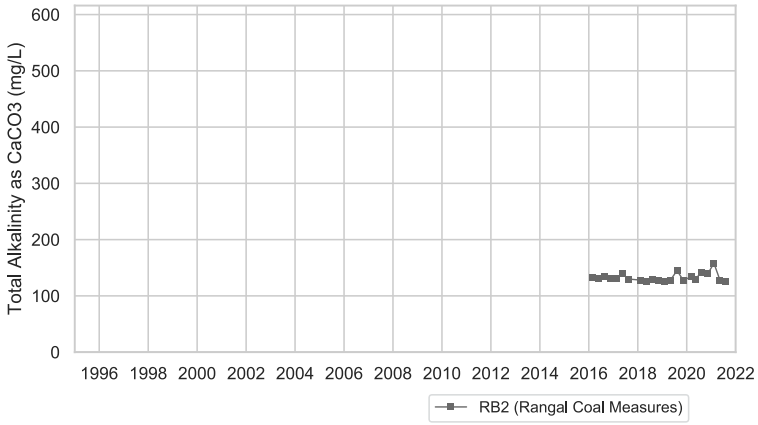

Total Alkalinity as CaCO3 (mg/L)
Janson (Fairhill)

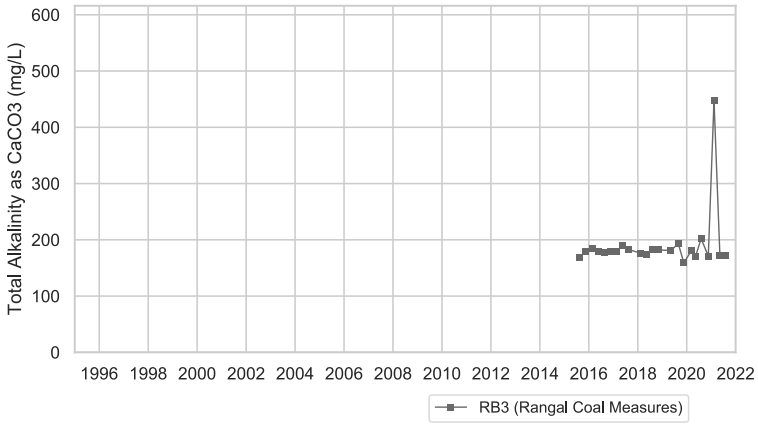

Total Alkalinity as CaCO3 (mg/L)
Railway Bore (Fairhill)

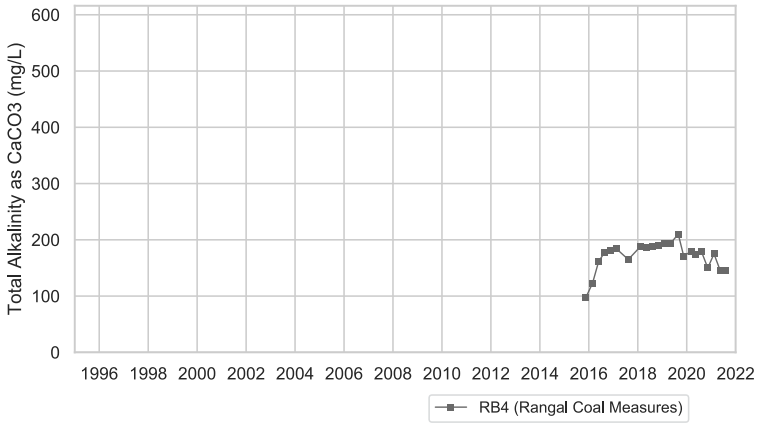
Total Alkalinity as CaCO3 (mg/L)
CYPRESS BORE (Rangal Coal Measures)

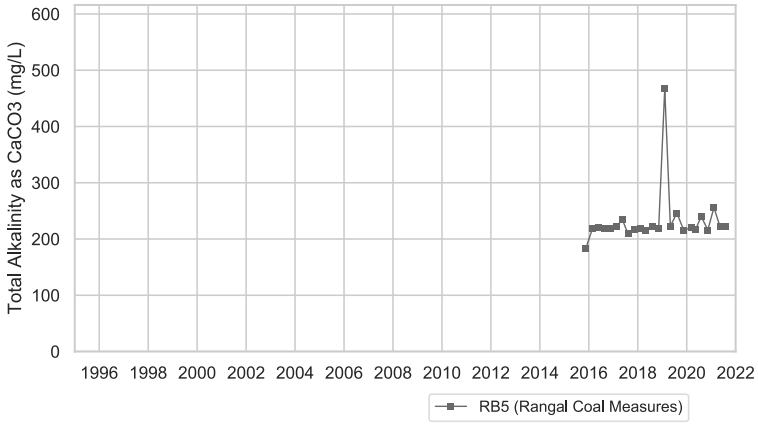

Total Alkalinity as CaCO3 (mg/L)
Karanga Bore (Rangal Coal Measures)

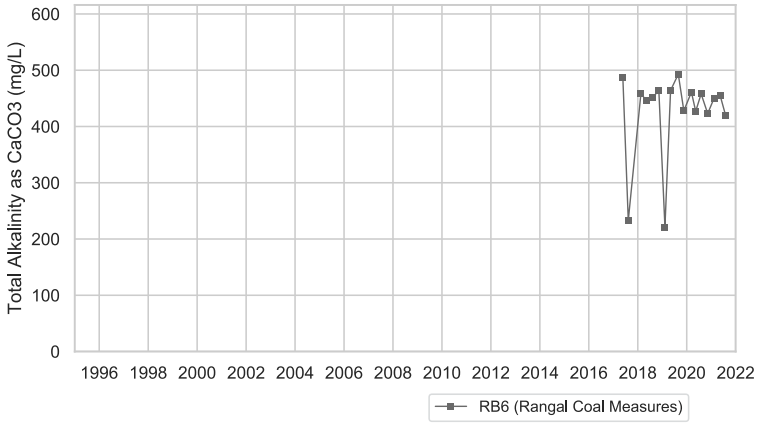

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

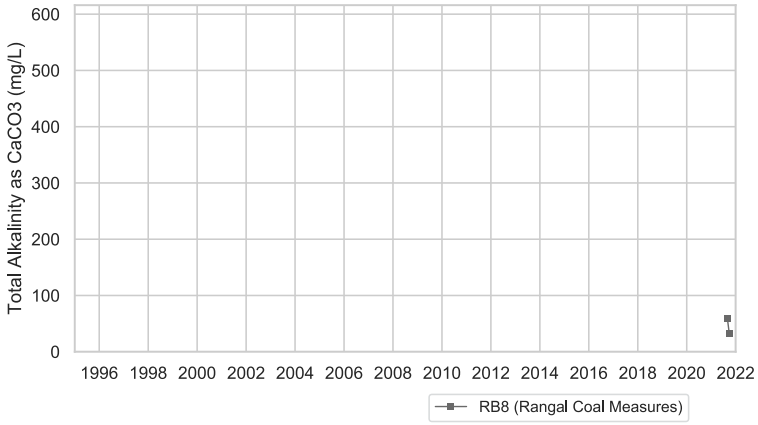

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

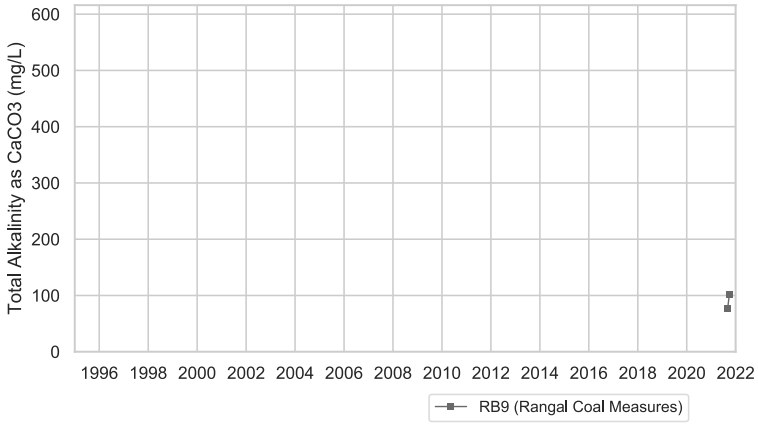

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

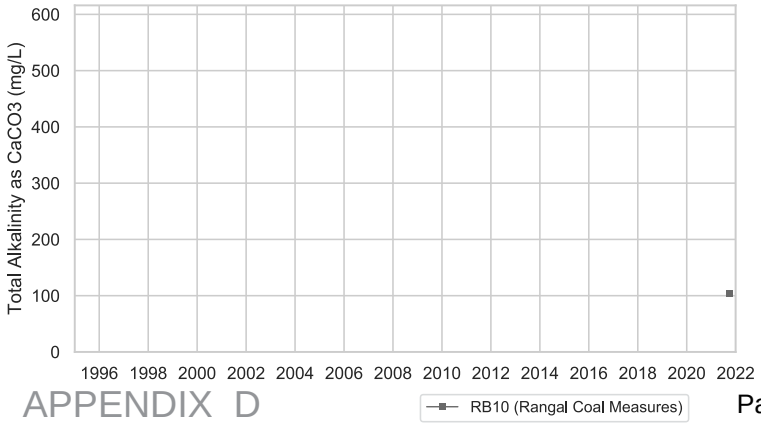

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

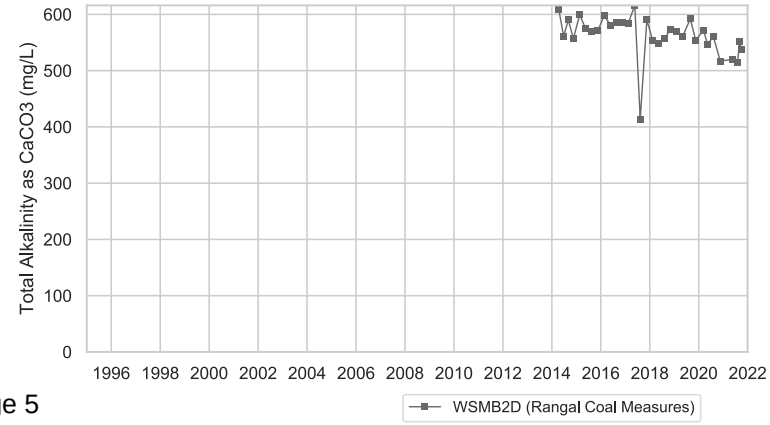

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

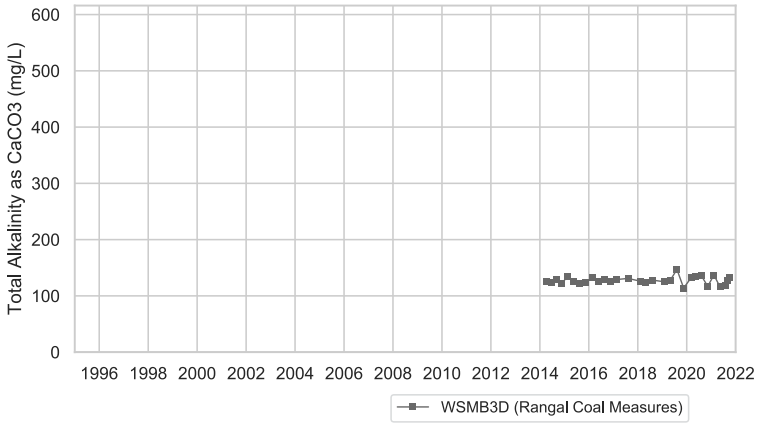

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

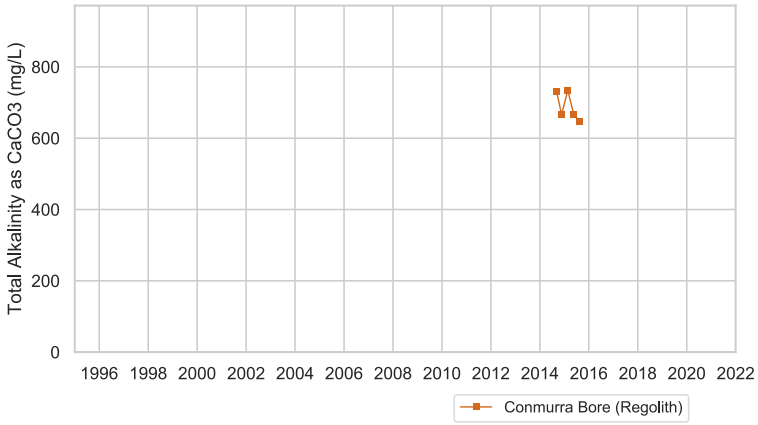

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

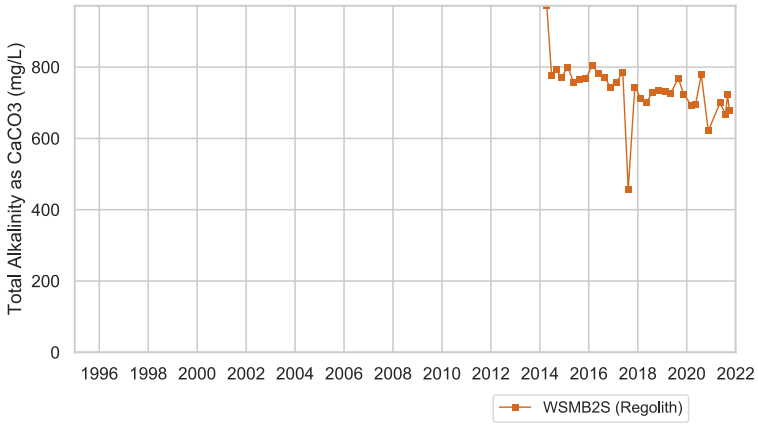

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

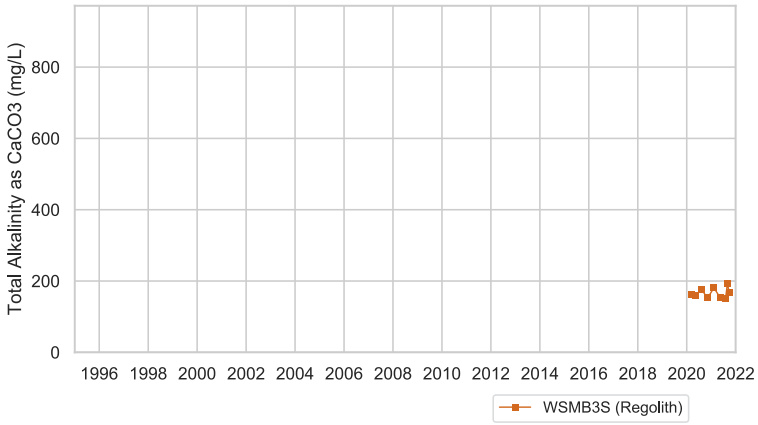

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

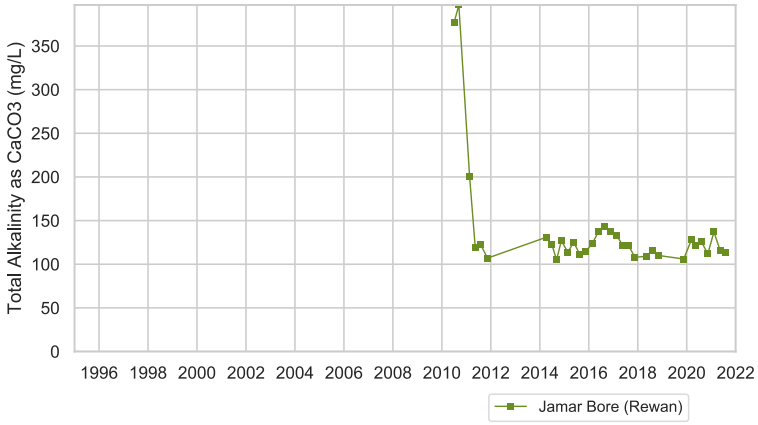

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

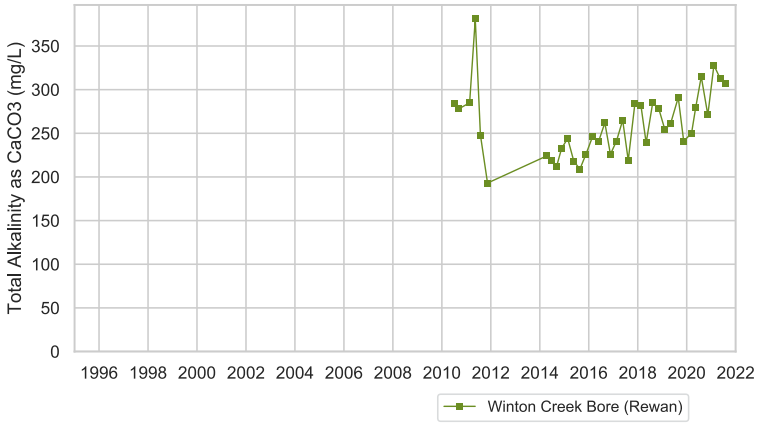

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

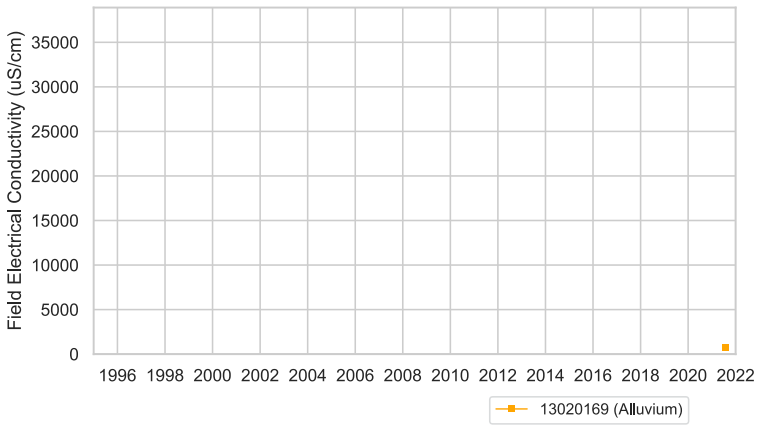

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

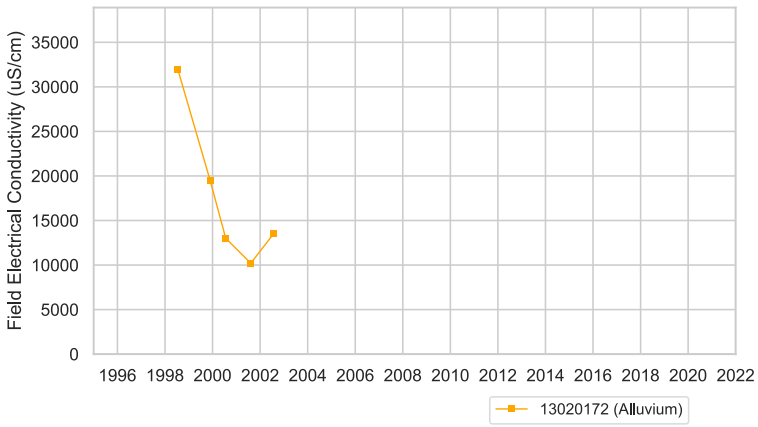

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

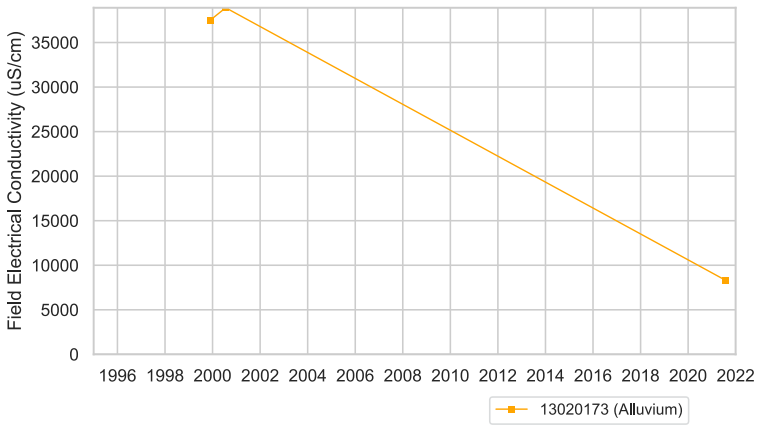

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

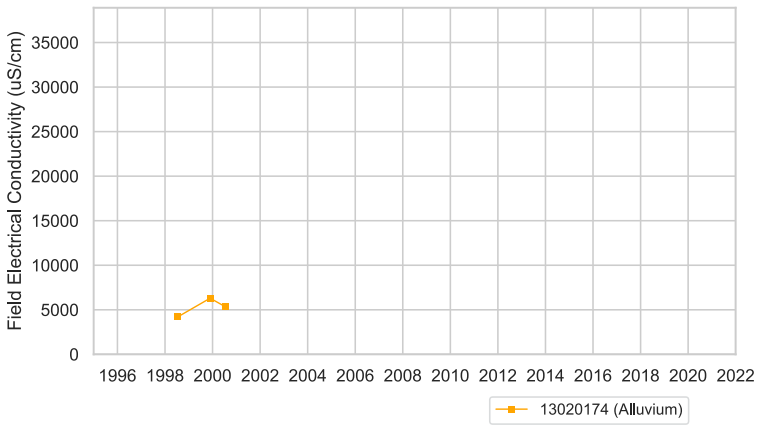

Total Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

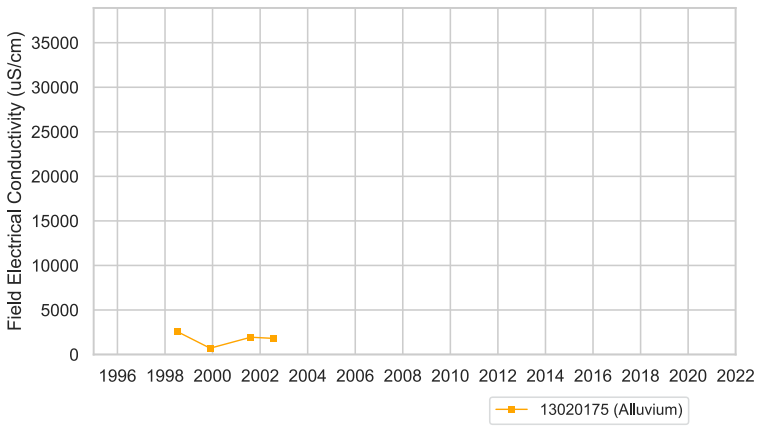

Total Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

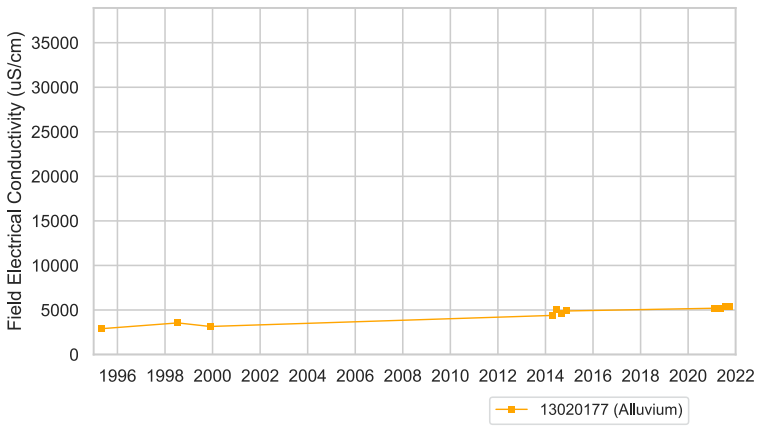

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

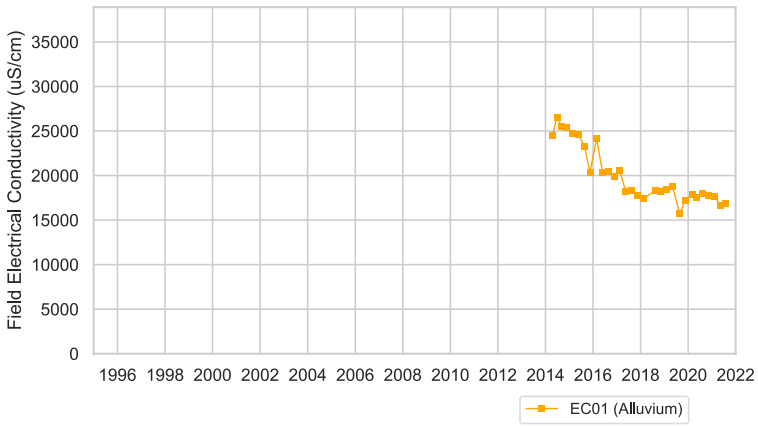

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

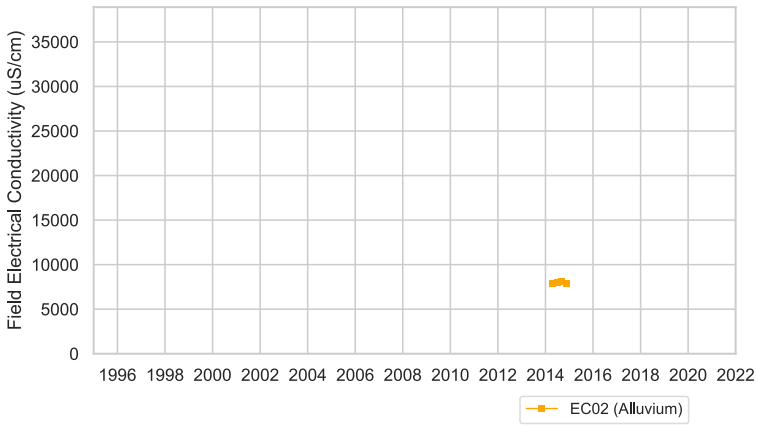

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

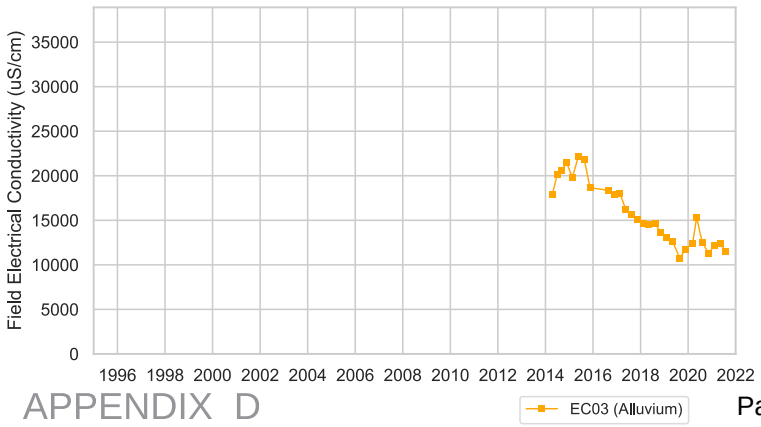

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

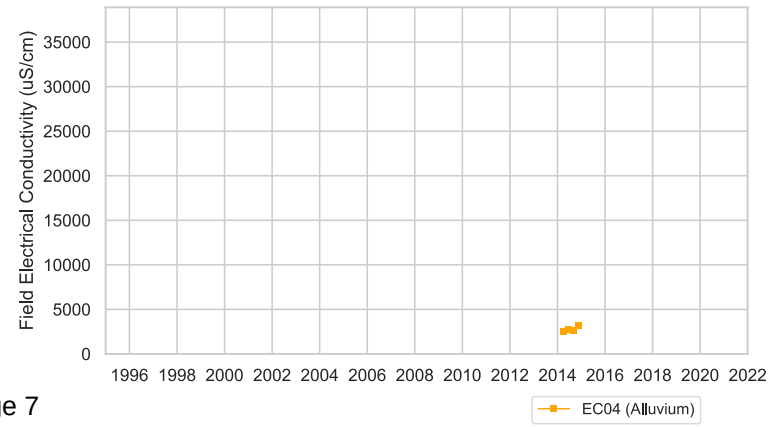

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

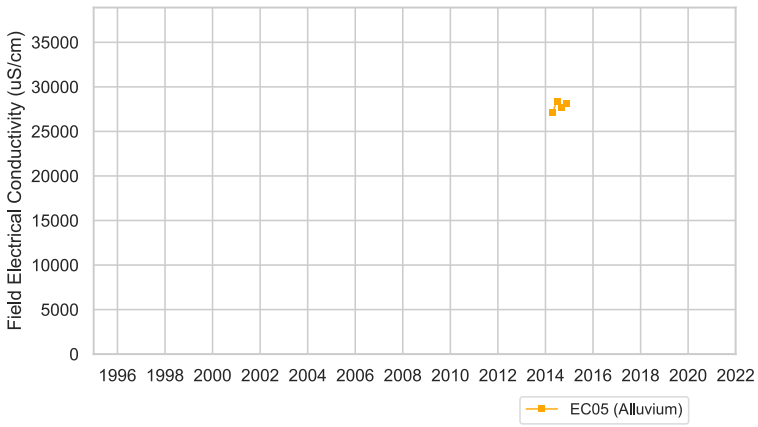

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

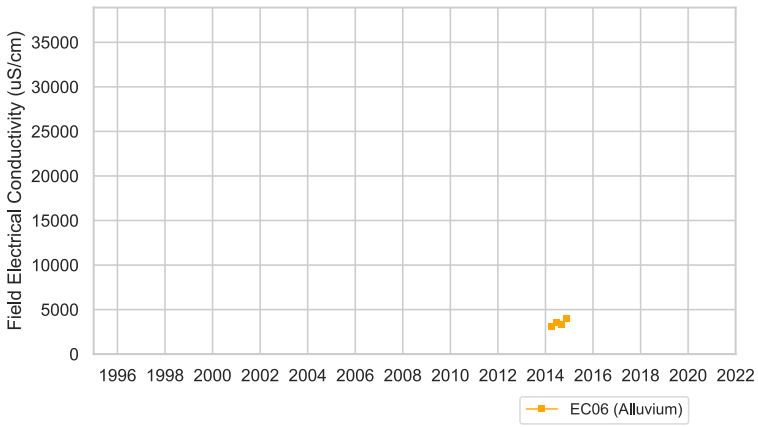

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

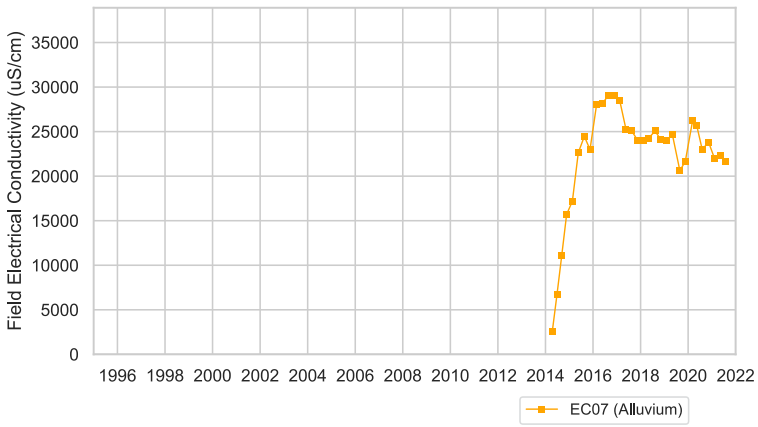

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

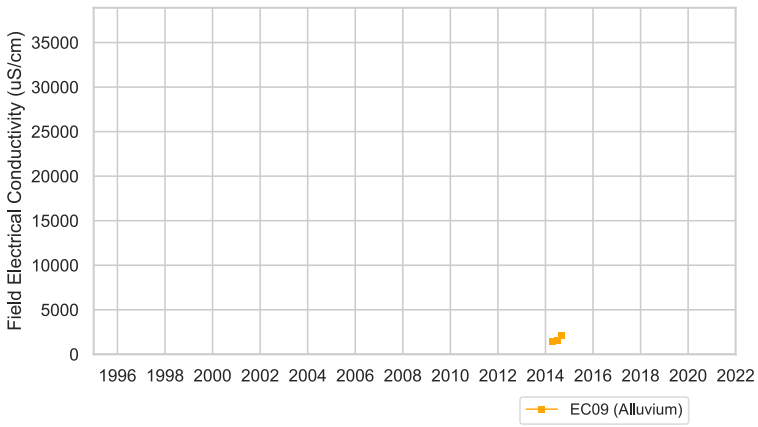

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

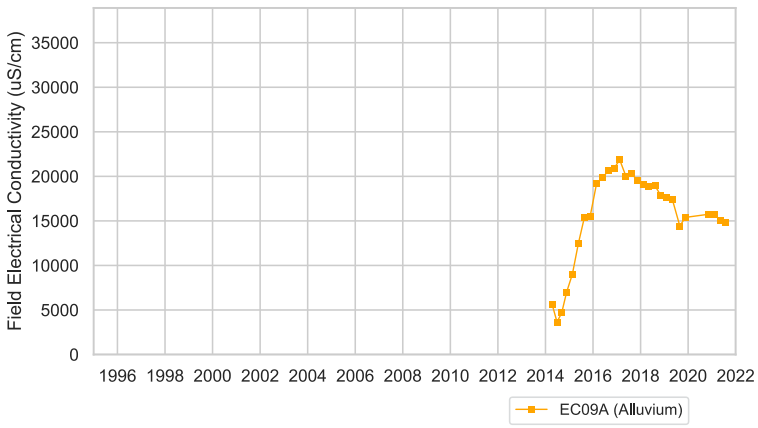

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

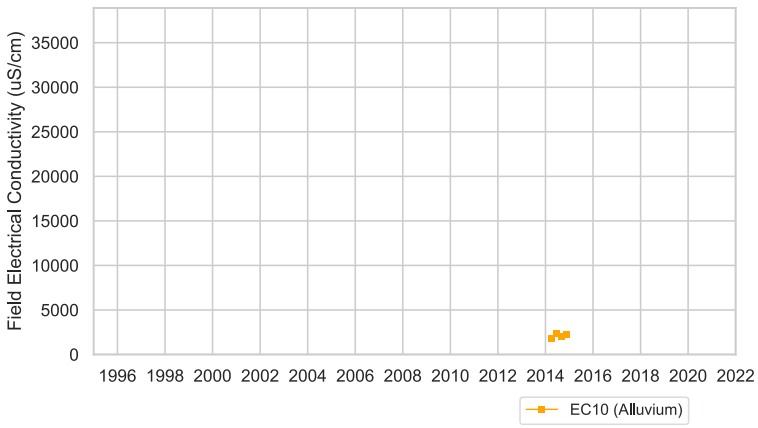

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

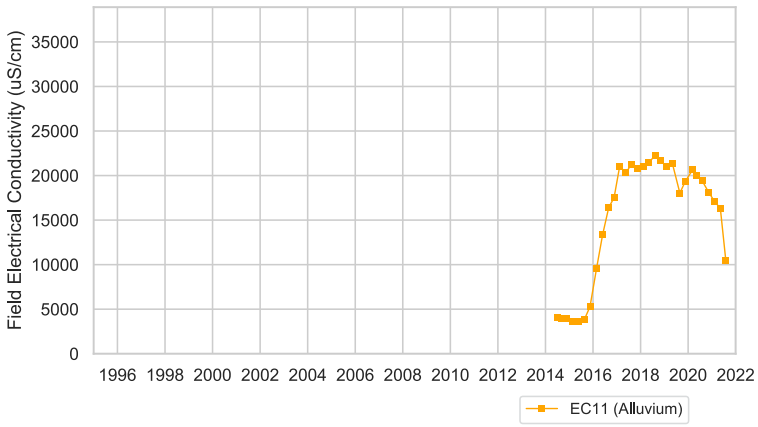

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

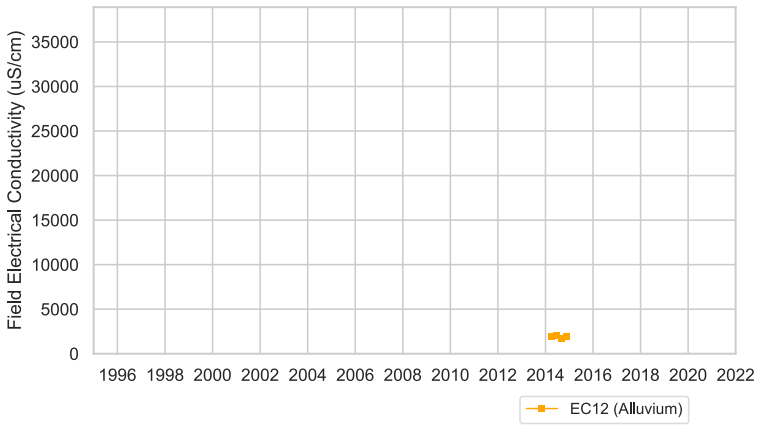

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

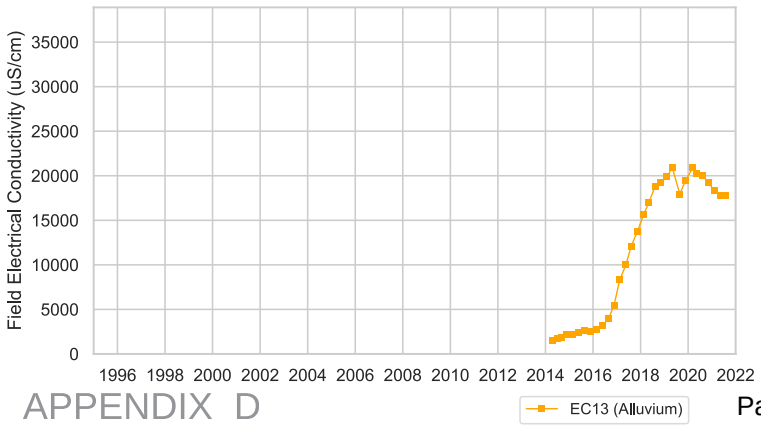

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

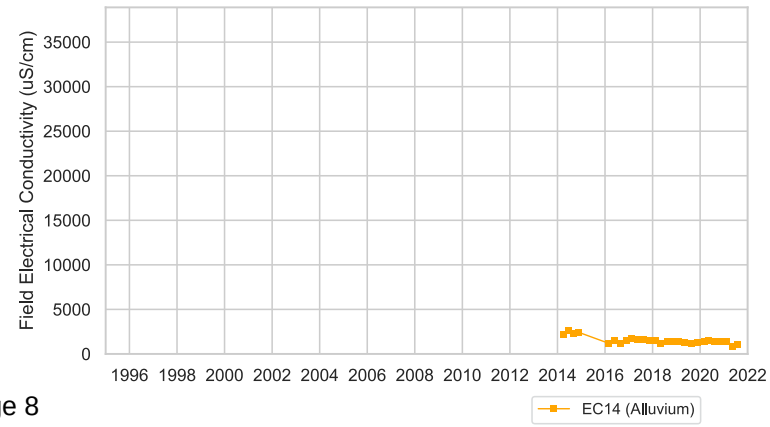

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

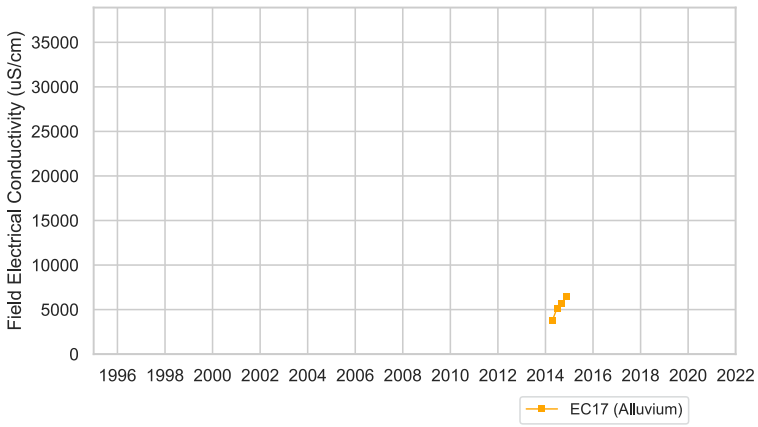

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

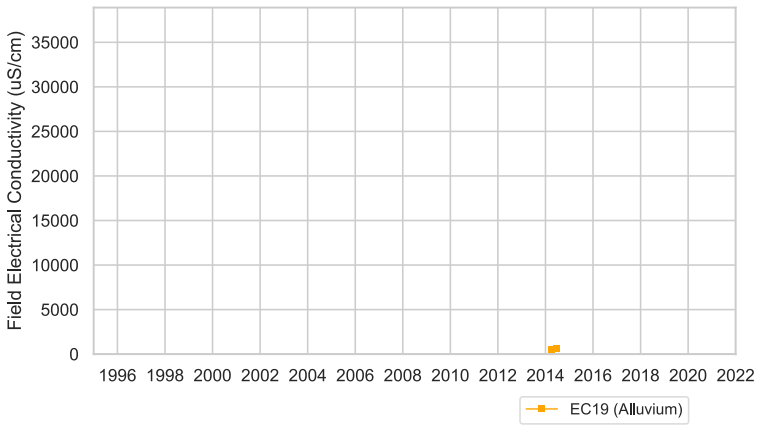

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

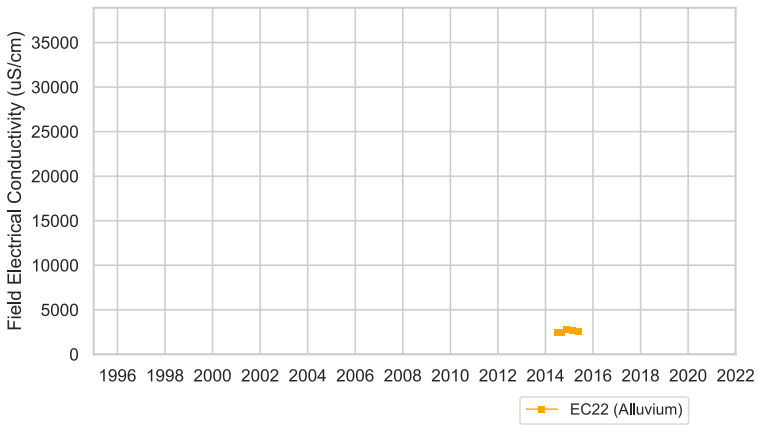

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

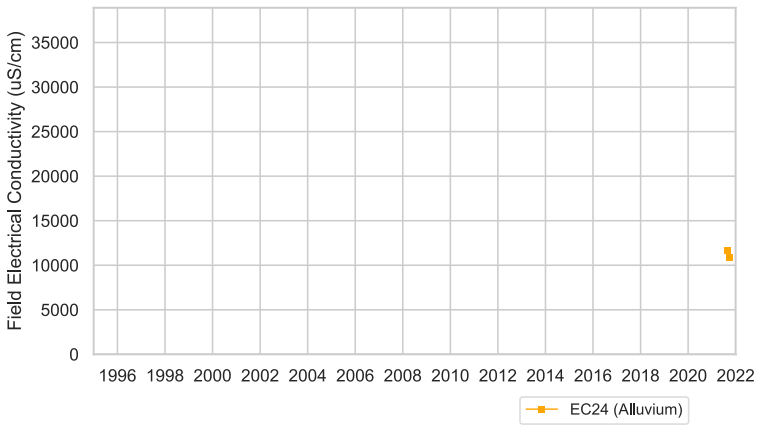

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

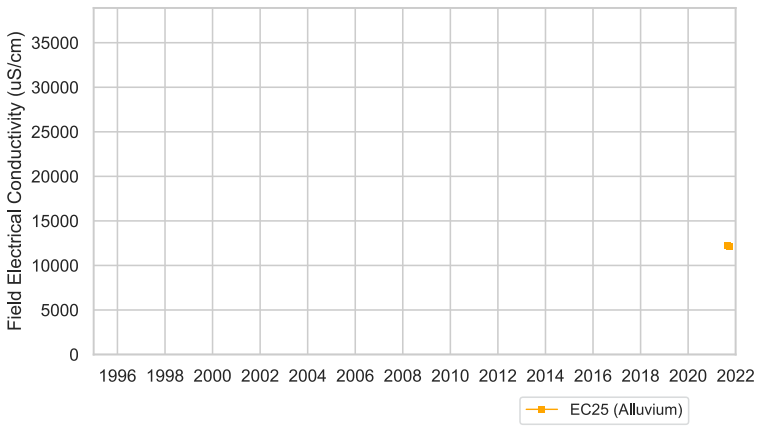

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

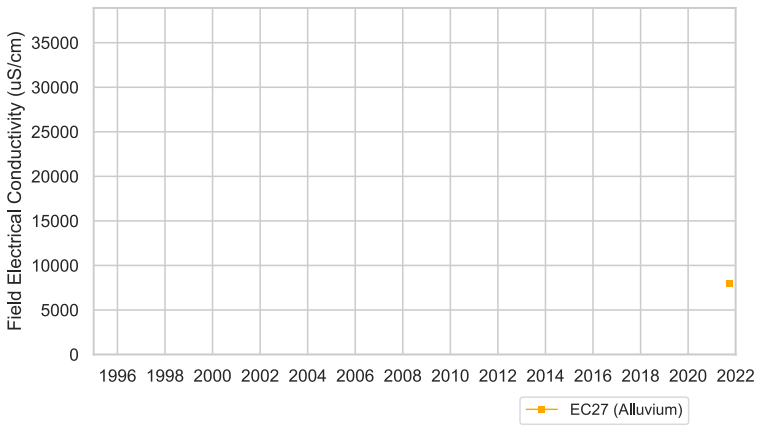

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

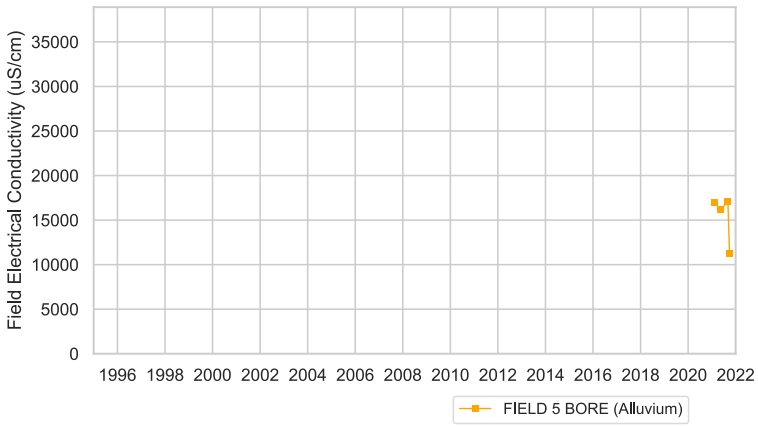

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

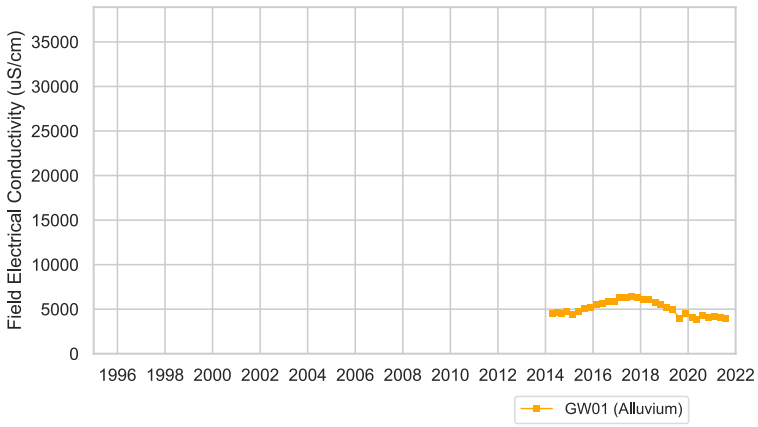

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

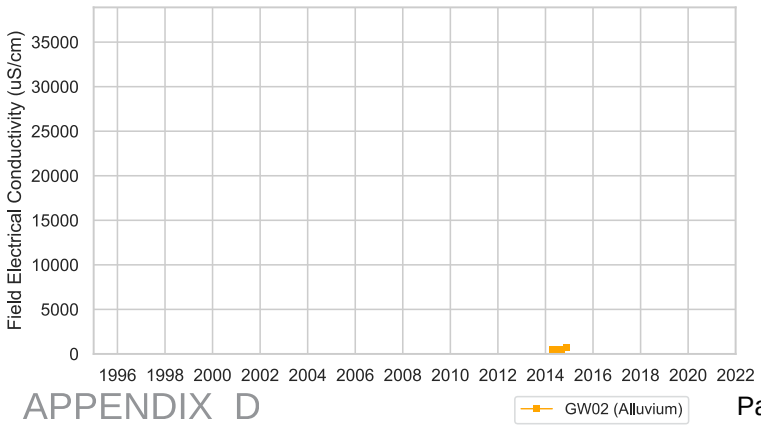

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

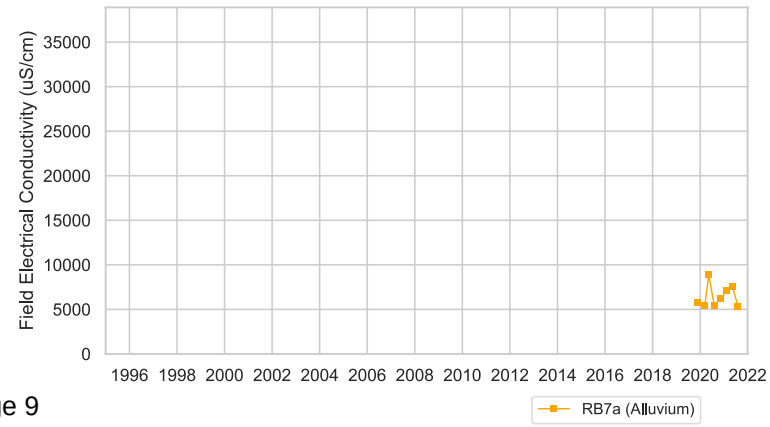

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

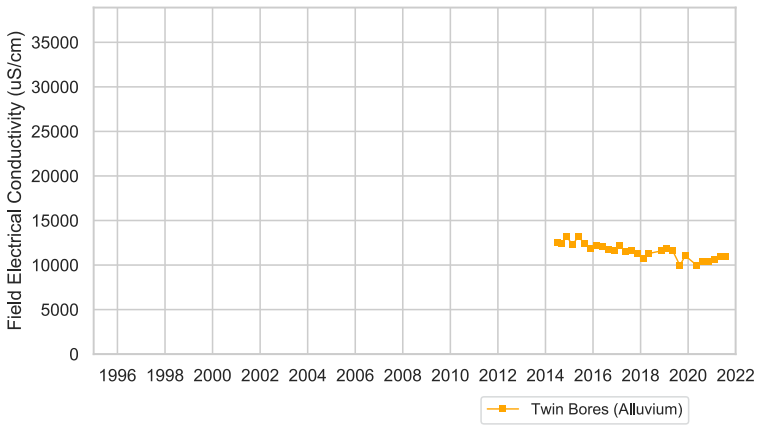

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

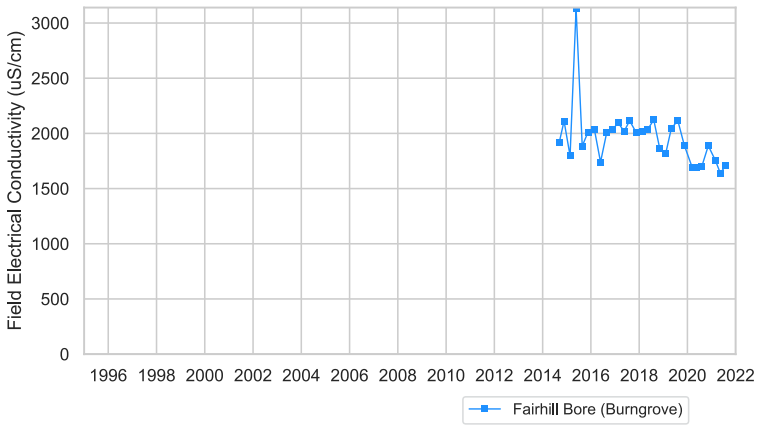

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

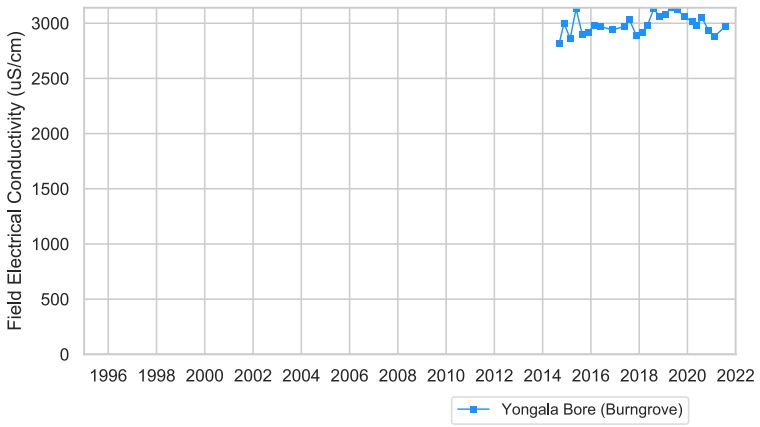

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

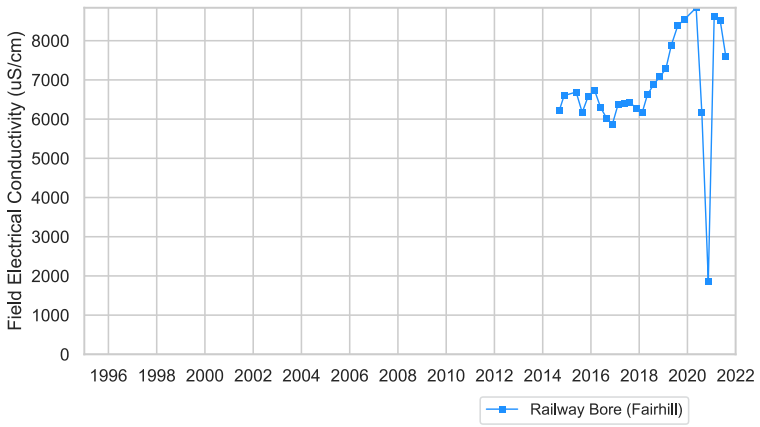

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

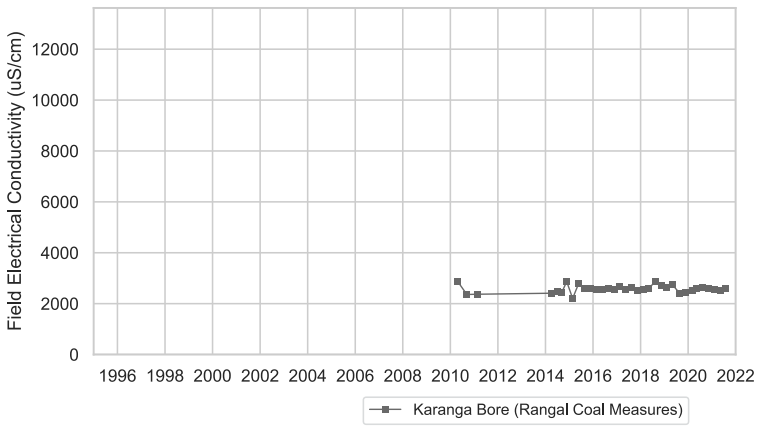

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

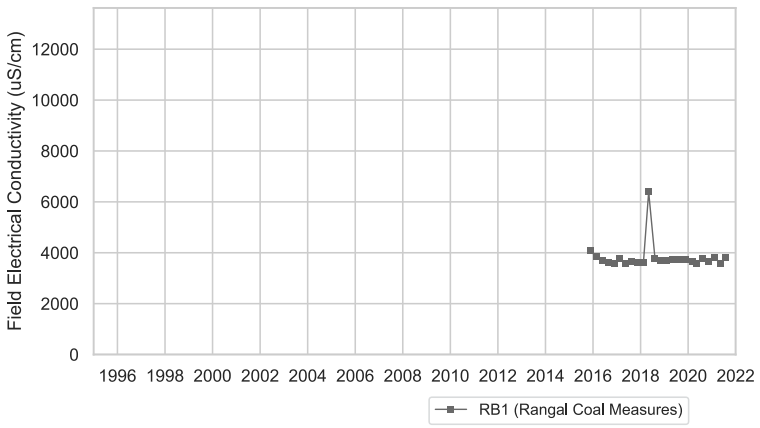

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

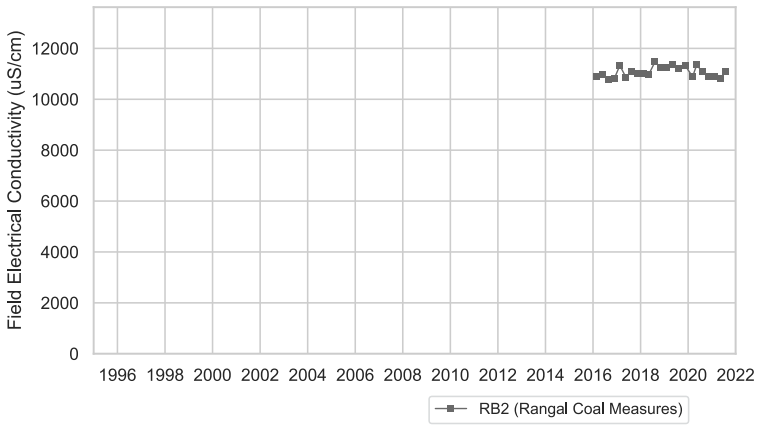

Field Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

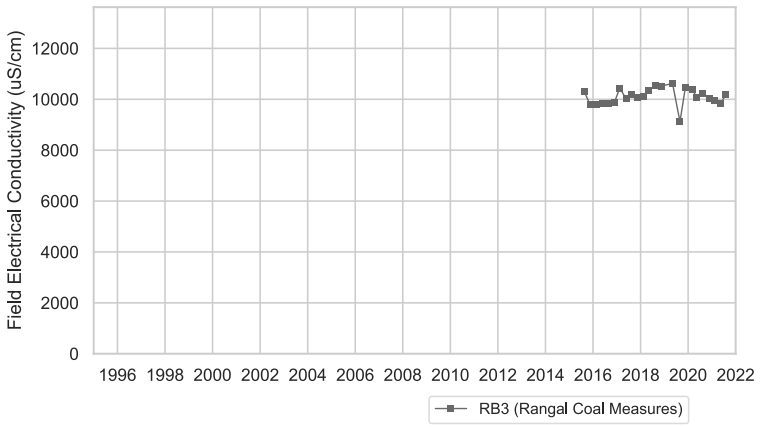

Field Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

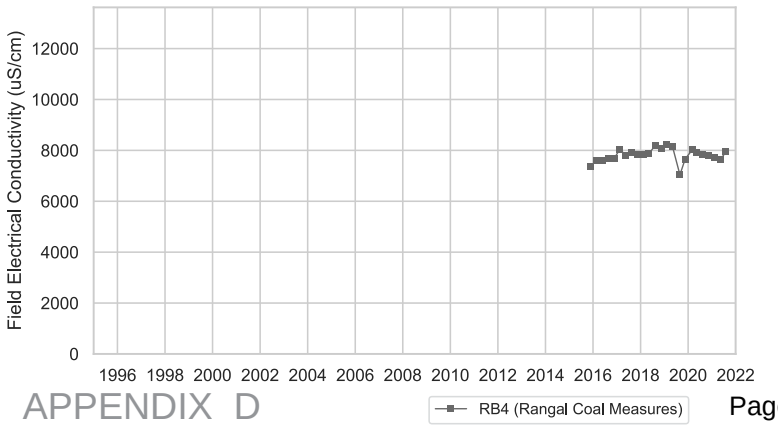

Field Electrical Conductivity (uS/cm)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

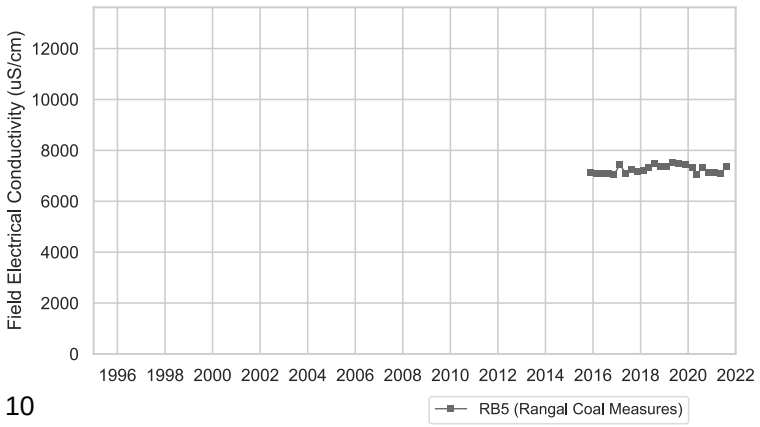

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

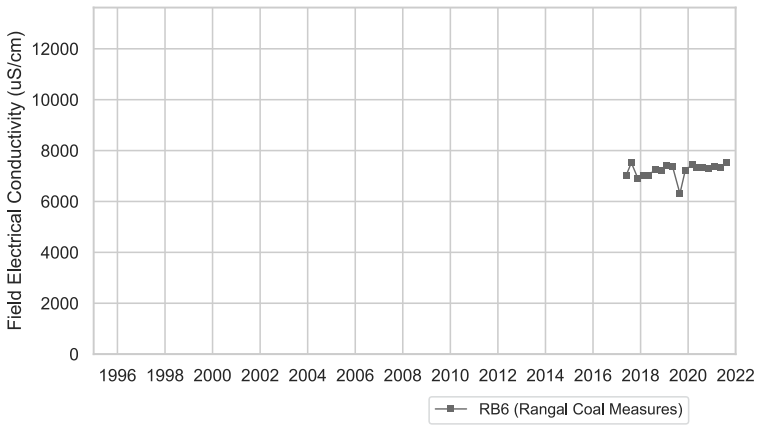

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

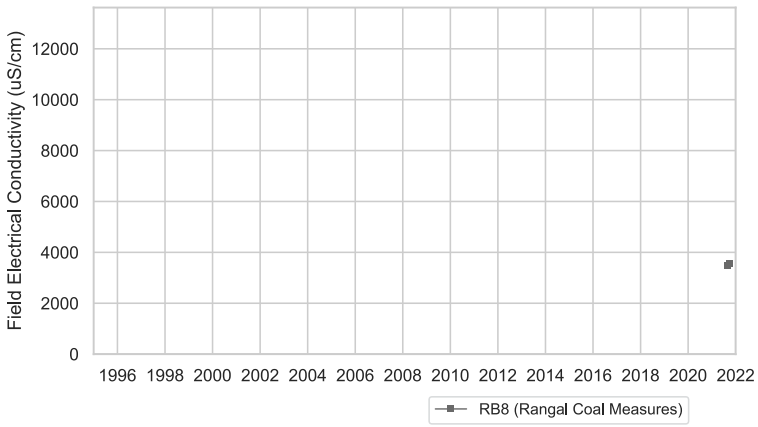

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

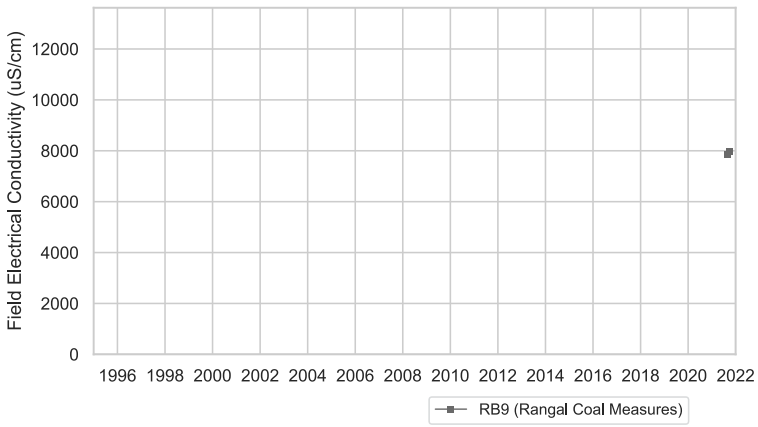

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

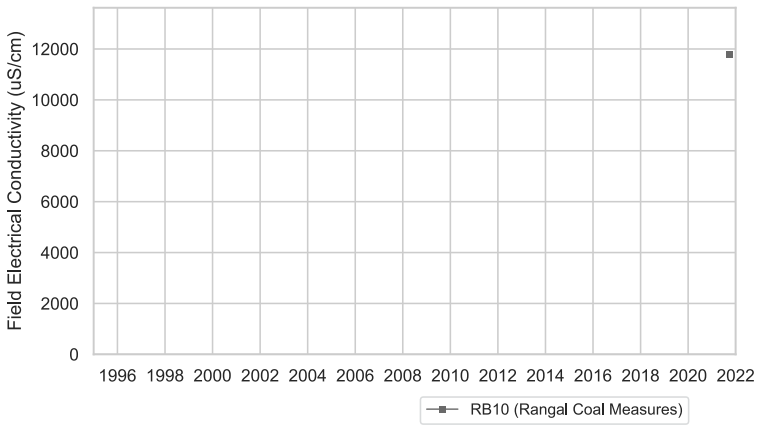

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

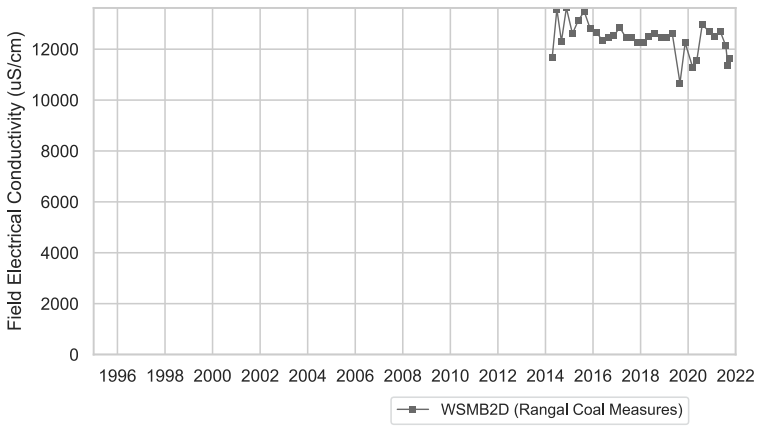

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

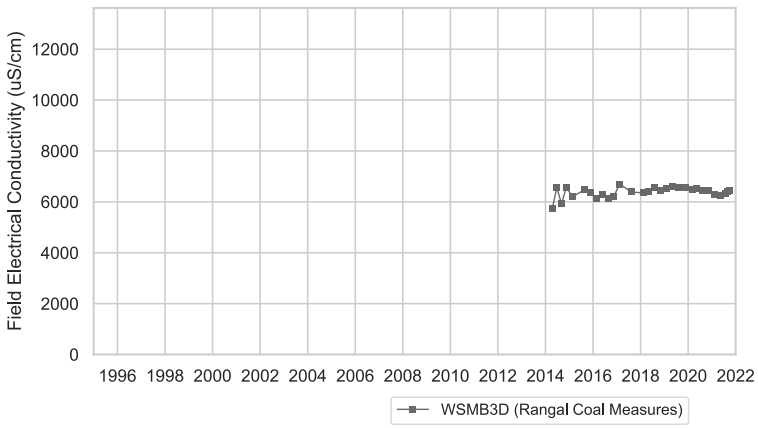

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

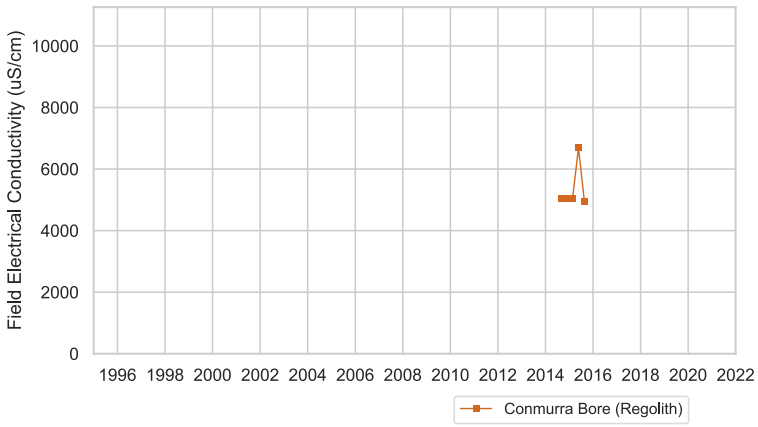

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)


Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

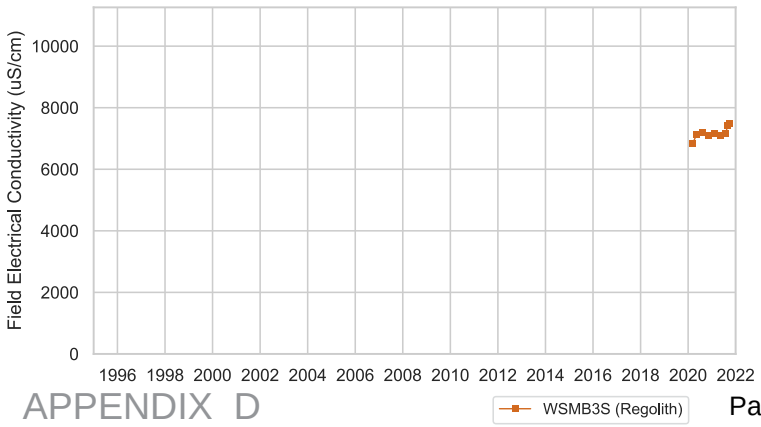

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

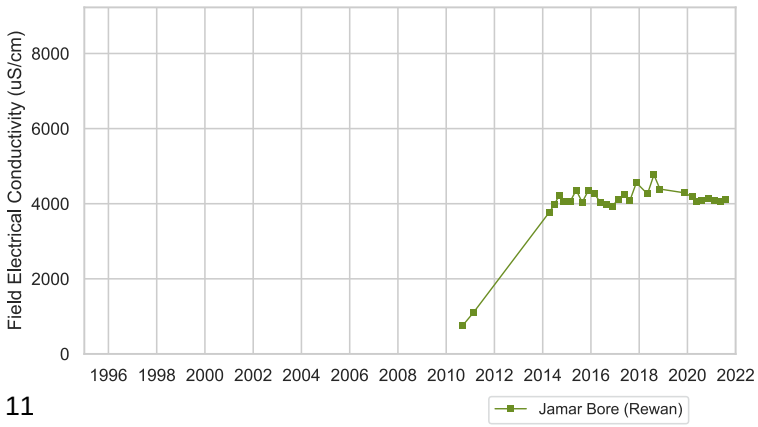

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

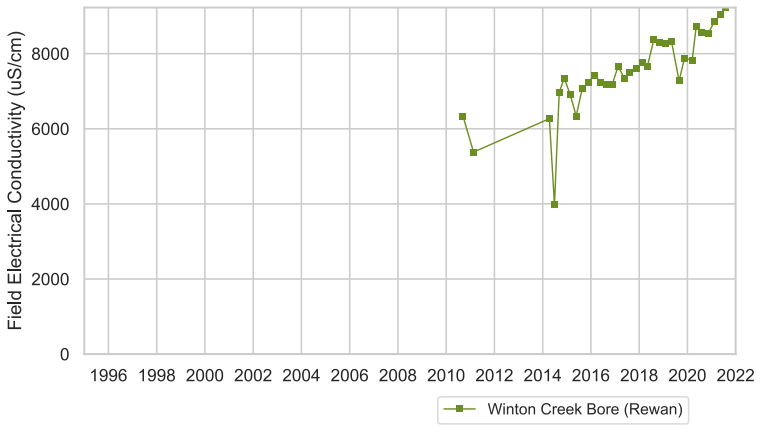

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

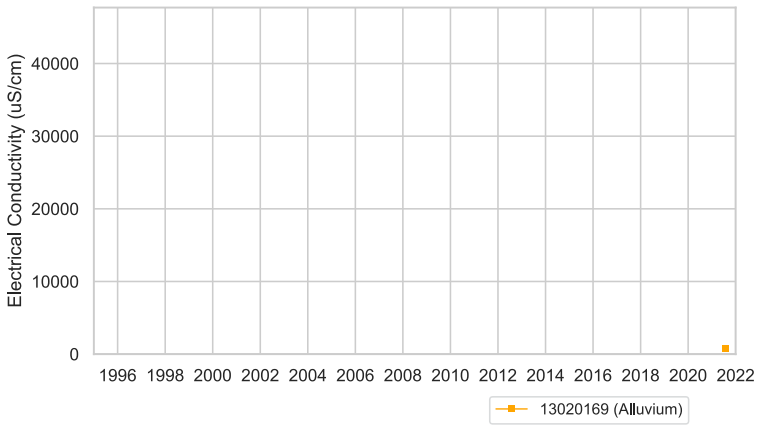

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

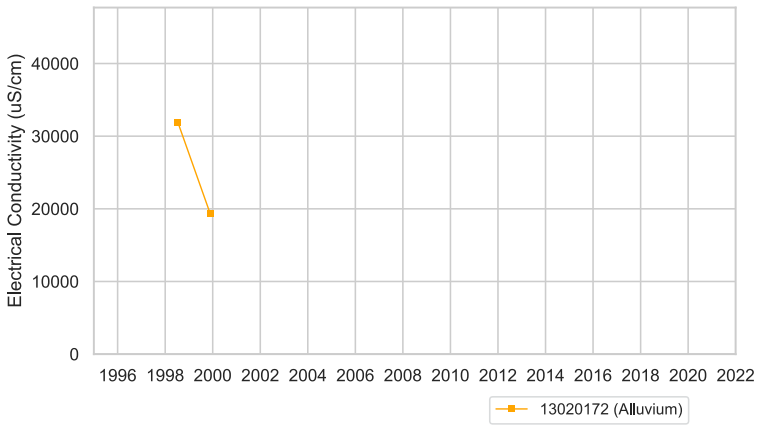
Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

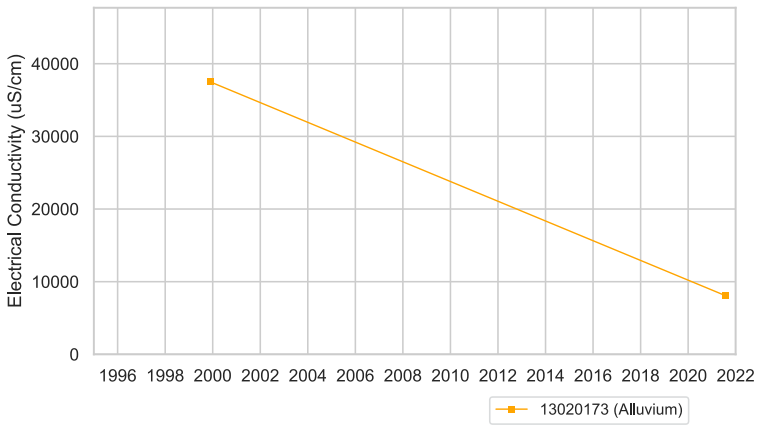

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

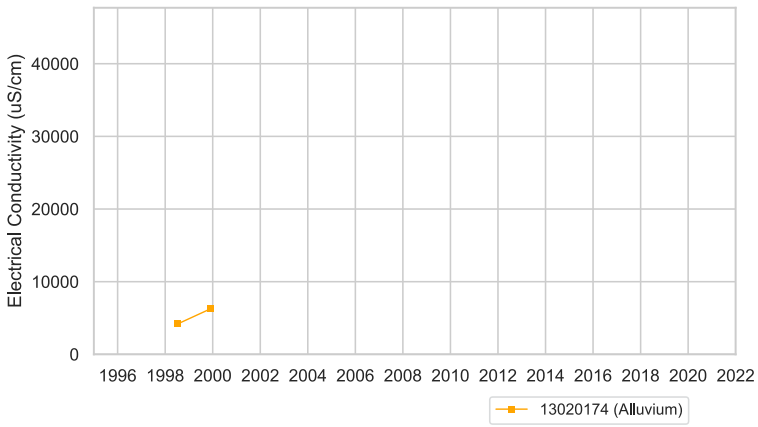

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

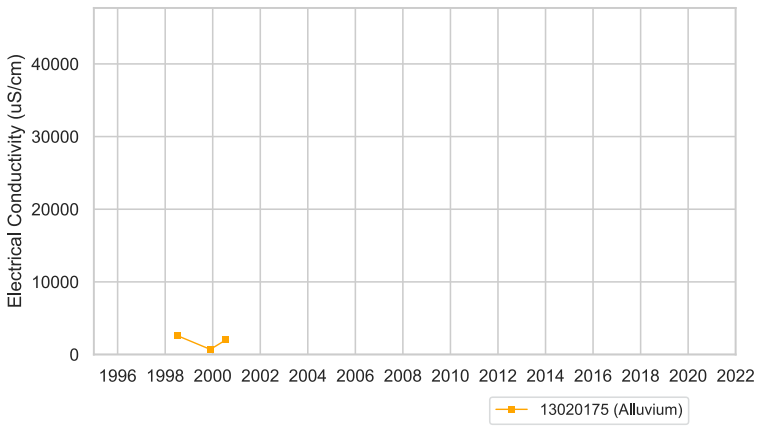

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

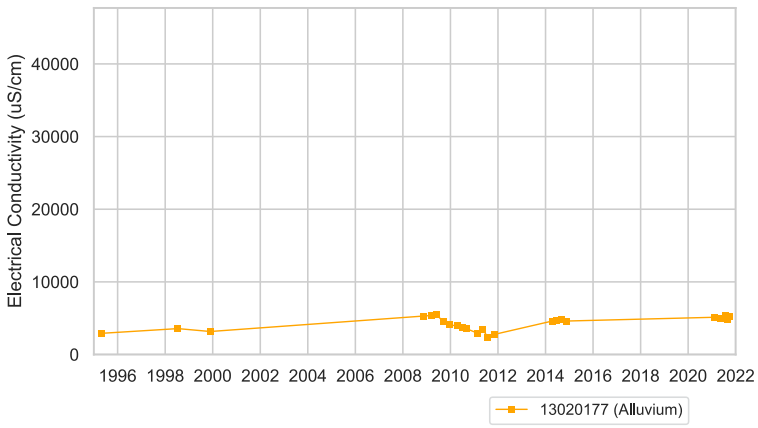

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

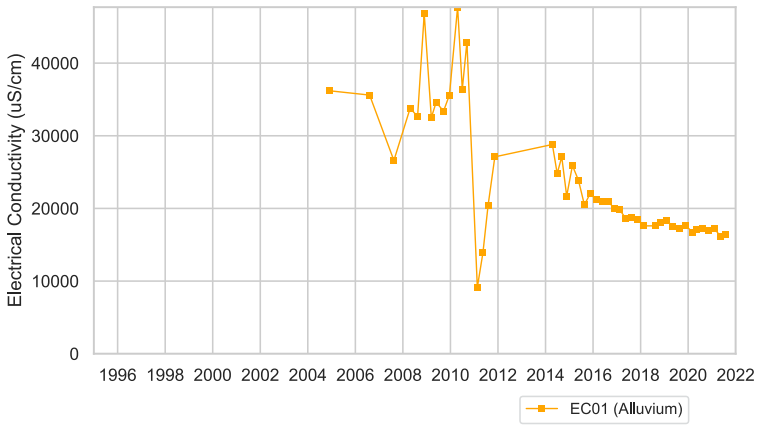

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

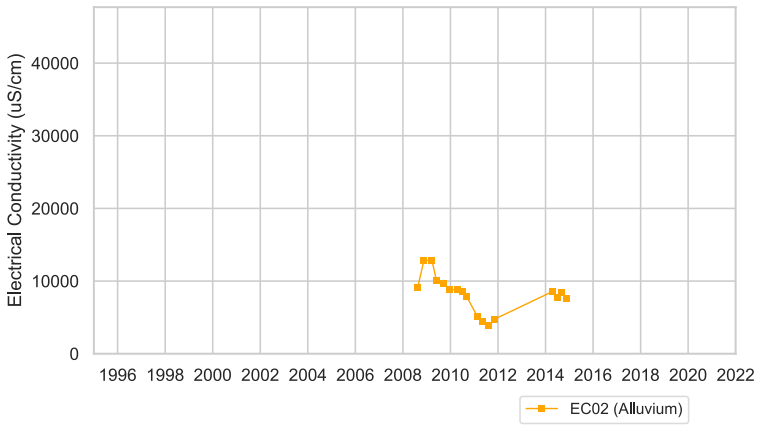

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

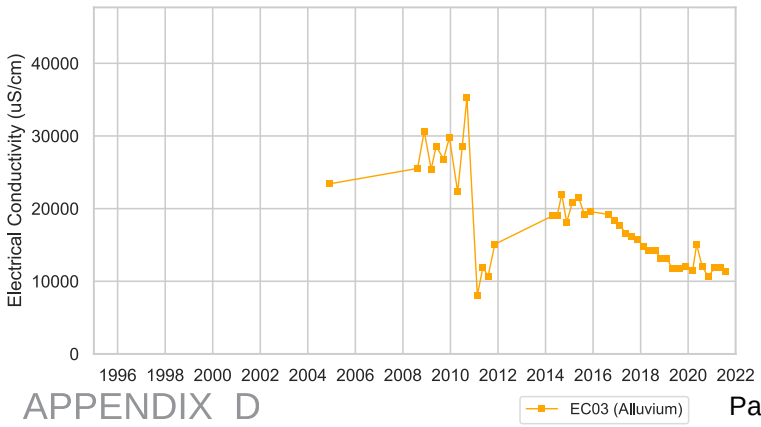

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

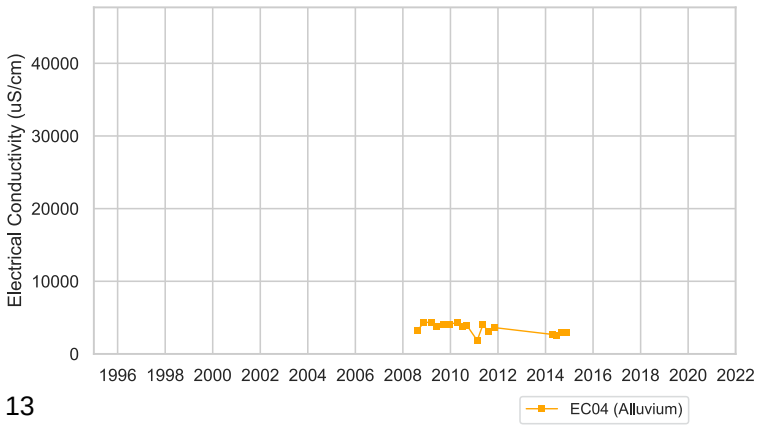

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

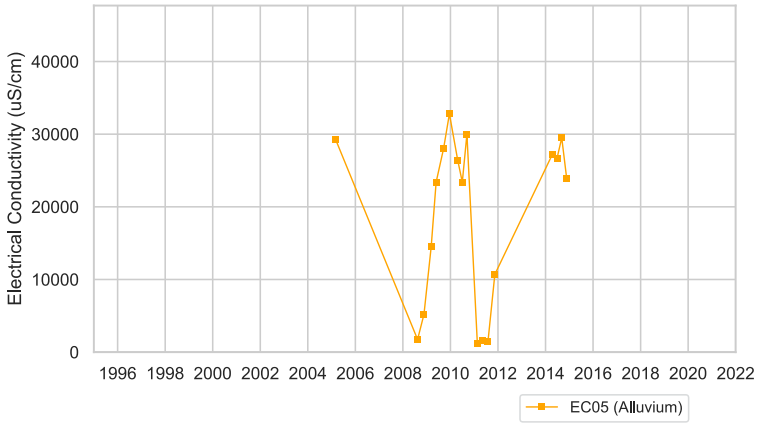

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

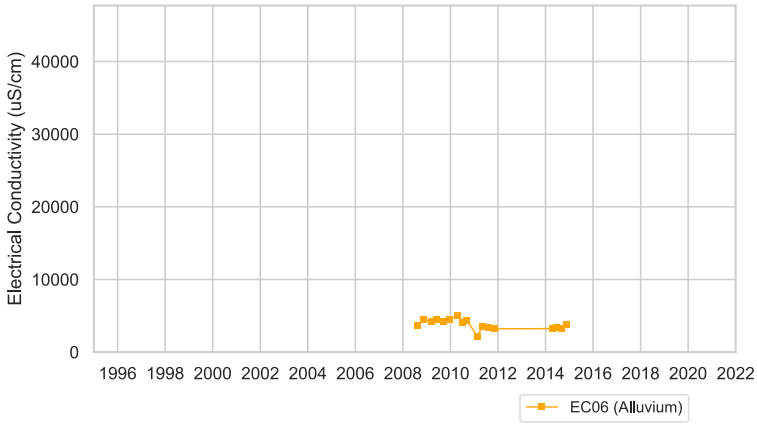

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

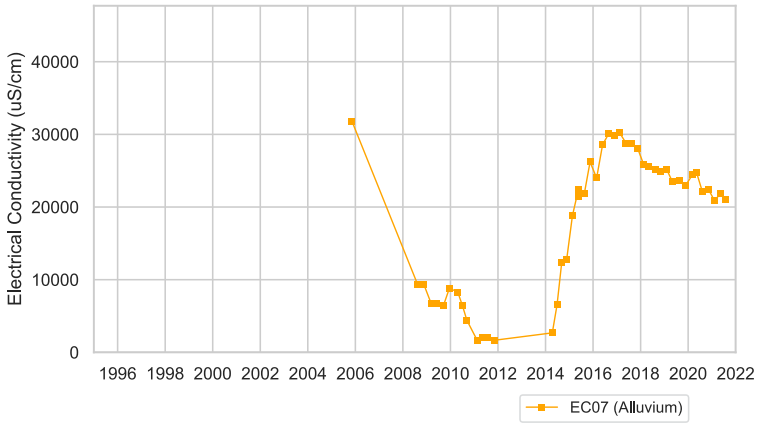

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

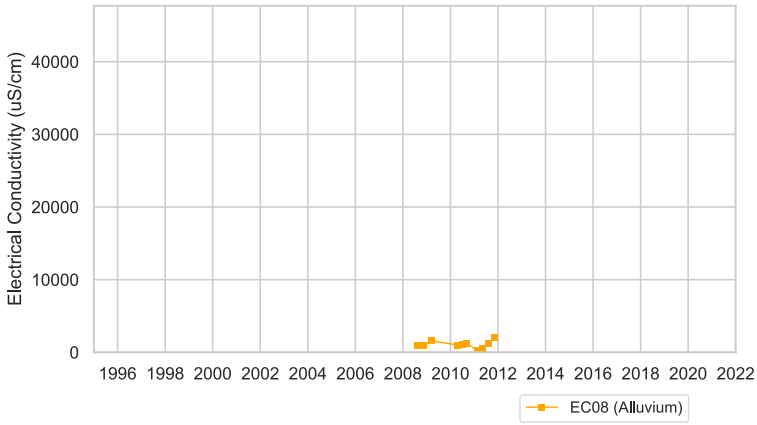

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

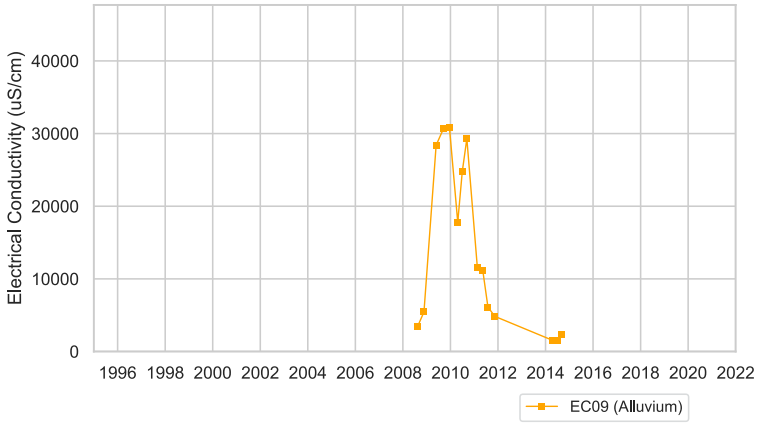

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

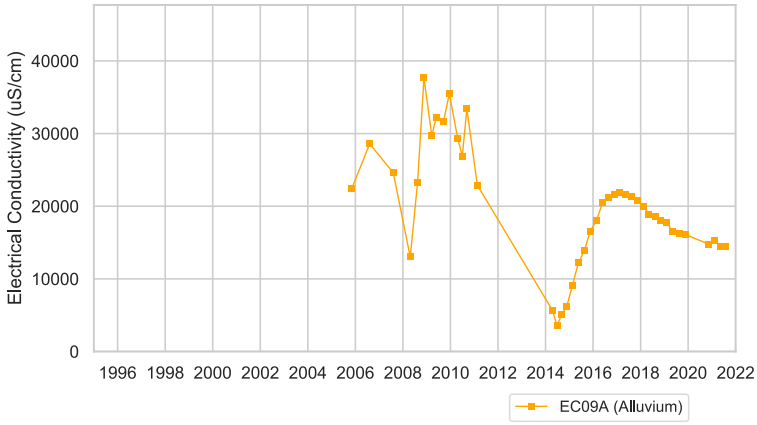

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

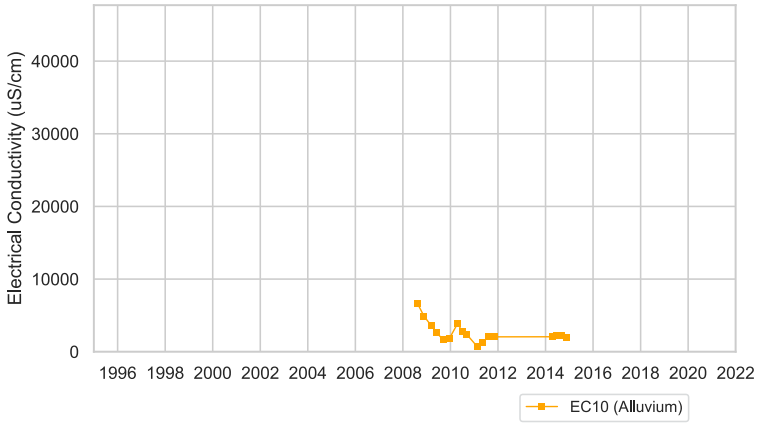

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

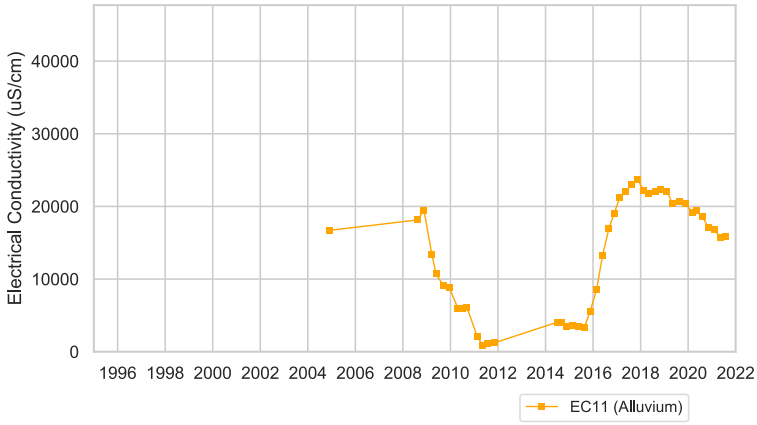

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

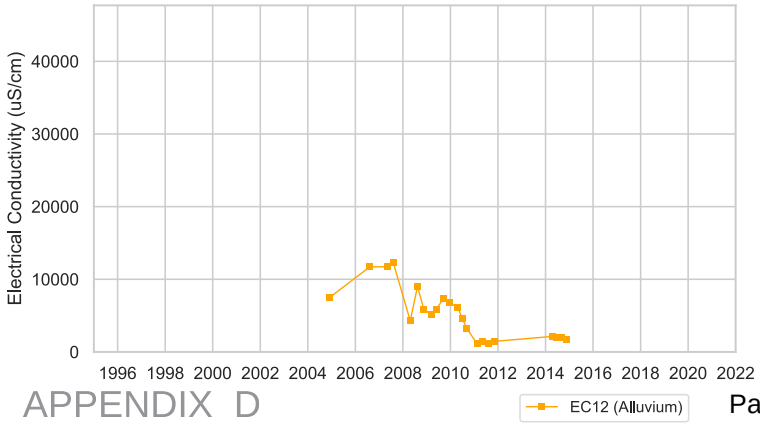

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

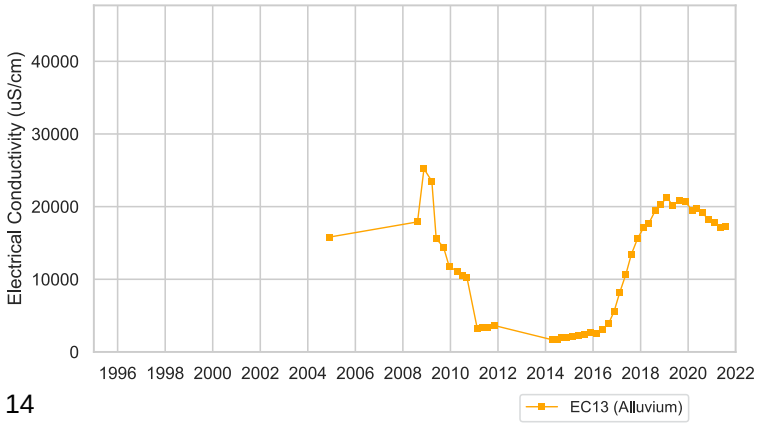

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

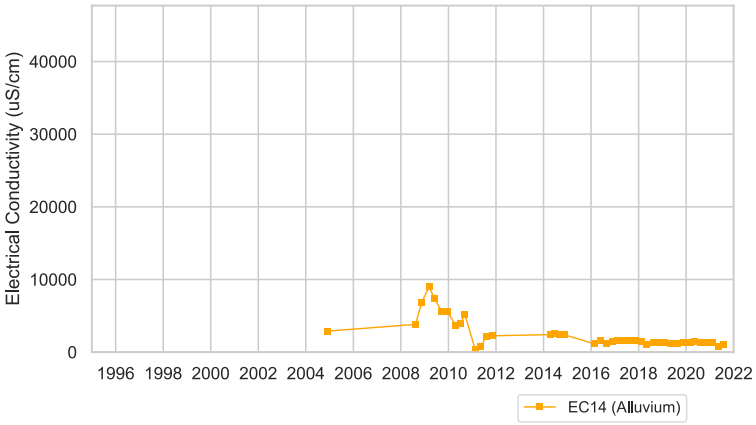

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

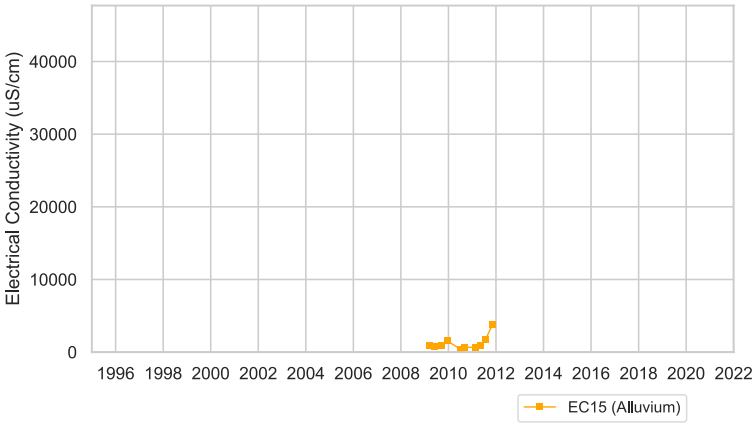

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

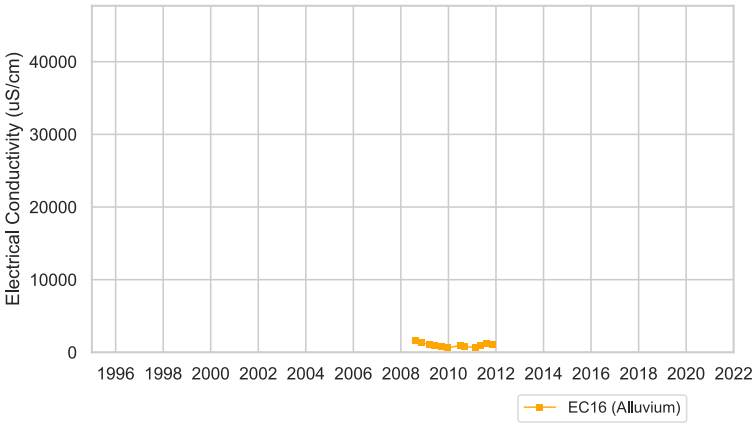

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

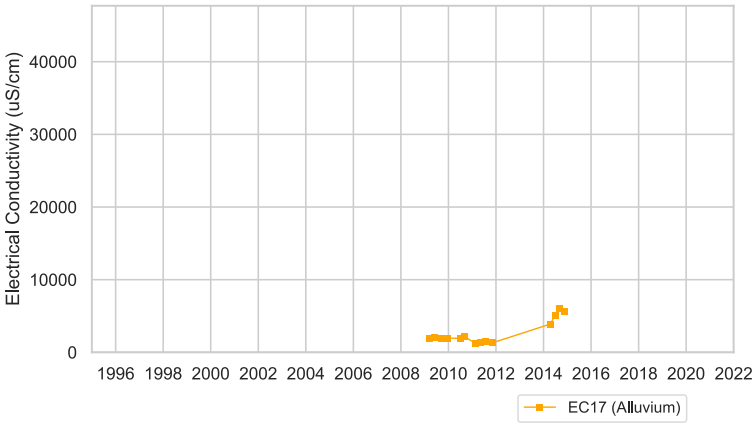

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

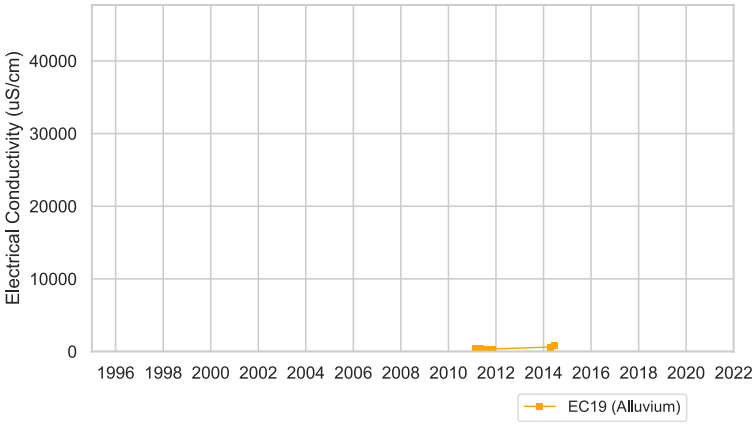

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

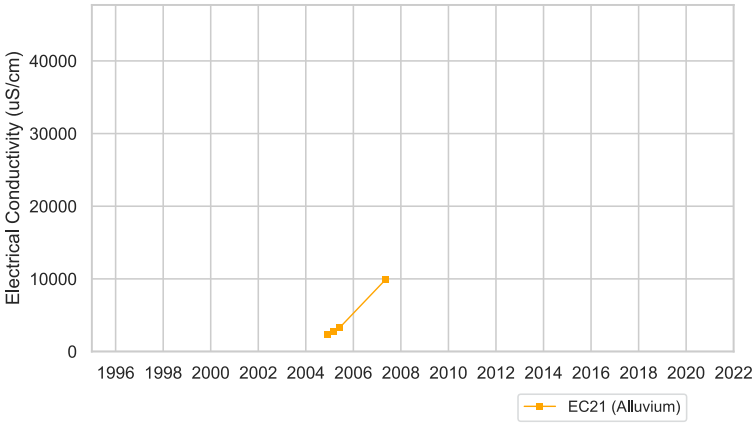

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

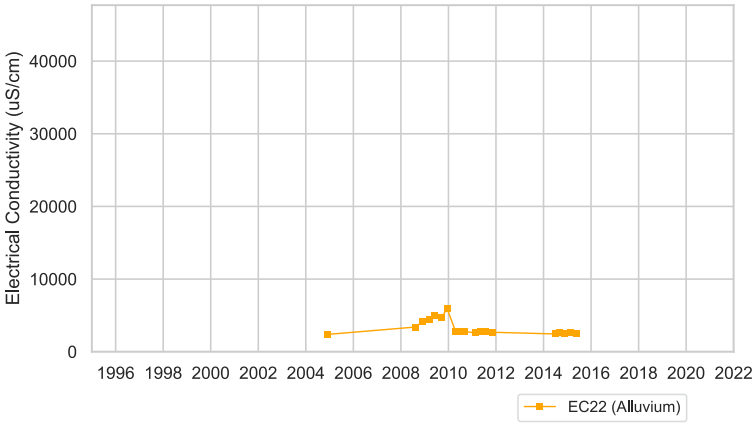

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

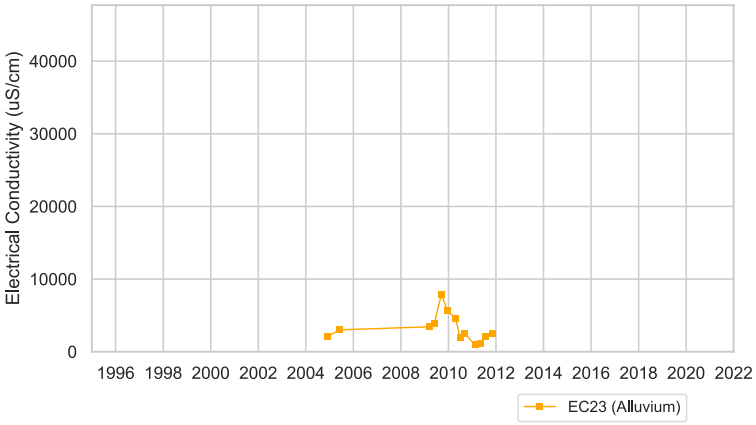

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

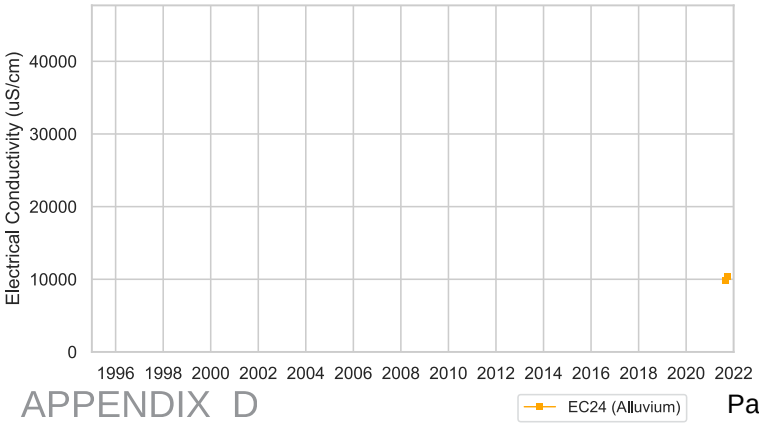

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

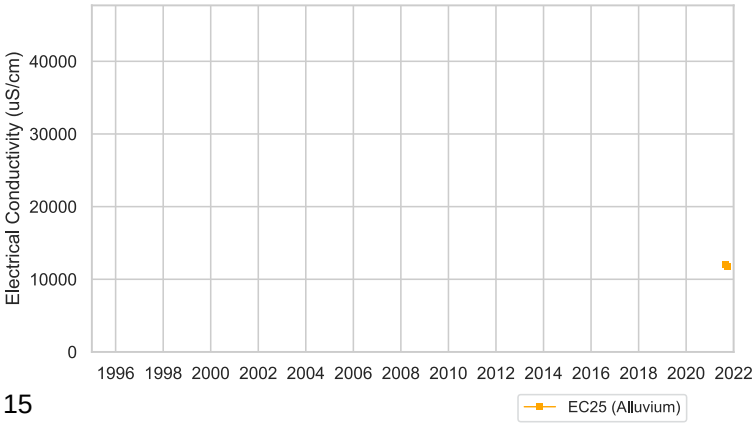

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

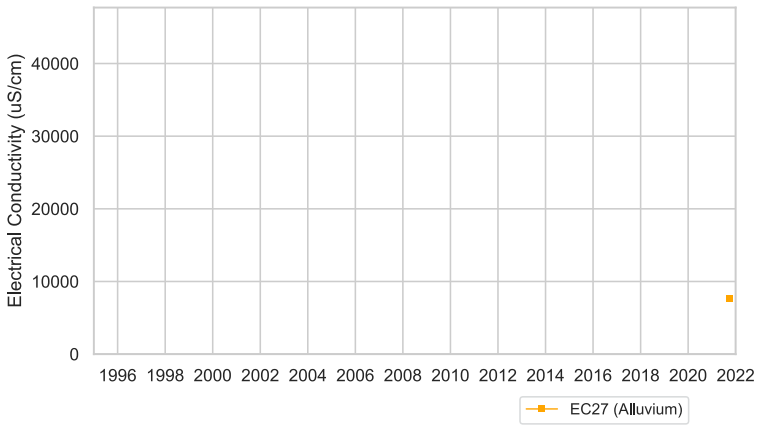

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

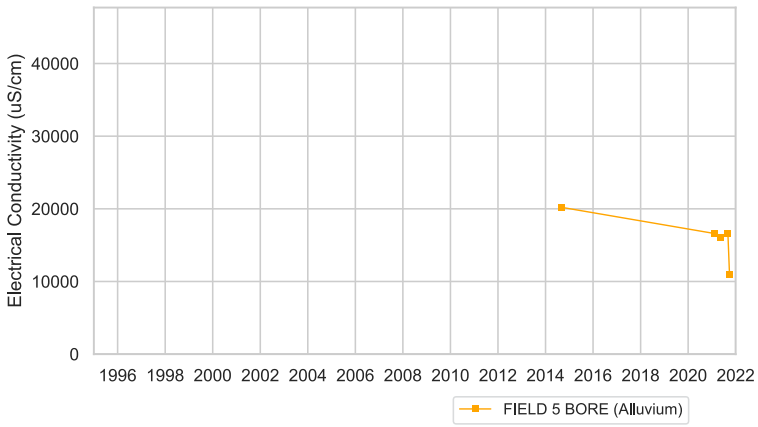

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

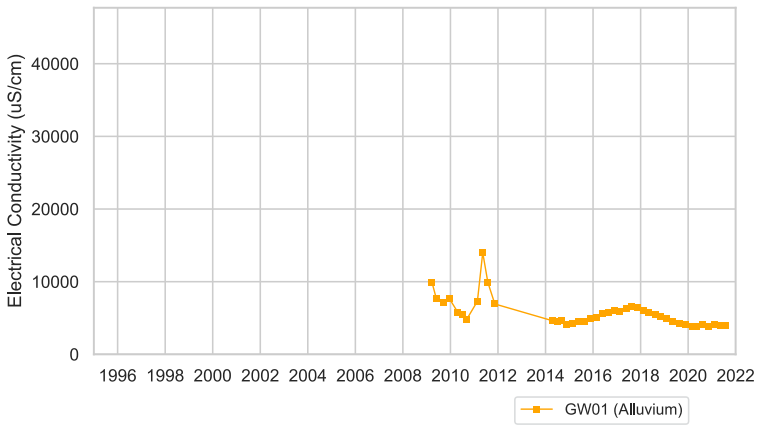

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

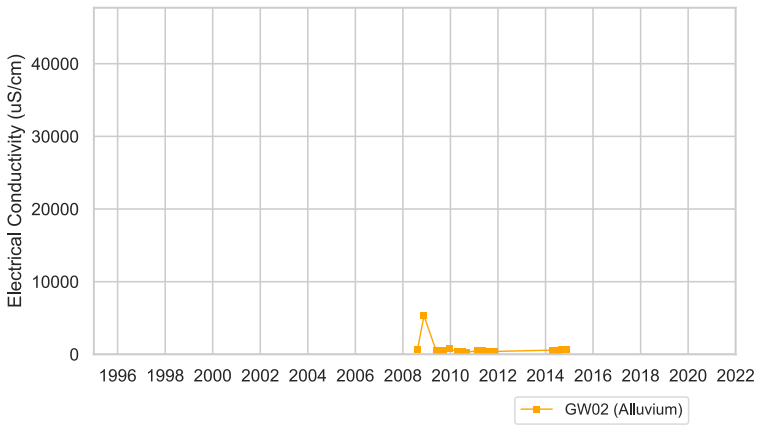

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

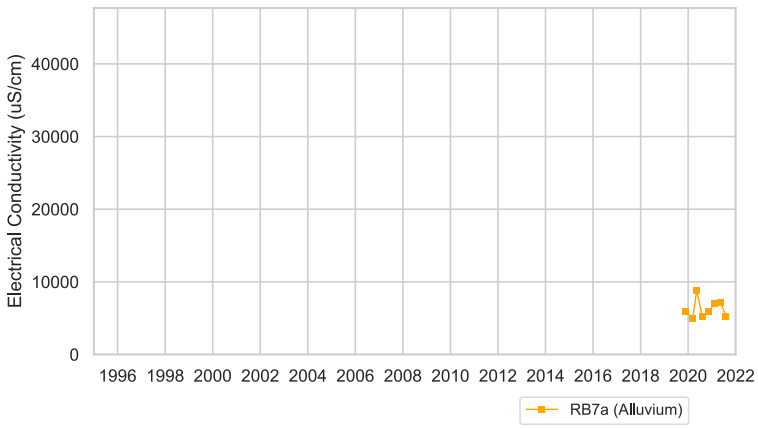

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

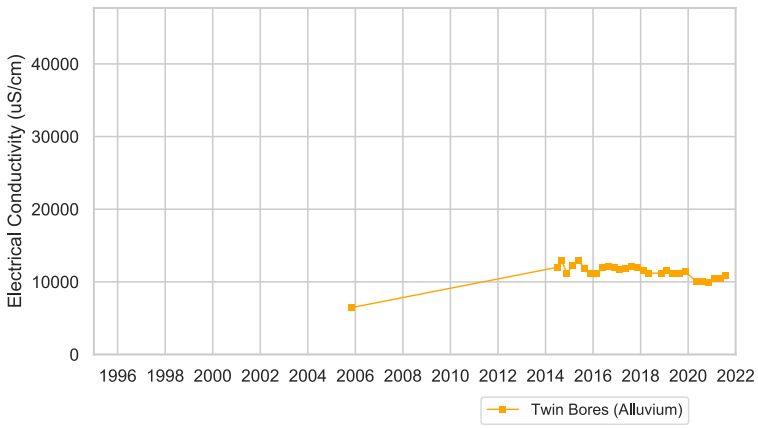

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

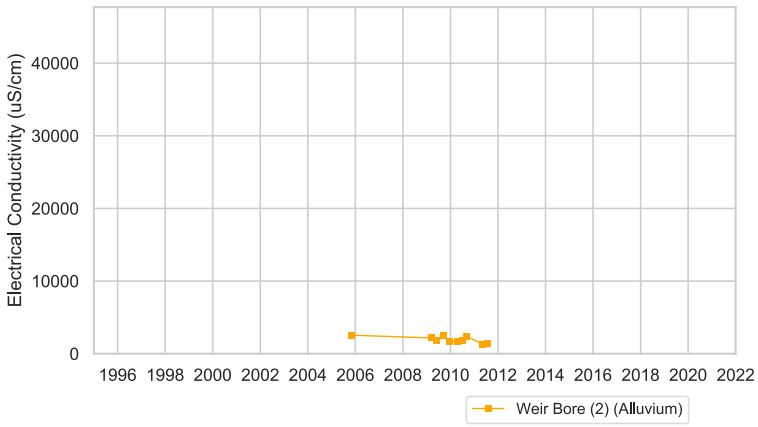

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

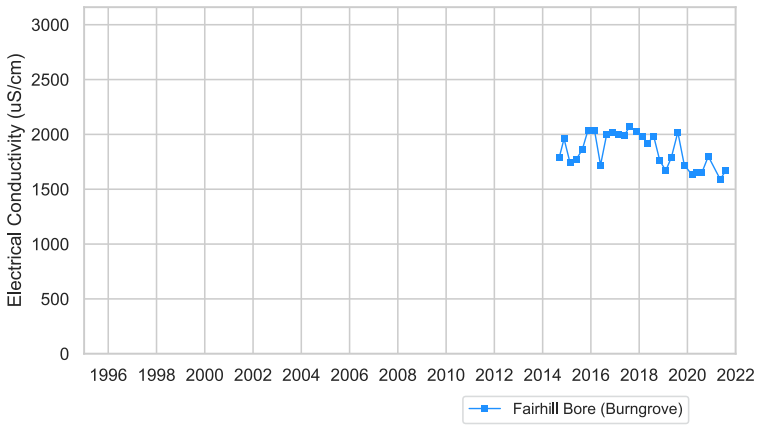

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

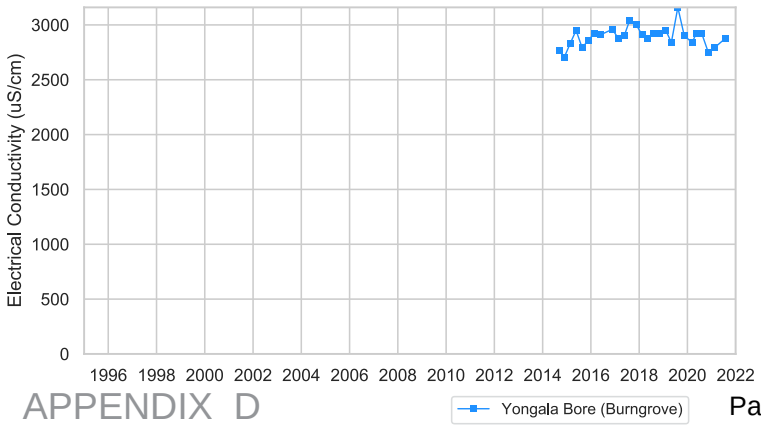

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

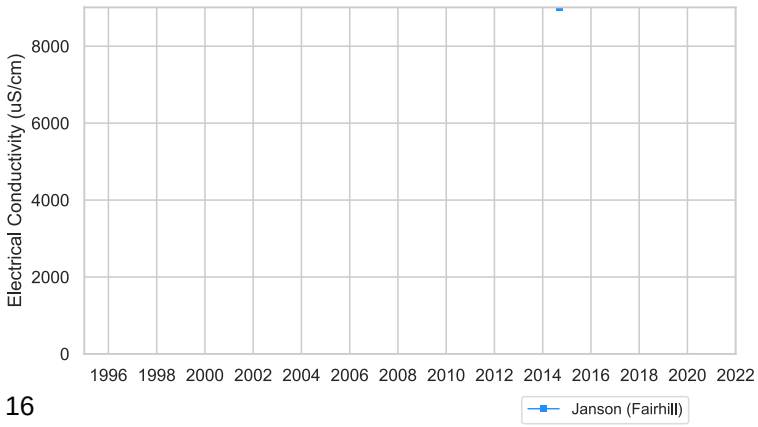

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

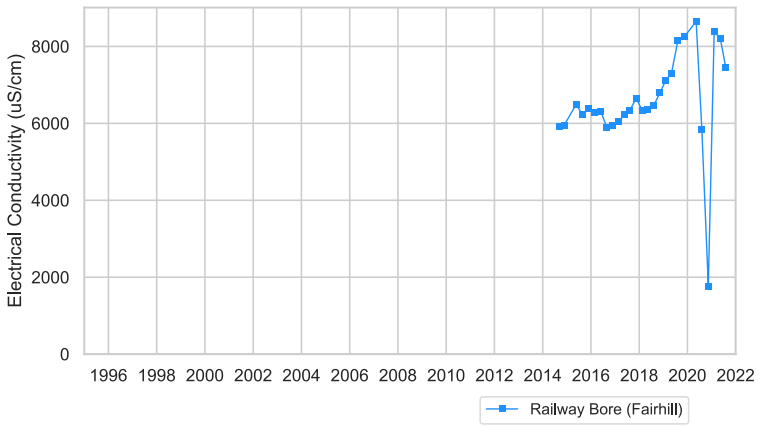

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

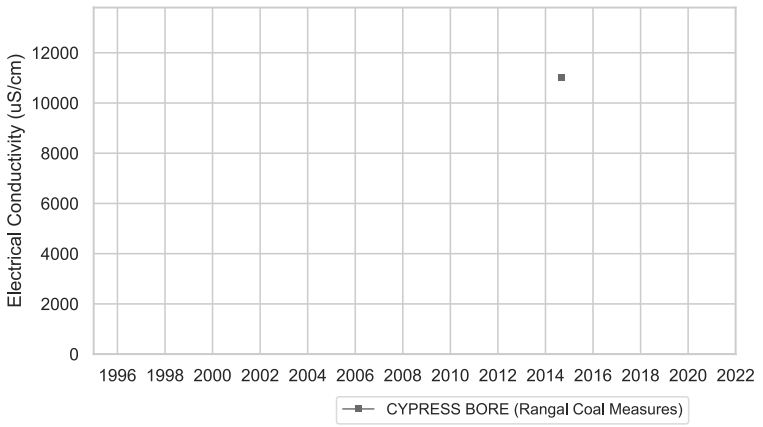

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

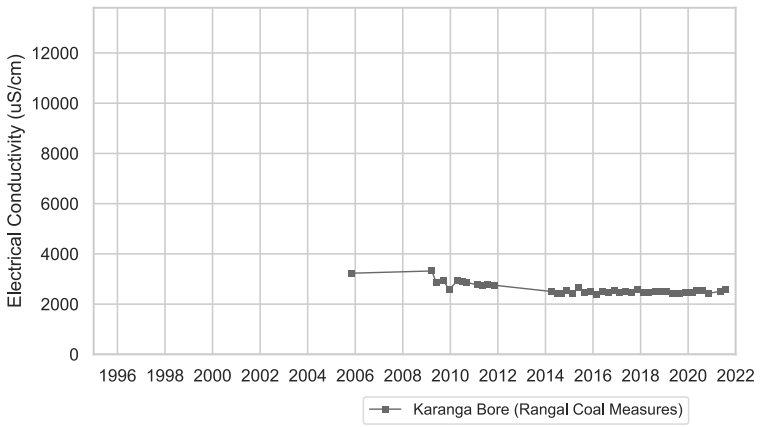

Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

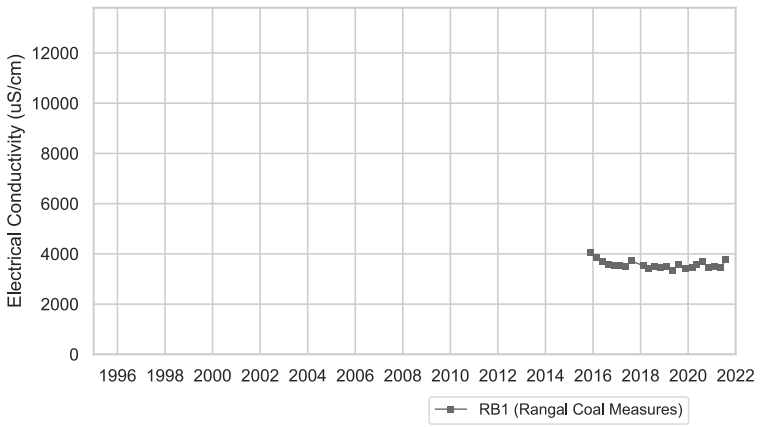

Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

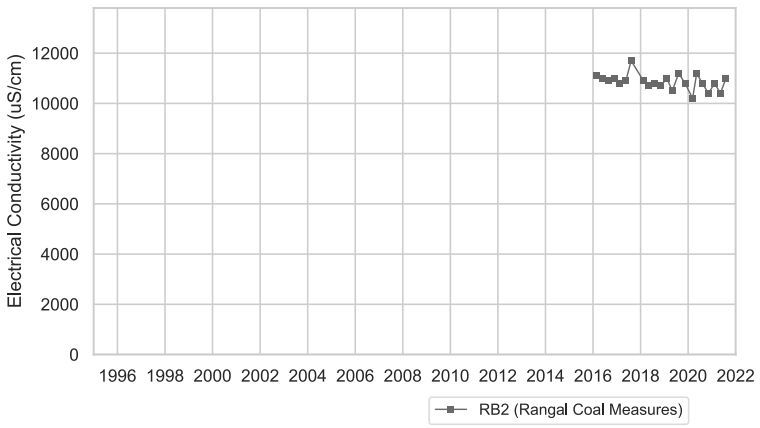

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

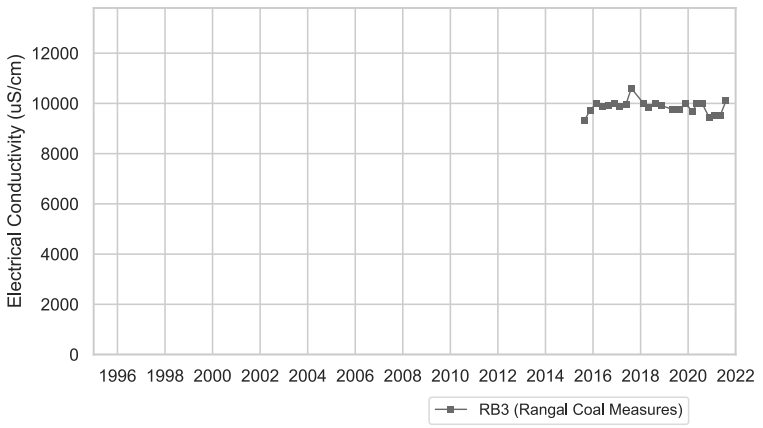

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

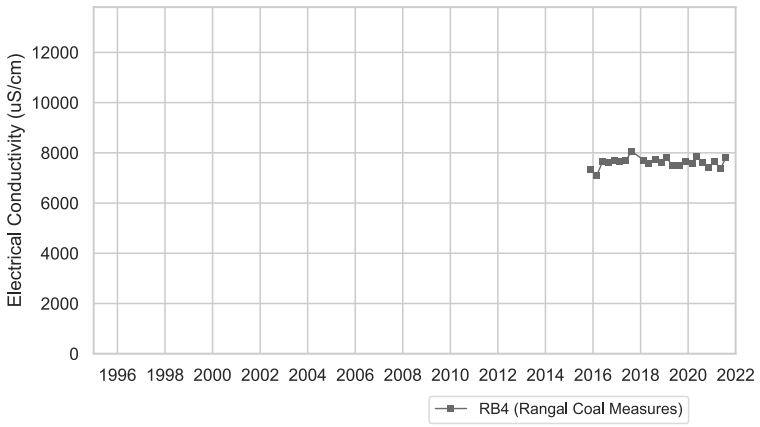

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

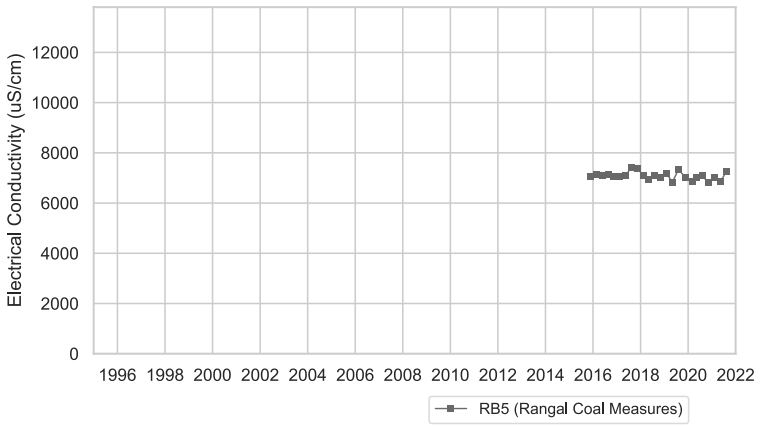

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

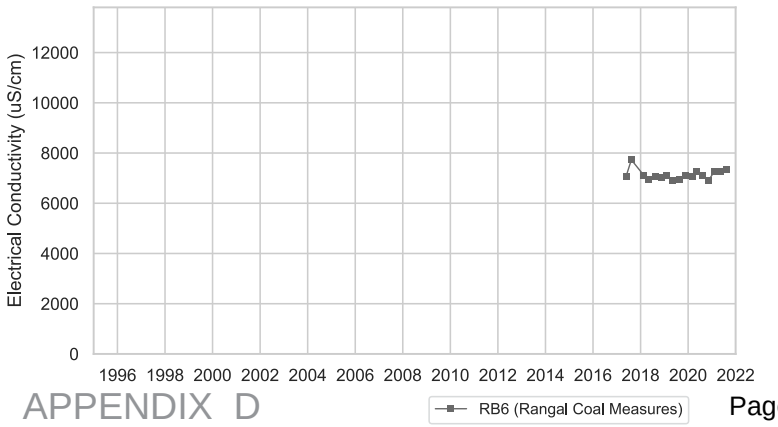

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

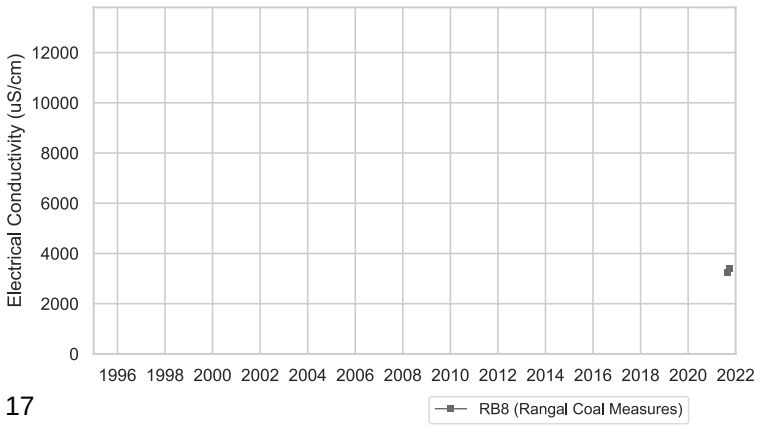

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

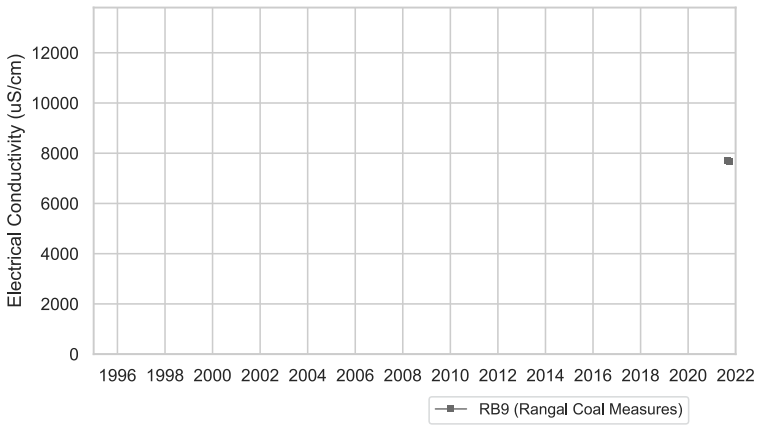

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

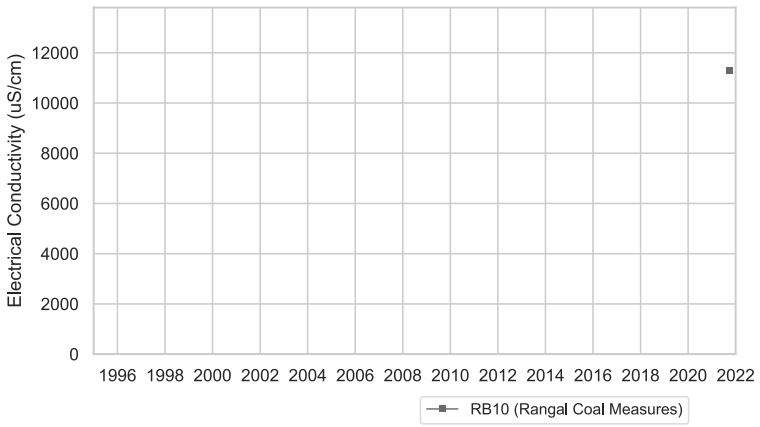

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

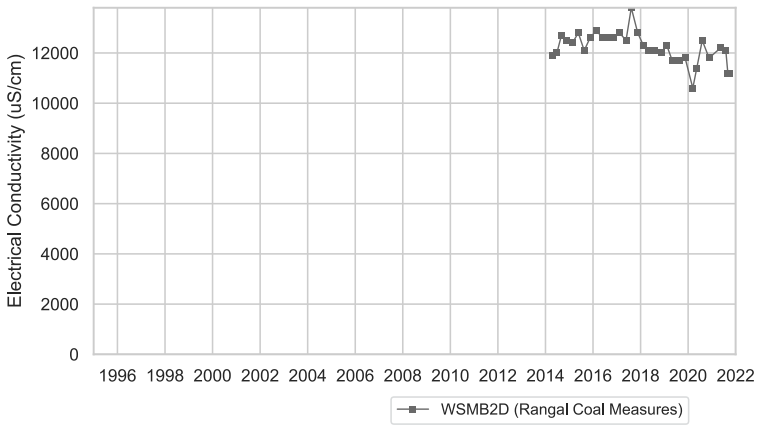

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

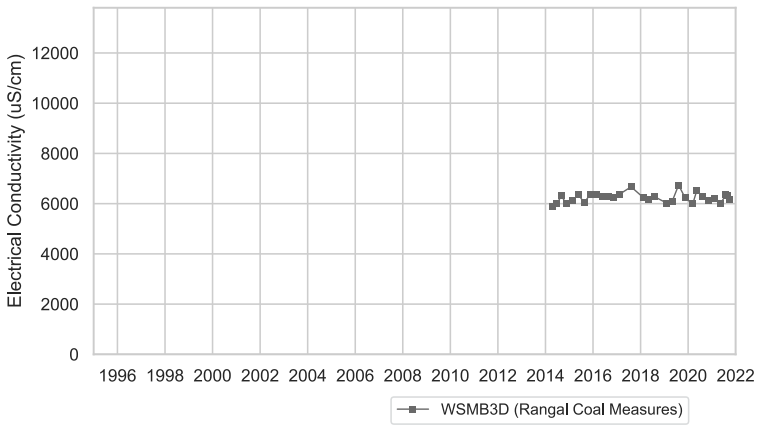

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

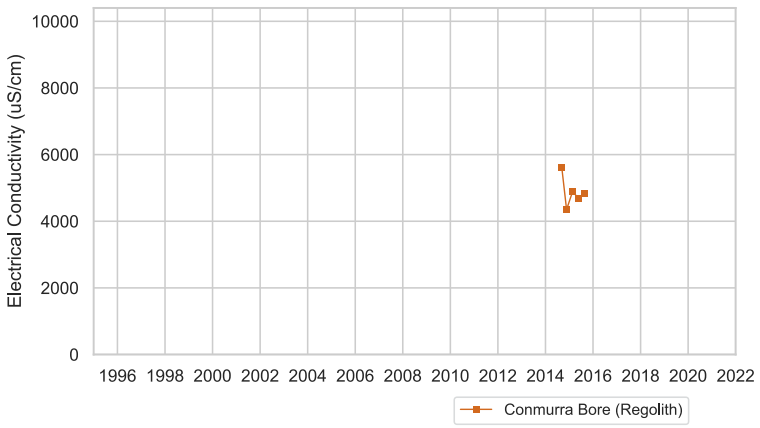

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

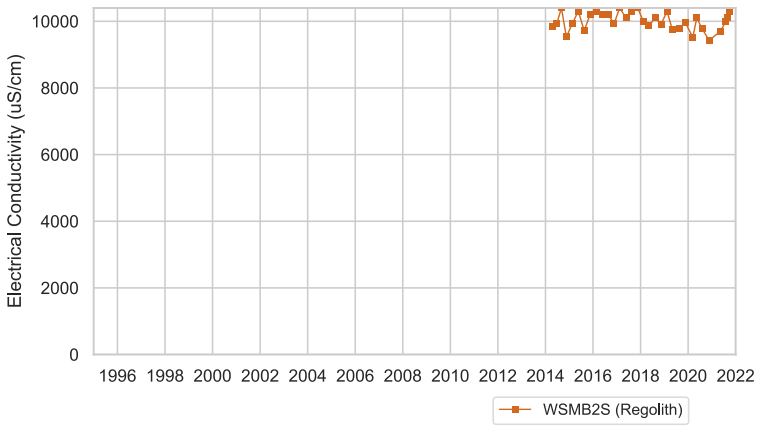

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

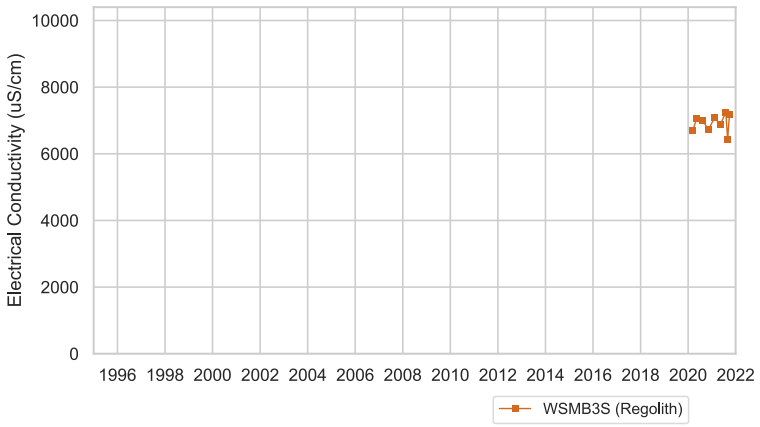

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

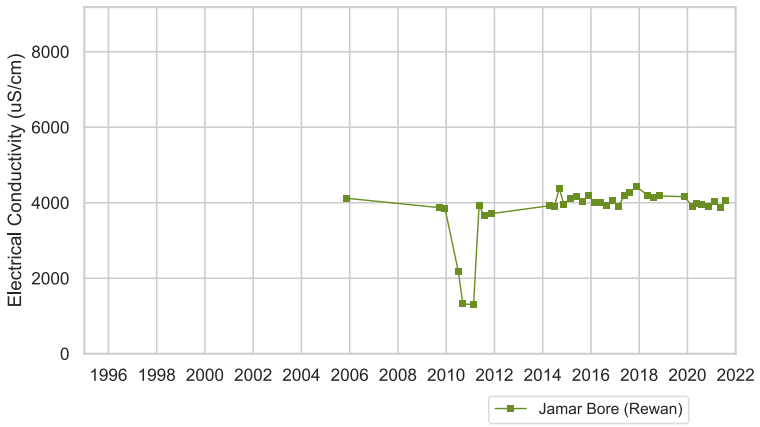

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

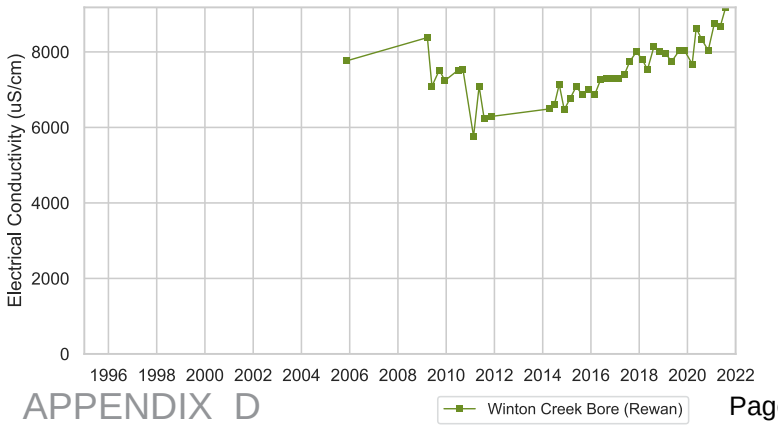

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

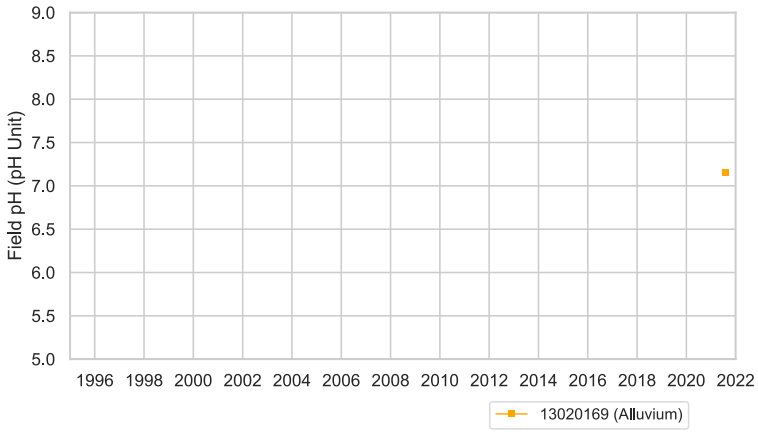

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

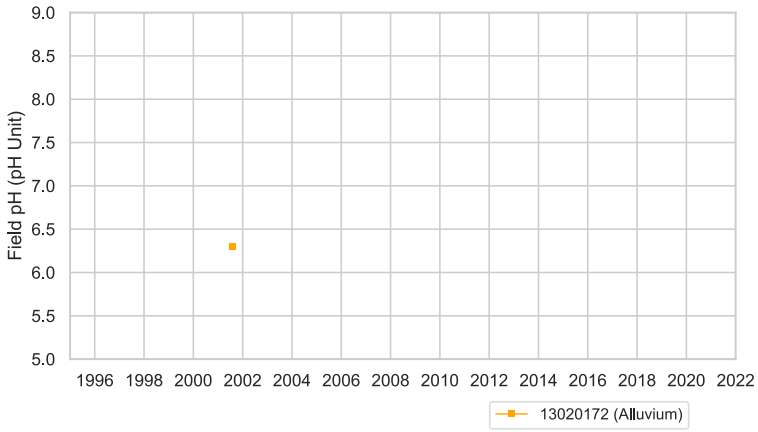

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

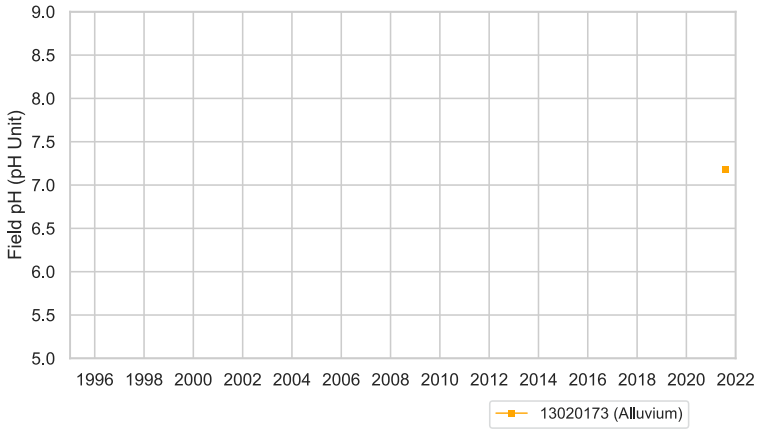

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

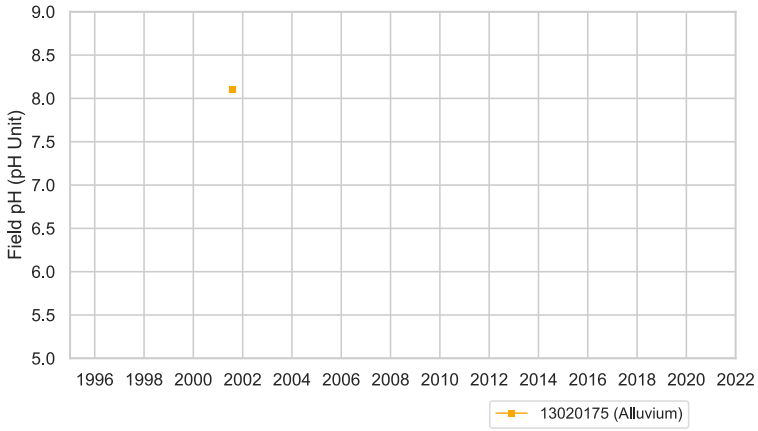

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

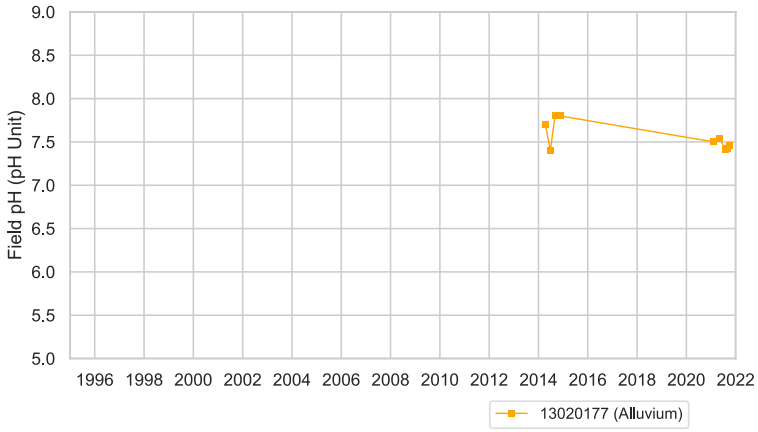

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

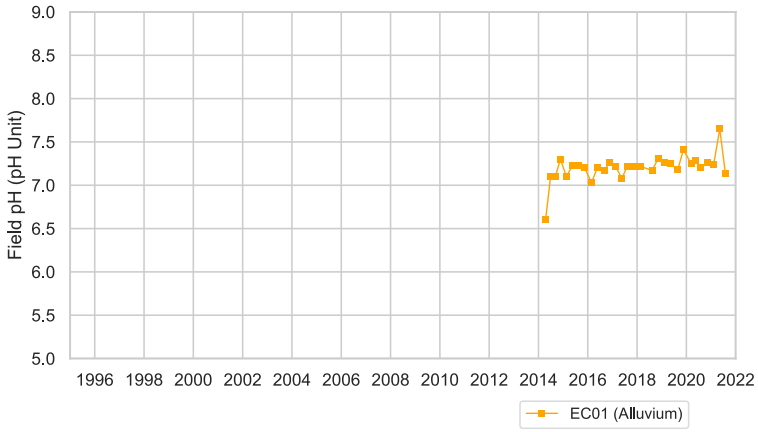

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

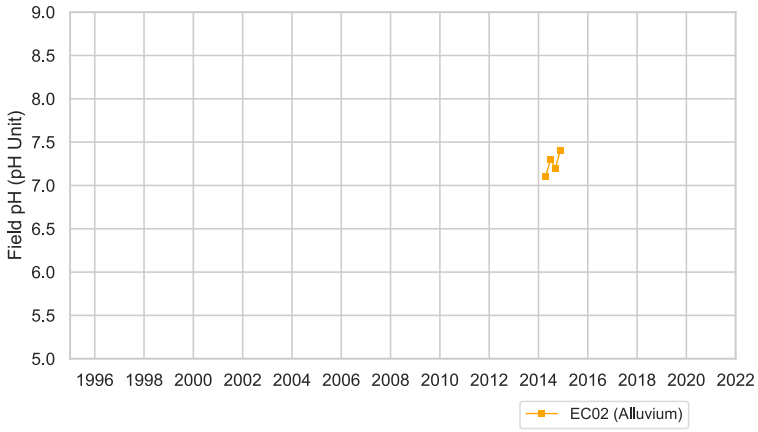

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

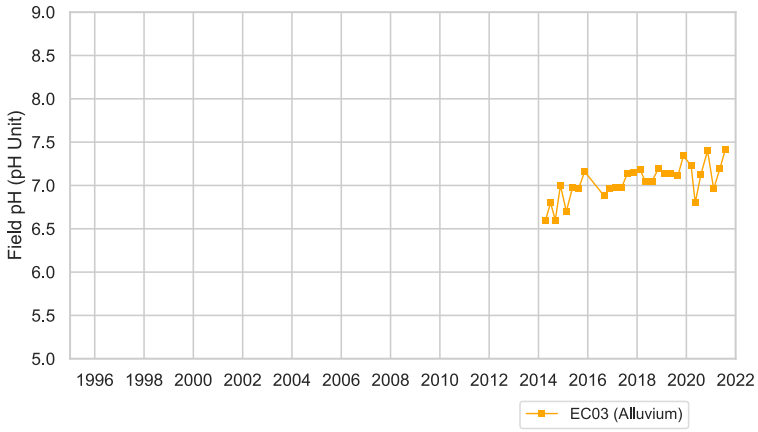

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

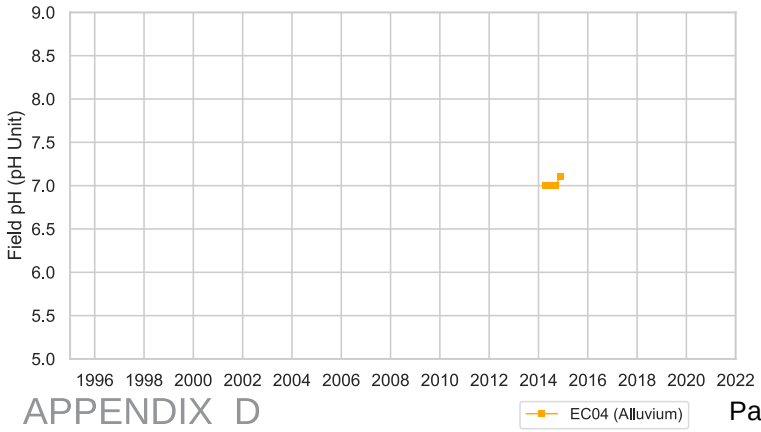

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

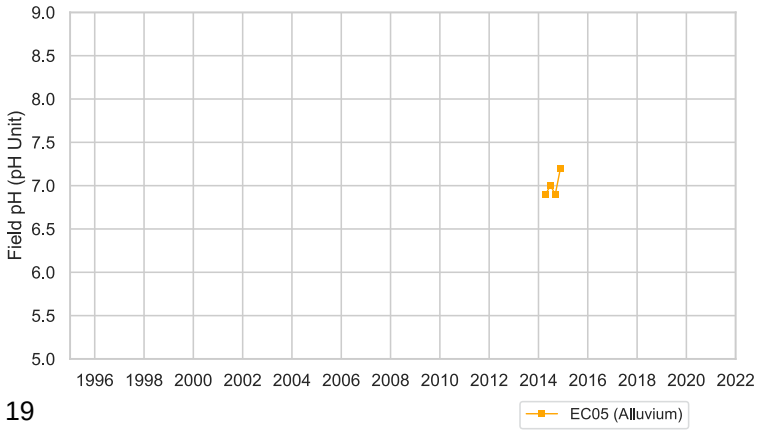

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

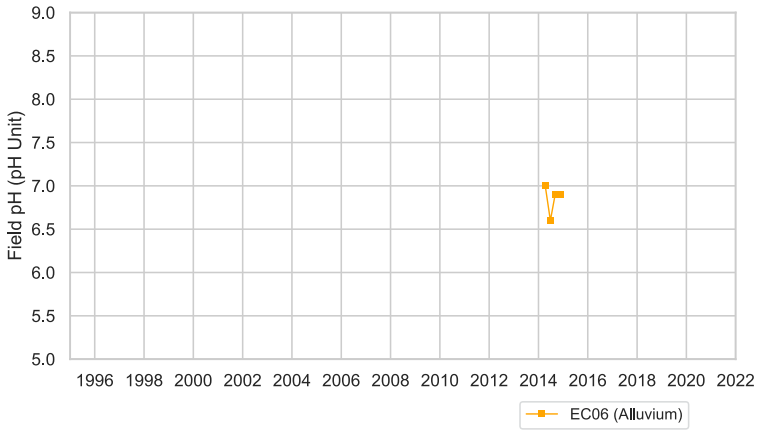

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

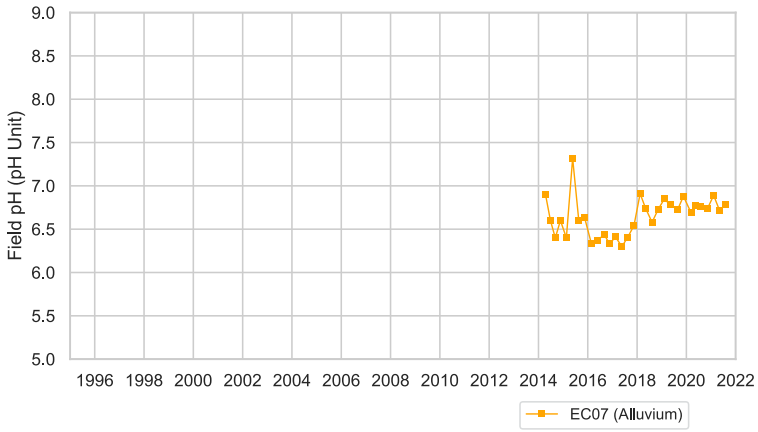

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

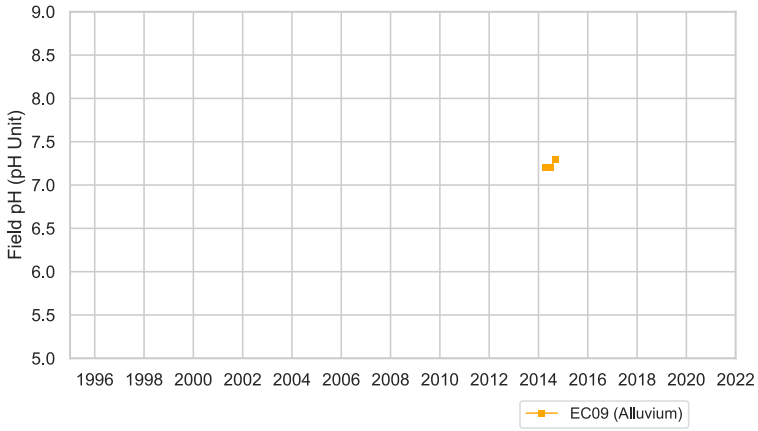

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

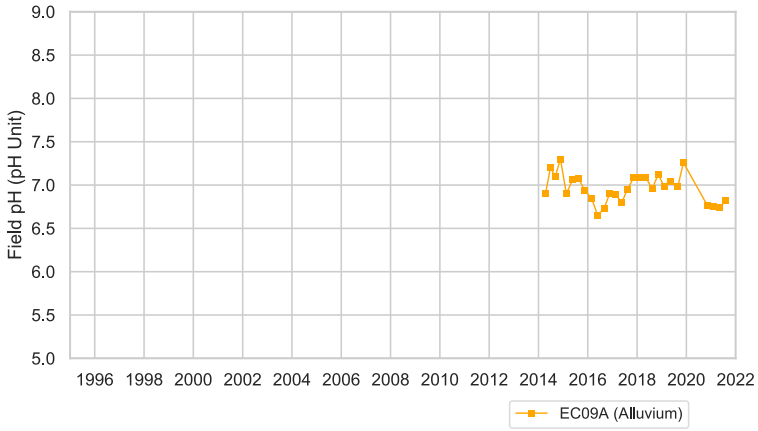

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

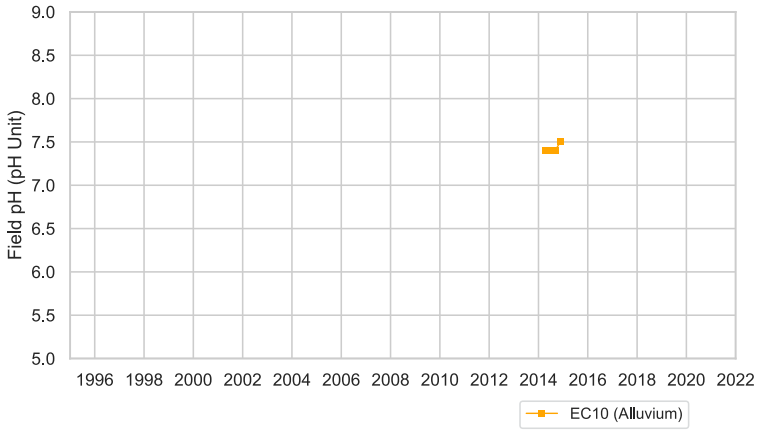

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

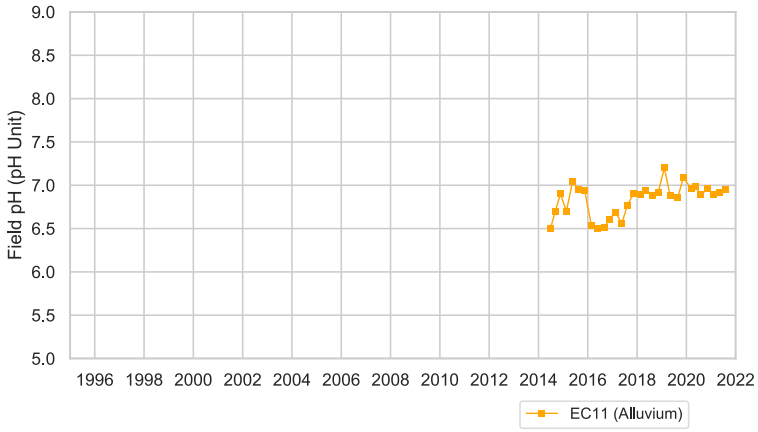

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

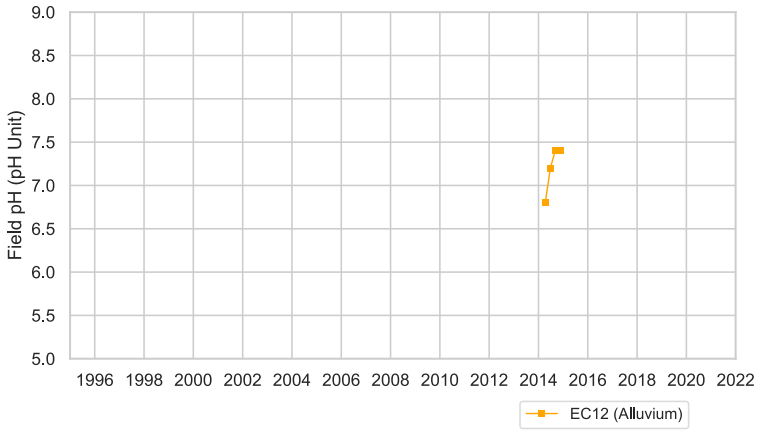

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

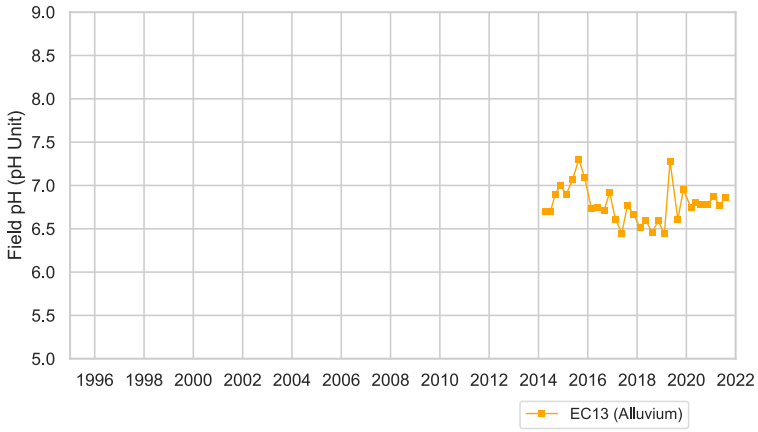

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

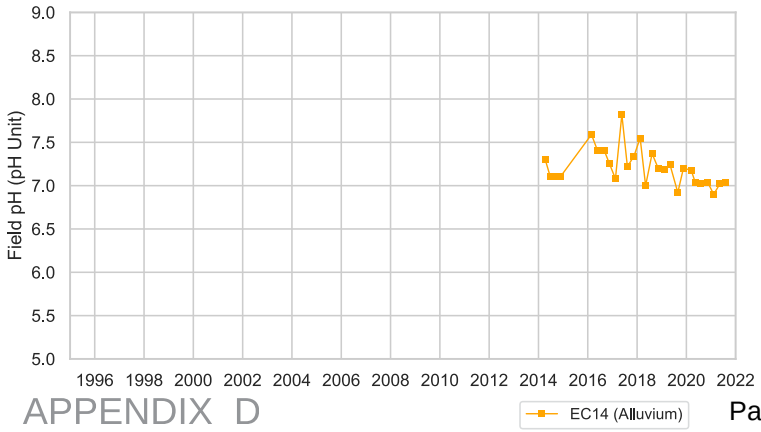

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

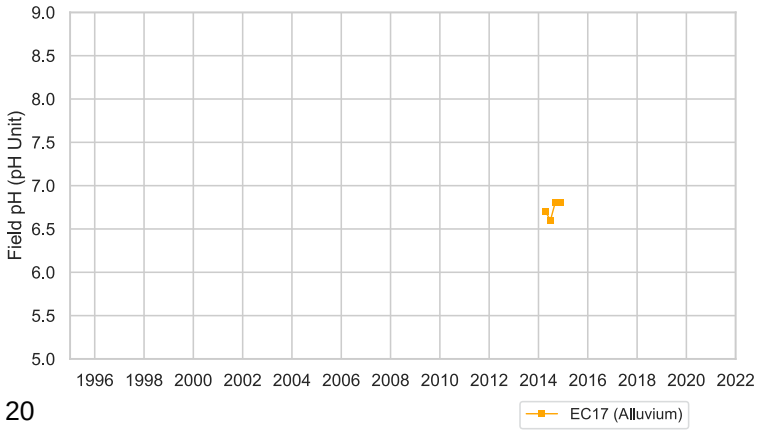

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

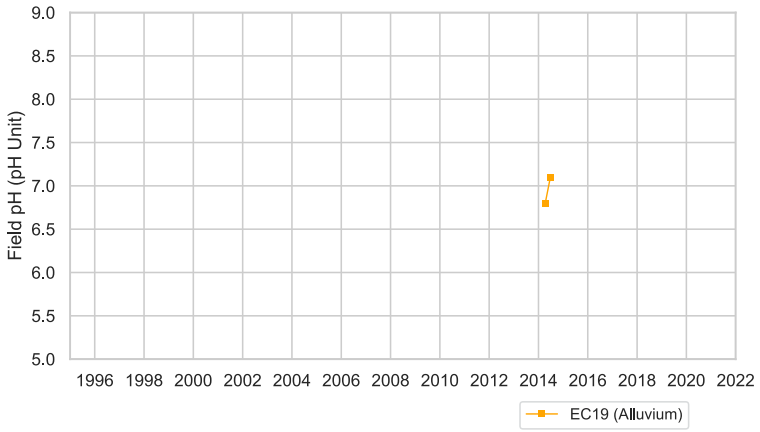

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

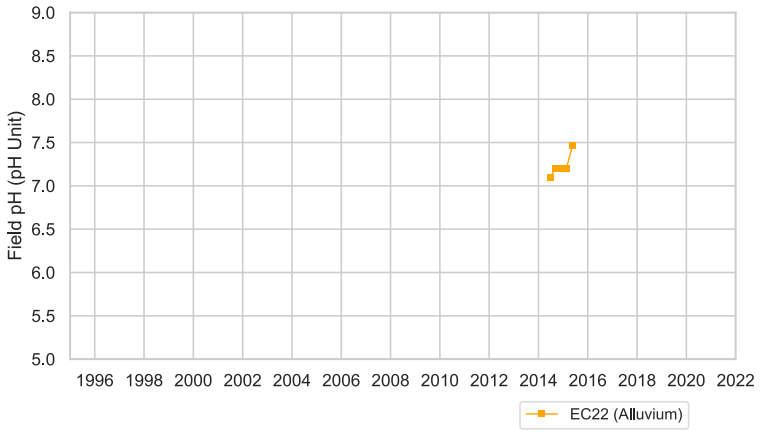

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

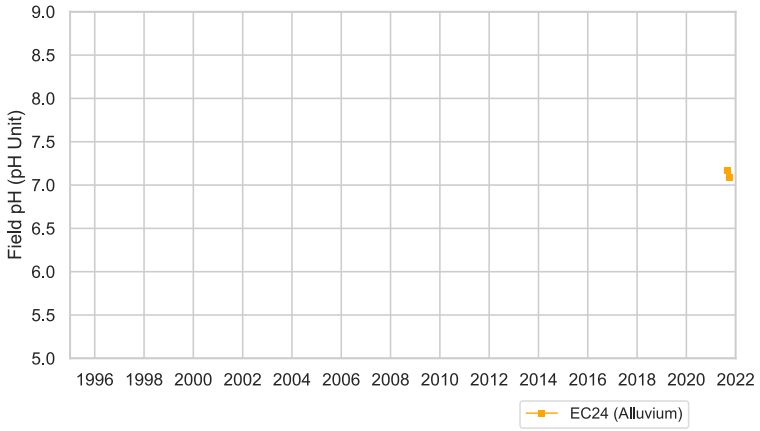

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

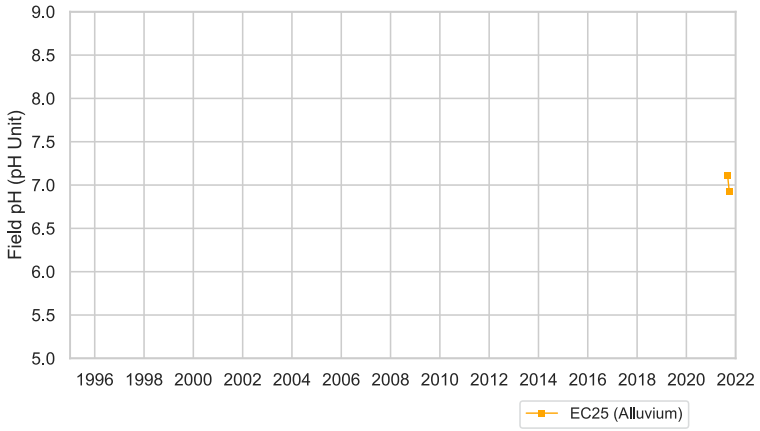

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

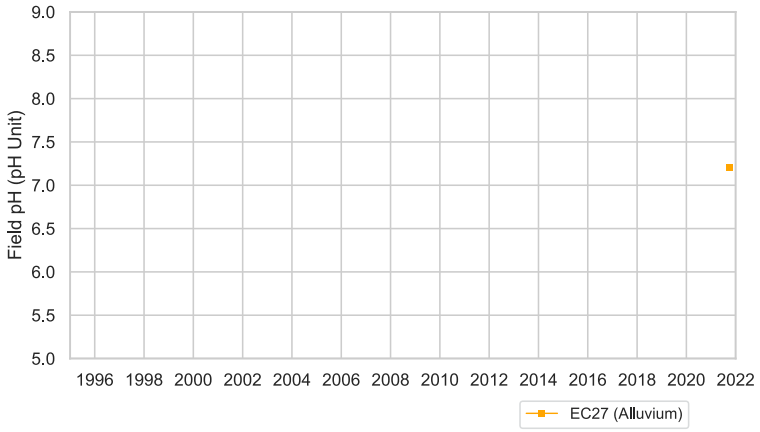

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

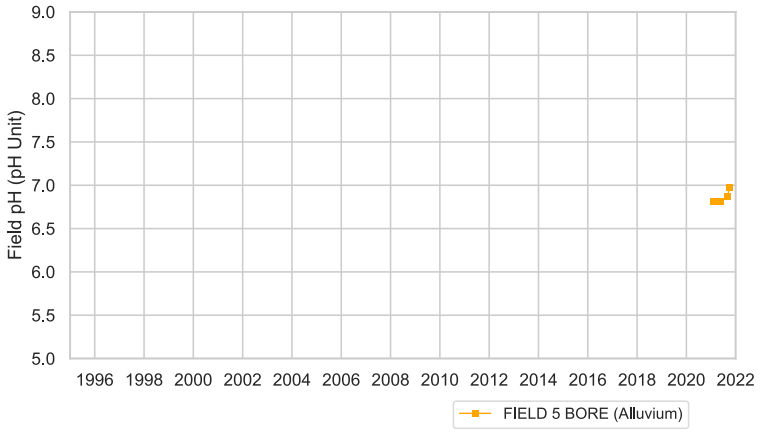

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

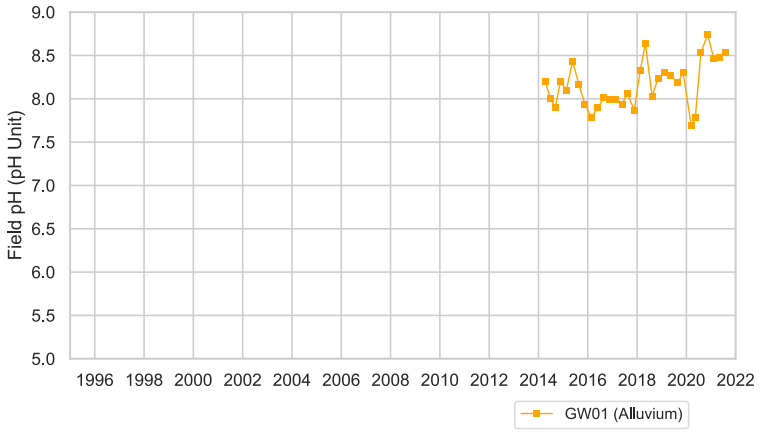

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

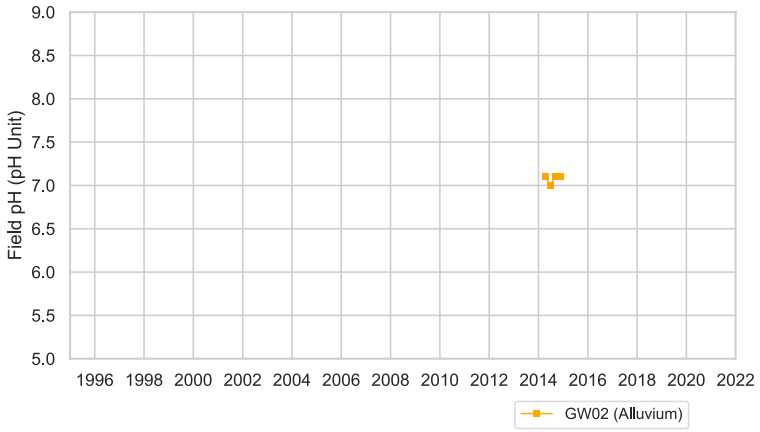

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

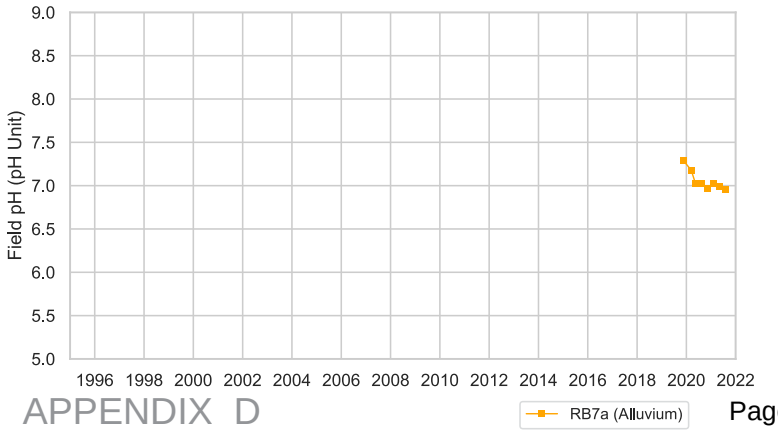

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

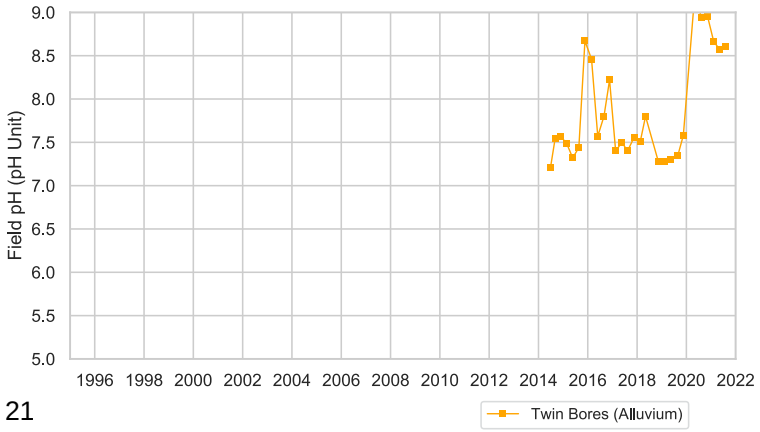

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

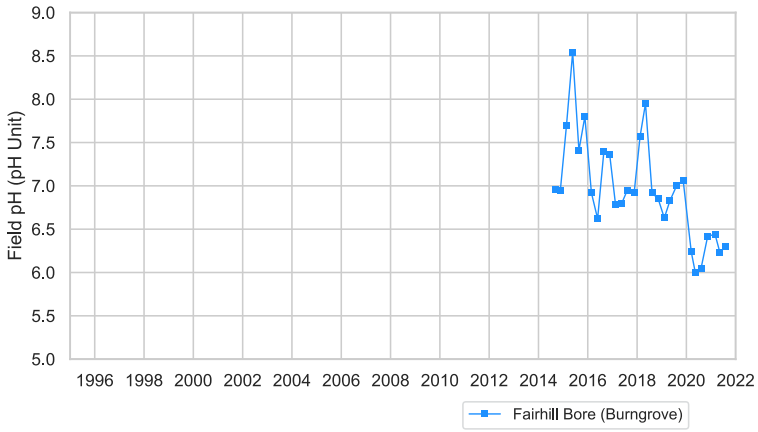

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

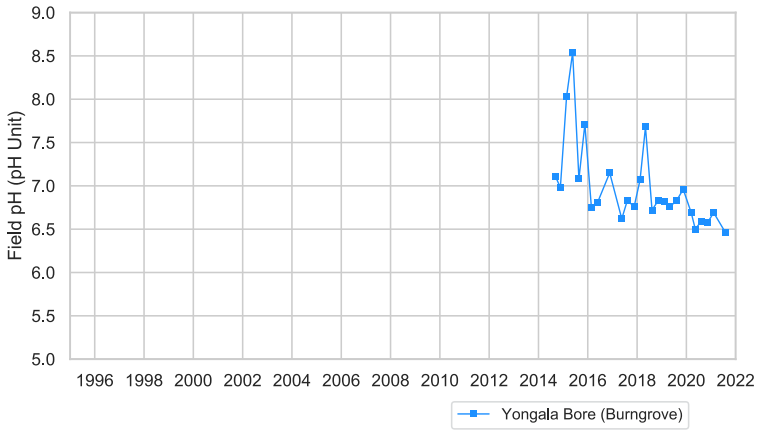

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

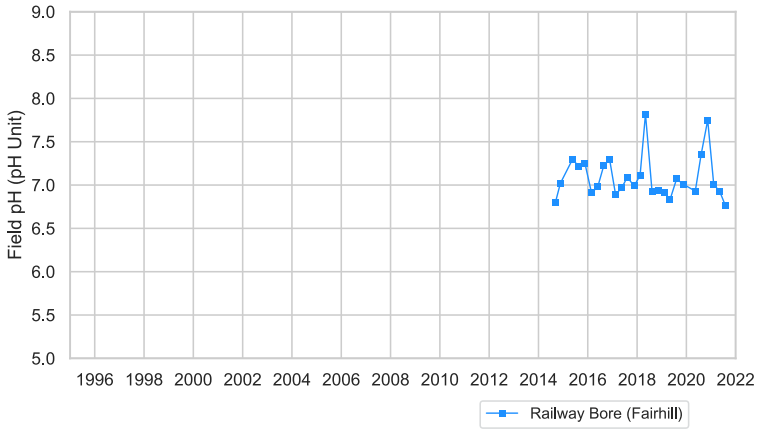

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

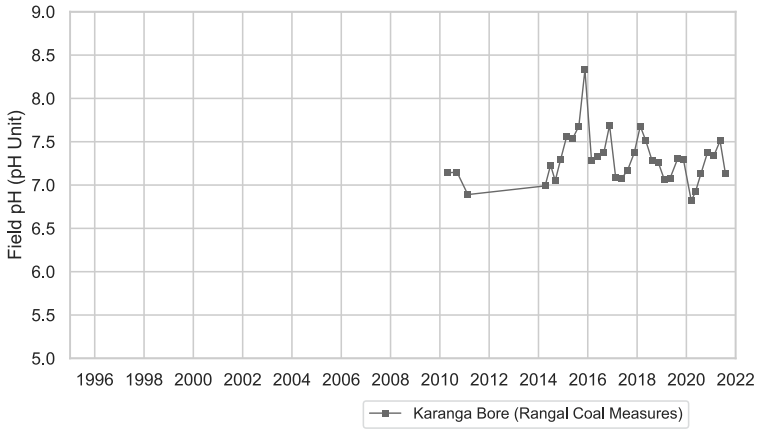

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

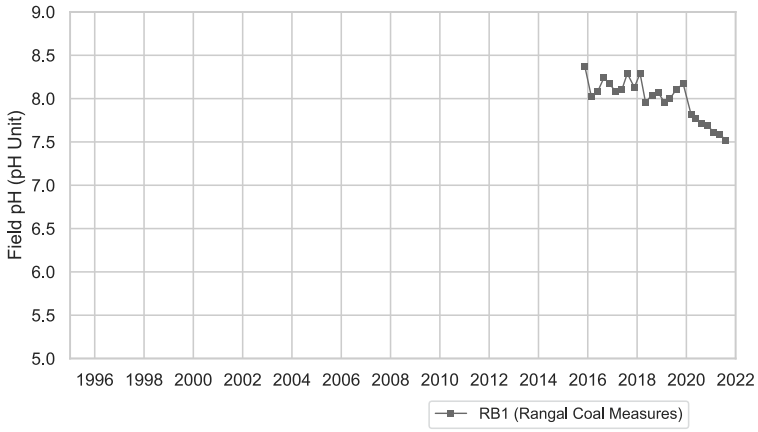

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

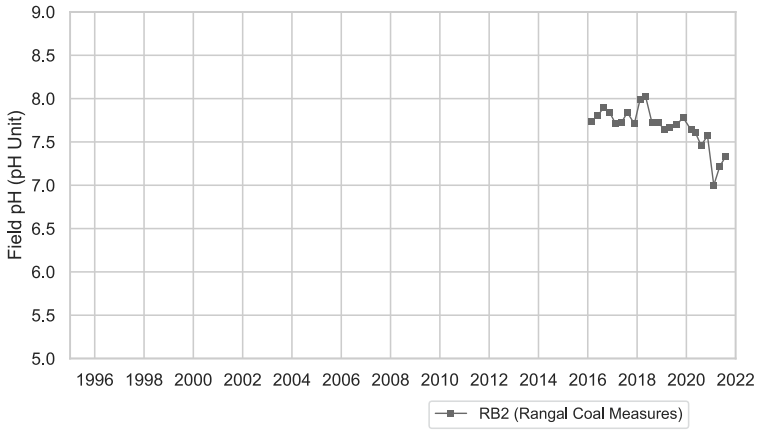

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

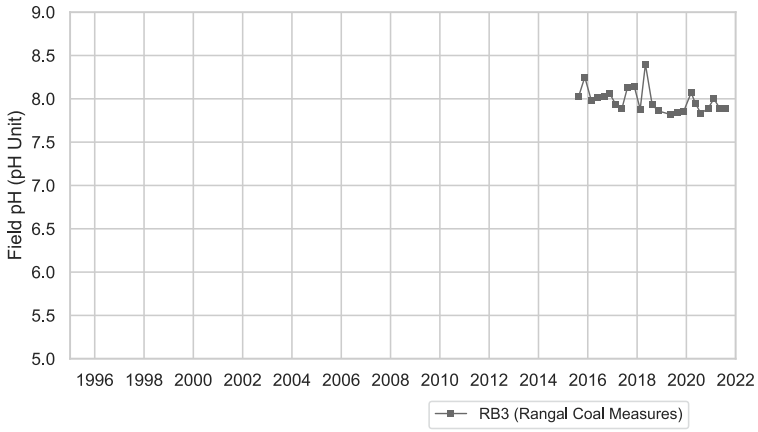

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

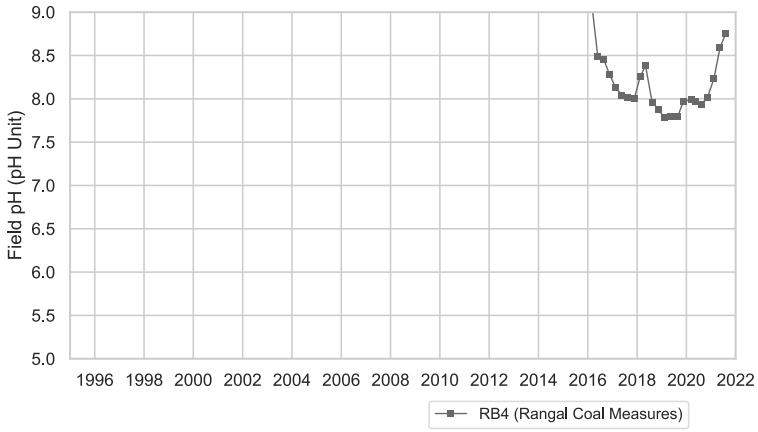

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

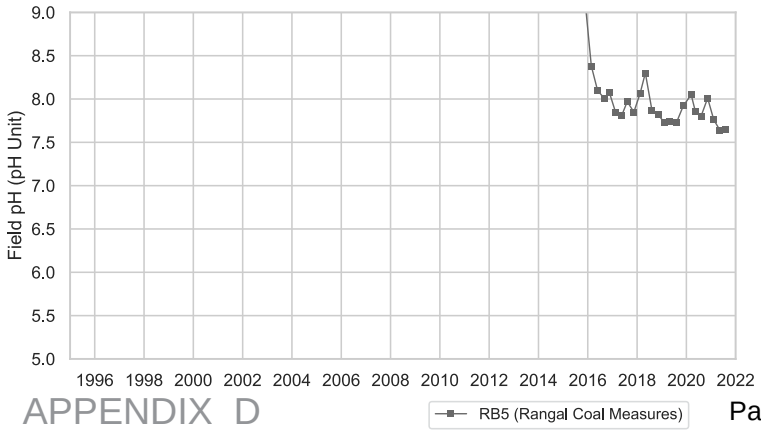

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

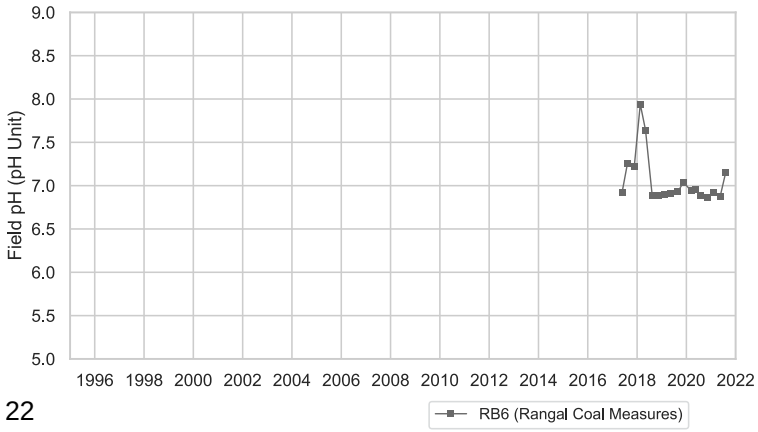

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

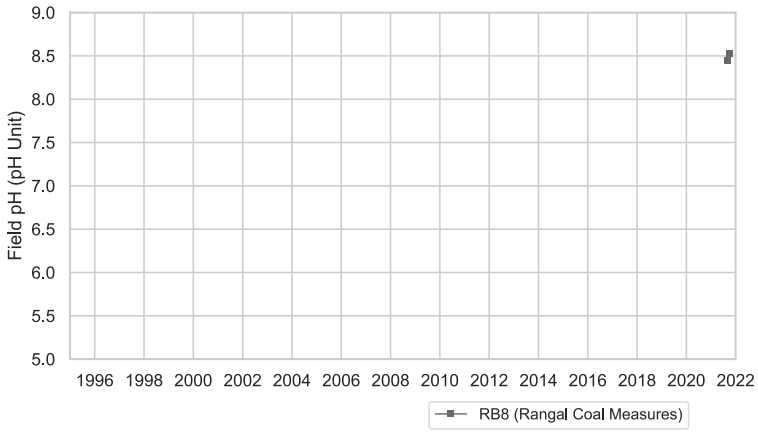

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

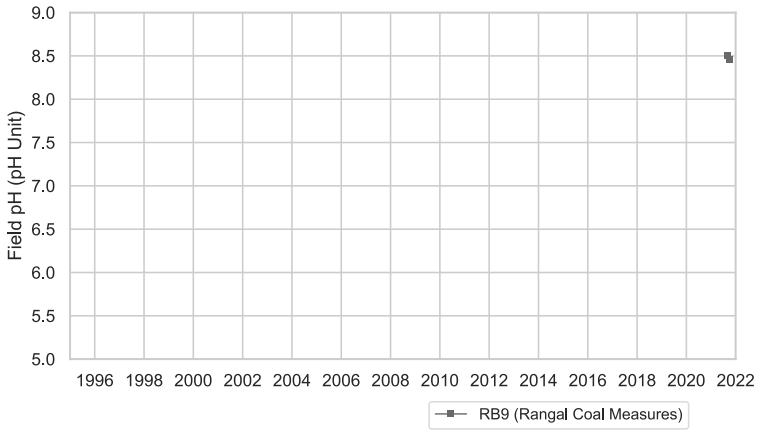

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

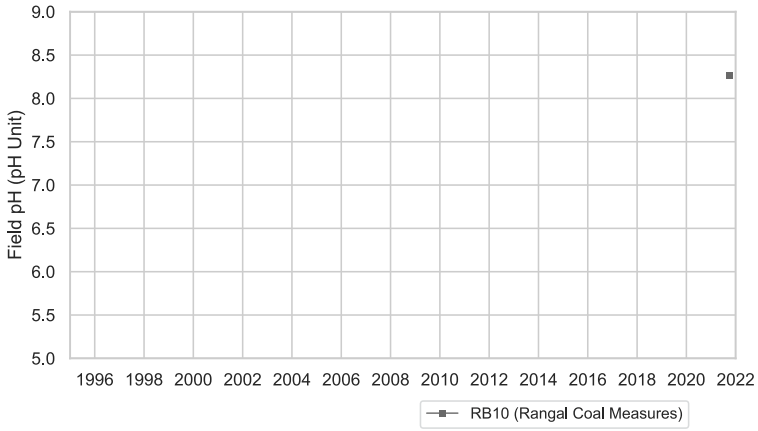

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

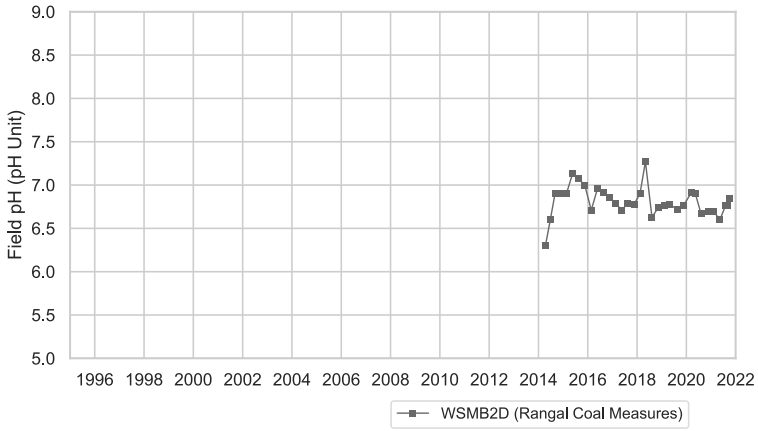

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

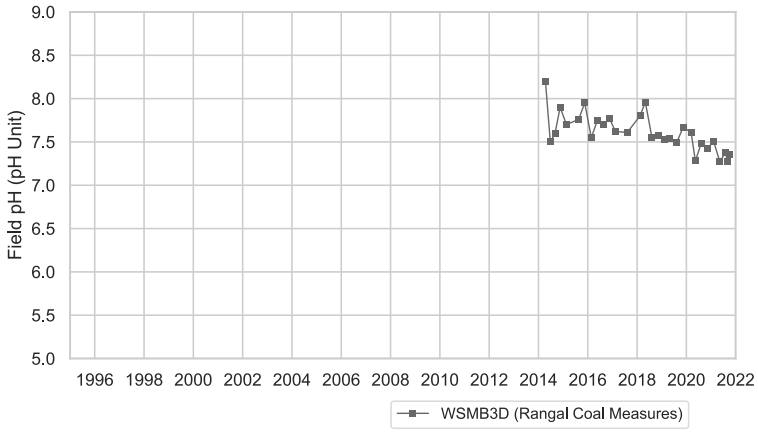

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

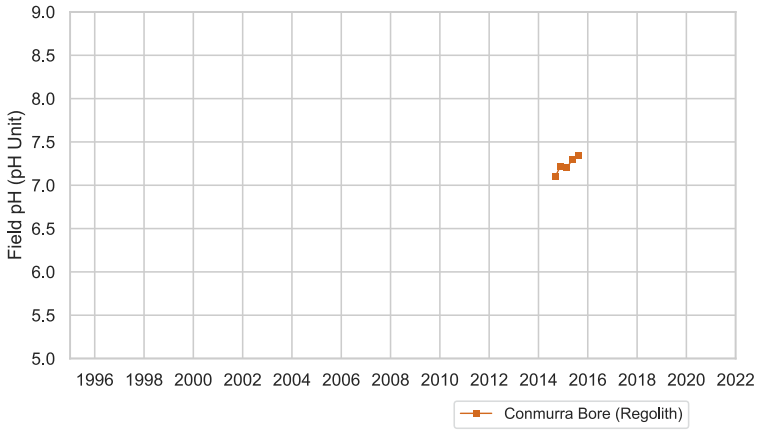

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

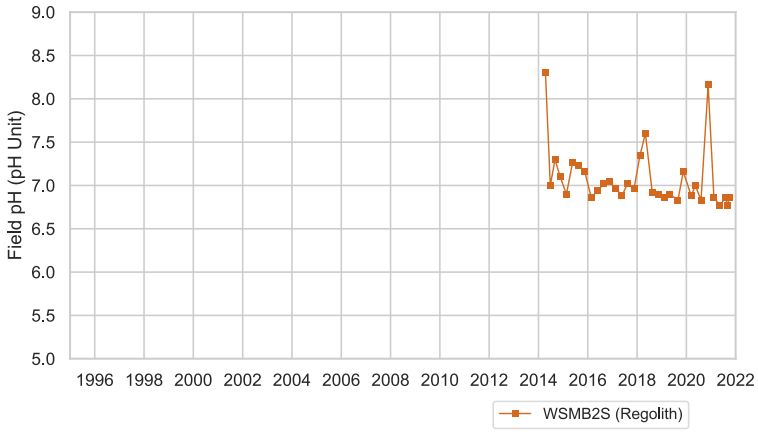

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

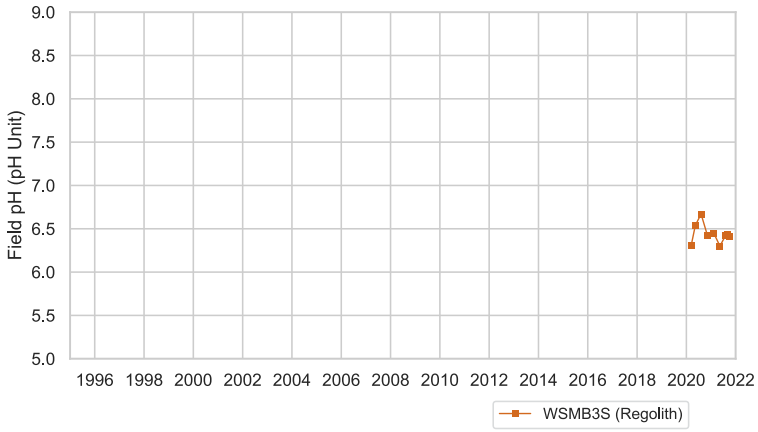

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

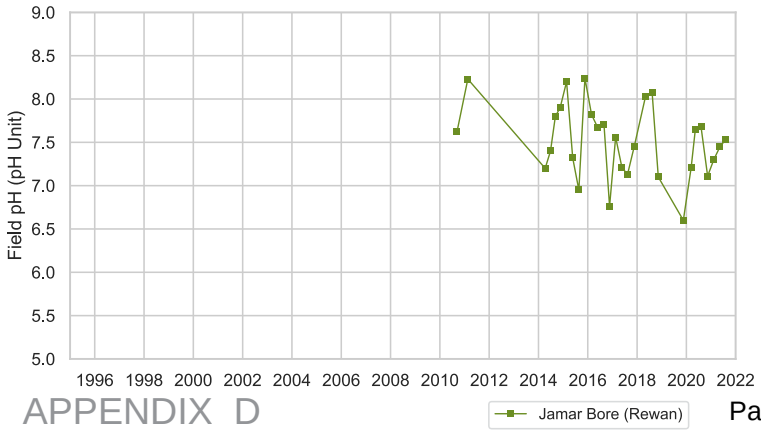

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

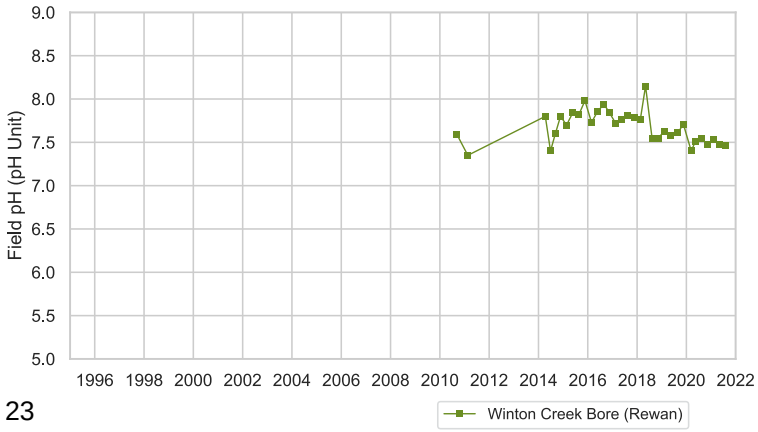

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

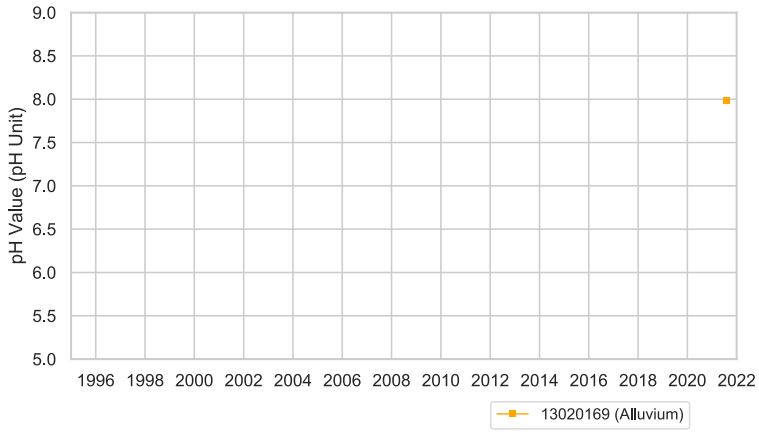

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

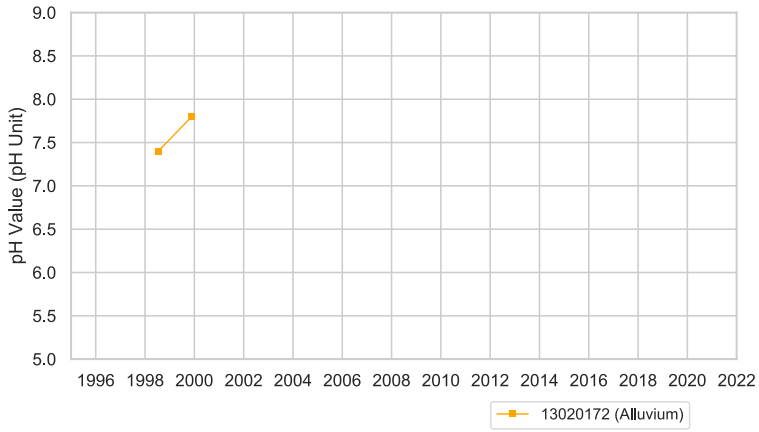

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

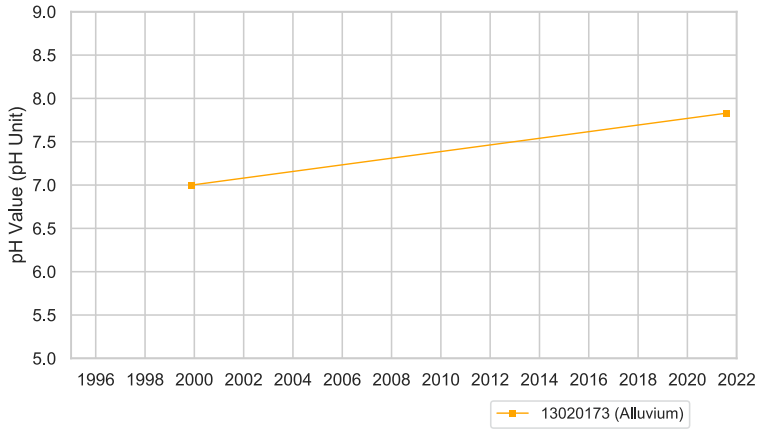

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

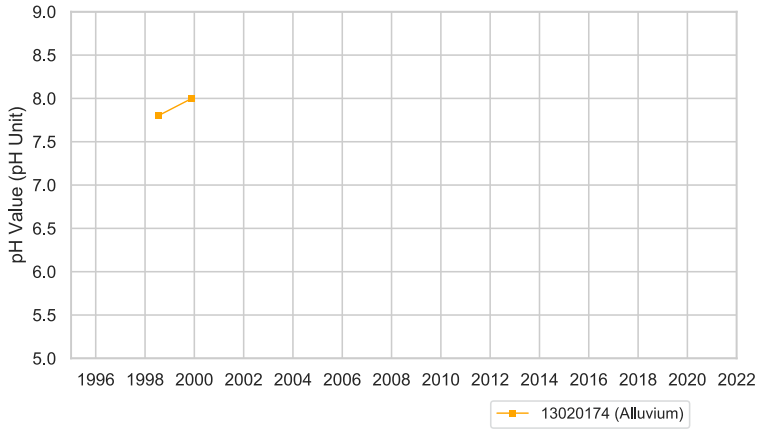

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

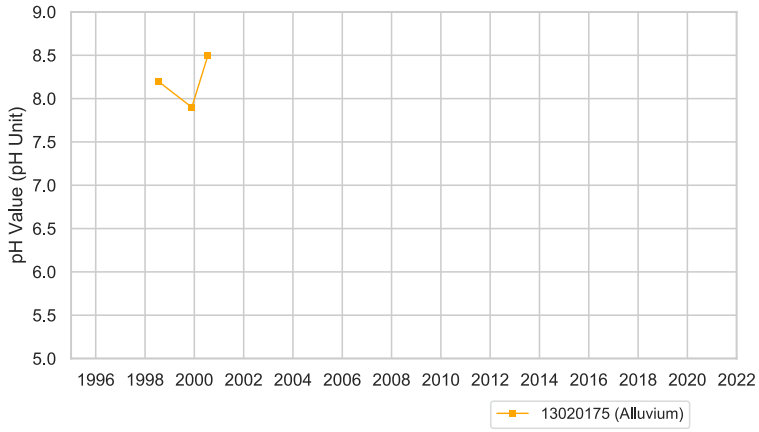

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

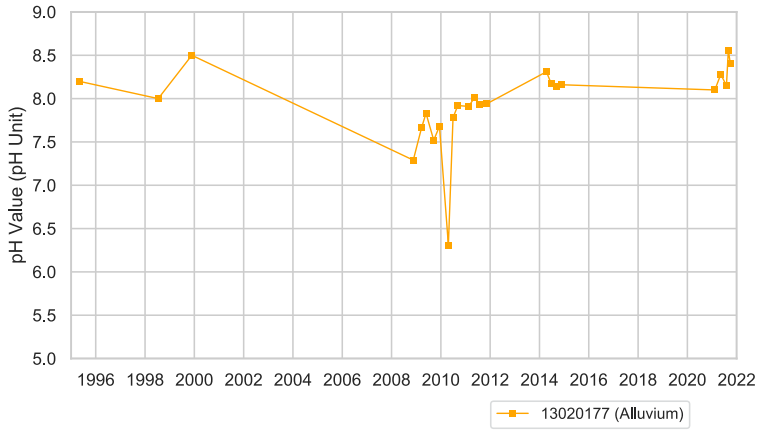

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

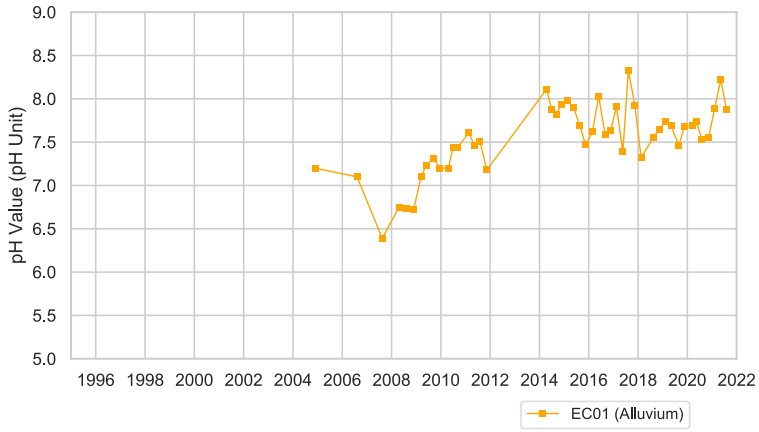

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

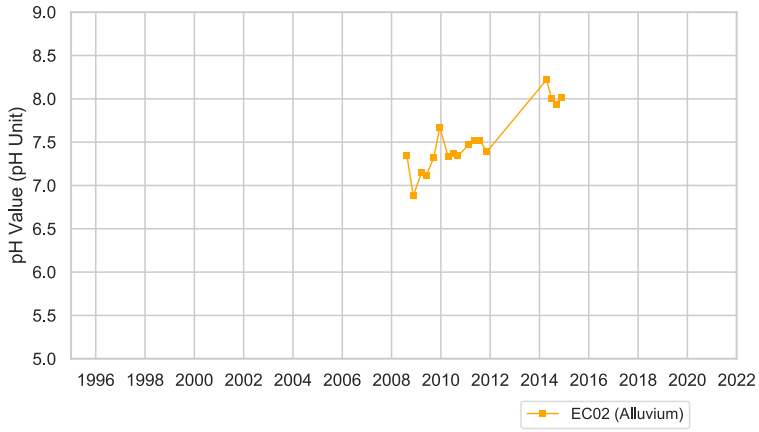

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

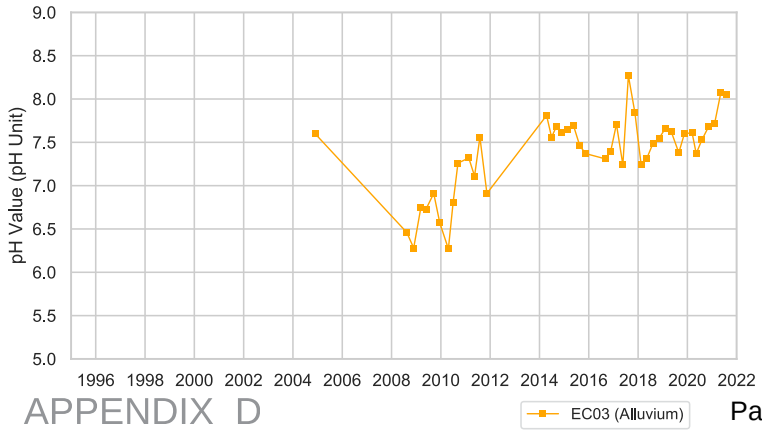

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

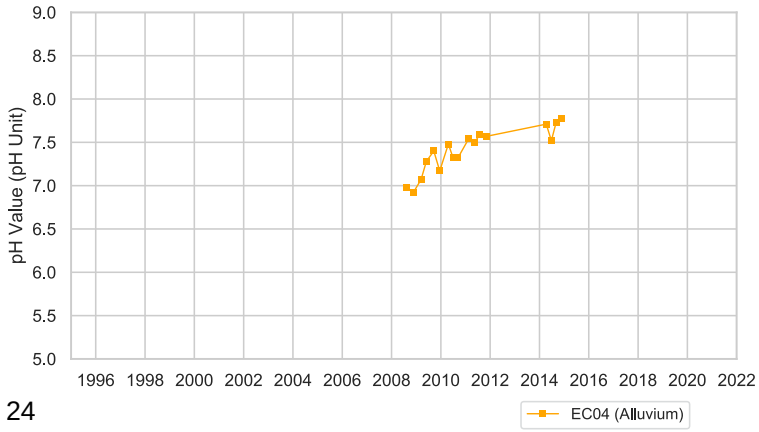

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

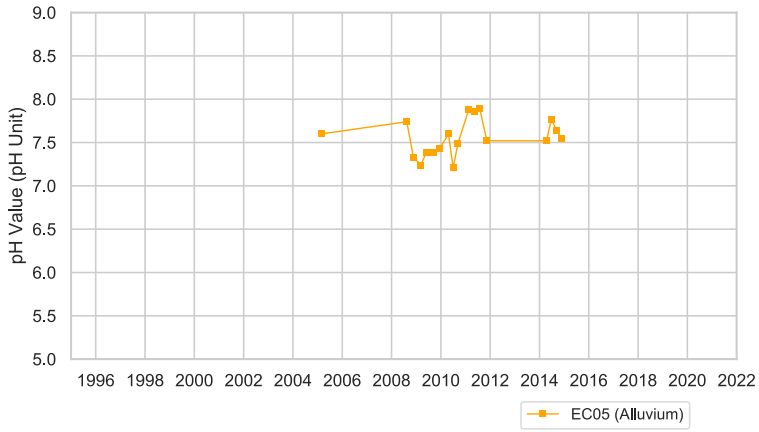

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

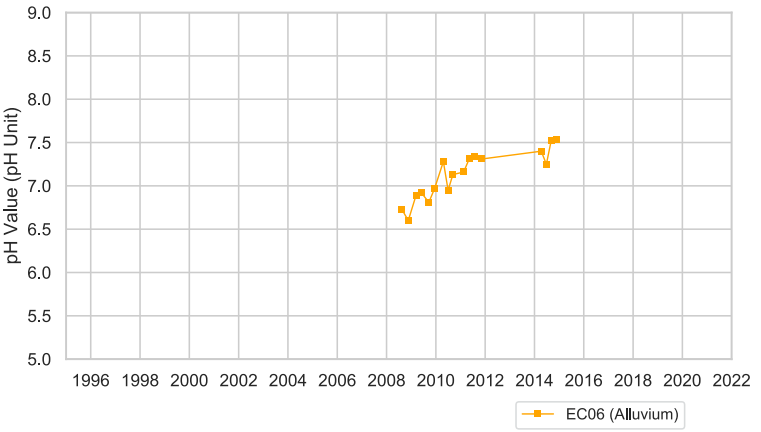

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

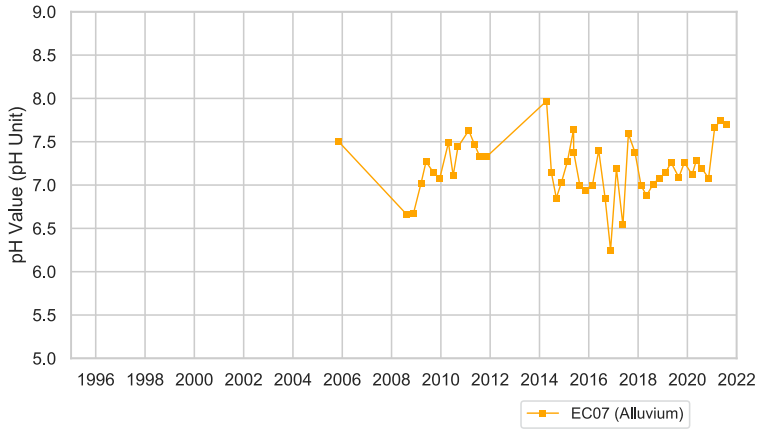

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

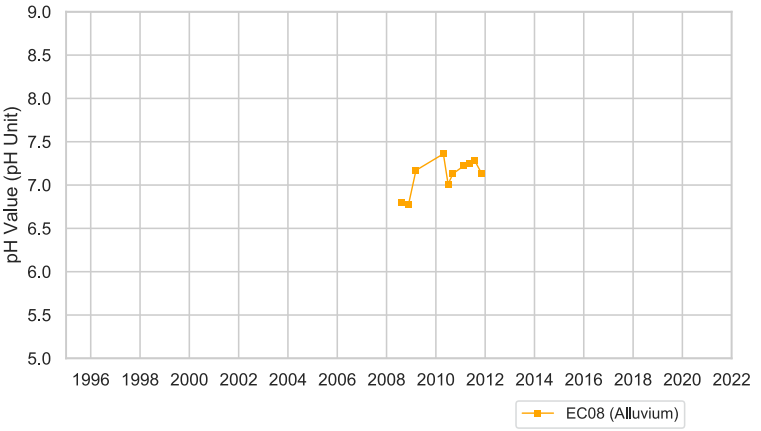

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

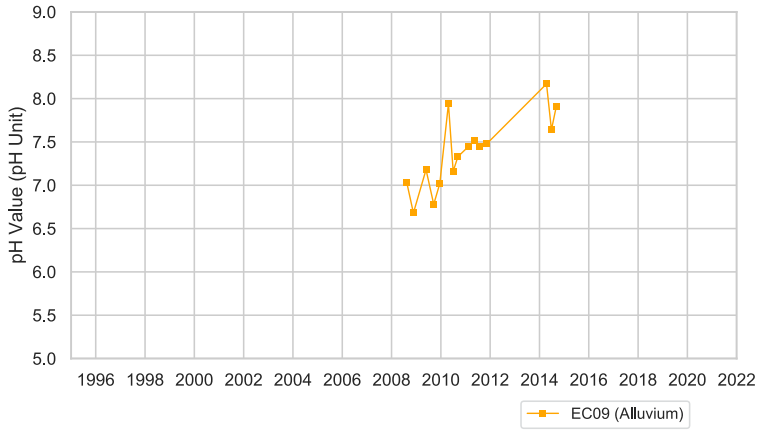

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

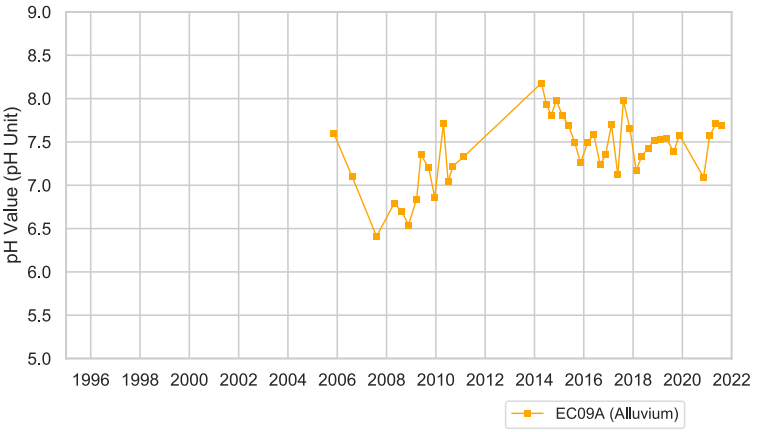

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

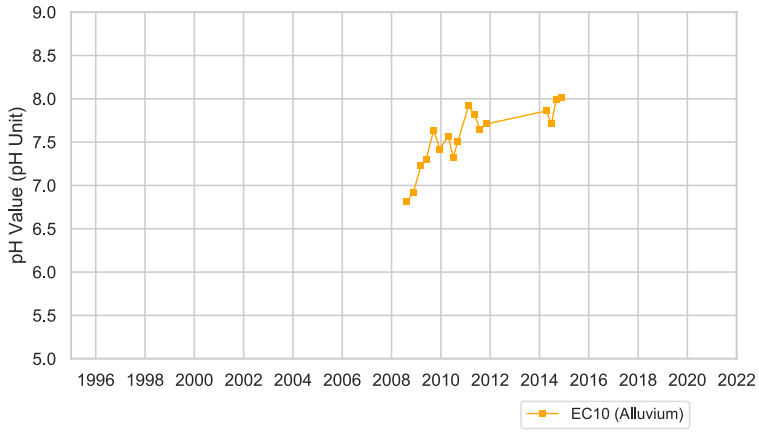

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

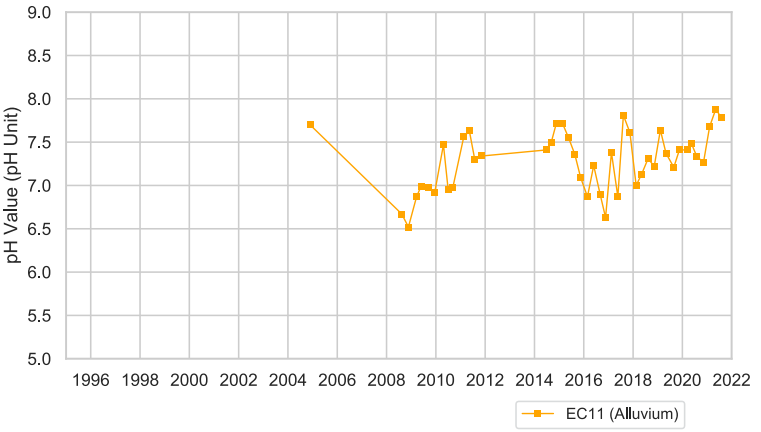

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

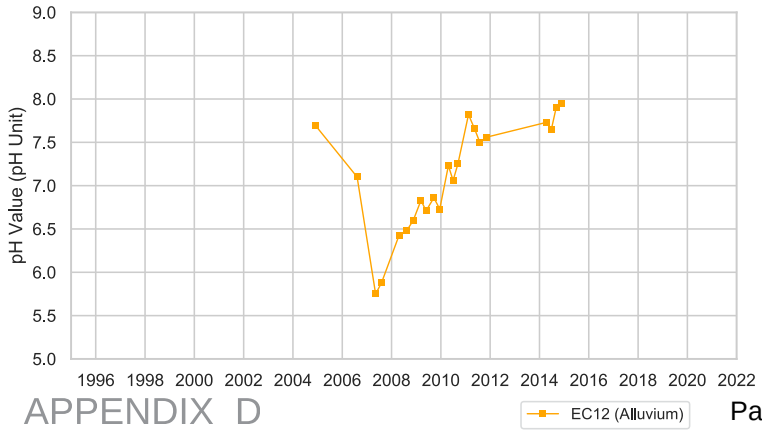

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

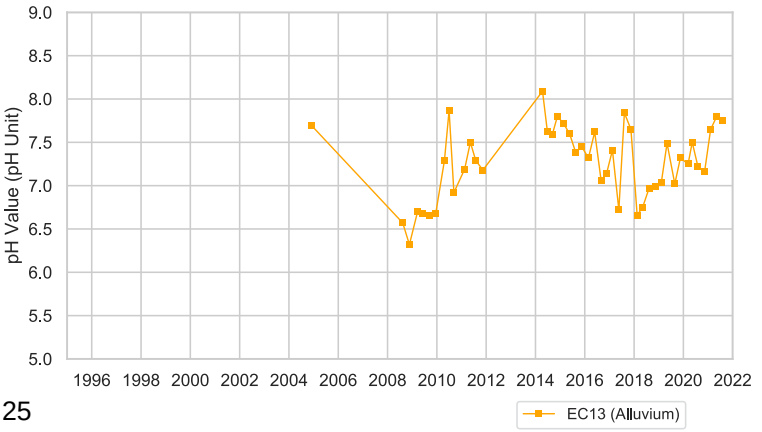

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

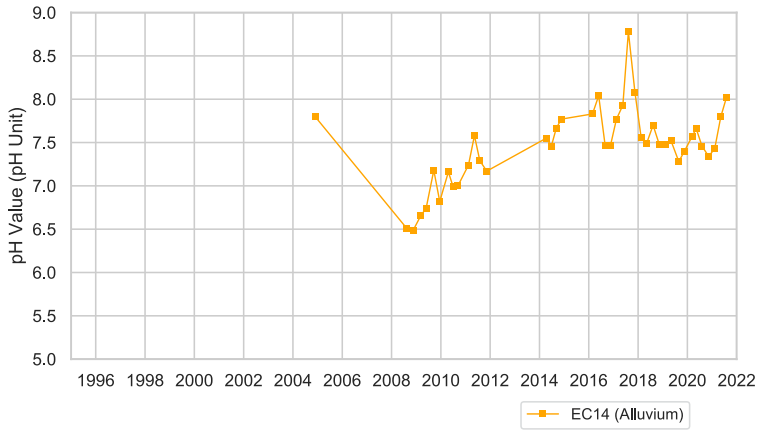

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

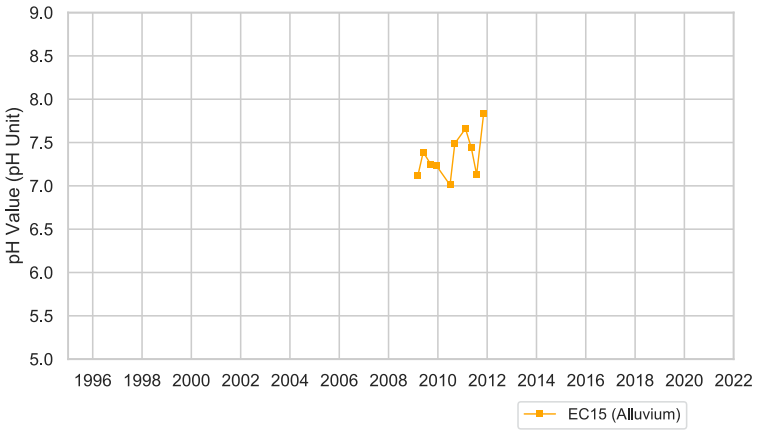

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

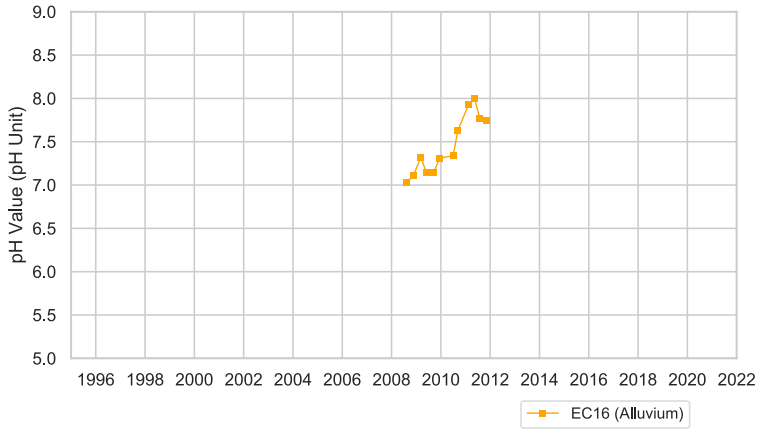

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

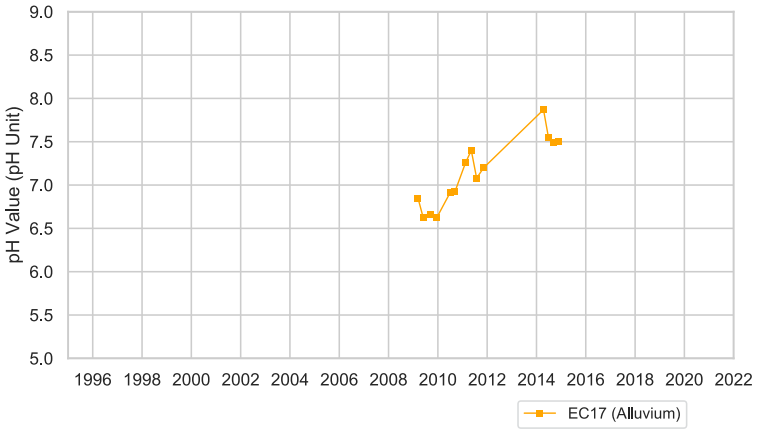

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

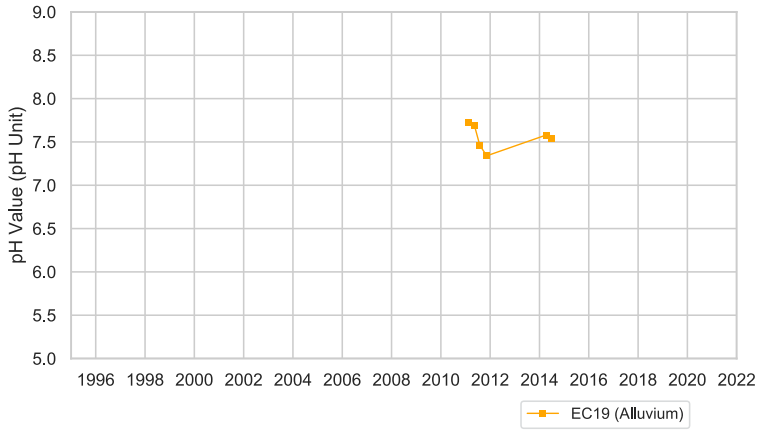

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

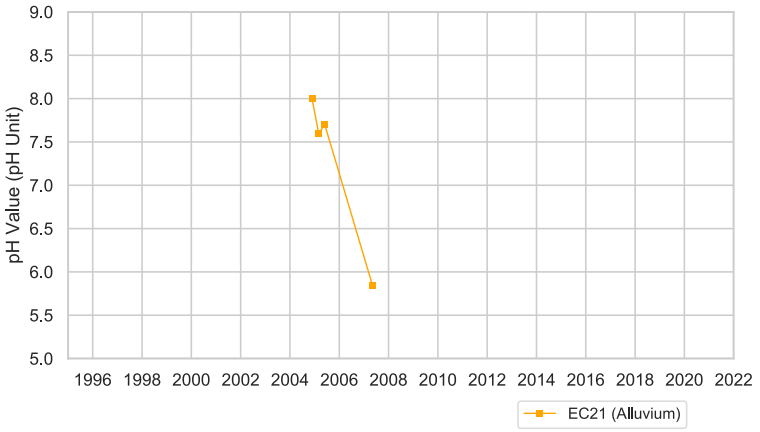

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

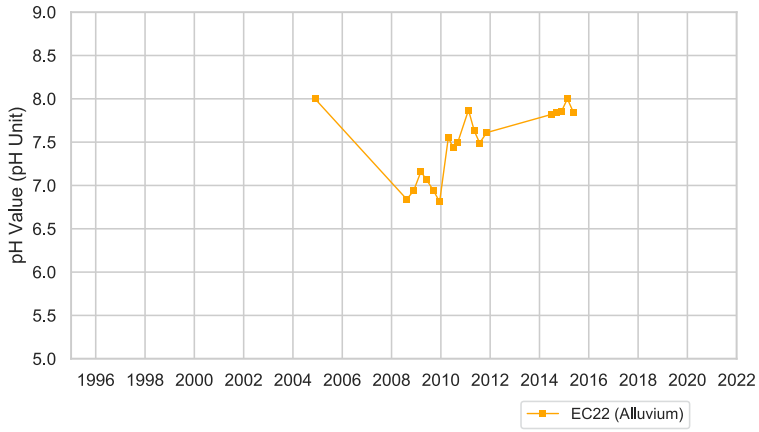

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

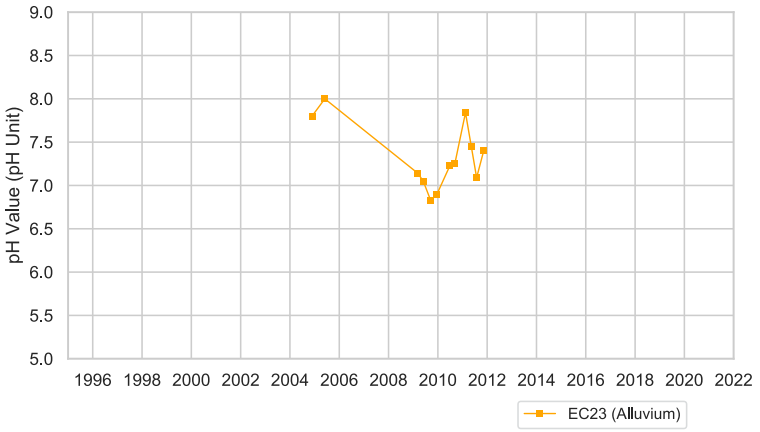

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

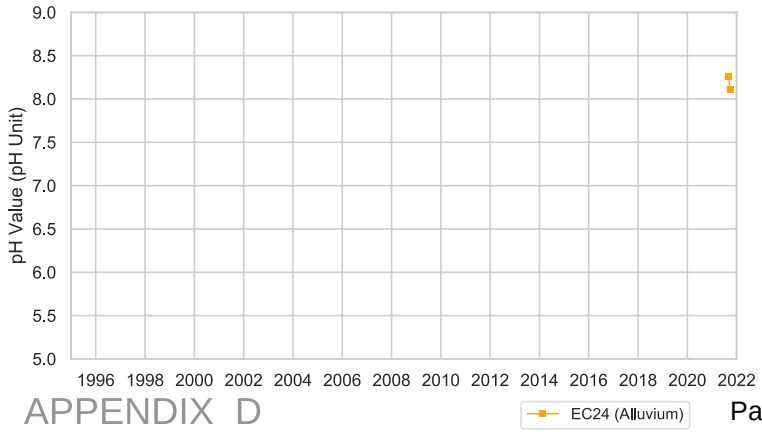

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

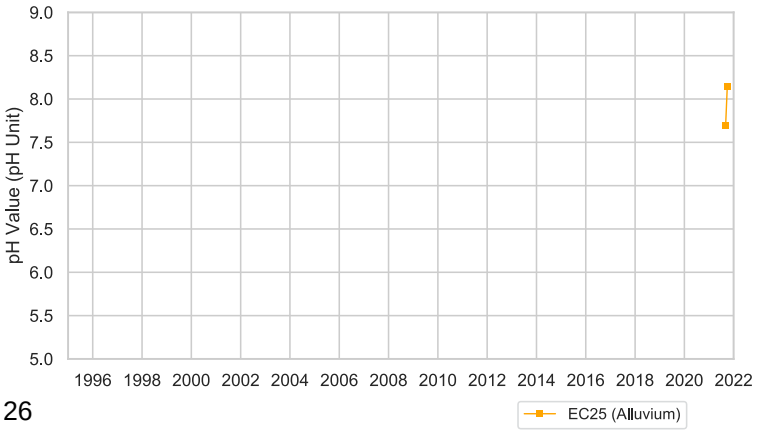

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

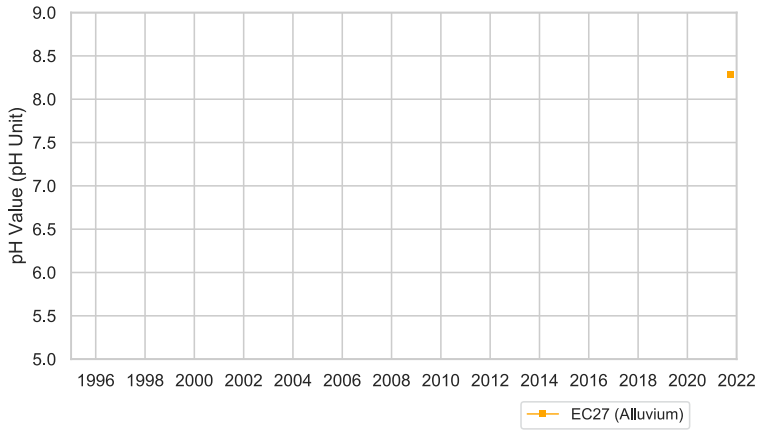

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

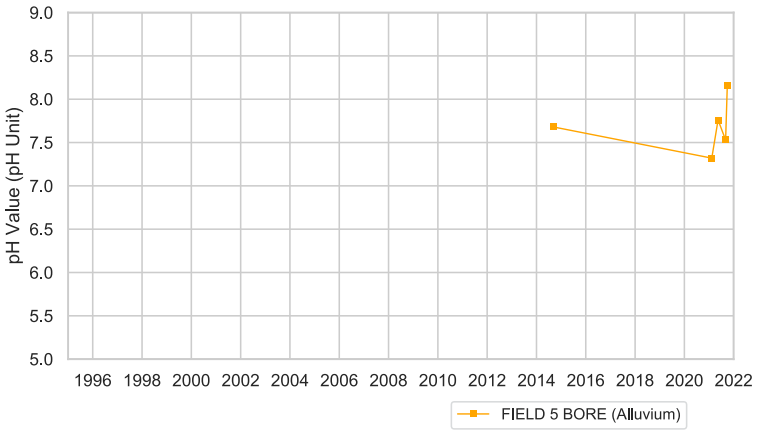

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

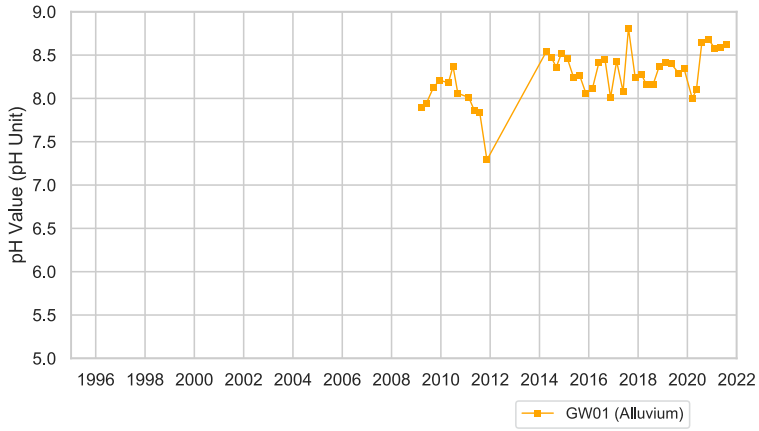

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

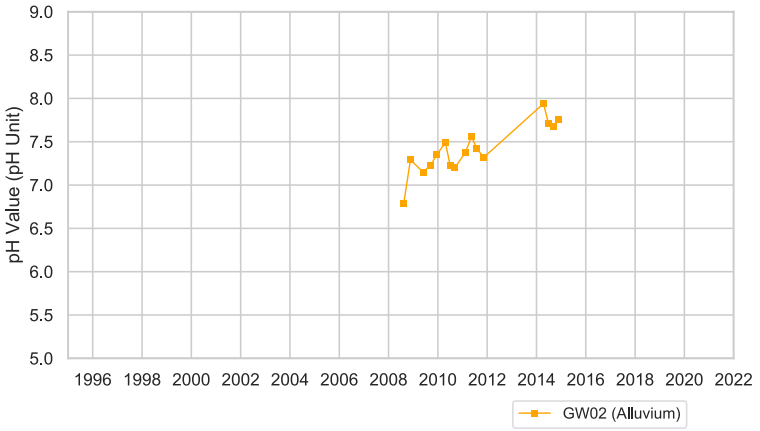

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

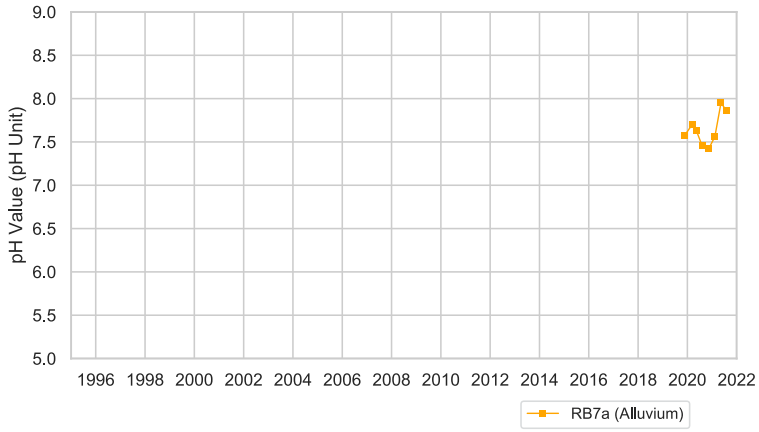

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

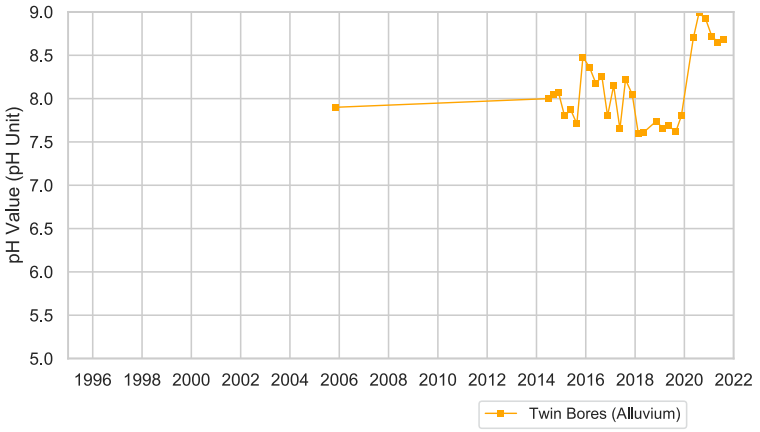

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

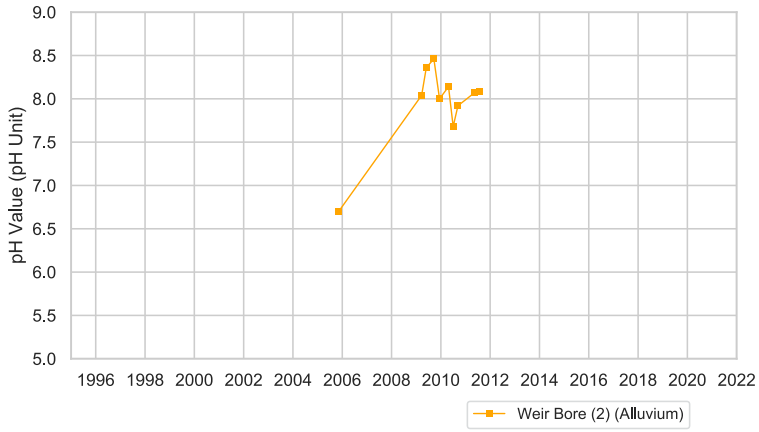

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

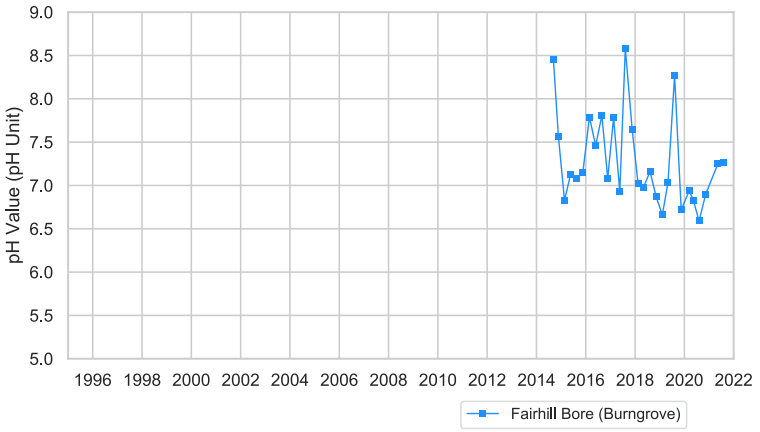

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

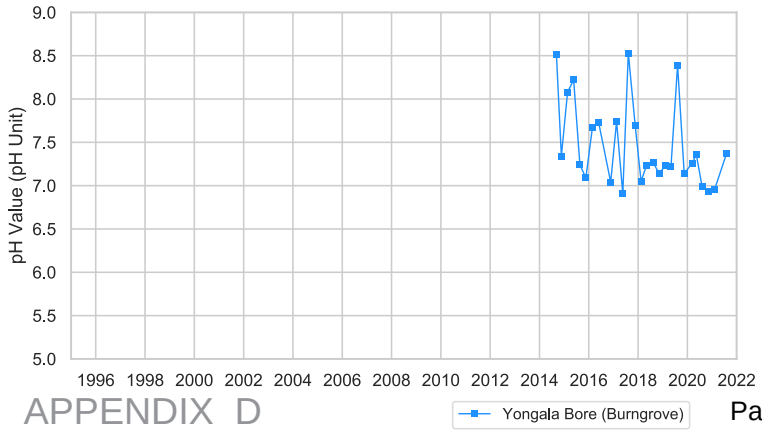

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

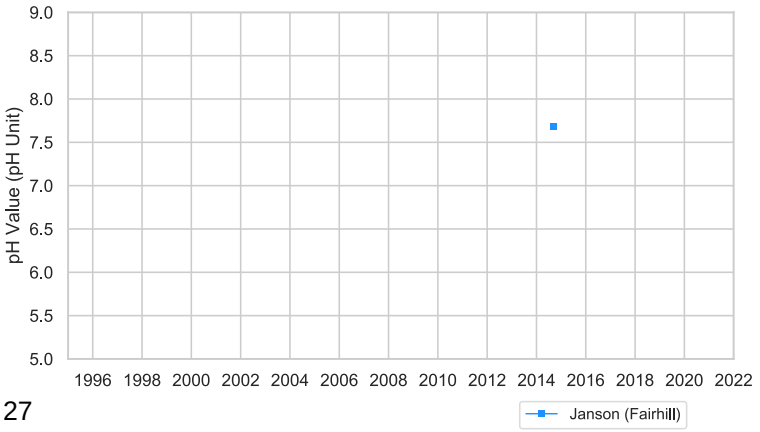

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

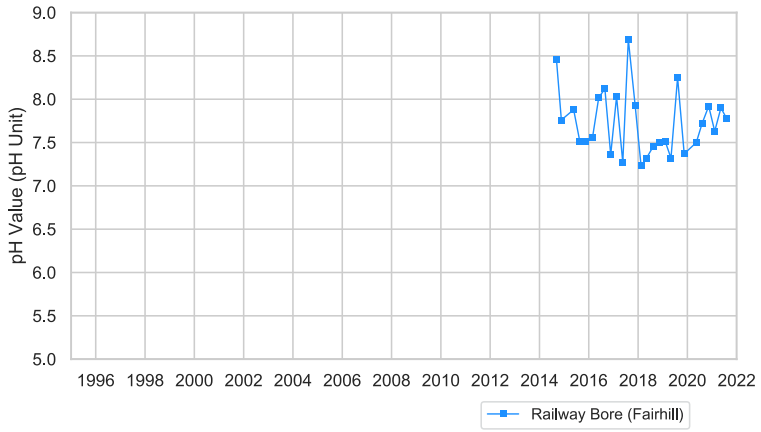

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

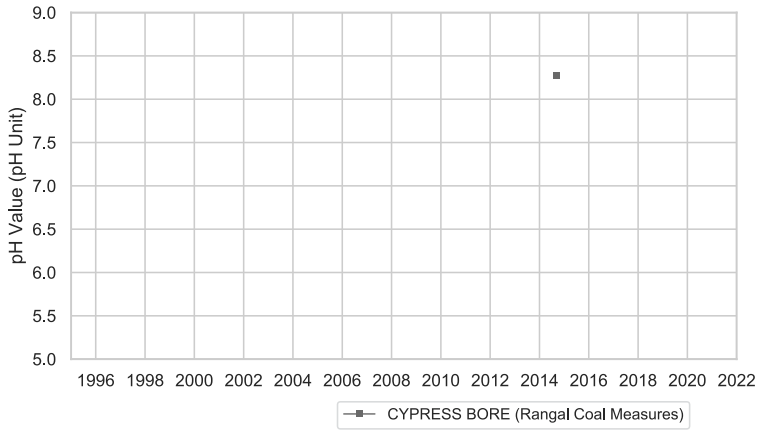

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

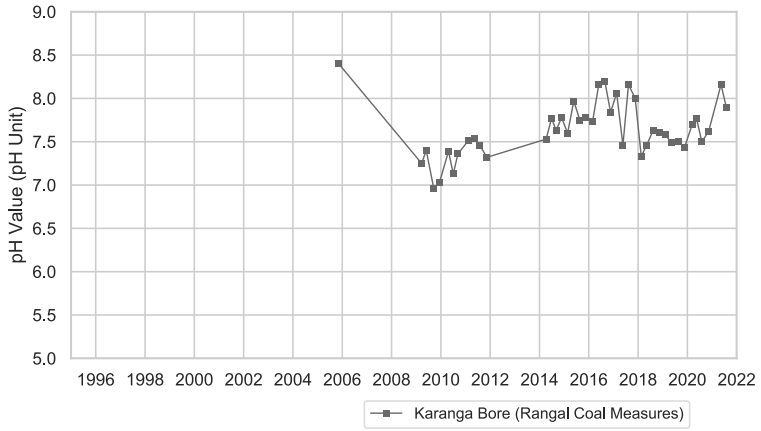

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

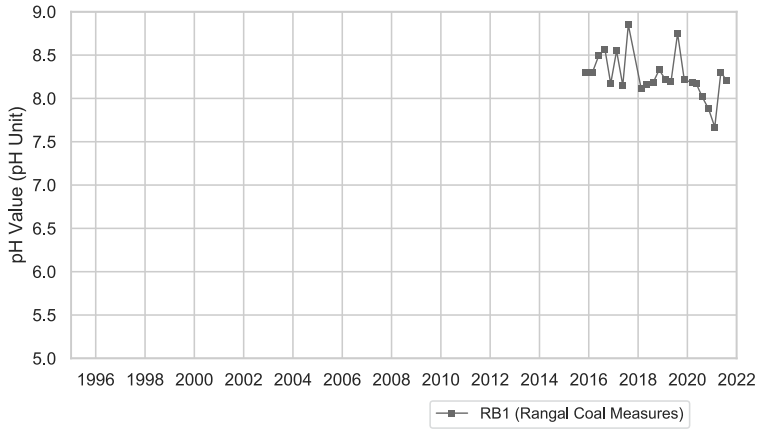

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

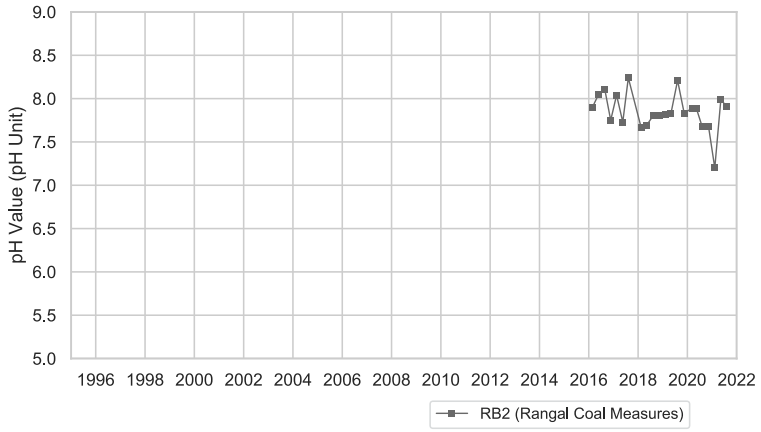

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

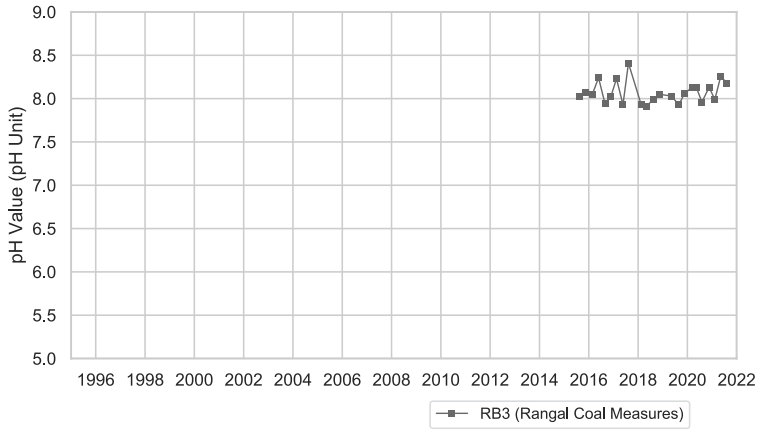

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

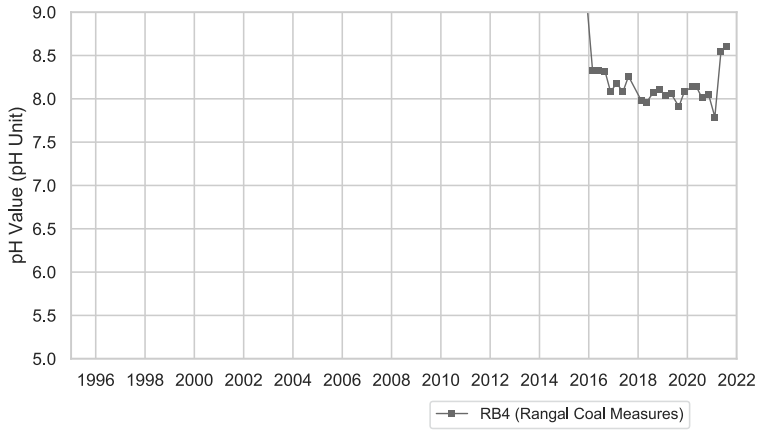

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

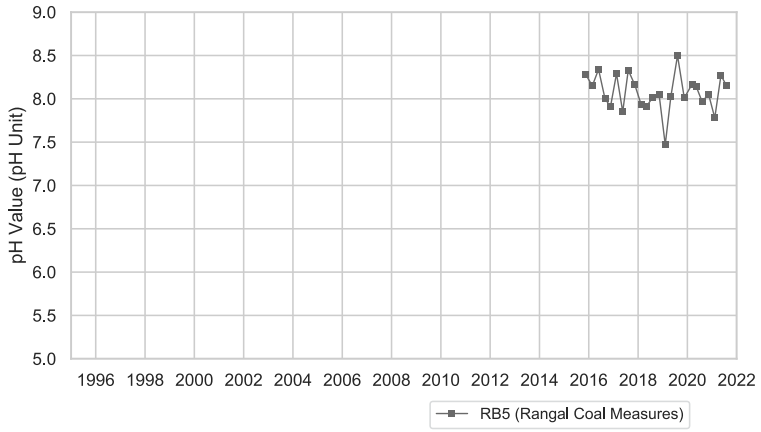

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

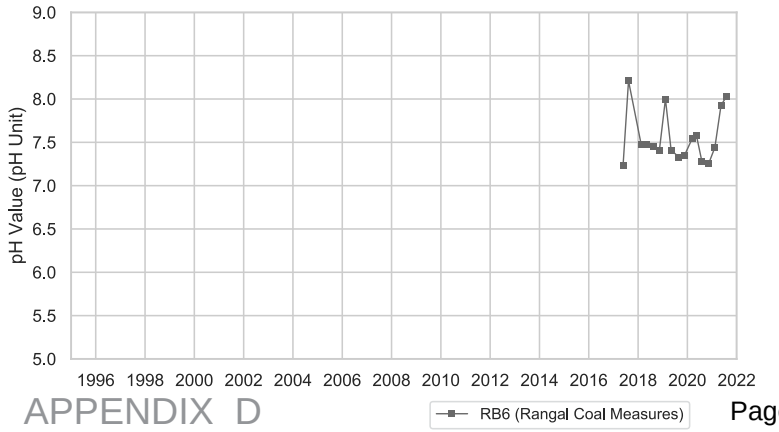

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

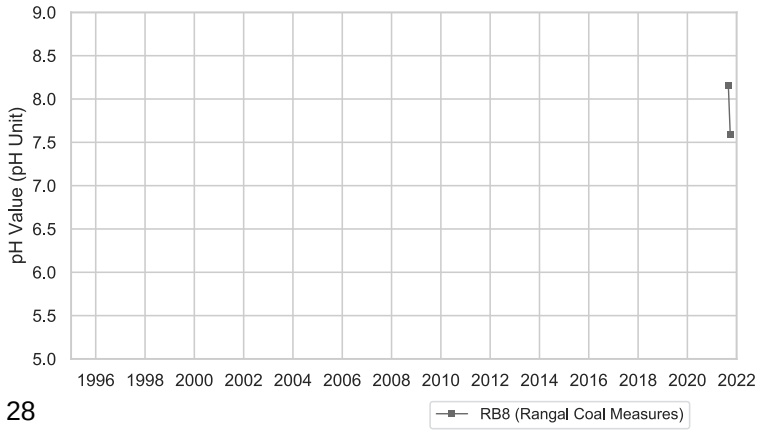

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

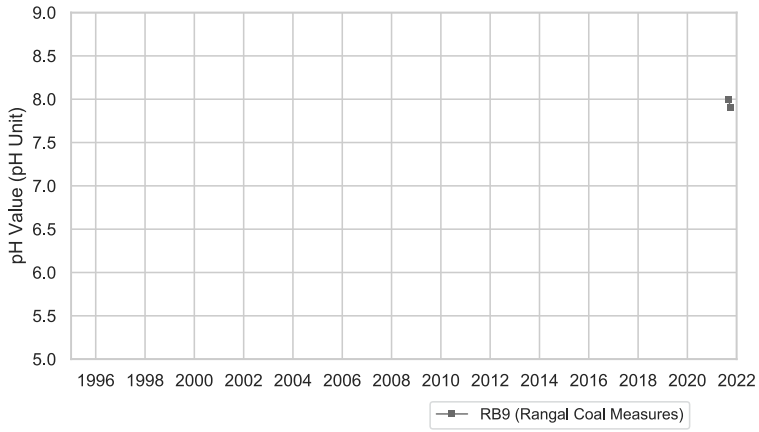

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

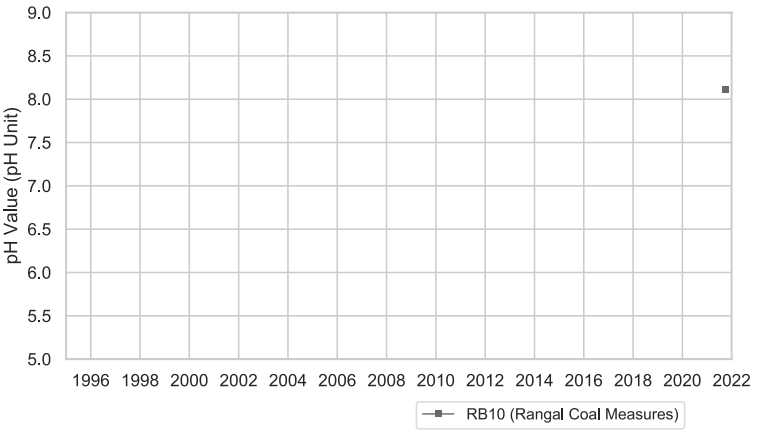

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

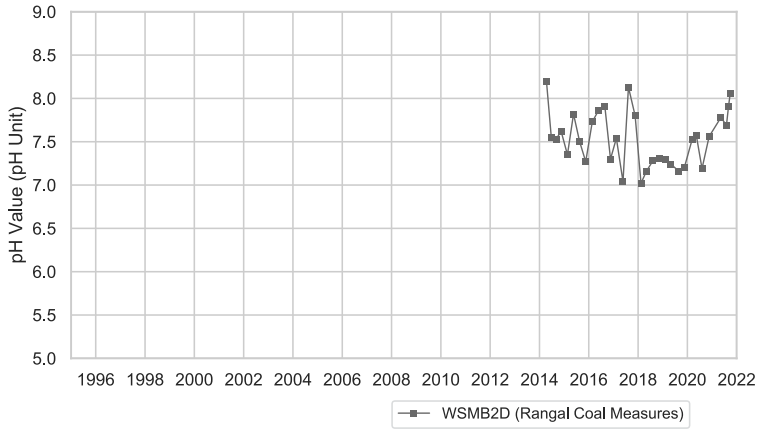

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

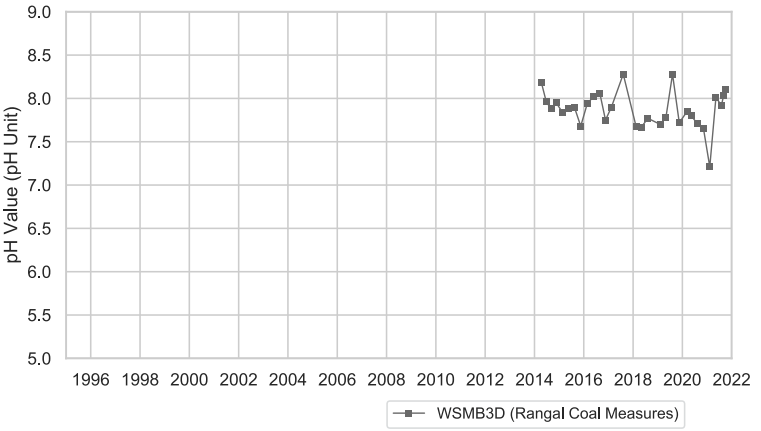

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

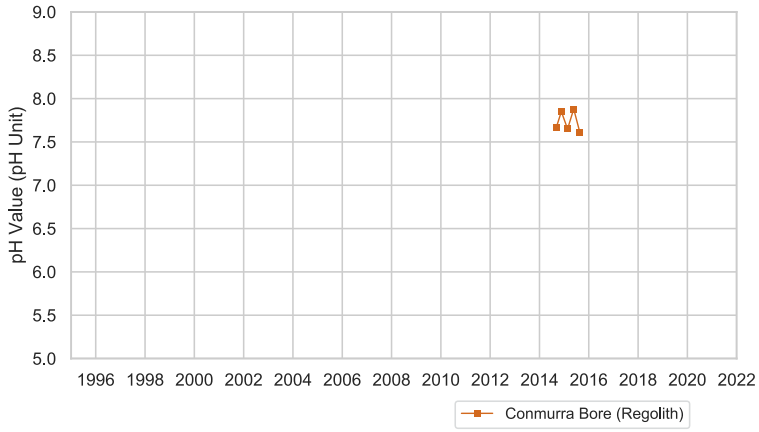

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

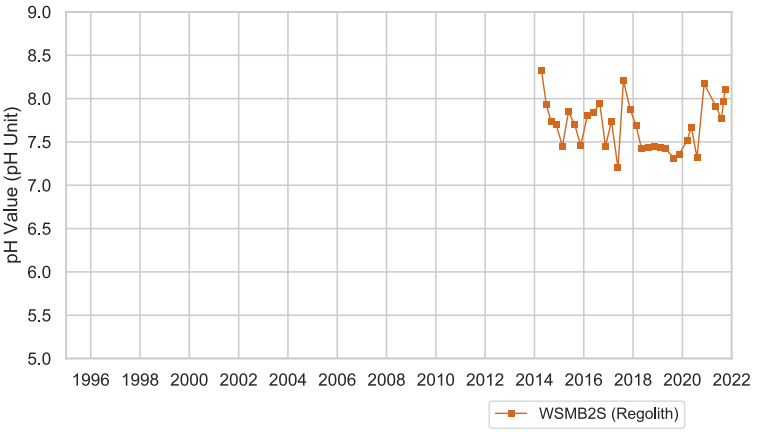

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

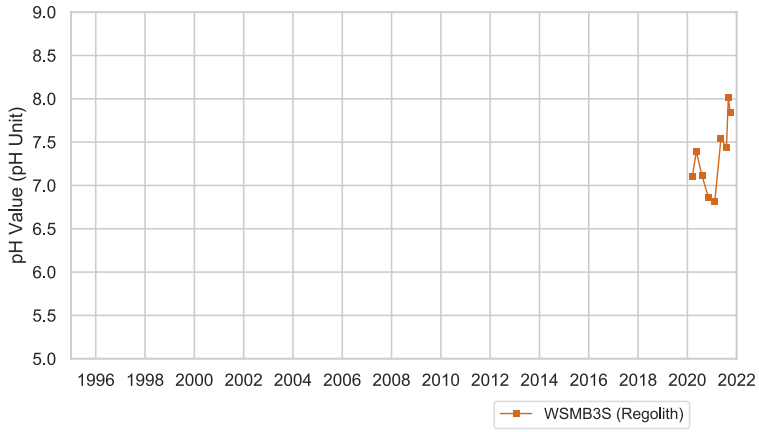

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

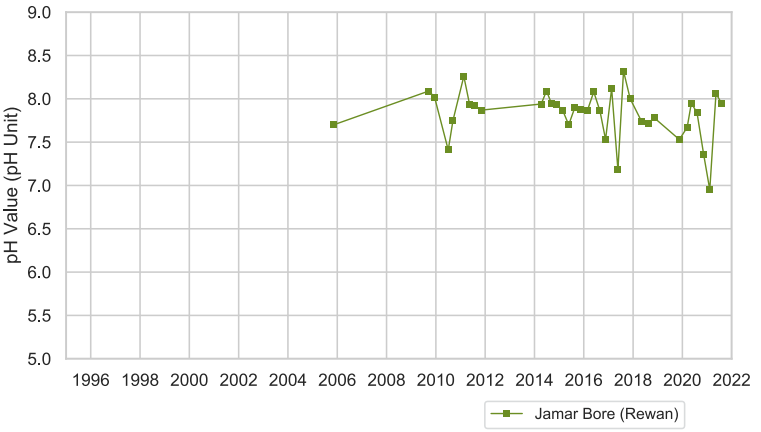

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

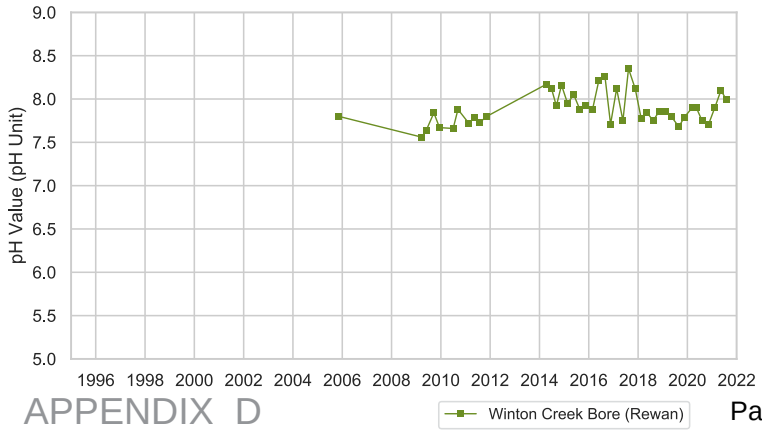

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

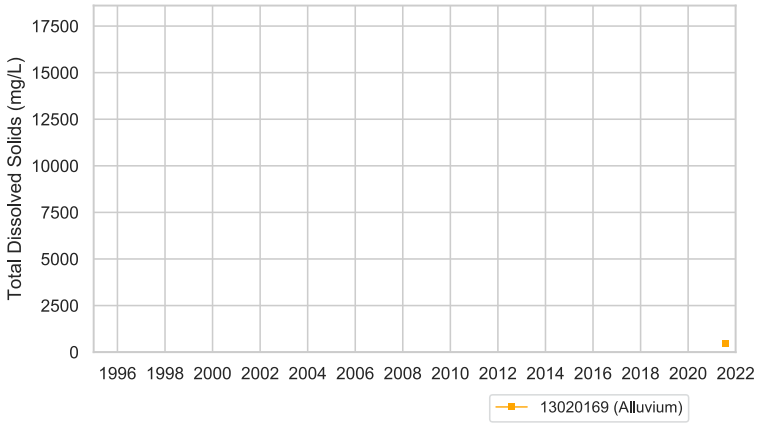

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

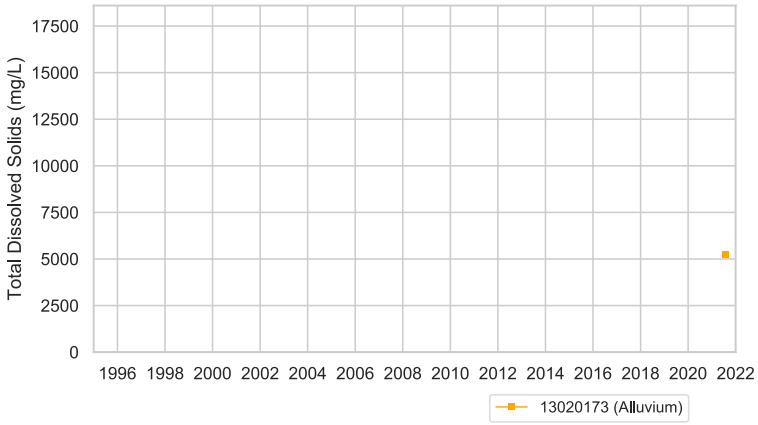

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

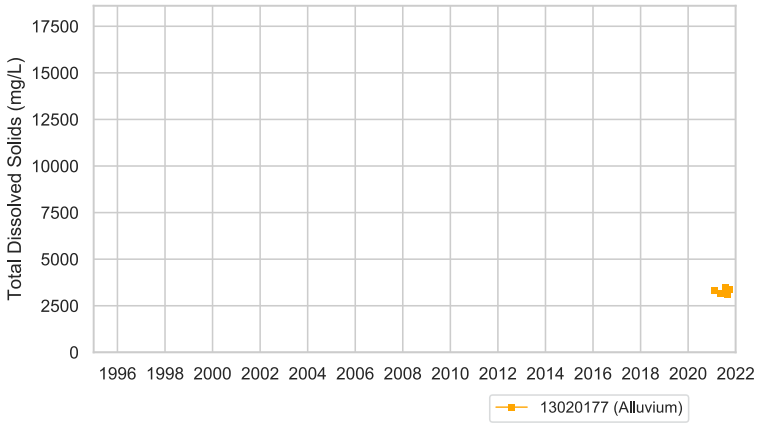

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

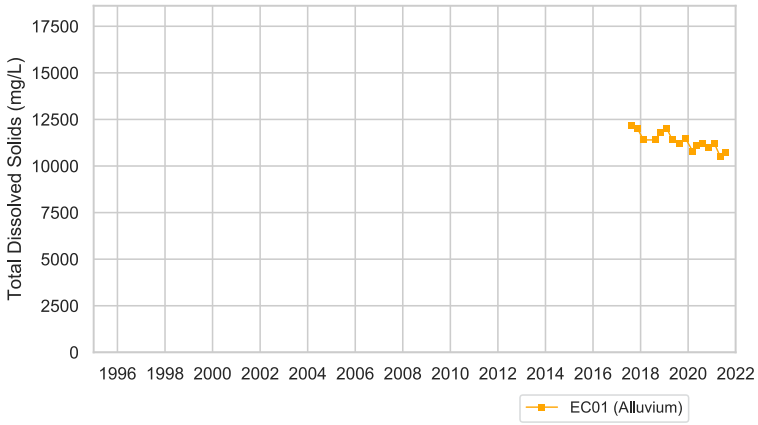

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

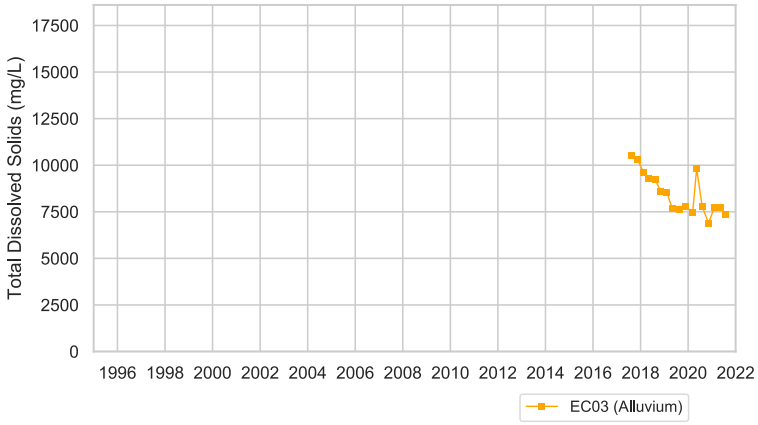

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

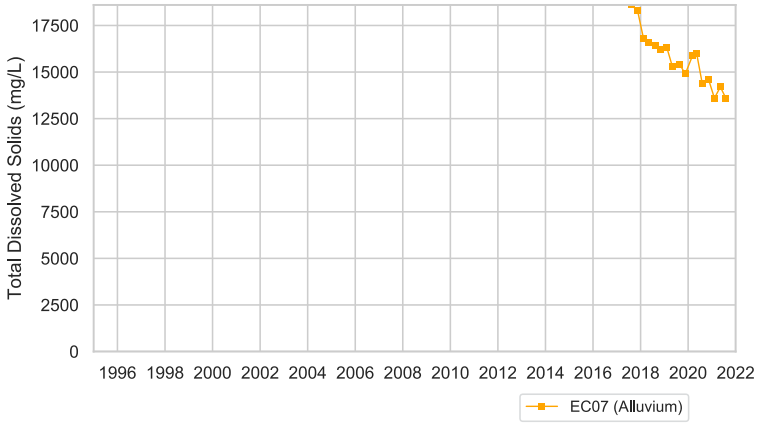

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

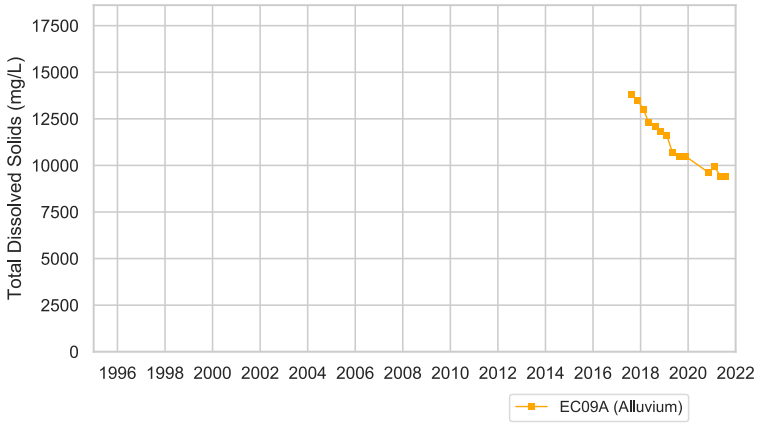

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

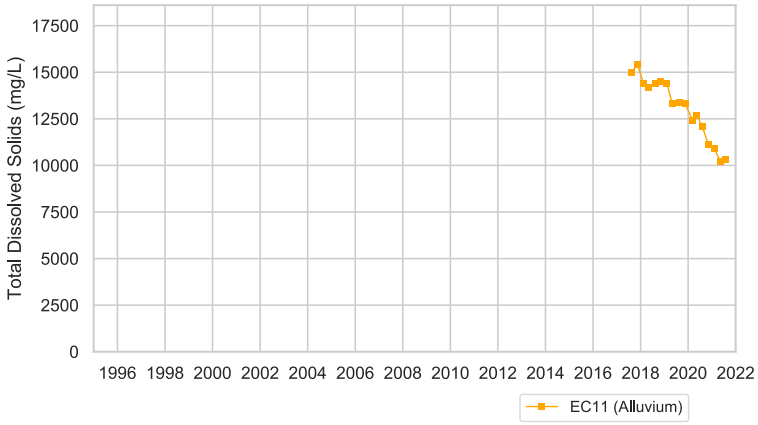

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

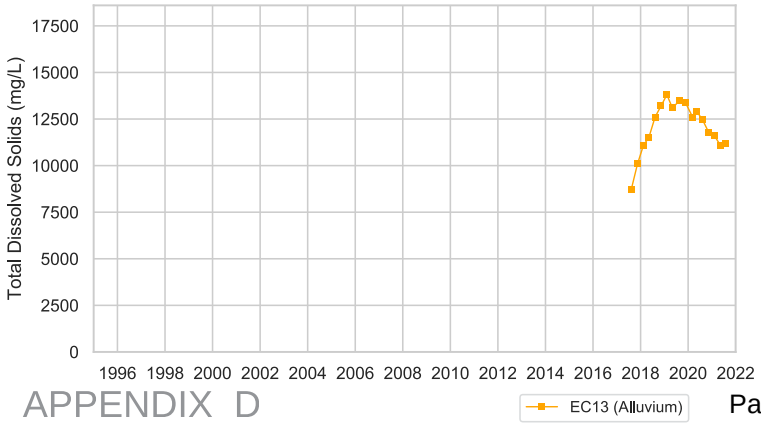

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

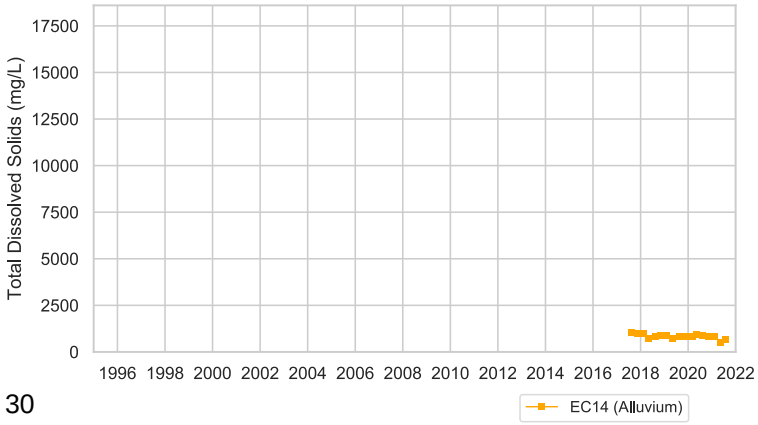

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

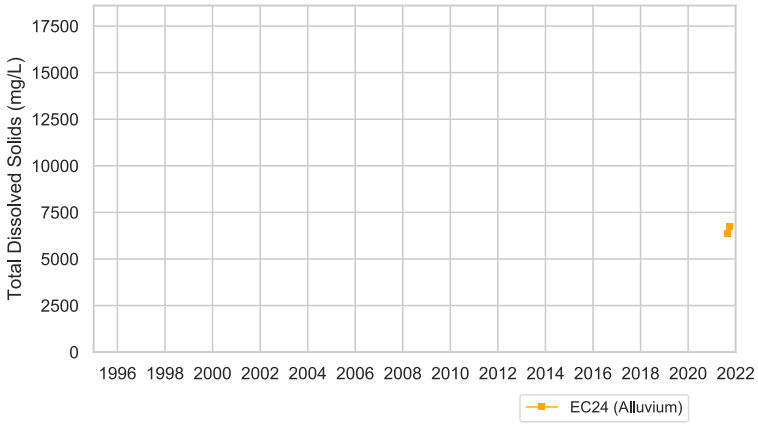

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

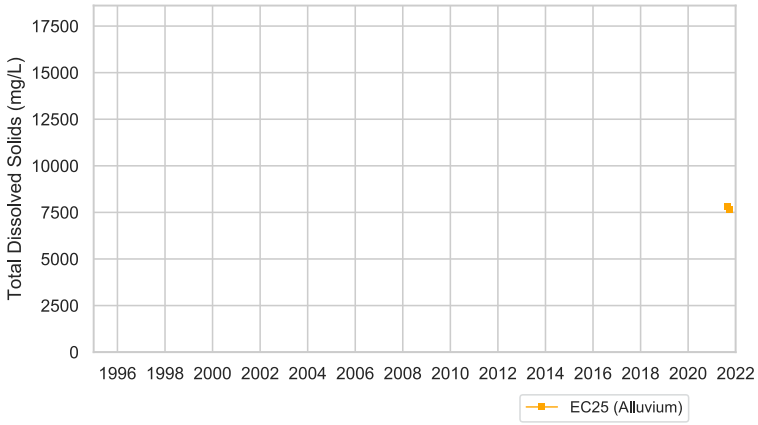

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

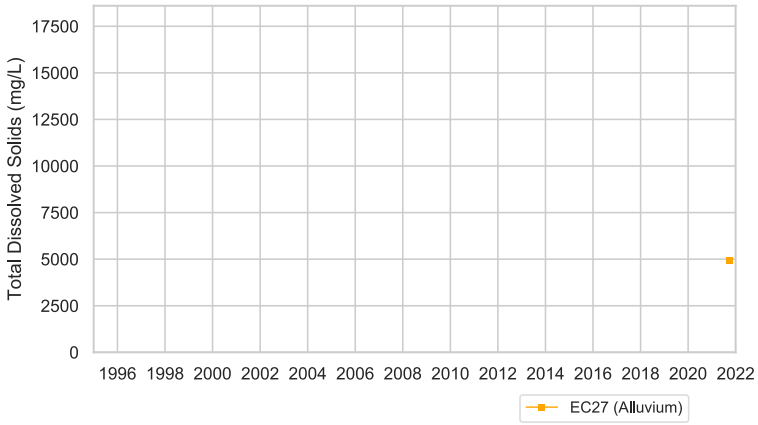

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

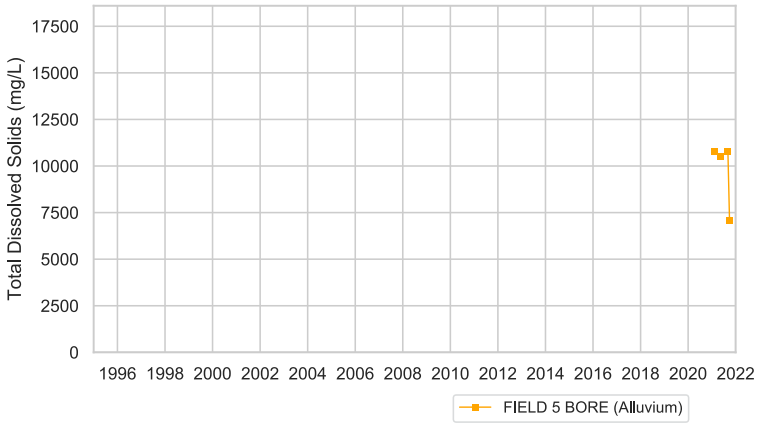

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

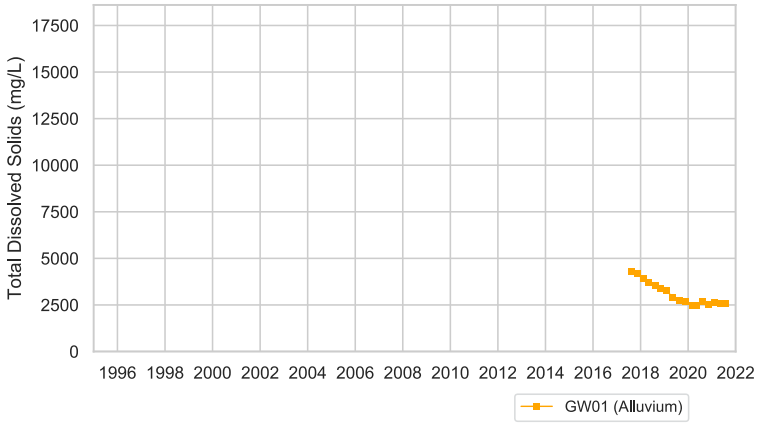

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

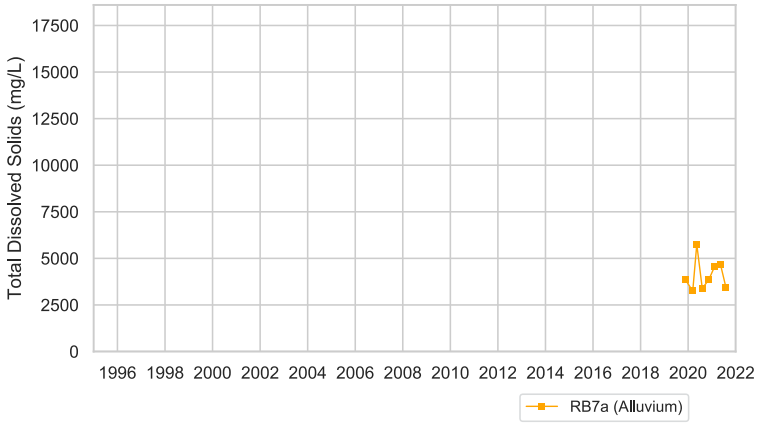

Total Dissolved Solids (mg/L)
EC24 (Alluvium)

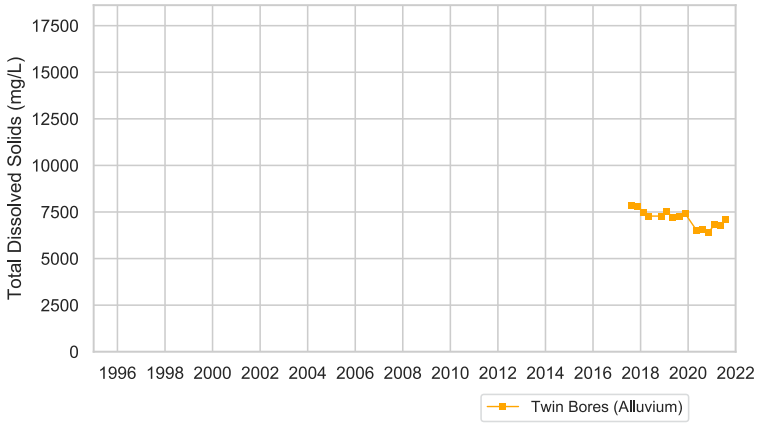

Total Dissolved Solids (mg/L)
EC25 (Alluvium)

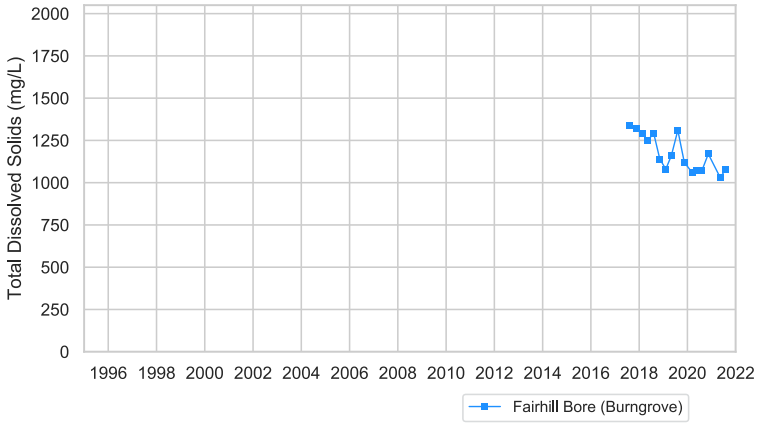

Total Dissolved Solids (mg/L)
EC27 (Alluvium)

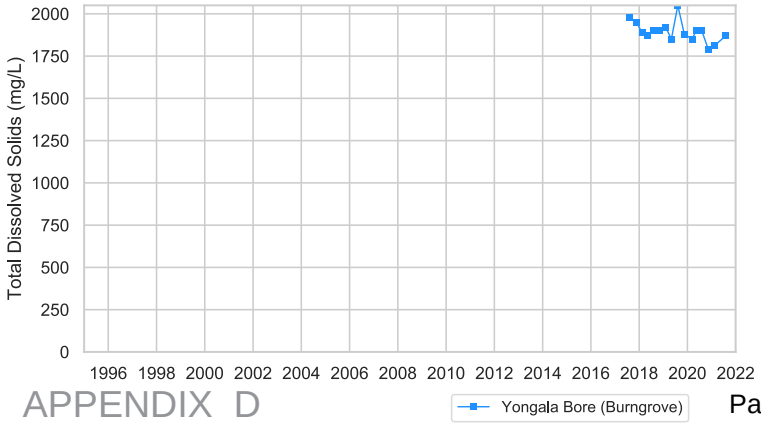

Total Dissolved Solids (mg/L)
FIELD 5 BORE (Alluvium)

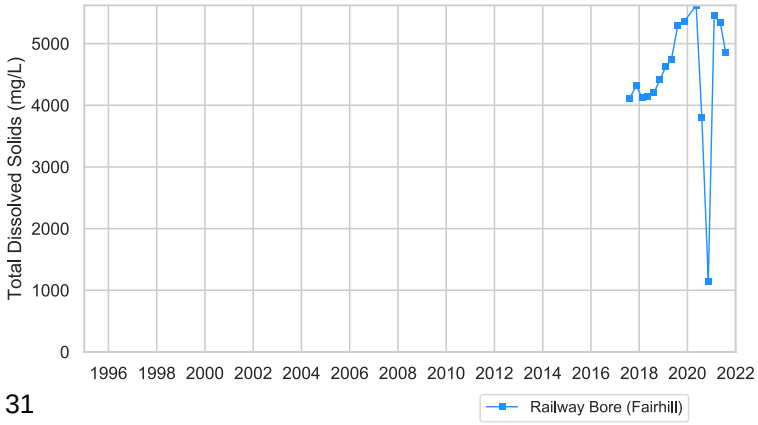

Total Dissolved Solids (mg/L)
GW01 (Alluvium)

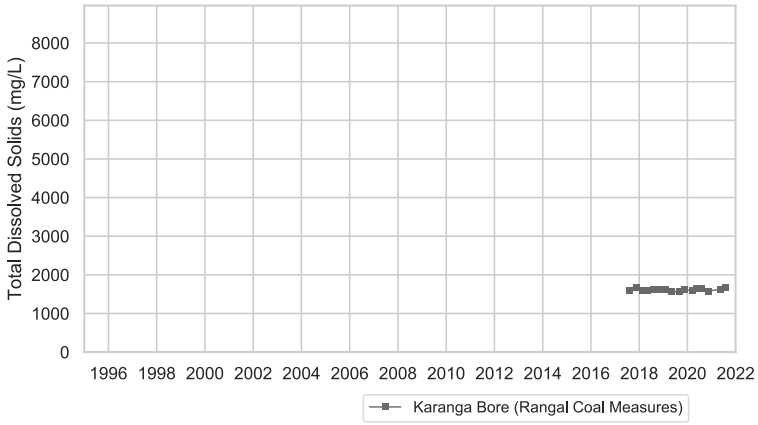

Total Dissolved Solids (mg/L)
RB7a (Alluvium)

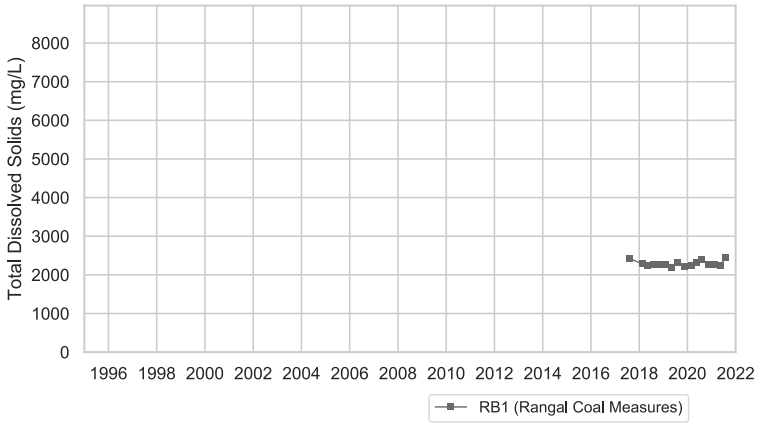

Total Dissolved Solids (mg/L)
Twin Bores (Alluvium)

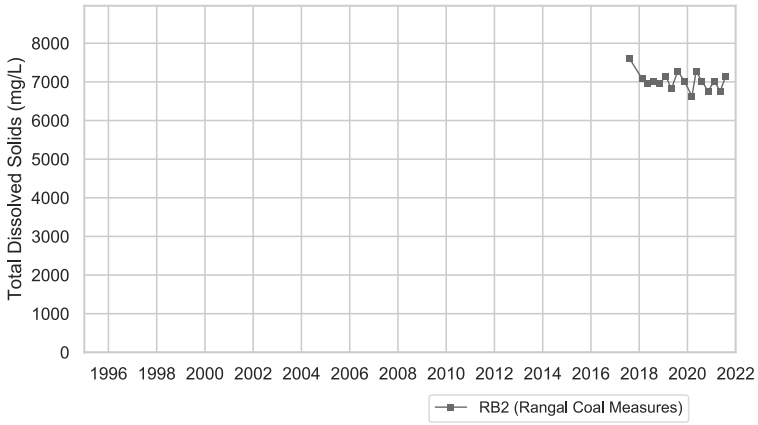

Total Dissolved Solids (mg/L)
Fairhill Bore (Burngrove)

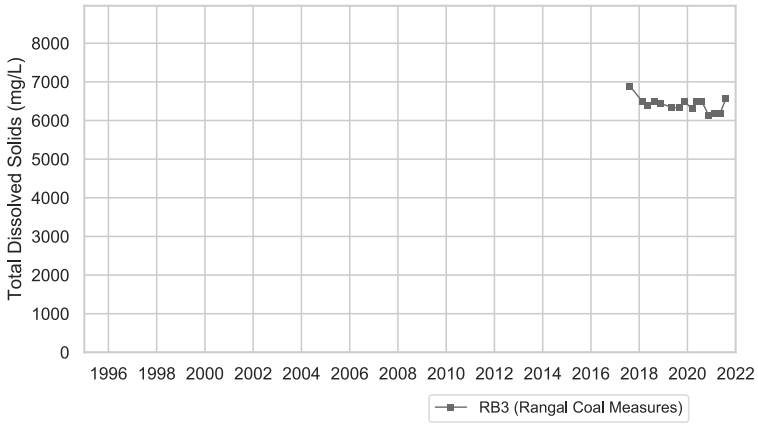

Total Dissolved Solids (mg/L)
Yongala Bore (Burngrove)

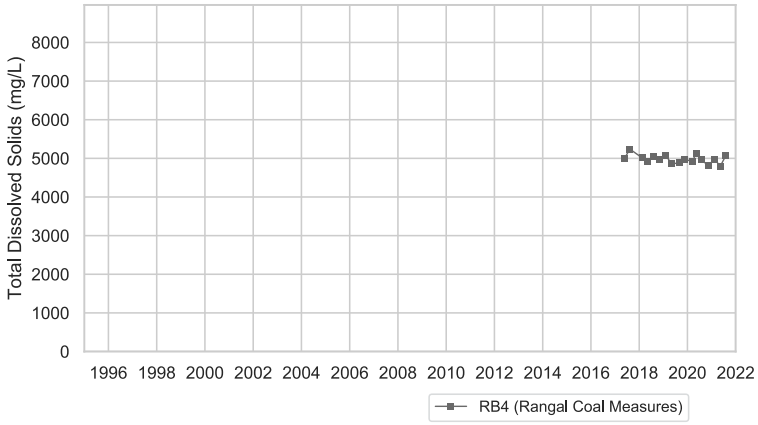

Total Dissolved Solids (mg/L)
Railway Bore (Fairhill)

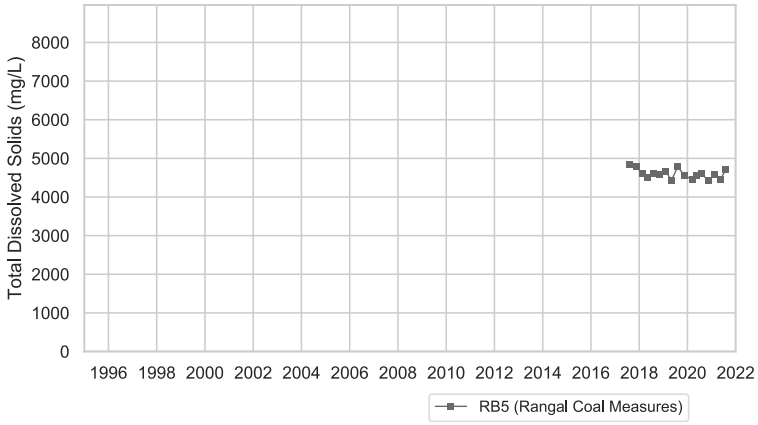

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

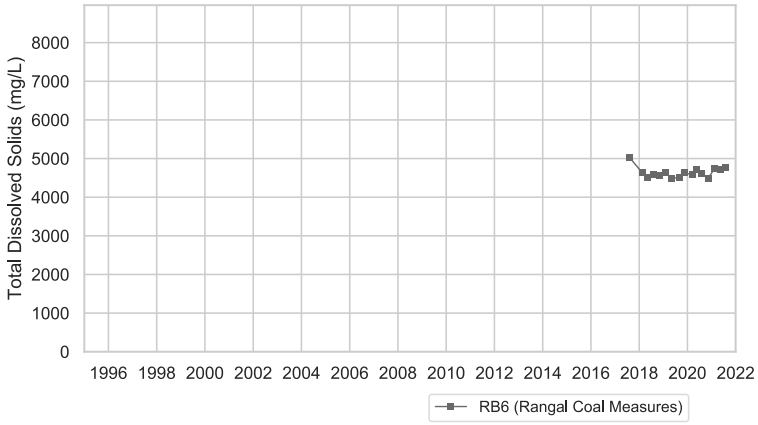

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

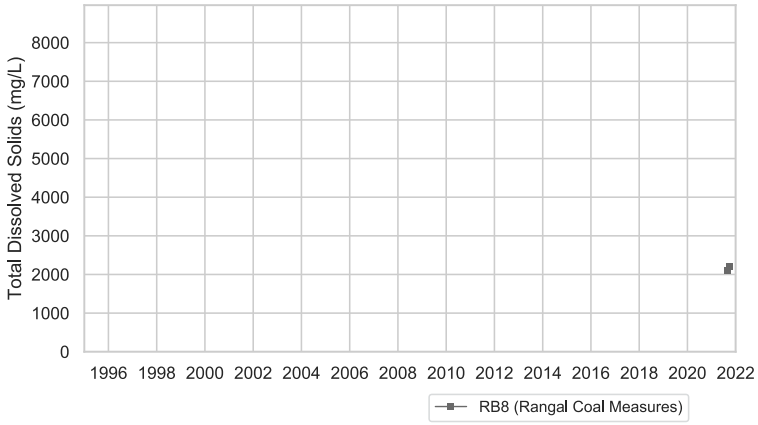

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

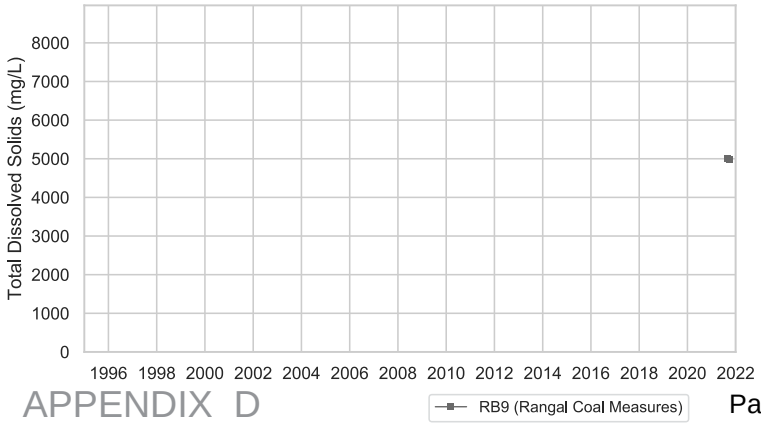

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

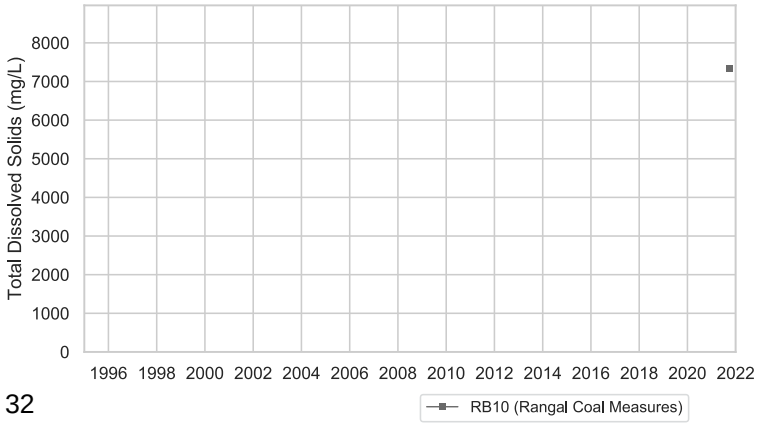

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

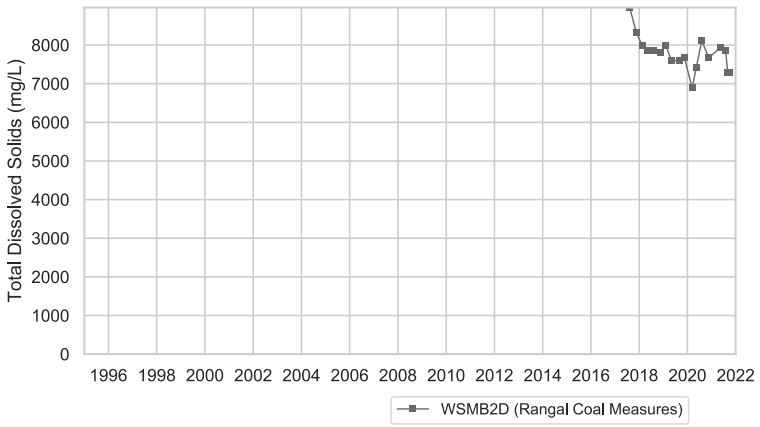

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

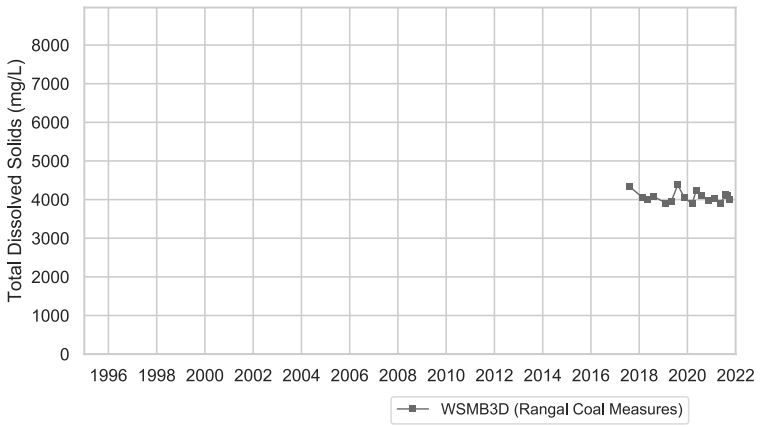

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

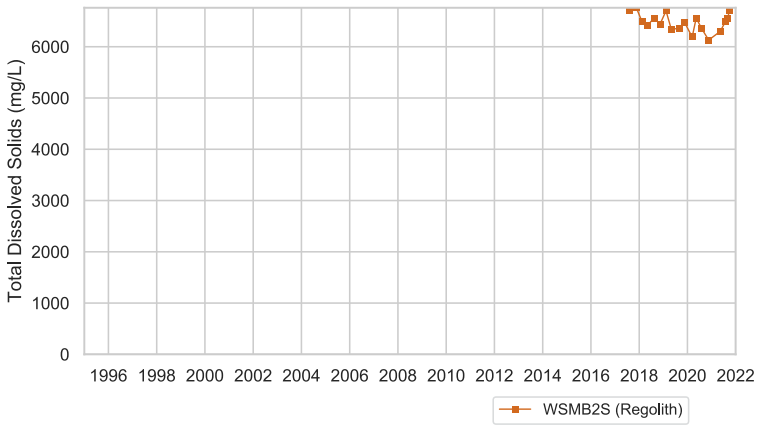

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

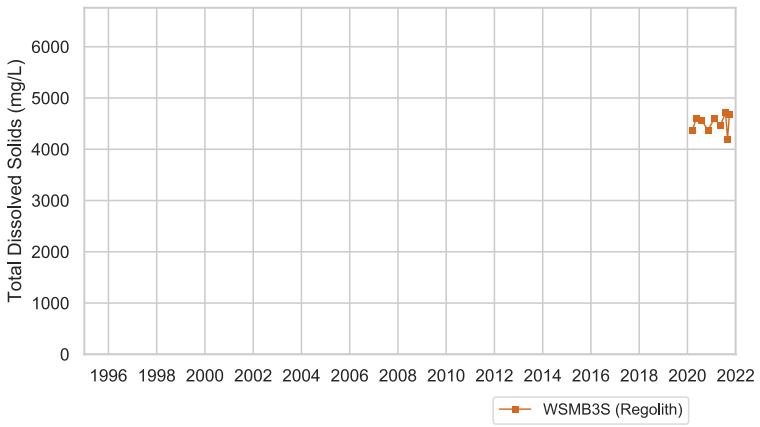

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

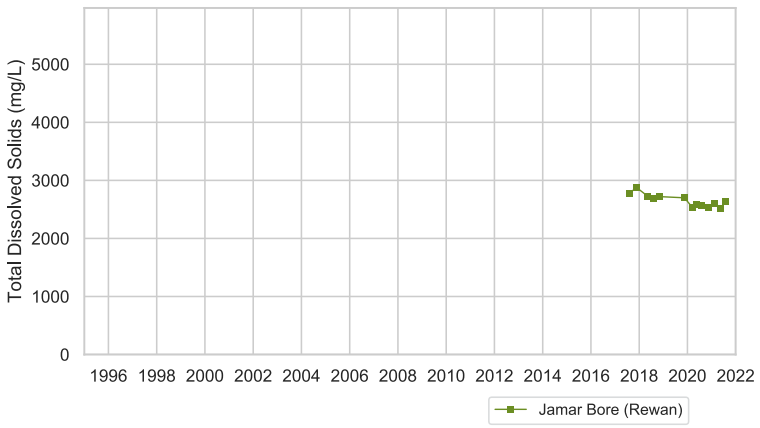

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

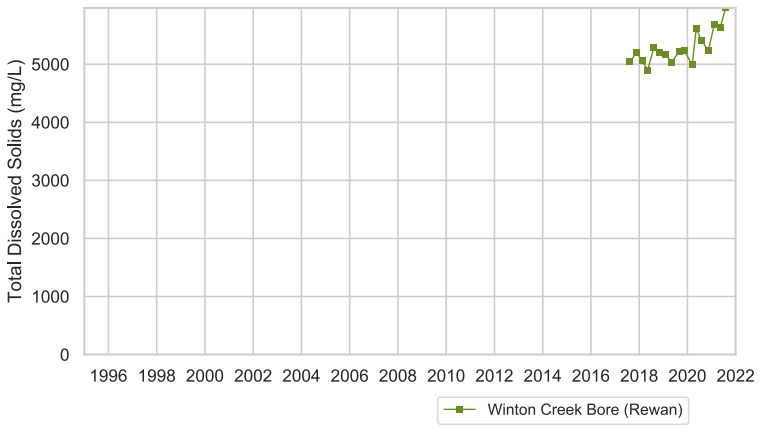

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

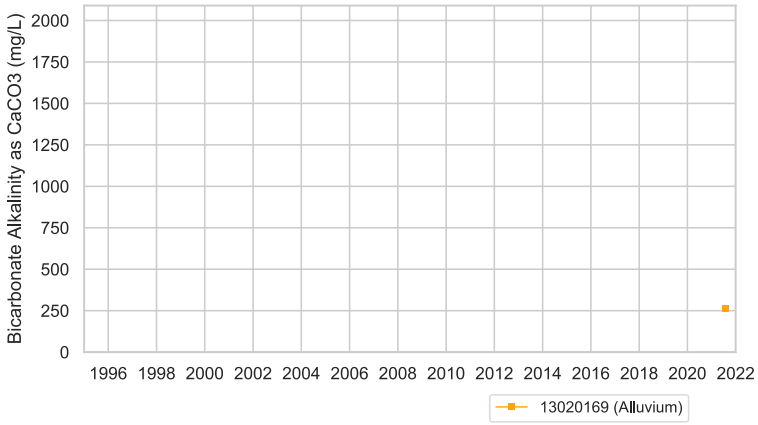

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

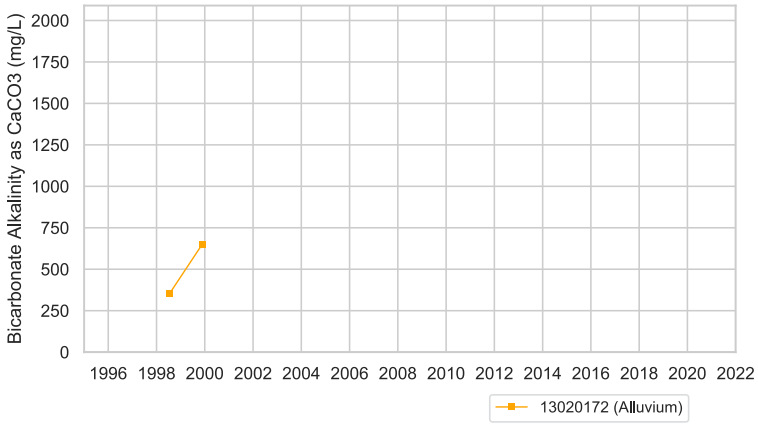

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

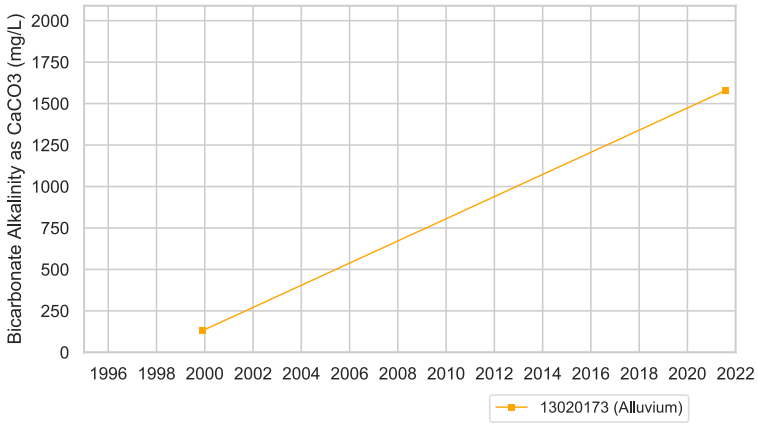

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

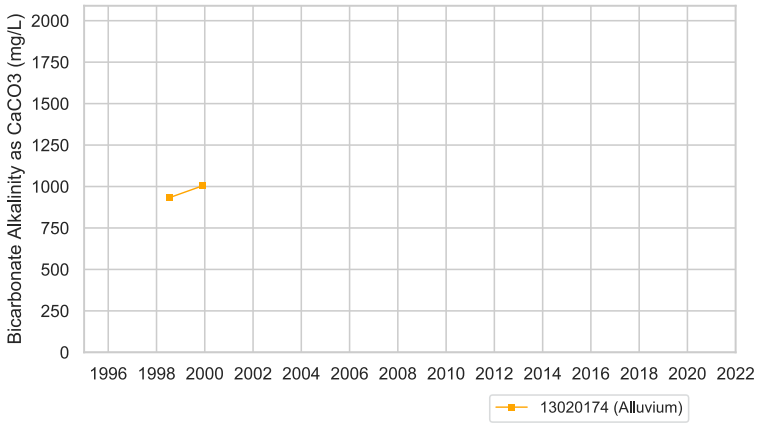

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

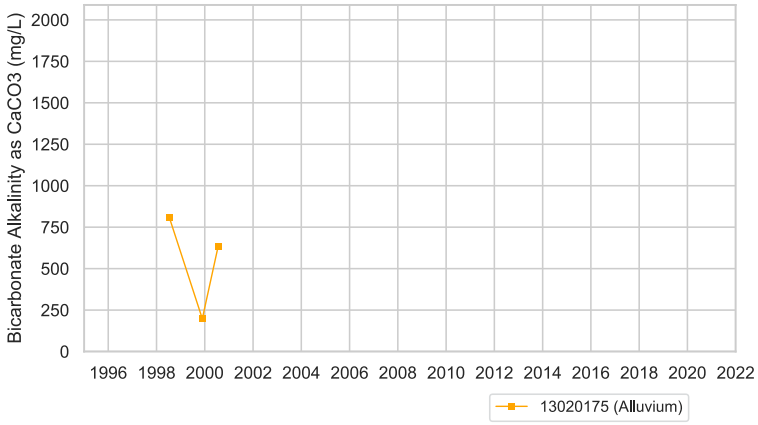

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

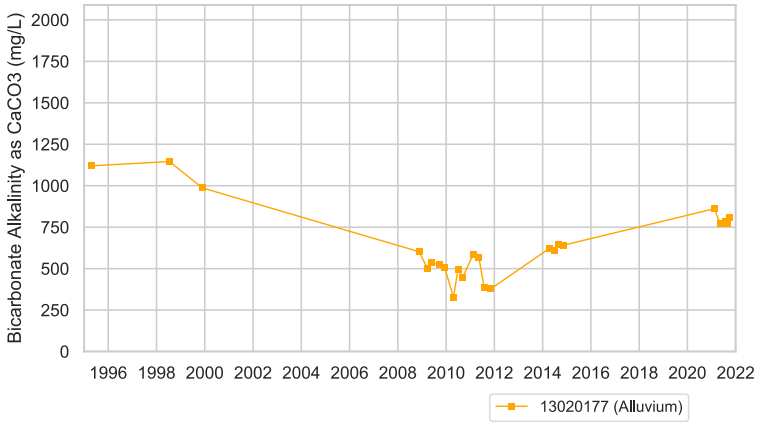

Bicarbonate Alkalinity as CaCO3 (mg/L)
13020169 (Alluvium)

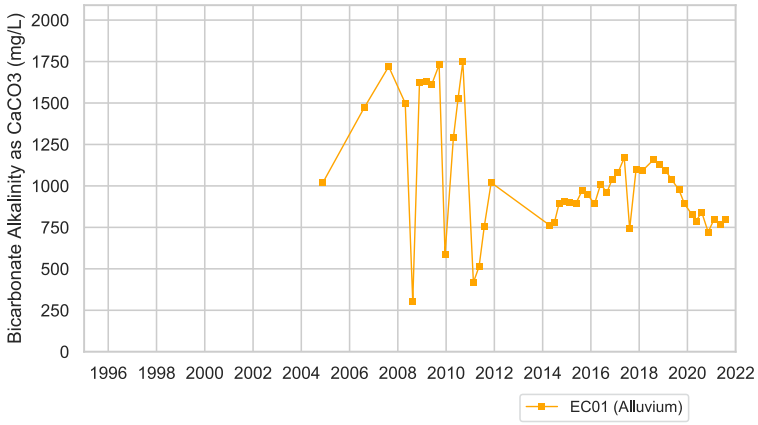

Bicarbonate Alkalinity as CaCO3 (mg/L)
13020172 (Alluvium)

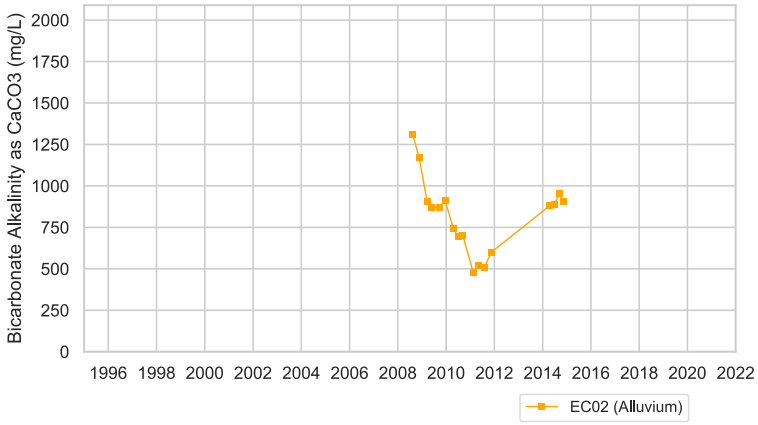

Bicarbonate Alkalinity as CaCO3 (mg/L)
13020173 (Alluvium)

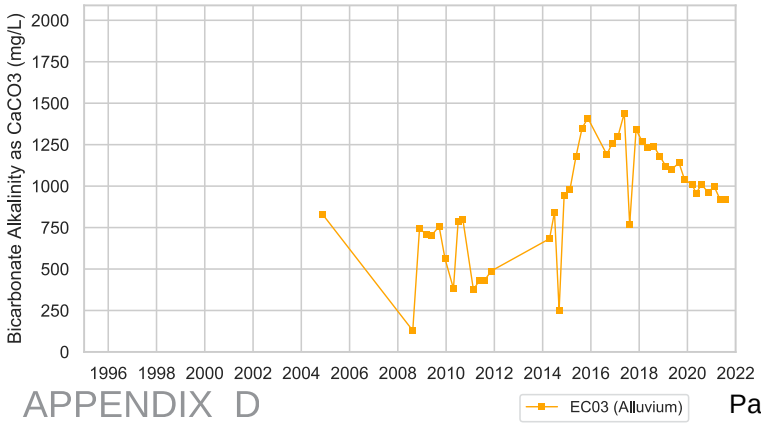

Bicarbonate Alkalinity as CaCO3 (mg/L)
13020174 (Alluvium)

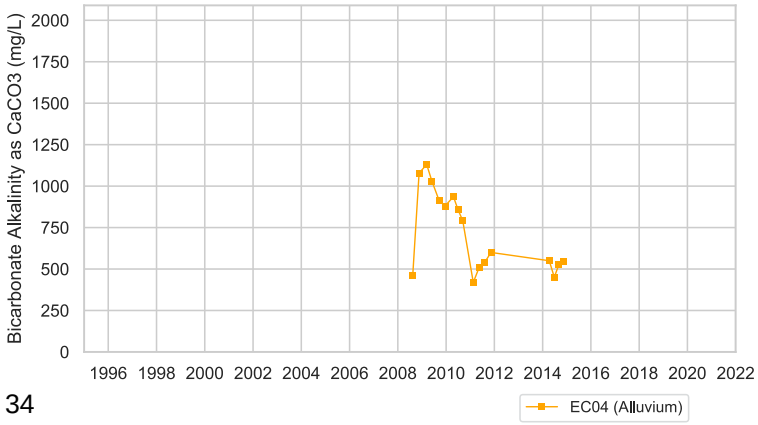

Bicarbonate Alkalinity as CaCO3 (mg/L)
13020175 (Alluvium)

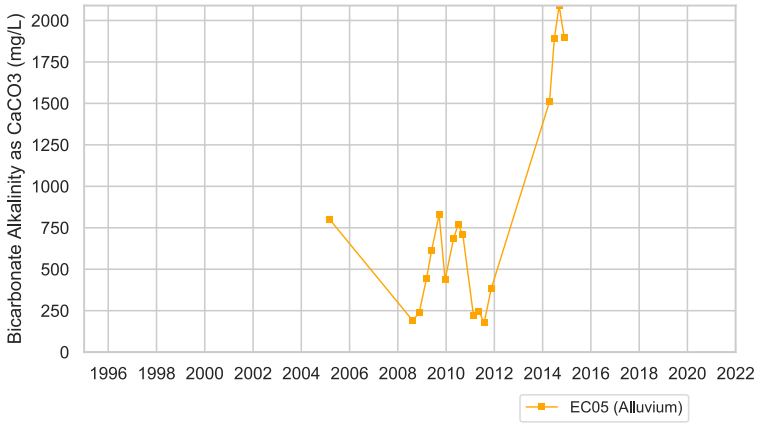

Bicarbonate Alkalinity as CaCO3 (mg/L)
13020177 (Alluvium)

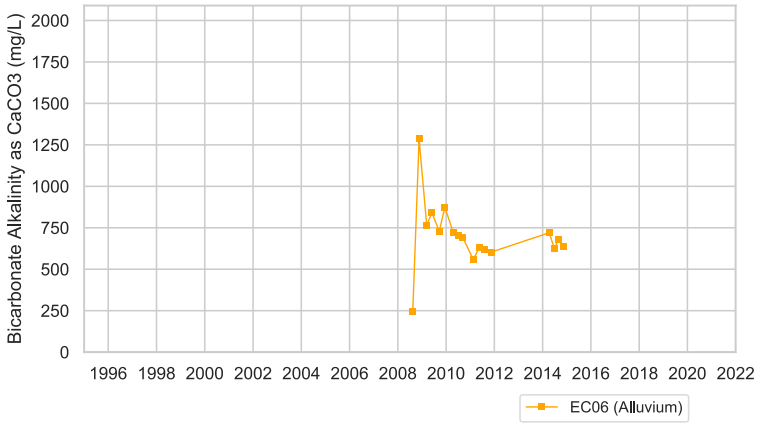

Bicarbonate Alkalinity as CaCO3 (mg/L)
EC01 (Alluvium)

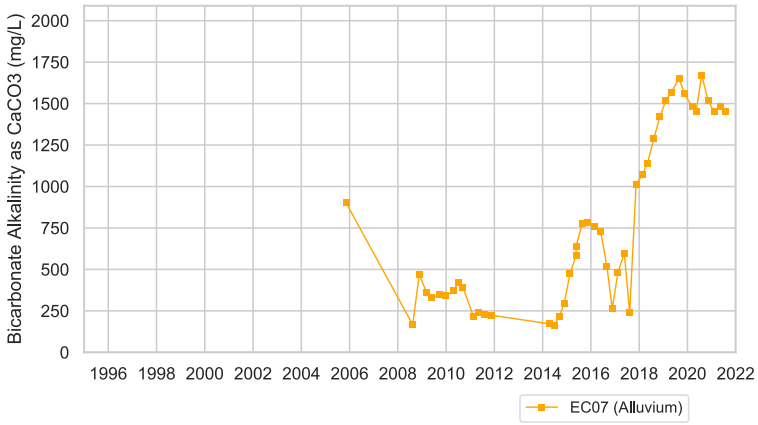

Bicarbonate Alkalinity as CaCO3 (mg/L)
EC02 (Alluvium)

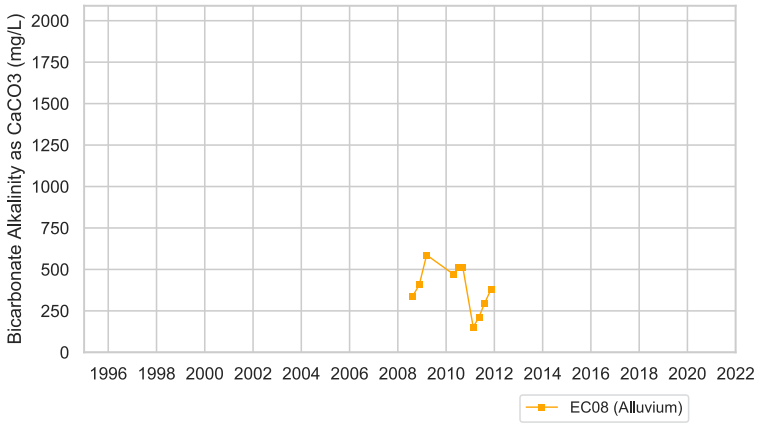

Bicarbonate Alkalinity as CaCO3 (mg/L)
EC03 (Alluvium)

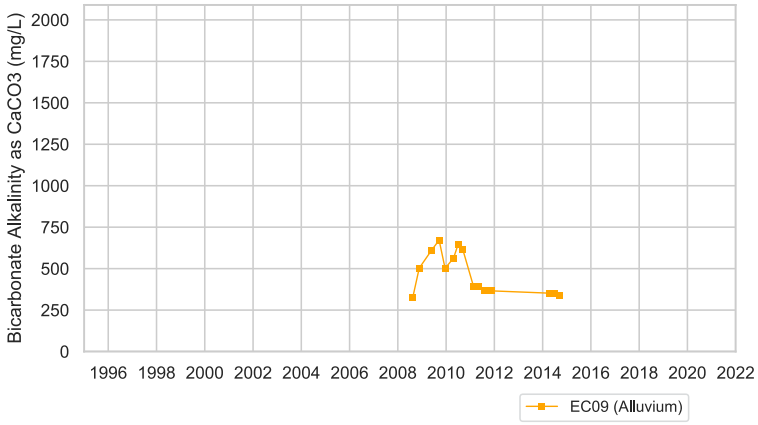

Bicarbonate Alkalinity as CaCO3 (mg/L)
EC04 (Alluvium)

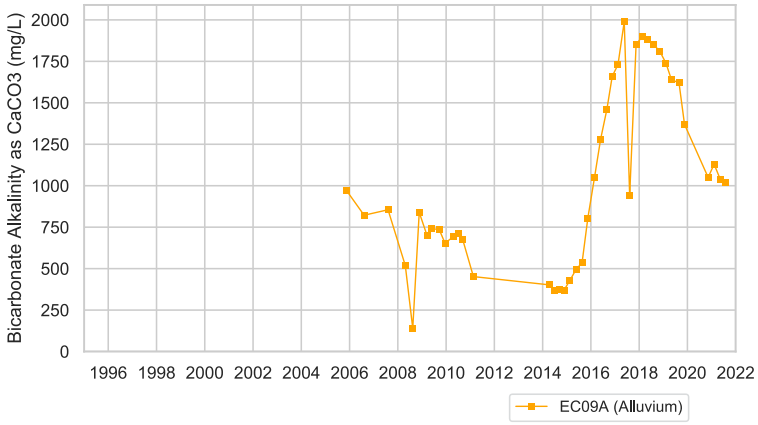

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

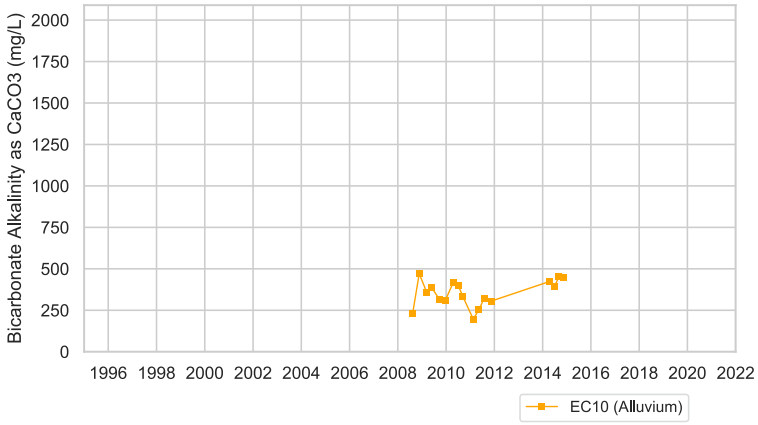

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

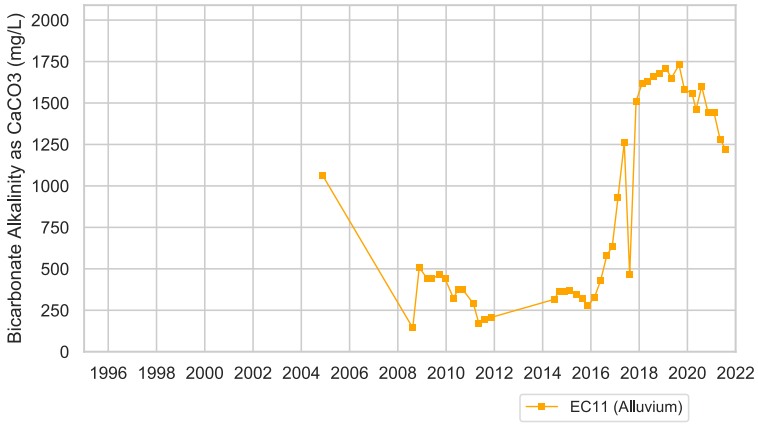

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

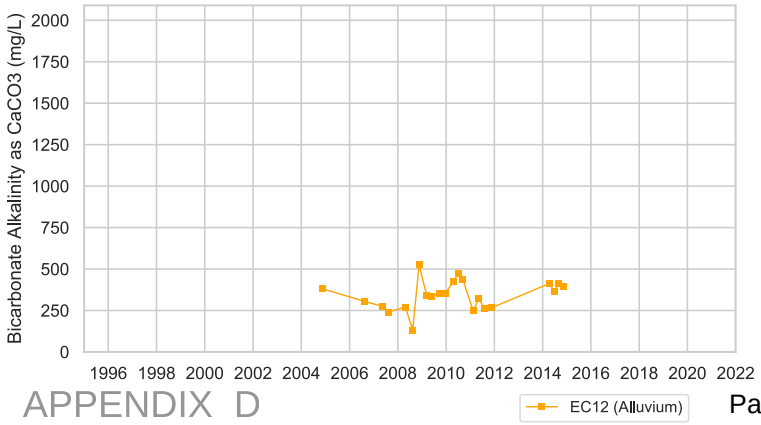

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

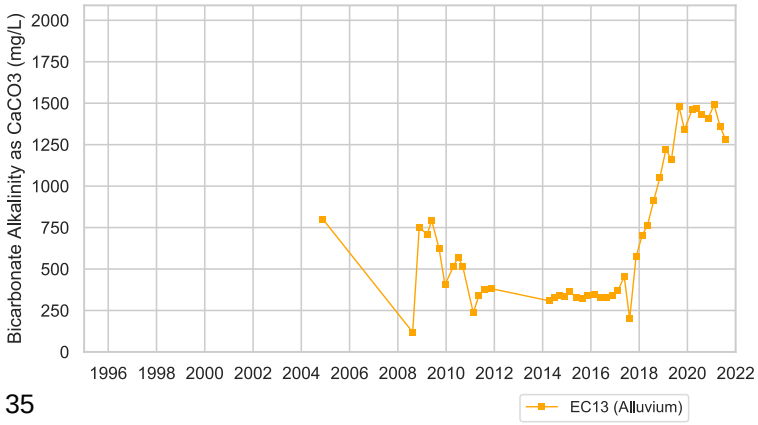

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

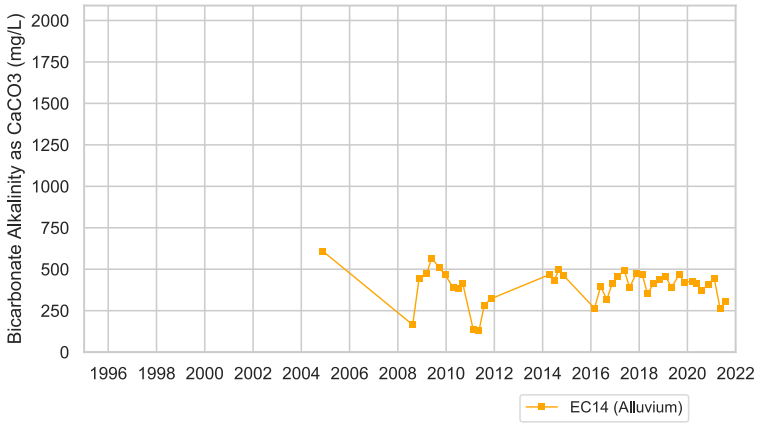

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

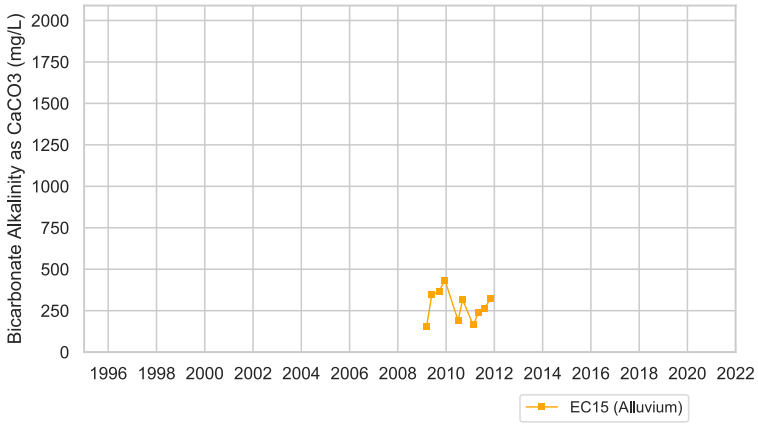

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

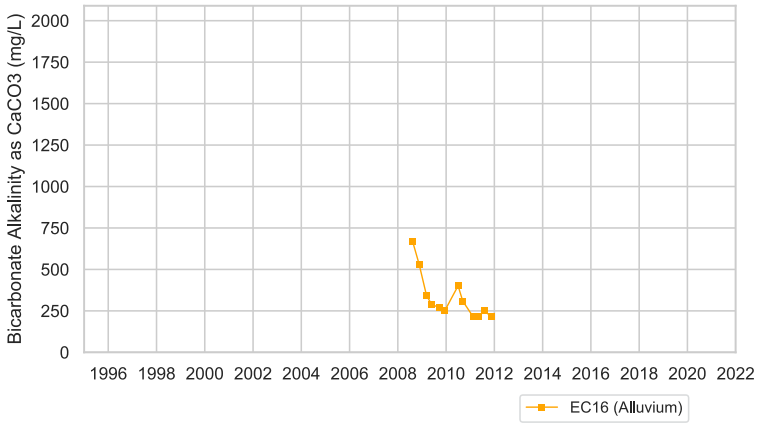

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

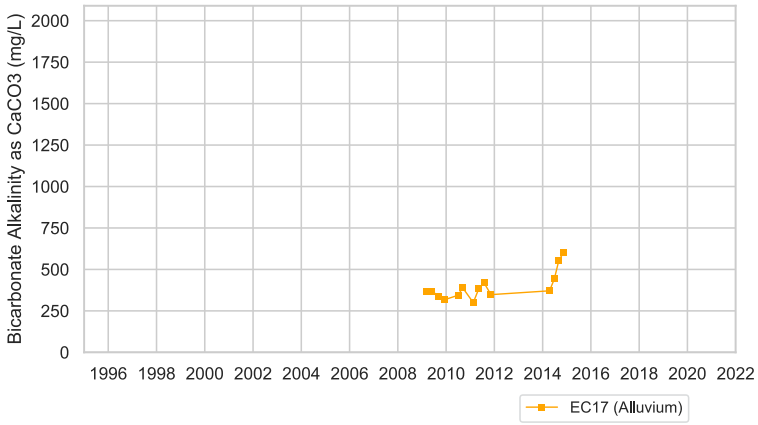

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

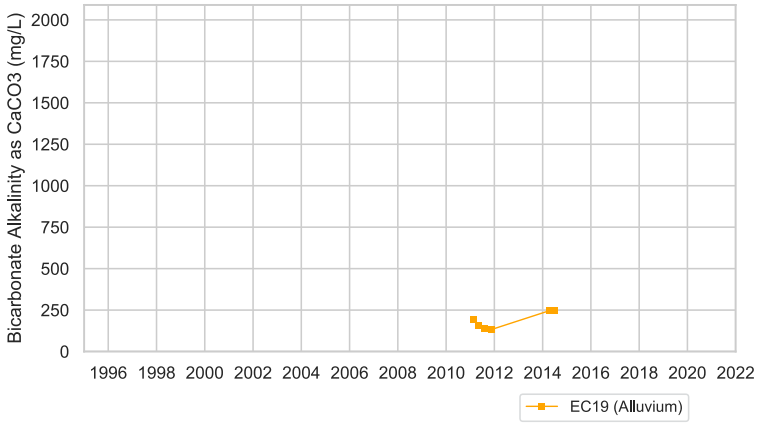

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

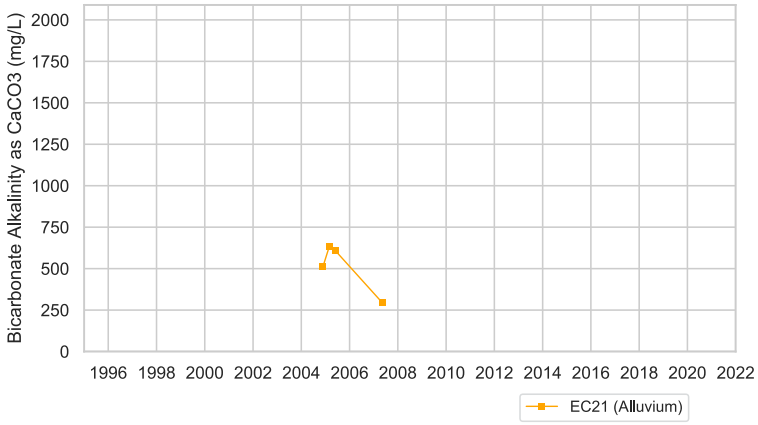

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

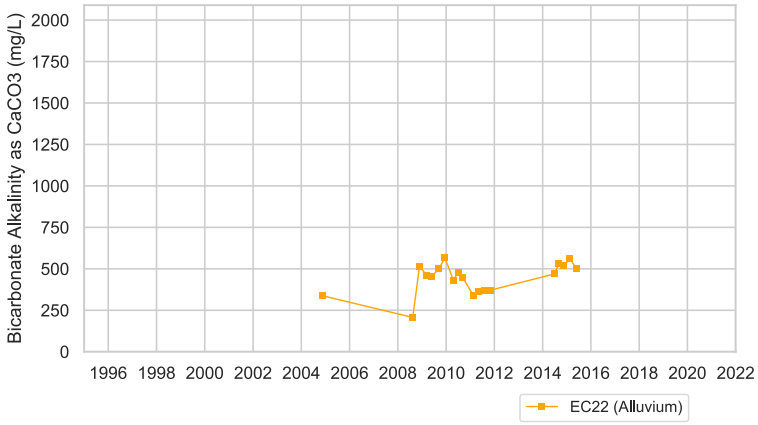

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

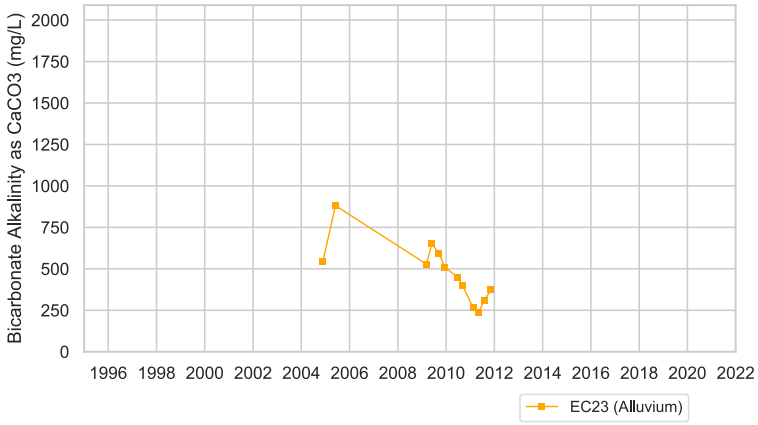

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

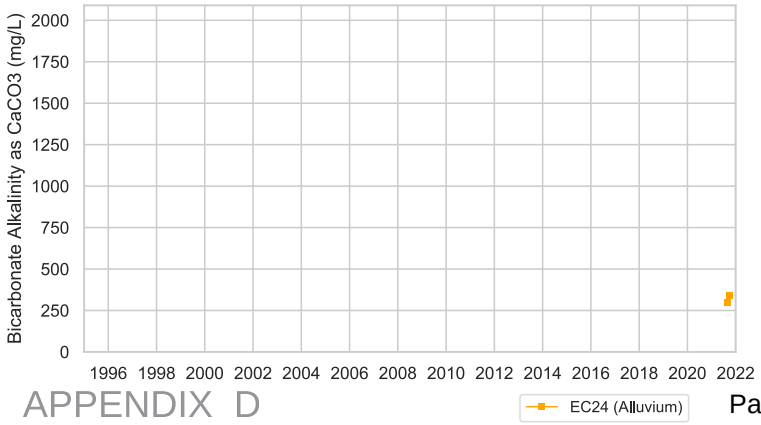

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

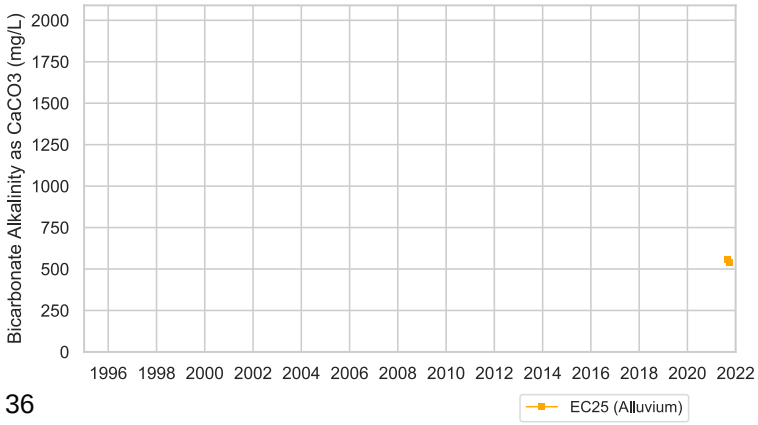

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

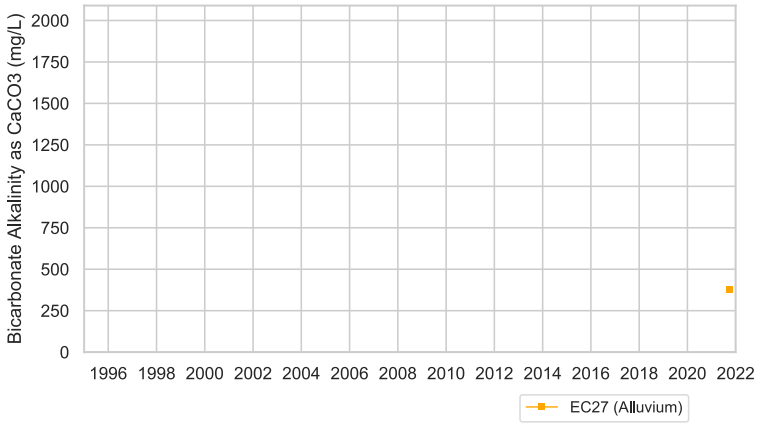

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

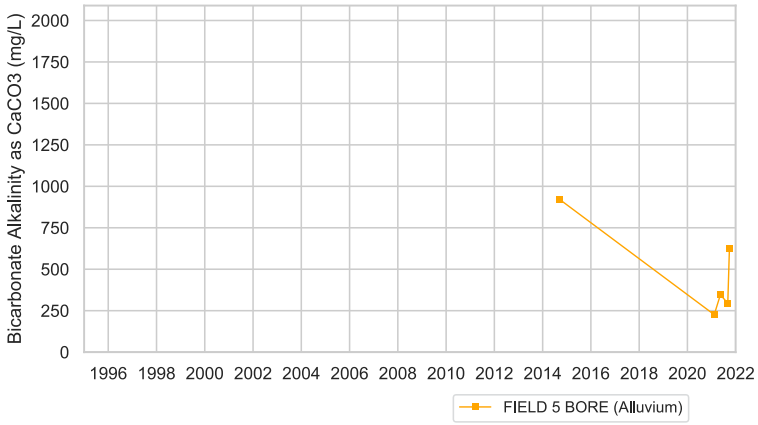

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

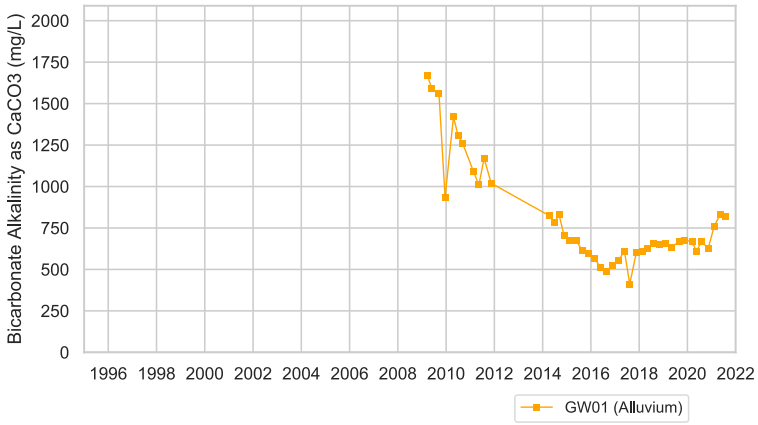

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

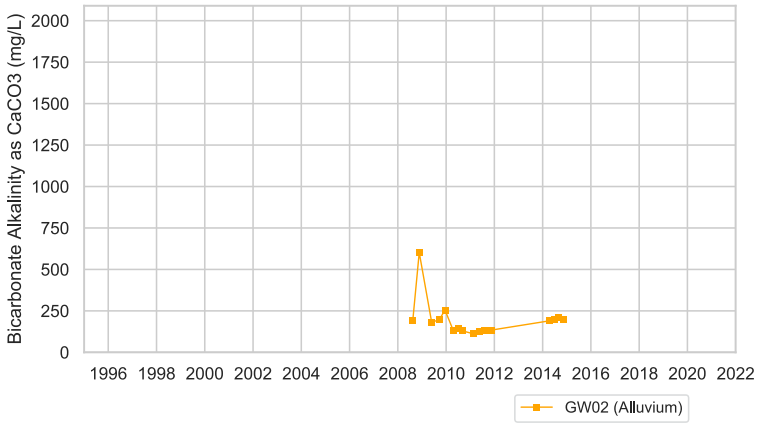

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

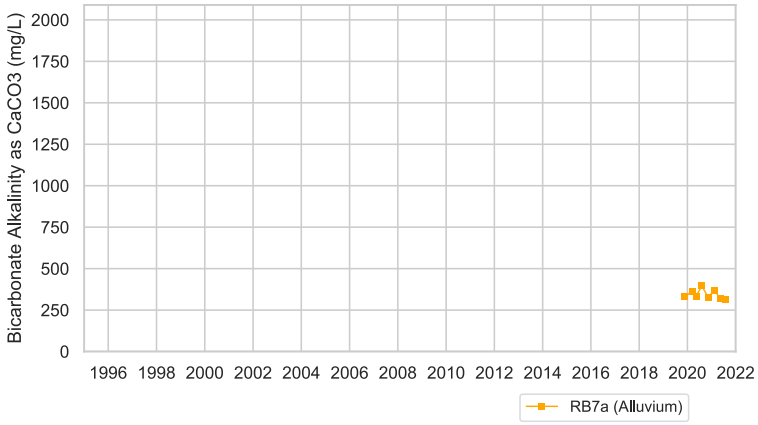

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

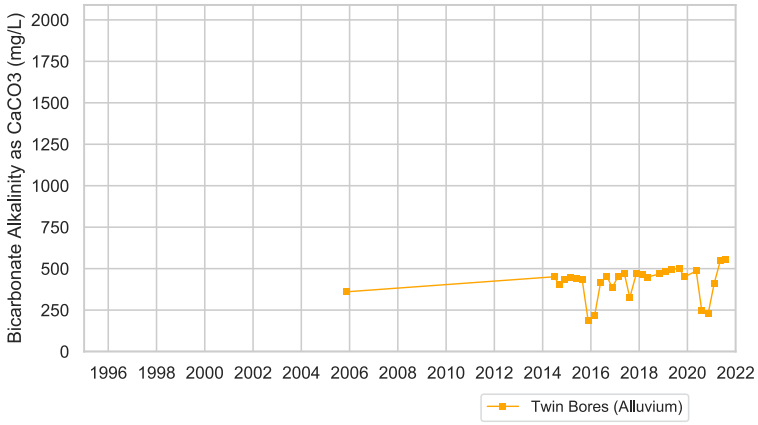

Bicarbonate Alkalinity as CaCO3 (mg/L)
EC27 (Alluvium)

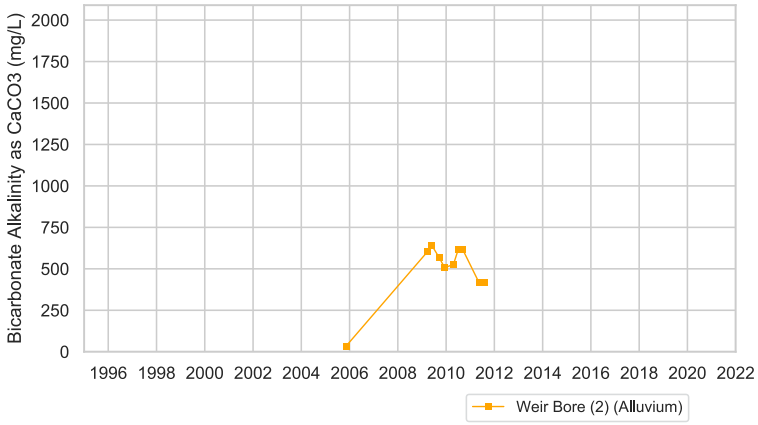

Bicarbonate Alkalinity as CaCO3 (mg/L)
FIELD 5 BORE (Alluvium)

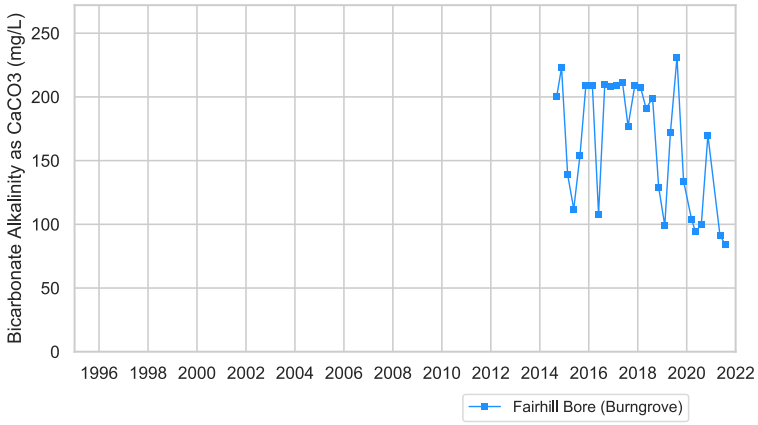

Bicarbonate Alkalinity as CaCO3 (mg/L)
GW01 (Alluvium)

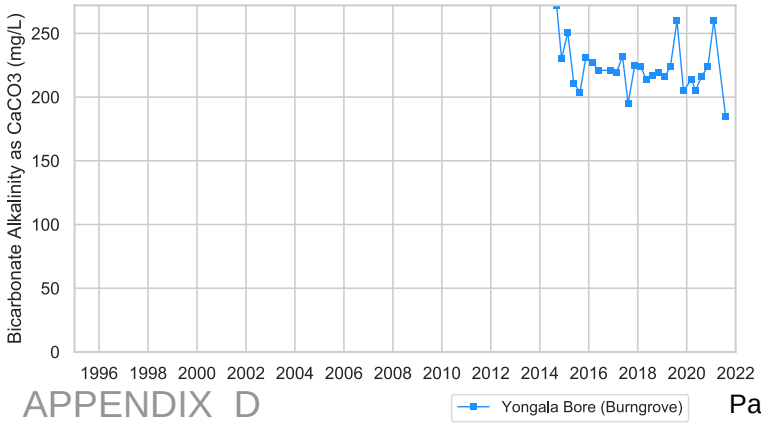

Bicarbonate Alkalinity as CaCO3 (mg/L)
GW02 (Alluvium)

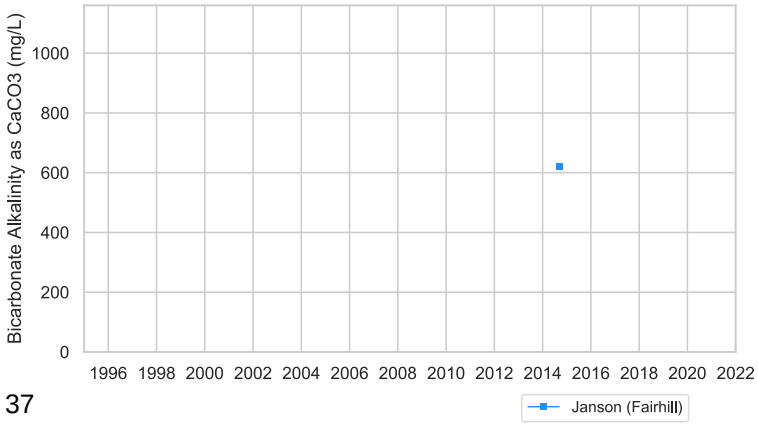

Bicarbonate Alkalinity as CaCO3 (mg/L)
RB7a (Alluvium)

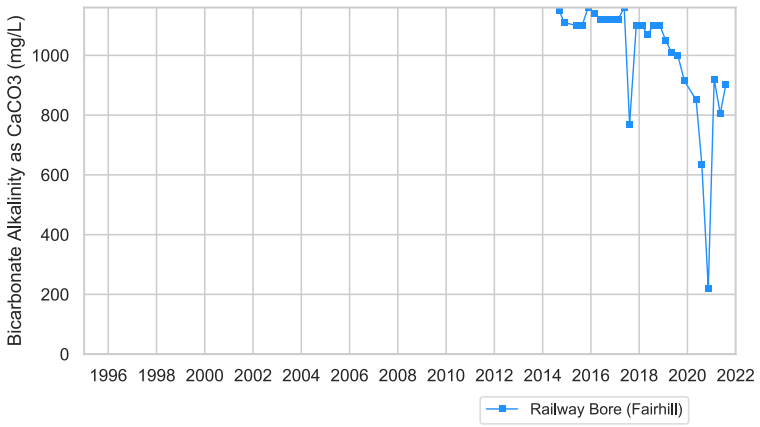

Bicarbonate Alkalinity as CaCO3 (mg/L)
Twin Bores (Alluvium)

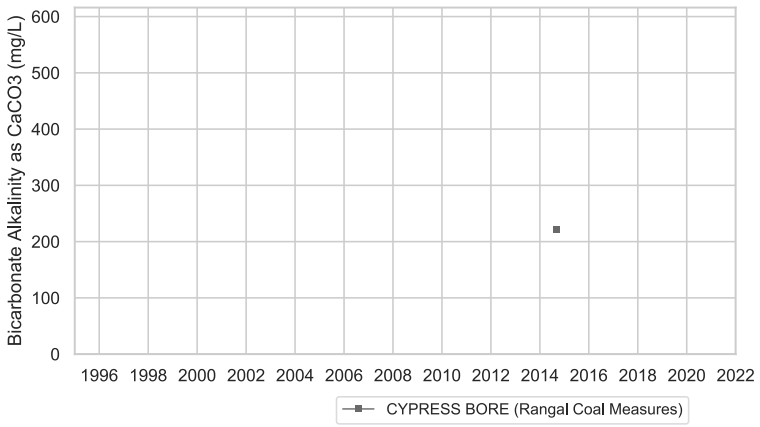

Bicarbonate Alkalinity as CaCO3 (mg/L)
Weir Bore (2) (Alluvium)

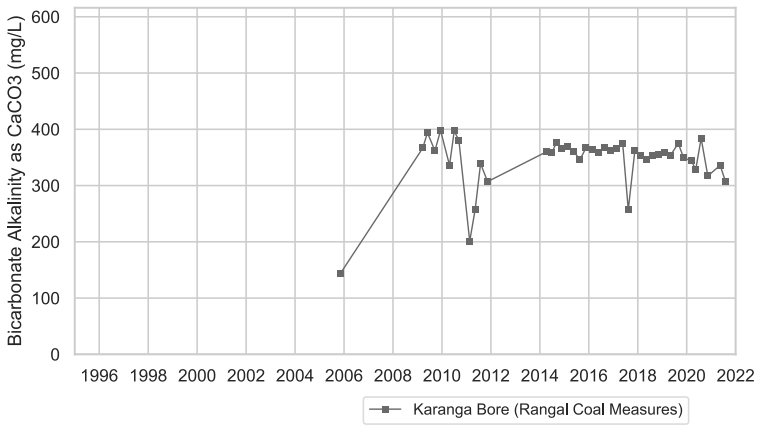

Bicarbonate Alkalinity as CaCO3 (mg/L)
Fairhill Bore (Burngrove)

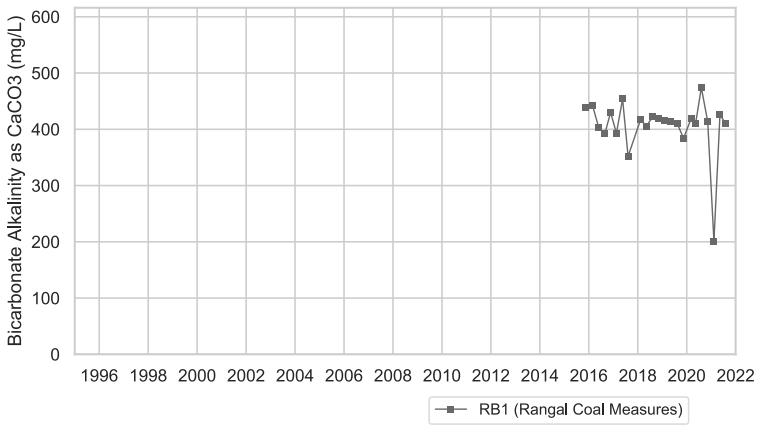

Bicarbonate Alkalinity as CaCO3 (mg/L)
Yongala Bore (Burngrove)

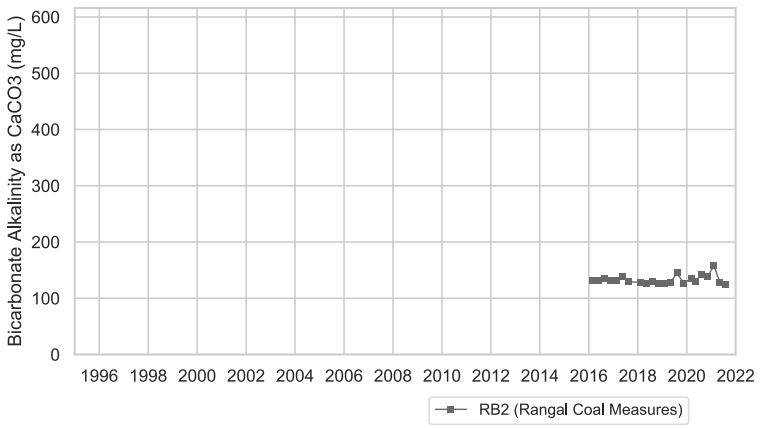

Bicarbonate Alkalinity as CaCO3 (mg/L)
Janson (Fairhill)

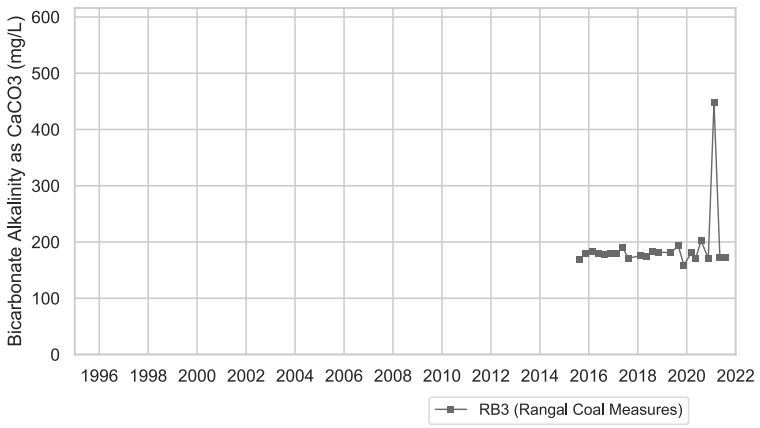

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

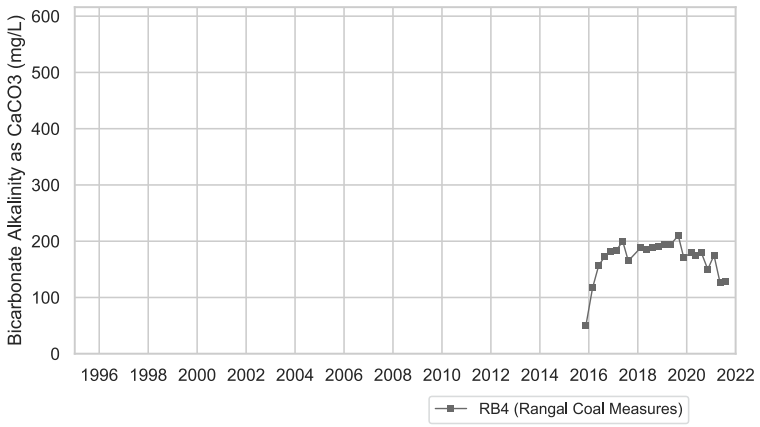

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

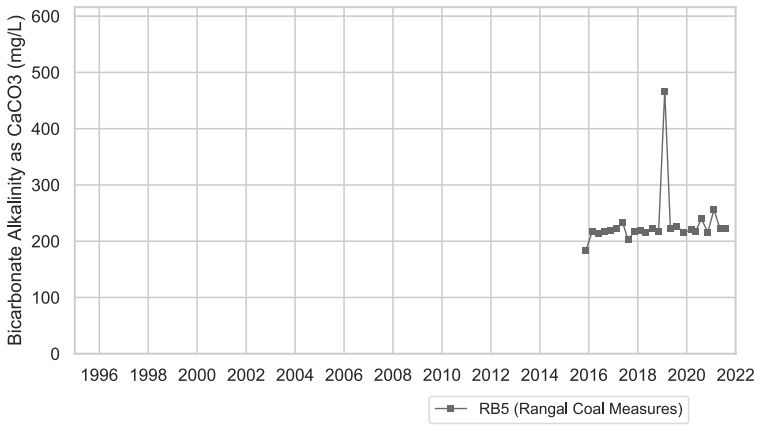

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

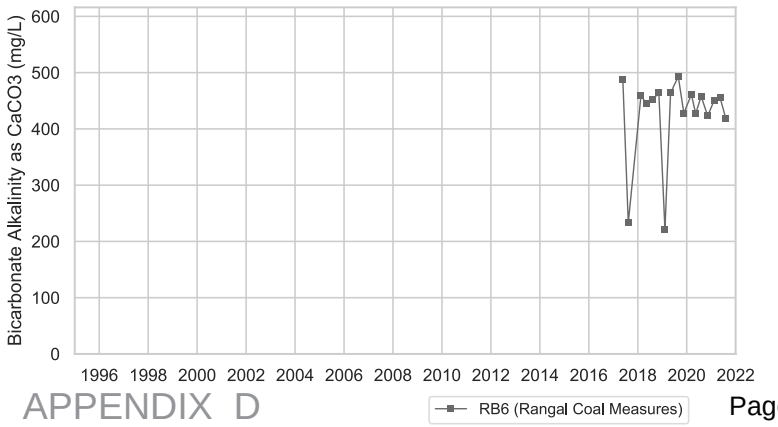

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

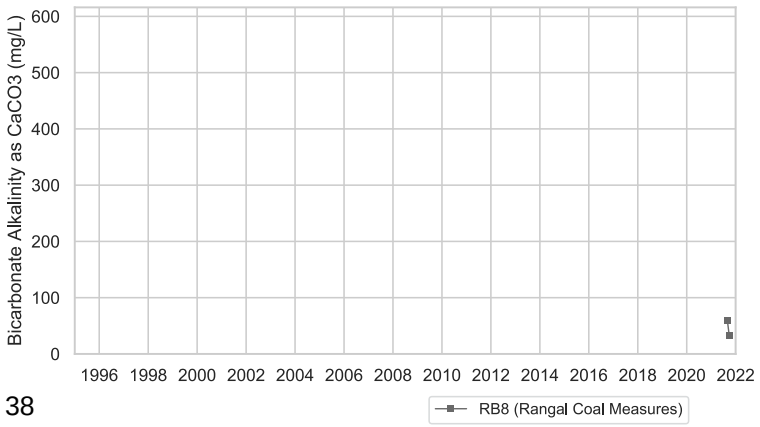

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

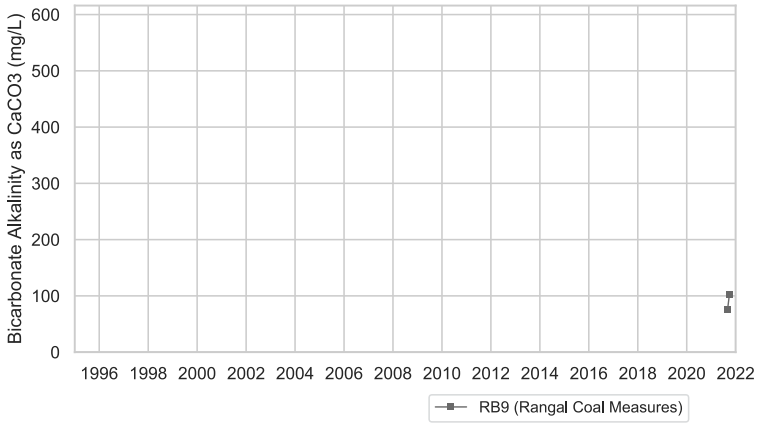

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

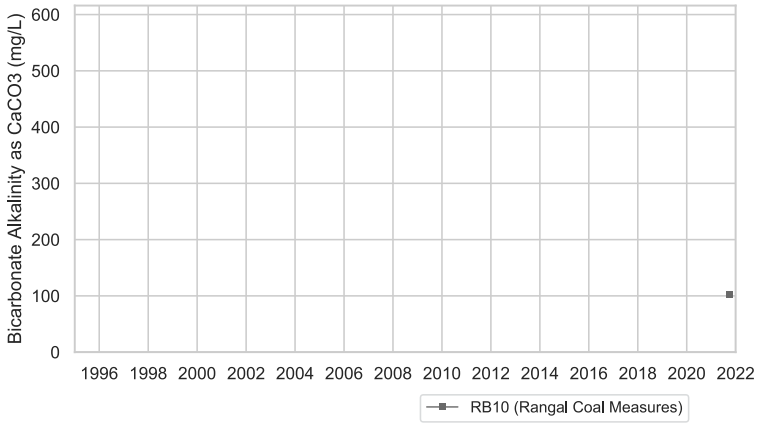

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

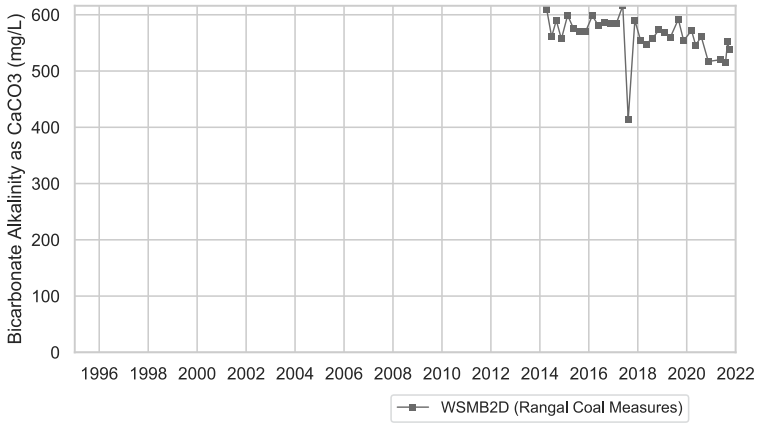

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

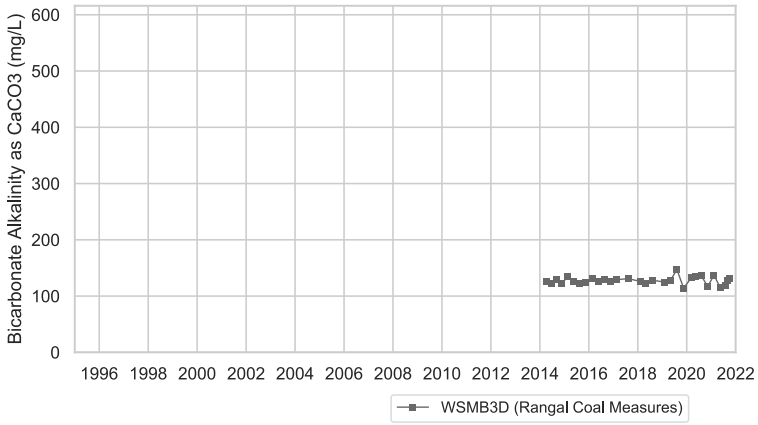

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

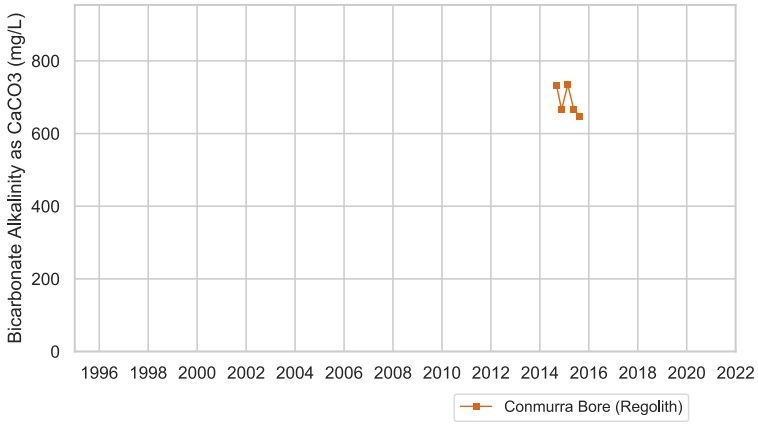

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

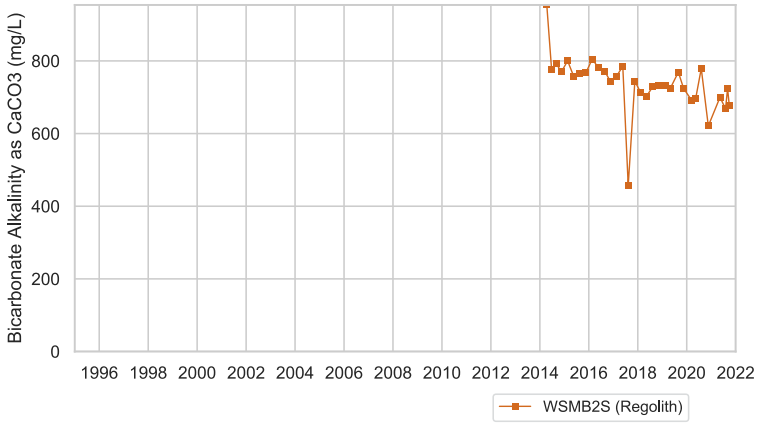

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

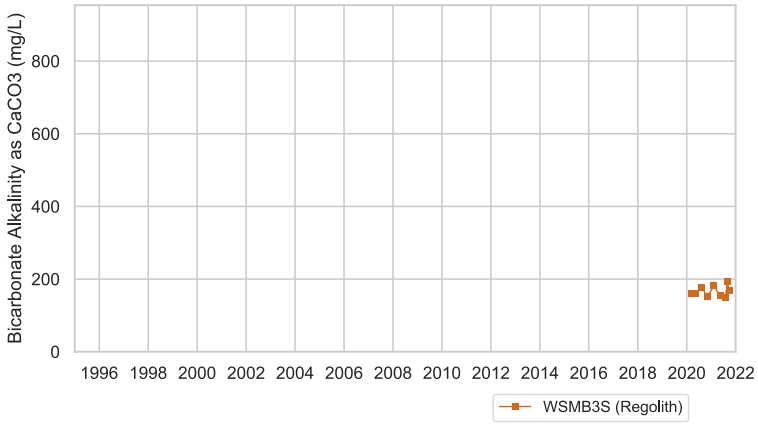

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

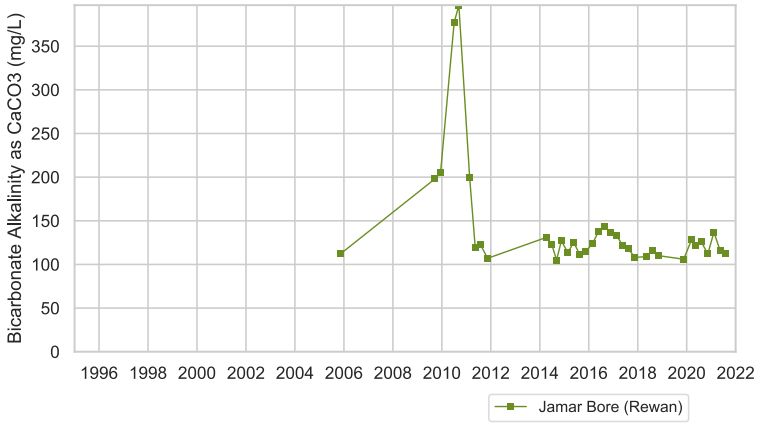

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

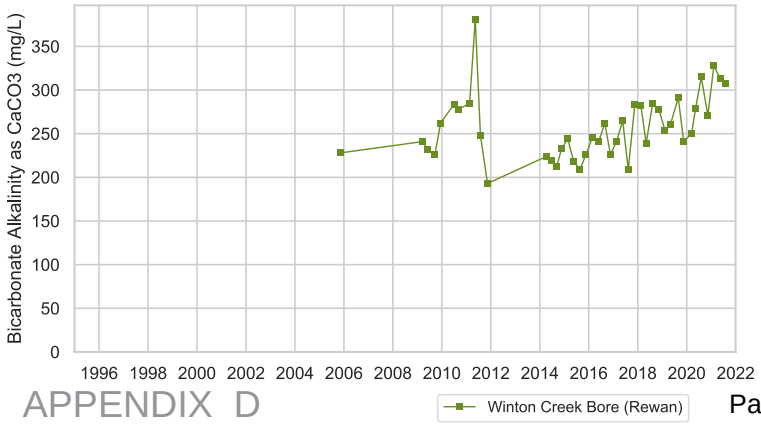

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

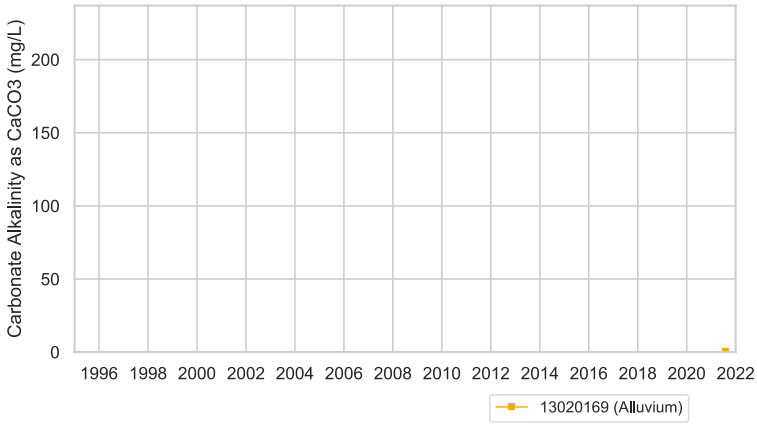

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

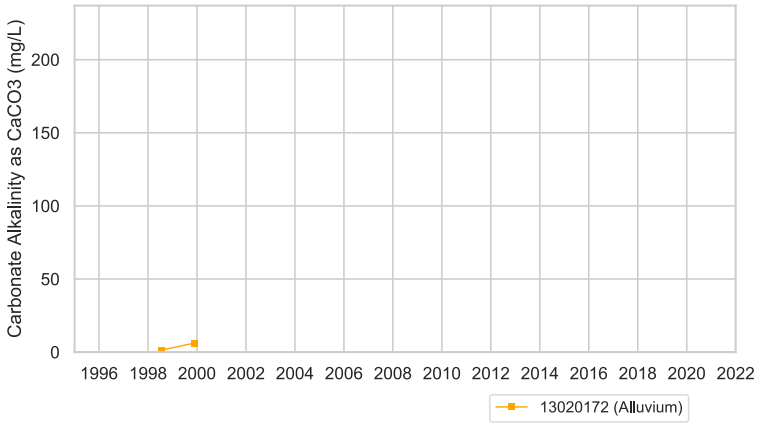

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

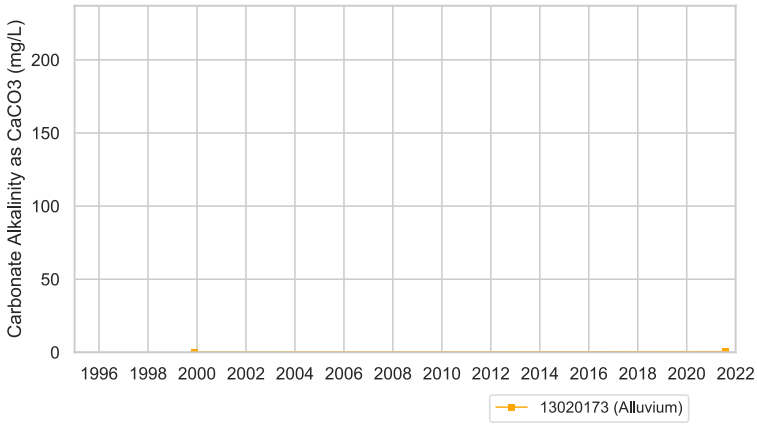

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

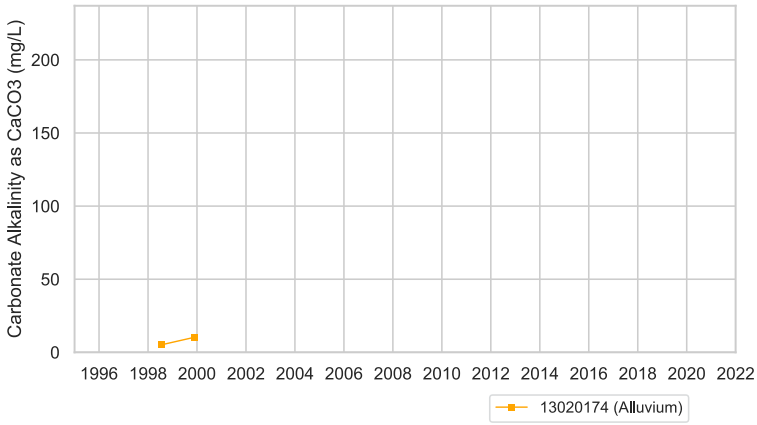

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

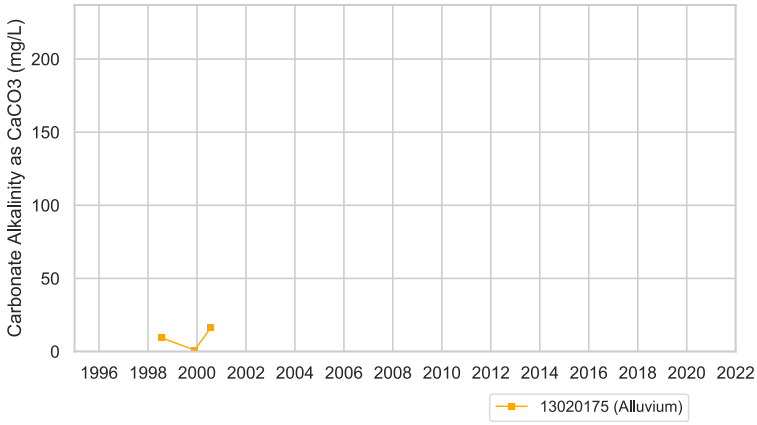

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

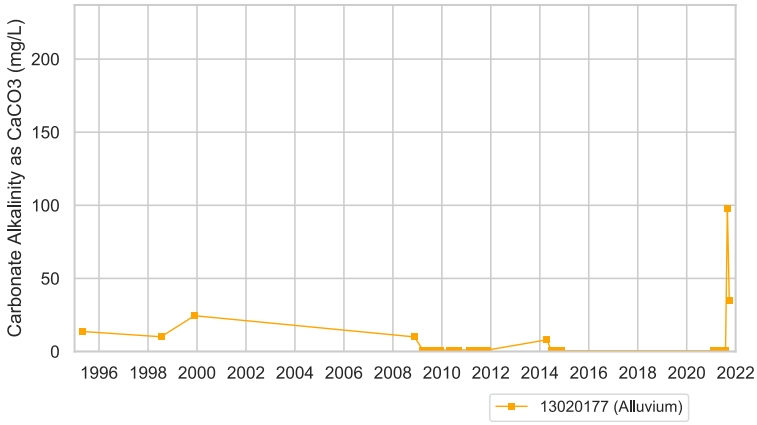

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

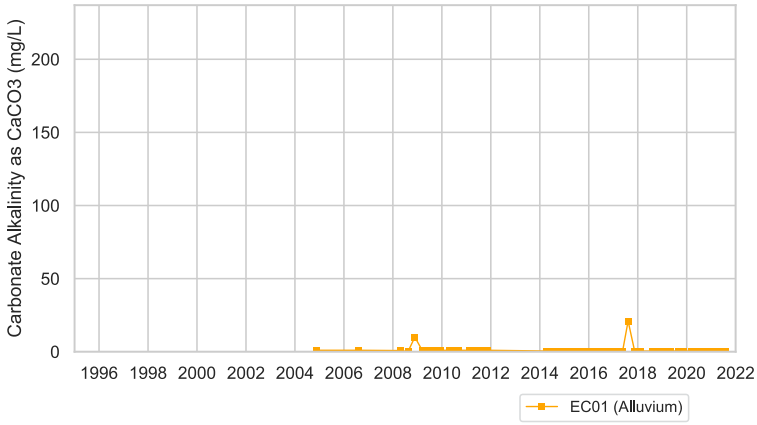

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

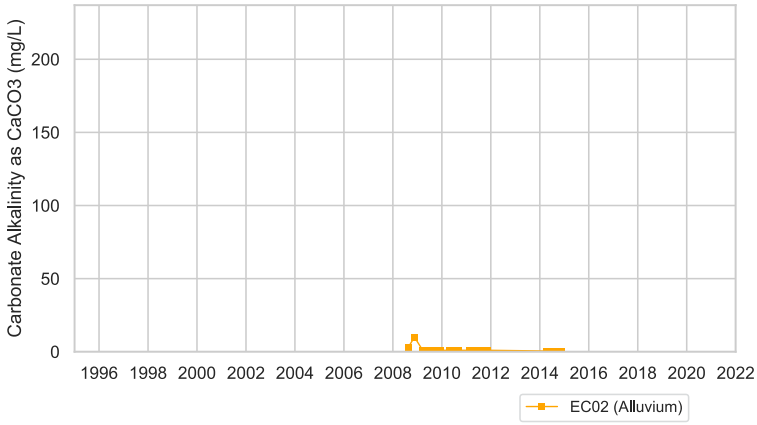

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

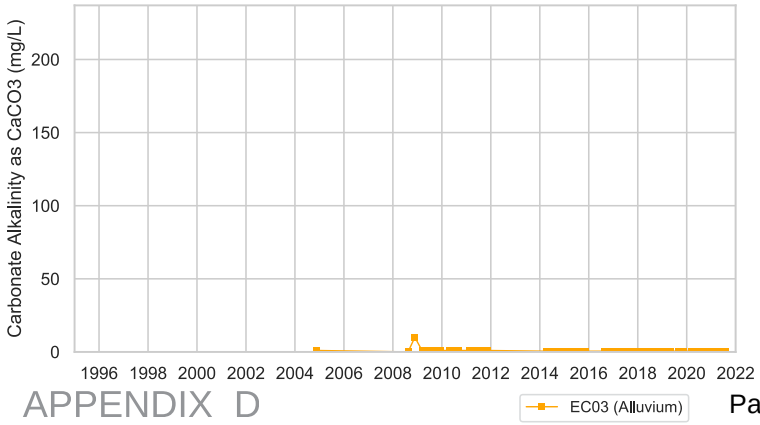

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

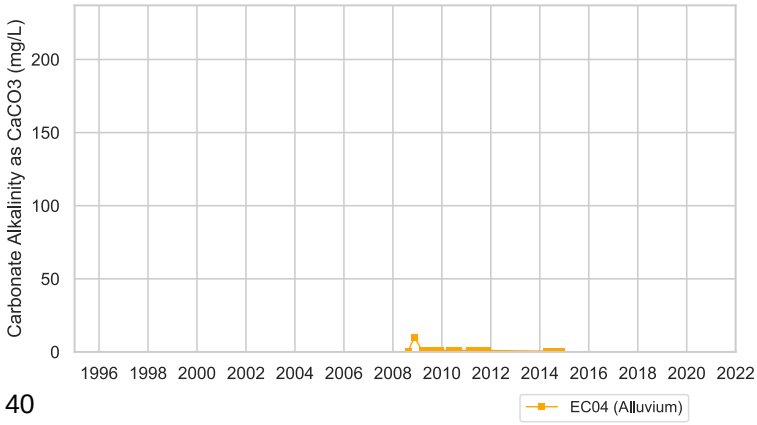

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

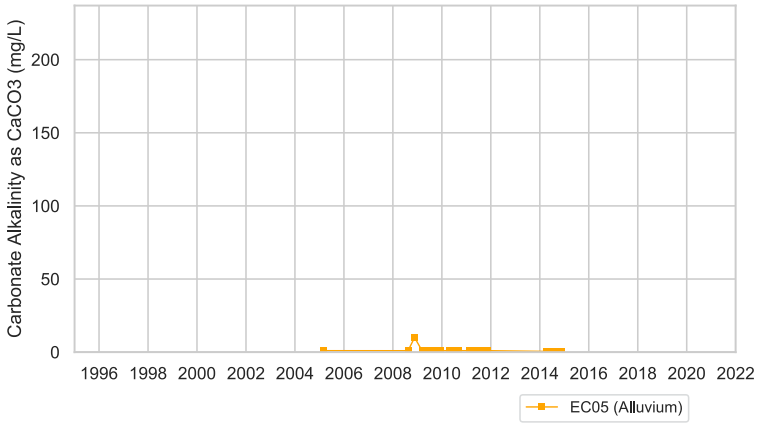

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

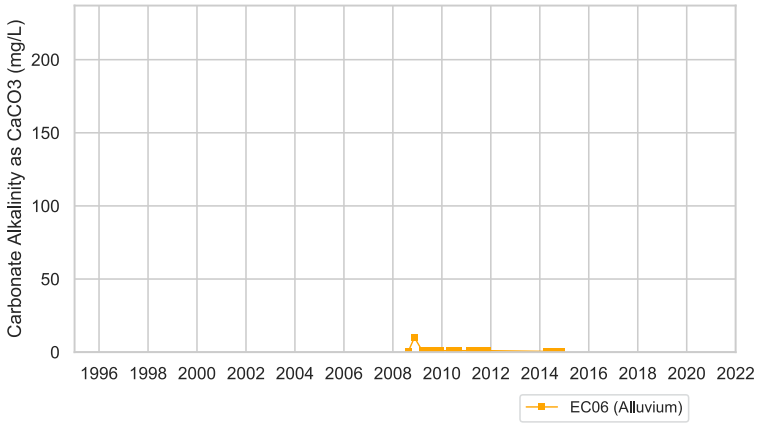

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

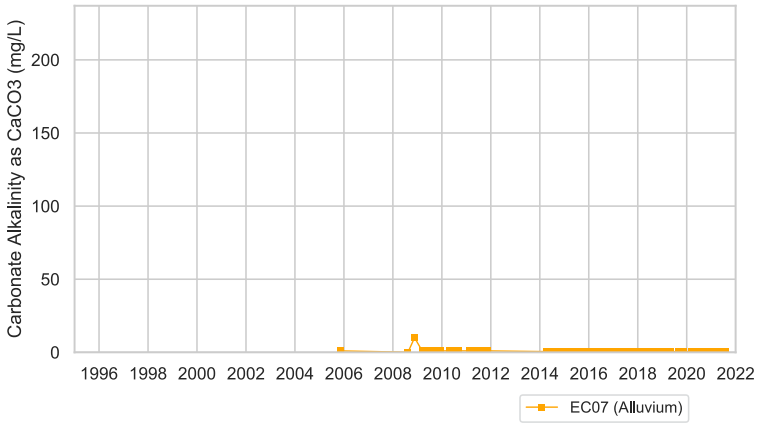

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

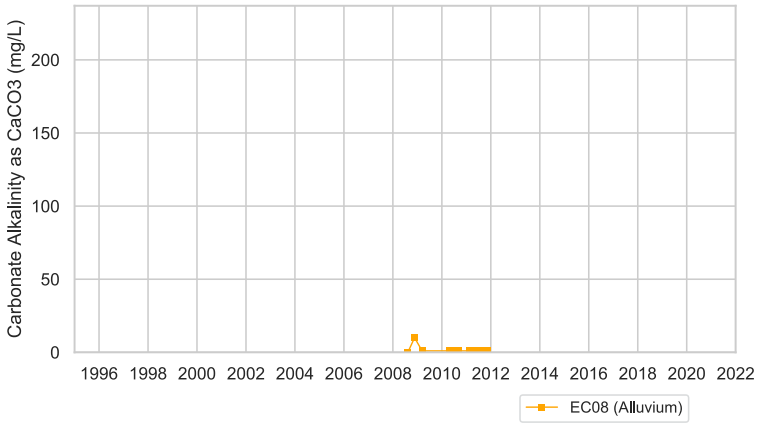

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

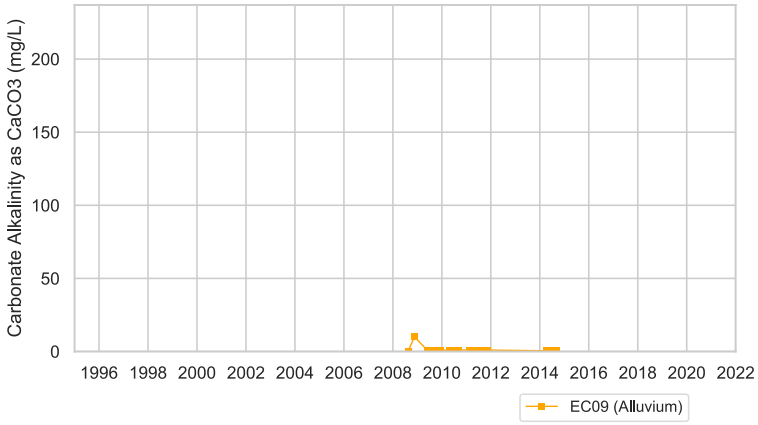

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

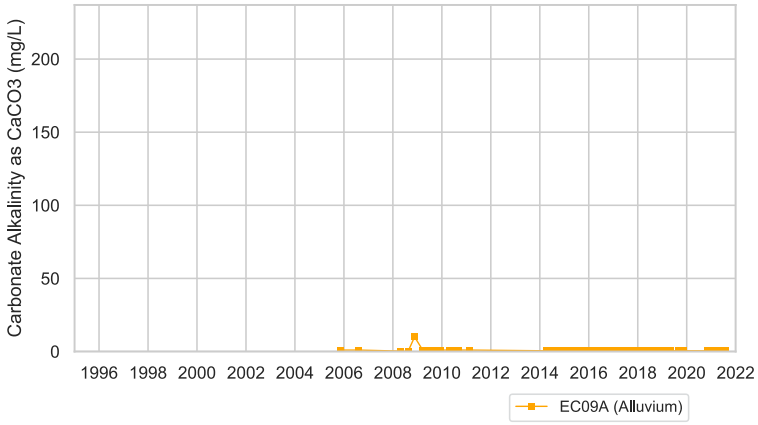

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

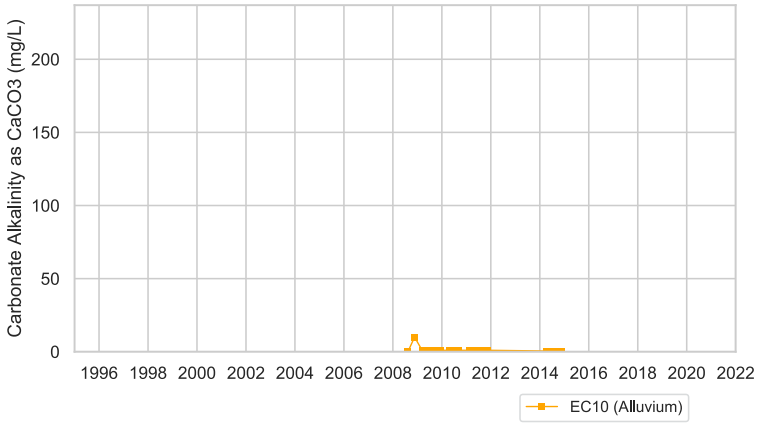

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

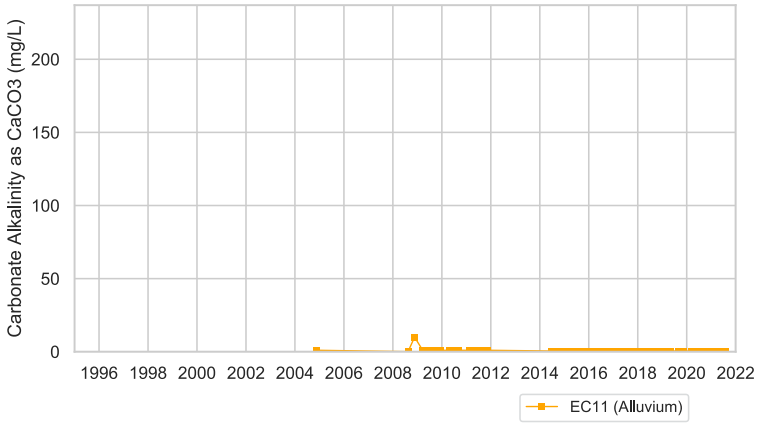

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

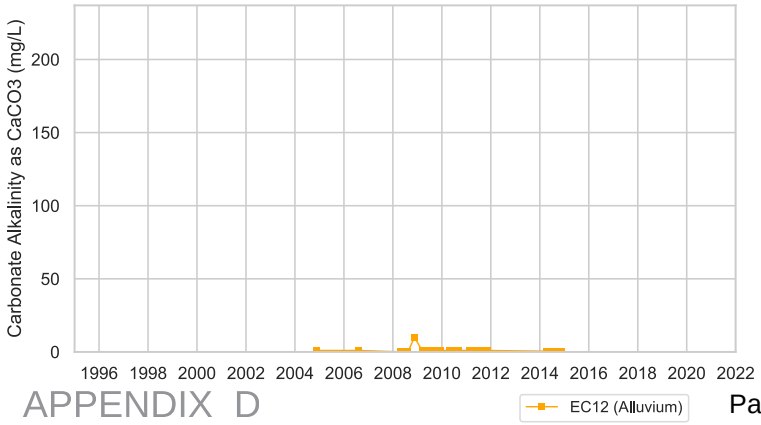

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

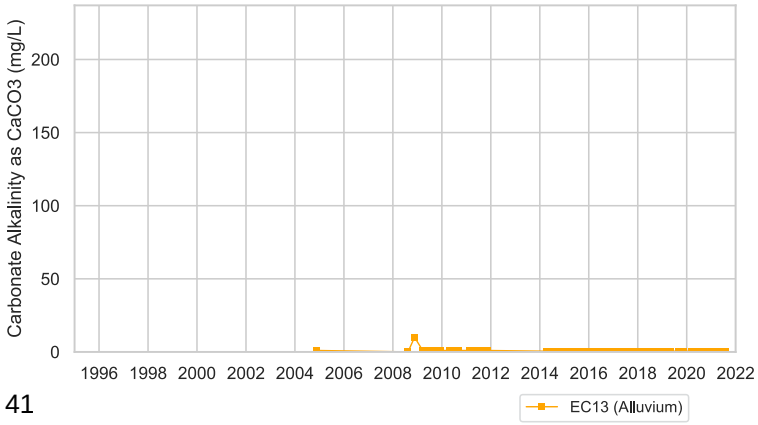

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

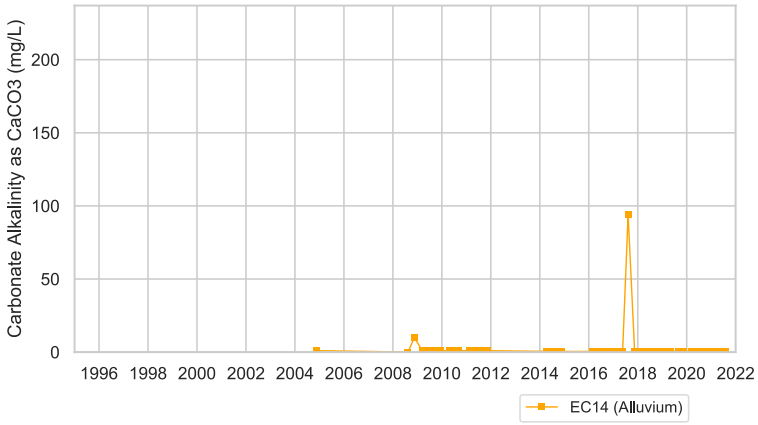

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

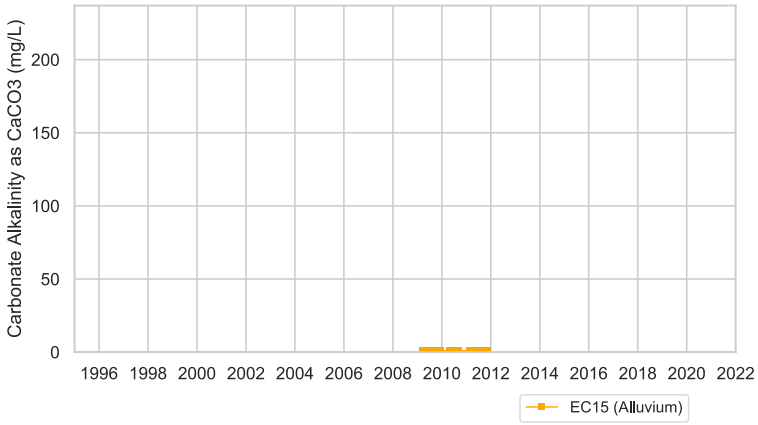

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

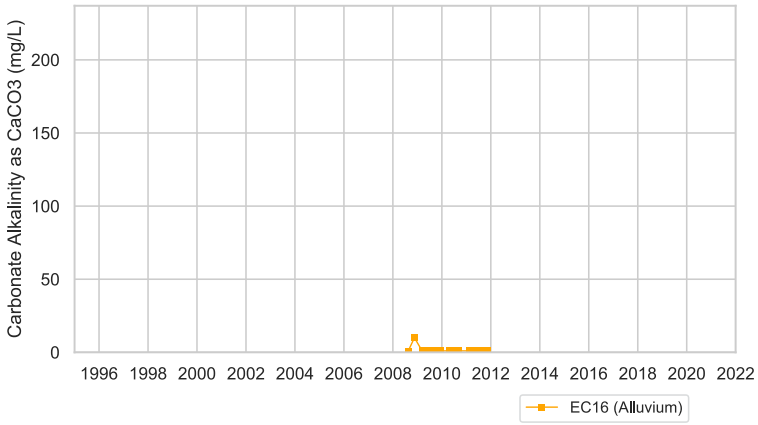

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

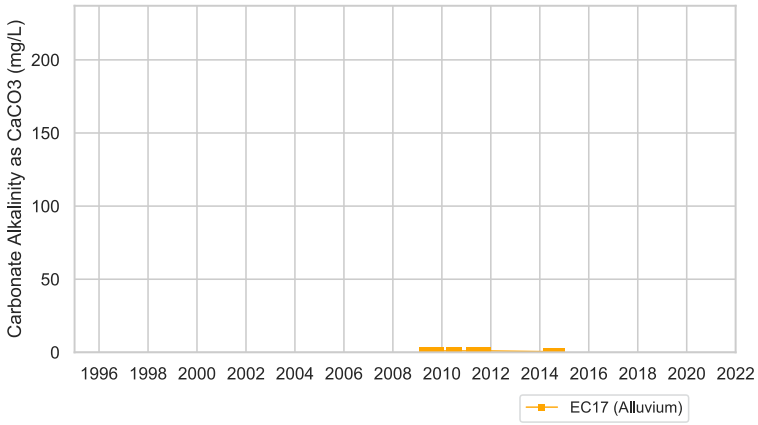

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

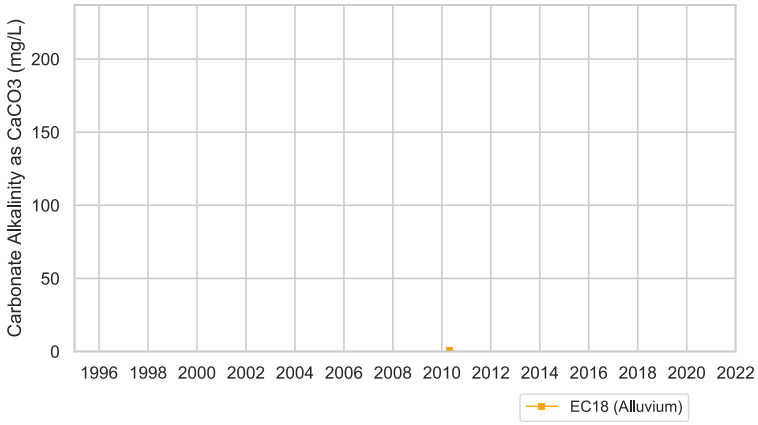

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

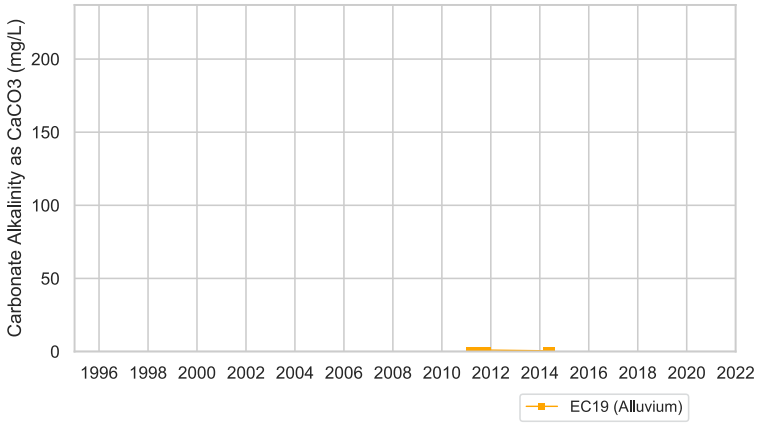

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

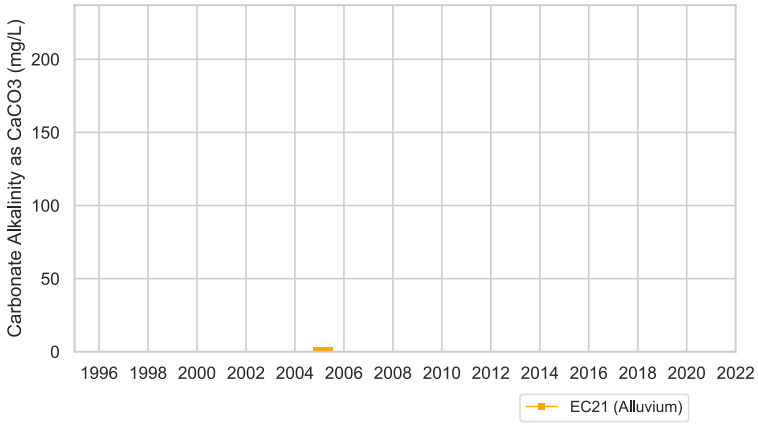

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

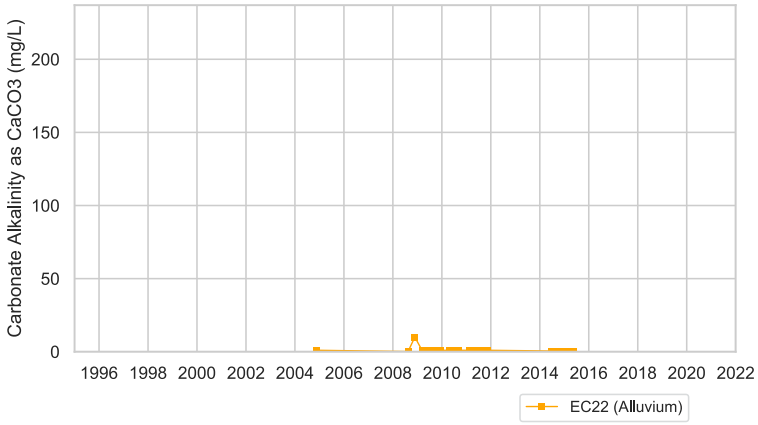

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

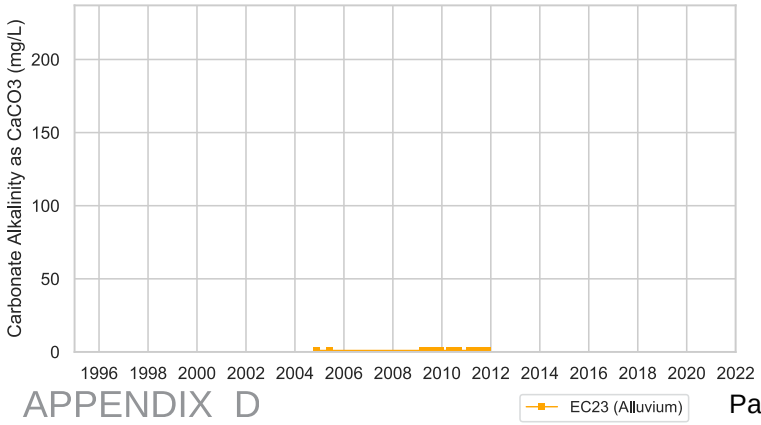

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

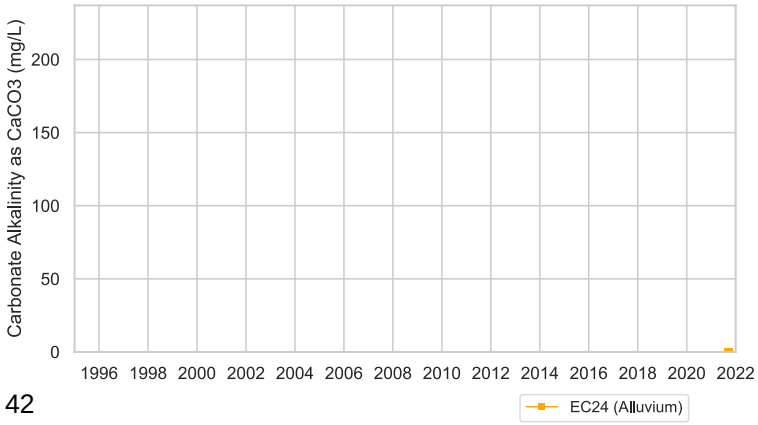

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

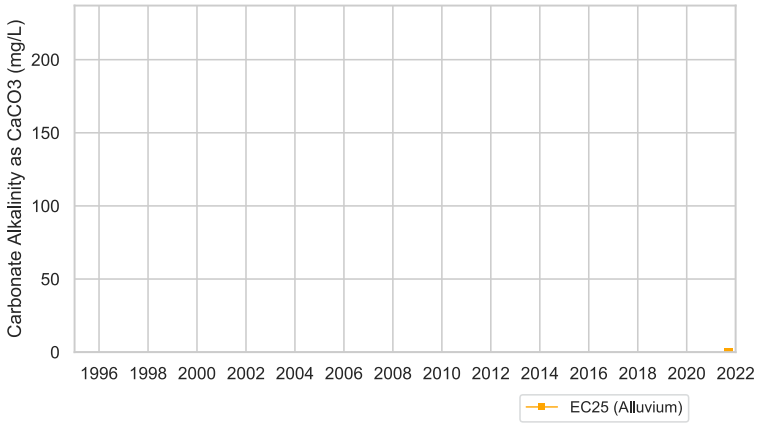

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

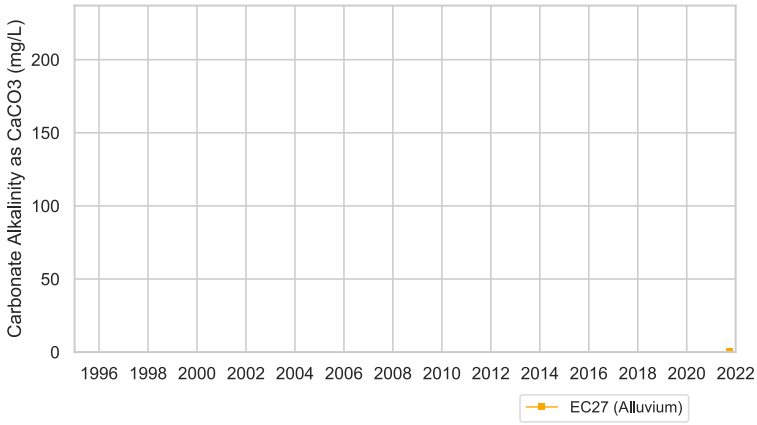

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

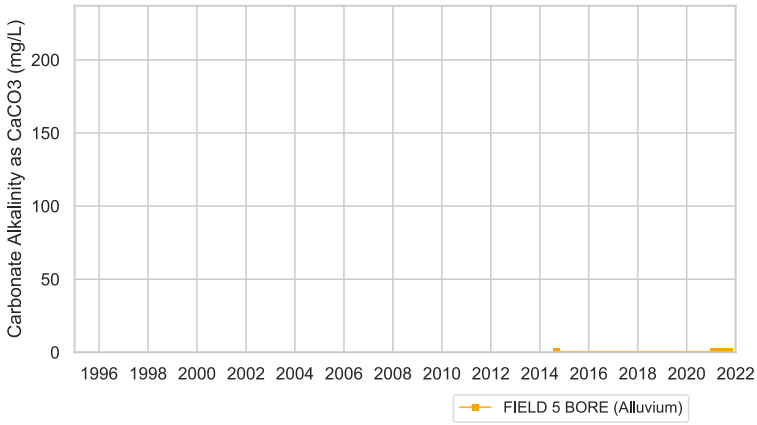

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

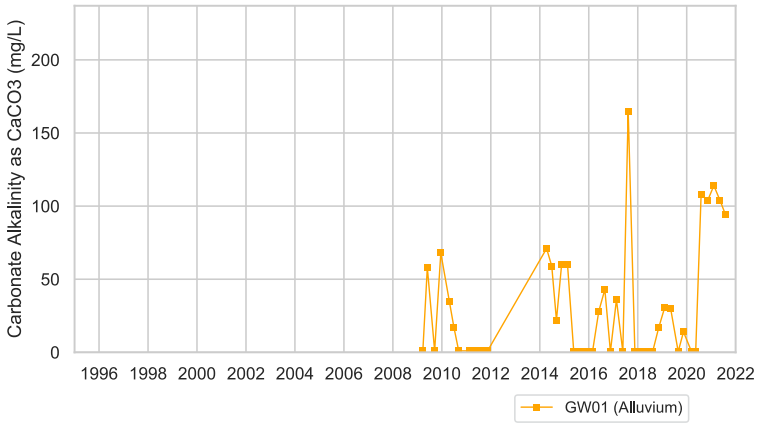

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

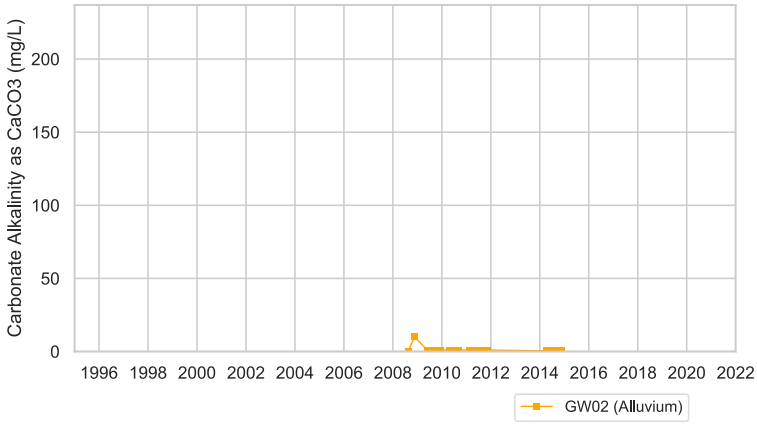

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

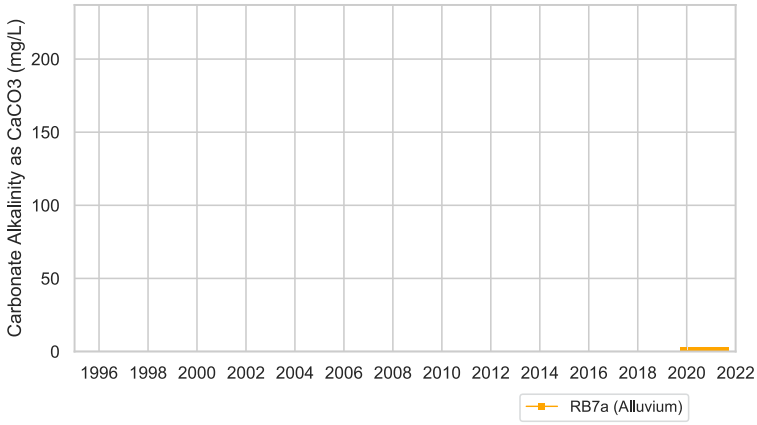

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

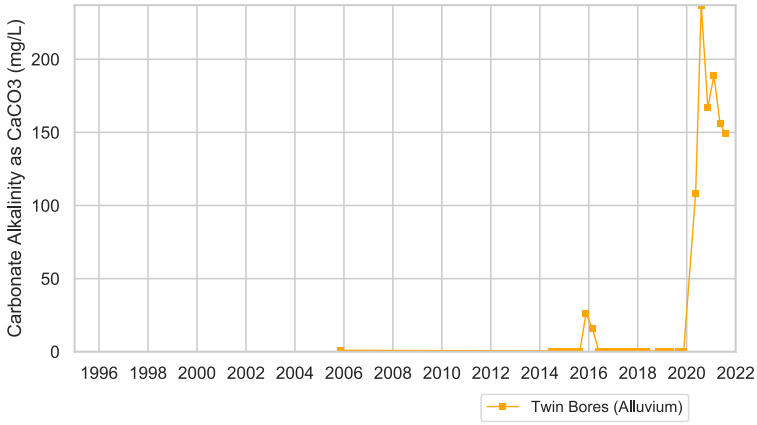

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

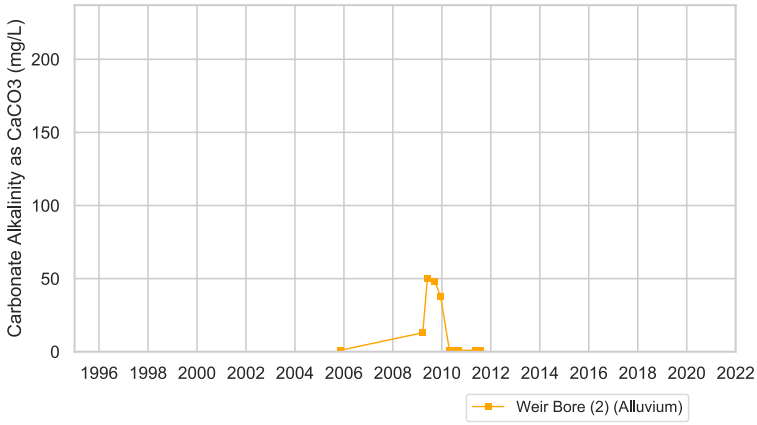

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

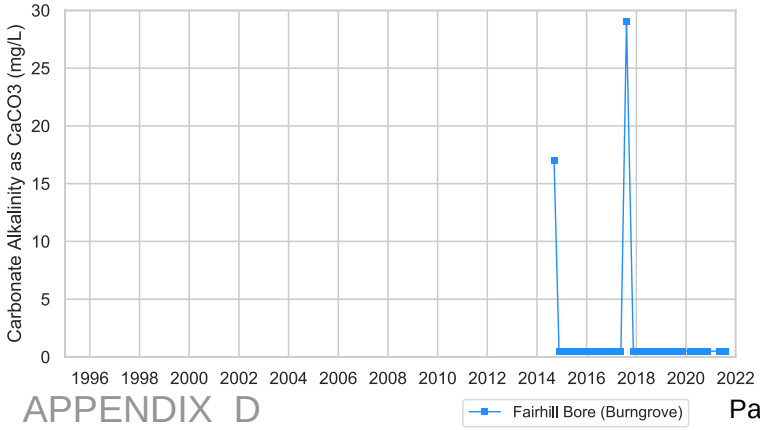

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

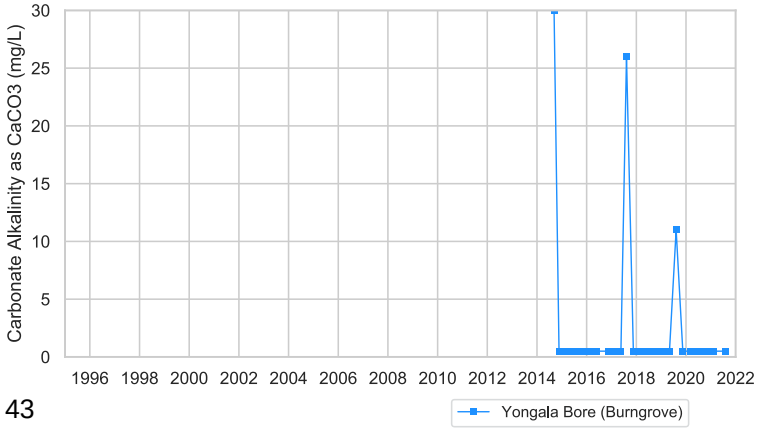

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

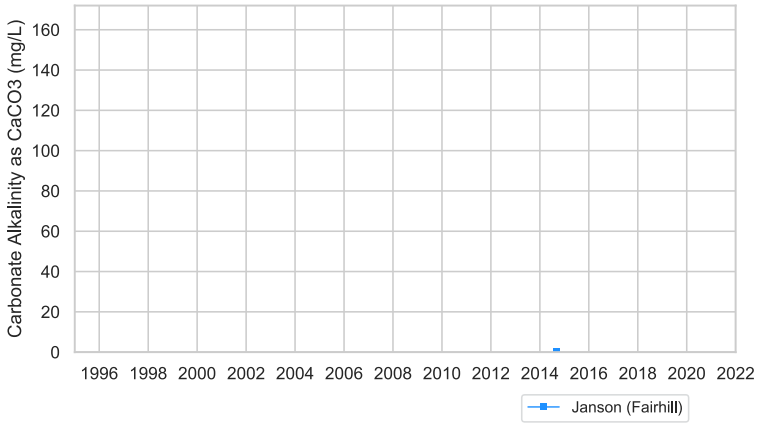

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

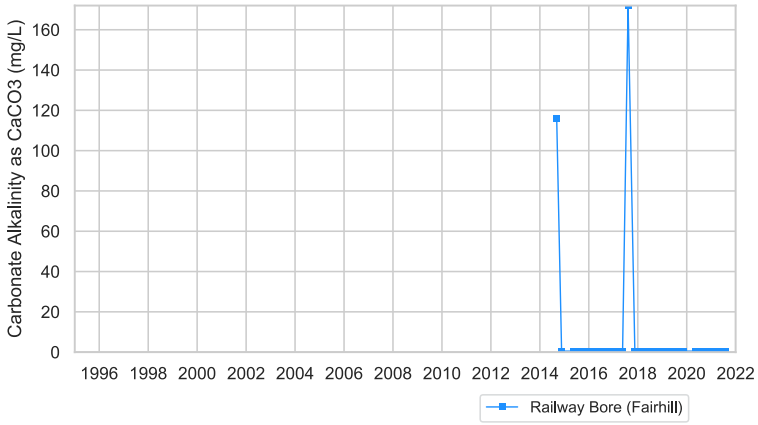

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

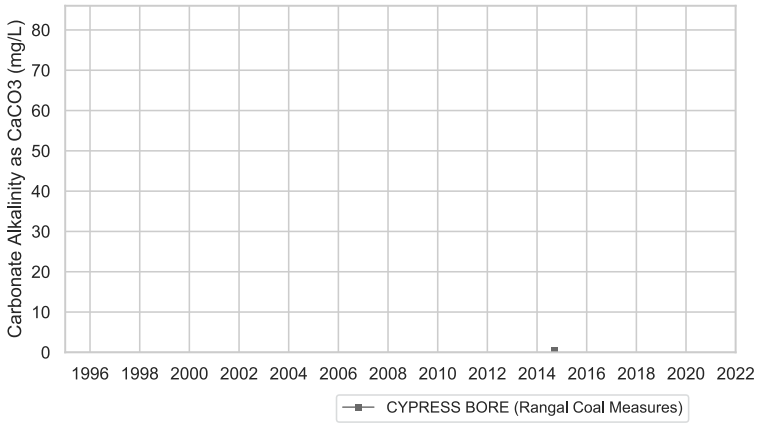

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

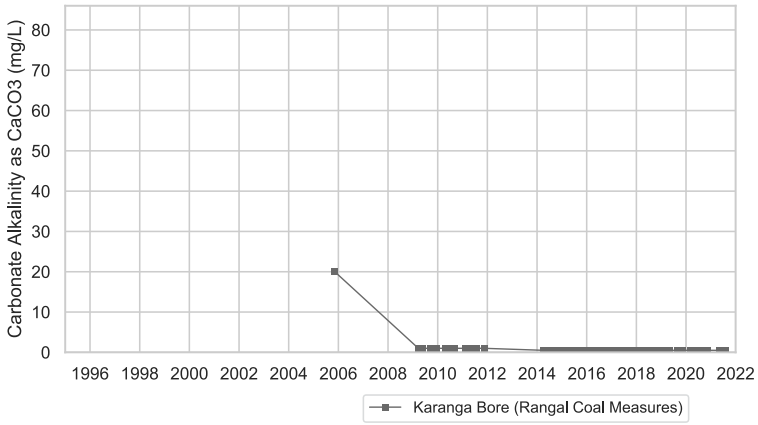

Carbonate Alkalinity as CaCO3 (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

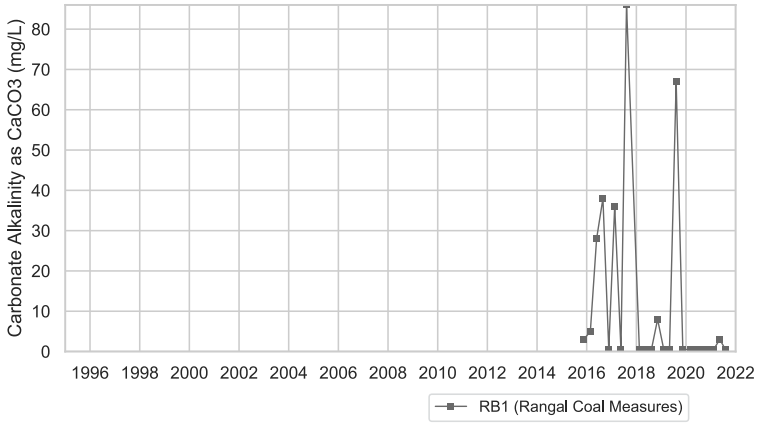

Carbonate Alkalinity as CaCO3 (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

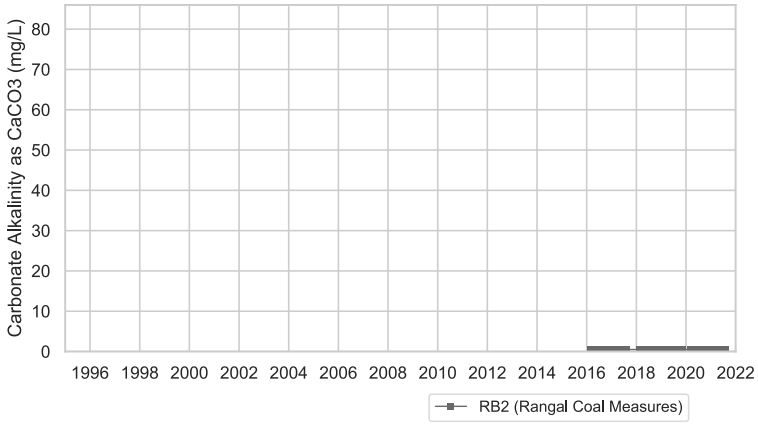

Carbonate Alkalinity as CaCO3 (mg/L)
0 20 40 60 80 100 120 140 160
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

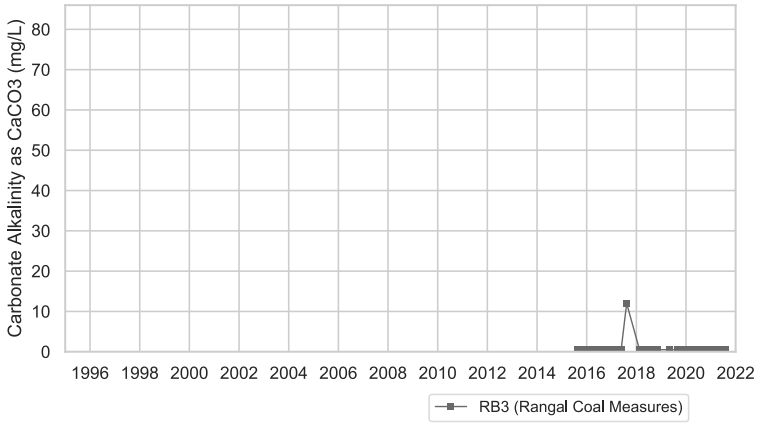

Carbonate Alkalinity as CaCO3 (mg/L)
0 20 40 60 80 100 120 140 160
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

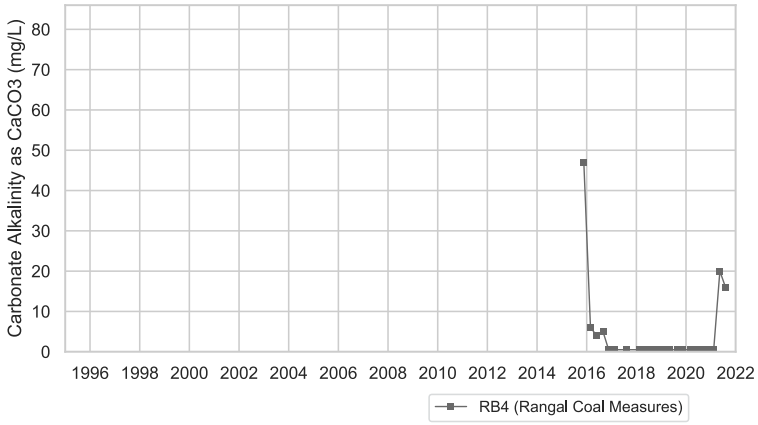

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

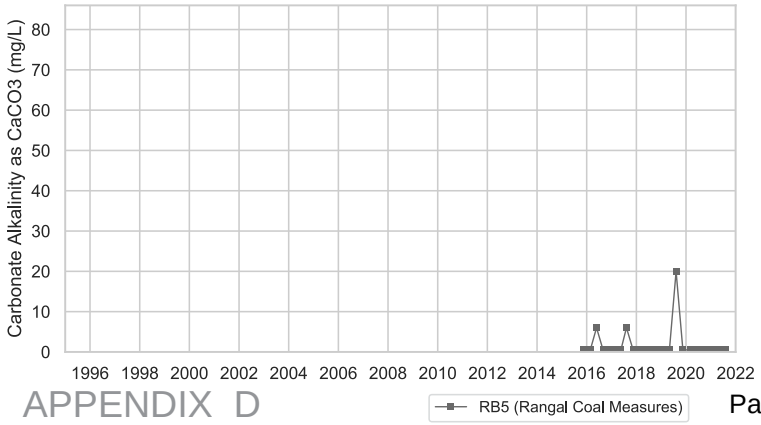

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

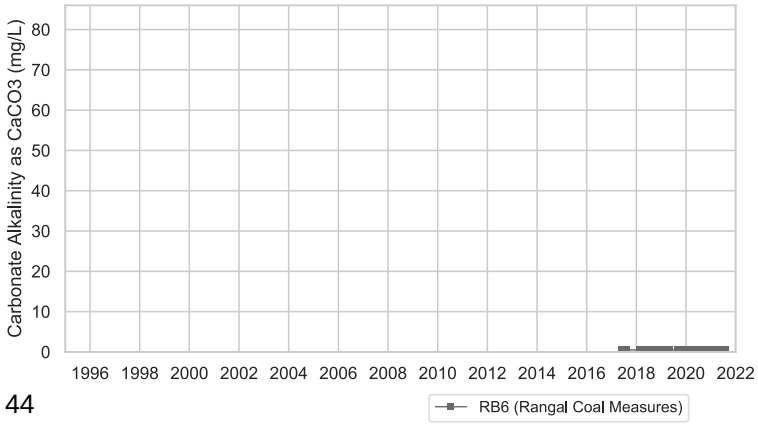

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

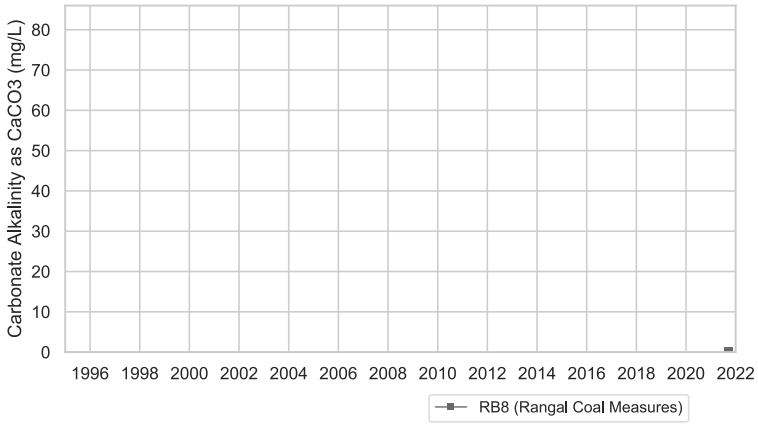

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

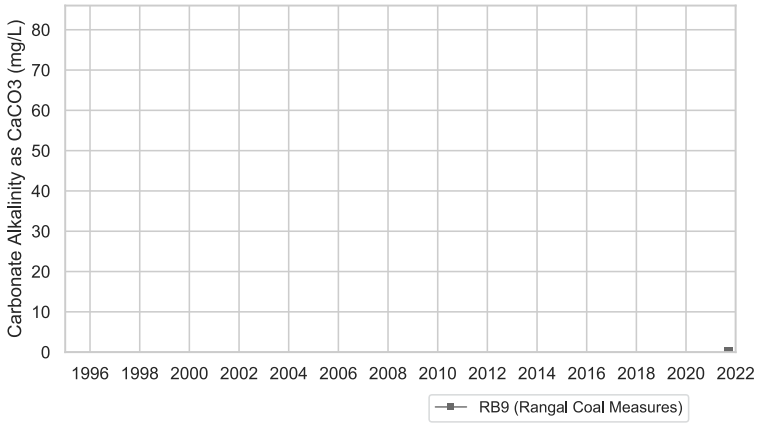

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

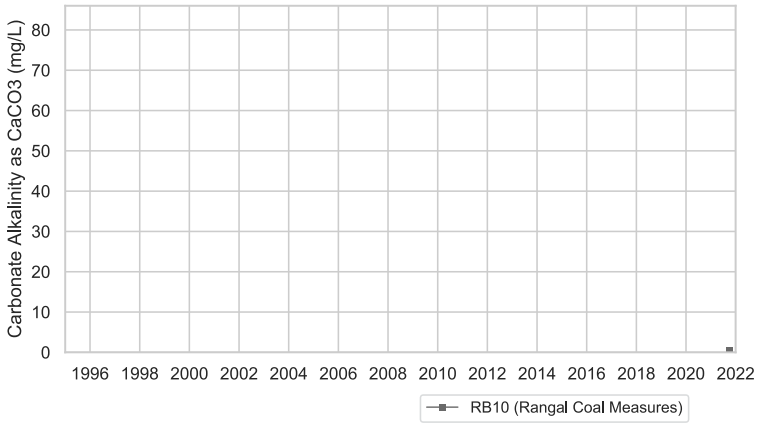

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

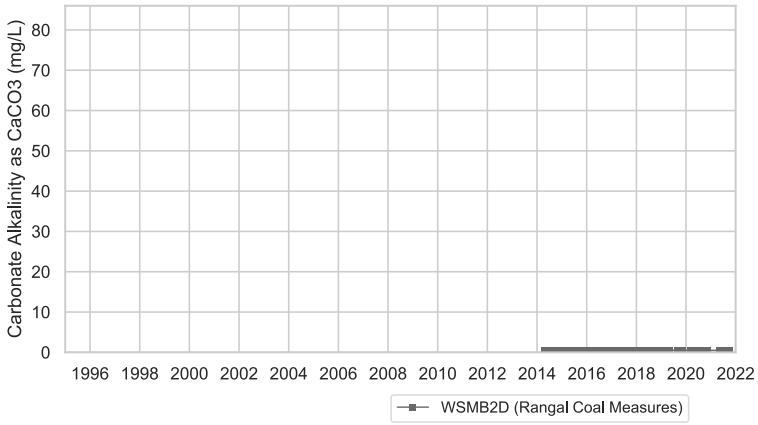

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

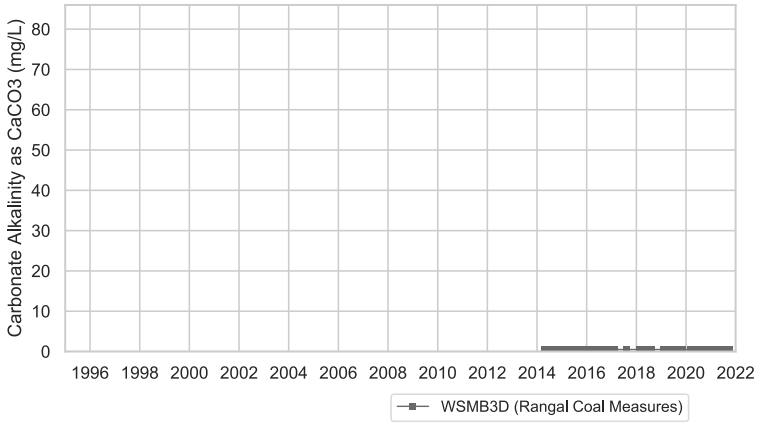

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

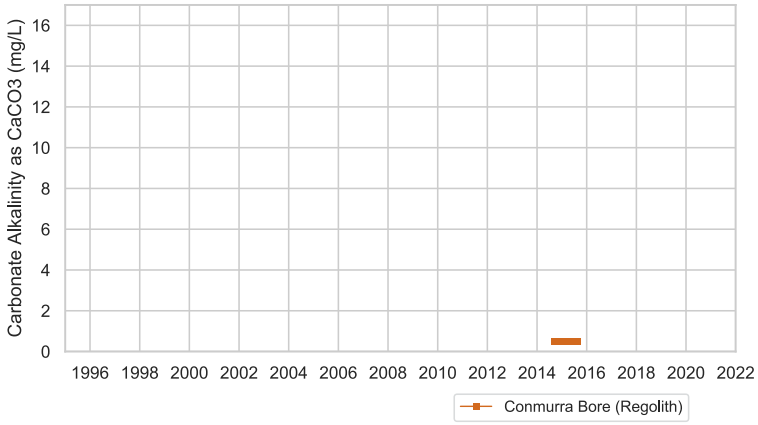

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

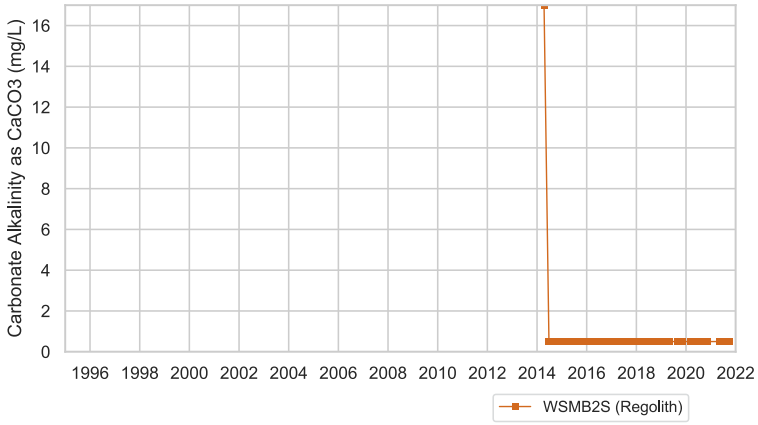

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)


Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

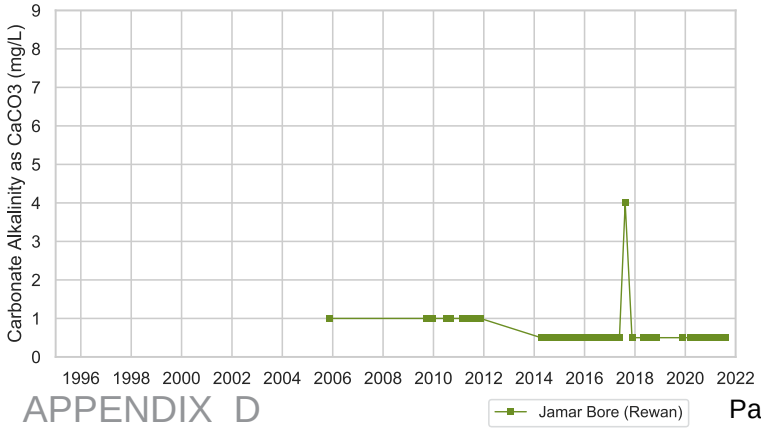

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

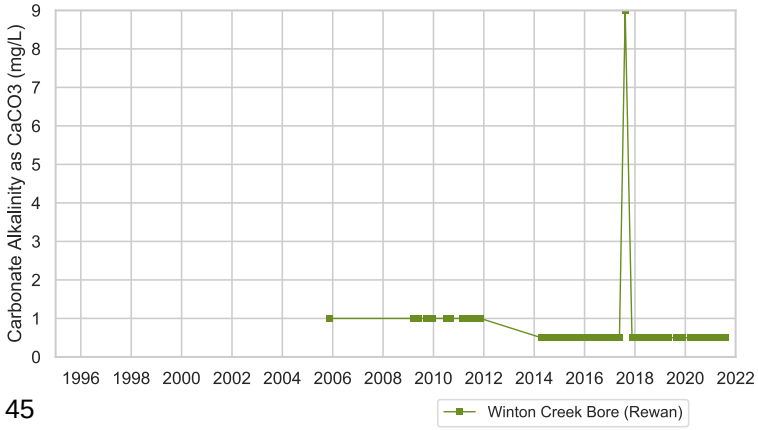

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

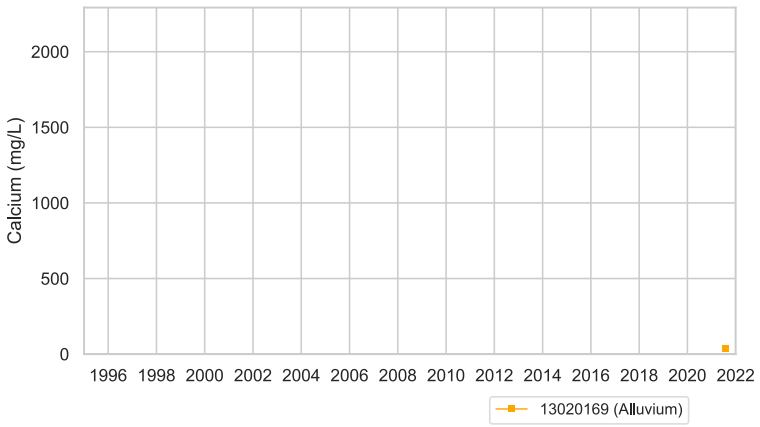

Carbonate Alkalinity as CaCO3 (mg/L)
0 2 4 6 8 10 12 14 16
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

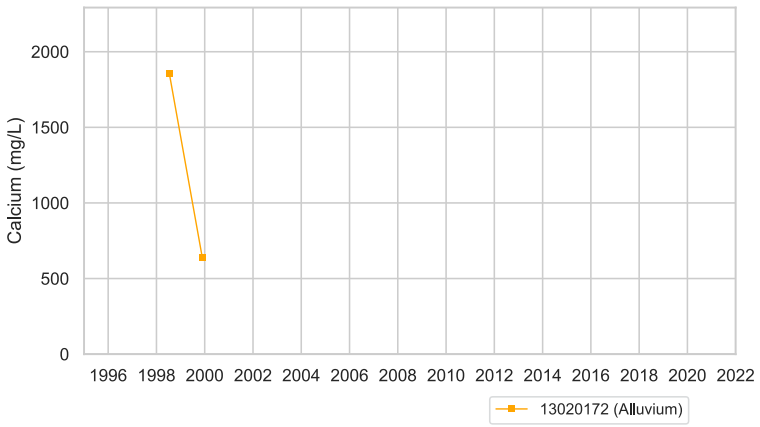

Carbonate Alkalinity as CaCO3 (mg/L)
0 2 4 6 8 10 12 14 16
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

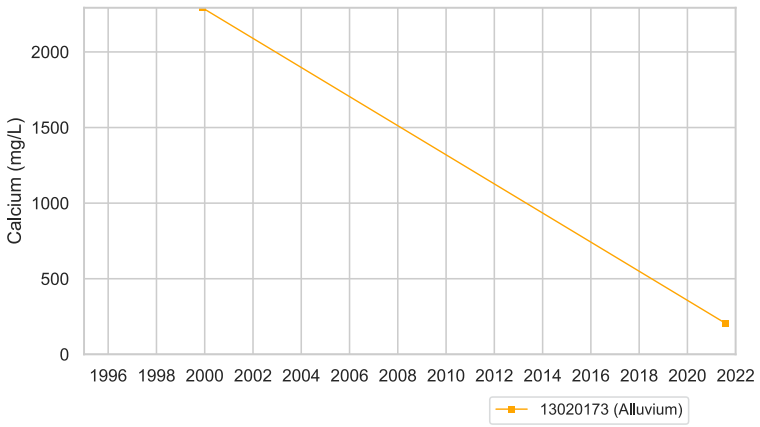
Carbonate Alkalinity as CaCO3 (mg/L)
0 2 4 6 8 10 12 14 16
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

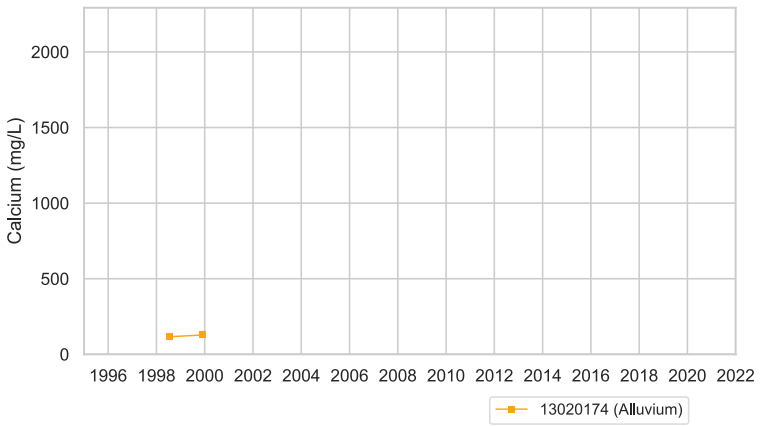

Carbonate Alkalinity as CaCO3 (mg/L)
0 1 2 3 4 5 6 7 8 9
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

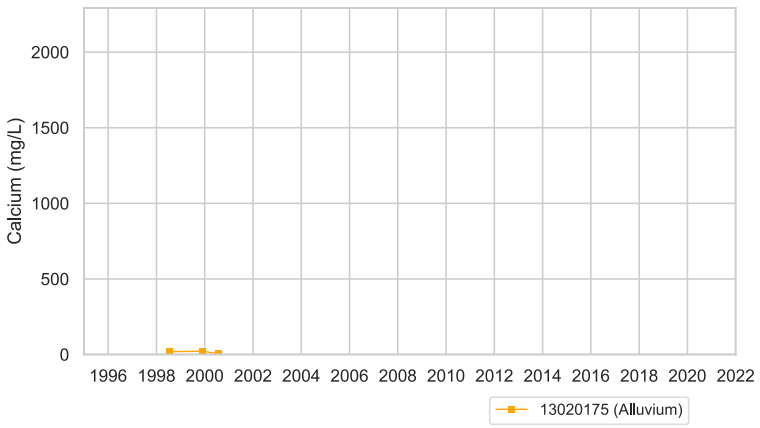

Carbonate Alkalinity as CaCO3 (mg/L)
0 1 2 3 4 5 6 7 8 9
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

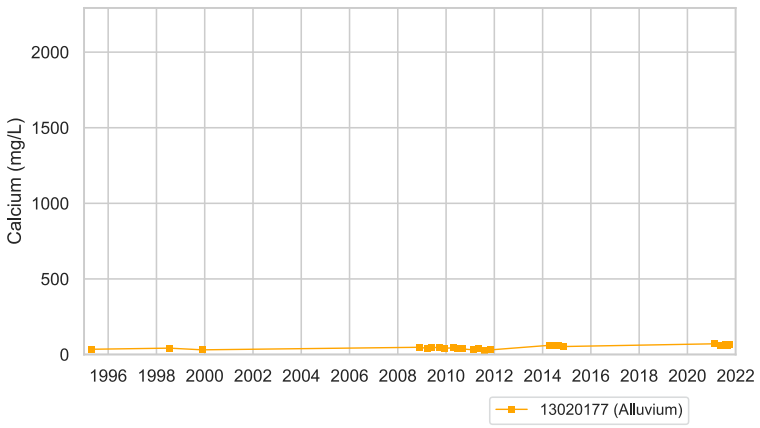

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

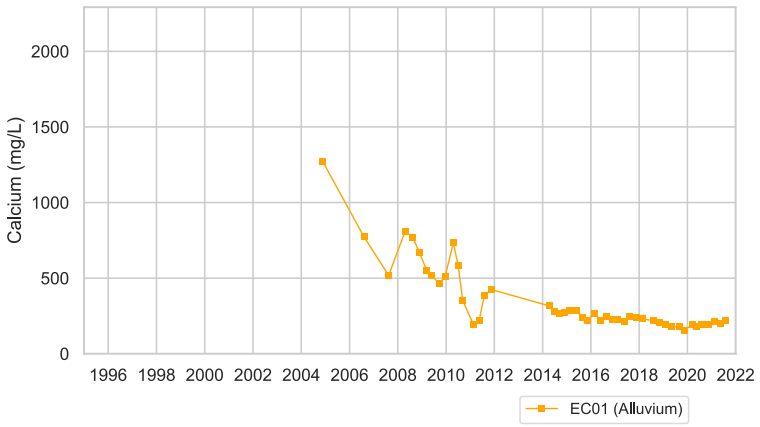

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

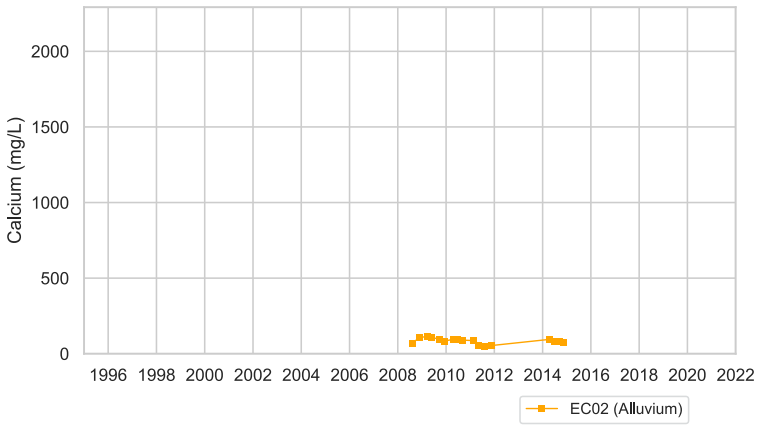

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

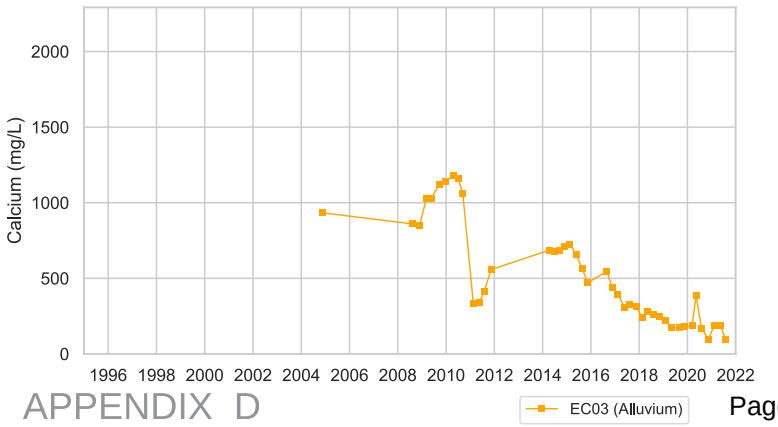

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

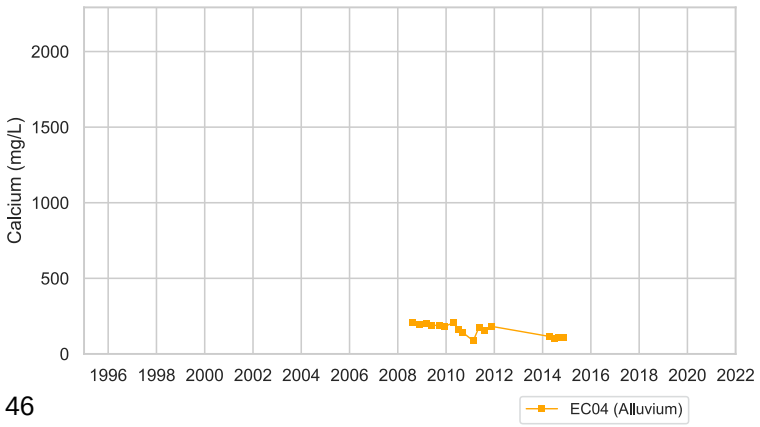

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

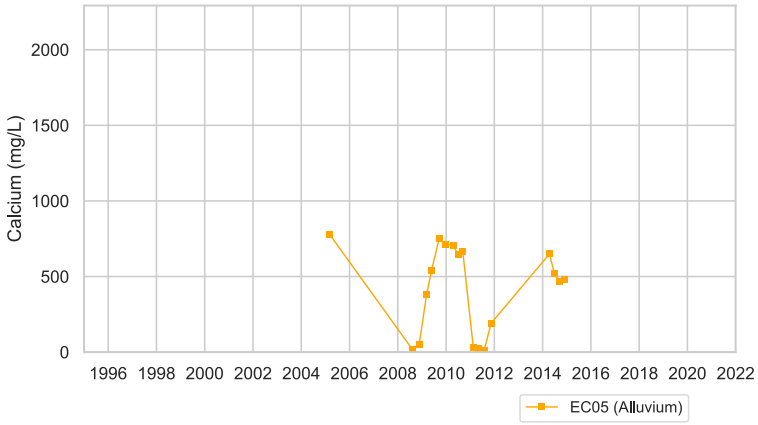

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

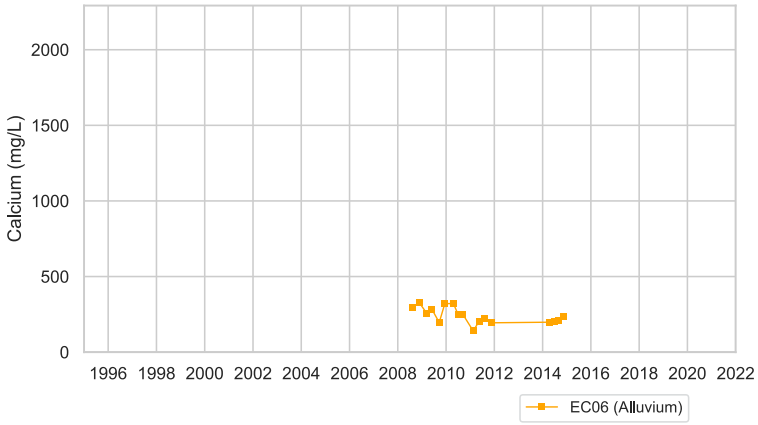

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

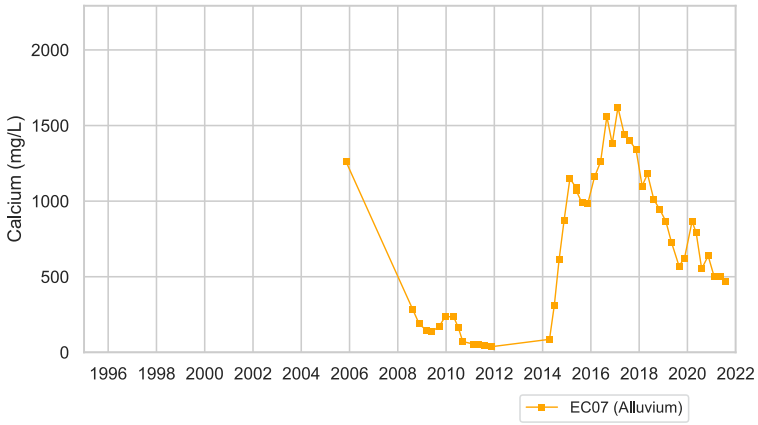

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

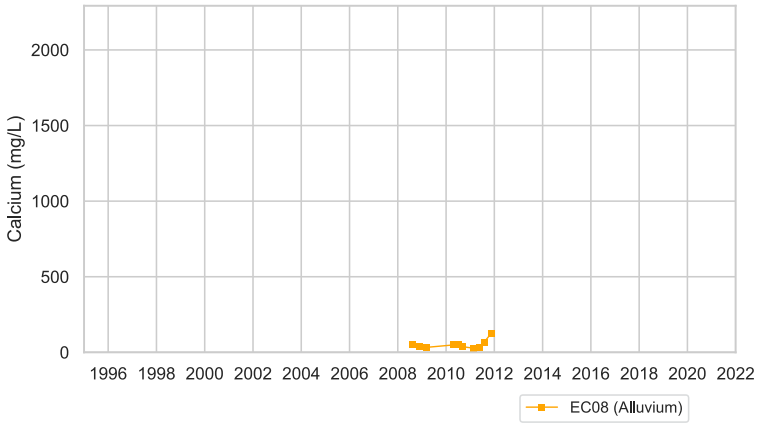

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

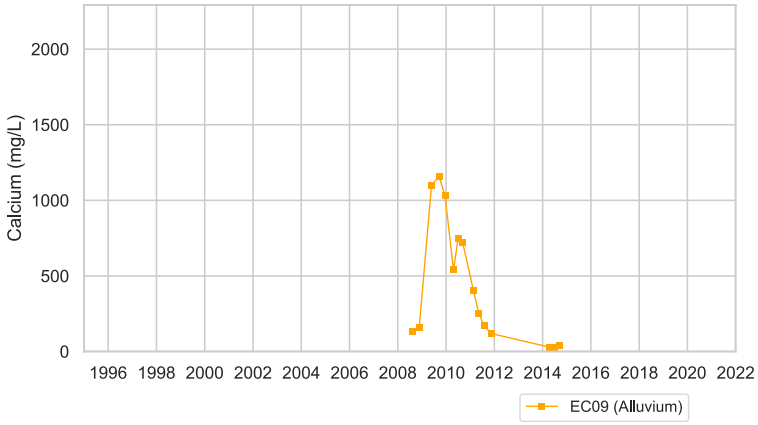

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

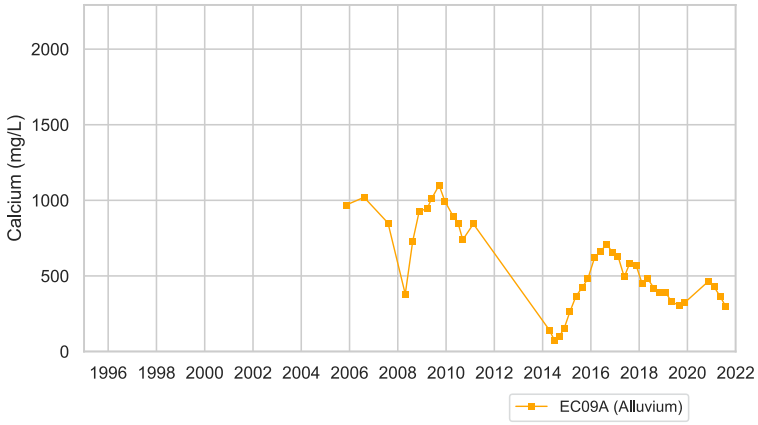

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

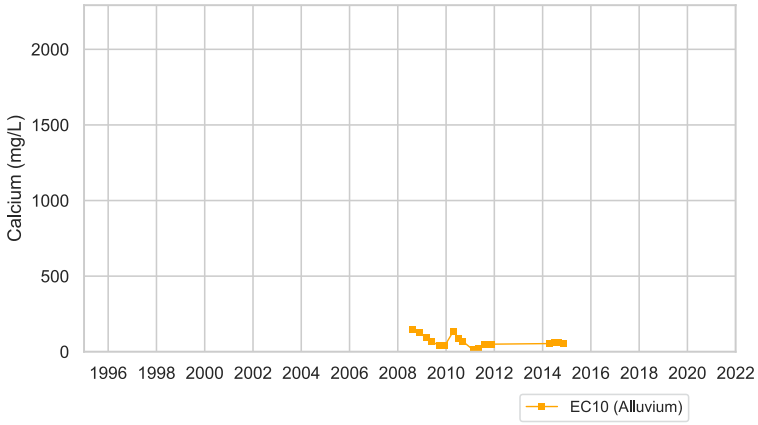

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

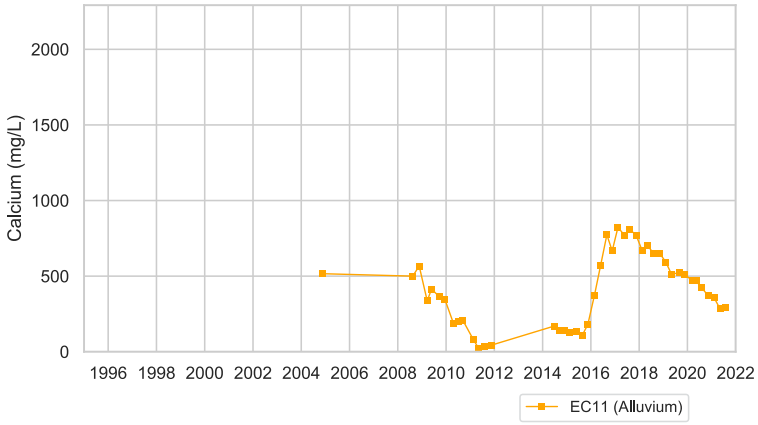

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

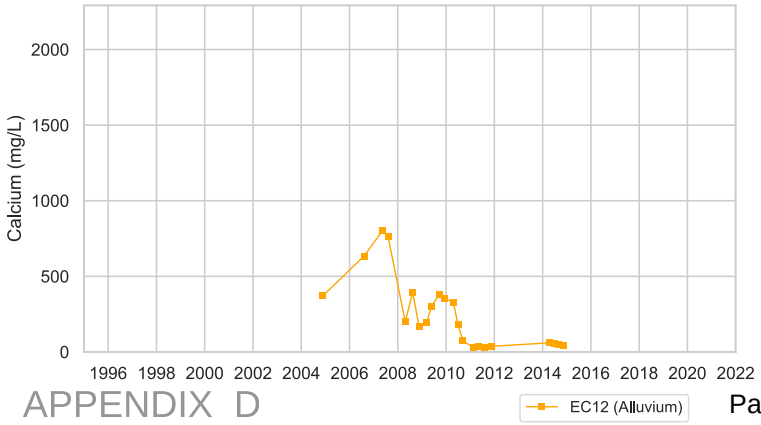

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

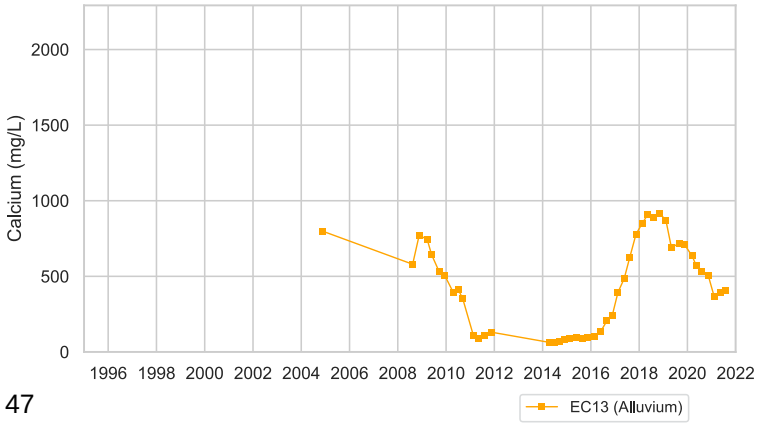

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

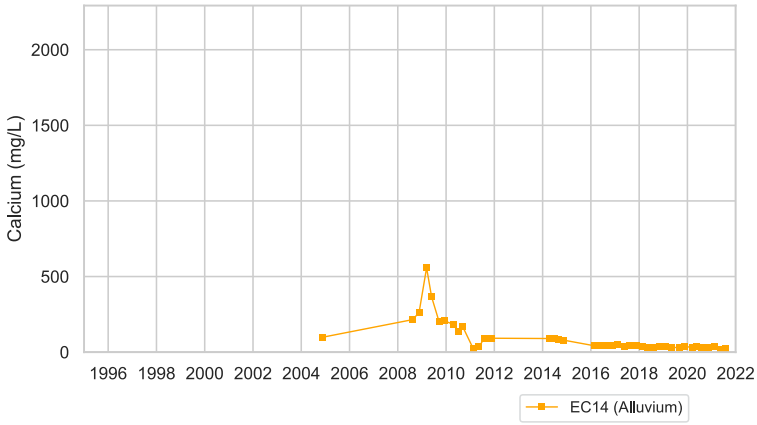

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

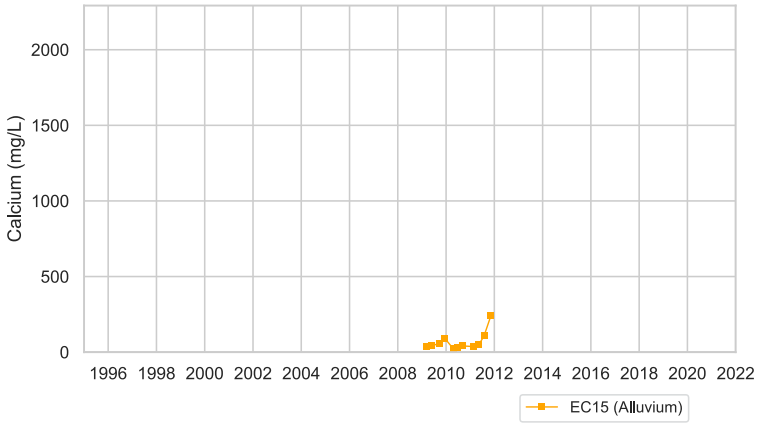

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

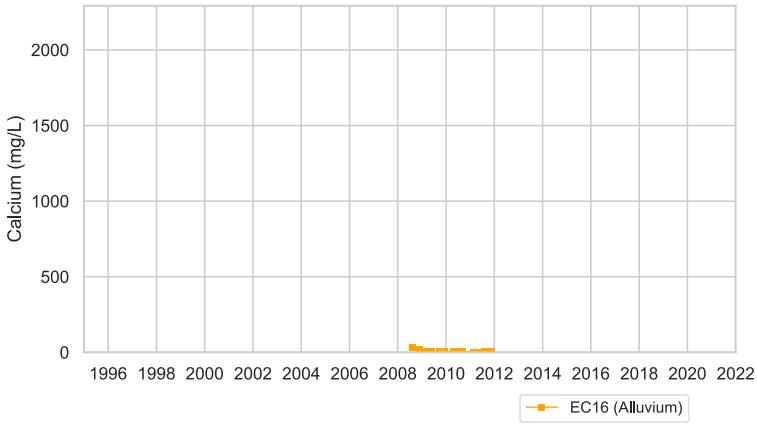

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

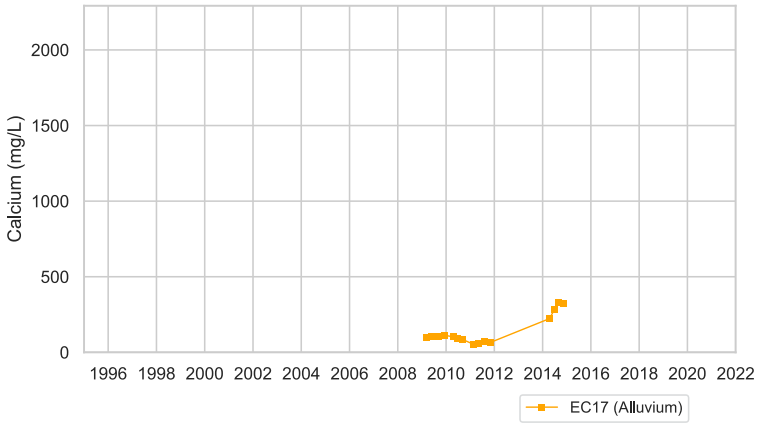

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

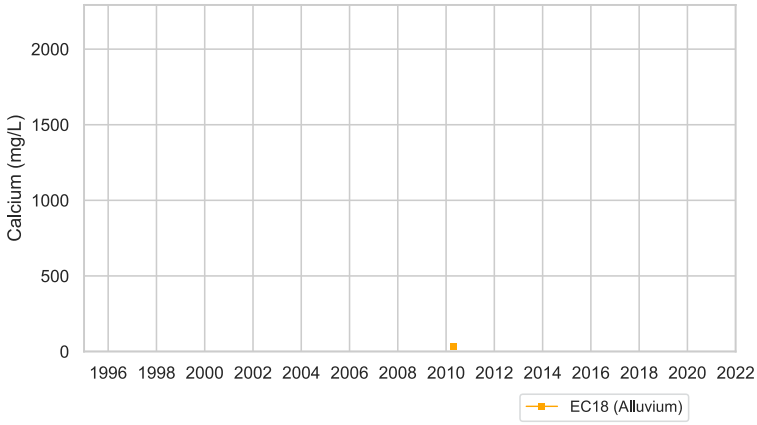

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

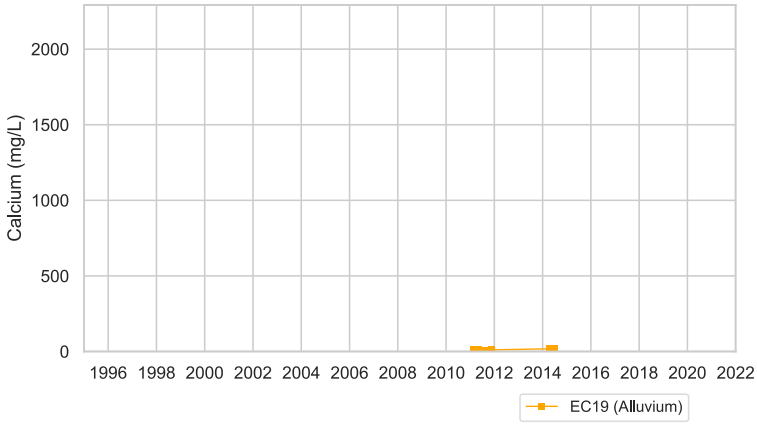

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

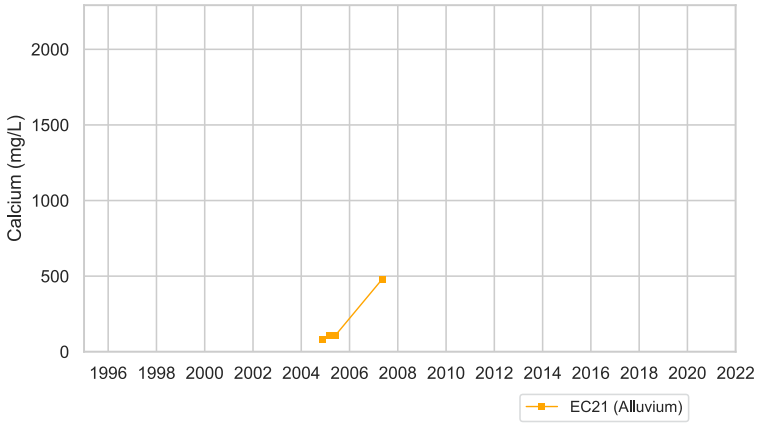

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

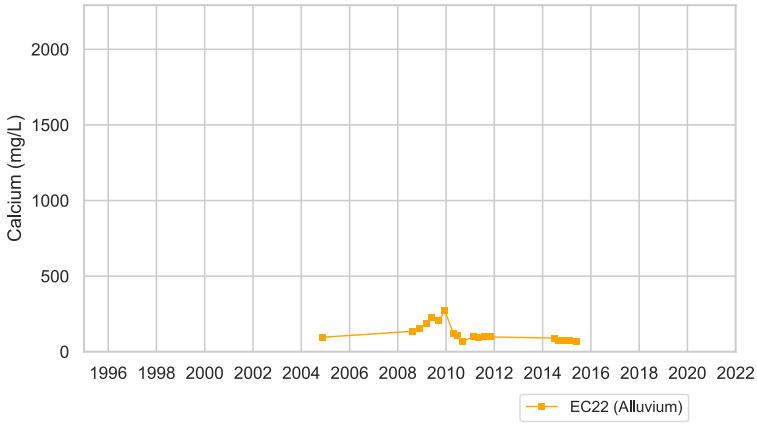

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

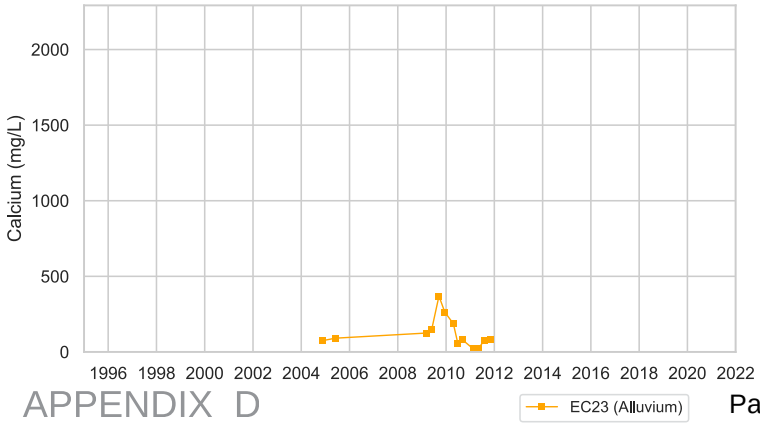

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

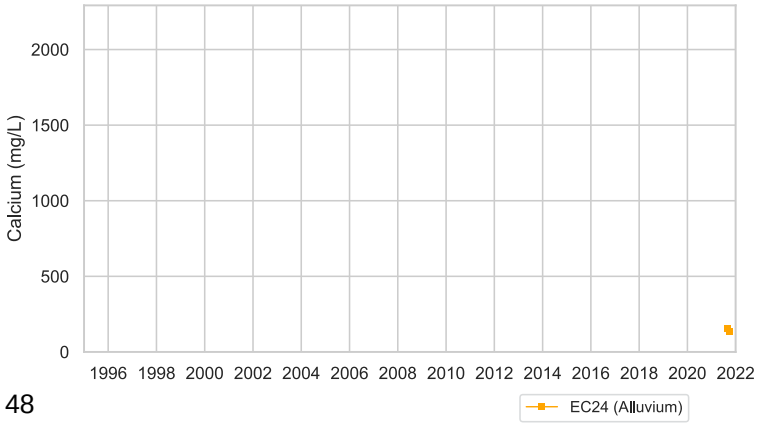

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

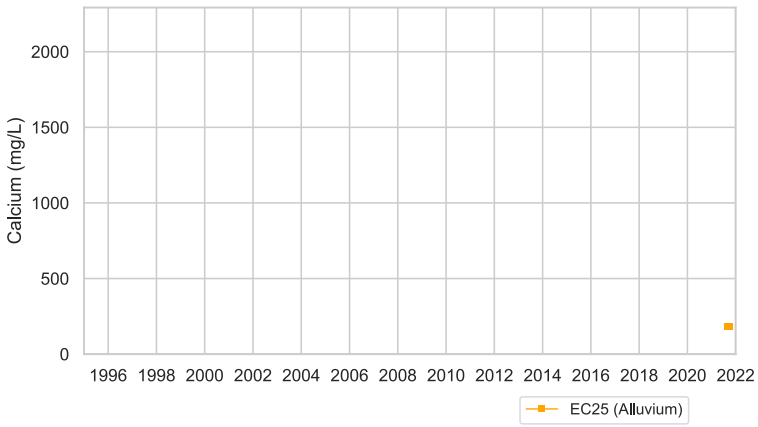

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

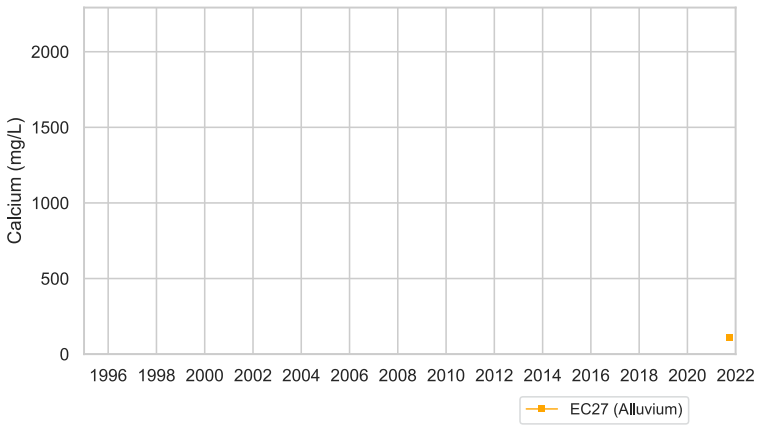

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

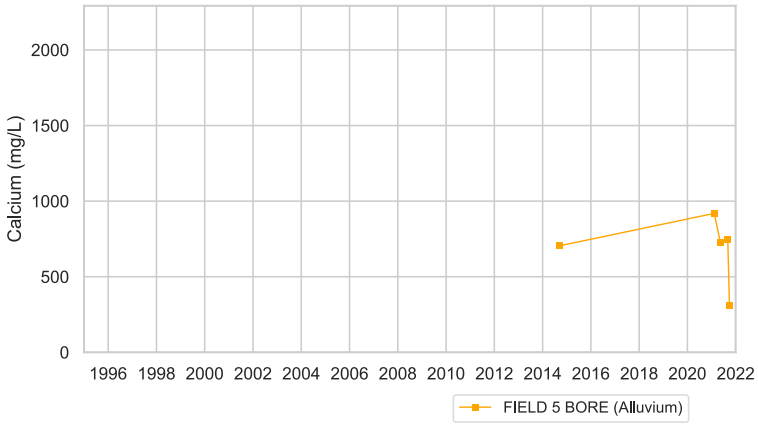

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

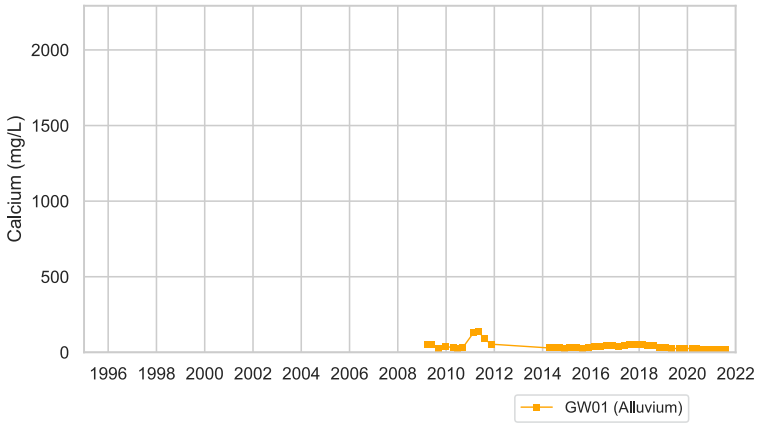

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

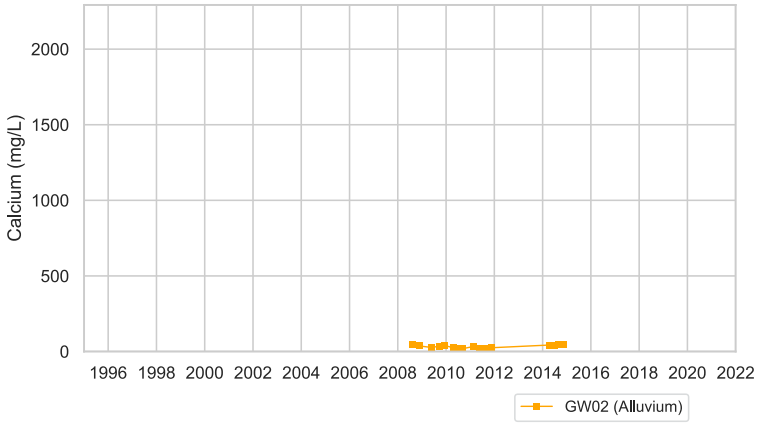

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

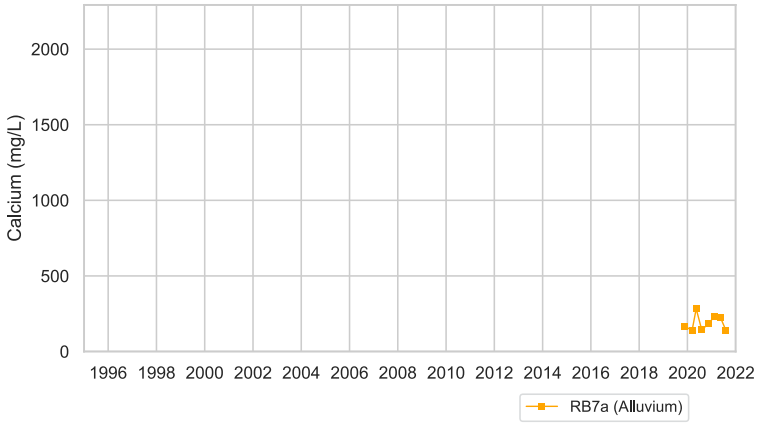

Calcium (mg/L)
EC25 (Alluvium)

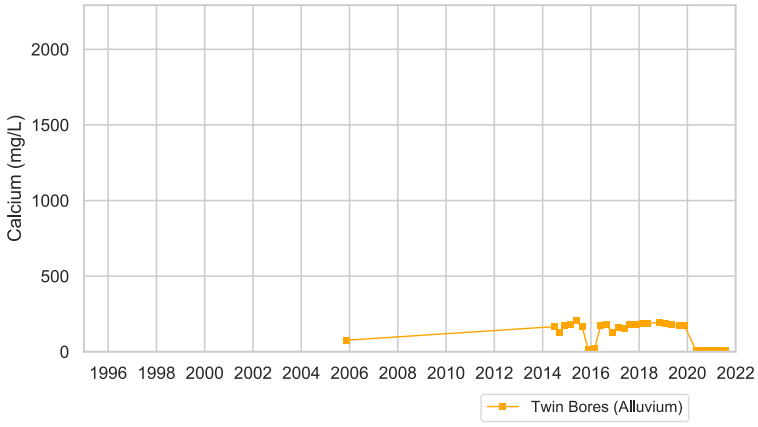

Calcium (mg/L)
EC27 (Alluvium)

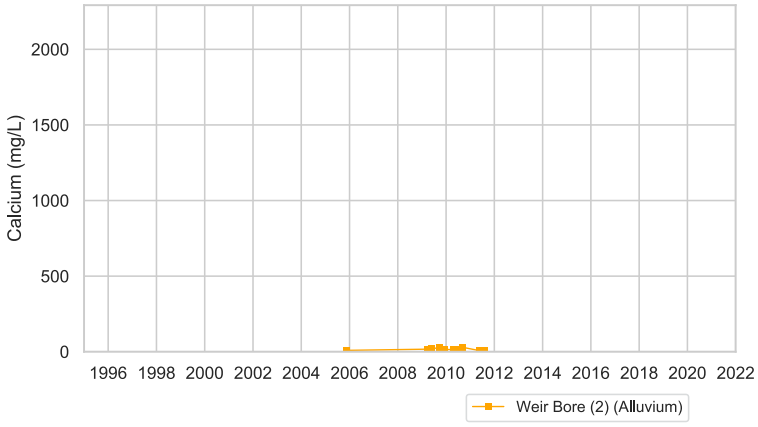

Calcium (mg/L)
FIELD 5 BORE (Alluvium)

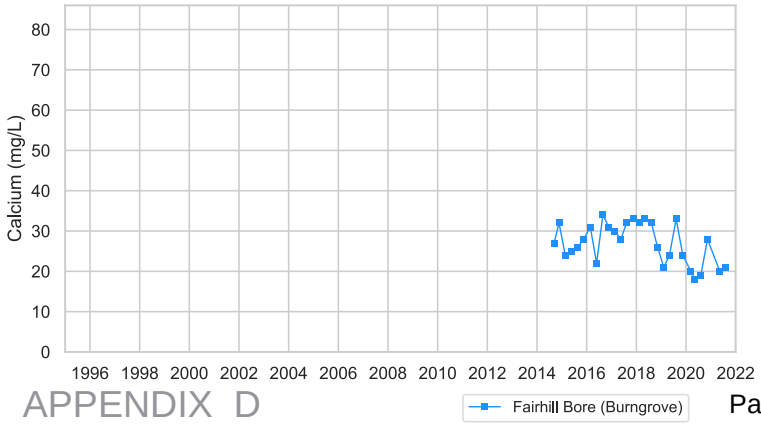

Calcium (mg/L)
GW01 (Alluvium)

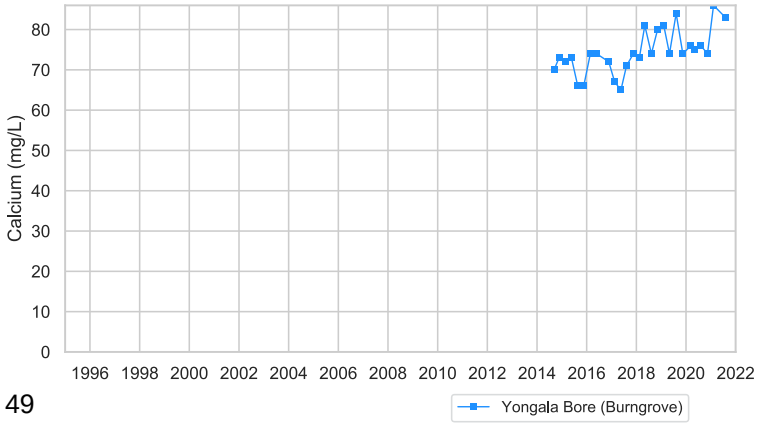

Calcium (mg/L)
GW02 (Alluvium)

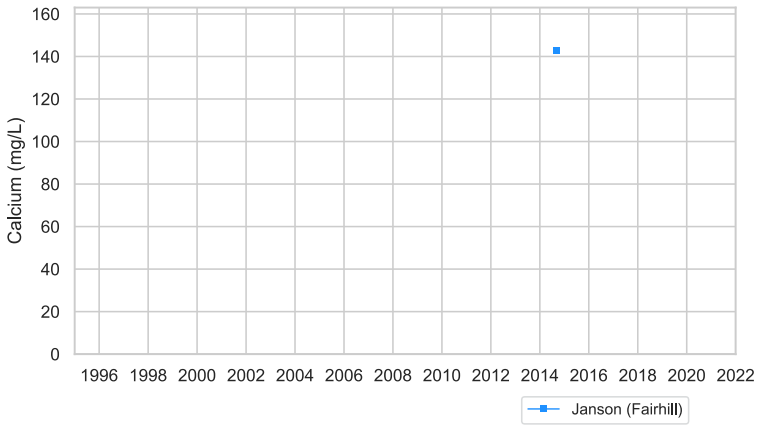

Calcium (mg/L)
RB7a (Alluvium)

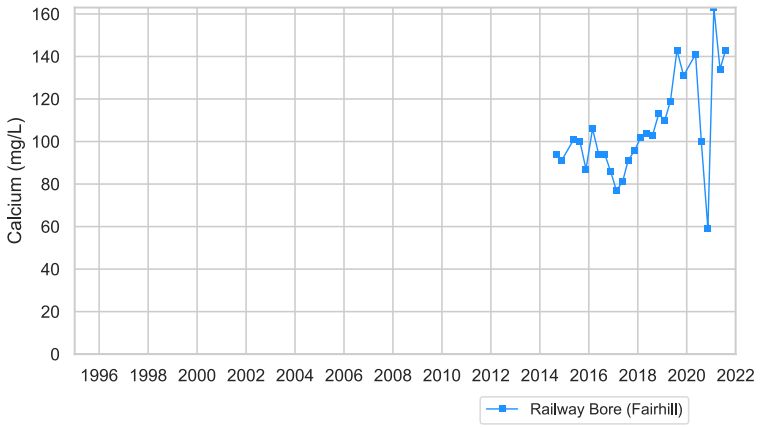

Calcium (mg/L)
Twin Bores (Alluvium)

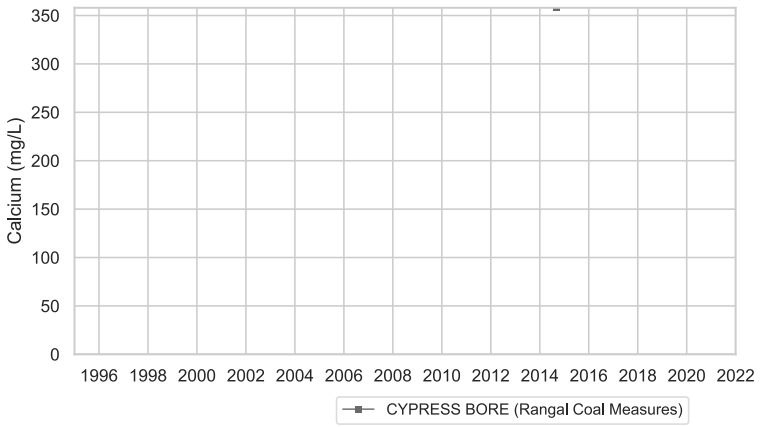

Calcium (mg/L)
Weir Bore (2) (Alluvium)

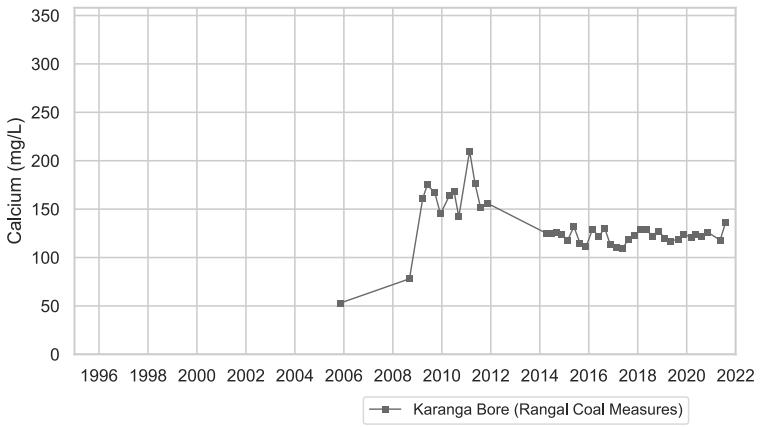

Calcium (mg/L)
Fairhill Bore (Burngrove)

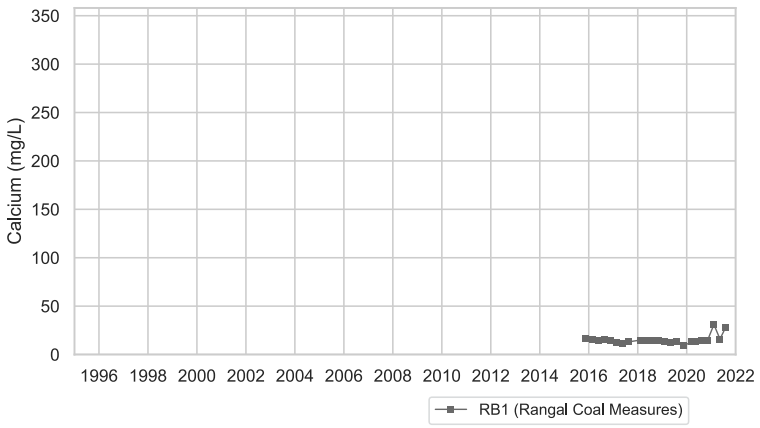

Calcium (mg/L)
Yongala Bore (Burngrove)

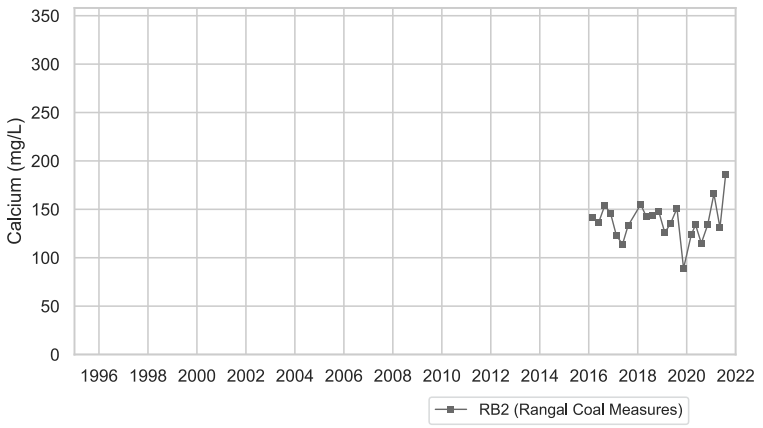

Calcium (mg/L)
Janson (Fairhill)

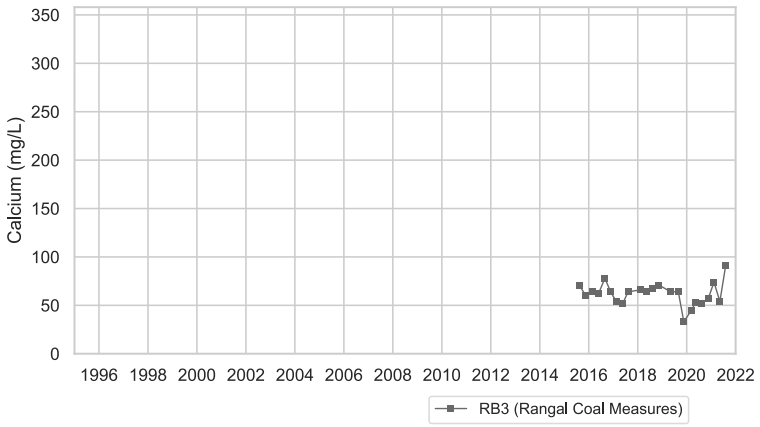

Calcium (mg/L)
Railway Bore (Fairhill)

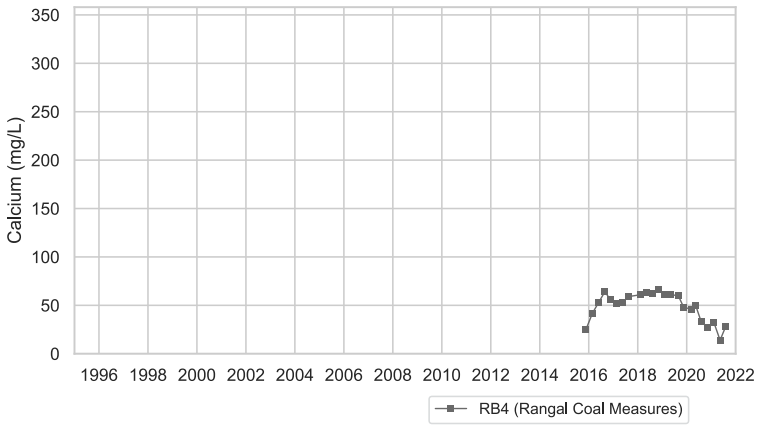

Calcium (mg/L)
CYPRESS BORE (Rangal Coal Measures)

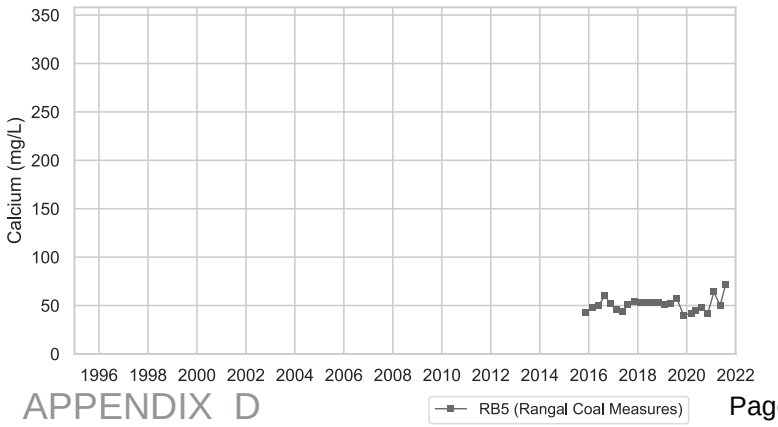

Calcium (mg/L)
Karanga Bore (Rangal Coal Measures)

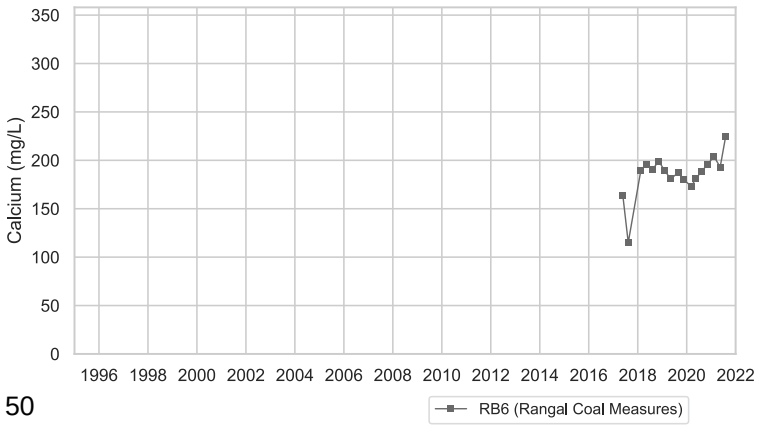

Calcium (mg/L)
RB1 (Rangal Coal Measures)

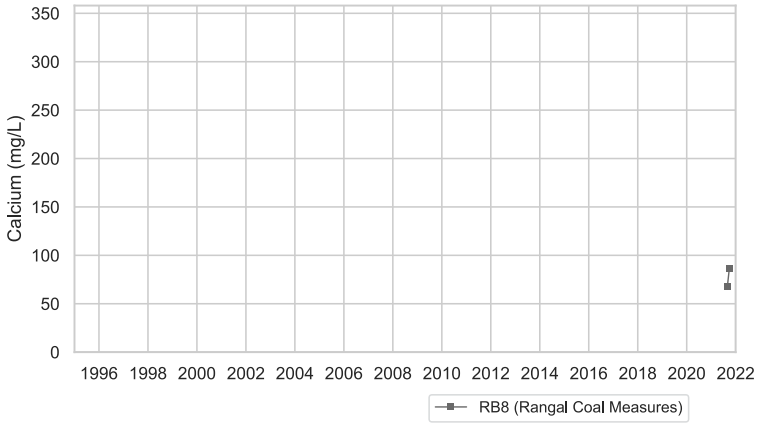

Calcium (mg/L)
RB2 (Rangal Coal Measures)

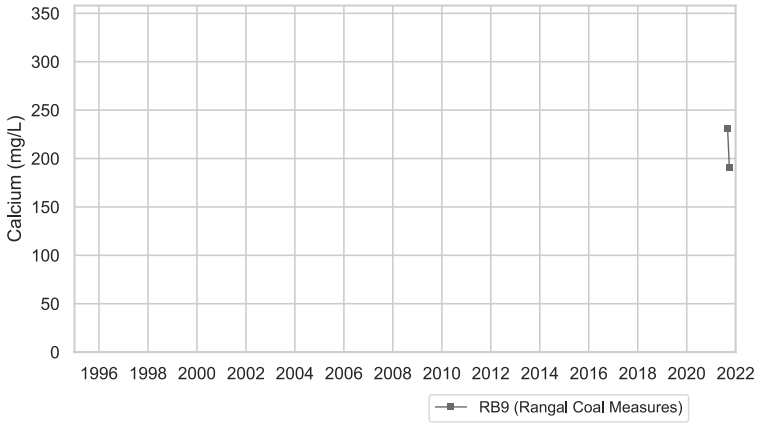

Calcium (mg/L)
RB3 (Rangal Coal Measures)

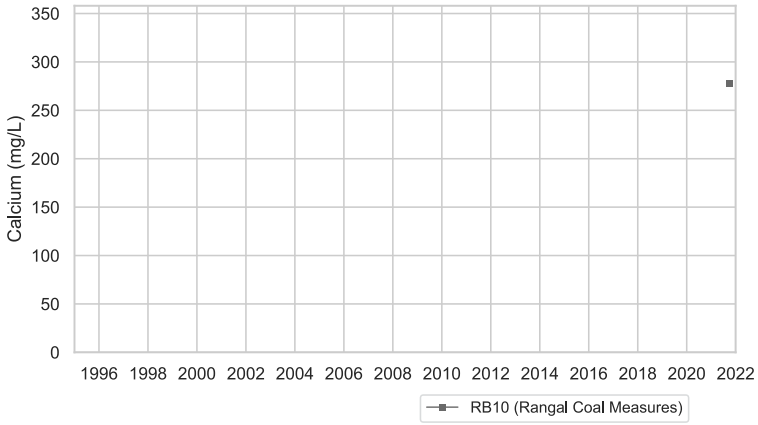

Calcium (mg/L)
RB4 (Rangal Coal Measures)

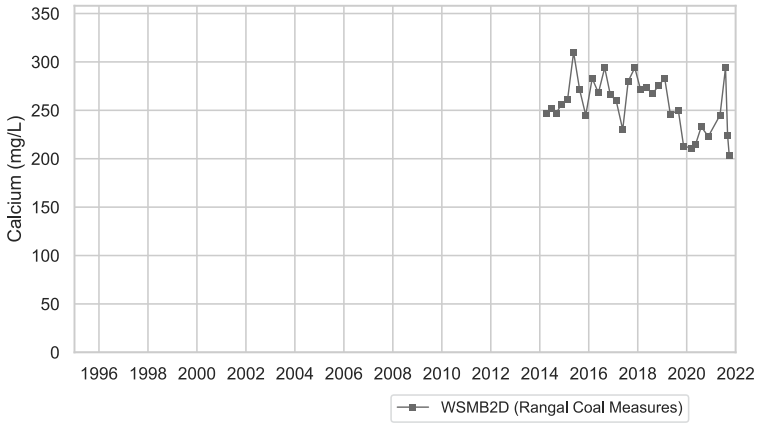

Calcium (mg/L)
RB5 (Rangal Coal Measures)

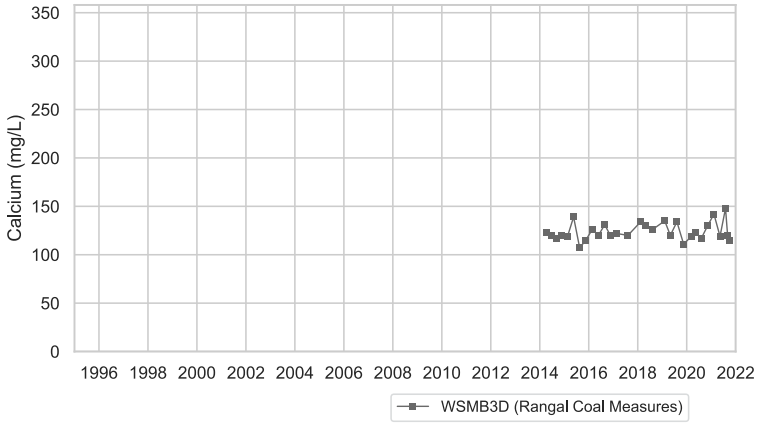

Calcium (mg/L)
RB6 (Rangal Coal Measures)

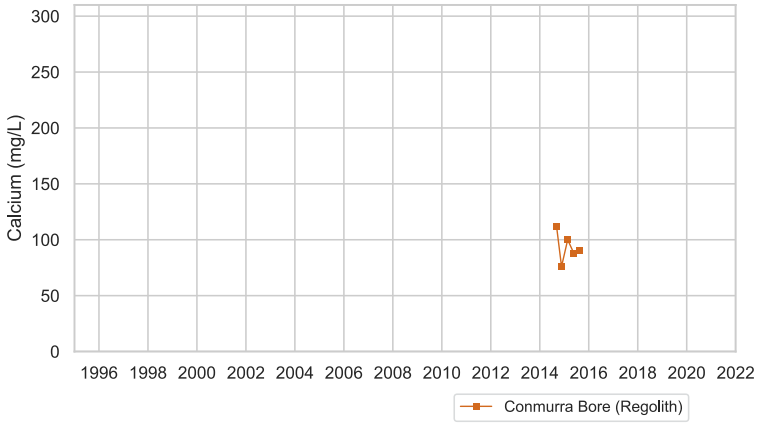

Calcium (mg/L)
RB8 (Rangal Coal Measures)

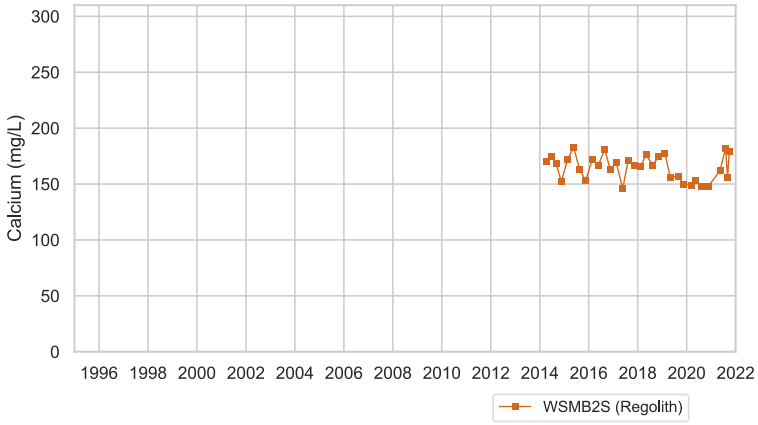

Calcium (mg/L)
RB9 (Rangal Coal Measures)


Calcium (mg/L)
RB10 (Rangal Coal Measures)

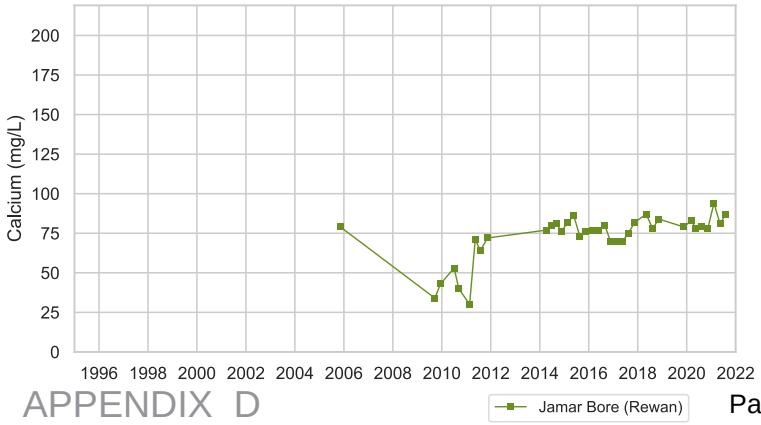

Calcium (mg/L)
WSMB2D (Rangal Coal Measures)

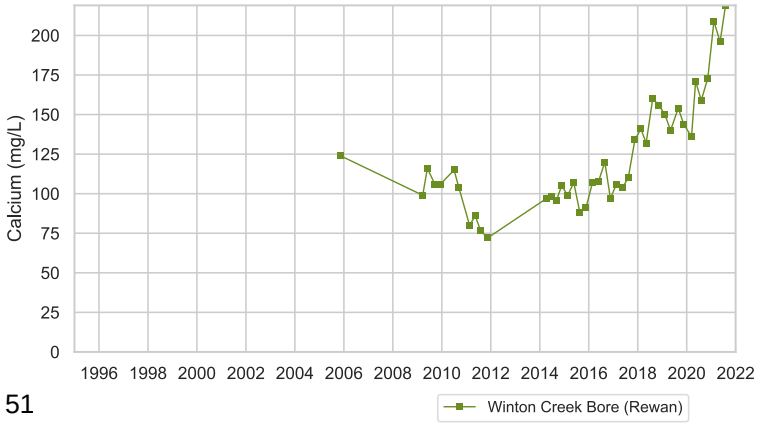

Calcium (mg/L)
WSMB3D (Rangal Coal Measures)

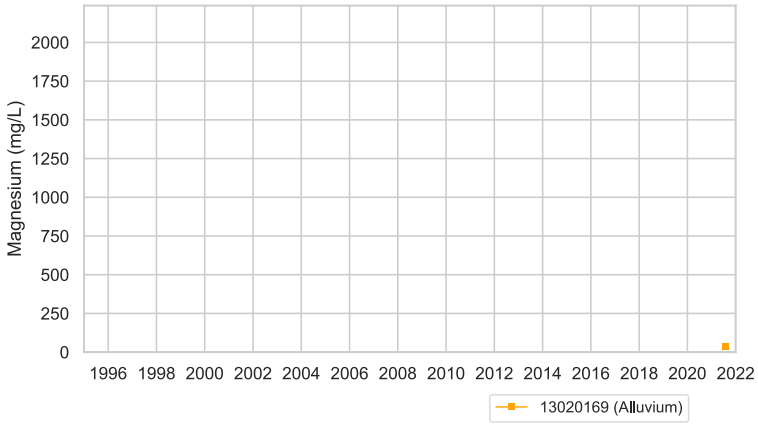

Calcium (mg/L)
Conmurra Bore (Regolith)

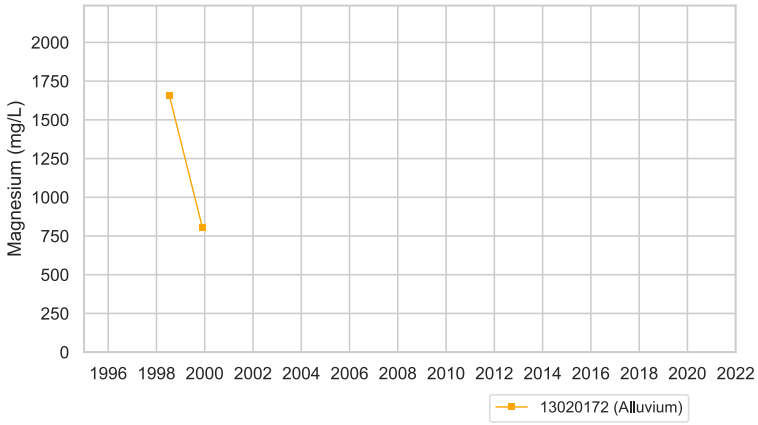

Calcium (mg/L)
WSMB2S (Regolith)

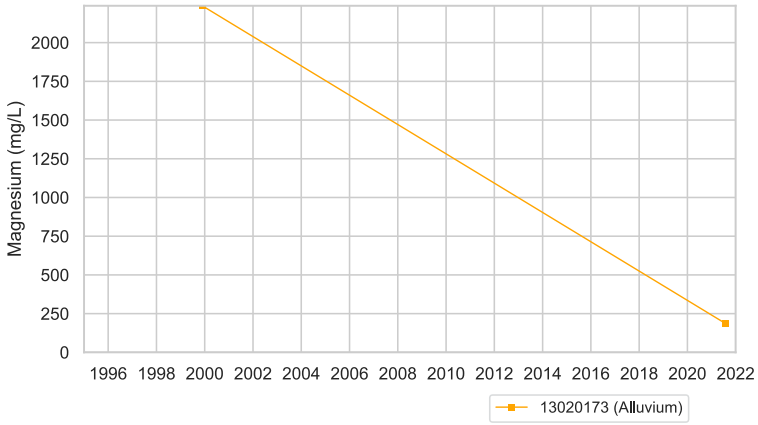
Calcium (mg/L)
WSMB3S (Regolith)

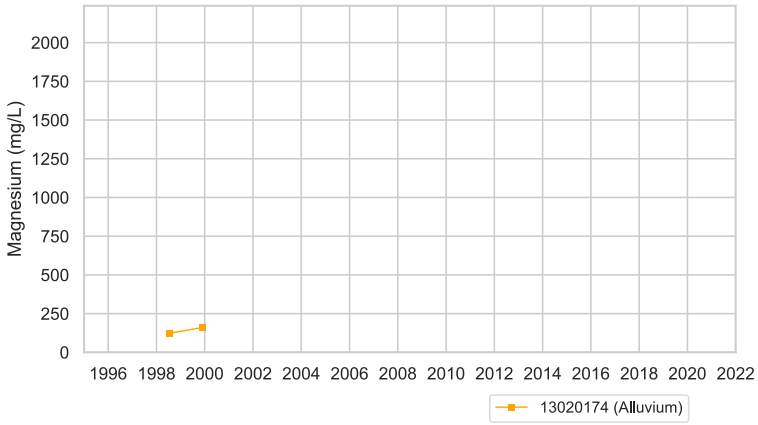

Calcium (mg/L)
Jamar Bore (Rewan)

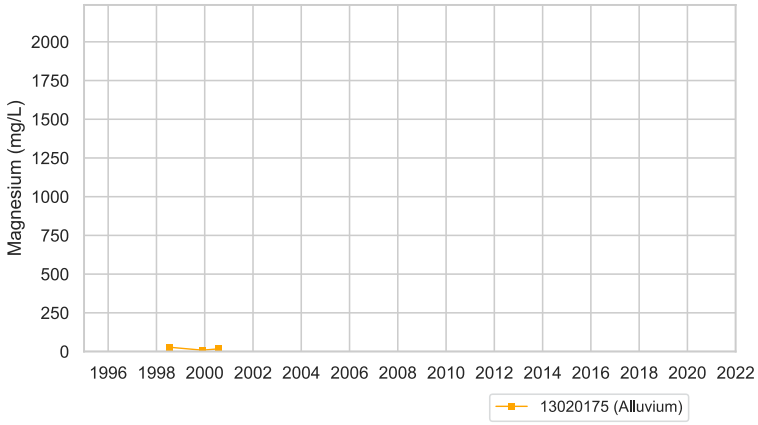

Calcium (mg/L)
Winton Creek Bore (Rewan)

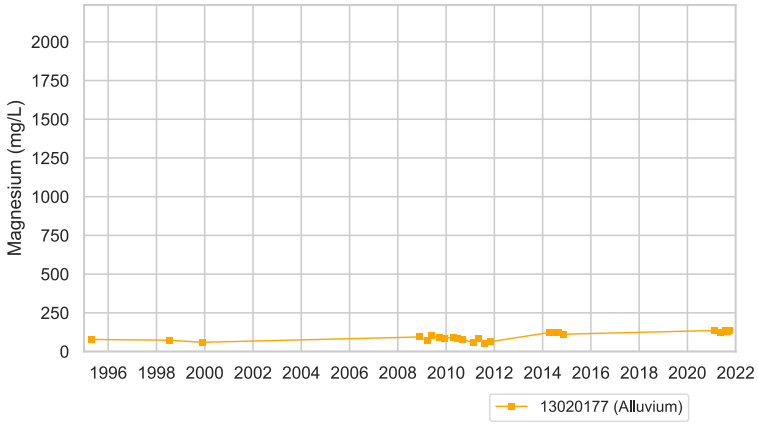

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

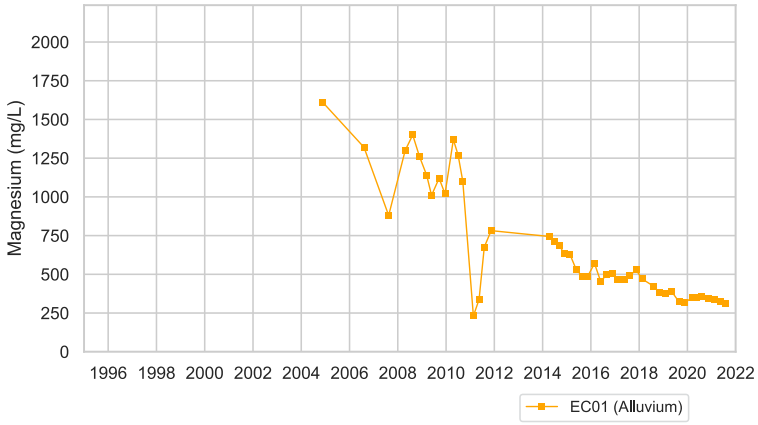

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

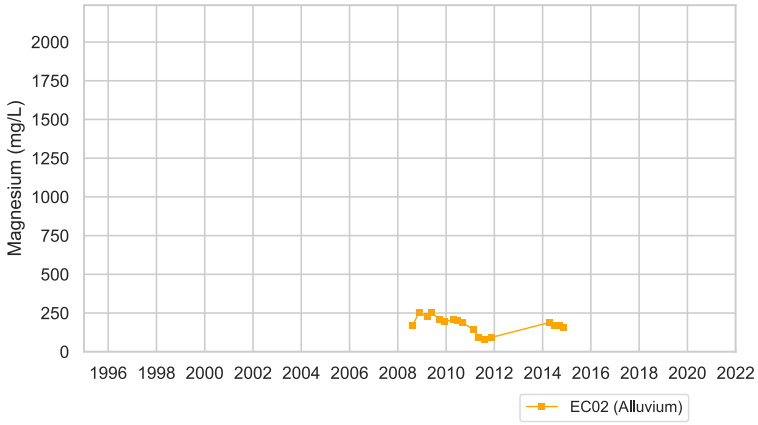

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

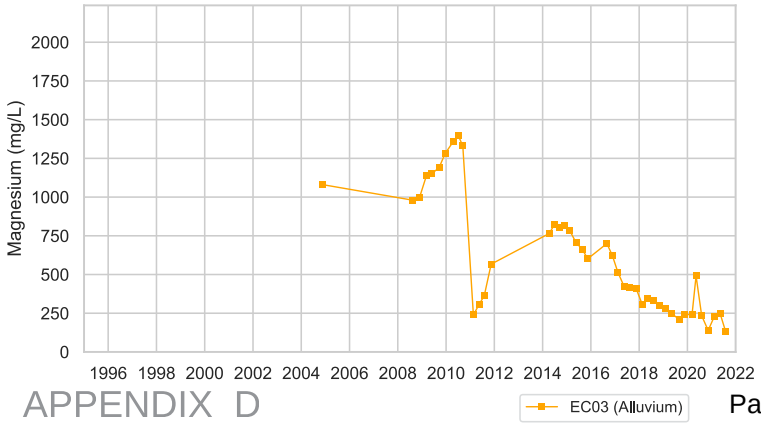

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

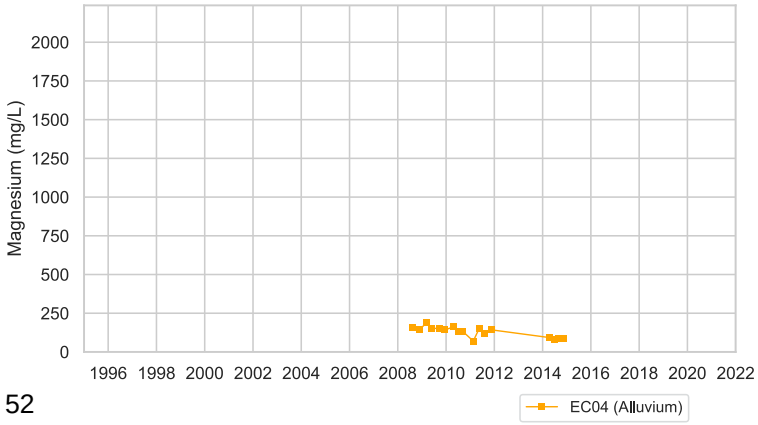

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

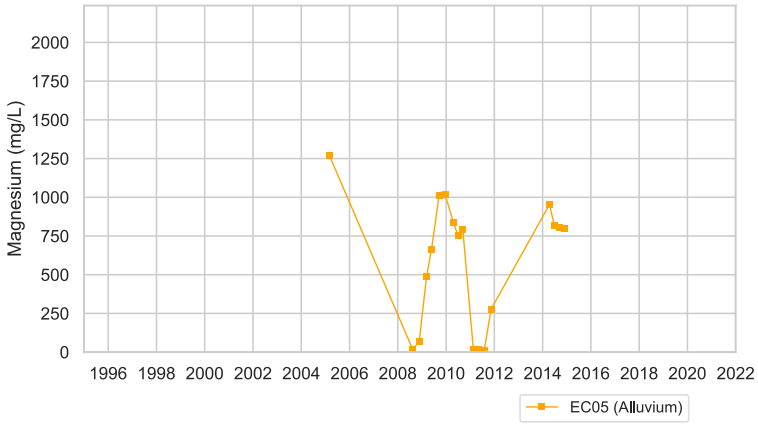

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

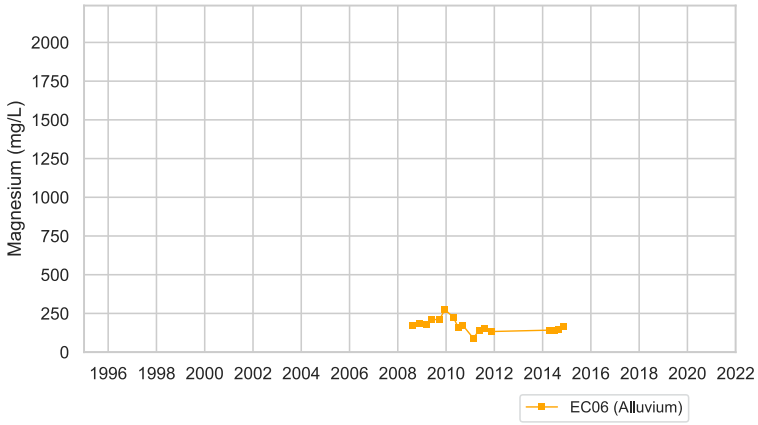

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

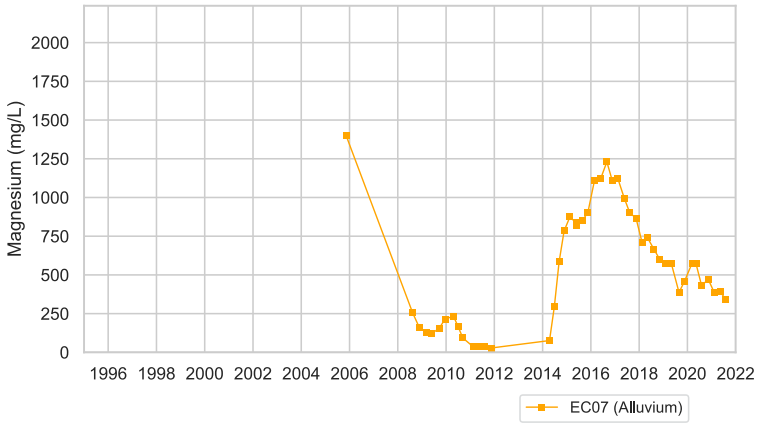

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

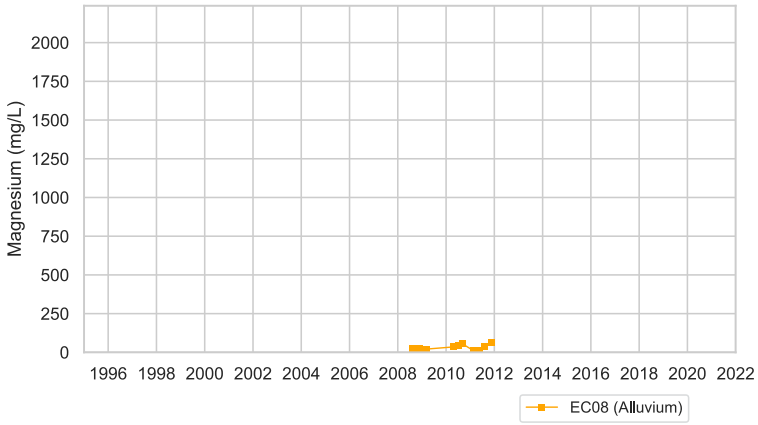

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

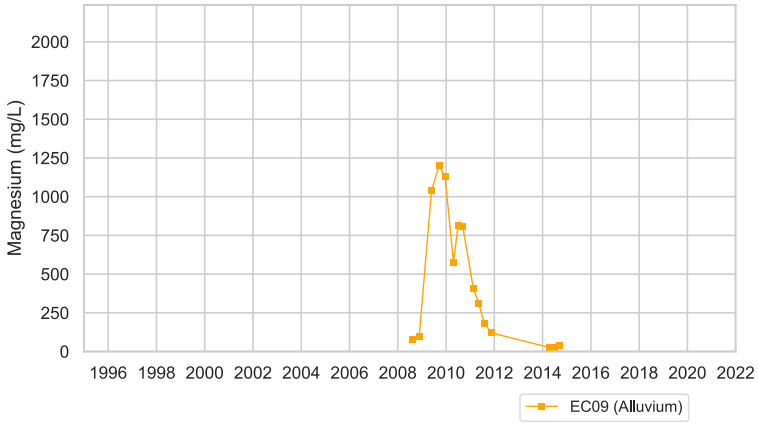

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

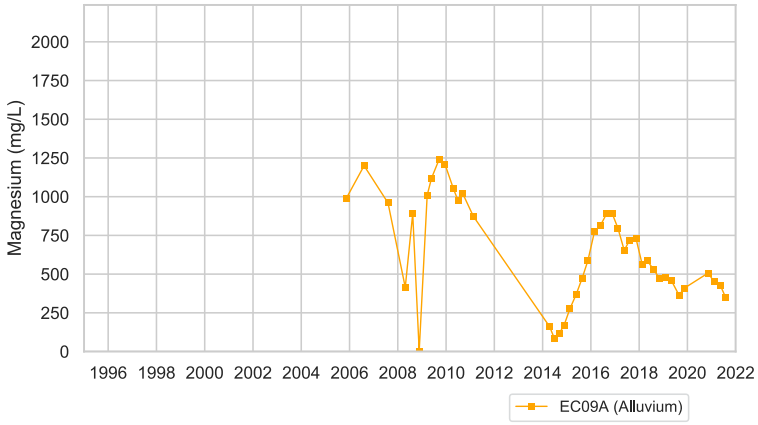

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

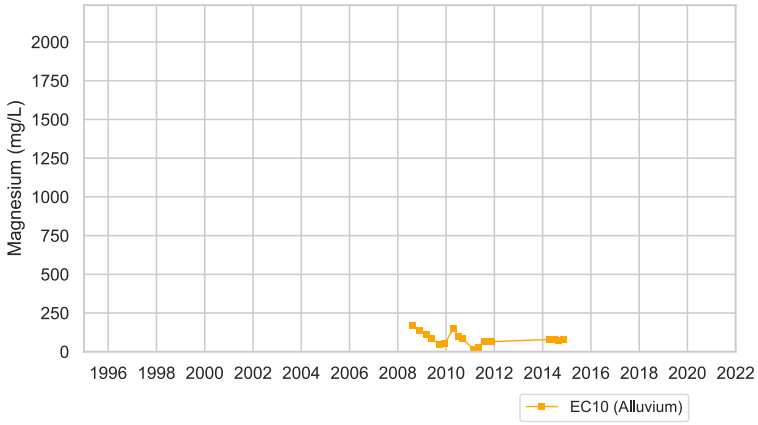

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

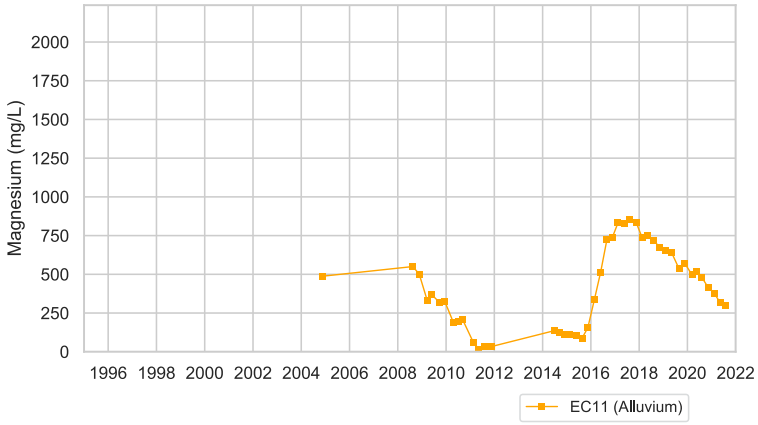

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

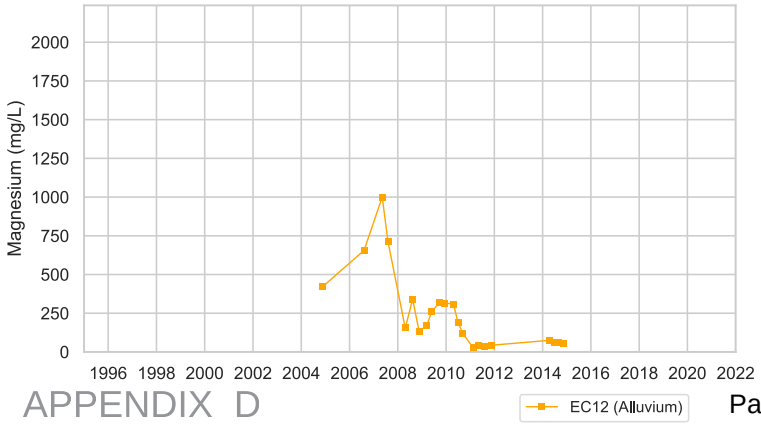

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

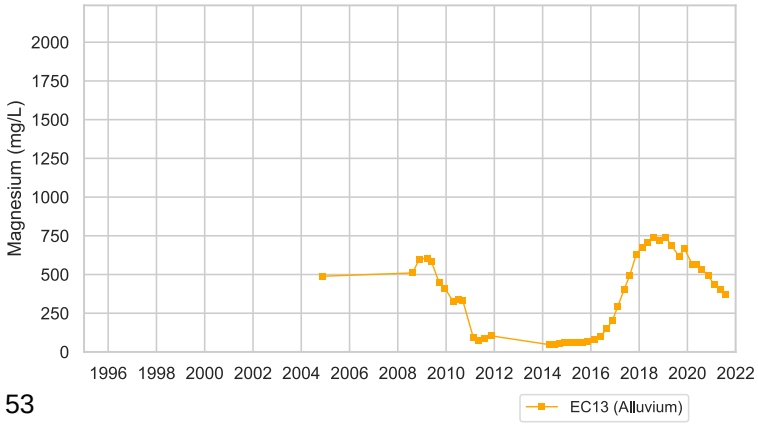

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

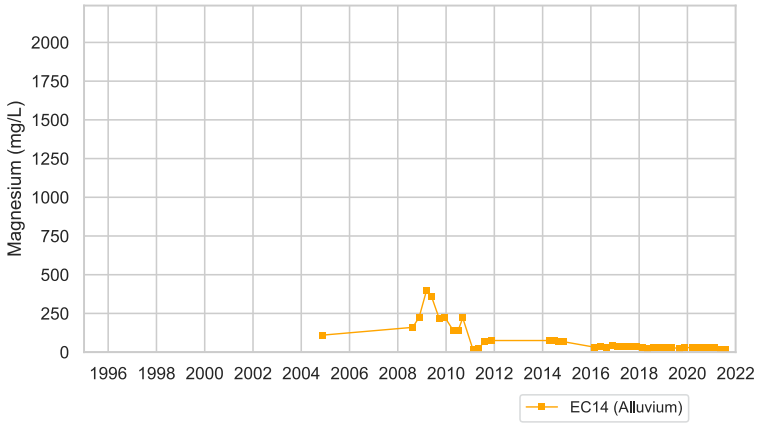

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

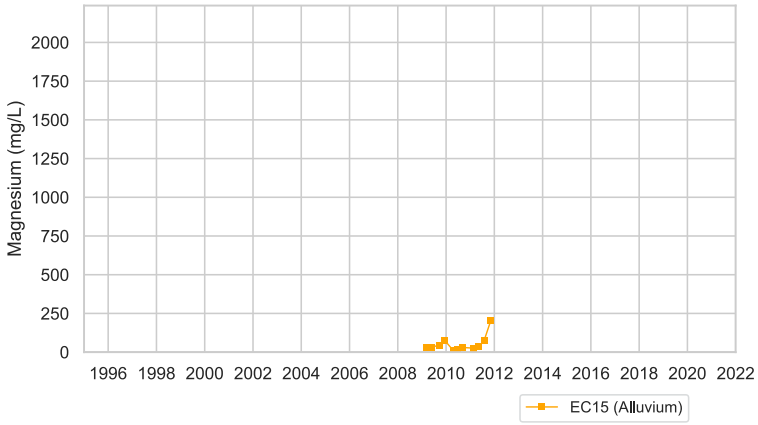

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

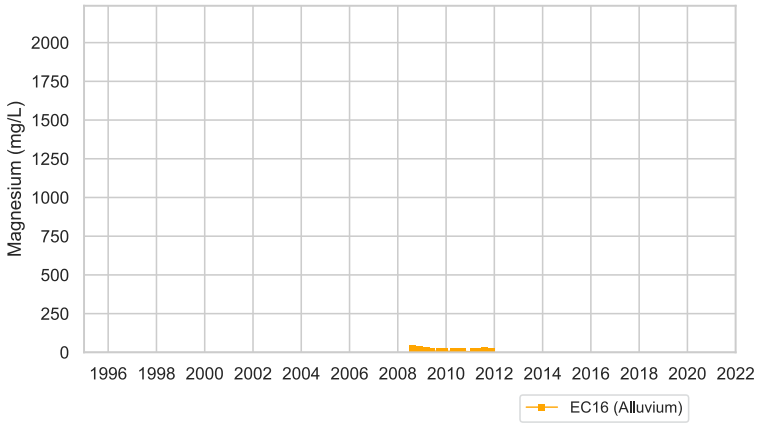

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

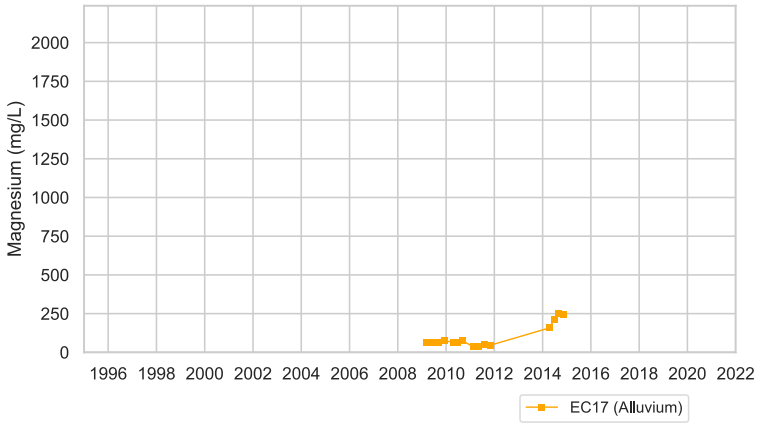

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

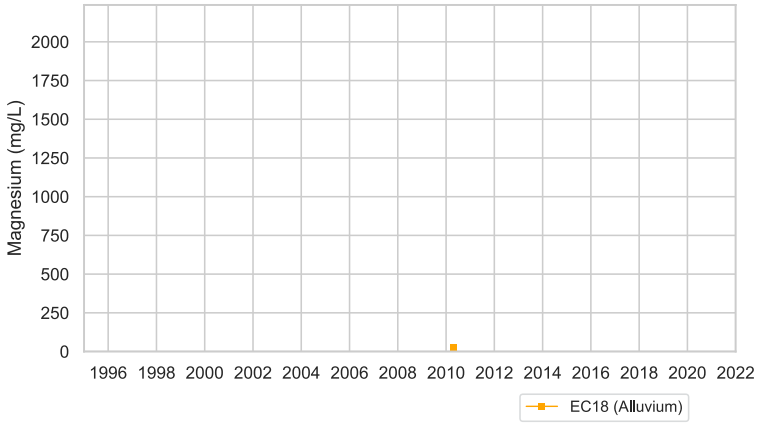

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

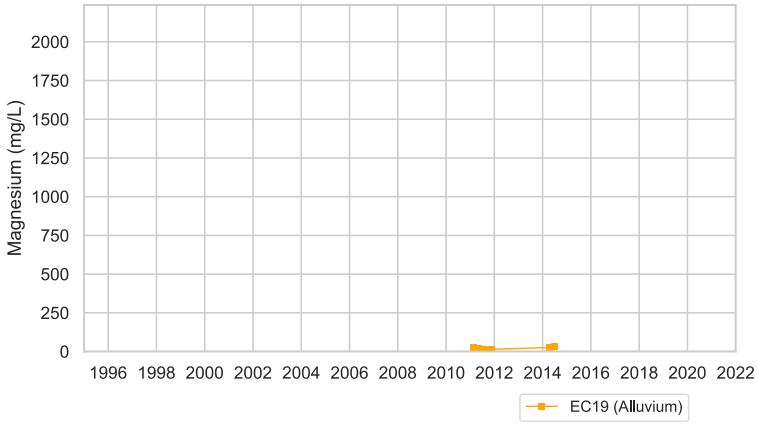

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

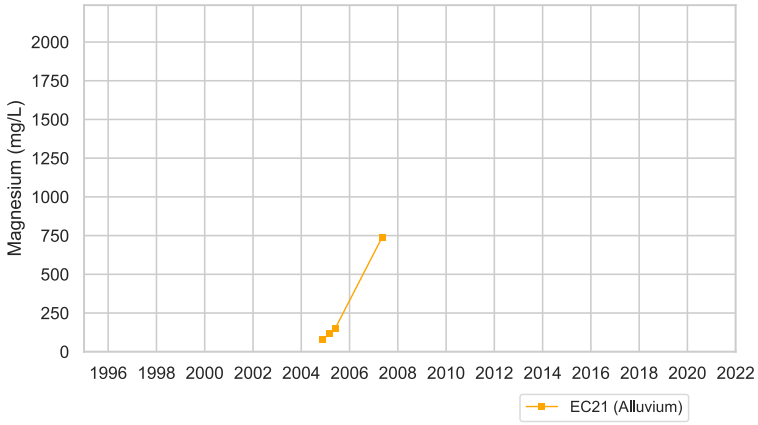

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

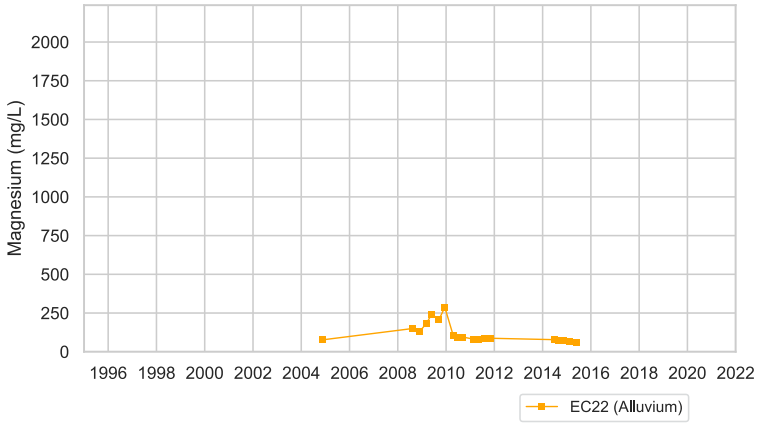

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

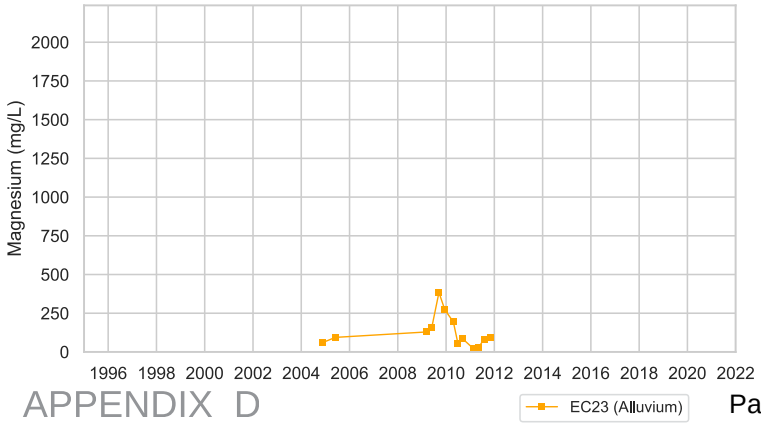

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

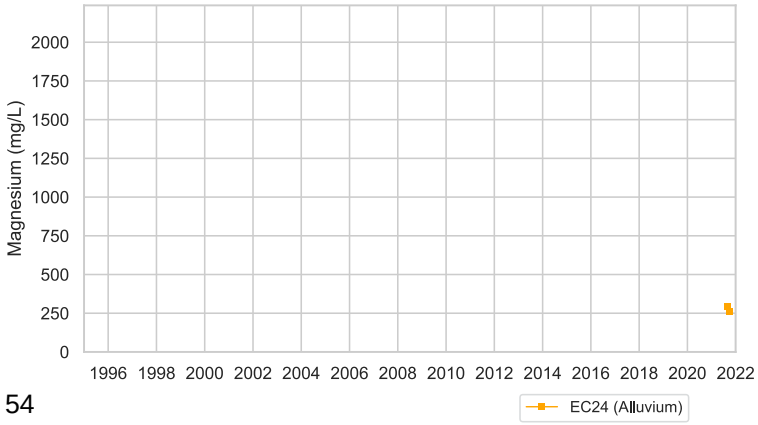

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

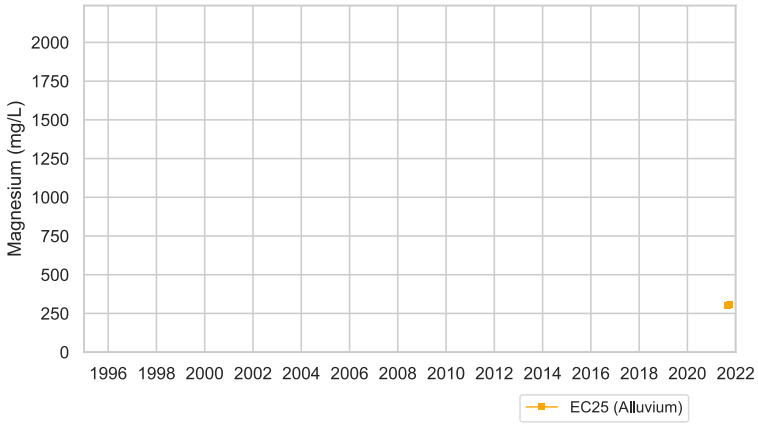

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

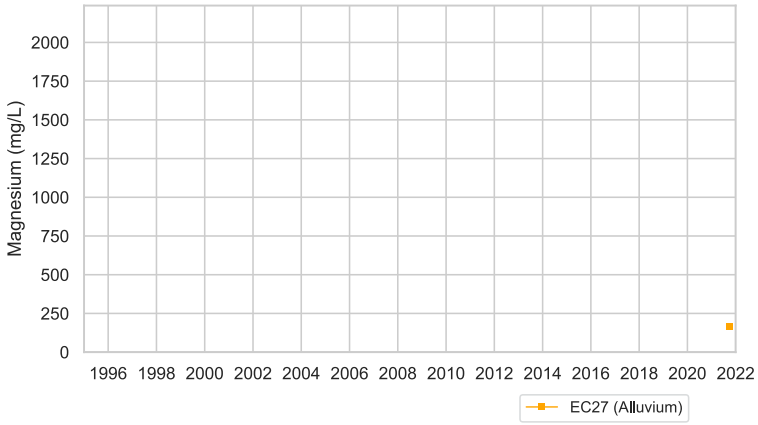

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

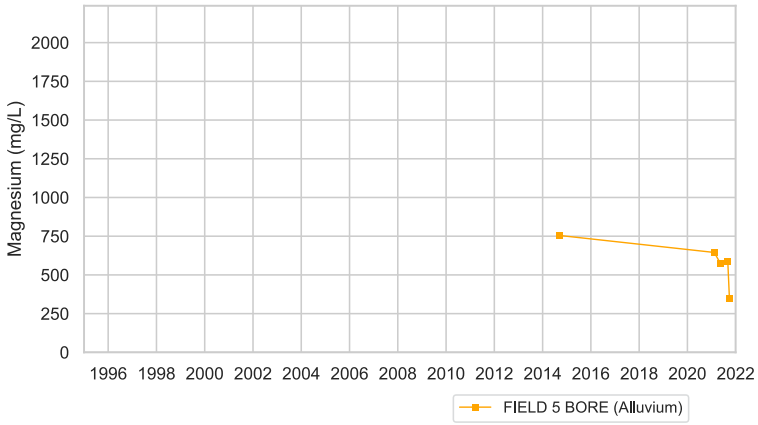

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

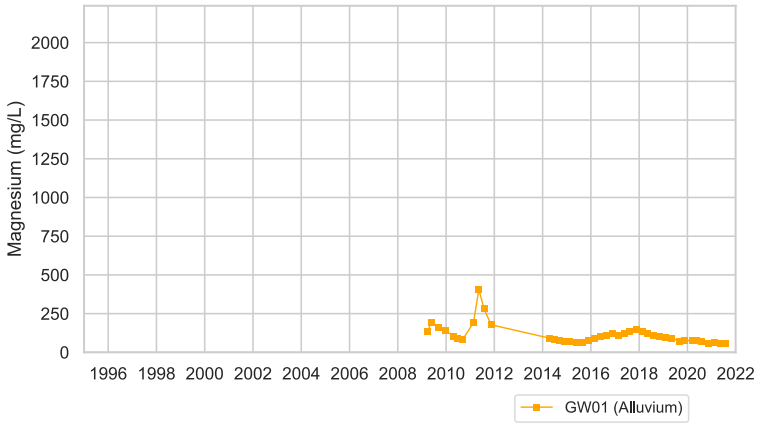

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

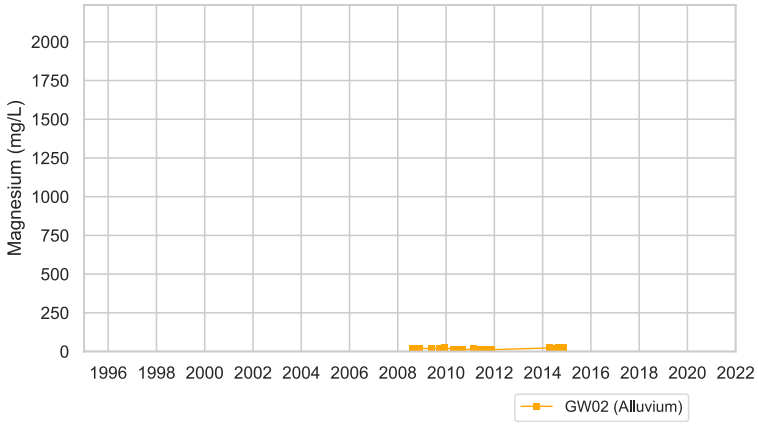

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

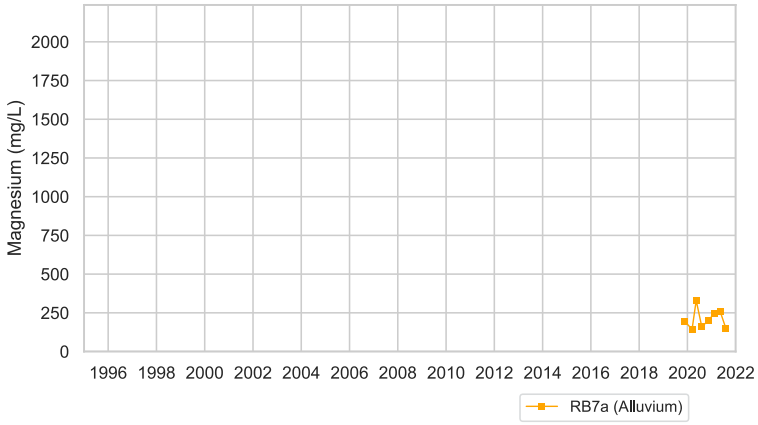

Magnesium (mg/L)
EC25 (Alluvium)

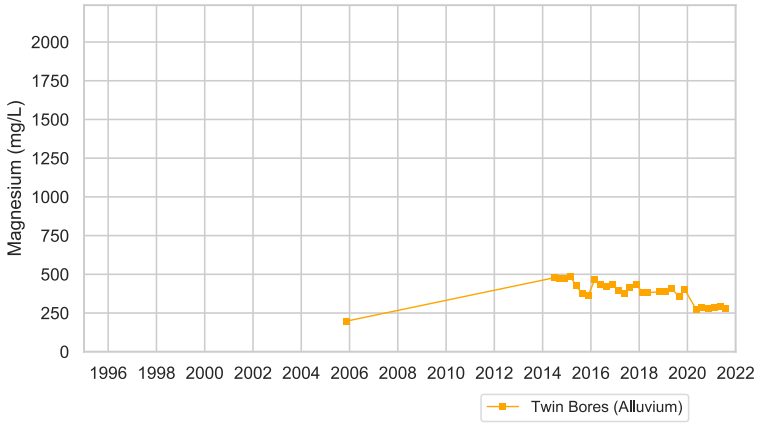

Magnesium (mg/L)
EC27 (Alluvium)

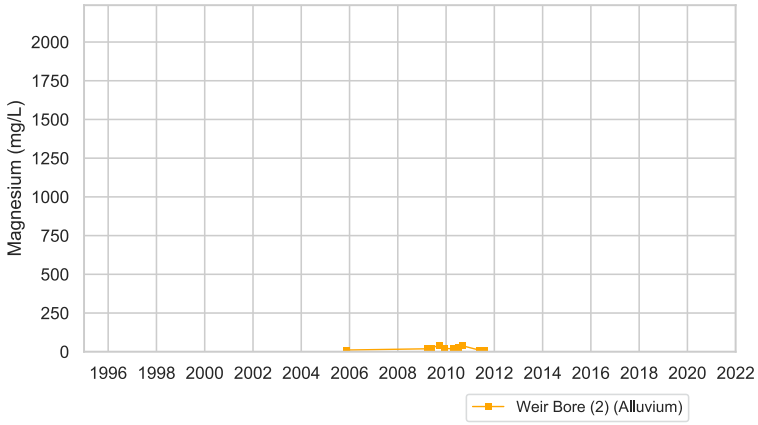

Magnesium (mg/L)
FIELD 5 BORE (Alluvium)

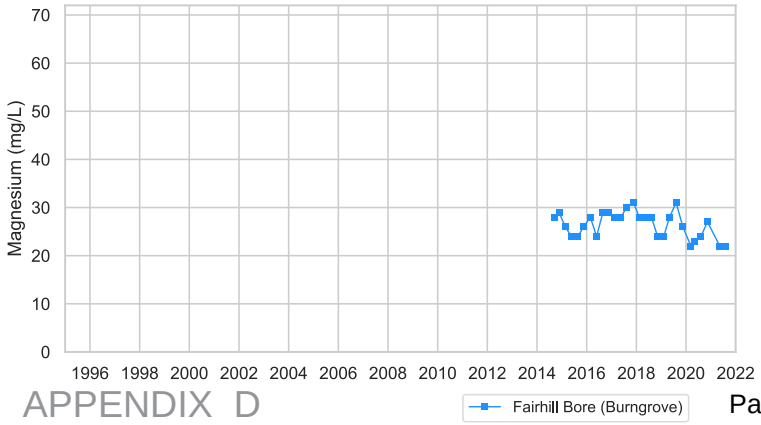

Magnesium (mg/L)
GW01 (Alluvium)

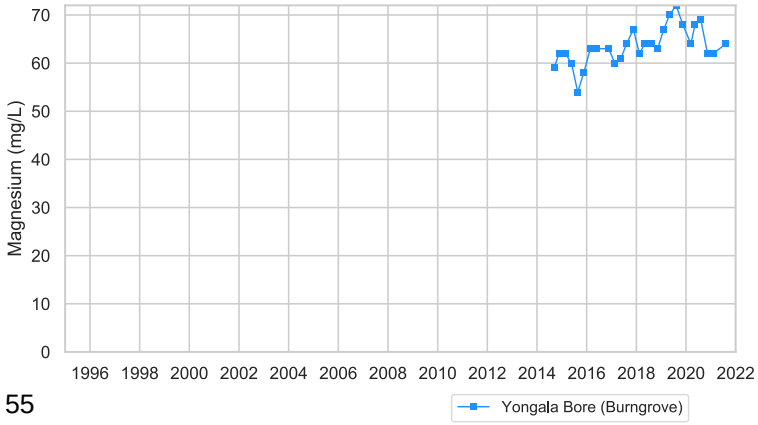

Magnesium (mg/L)
GW02 (Alluvium)

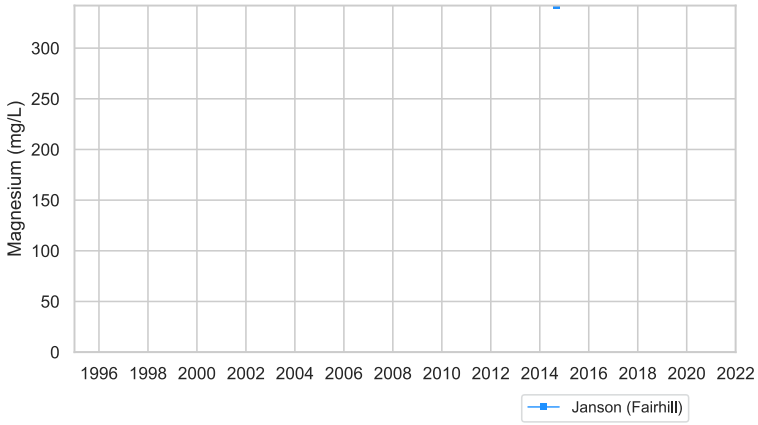

Magnesium (mg/L)
RB7a (Alluvium)

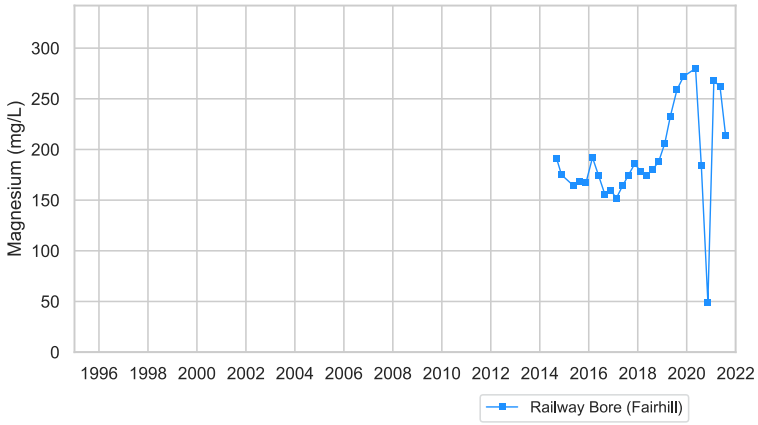

Magnesium (mg/L)
Twin Bores (Alluvium)

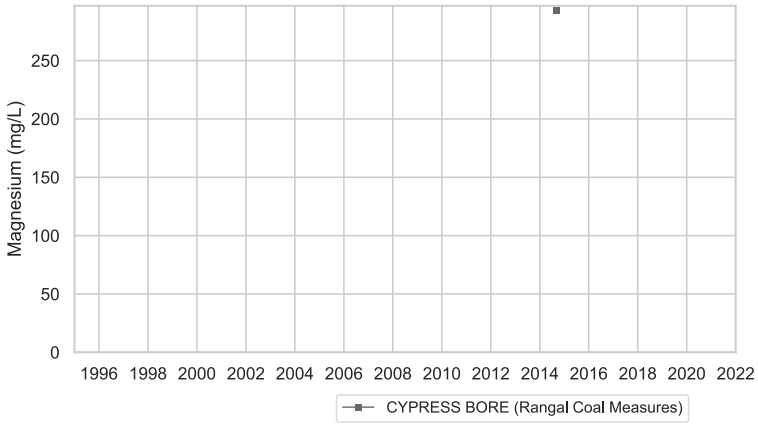

Magnesium (mg/L)
Weir Bore (2) (Alluvium)

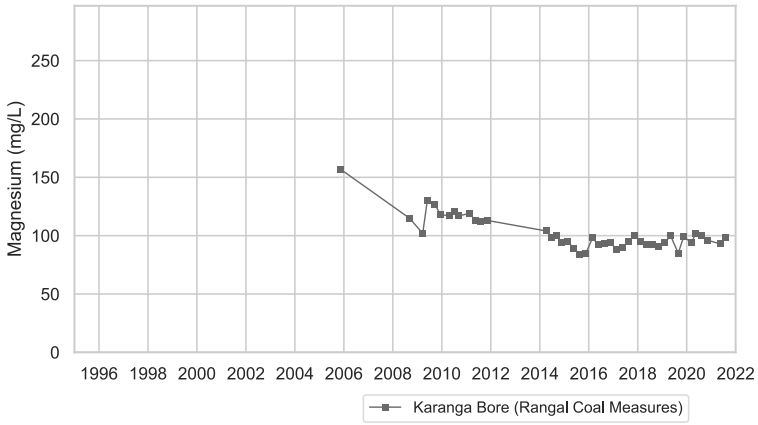

Magnesium (mg/L)
Fairhill Bore (Burngrove)

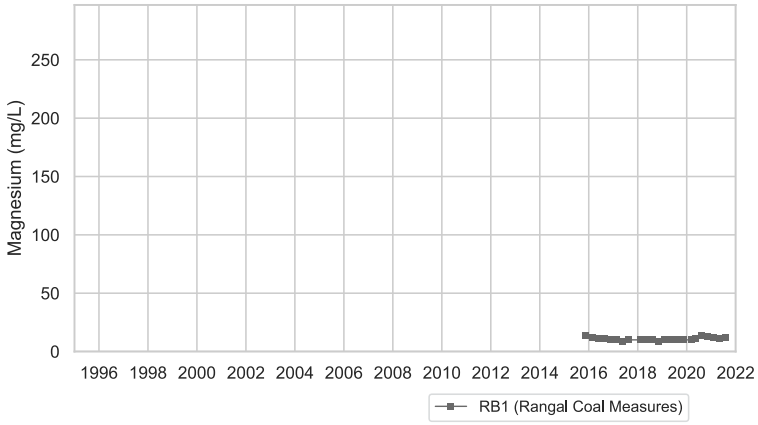

Magnesium (mg/L)
Yongala Bore (Burngrove)

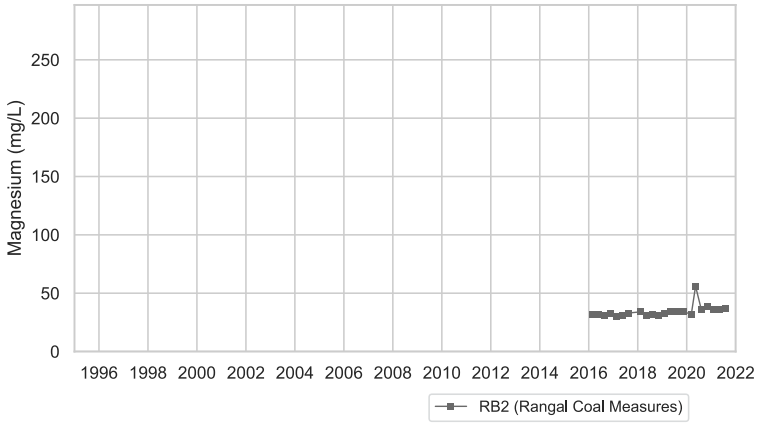

Magnesium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

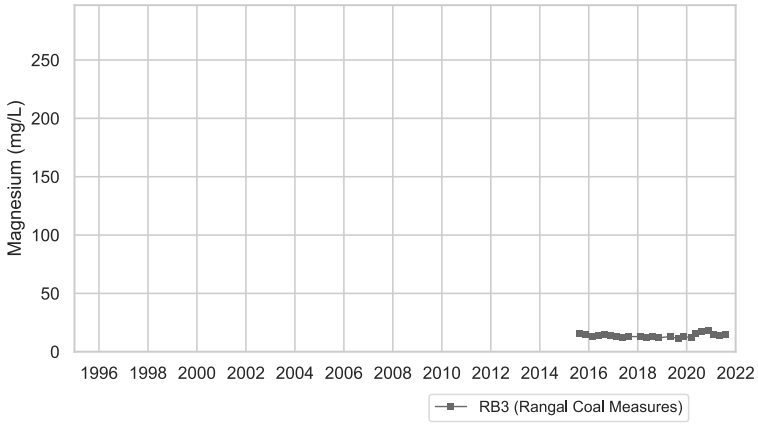

Magnesium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

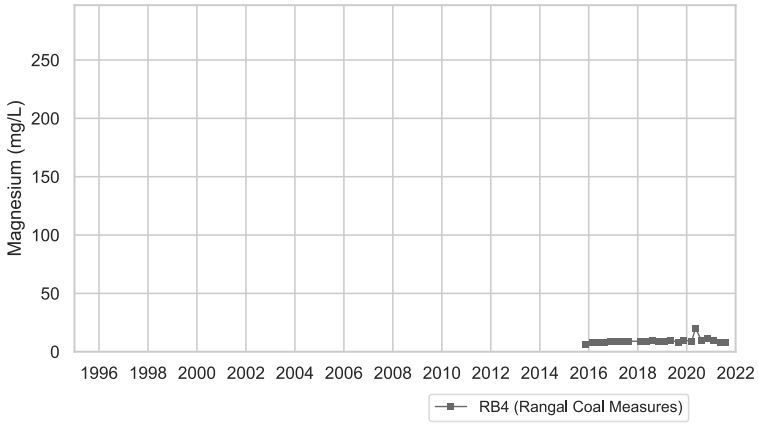

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

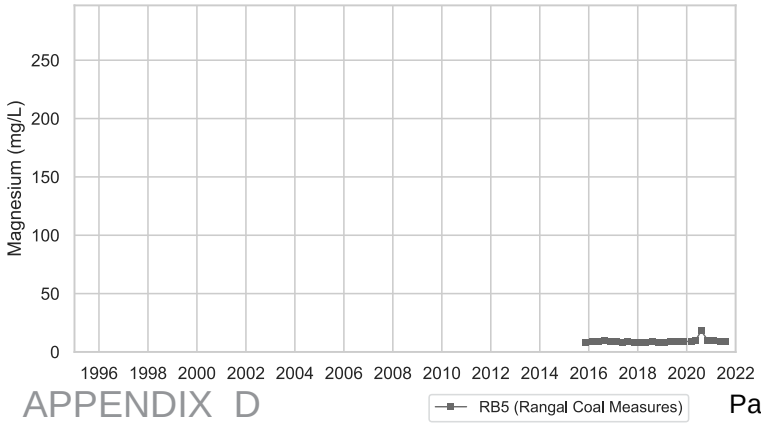

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

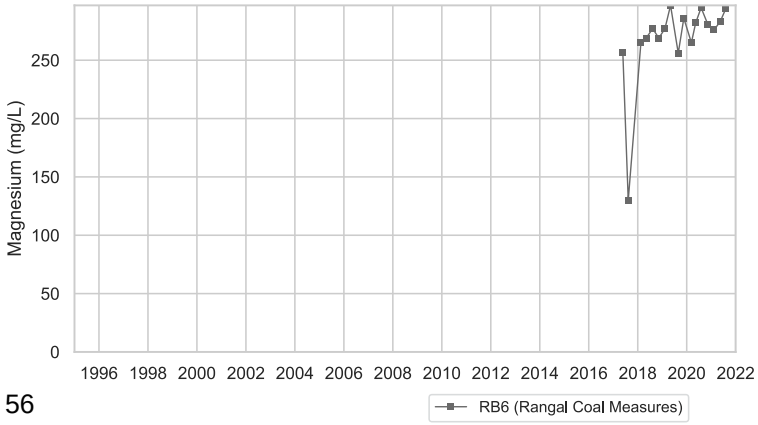

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

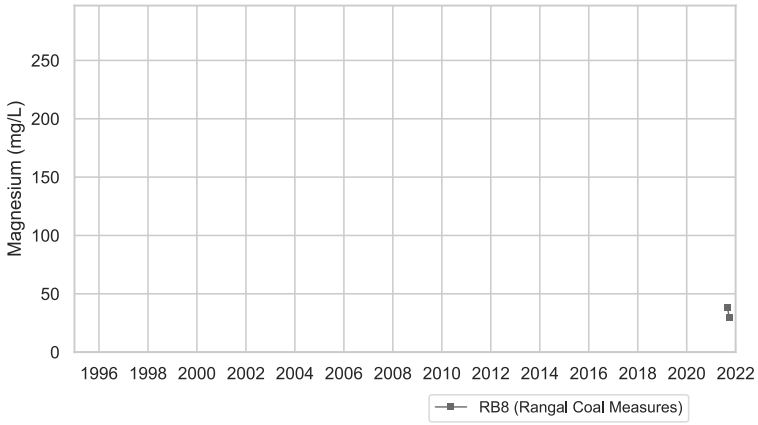

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

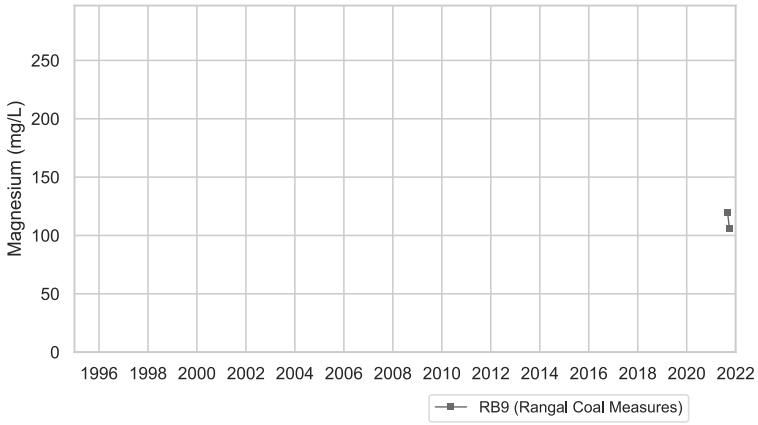

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

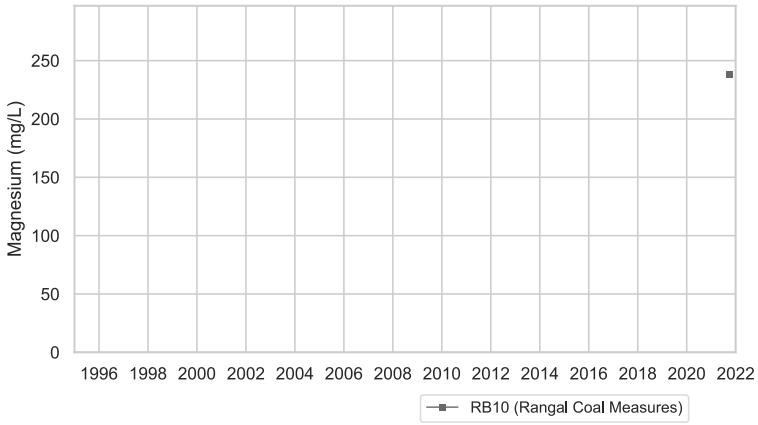

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

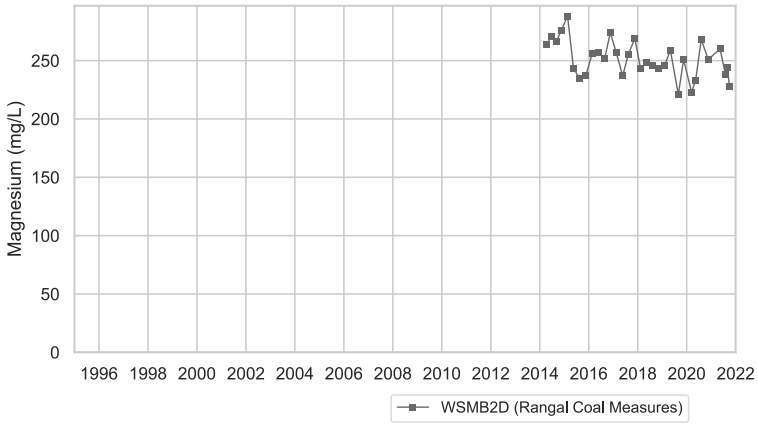

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

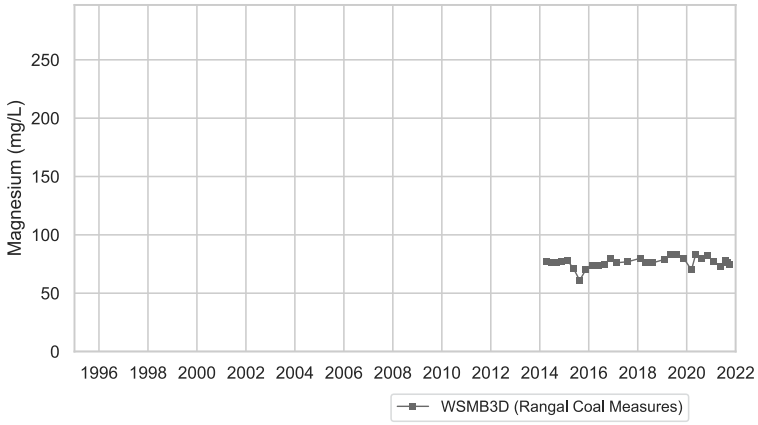

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

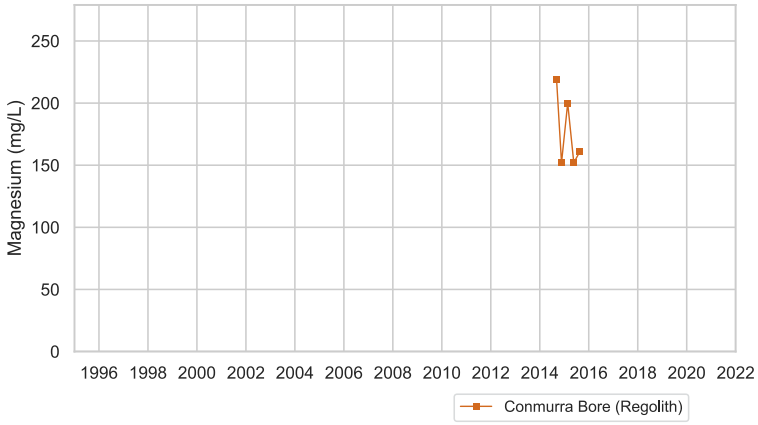

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

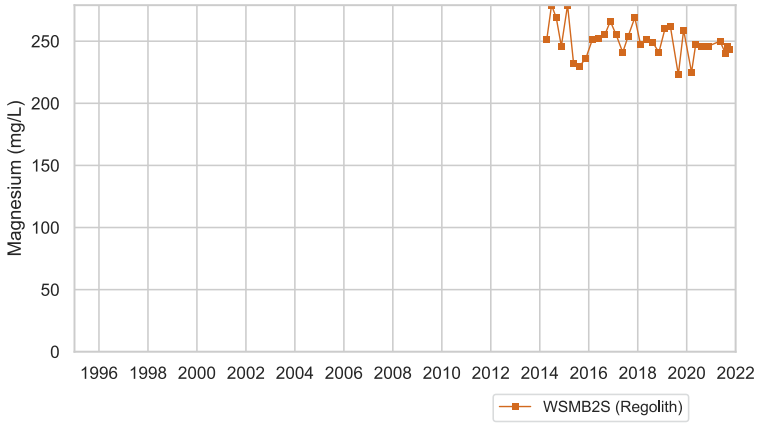

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

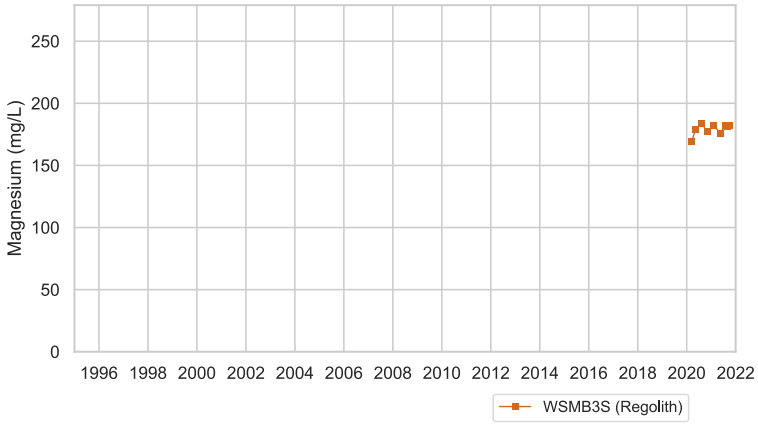

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

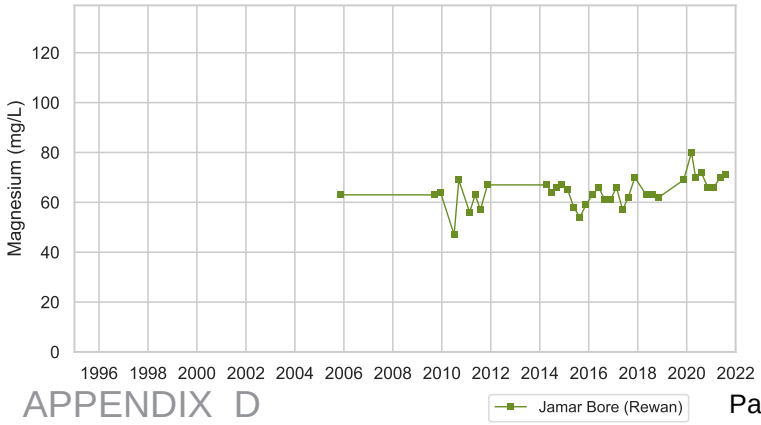

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

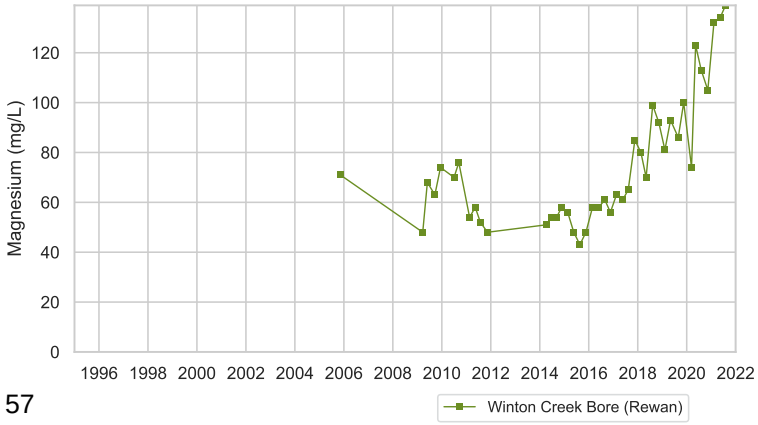

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

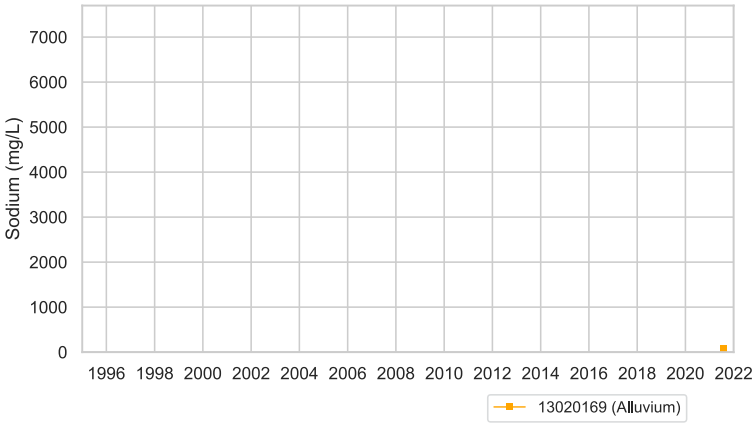

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

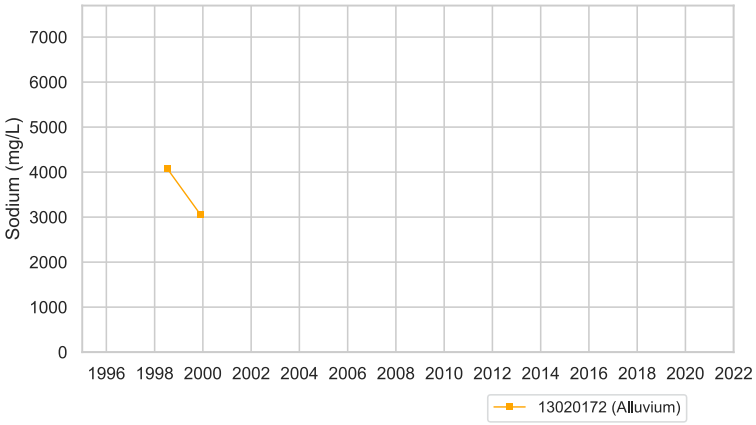

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

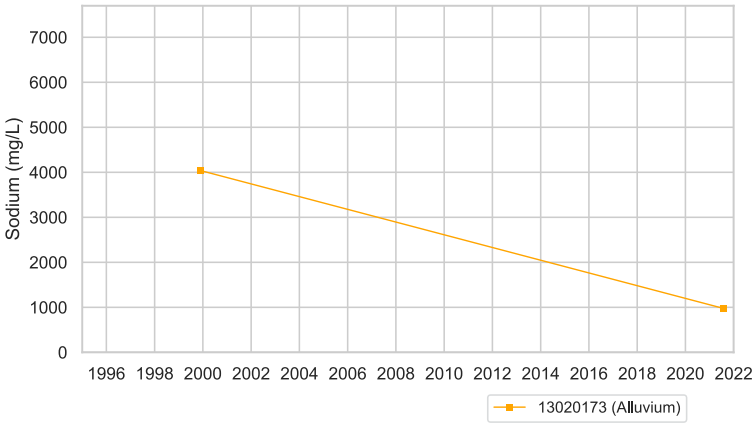

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

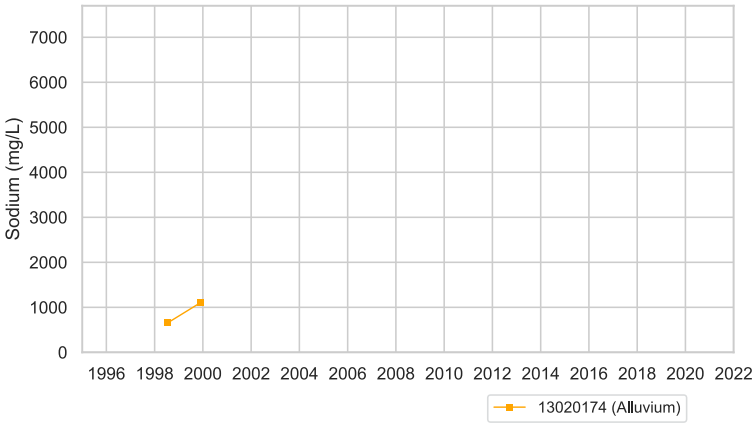

Magnesium (mg/L)
0
20
40
60
80
100
120
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

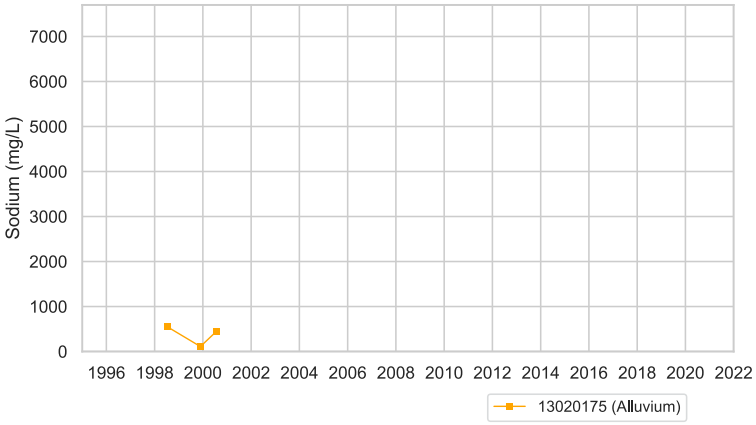

Magnesium (mg/L)
0
20
40
60
80
100
120
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

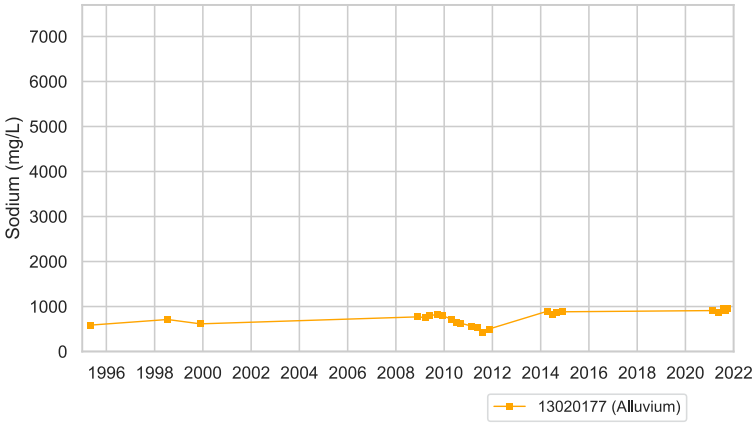

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

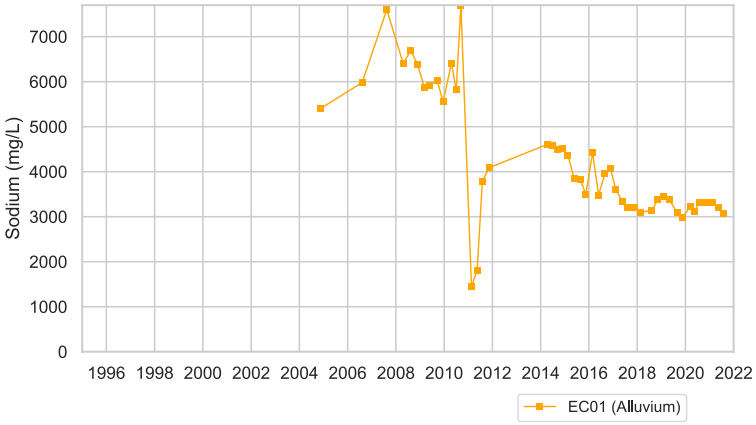

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

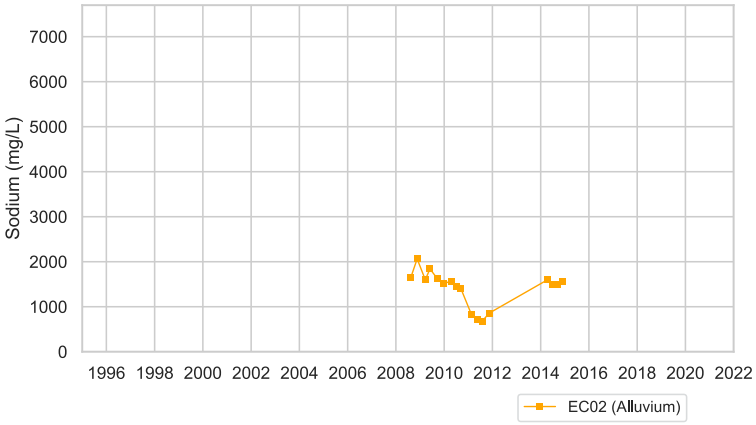

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

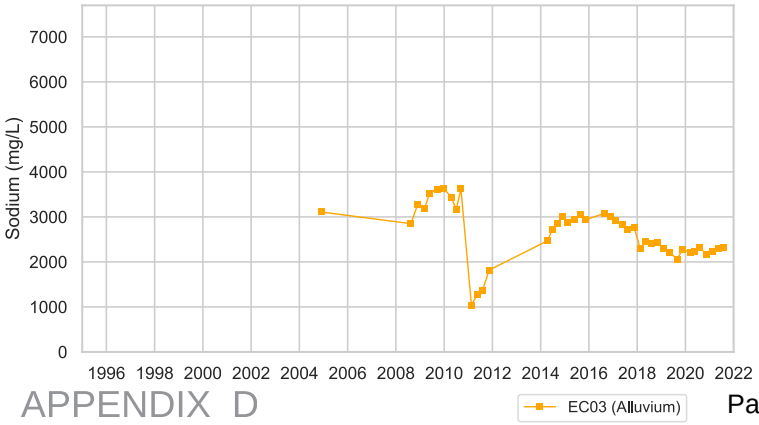

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

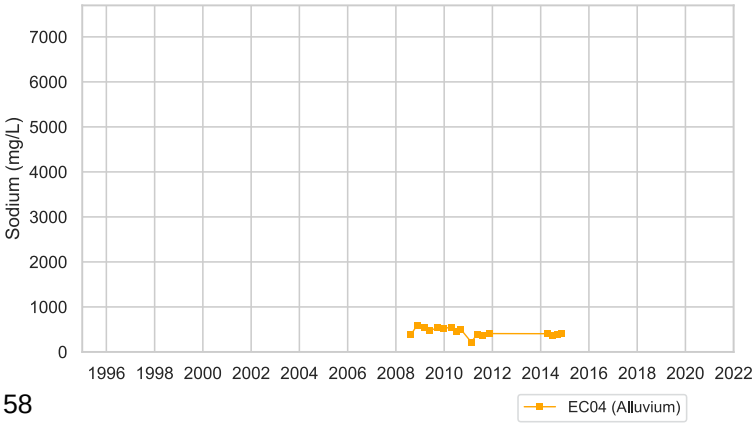

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

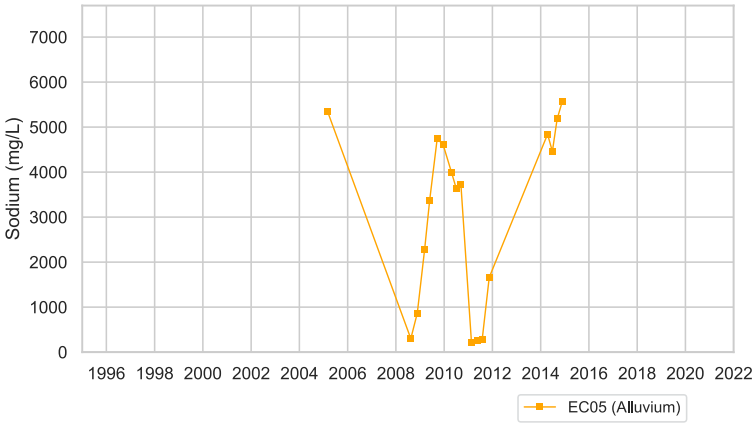

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

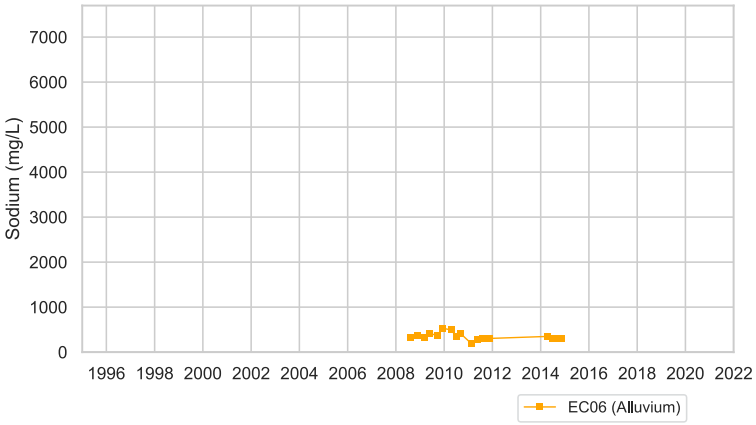

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

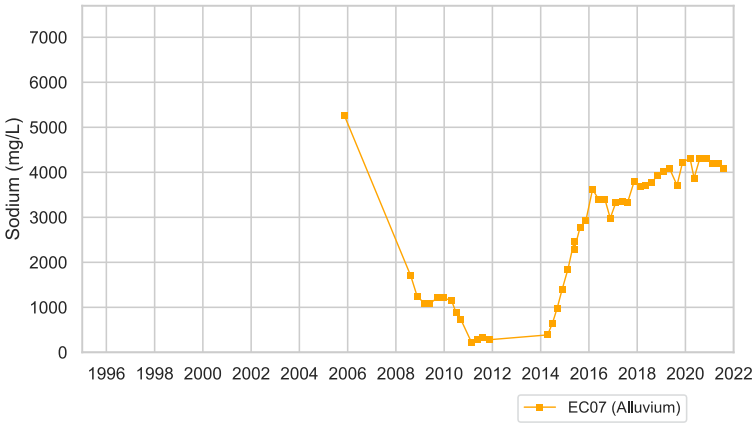

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

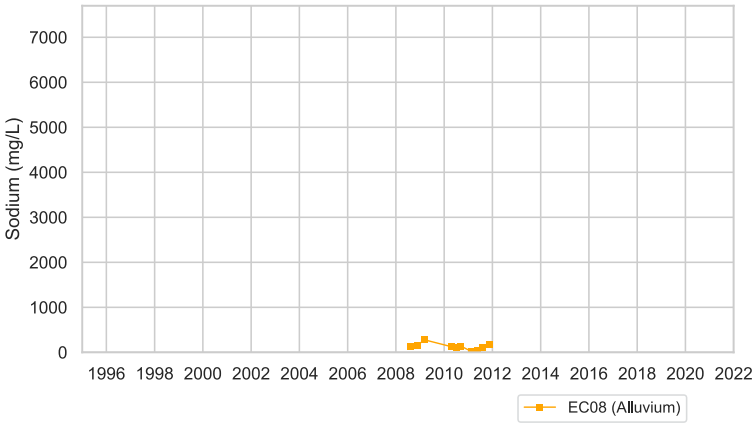

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

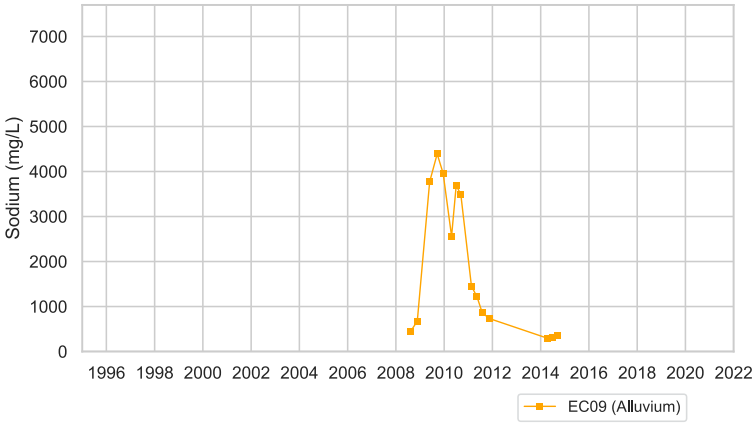

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

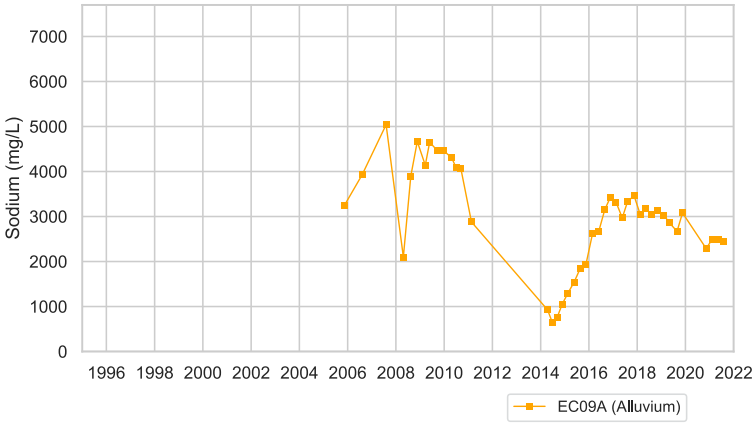

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

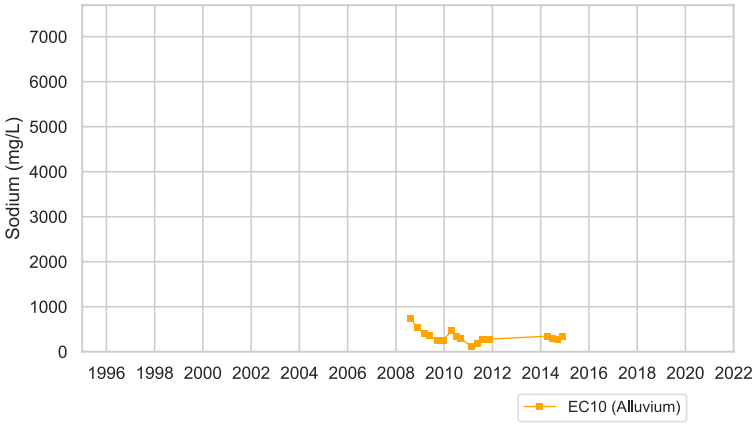

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

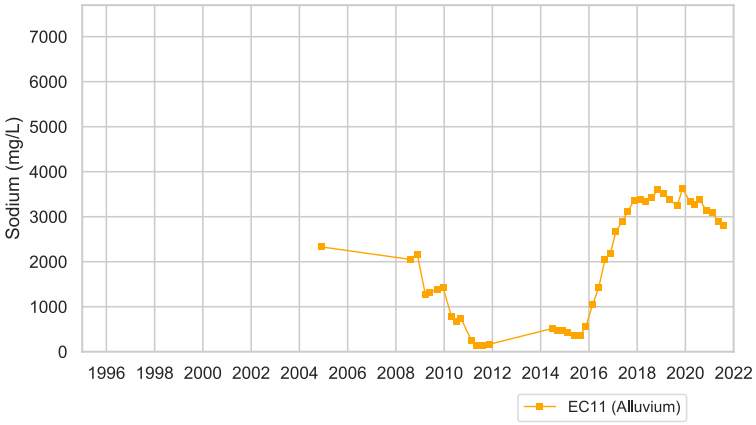

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

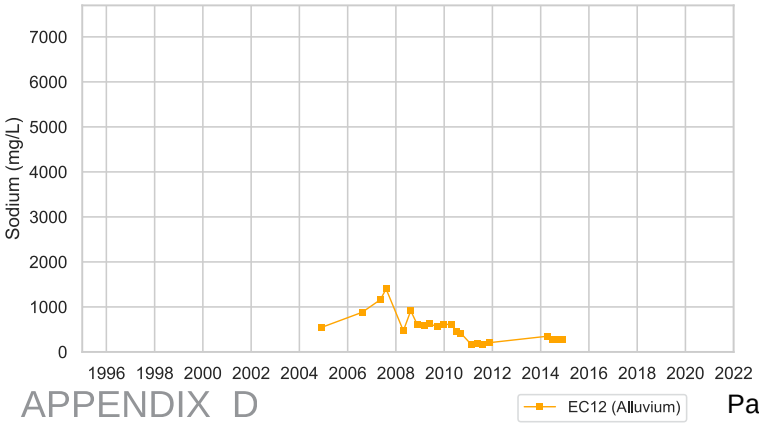

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

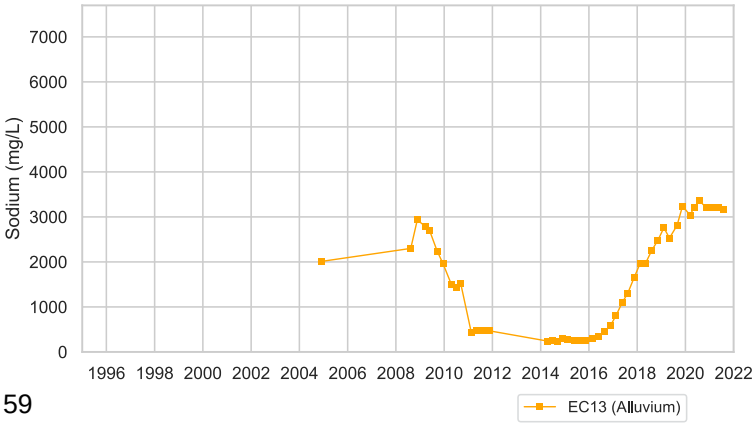

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

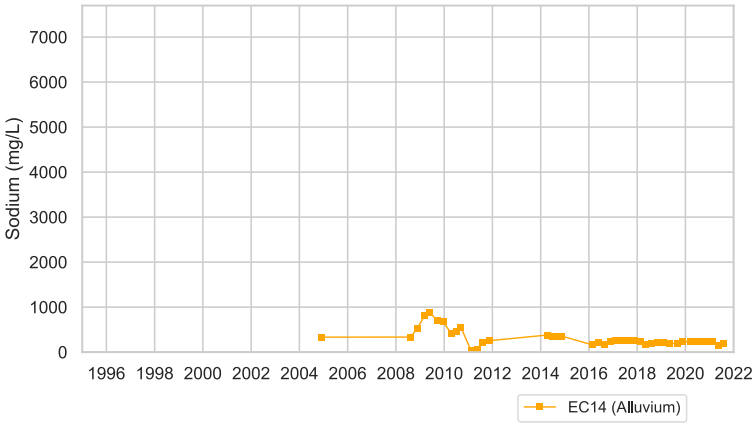

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

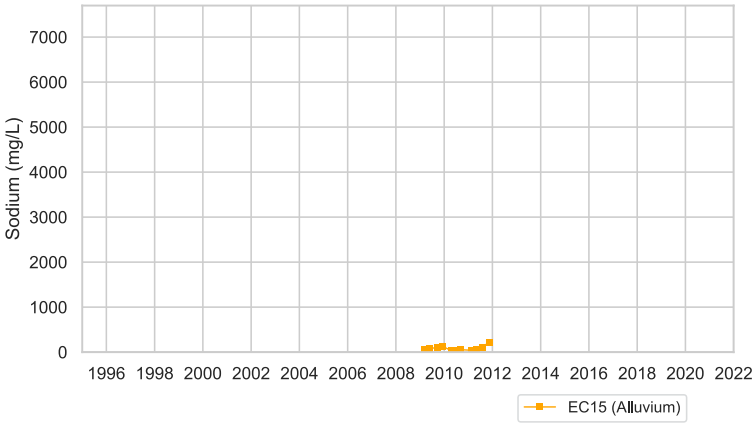

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

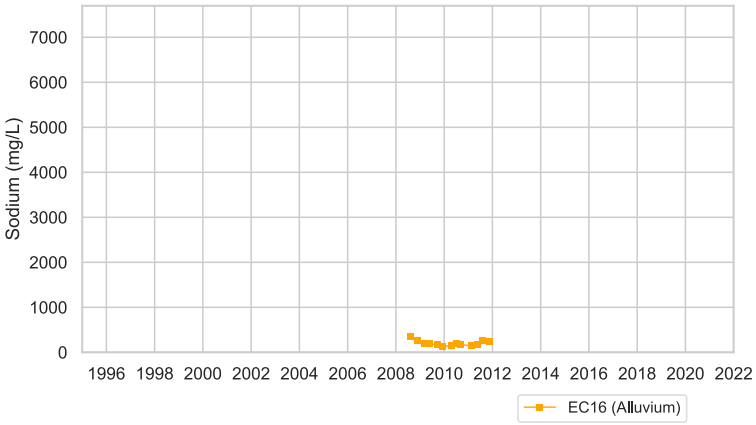

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

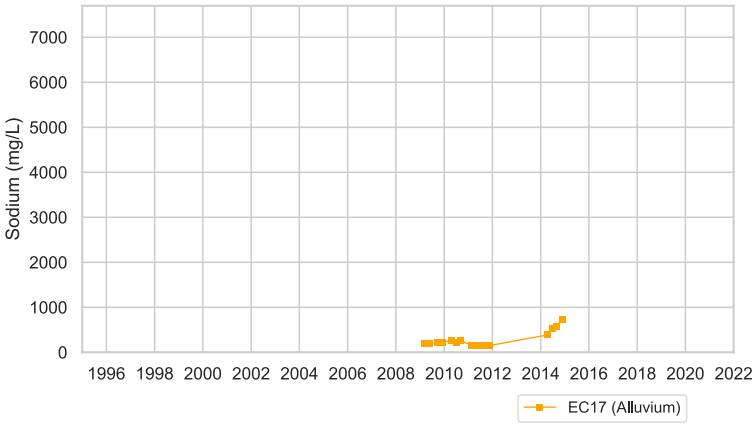

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

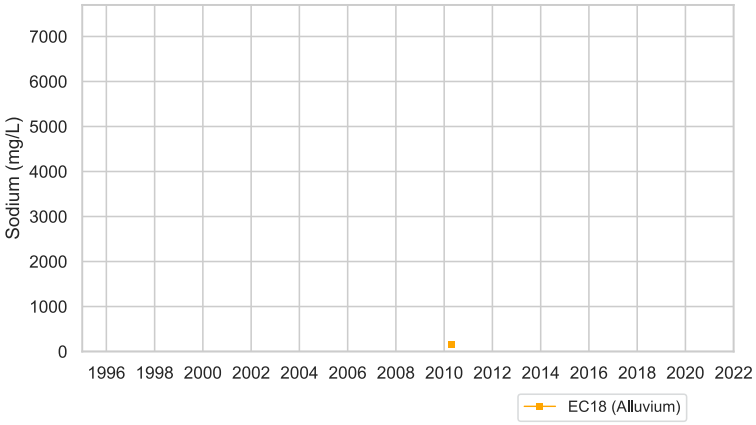

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

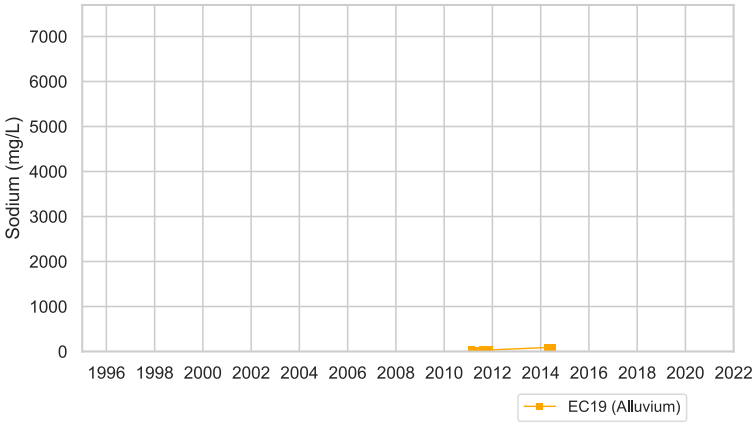

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

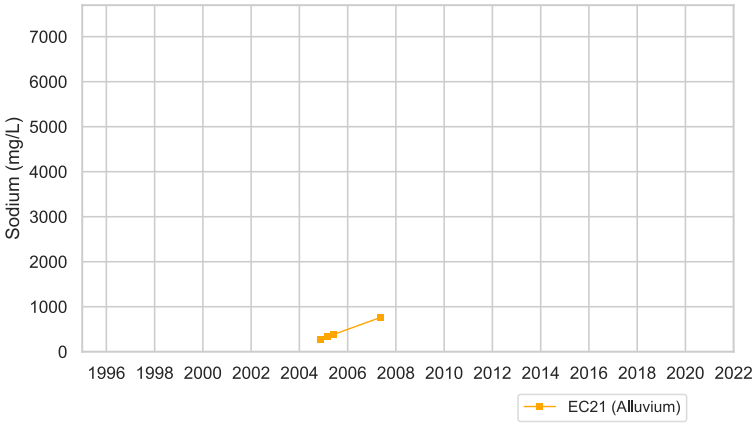

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

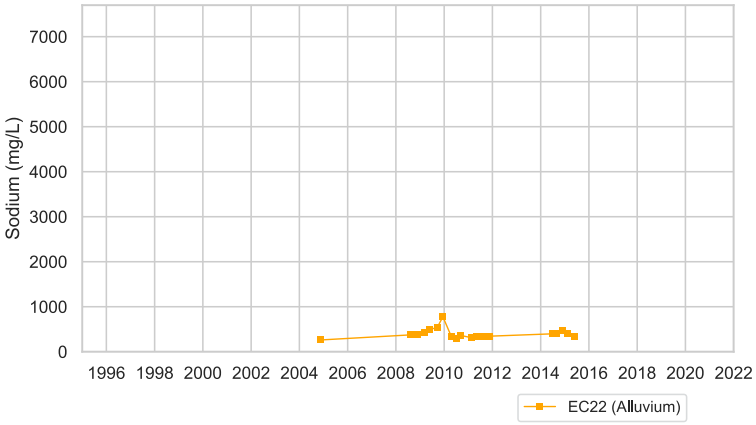

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

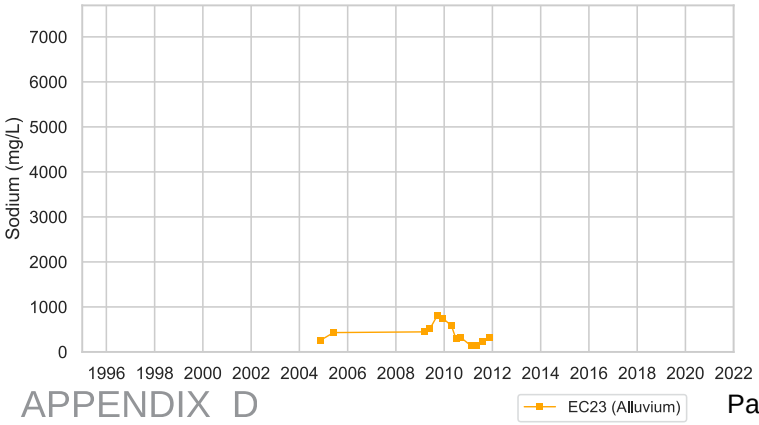

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

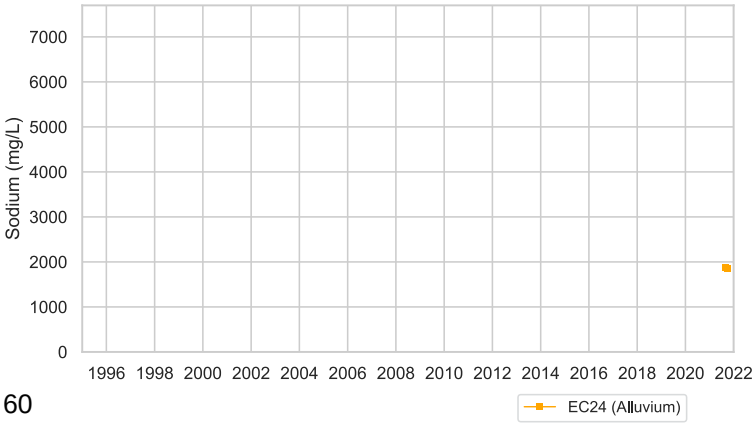

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

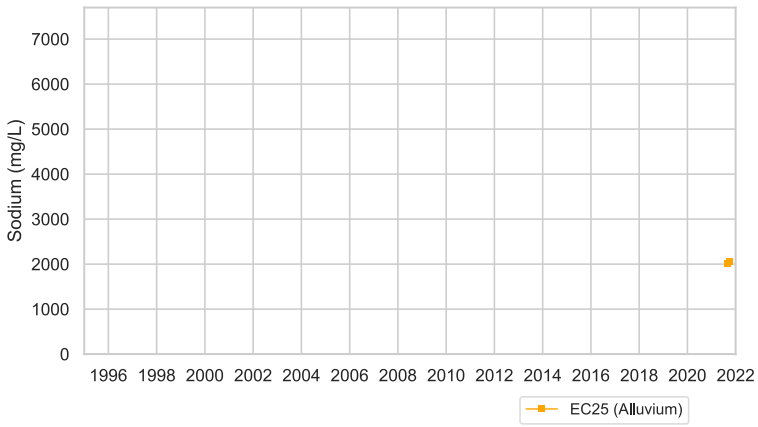

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

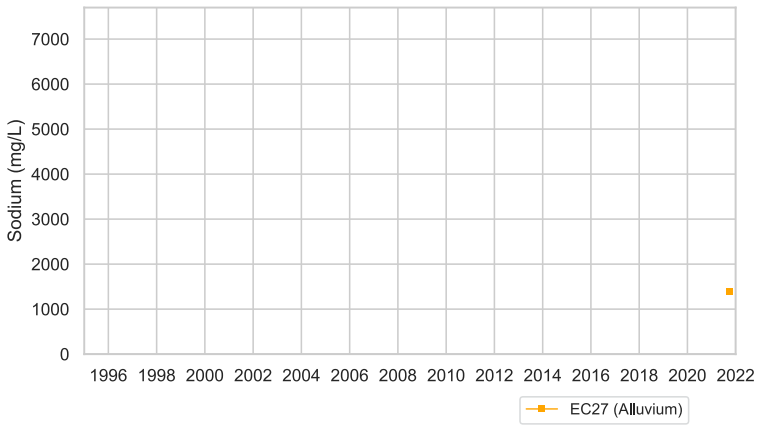

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

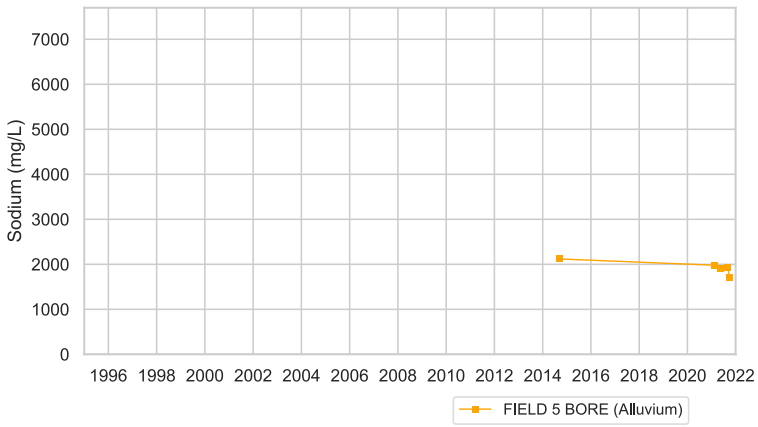

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

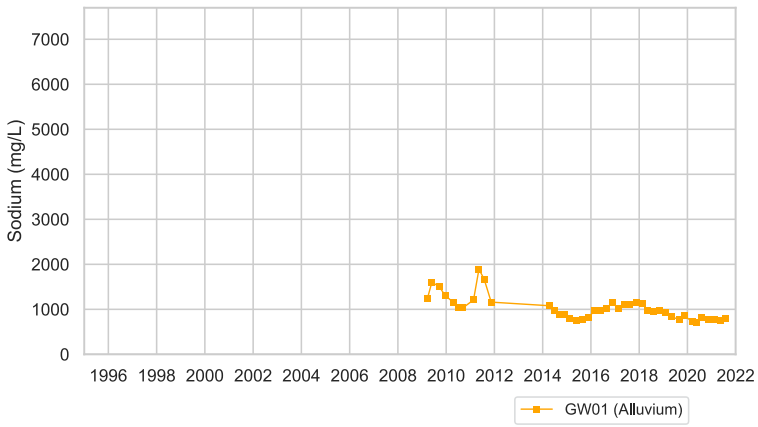

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

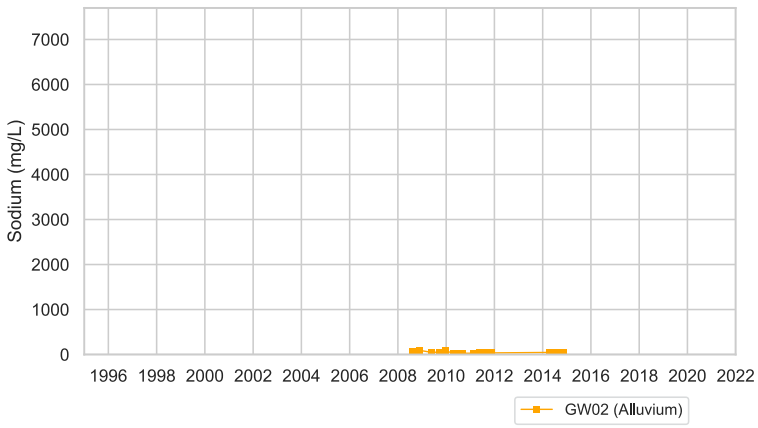

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

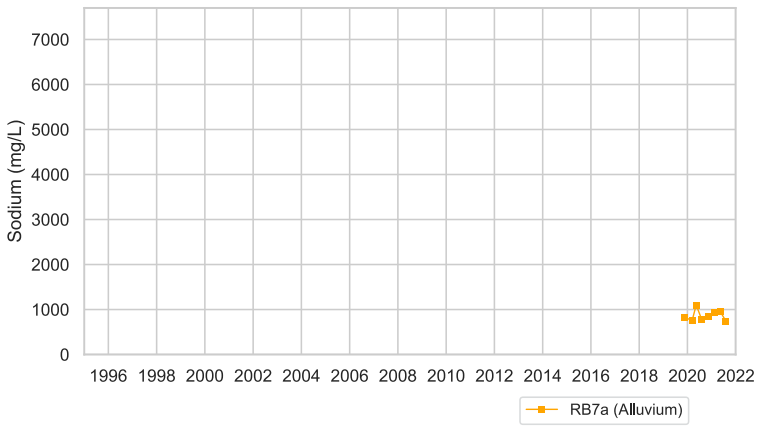

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

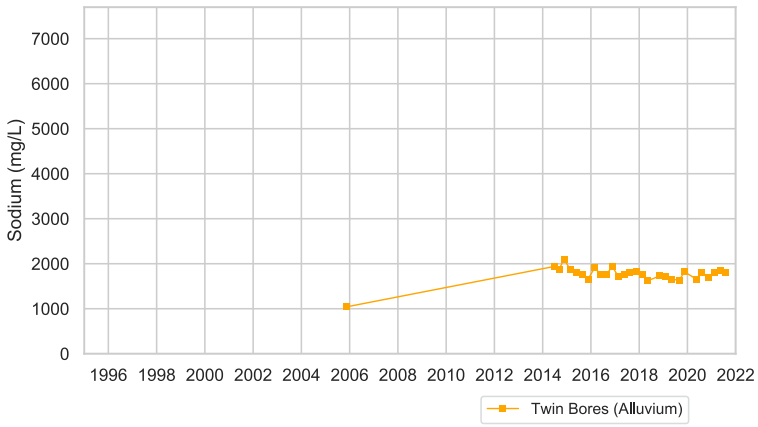

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

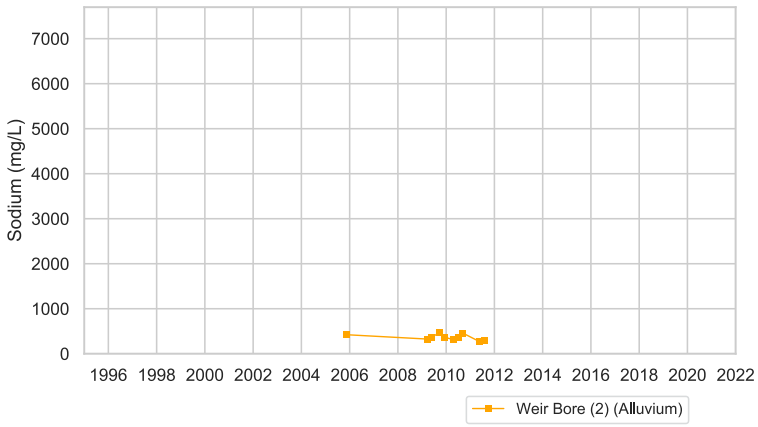

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

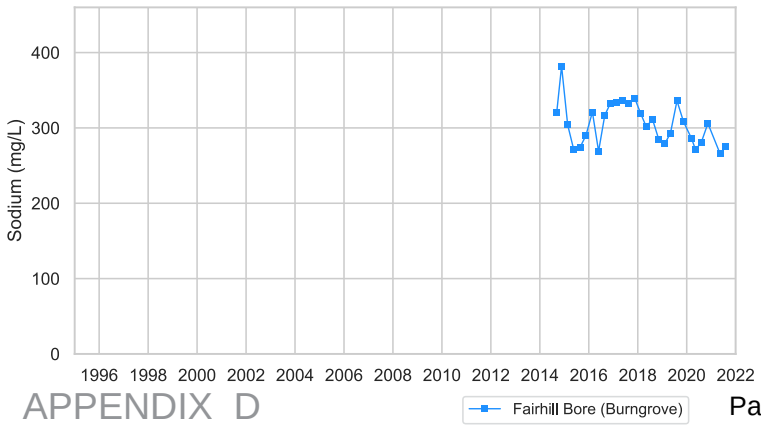

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

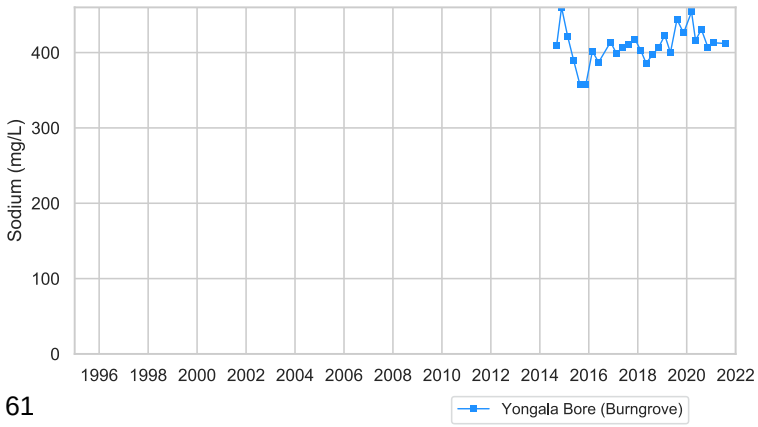

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

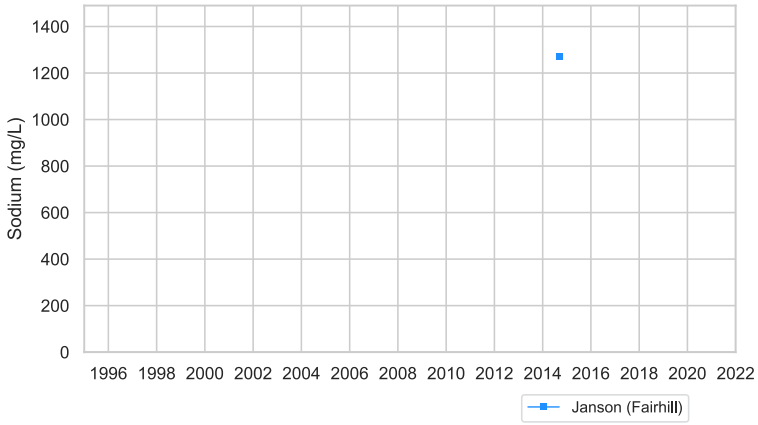

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

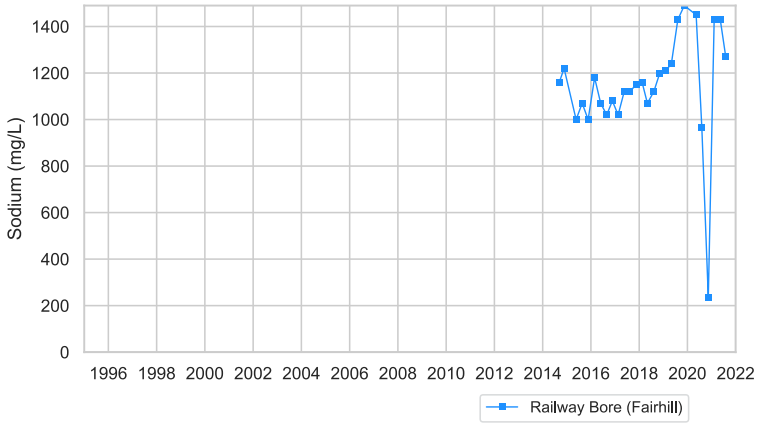

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

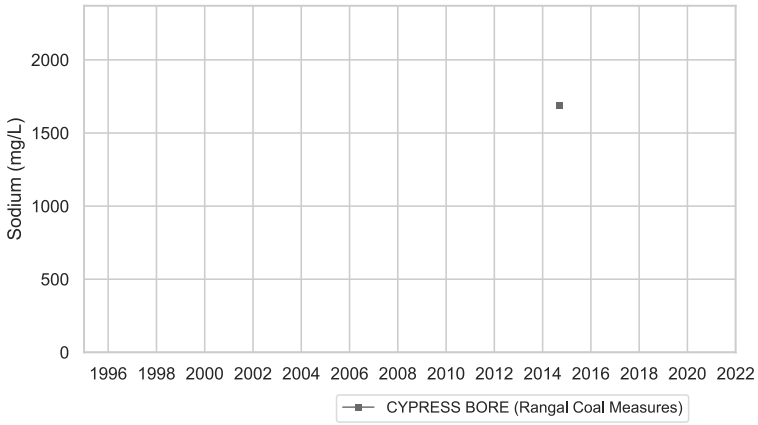

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

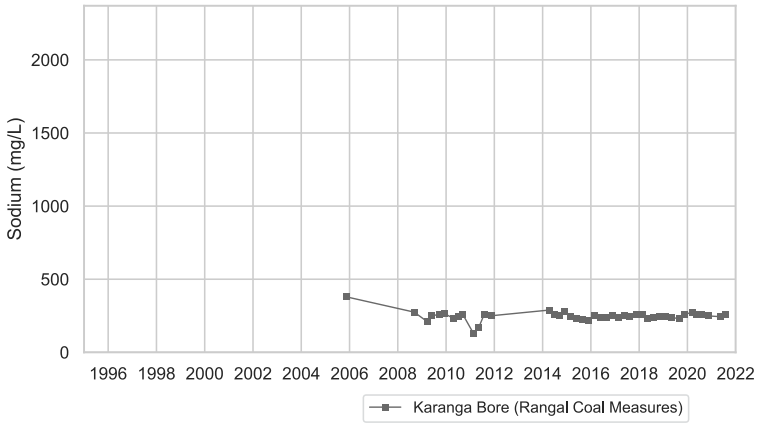

Sodium (mg/L)
0
100
200
300
400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

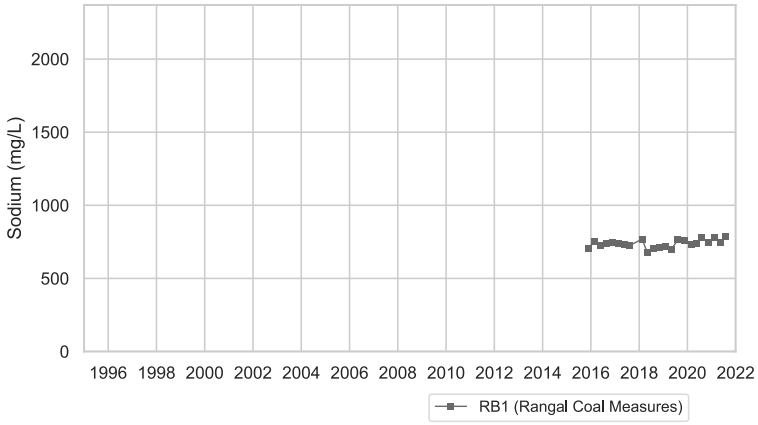

Sodium (mg/L)
0
100
200
300
400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

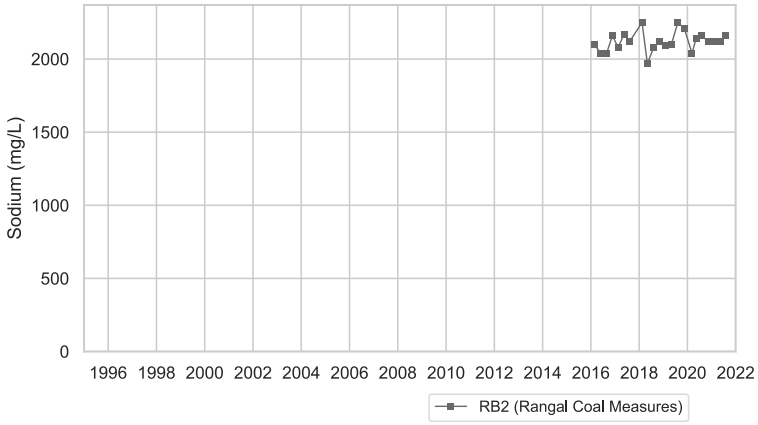

Sodium (mg/L)
0
200
400
600
800
1000
1200
1400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

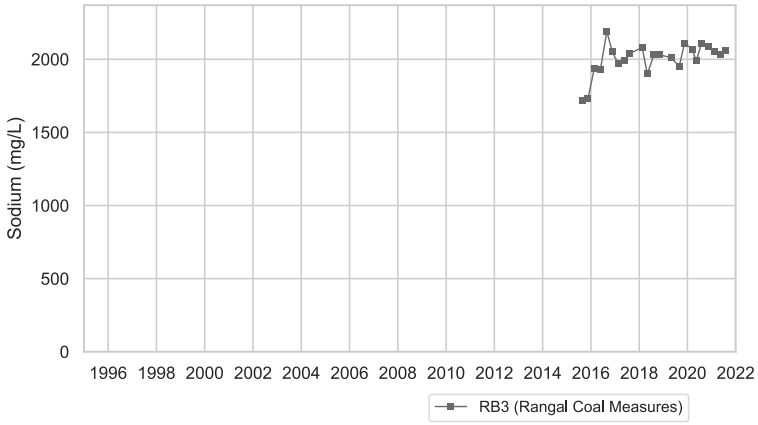

Sodium (mg/L)
0
200
400
600
800
1000
1200
1400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

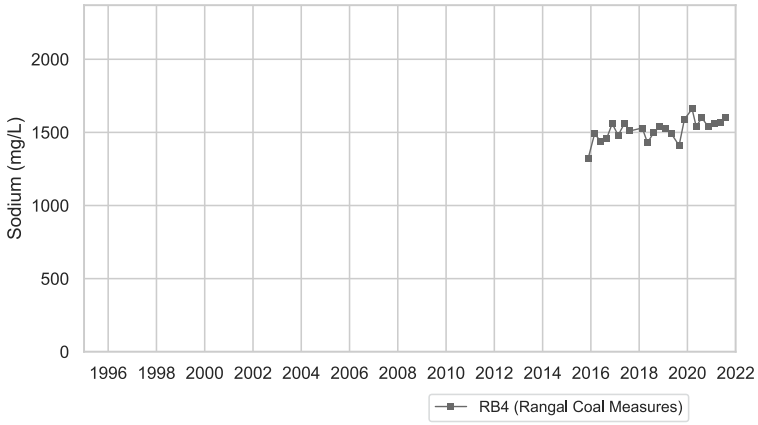

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

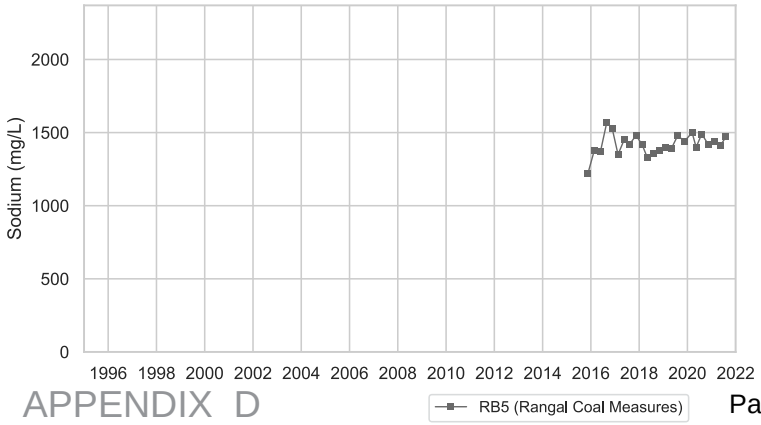

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

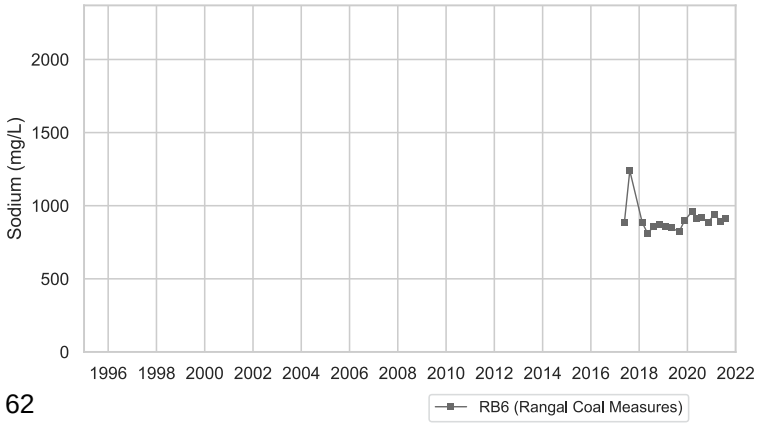

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

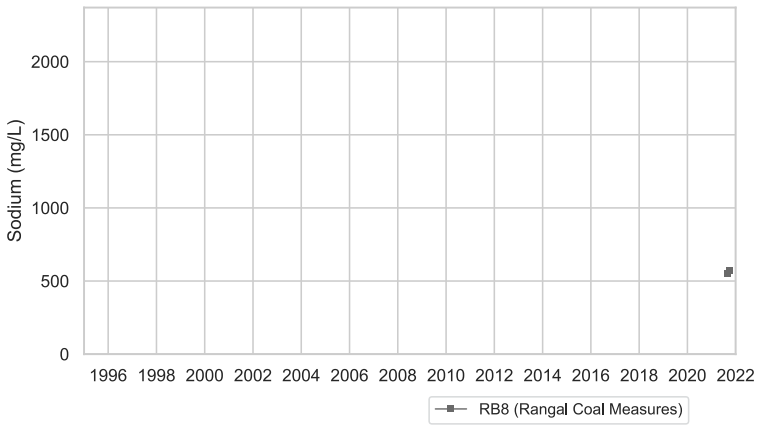

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

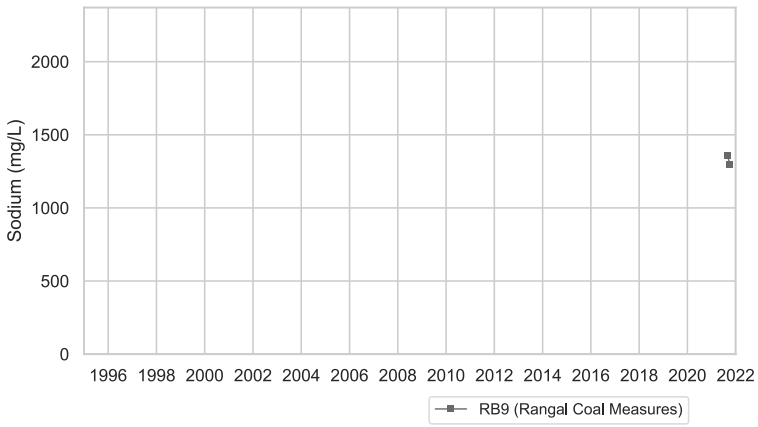

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

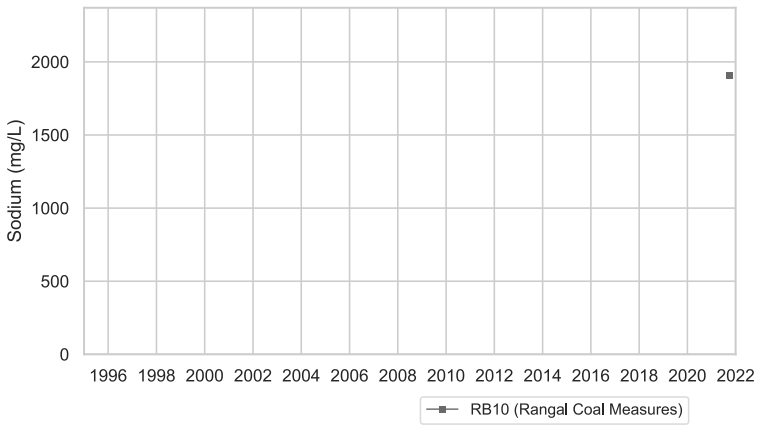

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

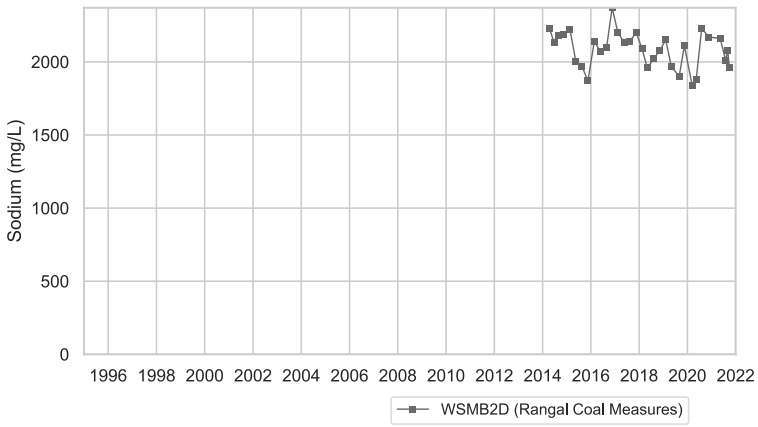

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

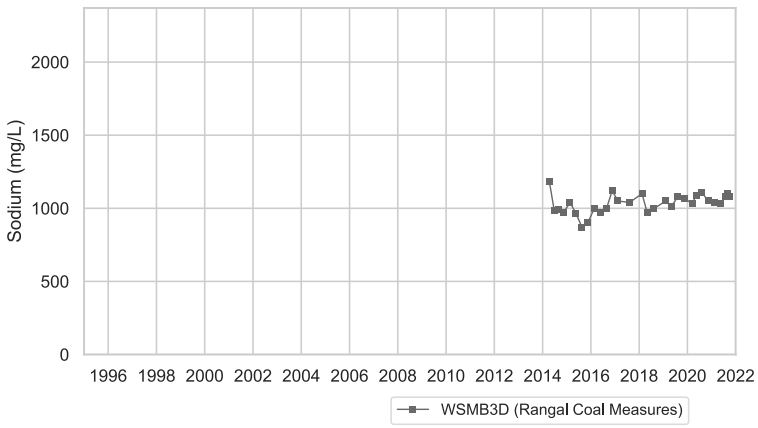

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

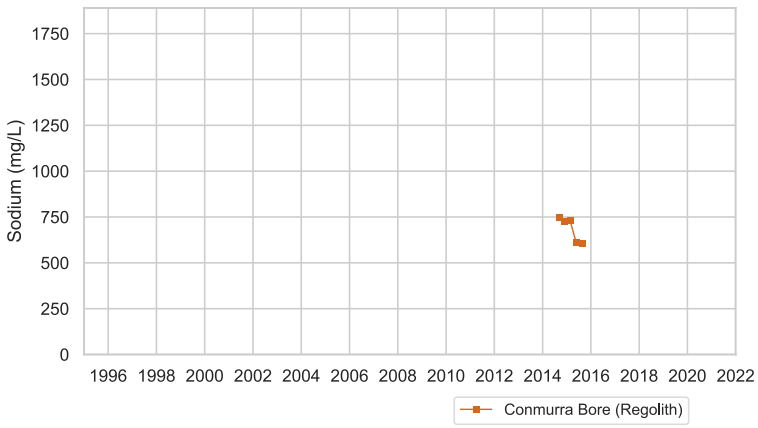

Sodium (mg/L)
RB8 (Rangal Coal Measures)


Sodium (mg/L)
RB9 (Rangal Coal Measures)

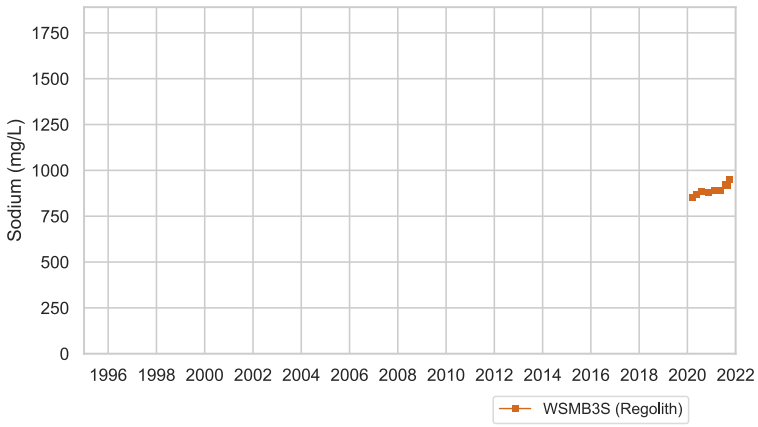

Sodium (mg/L)
RB10 (Rangal Coal Measures)

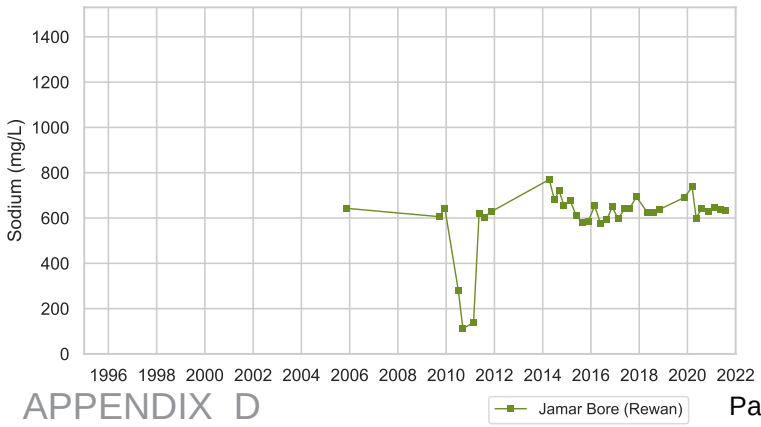

Sodium (mg/L)
WSMB2D (Rangal Coal Measures)

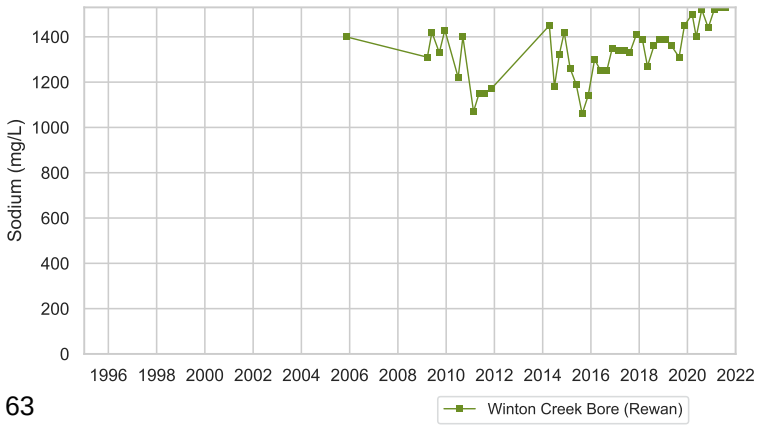

Sodium (mg/L)
WSMB3D (Rangal Coal Measures)

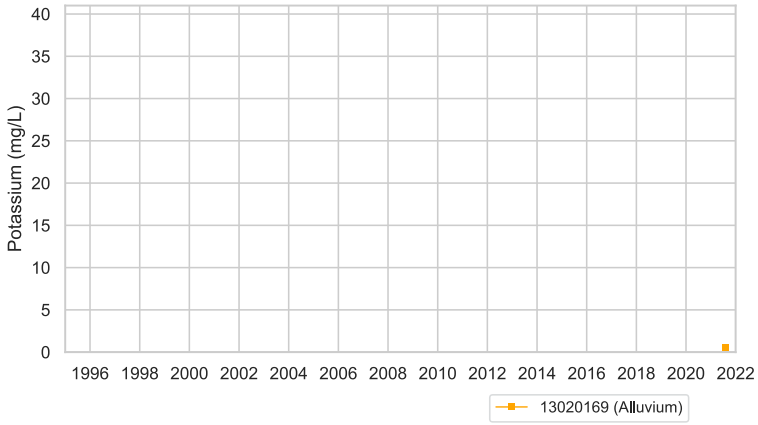

Sodium (mg/L)
Conmurra Bore (Regolith)

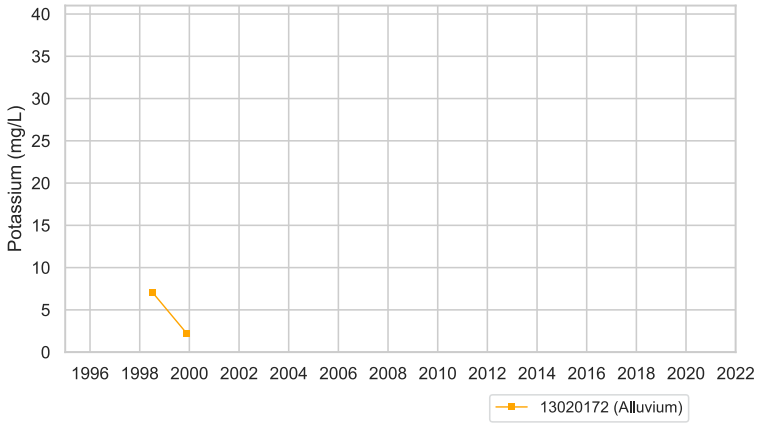
Sodium (mg/L)
WSMB2S (Regolith)

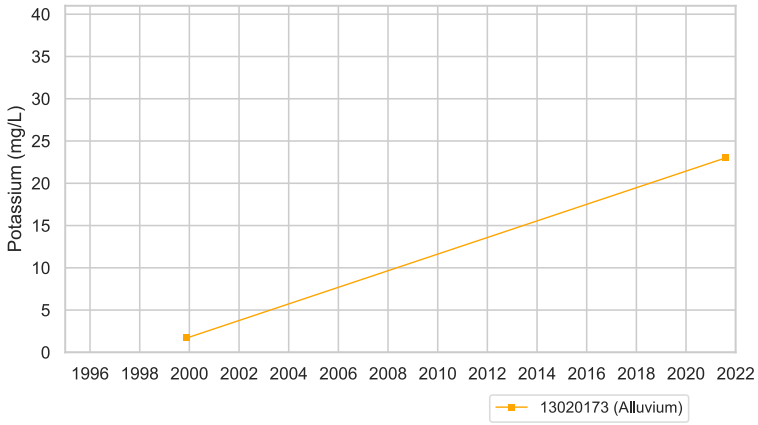

Sodium (mg/L)
WSMB3S (Regolith)

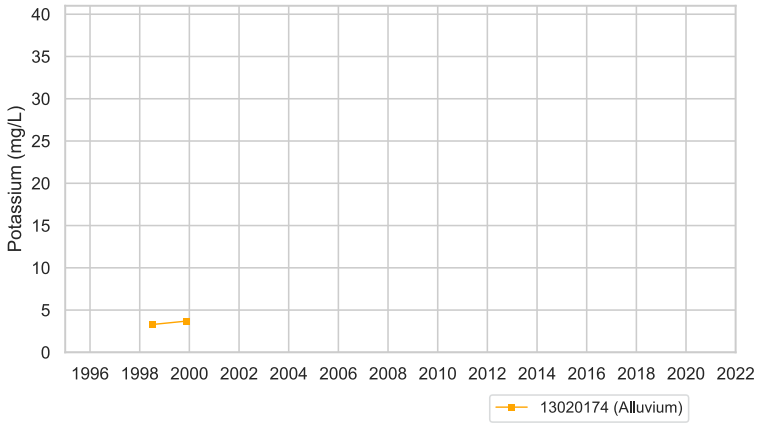

Sodium (mg/L)
Jamar Bore (Rewan)

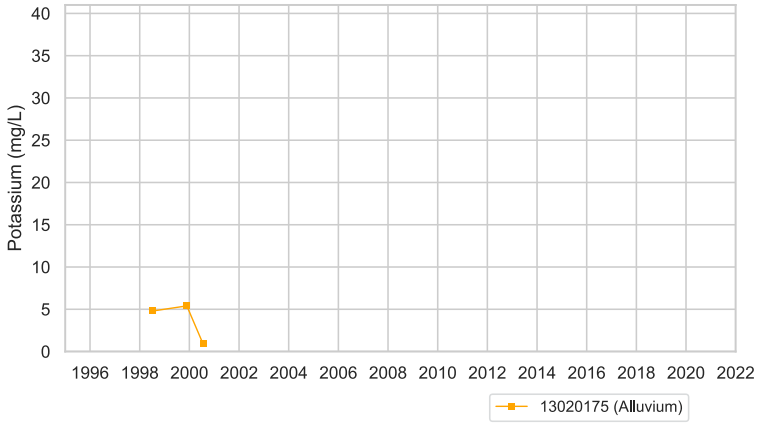

Sodium (mg/L)
Winton Creek Bore (Rewan)

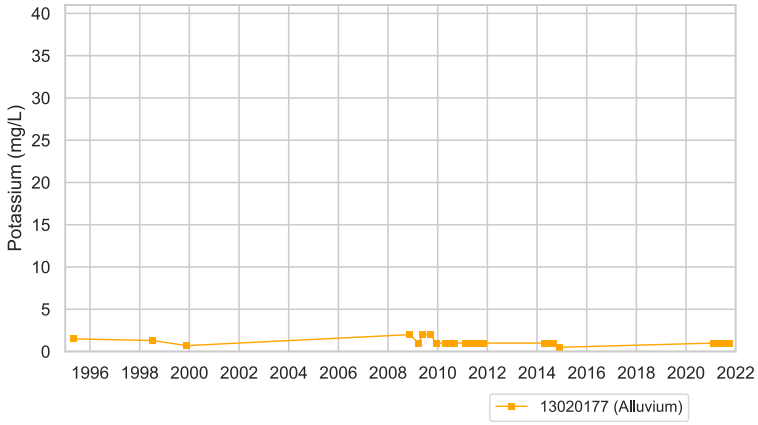

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

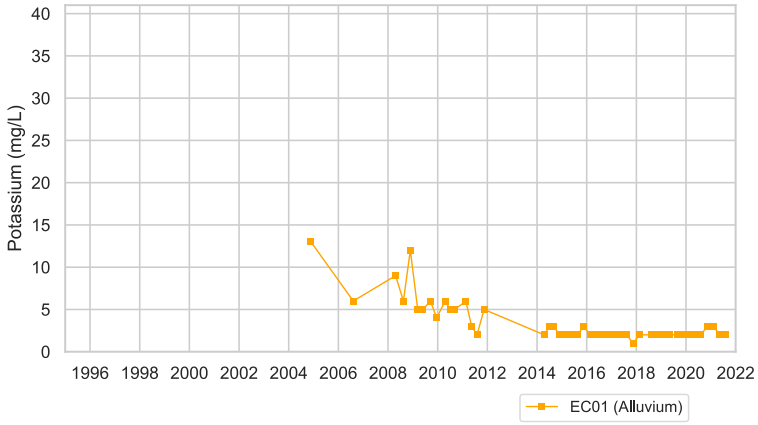

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

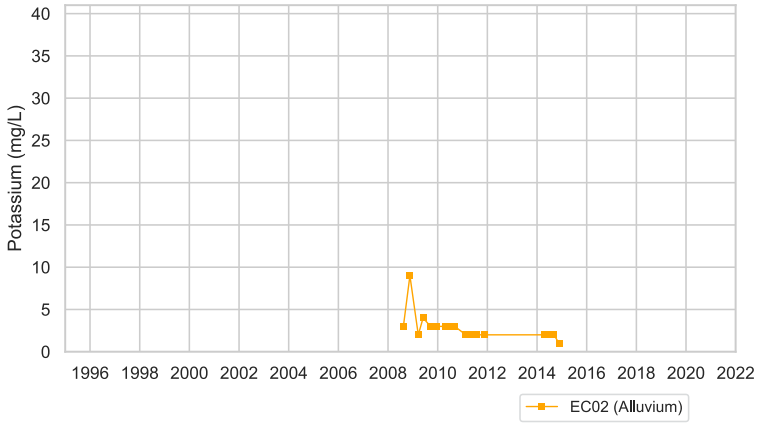

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

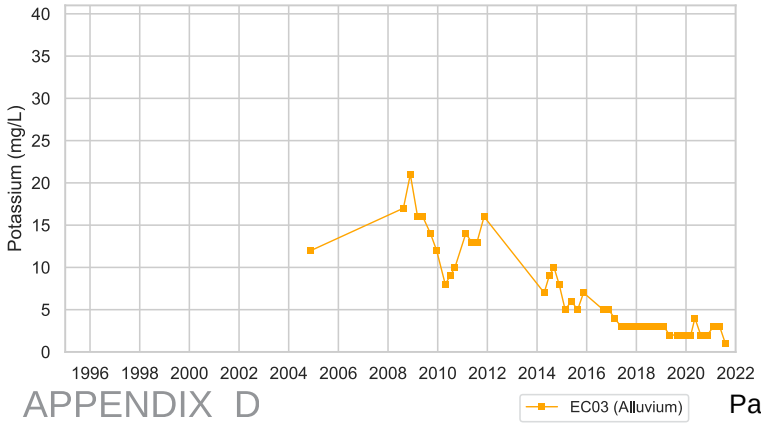

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

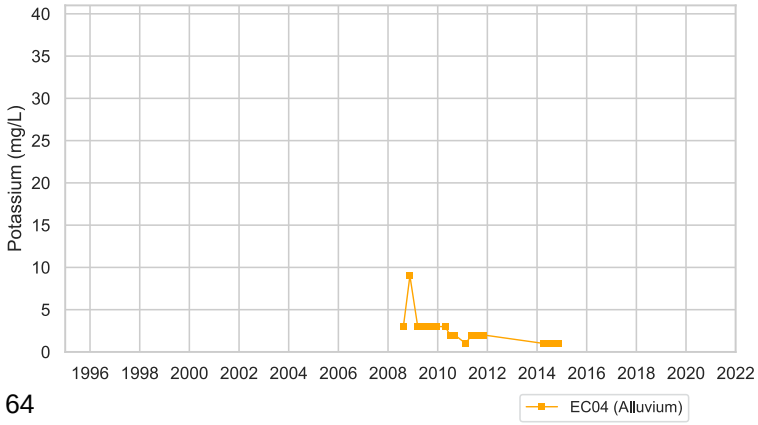

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

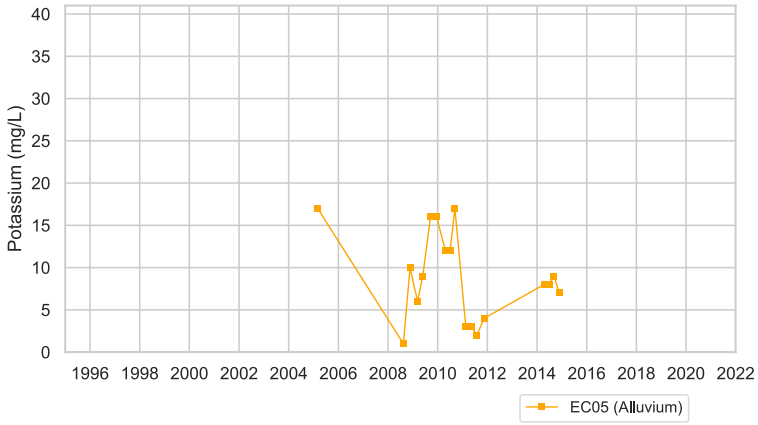

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

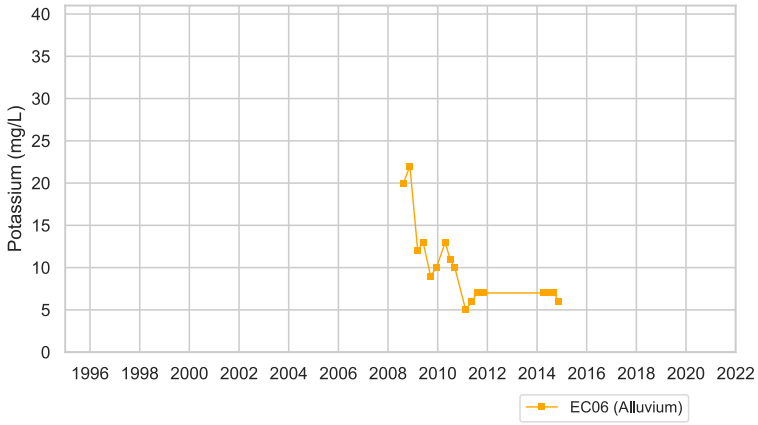

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

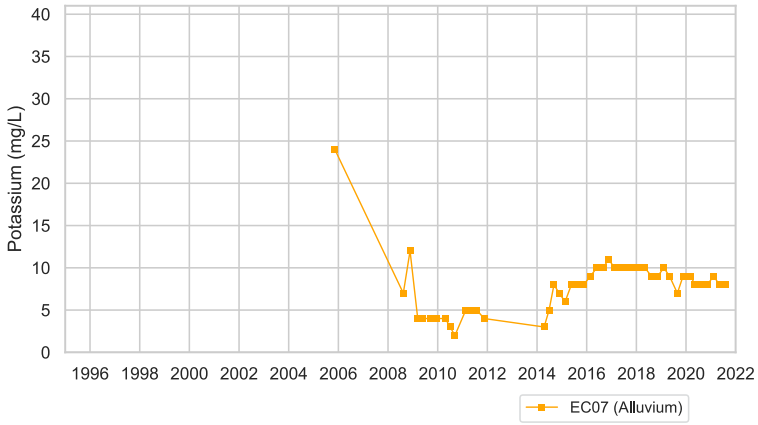

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

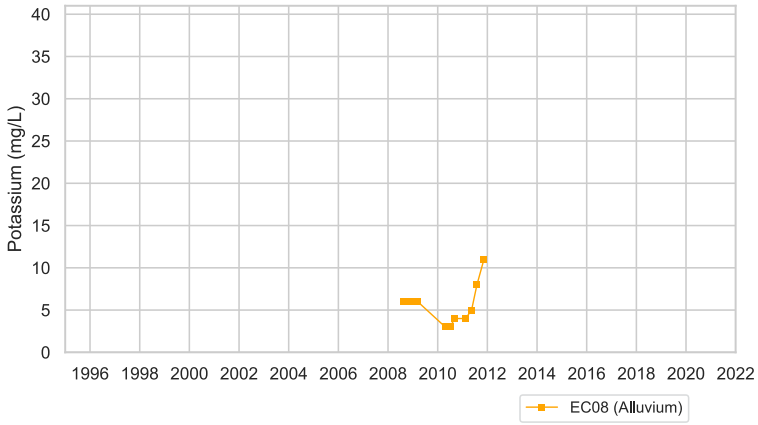

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

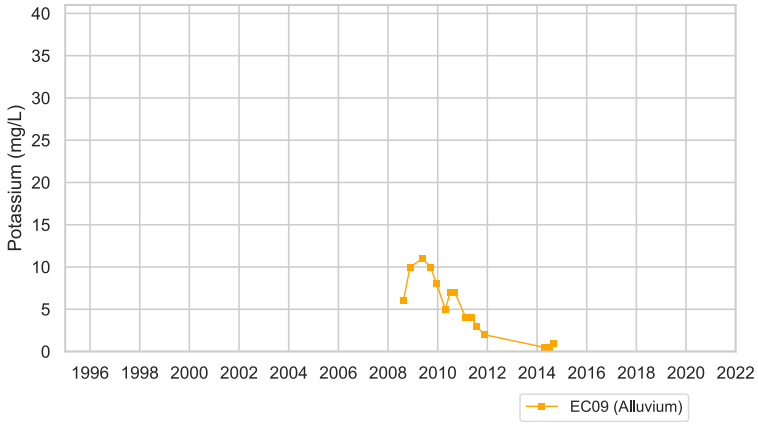

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

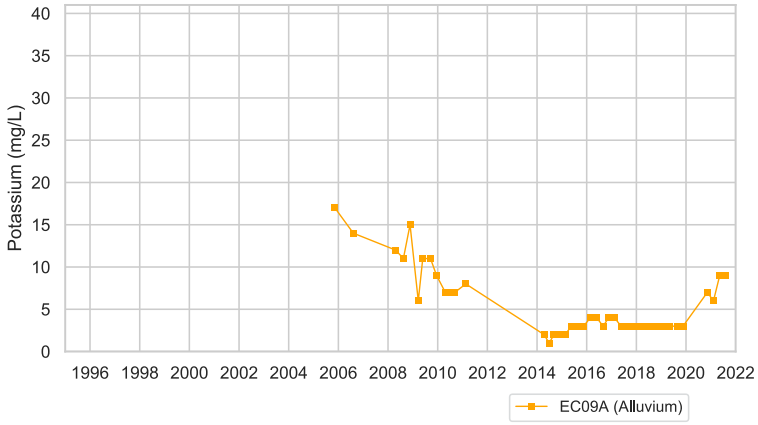

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

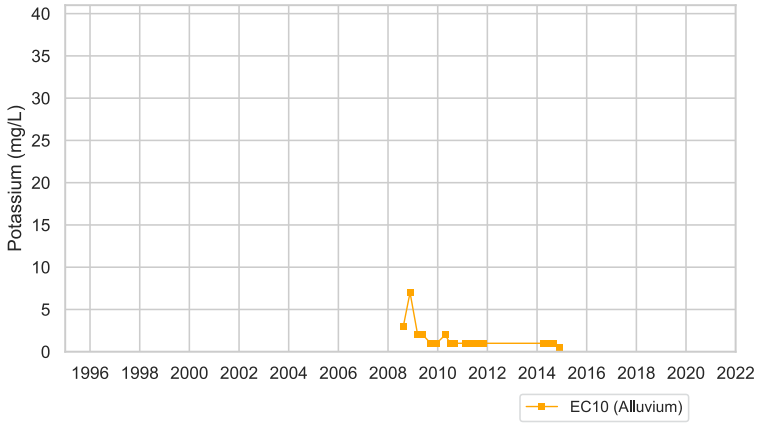

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

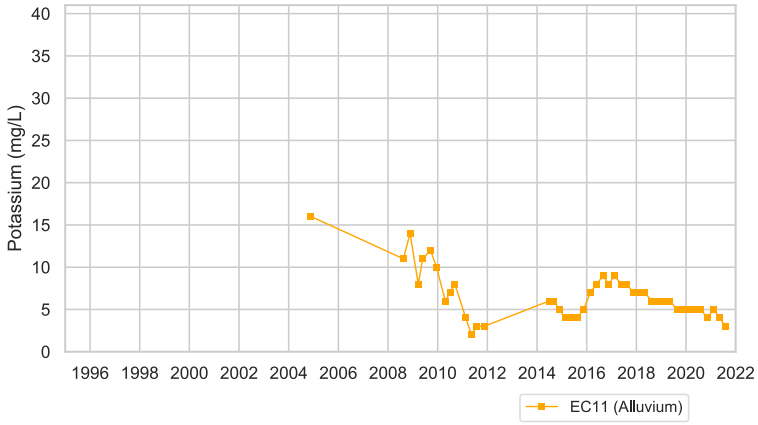

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

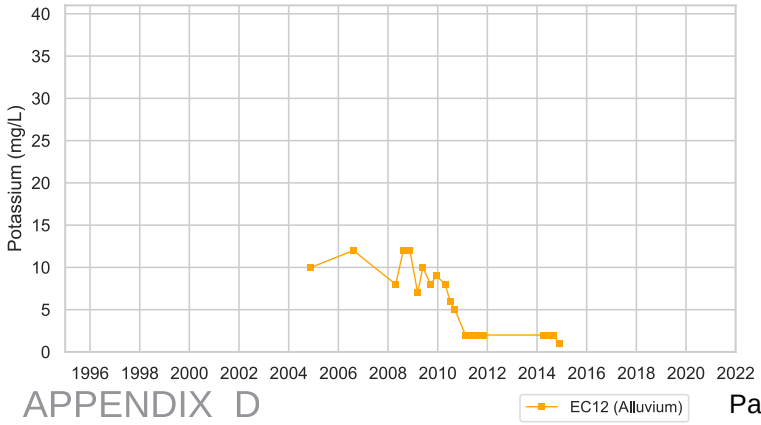

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

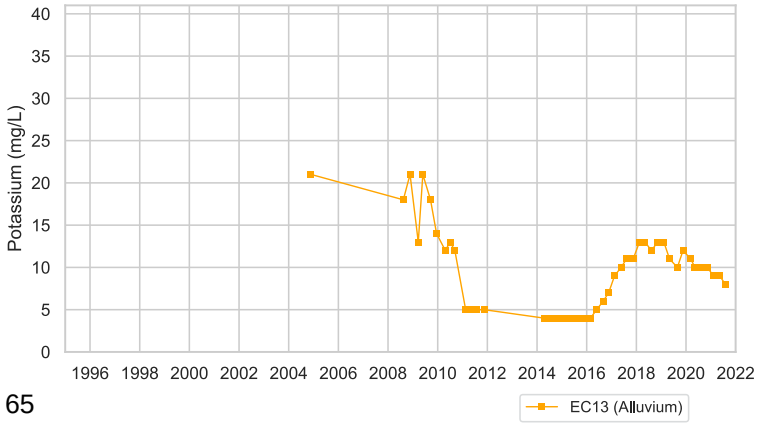

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

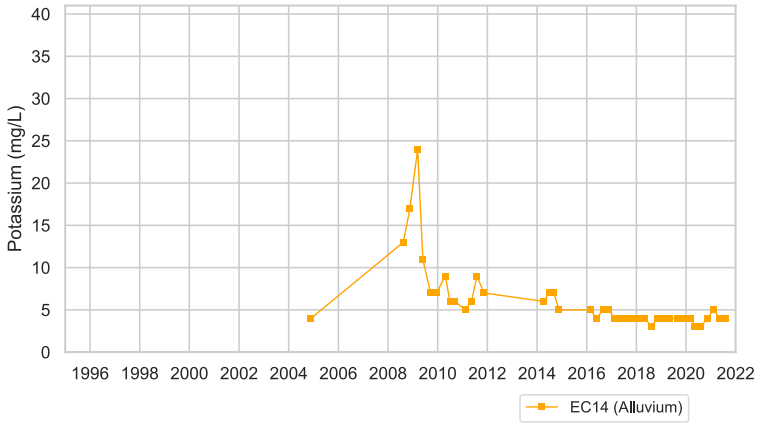

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

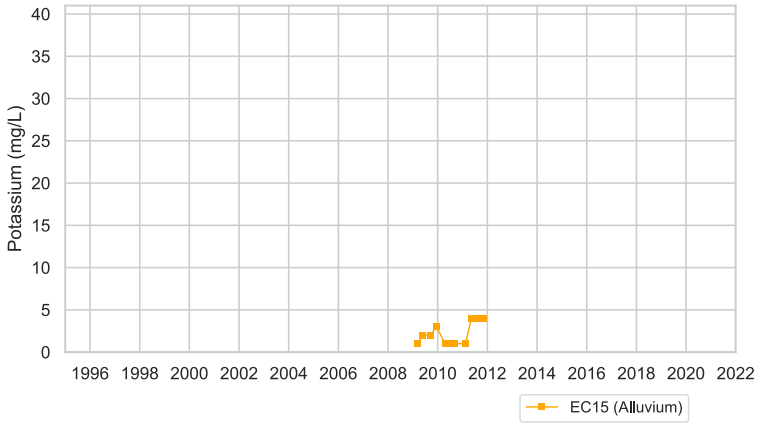

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

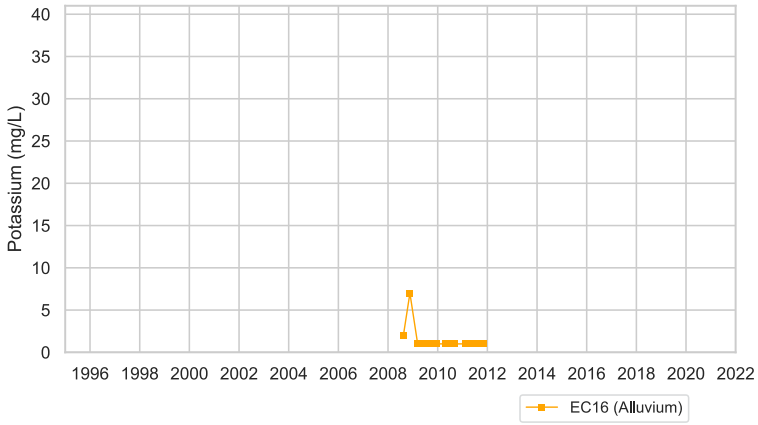

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

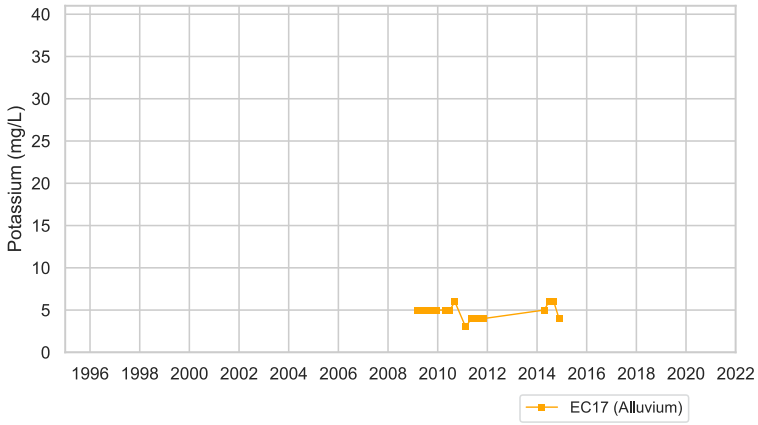

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

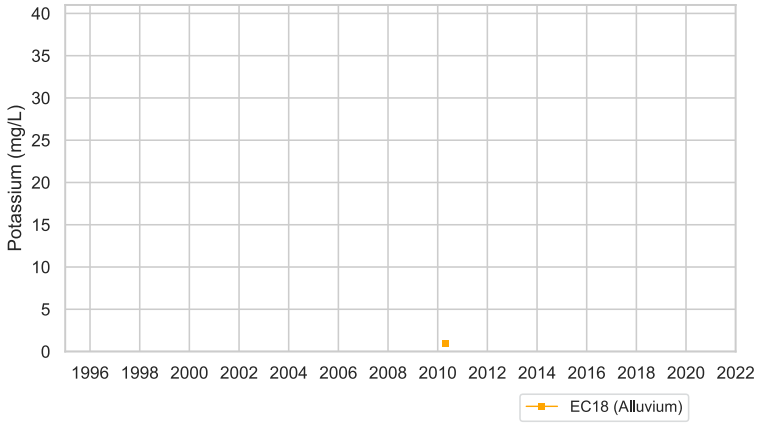

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

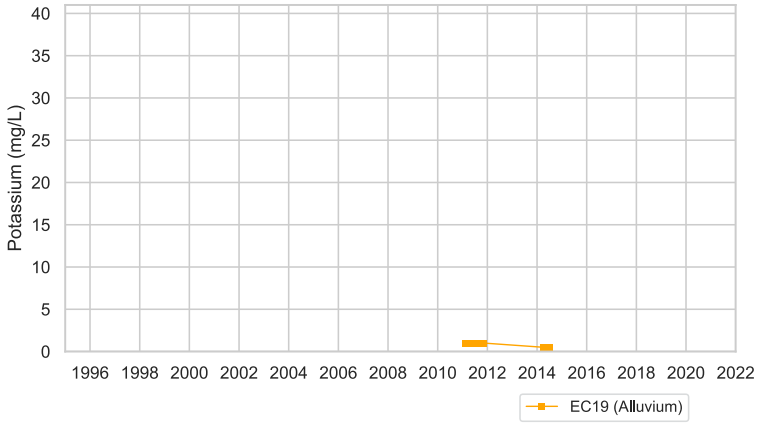

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

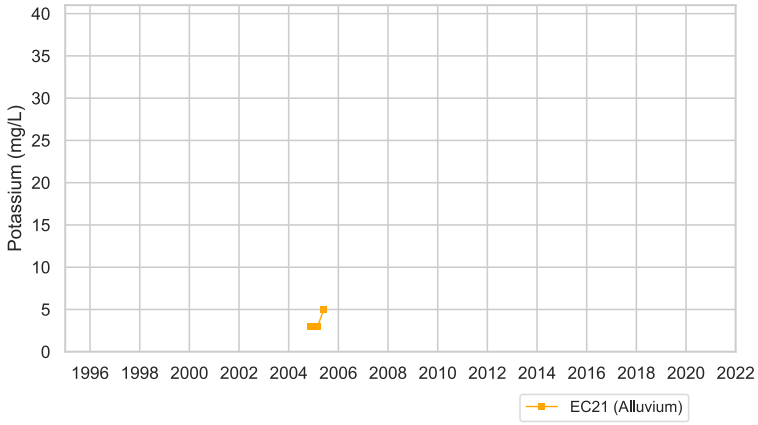

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

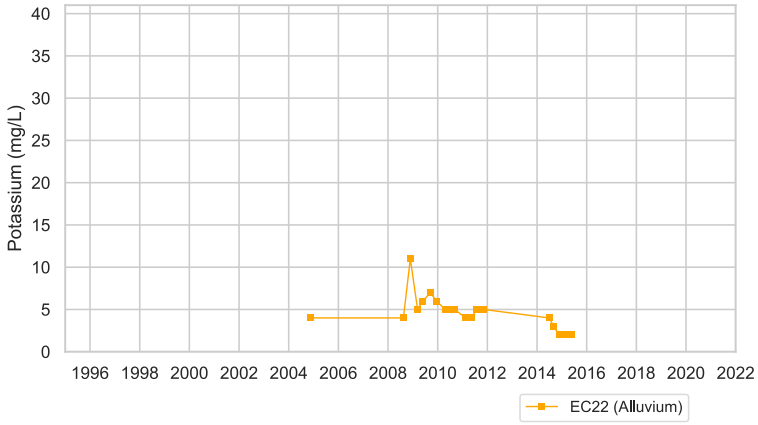

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

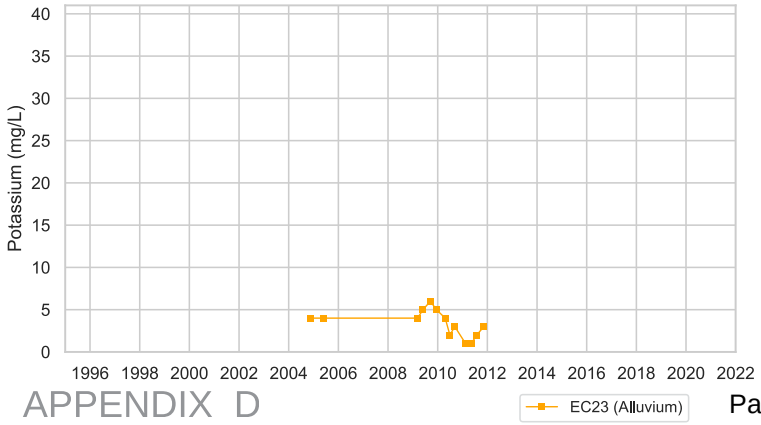

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

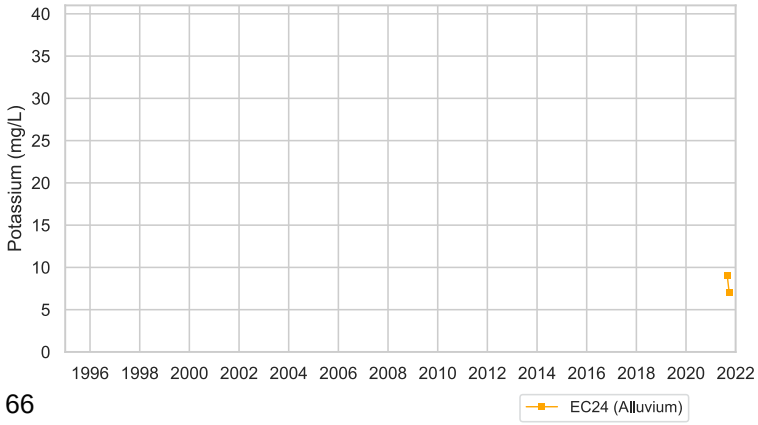

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

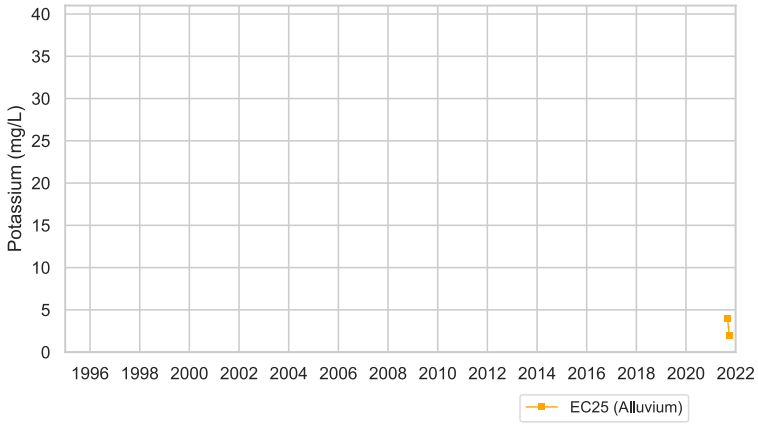

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

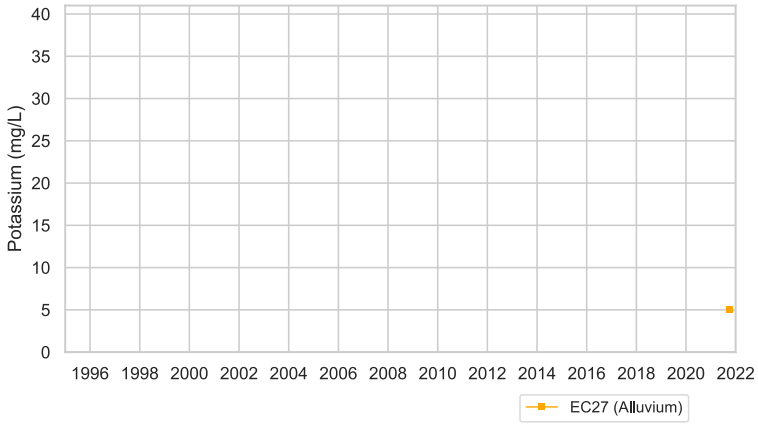

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

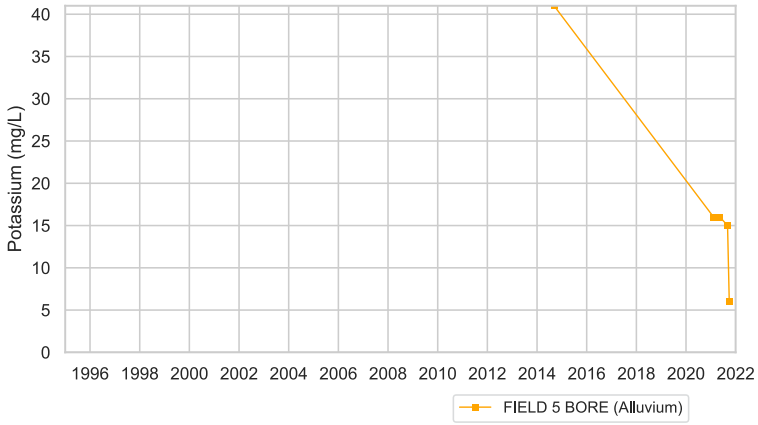

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

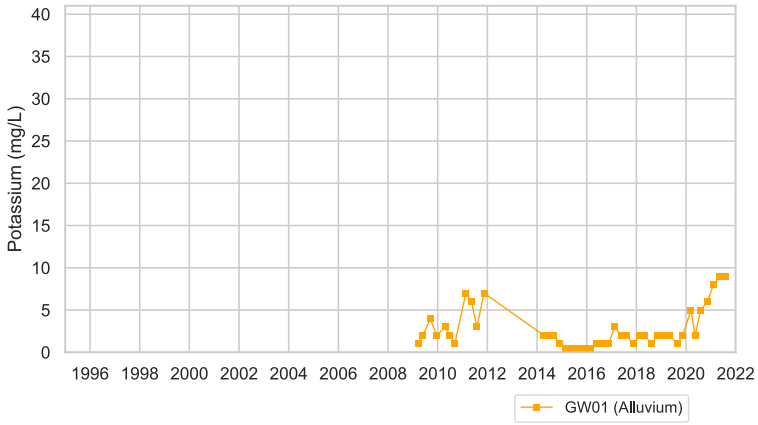

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

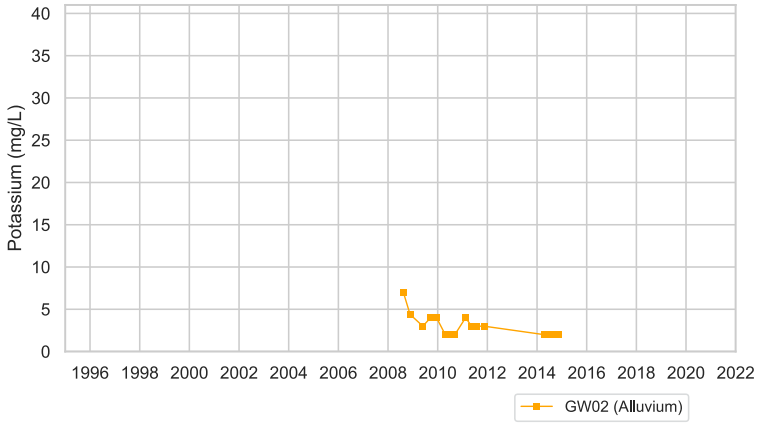

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

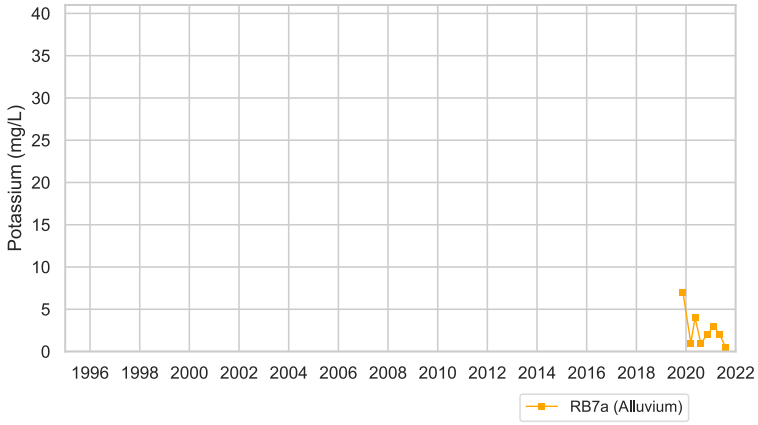

Potassium (mg/L)
EC25 (Alluvium)

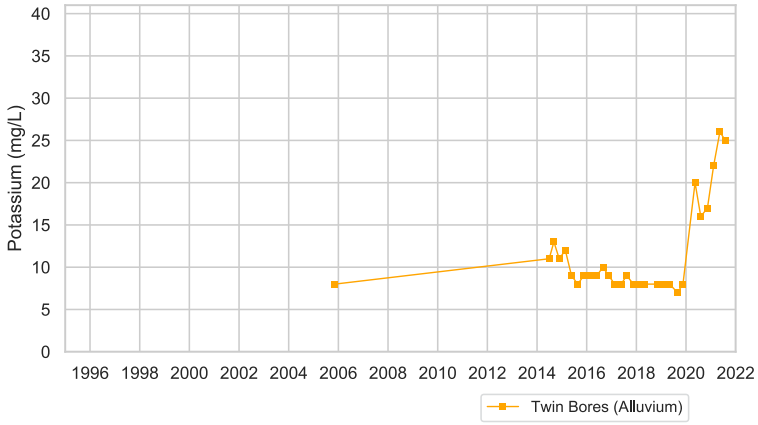

Potassium (mg/L)
EC27 (Alluvium)

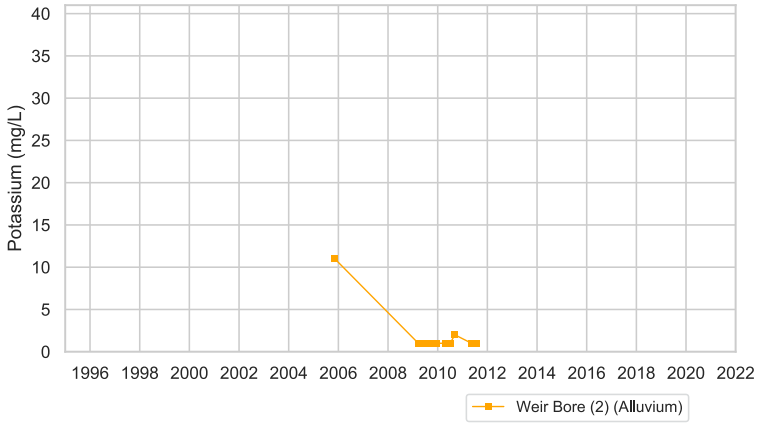

Potassium (mg/L)
FIELD 5 BORE (Alluvium)

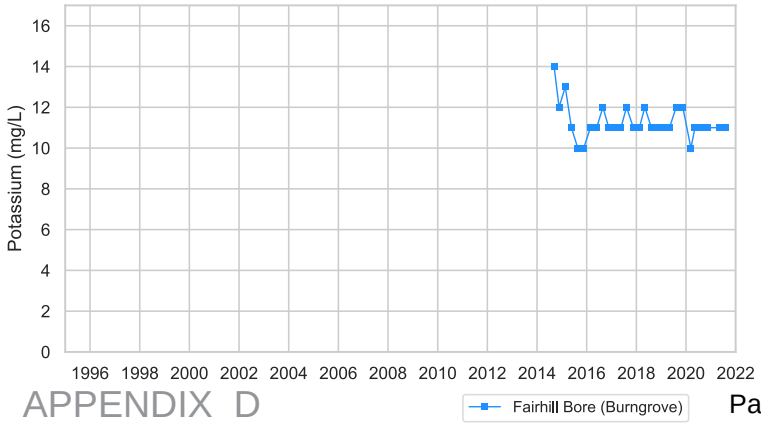

Potassium (mg/L)
GW01 (Alluvium)

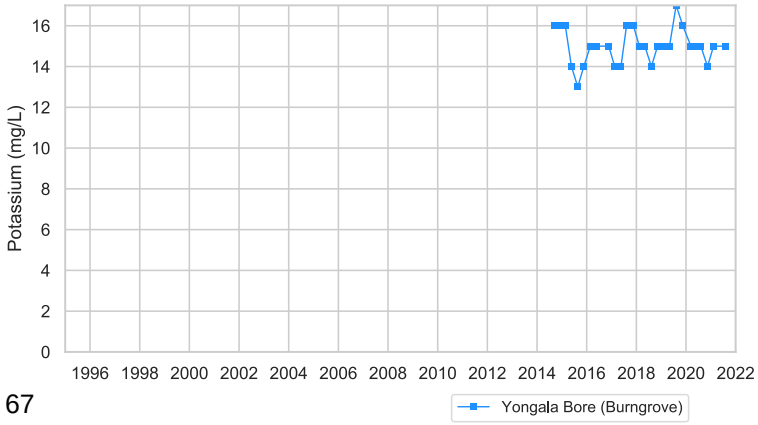

Potassium (mg/L)
GW02 (Alluvium)

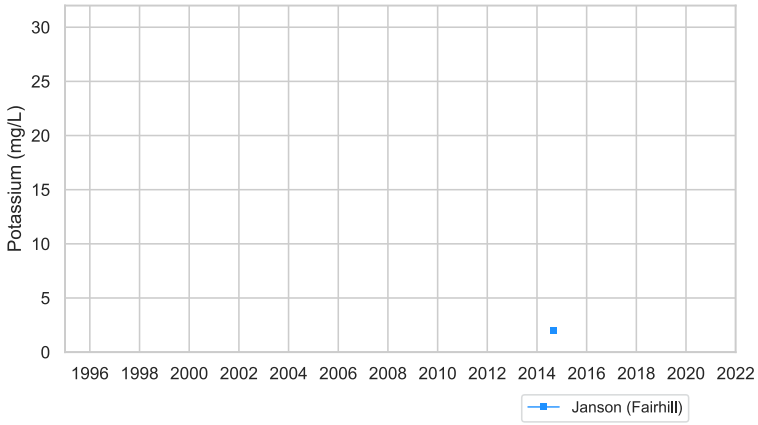

Potassium (mg/L)
RB7a (Alluvium)

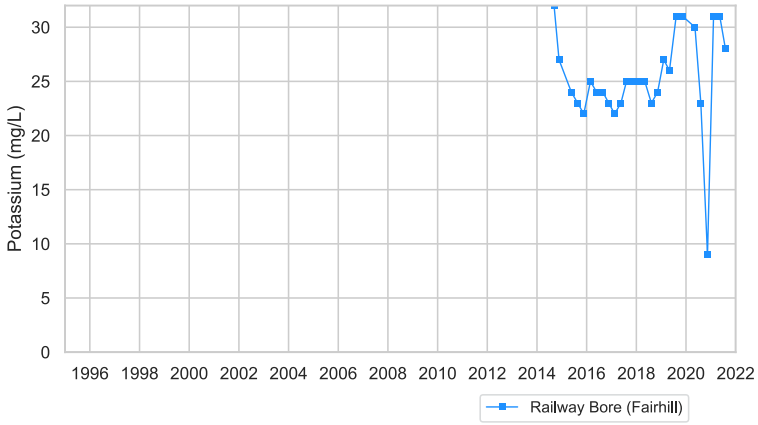

Potassium (mg/L)
Twin Bores (Alluvium)

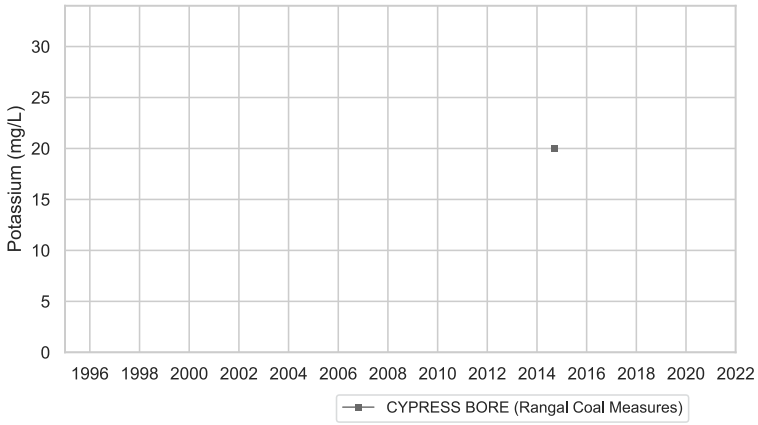

Potassium (mg/L)
Weir Bore (2) (Alluvium)

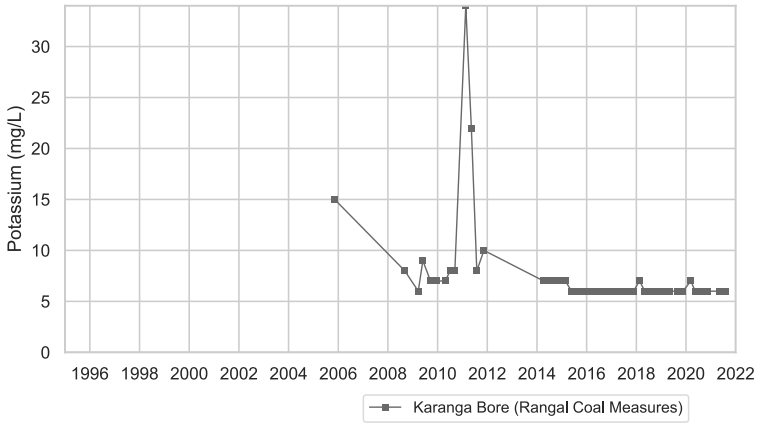

Potassium (mg/L)
Fairhill Bore (Burngrove)

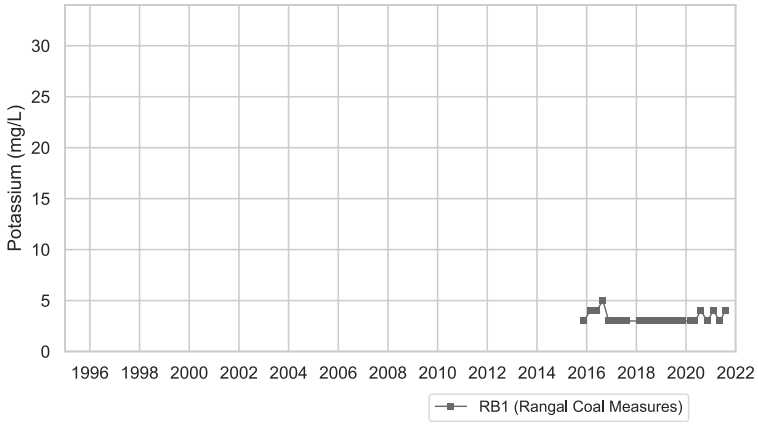

Potassium (mg/L)
Yongala Bore (Burngrove)

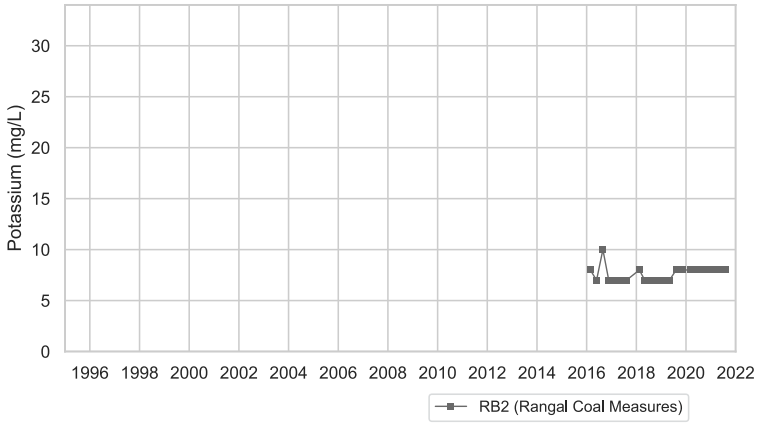

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

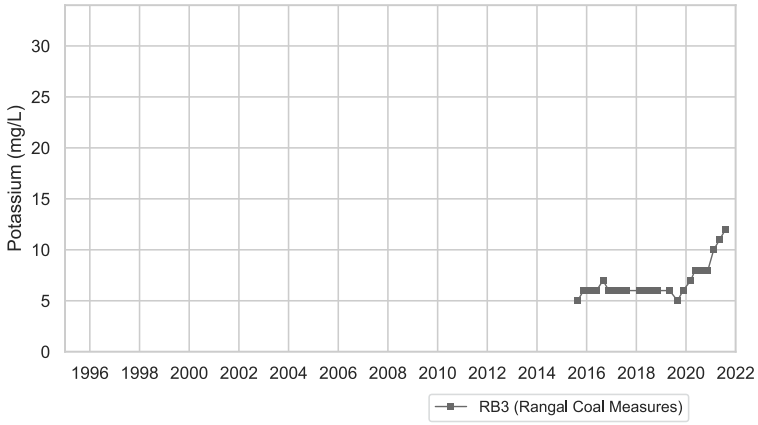

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

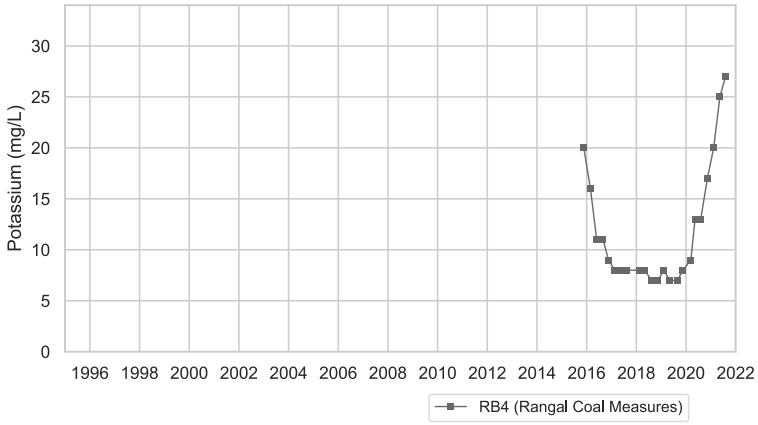

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

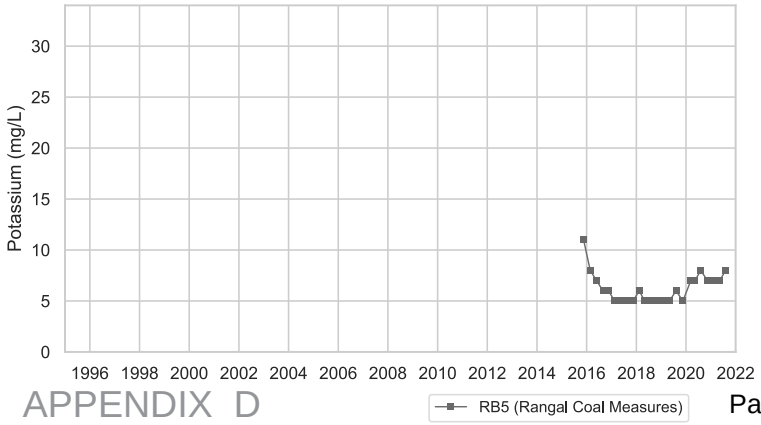

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

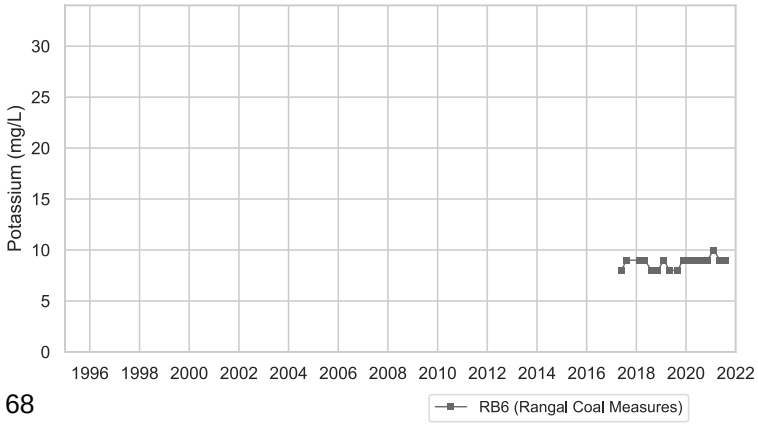

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

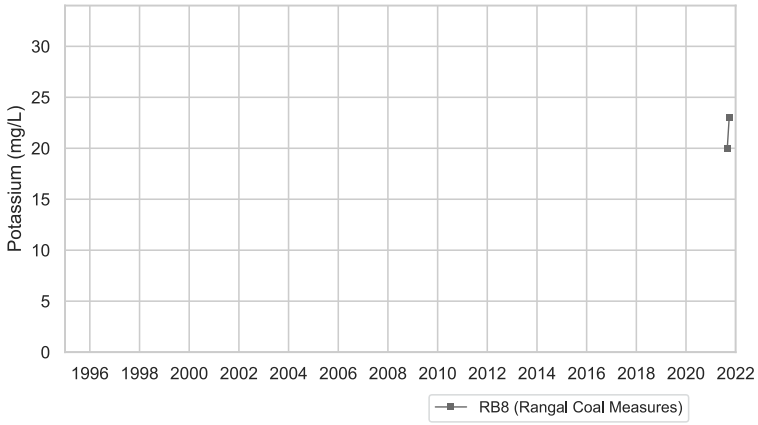

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

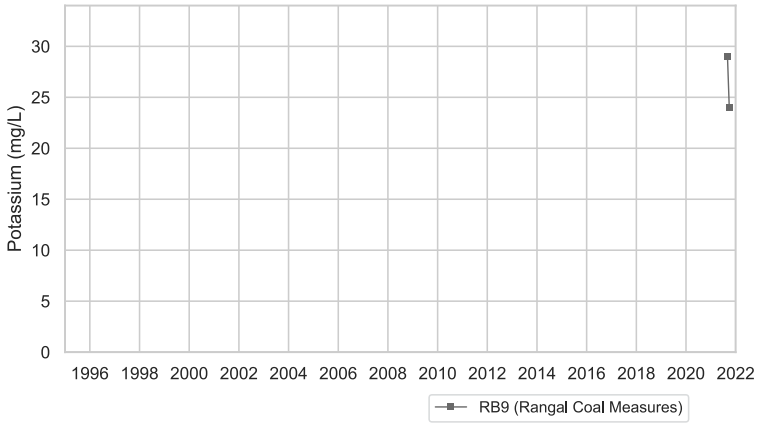

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

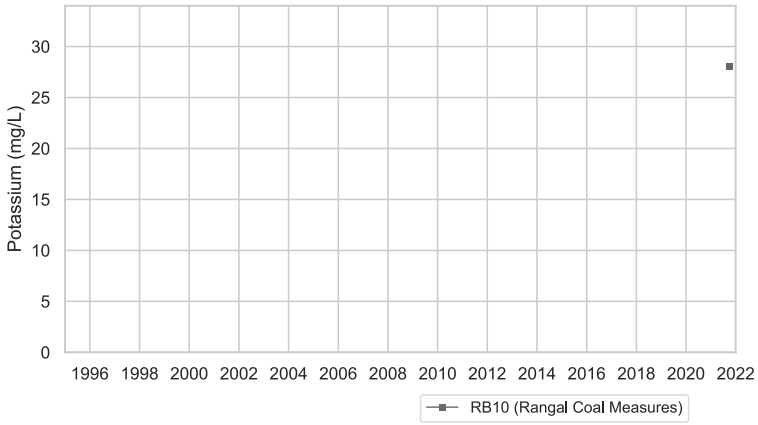

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

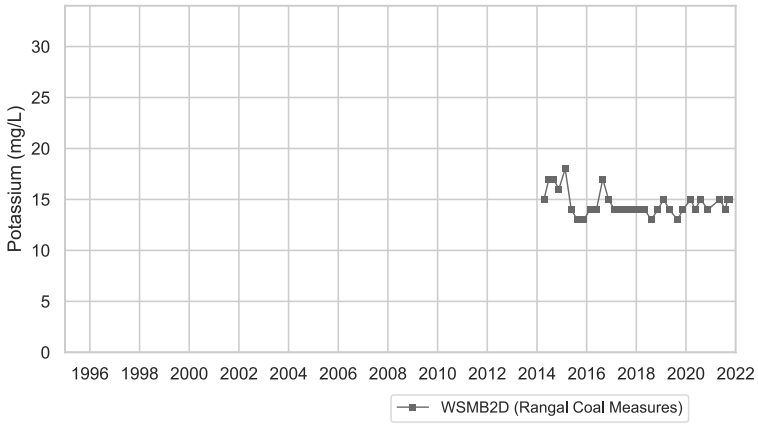

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

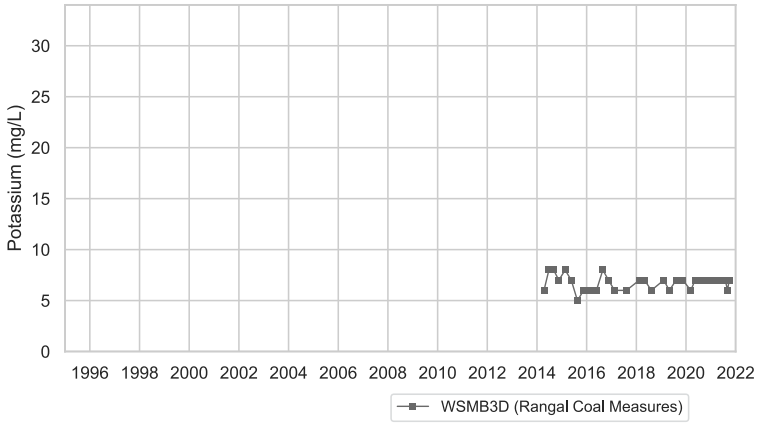

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

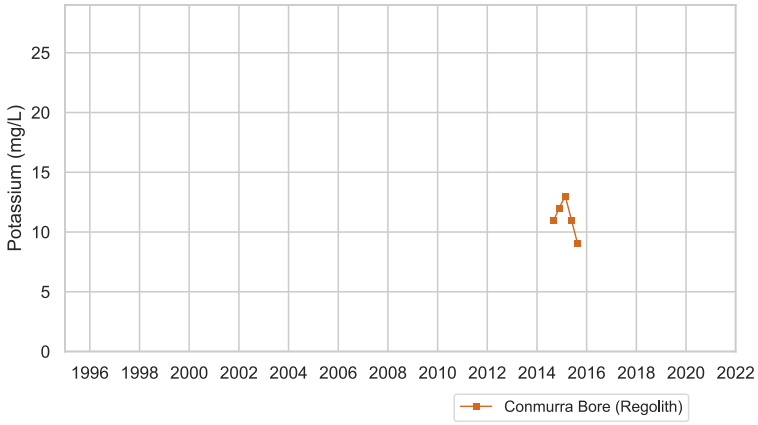

Potassium (mg/L)
RB8 (Rangal Coal Measures)

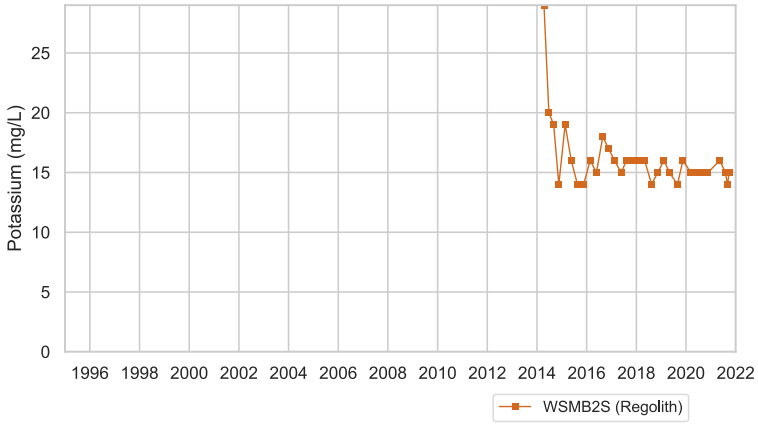

Potassium (mg/L)
RB9 (Rangal Coal Measures)

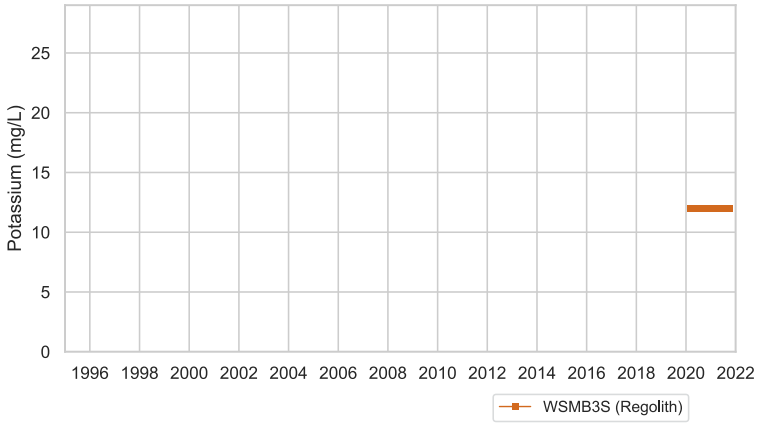

Potassium (mg/L)
RB10 (Rangal Coal Measures)

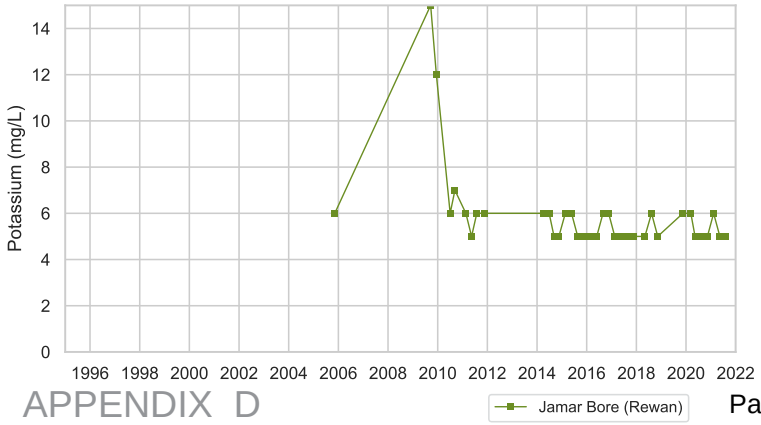

Potassium (mg/L)
WSMB2D (Rangal Coal Measures)

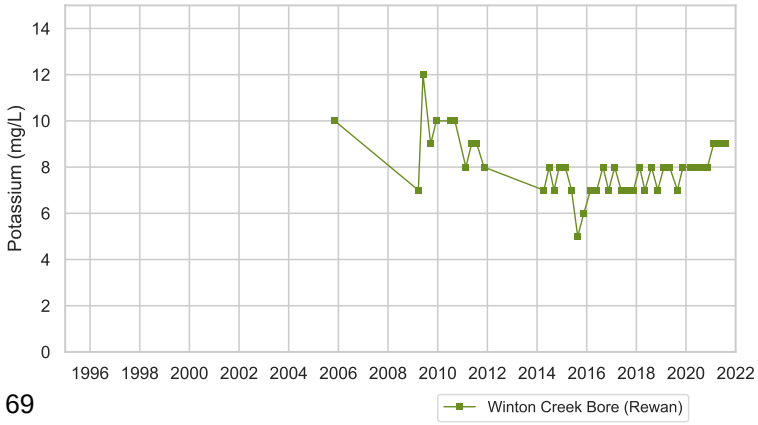

Potassium (mg/L)
WSMB3D (Rangal Coal Measures)

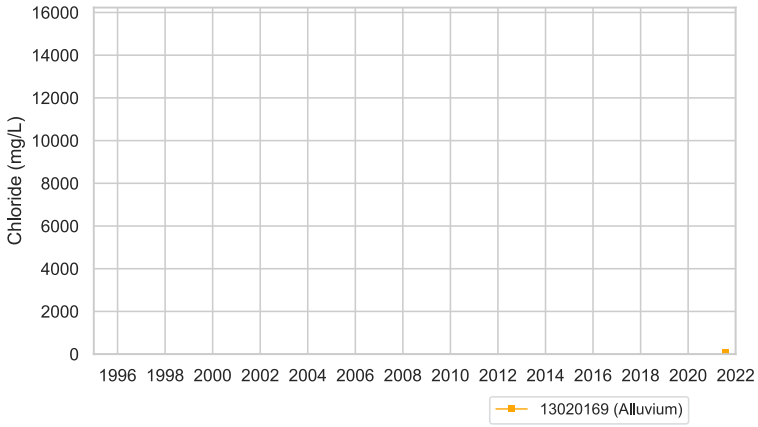

Potassium (mg/L)
Conmurra Bore (Regolith)

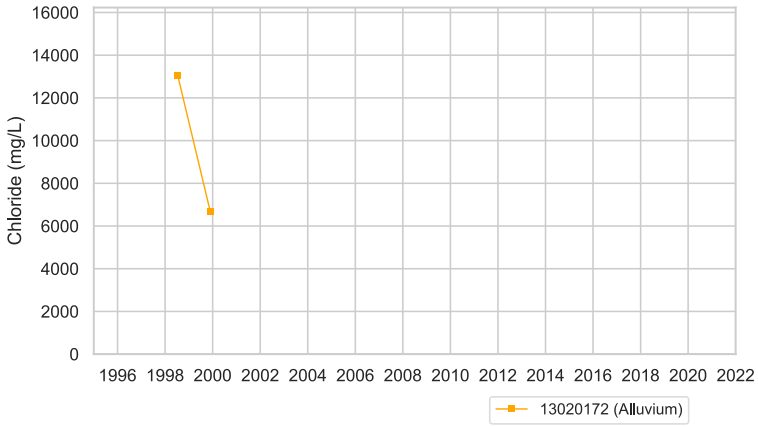

Potassium (mg/L)
WSMB2S (Regolith)

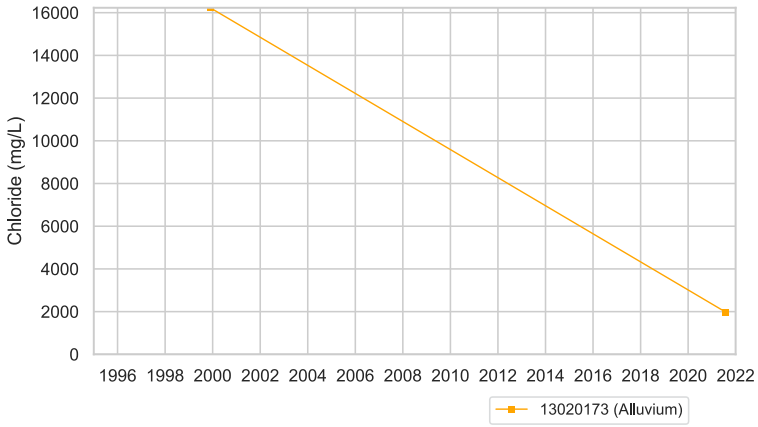

Potassium (mg/L)
WSMB3S (Regolith)

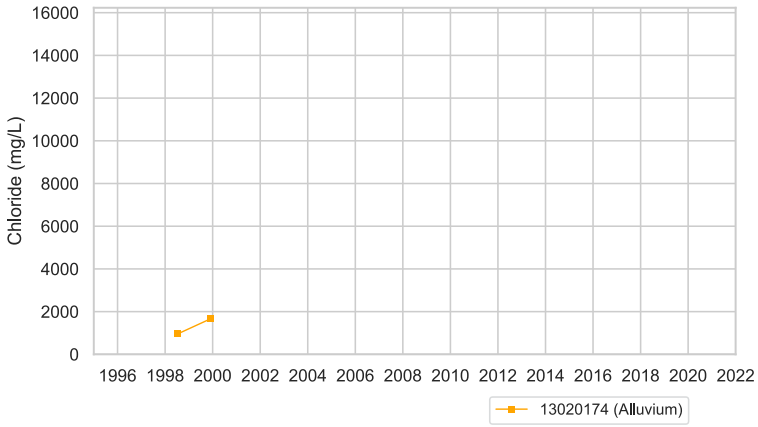

Potassium (mg/L)
Jamar Bore (Rewan)

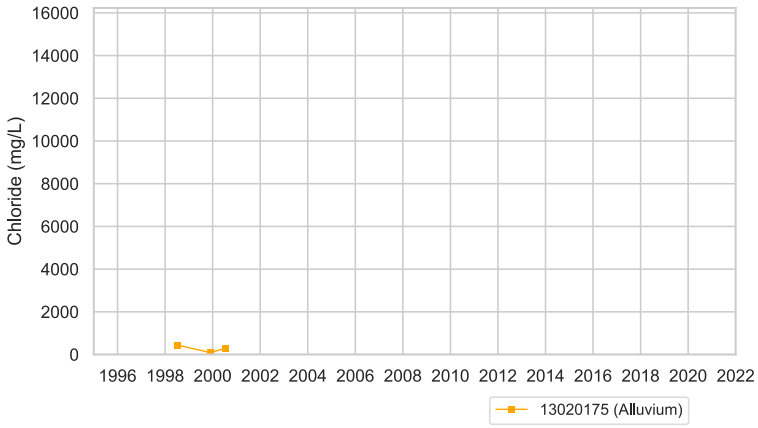

Potassium (mg/L)
Winton Creek Bore (Rewan)

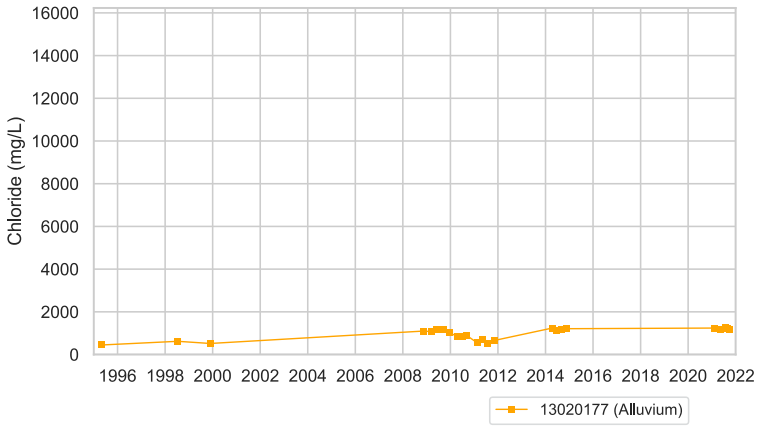

Chloride (mg/L)
13020169 (Alluvium)

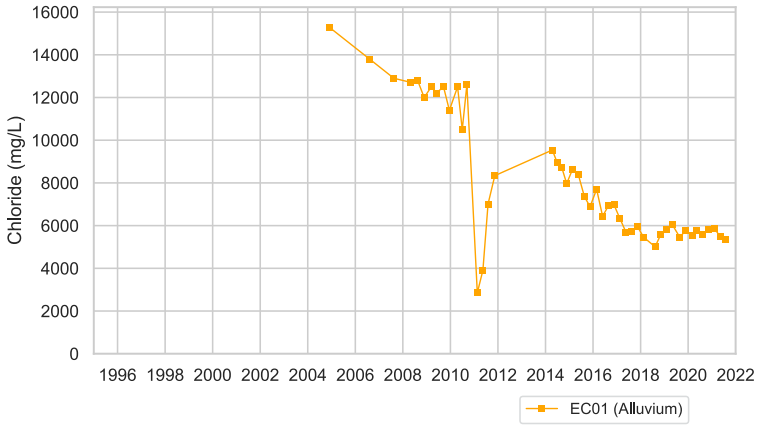

Chloride (mg/L)
13020172 (Alluvium)

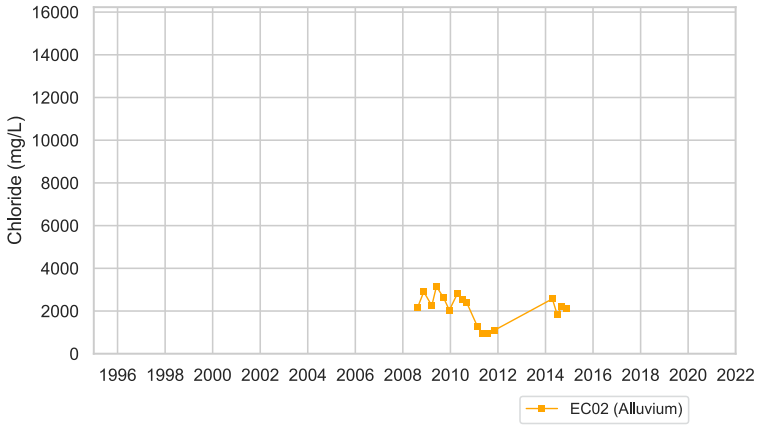

Chloride (mg/L)
13020173 (Alluvium)

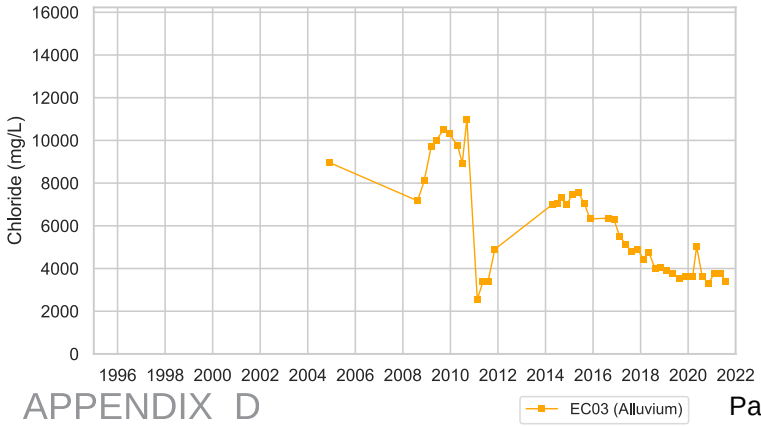

Chloride (mg/L)
13020174 (Alluvium)

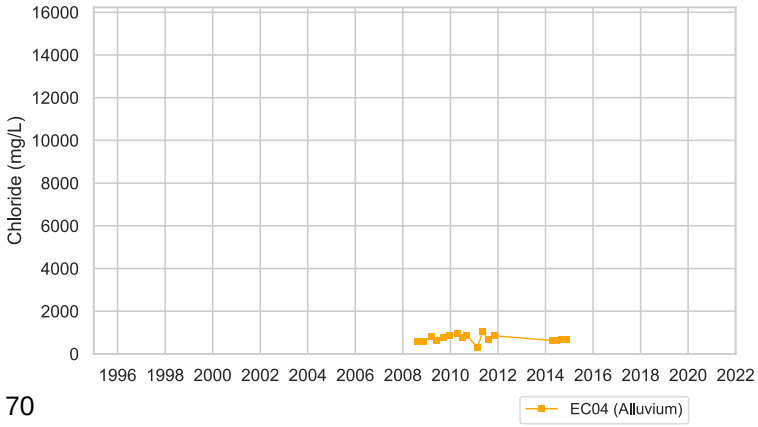

Chloride (mg/L)
13020175 (Alluvium)

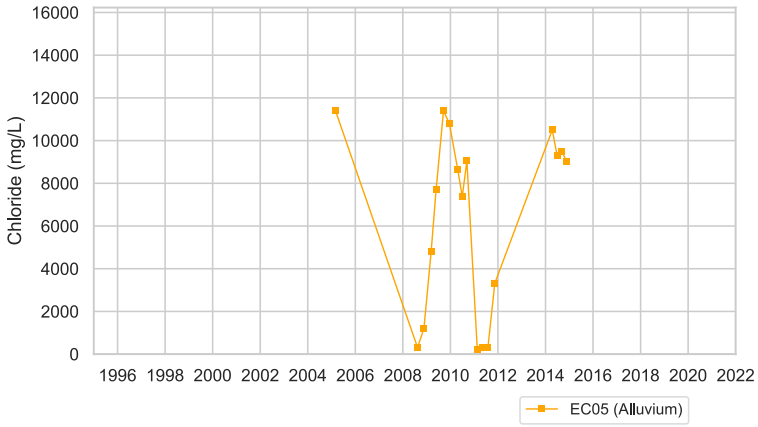

Chloride (mg/L)
13020177 (Alluvium)

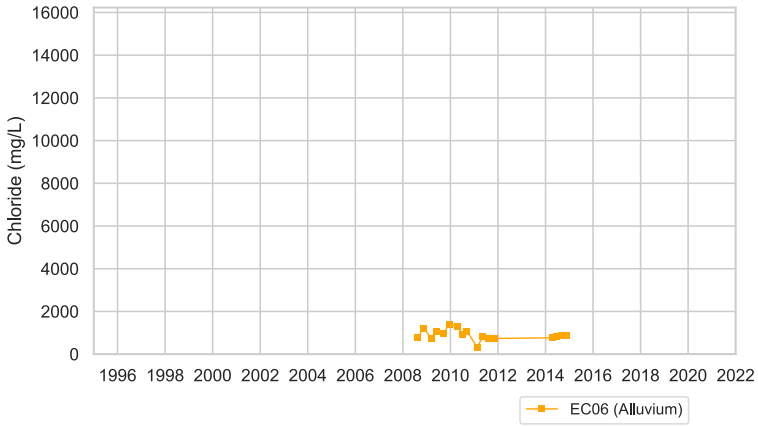

Chloride (mg/L)
EC01 (Alluvium)

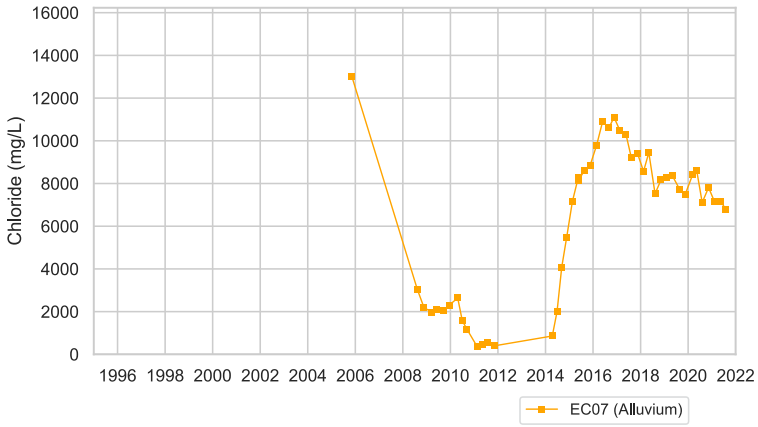

Chloride (mg/L)
EC02 (Alluvium)

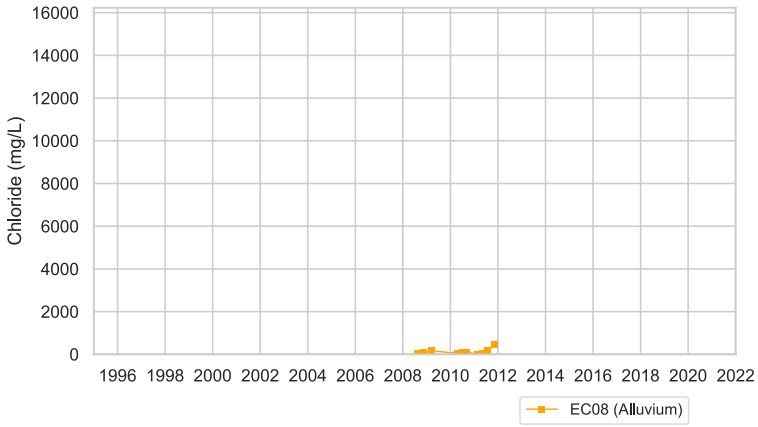

Chloride (mg/L)
EC03 (Alluvium)

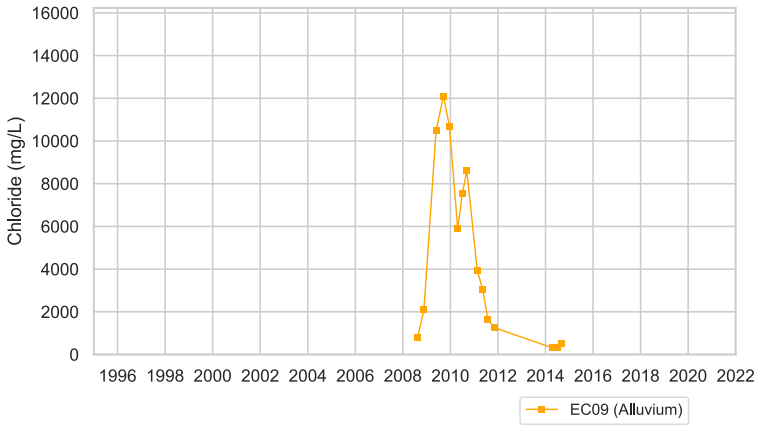

Chloride (mg/L)
EC04 (Alluvium)

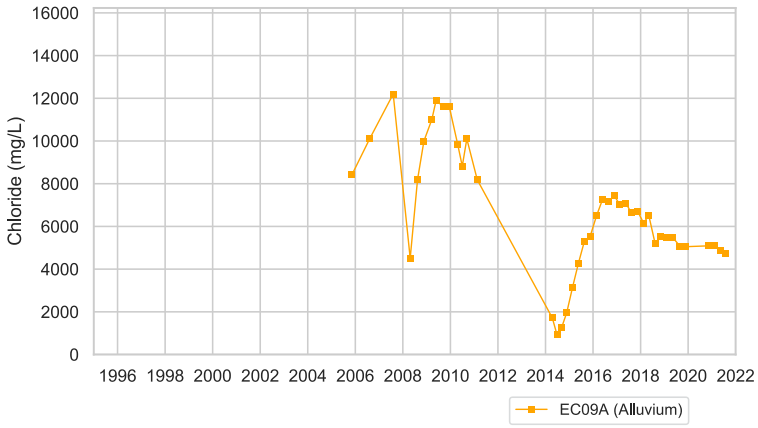

Chloride (mg/L)
EC05 (Alluvium)

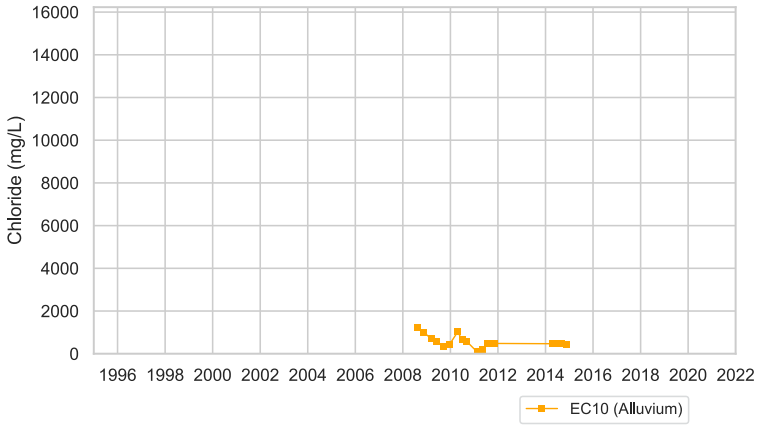

Chloride (mg/L)
EC06 (Alluvium)

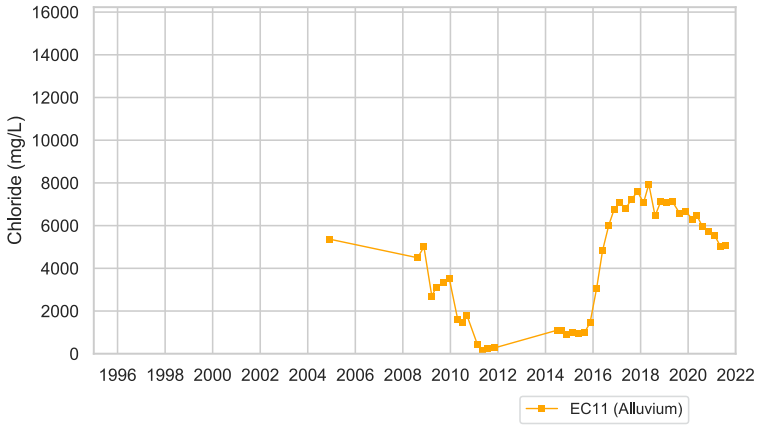

Chloride (mg/L)
EC07 (Alluvium)

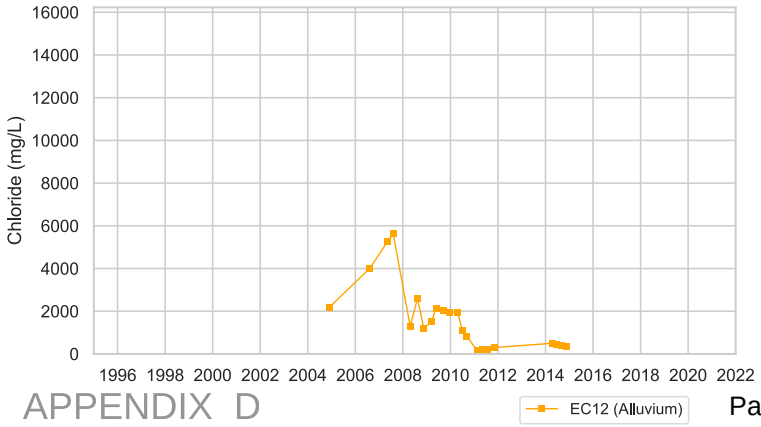

Chloride (mg/L)
EC08 (Alluvium)

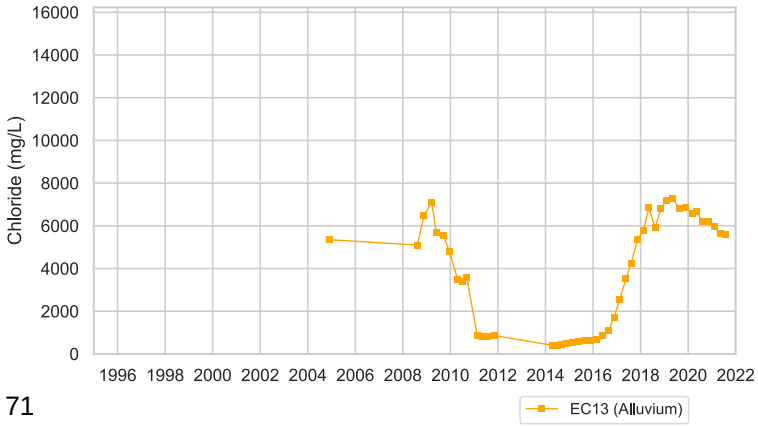

Chloride (mg/L)
EC09 (Alluvium)

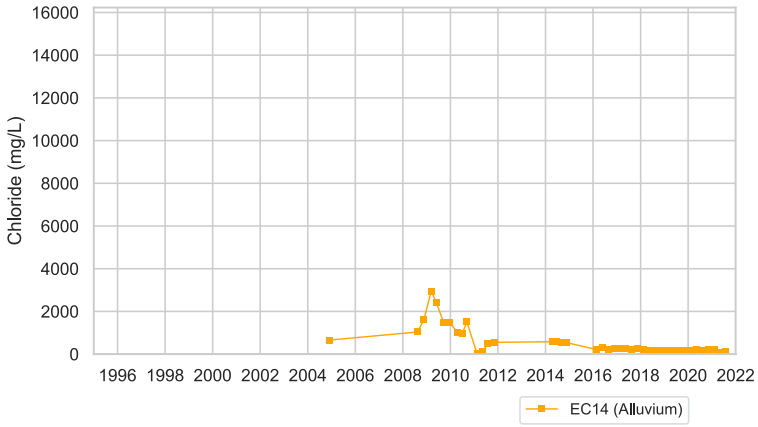

Chloride (mg/L)
EC09A (Alluvium)

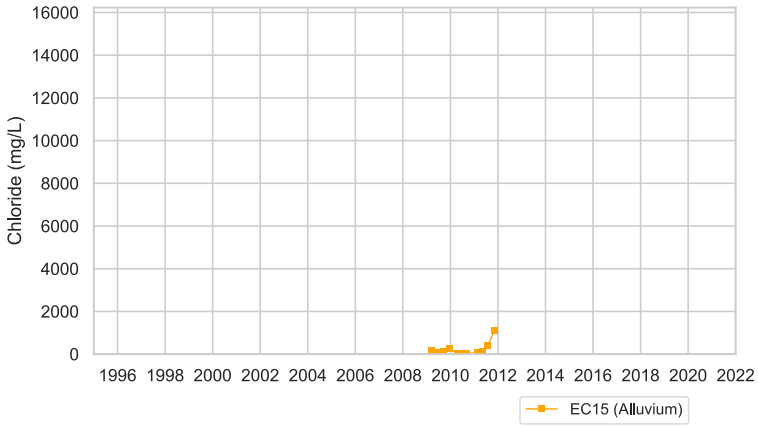

Chloride (mg/L)
EC10 (Alluvium)

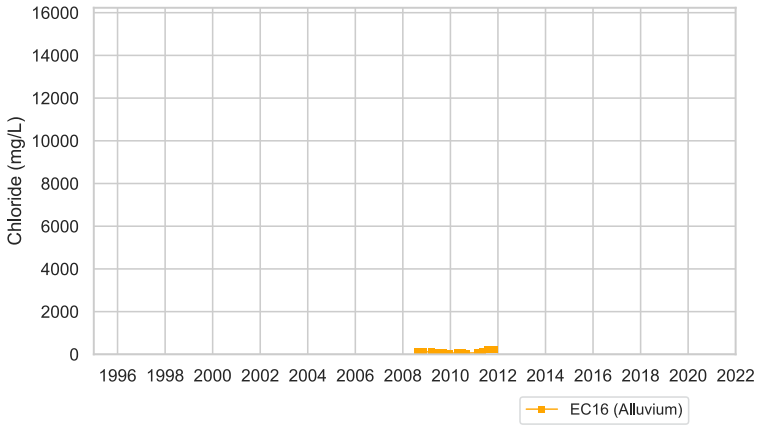

Chloride (mg/L)
EC11 (Alluvium)

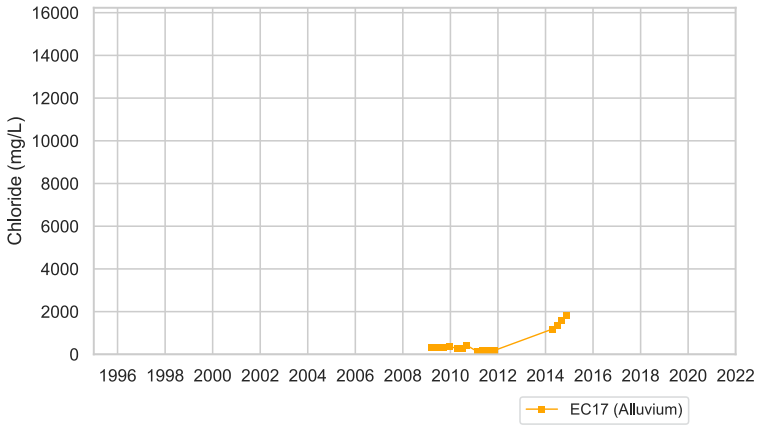

Chloride (mg/L)
EC12 (Alluvium)

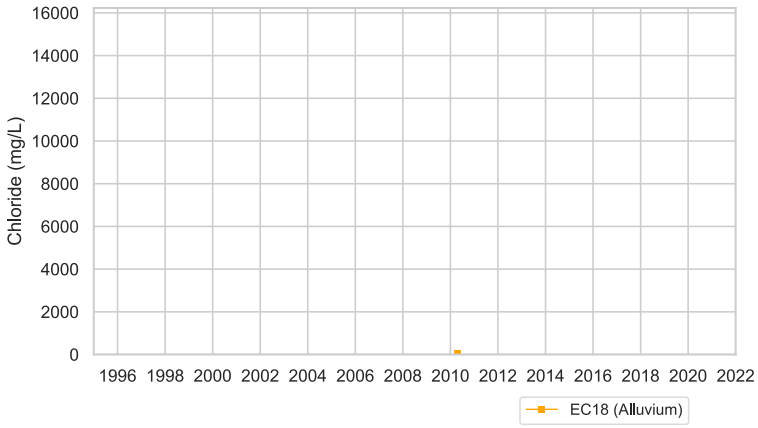

Chloride (mg/L)
EC13 (Alluvium)

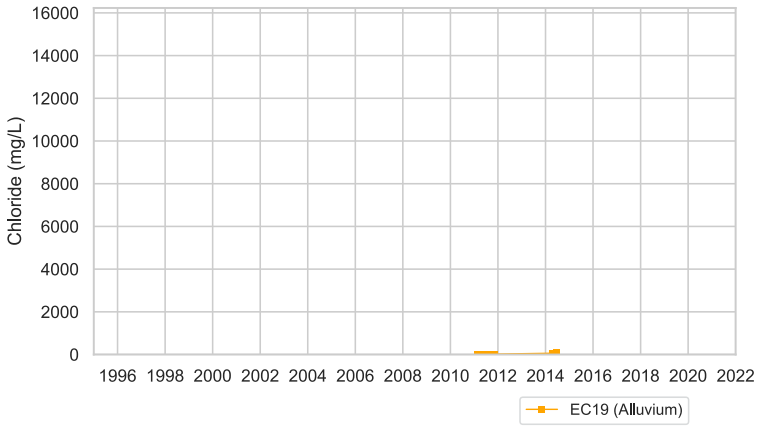

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

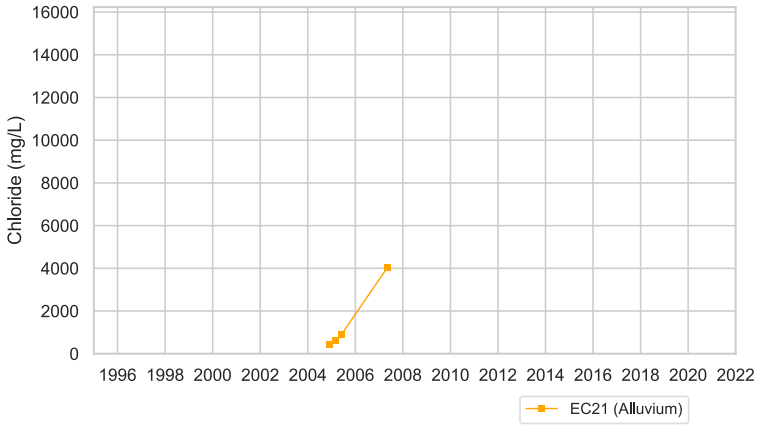

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

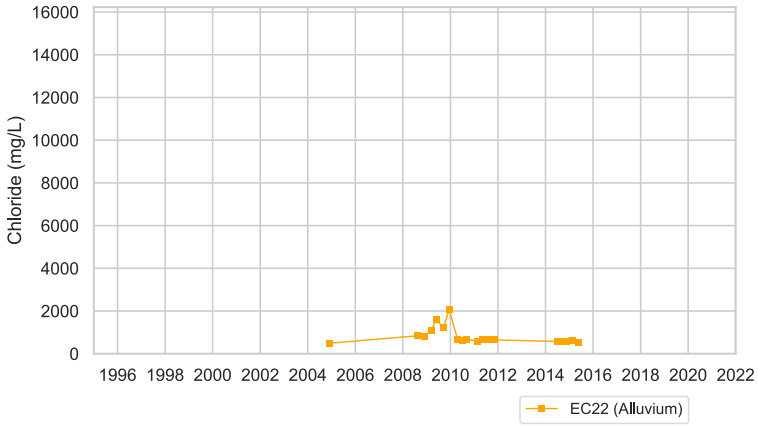

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

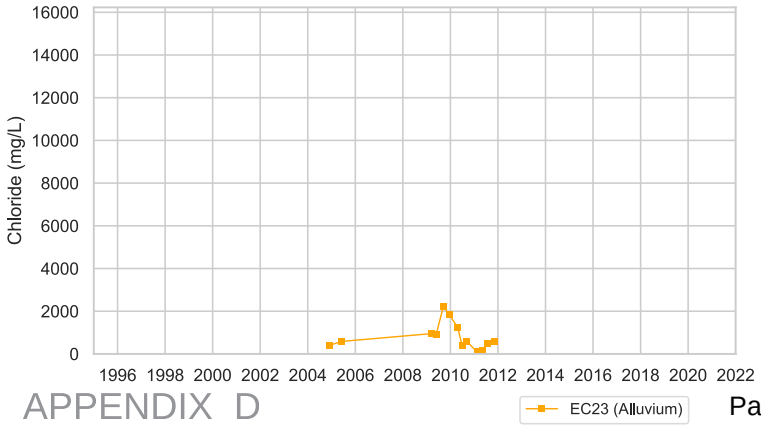

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

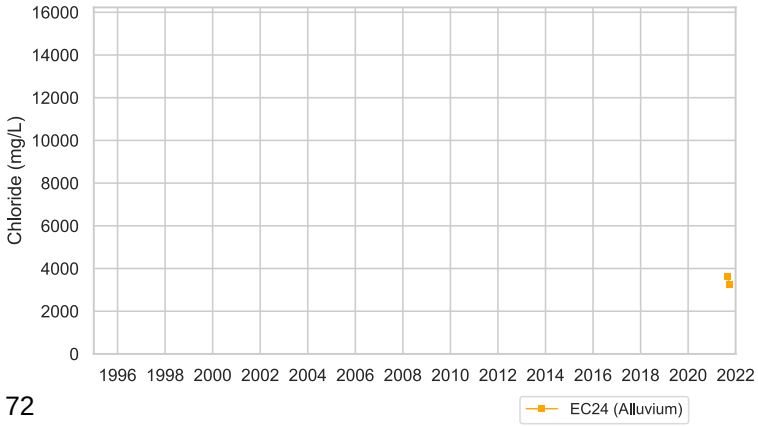

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

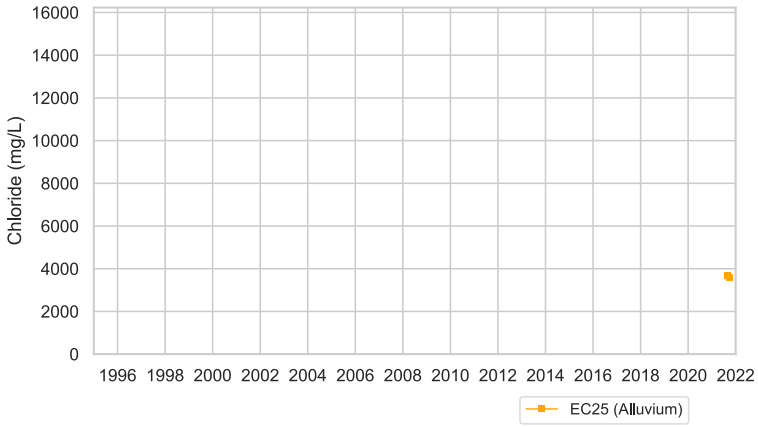

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

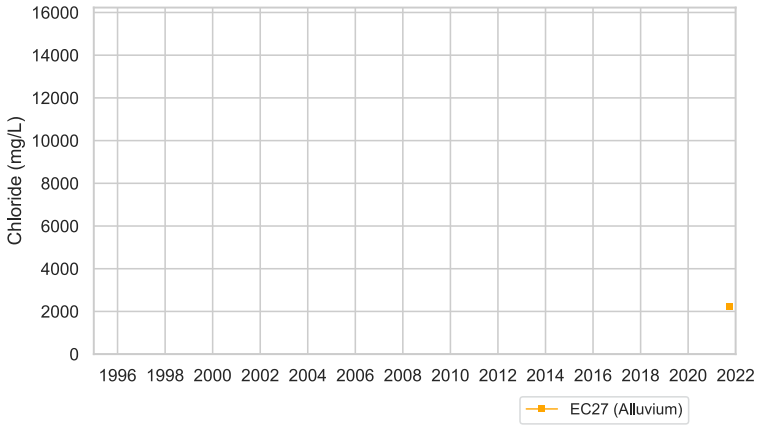

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

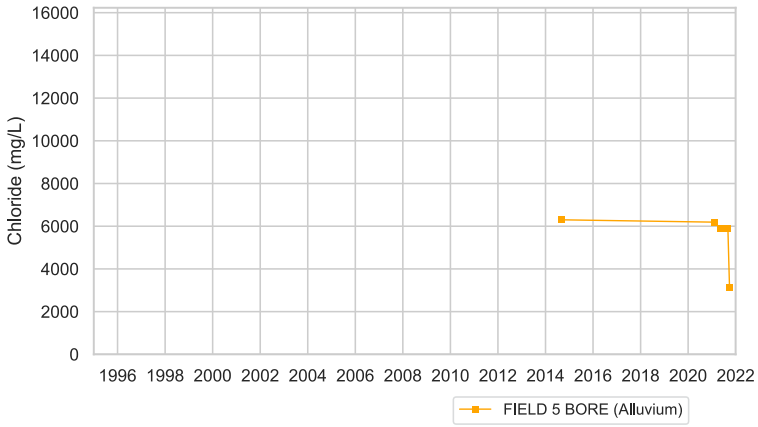

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

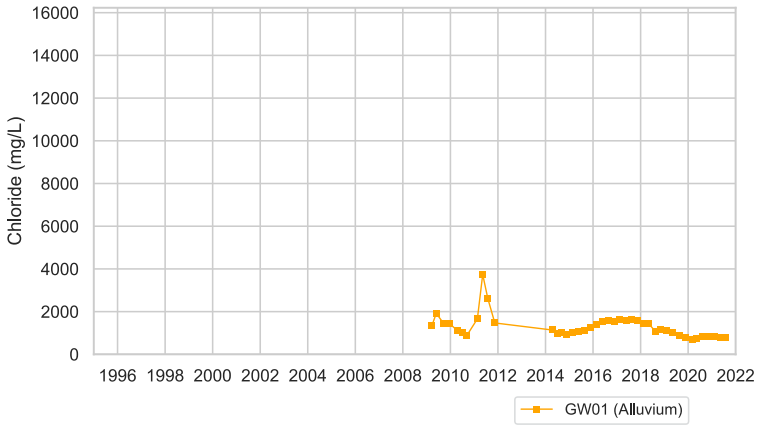

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

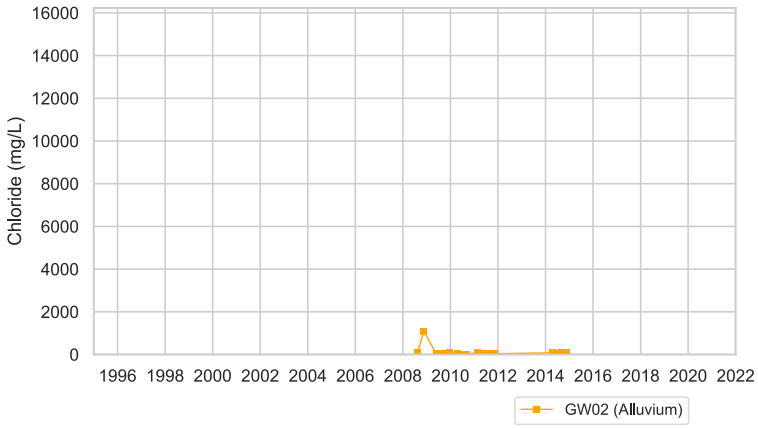

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

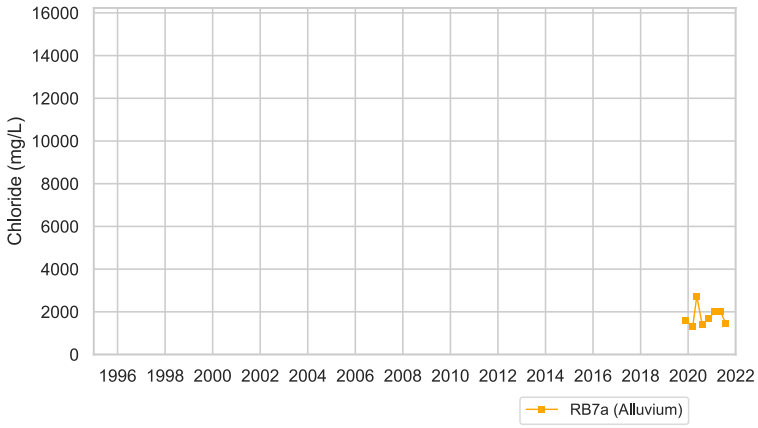

Chloride (mg/L)
EC25 (Alluvium)

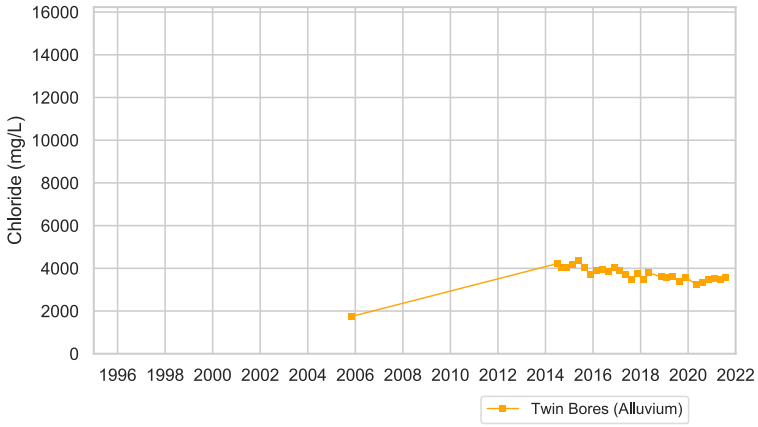

Chloride (mg/L)
EC27 (Alluvium)

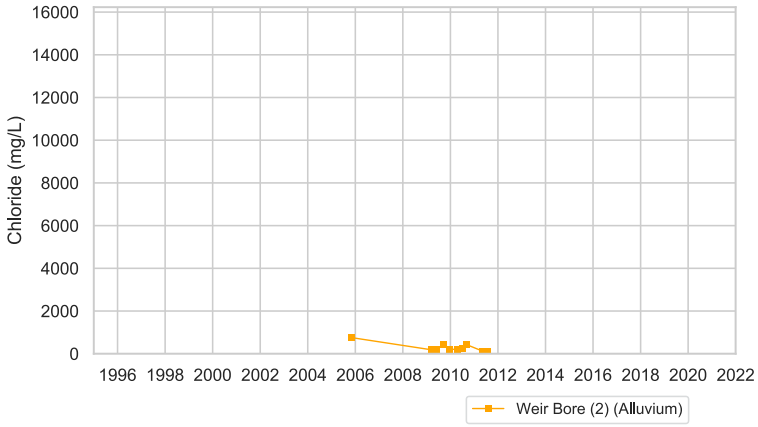

Chloride (mg/L)
FIELD 5 BORE (Alluvium)

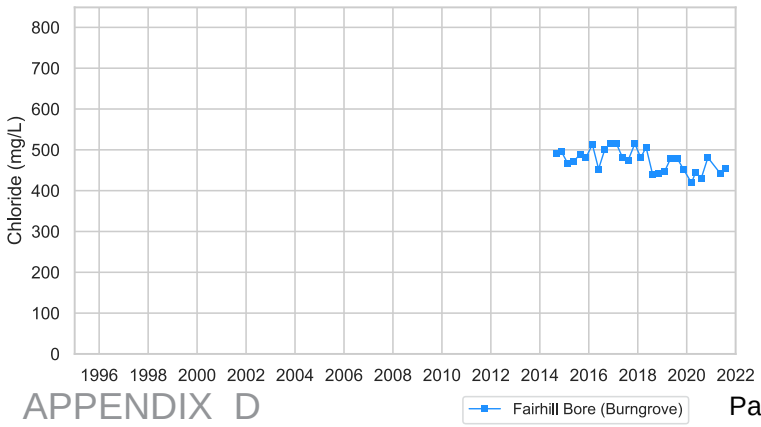

Chloride (mg/L)
GW01 (Alluvium)

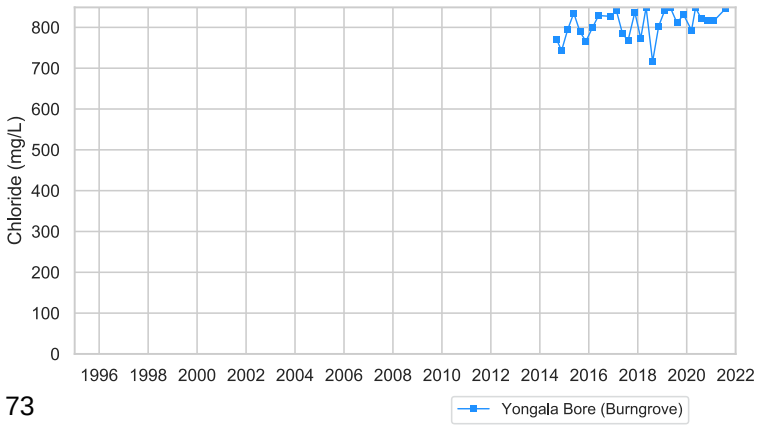

Chloride (mg/L)
GW02 (Alluvium)

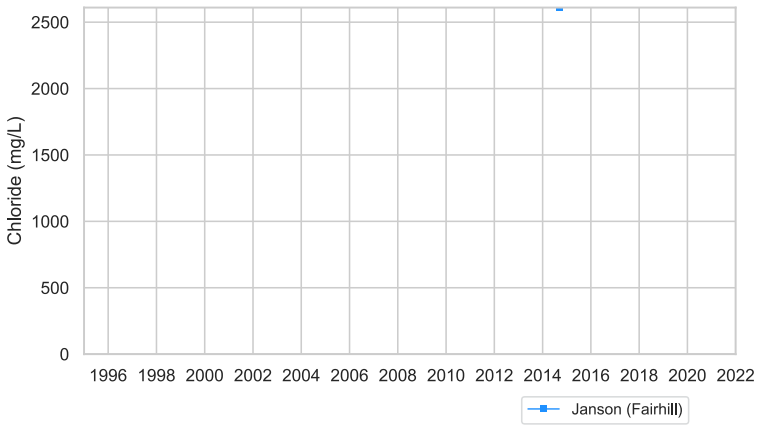

Chloride (mg/L)
RB7a (Alluvium)

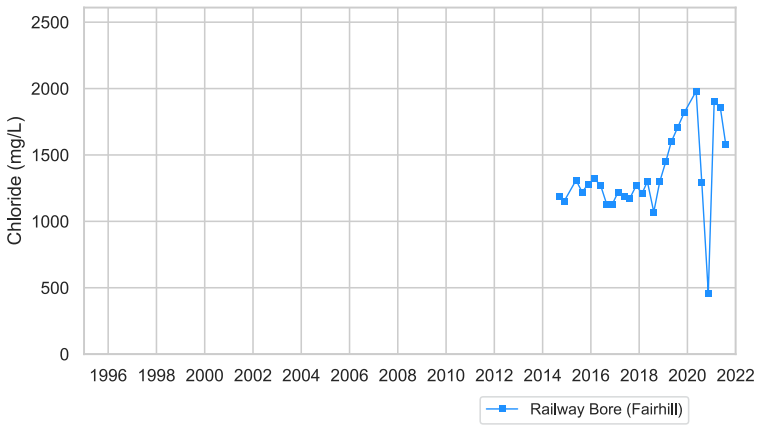

Chloride (mg/L)
Twin Bores (Alluvium)

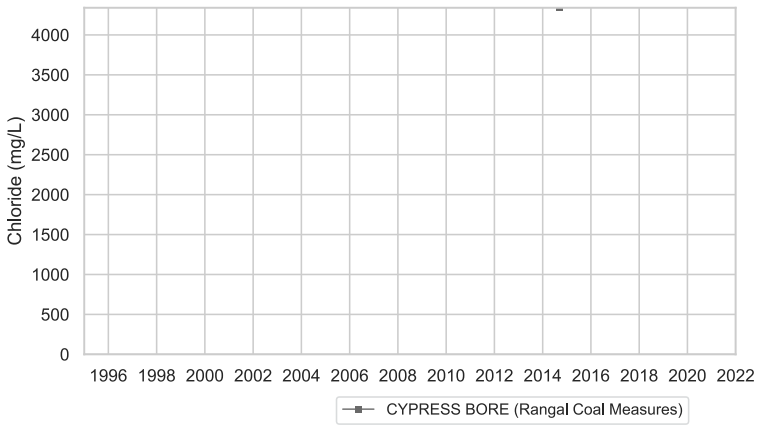

Chloride (mg/L)
Weir Bore (2) (Alluvium)

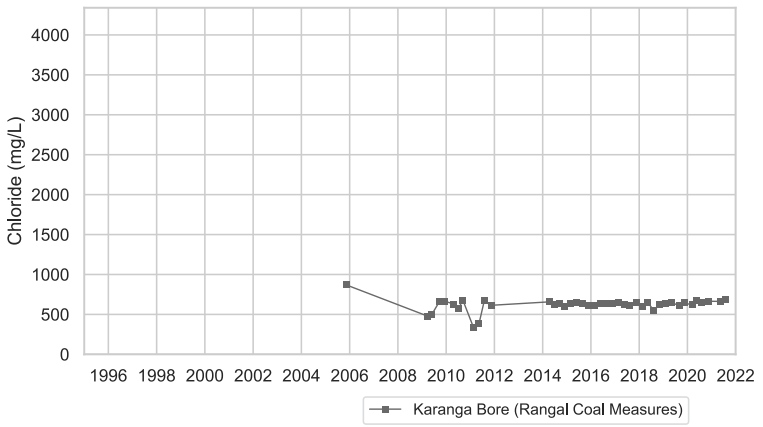

Chloride (mg/L)
Fairhill Bore (Burngrove)

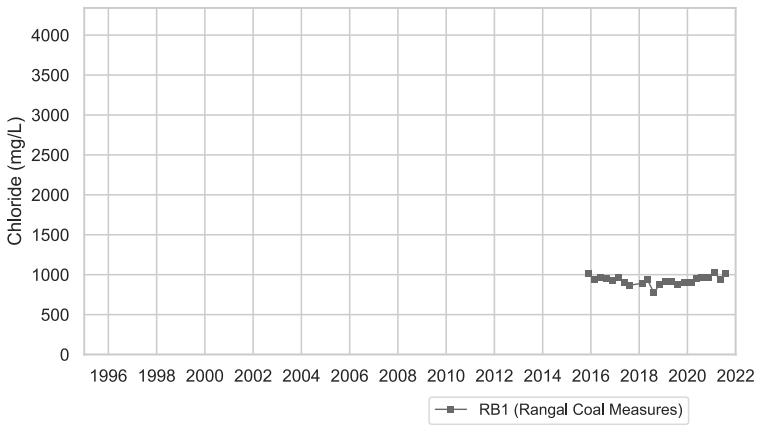

Chloride (mg/L)
Yongala Bore (Burngrove)

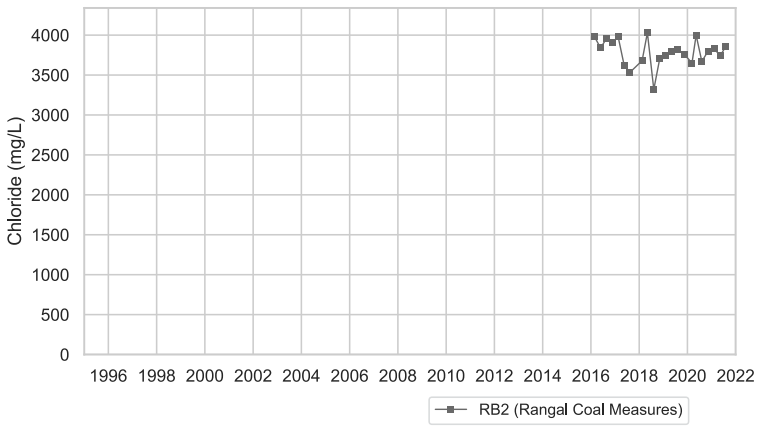

Chloride (mg/L)
Janson (Fairhill)

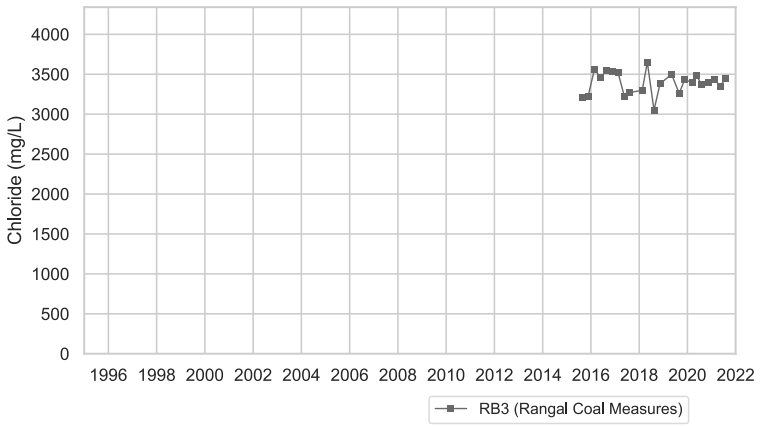

Chloride (mg/L)
Railway Bore (Fairhill)

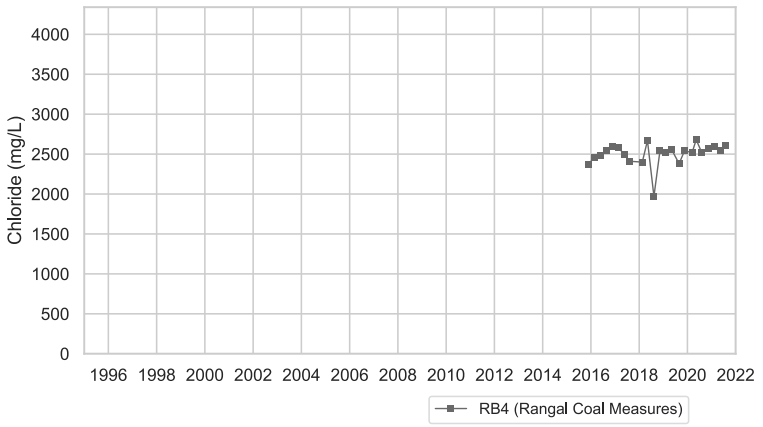

Chloride (mg/L)
CYPRESS BORE (Rangal Coal Measures)

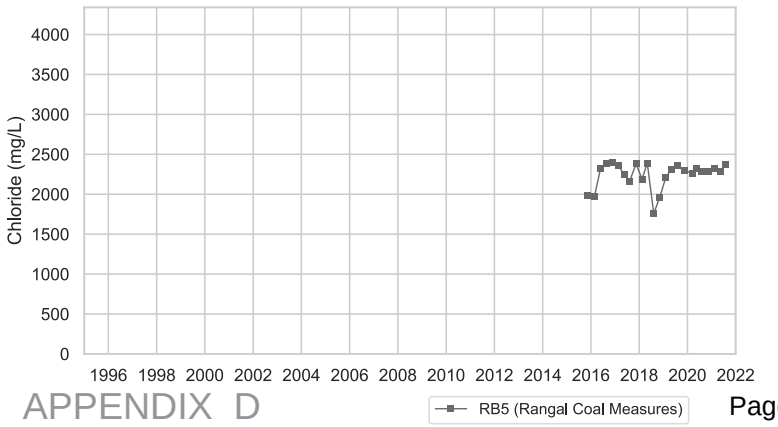

Chloride (mg/L)
Karanga Bore (Rangal Coal Measures)

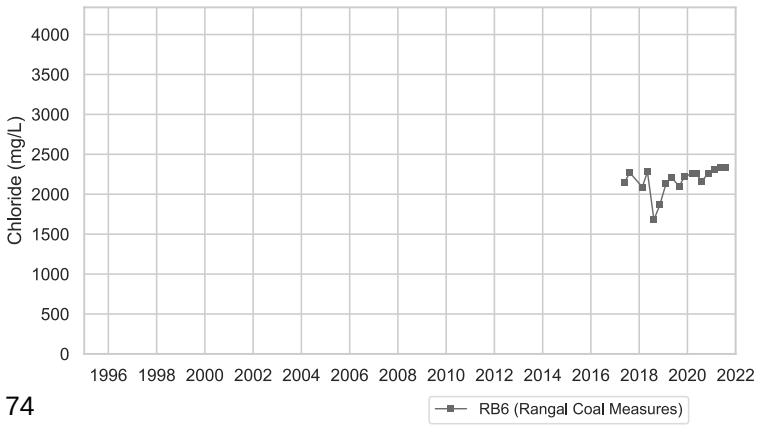

Chloride (mg/L)
RB1 (Rangal Coal Measures)

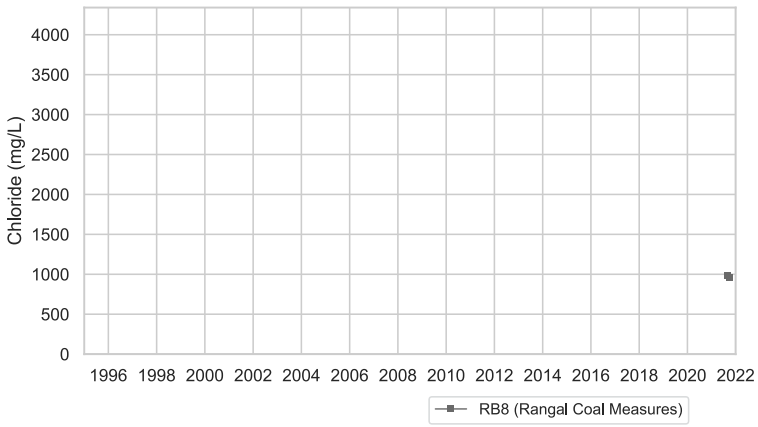

Chloride (mg/L)
RB2 (Rangal Coal Measures)

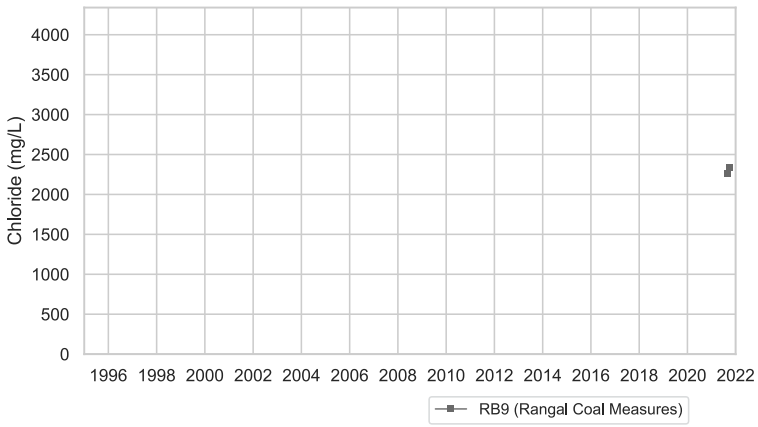

Chloride (mg/L)
RB3 (Rangal Coal Measures)

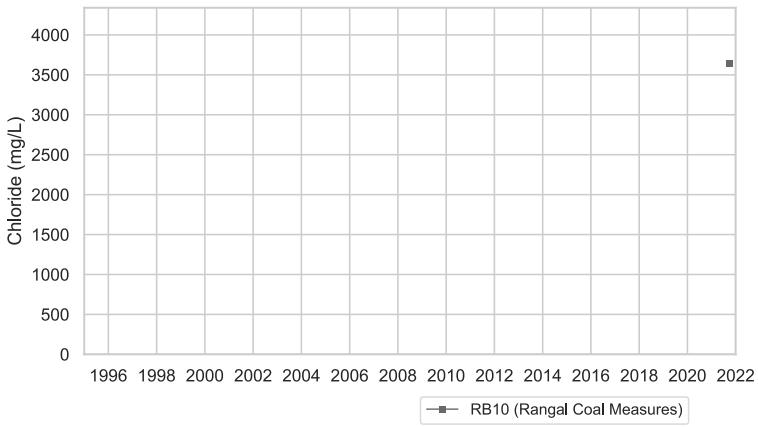

Chloride (mg/L)
RB4 (Rangal Coal Measures)

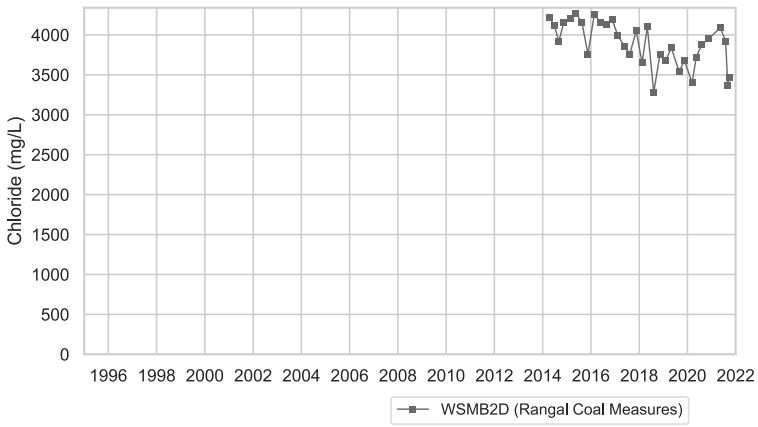

Chloride (mg/L)
RB5 (Rangal Coal Measures)

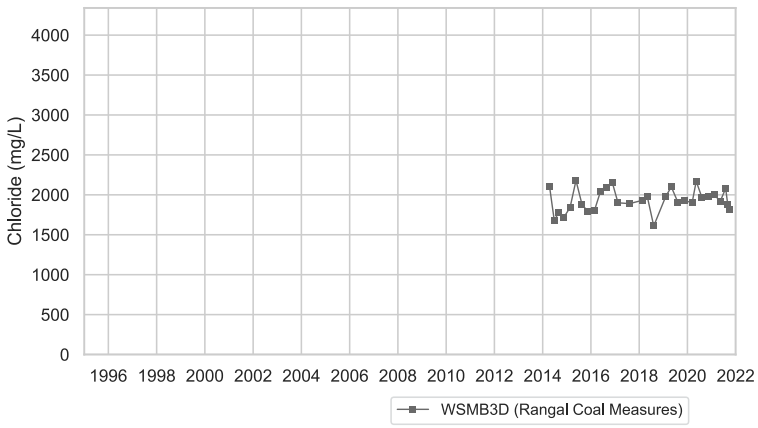

Chloride (mg/L)
RB6 (Rangal Coal Measures)

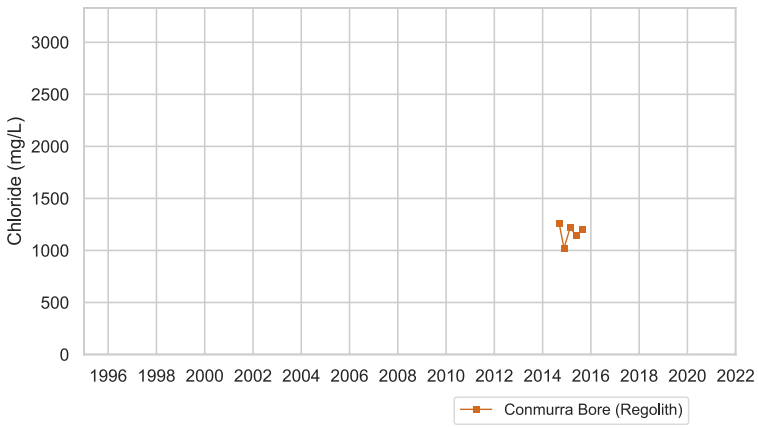

Chloride (mg/L)
RB8 (Rangal Coal Measures)

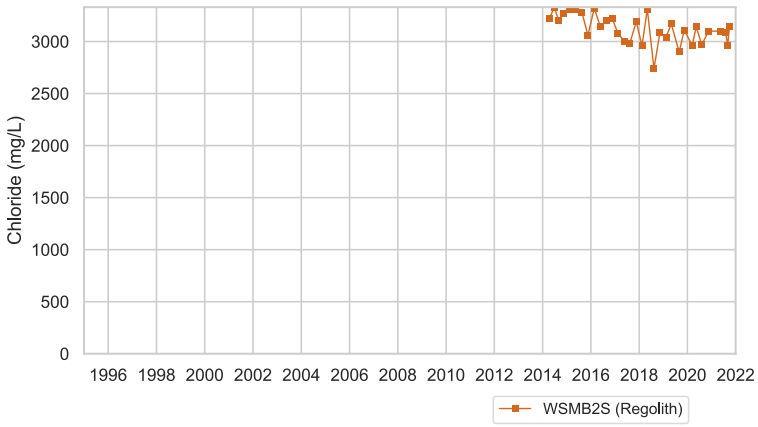

Chloride (mg/L)
RB9 (Rangal Coal Measures)

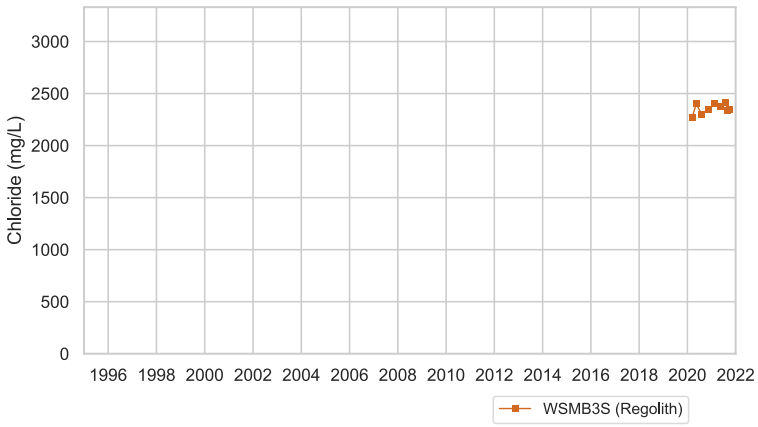

Chloride (mg/L)
RB10 (Rangal Coal Measures)

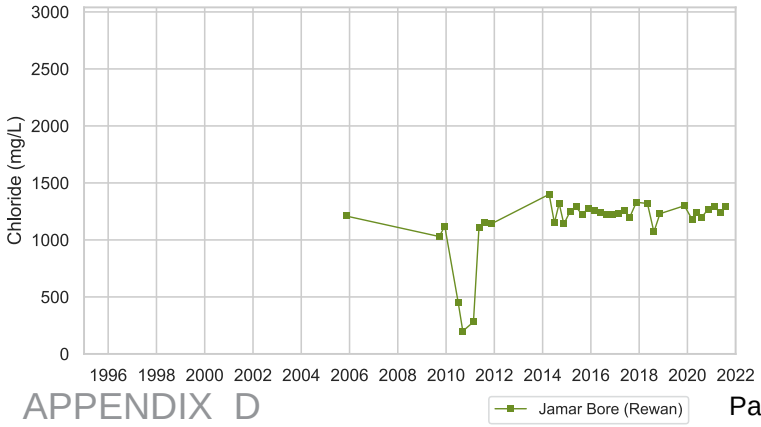

Chloride (mg/L)
WSMB2D (Rangal Coal Measures)

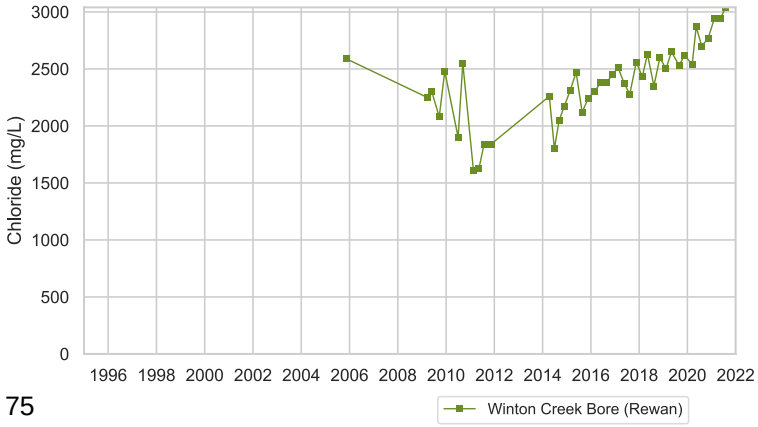

Chloride (mg/L)
WSMB3D (Rangal Coal Measures)

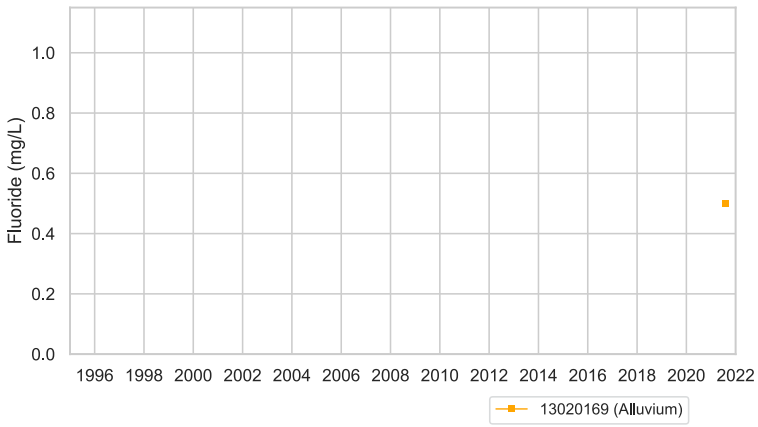

Chloride (mg/L)
Conmurra Bore (Regolith)

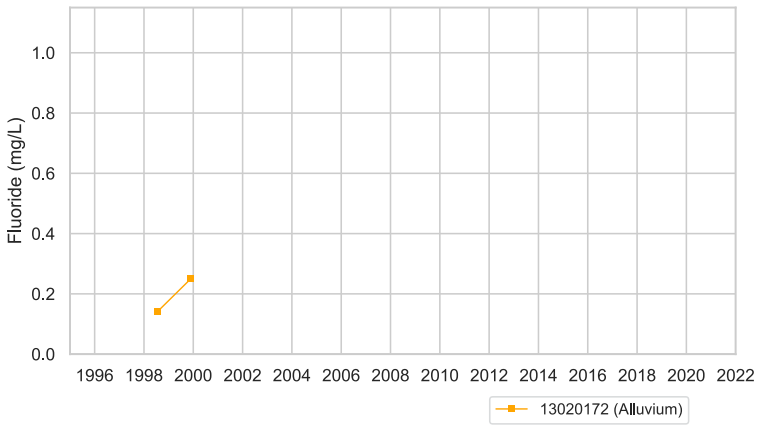

Chloride (mg/L)
WSMB2S (Regolith)

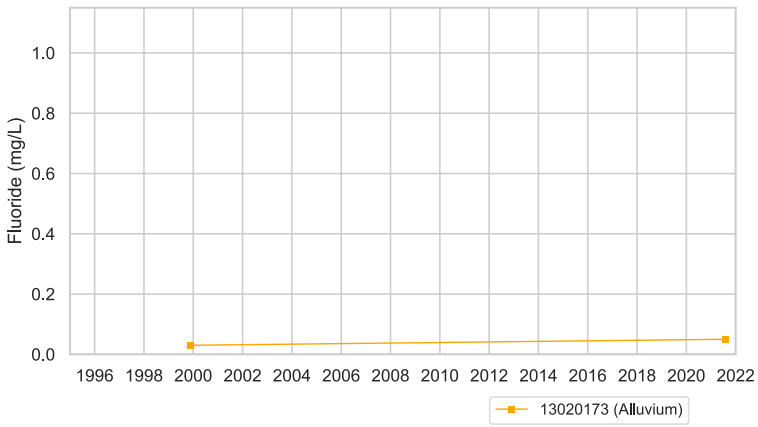

Chloride (mg/L)
WSMB3S (Regolith)

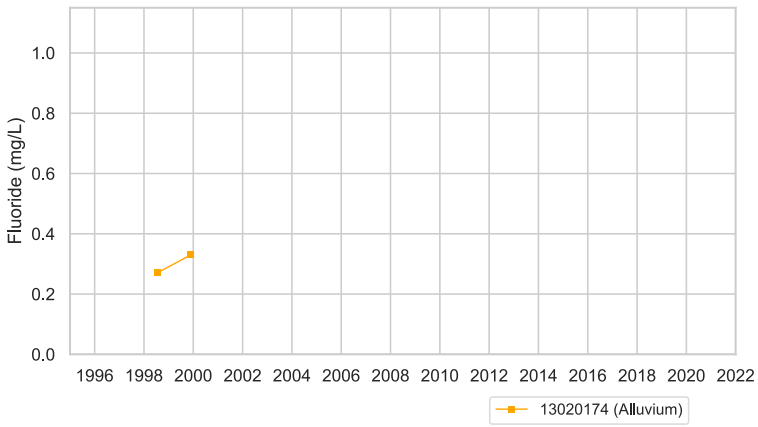

Chloride (mg/L)
Jamar Bore (Rewan)

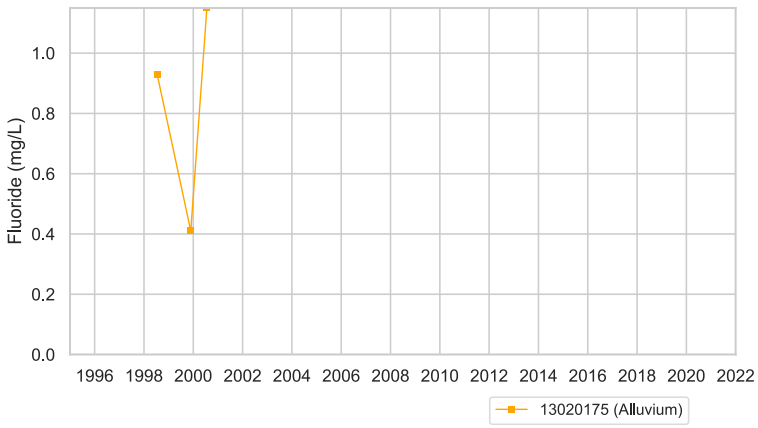

Chloride (mg/L)
Winton Creek Bore (Rewan)

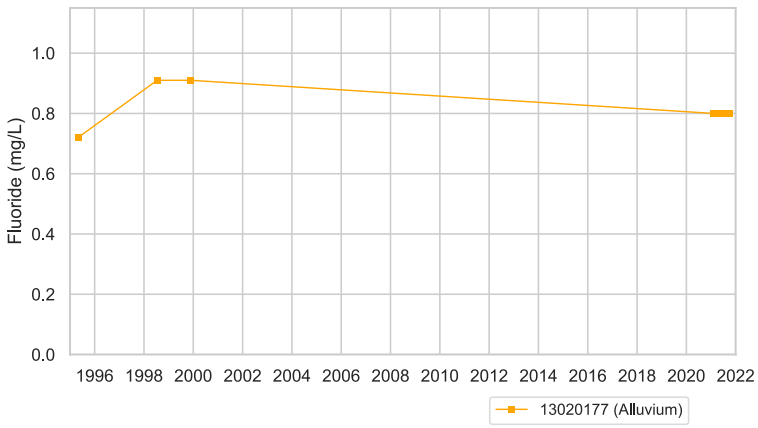

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

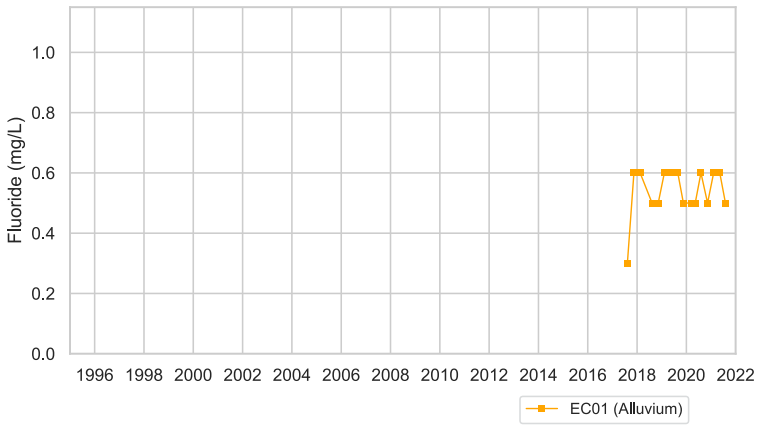

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

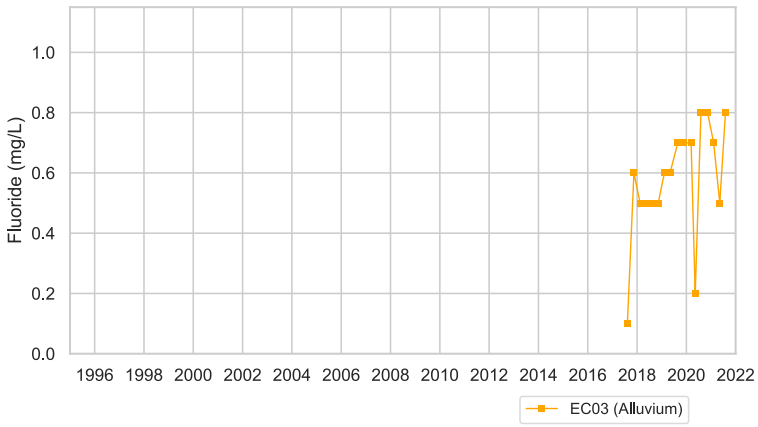

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

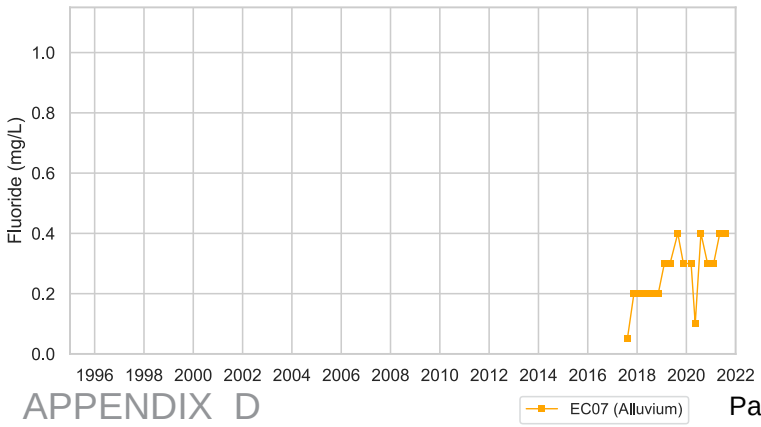

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

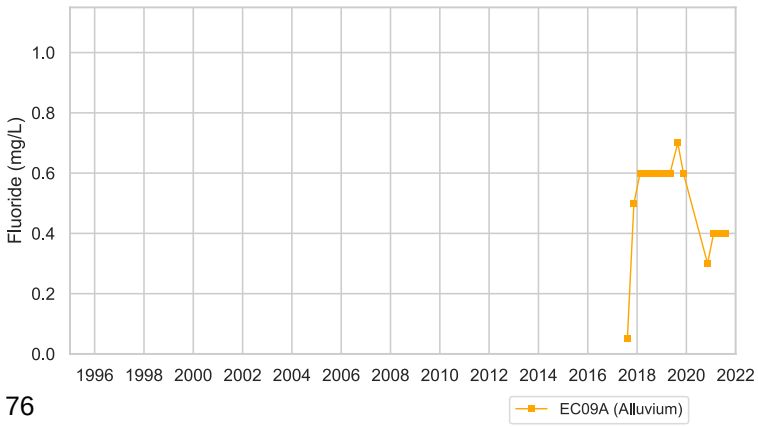

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

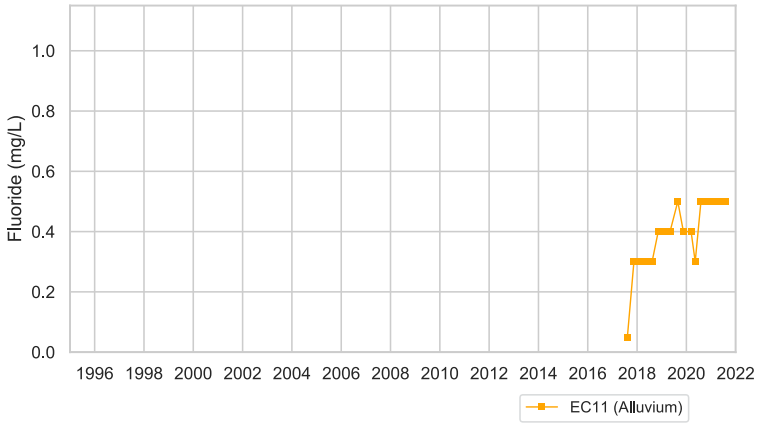

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

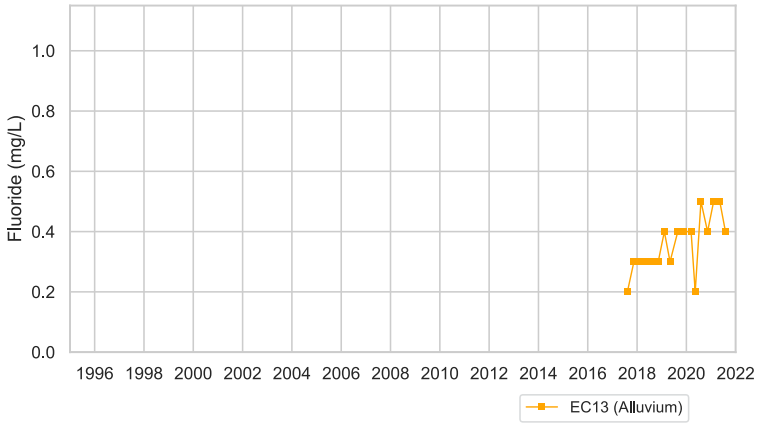

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

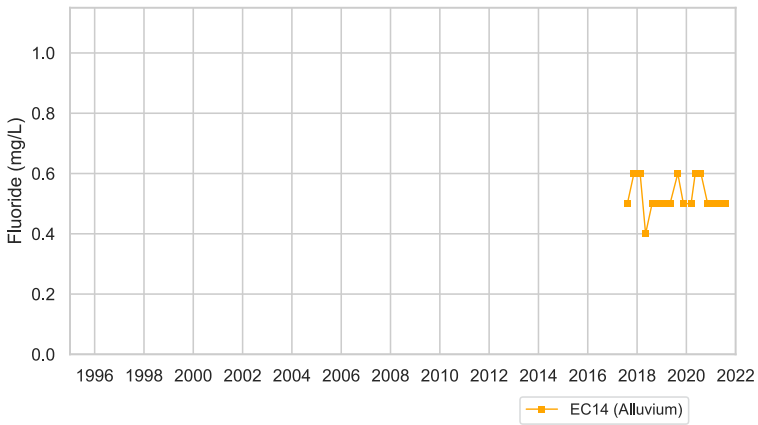

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

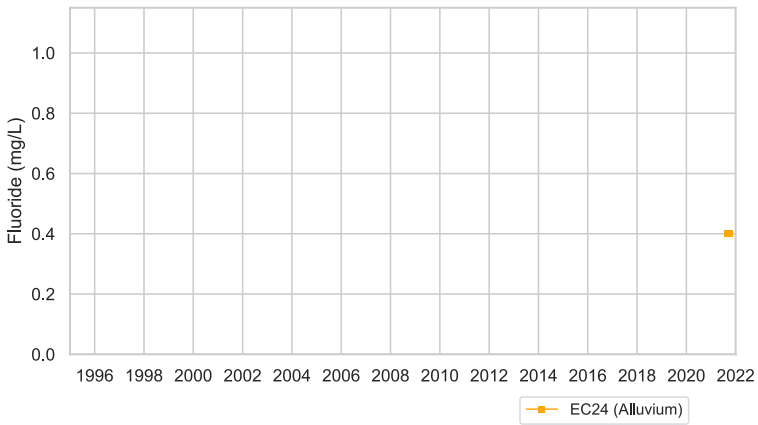

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

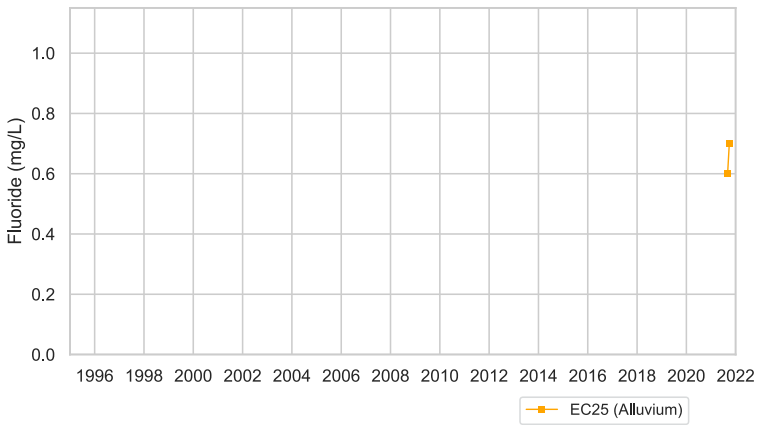

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

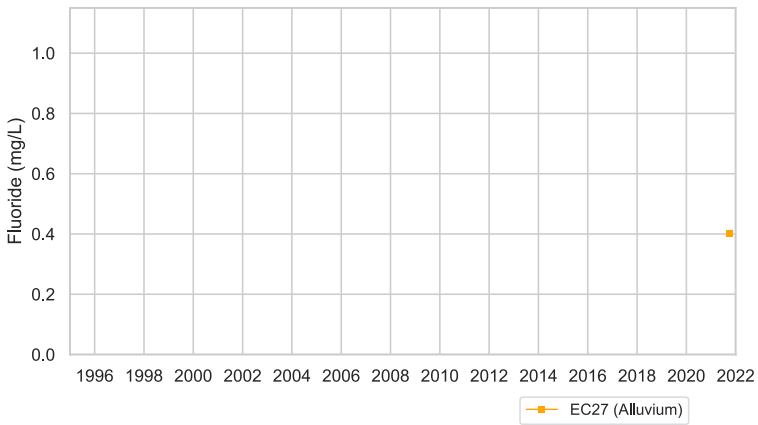

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

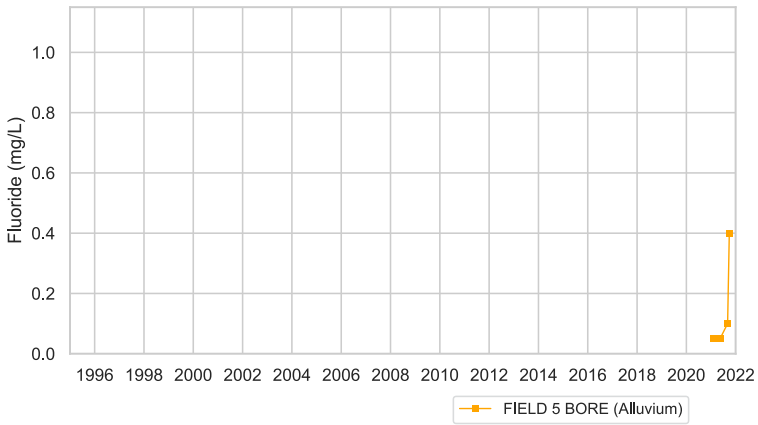

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

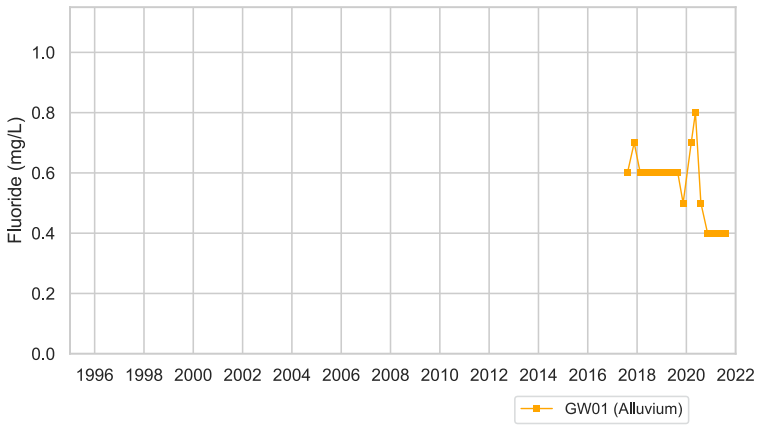

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

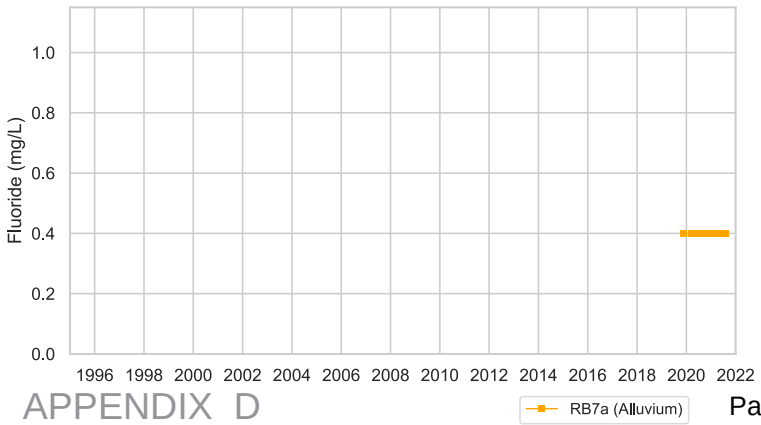

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

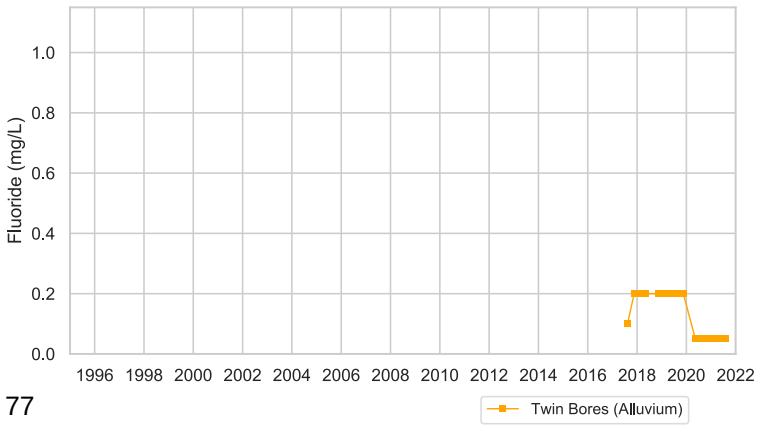

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

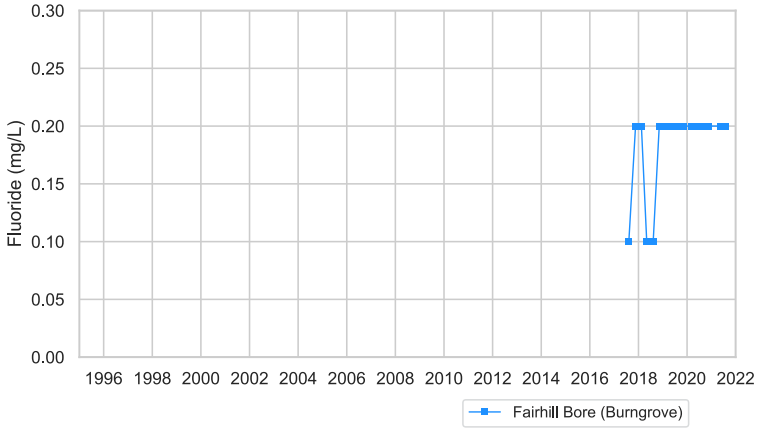

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

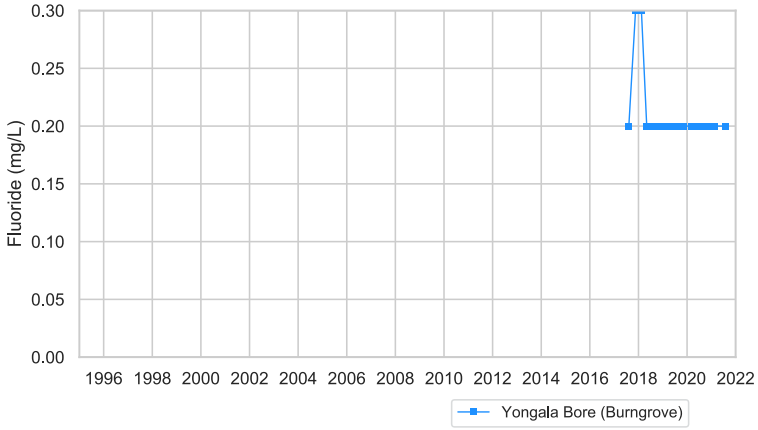

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

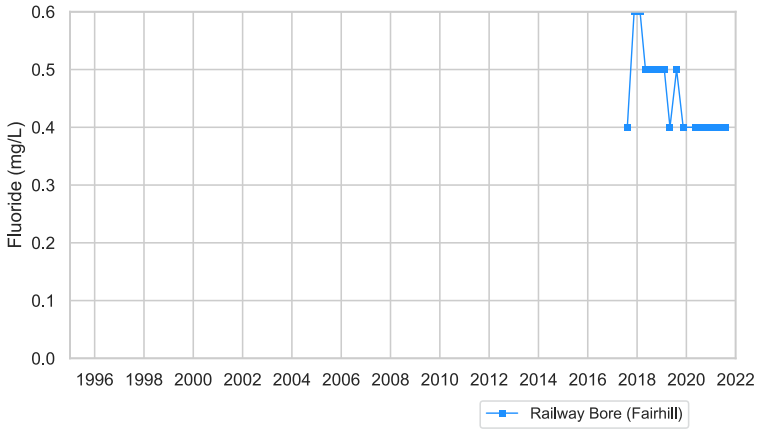

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

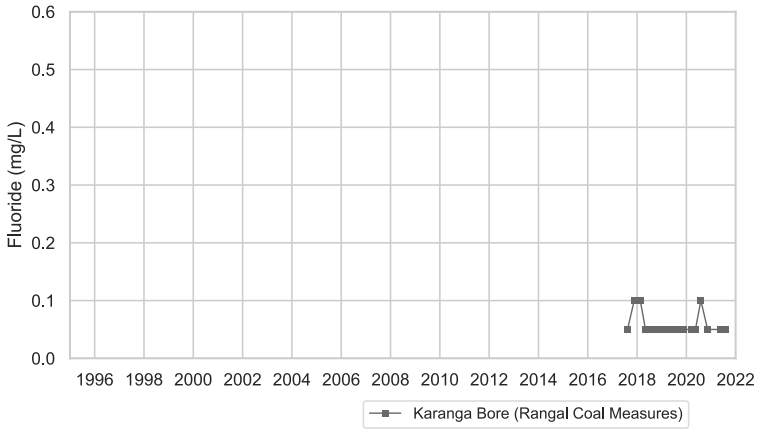

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

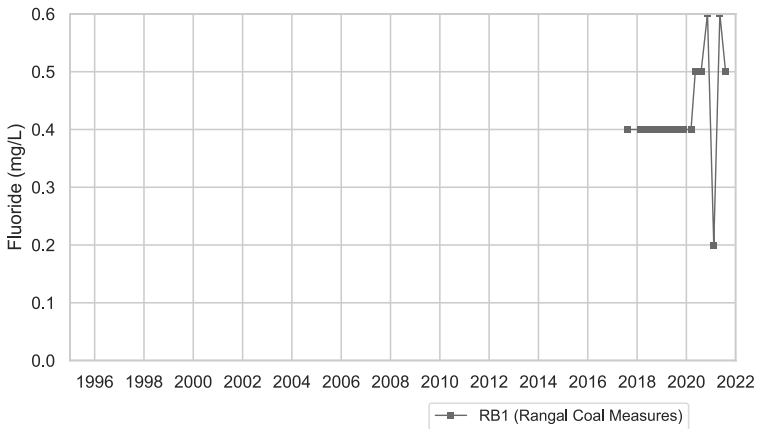

Fluoride (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

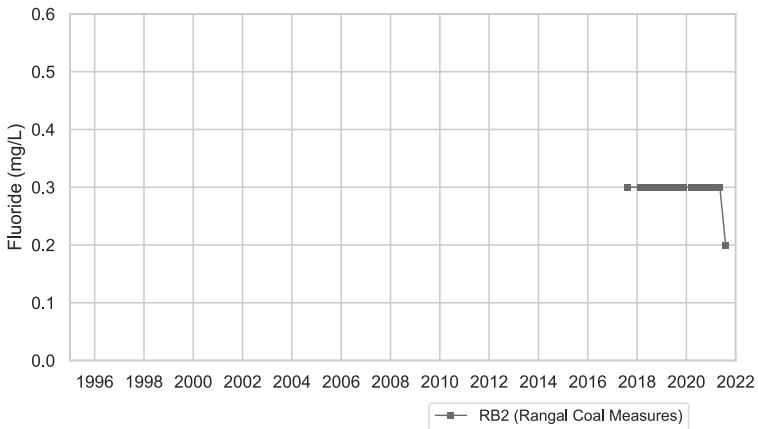

Fluoride (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

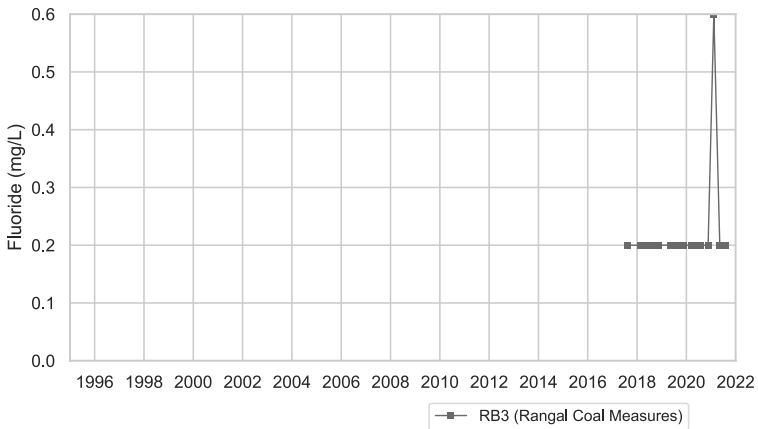

Fluoride (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

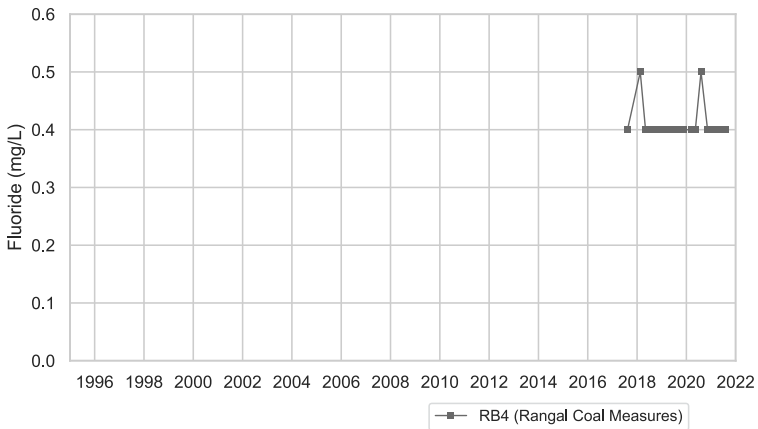

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

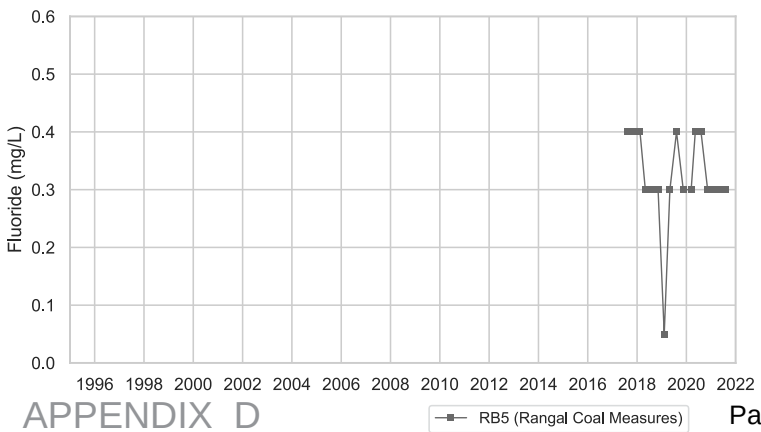

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

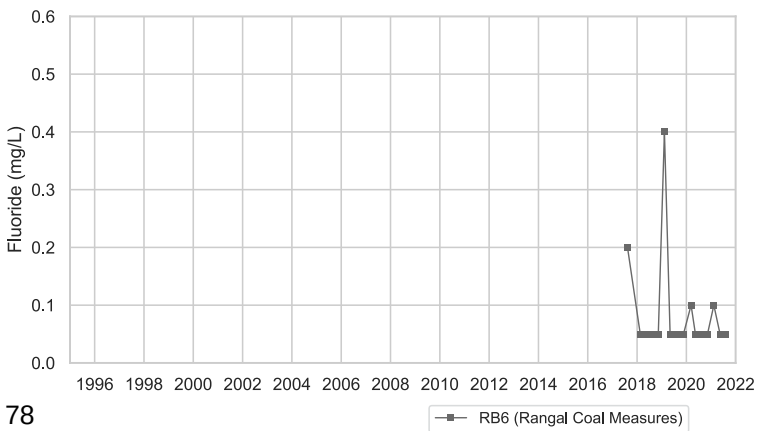

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

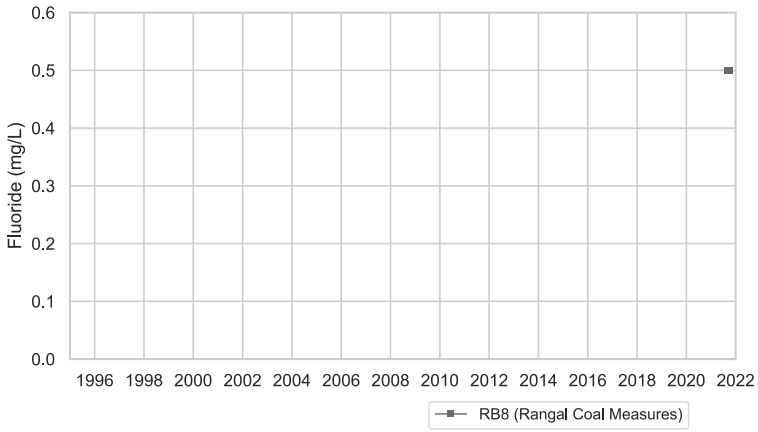

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

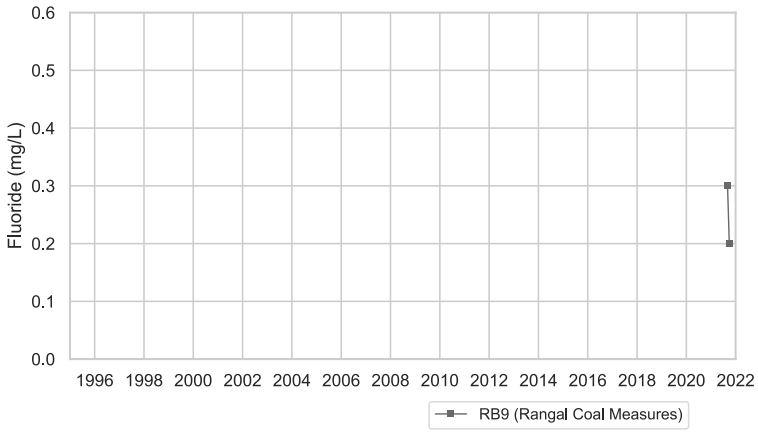

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

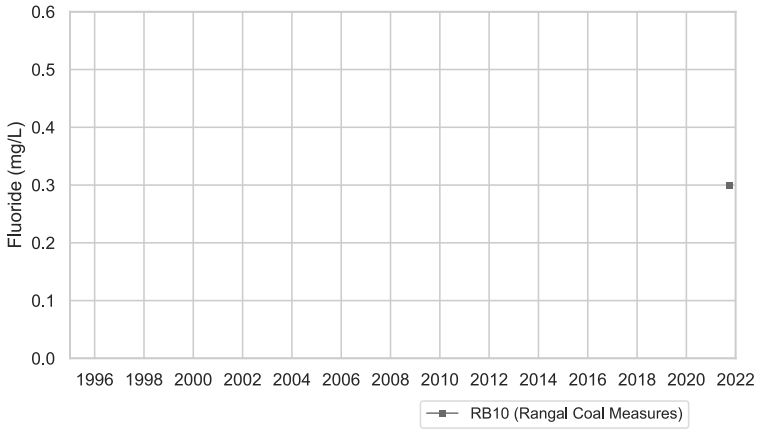

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

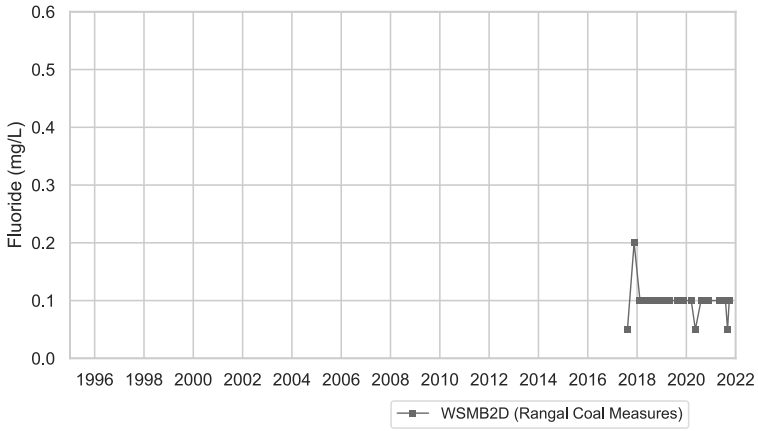

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

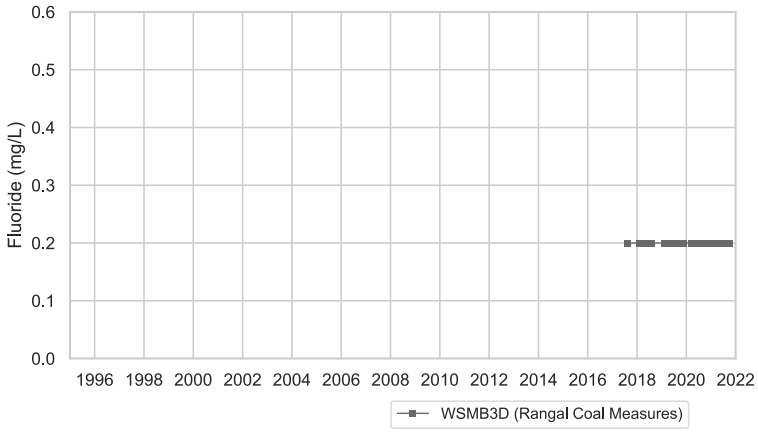

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

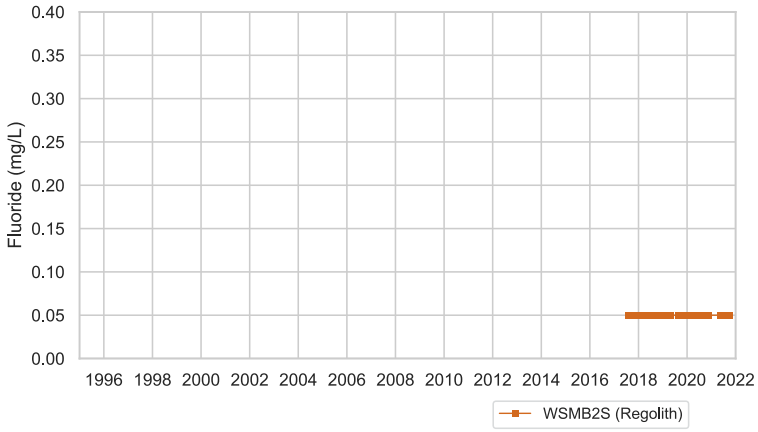

Fluoride (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

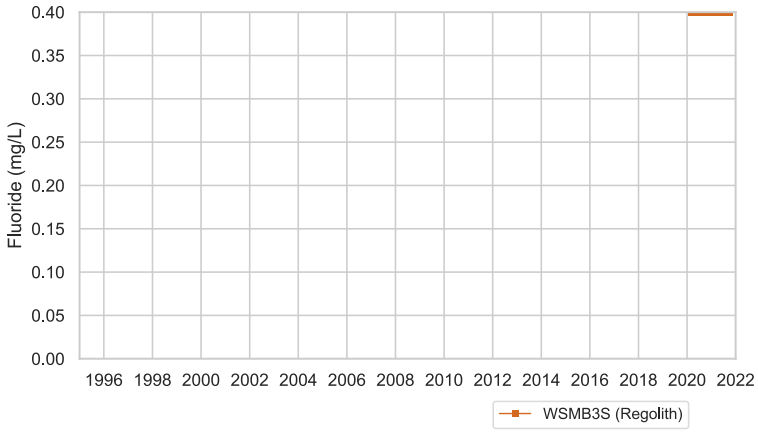

Fluoride (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

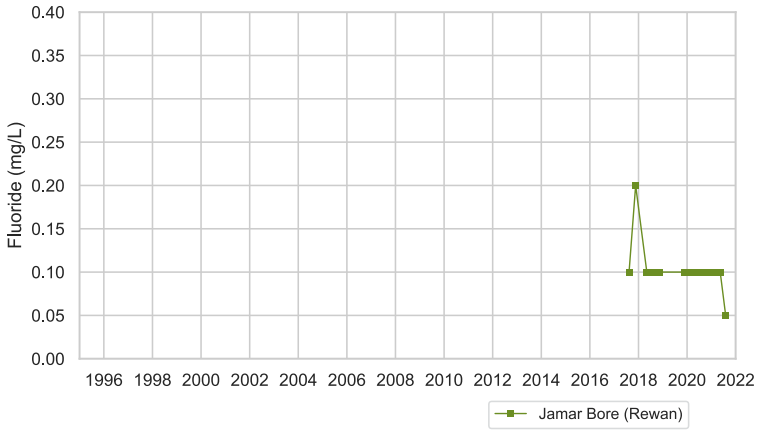

Fluoride (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

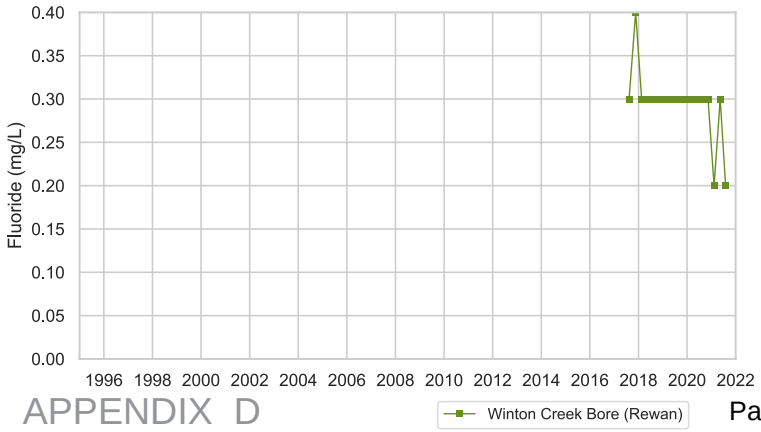

Fluoride (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

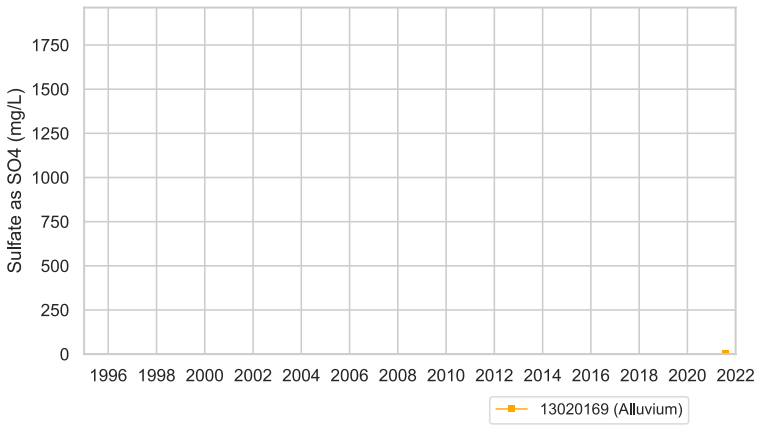

Fluoride (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

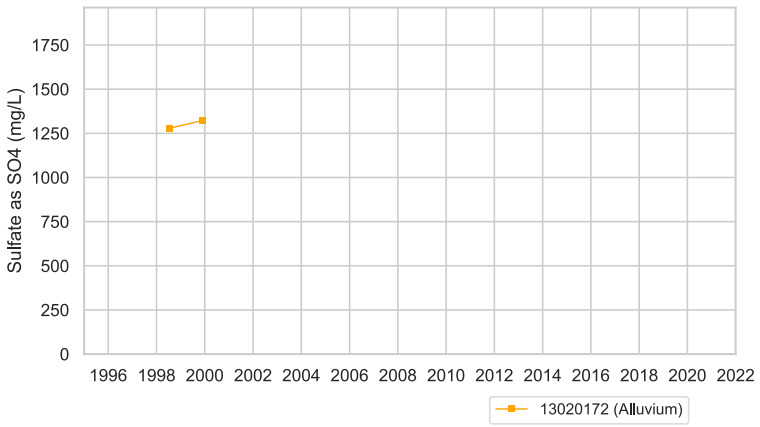

Fluoride (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

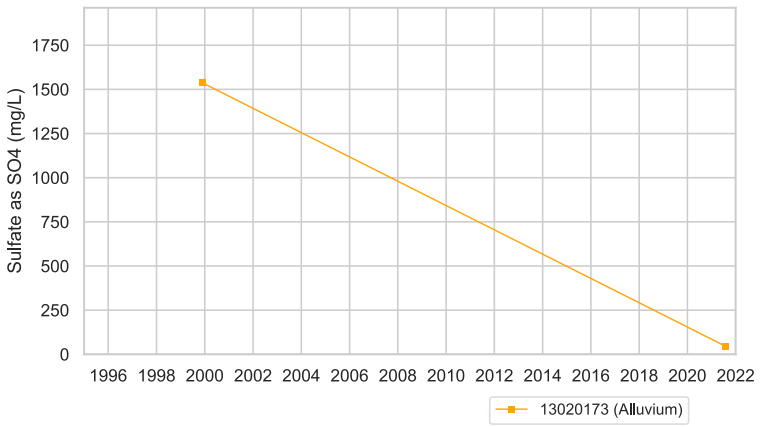

Fluoride (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

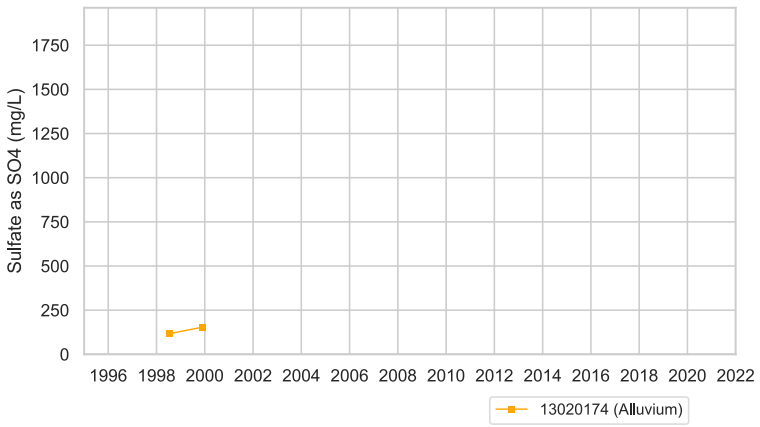

Fluoride (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

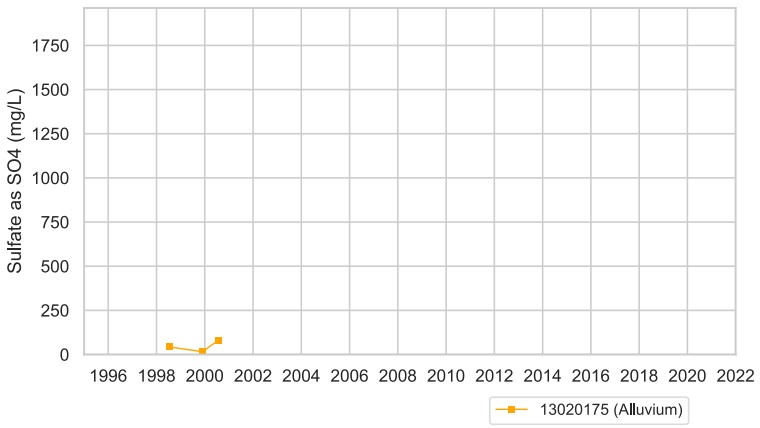

Fluoride (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

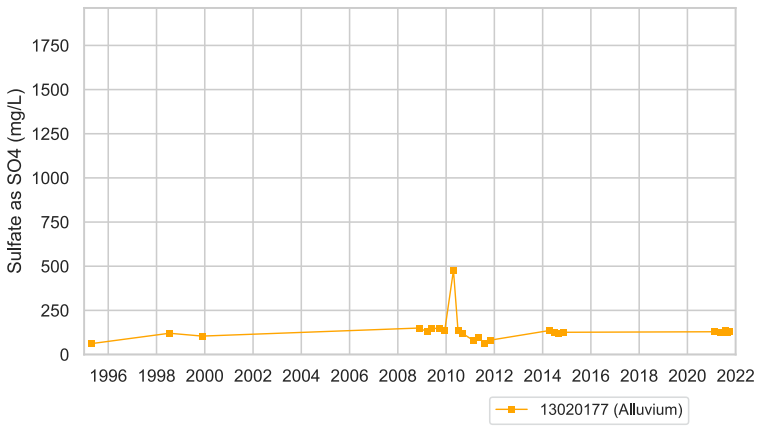

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

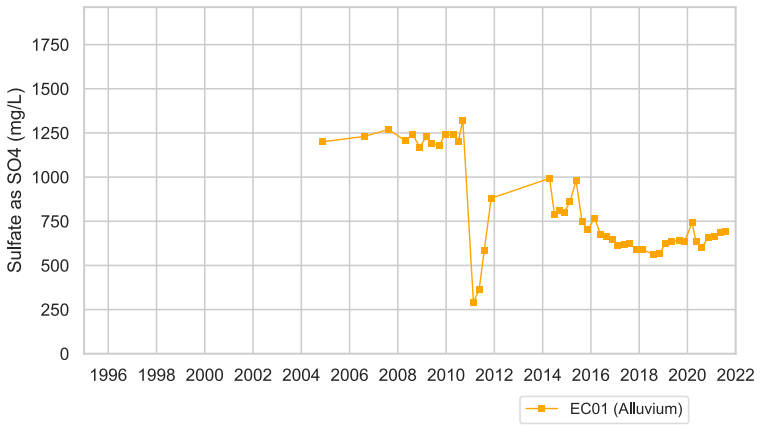

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

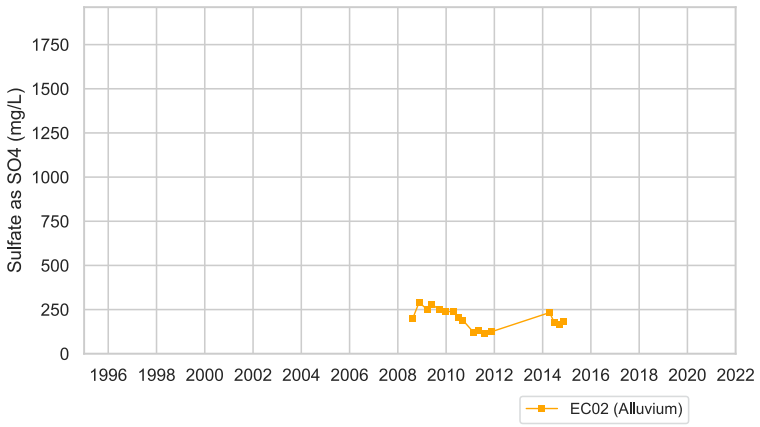

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

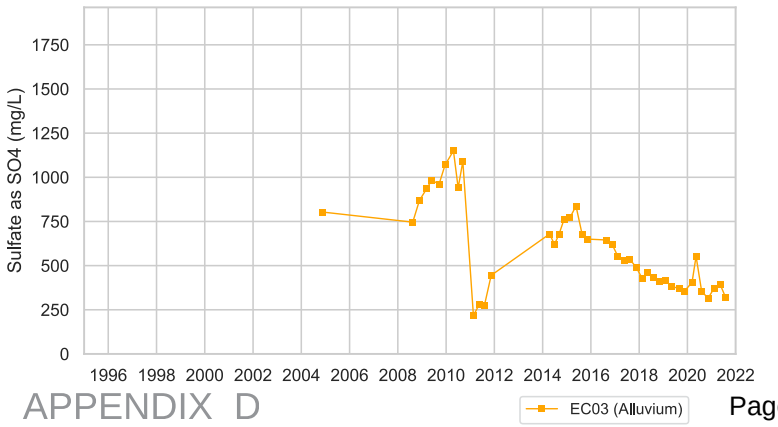

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

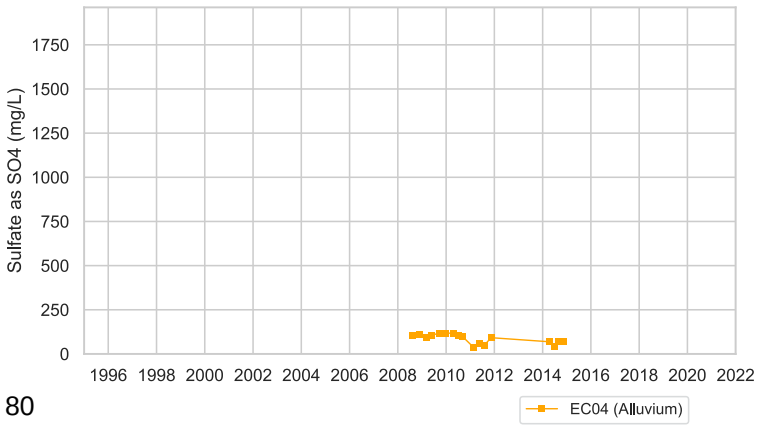

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

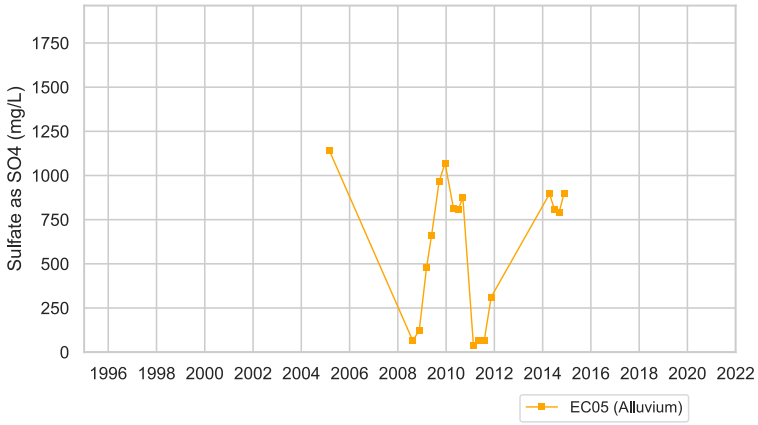

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

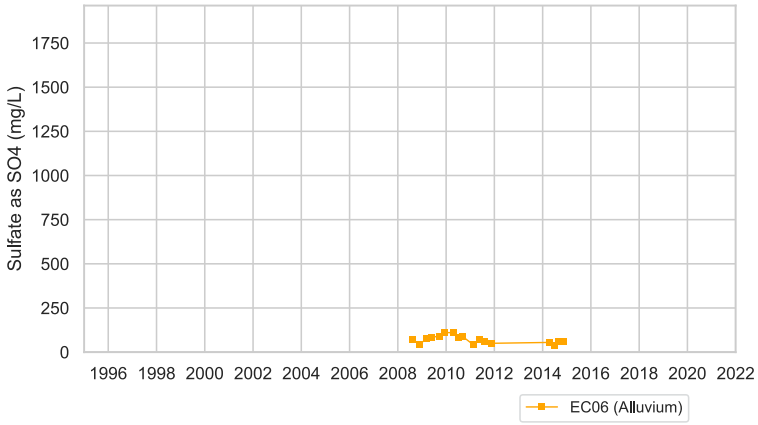

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

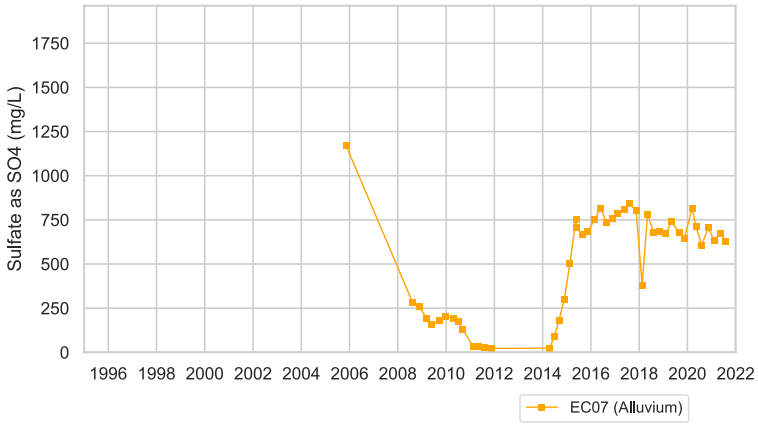

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

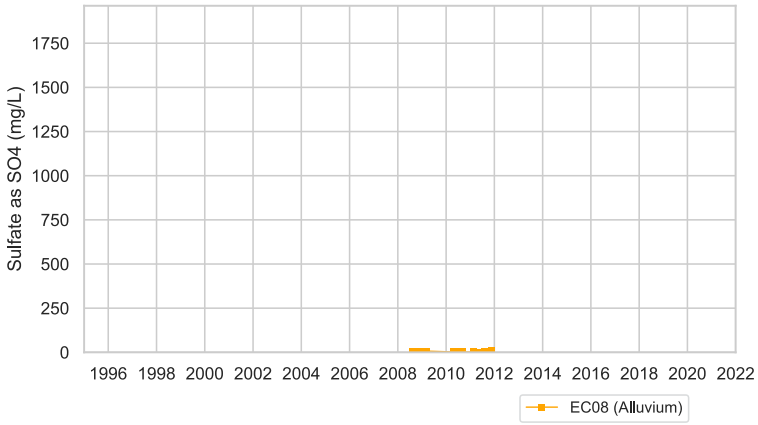

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

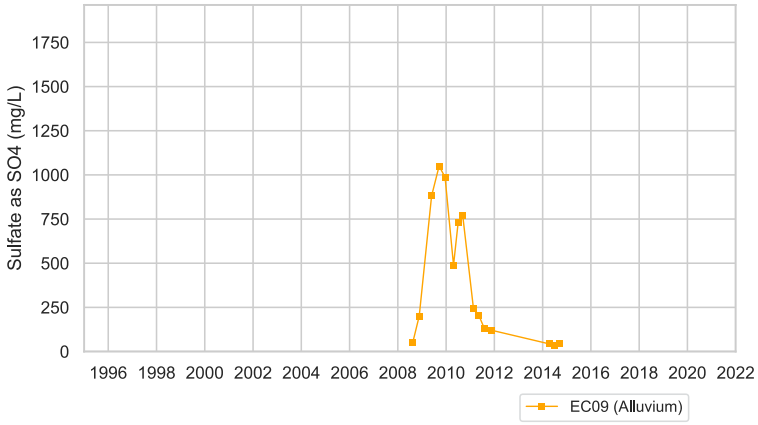

Sulfate as SO4 (mg/L)
1750
1500
1250
1000
750
500
250
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

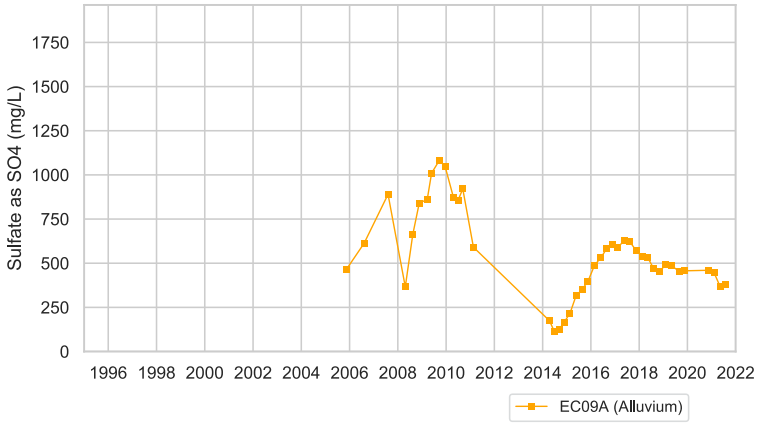

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

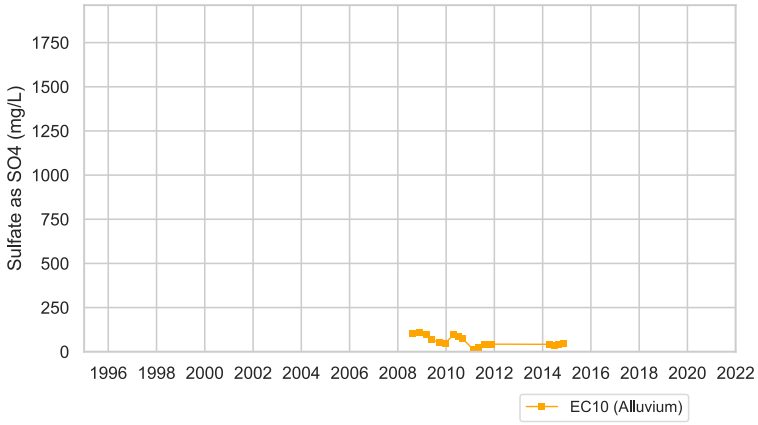

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

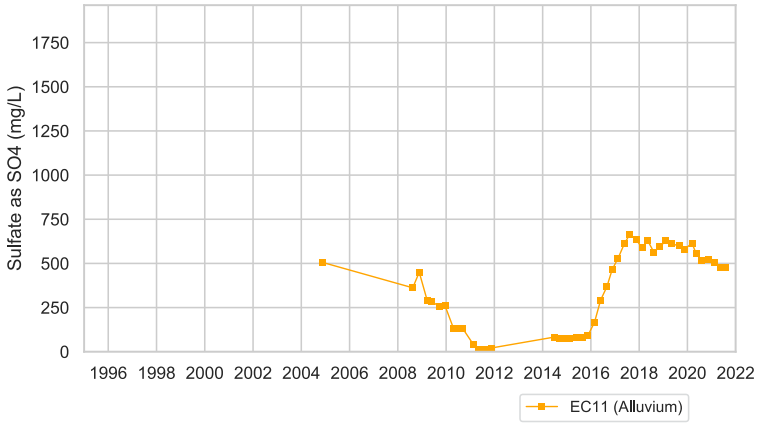

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

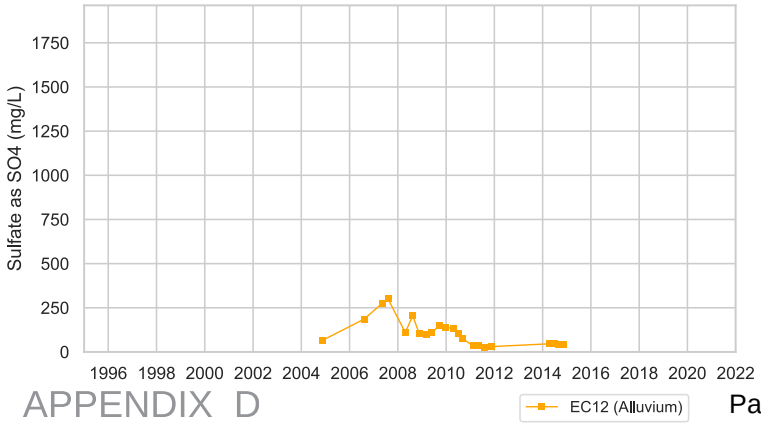

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

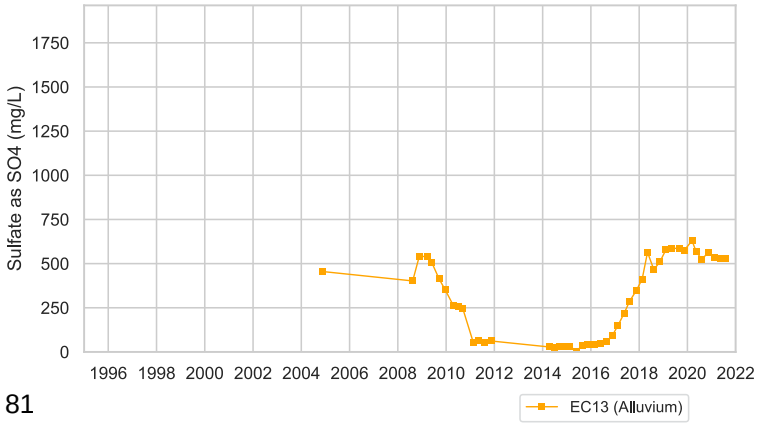

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

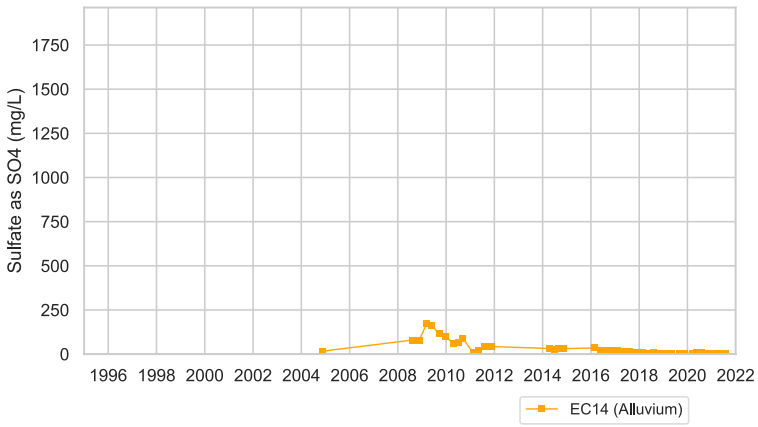

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

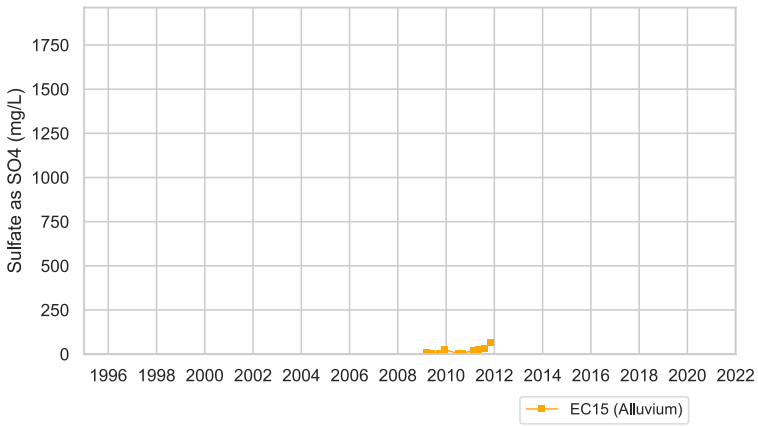

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

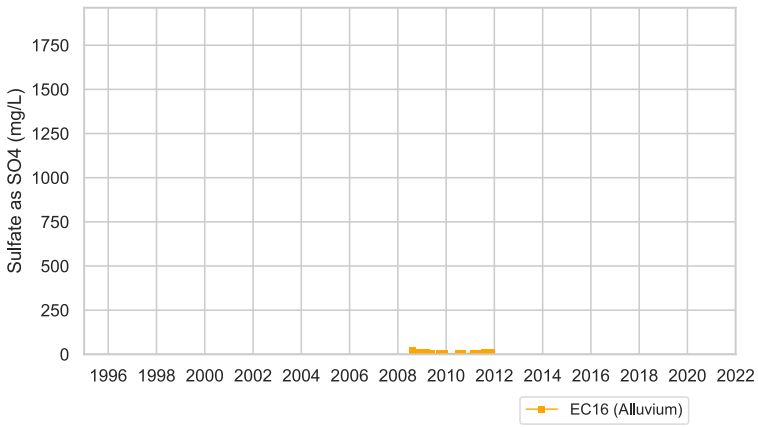

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

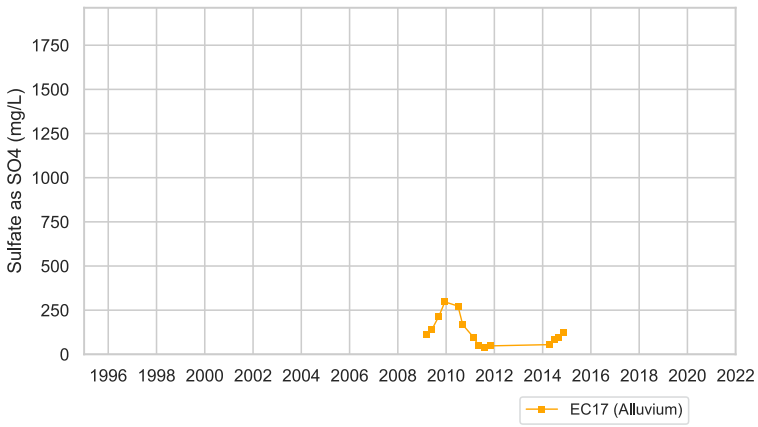

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

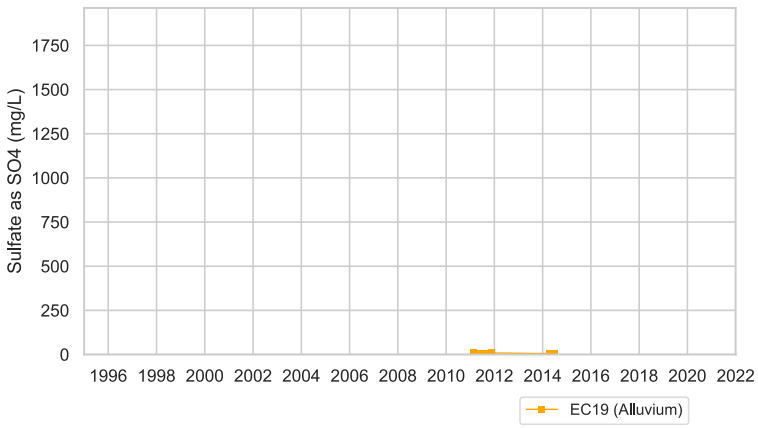

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

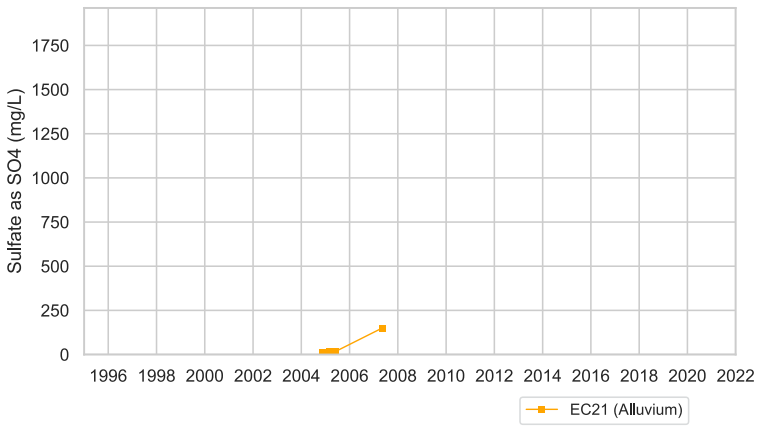

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

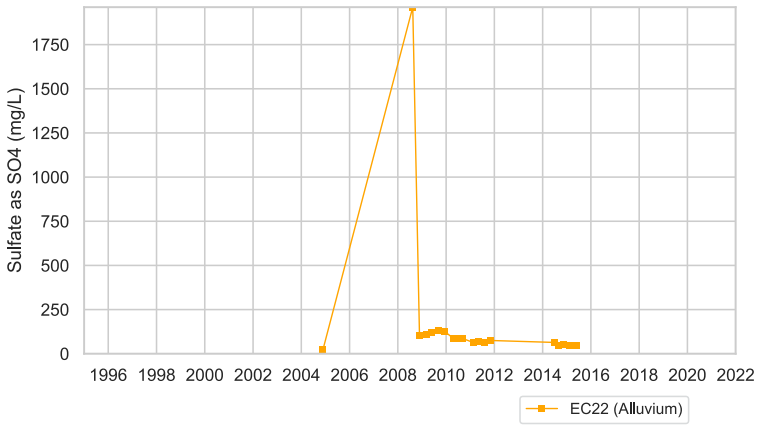

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

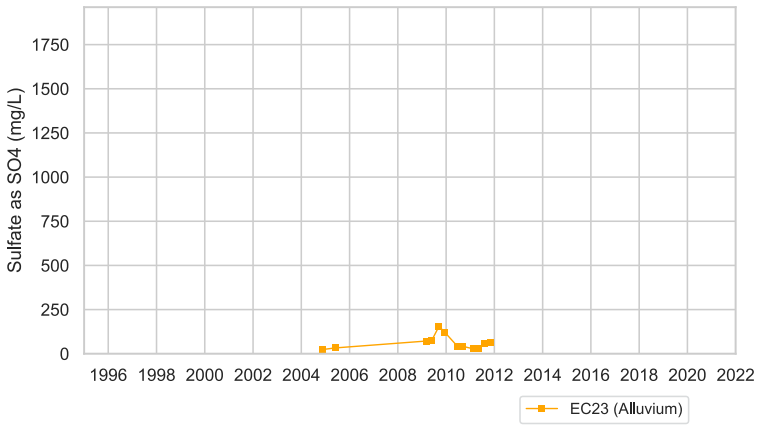

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

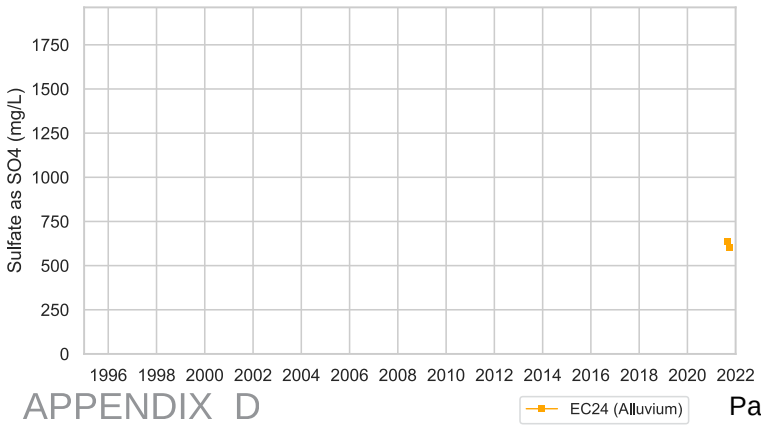

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

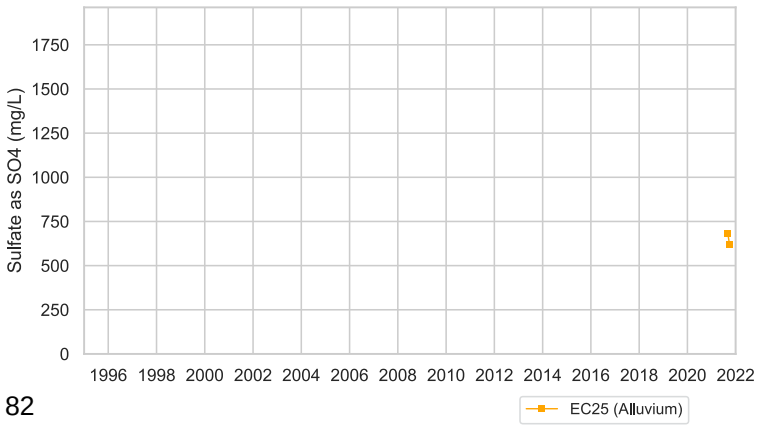

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

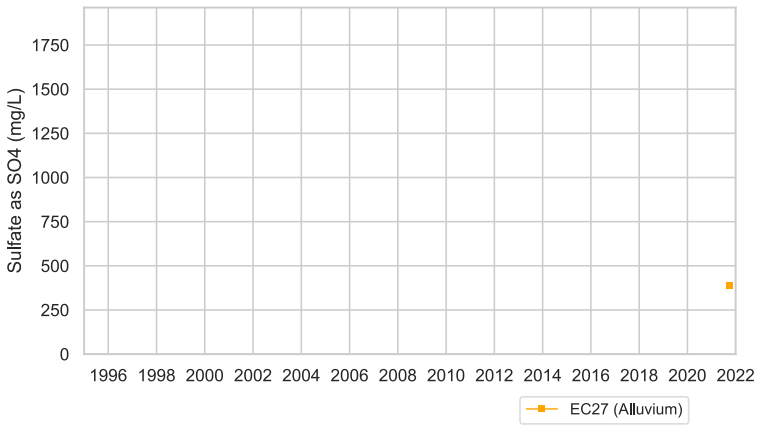

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

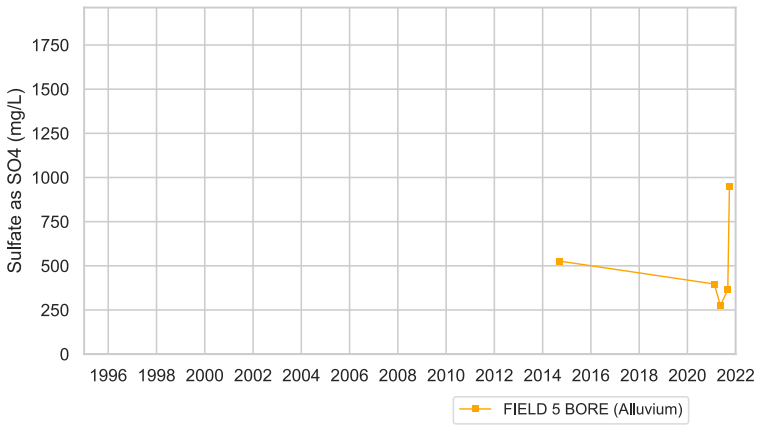

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

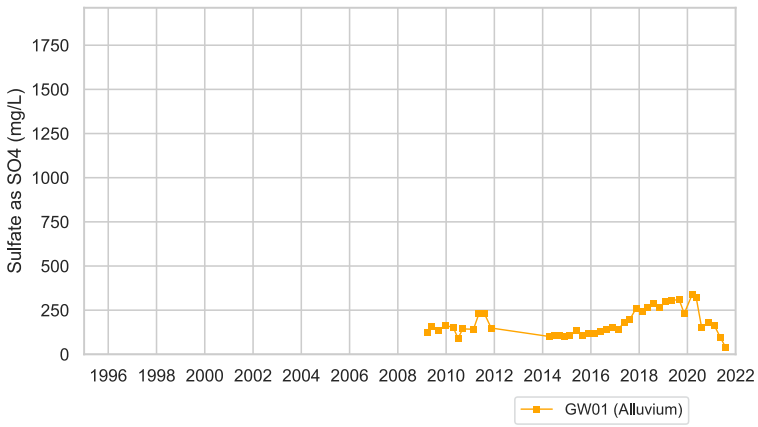

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

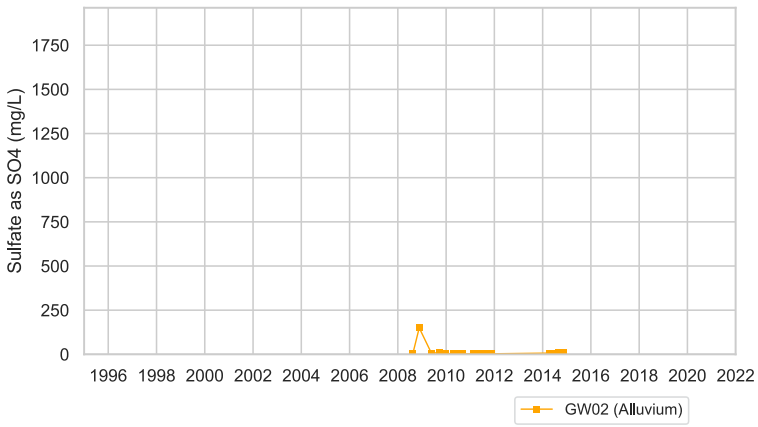

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

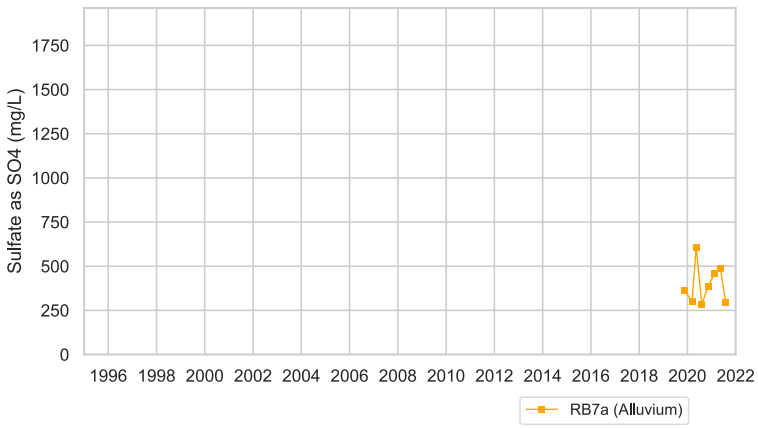

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

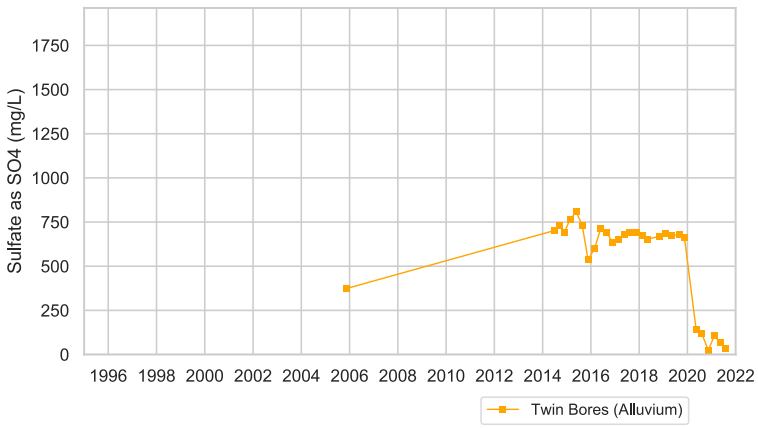

Sulfate as SO4 (mg/L)
EC27 (Alluvium)

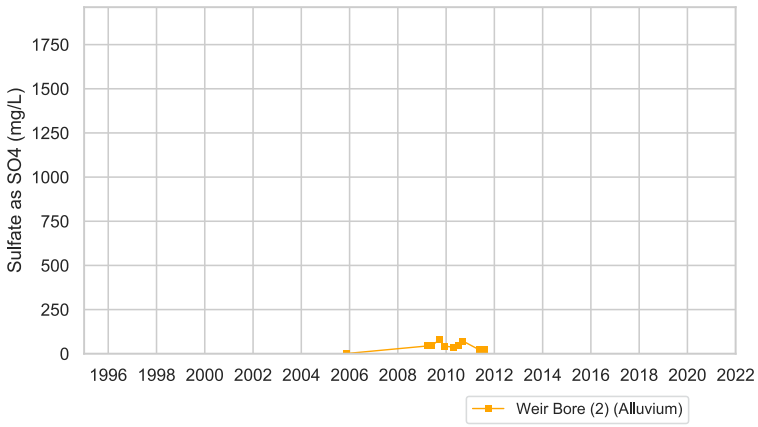

Sulfate as SO4 (mg/L)
FIELD 5 BORE (Alluvium)

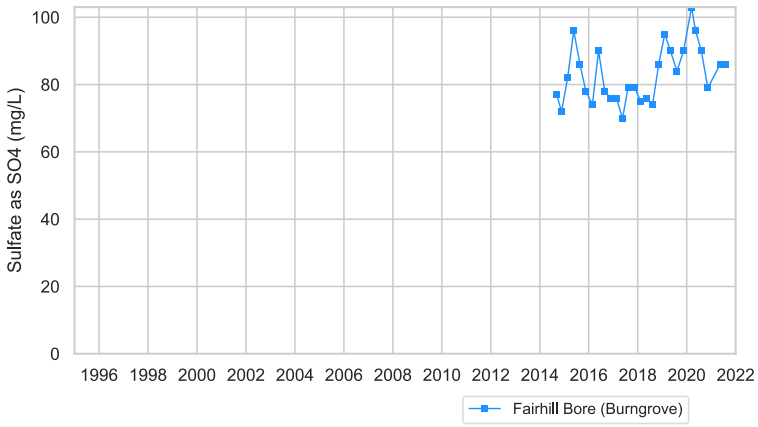

Sulfate as SO4 (mg/L)
GW01 (Alluvium)

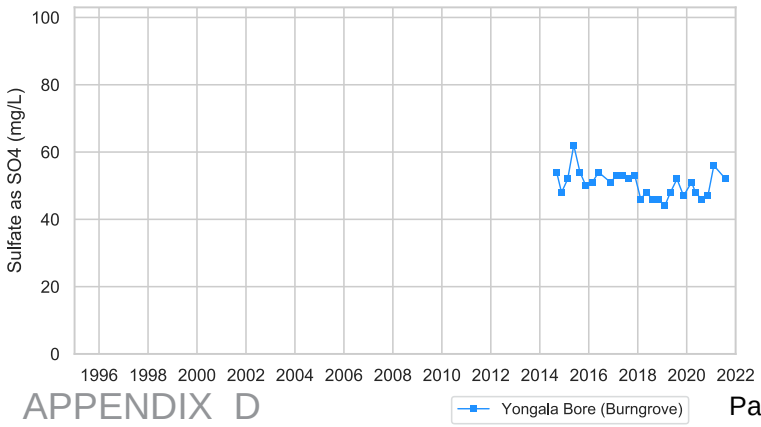

Sulfate as SO4 (mg/L)
GW02 (Alluvium)

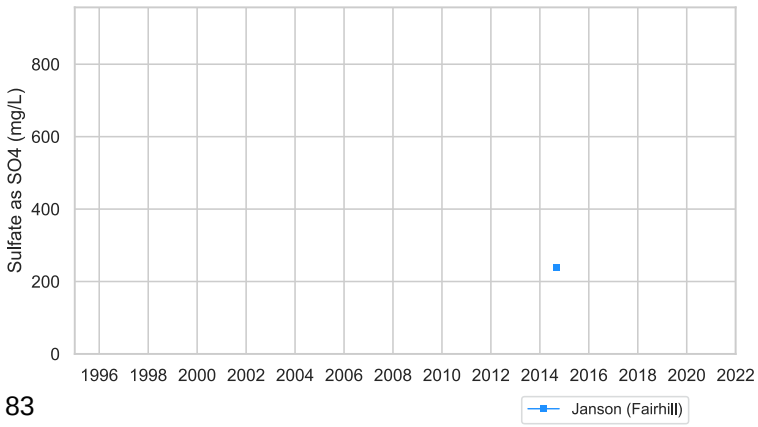

Sulfate as SO4 (mg/L)
RB7a (Alluvium)

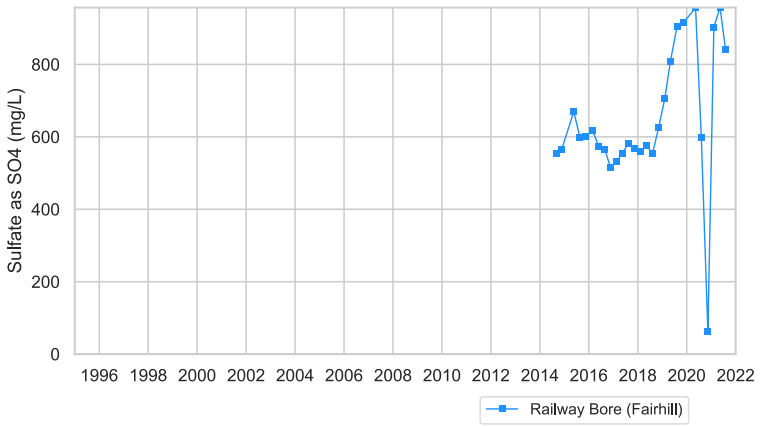

Sulfate as SO4 (mg/L)
Twin Bores (Alluvium)

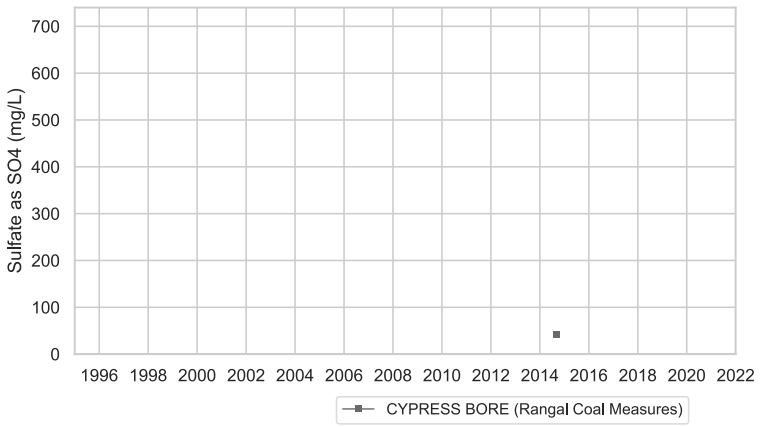

Sulfate as SO4 (mg/L)
Weir Bore (2) (Alluvium)

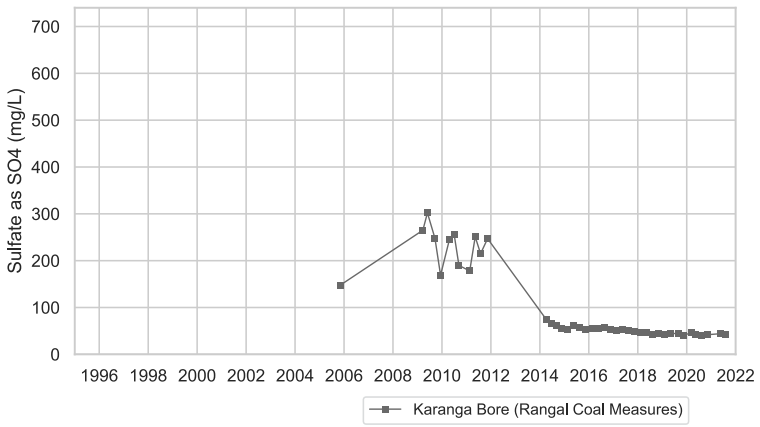

Sulfate as SO4 (mg/L)
Fairhill Bore (Burngrove)

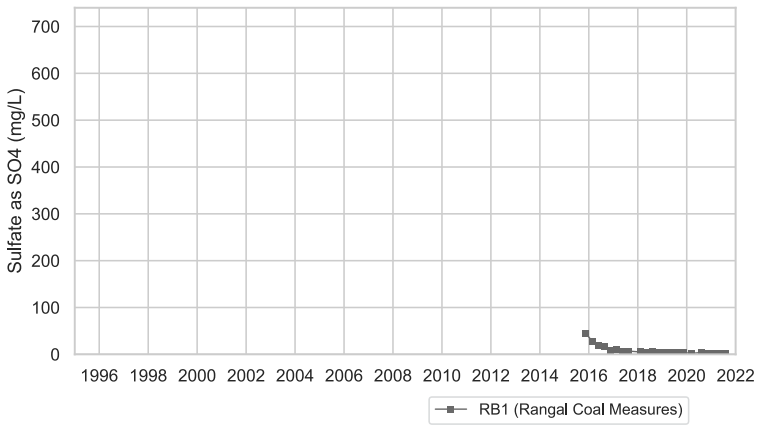

Sulfate as SO4 (mg/L)
Yongala Bore (Burngrove)

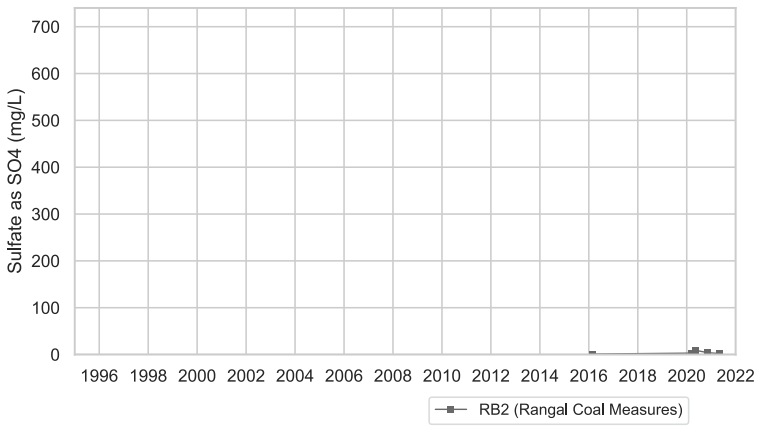

Sulfate as SO4 (mg/L)
Janson (Fairhill)

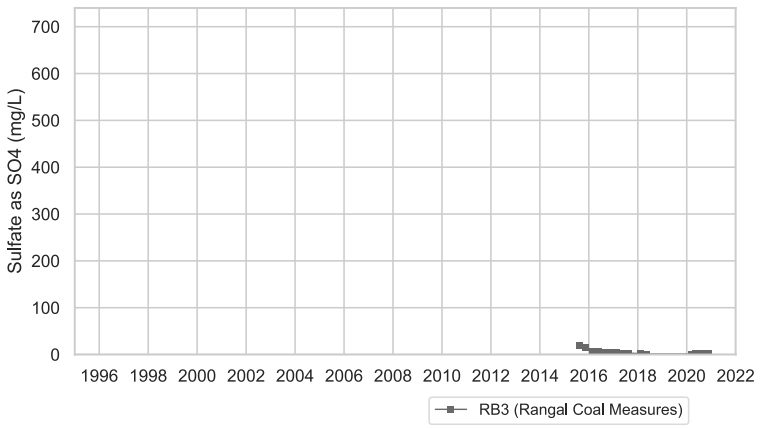

Sulfate as SO4 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

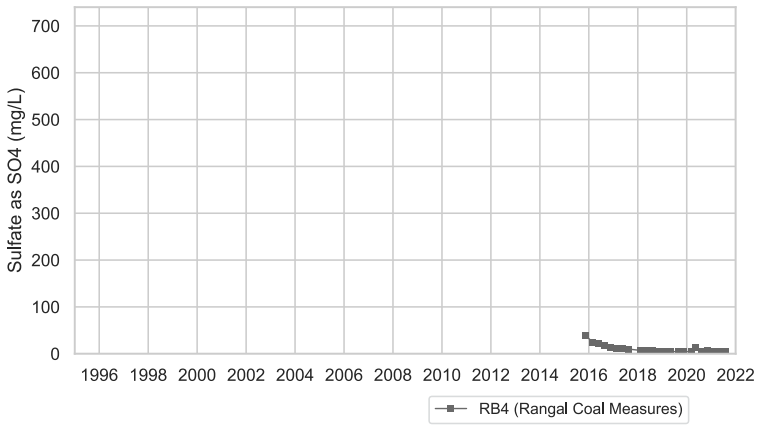

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

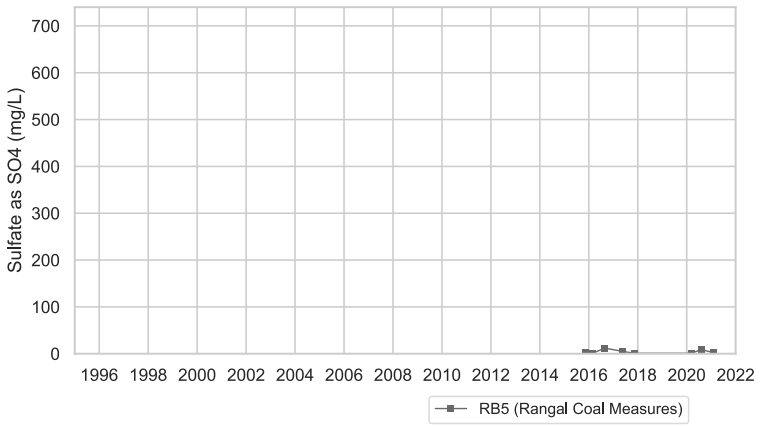

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

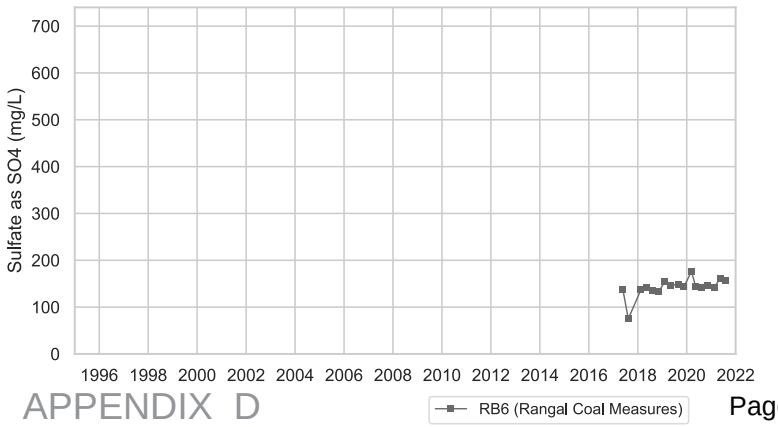

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

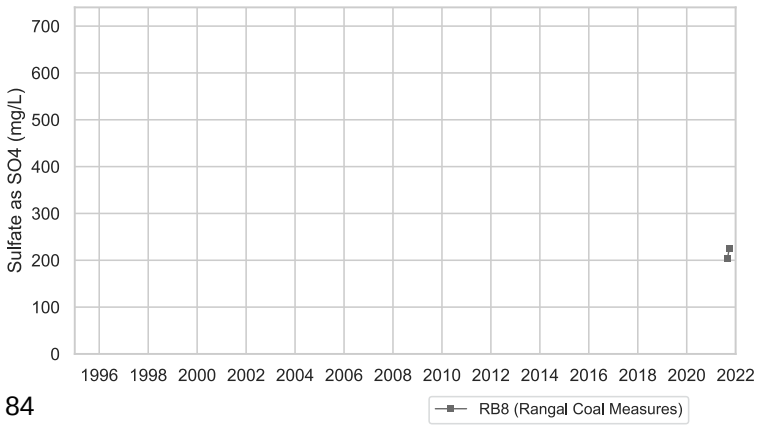

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

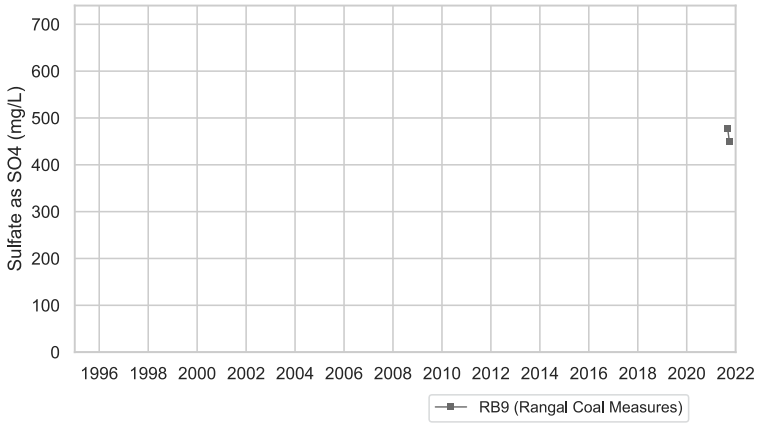

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

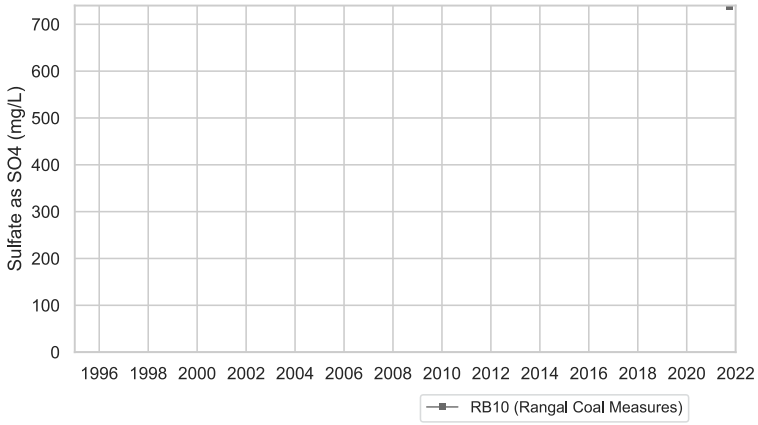

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

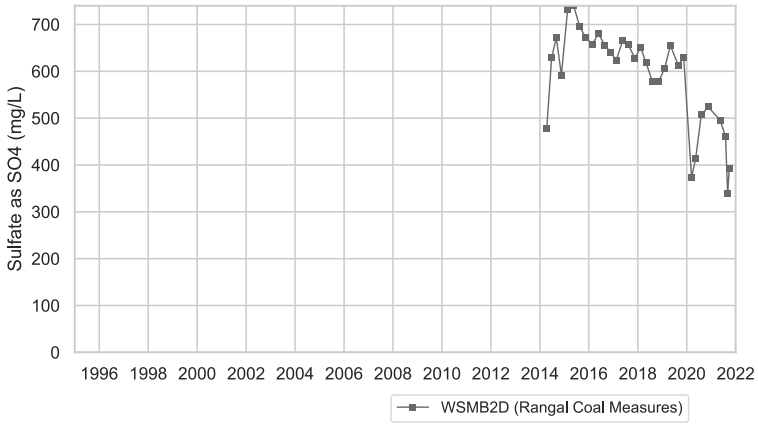

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

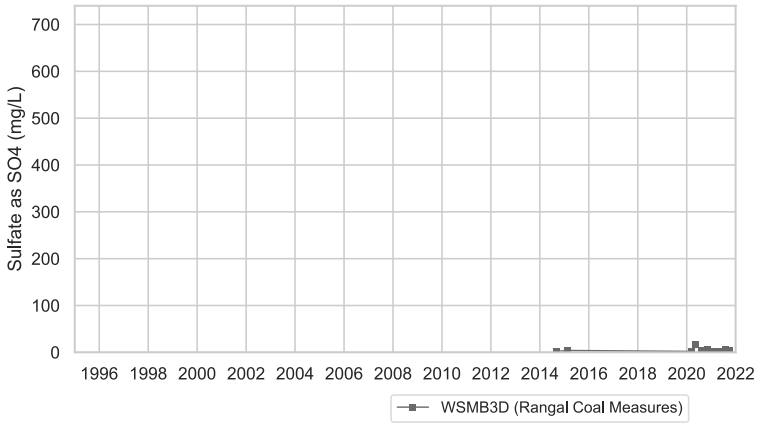

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

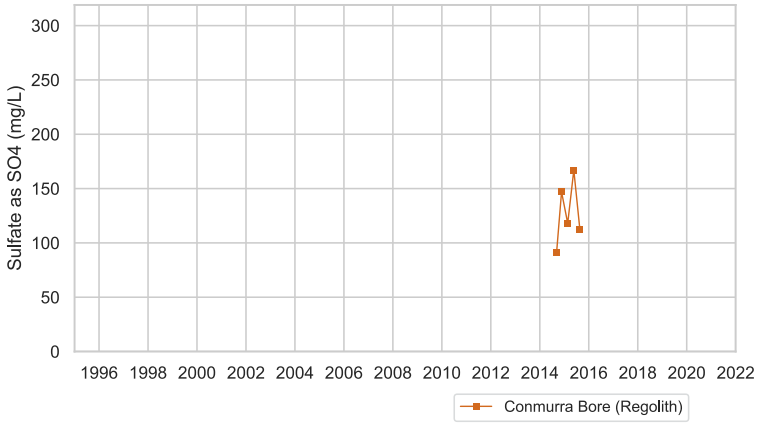

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

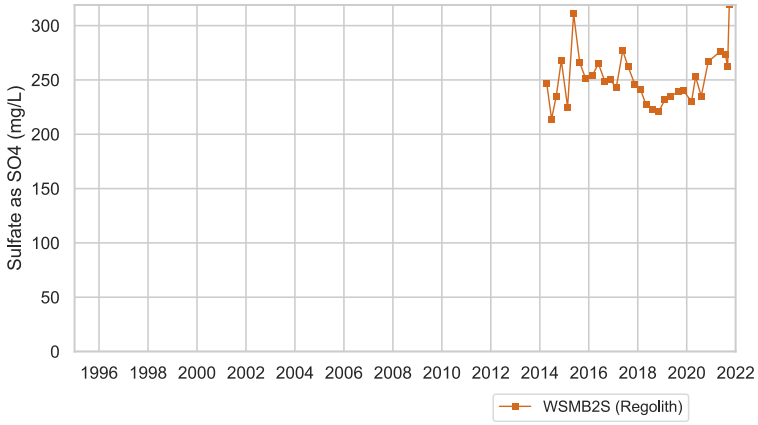

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)


Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

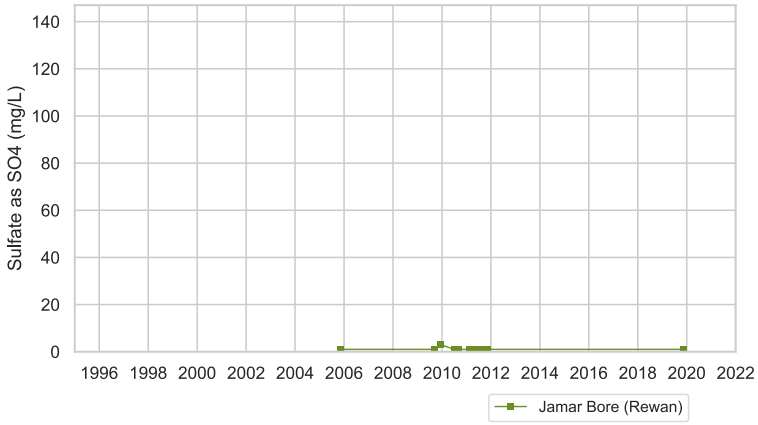

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

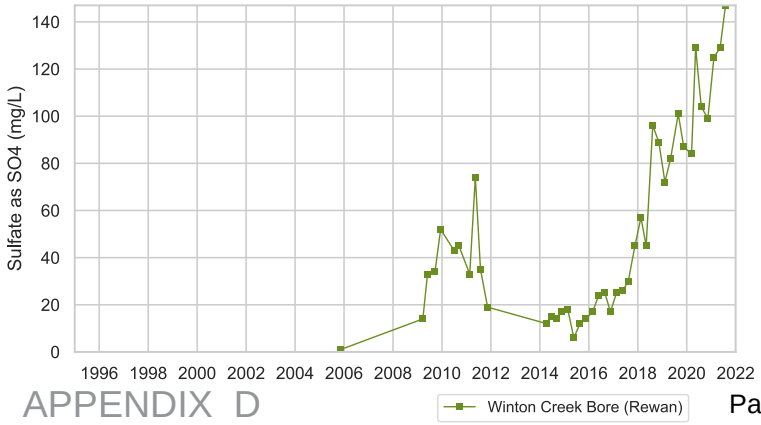

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

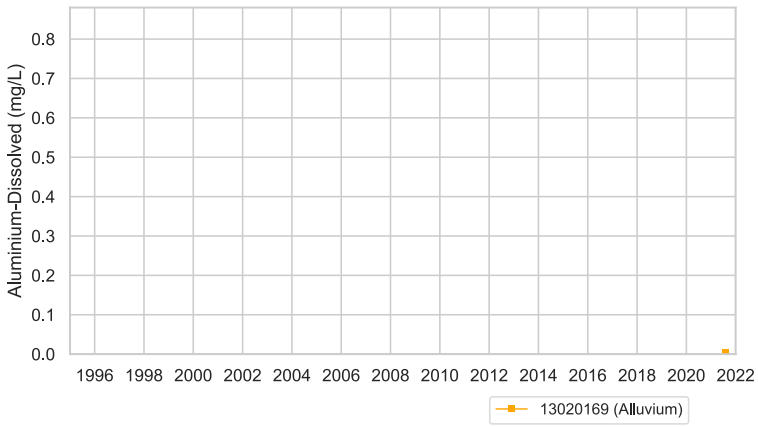

Sulfate as SO4 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

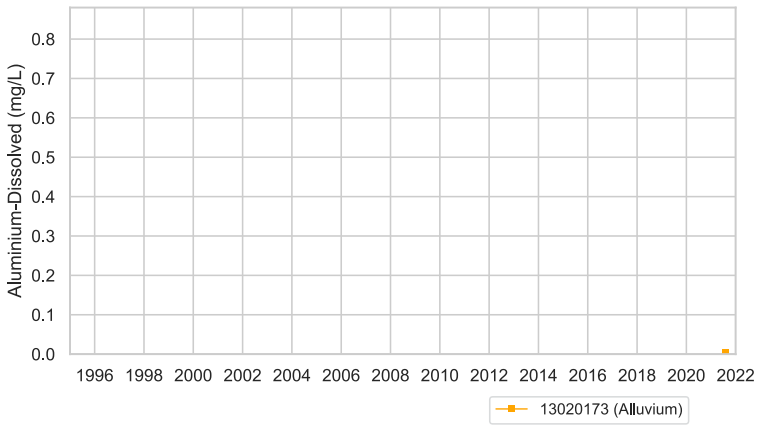

Sulfate as SO4 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

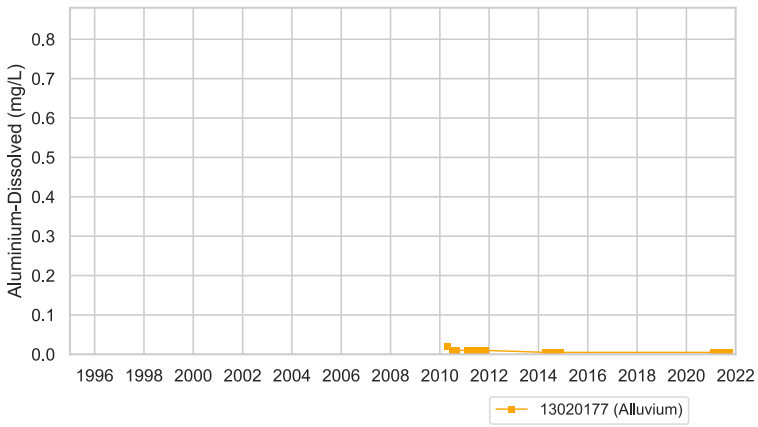
Sulfate as SO4 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

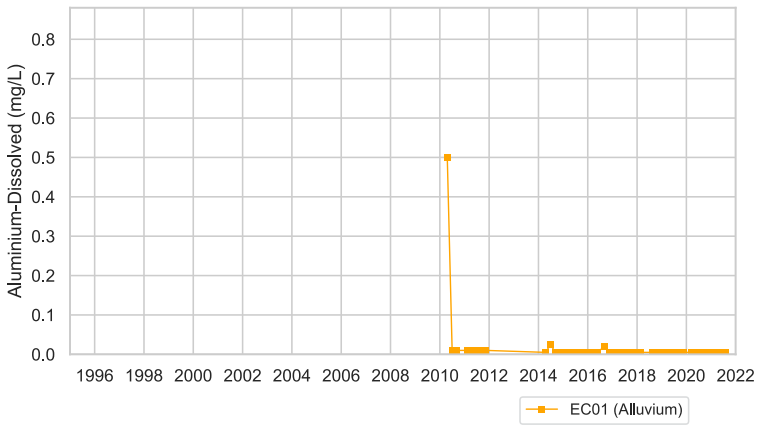

Sulfate as SO4 (mg/L)
0
20
40
60
80
100
120
140
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

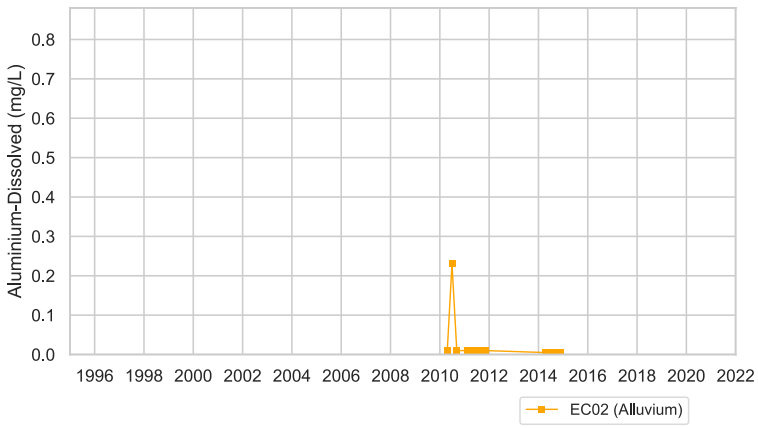

Sulfate as SO4 (mg/L)
0
20
40
60
80
100
120
140
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

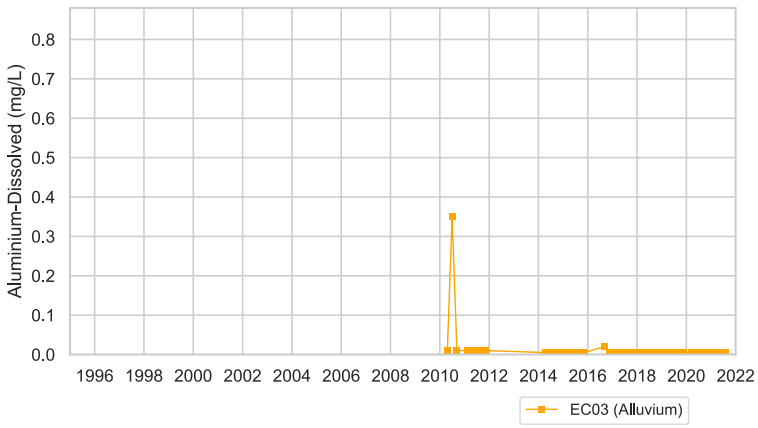

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

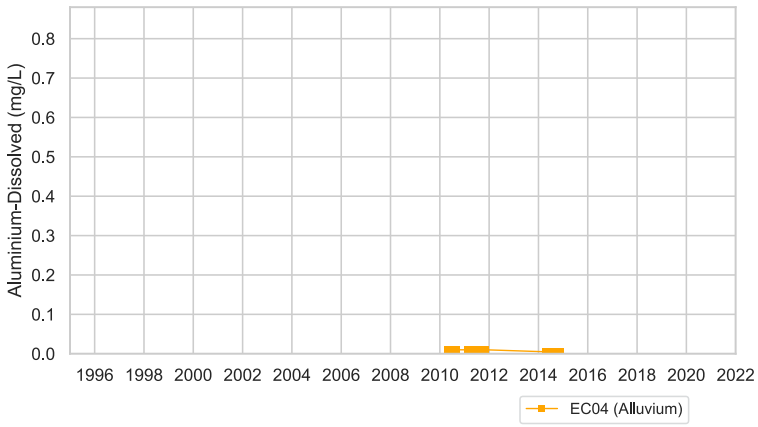

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

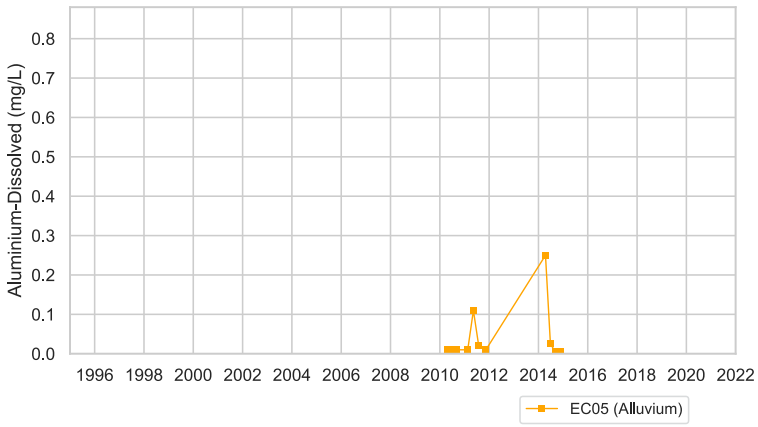

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

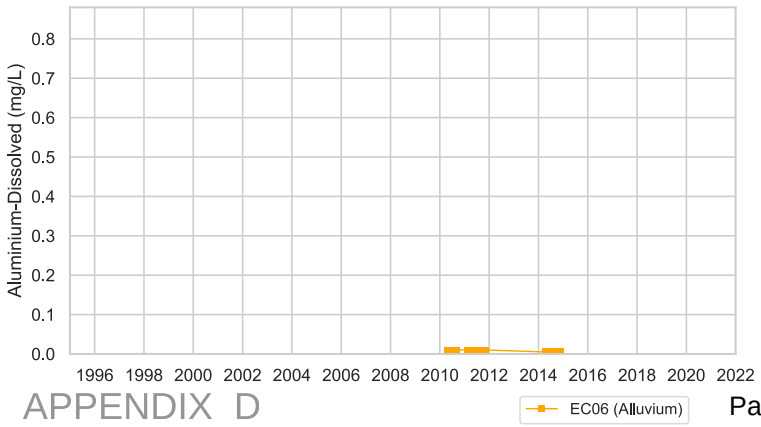

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

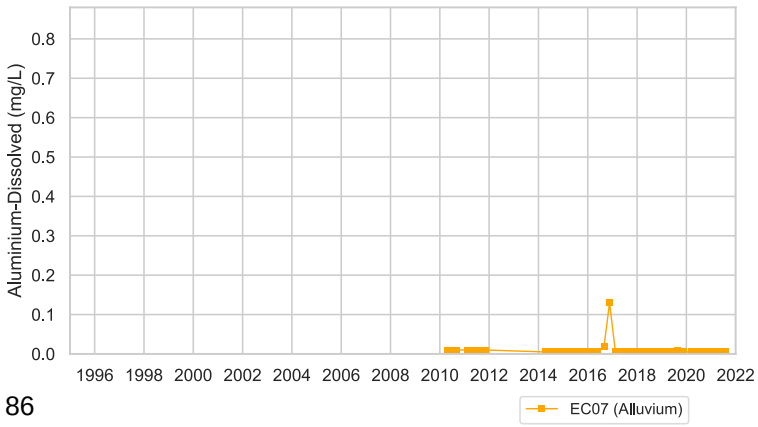

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

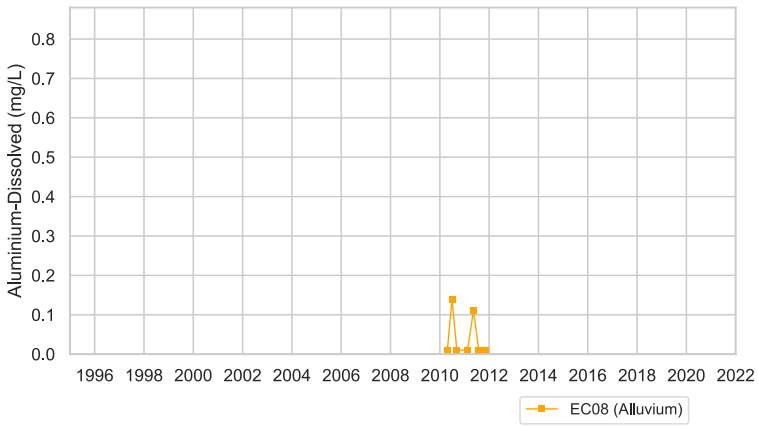

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

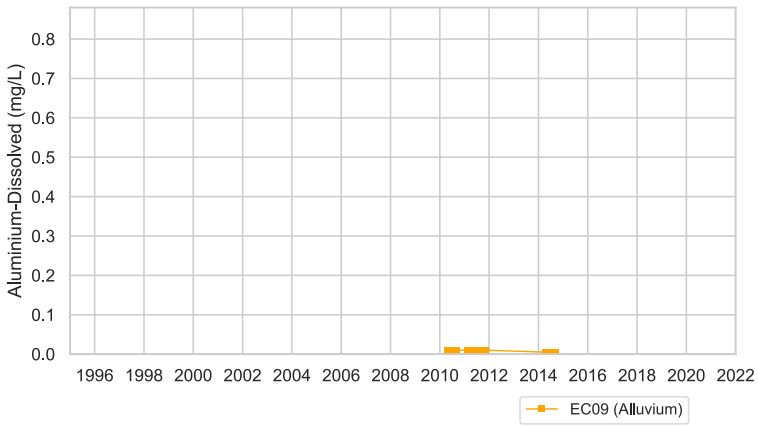

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

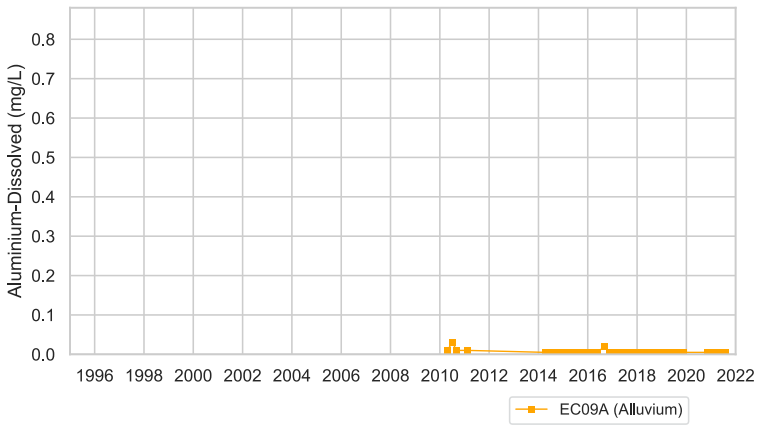

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

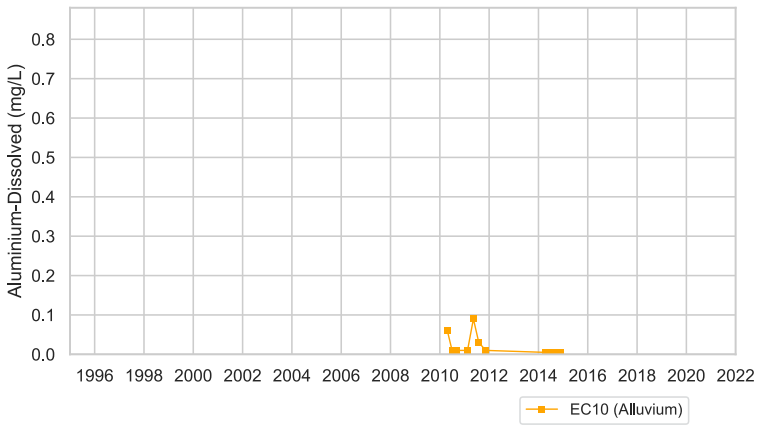

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

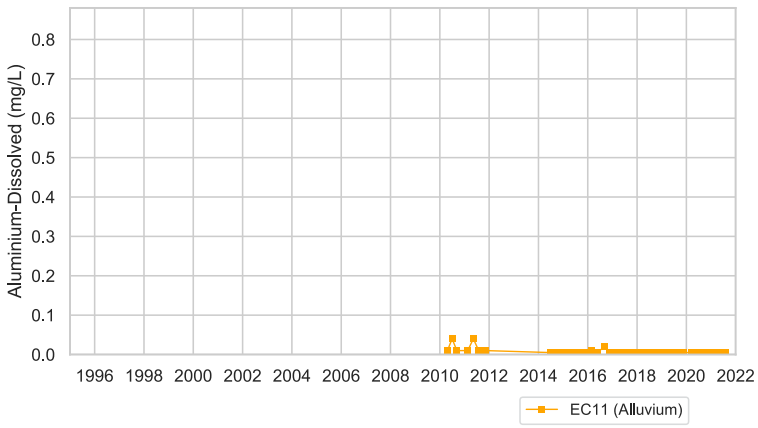

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

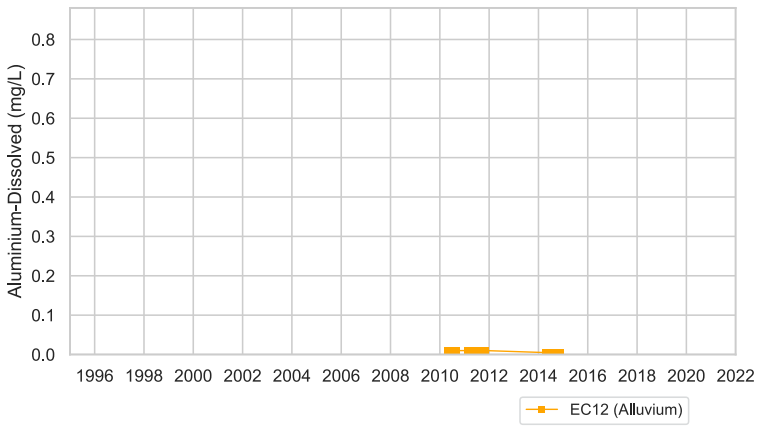

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

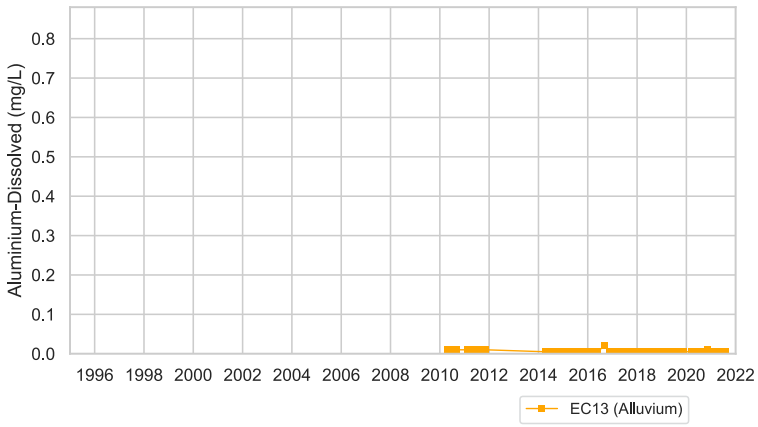

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

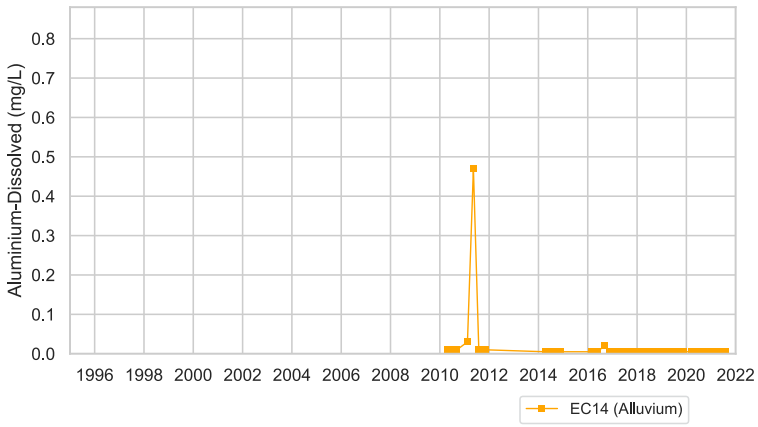

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

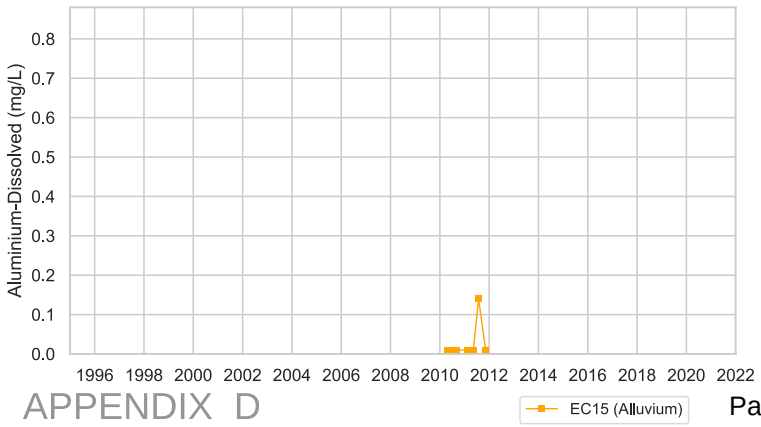

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

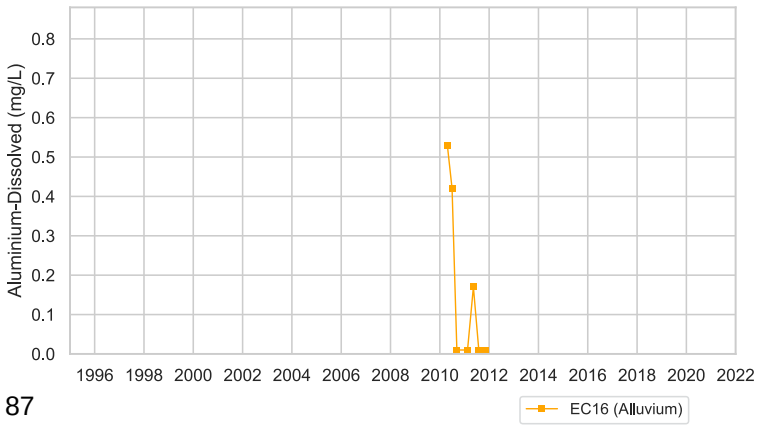

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

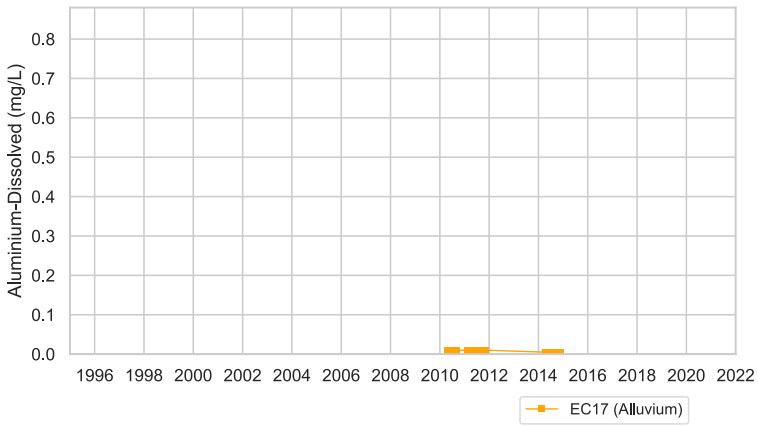

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

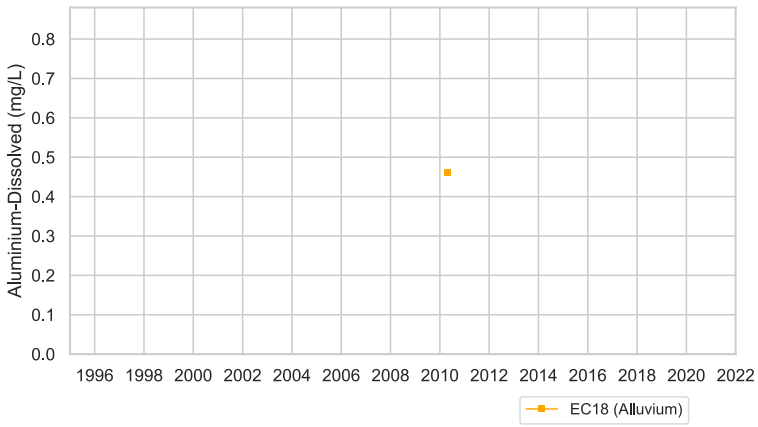

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

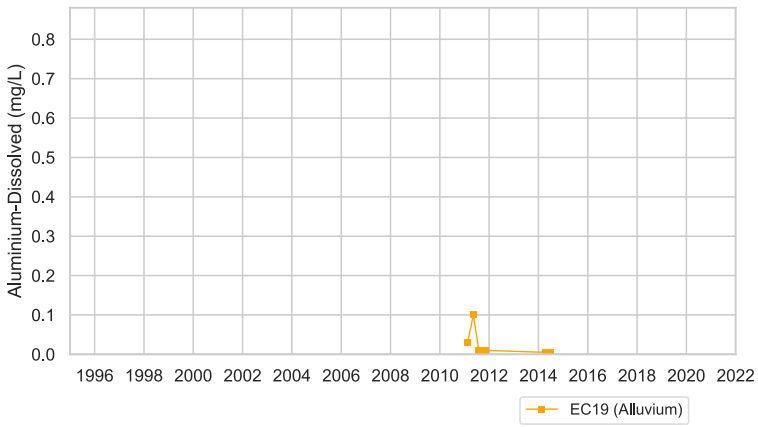

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

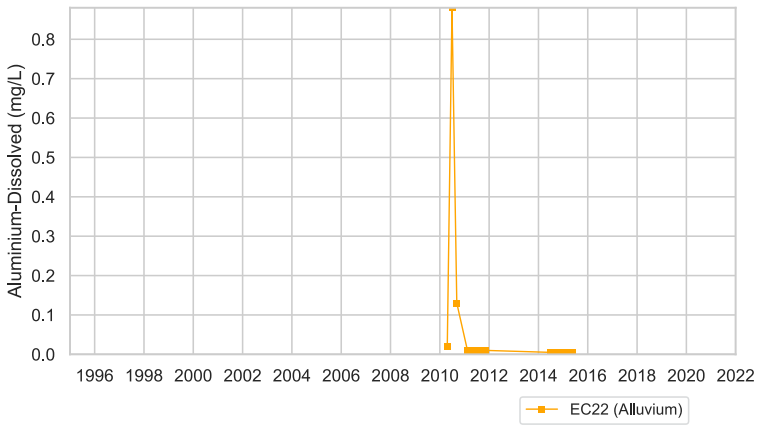

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

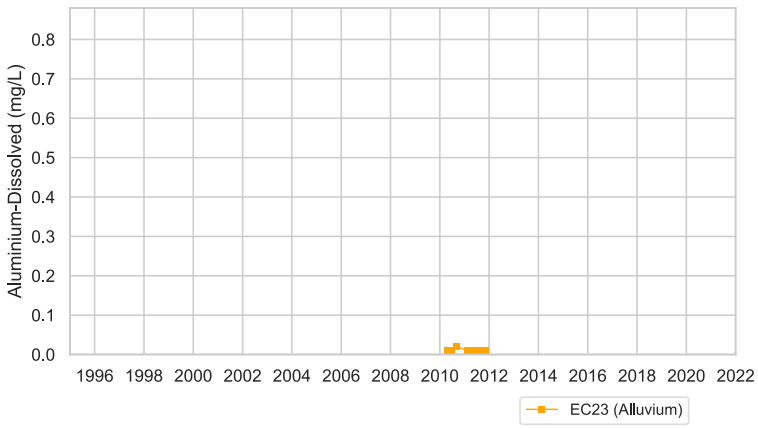

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

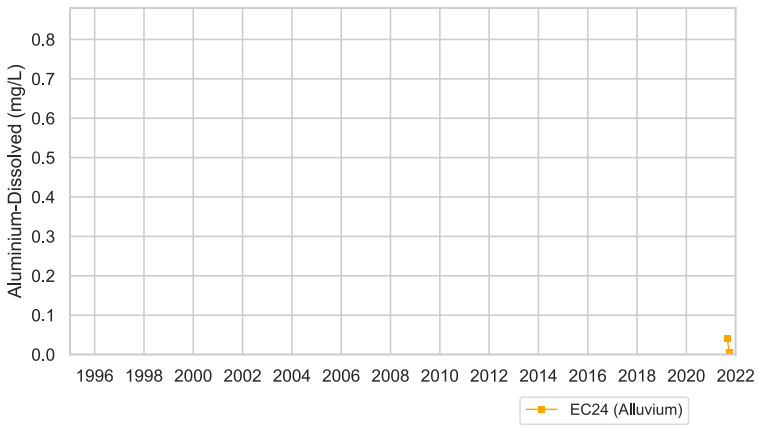

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

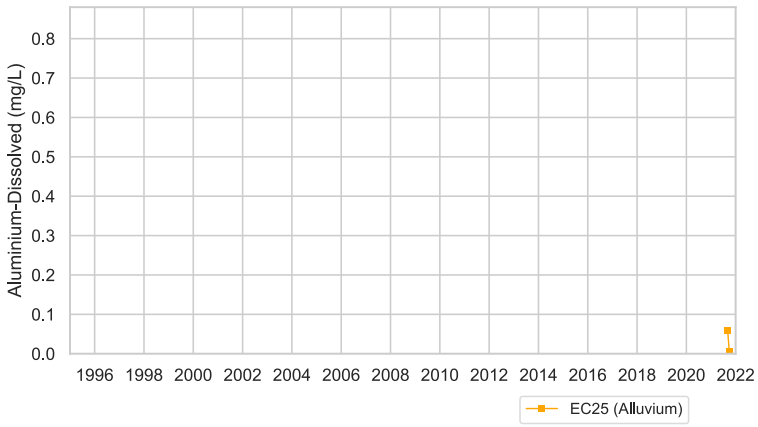

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

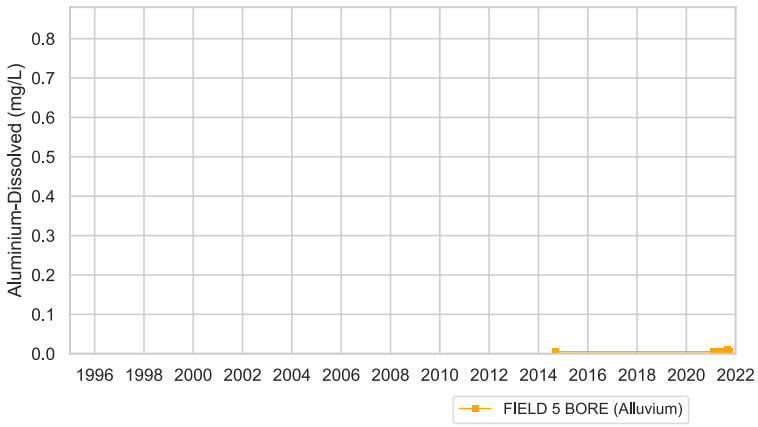

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

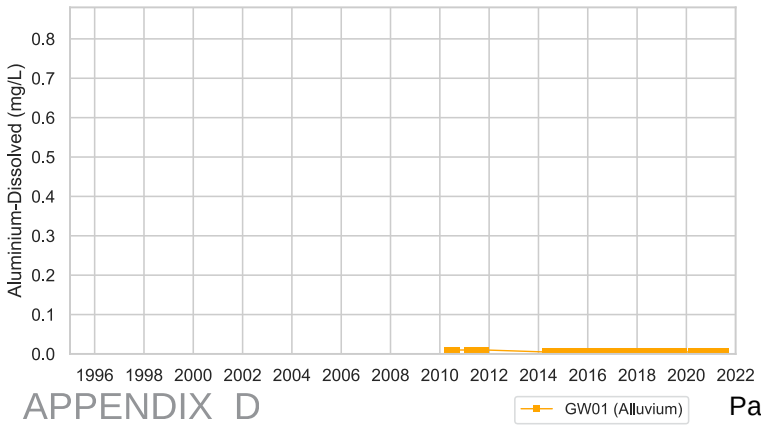

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

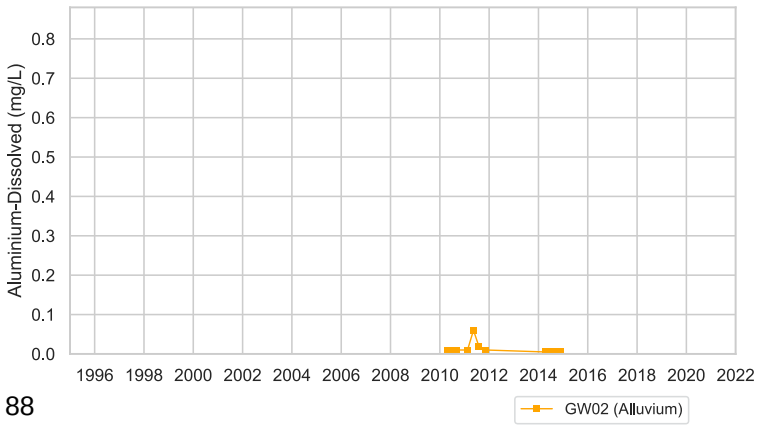

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

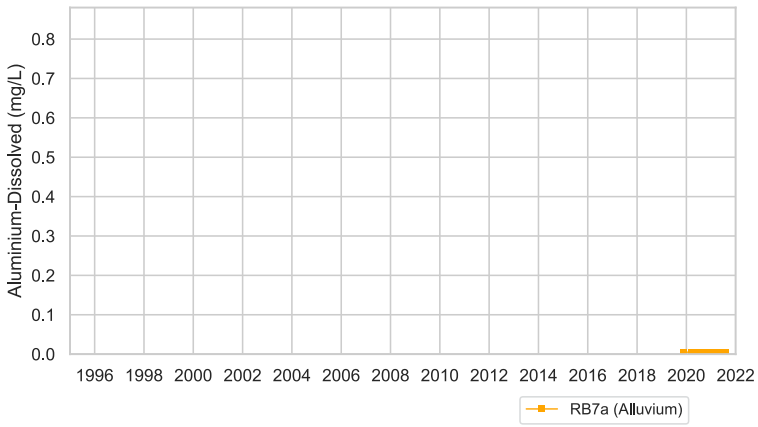

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

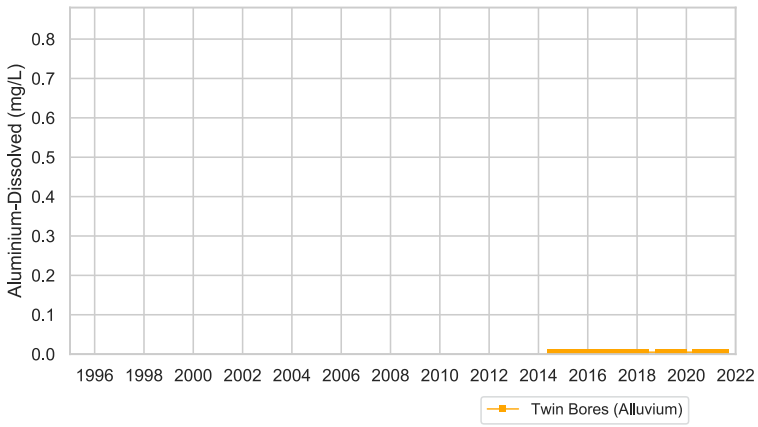

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

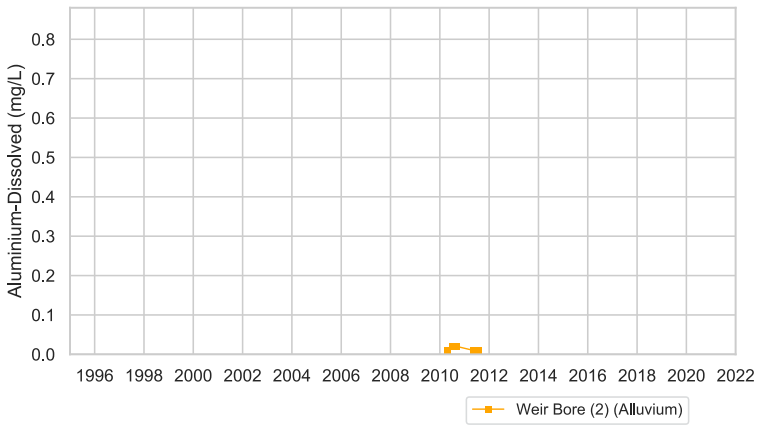

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

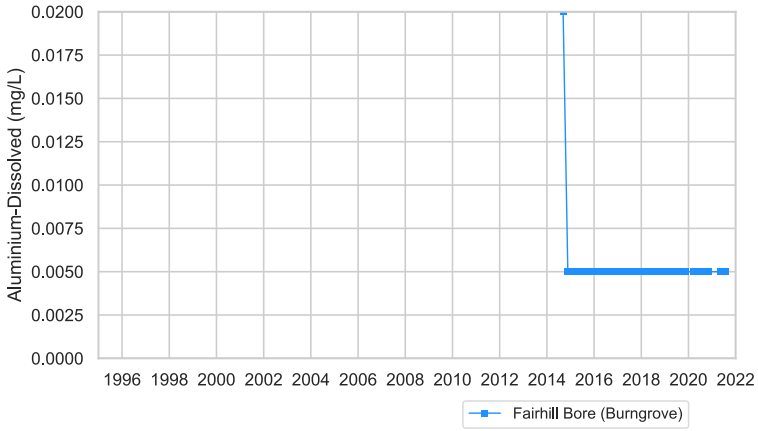

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

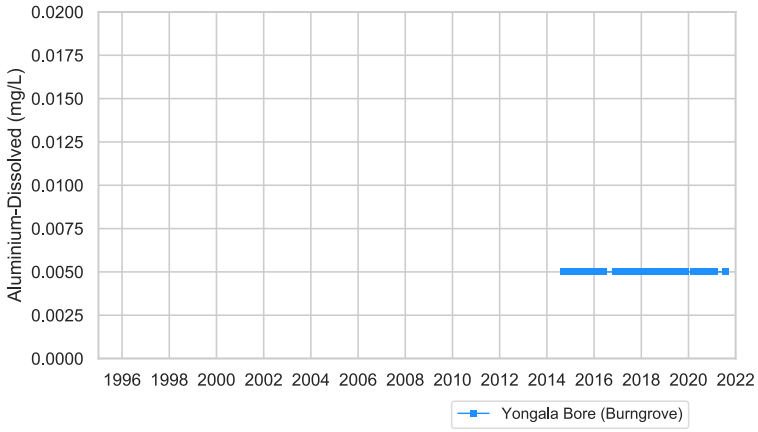

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

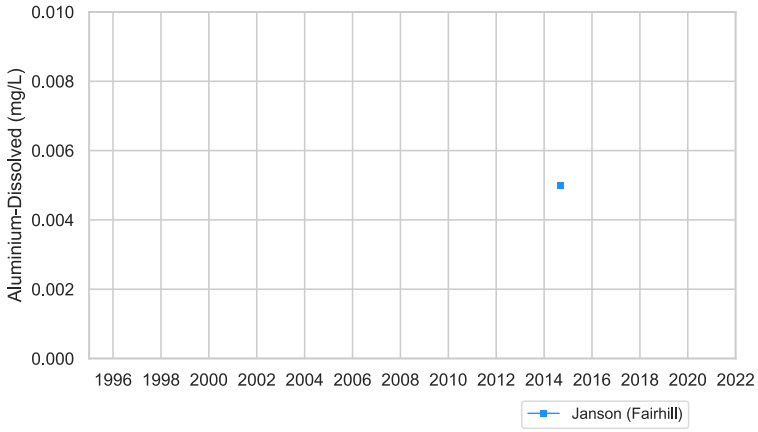

Aluminium-Dissolved (mg/L)
RB7a (Alluvium)

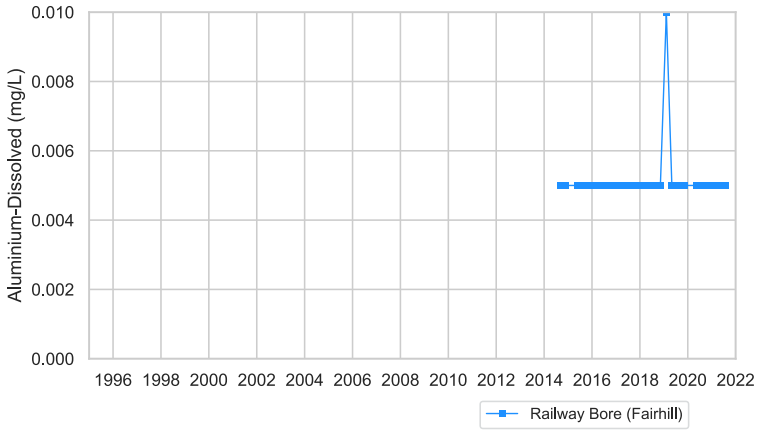

Aluminium-Dissolved (mg/L)
Twin Bores (Alluvium)

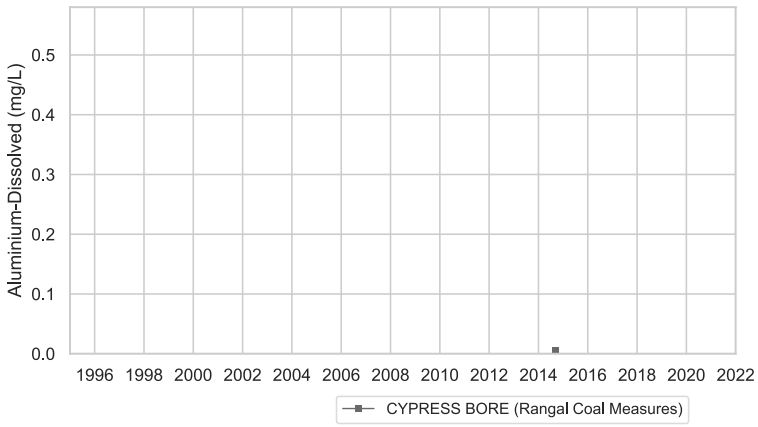

Aluminium-Dissolved (mg/L)
Weir Bore (2) (Alluvium)

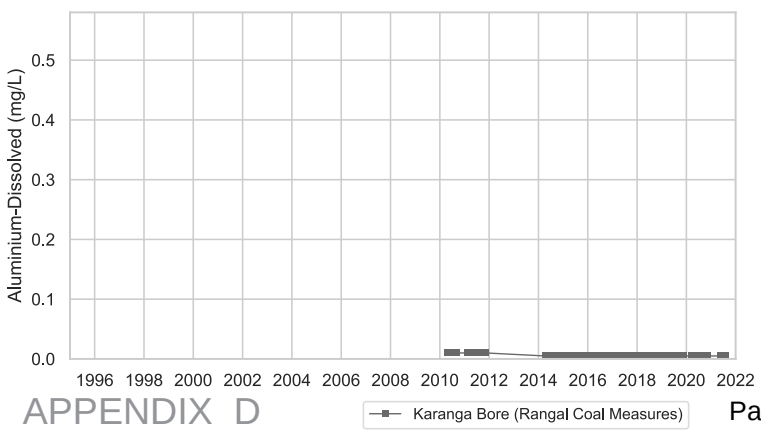

Aluminium-Dissolved (mg/L)
Fairhill Bore (Burngrove)

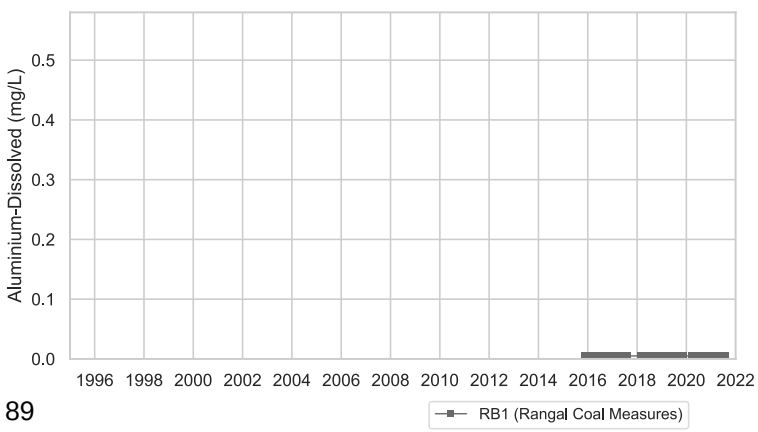

Aluminium-Dissolved (mg/L)
Yongala Bore (Burngrove)

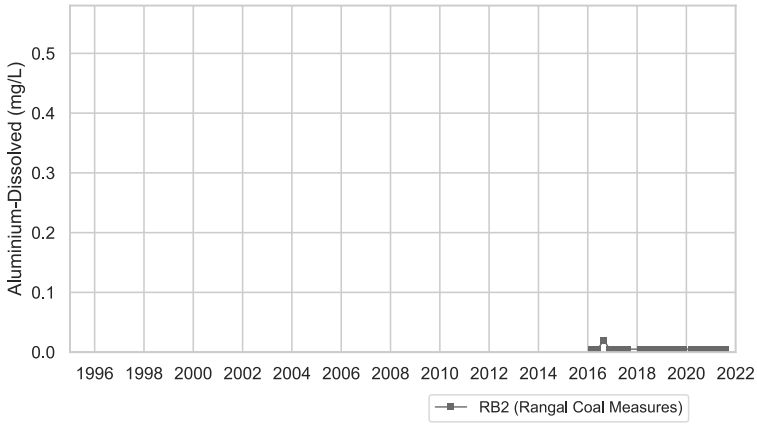

Aluminium-Dissolved (mg/L)
Janson (Fairhill)

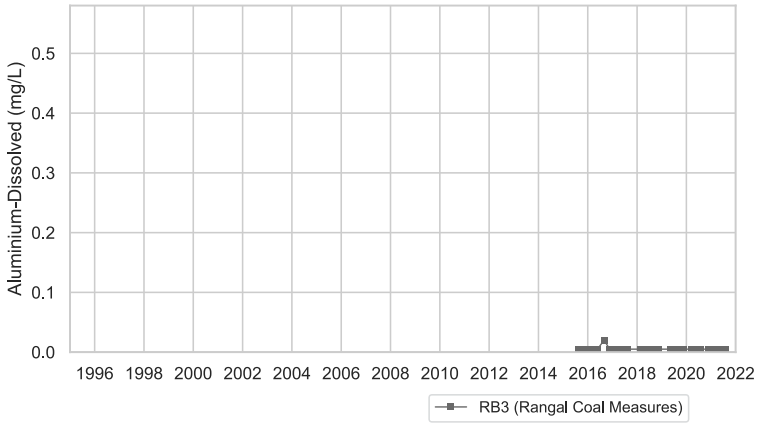

Aluminium-Dissolved (mg/L)
Railway Bore (Fairhill)

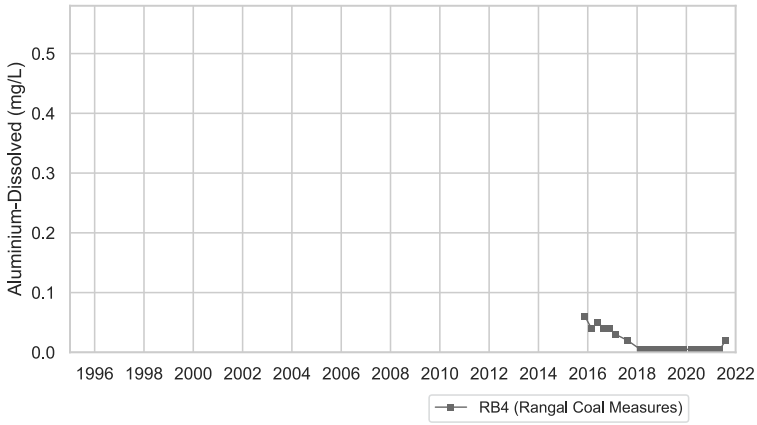

Aluminium-Dissolved (mg/L)
CYPRESS BORE (Rangal Coal Measures)

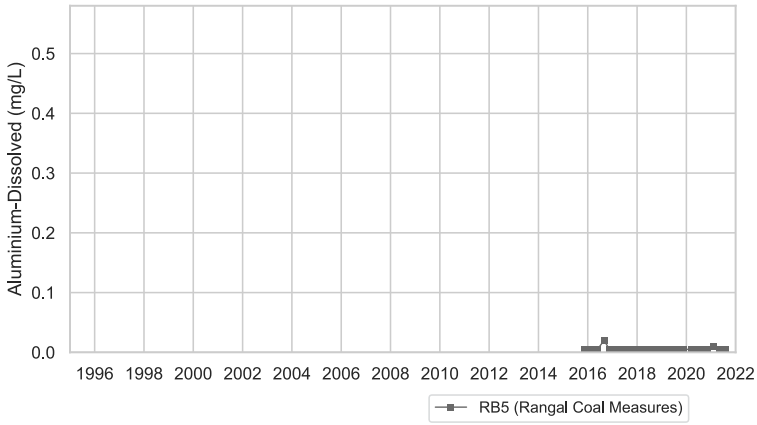

Aluminium-Dissolved (mg/L)
Karanga Bore (Rangal Coal Measures)

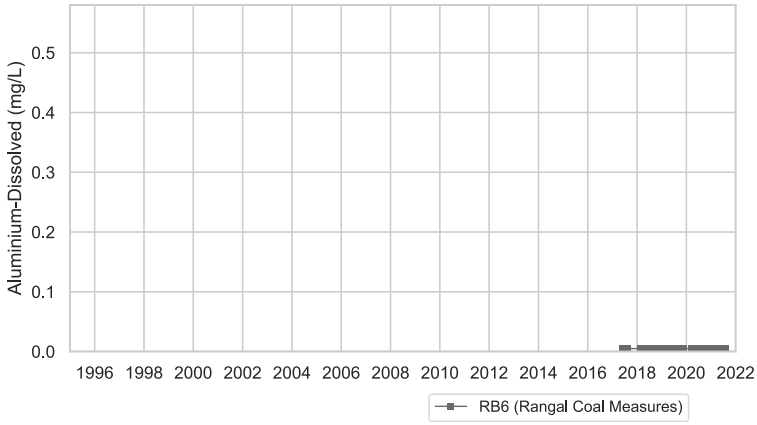

Aluminium-Dissolved (mg/L)
RB1 (Rangal Coal Measures)

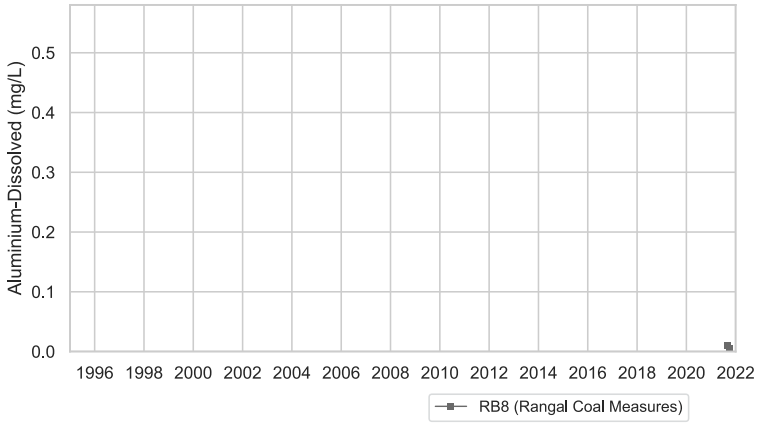

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

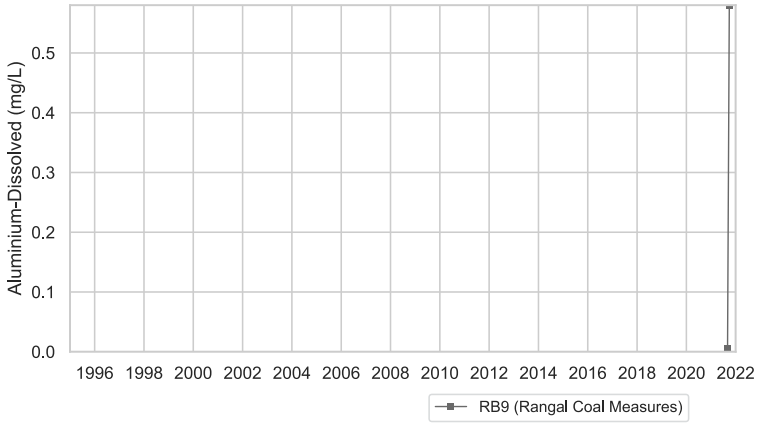

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

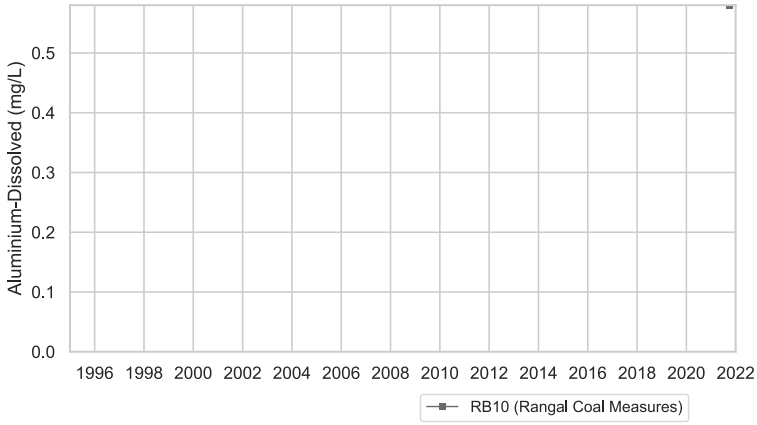

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

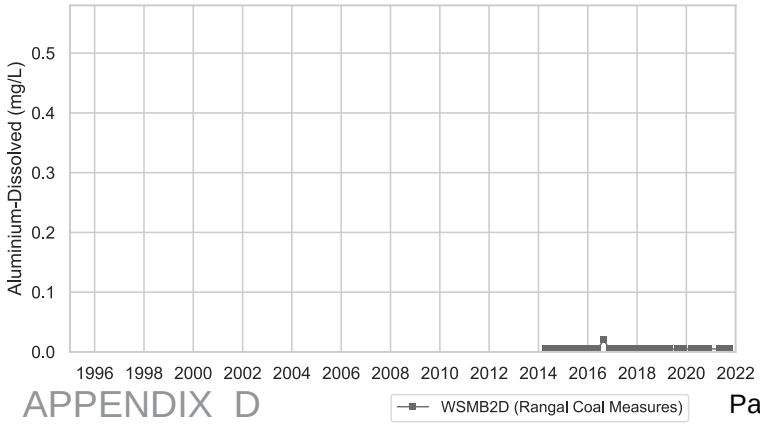

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

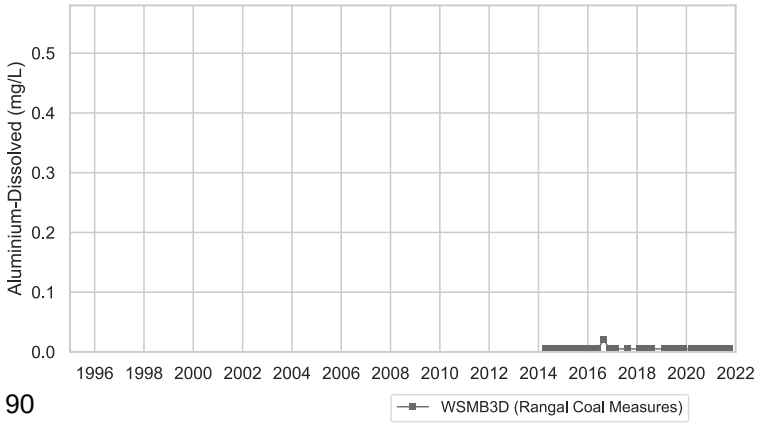

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

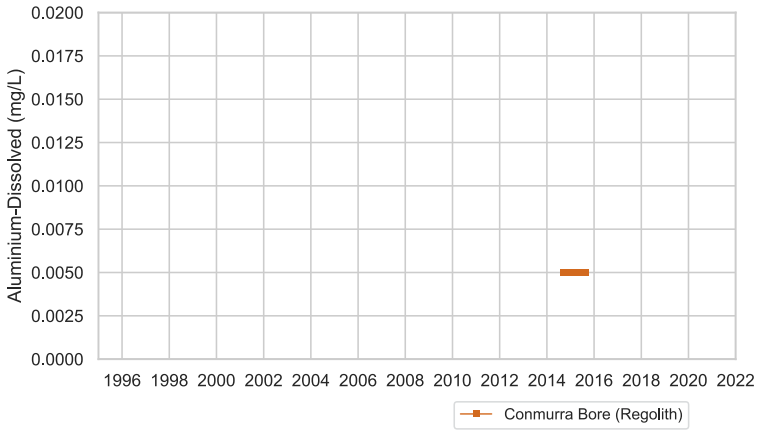

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

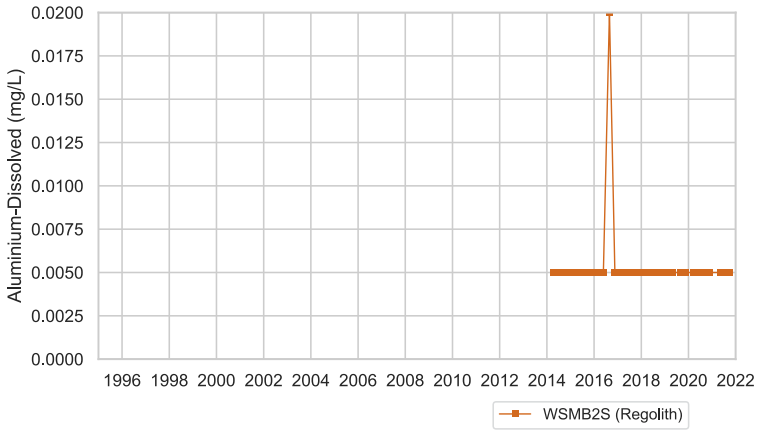

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

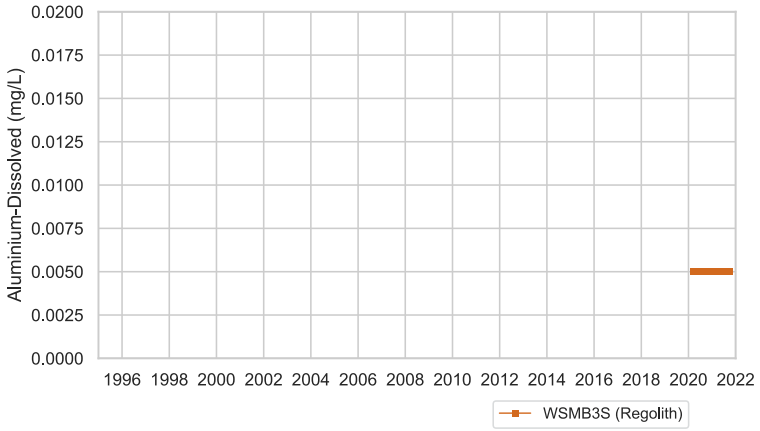

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

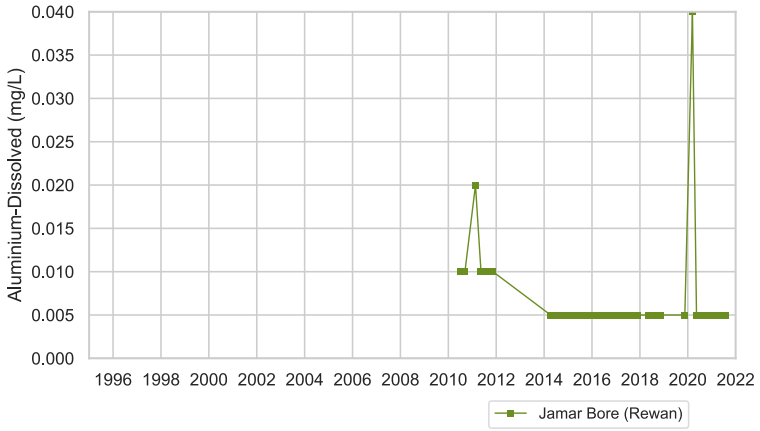

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

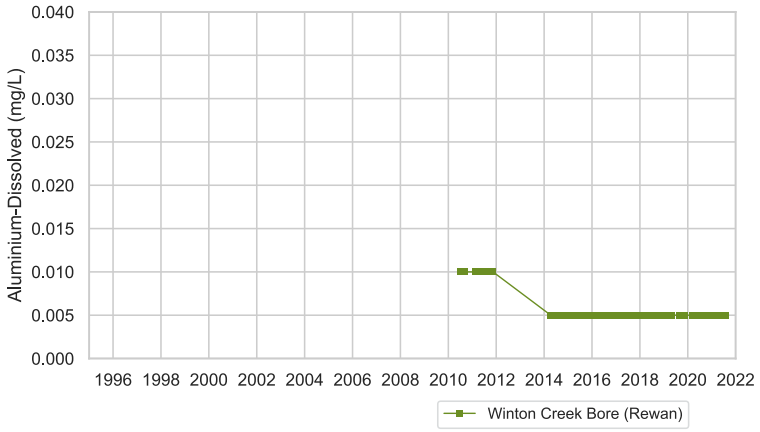

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

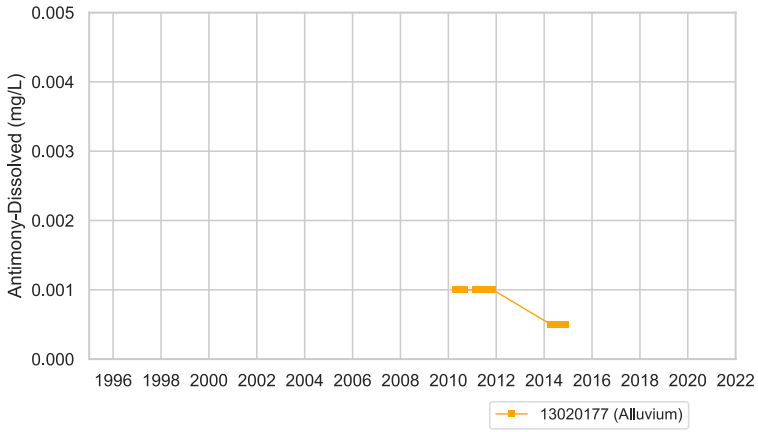

Aluminium-Dissolved (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

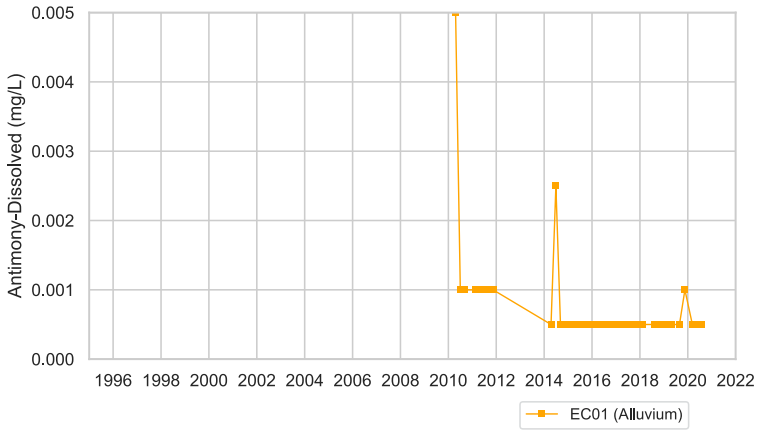

Aluminium-Dissolved (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

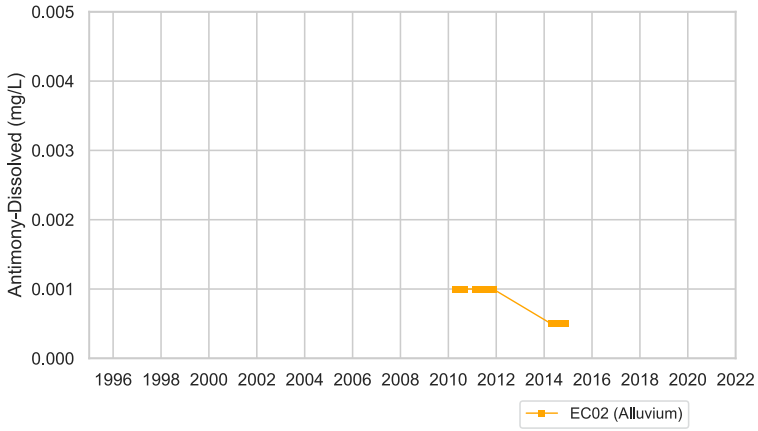

Aluminium-Dissolved (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

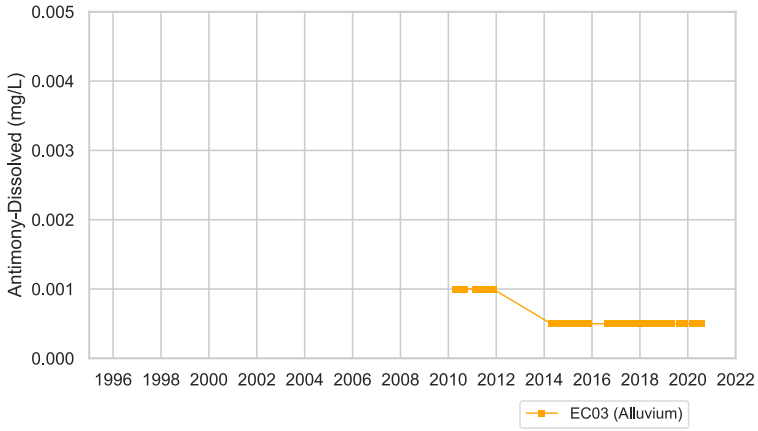

Aluminium-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

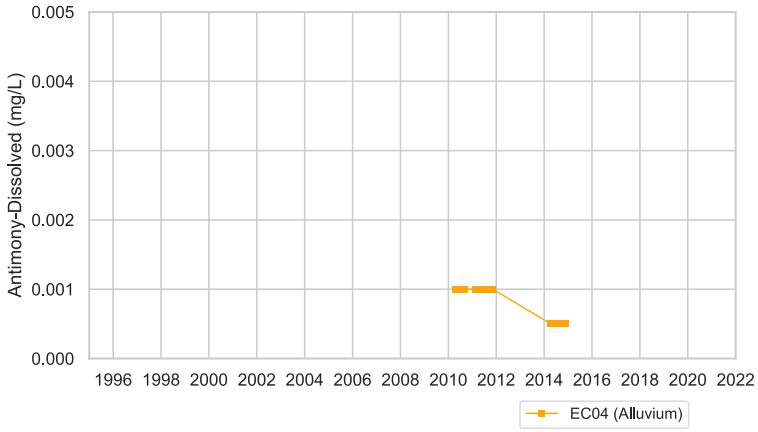

Aluminium-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

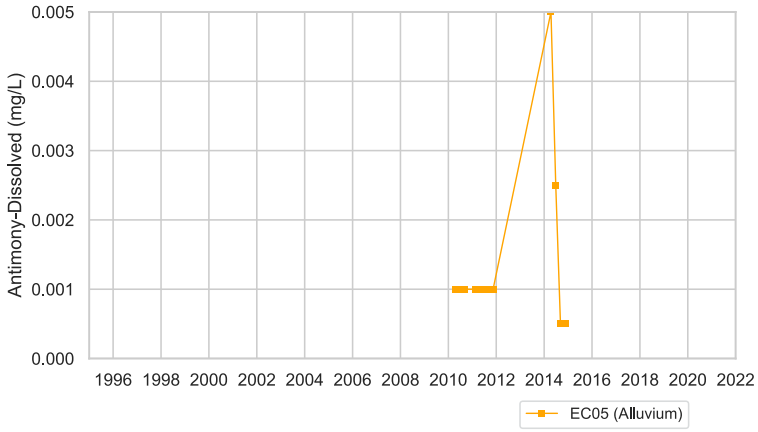

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

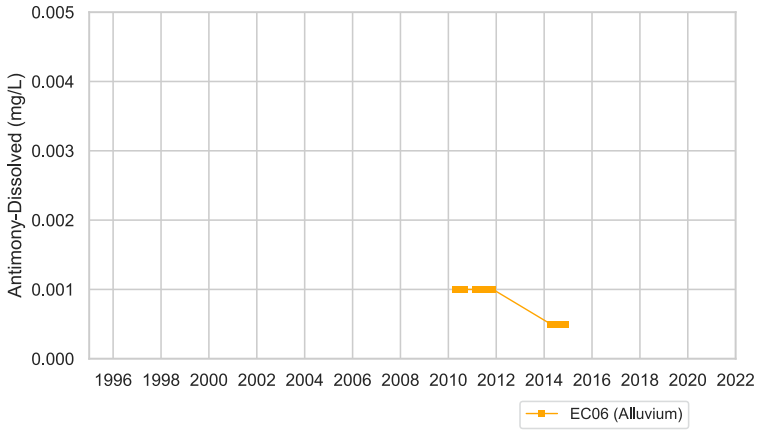

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

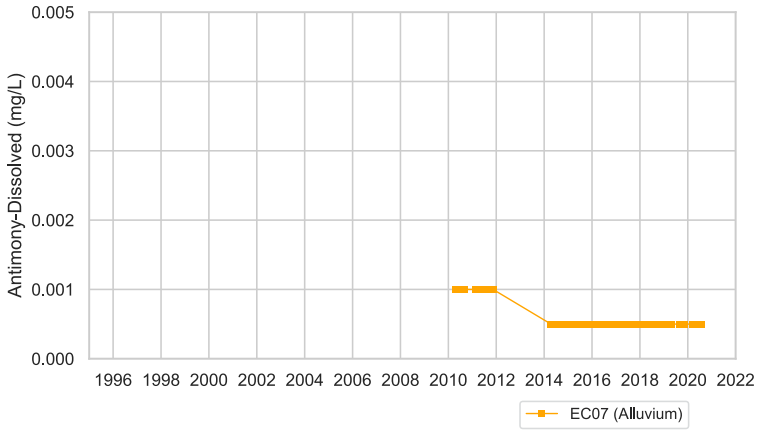

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

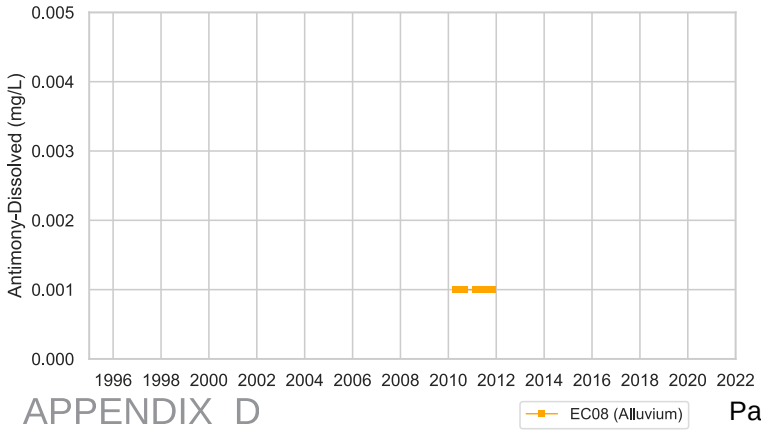

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

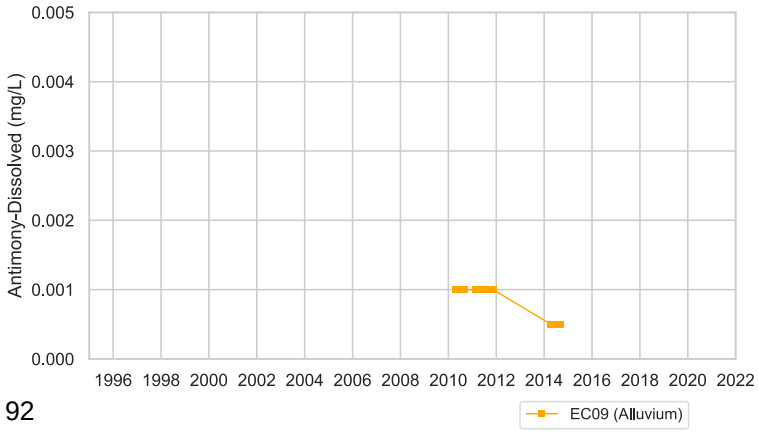

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

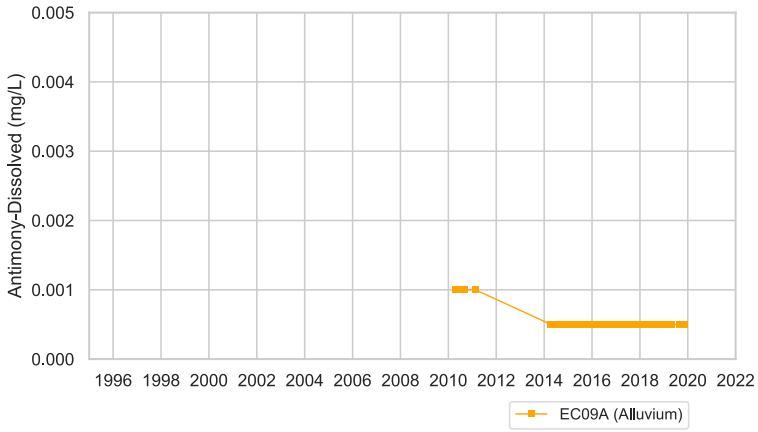

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

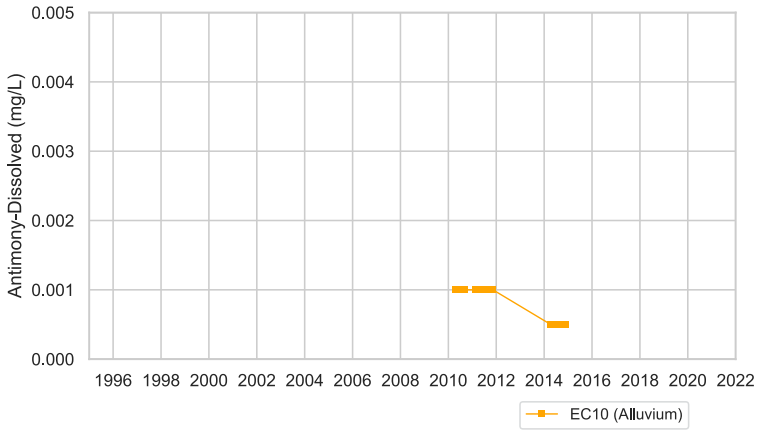

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

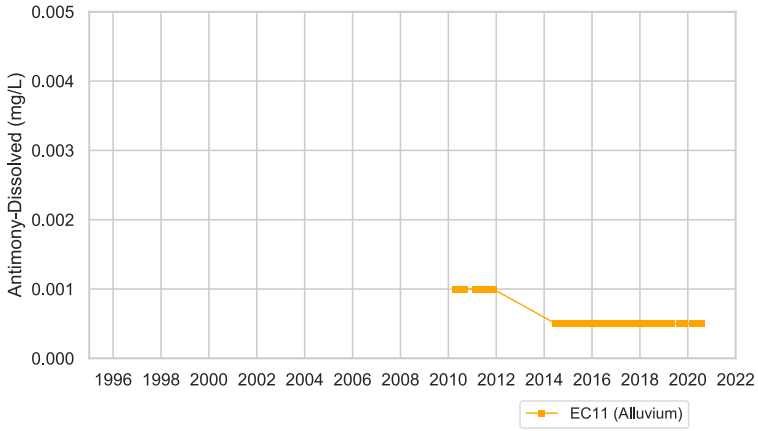

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

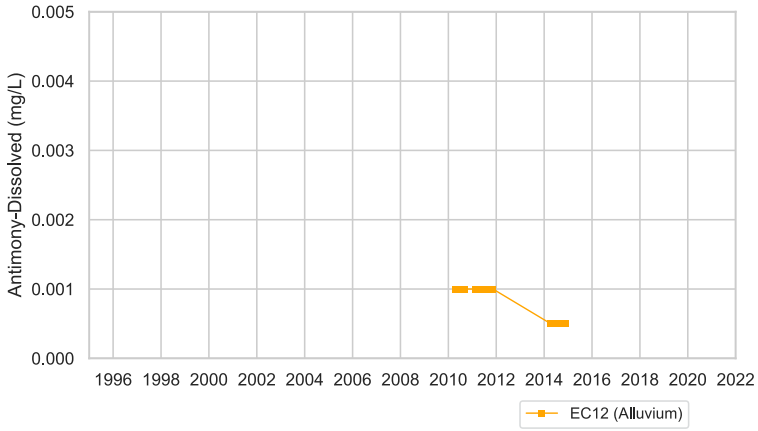

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

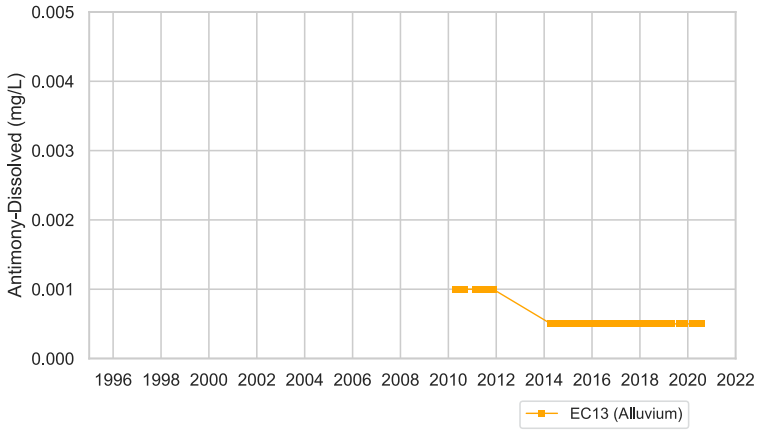

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

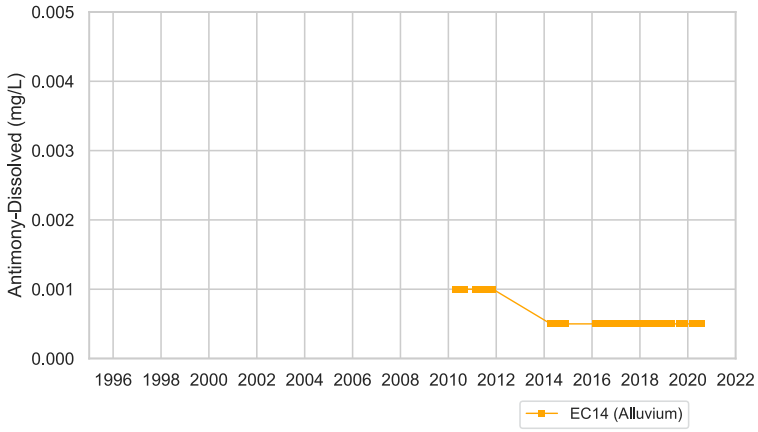

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

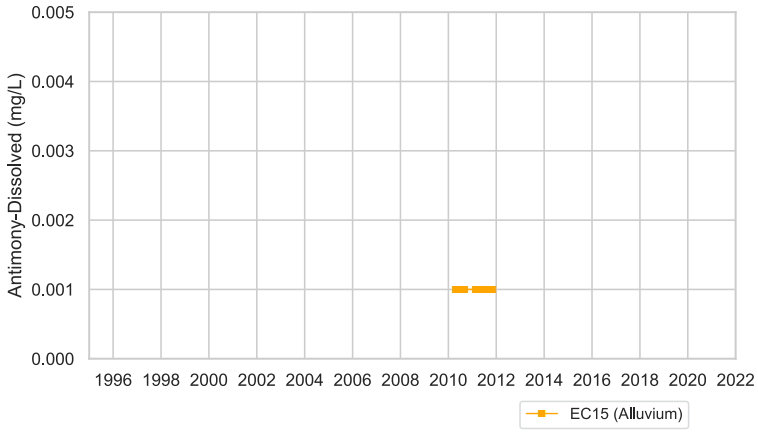

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

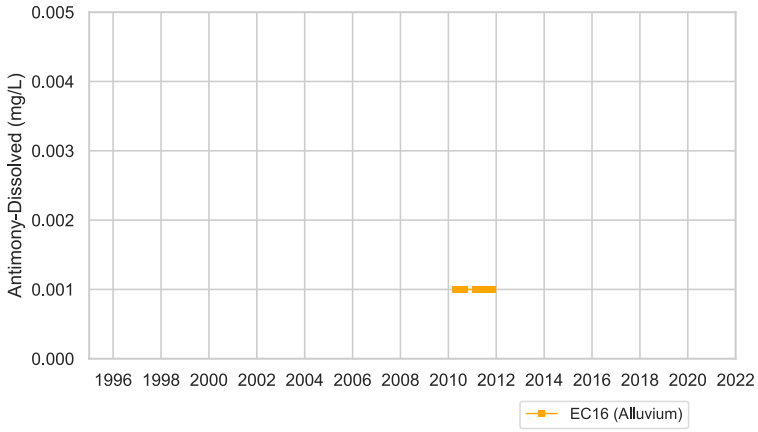

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

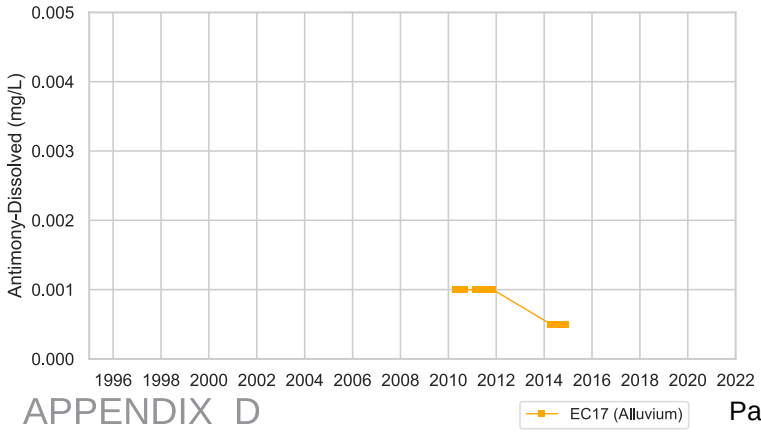

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

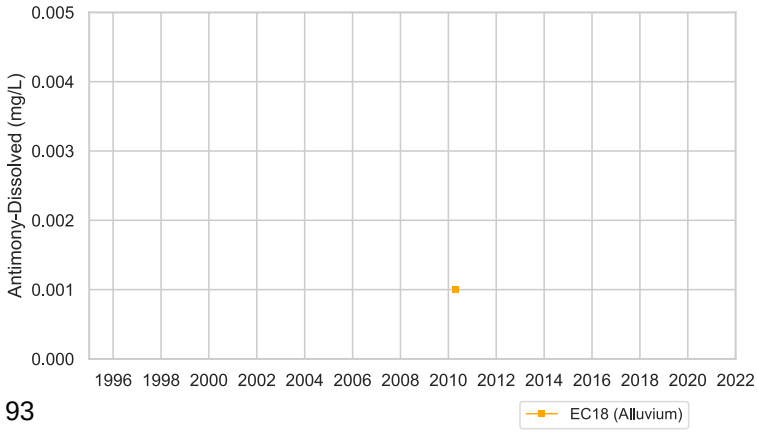

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

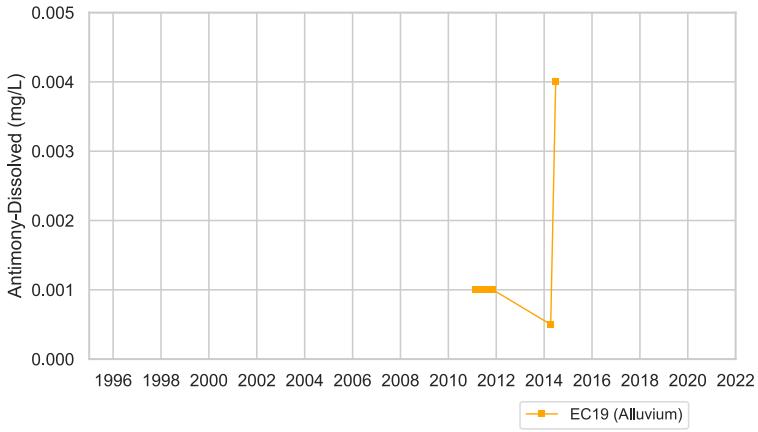

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

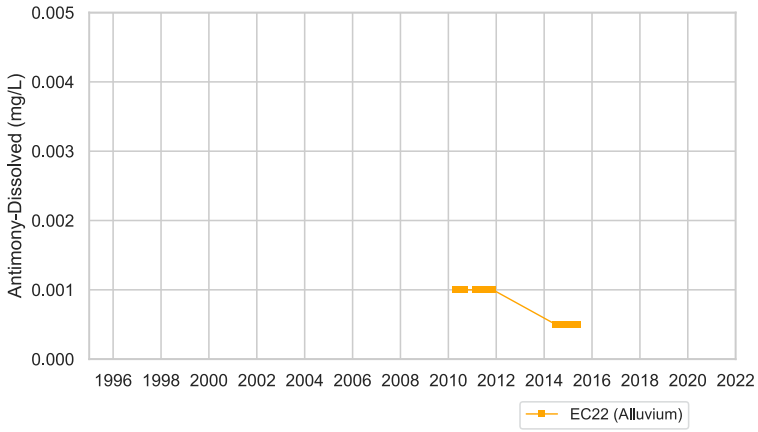

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

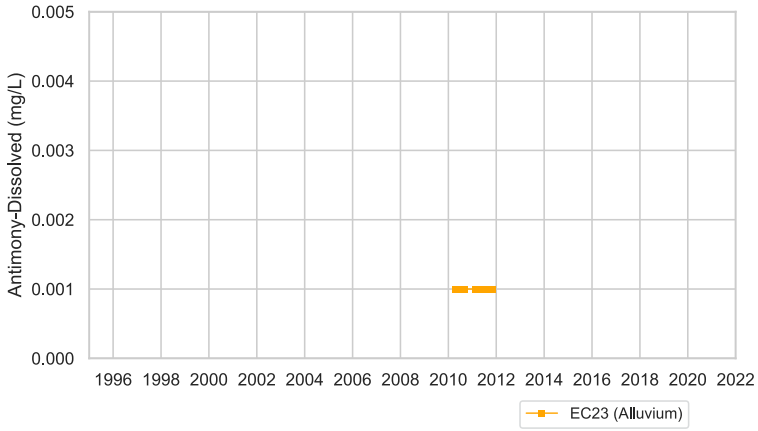

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

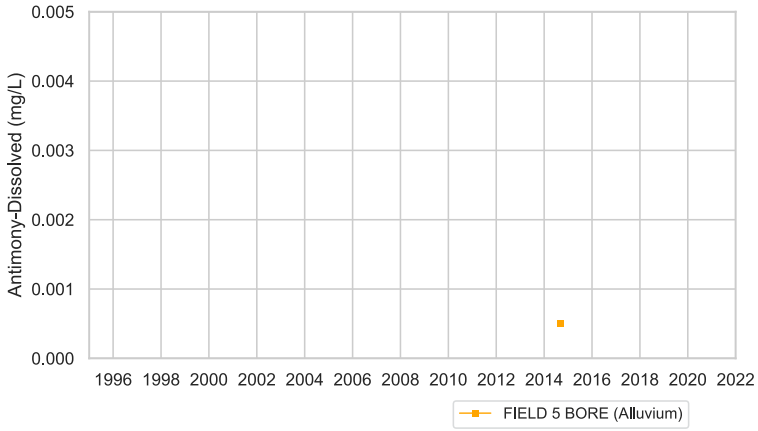

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

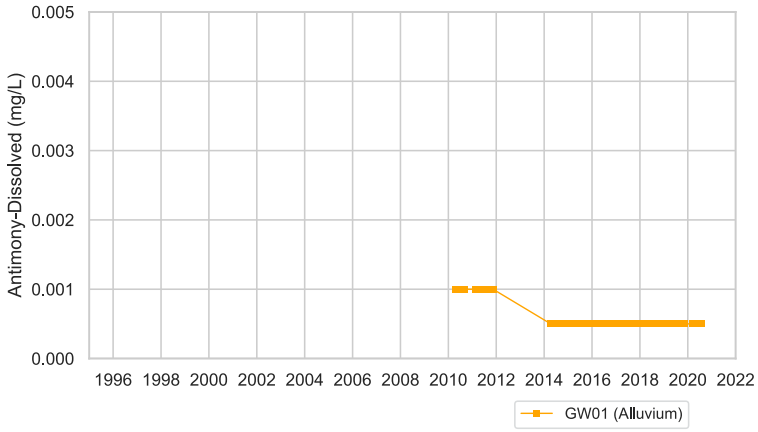

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

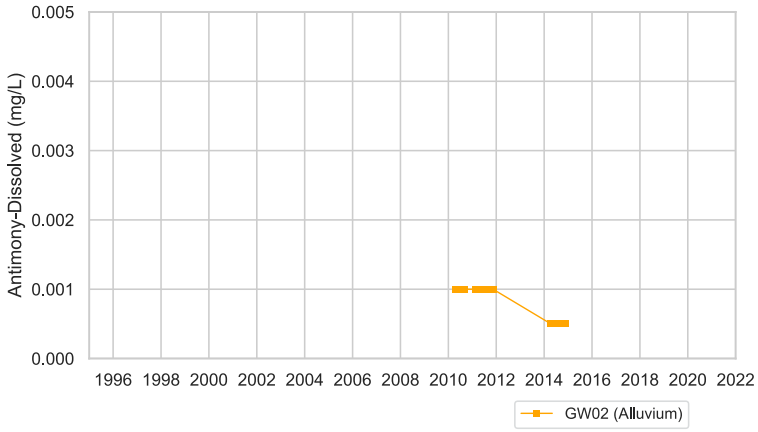

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

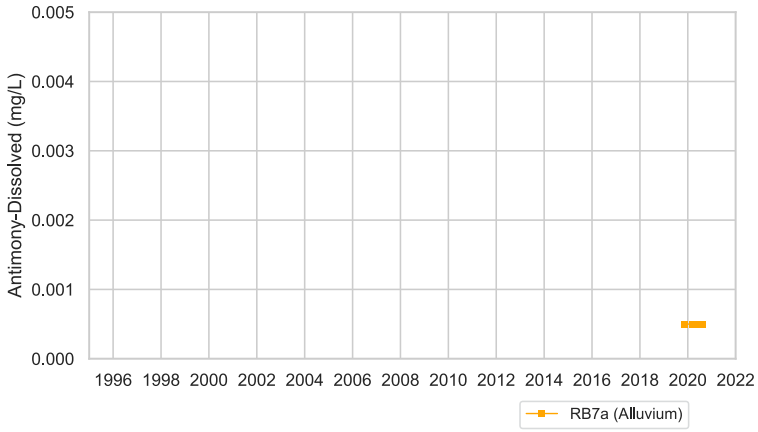

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

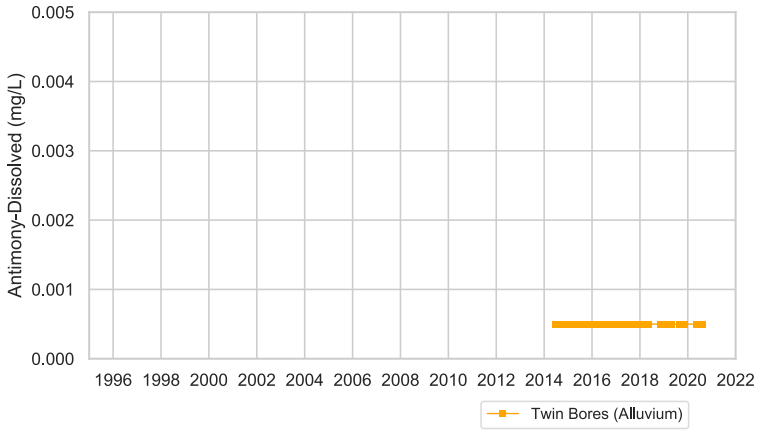

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

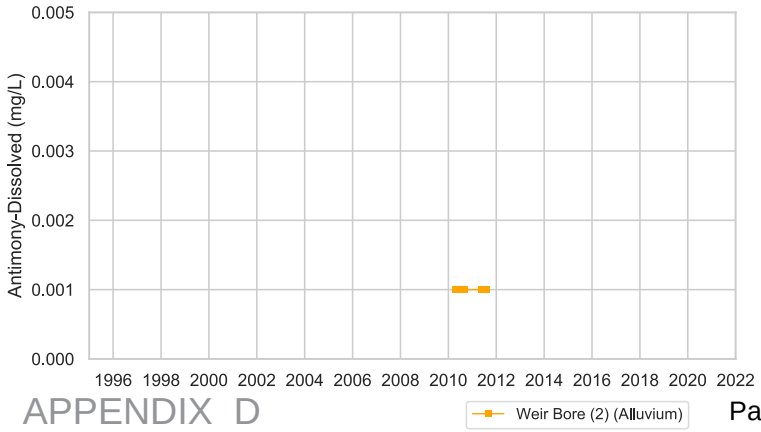

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

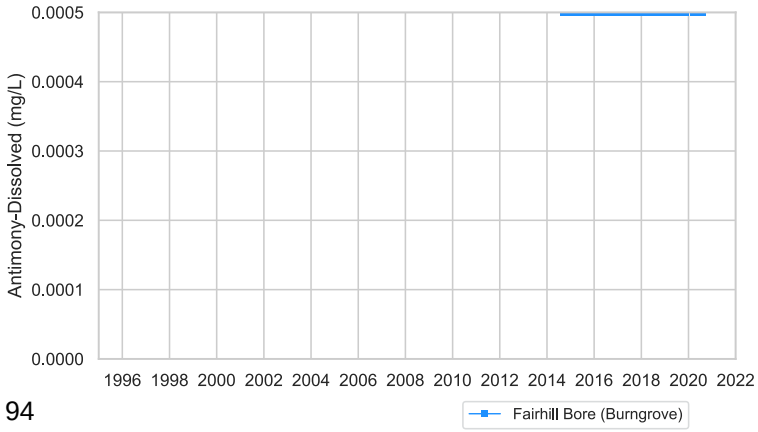

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

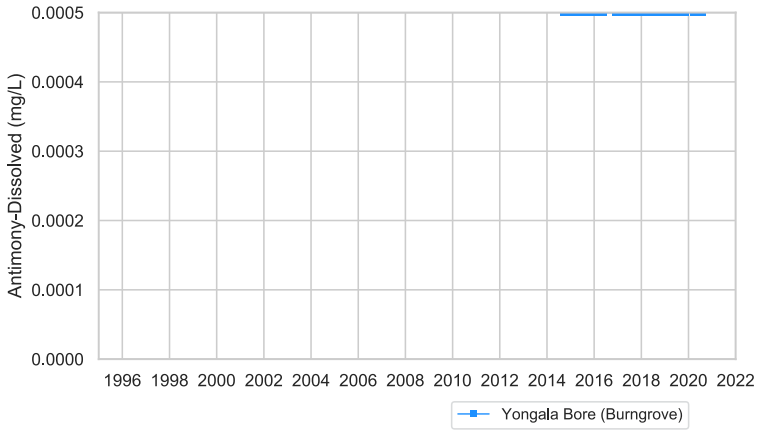

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

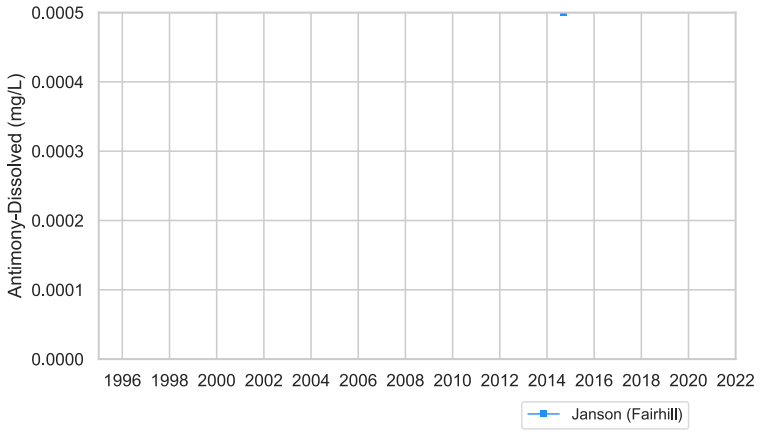

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

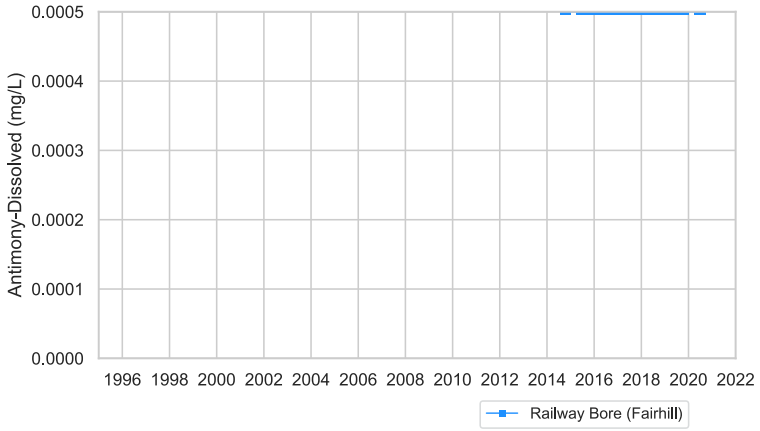

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

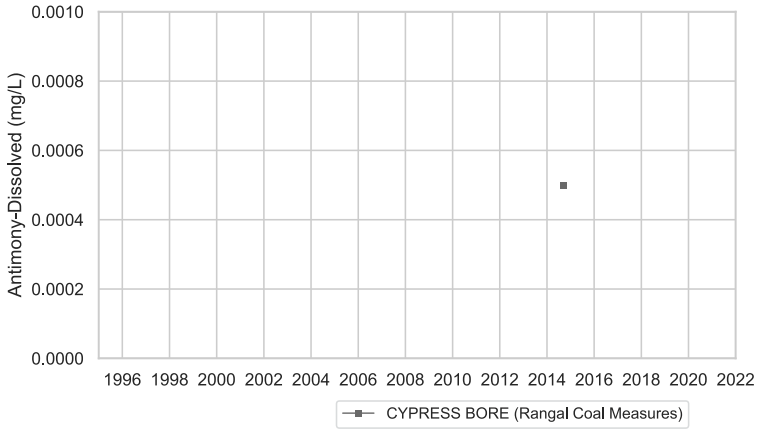

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

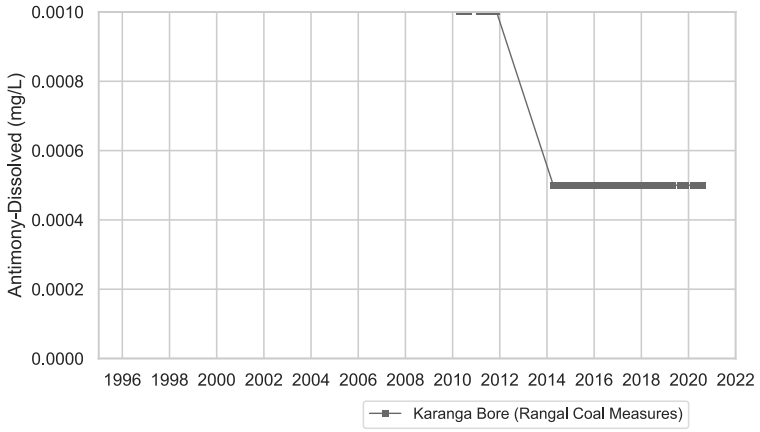

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

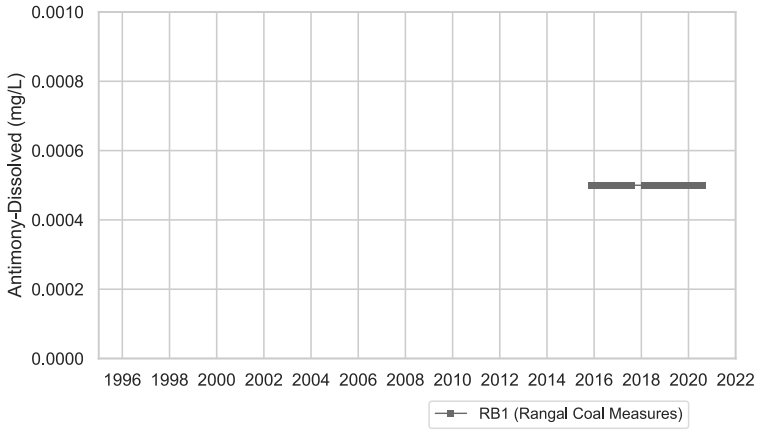

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

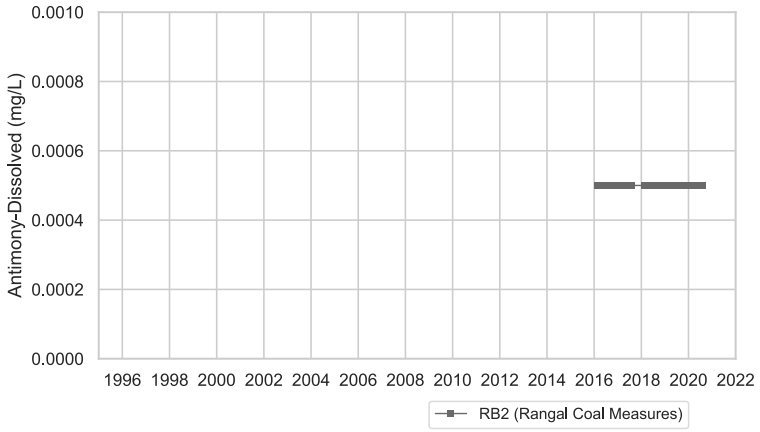

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

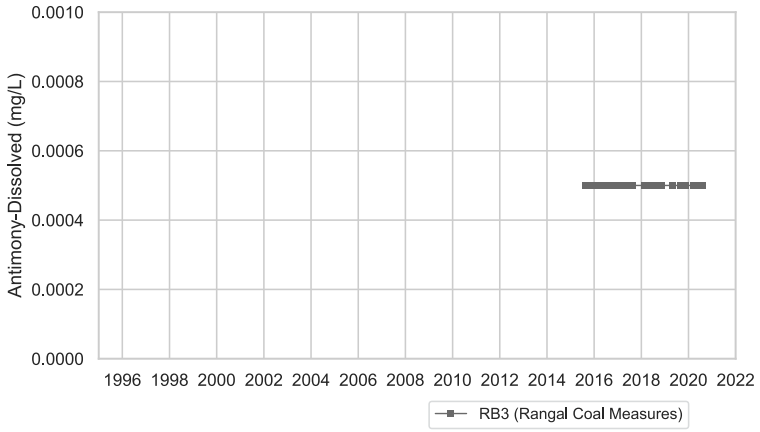

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

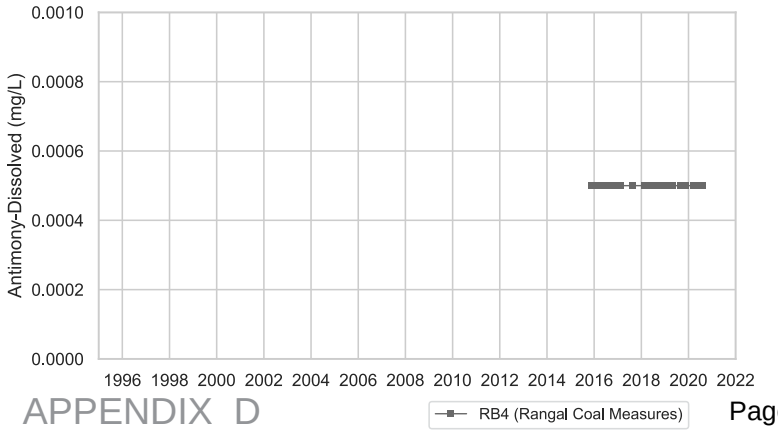

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

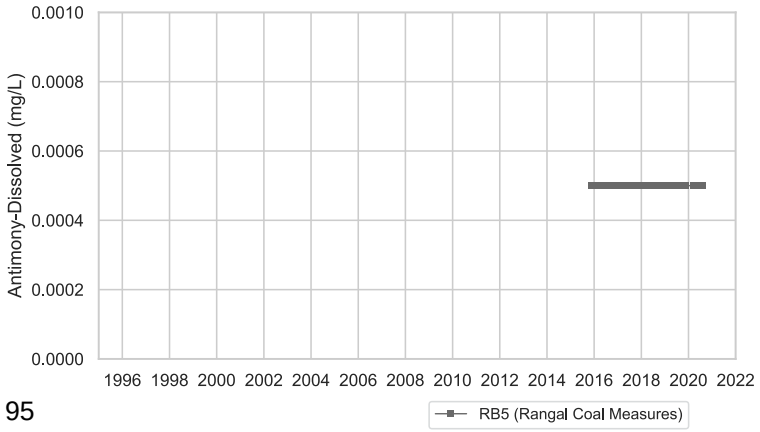

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

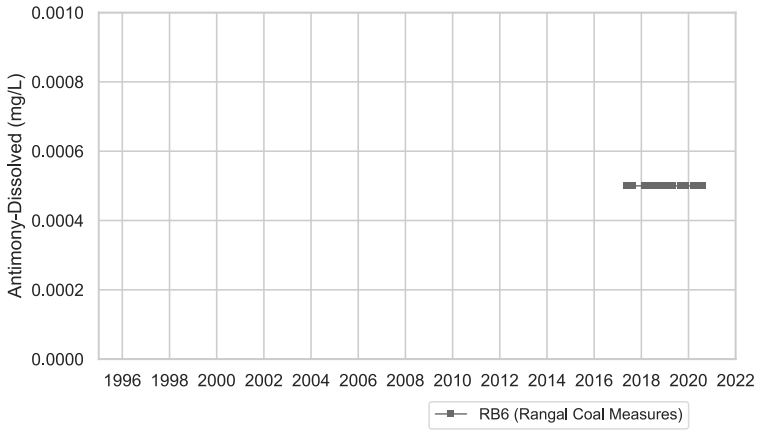

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

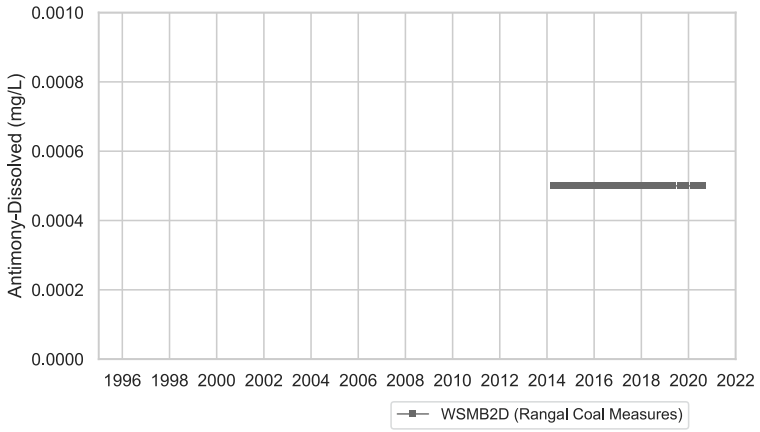

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

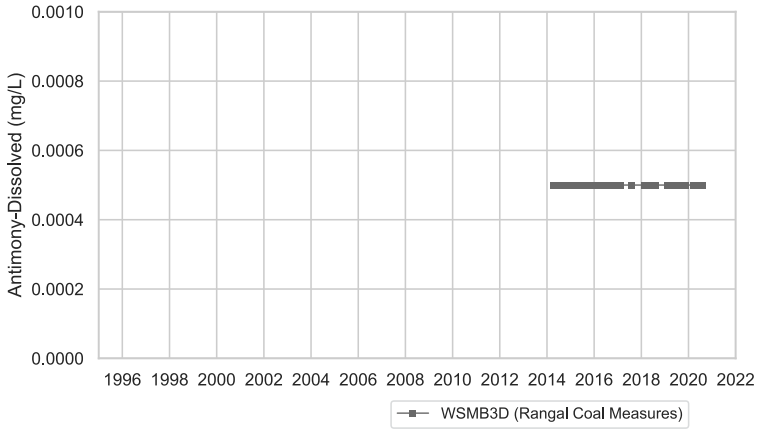

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

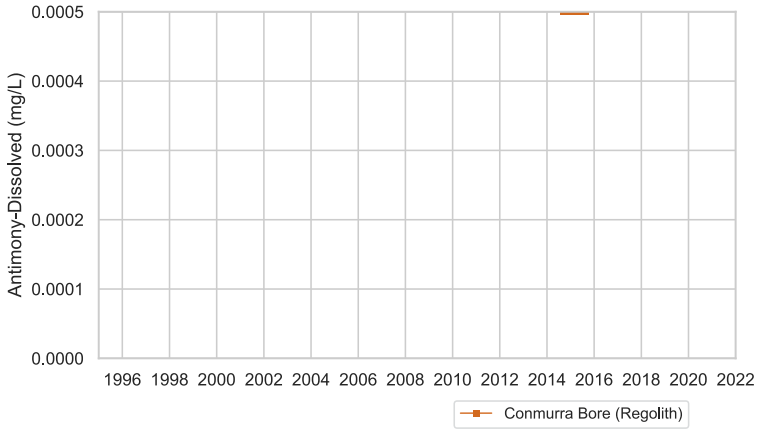

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

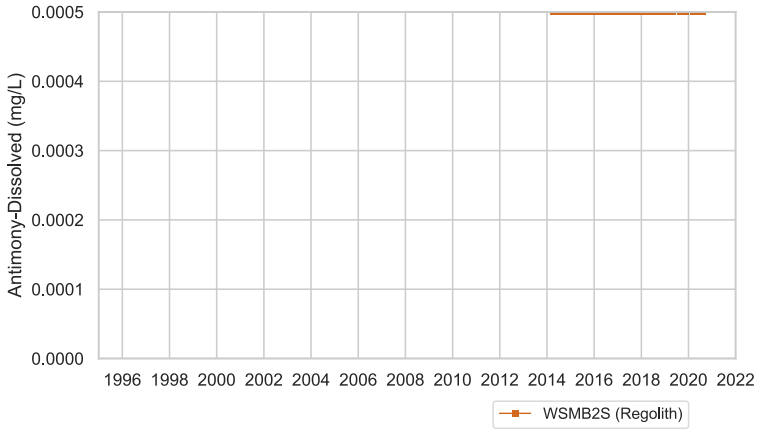

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

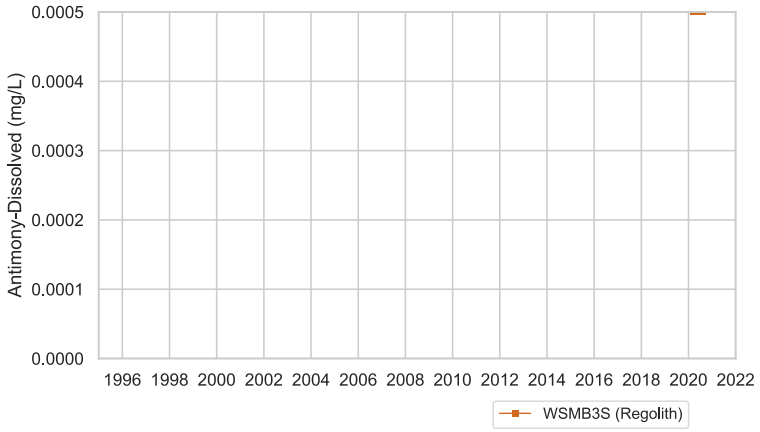

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

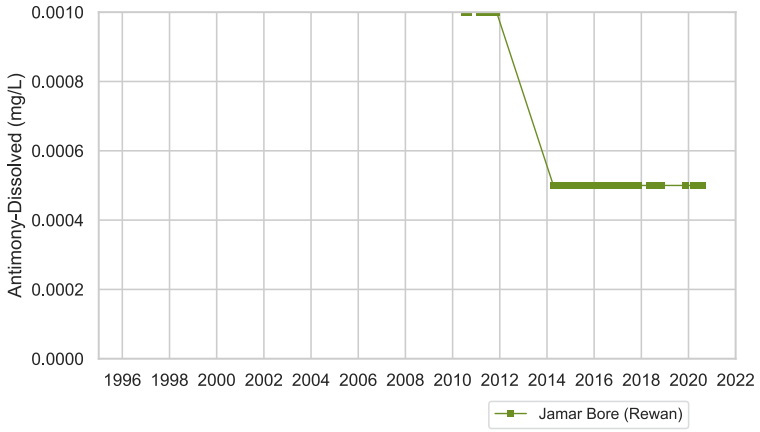

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

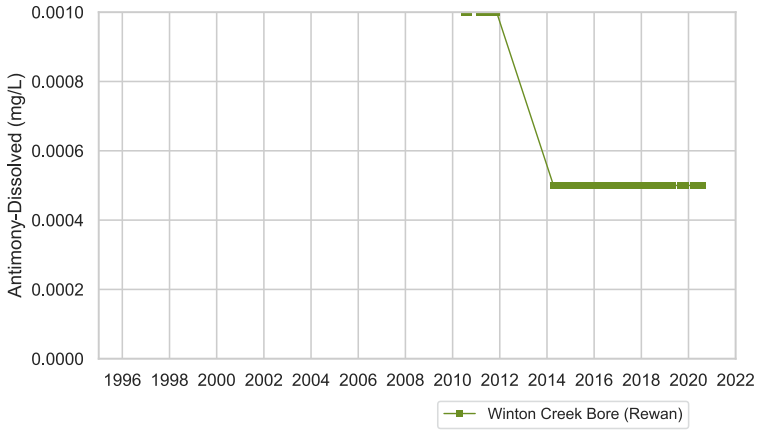

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

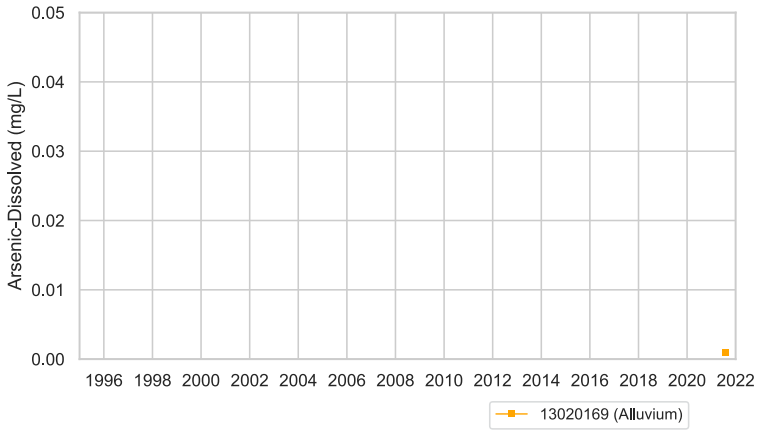

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

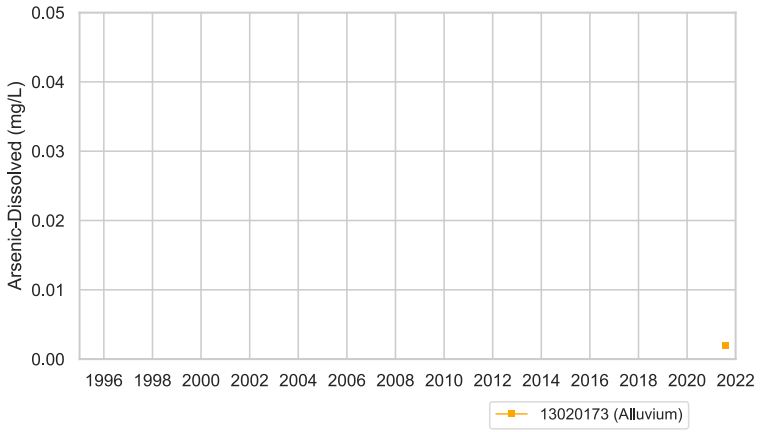

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

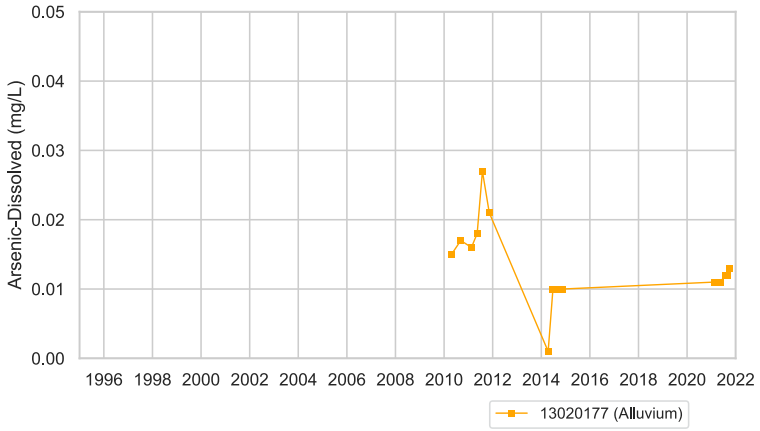

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

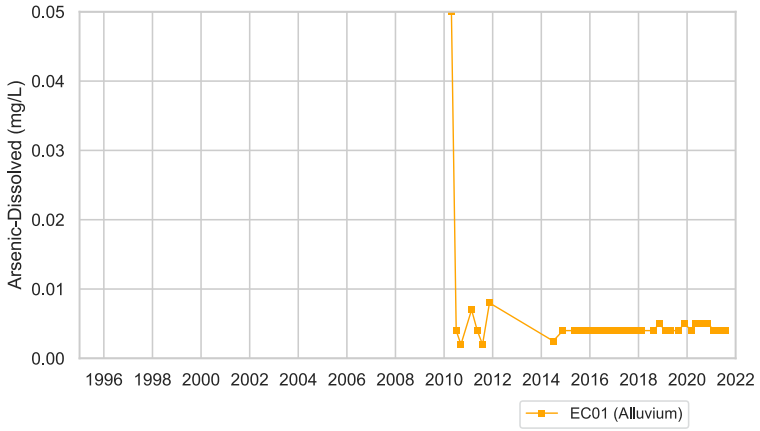

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

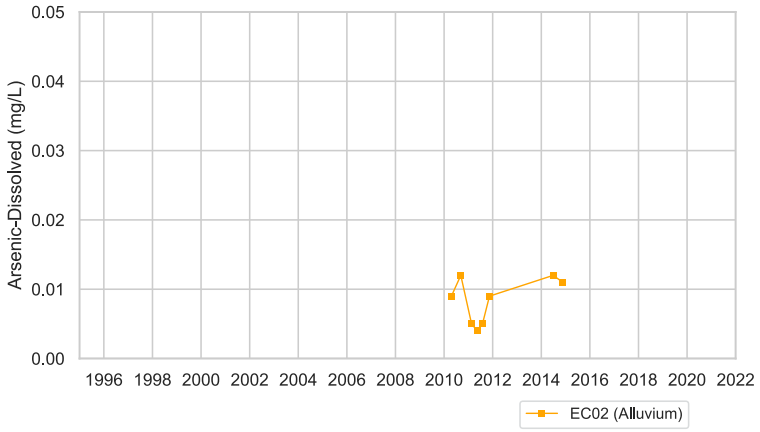

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

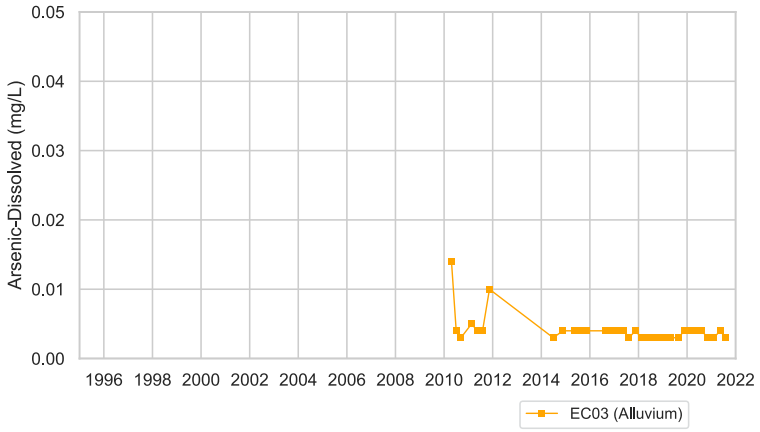

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

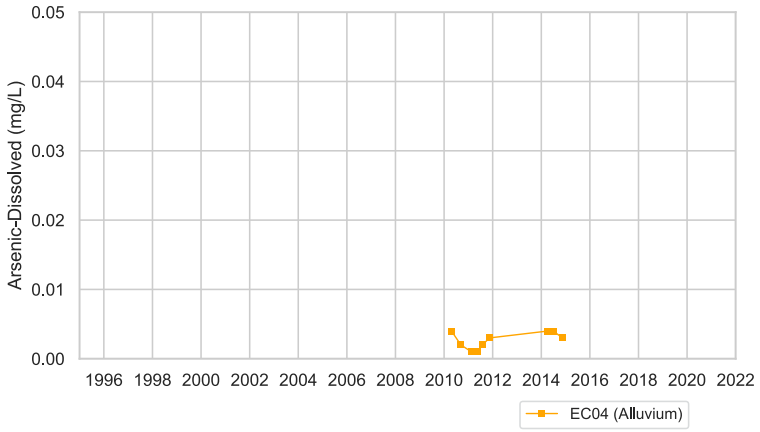

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

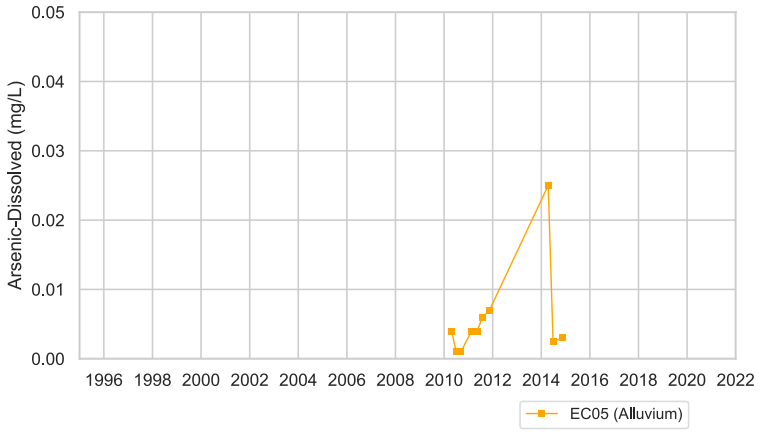

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

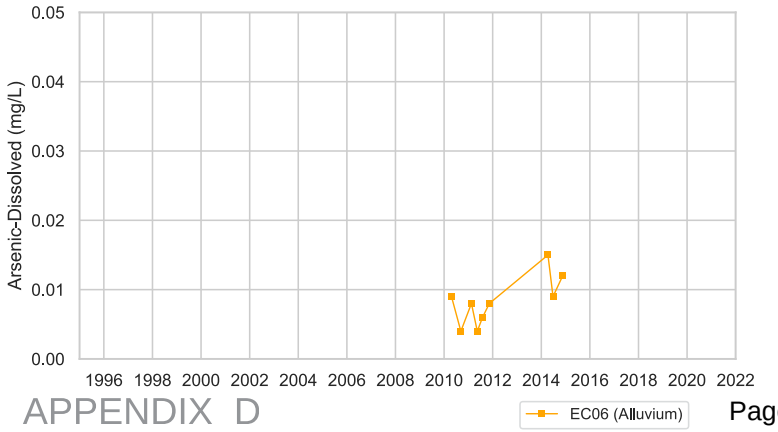

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

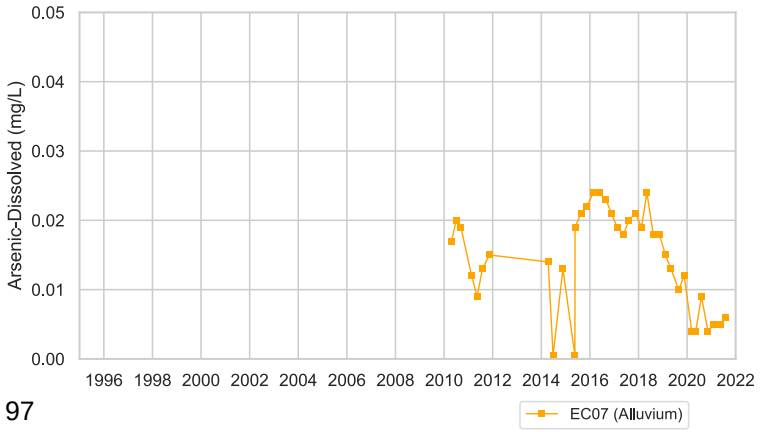

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

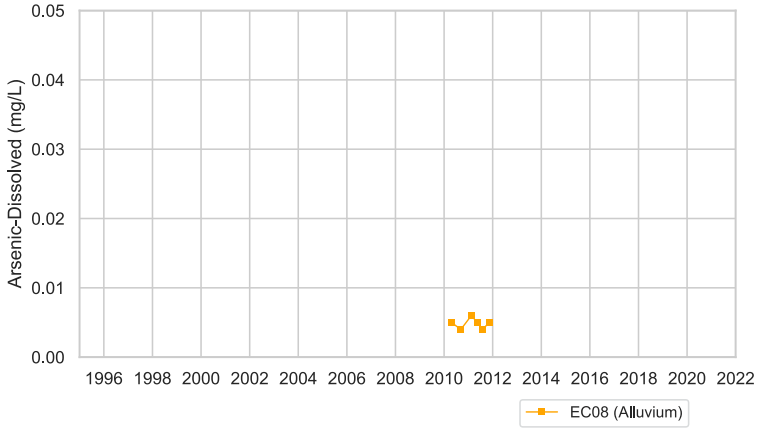

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

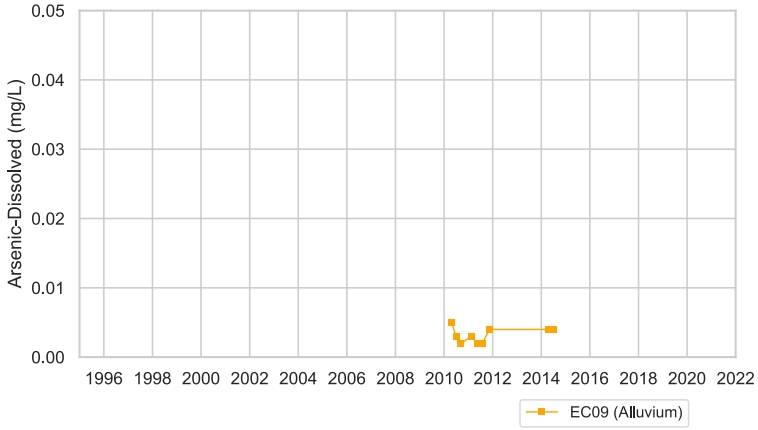

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

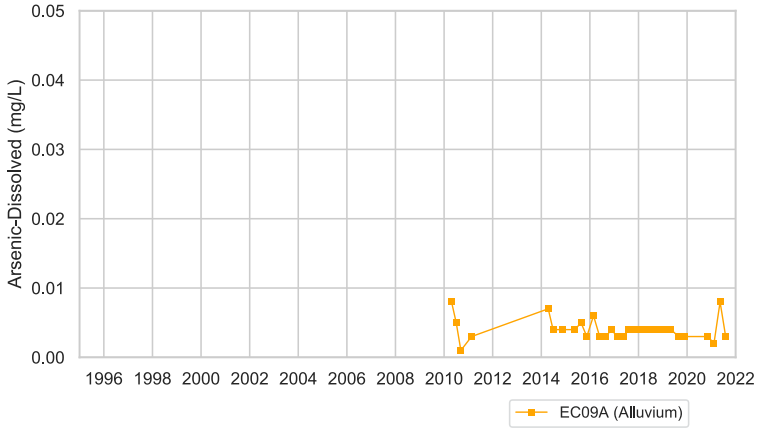

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

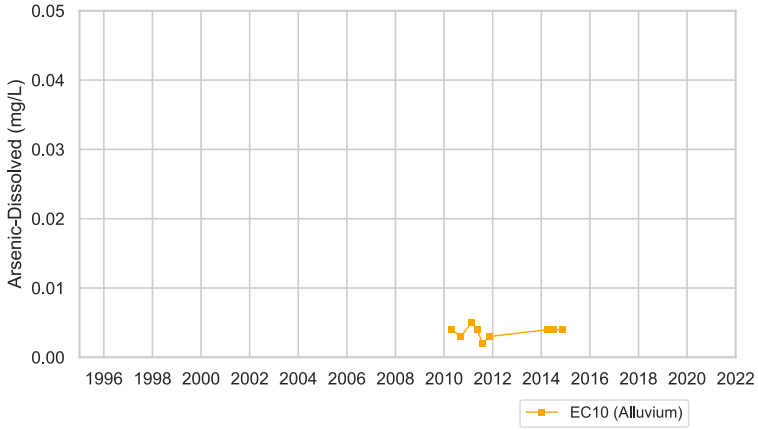

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

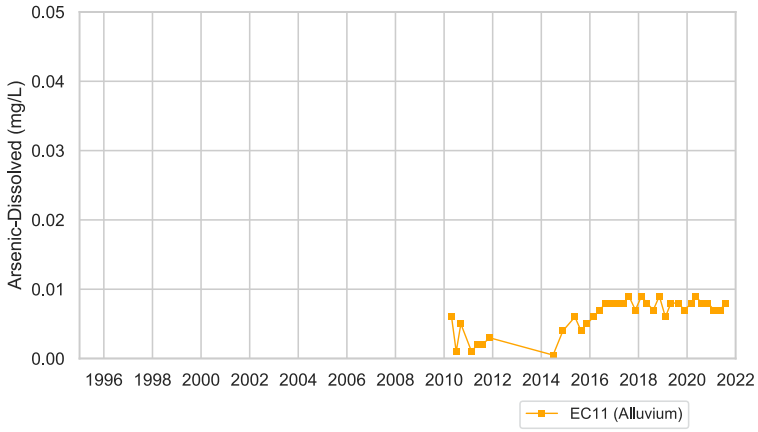

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

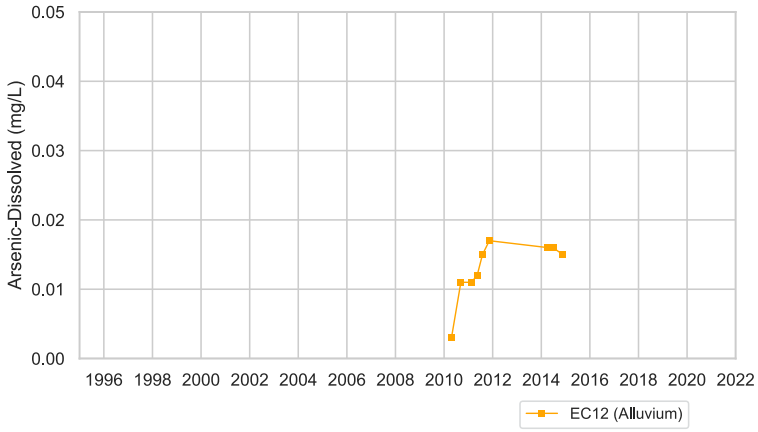

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

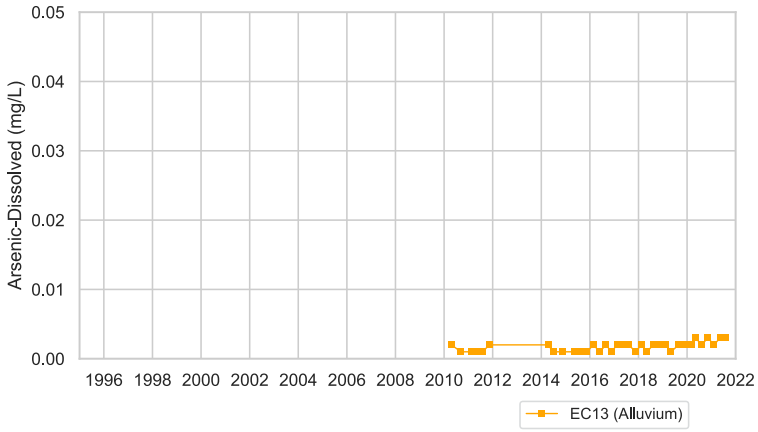

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

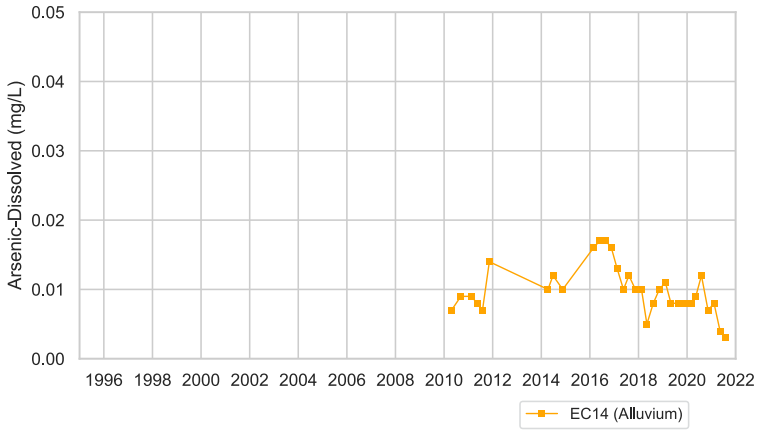

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

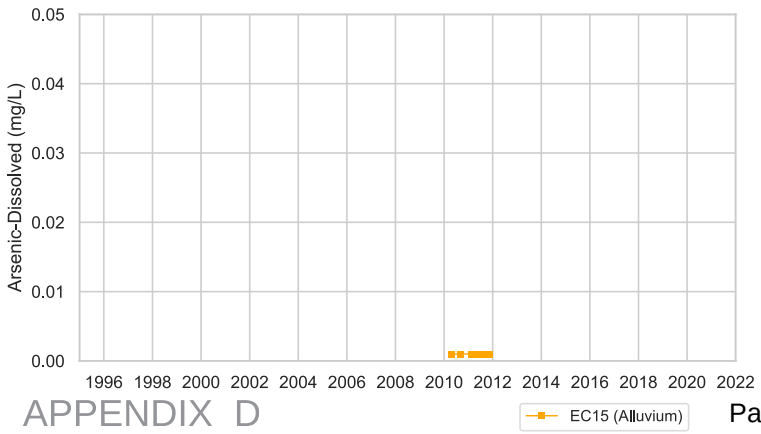

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

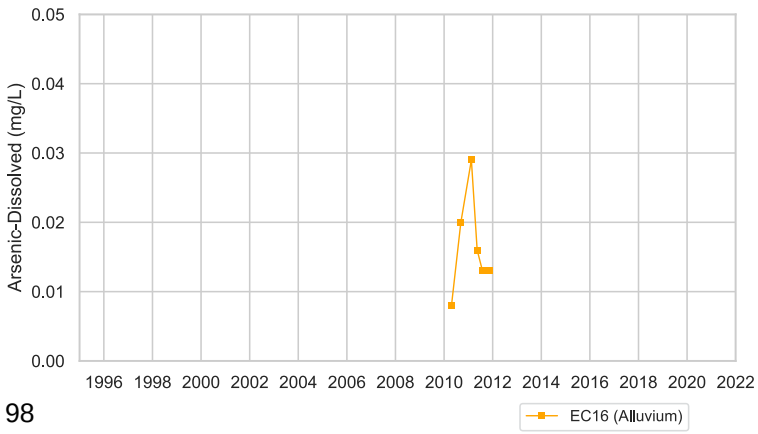

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

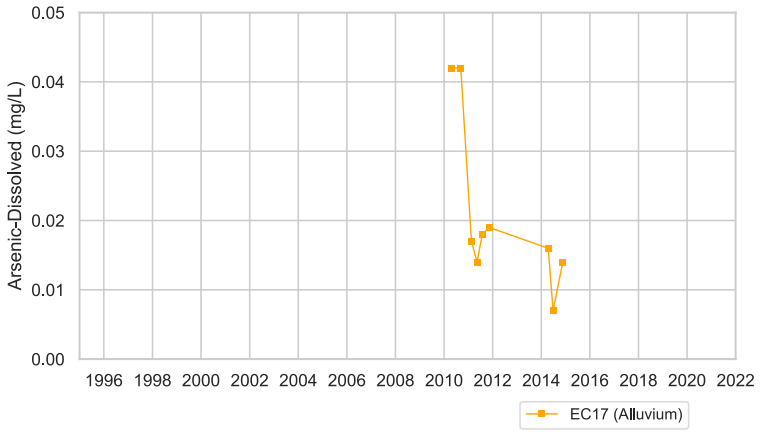

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

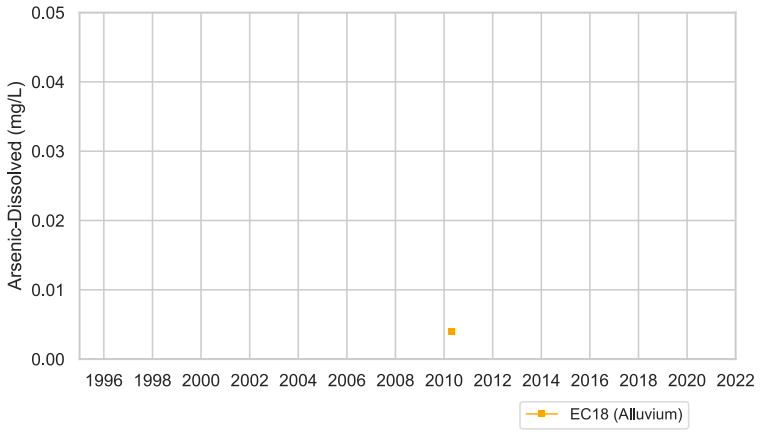

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

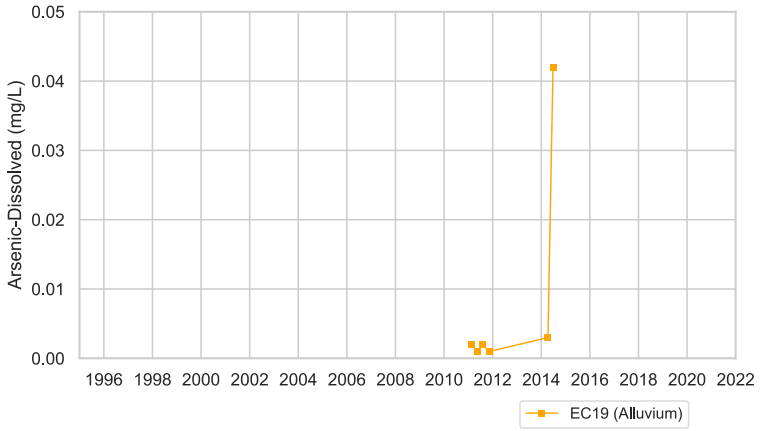

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

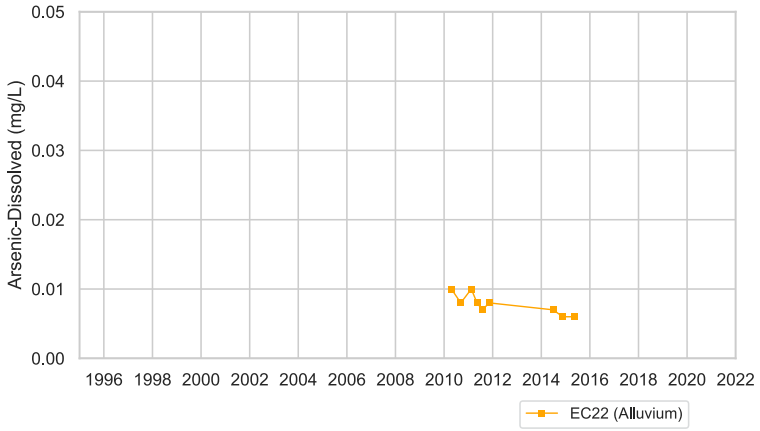

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

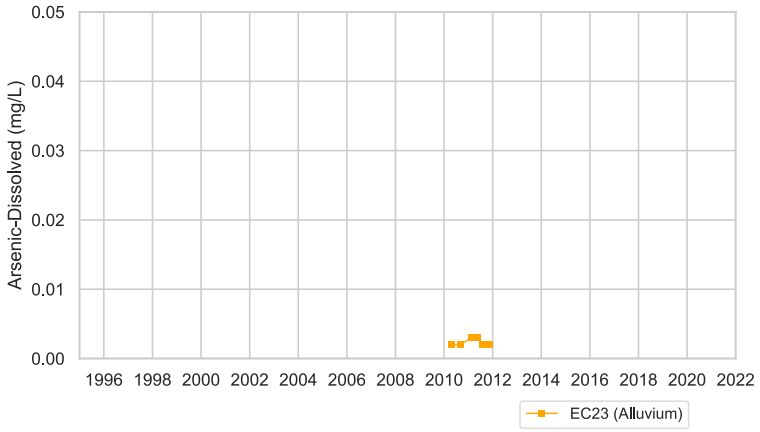

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

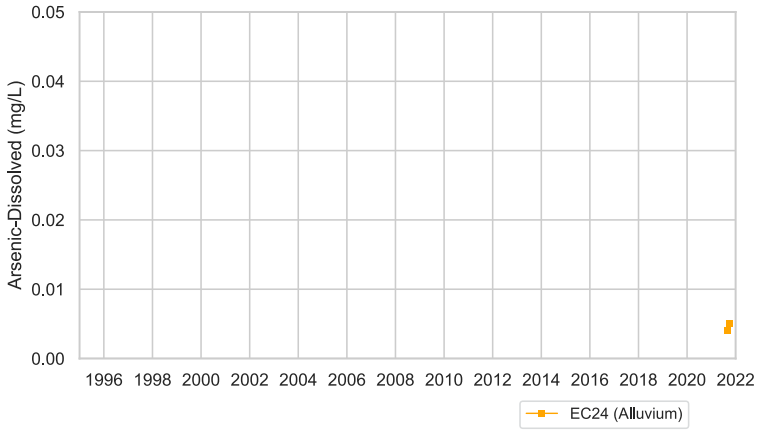

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

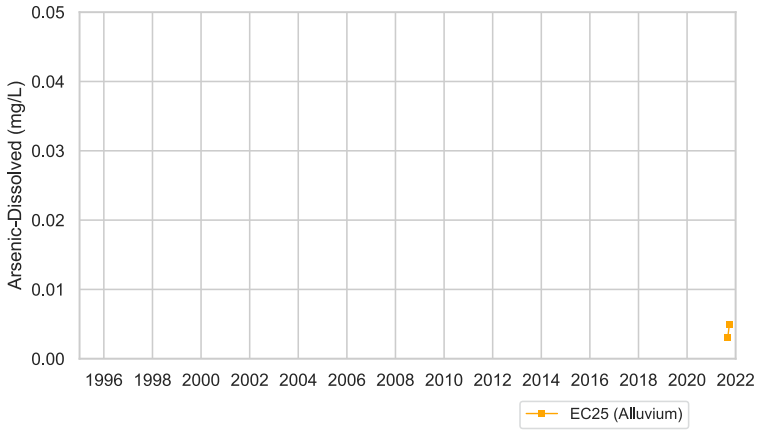

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

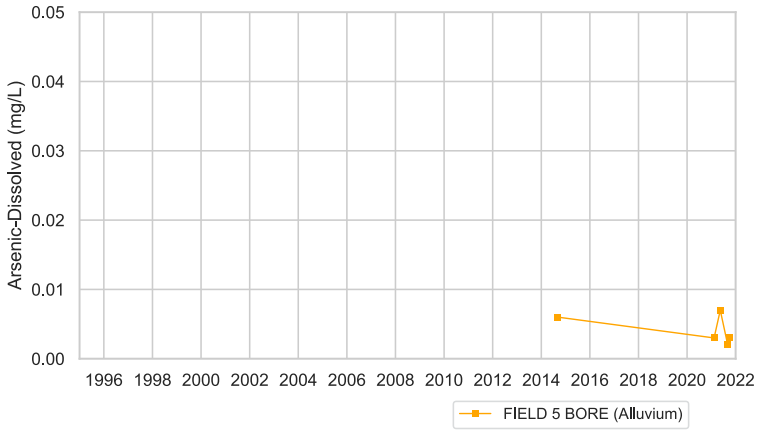

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

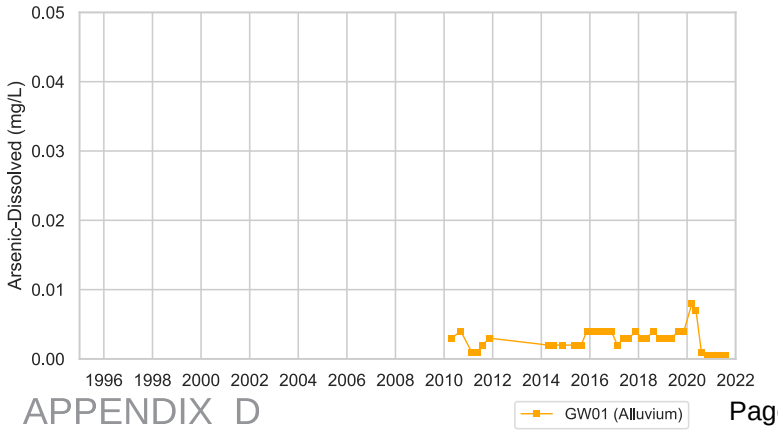

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

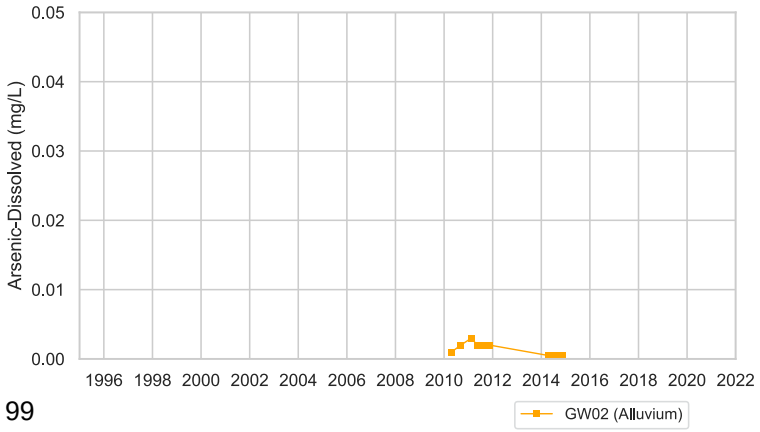

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

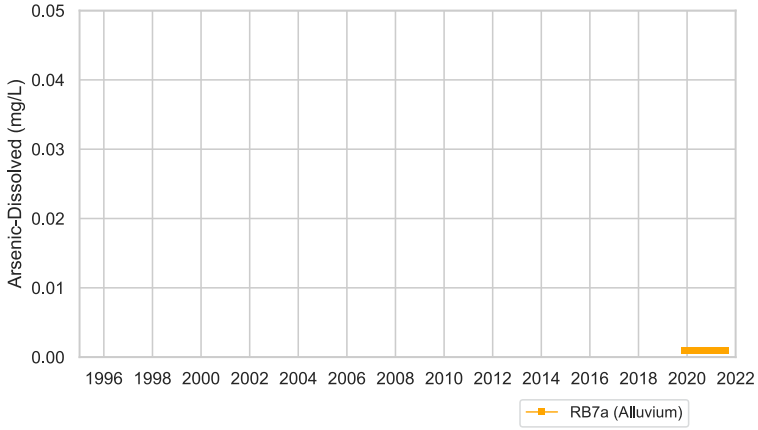

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

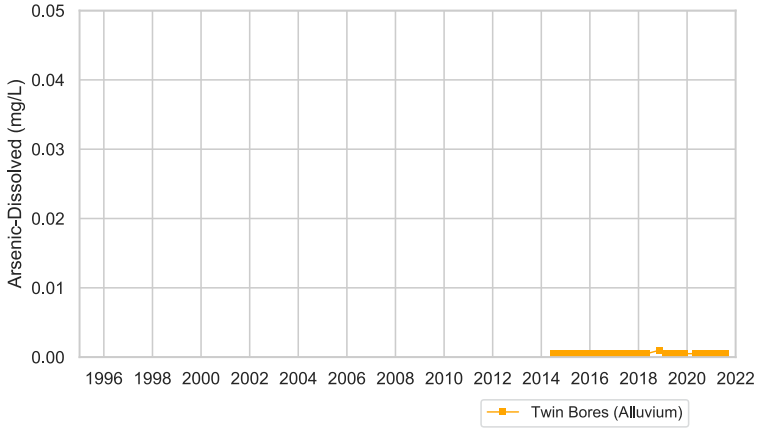

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

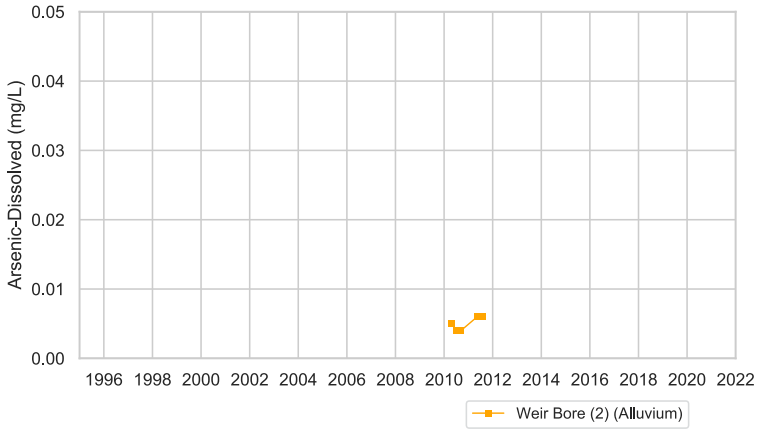

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

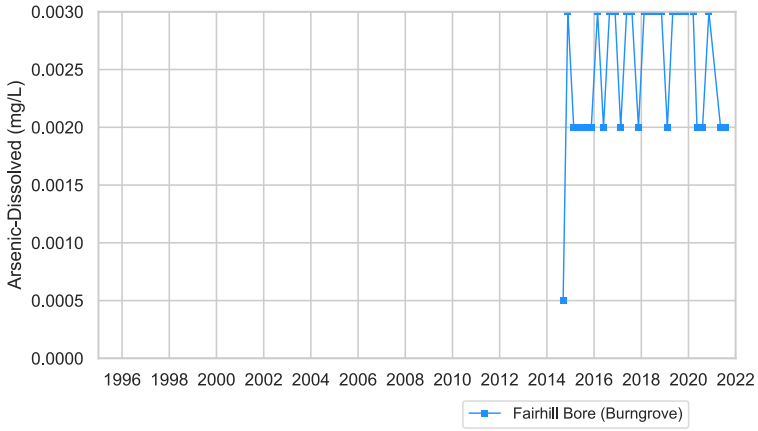

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

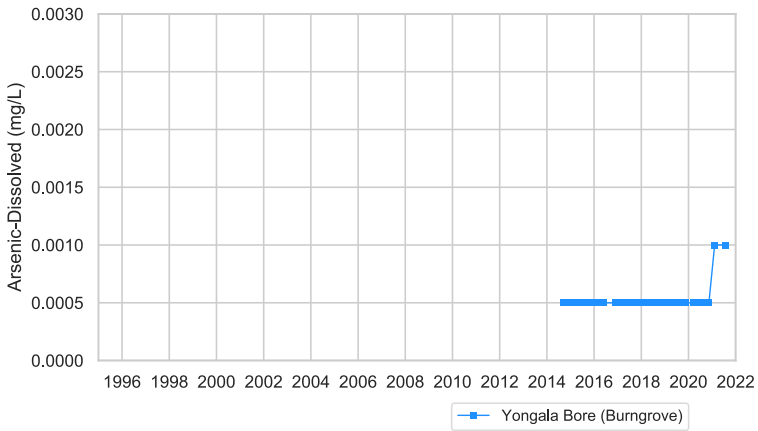

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

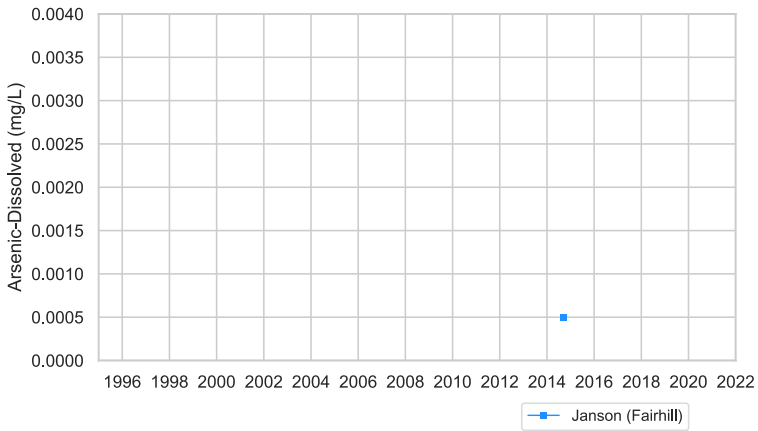

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

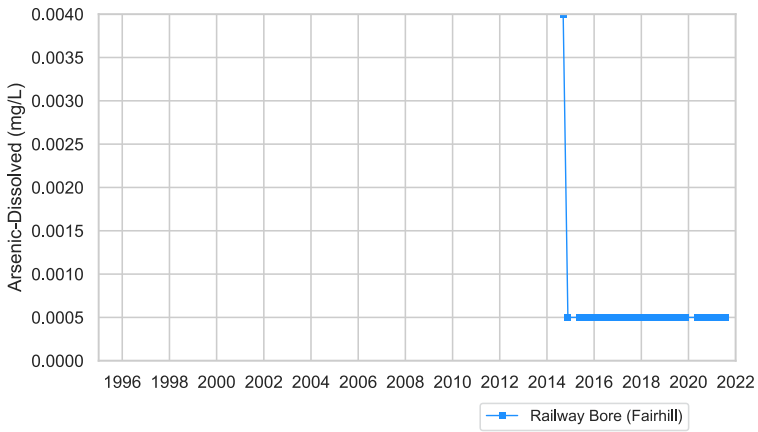

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

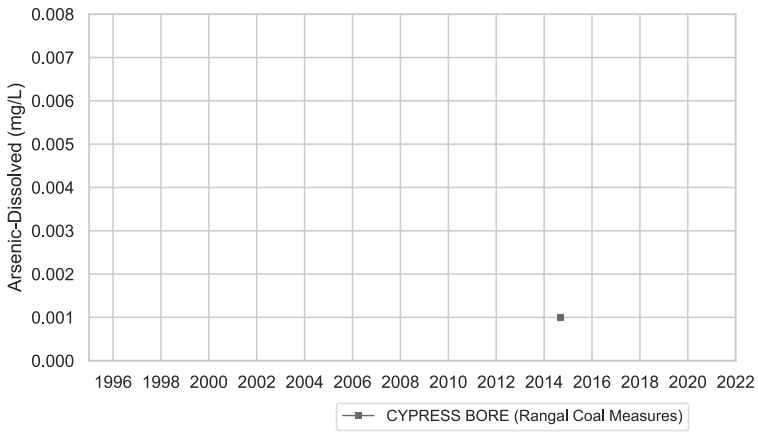

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

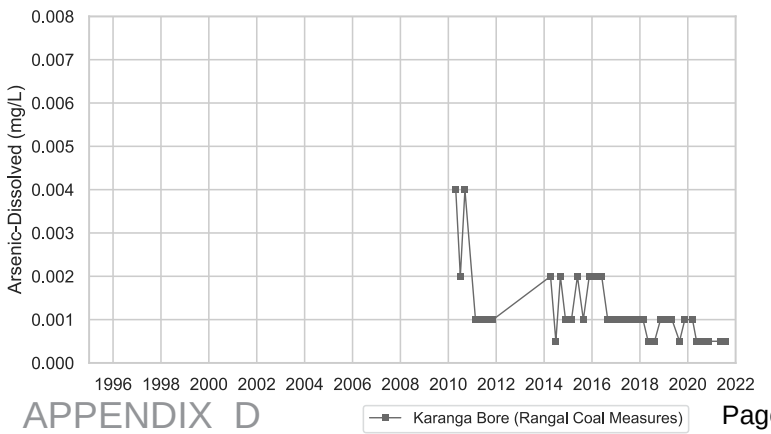

Arsenic-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

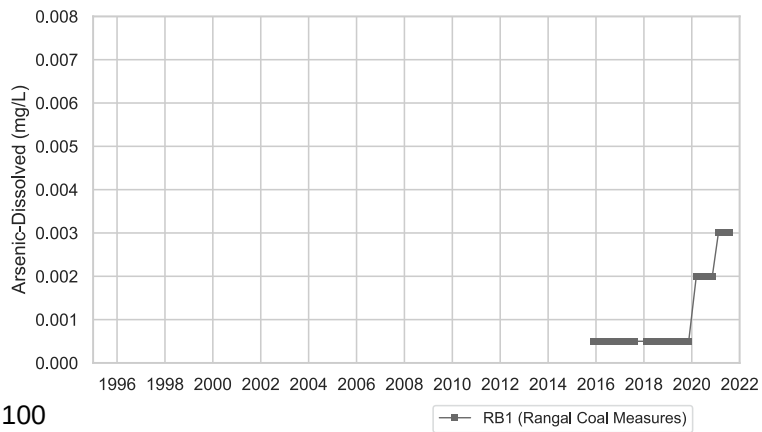

Arsenic-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

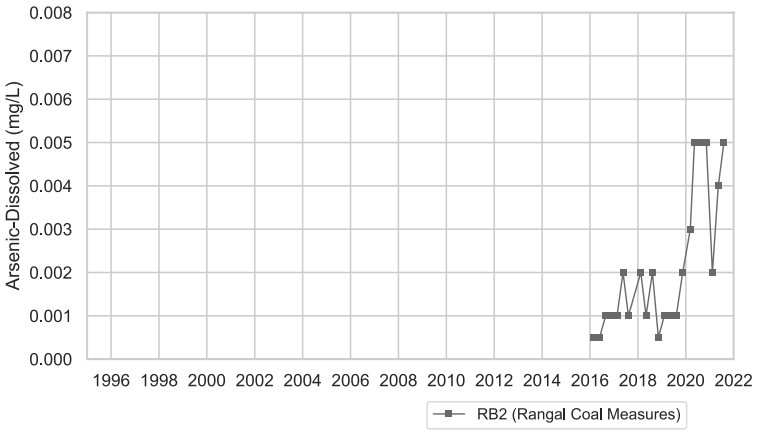

Arsenic-Dissolved (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

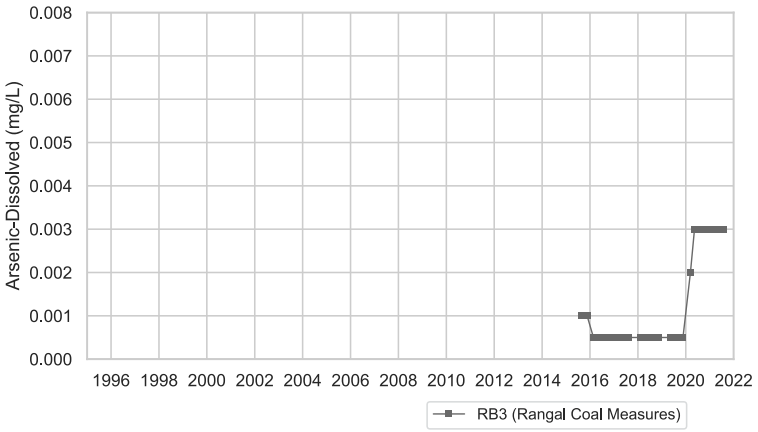

Arsenic-Dissolved (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

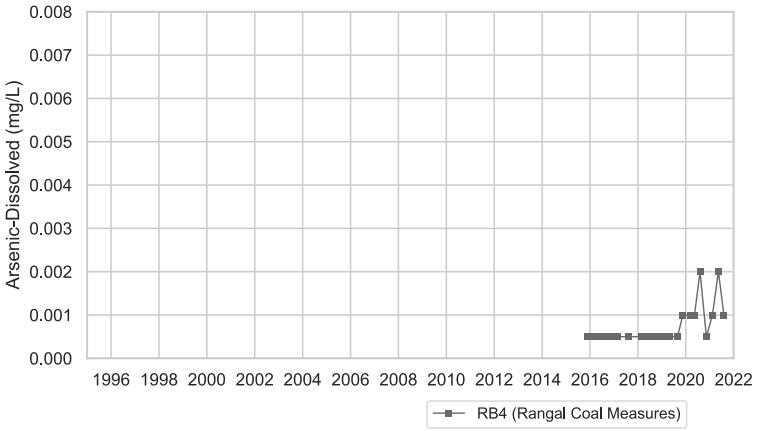

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

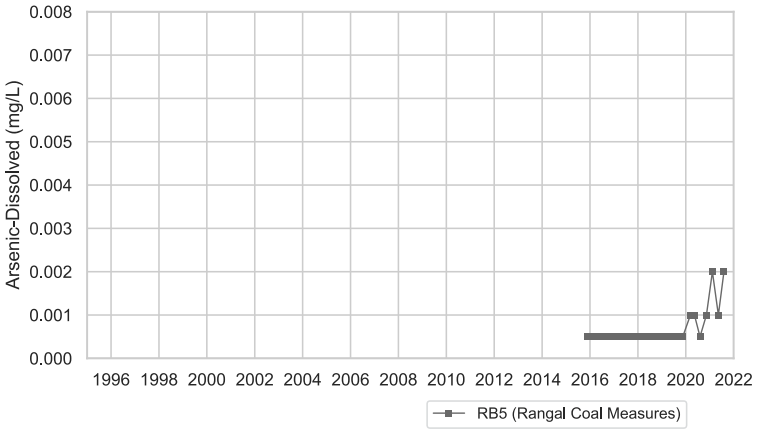

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

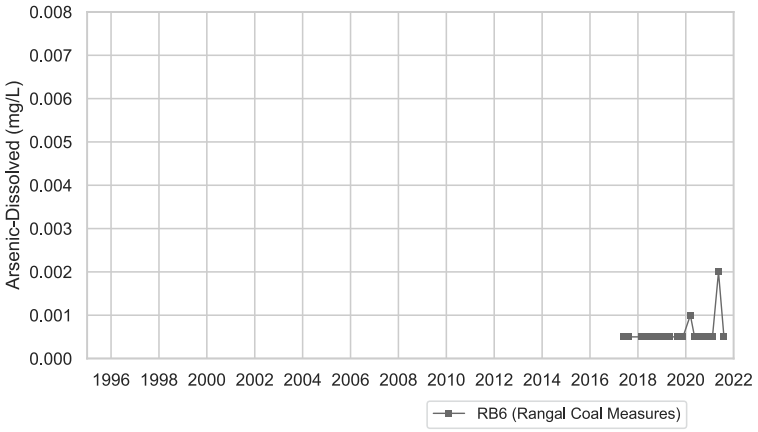

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

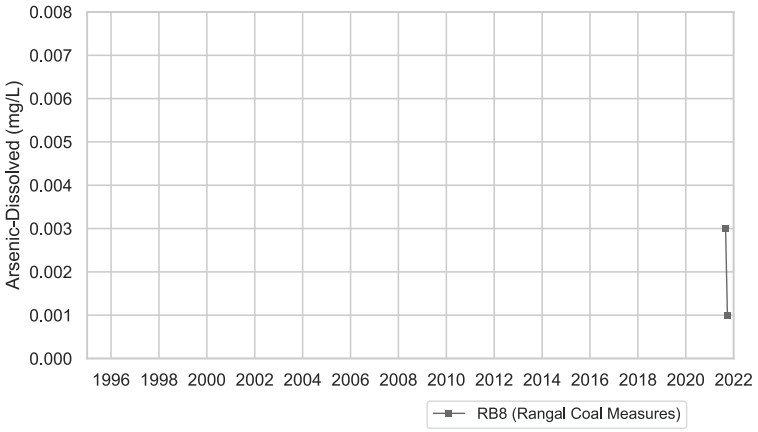

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

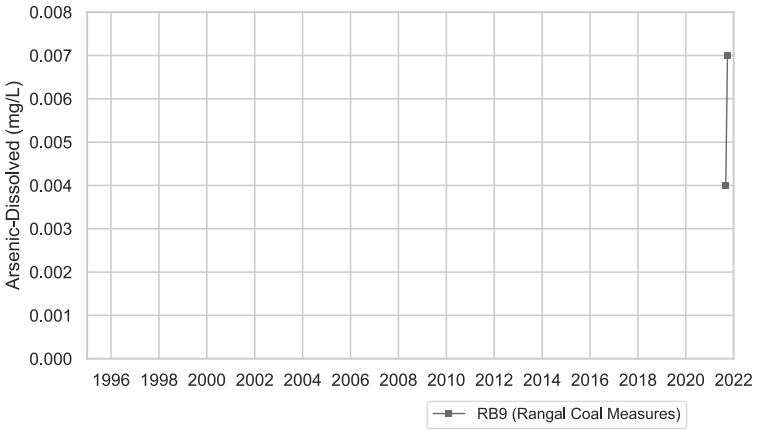

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

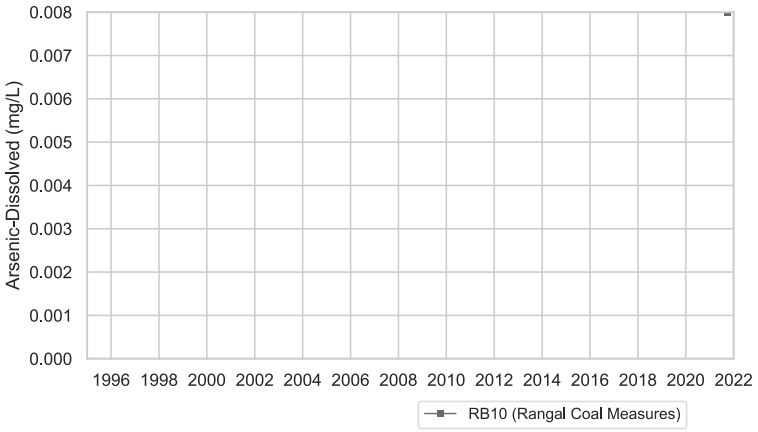

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

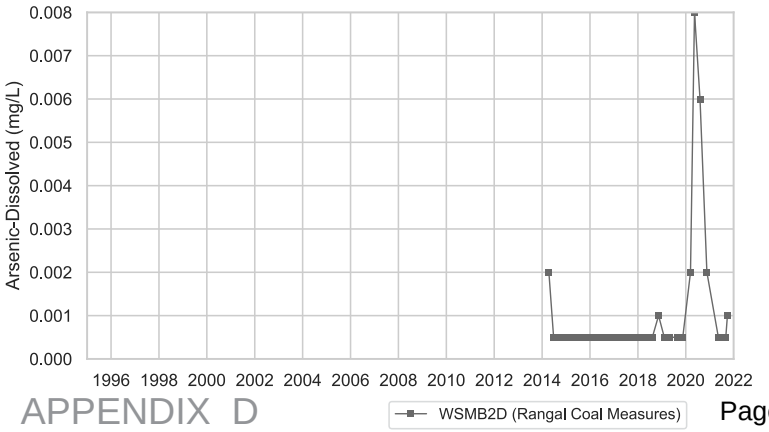

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

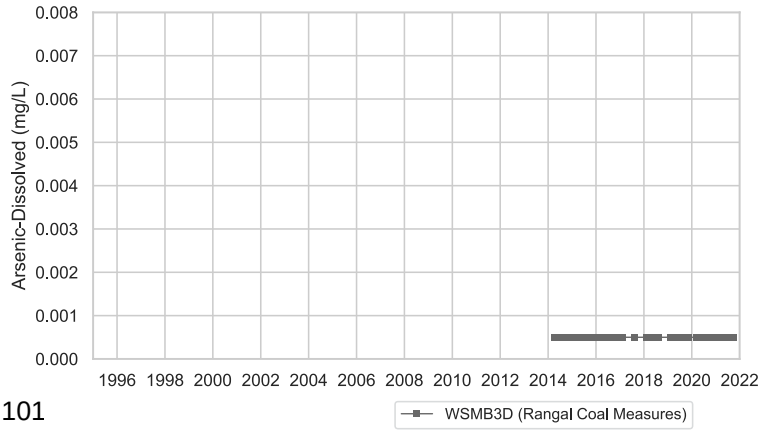

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

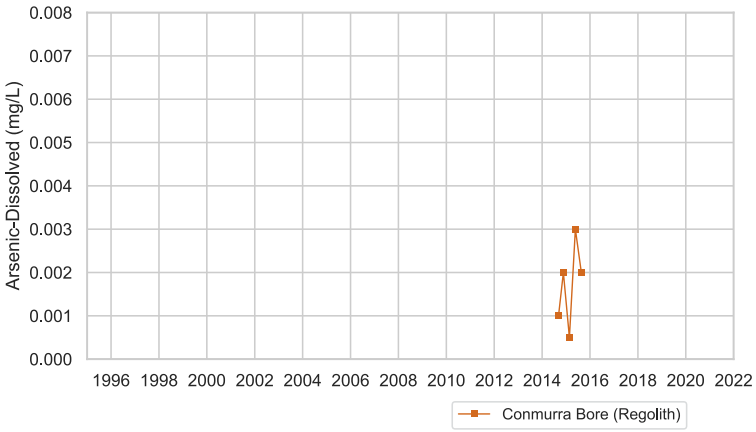

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

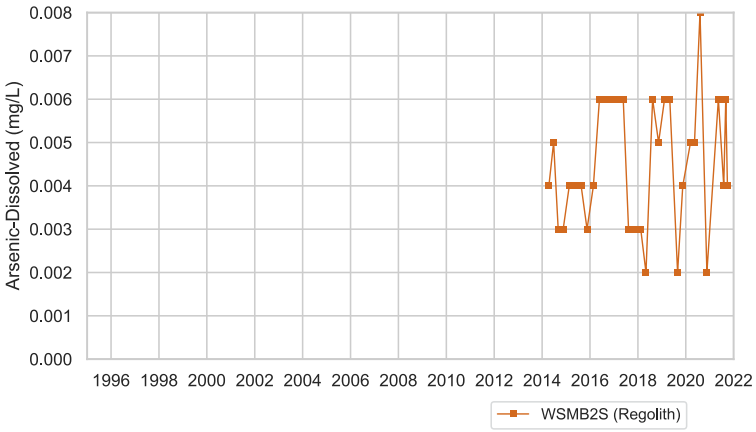

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

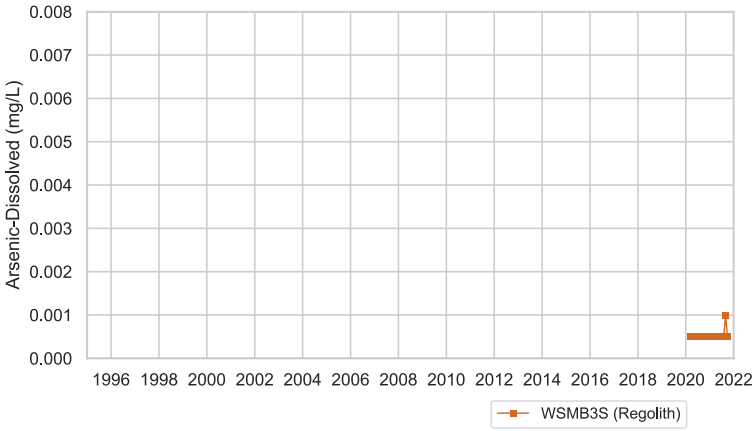

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

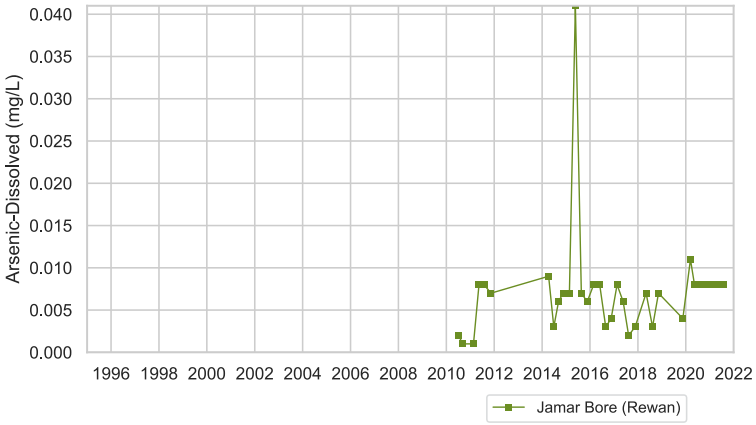

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

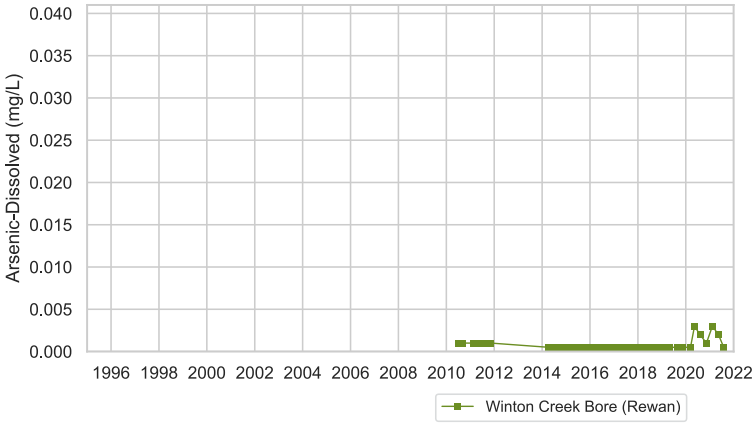

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

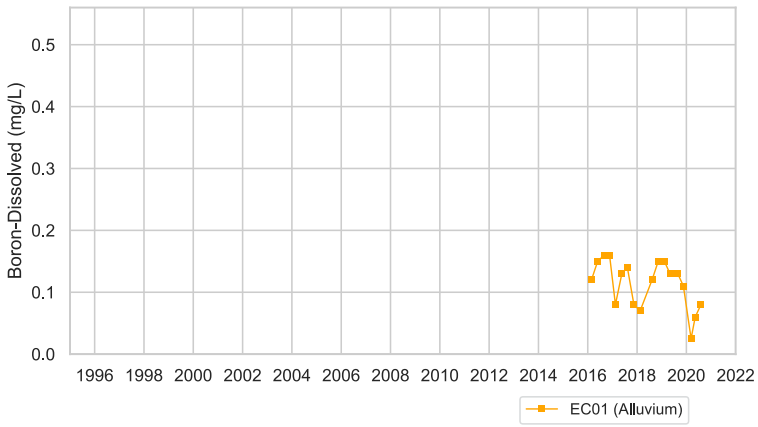

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

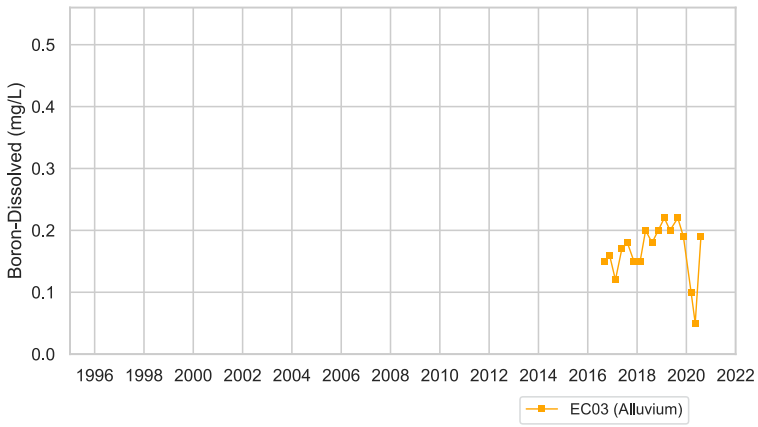

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

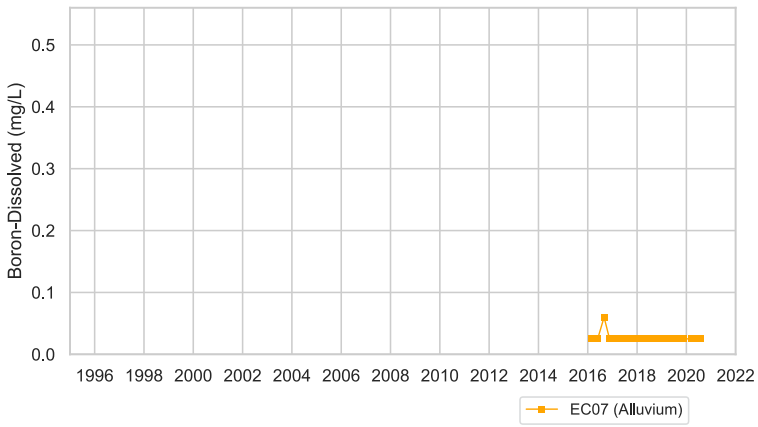

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

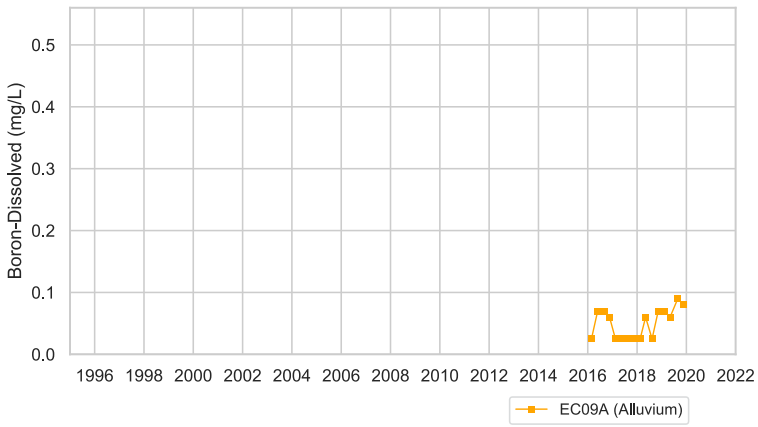

Arsenic-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

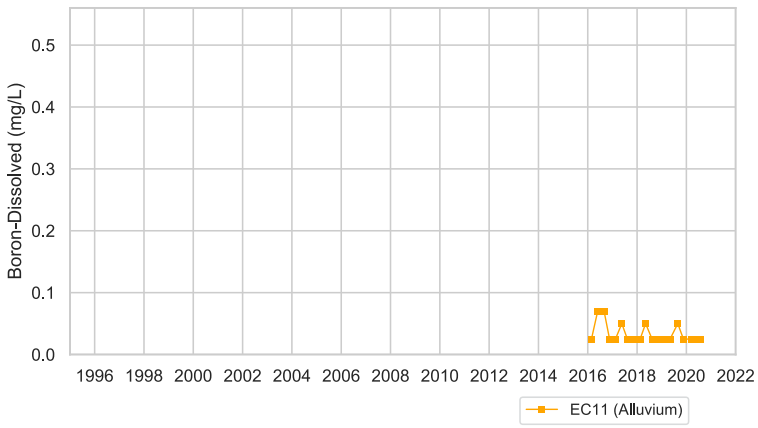

Arsenic-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

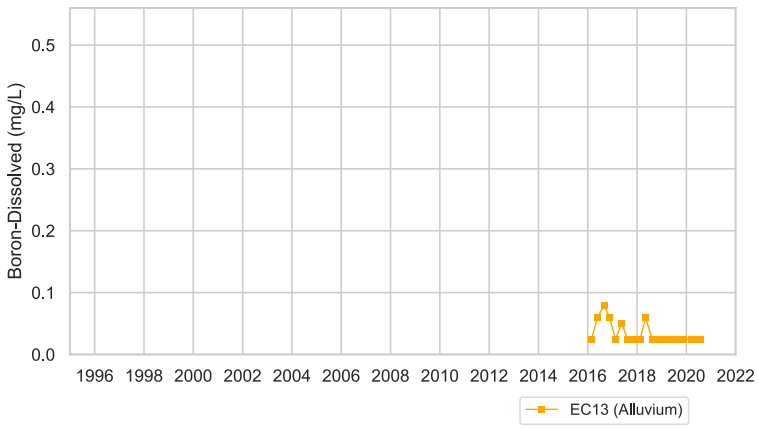

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

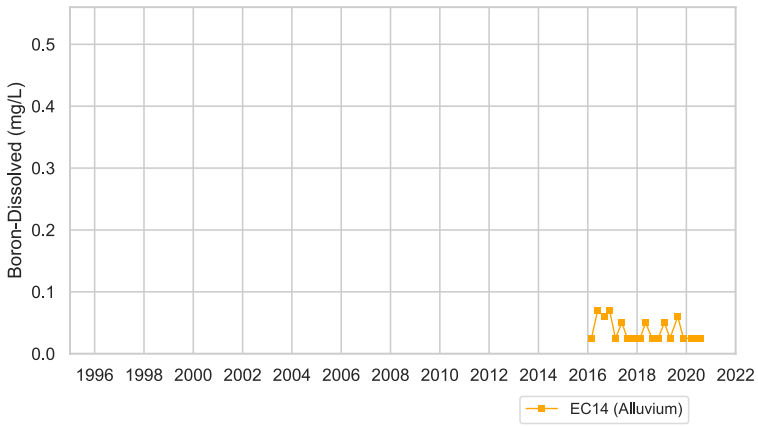

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

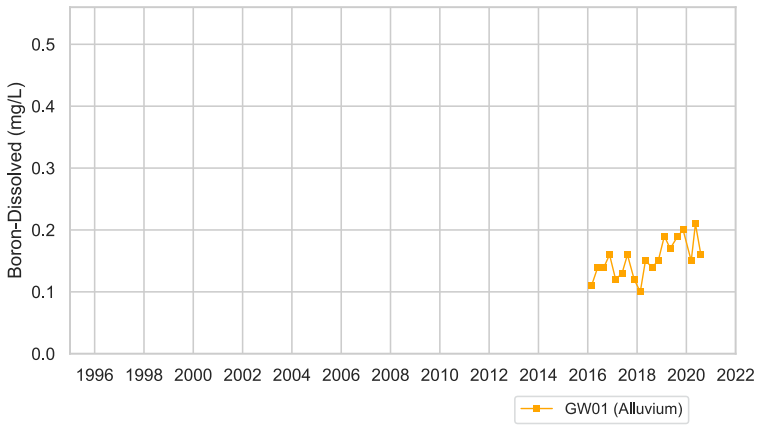

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

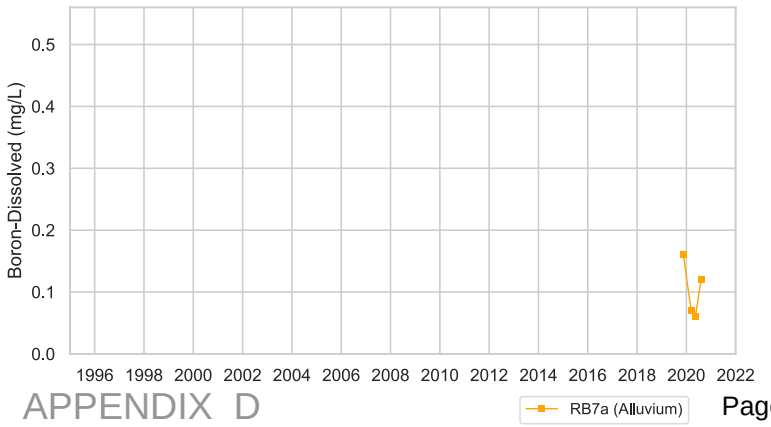

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

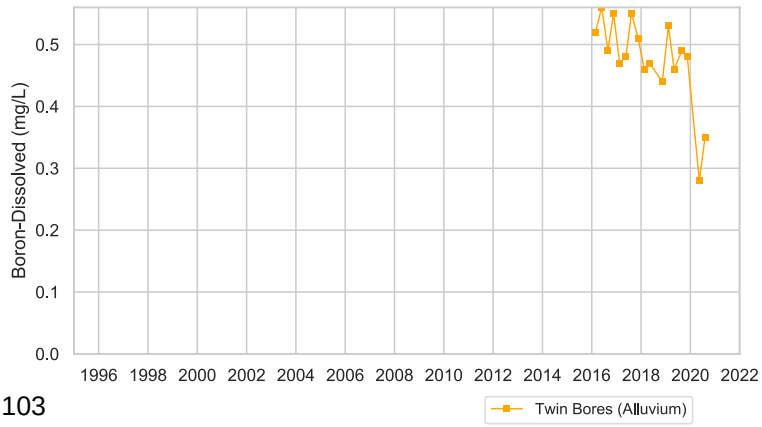

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

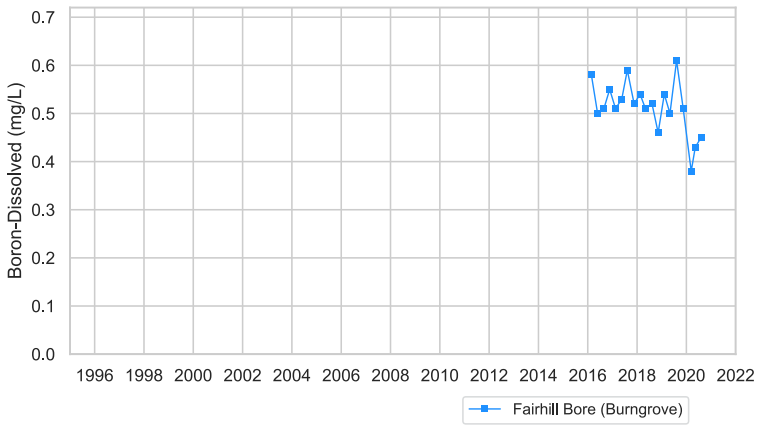

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

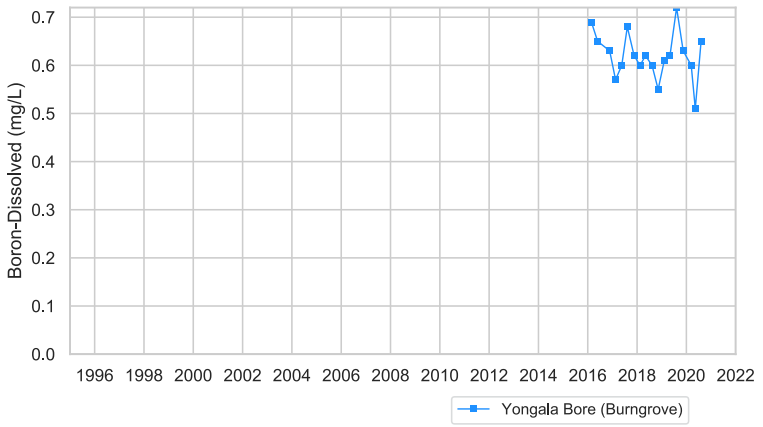

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

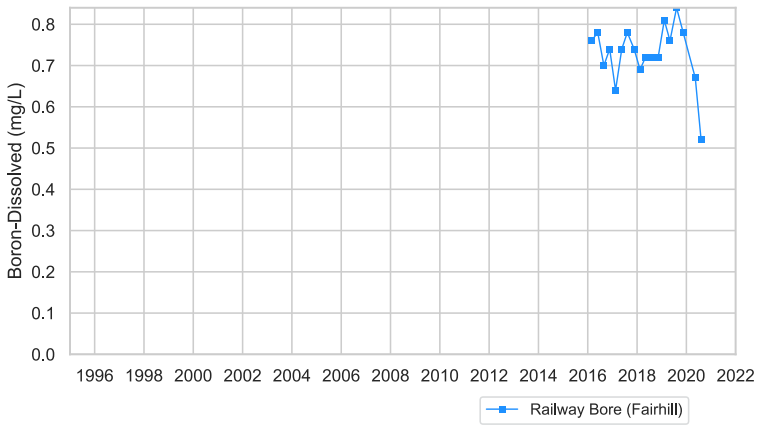

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

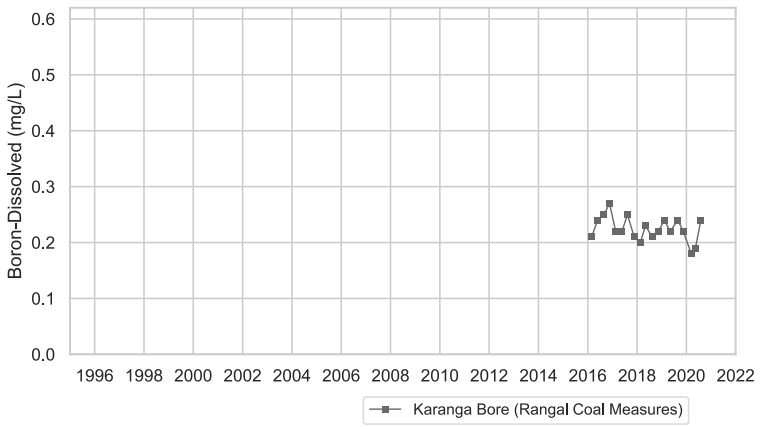

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

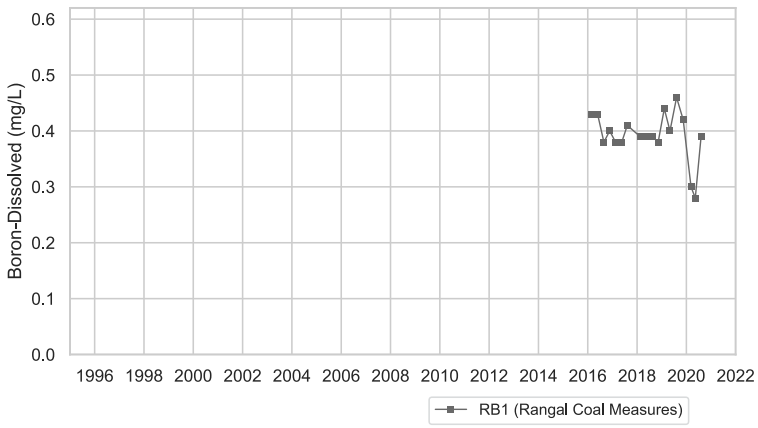

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

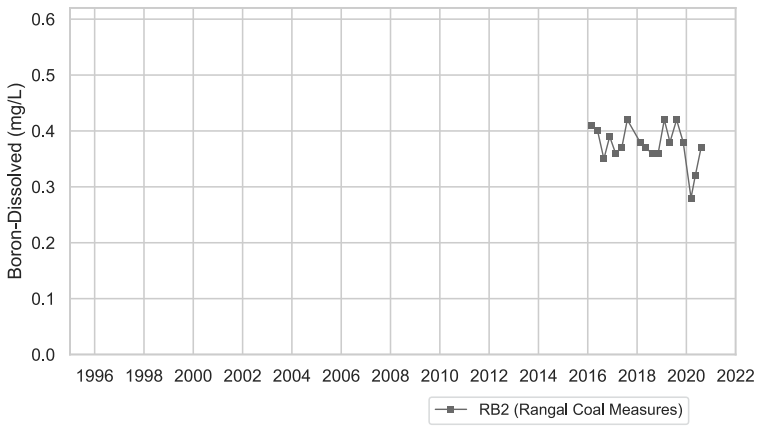

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

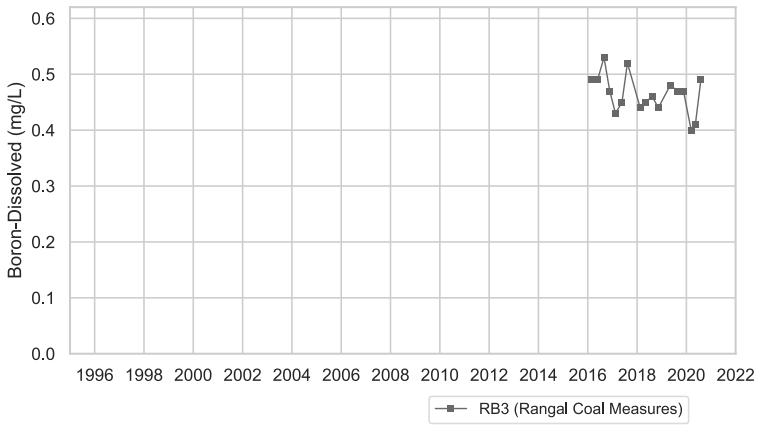

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

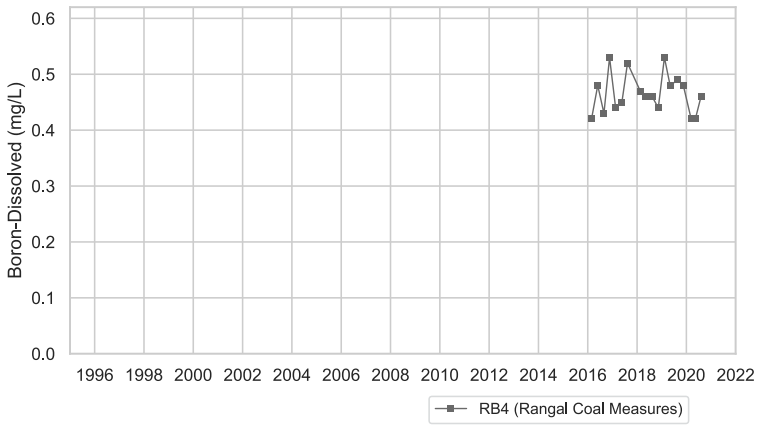

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

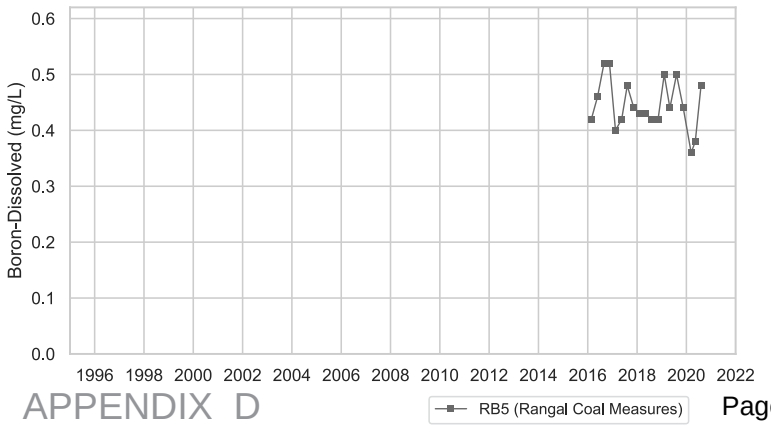

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

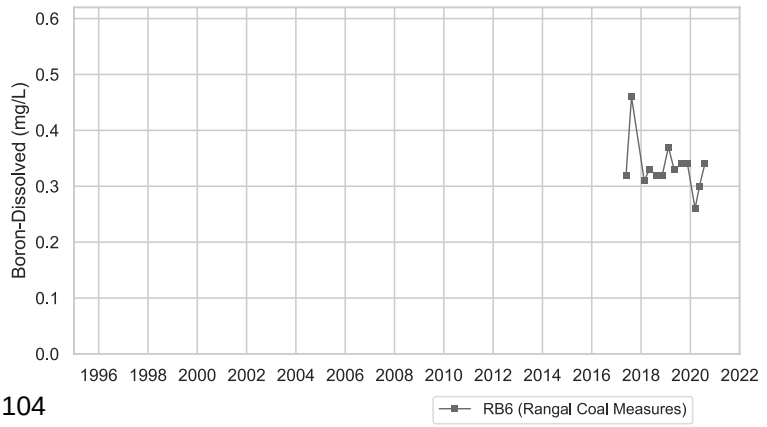

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

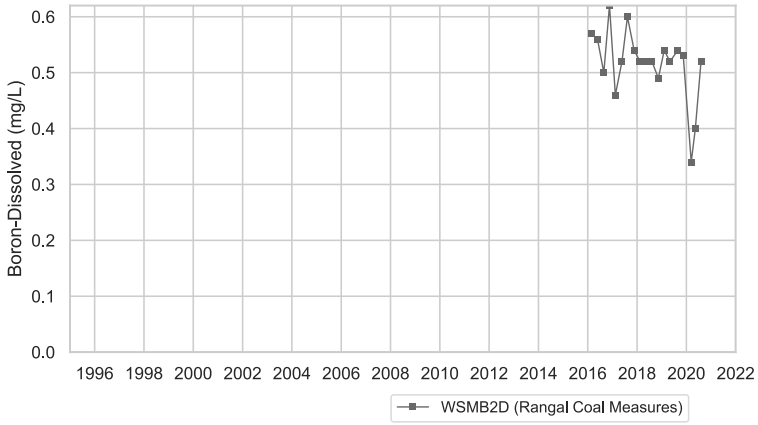

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

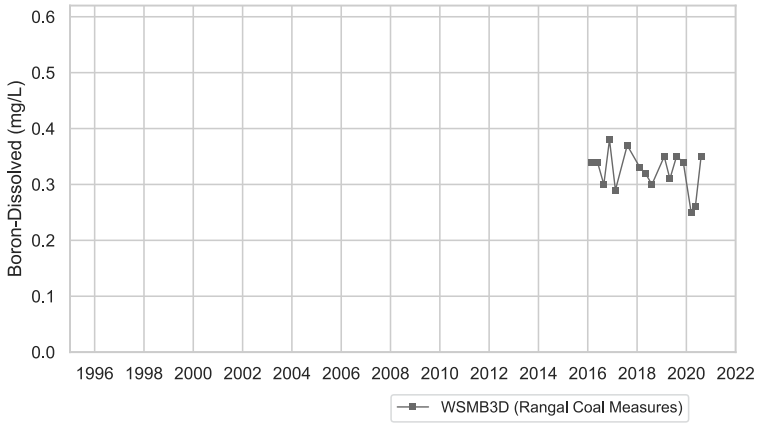

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

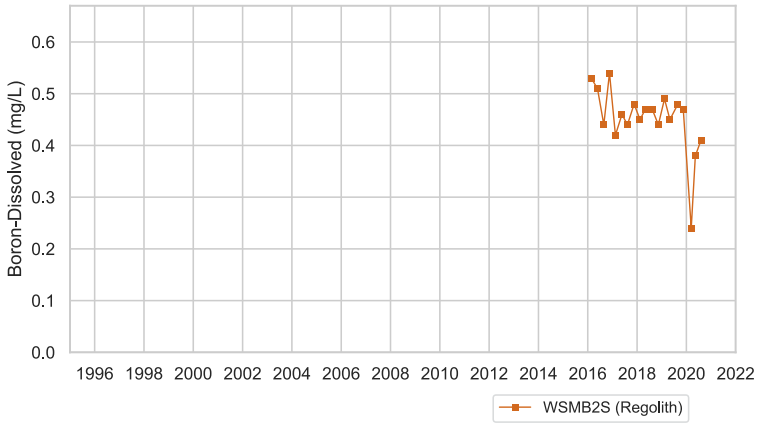

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

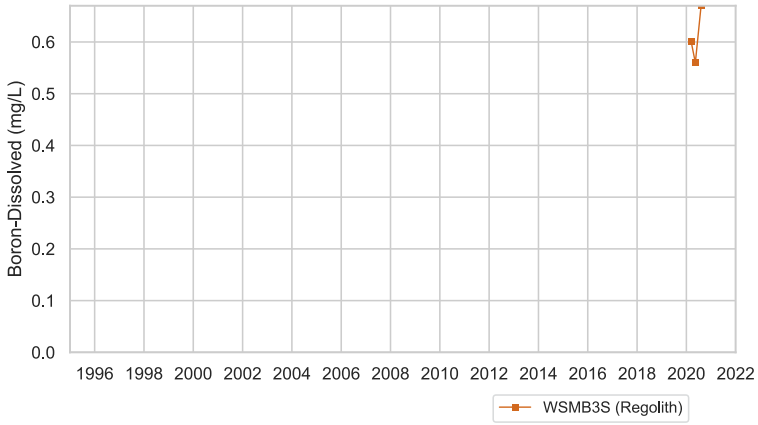

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

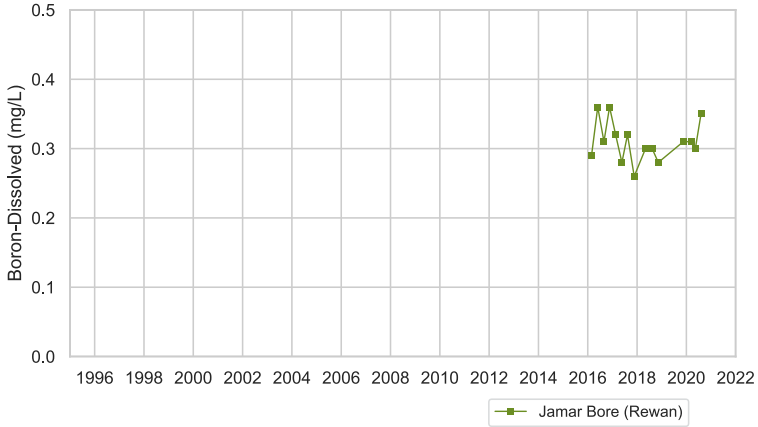

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

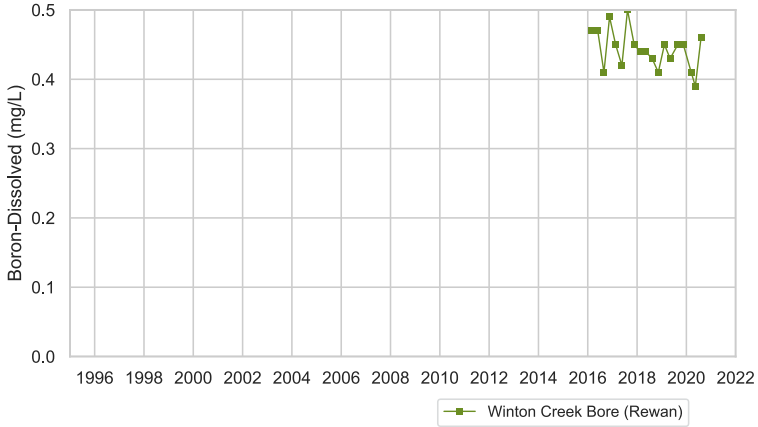

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

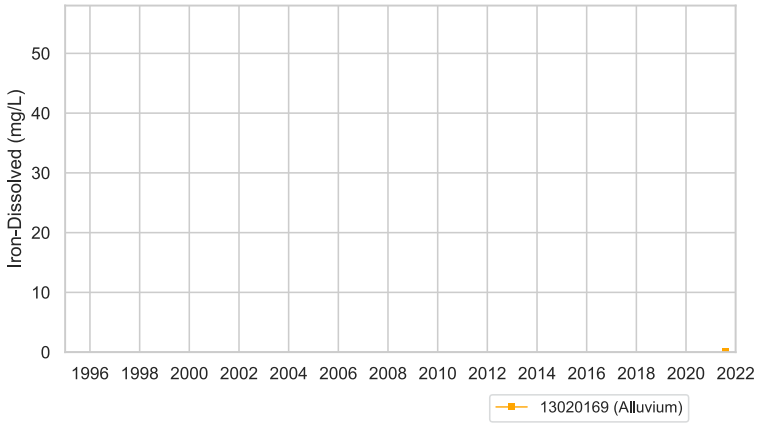

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

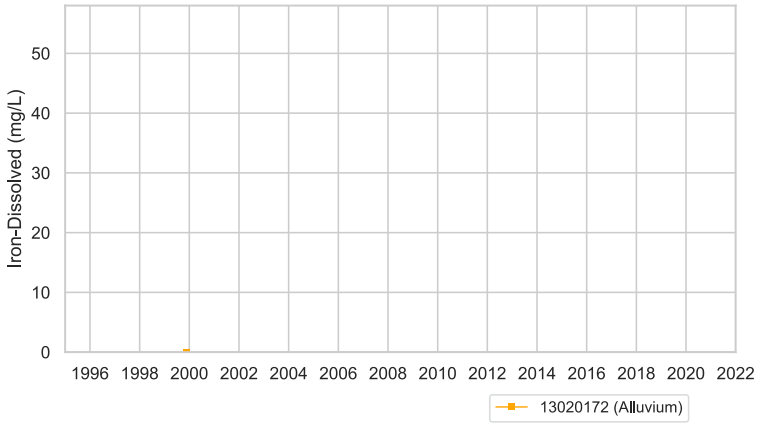

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

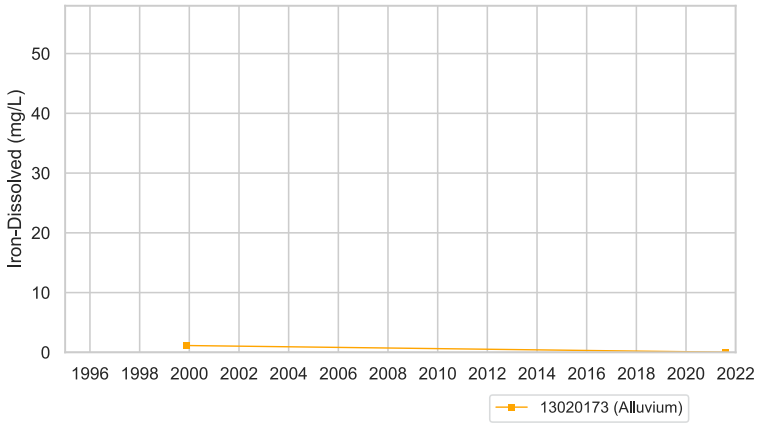

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

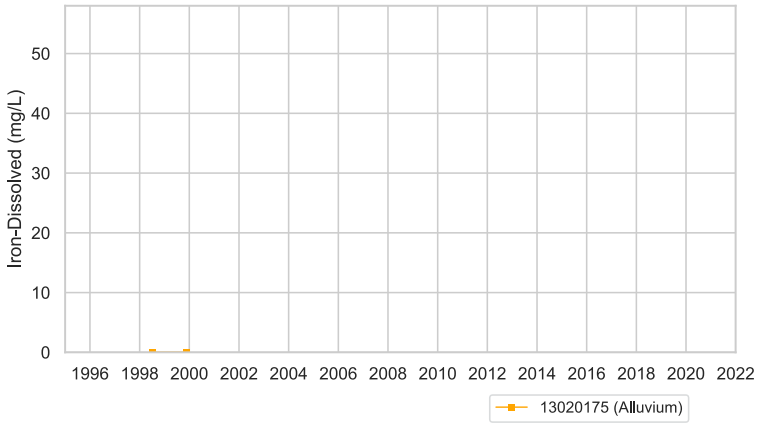

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

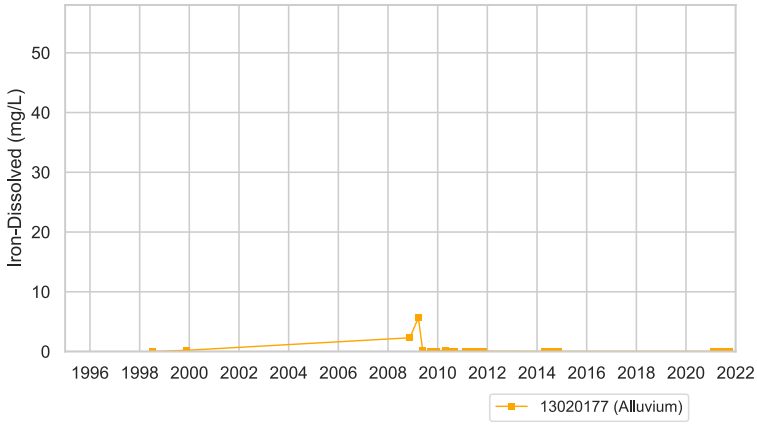

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

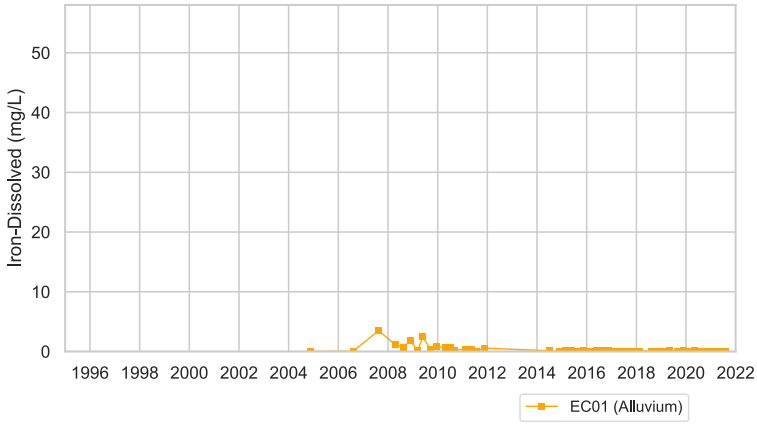

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

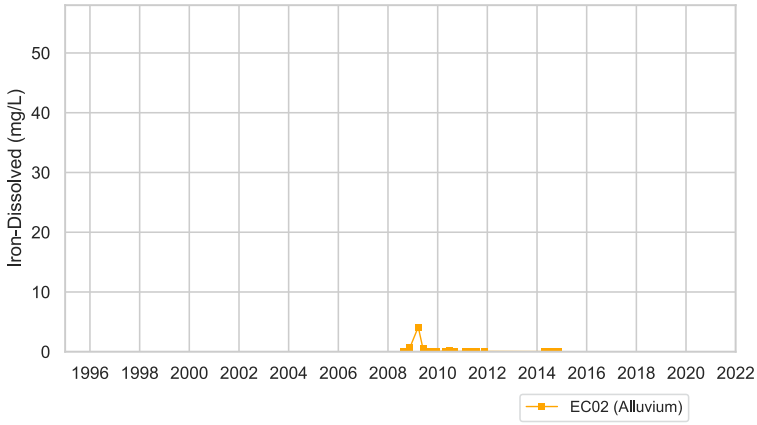

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

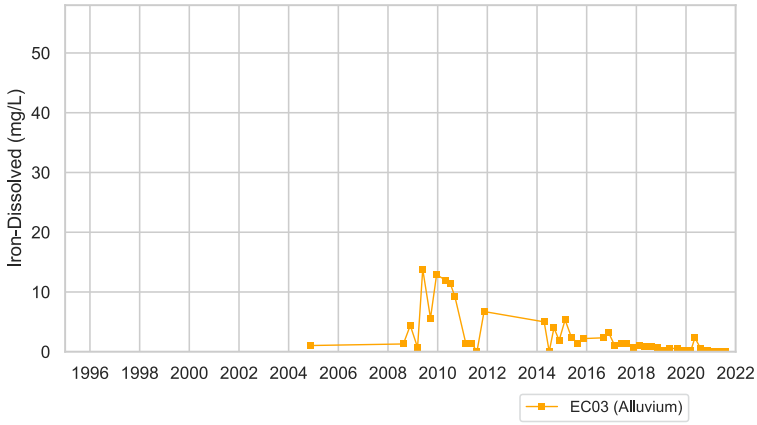

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

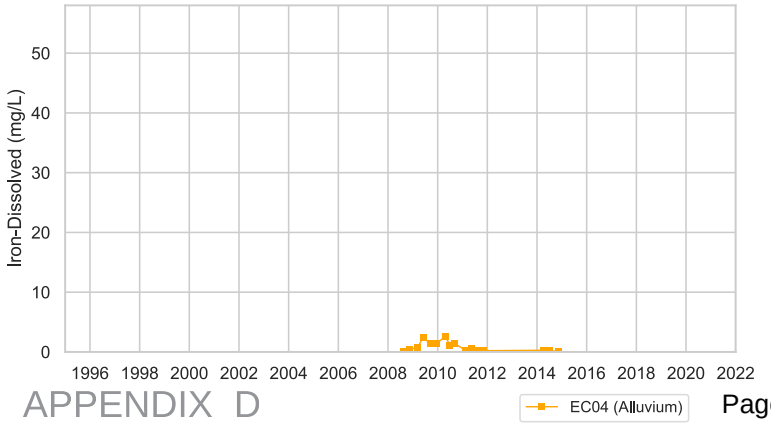

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

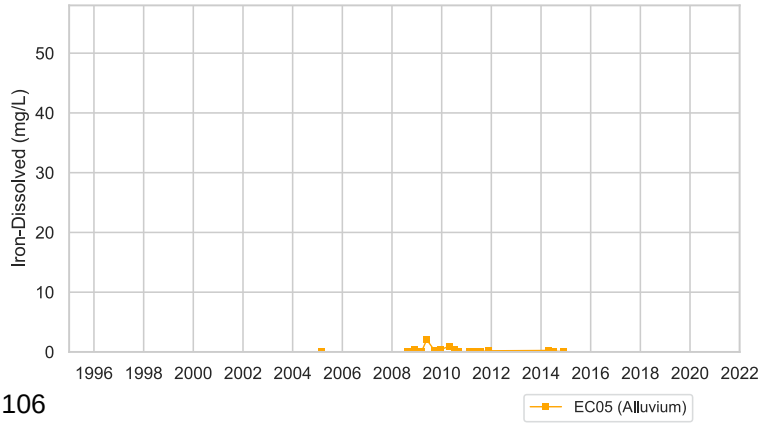

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

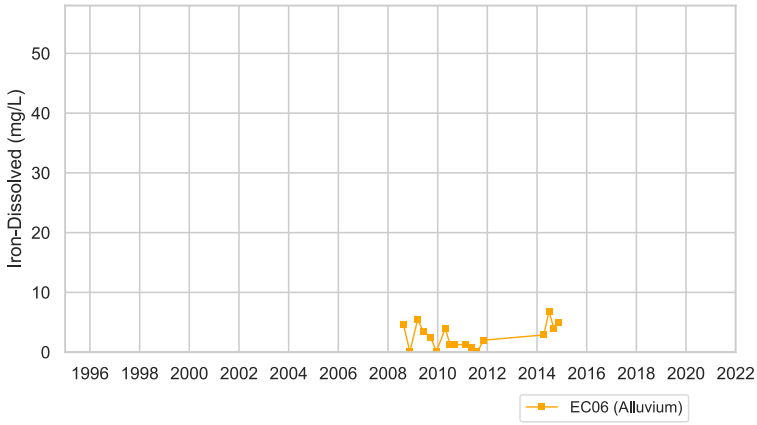

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

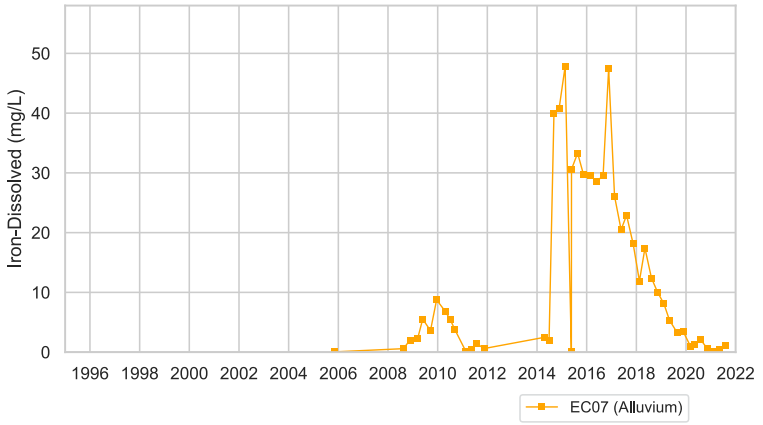

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

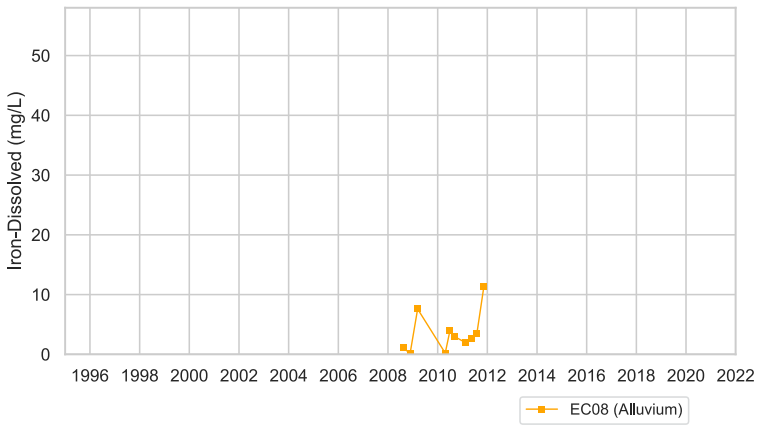

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

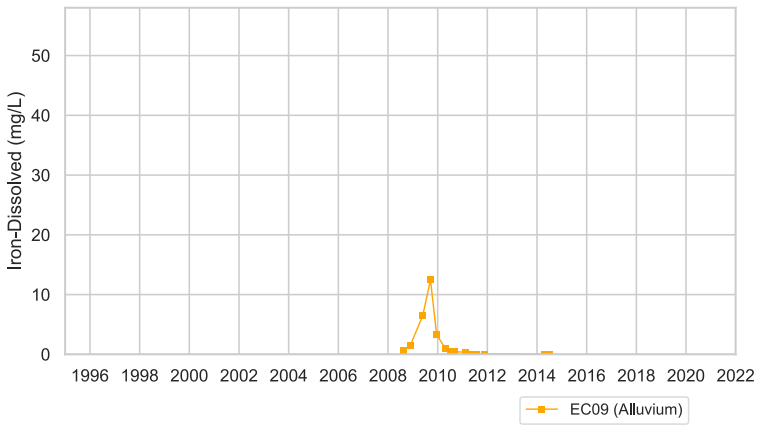

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

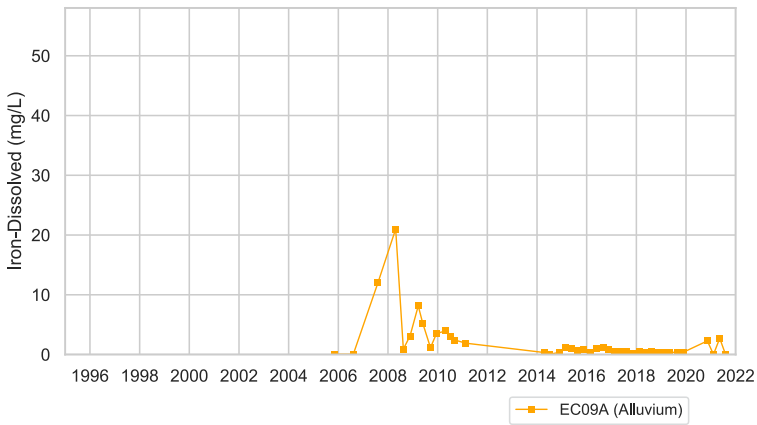

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

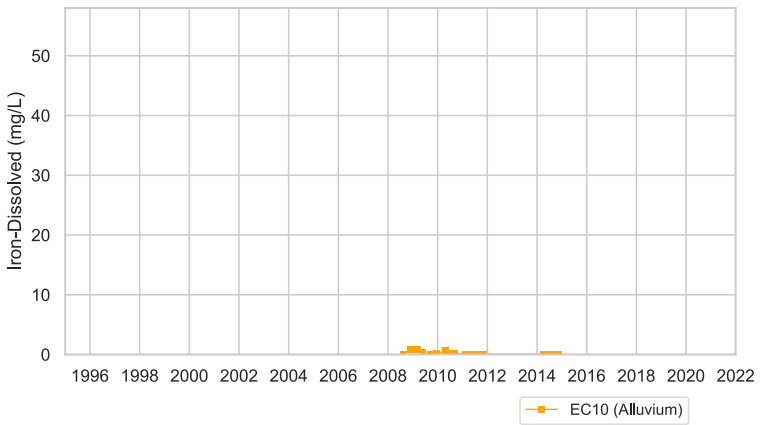

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

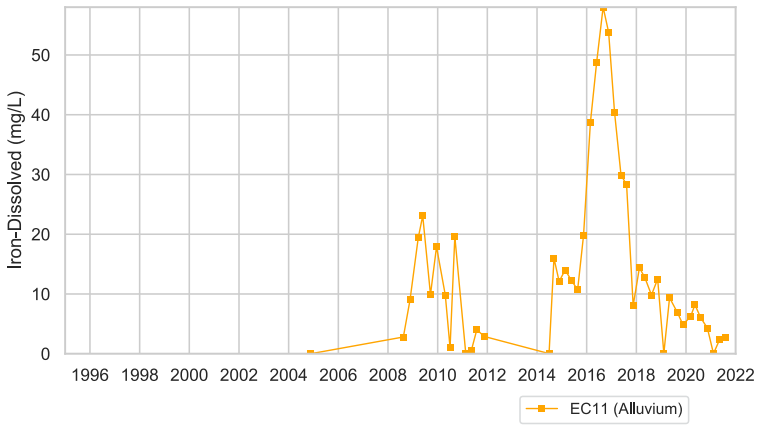

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

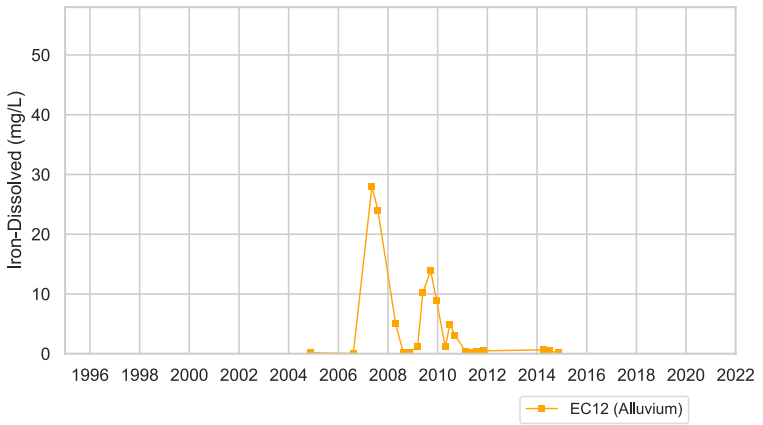

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

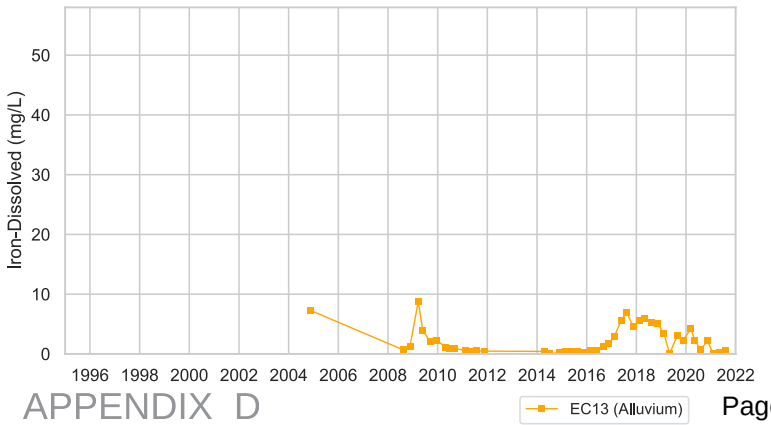

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

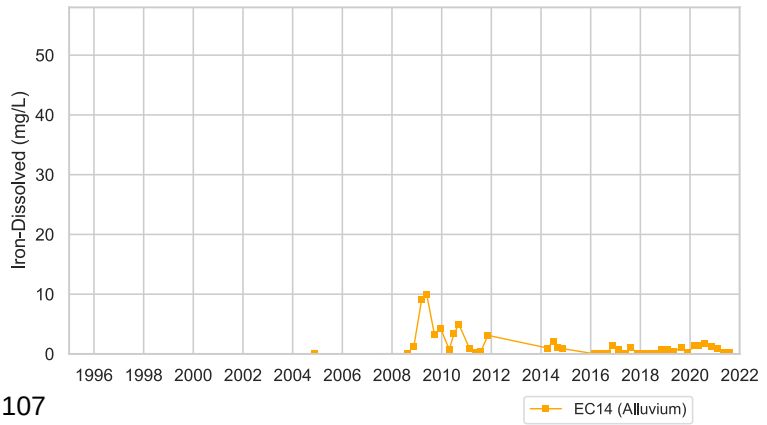

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

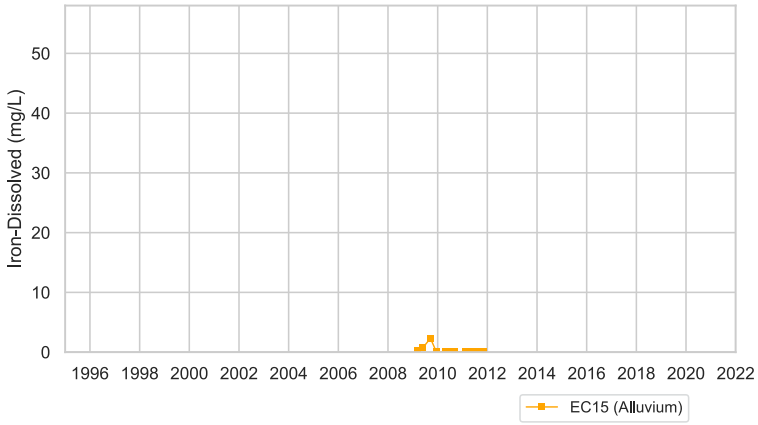

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

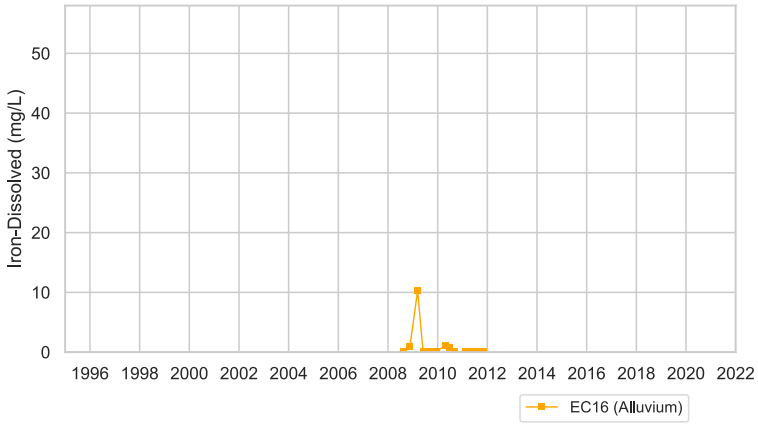

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

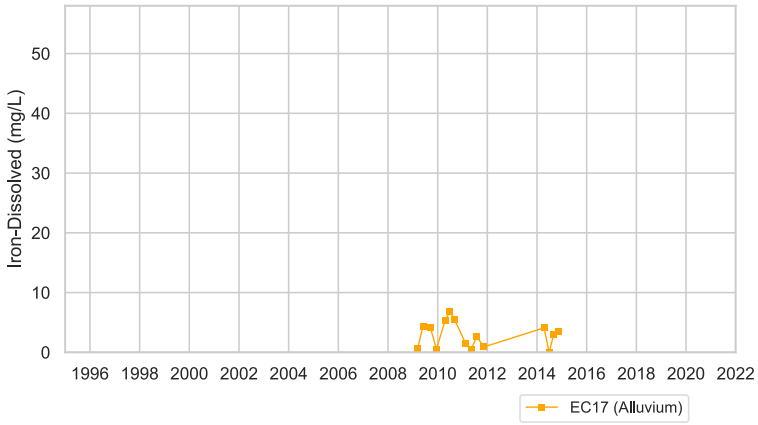

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

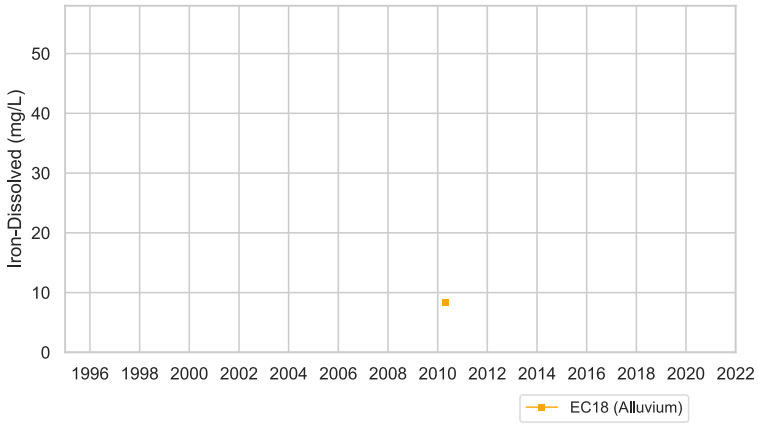

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

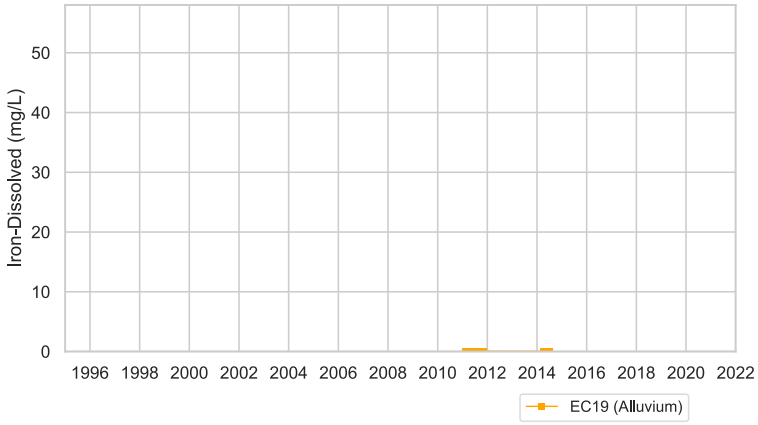

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

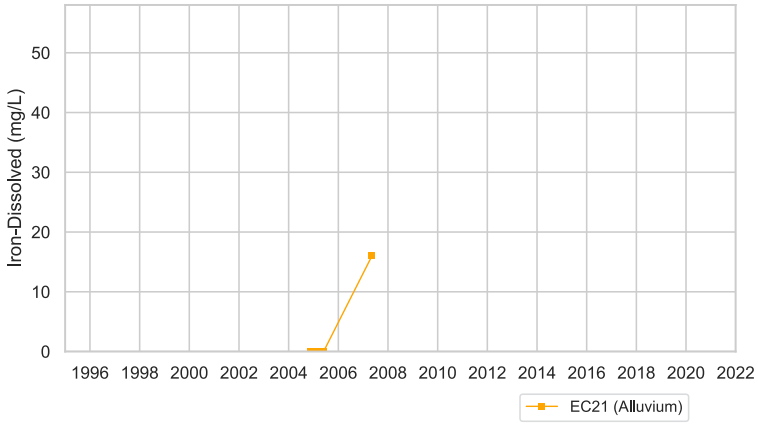

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

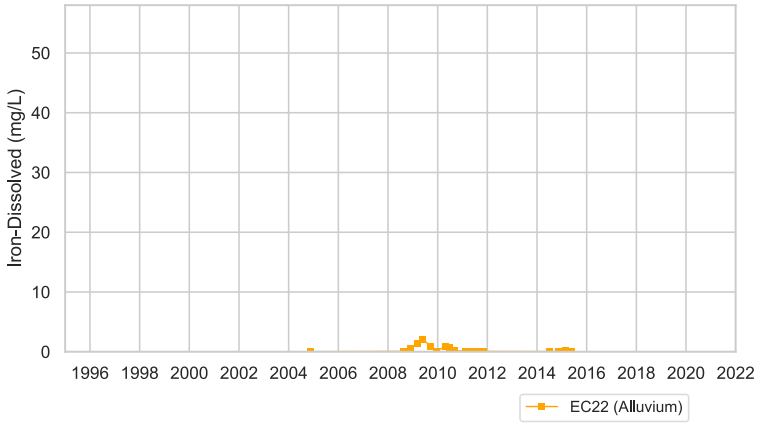

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

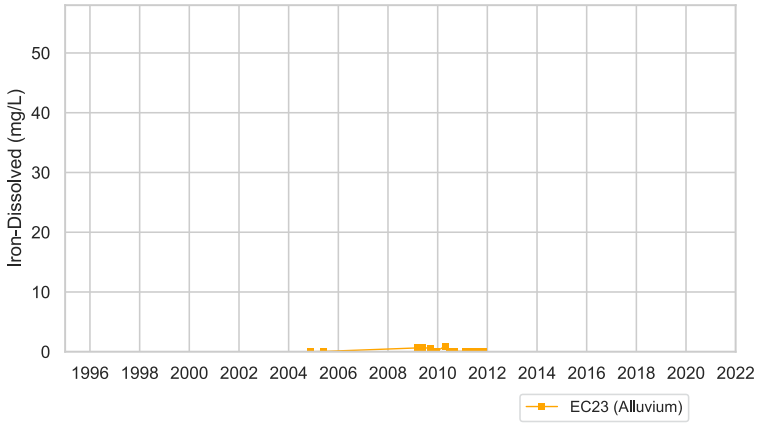

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)


Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

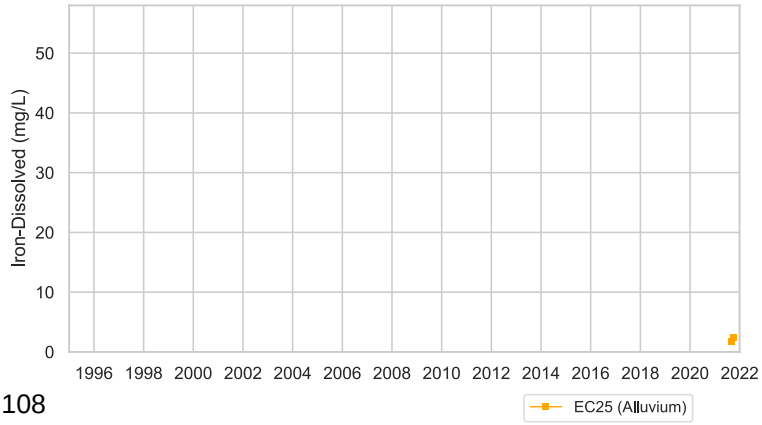

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

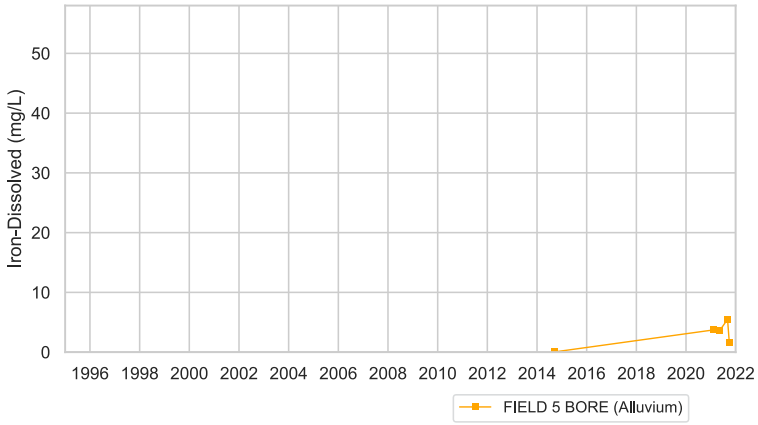

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

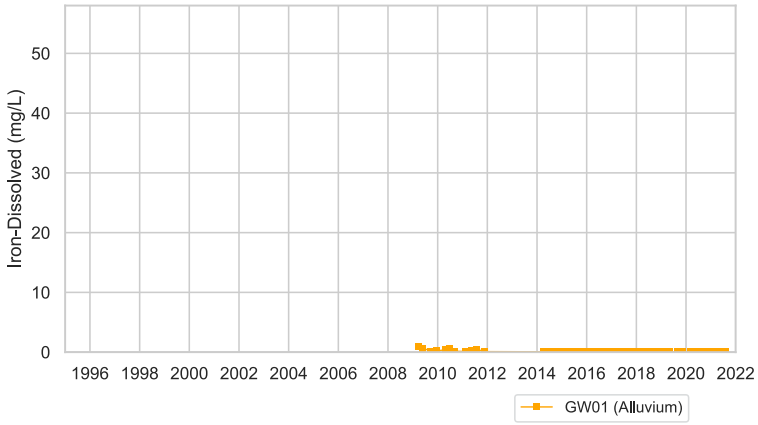

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

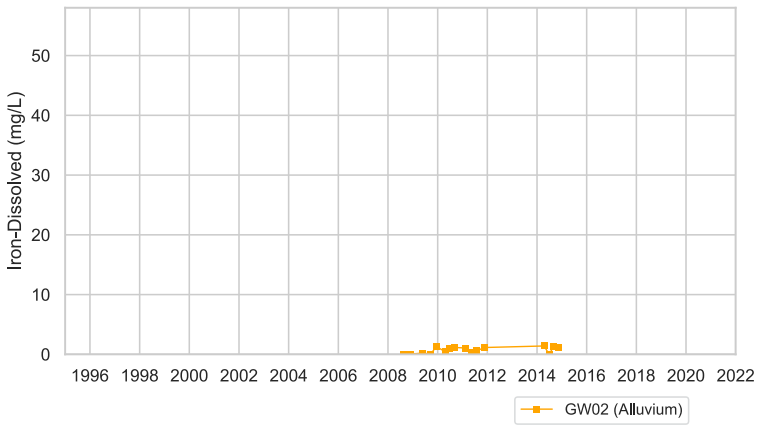

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

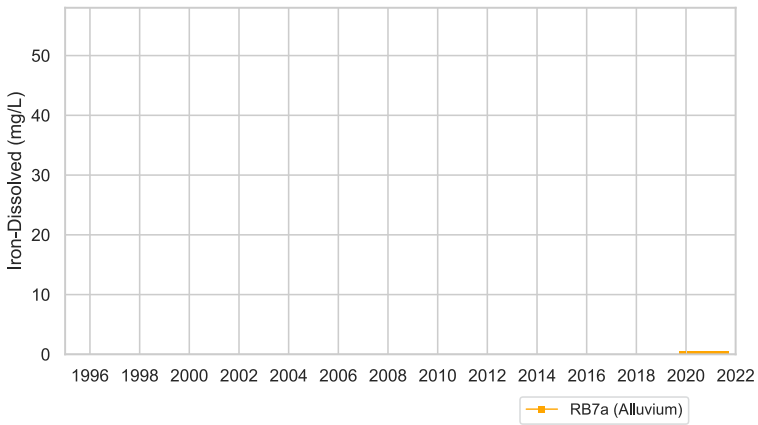
Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

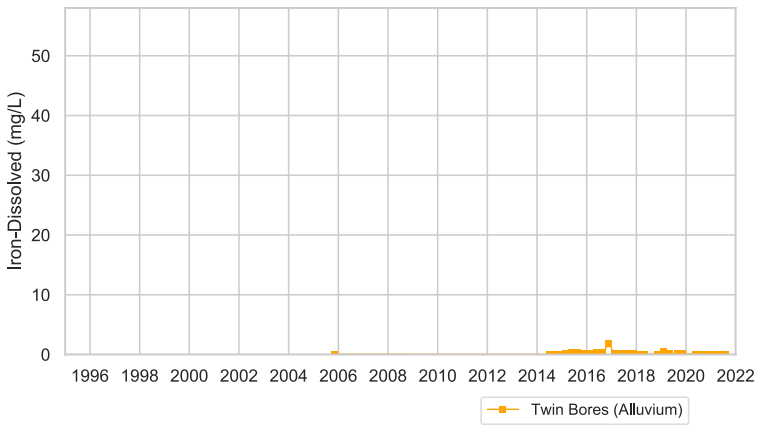

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

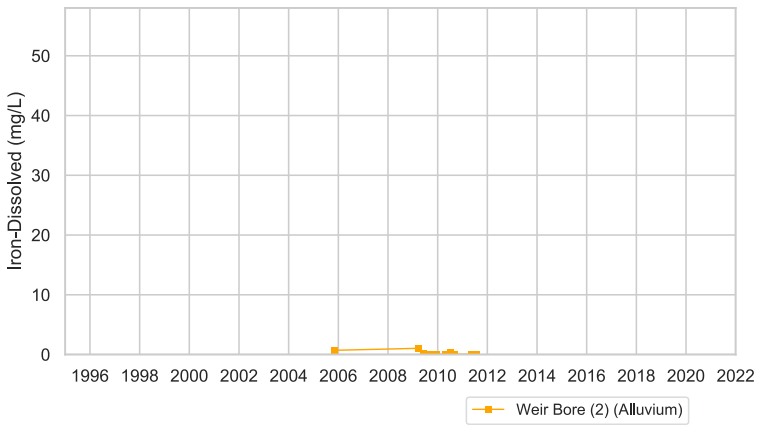

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

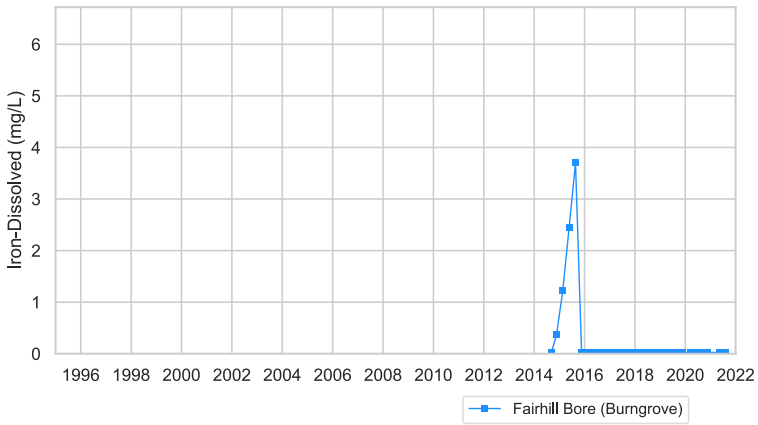

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

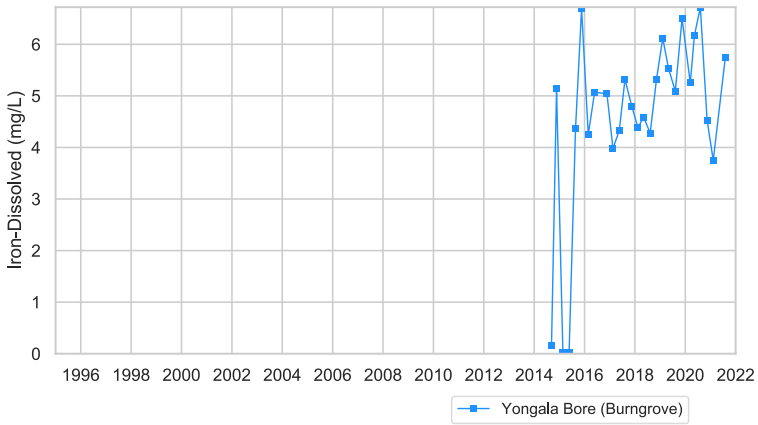

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

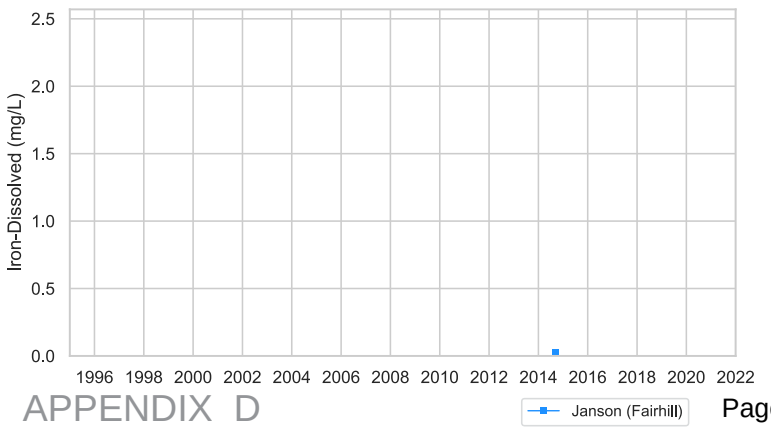

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

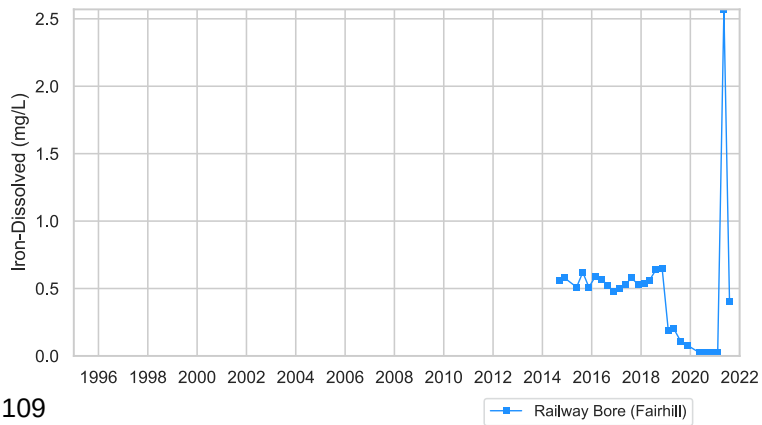

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

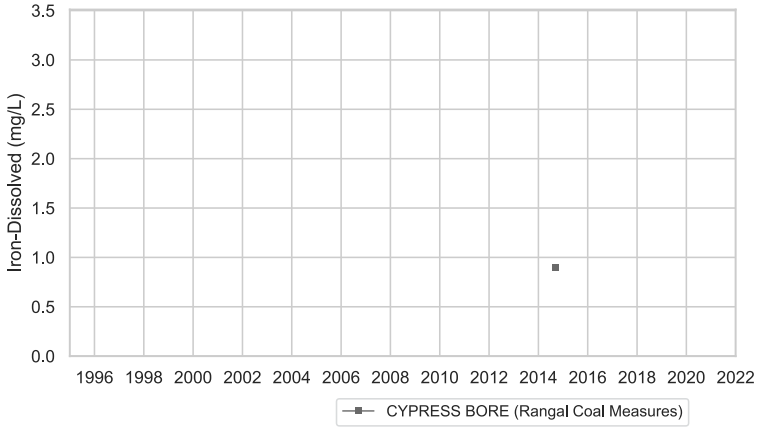

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

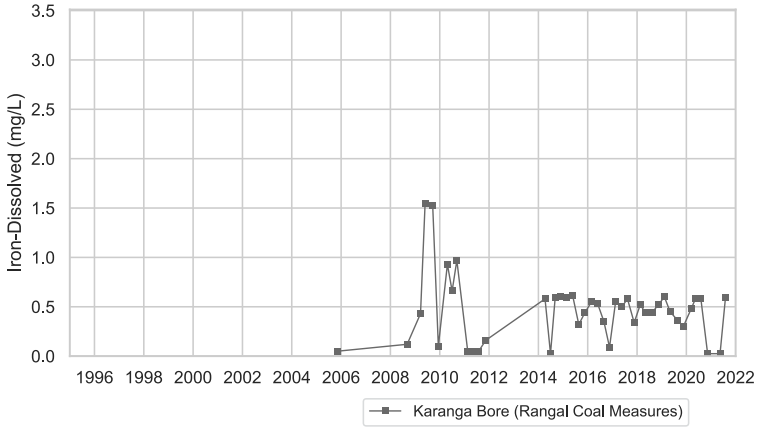

Iron-Dissolved (mg/L)
0
1
2
3
4
5
6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

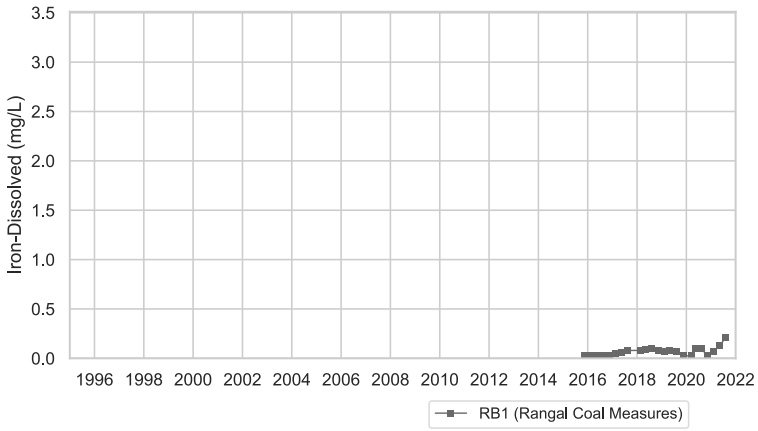

Iron-Dissolved (mg/L)
0
1
2
3
4
5
6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

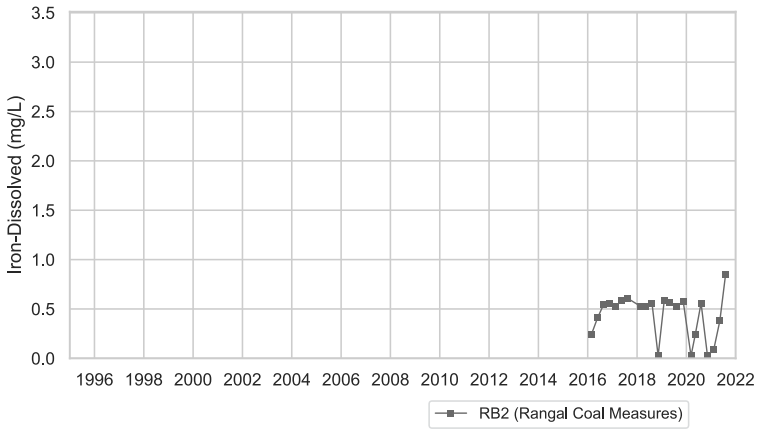

Iron-Dissolved (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

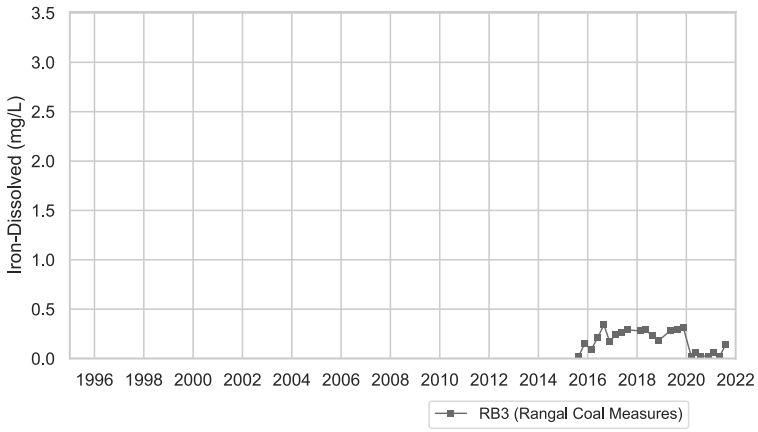

Iron-Dissolved (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

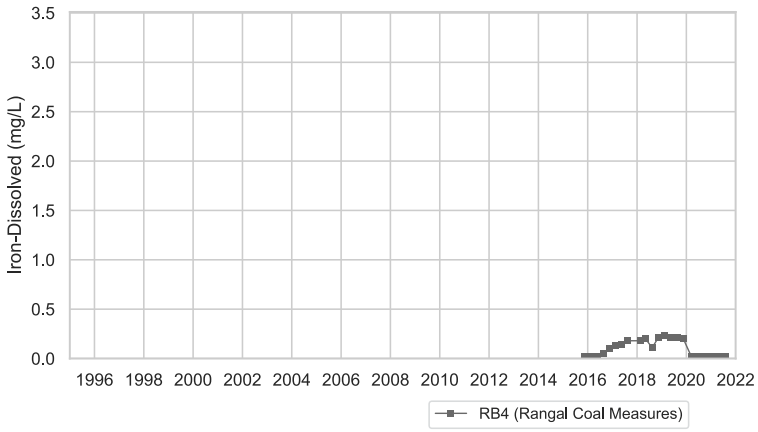

Iron-Dissolved (mg/L)
CYPRESS BORE (Rangal Coal Measures)

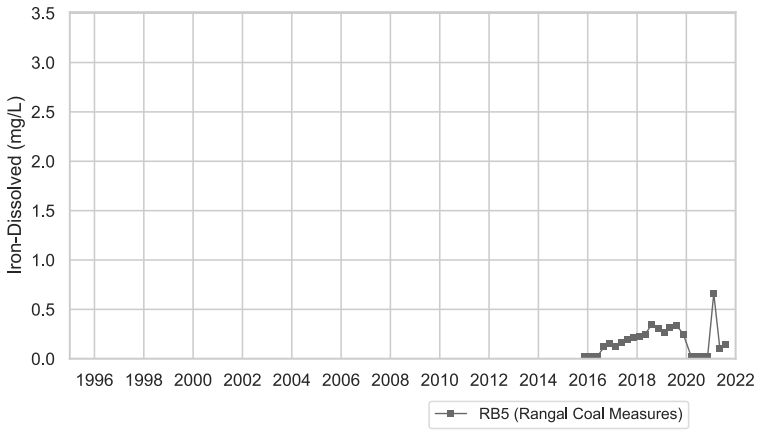

Iron-Dissolved (mg/L)
Karanga Bore (Rangal Coal Measures)

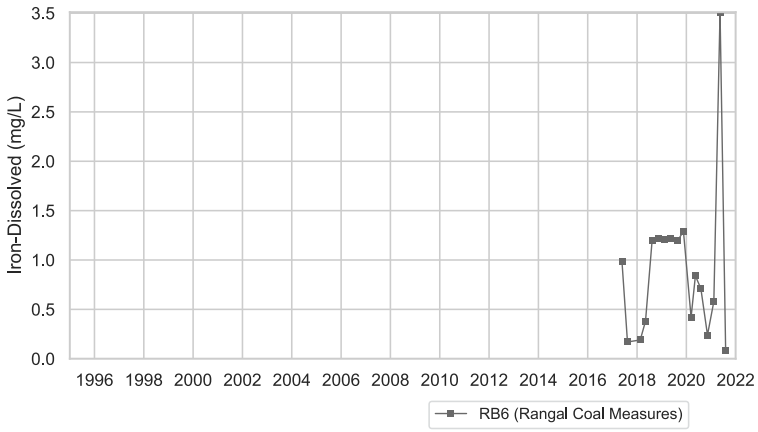

Iron-Dissolved (mg/L)
RB1 (Rangal Coal Measures)

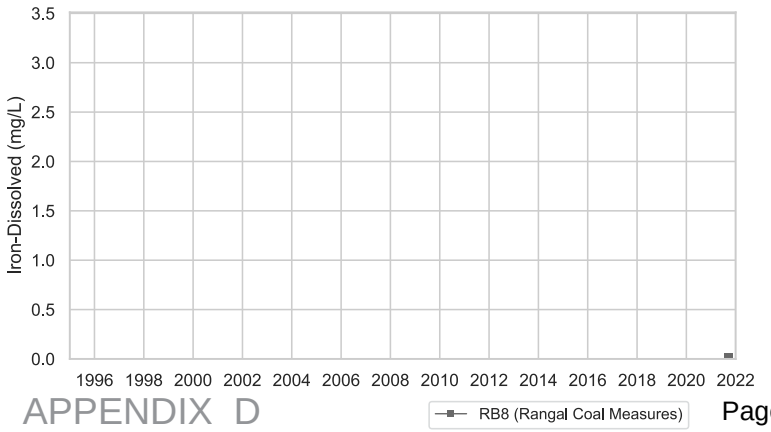

Iron-Dissolved (mg/L)
RB2 (Rangal Coal Measures)

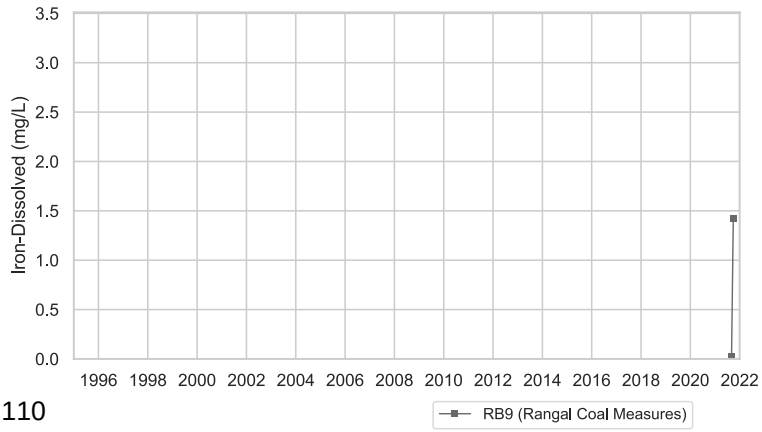

Iron-Dissolved (mg/L)
RB3 (Rangal Coal Measures)

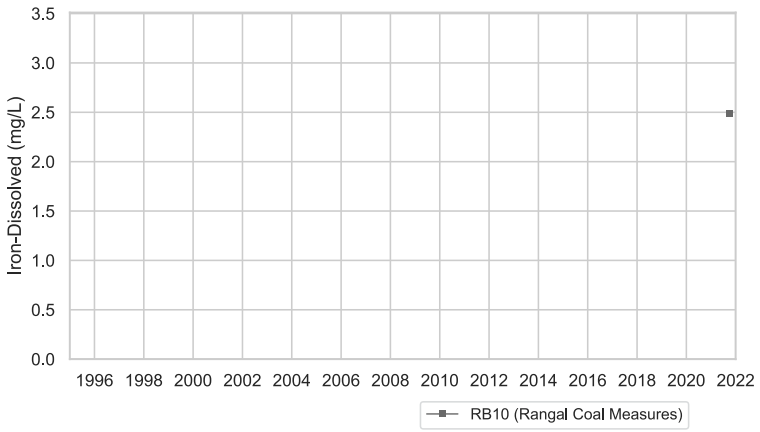

Iron-Dissolved (mg/L)
RB4 (Rangal Coal Measures)

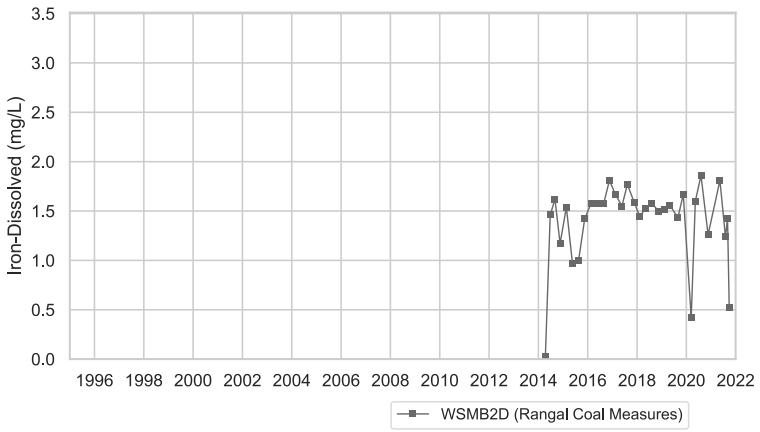

Iron-Dissolved (mg/L)
RB5 (Rangal Coal Measures)

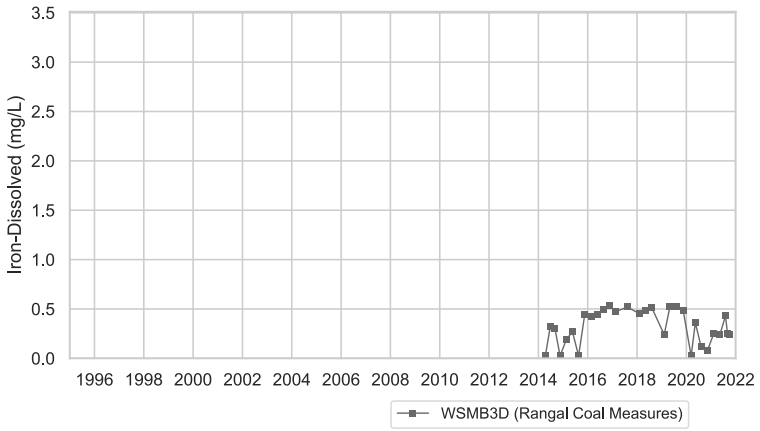

Iron-Dissolved (mg/L)
RB6 (Rangal Coal Measures)

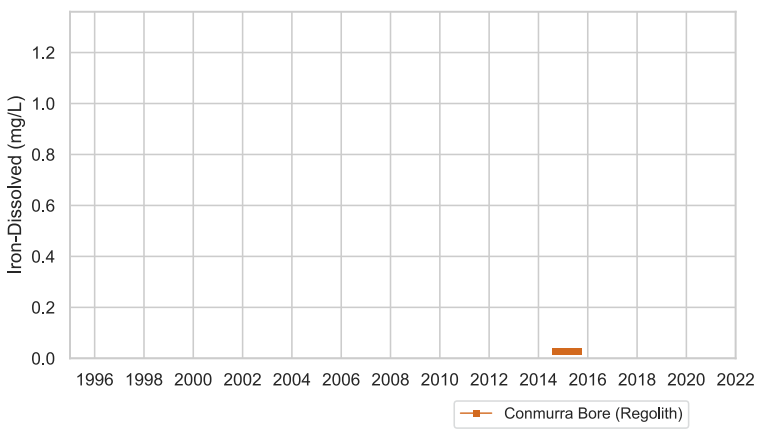

Iron-Dissolved (mg/L)
RB8 (Rangal Coal Measures)

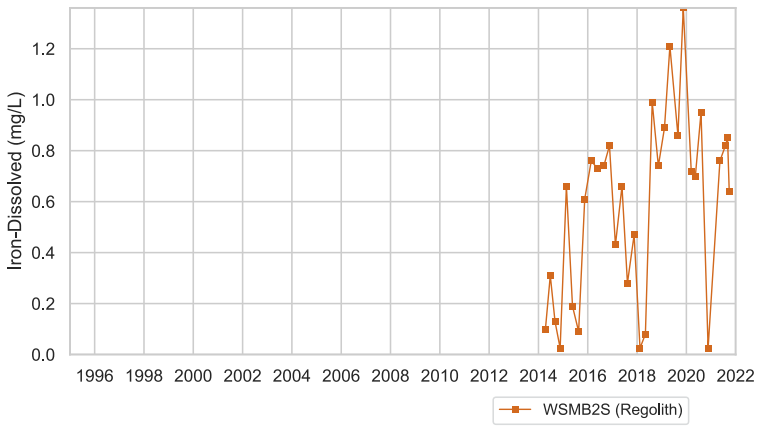

Iron-Dissolved (mg/L)
RB9 (Rangal Coal Measures)

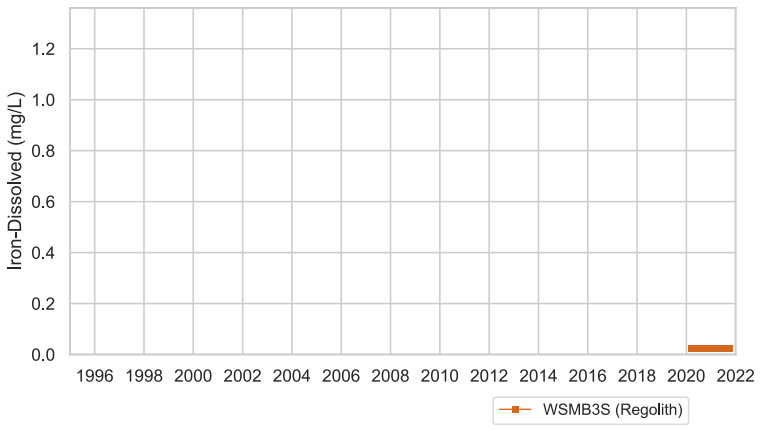

Iron-Dissolved (mg/L)
RB10 (Rangal Coal Measures)

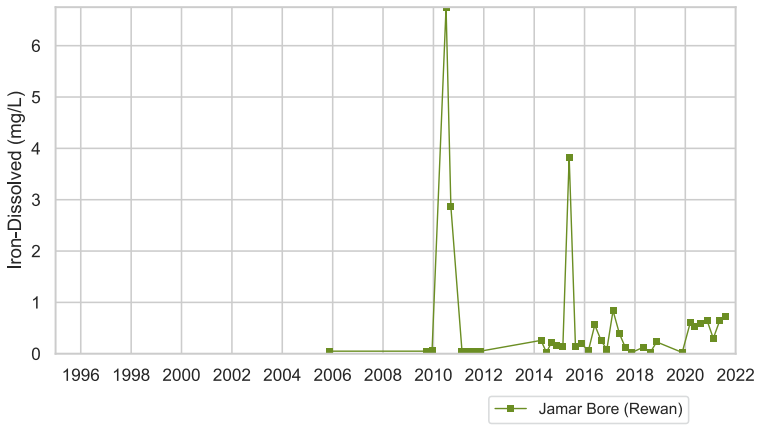

Iron-Dissolved (mg/L)
WSMB2D (Rangal Coal Measures)

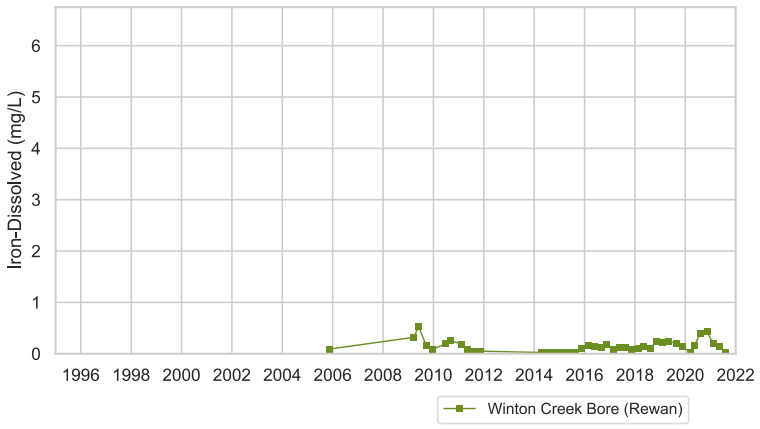

Iron-Dissolved (mg/L)
WSMB3D (Rangal Coal Measures)

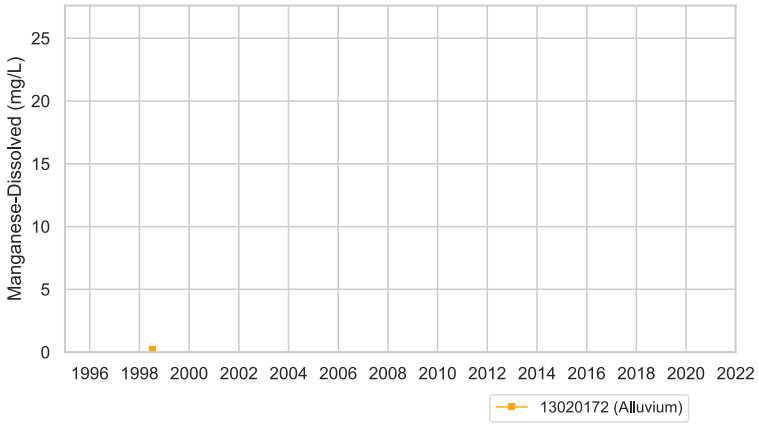

Iron-Dissolved (mg/L)
Conmurra Bore (Regolith)

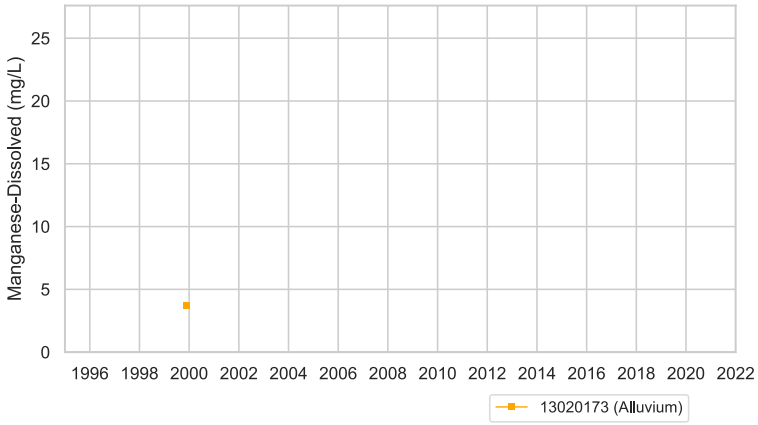

Iron-Dissolved (mg/L)
WSMB2S (Regolith)

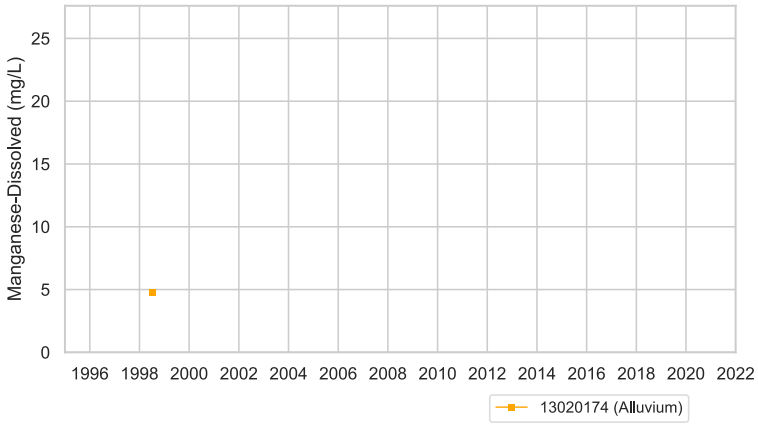

Iron-Dissolved (mg/L)
WSMB3S (Regolith)

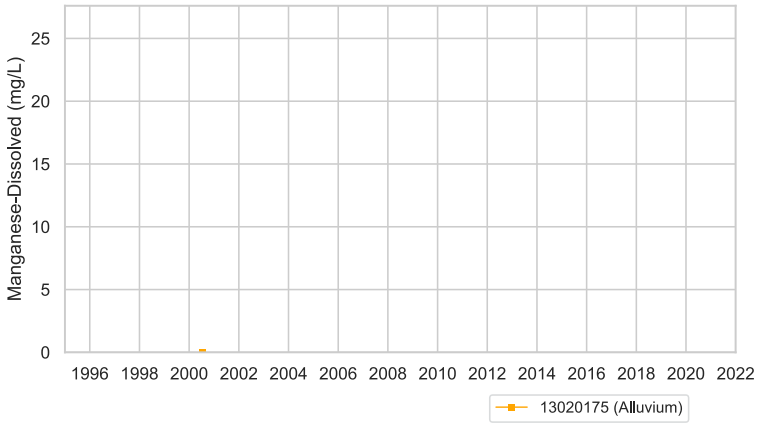

Iron-Dissolved (mg/L)
Jamar Bore (Rewan)

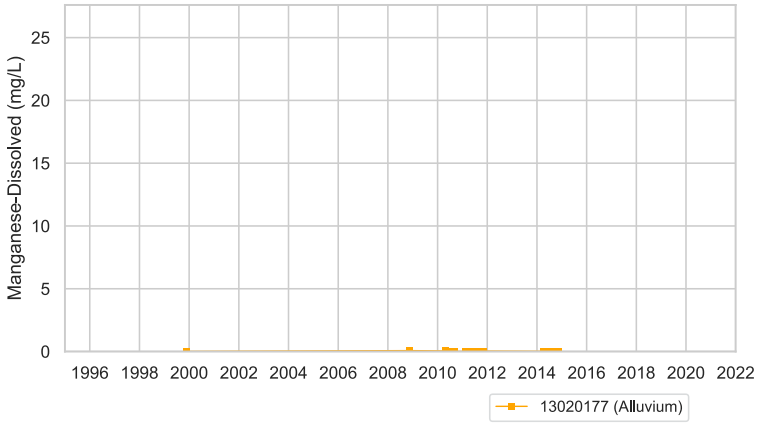

Iron-Dissolved (mg/L)
Winton Creek Bore (Rewan)

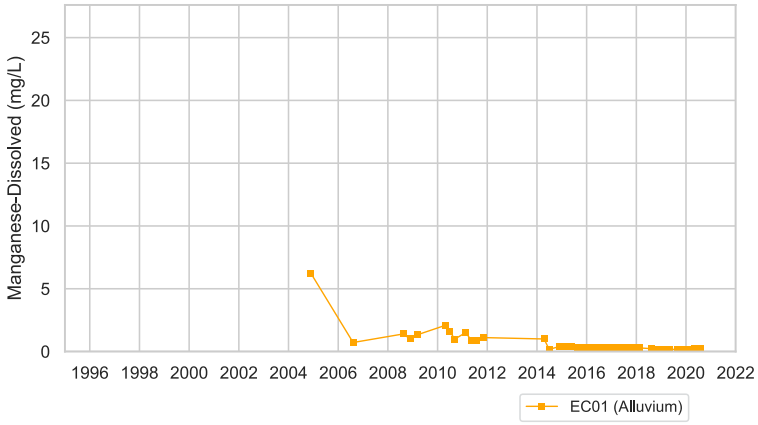

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

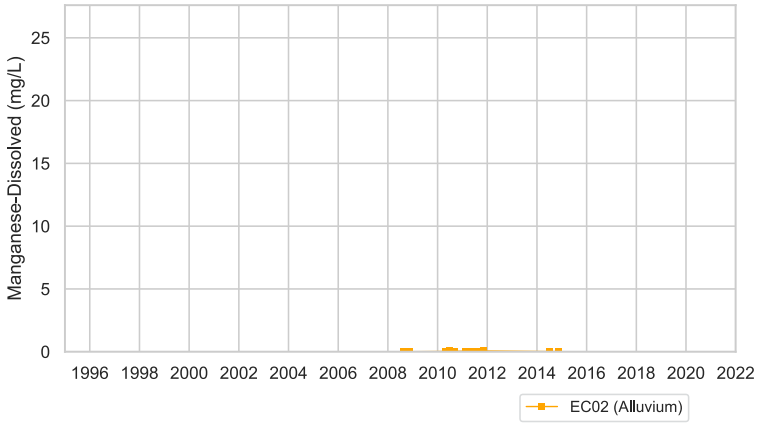

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

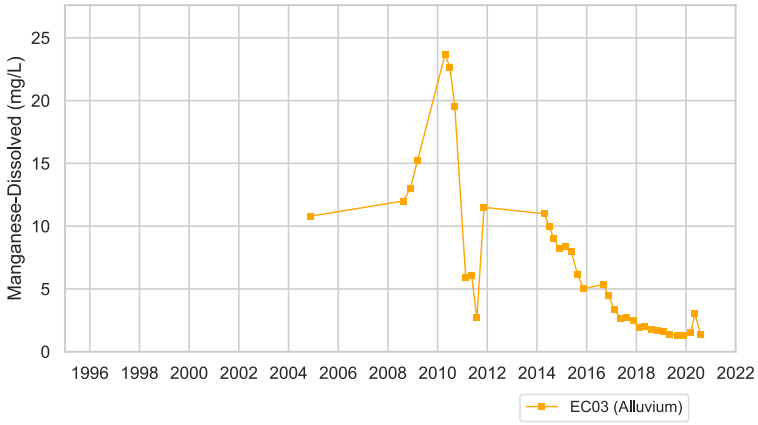

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

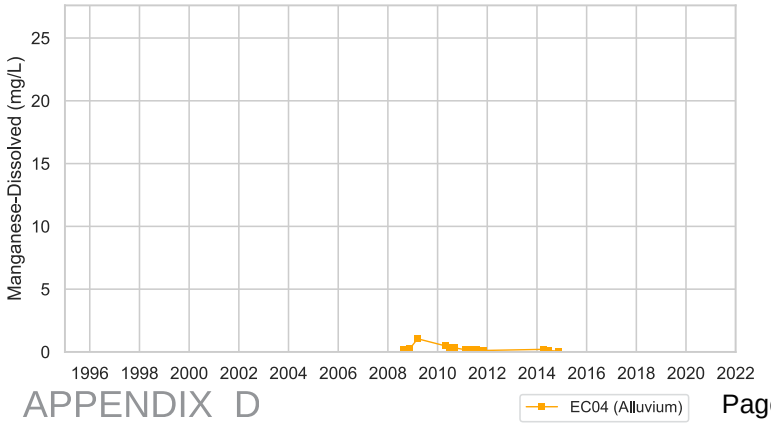

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

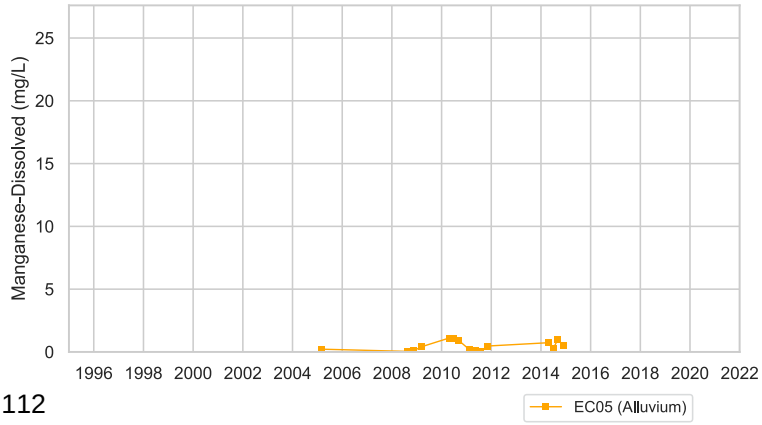

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

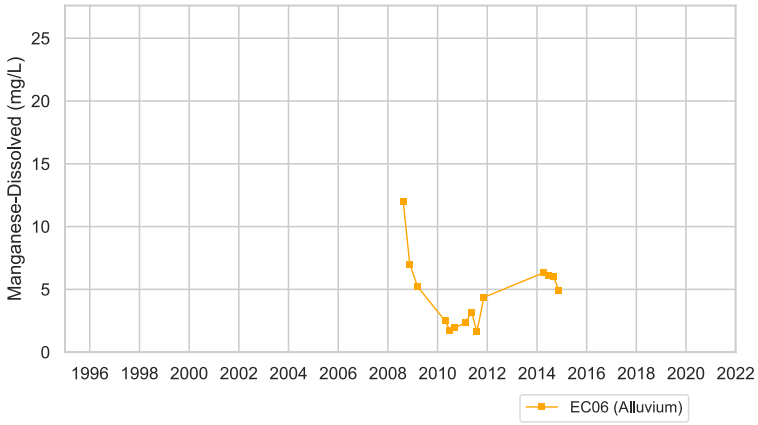

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

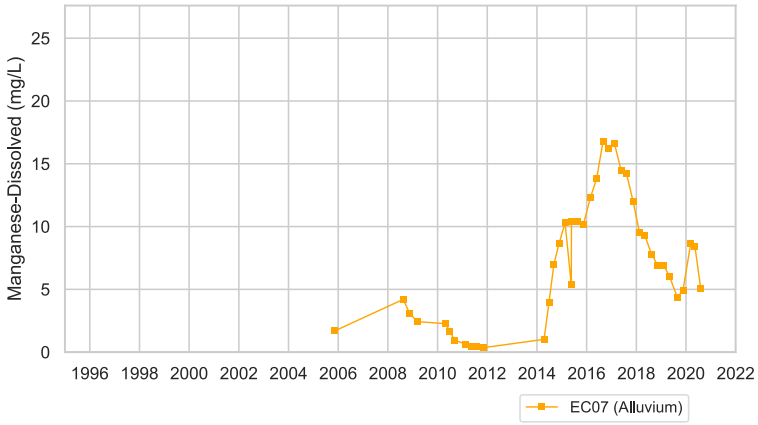

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

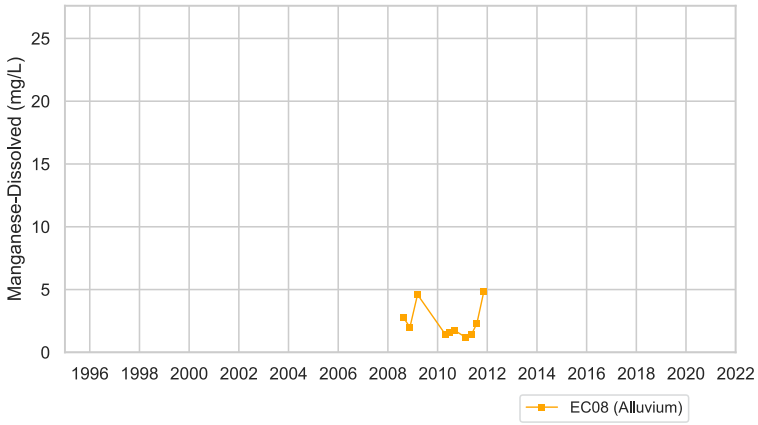

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

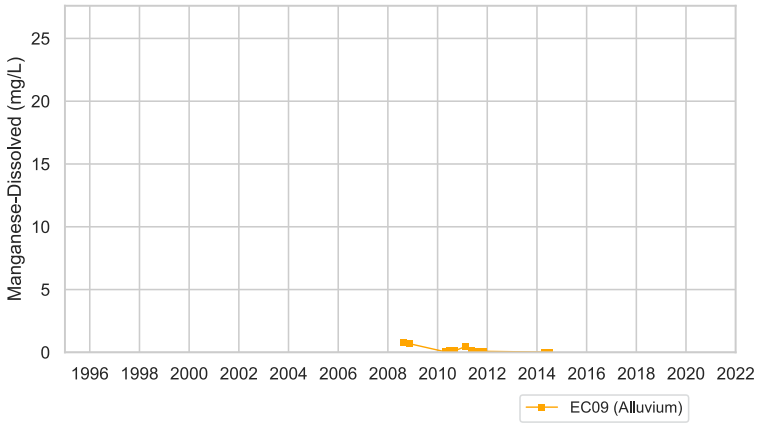

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

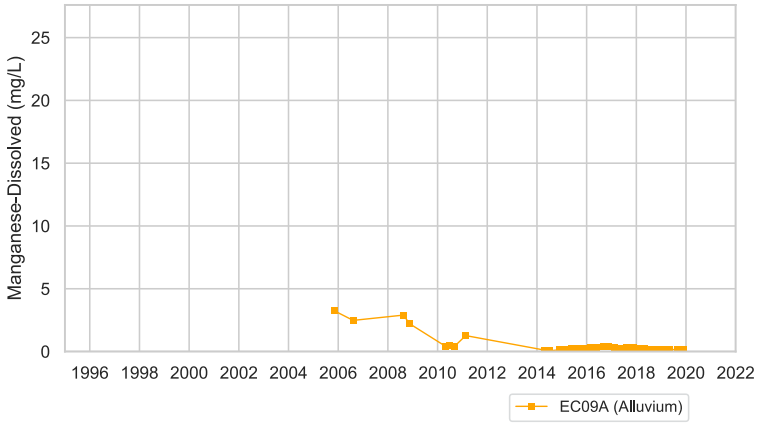

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

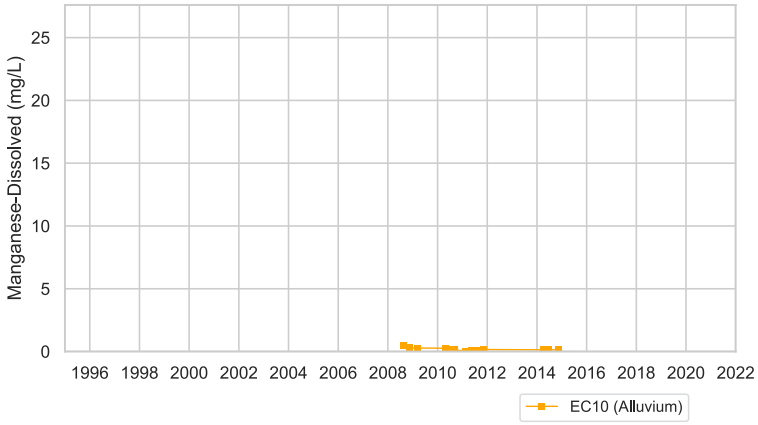

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

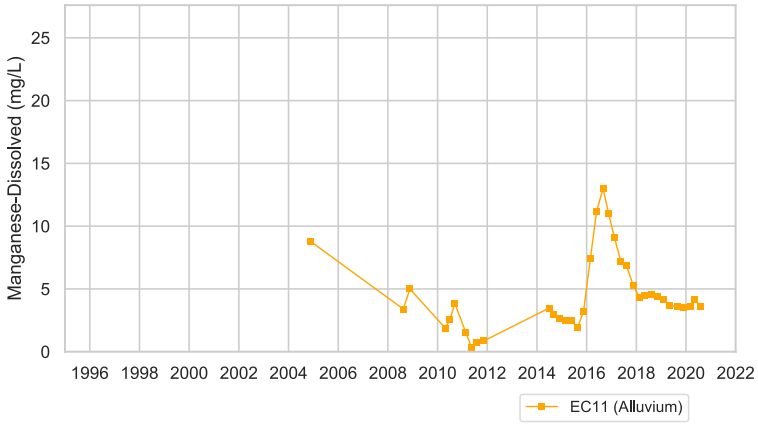

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

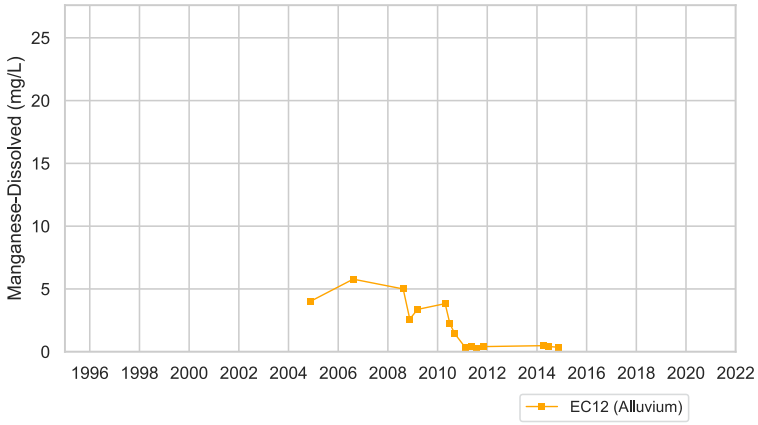

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

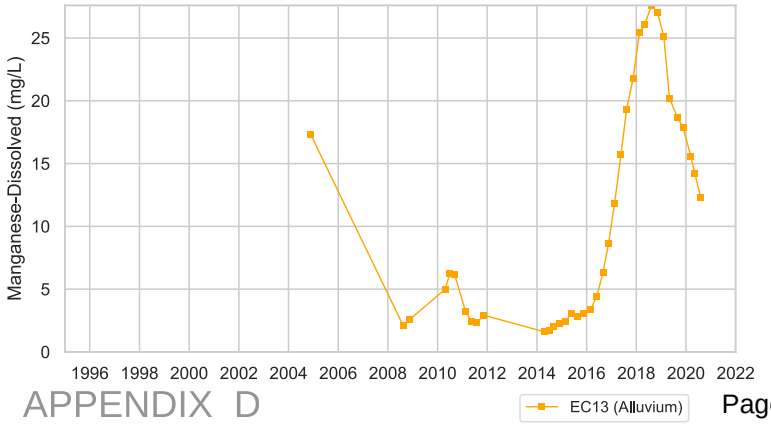

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

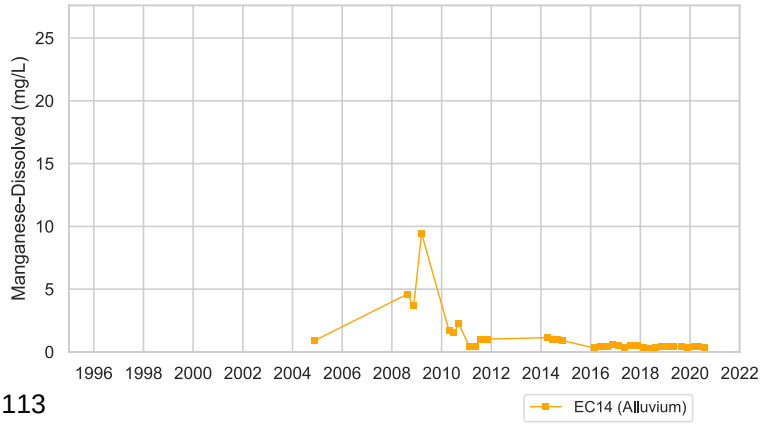

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

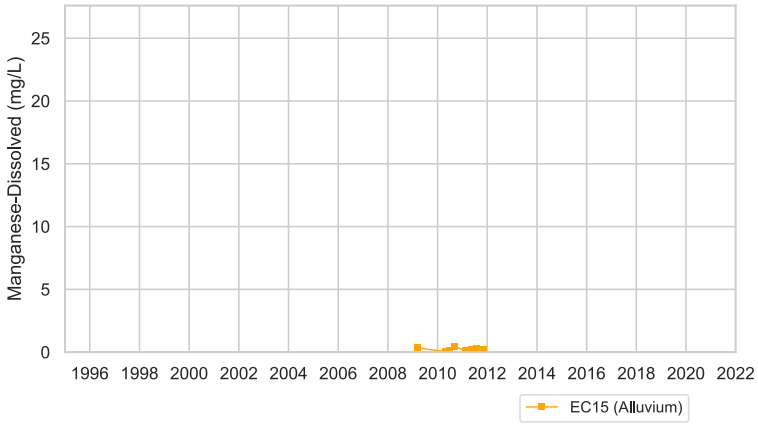

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

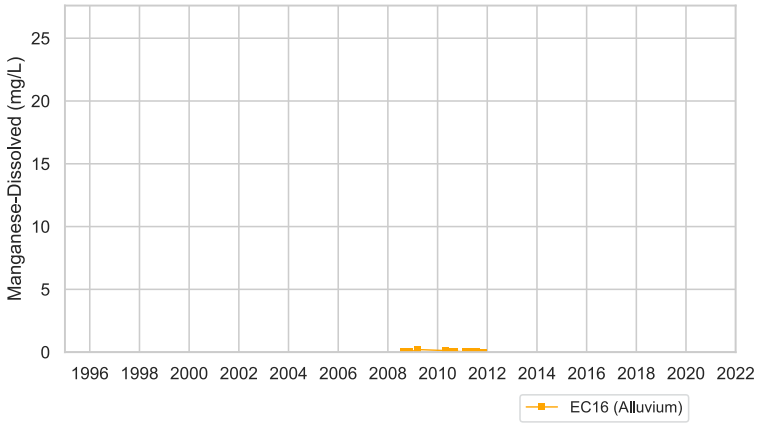

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

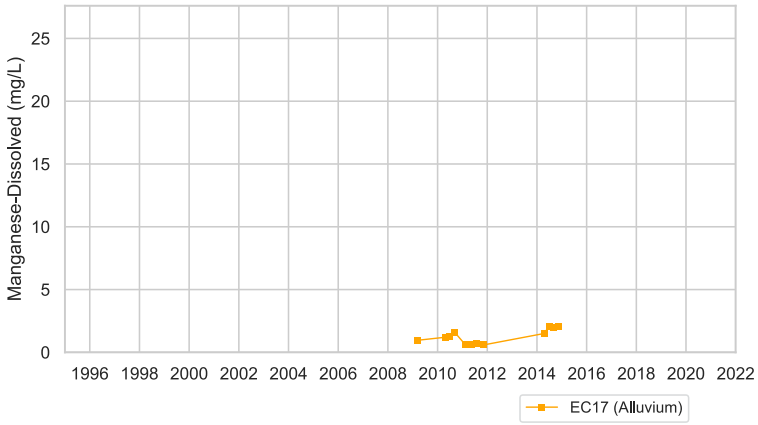

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

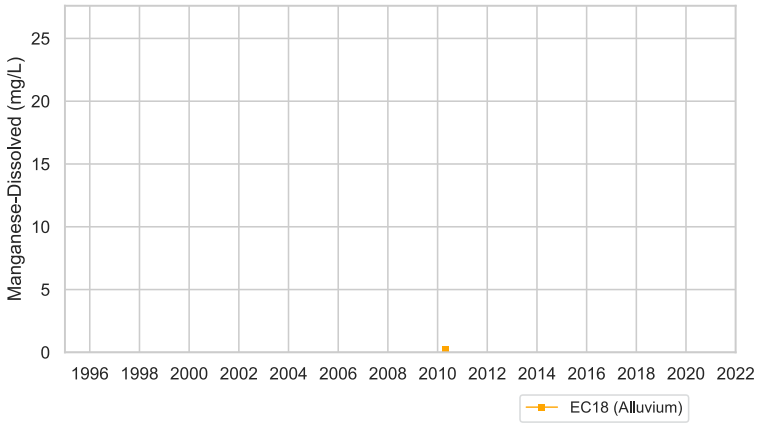

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

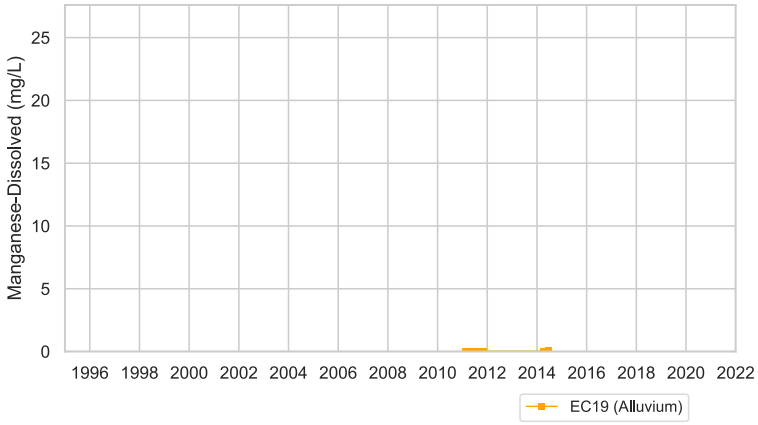

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

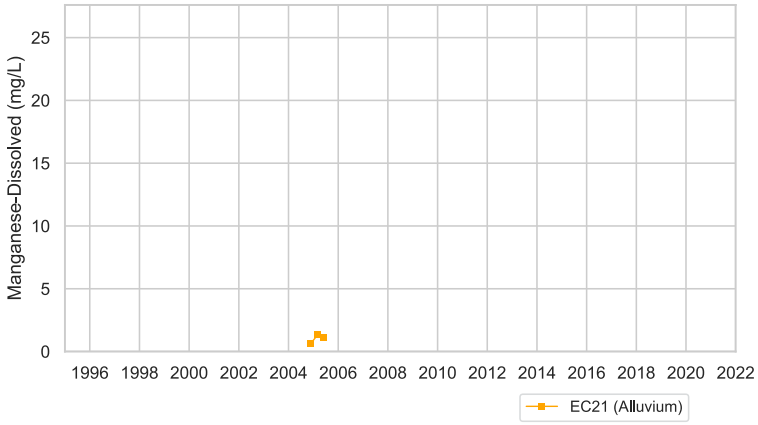

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

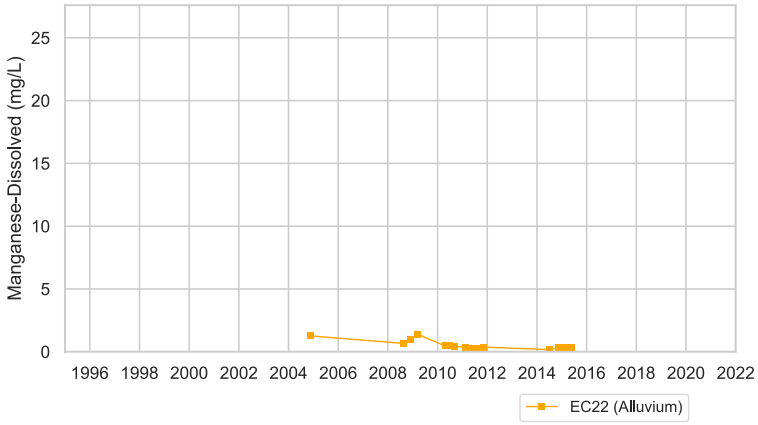

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

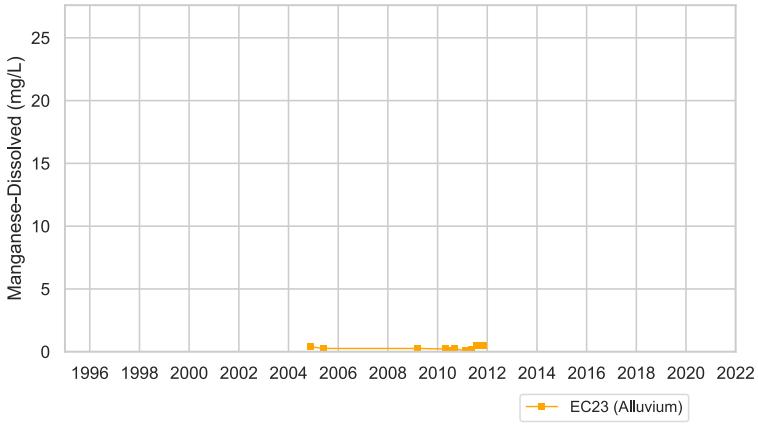

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

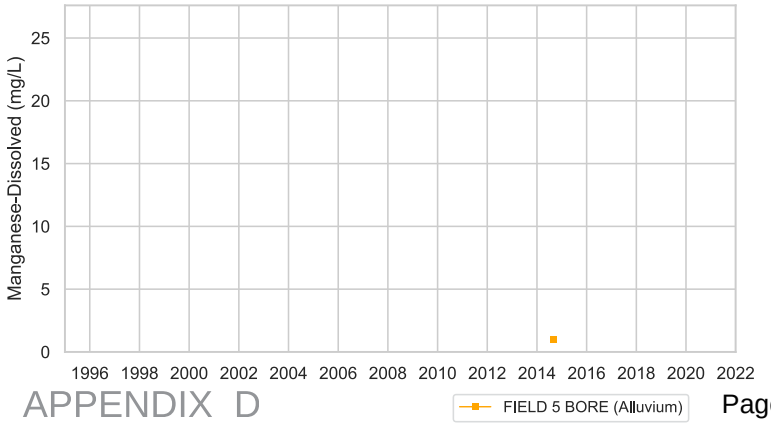

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

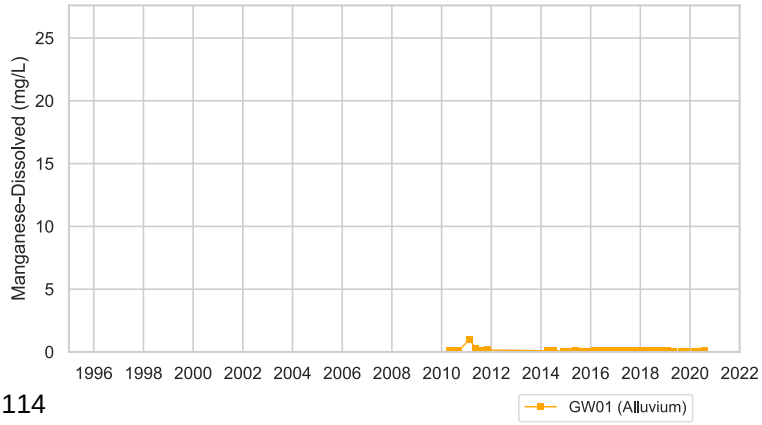

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

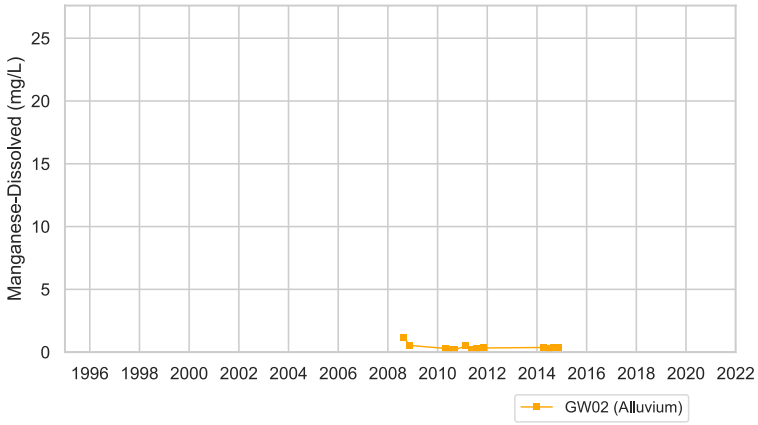

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

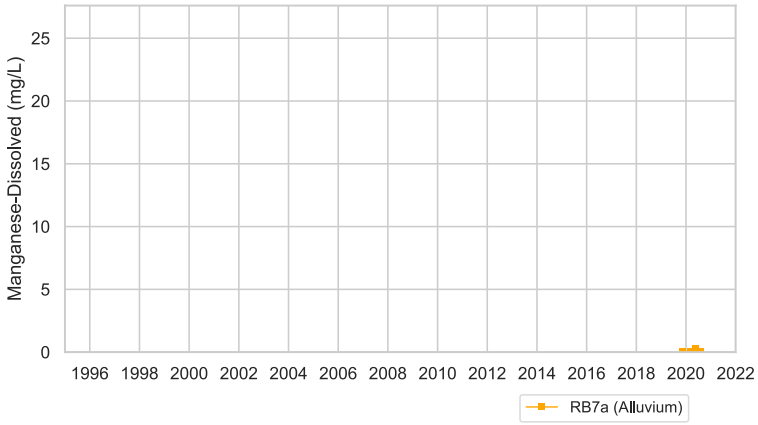

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

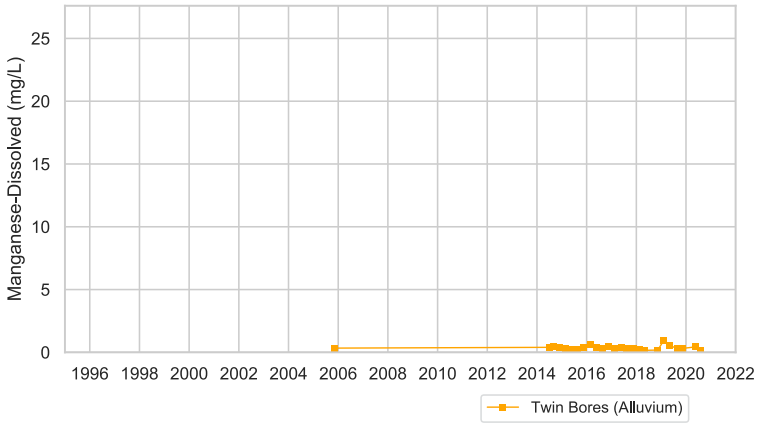

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

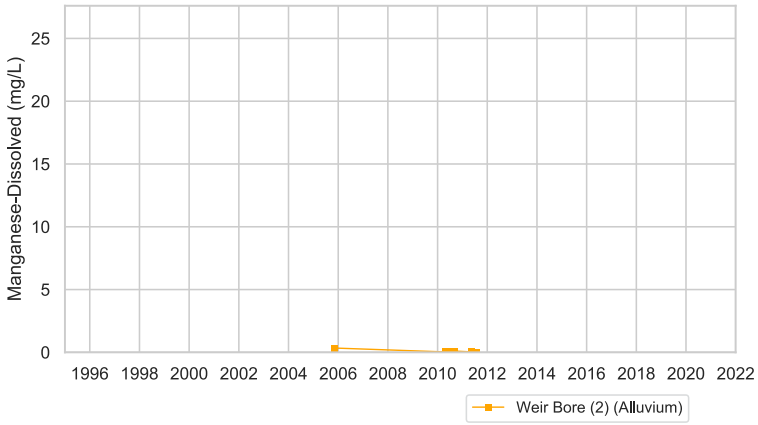

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

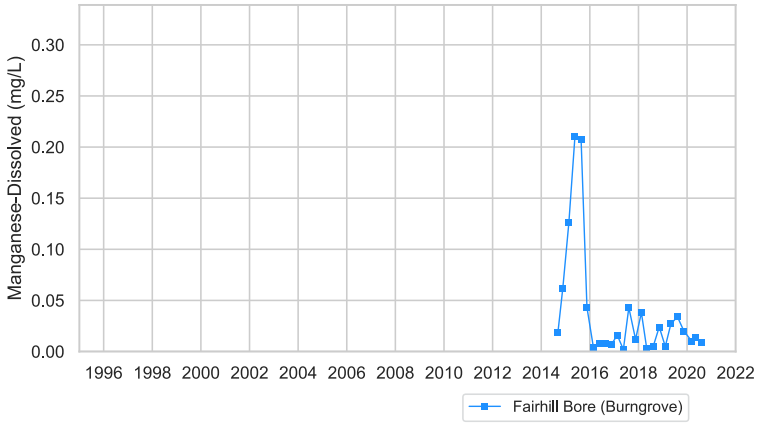

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

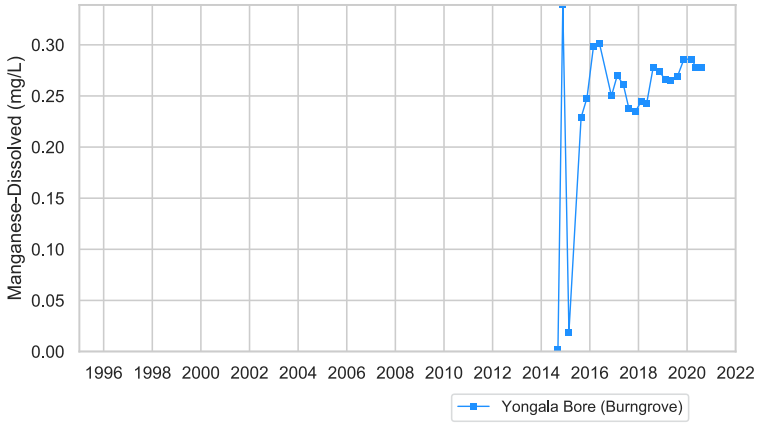

Manganese-Dissolved (mg/L)
GW02 (Alluvium)

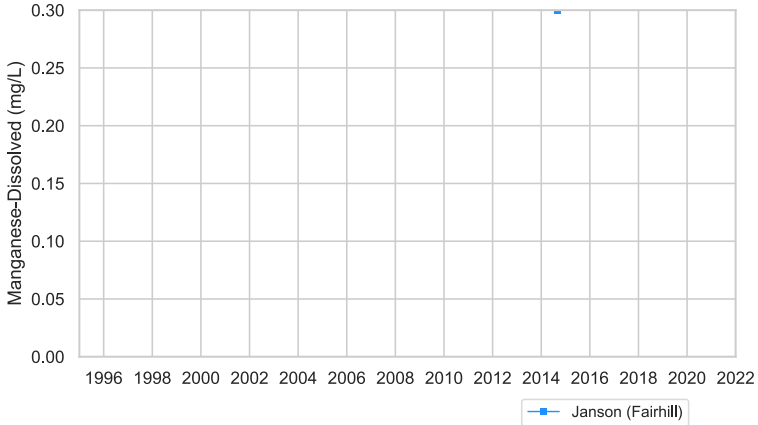

Manganese-Dissolved (mg/L)
RB7a (Alluvium)

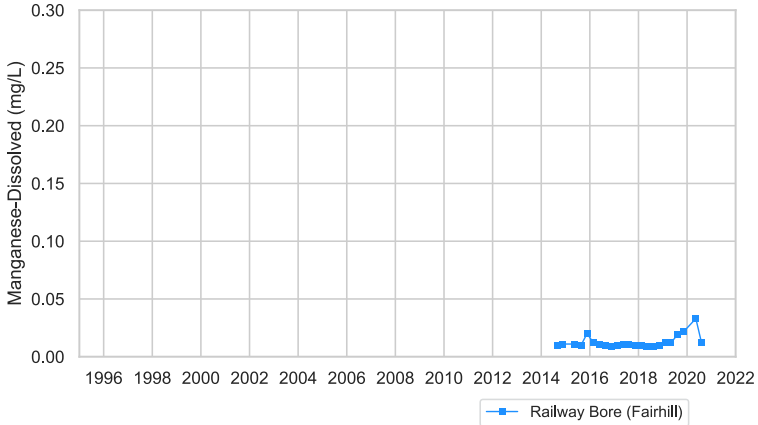

Manganese-Dissolved (mg/L)
Twin Bores (Alluvium)

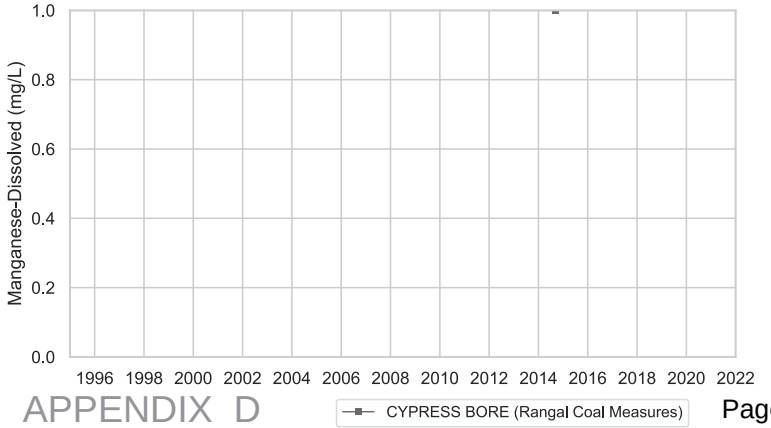

Manganese-Dissolved (mg/L)
Weir Bore (2) (Alluvium)

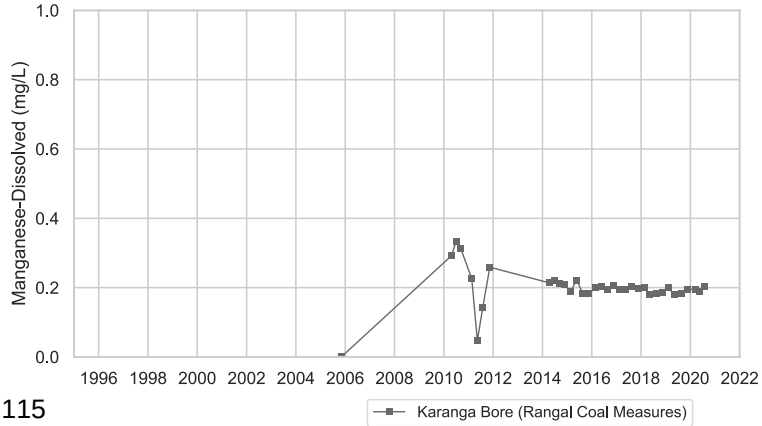

Manganese-Dissolved (mg/L)
Fairhill Bore (Burngrove)

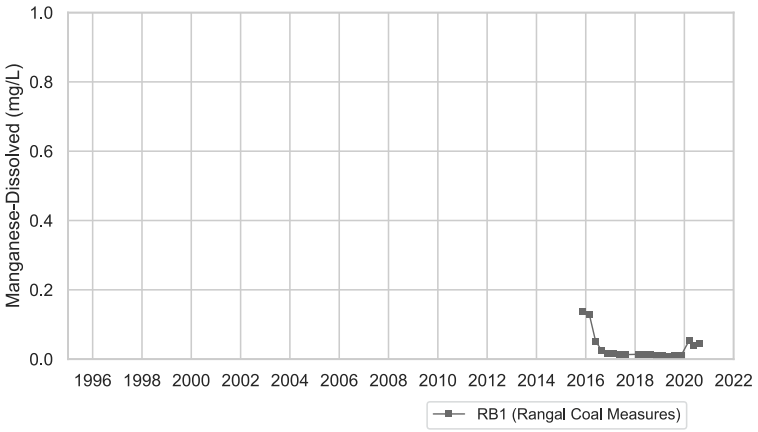

Manganese-Dissolved (mg/L)
Yongala Bore (Burngrove)

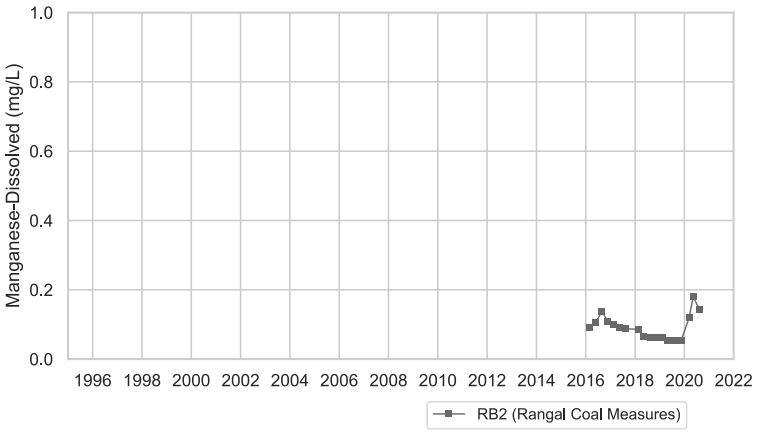

Manganese-Dissolved (mg/L)
Janson (Fairhill)

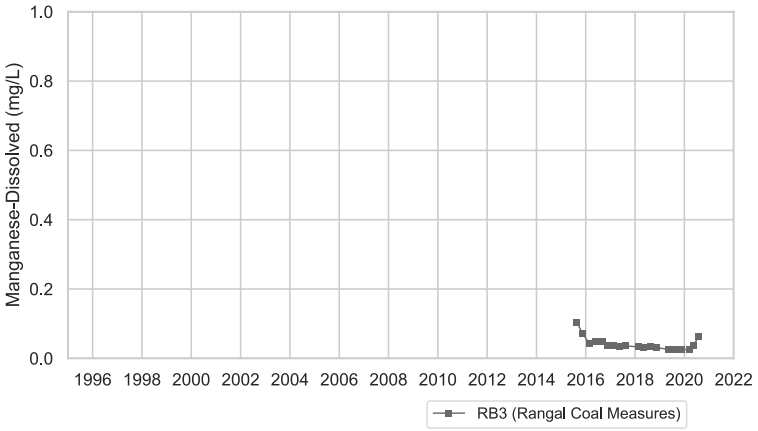

Manganese-Dissolved (mg/L)
Railway Bore (Fairhill)

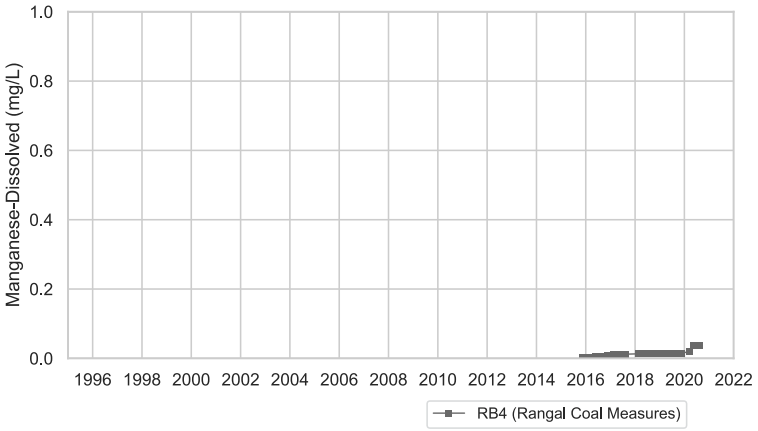

Manganese-Dissolved (mg/L)
CYPRESS BORE (Rangal Coal Measures)

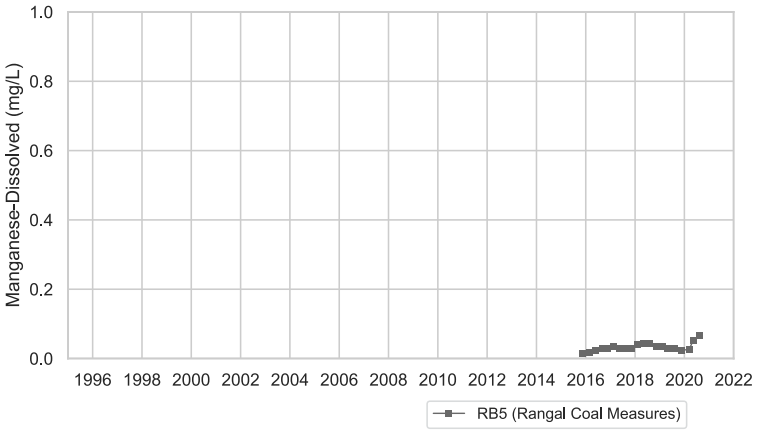

Manganese-Dissolved (mg/L)
Karanga Bore (Rangal Coal Measures)

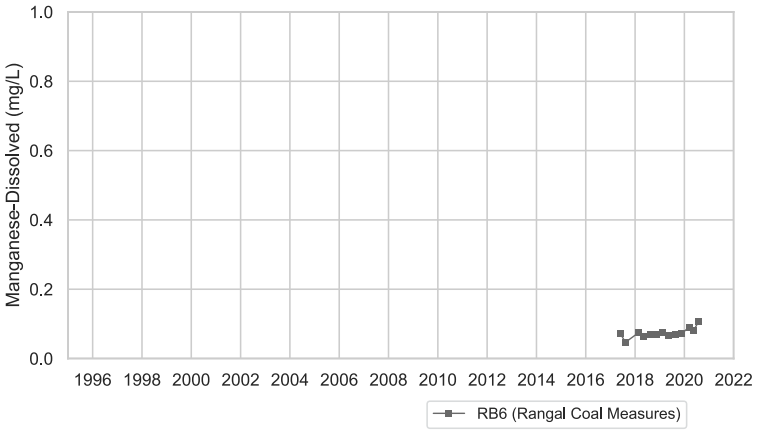

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

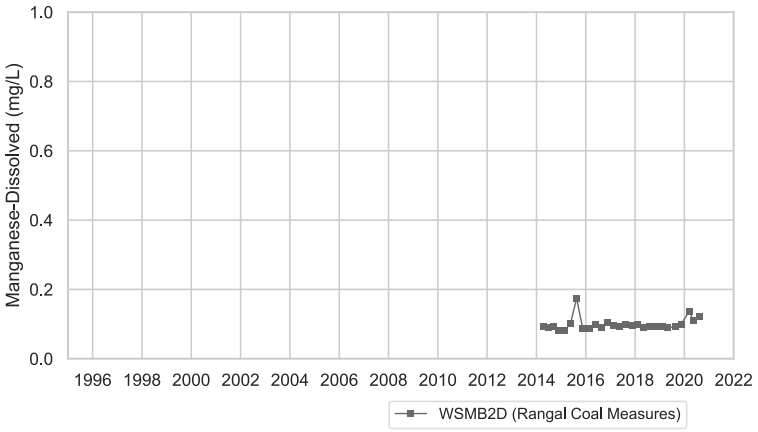

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

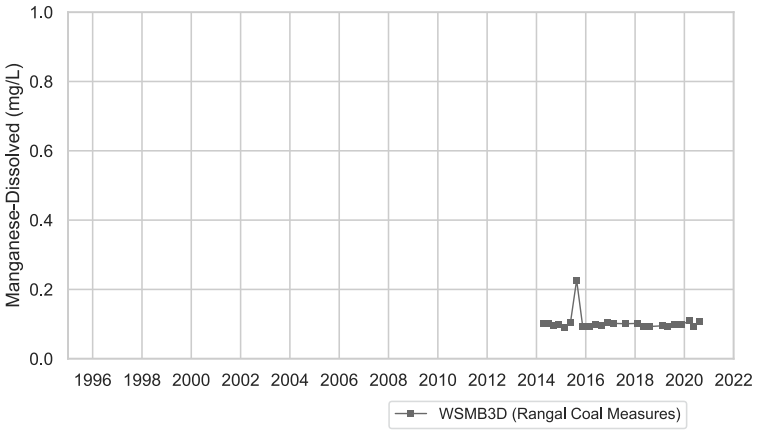

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

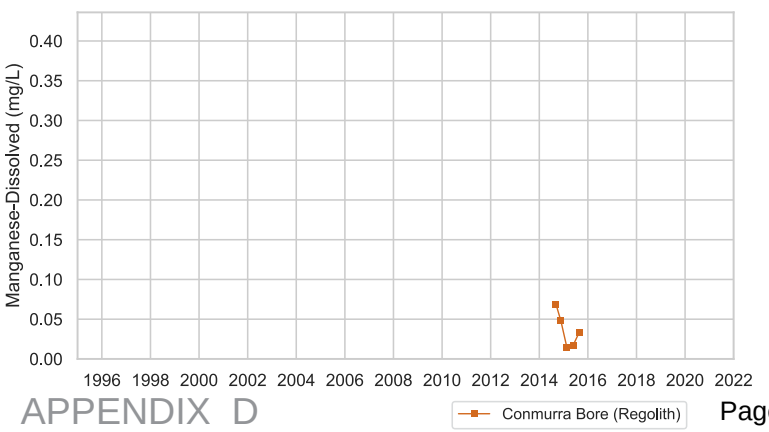

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

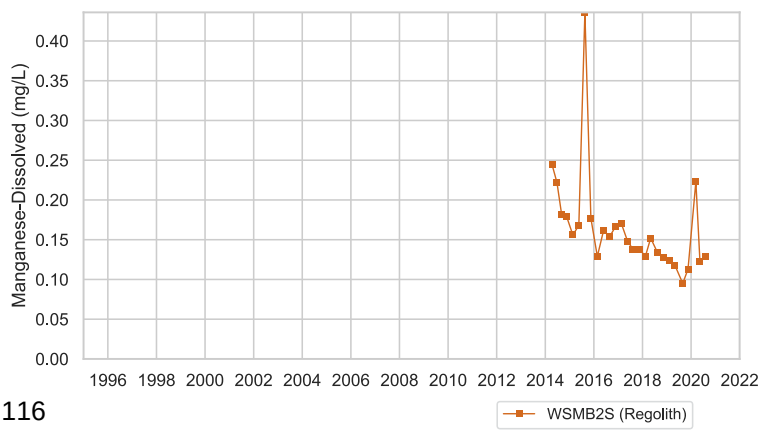

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

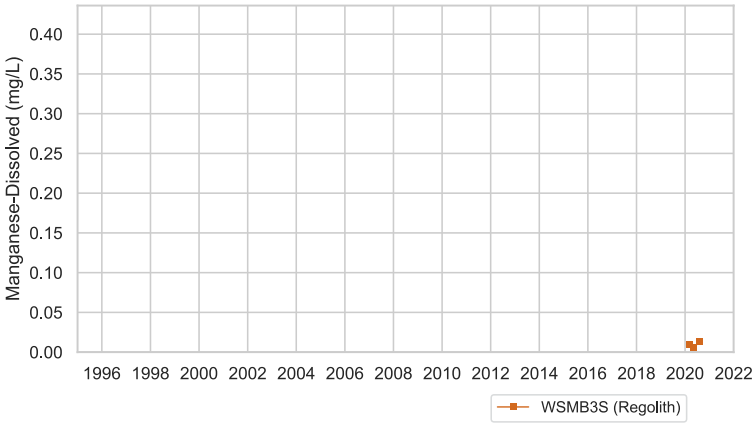

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

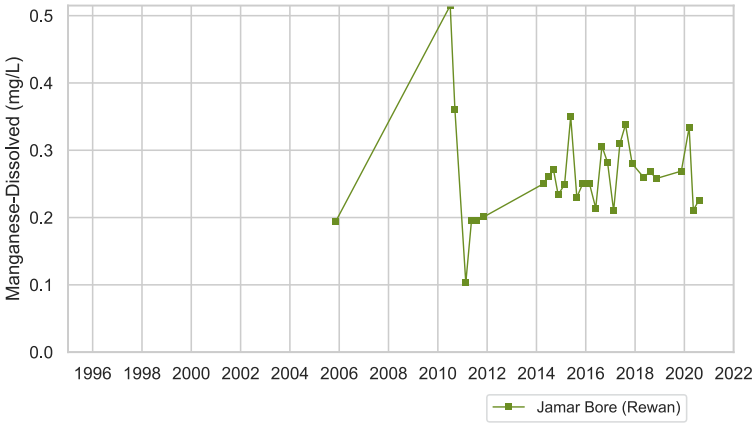

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

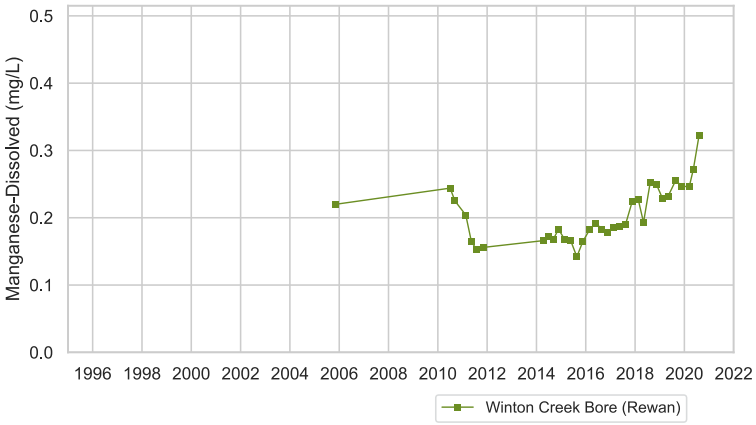

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

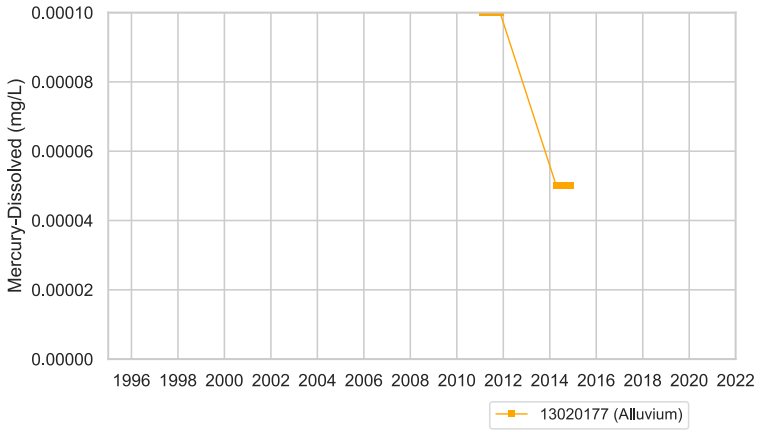

Manganese-Dissolved (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

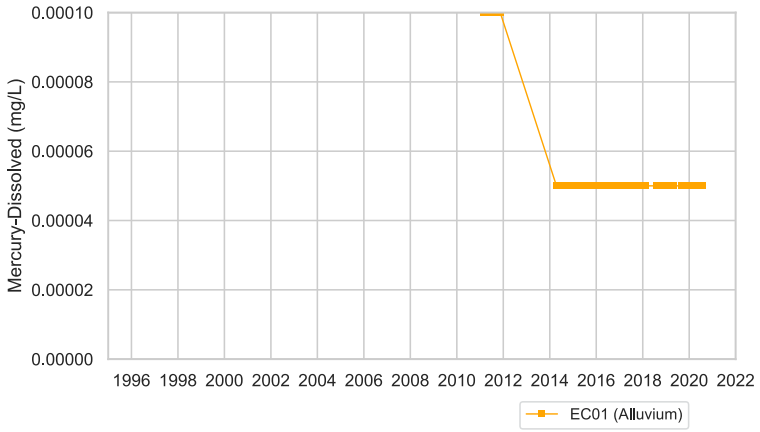

Manganese-Dissolved (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

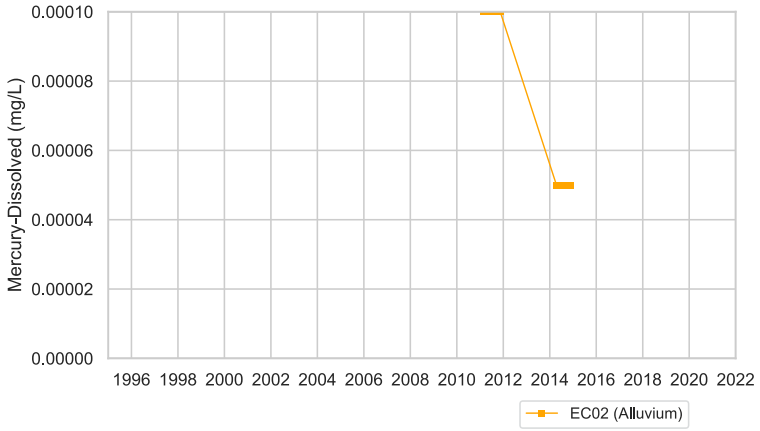

Manganese-Dissolved (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

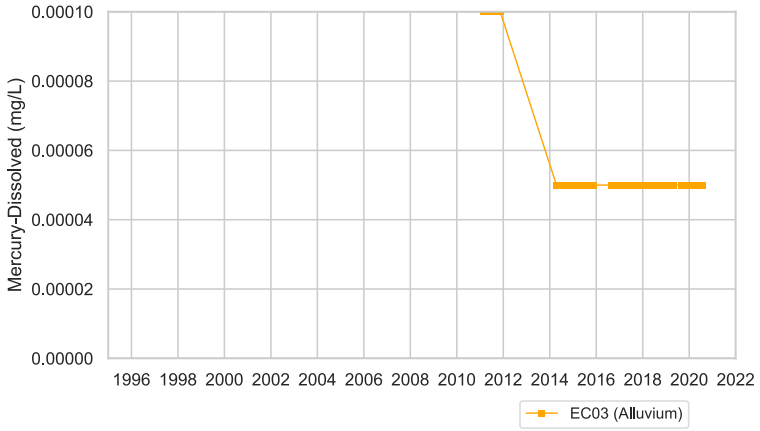

Manganese-Dissolved (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

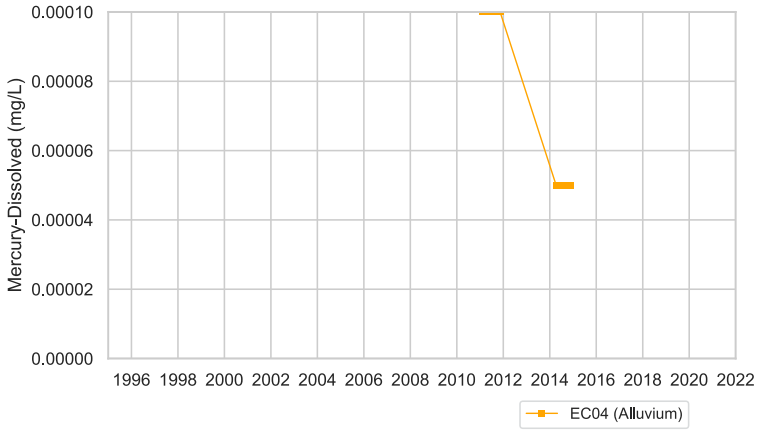

Manganese-Dissolved (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

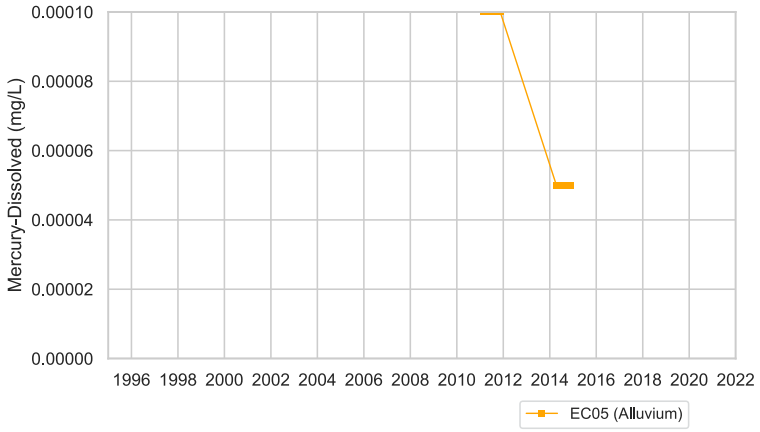

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

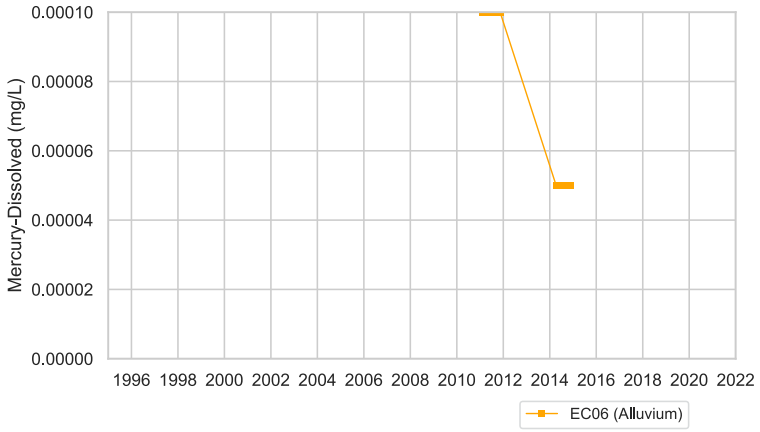

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

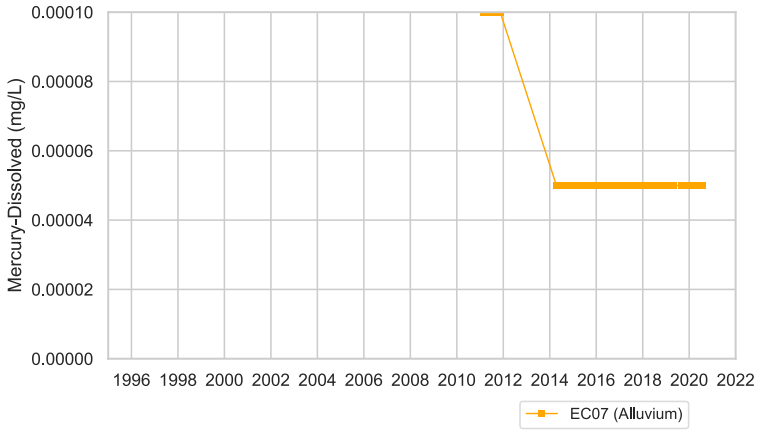

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

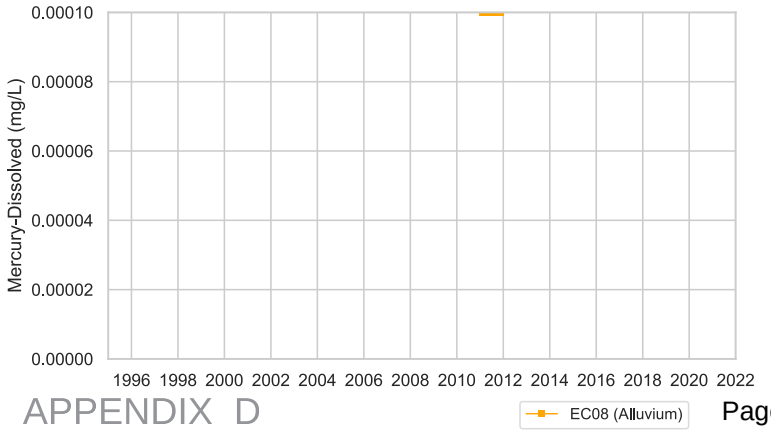

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

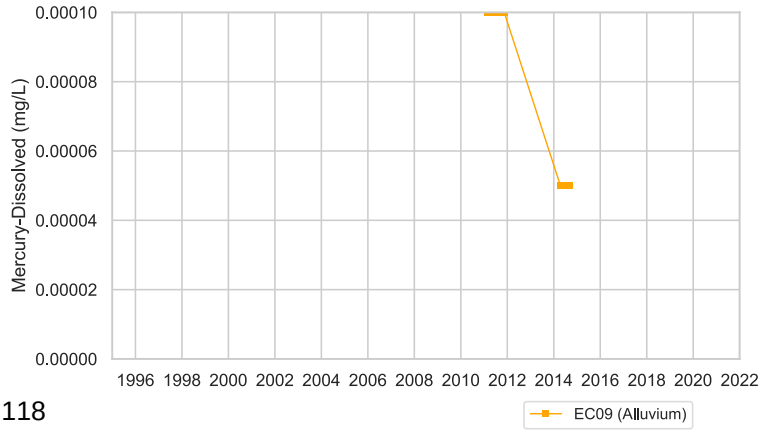

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

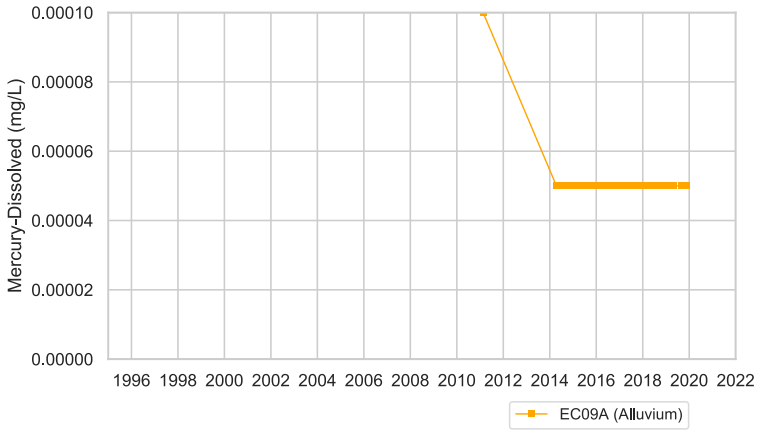

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

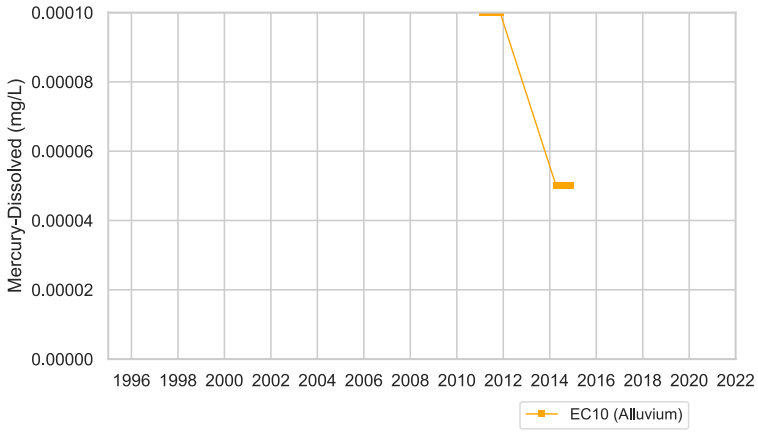

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

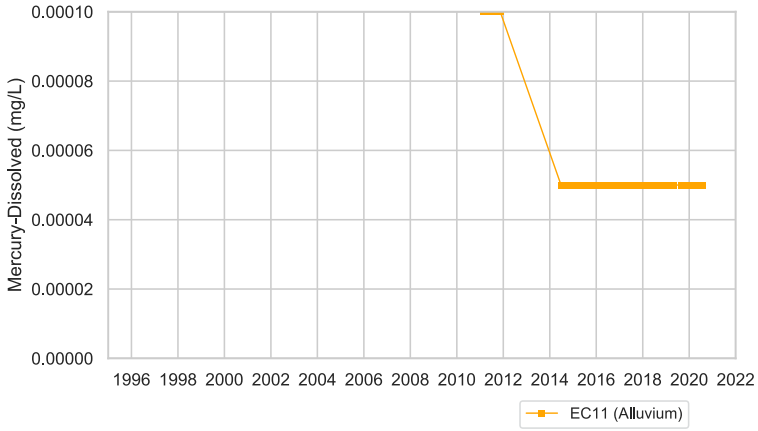

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

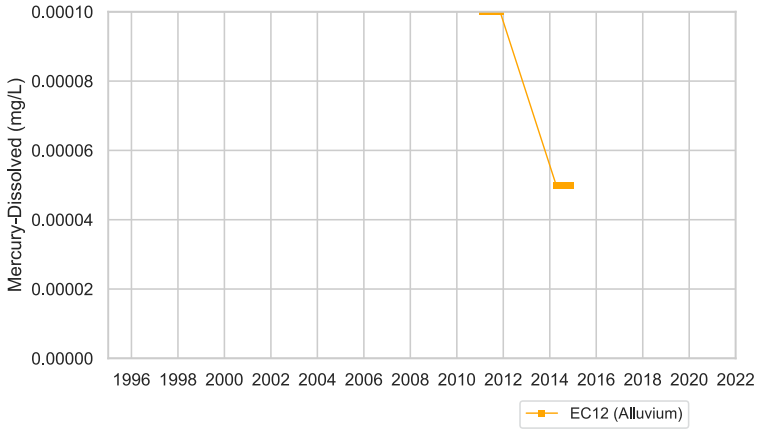

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

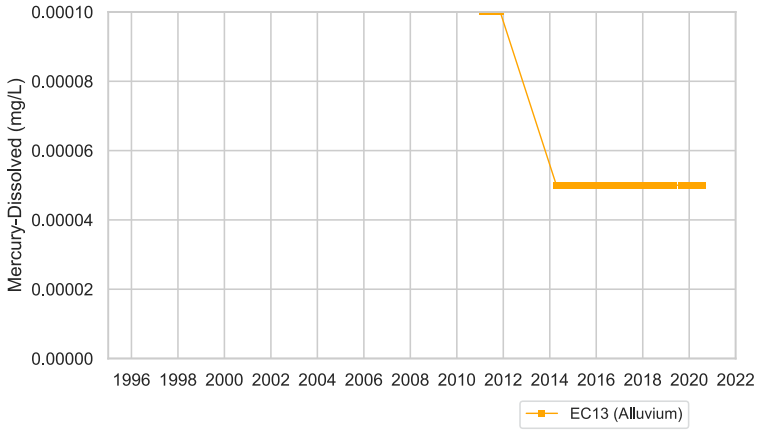

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

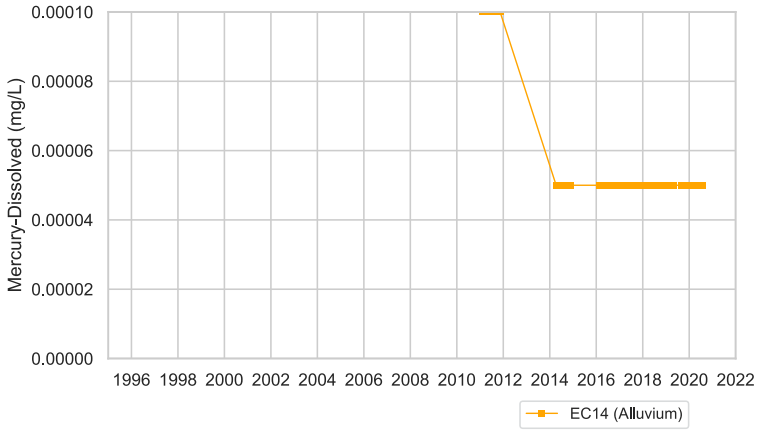

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

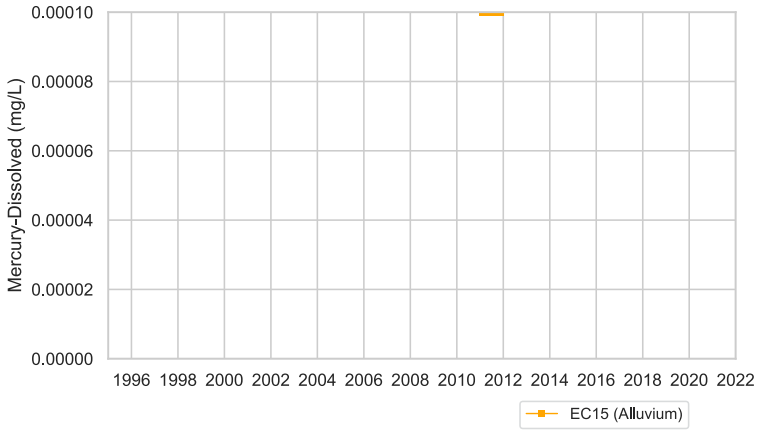

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

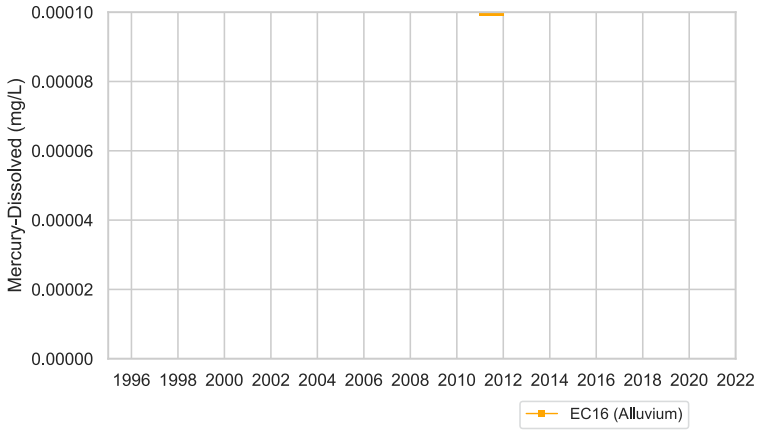

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

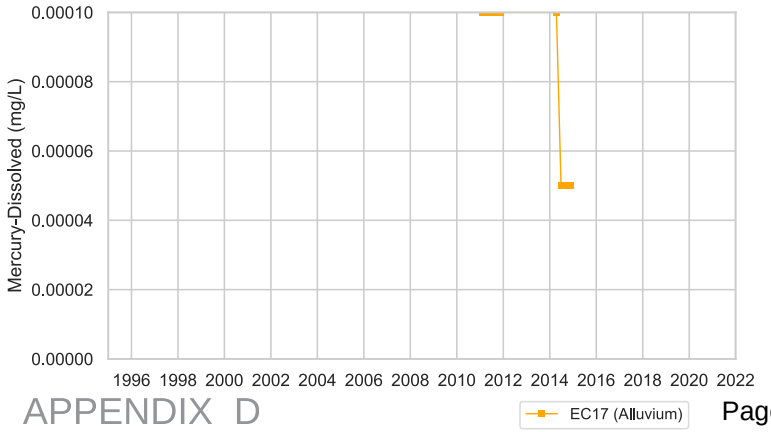

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

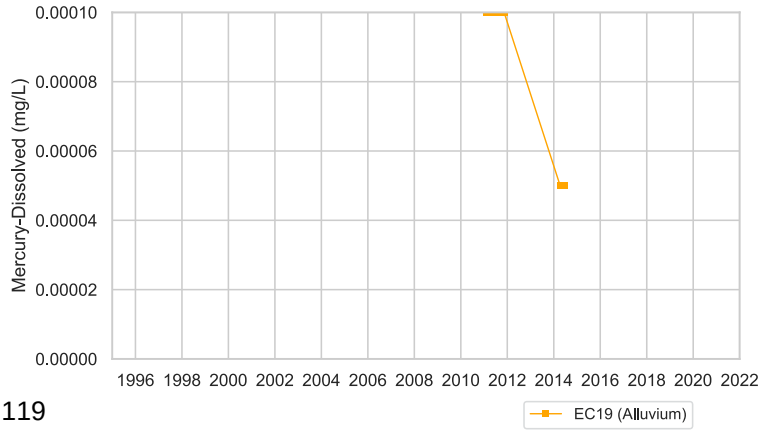

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

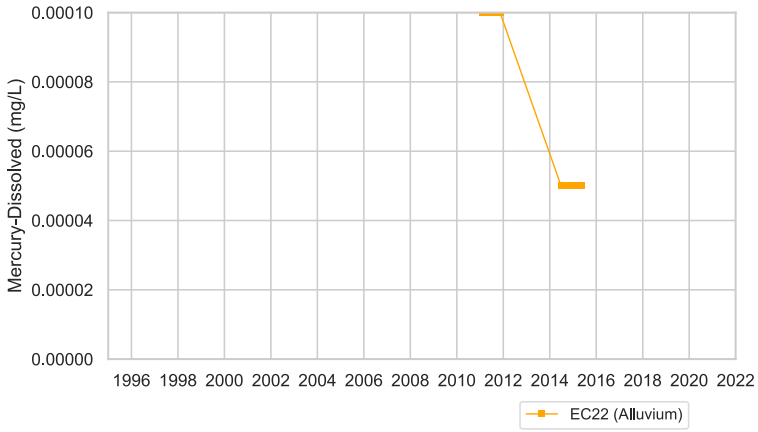

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

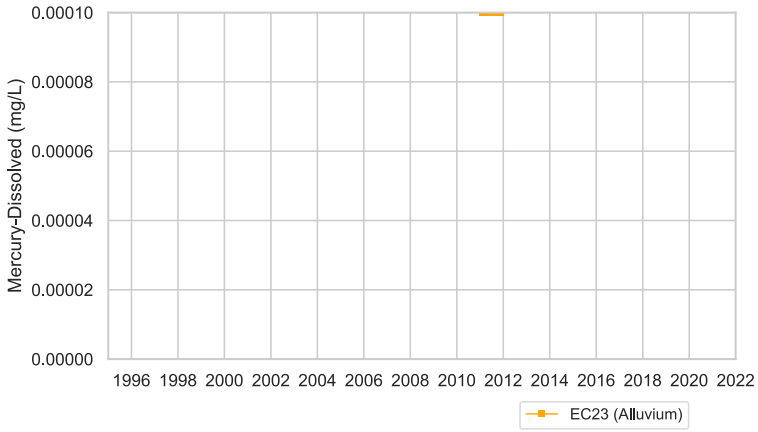

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

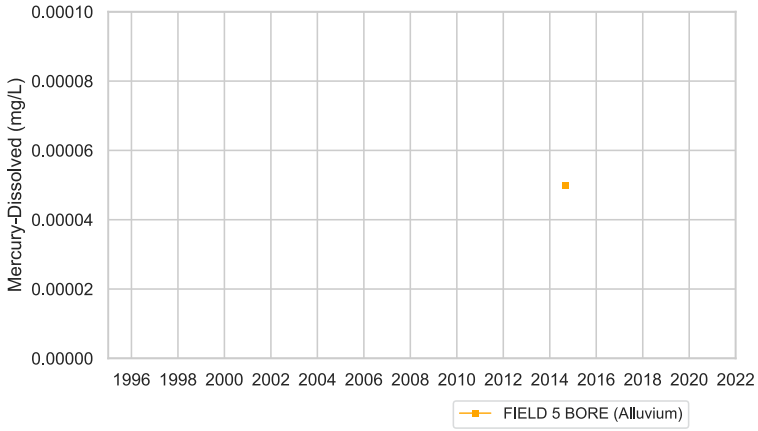

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

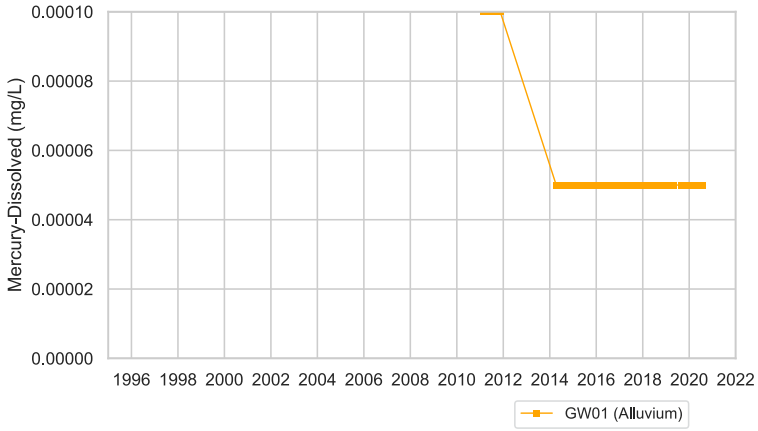

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

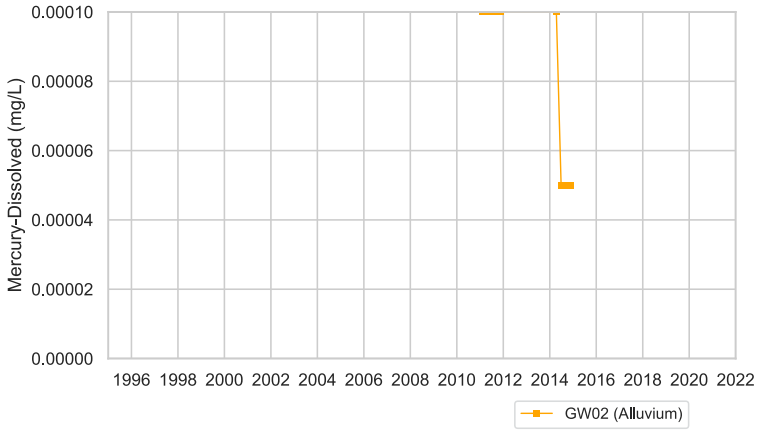

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

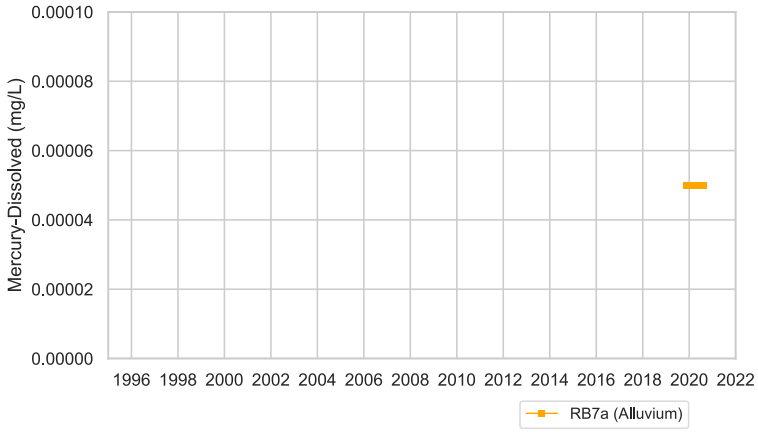

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

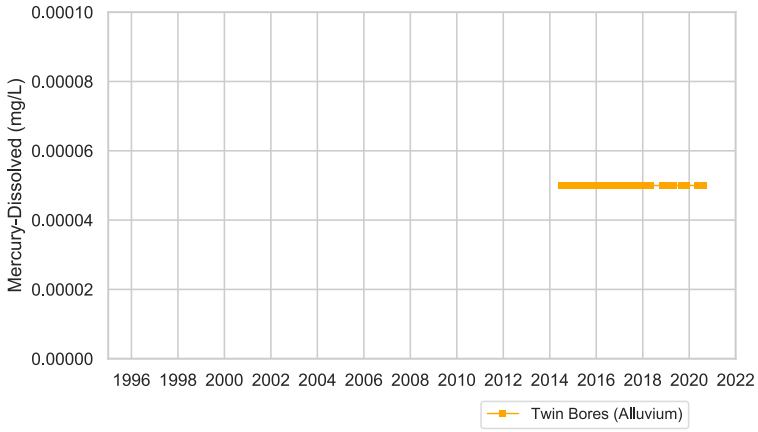

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

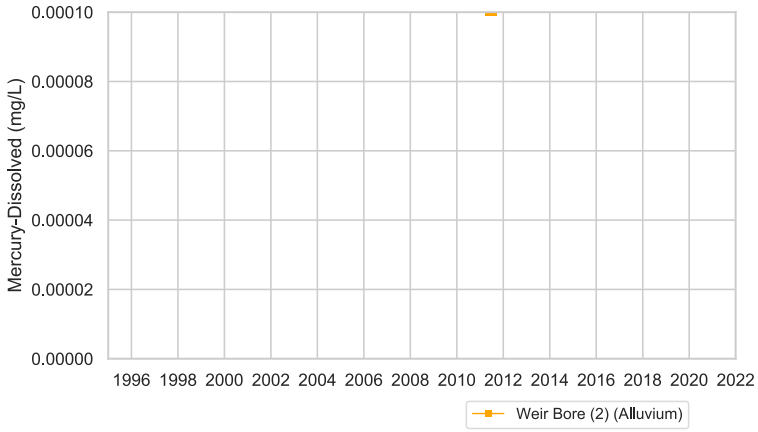

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

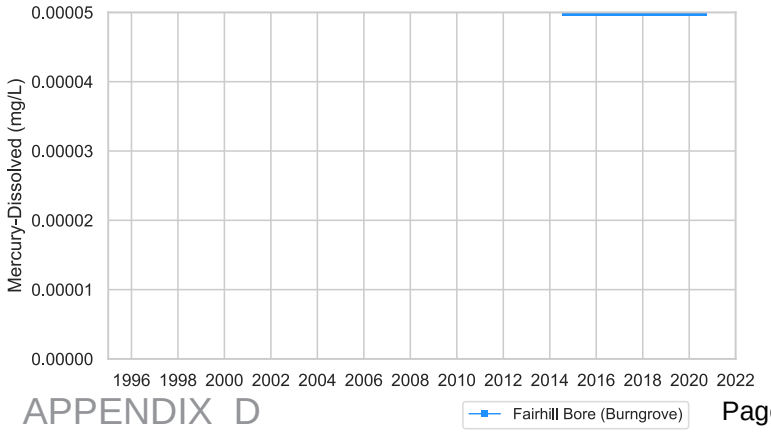

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

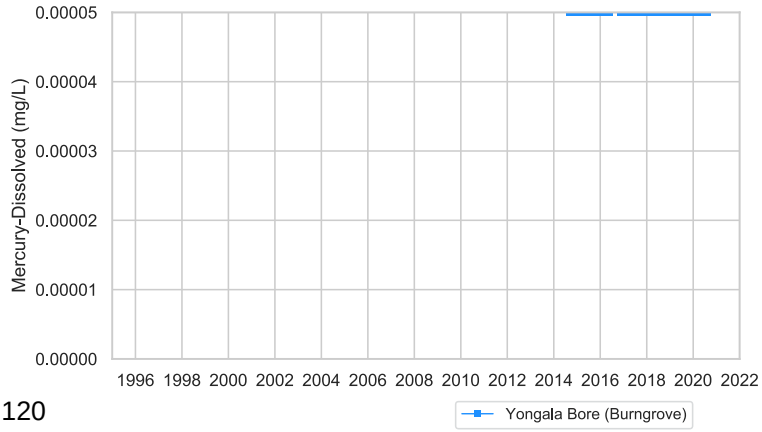

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

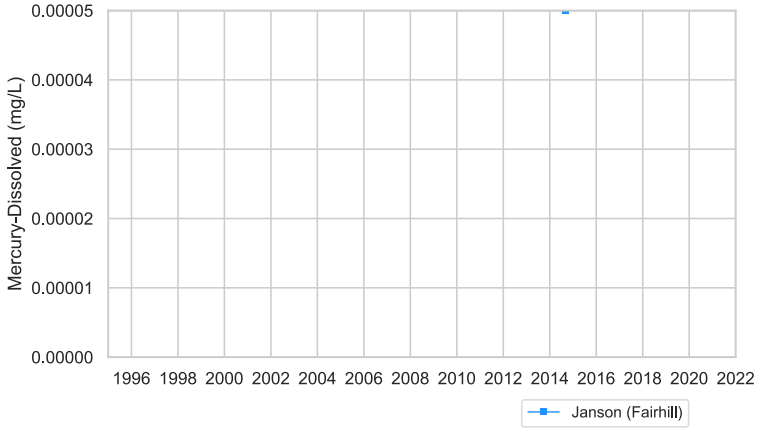

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

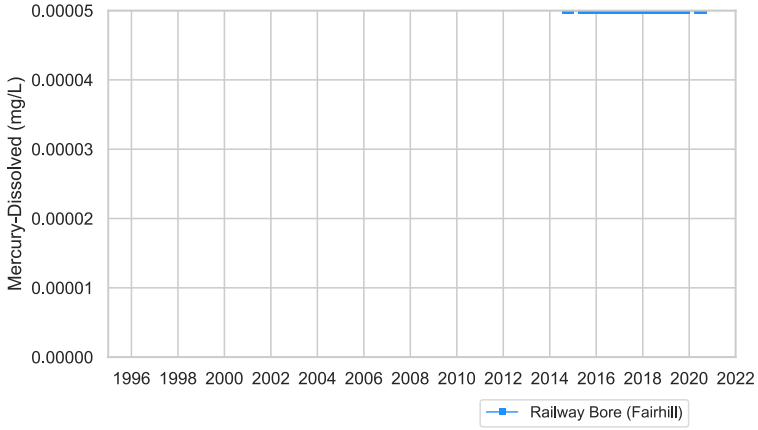

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

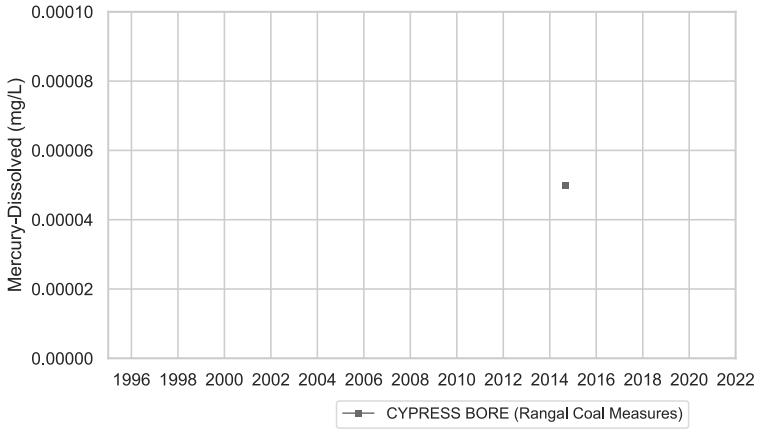

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

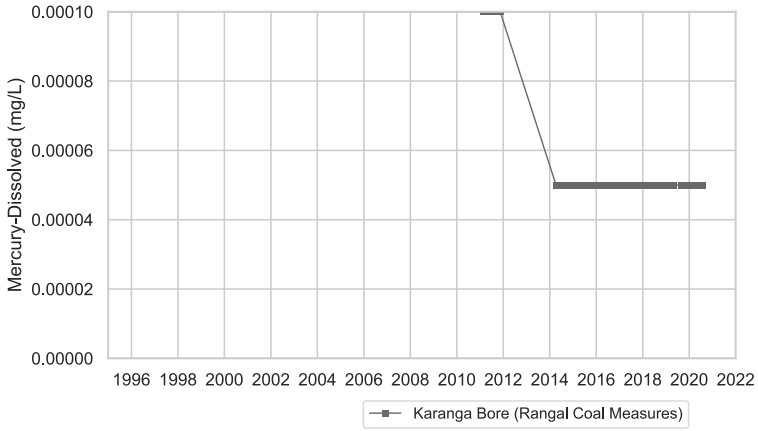

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

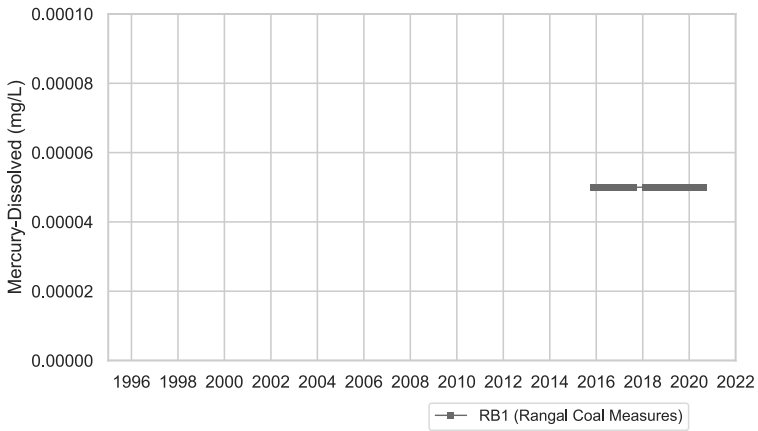

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

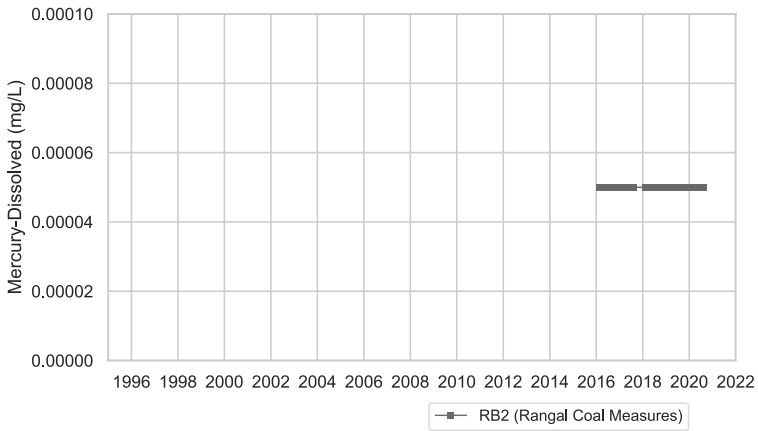

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

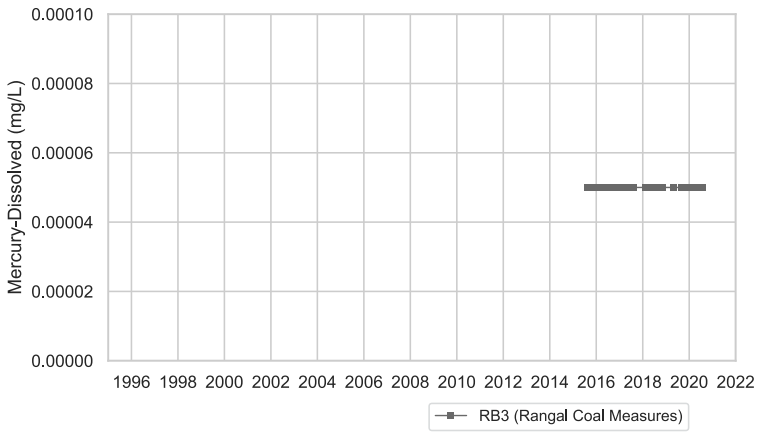

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

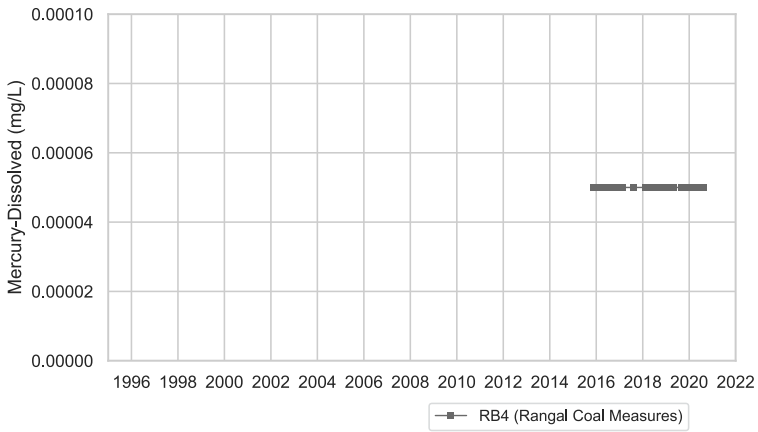

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

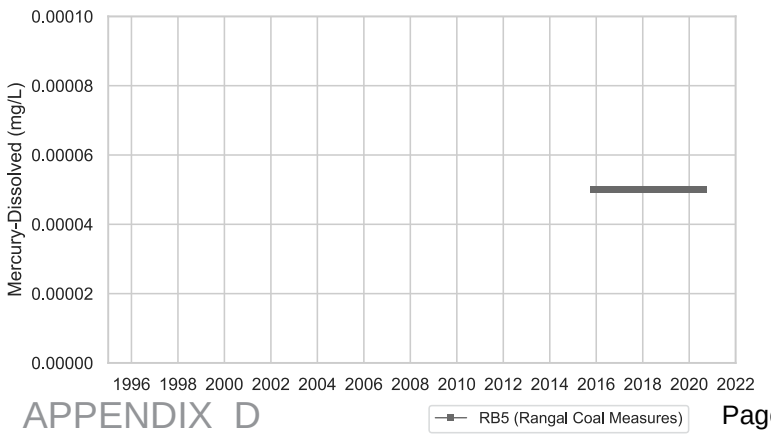

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

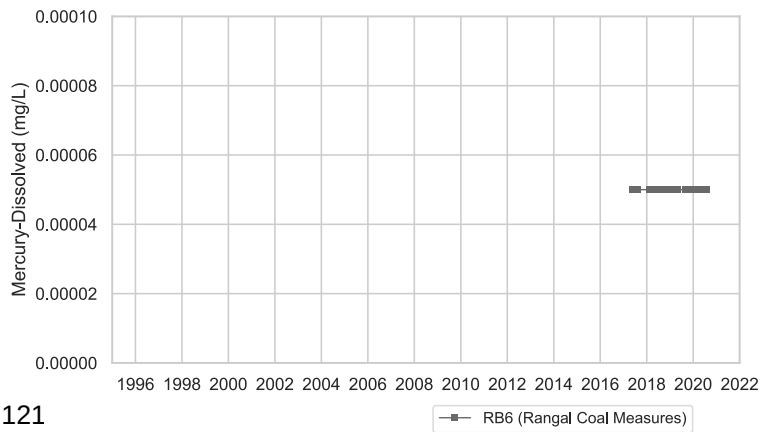

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

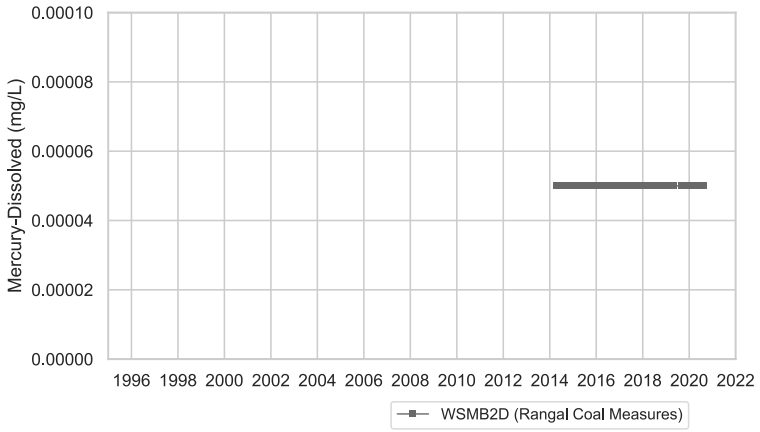

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

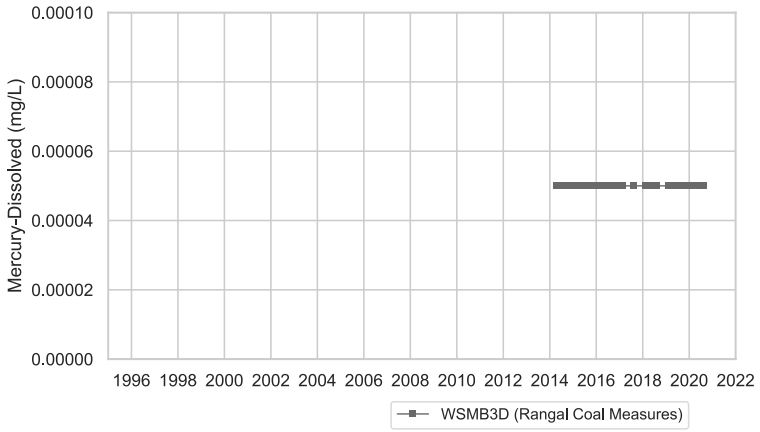

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

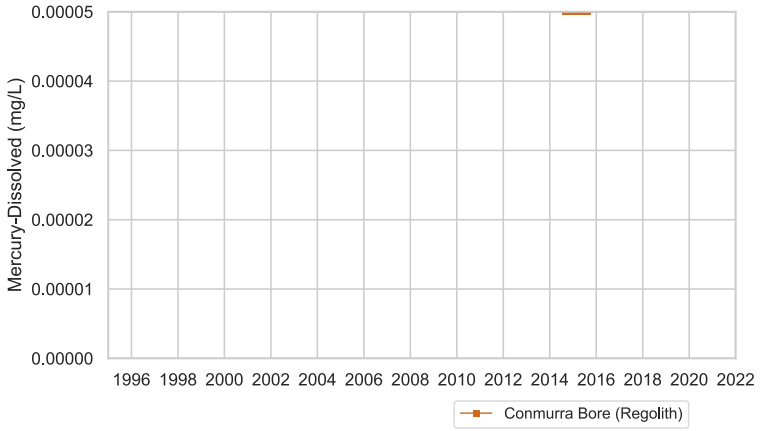

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)


Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)


Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

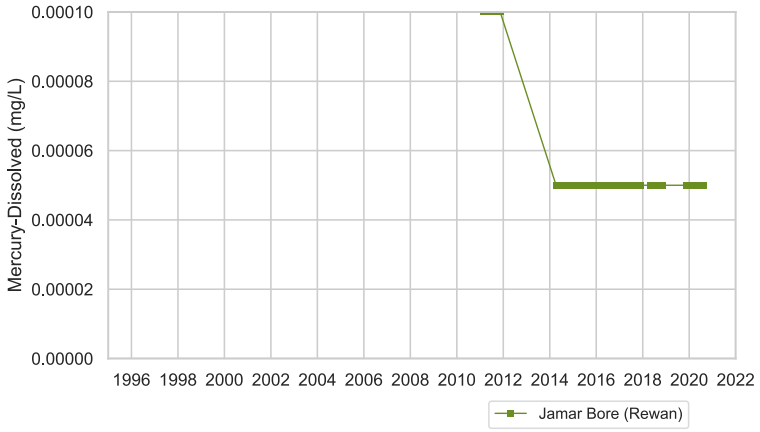

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

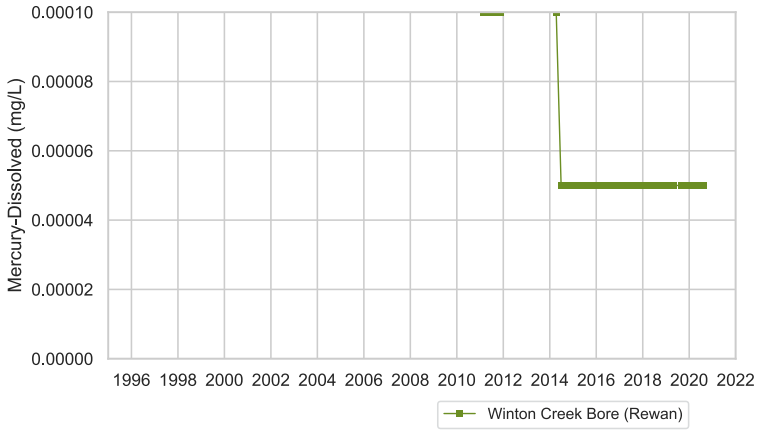

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

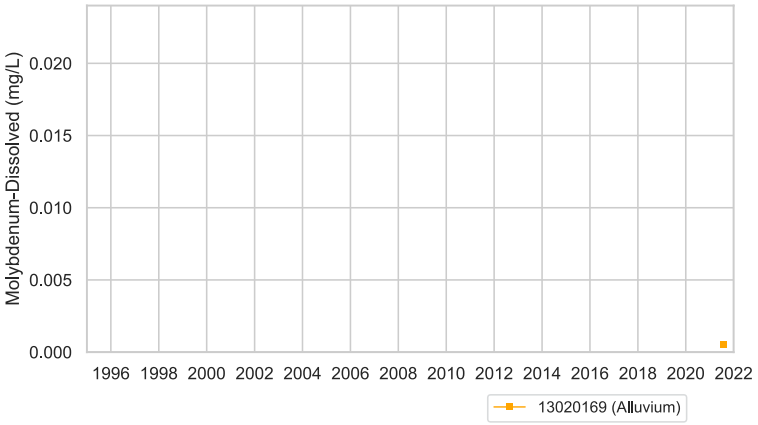

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

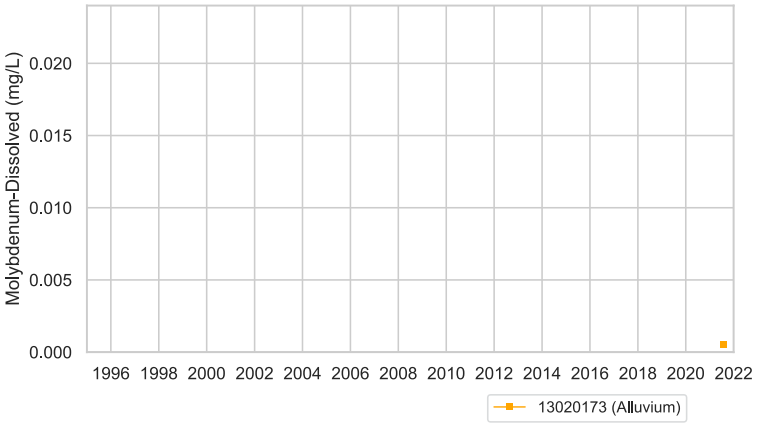
Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

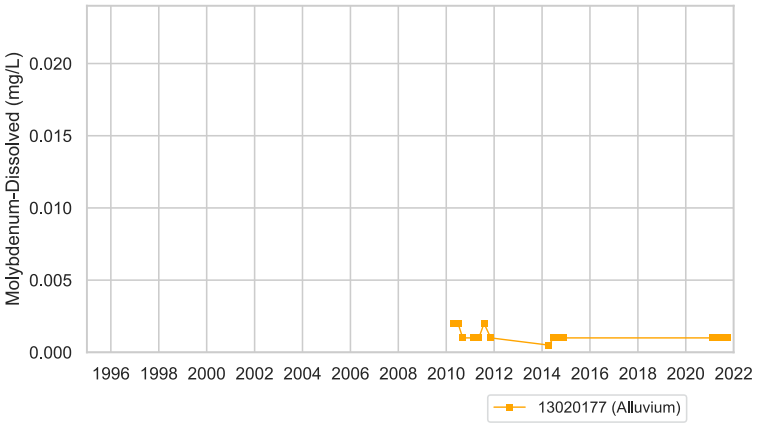
Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

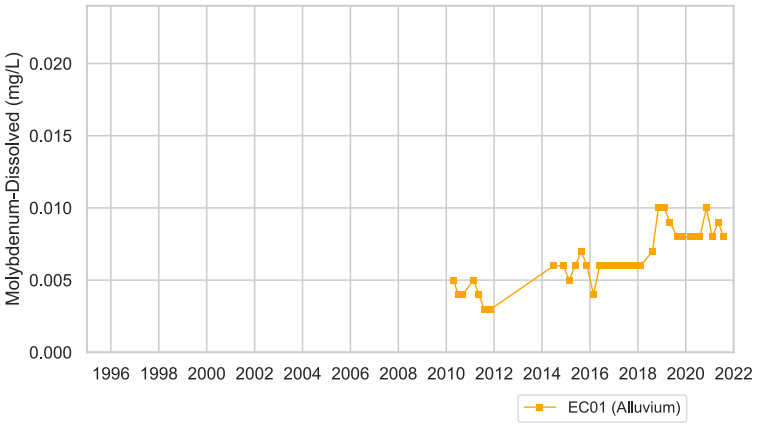

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

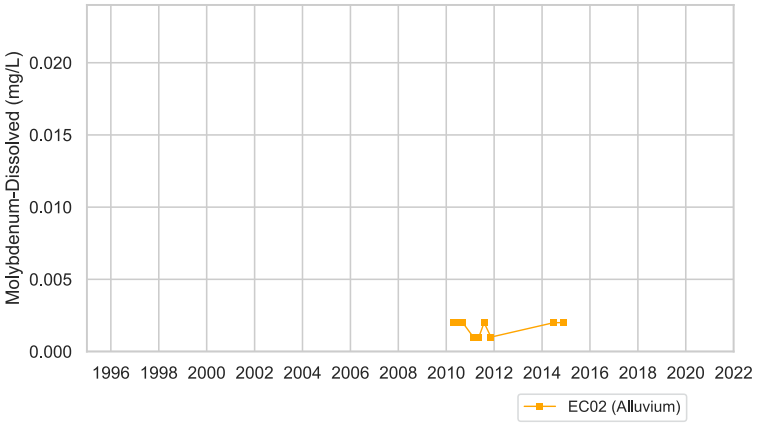

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

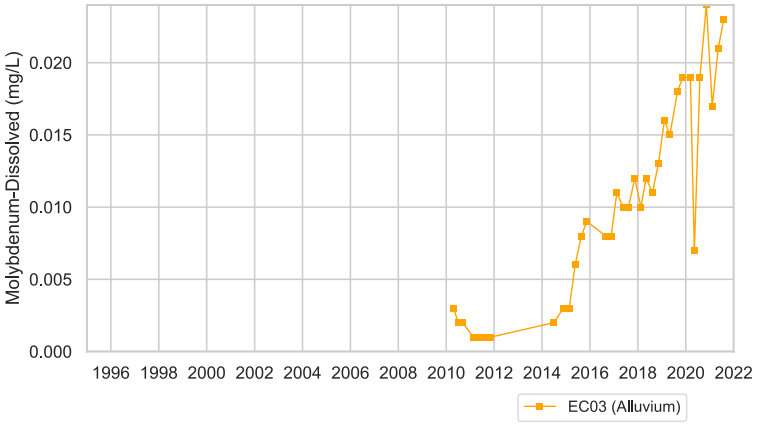

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

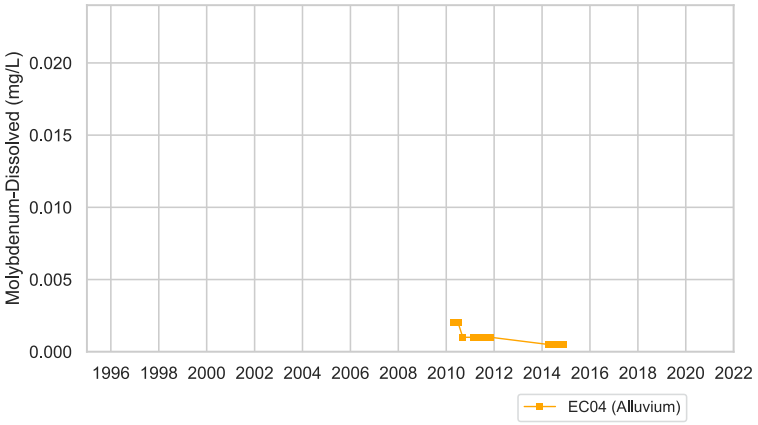

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

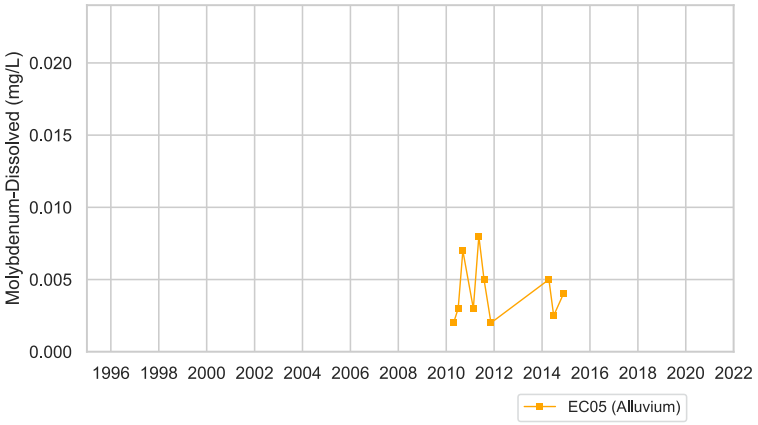

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

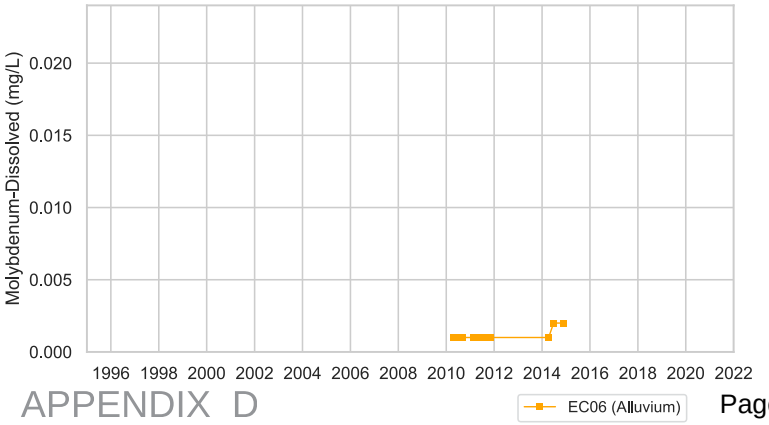

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

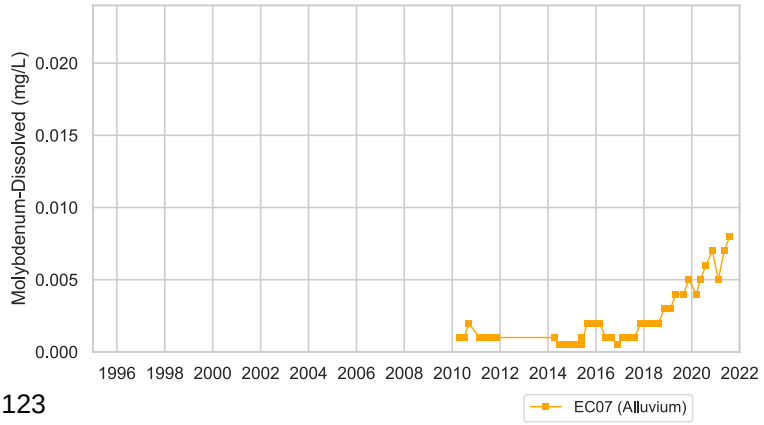

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

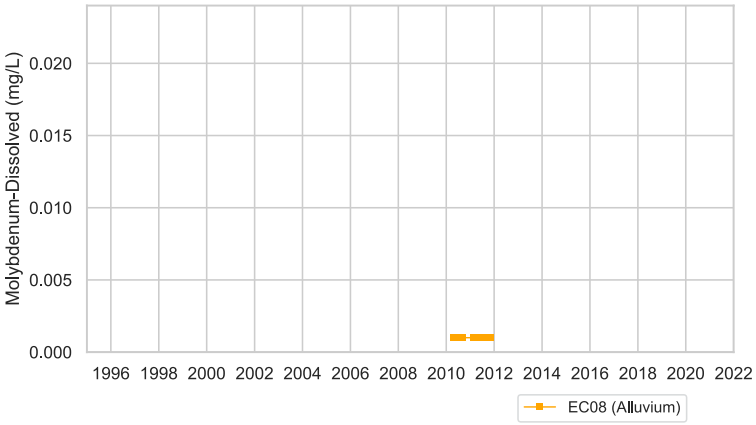

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

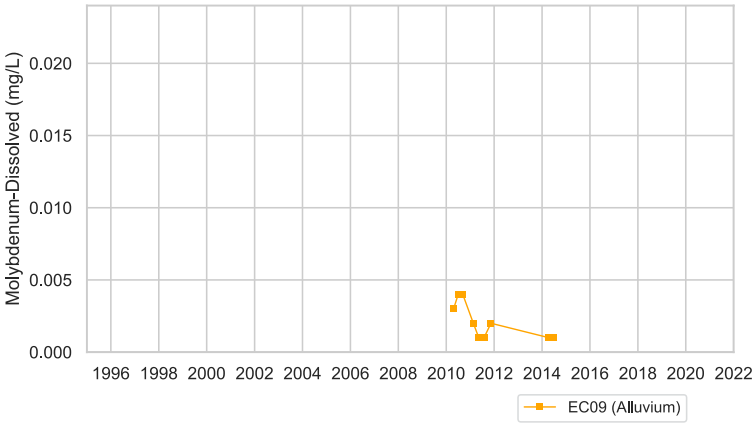

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

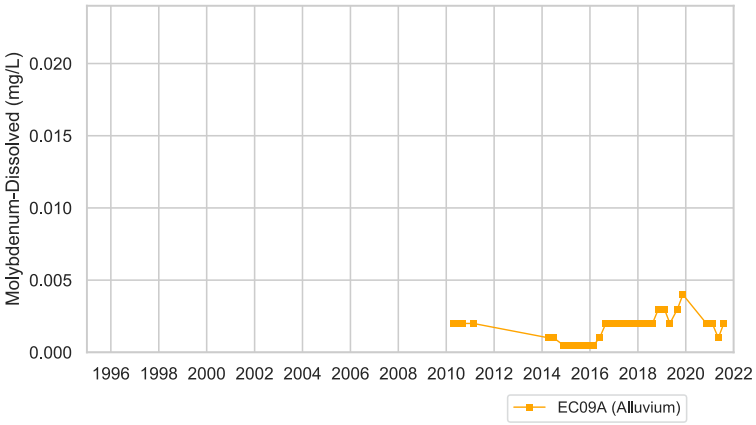

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

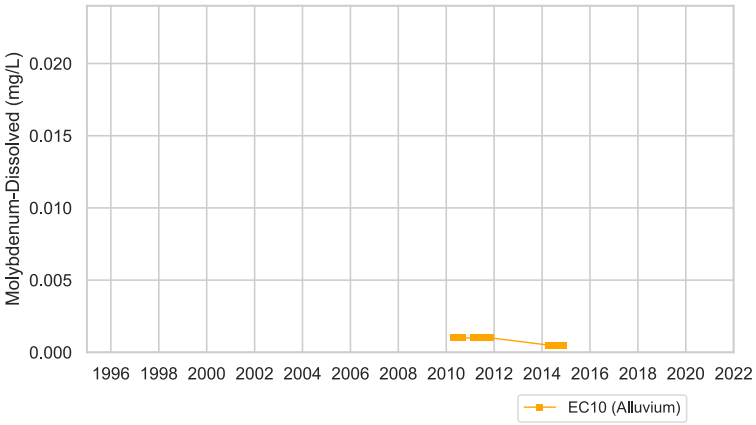

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

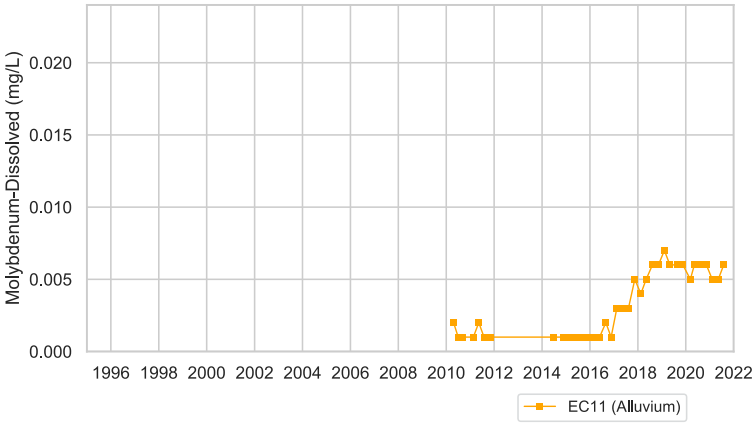

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

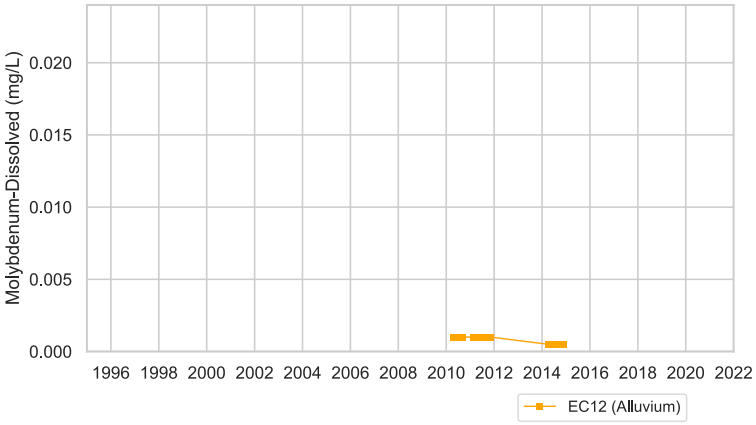

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

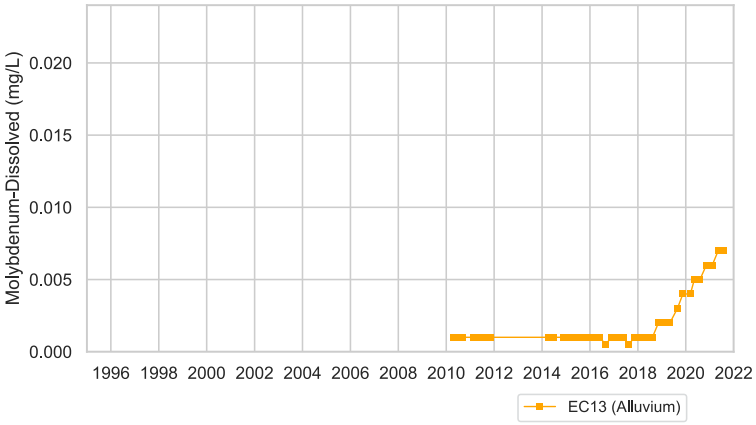

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

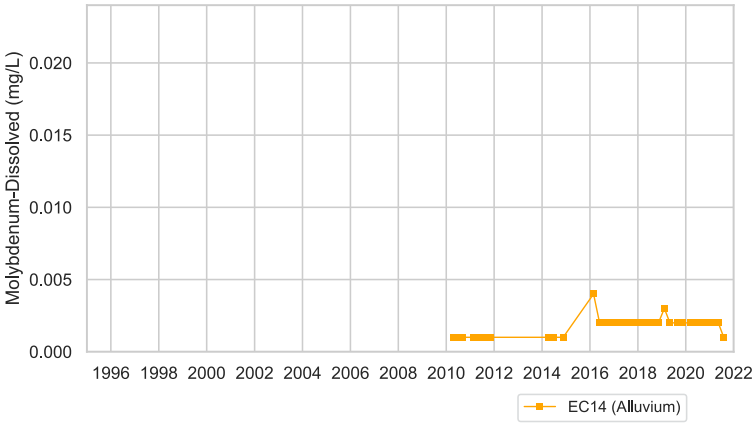

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

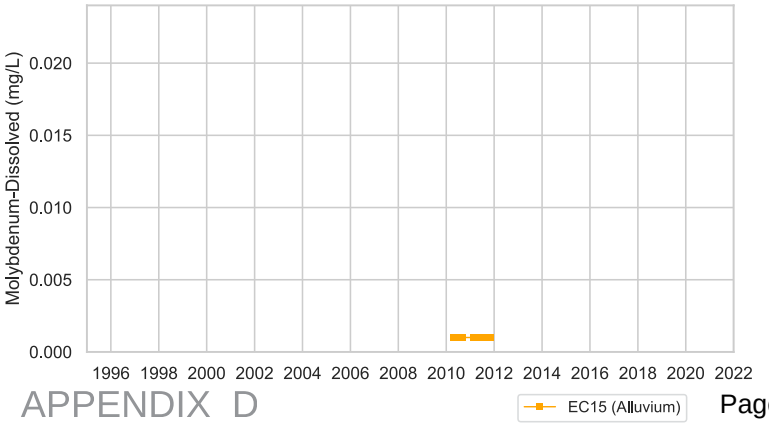

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

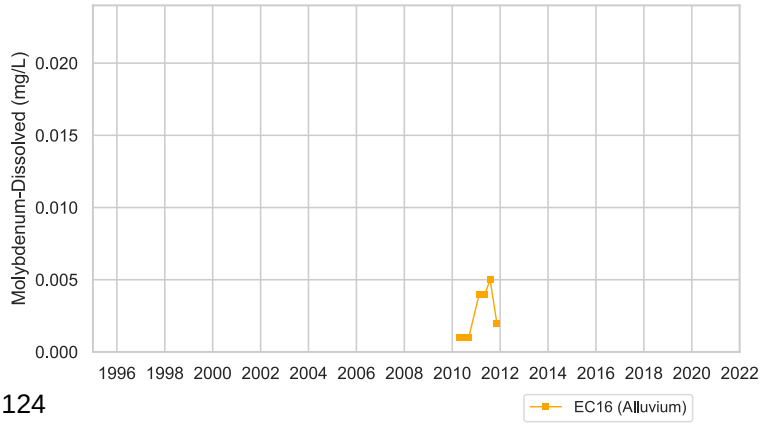

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

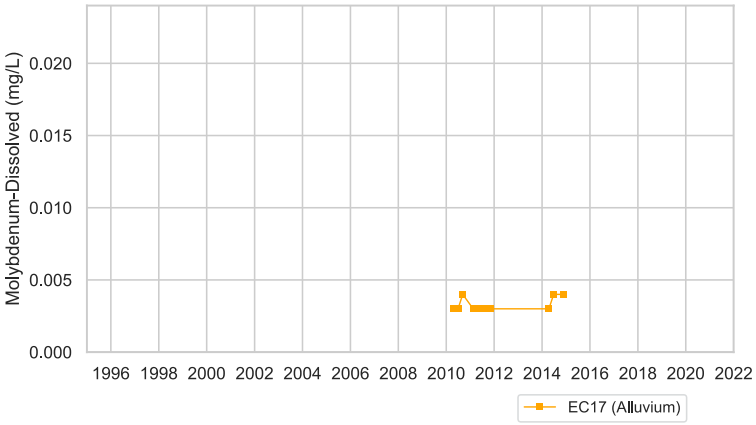

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

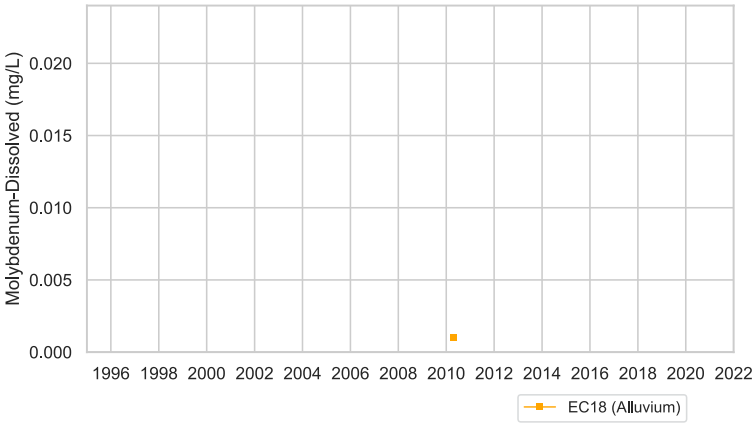

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

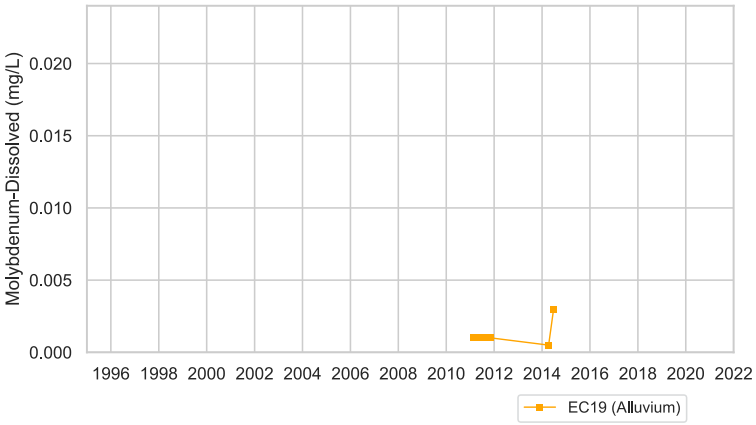

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

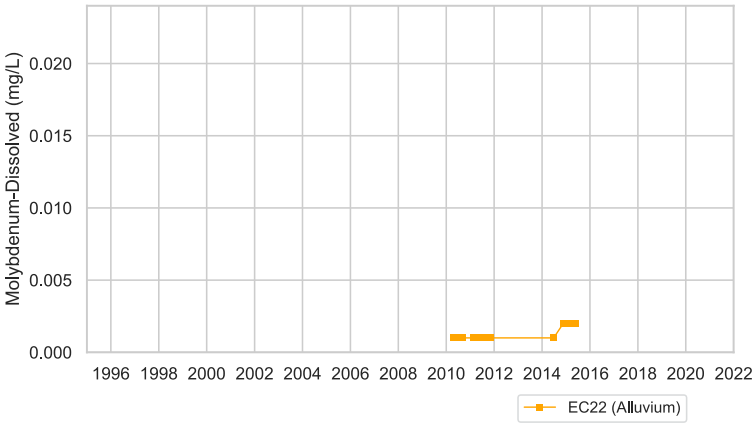

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

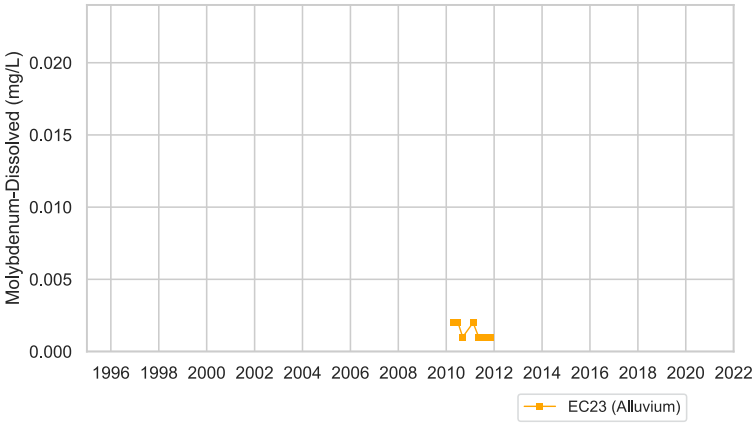

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

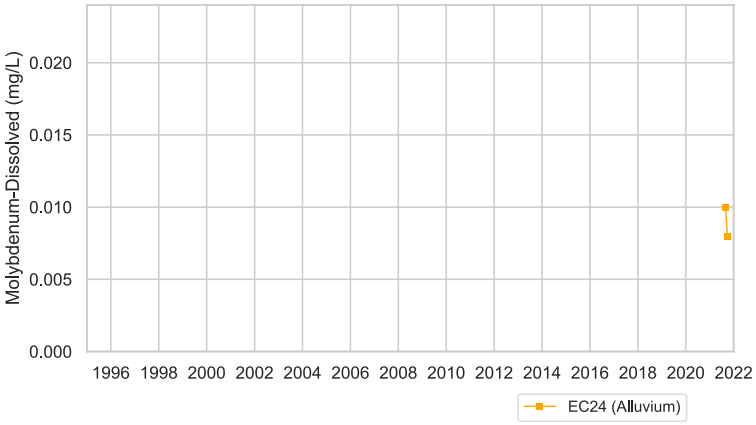

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

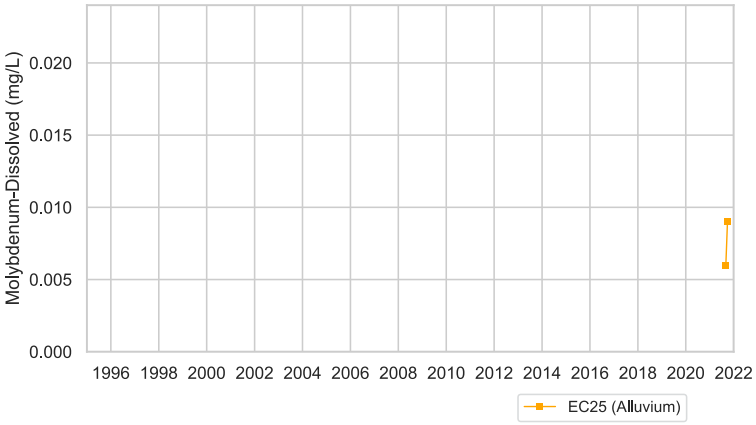

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

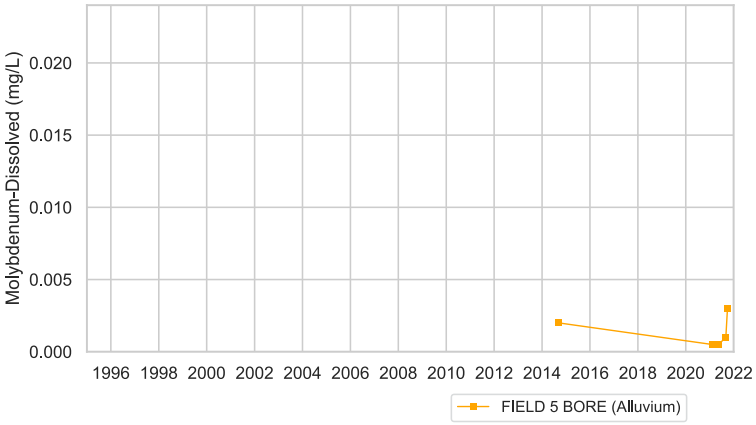

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

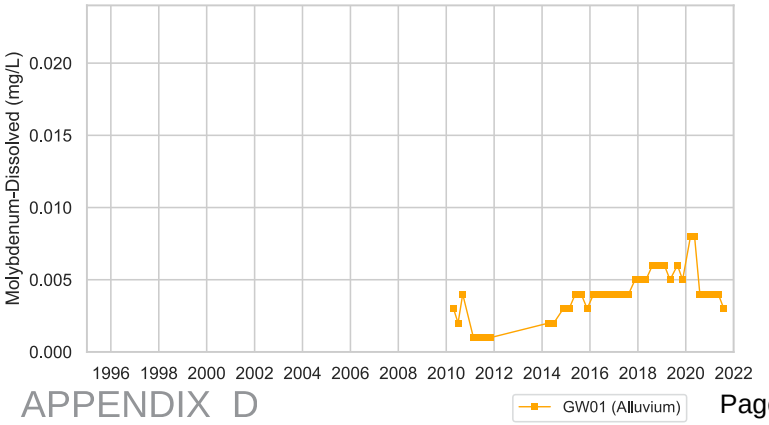

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

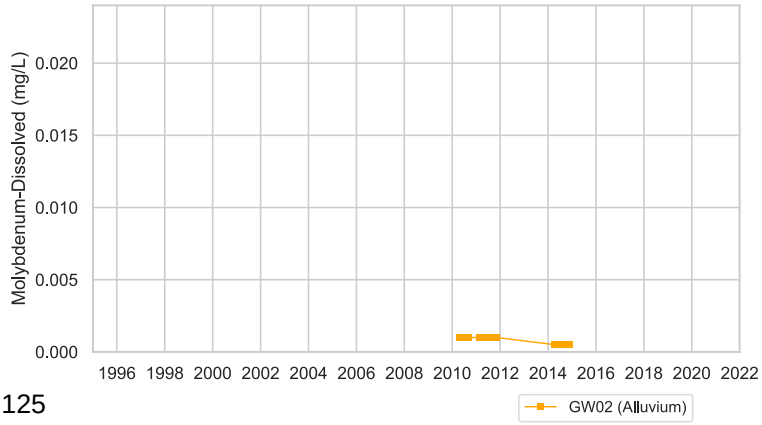

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

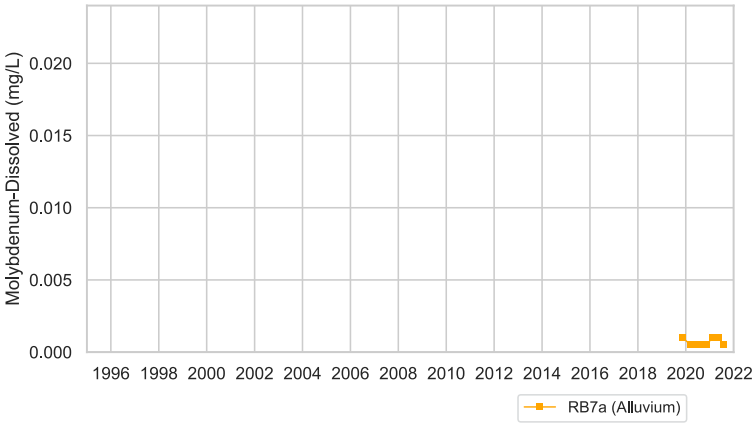

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

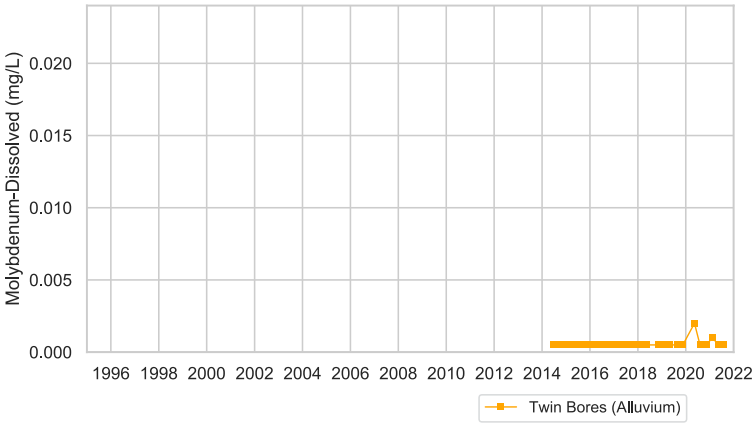

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

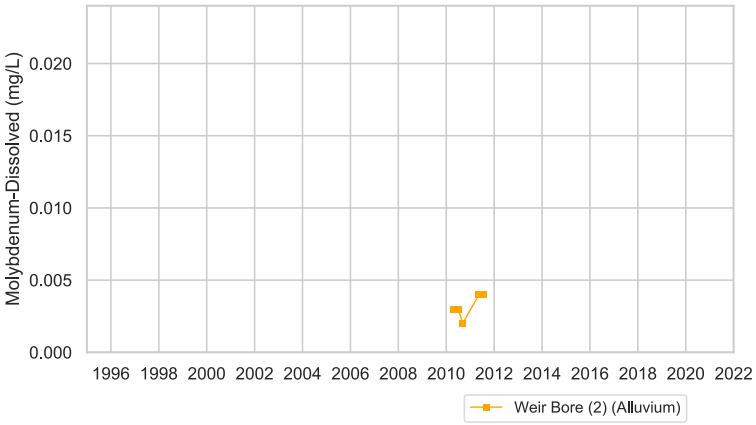

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

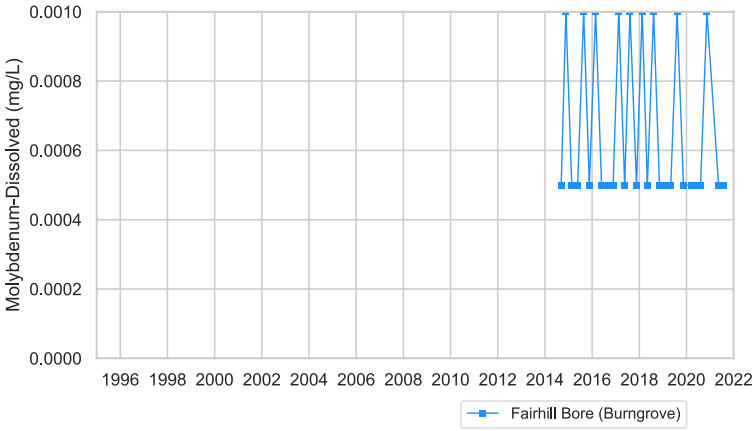

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

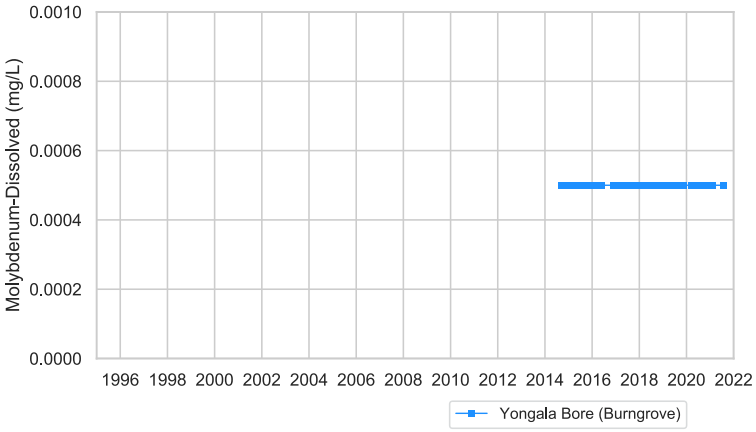

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

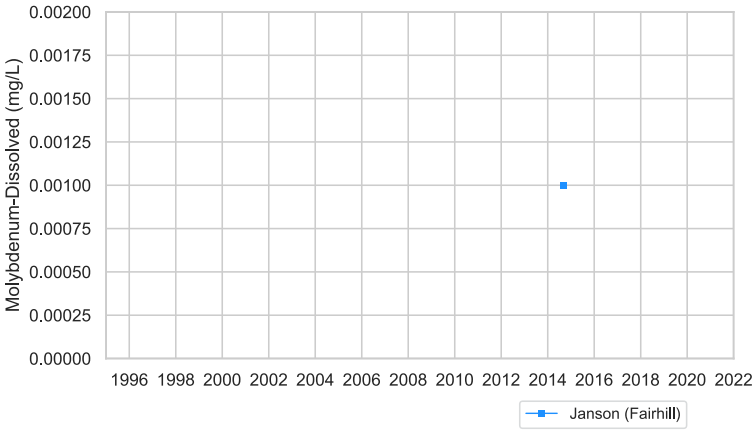

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

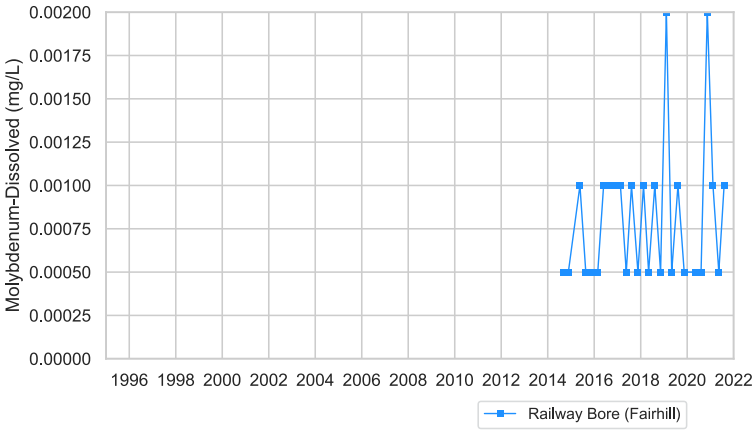

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

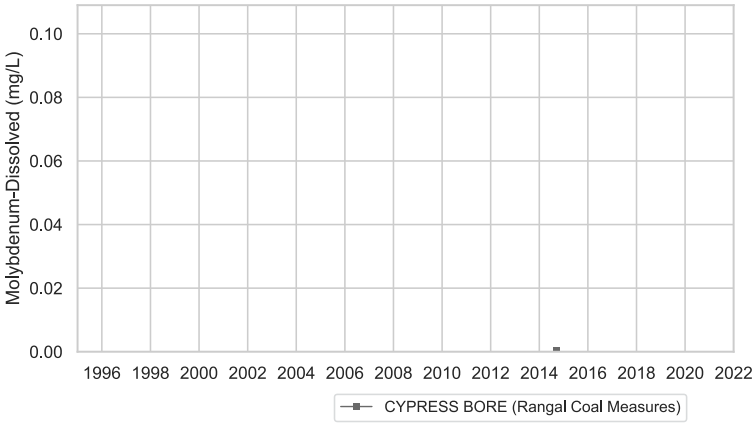

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

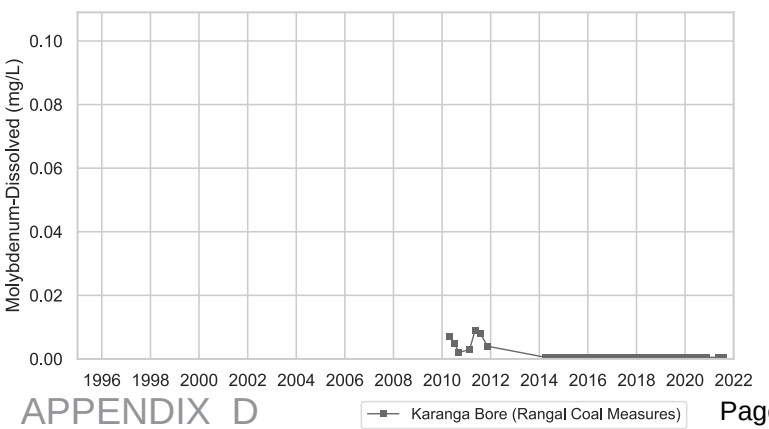

Molybdenum-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

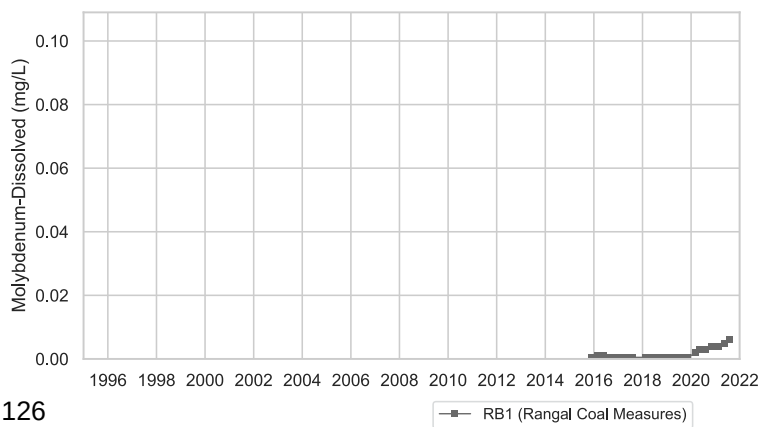

Molybdenum-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

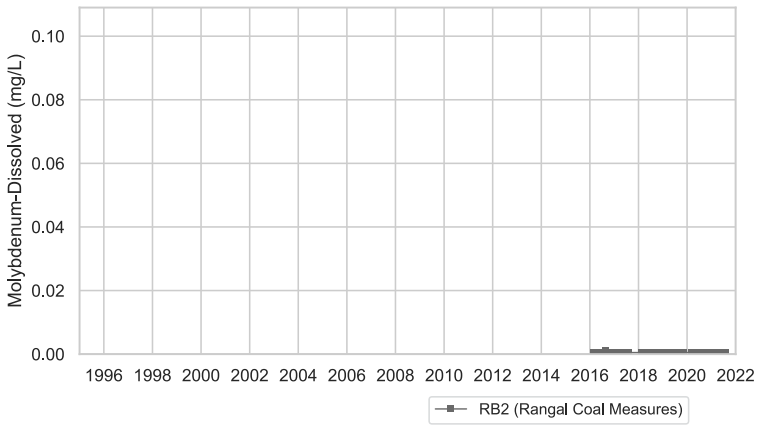

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

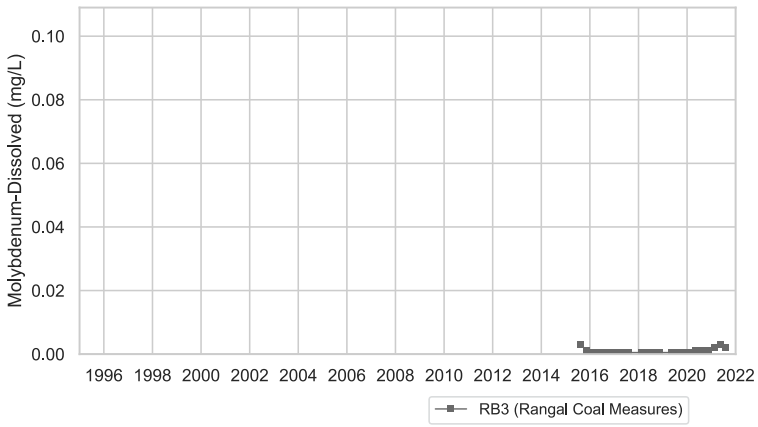

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

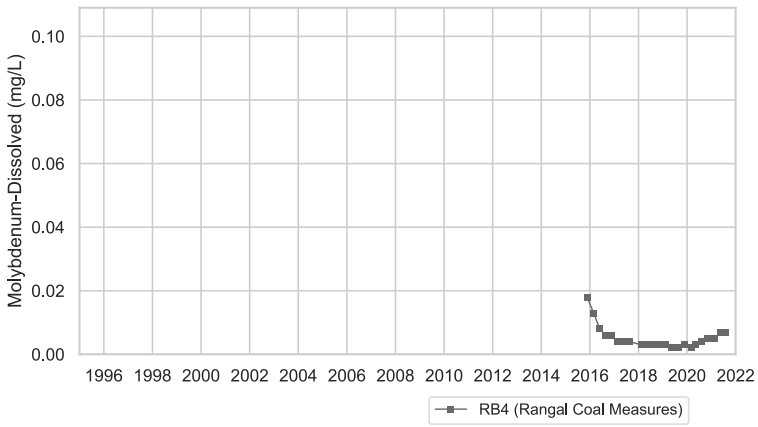

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

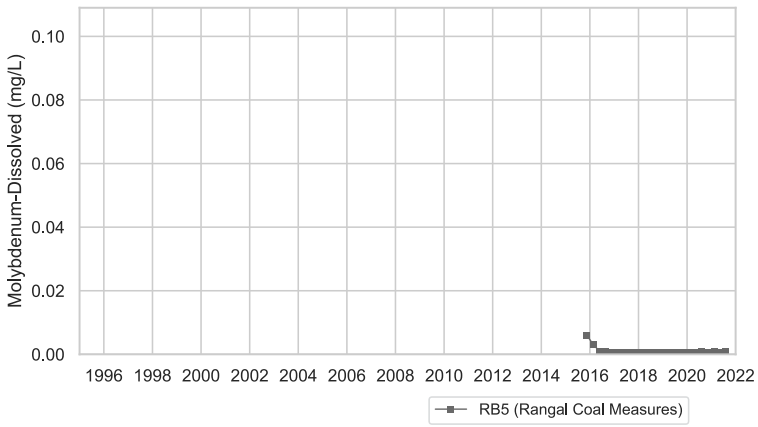

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

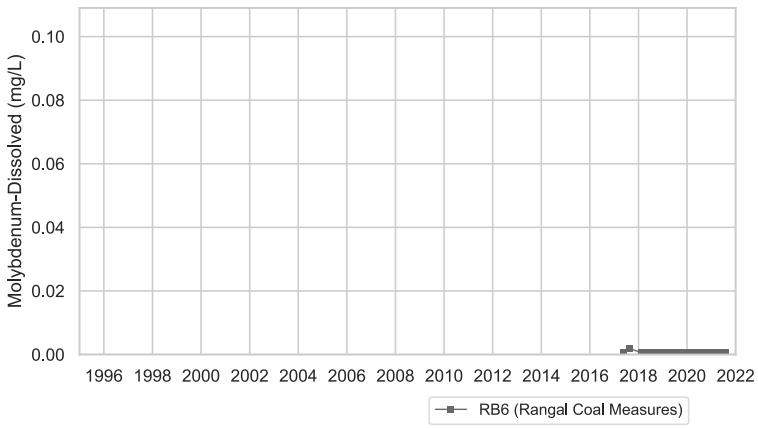

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

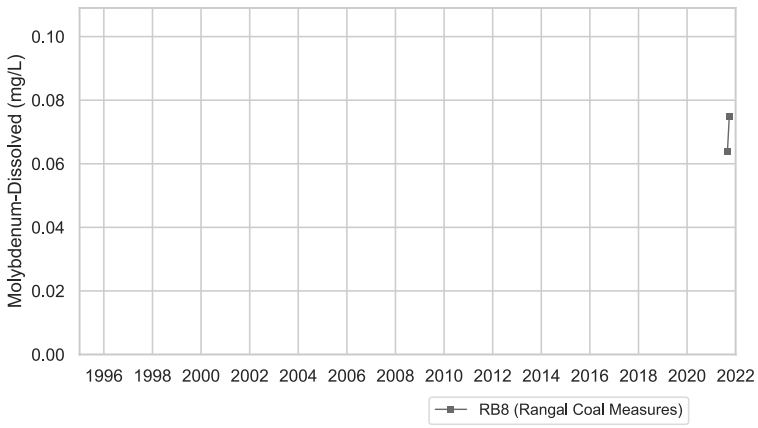

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

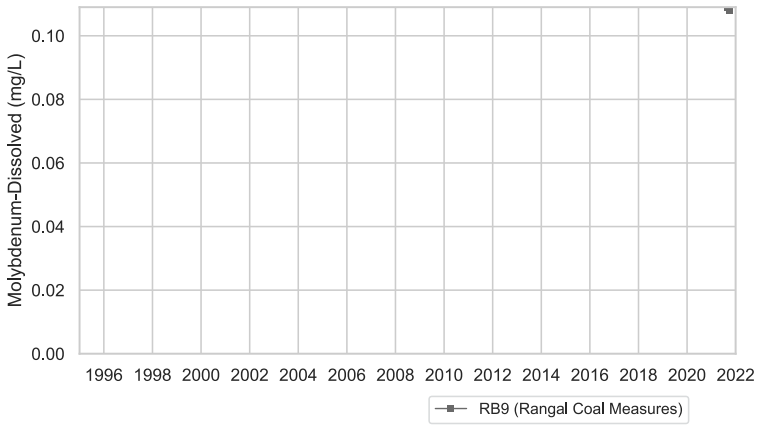

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

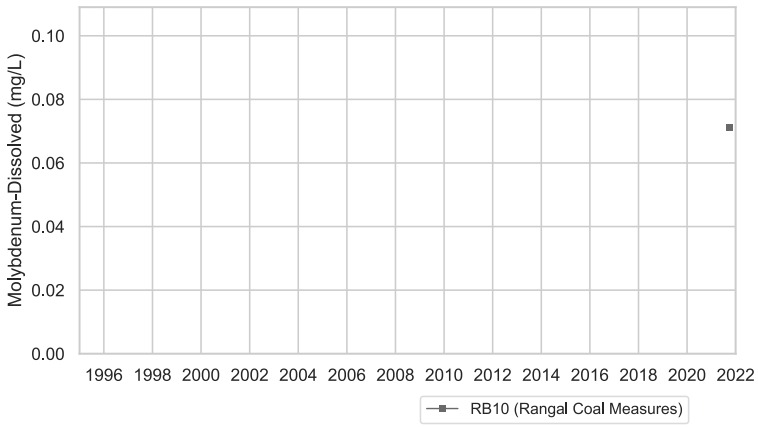

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

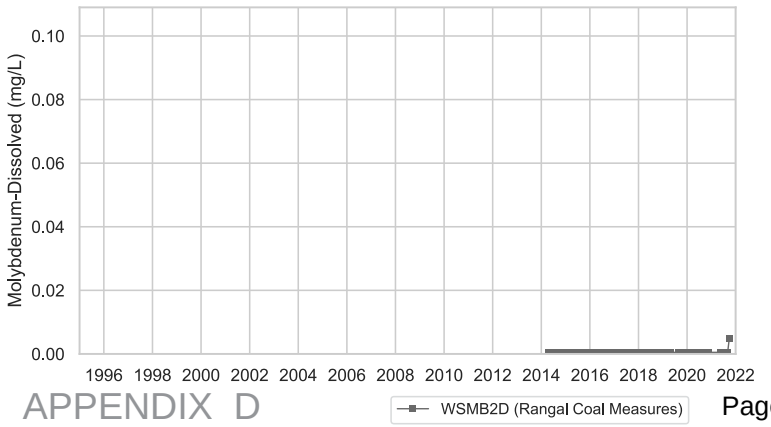

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

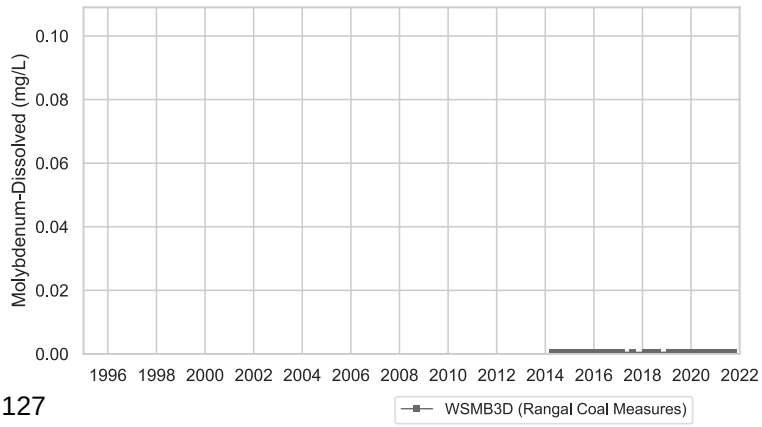

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

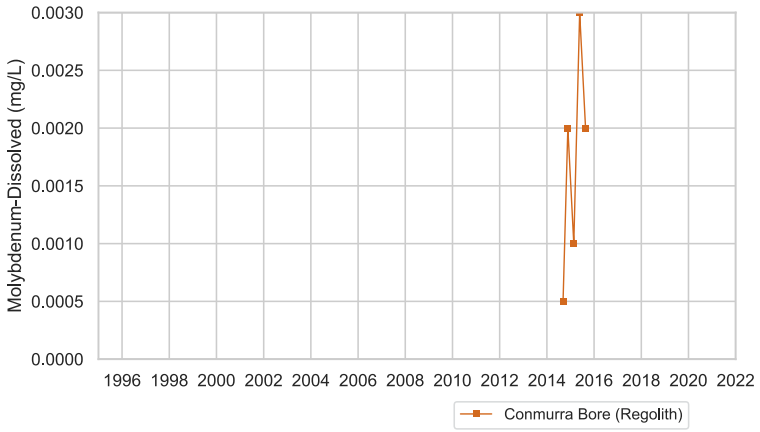

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

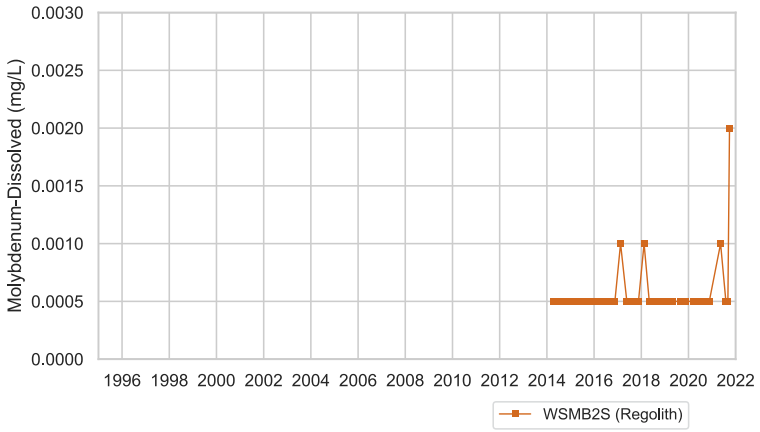

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

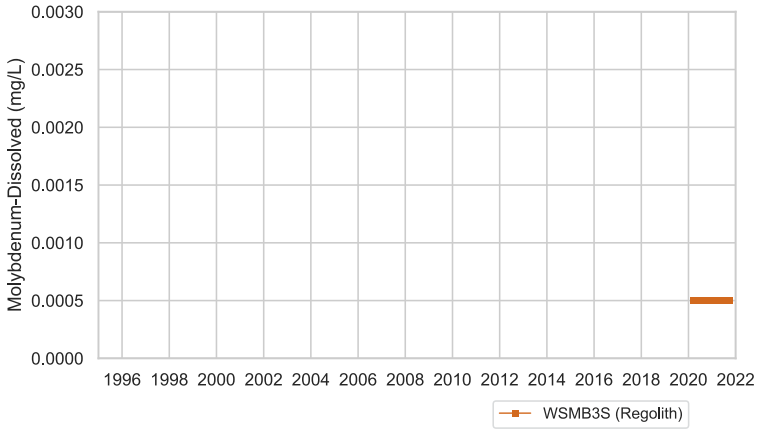

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

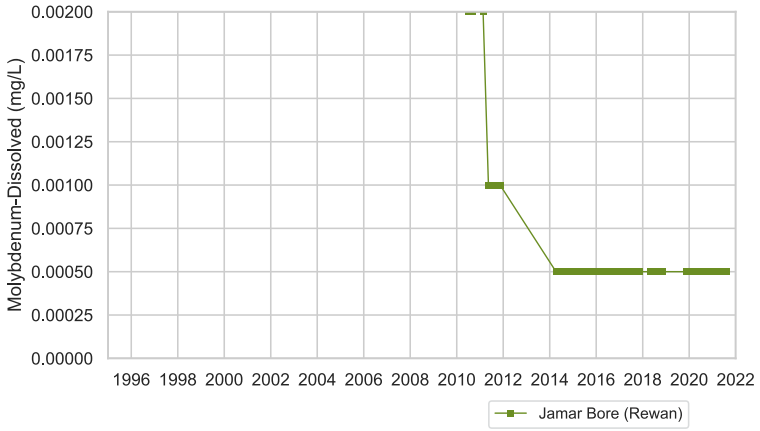

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

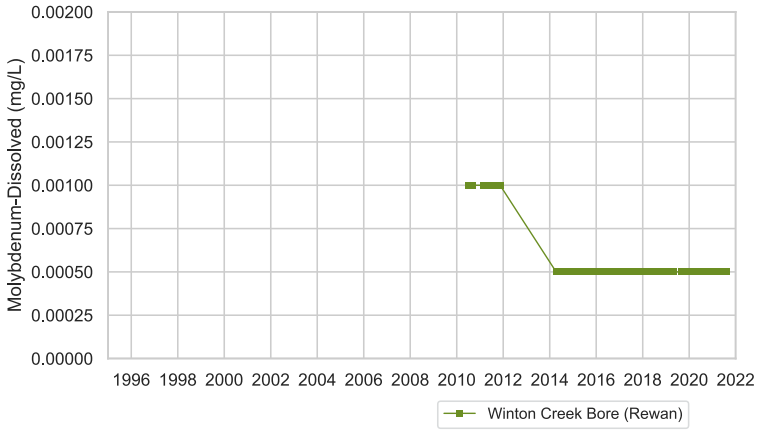

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

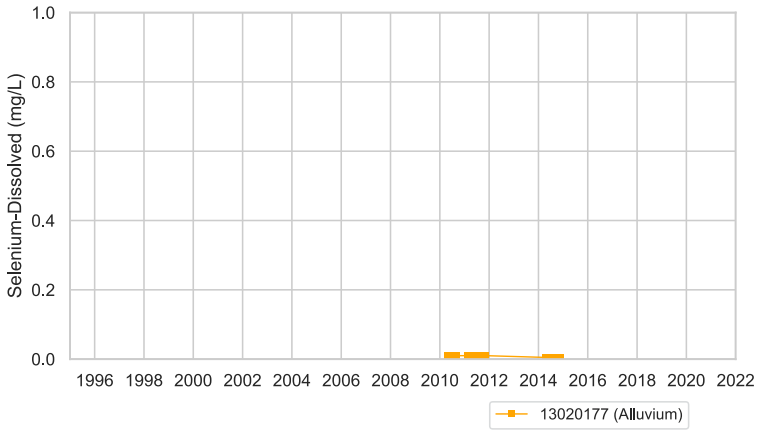

Molybdenum-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

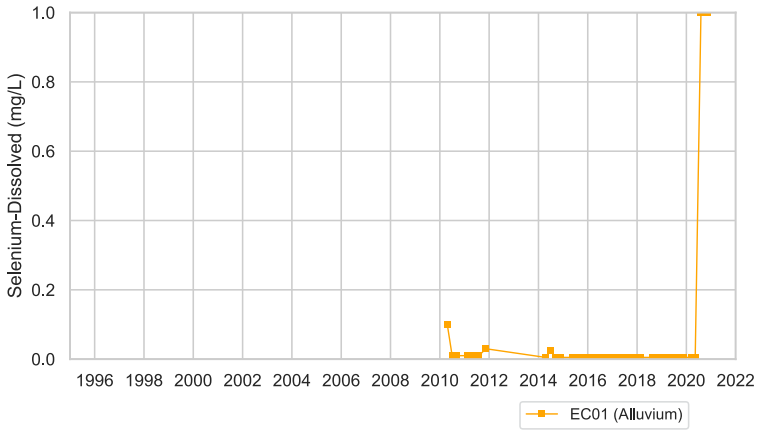

Molybdenum-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

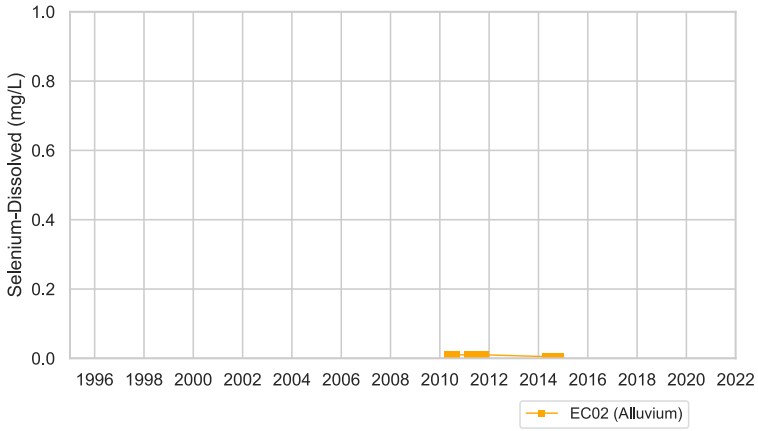

Molybdenum-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

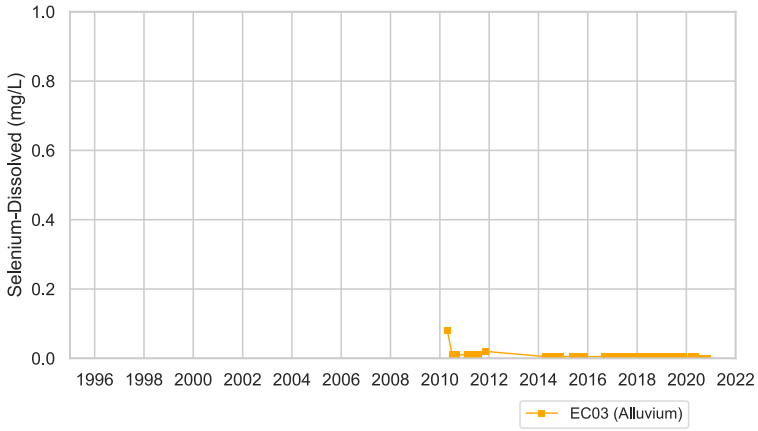

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

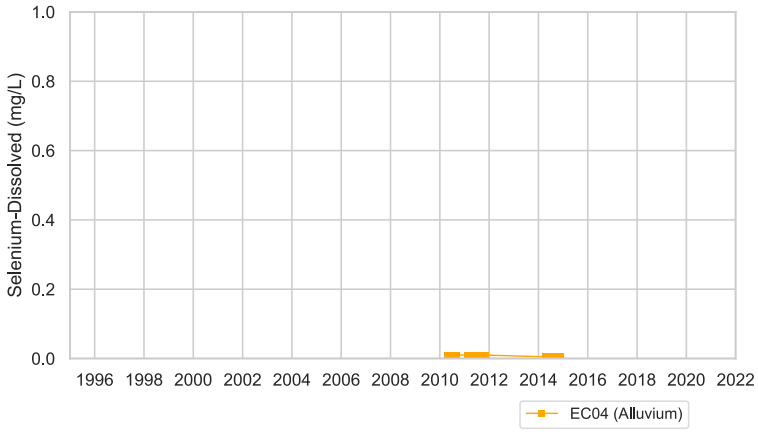

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

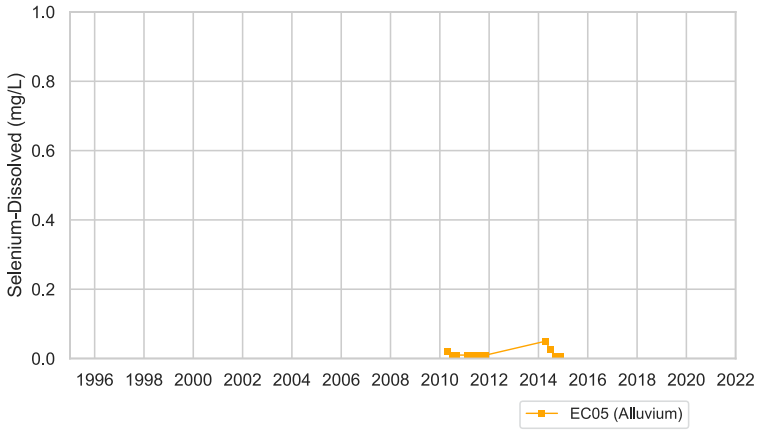

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

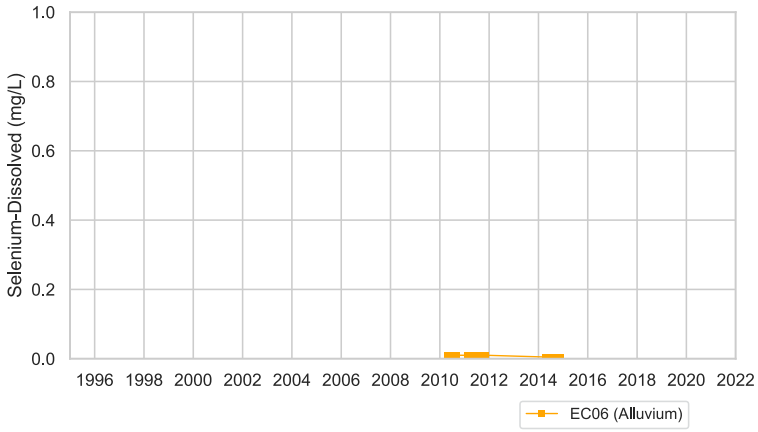

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

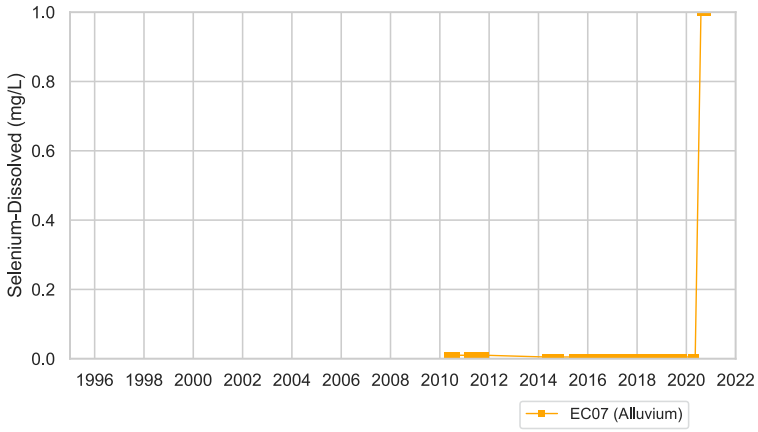

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

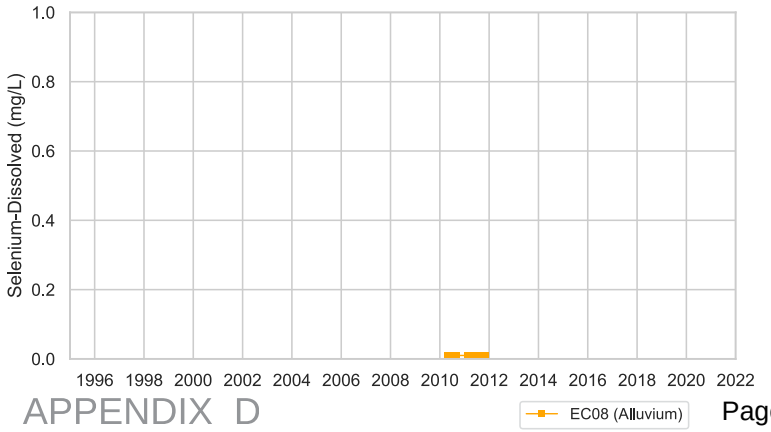

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

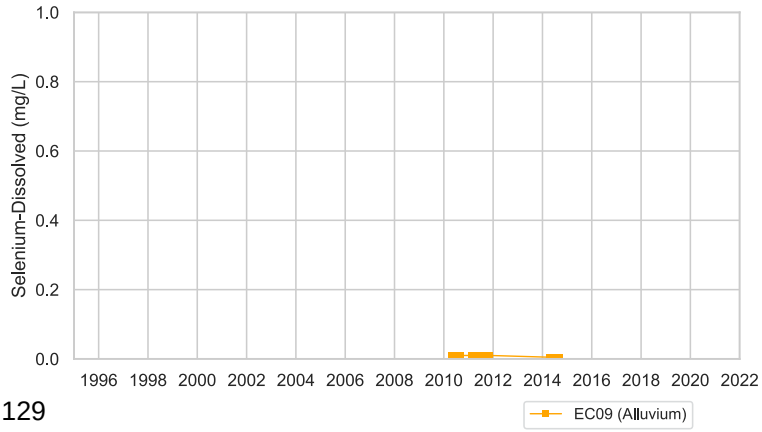

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

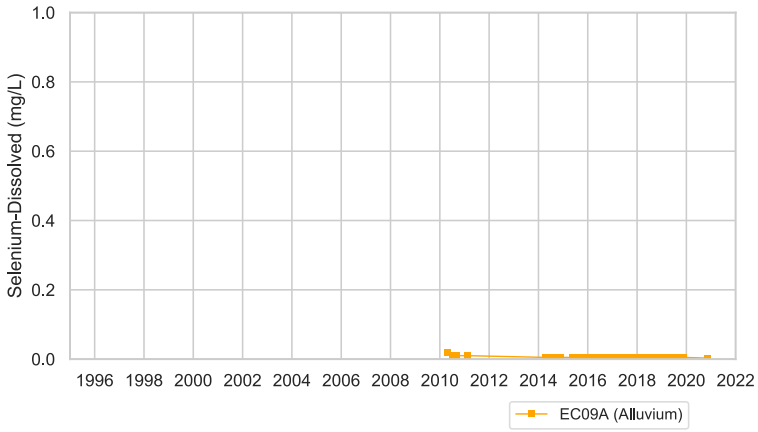

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

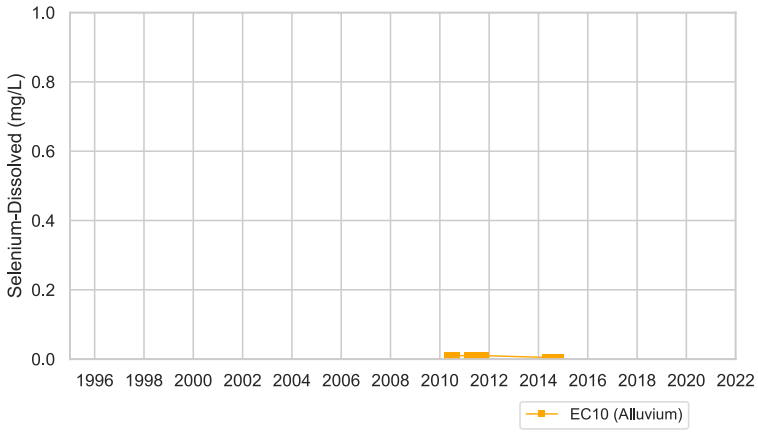

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

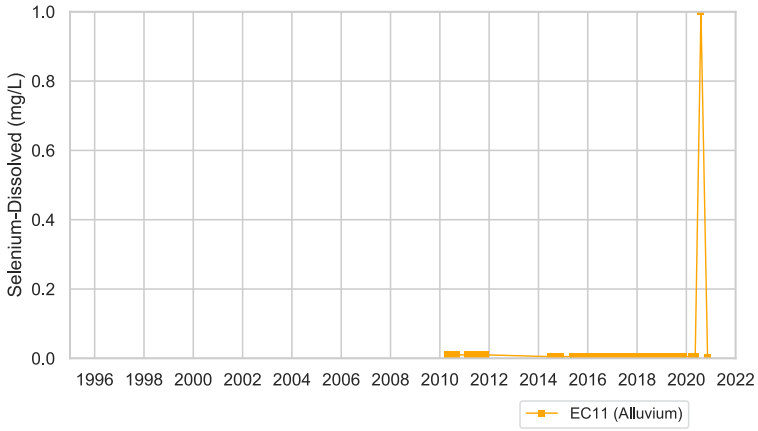

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

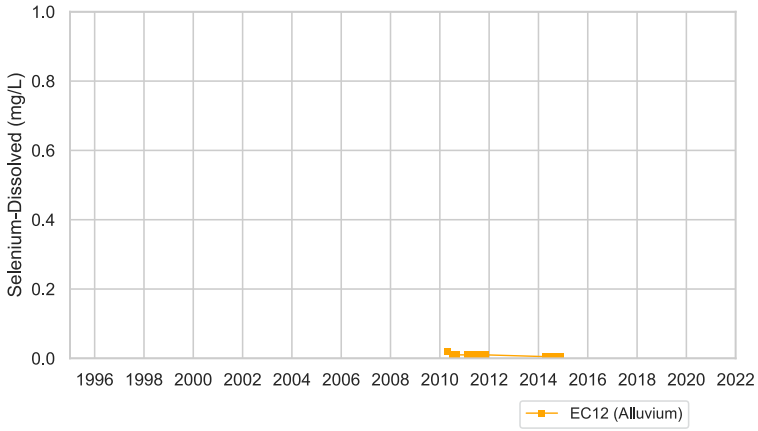

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

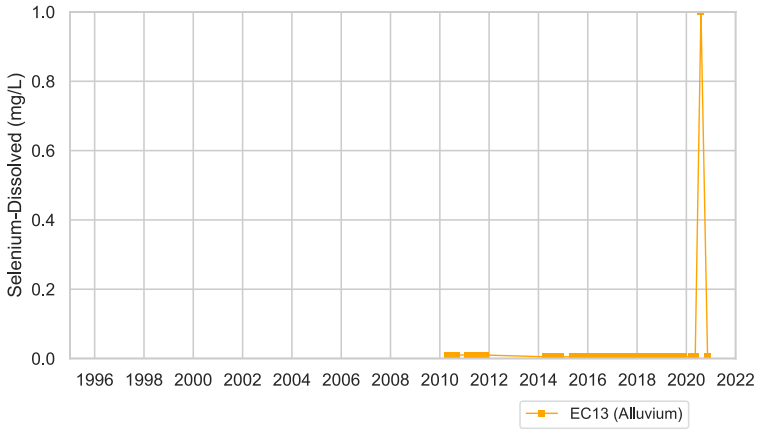

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

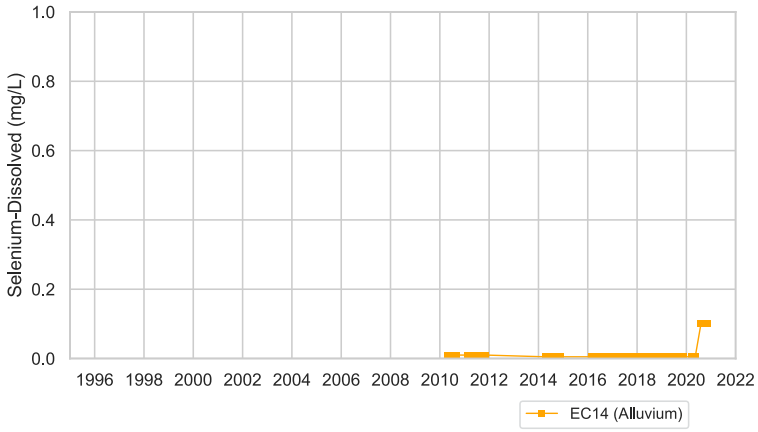

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

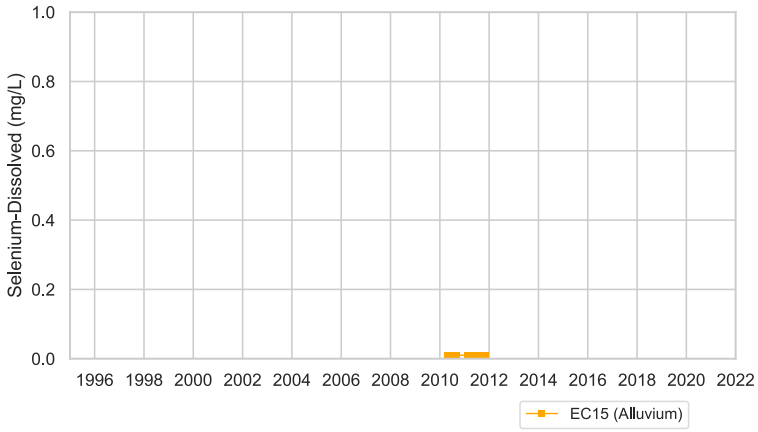

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

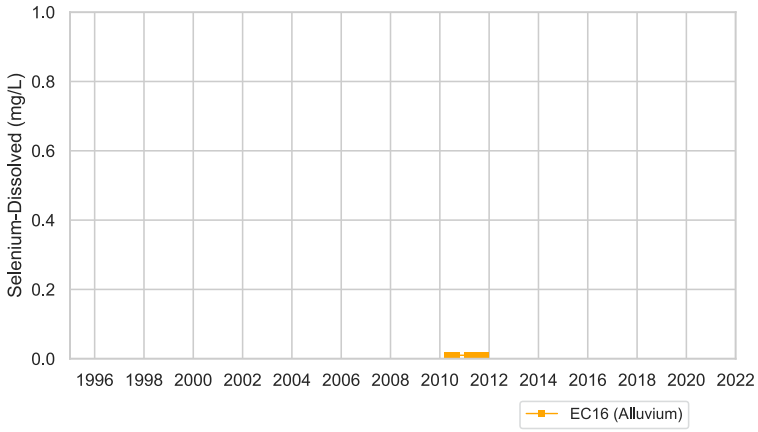

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

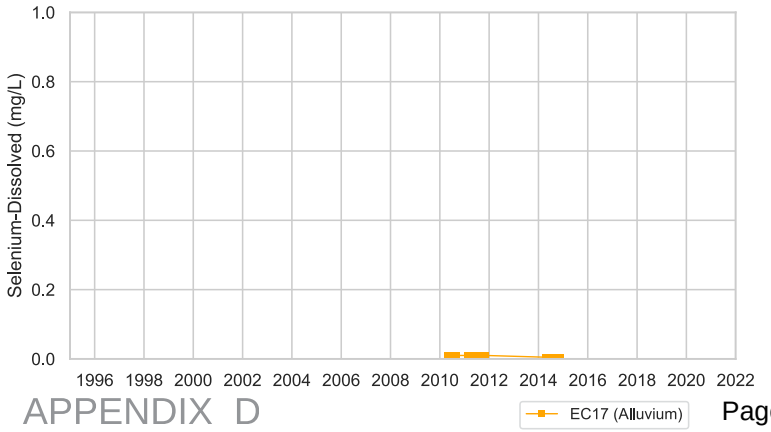

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

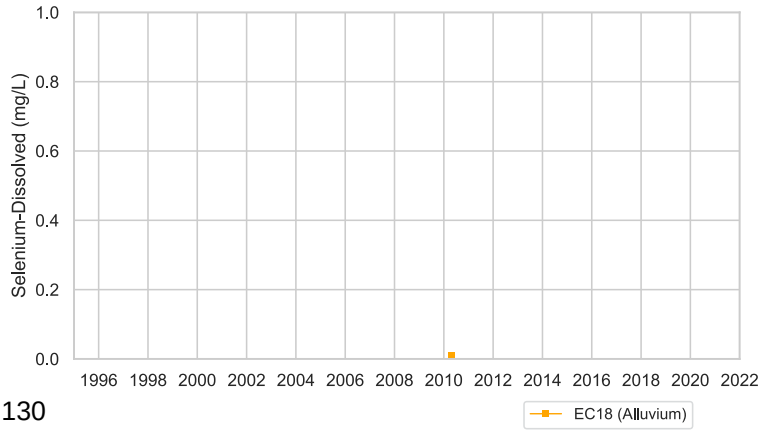

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

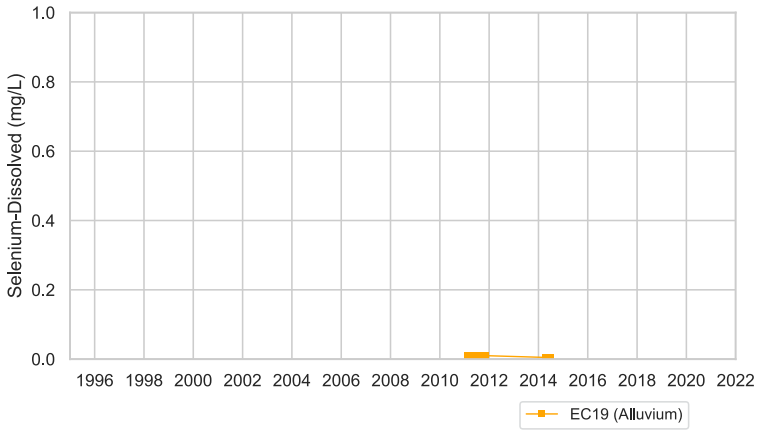

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

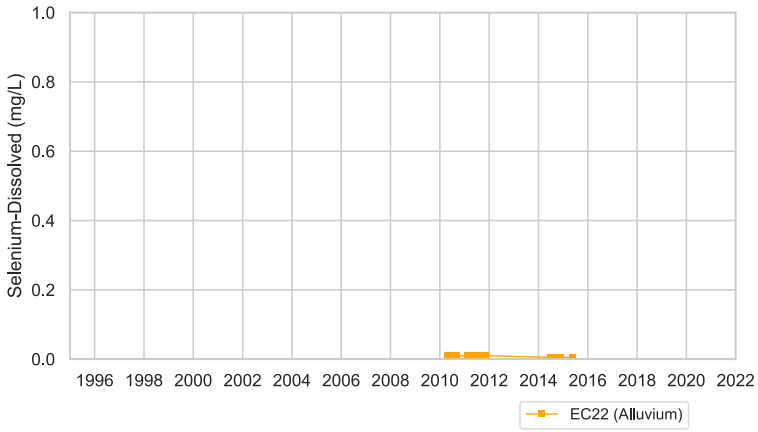

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

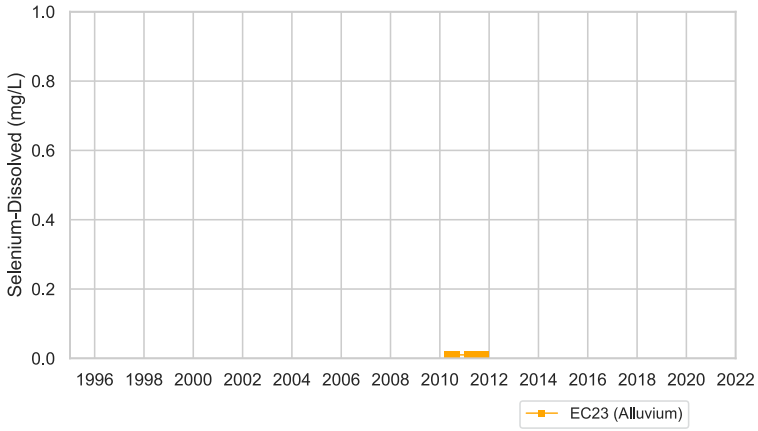

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

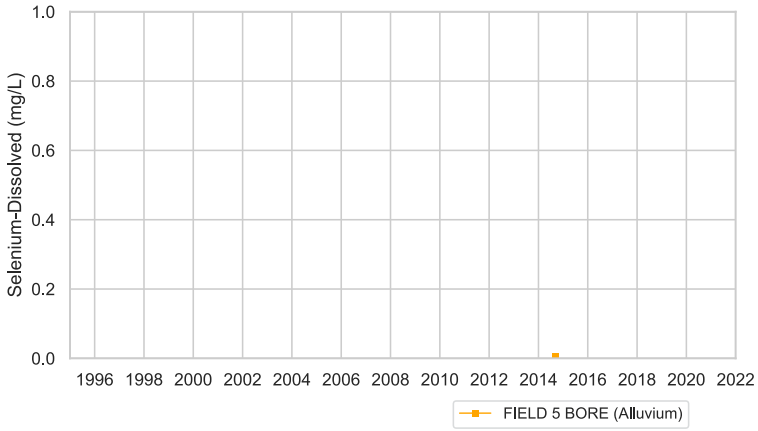

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

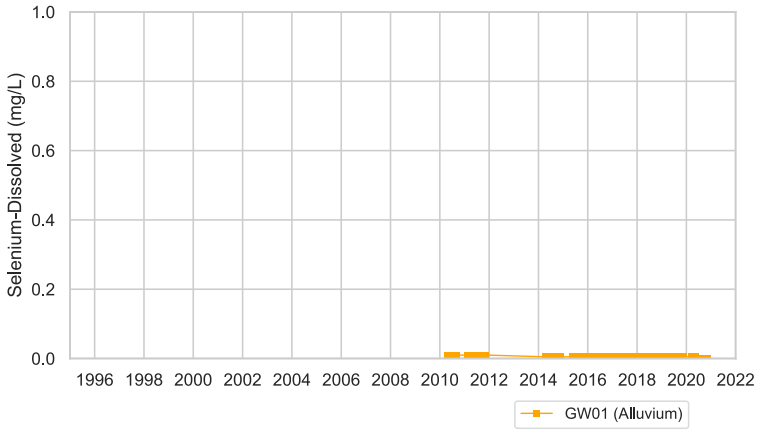

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

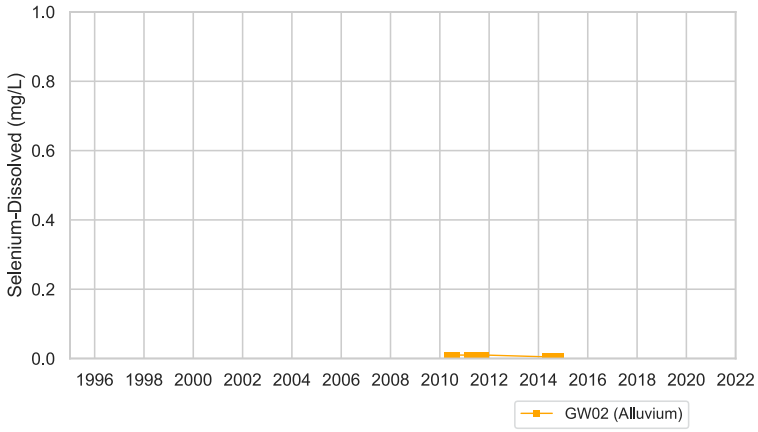

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

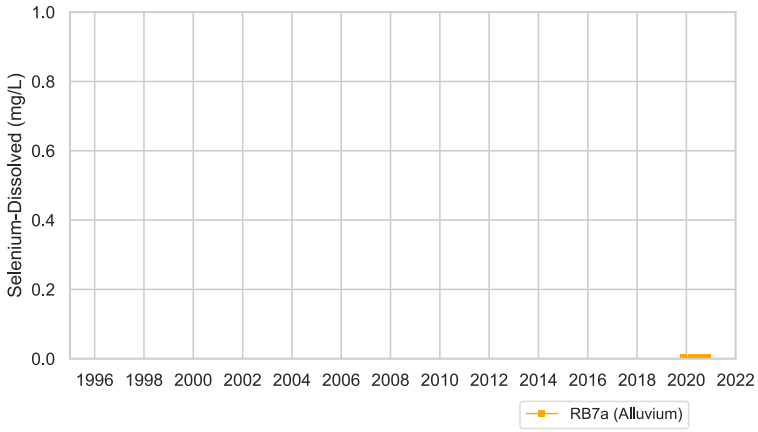

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

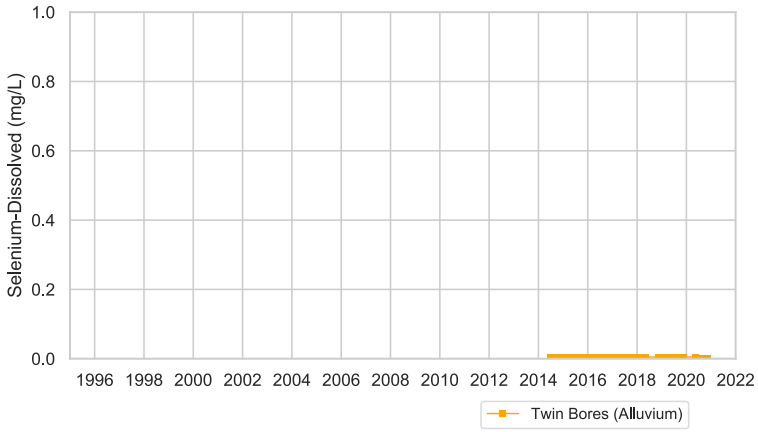

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

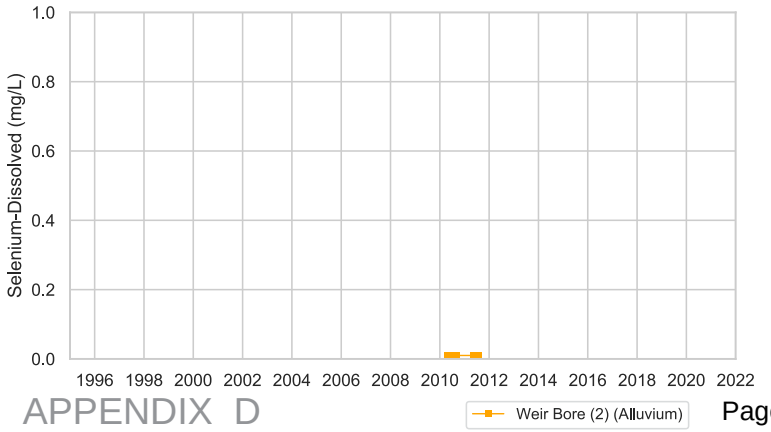

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

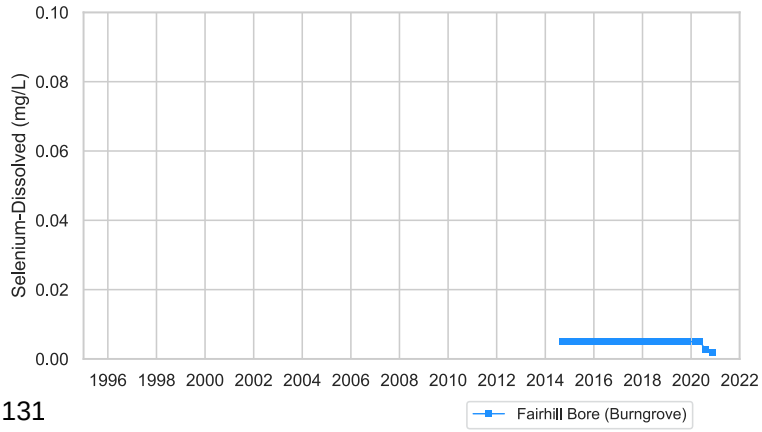

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

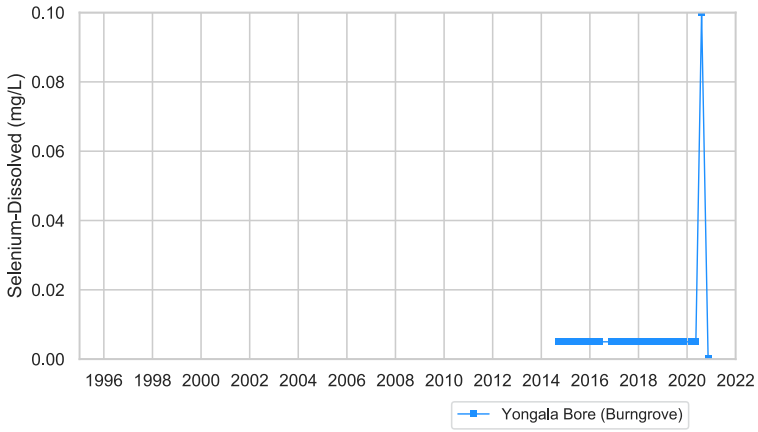

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

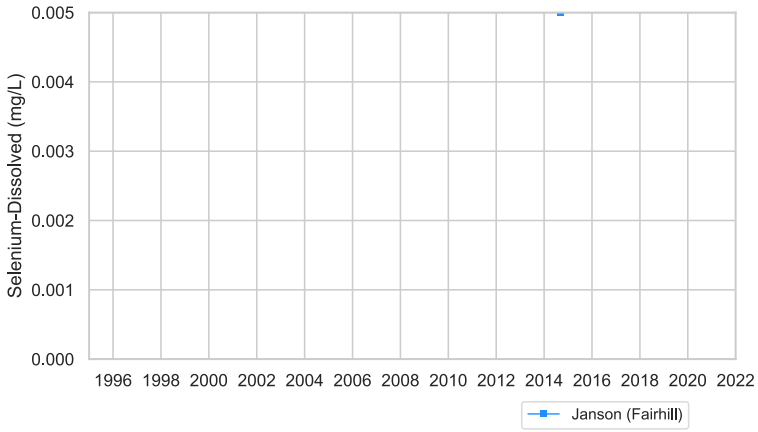

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

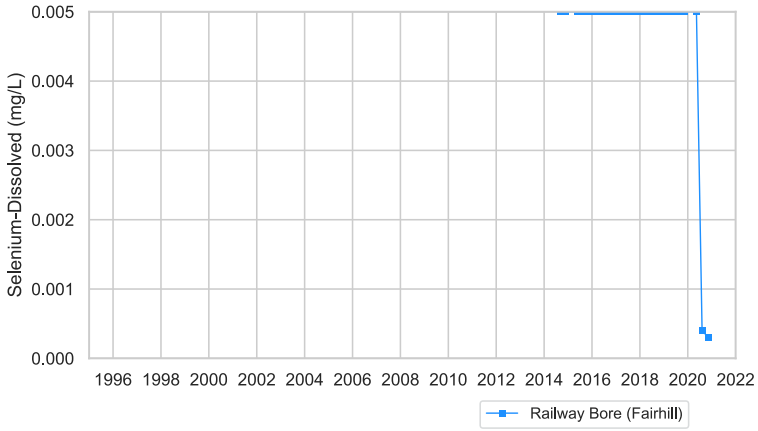

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

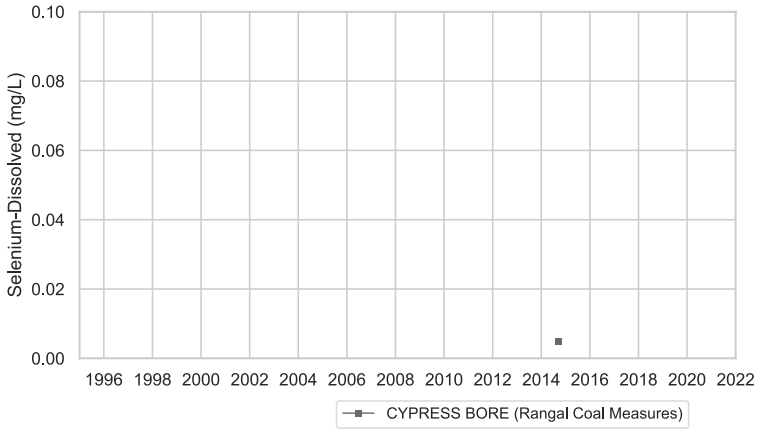

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

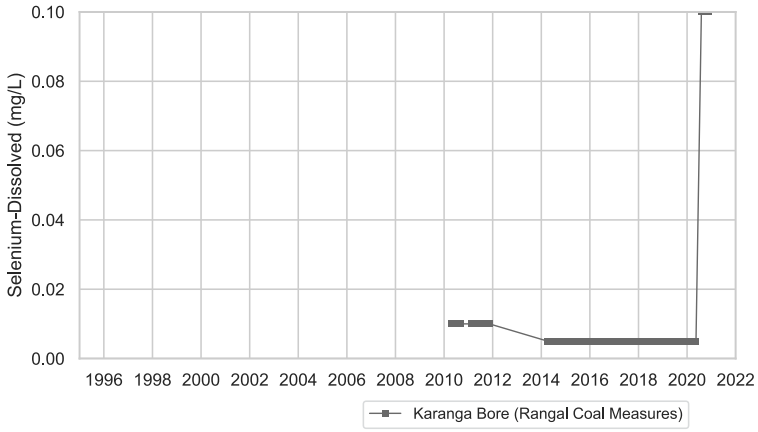

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

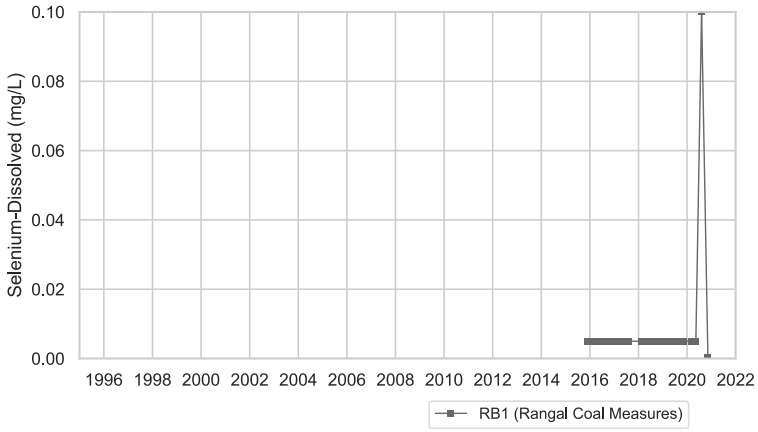

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

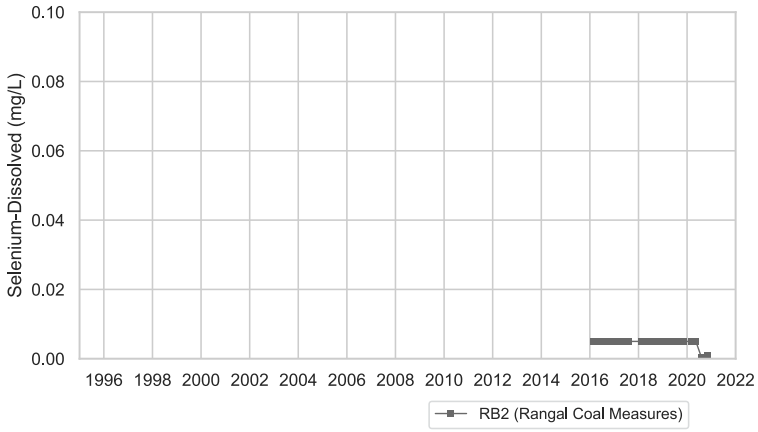

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

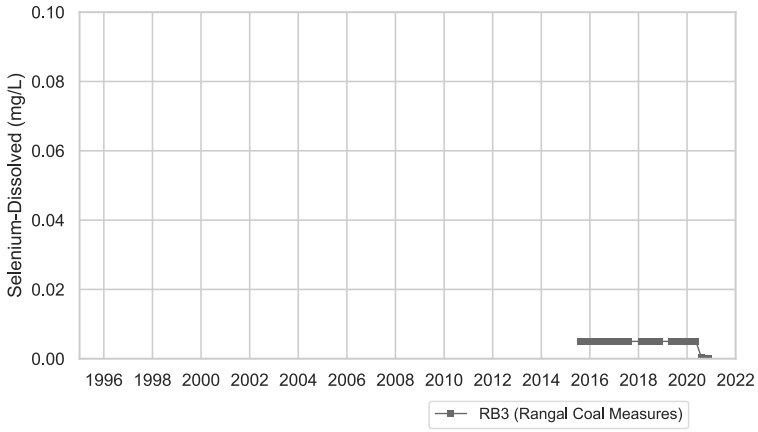

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

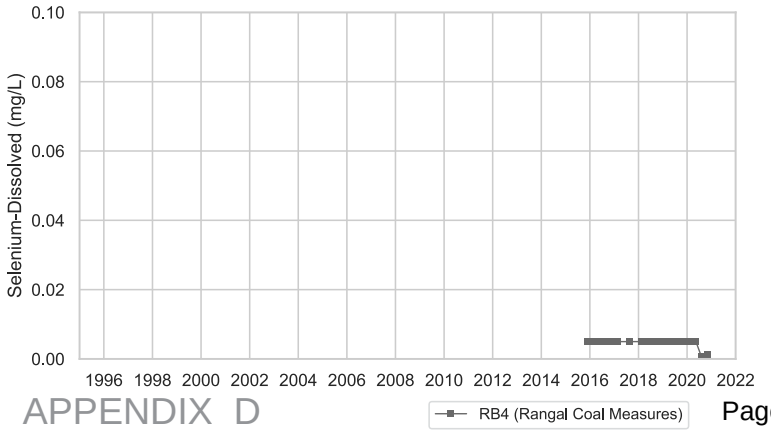

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

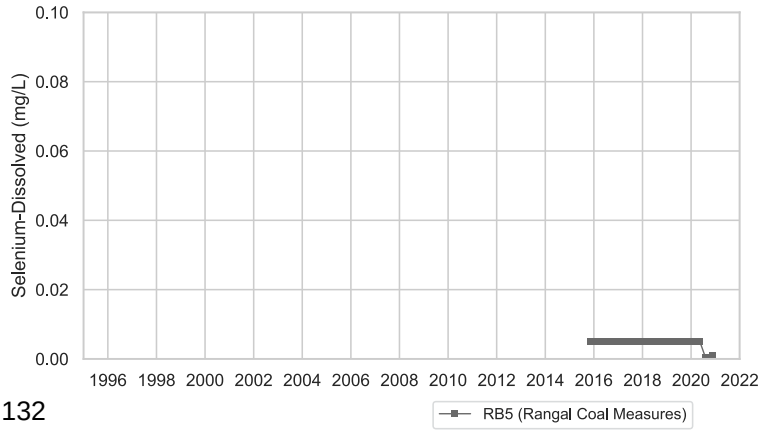

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

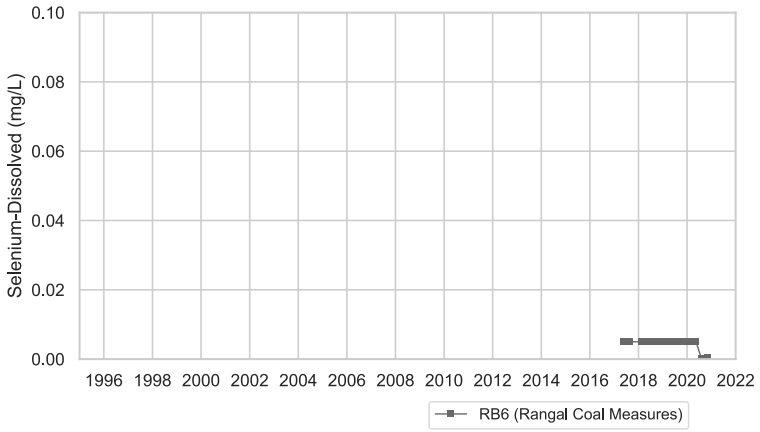

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

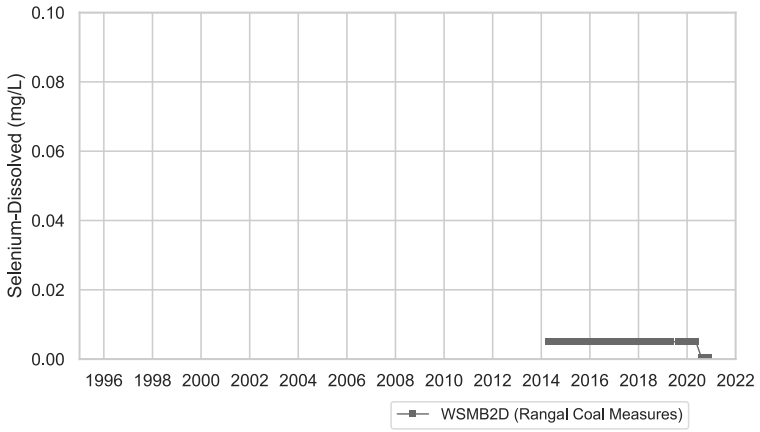

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

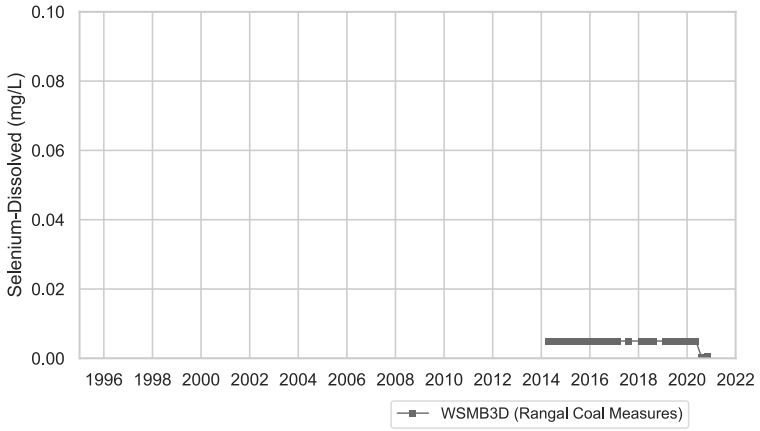

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

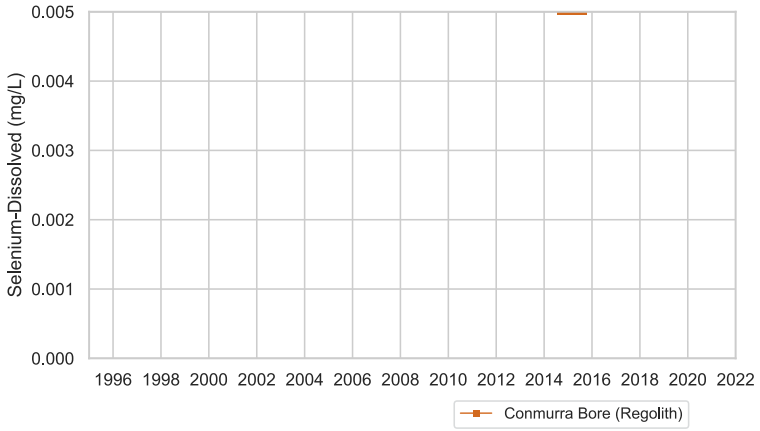

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

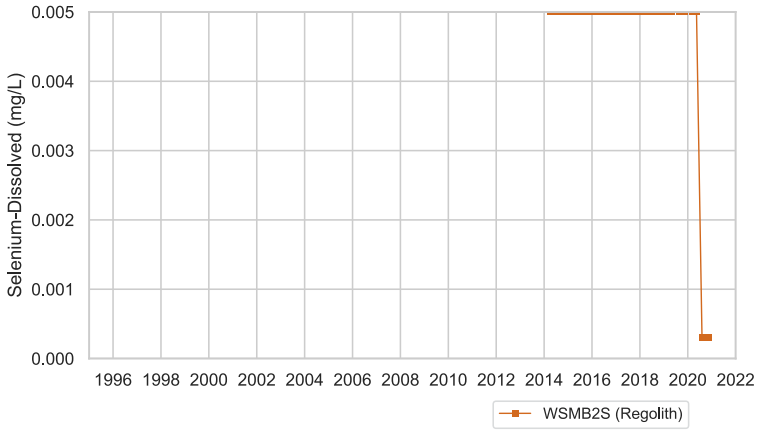

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

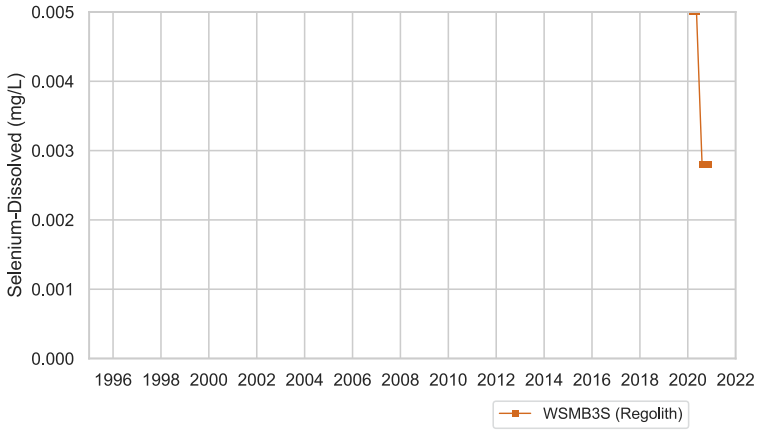

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

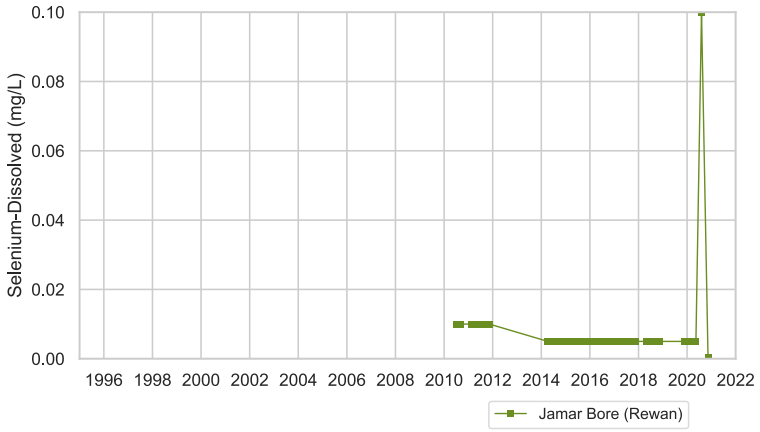

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

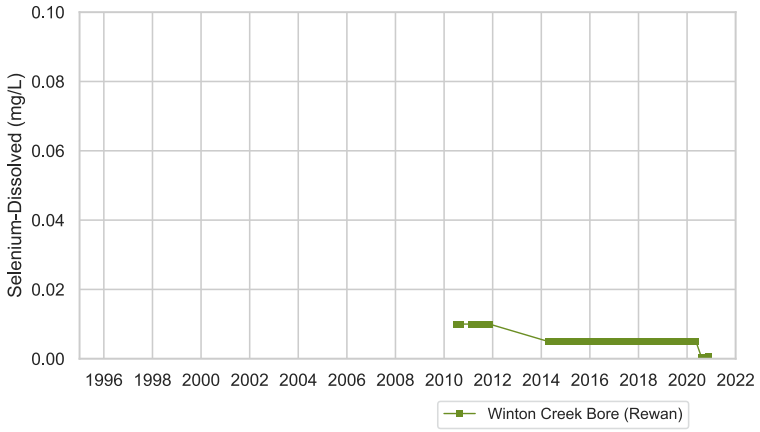

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

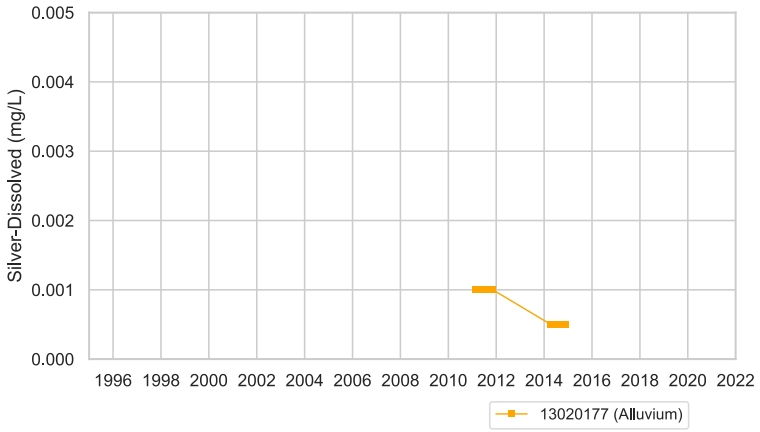

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

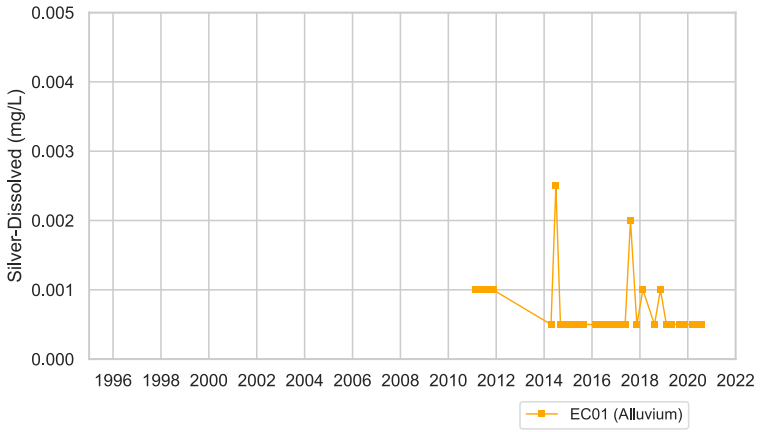

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

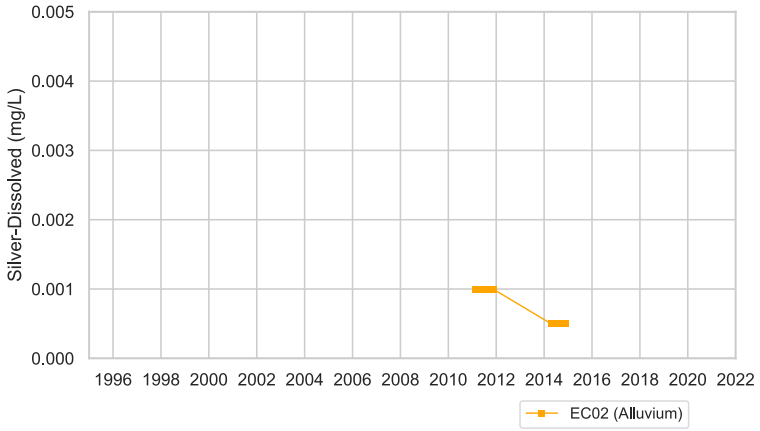

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

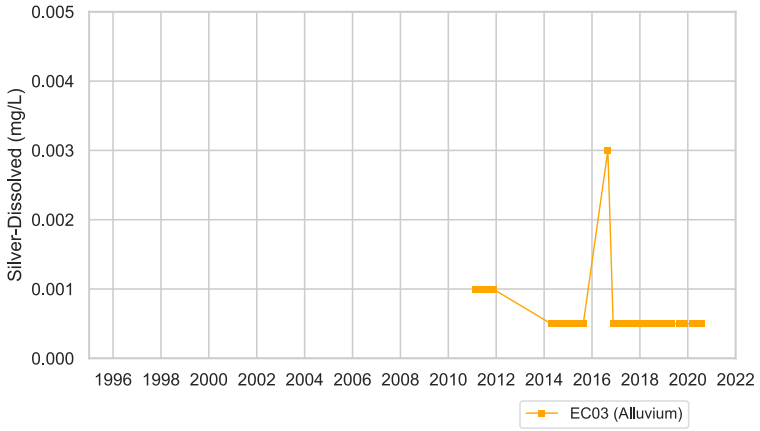

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

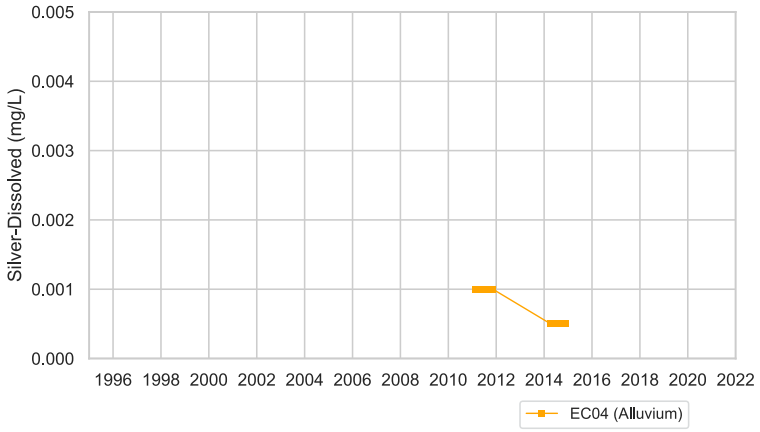

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

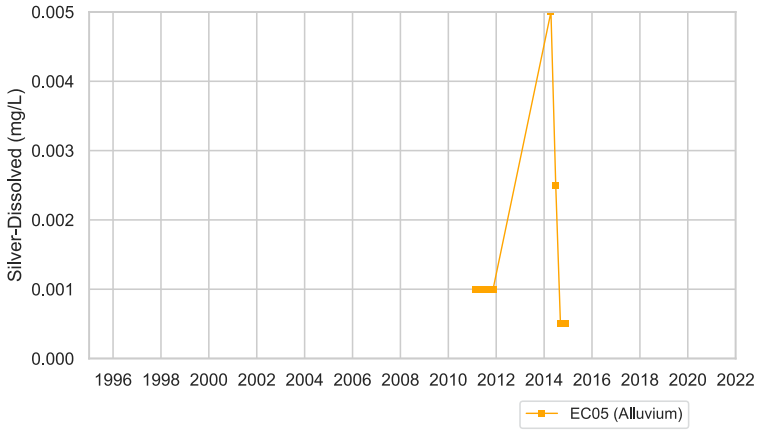

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

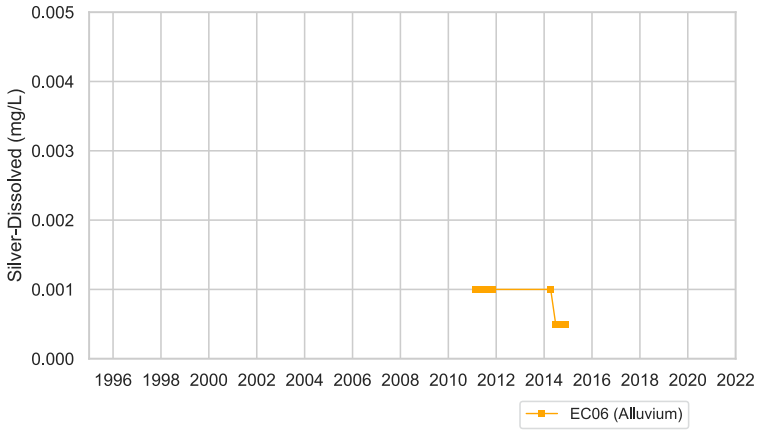

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

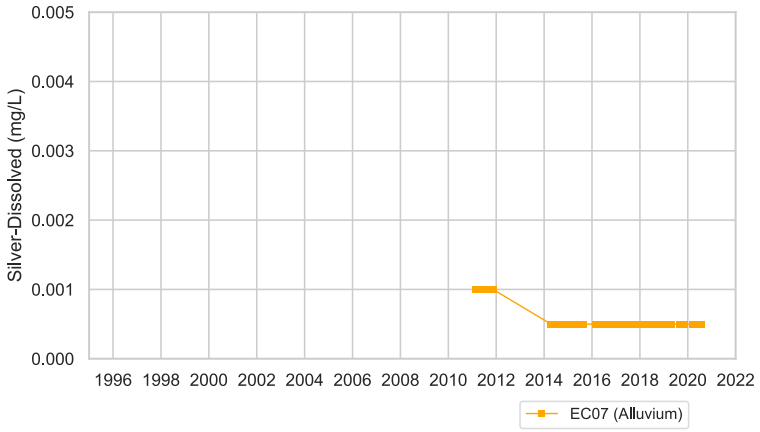

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

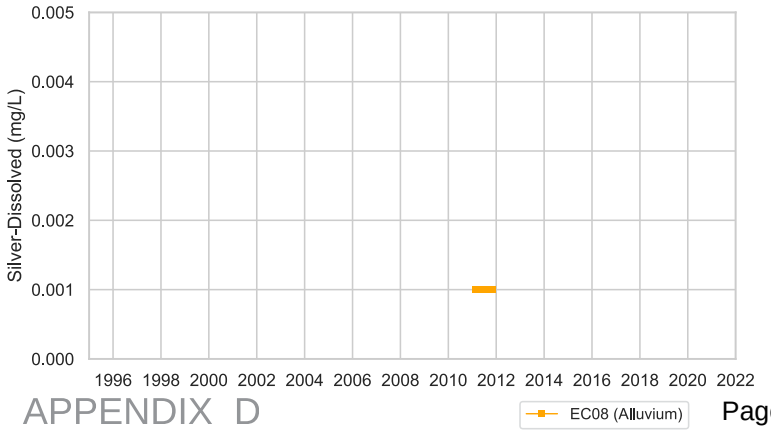

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

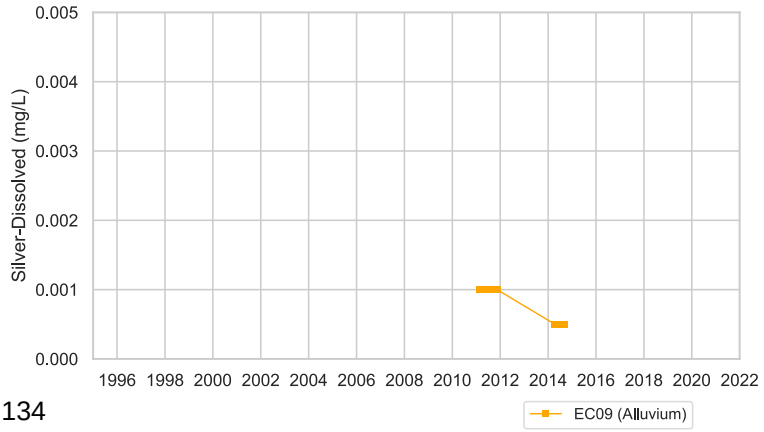

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

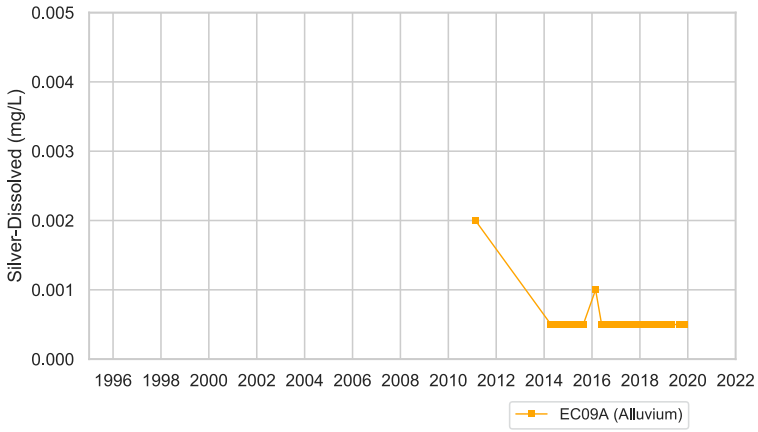

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

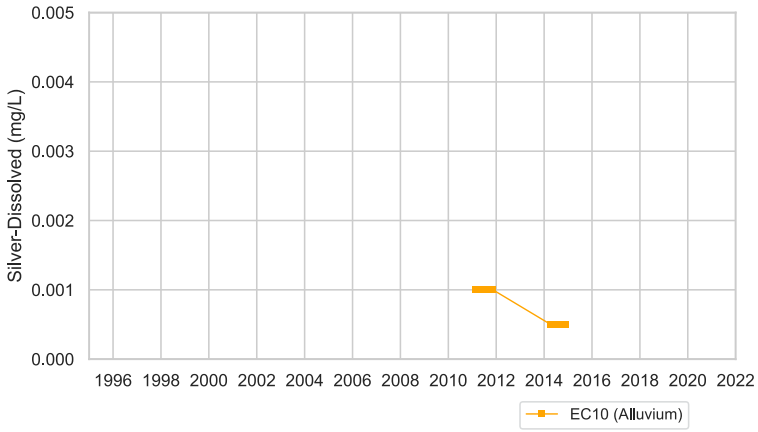

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

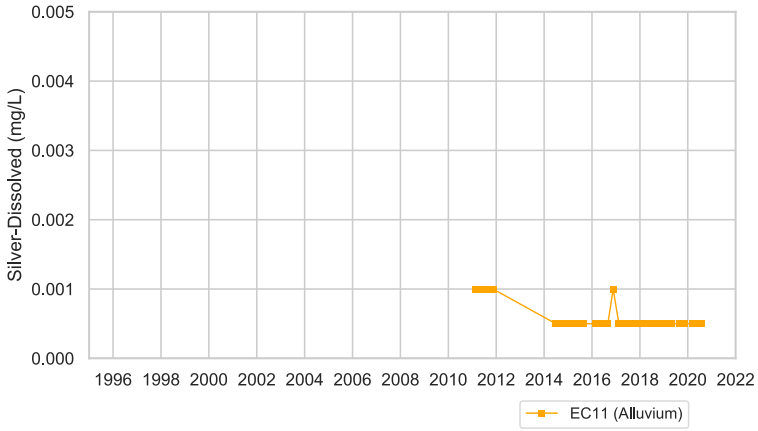

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

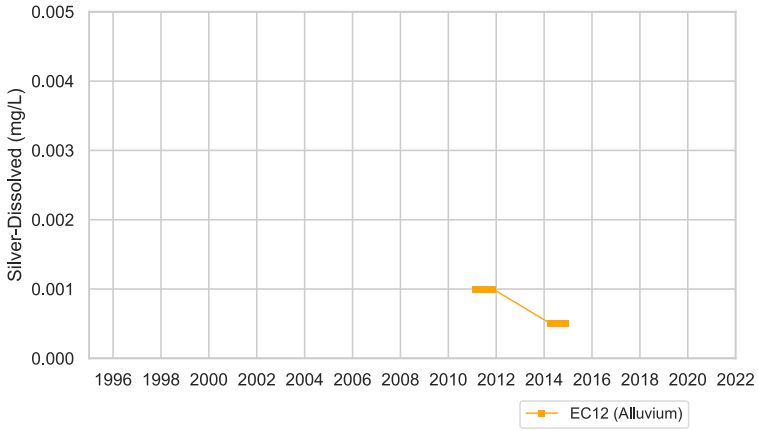

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

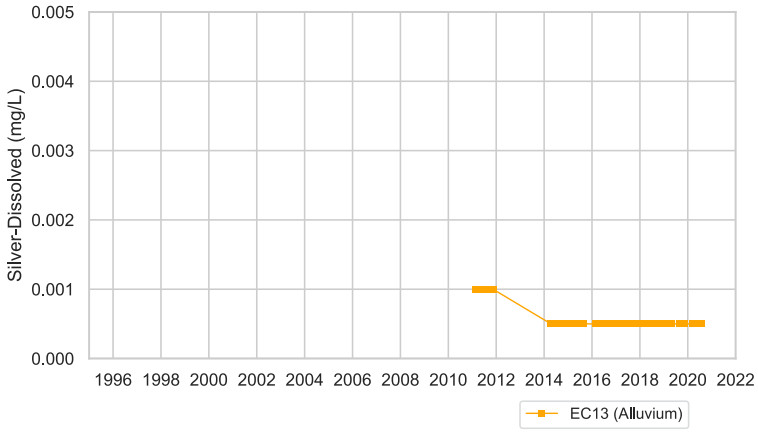

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

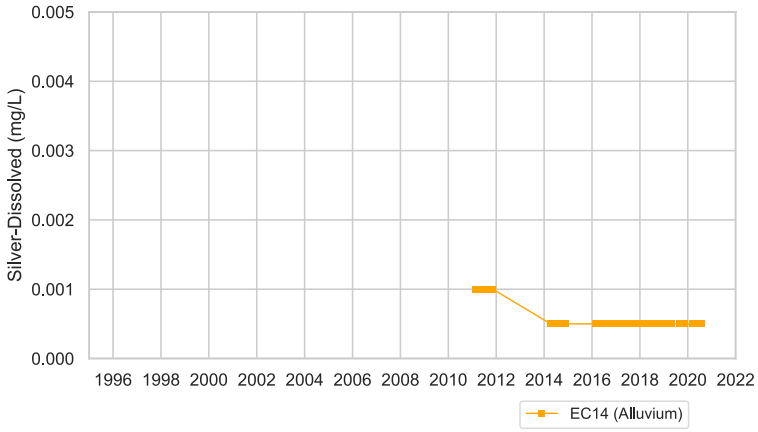

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

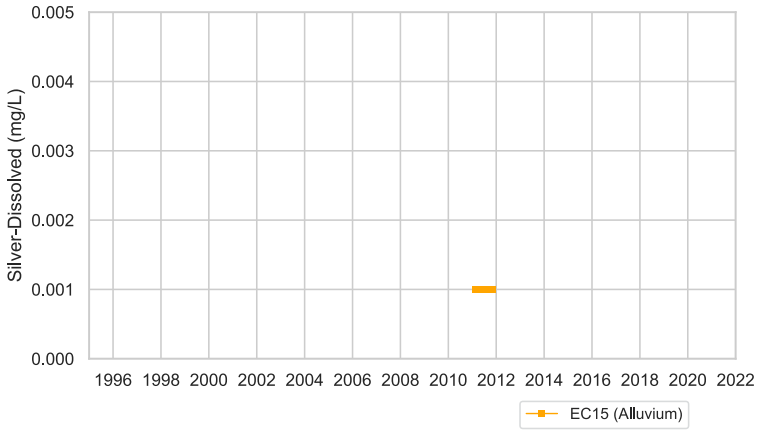

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

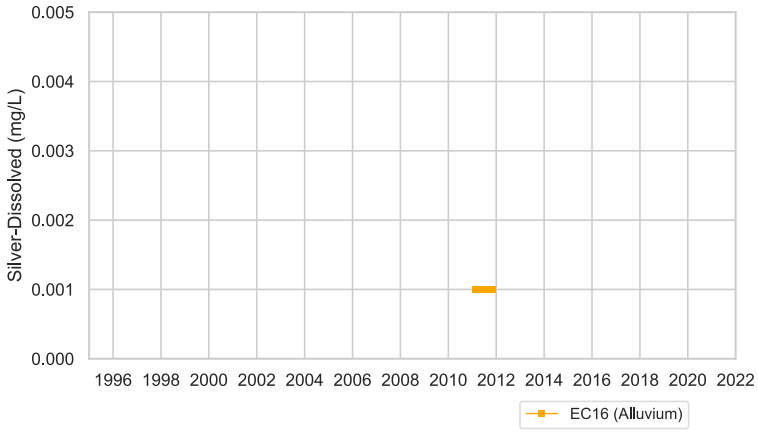

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

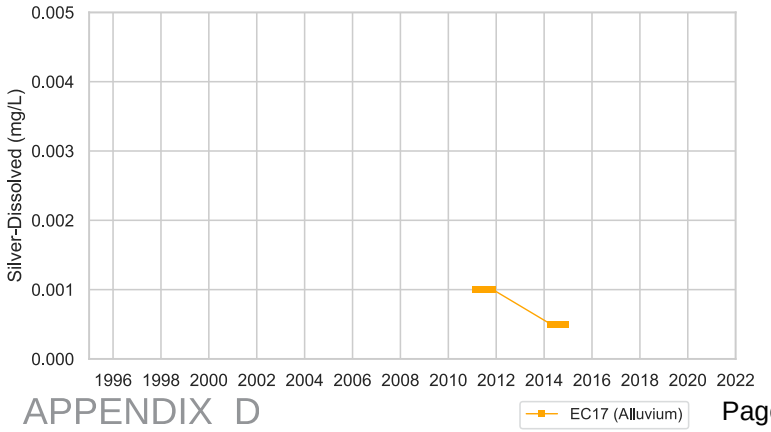

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

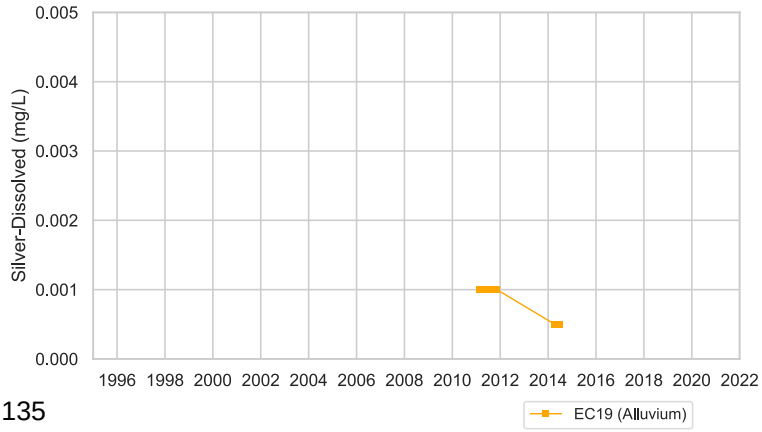

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

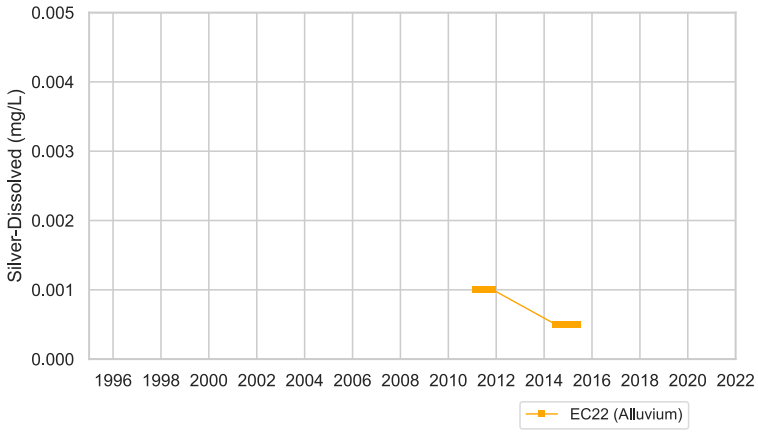

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

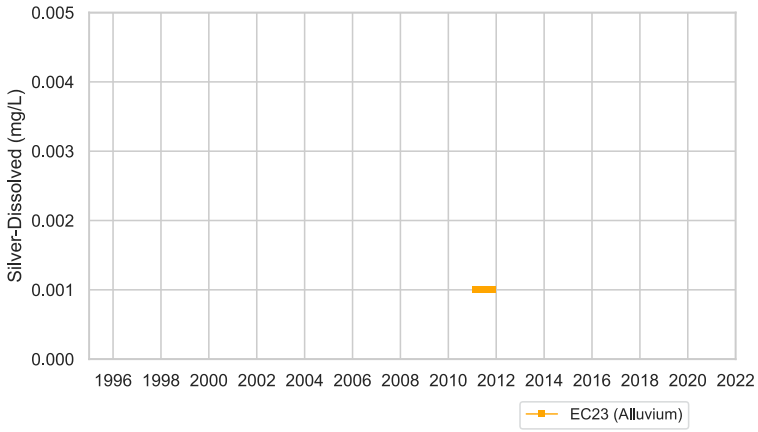

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

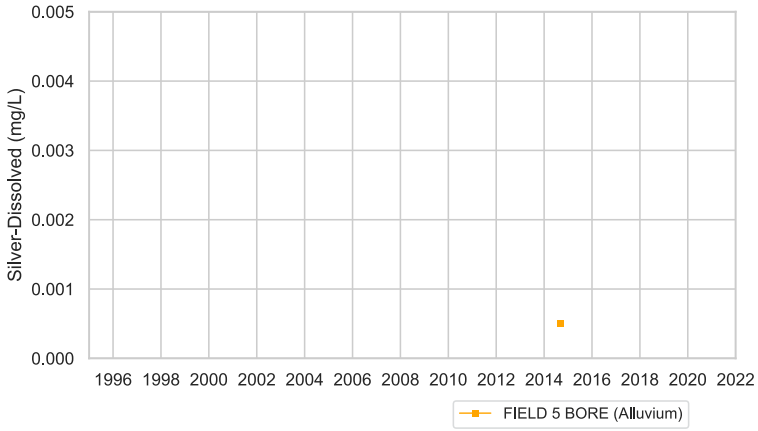

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

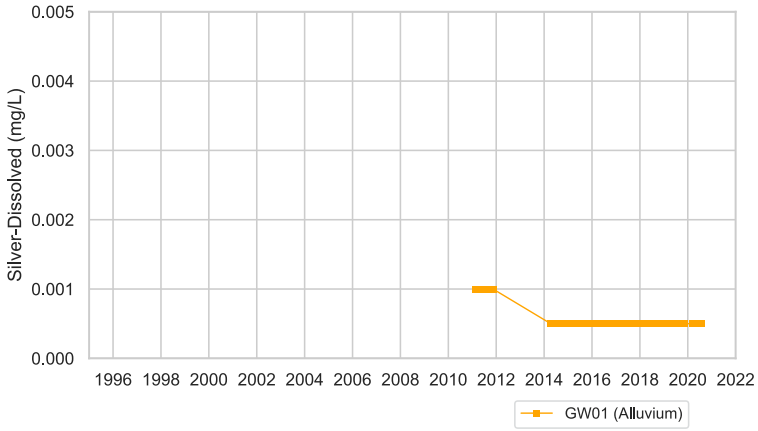

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

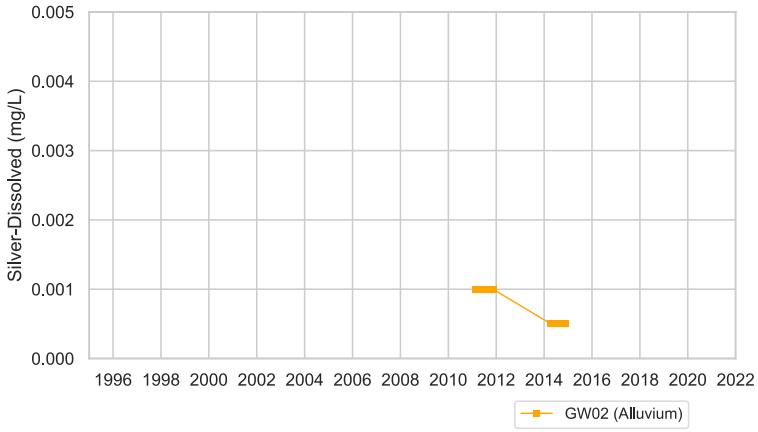

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

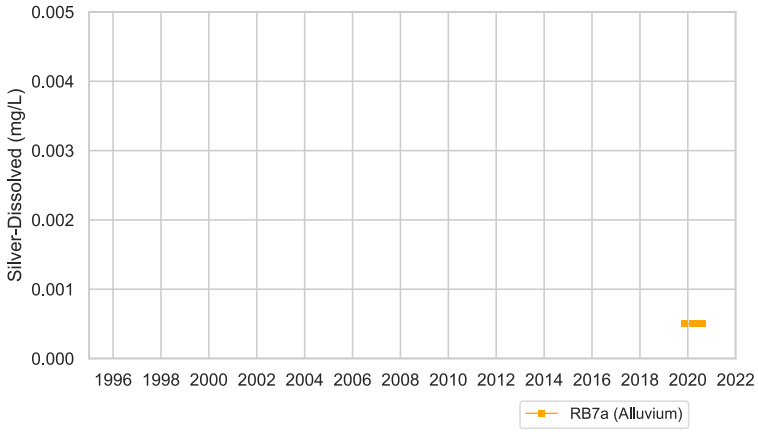

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

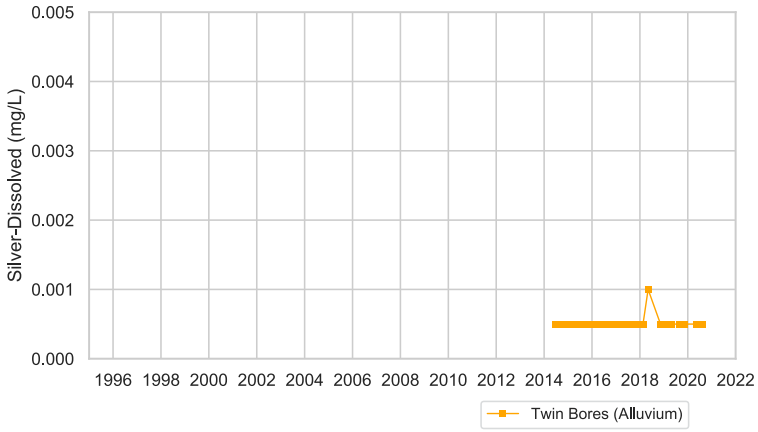

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

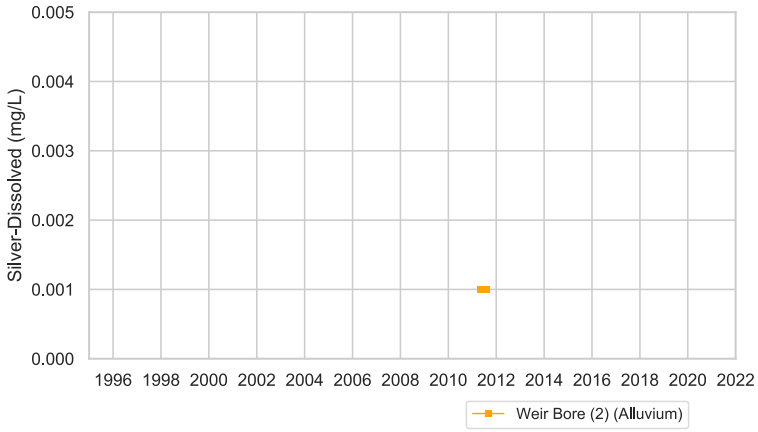

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

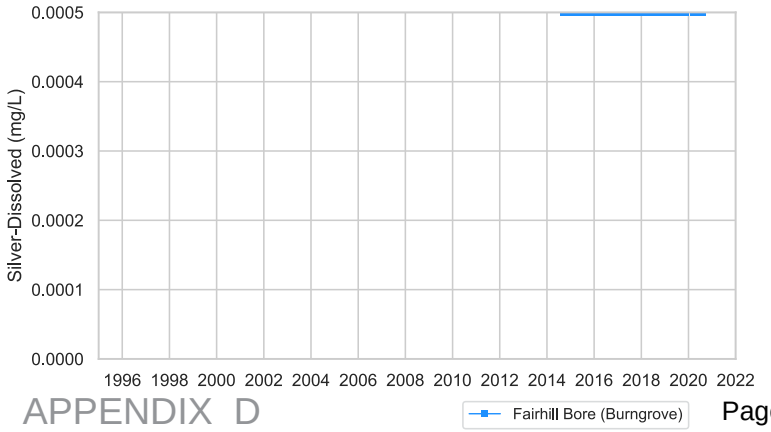

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

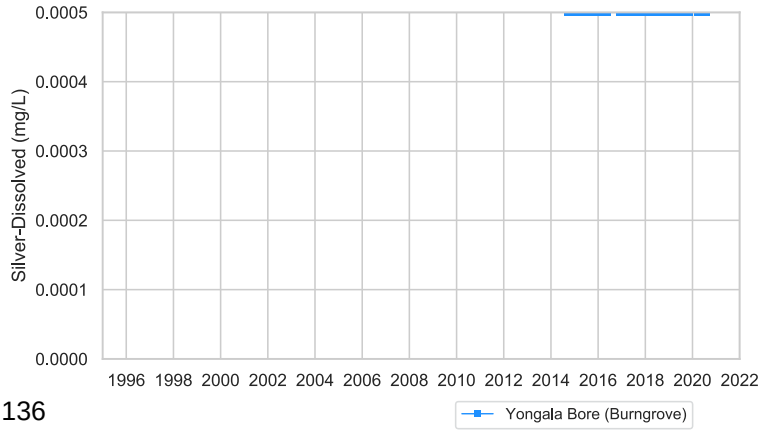

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

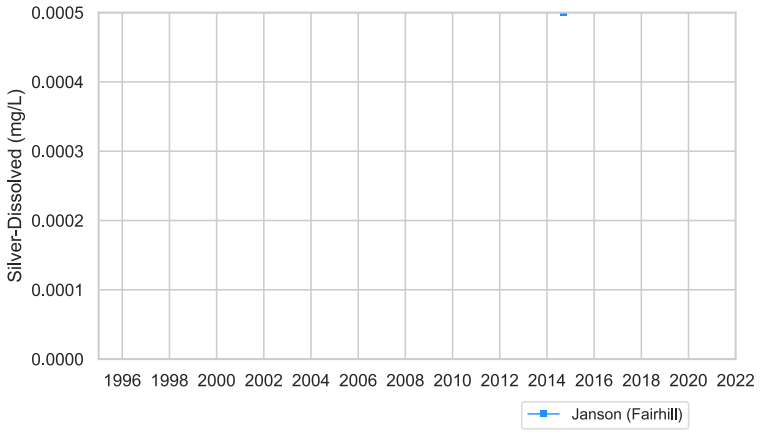

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

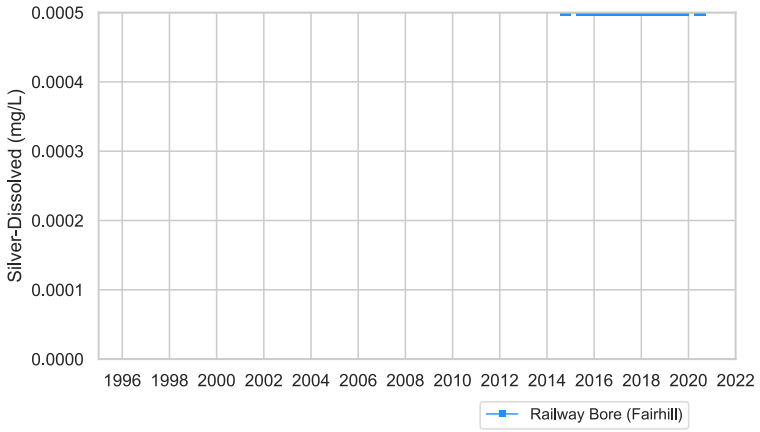

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

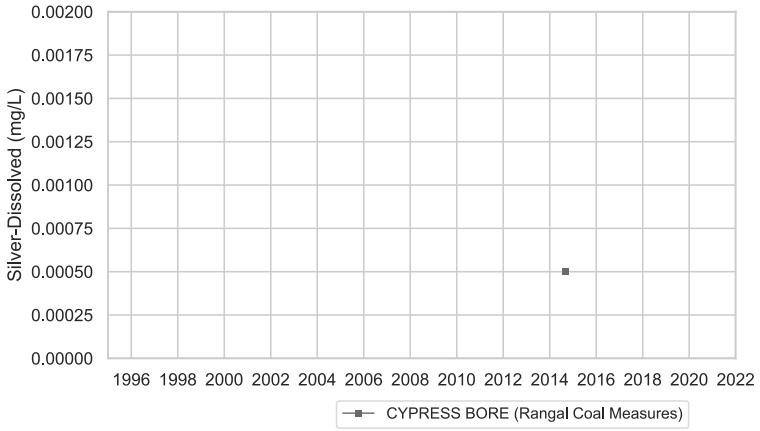

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

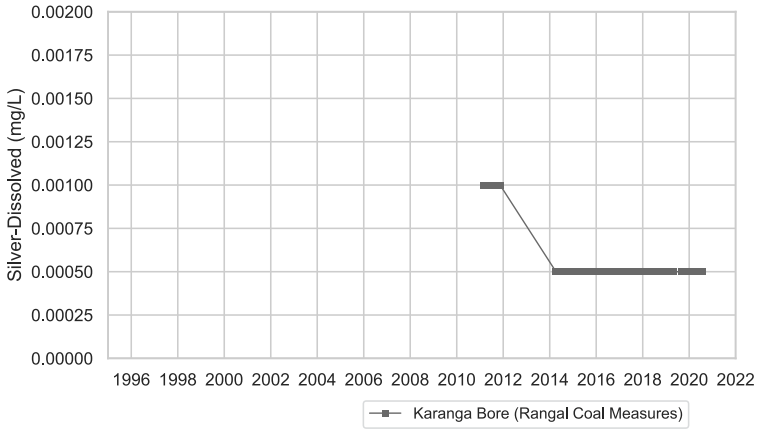

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

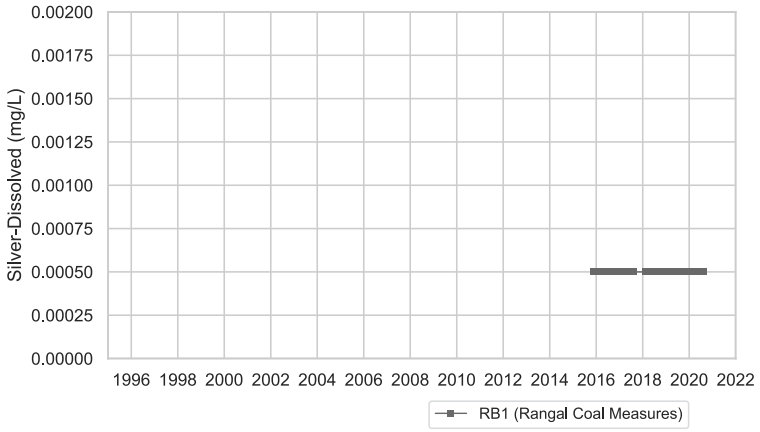

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

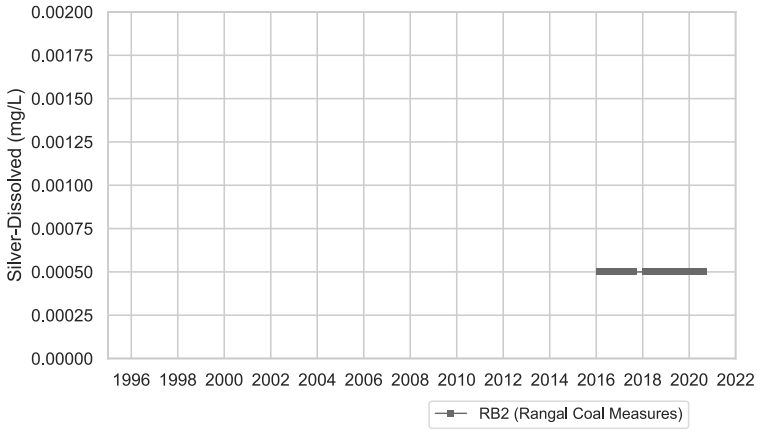

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

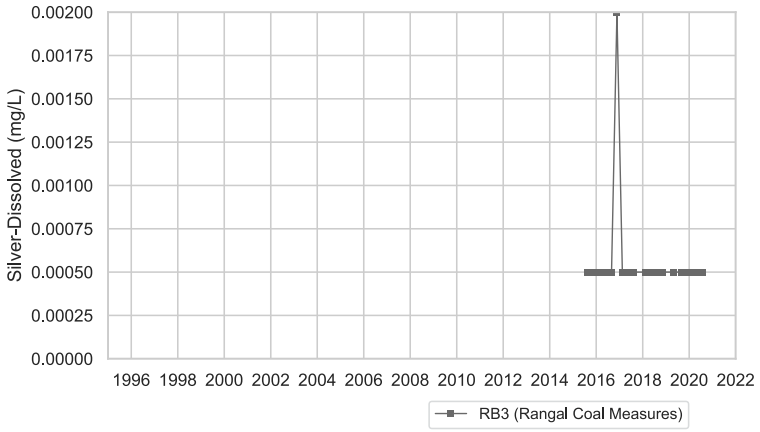

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

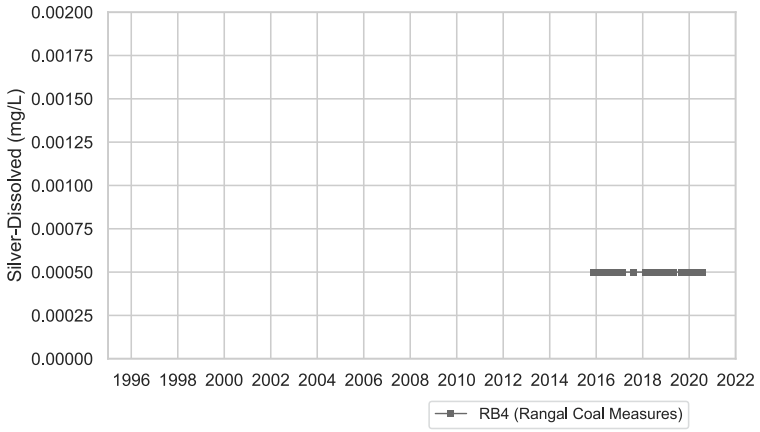

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

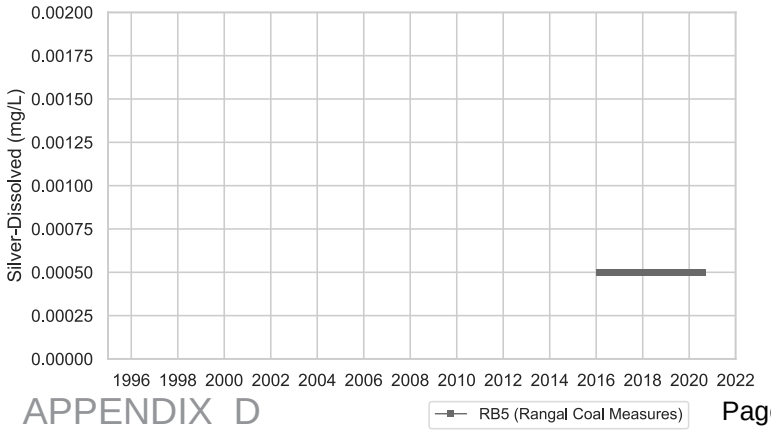

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

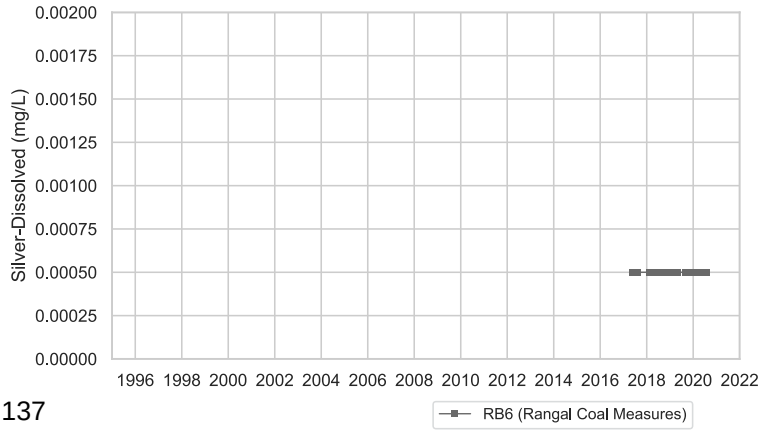

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

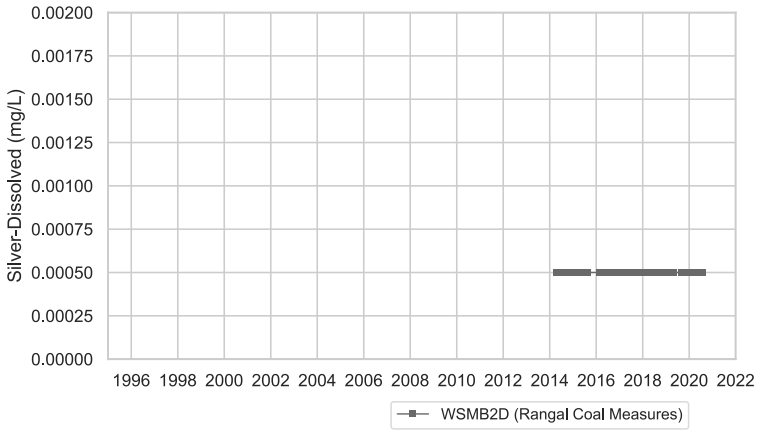

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

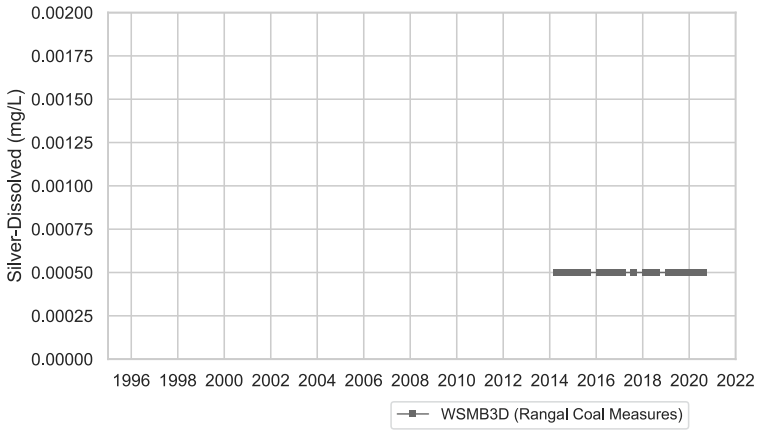

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

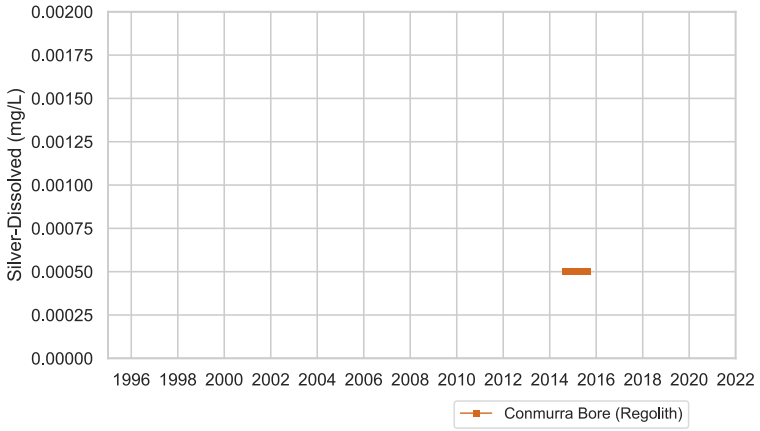

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

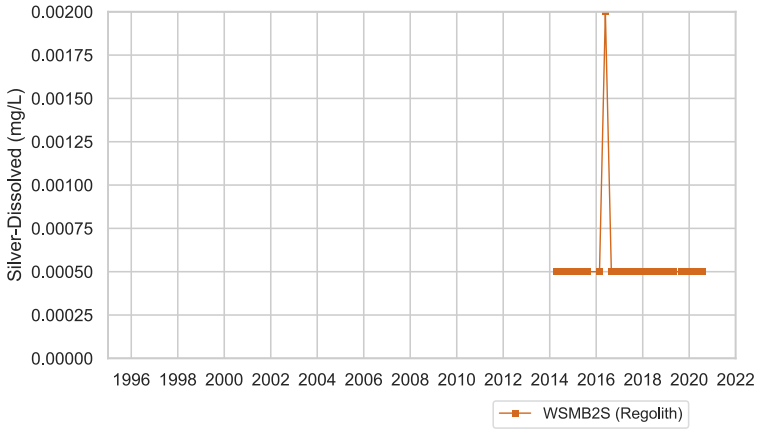

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)


Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

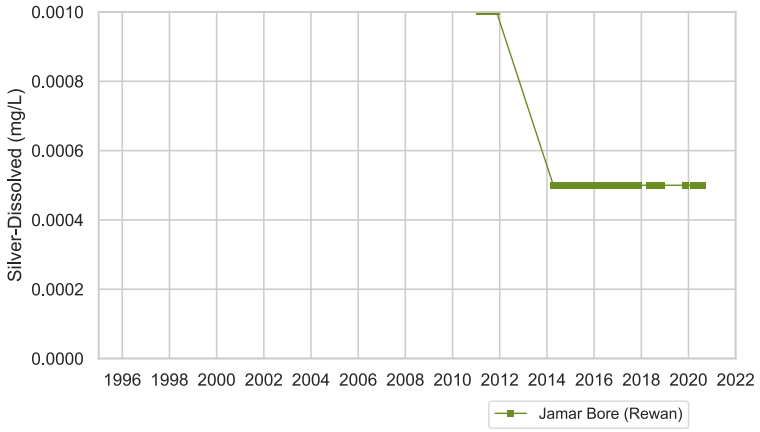

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)


Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

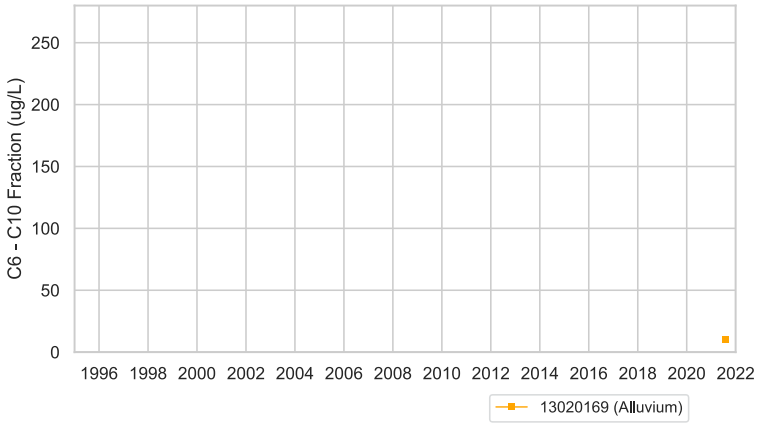

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

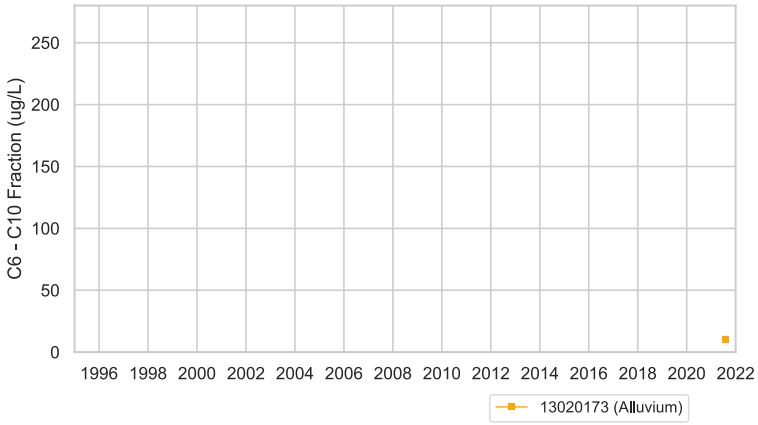

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

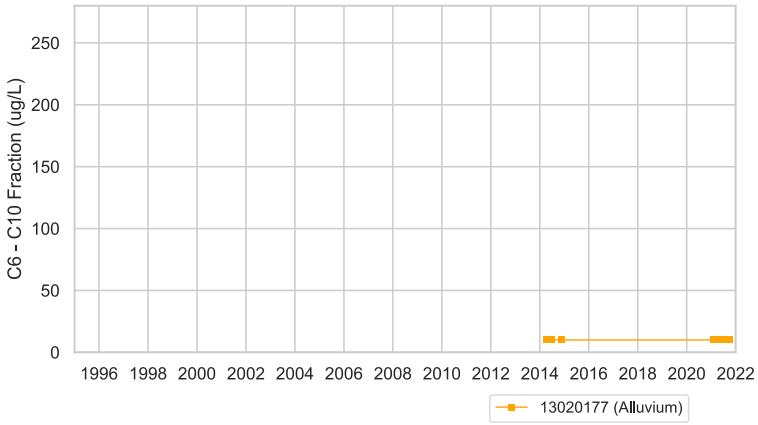
Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

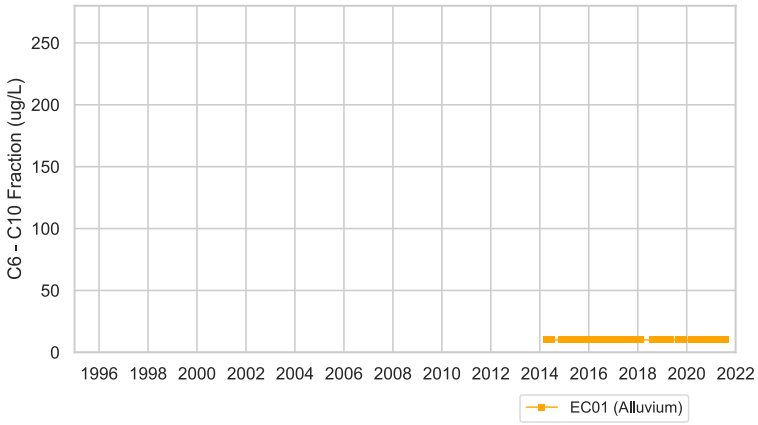

Silver-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

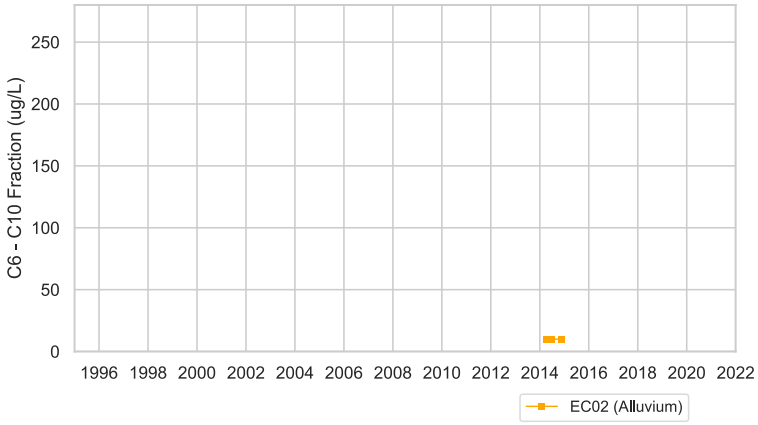
Silver-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

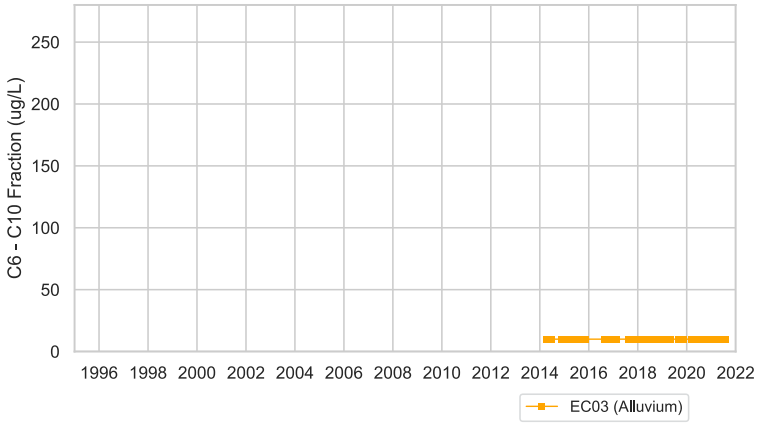

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

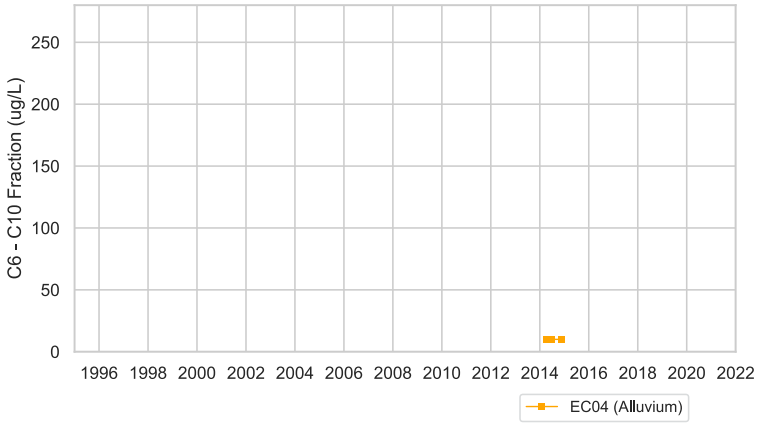

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

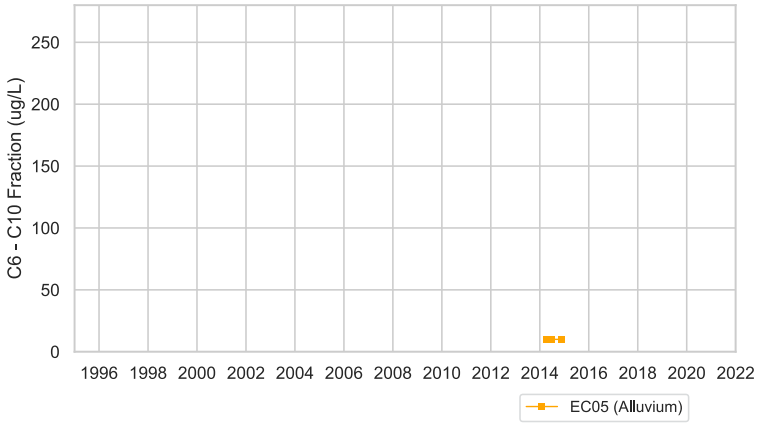

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

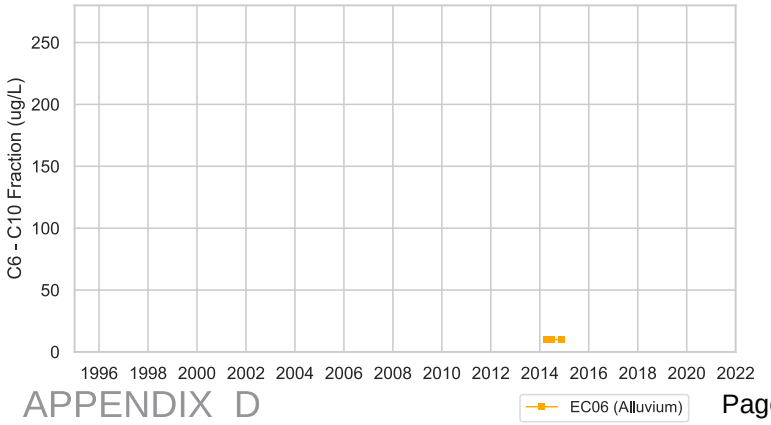

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

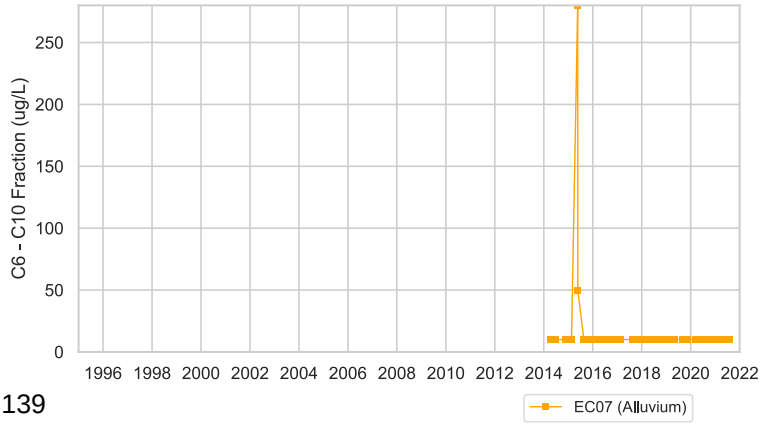

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

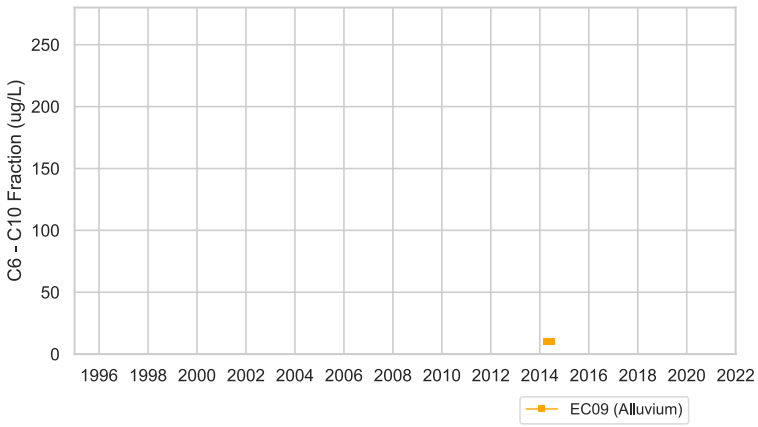

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

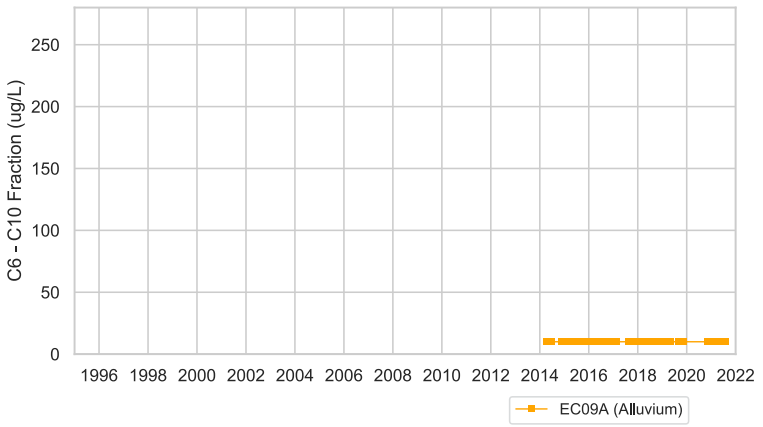

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

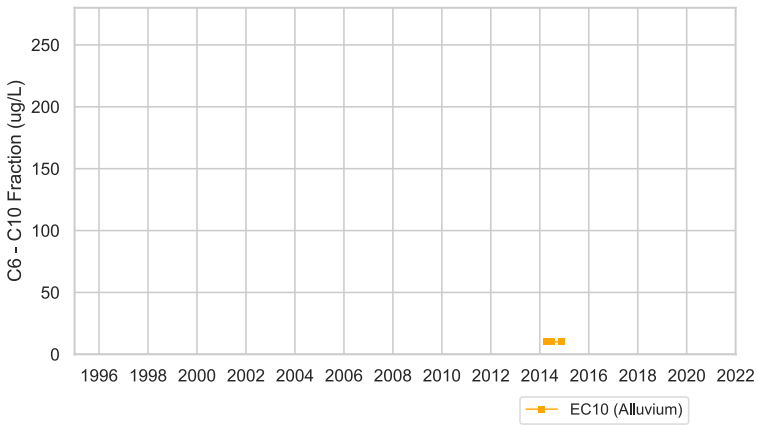

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

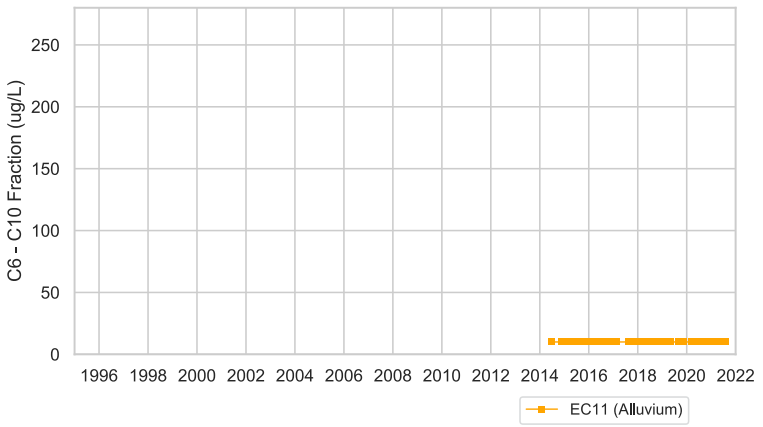

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

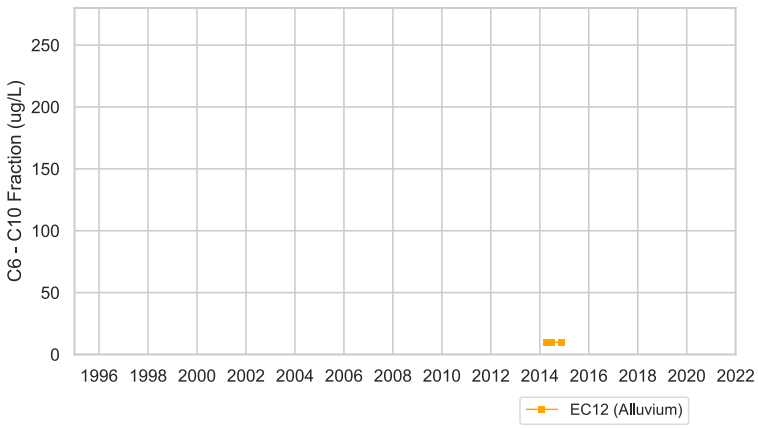

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

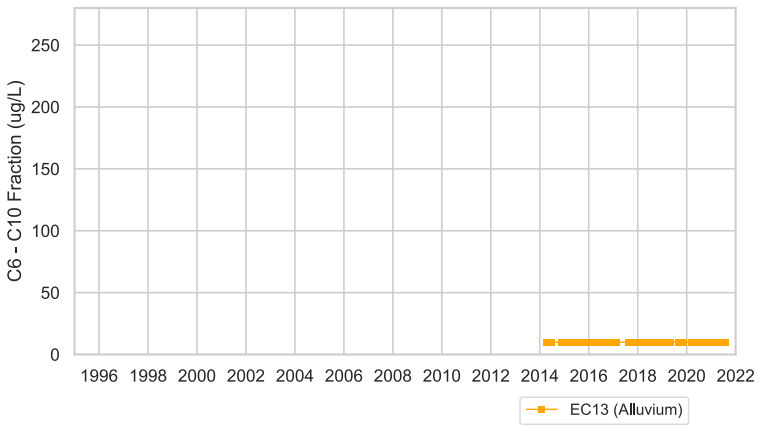

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

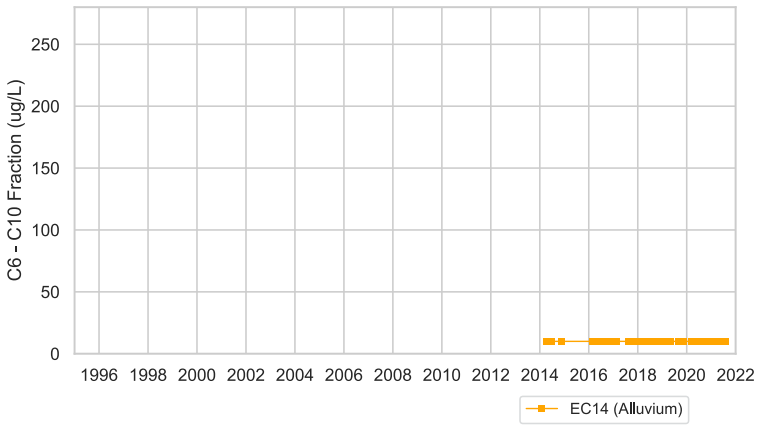

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

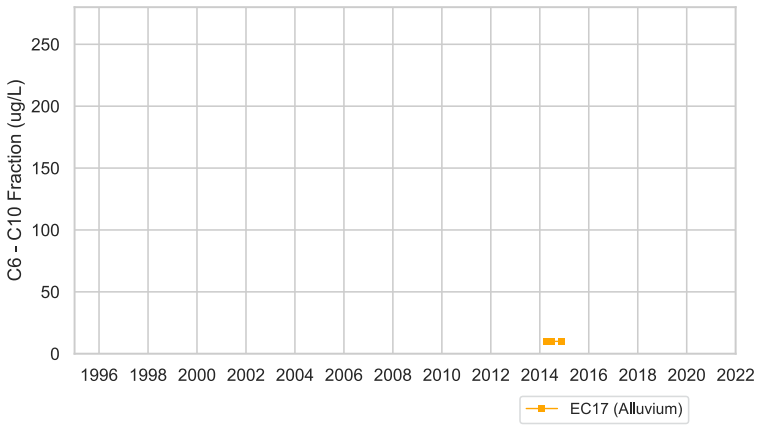

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

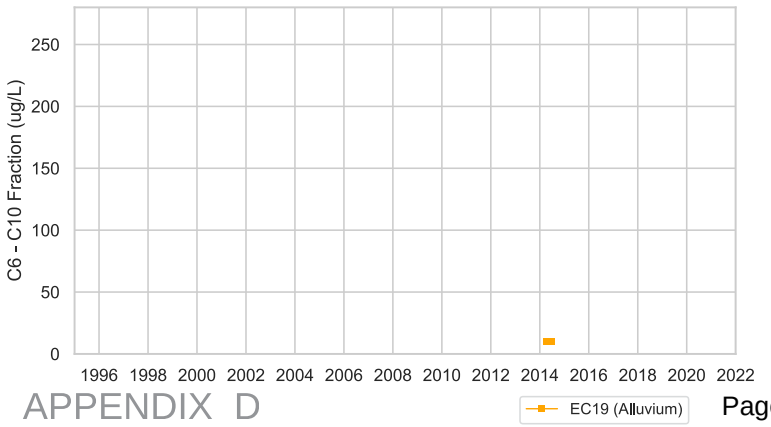

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

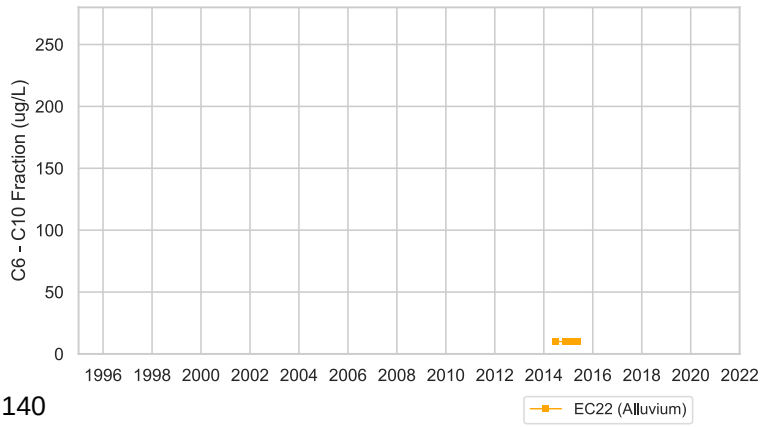

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

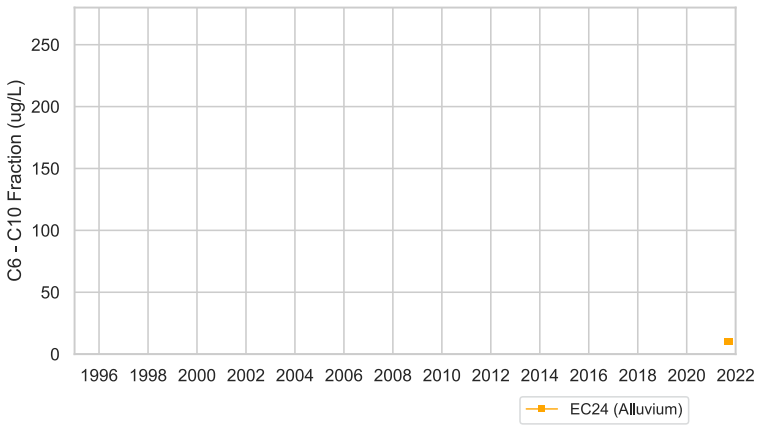

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

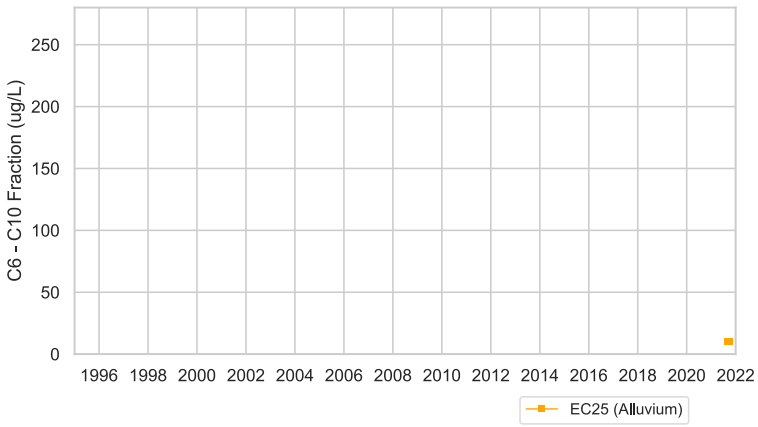

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

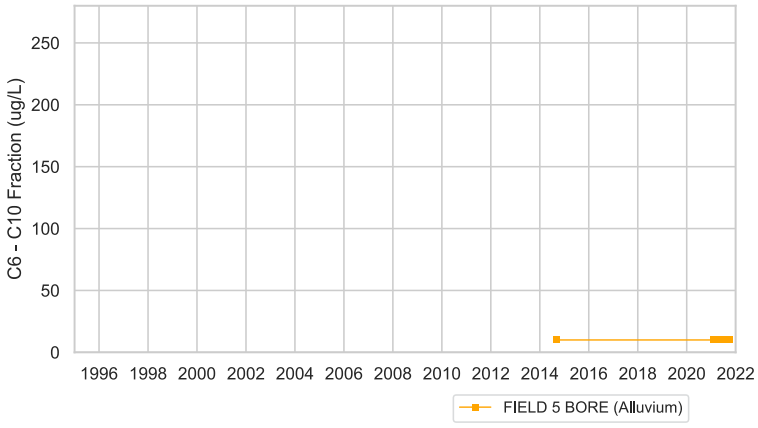

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

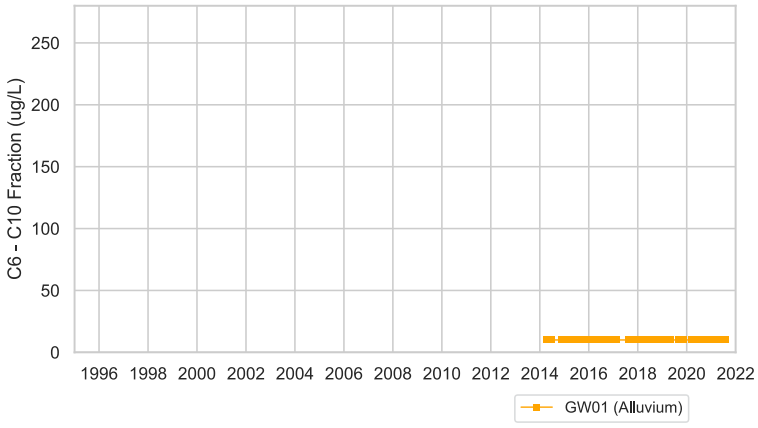

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

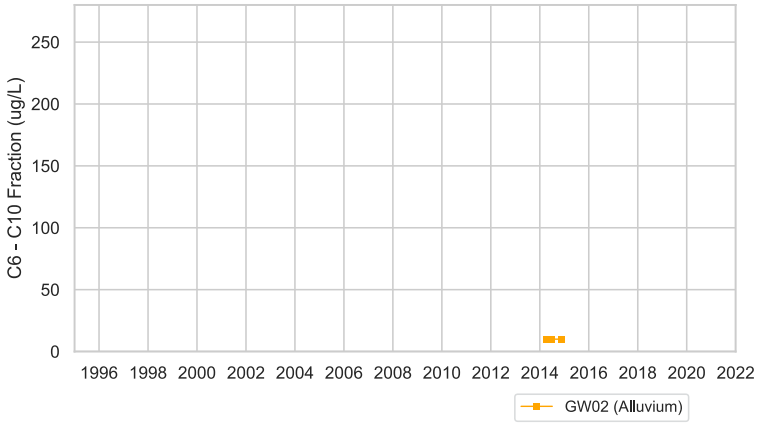

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

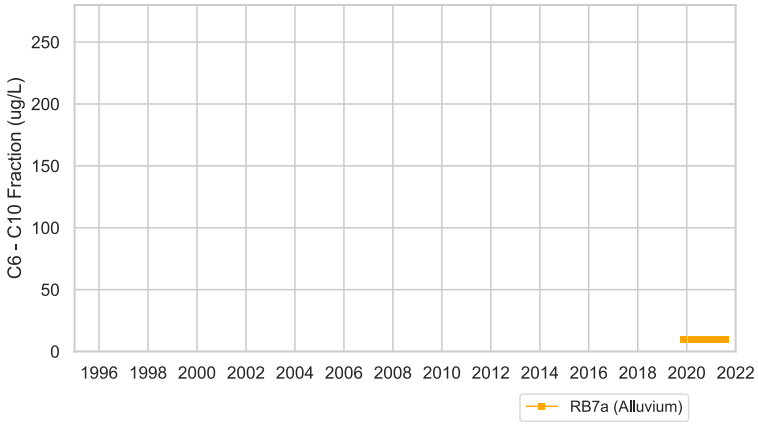

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

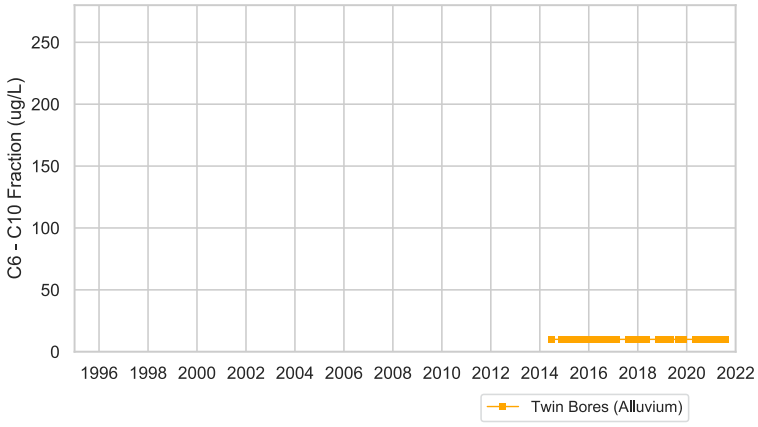

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

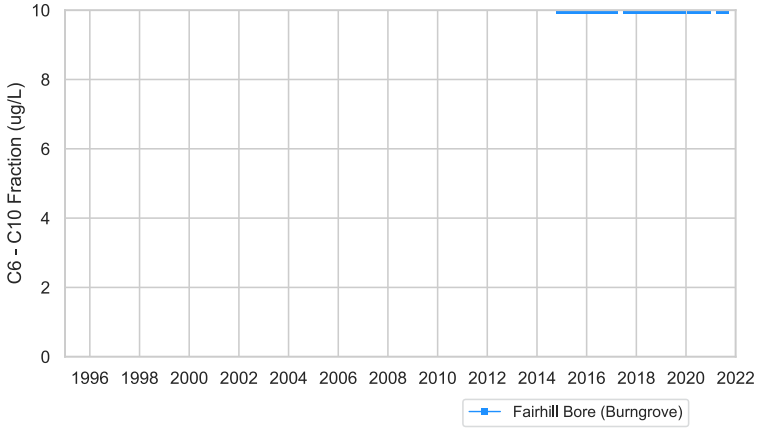

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

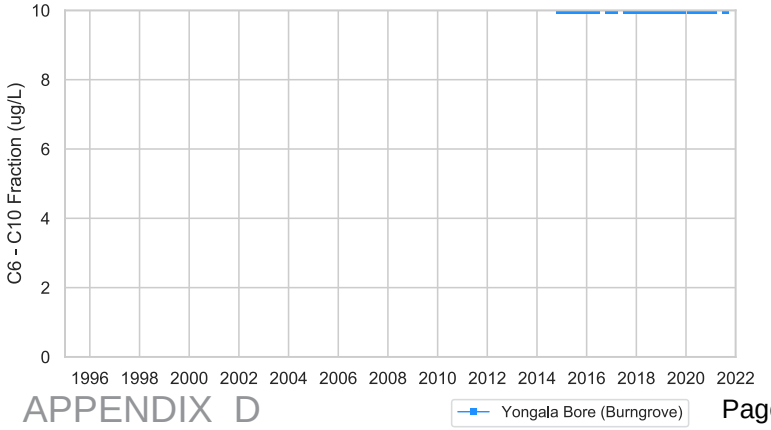

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

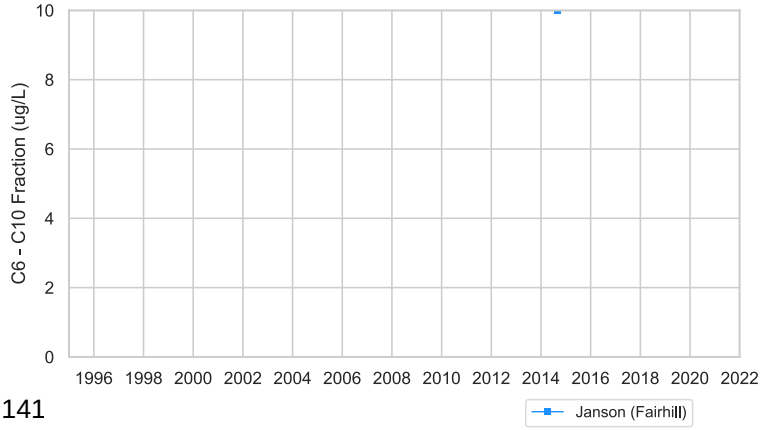

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

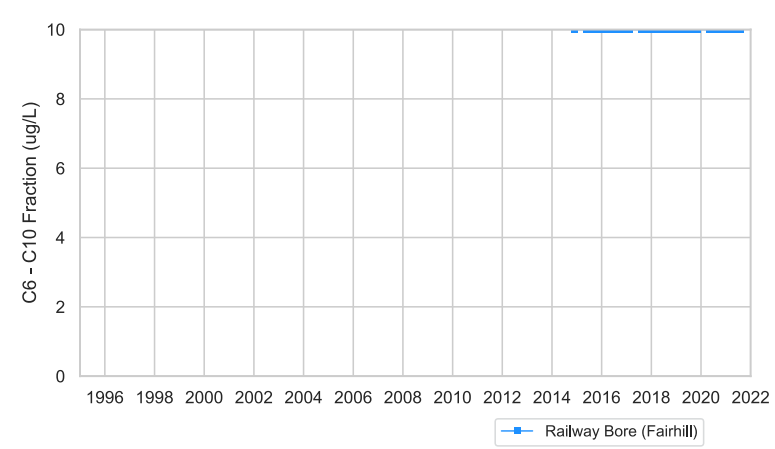

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

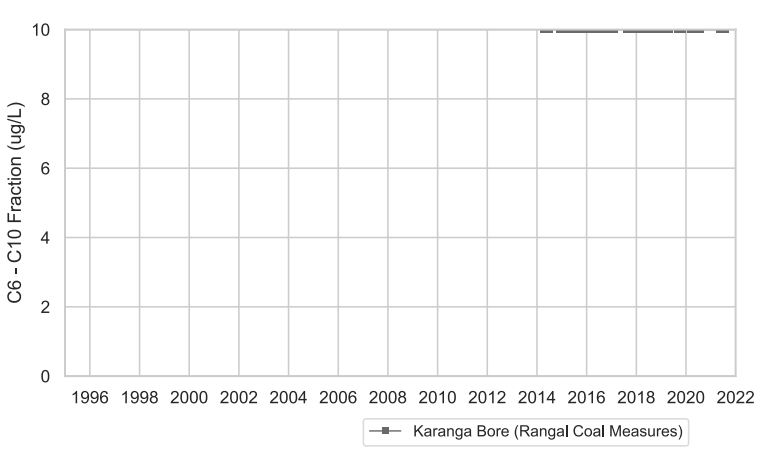

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

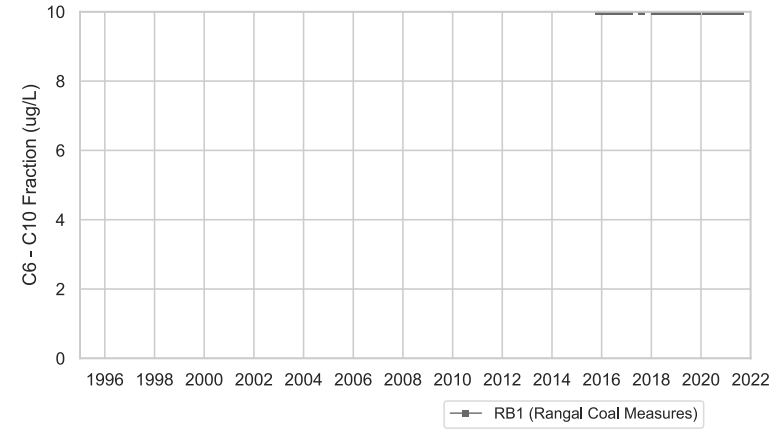

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

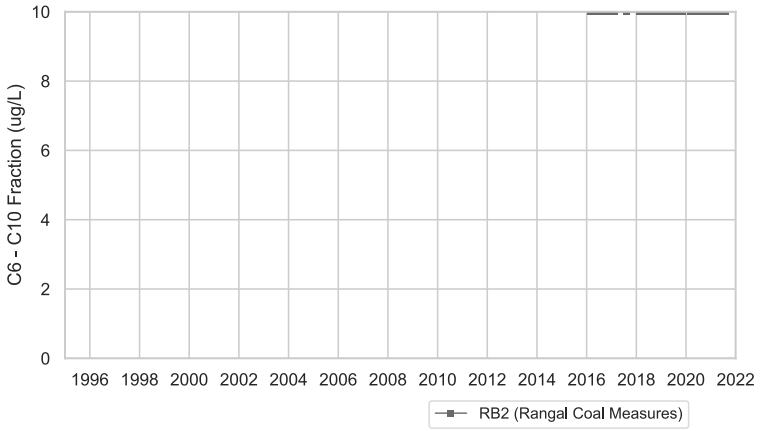

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

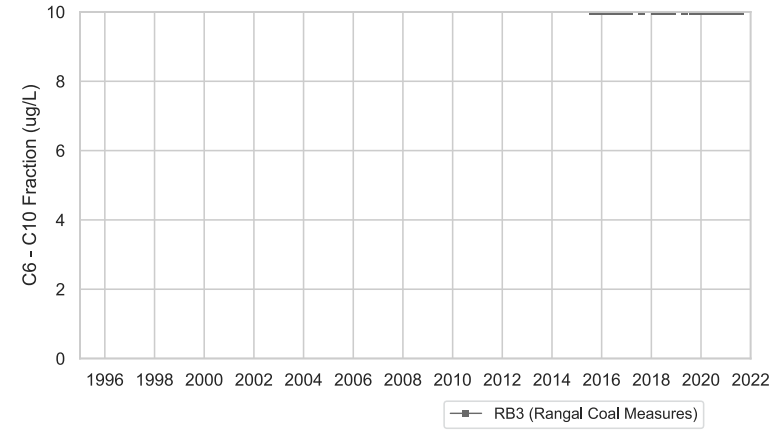

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

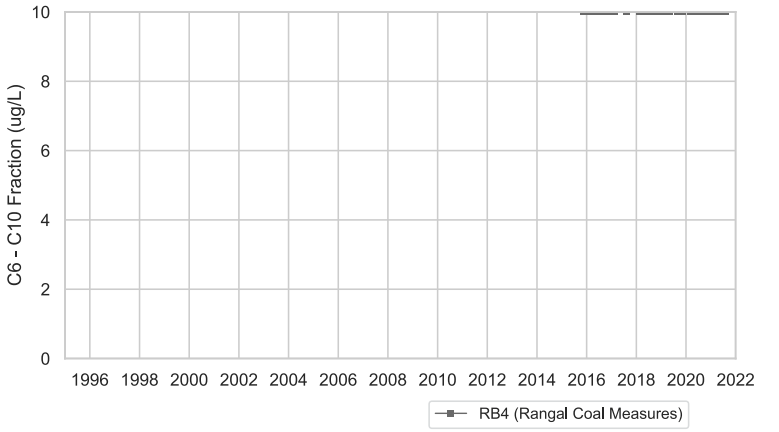

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

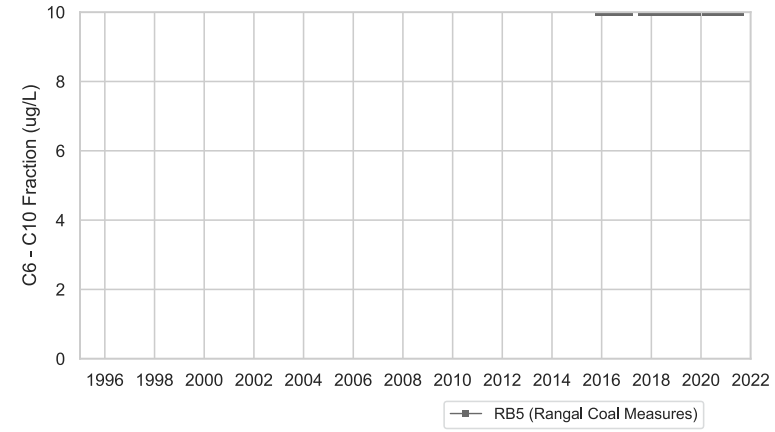

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

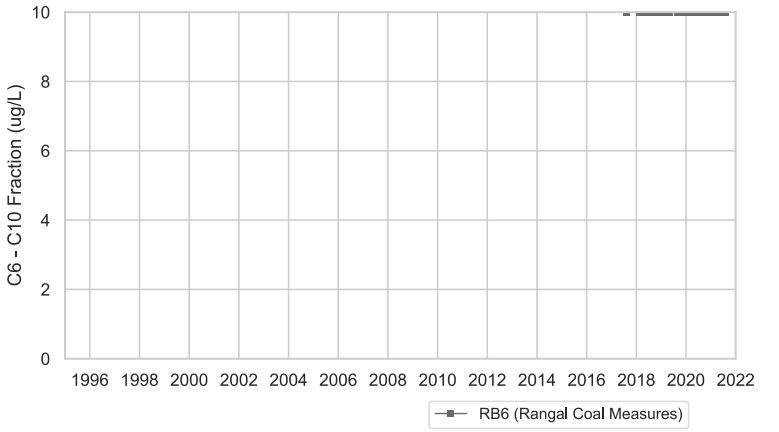

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

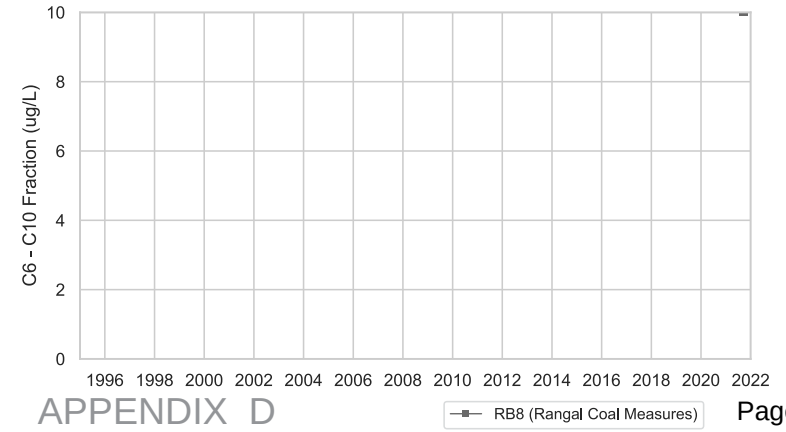

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

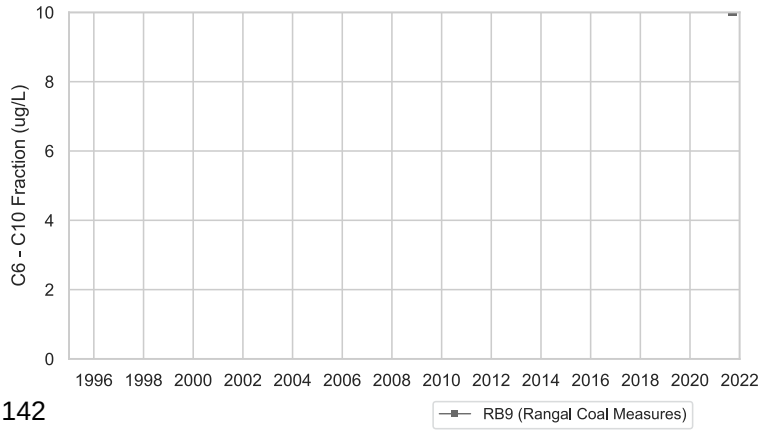

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

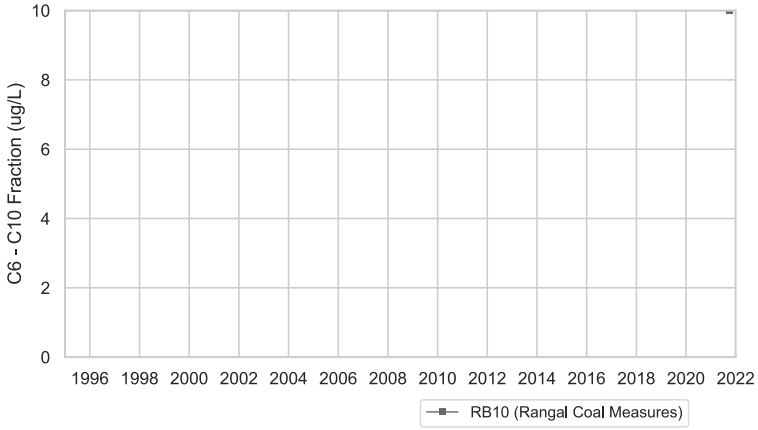

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

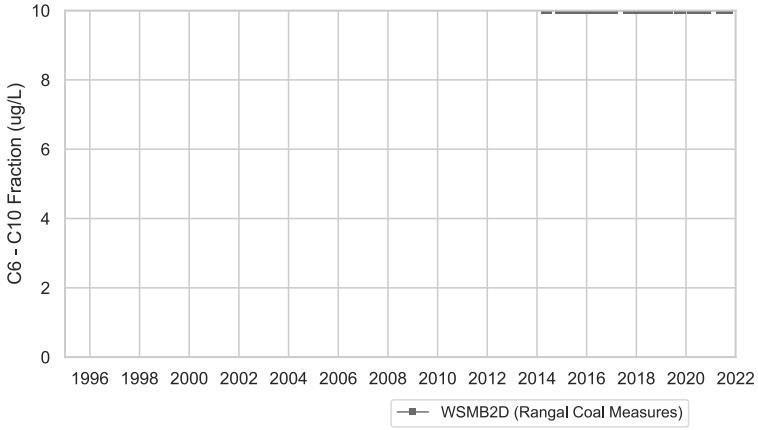

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

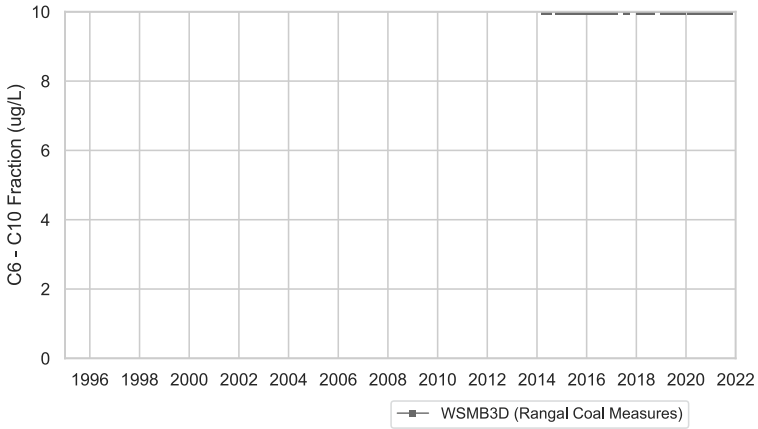

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

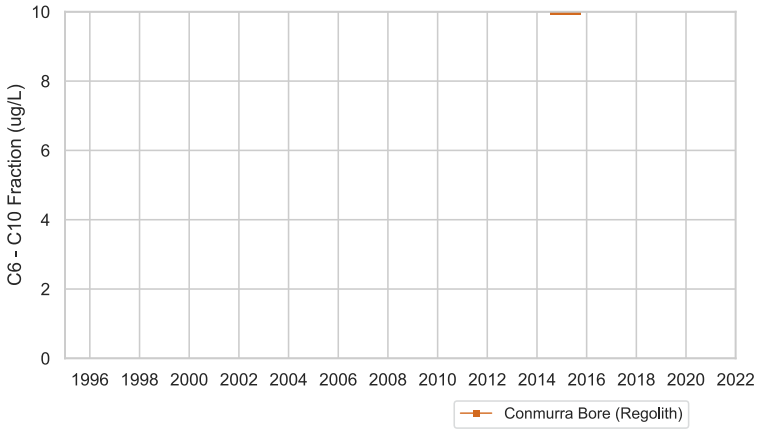

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

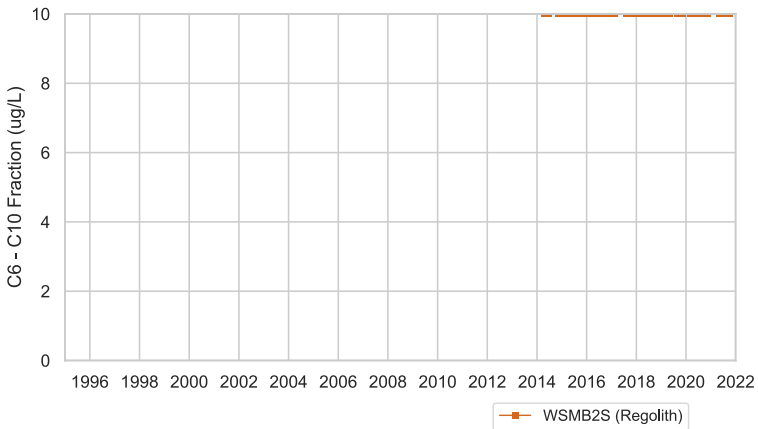

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

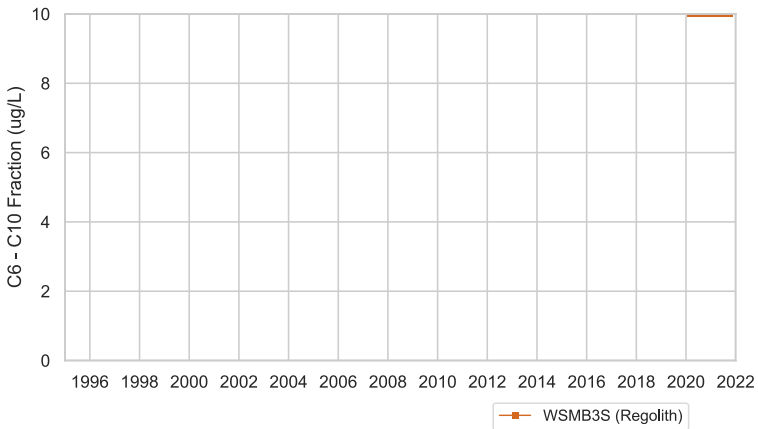

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

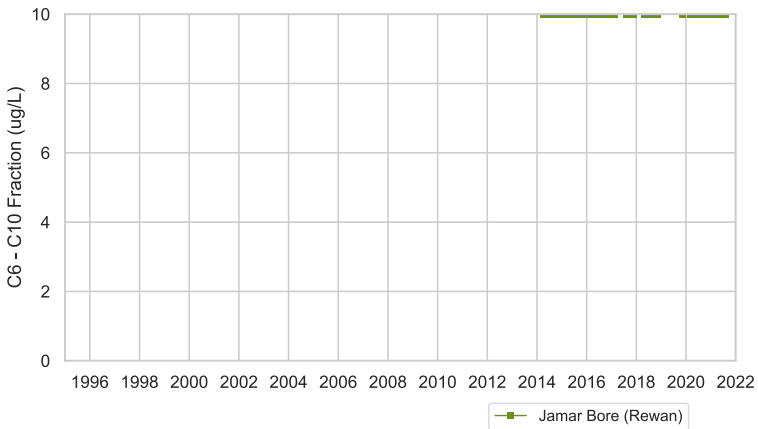

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

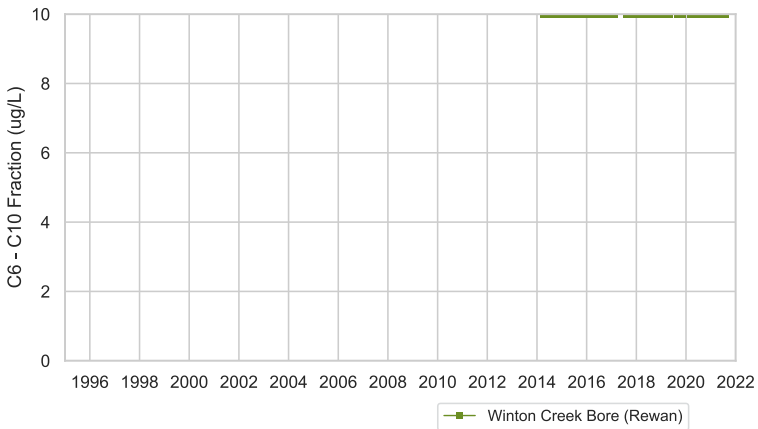

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

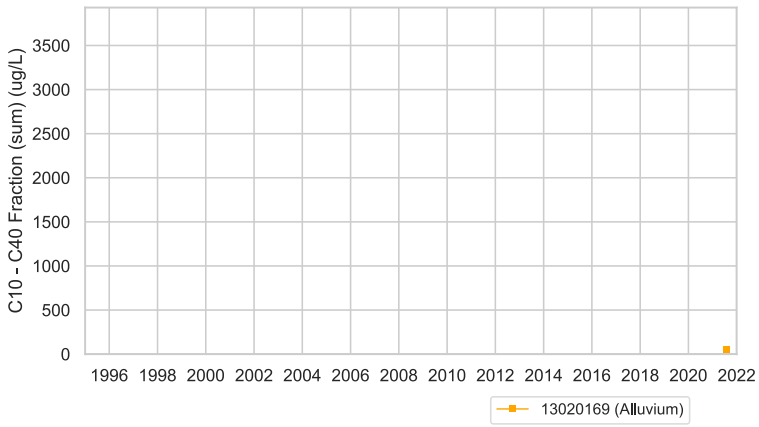

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

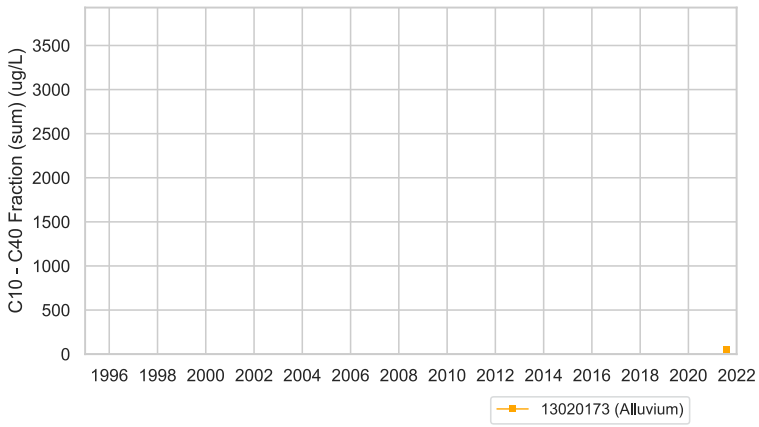

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

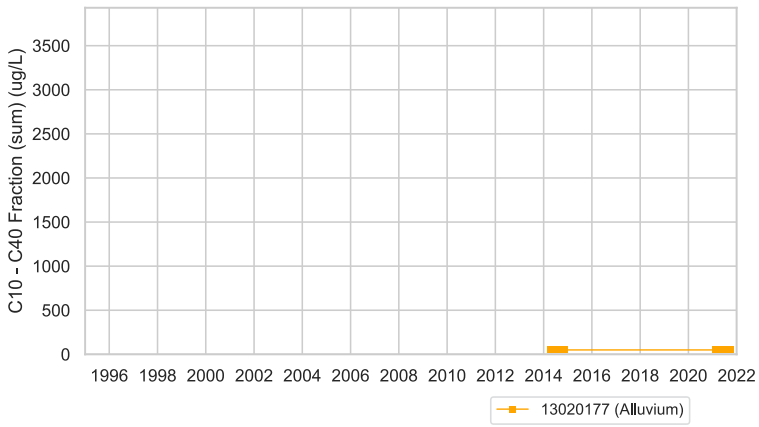

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

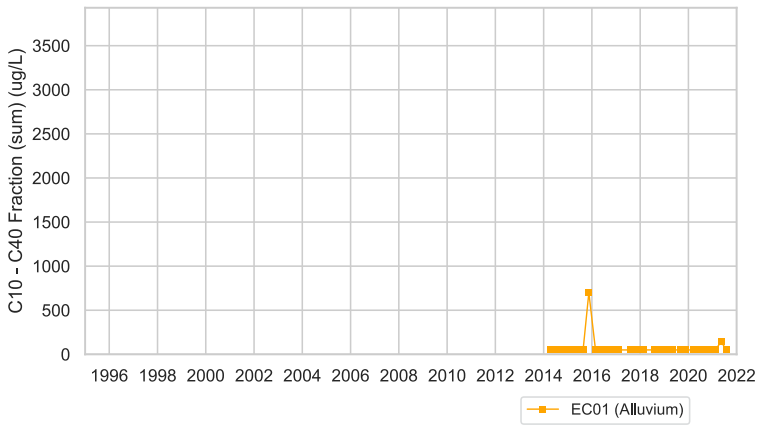

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

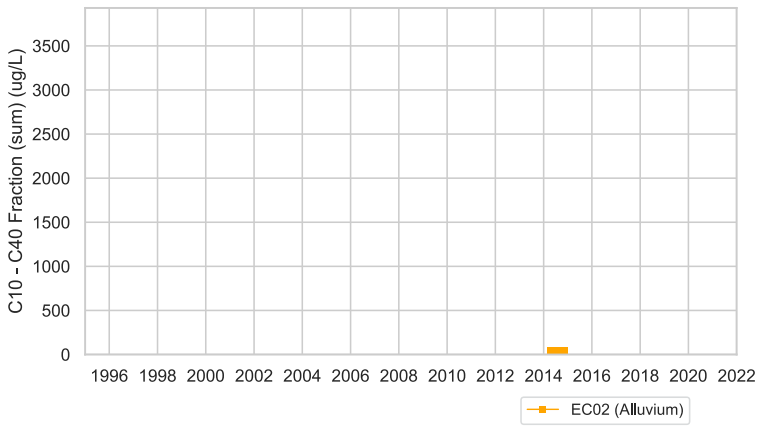

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

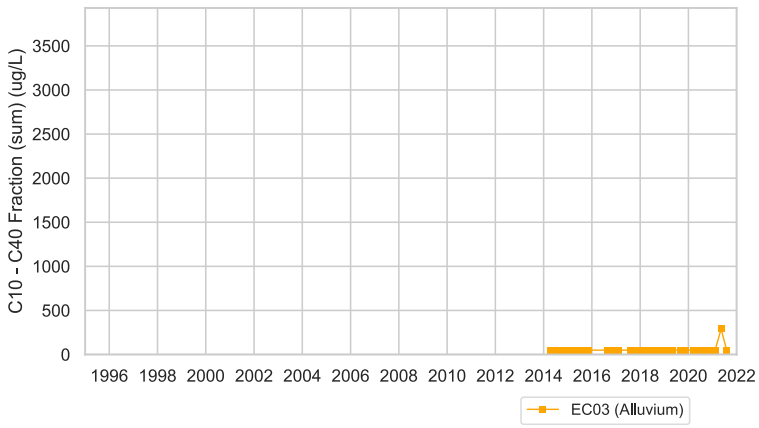

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

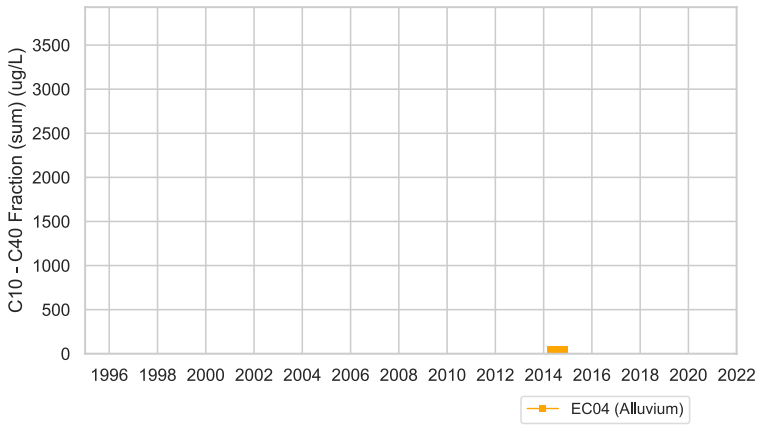

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

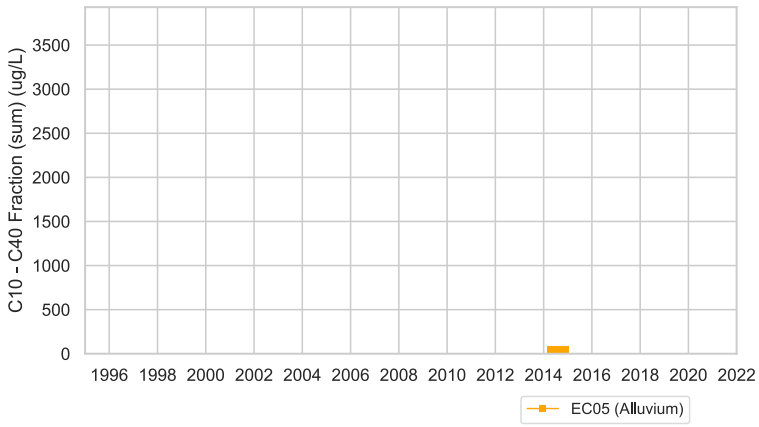

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

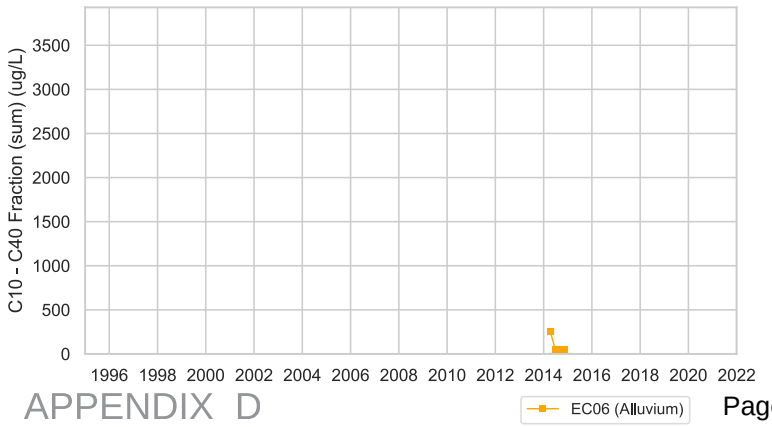

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

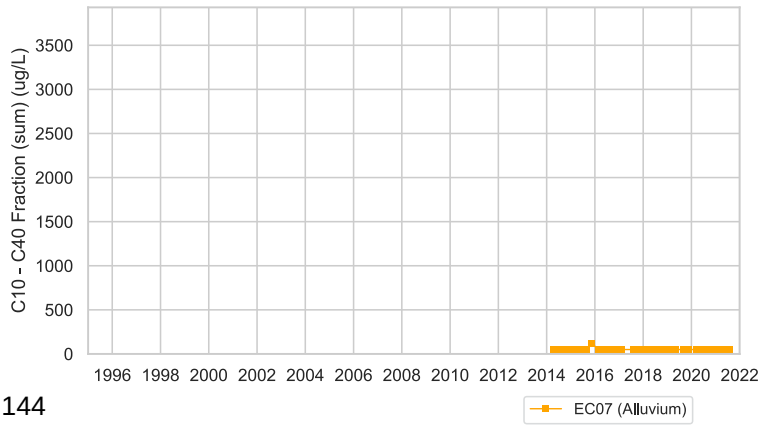

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

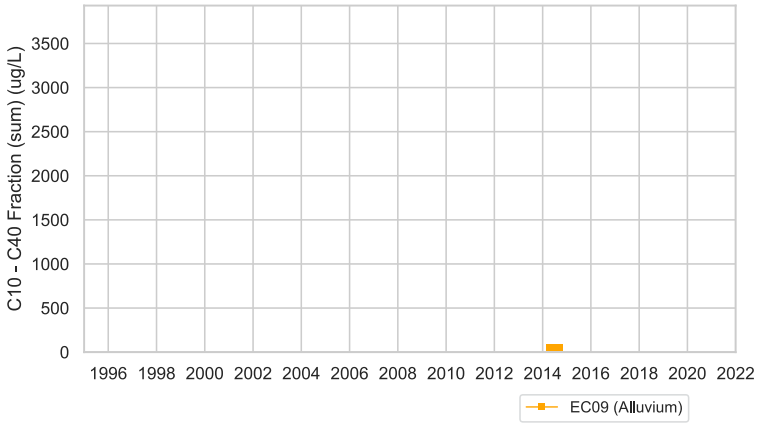

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

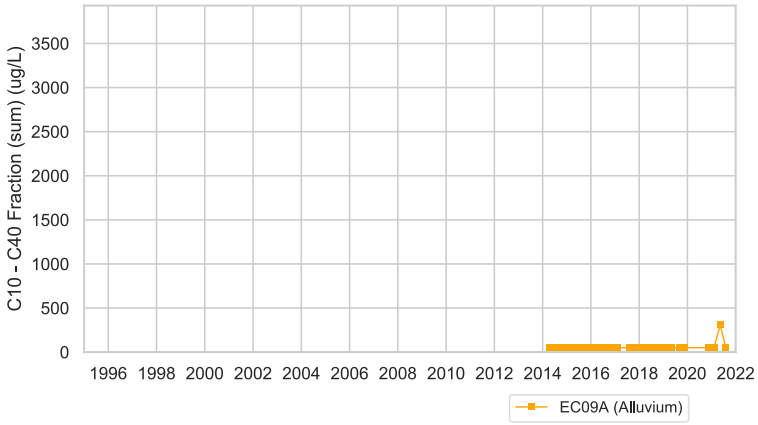

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

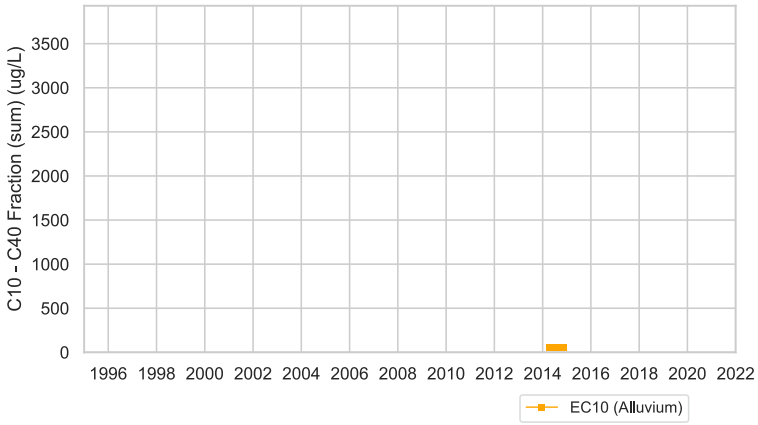

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

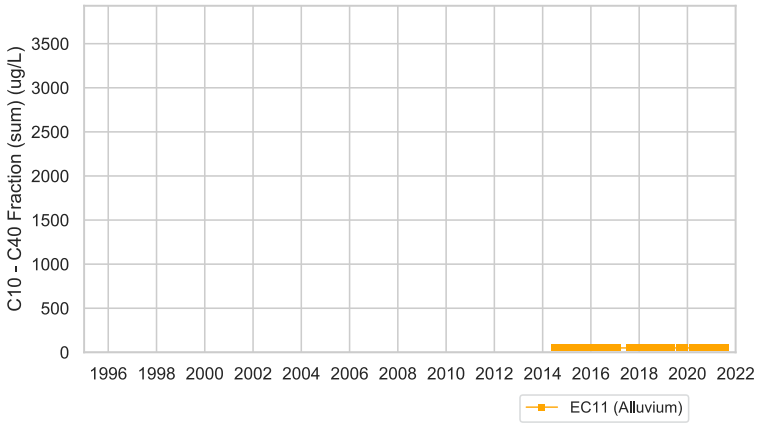

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

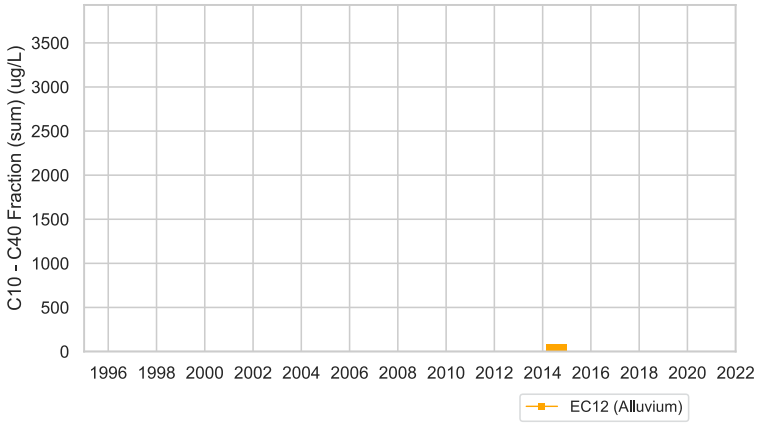

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

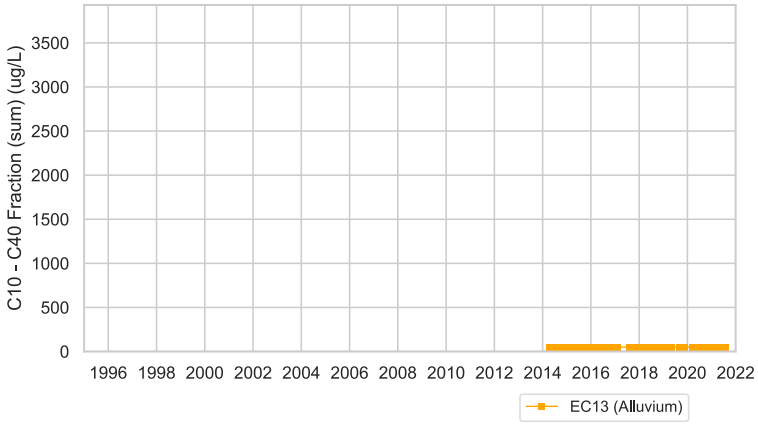

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

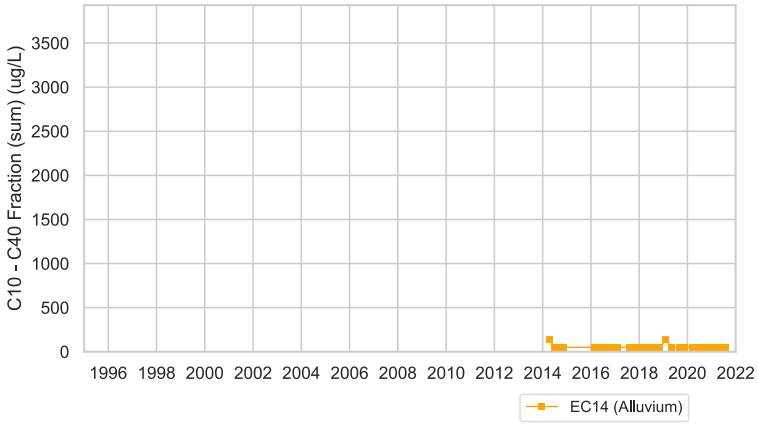

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

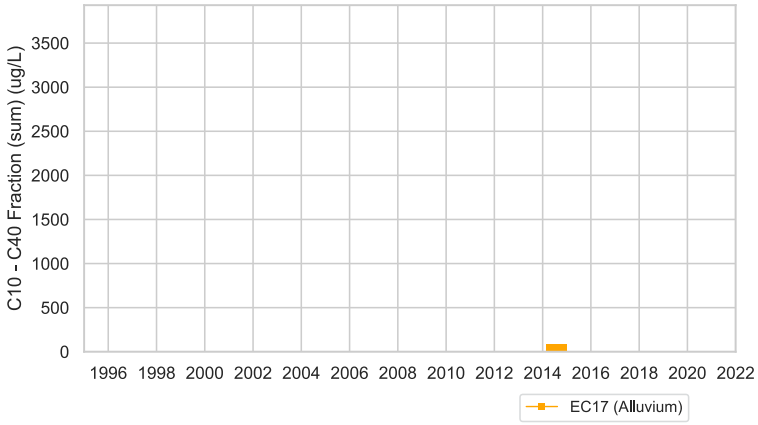

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

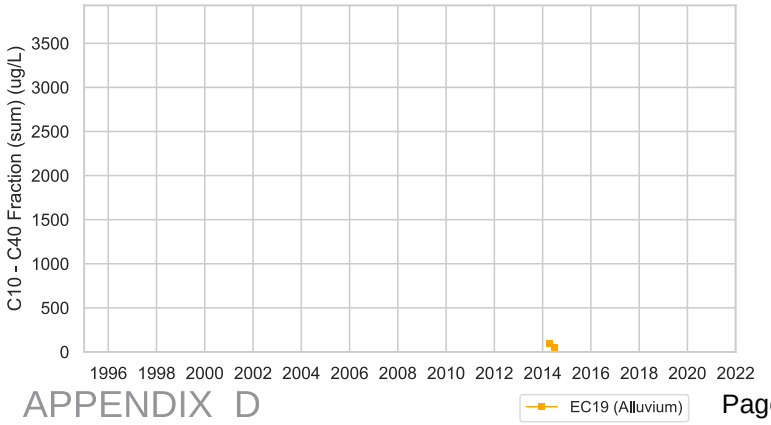

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

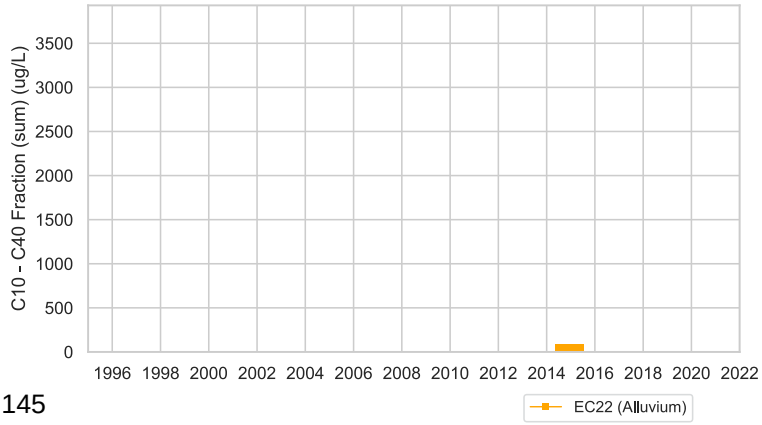

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

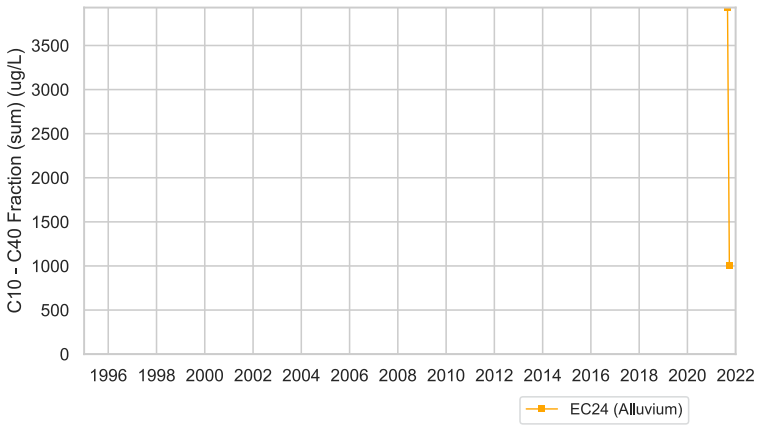

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

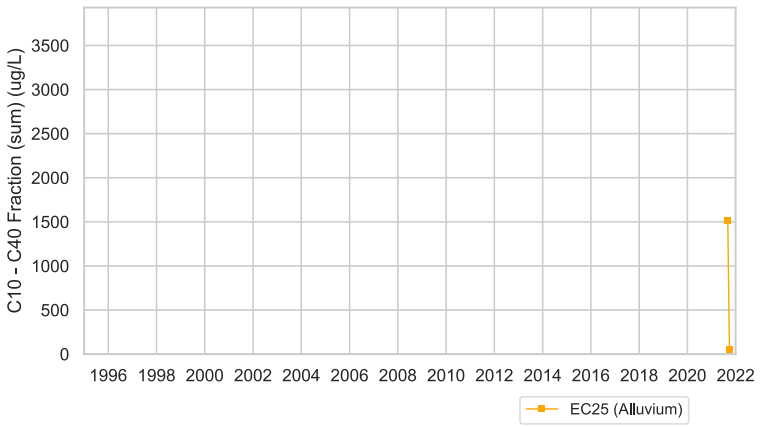

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

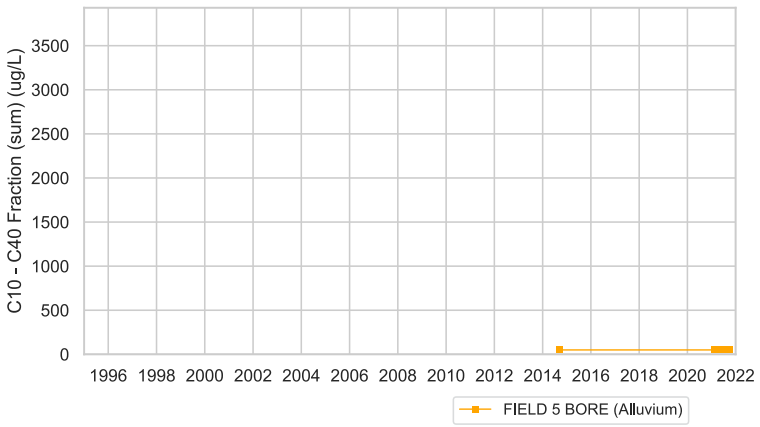

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

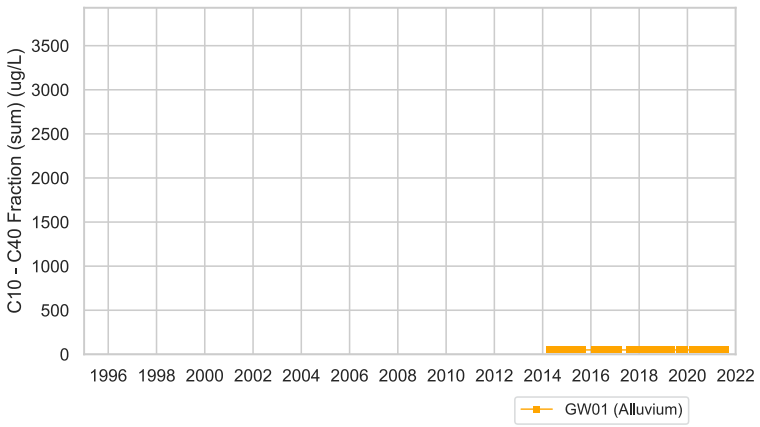

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

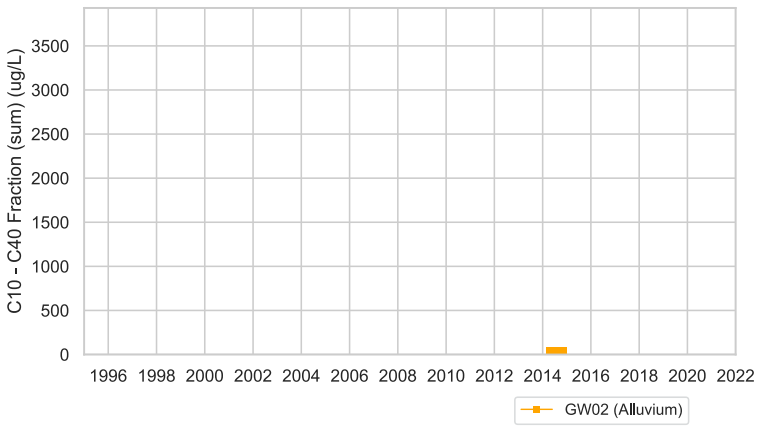

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

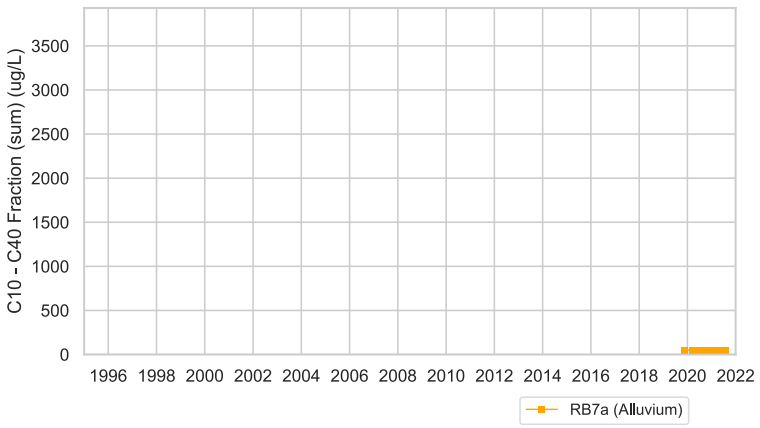

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

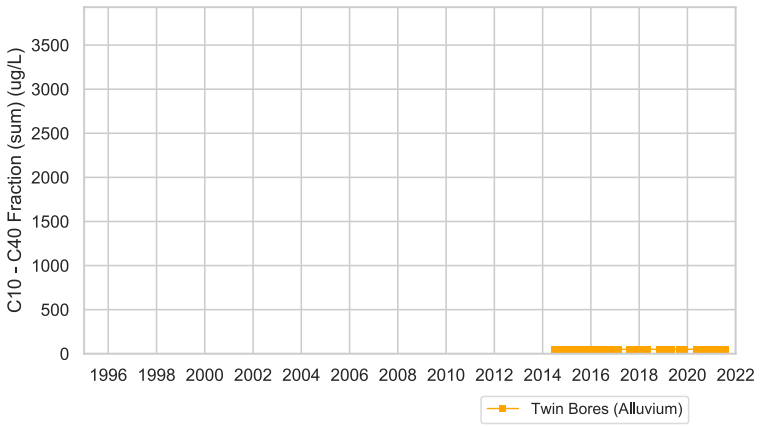

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

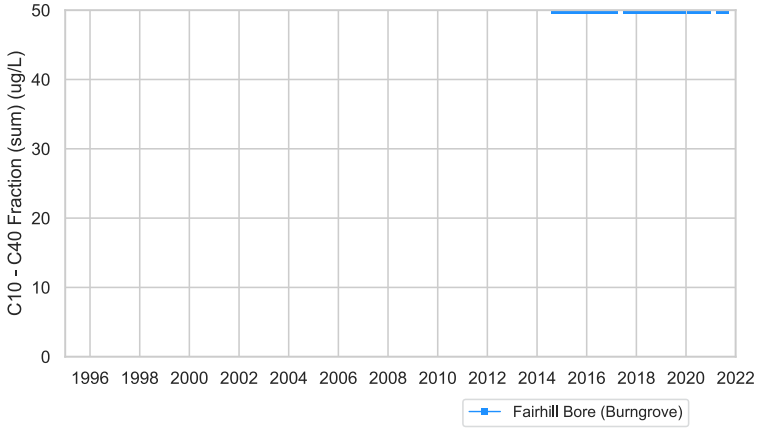

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

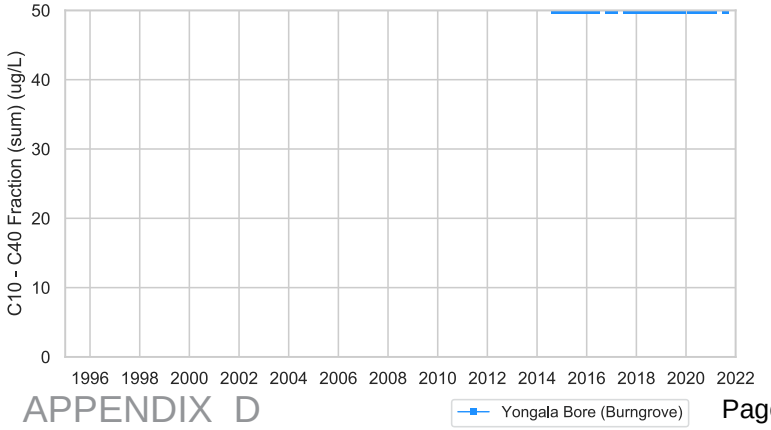

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

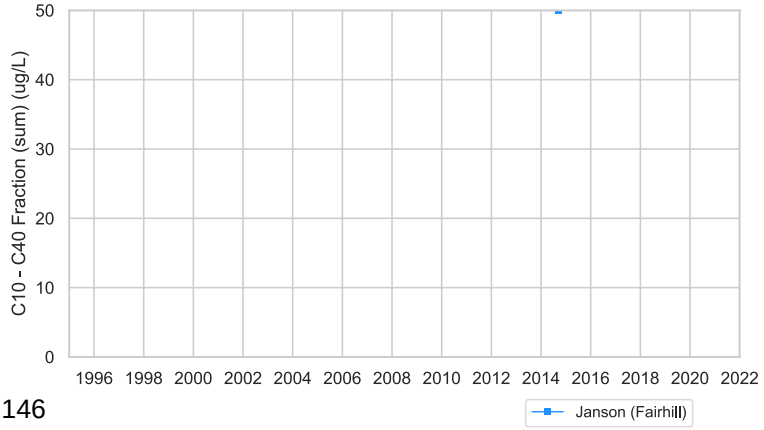

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

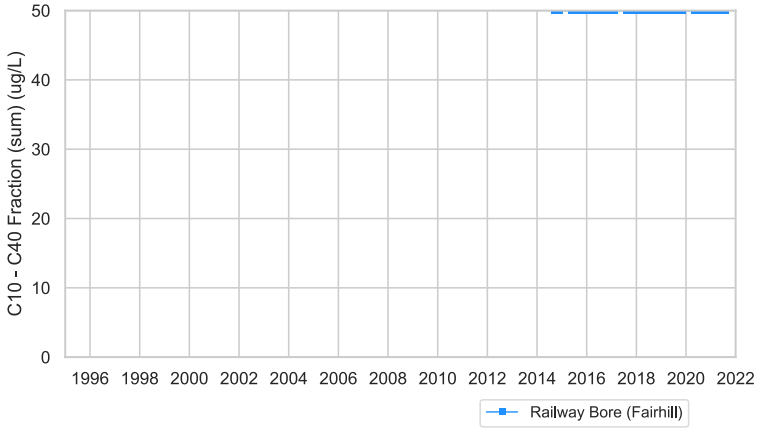

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

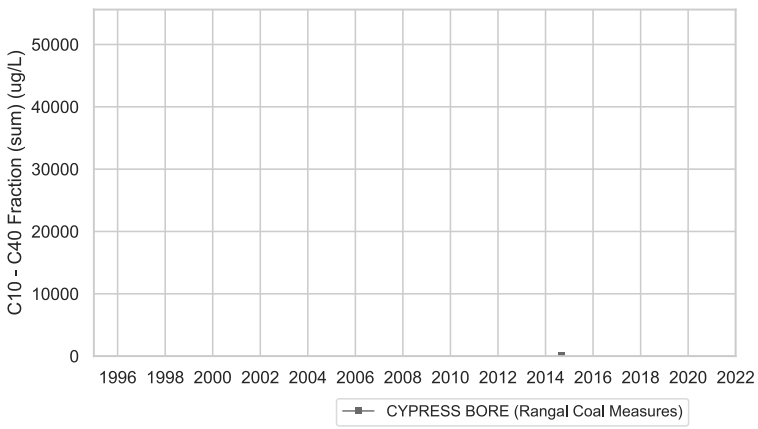

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

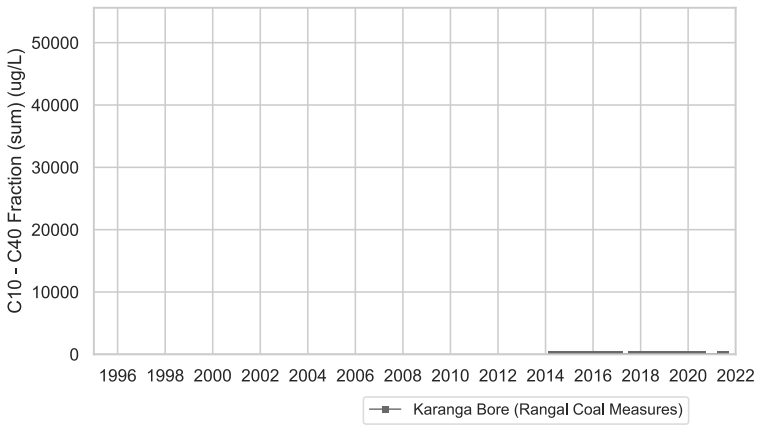

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

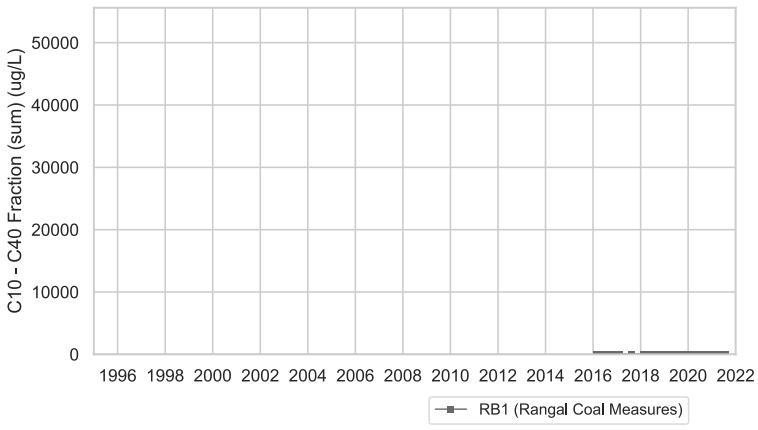

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

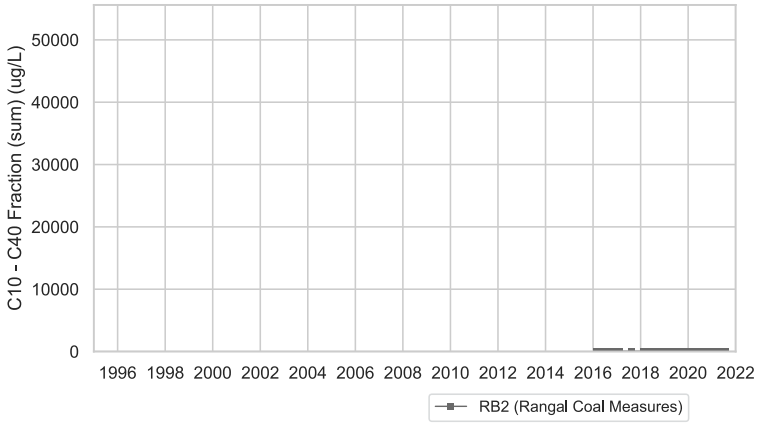

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

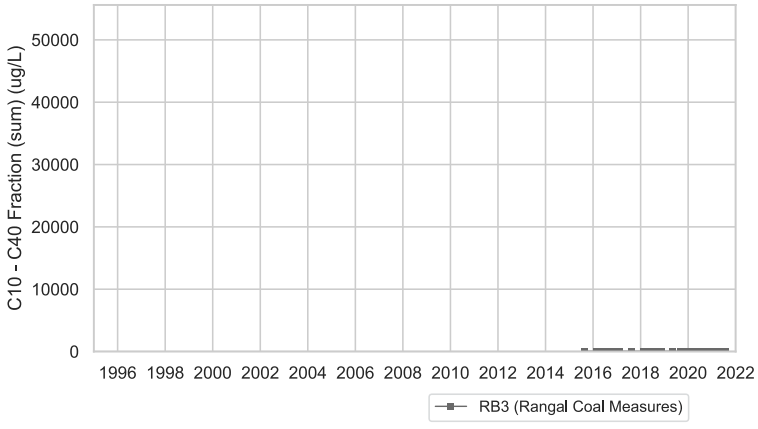

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

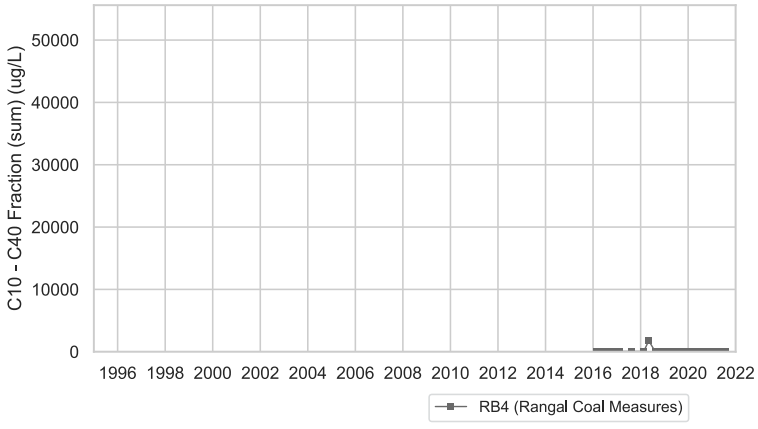

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

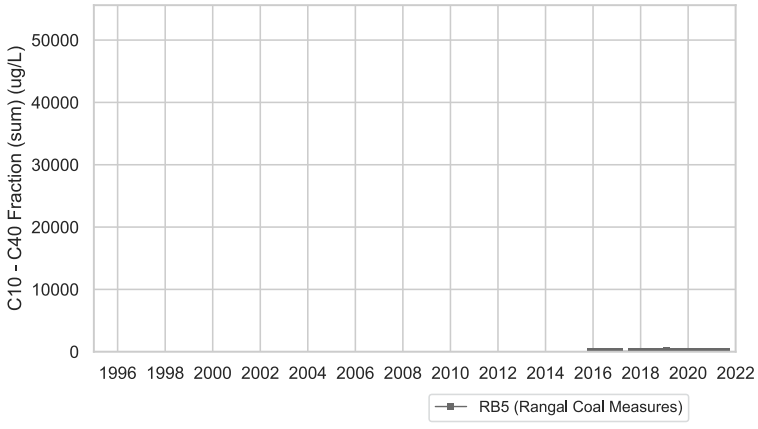

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

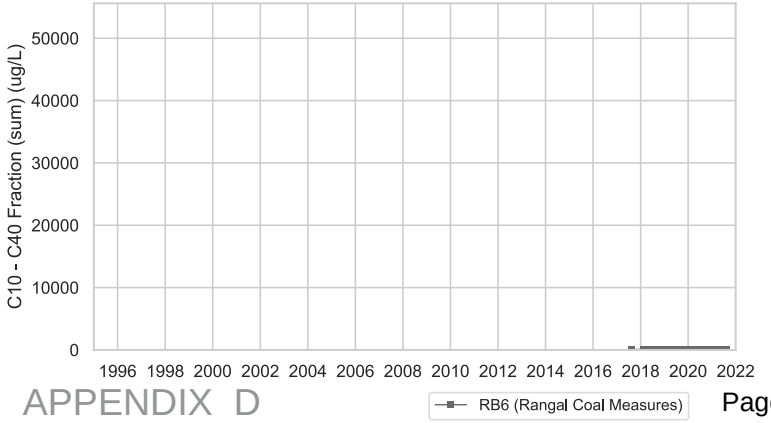

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

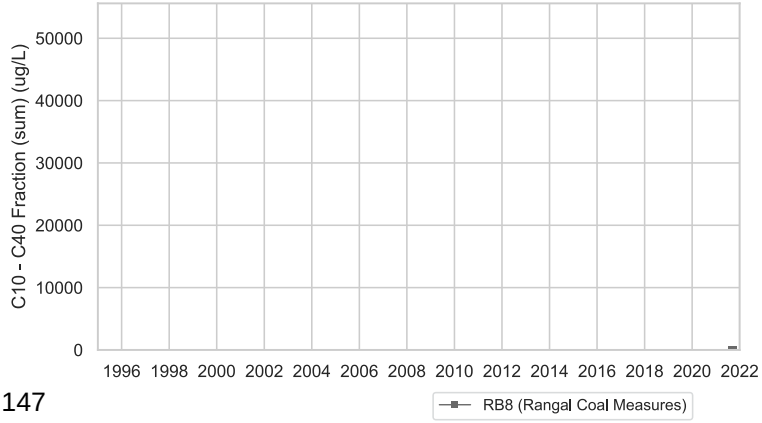

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

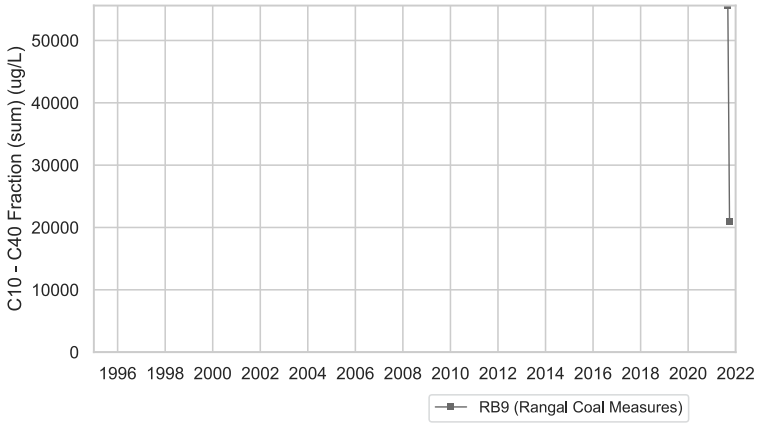

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

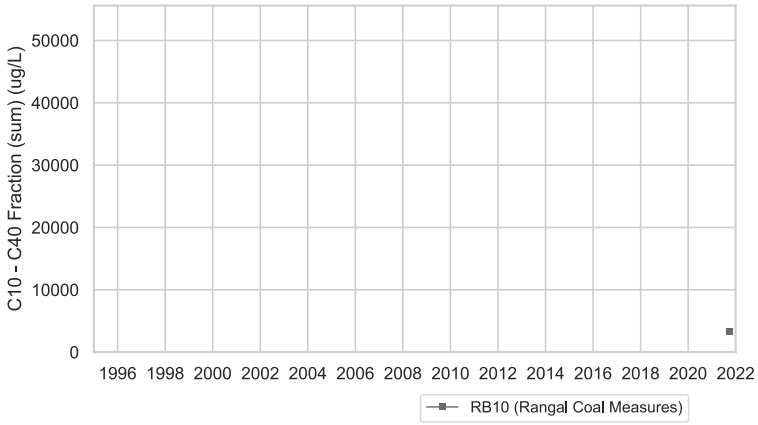

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

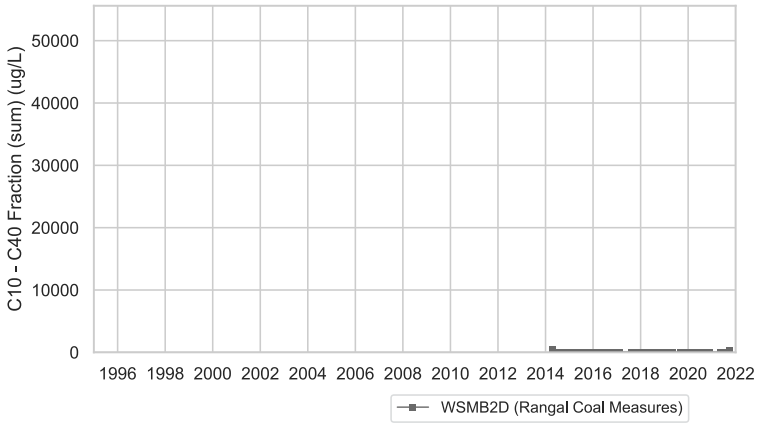

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

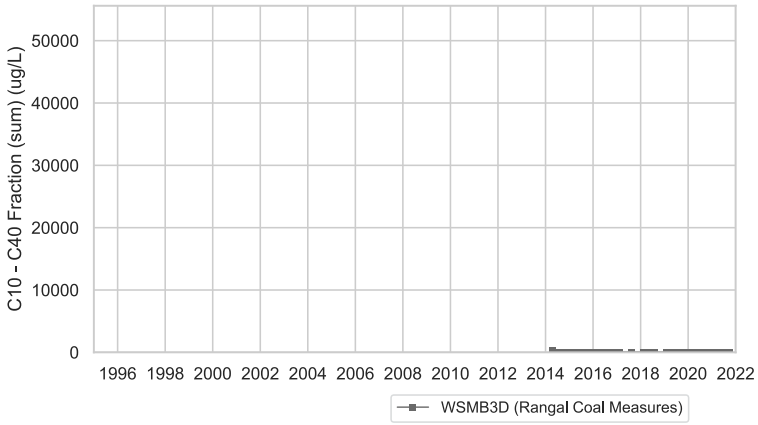

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

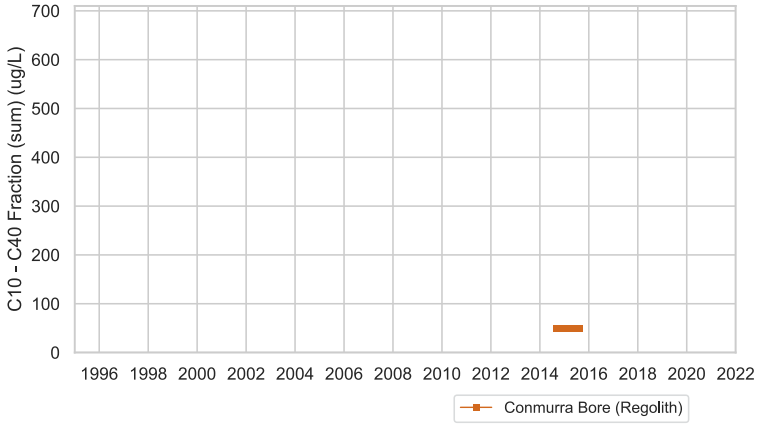

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

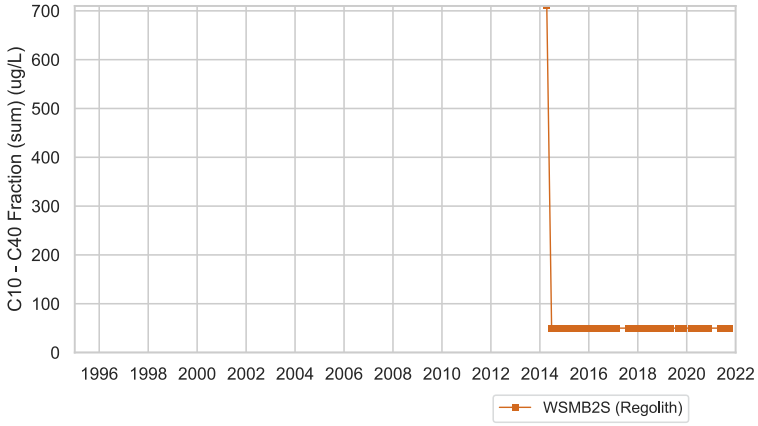

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

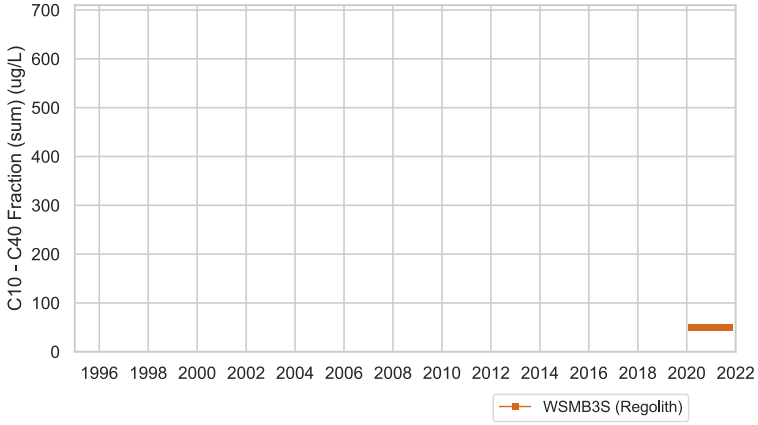

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

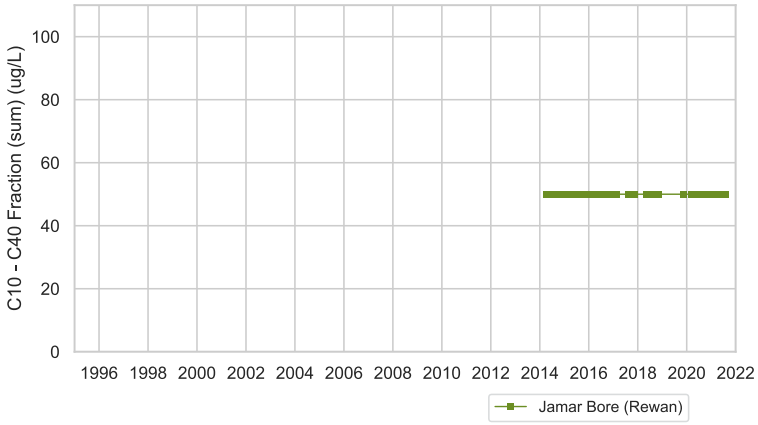

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

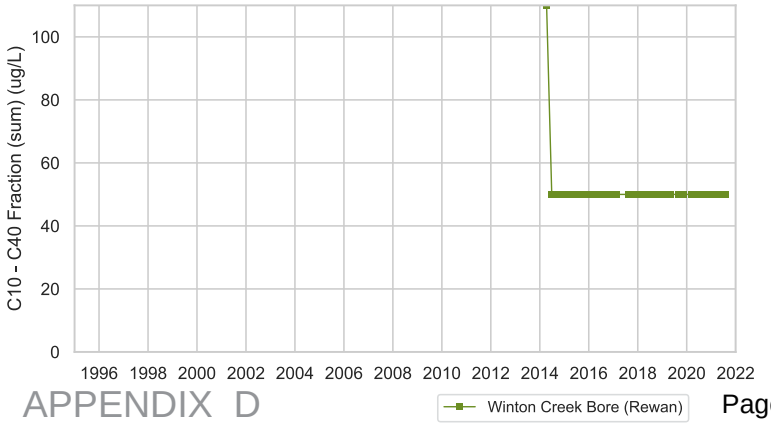

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)


C10 - C40 Fraction (sum) (ug/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)


C10 - C40 Fraction (sum) (ug/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)


C10 - C40 Fraction (sum) (ug/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

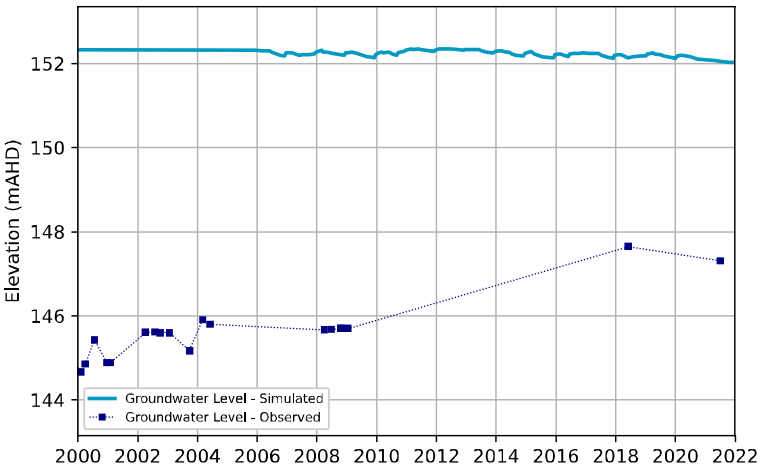

C10 - C40 Fraction (sum) (ug/L)
0
20
40
60
80
100
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)


C10 - C40 Fraction (sum) (ug/L)
0
20
40
60
80
100
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

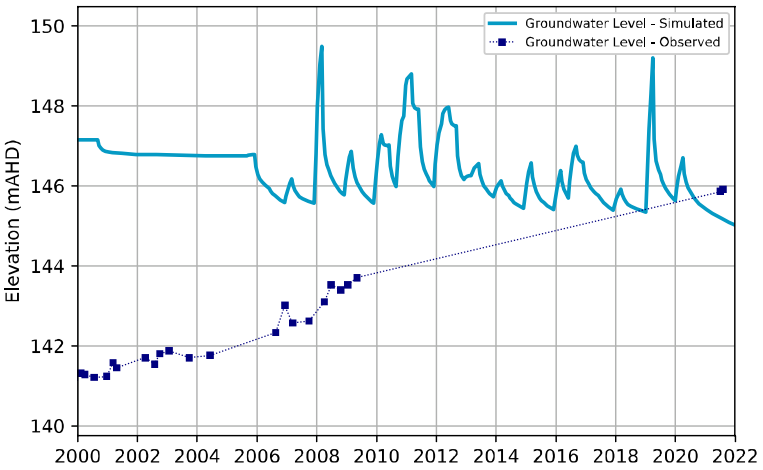
APPENDIX E

Calibration Hydrographs

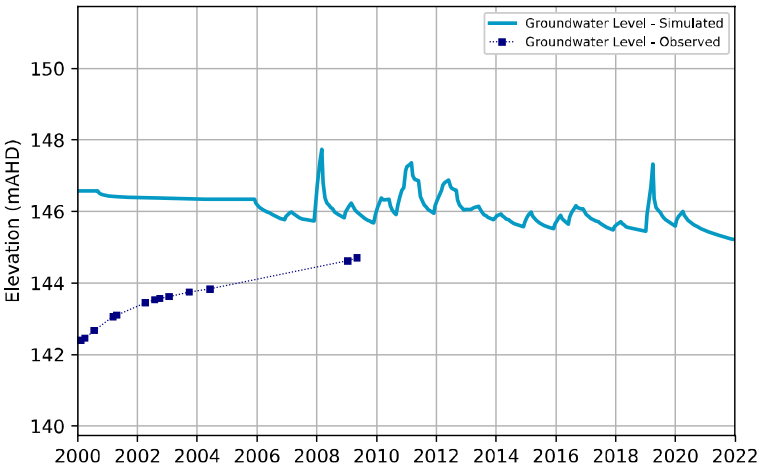
13020166 (Lower Alluvium)



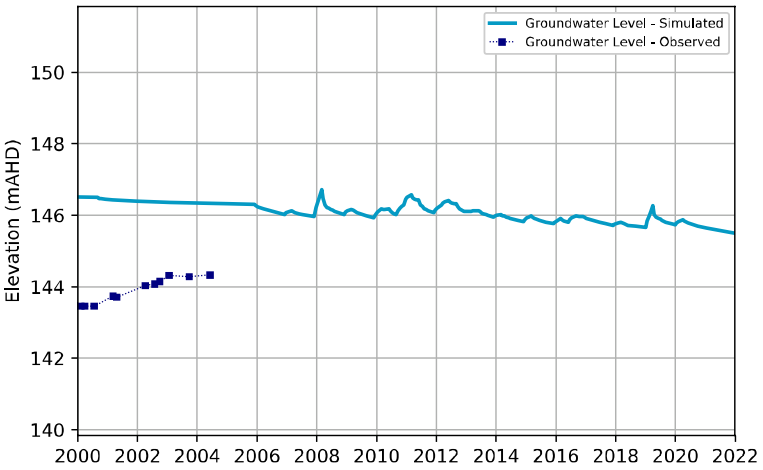
13020169 (Lower Alluvium)



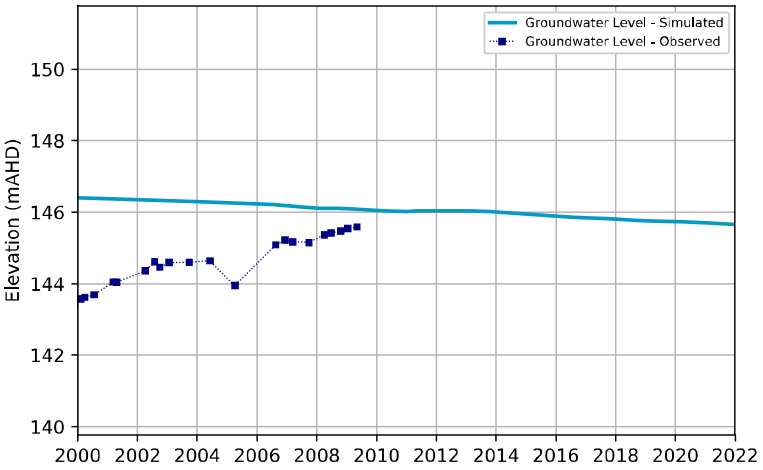
13020170 (Lower Alluvium)



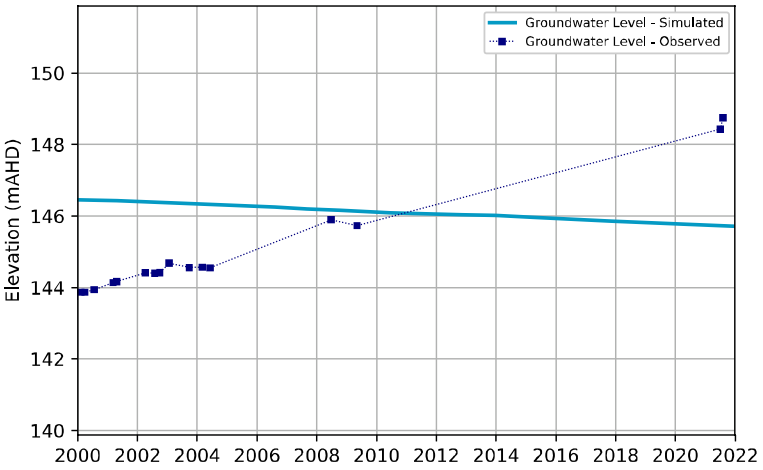
13020171 (Lower Alluvium)



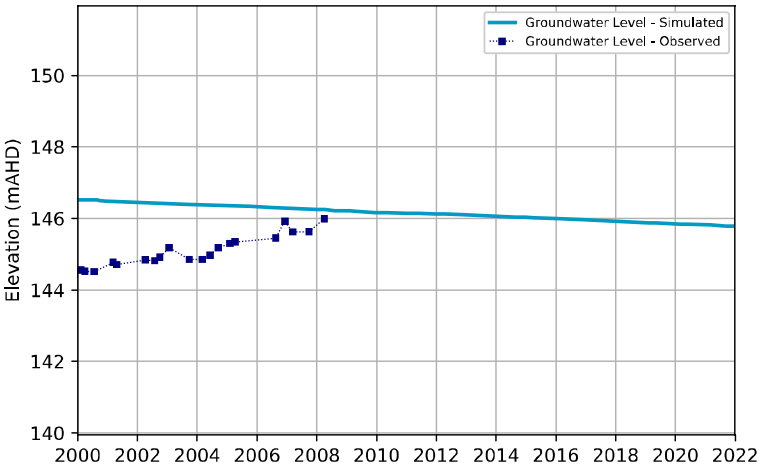
13020172 (Lower Alluvium)



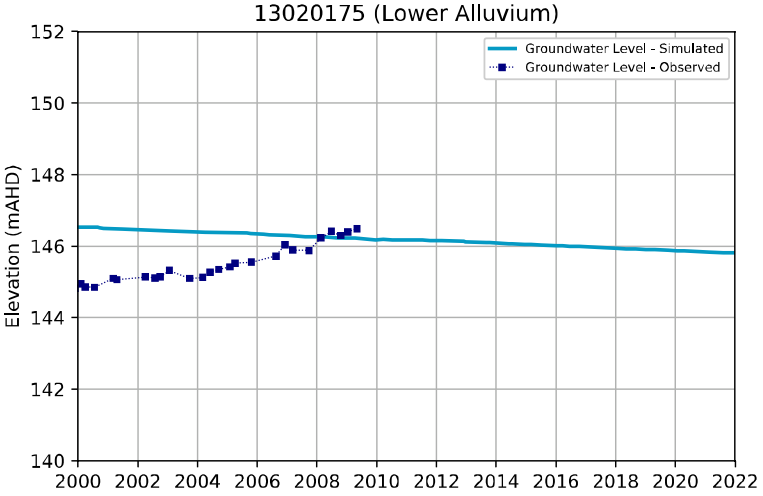
13020173 (Lower Alluvium)



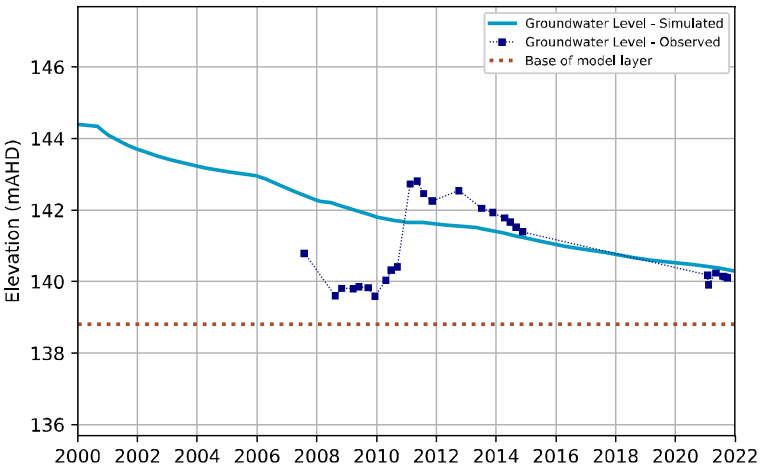
13020174 (Lower Alluvium)



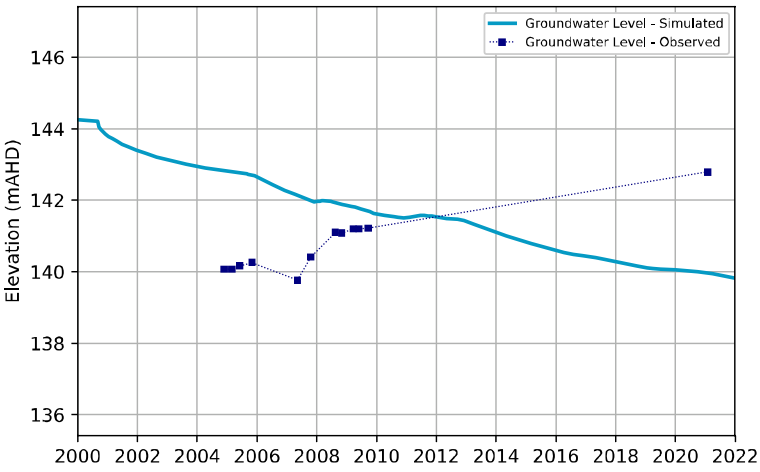
13020175 (Lower Alluvium)



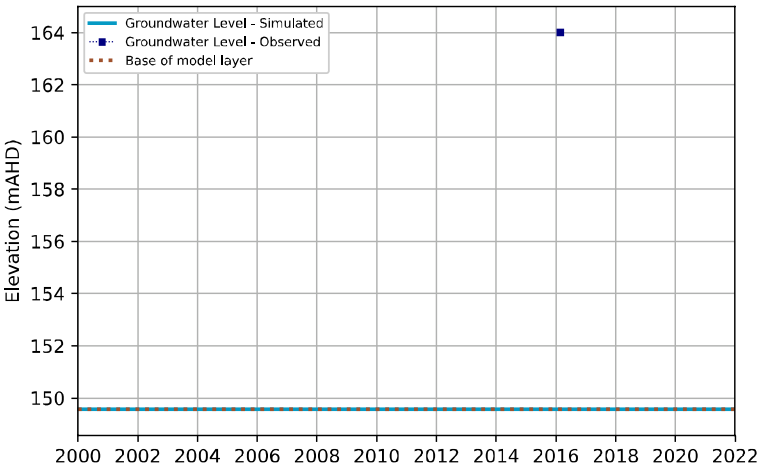
13020177 (Lower Alluvium)



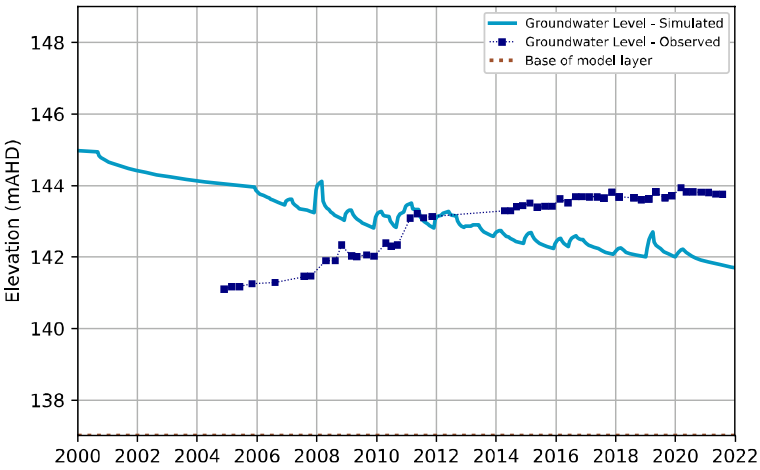
13020178 (Lower Alluvium)



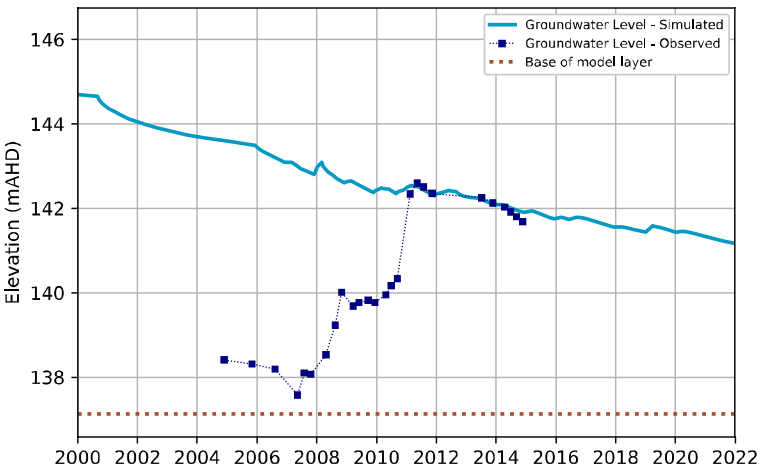
CONMURRA (Fairhill Formation)



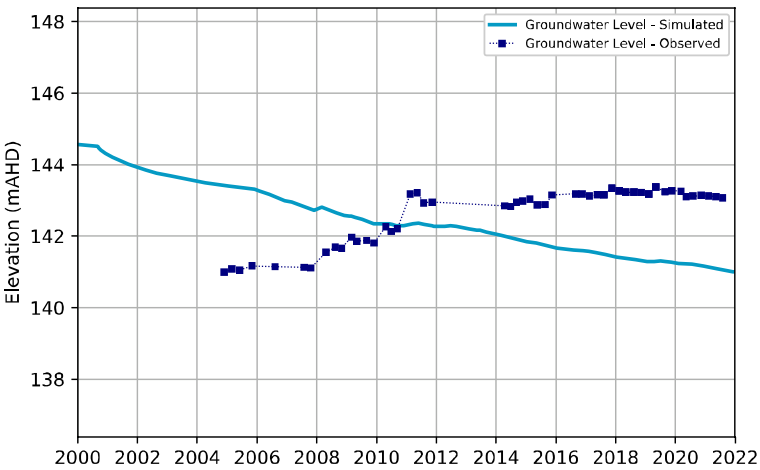
EC01 (Lower Alluvium)



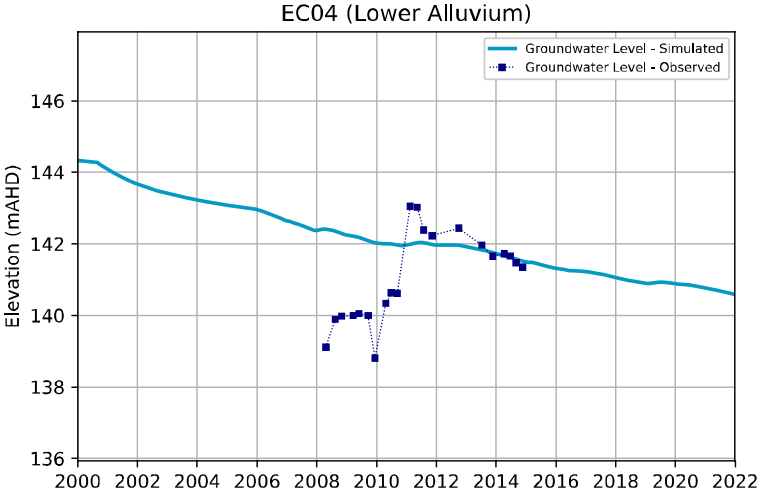
EC02 (Lower Alluvium)



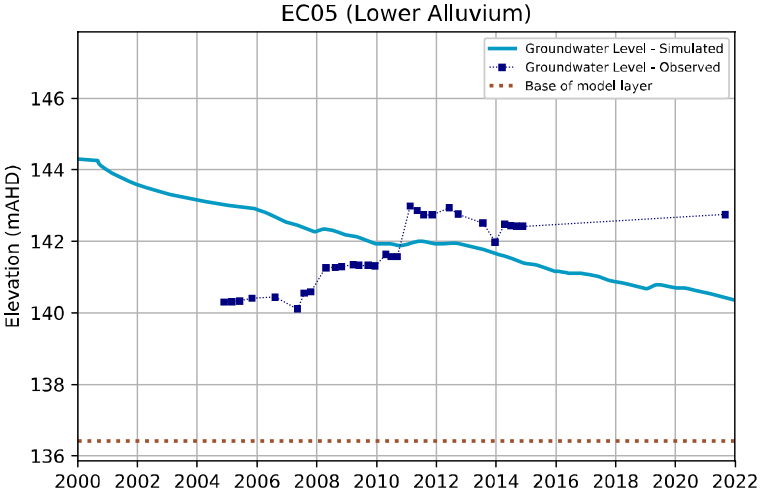
EC03 (Lower Alluvium)



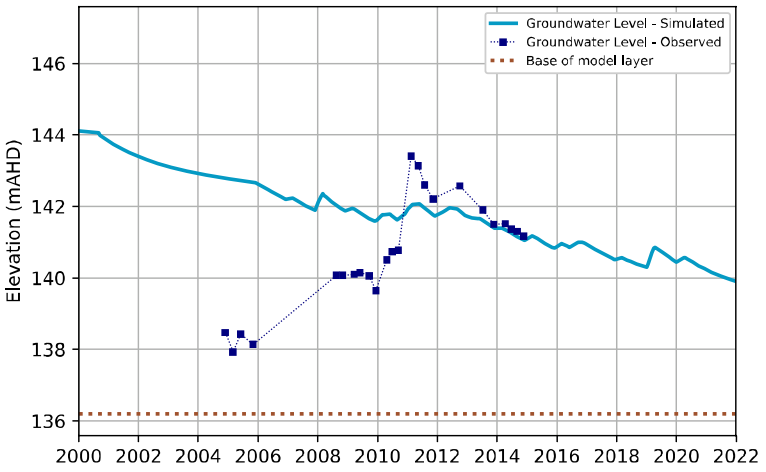
EC04 (Lower Alluvium)



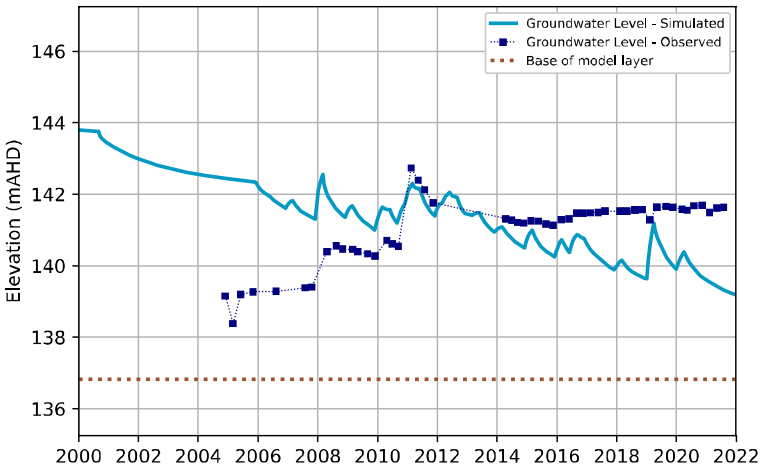
EC05 (Lower Alluvium)



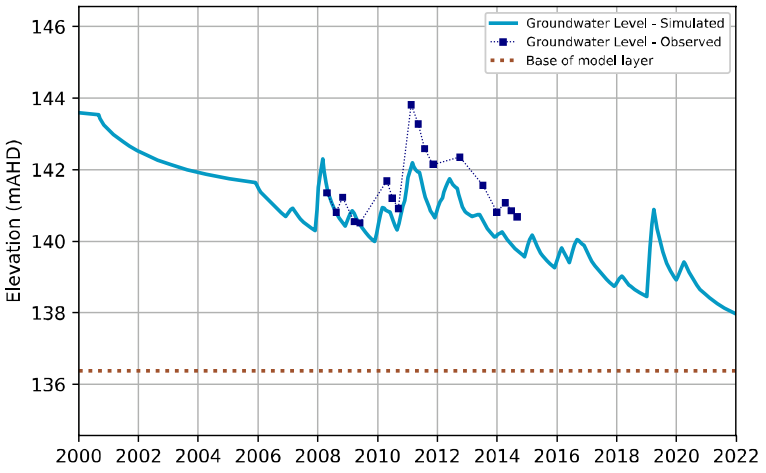
EC06 (Lower Alluvium)



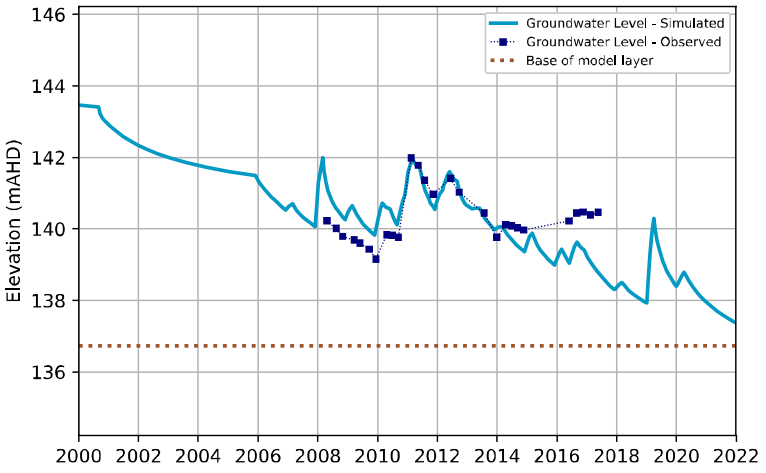
EC07 (Lower Alluvium)



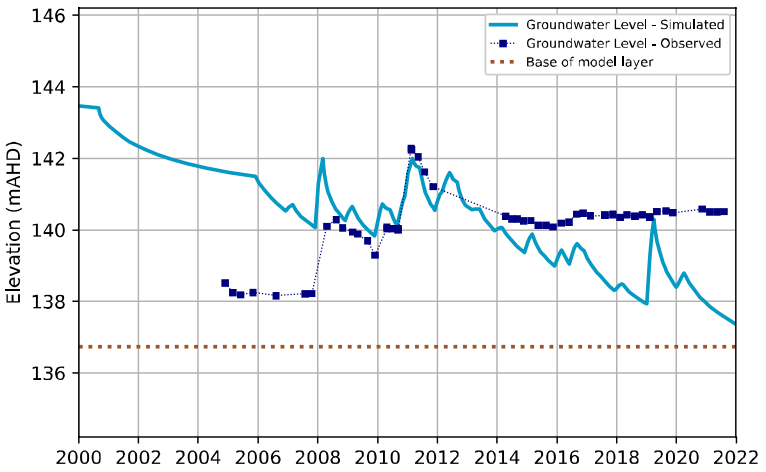
EC08 (Lower Alluvium)



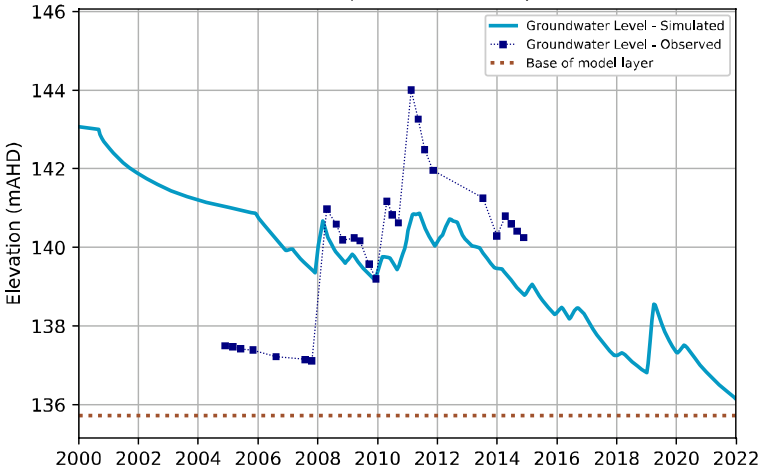
EC09 (Lower Alluvium)



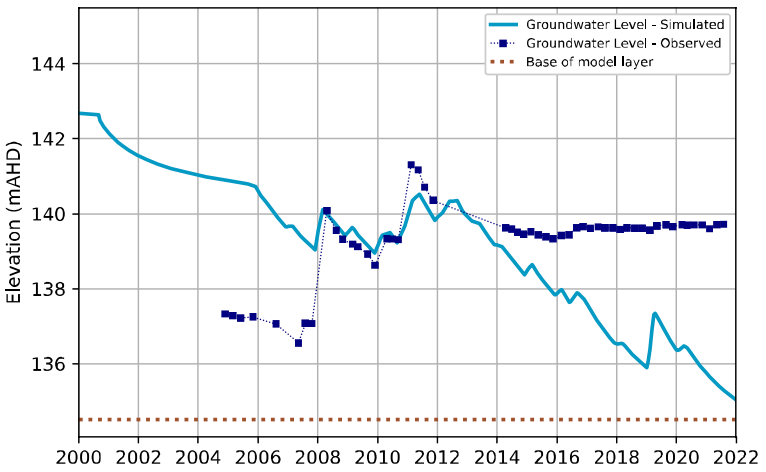
EC09A (Lower Alluvium)



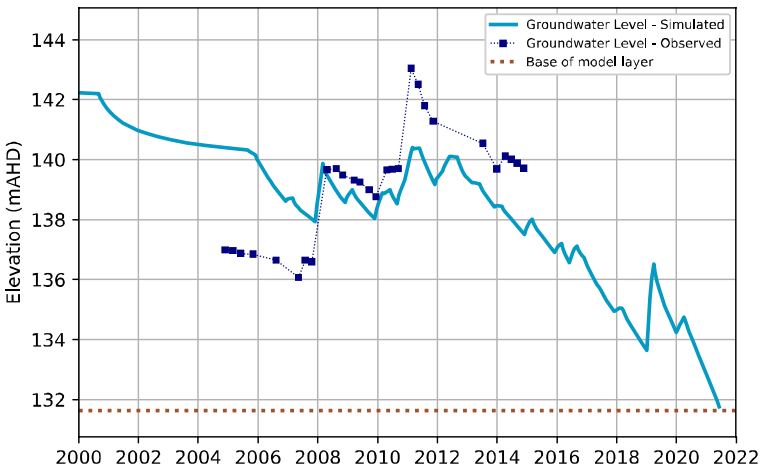
EC10 (Lower Alluvium)



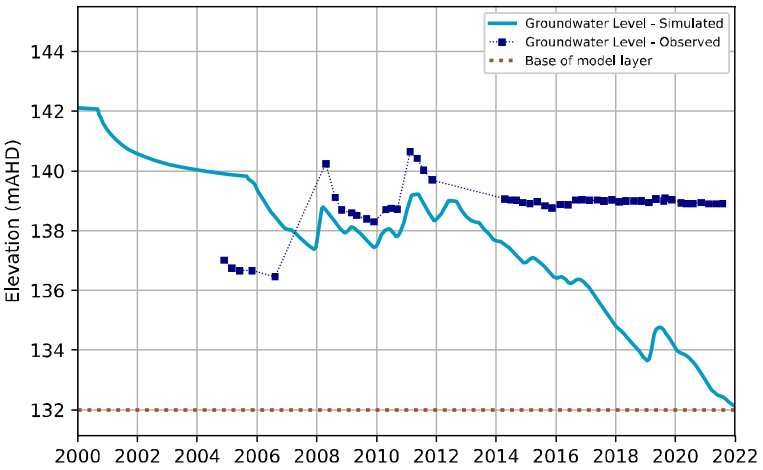
EC11 (Lower Alluvium)



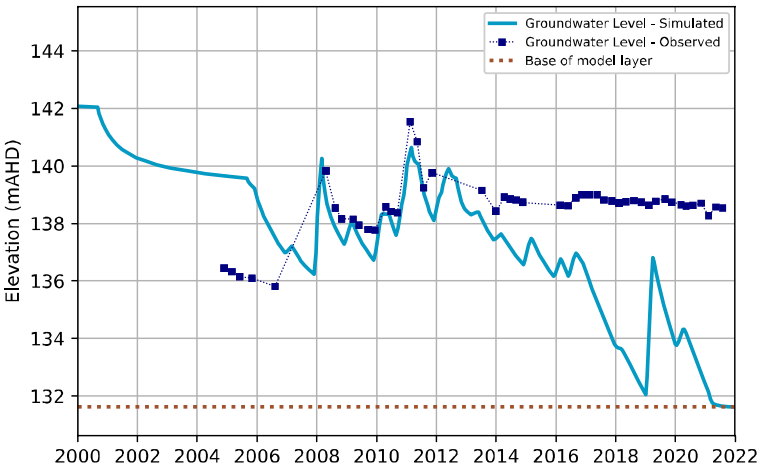
EC12 (Lower Alluvium)



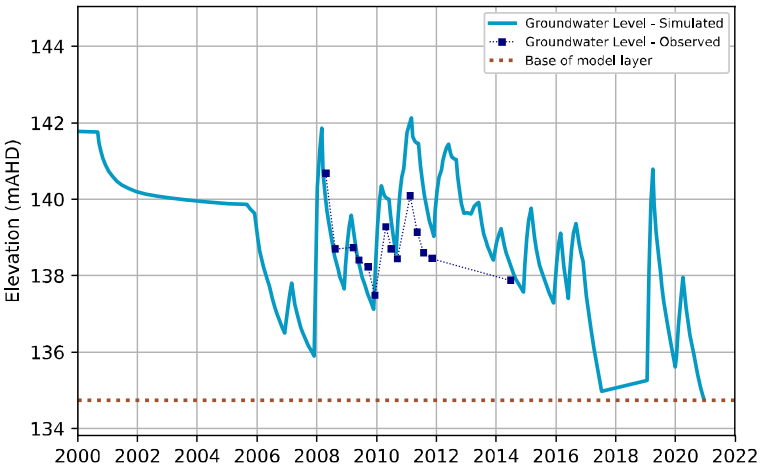
EC13 (Lower Alluvium)



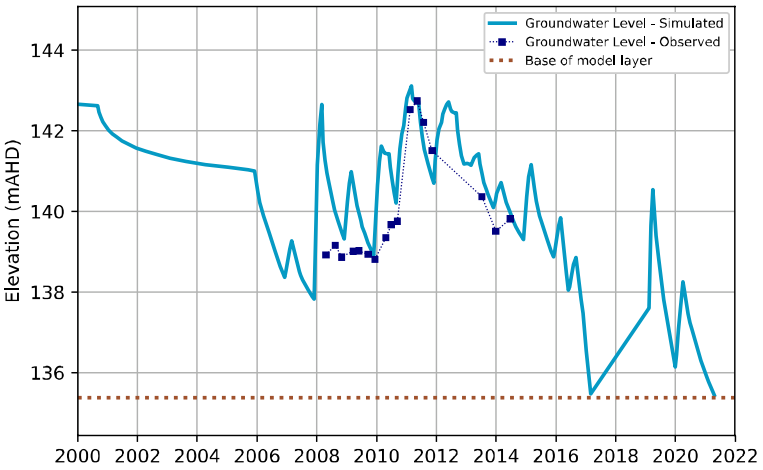
EC14 (Lower Alluvium)



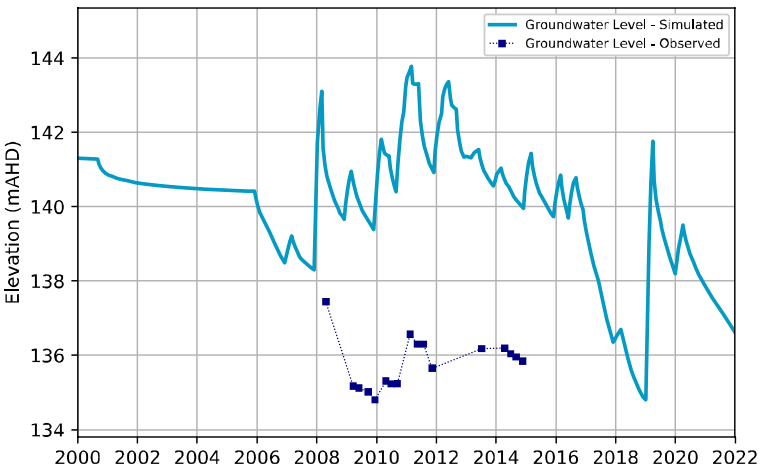
EC15 (Lower Alluvium)



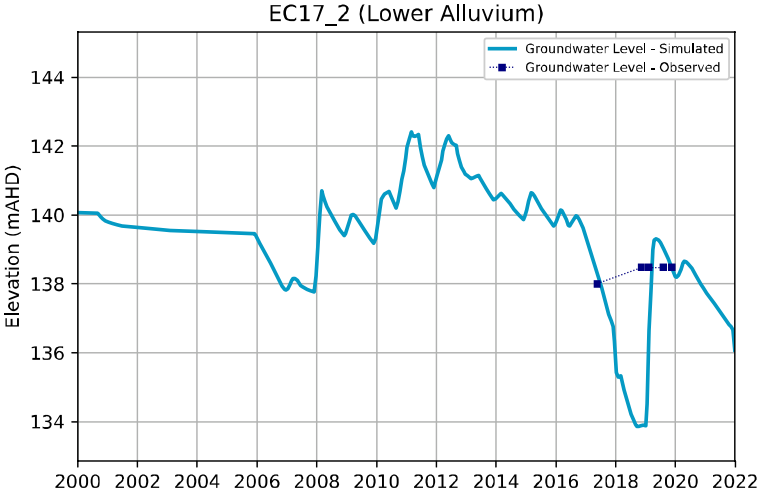
EC16 (Lower Alluvium)



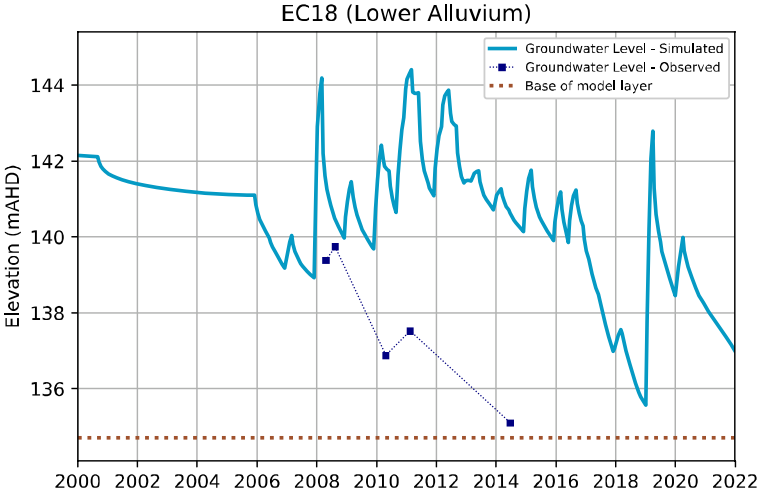
EC17 (Lower Alluvium)



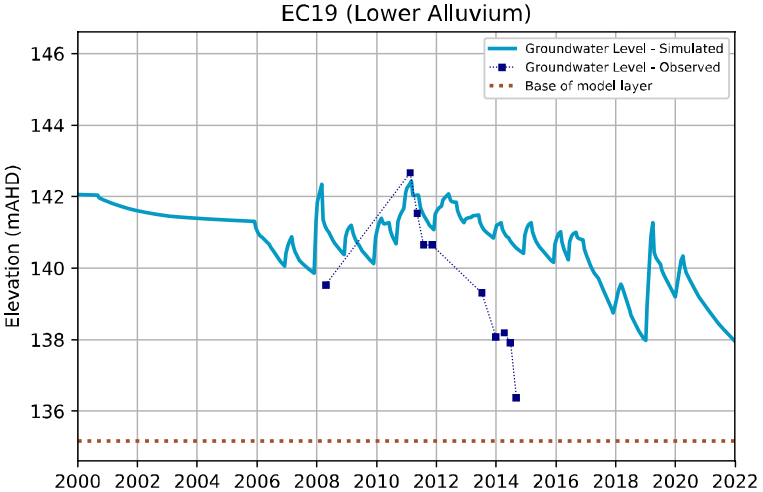
EC17_2 (Lower Alluvium)



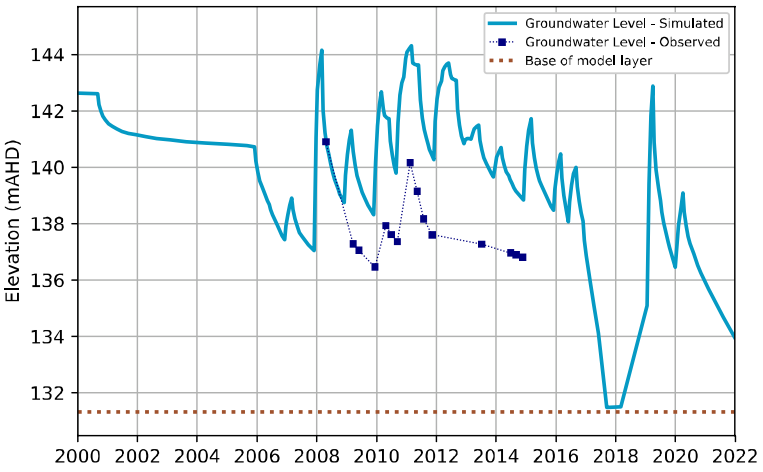
EC18 (Lower Alluvium)



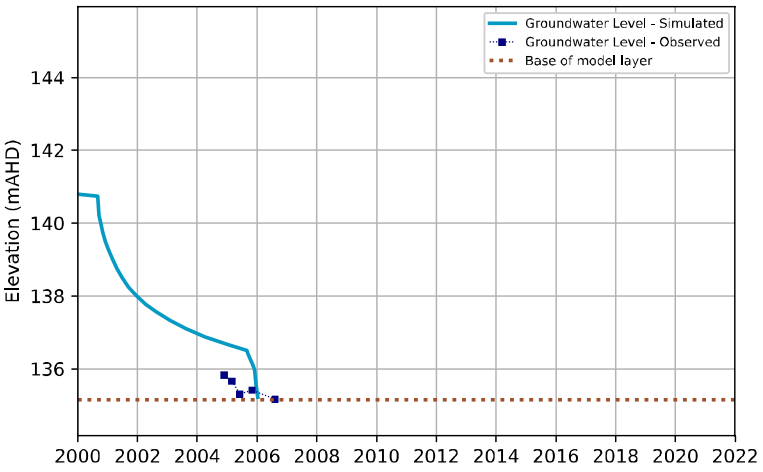
EC19 (Lower Alluvium)



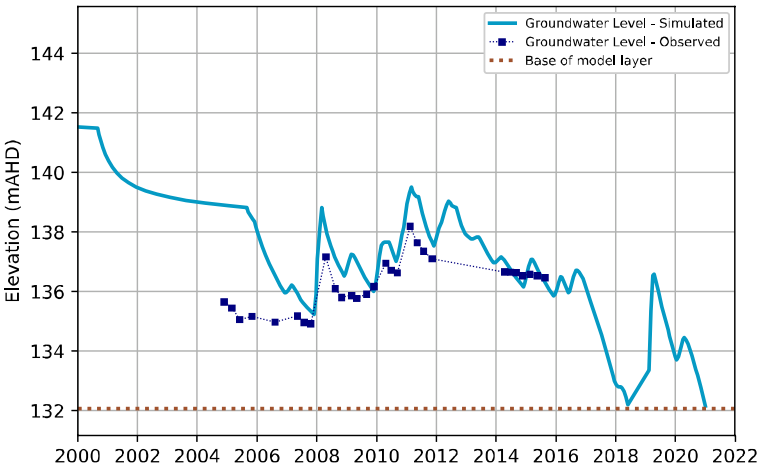
EC20 (Lower Alluvium)



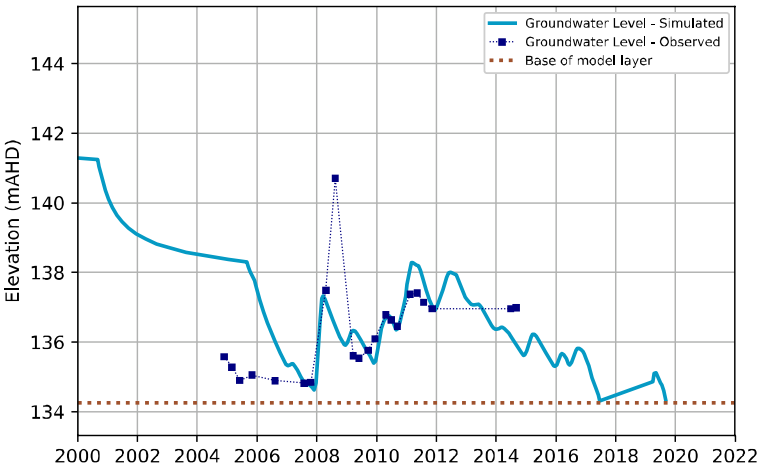
EC21 (Lower Alluvium)



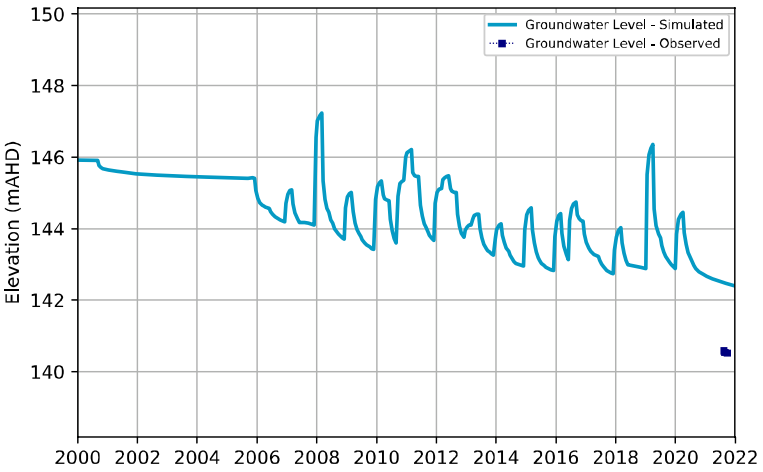
EC22 (Lower Alluvium)



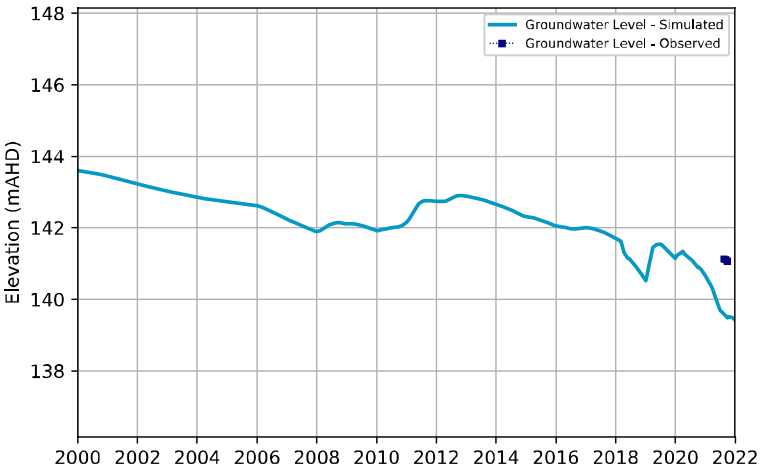
EC23 (Lower Alluvium)



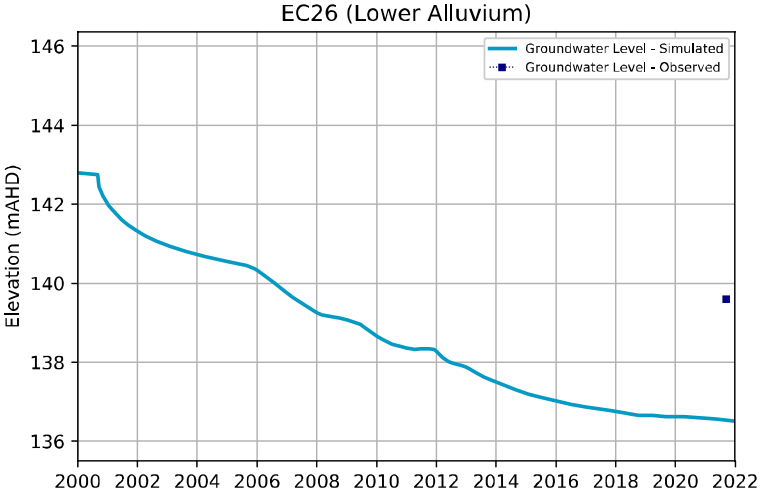
EC24 (Lower Alluvium)



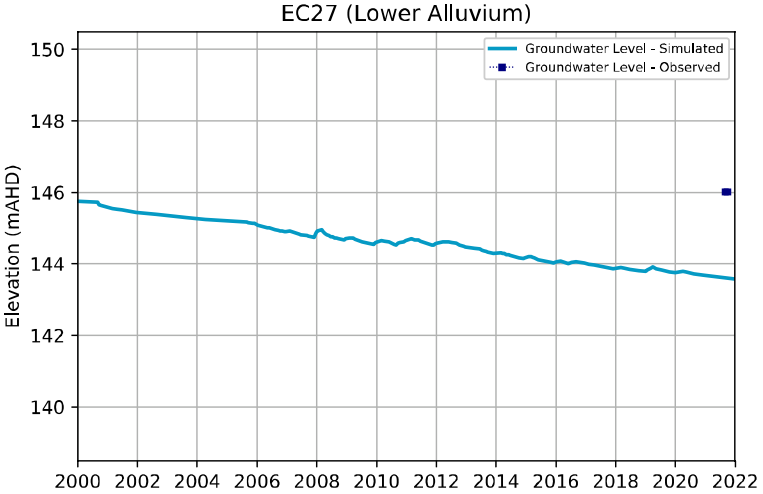
EC25 (Lower Alluvium)



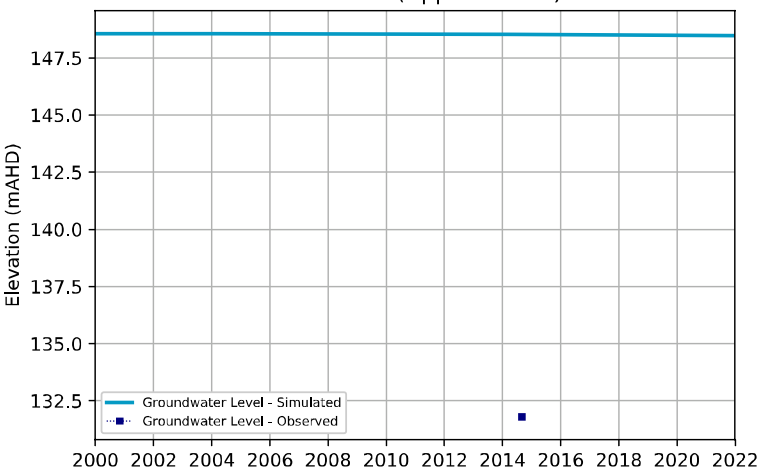
EC26 (Lower Alluvium)



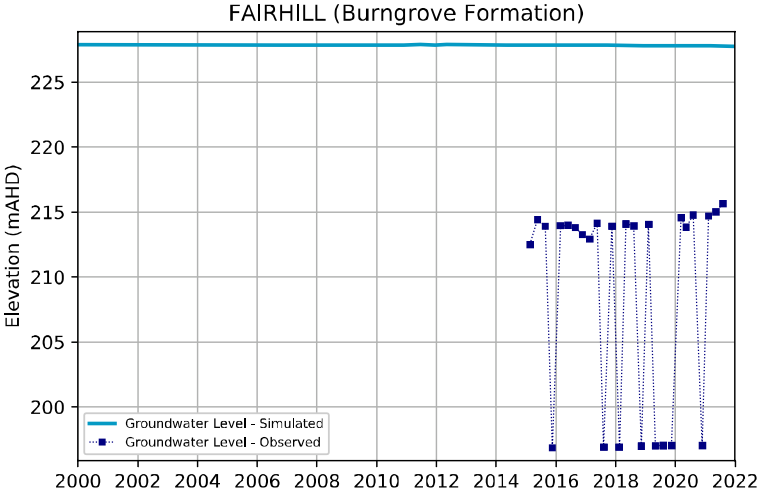
EC27 (Lower Alluvium)



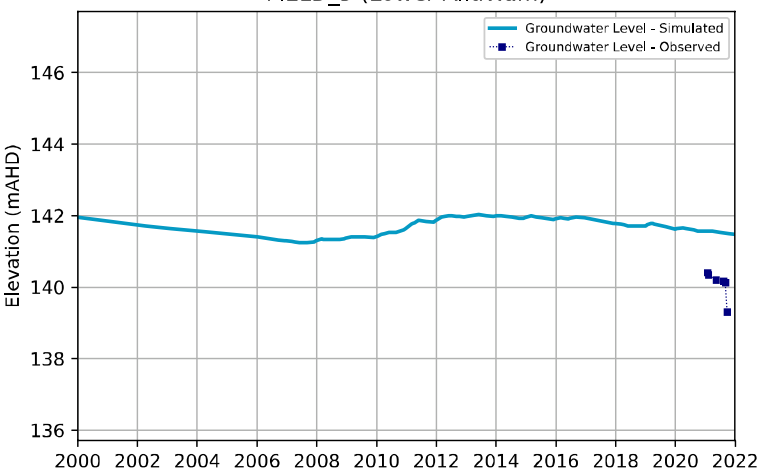
EUROPARK (Upper Rewan)



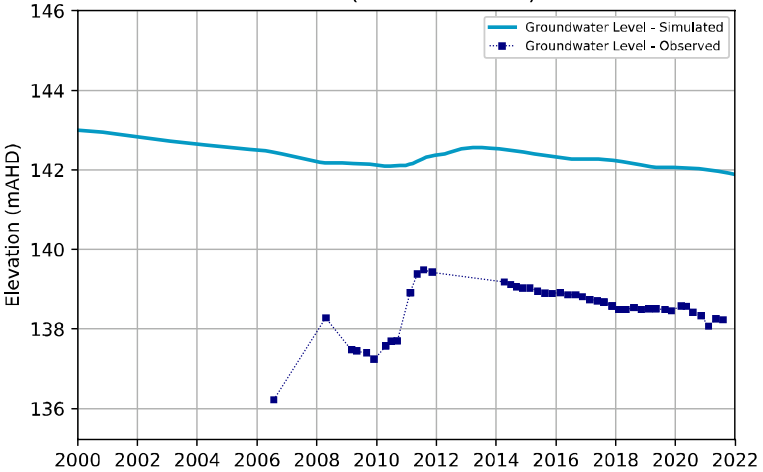
FAIRHILL (Burngrove Formation)



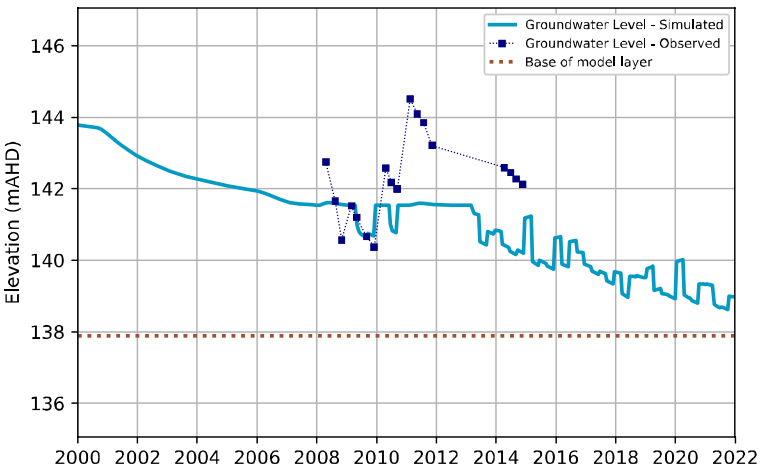
FIELD_5 (Lower Alluvium)



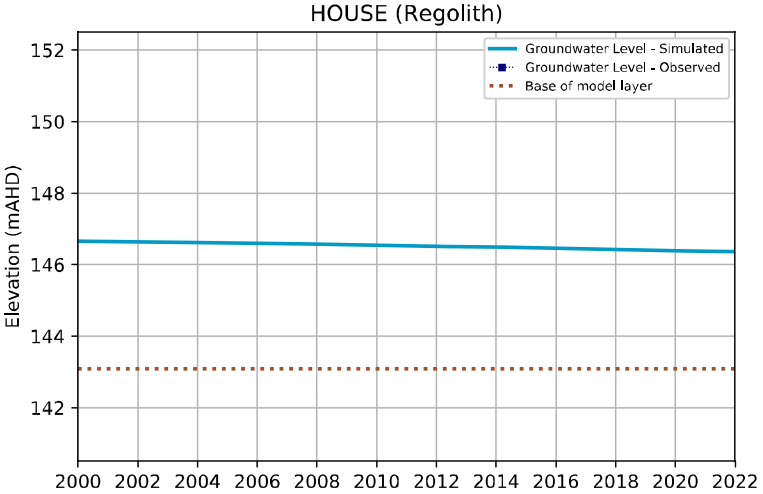
GW01 (Lower Alluvium)



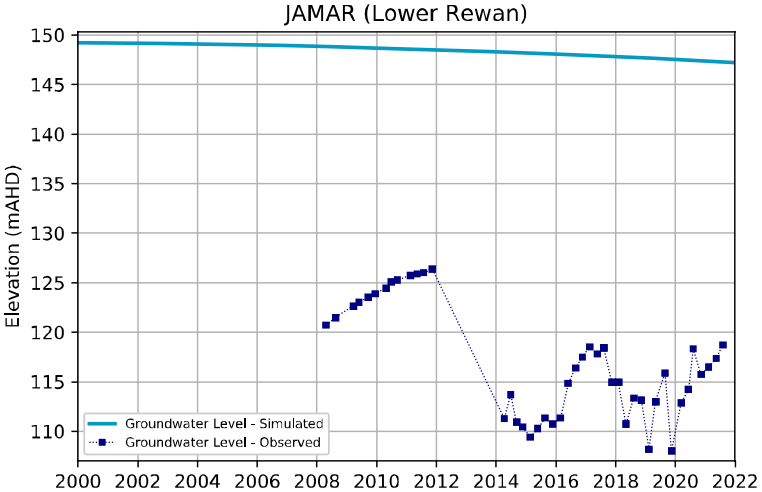
GW02 (Lower Alluvium)



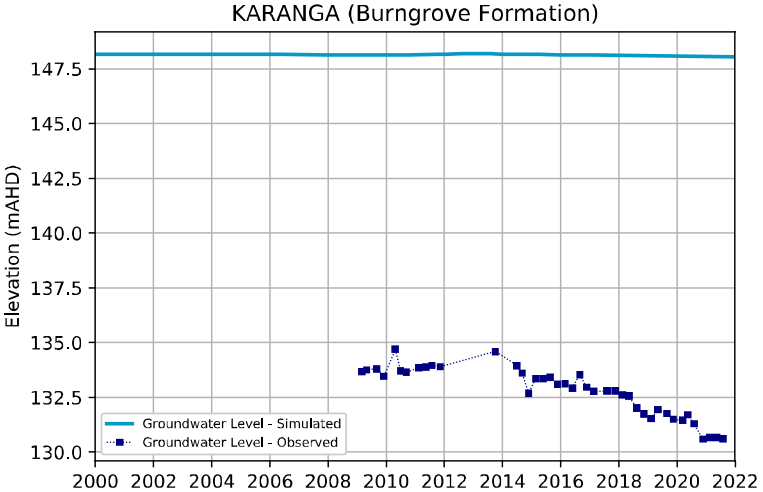
HOUSE (Regolith)



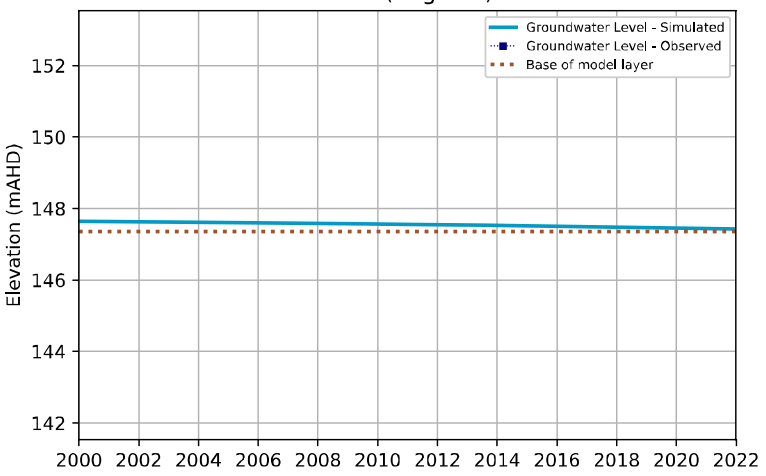
JAMAR (Lower Rewan)



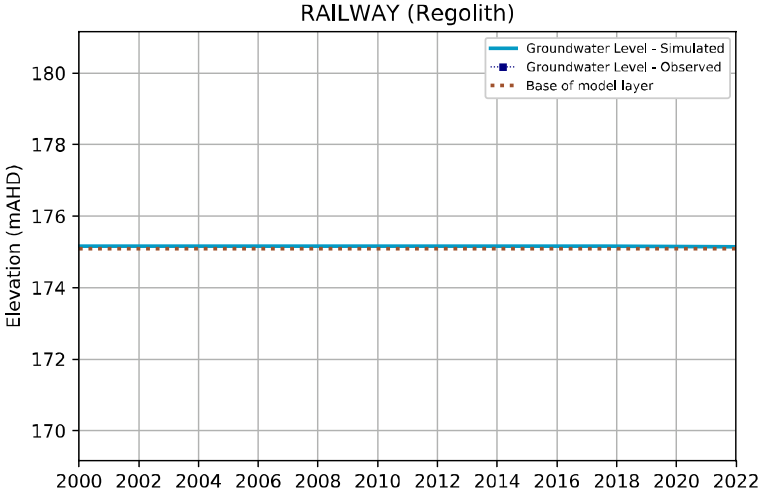
KARANGA (Burngrove Formation)



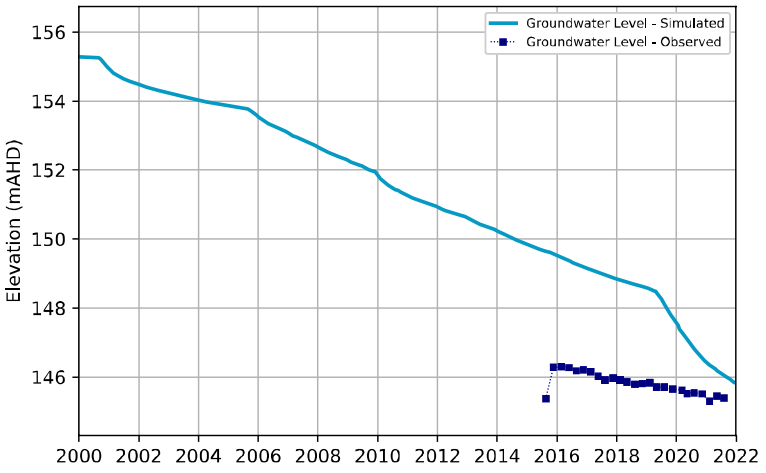
MINE (Regolith)



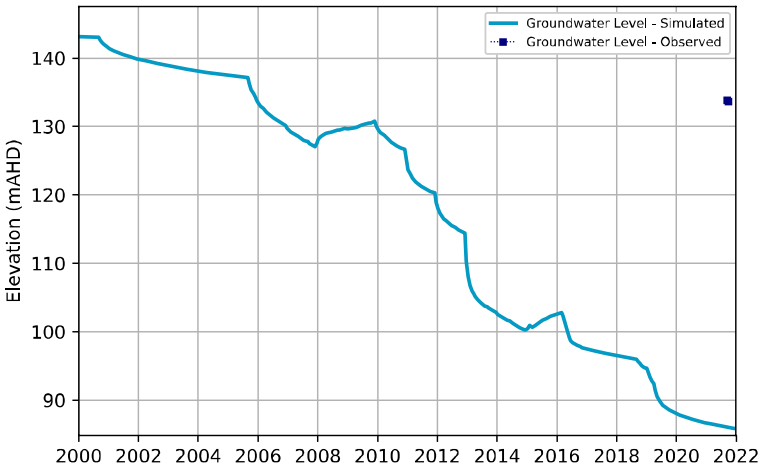
RAILWAY (Regolith)



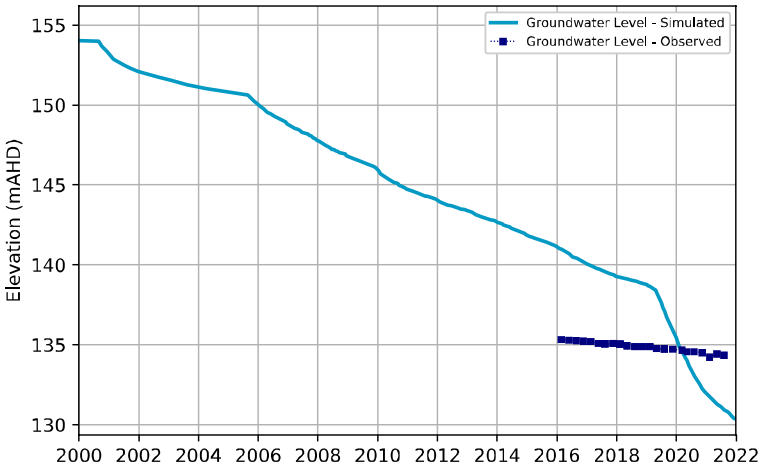
RB1 (Coal A2C Seam)



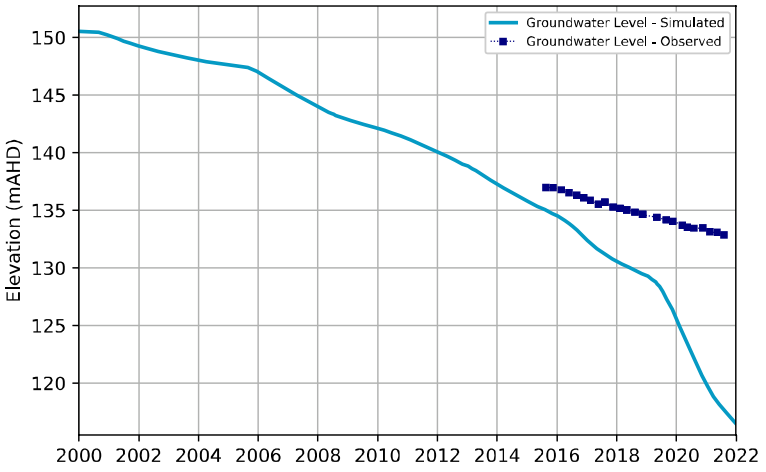
RB10 (Coal A2C Seam)



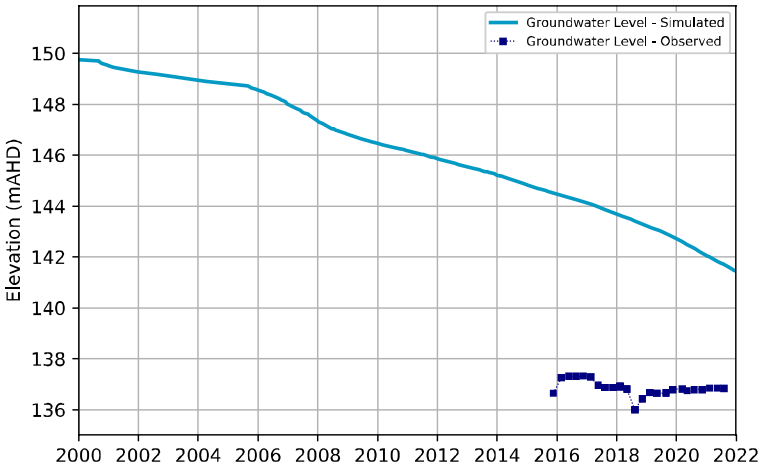
RB2 (Coal A2C Seam)



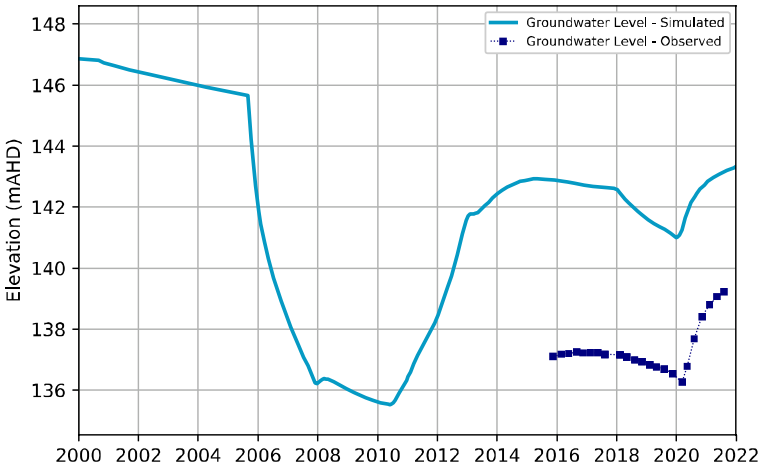
RB3 (Coal A2C Seam)



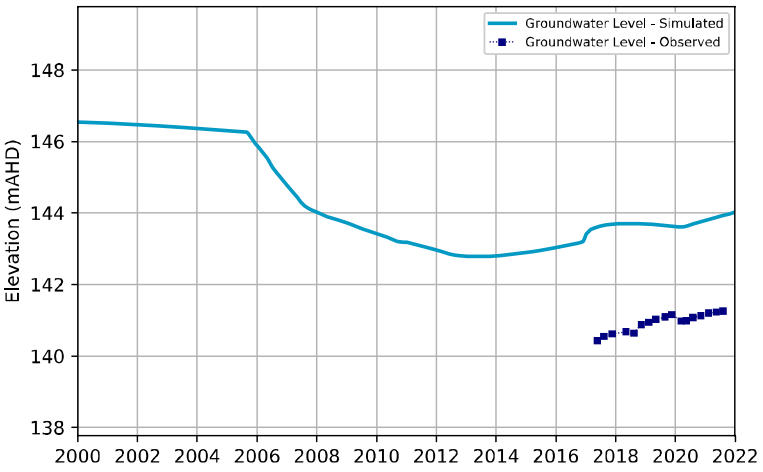
RB4 (Coal A2C Seam)



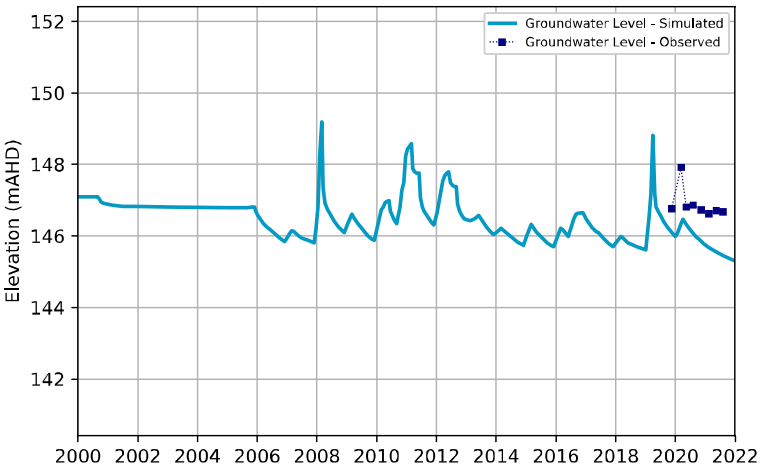
RB5 (Coal A2C Seam)



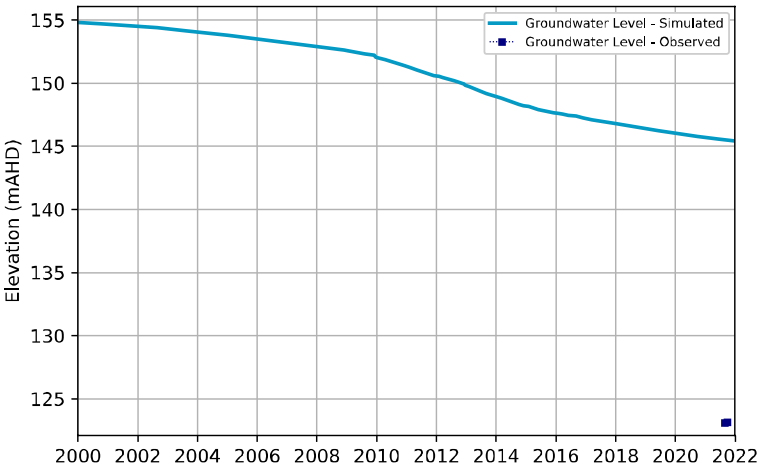
RB6 (Coal A2C Seam)



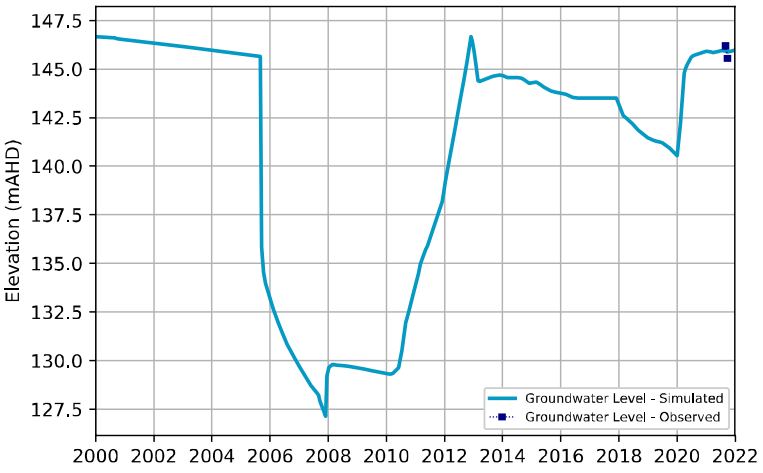
RB7A (Lower Alluvium)



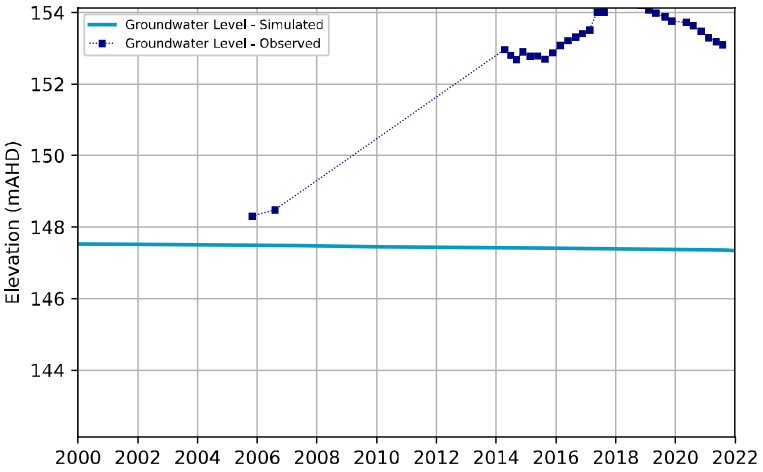
RB8 (Coal A2C Seam)



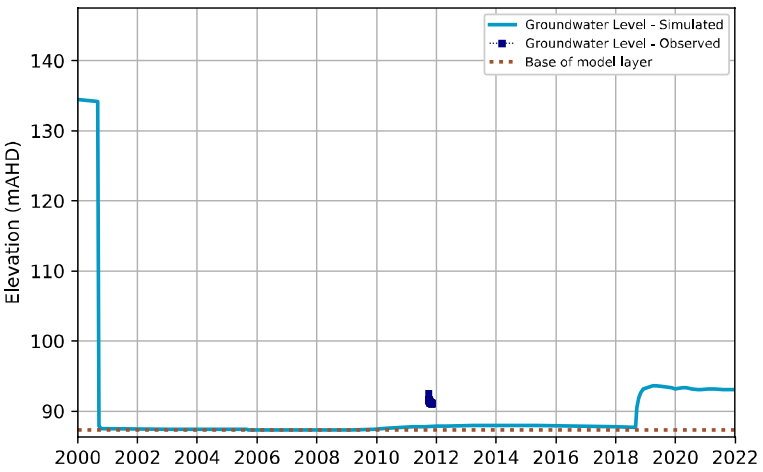
RB9 (Coal A2C Seam)



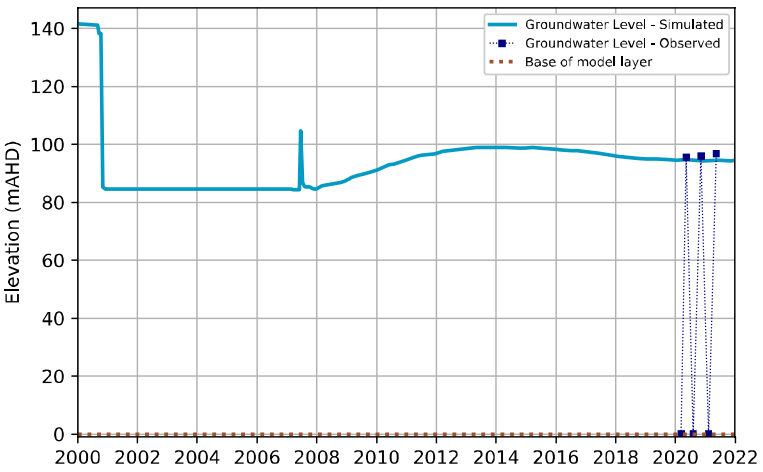
TWIN (Lower Alluvium)



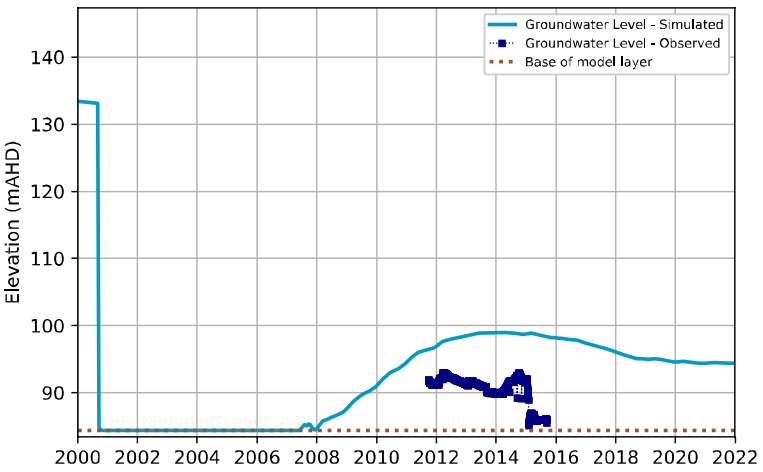
UG01 (Coal A2C Seam)

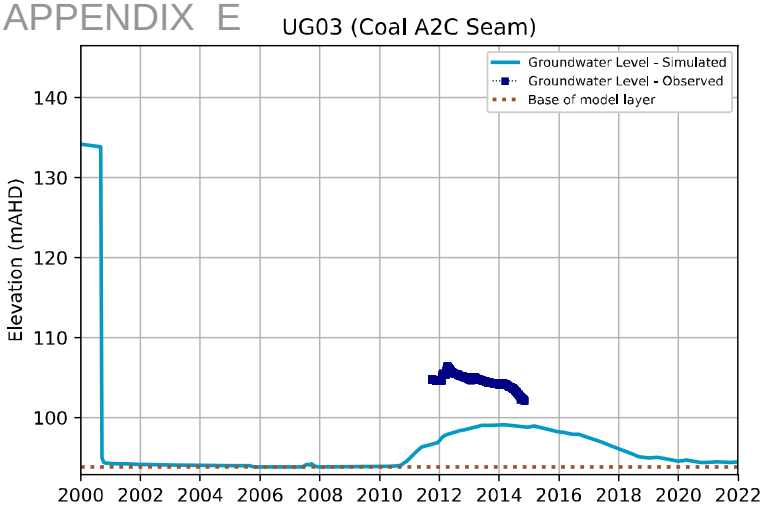


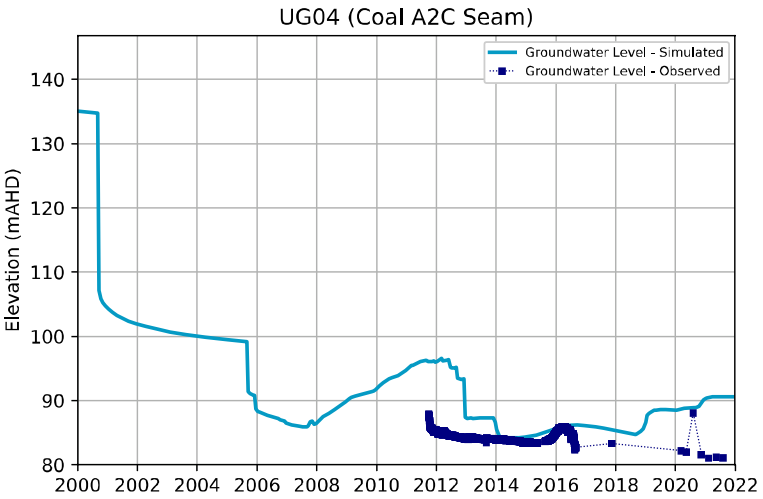
UG02 (Coal A2C Seam)

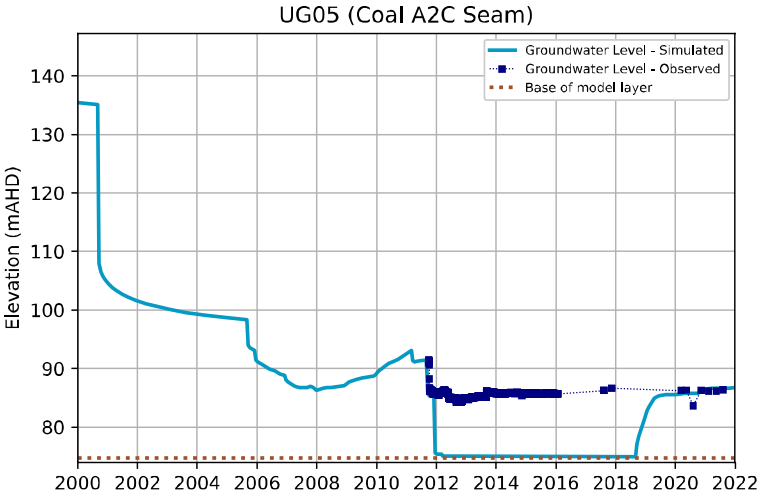


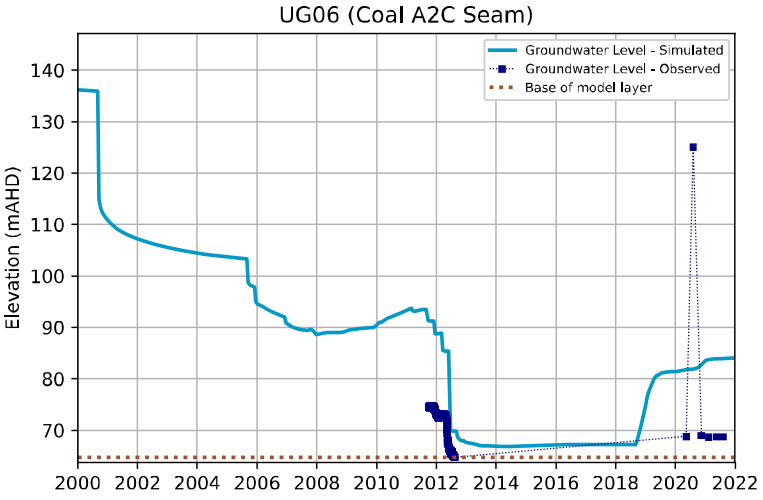
UG02B (Coal A2C Seam)

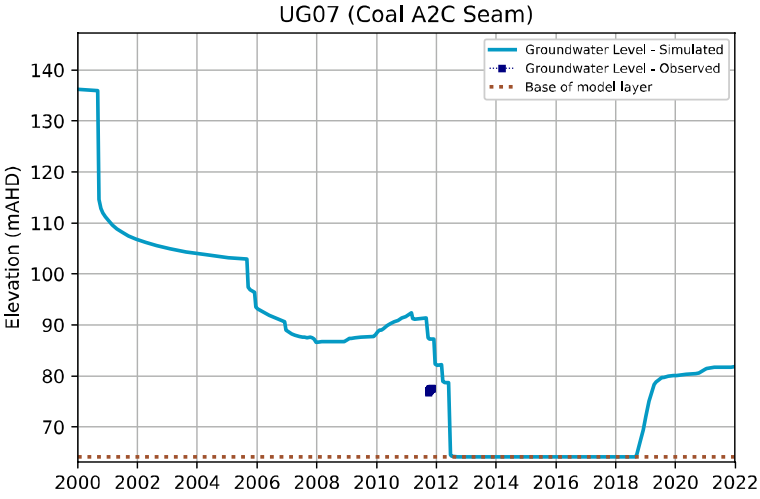


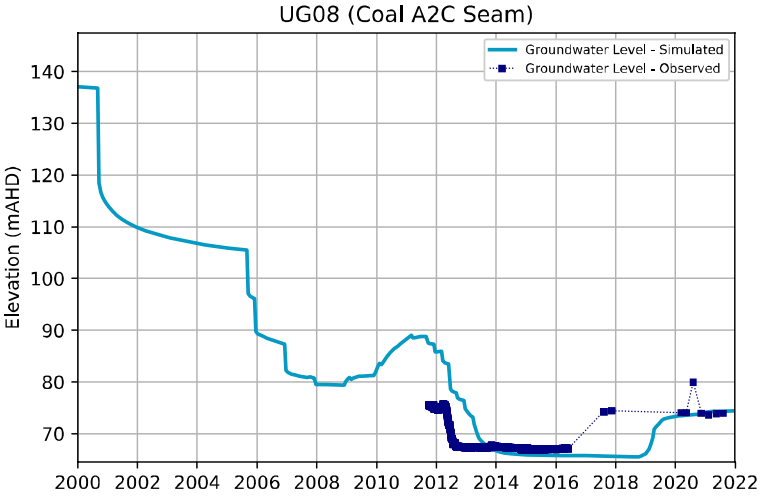

UG03 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

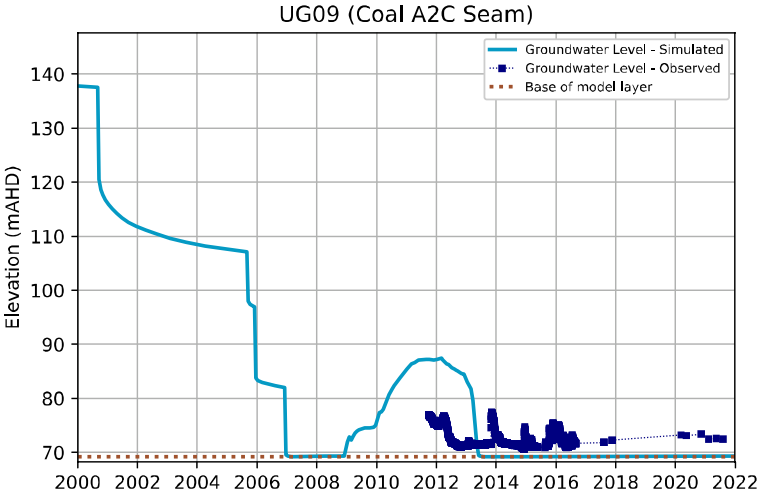

UG04 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
140
130
120
110
100
90
80
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

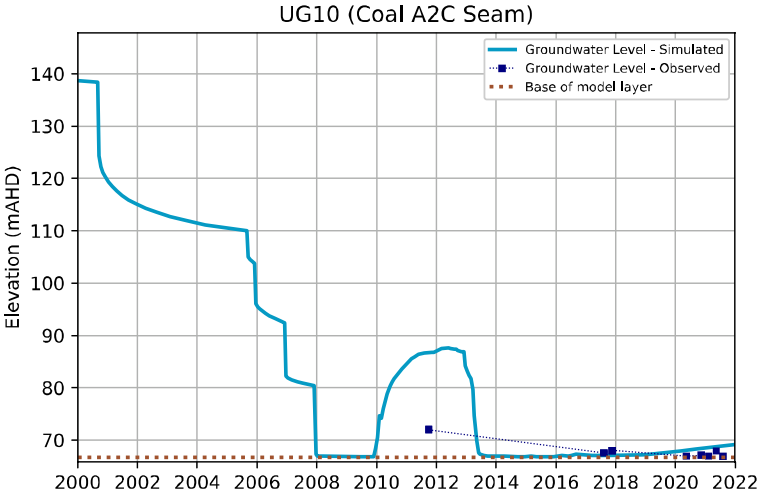

UG05 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
80
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022


UG06 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
80
70
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

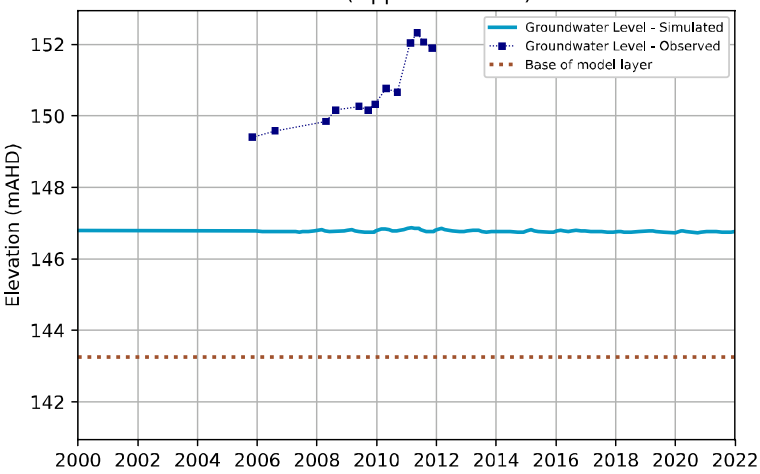

UG07 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
80
70
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022


UG08 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
140
130
120
110
100
90
80
70
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

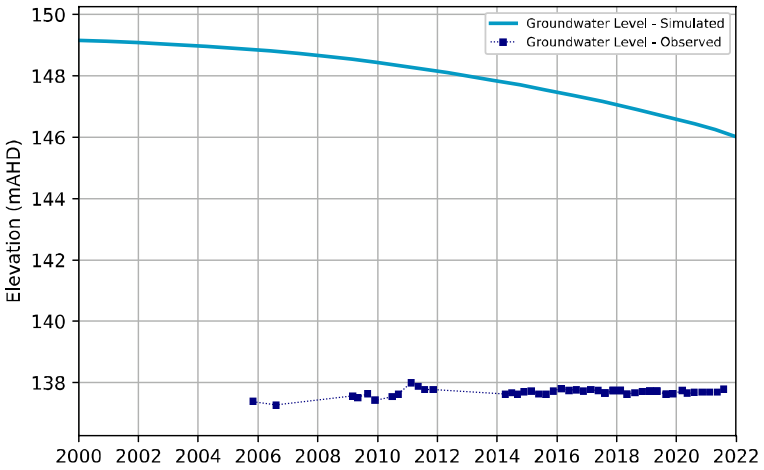

UG09 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
80
70
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022


UG10 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
80
70
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

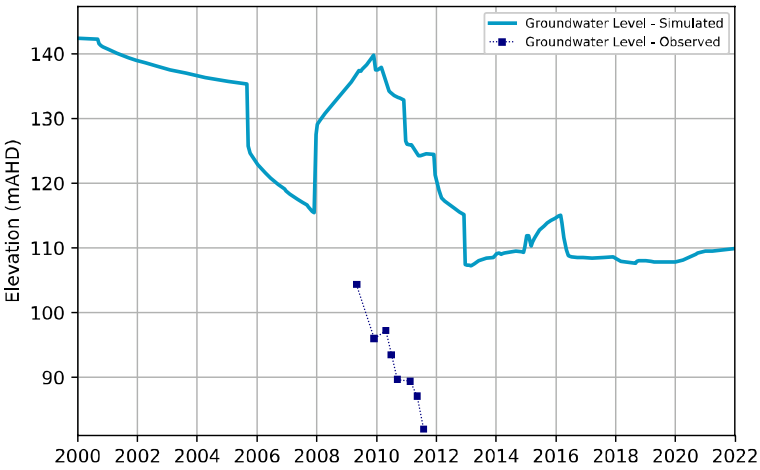
WEIR (Upper Alluvium)



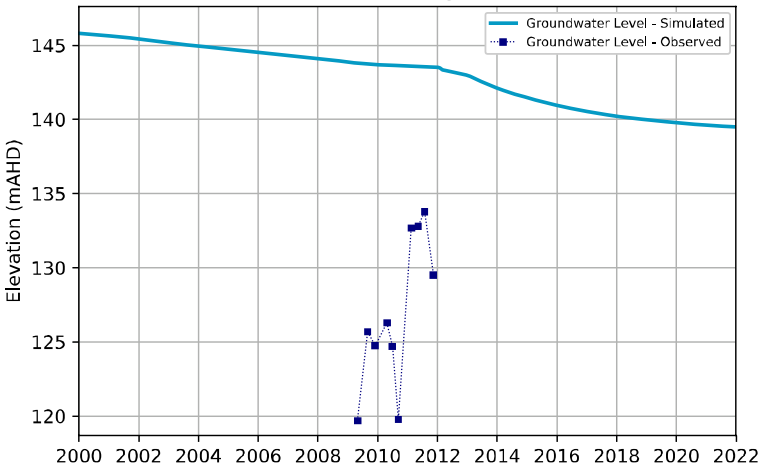
WINTON (Lower Rewan)



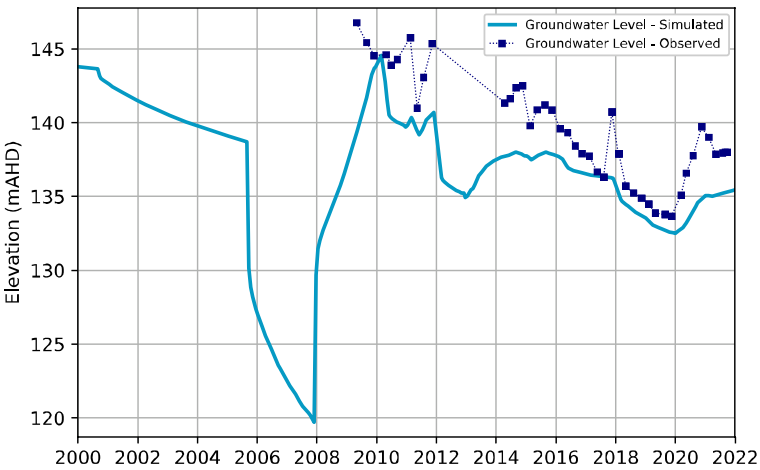
WSMB1D (Coal A2C Seam)



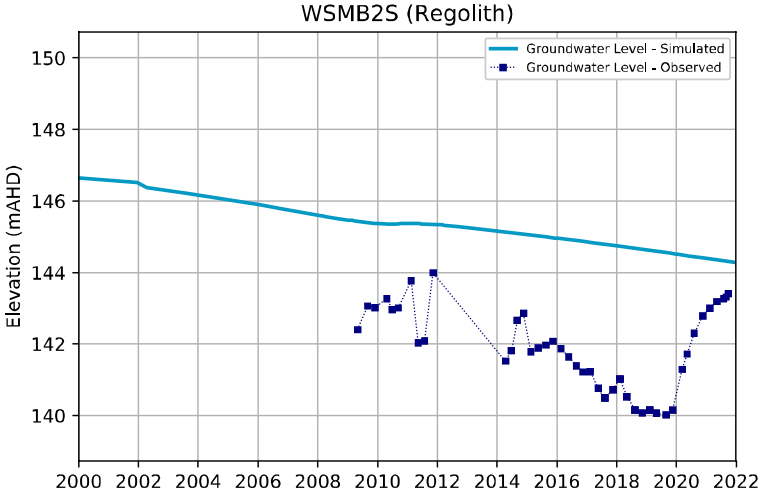
WSMB1S (Regolith)



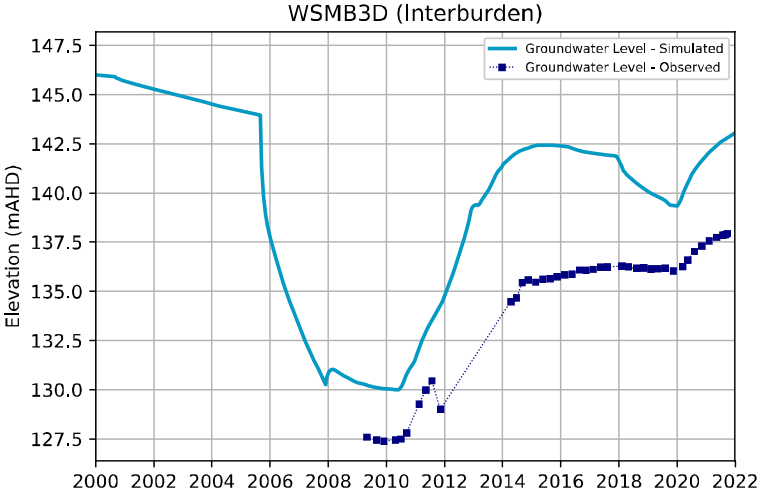
WSMB2D (Coal A2C Seam)



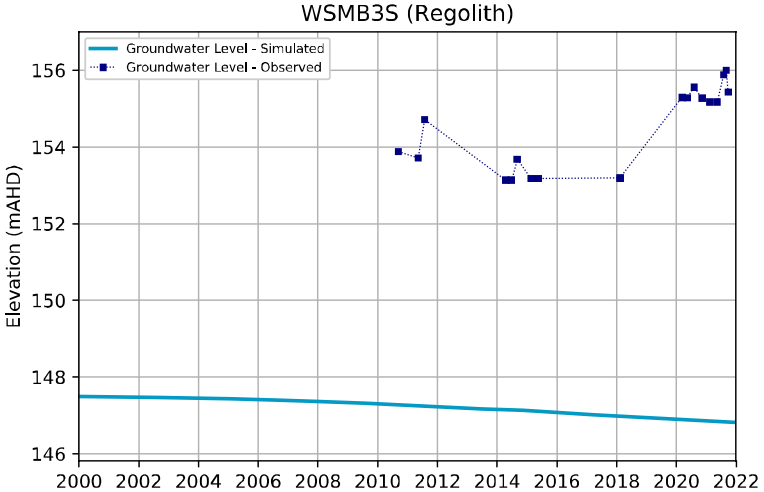
WSMB2S (Regolith)



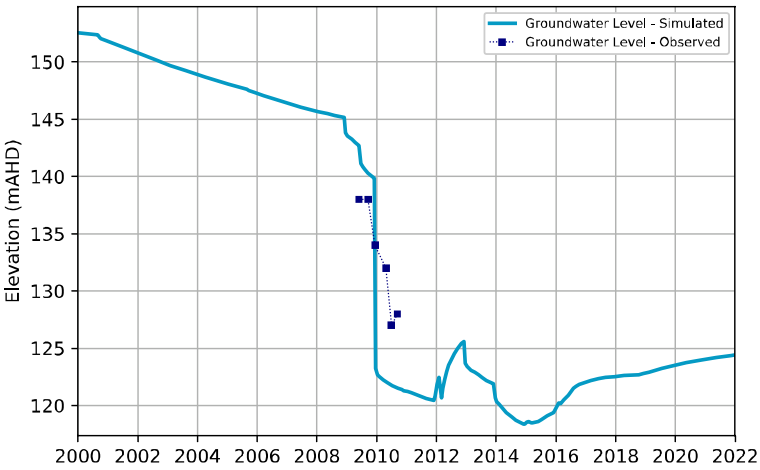
WSMB3D (Interburden)



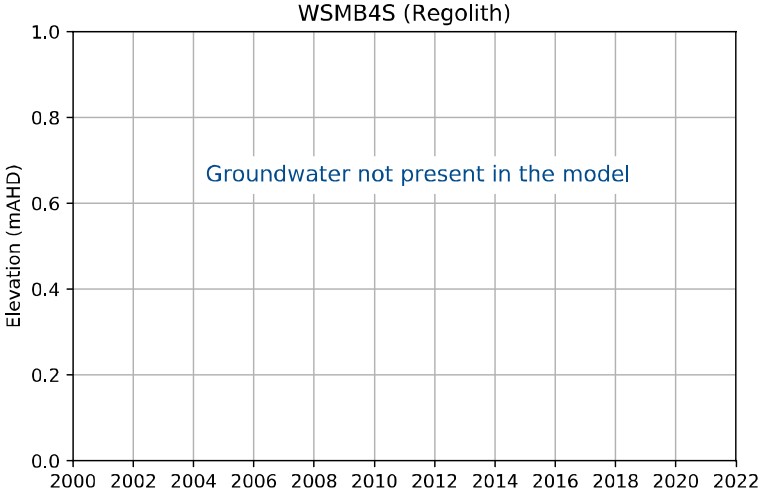
WSMB3S (Regolith)



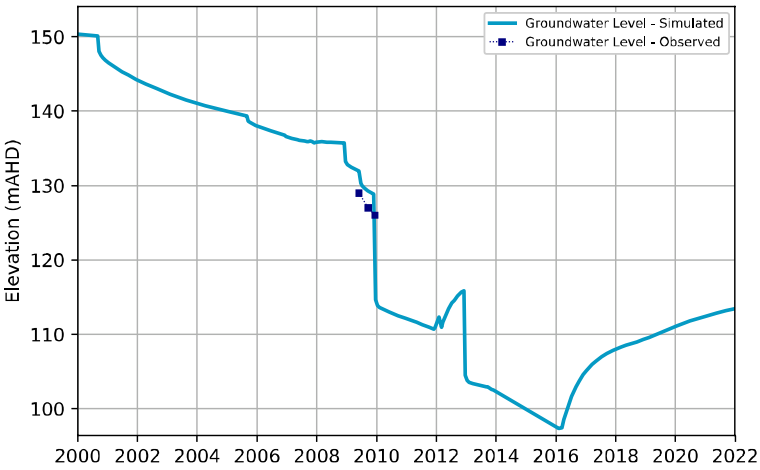
WSMB4D (Coal A2C Seam)



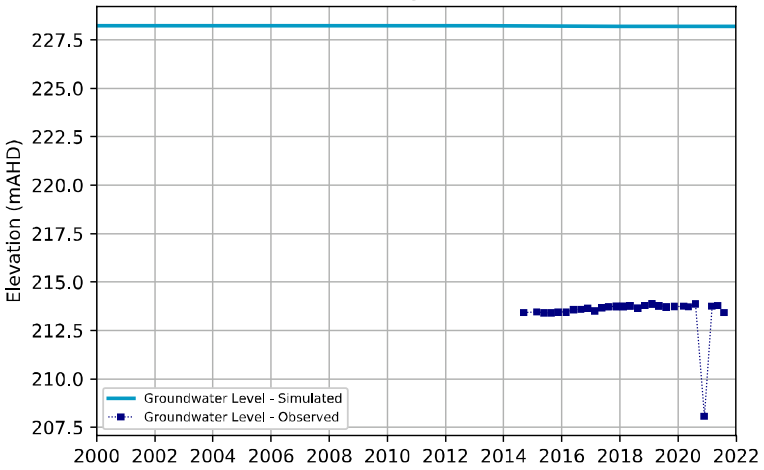
WSMB4S (Regolith)



WSMB5D (Coal A2C Seam)

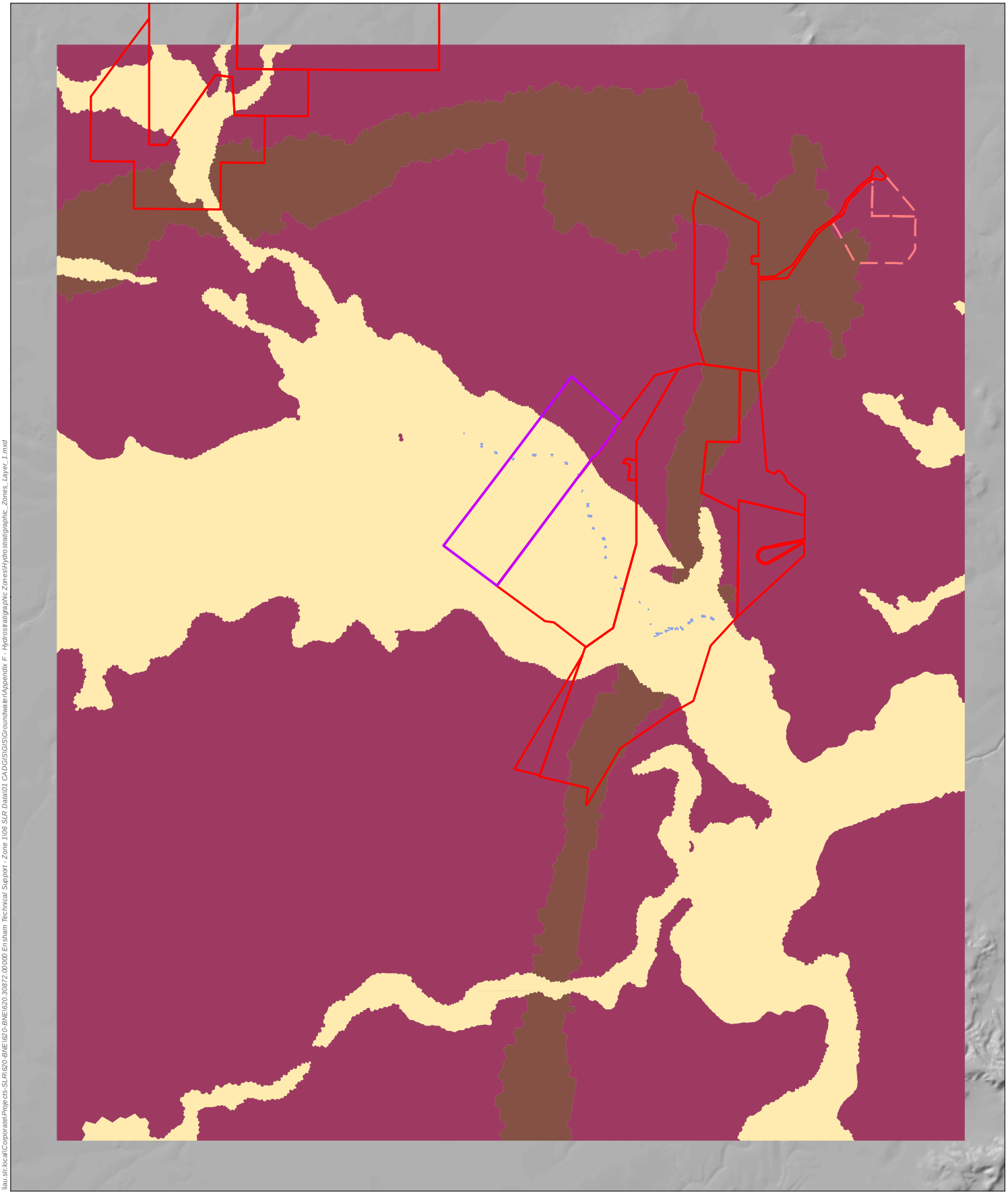


YONGALA (Burngrove Formation)



APPENDIX F

Hydraulic property zones



\\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_1.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L1 K Zones

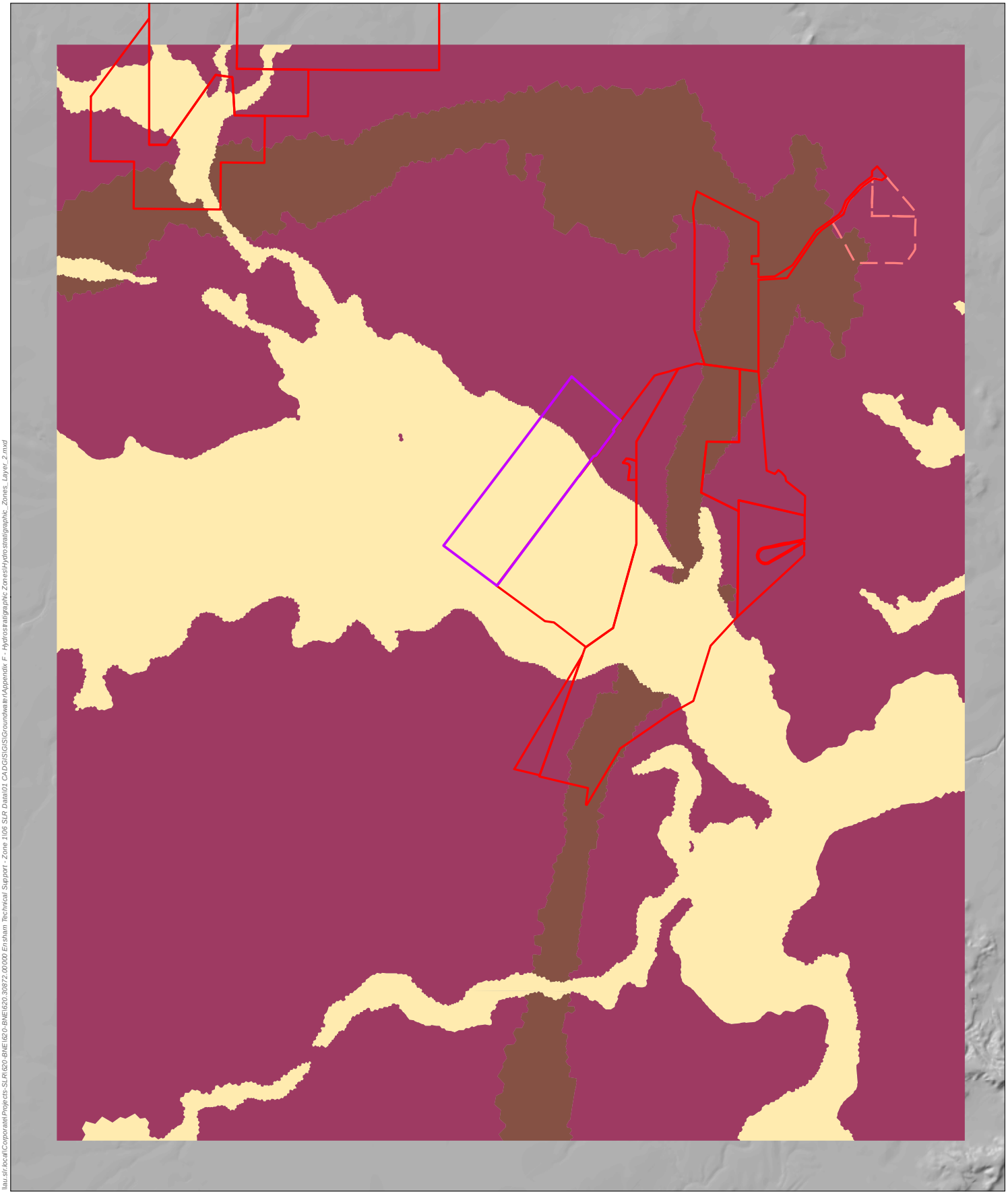
- Alluvium
- Nogoa River
- Regolith
- Shallow CM

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 1

F1-1



\\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE16220.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_2.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L2 K Zones

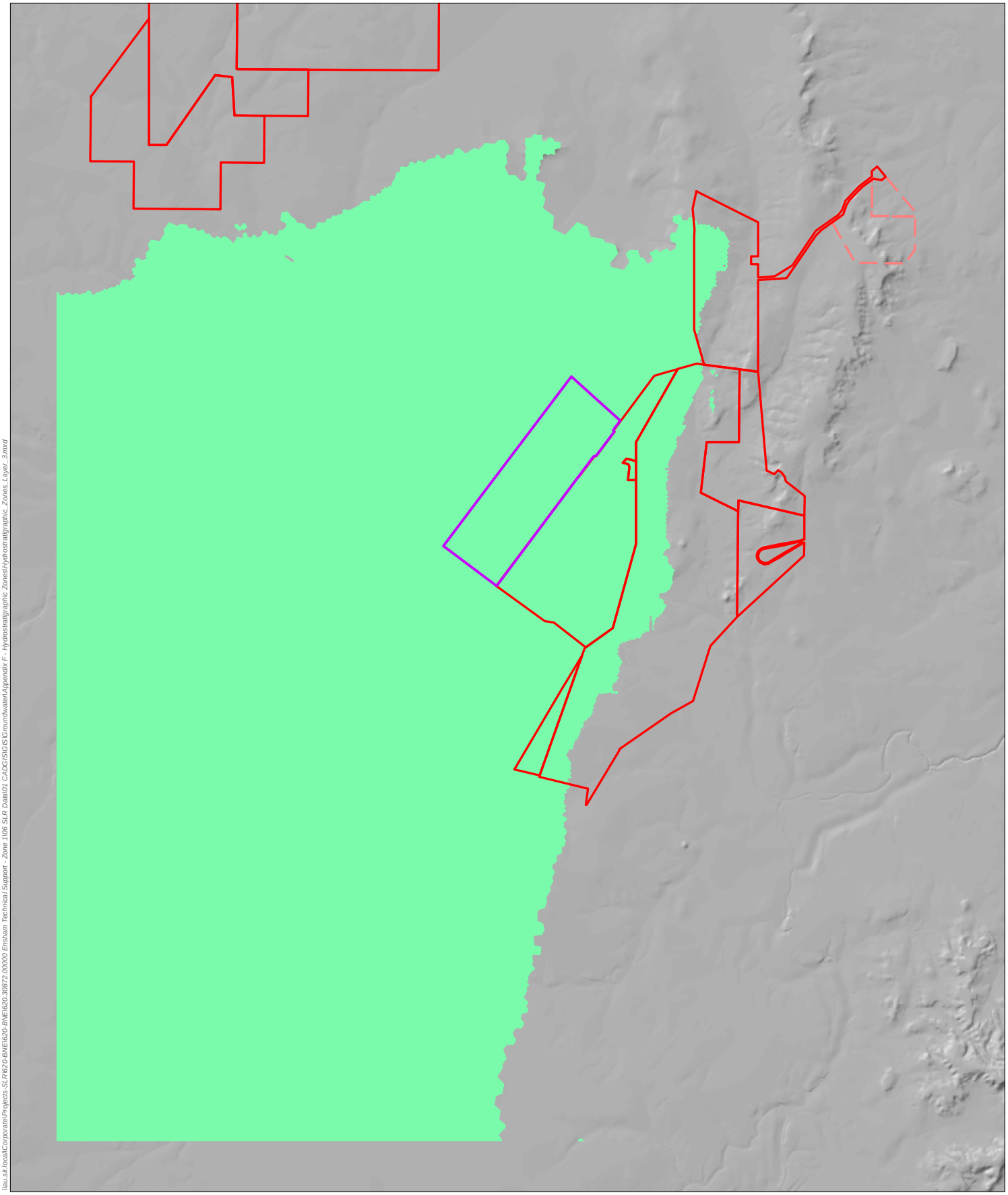
- Alluvium
- Regolith
- Shallow CM

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 2

F1-2



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L3 K Zones

- Rewan

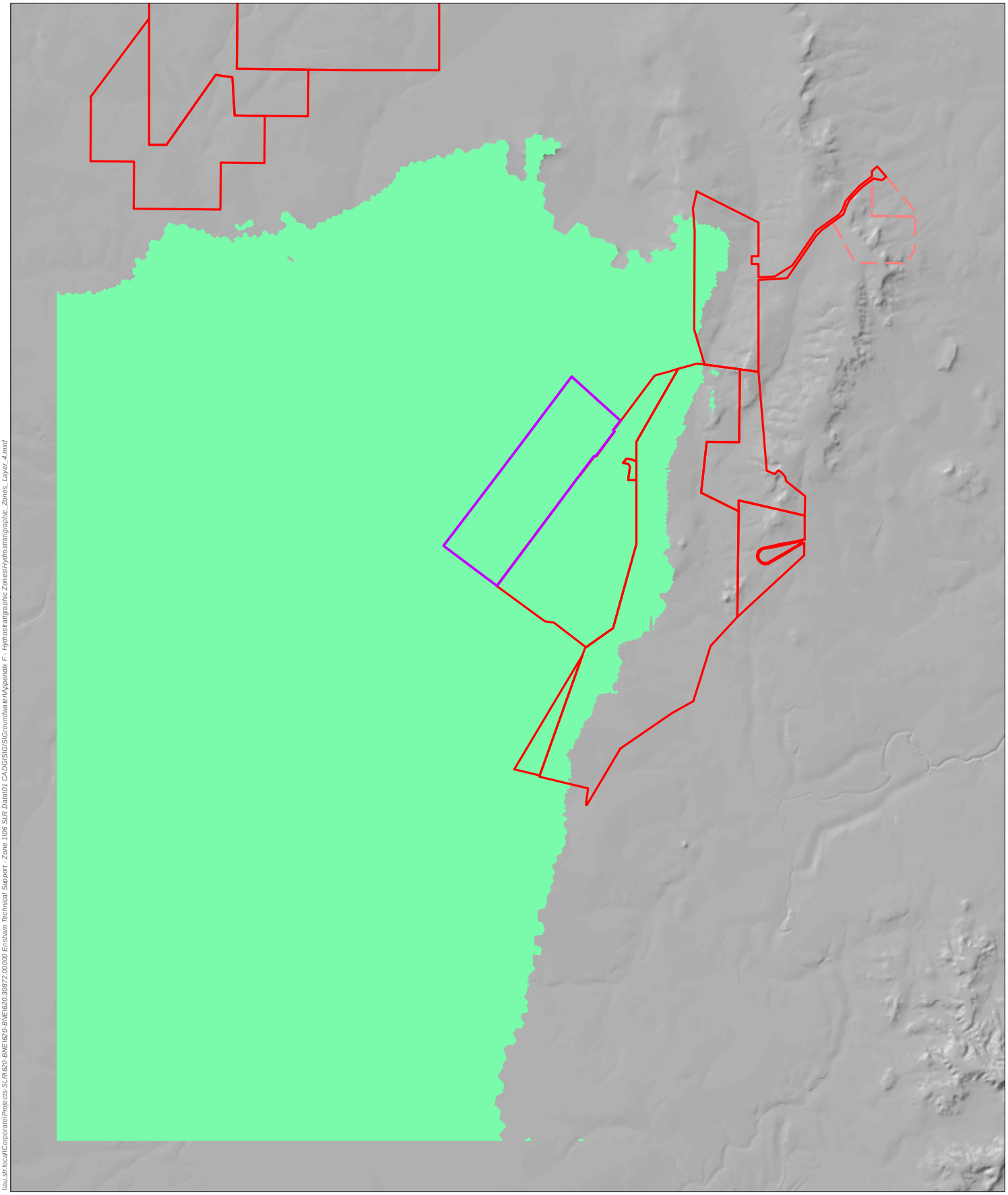
GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 3

F1-3

SLR
www.slrconsulting.com

\\au.slr.local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_3.mxd



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_4.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L4 K Zones

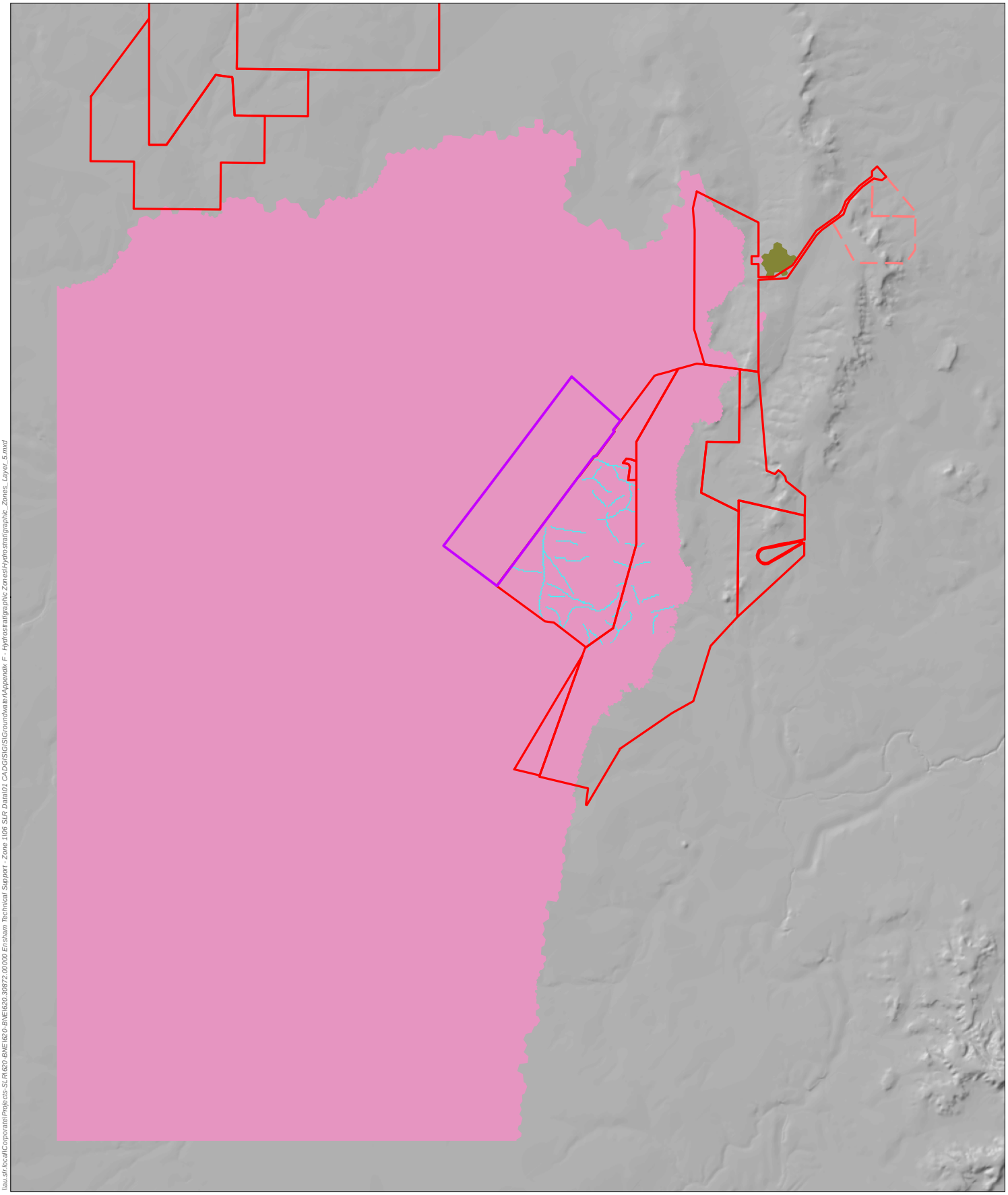
- Rewan

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 4

F1-4



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_5.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L5 K Zones

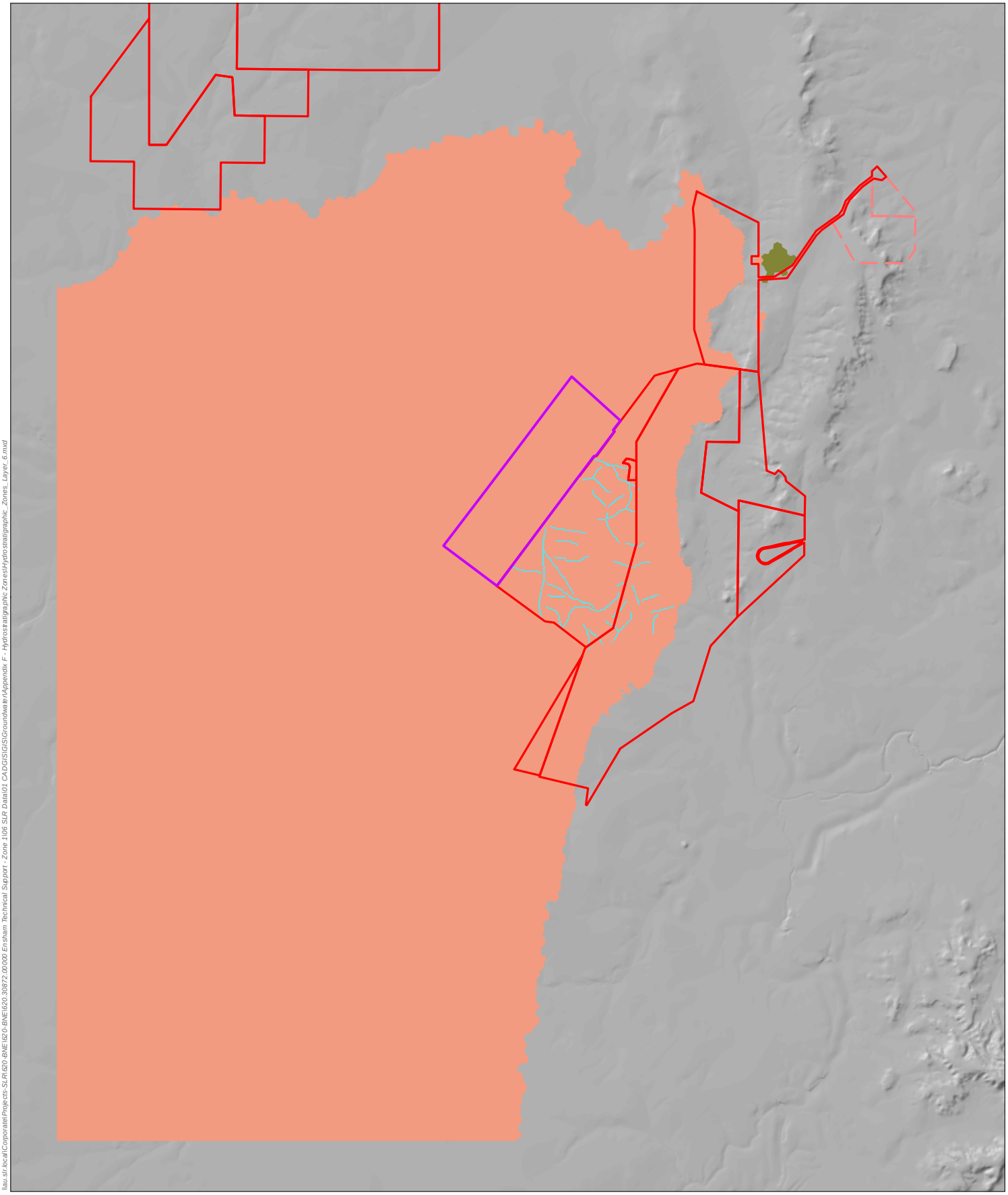
- Basement
- Fault
- Inter1

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 5

F1-5



\\au.sl\-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_6.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L6 K Zones

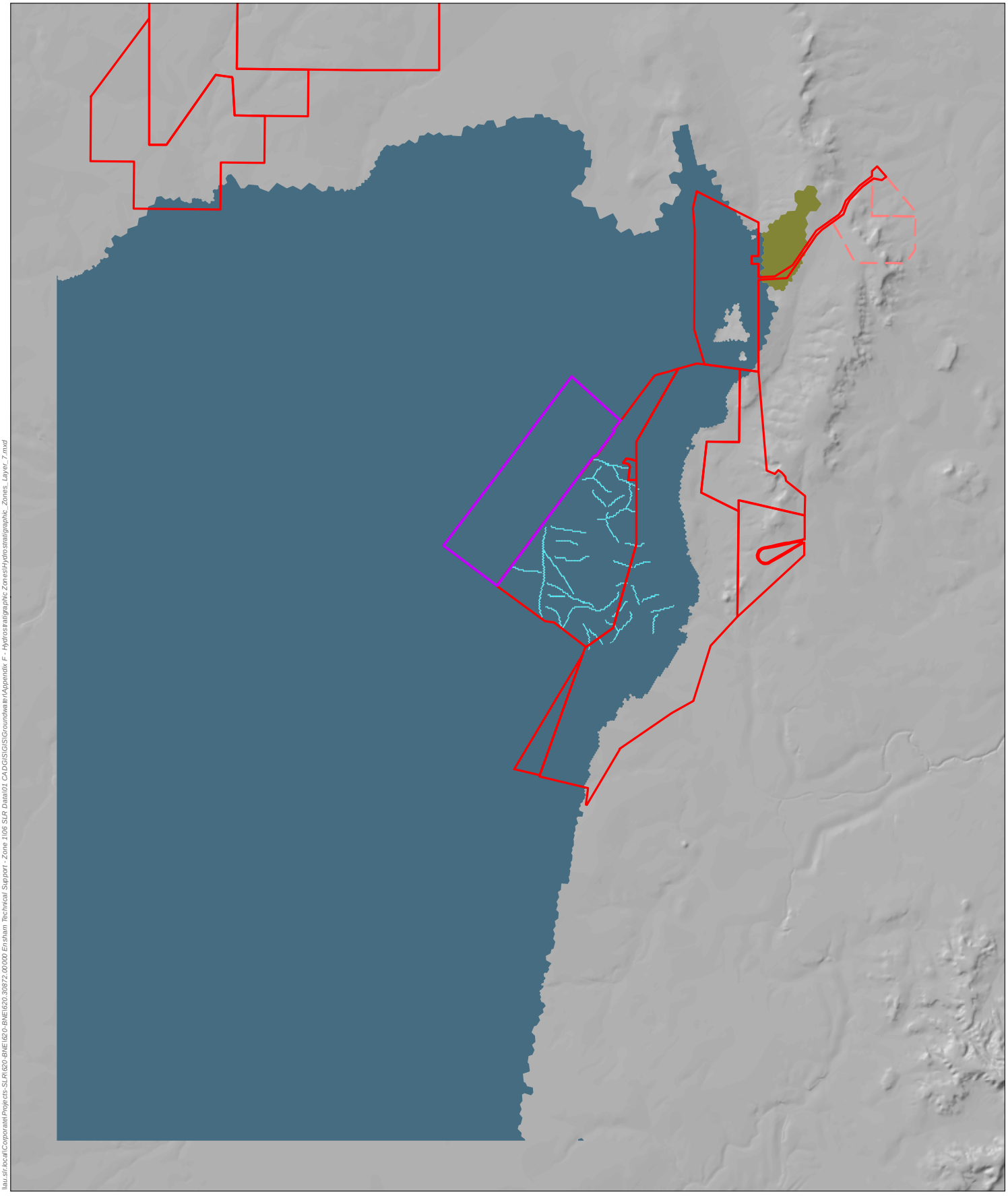
- Aries Seam
- Basement
- Fault

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 6

F1-6



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_7.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L7 K Zones

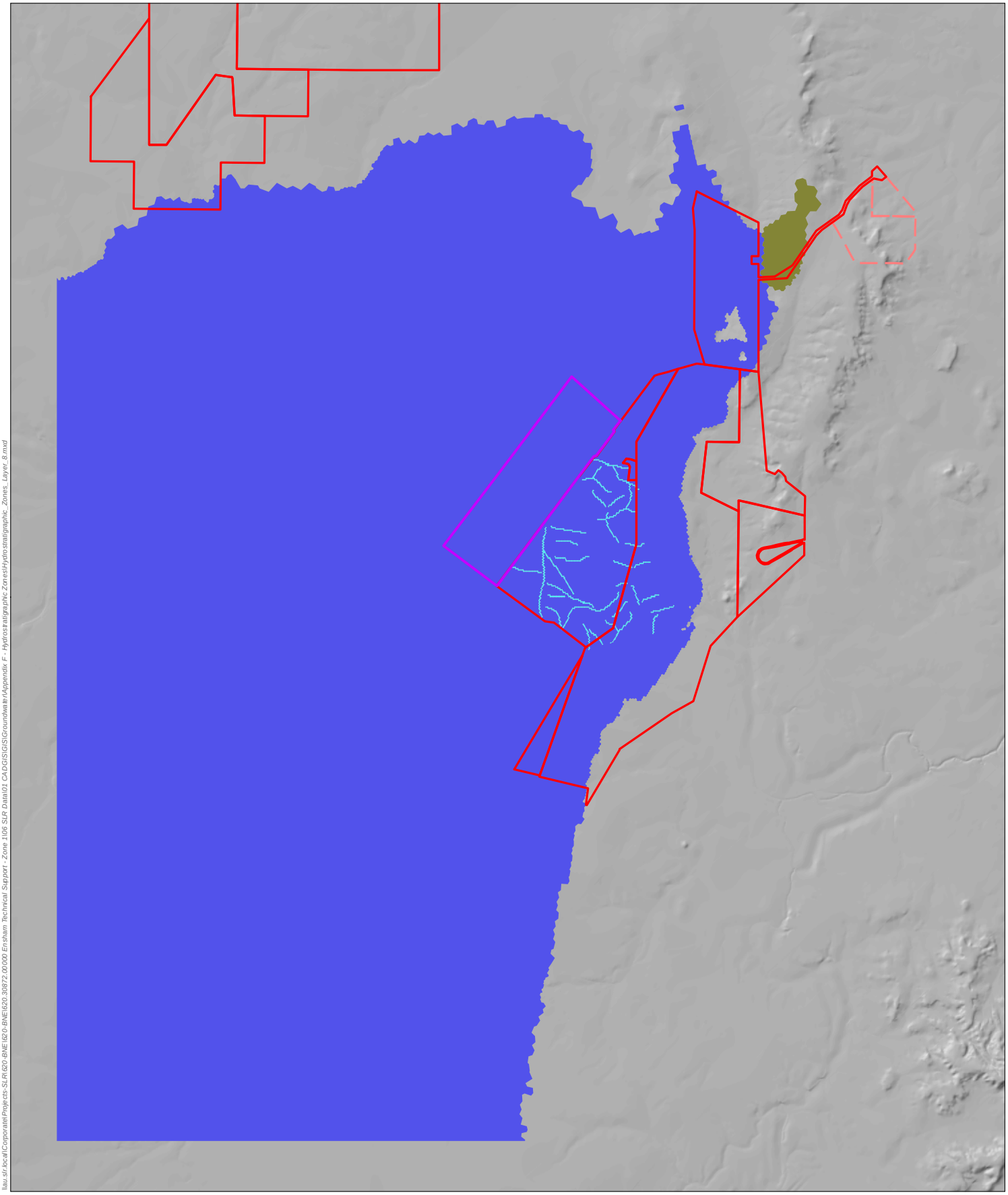
- Basement
- Fault
- Inter2

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 7

F1-7



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_8.mxd

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 8

F1-8

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

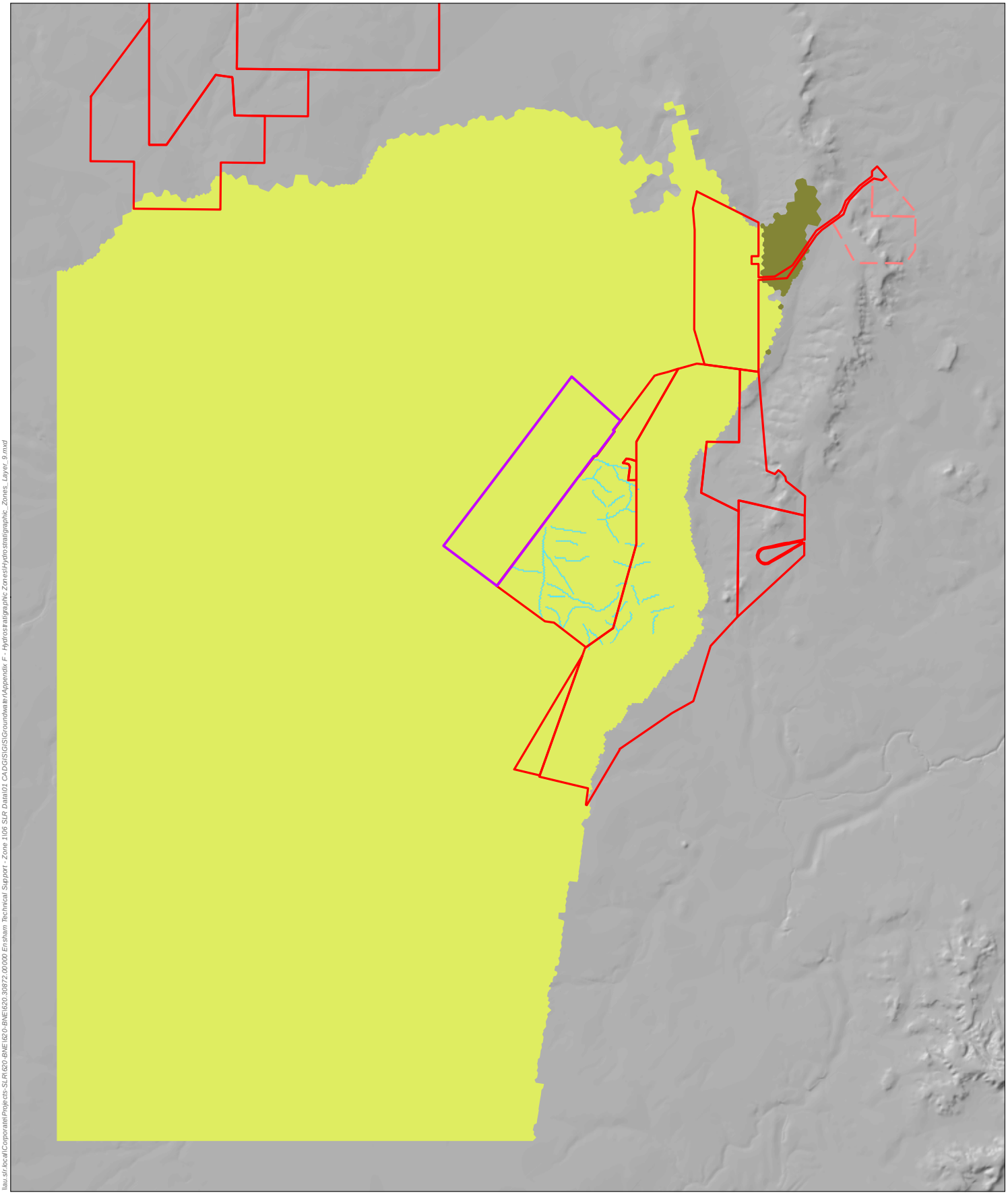
Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L8 K Zones

- Aries 2 and Castor
- Basement
- Fault

SLR
www.slrconsulting.com



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L9 K Zones

- Basement
- Fault
- Inter3

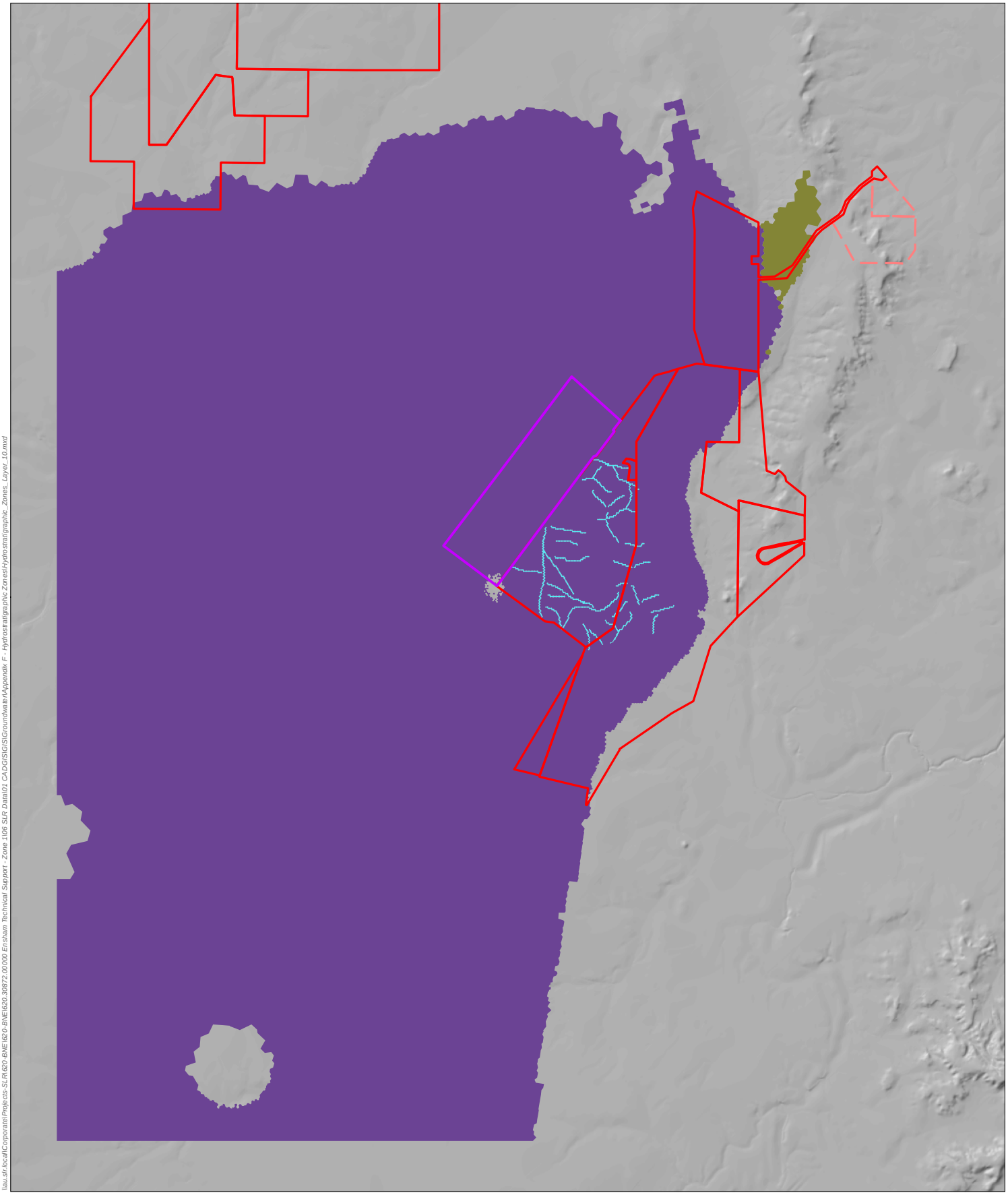
GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 9

F1-9

SLR
www.slrconsulting.com

\\au.sl\-local\Corporate\Projects-SLR\620-BNE\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_9.mxd



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_10.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L10 K Zones

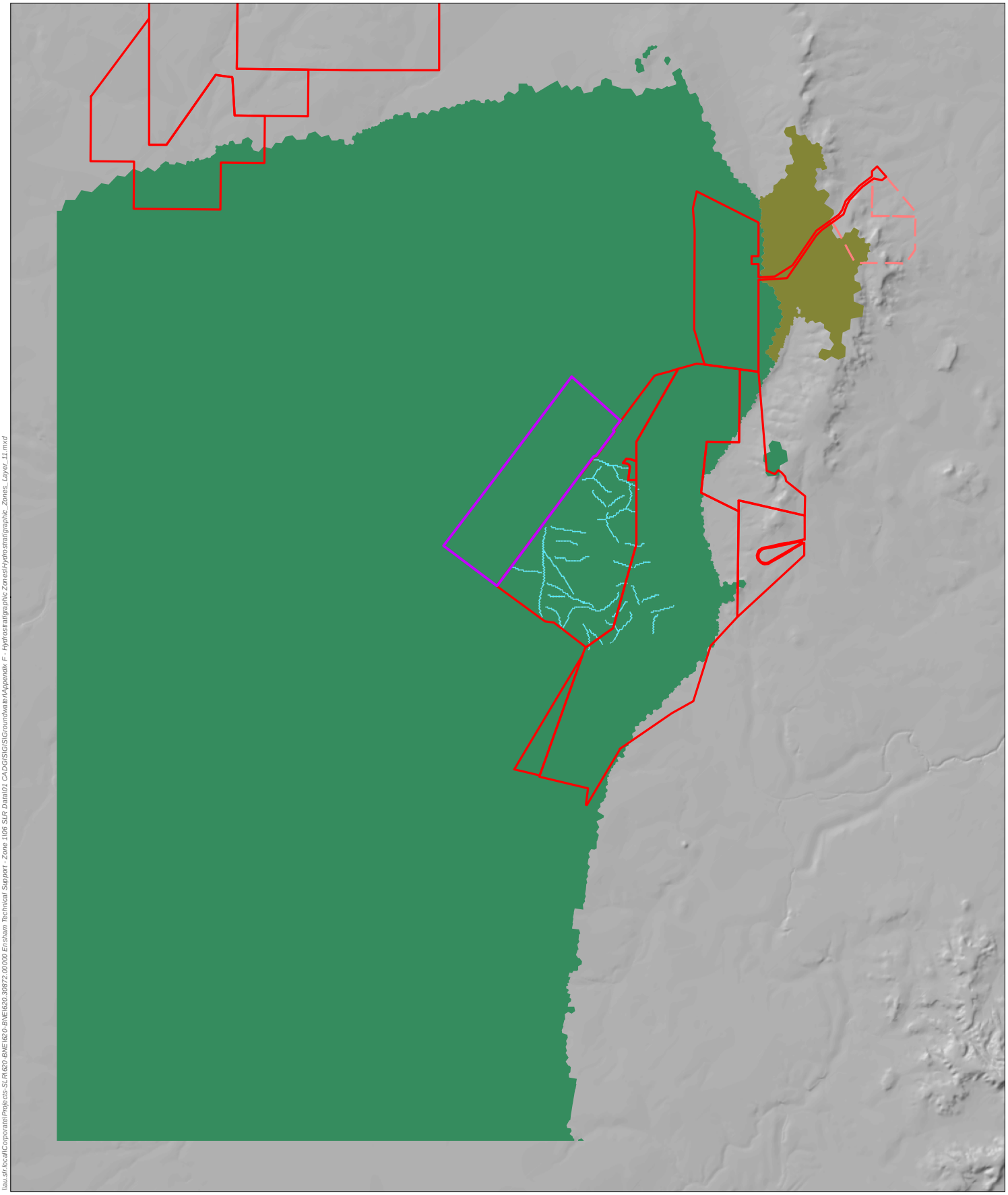
- Basement
- Fault
- Pollux Seam

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 10

F1-10



\\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE16220.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_11.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L11 K Zones

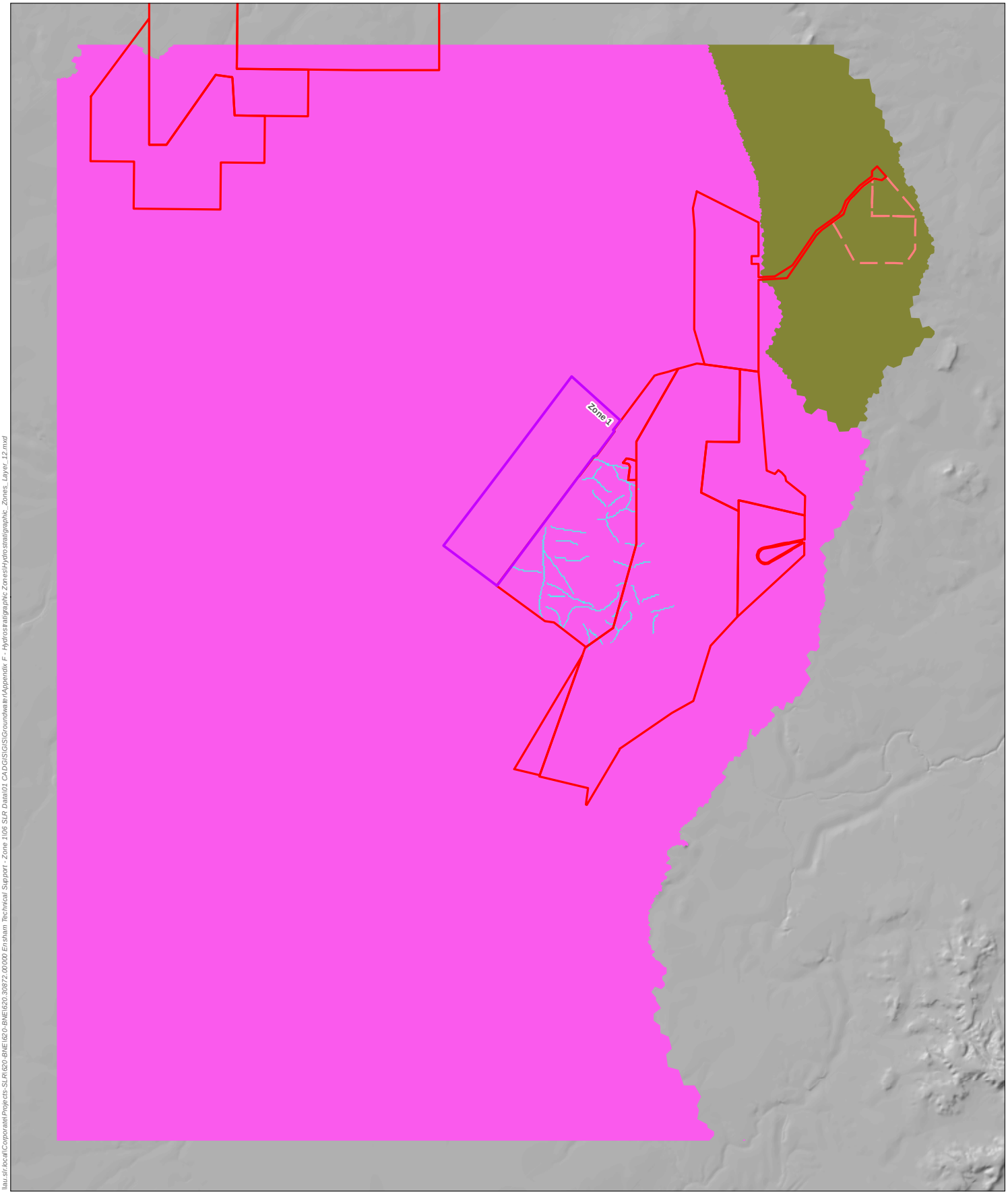
- Basement
- Fault
- Inter4

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 11

F1-11



\\au.slr-local\Corporate\Projects-SLR\620-BNE\620.30872.00000 Ensham Technical Support - Zone 106 SLR Data\01 CAD\GIS\GIS\Groundwater\Appendix F - Hydrostratigraphic Zones\Hydrostratigraphic_Zones_Layer_12.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	10-Jun-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 1

L12 K Zones

- Basement
- Burngrove
- Fault

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

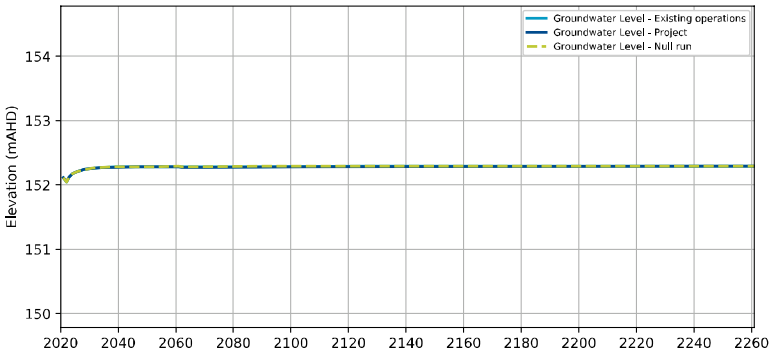
Hydrostratigraphic Zones - Layer 12

F1-12

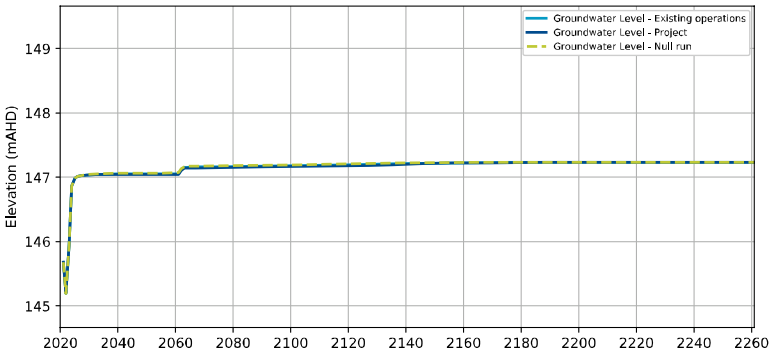
APPENDIX G

Prediction Hydrographs

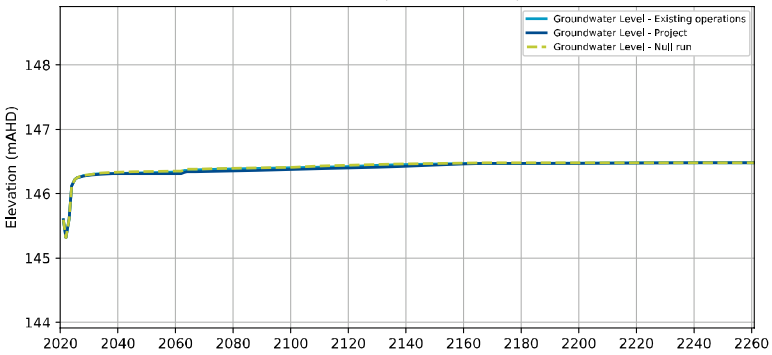
13020166 (Lower Alluvium)



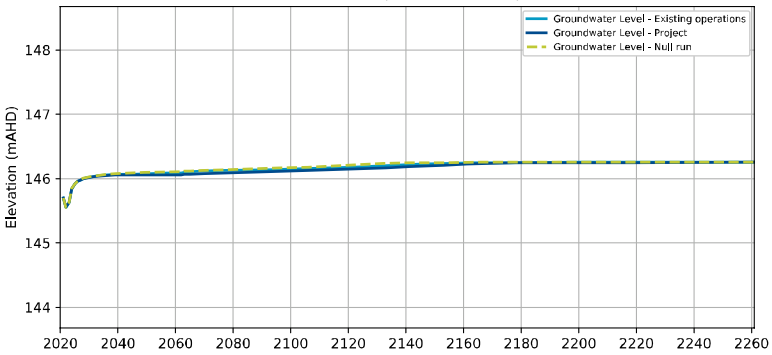
13020169 (Lower Alluvium)



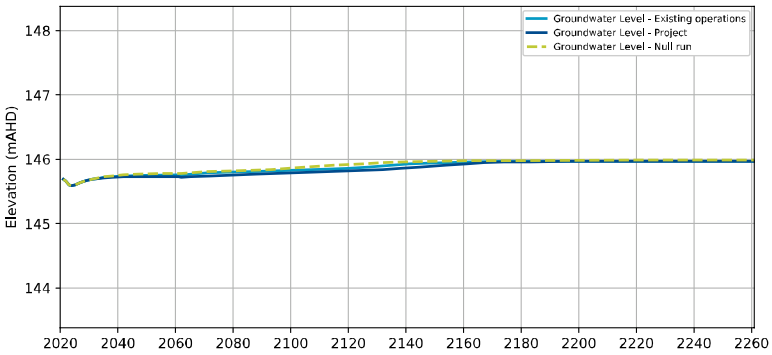
13020170 (Lower Alluvium)



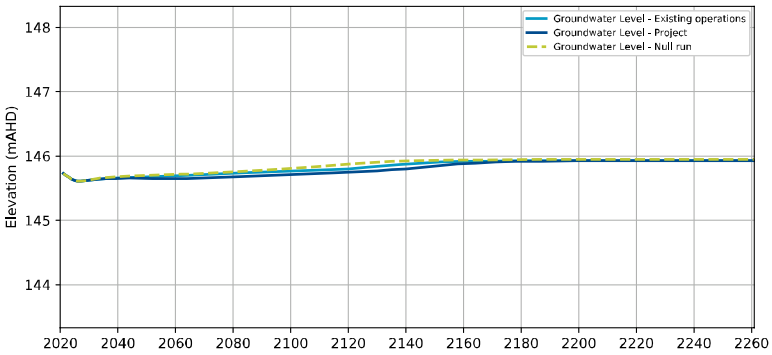
13020171 (Lower Alluvium)



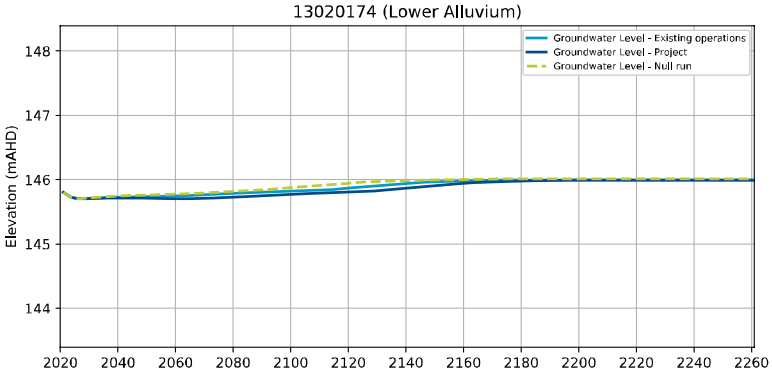
13020172 (Lower Alluvium)



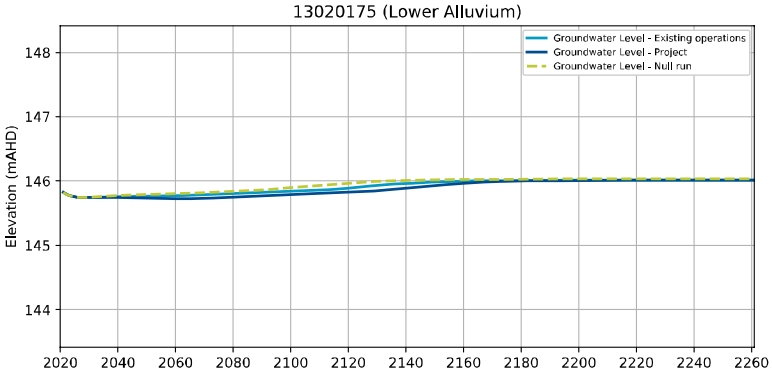
13020173 (Lower Alluvium)



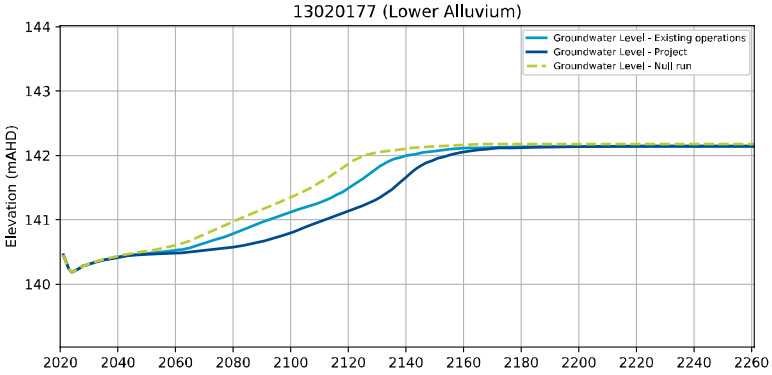
13020174 (Lower Alluvium)



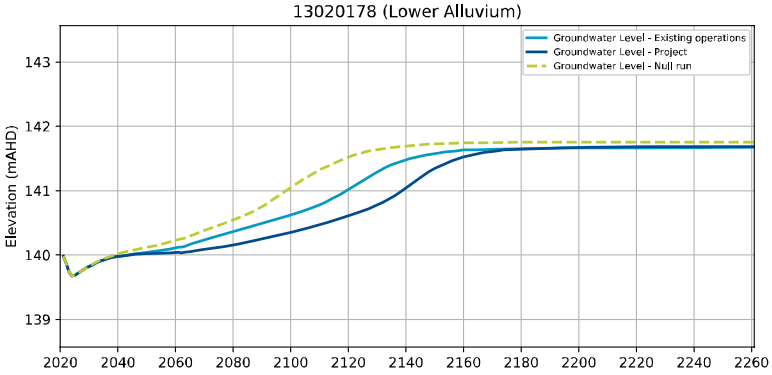
13020175 (Lower Alluvium)



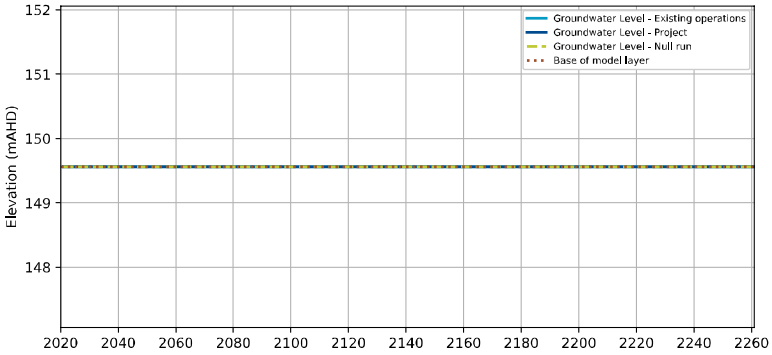
13020177 (Lower Alluvium)



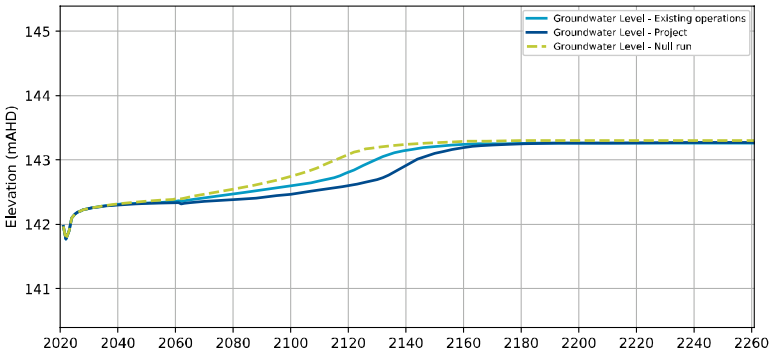
13020178 (Lower Alluvium)



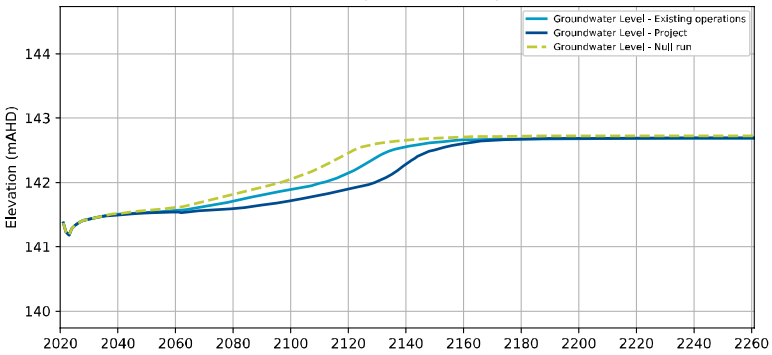
CONMURRA (Fairhill Formation)



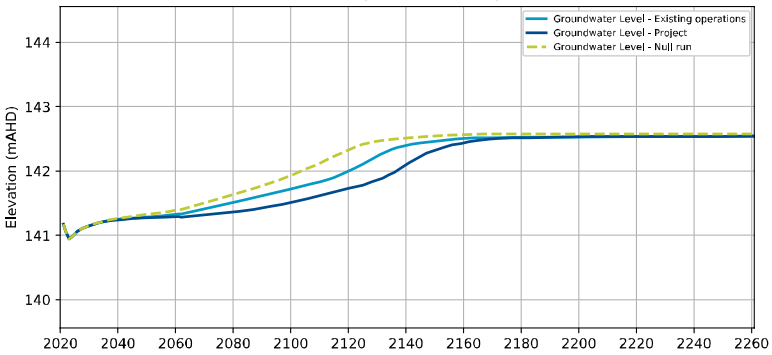
EC01 (Lower Alluvium)



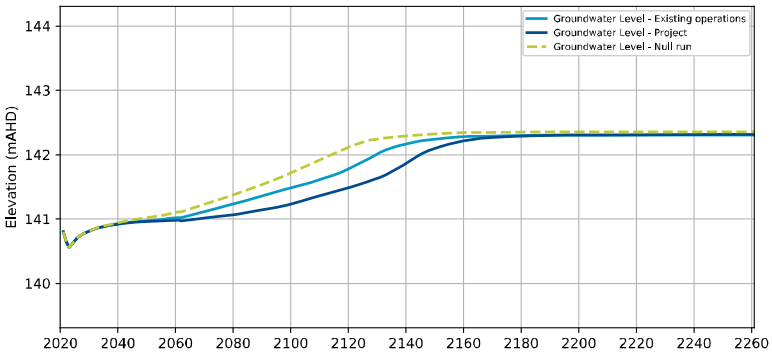
EC02 (Lower Alluvium)



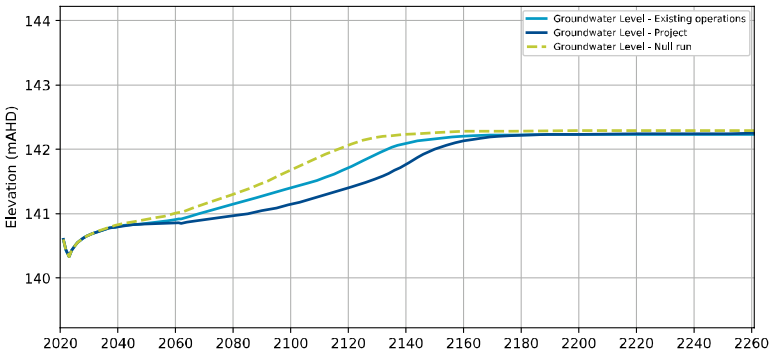
EC03 (Lower Alluvium)



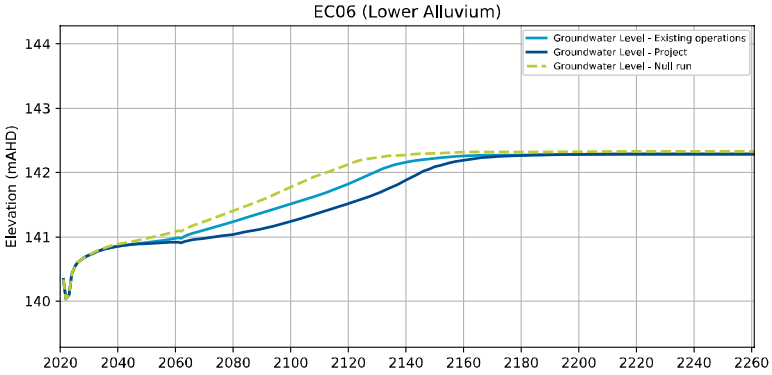
EC04 (Lower Alluvium)



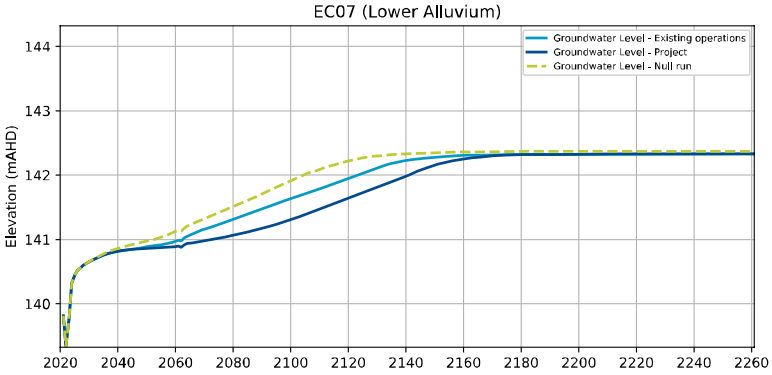
EC05 (Lower Alluvium)



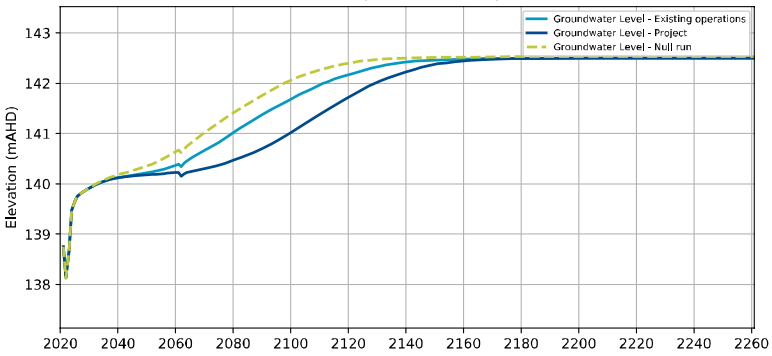
EC06 (Lower Alluvium)



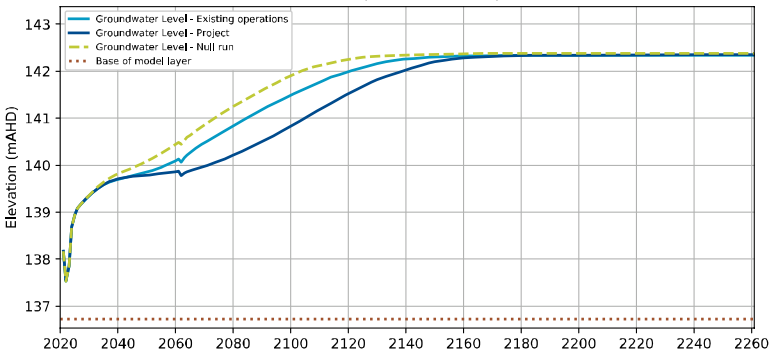
EC07 (Lower Alluvium)



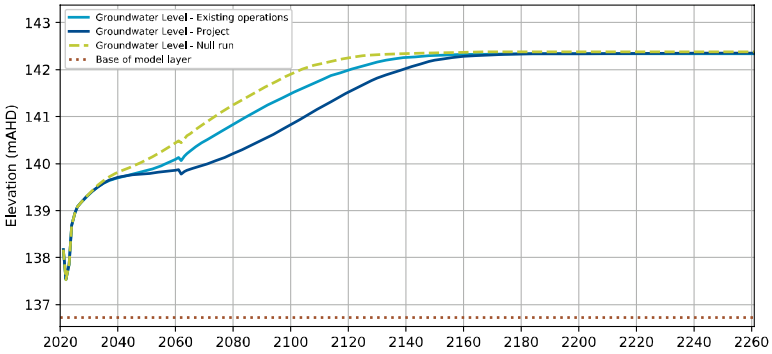
EC08 (Lower Alluvium)



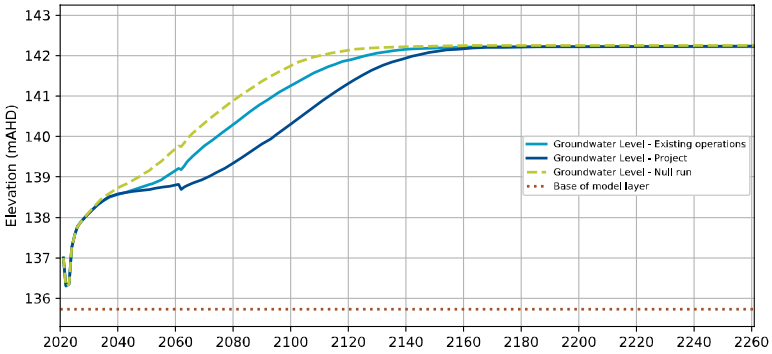
EC09 (Lower Alluvium)



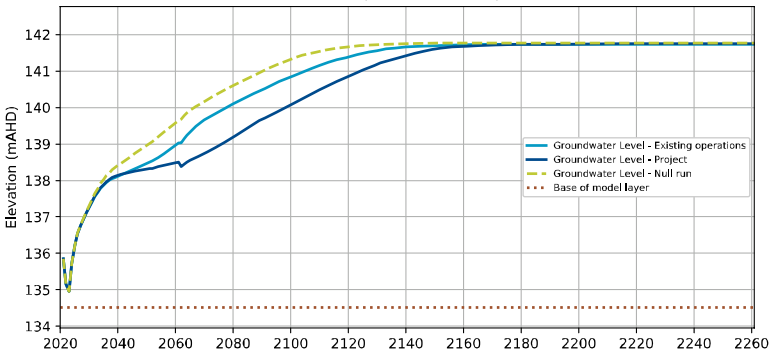
EC09A (Lower Alluvium)



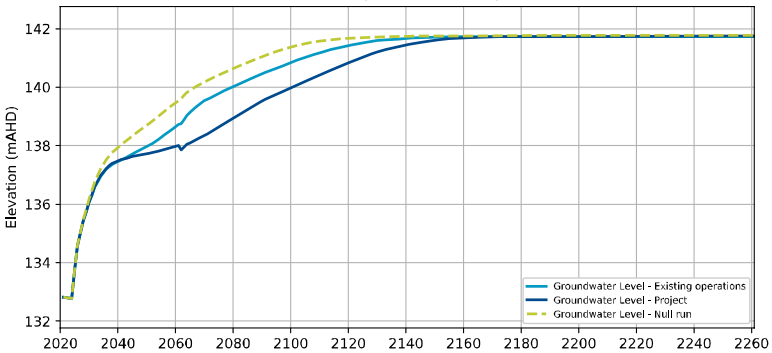
EC10 (Lower Alluvium)



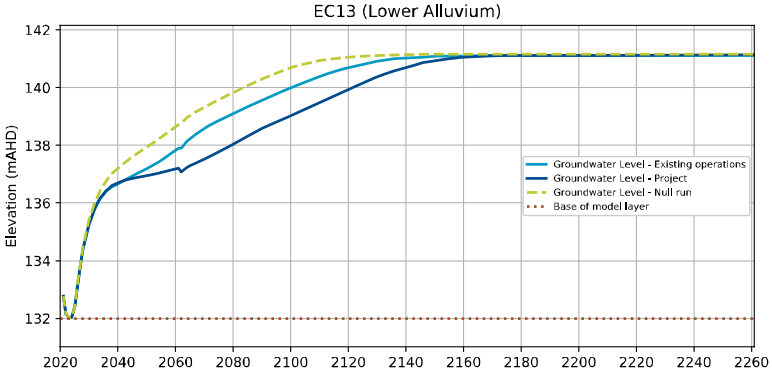
EC11 (Lower Alluvium)



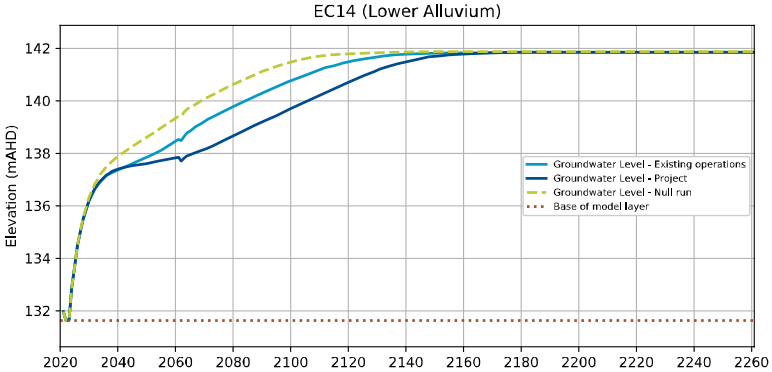
EC12 (Lower Alluvium)



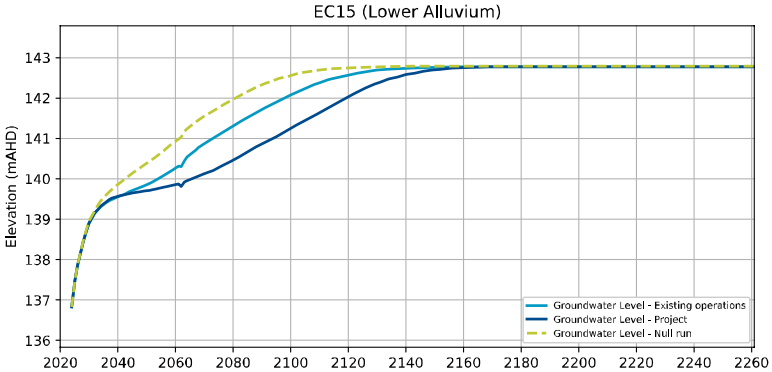
EC13 (Lower Alluvium)



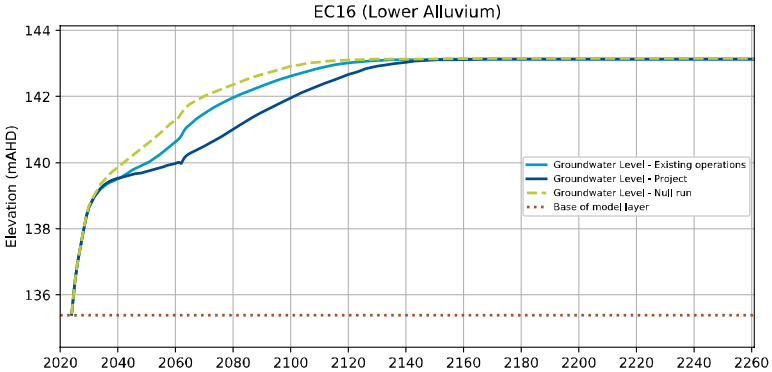
EC14 (Lower Alluvium)



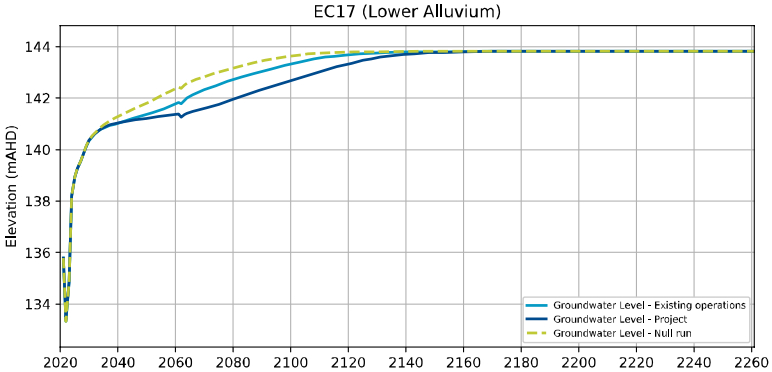
EC15 (Lower Alluvium)



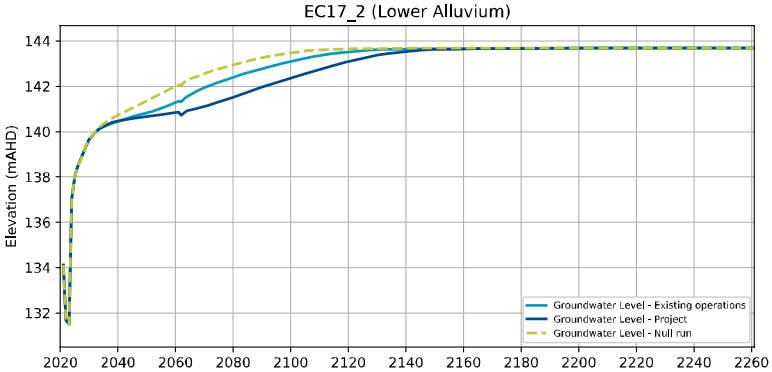
EC16 (Lower Alluvium)



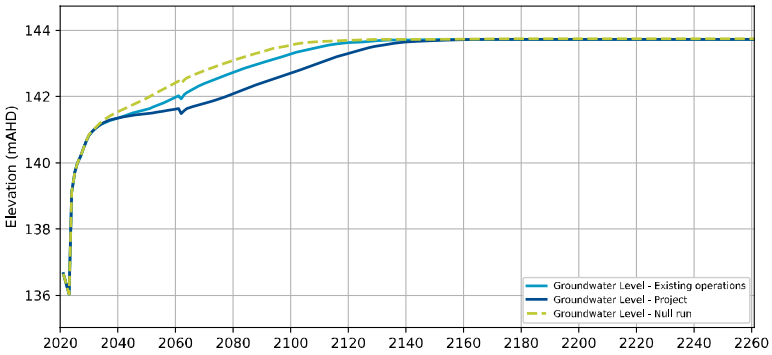
EC17 (Lower Alluvium)



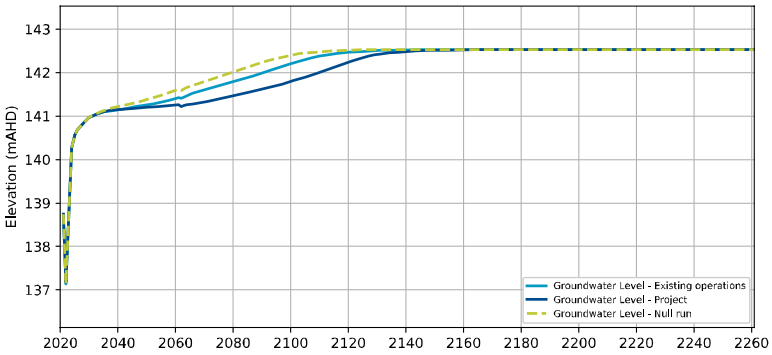
EC17_2 (Lower Alluvium)



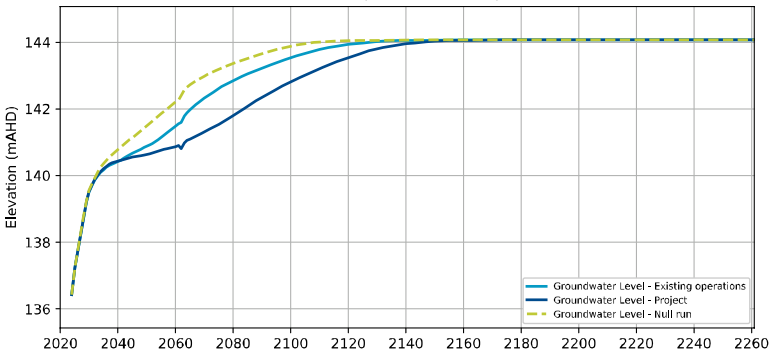
EC18 (Lower Alluvium)



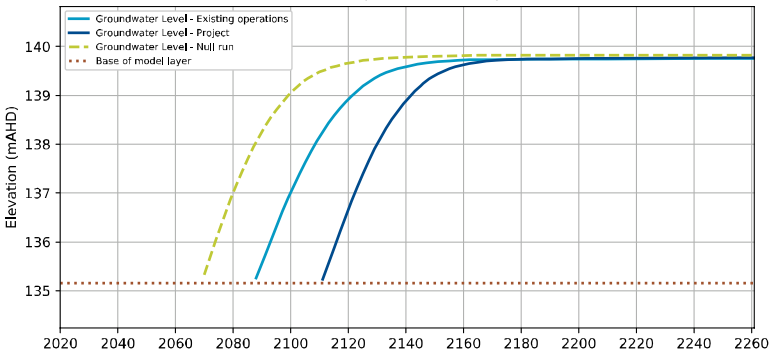
EC19 (Lower Alluvium)



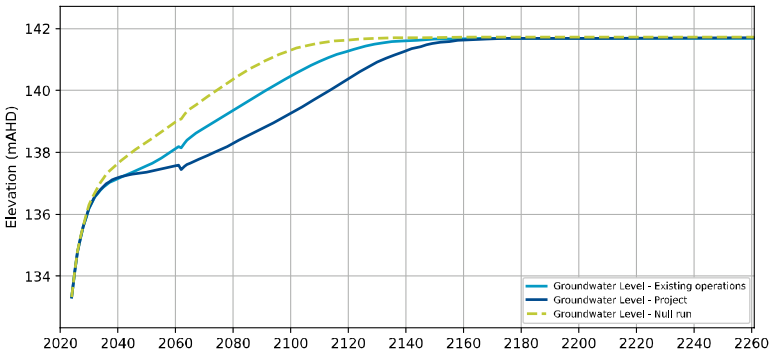
EC20 (Lower Alluvium)



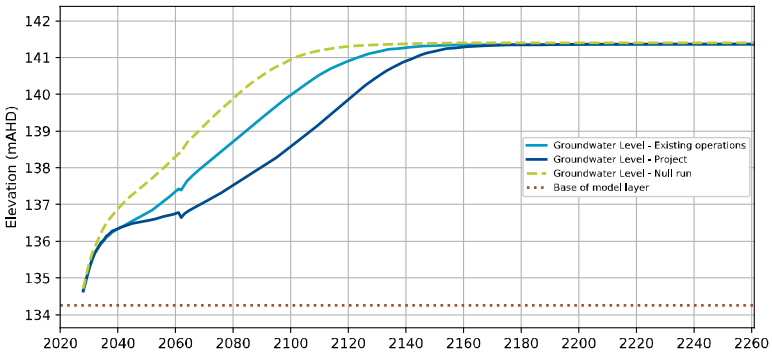
EC21 (Lower Alluvium)



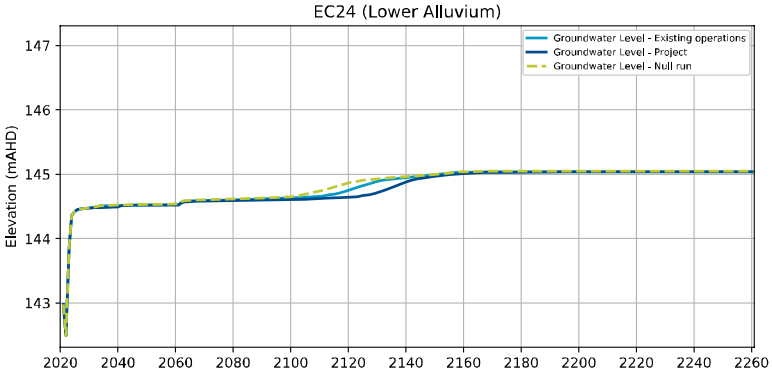
EC22 (Lower Alluvium)



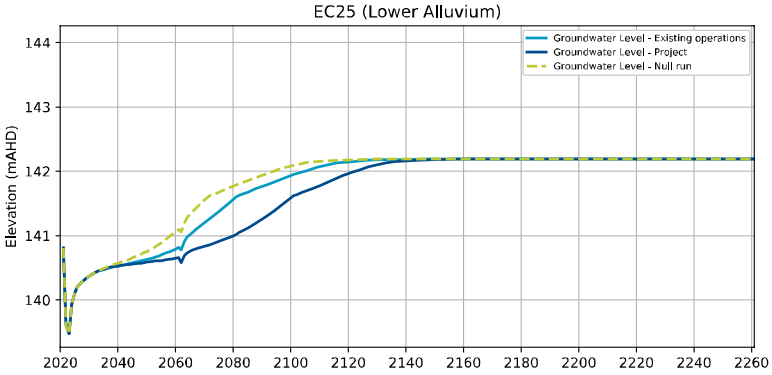
EC23 (Lower Alluvium)



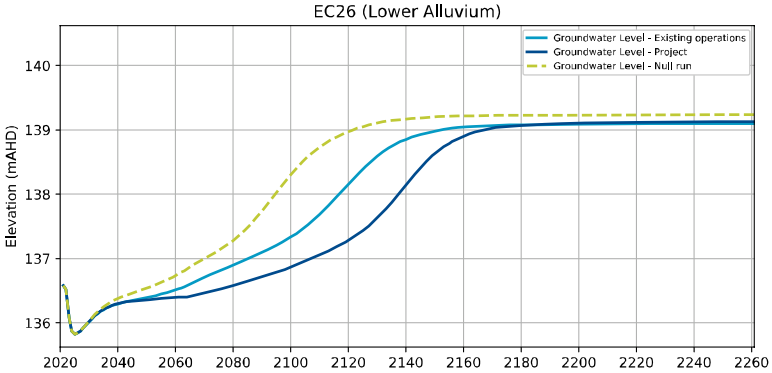
EC24 (Lower Alluvium)



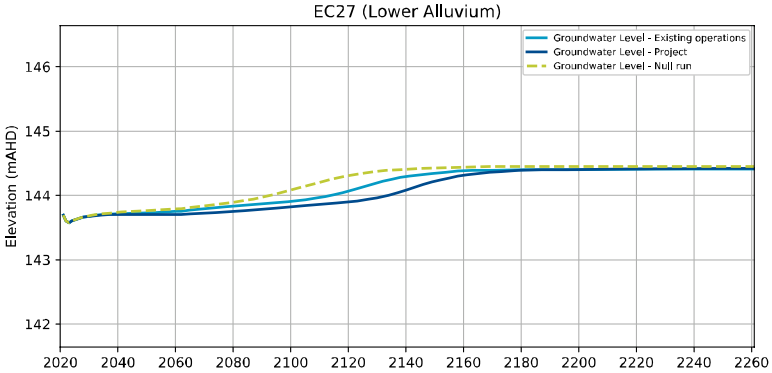
EC25 (Lower Alluvium)



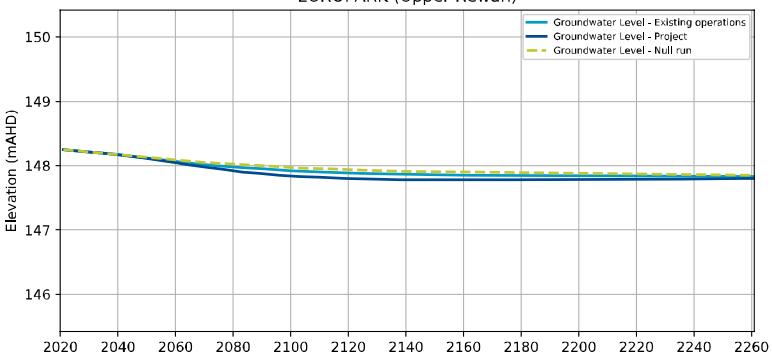
EC26 (Lower Alluvium)



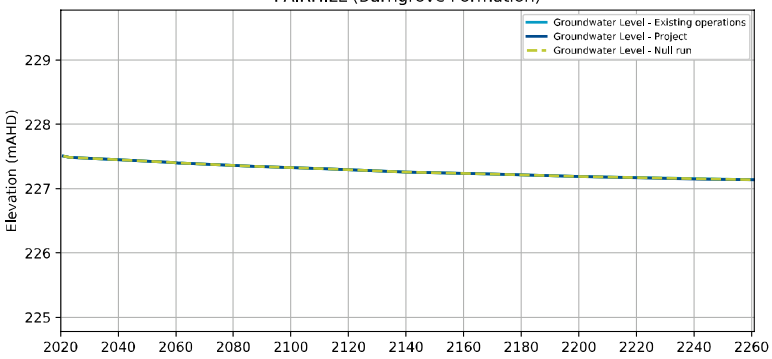
EC27 (Lower Alluvium)



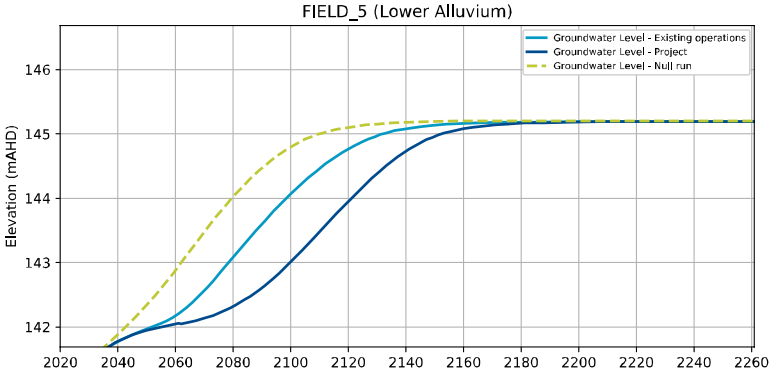
EUROPARK (Upper Rewan)



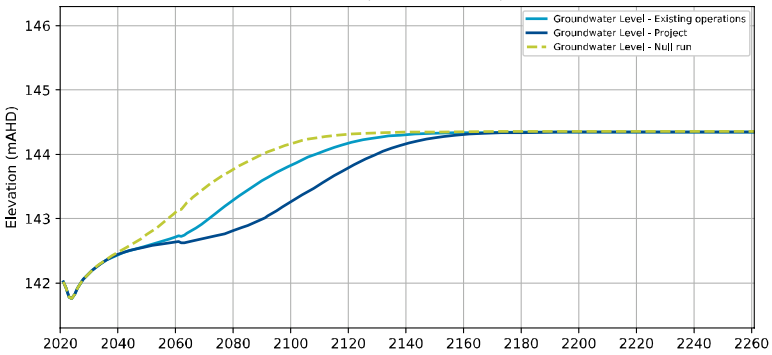
FAIRHILL (Burngrove Formation)



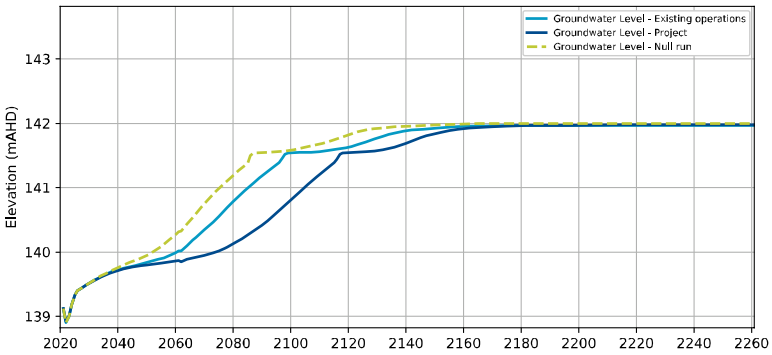
FIELD_5 (Lower Alluvium)



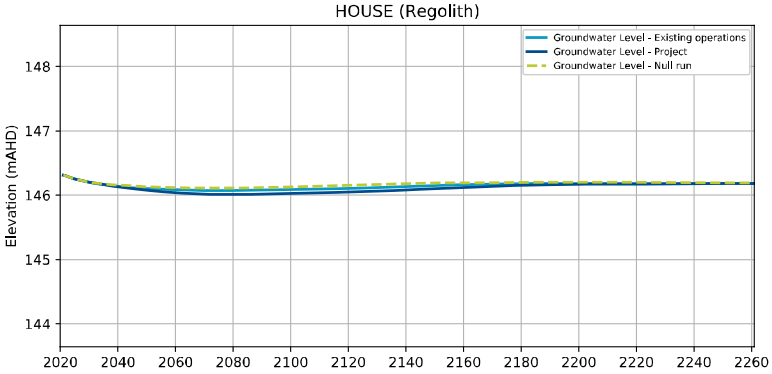
GW01 (Lower Alluvium)



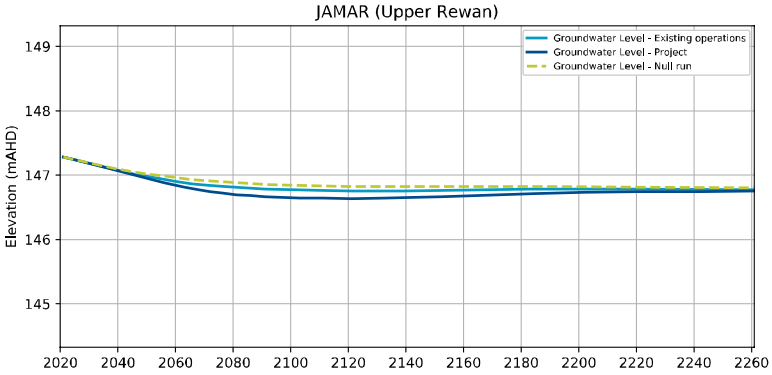
GW02 (Lower Alluvium)



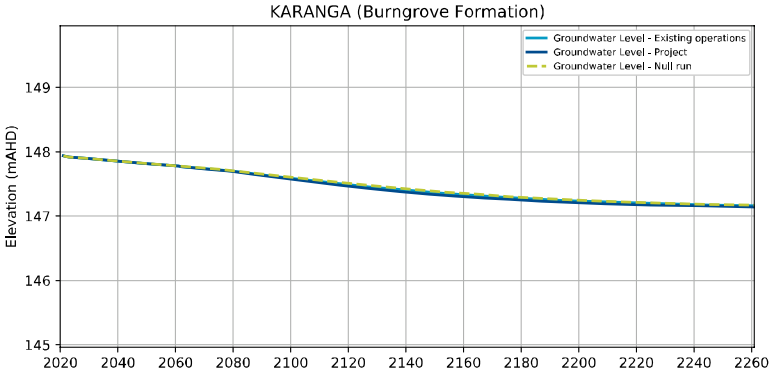
HOUSE (Regolith)



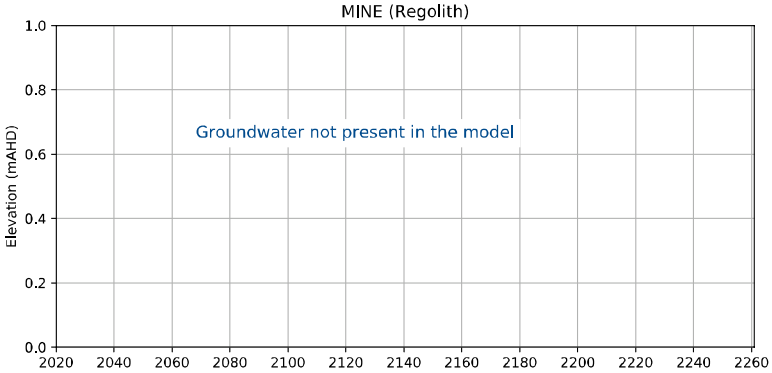
JAMAR (Upper Rewan)



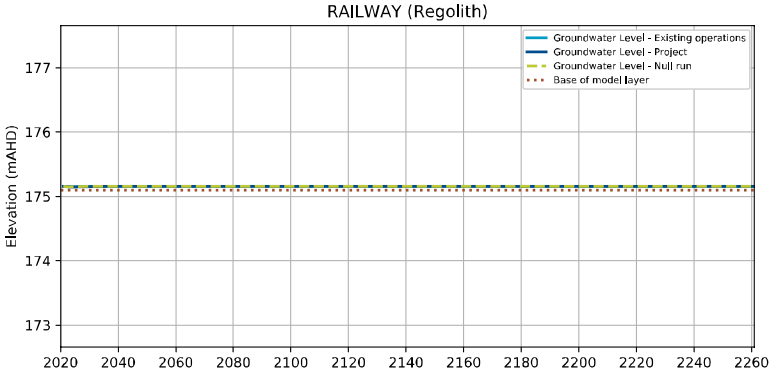
KARANGA (Burngrove Formation)



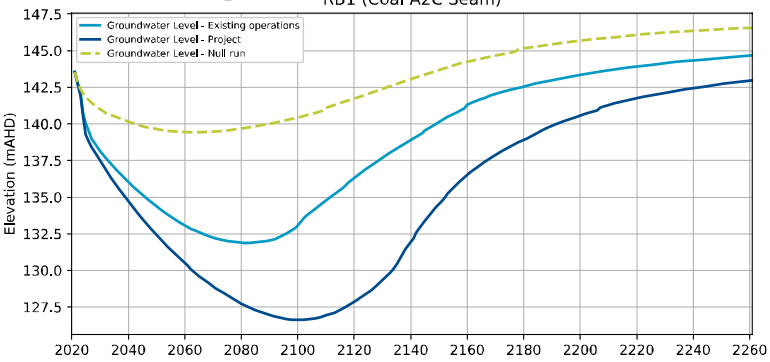
MINE (Regolith)



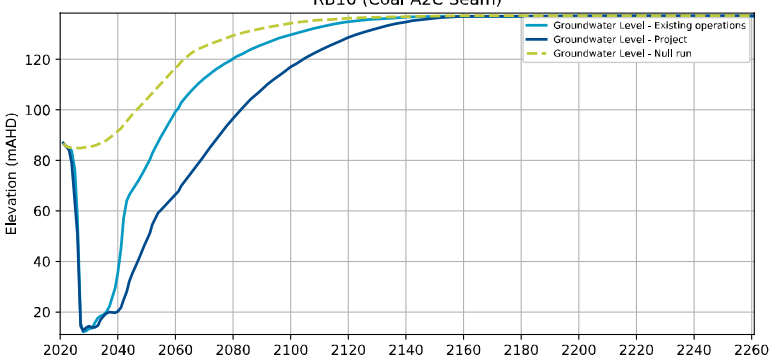
RAILWAY (Regolith)



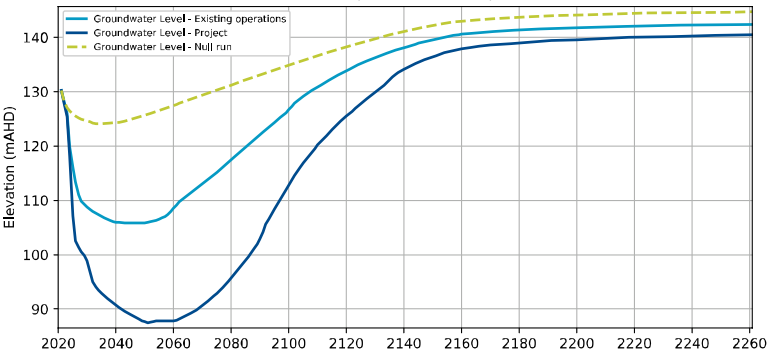
RB1 (Coal A2C Seam)



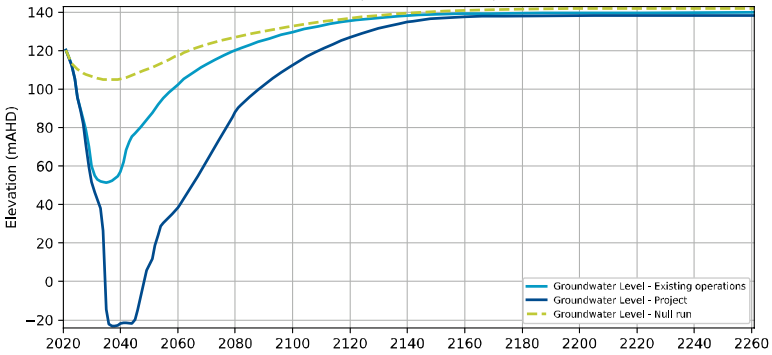
RB10 (Coal A2C Seam)



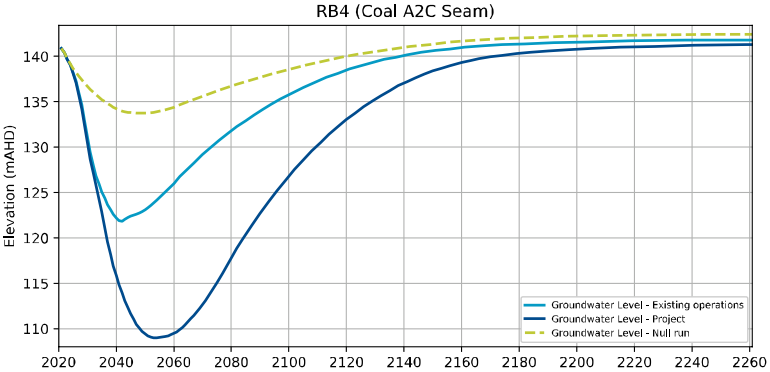
RB2 (Coal A2C Seam)



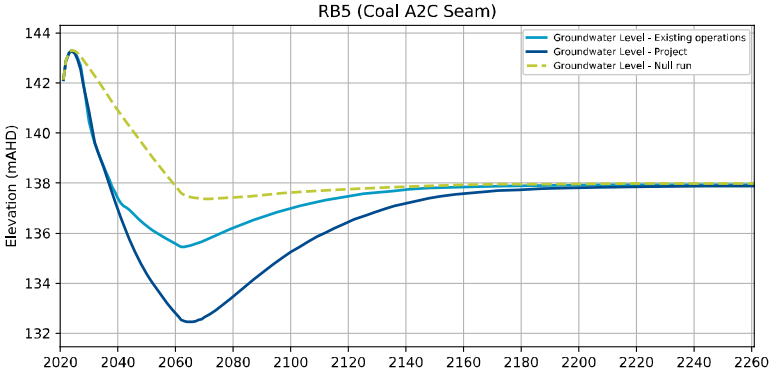
RB3 (Coal A2C Seam)



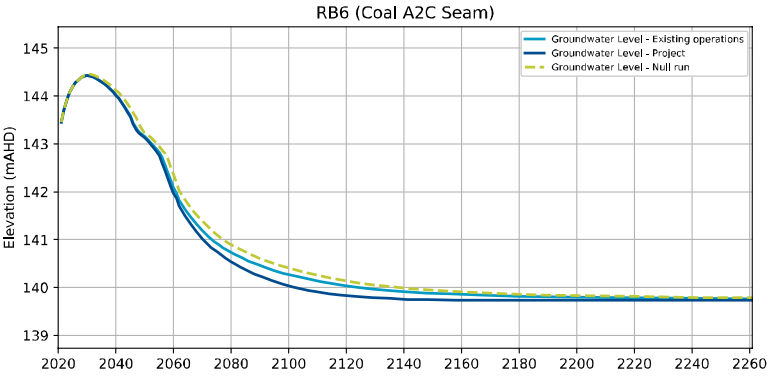
RB4 (Coal A2C Seam)



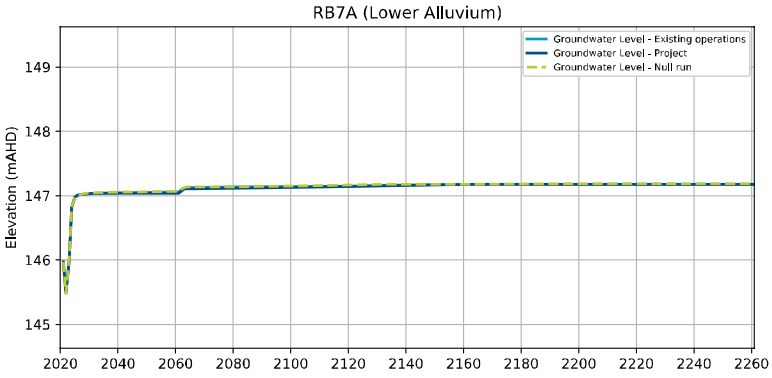
RB5 (Coal A2C Seam)



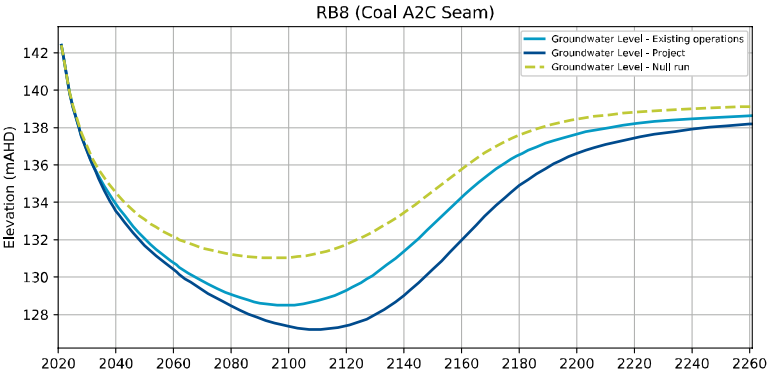
RB6 (Coal A2C Seam)



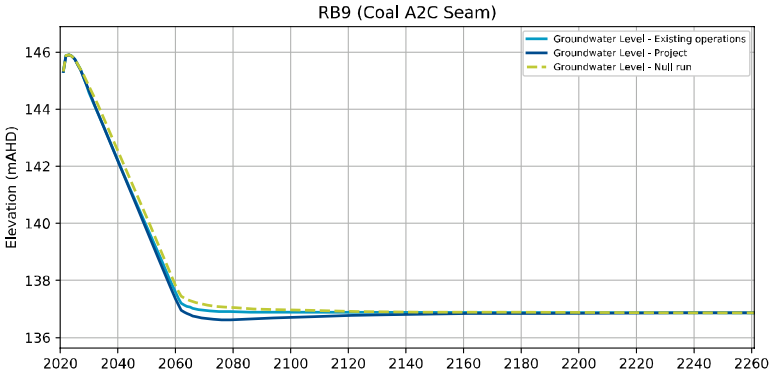
RB7A (Lower Alluvium)



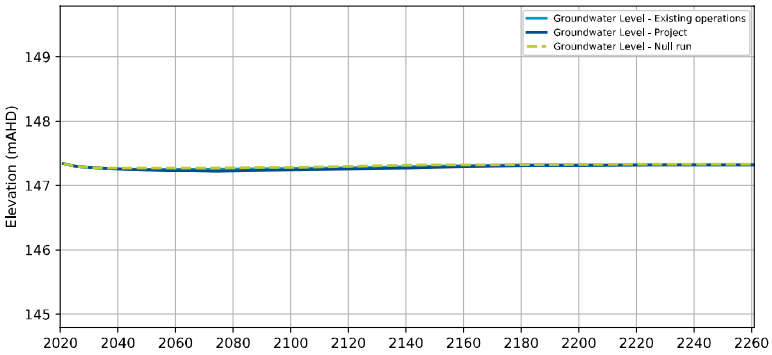
RB8 (Coal A2C Seam)



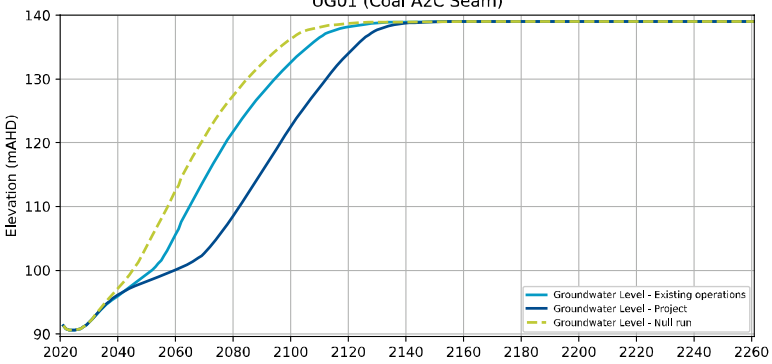
RB9 (Coal A2C Seam)



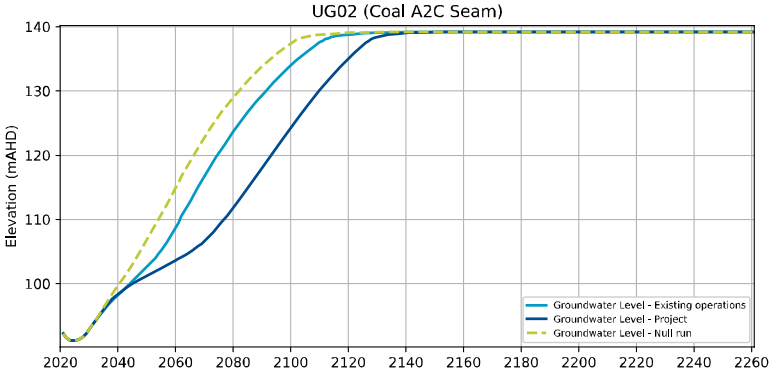
TWIN (Lower Alluvium)



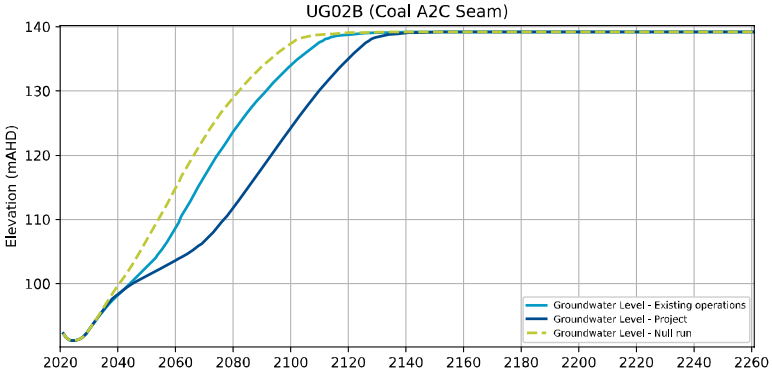
UG01 (Coal A2C Seam)



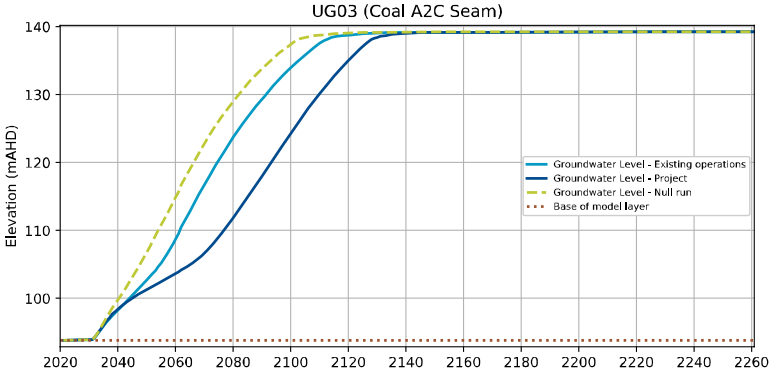
UG02 (Coal A2C Seam)



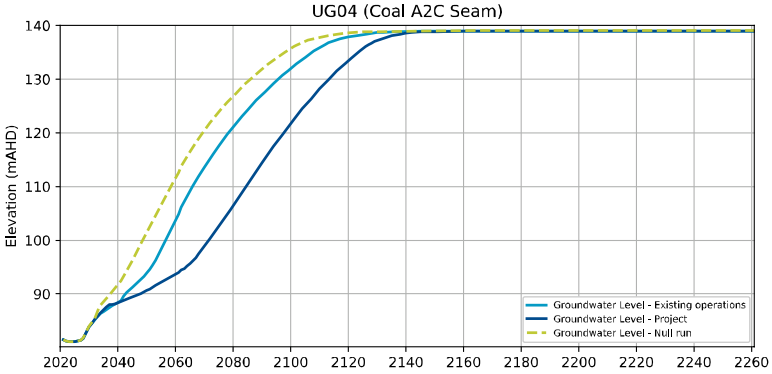
UG02B (Coal A2C Seam)



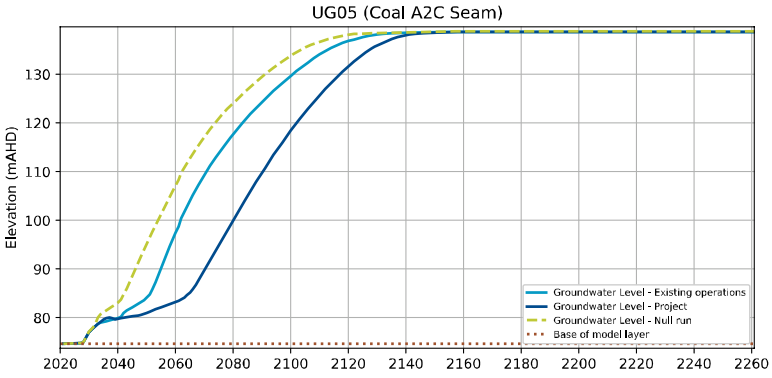
UG03 (Coal A2C Seam)



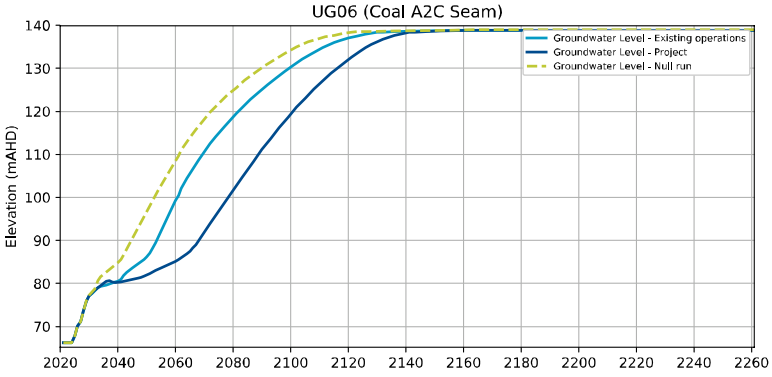
UG04 (Coal A2C Seam)



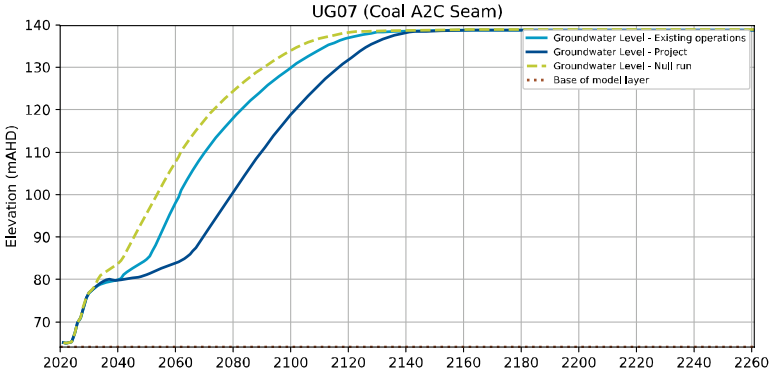
UG05 (Coal A2C Seam)



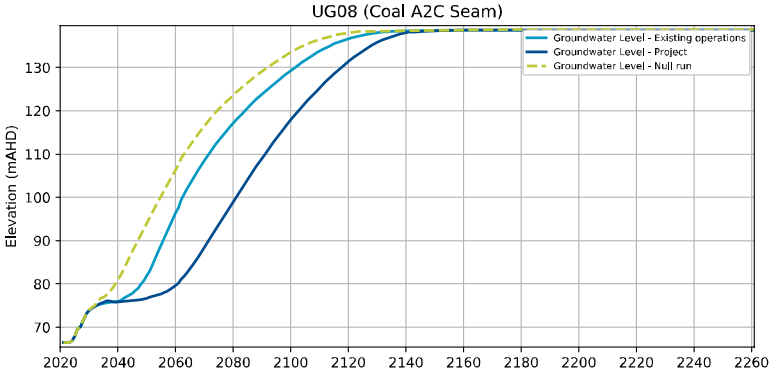
UG06 (Coal A2C Seam)



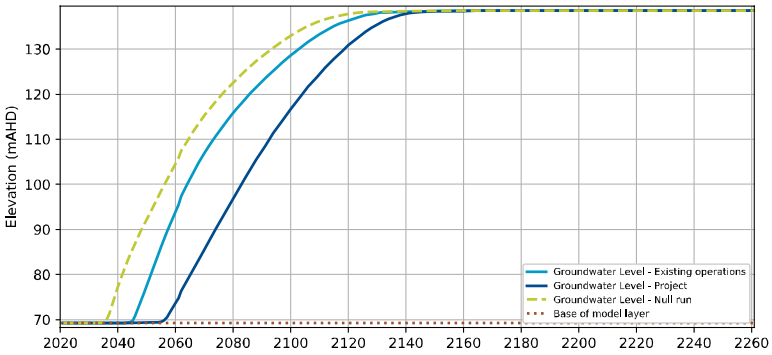
UG07 (Coal A2C Seam)



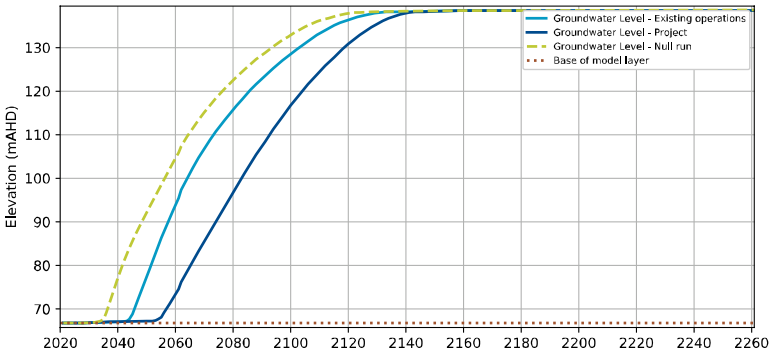
UG08 (Coal A2C Seam)



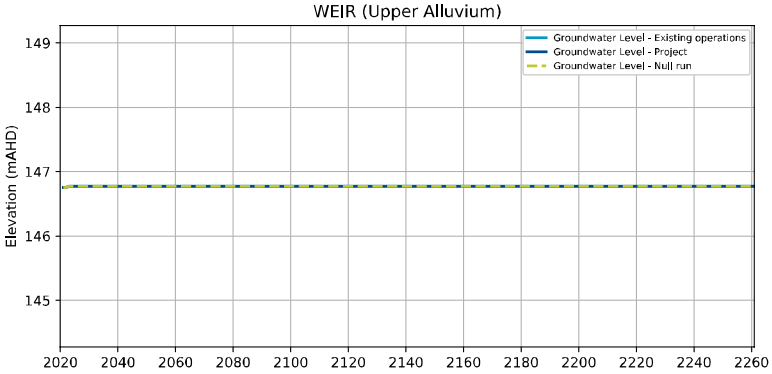
UG09 (Coal A2C Seam)



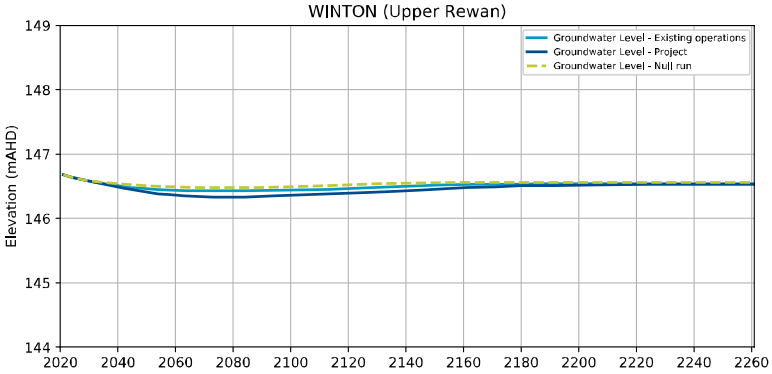
UG10 (Coal A2C Seam)



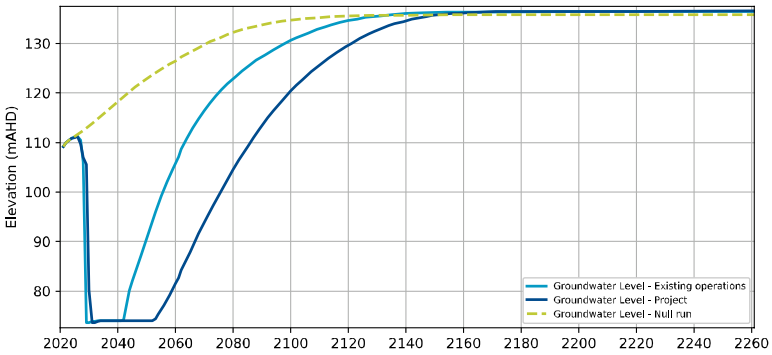
WEIR (Upper Alluvium)



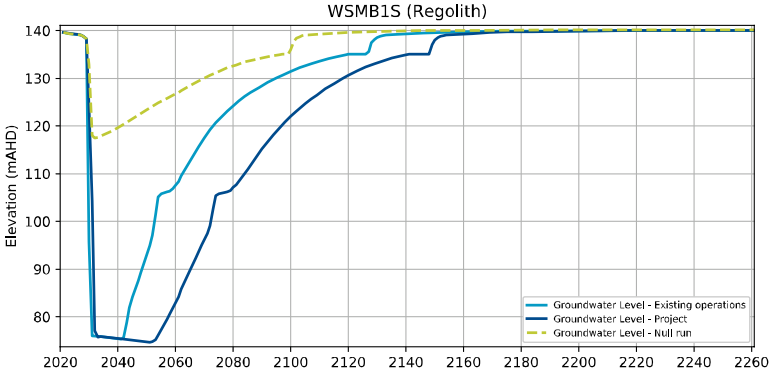
WINTON (Upper Rewan)



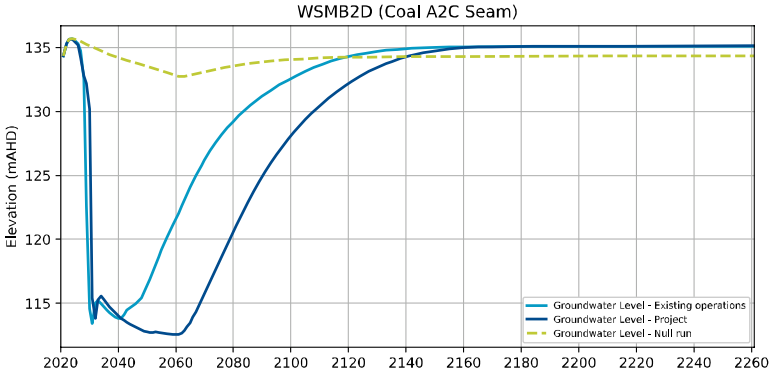
WSMB1D (Coal A2C Seam)



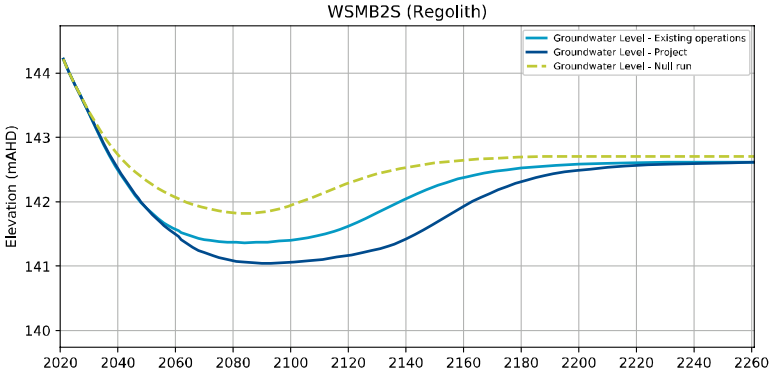
WSMB1S (Regolith)



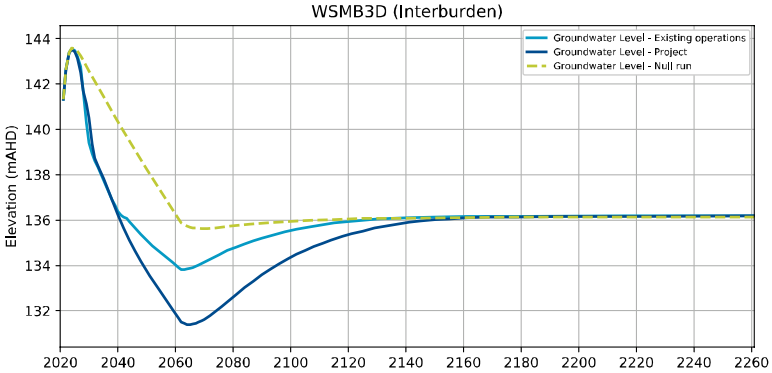
WSMB2D (Coal A2C Seam)



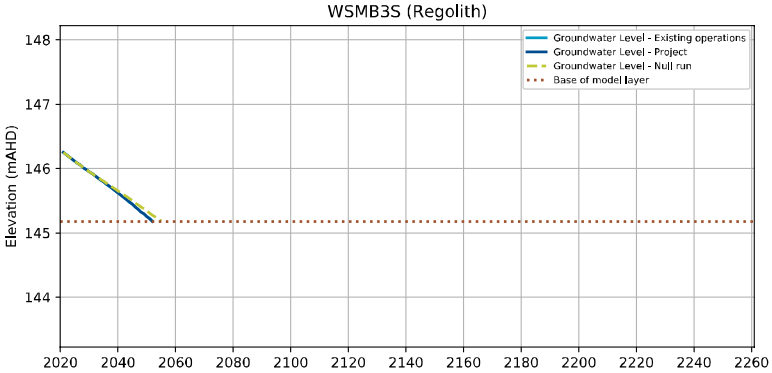
WSMB2S (Regolith)



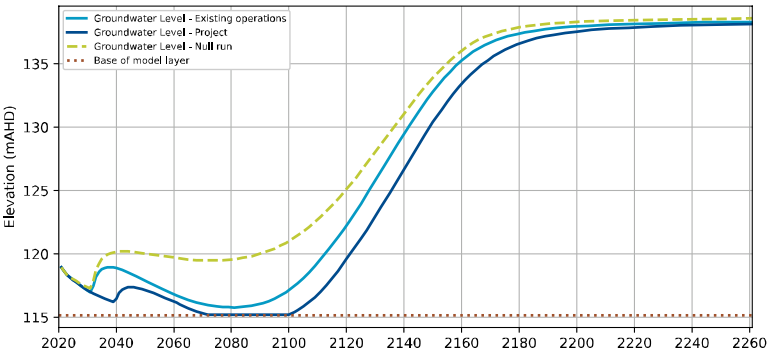
WSMB3D (Interburden)



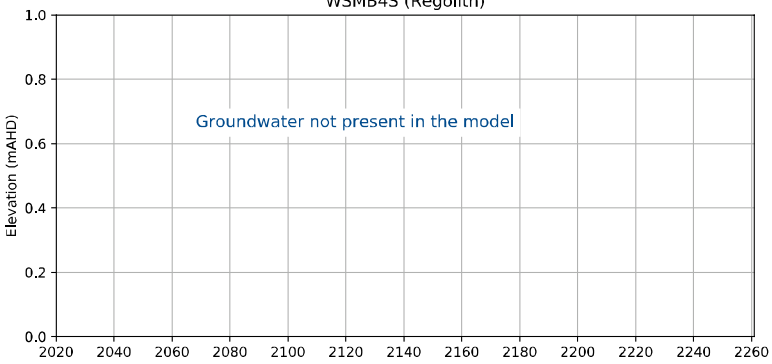
WSMB3S (Regolith)



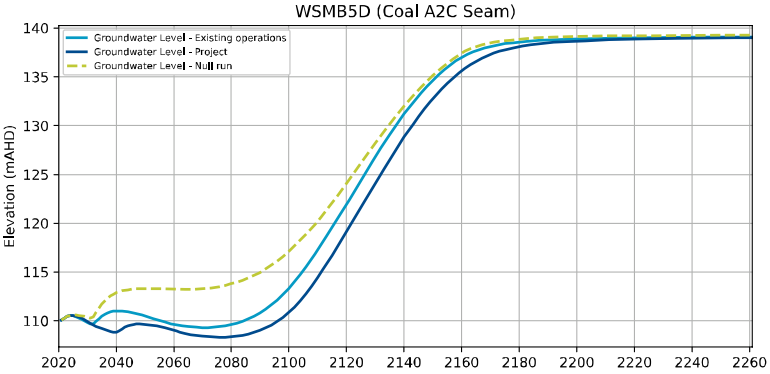
WSMB4D (Coal A2C Seam)



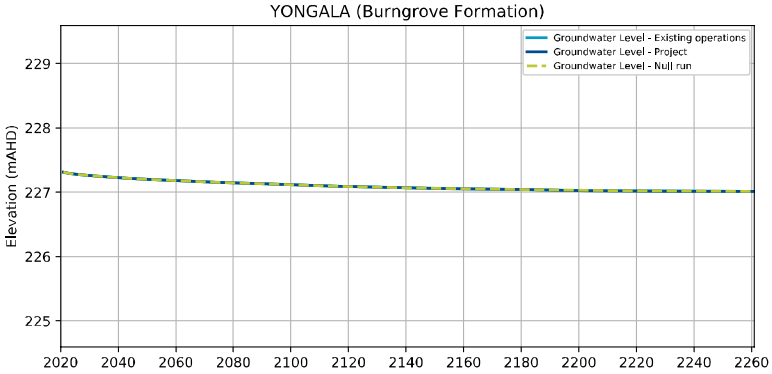
WSMB4S (Regolith)



WSMB5D (Coal A2C Seam)



YONGALA (Burngrove Formation)



ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

TOWNSVILLE SOUTH
12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

Appendix C

Ensham Life of Mine Extension Project – Zones 2 and 3: Groundwater Impact Assessment (SLR, 2022b)

ENSHAM LIFE OF MINE EXTENSION PROJECT - ZONES 2 AND 3

Groundwater Impact Assessment

Prepared for:

Ensham Resources Pty Ltd
Level 9/175 Eagle Street,
Brisbane QLD 4000

SLR Ref: 620.30686.00400-R01
Version No: Rev H
March 2022

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 16, 175 Eagle Street
Brisbane QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004)
T: +61 7 3858 4800
E: brisbane@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Ensham Resources Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30686.00400-R01-Rev H	10 March 2022	I Epari	Brian Rask, B Philby	Alex Koeman

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) was engaged by Ensham Resources Pty Ltd (Ensham) to assess the potential impacts on groundwater environmental values of the proposed Ensham Life of Mine Extension Project – Zones 2 and 3 (the Project), which is the subject of an environmental authority (EA) amendment application. The scope of this groundwater impact assessment is limited to the underground mining operations proposed within the Project. The impacts were assessed in two ways:

1. Incremental (change from existing mining operations to the Project); and
2. Additive (change from the current operation and Project to a hypothetical no underground mining scenario).

Ensham mine is an existing open-cut and underground bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald in Queensland. The Project will increase the life of the existing underground operations by extending the underground bord and pillar mine into an area identified as Zones 2 and 3, commencing from within Mining Lease (ML) 7459, ML 70326, ML 70365 and ML 70366.

The Project will produce up to approximately 4.5 million tonnes per annum and would extend the Ensham Life of Mine (LOM) to 2029. The extension of the underground operation using existing infrastructure (other than the addition of 4 gas drainage flares) means that no material surface construction or surface disturbance will be required.

Hydrogeological setting and sensitive receptors

The hydrogeological setting of the Study area (which is defined in this report as the groundwater model extent) comprises of two groundwater bearing units, the Quaternary aged alluvium and the Permian aged Rangal Coal Measures. These two key units are separated by a low permeability unit, the Rewan Group.

The Quaternary aged alluvium comprises shallow sequences of clay, silty sand and sand, underlain by basal sands and gravel. The groundwater in the alluvium shows high salinity, which makes it unsuitable for uses such as stock watering and irrigation. The alluvium is not well connected with Nogoa River, due to the difference in salinity between the more saline alluvial groundwater and the fresh river water. Some bores installed in the alluvium are sporadically dry, also indicating that there is no continuous recharge from Nogoa River.

The Rangal Coal Measures comprise economic coal seams interbedded with low permeability siltstone, sandstone and shale. The coal seams contain groundwater which is generally saline and not suitable for stock water supply or irrigation.

A review of environmental receptors identified 19 landholder bores, low potential aquatic GDEs and low potential terrestrial GDEs, and four monitoring bores with Stygofauna present. These receptors were also assessed in the subsequent impact assessment.

Set up of numerical groundwater model

A recent peer reviewed groundwater model (SLR, 2020) for the Ensham mine was used as the basis for the groundwater model that was in turn used for the groundwater impact assessment. The 2020 groundwater model:

- Represented both the existing underground mining and the above-ground open pit operations (HydroSimulations, 2020);
- Has a model domain (the Study area) that extends 43 km from north to south and 35 km from east to west; and
- Has stratigraphy that is discretised into 12 model layers.

For the impact assessment of Zone 2 and 3, the groundwater model was updated with the most recent groundwater observations and mining undertaken to date. The model was then validated against the new observation data set, and, with a scaled square root mean error of 5%, was deemed fit for purpose to assess the Project. For the model prediction, the existing mine plan and proposed mine plan for the Project were used.

Groundwater modelling predictions

Predictive groundwater modelling showed that the Project will result in additional groundwater inflow to the underground mine workings compared to the existing operations due to the proposed extended life of mine by two years. The order of magnitude of inflow for the Project remains similar to existing operations (i.e. 2 to 14 ML/day for the Project, compared to 2 to 12 ML/day for the existing operations before 2028).

Modelling also showed that the incremental alluvial flux (alluvial water seeping into lower formations) is limited to less than 0.1 ML/day, which is considered negligible. Nogoa River loss into the alluvium is not predicted to change for either the incremental or additive assessments.

The predicted incremental groundwater drawdown in the target coal seams at end of mining in 2029 extends 5 km to the north-west and 7 km to the west and the south-west. The drawdown is limited to the extent of the coal seams in the east where they outcrop or subcrop. The additive drawdown extends a kilometre further, i.e. around 6 km to the north-west and 8 km to the west and south-west.

The post-mining equilibrium groundwater water level was calculated over a timeframe of 220 years (compared to the 7-year mine life). Some permanent reduction is predicted for the water levels in the target coal seams. The groundwater recovery modelling showed that the open-cut pits are long-term sinks, as indicated by the recovered water table contours.

The model uncertainty was assessed by an extensive sensitivity analysis. Eleven selected model parameters were assessed, and the changes in the predictions, both from a water balance and drawdown perspective, were determined. The outcome of the sensitivity analysis was that the model predictions were robust, with most parameters showing little sensitivity. The few parameters that have been found to be sensitive showed results inconsistent with observations, which means it is unlikely that those parameter values are realistic. It was concluded that the groundwater model parameters chosen by the calibration were suitable to assess the impacts on the environmental receptors.

Groundwater impacts

The groundwater model was used to assess potential impacts on groundwater users. The impact assessment was carried out as incremental and additive assessments. There was some minor predicted incremental groundwater level drawdown within the alluvium east of the open-cut voids. There are no predicted water level reductions of greater than 2 m in any of the landholder bores. Jamar and Winton Creek bores show the largest incremental drawdown of 2 cm and additive drawdown of 10 cm. The modelling results predicted that the bores with Stygofauna, and the wetland would not be impacted by the additional groundwater extraction and cause any predicted drawdown. Two isolated locations show a groundwater drawdown between 0.5 to 2m in the shallow aquifer. These locations intersect parts of identified aquatic and terrestrial GDEs with low potential to host ecosystems. There are no impacts predicted on groundwater quality due to the Project. There are no predicted impacts from predicted subsidence on groundwater. There were no predicted changes to Nogoa River stream losses, and no leakage from the coal seams into the alluvium.

Management and mitigation of impacts

A comprehensive groundwater monitoring program is in place for the existing operations at Ensham mine. The monitoring network is fit for purpose to detect any groundwater level or quality changes for the Project. There are no proposed changes to the current EA conditions.

CONTENTS

1 INTRODUCTION 12
1.1 Overview 12
1.2 Project background 12
1.3 Previous studies 15
1.4 Existing infrastructure and mining operations 15
1.5 Proposed mining operations 17
1.6 Study objectives 17
2 LEGISLATIVE REQUIREMENTS AND RELEVANT GUIDELINES 18
2.1 Environment Protection and Biodiversity Conservation Act 1999 18
2.2 Water Act 2000 18
2.3 Environmental Protection Act 1994 18
2.3.1 Current Environmental Authority 21
3 SITE SETTING 22
3.1 Climate 22
3.2 Topography and drainage 25
3.3 Land use 27
3.3.1 Agriculture 27
3.3.2 Mining adjacent to the Project 30
3.3.2.1 Gregory Crinum and Kestrel 30
3.3.2.2 Wilton 31
3.3.2.3 Fairhill 31
3.3.3 Petroleum 32
4 GEOLOGY 33
4.1 Quaternary alluvium 37
4.2 Tertiary age sediments 37
4.3 Triassic age Rewan Group 37
4.4 Permian Rangal Coal Measures 37
4.5 Structural geology 38
5 HYDROGEOLOGY 39
5.1 Current groundwater monitoring 39
5.2 Hydraulic properties 42
5.2.1 Hydrogeological units 42
5.2.2 Faults 44
5.3 Groundwater levels, flow, recharge and discharge 46
5.3.1 Quaternary sediments (alluvium) 46

CONTENTS

5.3.1.1 Water levels 46
5.3.1.2 Groundwater flow 50
5.3.1.3 Interaction with surface water 52
5.3.2 Rewan Group 56
5.3.3 Permian Coal Measures 57
5.3.3.1 Water levels 57
5.3.3.2 Interaction with open cut pits 62
5.4 Groundwater quality 63
5.4.1 Physiochemical parameters 63
5.4.1.1 Alluvium 65
5.4.1.2 Rewan Group 69
5.4.1.3 Rangal Coal Measures 72
5.4.2 Metals and metalloids 75
5.5 Groundwater use and management 76
5.5.1 Groundwater dependent ecosystems 76
5.5.2 Stygofauna 77
5.5.3 Springs 77
5.5.4 Wetlands 77
5.5.5 Irrigation, farm supply / use and stock water (private bores) 78
5.6 Conceptual groundwater model 81
6 GROUNDWATER MODEL 84
6.1 Model objectives 84
6.2 Software 84
6.3 Model history and peer reviews 84
6.4 Model setup 85
6.4.1 Model grid and layers 85
6.4.2 Model properties 86
6.4.3 Boundary conditions 88
6.4.3.1 No flow boundary 88
6.4.3.2 General head boundary 88
6.4.3.3 Recharge and evaporation 88
6.4.3.4 Open-cut mining 90
6.4.3.5 Underground workings 90
6.4.3.6 Rivers 91
6.4.3.7 Other stresses 92
6.4.4 Temporal discretisation 92
6.4.5 Validation 93
6.4.5.1 Groundwater levels 93
6.4.5.2 Validated underground mine inflows 97
6.5 Model predictions 98
6.5.1 Groundwater model water balance 98

CONTENTS

6.5.2 Predicted groundwater interception 99
6.5.3 Predicted drawdown 100
6.5.3.1 Incremental drawdown 101
6.5.3.2 Additive drawdown 104
6.5.4 Incidental water impact 107
6.5.4.1 Influence on alluvium 107
6.5.4.2 Influence on baseflow 107
6.5.5 Post mining equilibrium 108
6.6 Sensitivity analysis 113
6.6.1 Scenario selection 113
6.6.2 Results 114
6.6.2.1 Drawdowns 114
6.6.2.2 Water fluxes 116
6.7 Model confidence 118
6.8 Model limitations 120
7 POTENTIAL IMPACTS 124
7.1 Assessment framework 124
7.2 Water licensing 124
7.3 Potential impact on aquatic and terrestrial ecosystems 125
7.4 Potential impact on private bores 127
7.5 Impact on groundwater quality 129
7.6 Climate change scenarios 129
7.6.1 Future climate scenarios and their impact on the alluvium 130
7.6.2 Future climate scenarios and their impact on the coal seams 131
7.7 Other potential impacts 132
8 MANAGEMENT AND MITIGATION 134
8.1 Mine affected water 134
8.2 Subsidence 134
8.3 Groundwater users 135
8.4 Groundwater monitoring program 135
8.4.1 Data management and reporting 135
9 CONCLUSIONS 136
10 RECOMMENDATIONS 137
11 REFERENCES 138

CONTENTS

DOCUMENT REFERENCES

TABLES

Table 1 Requirement for site-specific and amendment applications – underground water rights 19
Table 2 Priority agricultural land use in the Central Queensland regional plan area 28
Table 3 Proposed and current mining operations within 50 km from the Project 30
Table 4 Predicted drawdown at private bores from the Wilton Coal Project 31
Table 5 Exploration permits across the Study area 32
Table 6 Summary of stratigraphy in the Study area 34
Table 7 Monitoring network 39
Table 8 Summary of adopted hydraulic properties from other Bowen Basin studies 42
Table 9 Groundwater expression field observation 54
Table 10 Summary statistics of pH observations 64
Table 11 Summary statistics of EC observations 65
Table 12 Existent private groundwater bores 79
Table 13 Stratigraphy - model layer summary 86
Table 14 Simulated aquifer properties 86
Table 15 Adopted properties relative to field data ranges 87
Table 16 Recharge values 88
Table 17 Open-cut modelled water management 90
Table 18 Model and stress periods 92
Table 19 Model run selections 98
Table 20 Average simulated water balance during the prediction period (2022 to 2030) 99
Table 21 Sensitivity analysis – overview of scenarios 113
Table 22 Sensitivity analysis – changes to mining inflow and stream flow losses 116
Table 23 Groundwater model classification 119
Table 24 Groundwater model and data limitations 121
Table 25 Impact assessment framework for each environmental value 124
Table 26 Predicted maximum incremental drawdown at private bores due to the Project 127
Table 27 Predicted maximum additive drawdown at private bores due to the Project 128
Table 28 Change in rainfall for different climate scenarios (2090) 130
Table 29 Qualitative assessment of other potential impacts 132
Table 30 Release points and source water conditions (Table C1 of EPML00732813) 134

FIGURES

Figure 1 Project location and surrounding mine tenements 13
Figure 2 Underground mine plan (Existing operations and the Project) 14
Figure 3 Project mine tenements, pit shell boundaries and underground mining areas 16
Figure 4 Long-term annual rainfall statistics (1900-2021) 22
Figure 5 Average monthly rainfall and evaporation at Emerald Post office (1900-2021) 23
Figure 6 Monthly rainfall and CRD 24
Figure 7 Monthly rainfall at Ensham mine and Emerald Post office (2007-2021) 24
Figure 8 Topography and drainage 26

CONTENTS

Figure 9 Maximum monthly level for Nogoa River plotted against CRD 27
Figure 10 Priority Agricultural Areas and Strategic Cropping Land in the vicinity of the Project 29
Figure 11 Surface geology 35
Figure 12 Solid geology 36
Figure 13 Coal seam stratigraphy of the Rangal Coal Measures 38
Figure 14 Location of EA monitoring and existing mine monitoring bores 41
Figure 15 Local faults 45
Figure 16 Overview of alluvial bores and cross section 47
Figure 17 Hydrographs for upstream bores 48
Figure 18 Hydrographs for bores near Zone 2 49
Figure 19 Hydrographs for bores near or in the sub-crop area 50
Figure 20 Groundwater contours in the alluvium (2021) 51
Figure 21 Conceptual cross section through Nogoa River and quaternary sediments (Source: AGE 2006) 52
Figure 22 Piper Diagram comparing groundwater quality with the investigation sample 54
Figure 23 Water level comparison at Nogoa River (Duckponds) and EC03 55
Figure 24 EC comparison at Nogoa River (Duckponds) and EC03 55
Figure 25 Hydrographs for Rewan bores compared with RB04 (Coal measures) 56
Figure 26 Hydrographs for Permian bores (north) 58
Figure 27 Hydrographs for Permian Bores (Central Area) 59
Figure 28 Hydrographs for Permian bores (South) 60
Figure 29 Groundwater contours in the Rangal Coal Measures (2021) 61
Figure 30 Hydrographs for bores WSMB2D, WSMB2S, and surface water levels at Ramp 22 62
Figure 31 Hydrographs for bores WSMB3S, WSMB3D, RB5, RB6, RB9 with surface water level at Ramp 20 and 21 63
Figure 32 Piper plot alluvium 66
Figure 33 Lab EC – alluvium 66
Figure 34 Field EC - alluvium 67
Figure 35 Electrical conductivity (Lab) - EC04, EC06, EC16, EC17 and EC19 68
Figure 36 Field pH - alluvium 69
Figure 37 Piper plot - Rewan Group 70
Figure 38 Field EC - Rewan Group 71
Figure 39 Electrical conductivity (Lab) - Rewan Group 71
Figure 40 Field pH - Rewan Group 72
Figure 41 Piper Plot - Rangal Coal Measures 73
Figure 42 Field EC - Rangal Coal Measures 74
Figure 43 Field pH - Rangal Coal Measures 74
Figure 44 Number of bores with 80th percentile above ANZECC guidelines for aquatic ecosystem protection (95%) in the main hydrogeological units 75
Figure 45 Groundwater Dependent Ecosystems and Private bores 80
Figure 46 Conceptual groundwater model 82
Figure 47 Cross section along the alluvium and sub-crop 83
Figure 48 Model grid, boundary conditions and mine plan 89
Figure 49 Observed vs computed target water levels 94

CONTENTS

Figure 50 Calibration hydrographs (alluvium) 95
Figure 51 Calibration hydrographs (Coal seam) 95
Figure 52 Maps of average residuals 96
Figure 53 Predicted versus simulated underground mine inflows 97
Figure 54 Predicted underground mine inflow 100
Figure 55 Illustration of drawdown calculations 101
Figure 56 Maximum incremental drawdown due to the Project in the unconsolidated (L2) ... 102
Figure 57 Maximum incremental drawdown due to Project in the Aries and Castor seam (L8) 103
Figure 58 Maximum additive drawdown due to the Project in the Unconsolidated (L2) 105
Figure 59 Maximum additive drawdown due to the Project in the Aries and Castor seam (L8) 106
Figure 60 Flux from the Alluvium into underlying strata 107
Figure 61 Stream flow in Nogoa River 108
Figure 62 Recovery times series for two selected bores 109
Figure 63 Equilibrium groundwater level (2260) in the alluvium and regolith (L2) 110
Figure 64 Equilibrium groundwater level (2260) in the Aries and Castor seam (L8) 111
Figure 65 Equilibrium groundwater table (2260) 112
Figure 66 Sensitivity analysis for groundwater drawdown in the Aries and Castor Coal Seam (L8) 115
Figure 67 Underground mine inflow (sensitivity analysis) 117
Figure 68 Nogoa River net stream flow (sensitivity analysis) 118
Figure 69 Maximum incremental drawdown in the alluvium and GDEs 126
Figure 70 Long-term recovery hydrograph for alluvial bore EC25 131
Figure 71 Long-term recovery hydrograph for bore RB04 132

APPENDICES

Appendix A Layer extents and thickness
Appendix B Summary statistic of EA water quality parameters
Appendix C Water quality compared to regional and national guidelines - Boxplots
Appendix D Water Quality Parameters - Time Series
Appendix E Calibration Hydrographs
Appendix F Hydraulic properties zones
Appendix G Prediction Hydrographs

1 Introduction

1.1 Overview

SLR Consulting Australia Pty Ltd (SLR) was engaged by Ensham Resources Pty Ltd (Ensham) to assess the potential impacts on groundwater environmental values of the proposed Ensham Life of Mine Extension Project – Zones 2 and 3 (the Project), which is the subject of an environmental authority (EA) amendment application.

The scope of this assessment is to:

- Describe the existing hydrogeological environment of the Project and surrounds.
- Assess the potential impacts of the proposed extension of underground mining on the groundwater related environment.
- Propose measures to manage and/or mitigate any impacts to groundwater environmental values.

For the purpose of this assessment, the Study area is the extent of the groundwater model domain (Figure 1), which includes the Project and surrounds. The scope of this groundwater impact assessment is limited to the underground mining operations proposed within Zones 2 and 3 (Figure 2).

1.2 Project background

Ensham mine is an existing open-cut and underground bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald in Queensland. The existing bord and pillar operations are currently authorised to continue until January 2028 within Mining Lease (ML) 7459, ML 70326 and ML 70365 (Figure 1) and to extract a portion of the various combined Aries/Castor seam plies.

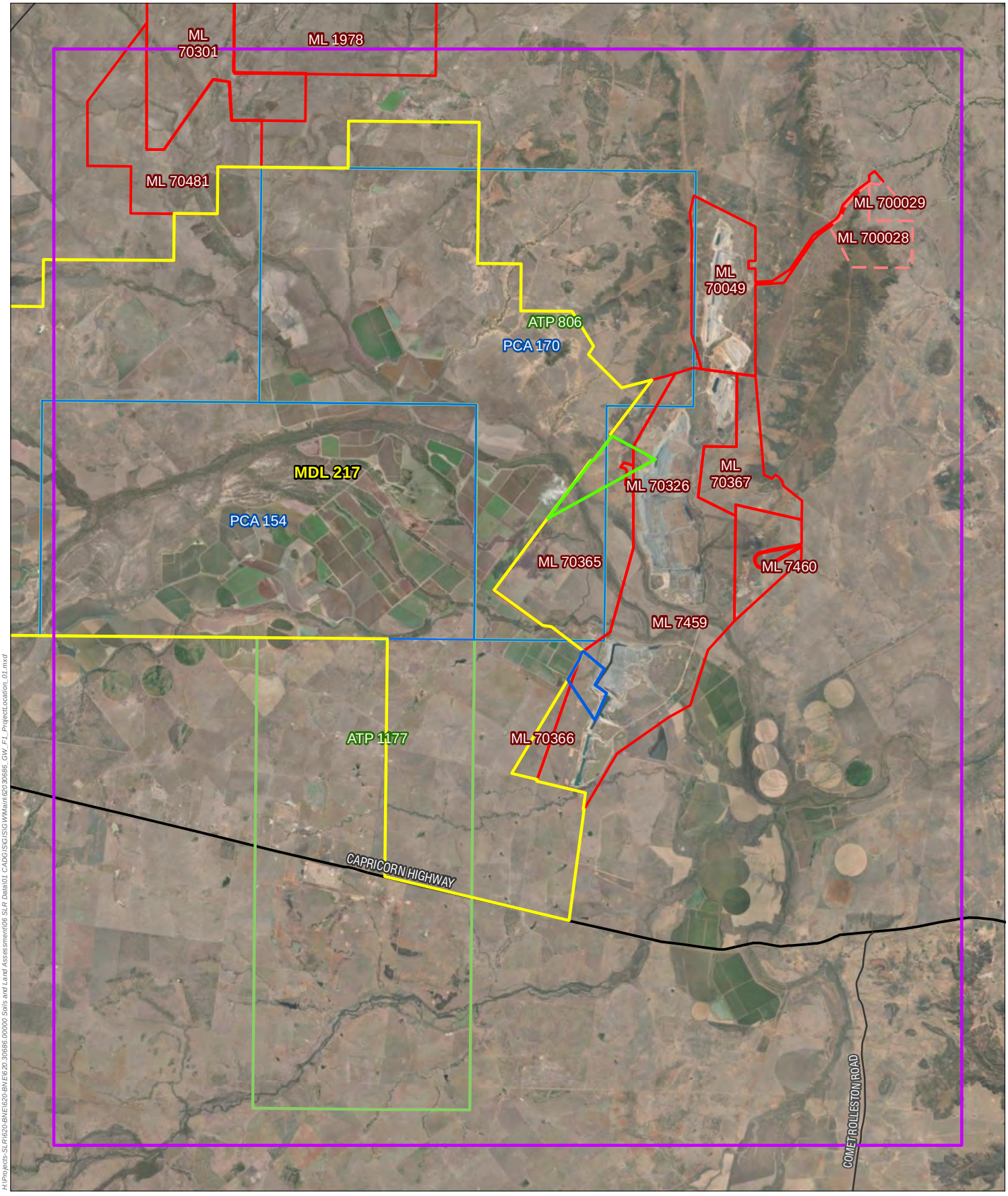
Pits C and D within the open-cut mine will be retained to allow for access to the underground mine portals, which will be rehabilitated towards the end of the rehabilitation program.

It is proposed to increase the life of the existing underground operations by extending the underground bord and pillar mine into an area identified as Zones 2 and 3, as shown in Figure 2.

The Project covers approximately 603 hectares (ha) and includes two zones:

- Zone 2: partially includes existing leases ML 70326, ML 70365, and ML 7459 (total area is approximately 394 ha of which 346 ha would represent the mining footprint).
- Zone 3: partially includes existing leases ML 7459 and ML 70366 (total area is approximately 209 ha of which 175 ha would represent the mining footprint).

The above-nominated mining footprint areas for Zones 2 and 3 are projected areas under which underground mining would occur.



H:\Projects-SLR\620-BNE\620-BNE16\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F1_ProjectLocation_01.mxd

0 5 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

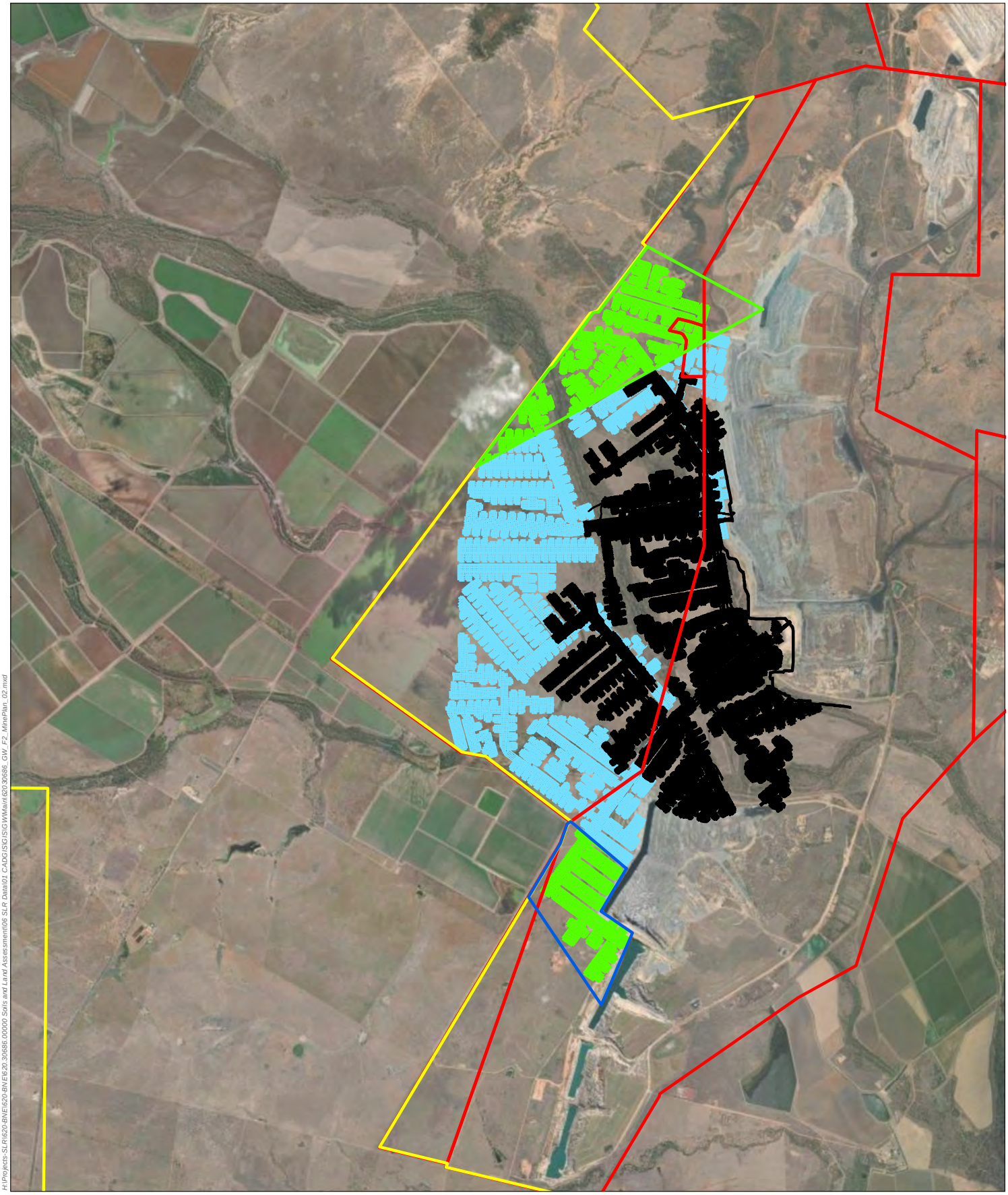
Legend

- Highway
- Major Road
- Zone 2
- Zone 3
- Study Area (Groundwater model domain)
- Mineral Development Licence (MDL) 217
- Mining Lease (Granted)
- Mining Lease (Application not related to the Project)
- Potential Commerical Area
- Exploration Permit for Petroleum

GROUNDWATER IMPACT ASSESSMENT

Project location and surrounding mine tenements

Figure 1



H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F2_MinePlan_02.mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Underground mine plan (Approved and the Project)

Figure 2

Projection: GDA 1994 MGA Zone 55
Scale: 1:75,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	SLR Consulting
Sheet Size:	A4

Legend

- Zone 2
- Zone 3
- Mineral Development Licence (MDL) 217
- Mining Lease (Granted)

Underground Mining Operations

- Mined Out UG

Future Mining

- Approved
- Project

SLR

1.3 Previous studies

The Life of Mine Extension Project Environmental Impact Statement (EIS) was submitted in March 2021. The EIS assessed impacts on diverse environmental receptors from extension Zones 1, 2 and 3. The EIS was on public display and an amended EIS (AEIS) was subsequently prepared to address submissions. The AEIS was submitted in August 2021. The Department of Environment and Science (DES) provided an EIS assessment report in November 2021.The recommendations from the EIS assessment report in relation to groundwater have been considered for this assessment.

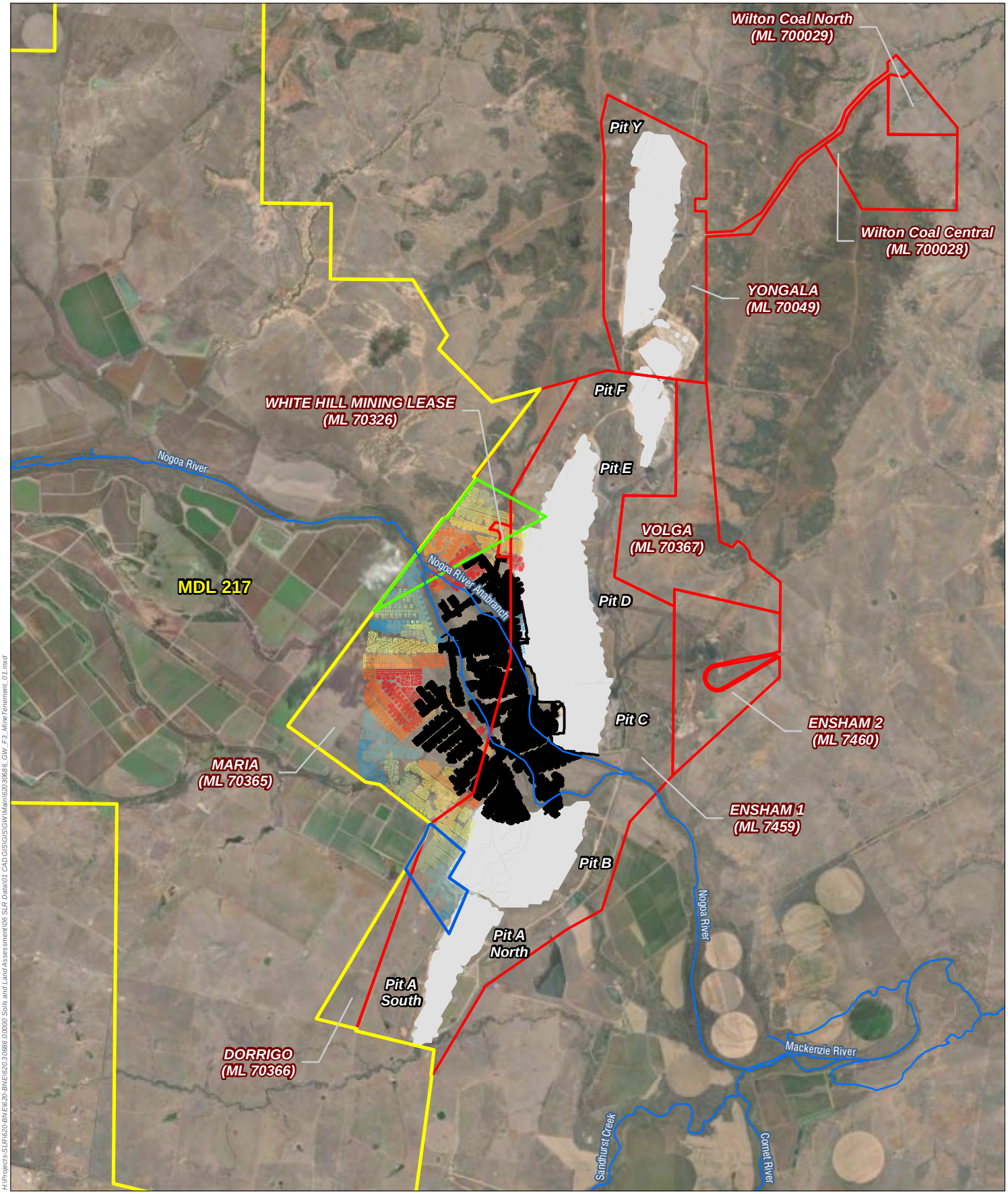
The groundwater assessment prepared for the EIS/AEIS was peer reviewed by the Sustainable Minerals Institute, University of Queensland, and was also reviewed by the Independent Expert Scientific Committee (IESC) and the Commonwealth Department of Agriculture, Water and the Environment (DAWE). This groundwater assessment only assesses impacts from mining proposed for Zones 2 and 3, therefore reducing the mine footprint by removing Zone 1. The methodology adopted for the EIS/AEIS has been peer reviewed and found to be acceptable, and has therefore been adopted for this groundwater assessment.

1.4 Existing infrastructure and mining operations

Ensham mine currently produces up to 4.5 million tonnes per annum (Mtpa) of coal for both the open-cut and underground operations. The open cut mine has been operating since 1993 and covers a strike length of over 20 km, from Pit A in the south to Pit Y in the north (Figure 3). The open-cut operation is due to close in 2022.

Current approved underground operations commenced in 2011 and the relevant mining leases are due for renewal in January 2028. Existing underground operations within the currently approved MLs are referred to as the “existing operations” in this report.

The main working seam follows through a portal from Pit C, progressing in a westerly direction underneath Nogoa River floodplain.



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GIS\GW\Main\620.30686_GW_F3_MineTenement_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

GROUNDWATER IMPACT ASSESSMENT

Project mine tenements pit shell boundaries and underground mining areas

Figure 3

Legend

- Watercourse
- Zone 2
- Zone 3
- Mineral Development Licence (MDL) 217
- Mining Lease

Underground Mining

- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
- Mined Out UG

- Open Cut to date

1.5 Proposed mining operations

The Project is an extension of current underground operations and will utilise existing underground and surface infrastructure and processes. The Project will continue to produce at a current production rate of up to approximately 4.5 Mtpa. This will extend the Ensham Life of Mine (LOM) by two years, to 2029. The Project is proposed to commence approximately at the end of H1 2022. The use of conventional underground mining equipment would continue for the Project.

This study assessed the potential impacts of bord and pillar mining, including the depressurisation of groundwater (i.e. the dewatering of the coal seam during mining).

1.6 Study objectives

The groundwater assessment was undertaken in accordance with the Queensland government requirements under Chapter 3 of the Water Act 2000 (Qld) (Water Act). To achieve the requirements of these regulatory requirements, the groundwater assessment comprised two parts:

(i) A description of the existing hydrogeological environment.

(ii) An assessment of the potential impacts of mining on the groundwater related environment.

2 Legislative Requirements and Relevant Guidelines

This section summarises the relevant groundwater legislation and policy relevant to the Project, inclusive of the following:

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).
- Queensland Water Act 2000 (Water Act).
  - Water Resource (Fitzroy Basin) Plan 2011.
  - Environmental Protection (Underground Water Management) and Other Legislation Amendment Act 2016.
- Queensland Environmental Protection Act 1994 (EP Act).
  - Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water).

2.1 Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is administered by DAWE. The EPBC Act is designed to protect national environmental assets, known as Matters of National Environmental Significance (MNES).

This assessment was carried out under State legislation. Commonwealth considerations were included in the Life of Mine Extension Project EIS (refer to Section 1.3).

2.2 Water Act 2000

The Water Act 2000, supported by the subordinate Water Regulation 2016, is the primary legislation regulating groundwater resources in Queensland. The purpose of the Water Act is to advance sustainable management and efficient use of water resources by establishing a system for the planning, allocation and use of water. The Water Act is enacted under a framework of catchment specific Water Plans (WPs).

Water resources within the Study area are captured under the Water Plan (Fitzroy Basin) 2011 (DEHP, 2011). This WP covers the surface water (zone WQ1303) associated with lower Nogoa River and groundwaters (zone WQ1310 – Fitzroy Basin groundwaters). Further, the Study area is covered by the Highlands Groundwater Management Area under the Water Plan (Fitzroy Basin) 2011.

As part of the Project, Ensham proposes to exercise underground water rights during the period in which resource activities will be carried out in Zones 2 and 3.

2.3 Environmental Protection Act 1994

Minimum reporting requirements for groundwater impact assessments are outlined within the Environmental Protection Act 1994 (Qld) (EP Act) guideline requirements for site-specific and amendment applications - underground water rights. A summary of the guideline requirements and where they have been addressed within this report are provided in Table 1.

Table 1 Requirement for site-specific and amendment applications – underground water rights

Part	Detail	Section in report
Part A	A statement that the applicant proposes to exercise underground water rights	Section 2.2
Part B	A description of the area/s in which underground water rights are proposed to be exercised	Sections 4 and 5
Part C	A description of the aquifer/s affected or likely to be affected	Section 5
	Aquifer type (confined, unconfined, fractured etc)	Section 5
	Geology/ stratigraphy for each aquifer	Section 4
	Depth to and thickness of the aquifers	Section 4 and Appendix A
	Physical integrity of the aquifer, fluvial processes and morphology	Section 4
	Depth to water level and seasonal changes in levels	Section 5.3
	Hydrogeological cross sections	Section 5.6
	Maps (spatial extent)	Extent of the units in Appendix A and Appendix F
Part D	An analysis of the movement of underground water to and from the aquifer	Sections 5.3
	Inputs (i.e. recharge) and outputs (i.e. baseflow and abstraction)	Section 5.3
	Underground water elevations (i.e. mapped groundwater flow directions)	Figure 20 and Figure 29
	Connectivity between aquifers and hydraulic properties	Sections 5.2 and 5.3
	Preferential flow pathways (i.e. faults)	Section 5.2.2
	Springs	Section 5.5.2
Part E	A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights	Section 7
	Predictions should: • Be made for the life of the resource project and for post resource tenure closure • Ne made about the timing, spatial extent and magnitude of maximum water level declines in affected aquifers • Be made about the timing and magnitude of groundwater level equilibrium in affected aquifers.	Section 7 and Appendix G

Part	Detail	Section in report
	Produce potentiometric contour maps showing maximum predicted water level decline for each affected aquifer.	Section 6.5.3
	Modelling methodology, including: • Model type (e.g. numerical or analytical) • Modelling platform • Model inputs • Model boundary conditions • Model assumptions and limitations • Sensitivity analysis and calibration results.	Section 6
Part F	The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights	Section 6.5.2
	Details on the methodology used for measuring extraction volumes and developing the extraction schedule	Section 6.4.3
Part G	Information on predicted impacts to the quality of groundwater that will, or may, happen because of the exercise of underground water rights	Section 7.5
	Identify the quality of the groundwater prior to the resource activity commencing	Section 5.4
	Explain the variation of chemical concentrations as a result of chemical reactions over the life of the Project due to the exercise of underground water rights (i.e. changes in salinity and concentration of dissolved gas)	Section 7.5
	Estimate extent and likelihood of groundwater quality impacts, with justification based on potential sources of contamination	Section 7.5
Part H	Identifying and describing environmental values: • Information on the environmental values that will, or may, be affected by the exercise of underground water rights • Describe and define environmental value of aquifers, presenting available raw data used. Document groundwater use, including details on operating bores within the areas predicted to be affected by the exercise of underground water rights	Section 5.5
	Nature and extent of the impacts on the environmental values (risk assessment): • The magnitude, relative size or actual extent of any impact in relation to the environmental value being affected • The vulnerability or resilience of the environmental value (severity and duration) • Uncertainty of impacts and any assumptions.	Section 7.3 and 7.4
	Surface subsidence impacts	Section 8.2

Part	Detail	Section in report
Part I	Information on strategies for avoiding, mitigating or managing the predicted impacts on the environmental values or predicted impacts on the quality of groundwater Strategies for avoiding, mitigating and managing the predicted impacts on both environmental values and predicted changes in groundwater quality should include: • Objectives which define the outcomes that are intended to be achieved (i.e. avoiding, mitigating and managing the predicted impacts) and a description of unavoidable impacts to environmental values • Measures (specific methods/procedures/tools) to be implemented to demonstrate how the objectives will be achieved • Indicators relevant to protection of the EVs (i.e. indicators are the values that are to be measured to gauge whether the objectives are being achieved and are used to are to be used in auditing the performance of measures) • A program for monitoring the indicators • A reporting program which includes triggers for the review of the strategies, and identifies additional data, assessment, analysis and reporting requirements	Section 8

2.3.1 Current Environmental Authority

The current EA, EPML00732813, for the existing mine includes mining activities on the following mining leases: ML 7459, ML 7460, ML 70326, ML 70049, ML 70365, ML 70366, and ML 70367 (Figure 1).

The EA conditions relevant to groundwater include C39 to C50 and Tables C10 and C11. These conditions detail monitoring and reporting requirements pertinent to groundwater level and quality. Quarterly groundwater monitoring is to be carried out for all bores included in Table C10 of the EA (refer to Table 7 for a list of EA bores) and for all parameters included in Table C11 of the EA. The monitoring network comprises site-based and regional observation bores, among which are included private landholder bores local to the mining area. The current groundwater monitoring network is presented in more detail in Section 5.1.

3 Site setting

3.1 Climate

The Central Highlands region has a sub-humid, sub-tropical climate, with distinct wet and dry seasons. Long-term rainfall, evaporation and temperature data sourced from Emerald Post Office (Bureau of Meteorology (BoM) station 35027) shows a long-term mean annual rainfall of 600 mm, a 20th percentile of 445 mm/year and an 80th percentile of 736 mm/year (Figure 4). In this figure, dry years are the years with less rain than the 20th percentile and wet year are years with more rain than the 80th percentile.

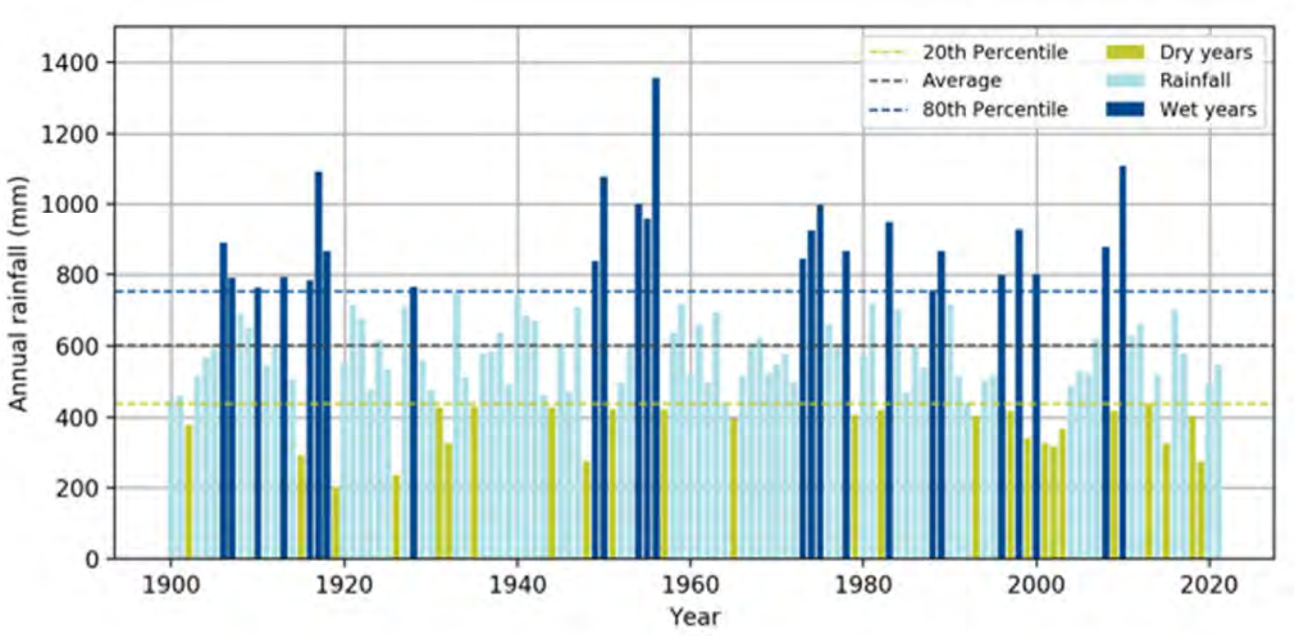


Figure 4 Long-term annual rainfall statistics (1900-2021)

The Scientific Information for Land Owners (SILO) data (Jeffrey, 2001) for rainfall and pan evaporation at this station (patched with surrounding stations after station closure in 1991) is presented on Figure 5. For each month, evaporation is approximately two to three times greater than the average monthly rainfall (Figure 5). Evapotranspiration takes place where water table is close to ground surface and / or within root zone depths (typically 1-2 m away from creek lines). Within the Study area the highest rates of potential evapotranspiration are along creek and river lines, in particular Nogoa River, Winton Creek and Boggy Creek, where the water table is closer to ground surface, and deeper rooting vegetation exists.

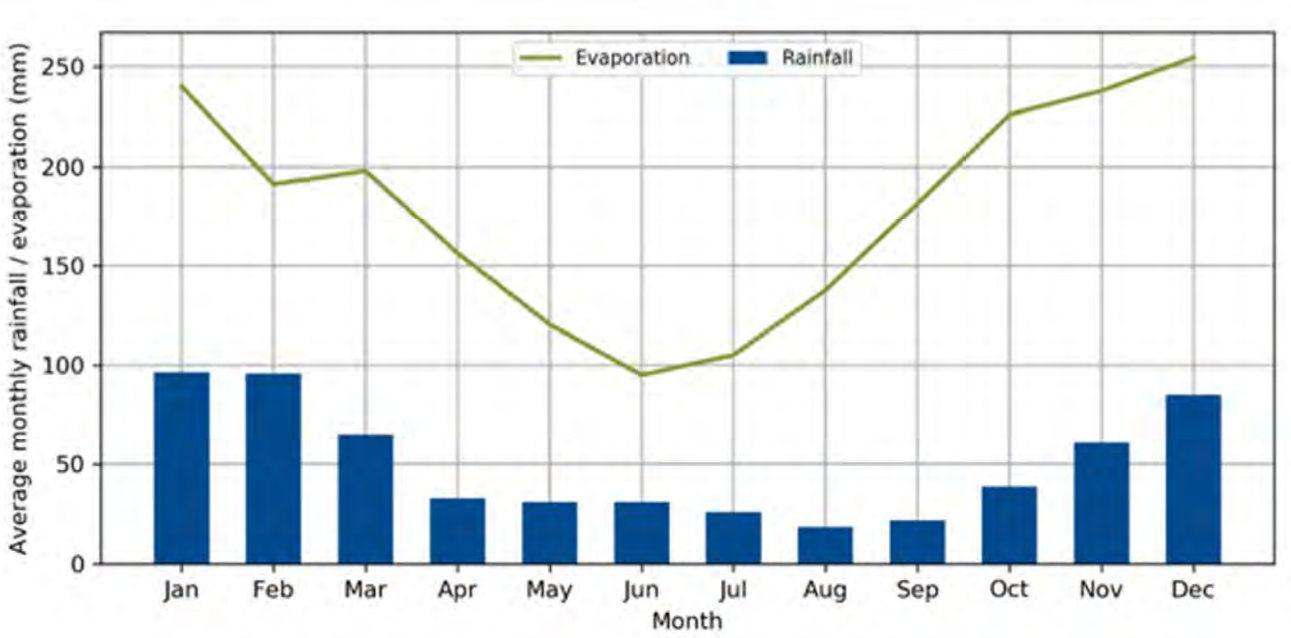


Figure 5 Average monthly rainfall and evaporation at Emerald Post office (1900-2021)

The monthly rainfall total and cumulative rainfall departure (CRD) are presented on Figure 6. The CRD has been calculated for the following location and time frame:

- Location: latitude -23.55/ longitude 148.15 (closest to Emerald Post Office).
- 1/1/1900 to 30/09/2021.

The CRD in Figure 6 is presented below between 1995 – current.

The CRD is used in the discussion of the observed groundwater levels as a means to characterise climatic conditions (e.g. dry and wet climatic conditions). The early 2000s showed prolonged drier than average conditions (decreasing slope in CRD), followed by a period of wetter conditions (2008-2012, increasing slope in CRD). Since then, the CRD shows a decreasing trend, however not as steep as in the early 2000s.

Site data are also available from 2007 onward. A comparison between monthly rainfall recorded at Ensham mine and monthly rainfall sourced from SILO for Emerald Post office is presented on (Figure 7). The data are reasonably consistent between the two data sets, with some local events being captured at one of the two sites only. Examples are January 2008 (Emerald Post office higher than site) and December 2010 (site rainfall higher than Emerald Post office). The highest monthly rainfall recorded at the site are, in a decreasing order, December 2010, March 2019, February 2010, March 2011 and January 2012.

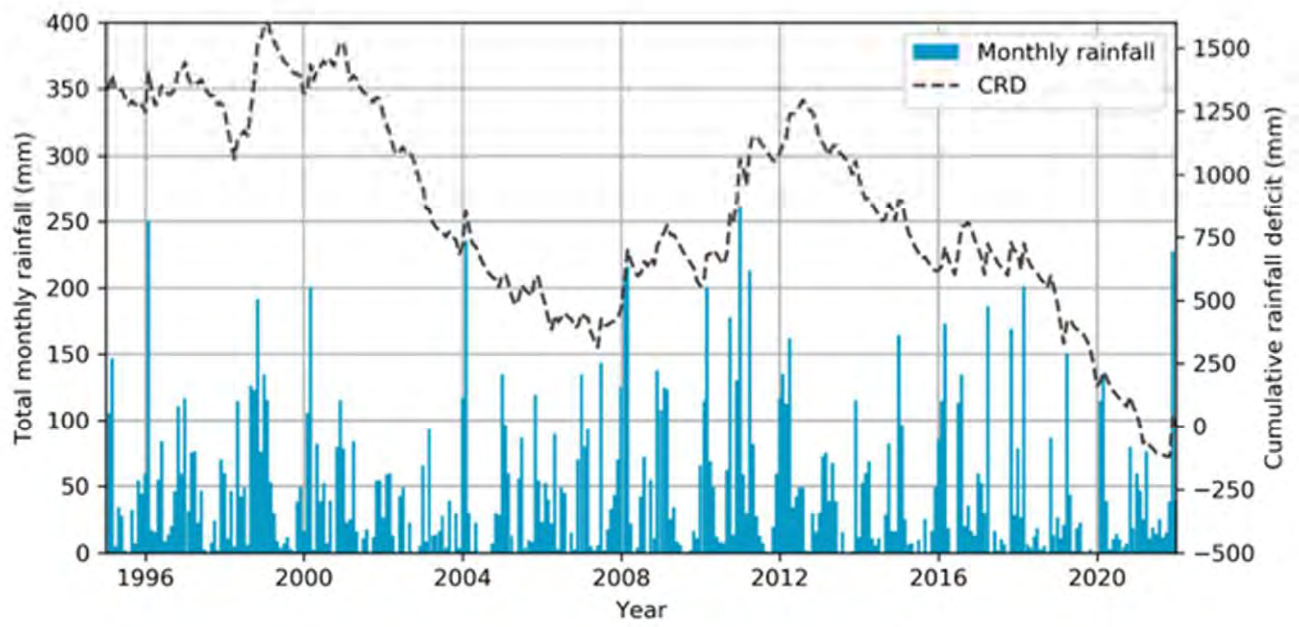


Figure 6 Monthly rainfall and CRD

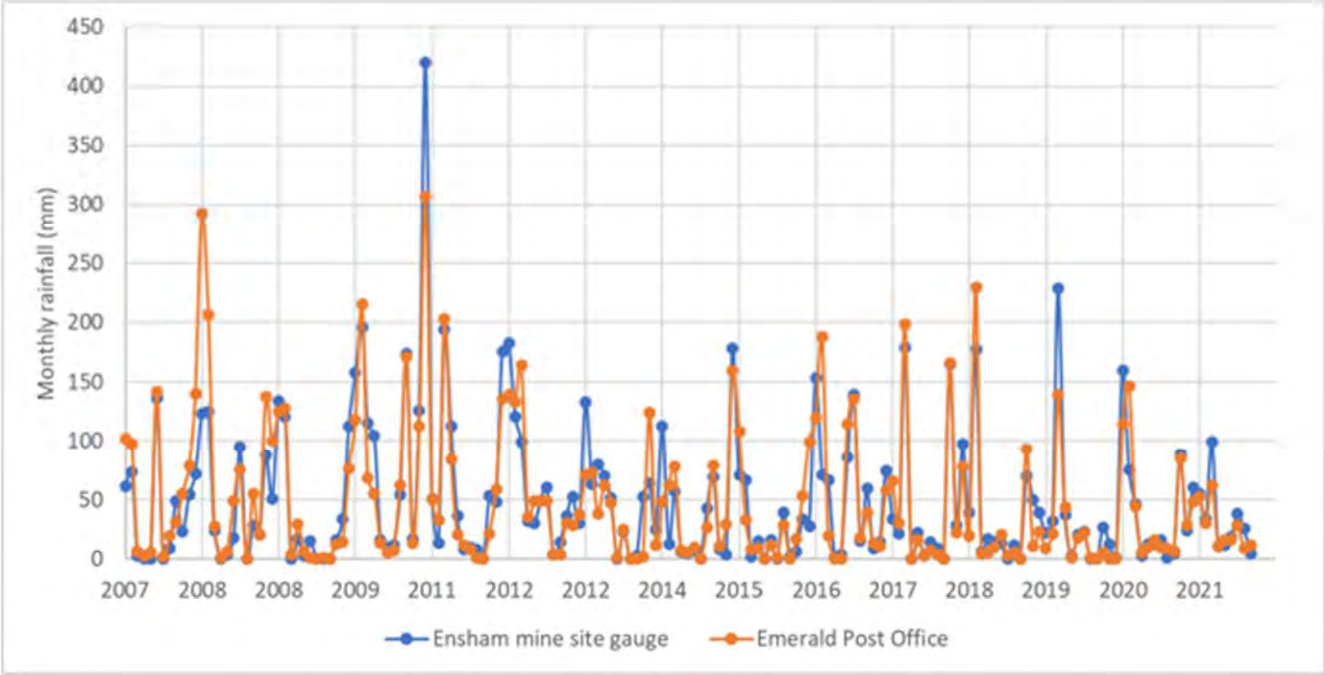


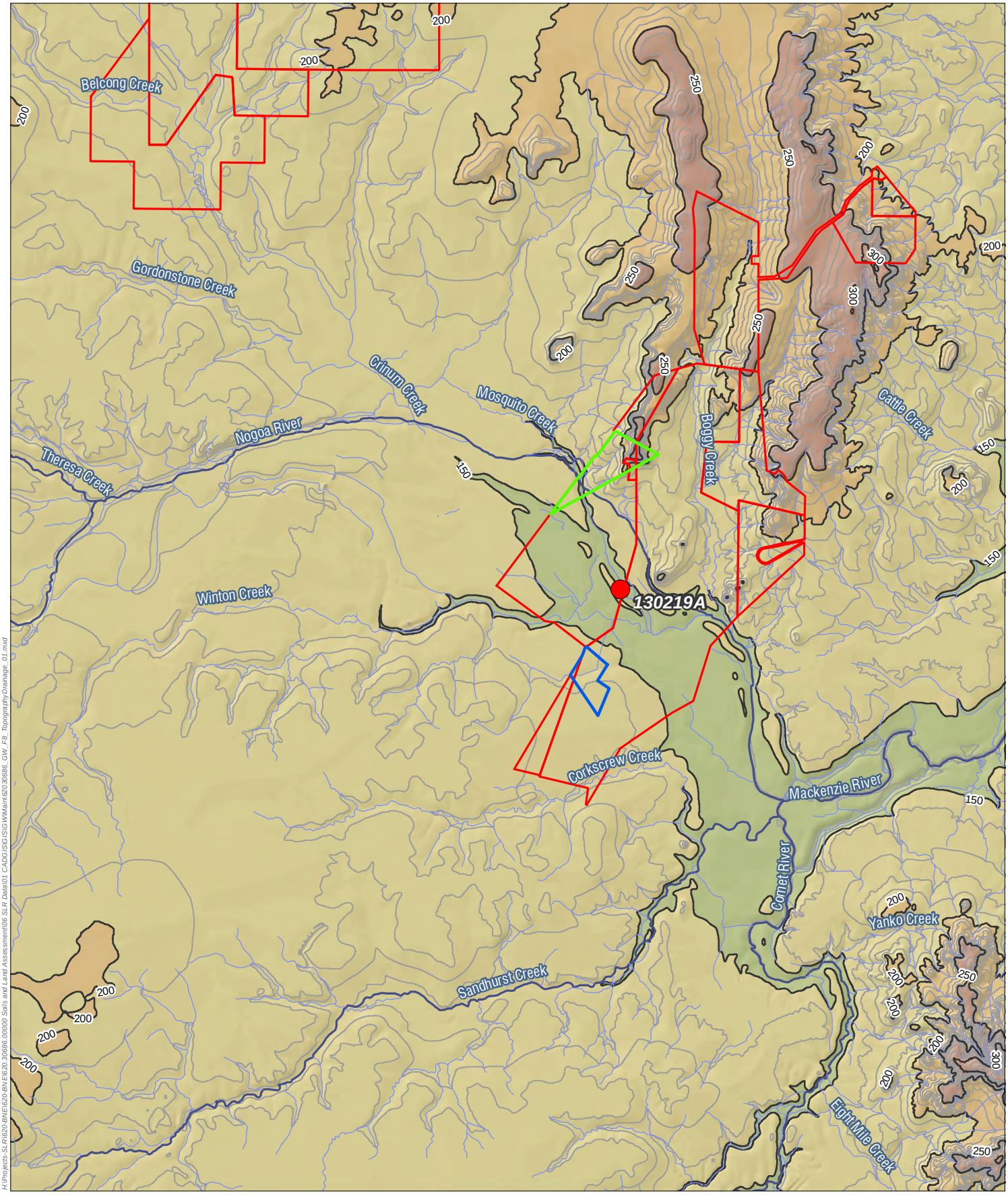
Figure 7 Monthly rainfall at Ensham mine and Emerald Post office (2007-2021)

3.2 Topography and drainage

The terrain in the Study area is generally low-lying, and the few hills within the area are capped by duricrusts. The main drainage of the area is via Nogoa River, which flows in an easterly and south-easterly direction through the Ensham mining leases before joining Mackenzie River near the town of Comet. In the Study area, the elevation of the Nogoa River banks average 150 mAHD. Nogoa River is used for irrigation and stock water supply, with flow maintained by releases from Fairbairn Dam south of Emerald. The low-lying area includes floodplains and riparian zones along Nogoa River and an anabranch, which runs to the north of Nogoa River (Figure 8).

Stream flow data for Nogoa River is collected on a daily basis by the Department of Regional Development, Manufacturing and Water at Nogoa River stream station 130219A (Duck Ponds). Figure 9 shows the monthly mean of maximum river level recorded at Duck Ponds compared against the CRD, which is based on rainfall measured on site. As shown on Figure 9, between 2009 and 2012 the Study area experienced above average rainfall and stream levels, followed by a gradual decline in rainfall to below average conditions between 2014 and 2016. Above average rainfall events between 2016 and 2018 were driving peak flows associated with events of 1:10 annual exceedance probability and these correspond to multiple stream level peaks. Low maximum stream levels since the beginning of 2018 have been the result of relatively low rainfall conditions and regulation of releases from Fairbairn Dam.

Bureau of Meteorology (BoM) (2021) classifies flood levels for station 130219A as minor, moderate and major for water level at respectively 9 m, 10 m, and 11 m above the riverbed. According to this classification, in January 2008 and December 2010 there were two major flood events, and in January 2012 there was a moderate flood event. The latest flood event in July 2016 was minor (Figure 9).



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F8_TopographyDrainage_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

Legend

- DNRME Gauge Station #130219A (Nogoa River at Duck Ponds)
- Major Watercourse
- Minor Watercourse
- Topographic Contour (50m)
- Topographic Contour (10m)
- Zone 2
- Zone 3
- Mining Lease

Elevation (m)

- < 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 350
- 350 - 500
- > 500

GROUNDWATER IMPACT ASSESSMENT

Topography and drainage

Figure 8

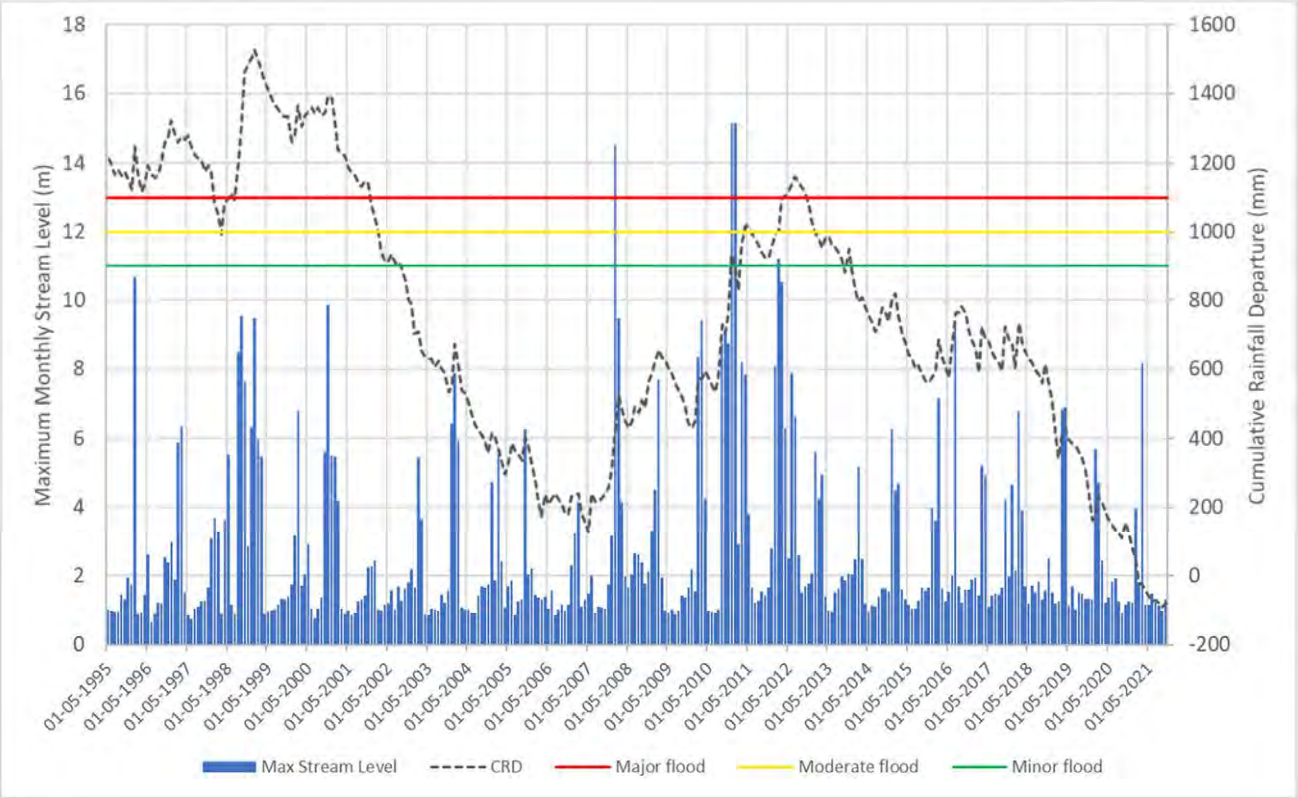


Figure 9 Maximum monthly level for Nogoa River plotted against CRD

3.3 Land use

Land use in the greater surrounds of the Study area is predominately agricultural and mining. In addition, there are coal seam gas (CSG) developments proposed in the area. These land uses are discussed in the sections below.

3.3.1 Agriculture

Agricultural activities include dry land cropping, cattle grazing and cropping (mainly irrigated cotton growing). In the vicinity of the Project, two areas of regional interest from the Regional Planning Interests Act 2014 (Qld) area applicable:

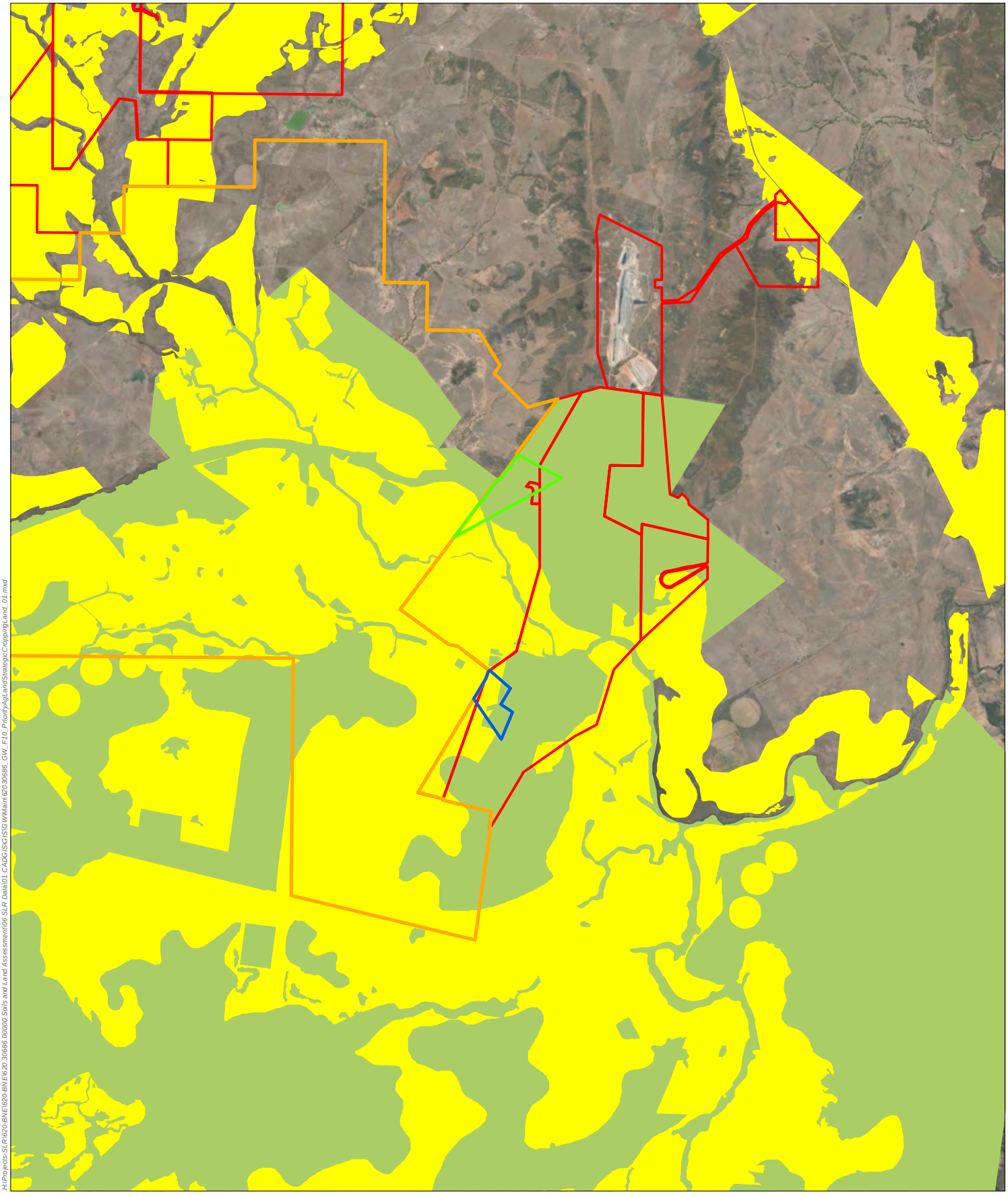
- Priority agricultural areas (PAAs).
- Strategic cropping areas (SCAs).

A PAA is an area of regionally significant agricultural production in which at least one area must be used for priority agricultural land use (PALU). PALUs applicable to the area are summarised in Table 2. PAAs and SCAs located in the Study area are mapped on Figure 10.

Table 2 Priority agricultural land use in the Central Queensland regional plan area

3 Production from dryland agriculture and plantations	4. Production from irrigated agriculture and plantations	5. Intensive uses
3.3.0 Cropping 3.4.0 Perennial horticulture 3.5.0 Seasonal horticulture	4.1.0 Irrigated plantation forestry 4.2.0 Grazing irrigated modified pastures 4.3.0 Irrigated cropping 4.4.0 Irrigated perennial horticulture 4.5.0 Irrigated seasonal horticulture 4.6.0 Irrigated land in transition	5.1.0 Intensive horticulture

In addition to the PAA, the Study area is located within the SCA Western Cropping zone. SCAs are land that is deemed highly suitable for cropping because of a combination of the soil, climate and landscape features (DILPG, 2014).



H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GIS\GWMain\620.30686_GW_F10_PriorityAgLandStrategicCroppingLand_01.mxd

0 5 km

GROUNDWATER IMPACT ASSESSMENT

Priority Agricultural Areas and Strategic Cropping Land in the vicinity of the project

Figure 10

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Zone 2
- Zone 3
- Mineral Development Licence (MDL) 217
- Mining Lease
- Strategic Cropping Land
- Priority Agricultural Land

SLR

3.3.2 Mining adjacent to the Project

The Project is located in an existing mining precinct with several coal mines operating nearby. Table 3 lists operating and proposed mines in a radius of 50 km from Ensham mine. Mine operations located within 30 km from the site are detailed in Section 3.3.2.1 to Section 3.3.2.3. All these mines target different coal seams than those targeted by the Project. As such, that cumulative impacts are not expected due to the interbedded low permeability layers (aquitards) separating the coal seams (refer to Section 4.4).

The mines located further than 30 km from Ensham mine are listed in Table 3, but are not discussed further. Of the six mines further than 30 km away, five are targeting the Rangal Coal Measures (same Coal Measures as the Project), however, the distance means it unlikely that cumulative impacts will occur. The groundwater model therefore did not include any other mining operations.

Table 3 Proposed and current mining operations within 50 km from the Project

Mine	Status	Type	Planned Start	Planned End	Distance from Project (km)	Target Coal	Surface water Catchment
Wilton	Proposed	Open-cut	2019	TBD	15	Fairhill Coal Measures	Upper Mackenzie
Kestrel	Operating	Underground	1992	2032	20	German Creek Coal Measures	Nogoa
Gregory Crinum	Operating	Open-cut and underground	1979	TBD	25	German Creek Coal Measures	Nogoa
Fairhill	Proposed	Open-cut	2019	TBD	25	Fairhill Coal Measures	Upper Mackenzie
Oaky Creek	Operating	Open-cut and underground	1982	2033	35	German Creek Coal Measures	Upper Mackenzie
Curragh	Operating	Open-cut	1983	2025	40	Rangal Coal Measures	Upper Mackenzie
Jellinbah	Operating	Open-cut	1989	TBD	45	Rangal Coal Measures	Upper Mackenzie
Blackwater	Operating	Open-cut	1967	2040	40	Rangal Coal Measures	Upper Mackenzie
Yarrabee	Operating	Open-cut	1982	TBD	40	Rangal Coal Measures	Upper Mackenzie
Grasstree	Operating	Underground	2002	2047	45	German Creek Coal Measures	Upper Mackenzie
Foxleigh	Operating	Open-cut	1999	2028	50	Rangal Coal Measures	Upper Mackenzie

3.3.2.1 Gregory Crinum and Kestrel

The Gregory Crinum and Kestrel mines are located 25 km and 20 km north-west of the Project, respectively. Both operations target the German Creek Coal Measures that underlie the Rangal Coal Measures targeted at Ensham mine.

Sojitz recently acquired the Gregory Crinum Mine (GCM), previously owned and operated by BHP Mitsubishi Alliance (BMA). Gregory open-cut mining operations commenced in 1979 while the Crinum underground mining operation started in 1997. The mine ceased production and was placed on care and maintenance by BMA in November 2015. Sojitz has resumed operations in October 2019.

The Kestrel Mine, owned by Kestrel Coal Resources and Mitsui Investments, is an underground coal mine which currently produces 7-8 Mtpa of predominantly hard coking and some thermal coal and more than 5 Mtpa of product. Mine life is currently estimated at 35 years with 2017 reserves of 146 Mt and resources of 241 Mt (QRC, 2019).

Both GCM and Kestrel share the same numerical groundwater flow model. According to the 2015 model update by AGE (2015), the maximum extent of drawdown in all hydrogeological units was predicted to be less than 15 km from the two mines. Therefore, as the mines are located over 20 km from the Project and are mining the Coal Seams in the German Creek Coal measures, there is limited potential for cumulative impacts.

3.3.2.2 Wilton

The Wilton Coal Project (WCP) is a proposed open-cut coal mine located 15 km north-east of the Project. WCP aims to excavate the high ash coal of the Burngrove Formation (Burngrove Seam), which will be trucked to established mining facilities at GCM for processing. Approximately 1.65 Mtpa of export quality thermal and coking coal products is expected to be produced from the WCP.

An analytical model developed by Northern Resources Consultant (NRC, 2018) predicted that some private bores intersecting the Burngrove Formation could be impacted by the WCP (Table 4).

Table 4 Predicted drawdown at private bores from the Wilton Coal Project

Registered RN (ID)	Bore name	Easting (mMGA)	Northing (mMGA)	Bore depth (m)	Use	Geology	Predicted drawdown from WCP (m)
89383	Yongala	657586	7415693	74	Stock	Burngrove Formation	1.9
89382	-	657253	7415184	74	Stock	Burngrove Formation	1.4
89384	-	657691	7416083	78	Stock	Burngrove Formation	2.6

The WCP targets the Burngrove Formation, which underlies the Rangal Coal Measures targeted at the Ensham mine. Due to the structural geology, discussed further in Section 4, the Rangal Coal Measures are absent at the WCP. Therefore, there is limited potential for cumulative impacts between the WCP and the Project.

3.3.2.3 Fairhill

The Fairhill Coal Project (FHCP) is located 25 km north-east of the Project. The FHCP tenement covers a total exploration area of approximately 3,045 ha. The FHCP is a proposed open-cut mine, proposed to produce a maximum of 1.7 Mtpa of primarily coking coal extracted from coal seams of the Fairhill Formation, which underlies the Burngrove Formation.

Mining operations proposed at the FHCP site are scheduled to last for seven years and will include the development of a shallow greenfield open-cut mine targeting coal from the Fairhill 1 and 2 coal seams. The operation will be by cut and fill method, with the mine excavation progressing from east to west. The pit will reach a minimum elevation of 130 mAHD, leaving a final void 20 m to 30 m deep.

A 2D numerical groundwater flow model was developed by SLR for the FHCP (SLR, 2019a). The model predicts a drawdown radius of 4.5 km from the open-cut pit. The groundwater assessment findings for FHCP and the geology of the site indicates there is no potential for cumulative impacts between the FHCP and the Project.

3.3.3 Petroleum

Exploration permits of varying types were identified within the Study area. Table 5 identifies the allocation type, permit number, holder of these existing permits and if the permit intersects Zone 2 and 3. The location of those permits is also shown on Figure 1.

The target coal seams for ATP 806 and associated PCA 170 are the Rangal Coal Measures, the same as targeted by the Project (Golder, 2017). The exact location of the potential CSG extraction wells is unknown.

For ATP 1177 and associated PCA 153 and 154, two well completion and abandonment reports were identified on GeoResGlobe (GeoResGlobe, 2020). These reports showed that two exploration wells were drilled into the Bandanna Formation (an equivalent for the Rangal Coal Measures), where they ended. As these coal measures are the shallowest of the Blackwater Group, it is interpreted that the potential future CSG wells would target the same coal seams as the Project.

Table 5 Exploration permits across the Study area

Allocation type	Permit Number	Purpose	Expiry date	Holder	Intersects Zone 2 and 3
Authority to Prospect	ATP 806	Petroleum	16 July 2022	Ome Resources Australia Pty Ltd (75%) and CNOOC Coal Seam Gas Company Pty Ltd (25%)	Zone 2
Potential Commercial Area - Petroleum	PCA 170	Petroleum	16 July 2022	Ome Resources Australia Pty Ltd (75%) and CNOOC Coal Seam Gas Company Pty Ltd (25%)	Zone 2
Authority to Prospect	ATP 1177	Petroleum	30 November 2021[1]	Denison Gas (Queensland) Pty Ltd	No
Potential Commercial Area – Petroleum	PCA 153	Petroleum	25 June 2029	Denison Gas (Queensland) Pty Ltd	No
Potential Commercial Area – Petroleum	PCA 154	Petroleum	25 June 2029	Denison Gas (Queensland) Pty Ltd	No

Notes: 1 ATP has expired by the time the report was issued.

4 Geology

The Project is located in the geological western Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin is the largest productive coal basin in the country. It stretches from Townsville to south of the Queensland-New South Wales border, in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap. The Rewan Formation is recognised as the base aquitard of the GAB (Habermehl, 1980 and 1998). An aquitard is defined as a geologic formation or stratum that lies adjacent to an aquifer and that allows only a small amount of liquid to pass. In the Study area, the Rewan Group is present at subcrop.

The stratigraphic sequence across the Study area comprises unconsolidated Quaternary aged sediments unconformably overlying consolidated Permian and Triassic aged sequences (Figure 11). The Permian and Triassic strata form regular layered fluvio-deltaic sedimentary sequences, while the Quaternary sediments are more complex and irregular. The coal deposits mined at Ensham mine are found within the Rangal Coal Measures, which is the uppermost Permian unit (Figure 12).

The surface geology of the Study area is dominated by the Nogoa River alluvium to the south and the Tertiary Sediment to the south and the north (Figure 11).

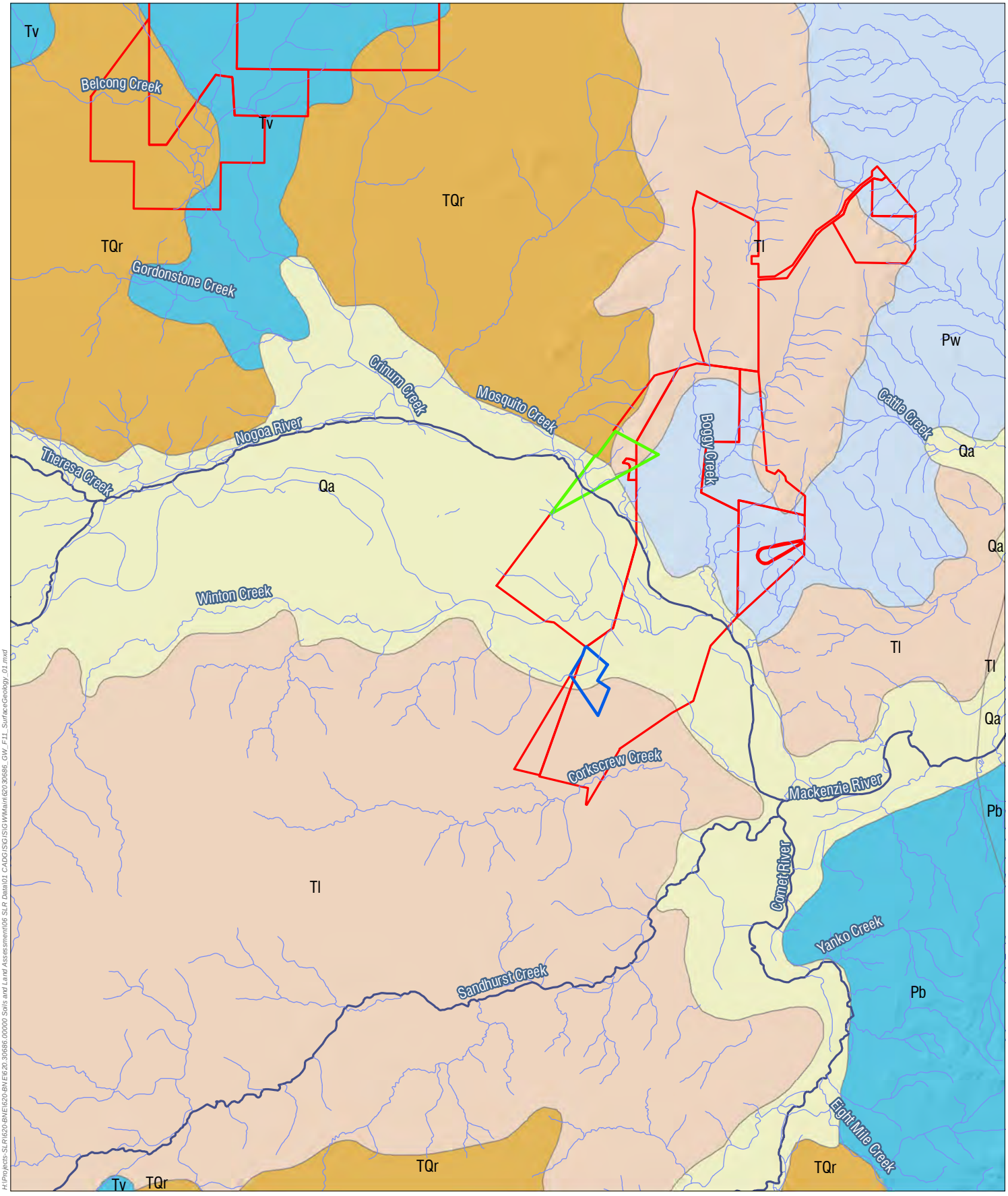
Table 6 provides a summary of the stratigraphy encountered in the Study area. Discussion on each of the main stratigraphic units relevant to the Project is included in Section 4.1 and Section 4.4, and details on the structural geology provided in Section 4.5. Appendix A presents the interpolated extent and thickness of all formations as well as the elevation of the base of each layer for the greater Ensham mine area.

Table 6 Summary of stratigraphy in the Study area

Age	Unit	Max Thickness[1] (m)	Description
Quaternary	-	25	Alluvium - silt, clay, sand and gravel
Tertiary	-	ND	Duricrusted palaeosols at the top of deep weathering profiles, including ferricrete and silcrete; duricrusted old land surfaces
	Emerald Formation	50	Fluviatile and lacustrine claystone and siltstone, quartzose sandstone, pebbly sandstone, gravel, lignite, oil shale, interbedded basalt; all deeply weathered in outcrop
	Basalt	ND	Tertiary volcanics (basalt) mapped as being present over 10 km west of the site
Triassic	Rewan Group	200	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at base); deposited in a fluvial-lacustrine environment
Permian	Rangal Coal Measures	125	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. Coal seams include the Aries, Castor, Pollux and Orion seams. The main economic seams at Ensham are the Aries 2 and Castor seams. Deeper seams include the Pollux and Orion seams.
	Burngrove Formation	200	Sandstones, siltstones and mudstones, and banded coal seams frequently interbedded with tuff and tuffaceous mudstones - coal seams include the Virgo and Leo seams
	Fair Hill Formation	150	Lithic and feldspathic labile sandstone, siltstone, mudstone and conglomerate
	Macmillan Formation	100	Lithic and feldspathic sublabile mudstone, siltstone and sandstone

[1] Approximate maximum thickness based on available exploration holes and/or relevant literature

ND: not defined, not enough data available



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F11_SurfaceGeology_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

Legend

- Major Watercourse
- Minor Watercourse
- Mining Lease
- Zone 2
- Zone 3

Surface Geology

Quaternary
- Quaternary alluvium (Qa)

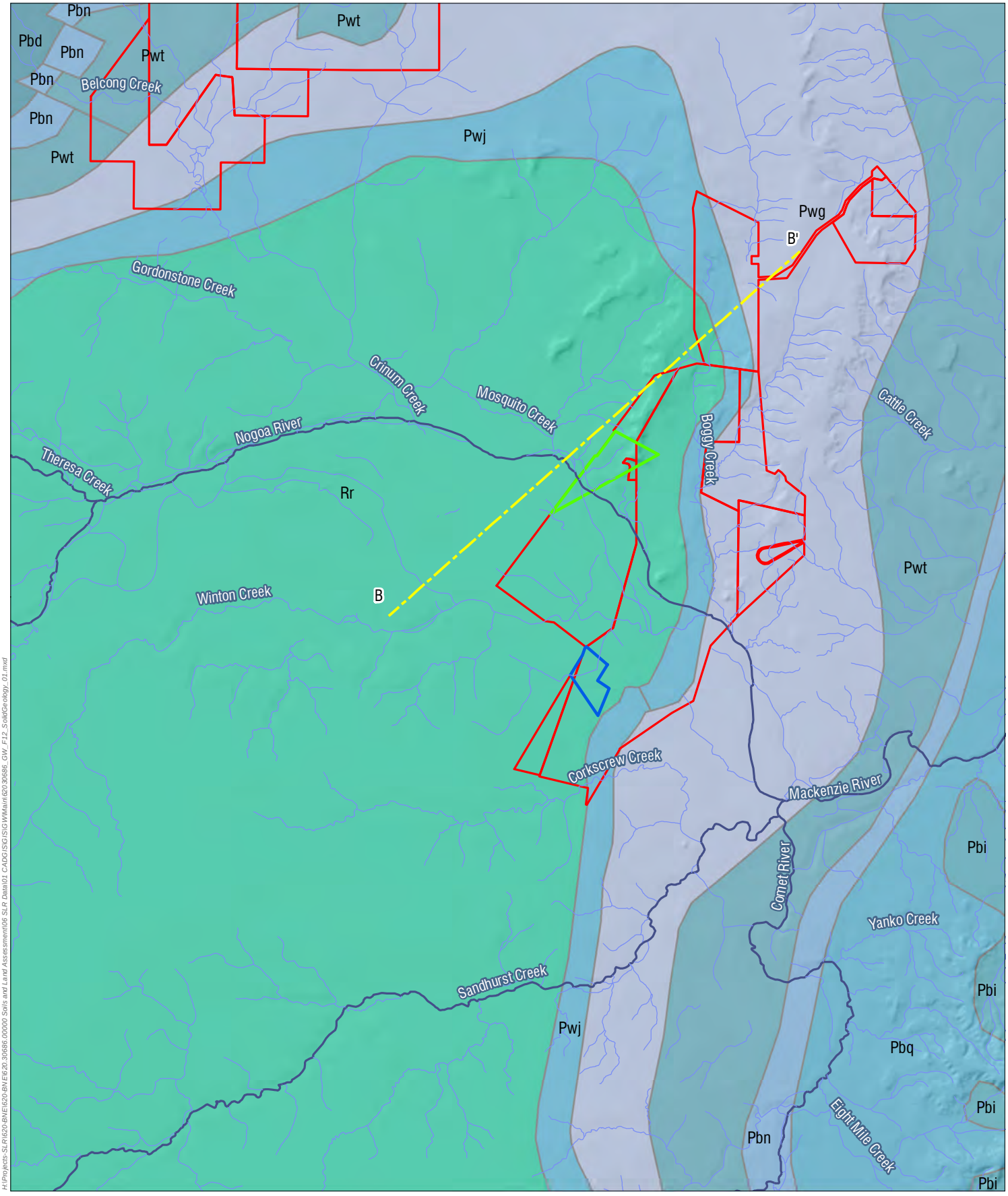
Tertiary
- Paleocene-Oligocene sediments (Tl)
- TQr-QLD (TQr)

Permian
- Blackwater Group (Pw)
- Back Creek Group (Pb)

GROUNDWATER IMPACT ASSESSMENT

Surface Geology

Figure 11



H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F12_SolidGeology_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	630.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

Legend

- Cross section
- Major Watercourse
- Minor Watercourse
- Zone 2
- Zone 3
- Mining Lease

Solid Geology

- Burngrove Formation (Pwg)
- Crocker Formation (Pbq)
- Fair Hill Formation,Fort Cooper Coal Measures (Pwt)
- German Creek Formation (Pbd)
- Ingelara Formation,Maria Formation (Pbi)
- MacMillan Formation (Pbn)
- Rangal Coal Measures (Pwj)
- Rewan Group (Rr)

GROUNDWATER IMPACT ASSESSMENT

Solid Geology

Figure 12

4.1 Quaternary alluvium

The Quaternary age alluvial sediments unconformably overlie the Triassic age Rewan Group and Permian age coal measures. A weathering surface is evident at the unconformable contact.

Within the Nogoa River floodplain, the alluvial sequence comprises silt and clay underlain by a basal unit of sand and gravel. The alluvium is itself overlain by a deep clay-rich black soil, which tends to be highly absorbent during rainfall events. The alluvial sequence varies in thickness, with a maximum observed depth of 25 m.

4.2 Tertiary age sediments

Tertiary formations include the duricrusted paleosols on top of deep weathering profiles (labelled as “Tertiary QLD” in the state geology database, accessed via QLD Globe) and the Emerald Formation. The Emerald Formation primarily consists of fluviatile and lacustrine claystone, siltstone, sandstone and mudstone, all deeply weathered in outcrop. Tertiary age volcanics (basalt) are mapped as being present over 10 km west from the site (Hydrosimulations, 2018).

4.3 Triassic age Rewan Group

The Rewan Group overlies the Permian coal measures and occurs as in-fill material, thickening to the west with the dip of the coal measures and thin to the east where the coal measures occur at outcrop (Figure 47). Where present, the Rewan Group has a distinct greenish tint in colour (non-marine deposits containing glauconite) and is composed of siltstone and mudstone, with interbeds of lithic and volcanic sandstones.

Based on exploration holes and groundwater bore holes, the Rewan Group is not expected to be more than 200 m thick in Study area. Across the Project it is between 50 m and 150 m thick. The Rewan Group forms an aquitard between the coal and the alluvium.

4.4 Permian Rangal Coal Measures

The Rangal Coal Measures consist of interbedded sandstone, siltstone, mudstone, and coal with tuff (towards the base) and have a thickness of up to 100 m in the Study area. The coal seams outcrop / subcrop over a strike length of about 80 km in north-south direction at the Ensham mine to the east of the Project. To the north, the outcrop / subcrop changes direction and is showing east to west. The shape of the outcrop / subcrop can be seen on Figure 12. It forms part of the syncline basin plunging to the south-west.

The coal seams targeted at Ensham mine include the Aries A1 Seam, Aries 2-Castor Seam (A2C) which has combined average thickness of 4.3 m, and the Castor Seam Lower Split (C22) which is between 0.2 m and 0.4 m thick. The seams are separated by a mudstone parting that varies between 0.1 m and 0.4 m in thickness. The Pollux Seam is a banded seam and is only mined within the Yongala (Y Pit) where it is close to the C22 Seam (AGE, 2006).

The targeted seams for the Project are the thickest Aries and Castor Seams (A2C1, A2C, A3C, A22C and A22C1) and Castor Seam (where the Aries seams thin out). A schematic representation of the coal seam stratigraphy across the area studied by (Gordon Geotechniques, 2016) is presented on Figure 13.

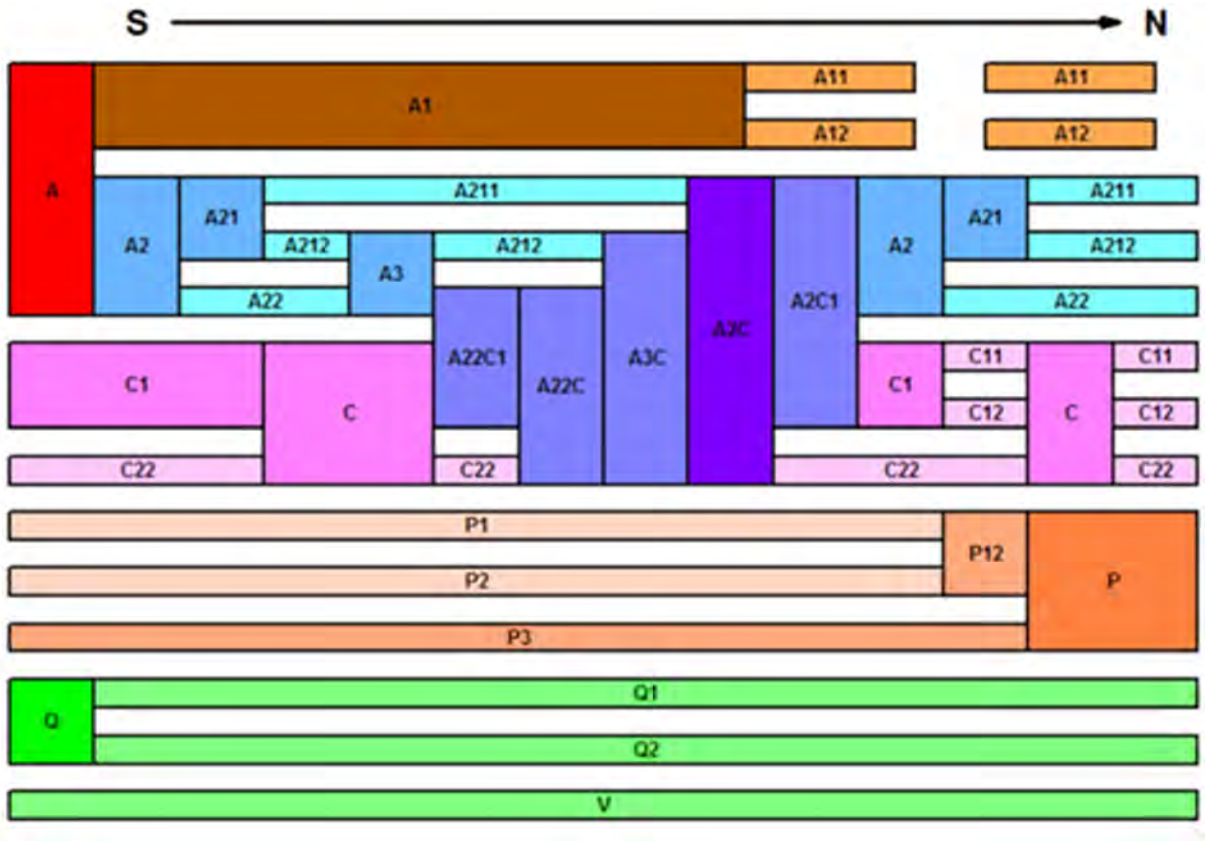


Figure 13 Coal seam stratigraphy of the Rangal Coal Measures

4.5 Structural geology

The structural geology of the Bowen Basin includes major north-west to south-east trending faults, like the Jellinbah Fault and Yarrabee Fault located over 40 km east of the Project. However, no regional-scale faults have been mapped within the Study area.

The Permian age lithostratigraphy at Ensham mine outcrops on the eastern side of a syncline structure that is plunging to the south-west (Figure 12).The Permian and Triassic sediments, intersected within the Ensham open-cut, dip in a westerly direction at generally less than five degrees towards the synclinal axis.

There is limited mapped information available with regards to faults in the region. AGE (2006) reported that, where present, faulting is generally normal, trending east to west, to south-east to north-west, with throws of less than 10 m, although occasional low angle thrust faulting has been noted. The local faults (AGE, 2017) are presented on Figure 15 in Section 5.2.2.

5 Hydrogeology

The principal groundwater bearing strata in the Study area are associated with the Permian coal seams and the Quaternary alluvium. The siltstones and sandstones that make up the majority of the overburden are considered aquitards.

This section discusses each of the hydrogeological units relevant to the Project, describing groundwater hydrology (groundwater occurrence, hydraulic gradients, recharge and discharge), hydraulic properties, groundwater quality and groundwater use and management. The existing conceptual model (SLR, 2020 and SLR, 2021) for the Study area was refined with the most recent groundwater monitoring dataset.

5.1 Current groundwater monitoring

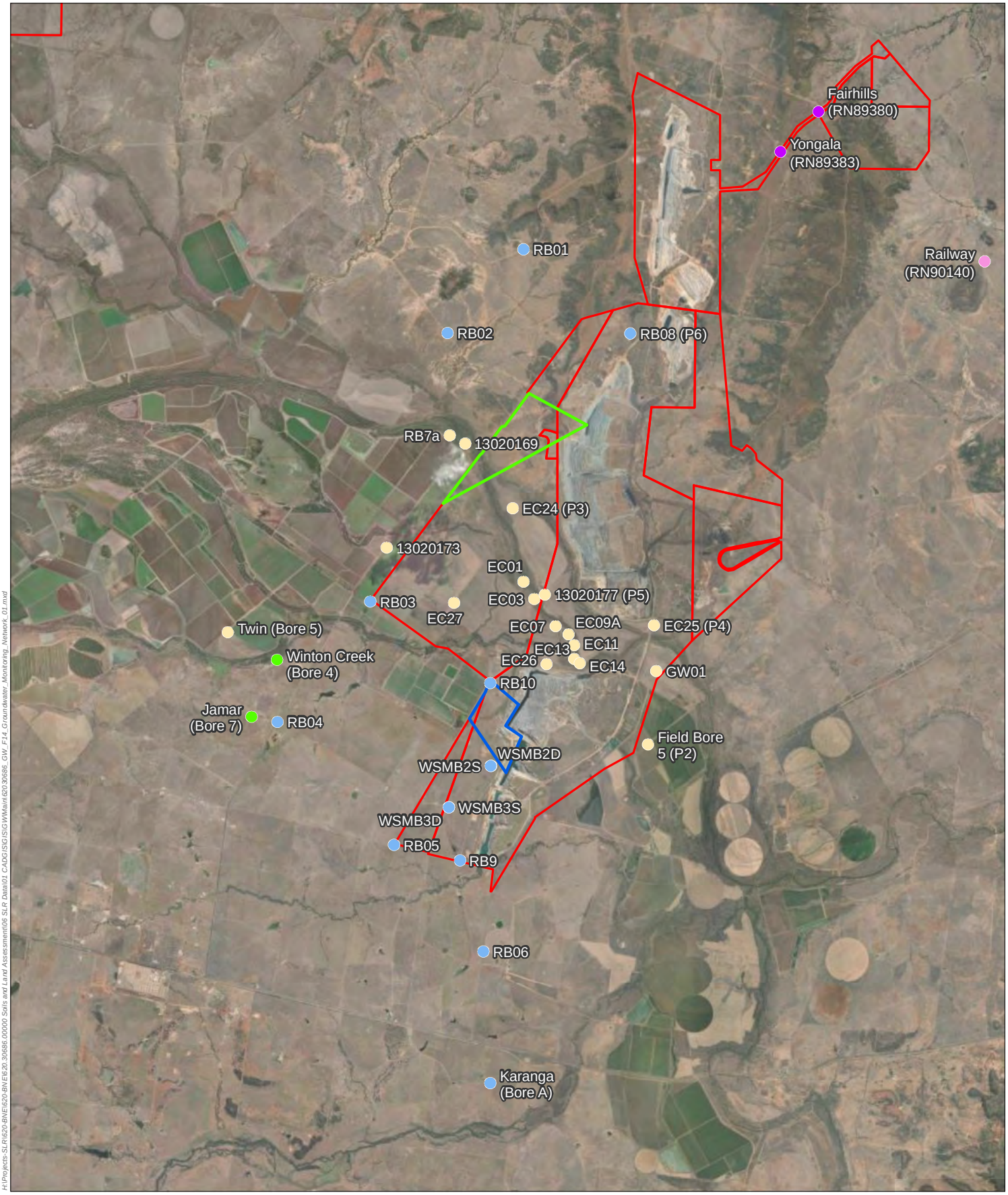
The existing mining activity at Ensham mine is operating under EA permit EPML00732813, which specifies a groundwater monitoring program. This groundwater monitoring program is presented in Table C10 of the current EA) and reproduced in Table 7, together with bores that are not part of the EA, but are monitored for operational or investigative purposes. The locations of the bores listed in Table 7 are presented in Figure 14.

Table 7 Monitoring network

EA location	Monitoring Point	Longitude	Latitude	TOC elevation (mAHD)	Screen Interval (mBGL)	Aquifer
Nogoa River Alluvium	EC01	148.46894	-23.47564	154.3	14-17	Alluvium
Nogoa River Alluvium	EC03	148.47213	-23.48024	153.2	12.3-15.3	Alluvium
Nogoa River Alluvium	EC07	148.47842	-23.48741	153.9	12.6-15.6	Alluvium
Nogoa River Alluvium	EC09A	148.48218	-23.48956	153.5	15.1-18.1	Alluvium
Nogoa River Alluvium	EC11	148.48380	-23.49236	152.7	14.3-17.3	Alluvium
Nogoa River Alluvium	EC13	148.48385	-23.49612	152	12.2-15.2	Alluvium
Nogoa River Alluvium	EC14	148.48542	-23.49721	146.1	8.7-11.7	Alluvium
Nogoa River Alluvium	GW01	148.50747	-23.49908	153	To 19.8	Alluvium
Residual void bore	WSMB2S	148.46012	-23.52475	173	43 - 49	Rangal Coal Measures Overburden
Residual void bore	WSMB2D	148.46009	-23.52475	173	97 - 107	Rangal Coal Measures (Coal Seam)
Residual void bore	WSMB3S	148.44814	-23.53586	174	6.0-21.0	Rangal Coal Measures Overburden
Residual void bore	WSMB3D	148.44814	-23.53588	174	60 - 72	Rangal Coal Measures (Coal Seam)
Residual void bore	Field Bore 5 (P2)	148.50532	-23.51853	151.22	Unknown, bore depth 27.6	Alluvium
Residual void bore	EC24 (P3)	148.46562	-23.45621	156.62	13-16	Alluvium
Residual void bore	EC25 (P4)	148.50678	-23.48696	150.817	12.5-15.5	Alluvium
Residual void bore	13020177 (P5)	148.47523	-23.47912	154.37	14.9-15.9	Alluvium

EA location	Monitoring Point	Longitude	Latitude	TOC elevation (mAHD)	Screen Interval (mBGL)	Aquifer
Residual void bore	RB08 (P6)	148.49898	-23.40952	187.212	104.5-107.5	Coal seam (not specified)
Regional bores (Ensham mine)	RB01	148.46797	-23.38737	187.73	95.5-97.0	Rangal Coal Measures Coal (A2C)
Regional bores (Ensham mine)	RB02	148.44638	-23.40987	160.6	149-153m	Rangal Coal Measures Coal
Regional bores (Ensham mine)	RB03	148.42485	-23.48143	156.49	137.5-143.5	Rangal Coal Measures Coal (A2C)
Regional bores (Ensham mine)	RB04	148.39852	-23.51356	175.89	205.25-208.25	Rangal Coal Measures Coal (A21)
Regional bores (Ensham mine)	RB05	148.43241	-23.54595	173.35	237.1-240.1	Rangal Coal Measures Coal (A21)
Regional bores (Ensham mine)	RB06	148.45845	-23.57410	177.06	227.3-230.3	Rangal Coal Measures Coal (A2C)
Regional bores (Ensham mine)	RB9	148.45142	-23.54991	163.694	96-99	Coal seam (not specified)
Regional bores (Ensham mine)	RB10	148.45969	-23.50267	157.19	149-153	Coal seam (A22)
Regional bores (Private Property)	Karanga (Bore A)	148.46087	-23.60897	172.97	54-60	Coal Measures (not specified)
Regional bores (Private Property)	Winton Creek (Bore 4)	148.39822	-23.49707	157.31	To 60	Rewan Group
Regional bores (Private Property)	Twin (Bore 5)	148.38392	-23.48989	158.39	To 18	Basal Alluvium
Regional bores (Private Property)	Jamar (Bore 7)	148.39107	-23.51226	183.43	To 90	Rewan Group
Regional bores (Private Property)	Yongala (RN89383)	148.54170	-23.36085	266	65 - 71	Burngrove Formation
Regional bores (Private Property)	Fairhills (RN89380)	148.55243	-23.35005	265	42 - 54	Burngrove Formation
Regional bores (Private Property)	Railway (RN90140)	148.60078	-23.38936	181	18 - 61	Fair Hill Formation
Additional (not in EA)	EC26	148.47595	-23.49749	153.449	10-13	Alluvium
Additional (not in EA)	EC27	148.44902	-23.48145	154.414	12.5-15.5	Alluvium
Additional (not in EA)	RB7a	148.44732	-23.43707	157.08	9-15	Alluvium
Additional (not in EA)	13020166	148.32675	-23.44064	161.87	15.2-17	Alluvium
Additional (not in EA)	13020169	148.45170	-23.43911	156.22	14-15.8	Alluvium
Additional (not in EA)	13020173	148.42945	-23.46697	155.43	9.2-11.20	Alluvium

mBGL – metres below ground level



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CADGIS\GIS\GWMain\620306686_GW_F14_Groundwater_Monitoring_Network_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:150,000

Project No.:	630.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Zone 2
- Zone 3
- Mining Lease

Monitoring Network by Aquifer

- Alluvium
- Rewan Group
- Rangal Coal Measures
- Burngrove Formation
- Fair Hill Formation

GROUNDWATER IMPACT ASSESSMENT

Groundwater Monitoring Network

Figure 14

5.2 Hydraulic properties

5.2.1 Hydrogeological units

Reported hydraulic and storage properties of key formations in the broader Bowen Basin have been gathered from various sources and summarised in Table 8. Not unexpectedly, there is a very wide range of values in each formation. Table 8 lists the horizontal hydraulic conductivity (Kh), the vertical hydraulic conductivity (Kv), the specific yield (Sy) and the specific storage (Ss).

Coffey (2014) compiled packer testing data from mines in the northern Bowen Basin and found that although there was a degree of variability in the dataset due to irregular fracturing, there is a general trend of reducing hydraulic conductivity with depth. This is likely due to increasing overburden pressure resulting in a reduction in fracture aperture with depth. Hydraulic conductivity of the coal seams is typically three times higher than that of the interburden.

A historic study by AQC-Pacific Pty Ltd (1986) found that the horizontal hydraulic conductivity of the Castor Seam ranged between 0.3 m/day and 5.9 m/day. A study was also conducted by Sigra in 2013 at Ensham mine, involving packer testing of two exploration holes that intersect the Rangal Coal Measures at Ensham mine, C4878 and C4879. The results indicate that hydraulic conductivity within the A22 and A2C seam can range between 0.07 m/day and 0.2 m/day at depths greater than 88.5 m below surface.

Table 8 Summary of adopted hydraulic properties from other Bowen Basin studies

Age	Formation	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	Source
Quaternary	Alluvium	1.00E+00 to 4.00E+01	1.00E-01 to 2.50E+01	5.00E-02 to 1.80E-01	5.00E-04	2
		1.00E+02	1.00E+01	2.50E-01	1.00E-03	1
		7.00E-01 to 1.50E+00				3
		1.00E+01	1.00E+00	2.00E-01	1.00E-04	7
		8.80E-02 to 3.80E-01				5
		1.00E+01	1.00E+00	1.00E-01	1.00E-05	10
			3.80E-01 to 8.40E+00			12
		1.50E+00	3.80E-01	1.20E-01	8.60E-06	14
		1.00E+00				15
		7.00E-03 to 4.20E+00				16
		2.00E-02	4.00E-03			15

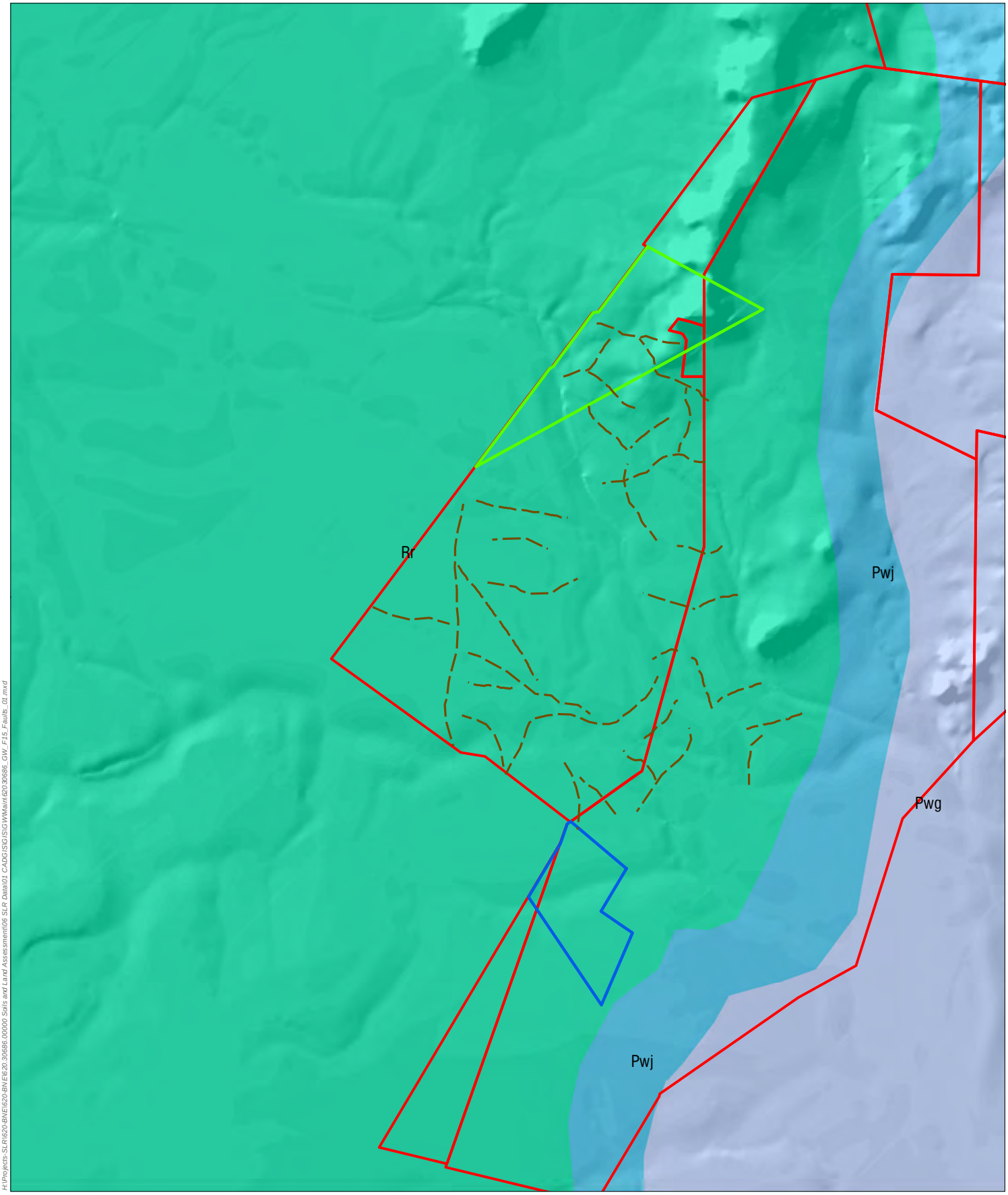
Age	Formation	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	Source
Tertiary	Basalt	1.00E-01 to 1.00E+01	5.00E-03 to 1.00E+00	5.00E-02 to 2.00E-01	5.00E-07 to 5.00E-05	2
		6.10E-03 to 6.20E-01				13
		1.10E-01				16
		5.00E-01	1.00E-01			15
	Undifferentiated Tertiary Sediments	4.30E-01				13
		5.00E-01	1.30E-01	5.00E-02	8.60E-06	14
		1.00E-02	2.00E-03			15
Triassic	Rewan Group	1.00E-05 to 1.00E-04	1.00E-06 to 1.00E-04	5.00E-03	1.00E-06	1
		1.00E-01		5.00E-02	5.00E-06	6
		1.00E-04	1.00E-05	1.00E-02	1.00E-05	10
		3.60E-04	7.40E-06			11
		1.30E-05 to 2.70E-03	5.80E-09	3.00E-05		12
			2.20E-08			13
		5.00E-04 to 5.00E-02	1.00E-07 to 1.00E-04	1.00E-01 to 2.50E-01	5.00E-06 to 5.00E-04	2
		2.00E-03	5.00E-04			14
		1.00E-03	2.00E-04	3.00E-02	8.60E-06	15
		9.00E-04	5.40E-05			9
Permian	Rangal Coal Measures – coal seams	2.80E-03 to 4.70E-02				4
		1.00E-05 to 5.00E-02	5.00E-04 to 5.00E-03	0.01 to 0.12	5.0E-6 to 5.0E-4	2
		1.00E-02	2.50E-03	5.00E-02	8.60E-06	14
		2.00E-05 to 2.30E+00	2.00E-06 to 1.00E-01			15
						3
		1.00E-06 to 1.00E+00	1.00E-06 to 1.00E+00	1.00E-02	1.00E-06	1
		1.10E-01 to 9.00E-01		8.00E-02	4.00E-04	7
		5.00E+00		5.00E-02	5.00E-06	6
		5.00E-02	5.00E-03	1.00E-02	1.00E-05	10
		9.00E-04	1.80E-05			9
	Rangal Coal Measures - Interburden	1.00E-04	7.00E-08	5.00E-02	1.00E-05	2
		1.20E-01	3.00E-02	3.00E-02	8.60E-06	14

Age	Formation	Kh [m/d]	Kv [m/d]	Sy	Ss [m^{-1}]	Source
		2.00E-05 to 2.00E-02	2.00E-05 to 2.00E-03			15
		1.00E-01		5.00E-02	5.00E-06	6
		1.00E-03	1.00E-05	1.00E-02	1.00E-05	10
1: AGE (2006); 2: Ausenco-Norwest (2012); 3: JBT (2012); 4: Parsons Brinckerhoff (2011); 5: URS (2009); 6: BHP Billiton Mitsubishi Alliance (2009); 7: Matrix Plus (2010); 9: AGE (2013); 10: CDM Smith (2013); 11: GHD (2013); 12: OGIA (2016); 13: Coffey (2014); 14: JBT(2016); 15: KCB (2016); 16: AGE (2016)						

5.2.2 Faults

Faults can increase permeability within strata parallel with the fault plane, and lower permeabilities within strata perpendicular to the fault plane (Jourde et al. 2002). Coffey (2014) developed a conceptual model for fault zone hydraulic characterisation in the Bowen Basin. The study found that strata perpendicular to the fault plane recorded a hydraulic conductivity one to three orders of magnitude lower than the regional host rock, and the damage zone (parallel to the fault plain) approximately one order of magnitude higher. However hydraulic conductivity within the damage zone is also dependent on timing, with hydrothermal alternation and mineralisation filing the fractured pore space over time (Paul et al. 2009; Uysal et al. 2000).

The Project targets Permian aged coal seams within the Bowen Basin, where faulting has been inactive for over 140 million years (Clark et al. 2011). No regional-scale faulting has been mapped according to basement geology mapping (refer to Section 4.5). However, site observations indicate that there is local faulting in the currently approved MLs (Figure 15). These faults (AGE, 2017) have been included in the groundwater model (refer to Section 6.4.2) as low permeability zones.



H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F15_Faults_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:75,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Faults
- Zone 2
- Zone 3
- Mining Leases

Solid Geology

- Rewan Group (Rr)
- Rangal Coal Measures (Pwj)
- Burngrove Formation (Pwg)

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Local faults

Figure 15

5.3 Groundwater levels, flow, recharge and discharge

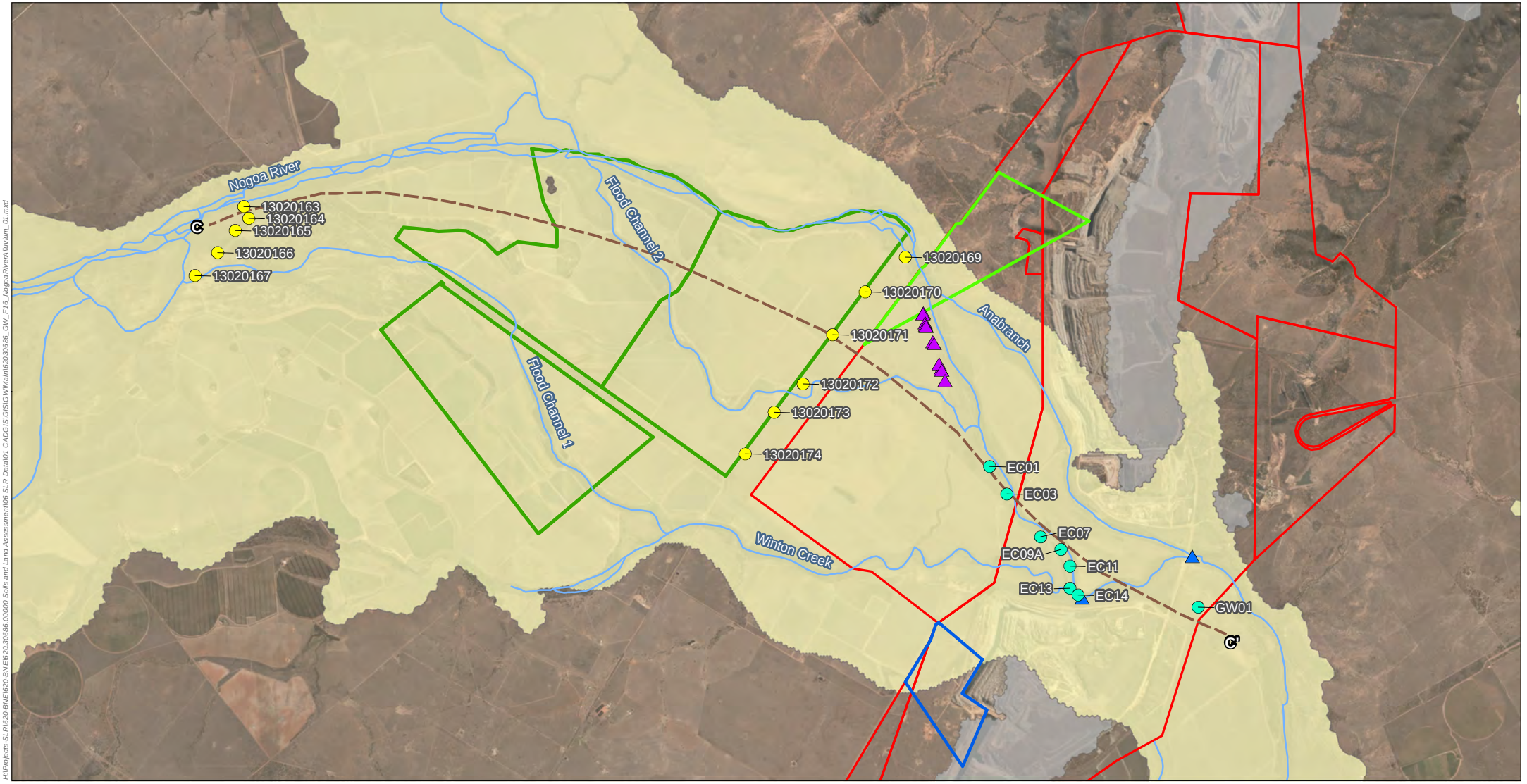
5.3.1 Quaternary sediments (alluvium)

5.3.1.1 Water levels

Nogoa River is conceptualised as having a limited connectivity to the alluvial groundwaters. To understand the dynamics of the groundwater interactions with Nogoa River, three sets of plots have been prepared for the following bores:

- Department of Resources bores RN13020163-13020167, located upstream of irrigation area, close to Nogoa River.
- Department of Resources bores RN13020169-13020174, located downstream of irrigation area, 13020169 located closest to Nogoa River, 13020174 located furthest from river, all bores upstream of current Ensham mine.
- EC-Bores series, located closer to Ensham mine, encompassing the sub-crop of the Rangal Coal measures.

Refer to Figure 16 for the location of the bores in relation to the surface water features, irrigation extent, alluvial extent, mining leases and Rangal Coal measures sub-crop.



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:100,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Existing Bore
- Nogoa River Spring
- Alluvial Bore
- Release Point
- Cross Section
- Watercourse
- Coal Outcrop/subcrop
- Alluvium
- Irrigation area
- Zone 2
- Zone 3
- Mining Lease

SLR

GROUNDWATER IMPACT ASSESSMENT

Nogoa River Alluvium

Figure 16

H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F16_NogoaRiverAlluvium_01.mxd

Upstream Bores

Water level data for bores RN1320163 to RN 1320166 are accessed via the Queensland Groundwater Database, (Department of Regional Development, Manufacturing and Water). The bores upstream of the irrigation and mine are deemed to reflect the natural interaction between the Nogoa River alluvium and Nogoa River. Particularly the time before 2000 is considered reflective of natural conditions, as no other anthropogenic impacts to the area were apparent at that time.

Nogoa River was subject to three flood events (January 1996: moderate, September 1998 and January 1999: minor, also refer to Figure 9). The bore closest to the river, RN13020163, was dry during that period and shows no response to the increased water level in the river. Bore RN13020164, second closest to the river, does not show any response to the moderate flood even in January 1996, however, this bore shows a continual rise in water level between 1997 and 2008. In 2008, there was a major flood event in January 2008 and this bore shows a response with a rise of groundwater levels of approximately one metre. All other bores stayed dry up to 2008 and then showed increasing water level (evidenced by only one round of observation in 2018).

Monitoring ceased in 2008 and there was another round of water level observations in 2018. In 2018, all of the bores showed an increased water level compared to the levels observed at the start of monitoring in 1995. The increase was overall approximately 2m for all bores and 4 metres for RN13020164. Section 5.3.1.3 further discusses how Nogoa River interacts with the alluvium.

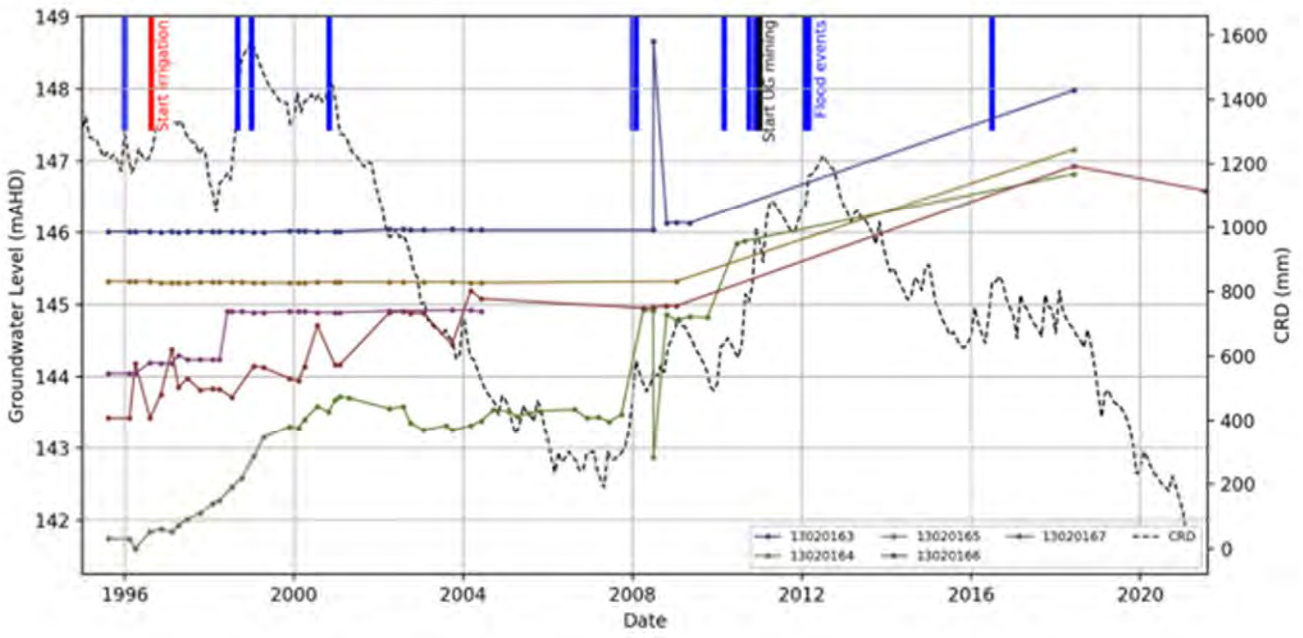


Figure 17 Hydrographs for upstream bores

Bores near Zone 2

Similar to the upstream bores, the bores RN13020169 to RN13020174 (Queensland Groundwater Database, Department of Regional Development, Manufacturing and Water) were installed in 1995 and were mostly found dry at that time. The bore closest to the river, RN13020169 did not show any response to the 1996 moderate flooding event, nor to the rainfall and floods in September 1998 to January 1999.

Some minor response is visible from the flood event in January 2008, with an increase of water level of approximately 0.5 m. However, this response is in line with the general upward trend observed in all of the depicted bores. The upward trend started around 2000, when rainfall indicates a severe drought period and a period with no flood events. No other sources were identified that could have had an impact on the groundwater during that time, so it was concluded that the irrigation had caused the increase in water levels in the alluvium. Since 1996, the water levels in these bores have increased by approximately 5-6 m, which is 3 m more than recorded in the upstream bores.

From anecdotal evidence (pers. comm., Ensham), the intensive irrigation west of the ecohydrological conceptual cross section (South-North) shown in Figure 16 was established in the late 1980's. For the purpose of these plots, the starting date was assumed to be 1996, as it was thought to have intensified during that time. This coincides with the groundwater level increases observed in some of the alluvial bore along the cross section. Furthermore, the groundwater levels were observed to be rising after 2000 when the climate signal (CRD) indicates drought conditions. For the ecohydrological conceptual model, it is interpreted that during all climatic conditions some recharge to the groundwater from intensive irrigation might occur. During wet conditions, this recharge is a combination of irrigation and rainfall.

It is also notable that the groundwater levels are generally higher further away from Nogoa River, which indicates a gradient towards the river. If the river was the main source of groundwater, the groundwater levels would be expected to be higher near the river. Again, the river would naturally be a losing stream, with limited recharge due to the fact that the shallow alluvium is of low permeability and the water would have to go through a few metres of clay material to reach the lower sandy aquifers.

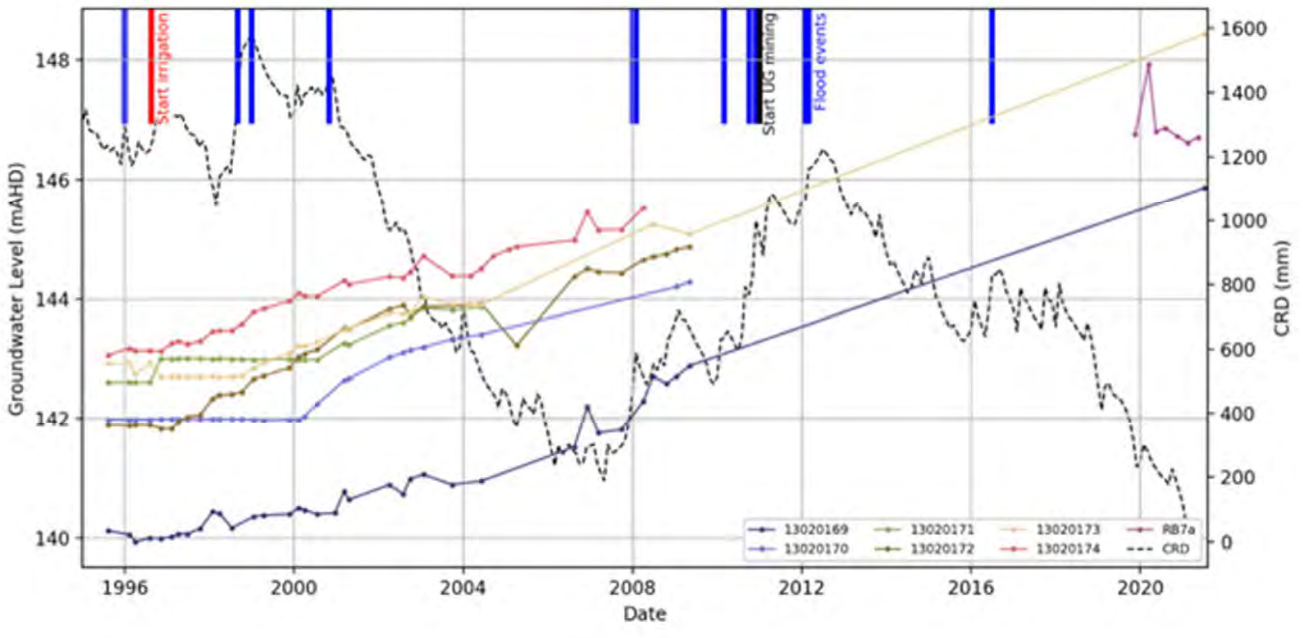


Figure 18 Hydrographs for bores near Zone 2

EC bores (sub-crop)

The EC bores series are located in the Nogoa River alluvium near or in the sub-crop of the Rangal Coal measures. For easier comparison, Figure 19 shows the same timeframe as Figure 17 and Figure 18, however monitoring the EC bores were not installed until 2004. The EC bores show a different response to flooding/climate than the bores discussed above. Specifically, EC07 to EC14 respond to the flooding in Nogoa River and/or rainfall (as indicated by the CRD). The water levels in these bores then also decrease over time, which was not observed in the database of relevant bores, which had a constantly increasing trend. The bores closest to the irrigation, EC01 and EC03, show no decrease of water levels over time, which could be interpreted that the upstream increase in alluvial water levels has moved towards EC01 an EC03. EC03 is further discussed in Section 5.3.1.3 in relation to surface water/groundwater interactions.

Figure 19 also displays the start of underground mining, which started in late 2011. None of the EC bores showed a response to the underground mining, which occurred below the alluvium in that area.

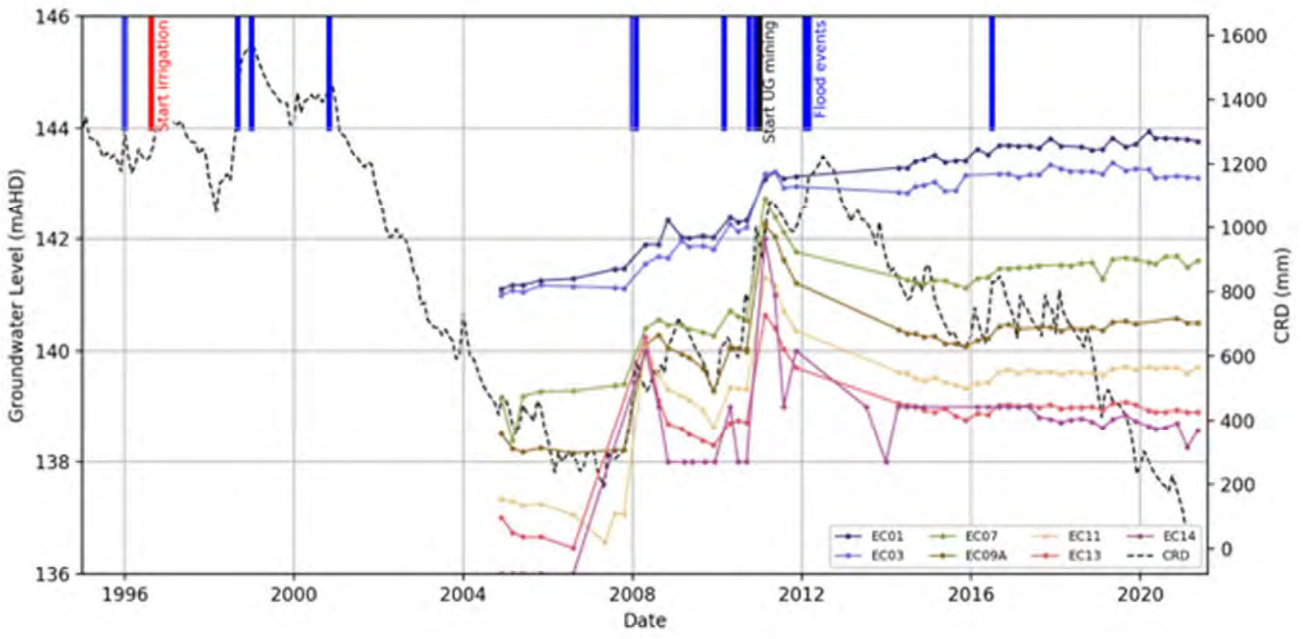
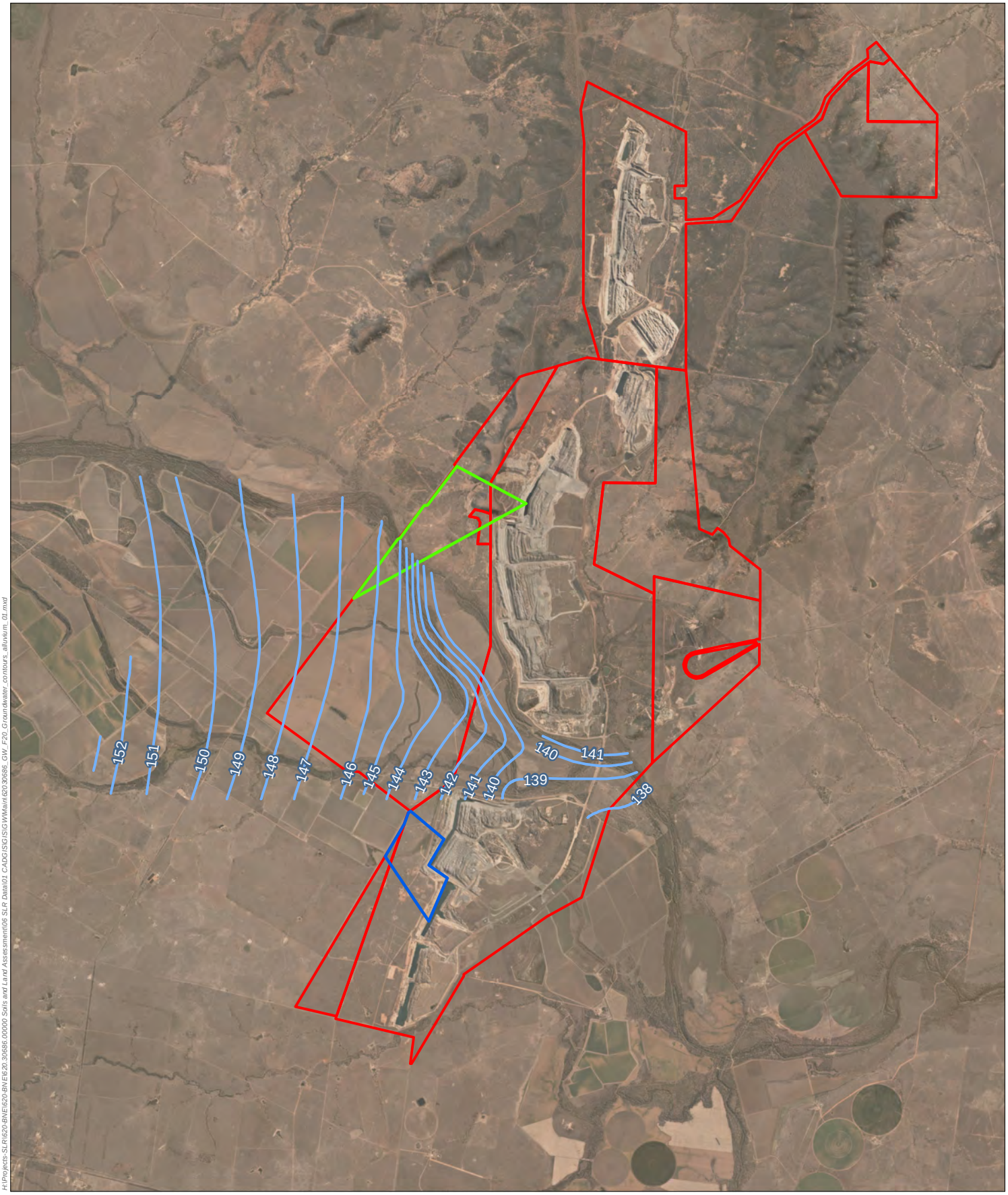


Figure 19 Hydrographs for bores near or in the sub-crop area

5.3.1.2 Groundwater flow

Groundwater flow in the alluvium follows topographical gradients, which is from north-west to south-east in the vicinity of the Project. To visualise the groundwater contours, the water level data from (of alluvial bores August 2021 was interpolated using the kriging method. The resulting contours are presented on Figure 20. The groundwater flow direction in the alluvium is from north-west to south-east and follows Nogoa River flow direction. As noted earlier, the alluvium might not be saturated continuously; the interpolated contours are the best approximation; however, the alluvial groundwater might not be connected, but rather form stagnant lenses with unsaturated regions (indicated by dry bores), as reflected in Section 5.4.1.1.



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F20_Groundwater_contours_alluvium_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Groundwater Contour in the Alluvium (2021)
- Zone 2
- Zone 3
- Mining Lease

GROUNDWATER IMPACT ASSESSMENT

Groundwater contours in the alluvium (2021)

Figure 20

5.3.1.3 Interaction with surface water

Figure 21 shows a conceptual cross section of the alluvium around Nogoa River (AGE, 2006). The upper part of the alluvium comprises silts and clay and may limit recharge. The silts and clays are underlain by a more permeable layer of sands and gravels (referred as basal gravel or basal alluvium). The shallow silts and clays are anticipated to be partially isolating Nogoa River, limiting leakage from the river into the basal sands and gravels. It is possible that leakage may occur where these clays are absent or where the basal sands are exposed within the river. However, there is no data confirming or rejecting this hypothesis. This hydraulic separation of the alluvium from Nogoa River means that whilst the water in the river is fresh, the underlying alluvium can be brackish to highly saline (Figure 21). The updated historical groundwater quality dataset (as discussed in Section 5.4) confirms the poor quality of the groundwater in the alluvium, which is generally brackish to highly saline.

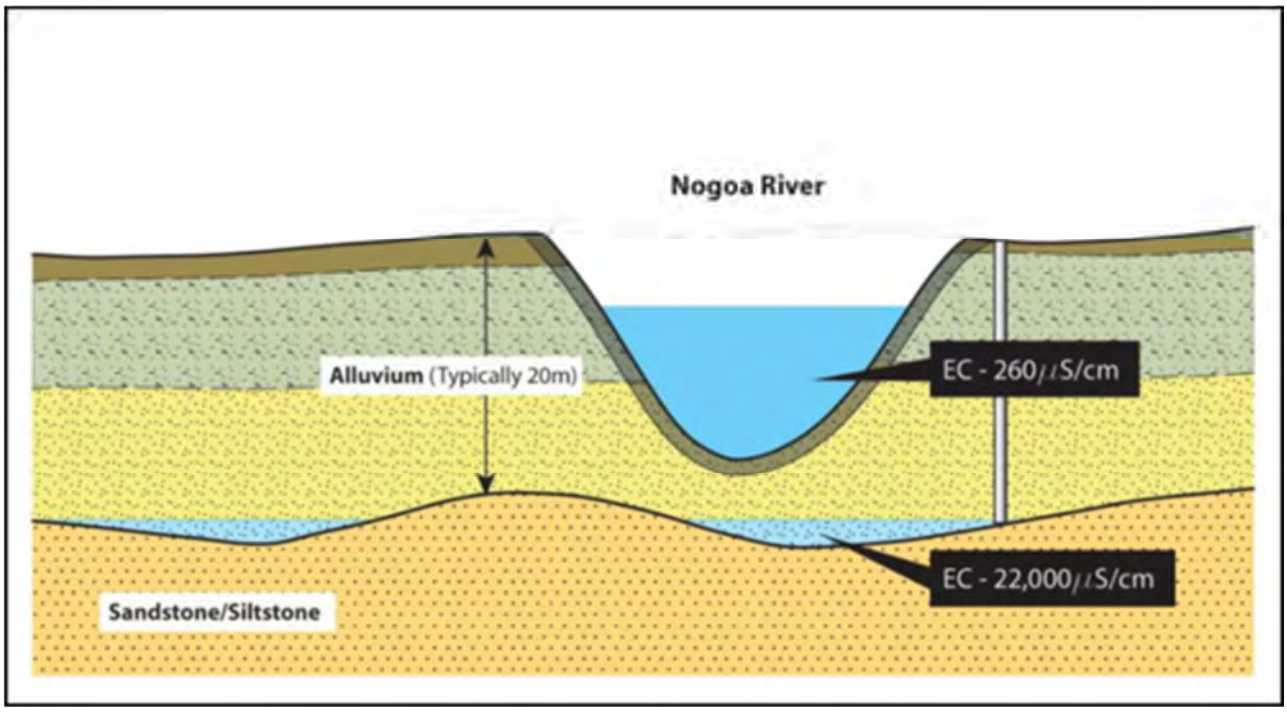


Figure 21 Conceptual cross section through Nogoa River and quaternary sediments (Source: AGE 2006)

An investigation in the Study area in 2004 (AGE, 2006) found that groundwater occurrence in the alluvium was highly variable within saturated zones of poor-quality water in deeper sections of an otherwise largely unsaturated formation. As part of the investigation, 23 shallow alluvial bores were drilled in the alluvium, of which nine were dry at the time of drilling. Water levels in the remaining bores ranged from 7.2 metres below ground level (mBGL) to 17.9 mBGL, with an average of 13.8 mBGL. Some bores of the EC series that were found to be repeatedly dry have been removed from the regular monitoring program.

The understanding of limited hydraulic interactions between Nogoa River and the alluvium were based on known historical data and the conceptual hydrogeological model of the Study area (AGE, 2006, SLR, 2021). This was supported by the data that the groundwater bores in the alluvium were dry in the late 1995s (Figure 17, Figure 18). Assuming Nogoa River is well connected and a major source for groundwater, the alluvium would be expected to contain groundwater of similar water quality than the river. However, back in 1995, the groundwater bores in the alluvium were dry and once they started to increase in water level, the water quality was saline. Further, as stated in Section 5.3.1.1, the groundwater levels along the cross section A-A' are generally higher further away from Nogoa River, which indicates a gradient towards the river. If the river was the main source of groundwater, the groundwater levels would be expected to be higher near the river. Furthermore, the river would naturally be a losing stream, with limited recharge due to the fact that the shallow alluvium is of low permeability and the water would have to go through a few metres of clay material to reach the lower sandy aquifers.

As discussed in Section 5.3.1.1, the most likely cause for the steady long-term increase in groundwater levels in the alluvium is the flood irrigation at and upstream of Zone 2. This is further supported as ground water levels were steadily rising between 2002 and 2008, when:

- No minor, moderate or major floods occurred in Nogoa River.
- The CRD indicates prolonged drought conditions.

A review of more recent data has revealed that the rising water level conditions in the alluvium upstream of Ensham mine may have caused an increase in water levels at EC01 and EC03.

A site inspection along Nogoa River on 24 July 2019 identified several groundwater expressions into Nogoa River, one of which has been formally documented. Another site reconnaissance undertaken on 22 July 2020 identified several more expressions, which were documented using a GPS. The extent of the expressions was limited to the those shown in Figure 16 (pers. comm., Environmental Superintendent, Ensham mine, 2020).

Table 9 lists the coordinates, a photograph, water quality parameters and water type assessment for the field observation in July 2019. The water type is a Sodium-Chloride (Na-Cl) water type, similar to the Nogoa River alluvium groundwater. The sulphate/chloride ratio is 0.16 milli-equivalents (meq), which indicates that the groundwater expression is unlikely to be related to mine affected water.

The groundwater expressions are not considered natural springs, but considered to be caused by upstream irrigation that is potentially causing elevated groundwater levels in the area upstream of EC01 that result in discharge into Nogoa River. The groundwater levels at EC01 and EC03 have been identified as being impacted by irrigation (refer to Section 5.3.1.1), with groundwater levels staying high whilst climatic conditions were dry and other alluvial bores showed a decline (Figure 19). No processes related to mining could be identified that would cause the high alluvial groundwater levels and the associated observed groundwater expression in this area upstream of mining activities.

The groundwater quality observed at this local groundwater expression is more saline than Nogoa River, hence this discharge could lead to decreasing water quality in Nogoa River.

Table 9 Groundwater expression field observation

Parameter	Value
Easting (GDA94, Z55)	649216.196
Northing (GDA94, Z55)	7405074.399
Photograph	
EC (field)	7,762 µS/cm
Sodium	1,110 mg/L
Chloride	1,980 mg/L
Sulphate	436 mg/L
Water type	Na-Mg-Cl type water - similar water type to alluvium

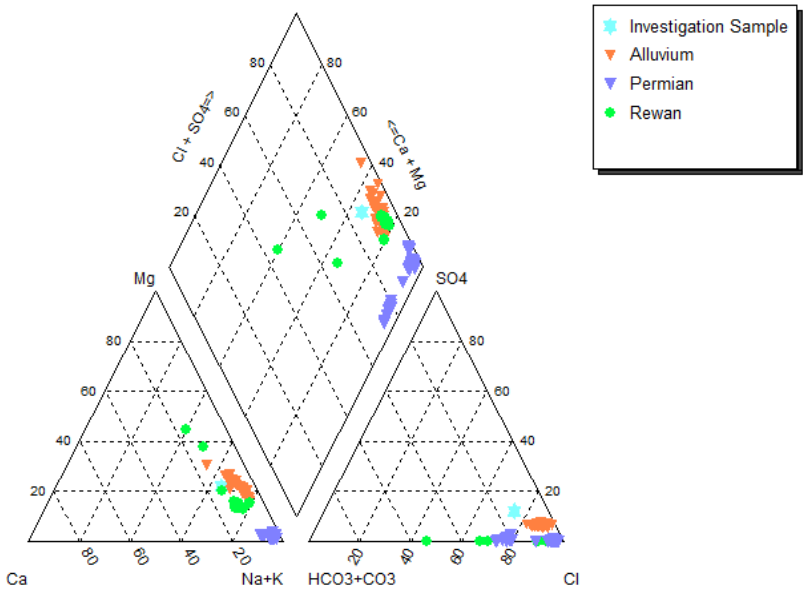


Figure 22 Piper Diagram comparing groundwater quality with the investigation sample

Figure 23 shows that historically the groundwater levels at EC03 were below the River stage, whereas they have reversed in 2009 and are now above the River stage, which is consistent with the newly formed springs.

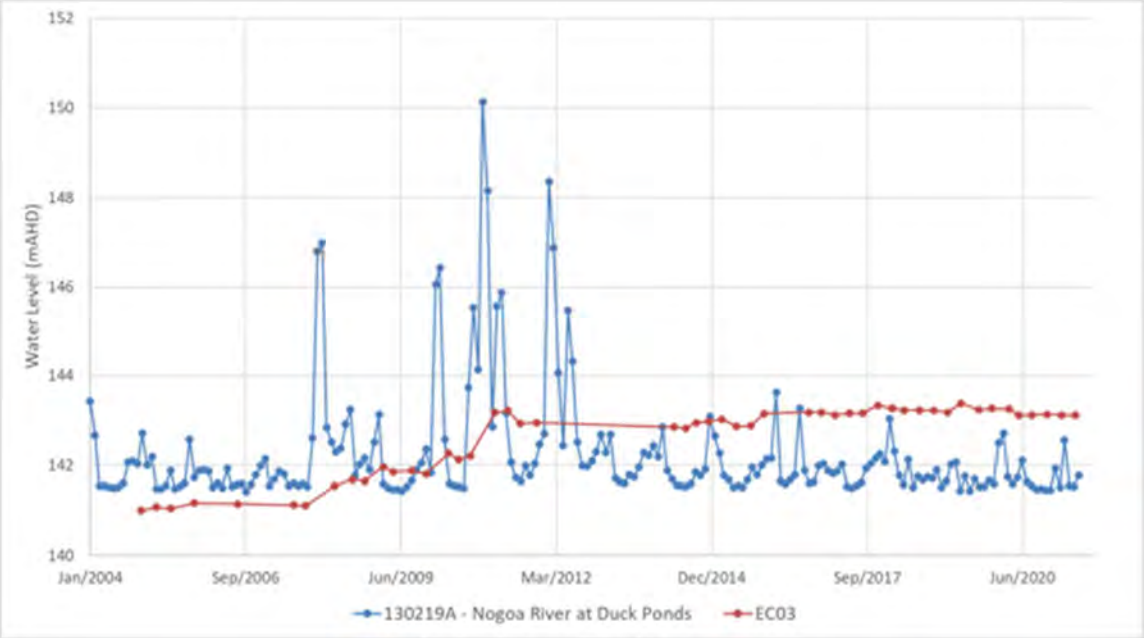


Figure 23 Water level comparison at Nogoa River (Duckponds) and EC03

The EC at EC03 was between 10,000 and 30,000 µS/cm (Figure 24). The monthly average EC in Nogoa River at Duckponds was historically between 500 and 1000 µS/cm, and has increased to 500 – 2000 µS/cm since 2018. If the springs are contributing water to Nogoa River during low flow times, this could be a cause of the increase in EC that has been observed in the river.

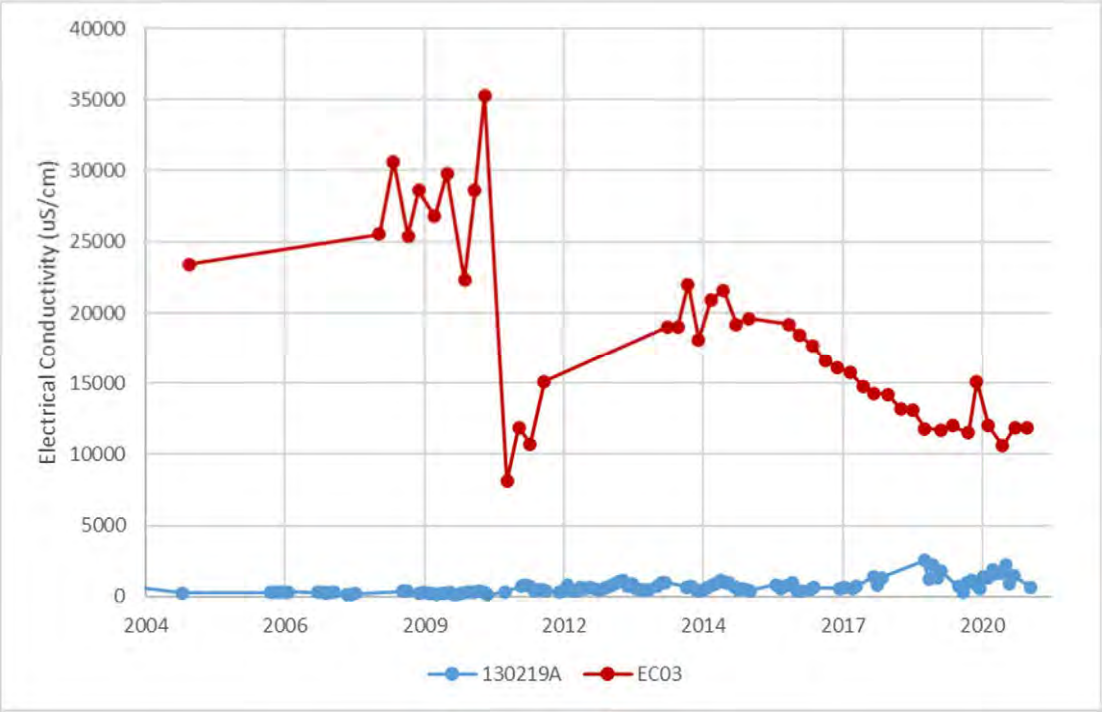


Figure 24 EC comparison at Nogoa River (Duckponds) and EC03

5.3.2 Rewan Group

The Rewan Group comprises low permeability siltstones, mudstones and lithic sandstones and is recognised to be a regional scale aquitard. Private landholder bores Jamar Bore and Winton Creek Bore have limited bore construction details available and are screened in the Rewan Group inferred from the bore log of the nearby bore RB04.

Groundwater level trends within the Rewan Group at Jamar bore and Winton Creek bore compared to groundwater level trends within the Aries Seam (RB04) are presented on Figure 25. The hydrograph shows groundwater elevations within the Rewan Group at Winton Creek bore are relatively stable, at around 137 mAHD, while levels within Jamar Bore are highly variable between 108 mAHD and 126 mAHD. Routine monitoring and reporting at Ensham mine indicates that the variability relates to private bore usage with localised drawdown and slow recovery of groundwater levels within the low permeability Rewan Group. In contrast, groundwater levels within the Aries Seam of the Rangal Coal Measures (RB04) records stable to slightly declining groundwater levels between 136 mAHD and 137 mAHD.

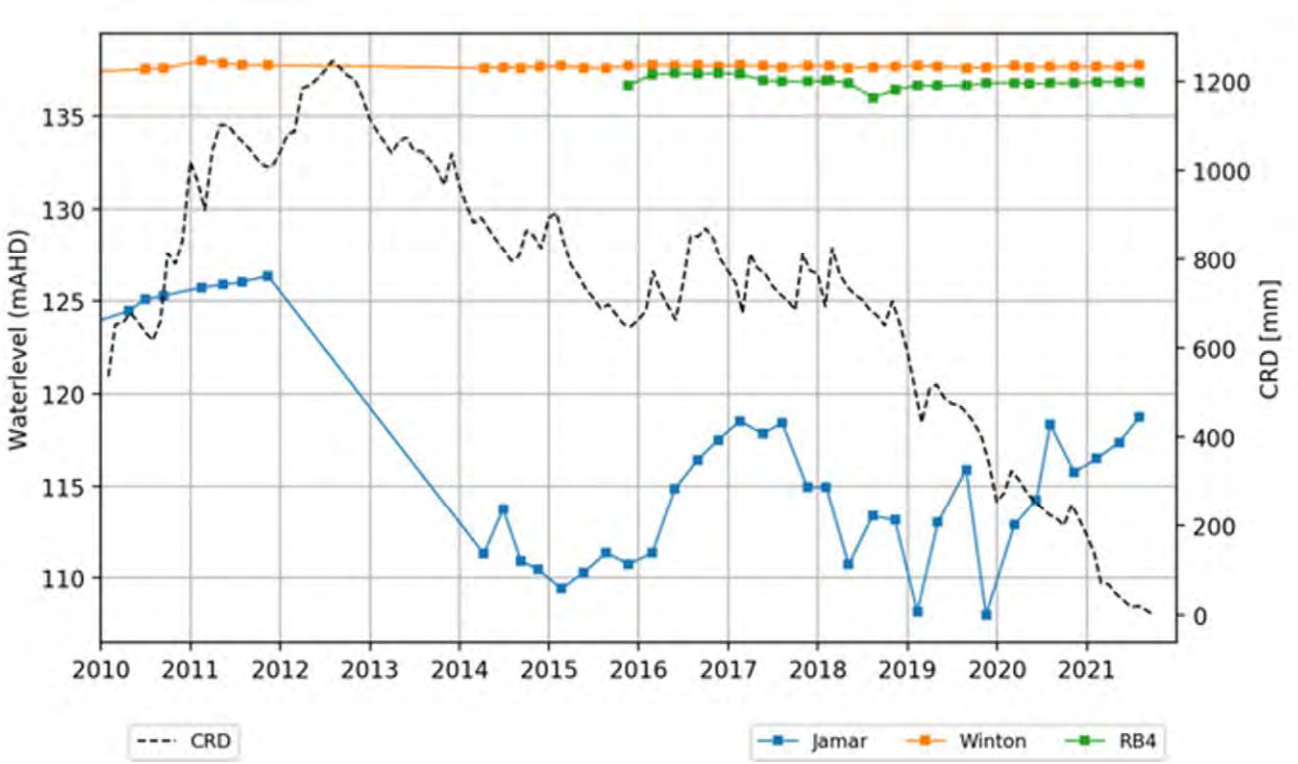


Figure 25 Hydrographs for Rewan bores compared with RB04 (Coal measures)

5.3.3 Permian Coal Measures

The most permeable lithological units at Ensham mine are the coal seams within the Rangal Coal Measures. The coal seams form aquifers that generally exhibit low transmissivities and are confined by overlying and underlying shales and mudstones (AGE, 2017). Groundwater storage and movement largely occurs within the coal seams, along cleats and occasionally within minor fault zones that intercept the seams. The other lithologies present in the overburden and interburden sequence are considered to form aquitards.

The Permian strata can be categorised into the following hydrogeological units:

- Very low to low permeability sediments that comprise the majority of the Permian age interburden and overburden within the coal measures.
- Low to moderately permeable coal seams, of varying degrees of competency (and therefore fracturing).

Recharge to the Permian Coal Measures occurs at the eastern edge of Ensham mine, where the Permian Coal Measures outcrop. Recharge would occur from direct rainfall on the ground surface, infiltrating into the underlying formations through the thin soil cover, weathered profile, as well as through the spoil at site. The coal measures also subcrop in localised zones beneath alluvium associated with Nogoa River, where the unit may be recharged by downward seepage where there is an absence of clay and silt layers.

Limited recharge may also occur via downward leakage from the Triassic age Rewan Group and Tertiary sediments, as well as from areas of site surface water storage (i.e. in-pit water storages from open-cut mining at Ensham mine). The coal seams are connected with the open-cut voids (which are the mined-out areas of the outcropping coal seams), refer to Section 5.3.3.2 for a detailed discussion of the interaction between the Rangal Coal Measures and the open-cut voids.

Discharge is occurring from bore abstraction and mine dewatering and regional flow.

5.3.3.1 Water levels

For the visualisation of the water levels at the 15 bores as hydrographs, the bores of the Permian Coal Measures have been grouped by approximate location:

- Northern Area: RB1, RB2, RB8.
- Central Area: WSMB2S, WSMB2D, RB3, RB4, RB10.
- Southern Area: Karanga Bore, RB5, RB6, RB9, WSMB3 S and WSMB3D.

Northern Area

Groundwater in the Rangal Coal Measures flows primarily towards the Ensham underground mine area (mine dewatering and depressurisation). Groundwater level trends within the Rangal Coal Measures west of Ensham mine (RB1, RB2 and RB8) are presented on Figure 26. Groundwater level trends for RB1 and RB2 are slightly declining, with groundwater elevations ranging between 122 mAHD (RB8) to 145 mAHD (RB1). The bore RB8 was installed in August 2021 and has only two observations. This bore is closest to the mine and shows the lowest water levels, confirming the gradient towards the mining area.

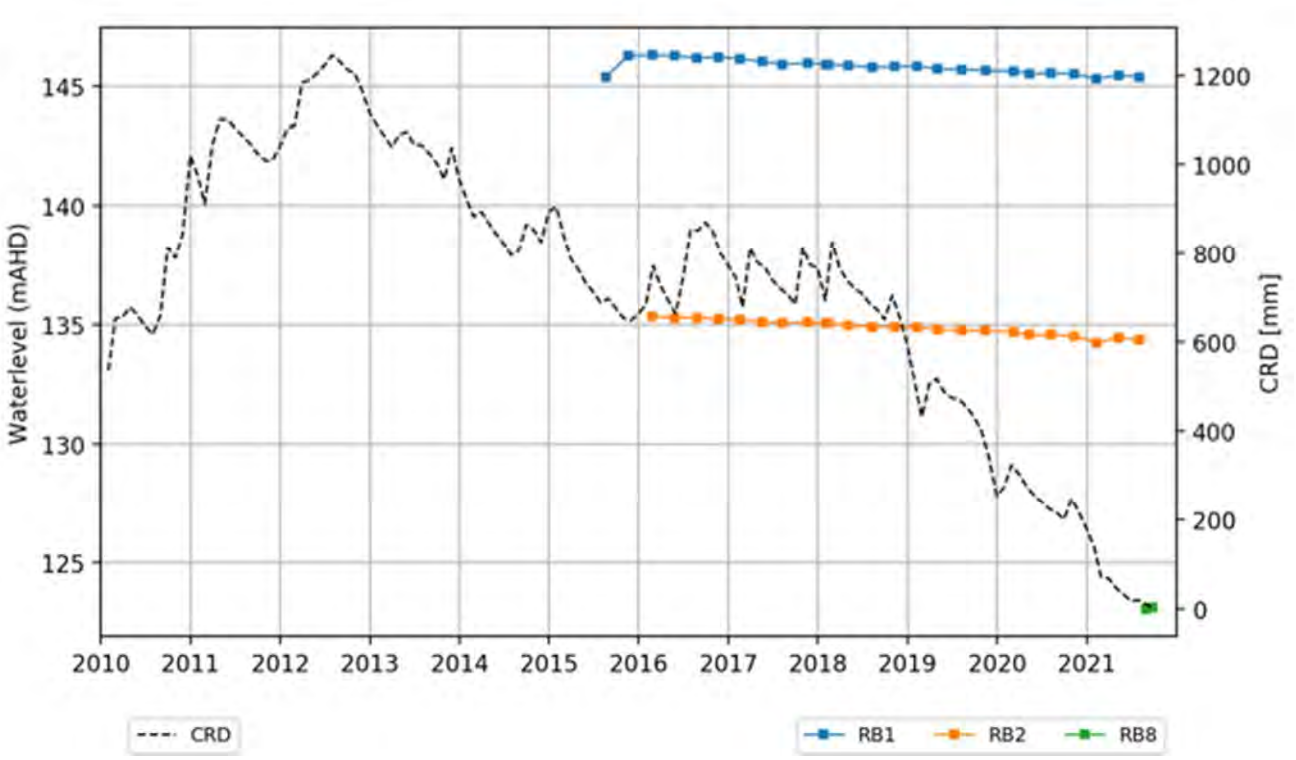


Figure 26 Hydrographs for Permian bores (north)

Central Area

Bore RB03 is located within 3 km of active underground mining and records a general decline in groundwater levels of around 4 m from 2016 to 2021. This trend is in line with predicted depressurisation of the Permian coal seams with existing operations (HydroSimulations, 2020). It is anticipated that the influence of the underground workings will transmit readily through the coal seams; however, vertical impediments (such as the Rewan Group and the Permian aquitards above and between the coal seams) would restrict the dewatering of bounding lithologies.

The water levels in the RB04 area are generally considered depressed relative to what is anticipated under natural conditions, lending weight to the prevalence of an abstraction signal in this area. The RB04 borehole has a comparatively low groundwater level of 136 mAHD (40 m unsaturated zone thickness). RB10 was installed in August 2021, and shows similar water levels as RB3. Once more data is available, the trend at this bore can be assessed.

Nested bore WSMB2S (shallow) and WSMB2D (deep) show that the depressurisation in the deeper bore is not impacting the shallow bore. The shallow bore follows the surface water level of near-by water storage pit Ramp 22 (refer to Section 5.3.3.2).

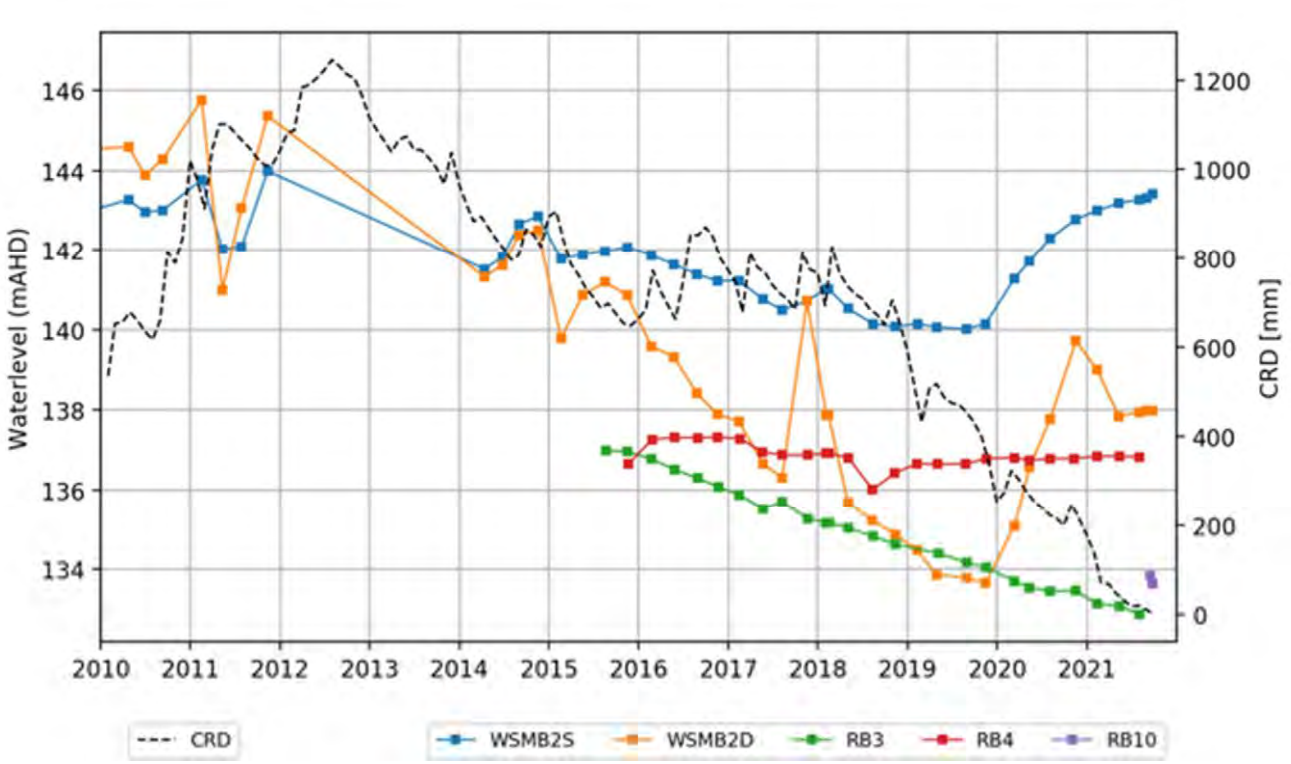


Figure 27 Hydrographs for Permian Bores (Central Area)

Southern Area

Bore RB06 and Private landholder bore Karanga Bore intersect the shallow Rangal Coal Measures 2.5 km and 6.5 km south of the Ensham mine open-cut, respectively. Groundwater level trends for the bores are presented on Figure 28. Karanga Bore, which is located further from the existing mine also shows influence from localised private bore usage. RB06 shows a slight increasing trend over the observation period of around 1 m, when the CRD indicates drier than normal climatic conditions. In Figure 28, the hydrographs for WSMB3S and WSMB3D have been plotted to compare with the trend in RB06. The water level in WSMB3D (monitoring the coal seam downdip of Pit A) is below the water level of RB06, whereas the water level in WSMB3S (monitoring the overburden downdip of Pit A) is higher than in RB06. There is potential for the water level in RB06 being influenced by the water level in Pit A, however, the limited number of data points is insufficient to assess trends at this time.

RB9 was installed in August 2021, and shows similar water levels around 5m higher than RB6. Once more data is available, the trend at this bore can be assessed.

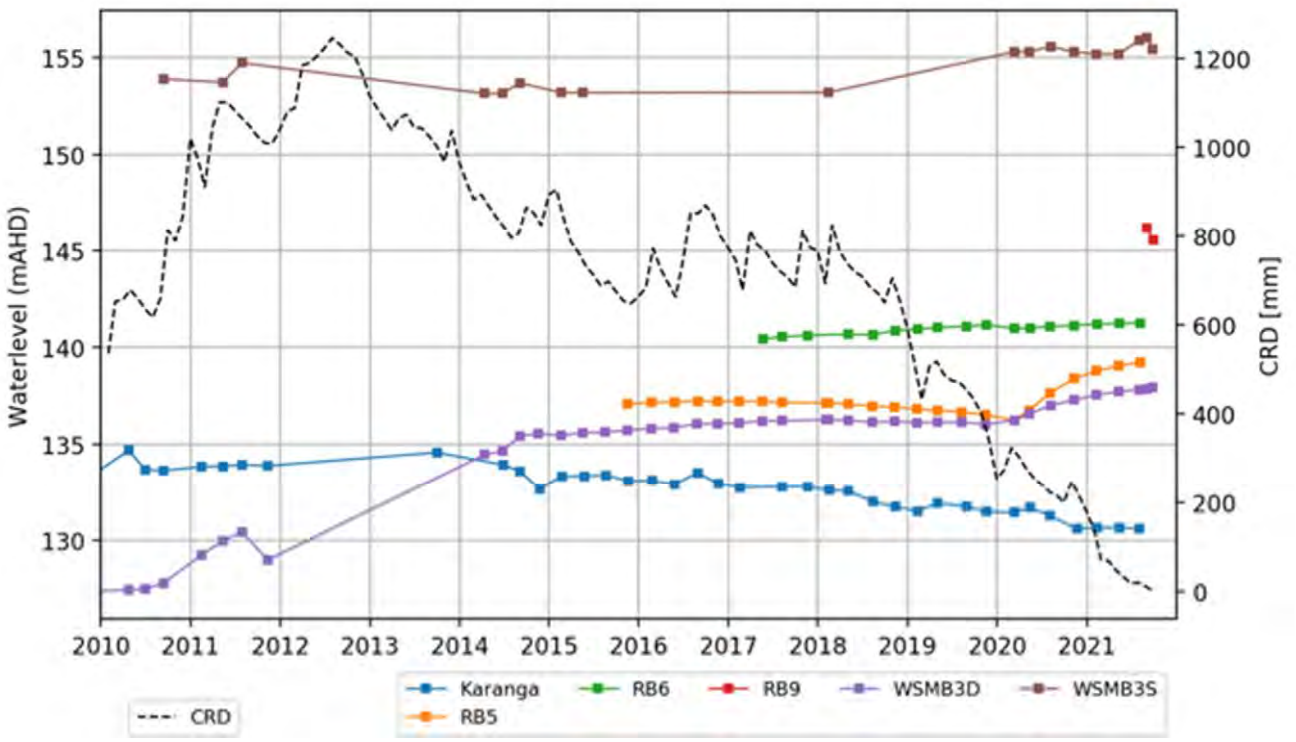
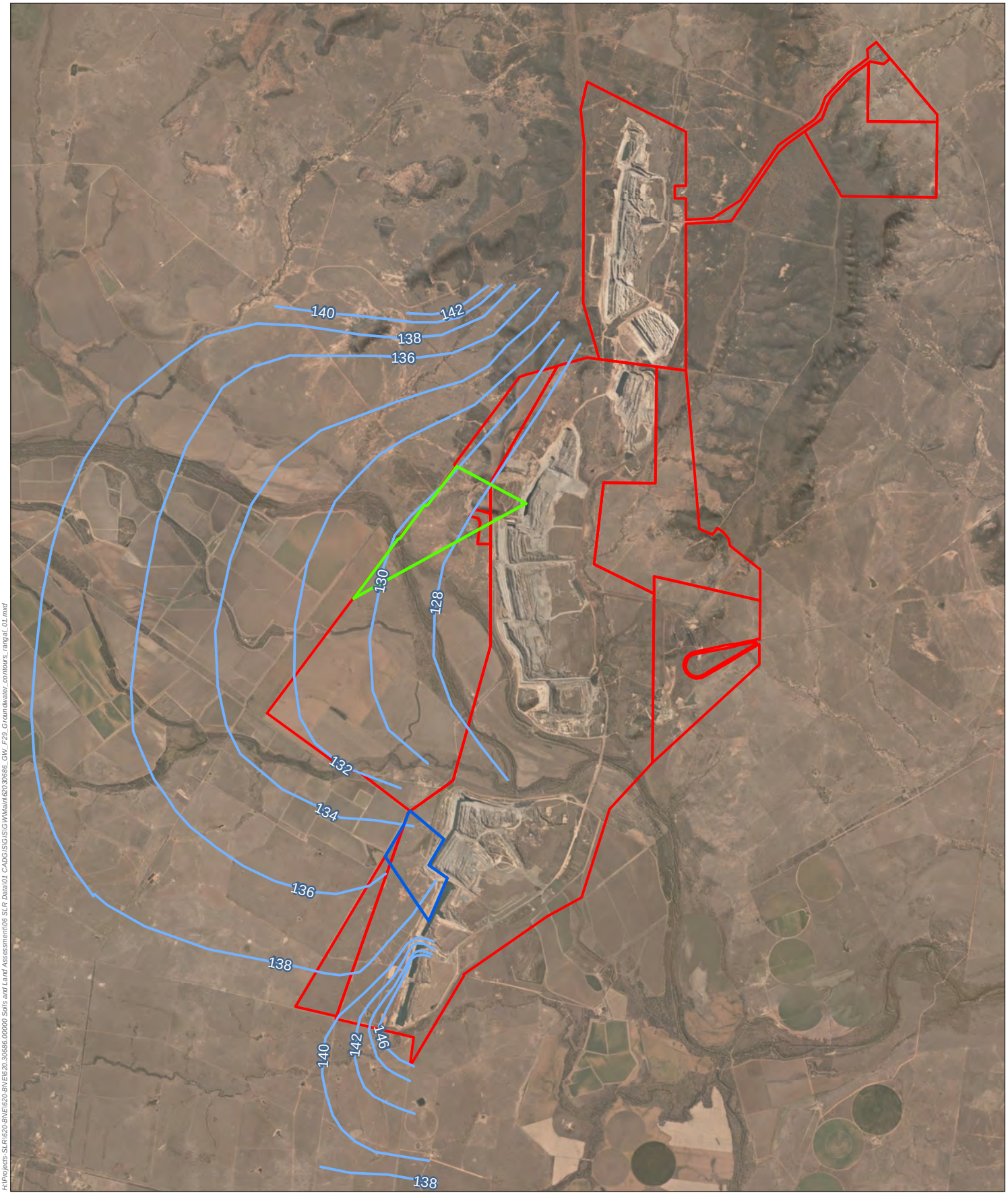


Figure 28 Hydrographs for Permian bores (South)

Figure 29 shows the groundwater level contour in the Rangal Coal Measures for September 2021. The groundwater flows from west to east towards the mine. In the south, the water storage in Pit A seems to cause higher groundwater levels and a flow away from the mine.



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F29_Groundwater_contours_rangal_01.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:125,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

GROUNDWATER IMPACT ASSESSMENT

Groundwater contours in the Rangal Coal Measures (2021)

Figure 29

Legend

- Groundwater Contour in the Rangal Coal Measures (2021)
- Zone 2
- Zone 3
- Mining Lease

5.3.3.2 Interaction with open cut pits

Groundwater level trends are also influenced by rehabilitation and water storage activities at Ensham mine open-cut, in addition to depressurisation from existing underground mining. Groundwater level trends for bores within the shallow Permian coal measures within 2 km west of A Pit and B Pit are shown on Figure 31 and Figure 30, along with trends for deeper bore RB05 located over 2 km west of the open-cut. The WSMB series are installed in "Coal Measures Overburden" [S] or "Coal Seams" [D].

Bores WSMB2S and WSMB2D are within 400 m of B Pit (Ramp 22) and overlying the existing operations mining area. Figure 31 shows WSMB2 recorded a generally upward gradient with higher groundwater elevations within the deeper bore until around 2013, after which time a downward gradient is visible. This coincides with progression of B Pit towards the bore. The deeper bore shows a more pronounced response to mining activities than the shallow one. In general, this also indicates low vertical hydraulic connectivity within the Rangal Coal Measures. In 2020, the water levels in Ramp 22 rose by 6m as those pits were used to store water previously stored in C-Pit. The deep bore mimics this increase very closely, meaning that the Permian strata is in connection with Ramp 22. The shallow bore also responds to the increase, however somewhat more subdued (increase of 4m).

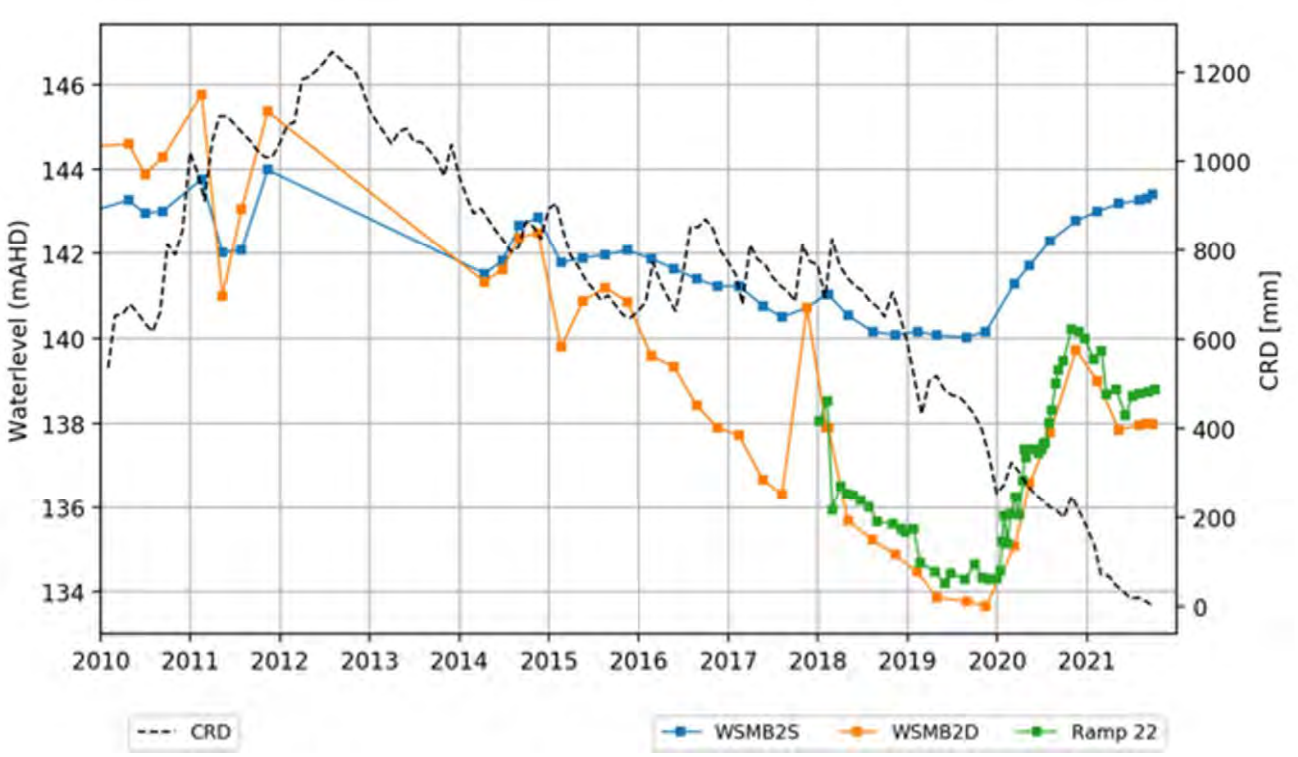


Figure 30 Hydrographs for bores WSMB2D, WSMB2S, and surface water levels at Ramp 22

WSMB3S and WSMB3D intersect Permian overburden and are located approximately 1 km west of A Pit Ramp 20 and Ramp 21. Bore WSMB3S has been screened to 21 m depth and has been recorded as dry since mid-2015. Groundwater levels within WSMB3D have gradually risen since 2009, which coincides with cessation of mining at A Pit and commencement of water storage within the pit. In 2020, the water levels in Ramps 21 and 22 rose by 10m as those pits were used to store water previously stored in C-Pit. Water levels in RB5 and WSMB3B respond to this increase in surface water with an increase of 2-3m.

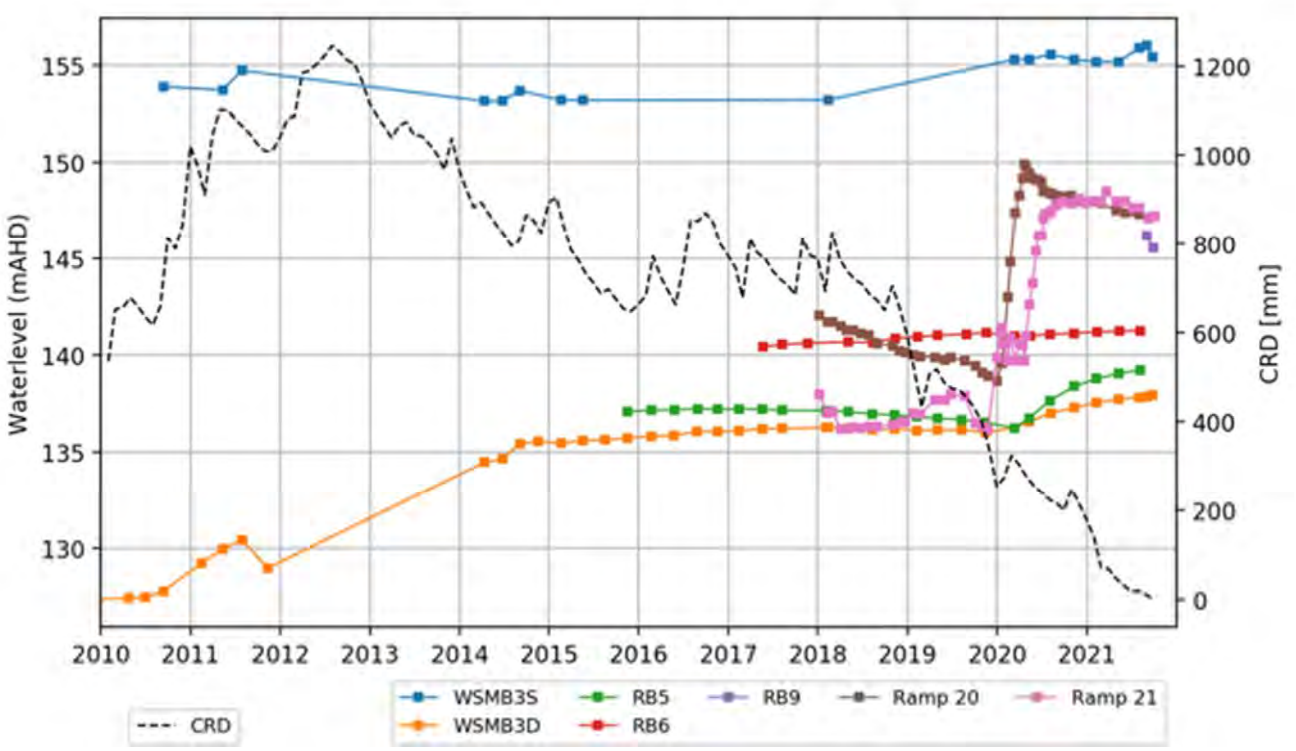


Figure 31 Hydrographs for bores WSMB3S, WSMB3D, RB5, RB6, RB9 with surface water level at Ramp 20 and 21

5.4 Groundwater quality

Recent groundwater quality data are available for 21 bores with parameters as outlined within the current EA for the Ensham mine (refer to Section 5.1). In addition, historical data are available for 65 bores across the mine site and its surroundings. In this section, only the bores for which the bearing strata is known are discussed. Summary statistics for all EA parameters and bores with a sufficiently long data set are presented in Appendix B.

Physiochemical parameters and metals are discussed for each groundwater unit in Section 5.4.1 and Section 5.4.2. The water quality results are compared as box-and-whisker plots against water quality triggers for relevant environmental values, as discussed in Section 5.5. These comparisons are shown in Appendix C. Time series of all groundwater parameter at all bores is provided in Appendix D.

5.4.1 Physiochemical parameters

Physiochemical parameters include:

- Major ions, i.e. calcium (Ca), sodium (Na), magnesium (Mg), potassium (K), sulphate (SO_4), chloride (Cl), bicarbonate (HCO_3).
- Electrical Conductivity (EC).
- Total Dissolved Solids (TDS).
- pH.

Major ions allow comparison of water types (ionic dominance) between bores. According to DES (2021), major anions and cations analysis enables characterisation of the groundwater regardless of the activity. The water type can also be used in correlation with other physiochemical parameters, precipitation records and groundwater level measurements to inform groundwater flow and hydrological processes.

Table 10 lists the 20th percentile, median and 80th percentile of the pH (field and laboratory) for the alluvium, the Rewan Group and the Rangal Coal Measures. The field pH is considered the more accurate measurement, as pH has a short holding time for laboratory analysis. However, the laboratory pH is listed here, because the field pH has not been measured until 2013.The waters are all neutral to slightly alkaline, with median field pH values of 7.1 for the alluvium, 7.6 for the Rewan Group and 7.7 for the Rangal Coal measures.

Table 10 Summary statistics of pH observations

		Number of observations	20th percentile	Median	80th percentile
Alluvium	Field pH	338	6.8	7.1	7.4
	pH Lab	667	7.1	7.5	7.9
Rewan	Field pH	62	7.4	7.6	7.8
	pH Lab	79	7.7	7.9	8.1
Coal Measures	Field pH	239	7.0	7.7	8.0
	pH Lab	242	7.5	7.9	8.2

EC and TDS both are both a measure of salinity levels in water. EC is generally recommended to measure salinity as it can be easily measured on site without requiring laboratory analysis. EC measured in the field is generally recommended over laboratory analysis due the potential for change in salt composition that can occur with temperature change during the sample transport and storage prior to analysis.

EC measured in the field is available for EA bores only, from 2014 onward. Where no EC field data are available, EC lab data is discussed instead.

Table 11 lists the 20th percentile, median and 80th percentile of the EC (field and laboratory) for the alluvium, the Rewan Group and the Rangal Coal Measures. The median EC in the alluvium is around double the median EC in the Rewan Group and the Rangal Coal Measures. This indicates generally poor water quality that may not be suitable for all users (this will be further discussed in Section 5.5).

Historical water quality records from DRNME bores showed high EC values in the alluvium before underground mining started, which indicates that these EC values are occurring naturally. The EC observations in the late 1990s and early 2000s ranged from 710 µS/cm in Bore RN13020175 to 38,900 µS/cm in Bore RN13020173.

Table 11 Summary statistics of EC observations

		Number of observations	20th percentile (µS/cm)	Median (µS/cm)	80th percentile (µS/cm)
Alluvium	Field EC	353	3,208	11,590	20,040
	EC Lab	668	2,124	6,150	19,360
Rewan Group	Field EC	62	4,069	5,825	7,750
	EC Lab	79	3,946	6,290	7,744
Rangal Coal Measures	Field EC	239	3,702	7,360	10,933
	EC Lab	242	3,454	7,105	10,780

Discussion on the physiochemical properties for each groundwater bearing unit is presented in Section 5.4.1.1 to Section 5.4.1.3.

5.4.1.1 Alluvium

Major ions analysis reveals that the majority of alluvium bores are of sodium-chloride (Na-Cl) water type dominance (Figure 32). As described in Section 5.3.1, most of the alluvium is hydraulically isolated from the Nogoa River, resulting in brackish to highly saline conditions. Slow infiltration recharge and evapotranspiration are likely to be the dominant processes resulting in salinisation of the alluvium.

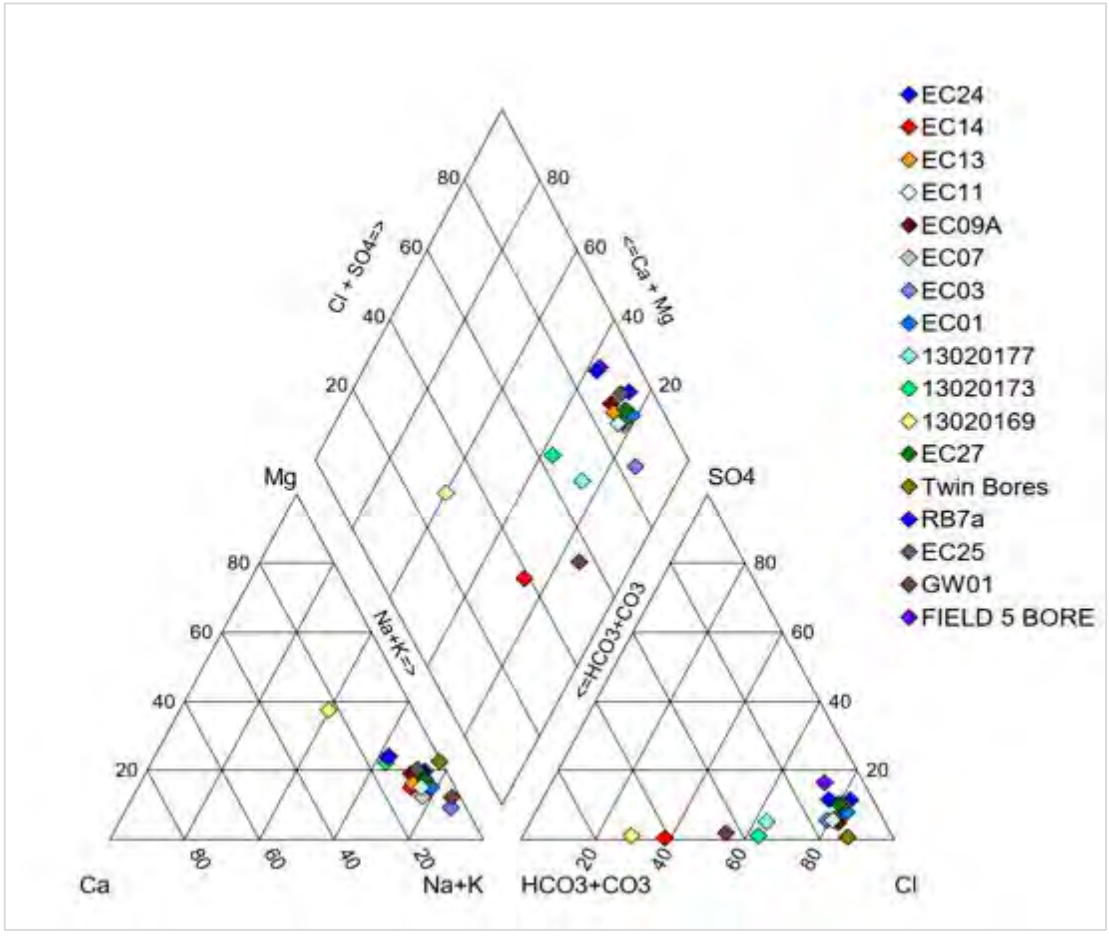


Figure 32 Piper plot alluvium

Alluvium bores show a wide range in salinity with recorded values from about 1,000 µS/cm to 30,000 µS/cm.

The data suggest that most alluvium bores are responsive to rainfall events indicating that rainfall infiltration is likely the main recharge process. The EC in bores EC07, EC09A, EC11 and EC13 is responsive to rainfall changes, with various delay of response (Figure 33 and Figure 34). A large recharge event reduces the EC and prolonged drought will increase the EC over time.

Those bores had a higher EC before the main recharge event in late 2010 (shown with an increasing CRD), and then decreased during the inflow of fresher water (blending). The bores have since increased in EC with different timing in onset, with EC07 (most upstream) starting in 2013 and EC13 (downstream) starting around 2016.

The reason for this increase is unclear. The corresponding increase from upstream to downstream along Nogoa River would indicate that the increase is not mining related. If it was a mining related effect, the EC increase would be expected to start in the bores closest to the mine (EC11 and EC13). At this stage, it is plausible that the continued drier conditions since the last major recharge event could lead to the increase in EC.

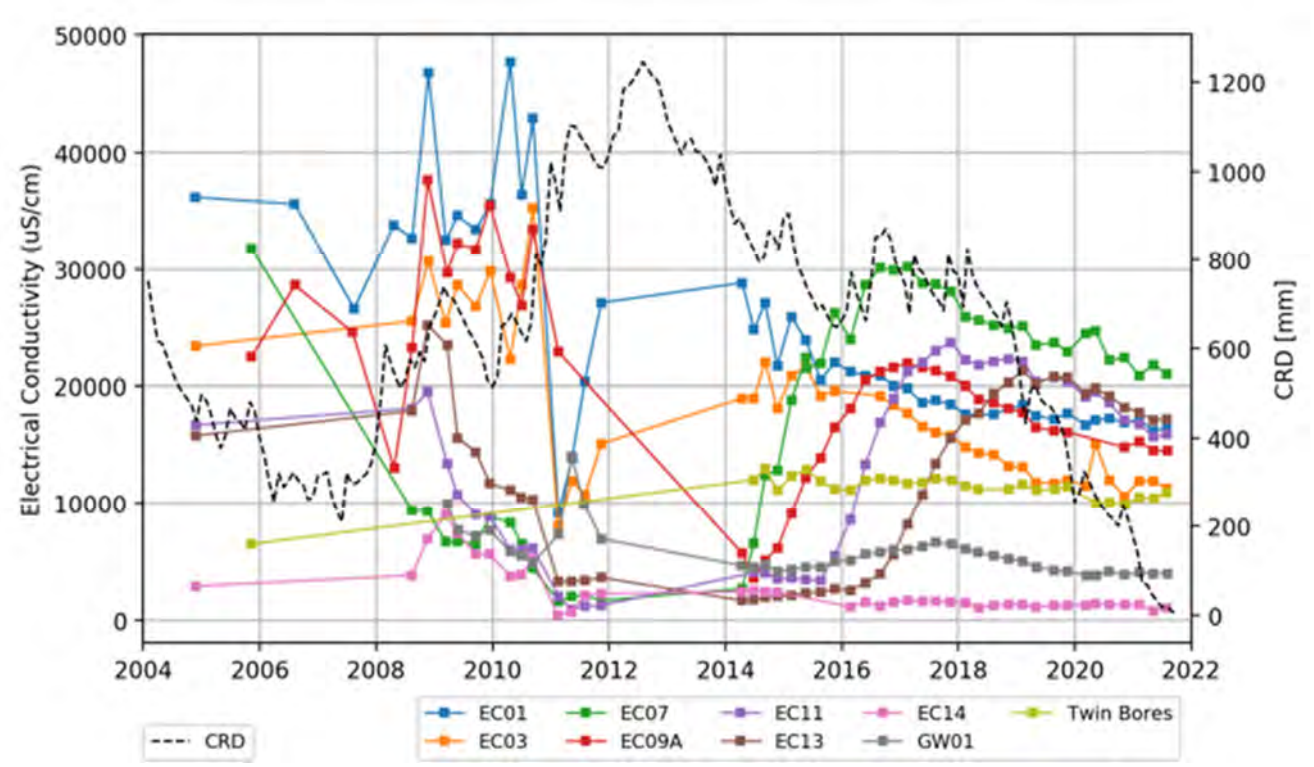


Figure 33 Lab EC – alluvium

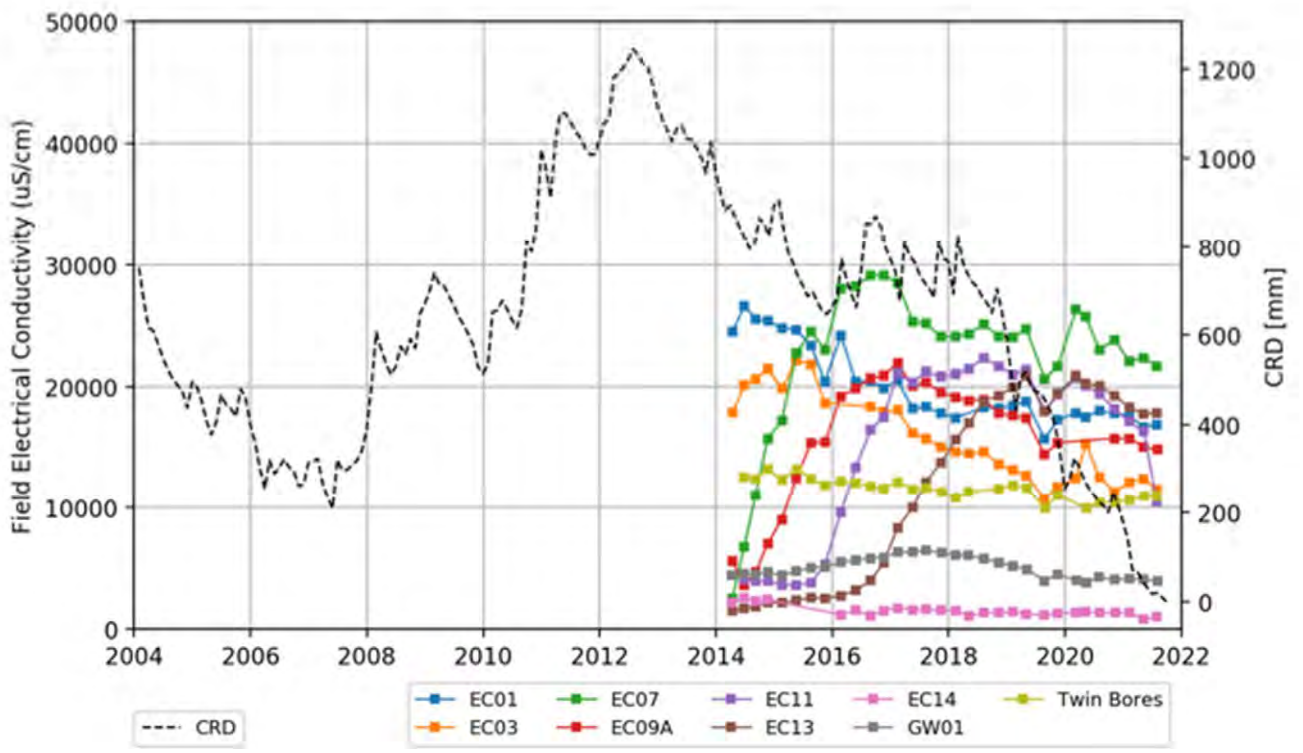


Figure 34 Field EC - alluvium

Bores that are not of NaCl dominance or bores that show high variation in water chemistry include EC04, EC06, EC14, EC16, EC17 and EC19 (the latest observation available for those bores were in 2014).

Bore EC04 and EC17 are of Mg-Na-Cl water type. The presence of Mg ions, which are strongly adsorbed in clay environments may indicate that these bores are located along a preferential flow path that receive recharge from rainfall or through baseflow from the Nogoa River. EC measurements at bores EC04 and EC17 (Figure 35) indicate less variability compared to other alluvium bores with mildly brackish water.

Bore EC06 is Mg-Cl dominant. Like EC04 and EC17, this bore may be located along a preferential flow path that receives more regular recharge than other alluvium bores.

Bores EC16 and EC19 are of Na-HCO3 and Mg-HCO3 dominance respectively. These bores monitor fresh to slightly brackish water and are likely located along a preferential recharge flow path. EC19 likely monitors younger groundwater (presence of Mg ions) with measured EC below 800 µS/cm (Figure 35).

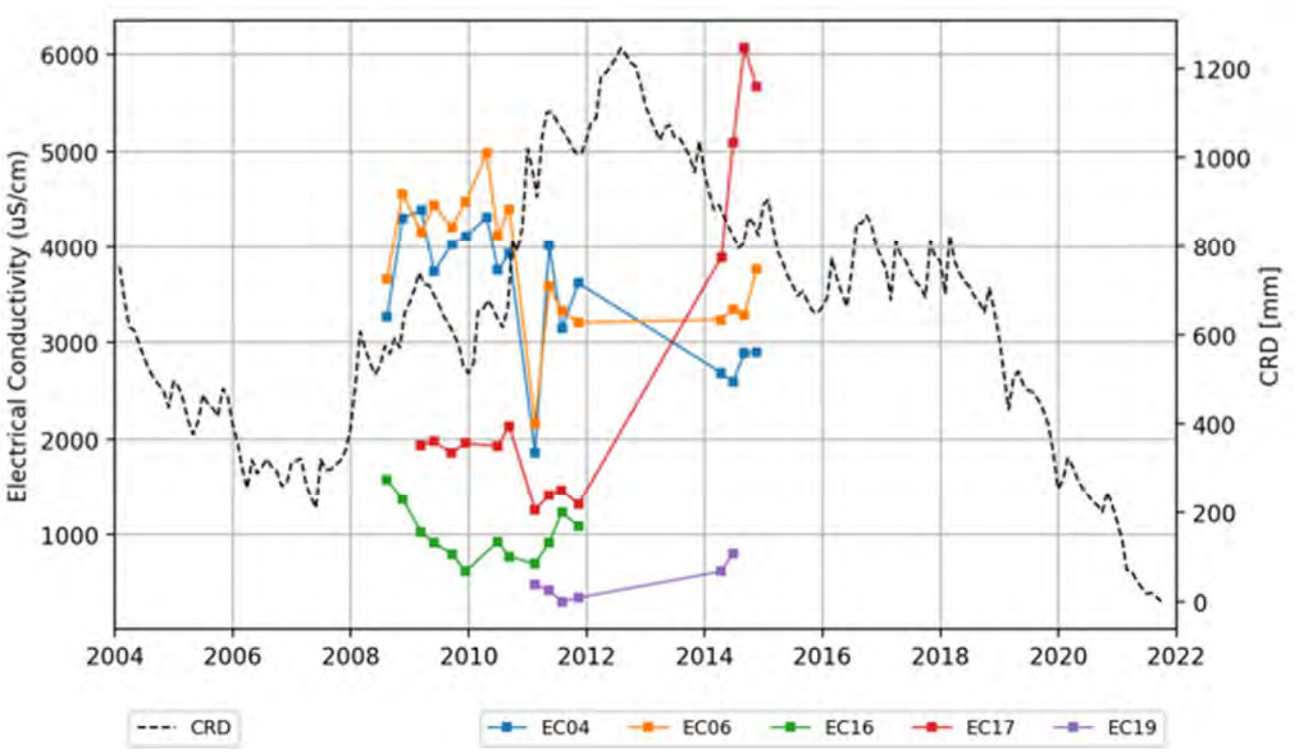


Figure 35 Electrical conductivity (Lab) - EC04, EC06, EC16, EC17 and EC19

Regional water quality objectives (WQO) for aquatic ecosystem protection are available for EC (DEHP, 2011). Several alluvium bores (EC01, EC03, EC05, EC07, EC09A, EC11 and EC13) show an 80th percentile above the regional WQO (Appendix C).

Variations in pH are generally small with the regional bore (Twin Bore) showing a higher degree of variability (Figure 36). Most measurements are between 6.5 and 8.5, which is within the lower Nogoa River EVs for aquatic ecosystem protection (DEHP, 2011b). Bore GW01 is slightly basic and has exceeded the upper WQO four times in the past ten years. The pH observations at Twin Bores increased in early 2020 to above 8.5 and have remained there since.

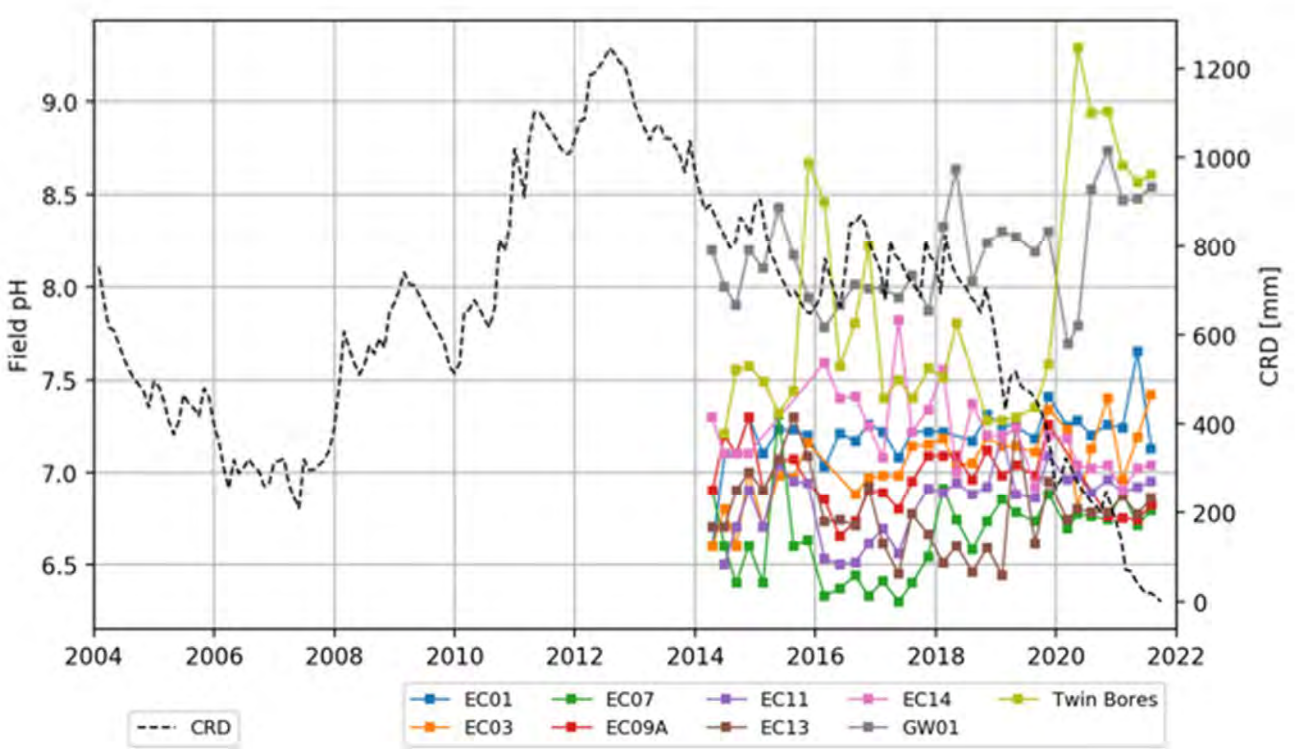


Figure 36 Field pH - alluvium

5.4.1.2 Rewan Group

Bores screened in the Rewan Group (Winton Creek Bore and Jamar Bore) are all Na-Cl dominant (Figure 37).

Laboratory EC available from 2004 at Winton Creek Bore and Jamar Bore show that these bores are likely to respond to very high intensity rainfall events and associated major flooding (refer to Figure 9), with EC level decreasing for a short period of time following such events (Figure 38). Jamar Bore shows consistent EC observations around 4,000 µS/cm. The EC at Winton Creek Bore displays an increasing trend since 2014 and in 2020 has exceeded the previous maximum of approximately 8,300 µS/cm, with EC now observed at 9,000 µS/cm. The water levels at this bore show little variation (Figure 25) that could explain this increase.

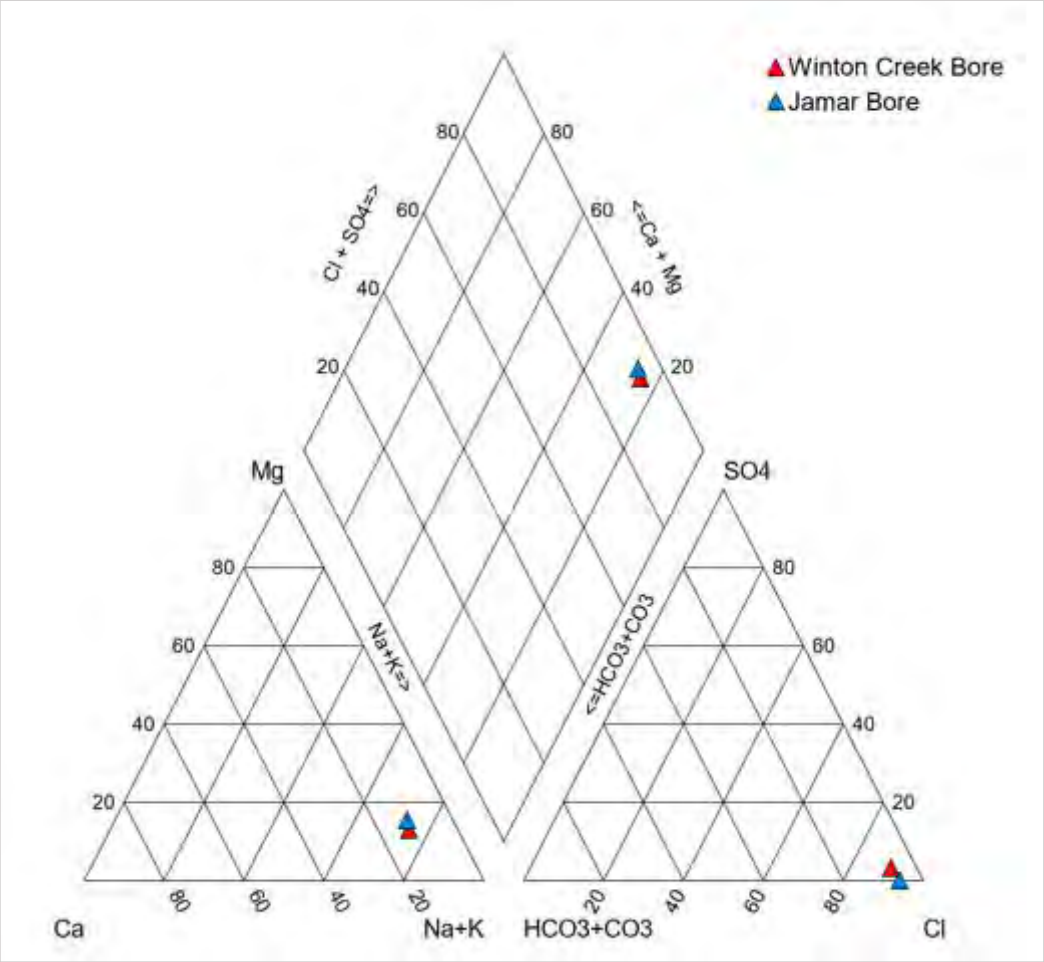


Figure 37 Piper plot - Rewan Group

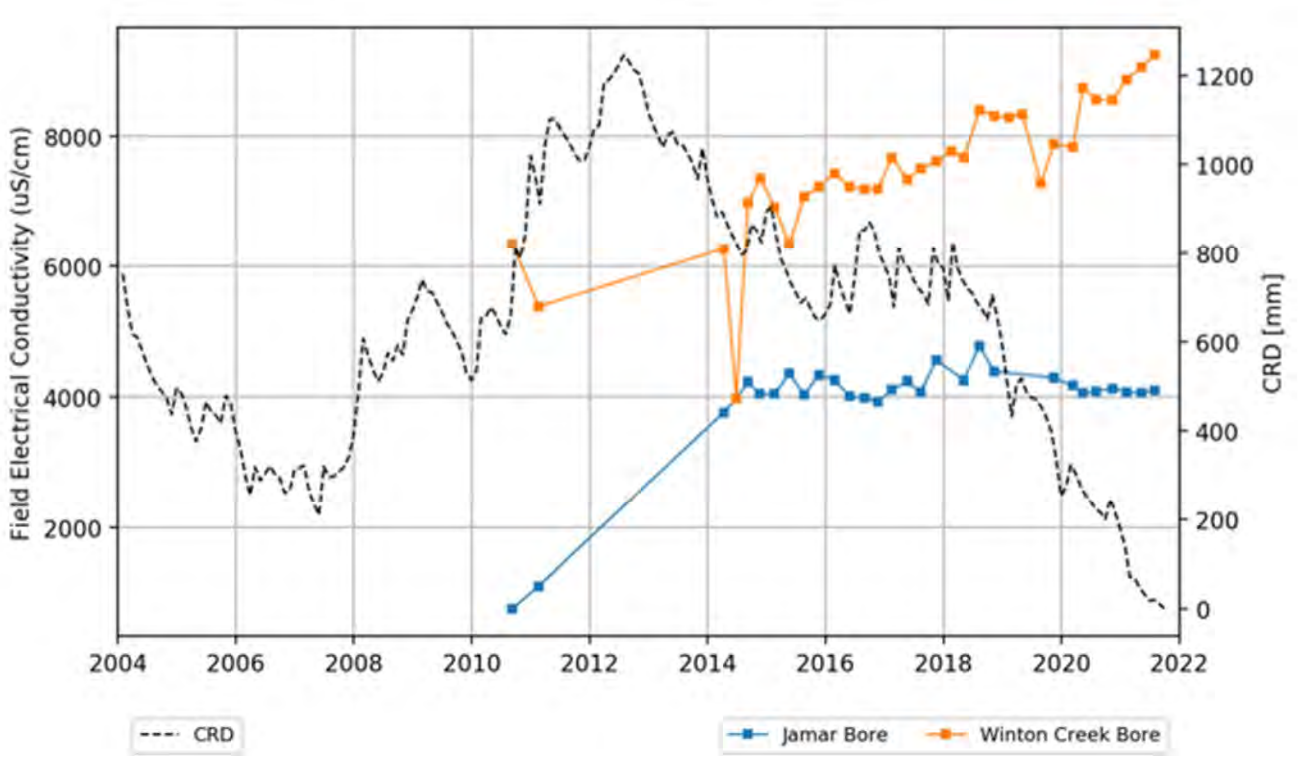


Figure 38 Field EC - Rewan Group

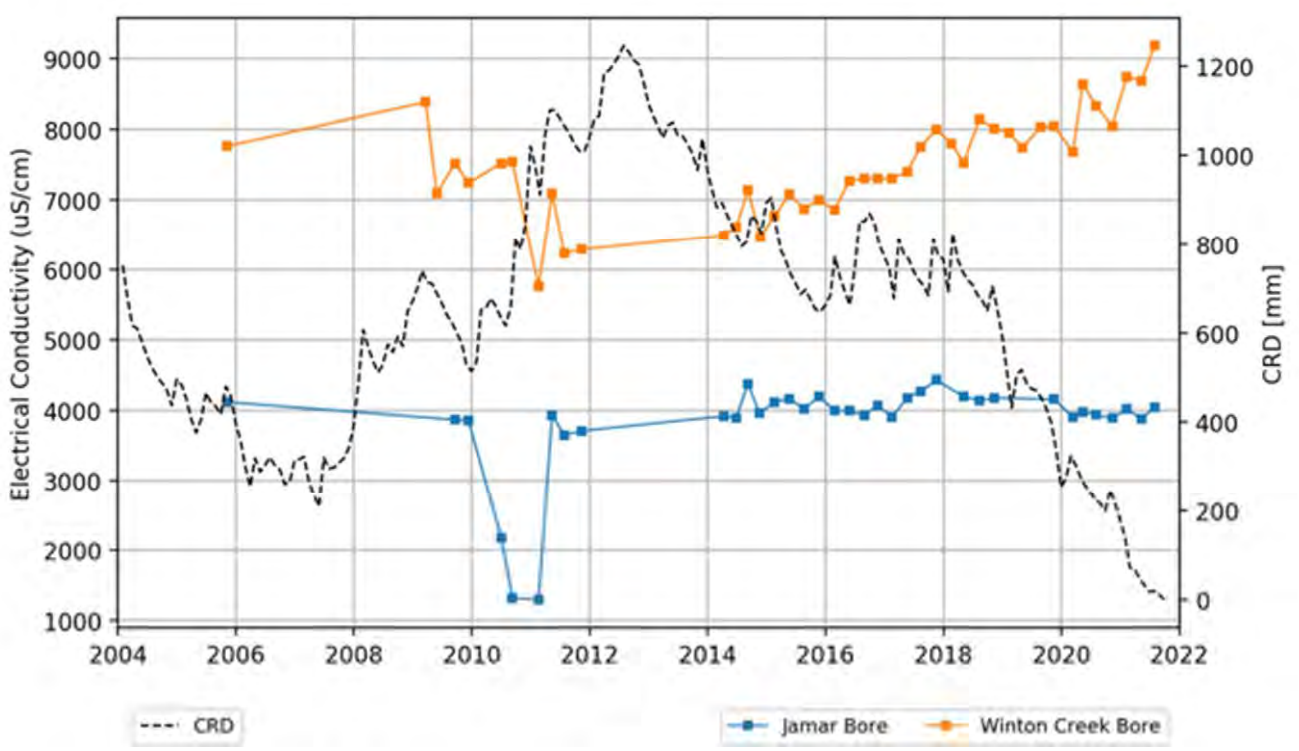


Figure 39 Electrical conductivity (Lab) - Rewan Group

The pH at both Rewan Group bores shows high variability, however, remain between 6.5 and 8.5 (Figure 40) at all times, which is within the lower Nogoa River WQOs for aquatic ecosystem protection (Appendix C).

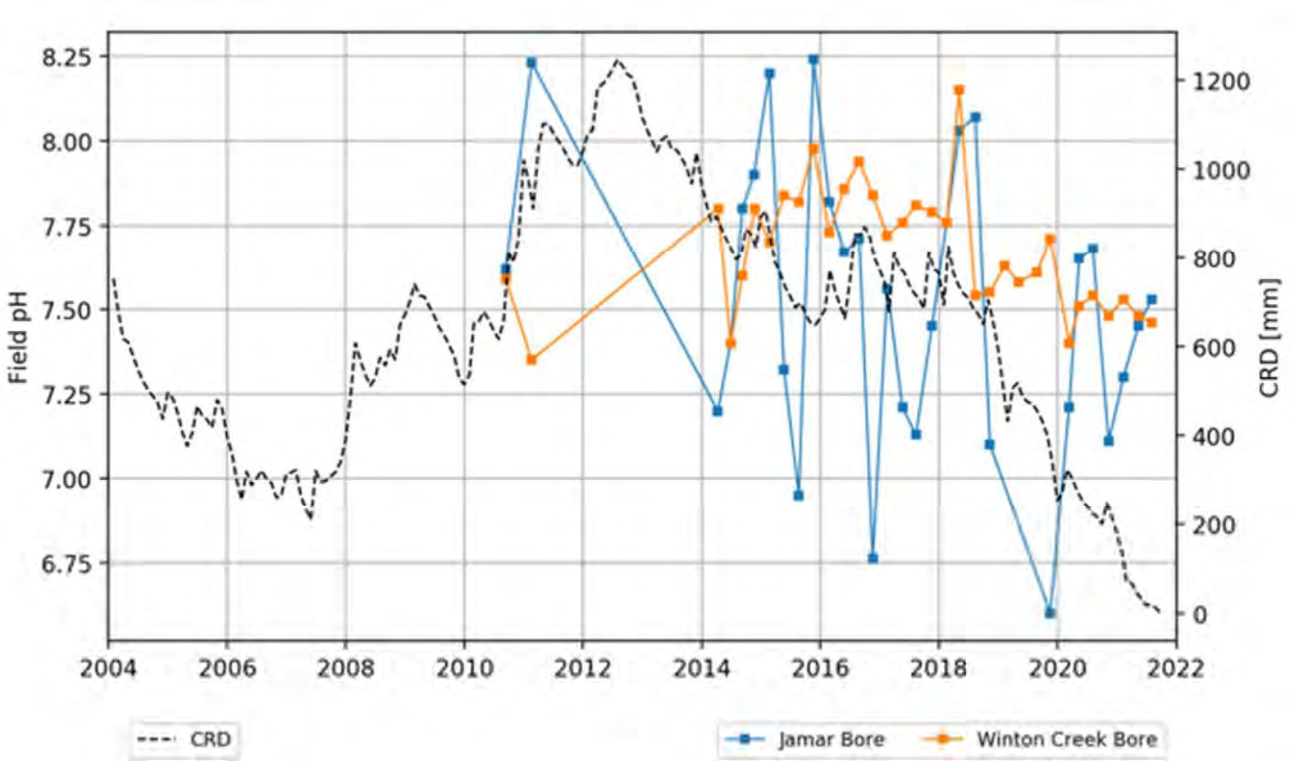


Figure 40 Field pH - Rewan Group

5.4.1.3 Rangal Coal Measures

All bores monitoring the Rangal Coal Measures are Na-Cl dominant with the exception of Karanga Bore (private bore to the south of the open-cut pits), which is Mg-Cl dominant (Figure 41). The presence of Mg ions, which are strongly adsorbed compared to K or Na ions may indicate that this bore monitors an area that receives higher recharge and where groundwater is younger. This corresponds with the location of the bore where the coal measures occur at outcrop and is consistent with persistent low EC value measured at Karanga Bore from 2014 onwards (Figure 42) and groundwater level variations.

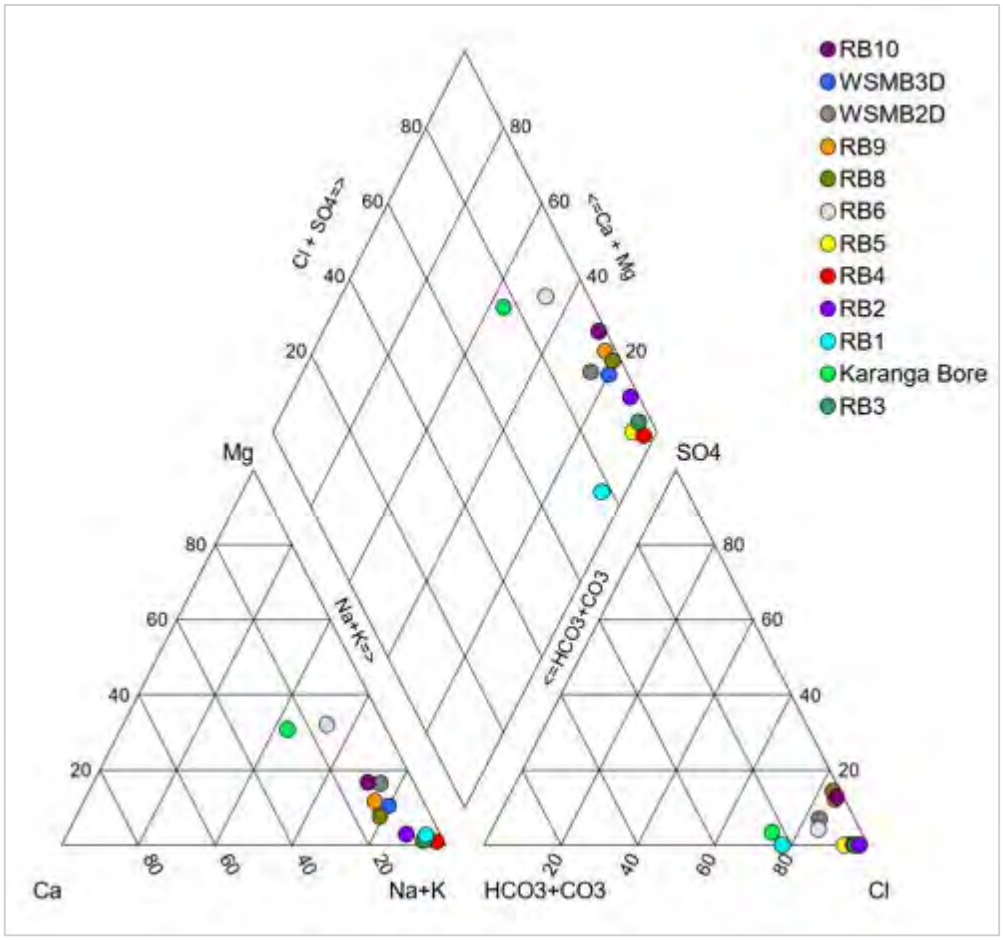


Figure 41 Piper Plot - Rangal Coal Measures

Bores screened within the deeper Rangal Coal Measures generally record relatively stable trends in EC, similar to relatively stable to slightly declining trends in groundwater levels. This highlights the relatively low response to rainfall recharge. An outlier can be seen in Figure 42 for RB01 (field EC), which is likely attributed to a measurement or transcription error.

Monitoring bores WSMB2D, RB02, RB03 and RB04 have 80th percentile above the regional WQO for EC (Appendix C).

The pH variations are between 6.3 and 9.8 (Figure 43), however, all bore have 80th percentiles within the lower Nogoa River EVs for aquatic ecosystem protection (Appendix C). Alkaline pH values at RB04 and RB05 for two sampling events following bore construction are likely due to poor development of the bore initially. RB04 has started to display an upwards trend in pH since mid 2020.

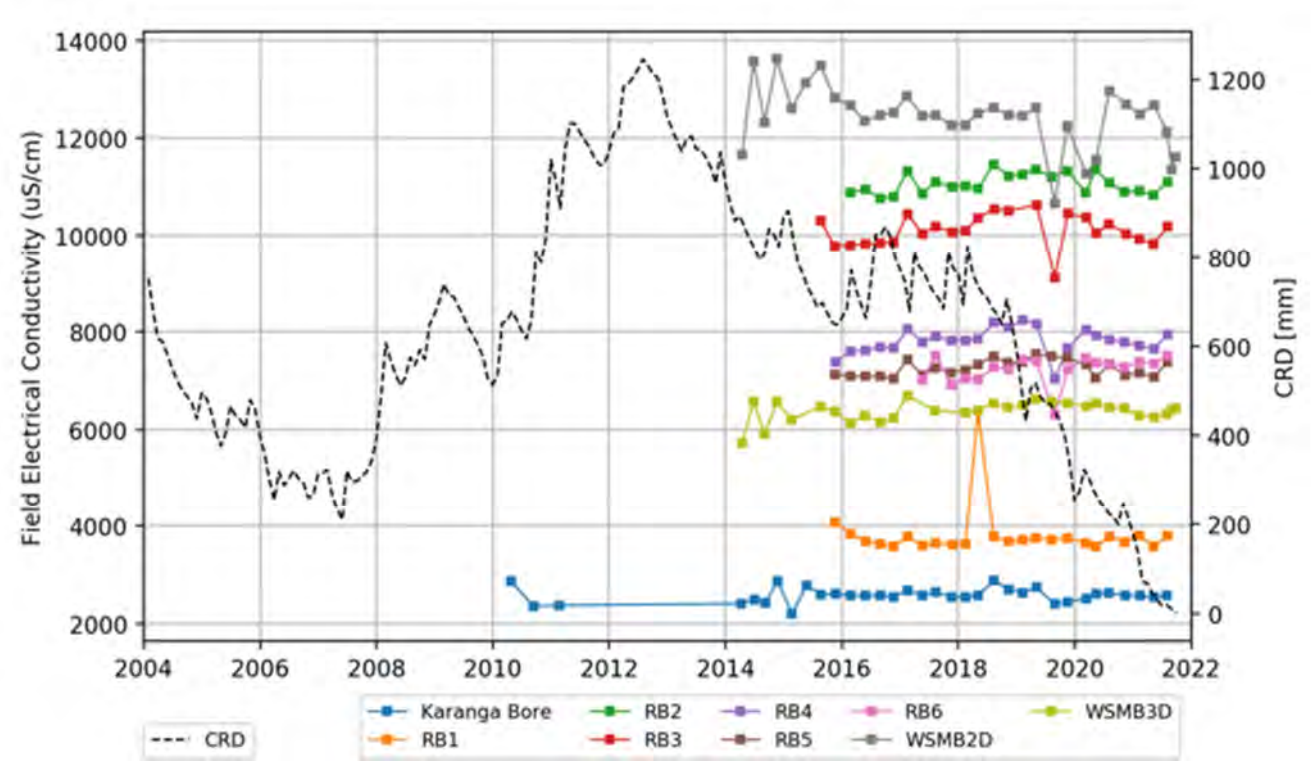


Figure 42 Field EC - Rangal Coal Measures

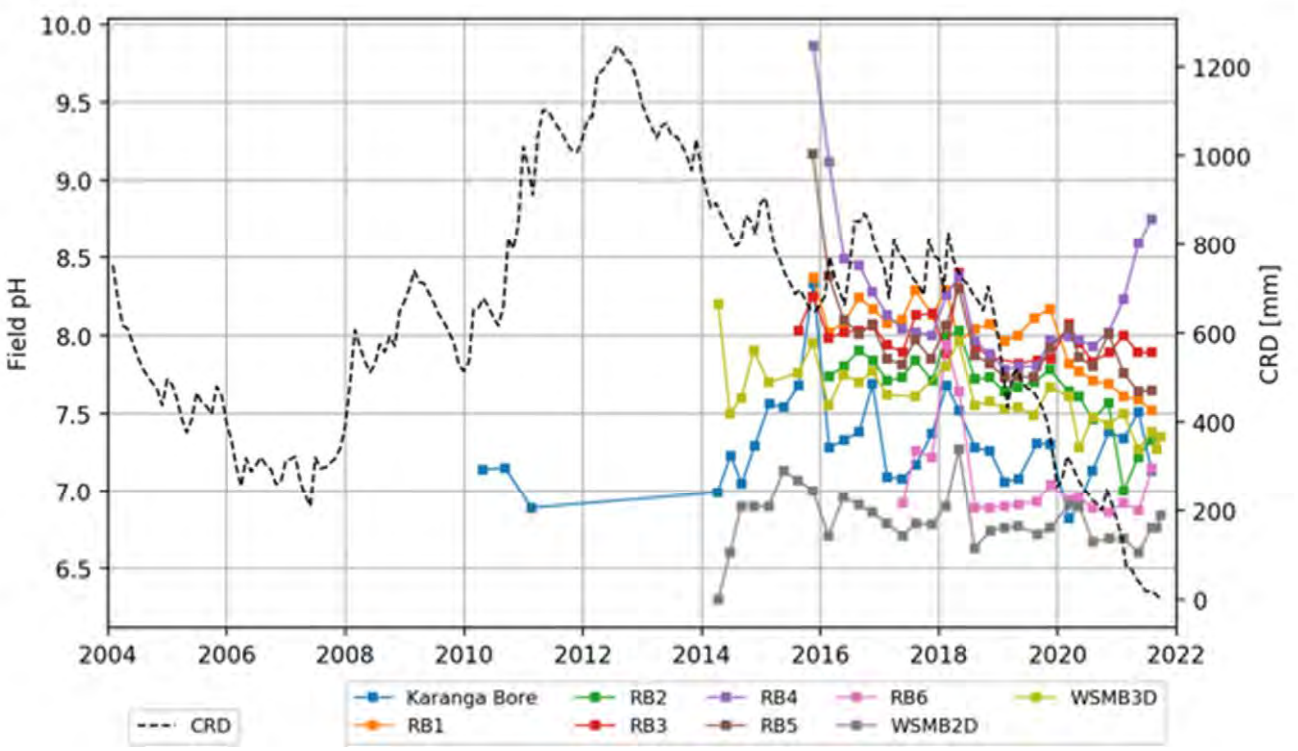


Figure 43 Field pH - Rangal Coal Measures

5.4.2 Metals and metalloids

Metal and metalloids identified as potential stressors in the current EA include iron, arsenic, aluminium, molybdenum and selenium. Metal and metalloids stressors are identified based on their abundance in the geological formations that are disturbed during mining and their potential for leaching.

For the purposes of this statistical analysis and visualisation, values reported as below the laboratory Limit of Reporting (LOR) in the dataset have been assigned a value equal to half of the LOR, consistent with the relevant DES (2021) Guideline. Data provided by the client before 2014 had been assigned a value equal to the LOR.

Figure 44 shows the number of bores with five or more data points that have 80th percentiles for EA metals above the ANZECC guideline for Aquatic Ecosystems (fresh water). Figure 44 shows that selenium, iron and molybdenum have the highest number of bores with an 80th percentile above the guideline. In the alluvium several bores have an 80th percentile above the guideline for these metals, and a few for the Rangal Coal Measures and other formations. A few bores in the alluvium also have an 80th percentile above the guideline for aluminium and arsenic.

Refer to Appendix C for the box-and-whisker plots of all bores, plotted with the local WQO and relevant guidelines.

Individual time series and trend for these bores, in addition with pH, EC and sulphate variations do not indicate that the water quality in these bores is likely impacted by mining activities. Time series for each bore and parameters are provided in Appendix D.

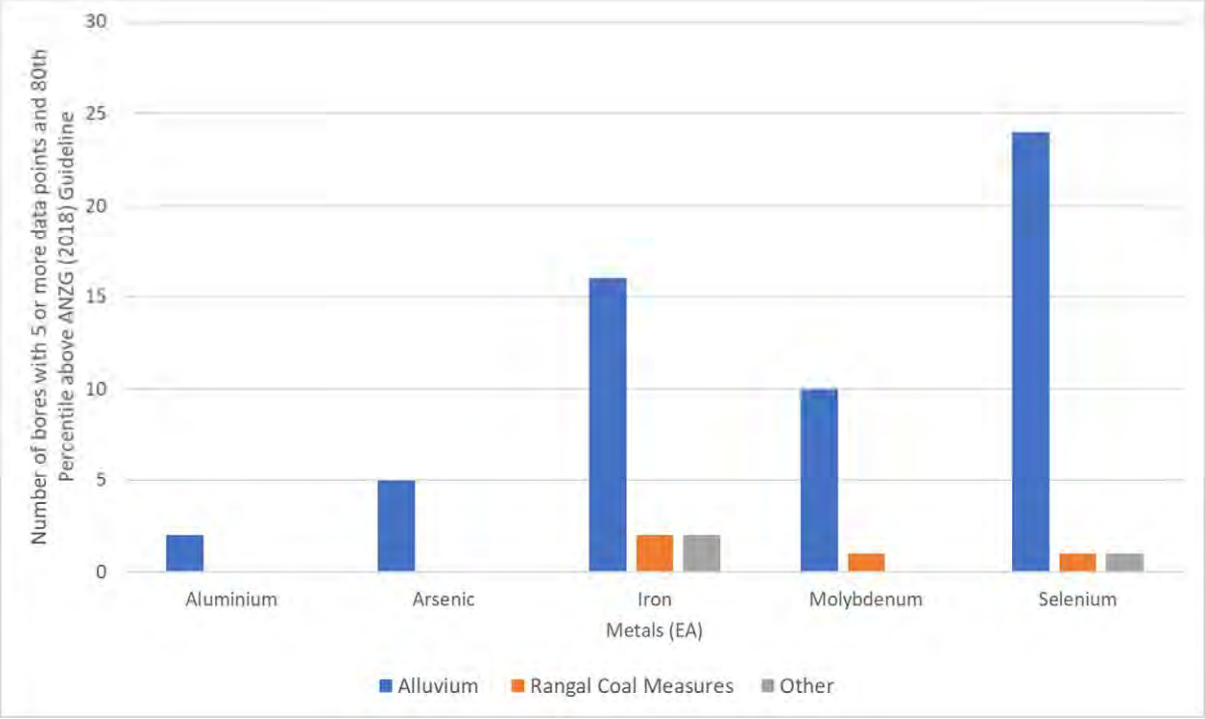


Figure 44 Number of bores with 80th percentile above ANZECC guidelines for aquatic ecosystem protection (95%) in the main hydrogeological units

5.5 Groundwater use and management

The Study area is covered by the Highlands Groundwater Management Area under the Fitzroy Water plan.

The Study area is located in the lower Nogoa Groundwaters of the Fitzroy Groundwater plan (DEHP, 2011). Environmental values (EVs)pertinent to the Project are listed in DEHP (2011b) as:

- Aquatic ecosystems.
- Irrigation.
- Farm supply/use.
- Stock water.
- Primary recreation.
- Drinking water.
- Cultural and spiritual values.

Primary recreation environmental values apply to water reservoirs and connected waterbodies. The lack of connectivity between groundwater and surface water within the Study area means that the primary recreation EV is not relevant to groundwater for the Project.

As presented in Section 5.4, the groundwater quality in the Study area is not suitable for drinking. Most bores are brackish to highly saline. A bore census undertaken by AGE (2017) revealed no bores were used for drinking water within a 10 km radius from Zones 2 and 3. Of the nine private bores identified as being in use, seven were reported to be used for stock water and two bores are in use for irrigation / stock and domestic.

Although groundwater in the Study area may have some cultural and spiritual values. Considering the brackish nature of the groundwater and the availability of freshwater in the nearby Nogoa River, it is unlikely that groundwater in the area will hold significant cultural or spiritual values.

As detailed in HydroSimulations, 2020, the EVs pertinent to groundwater in the vicinity of the Ensham mine are:

- Ecosystems.
- Irrigation.
- Farm supply / use and stock water supply.

5.5.1 Groundwater dependent ecosystems

Ecosystems (aquatic and terrestrial) that are dependent on groundwater or that may be affected by change in groundwater quality and levels are referred to as GDEs. GDE mapping is available from DES. The dataset contains shapefile data which can be grouped into the three categories of GDEs:

- Aquatic GDEs (and surface expressions).
- Terrestrial GDEs.
- Subterranean GDEs (including stygofauna).

The dataset contains information on both known and potential GDE areas. Known GDEs refers to areas that have been verified through field studies while potential GDEs refer to areas that have been mapped at a large scale primarily through analysis of GIS data. The dataset was queried to assess the presence of GDEs within a 10km buffer of the site. The search showed the following GDEs within a 10 km buffer of and are shown on Figure 45:

- Terrestrial GDEs – Potential, derived with low confidence (along the Nogoa River, Winton Creek and at the confluence of Nogoa River, Mackenzie River and Comet River).
- Aquatic GDEs – Potential, derived with low confidence (along the Nogoa River and Winton Creek).

Terrestrial GDEs are ecosystems that are dependent on the sub-surface presence of groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. A desktop assessment and field surveys were undertaken in 2019 and 2020 (AECOM, 2020). Field verified Regional Ecosystem mapping identified four vegetation communities within the terrestrial GDE mapping. Field observations including the lack of wetland flora indicator species, evidence of water stress or high availability of preferential freshwater surface flows confirmed the low likelihood of these communities to utilise and rely on groundwater.

There are no known or high confidence surface GDE expressions and no subterranean GDE expressions within 10km of the Project, with the main channel of the Nogoa River and its anabranches instead mapped as low confidence surface GDE expressions (FRC, 2022a). Aquatic and surface GDE expressions refers to ecosystems reliant on surface water hydraulically connected with groundwater. As discussed in Section 5.3.1, there is little potential for surface expression GDE around the Project.

5.5.2 Stygofauna

A comprehensive stygofauna assessment was undertaken for Zones 2 and 3 (FRC, 2022b). Of 26 groundwater monitoring bores sampled, stygofauna was found in four of the bores, all in the alluvium. These bores are EC 11, EC13, EC14 and RN13020177. The stygofauna assessment found that the environmental value of the stygofauna community within 10 km of the Project was:

- Moderate environmental value in alluvium.
- Low for the Rewan group and Rangal Coal Measures groundwater systems.

The moderate stygofauna values of the alluvial aquifer in the Study area will be managed via a groundwater level, water quality and stygofauna monitoring program that targets bores where stygofauna were recorded (FRC, 2022b).

5.5.3 Springs

A search for springs was conducted using the Springs – Active – Queensland dataset downloaded from QSpatial (DES, 2018). The search showed that there were no active springs within a 10km buffer of Zones 2 and 3 and that the closest active spring is approximately 58 km southeast of the Project.

5.5.4 Wetlands

A search for wetlands was conducted using the Wetland protection area - GBR high ecological significance wetland (DES, 2020). The search showed a wetland of high significance located approximately 5.5 km south of zone 3. Refer to Figure 44 for the location of this wetland. The wetland is surrounded by agriculturally used land, as indicated by farm dams and irrigation pivots in the area. The wetland has not been confirmed by a site visit. The dataset classifies the wetland as a Palustrine wetland. Palustrine wetlands are primarily vegetated non-channel environments of less than 8 hectares.

5.5.5 Irrigation, farm supply / use and stock water (private bores)

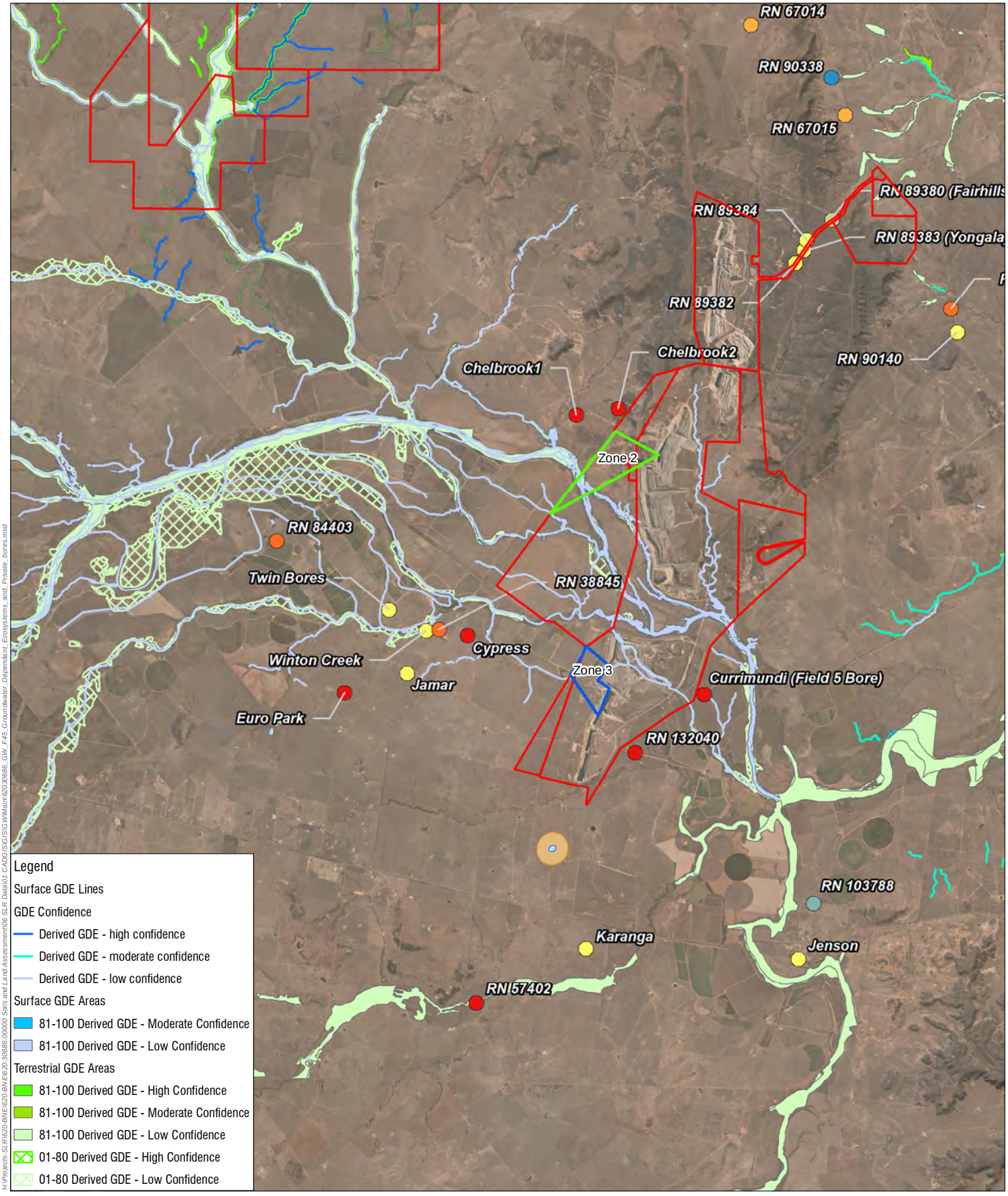
Several private bores extract groundwater adjacent to the mine lease boundary for irrigation, farm supply or stock water. AGE (2017) reported on a bore census conducted in September 2014 coupled with a database search for registered bores on the groundwater database (GWDB), hosted by the Department of Regional Development, Manufacturing and Water.

For this report, an additional database search was conducted and a summary of identified existing bores within a 15 km radius from the proposed lease is provided in Table 12. Overall, groundwater usage is limited in the district, given access to better quality water from the perennial Nogoa River.

The distribution of private bores, categorised according to use, is shown on Figure 45.

Table 12 Existent private groundwater bores

Registered RN (ID)	Bore name	Easting (mMGA)	Northing (mMGA)	Geology	Bore depth (m)	Use
103788	Conmurra	657954	7390072	Fair Hill Formation	66	Irrigation (stock and domestic)
132040	Currimundi	650966	7395998	Burngrove Formation	-	Not in use
57402	Kensington	644749	7386154	Tertiary undifferentiated	-	Not in use
84403	-	636913	7404293	Alluvium	-	Unknown
89380	Fair Hills	658696	7416877	Burngrove Formation	77	Stock and domestic
89383	Yongala	657586	7415693	Burngrove Formation	74	Stock
89382	-	657253	7415184	Burngrove Formation	74	Stock
89384	-	657691	7416083	Burngrove Formation	78	Stock
90140	Railway	663591	7412470	Fair Hill Formation	61	Stock
-	Chelbrook1	648661	7409238	Tertiary undifferentiated	24	Not in use
-	Chelbrook2	650303	7409481	Rangal Coal Measures	>100	Not in use
-	Currimundi (Field 5 bore)	653687	7398270	Alluvium	29	Not in use
-	Cypress	644408	7400570	Rangal Coal Measures	>160	Not in use
-	Euro Park	639581	7398327	Rewan Group	74	Not in use
-	Jamar	642025	7399084	Rewan Group	90	Stock
-	Jenson	657364	7387906	MacMillan Formation	41	Stock
-	Karanga	649043	7388304	Rangal Coal Measures	~50	Stock
-	Twin Bores	641319	7401567	Basal alluvium	18	Stock
-	Winton Creek	642771	7400758	Rewan Group	60	Stock



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F45_Groundwater_Dependant_Ecosystems_and_Private_bores.mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Groundwater Dependant Ecosystems and Private bores

Figure 45

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	630.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Wetland
- Wetland Protection Area
- Zone 2
- Zone 3
- Mining Lease
- Farm Supply (Potable)
- Irrigation, Stock, and Domestic
- Stock and Domestic
- Stock
- Unlikely used (very saline)
- Unknown
- Not in use

SLR

5.6 Conceptual groundwater model

A conceptual cross section for the Study area centred on the Ensham mine is shown in Figure 46. The location of the groundwater specific cross section (B-B') is shown on (Figure 12).

The conceptual regional cross section includes Nogoa River, the agricultural area within the flood plain and the Yongala pit. The Project targets the Aries and Castor seams at depth of 80 m to 210 m below surface. The Rewan Group, a regional aquifer of 100-200 m observed thickness at the Project site, separates the Nogoa River flood plain and alluvium from the proposed underground working. Recharge to the Permian Coal Measures occurs where the formations outcrop. The dewatering from mining results in a lowering of the groundwater levels in the Rangal Coal measures, consequently groundwater flows towards the mine in this formation.

A shallow cross section across the sub-crop is presented in Figure 47. The location of cross section is shown on Figure 16. This cross section is based on the groundwater model layers (Section 6.4.1), with some refinement around the monitoring bores in order to demonstrate how the subcrop is included in the groundwater model. Note that due to the location of the cross section, Nogoa River (Main channel) is crossed twice.

During the winter dry season, the ephemeral Winton Creek and Flood channel 2 are conceptualised as being dry. The ecology assessment observed standing pools of water in Flood channel 2 after a prolonged time with no substantial rainfall. It is not clear if this is stagnant water from the previous rain event or if some of the irrigation water is seeping into the drainage line (through the topsoil). This is marked on the cross section as potential shallow seepage from irrigation.

The groundwater is conceptualised not to receive any substantial amount of natural recharge during the dry season. The water levels in the alluvium are low and groundwater can form discontinued lenses of stagnant water that has high salinity. Nogoa River is disconnected from the groundwater. The saturated water level in the alluvium is approximately 140 mAHD, and the river stage is approximately 147 m AHD (estimated based on DEM, depth of riverbed and average water level in the river). If any seepage would occur, this would be disconnected unsaturated flow, which would be limited based on the surrounding clays.

During the wet season, the groundwater is conceptualised to receive the main recharge by irrigation and limited amounts of recharge through downward seepage from rainfall. The water levels in the wet season are higher than in the dry season and the EC is observed to decrease when groundwater levels increase.

The Rangal Coal measures subcrop below the alluvium in the area between Pit C and Pit B. The cross-section crosses Nogoa River and it is apparent that the River is not in direct connection with the coal measures, but rather separated by the shallow clay and deeper sand layer of the alluvium. The bores that are located along, at, or near the sub-crop are EC07, EC11 and EC14. The cross section shows the latest water levels at those bores, which show that they are below Nogoa River water levels.

The cross section further illustrates the inferred groundwater level between 13020171 and EC03 at two points in time (2004 and 2021), which shows how the rise of the groundwater levels upstream of EC03 may potentially cause the observed groundwater expressions.

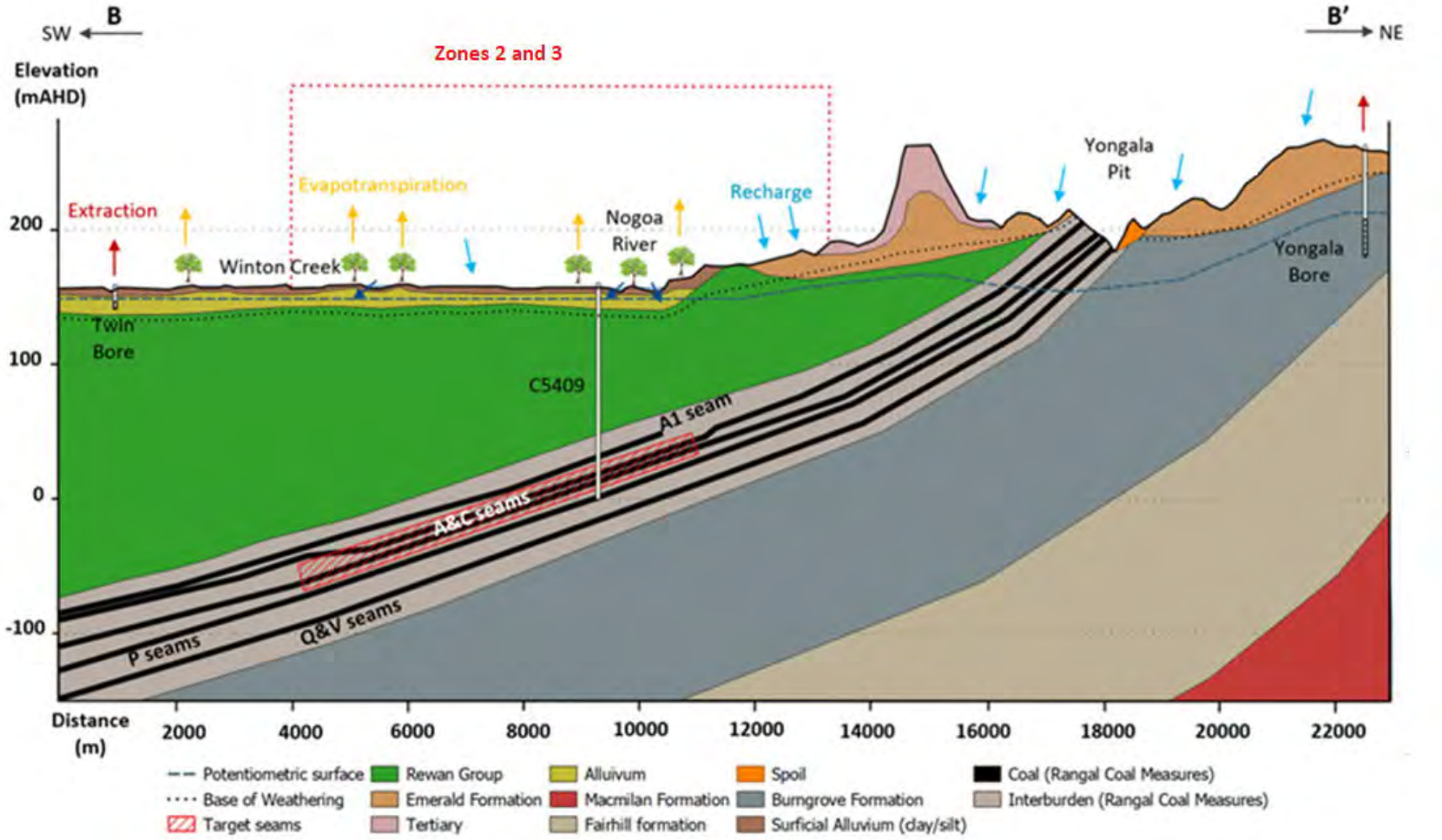


Figure 46 Conceptual groundwater model

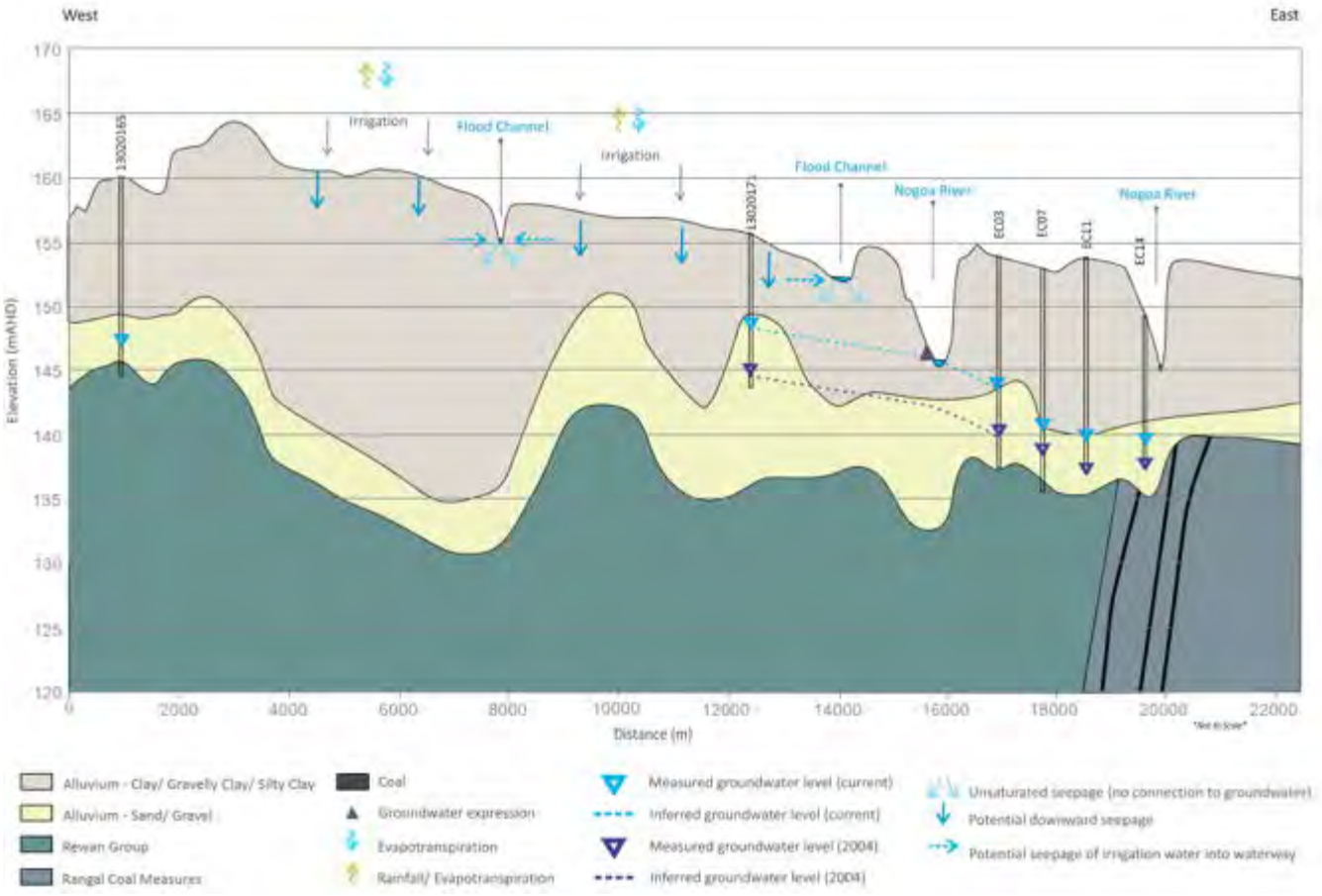


Figure 47 Cross section along the alluvium and sub-crop

6 Groundwater model

6.1 Model objectives

Numerical modelling was undertaken to assess the impact of the Project on the groundwater regime. The objectives of the predictive modelling were to:

- Estimate the groundwater inflow to the mine workings as a function of mine position and timing.
- Simulate and predict the extent and area of influence of dewatering and the level and rate of drawdown at specific locations (bores identified in Section 5.5.5 and the EA monitoring bores for ongoing model validation).
- Identify areas, where groundwater impact mitigation / control measures may be necessary.

6.2 Software

The groundwater model was originally constructed and calibrated in 2016 by AGE (2017) using MODFLOW-USG software, version 1.2.4 (Panday et al., 2013) coupled with mesh generation software AlgoMesh developed by HydroAlgorithmics Pty Ltd (Merrick and Merrick, 2015). Functionality of the MODFLOW-USG package has been employed to represent discontinuous lithology, time-variant hydraulic properties and improved model stability under desaturated conditions.

6.3 Model history and peer reviews

The groundwater model was originally constructed and calibrated by AGE (AGE, 2017). The AGE model was further refined for a final void study to assess several scenarios for final voids, the resulting peer reviewed groundwater model from this study is documented in HydroSimulations, 2020. The study assessed three final landform options. Since then, Scenario 2 (excluding the infrastructure to support a water storage facility) referred to as the Submitted option has been chosen as the final landform based on a triple bottom line assessment, and thus the modelling files for this scenario have been used in this study. This means that in addition to the existing underground mining operations and the Project, the final landforms for the Submitted option are considered in the groundwater model for this report. The open-cut portion of the model remained unchanged from (HydroSimulations 2020, Scenario 2, refer to Table 17 for details) and the underground mining was modelled as to assess the existing underground mining and the Project.

The model (SLR, 2020) was then used for an EIS application (Ensham, 2021) a nd has undergone a peer review by the Sustainable Minerals Institute, University of Queensland. Further, the model was reviewed by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC).

The SLR 2020 model has been modified for this study to reflect model updates (additional observation data and historical mining) and the changed future mine plan to include zones 2 and 3. To increase model performance and maintain better consistency between calibration and prediction periods, the calibration and prediction models (as used in SLR 2020 and previous model versions) have been merged into one model run.

This model development, as reported in this assessment for Zone 2 and 3, has also undergone peer review by SMI.

6.4 Model setup

A groundwater flow model is a computer-based three-dimensional mathematical representation of a groundwater system using the laws of physics. A model is generally developed for all or part of a groundwater system. The modelled area is referred to as the model domain, which exists in three dimensions. It is divided into a number of building blocks to represent key features of the groundwater flow system including the elevation of the ground surface and each geological formation present within the area.

The groundwater model presented here was established with a number of layers that represent the hydrogeological units (Section 6.4.1), based on the data collected and described in Section 5. The model layers get assigned aquifer parameters (Section 6.4.2), initial conditions (i.e. the water level at the start of the modelling period) and boundary conditions (Section 6.4.3). These conditions were adopted from previous model iterations (SLR, 2020).

The model will calculate the response of this conceptualised groundwater system to the following boundary conditions:

- No flow and general head boundary (Section 6.4.3.1 and 6.4.3.2).
- The climatic inputs and outputs, specifically the rainfall recharge and evapotranspiration (Section 6.4.3.3).
- Interactions of the groundwater system with open-cut mining operations (Section 6.4.3.4).
- Interactions of the groundwater system with the underground operations (Section 6.4.3.5).
- Interaction with natural surface water bodies (Section 6.4.3.6).

The model is not only discretised in space, but also in time. The time steps used in this model are described in Section 6.4.4.

6.4.1 Model grid and layers

Figure 48 shows the model domain and the model grid (a voronoi polygon mesh). Consistent with the previous model iterations, there are 12 layers in the model. As a fully unstructured model, the layers are not required to be present in all areas as was the case in former versions of MODFLOW.

All model iterations, including the model presented in this report (SLR 2019 model), utilise the pinching capability of MODFLOW-USG. This capability allows to reduce overall cell count, when a layer is not present at a location (for example coal outcrops). In this model, the maximum number of cells is 770,190 compared to 952,236 cells in an equivalent layered model. This represents a saving of about 20 percent.

The stratigraphic units that are represented by each model layer are summarised in Table 13. The alluvium and the Rewan Group are both discretised with two model layers. The alluvium is subdivided, because two distinct layers are observed (Section 5.3.1). The Rewan Group was subdivided to provide better vertical resolution. Further, the division into two layers allows to assign different parameters. The Rangal Coal Measures are split into seven layers, accounting for three coal seams and the overburden, interburden and underburden.

Table 13 Stratigraphy - model layer summary

Model layer	Geological age	Stratigraphic unit	
1	Quaternary	Low permeability alluvium and regolith	
2		Alluvium (basal gravel) and regolith	
3	Triassic	Rewan Group - fine grained sandstone and siltstone	
4			
5	Permian	Rangal Coal Measures	Sandstone, siltstone and shale
6			Aries 1 seam
7			Sandstone, siltstone and shale
8			Aries 2 seam and Castor seam
9			Sandstone, siltstone and shale
10			Pollux seam
11			Sandstone, siltstone and shale
12		Burngrove Formation	Sandstone, siltstone, shale and coal

6.4.2 Model properties

Summaries of the model layer calibrated properties from Hydrosimulation, 2018 and adopted in this model are presented in Table 14. A comparison between adopted hydraulic conductivities and field data is presented in Table 15. Appendix F, Figure F1-1 to Figure F1-12 show the hydrostratigraphic zones for each layer.

Table 14 Simulated aquifer properties

Model layer	Lithology	Horizontal hydraulic conductivity Kh (m/day)		Vertical hydraulic conductivity Kv (m/day)		Specific yield Sy (-)	Specific storage Ss (m)
		From (lower value)	To (upper value)	From (lower value)	To (upper value)		
1	Surficial alluvium (clay / silt)	1.00E-03	1.00E-03	5.00E-05	5.00E-05	7.50E-03	1.00E-06
1,2	Regolith	2.80E-01	2.80E-01	7.00E-03	7.00E-03	7.50E-03	1.00E-06
1,2	Permian subcrop	3.00E-02	3.00E-02	1.20E-04	1.20E-04	1.50E-02	1.00E-06
2	Basal alluvium (sand / gravel)	1.00E+01	1.00E+01	5.00E-01	5.00E-01	1.50E-01	5.00E-06
3	Rewan Group	4.20E-02	4.20E-02	2.10E-04	2.10E-04	7.50E-03	1.70E-06
4	Rewan Group	1.20E-04	1.20E-04	6.00E-07	6.00E-07	7.50E-03	1.50E-06
5	Sandstone / siltstone / shale	2.00E-04	2.00E-01	4.55E-06	4.55E-03	3.75E-02	1.00E-07
6	Aries 1 Seam	1.00E-02	1.00E+01	2.78E-04	2.78E-01	7.50E-03	1.00E-07
7	Sandstone / siltstone / shale	4.00E-04	2.00E-01	3.57E-06	3.57E-03	1.38E-03	5.00E-07
8	Aries 2 and Castor Seam	5.00E-03	5.00E-01	2.50E-04	2.50E-01	7.50E-03	5.00E-07
9	Sandstone / siltstone / shale	1.00E-04	1.00E-01	5.00E-06	5.00E-03	7.80E-04	5.00E-07
10	Pollux Seam	5.00E-03	5.00E+00	2.78E-04	2.78E-01	7.50E-03	5.00E-07

Model layer	Lithology	Horizontal hydraulic conductivity Kh (m/day)		Vertical hydraulic conductivity Kv (m/day)		Specific yield Sy (-)	Specific storage Ss (m)
		From (lower value)	To (upper value)	From (lower value)	To (upper value)		
11	Sandstone / siltstone / shale	1.00E-04	1.00E-01	4.17E-06	4.17E-03	7.73E-04	5.00E-07
12	Burngrove Formation	1.00E-05	1.00E-04	8.60E-06	8.60E-06	1.00E-03	5.00E-06
-	Spoil	1.00E+00	1.00E+00	1.00E-01	1.00E-01	4.00E-02	1.00E-03
-	Void	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+00	1.00E-04
-	Bord and Pillar zone	1.00E+02	1.00E+02	1.00E+02	1.00E+02	5.00E-01	1.00E-04
-	Faults	1.00E-05	1.00E-04	1.00E-06	1.00E-05	1.00E-02	1.00E-05

Table 15 Adopted properties relative to field data ranges

Model layer	Lithology	Validated horizontal hydraulic conductivity kh (m/day)		Field data horizontal hydraulic conductivity kh (m/day)	
		From (lower value)	To (upper value)	From (lower value)	To (upper value)
1	Surficial alluvium (clay / silt)	1.00E-03	1.00E-03	9.00E-04	1.00E-03
1,2	Regolith	2.80E-01	2.80E-01	4.30E-01	4.30E-01
1,2	Permian subcrop	3.00E-02	3.00E-02	-	-
2	Basal alluvium (sand / gravel)	1.00E+01	1.00E+01	9.00E-02	1.00E+02
3	Rewan Group	4.20E-02	4.20E-02	-	-
4	Rewan Group	1.20E-04	1.20E-04	-	-
5	Sandstone / siltstone / shale	2.00E-04	2.00E-01	4.00E-03	4.00E-03
6	Aries 1 Seam	1.00E-02	1.00E+01	9.00E-03	5.90E+00
7	Sandstone / siltstone / shale	4.00E-04	2.00E-01	1.80E-02	1.19E+00
8	Aries 2 and Castor Seam	5.00E-03	5.00E-01	9.00E-03	5.90E+00
9	Sandstone / siltstone / shale	1.00E-04	1.00E-01	1.80E-02	1.19E+00
10	Pollux Seam	5.00E-03	5.00E+00	9.00E-03	5.90E+00
11	Sandstone / siltstone / shale	1.00E-04	1.00E-01	1.80E-02	1.19E+00
12	Burngrove Formation	1.00E-04	1.00E-04	-	-
-	Spoil	1.00E+00	1.00E+00	-	-

6.4.3 Boundary conditions

The model boundary conditions that were applied consistent with the previous model iterations (SLR, 2020). Figure 48 shows the General head boundary (GHB) to the southwest and south of the model, the mining related drain boundaries and the surface water related River and Streamflow boundaries. They are described in more detail below.

6.4.3.1 No flow boundary

No-flow boundary conditions were applied for the north-west to eastern boundary, which means that no groundwater flow occurs across these boundaries. These boundaries were chosen by earlier model iterations and were kept consistent in this model.

6.4.3.2 General head boundary

General head boundaries represent regional inflow or outflow. The GHBs were chosen by earlier model iterations (Section 6.3) and were kept consistent in this model. The GHB is applied to the south and southwest of the model domain for all model layers. The GHB heads range is from 140 to 150 mAHD (no change over time).

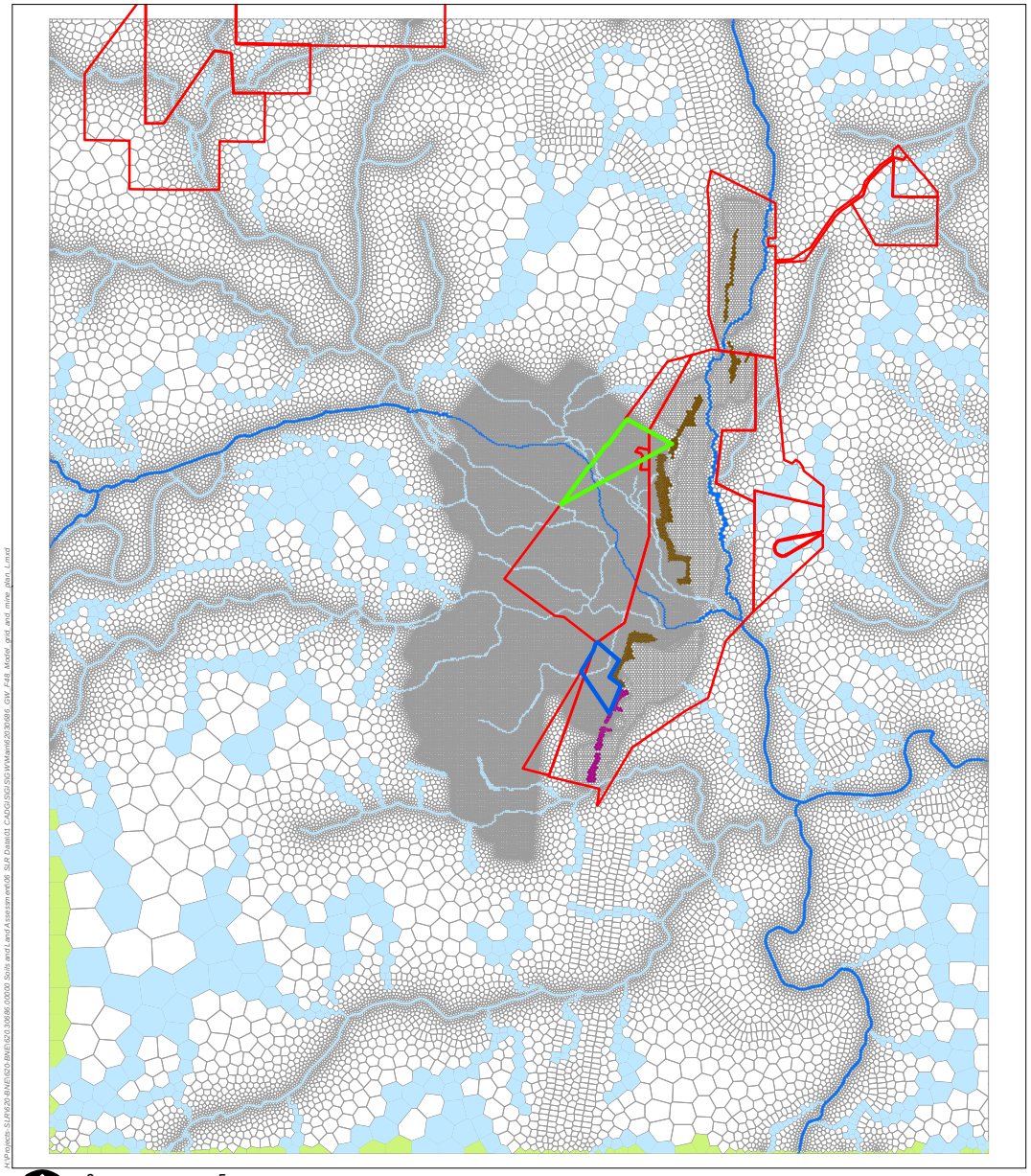
6.4.3.3 Recharge and evaporation

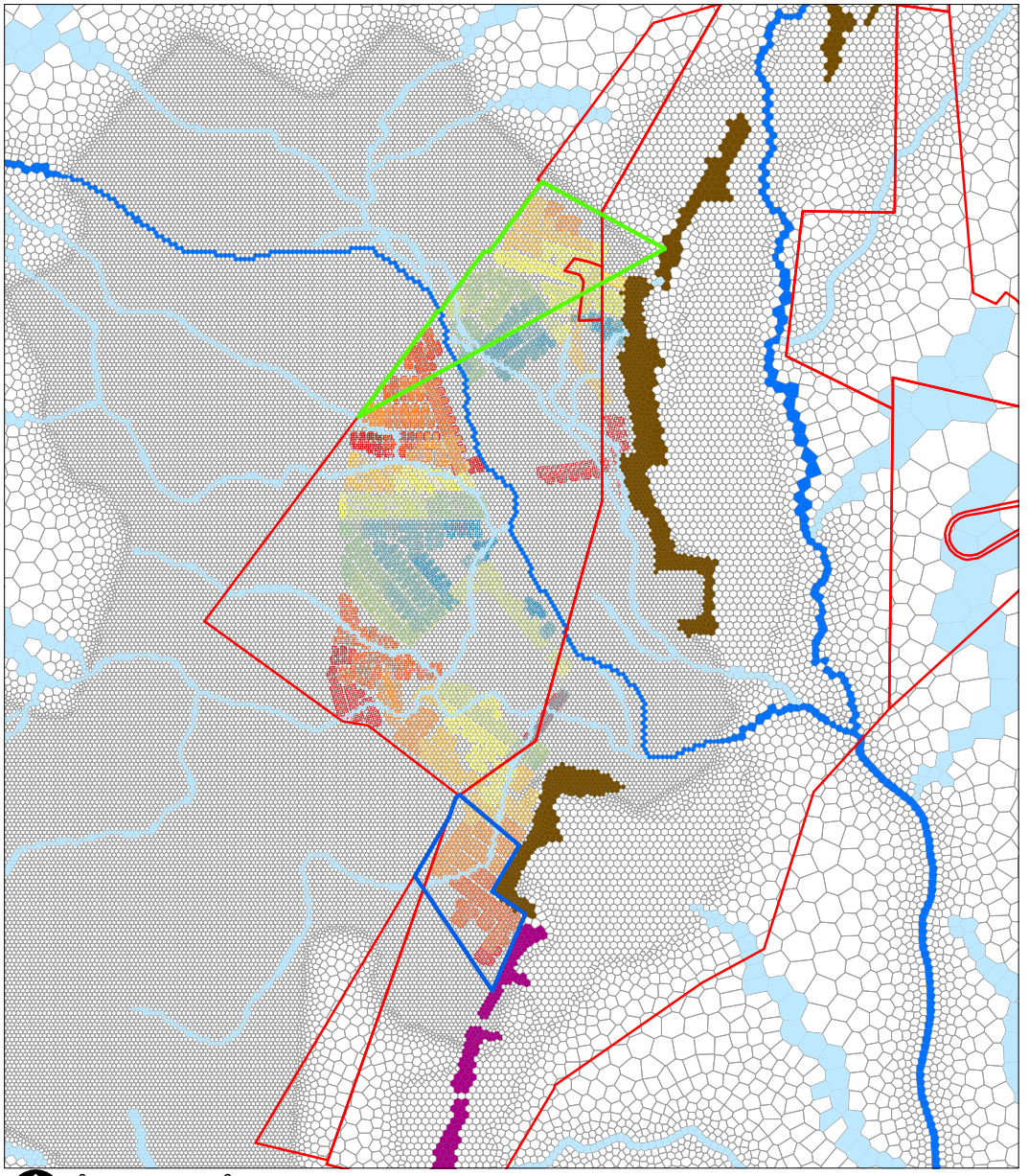
Recharge from rainfall assigned to the top model layer as a percentage of the rainfall. The calibrated values from HydroSimulations, 2020 are presented in Table 16 and were adopted in this model. Appendix F, Figure F2-1 presents the zones for the groundwater recharge.

Table 16 Recharge values

Zone	Diffuse recharge rate	
	mm / yr	Per cent of annual rainfall (%)
Surficial alluvium	5.18	0.8
Regolith	0.032	0.005
Permian subcrop	0.032	0.005
Spoil	53.1	8.2
Open-cut void	647.5	100

The evapotranspiration rates are 1,030 mm/year for the general areas and 1,650 mm/year for the open water bodies of the voids, which equates to 50% and 80% of the long-term pan evaporation observations of 2,062 mm/year. The rates are applied at the surface at the reported values and decrease linearly over depth to zero at the so-called extinction depth of 2 m BGL. This means that the evapotranspiration processes are most prevalent at the surface and expected to reach down to 2 m below ground surface, representing the root zone.





0 5 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:275,000

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:100,000

Project No.:620.30686
Date: 08-Mar-2022
Drawn by: PM
Sheet Size: A4

SLR

Legend

- Stream Cell (STR)
- River Cell (RIV)
- Open Cut Drain Cell (DRN)
- Constant Head Boundary (CHB)
- General Head Boundary (GHB)
- Zone 2
- Zone 3
- Model Grid
- Mining Lease

Underground Mining Year

- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029

GROUNDWATER IMPACT ASSESSMENT
Model grid, boundary conditions and mine plan

Figure 48

6.4.3.4 Open-cut mining

The open-cut mining is finishing in 2022. From then onwards, the open-cut pits will continue to be rehabilitated or used as water storages. Pit C and D remain dewatered to allow access to the portals for the underground mine.

The open-cut mine and associated spoils are implemented through the use of MODFLOW drain cells and the time variant materials (TVM) process. Figure 48 shows the modelled mine progression. The drain cell conductance was selected as 100 m^2 / day.

The drain cells approach was used based on the HydroSimulations model (2020). The implemented water management strategies for each pit from HydroSimulations (2020) have been adopted and are reproduced in Table 17.

After open-cut operations cease, pits will be backfilled with spoil. This creates a porous medium through which water can flow. This water is treated as groundwater and is included in the model through implementation of the TVM package. Similar to an aquifer, the waste material is assigned hydraulic properties (a conductivity of 1 m/day and storage properties, a specific yield of 0.04). Water stored in waste material impacts on rate of void water rebound and pit water level predictions. Having the material in place also reduces the evaporation volume compared to an open water surface setting. It is thus critical to include these flows in the groundwater model.

Table 17 Open-cut modelled water management

Pit	Water management
A south	Constant head boundary, level as observed up to 2021, then interpolated to the long-term estimate (HydroSimulations, 2020)
A north	Constant head boundary, level as observed up to 2021, then interpolated to the long-term estimate (HydroSimulations, 2020)
B	Actively dewatered to end 2028. Following this time natural rebound permitted*
C	Actively dewatered to end 2028. Following this time natural rebound permitted*
D	Actively dewatered to end 2028. Following this time natural rebound permitted*
E	Actively dewatered to end 2028. Following this time natural rebound permitted
F	Actively dewatered to end 2022. Following this time natural rebound permitted
Y	Actively dewatered to end 2017. Following this time natural rebound permitted

Note * The open-cut model drains switch off at the end of 2028, consistent with HS, 2020. However, should there be water in pits C and D after 2028, it will be dewatered until the end of the Project for underground access/mining/rehabilitation.

6.4.3.5 Underground workings

The underground bord and pillar mine simulates the gradually developing underground workings. The mine plan for the calibration model was updated to reflect mining since the latest model iterations (September 2018 to September 2021). The underground mine plan for the predictive model has been updated to include the Project mine plan.

The mining is modelled using drain cells. A drain cell in a groundwater model has two properties assigned to it, a water level (to which the model attempts to drain this cell to) and a conductance (a parameter that defines how much resistance the surrounding groundwater shows against the drain).

The model then calculates the inflow into the drain cell based on these two parameters. First, it compares the groundwater level to the drain level. If the groundwater is above this level, the drain cell will remove water until the groundwater and the drain cell head are at the same level, using the drain cell conductance as a factor. If the groundwater level is below the drain cell head, no water is removed from the groundwater. The heads in the drain cells in the model range from -74.85 mAHD in the west to 94 mAHD in the east for the underground workings, accounting for the dip in the westerly direction. The drain cell conductance was selected as 100 m^2 / day in accordance with previous model iterations (Section 6.3).

The underground mining is represented by two model packages.

- Firstly, as described above, when mining moves into a model cell, the model uses drain cells to actively dewater the area. The drains are active for two years. This approach is consistent with the previous model iterations (Section 6.3). Therefore, the model provides ingress predictions up to December 2030, ie two (2) full calendar years of active drains (2029 and 2030).
- Secondly, once the active mining moves out of the model cell, an underground void is left behind. This void is represented by changing the material properties of the area, using the TVM. The horizontal and vertical K was increased to 100 m/day. The specific yield for the underground workings after coal removal was set to 0.5 (i.e. 50% of coal left in place and 50% of void space created).

6.4.3.6 Rivers

Groundwater interaction with surface drainage was modelled using the stream routing (STR) package for major rivers and creeks and using the river (RIV) package for minor drainage lines. Both boundary conditions have a surface water head assigned to them (steady state or transient). The surface water level in each cell that has a STR or RIV component is compared to the groundwater level in the respective cell:

- If the groundwater level is higher than the surface water level, the model will calculate the discharge of groundwater into the surface water based on the stream or river bed conductance (a variable describing the permeability of a stream or river bed).
- If the surface water level is higher than the groundwater level, the model will calculate the infiltration of surface water into the groundwater based on the river bed conductance (STR package only).
- If the surface water and groundwater are in equilibrium, no flow is calculated.

Stream cells are set up to use the dynamic stage functionality of the STR package. This represents a basic flow volume - stage relationship. During the flood periods in particular, stream stages are elevated and there is an increase of water recharged into the groundwater system. Conductances are consistent with the previous model in the 200-300 m^2/day range. The low hydraulic conductivity in the upper alluvial layer is limiting the water flux between river and alluvium in line with the conceptual model.

River cells have moderate conductances ranging from 5 to 20 m^2 / day and are set up so that they act as drain cells (gaining water, but never losing water) (AGE, 2017). This boundary condition is used for smaller drainage lines.

6.4.3.7 Other stresses

In the model, irrigation by groundwater pumping is not explicitly represented because it is considered minor.

6.4.4 Temporal discretisation

Previously, two models were used to assess the impact of the Project on groundwater resources. These two models have now been combined into one model run. For the calibration period, the model run was only performed up to the end of 2021. For the prediction case, the full model run, from 1995 to 2261, was performed. The time dependent parameters (such as recharge and river levels) are assigned to the model with so called stress periods. These stress periods are quarterly for the predictive part of the model and annual for the recovery model. Quarterly stress periods can account for seasonality. When using annual stress periods, the annual mean of the parameter in question is assigned, which is often used for long-term model runs, where seasonality might not be relevant.

The groundwater model's temporal discretisation includes:

- Validation runs from 1995 to 2021 including historical open-cut and underground mining.
- Predictive runs to assess three scenarios:
  - the existing operations (Model 2a): with active mining from January 2022 to December 2027 (plus one more year of active drains), as approved under current EA. The model covers the time period from 2028 to 2262 to capture short term recovery (quarterly stress periods to model the initial recovery response) and long-term recovery (annual stress periods to model the long-term recovery response).
  - The Project (Model 2b): with active mining from January 2022 to December 2029 (plus one more year of active drains), as proposed for the Project. The model covers the time period from 2030 to 2262 to capture short term recovery (quarterly stress periods to model the initial recovery response) and long-term recovery (annual stress periods to model the long-term recovery response).
  - The Null run (Model 2c): no underground mining from January 2022 onwards, as a hypothetical "no future underground mining" scenario. The model covers the time period 2022 to 2262 to capture short term recovery (quarterly stress periods to model the initial recovery response) and long-term recovery (annual stress periods to model the long-term recovery response).

The set-up of the temporal discretisation is presented in Table 18.

Table 18 Model and stress periods

Model period	Stress period number	Stress period Length	Time frame covered	Comments
1 Validation model	1 - 2	5 years	1/9/1995-31/8/2005	
	3 - 55	3 months	1/9/2005-31/8/2018	
	56	4 months	1/9/2021-31/12/2018	Adjustment to calendar quarters
	57 - 68	3 months	1/1/2019- 31/12/2021	Additional validation period
2a Existing operations	68 - 96	3 months	1/1/2022-31/12/2028	Active dewatering[1]
	96 - 224	3 months	1/1/2029-31/12/2060	Short term recovery

Model period	Stress period number	Stress period Length	Time frame covered	Comments
	225 - 425	1 year	1/1/2061-31/12/2262	Long term recovery
2b Project	68 - 104	3 months	1/1/2022-31/12/2030	Active dewatering[1]
	105 - 224	3 months	1/1/2031-31/12/2060	Short term recovery
	225 - 425	1 year	1/1/2061-31/12/2262	Long term recovery
2c Null run	68 - 96	3 months	1/1/2022-31/12/2028	Active dewatering[2]
	96 - 224	3 months	1/1/2029-31/12/2060	Short term recovery
	225 - 425	1 year	1/1/2061-31/12/2262	Long term recovery

Notes: 1 Active mining with two years of active drains as per model conceptualisation (i.e mine year plus one additional year), 2 open cuts only, portals Pit C and D.

6.4.5 Validation

6.4.5.1 Groundwater levels

As the groundwater model was last calibrated in 2018 (HydroSimulations, 2020), the calibrated parameters of that peer-reviewed calibrated model were applied, and the model was then evaluated against the updated water level observations collected since the last calibration. The Australian groundwater modelling guidelines recommend a scaled root mean square (SRMS) error less than 10 per cent (Barnett et al. 2012).

The root mean square (RMS) error for the transient model is 7.85 m and the Scaled SRMS error is 5.0 per cent. This is within acceptable limits recommended by Barnett et al. (2012).

The comparison between the observed water levels and the water levels simulated for the validation period (01/09/2005 to 31/12/2021) is presented on Figure 49.

In addition to those observed versus modelled water levels, the figure shows three types of lines:

- Line of equality: This line represents the ideal modelling outcome, i.e. the line that represents the case where observed water levels are matched exactly by the model.
- The 95% confidence interval of equality line: The goal for model calibration is to have the 95% confidence interval lines fall either side of the equality line. In this instance, both lines are above the line of equality, which means that there is a slight bias in the modelled water levels.
- The 95% interval lines: the interval between those two lines represents the area where 95% of the total number of data points are expected to occur. In this instance, only 80% of the points (9,669 of 12,036 observations) fall within the line, showing some room for improvement for the calibrations.

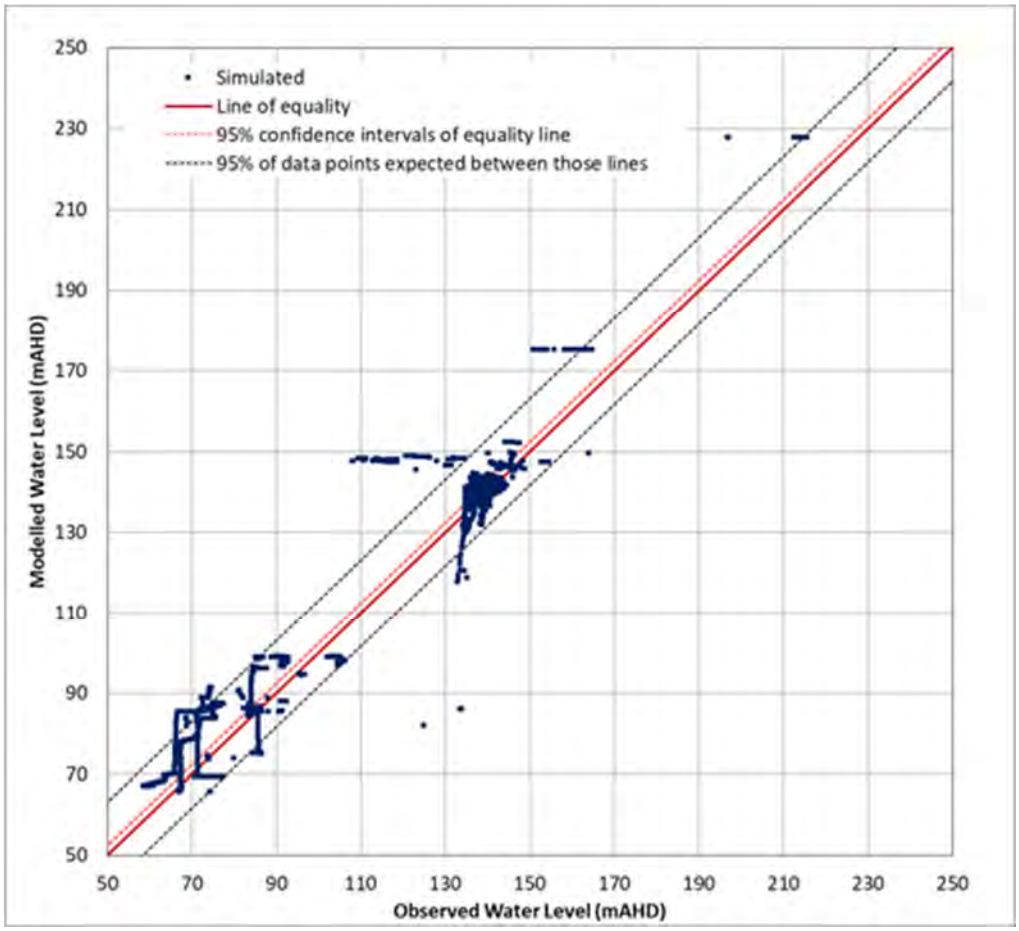


Figure 49 Observed vs computed target water levels

A full set of calibration hydrographs is presented in Appendix E. The hydrographs are consistent with the hydrographs presented in Hydrosimulations, 2018 and SLR, 2020.

Figure 50 presents four selected calibration hydrographs. Generally, the model reproduces water levels well within the alluvium, especially during the 2008 - 2014 period. Before that (1995-2008), the model is not reproducing the observations as well, this may be due to the initial conditions (sparse data available) and stress period length (5 yearly). As discussed in Section 5.3.1, EC01 is likely showing a response to irrigation which is not explicitly reproduced in the model. Prior to 2008, the model generally overestimates water levels in the alluvium and after 2014, the model generally underestimates water levels in the alluvium. However, the decreasing trend that is simulated from 2014 stabilises in 2018 and water levels show a slow increase in 2019, in accordance with observed values. In general, the model reproduces observed streamflow response and flood events quite well.

The RB series of bores (Regional Bores, refer to Table 7) is installed in coal seams at depths between 100 and 240 mBGL. Figure 51 presents two selected RB bores. There is some mining effect observed at RB03, with the modelled rate of drawdown being larger than observed. The model generally overestimates the heads at these bores by 0.5 to 7.0 m. RB5 shows the connection to the open-cut pits, with the water levels recovering in line with the observed pit water level (also refer to Section 5.3.3.2).

At each monitoring location, the average difference between the observed and the modelled water levels is calculated, and the result is the average residual. Figure 52 shows the spatial distribution of the average residuals over the model domain.

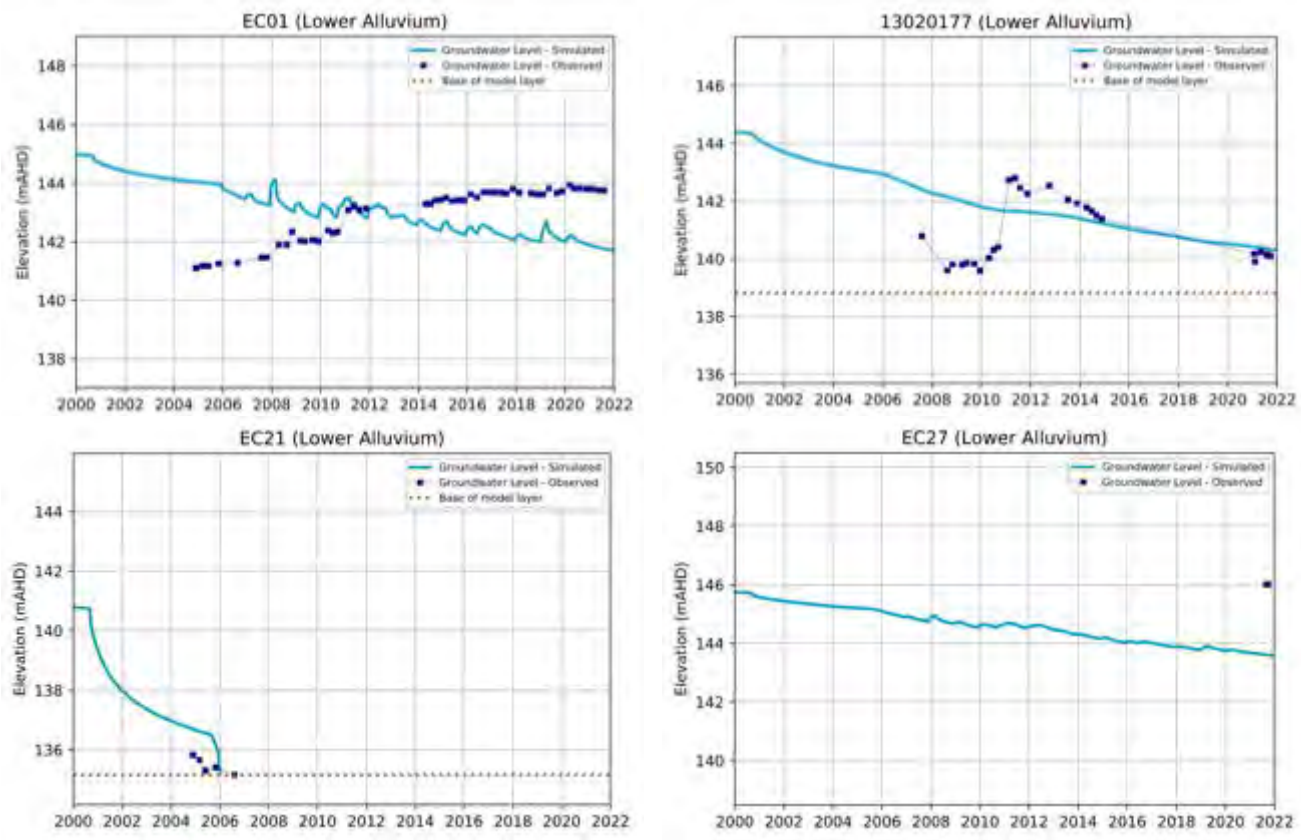


Figure 50 Calibration hydrographs (alluvium)

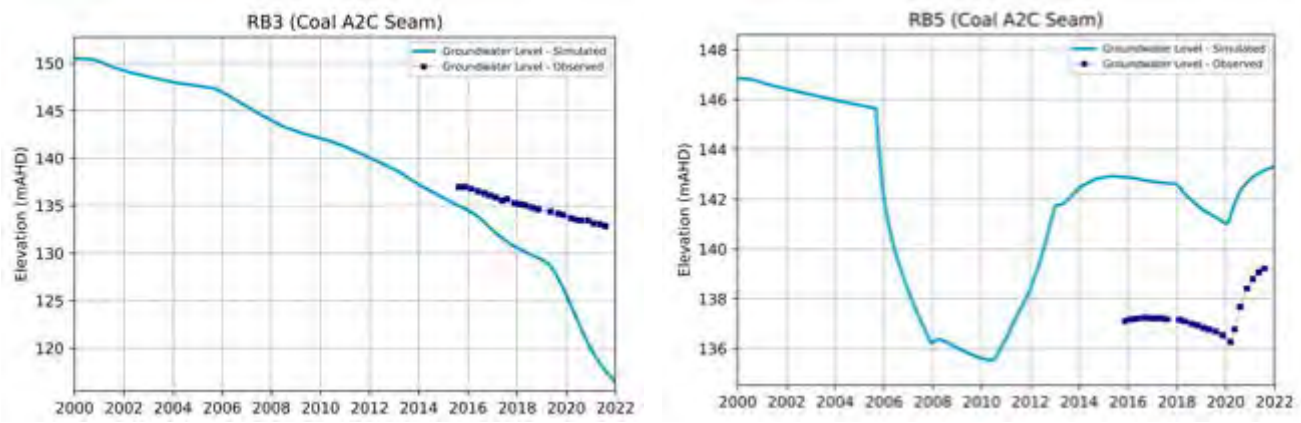
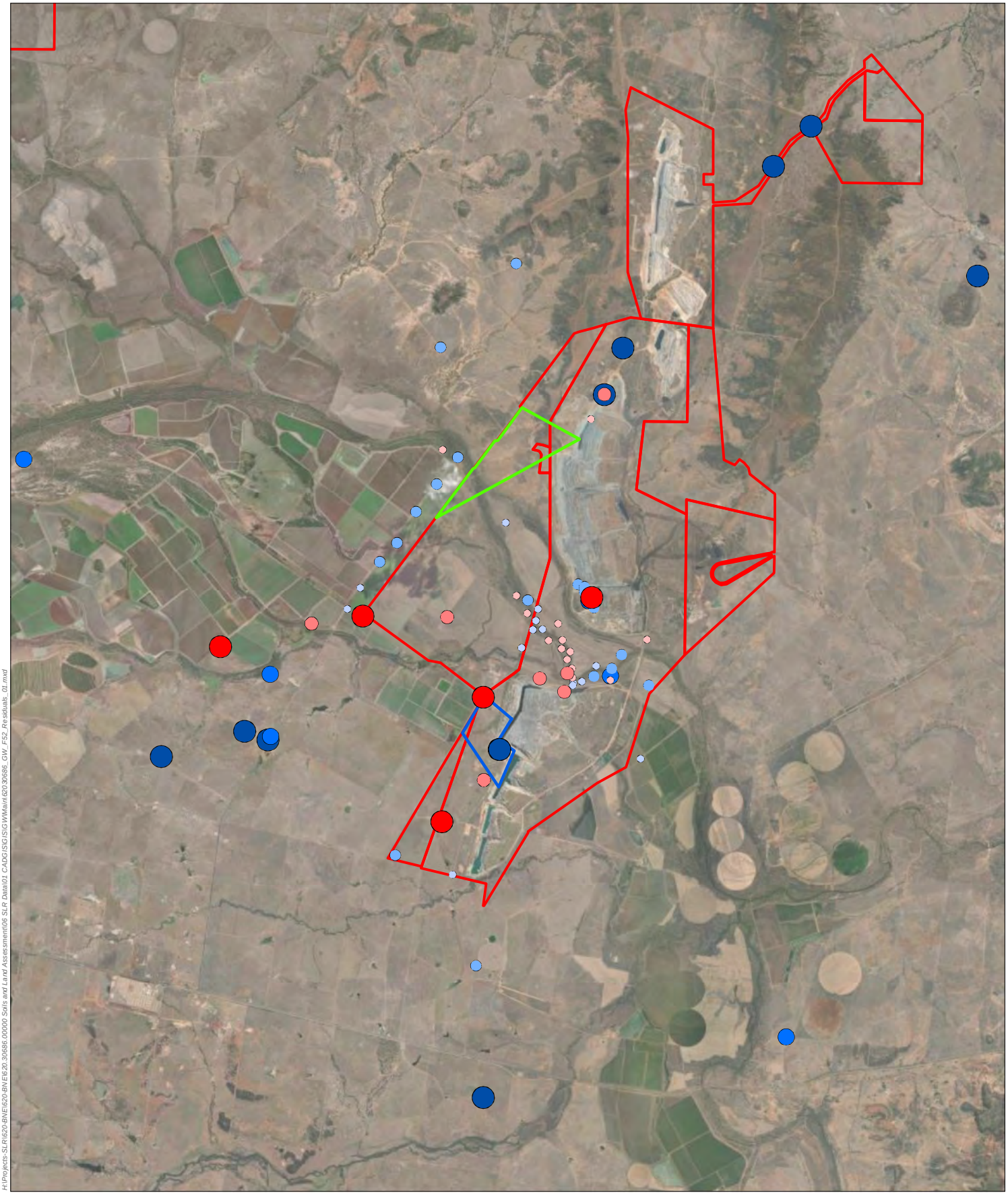


Figure 51 Calibration hydrographs (Coal seam)



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:150,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR

GROUNDWATER IMPACT ASSESSMENT

Map of Average Residuals

Figure 52

H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F52_Residuals_01.mxd

6.4.5.2 Validated underground mine inflows

The model simulated average inflows of 3- 5.5 ML/day into underground mining during the calibration period (Figure 53). Observed site inflows ranged from 0 to 5 ML / day between January 2015 and September 2021. Note that the underground inflow is not metered directly by one device but calculated from two other metered water flows. Ensham is currently pumping excess water into abandoned panels when suitable. Previously they were sealed and pumped full of inert gas. This practice can cause low groundwater inflow estimates based on the methodology of calculating the underground inflow from two metered flows. The ingress water is pumped back into the panel instead of the surface, which will assist with recovery in the future. The model cannot reflect this practice.

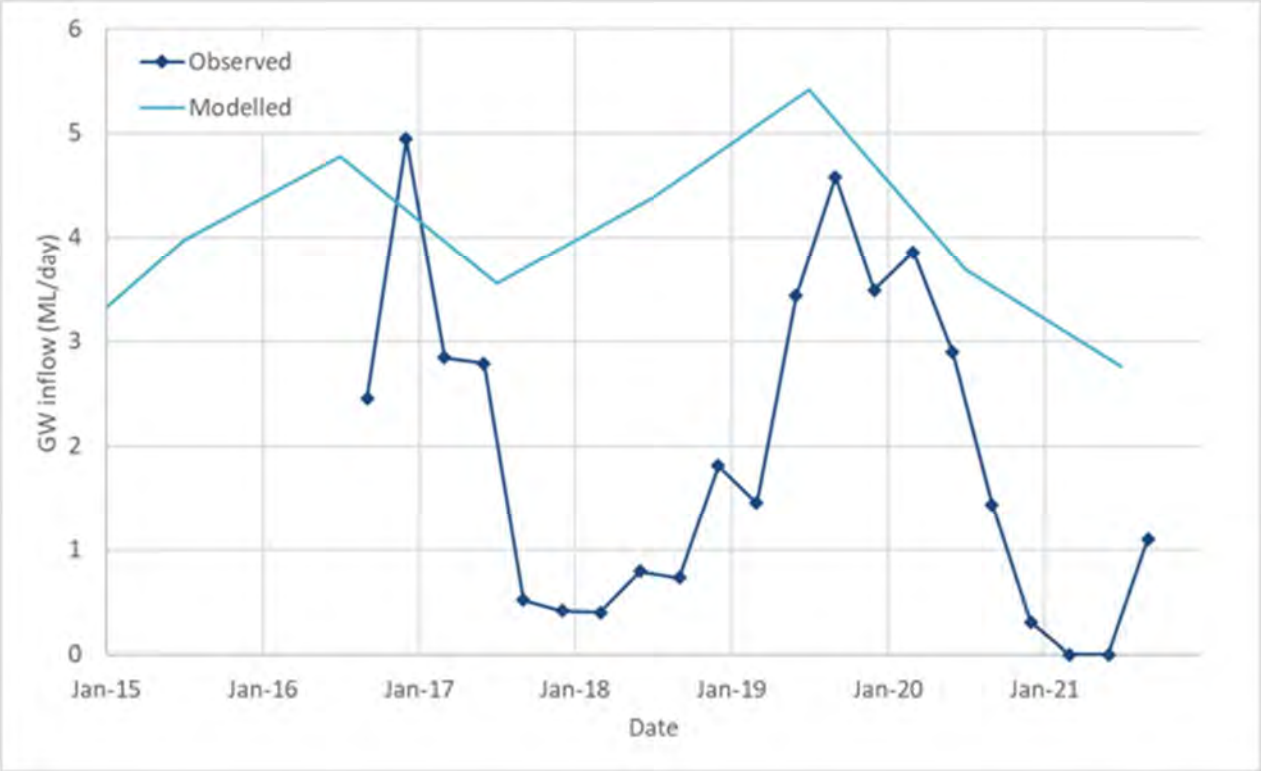


Figure 53 Predicted versus simulated underground mine inflows

6.5 Model predictions

The predictive model was run for three cases, as listed in Table 19. As stated in Section 6.4.4, there are three model runs, a Null run, the existing operations, and the Project. These three runs were used to assess:

- Additive impacts: represented by the difference in results predicted for the Null run and results predicted for the Project. For the purpose of this report, "additive impacts" refers to the impacts from underground operations compared to a hypothetical case where all underground mining stopped in December 2021. It does not refer to cumulative impacts from mining operations at other locations.
- Incremental impacts: represented by the difference in results predicted for the existing operations and results predicted for the Project.

The model predictions are mainly presented as incremental impacts, i.e. as a comparison between results obtained when modelling the existing operations (with end of mining in December 2027) and results obtained when modelling the Project (with end of mining in December 2029).

Table 19 Model run selections

Run name	Properties	Rationale
Null run	• Open cut (past and planned until 2030[1]) • no underground mining after January 2022)	The Null run was used to assess the additive impact from the underground mining (Null run – Project) . Because the underground mining at Ensham is a historical fact, the "No future mining" scenario start was set to January 2022 to coincide with the start of the predictive model.
Existing operations	• Open cut (past and planned until 2030[1]) • Future underground mining as approved (2028[2])	The existing operations was used to assess the incremental impacts between existing operations and Project, i.e. the impact of the extension only.
Project	• Open cut (past and planned until 2030[1]) • Further future underground mining as proposed (2030[2])	This run was used in both the additive impact assessment and incremental impact assessment. The Project run includes approved mining until December 2027[2] and the proposed extension to December 2029[2].

Notes: 1 open-cut mining active until 2022. However, some drains remain active in the model to 2030 to allow access to the underground. As the open-cuts have not been altered, these are the same as in HydroSimulations, 2020.

2 the underground mine plan was provided on an annual time scale. Last year of mining for the existing operations is 2027, drains stay active for 2 years (2027 and 2028). For the Project, the last year of mining is 2029, and the drains stay active for two years (2029 and 2030)

6.5.1 Groundwater model water balance

The groundwater model water balance for the Null Run, existing operations and the Project are presented in Table 20, as an average over the time period between 2022 and 2030.

The climatic components are comparable, with the evapotranspiration (ET) showing a negligible variation for the Null run. The flows from and to rivers (RIV package) and streams (STR package) are near identical for both for all three runs. This indicates stream flows are not changing as a result of the proposed mining extension.

The constant head boundary shows slightly different results for the Null Run, existing operations and the Project. However, these differences are not significant when the constant head fluxes are set into context with the climatic components, which are by an order of magnitude larger.

The difference in the drains (i.e. mining) outflow rates is due to the longer timeframe of the Project. Averaged over the assessment period, the Project is predicted to increase mining inflow on average by 2.55 ML / day. The temporal mining inflows are discussed in Section 6.5.2. The drain component for the Null run constitutes only of the open cut operations.

Table 20 Average simulated water balance during the prediction period (2022 to 2030)

Component	Null run		Existing operations		Project	
	Inflow (ML / d)	Outflow (ML / d)	Inflow (ML / d)	Outflow (ML / d)	Inflow (ML / d)	Outflow (ML / d)
Recharge (RCH)	7.31	0	7.31	0	7.31	0
ET (from GW) (EVT)	0	14.56	0	14.53	0	14.53
RIV	0	0.1	0	0.1	0	0.1
STR	13.80	0.44	13.81	0.44	13.81	0.44
Regional GW Flow (GHB)	0.12	0.45	0.12	0.45	0.12	0.45
Constant Head (CHD)	2.11	1.43	2.15	1.43	2.75	1.41
Mine inflows (DRN)	0	0.79 (OC) 0 (UG)	0	0.79 (OC) 3.95 (UG)	0	0.73 (OC) 6.50 (UG)
Storage	4.91	10.43	8.98	10.67	10.9	10.7
Total (ML / day)	28.25	28.2	32.36	32.34	34.88	34.85
Mass Balance	0.00		0.00		0.00	

Notes: OC = Open Cut, UG = underground

6.5.2 Predicted groundwater interception

The daily predicted inflow rates into the underground operations are shown on Figure 54 (left) for the existing operations and the Project. Figure 54 (right) shows the incremental inflows (difference between existing operations and Project) into the underground.

The Project inflows are the additive inflows (Project compared to Null run, which has no underground mining in the predictive period). As shown on Figure 54, both the existing operations and the Project show inflows of 2-14 ML/day for the period between 2021 and 2030. Lower inflows can be expected when mining remains in an area for a longer time. When going into new areas, the inflows can increase, as no previous dewatering was active there. The inflows for the existing operations then cease (end of mining December 2027, drains active until December 2028). The Project (mining up to December 2029) shows further inflow until the model drains are inactive (December 2030). These inflow estimates are likely an overestimation because the model does not account for active management measures to reduce inflows after mining has passed through an area. For the context of the impact assessment, an overestimation of inflow will result in a larger drawdown and hence a conservative impact assessment.

The inflows are a combination of the losses from coal removal (water in pore space) and active pumping within the underground workings. The model does not quantify the losses from the coal removal. This means that the actual requirement for pumping will be lower than this total estimate.

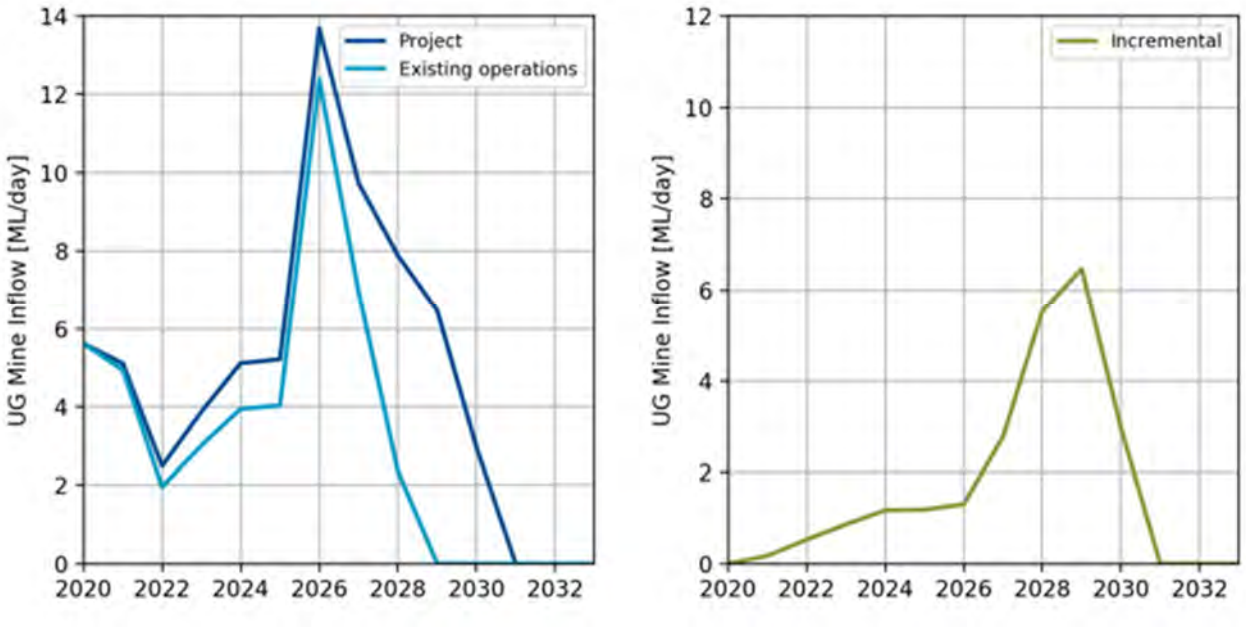


Figure 54 Predicted underground mine inflow

6.5.3 Predicted drawdown

The process of mine dewatering directly and indirectly (induced flow) reduces water levels in surrounding groundwater units. The extent of the zone affected by the mine dewatering (resulting in decreased water levels) is dependent on the hydraulic properties of the aquifers / aquitards and is referred to as the zone of depressurisation in a confined aquifer and zone of drawdown within the (unconfined aquifer) water table. Depressurisation and drawdown of groundwater levels are greatest at the mine working coal-face, and reduces with distance from the mine.

The maximum incremental drawdown over the entire model timeframe was calculated as follows:

- At each model cell and at each timestep, the water level (or pressure) for the existing operations and the Project are exported.
- These two levels are then compared.
- Starting at the first timestep, this difference is stored as the maximum drawdown and the next timestep will be evaluated.
- If the difference is larger than in the previous time step, the new difference will become the maximum drawdown at that model cell.

It is worth noting that the resulting map of maximum drawdowns is not a snapshot of one particular point in time, because the maximum difference in water level will not occur at the same point in time for all locations. This is illustrated in Figure 55, where the incremental and additive maximum drawdowns are occurring at different times due to the water level recovery in the existing operations.

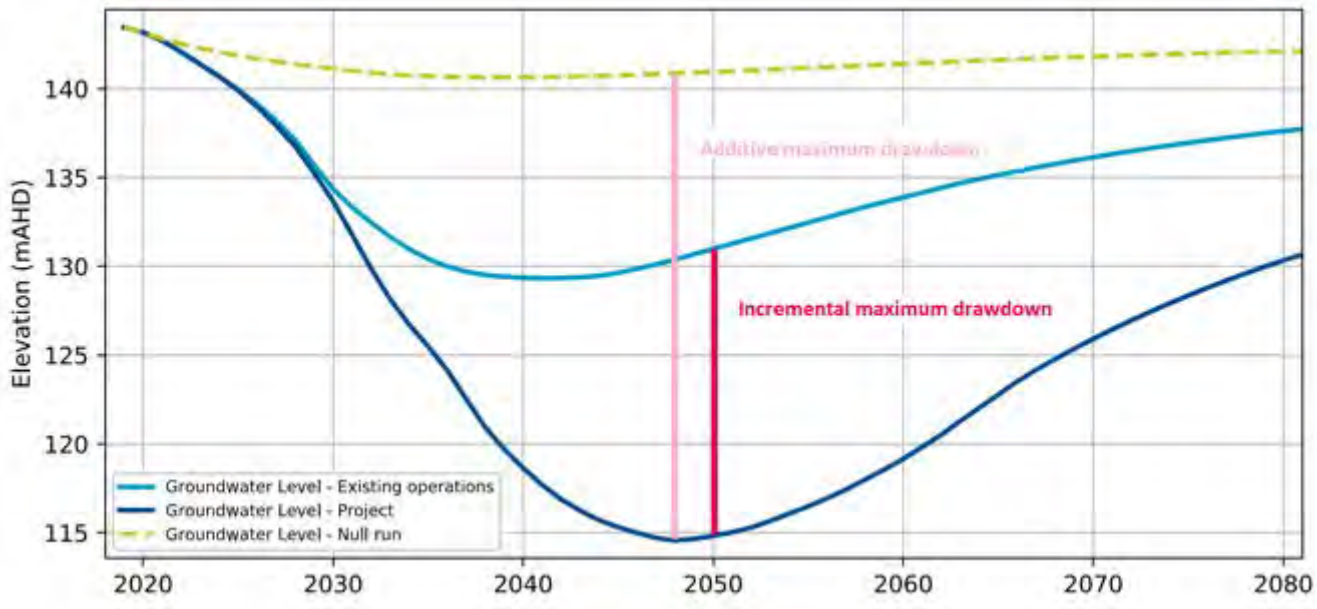


Figure 55 Illustration of drawdown calculations

6.5.3.1 Incremental drawdown

The maximum incremental drawdown for the unconsolidated (L2) and target coal seam (L8) are shown on Figure 56 and Figure 57 respectively.

Figure 56 shows the maximum incremental drawdown due to the Project within layer 2 (L2), where the unit is predicted to be saturated. As shown on Figure 56, the predicted drawdown in the alluvium is localised between the open-cut pits.

Figure 57 shows the maximum incremental drawdown due to the Project within the mined Aries 2 and Castor Seams (A2C, layer 8 (L8)). As shown on Figure 57 the maximum groundwater level drawdown within the A2C seams is predicted to extend up to 10 km to the west (0.5 m drawdown contour) of the Project. Groundwater level drawdown within the A2C seams is limited to where the coal seam is present (outcrop to the east).

Based on the comparison of drawdown in Layer 2 (Figure 56) and the drawdown in the target coal seam (Figure 57), it is apparent that the drawdown introduced by mine dewatering in the coal seams is not causing wide-spread drawdown in the shallow layer, meaning that there is limited hydraulic connection between the two units, as conceptualised with the Rewan Group acting as a barrier of flow.

H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F56_Maximum_additional_drawdown_due_to_Project_in_the_Alluvium_(L2).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Zone 2
- Zone 3

Drawdown (m)

- 1
- 2

L2 K Zones

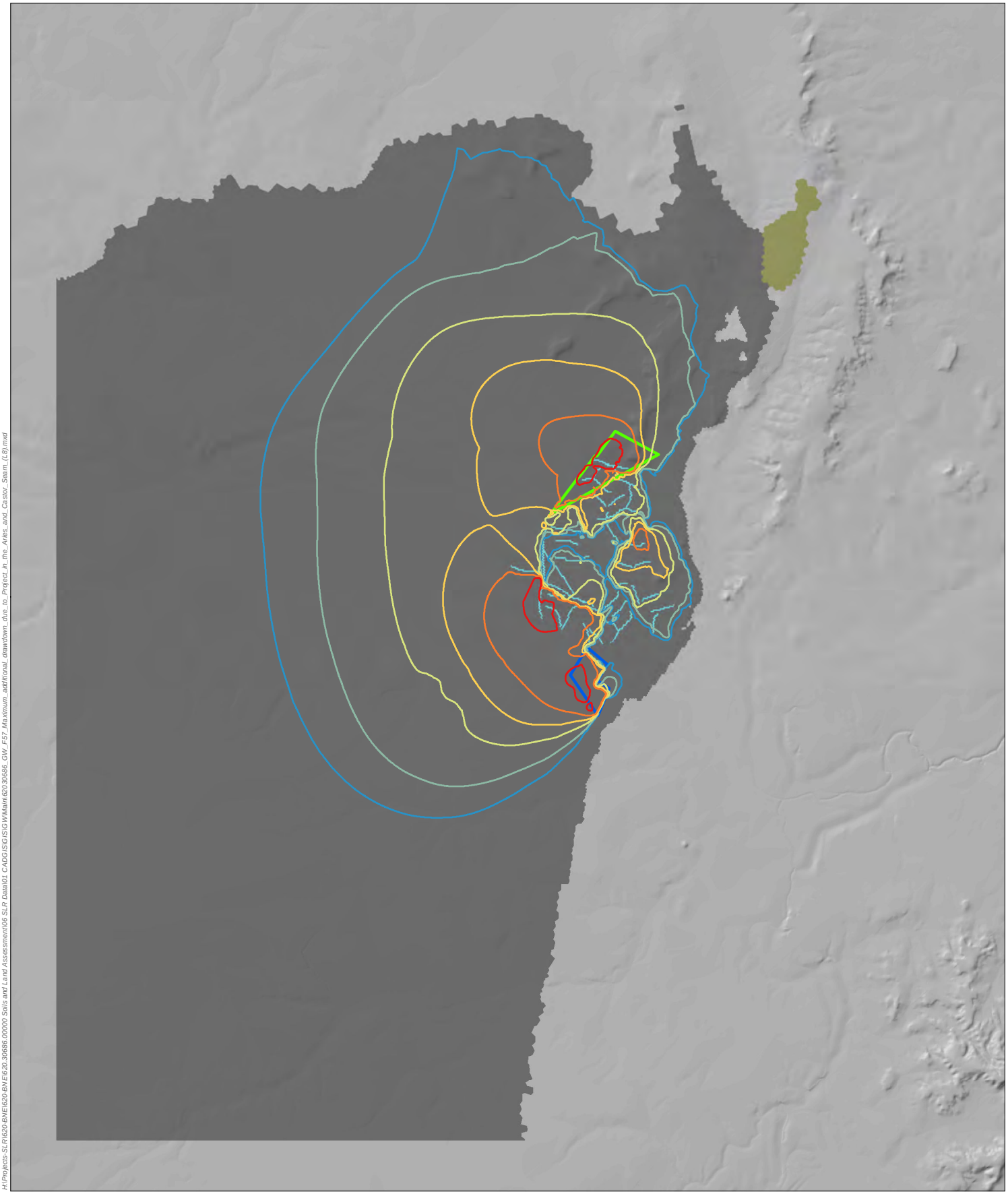
- Alluvium
- Regolith
- Shallow CM

GROUNDWATER IMPACT ASSESSMENT

Maximum incremental drawdown due to the Project in the unconsolidated (L2)

Figure 56

SLR
www.slrconsulting.com



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Maximum incremental drawdown due to Project in the Aries and Castor seam (L8)

Figure 57

H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F57_Maximum_additional_drawdown_due_to_Project_in_the_Aries_and_Castor_Seam_(L8).mxd

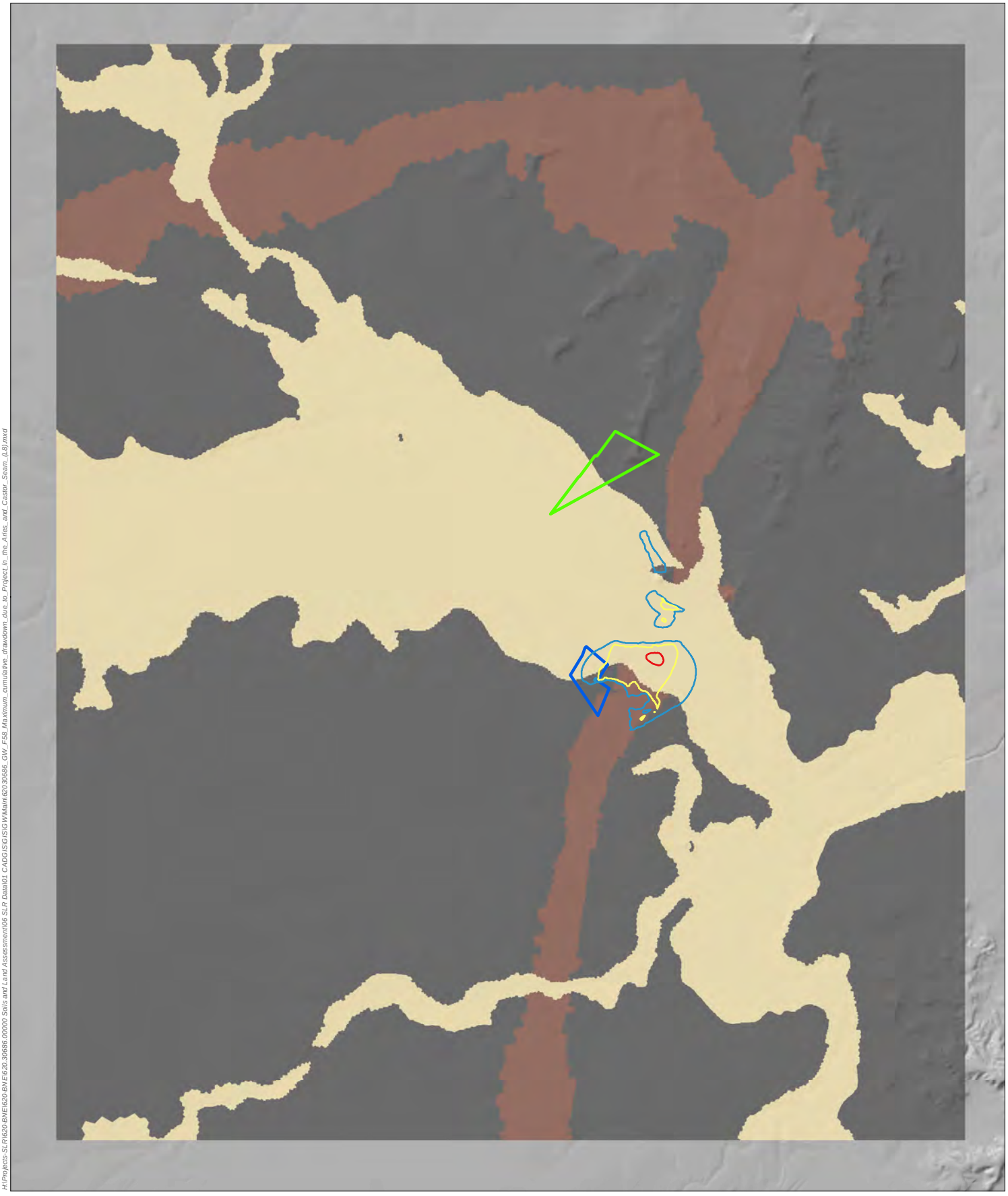
6.5.3.2 Additive drawdown

The maximum additive drawdown was assessed based on the difference between the existing operation plus the Project, and the hypothetical scenario where all underground mining stops at the end of 2021.

Figure 58 shows incremental drawdown due to the Project within layer 2 (L2), where the unit is predicted to be saturated. As shown on the figure, the drawdown in the alluvium is localised between the open-cut pits. Compared to the incremental drawdown, there is an additional area in the additive assessment to the east of Zone 3. This is related to the difference in recovery timing, with the water levels in the Null run recovering from 2021 onwards and the modelled water levels for the Project starting to recover in 2030 (drain cells are active for two years in the model). The impacted area is the spoil to the east of C-Pit.

The maximum additive drawdown in the target Aries 2 and Castor seams is shown in Figure 59. The additive 5 m drawdown curve is extending approximately 8 km from the Project to the west. An impact to this formation is expected, as it needs to be depressurised for safe working conditions underground.

Based on the comparison of the additive maximum drawdown in Layer 2 (Figure 58) and the additive maximum drawdown in the target coal seam (Figure 59), it is apparent that the drawdown introduced by mine dewatering in the coal seams is not causing wide-spread drawdown in the shallow layer, meaning that there is limited hydraulic connection between the two units, as conceptualised with the Rewan Group acting as a barrier of flow.



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F58_Maximum_cumulative_drawdown_due_to_Project_in_the_Aries_and_Castor_Seam_(L6).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

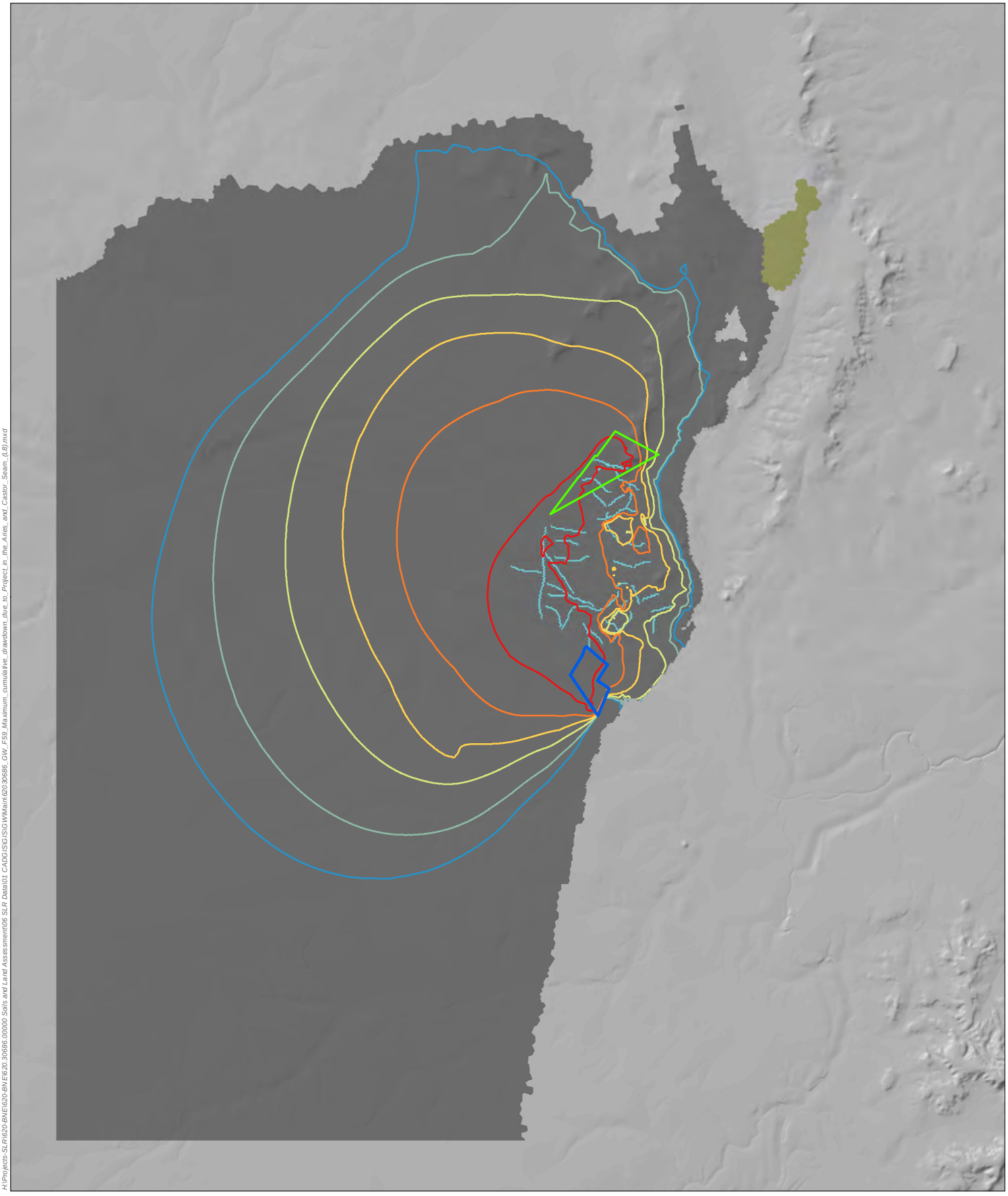
Project No.:	620.30686
Date:	24-Feb-2022
Drawn by:	PM
Sheet Size:	A4

GROUNDWATER IMPACT ASSESSMENT

Maximum additive drawdown due to the Project in the unconsolidated (L2)

Figure 58

SLR
www.slrconsulting.com



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Maximum additive drawdown due to Project in the Aries and Castor seam (L8)

Figure 59

H:\Projects-SLR\620-BNE\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F59_Maximum_cumulative_drawdown_due_to_Project_in_the_Aries_and_Castor_Seam_(L8).mxd

6.5.4 Incidental water impact

6.5.4.1 Influence on alluvium

Figure 60 (left) shows the flux from the alluvium into the underlying formations ("Alluvial Take") for the Null run, the existing operations and the Project. The three cases are near identical. Between 2028 and 2031, the Project run shows a marginally higher flux than the other two runs, which is due to the longer mining period. This is further illustrated in Figure 60 (right), which shows that the changes in Alluvial Take are at a maximum for the two years of additional mining for the Project. This peak incremental and additive change of Alluvial Take is 0.05 ML/day.

The long-term average alluvial take based on annual climatic inputs is around 1.2 ML / day for all three model runs (recovery model 2060-2260).

Interference of the alluvial groundwater only relates to increased leakage to the underlying stratigraphy, induced by depressurisation of the Permian coal measures. This is distinct from direct interception of alluvial groundwater.

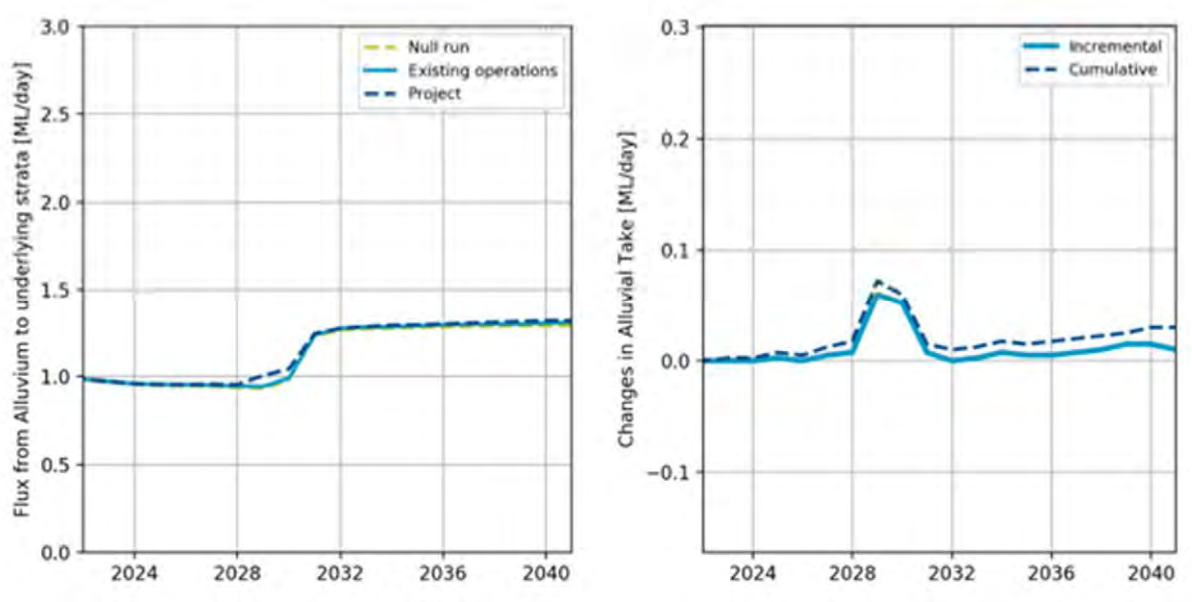


Figure 60 Flux from the Alluvium into underlying strata

6.5.4.2 Influence on baseflow

The model predicts a net baseflow for Nogoa River to the groundwater system of 3.8 to 4 ML/day over the model domain, as shown in Figure 61 (left). The net baseflow is a the net flow between the River and the shallow unconsolidated formations. The model predicts no measurable reduction in baseflow in Nogoa River between the Null run, existing operations, and the Project over the life of the mine. This is further illustrated in Figure 61 (right), which shows the incremental and additive changes in base flow of the Nogoa River. These changes are negligible compared to the predicted net fluxes of 3.8-4 ML/day from Nogoa River to the groundwater system To put this into context, the mean daily discharge of Nogoa River at Duck Ponds is 1,690 ML/day.

The long-term net baseflow based on annual climatic inputs is around 2.1 ML / day (recovery model 2060-2260) for the Null run, the existing operations and Project.

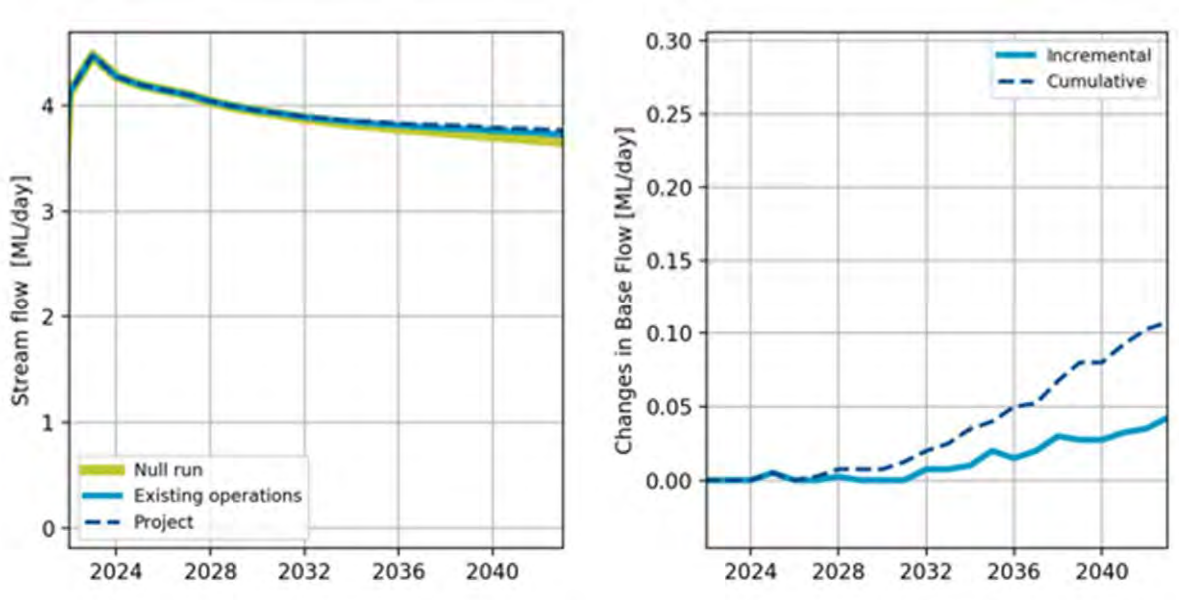


Figure 61 Stream flow in Nogoa River

6.5.5 Post mining equilibrium

The model was run from 2040 to 2060 in quarterly stress periods and then from 2060 to 2260 in annual stress periods to simulate long-term recovery with annual averaged climatic inputs. Figure 62 shows the water levels for the Null run, the existing operations, and the Project for alluvium near Ensham mine at EC03, and for the Permian coal measures to the south-west of the Project extent at RB04. Appendix G shows the prediction hydrographs for all relevant bores.

The post-mining long-term groundwater levels at alluvial bore EC03 (Figure 62, top) are predicted to increase by approximately 1 m over 200 years, however, some minor differences are predicted for the mining scenarios, when compared with the Null scenario.

The bore RB04 (refer to Figure 62, bottom) is located within the target coal seams (Aries 2 and Castor). The results show that the drawdown predicted at this bore is greatest for the Project, compared with that predicted for current operations and that predicted by the Null run. In the long-term, the groundwater levels at RB4 for all three scenarios recover to the same levels.

The impact of climate change on the predictions and recovery is discussed in Section 7.6.

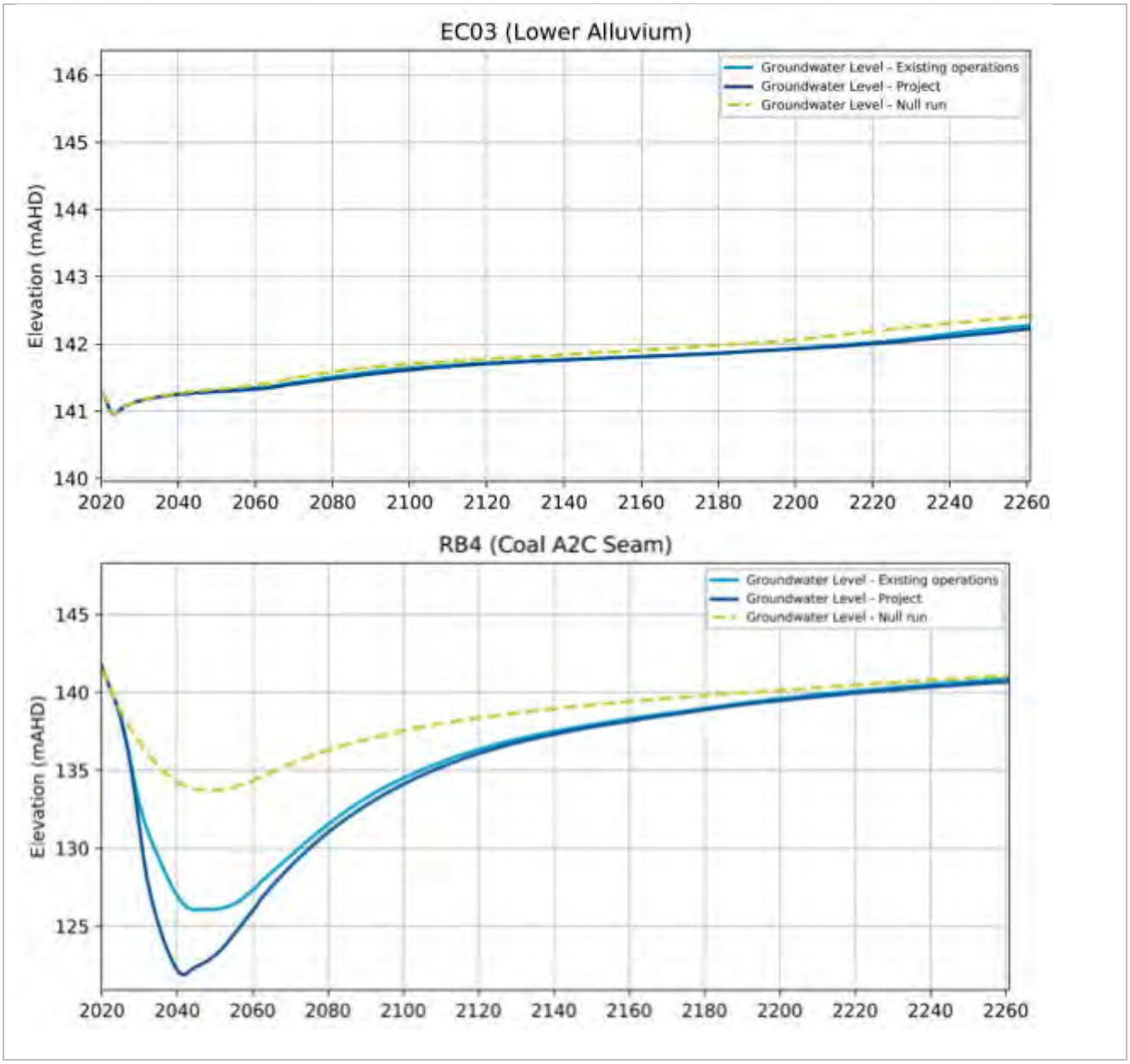
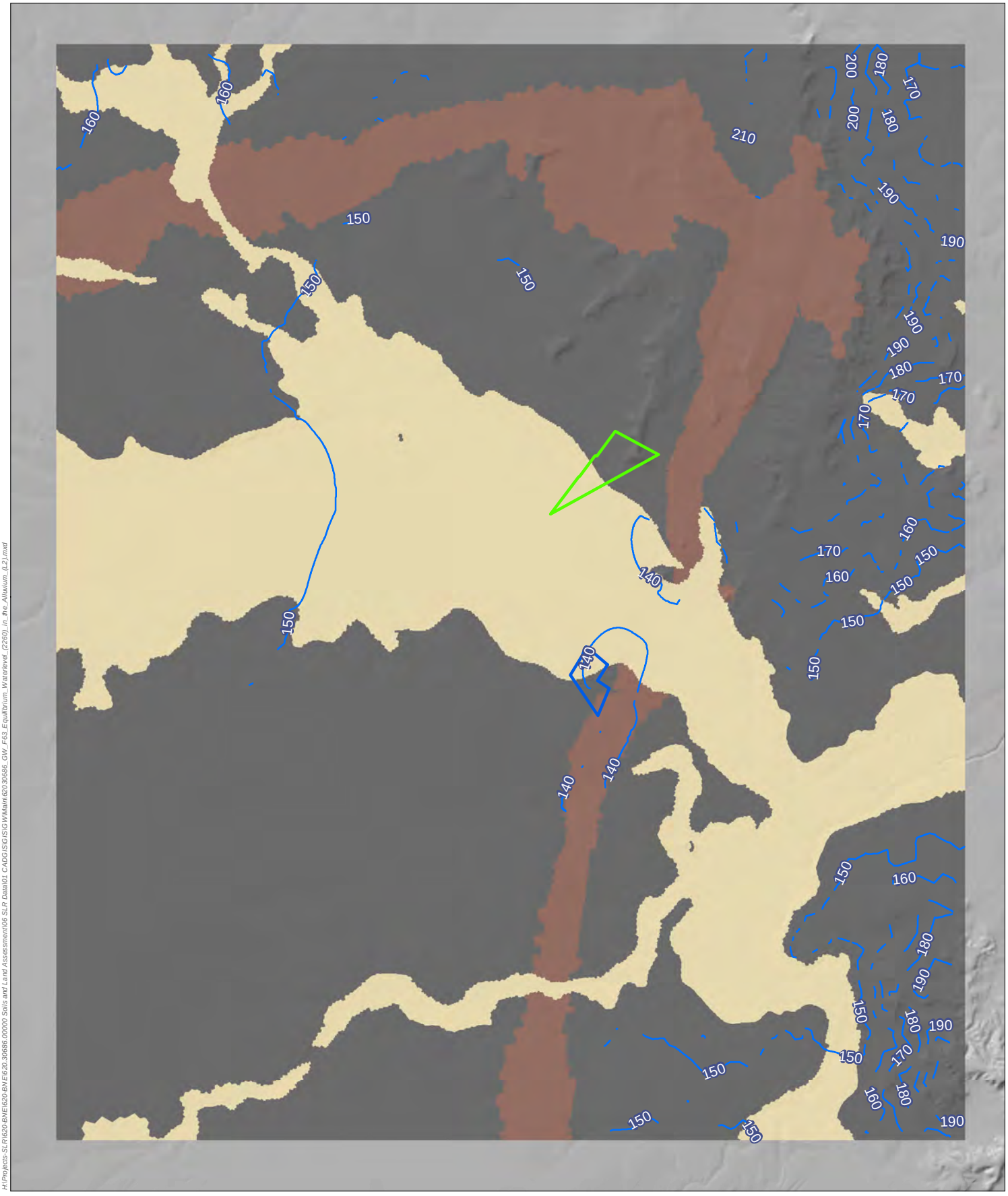


Figure 62 Recovery times series for two selected bores

Figure 63 and Figure 64 show the post mining equilibrium water levels in the alluvium and regolith (model layer 2) and the Aries 2 and Castor coal seams (model layer 8) respectively. The alluvial water levels show the same general flow direction as Nogoa River (west to east).

As expected, the water level contours in the coal seams (in 2260) show a lower water level in the area where the underground mining was occurring. The water levels are around 5-10 m lower than in the surrounds, with the largest remaining drawdown remaining around zone 2.

The groundwater recovery modelling showed that the open-cut pits are long-term sinks, as indicated by the recovered water table contours (Figure 65).



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

Zone 2
Zone 3

Potentiometric Surface

L2 K Zones

Alluvium
Regolith
Shallow CM

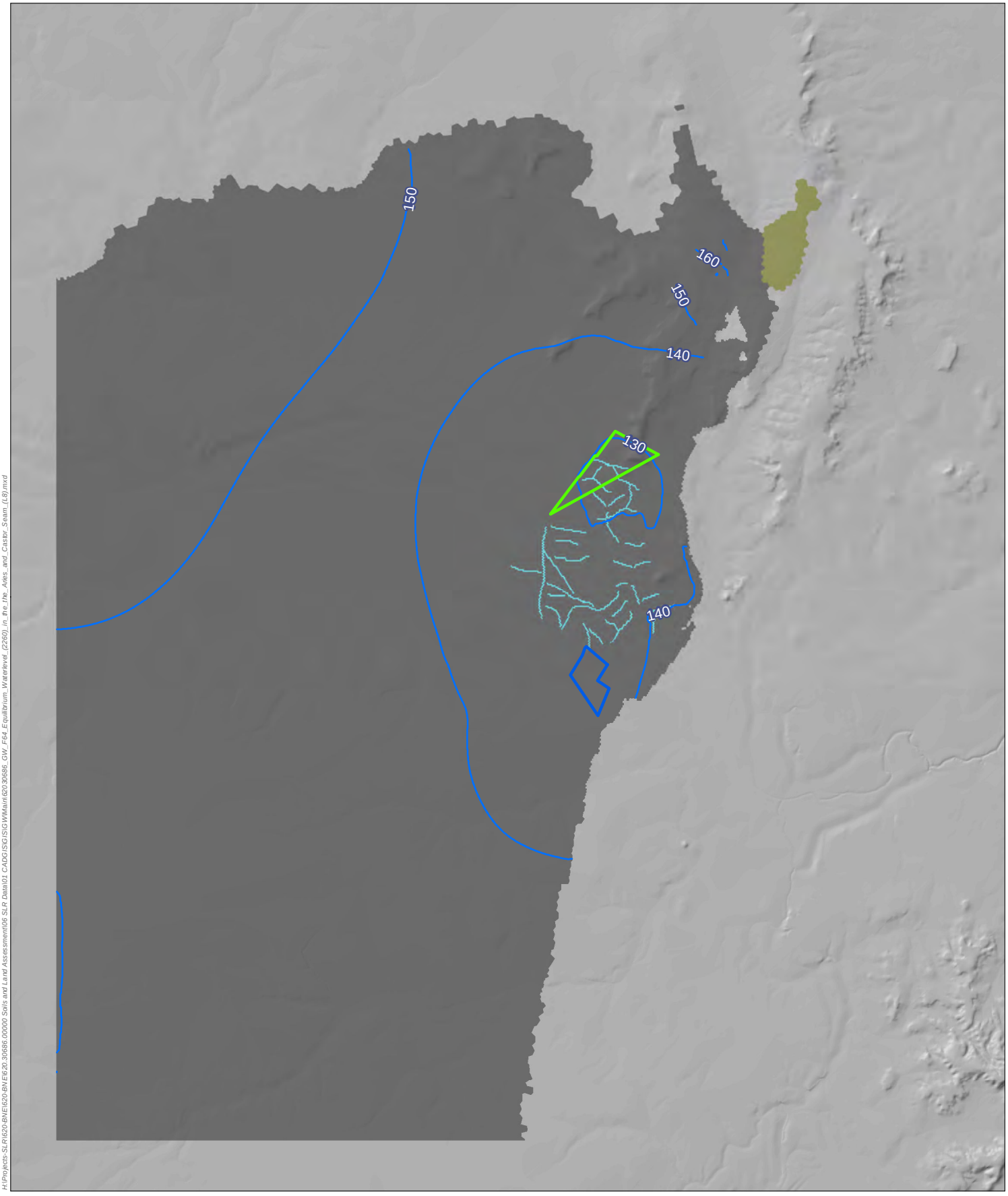
GROUNDWATER IMPACT ASSESSMENT

Equilibrium groundwater level (2260) in the unconsolidated (L2)

Figure 63

SLR
www.slrconsulting.com

H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F63_Equilibrium_Waterlevel_(2260)_In_the_Alluvium_(L2).mxd



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F64_Equilibrium_Waterlevel_(2260)_In_the_the_Aries_and_Castor_Seam_(L8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

Zone 2
Zone 3

Potentiometric Surface

L8 K Zones

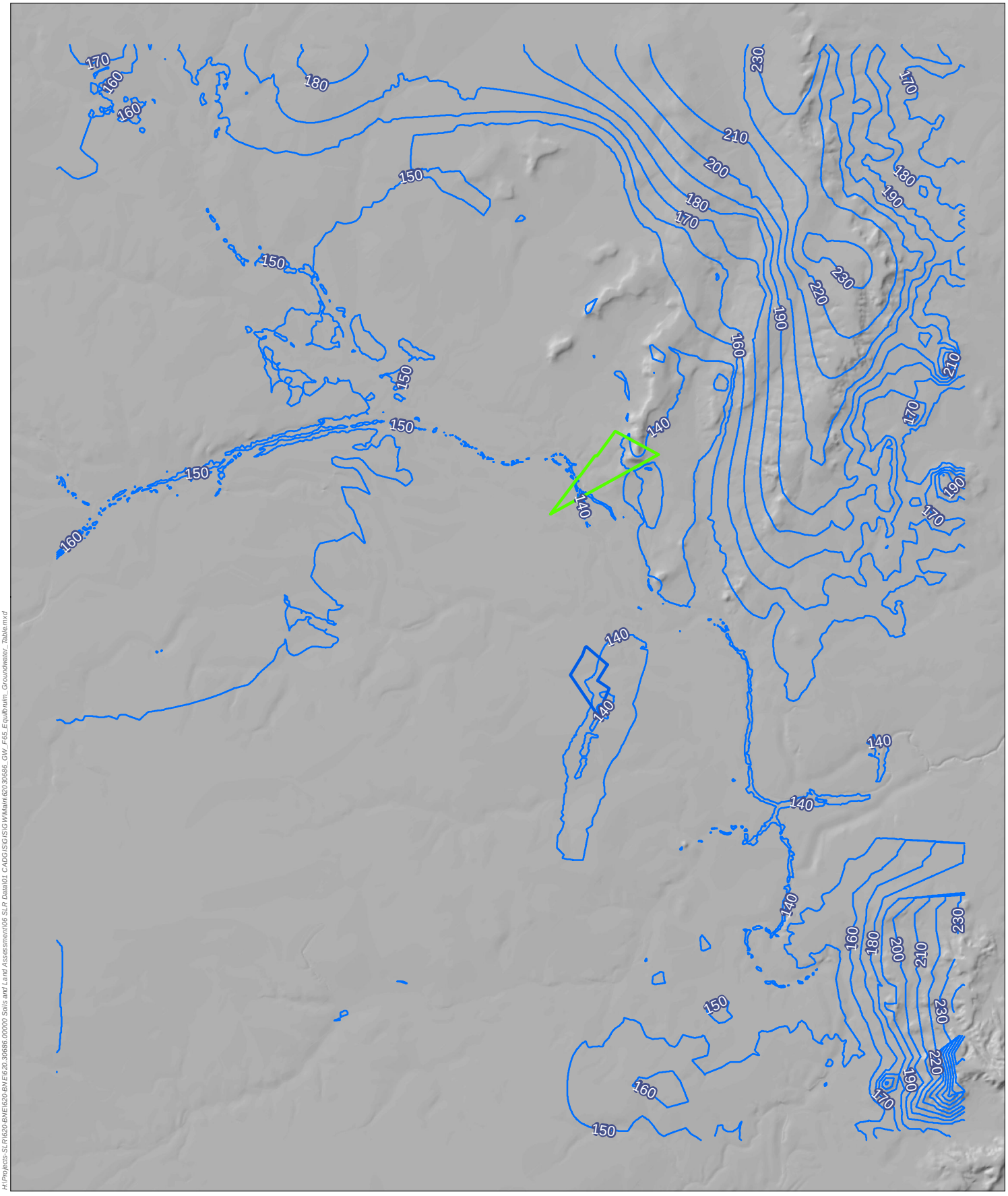
Aries 2 and Castor
Basement
Fault

GROUNDWATER IMPACT ASSESSMENT

Equilibrium groundwater level (2260) in the Aries and Castor seam (L8)

Figure 64

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620.30686_GW_F65_Equilibrium_Groundwater_Table.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	17-Feb-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Water Table Contour
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Equilibrium groundwater table (2260)

Figure 65

SLR
www.slrconsulting.com

6.6 Sensitivity analysis

The uncertainty of model predictions was assessed with a deterministic approach to sensitivity analysis. Sensitivity analysis evaluates the effects of model parameters on model results and provides information on the degree to which the adopted values for the various parameters in the model influence predictions. It can provide an indication of the uncertainty in the results and guide future data collection to reduce this uncertainty.

6.6.1 Scenario selection

Parameter sensitivity on the predictive period (model run 2b, simulating the Project) was explored through additional model simulations where model parameters were varied. These parameters and model inputs were considered because they could potentially impact the model predictions. The eleven analysed parameters are listed in Table 21 together with the magnitude of change imposed on each parameter. A total of 19 runs were performed in addition to the base case (described in Section 6.4). The upper and lower bounds have been chosen as a wide range (refer to Table 8). The results should not be viewed as absolute; this analysis is performed to assess relative changes and identify parameters that might need further investigation.

Table 21 Sensitivity analysis – overview of scenarios

Parameter and Scenario number	Lower bound	Base case (S1)	Upper bound
Stream conductance (S2 and S3)	Factor 10 lower	1-1000 m²/day (depending on cell size)	Factor 10 higher
Alluvium horizontal hydraulic conductivity (S4 and S5)	Factor 10 lower	L1: 0.001 m/day L2: 10 m/day	Factor 10 higher
Alluvium vertical hydraulic conductivity (S6 and S7)	Factor 10 lower	L1: 5.60E-05 m/day L2: 0.5m/day	Factor 10 higher
Coal (L8) horizontal hydraulic conductivity (S8 and S9)	Factor 10 lower	0.004 - 1.250 m/day	Factor 10 higher
Coal (L8) vertical hydraulic conductivity (S10 and S11)	Factor 10 lower	2.53E-04 - 0.186 m/day	Factor 10 higher
Coal (L8) specific yield (S12 and S13)	0.01	0.04	0.07
UG workings specific yield (S14 and S15)	0.4	0.5	0.6
Recharge (S16 and S17)	20% decrease	Surficial alluvium: 5.18 mm/yr Regolith: 0.64 mm/yr Permian subcrop: 0.64 mm/yr Spoil: 53.1 mm/yr Open-cut void: 647.5 mm/yr	20% increase
Rewan (L3 and L4) vertical hydraulic conductivity (S18)	Not calculated	Layer 3: 4.20E-02m/day Layer 4: 1.20E-04m/day	Factor 10 higher
Rewan (L3 and L4) horizontal hydraulic conductivity (S19)	Not calculated	Layer 3: 2.10E-04 m/day Layer 4: 6.00E-07 m/day	Factor 10 higher
General Head Boundary (S20 and S21)	-10 m	140-150 mAHD	+10 m

The predictive sensitivity analysis was based on the calibrated parameter set (base case). In each run, one parameter was changed by an order of magnitude (or by a relevant percentage) in each run. The results for all 20 runs are presented in Section 6.6.2 and the most sensitive parameters are discussed in Section 6.6.2.
By changing only one parameter at a time, it is assumed that the calibrated data set would still be matched adequately, and the predictions could still be considered a potential outcome.

There was no run where several parameters were changed. If several parameters were changed in one run, the model calibration would not be valid for this parameter set, and as such, the prediction would not be meaningful. Further, the change of multiple parameters into a worst-case direction may stress the boundaries of physically possible values and result in a failure for the groundwater model to run, because of numerical instabilities.

6.6.2 Results

This section discusses the results of the sensitivity analysis. The changes in predicted drawdown in the coal seam (model layer 8), inflow into the mine during mining and the loss from Nogoa River were assessed. In summary, the predictions were most sensitive to the horizonal hydraulic conductivity of the coal seams. This means that uncertainties in the hydraulic conductivity of the coal seams leads to uncertainty about the absolute value of the predicted impact (drawdown or mine inflow). However, since the impacts are on the coal seams and therefore do not affect water users and GDEs in the shallower formations, certainty about absolute value of impact is not essential to assess impacts from the Project on these types of receptors.

6.6.2.1 Drawdowns

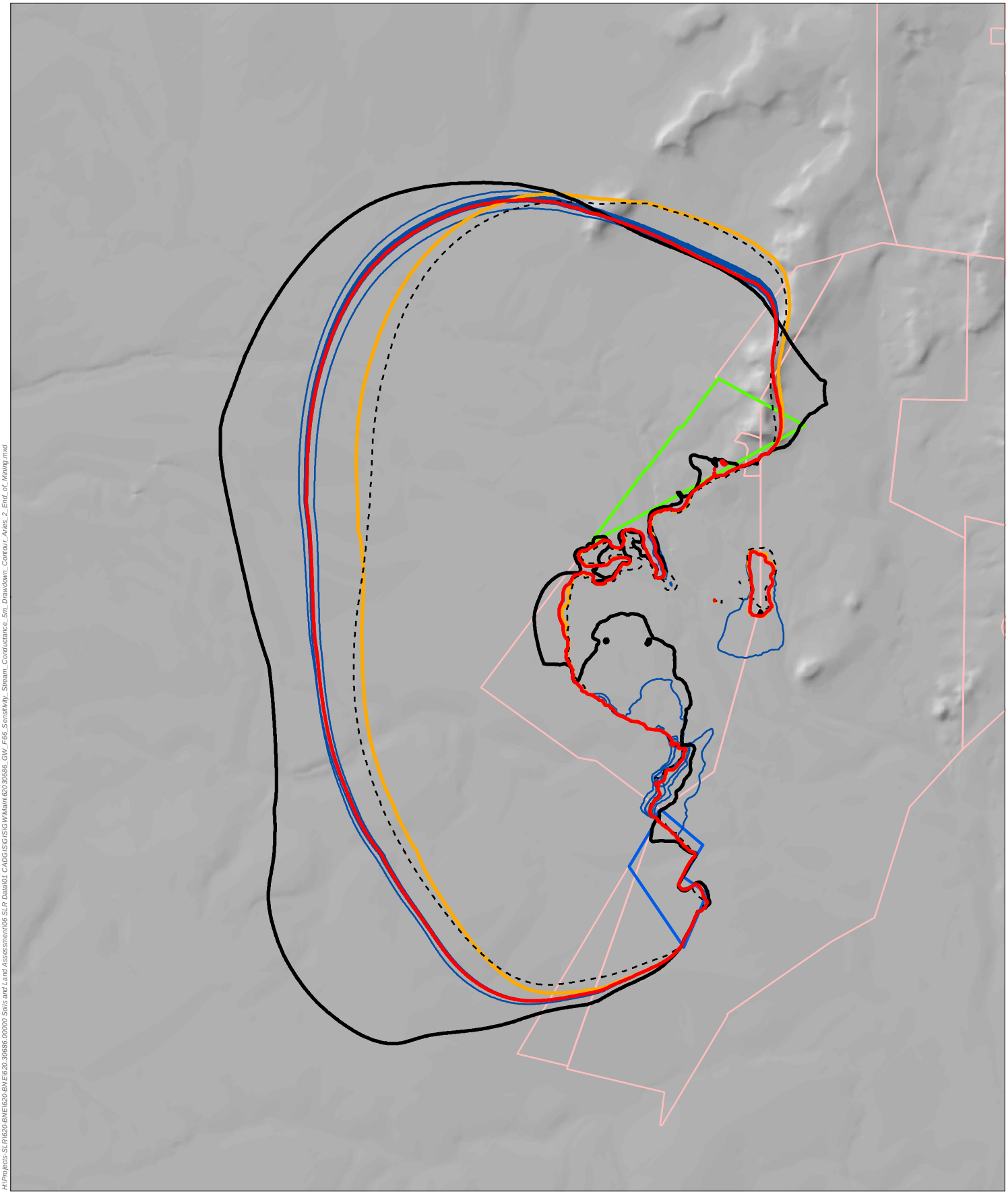
Figure 66 presents the incremental 5m drawdown contours at the end of mining (2030) for the base case compared to all 20 scenarios. The base case incremental 5 m drawdown curve is shown together with the incremental 5 m drawdown contour for each of the parameter permutation scenarios. The sensitivity was assessed for L8 (A2C seam) only, as the alluvium is predicted to have little or no drawdown due to the underground mining in Zones 2 and 3.

In general, most scenarios show the same extent of the 5 m drawdown curve to the north, west and south. To the east towards the outcrops, some changes are apparent. These are minor and likely attributed to the difference in recovery. Note that most scenarios are not visible in Figure 66 because the drawdown line of most scenarios is identical to that obtained for the base case. This means that for most scenarios, parameter value selection does not impact on the prediction of drawdown.

Scenario 8 and scenario 9 (horizontal hydraulic conductivity in the Coal L8), however, show a change in the extent of the 5 m drawdown curve. A reduced horizontal hydraulic conductivity results in a reduction of the 5 m drawdown curve by approximately 1 km in north-westerly (along strike) direction, whereas an increased horizontal hydraulic conductivity results in an extension of the 5 m drawdown curve by 1.3 km in westerly (down dip) direction.

In Scenario 18, a greater vertical conductivity was assigned to the Rewan Group, which resulted in the model predicting an increased leakage from the Rewan Group and thus predicting a reduction of the drawdown in the coal seams.

In summary, the extent of the drawdown curve to the west (down dip) is not sensitive to any parameter changes except the coal horizontal hydraulic conductivity. Should new bores be drilled in the coal seams in that area, it would be beneficial to undertake hydraulic testing of the aquifer properties to assess the hydraulic conductivity in general and the potential decrease of hydraulic conductivity with depth.



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GWMain\620306686_GW_F66_Sensitivity_Stream_Conductance_5m_Drawdown_Contour_Aries_2_End_of_Mining.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:100,000

Project No.:	665.ENS02.10000
Date:	23-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Sensitivity analysis for groundwater drawdown in the Aries and Castor Coal Seam (L8)

FIGURE 66

Legend

- Zone 2
- Zone 3
- Mining Lease

5m incremental drawdown curves

- Scenario 1 Base case
- Scenario 8
- Scenario 9
- Scenario 18
- All other scenarios

6.6.2.2 Water fluxes

Table 22 lists the average percent change for the underground mine inflow predictions for all 20 sensitivity scenarios compared to the base case, for the period 2022 and 2030. Note that for the sensitivity analysis, the numbers reported are for the Project only. The mine inflow rates over time are presented on Figure 67.

It is apparent that the underground mine inflow estimates are most sensitive to the coal horizontal hydraulic conductivity (a 10% increase, which results in inflows that are 144% greater) and to a lesser degree to the alluvial horizontal hydraulic conductivity (+41 per cent). Other sensitive parameters include the recharge, the specific yield of the coal seams and of the underground workings.

Table 22 lists the average percent change for the Nogoa River stream losses for all 20 sensitivity scenarios compared to the base case, for the period 2022 and 2030. An increase in stream conductance and alluvial horizonal hydraulic conductivity increases the stream losses by 37 per cent and 84 per cent, respectively. A decrease in those parameters is resulting in a decrease of 81 per cent and 38 per cent, respectively. Changing the vertical alluvial hydraulic conductivity results in changes in stream losses (-6 per cent and +15 per cent, respectively). All other parameters are not sensitive for the stream flow predictions. The base flow changes over time are presented on Figure 68.

In summary, the flows (both mine inflow and Nogoa River baseflow) are sensitive to the stream conductance, alluvial horizontal and vertical hydraulic conductivity, and coal hydraulic conductivity. The flows are not sensitive to an increased vertical hydraulic conductivity of the Rewan Group.

The extent of the drawdown curves is not sensitive to the west (except for coal seam hydraulic conductivity). The drawdown curves show higher variability towards the outcrop, where the coal seams interact with other formations and the open-cut pits. This aligns with the sensitivity to the flows, because at those locations, the drawdown will be influenced by availability of water from the pits, and the streams.

Table 22 Sensitivity analysis – changes to mining inflow and stream flow losses

Scenario #	Description	Change of model parameter value	UG mine inflows % change	Nogoa River streamflow losses % change
1	Base case	(none)	NA	NA
2	Stream conductance (lower)	÷ 10	-5%	-81%
3	Stream conductance (higher)	* 10	7%	37%
4	Alluvium Kh (lower)	÷ 10	-8%	-38%
5	Alluvium Kh (higher)	* 10	41%	85%
6	Alluvium Kv (lower)	÷ 10	-1%	-6%
7	Alluvium Kv (higher)	* 10	-1%	15%
8	Coal L8 Kh (lower)	÷ 10	-20%	-4%
9	Coal L8 Kh (higher)	* 10	144%	12%
10	Coal L8 Kv (lower)	÷ 10	-1%	0%
11	Coal L8 Kv (higher)	* 10	0%	0%
12	Coal L8 Sy (lower)	- 0.03	-10%	0%
13	Coal L8 Sy (higher)	+ 0.03	9%	0%

Scenario #	Description	Change of model parameter value	UG mine inflows % change	Nogoa River streamflow losses % change
14	UG workings Sy (lower)	- 0.1	6%	0%
15	UG workings Sy (higher)	+ 0.1	-4%	0%
16	Recharge (lower)	* 0.8	-1%	1%
17	Recharge (higher)	*1.2	1%	-1%
18	Rewan Kv L3/L4 (higher)	* 10	3%	5%
19	Rewan Kh L3/L4 (higher)	* 10	3%	6%
20	GHB (lower)	-10m	0%	0%
21	GHB (upper)	+10m	-1%	0%

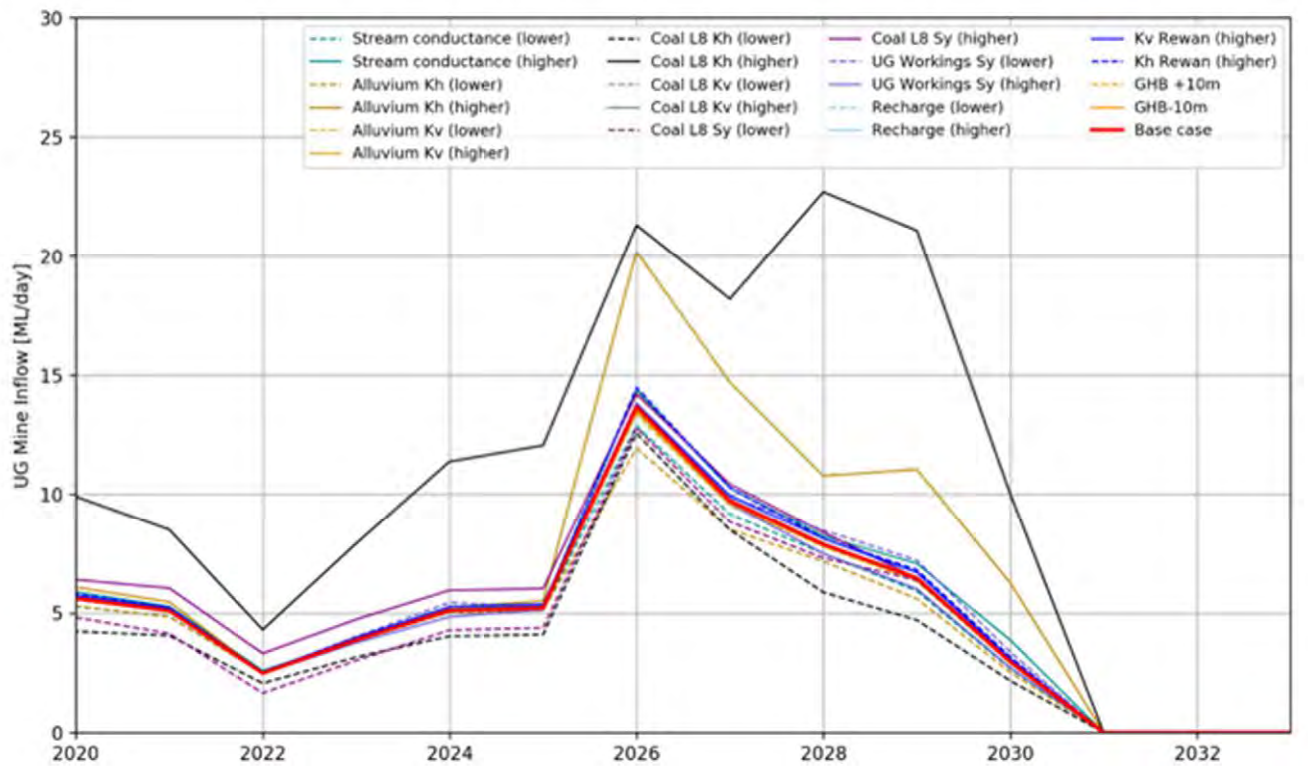


Figure 67 Underground mine inflow (sensitivity analysis)

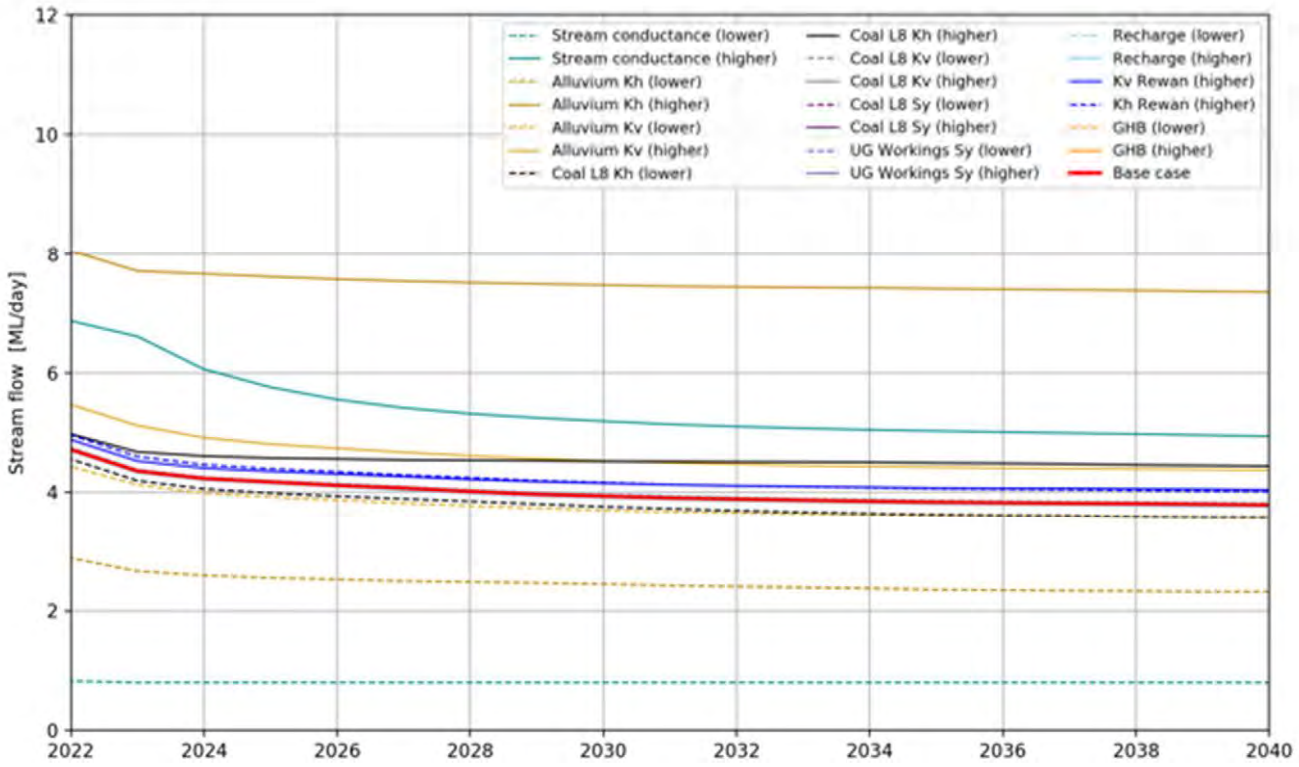


Figure 68 Nogoa River net stream flow (sensitivity analysis)

6.7 Model confidence

Groundwater modelling has been conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012) and the Murray Darling Basin Commission Groundwater Flow Modelling Guideline (Middlemis et al., 2001). As these are mostly generic guides, there are no specific guidelines on special applications, such as coal mine modelling or mine closure.

Under the earlier MDBC modelling guideline (Middlemis et al., 2001), the model is best categorised as an Impact Assessment Model of medium complexity. That earlier guide (Middlemis et al., 2001) describes this model type as follows:

“Impact Assessment model - a moderate complexity model, requiring more data and a better understanding of the groundwater system dynamics, and suitable for predicting the impacts of proposed developments or management policies.”

The 2012 guide has replaced the model complexity classification of the previous guideline by a "model confidence level", (Class 1, Class 2 or Class 3 in order of increasing confidence) typically depending on:

- Available data (and the accuracy of that data) for the conceptualisation, design and construction phases of a model.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

Table 23 (based on Table 2.1, Barnett et al., 2012) summarises the classification criteria and shows a scoring system allowing model classification. Based on Table 23, the groundwater model developed for this groundwater assessment may be classified as a mixture of Class 2 (about 40 per cent) and Class 3 (about 60 per cent).

Table 23 Groundwater model classification

Class	Data		Calibration		Prediction		Indicators		TOTAL
1	Not much		Not Possible		Timeframe>> calibration		Timeframe>10x		1
	Sparse		Large error statistics		Long stress periods		Stresses>5x		
	No metered usage	✓	Inadequate data spread		Transient prediction but steady state calibration		Mass balance>1% (or single 5%)		
	Remote climate data		Targets incompatible with model purpose		Bad verification		Properties<>Field		
							Bad discretisation		
							No review		
2	Some	✓	Partial performance	✓	Timeframe> calibration	✓	Timeframe=3-10x	✓	10
	Poor coverage		Long-term trends wrong		Long stress periods		Stresses=2-5x	✓	
	Some usage info	✓	Short time record	✓	New stresses not in calibration	✓	Mass balance<1%		
	Baseflow estimates		Weak seasonal replication		Poor verification	✓	Some properties<> Field measurements		
			No use of targets compatible with model purpose				Some key coarse discretisation		
							Reviewed by hydrogeologist	✓	

Class	Data		Calibration		Prediction		Indicators		TOTAL
3	Lots		Good performance stats		Timeframe~ calibration		Timeframe<3x		12
	Good aquifer geometry	✓	Long-term trends replicated	✓	Similar stress periods	✓	Stresses<2x		
	Good usage info		Seasonal fluctuations represented well	✓	Similar stresses to those in calibration	✓	Mass balance<0.5%	✓	
	Local climate info		Present day data targets	✓	Steady state prediction consistent with steady state calibration		Properties~ Field measurements	✓	
	K measurement	✓	Head and flux targets		Good verification		Some key coarse discretisation	✓	
	Hi -res Digital Elevation Model (DEM)	✓					Reviewed by modeller	✓	

6.8 Model limitations

The IESC Uncertainty analysis – Guidance for groundwater modelling within a risk management framework (Middlemis and Peeters, 2018) also identifies four key sources of scientific uncertainty affecting groundwater model simulations:

- Structural / conceptual.
- Parameterisation.
- Measurement error.
- Scenario uncertainties.

These four sources of scientific uncertainty have been qualitatively assessed and are presented in Table 24. Overall, it is considered that the groundwater model is fit for the purpose for addressing the objectives of the Project as outlined in Section 6.1.

The groundwater model was used to assess the impacts of underground mining in this complex setting. The complexity is based on the history of mining (both open-cut and underground mining), complex geology, interactions between aquifers, interactions between groundwater and surface water, changes in material properties over time and so forth. Due to the aforementioned complexity, some of the modelling results might not be easily attributed to certain inputs, processes or settings. The presented potential impacts need to be accepted based on the model set-up, parametrisation and choice of result display.

Table 24 Groundwater model and data limitations

Type	Part	Status	Comment
Structural / conceptual geology / structure	Grid	Fit for purpose	Model has unstructured Voronoi grid that includes detailed cell refinement around site and along drainage features.
	Layer 1 to layer 2	Fit for purpose	Top of layer 1 based on LiDAR data at site and DEM outside of site. Alluvium thickness based on site drill data where available.
	Layer 3 to layer 4	Fit for purpose	Top of Rewan Group based on bottom of alluvium Bottom of Rewan Group based on top of Rangal Coal Measures from a mine geological model.
	Layer 4 to layer 11	Fit for purpose	The structure to Layers 4 to 11 is based on previous peer reviewed model iterations. Rangal Coal Measures at site were based on detailed geological model, which captures minor fault displacements in coal measures in the approved area. The layer divisions were based on hydrostratigraphic horizons available within geological models and extrapolated beyond the limit of these using available data where applicable.
	Geological structure	Fit for purpose with future improvements	The structure of the geology is based on previous peer reviewed model iterations. Those models were based on site and regional geological mapping to understand the outcrop extents, strike and dip of the Permian Coal Measures. There is limited fault mapping in the area, which was used in the model (Figure 15 and Appendix F, Figures F-5 to F-12). Understanding of faults can potentially be further improved with analysing data from the ongoing collection of site geological information. Potential connectivity between the coal seam and the shallow formations was tested during sensitivity analysis. The vertical hydraulic conductivity of the Rewan Formation was increased by a factor of 10 to simulate how faulting or fractures could impact the model predictions.
Parameterisation	Hydraulic conductivity	Fit for purpose	Field testing of hydraulic conductivity (horizontal and vertical) has been conducted at the site and surrounds for the coal seams and the alluvium. Values for the other hydrostratigraphic units were taken from the literature (Table 8). Model parameters calibrated in line with field data ranges and in consideration of model parameters used in the region. Scenario analysis was run to test hydraulic properties by varying them by an order of magnitude within the alluvium, the Rewan Group and the Rangal Coal Measures in order to understand the influence this had on the model predictions.

Type	Part	Status	Comment
	Storage properties	Fit for purpose	Limited site data available for the storage properties, but values matched to align with parameters used at surrounding mines and consistent with current literature (i.e. Rau et al 2018).
	Recharge	Fit for purpose	Recharge parameters were zoned based on surface geology / land use and calibrated in the steady state calibration. Recharge in the transient calibration was represented based on actual quarterly rainfall to capture seasonal variability.
	Mine inflows	Future improvements	The approach how adopted to simulate mine inflows was kept consistent with previous models (drain cells active for two years when mining commences at a location). This is a conservative approach and may lead to overestimation of the mine inflows.
Measurement Error	Observation Data quality	Fit for purpose with future improvements	As part of the conceptualisation the quality of data was reviewed, including review of groundwater level and quality trends to verify target lithology. The quality of the observation data for water levels is fit for purpose. There is a need for more accurate collection of groundwater dewatering data from underground.
	Spatial spread	Fit for purpose	Observation targets are available for most model layers across the model domain.
	Temporal spread	Fit for purpose with future improvements	Groundwater levels have been recorded on a quarterly basis across the network. Groundwater level readings for bores within the existing mine have historical data from around 2005 to 2019, capturing responses to rainfall events and mining in the region over the calibration period. Ongoing monitoring of the bores will be conducted, which will be incorporated into future iterations of the groundwater model. The model changes from quarterly to annual time steps in 2060. For some bores, this change is visible in the hydrographs. This can be improved for future model iterations.
Scenario uncertainties future stresses/ conditions	Calibration	Fit for purpose	Previous transient calibration from December 2005 to September 2021 with quarterly stress periods. The calibration data set (water levels) is well suited in the vicinity of the mine. The bores of the RB-series (observing the target coal seam) have shown a clear mining impact.
	Predictive	Fit for purpose	Predictive model January 2022 to December 2030 (9 years) with quarterly stress periods. Model predictive time frame is less than 3 times the duration of transient calibration. Temporal discretisation varies to calibration, in order to align with mine plan design timing.

Type	Part	Status	Comment
	Recovery	Fit for purpose	Recovery model was run in quarterly time steps between 2030 and 2060 and then in annual time steps between 2060 and 2260. The total recovery period is 230 years and the hydrographs are flattening out for all bores, which indicates long-term equilibrium has been captured.
	Sensitivity	Fit for purpose with future improvements	Eleven key parameters were selected and changed by permutation to assess the predictive uncertainty for the drawdown, the Project inflows and the stream flow losses.

7 Potential Impacts

7.1 Assessment framework

The potential impacts of the Project on the groundwater resources is assessed both in term of change in groundwater levels and groundwater quality, in accordance with the requirements listed in Table 1. Note that the impacts presented are incremental impacts, i.e. the additional impact of the Project compared to the existing operations.

Each EV (as detailed in Section 5.5) may be impacted differently by changes in groundwater levels and groundwater quality. The basis for assessing impact for each groundwater EV is presented in Table 25.

Table 25 Impact assessment framework for each environmental value

EVs pertinent to Ensham	Potential impact 1 – groundwater drawdown	Impact assessment 1	Potential impact 2 – Groundwater quality degradation	Impact assessment 2
Aquatic ecosystem	A decrease of the groundwater table may reduce the ability for some vegetation to access groundwater. It may also affect baseflow in connected waterways as well as habitat for stygofauna.	Drawdown (m) in the alluvium, at a wetland and mapped GDE area	Changes in groundwater quality may affect the health of groundwater dependant ecosystems	Predicted change in quality, area affected and potential impact on GDE.
Irrigation; farm supply / use; stock water	A decrease of the groundwater table may reduce bore yield or degrade groundwater quality (e.g. increase EC).	Drawdown (m) in all affected private bores	Change in groundwater quality may reduce potential use of groundwater depending on groundwater usage	Predicted change in quality, private bores affected and potential impact for each bore based on usage.

7.2 Water licensing

As outlined in Section 2.2, the Project is located within the Water Plan (Fitzroy Basin), which covers surface water resources only. The model predicts no reduction in baseflow in Nogoa River over the life of the existing mine from the existing operations or for the Project.

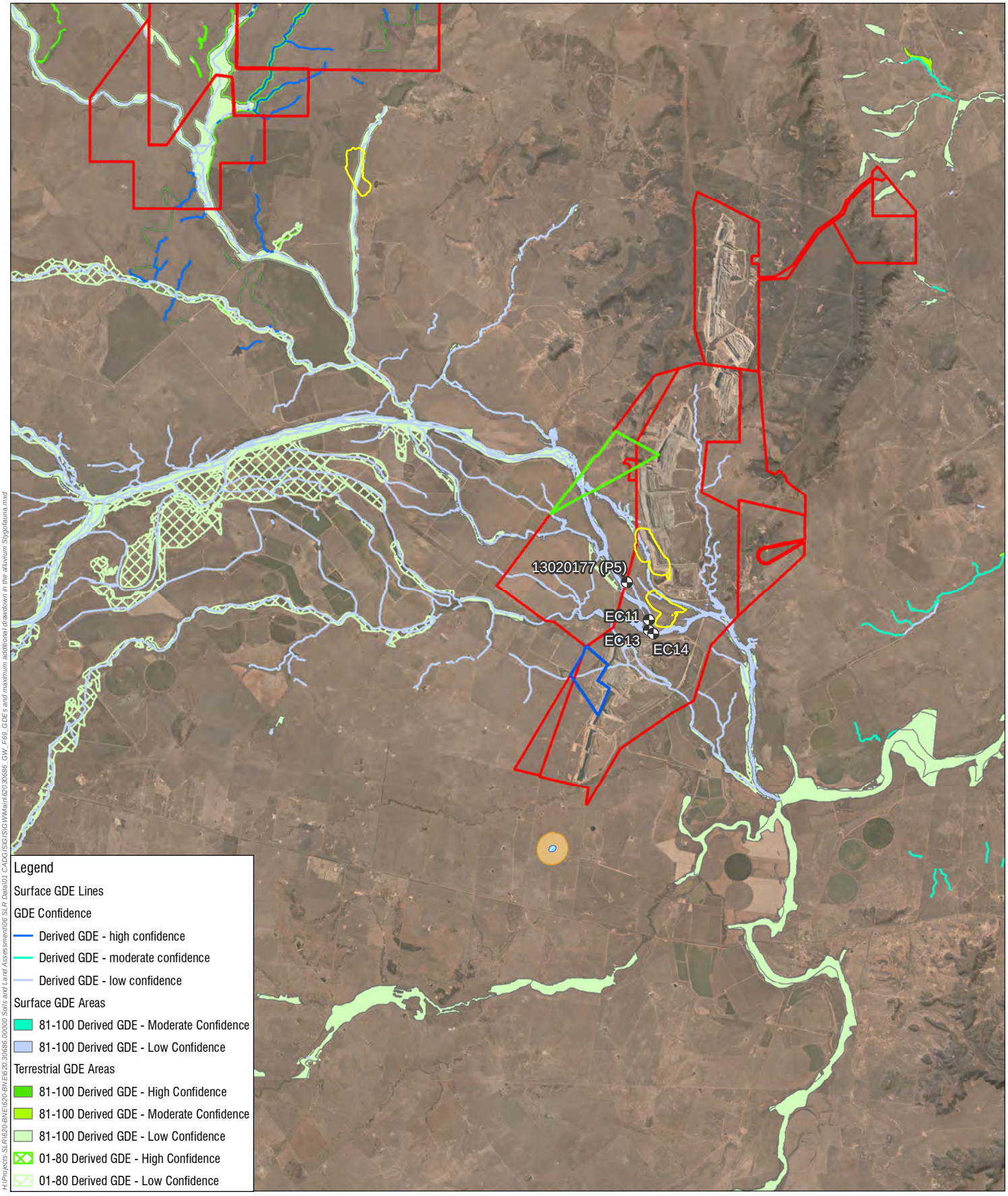
Groundwater is regulated in the Highlands Groundwater Management Area under the Water Plan (Fitzroy Basin) 2011. The associated water take (groundwater inflows into the pit area) does not require a water entitlement under the Water Plan.

Chapter 3 of the Water Act, which regulates the take of underground water, will apply to proposed project activities. An underground water impact report (UWIR) will be prepared for the take of associated water. Any non-associated take of underground water for mining activities would require a water entitlement. However, Ensham does not use any groundwater for non-associated activities.

7.3 Potential impact on aquatic and terrestrial ecosystems

The potential impact on aquatic and terrestrial ecosystems was assessed by reviewing the potential alluvial drawdown in the context of the aquatic and terrestrial ecosystems. Figure 69 shows the aquatic and terrestrial ecosystems identified in Section 5.5.1 with the 0.5 m contour of the maximum incremental drawdown in the unconsolidated material (model layer 2). This maximum incremental drawdown contour intersects part of a surface expression GDE (which was assessed as "low confidence", Section 5.5.1) where the coal measures sub-crop the alluvium. The maximum incremental drawdown also intersects parts of a low confidence surface expression GDE and parts of a low confidence terrestrial GDEs in the northwest of the Project.

Further, Figure 69 shows the four bores that were identified to have Stygofauna present (FRC, 2022b). None of the bores are predicted to be impacted by the Project.



H:\Projects-SLR\620-BNE\620.30686.00000 Soils and Land Assessment\06 SLR Data\01 CAD\GIS\GIS\GIS\WWMain\620306686_GW_F69_GDEs and maximum additional drawdown in the alluvium Stygofauna.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	620.30686
Date:	25-Feb-2022
Drawn by:	PM
Sheet Size:	A4

SLR
www.slrconsulting.com

Legend

- Groundwater Bore - Stygofauna detected
- Wetland
- Wetland Protection Area
- Zone 2
- Zone 3
- Mining Lease

Drawdown (m)
- 0.5

GROUNDWATER IMPACT ASSESSMENT

Maximum incremental drawdown in the unconsolidated and GDE's

Figure 69

7.4 Potential impact on private bores

The potential incremental and additive impact on each private bore (irrigation, farm supply/use and stock water) identified within 15 km radius of the Project are presented in Table 26 and Table 27 respectively. Some bores are not in use or screened within units that have not been identified / logged. For these bores, the impacts cannot readily be assessed.

The bores with the largest incremental drawdown impact are Jamar Bore (0.02 m) and Winton Creek Bore (0.01 m), both taking water from the Rewan Group. The additive drawdowns for those bores are 0.07 m and 0.05 m respectively. These drawdowns are considered negligible.

These bores were previously (HydroSimulations, 2020) attributed to model layer 4 (lower Rewan). The re-assessment of the bore log for RB04 and the reported depths of Jamar and Winton Creek bores in comparison with the model geometry concluded that these bores are screened in model layer 3 (Upper Rewan). The impacts were assessed for model Layer 3 (Table 26 and Table 27).

Table 26 Predicted maximum incremental drawdown at private bores due to the Project

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum additional DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
103788	Conmurra	66	Irrigation (stock & domestic)	Regolith	140	0	NA	0
132040	Currimundi	-	Not in use	Unknown	Unknown	NC	NC	NC
57402	Kensington	-	Not in use	Unknown	Unknown	NC	NC	NC
84403	-	-	Unknown	Unknown	Unknown	NC	NC	NC
89380	Fair Hills	77	Stock & domestic	Burngrove	196-214	0.0003	2255	0.0002
89383	Yongala	74	Stock	Burngrove	213	0.0019	2257	0.0019
89382		74	Stock	Unknown	213	NC	NC	NC
89384		78	Stock	Unknown	213	NC	NC	NC
90140	Railway	61	Stock	Regolith	130 - 160	0	NA	0
-	Chelbrook1	24	Not in use	Unknown	Unknown	NC	NC	NC
-	Chelbrook2	>100	Not in use	Unknown	Unknown	NC	NC	NC
-	Currimundi (Field 5 Bore)	29	Not in use	Unknown	Unknown	NC	NC	NC
-	Cypress	>160	Not in use	Unknown	Unknown	NC	NC	NC
-	Euro Park	74	Not in use	Rewan (upper)	Unknown	0.0118	2085	0.0022
-	Jamar	90	Stock	Rewan (upper)	108 - 126	0.0186	2063	0
-	Jenson	41	Stock	Unknown	Unknown	NC	NC	NC
-	Karanga	~50	Stock	Burngrove	133	0.0071	2116	0.0024
-	Twin Bore	18	Stock	Alluvium	153	0.0035	2053	0.0003

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum additional DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
-	Winton Creek	60	Stock	Rewan (upper)	138	0.015	2050	0
67014		80	Unlikely used (very saline)	Unknown	164.3 (1983)	NC	NC	NC
90338		30	Farm supply (potable)	Unknown	Unknown	NC	NC	NC
67015		44	Unlikely used (very saline)	Unknown	Unknown	NC	NC	NC
38845		70	Unknown	Unknown	Unknown	NC	NC	NC
90337		31	Unknown	Unknown	Unknown	NC	NC	NC

NC: not calculated: bore not in use or geology not known (if geology is unknown, it is unknown in which model layer the bore would be and hence not results can be extracted), DD: drawdown (base case). NA: if drawdowns is zero, no year can be extracted, as this is valid during the entire model run.

Table 27 Predicted maximum additive drawdown at private bores due to the Project

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum additional DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
103788	Conmurra	66	Irrigation (stock & domestic)	Regolith	140	0.0001	2066	0
132040	Currimundi	-	Not in use	Unknown	Unknown	NC	NC	NC
57402	Kensington	-	Not in use	Unknown	Unknown	NC	NC	NC
84403	-	-	Unknown	Unknown	Unknown	NC	NC	NC
89380	Fair Hills	77	Stock & domestic	Burngrove	196-214	0.0004	2256	0.0003
89383	Yongala	74	Stock	Burngrove	213	0.0025	2258	0.0025
89382		74	Stock	Unknown	213	NC	NC	NC
89384		78	Stock	Unknown	213	NC	NC	NC
90140	Railway	61	Stock	Regolith	130 - 160	0	NA	0
-	Chelbrook1	24	Not in use	Unknown	Unknown	NC	NC	NC
-	Chelbrook2	>100	Not in use	Unknown	Unknown	NC	NC	NC
-	Currimundi (Field 5 Bore)	29	Not in use	Unknown	Unknown	NC	NC	NC
-	Cypress	>160	Not in use	Unknown	Unknown	NC	NC	NC
-	Euro Park	74	Not in use	Rewan (upper)	Unknown	0.05	2105	0.03
-	Jamar	90	Stock	Rewan (upper)	108 - 126	0.07	2079	0.05
-	Jenson	41	Stock	Unknown	Unknown	NC	NC	NC
-	Karanga	~50	Stock	Burngrove	133	0.02	2147	0.01

Registered RN (ID)	Bore name	Bore depth (m)	Use	Geology (in GW model)	SWL (mAHD)	Maximum additional DD (m)	Time of max. DD occurring (year)	Long-term additional impact (m) (year 2260)
-	Twin Bore	18	Stock	Alluvium	153	0.02	2240	0.02
-	Winton Creek	60	Stock	Rewan (upper)	138	0.05	2058	0.04
67014		80	Unlikely used (very saline)	Unknown	164.3 (1983)	NC	NC	NC
90338		30	Farm supply (potable)	Unknown	Unknown	NC	NC	NC
67015		44	Unlikely used (very saline)	Unknown	Unknown	NC	NC	NC
38845		70	Unknown	Unknown	Unknown	NC	NC	NC
90337		31	Unknown	Unknown	Unknown	NC	NC	NC

NC: not calculated: bore not in use or geology not known (if geology is unknown, it is unknown in which model layer the bore would be and hence not results can be extracted), DD: drawdown (base case). NA: if drawdowns is zero, no year can be extracted, as this is valid during the entire model run.

7.5 Impact on groundwater quality

The Project does not include any new infrastructure, construction phase or spoil emplacements, which could potentially impact the groundwater quality. The Project is exclusively underground bord and pillar mining, leaving the excavated underground voids in the coal body to recharge naturally over time. The inflowing water will have the same quality as the water previously stored in the coal seam.

As discussed in Section 5.4.1.1, the alluvial groundwater shows a great range in salinity with recorded values ranging from about 1,000 µS / cm to 50,000 µS / cm. Based on the groundwater modelling, the alluvium is predicted to have minor incremental drawdowns, consequently the groundwater quality is not predicted to change due to the Project.

Current recharge and discharge mechanisms (recharge through large rain or flood events and discharge through evapotranspiration) will have a greater impact on the groundwater quality in the alluvium (reduction of EC in wet periods by dilution and increase of EC during droughts) than mining.

7.6 Climate change scenarios

The Climate Future Tool (CSIRO and BOM, 2020) was interrogated for the cluster East Coast North, which is the relevant sub-cluster for the Ensham mine. The general rainfall projection for this cluster was summarised as:

“Natural climate variability is projected to remain the major driver of rainfall changes in the next few decades. Models show a range of results, with little change or decrease being more common particularly in winter and spring. Impact assessment in this region should consider the risk of both a drier and wetter climate.”

In the Climate Futures Tool, the functionality “Explore projections” was used to quantify the predicted change in annual rainfall. There are four Representative Concentration Pathways (RCPs), which represent different greenhouse gas concentration scenarios. These are (CSIRO and BOM, 2020):

- RCP8.5 - a future with little curbing of emissions, with a CO_2 concentration continuing to rapidly rise, reaching 940 ppm by 2100.
- RCP6.0 – lower emissions, achieved by application of some mitigation strategies and technologies. CO_2 concentration rising less rapidly (than RCP8.5), but still reaching 660 ppm by 2100 and total radiative forcing stabilising shortly after 2100.
- RCP4.5 - CO_2 concentrations are slightly above those of RCP6.0 until after mid-century, but emissions peak earlier (around 2040), and the CO_2 concentration reaches 540 ppm by 2100.
- RCP2.6 - the most ambitious mitigation scenario, with emissions peaking early in the century (around 2020), then rapidly declining. The CO_2 concentration reaches 440 ppm by 2040 then slowly declines to 420 ppm by 2100).

In the projections explorer, each RCP can be assessed at different points in time (up to 2090). For the long-term recovery, the projections' change in annual rainfall was assessed for the year 2090. The results are presented in Table 28. The percentage value for each RCP indicates the percentage of models which had the corresponding outcome of percent change in rainfall. For example, in 2090 for RCP 2.6, 28% (8 of 29) models predicted a reduction in rainfall of more than 15%. For RCP 8.5 37% (26 of 70) models predicted a reduction in rainfall of more than 15%.

Table 28 Change in rainfall for different climate scenarios (2090)

% Annual Rainfall Comparison	RCP 2.6 (n=29)	RCP 4.5 (n=68)	RCP 6.0 (n=22)	RCP 8.5 (n=70)
>15% (much wetter)	-	-	9%	6%
5 to 15% (wetter)	14%	15%	23%	13%
-5 to 5 (little change)	34%	29%	27%	21%
-15 to -5 (drier)	24%	40%	23%	23%
> -15% (much drier)	28%	16%	18%	37%

Notes: n refers to the number of models in each of the RCP categories

7.6.1 Future climate scenarios and their impact on the alluvium

The impact of the climate change scenarios and their impact on the alluvium is illustrated in Figure 70, with the example hydrograph for EC25. The figure shows the calculated hydrographs for this bore for the Existing operations scenario and the Project, both for the average climate, the 20% more recharge scenario and the 20% less recharge scenario. Based on Table 28, the climate is more likely to get drier over time with climate change.

The figure shows the following:

- The estimated water level variation under average quarterly recharge and river stages into the groundwater model (2020-2060) is approximately 1 m. This represents the natural variability of the groundwater levels.
- The difference between Project and Existing represent the mining impact. The Existing scenario results in slightly higher alluvial water levels in the long-term. The mining impact is approximately 5 cm.

- The difference between the Project and "the Project with 20% more and less recharge" represents the climate change impact. The estimate of the climate change impact on the alluvium is approximately 5cm.

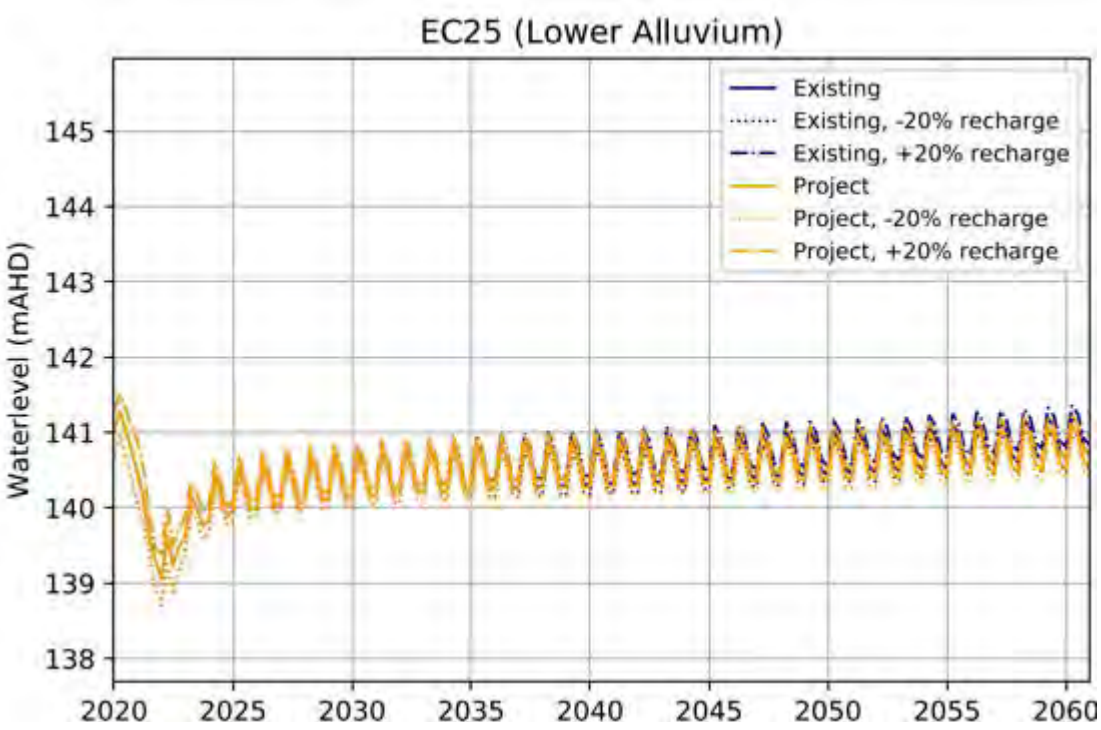


Figure 70 Long-term recovery hydrograph for alluvial bore EC25

In summary, the predicted long-term groundwater level changes at bore EC25 result in decrease of approximately 5 cm for the climate change (20% decrease in rainfall recharge) and an increase of approximately 5 cm for the mining impact, which is considered an effect from the different drawdown and recovery curves compared to the existing operations. These changes are likely to be masked by the natural variability, which was shown to be 1 m for an average quarterly input of climate data into the groundwater model.

7.6.2 Future climate scenarios and their impact on the coal seams

The impact of the climate change scenarios and their impact on the coal seam is illustrated in Figure 71, with the example hydrograph for RB04. The figure shows the calculated hydrographs for this bore for the Existing operations scenario and the Project, both for the average climate, the 20% more recharge scenario and the 20% less recharge scenario. Based on Table 28, the climate is more likely to get drier over time.

Similar to the alluvial bore, the impact from climate change on the water levels in the coal seam is minor (cm range). Due to depressurisation of the coal seam, the mining impact is larger (approximately 5m). This shows that the predictions for the water level drawdowns are not sensitive to climate change.

Figure 71 Long-term recovery hydrograph for bore RB04

7.7 Other potential impacts

This section covers other potential impacts on the groundwater resources from the extension of the underground mine. These potential impacts have been qualitatively assessed and are presented in Table 29.

Table 29 Qualitative assessment of other potential impacts

Potential Impact	Qualitative assessment
Contamination from underground machinery, fuel storage, workshops, waste storage	The extension of the underground coal mine will not have any additional impacts compared to the existing operations. The same methods of underground mining will be used. The only difference to the existing operations in this context is the duration of mining (6 years for the existing operations versus 8years for the Project).
Incidental mine gas	The measured seam gas content in the current ML 7459 and ML 70365 areas is generally low. The current operational procedures will be utilised for incidental mine gas hazard management. The current ventilation system and proposed flaring will be utilised to manage incidental gas for the underground mining in the Zone 2 and 3. There is no likely impact on landholder bores. Should any of the bores become gassy, the Groundwater Management Plan (GWMP) should be amended to include gas sampling at these bores.

Potential Impact	Qualitative assessment
Flood mitigation measures	There are no additional surface water infrastructure features planned, hence there are no additional impacts on the groundwater.
Any ventilation shafts	No additional ventilation shafts are required, hence no additional impact on the groundwater is expected.

8 Management and mitigation

8.1 Mine affected water

Mine-affected water will be managed using the existing mine water management system (SLR, 2022). No new infrastructure will be required. The existing water management system is regulated through the Environmental Authority EPML00732813.

The current EA defines conditions for the release of mine affected water including release points, sources, release limits and receiving water. The source of water associated with the Project will be Ramp 24 Fill Point Dam and Ramp 3 / 4 Drain (Table 30).

Table 30 Release points and source water conditions (Table C1 of EPML00732813)

Release point	Easting (GDA94)	Northing (GDA 94)	Mine affected water source and location	Monitoring point	Receiving waters description
RP1	653731	7401335	Ramp 24 Fill Point Dam, Ramp 3 / 4 Drain, A, B, C, D, E, F and Y pits	End of pipe	Nogoa River
RP3	651680	740068	Ramp 24 Fill Point Dam, Ramp 3 / 4 Drain, A, B, C, D, E, F and Y pits	End of pipe	Nogoa River

8.2 Subsidence

Ensham is currently operating a bord and pillar mine downdip of the open-cut and is planning to extend mining operations into Zone 2 and 3 using the same mining methodology. This mining system forms a regular array of stable coal pillars and roadways in each panel and does not cause large scale overburden fracturing or subsidence. In the thicker seam areas, additional coal may also be recovered from the floor of the roadways.

Gordon Geotechniques (2022) assessed the subsidence risk for the Project and the study has been peer reviewed by Mine Advice. The assessment of the stability of the coal pillars in Zone 2 and 3 has been carried out using the industry accepted University of New South Wales Pillar Design Procedure. There is a high degree of confidence in these subsidence predictions due to the amount of information from the existing bord and pillar mining at Ensham with similar mining heights, depth of cover and mining methodology. This assessment has confirmed the long-term stability of the proposed mine layout.

Due to the nature of the bord and pillar mining method, subsidence related to the Project is predicted to be typically less than 35 mm; RTK-GPS monitoring at Ensham indicates subsidence levels of less than 10 mm above mined underground panels and confirms this maximum subsidence prediction for the Project. To provide context, DAWE states that seasonal variation in surface levels can be as high as 50 mm as a result of changes in moisture content.

Due to the low levels of subsidence and associated strains and tilts, no surface cracking is anticipated within the Zones 2 and 3. The expected low levels of subsidence are also unlikely to result in the formation of significant depressions in the surface topography where ponding of the surface drainage may occur. This is consistent with experience at the existing Ensham mine operations where no surface cracking or ponding has been observed above the operating bord and pillar mine areas.

Subsidence or ground instability due to the removal of groundwater and coal is, based on the geology overlying the target coal seams, deemed to be limited.

8.3 Groundwater users

As reported in Section 7.4, there are two private bores (Jamar Bore and Winton Creek Bore, in the Rewan Group) that may experience an incremental drawdown of 2 cm and an additive drawdown of less than 10 cm due to the Project.

Make good measures would be put in place with landholders with bores predicted to be affected by the Project mine dewatering (where groundwater levels are predicted to decrease by more than 2 m in the alluvium and by more than 5 m in the consolidated hydrostratigraphic units, as defined thresholds in the Water Act, Section 362) to ensure the bore owner has access to a similar quantity and quality of water for the water bore's authorised purpose. As the modelled drawdowns are below the thresholds above, no make good measures are required to be put in place. The two private bores (Jamar Bore and Winton Creek Bore) are currently monitored (water level and water quality) on a quarterly basis as required under the EA.

8.4 Groundwater monitoring program

The groundwater monitoring bore network as per the current EA EPML00732813 is extensive and allows for the compilation of groundwater monitoring data from the Quaternary (alluvium), Triassic age sediments, Rewan Group and Rangal Coal Measures for the currently approved operations at Ensham. This network is presented in Section 5.1 (Table 7) and is deemed suitable to assess the impacts of the two years of additional mining for the Project.

8.4.1 Data management and reporting

In accordance with the current EA the following will apply :

- The groundwater monitoring at all bores will be conducted on a quarterly basis or as defined in the EA.
- Data will be stored within the existing consolidated groundwater database.
- Quality assurance and quality control procedures, such as field sampling procedures and the use of NATA accredited laboratories, will continue to be in place to assess the accuracy of data entered into the database.

In accordance with the current EA, findings from the quarterly monitoring events will continue to be documented:

- The quarterly review will include identification of any groundwater quality trigger exceedances.
- Where a trigger exceedance is identified, the regulator will be notified within 28 days and an investigation into the potential for environmental harm will be completed. The groundwater database and factual quarterly documentation will be available for provision to the regulator upon request.
- Each year an annual review of groundwater level and quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm.

9 Conclusions

The key conclusions of this groundwater assessment are:

- The Project has a predicted underground mine inflow between 2 and 14 ML / day, with an average inflow of 8.9 ML / day. With the methodology that was used, these inflows are considered a conservative over-estimate.
- The total inflow for the Project is greater than that predicted for the existing operations. This is because the Project extends the life of mine by two years, and as such, inflows continue for a longer duration. Daily inflow rates are similar to those from existing operations.
- The predicted maximum incremental groundwater level drawdown within the alluvium as a result of the Project is 2m. However, these maximum incremental drawdowns in the alluvium are very localised, specifically east of the open-cut voids and can be attributed to a difference in recovery rather than an addition in total drawdown. Most parts of the alluvium have no drawdown predicted due to mining.
- The maximum incremental drawdown (0.5m) intersects part of a surface expression GDE (which was assessed as “low confidence”) where the coal measures sub-crop the alluvium. The maximum incremental drawdown also intersects parts of a low confidence surface expression GDE and parts of a low confidence terrestrial GDEs in the northwest of the Project. Accordingly, impacts on identified potential GDEs are negligible.
- The incremental groundwater level drawdown within the Rangal Coal Measures (coal seam) is predicted to extend in range of up to 7 km to the west and south-west (down dip) of the Project.
- The additive drawdown within the Rangal Coal Measures (coal seam) extends up to 8 km to the west and southwest of the Project.
- No private landholder bores are predicted to have an incremental drawdown in groundwater levels greater than 2 m at any point in time in the long term (after the life of the Project). The largest predicted incremental drawdowns in landholder bores are 2 cm. The largest predicted additive drawdowns in landholder bores are less than 10 cm.
- The incremental net indirect loss of groundwater from the alluvium to underlying strata due to the Project is predicted to be about 0.01 ML / day on average. This is considered negligible.
- The predicted change in baseflow of the Nogoa River due to the Project is negligible, both for the incremental and additive change.
- There is no leakage from the coal measures predicted to flow into the alluvium for the Project.
- There are no impacts on groundwater quality predicted for the Project.
- Post mining, the groundwater levels are predicted to recover slowly based on 200-year recovery simulations. Some permanent reduction in water levels is predicted in the target coal seams.
- The groundwater recovery modelling showed that the open-cut pits are long-term sinks, as indicated by the recovered water table contours.

10 Recommendations

The groundwater monitoring bore network as per the current EA EPML00732813 is extensive and allows for the compilation of groundwater monitoring data from the Quaternary (alluvium), Triassic age sediments, Rewan Group and Rangal Coal Measures for the currently approved operations at Ensham. This groundwater monitoring network was deemed suitable to assess the impacts of the two years of additional mining for the Project. It is recommended to continue groundwater monitoring according to the existing groundwater monitoring plan (GWMP).

11 References

AQC-Pacific Pty Ltd 1986, Geology and Coal Resources of the Ensham Open Cut Area, A to P 426C, reported in AGE 2006¸ Ensham Alluvial Project Phase 1 Hydrogeological Assessment, Project G1229, prepared for Hansen Consulting, August 2004.

AECOM, 2020, Ensham Life of Mine Extension Project - Flora Technical Report, prepared for Ensham Resources Pty Ltd, 12 August 2020

Ausenco-Norwest 2012, Groundwater Model, Northern Bowen Basin Regional Model Impact Predictions, Queensland, Australia, Prepared for Arrow Energy Pty Ltd.

Australasian Groundwater and Environmental (AGE) Consultants 2006, Report on Ensham Central Project – EIA, Groundwater Impact Assessment, Project No. G1258, Appendix C of EIS, February 2006.

Australasian Groundwater and Environmental Consultants 2013, Minyango Project Groundwater, Proj G1562, Report for Hansen Bailey, April 2013.

Australasian Groundwater and Environmental Consultants 2015, Gregory Crinum Kestrel Groundwater Model Update, Prepared for BHP Billiton Mitsubishi Alliance. March 2015.

Australasian Groundwater and Environmental Consultants 2017, Ensham Underground Groundwater Model, Report prepared for Ensham Resources Pty Ltd. February 2017.

Barnett, B, Townley, LR, Post, V, Evans, RE, Hunt, RJ, Peeters, L, Richardson, S, Werner, AD, Knapton, A & Boronkay, A, 2012. Australian Groundwater Modelling Guidelines. Waterlines Report 82, National Water Commission, Canberra.

BHP Billiton Mitsubishi Alliance, 2009. Daunia Coal Mine Project - Environmental Impact Statement', Appendix H Technical Report: Groundwater Modelling Assessment of Impact of Daunia Coal Mine on Regional Groundwater Aquifers.

Bureau of Meteorology (BOM), 2021. Latest River Heights for Nogoa R at Duckponds, http://www.bom.gov.au/fwo/IDQ65392/IDQ65392.535097.plt.shtml#notes , accessed 8 November 2021

CDM Smith, 2013, Springsure Creek Coal Mine Project: EIS Chapter 9 – Groundwater, Report for Springsure Creek Coal Pty Ltd.

Clark, D, McPherson, A & Collins, C 2011, Australia's seismogenic neotectonic record, Geoscience Australia record 2011/11.

Coffey, 2014, Appendix E - Supplementary Groundwater Assessment, Arrow Energy Bowen Gas Project. Supplementary Report to the EIS, 17 April 2014.

Department of Environment and Heritage Protection, 2011. Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin. Environmental Protection (Water) Policy 2009. September 2011.

DES (Department of Environment and Science), 2018, Springs – Active – Queensland. Accessed 24 November 2021, available at http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Springs - Active - Queensland%22

DES (Department of Environment and Science), 2020, Wetland protection area - GBR high ecological significance wetland. Accessed 29 November 2021, available at http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Wetland protection area - GBR high ecological significance wetland%22

Department of Science (DES), 2021, Using monitoring data to assess groundwater quality and potential environmental impacts, Version 2, Brisbane, Australia: Queensland Government.

FRC, 2022a, Ensham Life of Mine Extension – Zones 2 and 3 Aquatic Ecology Assessment, Prepared for: Ensham Resources Pty Ltd, Ref 211010, Draft Report, 19 January 2022

FRC, 2022b, Ensham Life of Mine Extension – Zones 2 and 3 Comprehensive Stygofauna Assessment, Prepared for: Ensham Resources Pty Ltd, Ref 211010, Draft report, 21 January 2022

GeoResGLobe, 2020, GeoResGlobe - A new and improved mapping application, visited 07 April 2020, < https://georesglobe.information.qld.gov.au/>.

GHD, 2013, Carmichael Coal Mine and Rail Project SEIS - Mine Hydrogeology Report Addendum. Report 41/26422/452475, October 2013.

Golder Associates, 2017, Human Health and Ecological Chemical Assessment – Hydraulic stimulation chemical assessment QGC Surat and Bowen Basin operation. Report 127635006-004-R-Rev4-05300, 29 June 2017

Gordon Geotechniques, 2016, Geotechnical review of the mine plan extension into MDL217, Report prepared for Ensham Resources Pty Ltd, September 2016.

Gordon Geotechniques, 2022, Subsidence Report for the Ensham Life of Mine Extension - Zones 2 and 3, Prepared for Aecom Australia Pty Ltd on behalf of Ensham Resources Pty Ltd, January 2022

Habermehl MA, 1980, The Great Artesian Basin, Australia. BMR Journal of Geology & Geophys. 5, 9-38.

Habermehl MA, 1998, Hydrogeology and hydrochemistry of the Great Artesian Basin, Australia. AGSO (Geoscience Australia) Canberra, ACT

Hancock PJ and Boulton AJ, 2008. Stygofauna biodiversity and endemism in four alluvial aquifers in eastern Australia. Invertebrate Systematics, 22: 117–126.

Hose et al., 2015. Stygofauna in Australian groundwater systems: Extent of knowledge. Report to the Australian Coal Association Research Program (ACARP). CSIRO, Australia.

HydroSimulations, 2020, Ensham Resources Residual Void Project - Groundwater Assessment Stage 3, Prepared for Ensham Resources Pty Ltd, Rev R, April 2020.

JBT Consulting, 2012, Report on Groundwater Seepage Studies and Operational Monitoring Review: Baralaba North Project, Report for CCL, December 2012.

JBT Consulting, 2016, Lake Vermont Northern Extension Groundwater Impact Assessment, Prepared for AARC on Behalf of Bowen Basin Coal Pty Ltd.

Jeffrey, SJ, Carter, JO, Moodie, KB and Beswick, AR (2001), Using spatial interpolation to construct a comprehensive archive of Australian climate data, Environmental Modelling and Software, Vol 16/4, pp 309-330. DOI: 10.1016/S1364-8152(01)00008-1.

Jourde, H, Flodin, EA, Aydin, A, Durlofsky, LJ, & Wen, XH, 2002, Computing permeability of fault zones in eolian sandstone from outcrop measurements, AAPG Bulletin, v. 86, no. 7, p. 1187–1200

KCB, 2016. Isaac Plains East Project Groundwater Modelling Report. Prepared for Hansen Bailey, EAR Groundwater Report Appendix IV.

Matrix Plus, 2010. Groundwater Impact Assessment for Millennium Expansion Project EIS.

Merrick, DP & Merrick, NP, 2015, AlgoMesh: A New Software Tool for Building Unstructured Grid Models, MODFLOW and More 2015 Proceedings, Colorado School of Mines, Integrated Groundwater Modeling Center, May 31 – June 3, 2015, 321-325.

Middlemis H and Peeters LJM (2018) Uncertainty analysis—Guidance for groundwater modelling within a risk management framework. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2018.

Northern Resource Consultants (NRC), 2018. Wilton Coal Project, Response to information Request – Groundwater. Prepared for Wilton Coking Coal Pty ltd. February 2019.

Office of Groundwater Impact Assessment 2016, Groundwater modelling report for the Surat Cumulative Management Area. State of Queensland, September 2019.

Panday, S, Langevin, CD, Niswonger, RG, Ibaraki, Motomu, & Hughes, JD, 2013, MODFLOW– USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p. < https://pubs.usgs.gov/tm/06/a45>

Parsons Brinckerhoff, 2011, Middlemount Coal Project Stage 2 Environmental Impact Statement - Chapter 10 Groundwater, Prepared for Middlemount Coal.

Paul PK, Zoback MD & Hennings PH, 2009, Fluid Flow in a Fractured Reservoir Using a Geomechanically Constrained Fault-Zone-Damage Model for Reservoir Simulation, SPE Reservoir Evaluation & Engineering, Volume 12, Number 4, p. 562-575.

SLR Consulting (SLR), 2019a, Fairhill Coal Project, Underground Water Impact Report, Prepared for Fairhill Coking Coal Pty Ltd, May 2019.

SLR Consulting (SLR), 2019b, Ensham Mine Groundwater 3rd Quarter Report 2019 Prepared for: Ensham Resources Pty Ltd Ensham Mine, Ref: 620.12225.10000-R23, Version No: -v3.0 , October 2019.

SLR Consulting (SLR), 2020, Ensham Life Of Mine Extension Project Groundwater Impact Assessment, Prepared for: AECOM Australia Pty Ltd on behalf of Ensham. Ref: 665.ENS02.10000-R01-02, May 2020.

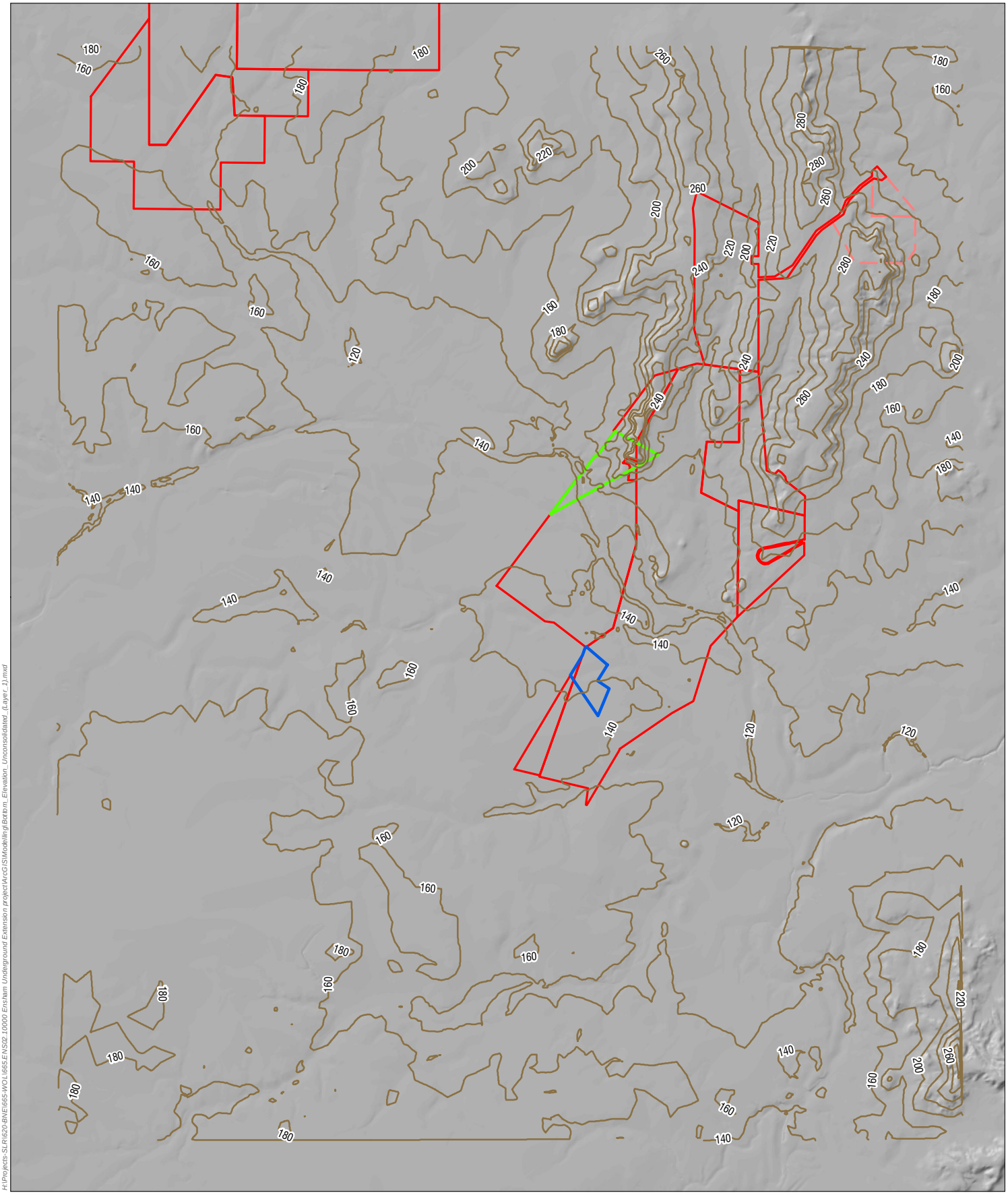
SLR Consulting (SLR), 2021, Ensham Life Of Mine Extension Project Groundwater Impact Assessment - Amendment, Prepared for: Ensham Resources Pty Ltd. Ref: 665.ENS02.10202-R04-v1.0, August 2021.

SLR Consulting (SLR), 2022, ENSHAM LIFE OF MINE EXTENSION PROJECT - ZONES 2 AND 3- Water Balance Model, Prepared for: Ensham Resources Pty Ltd. In prep, February 2022

Uysal, T, Golding, S & Glikson, M, 2000, Thermal and Fluid Flow History in the Bowen Basin, Bowen Basin Symposium 2000.

APPENDIX A

Aquifer depths and thicknesses



GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Unconsolidated (Layer 1)

A1-1

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

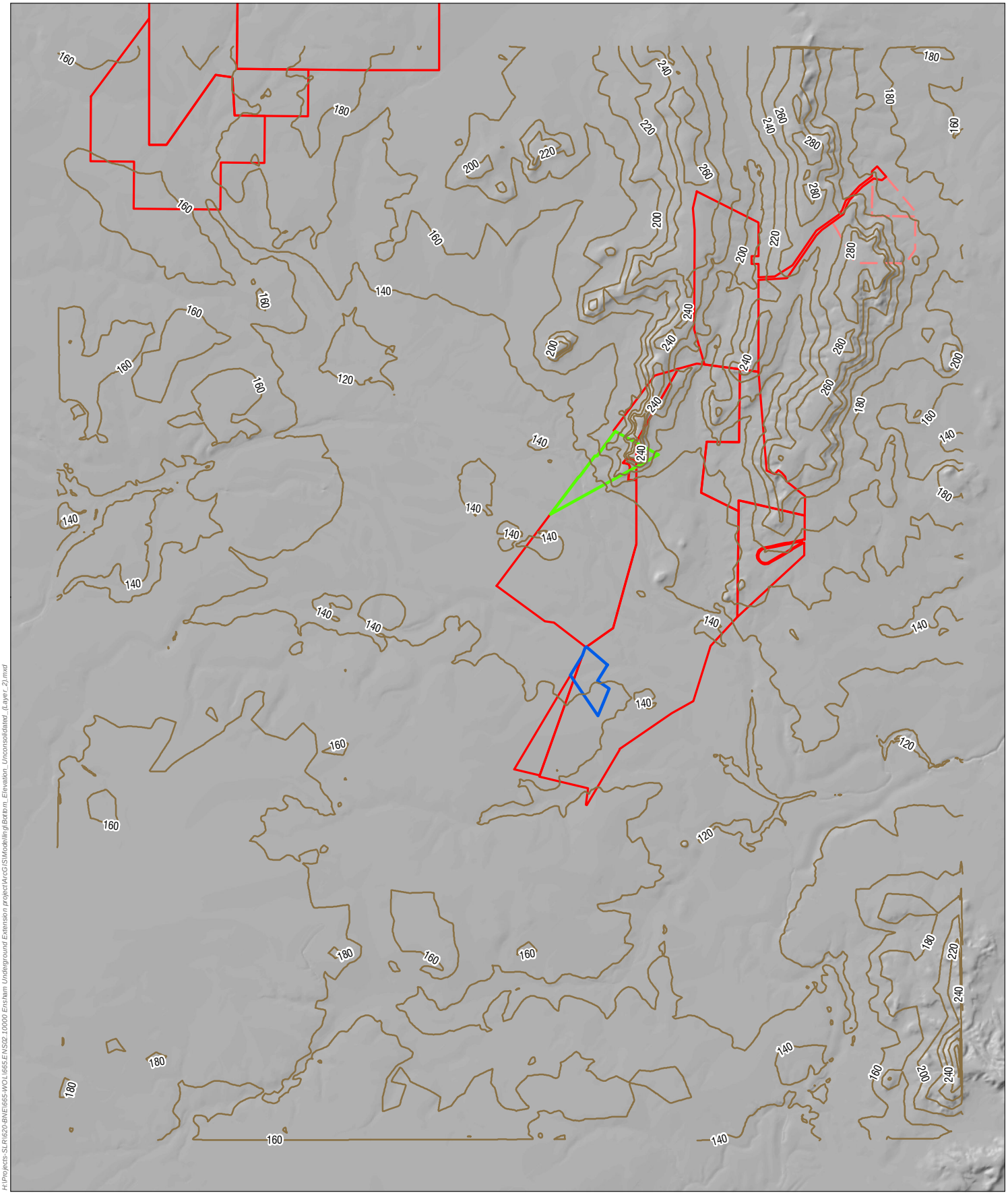
Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

SLR
www.slrconsulting.com

H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\SIM\modelling Bot\p m_Elevation_Unconsolidated_(Layer_1).mxd



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Bottom_Elevation_Unconsolidated_(Layer_2).mxd

0 2 km

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Unconsolidated (Layer 2)

A1-2

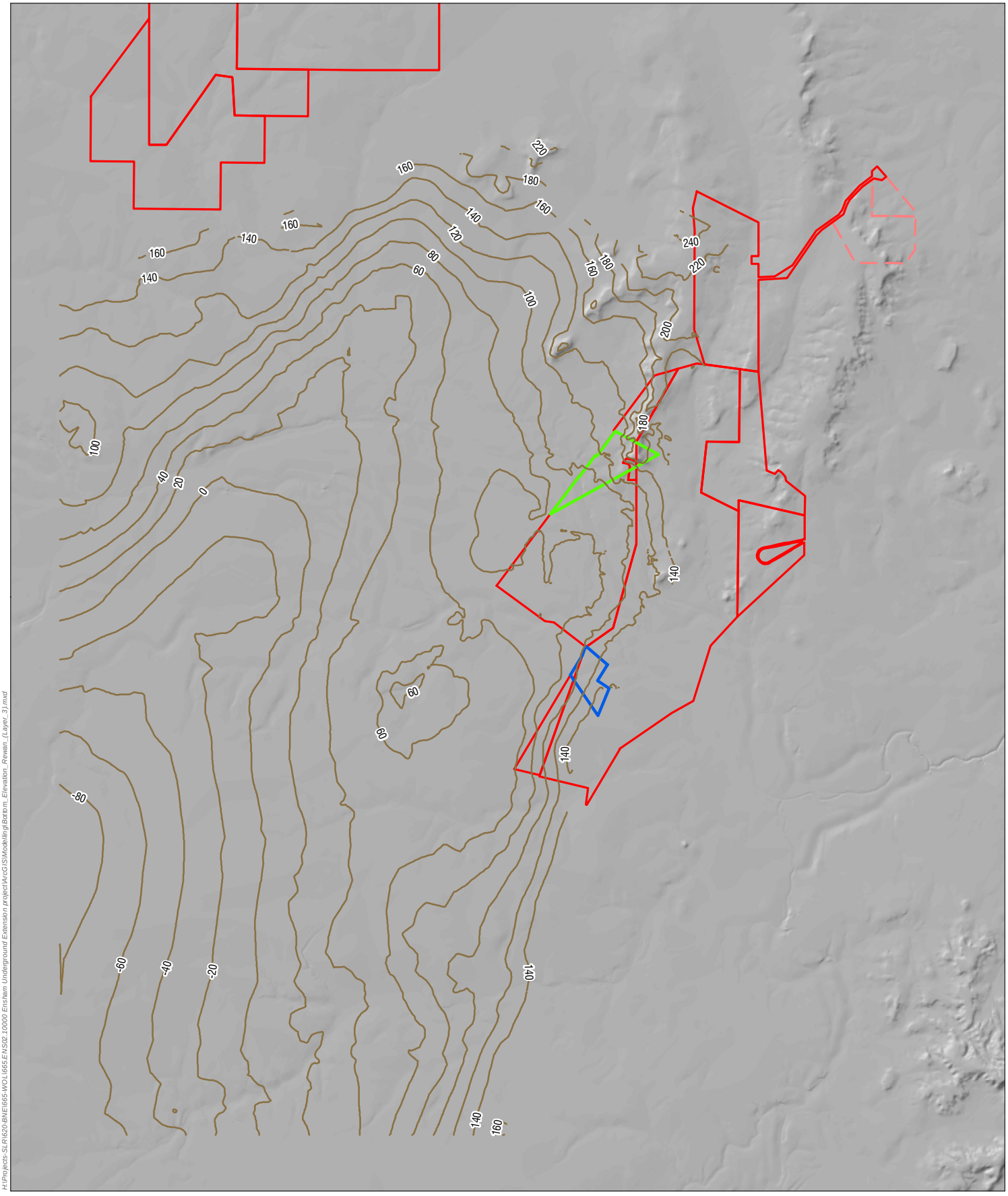
Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\ISModelling Bottom_Elevation_Rewan_(Layer_3).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

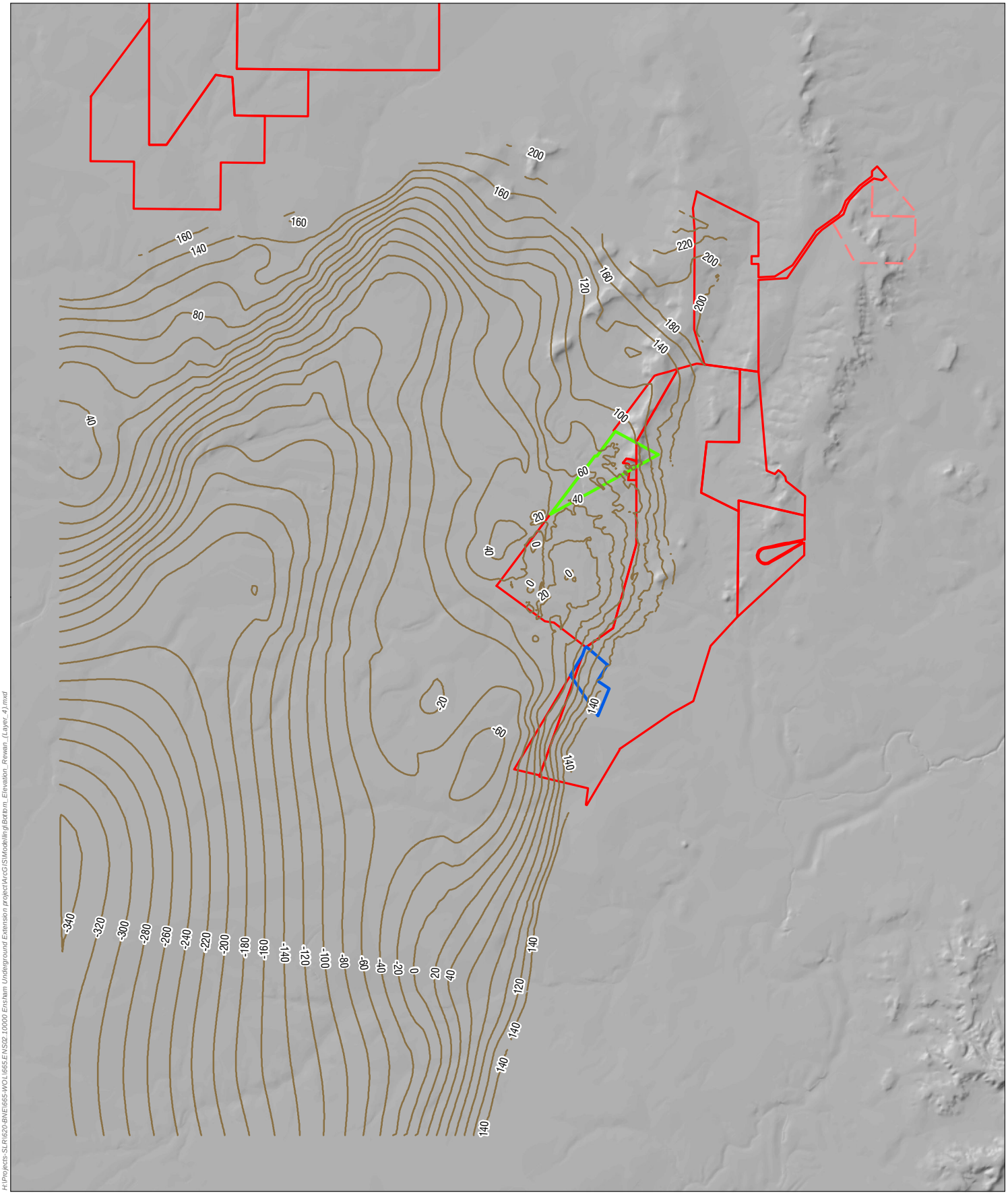
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Rewan (Layer 3)

A1-3

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Bottom_Elevation_Rewan_(Layer_4).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

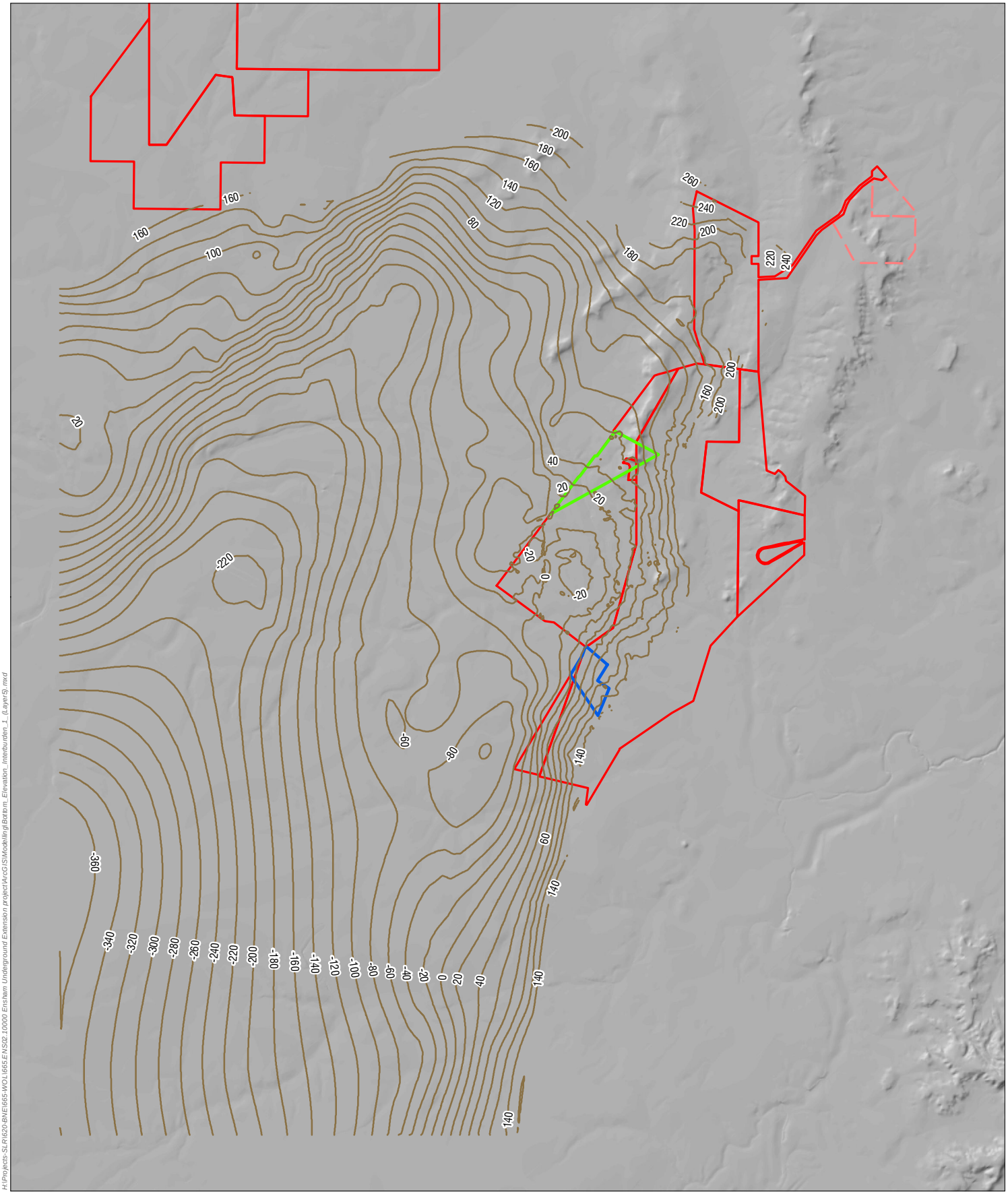
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3
- Elevation Contours (mAHD)

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Rewan (Layer 4)

A1-4

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\ModellingBottom_Elevation_Interburden_1_(Layer5).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

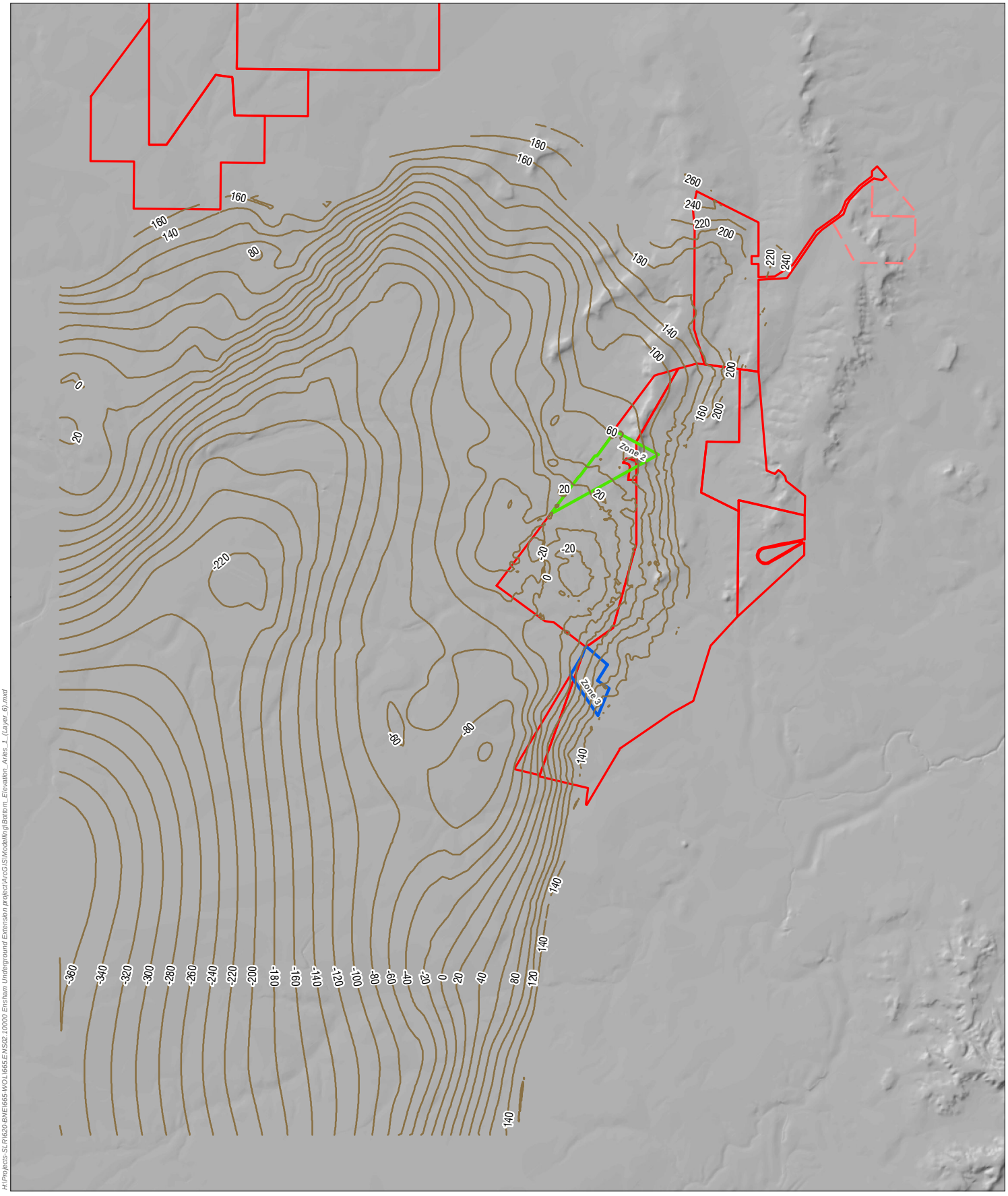
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 1 (Layer5)

A1-5

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling Bottom_Elevation_Aries_1_(Layer_6).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

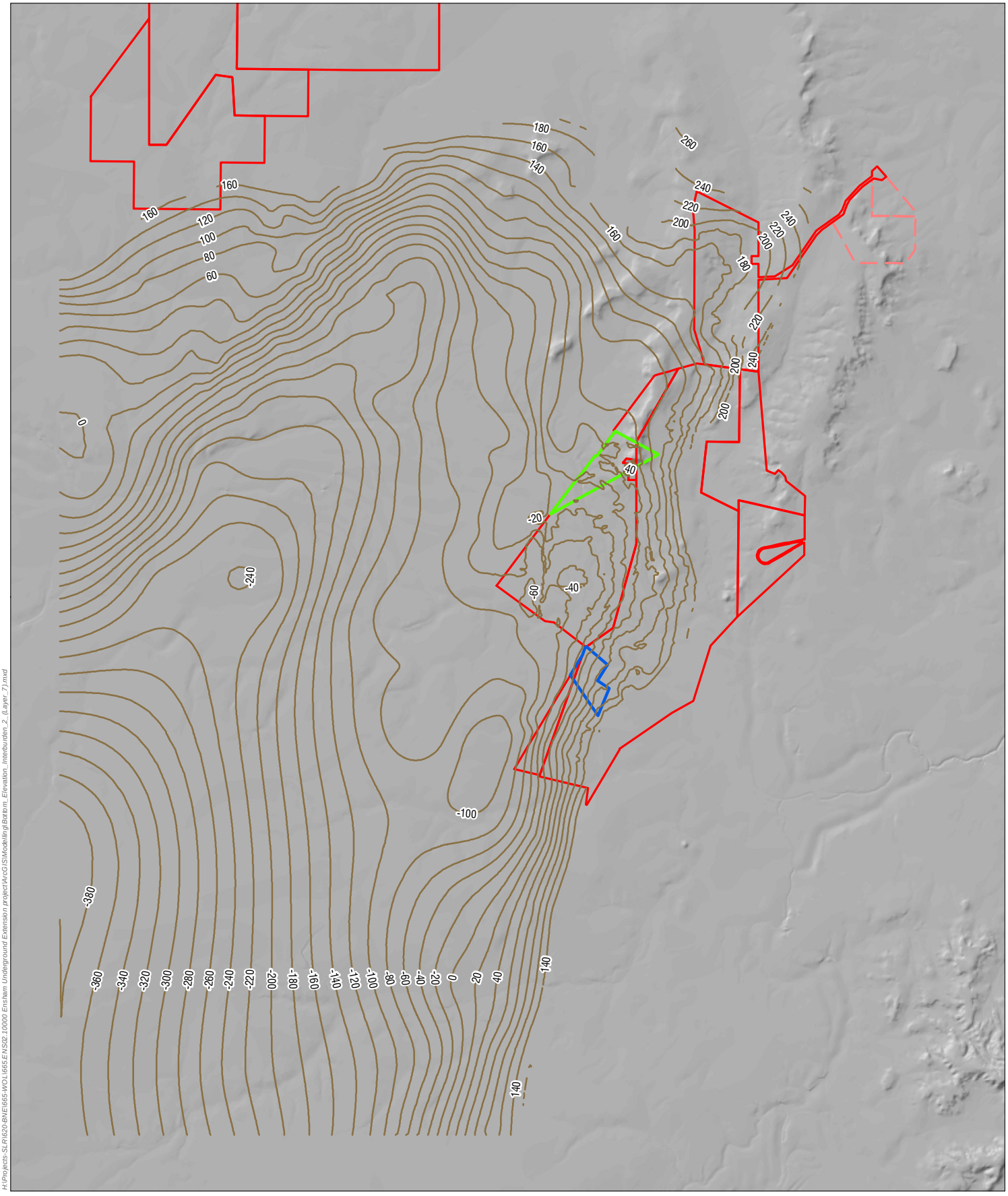
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Aries 1 (Layer 6)

A1-6

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Bottom_Elevation_Interburden_2_(Layer_7).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

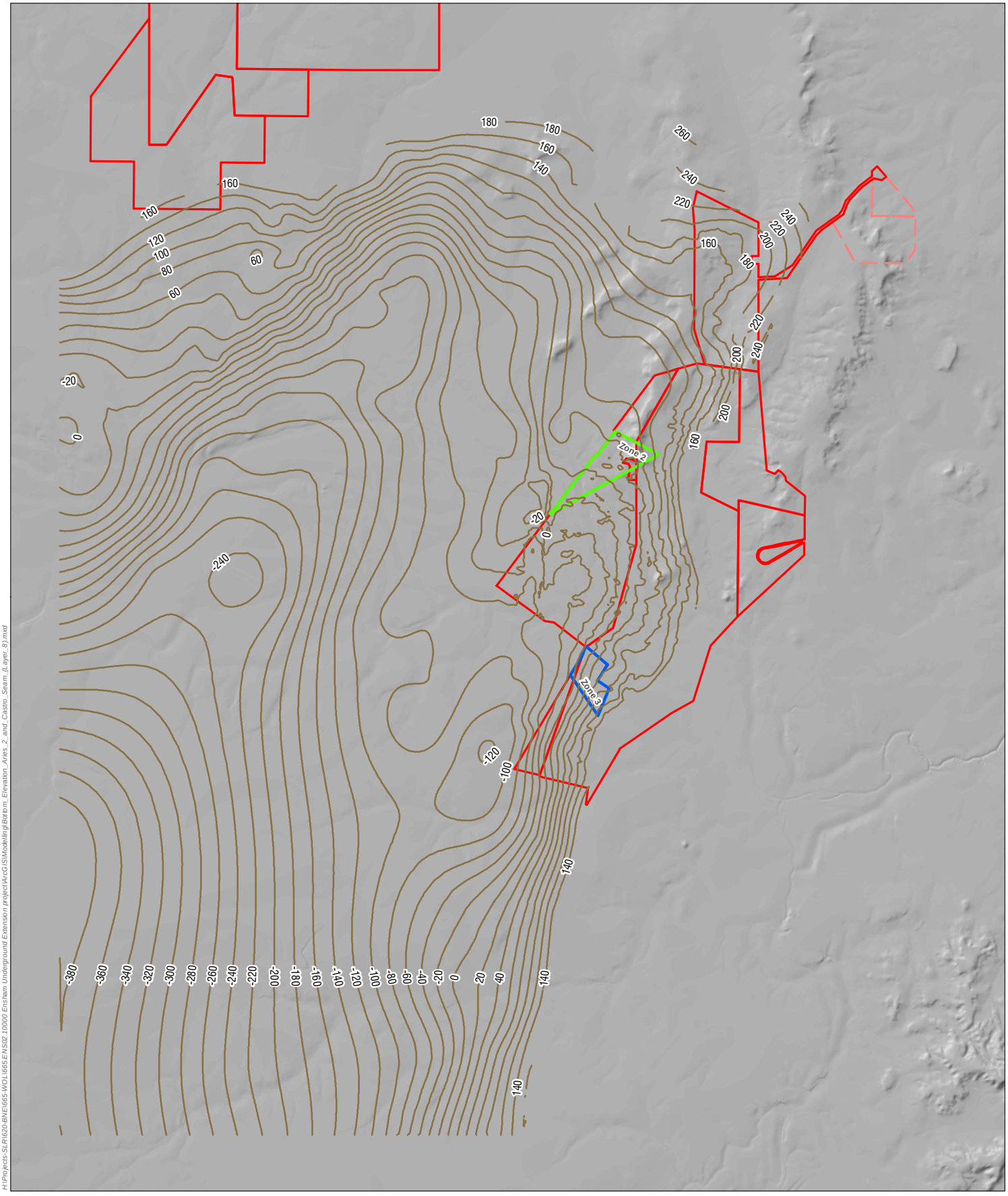
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 2 (Layer 7)

A1-7

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling Bottom_Elevation_Aries_2_and_Castro_Seam_(Layer_8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

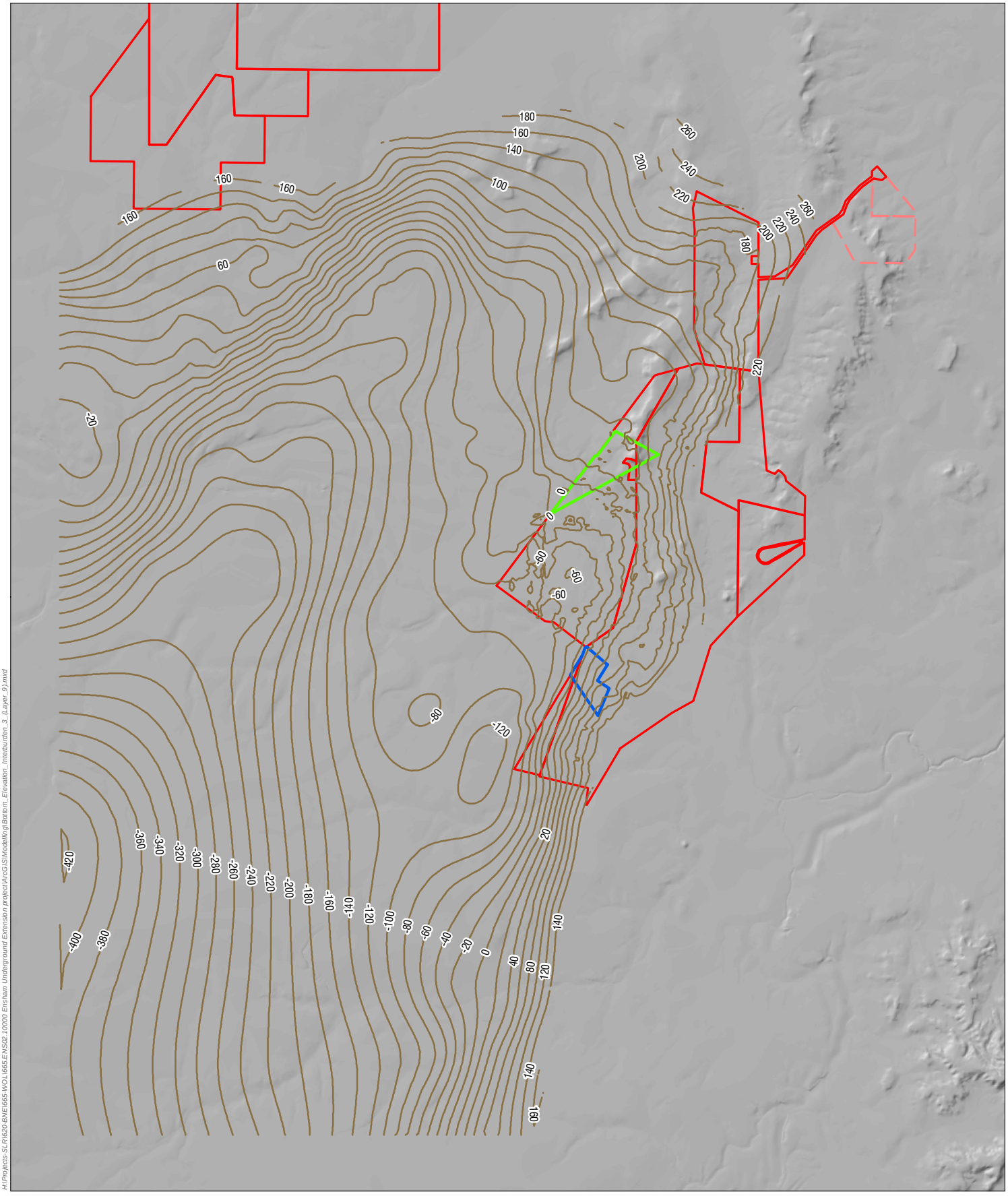
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Aries 2 and Castro Seam (Layer 8)

A1-8

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\MXD\Modelling\Bottom_Elevation_Interburden_3_(Layer_9).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

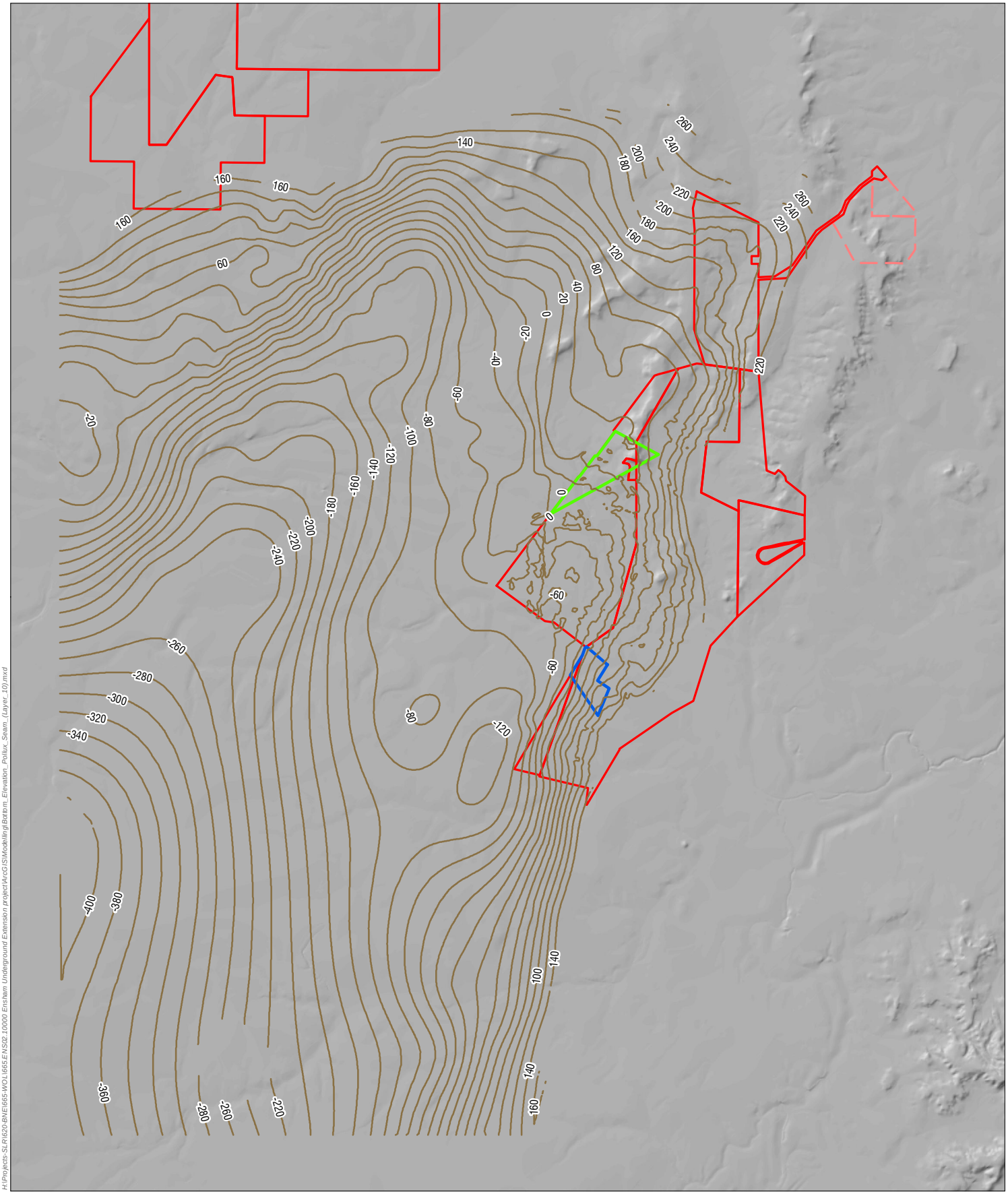
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 3 (Layer 9)

A1-9

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling Bottom_Elevation_Pollux_Seam_(Layer_10).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

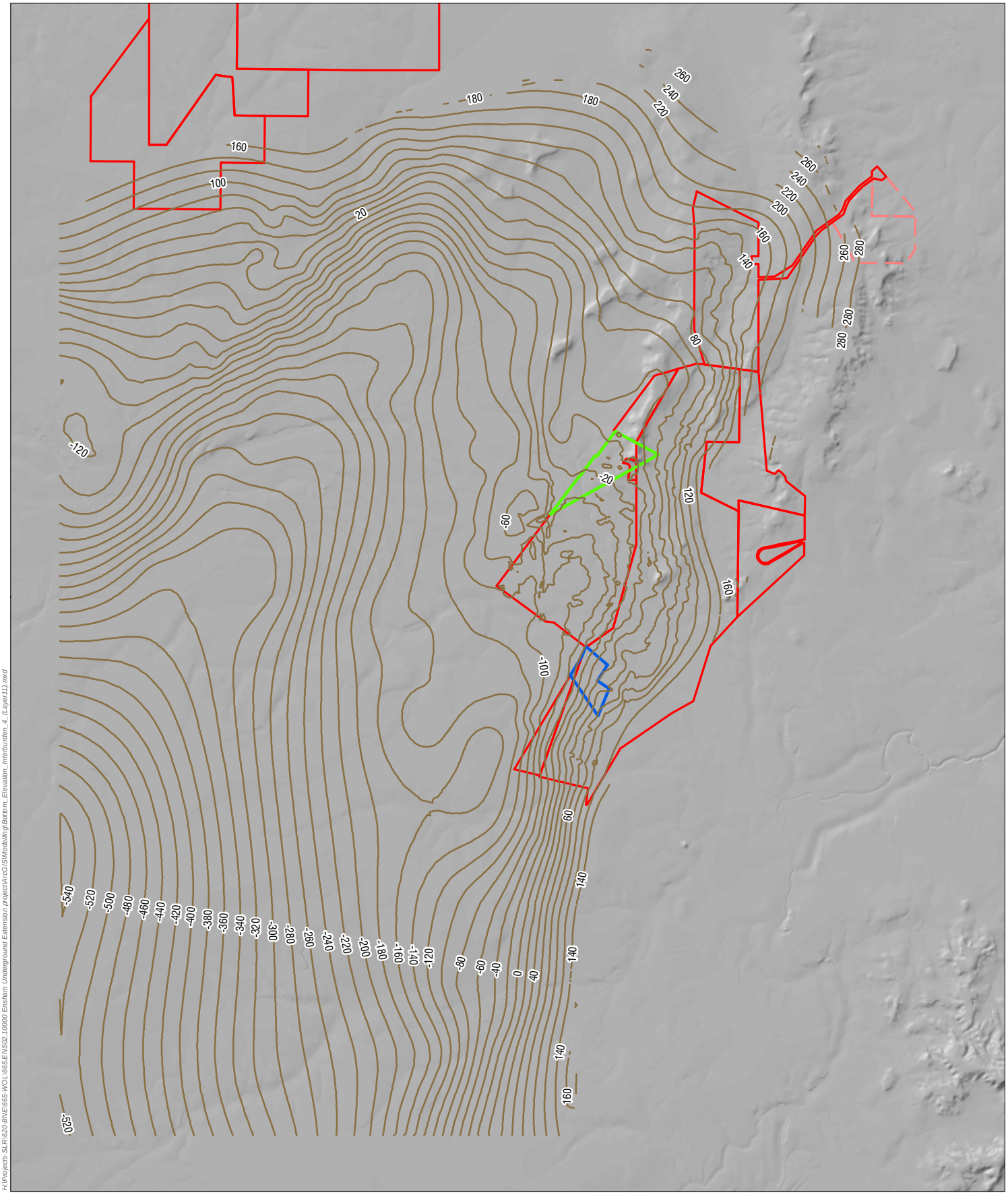
- Elevation Contours (mAHD)
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Pollux Seam (Layer 10)

A1-10

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\ISModelling\Bottom_Elevation_Interburden_4_(Layer11).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

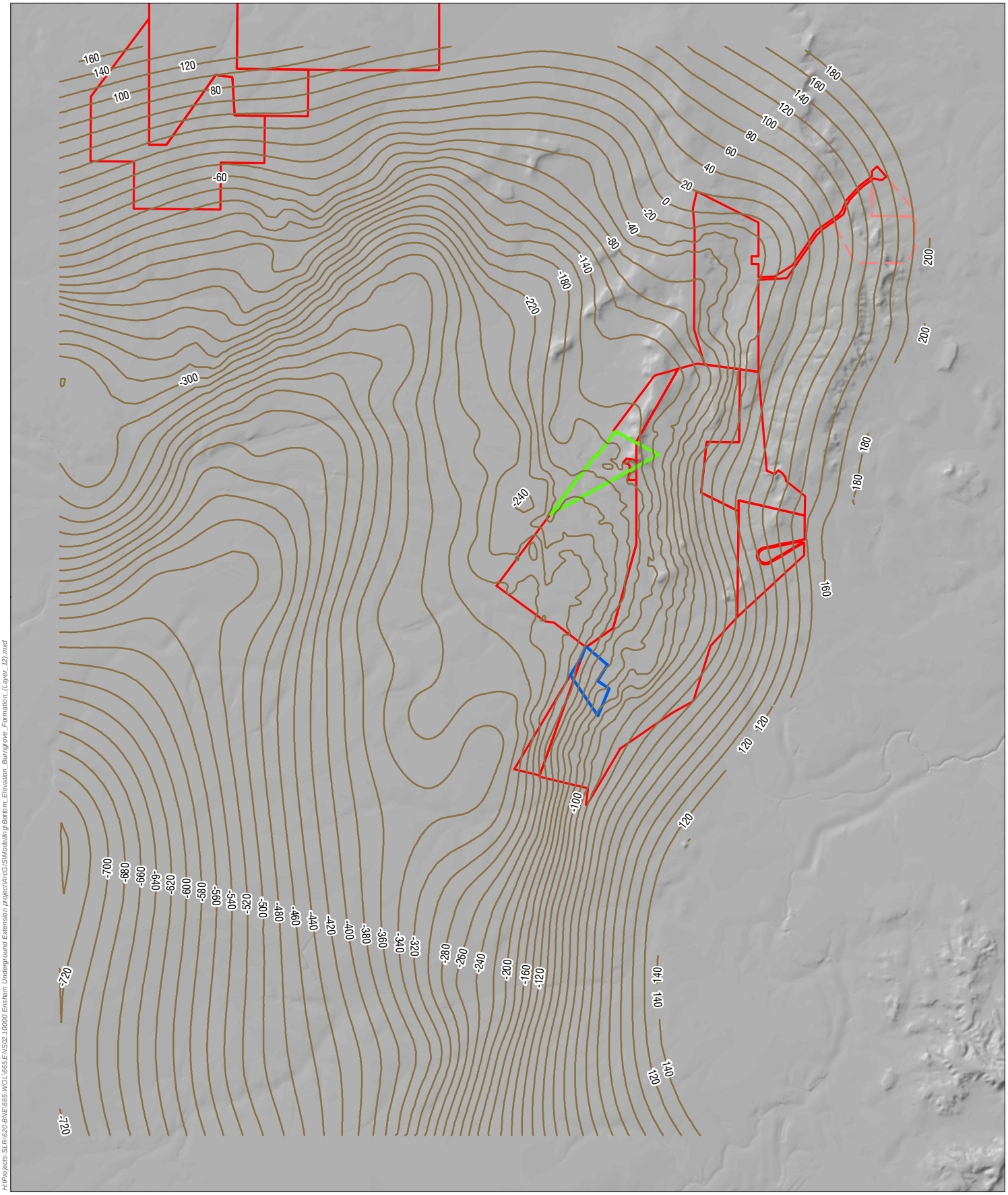
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3
- Elevation Contours (mAHD)

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Interburden 4 (Layer11)

A1-11

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\IModelling Bottom_Elevation_Burngrove_Formation_(Layer_12).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	03-Mar-2022
Drawn by:	PM
Sheet Size:	A4

Legend

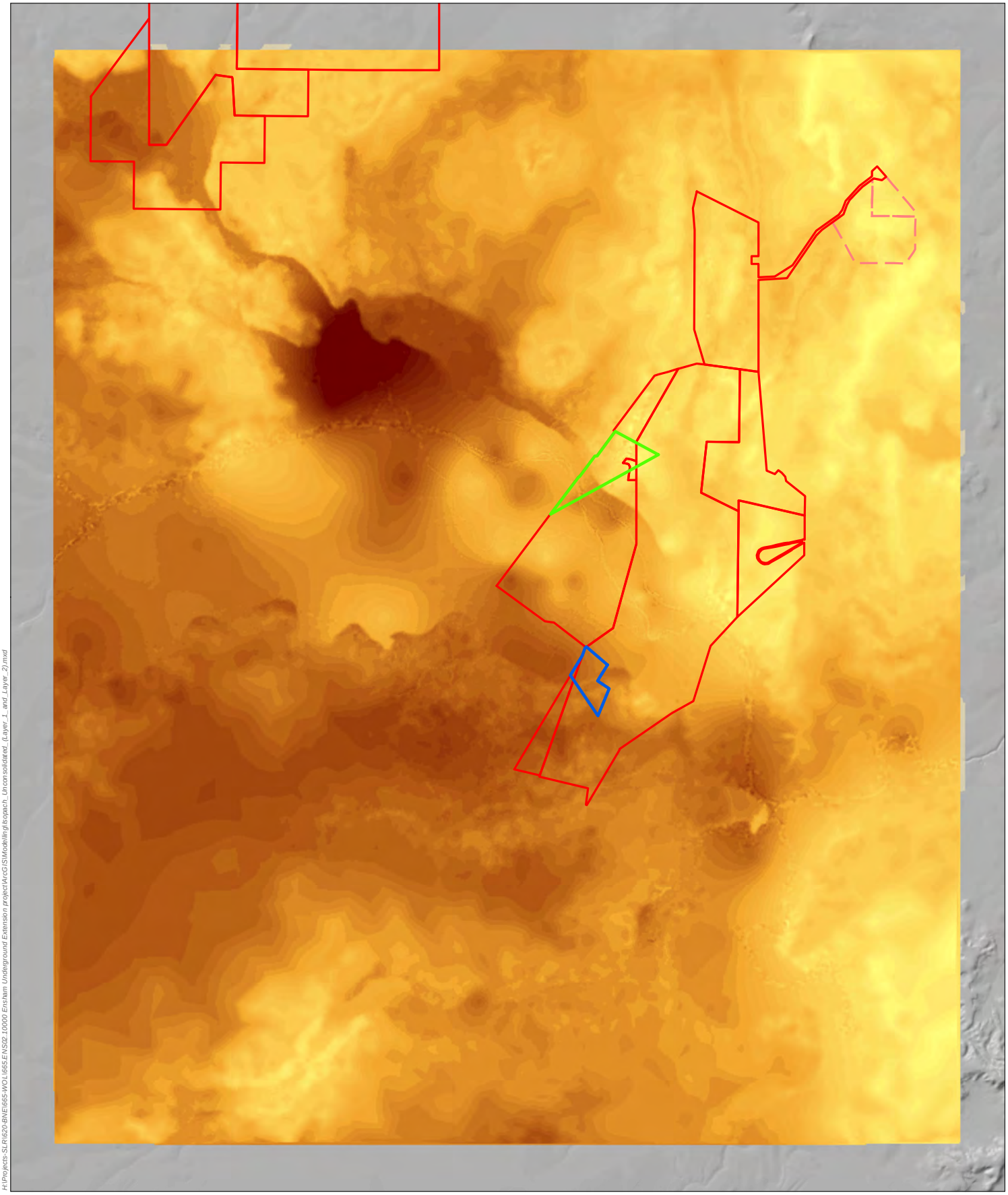
- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3
- Elevation Contours (mAHD)

GROUNDWATER IMPACT ASSESSMENT

Bottom Elevation Burngrove Formation (Layer 12)

A1-12

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Unconsolidated_(Layer_1_and_Layer_2).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

- High : 46
- Low : 1

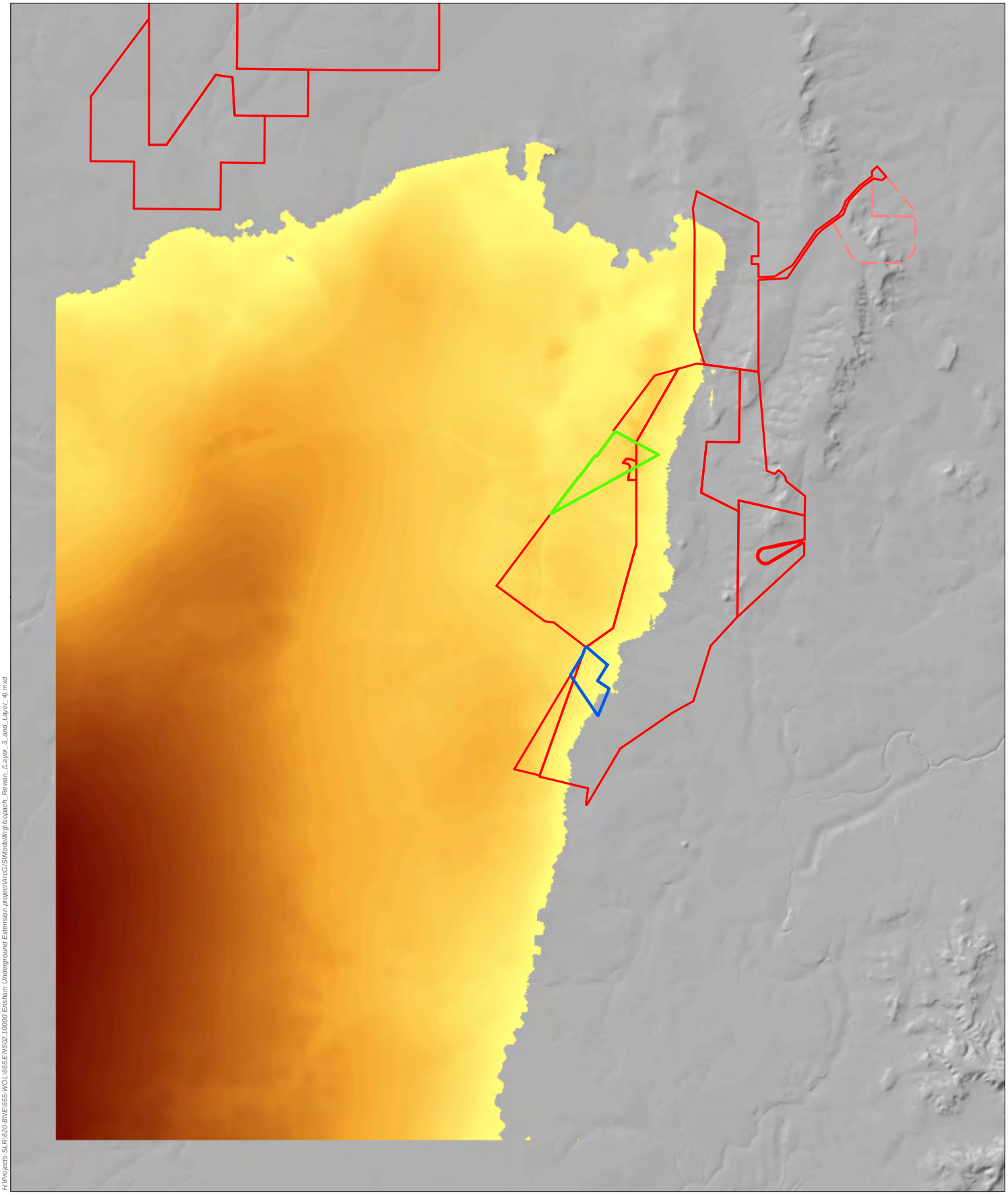
Modelled Alluvial Extents

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Unconsolidated (Layer 1 and Layer 2)

A2-1



0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 518

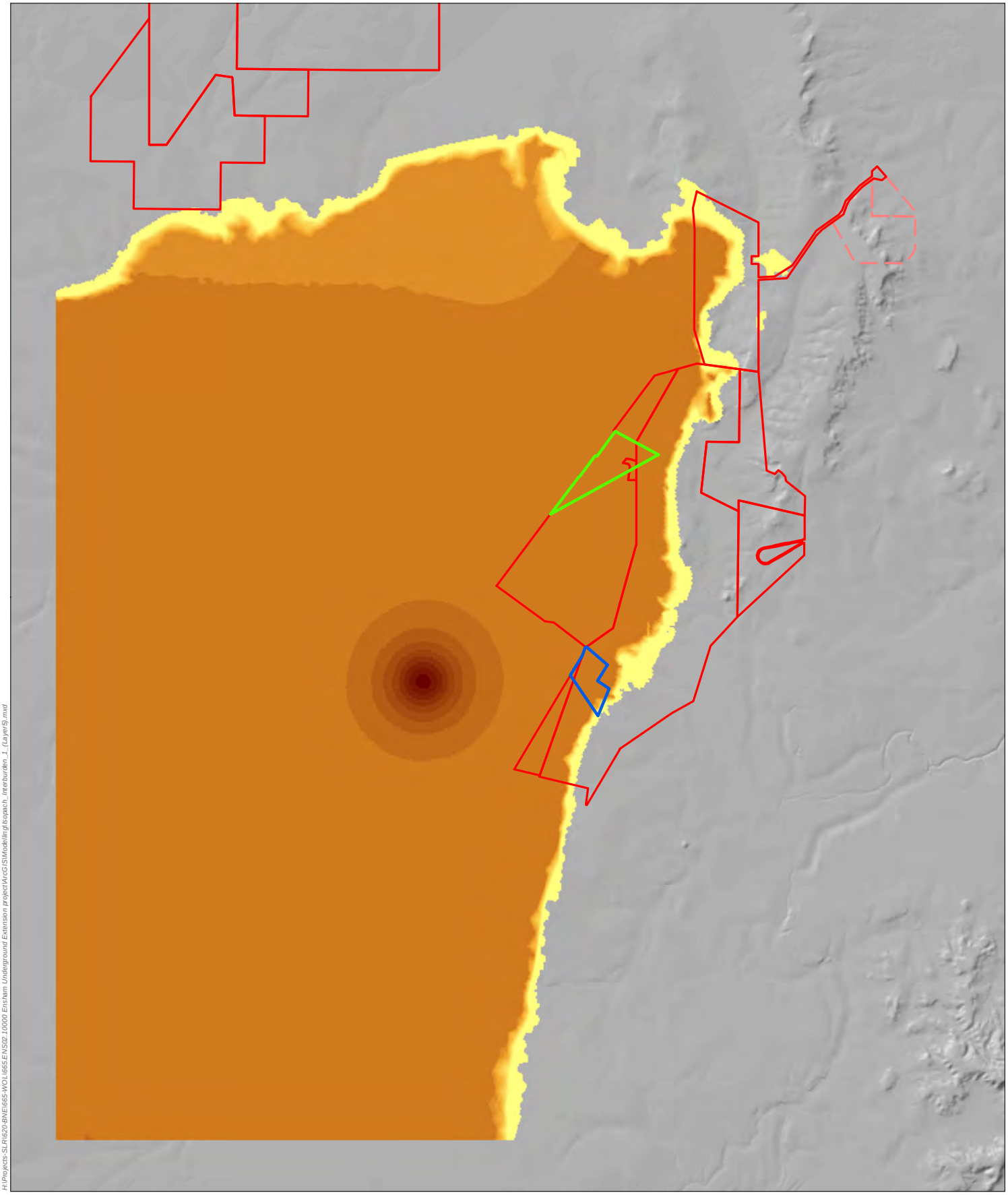
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Rewan (Layer 3 and Layer 4)

A2-2



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Interburden_1_(Layer5).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 37

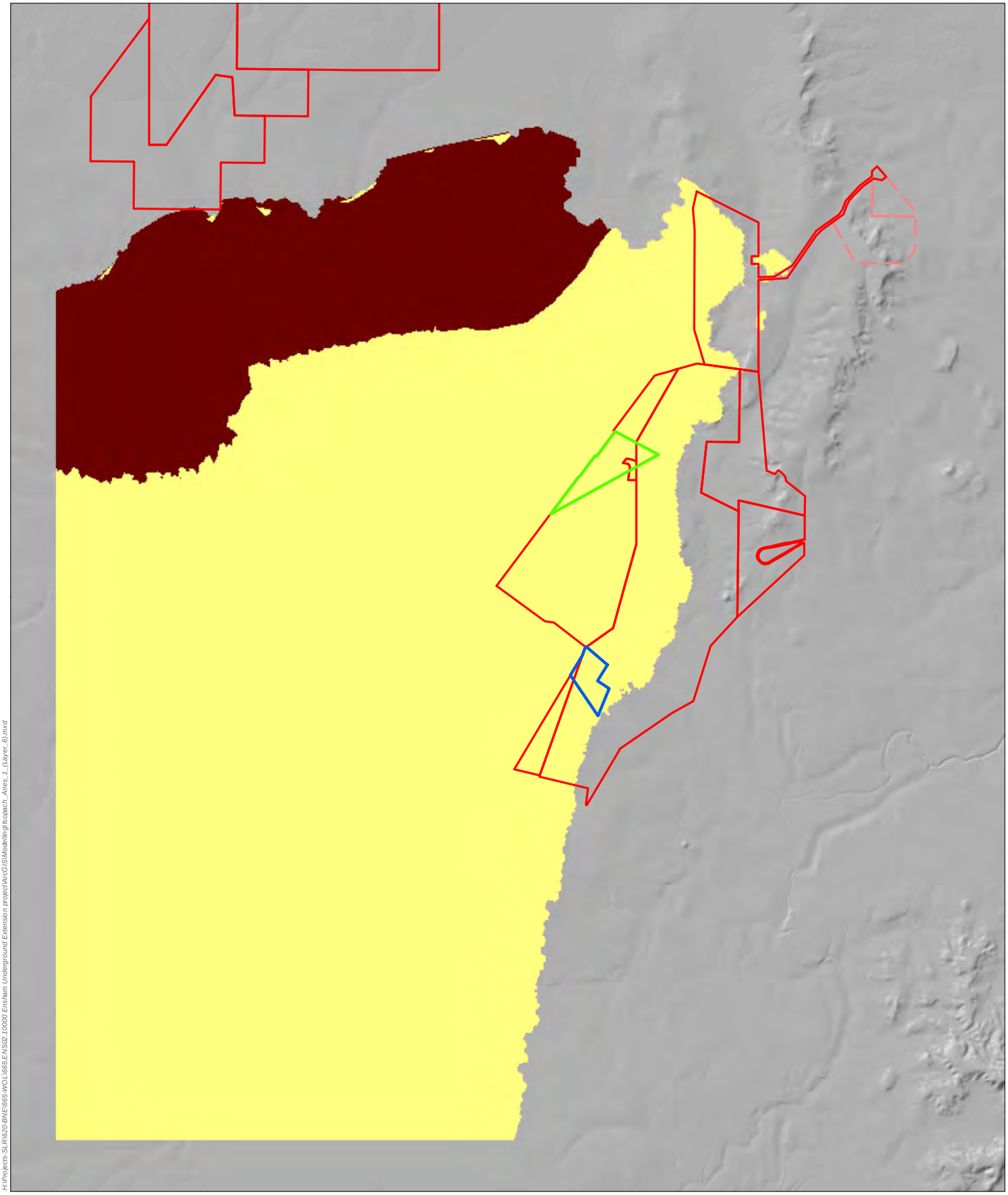
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 1 (Layer5)

A2-3



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Aries_1_(Layer_6).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 1

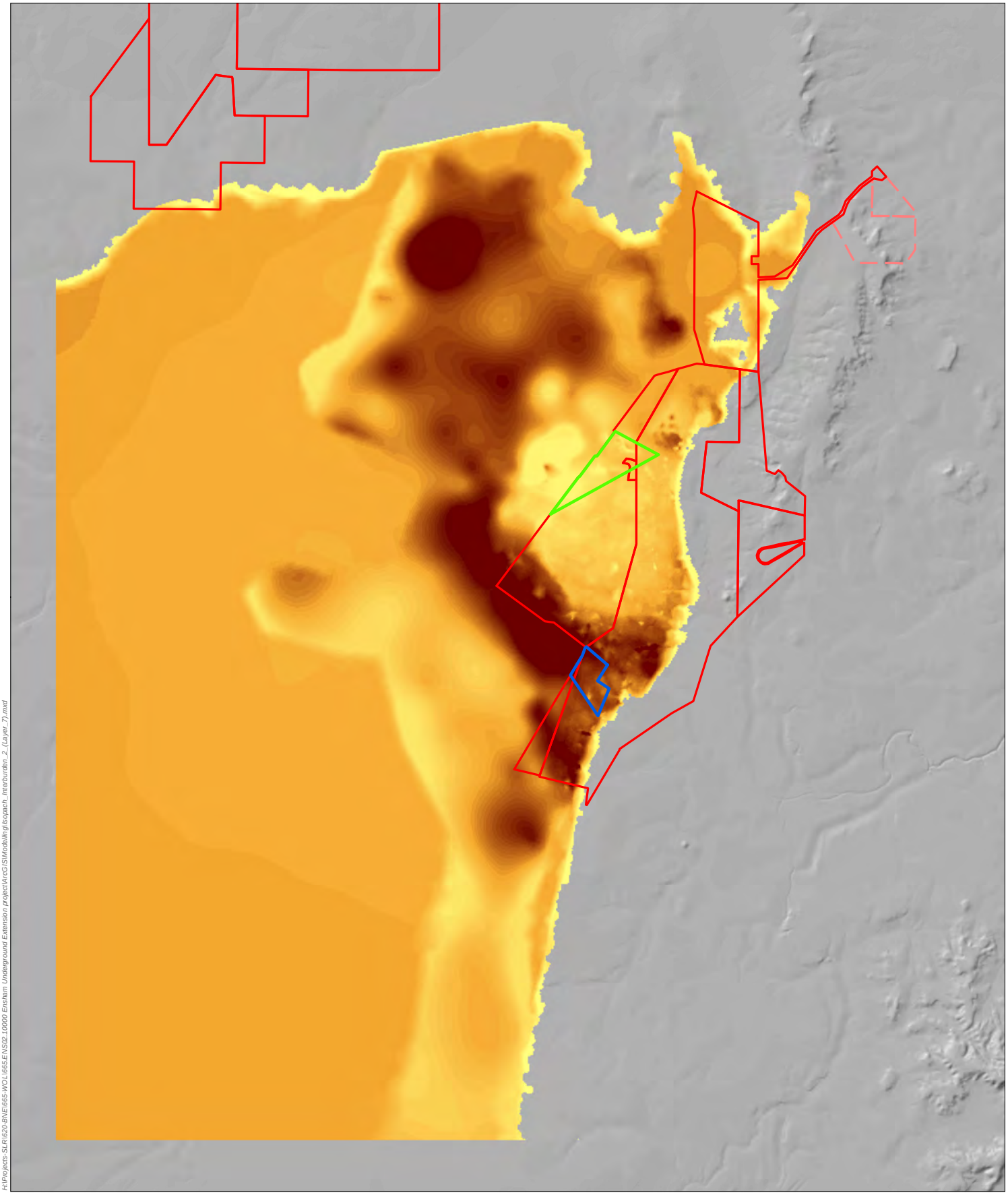
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Aries 1 (Layer 6)

A2-4



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Interburden_2_(Layer_7).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 48

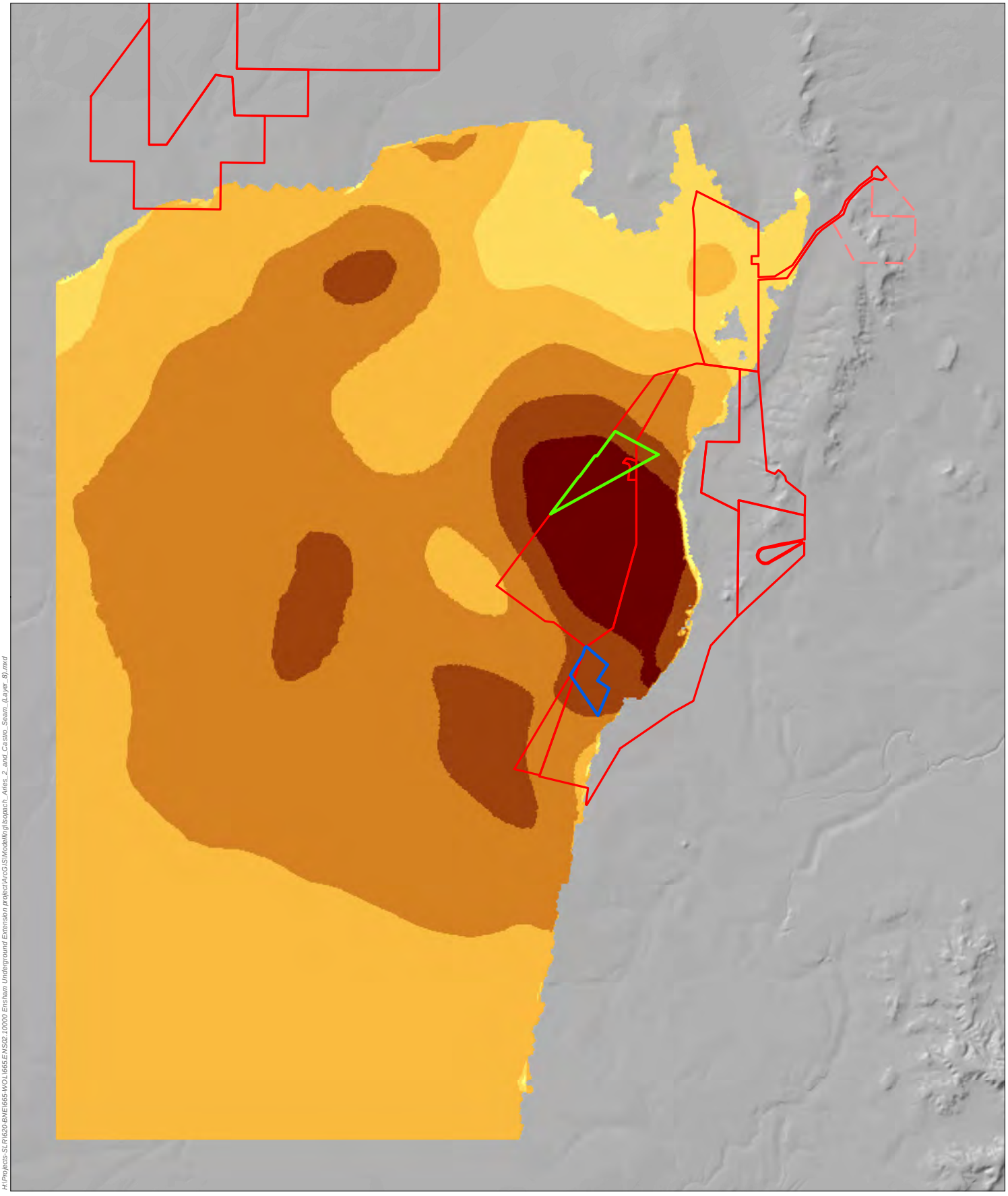
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 2 (Layer 7)

A2-5



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Aries_2_and_Castro_Seam_(Layer_8).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 5

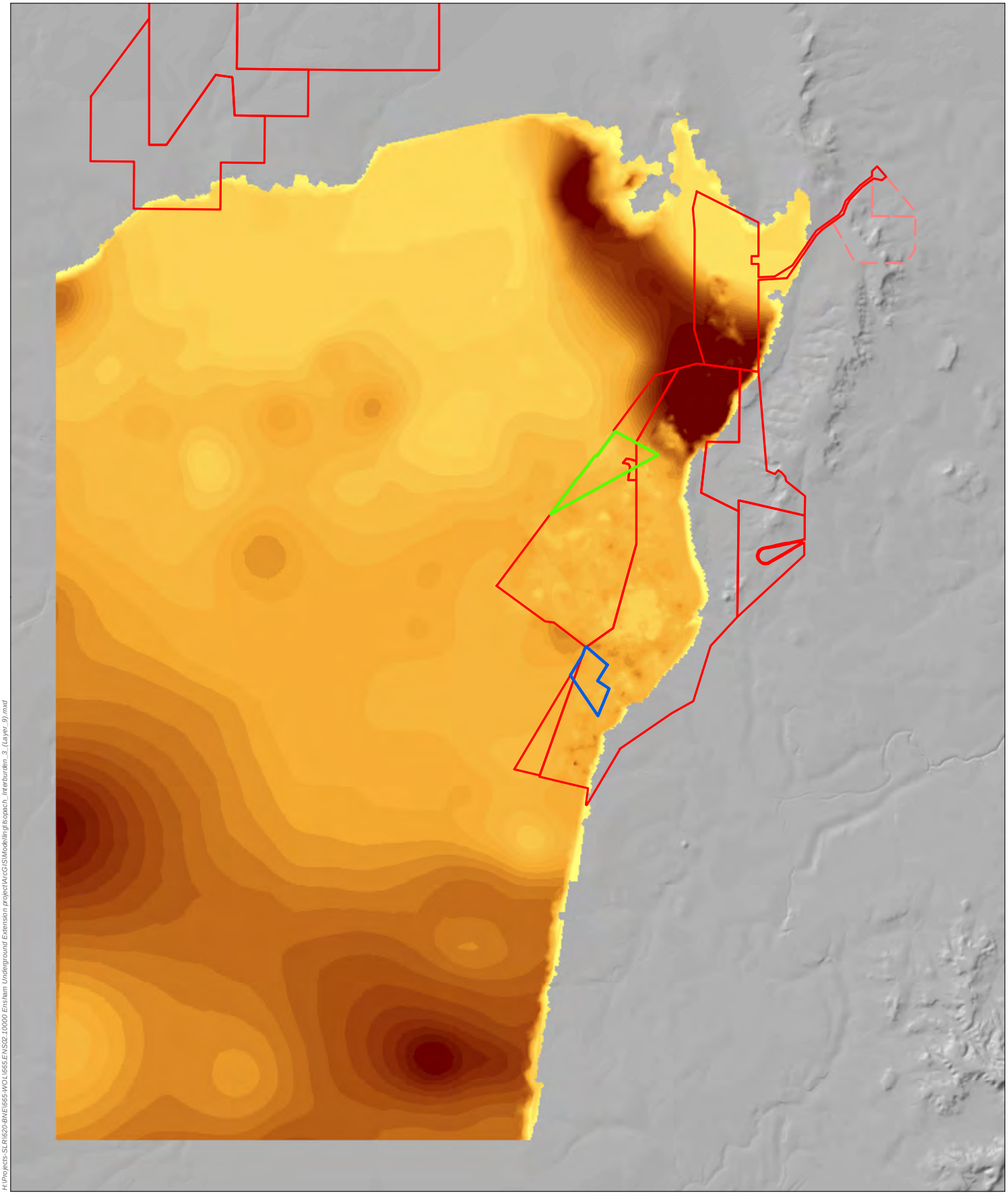
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Aries 2 and Castro Seam (Layer 8)

A2-6



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Interburden_3_(Layer_9).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 32

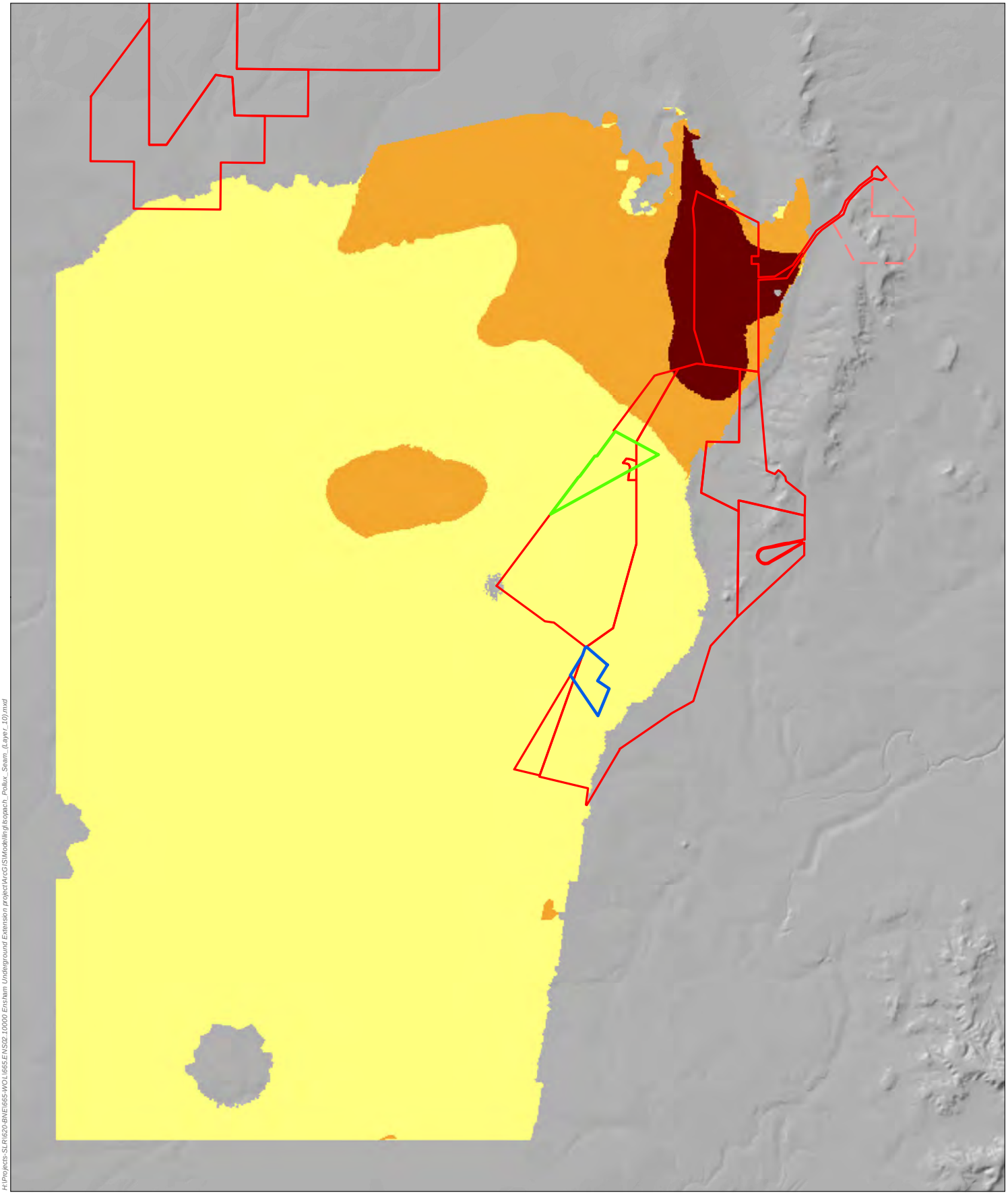
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 3 (Layer 9)

A2-7



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Pollux_Seam_(Layer_10).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 2

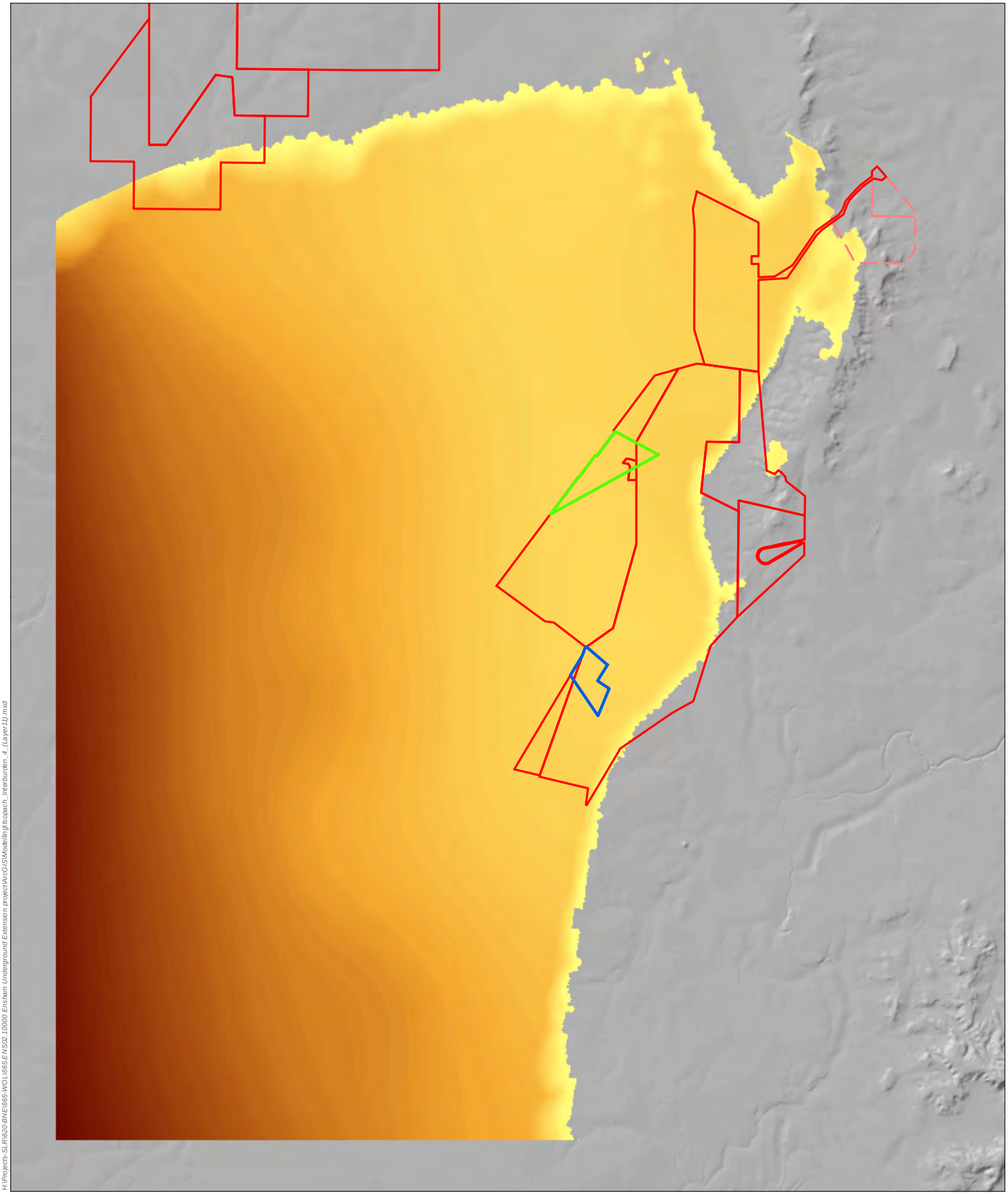
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Pollux Seam (Layer 10)

A2-8



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Interburden_4_(Layer11).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 132

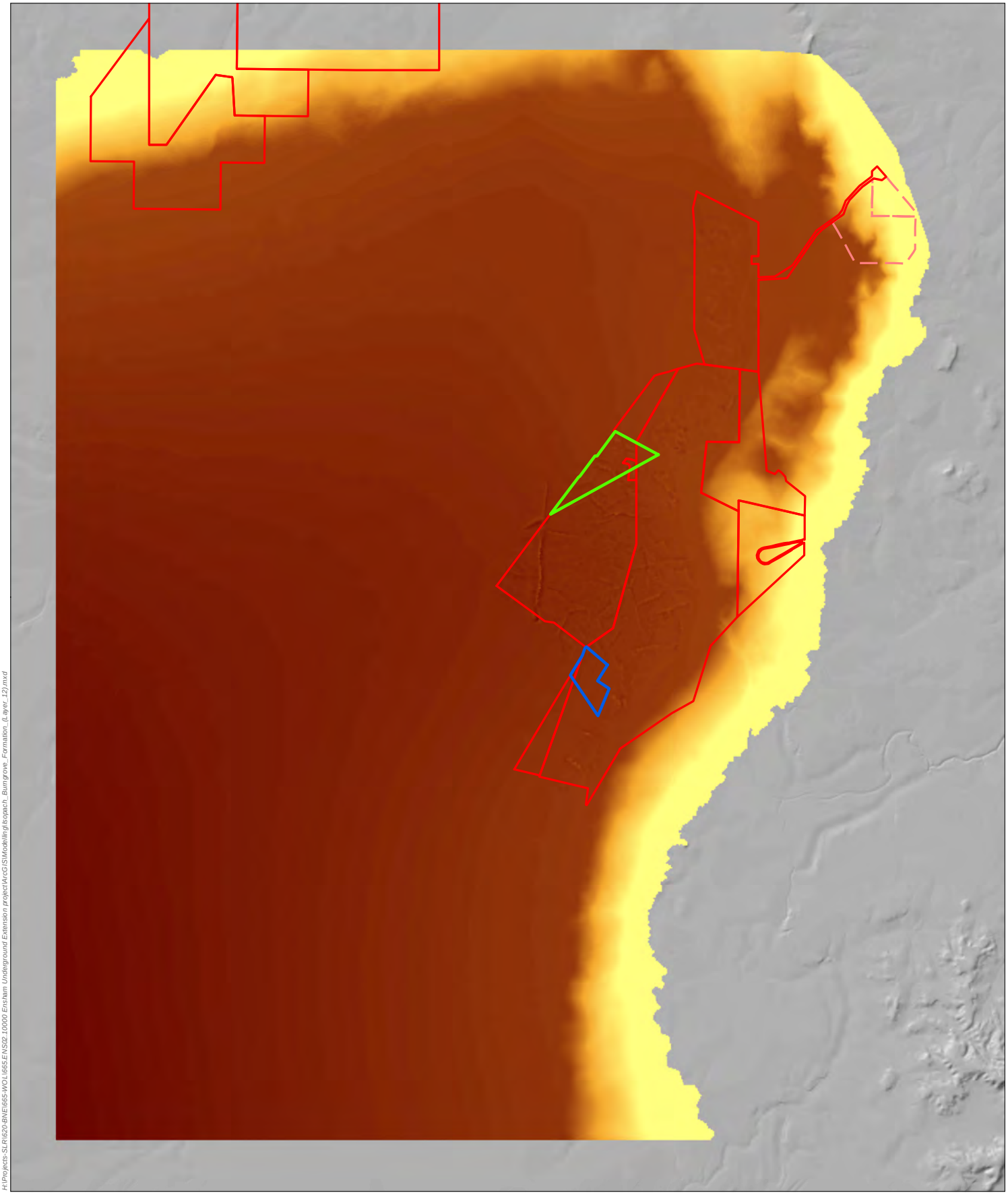
Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Interburden 4 (Layer11)

A2-9



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Isopach_Burngrove_Formation_(Layer_12).mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

Value

High : 197

Low : 0

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Isopach - Burngrove Formation (Layer 12)

A2-10

APPENDIX B

Summary statistic of EA water quality parameters

APPENDIX B

Water quality summary table

Bore	Aquifer	Statistic	pH (field)	EC (field)	pH (Lab)	EC (Lab)	TDS	Ca	Na	K	Cl	Mg	SO4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Al (diss)	Al (total)	Sb (diss)	Sb (total)	As (diss)	As (total)	B (diss)	B (total)	Fe (diss)	Fe (total)	Mn (diss)	Mn (total)	Hg (diss)	Hg (total)	Mo (diss)	Mo (total)	Se (diss)	Se (total)	Ag (diss)	Ag (total)	TPH C10_C40	TPH C6_C10
		unit	-	µS/cm	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Guideline	WQO Zone 43 (Shallow) 80th percentile		8.2	15495	8.2	15495	-	-	-	-	-	-	387	0.91	-	-	-	-	-	-	-	-	-	-	-	0.115	0.115	3.755	3.755	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 80th percentile		8.4	7720	8.4	7720	-	-	-	-	-	-	362	0.31	-	-	-	-	-	-	-	-	-	-	-	0.856	0.856	0.054	0.054	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Shallow) 20th percentile		7.09	-	7.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 20th percentile		7.7	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ANZG (2018)		8.5	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	0.055	0.055	0.009	0.009	0.013	0.013	-	-	0.7	0.7	-	-	-	-	0.0034	0.0034	0.005	0.005	-	-	-	-
	ANZG (2018) lower		6.5	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DES (2013)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
13020172	Alluvium	count	NC	5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	mini	NC	10200	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	max	NC	32000	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	median	NC	13540	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	20th	NC	12456	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020172	Alluvium	80th	NC	22000	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
13020177	Alluvium	count	9	12	24	24	5	24	24	24	24	24	24	8	24	24	16	16	5	11	7	15	12	NC	NC	23	12	13	7	8	7	16	12	11	12	8	7	9	8
13020177	Alluvium	mini	7.4	2900	6.31	2400	3120	27	429	0.5	447.1	52	62.2	0.72	0.5	327	327	0.005	0.42	0.0005	0.0005	0.001	0.01	NC	NC	0.01	0.14	0.01	0.014	0.00005	0.00005	0.0005	0.001	0.005	0.005	0.0005	0.0005	50	10
13020177	Alluvium	max	7.8	5444	8.56	5540	3460	71	963	2	1260	136	477	0.91	98	1145.8	872	0.02	1.49	0.001	0.001	0.027	0.029	NC	NC	5.66	3.32	0.073	0.05	0.0001	0.0002	0.002	0.002	0.01	0.01	0.001	0.001	50	10
13020177	Alluvium	median	7.5	4980	8.005	4550	3330	45	782	1	1085	91	126	0.8	1	604.5	618.5	0.005	0.85	0.001	0.0005	0.012	0.0115	NC	NC	0.05	0.82	0.016	0.021	0.000075	0.00005	0.001	0.001	0.01	0.005	0.00075	0.0005	50	10
13020177	Alluvium	20th	7.422	3718	7.74	3308	3168	36.16	603.48	1	645.12	72.66	101.44	0.8	0.5	499.6	449	0.005	0.484	0.0005	0.0005	0.01	0.01	NC	NC	0.025	0.224	0.0138	0.02	0.00005	5E-05	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
13020177	Alluvium	80th	7.74	5368.4	8.232	5146	3380	58.4	888.6	1.12	1194	123.4	136	0.866	10.04	793.2	784	0.01	1.434	0.001	0.001	0.0172	0.0194	NC	NC	0.114	1.466	0.032	0.0274	0.0001	0.0001	0.001	0.002	0.01	0.009	0.001	0.001	50	10
EC01	Alluvium	count	30	30	47	47	16	47	47	46	47	47	47	16	46	47	37	37	16	33	29	34	31	18	17	45	33	37	28	30	29	35	31	33	33	29	29	29	29
EC01	Alluvium	mini	6.60	15730	6.39	9130	10500	156	1450	1	2850	231	292	0.3	0.15	303	418	0.005	0.1	0.0005	0.0005	0.002	0.0025	0.025	0.025	0.01	0.2	0.164	0.18	0.00005	0.00005	0.003	0.003	0.005	0.005	0.0005	0.0005	50	10
EC01	Alluvium	max	7.65	26570	8.33	47700	12200	1270	7700	13	15300	1610	1320	0.6	21	1750	1750	0.5	4.58	0.005	0.0025	0.05	0.013	0.16	0.18	3.5	30.6	6.25	1.36	0.0001	0.0001	0.01	0.012	1	0.025	0.0025	0.0025	700	10
EC01	Alluvium	median	7.22	18390	7.59	20900	11300	243	3830	2	6970	506	702	0.55	0.5	971	904	0.005	1.23	0.0005	0.0005	0.004	0.005	0.125	0.13	0.11	2.45	0.337	0.341	0.00005	0.00005	0.006	0.007	0.005	0.005	0.0005	0.0005	50	10
EC01	Alluvium	20th	7.12	17591	7.21	17340	11000	204	3200	2	5620	349.8	617.8	0.5	0.5	782.4	782.4	0.005	0.6	0.0005	0.0005	0.004	0.004	0.08	0.102	0.05	1.224	0.2246	0.2474	0.00005	0.00005	0.005	0.006	0.005	0.005	0.0005	0.0005	50	10
EC01	Alluvium	80th	7.26	24218	7.89	33248	11800	515.2	5852	5	12160	1084	1198	0.6	1	1266	1090	0.01	2.57	0.001	0.0005	0.005	0.005	0.15	0.158	0.45	4.254	1	0.4496	0.00005	0.00005	0.008	0.01	0.01	0.005	0.001	0.0005	50	10
EC02	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	8	5	NC	NC	17	6	11	5	8	7	9	5	11	7	8	7	NC	NC
EC02	Alluvium	mini	NC	NC	6.88	3850	NC	49	682	1	935	82	114	NC	0.5	476	476	0.005	NC	0.0005	0.0005	0.004	0.005	NC	NC	0.025	0.24	0.002	0.023	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC02	Alluvium	max	NC	NC	8.22	12900	NC	113	2063	9	3150	256	291	NC	10	1310	953	0.23	NC	0.001	0.001	0.012	0.011	NC	NC	4.13	3.21	0.07	0.097	0.0001	0.0002	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC02	Alluvium	median	NC	NC	7.39	8530	NC	87	1510	2	2210	187	200	NC	1	870	702	0.01	NC	0.001	0.0005	0.009	0.009	NC	NC	0.05	1.08	0.036	0.07	0.000075	0.00005	0.002	0.002	0.01	0.005	0.00075	0.0005	NC	NC
EC02	Alluvium	20th	NC	NC	7.322	5646	NC	69.6	968.4	2	1400	145.6	137.4	NC	0.6	618.2	520	0.005	NC	0.0005	0.0005	0.005	0.0058	NC	NC	0.03	0.59	0.013	0.0246	0.00005	5E-05	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC02	Alluvium	80th	NC	NC	7.886	9556	NC	95.8	1624	3	2618	209.4	248	NC	1	912	890	0.01	NC	0.001	0.001	0.0116	0.011	NC	NC	0.206	1.92	0.049	0.0786	0.0001	0.0001	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC03	Alluvium	count	29	29	43	43	17	43	43	43	43	43	43	17	43	43	36	36	17	32	28	33	30	17	16	43	32	36	28	29	28	34	30	32	32	28	28	28	27
EC03	Alluvium	mini	6.60	10760	6.27	8090	6890	96	1040	1	2550	131	218	0.1	0.035	129	249	0.005	0.52	0.0005	0.0005	0.003	0.002	0.05	0.025	0.025	1.39	1.27	1.3	0.00005	0.00005	0.001	0.001	0.0003	0.005	0.0005	0.0005	50	10
EC03	Alluvium	max	7.42	22120	8.27	35300	10500	1180	3640	21	11000	1400	1150	0.8	10	1440	1440	0.35	32	0.001	0.001	0.014	0.009	0.22	0.24	13.8	43.2	23.7	14	0.0001	0.0001	0.024	0.028	0.08	0.02	0.003	0.004	290	10
EC03	Alluvium	median	7.05	15060	7.49	16600	7800	413	2730	5	5130	513	551	0.6	0.5	958	1004.5	0.005	4.45	0.0005	0.0005	0.004	0.005	0.18	0.18	1.4	10.9	5.18	3.235	0.00005	0.00005	0.01	0.0105	0.005	0.005	0.0005	0.0005	50	10
EC03	Alluvium	20th	6.93	12431	6.99	11900	7614	201	2234	3	3692	248.4	376	0.5	0.5	691	768	0.005	3.112	0.0005	0.0005	0.003	0.004	0.15	0.14	0.372	5.3	1.81	1.706	0.00005	0.00005	0.0026	0.0048	0.005	0.005	0.0005	0.0005	50	10
EC03	Alluvium	80th	7.18	19128	7.68	22960	9556	855.2	3098	12.6	7884	989.6	823.4	0.7	1	1214	1240	0.01	9.282	0.0009	0.0005	0.004	0.007	0.2	0.21	4.76	21.16	11	7.962	0.00005	0.00005	0.0174	0.0204	0.009	0.005	0.0005	0.0005	50	10
EC04	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	9	6	NC	NC	16	6	13	6	8	7	11	7	11	7	8	7	NC	NC
EC04	Alluvium	mini	NC	NC	6.92	1860	NC	87	216	1	311	70	39	NC	0.416	419	419	0.005	NC	0.0005	0.0005	0.001	0.001	NC	NC	0.06	0.94	0.061	0.066	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC04	Alluvium	max	NC	NC	7.78	4390	NC	210	594	9	1030	187	118	NC	10	1130	936	0.01	NC	0.001	0.001	0.004	0.005	NC	NC	2.58	2.68	1.05	0.25	0.0001	0.0001	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC04	Alluvium	median	NC	NC	7.48	3740	NC	177	408	2	684	142	92	NC	1	600	548	0.01	NC	0.001	0.0005	0.003	0.0035	NC	NC	0.47	1.32	0.207	0.171	0.000075	0.00005	0.001	0.001	0.01	0.005	0.00075	0.0005	NC	NC
EC04	Alluvium	20th	NC	NC	7.192	2892	NC	112.8	380.4	1	616	90.6	60.2	NC	0.5	512.8	509	0.005	NC	0.0005	0.0005	0.0016	0.002	NC	NC	0.21	1.11	0.1398	0.109	0.00005	5E-05	0.0005	0.0006	0.005	0.005	0.0005	0.0005	NC	NC
EC04	Alluvium	80th	NC	NC	7.586	4094	NC	194.2	529.6	3	861.4	152	110	NC	1	931.2	791	0.01	NC	0.001	0.001	0.004	0.004	NC	NC	1.4	1.54	0.3416	0.226	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC05	Alluvium	count	NC	NC	18	18	NC	18	18	18	18	18	18	NC	18	18	11	11	NC	11	7	10	6	NC	NC	17	6	15	7	8	7	10	6	11	7	8	7	NC	NC
EC05	Alluvium	mini	NC	NC	7.21	1240	NC	12	220	1	212	12	40	NC	0.5	178	178	0.005	NC	0.0005	0.0005	0.001	0.0025	NC	NC	0.01	1	0.044	0.094	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	NC	NC
EC05	Alluvium	max	NC	NC	7.89	32800	NC	781	5560	17	11400	1270	1140	NC	10	2090	2090	0.25	NC	0.005	0.005	0.025	0.025	NC	NC	2.05	9.06	1.11	1	0.0001	0.0001	0.008	0.008	0.05	0.05	0.005	0.005	NC	NC
EC05	Alluvium	median	NC	NC	7.54	23650	NC	501.5	3685	8.5	8175	771	799	NC	1	647	708	0.01	NC	0.001	0.001	0.004	0.0065	NC	NC	0.125	2.28	0.411	0.559	0.000075	0.00005	0.0035	0.005	0.01	0.01	0.001	0.001	NC	NC
EC05	Alluvium	20th	NC	NC	7.38	3128	NC	38	526.8	3.4	665.4	39.2	88.2	NC	0.6924	241.4	245	0.01	NC	0.001	0.0006	0.0022	0.004	NC	NC	0.05	1	0.1164	0.274	0.00005	5E-05	0.0024	0.0025	0.01	0.006	0.0007	0.0006	NC	NC
EC05	Alluvium	80th	NC	NC	7.76	28780	NC	688	4800	14.4	10100	906.8	898.4	NC	1	1238.4	1890	0.025	NC	0.001	0.0022	0.0062	0.008	NC	NC	0.43	5.69	0.9248	0.6998	0.0001	0.0001	0.0054	0.005	0.02	0.024	0.0019	0.0022	NC	NC
EC06	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	9	6	NC	NC	17	7	14	7	8	7	10	6	11	7	8	7	NC	NC
EC06	Alluvium	mini	NC	NC	6.6	2160	NC	140	191	5	332	90	39	NC	0.123	243	558	0.005	NC	0.0005	0.0005	0.004	0.009	NC	NC	0.05	11	1.63	1.54	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC06	Alluvium	max	NC	NC	7.53	4980	NC	329	530	22	1400	274	111	NC	10	1286	720	0.01	NC	0.001	0.001	0.015	0.021	NC	NC	6.83	26	12	7.33	0.0001	0.0001	0.002	0.002	0.01	0.01	0.001	0.001	NC	NC
EC06	Alluvium	median	NC	NC	7.16	3770	NC	235	320	9	856	166	72	NC	1	692	636	0.01	NC	0.001	0.0005	0.008	0.0125	NC	NC	2.53	19.9	4.615	4.86	0.000075	0.00005	0.001	0.0015	0.01	0.005	0.001	0.0005	NC	NC
EC06	Alluvium	20th	NC	NC	6.896	3298	NC	199.2	304	7	752.8	142	51	NC	0.5	619.6	618	0.005	NC	0.0005	0.0005	0.0052	0.01	NC	NC	0.844	15.2	2.182	4.034	0.00005	5E-05	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC06	Alluvium	80th	NC	NC	7.336	4432	NC	292.8	401.8	12.8	1078	203.4	87.2	NC	1	758.4	704	0.01	NC	0.001	0.001	0.0102	0.016	NC	NC	4.56	22.4	6.186	6.04	0.0001	0.0001	0.0012	0.002	0.01	0.01	0.001	0.001	NC	NC
EC07	Alluvium	count	32	32	46	46	17	46	46	46	46	46	46	17	46	46	39	39	17	35	31	37	34	19	18	46	35	39	31	32	31	39	34	35	35	31	31	31	30
EC07	Alluvium	mini	6.30	2540	6.25	1620	13600	37	224	2	351	28	22	0.05	0.072	162	162	0.005	0.91	0.0005	0.0005	0.0005	0.006	0.025	0.025	0.025	3.9	0.36	0.545	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
EC07	Alluvium	max	7.31	29100	7.97	31800	18600	1620	5270	24	13000	1400	1170	0.4	10	1670	1670	0.13	46.5	0.001	0.0025	0.024	0.047	0.06	0.08	47.8	78.7	16.8	18.7	0.0001	0.0001	0.008	0.008	1	0.025	0.001	0.003	120	280
EC07	Alluvium	median	6.70	24035	7.17	22050	15900	683.5	3160	8	7510	571	657	0.3	0.5	590.5	730	0.005	3.85	0.0005	0.0005	0.015	0.0205	0.025	0.025	5.415	22	6.92	8.56	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	50	10
EC07	Alluvium	20th	6.40	21640	7.00	6670	14440	171	1080	5	2060	162	178	0.2	0.5	265	255	0.005	2.516	0.0005	0.0005	0.0066	0.013	0.025	0.025	0.89	7.4	2.038	4.99	5E-05	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC07	Alluvium	80th	6.84	25631	7.47	25900	16560	1160	4010	10	9230	875	754	0.38	1	1450	1462	0.01	6.788	0.0006	0.0005	0.0208	0.026	0.025	0.025	28.5	49.46	11.04	12.8	0.00005	0.00005	0.004	0.005	0.01	0.005	0.0005	0.0005	50	10
EC08	Alluvium	count	NC	NC	10	10	NC	10	10	10	10	10	10	NC	10	10	7	7	NC	7	NC	6	NC	NC	NC	10	NC	10	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC08	Alluvium	mini	NC	NC	6.77	311	NC	28	20	3	9	12	1	NC	0.201	152	152	0.01	NC	0.001	NC	0.004	NC	NC	NC	0.06	NC	1.2	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	max	NC	NC	7.36	1990	NC	124	277	11	440	62	8	NC	10	587	514	0.14	NC	0.001	NC	0.006	NC	NC	NC	11.4	NC	4.85	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	median	NC	NC	7.15	1020	NC	44.5	130	5.5	67	30	2	NC	1	393.5	380	0.01	NC	0.001	NC	0.005	NC	NC	NC	2.8	NC	1.87	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	20th	NC	NC	6.968	830.8	NC	32.8	97	3.8	39.4	19.8	2	NC	1	276.2	228.8	0.01	NC	0.001	NC	0.004	NC	NC	NC	1.002	NC	1.446	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC08	Alluvium	80th	NC	NC	7.256	1298	NC	56	161.6	6.4	175.4	44.4	7	NC	1	513.2	504.6	0.09	NC	0.001	NC	0.005	NC	NC	NC	4.726	NC	3.16	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC09	Alluvium	count	NC	NC	15	15	NC	15	15	15	15	15	15	NC	15	15	10	10	NC	10	6	9	5	NC	NC	14	6	11	5	7	6	9	5	10	6	7	6	NC	NC
EC09	Alluvium	mini	NC	NC	6.68	1550	NC	27	295	0.5	316	25	37	NC	0.328	326	340	0.005	NC	0.0005	0.0005	0.002	0.003	NC	NC	0.025	0.76	0.018	0.062	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC09	Alluvium	max	NC	NC	8.17	30900	NC	1160	4390	11	12100	1200	1050	NC	10	672	647	0.01	NC	0.001	0.001	0.005	0.005	NC	NC	12.5	20.7	0.747	0.212	0.0001	0.0002	0.004	0.002	0.01	0.01	0.001	0.001	NC	NC
EC09	Alluvium	median	NC	NC	7.45	11200	NC	252	1220	5	3040	311	204	NC	1	395	379.5	0.01	NC	0.001	0.00075	0.003	0.004	NC	NC	0.485	9.525	0.122	0.113	0.0001	0.000075	0.002	0.001	0.01	0.0075	0.001	0.00075	NC	NC
EC09	Alluvium	20th	NC	NC	7.03	3208	NC	103.6	436.2	1.8	726	71.6	50.4	NC	0.5	351.8	351.8	0.005	NC	0.0005	0.0005	0.002	0.003	NC	NC	0.05	3.72	0.045	0.0756	5E-05	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	NC	NC
EC09	Alluvium	80th	NC	NC	7.69	28580	NC	802.8	3706	8.4	8980	860.8	790.6	NC	1	612	573.6	0.01	NC	0.001	0.001	0.004	0.005	NC	NC	2.164	13.6	0.471	0.1528	0.0001	0.0001	0.0034	0.002	0.01	0.01	0.001	0.001	NC	NC
EC09A	Alluvium	count	28	28	42	42	14	42	42	41	42	42	42	14	41	42	32	32	14	28	24	30	27	16	15	41	28	31	23	25	24	31	27	28	28	24	24	27	26
EC09A	Alluvium	mini	6.65	3650	6.41	3590	9420	75	645	1	922	3	113	0.05	0.066	140	368	0.005	0.33	0.0005	0.0005	0.001	0.003	0.025	0.025	0.025	0.95	0.056	0.063	0.00005	0.00005	0.0005	0.0005	0.003	0.005	0.0005	0.0005	50	10
EC09A	Alluvium	max	7.3	21860	8.18	37650	13800	1100	5040	17	12200	1240	1080	0.7	10	1990	1990	0.03	4.17	0.001	0.001	0.008	0.011	0.09	0.1	21	10.1	3.23	0.373	0.0001	0.00005	0.004	0.004	0.02	0.005	0.002	0.002	310	10
EC09A	Alluvium	median	6.955	16572	7.46	19450	11150	489	3045	4	6510	585.5	512	0.6	0.5	897.5	1050	0.005	0.73	0.0005	0.0005	0.004	0.004	0.06	0.07	0.7	1.595	0.254	0.23	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	50	10
EC09A	Alluvium	20th	6.808	13244	7.104	14500	9812	336	2138	3	4890	374.8	369.2	0.4	0.5	522.6	502.6	0.005	0.51	0.0005	0.0005	0.003	0.003	0.025	0.045	0.34	1.204	0.182	0.1898	0.00005	0.00005	0.001	0.0006	0.005	0.005	0.0005	0.0005	50	10
EC09A	Alluvium	80th	7.09	19732	7.698	26440	12580	849.6	4042	9	9636	971.2	804.4	0.6	1	1656	1738	0.005	1.672	0.0005	0.0005	0.0042	0.004	0.07	0.072	2.71	3.428	0.434	0.3338	0.00005	0.00005	0.002	0.003	0.005	0.005	0.0005	0.0005	50	10
EC10	Alluvium	count	NC	NC	17	17	NC	17	17	17	17	17	17	NC	17	17	11	11	NC	11	7	9	6	NC	NC	17	7	13	6	8	7	11	7	11	7	8	7	NC	NC
EC10	Alluvium	mini	NC	NC	6.81	725	NC	12	115	0.5	88	16	12	NC	0.141	197	197	0.005	NC	0.0005	0.0005	0.002	0.003	NC	NC	0.025	3	0.031	0.098	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC10	Alluvium	max	NC	NC	8.02	6635	NC	150	740	7	1235	170	111	NC	10	471	453	0.09	NC	0.001	0.001	0.005	0.009	NC	NC	0.86	26.9	0.501	0.37	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC10	Alluvium	median	NC	NC	7.64	2170	NC	58	298	1	478	78	47	NC	1	360	391	0.01	NC	0.001	0.0005	0.004	0.0045	NC	NC	0.05	9.21	0.14	0.223	0.000075	0.00005	0.001	0.0005	0.01	0.005	0.00075	0.0005	NC	NC
EC10	Alluvium	20th	NC	NC	7.30	1858	NC	43.6	261.6	1	422.8	54.4	40.2	NC	0.5	305.2	305	0.005	NC	0.0005	0.0005	0.003	0.004	NC	NC	0.03	6.612	0.1114	0.142	0.00005	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC10	Alluvium	80th	NC	NC	7.85	3428	NC	90.8	397.4	2	689.6	111.4	94.6	NC	1	422.4	423	0.03	NC	0.001	0.001	0.004	0.006	NC	NC	0.276	15.766	0.2736	0.285	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC11	Alluvium	count	30	30	44	44	17	44	44	44	44	44	44	17	44	44	37	37	17	33	29	35	32	19	18	44	33	36	29	30	29	36	31	33	33	29	29	29	28
EC11	Alluvium	mini	6.5	3640	6.52	903	10200	20	128	2	156	17	13	0.05	0.063	144	170	0.005	0.02	0.0005	0.0005	0.0005	0.003	0.025	0.025	0.01	4.28	0.368	0.542	0.00005	0.00005	0.001	0.001	0.003	0.005	0.0005	0.0005	50	10
EC11	Alluvium	max	7.2	22290	7.88	23700	15400	823	3620	16	7940	852	664	0.5	10	1730	1730	0.04	11.3	0.001	0.001	0.009	0.018	0.07	0.09	58	59	13	12.4	0.0001	0.0001	0.007	0.008	1	0.01	0.001	0.002	50	10
EC11	Alluvium	median	6.89	18091	7.335	16300	13300	394.5	2108	6	5020	396.5	409	0.4	0.5	486	634	0.005	1.42	0.0005	0.0005	0.007	0.008	0.025	0.025	9.82	17.5	3.645	3.82	0.00005	0.00005	0.003	0.005	0.005	0.005	0.0005	0.0005	50	10
EC11	Alluvium	20th	6.674	5056	6.968	4046	11300	158	502.6	4	1096	130.4	81.4	0.3	0.5	326.2	323.4	0.005	0.128	0.0005	0.0005	0.004	0.005	0.025	0.025	2.796	8.282	2.46	2.676	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC11	Alluvium	80th	6.952	21002	7.618	20900	14400	648.8	3334	8	6774	690.6	590.8	0.5	1	1568	1596	0.01	4.594	0.0008	0.0005	0.008	0.01	0.05	0.06	19.68	37	6.84	7.452	0.00005	0.00005	0.006	0.007	0.01	0.005	0.0005	0.0005	50	10
EC12	Alluvium	count	NC	NC	22	22	NC	22	22	20	22	22	22	NC	20	22	11	11	NC	11	7	9	6	NC	NC	21	7	15	6	8	7	11	6	11	7	8	7	NC	NC
EC12	Alluvium	mini	NC	NC	5.75	1110	NC	28	164	1	159	28	24	NC	0.037	132	249	0.005	NC	0.0005	0.0005	0.003	0.017	NC	NC	0.05	1.37	0.278	0.354	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC12	Alluvium	max	NC	NC	7.95	12300	NC	800	1400	12	5630	1000	300	NC	10	526	476	0.01	NC	0.001	0.001	0.017	0.022	NC	NC	28	6.77	5.78	0.544	0.0001	0.0001	0.001	0.001	0.02	0.01	0.001	0.001	NC	NC
EC12	Alluvium	median	NC	NC	7.17	4900	NC	187.5	505.5	6.5	1245	162	102	NC	1	347.5	392	0.01	NC	0.001	0.0005	0.015	0.0195	NC	NC	0.65	2.55	1.44	0.438	0.000075	0.00005	0.001	0.001	0.01	0.005	0.00075	0.0005	NC	NC
EC12	Alluvium	20th	NC	NC	6.62	1764	NC	46	267.6	2	369.8	56	42.2	NC	0.5	266.2	265	0.005	NC	0.0005	0.0005	0.011	0.018	NC	NC	0.25	1.982	0.3898	0.379	0.00005	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC12	Alluvium	80th	NC	NC	7.69	7428	NC	376.8	620.2	10	2162	335.6	146.4	NC	1	411.8	422	0.01	NC	0.001	0.001	0.016	0.022	NC	NC	8.95	4.776	3.87	0.478	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC13	Alluvium	count	31	31	45	45	17	45	45	45	45	45	45	17	45	45	38	38	17	34	30	35	33	19	18	44	34	37	30	31	30	37	32	34	34	30	30	30	29
EC13	Alluvium	mini	6.44	1527	6.32	1670	8710	63	241	4	406	47	5	0.2	0.042	119	199	0.005	0.03	0.0005	0.0005	0.001	0.001	0.025	0.025	0.025	0.83	1.61	1.83	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
EC13	Alluvium	max	7.3	20880	8.09	25200	13800	914	3360	21	7270	741	630	0.5	10	1490	1490	0.02	15.2	0.001	0.002	0.003	0.011	0.08	0.08	8.79	34.5	27.6	29.8	0.0001	0.0001	0.007	0.008	1	0.01	0.001	0.009	50	10
EC13	Alluvium	median	6.77	13770	7.29	13400	12500	415	1650	10	4800	405	345	0.4	0.5	517	484.5	0.005	0.97	0.0005	0.0005	0.002	0.002	0.025	0.025	1.225	4.02	6.28	10.115	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC13	Alluvium	20th	6.61	2540	6.886	3056	11120	102	330	4.8	797.4	79.2	45.8	0.3	0.5	332.6	331.8	0.005	0.364	0.0005	0.0005	0.001	0.002	0.025	0.025	0.444	2.528	2.488	2.76	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10

APPENDIX B

Water quality summary table

Bore	Aquifer	Statistic	pH (field)	EC (field)	pH (Lab)	EC (Lab)	TDS	Ca	Na	K	Cl	Mg	SO4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Al (diss)	Al (total)	Sb (diss)	Sb (total)	As (diss)	As (total)	B (diss)	B (total)	Fe (diss)	Fe (total)	Mn (diss)	Mn (total)	Hg (diss)	Hg (total)	Mo (diss)	Mo (total)	Se (diss)	Se (total)	Ag (diss)	Ag (total)	TPH C10_C40	TPH C6_C10
		unit	-	µS/cm	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Guideline	WQO Zone 43 (Shallow) 80th percentile		8.2	15495	8.2	15495	-	-	-	-	-	-	387	0.91	-	-	-	-	-	-	-	-	-	-	-	0.115	0.115	3.755	3.755	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 80th percentile		8.4	7720	8.4	7720	-	-	-	-	-	-	362	0.31	-	-	-	-	-	-	-	-	-	-	-	0.856	0.856	0.054	0.054	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Shallow) 20th percentile		7.09	-	7.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 20th percentile		7.7	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ANZG (2018)		8.5	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	0.055	0.055	0.009	0.009	0.013	0.013	-	-	0.7	0.7	-	-	-	-	0.0034	0.0034	0.005	0.005	-	-	-	-
	ANZG (2018) lower		6.5	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DES (2013)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
EC13	Alluvium	80th	6.92	19250	7.65	19400	13180	723.2	2834.4	13	6518	607.4	540.2	0.4	1	1232	1316	0.01	3.322	0.0007	0.0005	0.002	0.003	0.054	0.06	4.366	9.05	19.18	22.62	0.00005	0.00005	0.0038	0.004	0.01	0.005	0.0005	0.001	50	10
EC14	Alluvium	count	27	27	41	41	17	41	41	41	41	41	41	17	41	41	34	34	16	30	26	32	29	19	18	41	30	34	26	27	26	33	29	31	30	27	26	26	25
EC14	Alluvium	mini	6.90	822	6.49	419	512	20	28	3	27	14	2	0.4	0.05	128	128	0.005	3.07	0.0005	0.0005	0.003	0.002	0.025	0.025	0.02	1.14	0.26	0.47	0.00005	0.00005	0.001	0.0005	0.005	0.005	0.0005	0.0005	50	10
EC14	Alluvium	max	7.82	2576	8.78	9000	1040	558	887	24	2950	400	172	0.6	94	608	497	0.47	54.7	0.001	0.001	0.017	0.04	0.07	0.16	9.87	106	9.45	1.62	0.0001	0.0002	0.004	0.007	0.1	0.01	0.001	0.001	140	10
EC14	Alluvium	median	7.19	1396	7.48	1550	845	42	242	5	244	37	18	0.5	0.5	416	414.5	0.005	15.1	0.0005	0.0005	0.0095	0.012	0.025	0.05	0.88	21	0.471	0.7175	0.00005	0.00005	0.002	0.001	0.005	0.005	0.0005	0.0005	50	10
EC14	Alluvium	20th	7.04	1211	7.17	1250	755.2	33	197	4	177	28	6	0.5	0.5	322	320	0.005	5.24	0.0005	0.0005	0.008	0.011	0.025	0.025	0.1	9.59	0.4056	0.57	5E-05	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
EC14	Alluvium	80th	7.36	1623	7.77	3720	907	135	380	7	956	138	62	0.6	1	469	462.8	0.01	33	0.001	0.0005	0.012	0.018	0.054	0.06	1.83	41.32	1.068	1.07	0.00005	0.00005	0.002	0.002	0.01	0.005	0.0005	0.0005	50	10
EC15	Alluvium	count	NC	NC	10	10	NC	11	11	11	11	11	10	NC	11	10	6	7	NC	7	NC	6	NC	NC	NC	11	NC	8	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC15	Alluvium	mini	NC	NC	7.01	426	NC	22	29	1	10	10	4	NC	1	153	164	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.05	NC	0.04	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	max	NC	NC	7.84	3870	NC	242	222	4	1110	207	67	NC	1	435	323	0.14	NC	0.001	NC	0.001	NC	NC	NC	2.32	NC	0.452	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	median	NC	NC	7.32	886	NC	41	68	2	102	32	14	NC	1	290.5	253.5	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.05	NC	0.1905	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	20th	NC	NC	7.128	666.2	NC	37	41	1	26	26	5	NC	1	186.4	192	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.05	NC	0.121	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC15	Alluvium	80th	NC	NC	7.524	1600	NC	91	105	4	286	73	28.2	NC	1	349.6	316	0.01	NC	0.001	NC	0.001	NC	NC	NC	0.24	NC	0.316	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	count	NC	NC	12	12	NC	13	13	13	13	13	12	NC	13	12	6	7	NC	7	NC	6	NC	NC	NC	13	NC	10	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC16	Alluvium	mini	NC	NC	7.03	621	NC	2	140	1	60	3	2	NC	0.671	214	214	0.01	NC	0.001	NC	0.008	NC	NC	NC	0.04	NC	0.008	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	max	NC	NC	8.00	1578	NC	32	350	7	239	26	22	NC	10	666	401	0.53	NC	0.001	NC	0.029	NC	NC	NC	10.3	NC	0.207	NC	NC	NC	0.005	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	median	NC	NC	7.33	920	NC	5	186	1	90	7	6	NC	1	279	233.5	0.01	NC	0.001	NC	0.0145	NC	NC	NC	0.05	NC	0.0145	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	20th	NC	NC	7.14	778	NC	3	155.6	1	67	6	4	NC	1	223.6	216	0.01	NC	0.001	NC	0.013	NC	NC	NC	0.05	NC	0.012	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC16	Alluvium	80th	NC	NC	7.77	1202	NC	7.6	247	1	138	9.6	9	NC	1	388.8	309	0.37	NC	0.001	NC	0.02	NC	NC	NC	0.832	NC	0.089	NC	NC	NC	0.004	NC	0.01	NC	NC	NC	NC	NC
EC17	Alluvium	count	NC	NC	14	14	NC	15	15	15	15	15	14	NC	15	14	10	11	NC	11	7	9	6	NC	NC	15	7	12	7	8	7	10	6	11	7	8	7	NC	NC
EC17	Alluvium	mini	NC	NC	6.62	1260	NC	54	148	3	131	36	36	NC	0.5	300	300	0.005	NC	0.0005	0.0005	0.007	0.015	NC	NC	0.025	5	0.585	0.625	0.00005	0.00005	0.003	0.003	0.005	0.005	0.0005	0.0005	NC	NC
EC17	Alluvium	max	NC	NC	7.87	6070	NC	328	735	6	1800	250	297	NC	1	605	605	0.01	NC	0.001	0.001	0.042	0.033	NC	NC	6.81	16.1	2.08	2.23	0.0001	0.0001	0.004	0.004	0.01	0.01	0.001	0.001	NC	NC
EC17	Alluvium	median	NC	NC	7.14	1950	NC	102	224	5	320	64	106.5	NC	1	370	386.5	0.01	NC	0.001	0.0005	0.017	0.018	NC	NC	3	7.5	1.25	1.67	0.0001	0.00005	0.003	0.003	0.01	0.005	0.00075	0.0005	NC	NC
EC17	Alluvium	20th	NC	NC	6.774	1446	NC	71.8	157	4	185.2	48.6	52.2	NC	0.5	341.6	347.2	0.005	NC	0.0005	0.0005	0.014	0.017	NC	NC	0.622	6.14	0.6154	0.8058	0.00005	5E-05	0.003	0.003	0.005	0.005	0.0005	0.0005	NC	NC
EC17	Alluvium	80th	NC	NC	7.494	4370	NC	234.8	415.6	5.2	1214	169	187.6	NC	1	428.6	465.6	0.01	NC	0.001	0.001	0.0282	0.029	NC	NC	4.568	10.826	1.92	2.096	0.0001	0.0001	0.004	0.004	0.01	0.01	0.001	0.001	NC	NC
EC19	Alluvium	count	NC	NC	6	6	NC	6	6	6	6	6	6	NC	6	6	6	6	NC	6	5	6	5	NC	NC	6	5	6	5	6	5	6	5	6	5	6	5	NC	NC
EC19	Alluvium	mini	NC	NC	7.34	307	NC	9	31	0.5	15	14	4	NC	0.5	132	132	0.005	NC	0.0005	0.0005	0.001	0.002	NC	NC	0.025	0.18	0.009	0.031	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
EC19	Alluvium	max	NC	NC	7.72	802	NC	21	98	1	88	30	12	NC	1	246	246	0.1	NC	0.004	0.003	0.042	0.044	NC	NC	0.05	1.49	0.061	0.073	0.0001	0.0001	0.003	0.003	0.01	0.01	0.001	0.01	NC	NC
EC19	Alluvium	median	NC	NC	7.56	454	NC	14.5	42.5	1	20	22	7	NC	1	176.5	176.5	0.01	NC	0.001	0.001	0.002	0.002	NC	NC	0.05	1.19	0.0175	0.051	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
EC19	Alluvium	20th	NC	NC	7.46	348	NC	11	35	0.5	19	14	5	NC	0.5	136	136	0.005	NC	0.001	0.0009	0.001	0.002	NC	NC	0.025	0.876	0.009	0.0318	0.00005	0.00005	0.001	0.0009	0.005	0.005	0.0005	0.0005	NC	NC
EC19	Alluvium	80th	NC	NC	7.69	620	NC	18	89	1	61	26	9	NC	1	245	245	0.03	NC	0.001	0.0014	0.003	0.0112	NC	NC	0.05	1.346	0.025	0.0626	0.0001	1E-04	0.001	0.0014	0.01	0.01	0.001	0.0028	NC	NC
EC22	Alluvium	count	5	5	19	19	NC	19	19	19	19	19	19	NC	19	19	12	12	NC	12	8	9	7	NC	NC	18	8	15	8	9	8	11	7	11	8	9	8	5	NC
EC22	Alluvium	mini	7.1	2420	6.81	2380	NC	67	262	2	490	60	22	NC	0.135	207	342	0.005	NC	0.0005	0.0005	0.006	0.007	NC	NC	0.01	14.1	0.17	0.453	0.00005	0.00005	0.001	0.0005	0.005	0.005	0.0005	0.0005	50	NC
EC22	Alluvium	max	7.47	2750	8	5910	NC	271	776	11	2070	287	1962	NC	10	566	560	0.88	NC	0.001	0.001	0.01	0.047	NC	NC	2.11	34.4	1.4	1	0.0001	0.0002	0.002	0.002	0.01	0.01	0.001	0.001	50	NC
EC22	Alluvium	median	7.2	2607	7.55	2730	NC	99	375	5	647	87	75	NC	1	462	458	0.01	NC	0.001	0.0005	0.008	0.025	NC	NC	0.11	25.55	0.368	0.529	0.00005	0.00005	0.001	0.001	0.01	0.005	0.0005	0.0005	50	NC
EC22	Alluvium	20th	7.18	2444	7.018	2554	NC	76.6	332.2	3.6	574.6	75.4	52	NC	0.5	369.6	372	0.005	NC	0.0005	0.0005	0.0066	0.0112	NC	NC	0.05	18.16	0.324	0.4808	0.00005	0.00005	0.001	0.0006	0.005	0.005	0.0005	0.0005	50	NC
EC22	Alluvium	80th	7.254	2646	7.844	4285	NC	165.4	439.2	5.4	944.6	164	112.6	NC	1	517.4	517.6	0.018	NC	0.001	0.001	0.0088	0.0288	NC	NC	0.852	34.12	0.7336	0.6392	0.0001	0.0001	0.002	0.001	0.01	0.01	0.001	0.001	50	NC
EC23	Alluvium	count	NC	NC	12	13	NC	13	13	13	13	13	12	NC	13	12	6	7	NC	7	NC	6	NC	NC	NC	13	NC	10	NC	NC	NC	7	NC	7	NC	NC	NC	NC	NC
EC23	Alluvium	mini	NC	NC	6.83	954	NC	21	134	1	100	23	24	NC	1	239	239	0.01	NC	0.001	NC	0.002	NC	NC	NC	0.01	NC	0.078	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	max	NC	NC	8.00	7910	NC	369	799	6	2230	384	155	NC	1	881	449	0.02	NC	0.001	NC	0.003	NC	NC	NC	0.9	NC	0.497	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	median	NC	NC	7.24	2500	NC	82	322	4	585	92	51	NC	1	479	340.5	0.01	NC	0.001	NC	0.002	NC	NC	NC	0.08	NC	0.2475	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	20th	NC	NC	7.06	2016	NC	62	241.6	2	396	57.4	29	NC	1	321	265	0.01	NC	0.001	NC	0.002	NC	NC	NC	0.05	NC	0.1464	NC	NC	NC	0.001	NC	0.01	NC	NC	NC	NC	NC
EC23	Alluvium	80th	NC	NC	7.73	4280	NC	172.2	553.6	4.6	1136	179.2	75.2	NC	1	583.4	398	0.01	NC	0.001	NC	0.003	NC	NC	NC	0.588	NC	0.4038	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
FIELD 5 BORE	Alluvium	count	NC	NC	5	5	NC	5	5	5	5	5	5	NC	5	5	5	5	NC	NC	NC	5	5	NC	NC	5	5	NC	NC	NC	NC	5	5	NC	5	NC	NC	5	5
FIELD 5 BORE	Alluvium	mini	NC	NC	7.32	10900	NC	312	1700	6	3110	346	276	NC	0.5	226	226	0.005	NC	NC	NC	0.002	0.002	NC	NC	0.025	1.91	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	max	NC	NC	8.16	20200	NC	919	2120	41	6300	755	947	NC	0.5	923	923	0.01	NC	NC	NC	0.007	0.016	NC	NC	5.48	20.2	NC	NC	NC	NC	0.003	0.003	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	median	NC	NC	7.68	16600	NC	727	1940	16	5890	588	397	NC	0.5	346	346	0.005	NC	NC	NC	0.003	0.005	NC	NC	3.67	5.7	NC	NC	NC	NC	0.001	0.002	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	20th	NC	NC	7.488	15060	NC	625.6	1860	13.2	5326	529.2	346.4	NC	0.5	281.2	281.2	0.005	NC	NC	NC	0.0028	0.0028	NC	NC	1.357	4.55	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
FIELD 5 BORE	Alluvium	80th	NC	NC	7.84	17320	NC	779	2008	21	6212	667	611	NC	0.5	687	687	0.006	NC	NC	NC	0.0062	0.0096	NC	NC	4.072	9.296	NC	NC	NC	NC	0.0022	0.0022	NC	0.005	NC	NC	50	10
GW01	Alluvium	count	31	31	42	42	17	42	42	42	42	42	42	17	42	42	38	38	12	34	30	35	33	19	18	42	34	33	29	31	30	37	32	34	34	31	30	29	29
GW01	Alluvium	mini	7.69	3861	7.29	3780	2460	16	701	0.5	702	60	38	0.4	0.5	412	525	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.1	0.11	0.025	0.13	0.006	0.059	0.00005	0.00005	0.001	0.0005	0.0002	0.005	0.0005	0.0005	50	10
GW01	Alluvium	max	8.74	6460	8.81	14000	4290	137	1890	9	3740	406	339	0.8	165	1670	1460	0.01	22.4	0.001	0.001	0.008	0.009	0.21	0.42	0.98	26	1.03	0.338	0.0001	0.0001	0.008	0.008	0.01	0.01	0.001	0.001	50	10
GW01	Alluvium	median	8.17	4940	8.27	5150	2760	31.5	970	2	1125	94	150.5	0.6	15.5	672	682.5	0.005	0.045	0.0005	0.0005	0.003	0.003	0.15	0.16	0.06	0.47	0.084	0.097	0.00005	0.00005	0.004	0.005	0.005	0.005	0.0005	0.0005	50	10
GW01	Alluvium	20th	7.94	4161	8.06	4184	2580	25.2	791.8	1	879	70.2	110.4	0.42	0.5	608	604.4	0.005	0.022	0.0005	0.0005	0.0018	0.002	0.126	0.124	0.025	0.21	0.0712	0.076	0.00005	0.00005	0.003	0.0032	0.005	0.005	0.0005	0.0005	50	10
GW01	Alluvium	80th	8.43	5890	8.47	6574	3696	48.8	1160	4.8	1584	136.2	258.6	0.6	60	1018	927.4	0.005	0.08	0.0007	0.0005	0.004	0.004	0.178	0.18	0.154	1.256	0.118	0.129	0.00005	0.00005	0.005	0.006	0.007	0.005	0.0005	0.0005	50	10
GW02	Alluvium	count	NC	NC	16	16	NC	16	16	16	16	16	16	NC	16	16	11	11	NC	11	7	10	7	NC	NC	16	7	13	7	8	7	11	7	11	7	8	7	NC	NC
GW02	Alluvium	mini	NC	NC	6.79	303	NC	19	27	2	19	10	2	NC	0.11	112	112	0.005	NC	0.0005	0.0005	0.0005	0.0005	NC	NC	0.025	1.89	0.178	0.355	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
GW02	Alluvium	max	NC	NC	7.94	5300	NC	49	94	7	1100	25	150	NC	10	602	211	0.06	NC	0.001	0.001	0.003	0.004	NC	NC	1.4	19.4	1.2	0.472	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
GW02	Alluvium	median	NC	NC	7.365	517.5	NC	34	44.5	3	63.5	19.5	4	NC	1	186	134	0.01	NC	0.001	0.0005	0.0015	0.002	NC	NC	0.77	3.81	0.331	0.381	0.0001	0.00005	0.001	0.0005	0.01	0.005	0.00075	0.0005	NC	NC
GW02	Alluvium	20th	NC	NC	7.23	389	NC	23	29	2	38	12	2	NC	0.5	129	129	0.005	NC	0.0005	0.0005	0.0005	0.0006	NC	NC	0.05	2.292	0.2622	0.3726	0.00005	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	NC	NC
GW02	Alluvium	80th	NC	NC	7.68	687	NC	43	54	4	96	23	9	NC	1	197	196	0.01	NC	0.001	0.001	0.002	0.002	NC	NC	1.18	8.096	0.4622	0.3972	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	NC	NC
RB7a	Alluvium	count	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7	NC	NC	8	8	NC	NC	8	5	NC	NC	NC	NC	8	8	5	8	NC	NC	8	8
RB7a	Alluvium	mini	6.96	5376	7.42	5000	3250	140	745	0.5	1310	145	284	0.4	0.5	311	311	0.005	0.02	NC	NC	0.001	0.0005	NC	NC	0.025	0.07	NC	NC	NC	NC	0.0005	0.0005	0.0028	0.005	NC	NC	50	10
RB7a	Alluvium	max	7.29	8903	7.95	8840	5750	283	1100	7	2740	330	608	0.4	0.5	396	396	0.005	0.21	NC	NC	0.001	0.003	NC	NC	0.025	0.25	NC	NC	NC	NC	0.001	0.002	0.005	0.005	NC	NC	50	10
RB7a	Alluvium	median	7.02	6036	7.60	5930	3855	175.5	835.5	2	1630	197	375	0.4	0.5	333	333	0.005	0.04	NC	NC	0.001	0.001	NC	NC	0.025	0.08	NC	NC	NC	NC	0.0005	0.0005	0.005	0.005	NC	NC	50	10
RB7a	Alluvium	20th	6.98	5388	7.50	5242	3410	142.4	762.8	1	1410	155	297.2	0.4	0.5	321	321	0.005	0.024	NC	NC	0.001	0.0007	NC	NC	0.025	0.07	NC	NC	NC	NC	0.0005	0.0005	0.0032	0.005	NC	NC	50	10
RB7a	Alluvium	80th	7.12	7346	7.80	7106	4620	228.8	948.2	3.6	2000	252.4	476.2	0.4	0.5	366	366	0.005	0.098	NC	NC	0.001	0.0016	NC	NC	0.025	0.202	NC	NC	NC	NC	0.001	0.001	0.005	0.005	NC	NC	50	10
Twin Bores	Alluvium	count	28	28	29	29	15	29	29	29	29	29	29	15	29	29	28	28	12	24	24	28	28	17	17	29	28	25	24	24	24	28	28	25	28	24	24	27	26
Twin Bores	Alluvium	mini	7.21	9960	7.6	6470	6420	6	1040	7	1750	197	24	0.05	0.5	188	214	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.28	0.34	0.025	0.25	0.159	0.17	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
Twin Bores	Alluvium	max	9.29	13230	8.99	13000	7860	206	2100	26	4350	486	807	0.2	237	558	707	0.005	0.13	0.0005	0.0005	0.001	0.001	0.56	0.64	1.77	5.45	0.948	0.9	0.00005	0.00005	0.002	0.002	0.005	0.005	0.001	0.0005	50	10
Twin Bores	Alluvium	median	7.565	11610	8.05	11400	7280	166	1770	9	3700	391	673	0.2	0.5	449	452	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.48	0.53	0.12	1.325	0.337	0.352	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Twin Bores	Alluvium	20th	7.37	10845.2	7.702	10740	6720	14.6	1684	8	3490	291.6	279.4	0.05	0.5	375.6	409.4	0.005	0.032	0.0005	0.0005	0.0005	0.0005	0.46	0.484	0.04	0.636	0.2534	0.2624	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Twin Bores	Alluvium	80th	8.594	12258	8.548	12000	7492	181.4	1852	14.2	4030	437	696	0.2	58.8	477.2	491.6	0.005	0.07	0.0005	0.0005	0.0005	0.0005	0.528	0.55	0.248	2.306	0.4358	0.4758	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Weir Bore (2)	Alluvium	count	NC	NC	10	10	NC	10	10	10	10	10	10	NC	10	10	5	5	NC	5	NC	5	NC	NC	NC	10	NC	6	NC	NC	NC	5	NC	5	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	mini	NC	NC	6.70	1330	NC	7	275	1	118	10	1	NC	1	34	417	0.01	NC	0.001	NC	0.004	NC	NC	NC	0.05	NC	0.001	NC	NC	NC	0.002	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	max	NC	NC	8.46	2550	NC	29	466	11	753	43	78	NC	50	641	615	0.02	NC	0.001	NC	0.006	NC	NC	NC	1.04	NC	0.342	NC	NC	NC	0.004	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	median	NC	NC	8.06	1815	NC	16.5	368	1	206.5	20.5	43.5	NC	1	548	529	0.01	NC	0.001	NC	0.005	NC	NC	NC	0.05	NC	0.0595	NC	NC	NC	0.003	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	20th	NC	NC	7.87	1566	NC	8.8	304.8	1	170.8	11	23	NC	1	417.8	417.8	0.01	NC	0.001	NC	0.004	NC	NC	NC	0.05	NC	0.032	NC	NC	NC	0.0028	NC	0.01	NC	NC	NC	NC	NC
Weir Bore (2)	Alluvium	80th	NC	NC	8.18	2386	NC	20.8	430	1.2	424.6	27.6	52.8	NC	40	615	615	0.02	NC	0.001	NC	0.006	NC	NC	NC	0.398	NC	0.102	NC	NC	NC	0.004	NC	0.01	NC	NC	NC	NC	NC
Fairhill Bore	Burngrove	count	29	29	28	28	16	28	28	28	28	28	28	16	28	28	28	28	7	25	25	28	28	19	18	28	14	25	25	25	25	28	28	26	28	25	25	27	26
Fairhill Bore	Burngrove	mini	6	1641	6.59	1590	1030	18	266	10	419	22	70	0.1	0.5	84	84	0.005	0.01	0.0005	0.0005	0.0005	0.001	0.38	0.45	0.025	0.06	0.002	0.002	0.00005	0.00005	0.0005	0.0005	0.0018	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	max	8.54	3130	8.58	2070	1340	34	382	14	516	31	103	0.2	29	231	231	0.02	0.02	0.0005	0.0005	0.003	0.003	0.61	0.6	3.7	7.08	0.21	0.228	0.00005	0.0001	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	median	6.92	2006	7.105	1830	1150	27.5	305	11	479	27.5	80.5	0.2	0.5	174.5	181.5	0.005	0.02	0.0005	0.0005	0.003	0.003	0.51	0.55	0.025	0.315	0.016	0.023	0.00005	0.00005	0.0005	0.00075	0.005	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	20th	6.432	1747.8	6.882	1690	1070	21.4	276.6	11	446.2	24	76	0.2	0.5	105.6	105.6	0.005	0.01	0.0005	0.0005	0.002	0.002	0.484	0.5	0.025	0.082	0.0066	0.008	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Fairhill Bore	Burngrove	80th	7.404	2066	7.728	2012	1290	32	332.6	12	498.6	28.6	90	0.2	0.5	209	209	0.005	0.02	0.0005	0.0005	0.003	0.003	0.544	0.57	0.025	0.628	0.043	0.0532	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	count	26	26	27	27	16	27	27	27	27	27	27	16	27	27	27	27	13	24	24	27	27	18	17	27	25	23	23	24	24	27	27	25	27	24	24	26	25
Yongala Bore	Burngrove	mini	6.46	2820	6.91	2700	1790	65	357	13	716	54	44	0.2	0.5	185	185	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.51	0.55	0.025	1.97	0.002	0.023	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	max	8.54	3140	8.53	3160	2050	86	460	17	849	72	62	0.3	30	272	303	0.005	0.2	0.0005	0.0005	0.001	0.004	0.72	0.74	6.72	10.9	0.339	0.374	0.00005	0.00005	0.0005	0.0005	0.1	0.005	0.0005	0.001	50	10
Yongala Bore	Burngrove	median	6.83	2978	7.26	2900	1895	74	410	15	816	63	51	0.2	0.5	221	221	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.62	0.66	5.04	6.56	0.266	0.287	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	20th	6.69	2920	7.06	2832	1850	71.2	397.4	14	775.2	61.2	47	0.2	0.5	211.6	214	0.005	0.014	0.0005	0.0005	0.0005	0.0005	0.6	0.632	4.256	5.536	0.24	0.2546	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Yongala Bore	Burngrove	80th	7.11	3060	7.74	2944	1920	79.2	422.6	16	840.2	67	53	0.2	0.5	230.8	230.8	0.005	0.098	0.0005	0.0005	0.0005	0.001	0.65	0.696	5.698	7.94	0.2828	0.2972	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	count	27	27	27	27	16	27	27	27	27	27	27	16	27	27	27	27	5	23	23	27	27	18	17	27	26	23	23	23	23	27	26	24	27	23	23	26	25
Railway Bore	Fairhill	mini	6.76	1857	7.23	1770	1150	59	235	9	458	49	62	0.4	0.5	219	219	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.52	0.52	0.025	0.11	0.009	0.008	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	max	7.82	8840	8.69	8650	5620	163	1490	32	1980	280	957	0.6	172	1160	1270	0.01	0.07	0.0005	0.0005	0.004	0.0005	0.84	0.84	2.57	3.74	0.033	0.177	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	median	7.01	6600	7.63	6370	4520	101	1150	25	1280	180	598	0.4	0.5	1100	1100	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.74	0.76	0.52	0.58	0.011	0.011	0.00005	0.00005	0.0005	0.00075	0.005	0.005	0.0005	0.0005	50	10

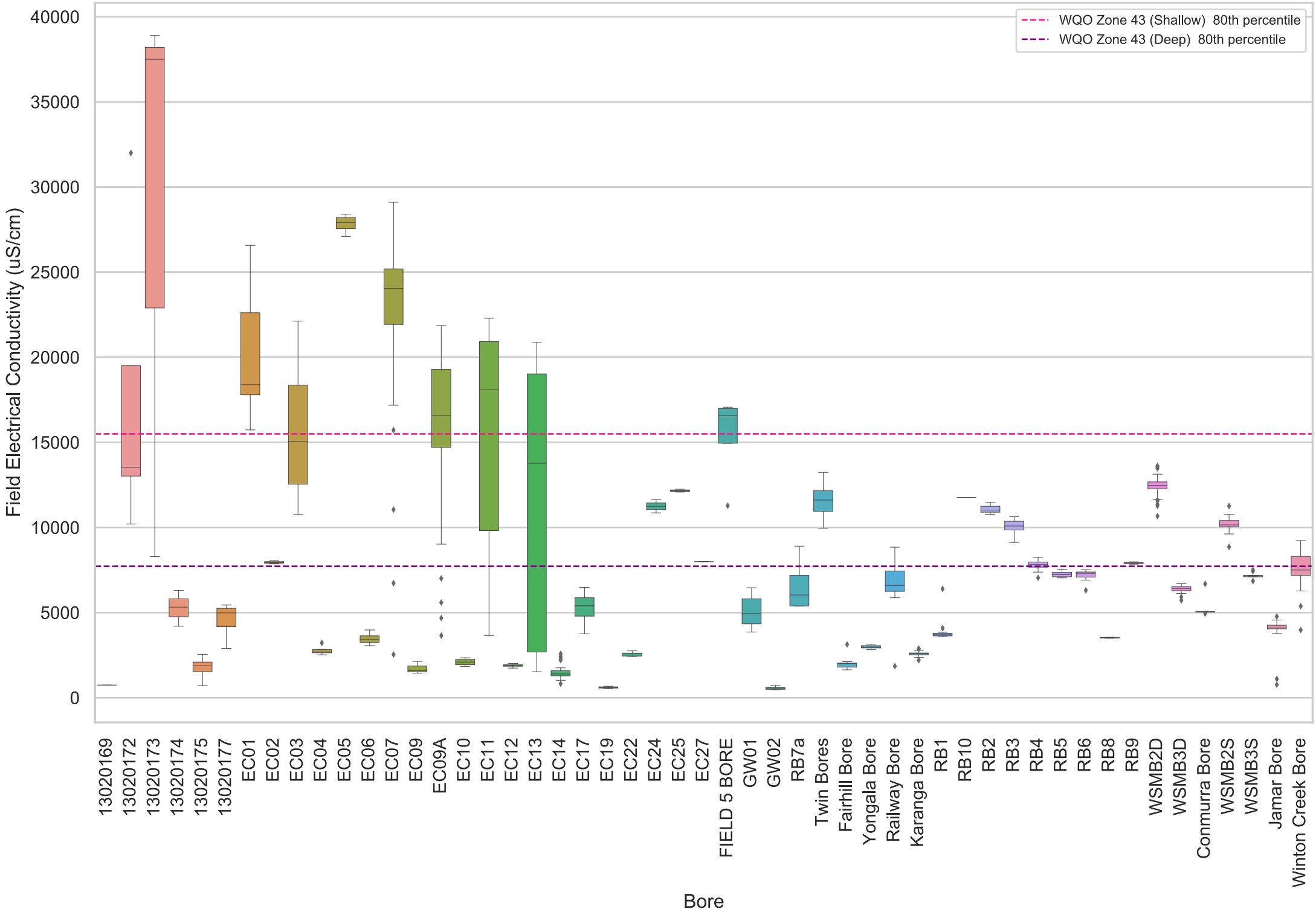
Water quality summary table

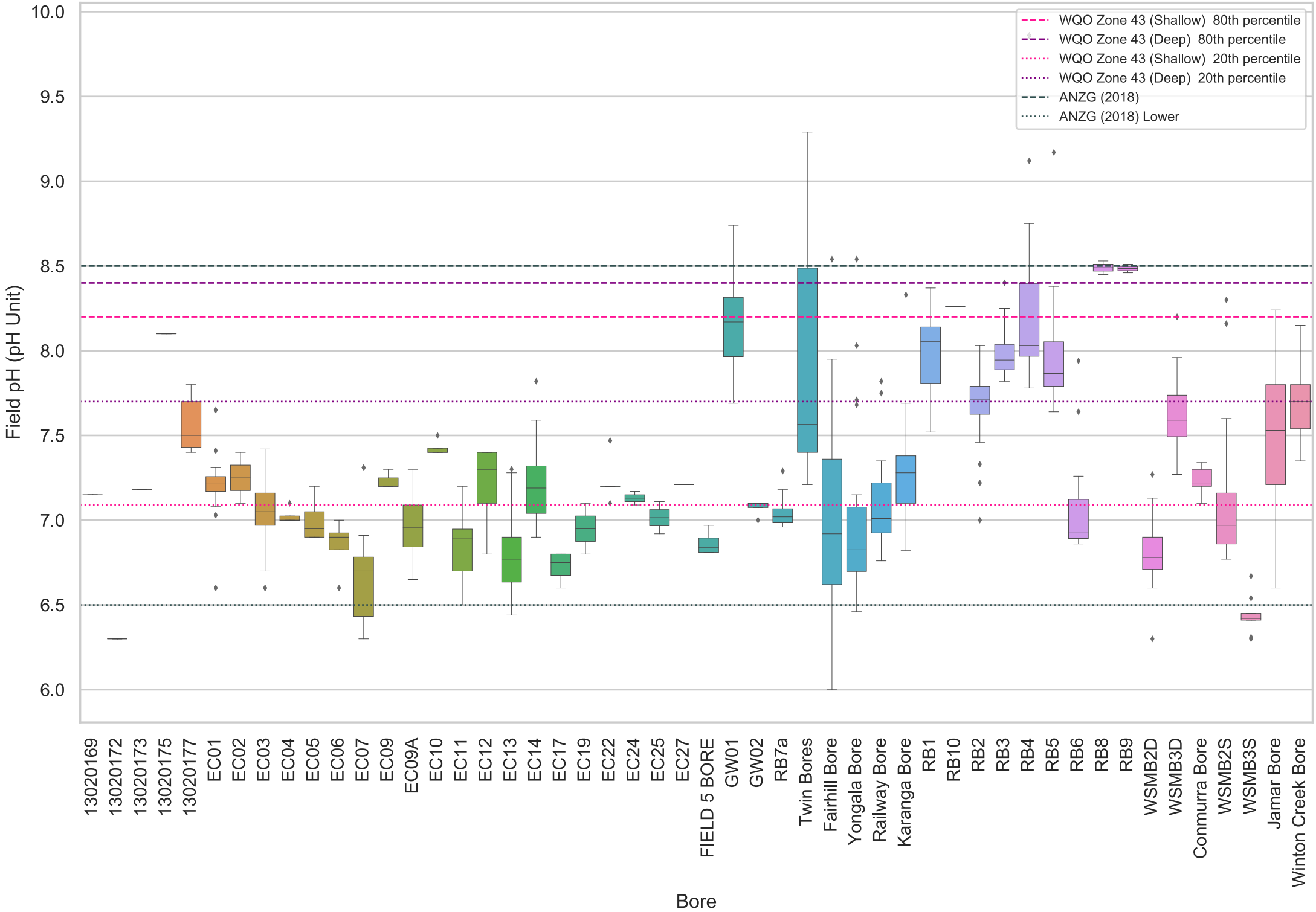
Bore	Aquifer	Statistic	pH (field)	EC (field)	pH (Lab)	EC (Lab)	TDS	Ca	Na	K	Cl	Mg	SO4	F	Carbonate Alkalinity	Bicarbonate Alkalinity	Total Alkalinity	Al (diss)	Al (total)	Sb (diss)	Sb (total)	As (diss)	As (total)	B (diss)	B (total)	Fe (diss)	Fe (total)	Mn (diss)	Mn (total)	Hg (diss)	Hg (total)	Mo (diss)	Mo (total)	Se (diss)	Se (total)	Ag (diss)	Ag (total)	TPH C10_C40	TPH C6_C10
		unit	-	µS/cm	-	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
Guideline	WQO Zone 43 (Shallow) 80th percentile		8.2	15495	8.2	15495	-	-	-	-	-	-	387	0.91	-	-	-	-	-	-	-	-	-	-	-	0.115	0.115	3.755	3.755	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 80th percentile		8.4	7720	8.4	7720	-	-	-	-	-	-	362	0.31	-	-	-	-	-	-	-	-	-	-	-	0.856	0.856	0.054	0.054	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Shallow) 20th percentile		7.09	-	7.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQO Zone 43 (Deep) 20th percentile		7.7	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ANZG (2018)		8.5	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	0.055	0.055	0.009	0.009	0.013	0.013	-	-	0.7	0.7	-	-	-	-	0.0034	0.0034	0.005	0.005	-	-	-	-
	ANZG (2018) lower		6.5	-	6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	DES (2013)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	20
Railway Bore	Fairhill	20th	6.912	6180.8	7.386	5968	4120	91	1030	23	1174	164.6	555.8	0.4	0.5	903.8	916	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.694	0.732	0.126	0.29	0.01	0.0104	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Railway Bore	Fairhill	80th	7.246	7833.8	8.002	7426	5340	128.6	1264	29.6	1596	229.2	834.6	0.5	0.5	1120	1120	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.78	0.834	0.58	0.67	0.012	0.0158	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	count	34	34	42	42	16	43	43	43	42	43	42	16	42	42	37	37	NC	34	30	37	33	19	18	43	33	35	30	31	30	37	33	35	33	31	30	28	27
Karanga Bore	Rangal Coal Measures	mini	6.82	2204	6.96	2400	1570	53	130	6	336	84	41	0.05	0.5	144	201	0.005	NC	0.0005	0.0005	0.0005	0.0005	0.18	0.18	0.025	0.05	0.001	0.055	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	max	8.33	2880	8.40	3320	1680	210	380	34	870	157	302	0.1	20	398	397	0.01	NC	0.001	0.001	0.004	0.002	0.27	0.27	1.55	0.7	0.334	0.276	0.0001	0.0001	0.009	0.011	0.1	0.01	0.001	0.001	50	10
Karanga Bore	Rangal Coal Measures	median	7.28	2575	7.61	2510	1615	125	249	6	633.5	98	54.5	0.05	0.5	359	358	0.005	NC	0.0005	0.0005	0.001	0.001	0.22	0.24	0.48	0.61	0.198	0.201	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	20th	7.08	2473	7.41	2450	1590	118	233.2	6	609.2	92	44.2	0.05	0.5	336	336	0.005	NC	0.0005	0.0005	0.0005	0.0005	0.21	0.224	0.108	0.564	0.1838	0.1914	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Karanga Bore	Rangal Coal Measures	80th	7.51	2662	7.88	2768	1640	149.2	259	7.6	657	114.2	187.6	0.05	1	369.4	367	0.005	NC	0.0007	0.0005	0.002	0.001	0.24	0.256	0.59	0.652	0.2154	0.2154	0.00005	0.00005	0.0005	0.0005	0.01	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	count	24	24	23	23	16	23	23	23	23	23	22	16	23	23	23	23	14	19	19	23	23	18	17	23	23	19	19	19	19	23	23	20	23	19	19	21	22
RB1	Rangal Coal Measures	mini	7.52	3578	7.67	3350	2180	9	677	3	776	9	1	0.2	0.5	201	201	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.28	0.34	0.025	0.12	0.009	0.011	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	max	8.37	6390	8.85	4040	2450	31	789	5	1030	14	44	0.6	86	474	478	0.005	0.81	0.0005	0.0005	0.003	0.004	0.46	0.48	0.21	14.4	0.137	0.832	0.00005	0.00005	0.006	0.006	0.1	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	median	8.055	3700	8.21	3520	2270	14	737	3	938	10	4	0.4	0.5	414	428	0.005	0.105	0.0005	0.0005	0.0005	0.0005	0.39	0.42	0.07	0.36	0.014	0.02	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	20th	7.746	3622	8.154	3458	2240	13	712.6	3	895.6	10	2.2	0.4	0.5	397.4	411.2	0.005	0.026	0.0005	0.0005	0.0005	0.0005	0.38	0.4	0.025	0.144	0.011	0.014	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB1	Rangal Coal Measures	80th	8.17	3793.6	8.426	3686	2330	16	762.8	4	967.8	12	10.6	0.5	20	428.4	440.4	0.005	0.482	0.0005	0.0005	0.002	0.002	0.426	0.458	0.096	0.796	0.0472	0.0626	0.00005	0.00005	0.003	0.004	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	count	23	23	22	22	16	22	22	22	22	22	5	16	22	22	22	22	11	18	18	22	22	18	17	22	22	18	18	18	18	22	22	19	22	18	18	21	21
RB2	Rangal Coal Measures	mini	7.00	10770	7.20	10200	6630	89	1970	7	3320	30	1	0.2	0.5	125	125	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.28	0.32	0.025	0.38	0.054	0.056	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	max	8.03	11470	8.24	11700	7600	186	2250	10	4030	56	9	0.3	0.5	158	158	0.02	0.52	0.0005	0.0005	0.005	0.006	0.42	0.45	0.85	1.18	0.181	0.196	0.00005	0.00005	0.001	0.002	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	median	7.71	11020	7.83	10850	7020	135.5	2120	8	3795	33	3	0.3	0.5	130.5	130.5	0.005	0.06	0.0005	0.0005	0.0015	0.002	0.375	0.41	0.53	0.685	0.089	0.094	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	20th	7.59	10884	7.70	10700	6820	124.4	2080	7	3672	31.2	1.8	0.3	0.5	127.2	127.2	0.005	0.02	0.0005	0.0005	0.001	0.001	0.36	0.372	0.24	0.526	0.062	0.0624	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB2	Rangal Coal Measures	80th	7.82	11302	8.03	11000	7150	150.4	2160	8	3950	36	5	0.3	0.5	138.2	138.2	0.005	0.09	0.0005	0.0005	0.0038	0.0038	0.406	0.42	0.578	0.758	0.1154	0.1226	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	count	24	24	23	23	15	23	23	23	23	23	15	15	23	23	23	23	10	19	19	23	23	17	16	23	23	19	19	19	19	23	23	20	22	19	19	21	22
RB3	Rangal Coal Measures	mini	7.82	9120	7.91	9310	6140	33	1720	5	3050	11	1	0.2	0.5	159	159	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.4	0.38	0.025	0.11	0.025	0.029	0.00005	0.00005	0.0005	0.0005	0.0002	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	max	8.4	10630	8.41	10600	6890	91	2190	12	3650	18	19	0.6	12	448	448	0.02	0.15	0.0005	0.0005	0.003	0.004	0.53	0.54	0.34	0.66	0.104	0.122	0.00005	0.00005	0.003	0.004	0.005	0.005	0.002	0.0005	50	10
RB3	Rangal Coal Measures	median	7.945	10085	8.05	9920	6450	64	2030	6	3400	13	3	0.2	0.5	180	180	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.47	0.49	0.18	0.35	0.036	0.041	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	20th	7.872	9833.6	7.948	9706	6278	53.4	1944	6	3264	12.4	2	0.2	0.5	171.4	172	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.44	0.46	0.039	0.3	0.0284	0.0316	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB3	Rangal Coal Measures	80th	8.064	10399.2	8.16	10000	6500	68.8	2076	8	3512	15	7	0.2	0.5	183.6	183.6	0.005	0.108	0.0005	0.0005	0.003	0.002	0.49	0.52	0.286	0.464	0.05	0.0522	0.00005	0.00005	0.001	0.002	0.005	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	count	24	24	23	23	17	23	24	24	23	23	24	16	22	23	22	22	16	18	18	22	22	18	17	23	23	19	19	18	18	23	23	19	22	18	18	21	22
RB4	Rangal Coal Measures	mini	7.78	7040	7.79	7100	4800	14	1320	7	1970	6	4	0.4	0.5	51	98	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.42	0.41	0.025	0.09	0.001	0.007	0.00005	0.00005	0.002	0.003	0.0006	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	max	9.86	8240	9.23	8070	5240	66	1660	27	2680	20	38	0.5	47	210	210	0.06	0.78	0.0005	0.0005	0.002	0.002	0.53	0.56	0.23	1.18	0.037	0.071	0.00005	0.00005	0.018	0.019	0.005	0.005	0.0005	0.0005	1760	10
RB4	Rangal Coal Measures	median	8.03	7820	8.08	7640	4980	53	1535	8.5	2540	9	6	0.4	0.5	180	179	0.005	0.06	0.0005	0.0005	0.0005	0.0005	0.46	0.49	0.1	0.26	0.013	0.017	0.00005	0.00005	0.004	0.005	0.005	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	20th	7.95	7655	8.02	7488	4888	32.4	1472	8	2430	8	5	0.4	0.5	152.8	152.4	0.005	0.05	0.0005	0.0005	0.0005	0.0005	0.434	0.47	0.025	0.194	0.0078	0.0112	0.00005	0.00005	0.003	0.003	0.005	0.005	0.0005	0.0005	50	10
RB4	Rangal Coal Measures	80th	8.47	8049	8.33	7734	5064	61	1564	16.4	2592	10	14	0.4	4.8	189.6	188.8	0.038	0.33	0.0005	0.0005	0.001	0.001	0.486	0.52	0.2	0.47	0.0144	0.0204	0.00005	0.00005	0.0066	0.007	0.005	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	count	24	24	24	24	17	24	24	24	24	24	8	17	24	24	24	24	17	20	20	24	24	19	18	24	24	20	20	20	20	24	24	21	24	19	20	23	23
RB5	Rangal Coal Measures	mini	7.64	7040	7.47	6800	4420	40	1220	5	1760	8	1	0.05	0.5	183	183	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.36	0.38	0.025	0.17	0.015	0.027	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	max	9.17	7540	8.5	7430	4830	72	1570	11	2400	18	12	0.4	20	467	467	0.02	0.38	0.0005	0.0005	0.002	0.002	0.52	0.52	0.66	1.43	0.067	0.079	0.00005	0.00005	0.006	0.006	0.005	0.005	0.0005	0.0005	120	10
RB5	Rangal Coal Measures	median	7.865	7235	8.05	7070	4570	51	1420	6	2295	9	2.5	0.3	0.5	219	219.5	0.005	0.07	0.0005	0.0005	0.0005	0.0005	0.44	0.47	0.155	0.43	0.03	0.0355	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	20th	7.752	7086	7.928	6976	4462	44.6	1376	5	2178	8	1	0.3	0.5	216	216.6	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.42	0.444	0.025	0.37	0.0262	0.0308	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB5	Rangal Coal Measures	80th	8.064	7400	8.274	7162	4702	53.4	1480	7	2364	9.4	7.4	0.4	0.5	224.2	227.4	0.005	0.148	0.0005	0.0005	0.001	0.001	0.488	0.49	0.286	0.67	0.0412	0.0482	0.00005	0.00005	0.001	0.001	0.005	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	count	18	18	17	17	16	17	17	17	17	17	17	16	17	17	17	17	16	13	13	17	17	13	12	17	17	13	13	13	13	17	17	14	17	13	13	16	16
RB6	Rangal Coal Measures	mini	6.86	6310	7.23	6890	4480	115	813	8	1680	130	75	0.05	0.5	221	221	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.26	0.24	0.08	0.81	0.047	0.088	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	max	7.94	7520	8.21	7730	5020	225	1240	10	2330	297	176	0.4	0.5	493	493	0.005	17.4	0.0005	0.0005	0.002	0.009	0.46	0.44	3.51	62.9	0.108	1.28	0.00005	0.00005	0.002	0.002	0.005	0.005	0.0005	0.0005	100	10
RB6	Rangal Coal Measures	median	6.93	7309	7.45	7110	4625	189	888	9	2220	277	143	0.05	0.5	452	452	0.005	2.52	0.0005	0.0005	0.0005	0.002	0.33	0.37	0.84	7.45	0.071	0.217	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	20th	6.89	7028	7.33	6972	4520	180.2	856.8	8	2106	265	137.2	0.05	0.5	423.8	423.8	0.005	0.75	0.0005	0.0005	0.0005	0.0005	0.314	0.332	0.268	2.756	0.0674	0.1056	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
RB6	Rangal Coal Measures	80th	7.19	7408	7.86	7266	4720	196	919	9	2278	285.4	153	0.1	0.5	463.4	463.4	0.005	9.42	0.0005	0.0005	0.0005	0.003	0.34	0.388	1.218	17.68	0.0784	0.3948	0.00005	0.00005	0.0005	0.001	0.005	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	count	33	33	32	32	18	32	32	32	32	32	32	18	32	32	32	32	15	27	27	32	32	19	18	32	32	27	27	27	27	32	32	28	31	26	27	31	30
WSMB2D	Rangal Coal Measures	mini	6.3	10670	7.02	10600	6890	203	1840	13	3280	221	340	0.05	0.5	414	414	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.34	0.38	0.025	0.46	0.081	0.079	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	max	7.27	13620	8.2	13800	8970	310	2370	18	4270	288	740	0.2	0.5	616	616	0.02	0.16	0.0005	0.0005	0.008	0.007	0.62	0.63	1.86	3.44	0.175	0.183	0.00005	0.00005	0.005	0.005	0.005	0.005	0.0005	0.0005	420	10
WSMB2D	Rangal Coal Measures	median	6.78	12470	7.535	12250	7830	258	2105	14	3920	251	626	0.1	0.5	569.5	569.5	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.52	0.56	1.535	1.675	0.093	0.1	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	20th	6.698	12177.4	7.246	11800	7486	230.6	1970	14	3680	237.2	498.2	0.1	0.5	548.8	548.8	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.496	0.52	1.244	1.46	0.0902	0.0944	5E-05	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2D	Rangal Coal Measures	80th	6.906	12769.6	7.816	12600	8000	279.2	2188	15	4150	265.6	664.4	0.1	0.5	589.2	589.2	0.005	0.068	0.0005	0.0005	0.0009	0.001	0.548	0.586	1.616	1.772	0.1008	0.1114	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	count	30	30	30	30	17	30	30	30	30	30	11	17	30	30	30	30	13	24	24	30	30	16	15	30	30	24	24	24	24	30	30	25	30	23	24	30	29
WSMB3D	Rangal Coal Measures	mini	7.27	5720	7.21	5890	3890	107	871	5	1610	61	2	0.2	0.5	114	114	0.005	0.01	0.0005	0.0005	0.0005	0.0005	0.25	0.28	0.025	0.19	0.089	0.09	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	max	8.20	6700	8.28	6740	4380	148	1180	8	2180	83	17	0.2	0.5	147	147	0.02	0.09	0.0005	0.0005	0.0005	0.001	0.38	0.39	0.54	0.6	0.227	0.26	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	360	10
WSMB3D	Rangal Coal Measures	median	7.59	6421	7.88	6245	4050	120	1040	7	1925	76.5	3	0.2	0.5	127	127	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.335	0.35	0.34	0.505	0.098	0.103	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	20th	7.47	6249	7.71	6036	3962	118.6	983.6	6	1816	74	2	0.2	0.5	122.8	122.8	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.3	0.334	0.176	0.308	0.093	0.098	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3D	Rangal Coal Measures	80th	7.76	6550	8.02	6360	4124	131.6	1082	7	2082	80	5	0.2	0.5	132.2	132.2	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.35	0.36	0.482	0.59	0.1028	0.109	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	count	5	5	5	5	NC	5	5	5	5	5	5	NC	5	5	5	5	NC	5	5	5	5	NC	NC	5	5	5	5	5	5	5	NC	5	5	5	5	5	5
Conmurra Bore	Regolith	mini	7.1	4940	7.61	4350	NC	76	605	9	1020	152	91	NC	0.5	648	648	0.005	NC	0.0005	0.0005	0.0005	0.001	NC	NC	0.025	0.54	0.014	0.03	0.00005	0.00005	0.0005	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	max	7.34	6690	7.88	5620	NC	112	745	13	1260	219	167	NC	0.5	734	734	0.005	NC	0.0005	0.0005	0.003	0.01	NC	NC	0.025	11	0.069	0.757	0.00005	0.00005	0.003	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	median	7.22	5050	7.67	4840	NC	90	728	11	1200	161	118	NC	0.5	666	666	0.005	NC	0.0005	0.0005	0.002	0.004	NC	NC	0.025	2.73	0.033	0.076	0.00005	0.00005	0.002	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	20th	7.18	5012	7.642	4622	NC	85.6	610.6	10.6	1116	152	107.8	NC	0.5	662.4	662.4	0.005	NC	0.0005	0.0005	0.0009	0.0018	NC	NC	0.025	1.932	0.0164	0.046	0.00005	0.00005	0.0009	NC	0.005	0.005	0.0005	0.0005	50	10
Conmurra Bore	Regolith	80th	7.308	5378	7.856	5036	NC	102.4	733	12.2	1228	203.8	151	NC	0.5	731.6	731.6	0.005	NC	0.0005	0.0005	0.0022	0.0068	NC	NC	0.025	6.248	0.0522	0.2162	5E-05	5E-05	0.0022	NC	0.005	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	count	33	33	32	32	18	32	32	32	32	32	32	18	32	32	32	32	18	27	27	32	32	19	18	32	32	27	27	27	27	32	32	28	31	26	27	31	30
WSMB2S	Regolith	mini	6.77	8860	7.20	9430	6130	146	1470	14	2740	223	214	0.05	0.5	457	457	0.005	0.06	0.0005	0.0005	0.002	0.002	0.24	0.43	0.025	0.77	0.095	0.137	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	max	8.30	11260	8.33	10400	6760	183	1890	29	3330	279	319	0.05	17	954	972	0.02	19.2	0.0005	0.0005	0.008	0.022	0.54	0.56	1.36	31	0.436	0.524	0.00005	0.0001	0.002	0.003	0.005	0.005	0.002	0.0005	710	10
WSMB2S	Regolith	median	6.97	10152	7.70	9995	6485	167	1655	15.5	3125	249.5	248	0.05	0.5	744	744	0.005	0.96	0.0005	0.0005	0.004	0.008	0.46	0.495	0.68	7.34	0.152	0.241	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	20th	6.86	10018	7.44	9772	6344	153	1592	15	2984	241	232.6	0.05	0.5	700.2	700.2	0.005	0.218	0.0005	0.0005	0.003	0.005	0.432	0.468	0.142	1.794	0.1282	0.187	5E-05	5E-05	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB2S	Regolith	80th	7.20	10470	7.93	10300	6644	175	1720	16	3260	259.8	266.8	0.05	0.5	778.4	778.4	0.005	7.924	0.0005	0.0005	0.006	0.012	0.484	0.522	0.844	14.44	0.1786	0.3026	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
WSMB3S	Regolith	count	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	NC	NC	9	9	NC	NC	9	9	NC	NC	NC	NC	9	9	NC	9	NC	NC	9	9
WSMB3S	Regolith	mini	6.3	6853	6.81	6440	4190	280	854	12	2270	169	66	0.4	0.5	150	150	0.005	0.29	NC	NC	0.0005	0.0005	NC	NC	0.025	0.49	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	max	6.67	7503	8.01	7250	4710	310	949	12	2410	184	81	0.4	0.5	193	193	0.005	25.5	NC	NC	0.001	0.003	NC	NC	0.025	46.6	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	median	6.42	7159	7.39	7010	4560	290	888	12	2350	181	72	0.4	0.5	161	161	0.005	5.21	NC	NC	0.0005	0.0005	NC	NC	0.025	10.2	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	20th	6.37	7105	7.004	6718	4366	286.4	874.8	12	2324	176.6	70	0.4	0.5	153.6	153.6	0.005	1.548	NC	NC	0.0005	0.0005	NC	NC	0.025	2.664	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
WSMB3S	Regolith	80th	6.486	7280.4	7.66	7120	4628	304.4	919.6	12	2400	182	74.4	0.4	0.5	178	178	0.005	14.52	NC	NC	0.0005	0.0024	NC	NC	0.025	27.5	NC	NC	NC	NC	0.0005	0.0005	NC	0.005	NC	NC	50	10
Jamar Bore	Rewan	count	29	29	36	36	13	36	36	36	36	36	10	13	36	36	33	33	NC	29	26	33	30	15	14	36	28	30	26	27	26	33	30	30	30	27	26	26	26
Jamar Bore	Rewan	mini	6.60	764	6.95	1300	2520	30	112	5	200	47	1	0.05	0.5	105	105	0.005	NC	0.0005	0.0005	0.001	0.002	0.26	0.3	0.025	0.05	0.103	0.198	0.00005	0.00005	0.0005	0.0005	0.0003	0.005	0.0005	0.0005	50	10
Jamar Bore	Rewan	max	8.24	4770	8.32	4430	2880	94	770	15	1400	80	3	0.2	4	397	397	0.04	NC	0.001	0.001	0.041	0.042	0.36	0.37	6.75	4.49	0.515	0.357	0.0001	0.0001	0.002	0.001	0.1	0.01	0.001	0.001	50	10
Jamar Bore	Rewan	median	7.53	4091	7.88	3990	2630	77.5	635	5.5	1225	64	1	0.1	0.5	122.5	122	0.005	NC	0.0005	0.0005	0.007	0.007	0.31	0.33	0.175	0.39	0.2545	0.2625	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Jamar Bore	Rewan	20th	7.17	4008	7.70	3880	2548	70	596	5	1140	61	1	0.1	0.5	112	111.4	0.005	NC	0.0005	0.0005	0.003	0.004	0.288	0.316	0.05	0.2	0.2108	0.23	5E-05	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Jamar Bore	Rewan	80th	7.85	4272	8.02	4170	2726	82	655	6	1290	69	1	0.1	1	137	135.4	0.008	NC	0.0007	0.0005	0.008	0.008	0.326	0.36	0.6	0.72	0.3068	0.282	0.00005	0.00005	0.0005	0.0005	0.01	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	count	33	33	42	42	17	42	42	42	42	42	42	17	42	42	37	37	16	33	30	37	34	19	18	42	34	34	30	31	30	37	34	34	34	31	30	30	30
Winton Creek Bore	Rewan	mini	7.35	3980	7.56	5760	4890	72	1060	5	1610	43	1	0.2	0.5	193	193	0.005	0.02	0.0005	0.0005	0.0005	0.0005	0.39	0.37	0.025	0.12	0.142	0.16	0.00005	0.00005	0.0005	0.0005	0.0004	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	max	8.15	9228	8.35	9180	5970	219	1530	12	3040	139	147	0.4	9	381	381	0.01	0.18	0.001	0.001	0.003	0.003	0.5	0.54	0.53	1.66	0.322	0.331	0.0001	0.0001	0.001	0.001	0.01	0.01	0.001	0.001	110	10
Winton Creek Bore	Rewan	median	7.7	7500	7.86	7520	5220	109	1345	8	2405	66.5	34.5	0.3	0.5	249	254	0.005	0.04	0.0005	0.0005	0.0005	0.0005	0.45	0.475	0.125	0.355	0.191	0.2015	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	20th	7.518	7010	7.734	6896	5046	97.2	1226	7	2130	54	17	0.3	0.5	226	226	0.005	0.03	0.0005	0.0005	0.0005	0.0005	0.416	0.45	0.03	0.21	0.1672	0.184	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10
Winton Creek Bore	Rewan	80th	7.816	8362	8.09	8038	5570	153.2	1428	9	2616	92.8	88.6	0.3	1	284	284.8	0.005	0.06	0.0005	0.0005	0.001	0.001	0.464	0.5	0.2	0.884	0.2448	0.261	0.00005	0.00005	0.0005	0.0005	0.005	0.005	0.0005	0.0005	50	10

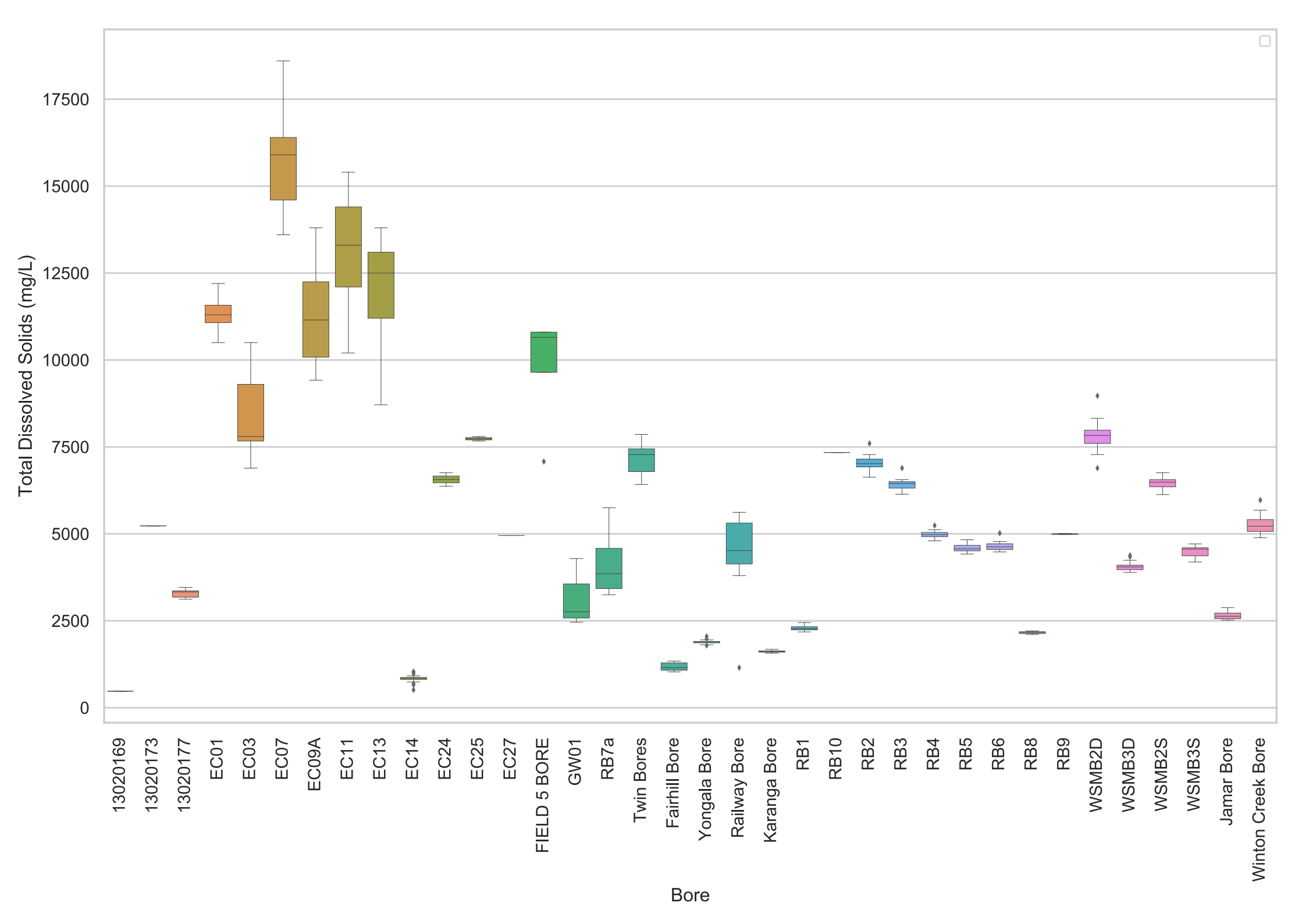
NC = Not Calculated (less than 4 data points)

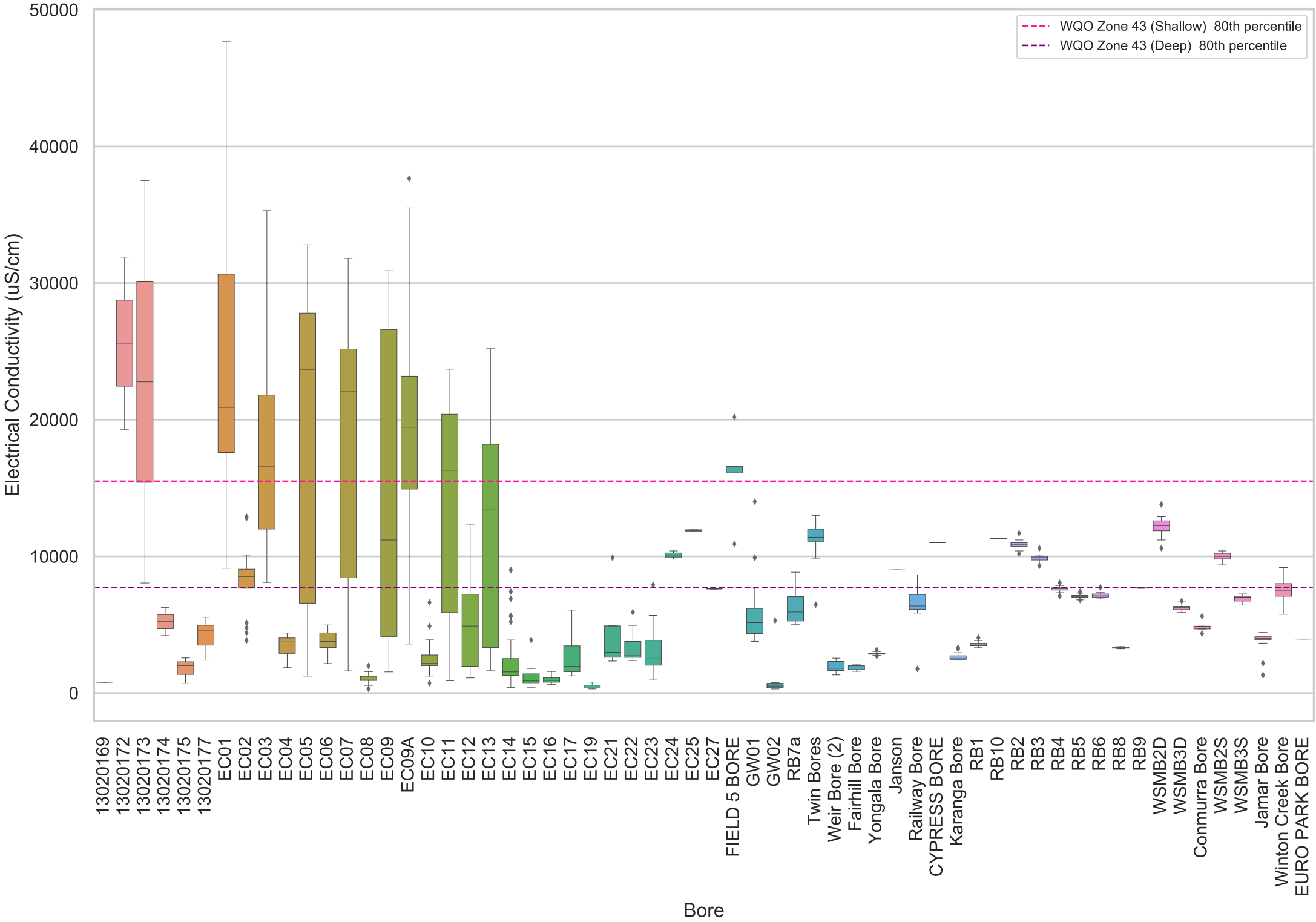
APPENDIX C

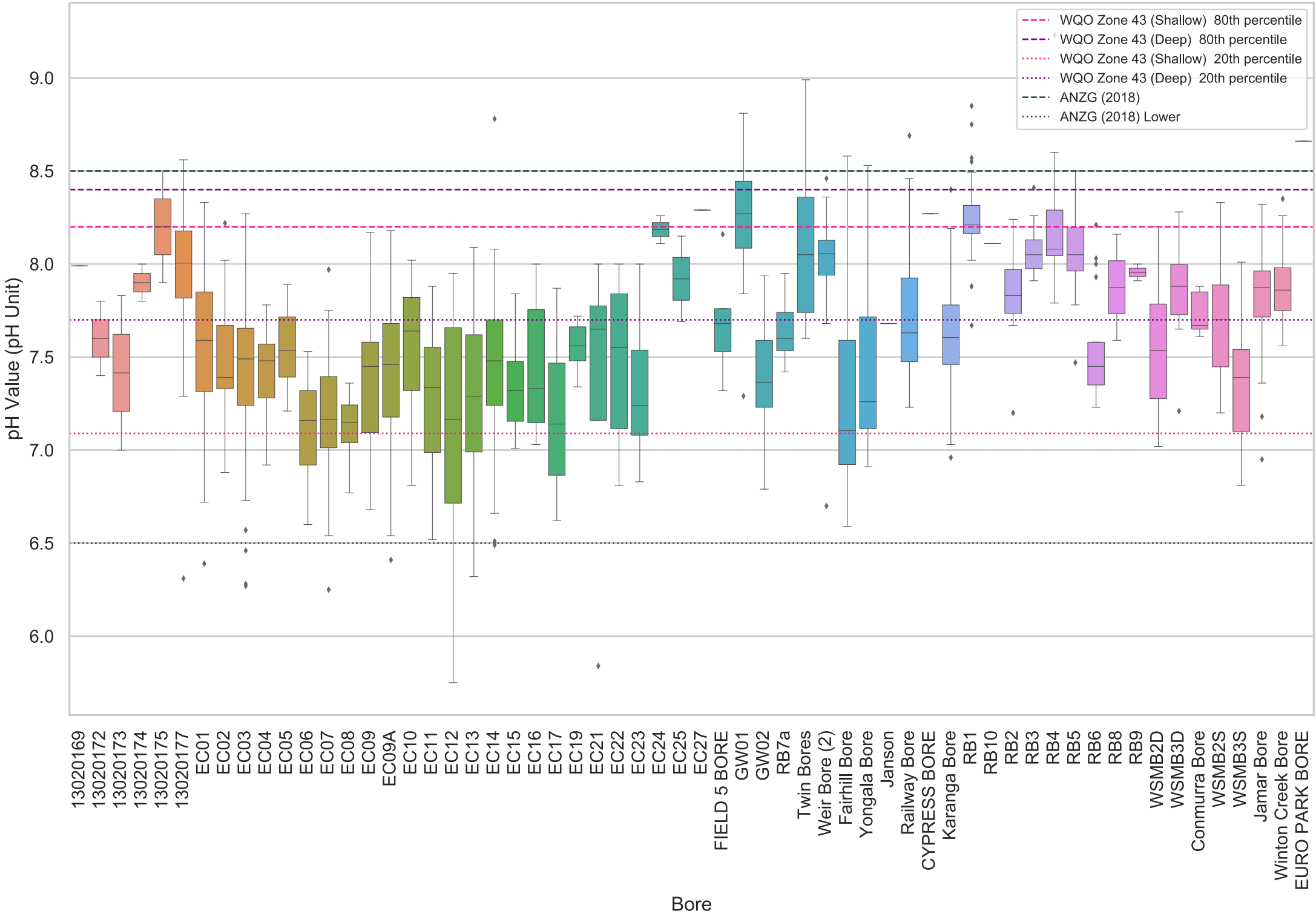
Water quality compared to regional and national guidelines - boxplots

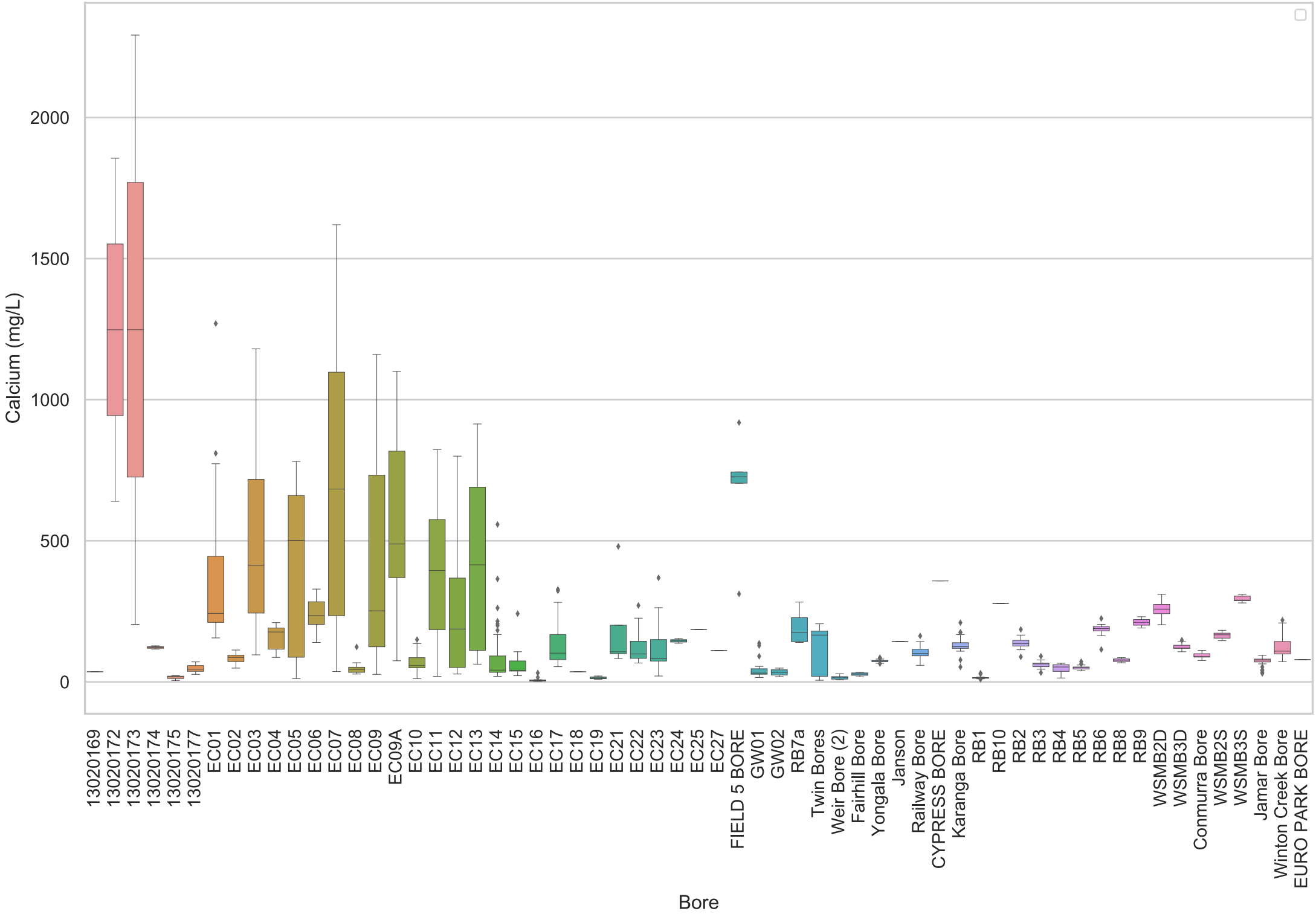

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Field Electrical Conductivity (uS/cm)
40000
35000
30000
25000
20000
15000
10000
5000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

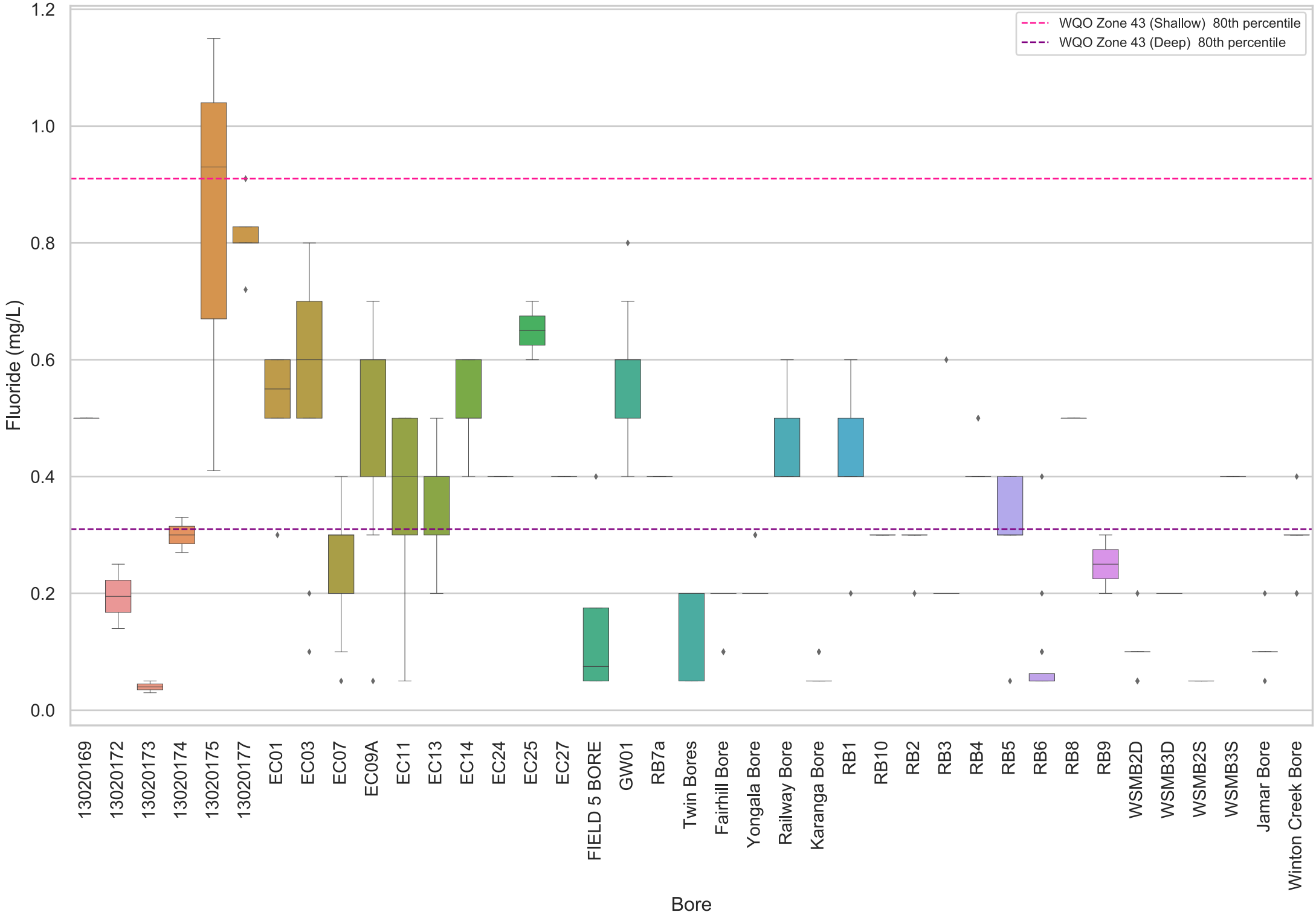

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
WQO Zone 43 (Shallow) 20th percentile
WQO Zone 43 (Deep) 20th percentile
ANZG (2018)
ANZG (2018) Lower
Field pH (pH Unit)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
13020169
13020172
13020173
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

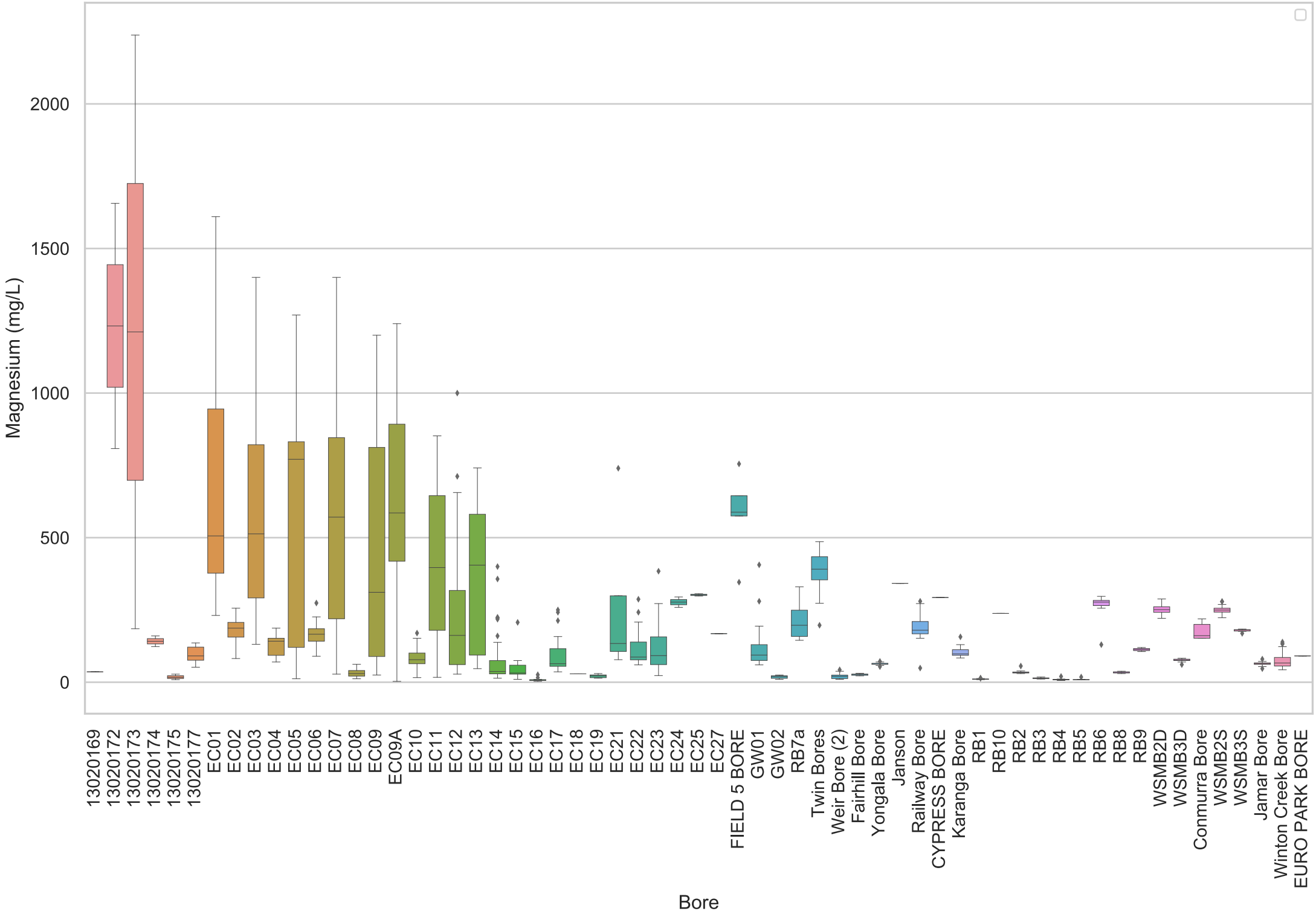

Total Dissolved Solids (mg/L)
0
2500
5000
7500
10000
12500
15000
17500
13020169
13020173
13020177
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
EC24
EC25
EC27
FIELD 5 BORE
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

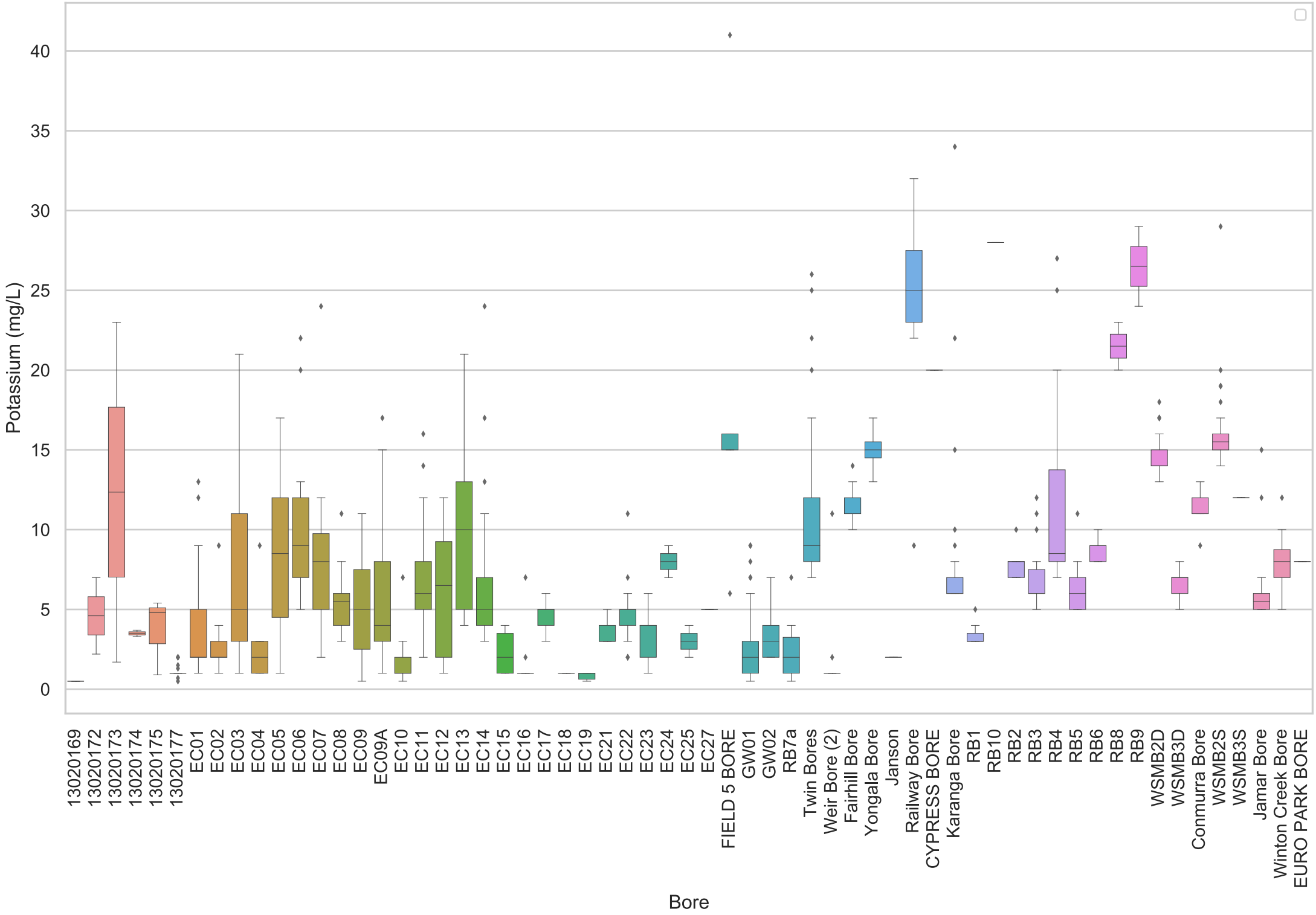

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Electrical Conductivity (uS/cm)
50000
40000
30000
20000
10000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

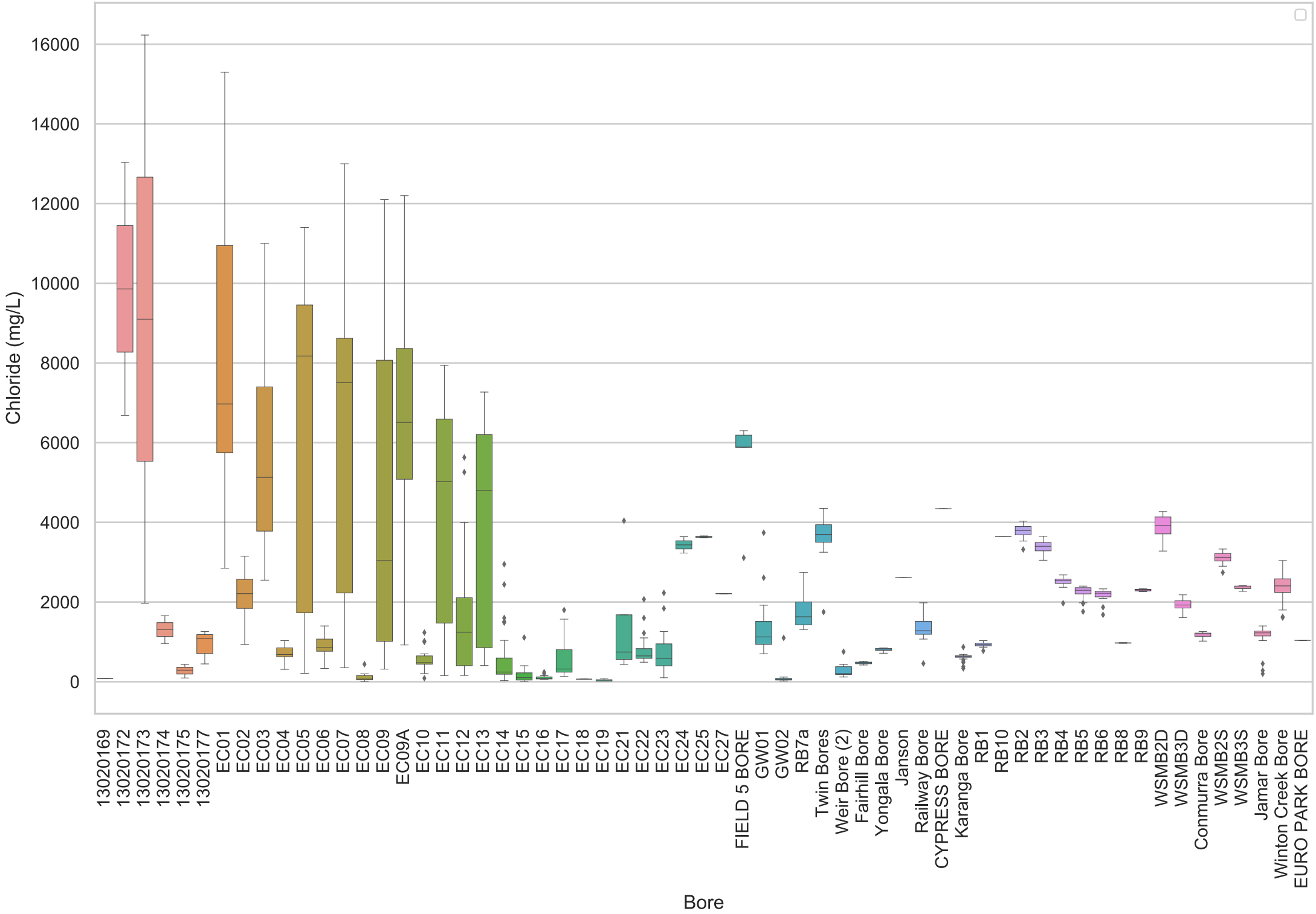

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
WQO Zone 43 (Shallow) 20th percentile
WQO Zone 43 (Deep) 20th percentile
ANZG (2018)
ANZG (2018) Lower
pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

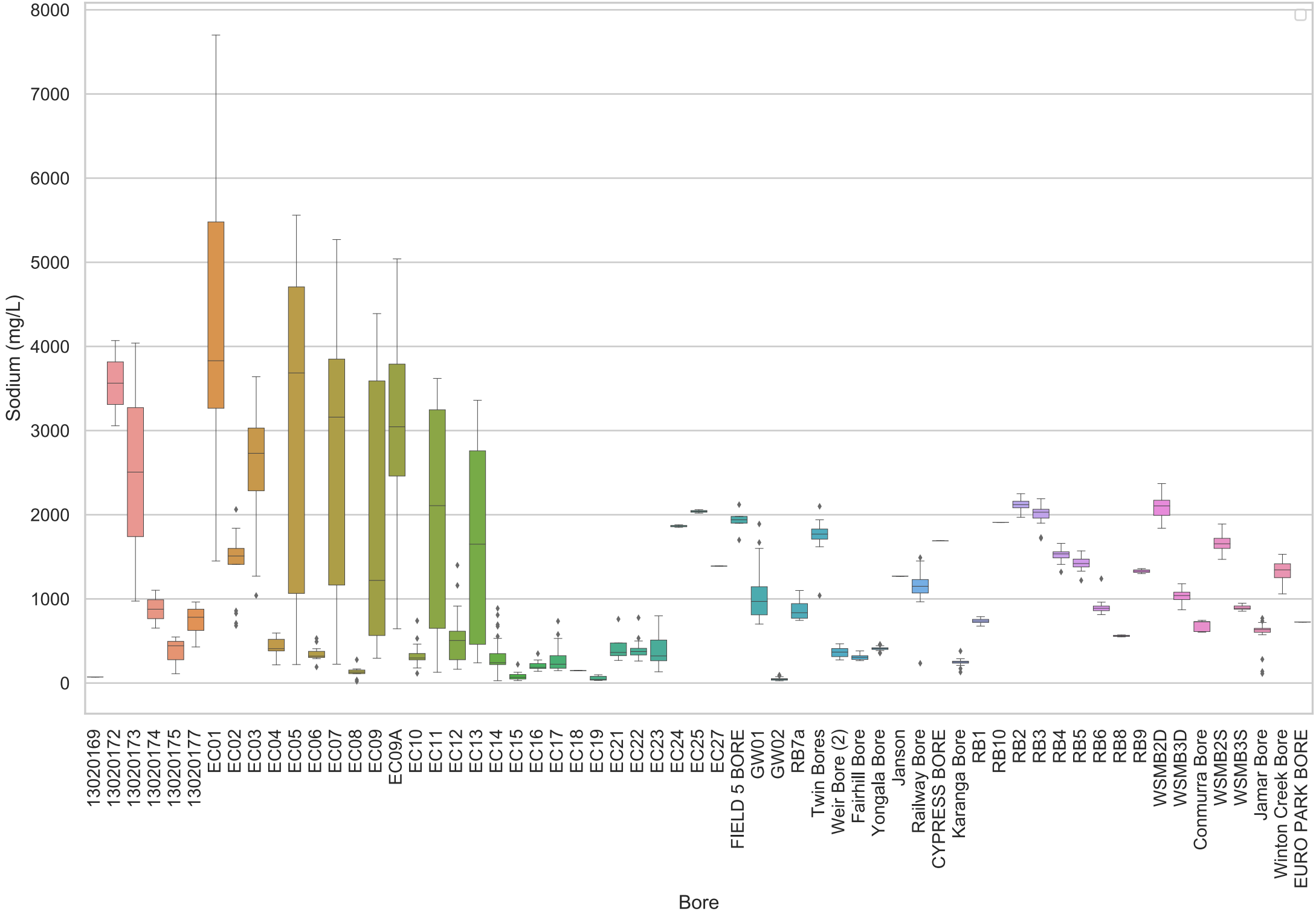

Calcium (mg/L)
0
500
1000
1500
2000
Bore
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

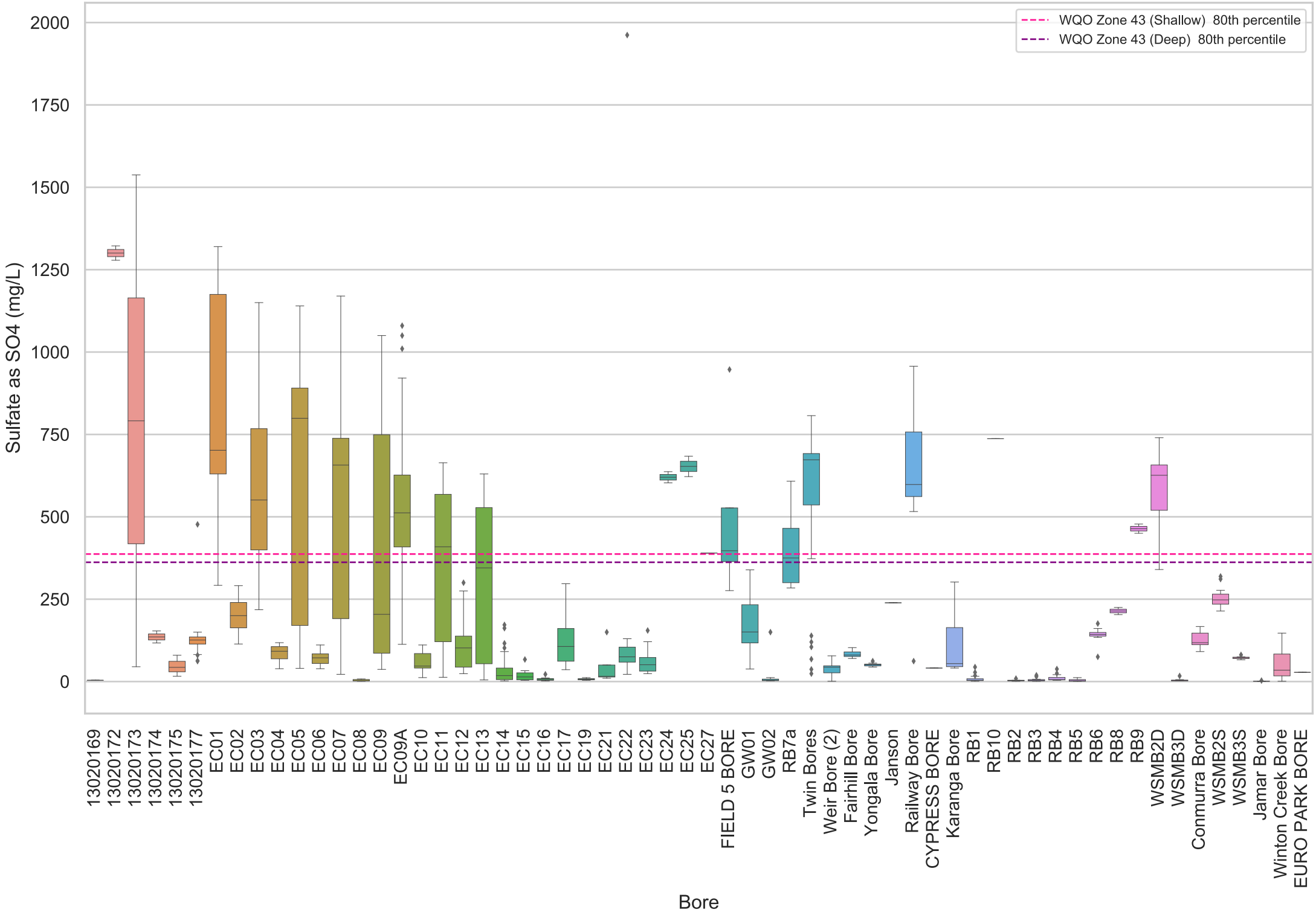

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Fluoride (mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
EC24
EC25
EC27
FIELD 5 BORE
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

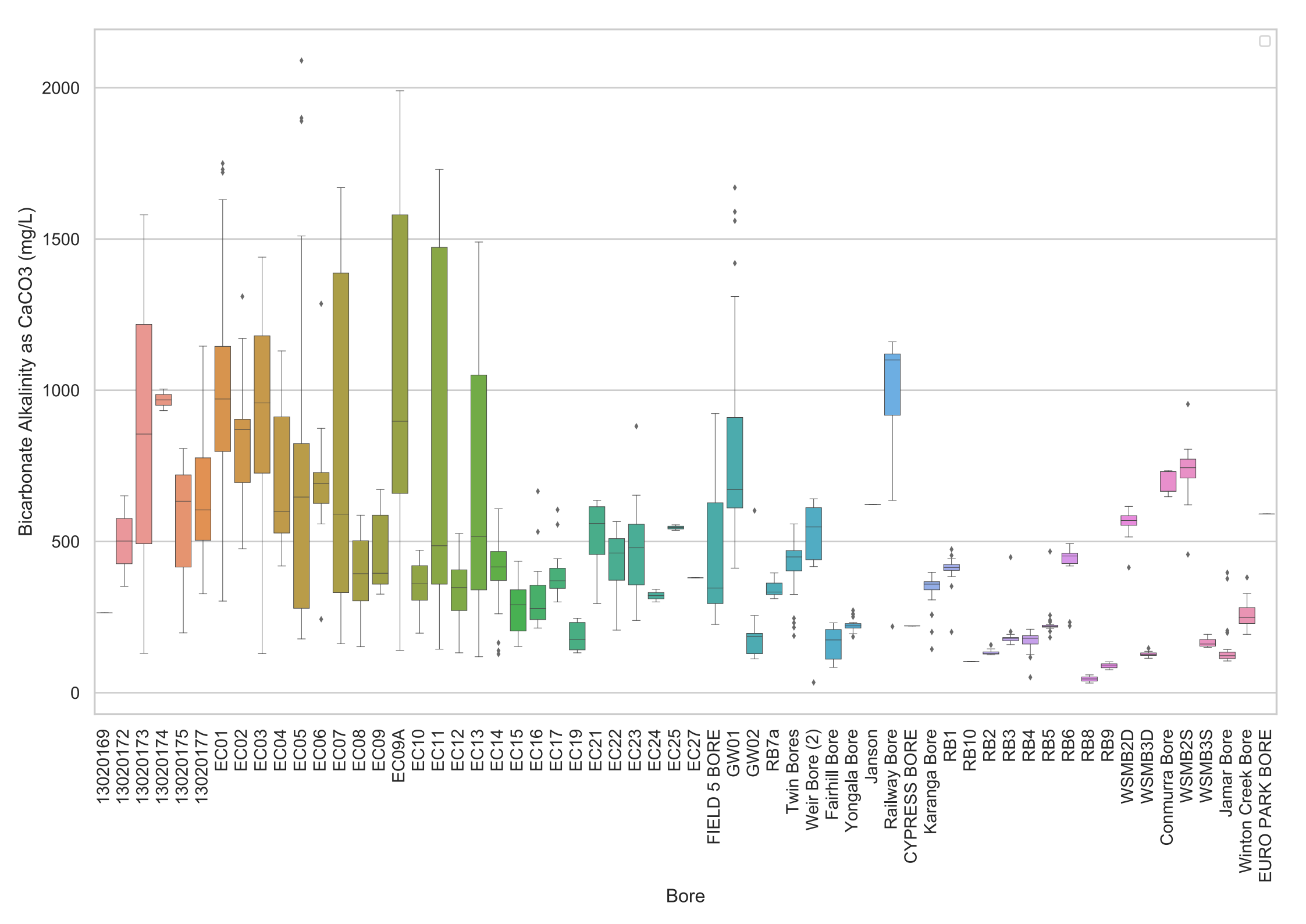

Magnesium (mg/L)
2000
1500
1000
500
0
Bore
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

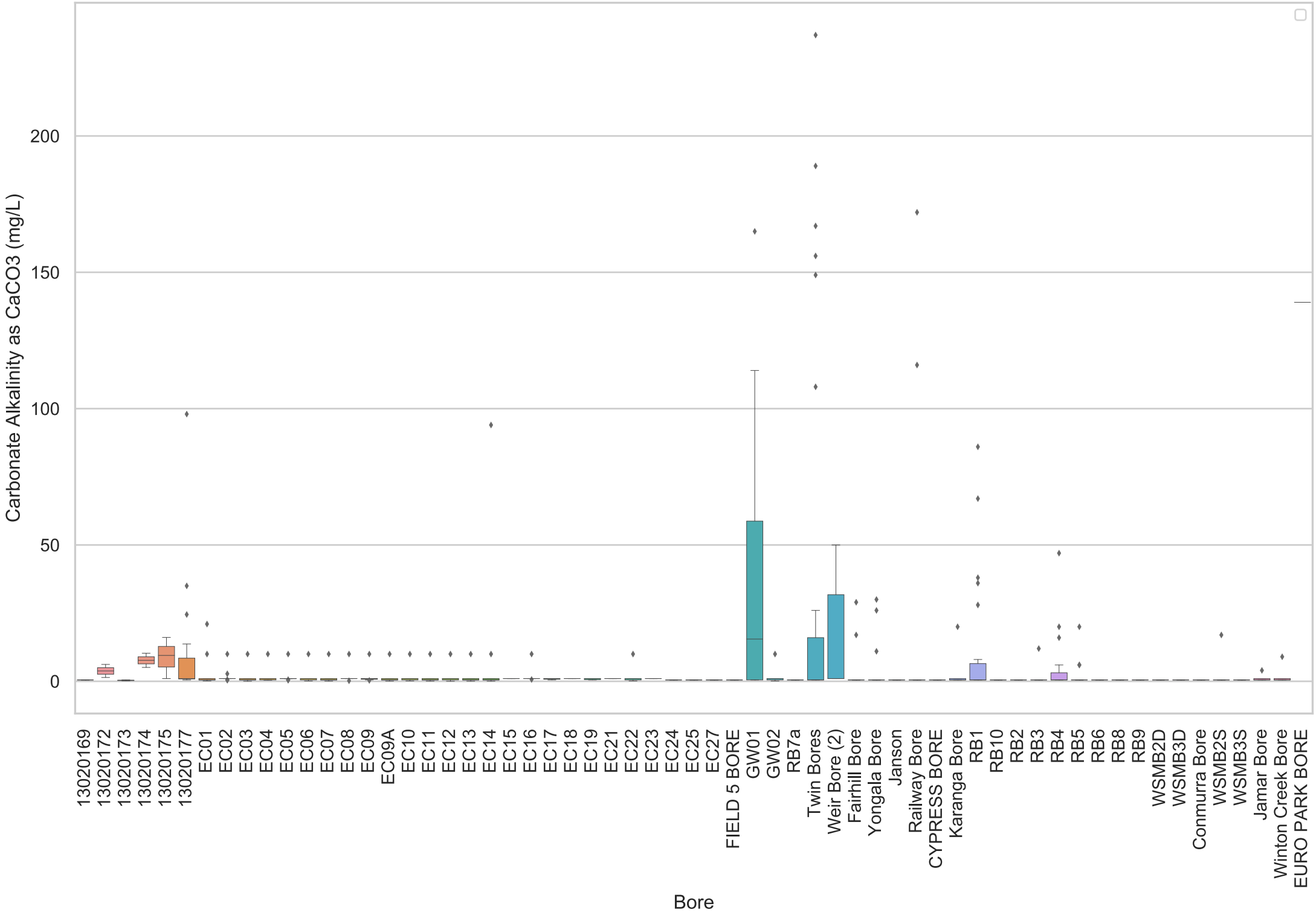

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
Bore
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

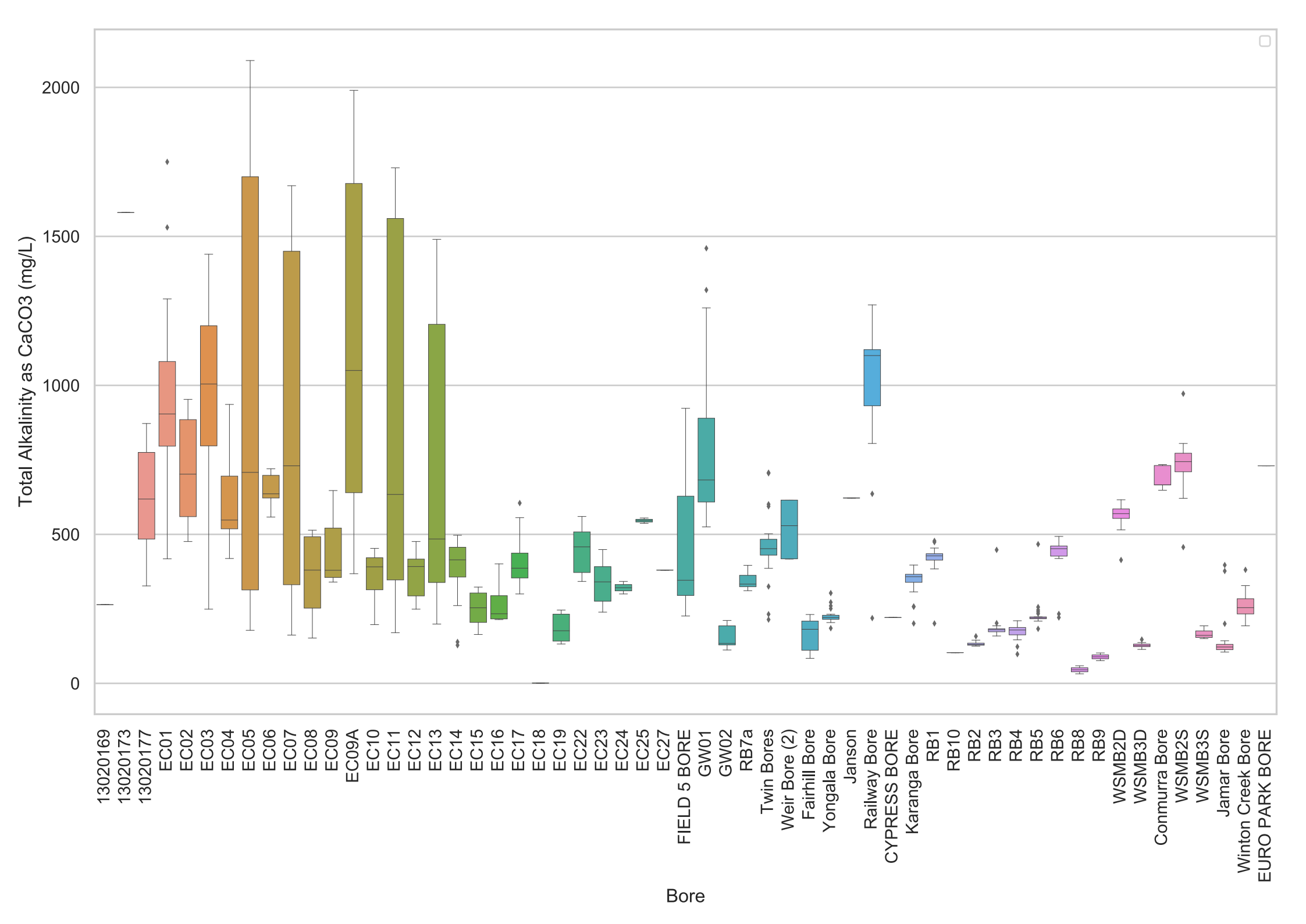

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

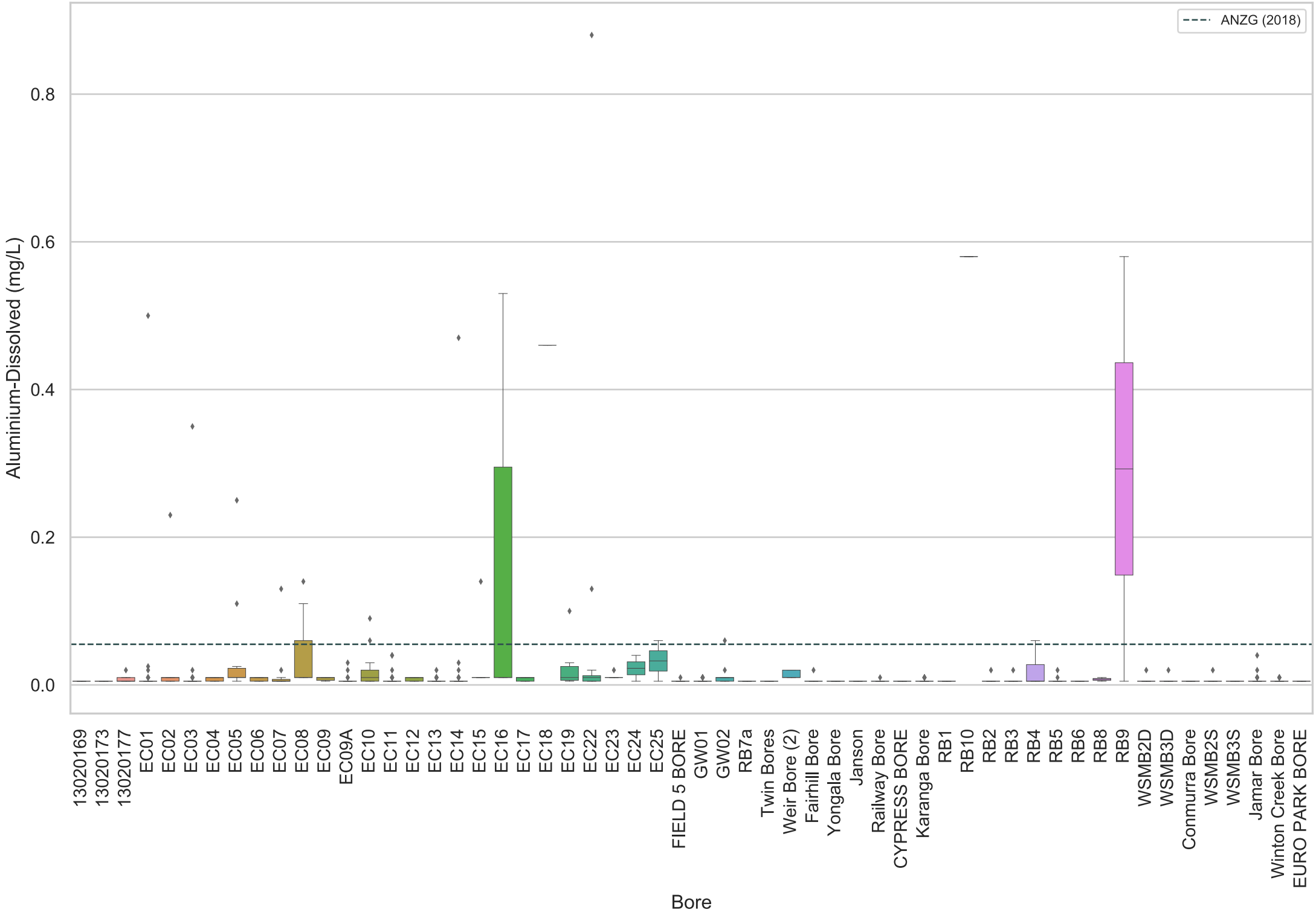

Sodium (mg/L)
8000
7000
6000
5000
4000
3000
2000
1000
0
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

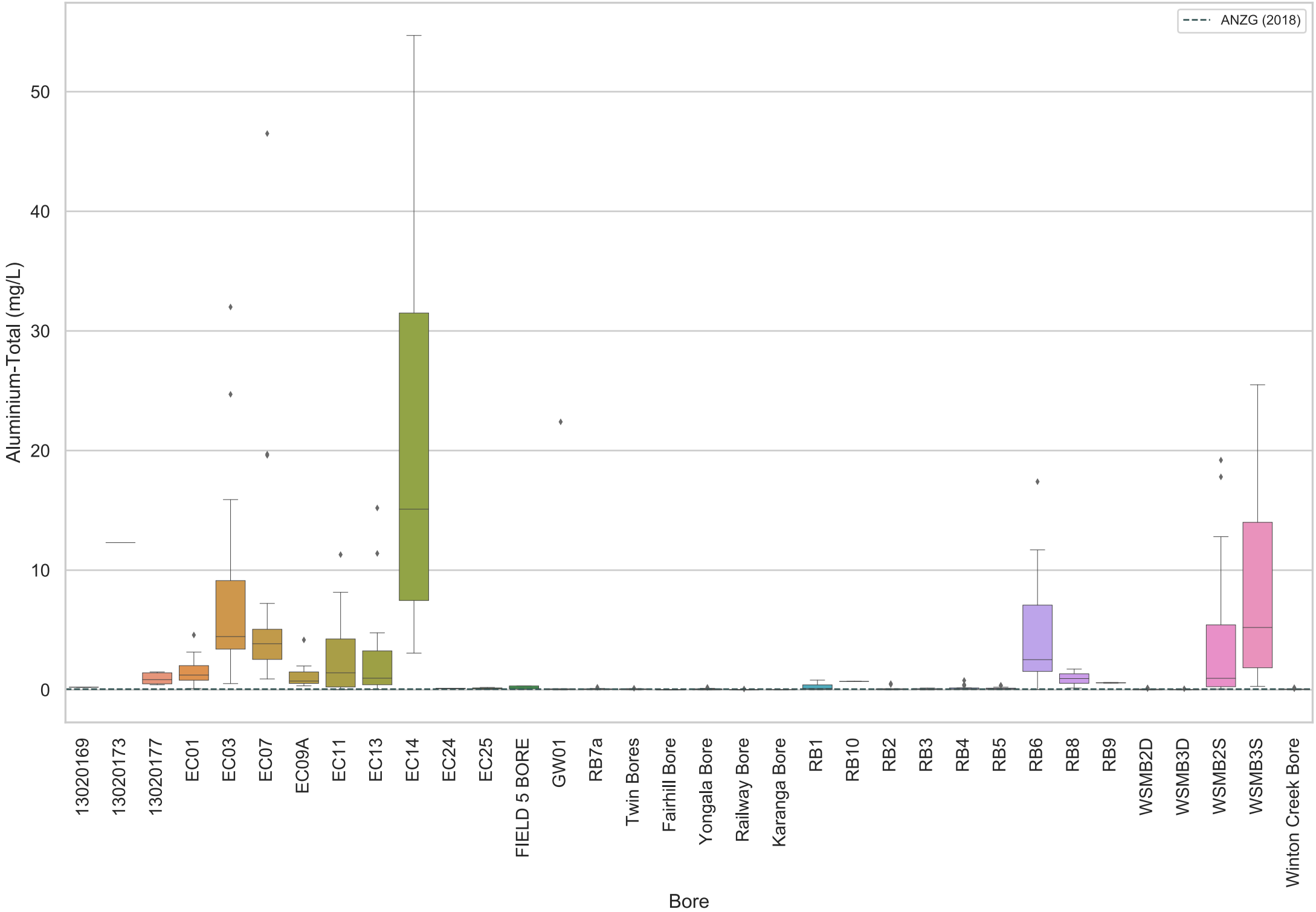

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Sulfate as SO4 (mg/L)
2000
1750
1500
1250
1000
750
500
250
0
Bore
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE


Bicarbonate Alkalinity as CaCO3 (mg/L)
0
500
1000
1500
2000
Bore
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

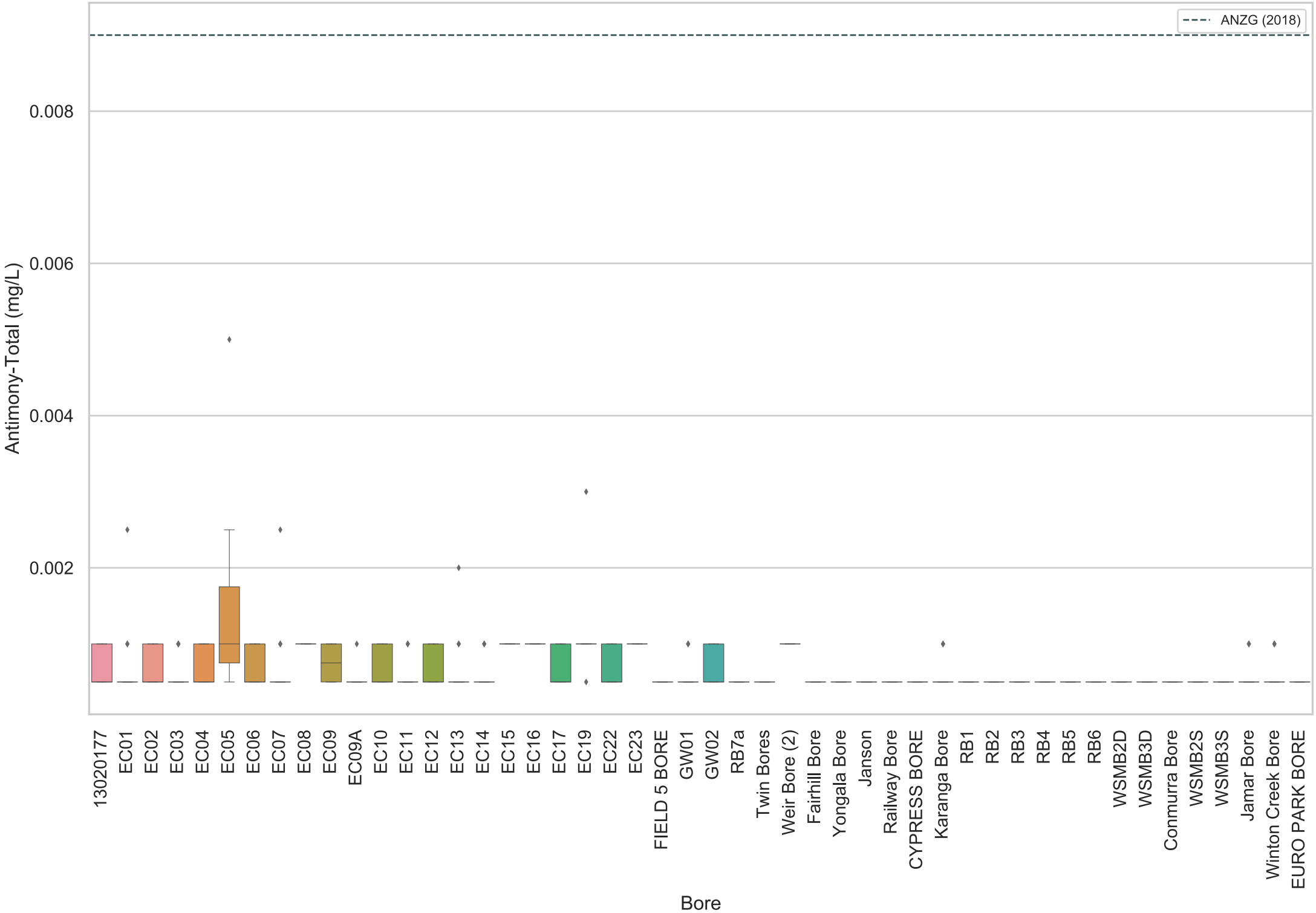

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
Bore
13020169
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

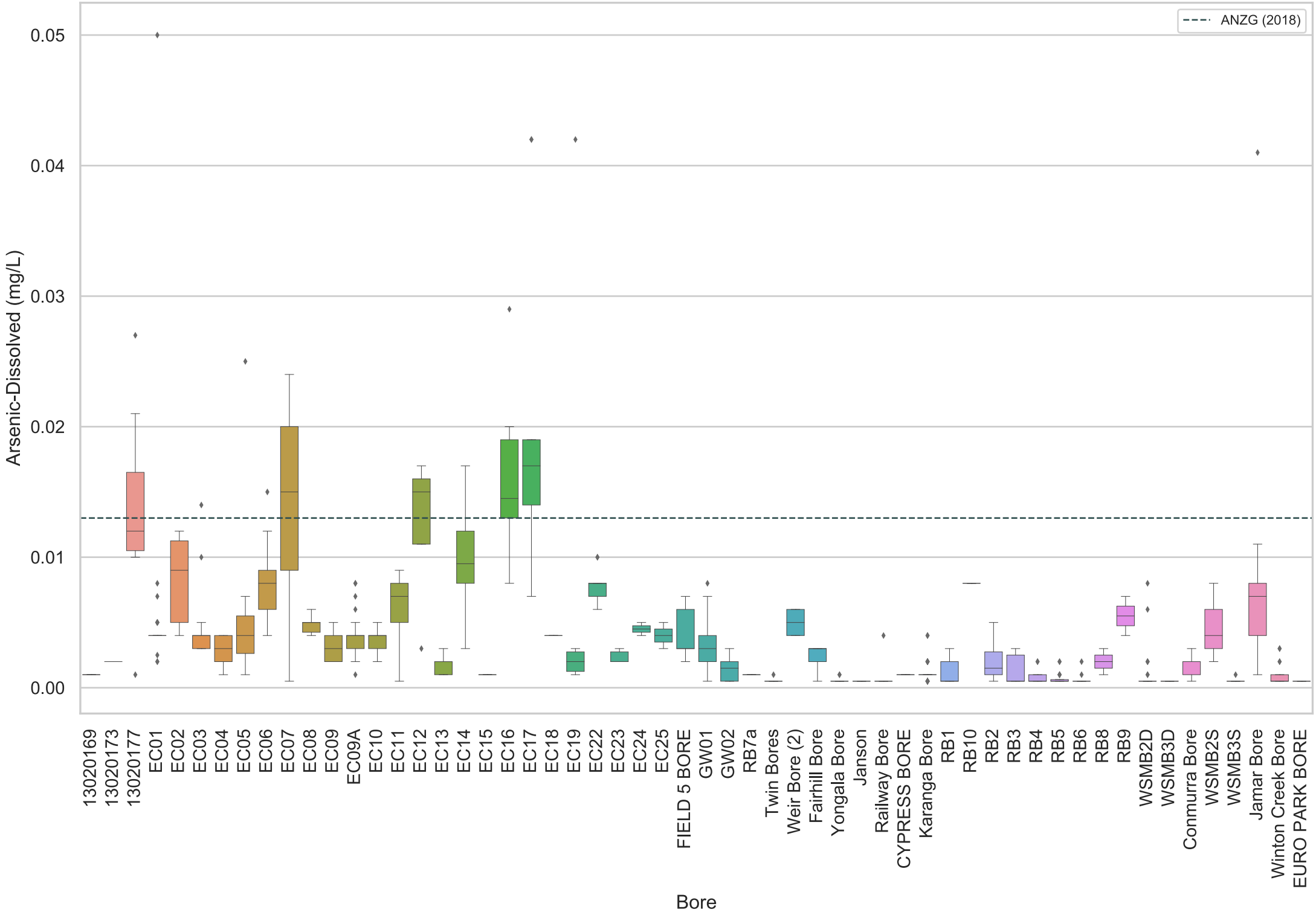

Total Alkalinity as CaCO3 (mg/L)
2000
1500
1000
500
0
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
EC27
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

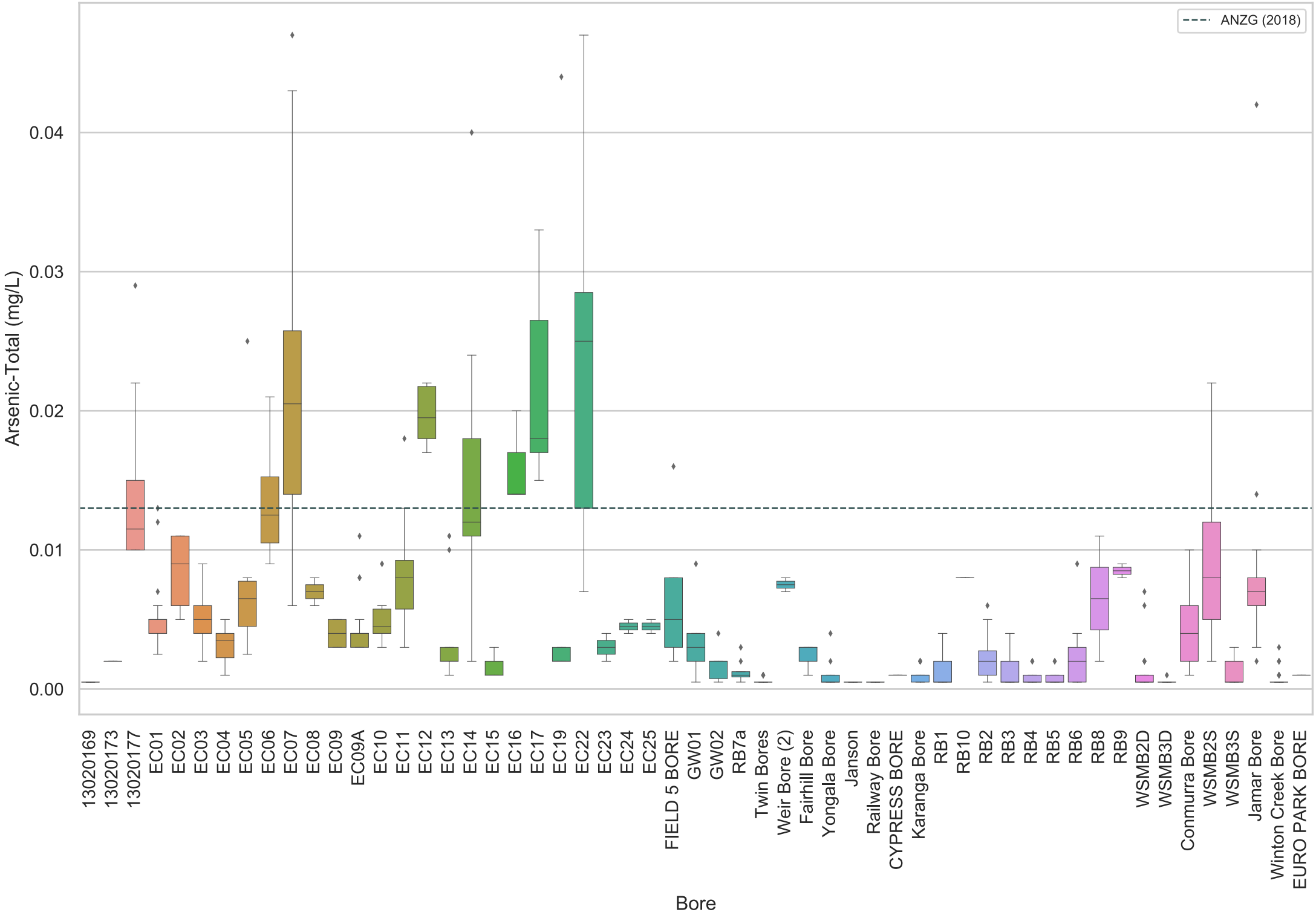

ANZG (2018)
Aluminium-Dissolved (mg/L)
0.0
0.2
0.4
0.6
0.8
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

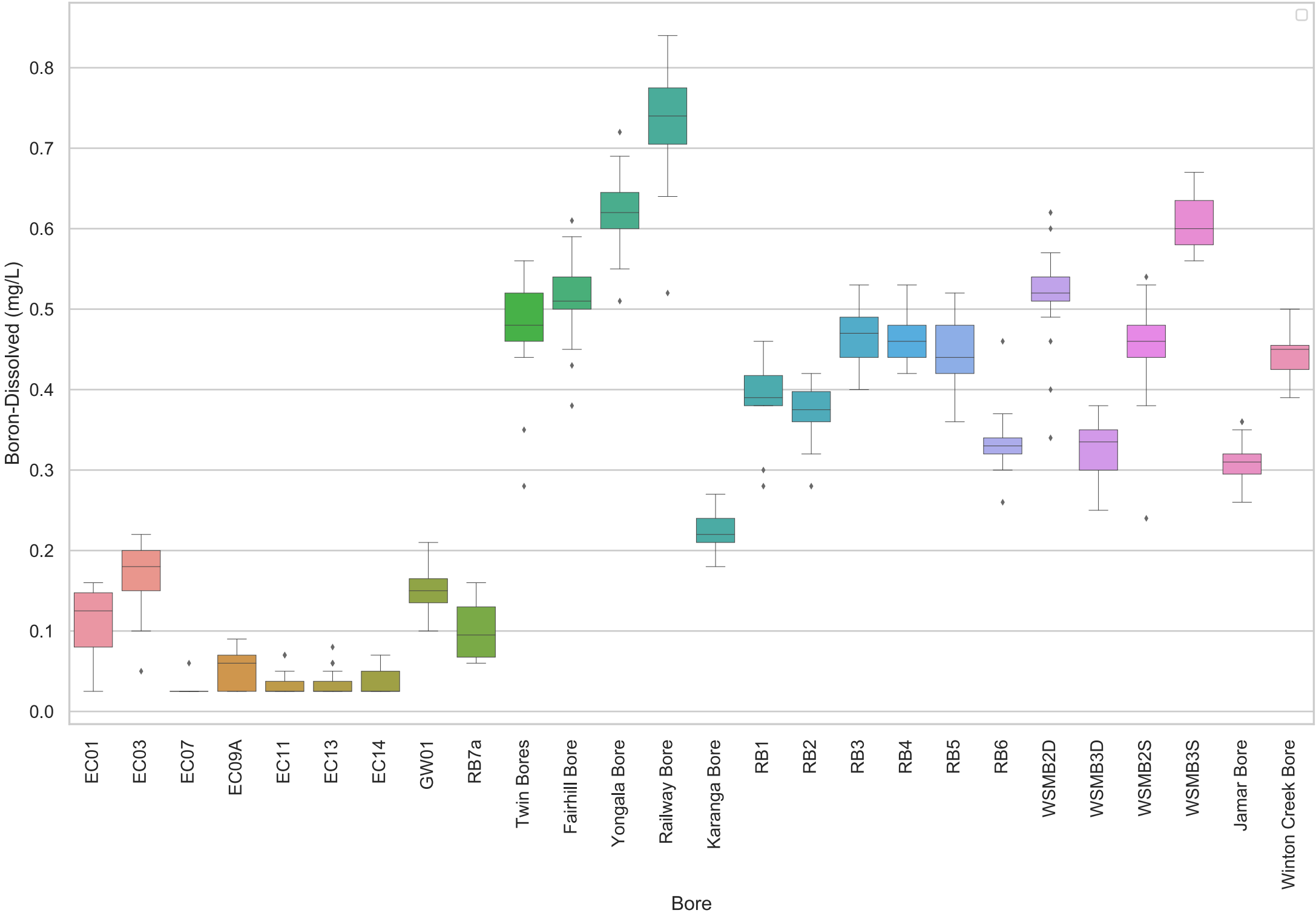

ANZG (2018)
Aluminium-Total (mg/L)
0
10
20
30
40
50
13020169
13020173
13020177
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
EC24
EC25
FIELD 5 BORE
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Winton Creek Bore
Bore

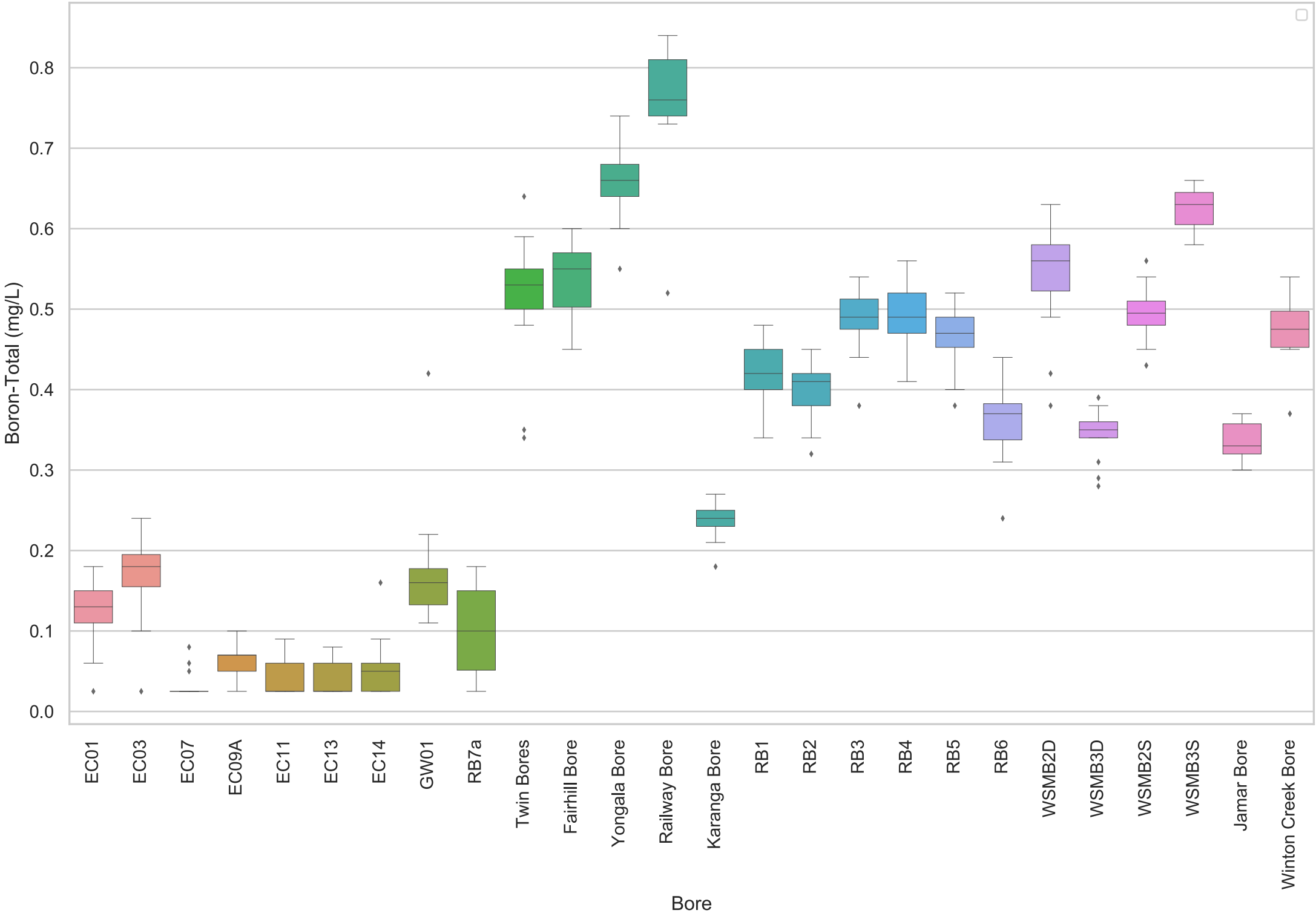
ANZG (2018)
0.008
0.006
0.004
0.002
Antimony-Dissolved (mg/L)
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

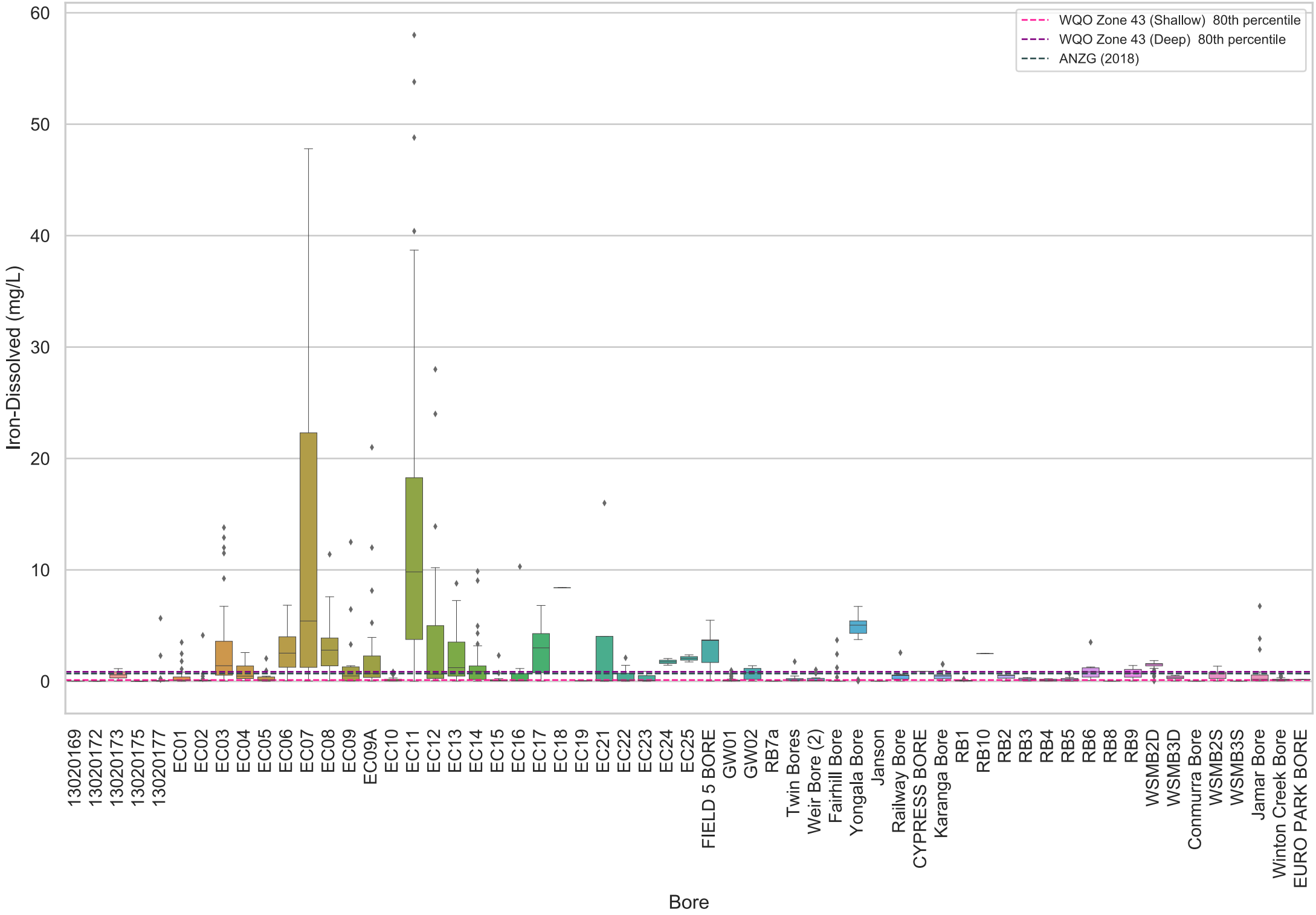

ANZG (2018)
Antimony-Total (mg/L)
0.008
0.006
0.004
0.002
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

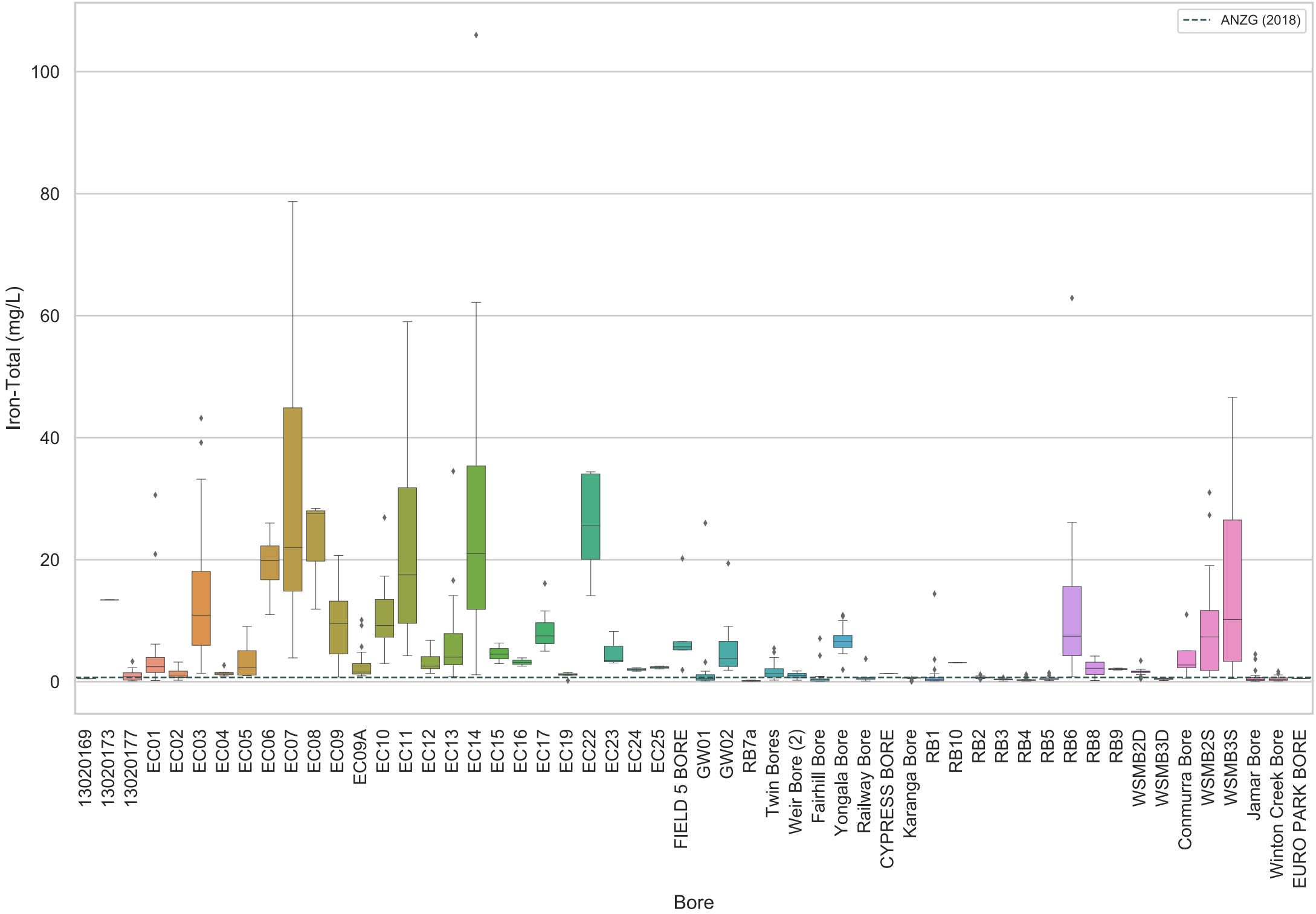

ANZG (2018)
Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

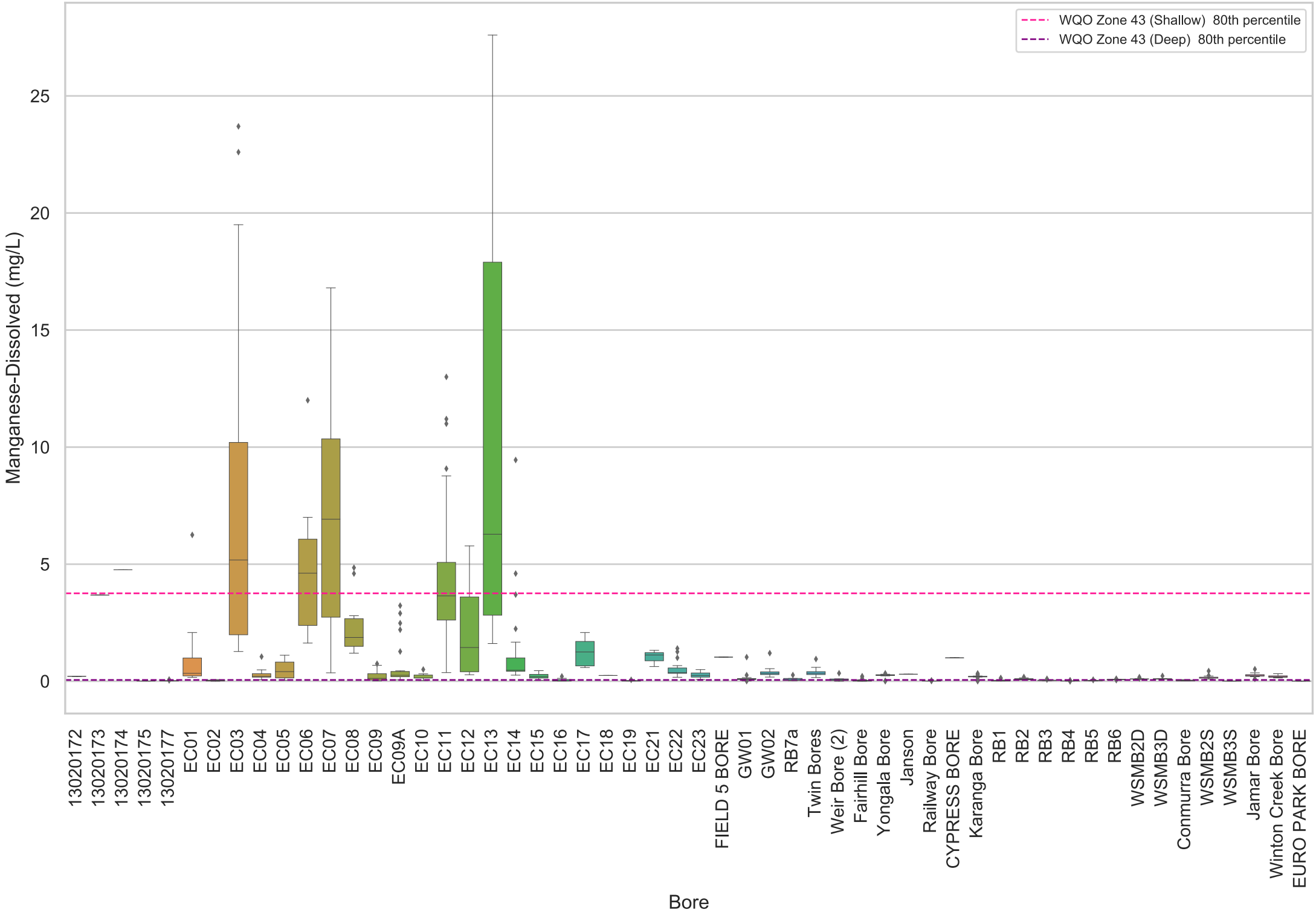

ANZG (2018)
Arsenic-Total (mg/L)
0.00
0.01
0.02
0.03
0.04
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

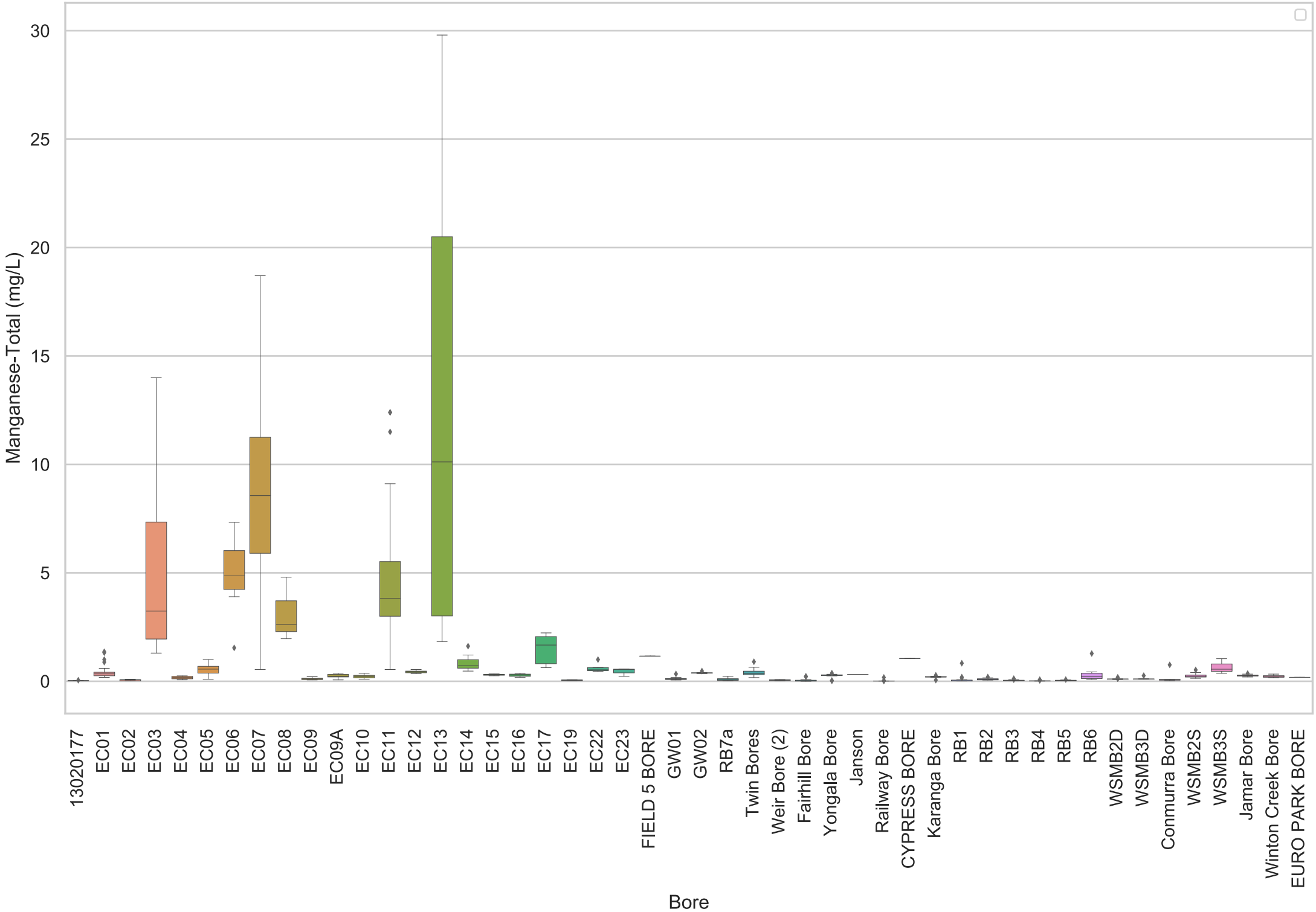

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

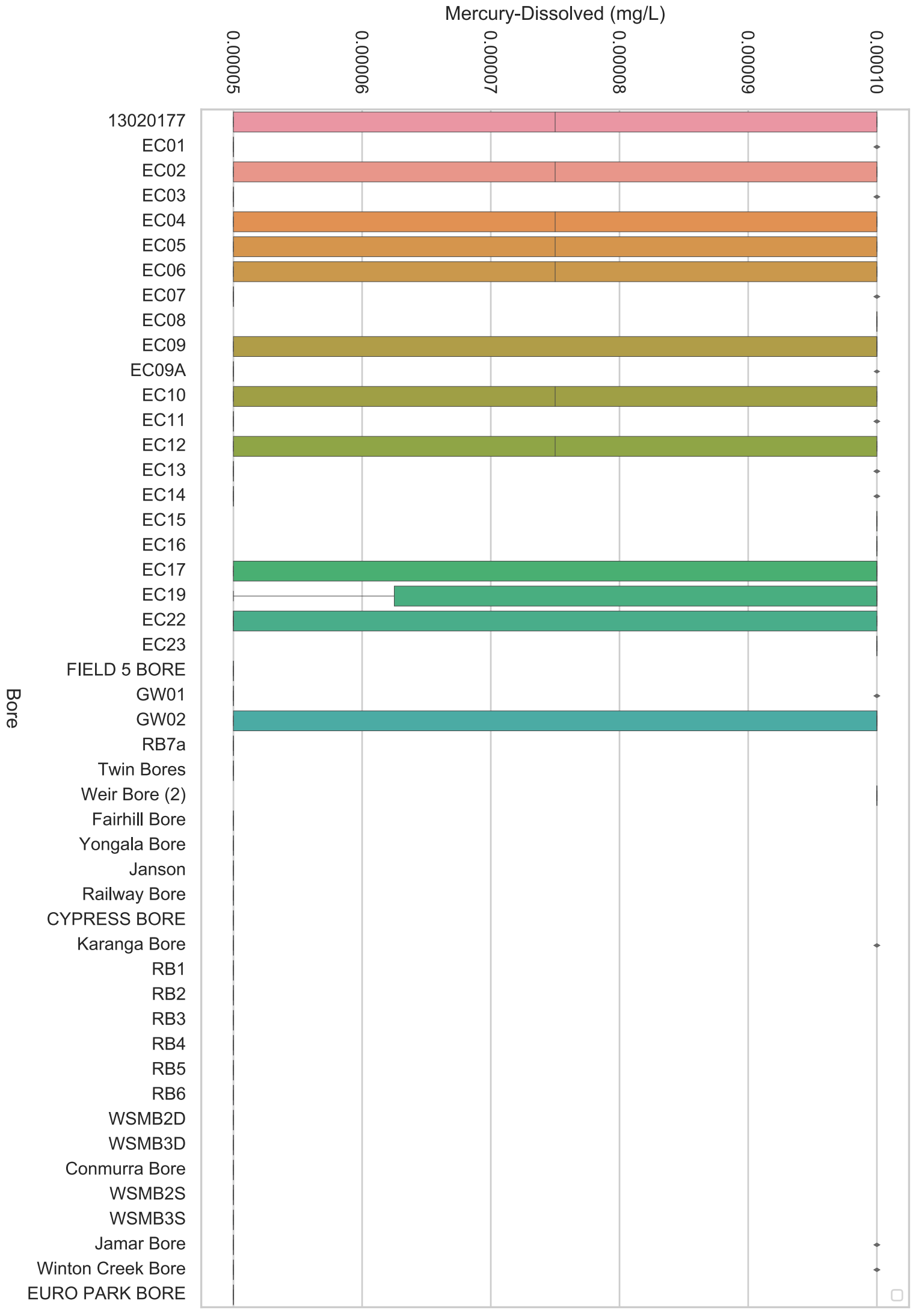

Boron-Total (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
EC01
EC03
EC07
EC09A
EC11
EC13
EC14
GW01
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Railway Bore
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

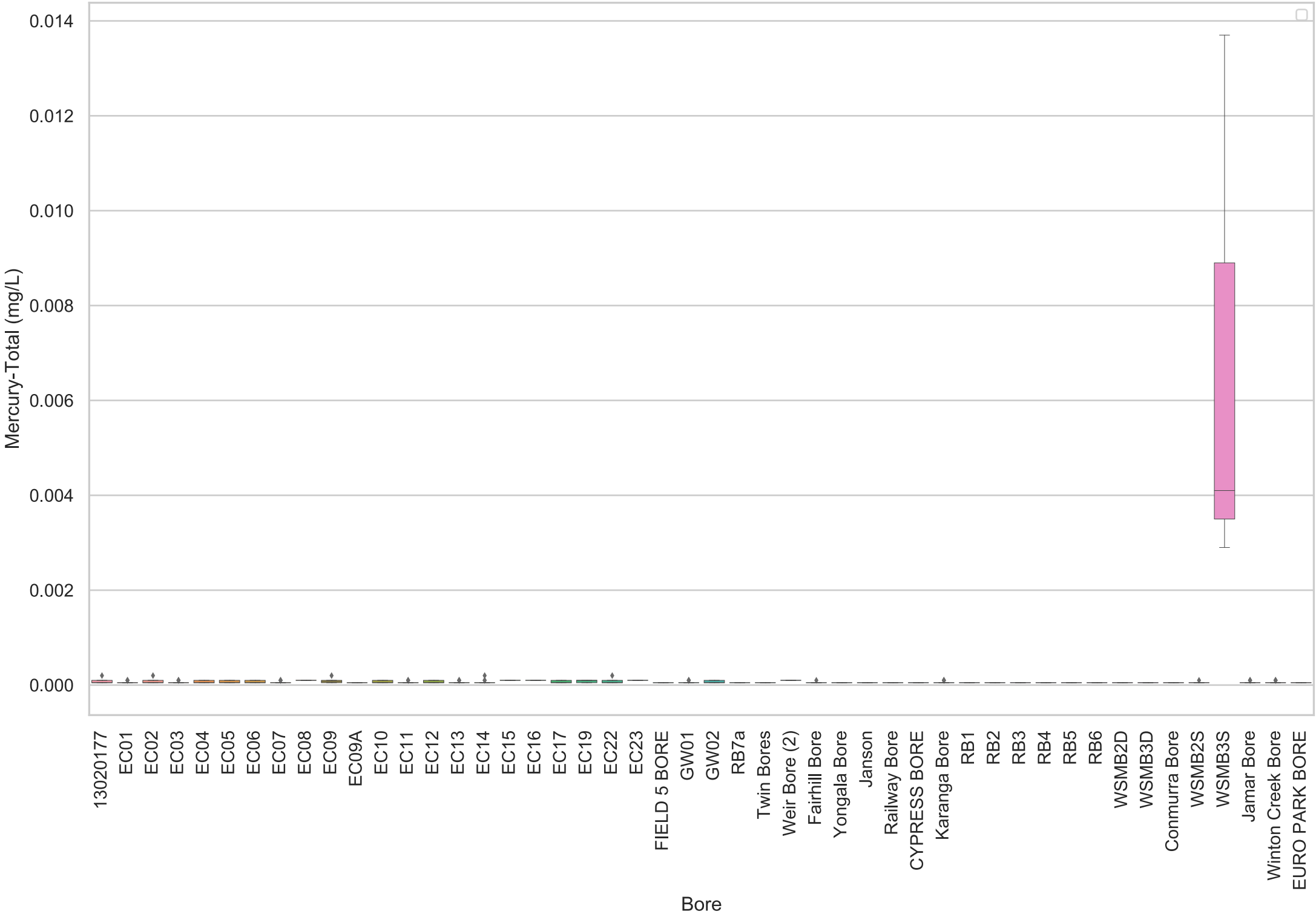

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
ANZG (2018)
Iron-Dissolved (mg/L)
60
50
40
30
20
10
0
13020169
13020172
13020173
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

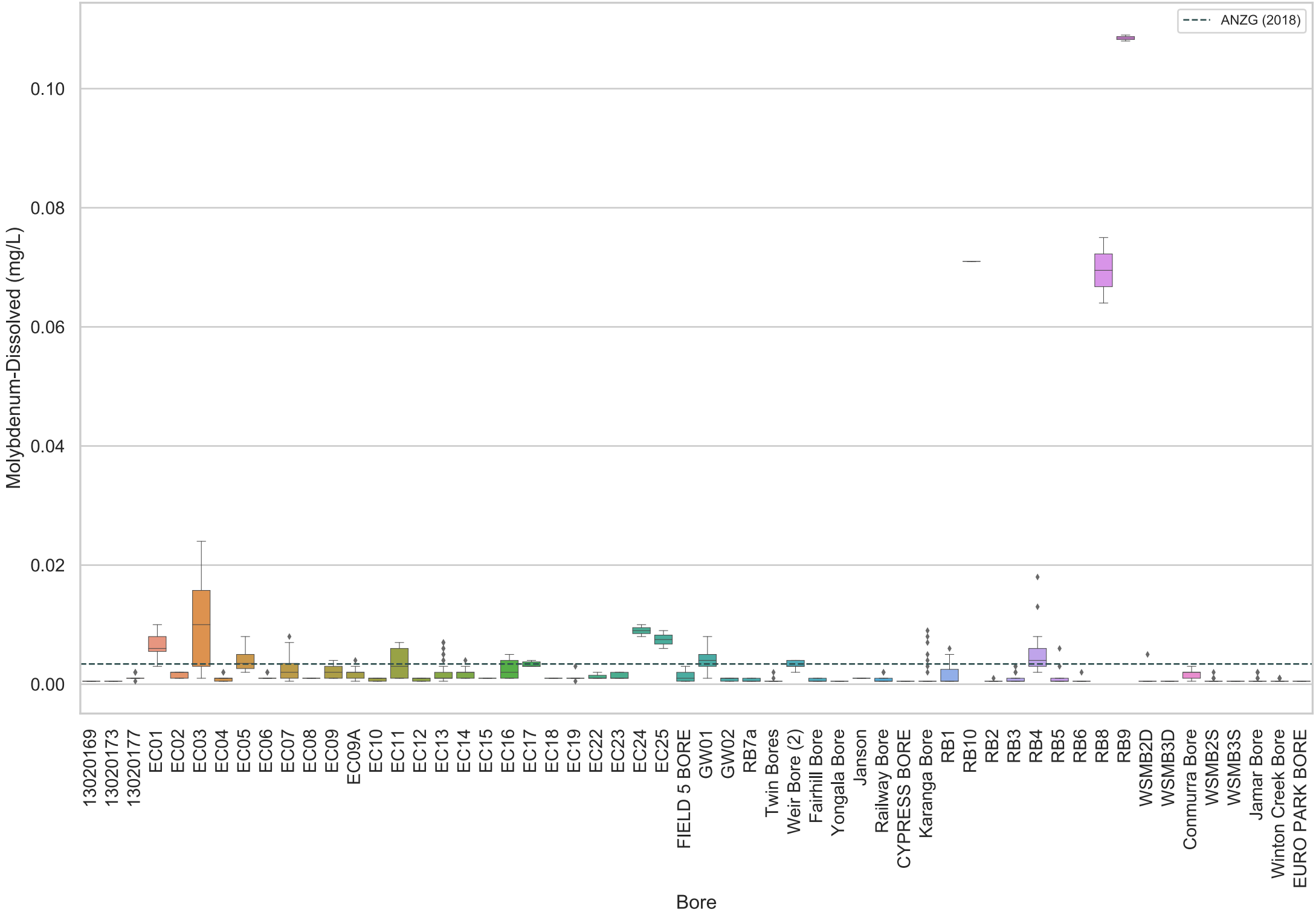

ANZG (2018)
Iron-Total (mg/L)
0
20
40
60
80
100
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

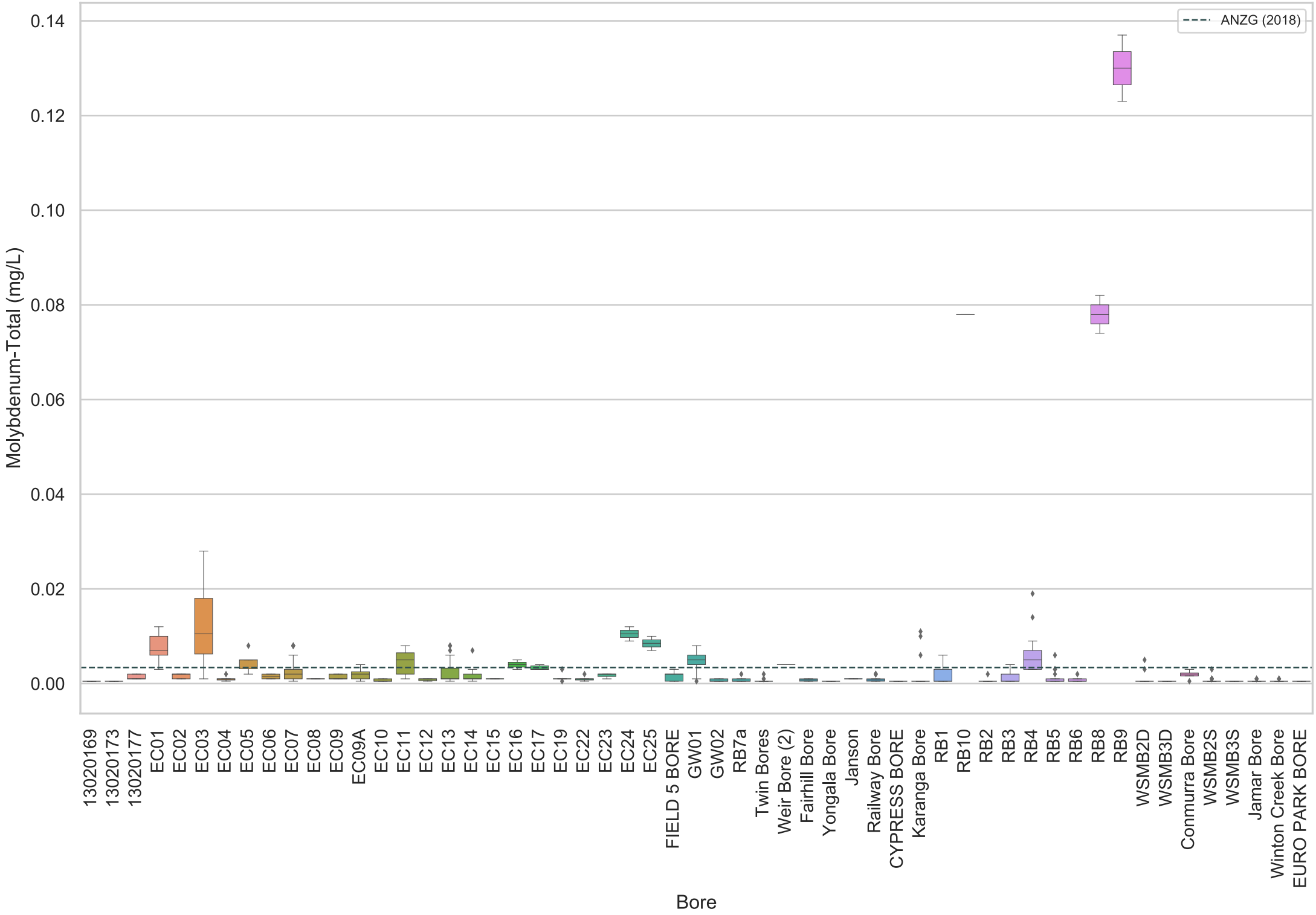

WQO Zone 43 (Shallow) 80th percentile
WQO Zone 43 (Deep) 80th percentile
Manganese-Dissolved (mg/L)
0
5
10
15
20
25
13020172
13020173
13020174
13020175
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC21
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

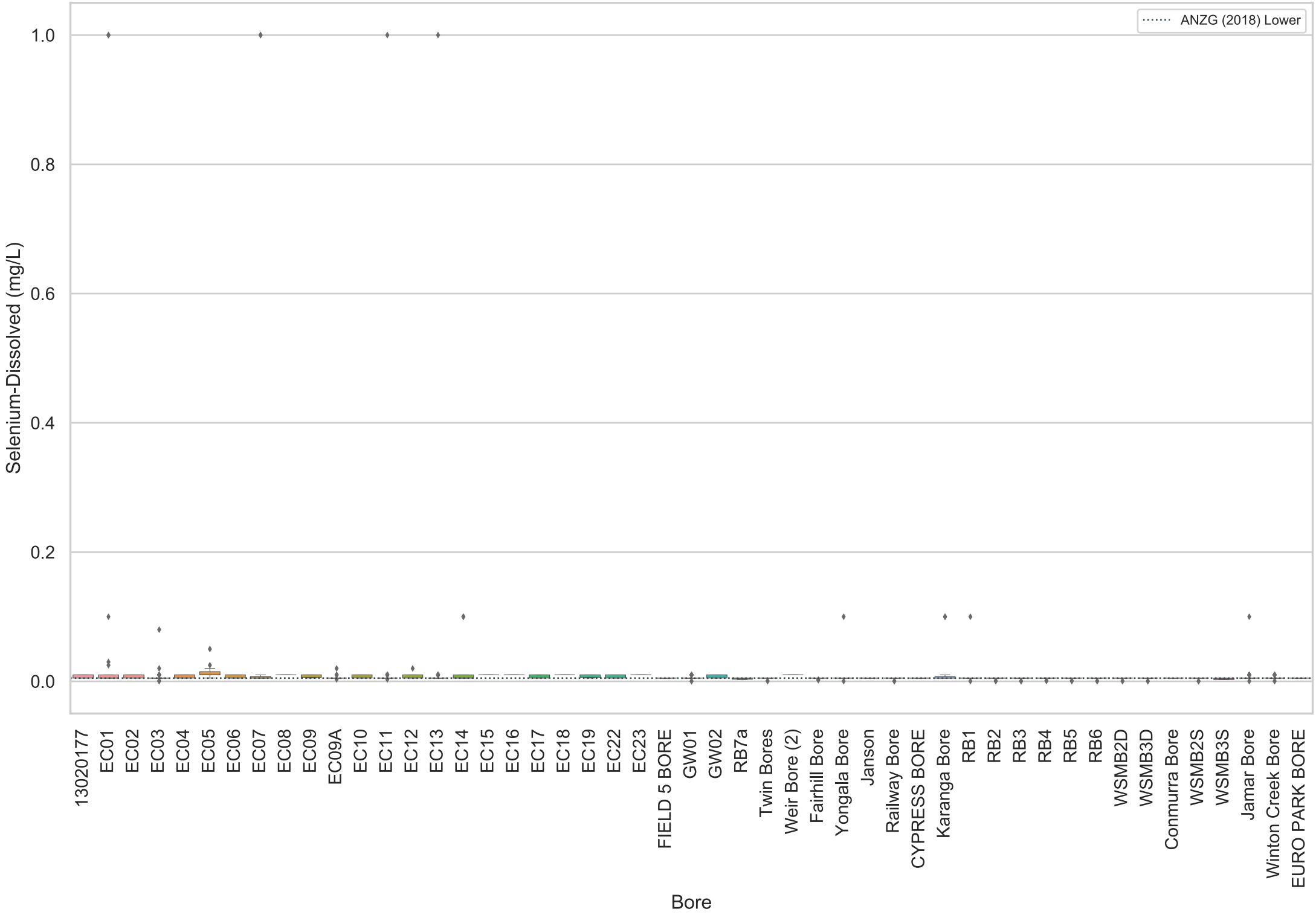

Manganese-Total (mg/L)
30
25
20
15
10
5
0
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

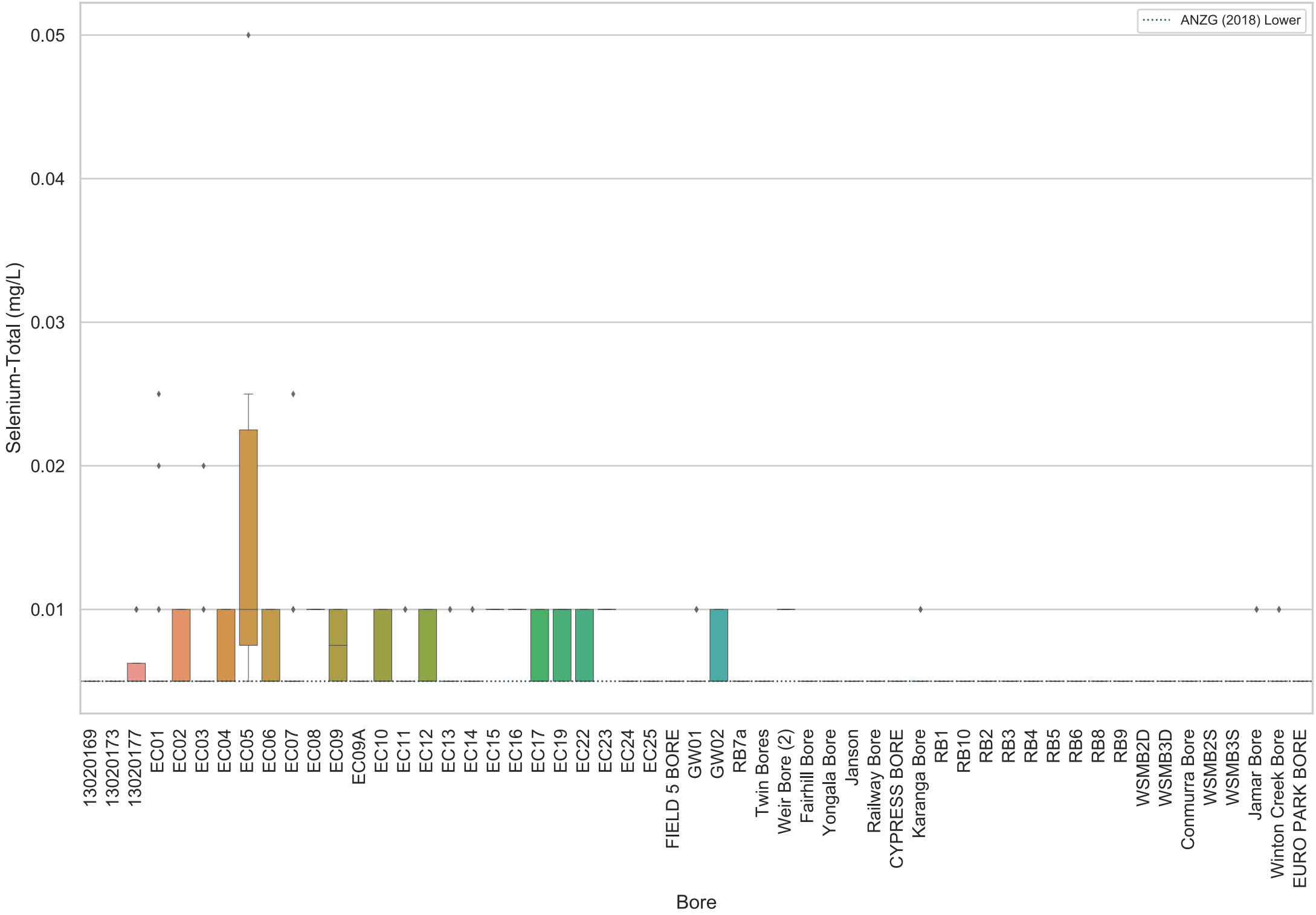

Mercury-Dissolved (mg/L)
0.00005
0.00006
0.00007
0.00008
0.00009
0.00010
Bore
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

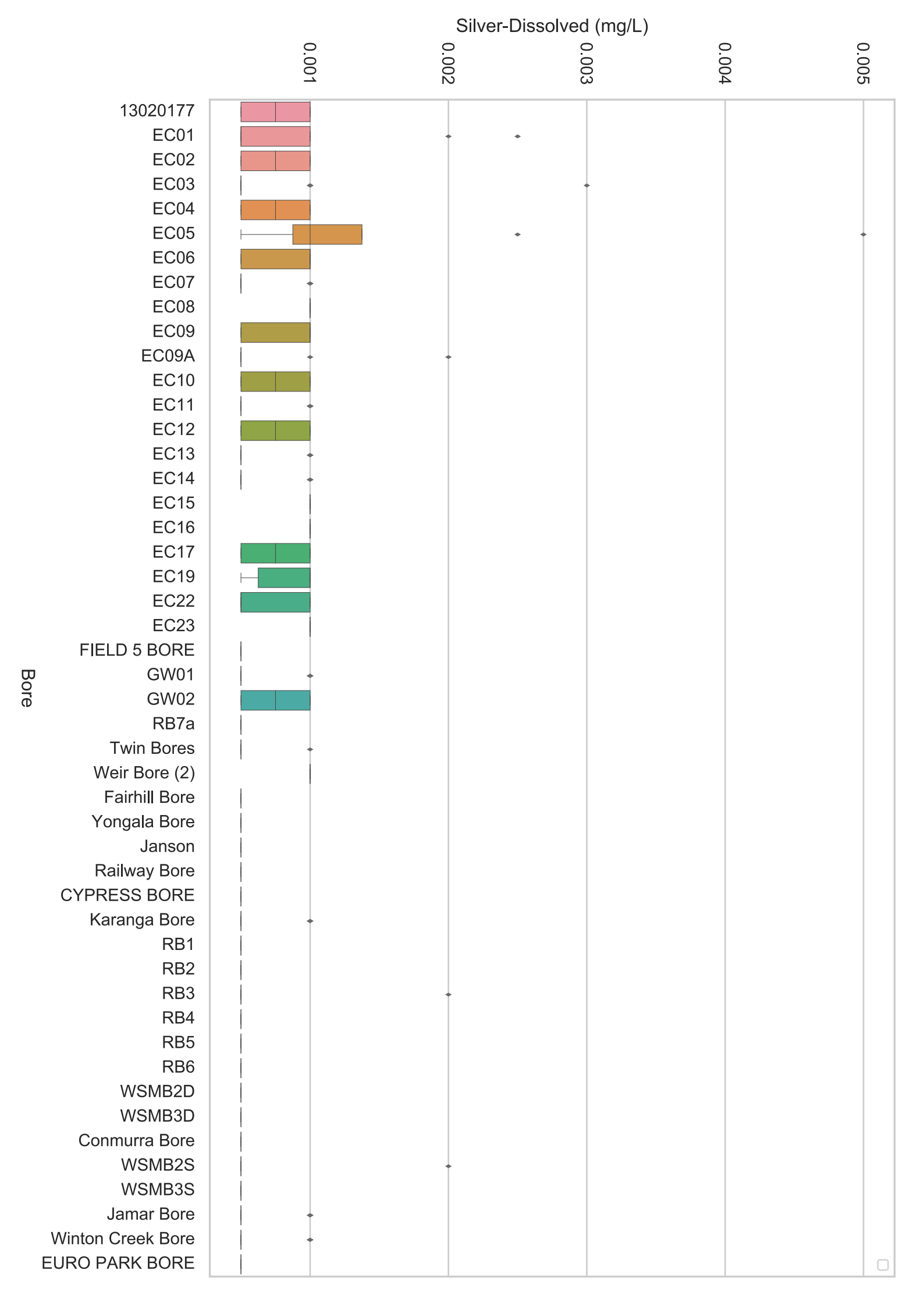

Mercury-Total (mg/L)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

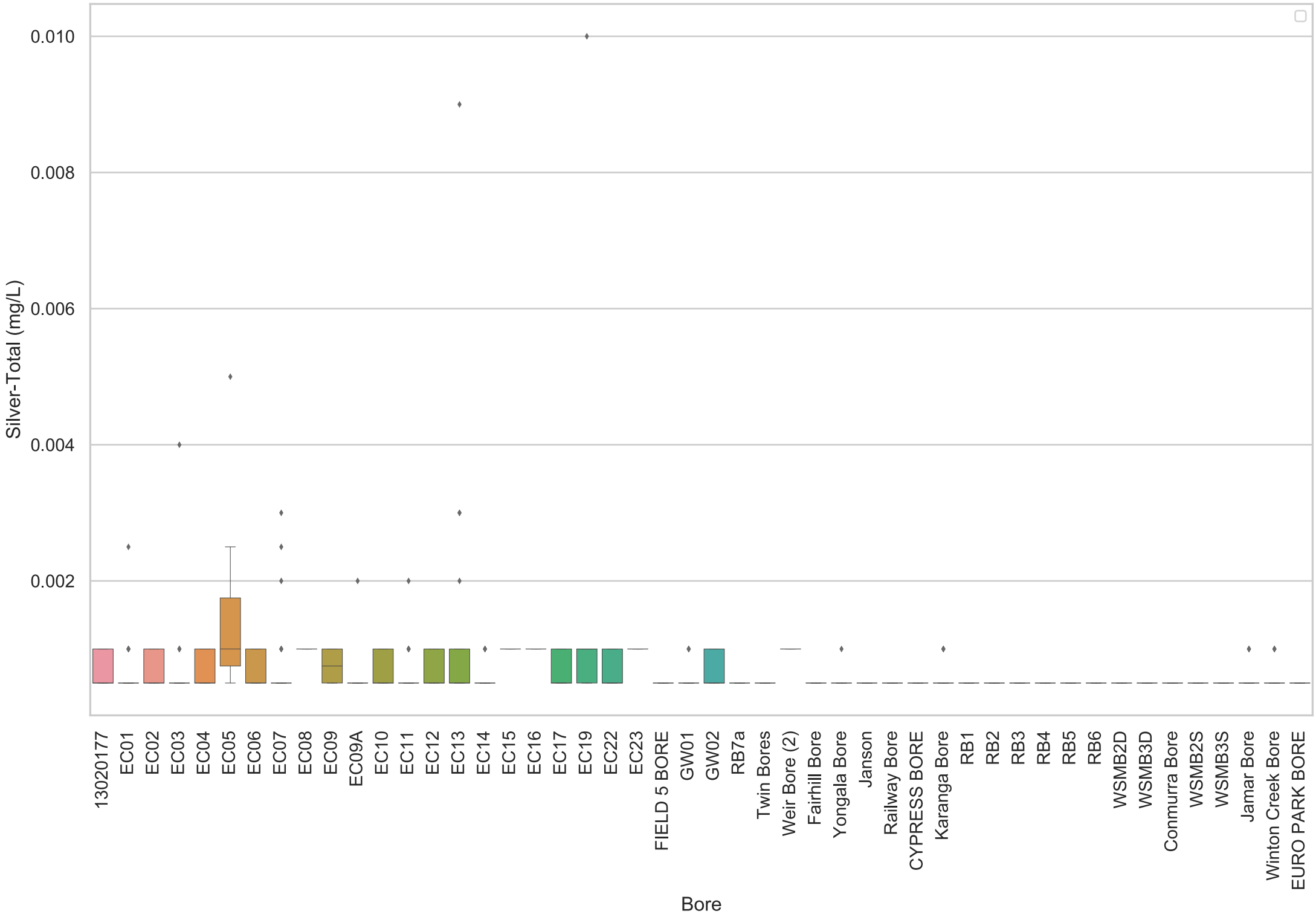

ANZG (2018)
Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

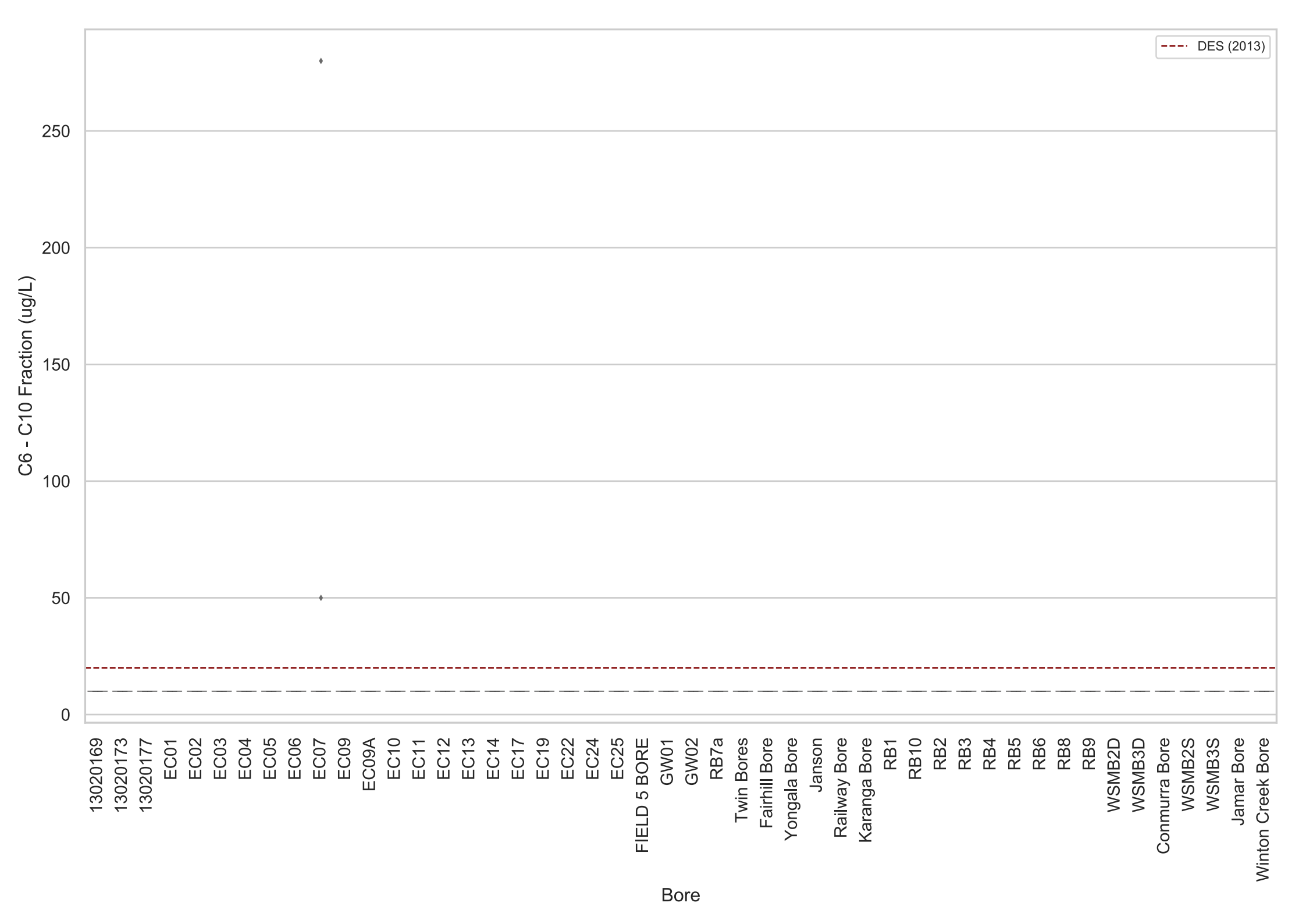

ANZG (2018)
Molybdenum-Total (mg/L)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

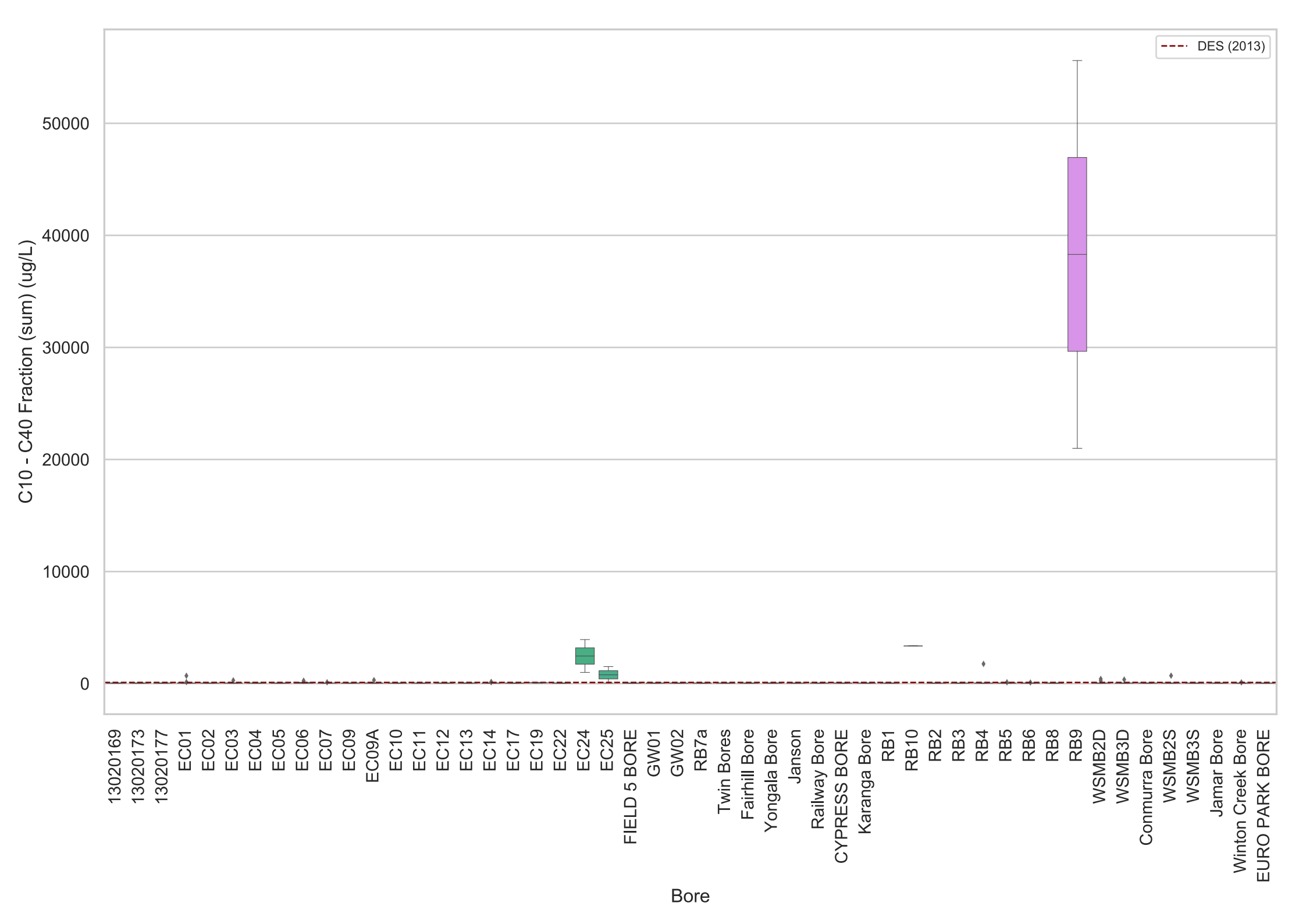

ANZG (2018) Lower
Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC18
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore


ANZG (2018) Lower
0.05
0.04
0.03
0.02
0.01
Selenium-Total (mg/L)
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore


Silver-Dissolved (mg/L)
0.001
0.002
0.003
0.004
0.005
Bore
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE

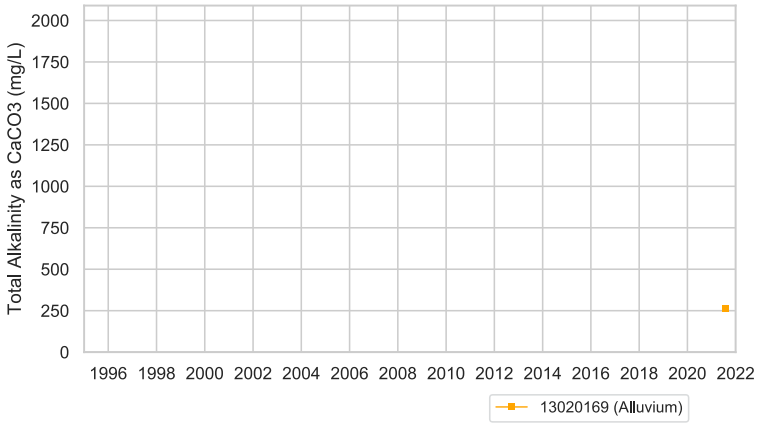

Silver-Total (mg/L)
0.010
0.008
0.006
0.004
0.002
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC08
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC15
EC16
EC17
EC19
EC22
EC23
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Weir Bore (2)
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB2
RB3
RB4
RB5
RB6
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

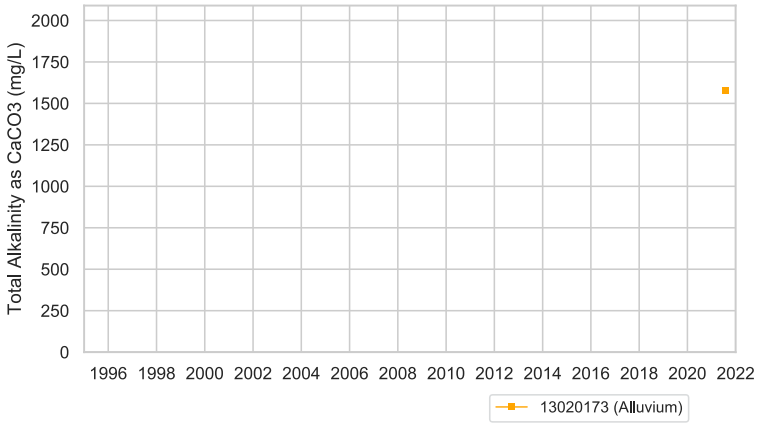

DES (2013)
C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Janson
Railway Bore
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
Bore

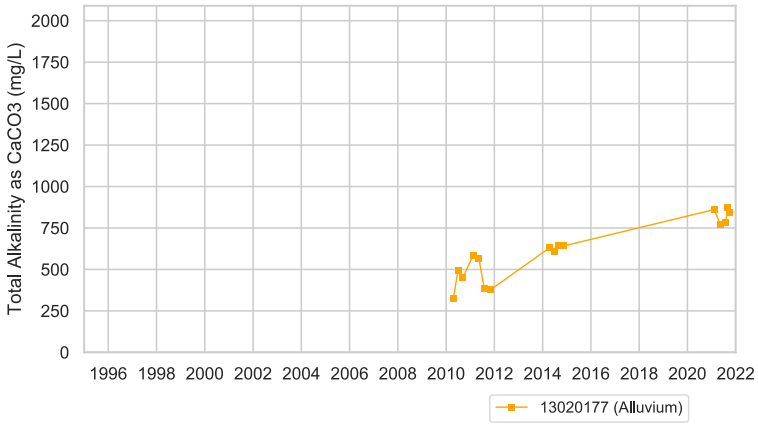

DES (2013)
C10 - C40 Fraction (sum) (ug/L)
50000
40000
30000
20000
10000
0
13020169
13020173
13020177
EC01
EC02
EC03
EC04
EC05
EC06
EC07
EC09
EC09A
EC10
EC11
EC12
EC13
EC14
EC17
EC19
EC22
EC24
EC25
FIELD 5 BORE
GW01
GW02
RB7a
Twin Bores
Fairhill Bore
Yongala Bore
Janson
Railway Bore
CYPRESS BORE
Karanga Bore
RB1
RB10
RB2
RB3
RB4
RB5
RB6
RB8
RB9
WSMB2D
WSMB3D
Conmurra Bore
WSMB2S
WSMB3S
Jamar Bore
Winton Creek Bore
EURO PARK BORE
Bore

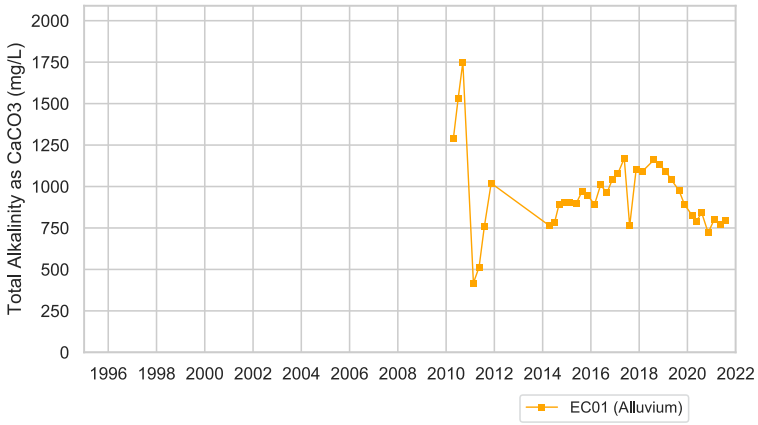
APPENDIX D

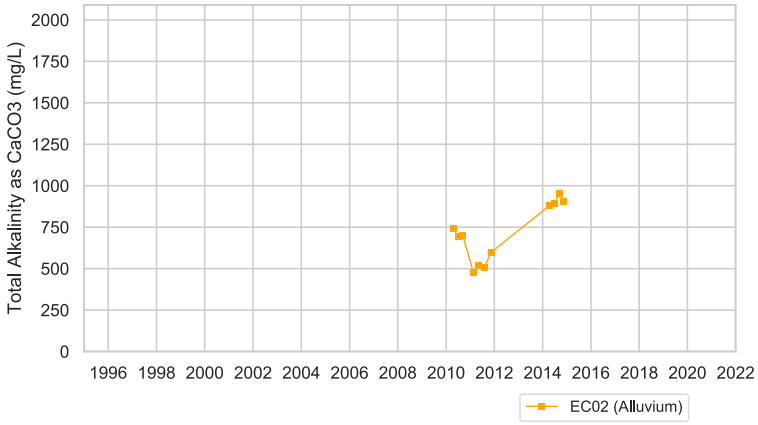
Water quality parameters – time series

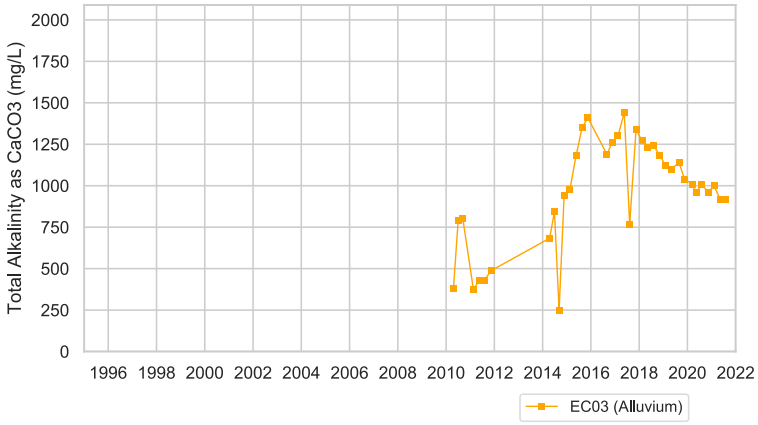

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

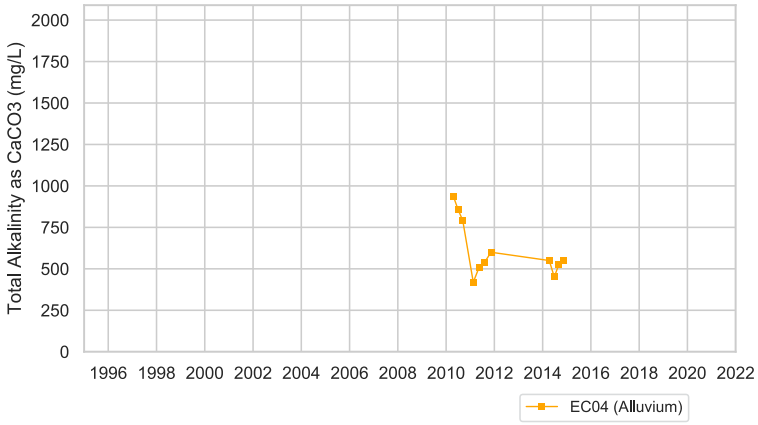

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

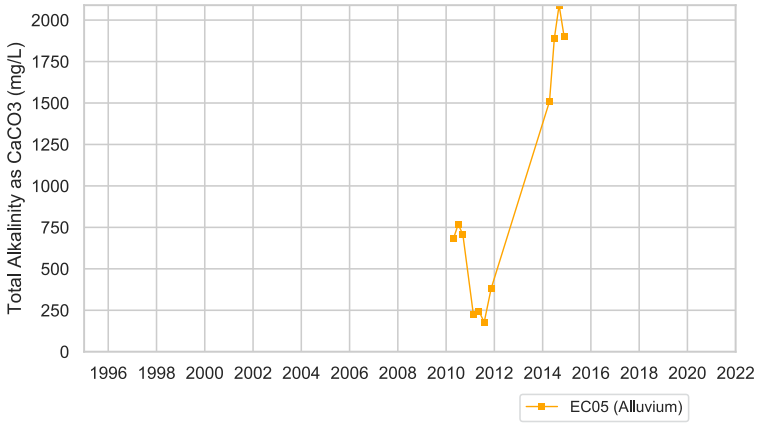

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

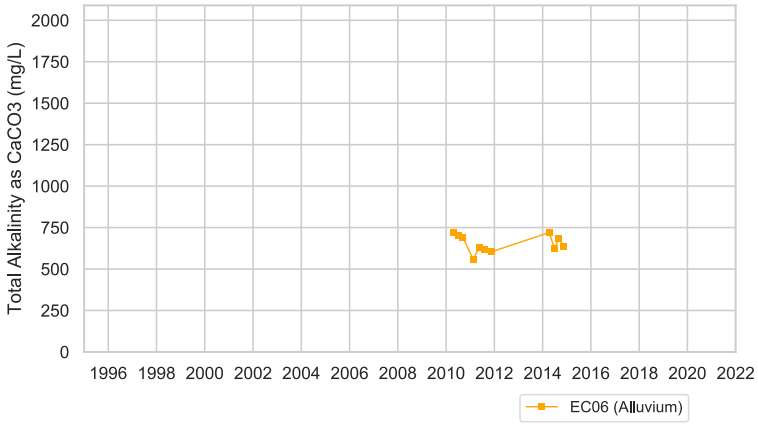

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

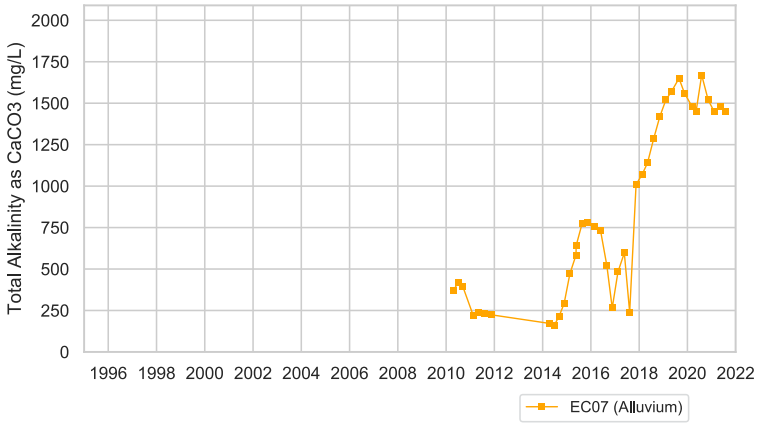

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

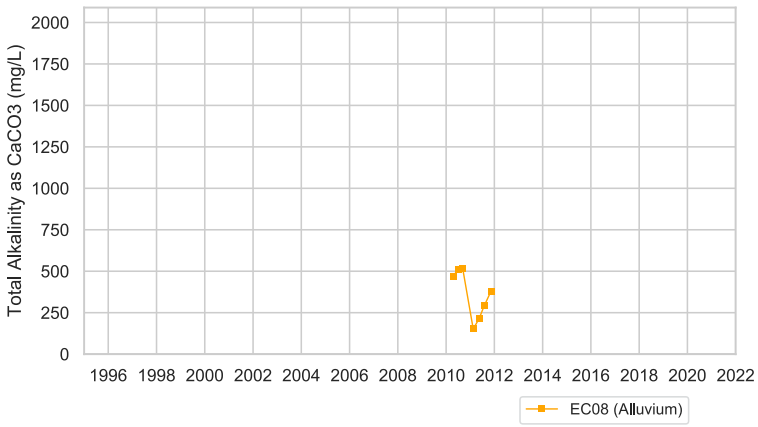

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

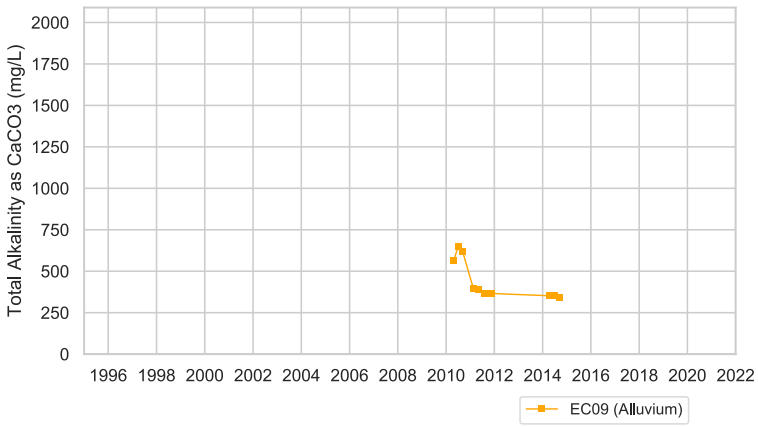

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

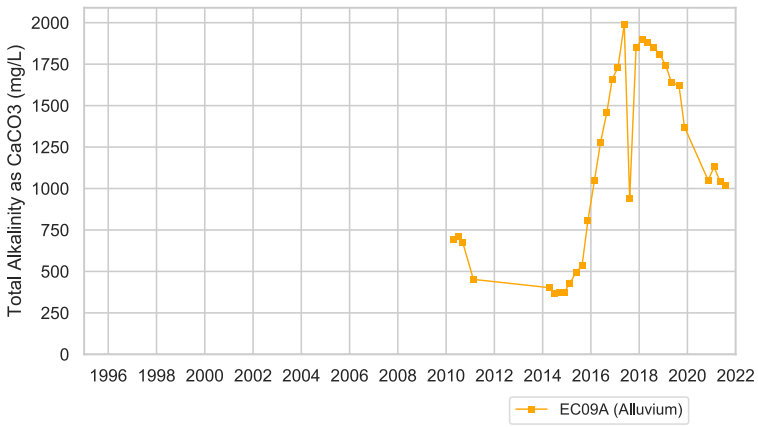

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

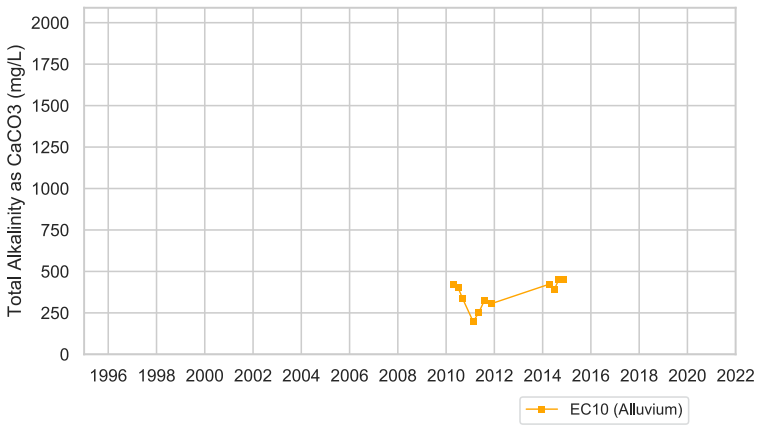

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

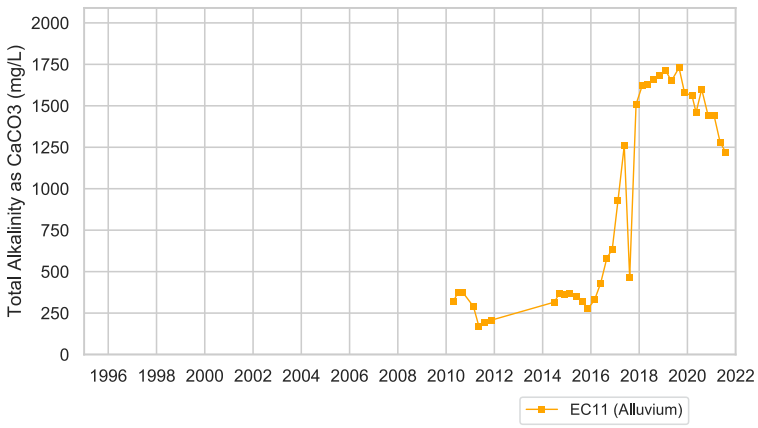

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

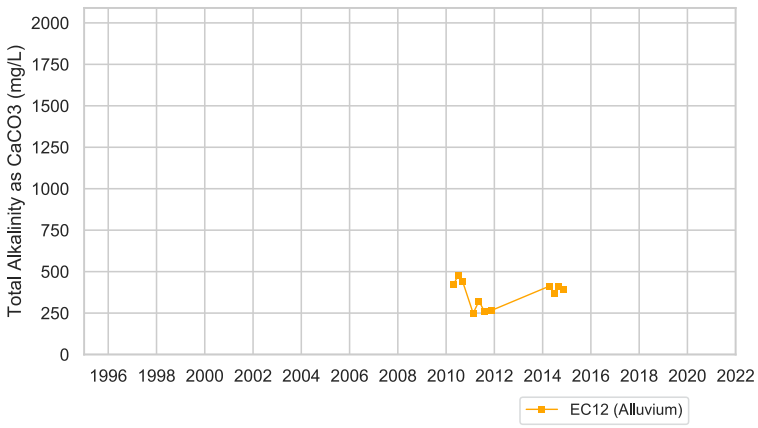

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

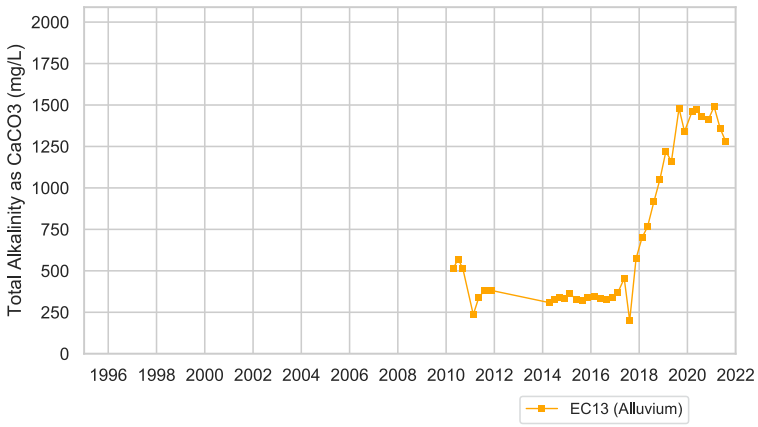

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

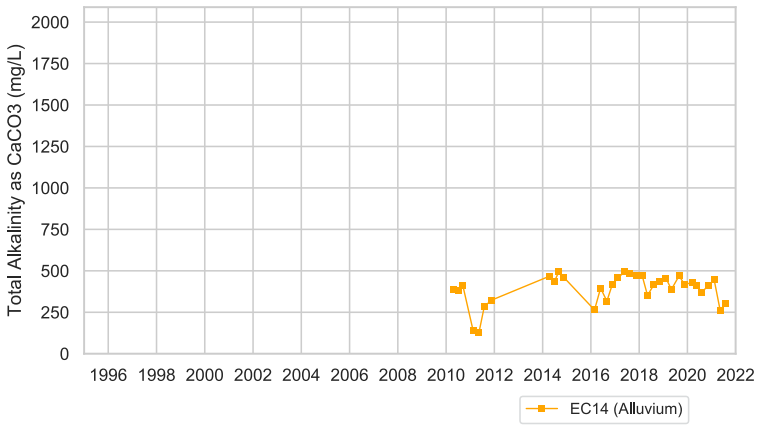

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

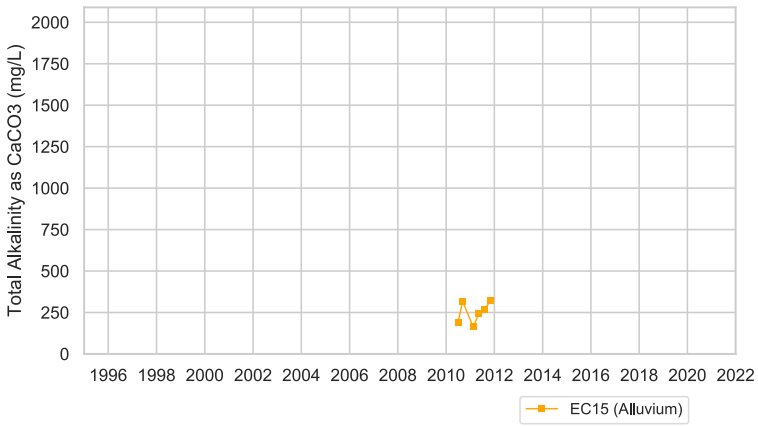

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

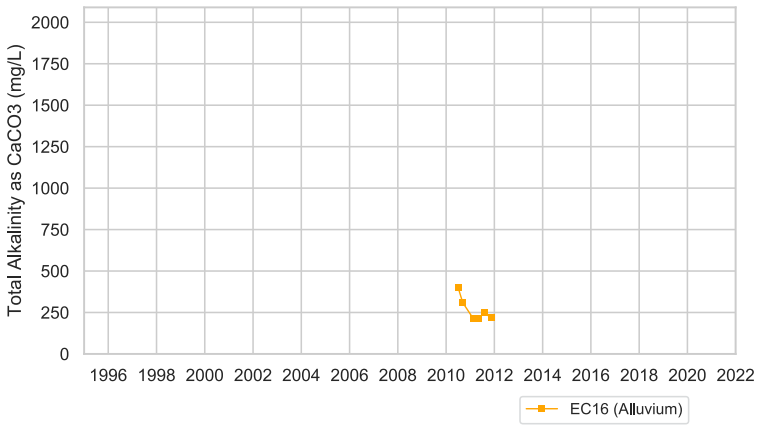

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

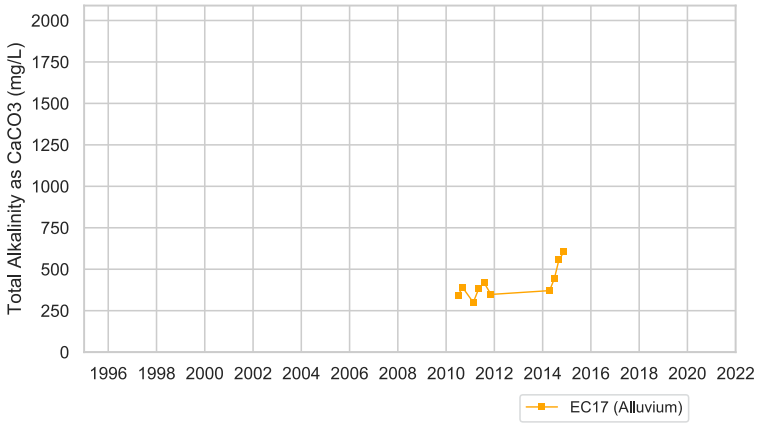

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

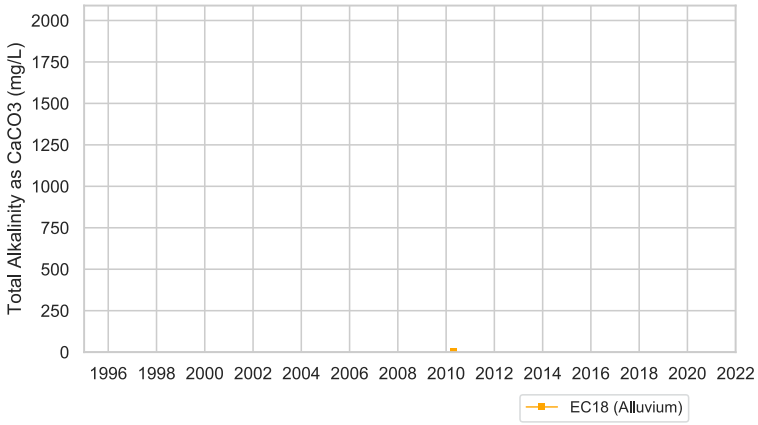

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

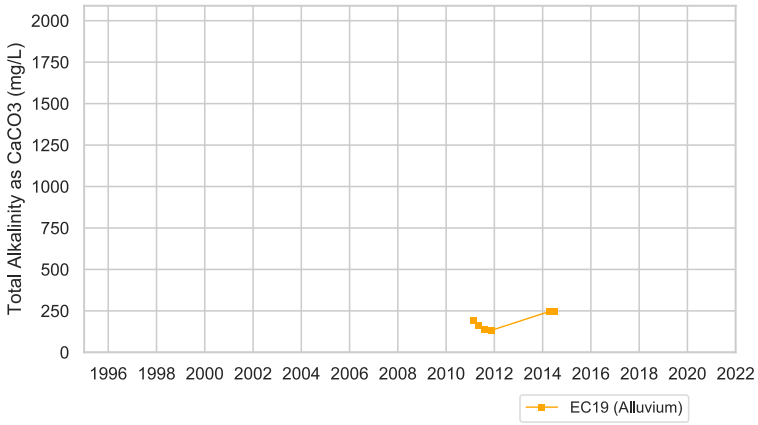

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

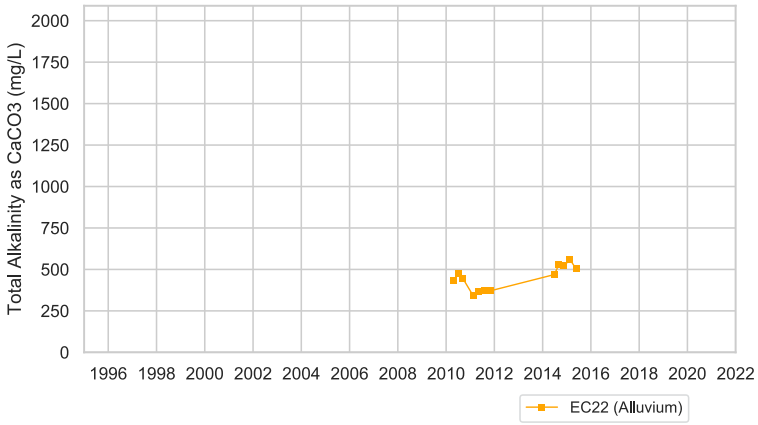

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

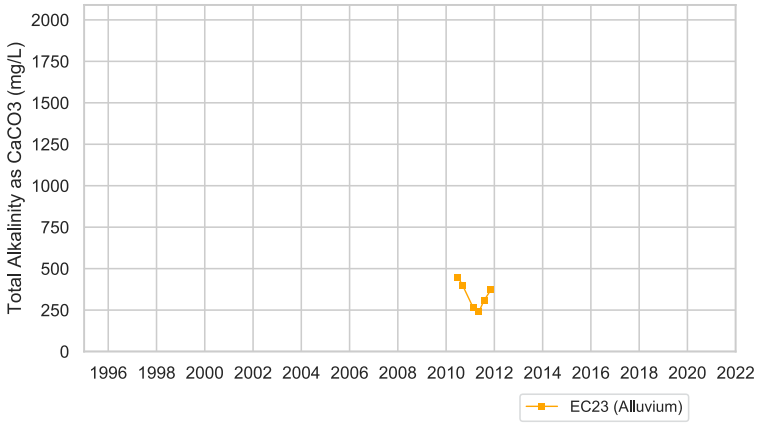

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

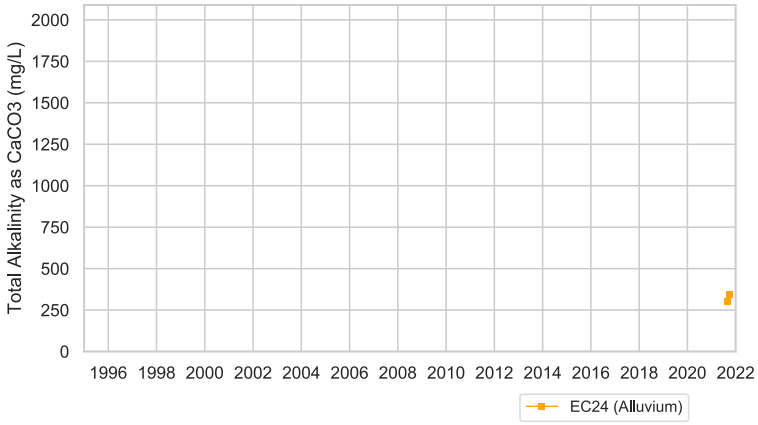

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

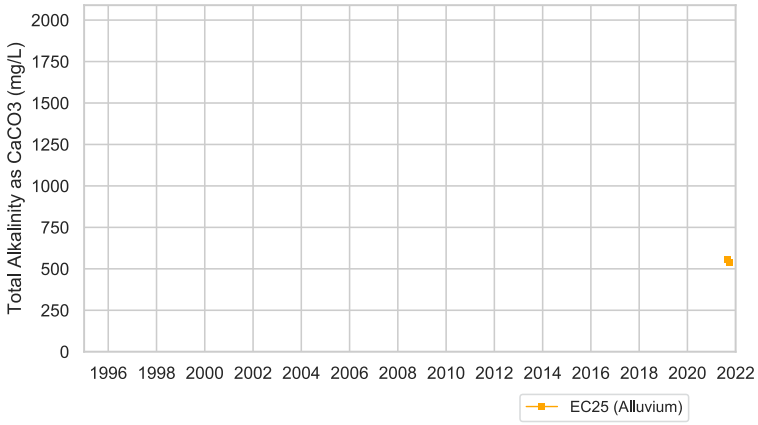

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

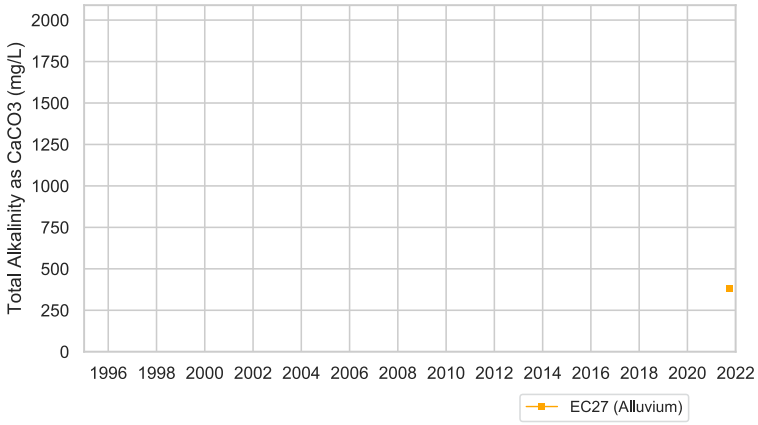

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

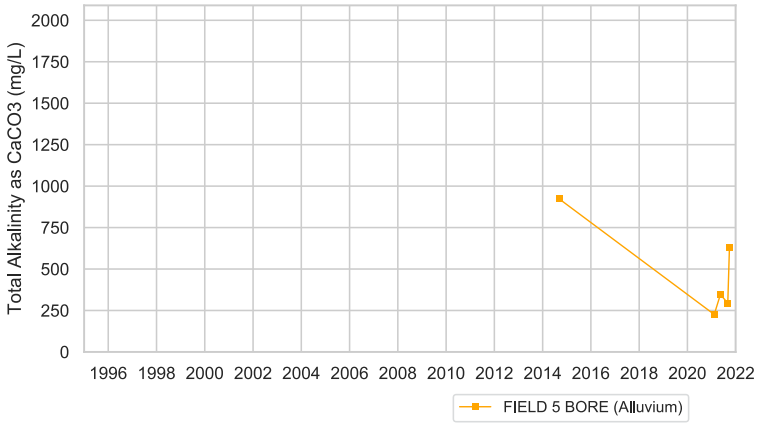

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

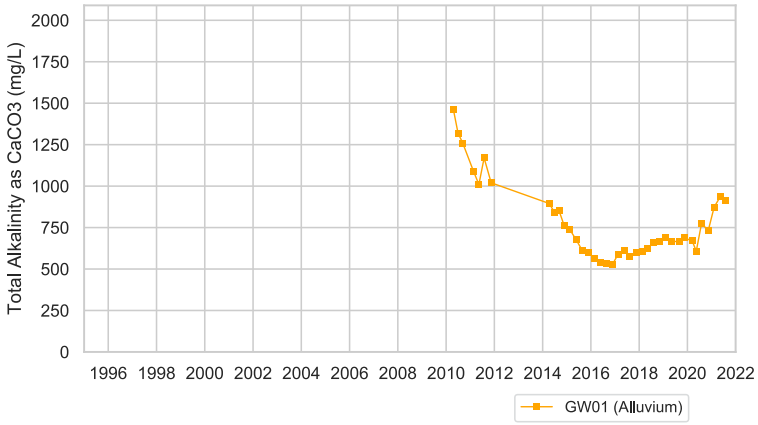

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

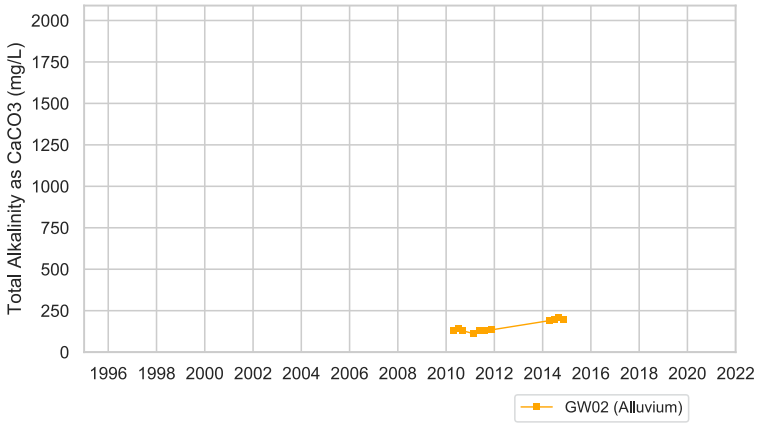

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

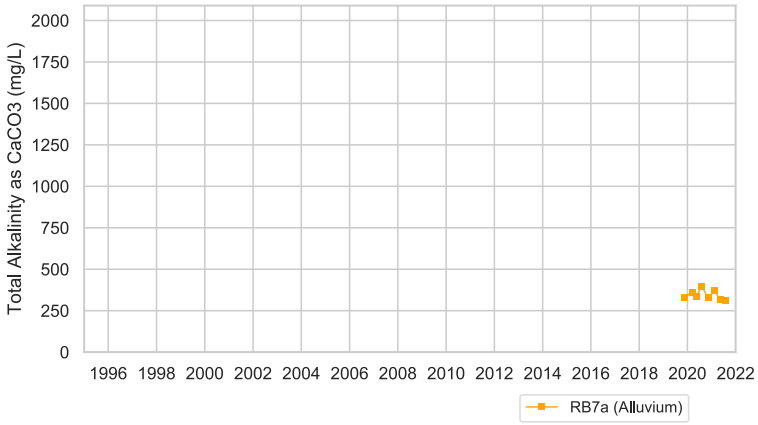

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

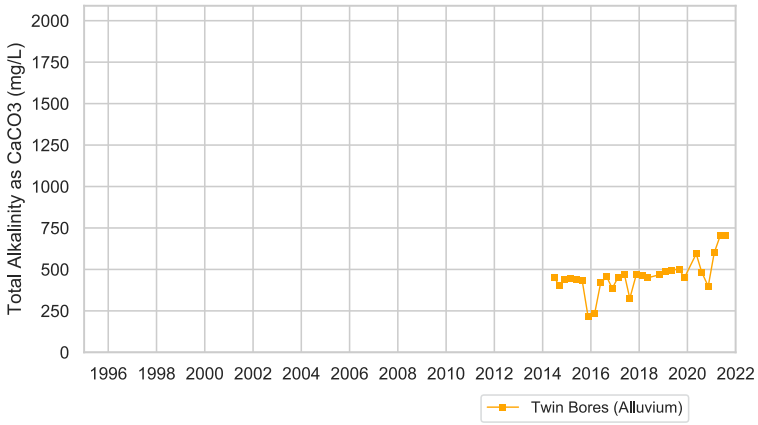

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

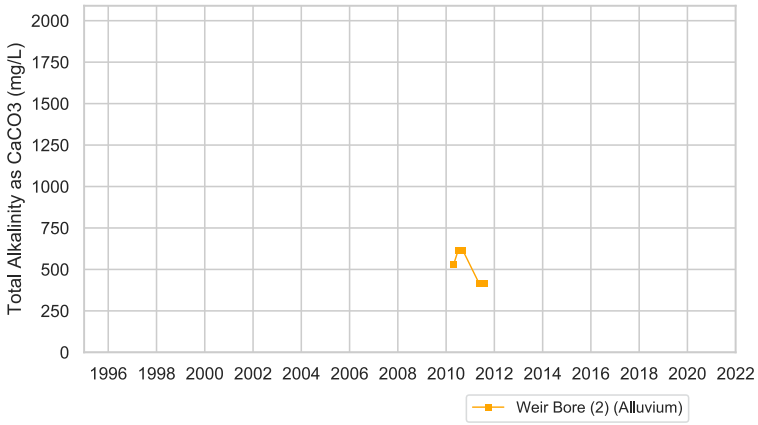

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

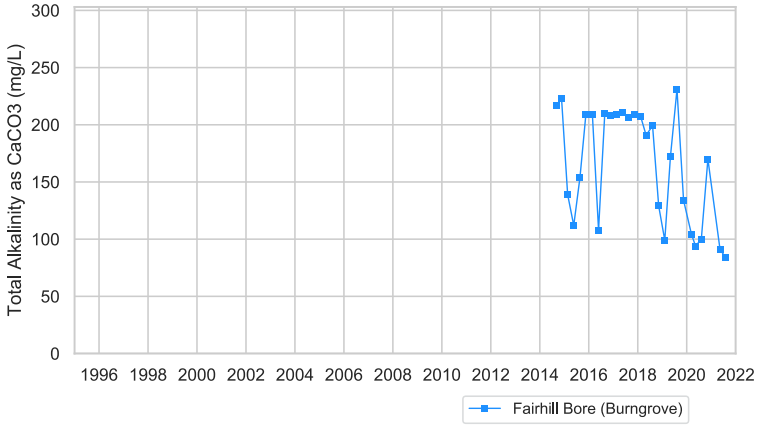

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

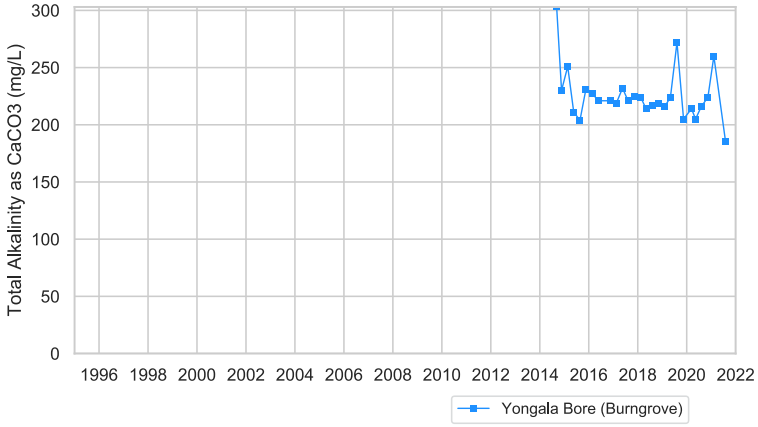

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

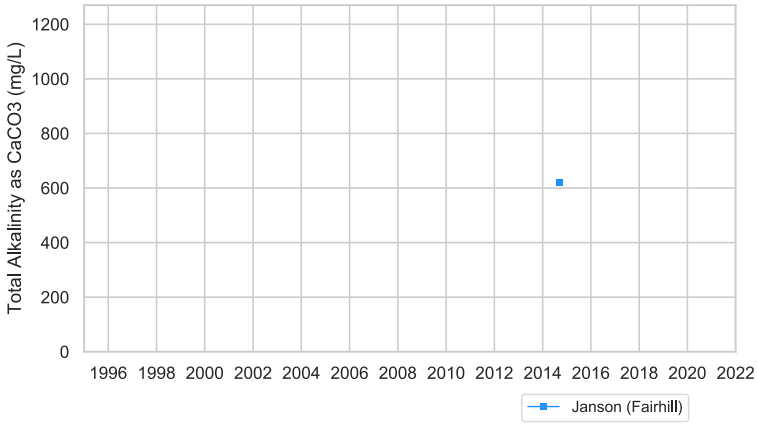

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

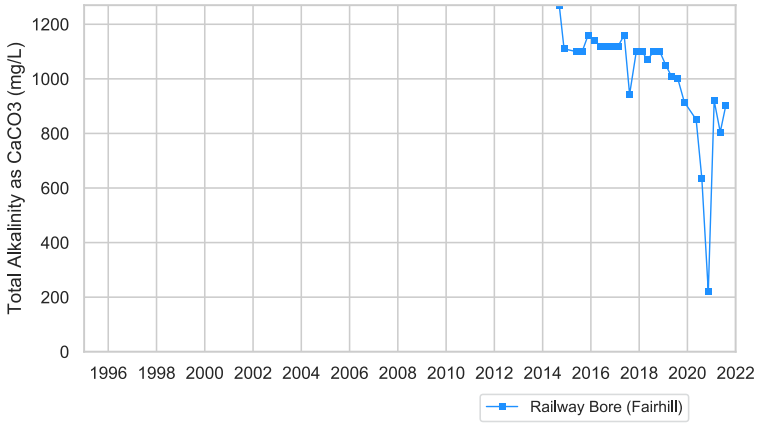

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

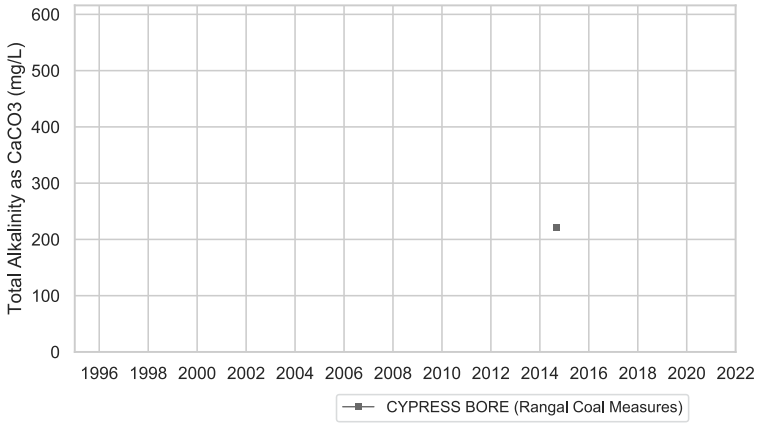

Total Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

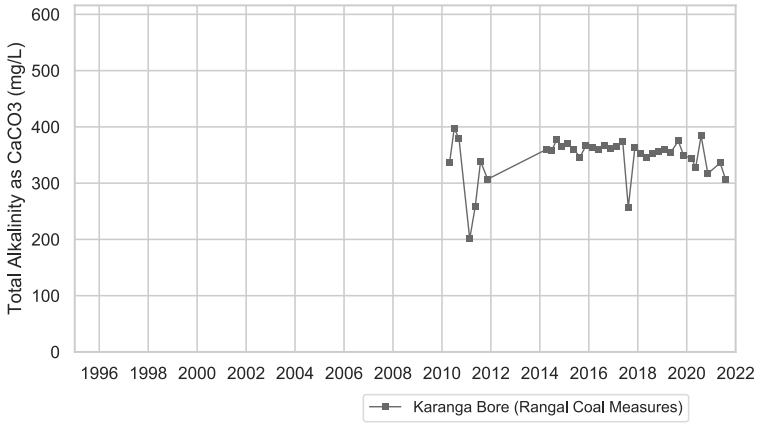

Total Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

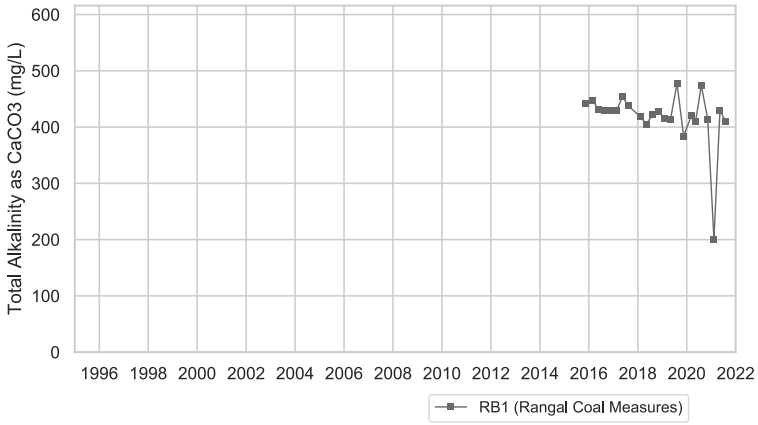

Total Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

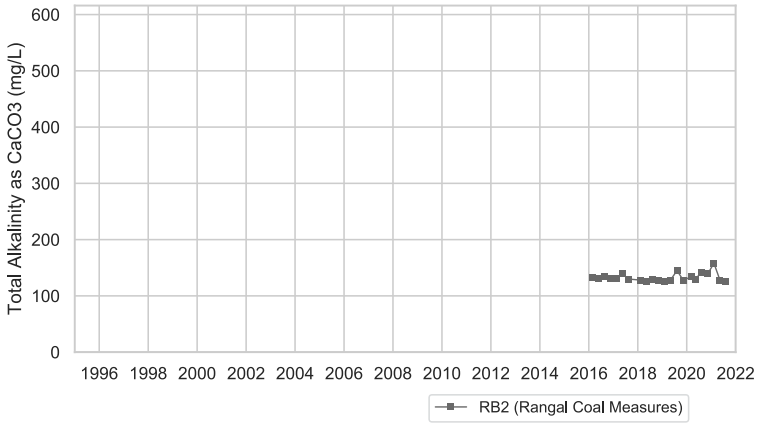

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1000
1200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

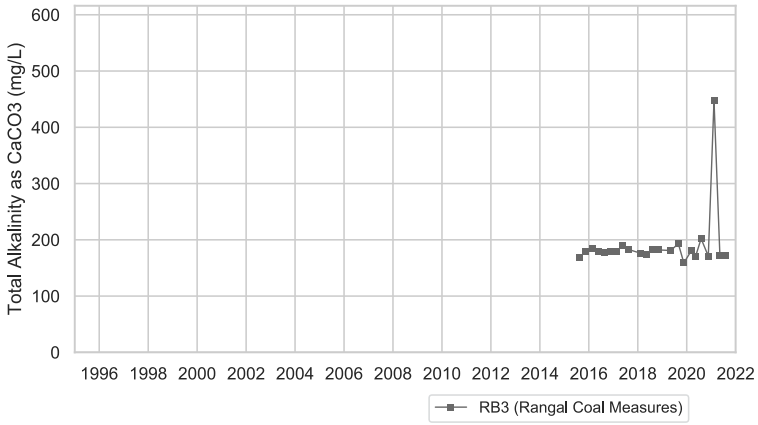

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1000
1200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

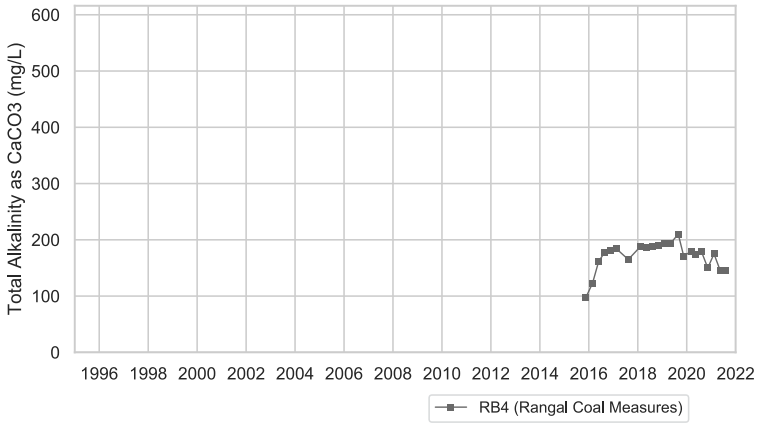

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

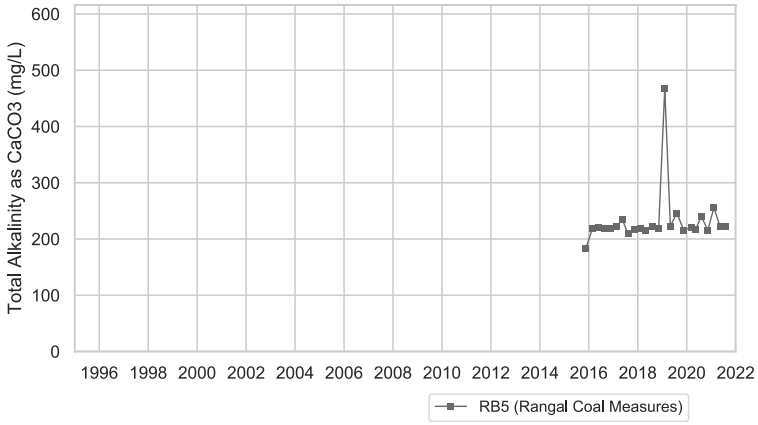

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

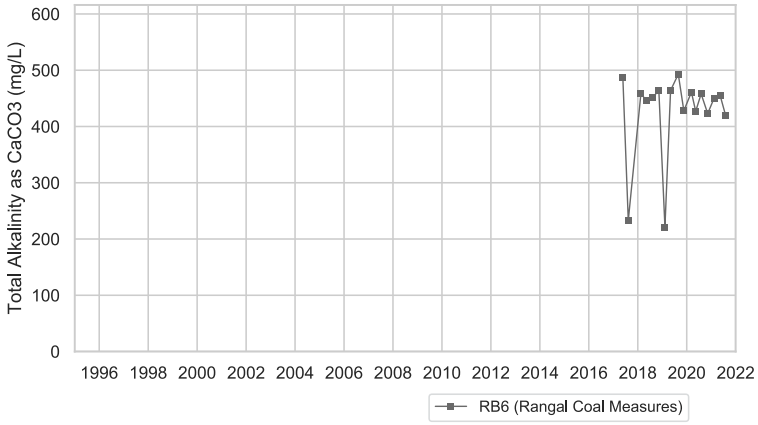

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

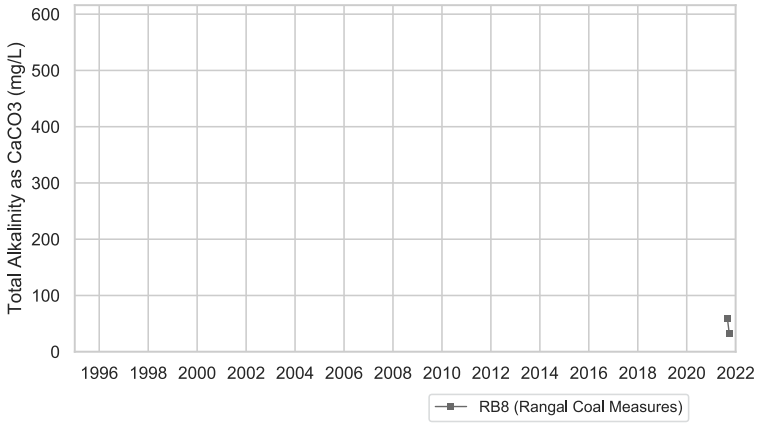

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

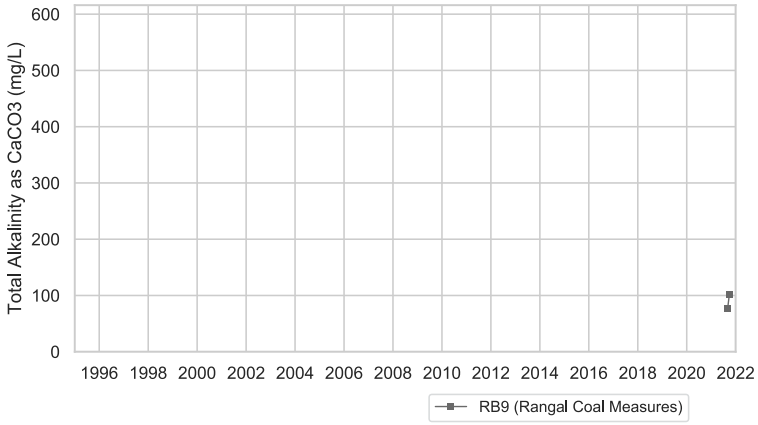

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

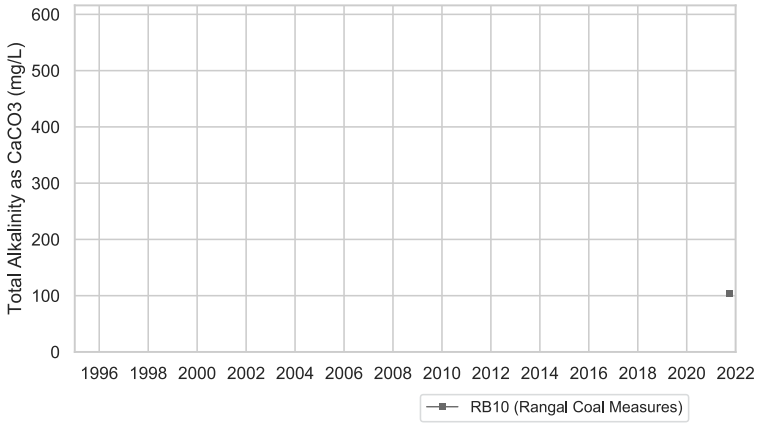

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

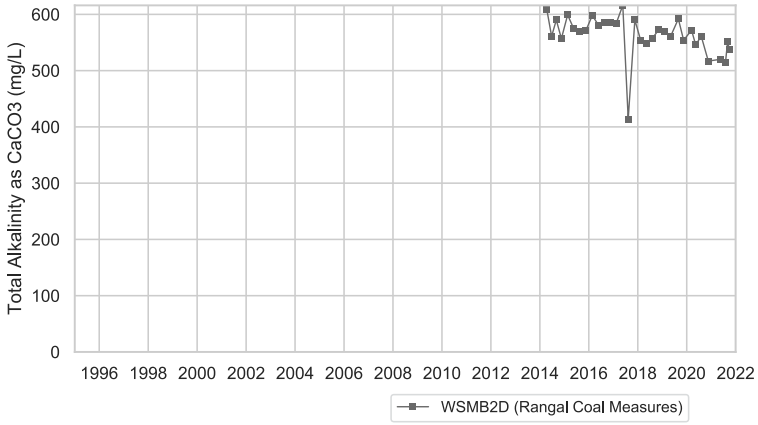

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

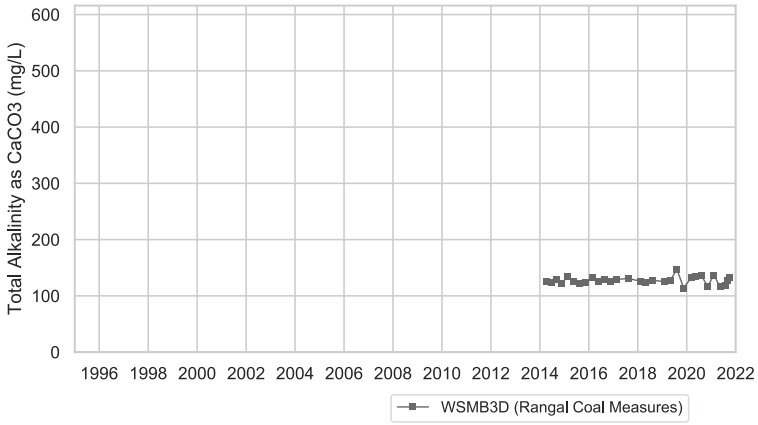

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

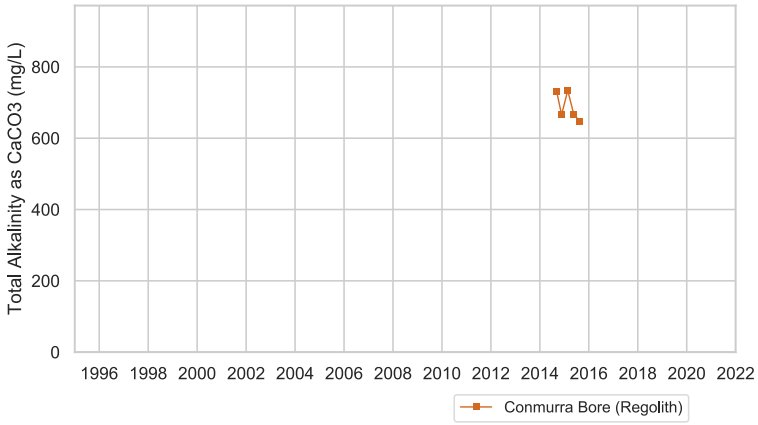

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

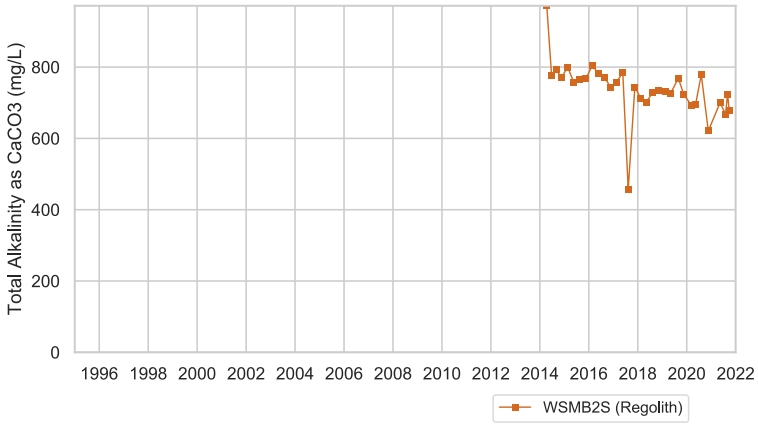

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

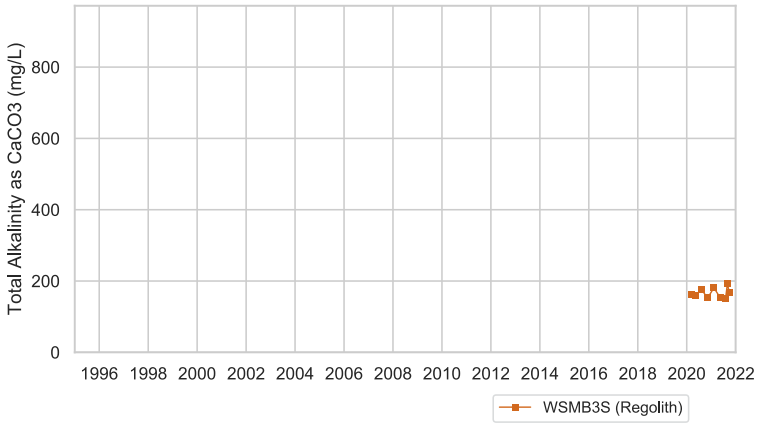

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

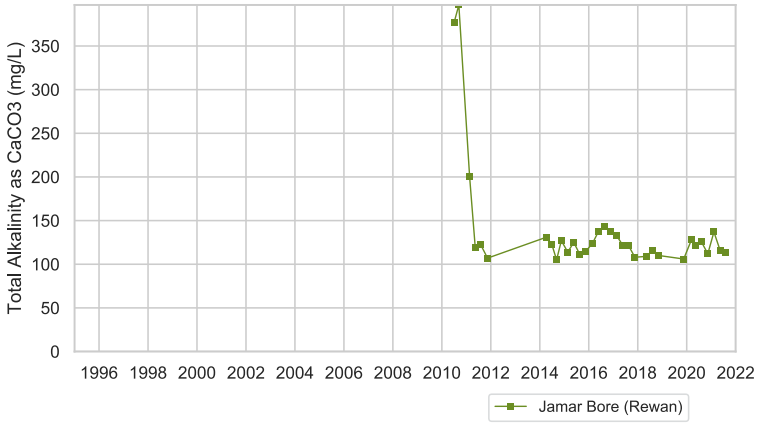

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

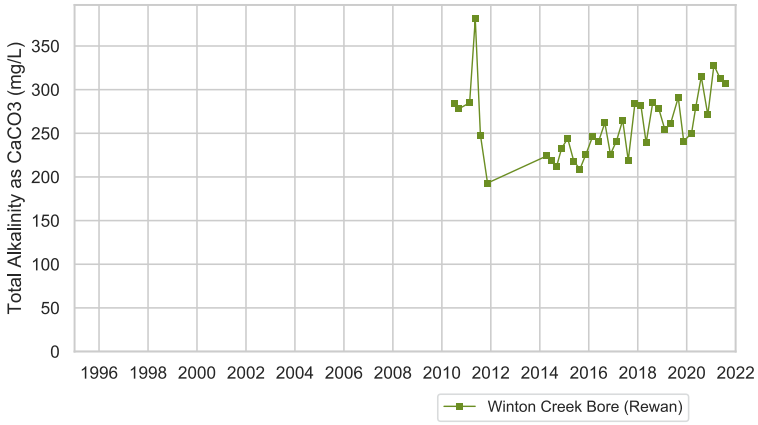

Total Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

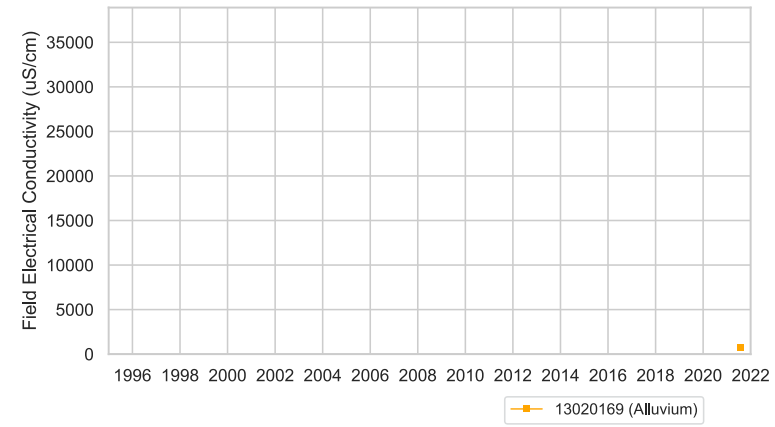

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

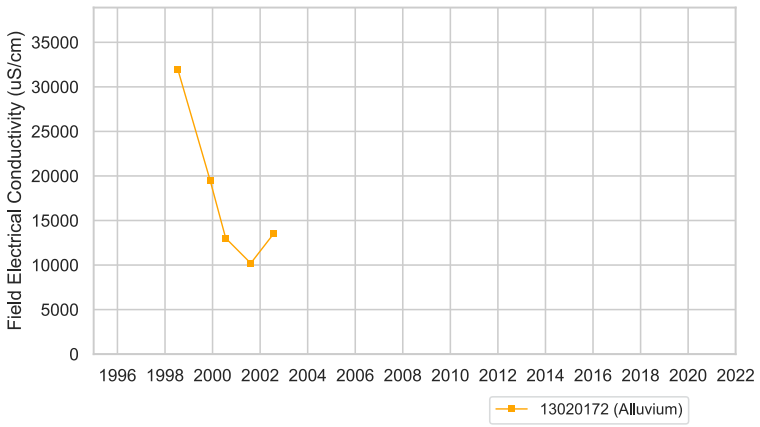

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

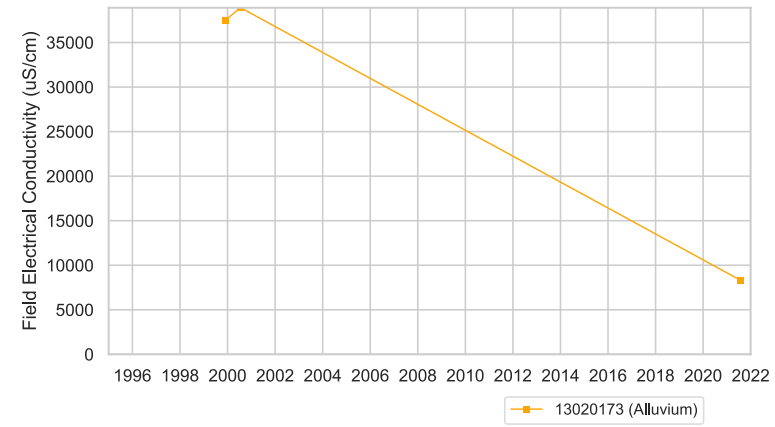

Total Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

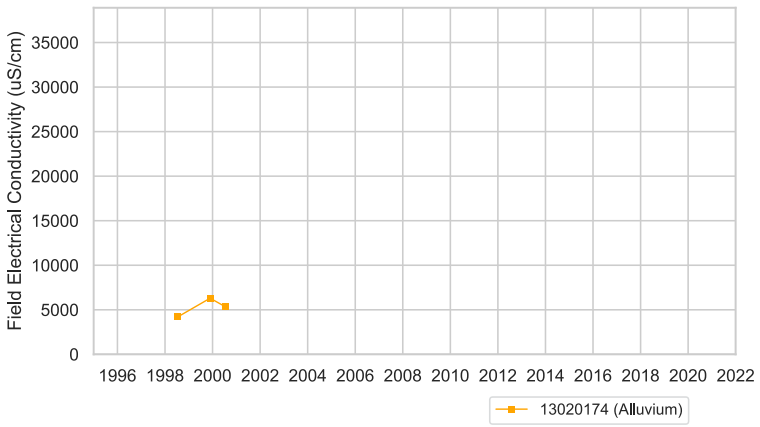

Total Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

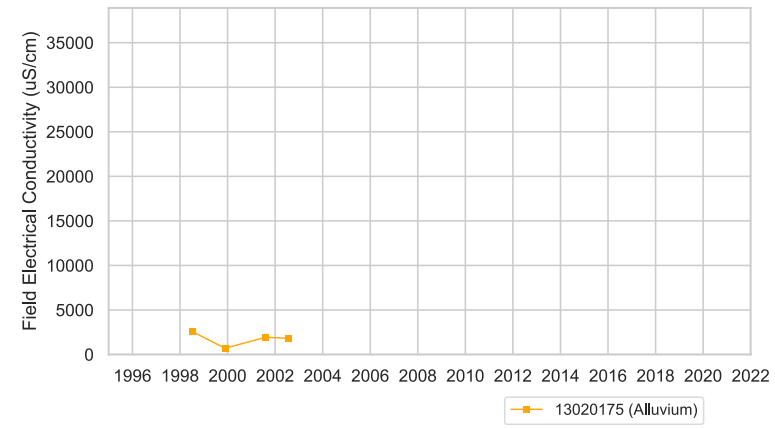

Total Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

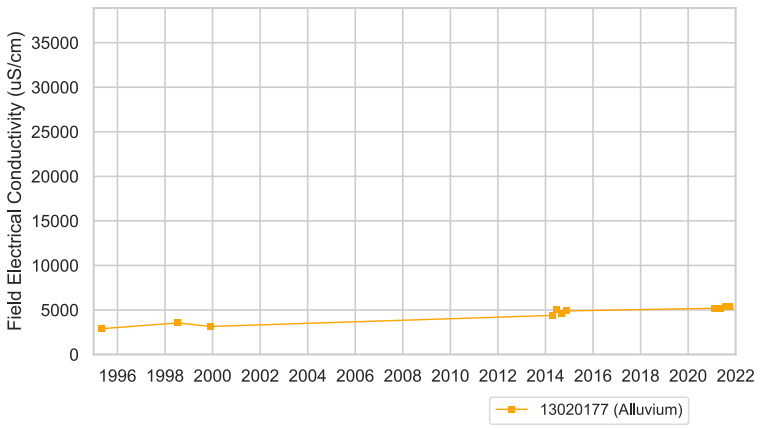

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

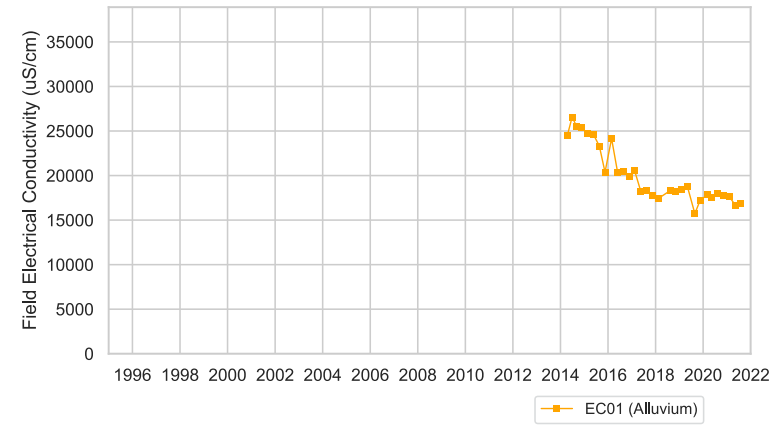

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

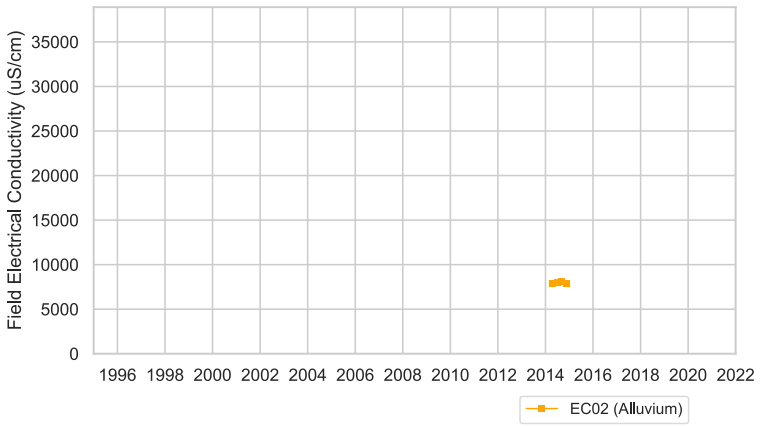

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

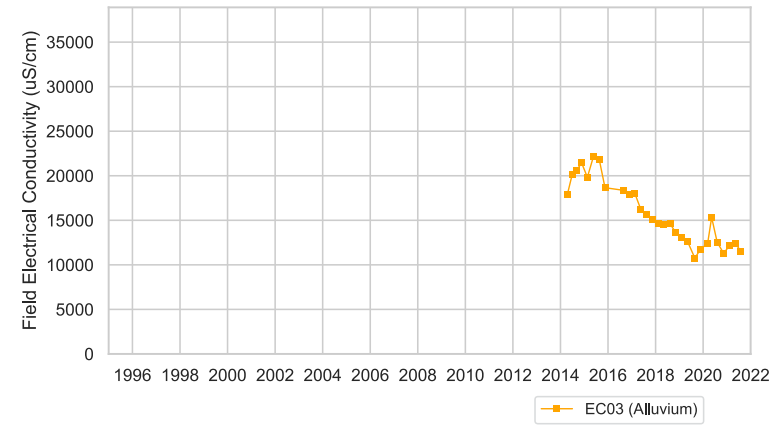

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

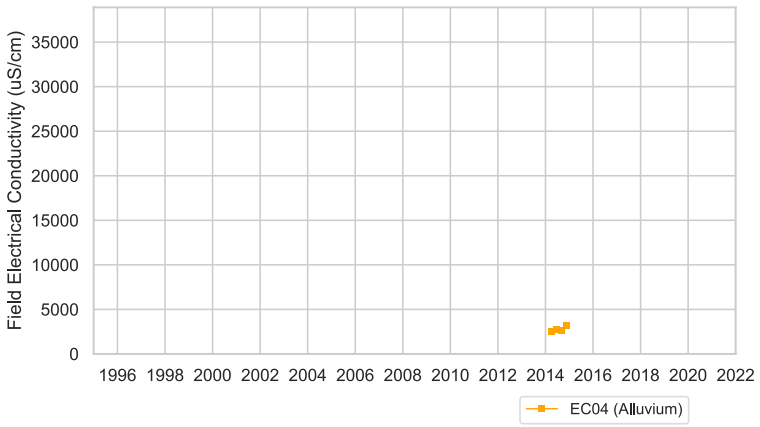

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

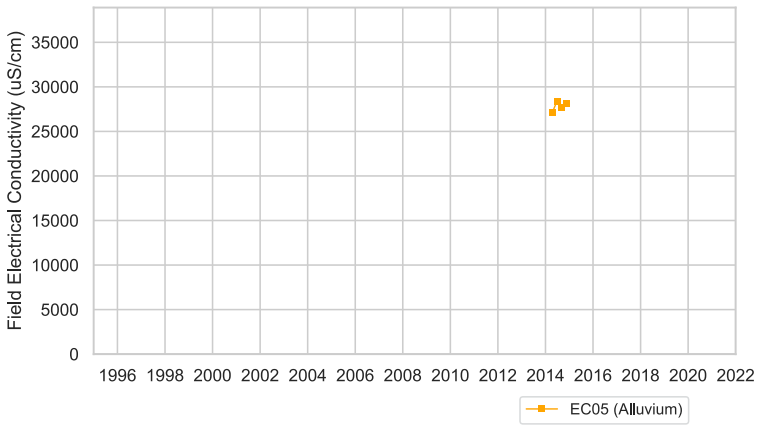

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

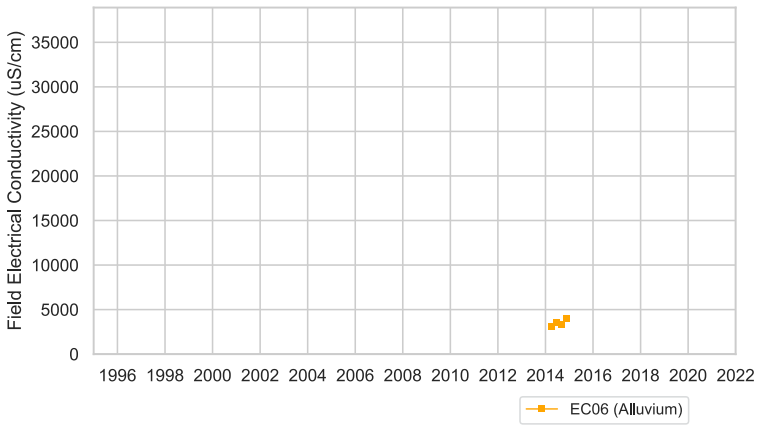

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

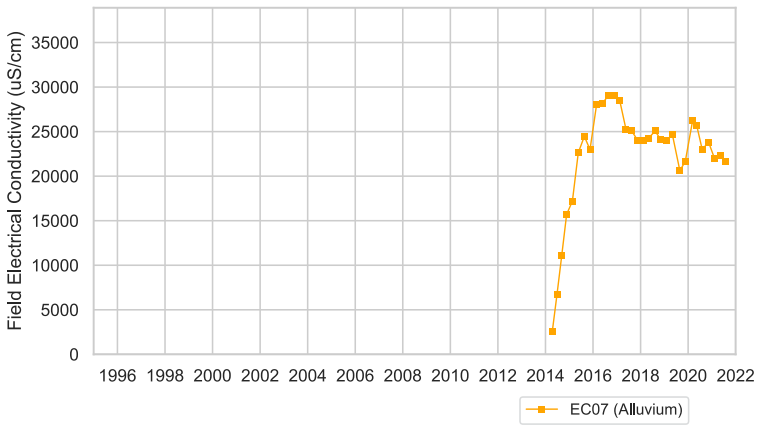

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

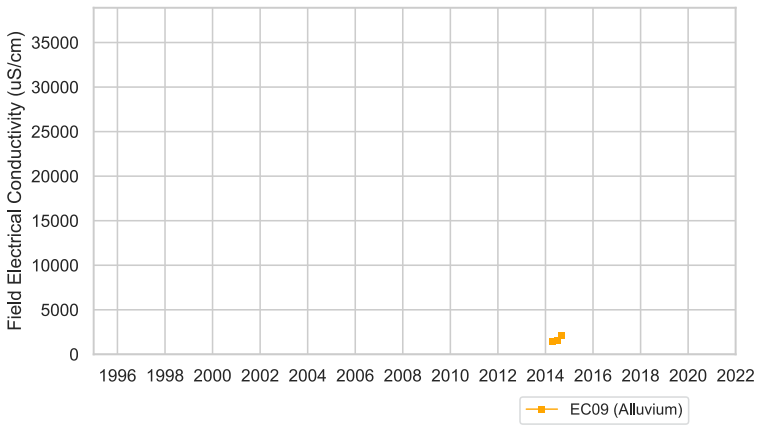

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

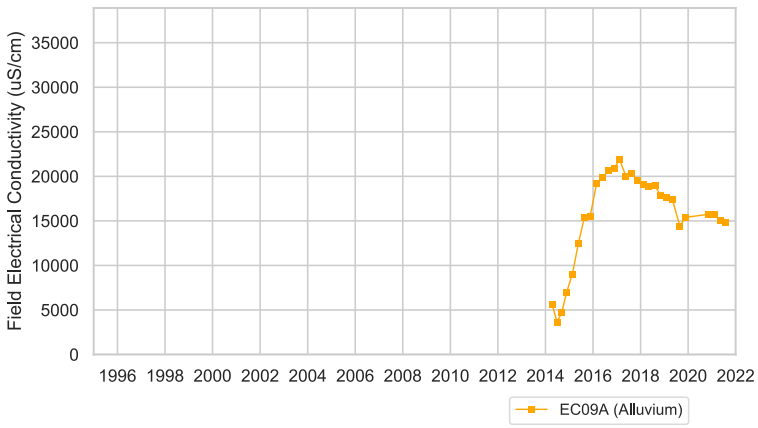

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

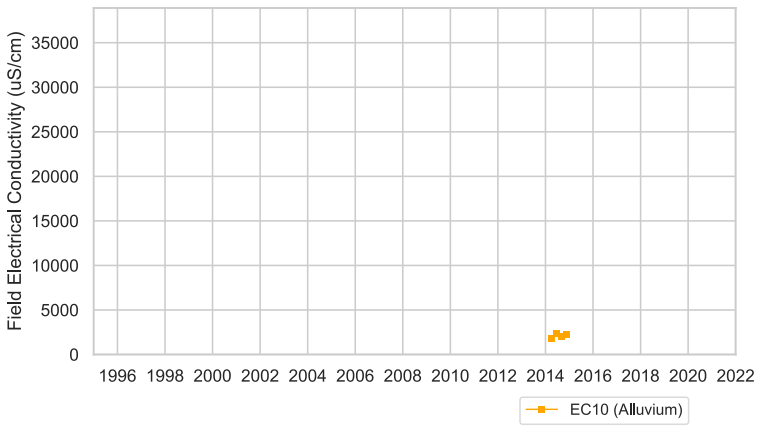

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

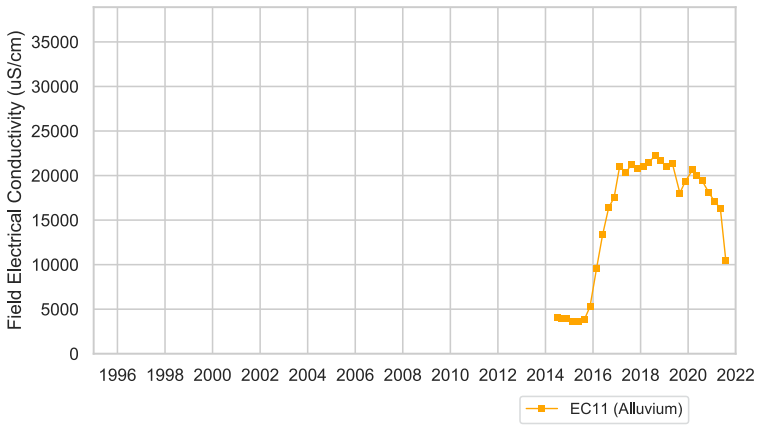

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

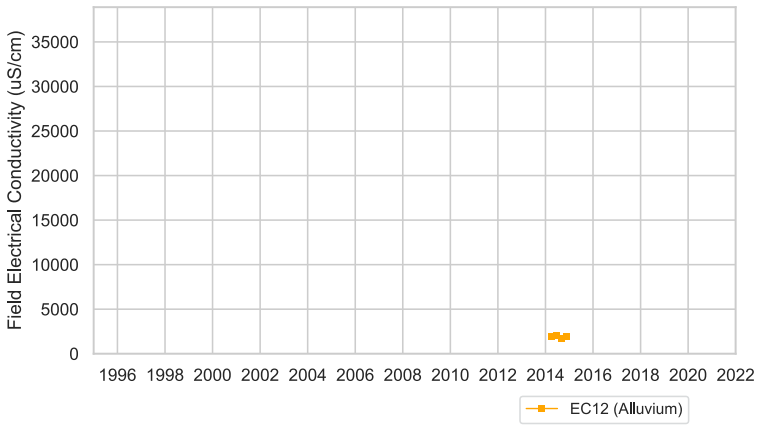

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

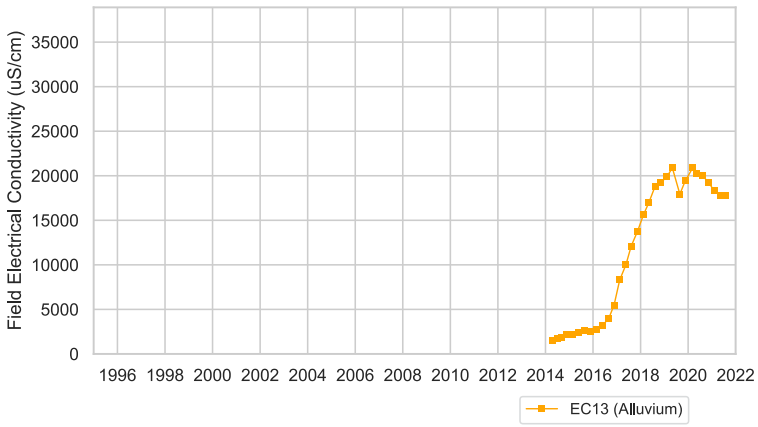

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

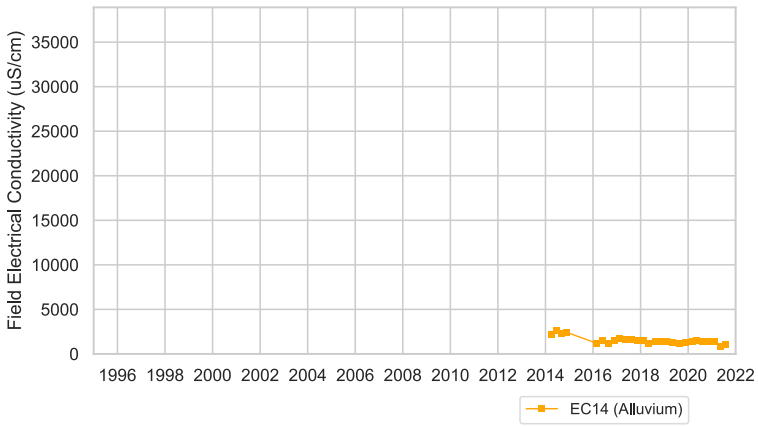

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

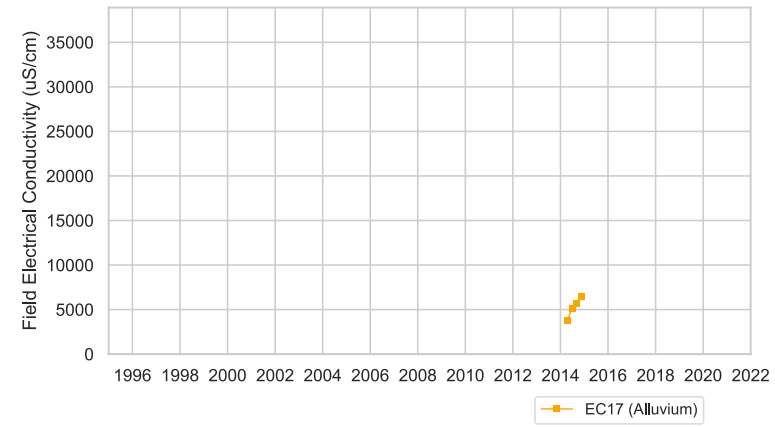

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

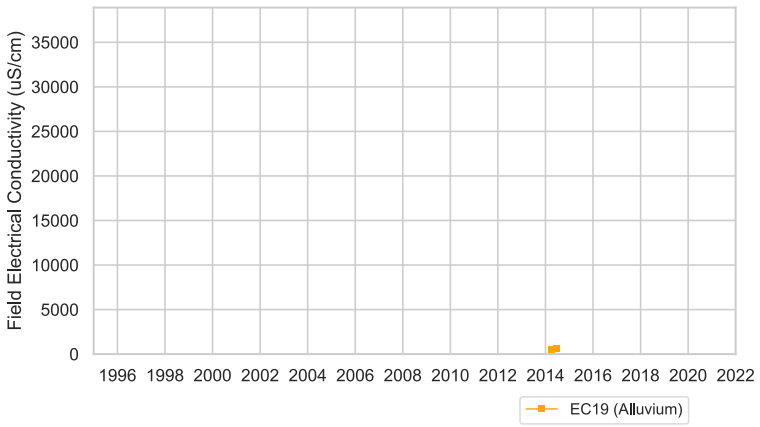

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

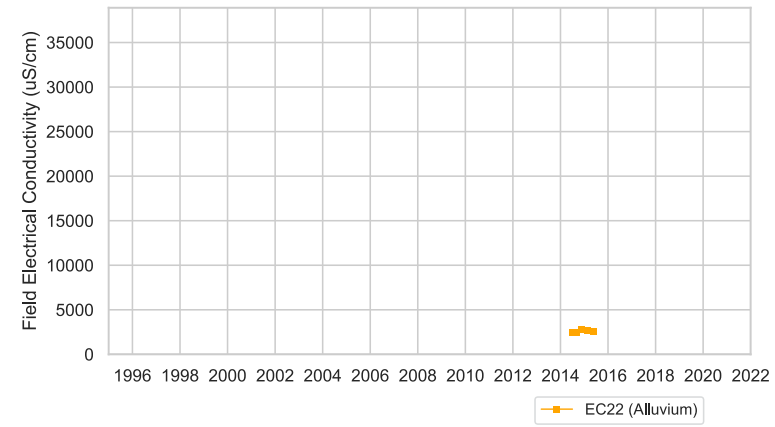

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

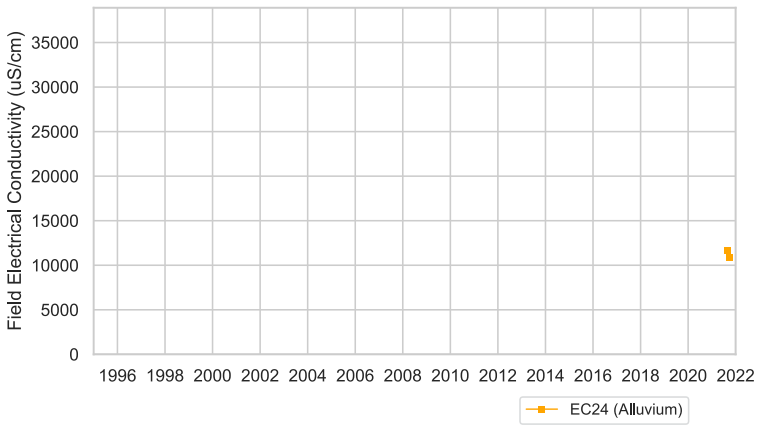

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

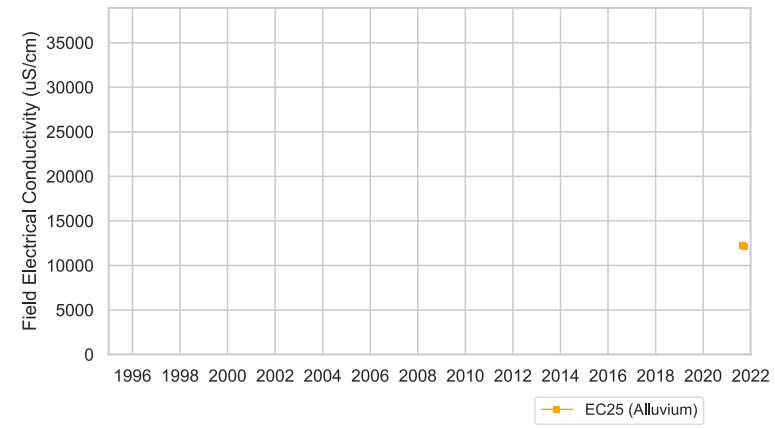

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

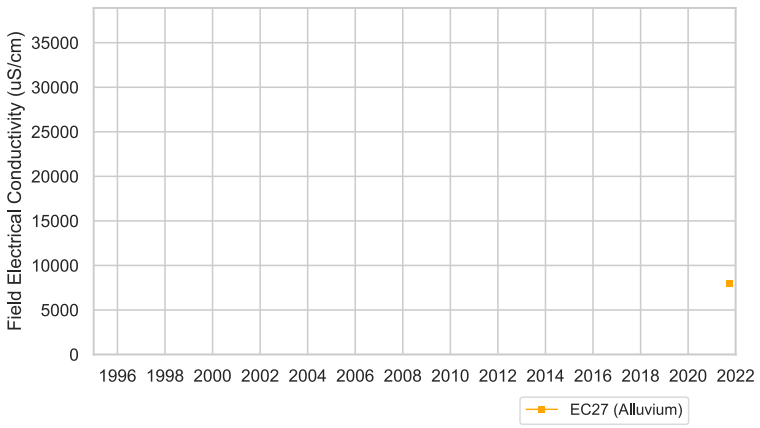

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

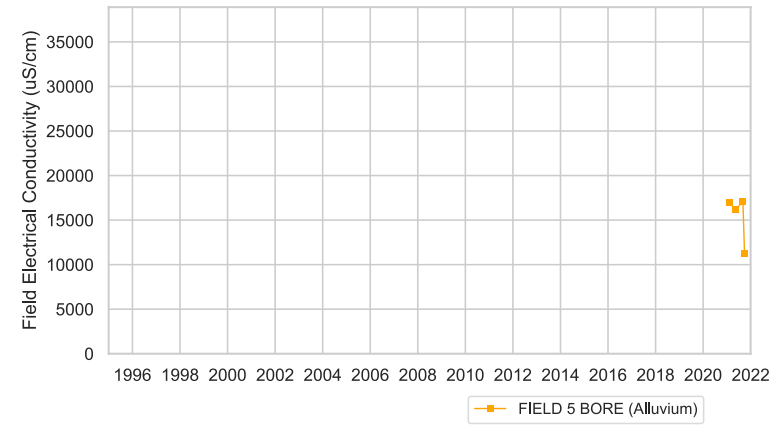

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

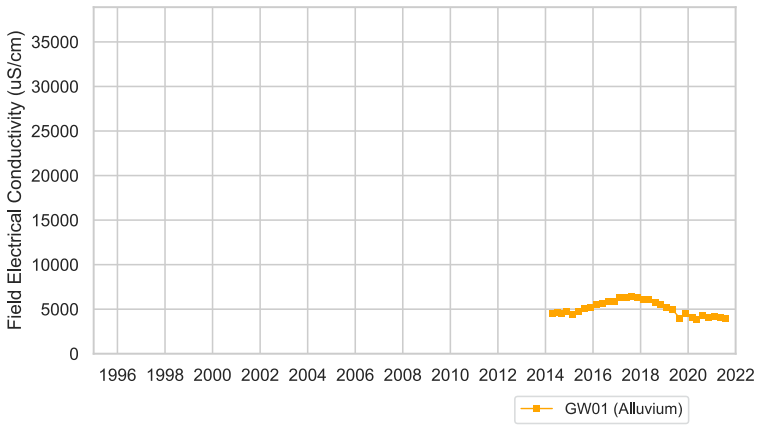

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

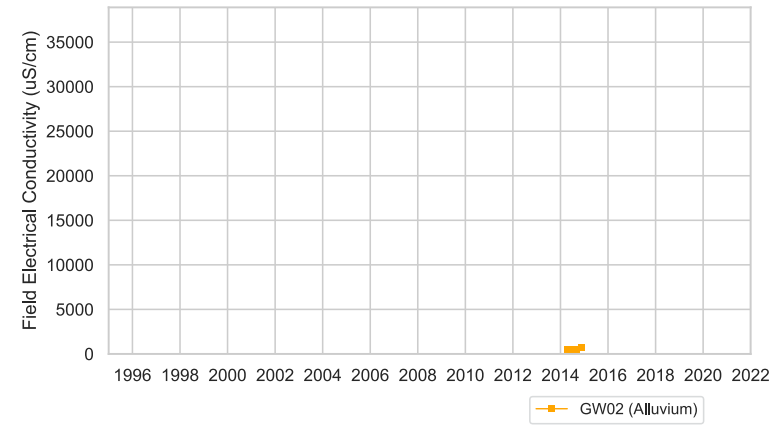

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

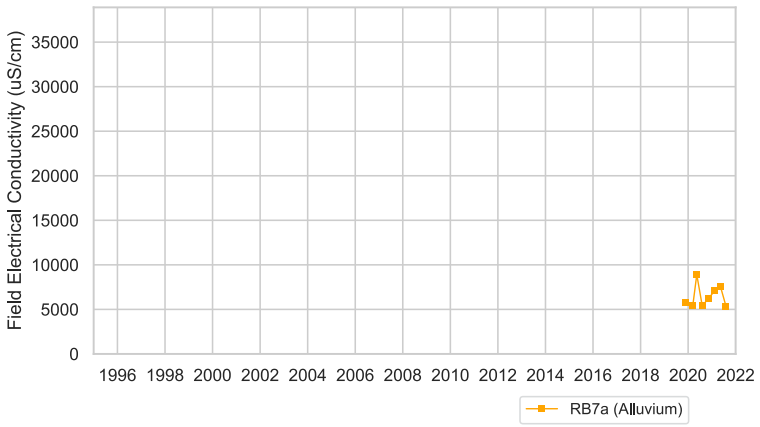

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

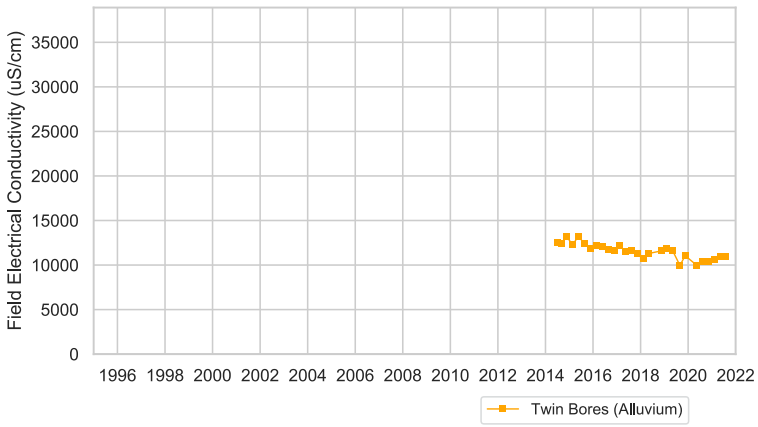

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

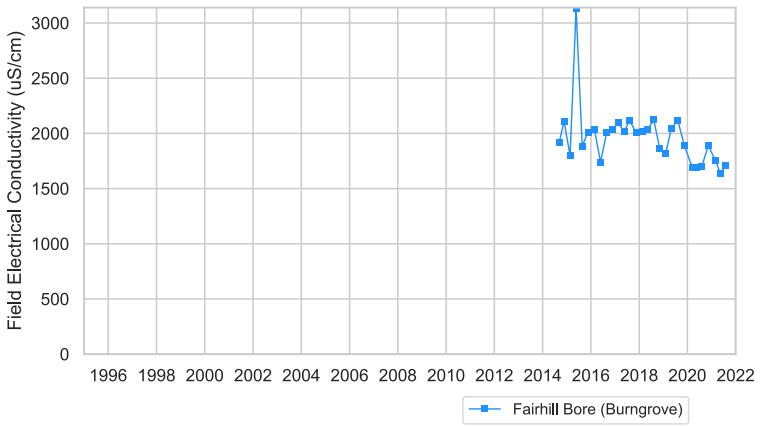

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

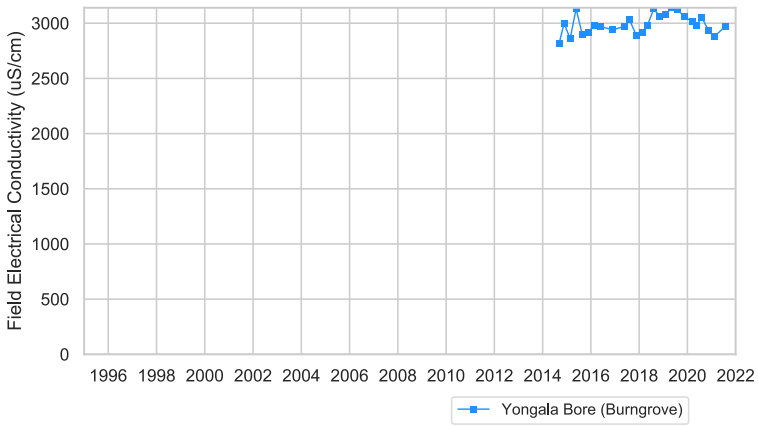

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

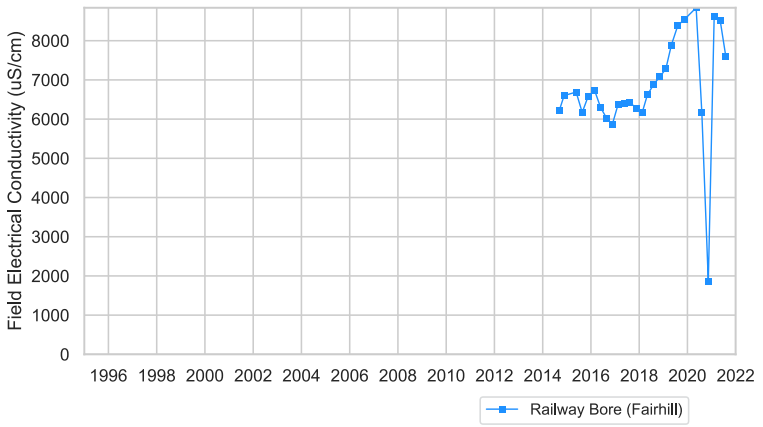

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

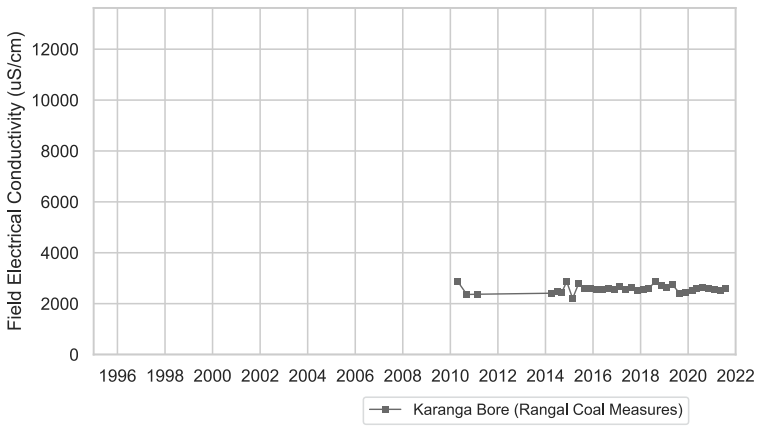

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

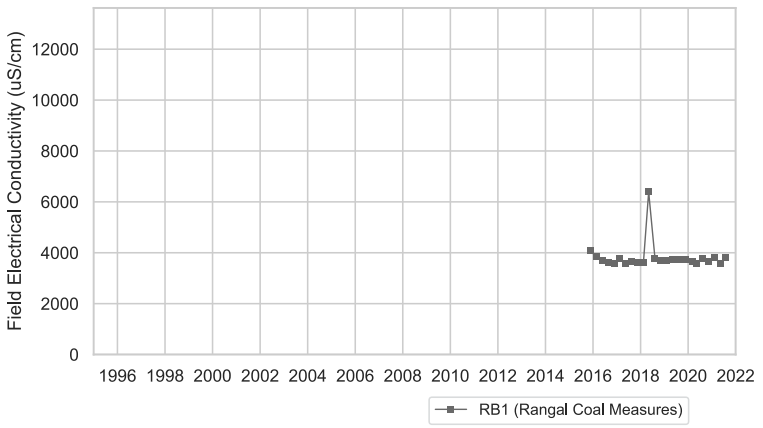

Field Electrical Conductivity (uS/cm)
0
5000
10000
15000
20000
25000
30000
35000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

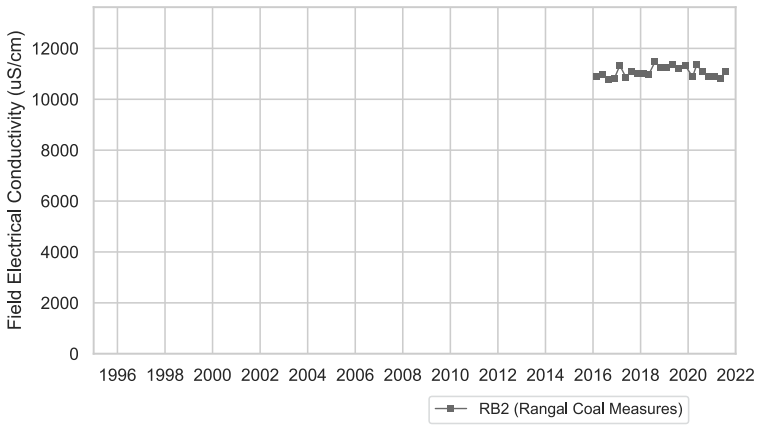

Field Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

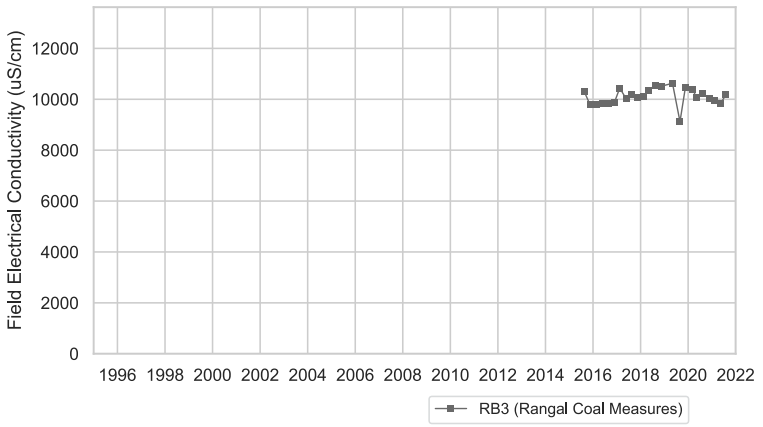

Field Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

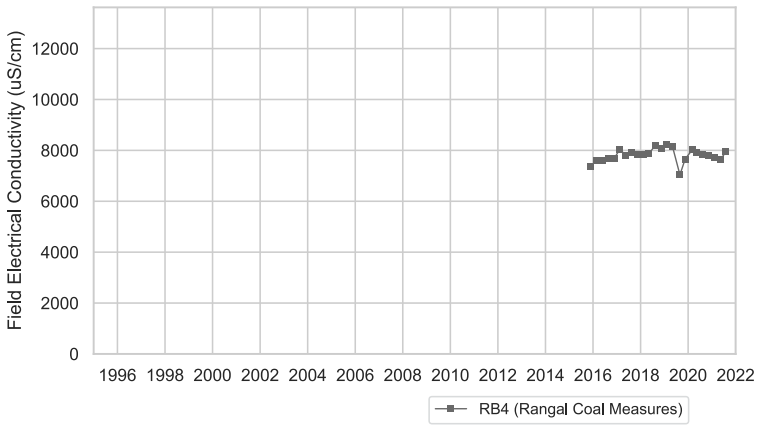

Field Electrical Conductivity (uS/cm)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

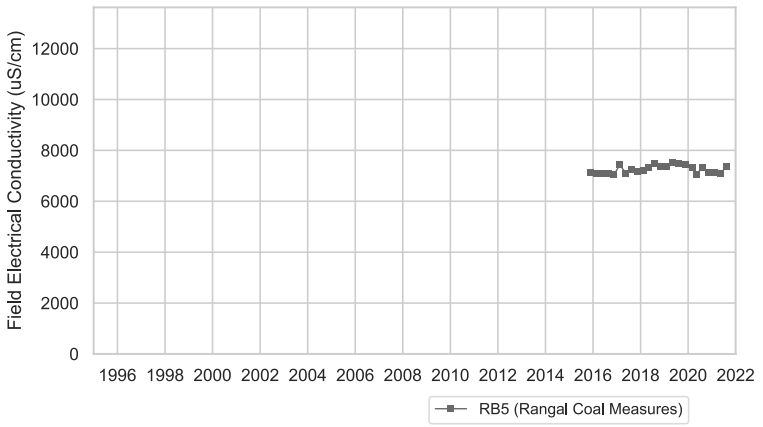

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

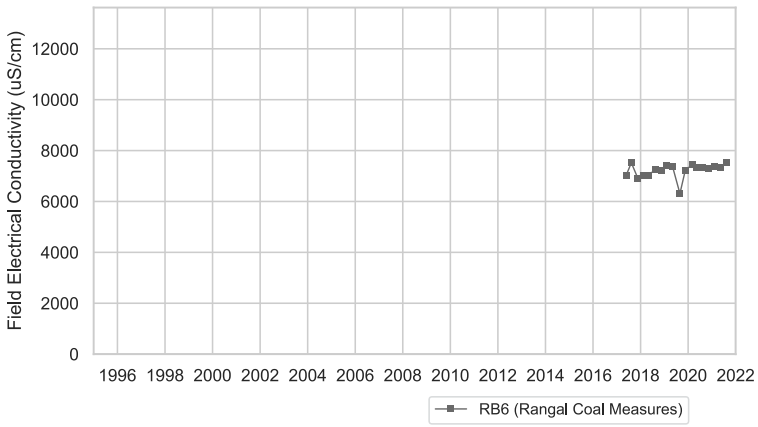

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

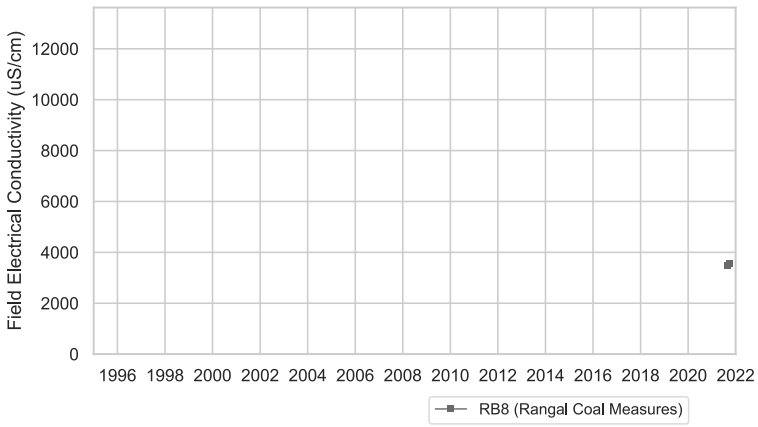

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

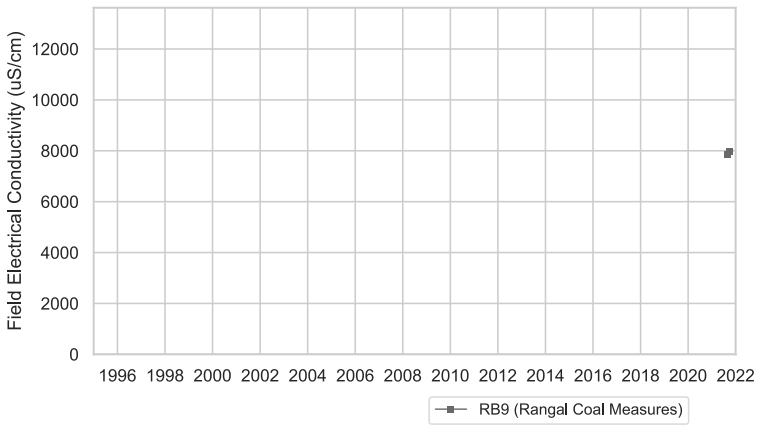

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

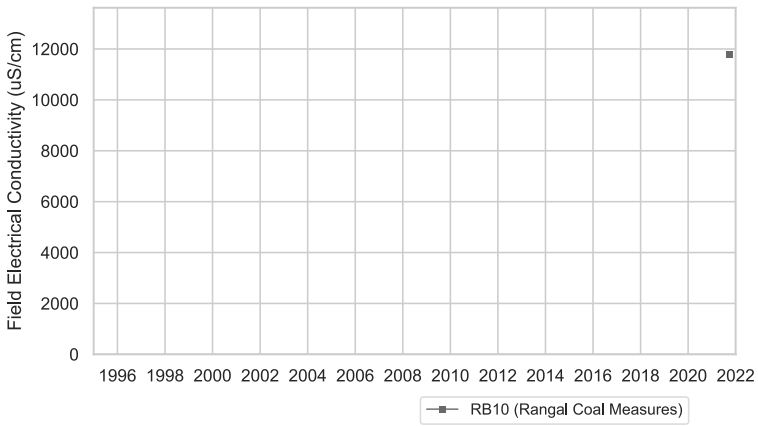

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

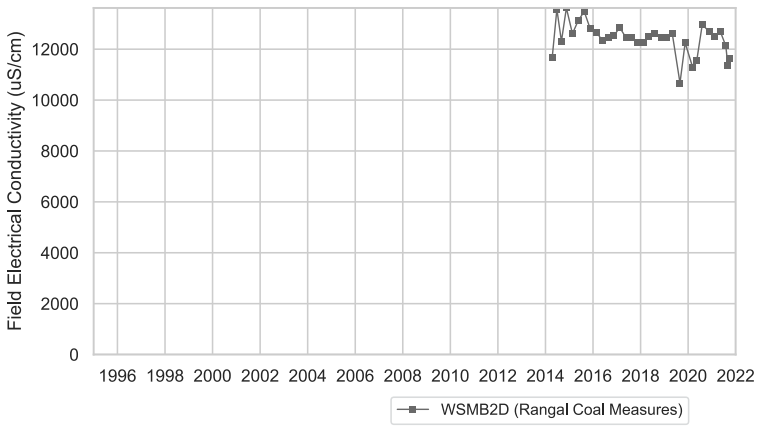

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

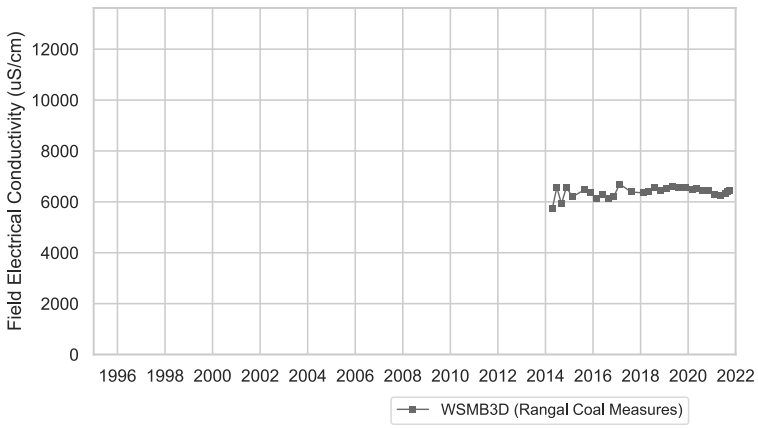

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

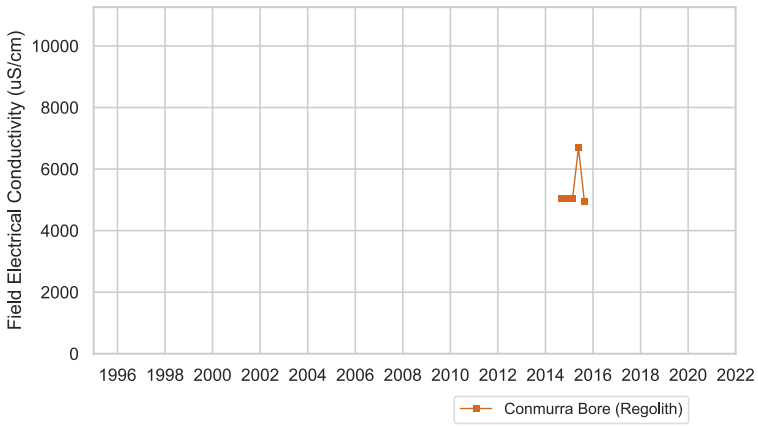

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)


Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)


Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

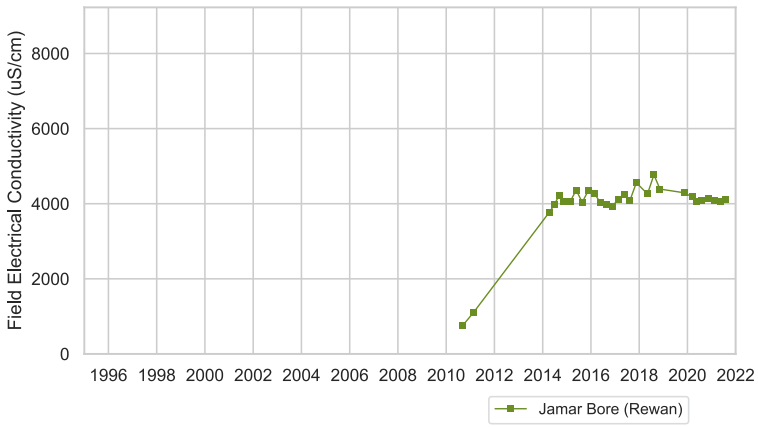

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

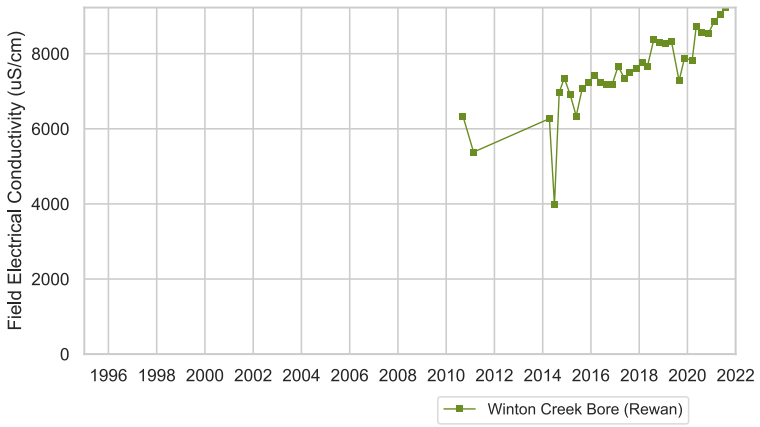

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

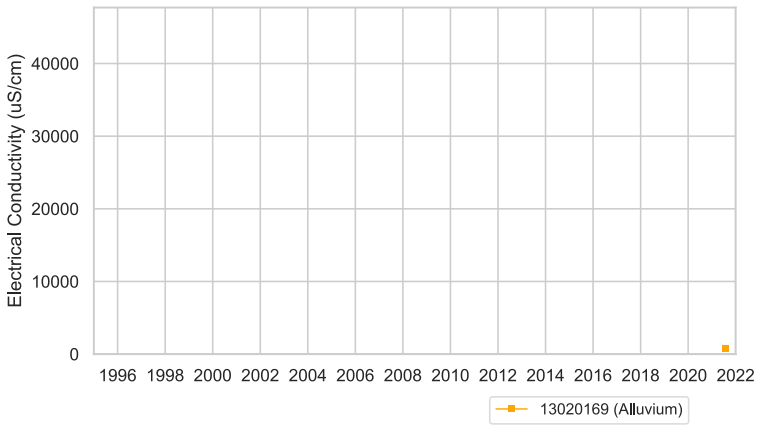

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

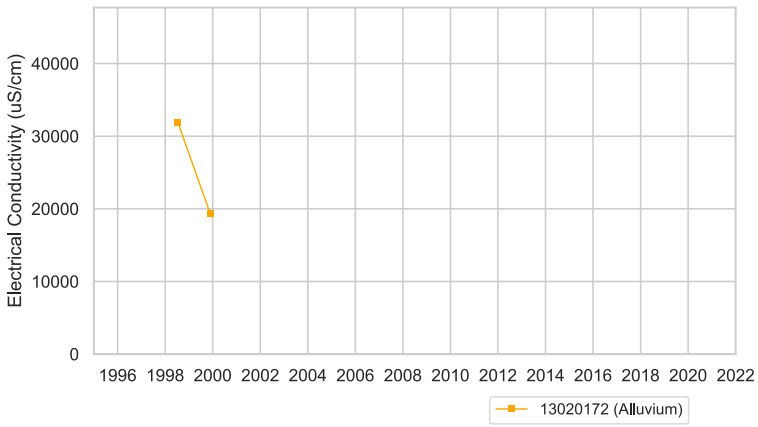
Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

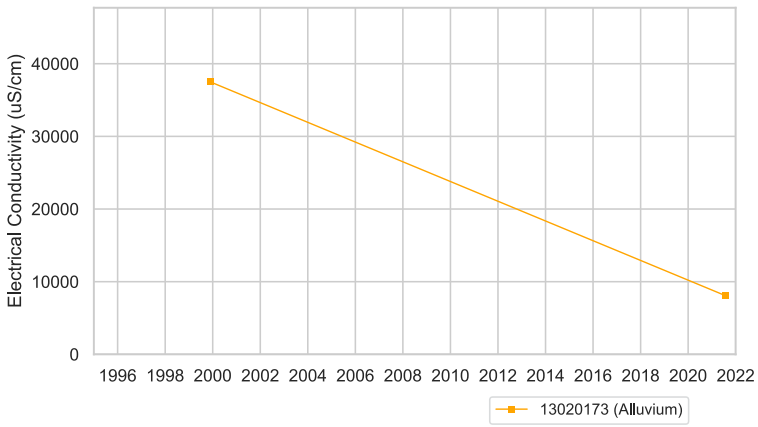
Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

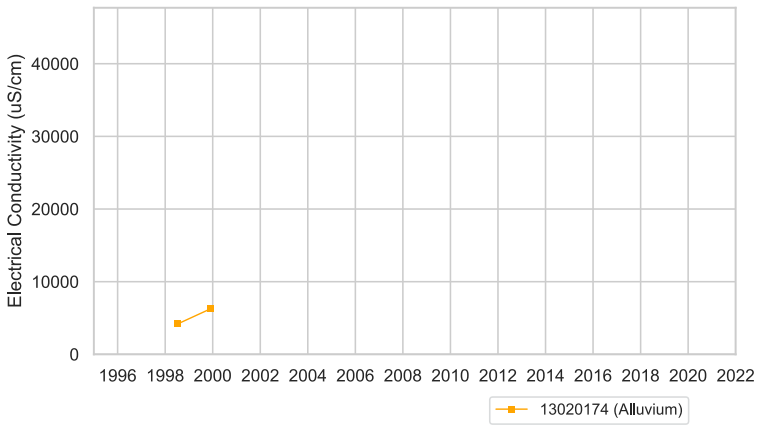

Field Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

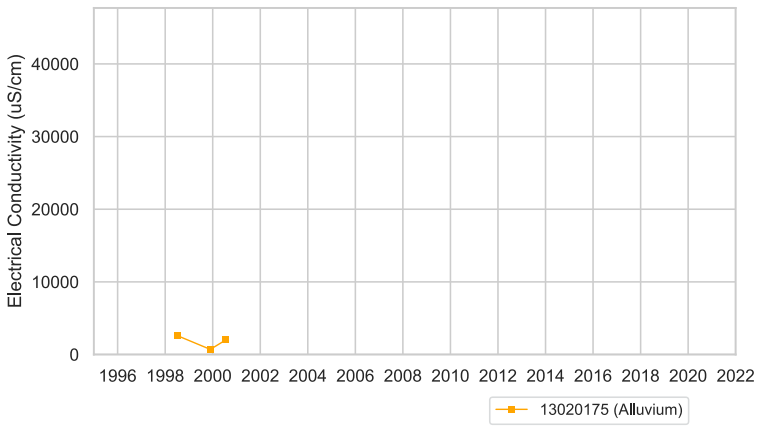

Field Electrical Conductivity (uS/cm)
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

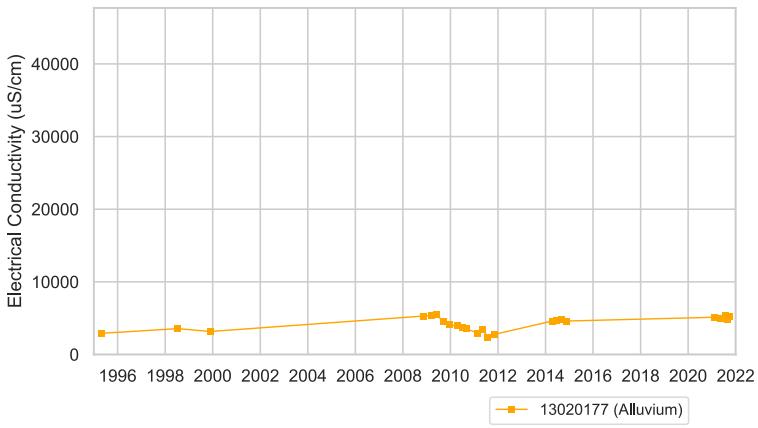

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

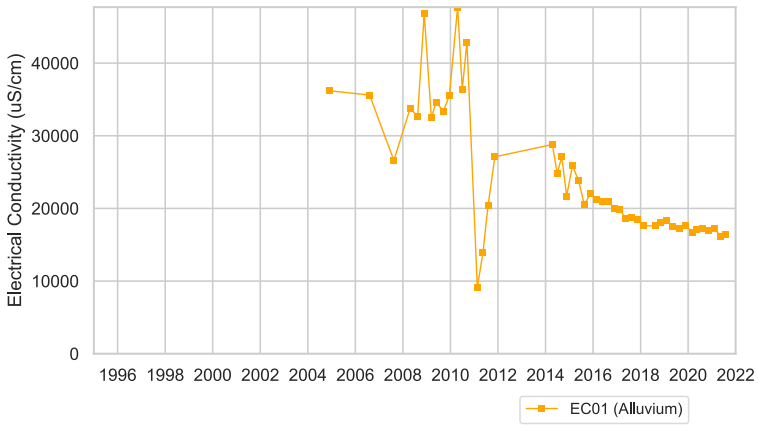

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

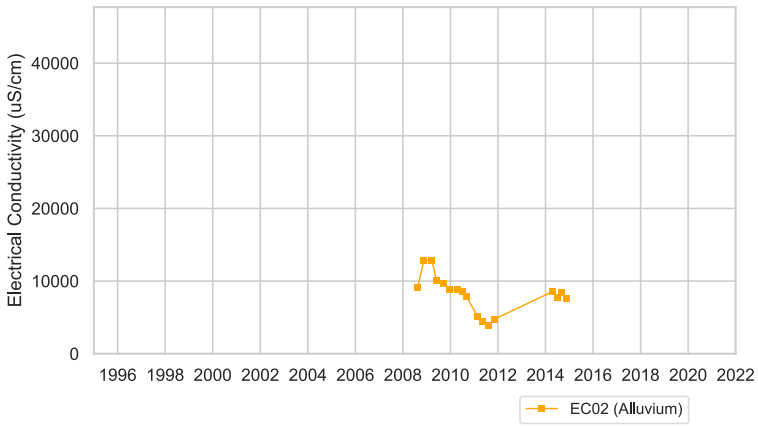

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

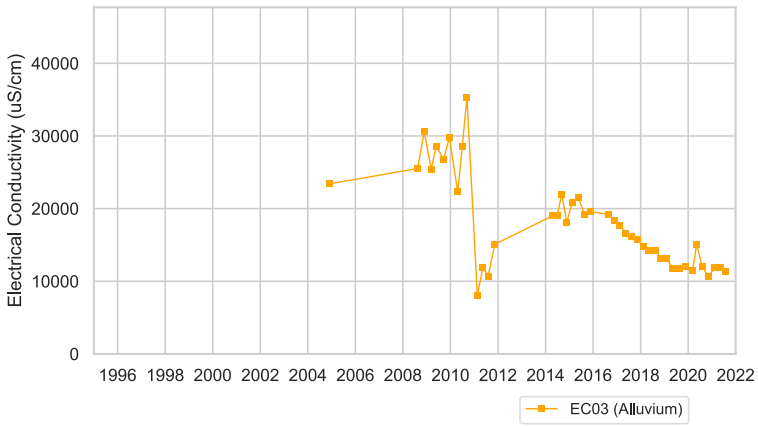

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

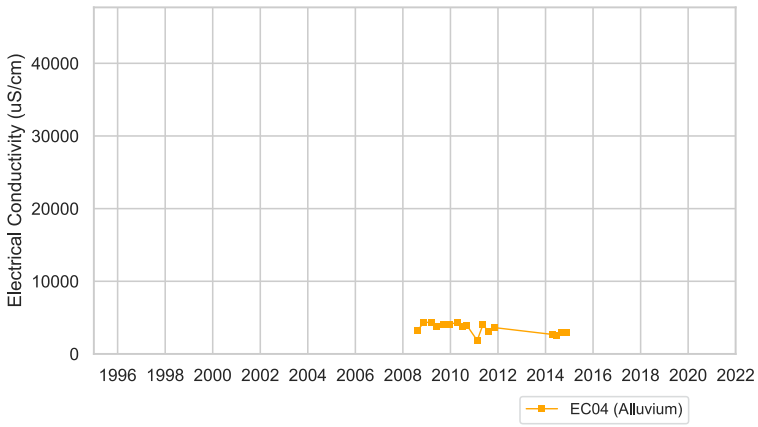

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

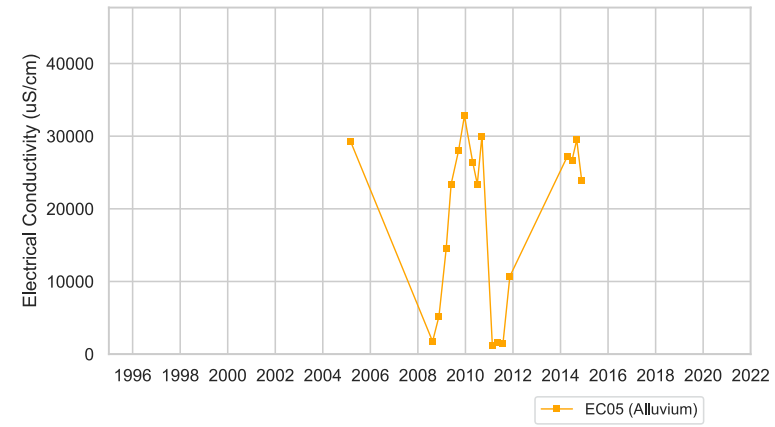

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

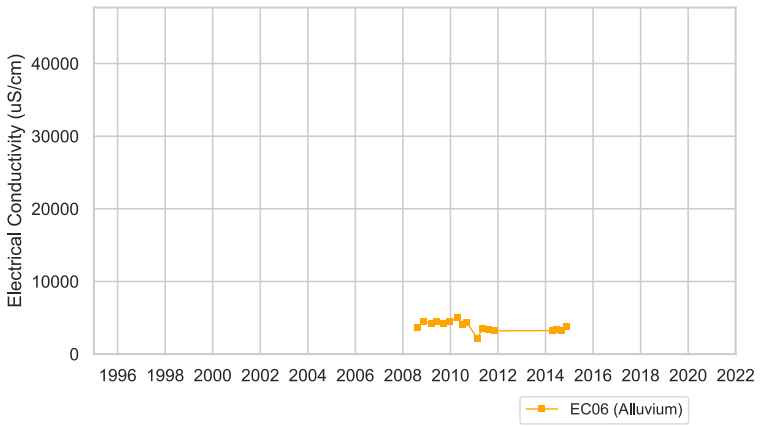

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

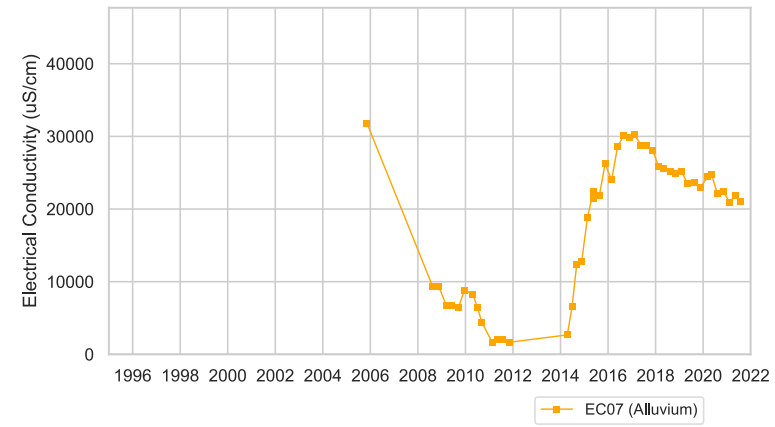

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

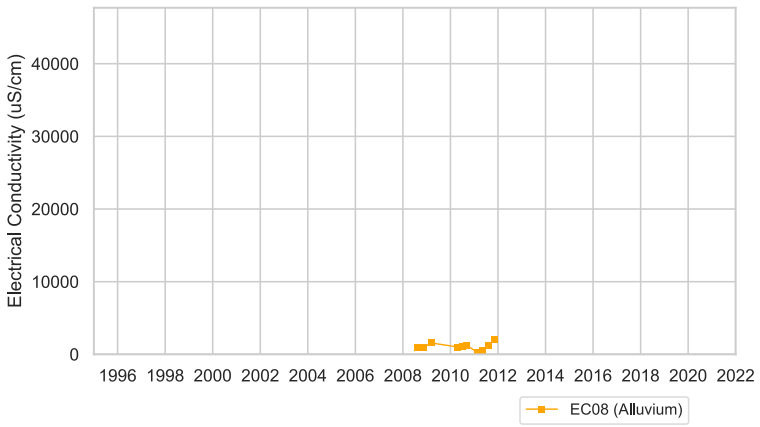

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

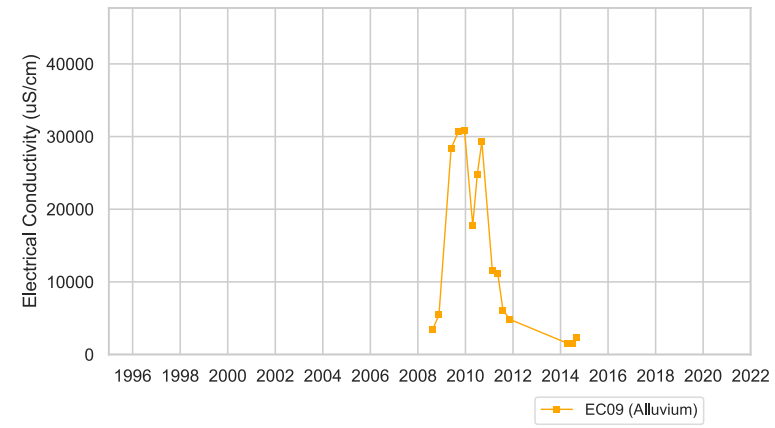

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

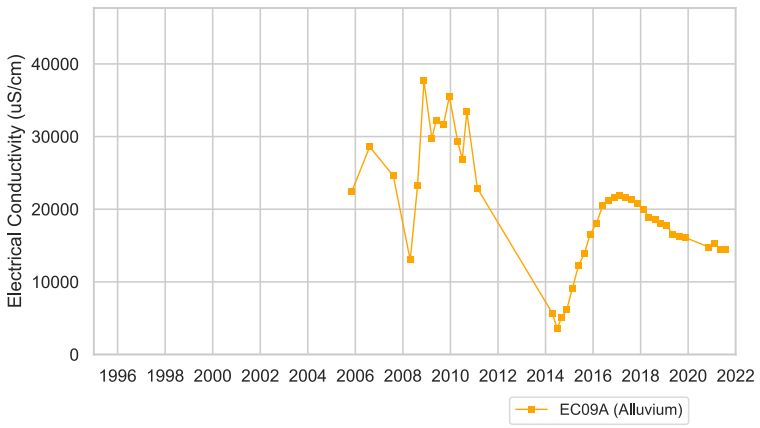

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

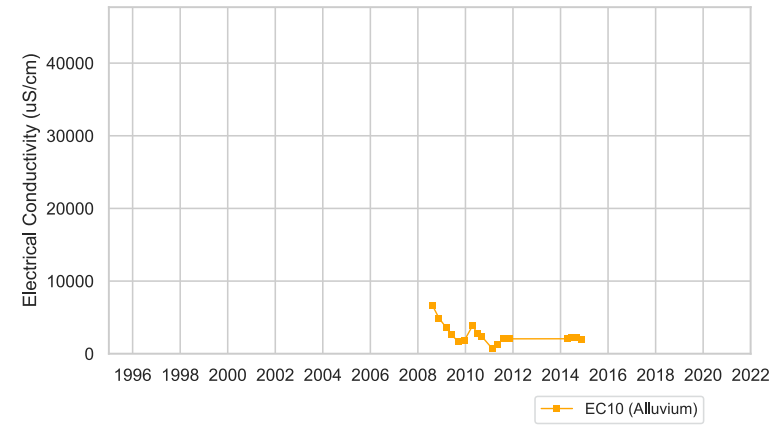

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

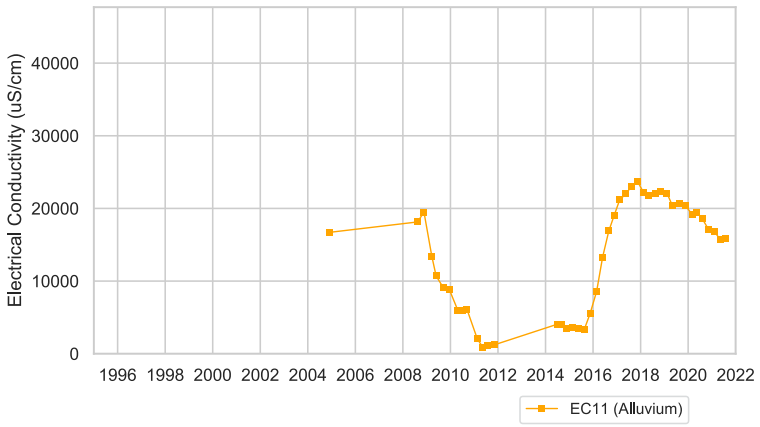

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

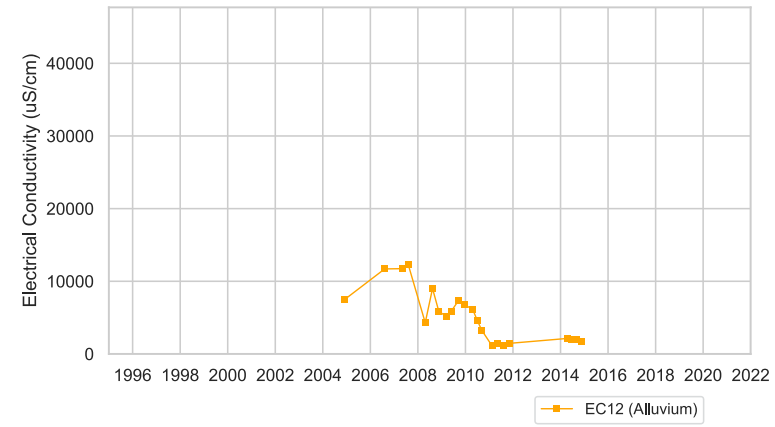

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

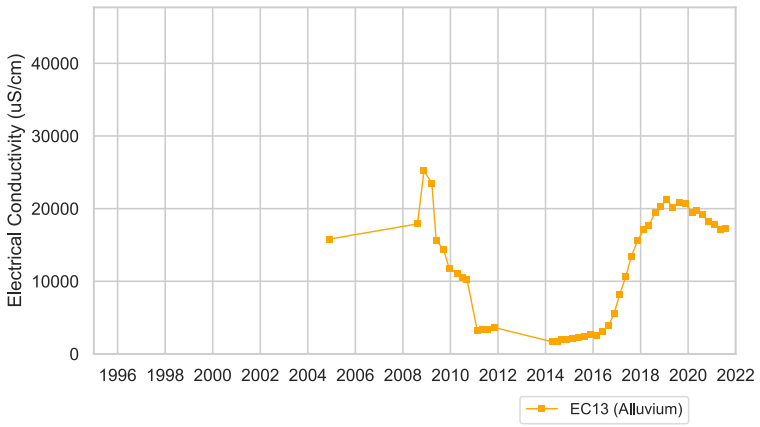

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

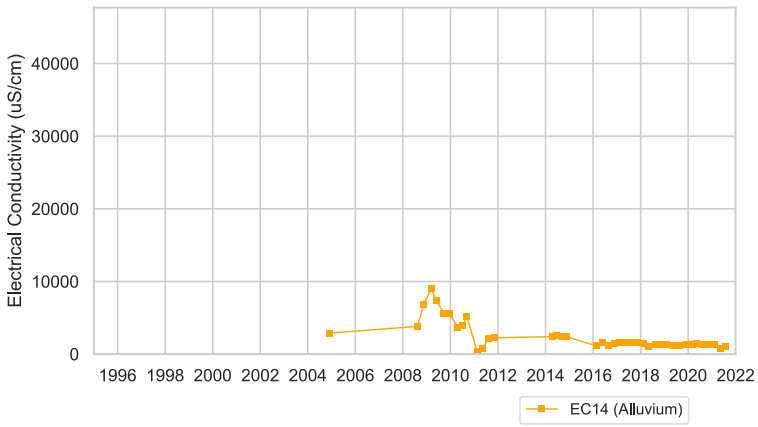

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

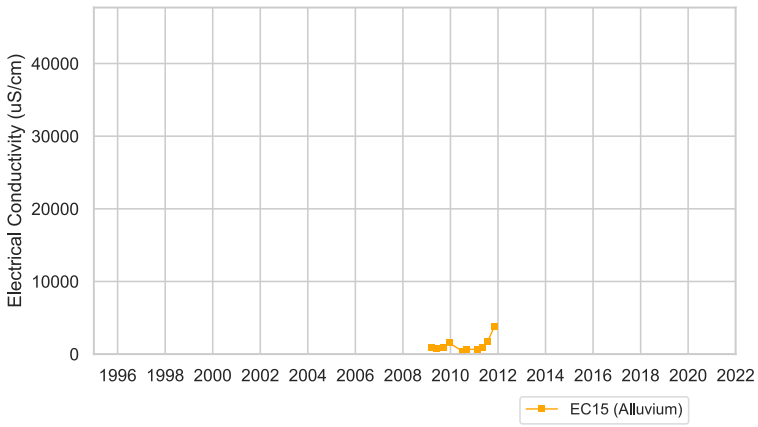

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

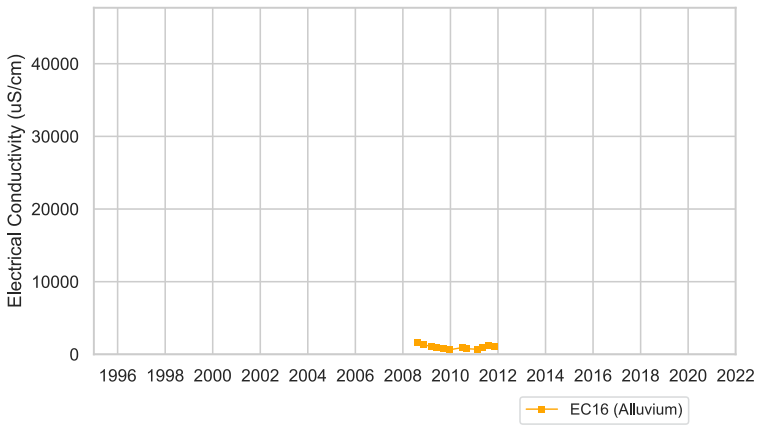

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

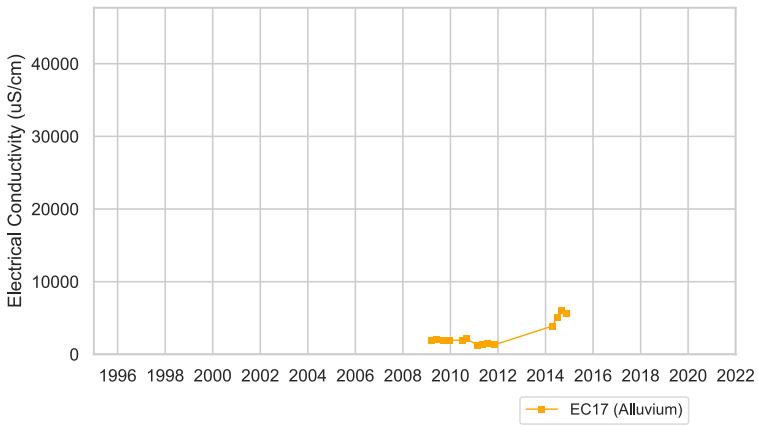

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

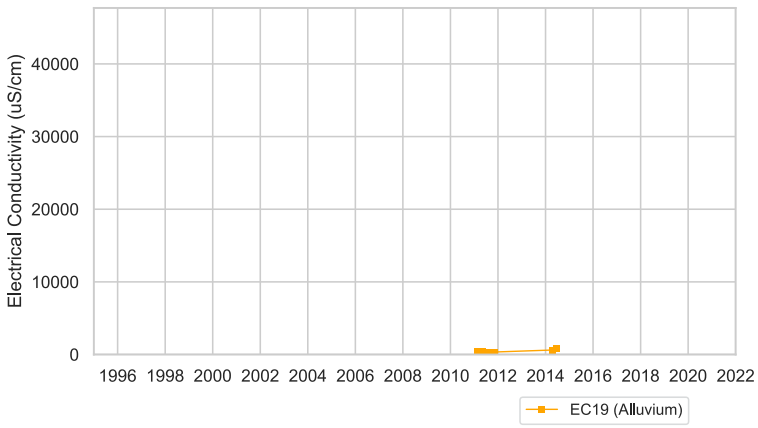

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

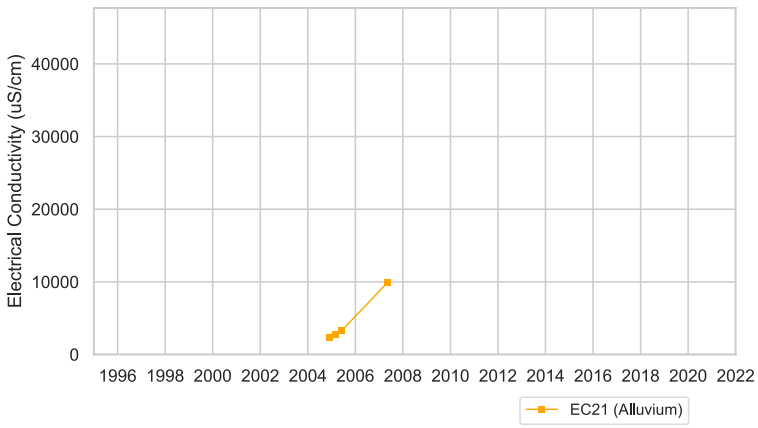

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

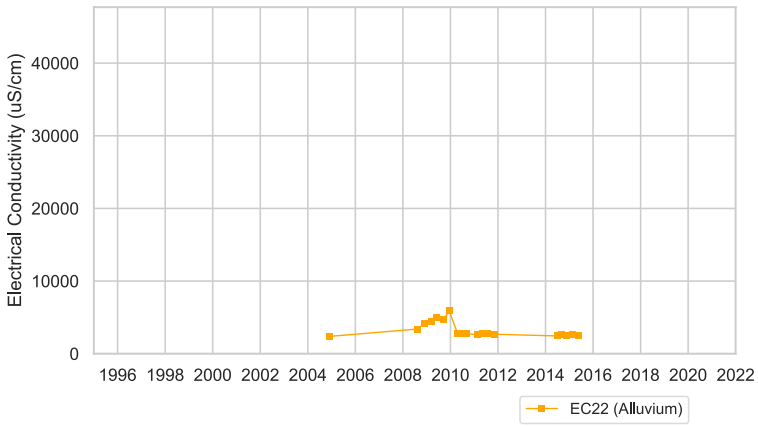

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

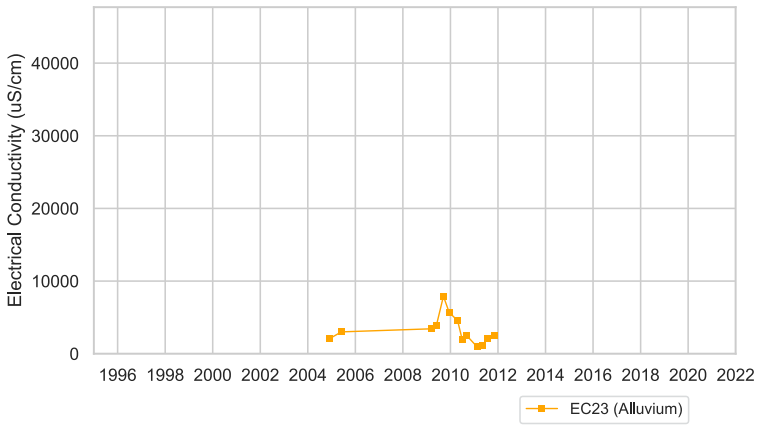

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

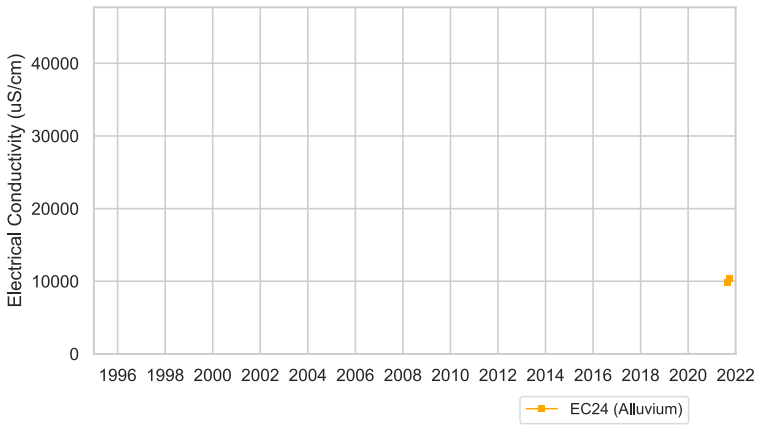

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

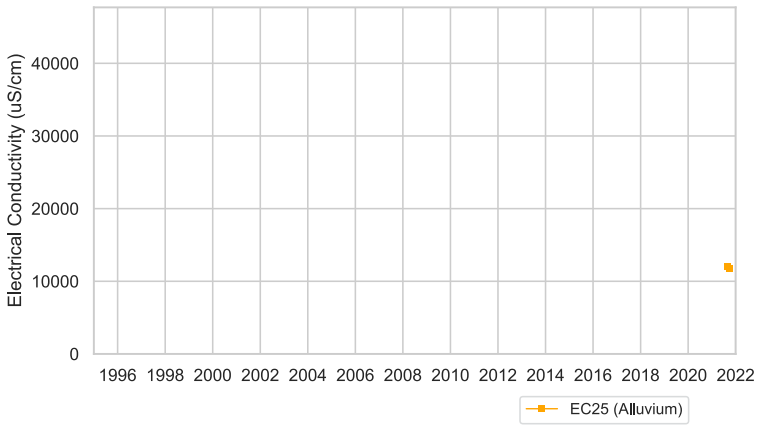

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

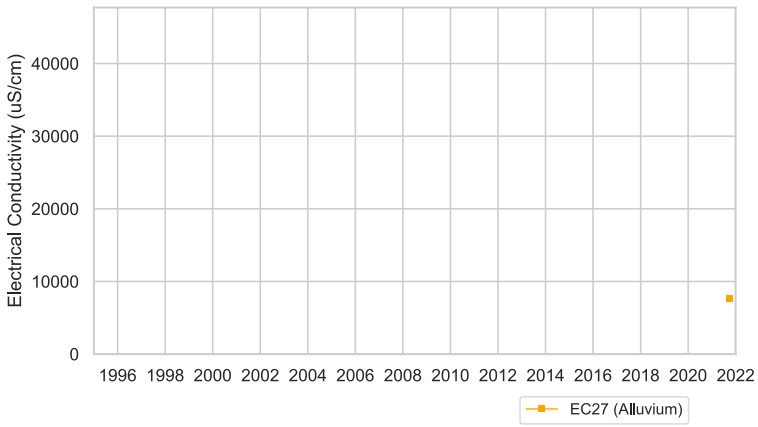

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

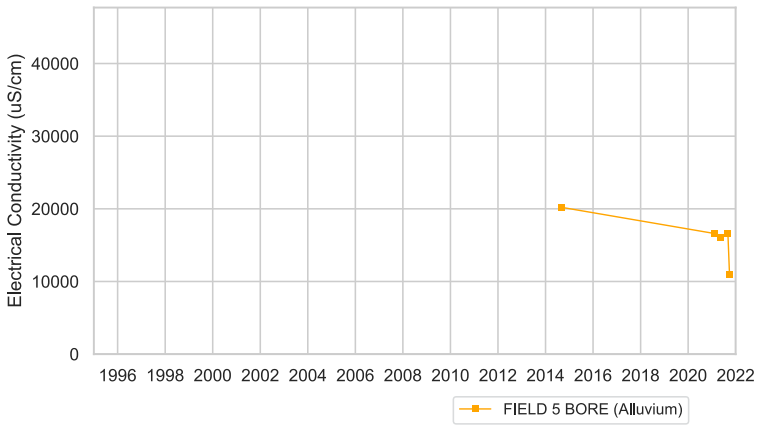

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

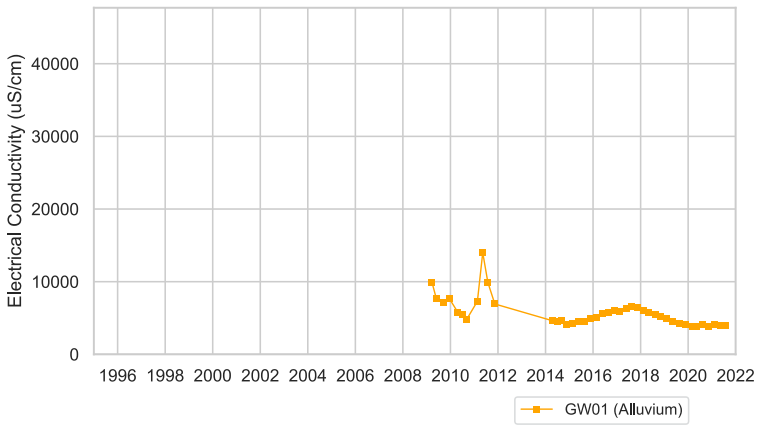

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

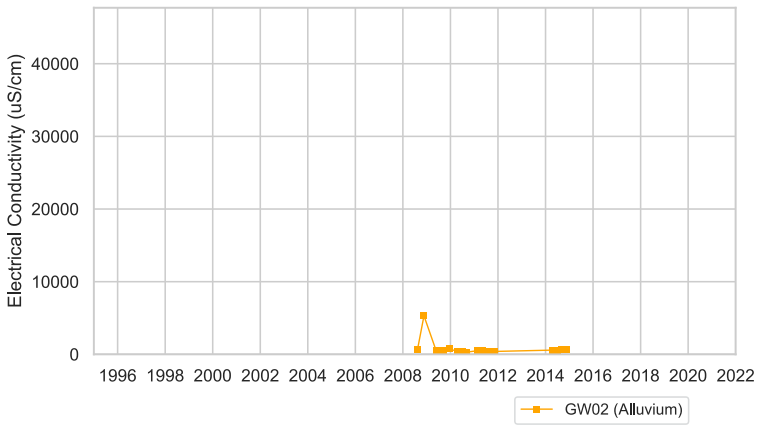

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

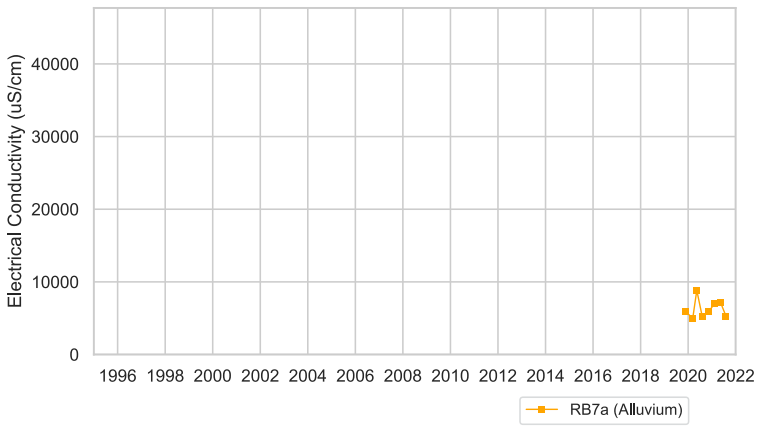

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

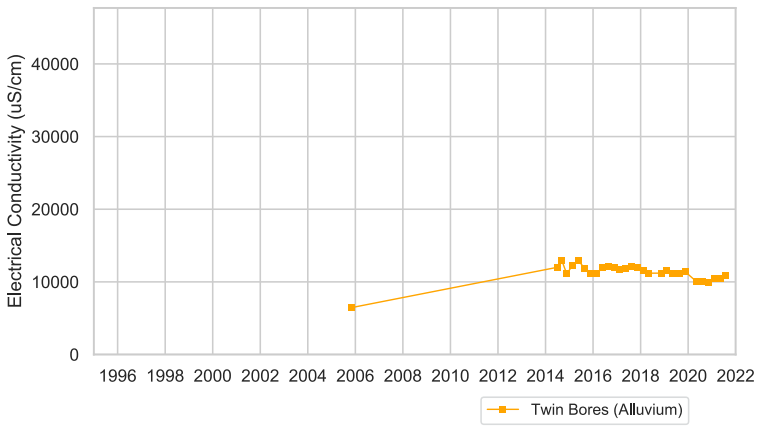

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

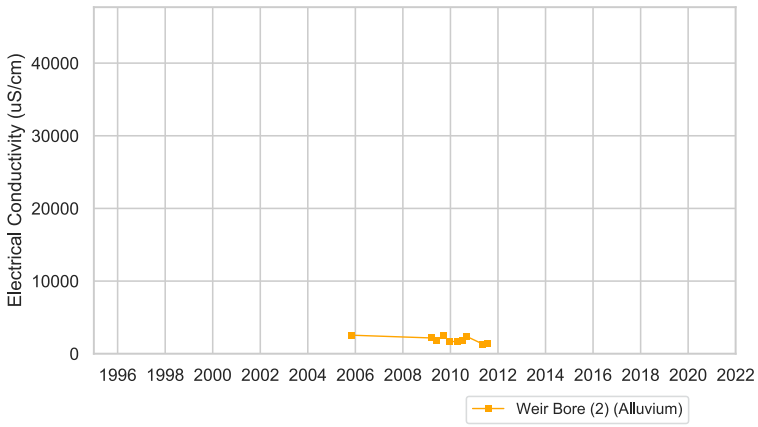

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

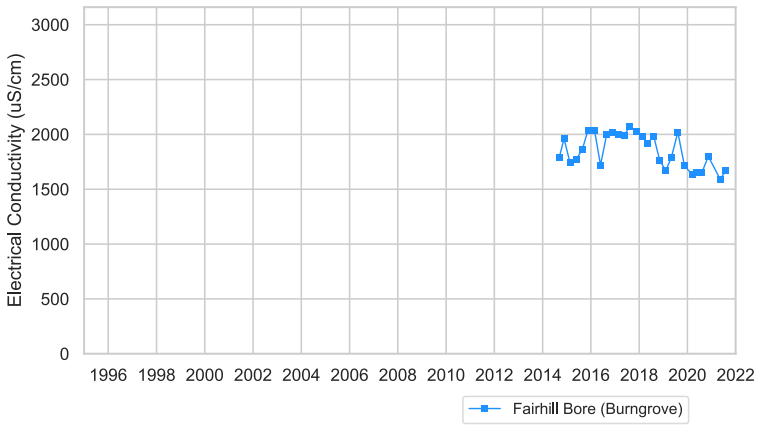

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

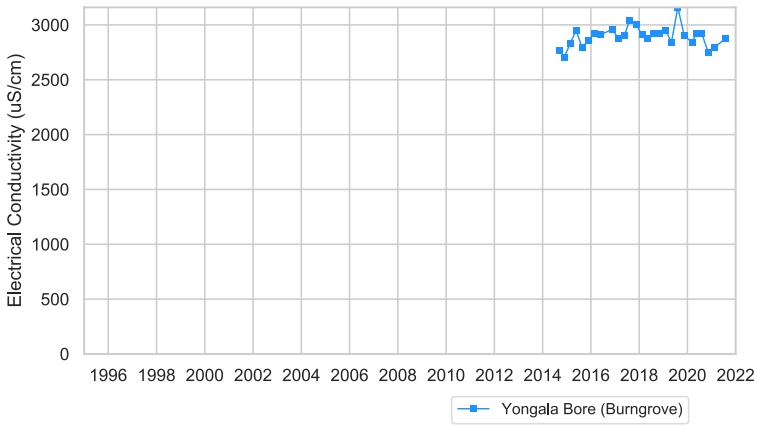

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

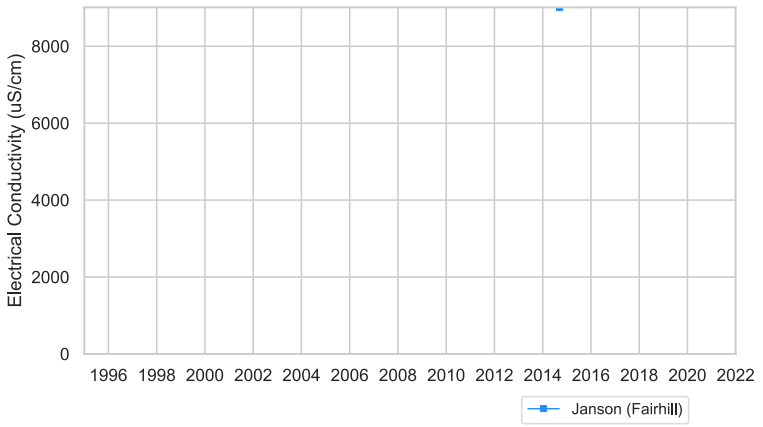

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

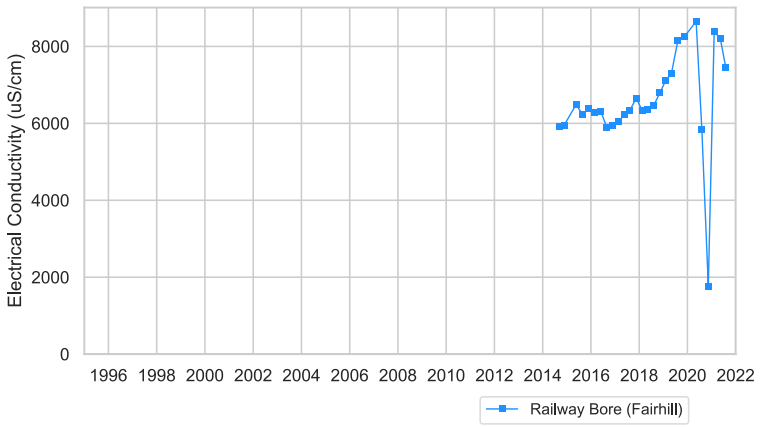

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

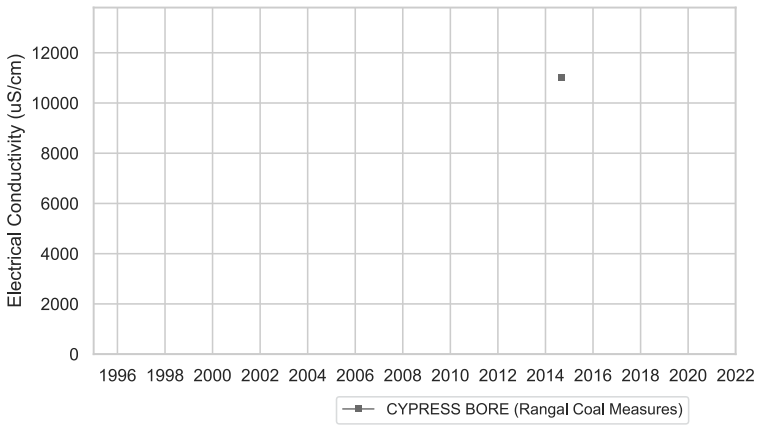

Electrical Conductivity (uS/cm)
0
10000
20000
30000
40000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

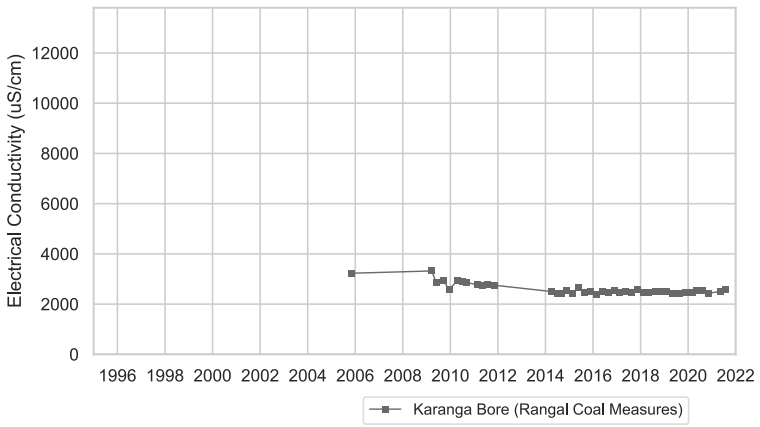

Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

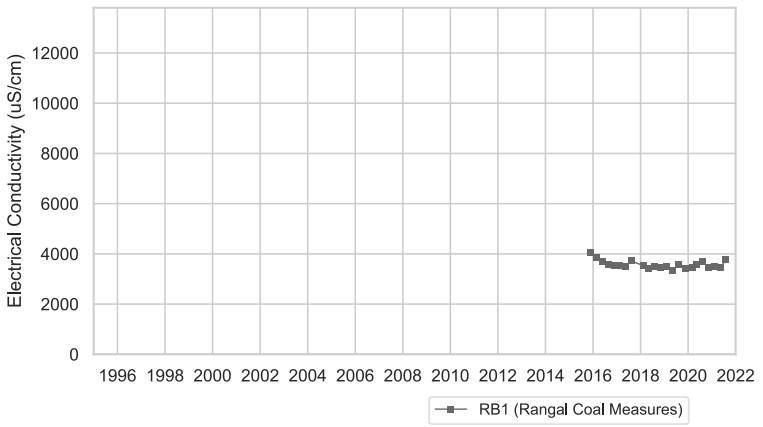

Electrical Conductivity (uS/cm)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

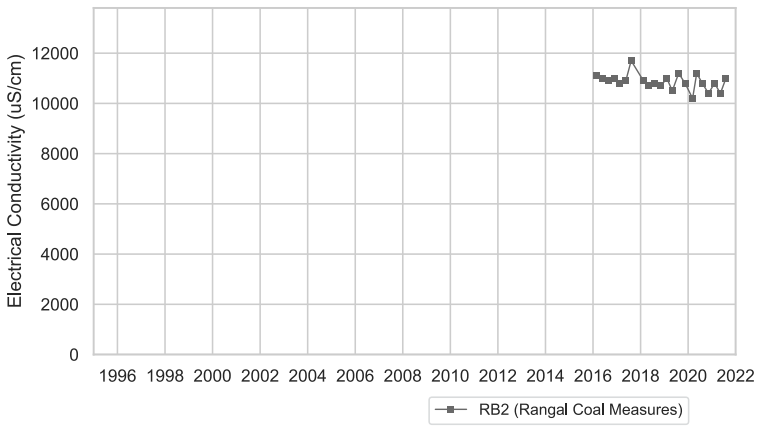

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

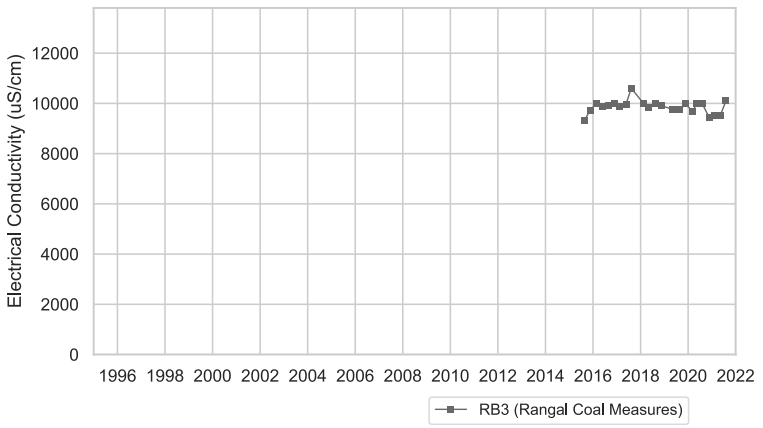

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

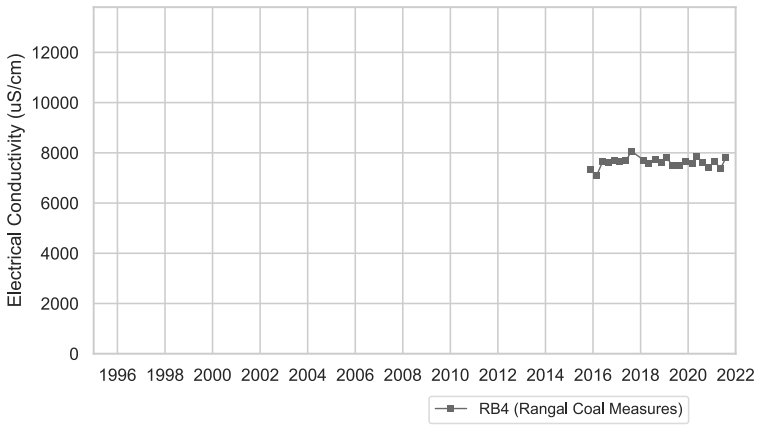

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

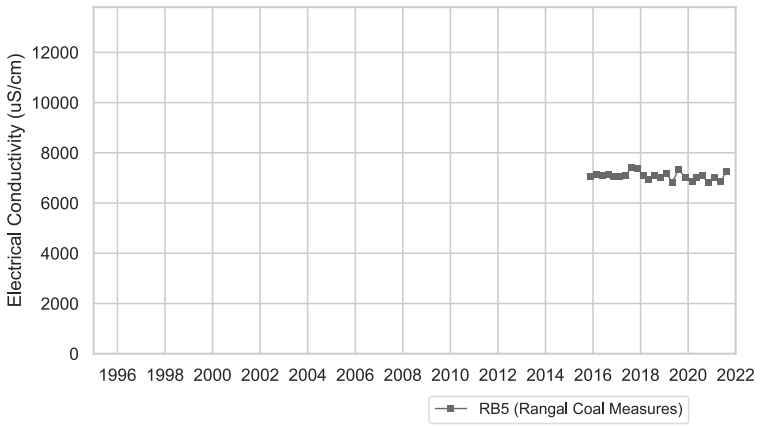

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

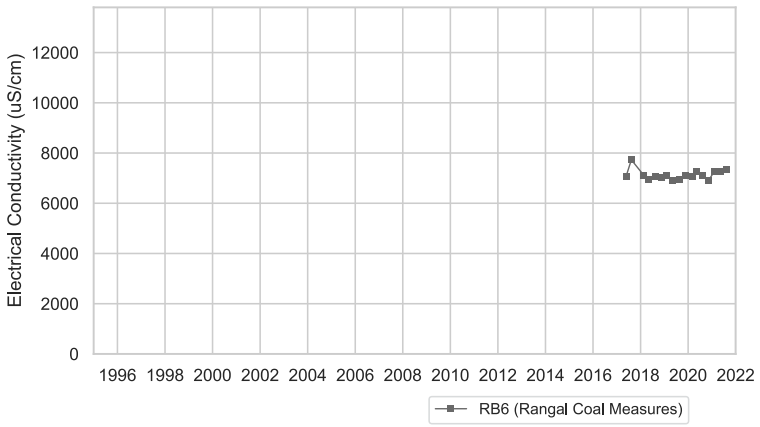

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

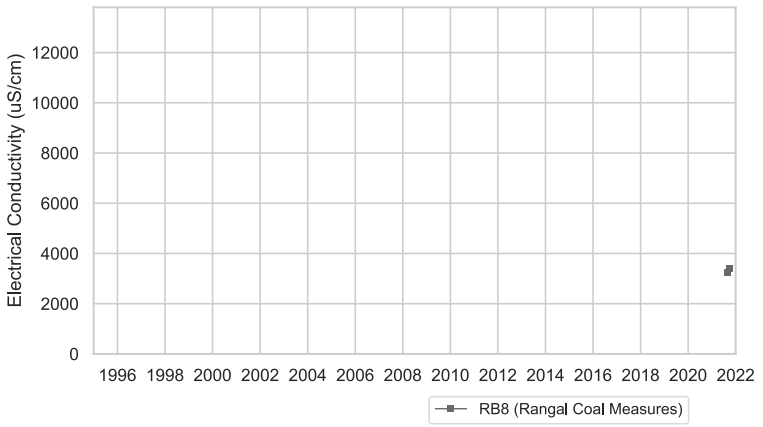

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

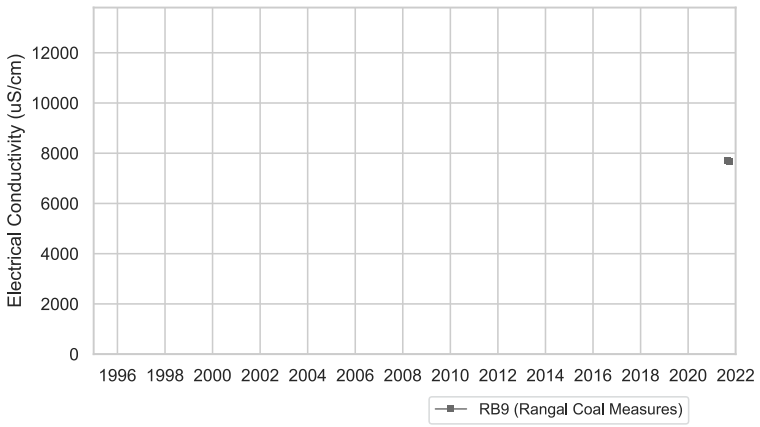

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

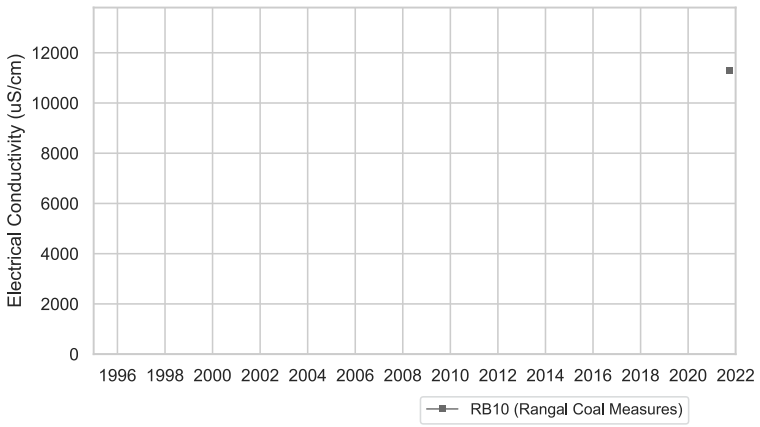

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

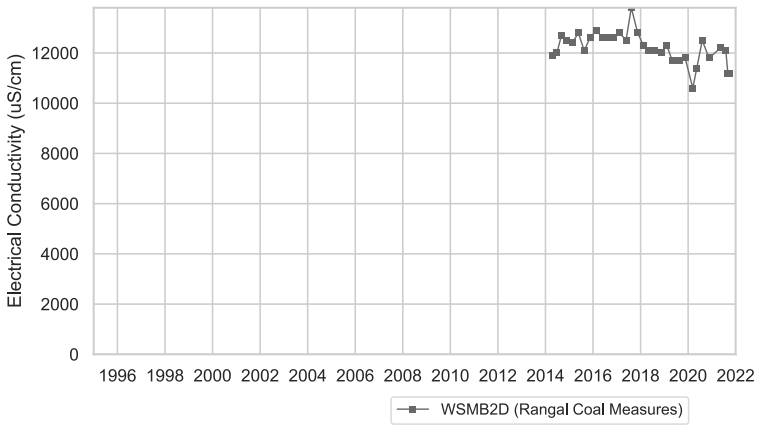

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

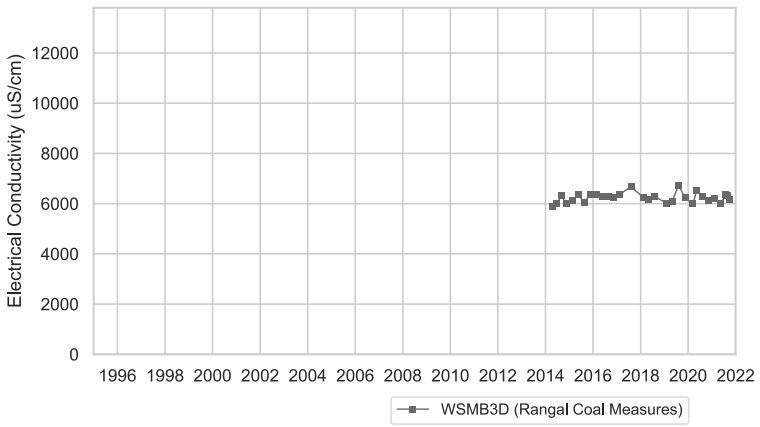

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

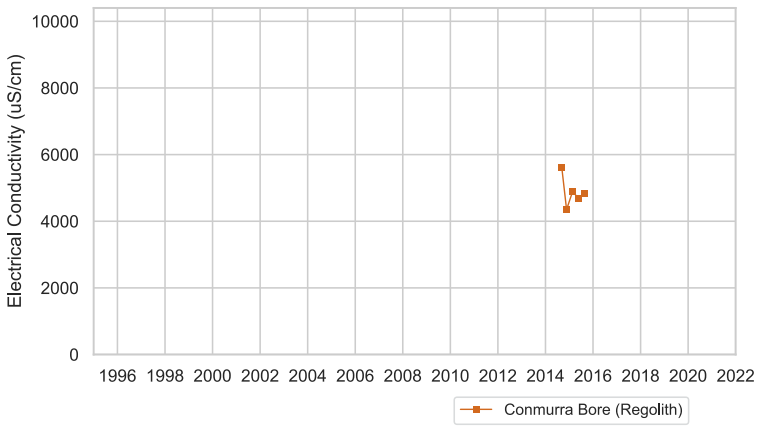

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

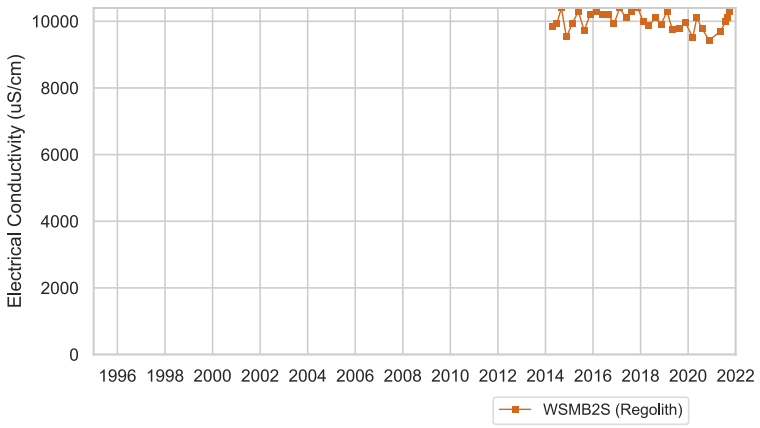

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

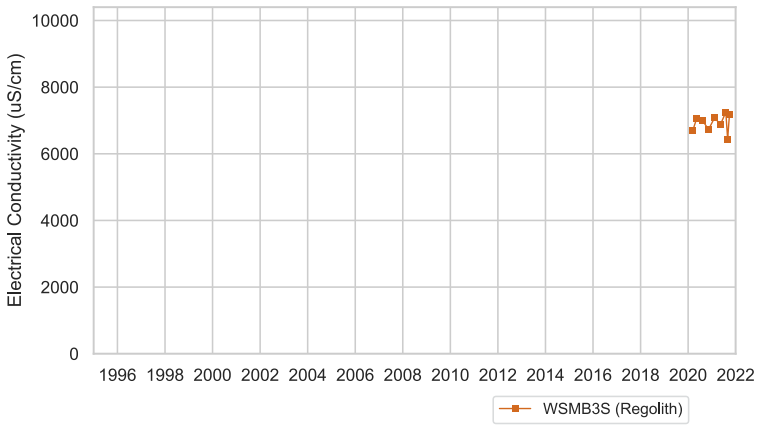

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

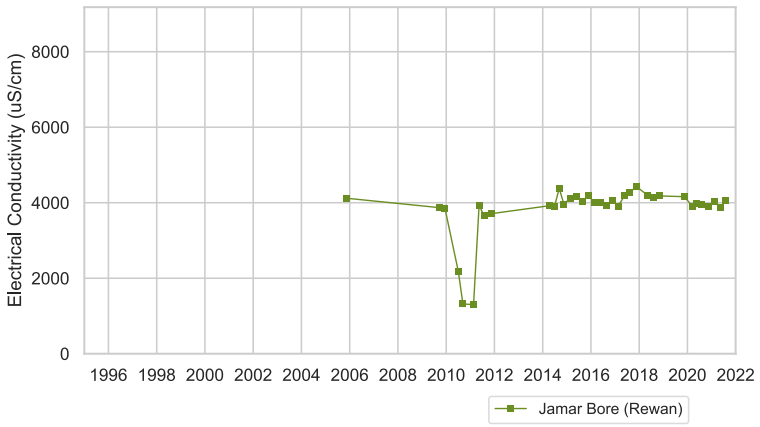

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

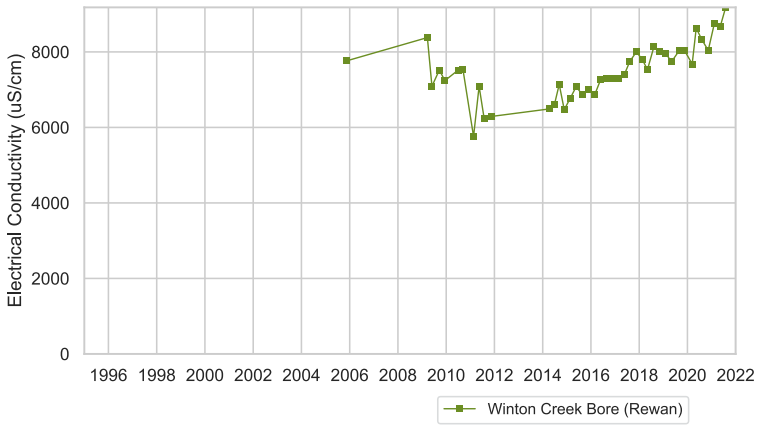

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
12000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

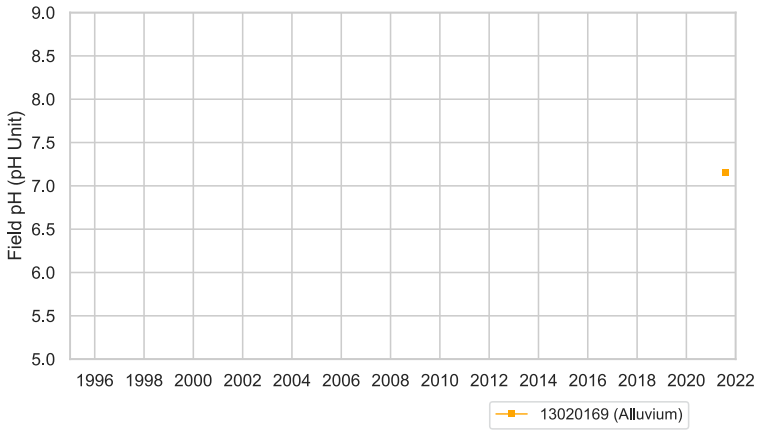

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

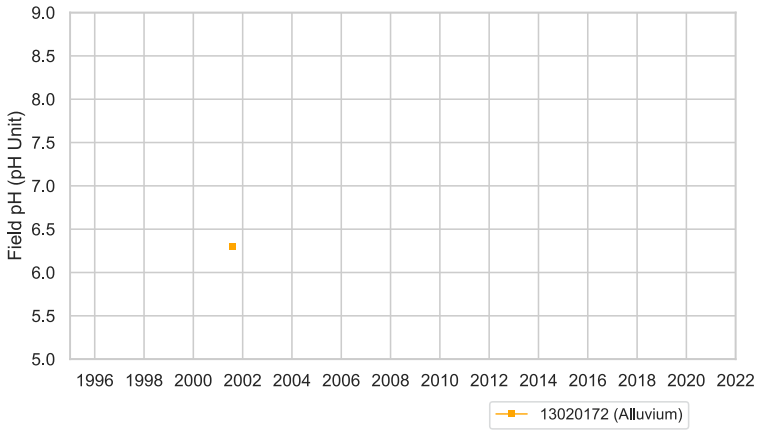

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

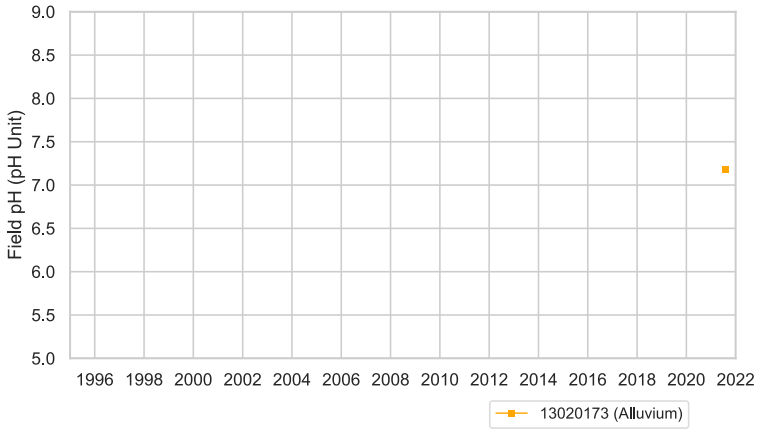

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
10000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

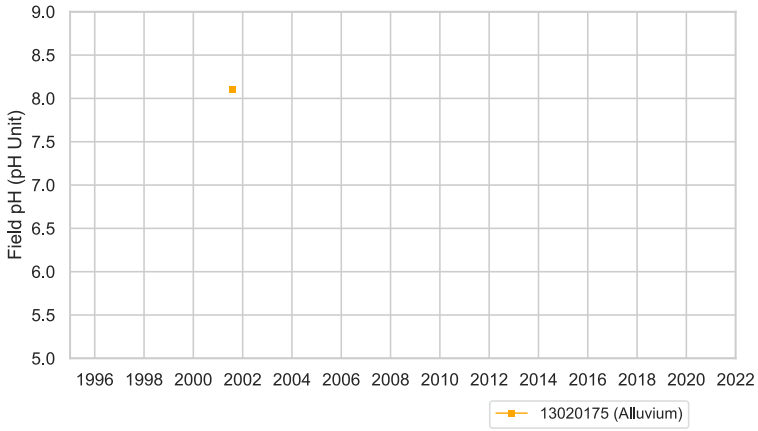

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

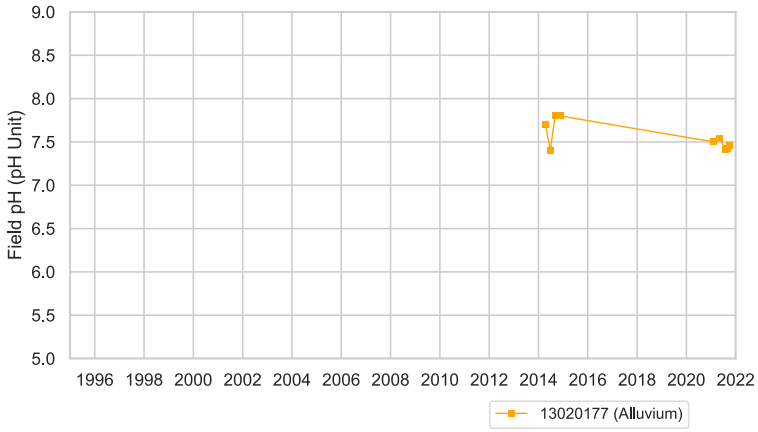

Electrical Conductivity (uS/cm)
0
2000
4000
6000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

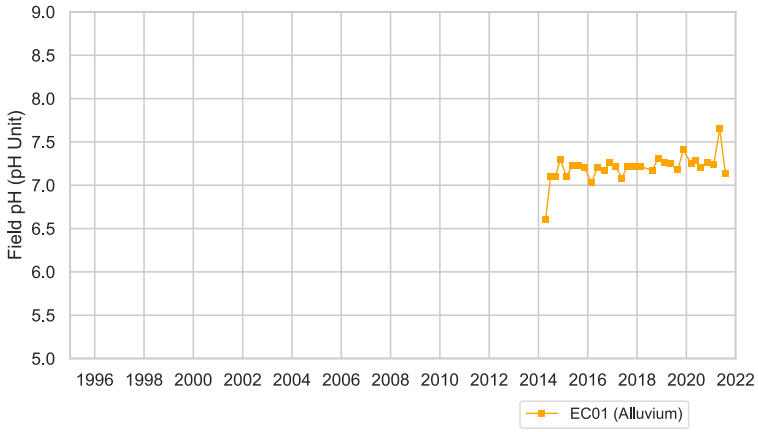

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

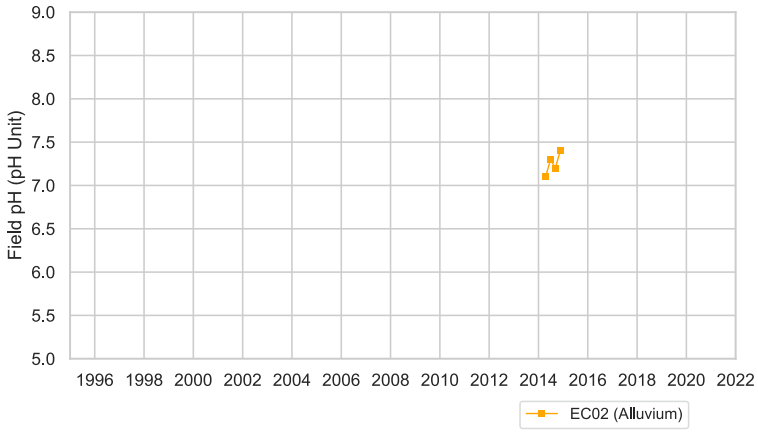

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

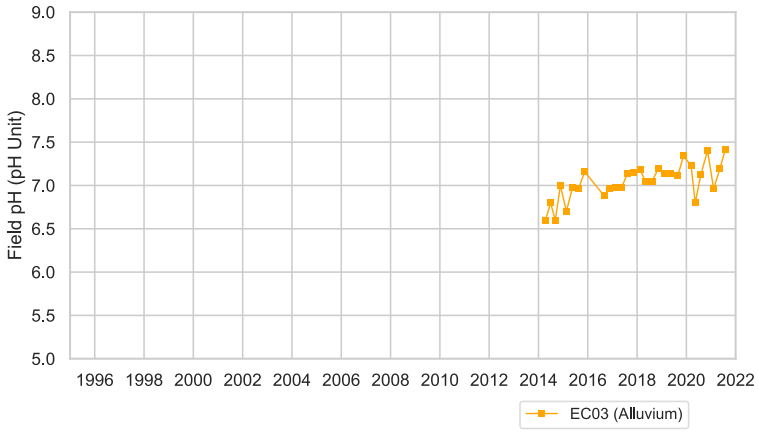

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

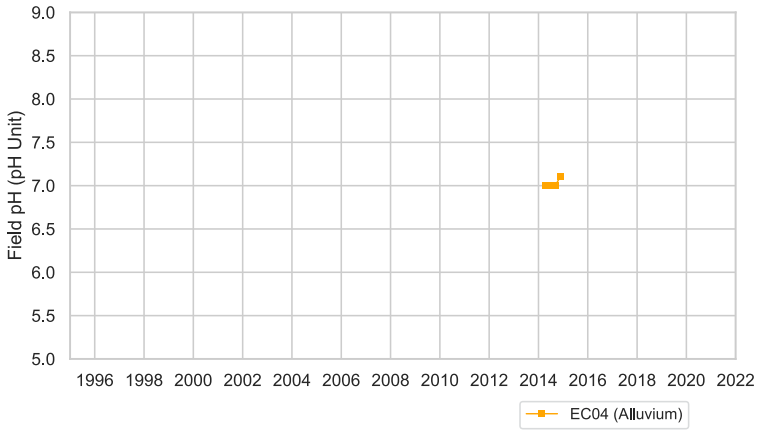

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

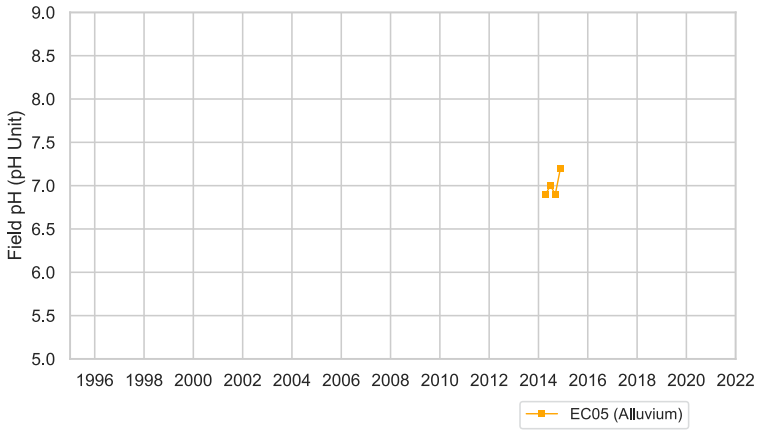

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

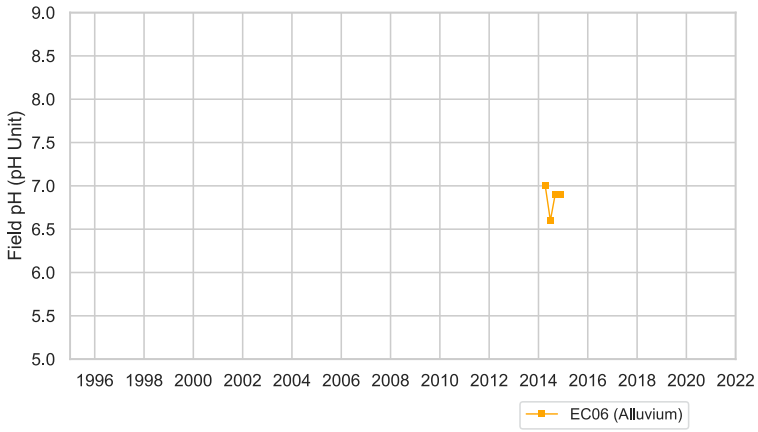

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

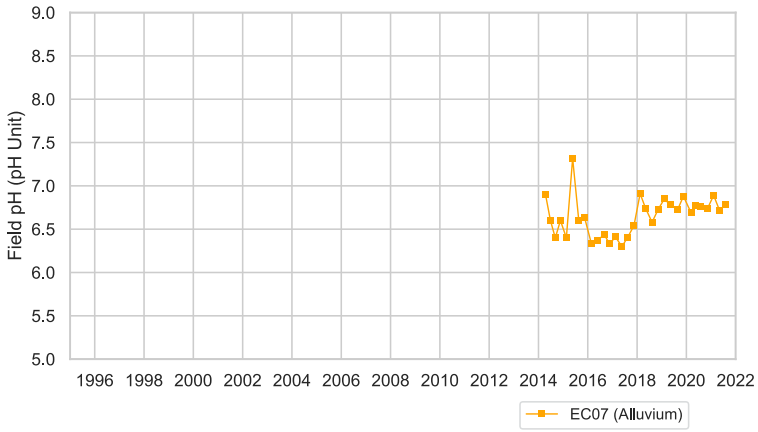

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

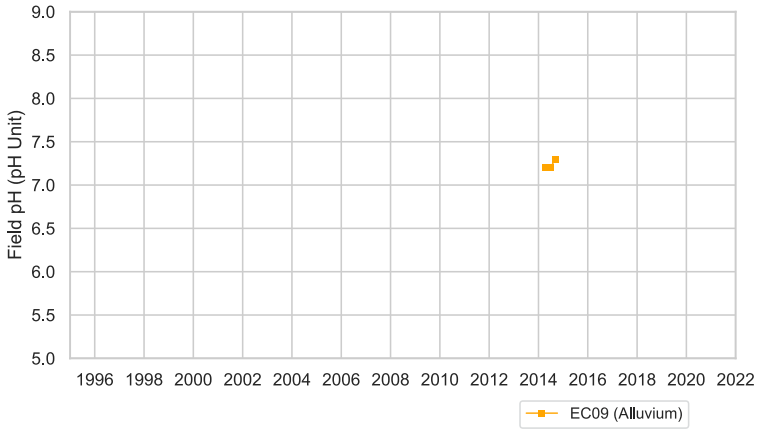

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

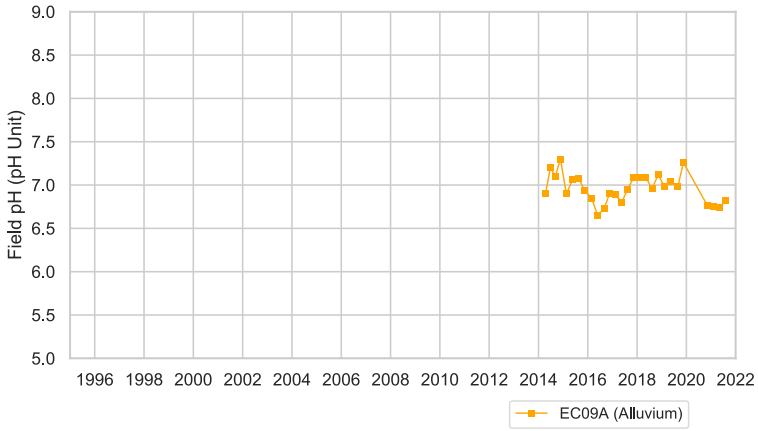

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

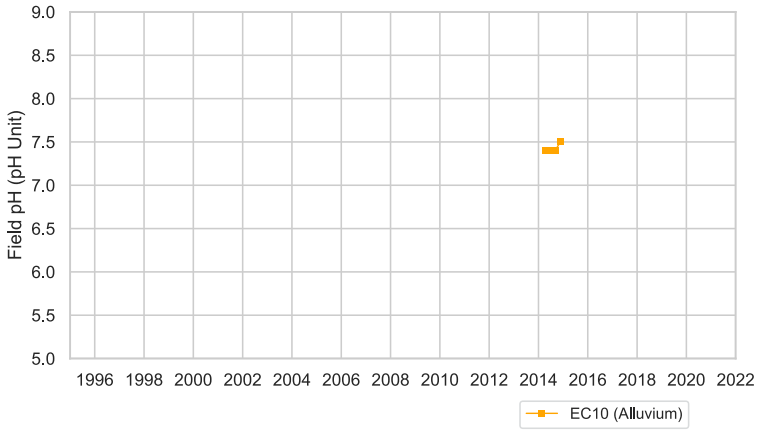

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

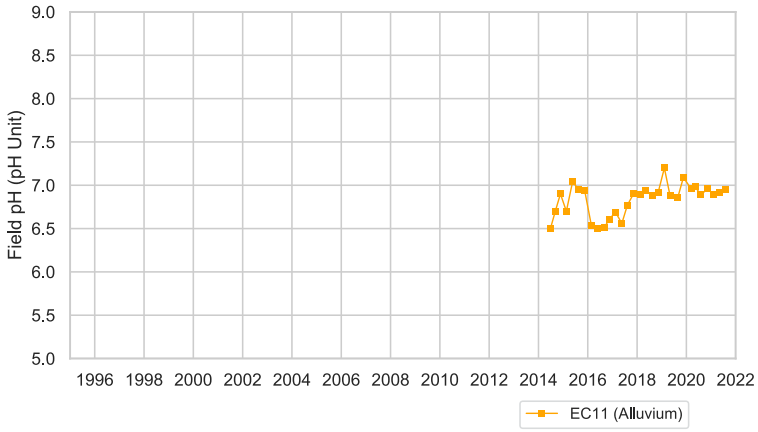

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

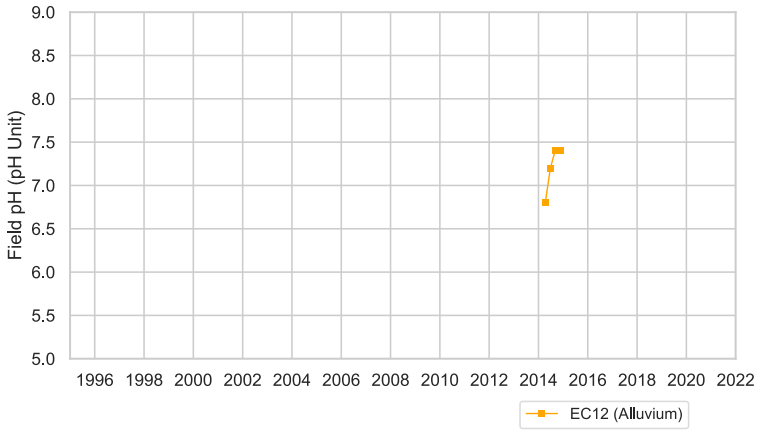

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

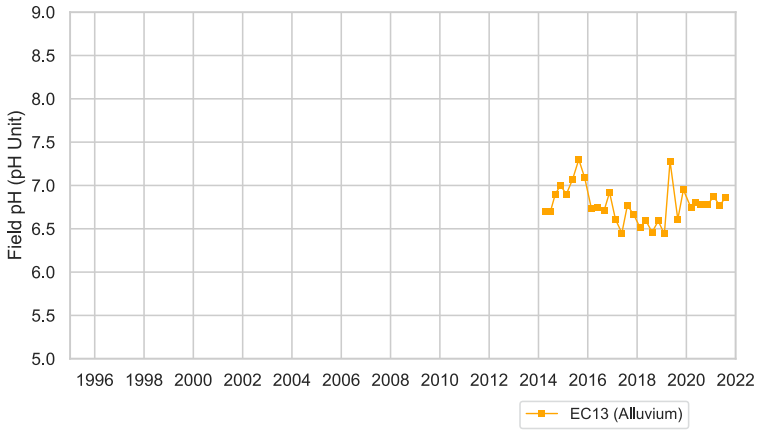

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

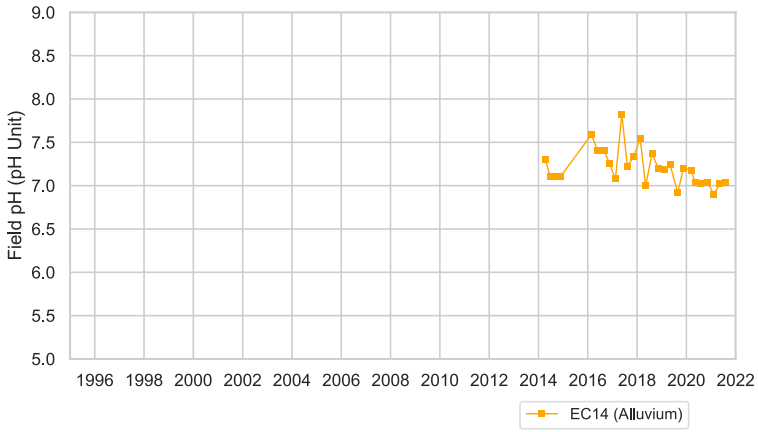

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

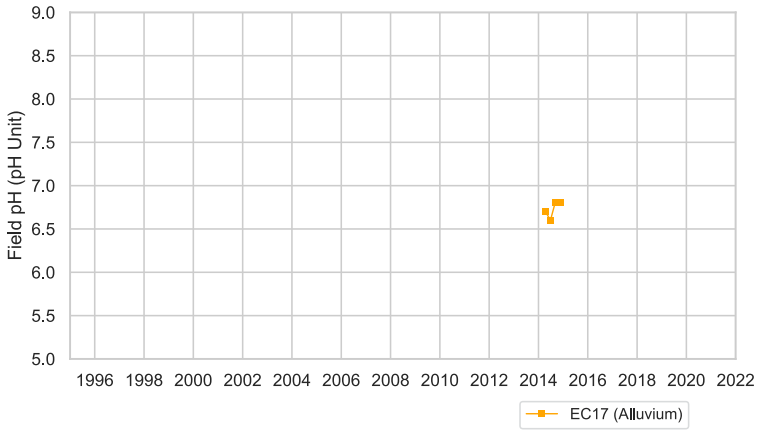

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

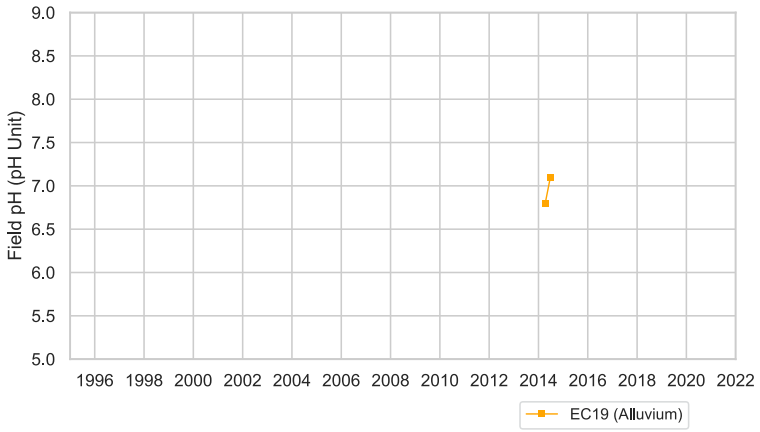

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

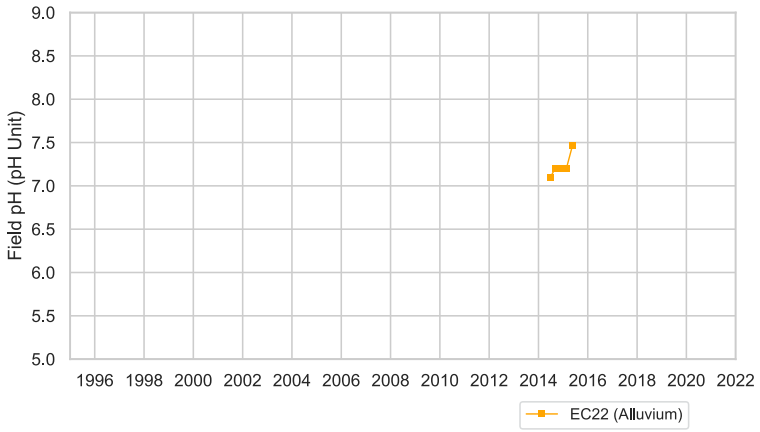

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

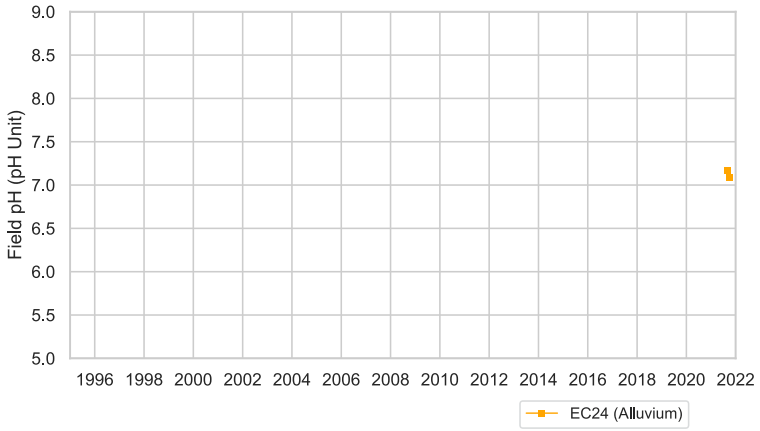

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

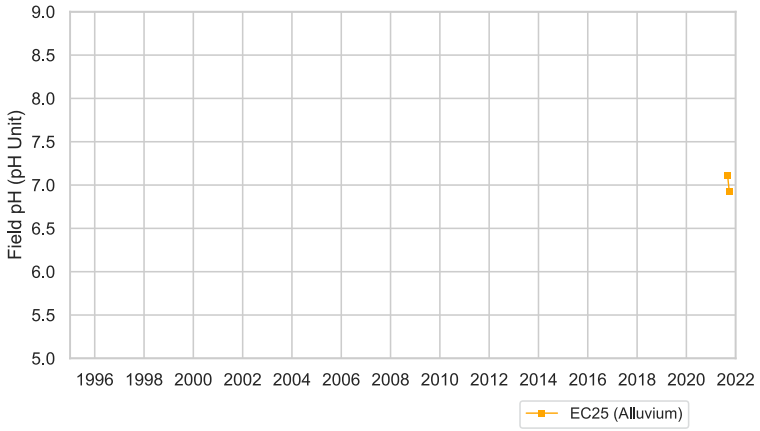

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

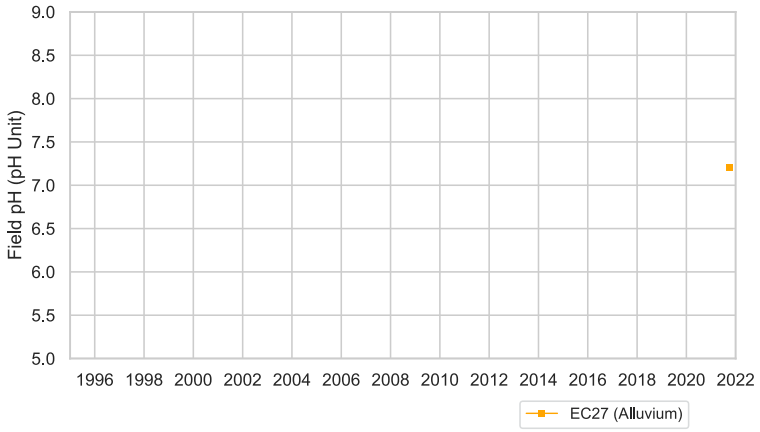

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

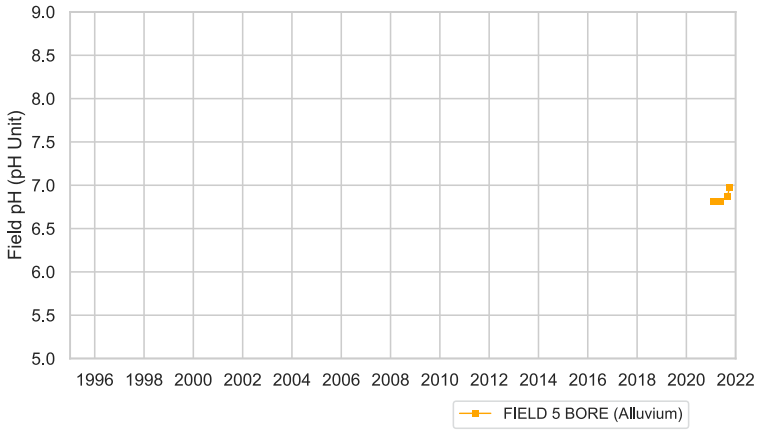

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

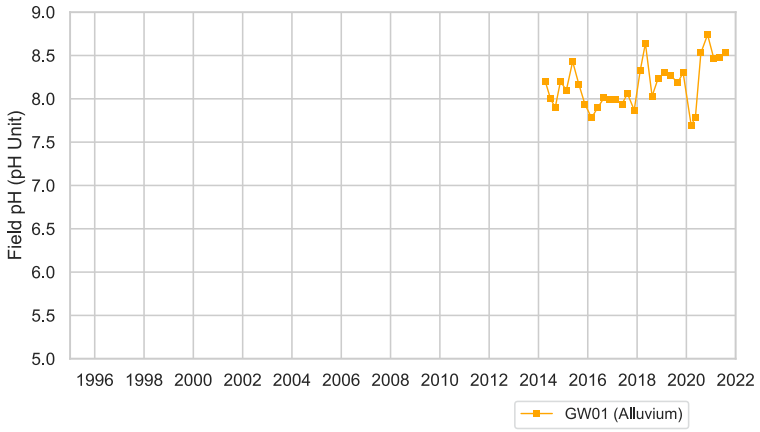

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

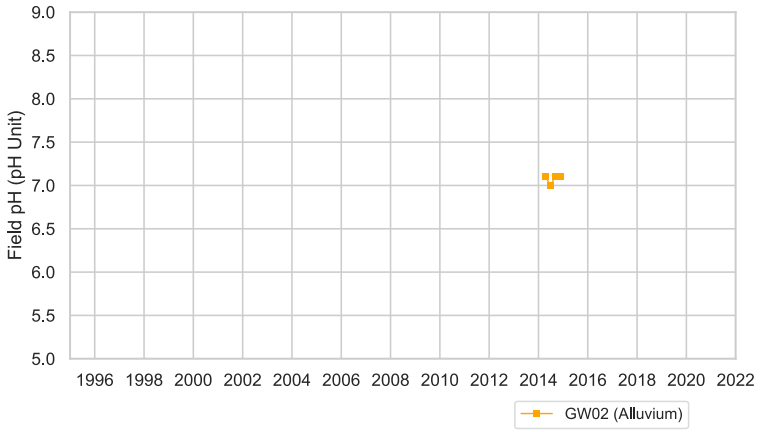

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

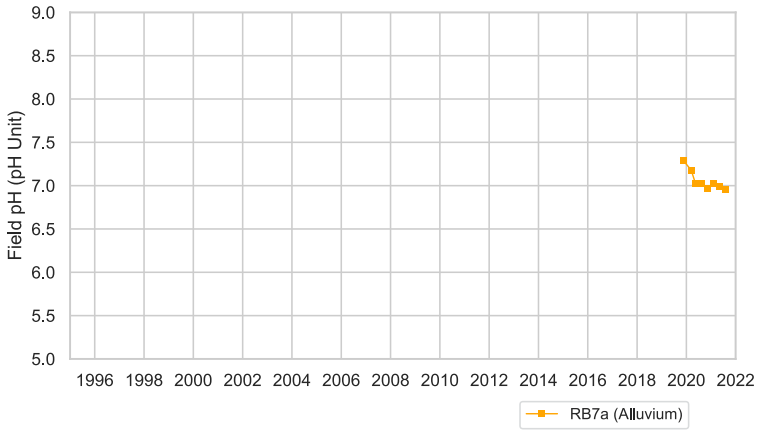

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

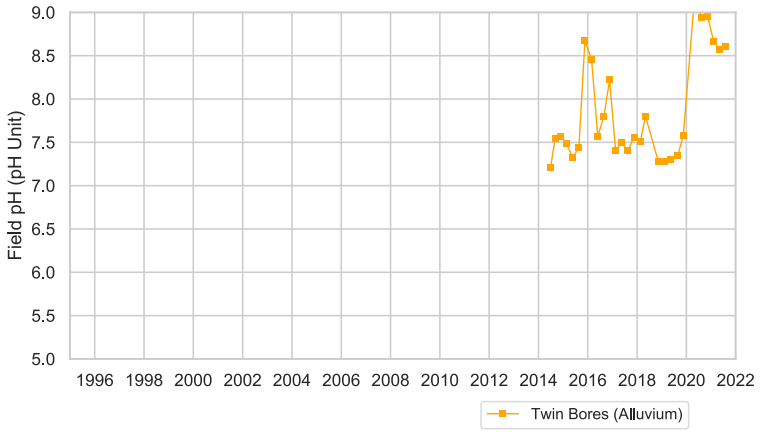

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

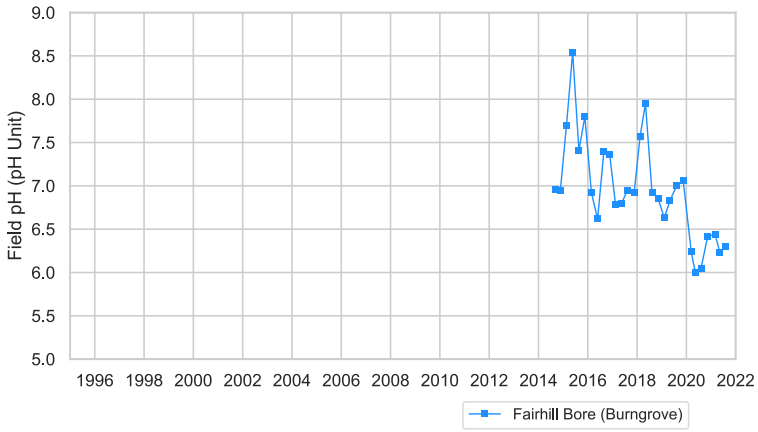

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

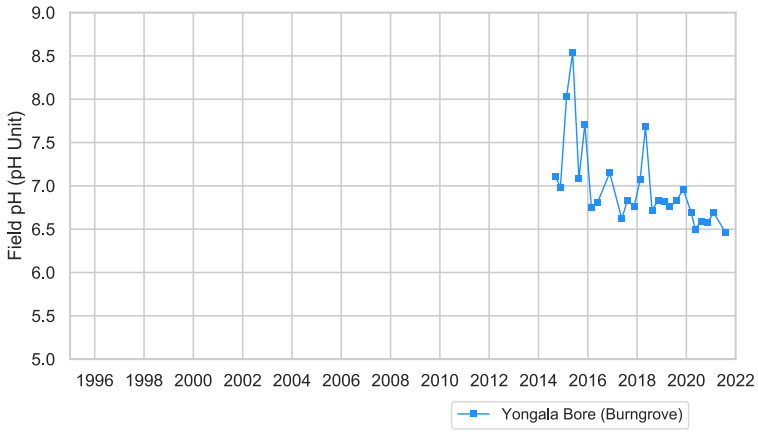

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

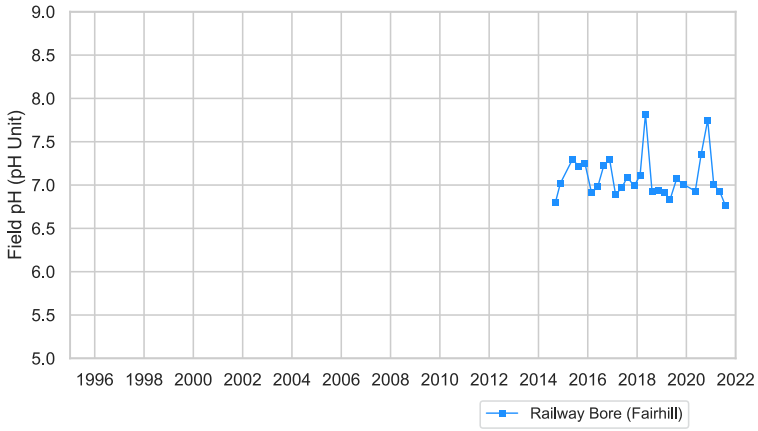

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

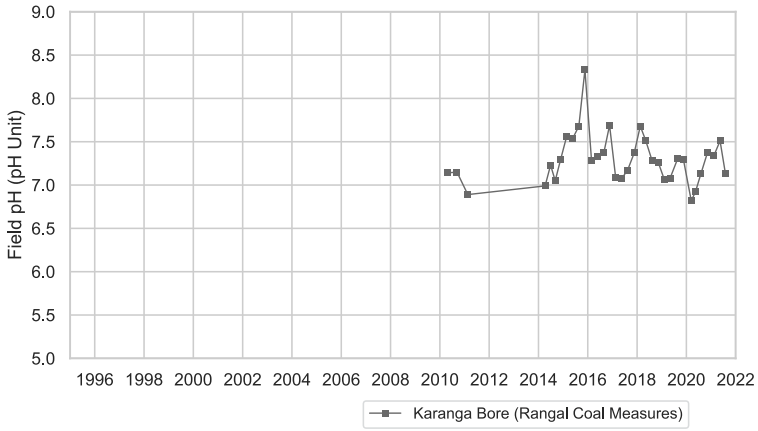

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

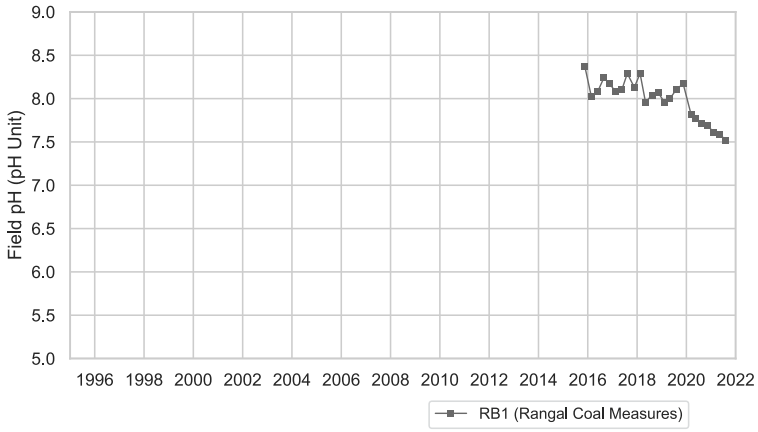

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

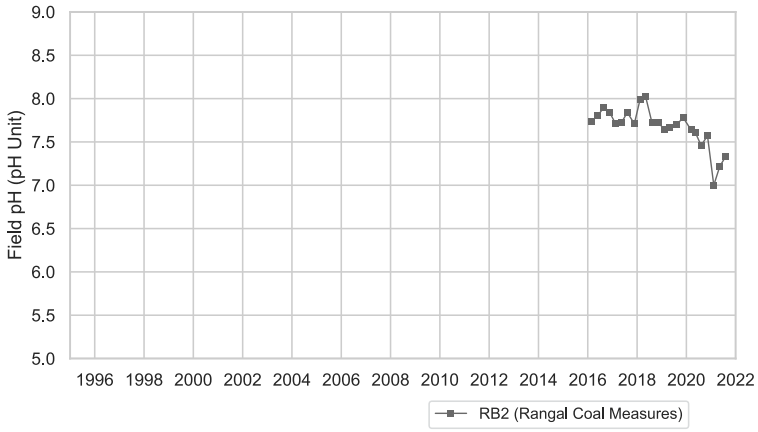

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

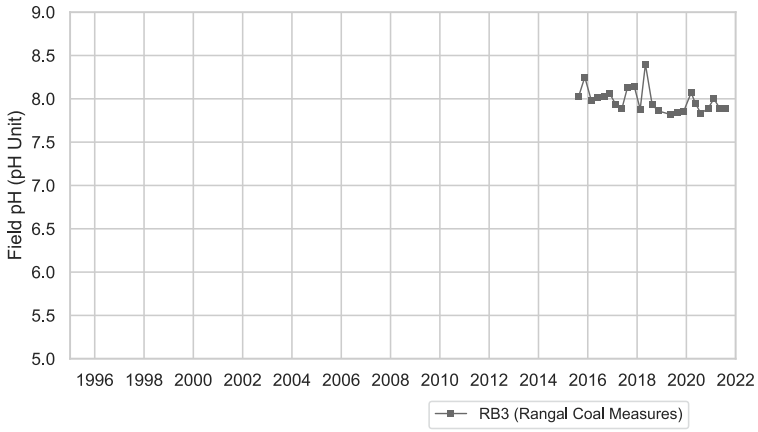

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

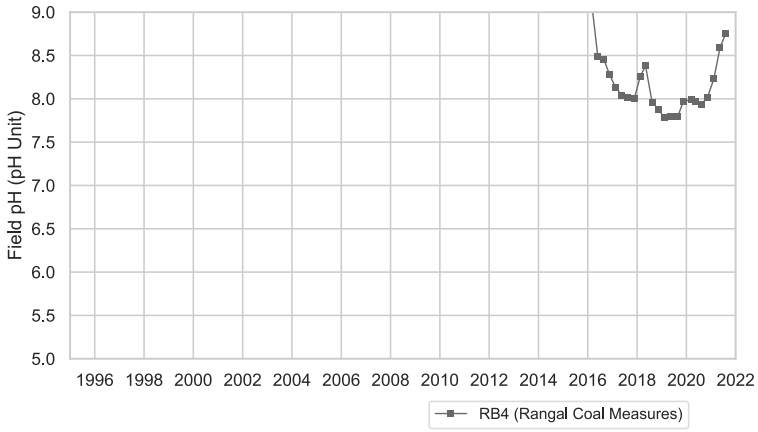

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

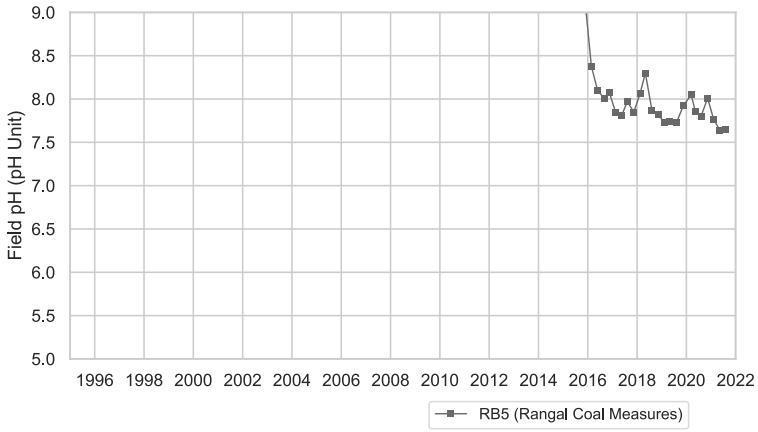

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

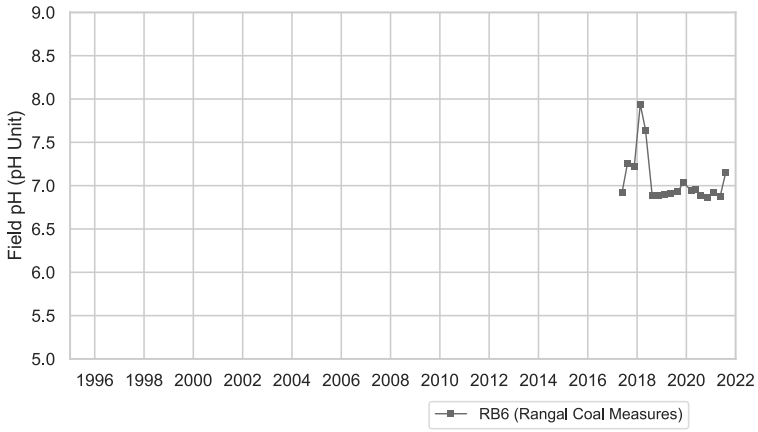

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

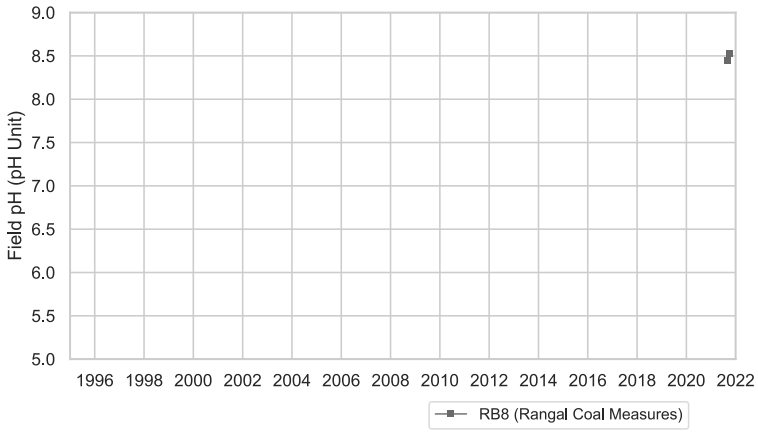

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

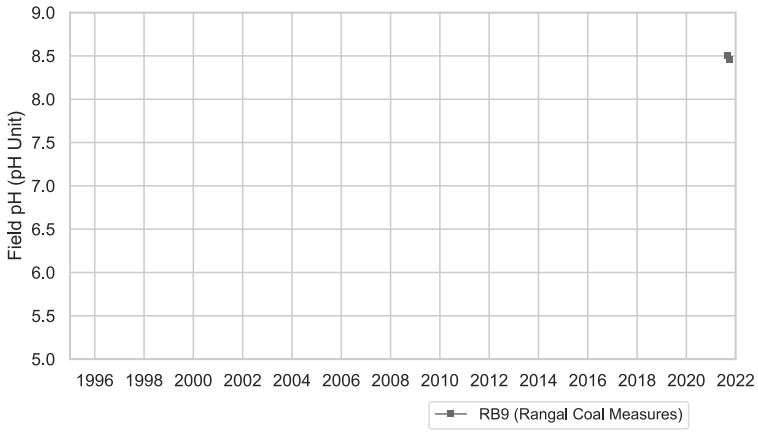

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

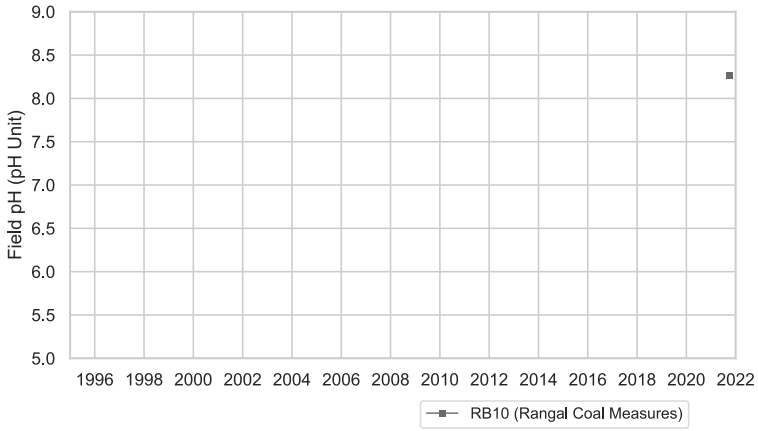

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

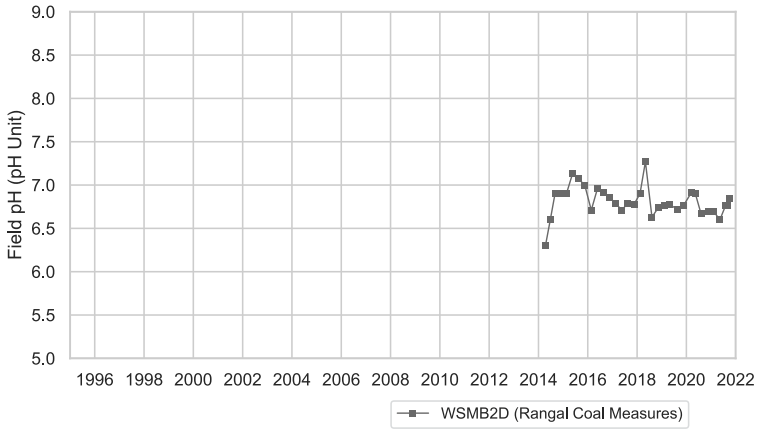

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

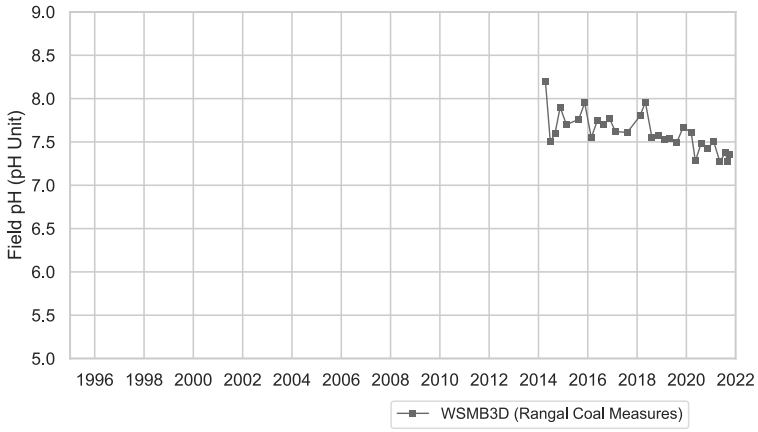

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

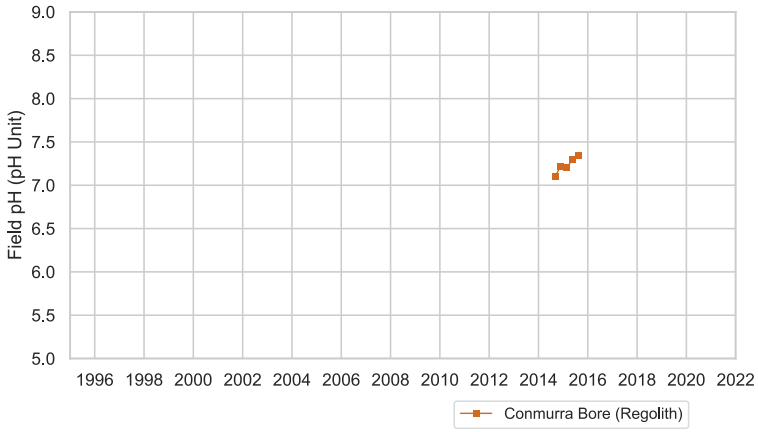

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

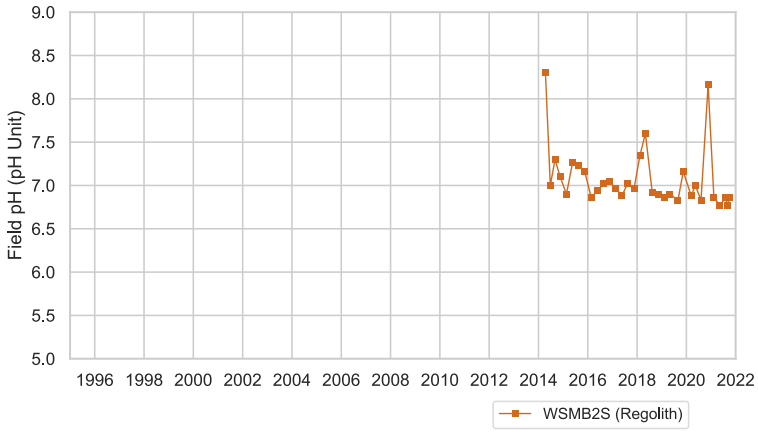

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

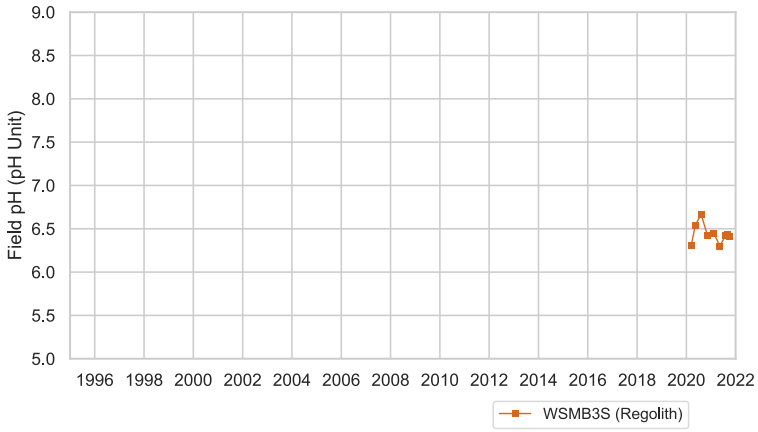

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

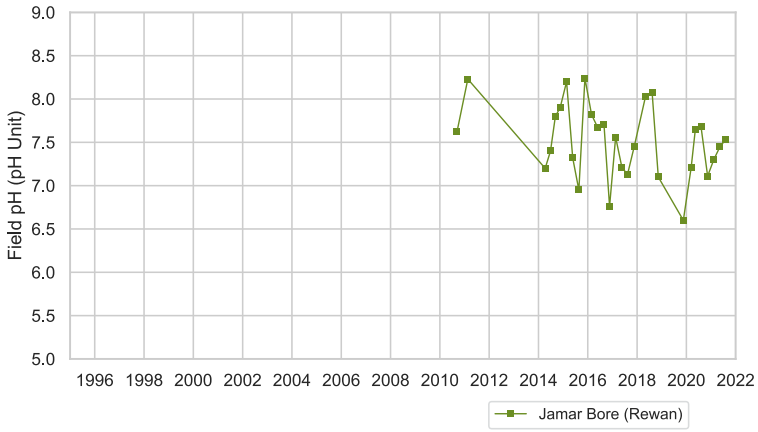

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

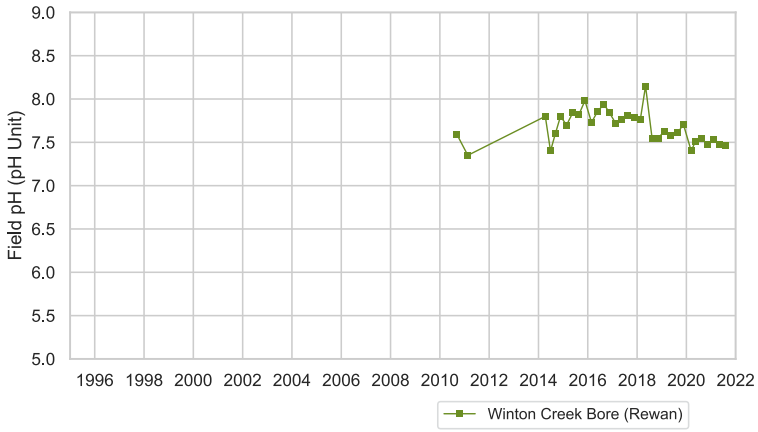

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

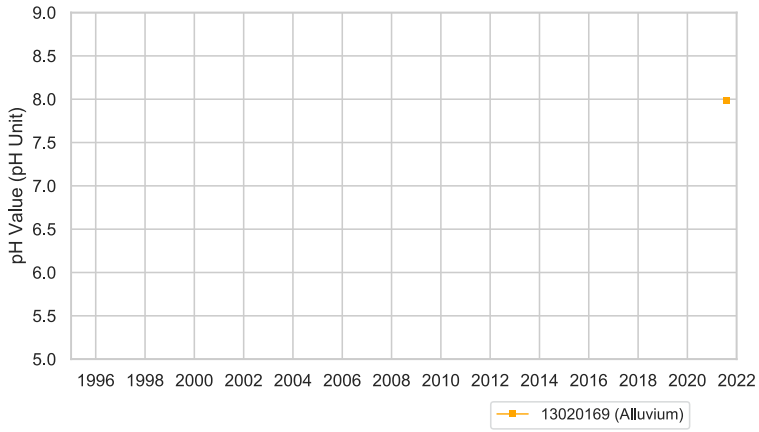

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

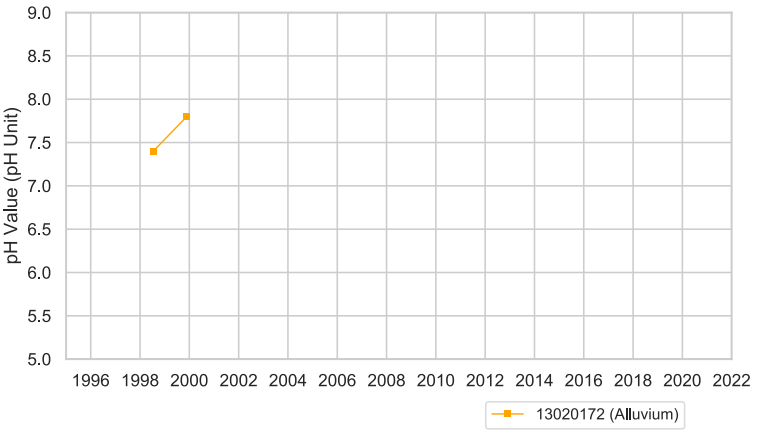

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

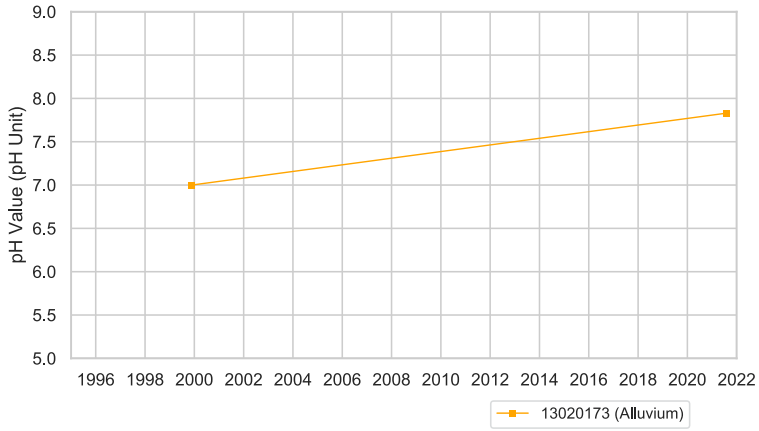

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

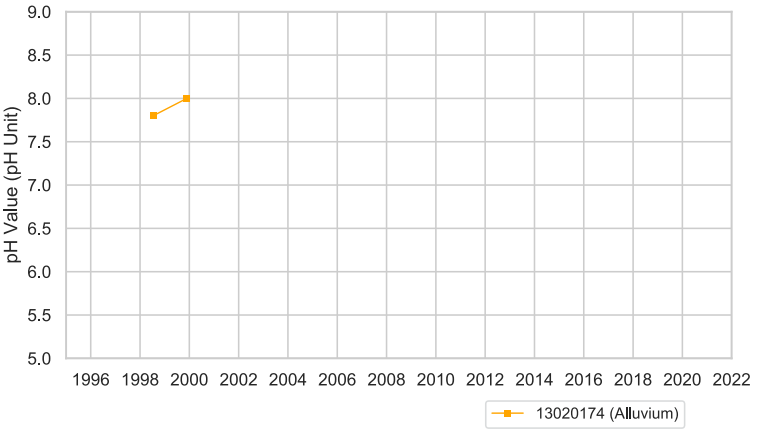

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

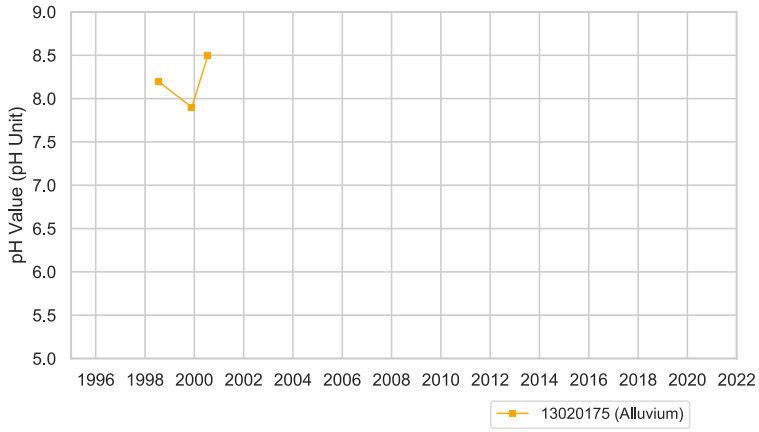

Field pH (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

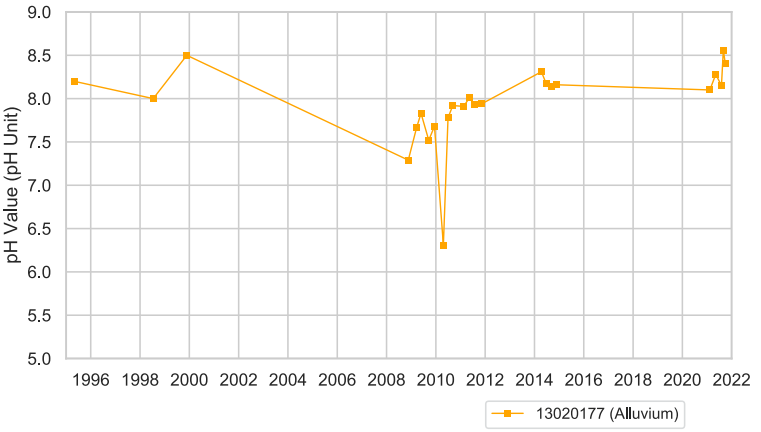

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

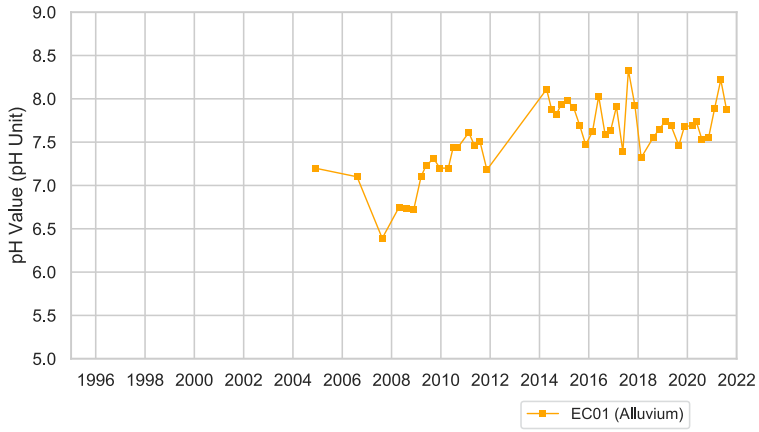

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

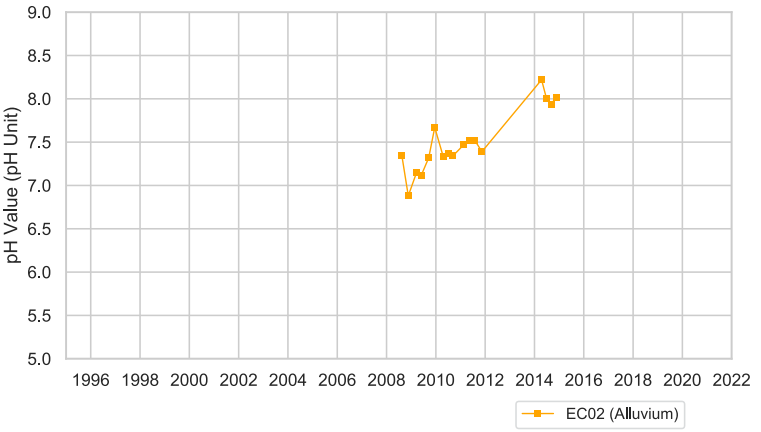

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

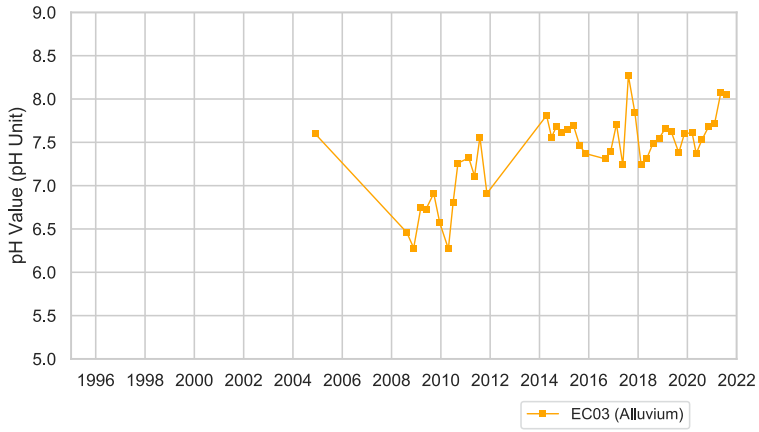

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

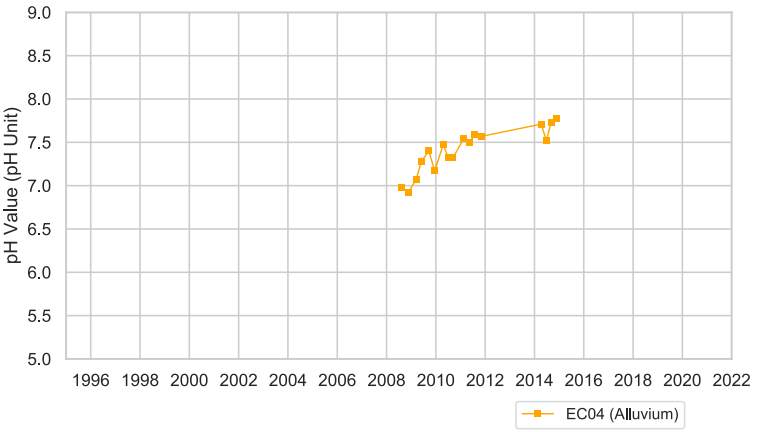

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

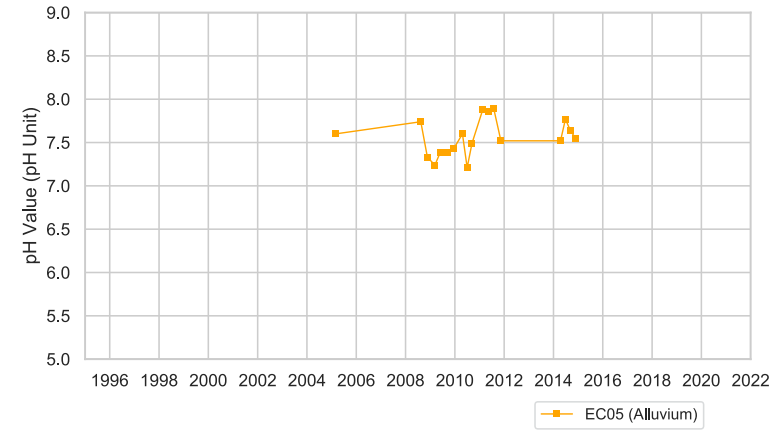

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

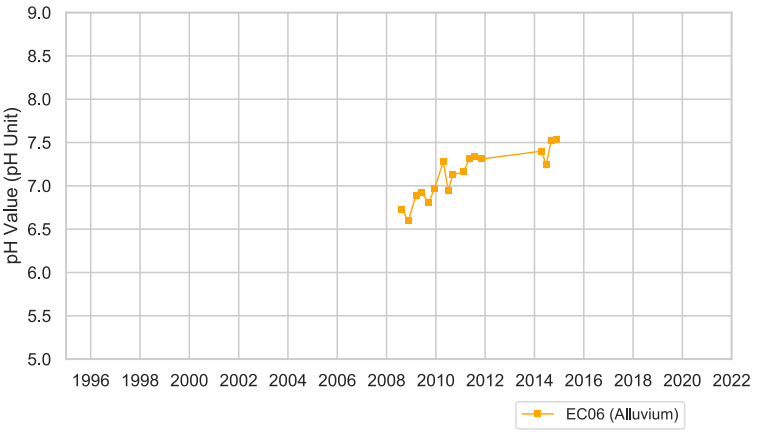

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

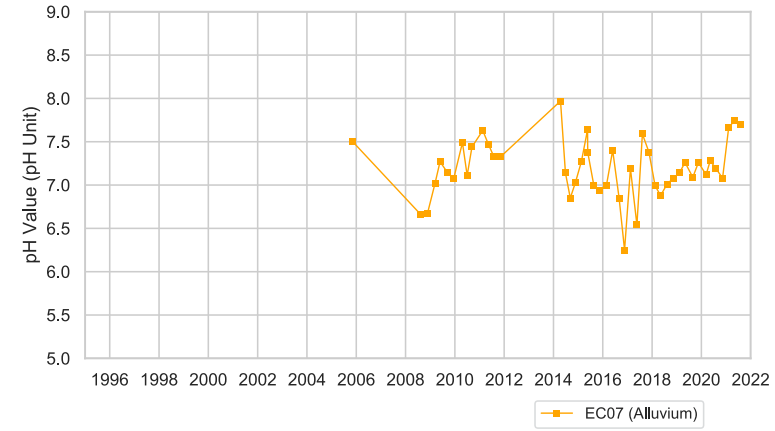

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

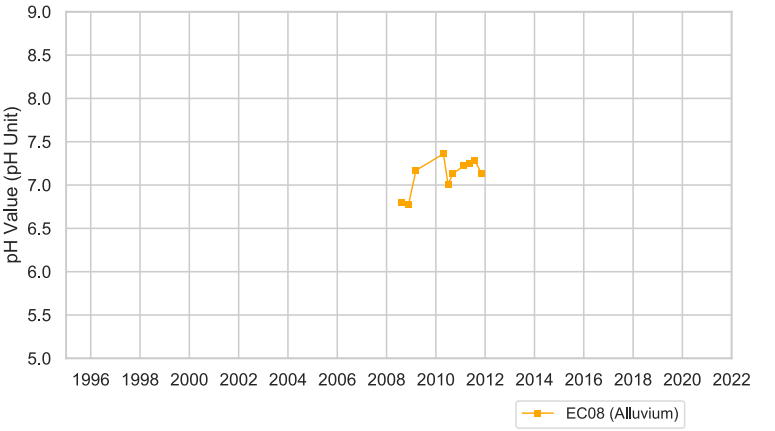

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

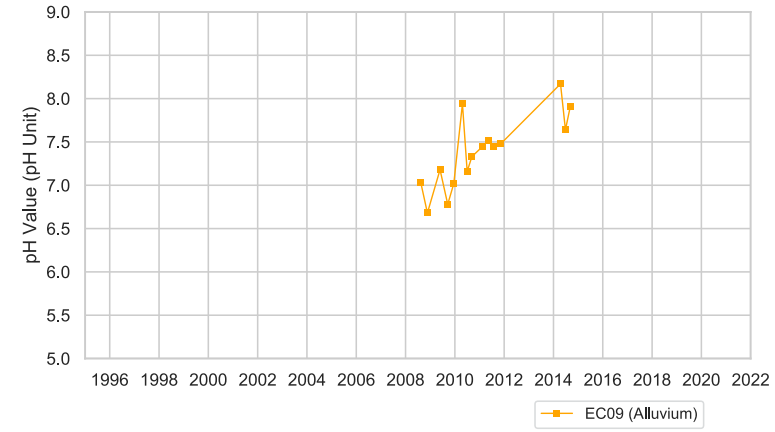

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

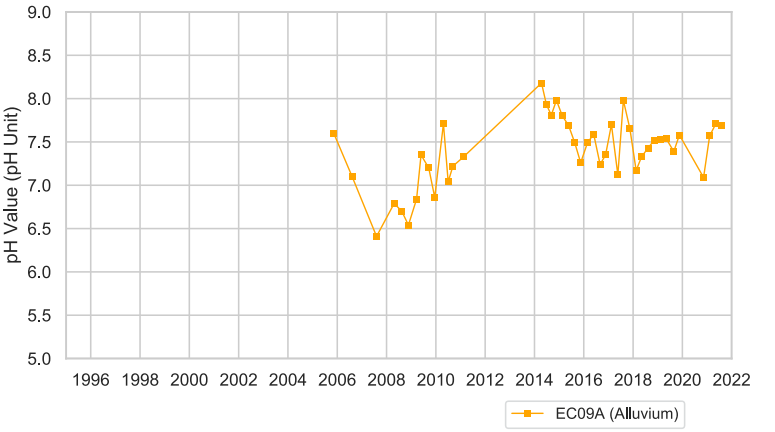

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

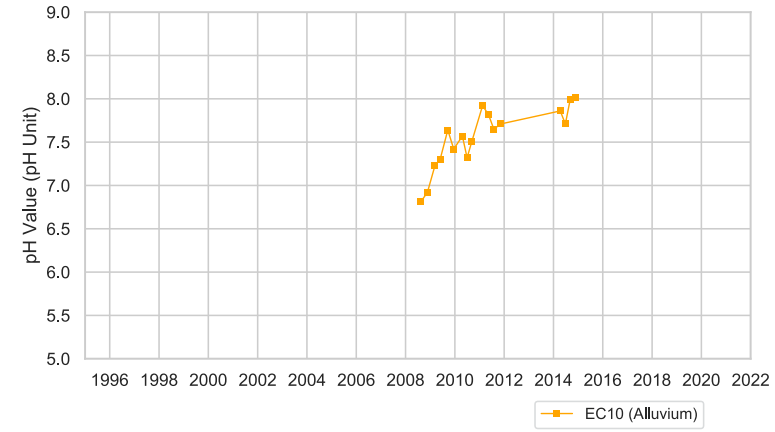

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

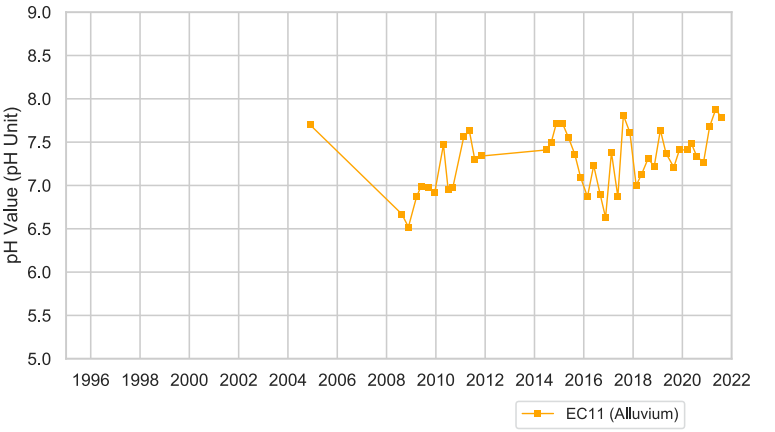

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

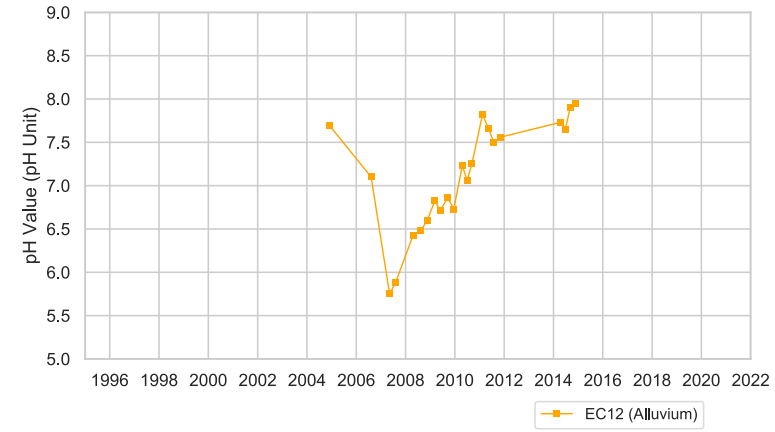

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

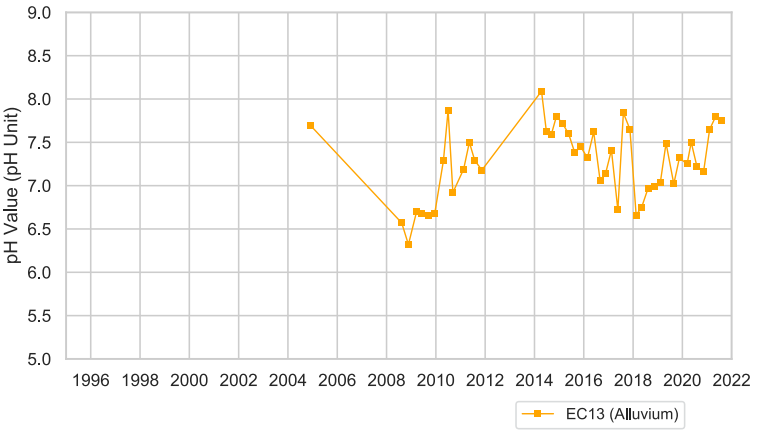

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

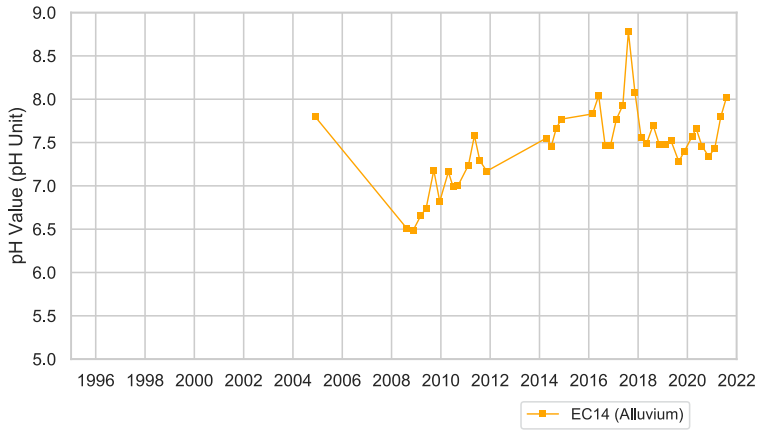

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

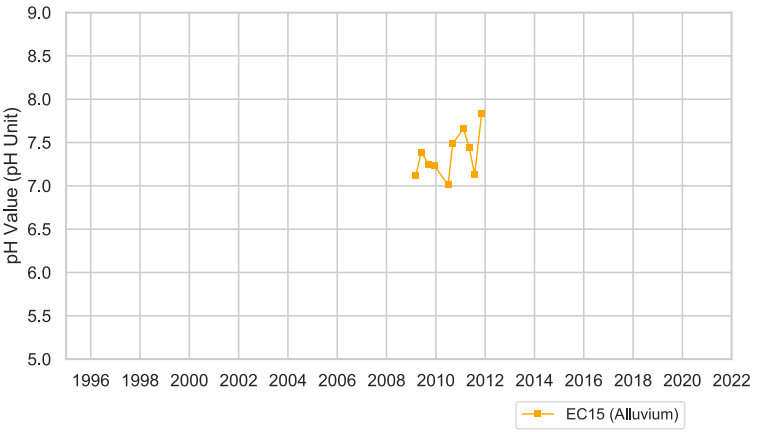

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

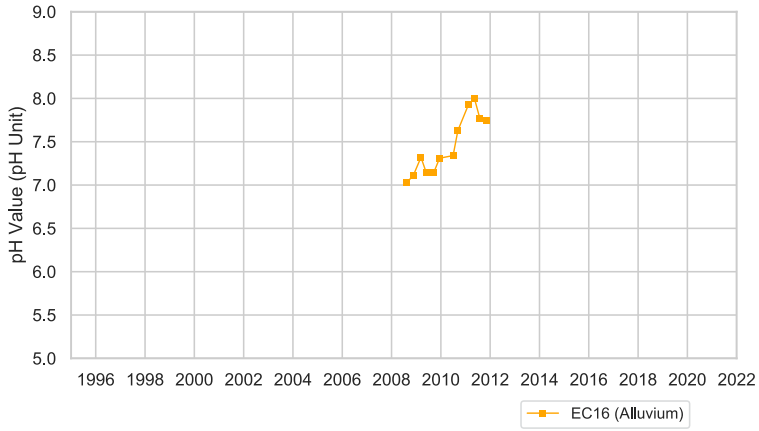

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

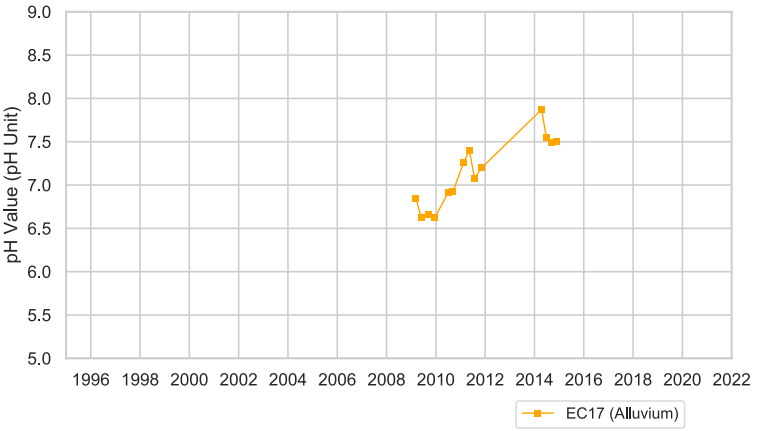

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

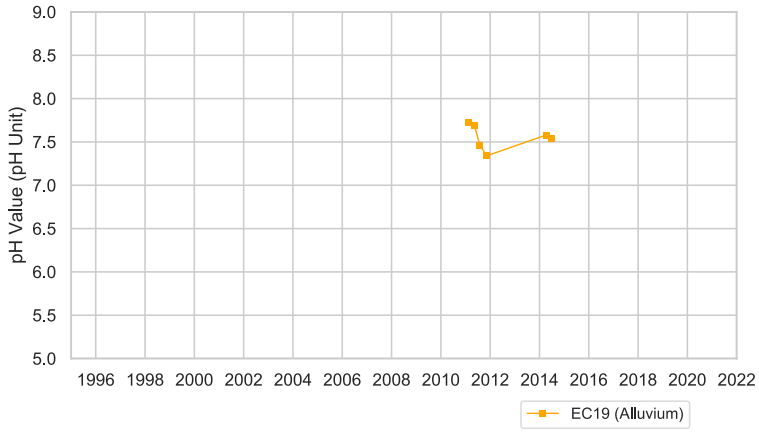

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

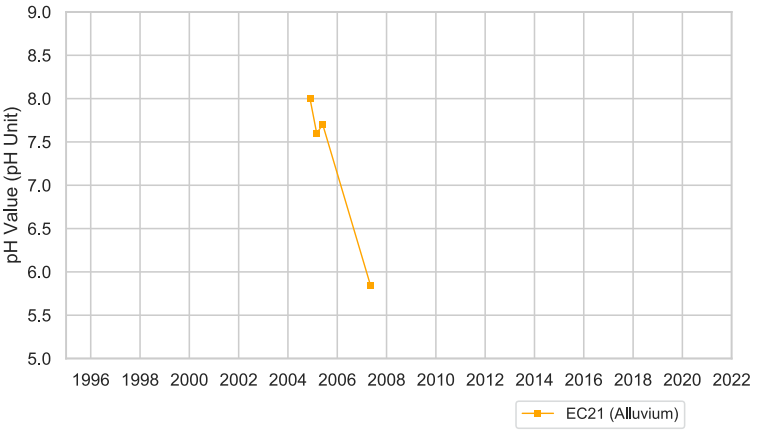

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

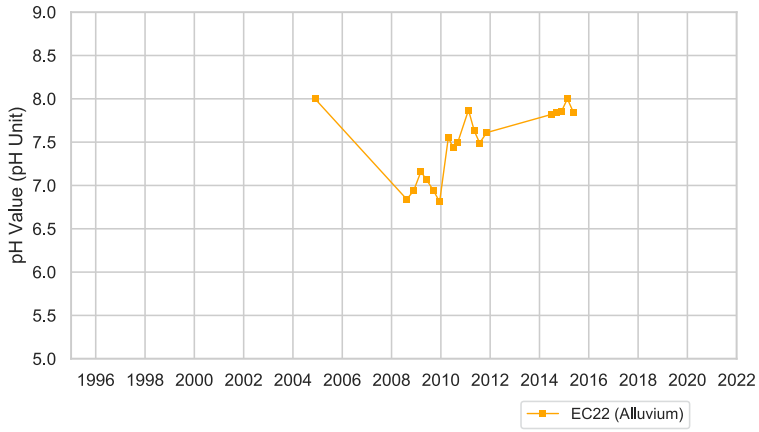

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

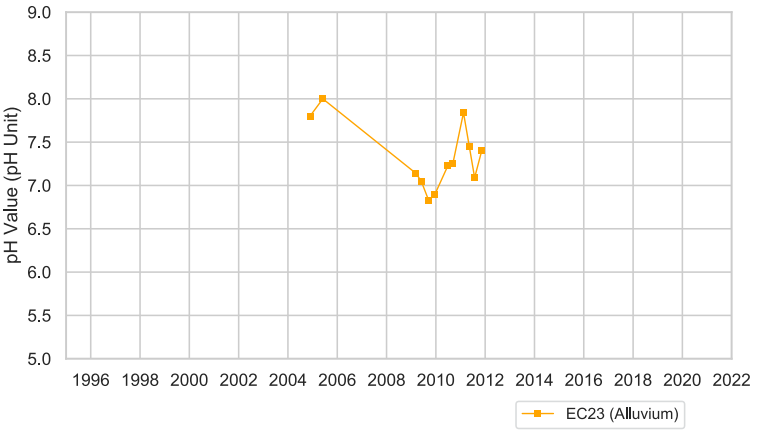

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

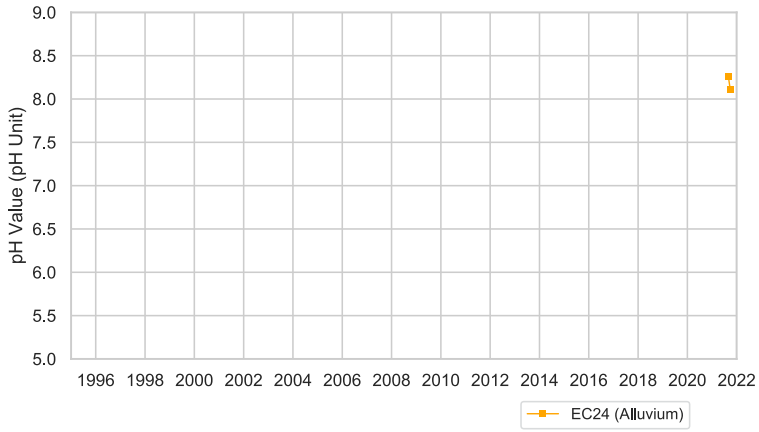

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

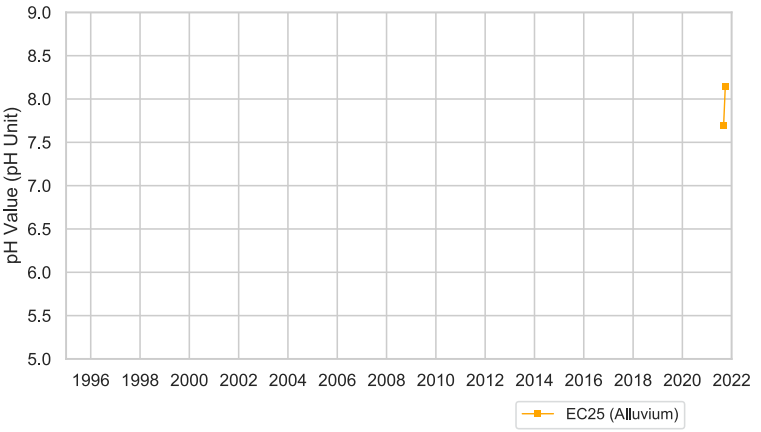

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

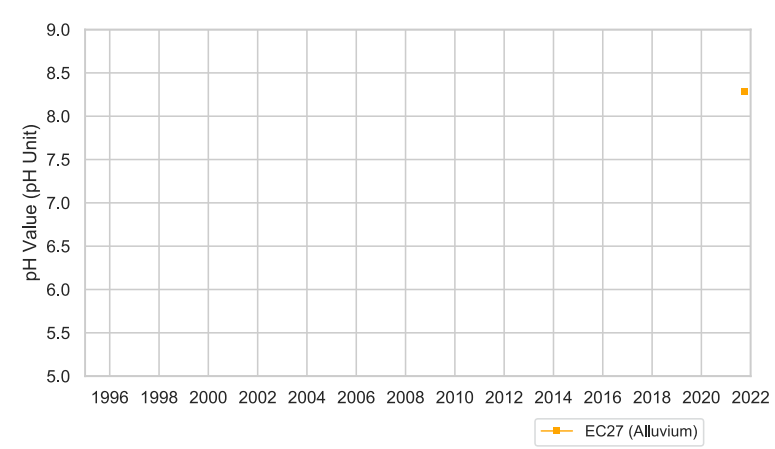

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

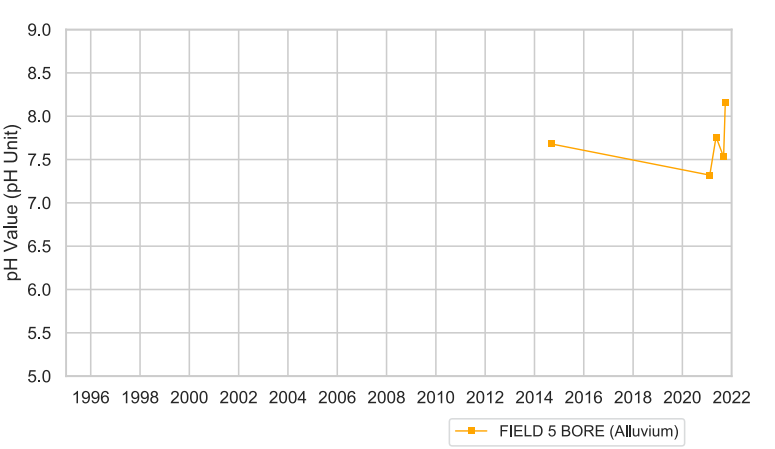

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

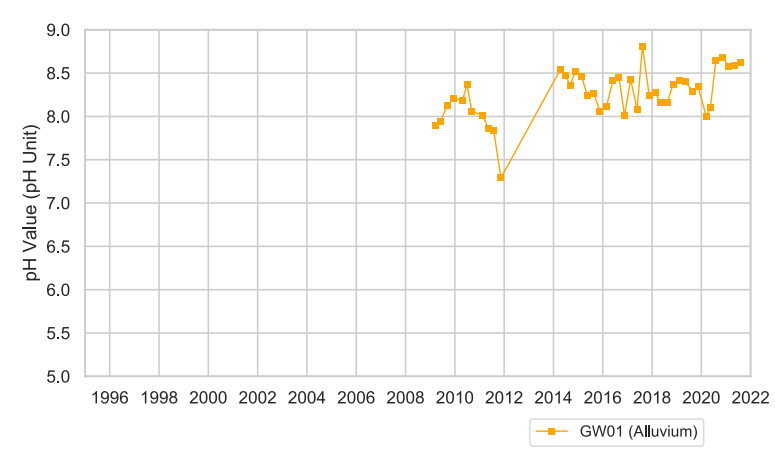

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

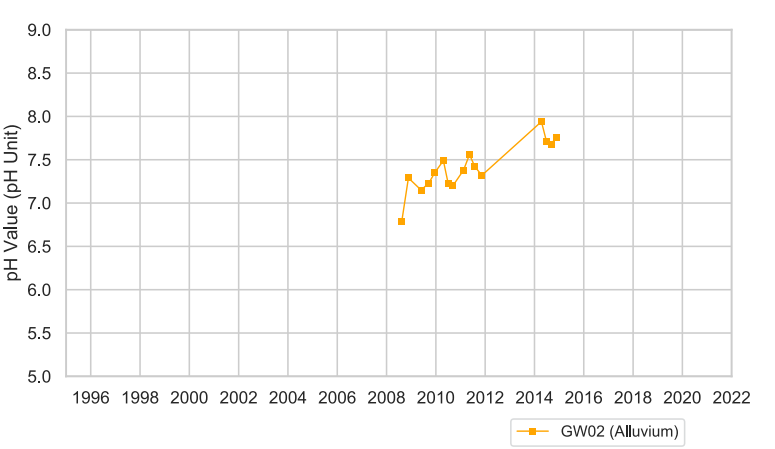

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

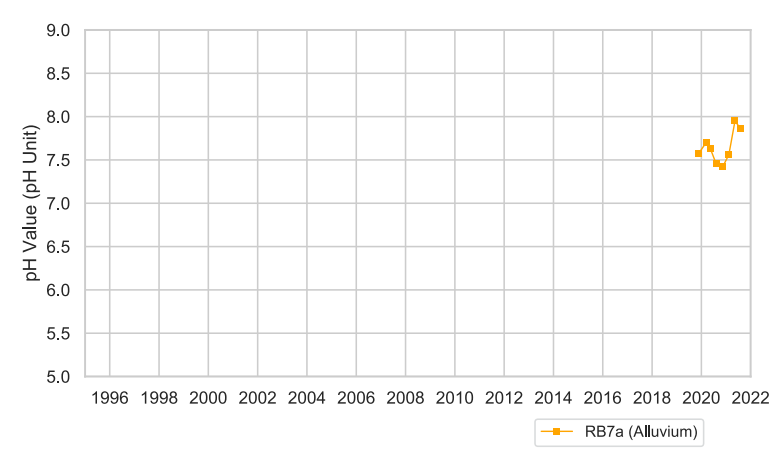

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

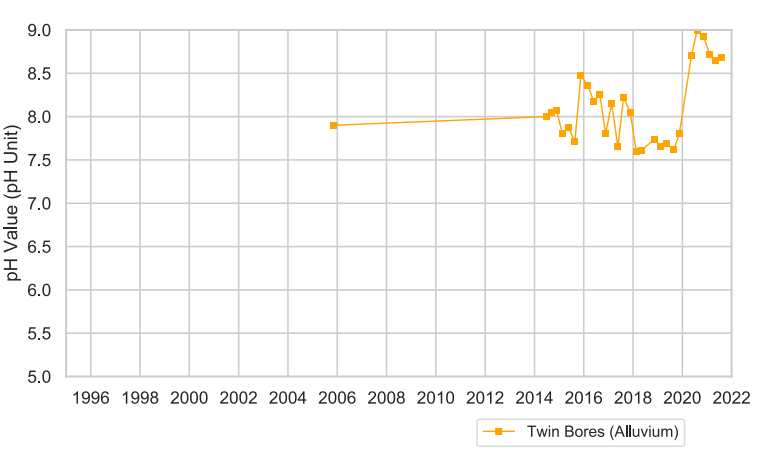

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

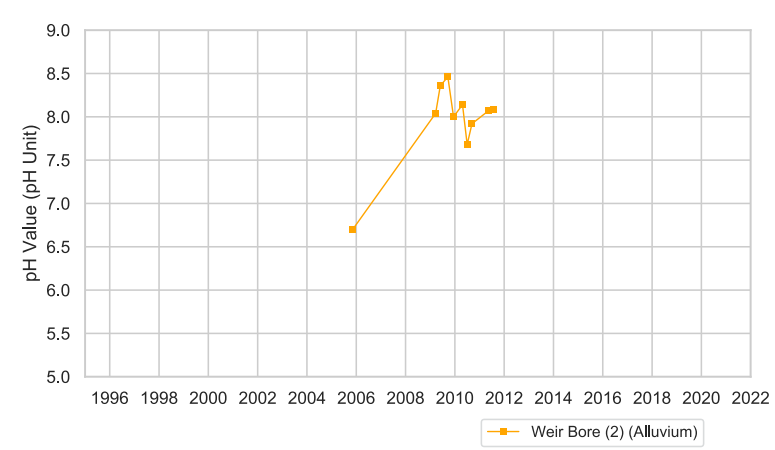

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

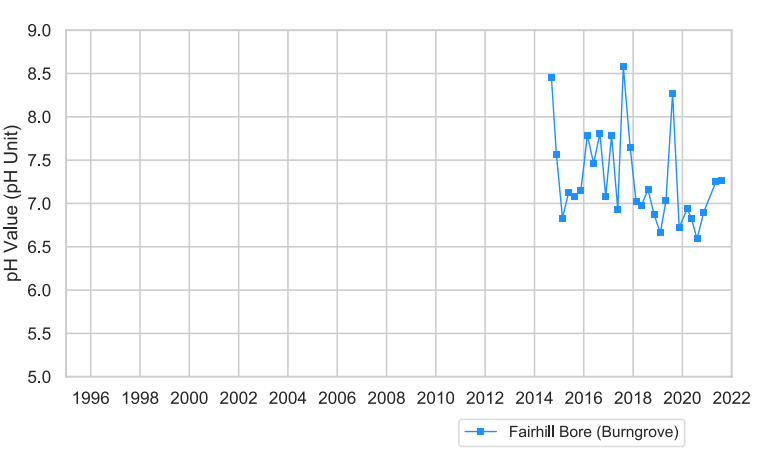

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

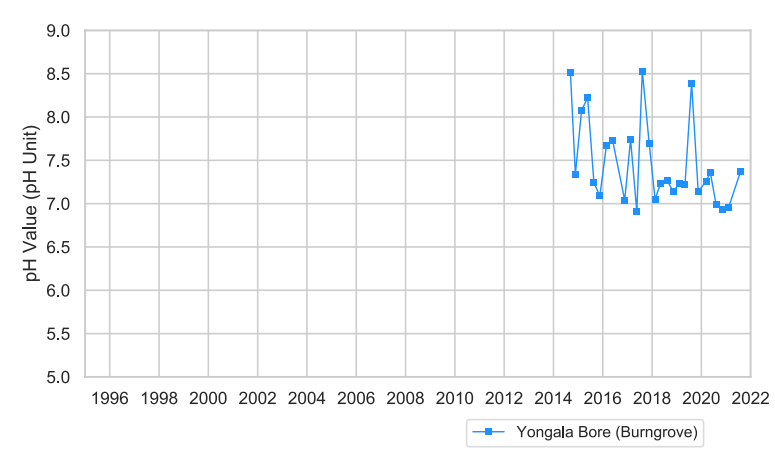

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

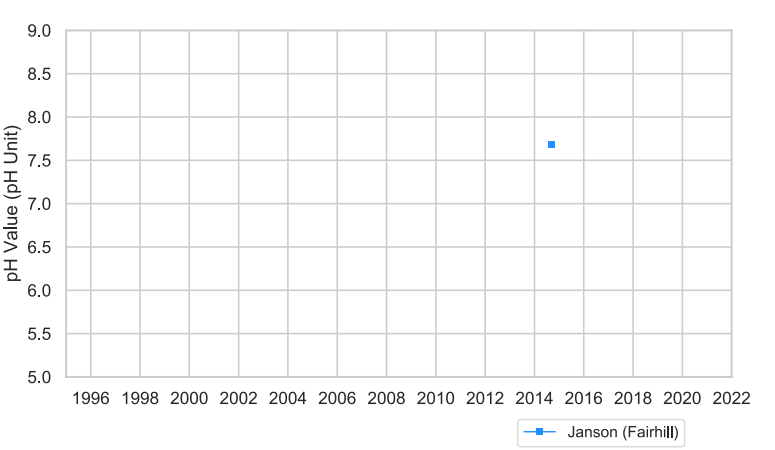

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

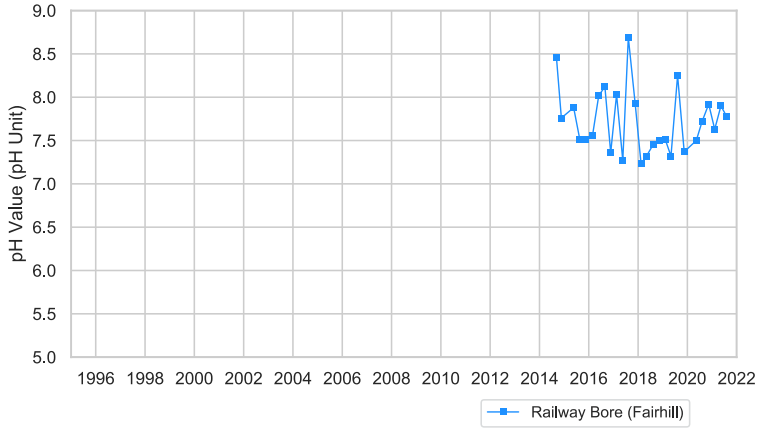

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

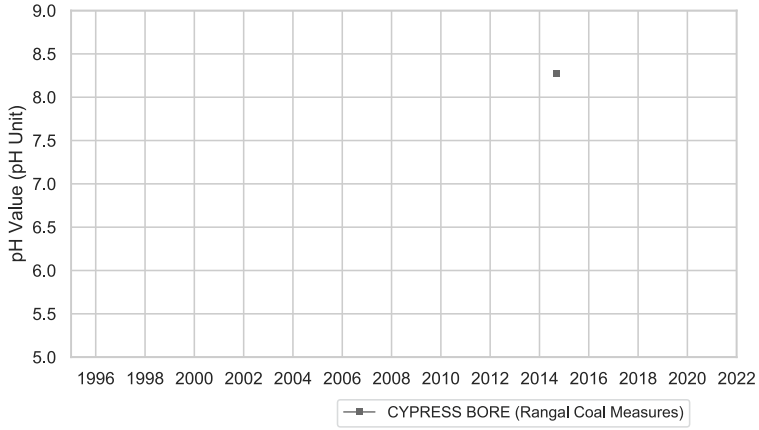

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

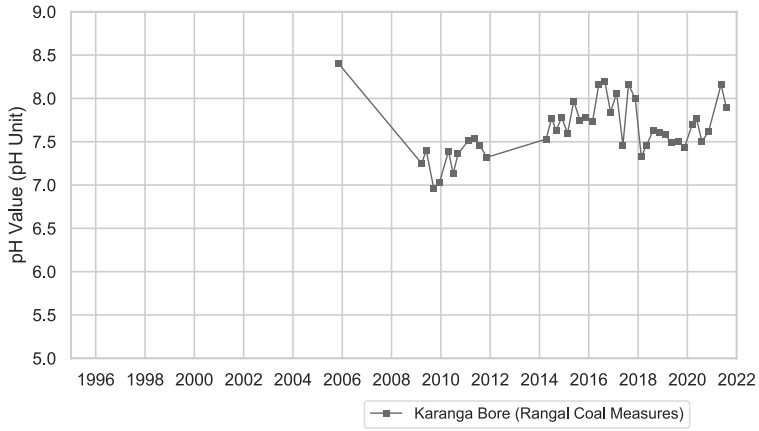

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

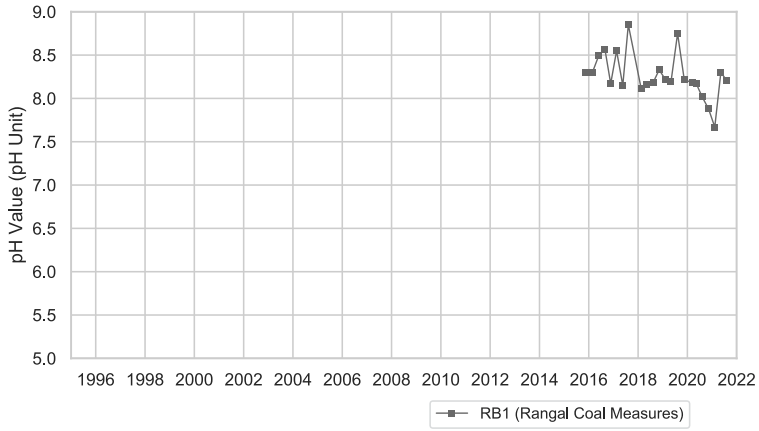

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

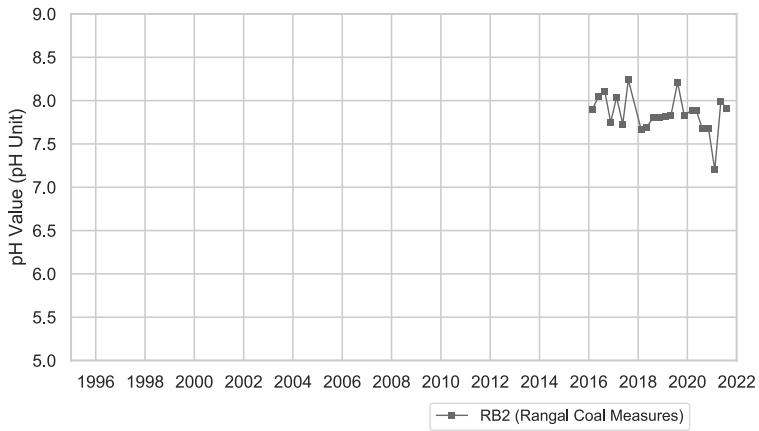

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

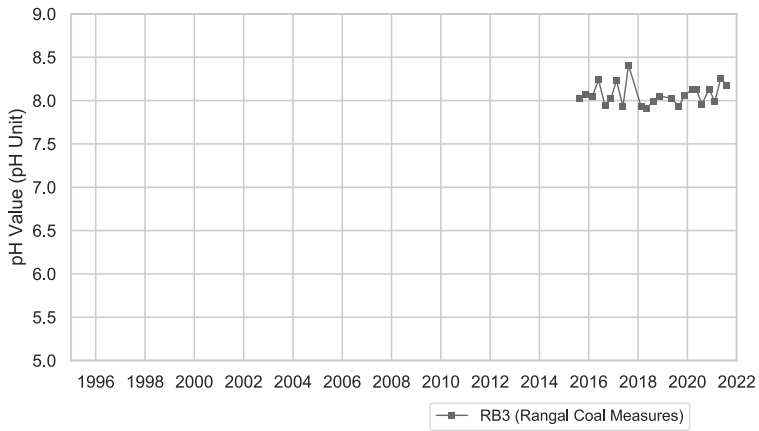

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

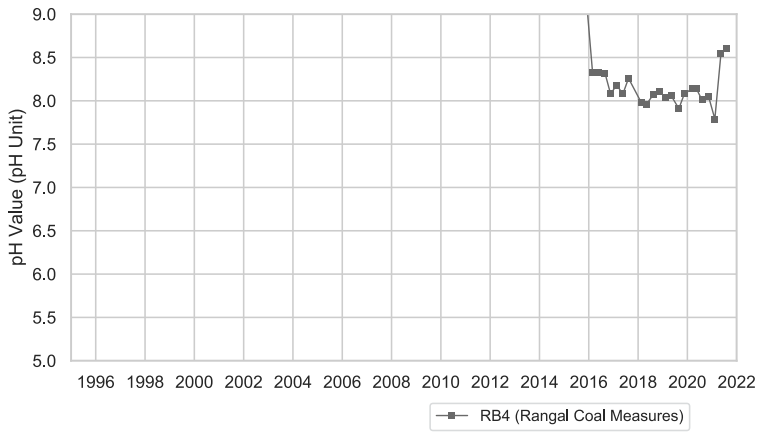

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

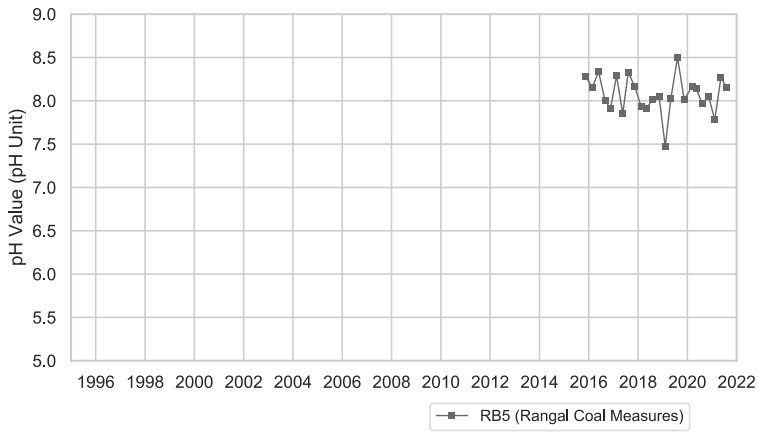

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

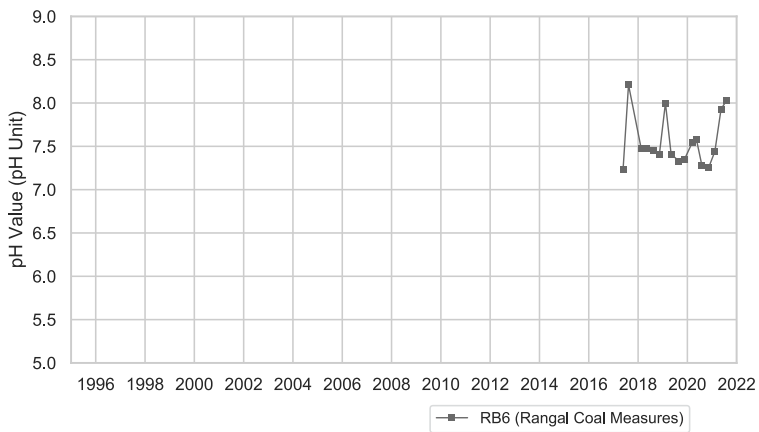

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

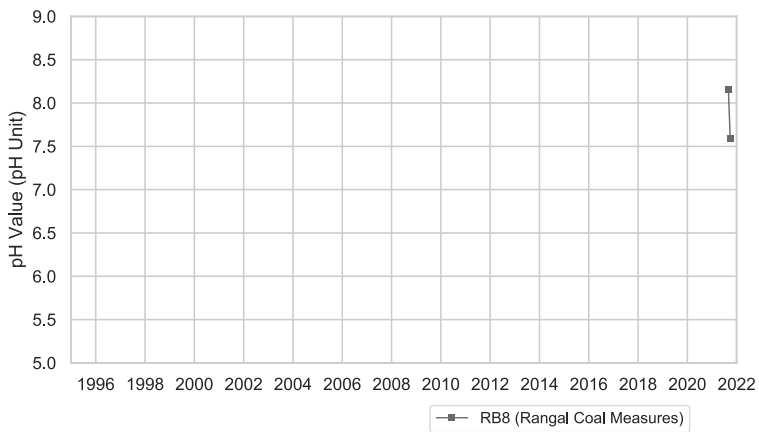

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

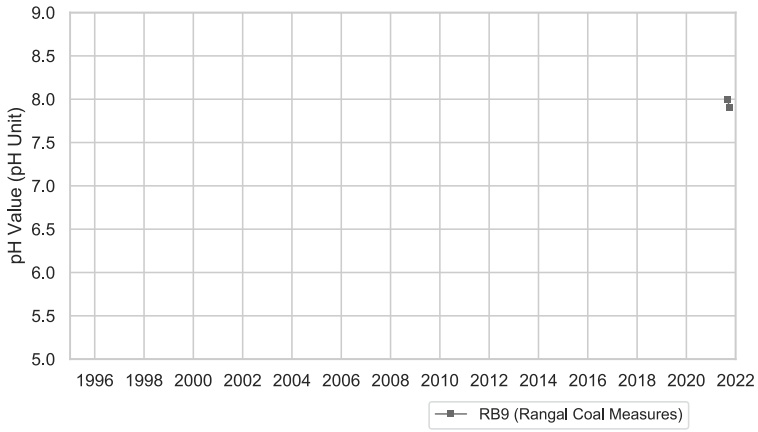

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

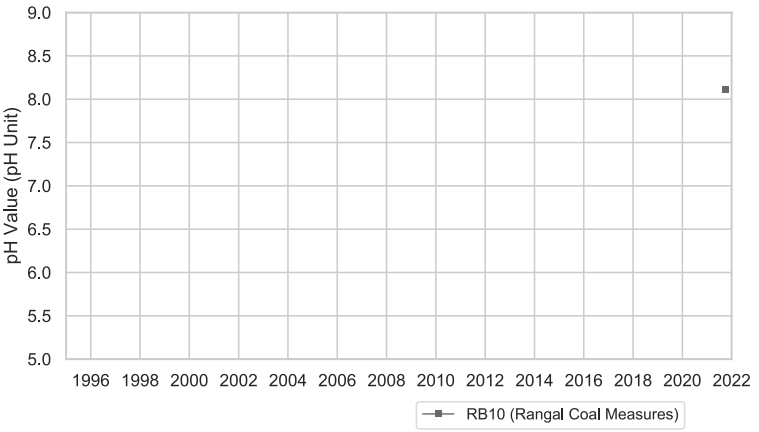

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

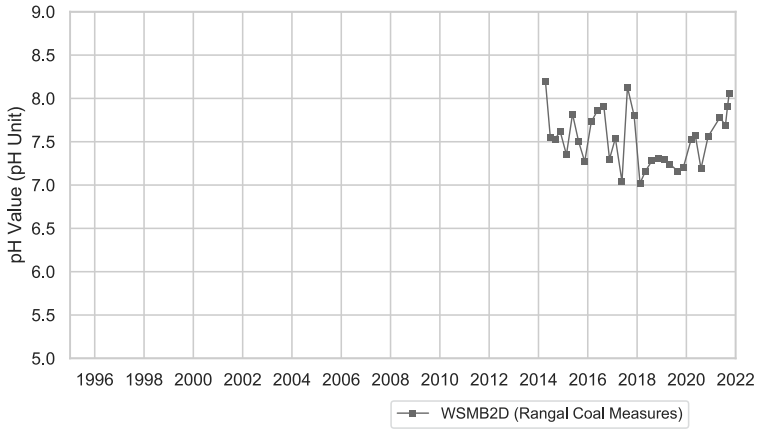

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

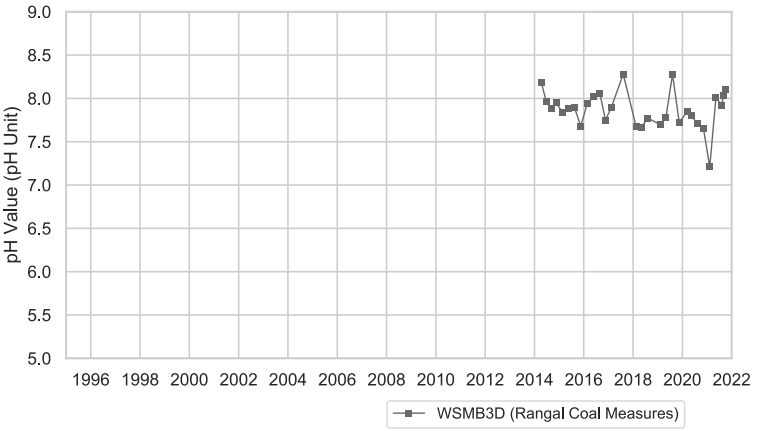

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

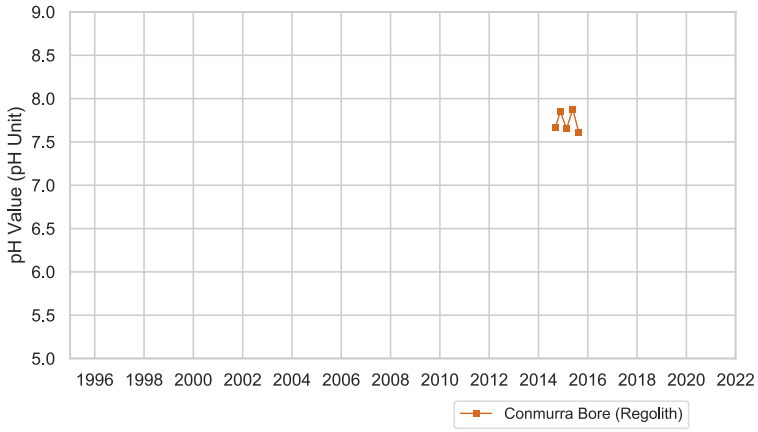

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

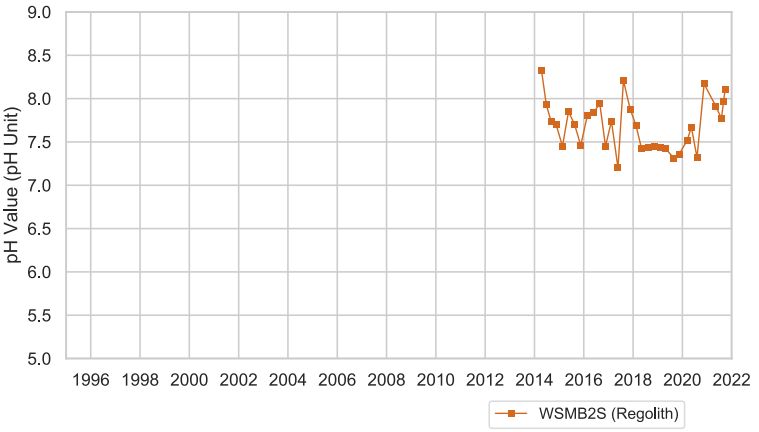

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

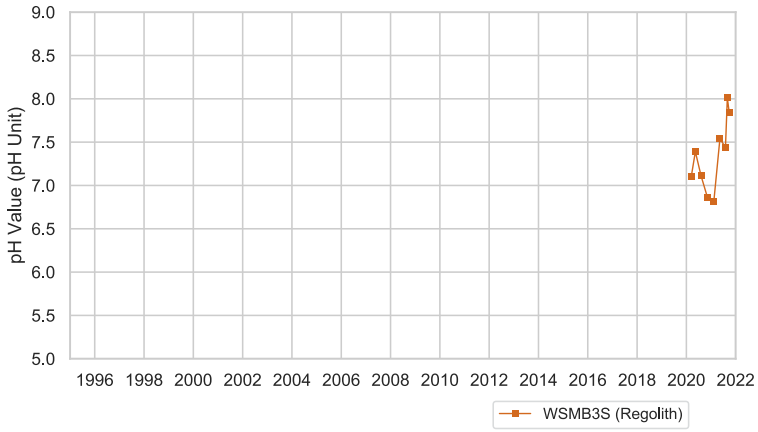

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

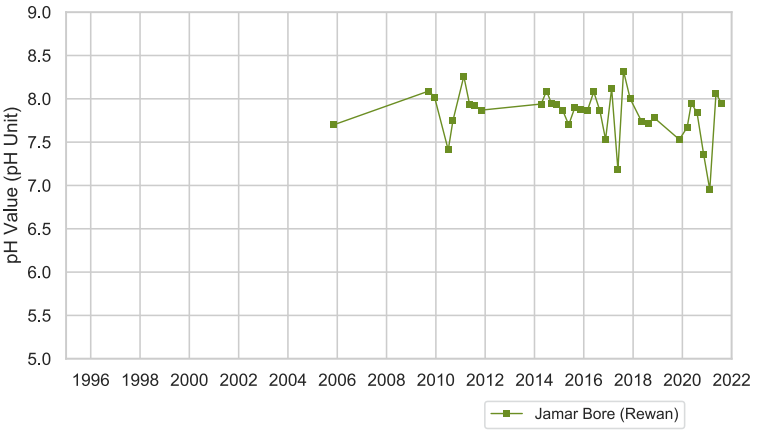

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

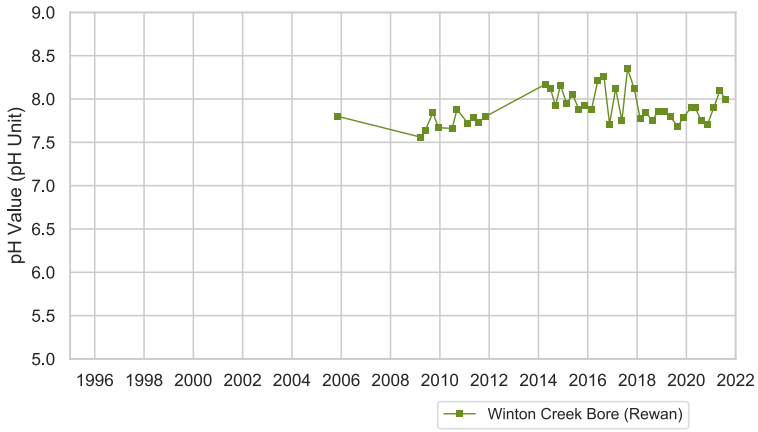

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

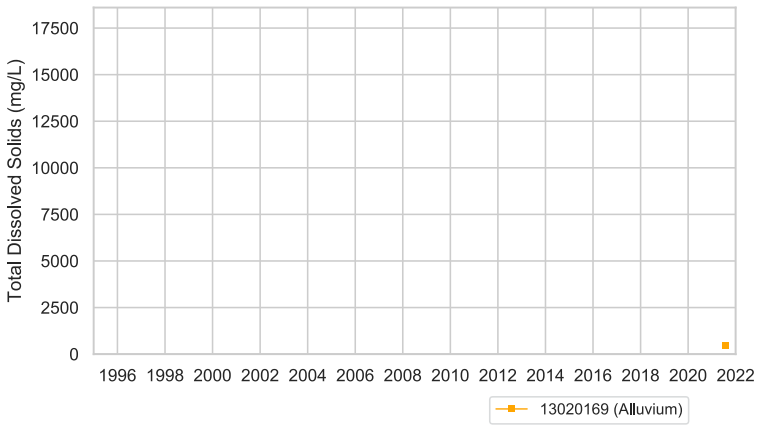

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

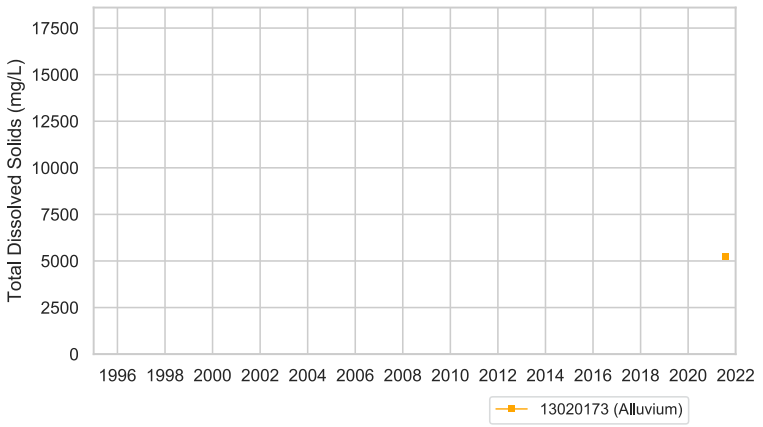

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

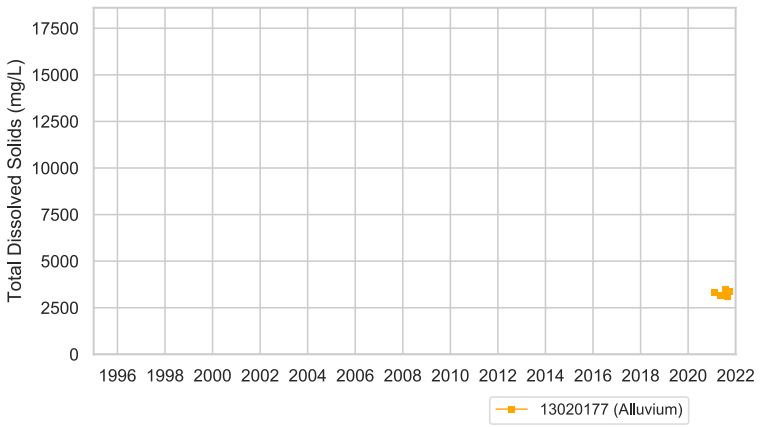

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

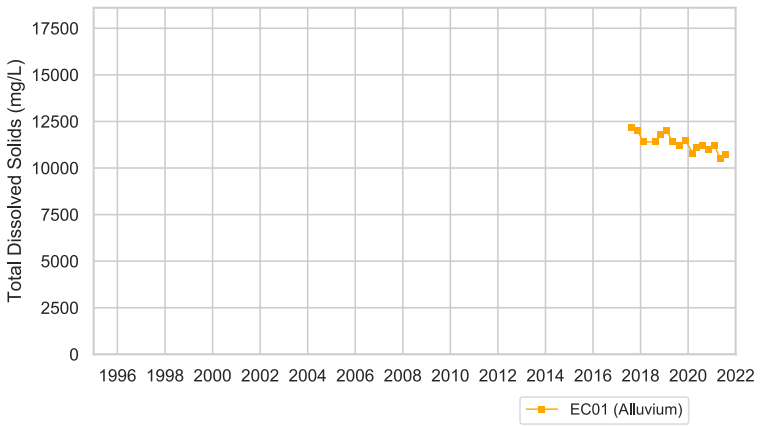

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

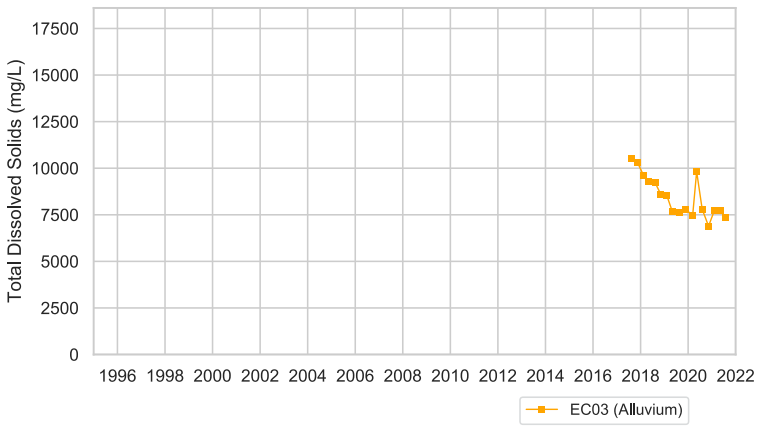

pH Value (pH Unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

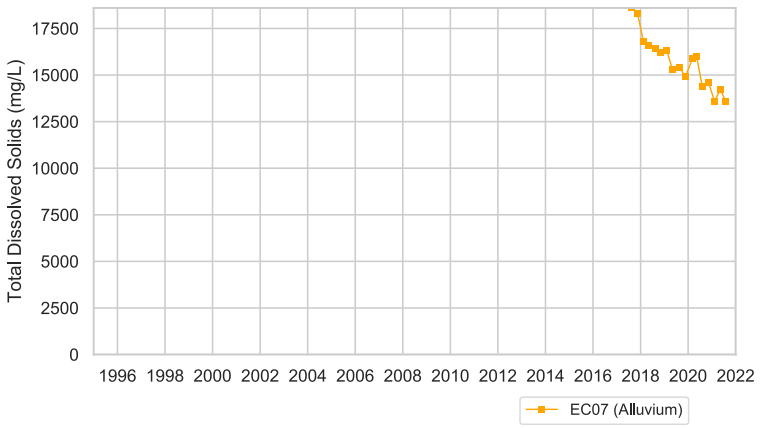

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

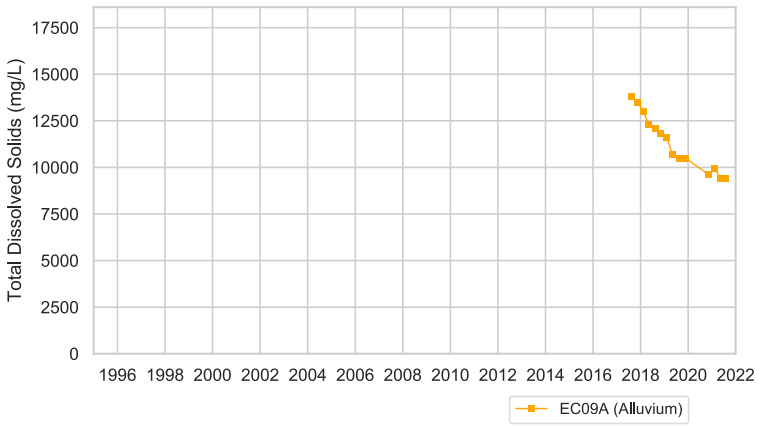

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

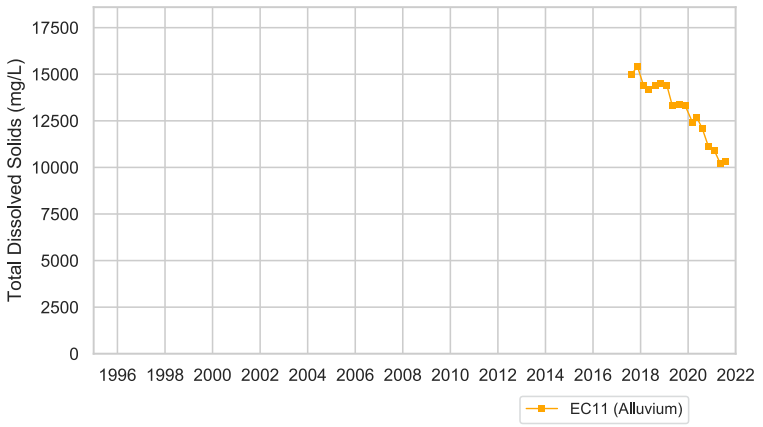

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

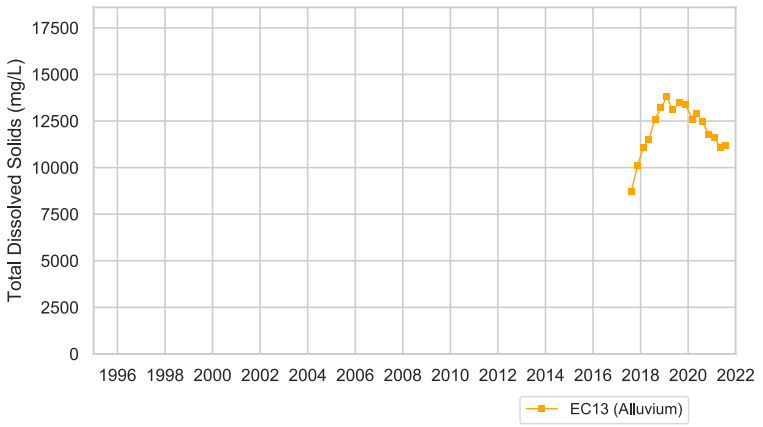

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

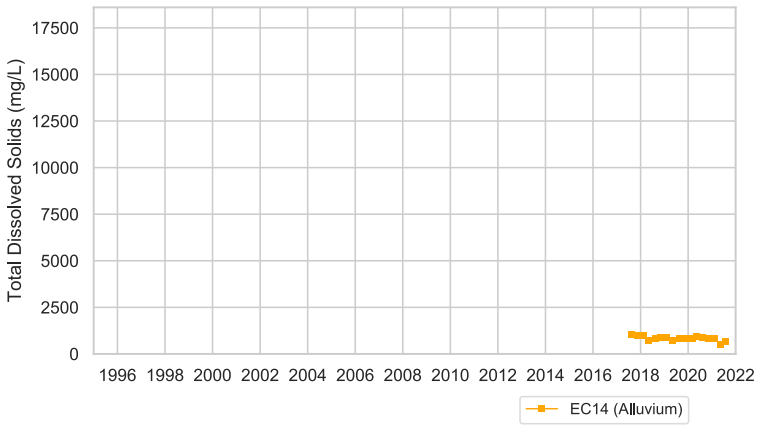

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

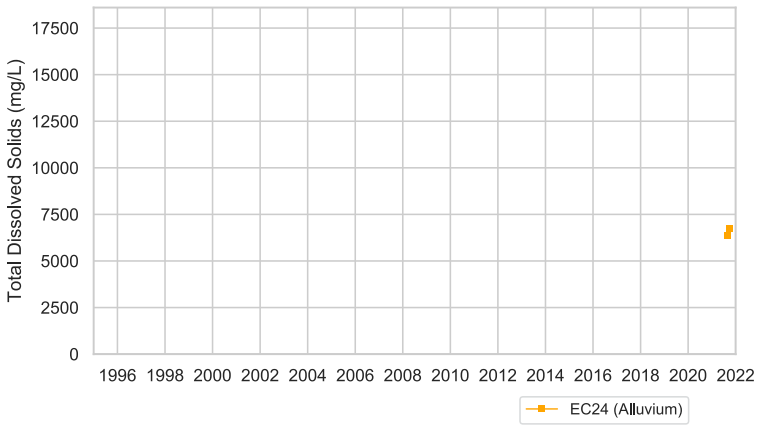

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

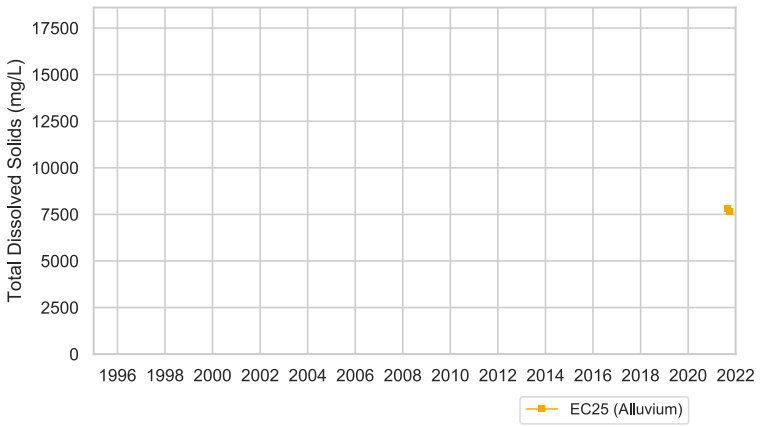

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

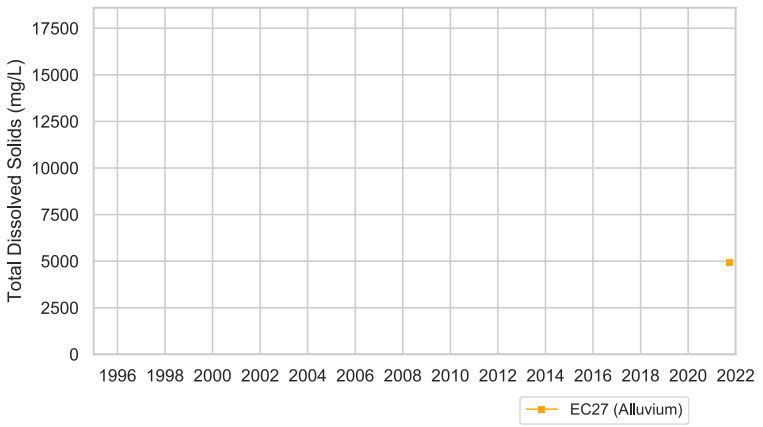

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

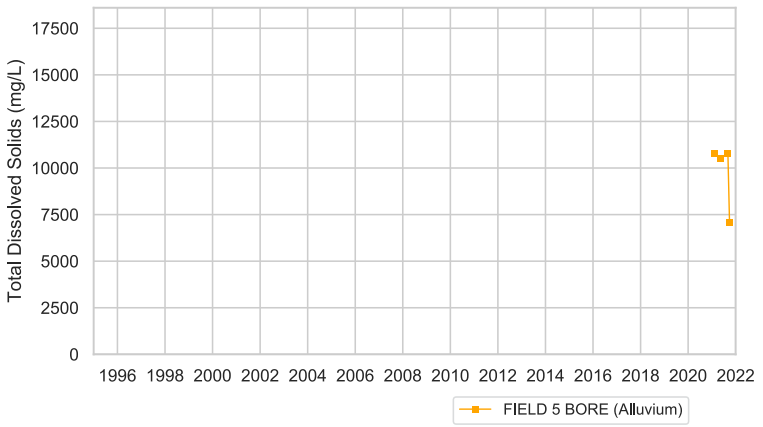

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

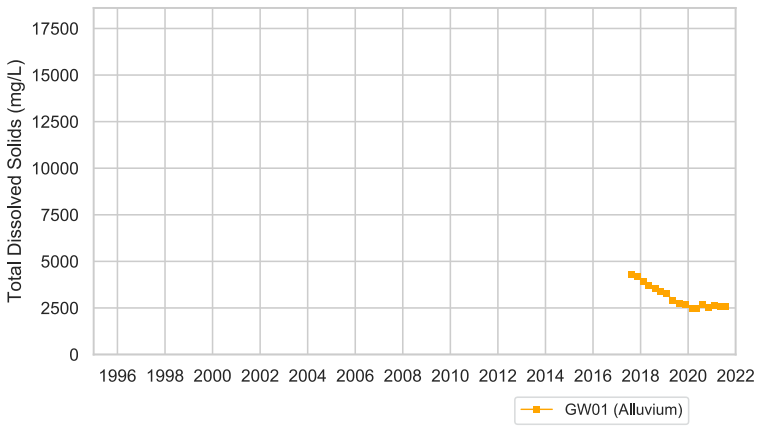

Total Dissolved Solids (mg/L)
17500
15000
12500
10000
7500
5000
2500
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

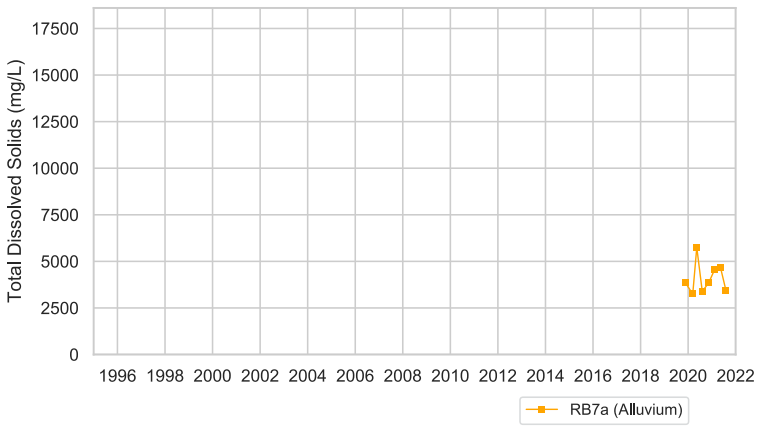

Total Dissolved Solids (mg/L)
EC24 (Alluvium)

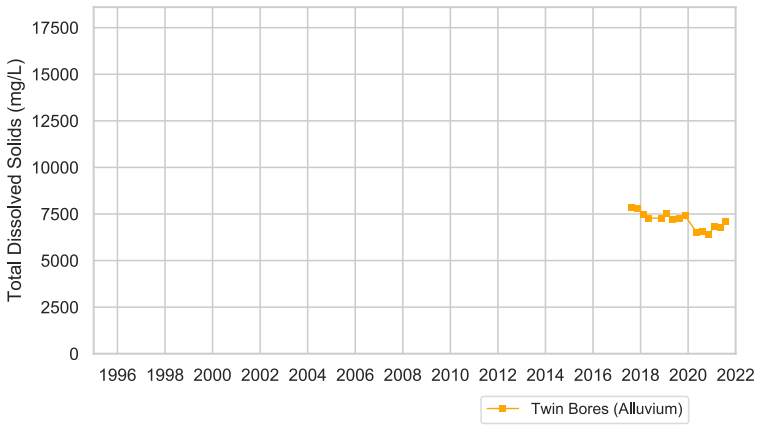

Total Dissolved Solids (mg/L)
EC25 (Alluvium)

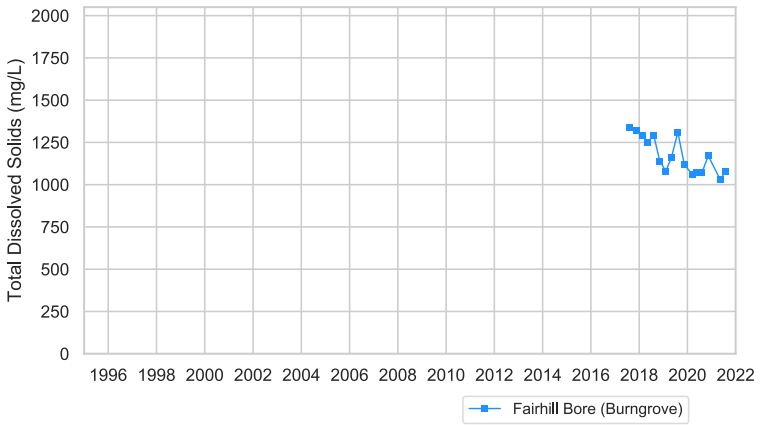

Total Dissolved Solids (mg/L)
EC27 (Alluvium)

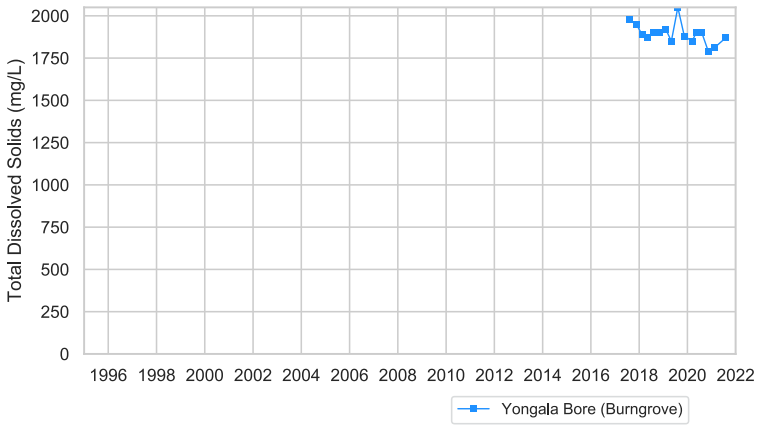

Total Dissolved Solids (mg/L)
FIELD 5 BORE (Alluvium)

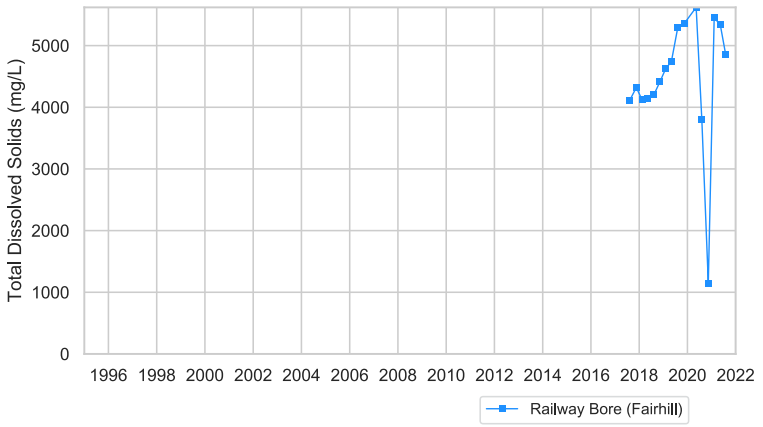

Total Dissolved Solids (mg/L)
GW01 (Alluvium)

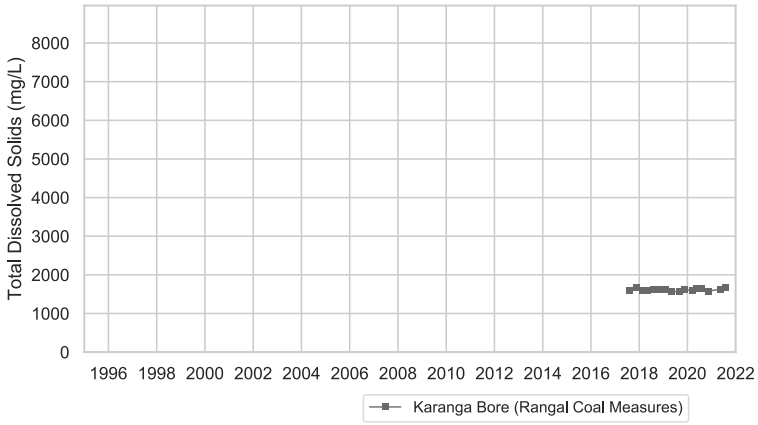

Total Dissolved Solids (mg/L)
RB7a (Alluvium)

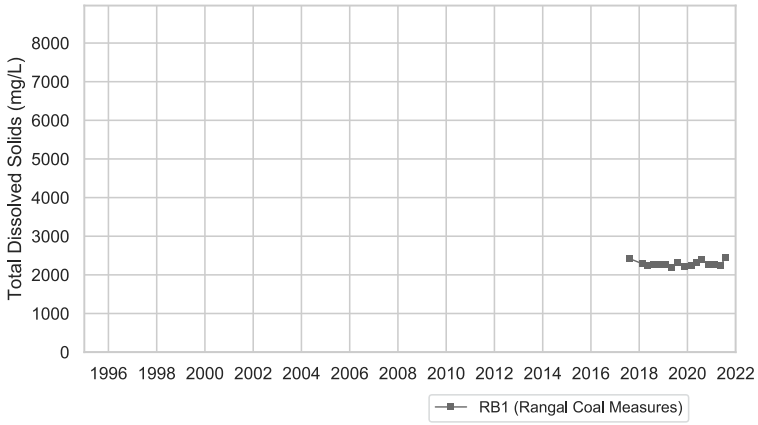

Total Dissolved Solids (mg/L)
Twin Bores (Alluvium)

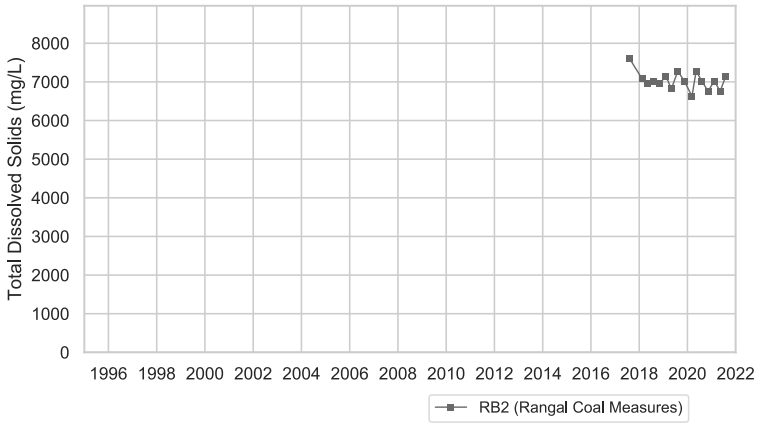

Total Dissolved Solids (mg/L)
Fairhill Bore (Burngrove)

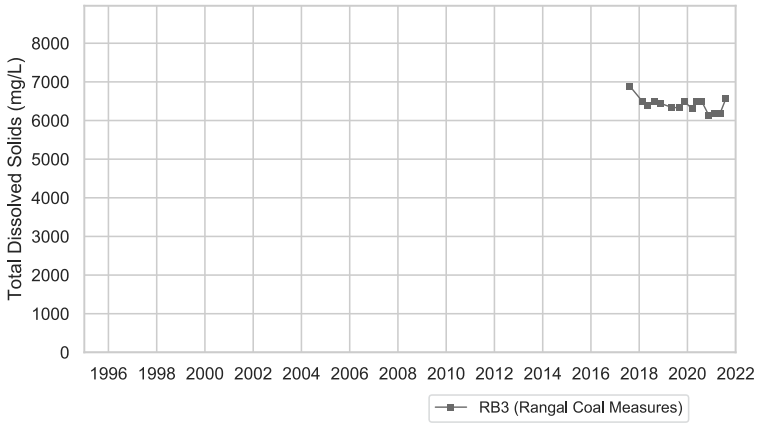

Total Dissolved Solids (mg/L)
Yongala Bore (Burngrove)

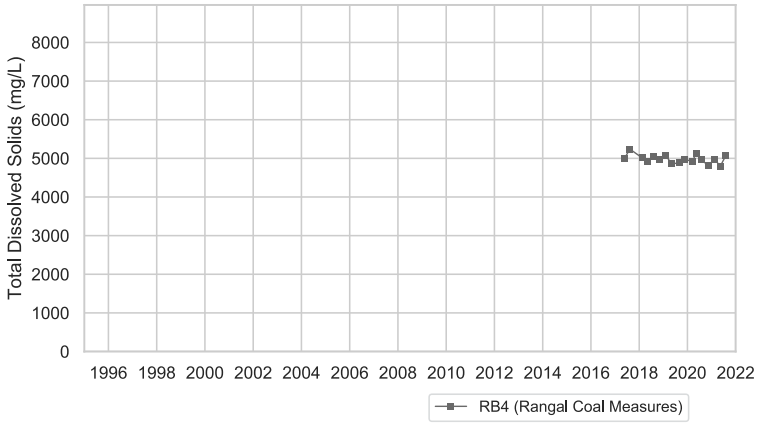

Total Dissolved Solids (mg/L)
Railway Bore (Fairhill)

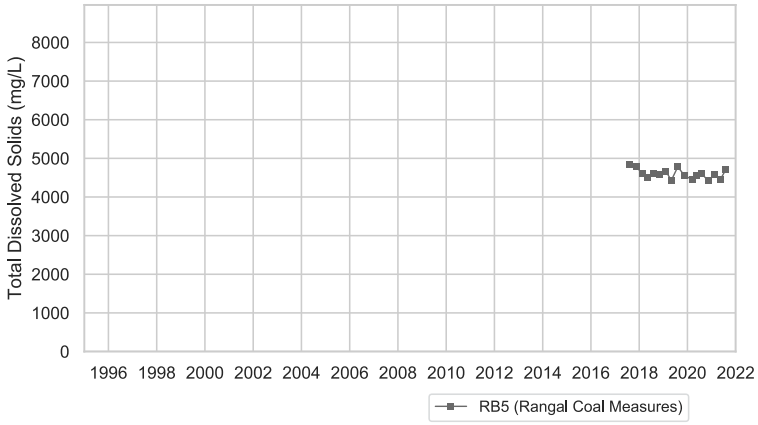

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

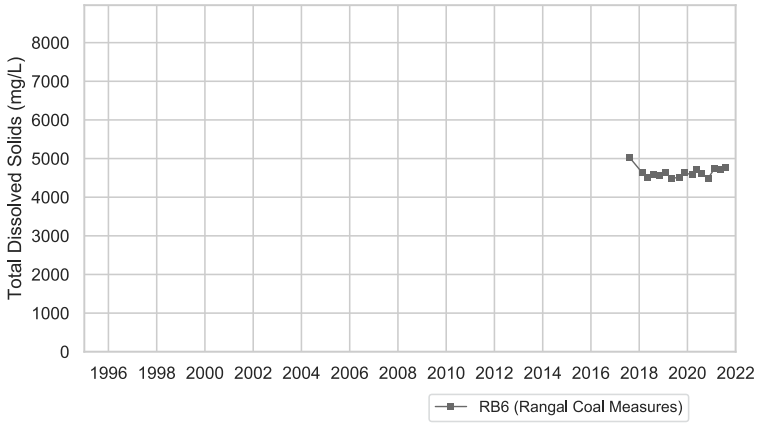

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

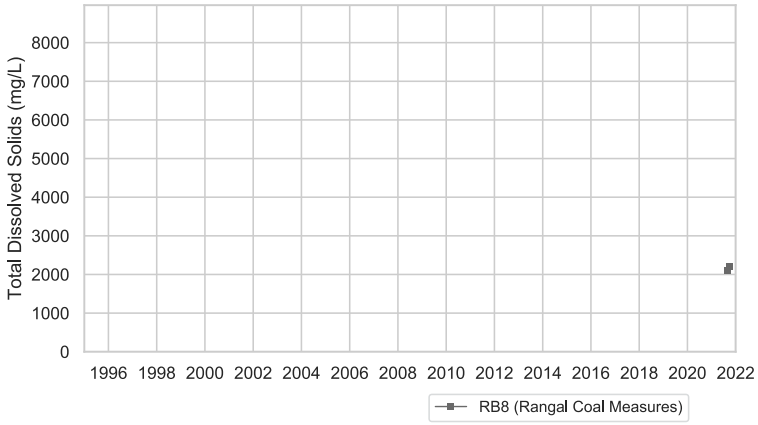

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

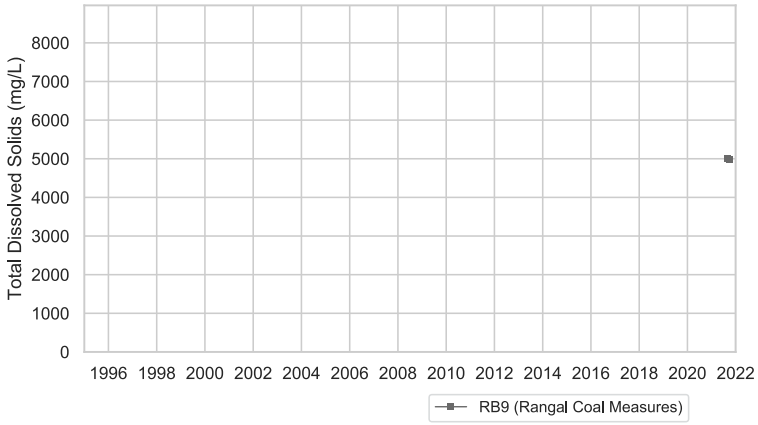

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

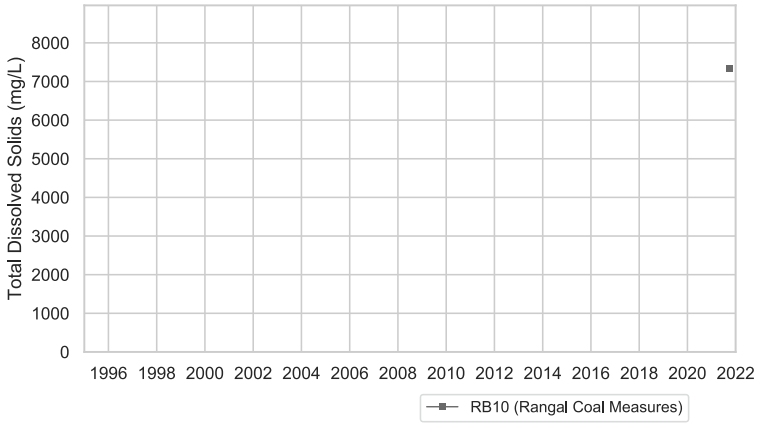

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

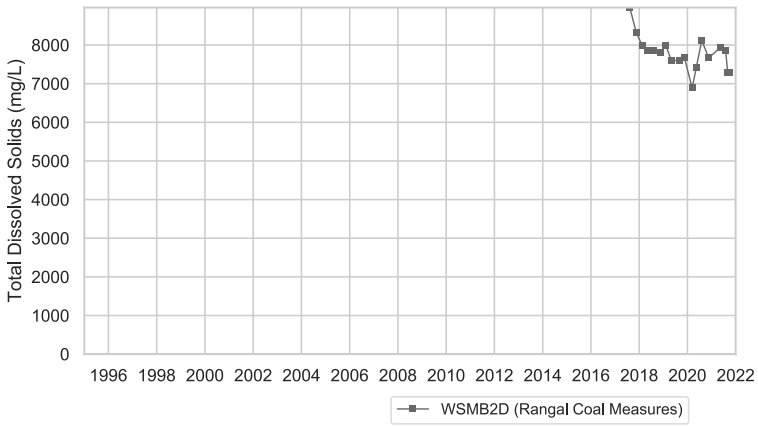

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

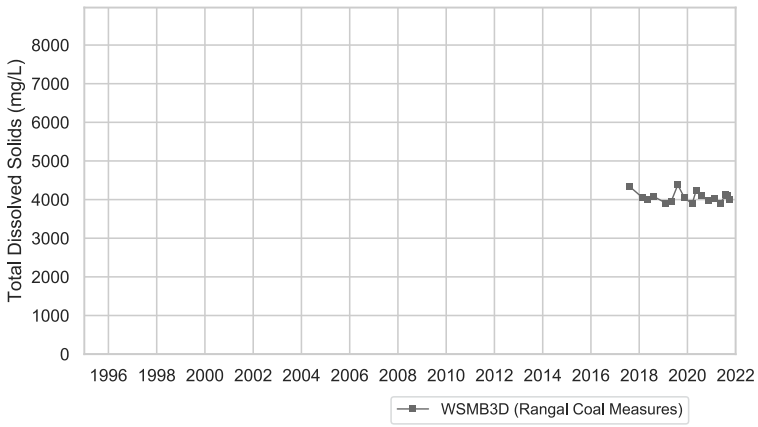

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

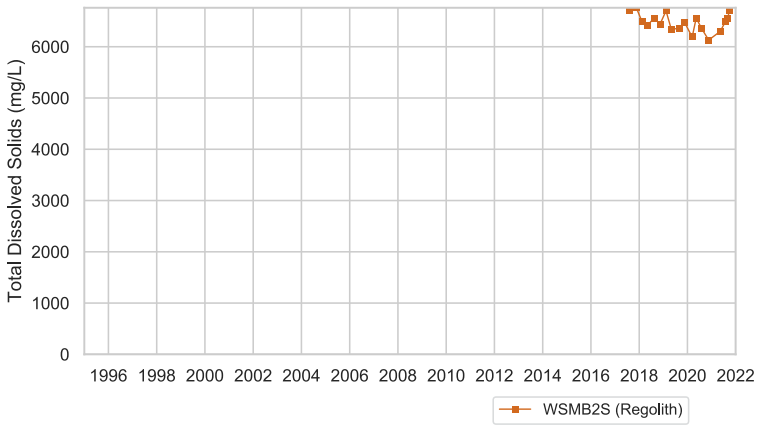

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

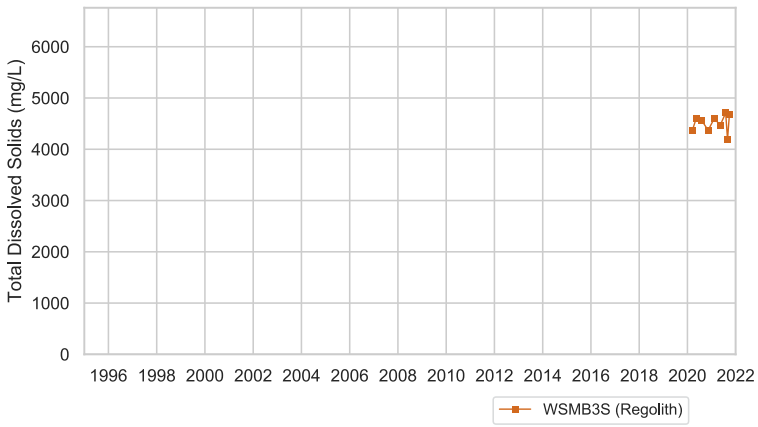

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

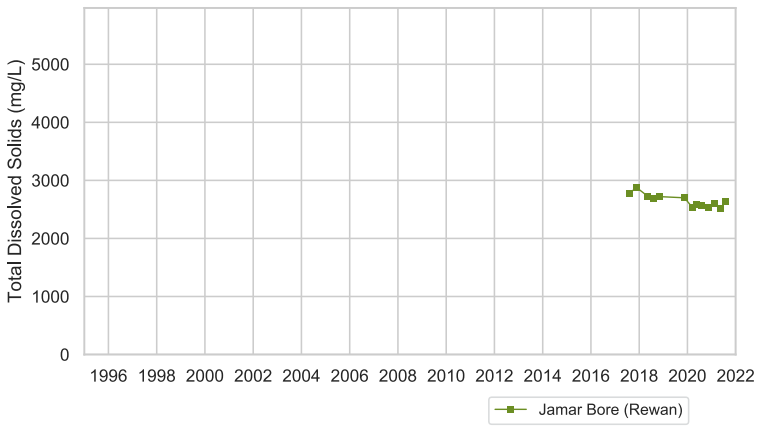

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

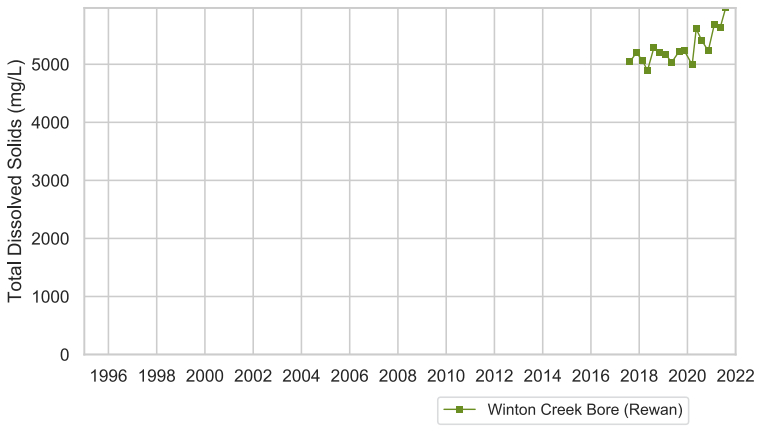

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

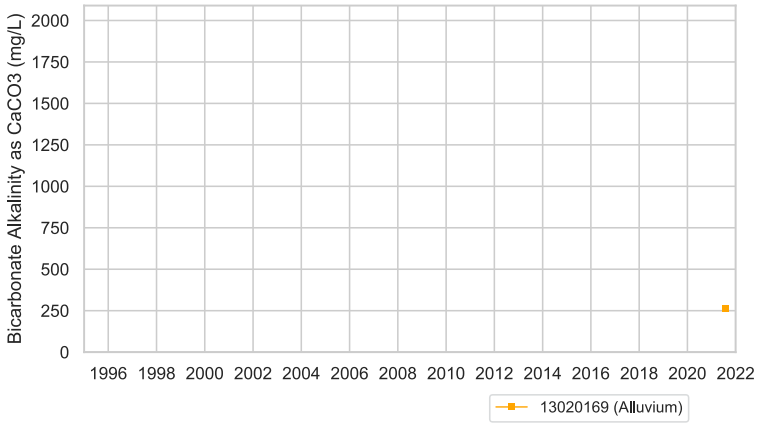

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
8000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

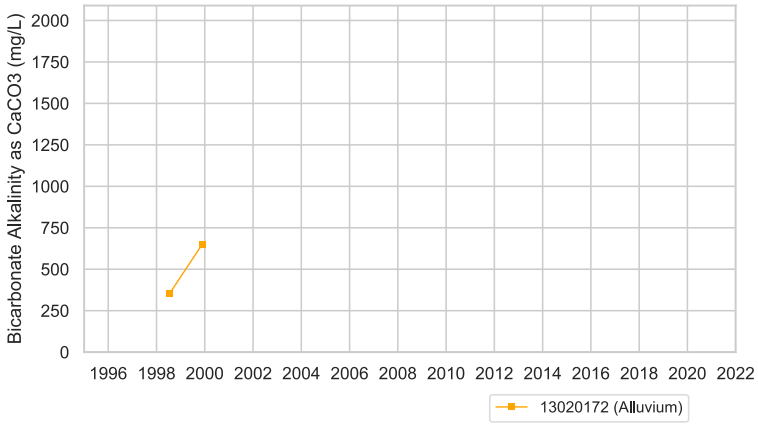

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

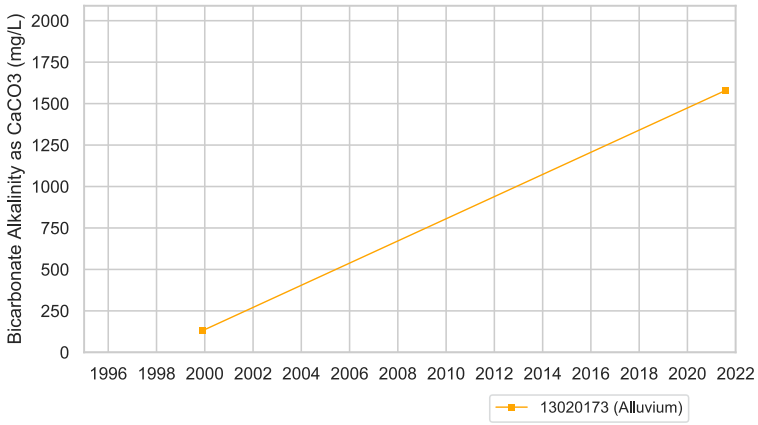

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
6000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

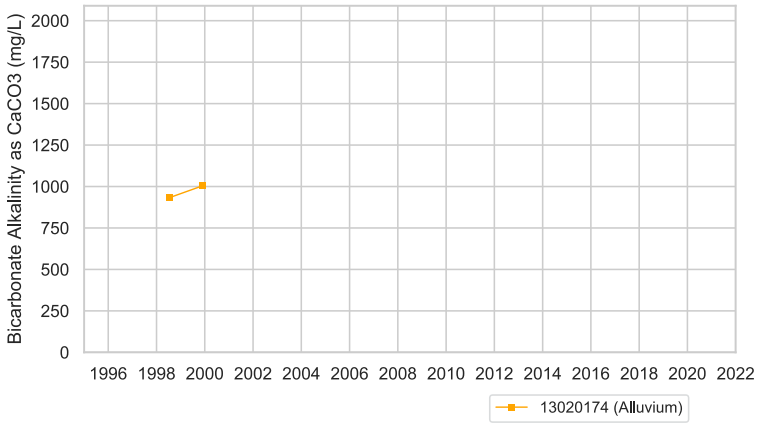

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

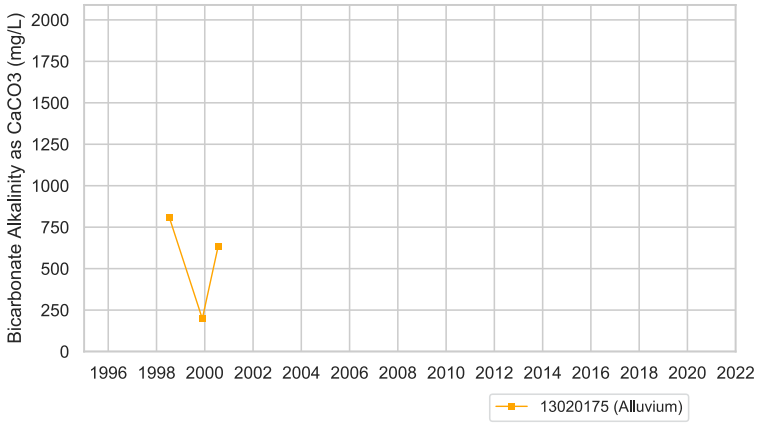

Total Dissolved Solids (mg/L)
0
1000
2000
3000
4000
5000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

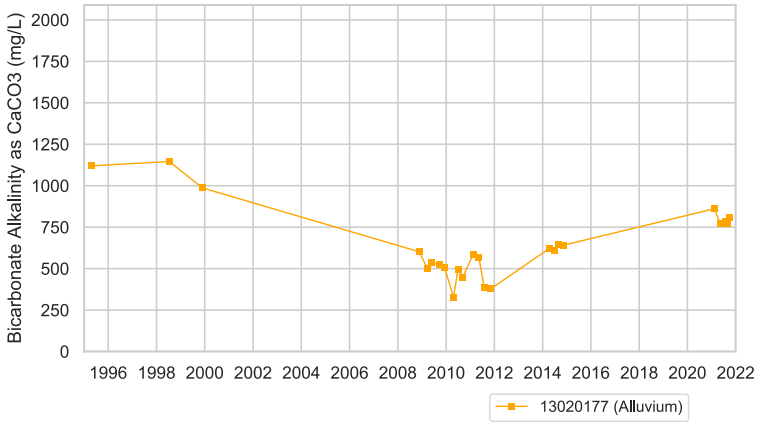

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

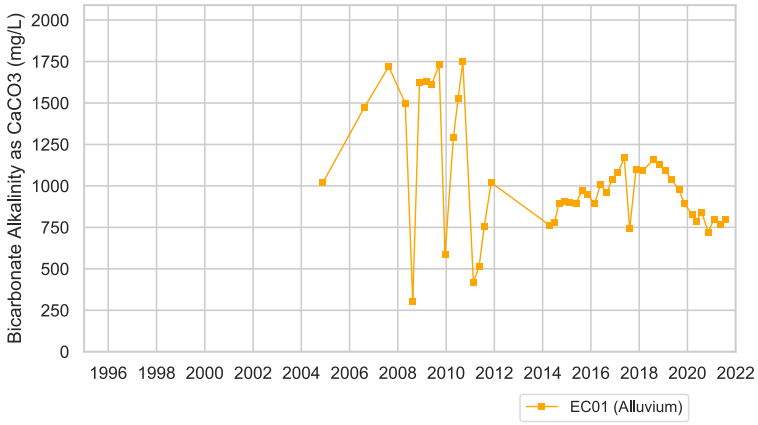

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

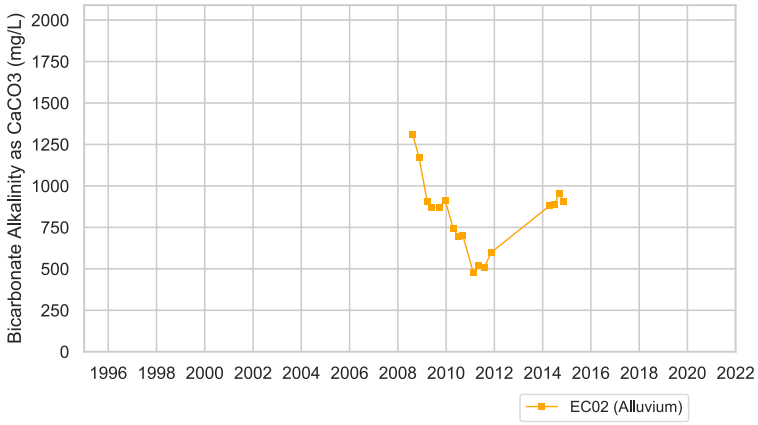

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

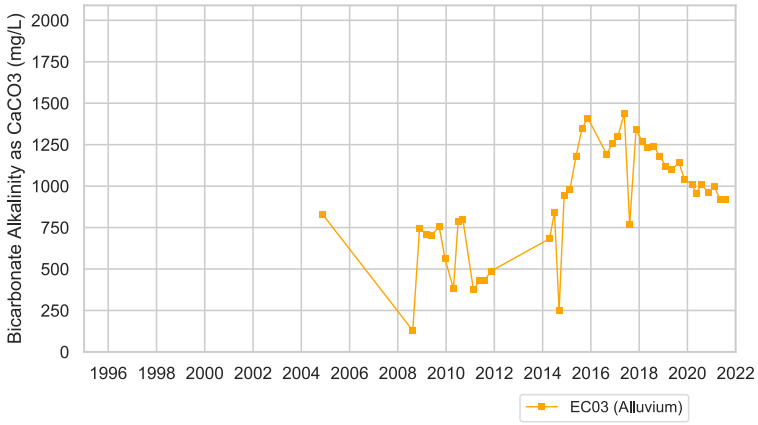

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

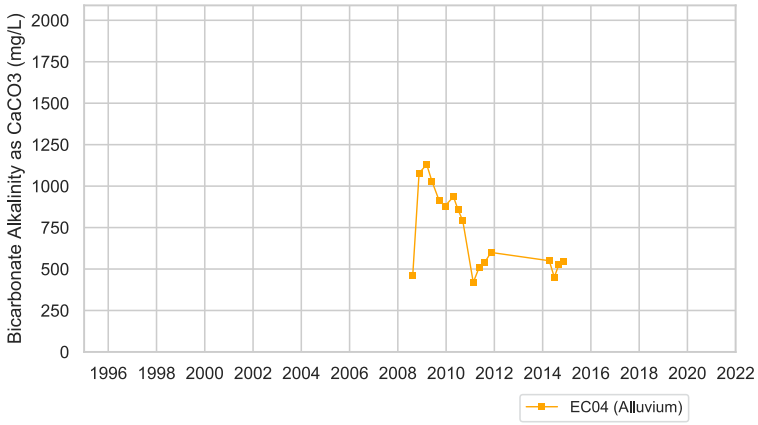

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

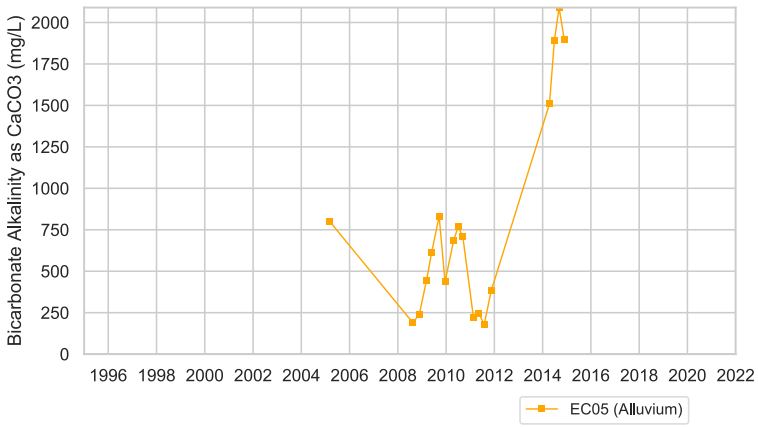

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

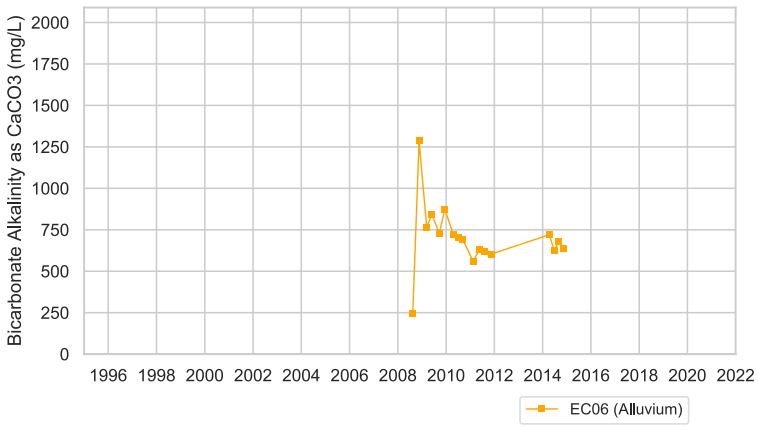

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

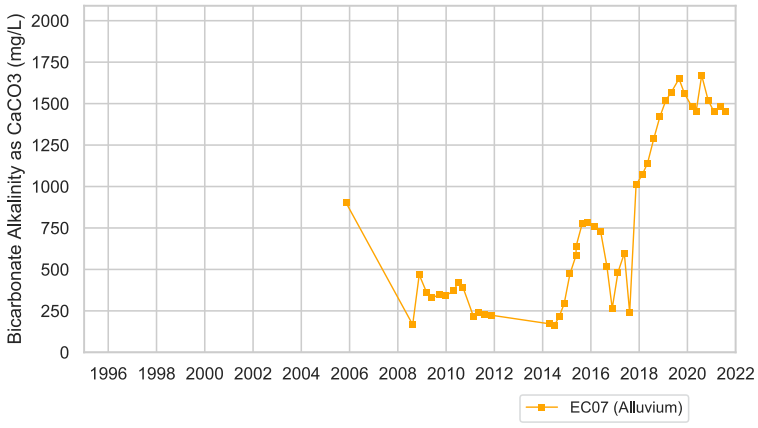

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

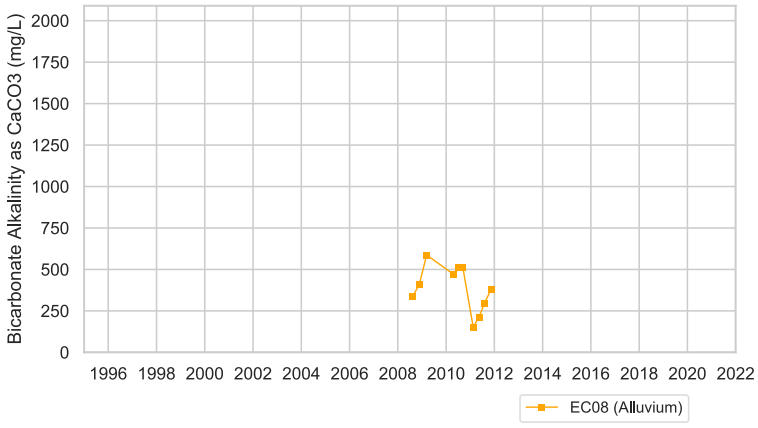

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

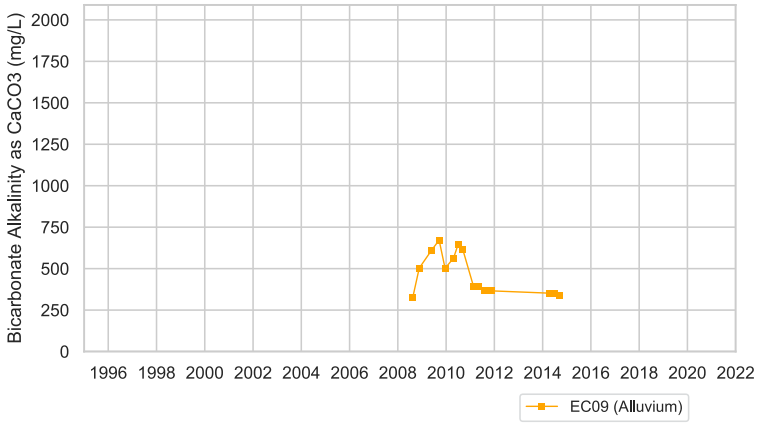

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

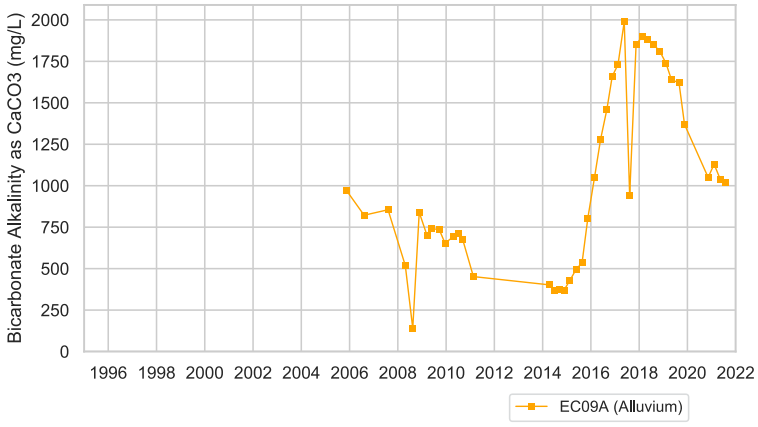

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

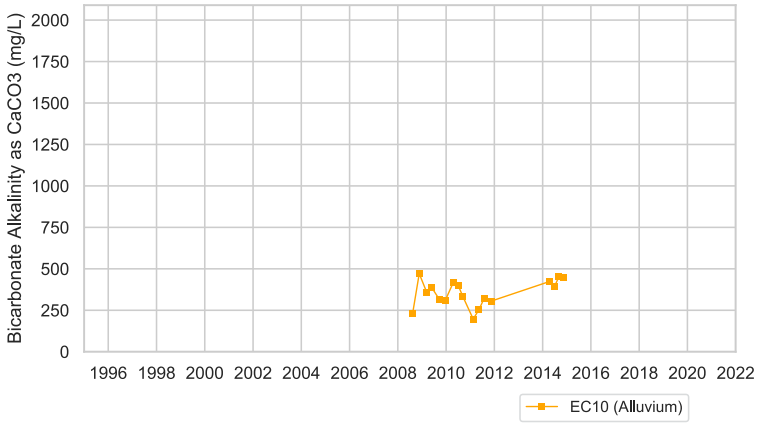

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

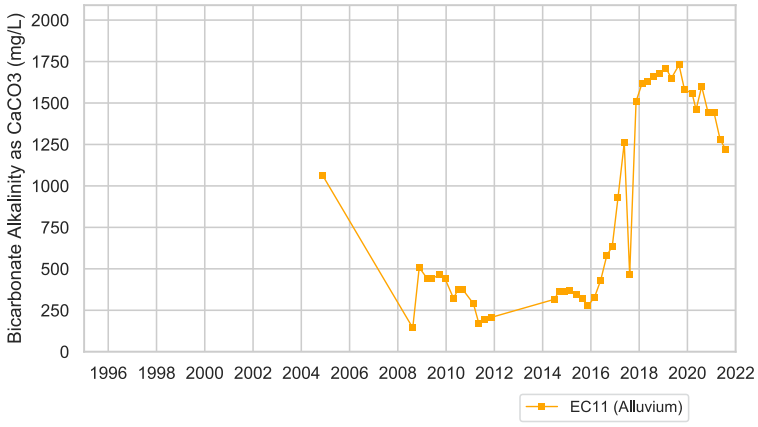

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

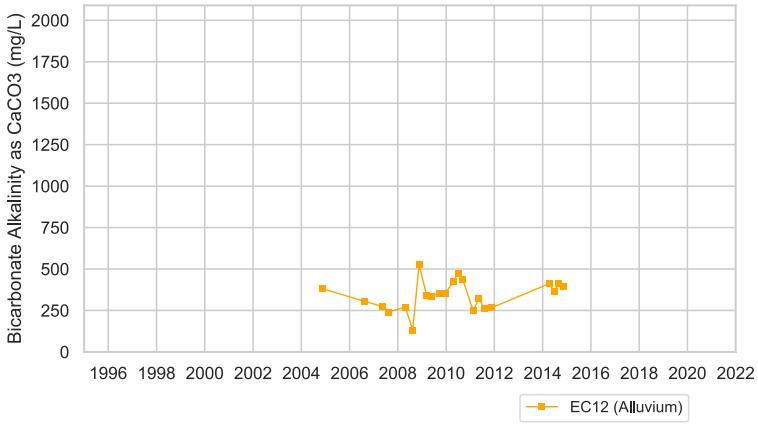

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

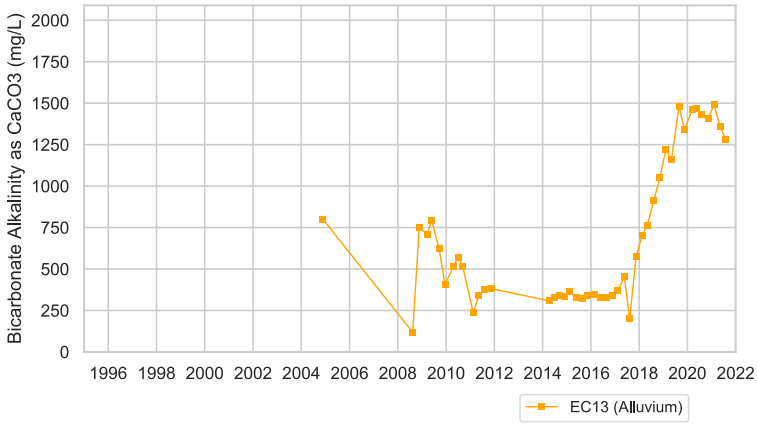

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

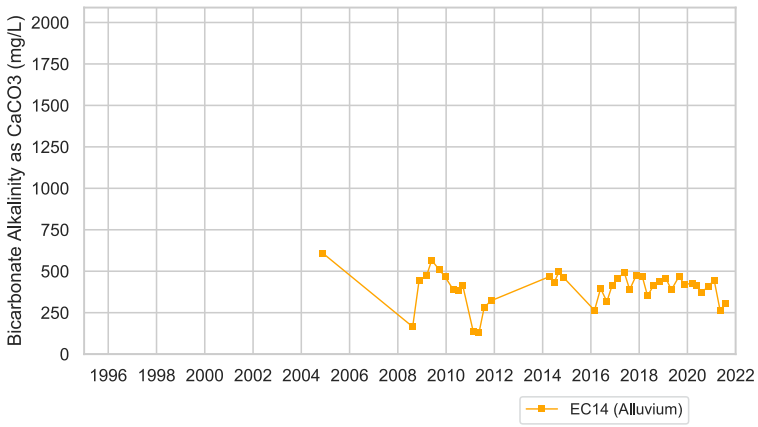

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

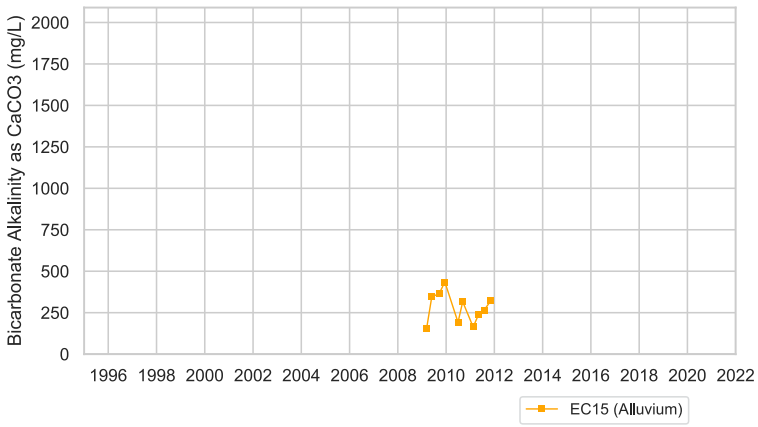

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

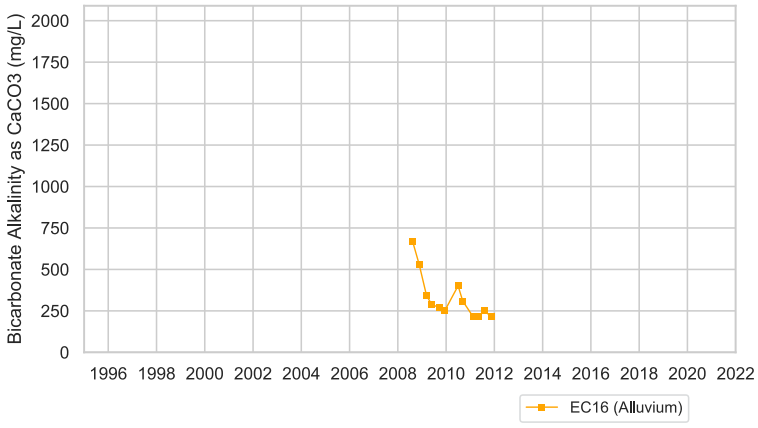

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

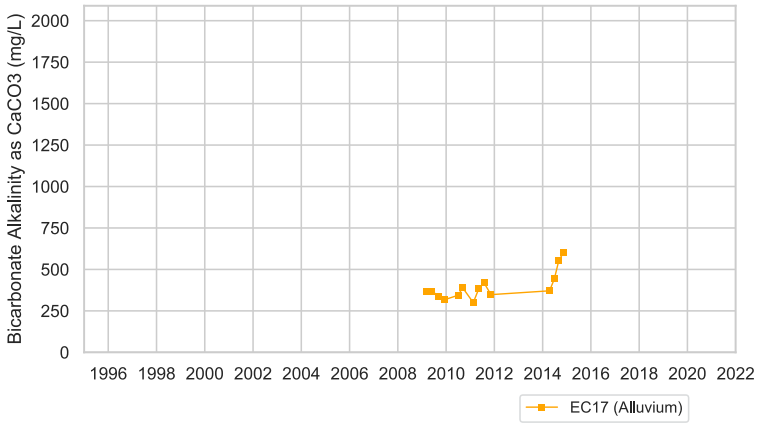

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

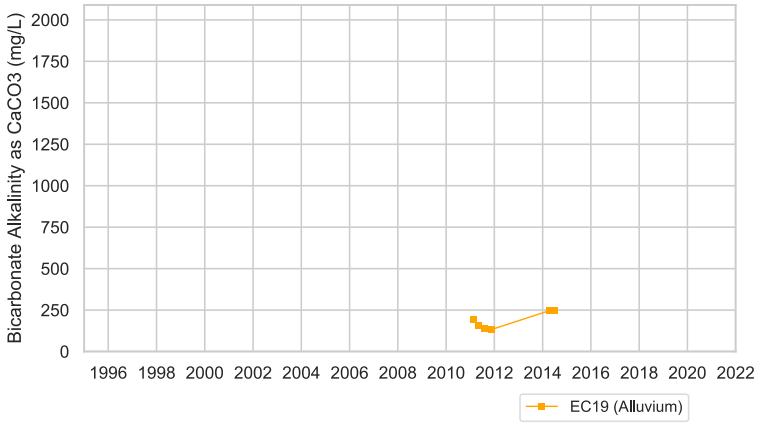

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

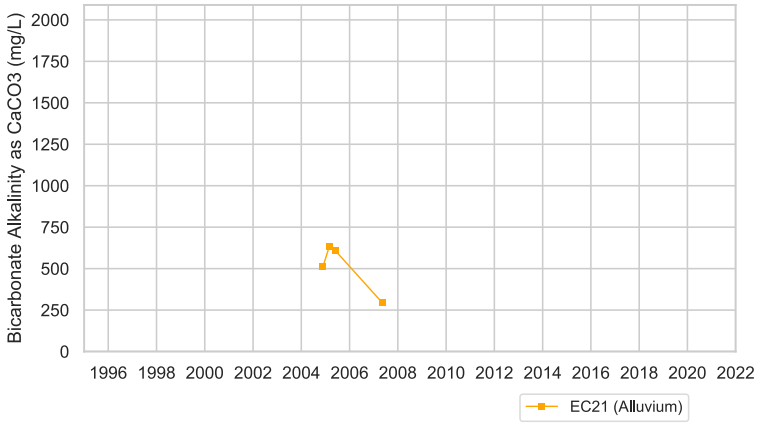

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

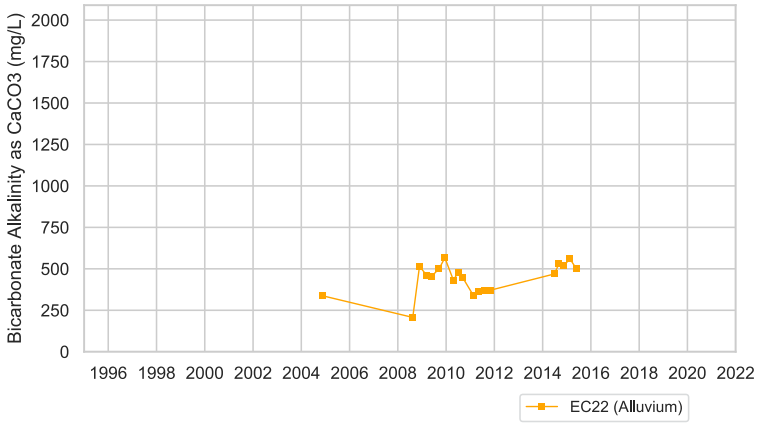

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

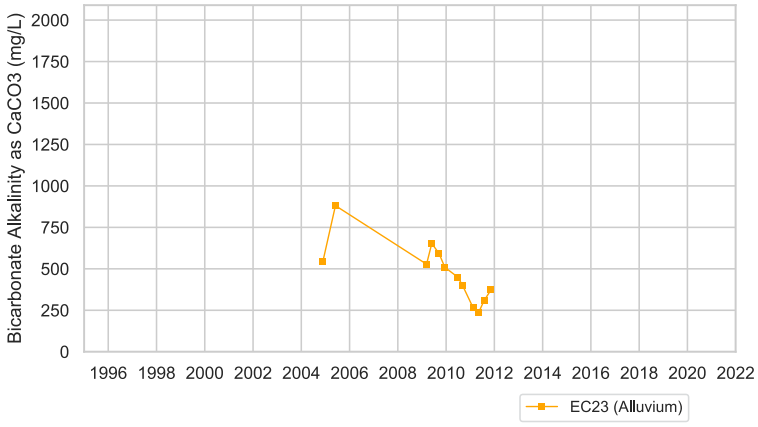

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

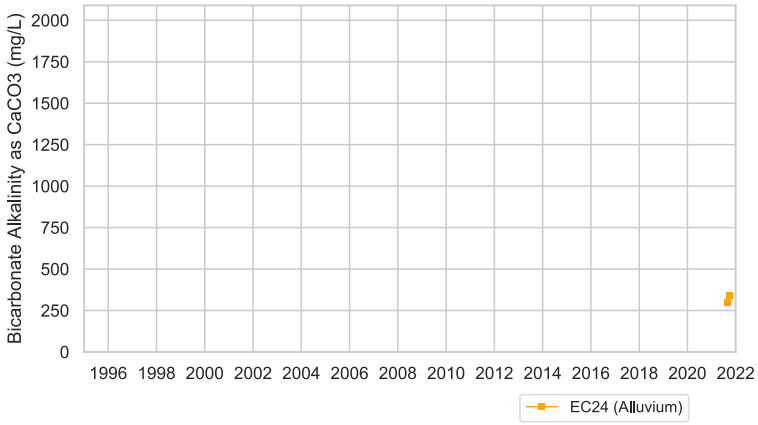

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

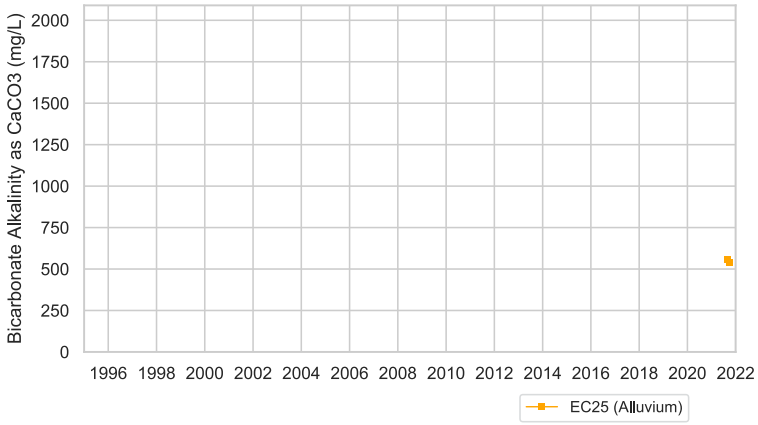

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

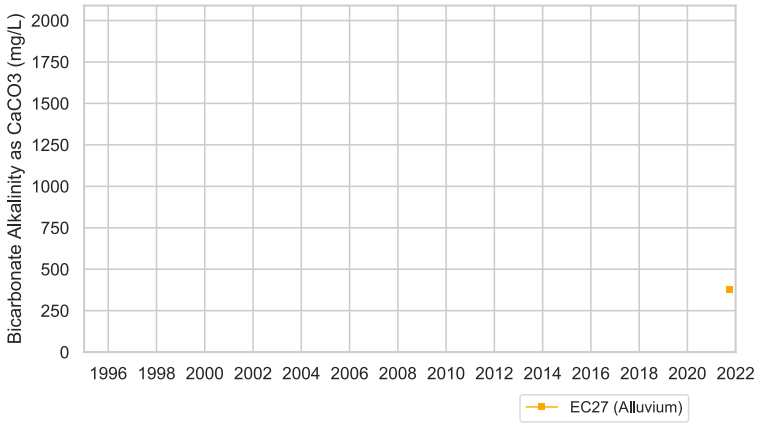

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

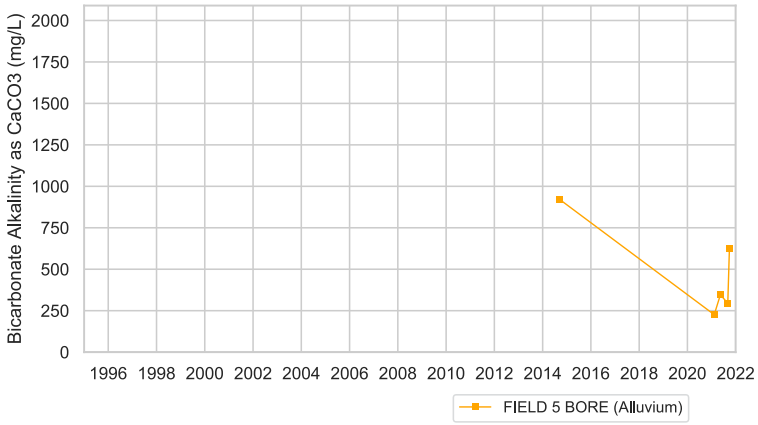

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

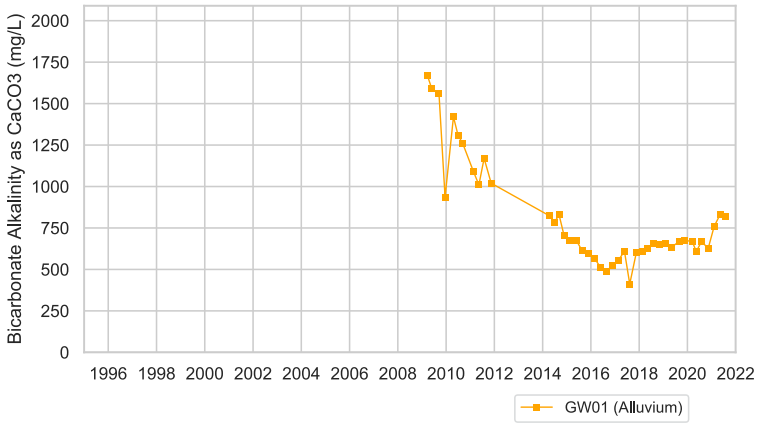

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

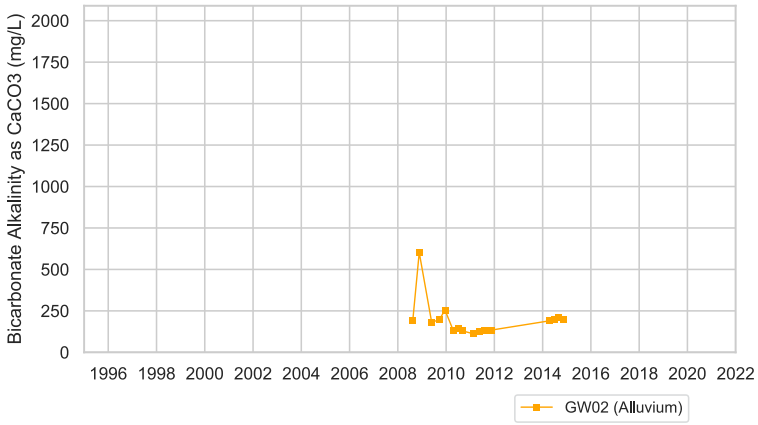

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

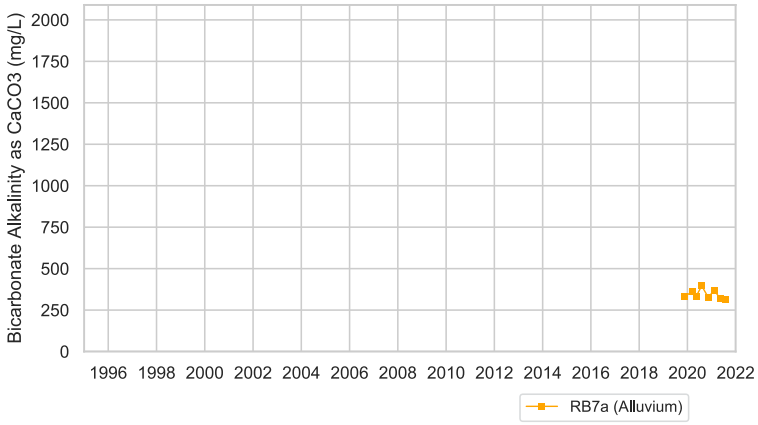

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

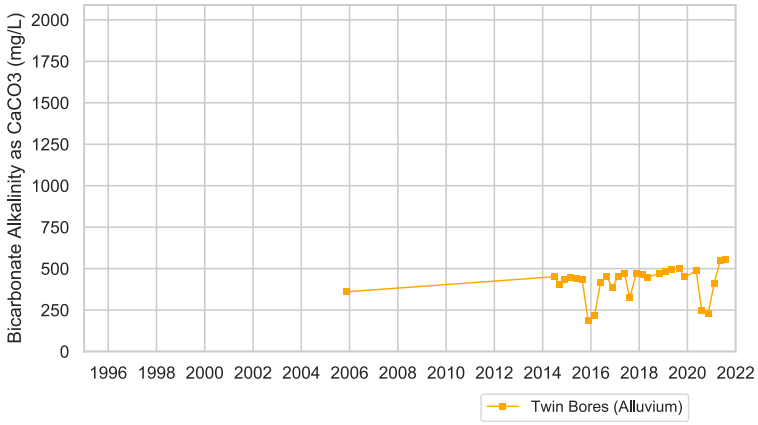

Bicarbonate Alkalinity as CaCO3 (mg/L)
EC27 (Alluvium)

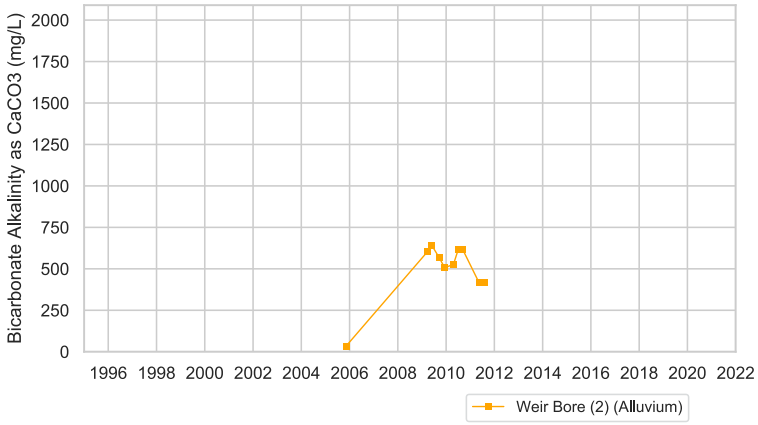

Bicarbonate Alkalinity as CaCO3 (mg/L)
FIELD 5 BORE (Alluvium)

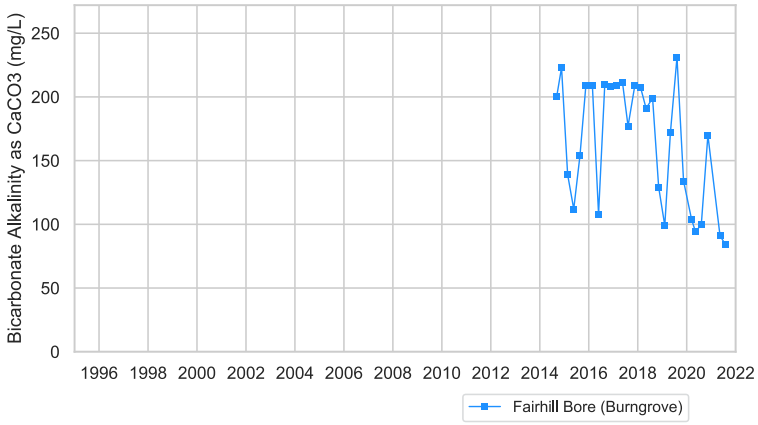

Bicarbonate Alkalinity as CaCO3 (mg/L)
GW01 (Alluvium)

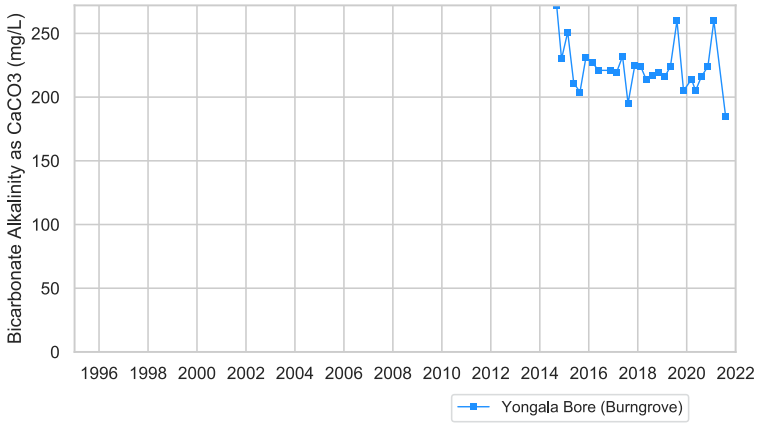

Bicarbonate Alkalinity as CaCO3 (mg/L)
GW02 (Alluvium)

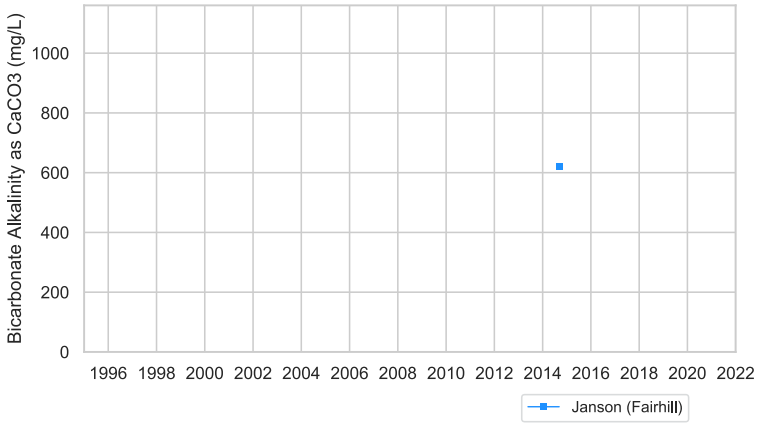

Bicarbonate Alkalinity as CaCO3 (mg/L)
RB7a (Alluvium)

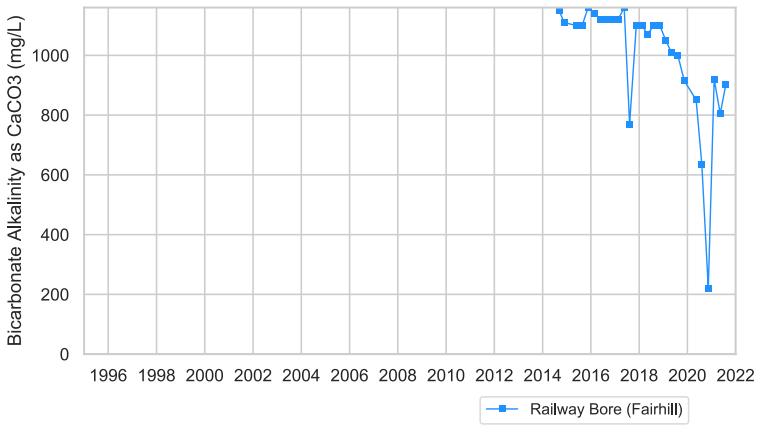

Bicarbonate Alkalinity as CaCO3 (mg/L)
Twin Bores (Alluvium)

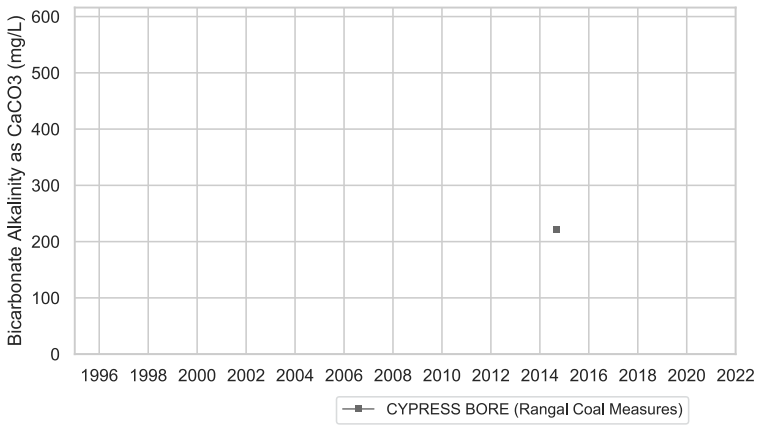

Bicarbonate Alkalinity as CaCO3 (mg/L)
Weir Bore (2) (Alluvium)

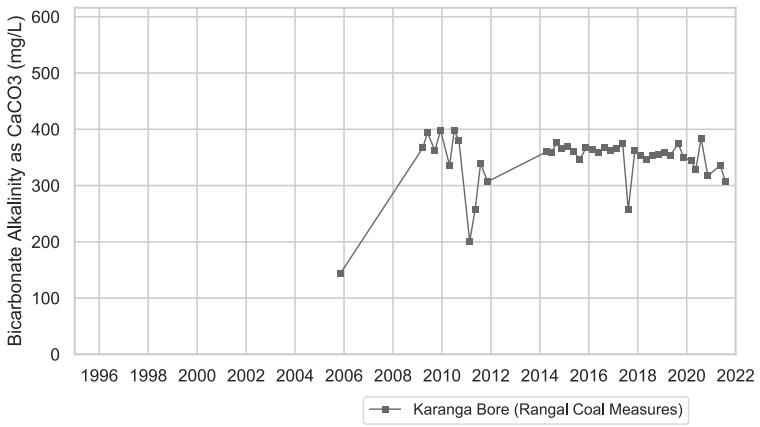

Bicarbonate Alkalinity as CaCO3 (mg/L)
Fairhill Bore (Burngrove)

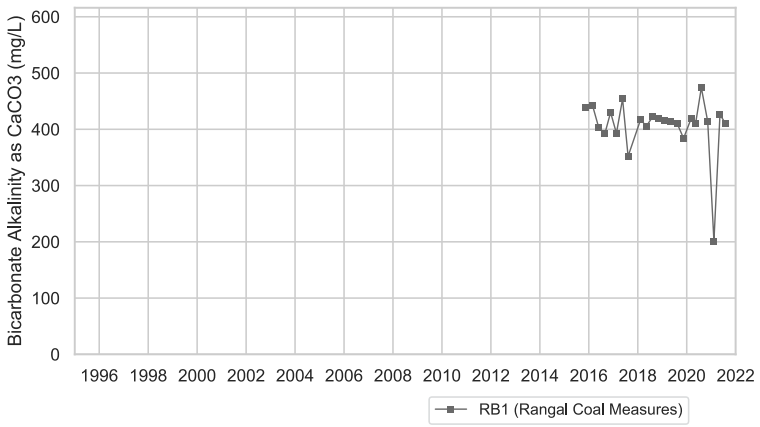

Bicarbonate Alkalinity as CaCO3 (mg/L)
Yongala Bore (Burngrove)

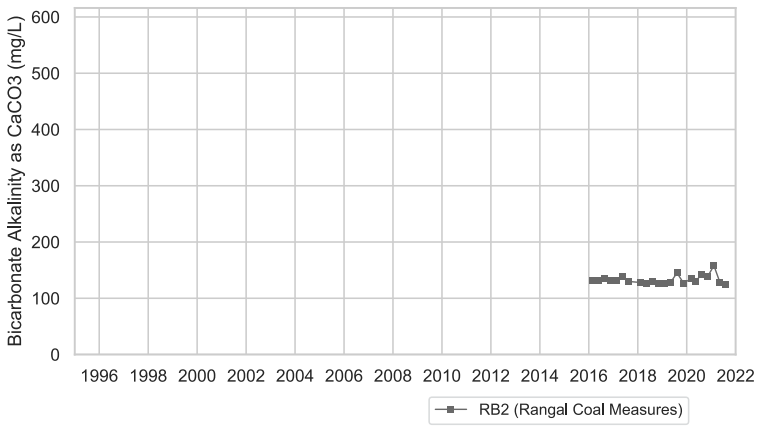

Bicarbonate Alkalinity as CaCO3 (mg/L)
Janson (Fairhill)

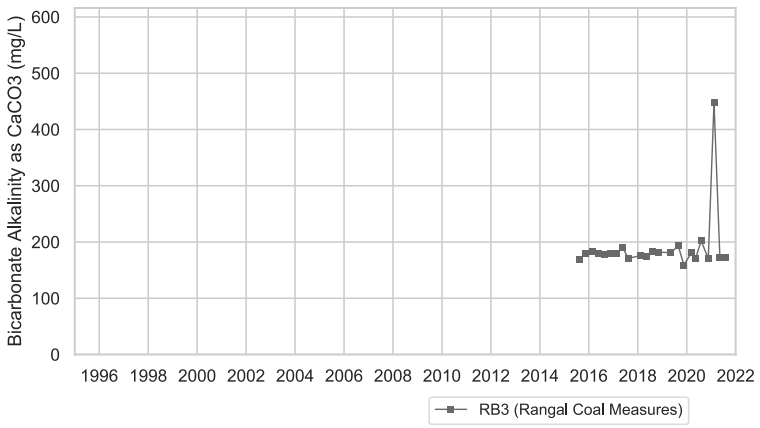

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

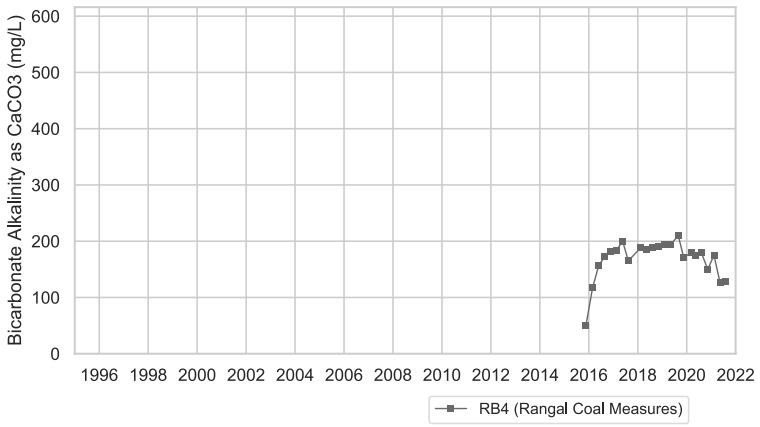

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

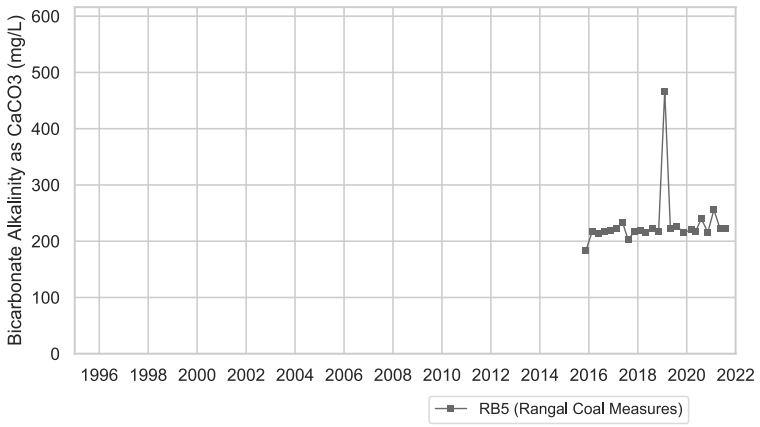

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

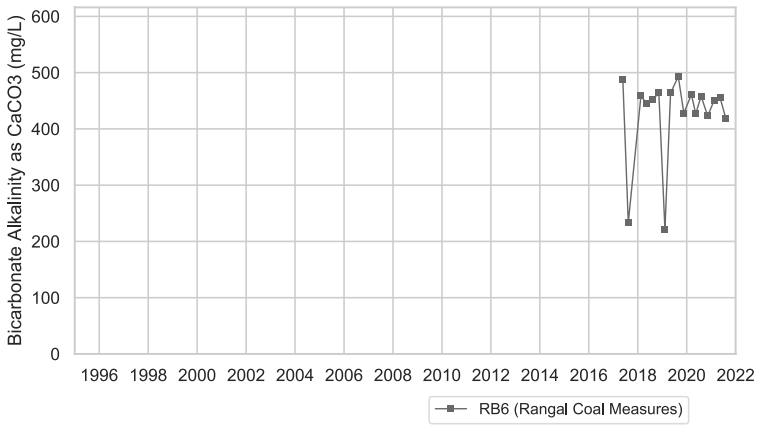

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

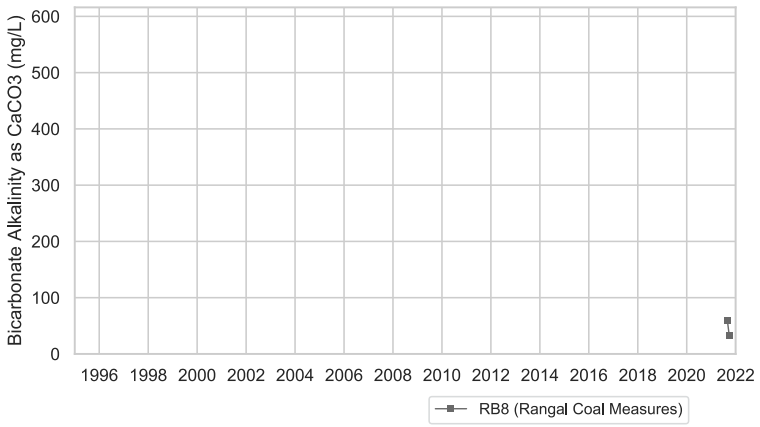

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

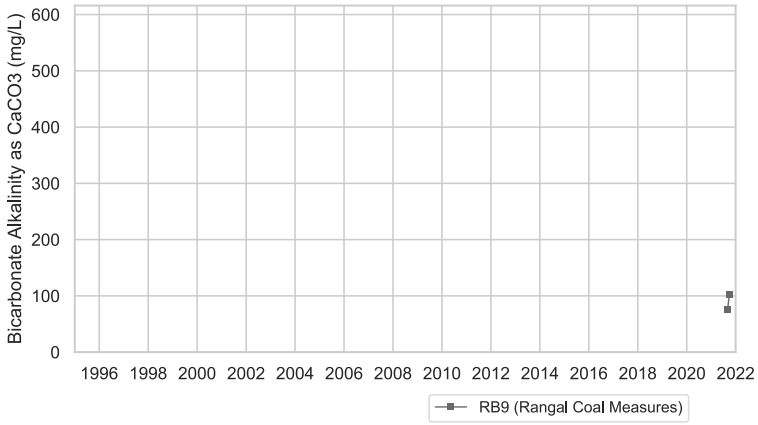

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

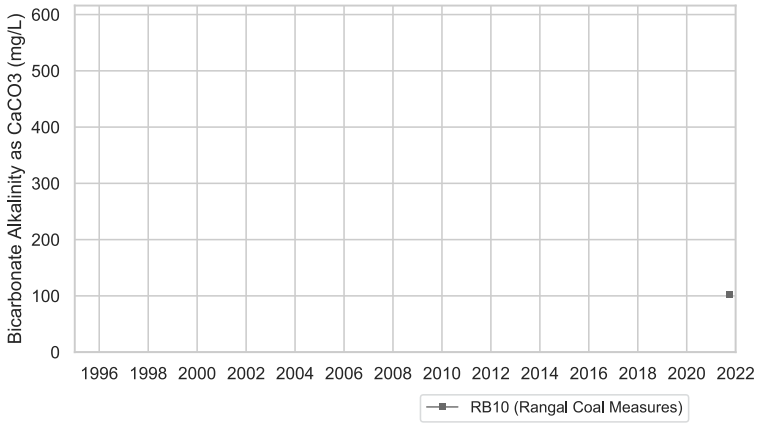

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

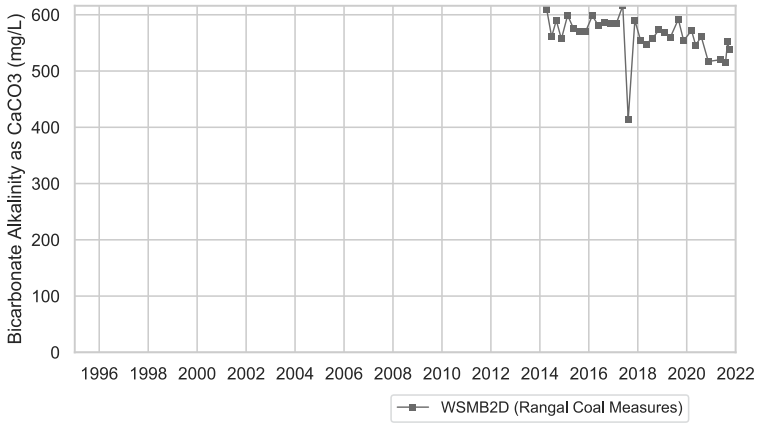

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

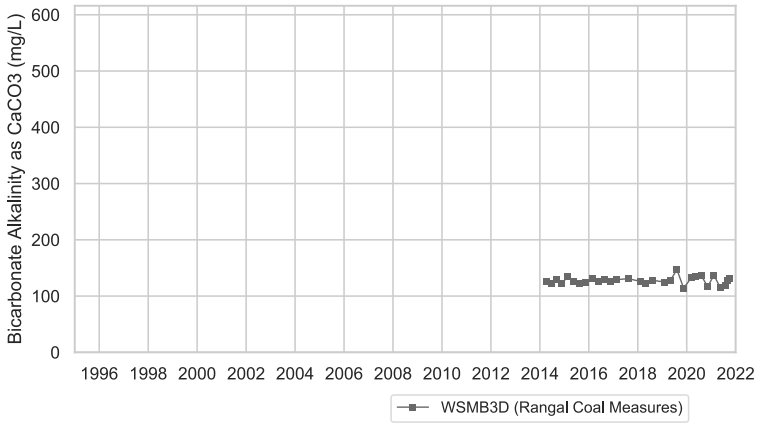

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

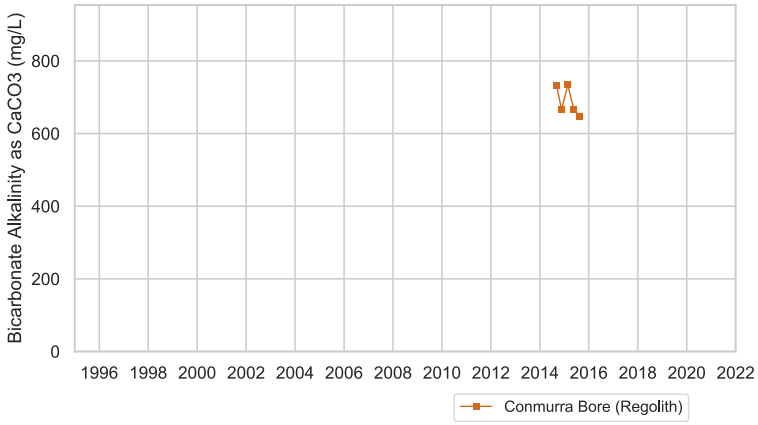

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

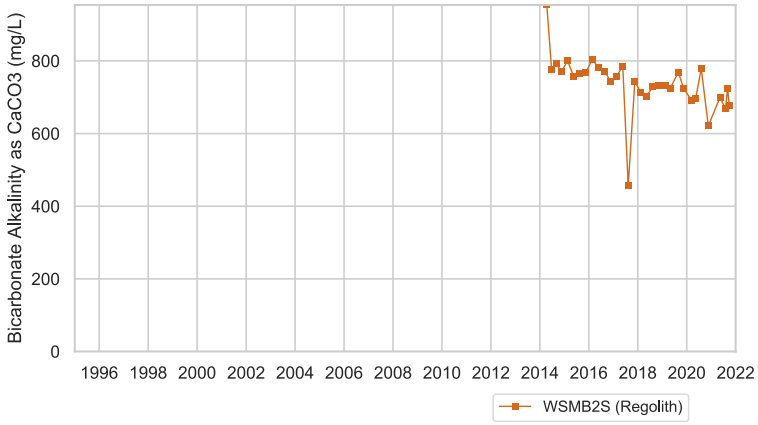

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

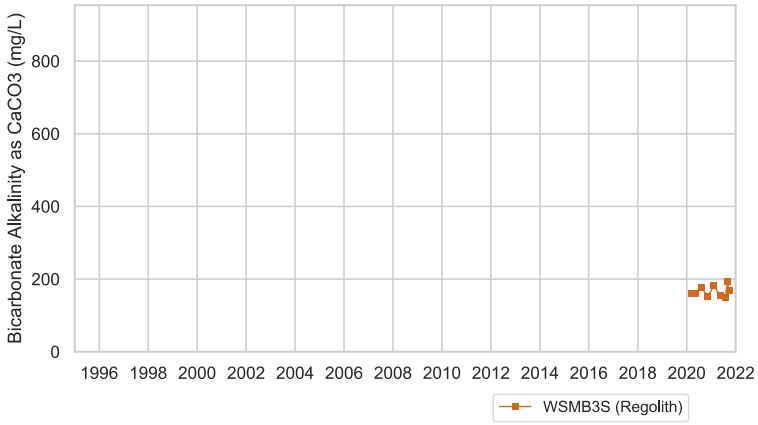

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

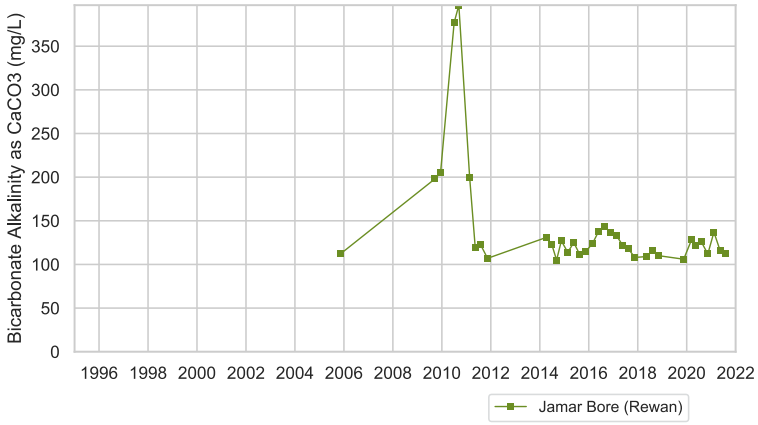

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

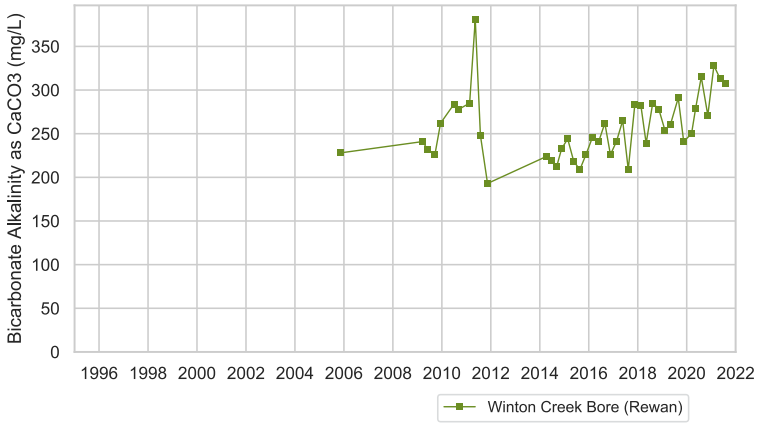

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
100
200
300
400
500
600
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

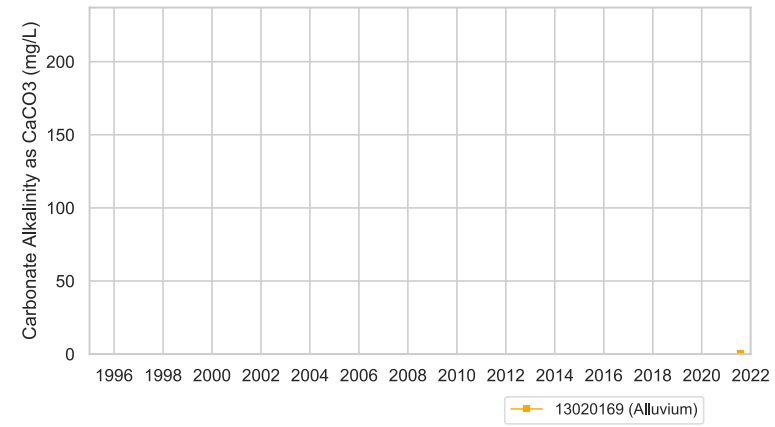

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

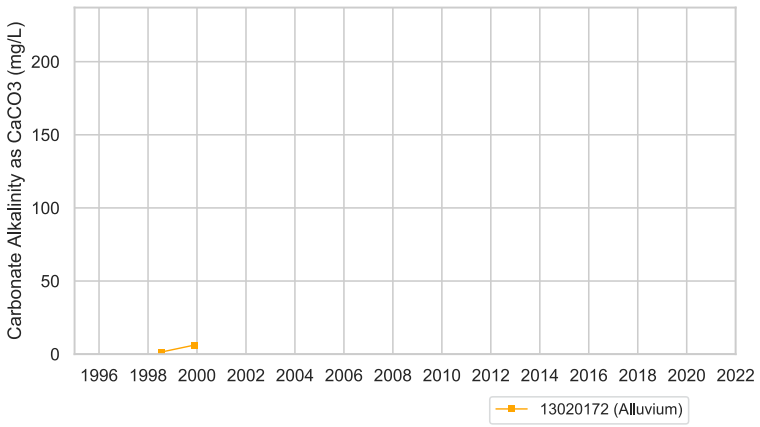

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

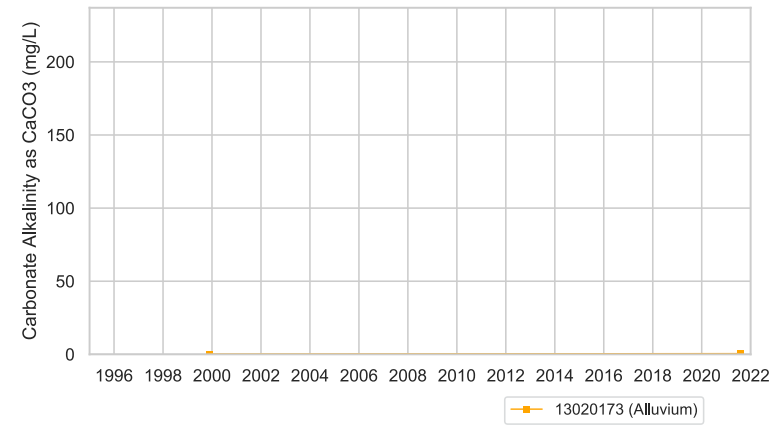

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

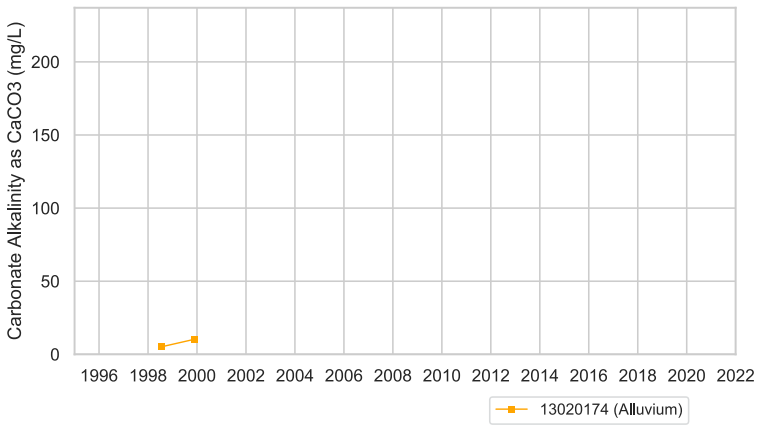

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

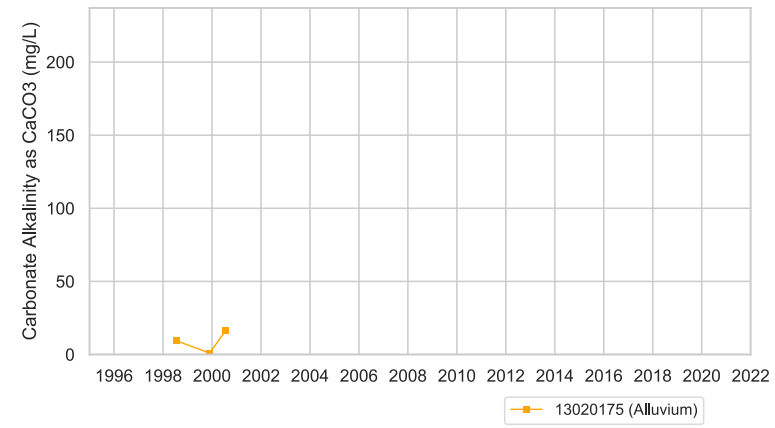

Bicarbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

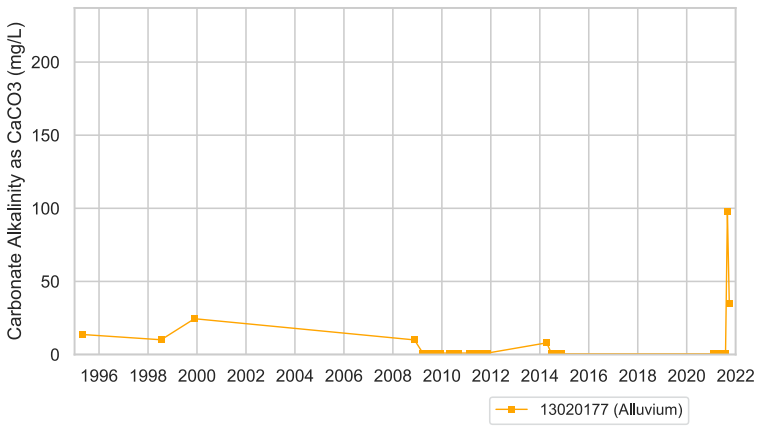

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

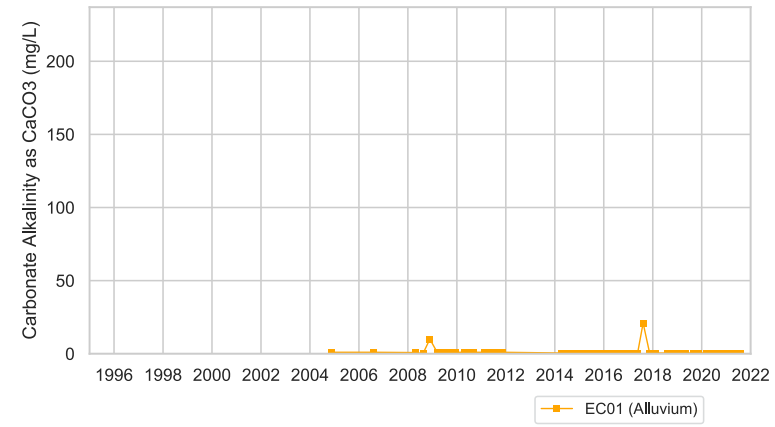

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

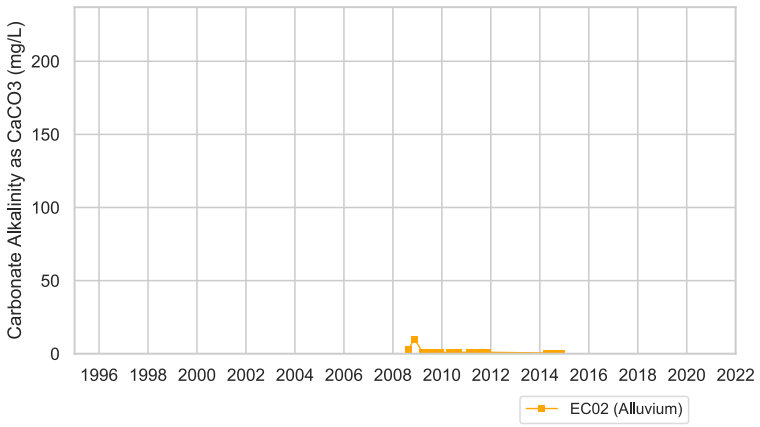

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

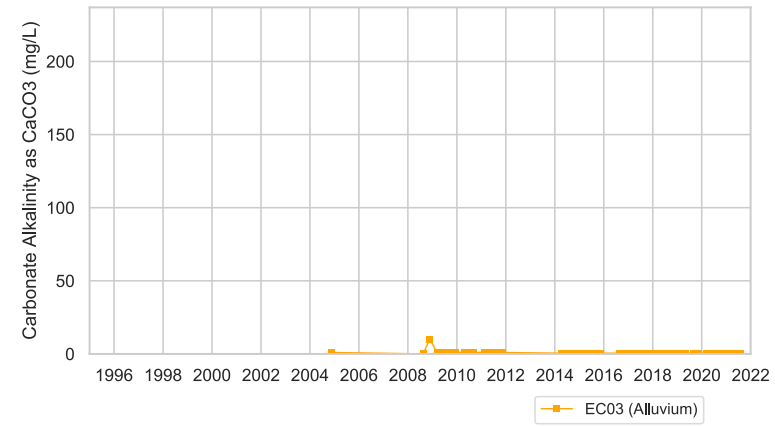

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

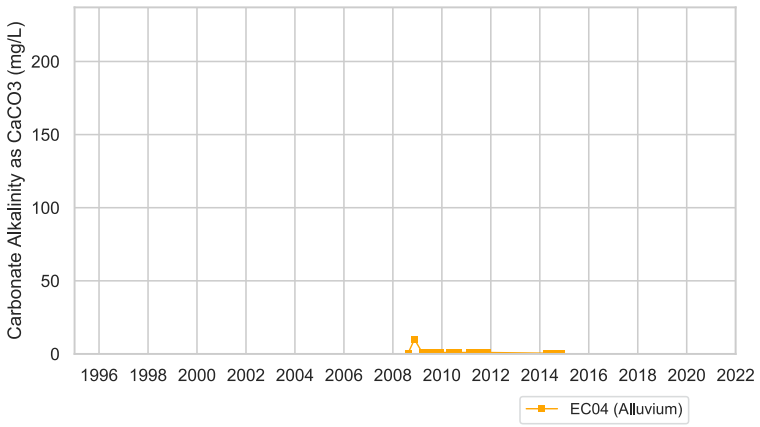

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

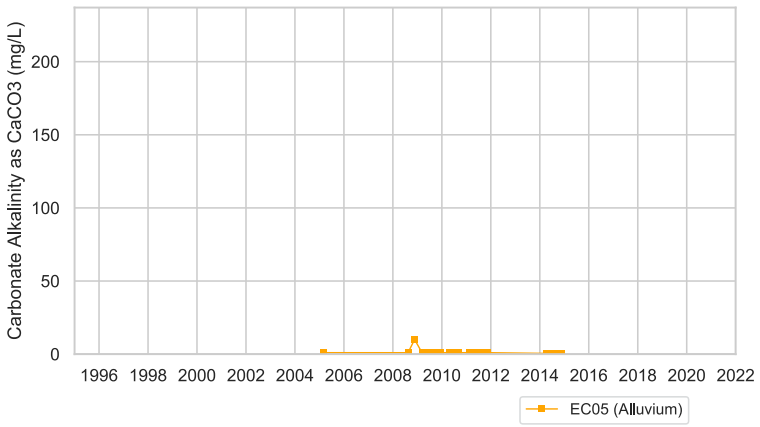

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

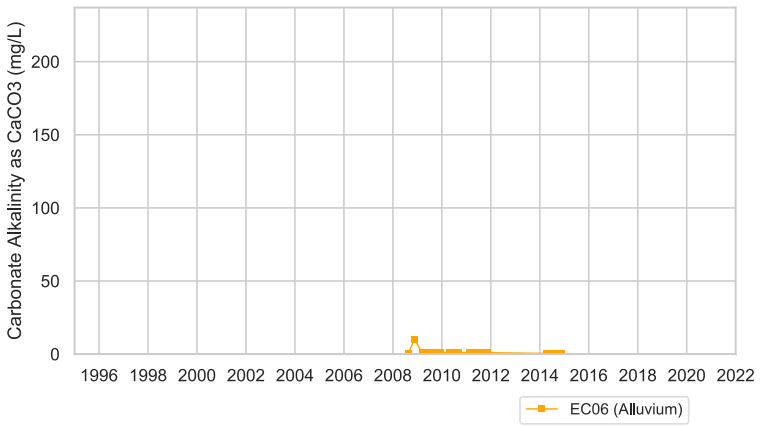

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

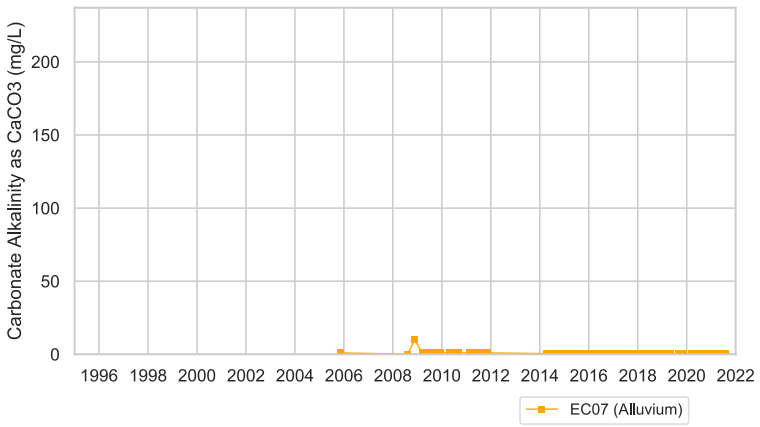

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

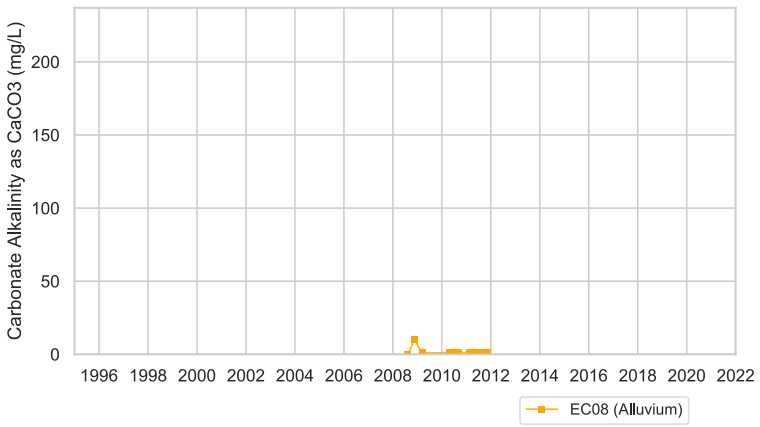

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

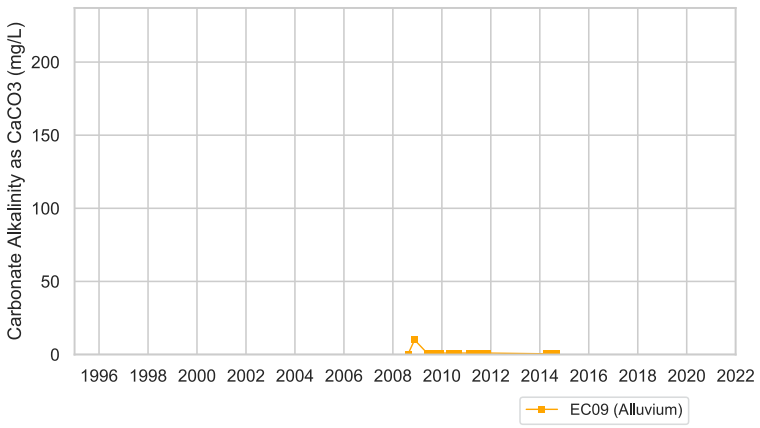

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

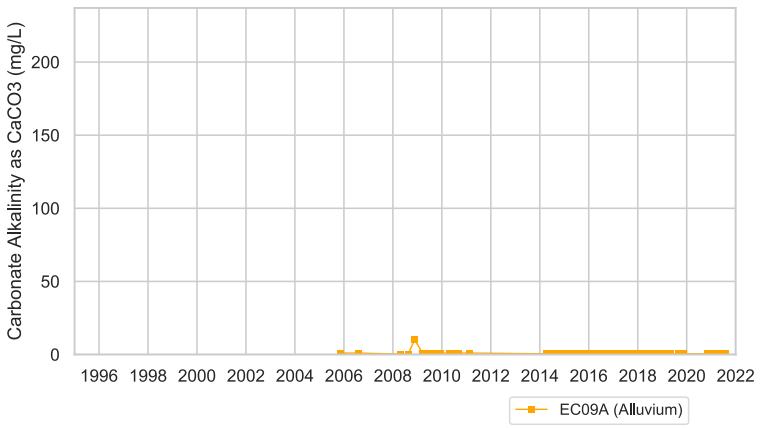

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

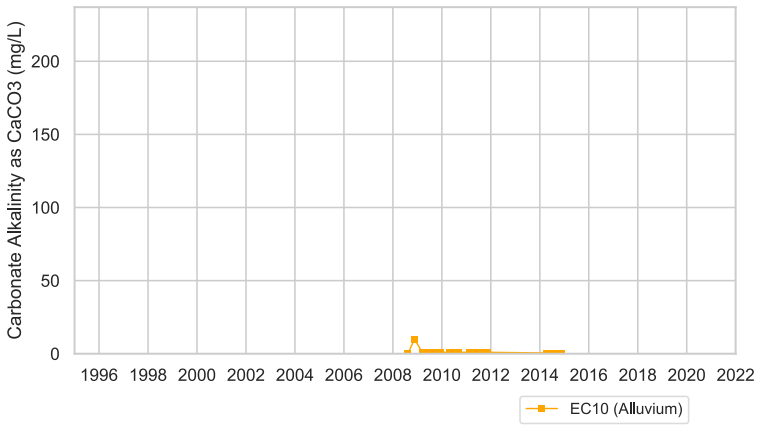

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

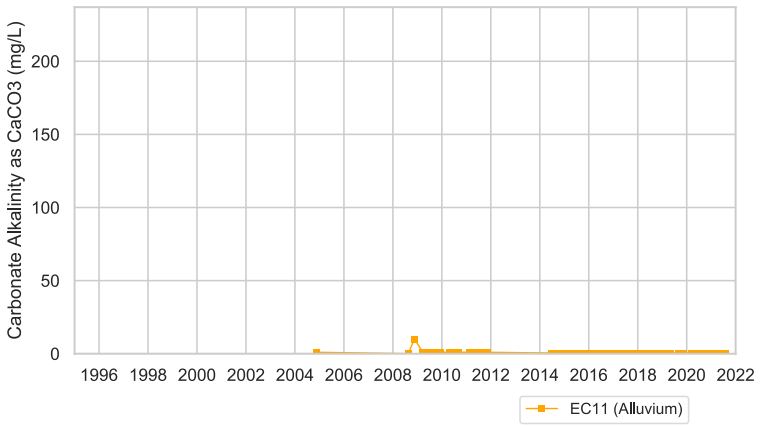

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

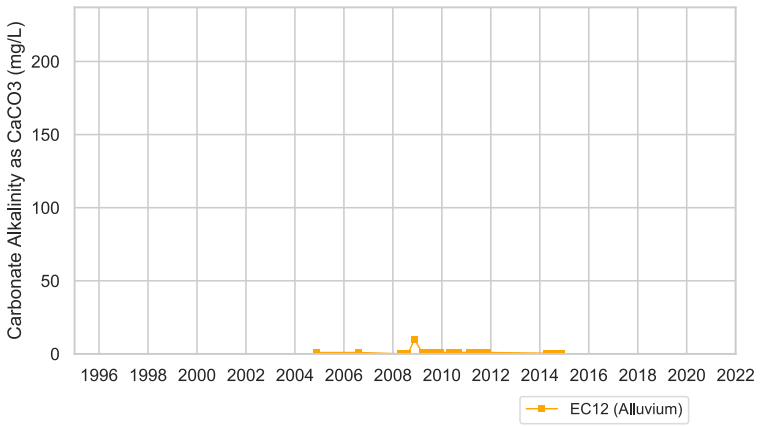

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

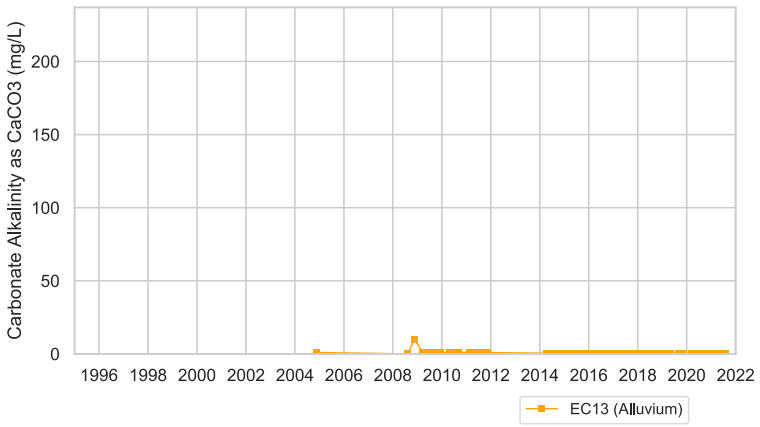

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

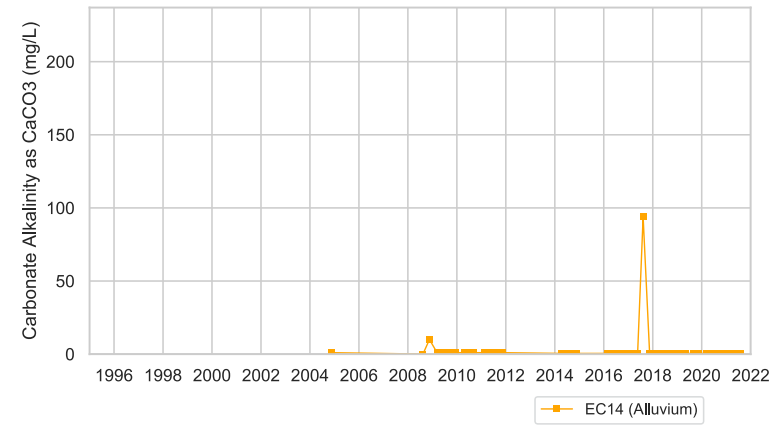

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

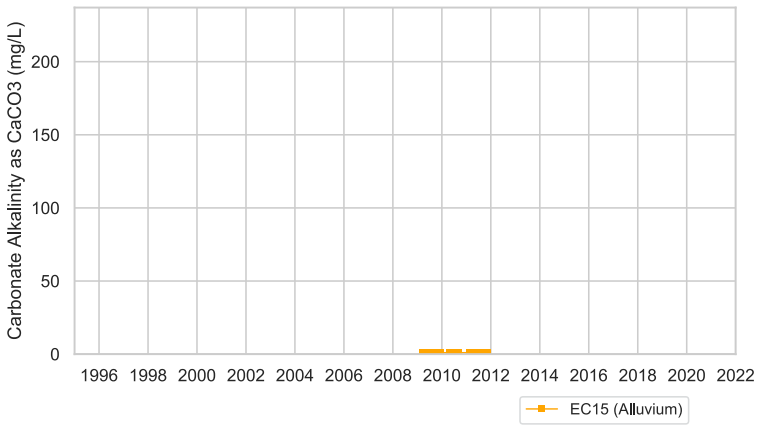

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

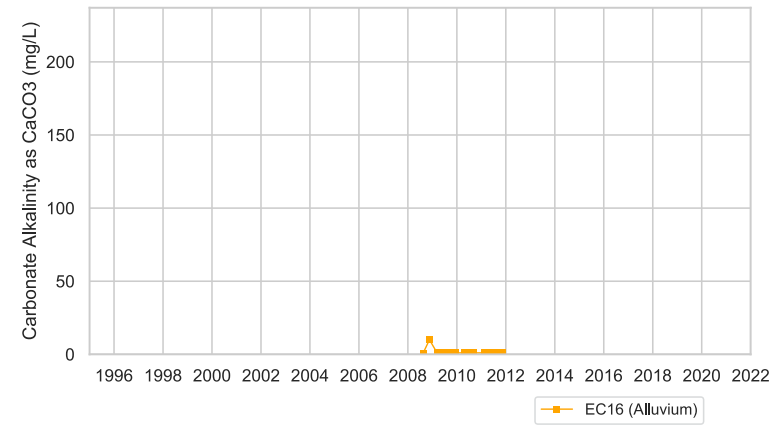

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

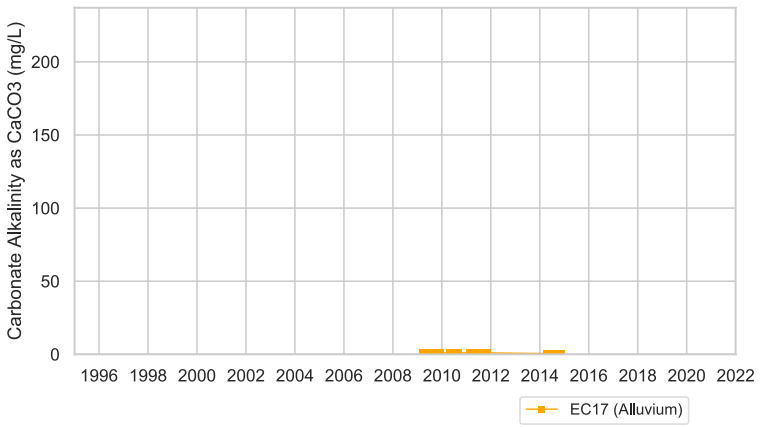

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

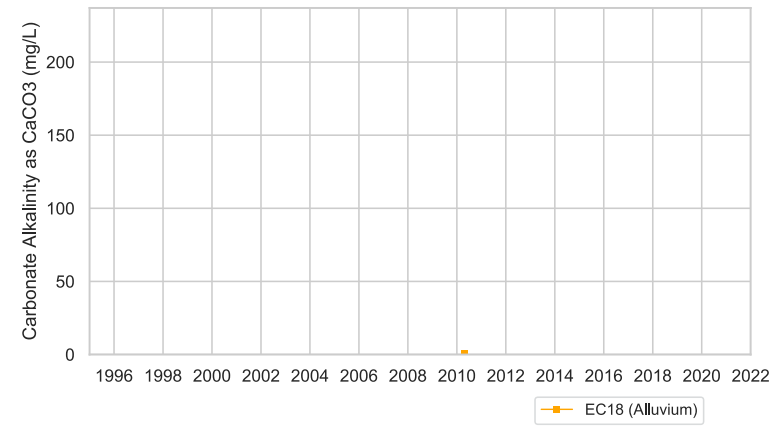

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

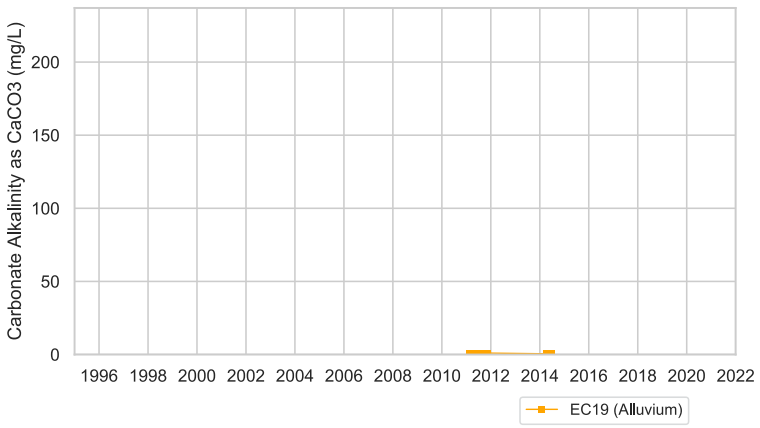

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

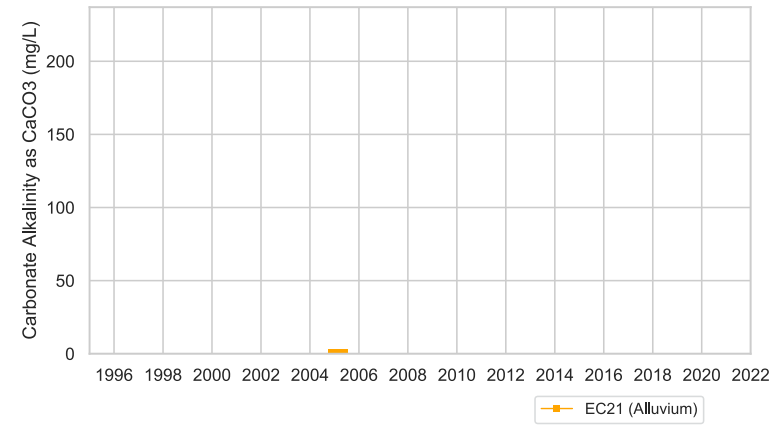

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

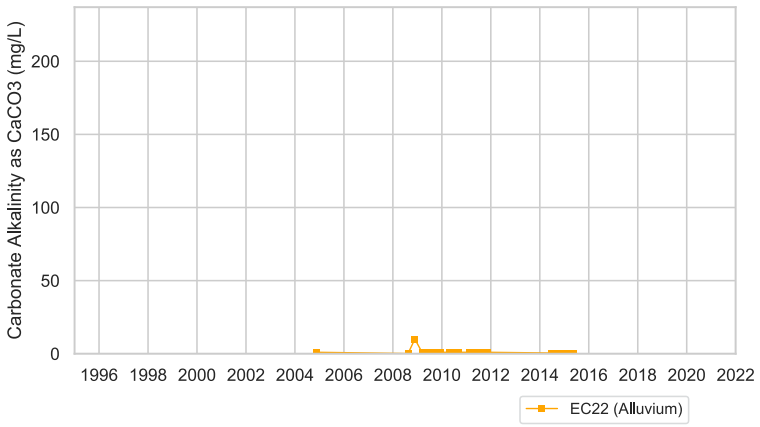

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

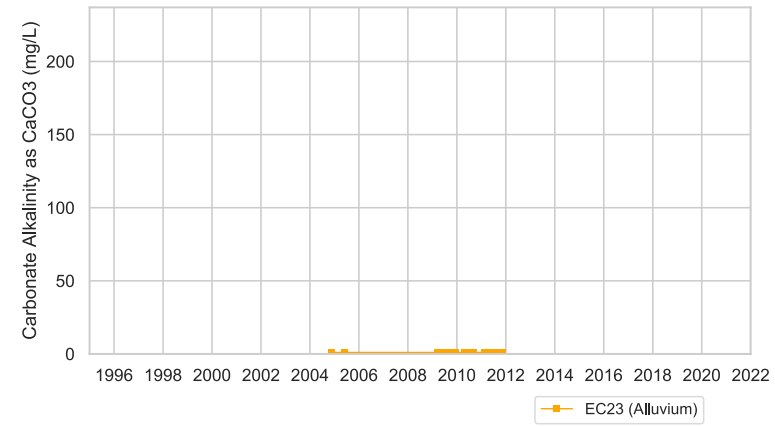

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

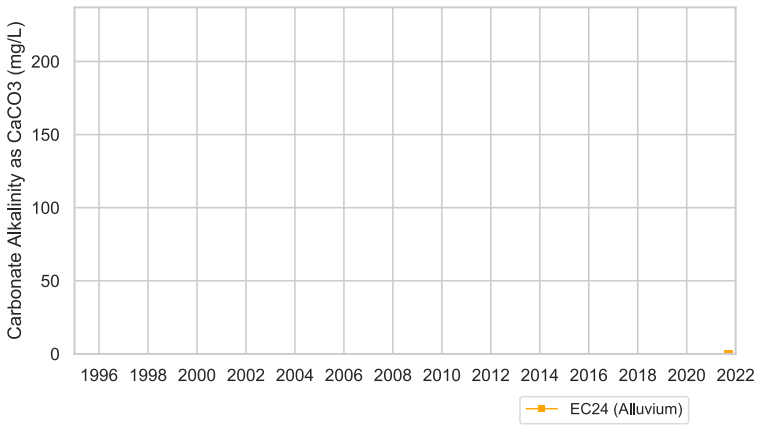

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

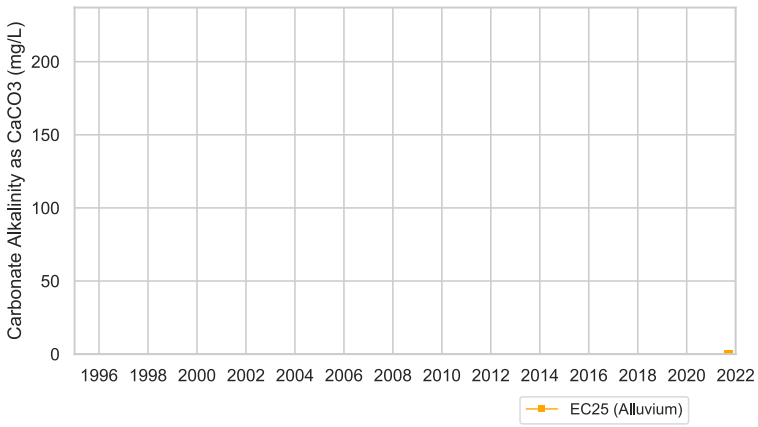

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

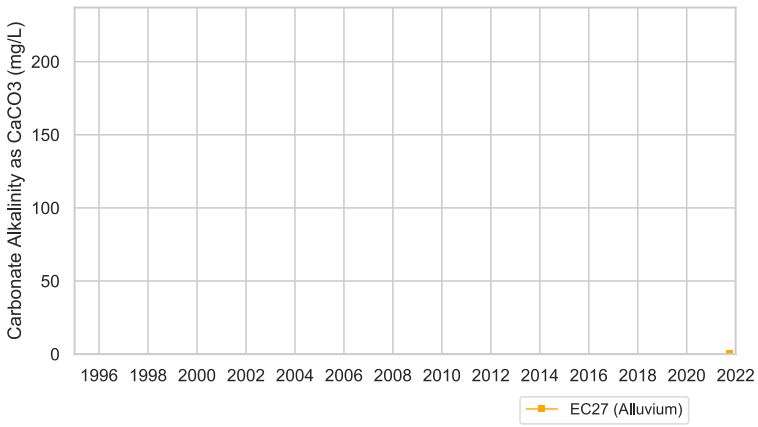

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

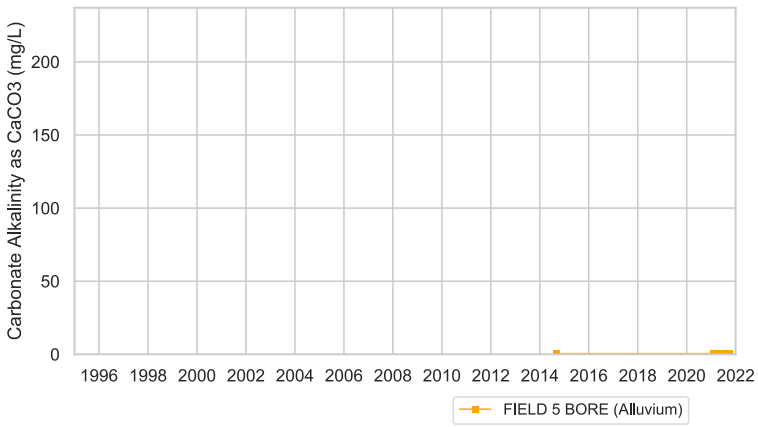

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

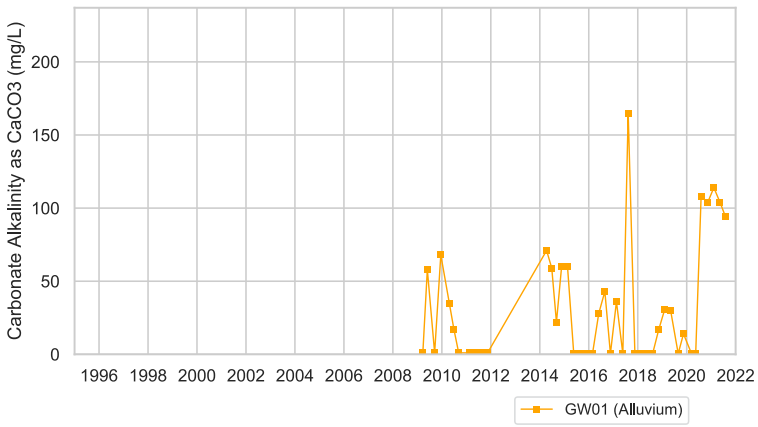

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

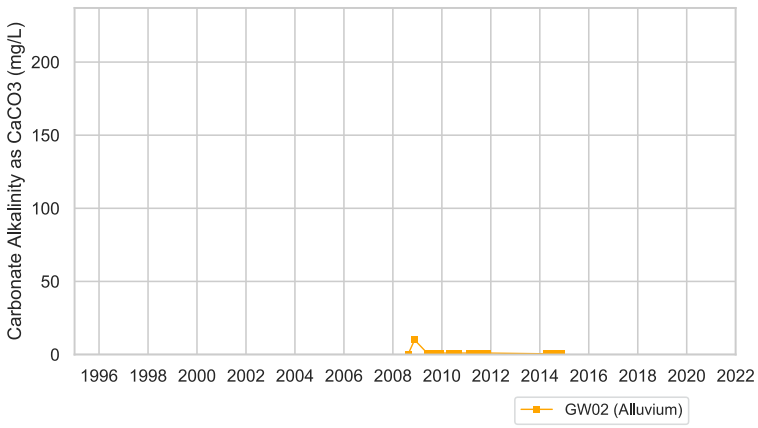

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

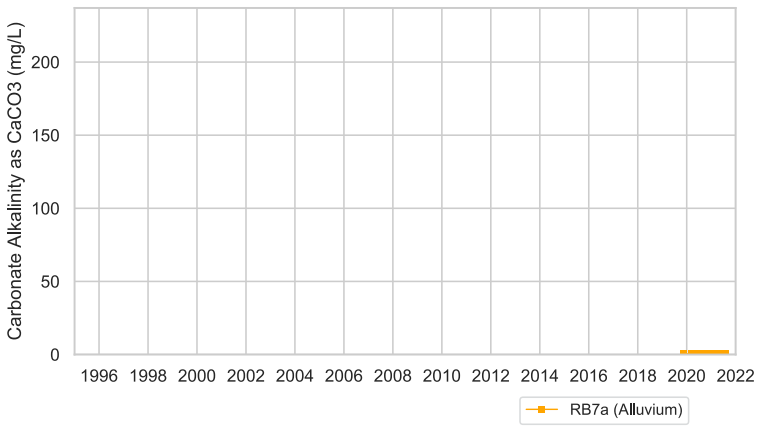

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

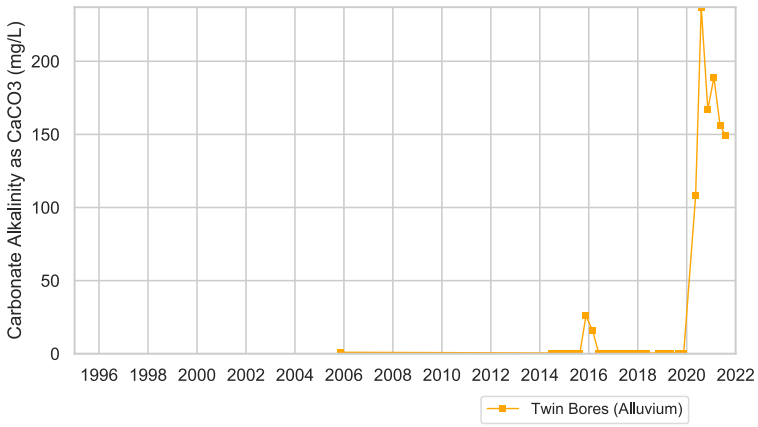

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

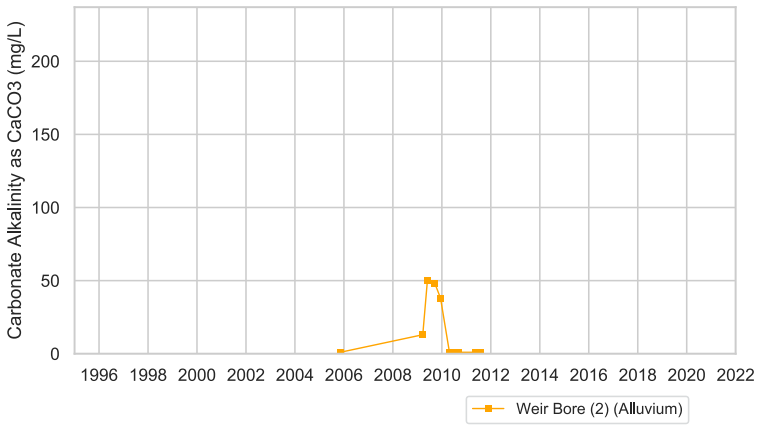

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

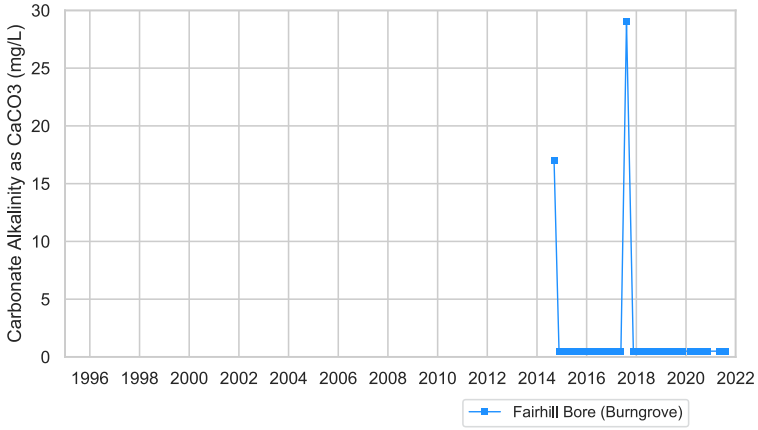

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

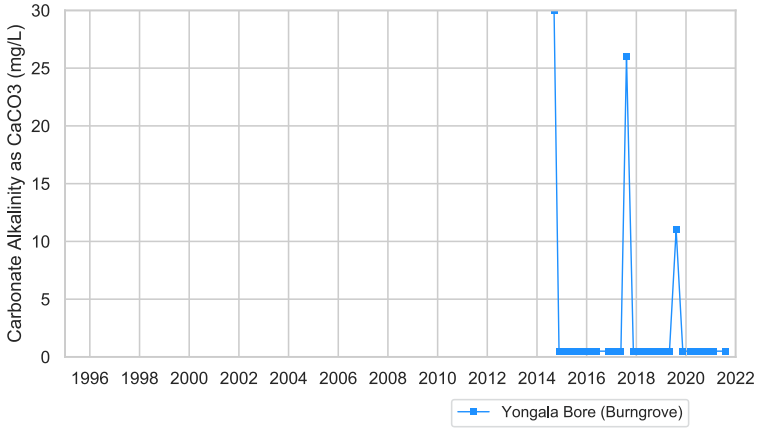

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

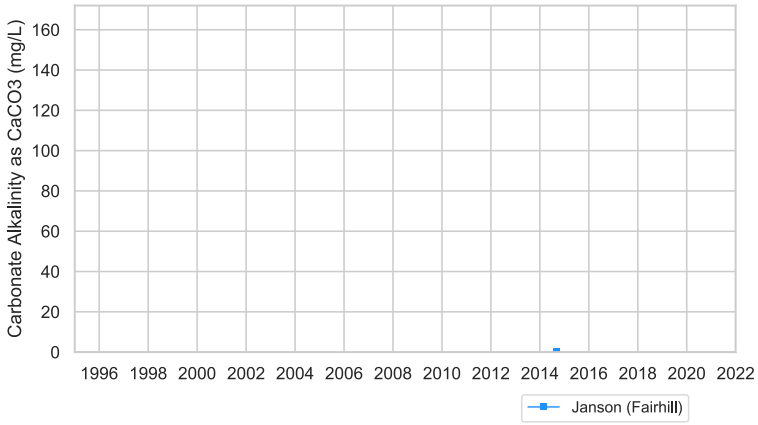

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

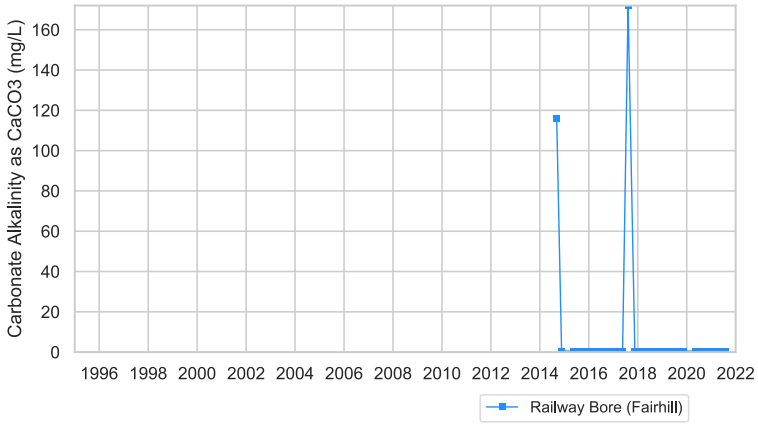

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

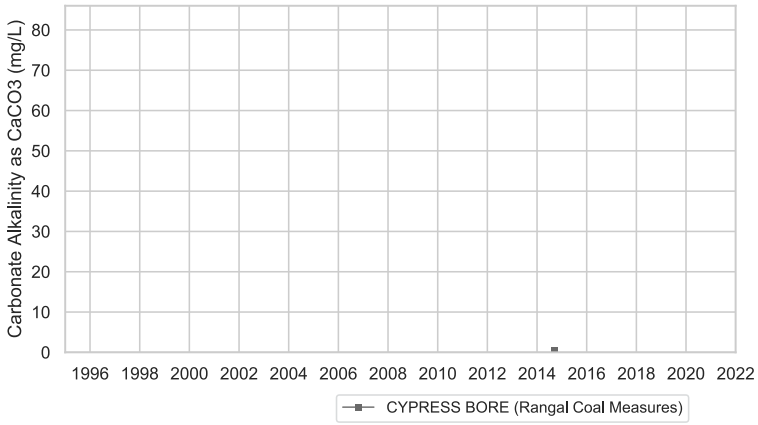

Carbonate Alkalinity as CaCO3 (mg/L)
0
50
100
150
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

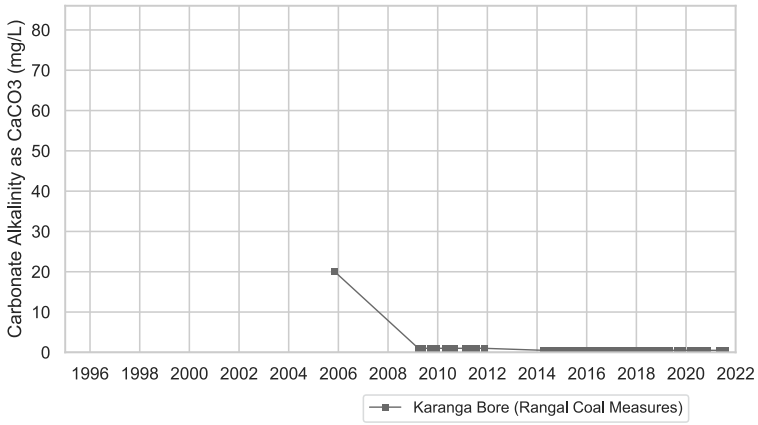

Carbonate Alkalinity as CaCO3 (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

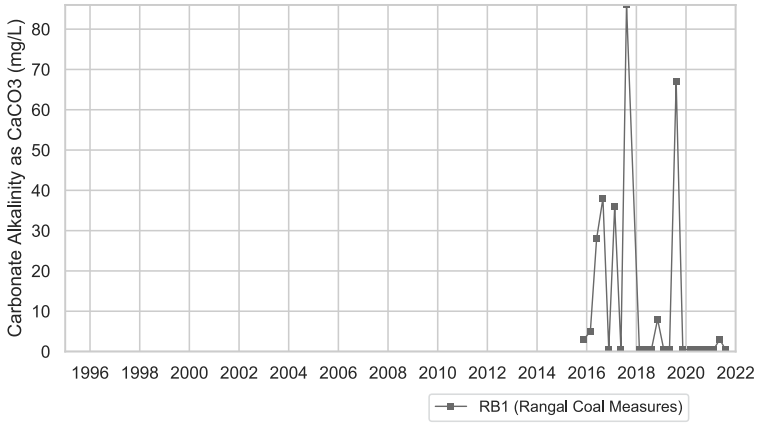

Carbonate Alkalinity as CaCO3 (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

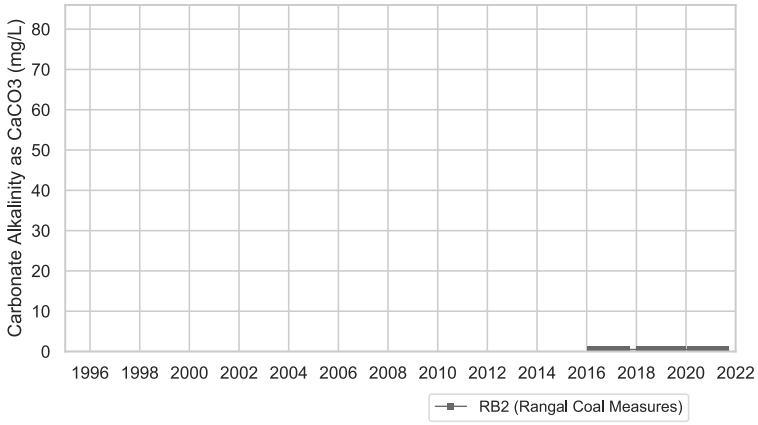

Carbonate Alkalinity as CaCO3 (mg/L)
0 20 40 60 80 100 120 140 160
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

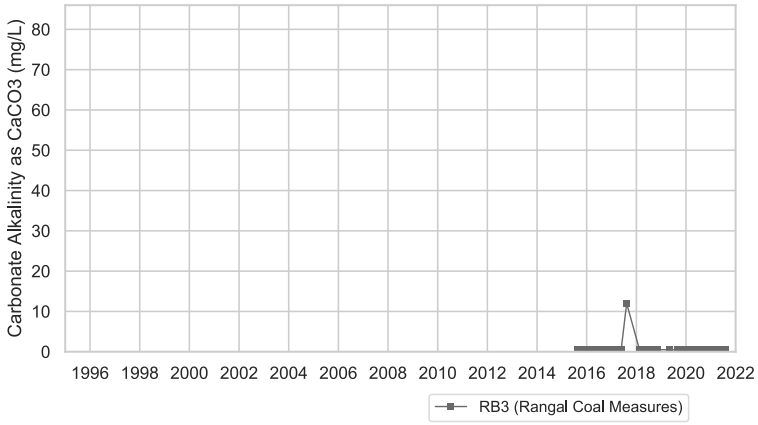

Carbonate Alkalinity as CaCO3 (mg/L)
0 20 40 60 80 100 120 140 160
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

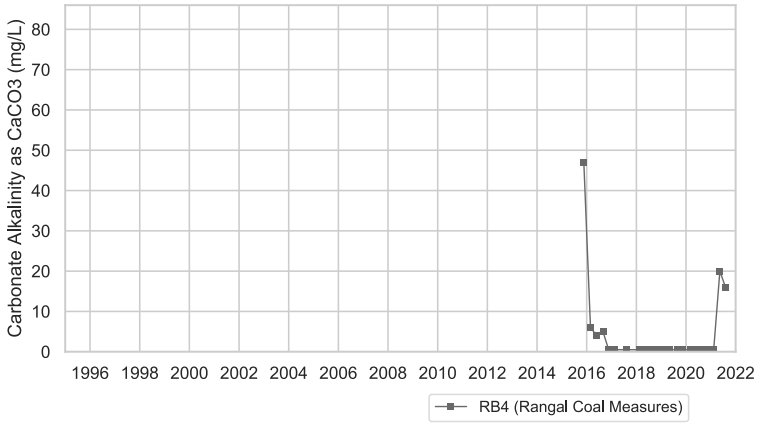

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

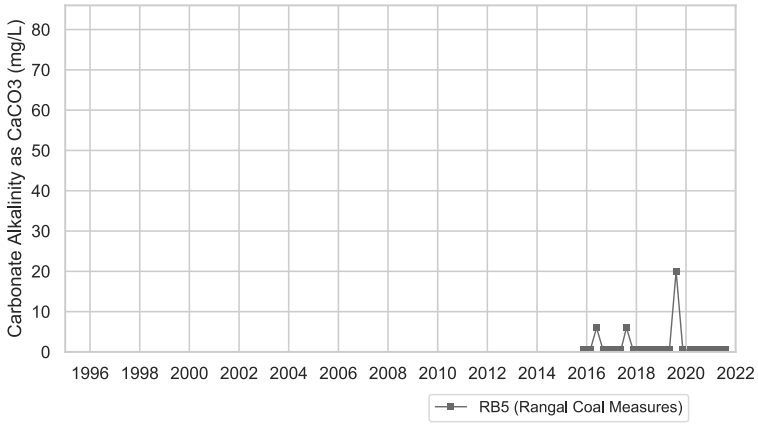

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

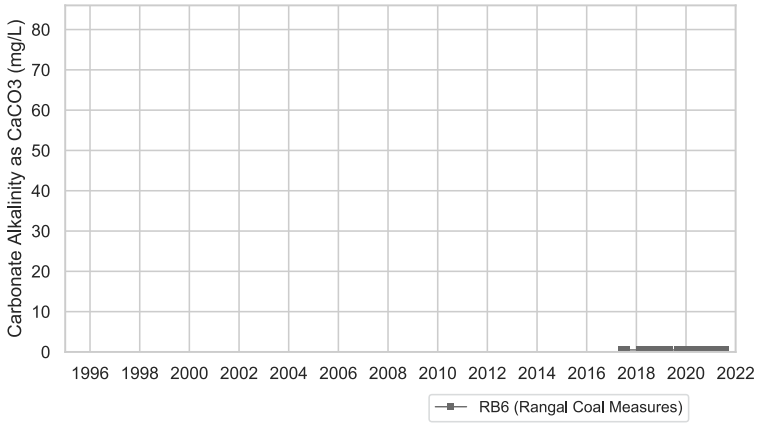

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

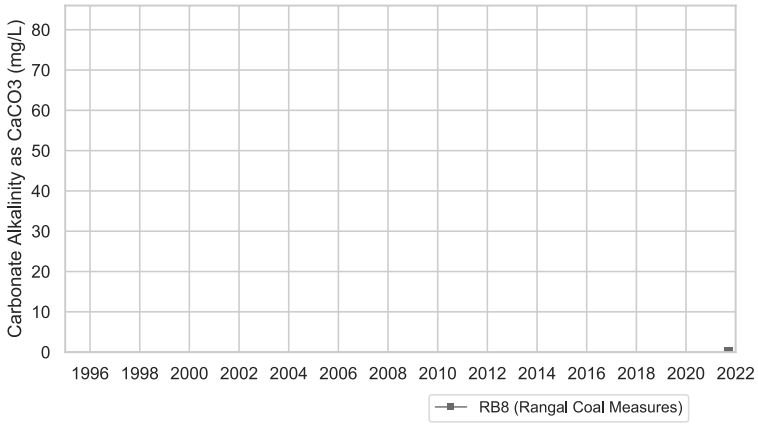

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

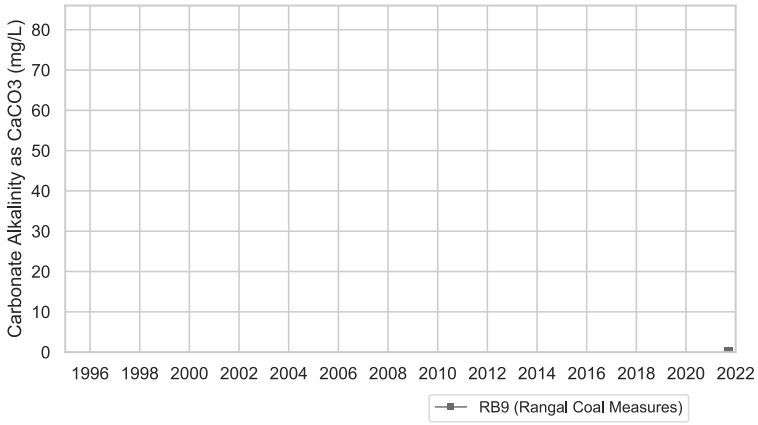

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

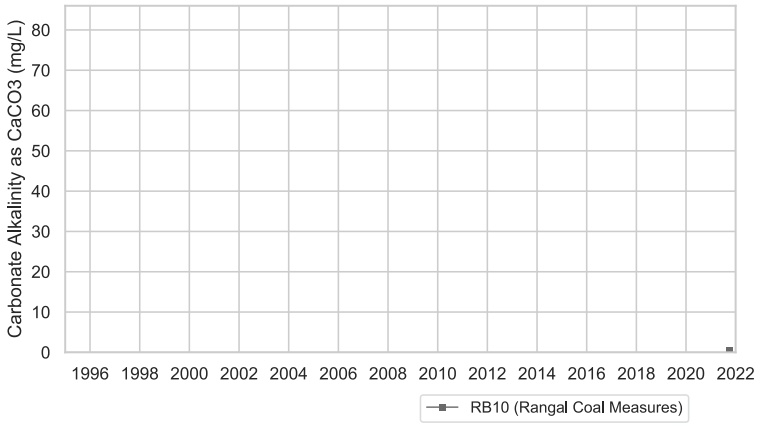

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

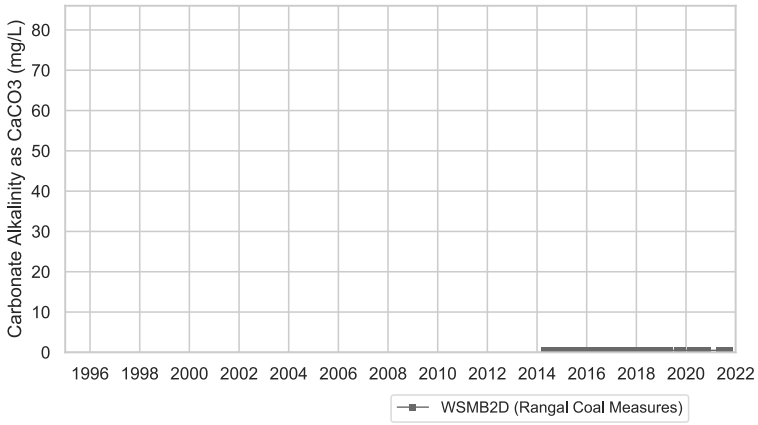

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

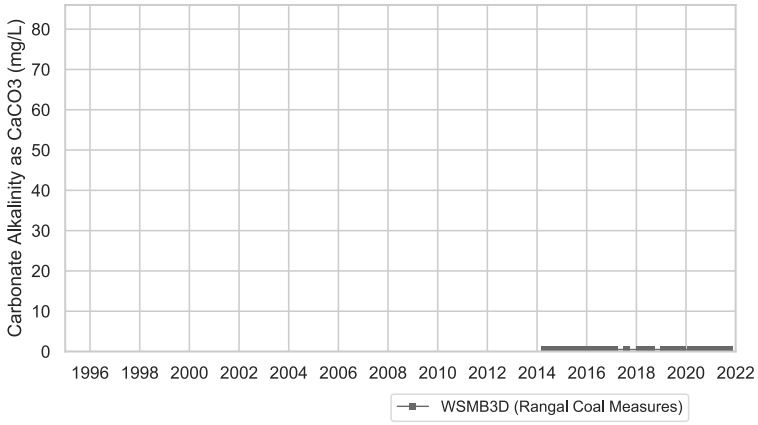

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

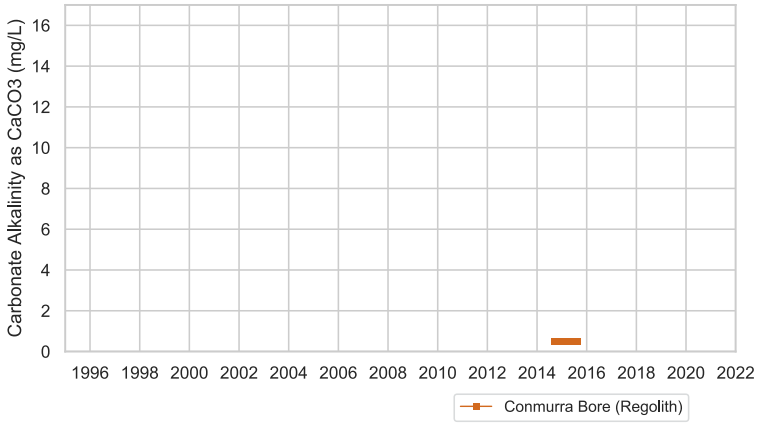

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

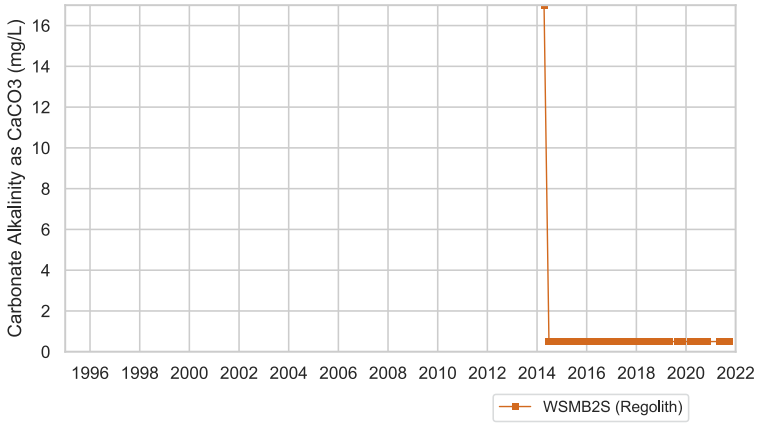

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)


Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

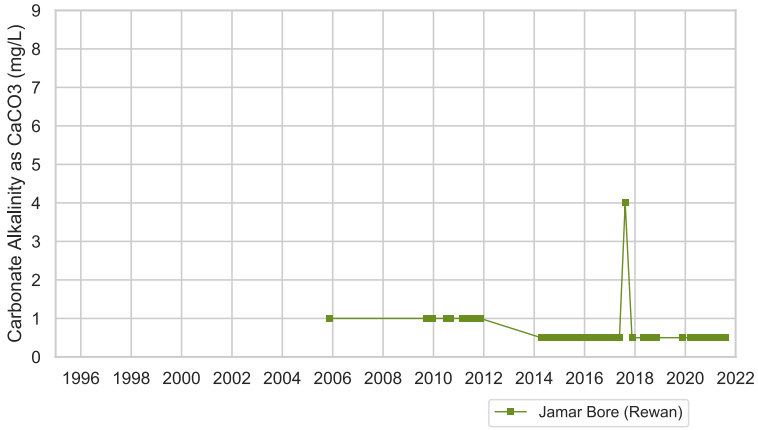

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

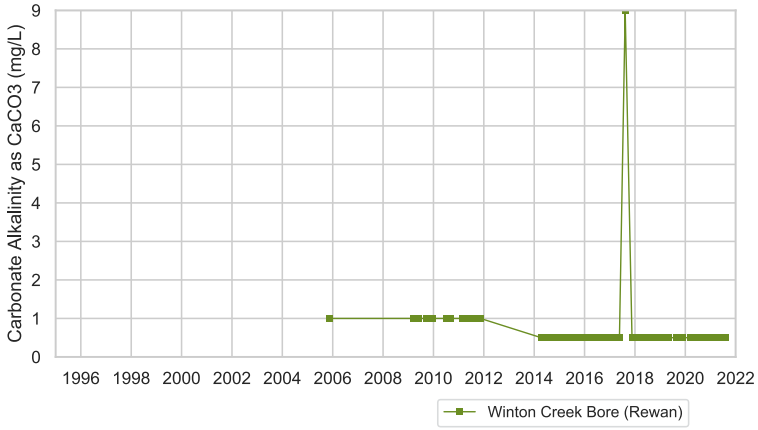

Carbonate Alkalinity as CaCO3 (mg/L)
0 10 20 30 40 50 60 70 80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

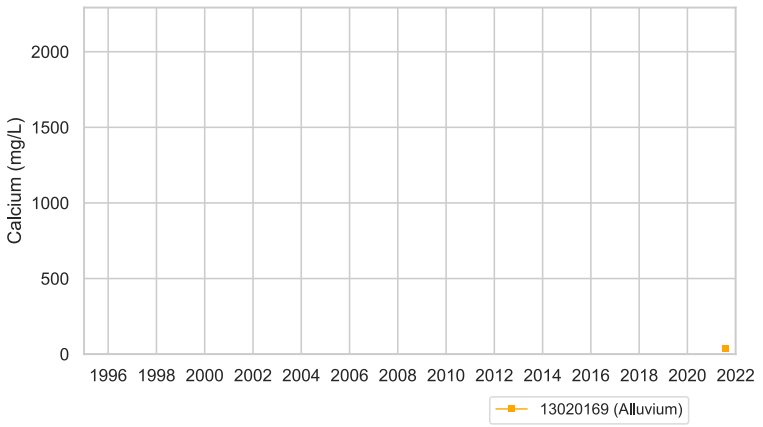

Carbonate Alkalinity as CaCO3 (mg/L)
0 2 4 6 8 10 12 14 16
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

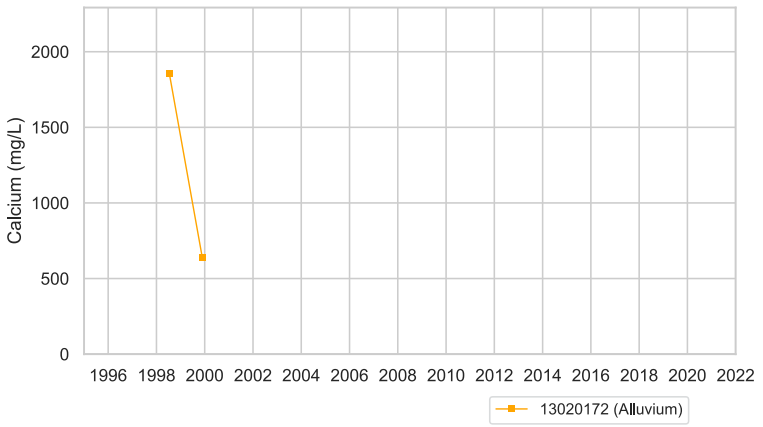

Carbonate Alkalinity as CaCO3 (mg/L)
0 2 4 6 8 10 12 14 16
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

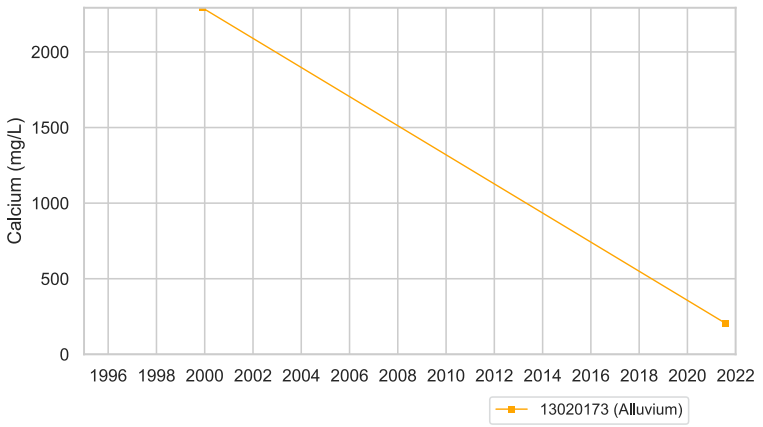
Carbonate Alkalinity as CaCO3 (mg/L)
0 2 4 6 8 10 12 14 16
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

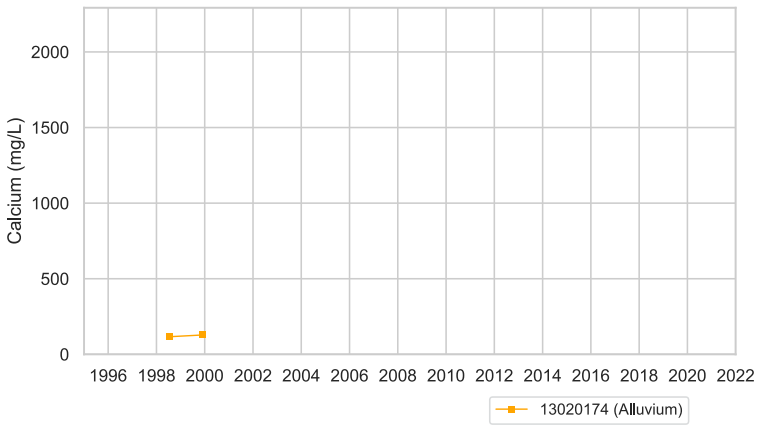

Carbonate Alkalinity as CaCO3 (mg/L)
0 1 2 3 4 5 6 7 8 9
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

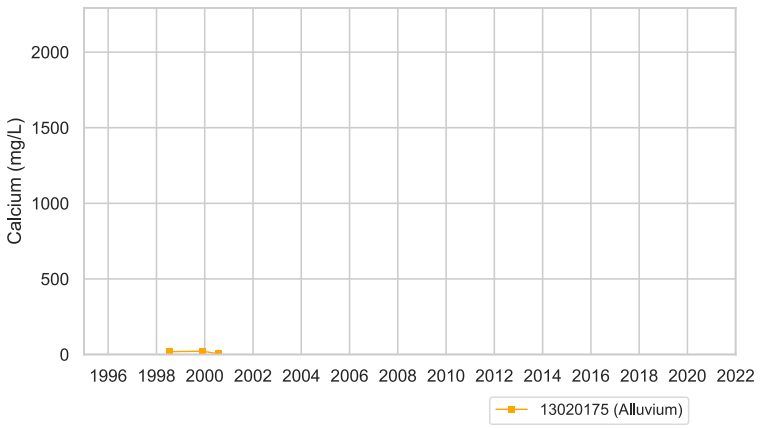

Carbonate Alkalinity as CaCO3 (mg/L)
0 1 2 3 4 5 6 7 8 9
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

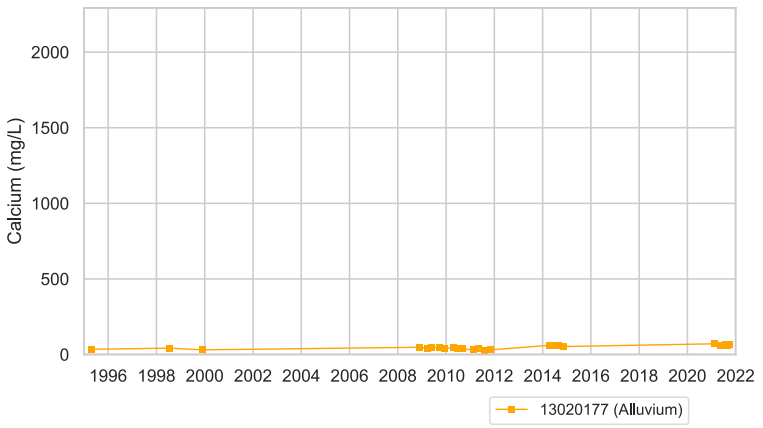

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

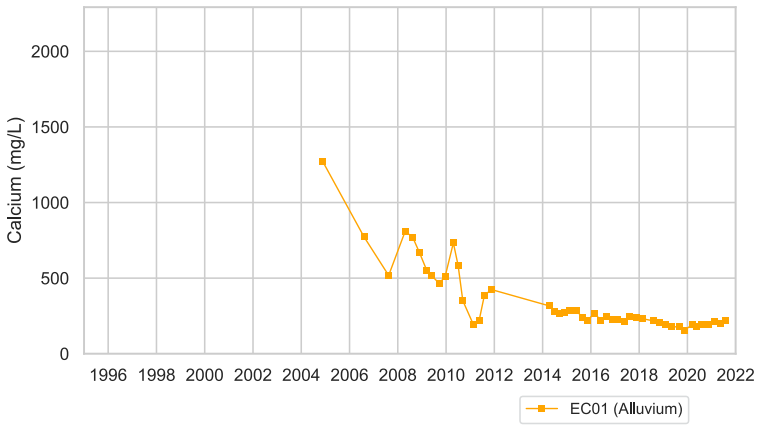

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

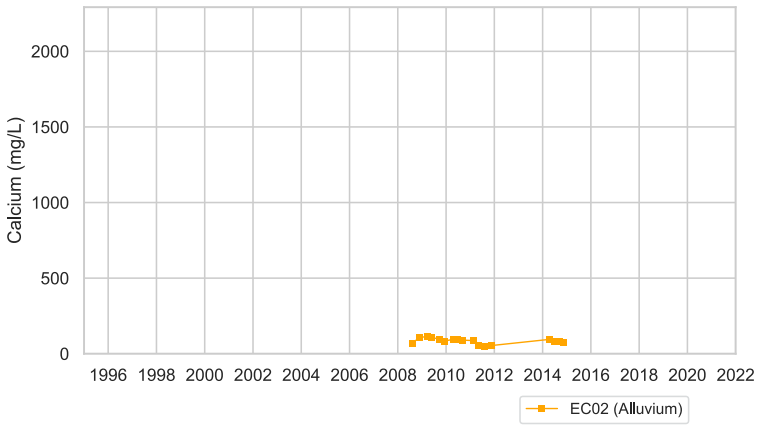

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

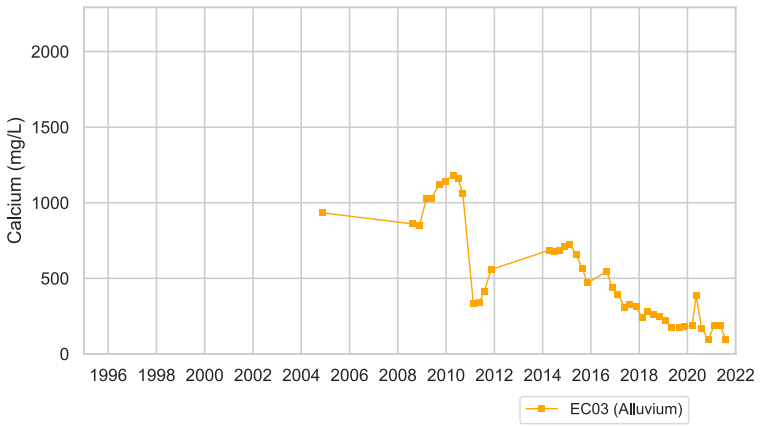

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

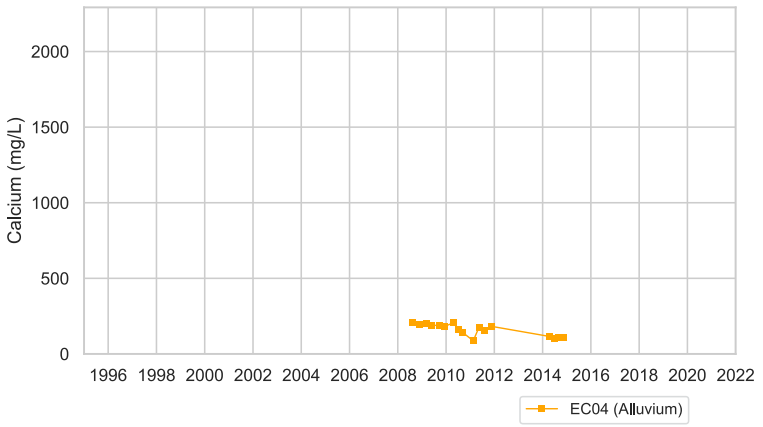

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

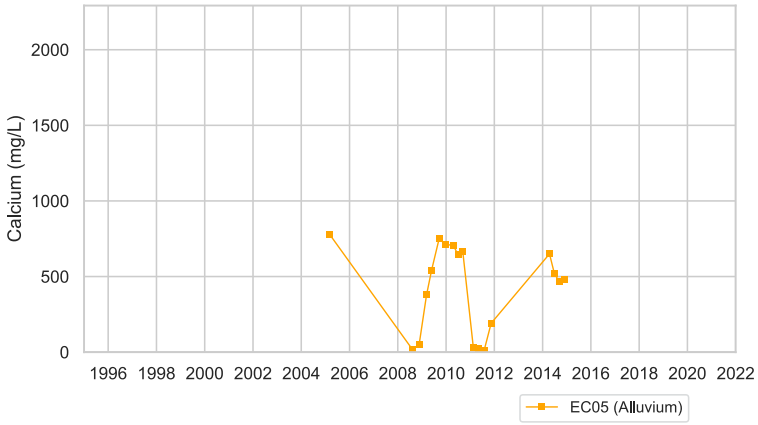

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

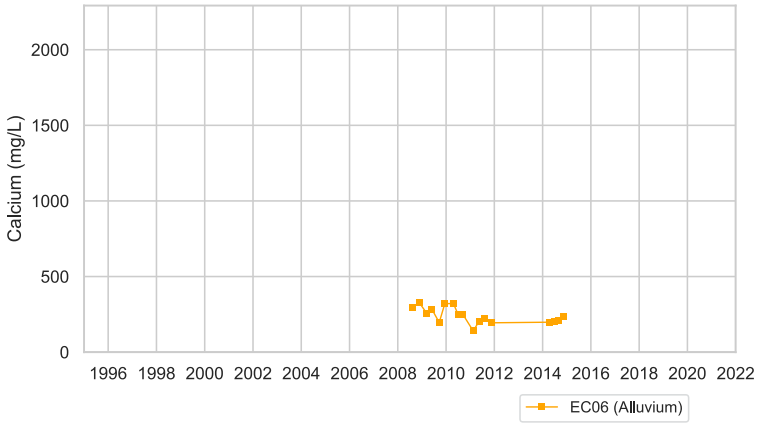

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

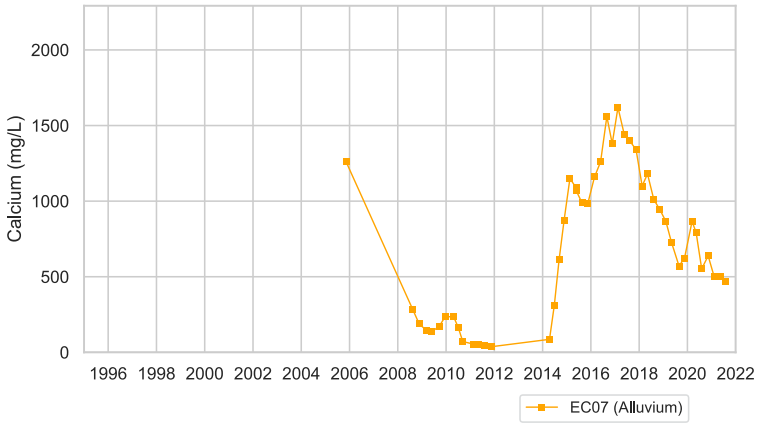

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

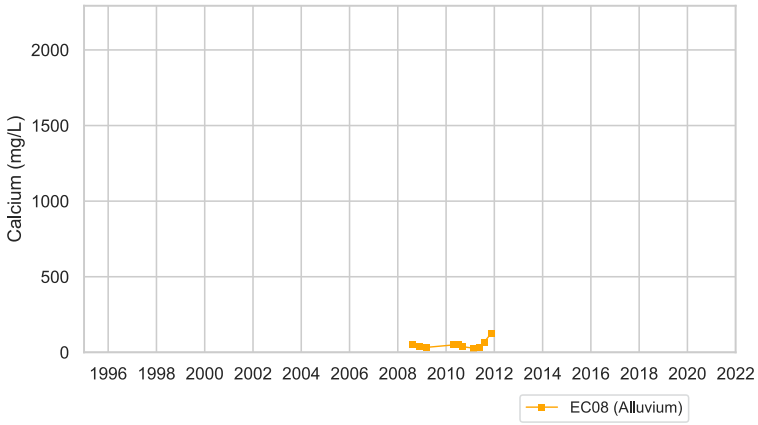

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

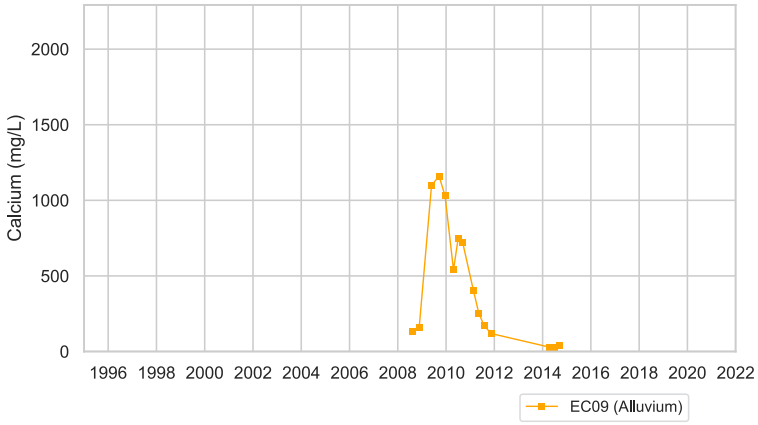

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

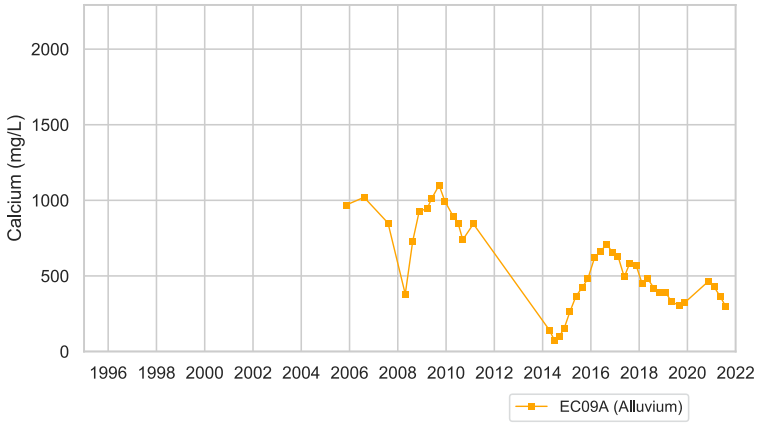

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

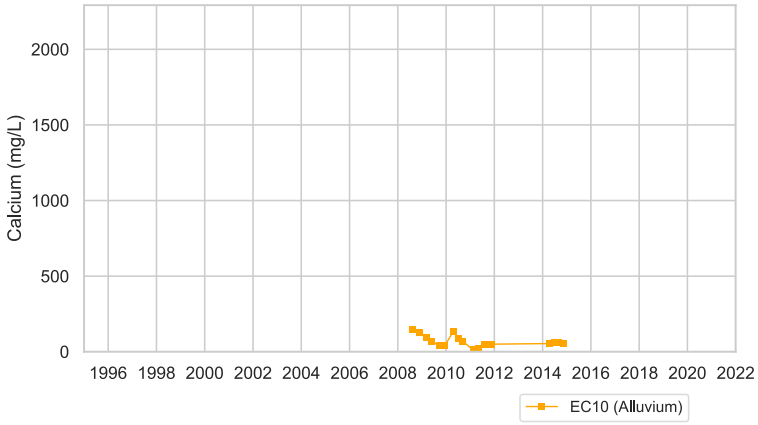

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

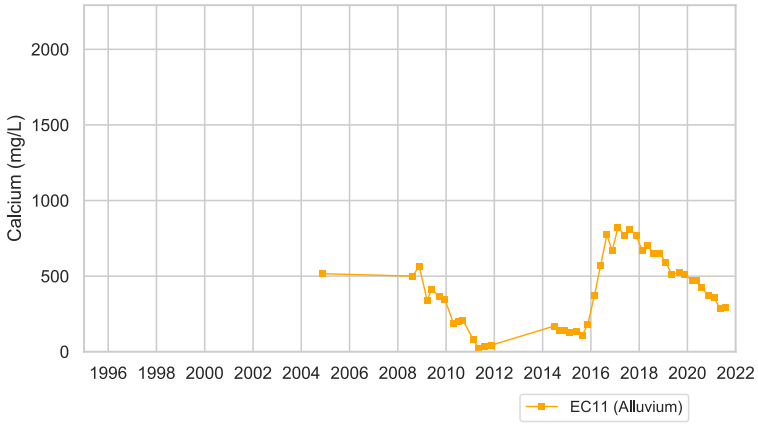

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

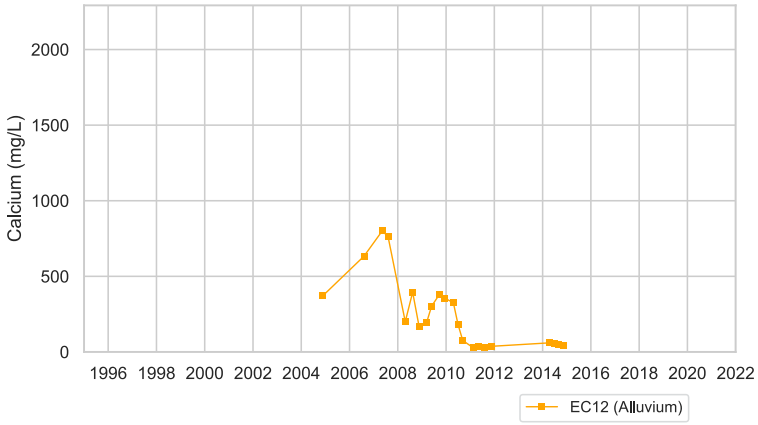

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

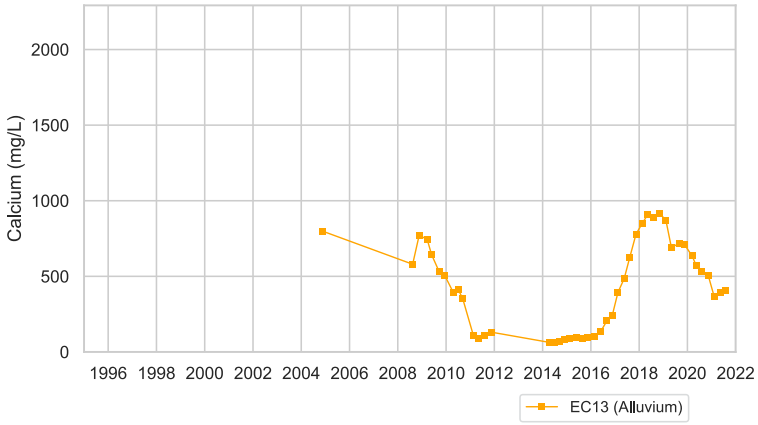

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

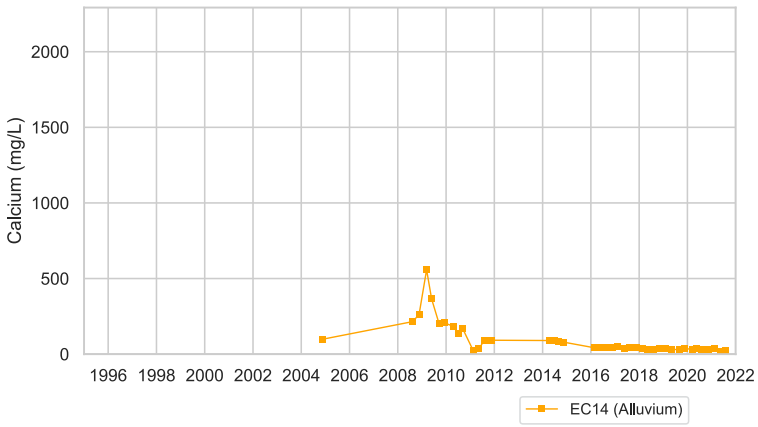

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

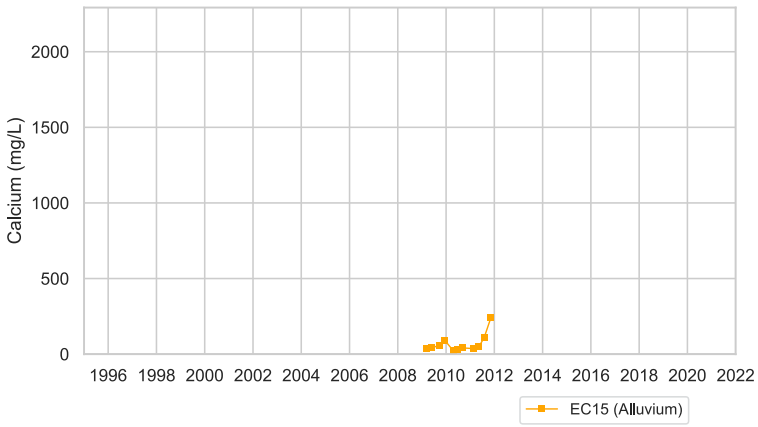

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

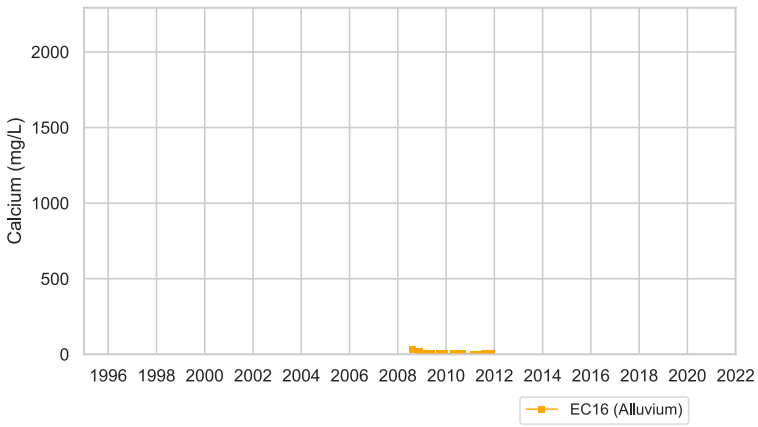

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

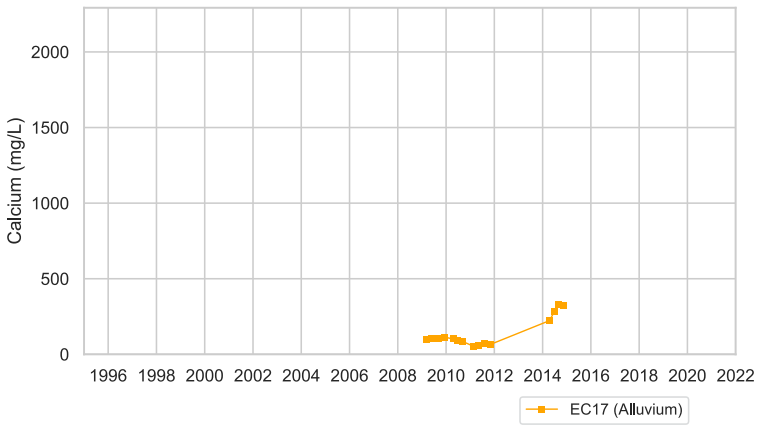

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

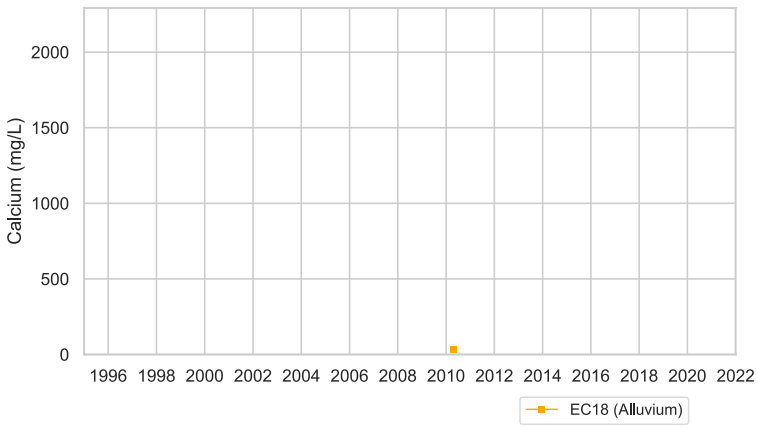

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

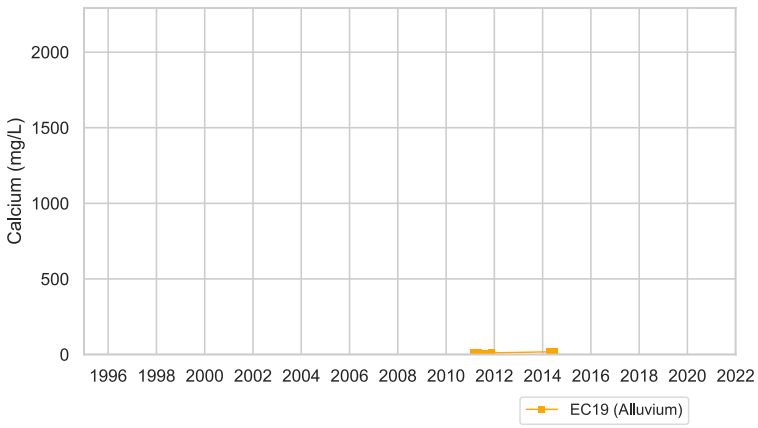

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

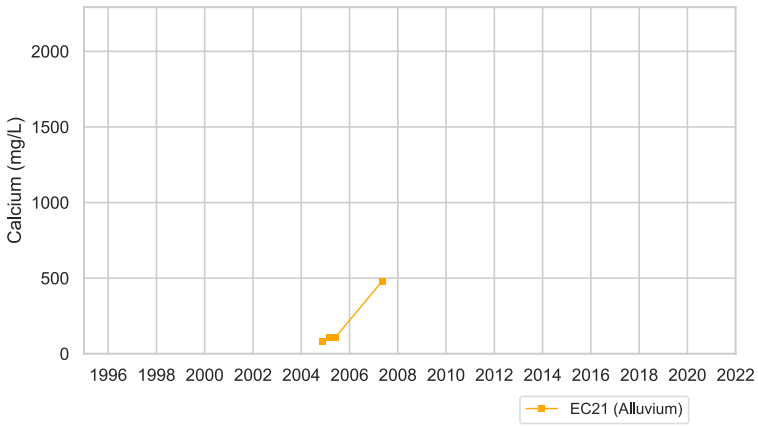

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

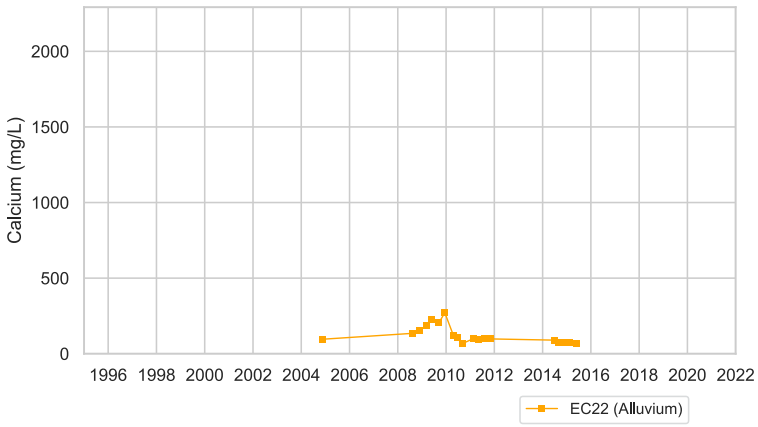

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

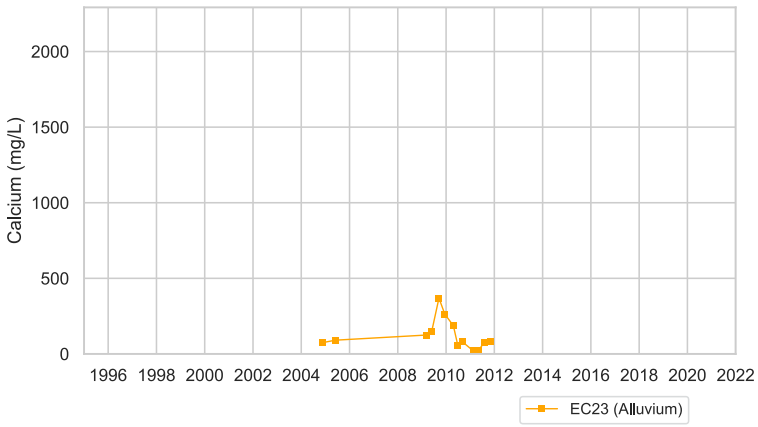

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

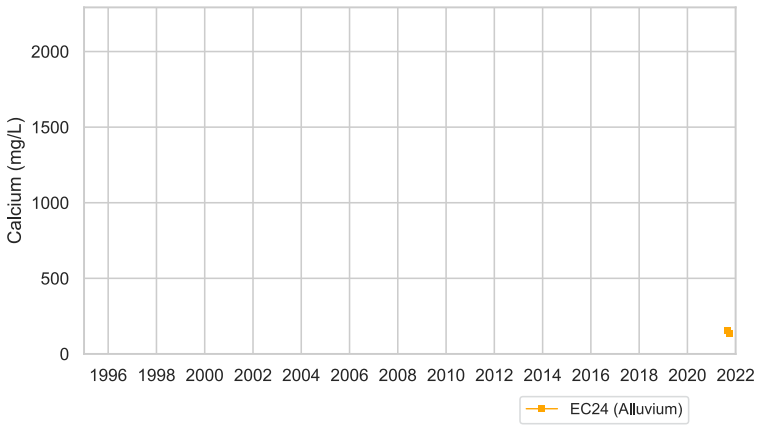

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

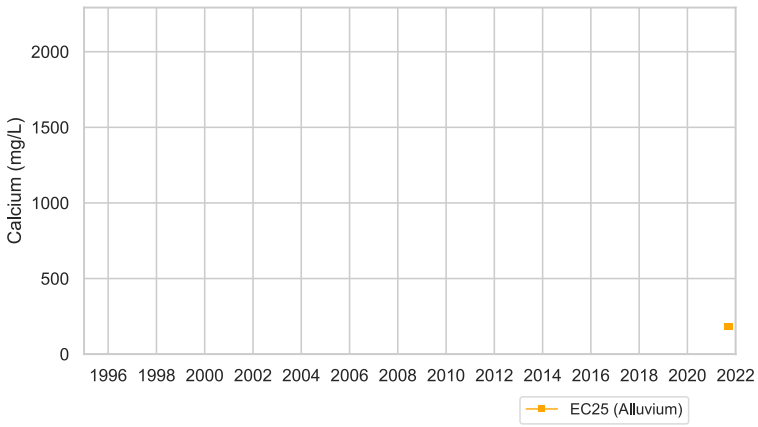

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

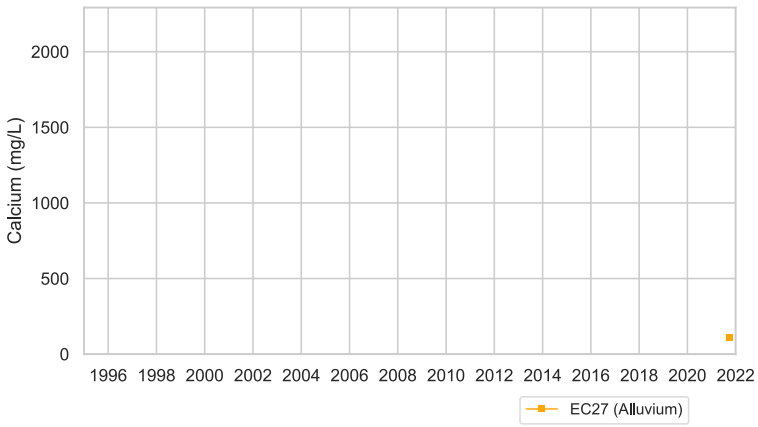

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

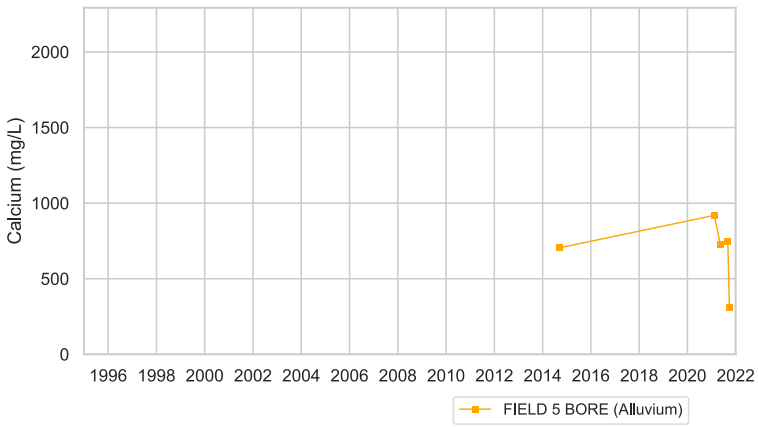

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

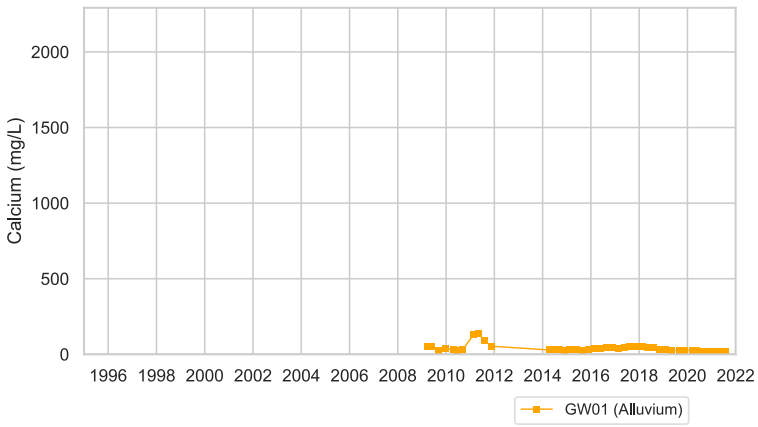

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

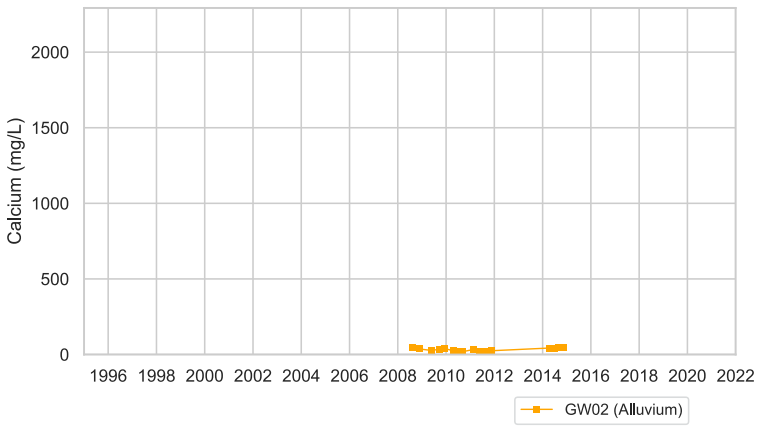

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

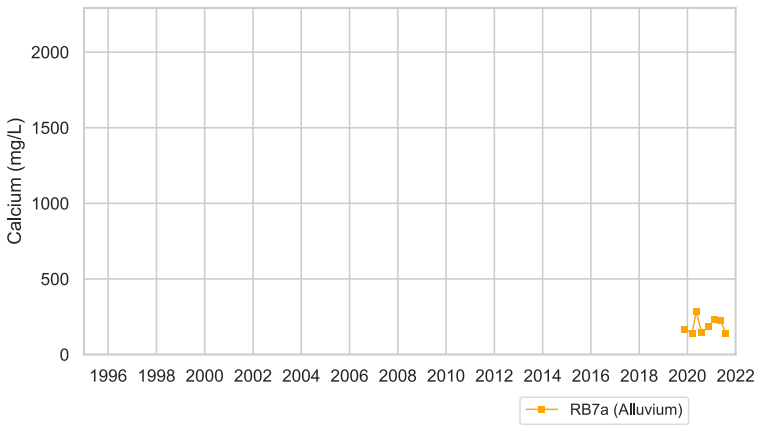

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

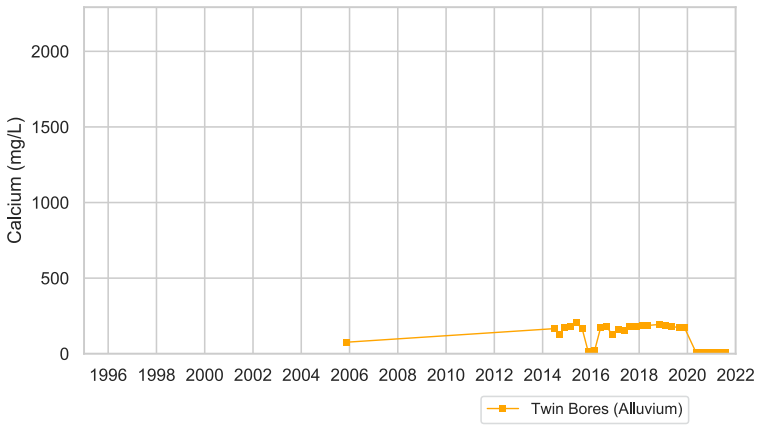

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

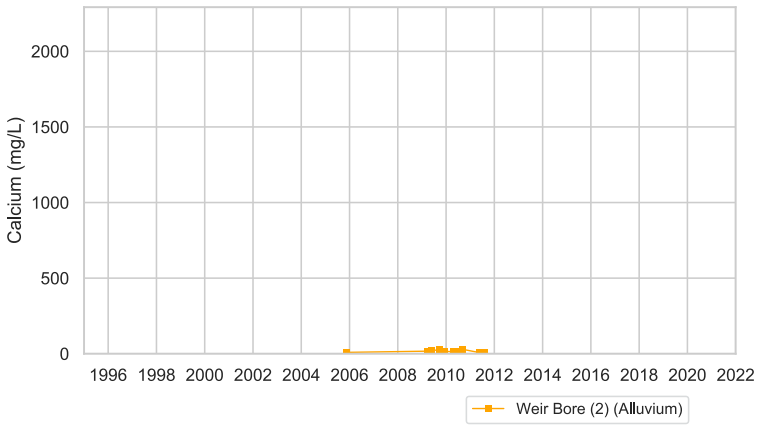

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

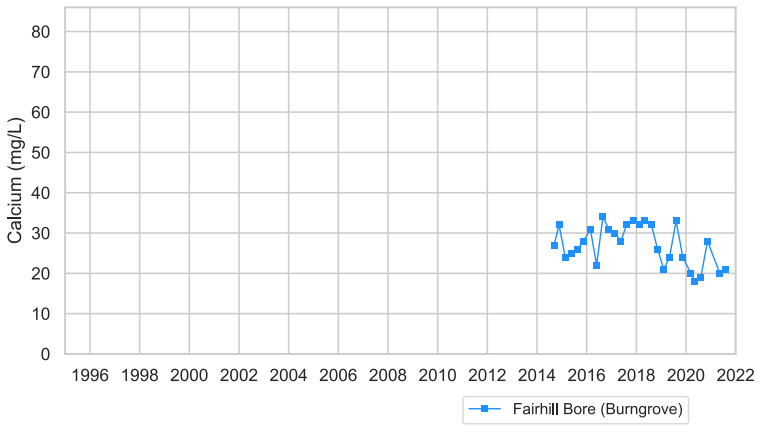

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

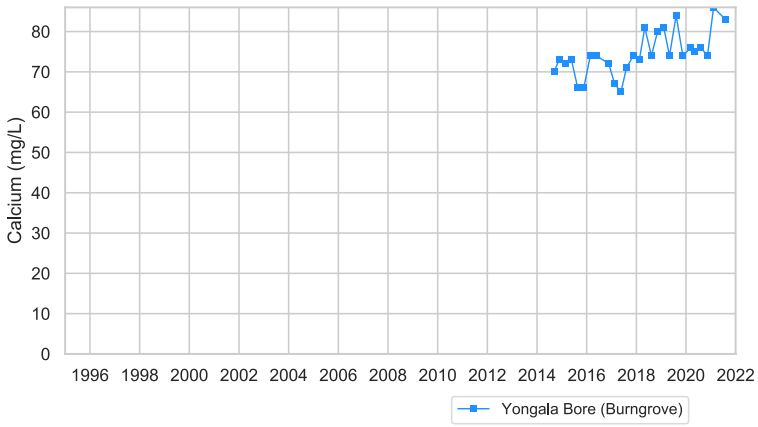

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

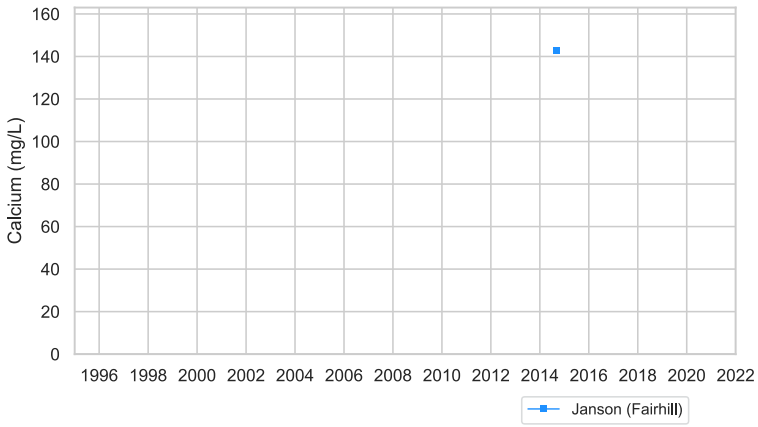

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

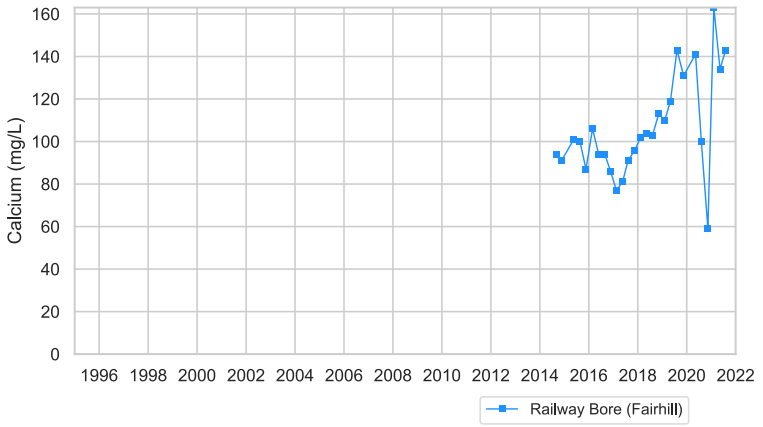

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

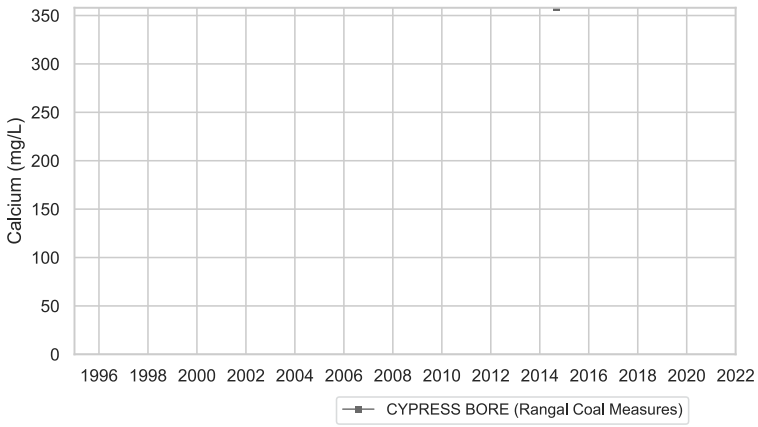

Calcium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

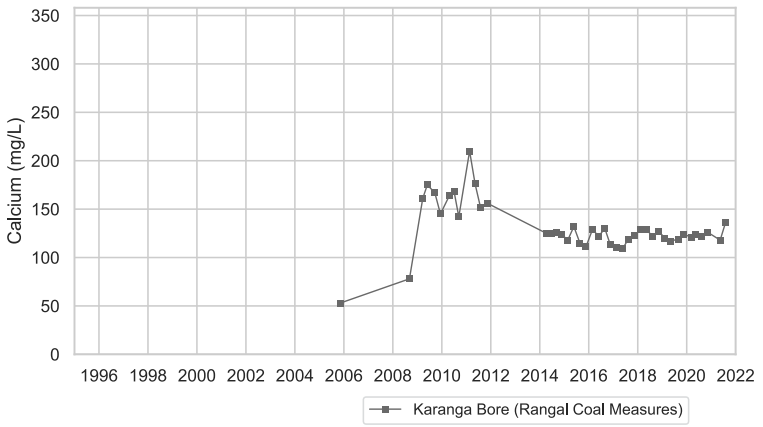

Calcium (mg/L)
0
10
20
30
40
50
60
70
80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

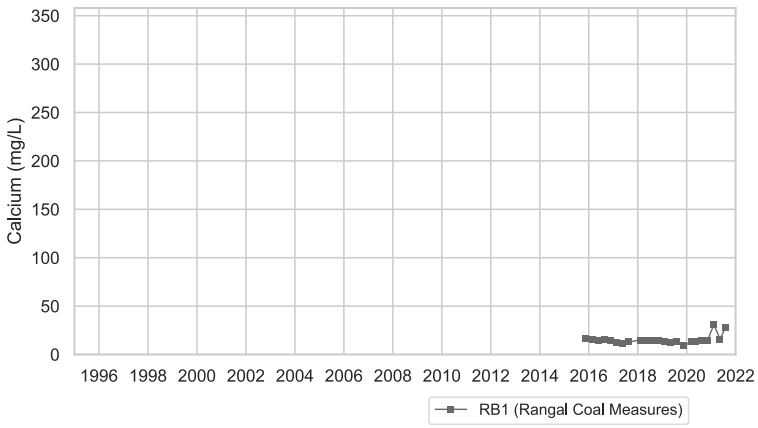

Calcium (mg/L)
0
10
20
30
40
50
60
70
80
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

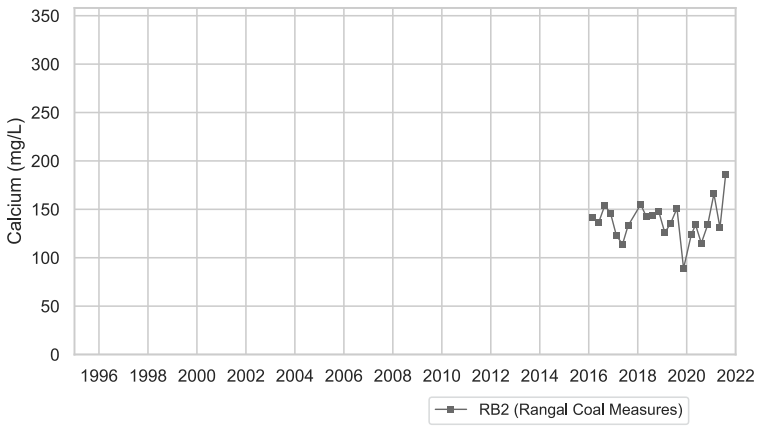

Calcium (mg/L)
0
20
40
60
80
100
120
140
160
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

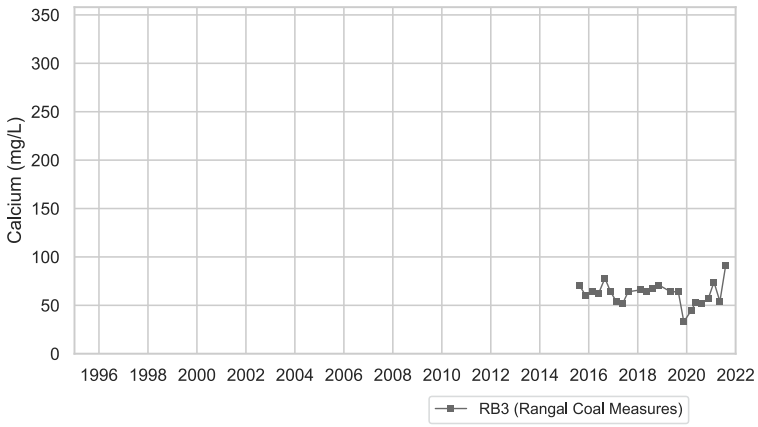

Calcium (mg/L)
0
20
40
60
80
100
120
140
160
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

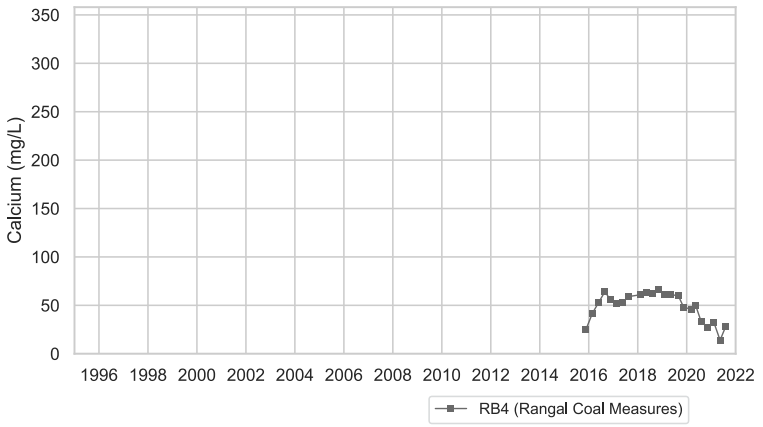

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

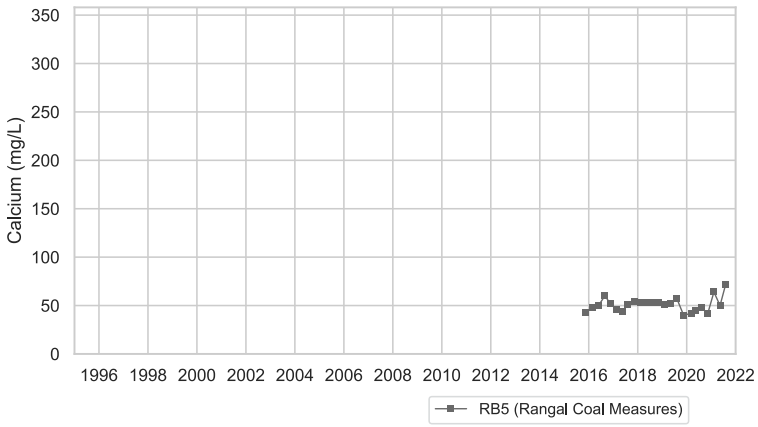

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

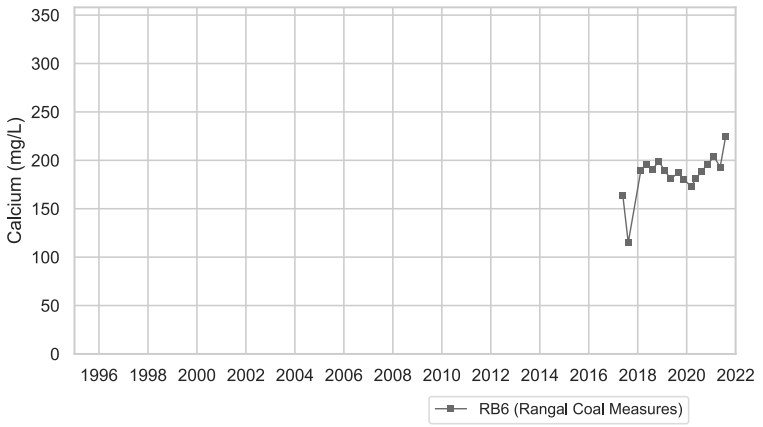

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

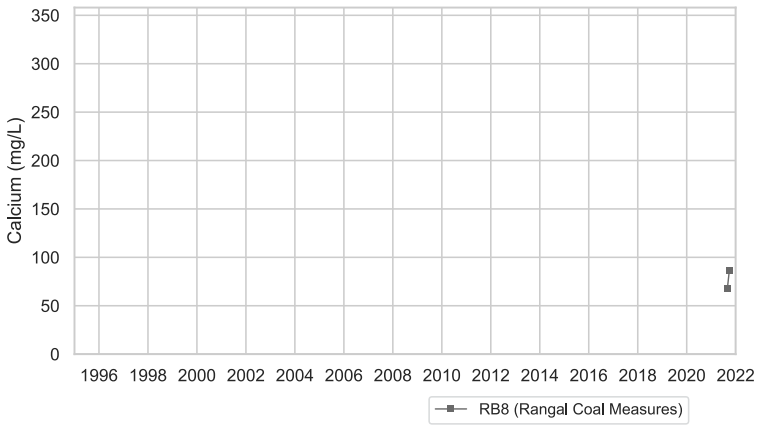

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

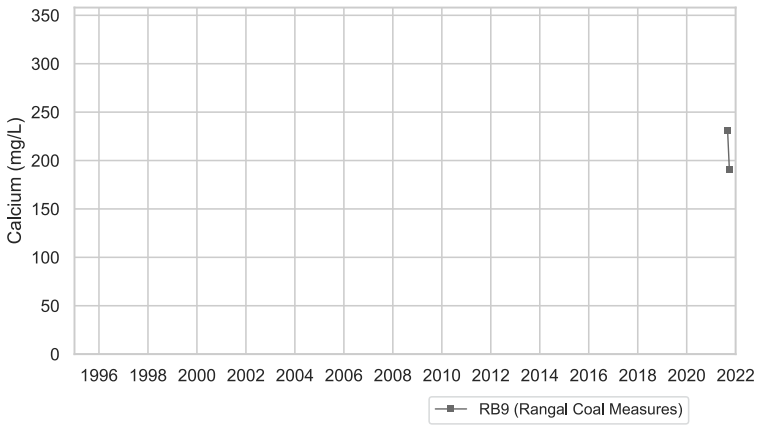

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

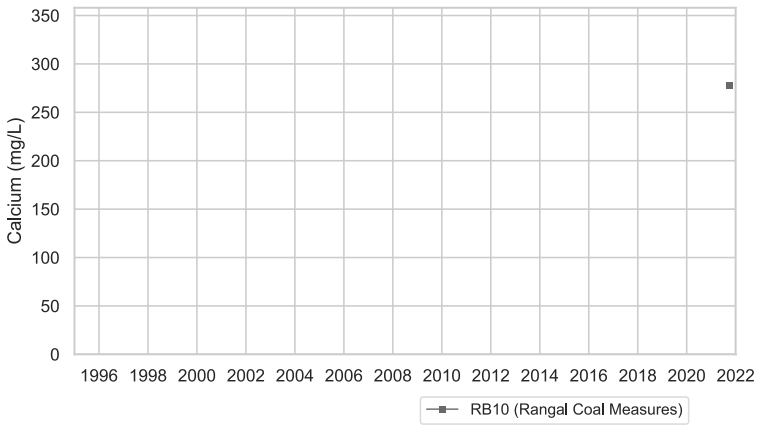

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

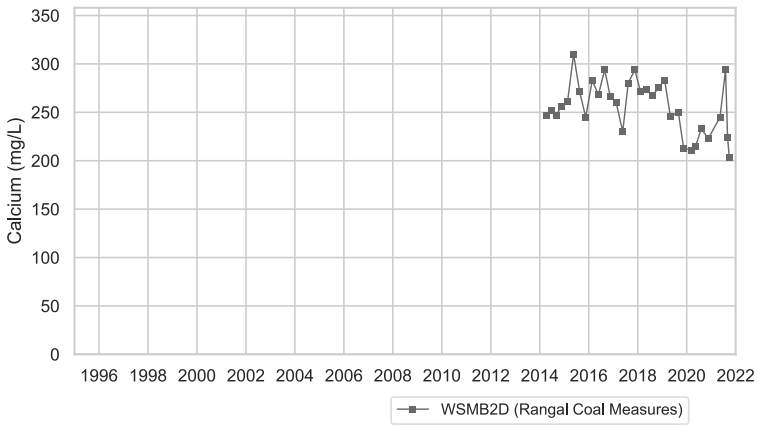

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

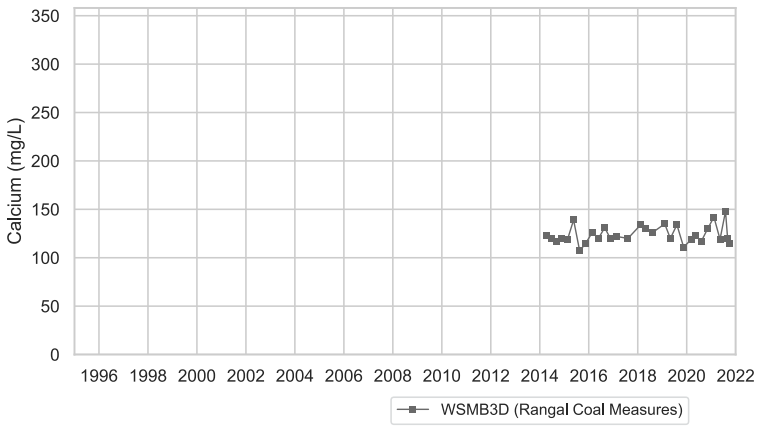

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

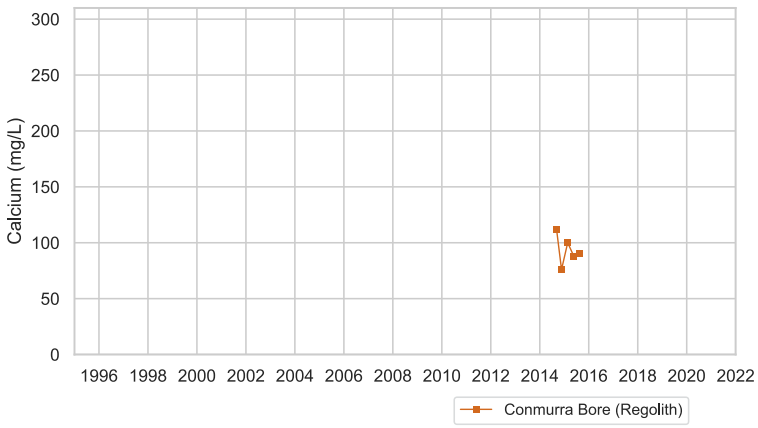

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

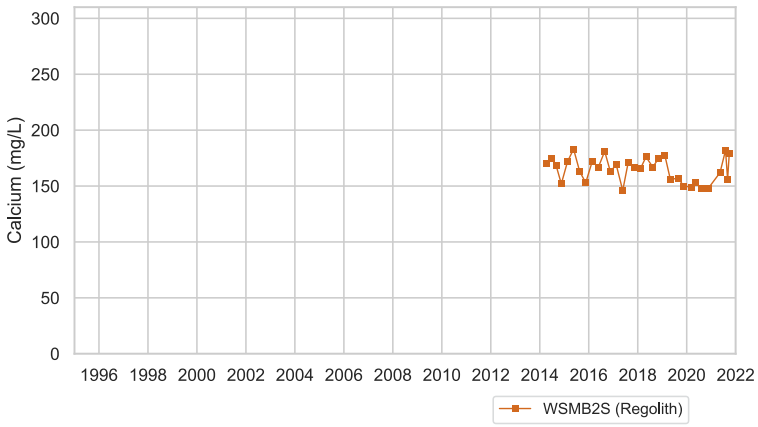

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

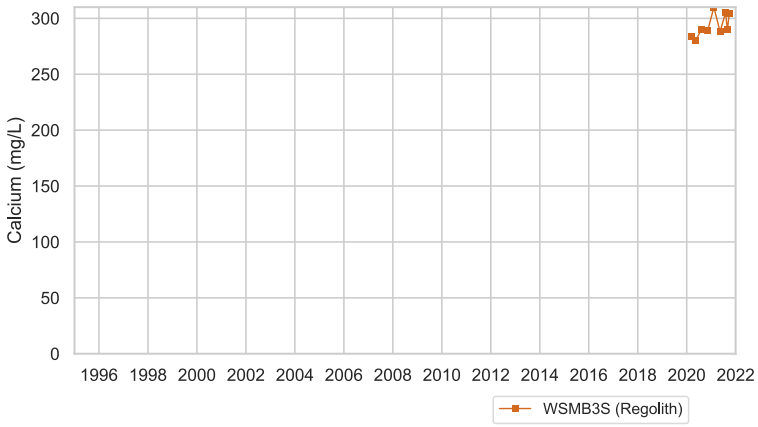

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

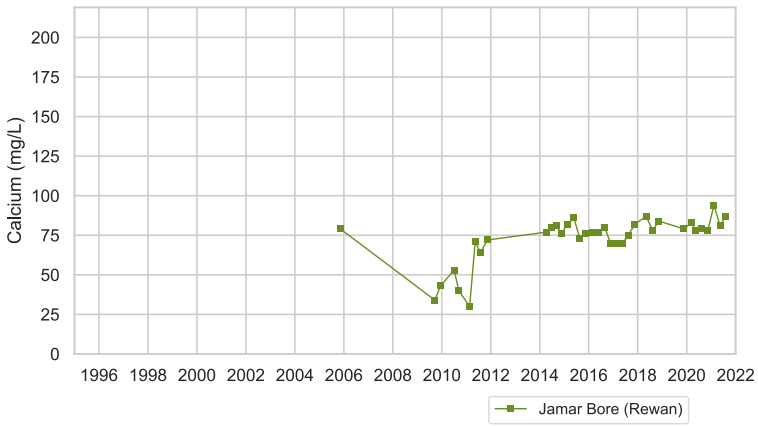

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

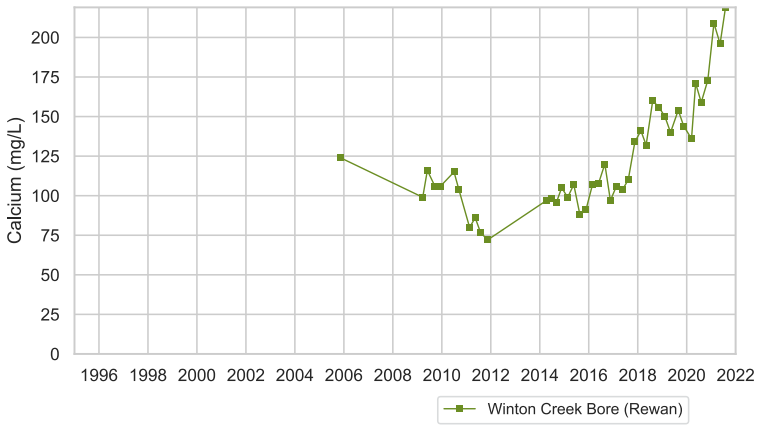

Calcium (mg/L)
0
50
100
150
200
250
300
350
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

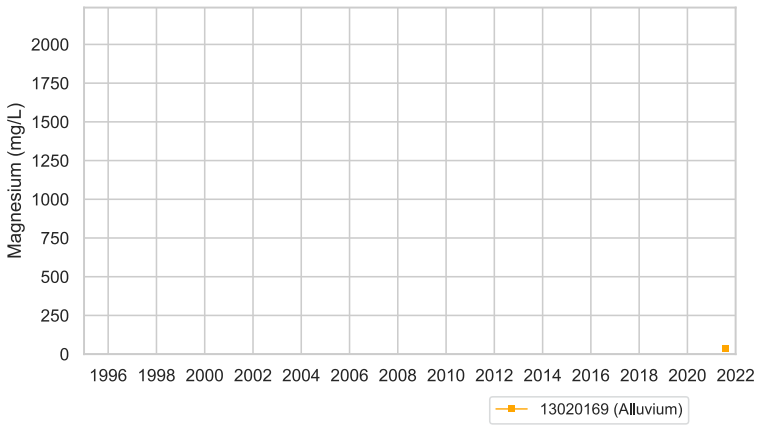

Calcium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

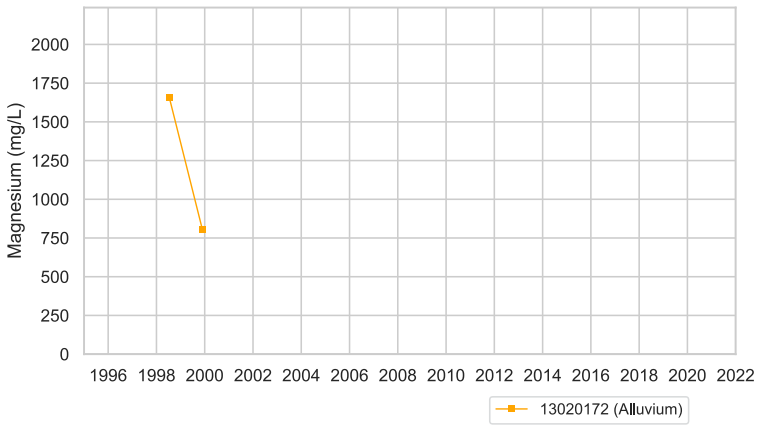

Calcium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

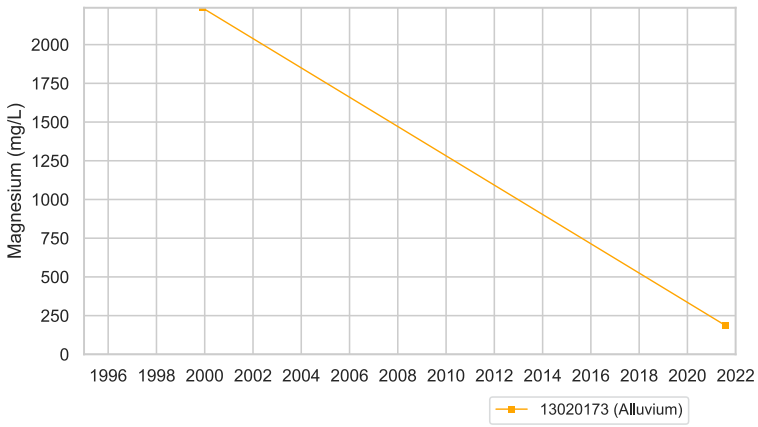

Calcium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

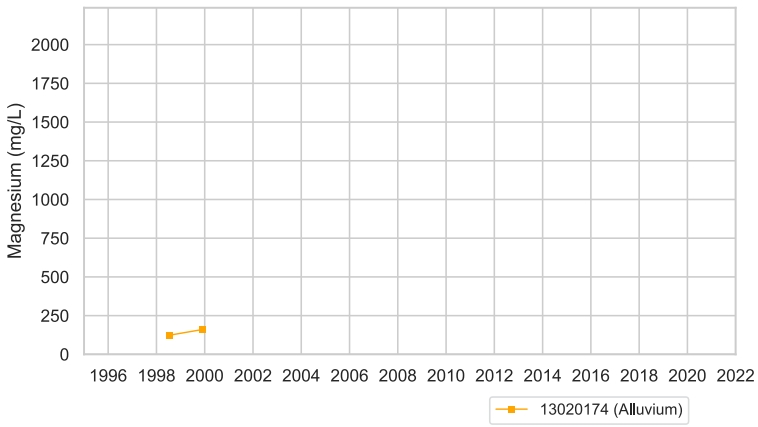

Calcium (mg/L)
0
25
50
75
100
125
150
175
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

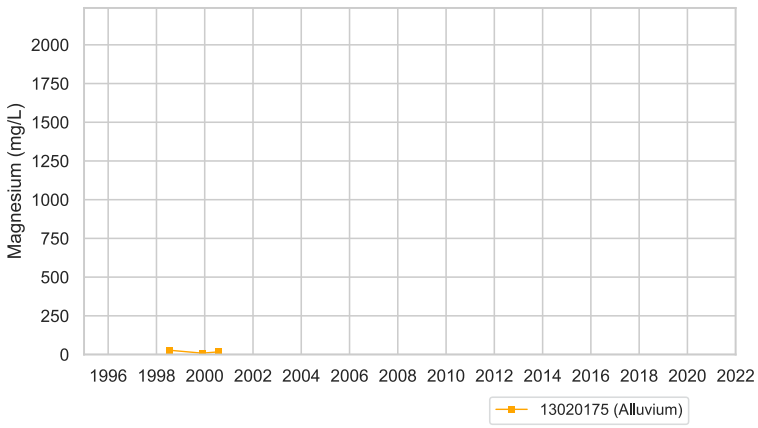

Calcium (mg/L)
0
25
50
75
100
125
150
175
200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

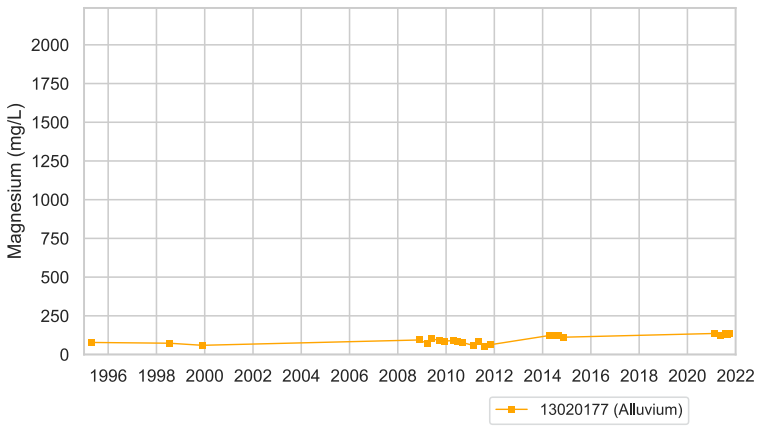

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

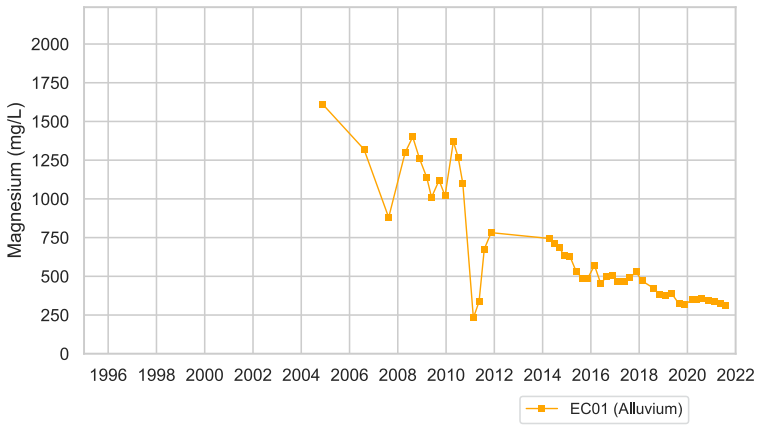

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

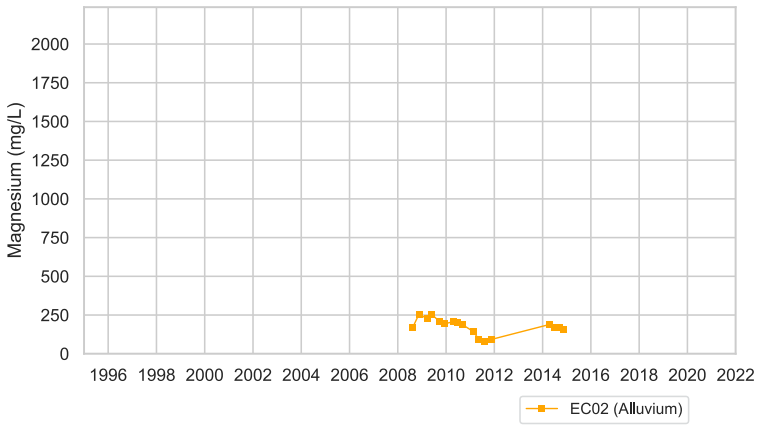

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

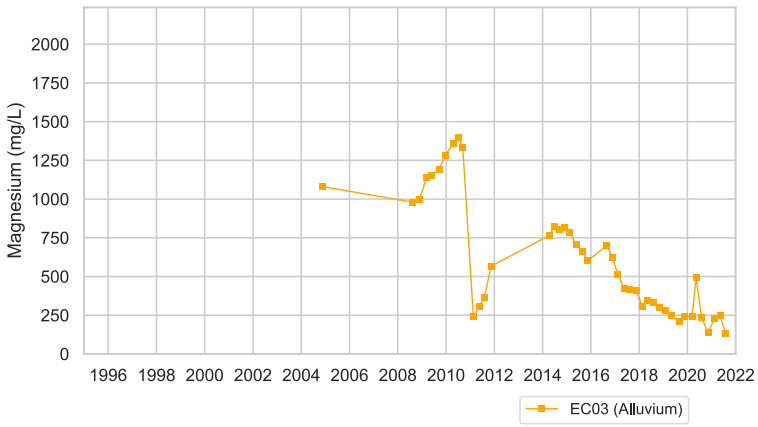

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

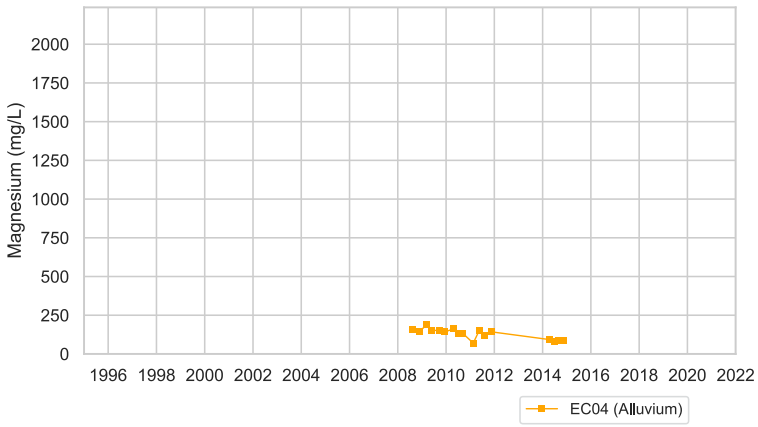

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

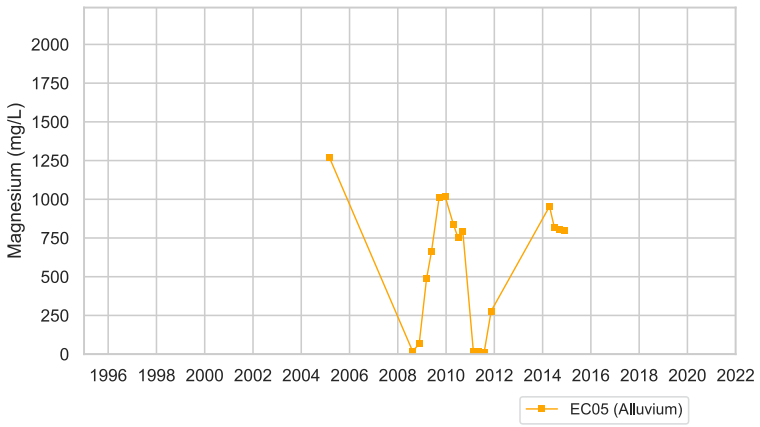

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

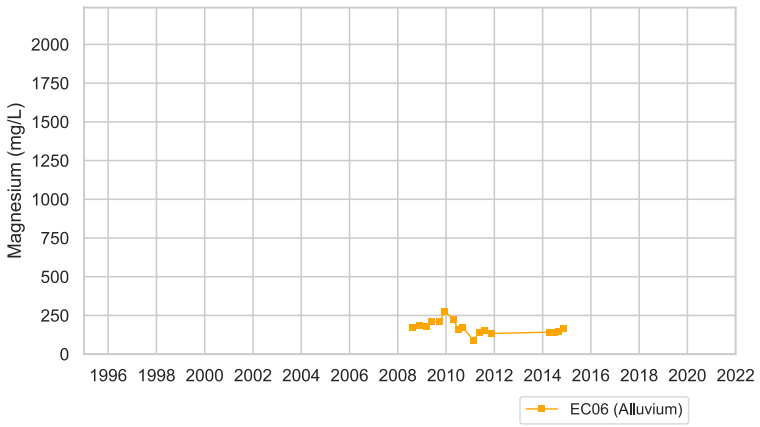

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

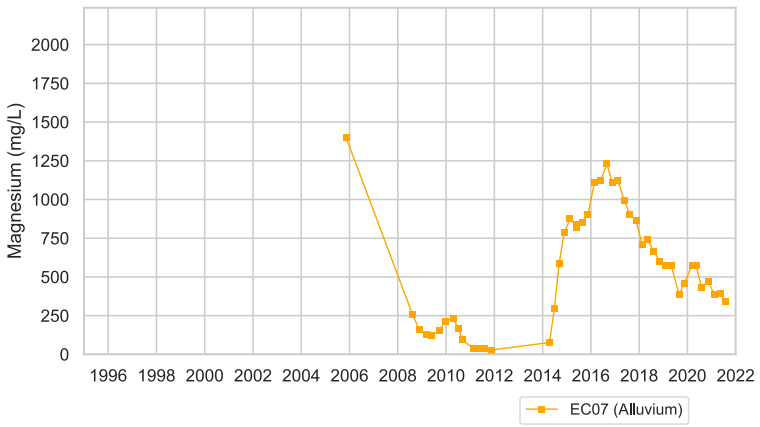

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

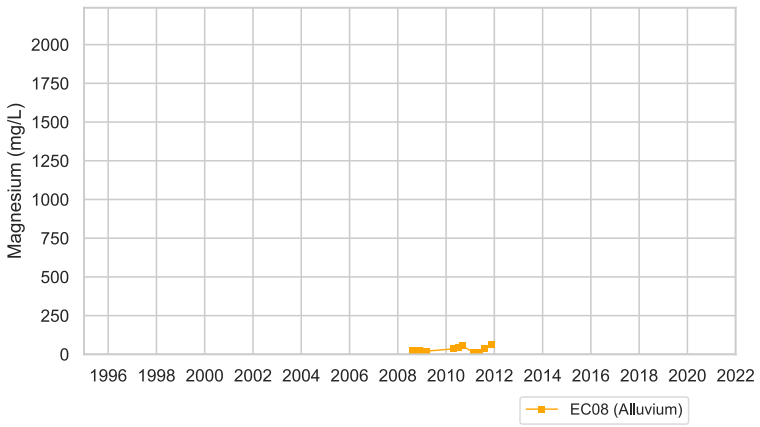

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

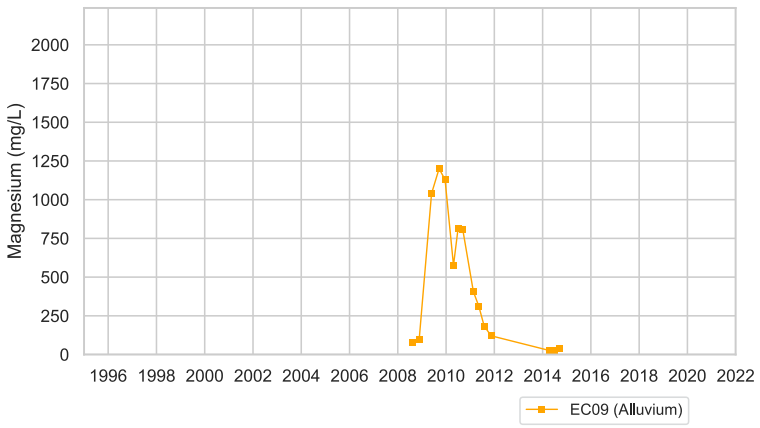

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

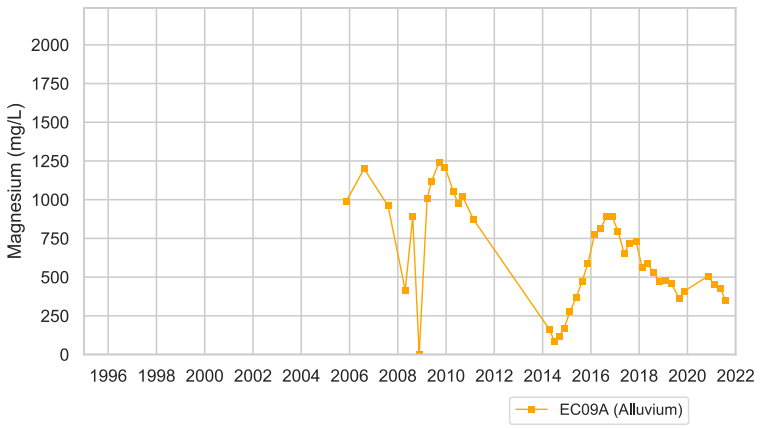

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

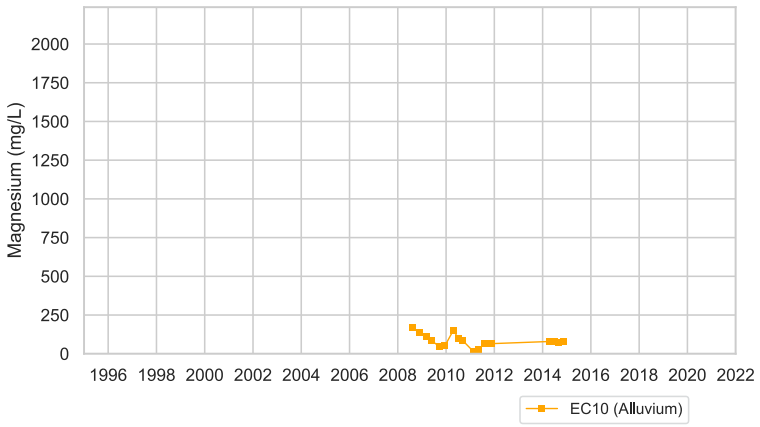

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

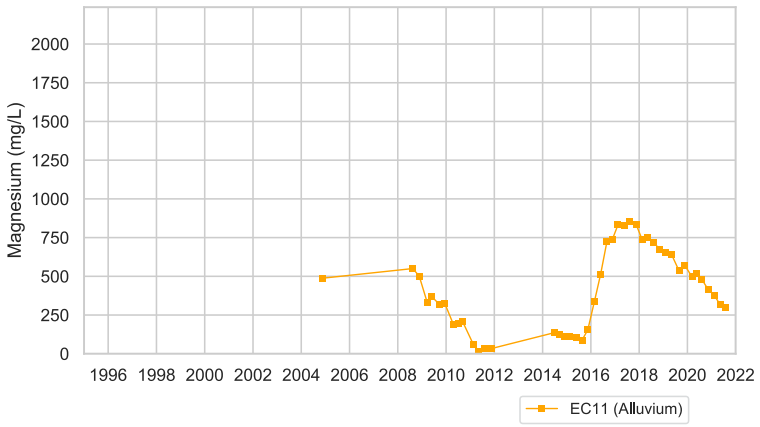

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

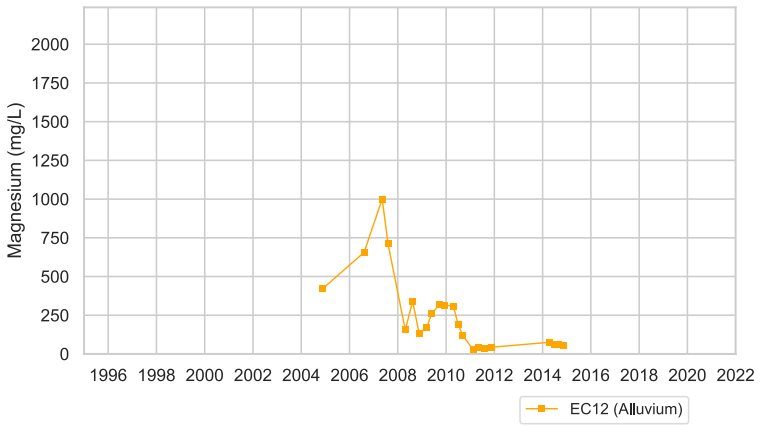

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

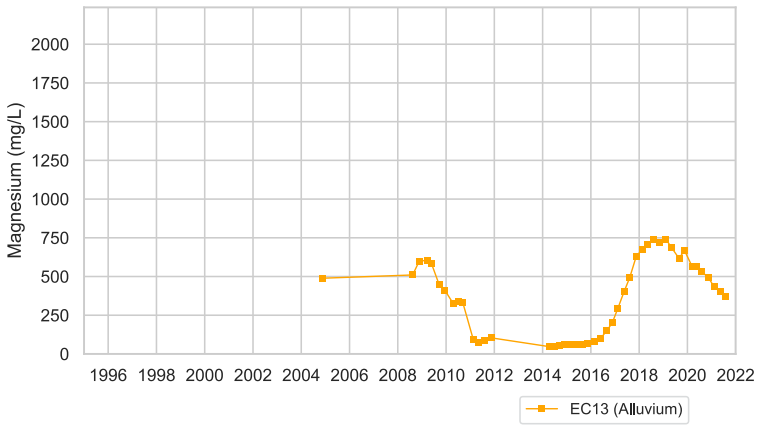

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

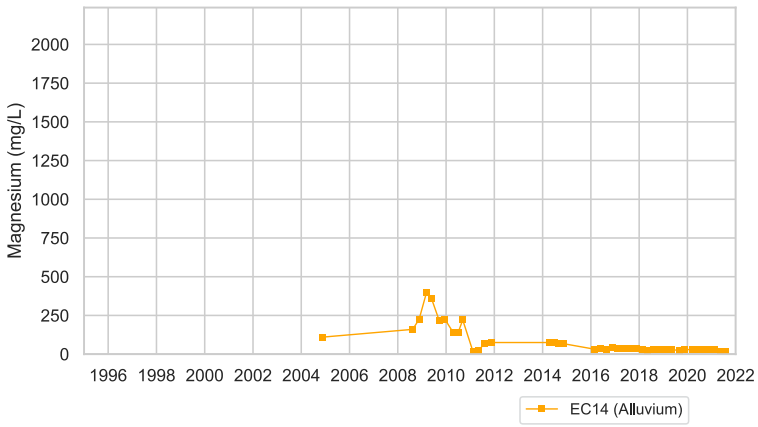

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

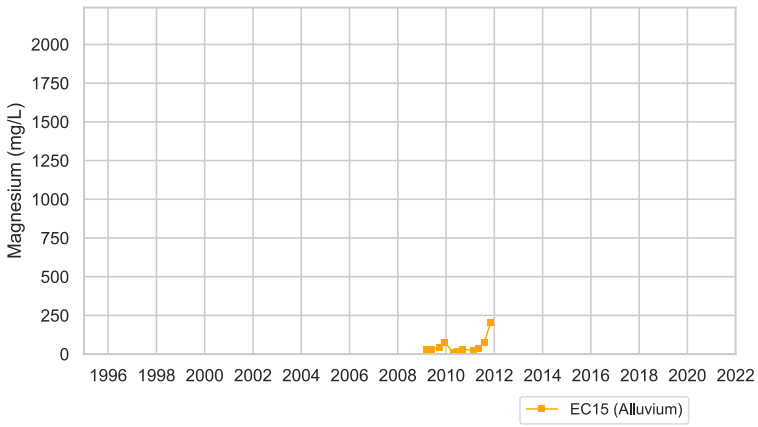

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

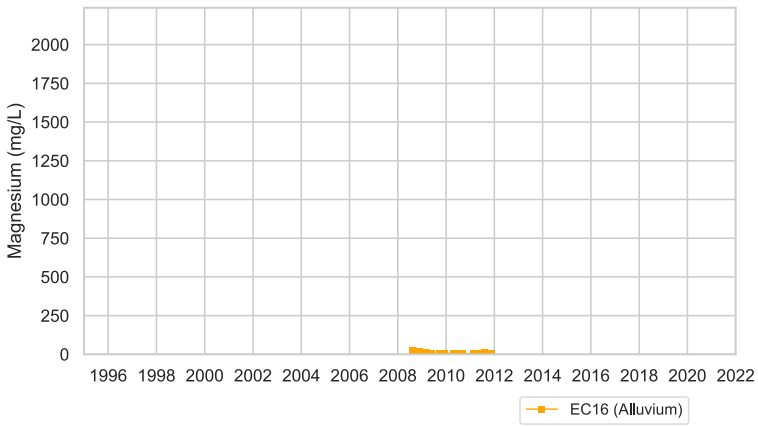

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

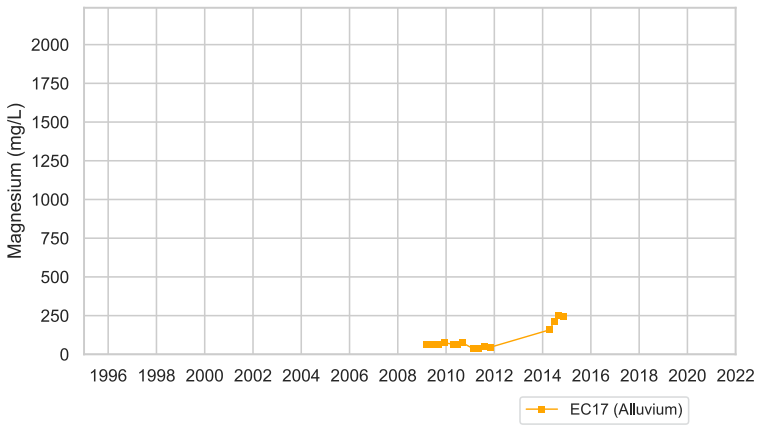

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

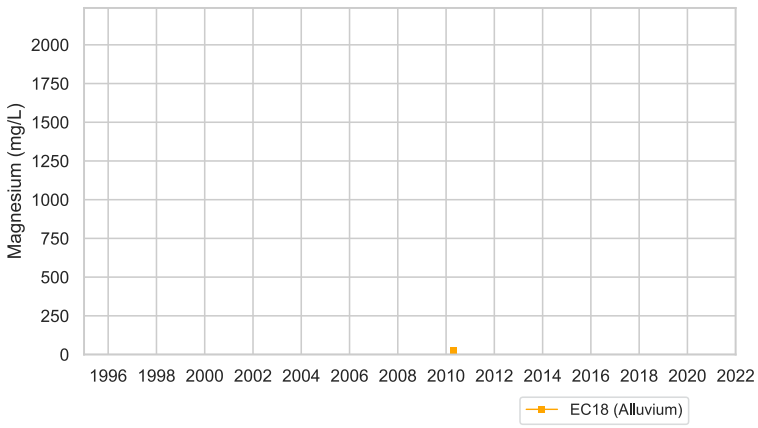

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

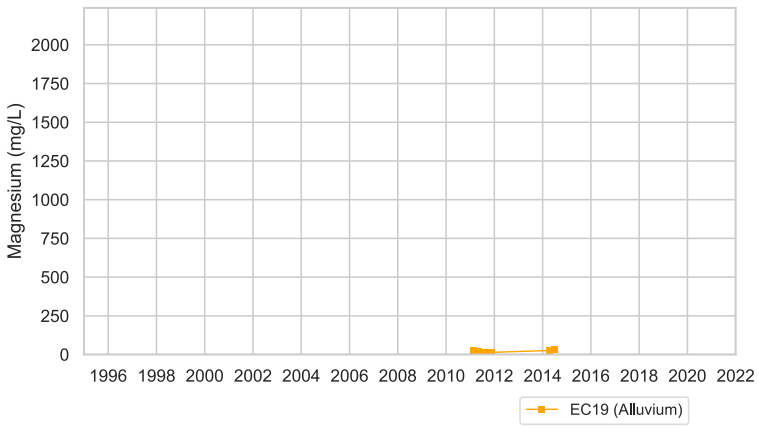

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

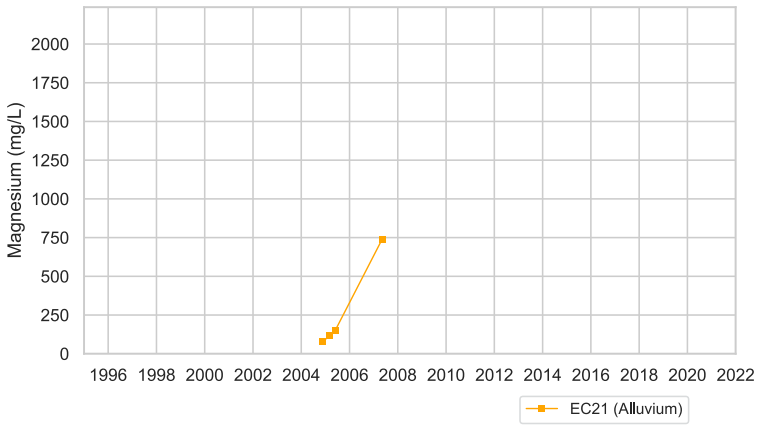

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

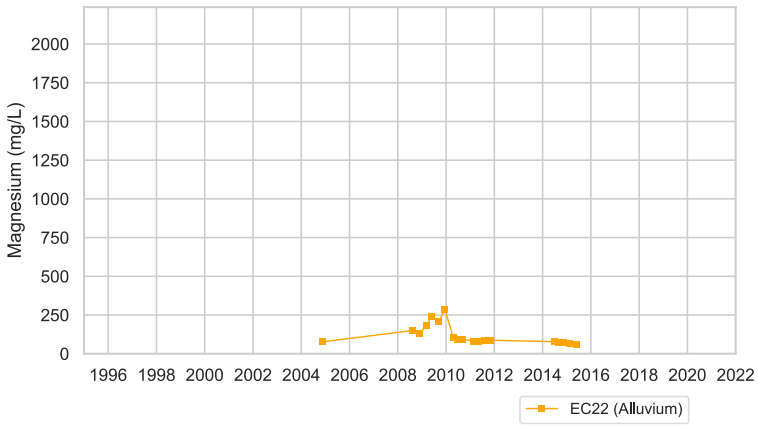

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

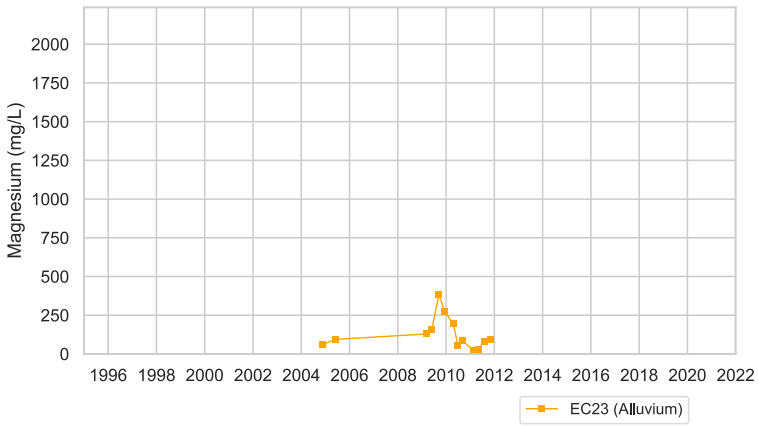

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

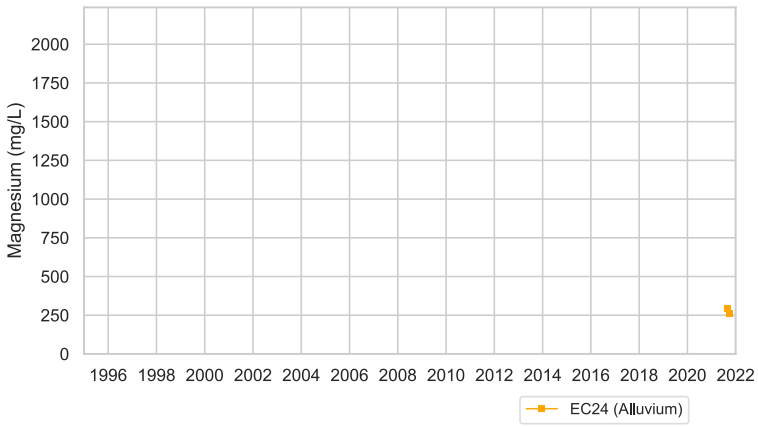

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

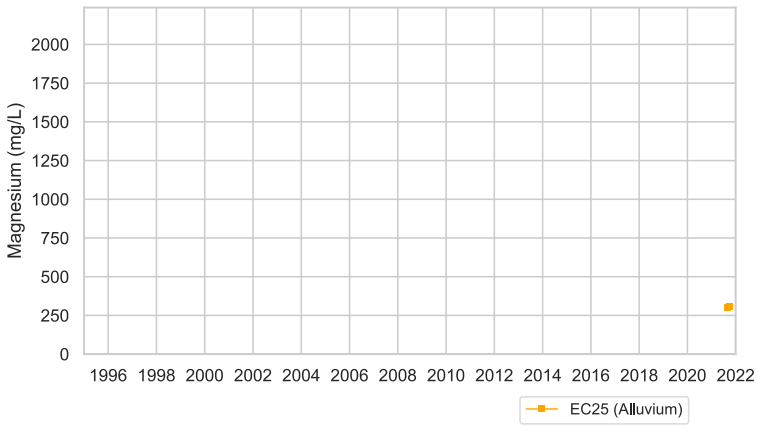

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

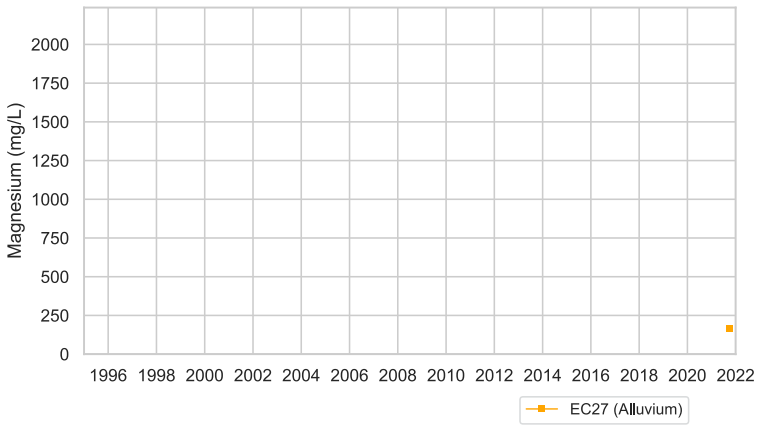

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

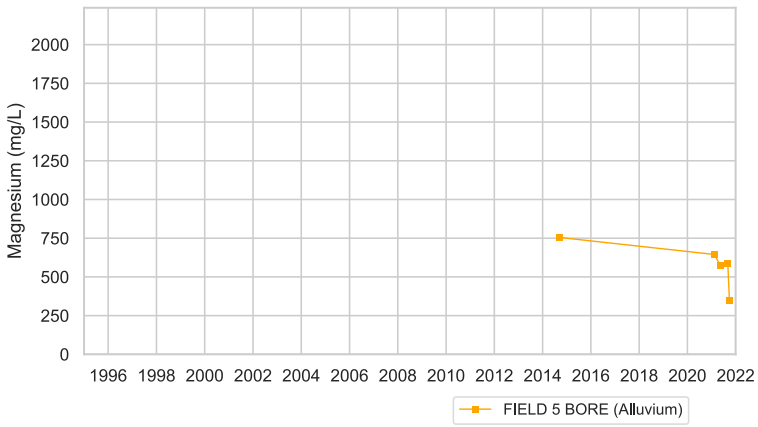

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

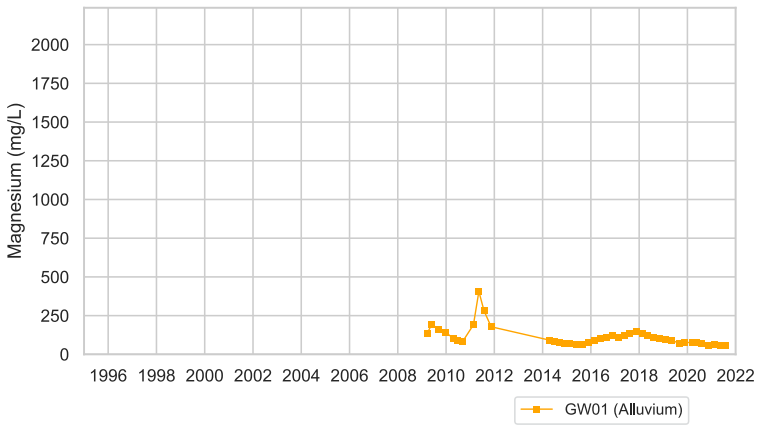

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

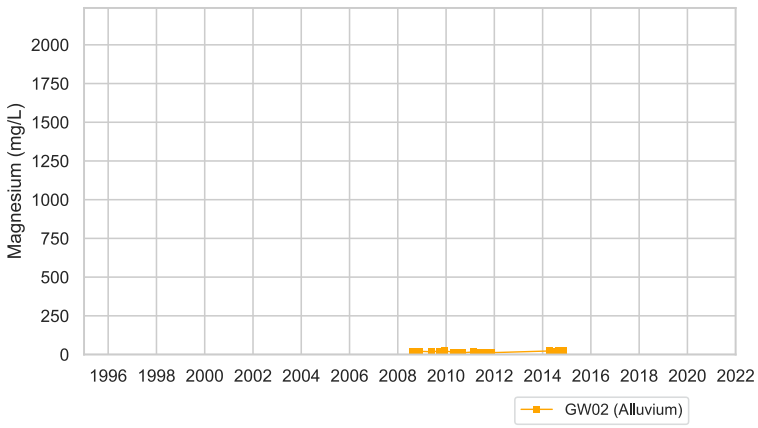

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

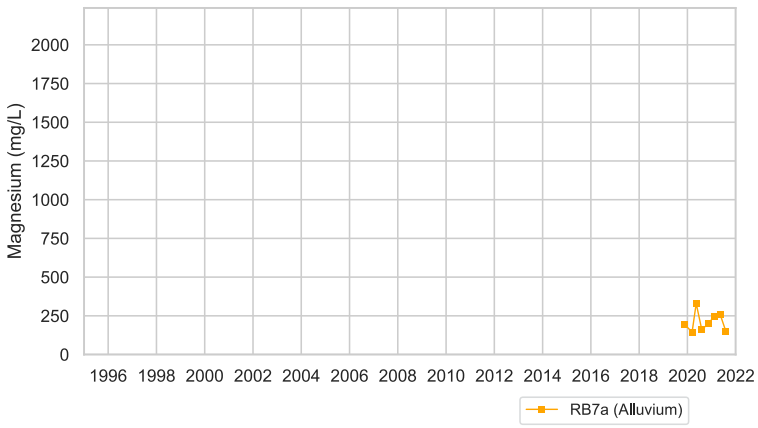

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

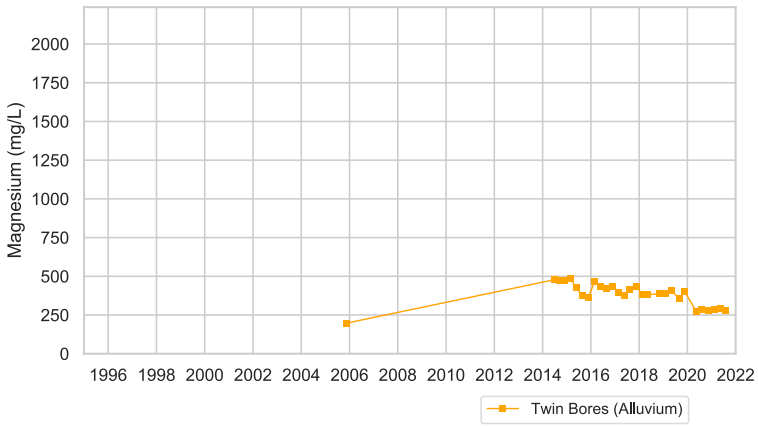

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

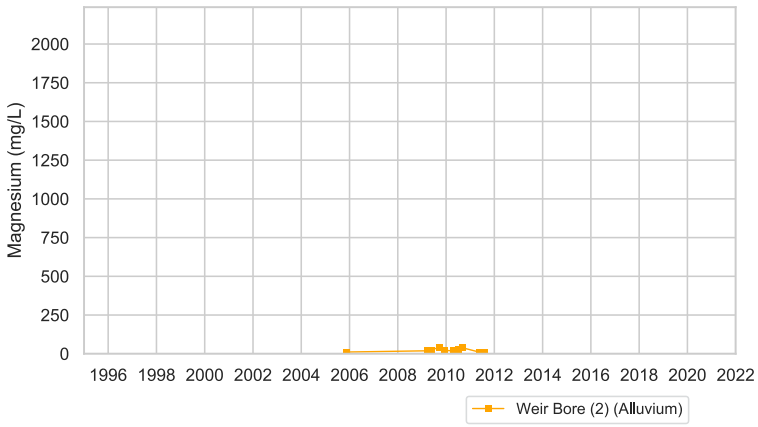

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

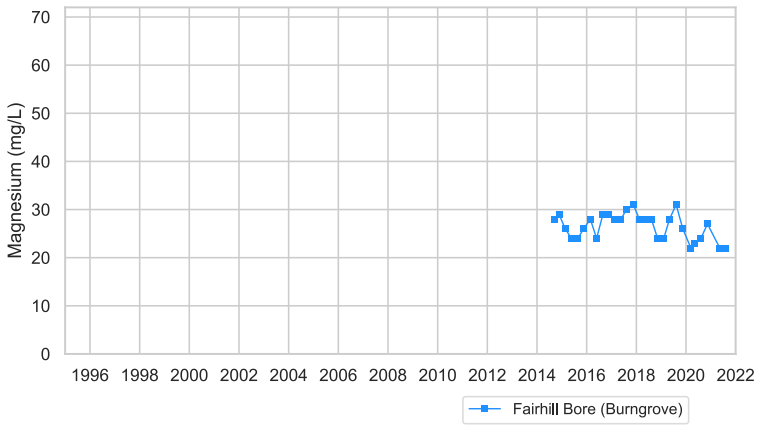

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

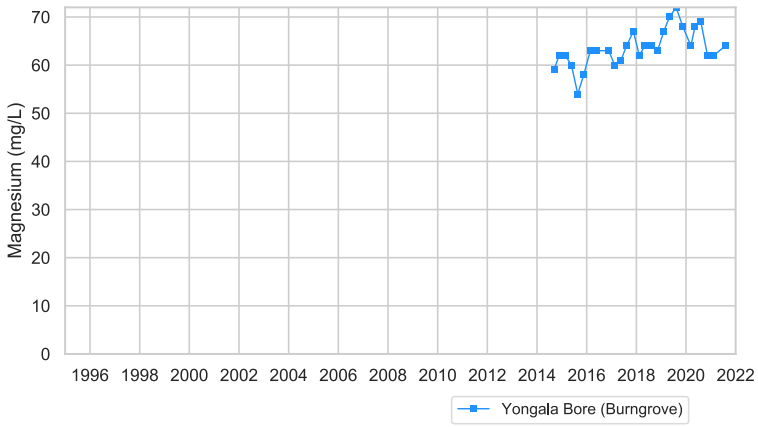

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

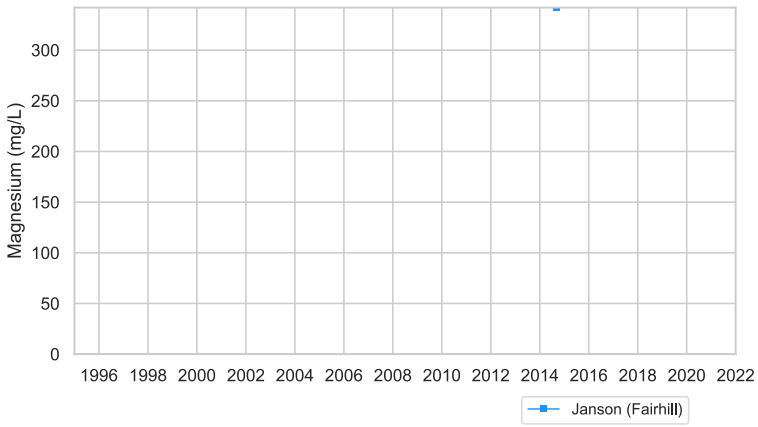

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

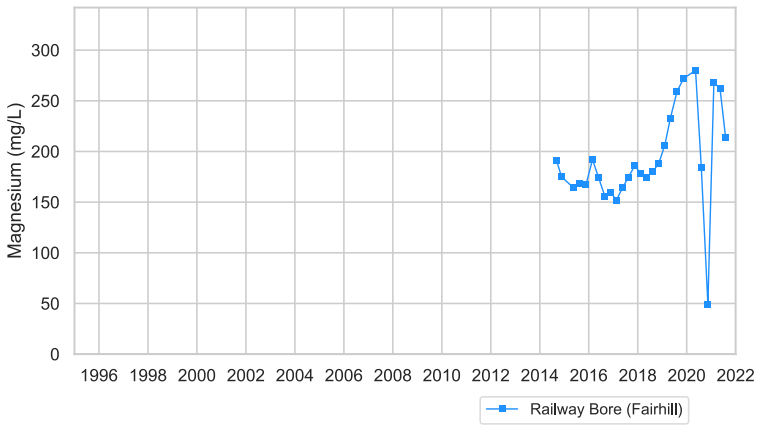

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

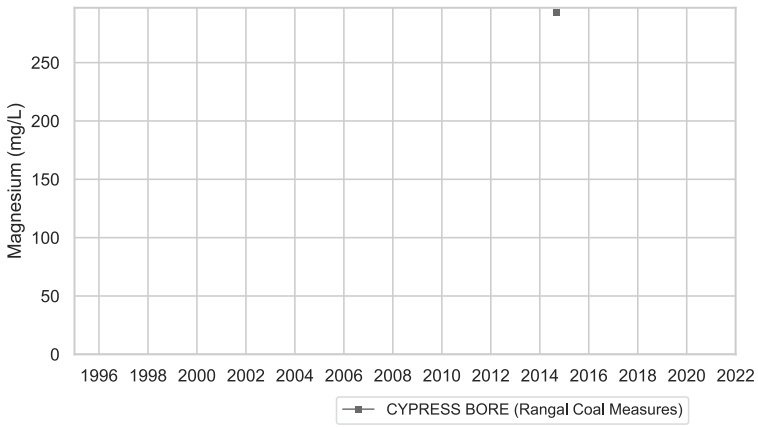

Magnesium (mg/L)
0
250
500
750
1000
1250
1500
1750
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

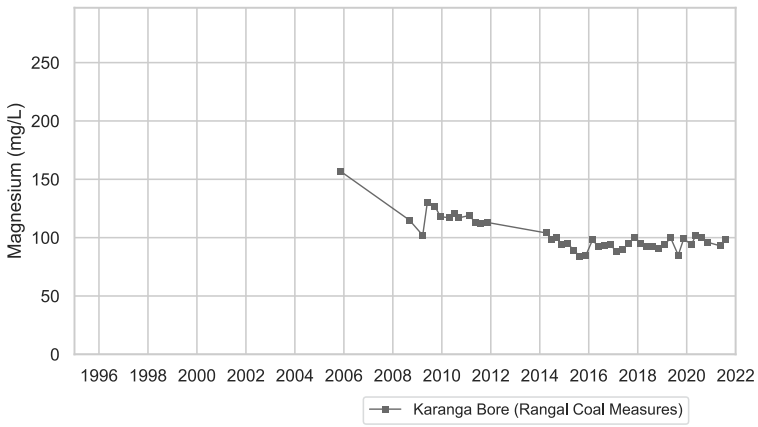

Magnesium (mg/L)
0
10
20
30
40
50
60
70
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

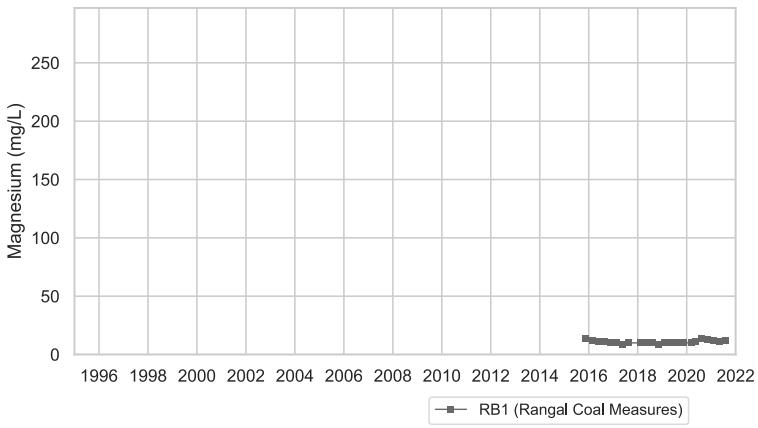

Magnesium (mg/L)
0
10
20
30
40
50
60
70
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

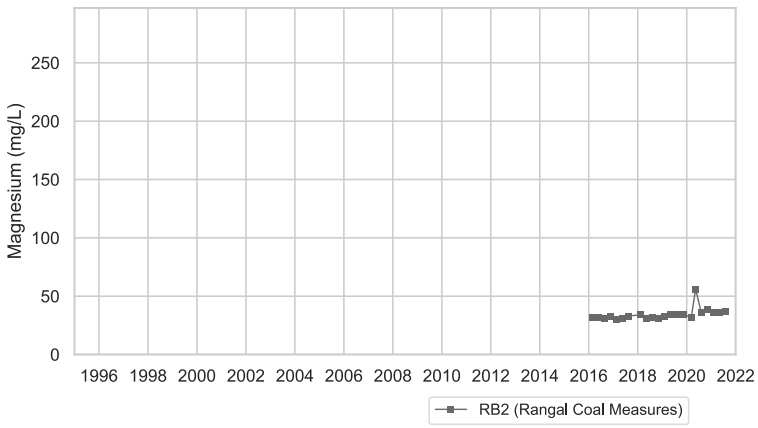

Magnesium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

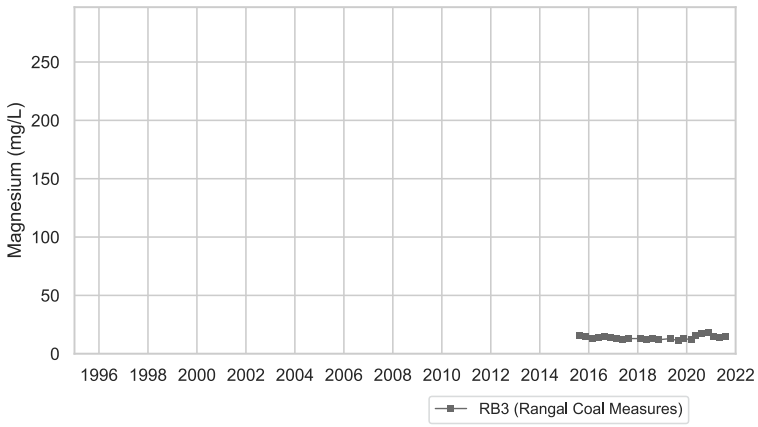

Magnesium (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

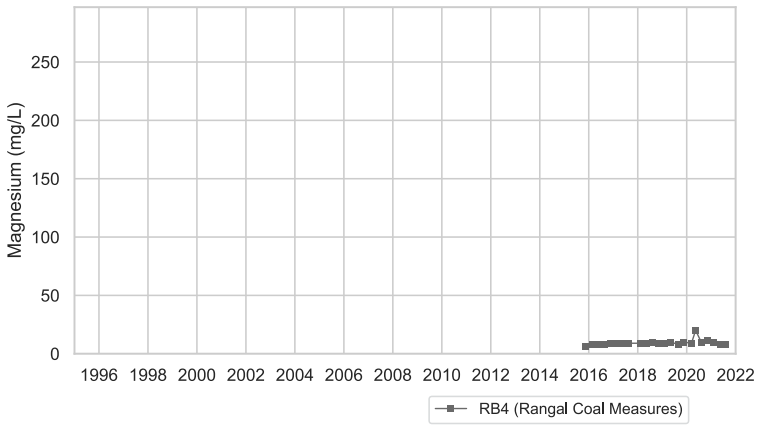

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

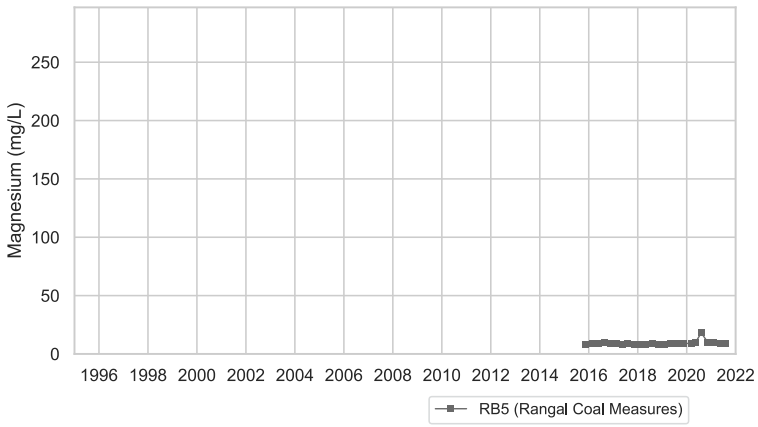

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

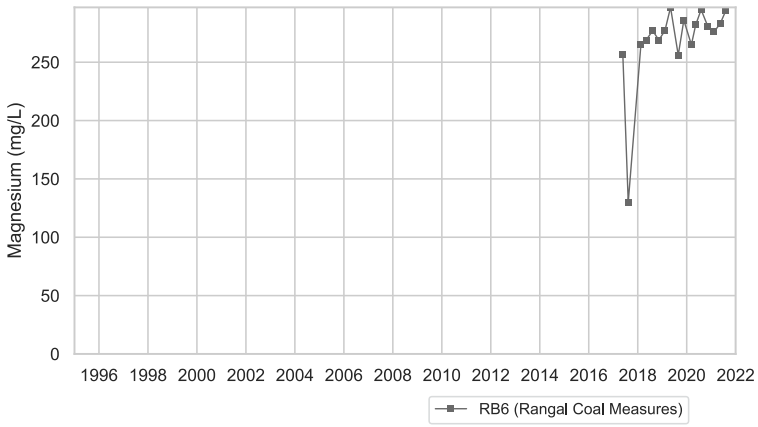

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

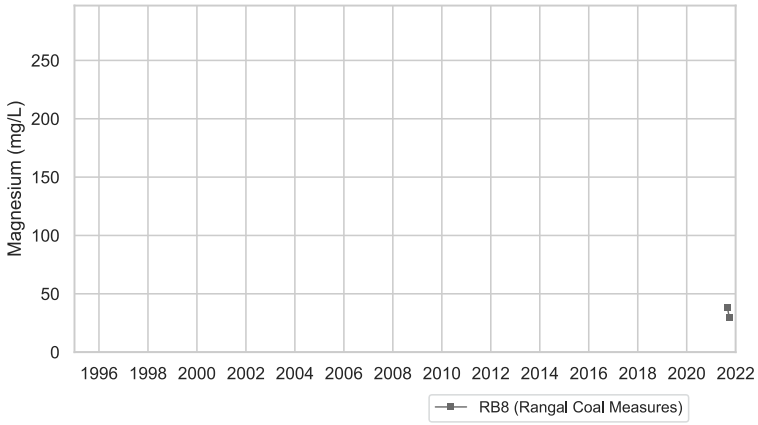

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

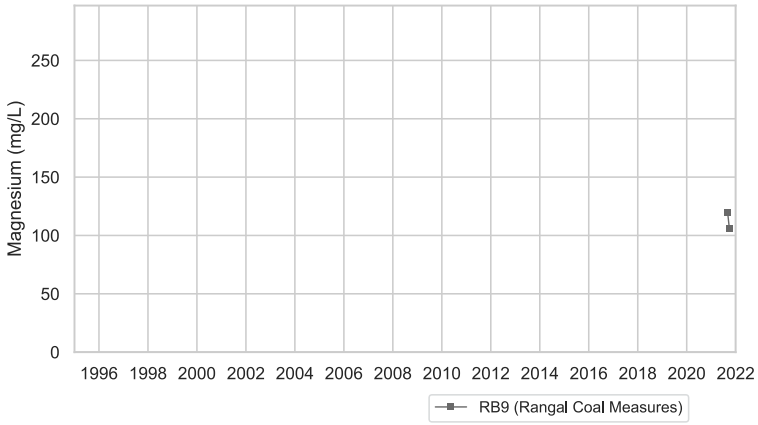

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

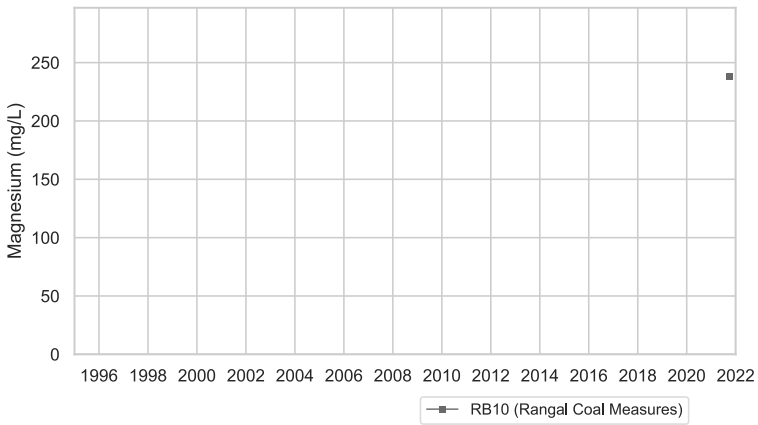

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

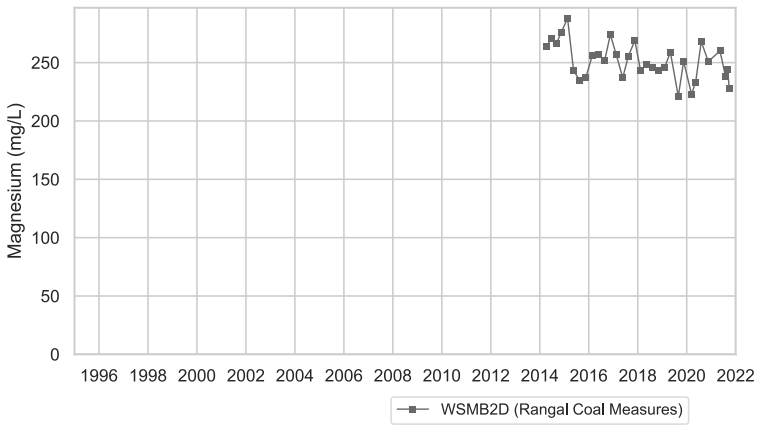

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

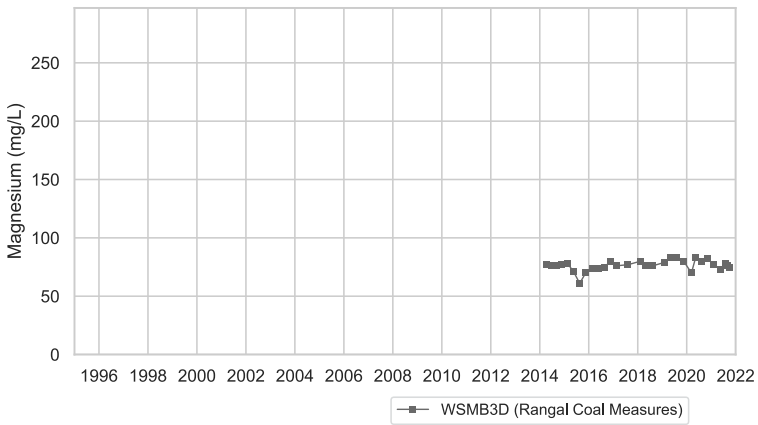

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

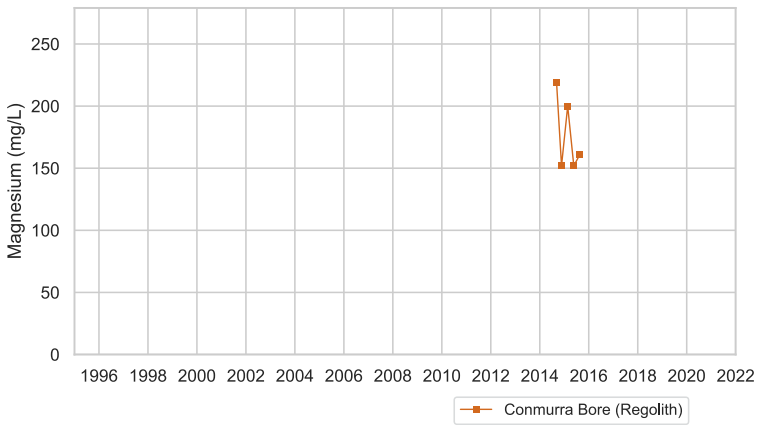

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

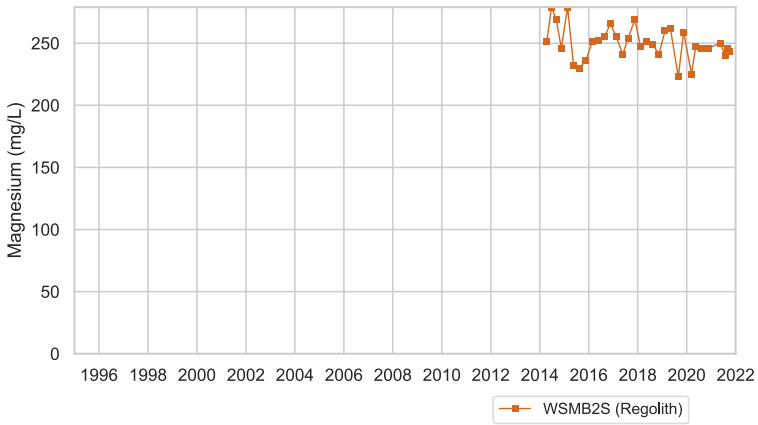

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

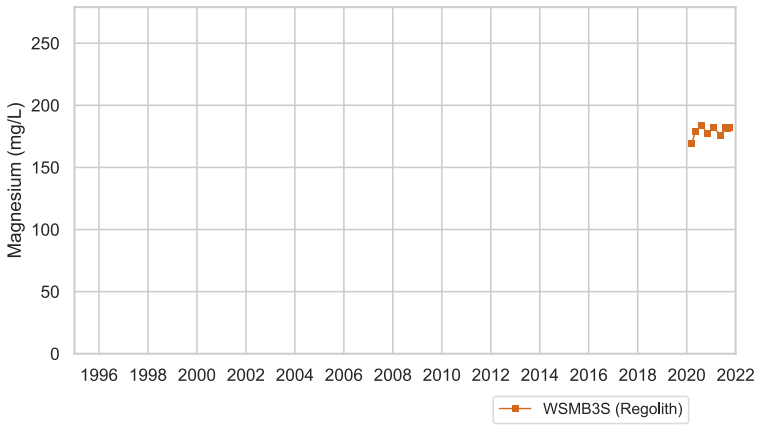

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

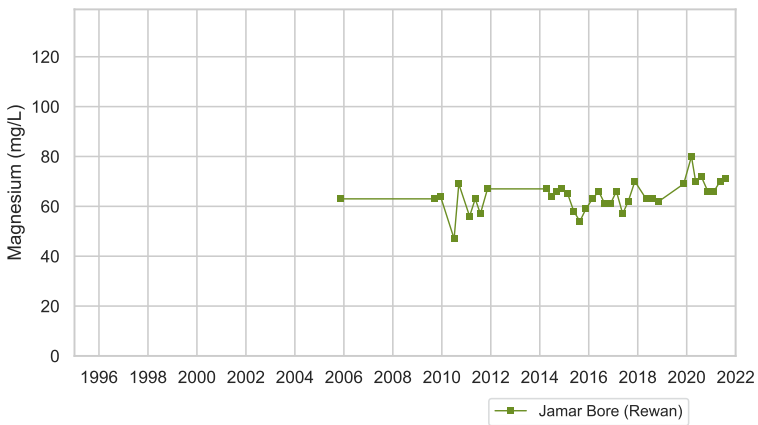

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

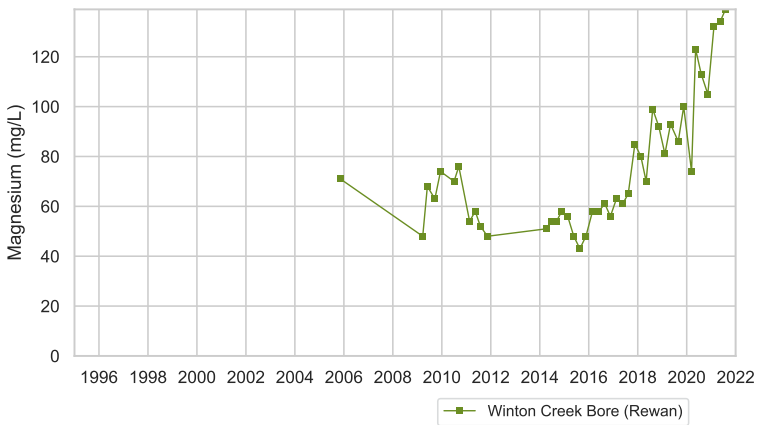

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

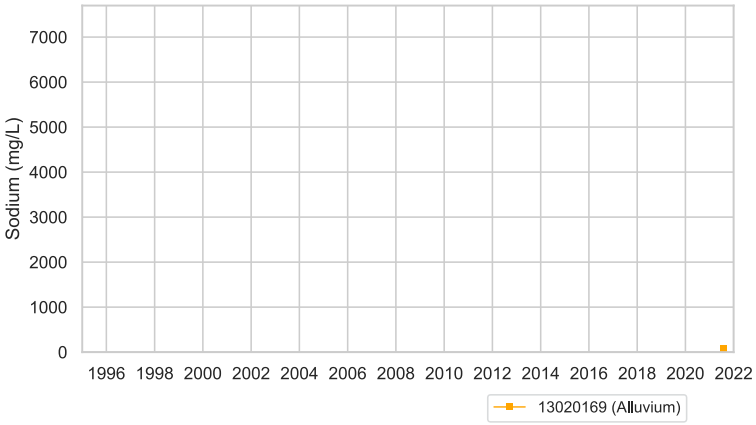

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

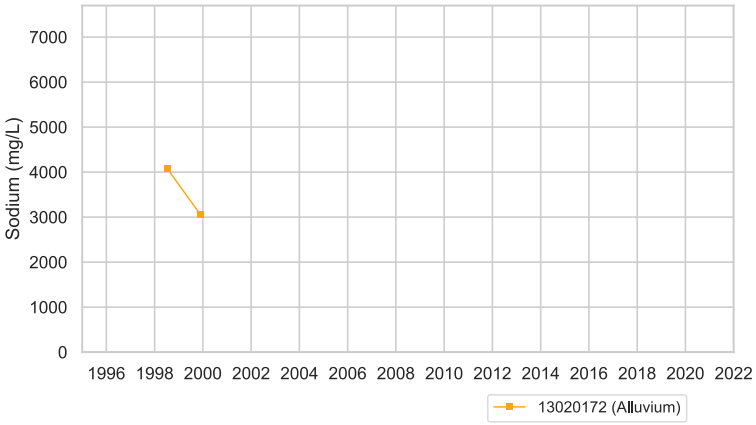

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

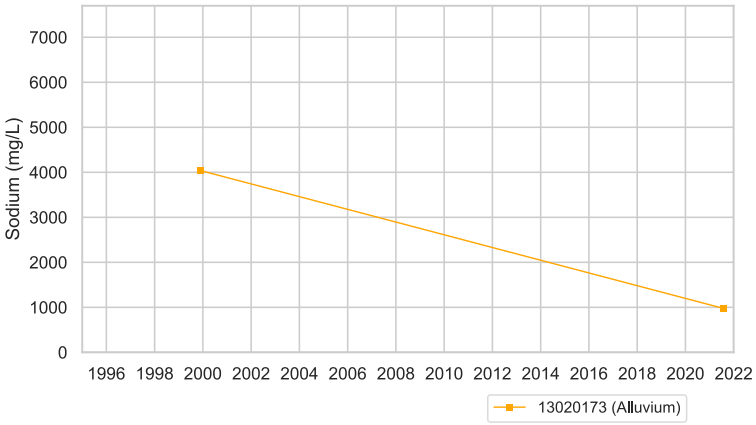

Magnesium (mg/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

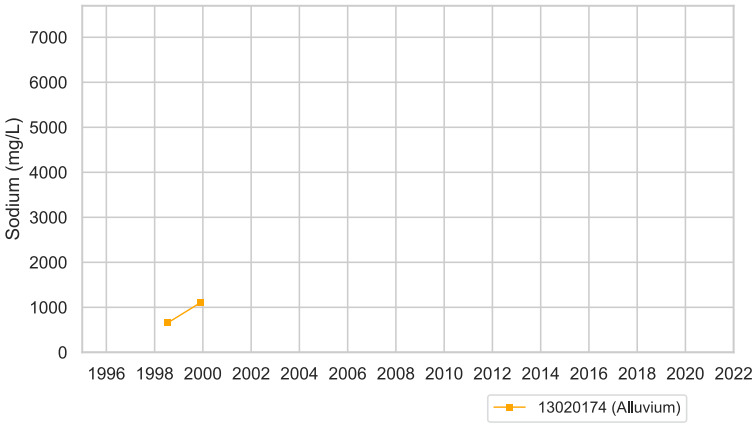

Magnesium (mg/L)
0
20
40
60
80
100
120
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

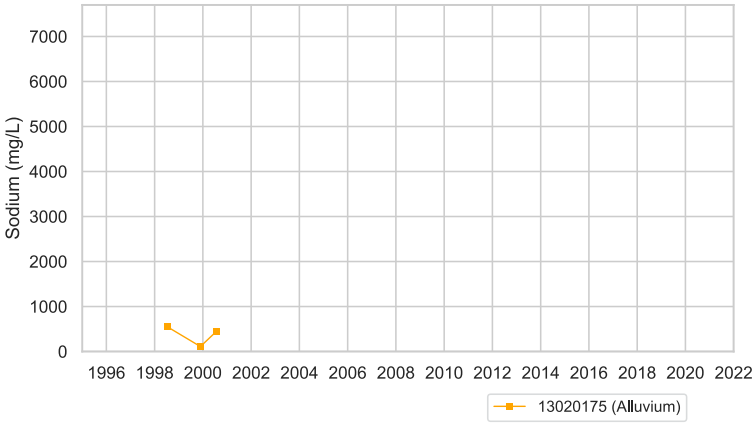

Magnesium (mg/L)
0
20
40
60
80
100
120
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

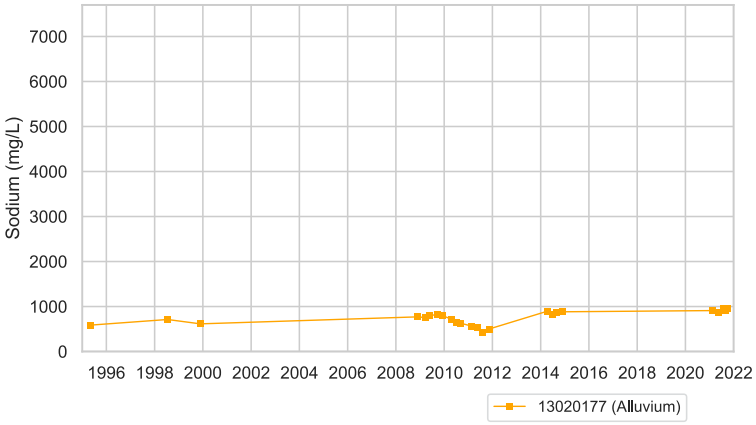

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

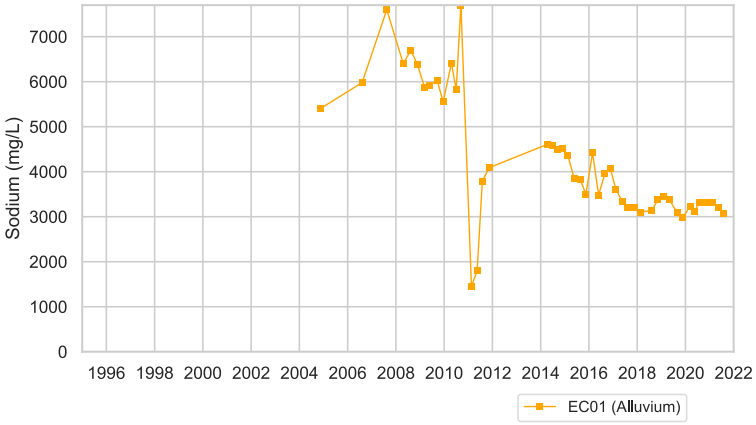

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

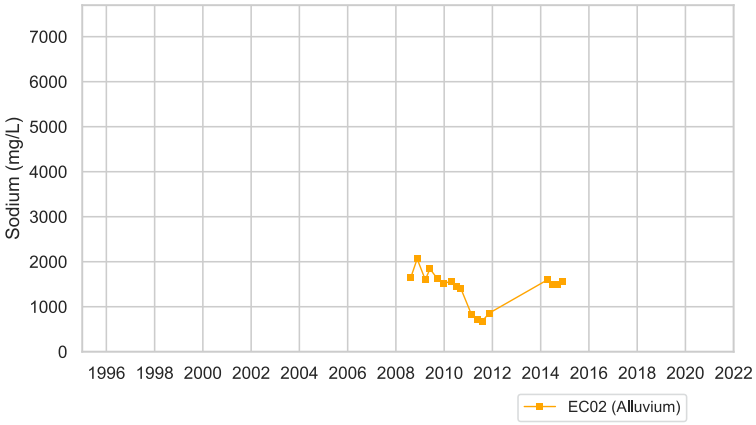

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

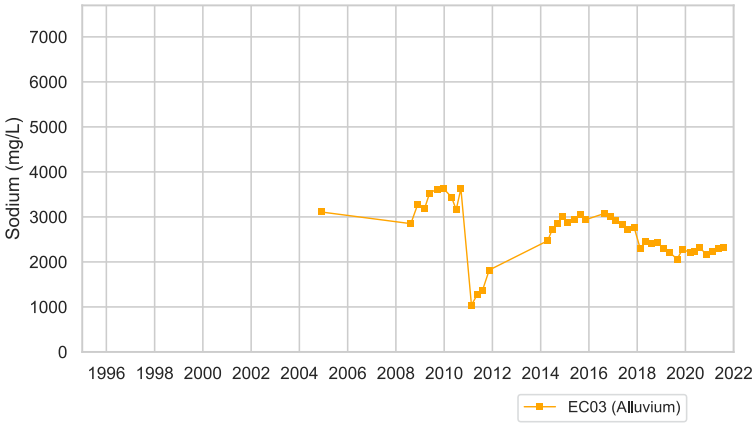

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

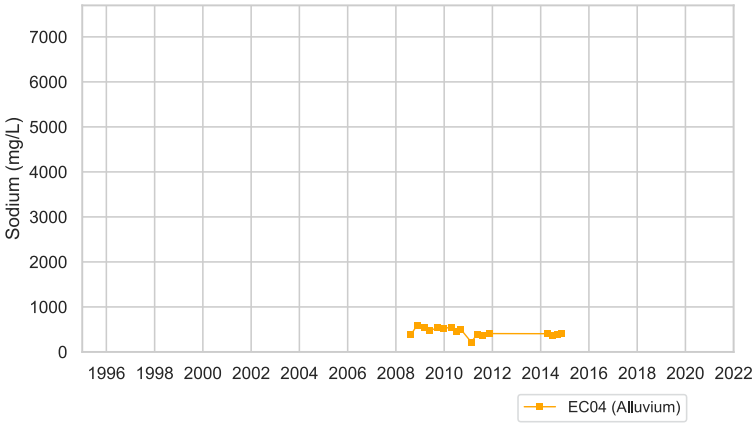

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

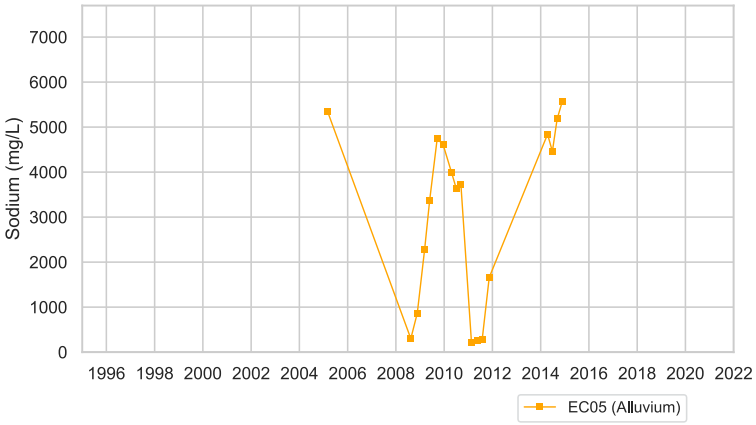

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

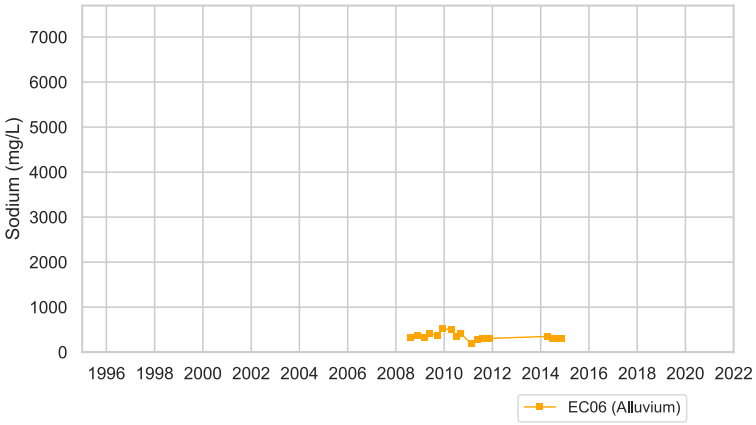

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

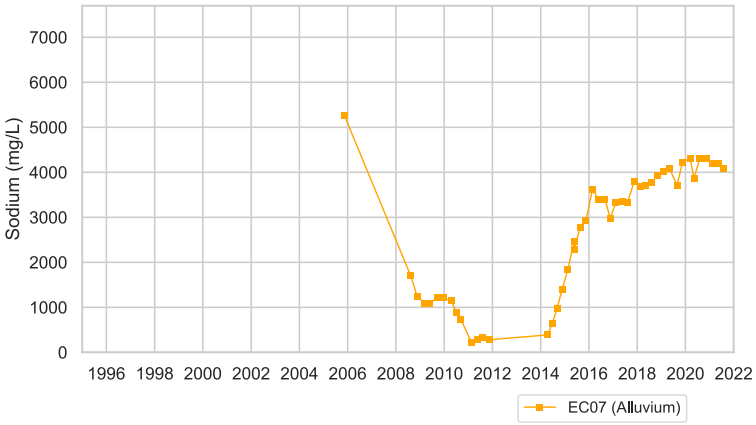

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

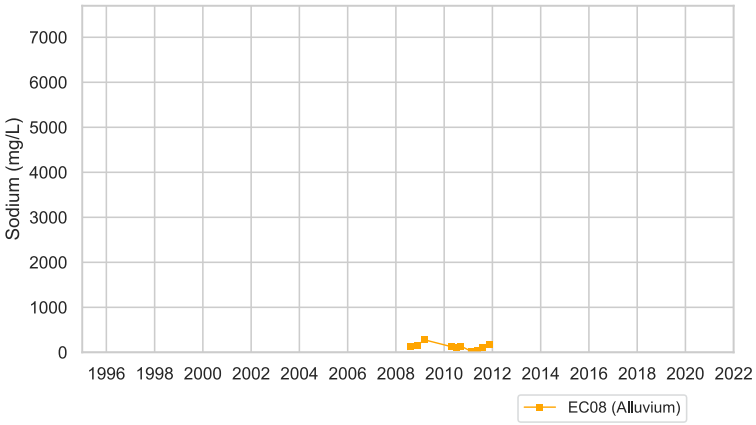

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

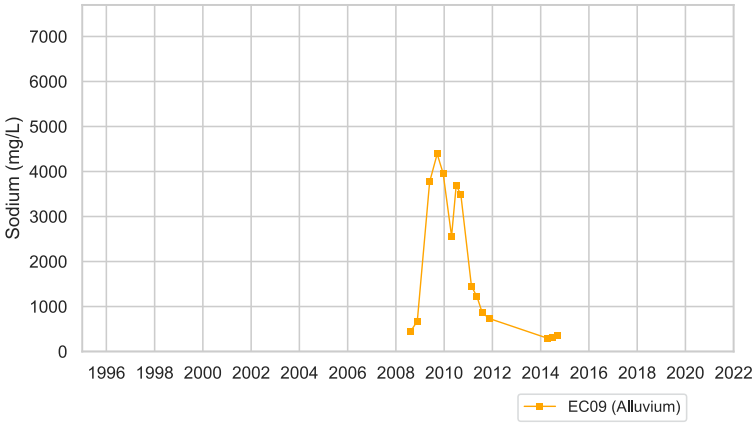

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

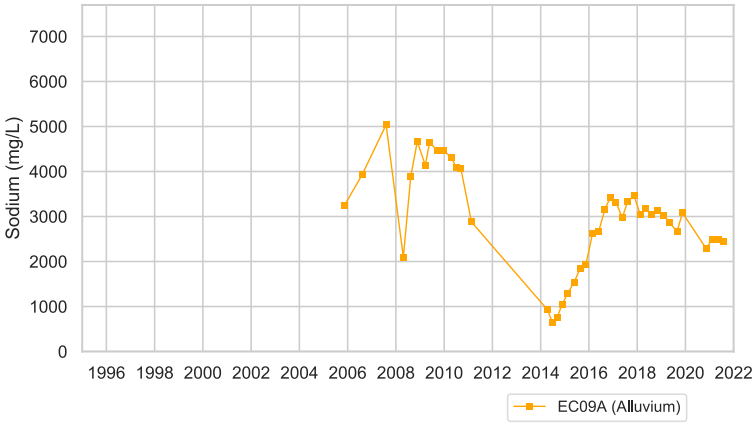

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

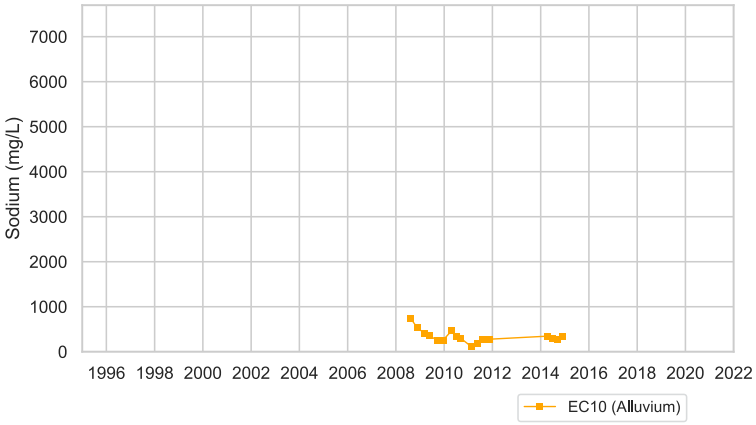

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

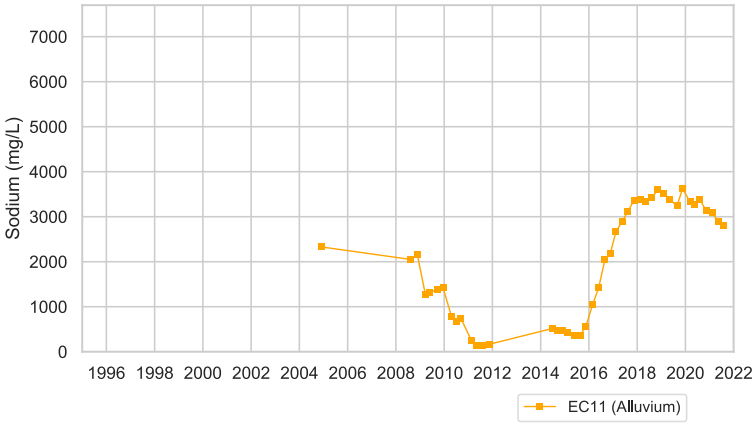

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

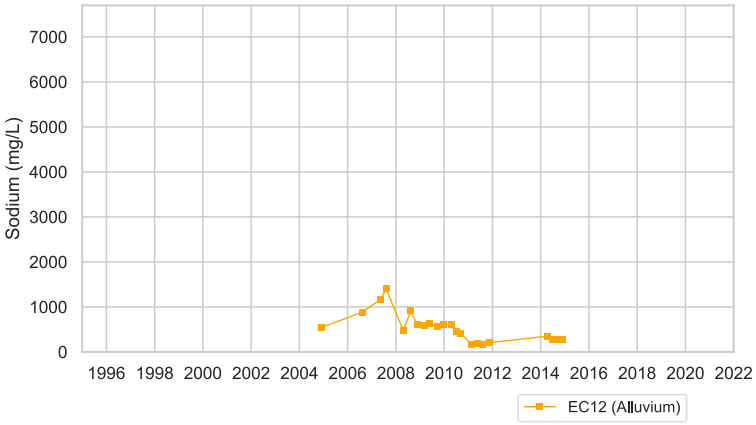

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

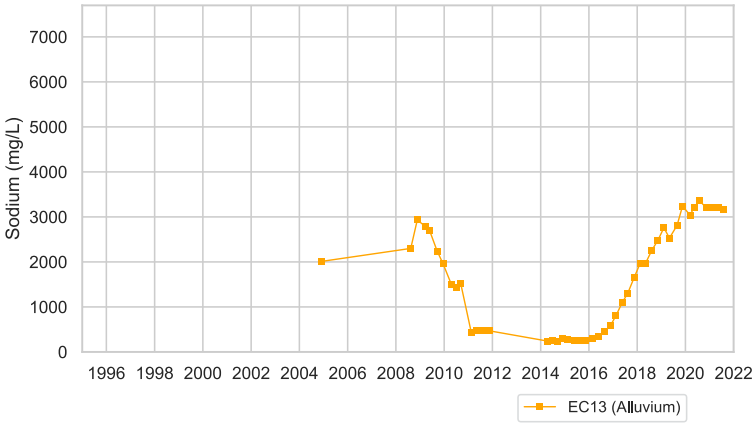

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

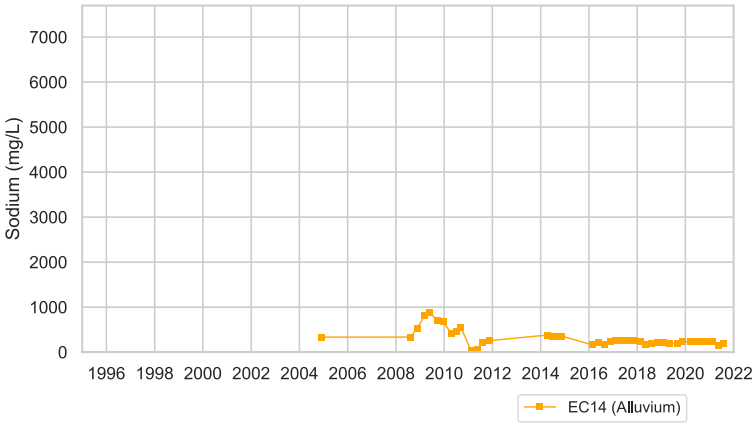

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

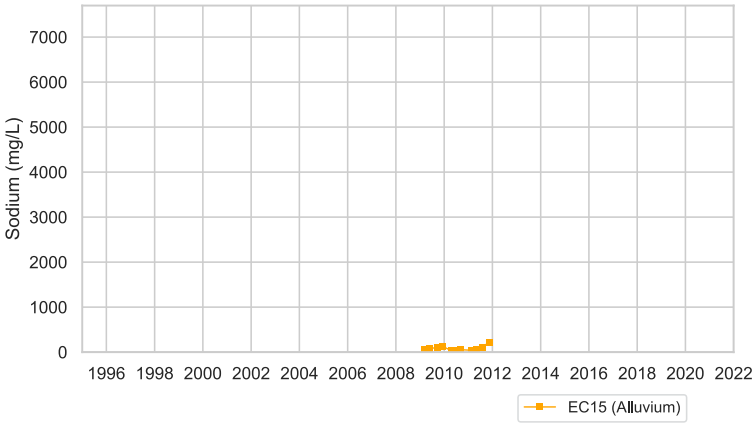

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

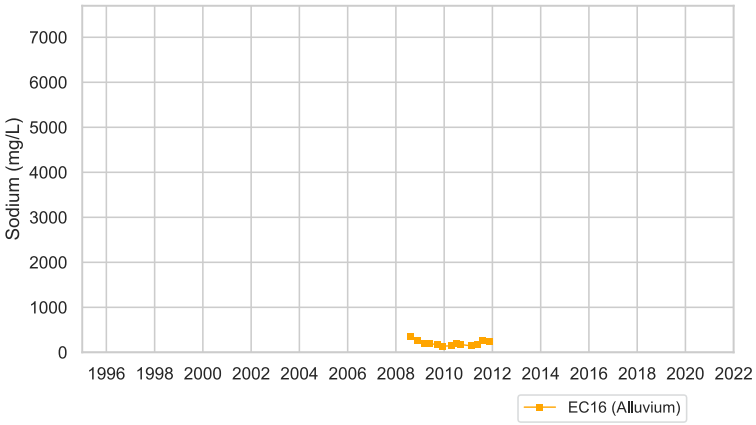

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

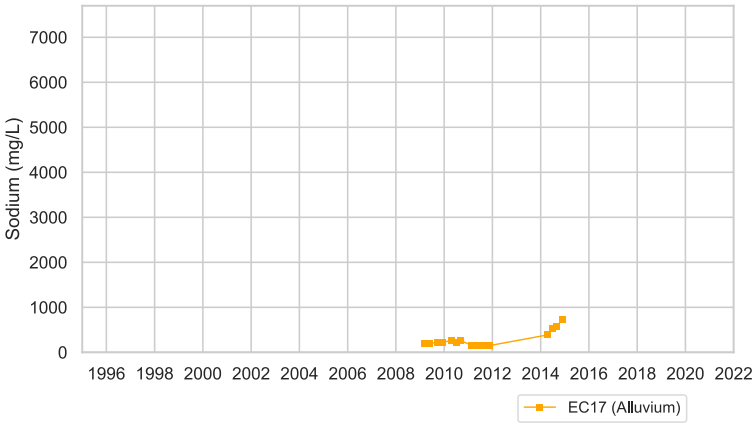

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

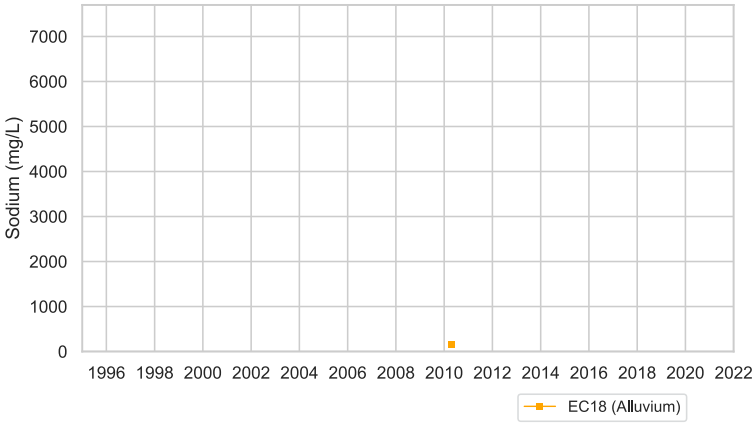

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

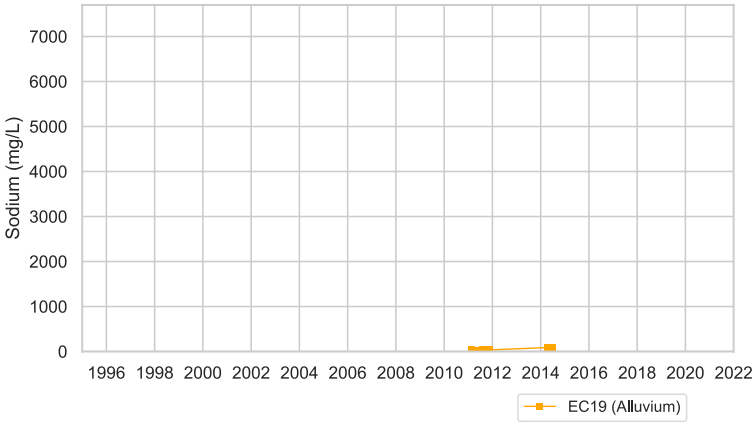

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

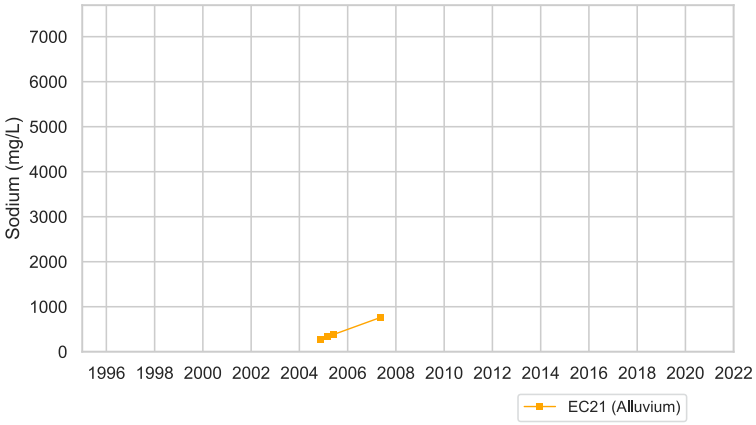

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

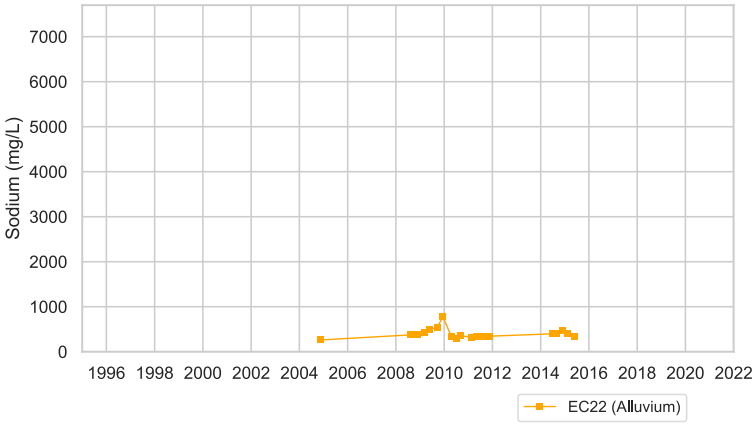

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

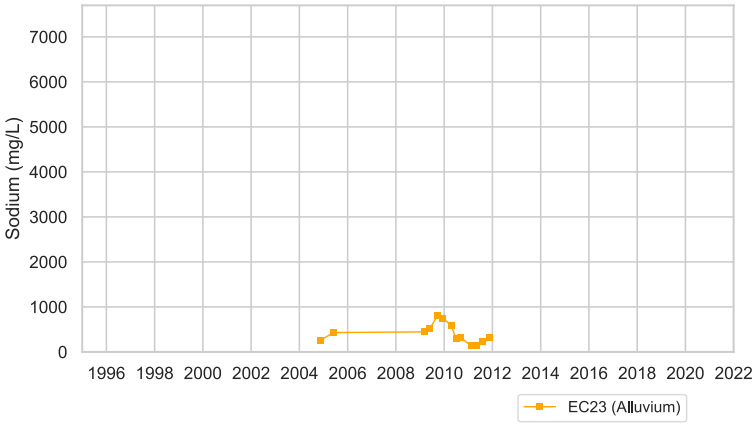

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

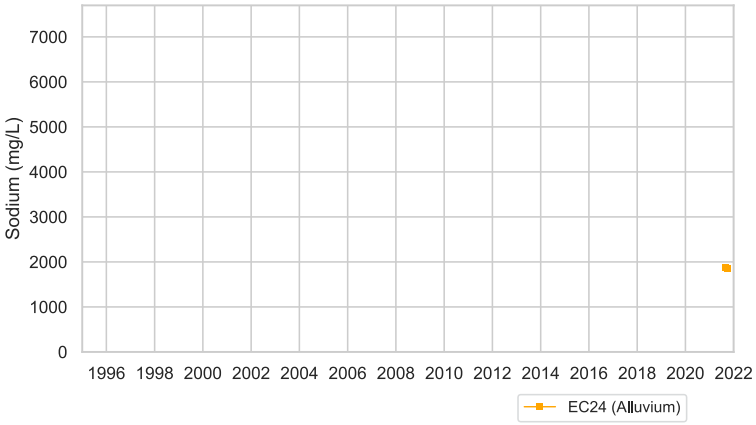

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

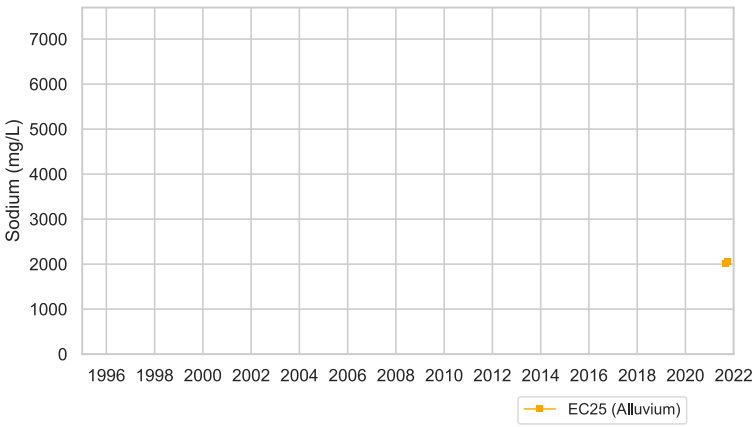

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

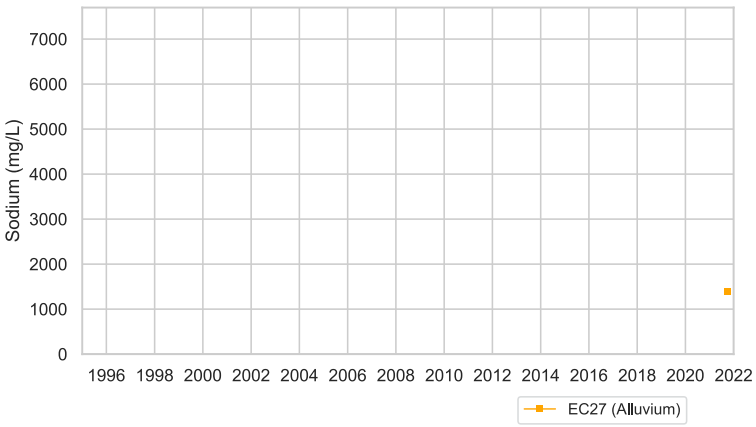

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

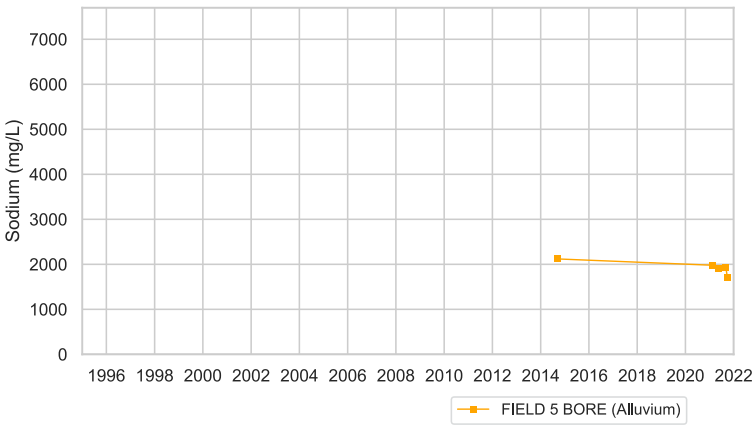

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

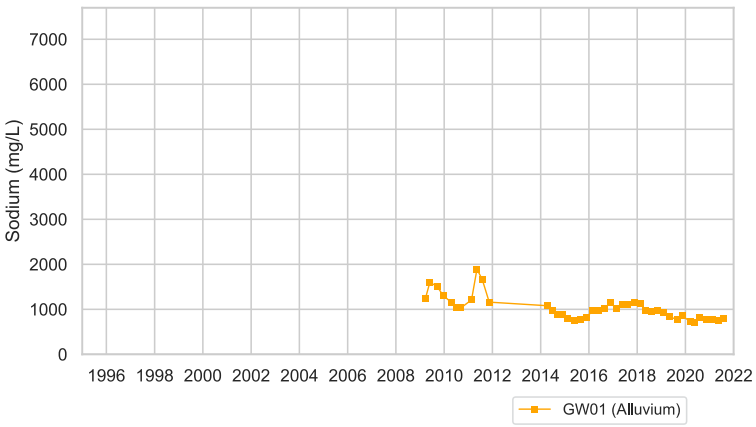

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

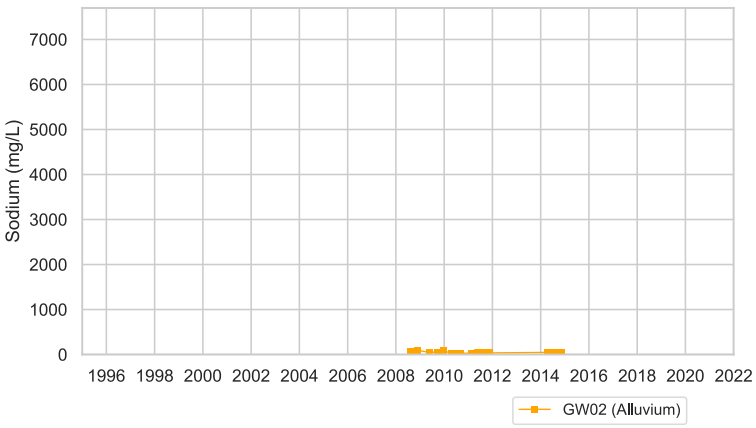

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

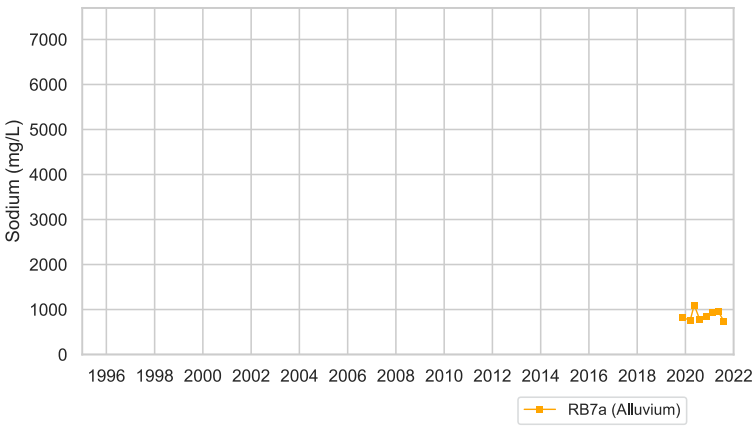

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

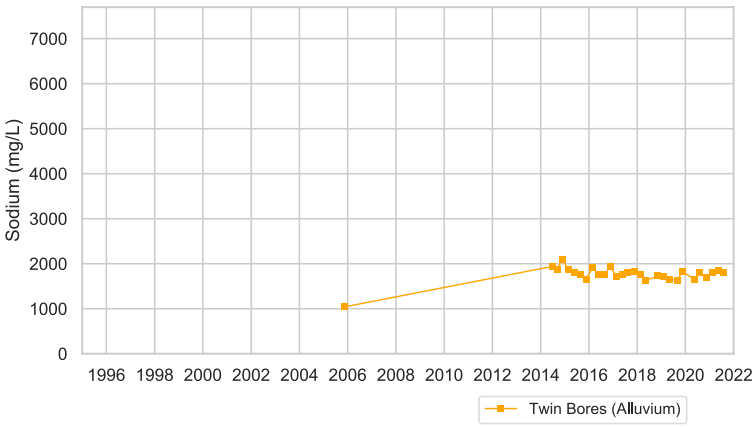

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

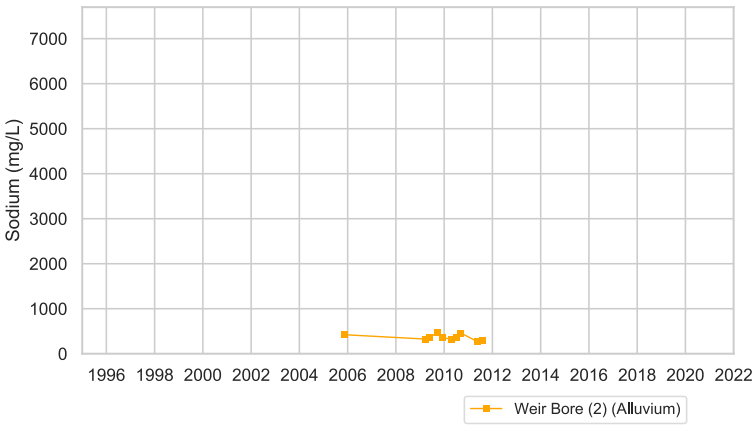

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

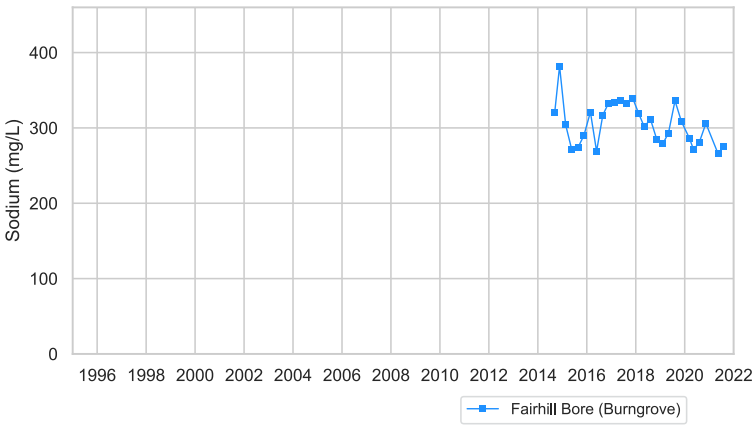

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

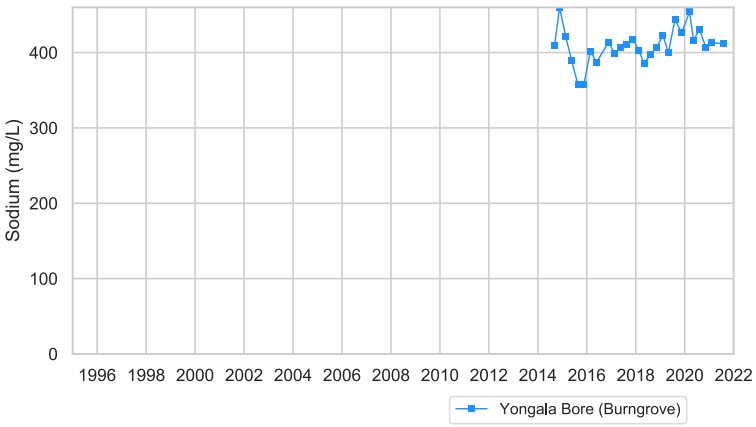

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

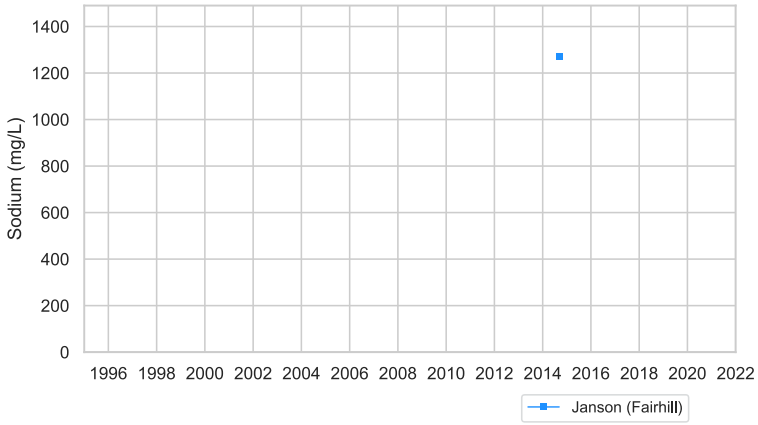

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

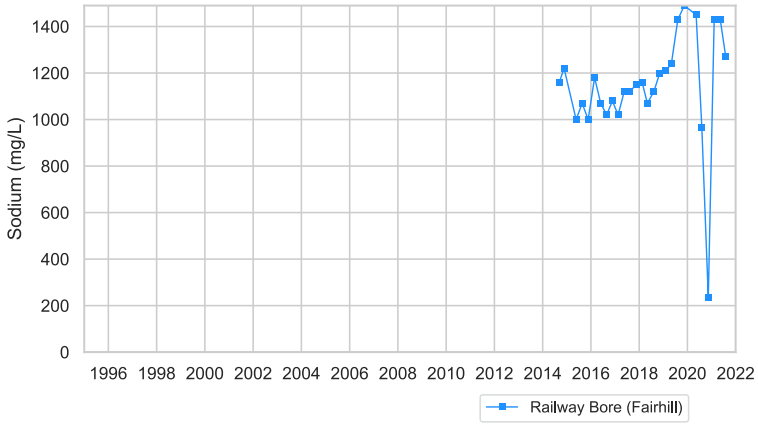

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

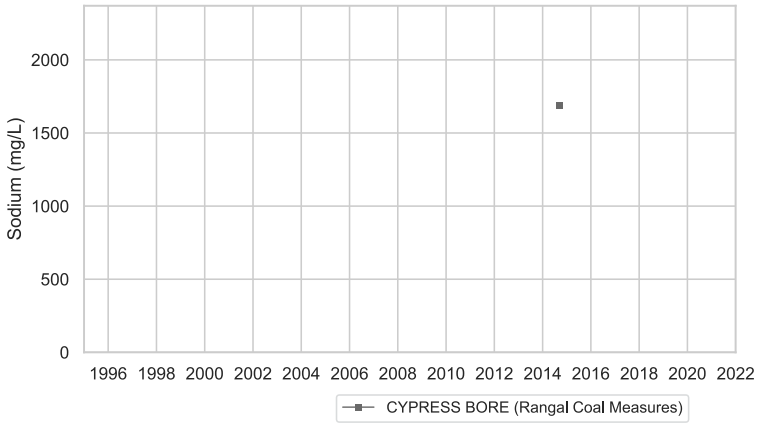

Sodium (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

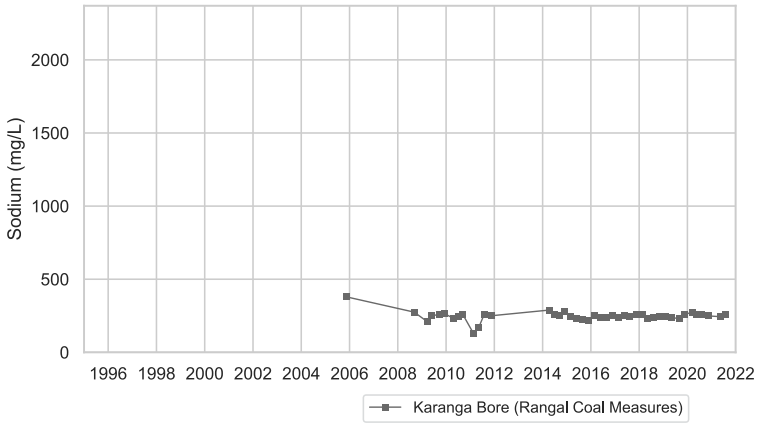

Sodium (mg/L)
0
100
200
300
400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

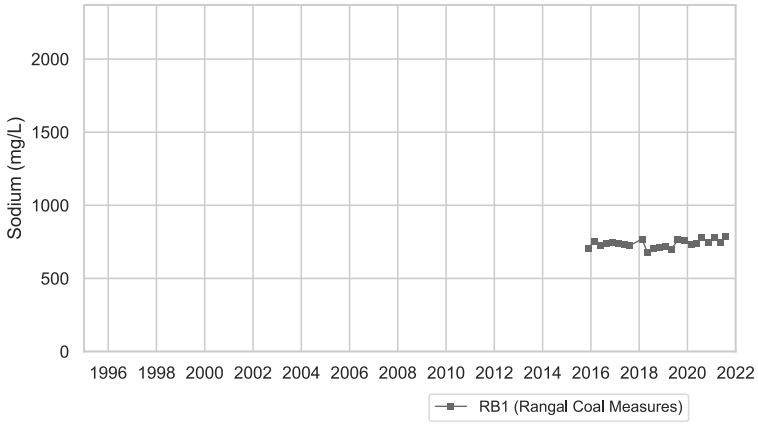

Sodium (mg/L)
0
100
200
300
400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

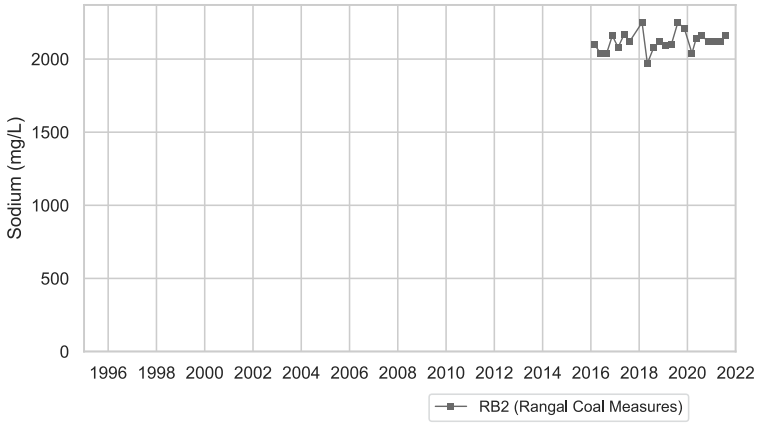

Sodium (mg/L)
0
200
400
600
800
1000
1200
1400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

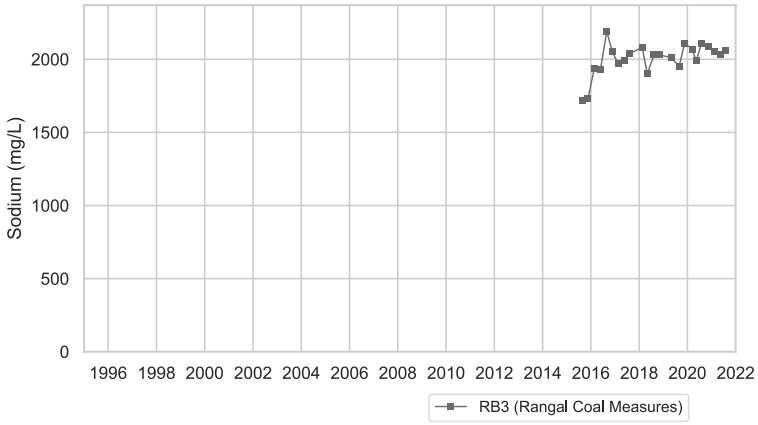

Sodium (mg/L)
0
200
400
600
800
1000
1200
1400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

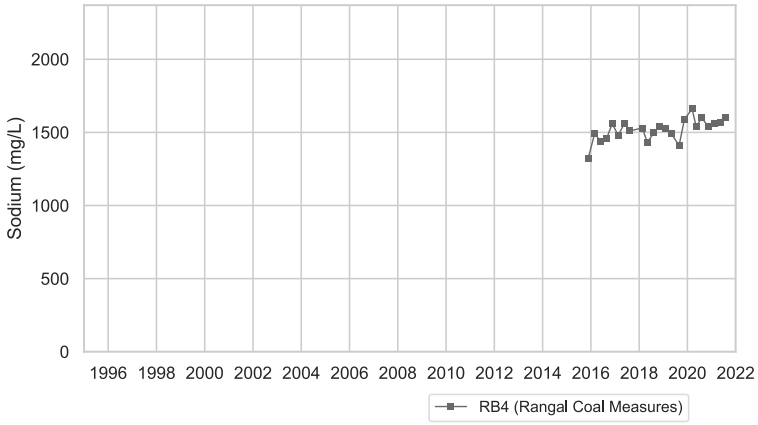

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

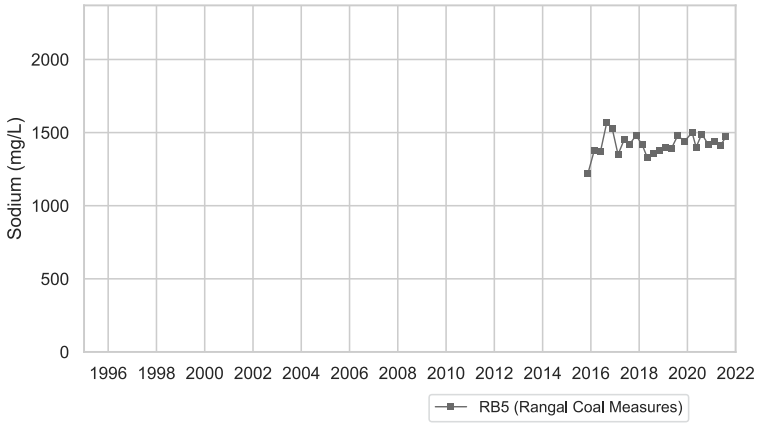

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

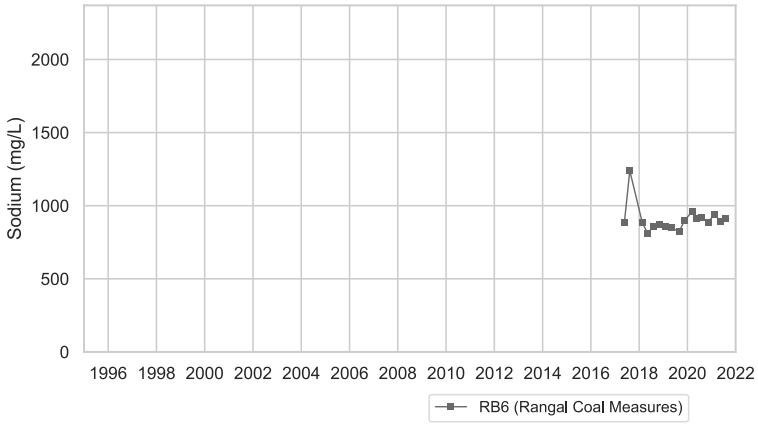

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

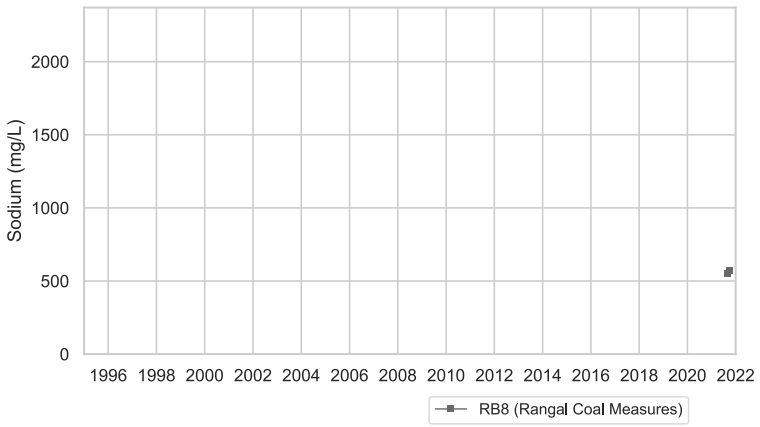

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

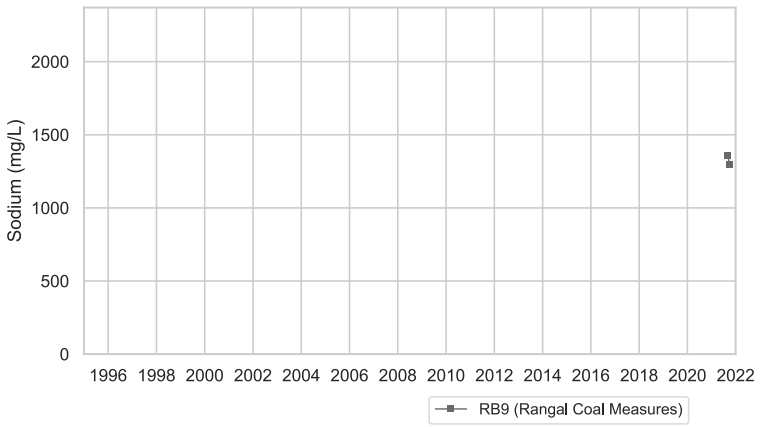

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

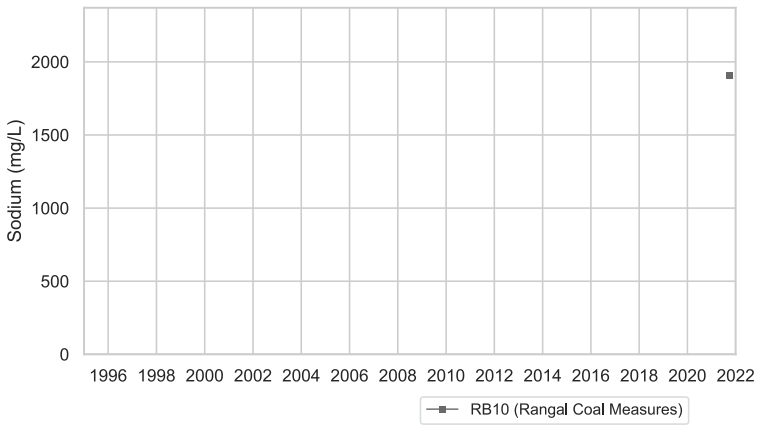

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

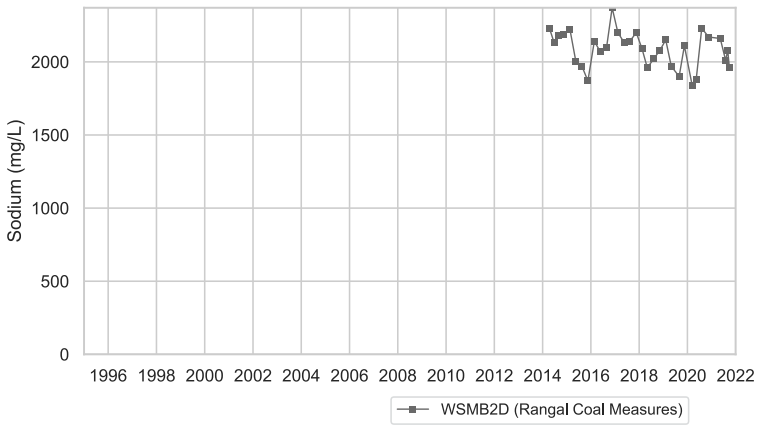

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

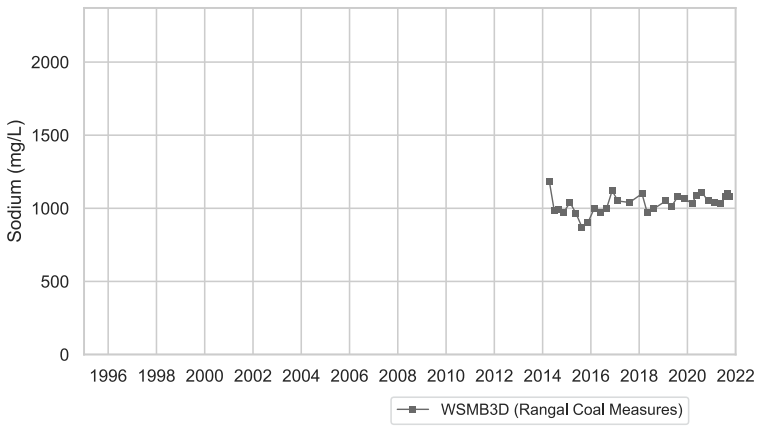

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

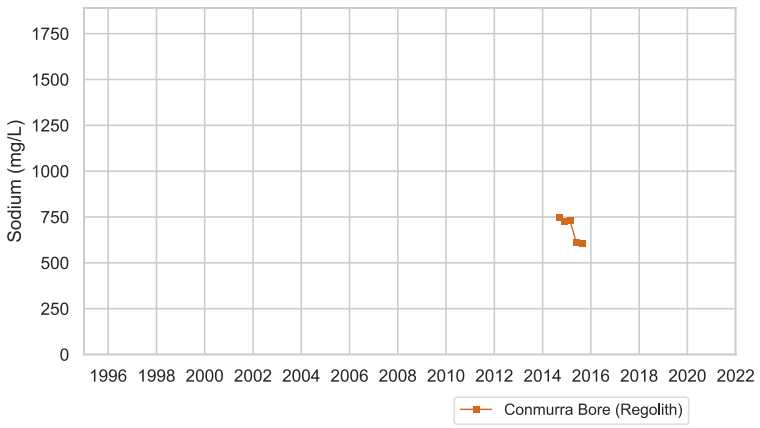

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)


Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

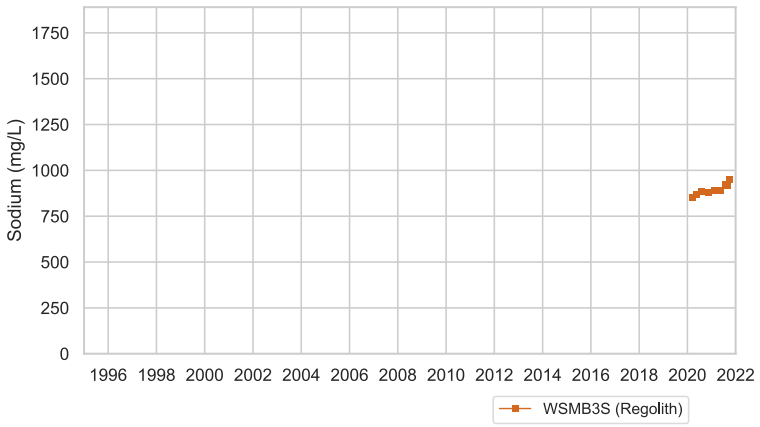

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

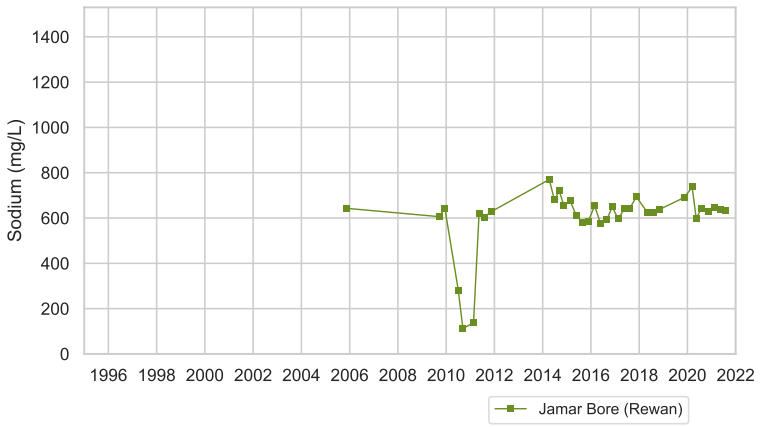

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

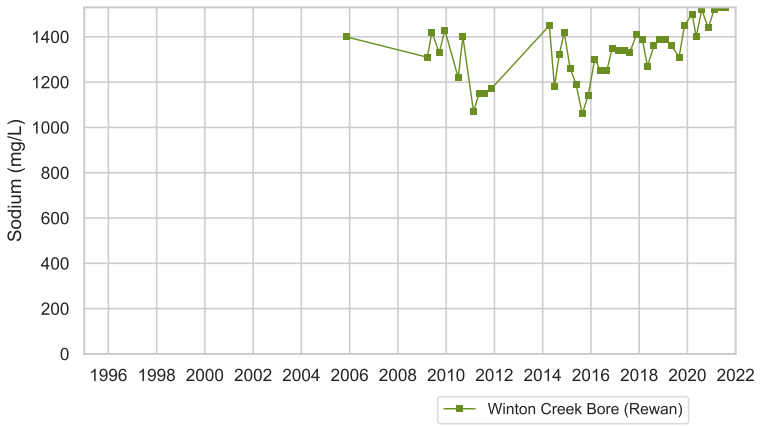

Sodium (mg/L)
0
500
1000
1500
2000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

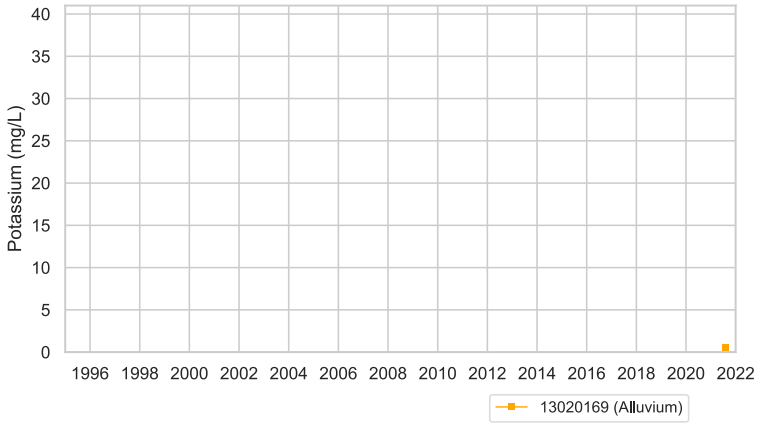

Sodium (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

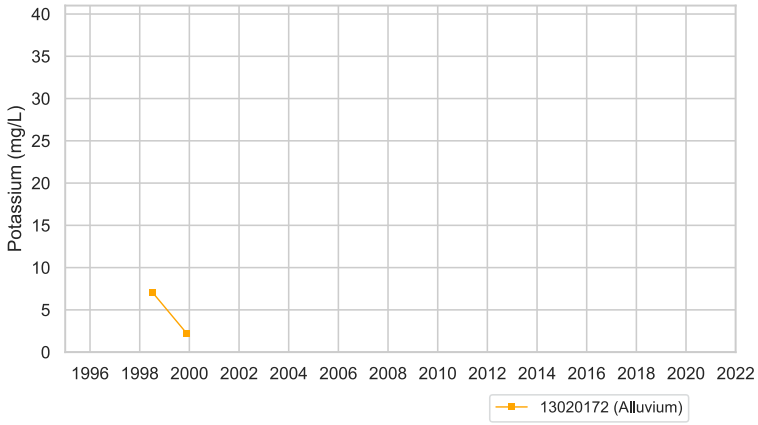
Sodium (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

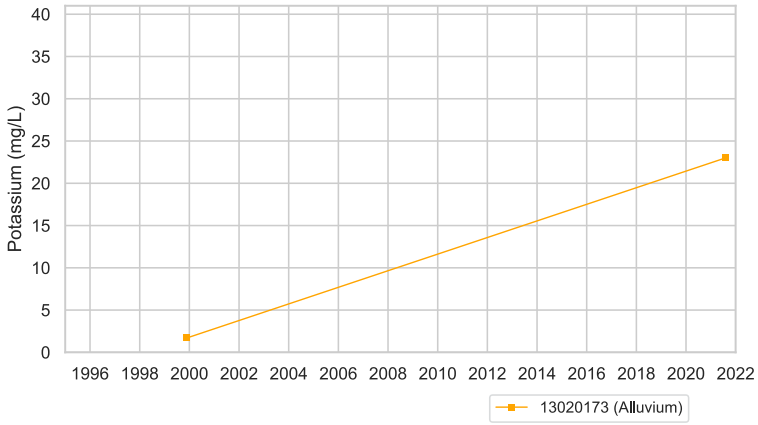

Sodium (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

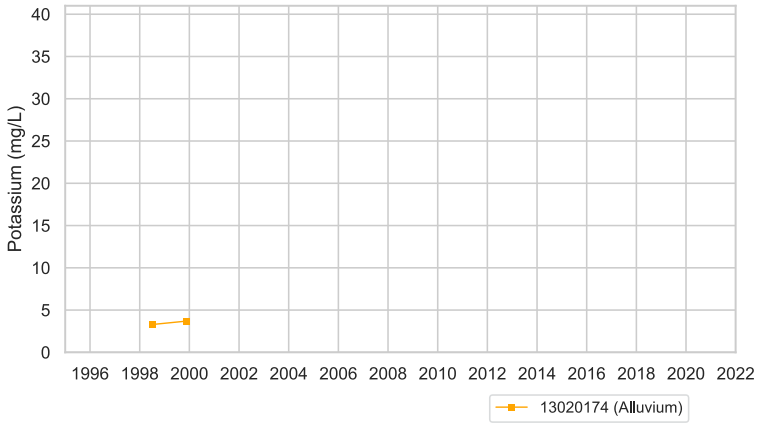

Sodium (mg/L)
0
200
400
600
800
1000
1200
1400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

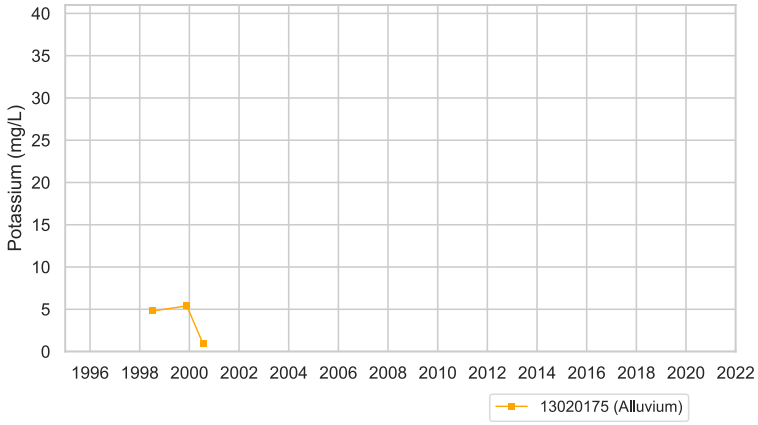

Sodium (mg/L)
0
200
400
600
800
1000
1200
1400
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

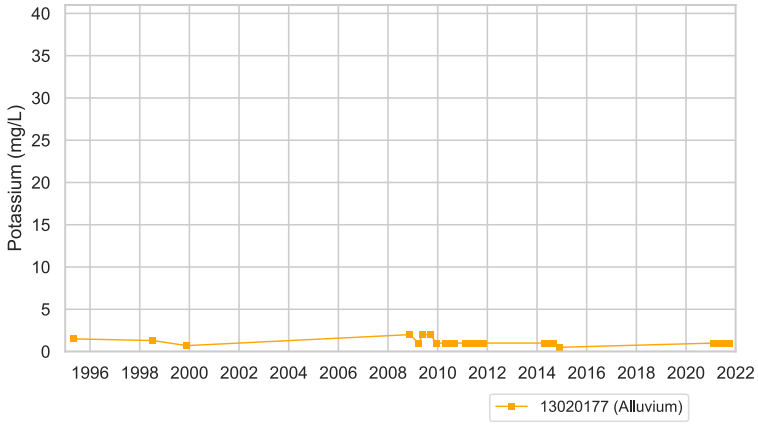

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

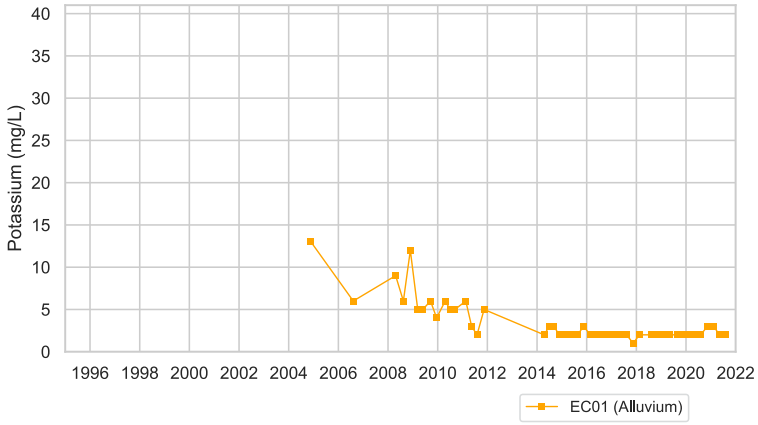

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

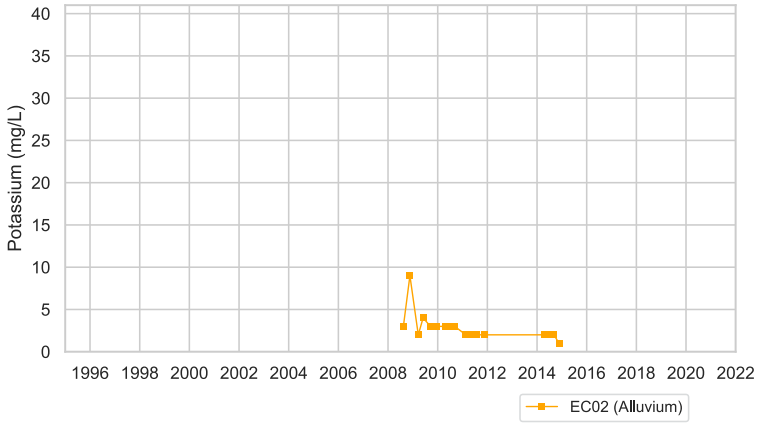

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

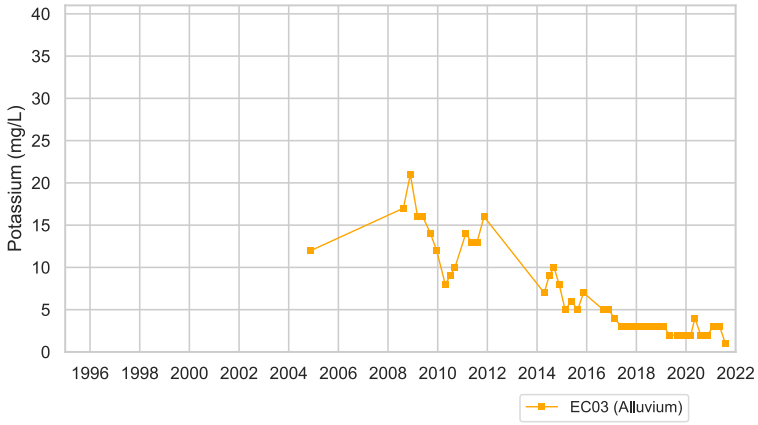

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

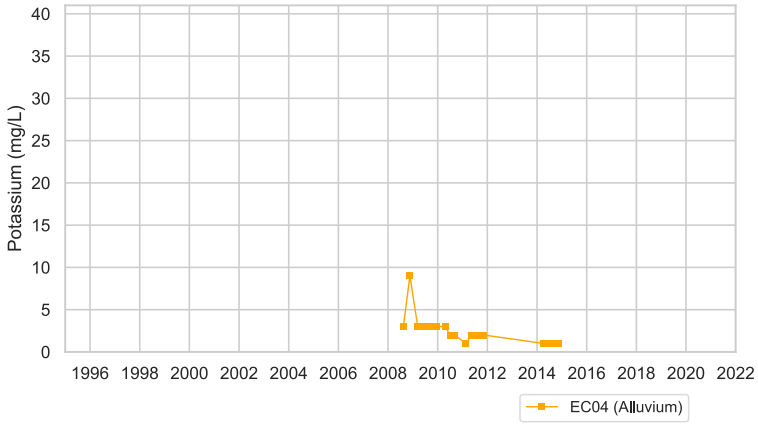

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

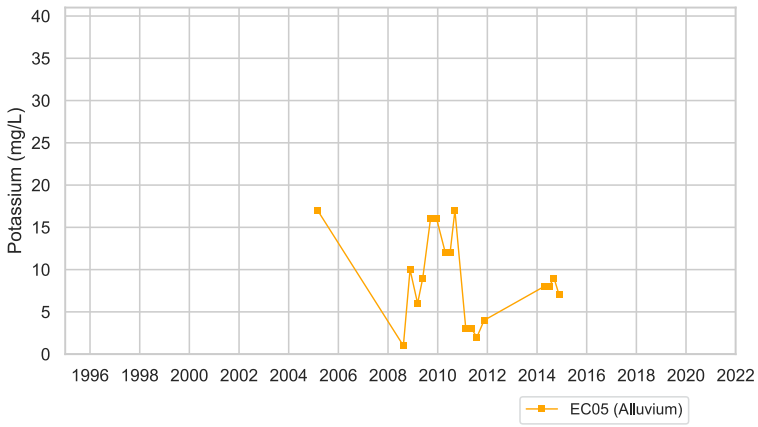

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

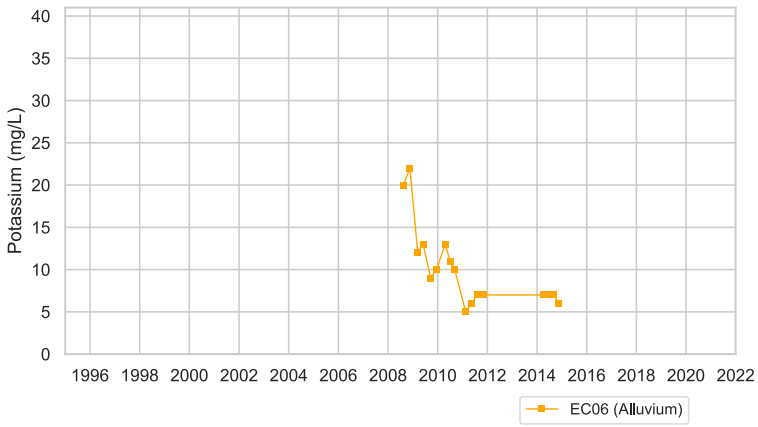

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

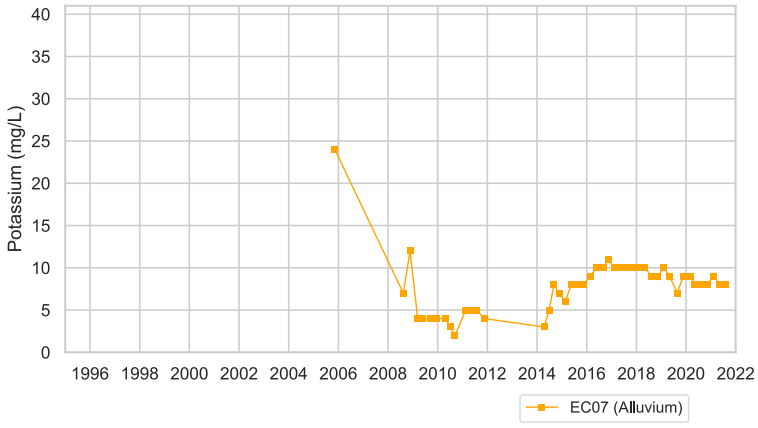

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

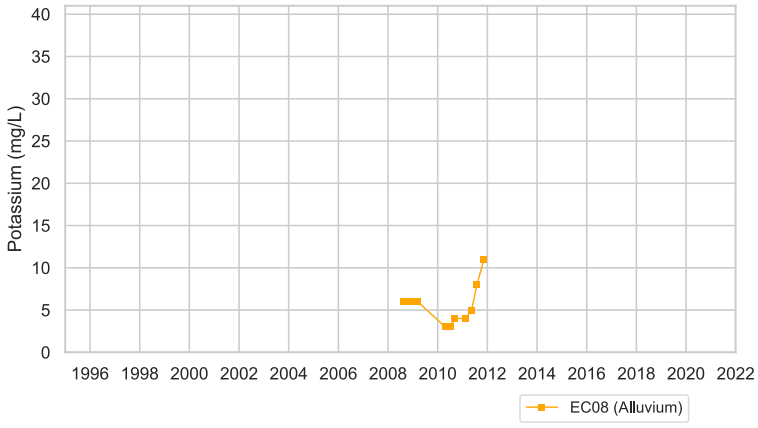

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

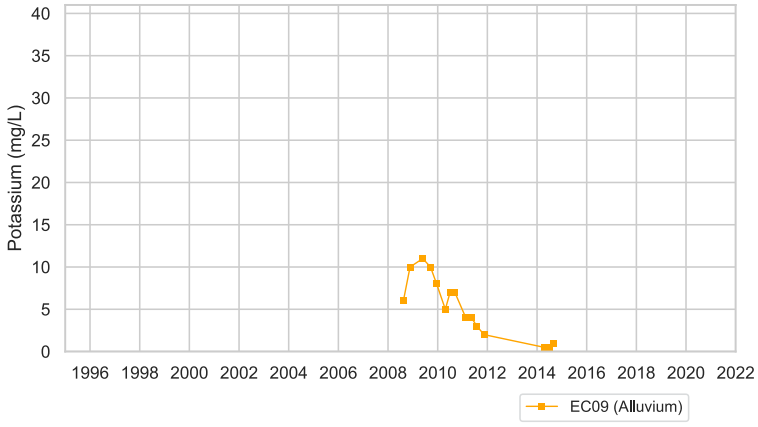

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

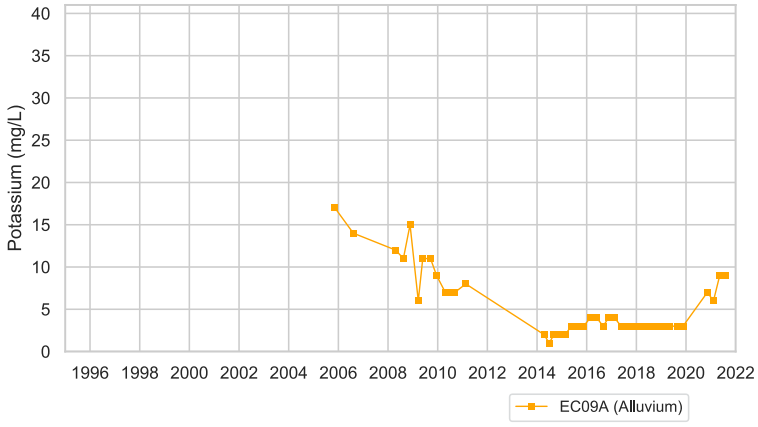

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

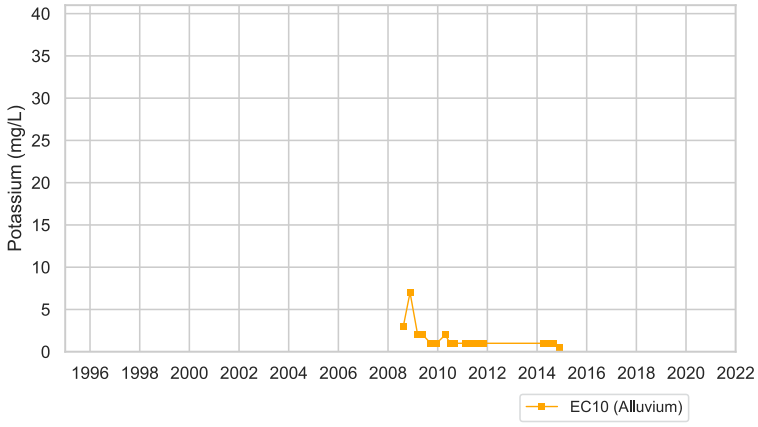

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

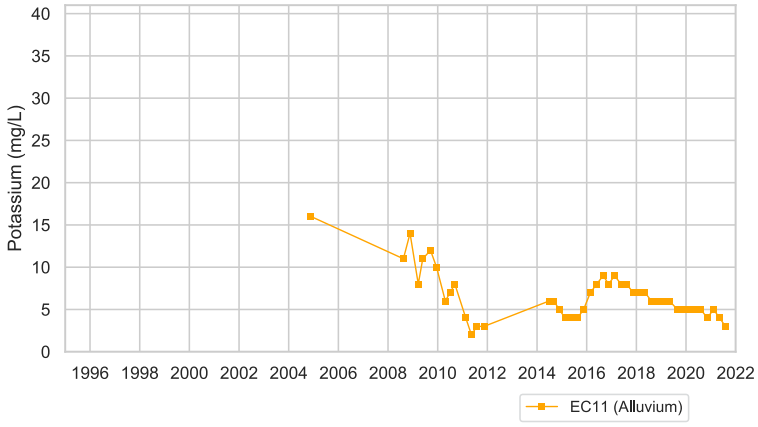

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

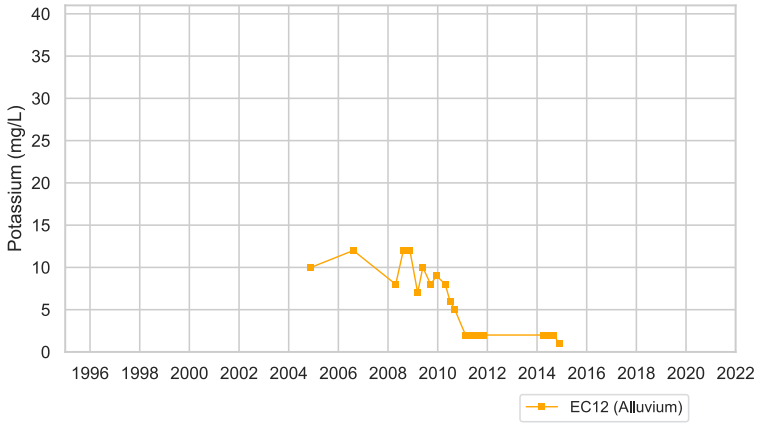

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

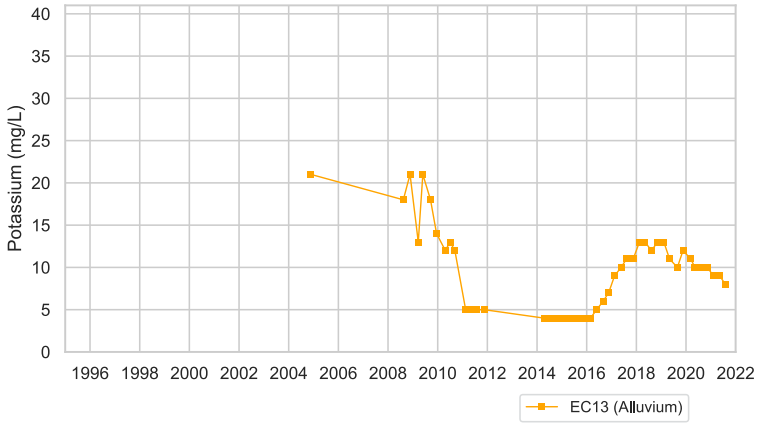

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

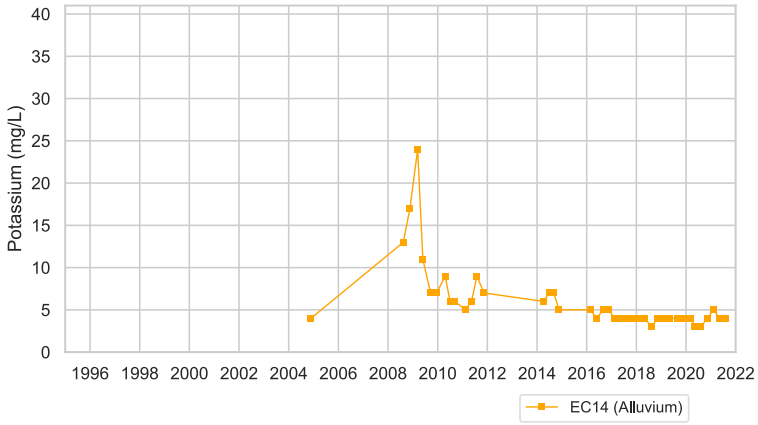

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

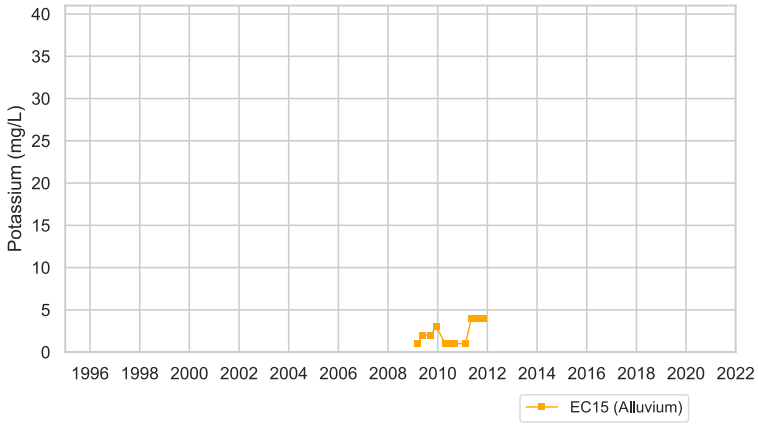

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

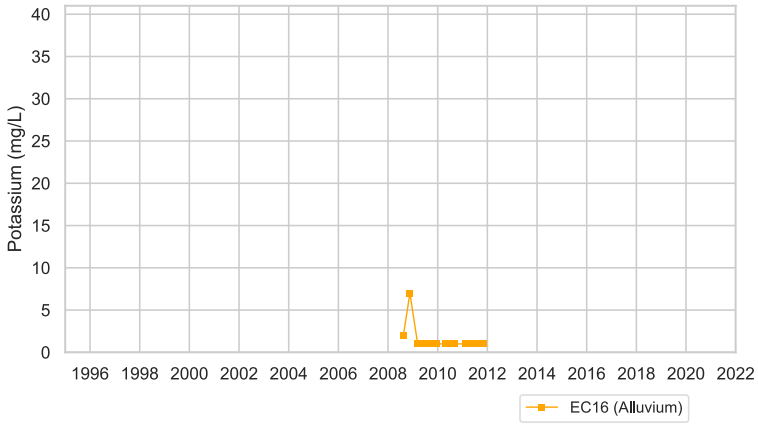

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

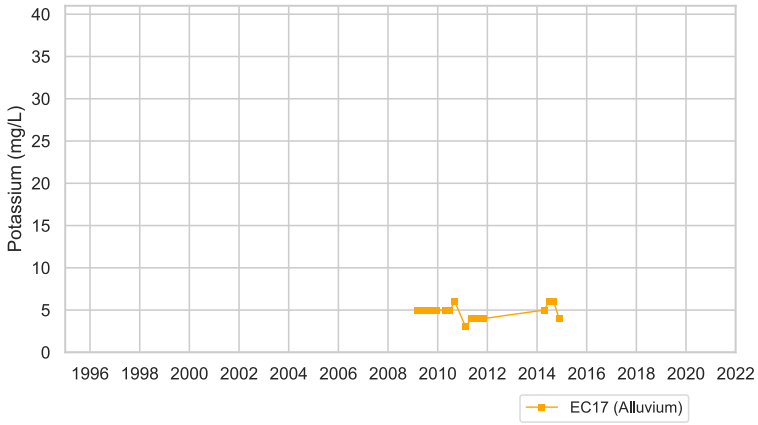

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

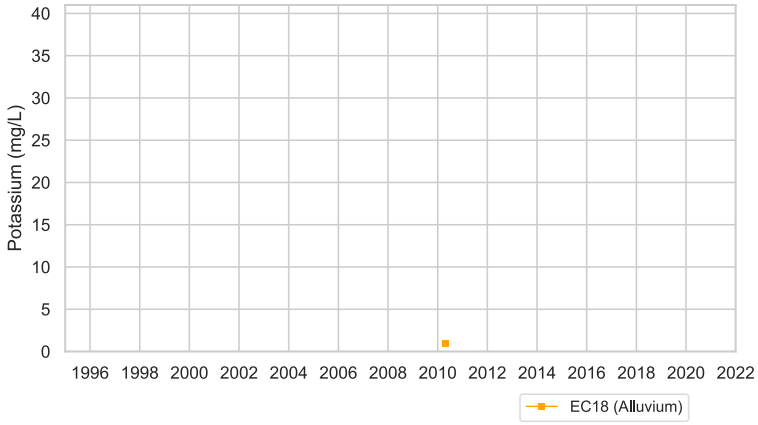

Potassium (mg/L)
0
5
10
15
20
25
30
35
40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

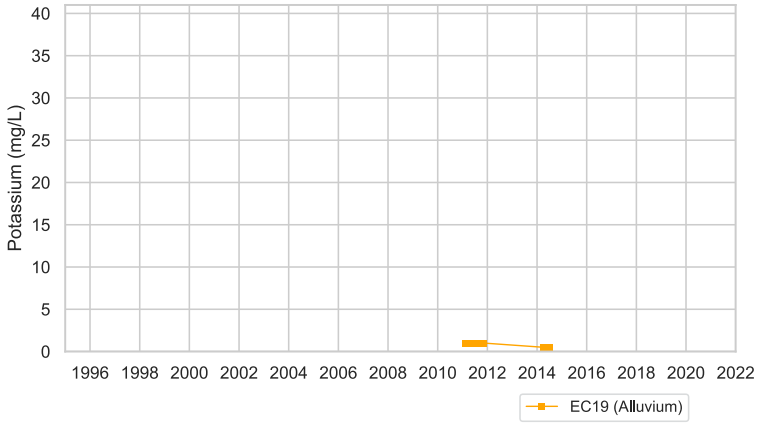

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

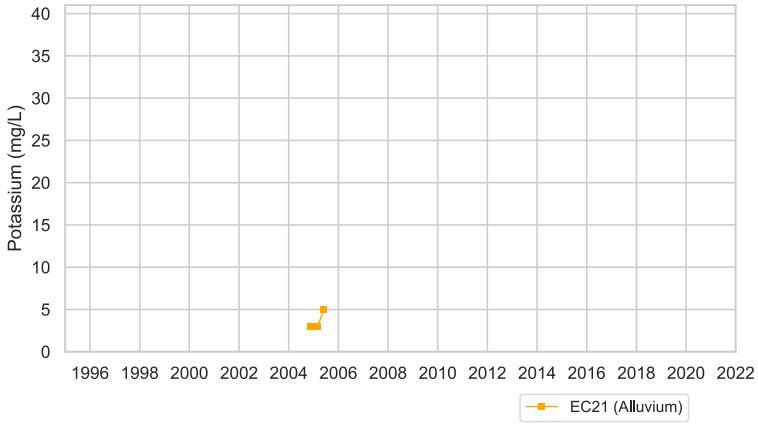

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

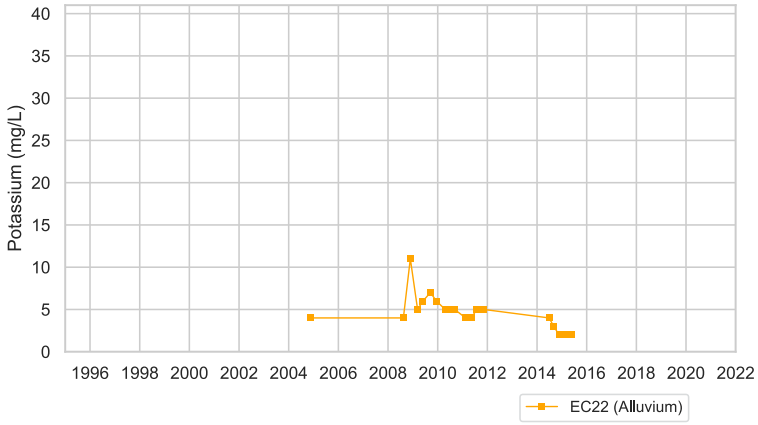

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

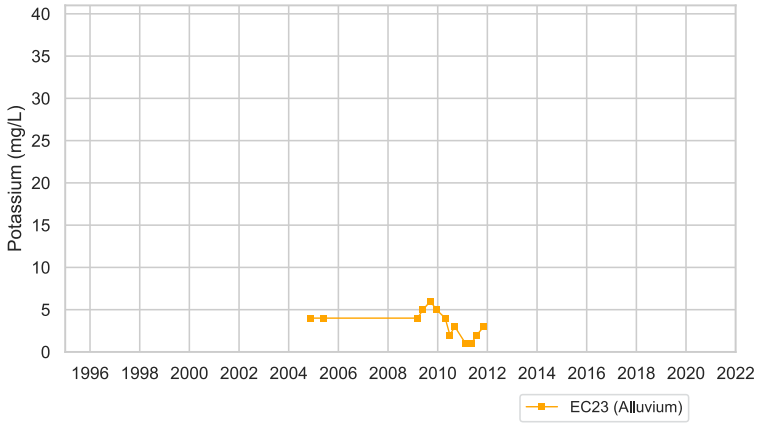

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

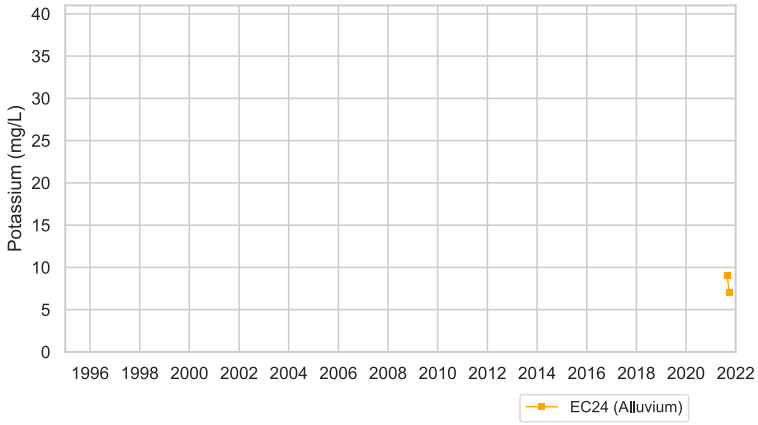

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

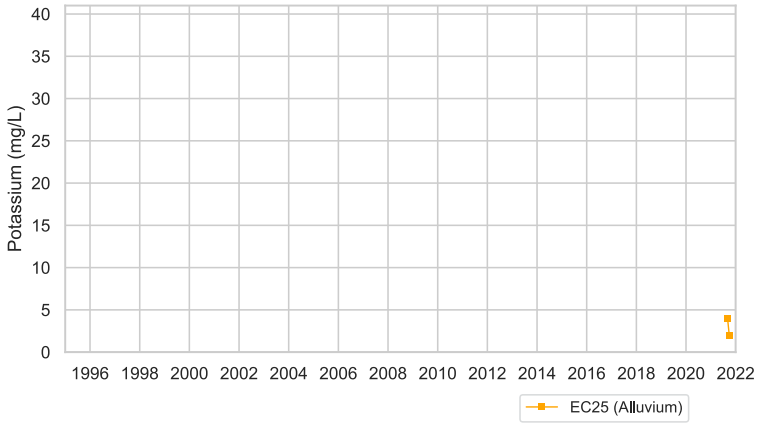

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

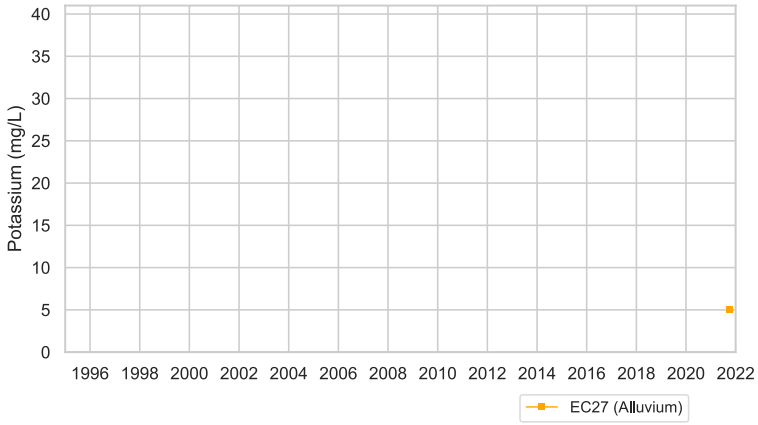

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

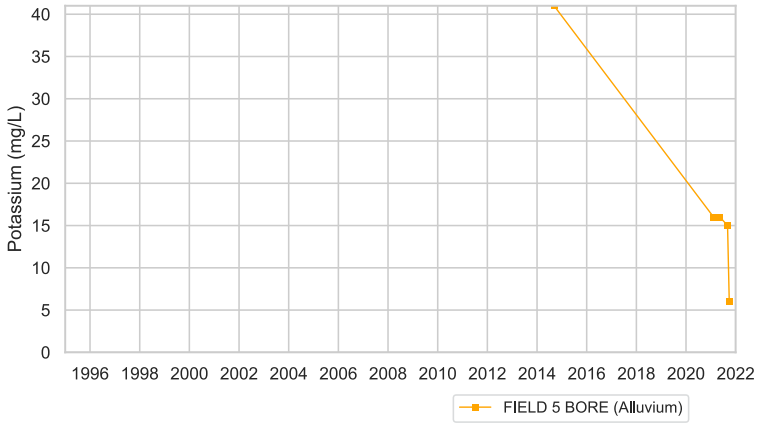

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

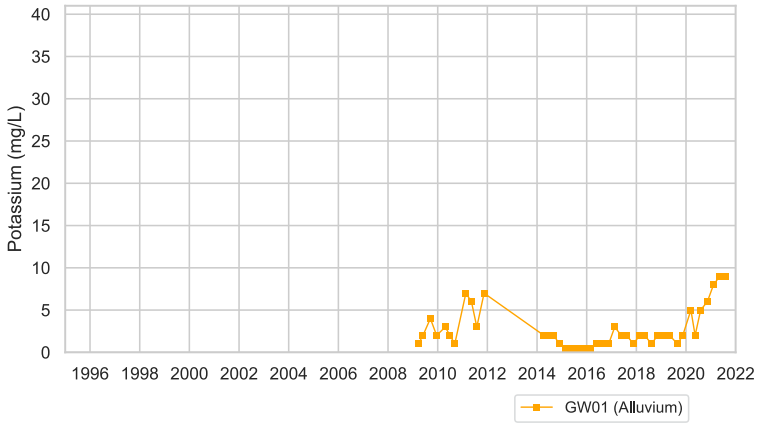

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

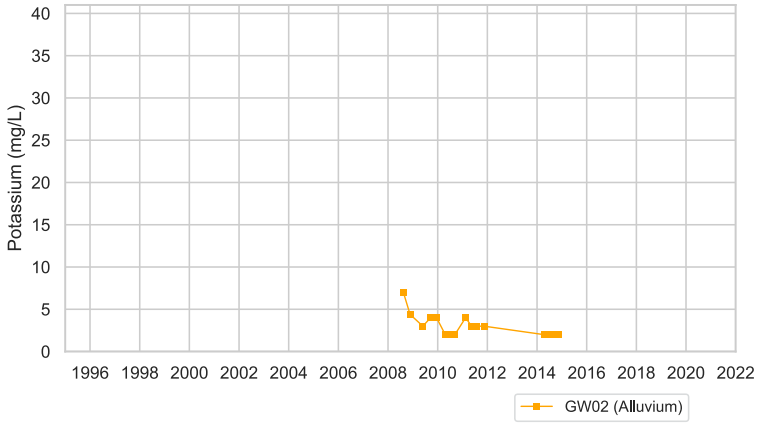

Potassium (mg/L)
0 5 10 15 20 25 30 35 40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

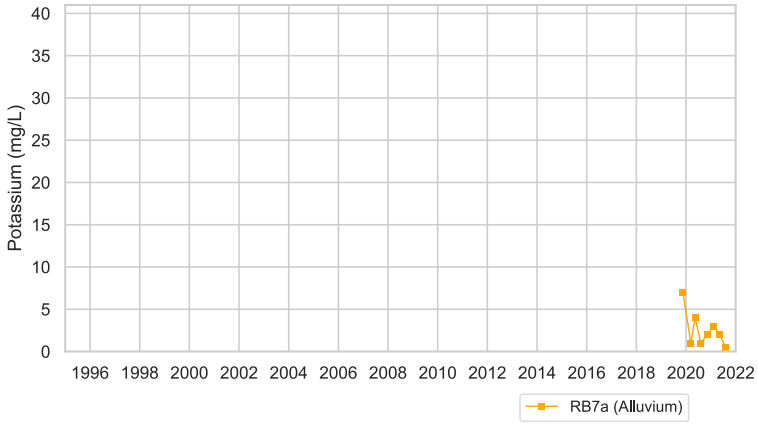

Potassium (mg/L)
EC25 (Alluvium)

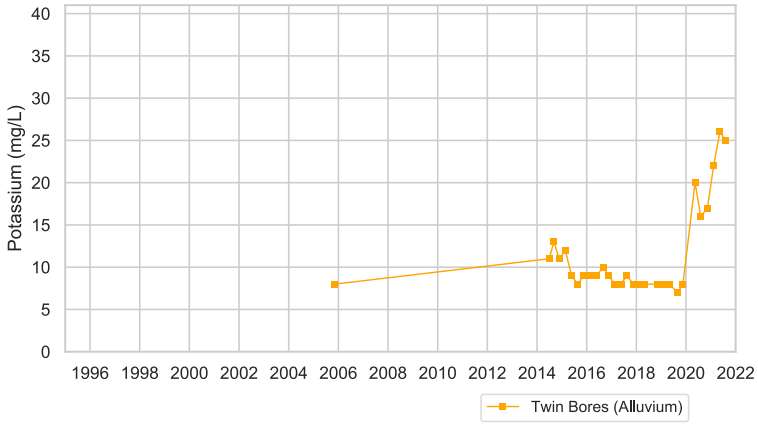

Potassium (mg/L)
EC27 (Alluvium)

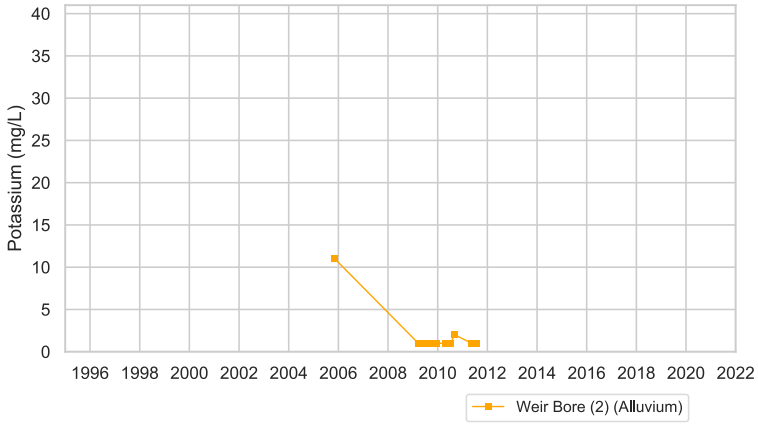

Potassium (mg/L)
FIELD 5 BORE (Alluvium)

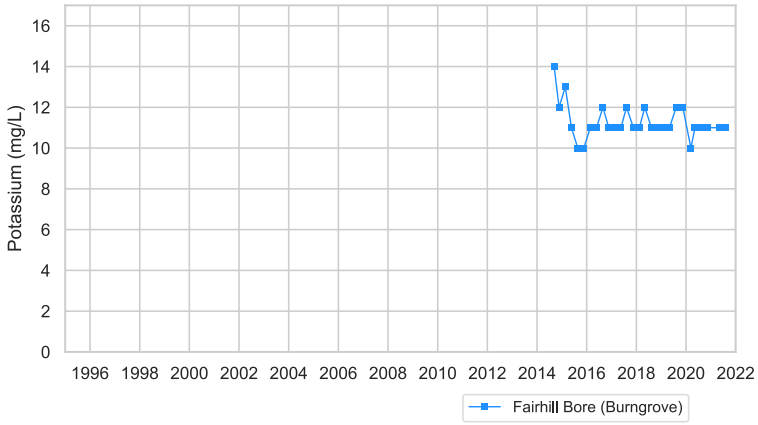

Potassium (mg/L)
GW01 (Alluvium)

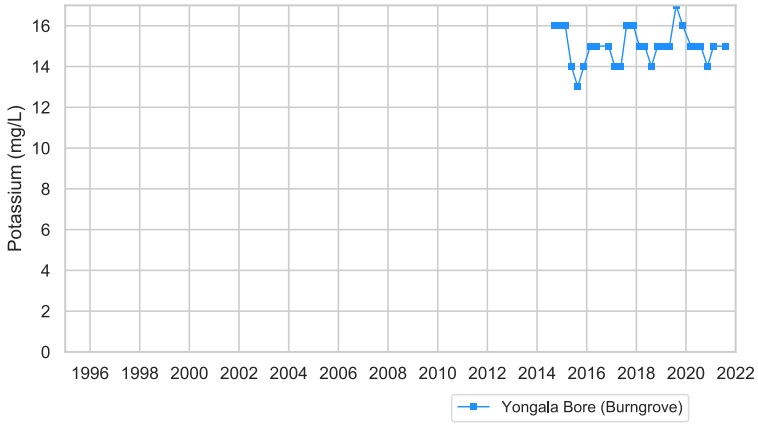

Potassium (mg/L)
GW02 (Alluvium)

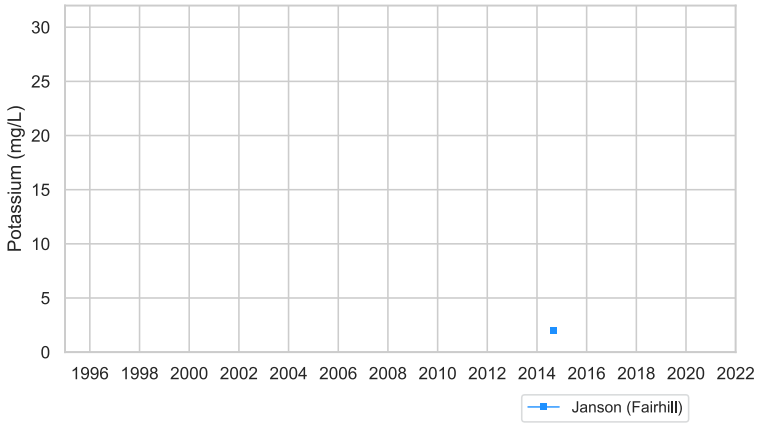

Potassium (mg/L)
RB7a (Alluvium)

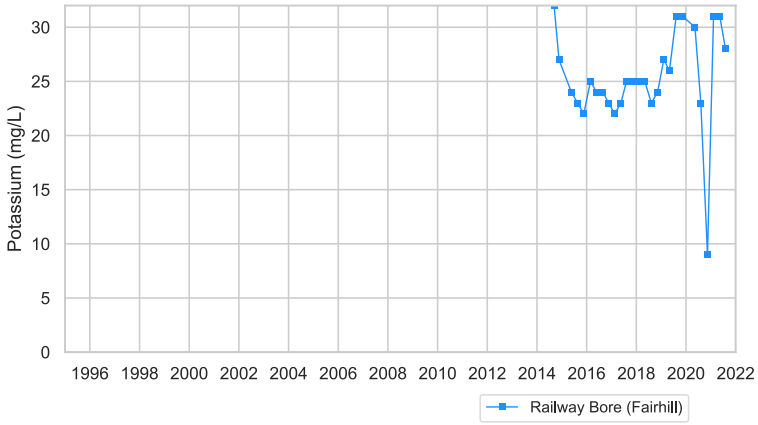

Potassium (mg/L)
Twin Bores (Alluvium)

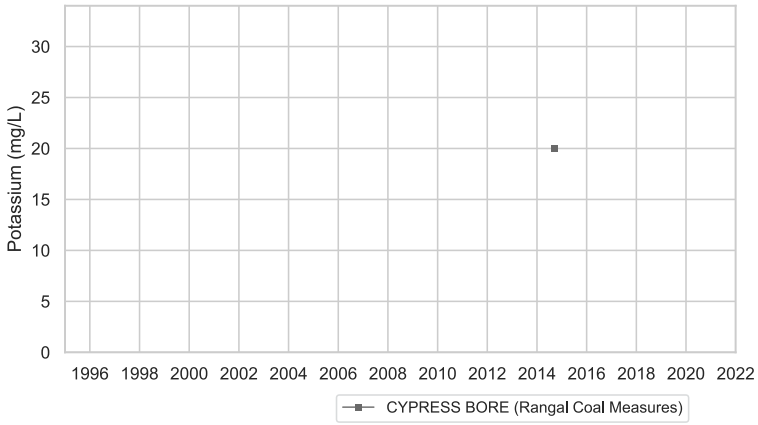

Potassium (mg/L)
Weir Bore (2) (Alluvium)

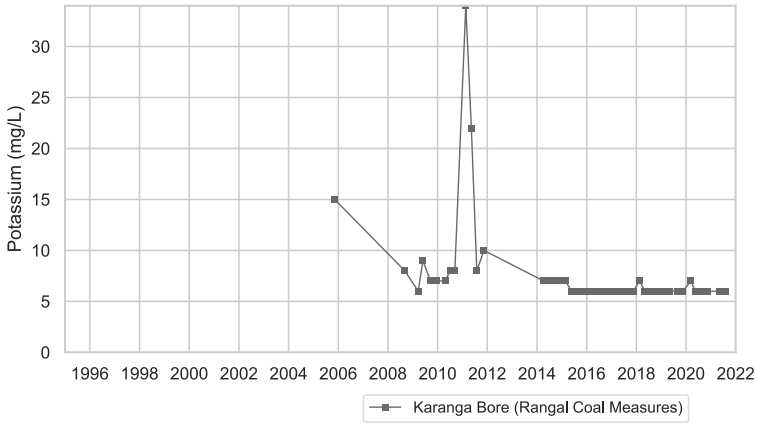

Potassium (mg/L)
Fairhill Bore (Burngrove)

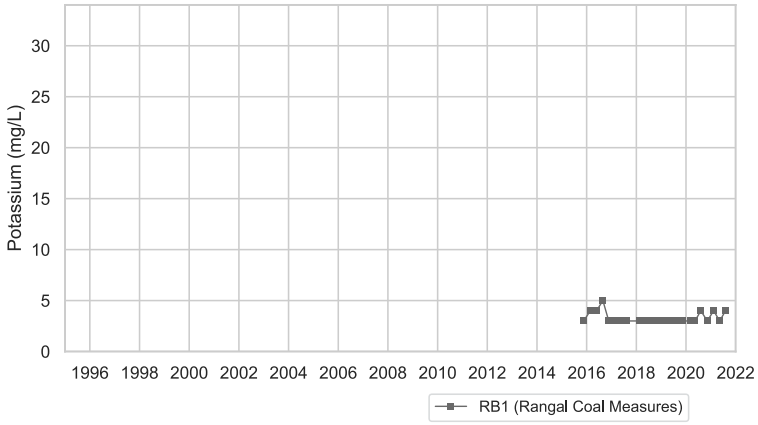

Potassium (mg/L)
Yongala Bore (Burngrove)

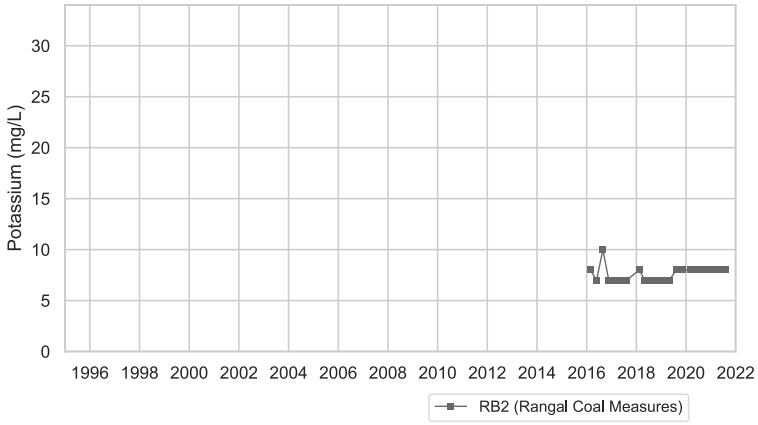

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

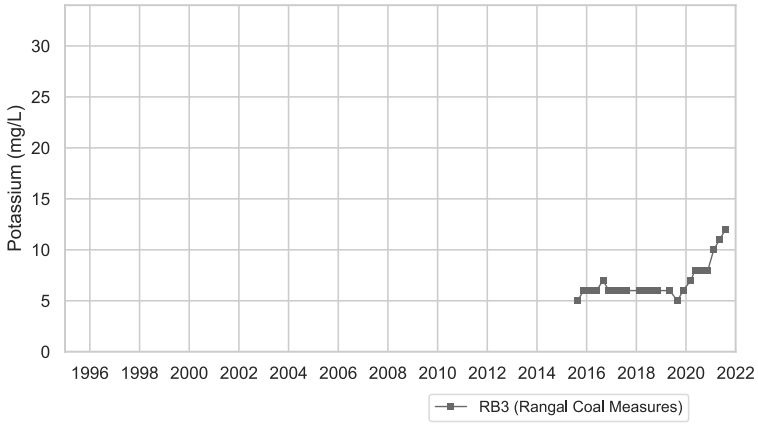

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

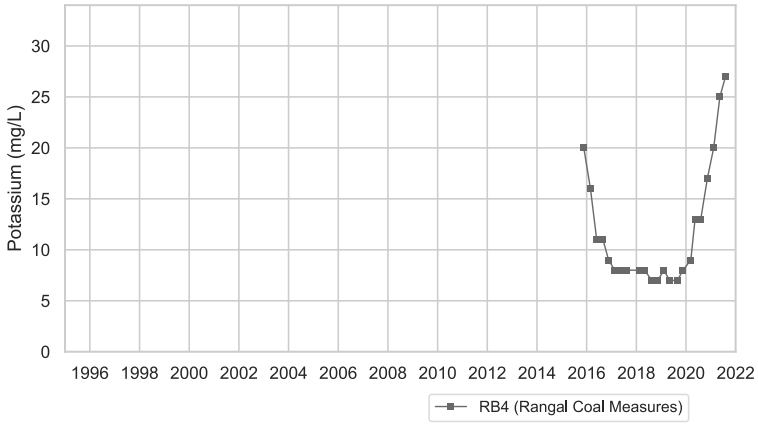

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

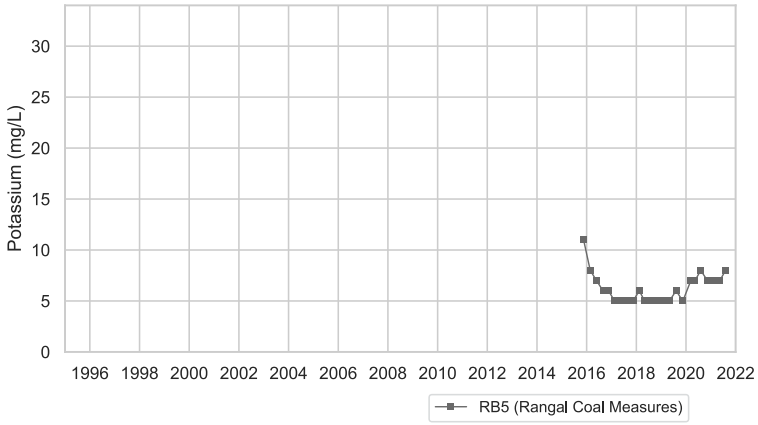

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

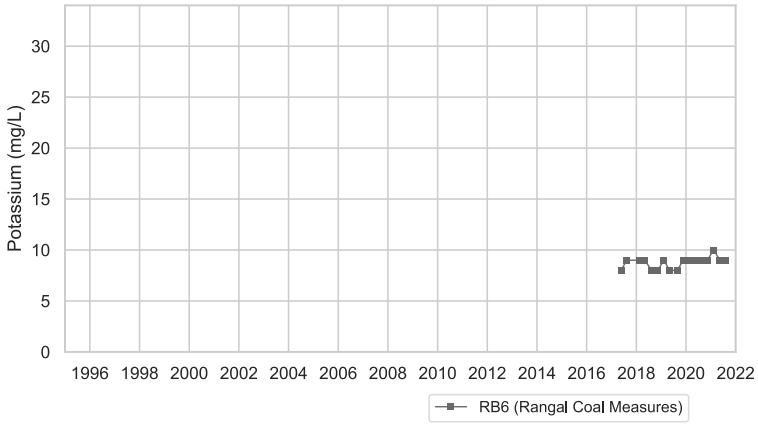

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

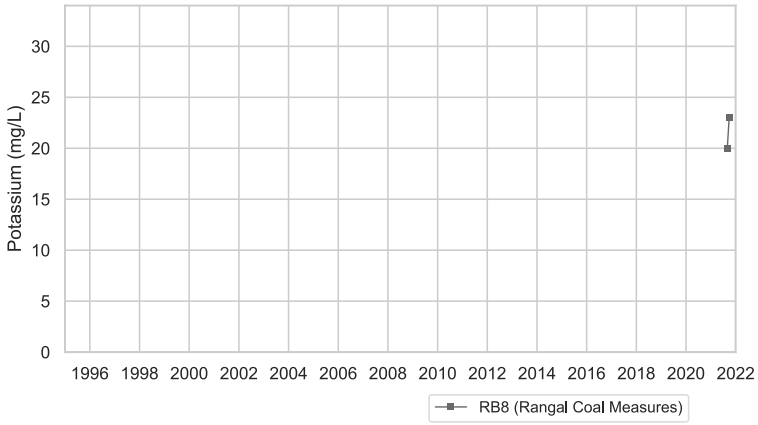

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

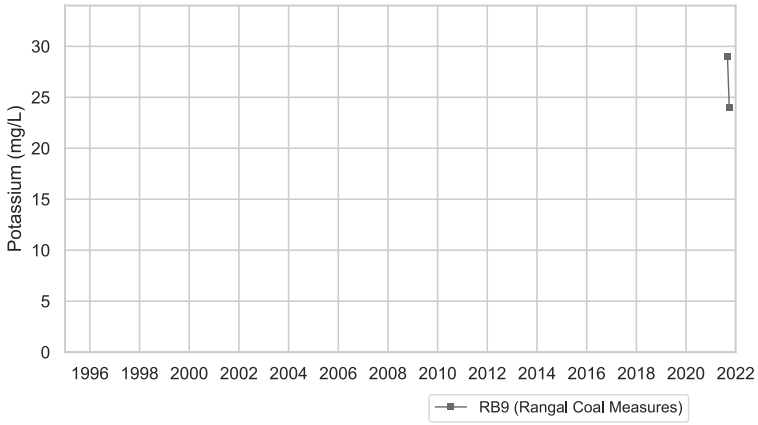

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

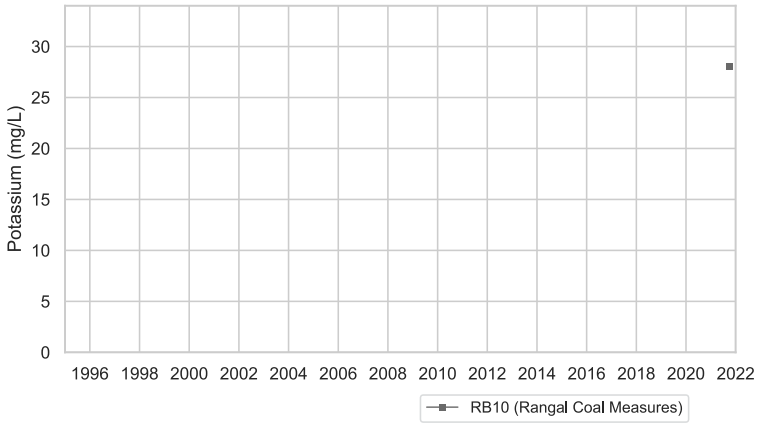

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

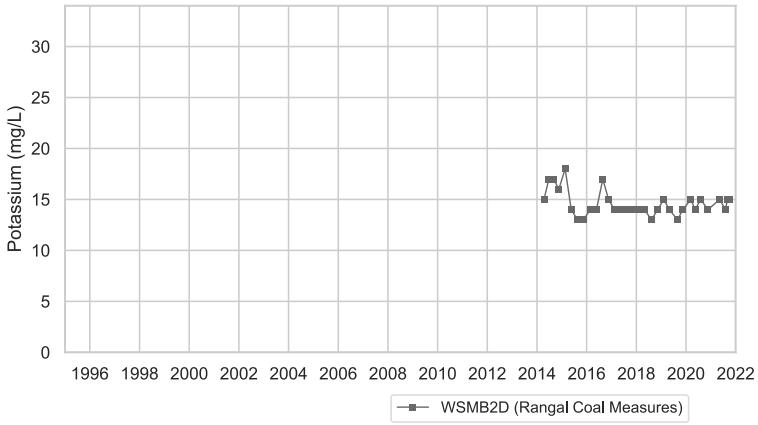

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

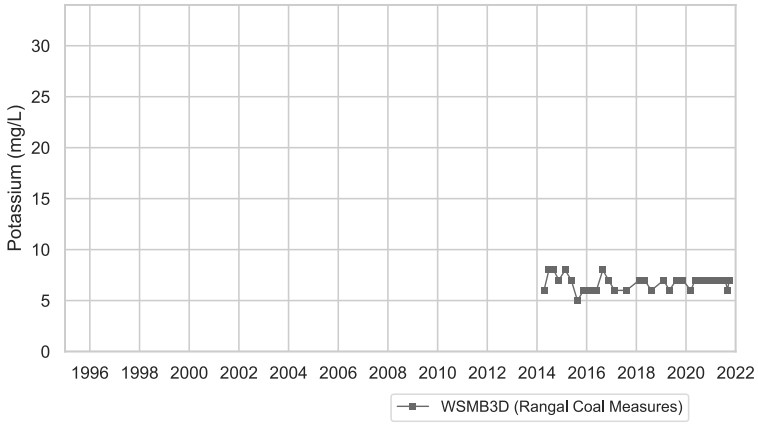

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

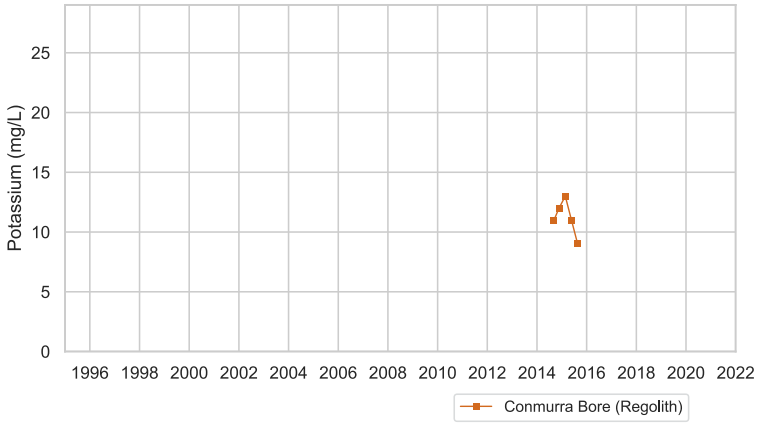

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

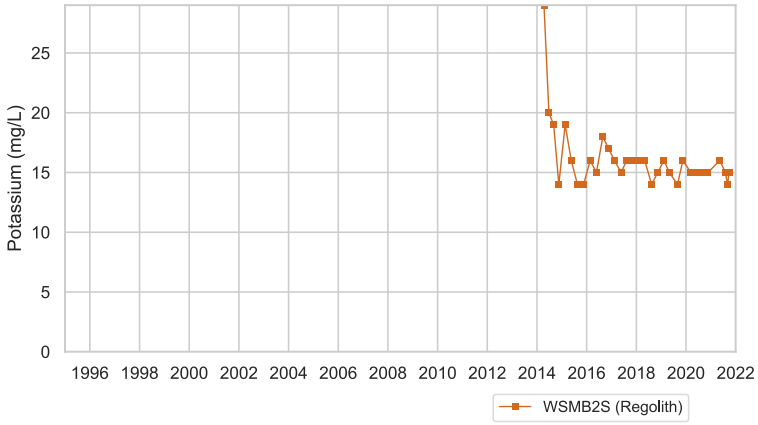

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

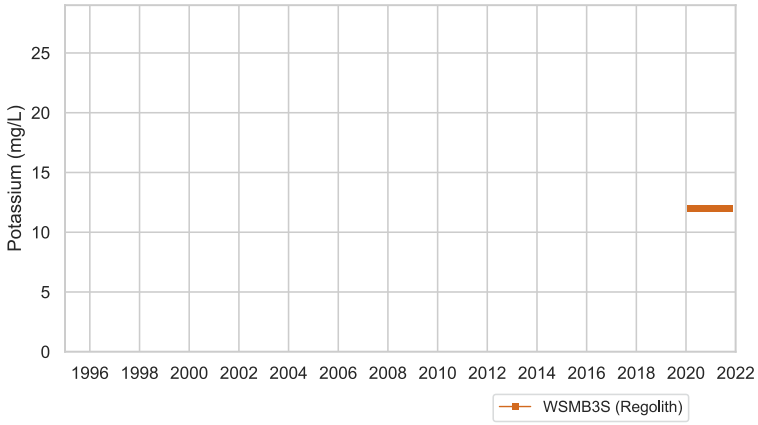

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

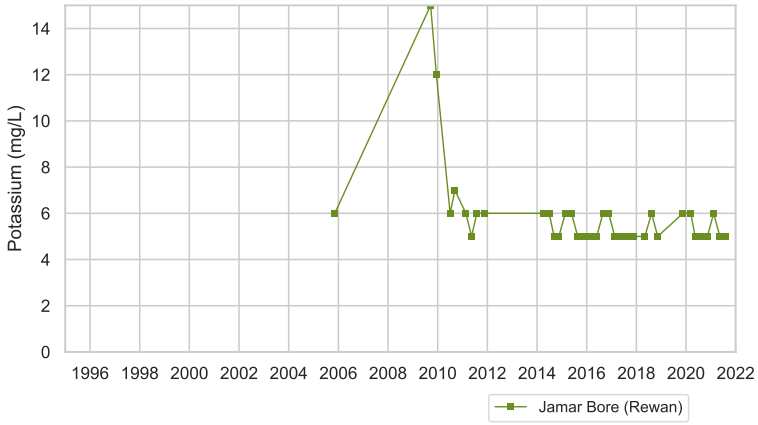

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

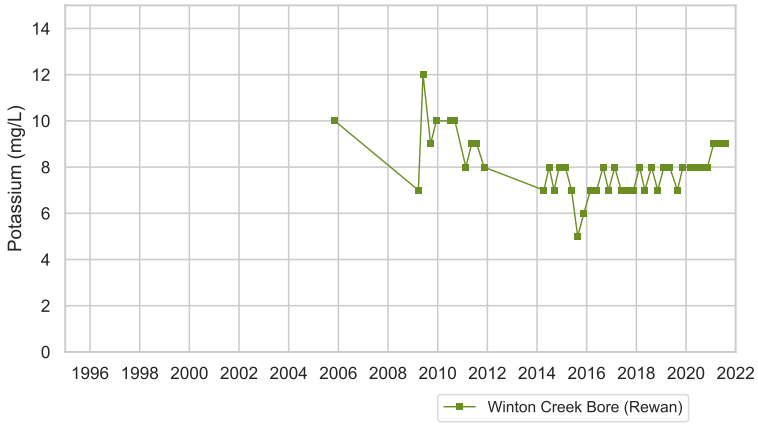

Potassium (mg/L)
0
5
10
15
20
25
30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

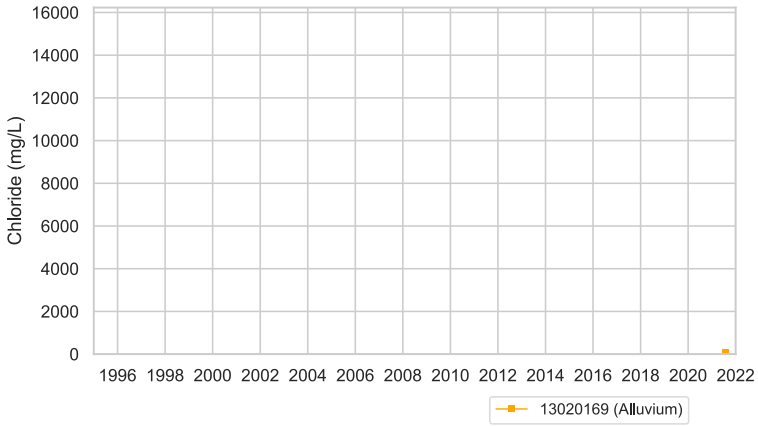

Potassium (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

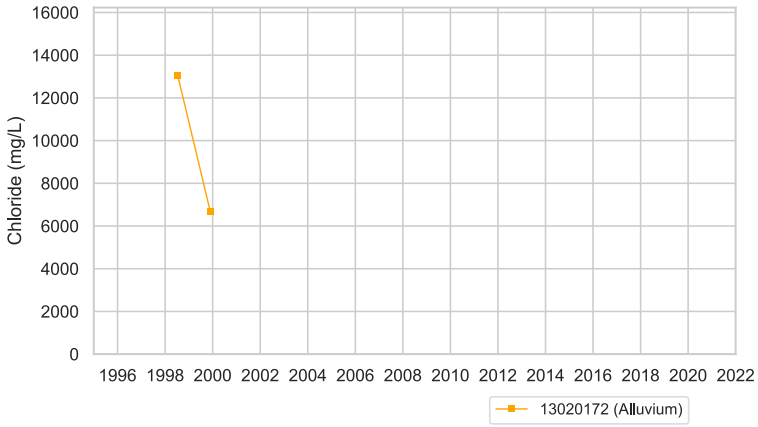

Potassium (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

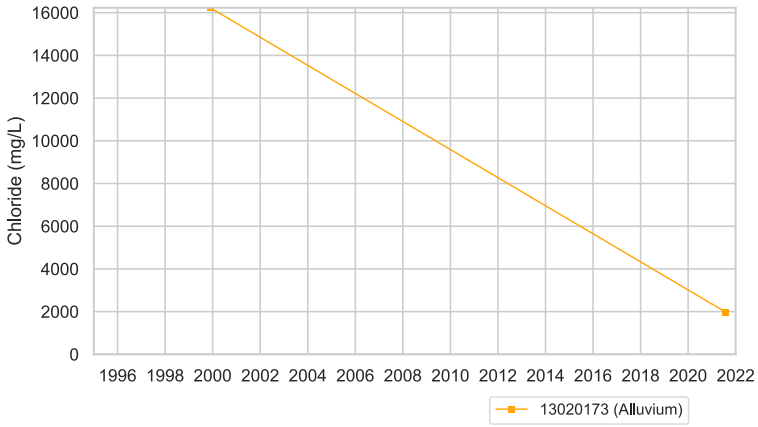

Potassium (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

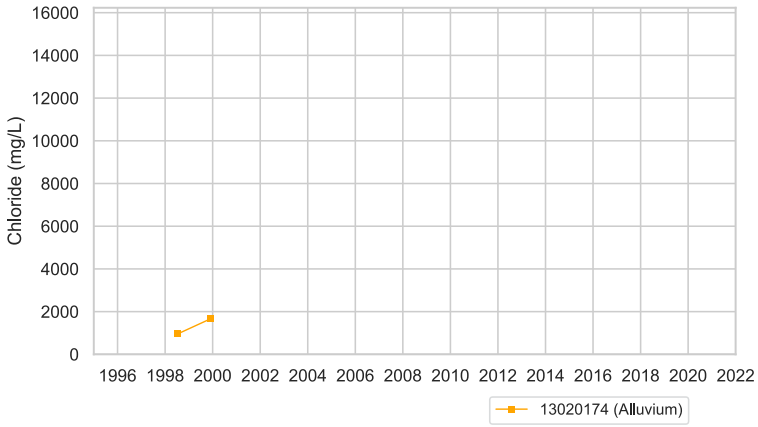

Potassium (mg/L)
0
2
4
6
8
10
12
14
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

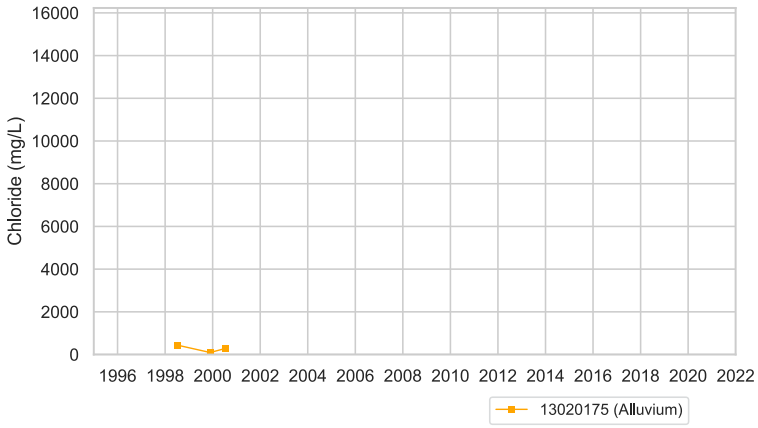

Potassium (mg/L)
0
2
4
6
8
10
12
14
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

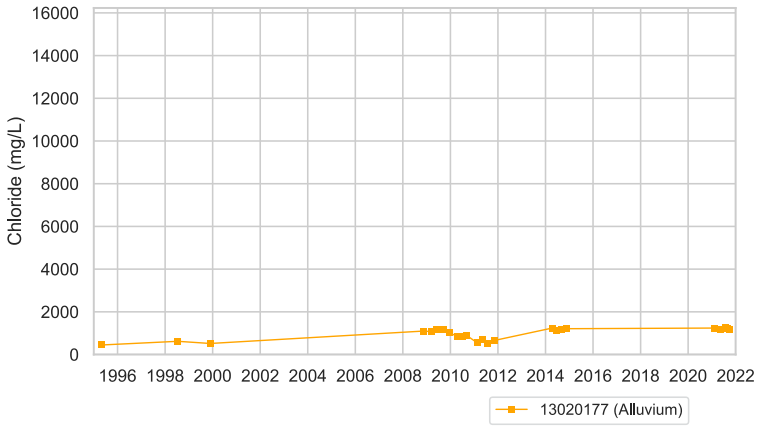

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

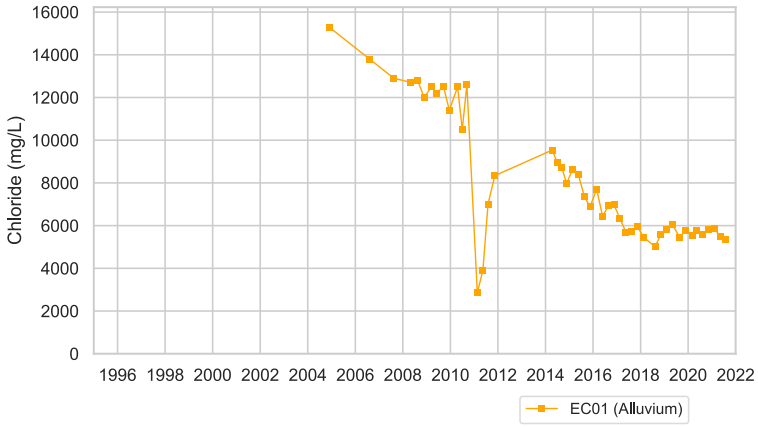

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

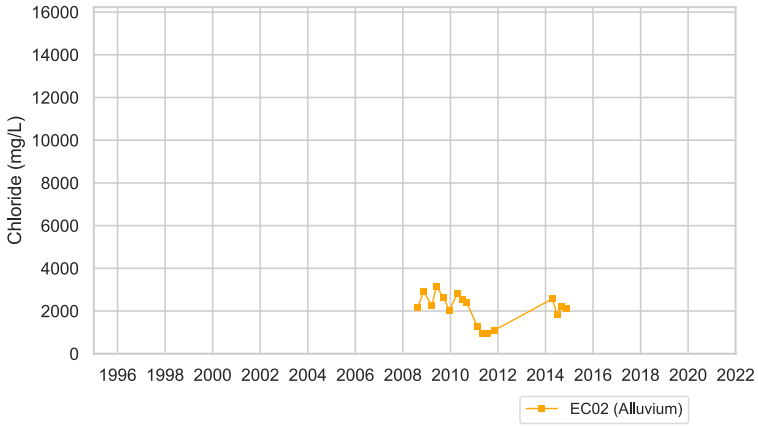

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

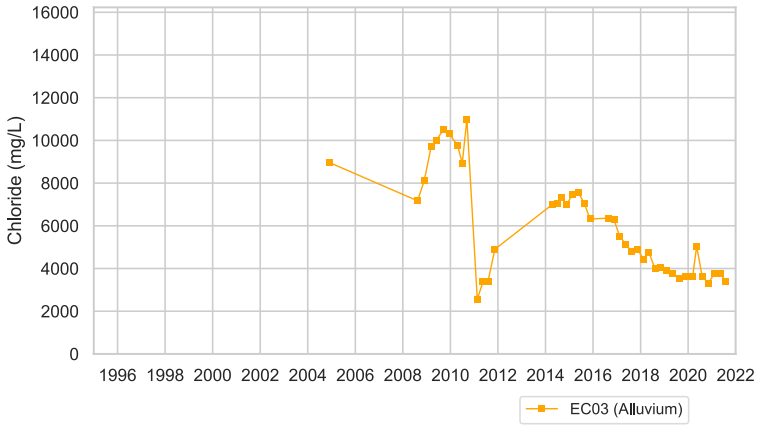

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

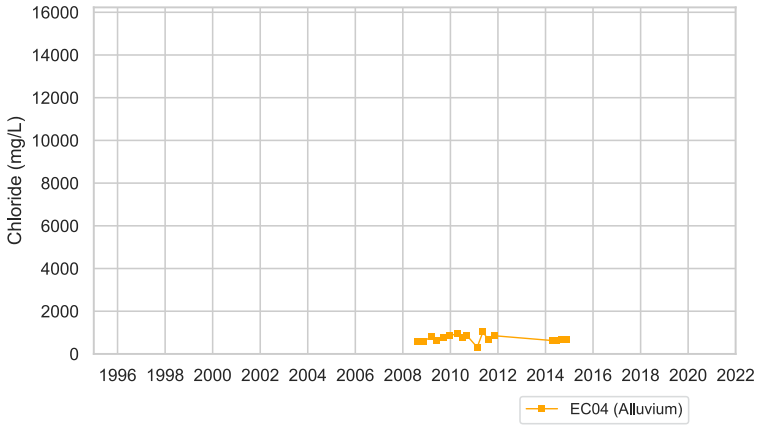

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

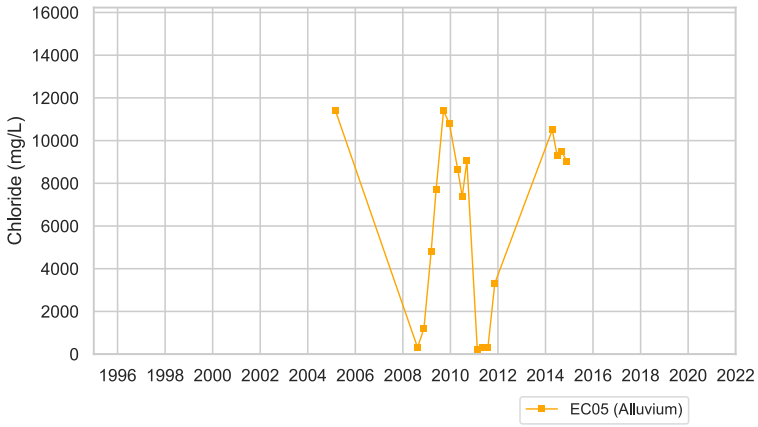

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

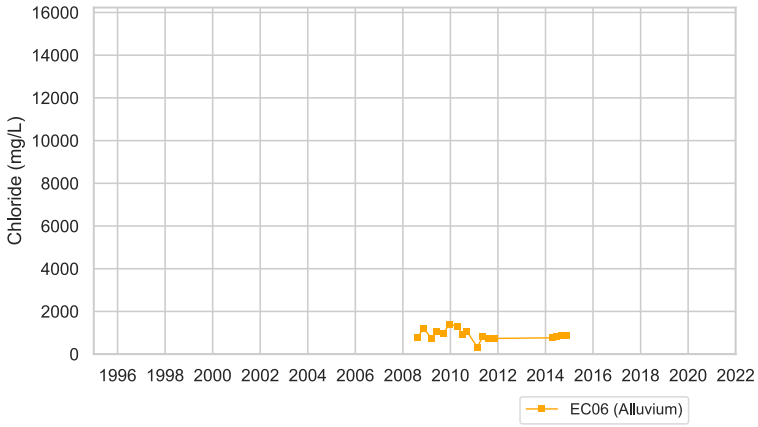

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

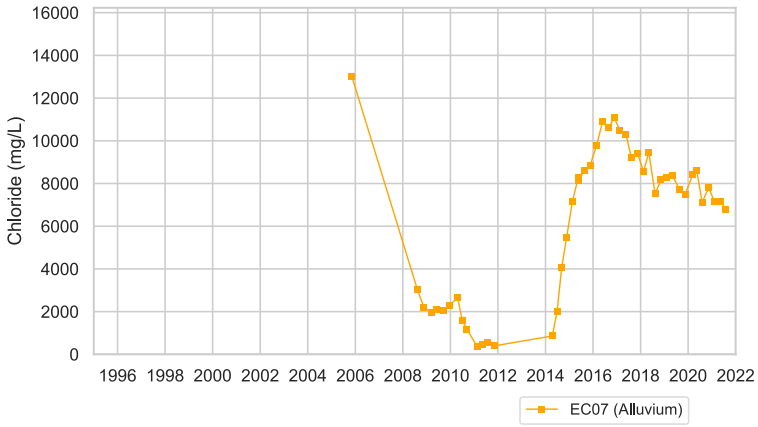

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

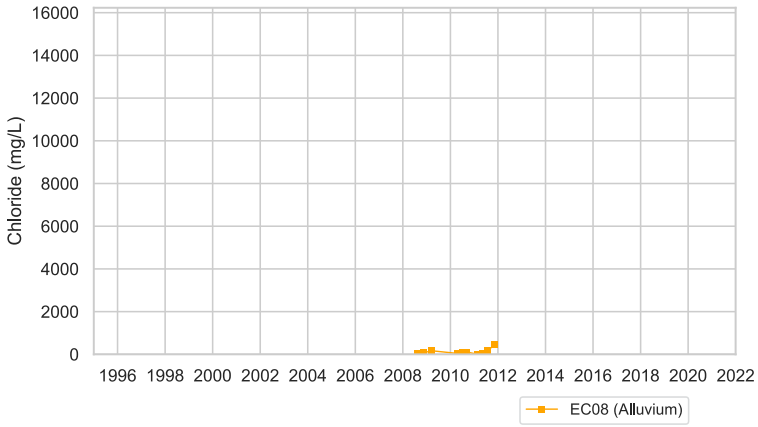

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

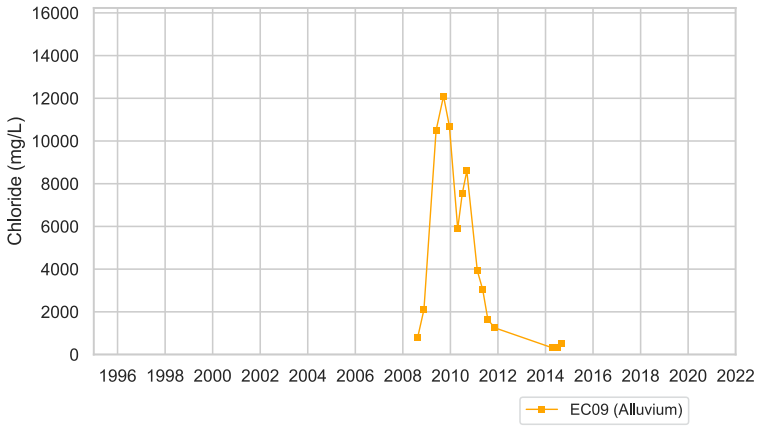

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

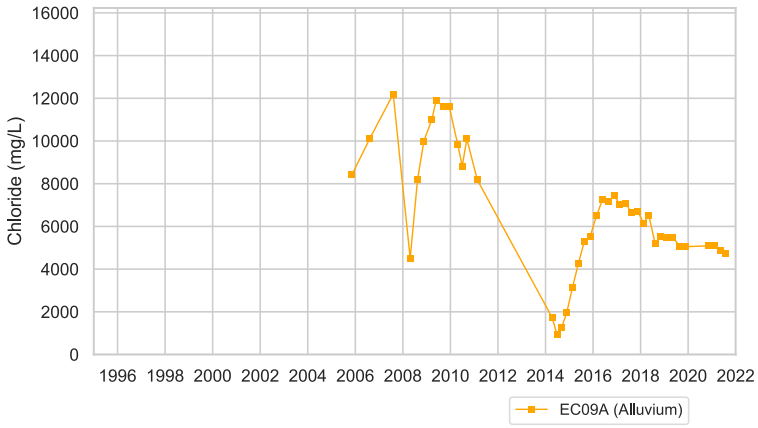

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

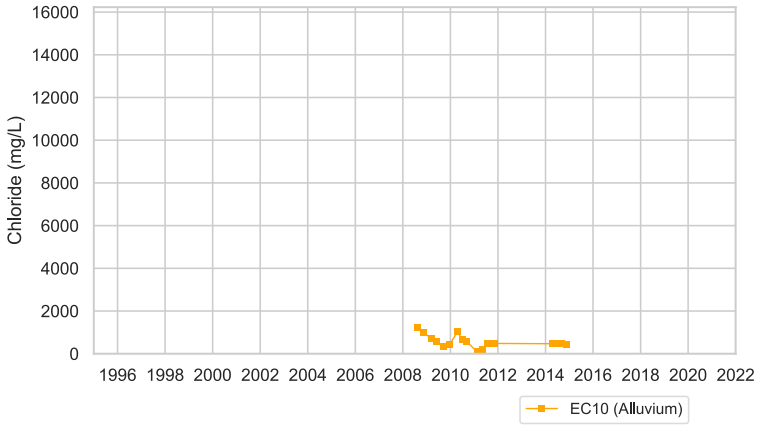

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

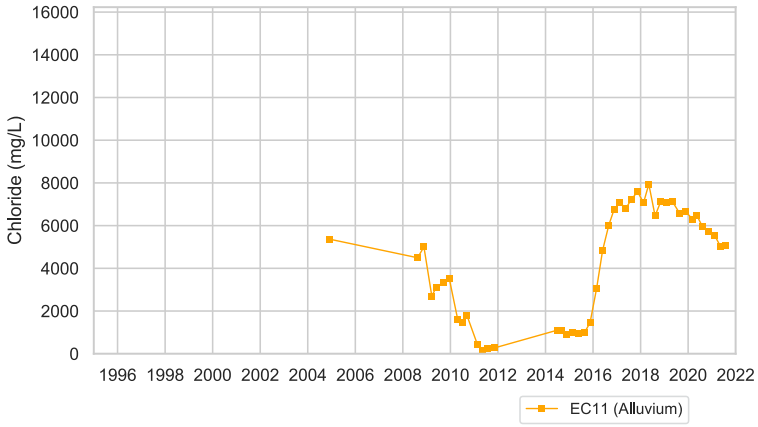

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

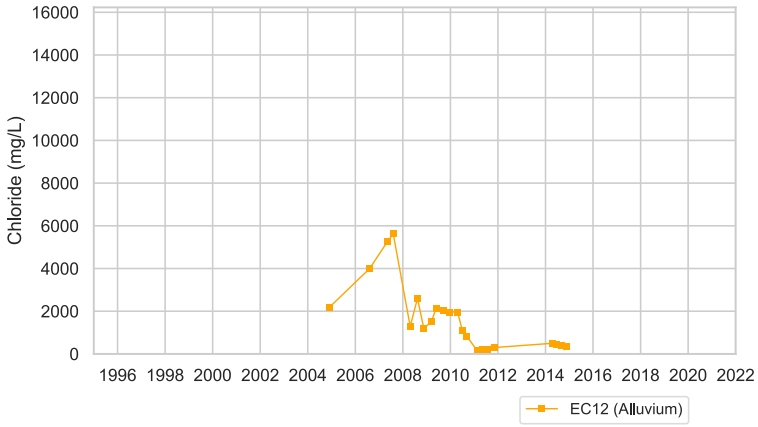

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

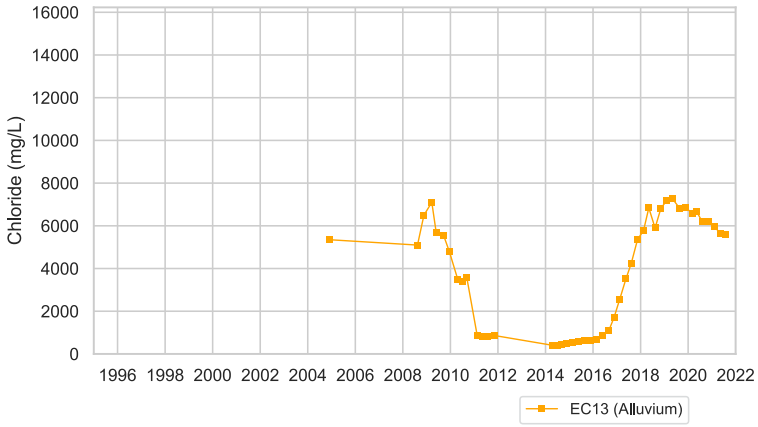

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

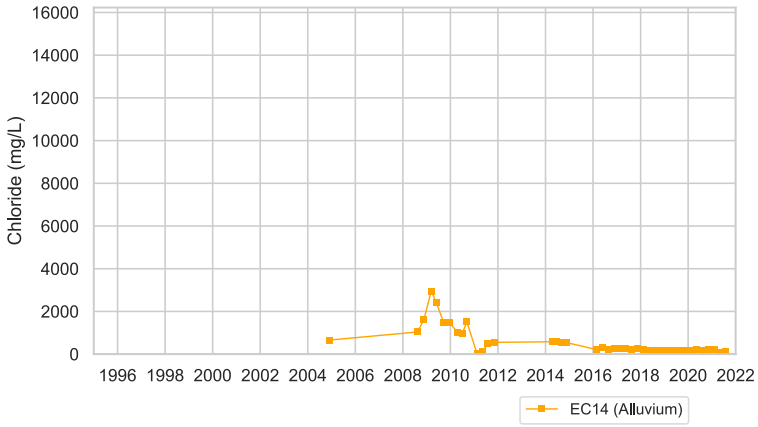

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

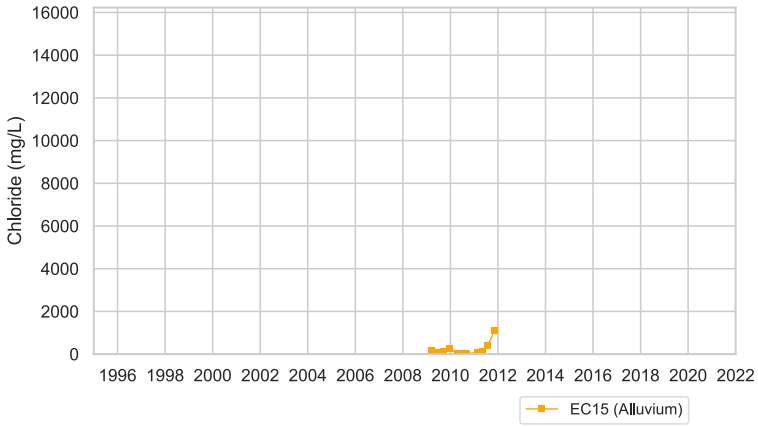

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

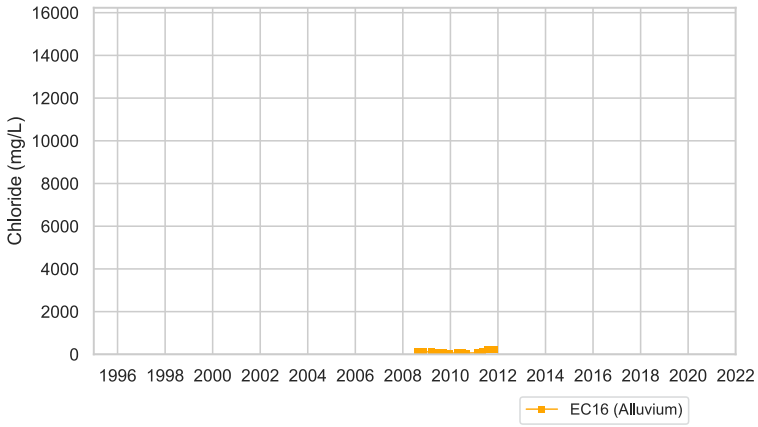

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

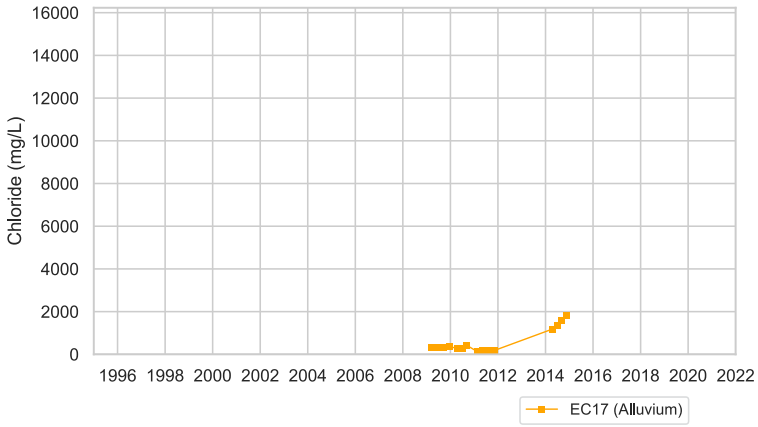

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

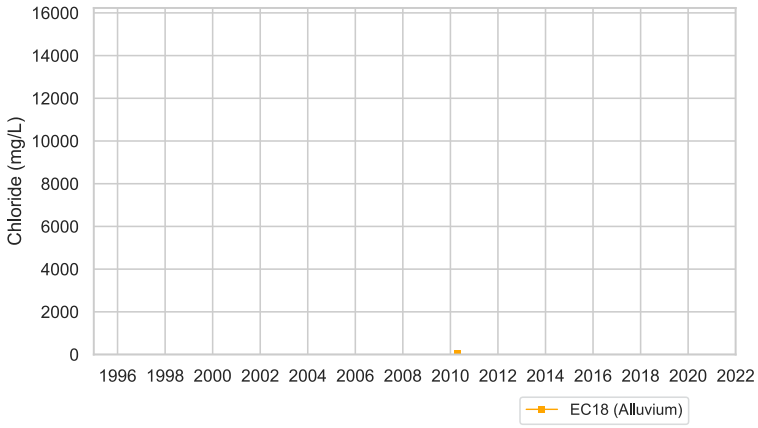

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

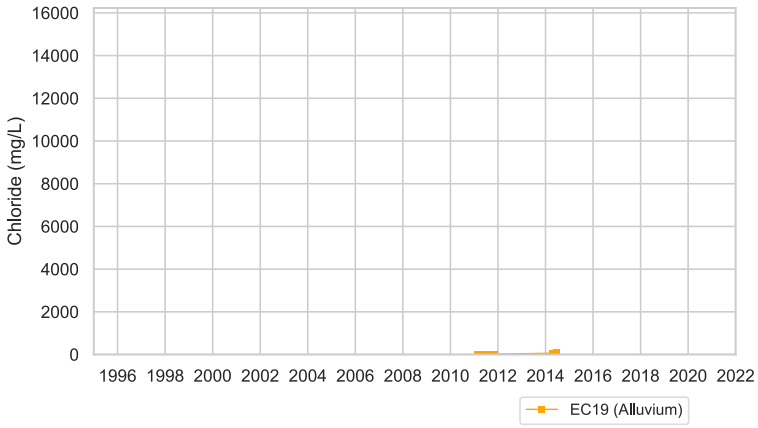

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

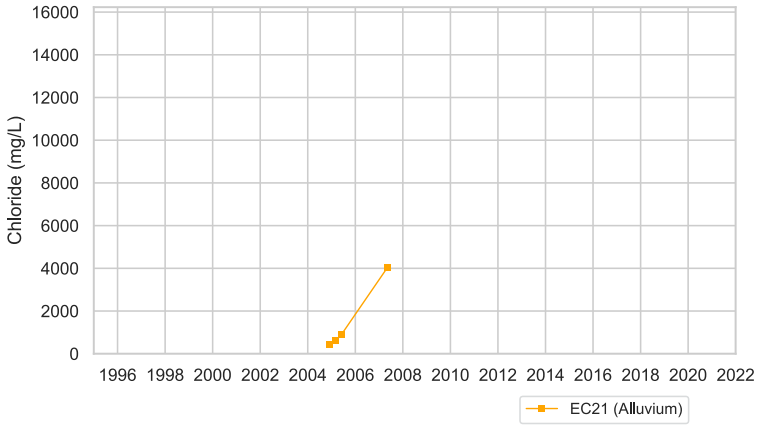

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

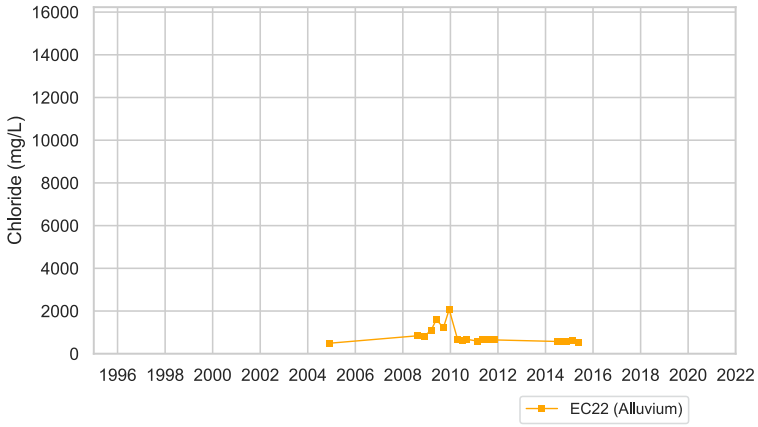

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

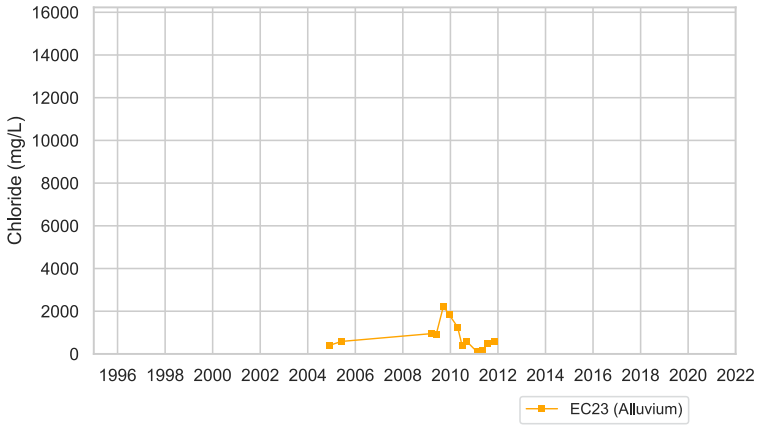

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

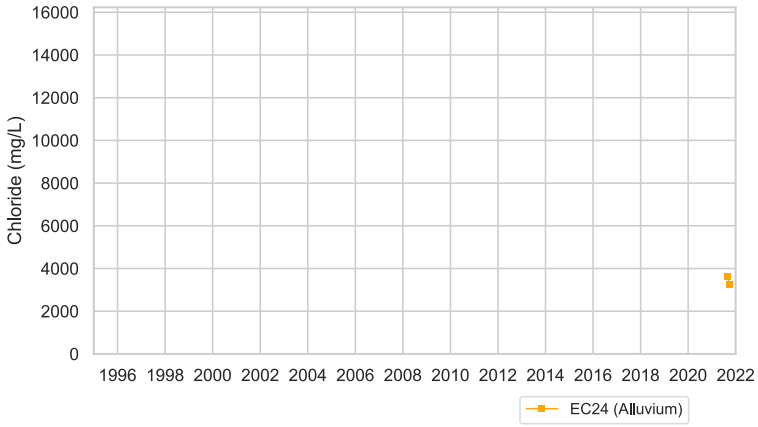

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

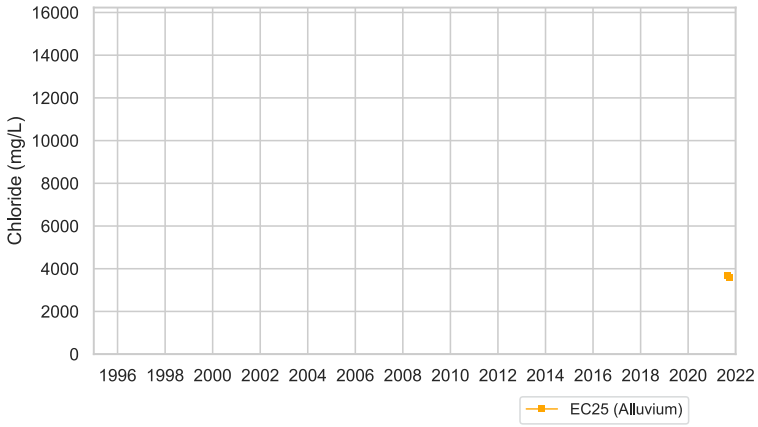

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

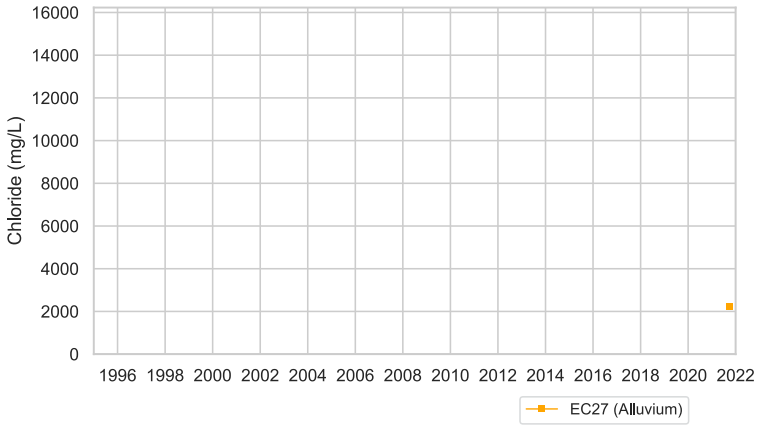

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

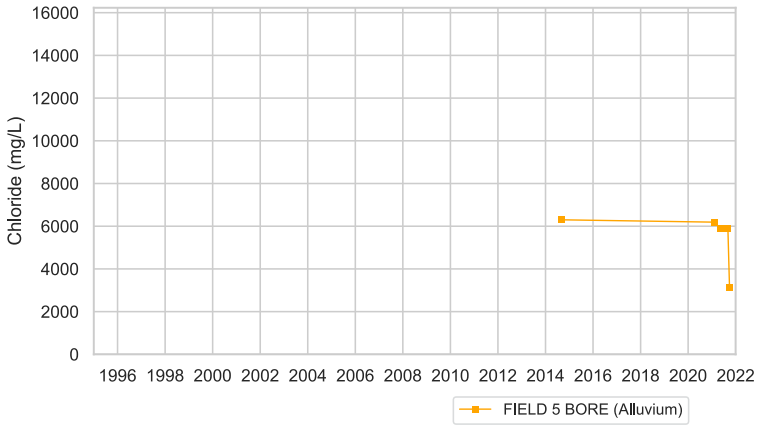

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

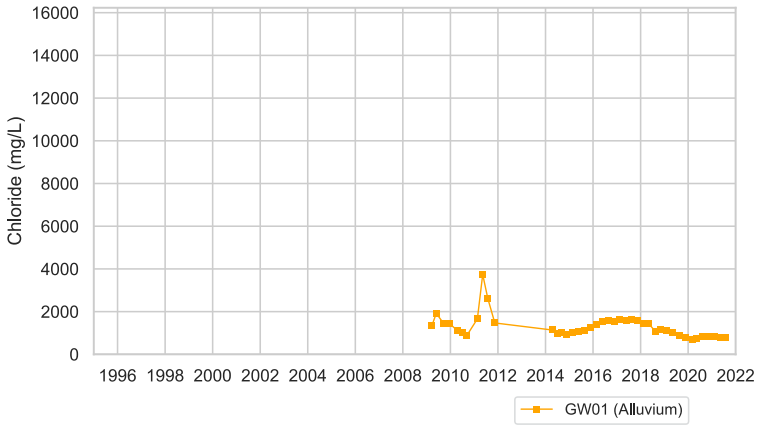

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

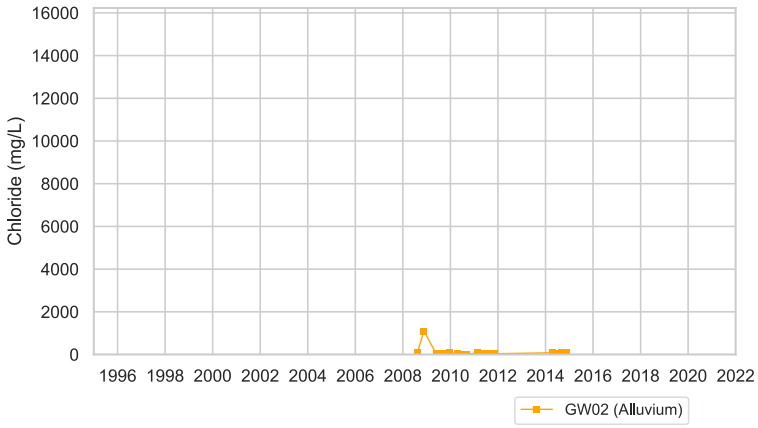

Chloride (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

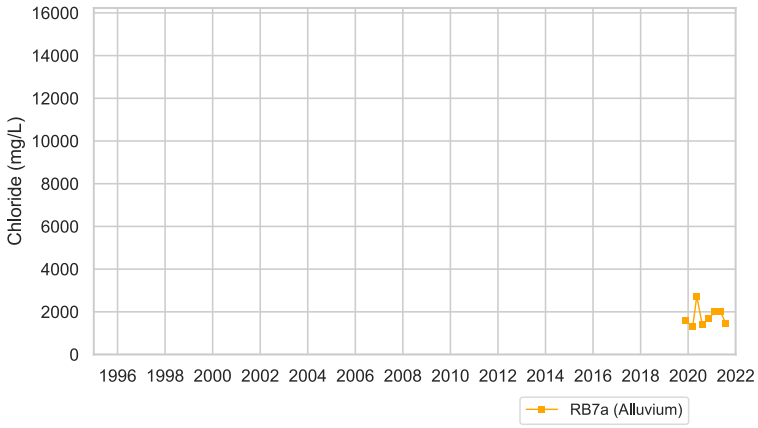

Chloride (mg/L)
EC25 (Alluvium)

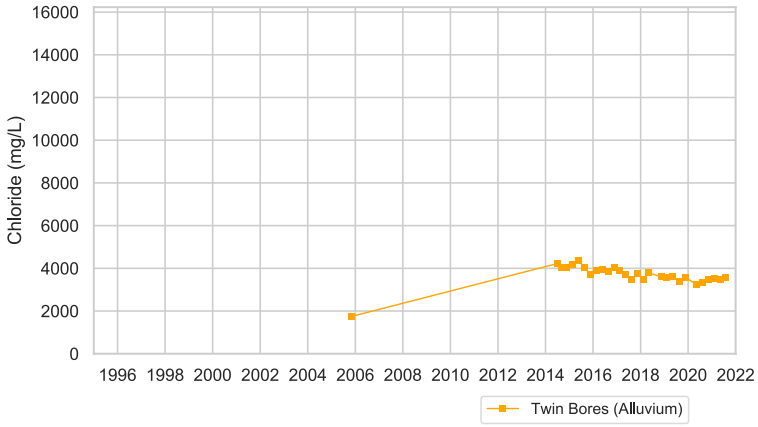

Chloride (mg/L)
EC27 (Alluvium)

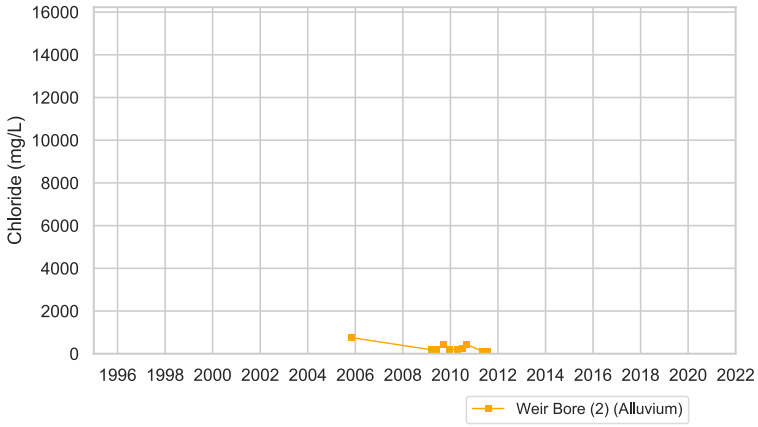

Chloride (mg/L)
FIELD 5 BORE (Alluvium)

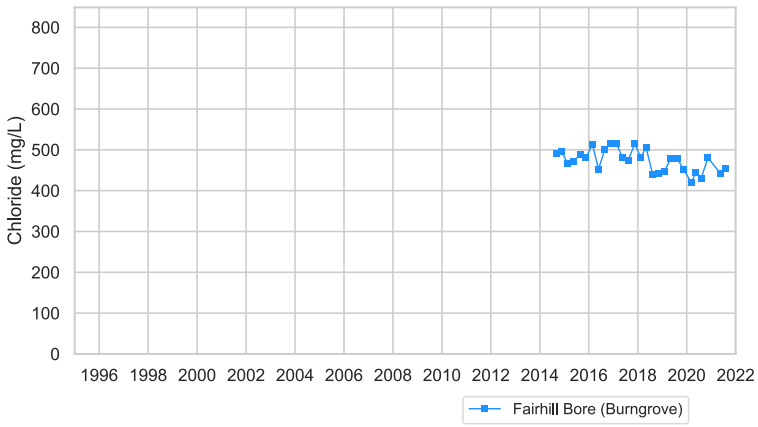

Chloride (mg/L)
GW01 (Alluvium)

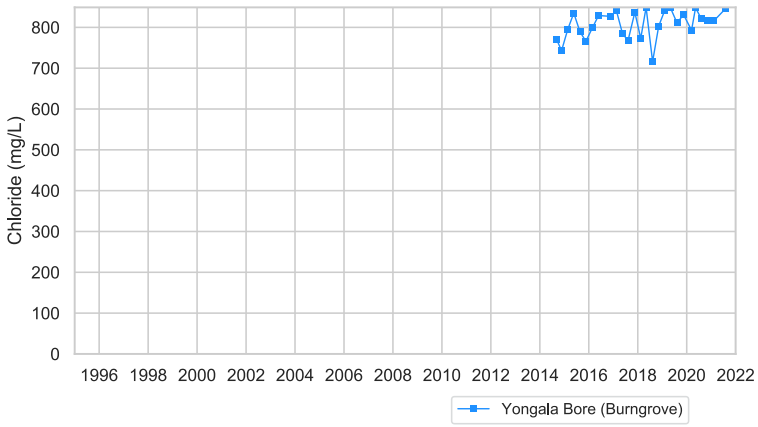

Chloride (mg/L)
GW02 (Alluvium)

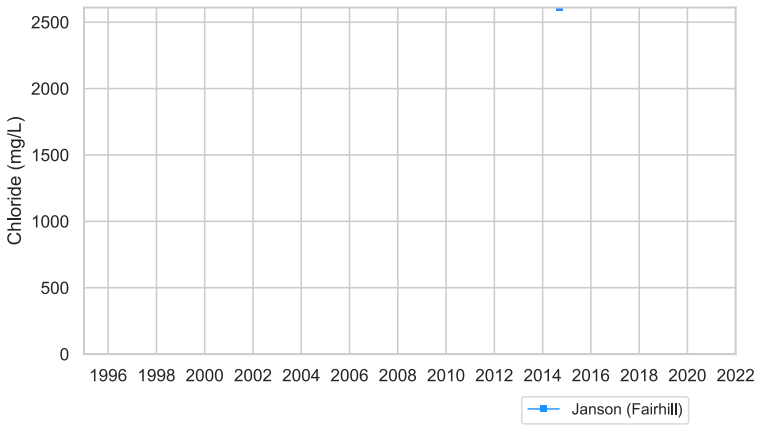

Chloride (mg/L)
RB7a (Alluvium)

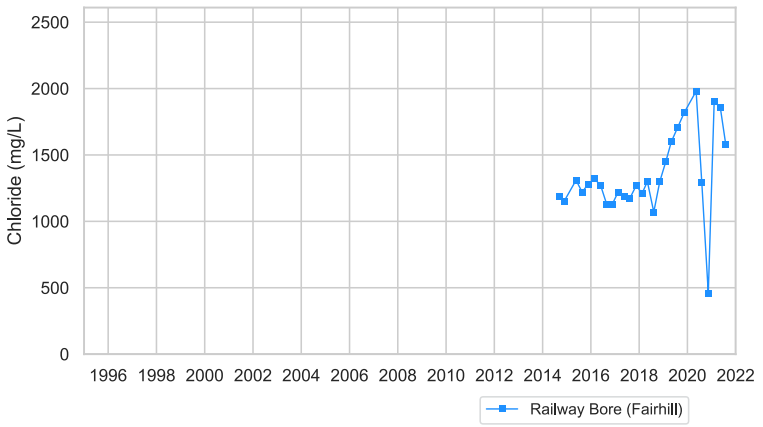

Chloride (mg/L)
Twin Bores (Alluvium)

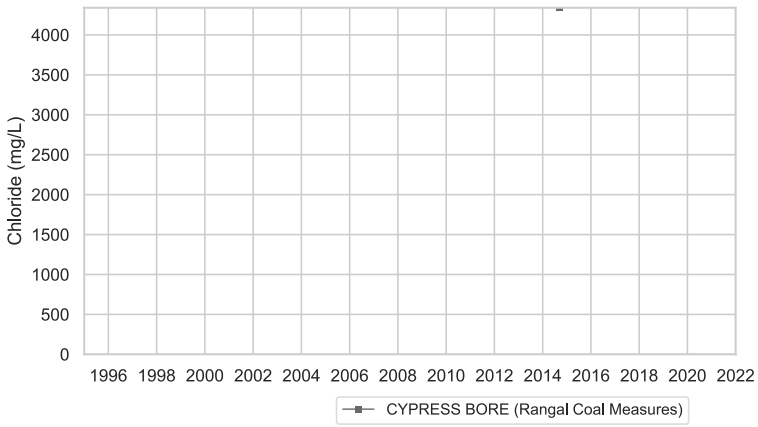

Chloride (mg/L)
Weir Bore (2) (Alluvium)

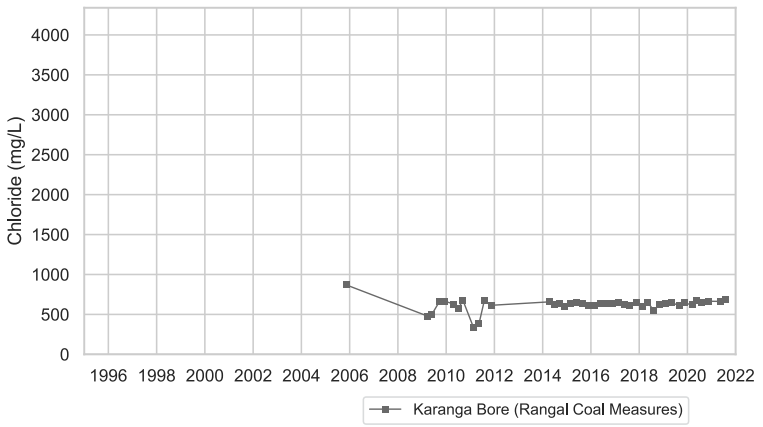

Chloride (mg/L)
Fairhill Bore (Burngrove)

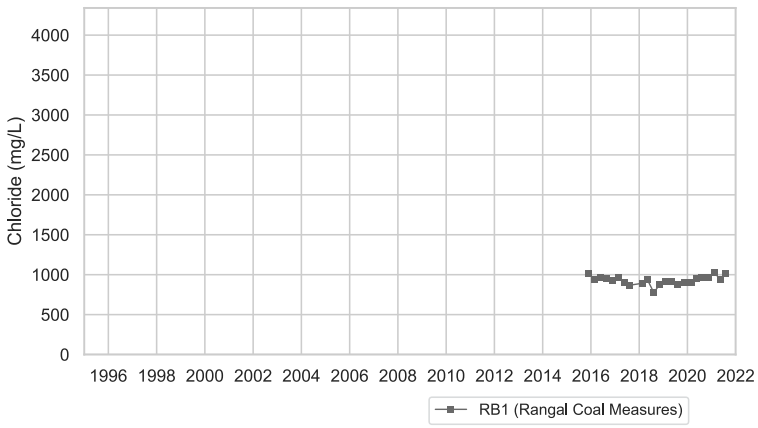

Chloride (mg/L)
Yongala Bore (Burngrove)

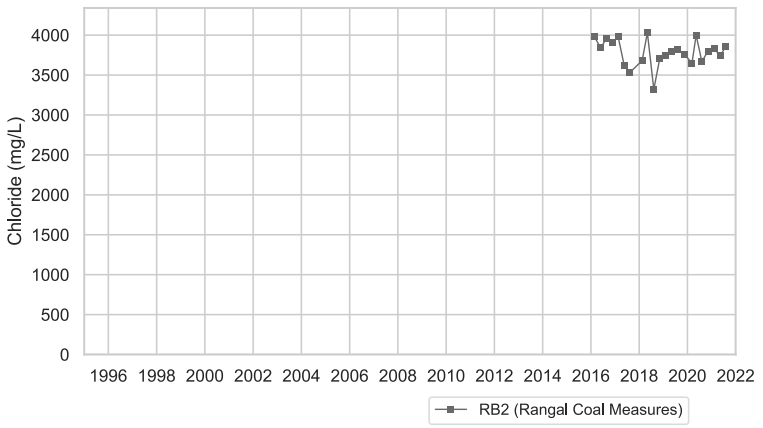

Chloride (mg/L)
0
500
1000
1500
2000
2500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

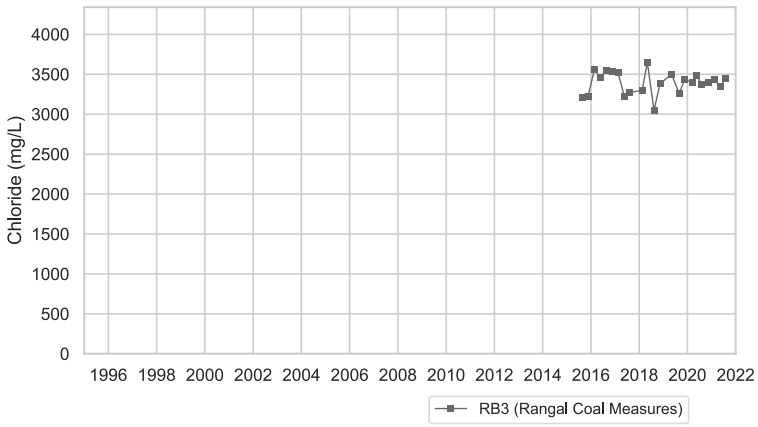

Chloride (mg/L)
0
500
1000
1500
2000
2500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

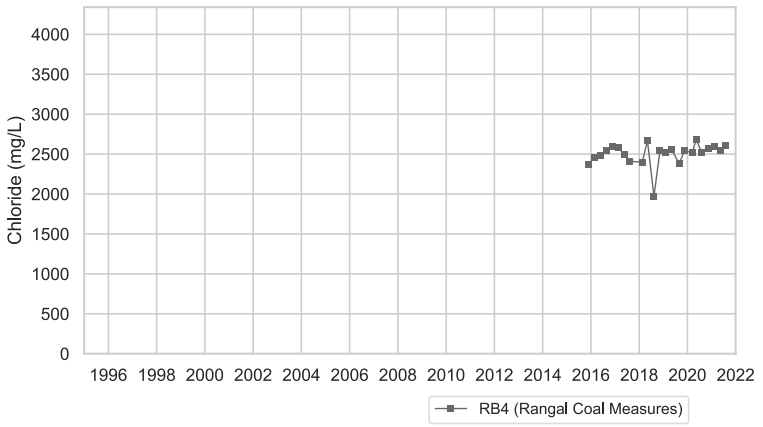

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

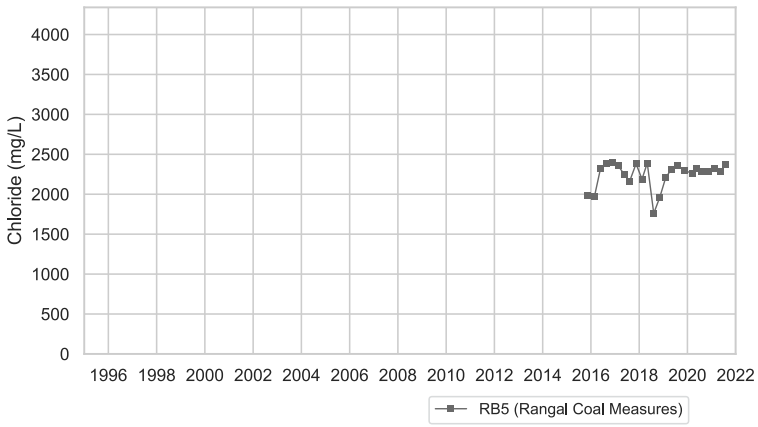

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

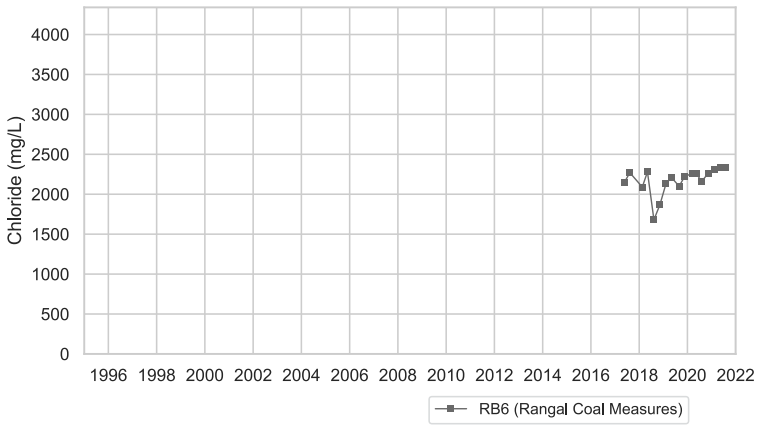

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

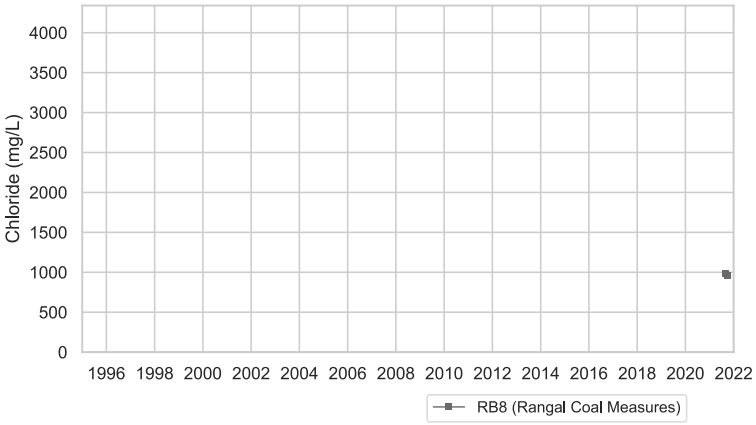

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

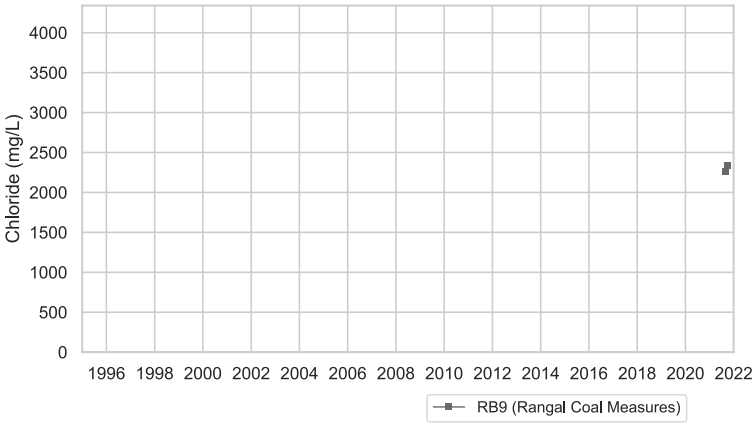

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

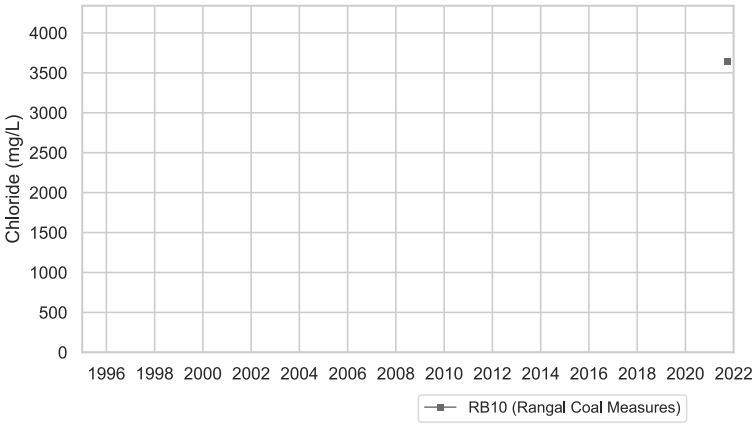

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

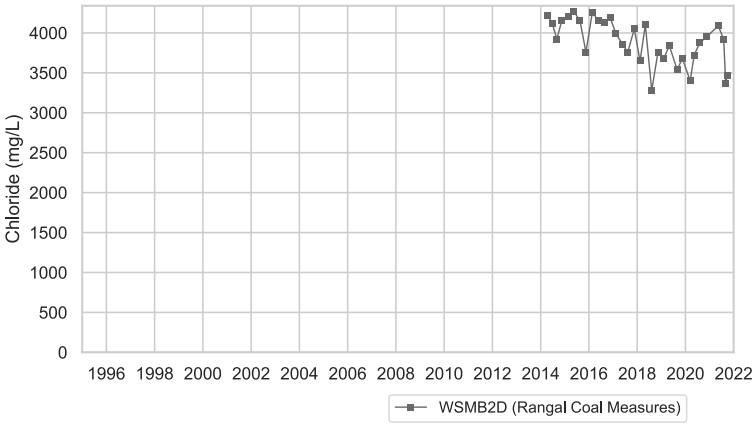

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

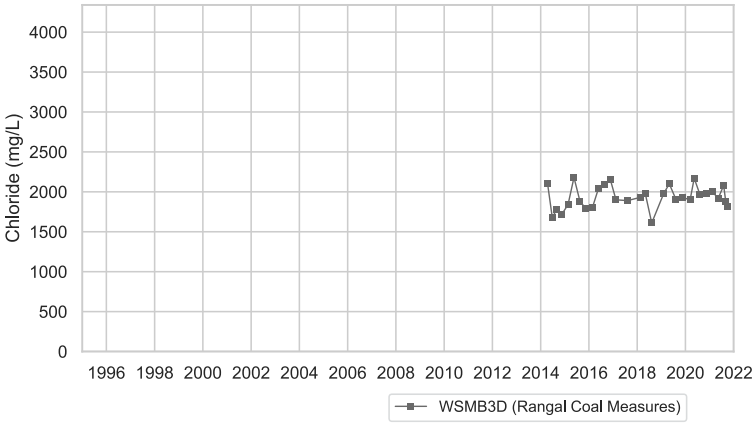

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

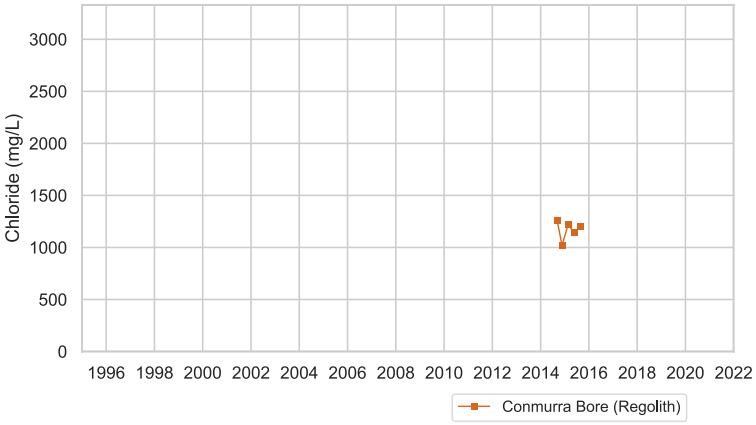

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

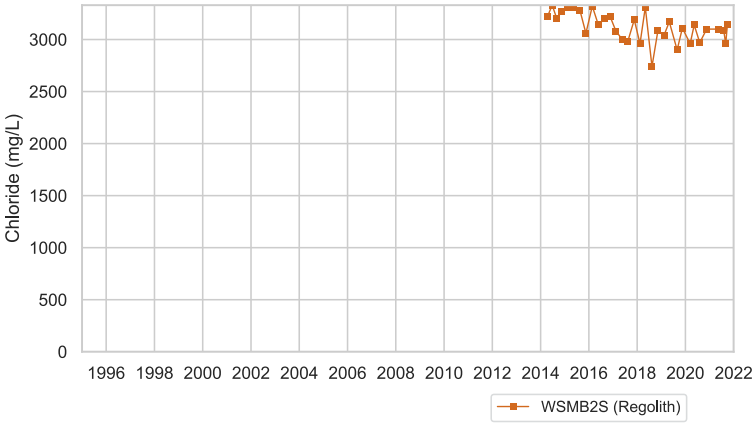

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

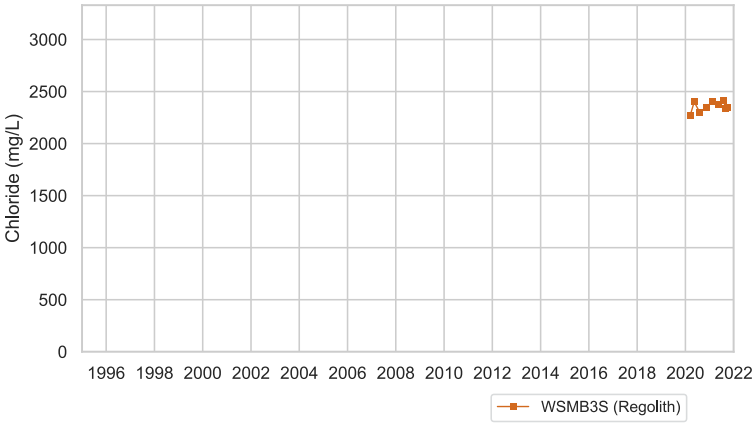

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

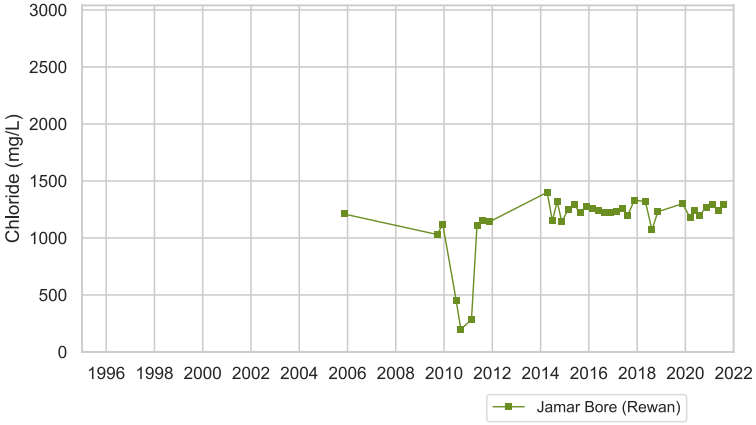

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

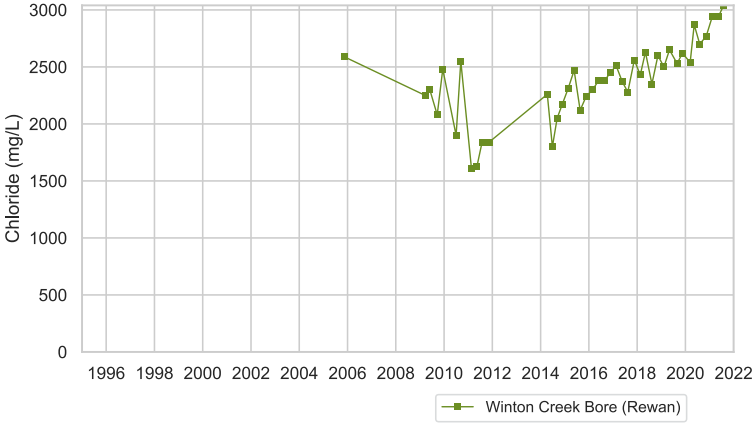

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
3500
4000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

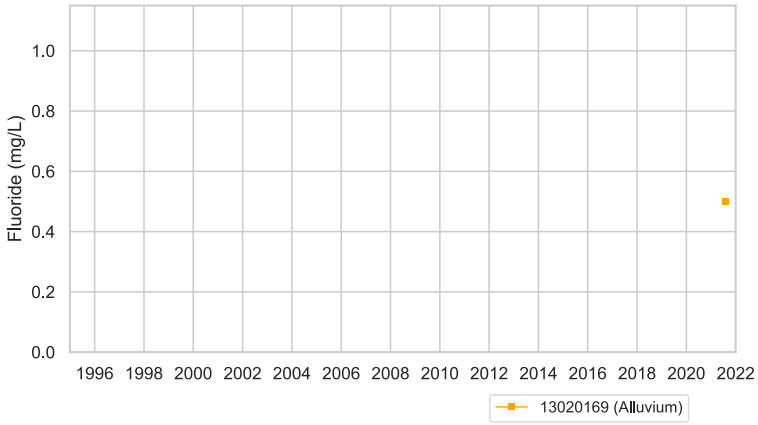

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

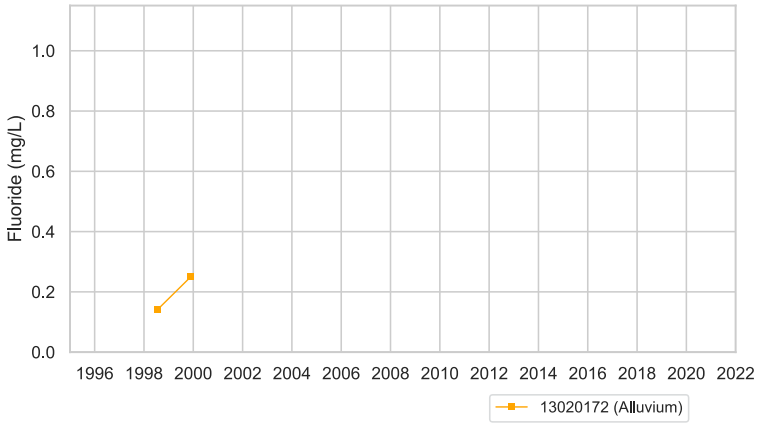

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

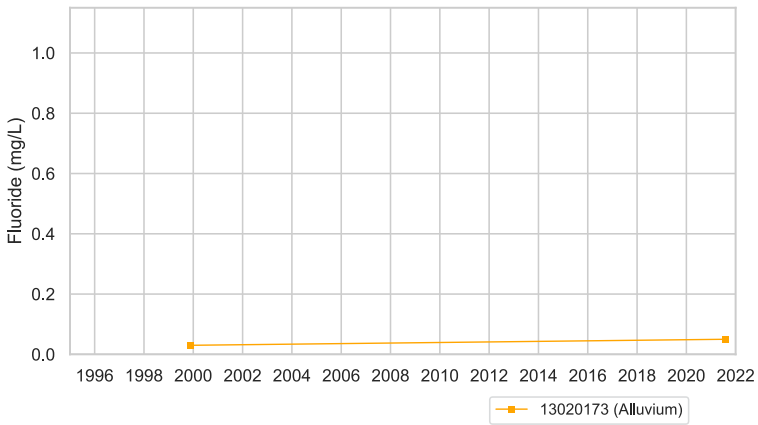

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

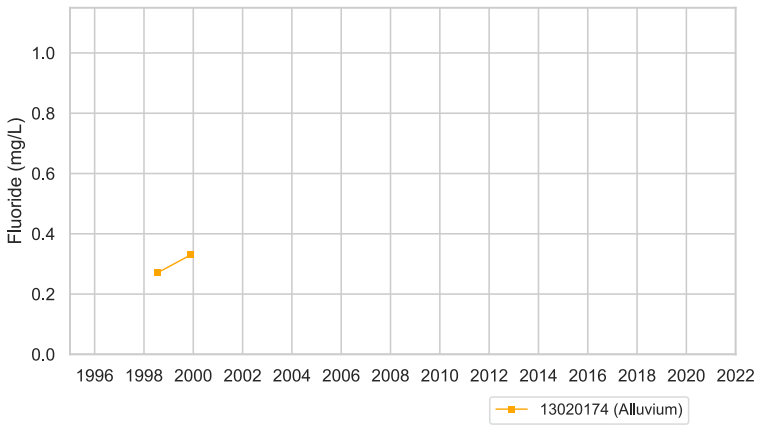

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

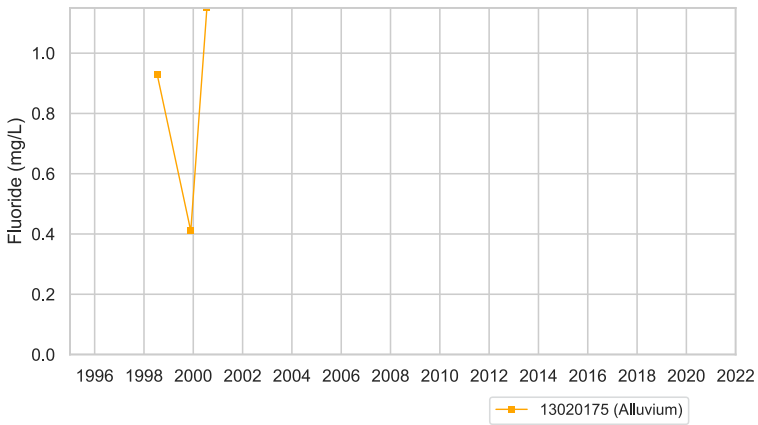

Chloride (mg/L)
0
500
1000
1500
2000
2500
3000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

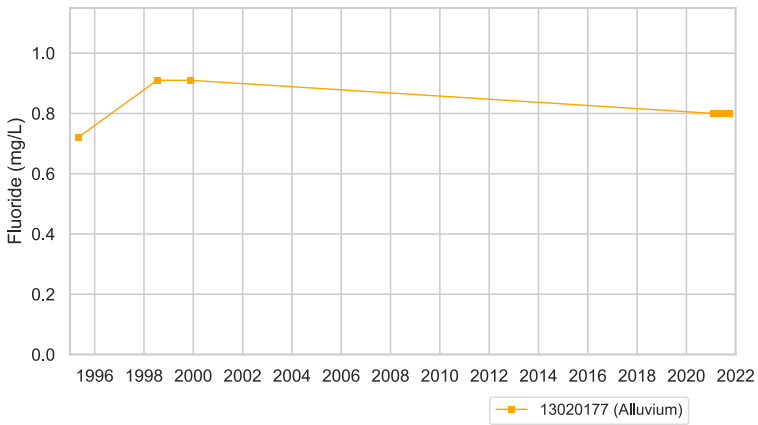

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

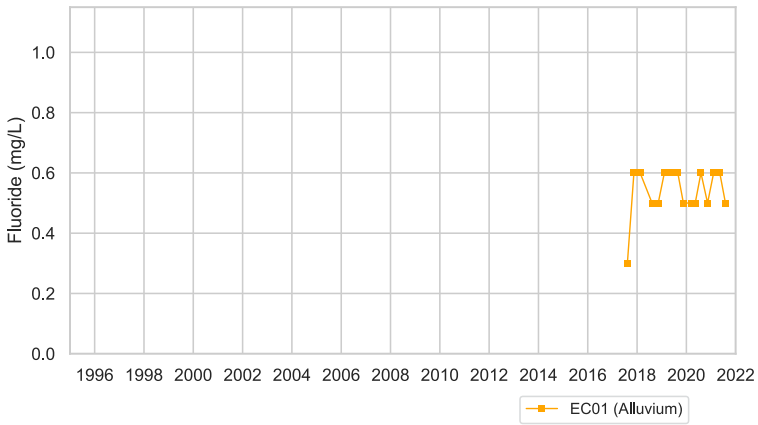

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

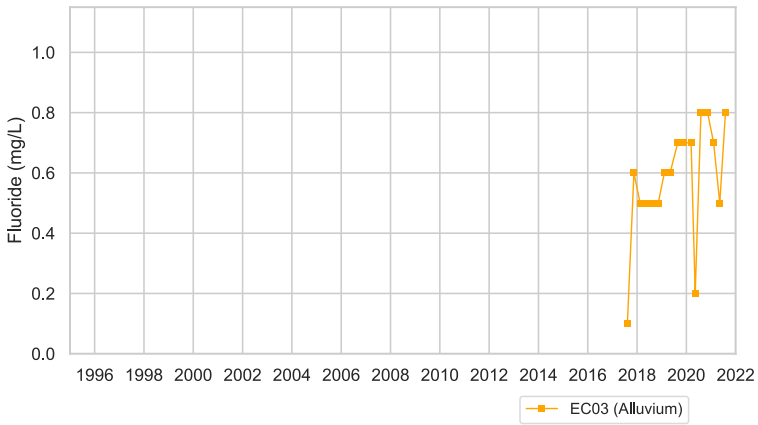

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

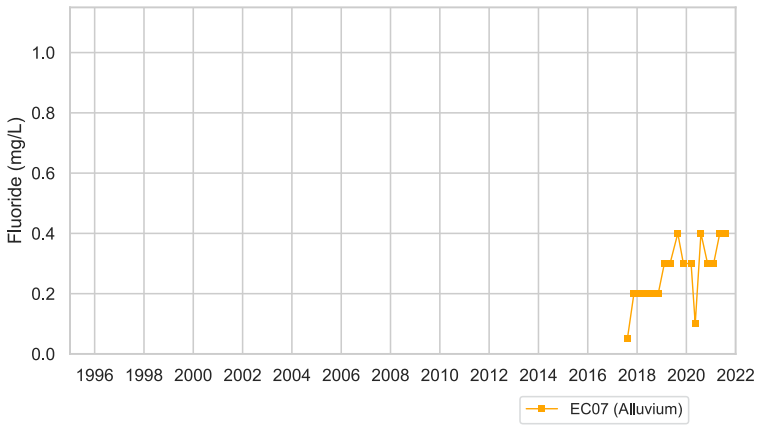

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

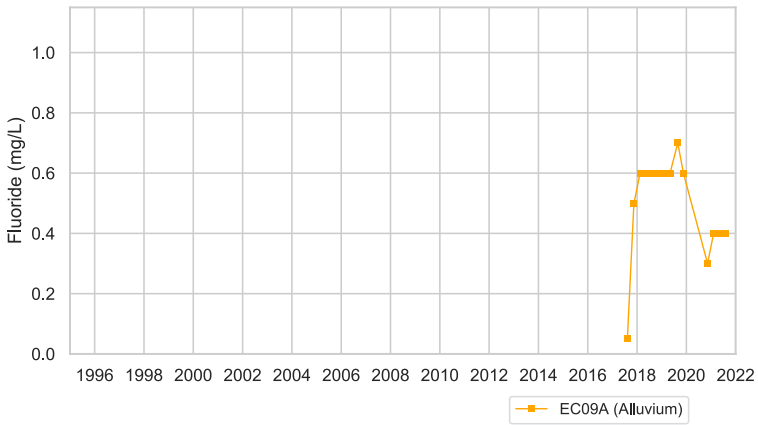

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

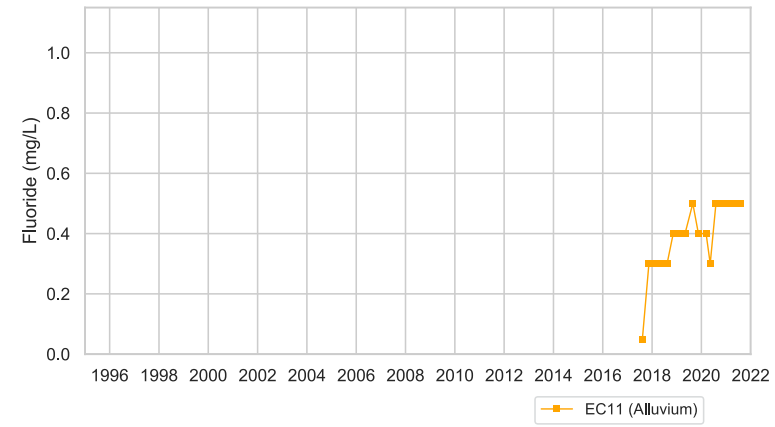

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

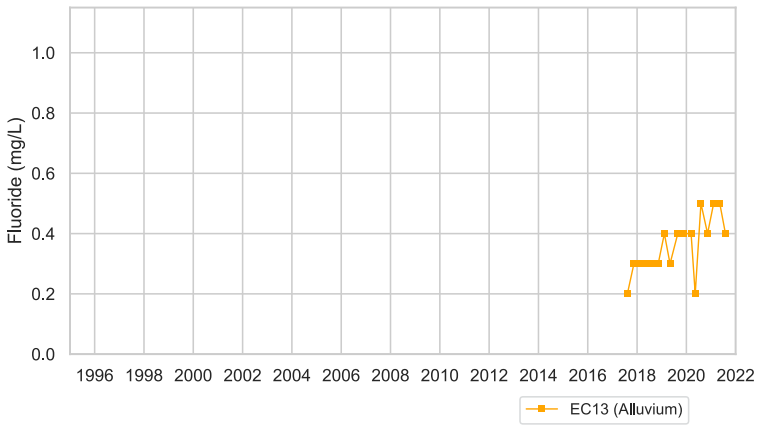

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

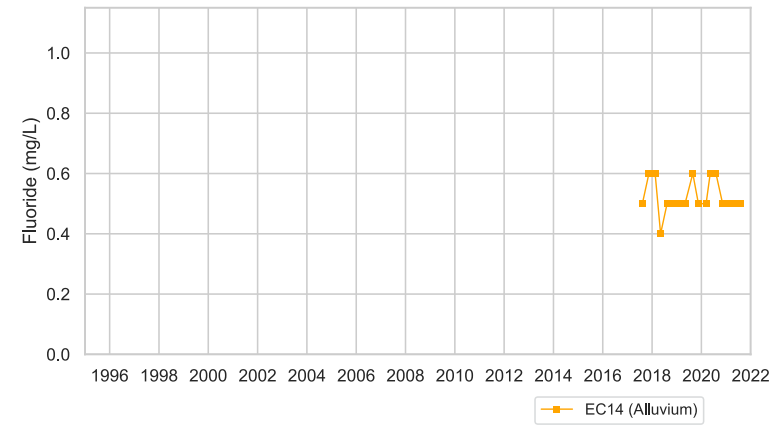

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

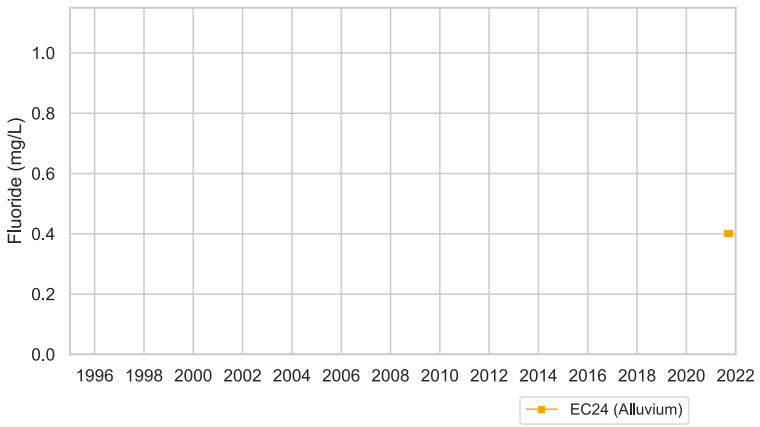

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

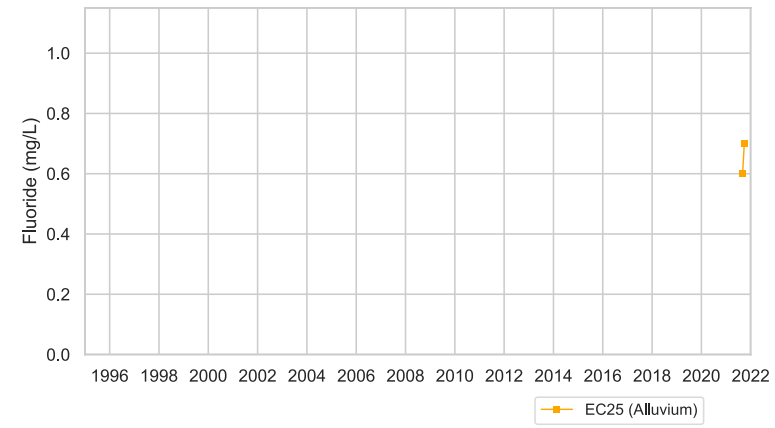

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

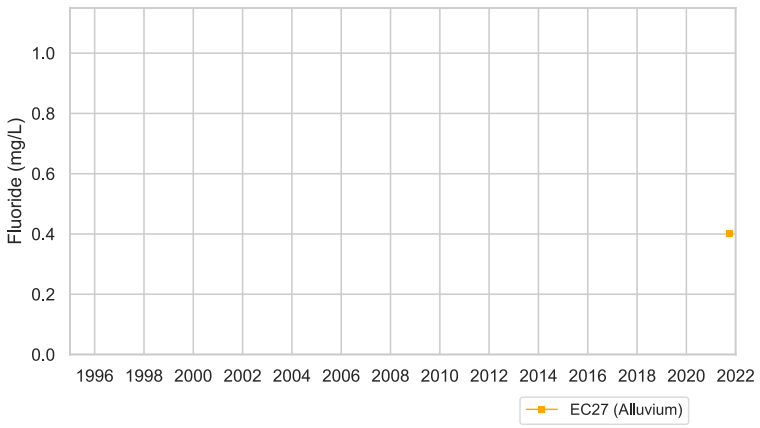

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

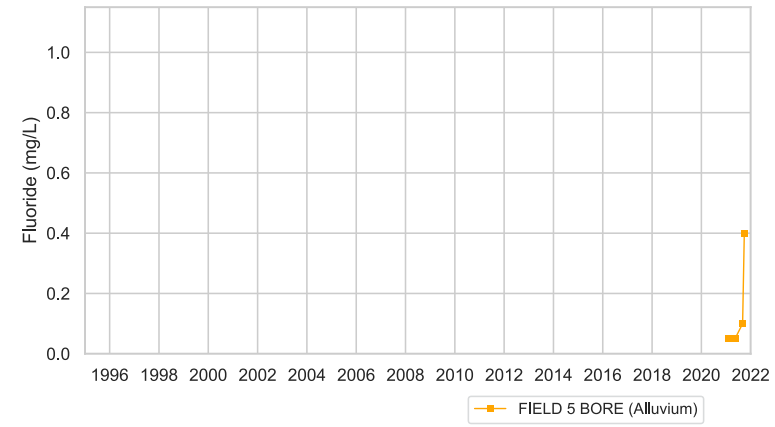

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

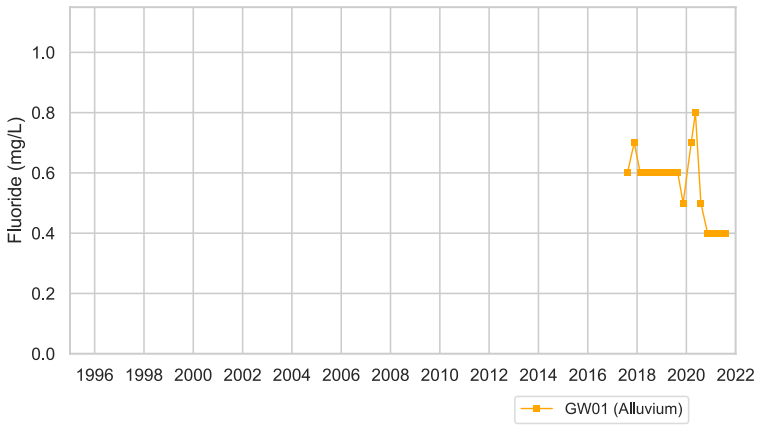

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

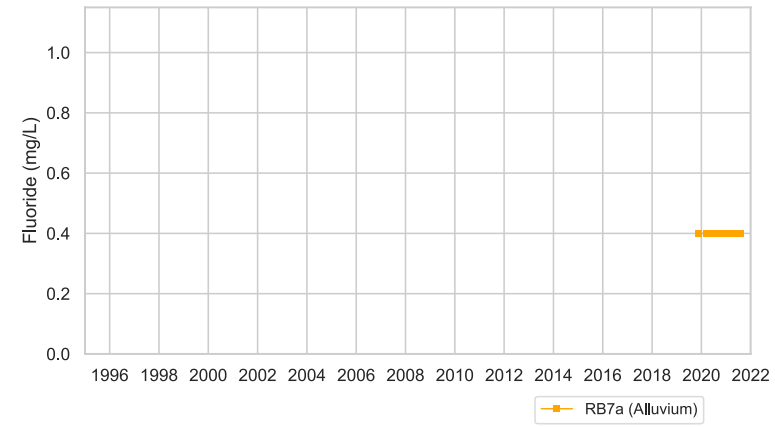

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

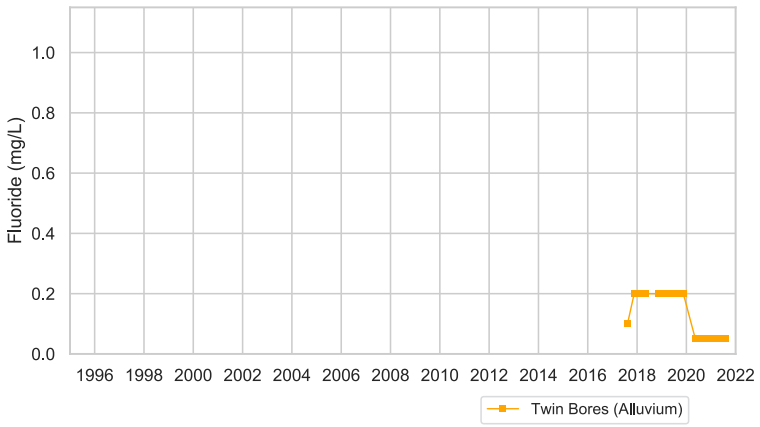

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

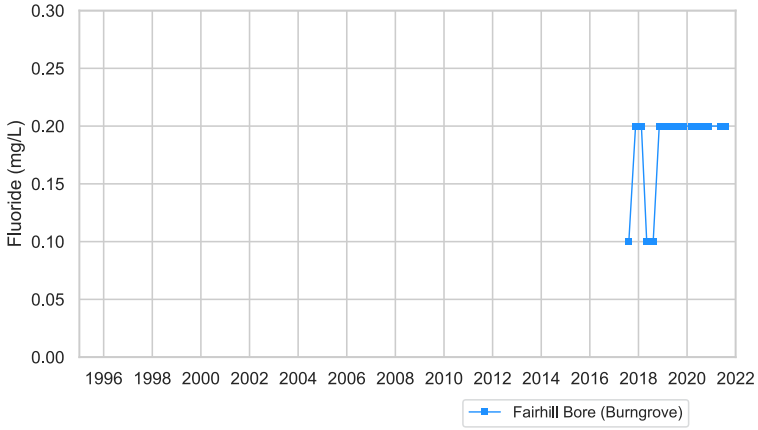

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

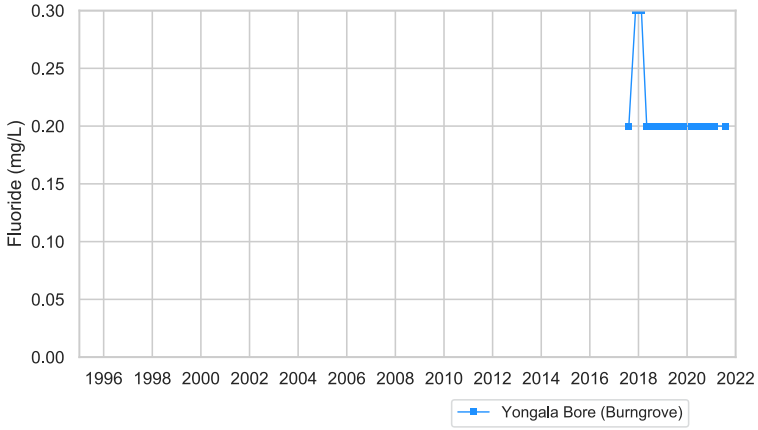

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

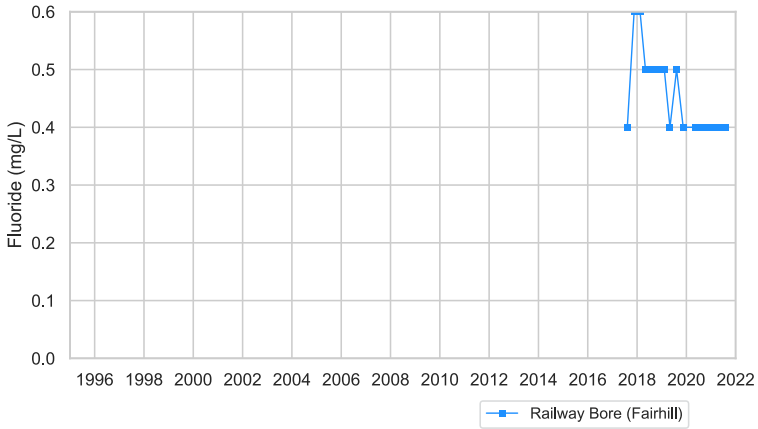

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

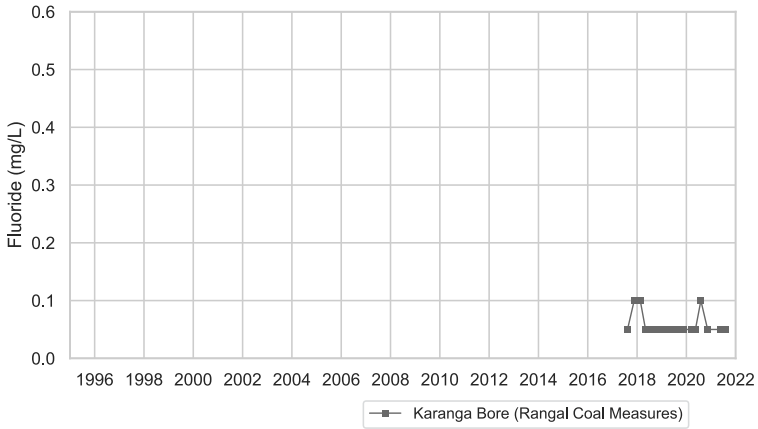

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

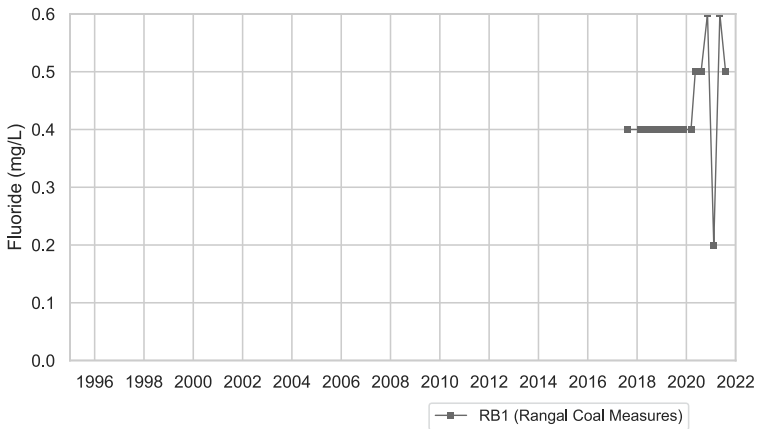

Fluoride (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

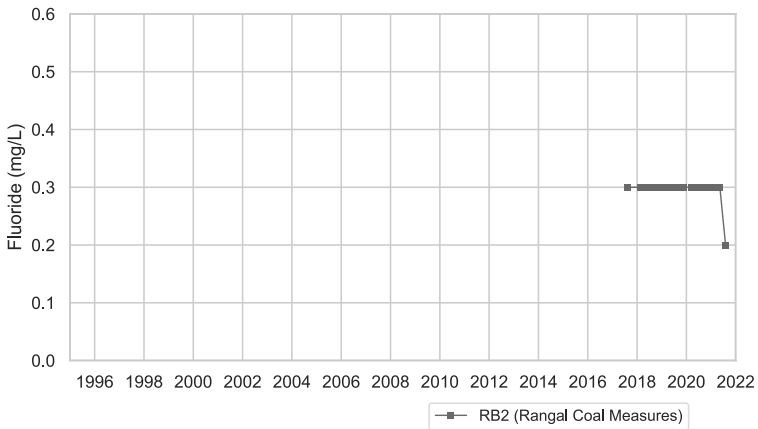

Fluoride (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

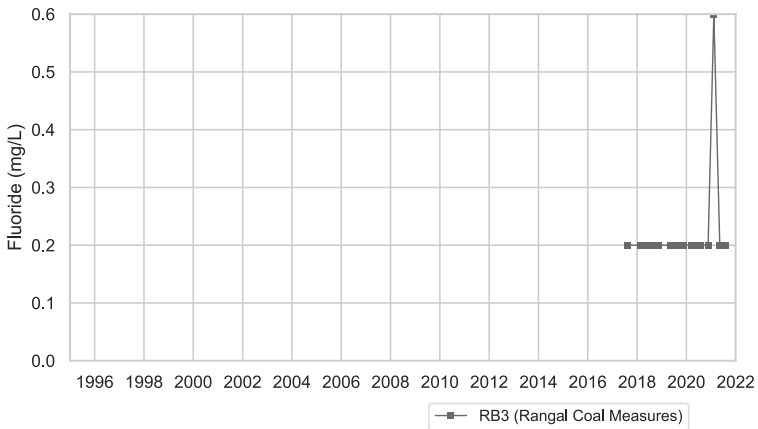

Fluoride (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

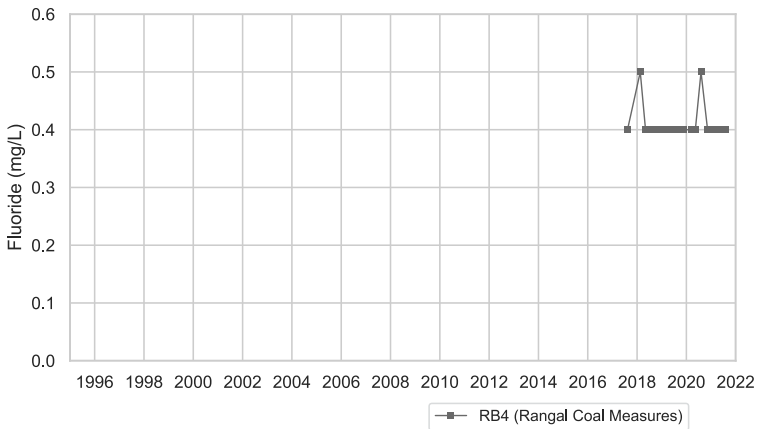

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

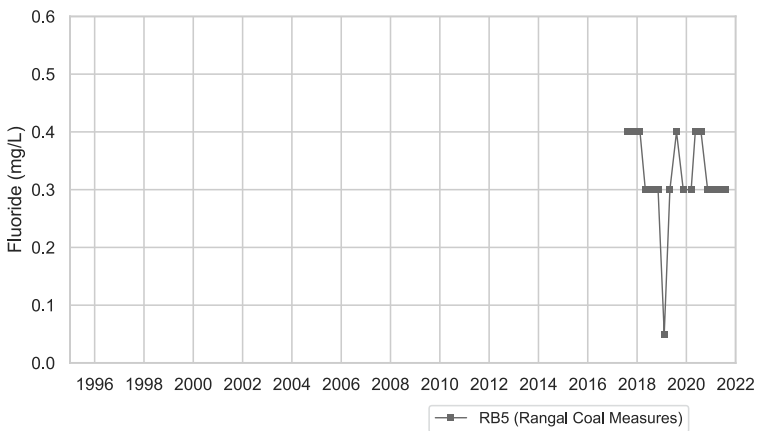

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

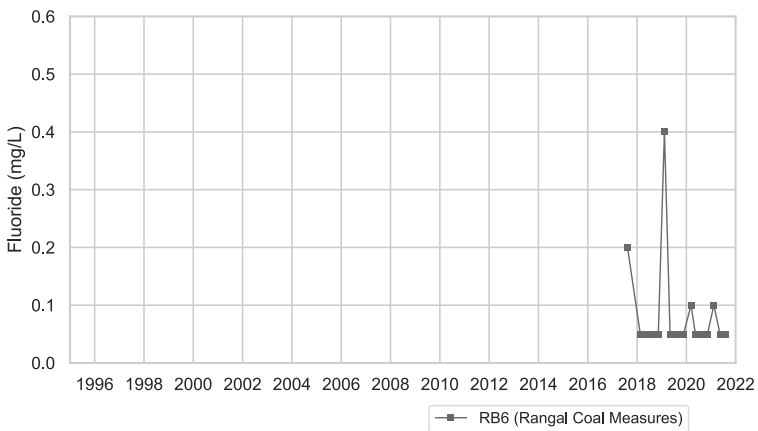

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

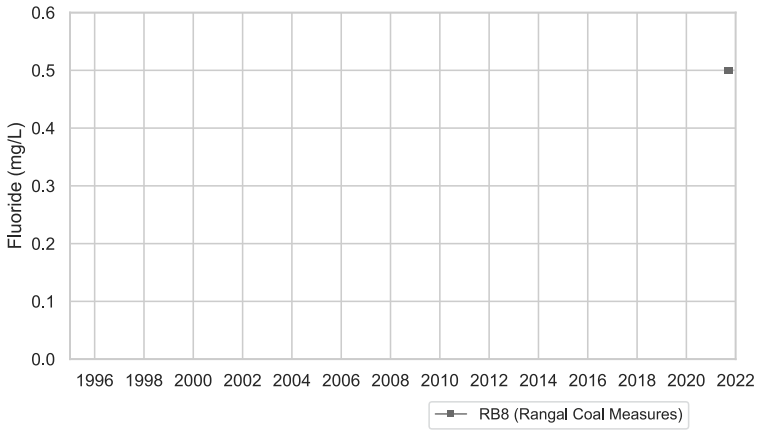

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

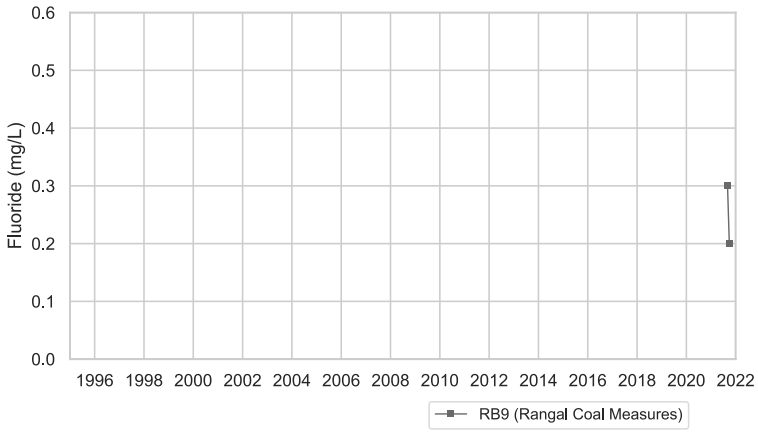

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

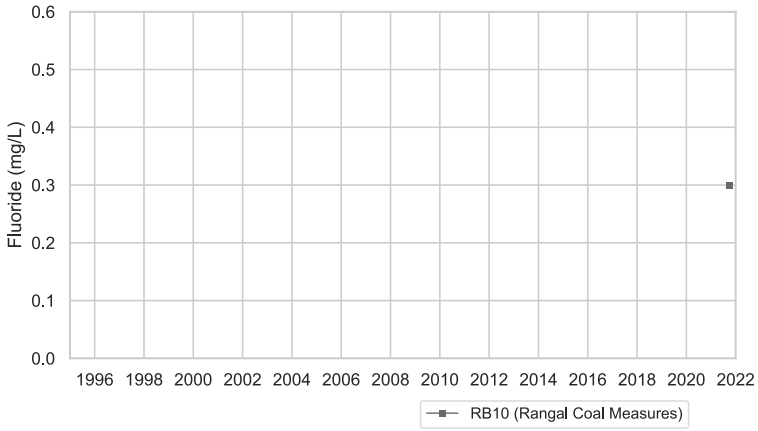

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

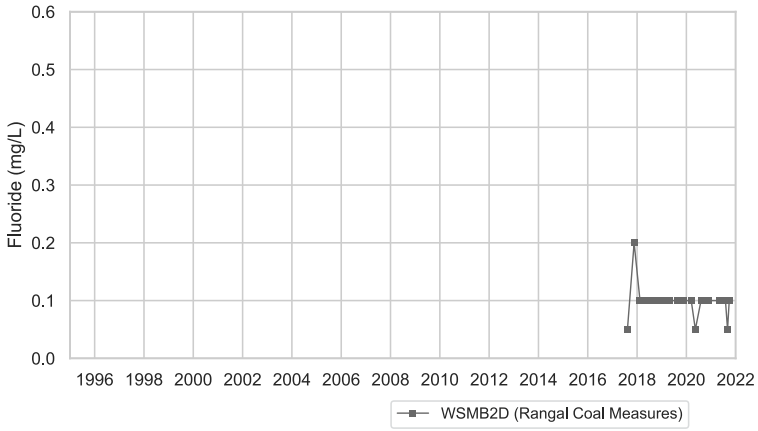

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

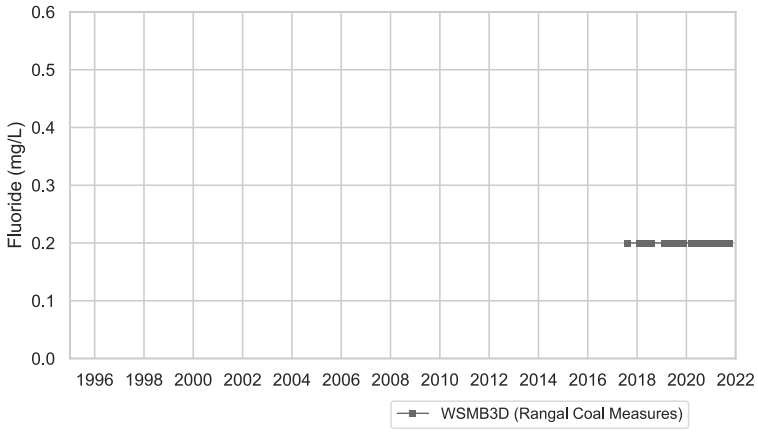

Fluoride (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

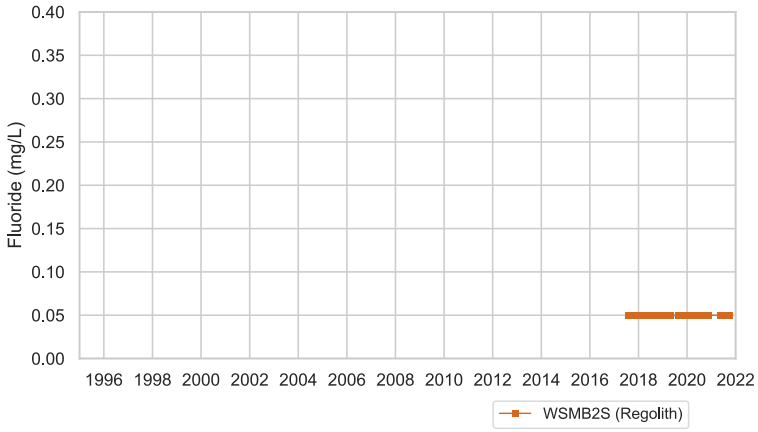

Fluoride (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

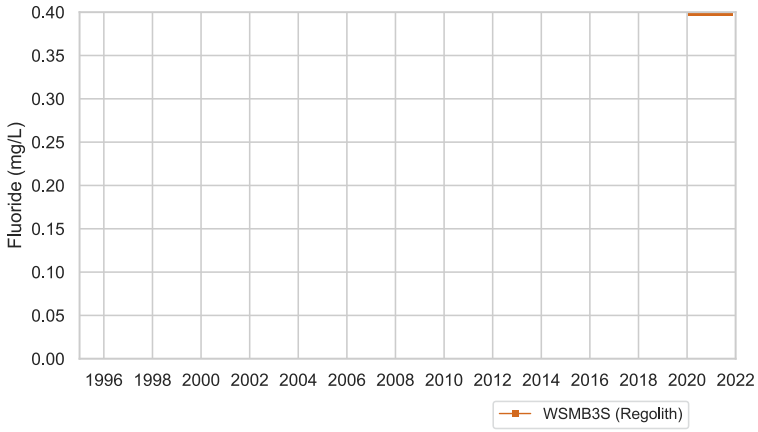

Fluoride (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

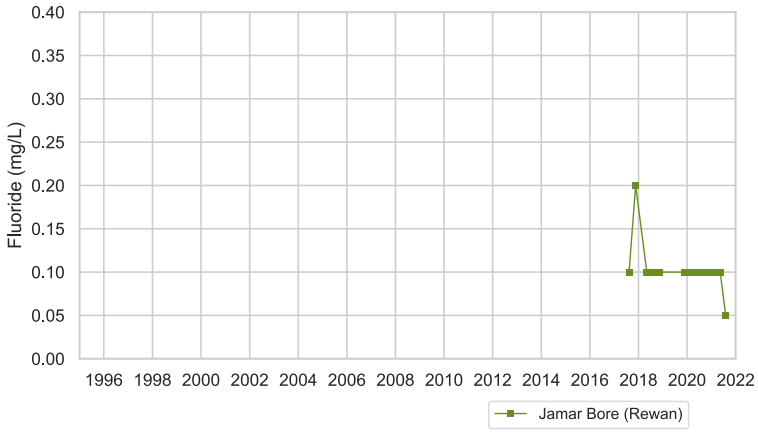

Fluoride (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

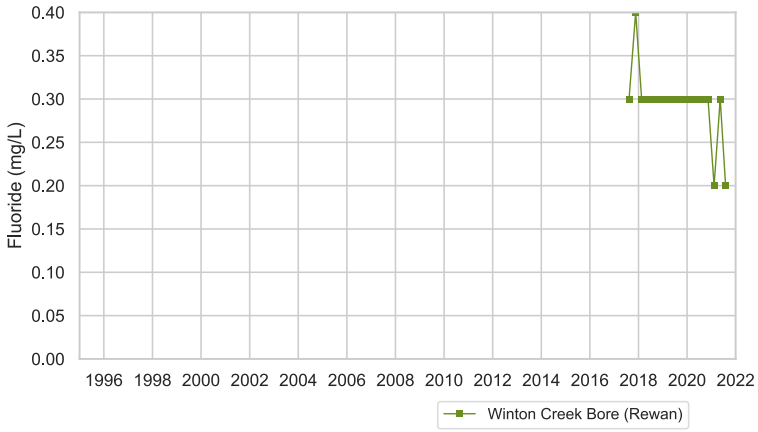

Fluoride (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

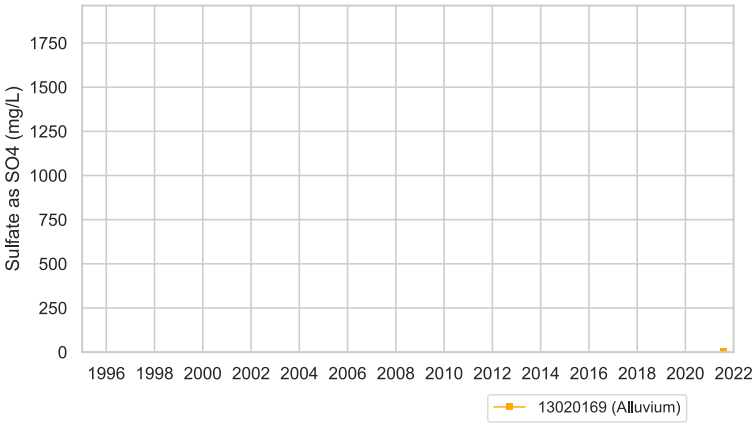

Fluoride (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

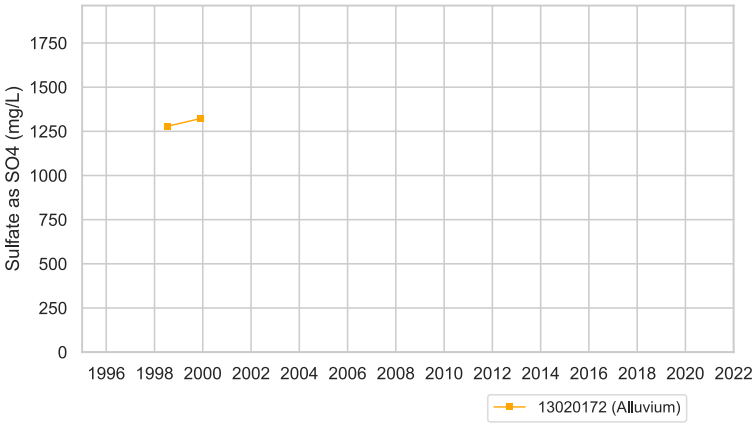

Fluoride (mg/L)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

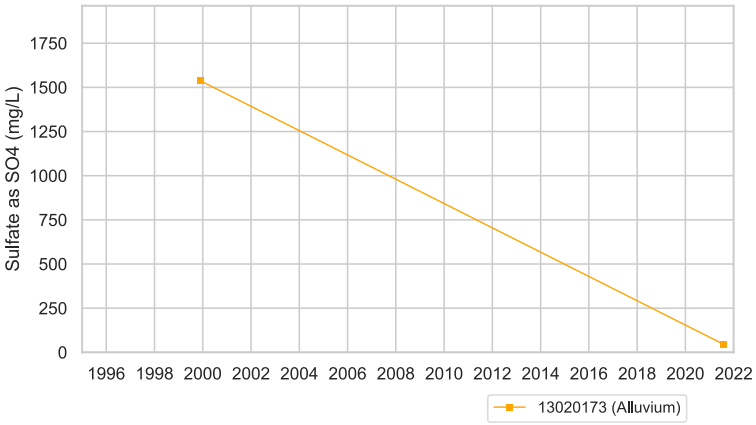

Fluoride (mg/L)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

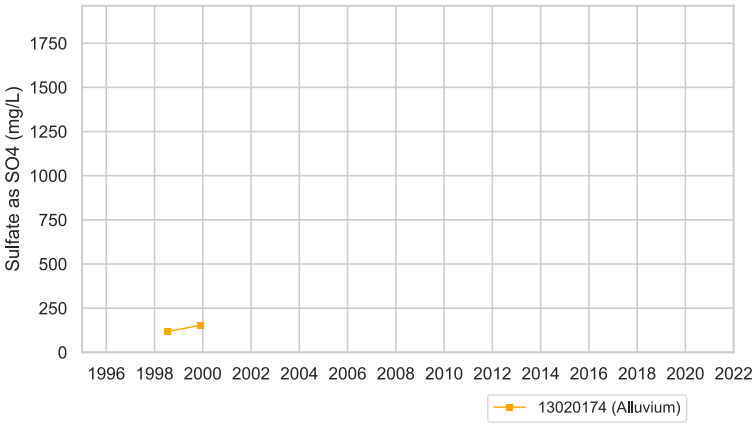

Fluoride (mg/L)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

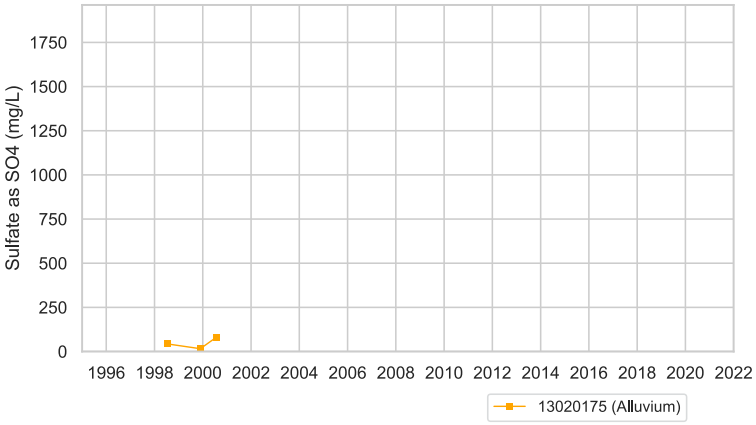

Fluoride (mg/L)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

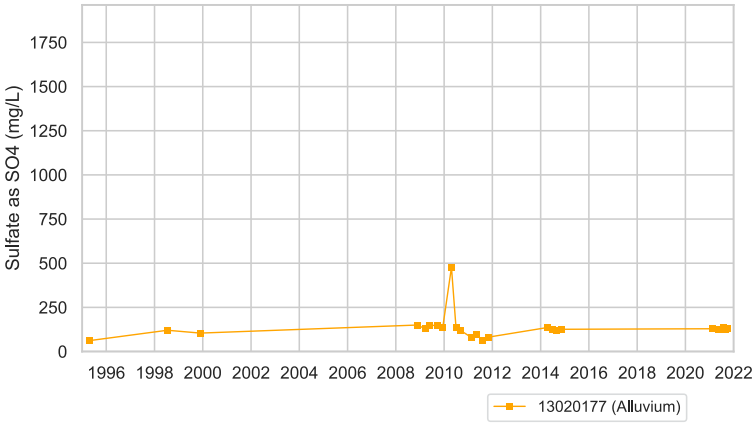

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

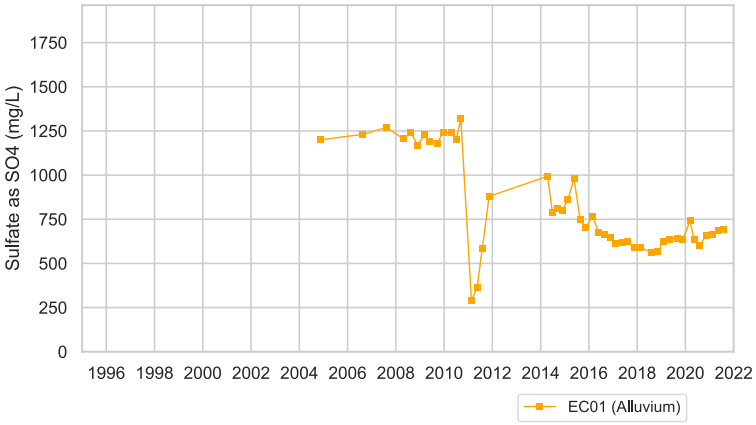

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

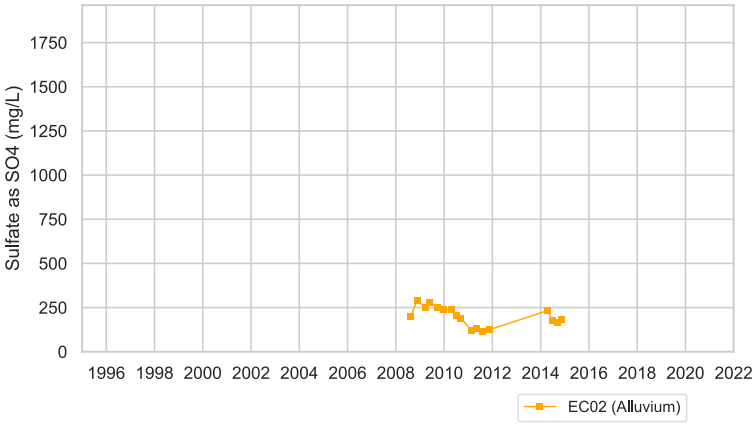

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

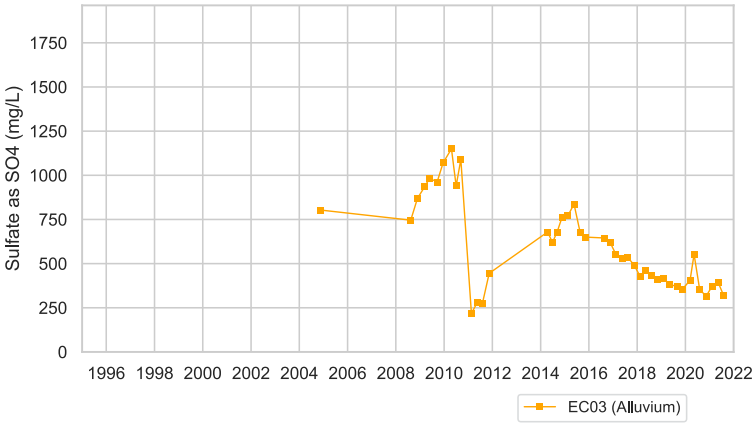

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

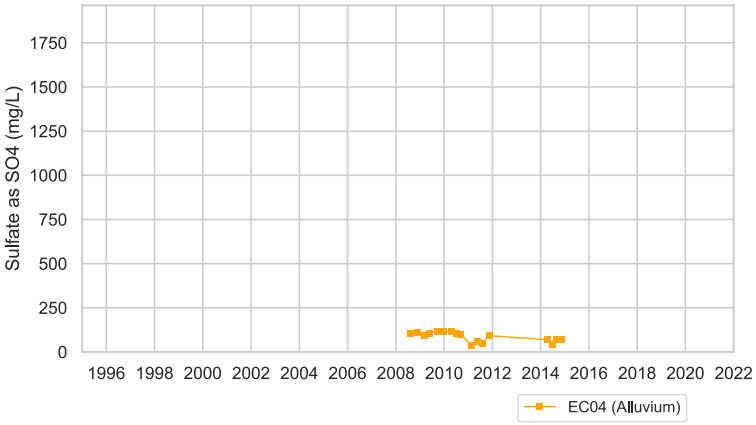

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

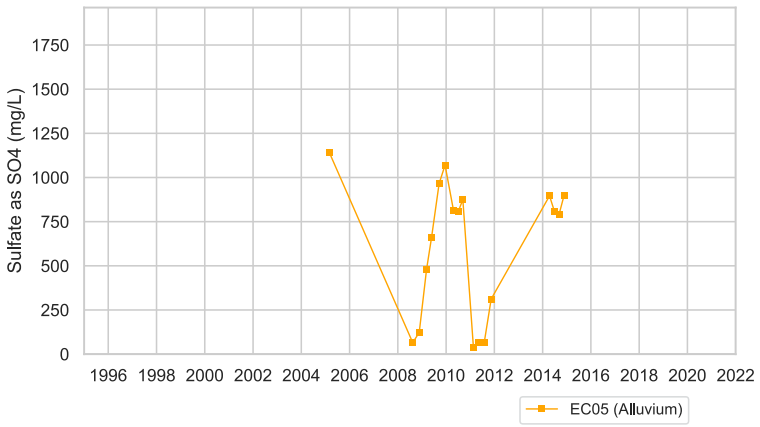

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

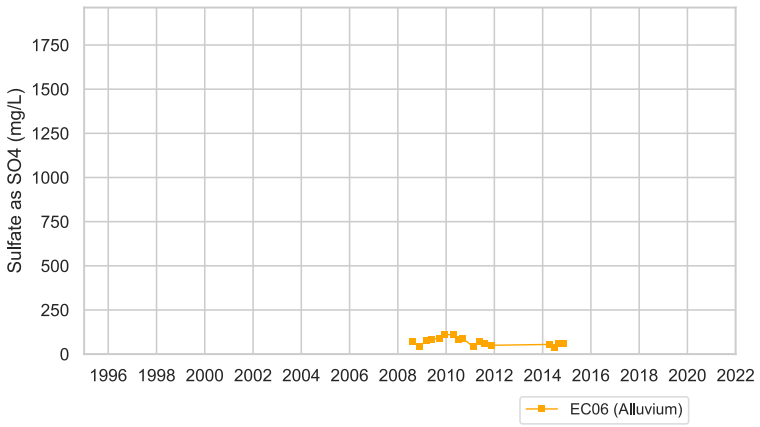

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

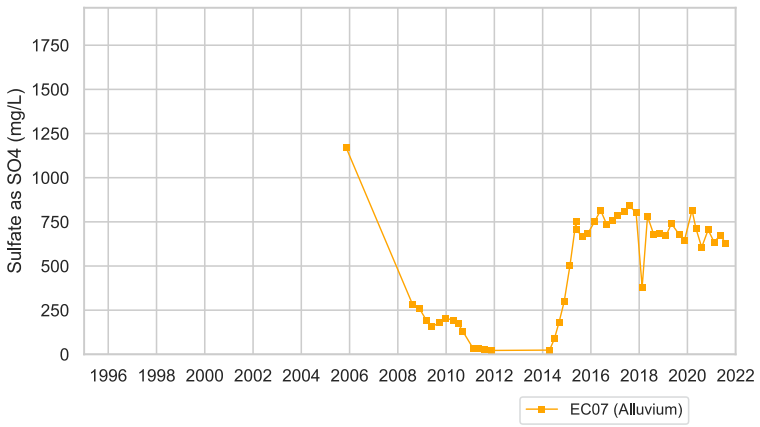

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

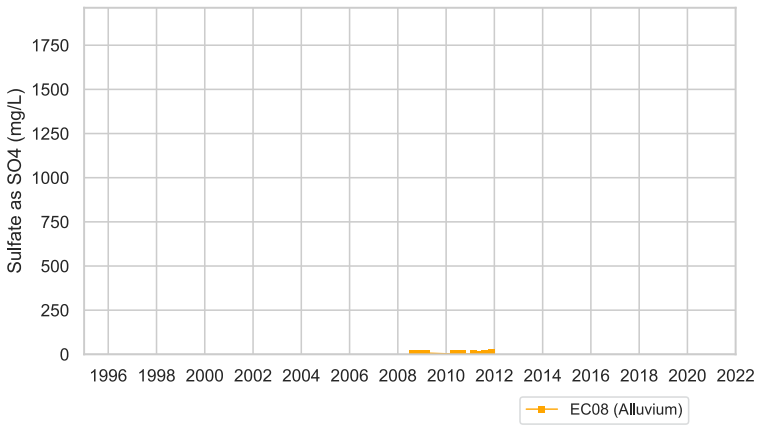

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

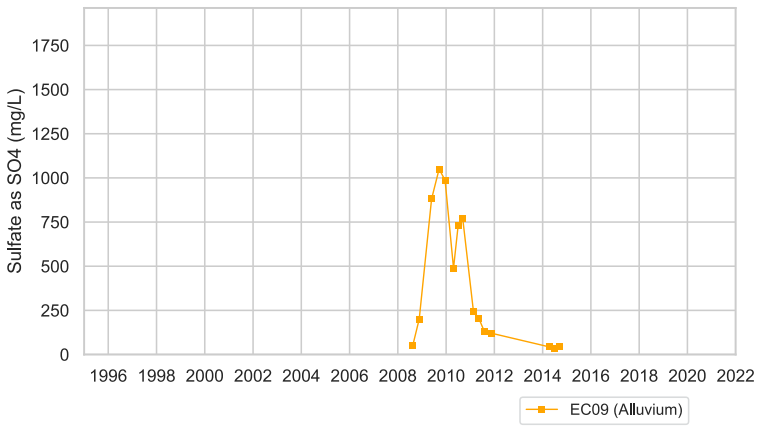

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

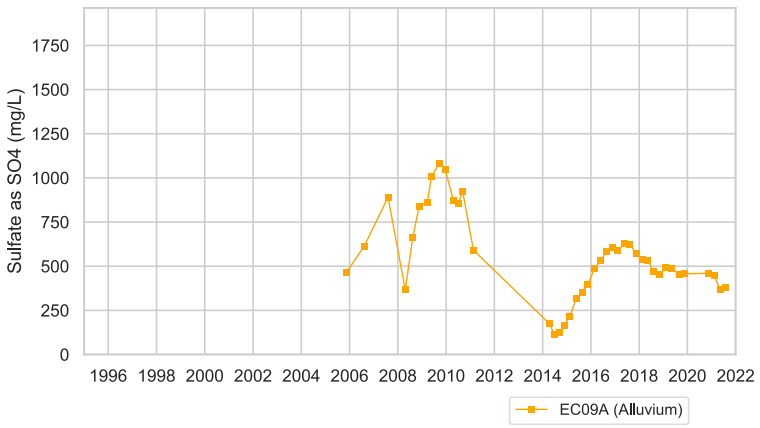

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

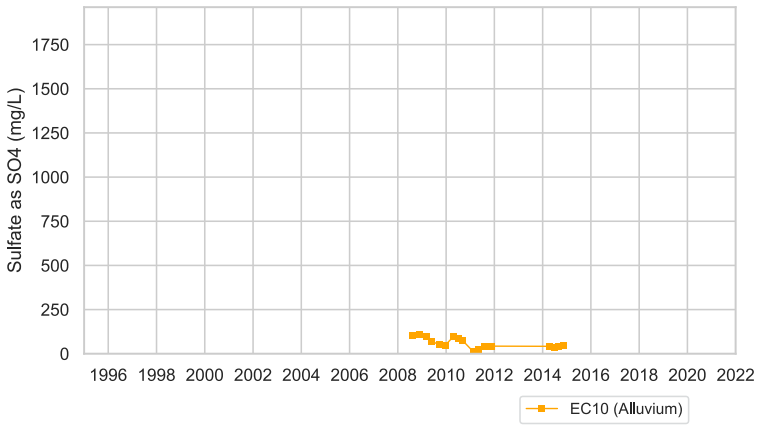

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

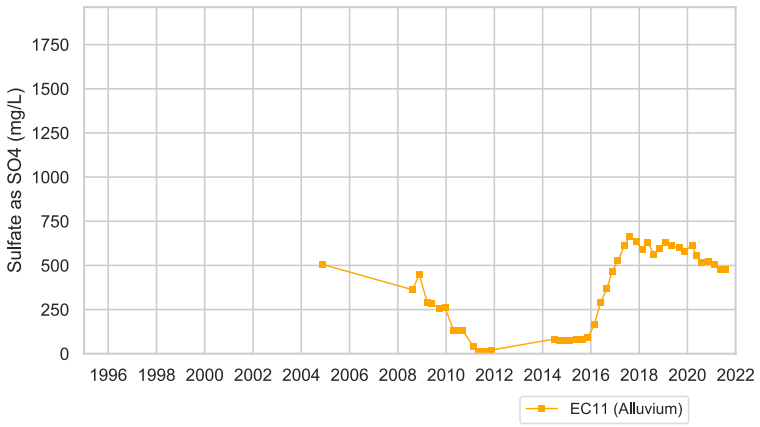

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

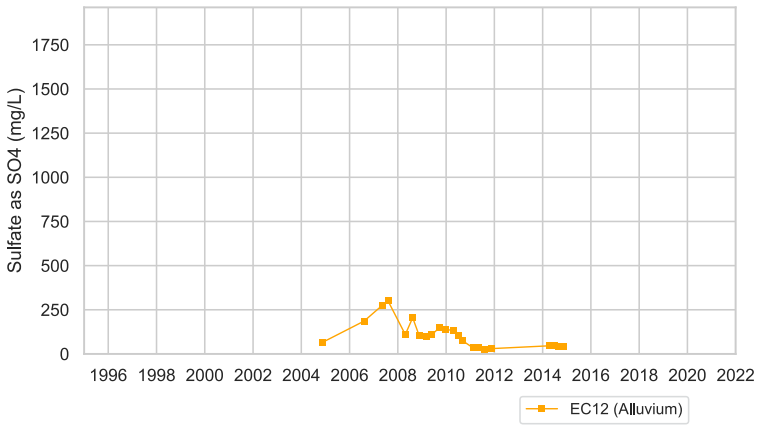

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

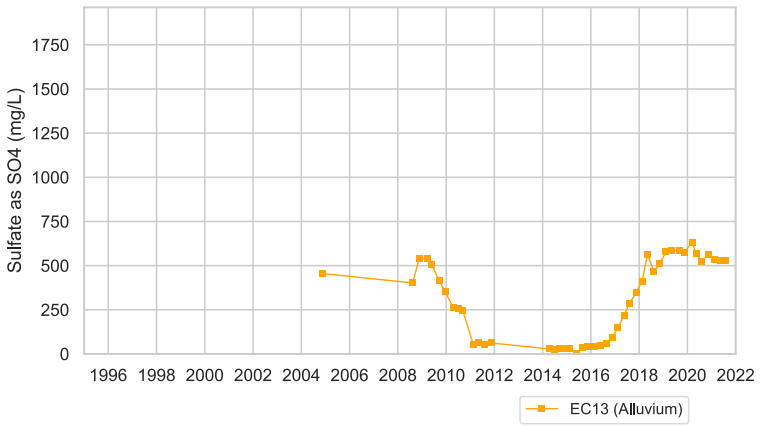

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

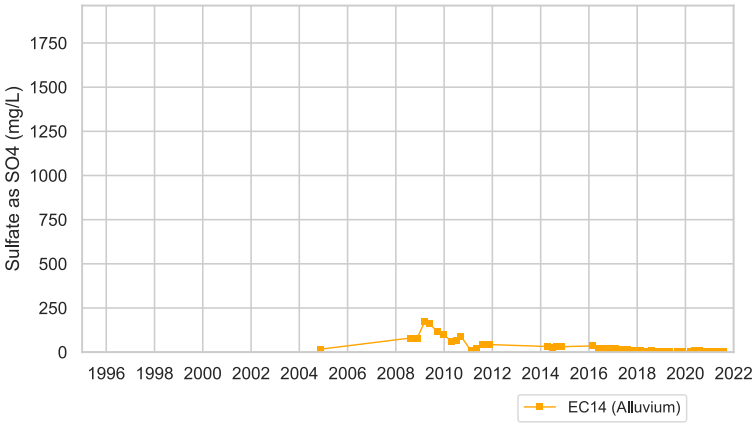

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

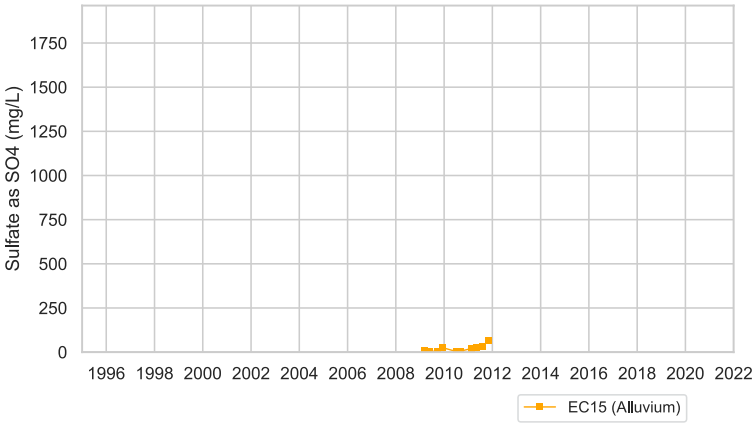

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

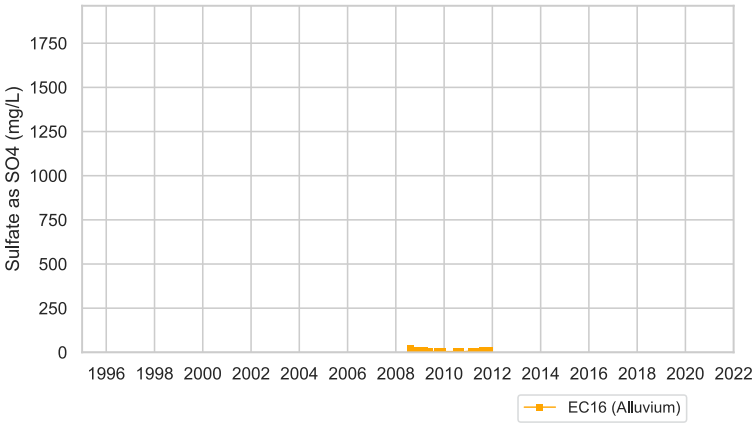

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

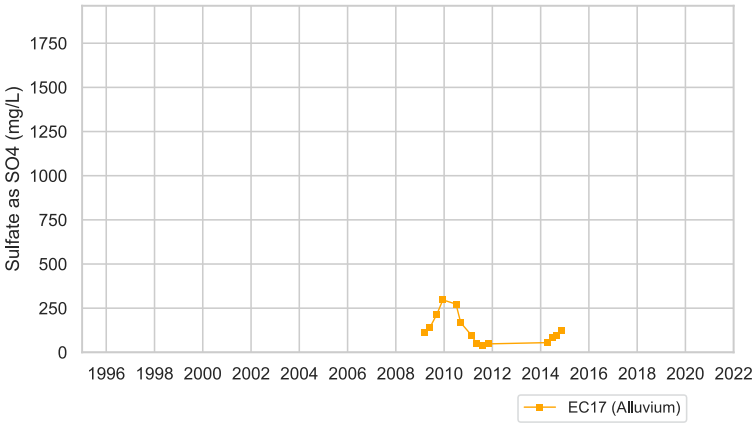

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

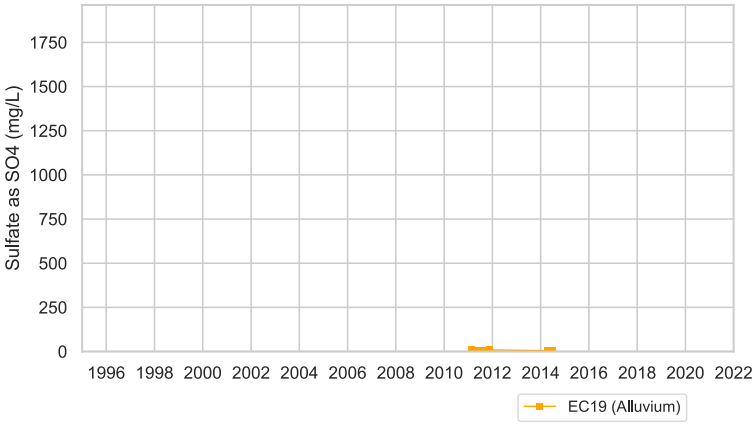

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

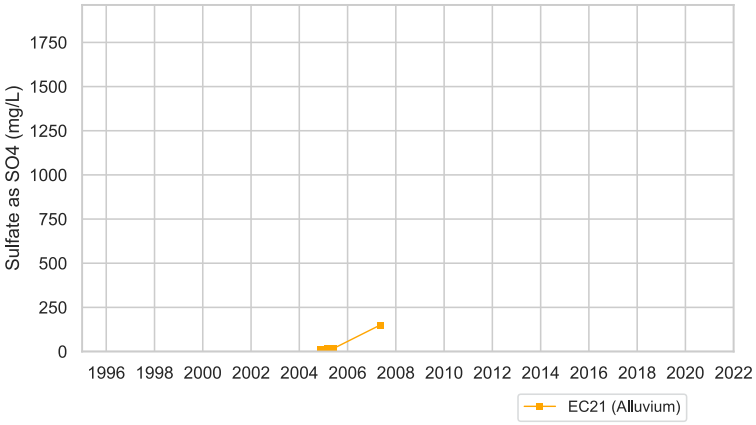

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

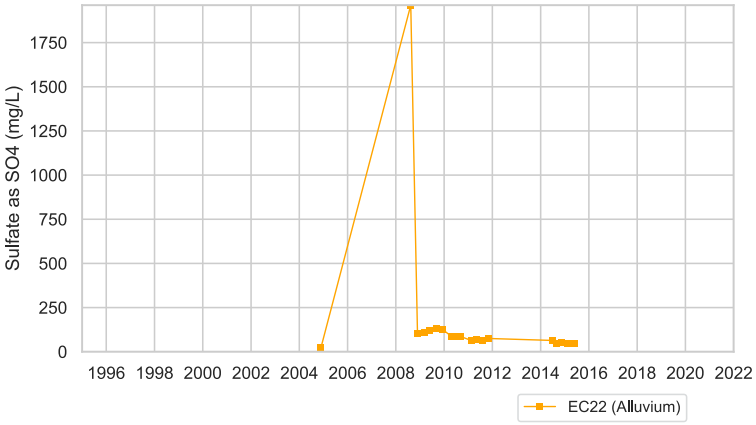

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

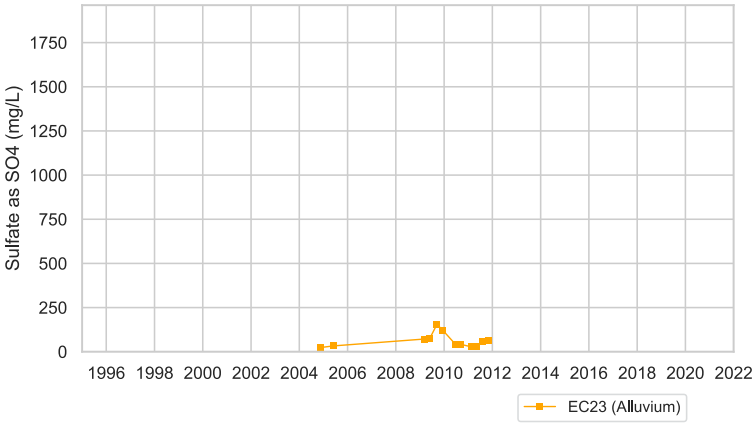

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

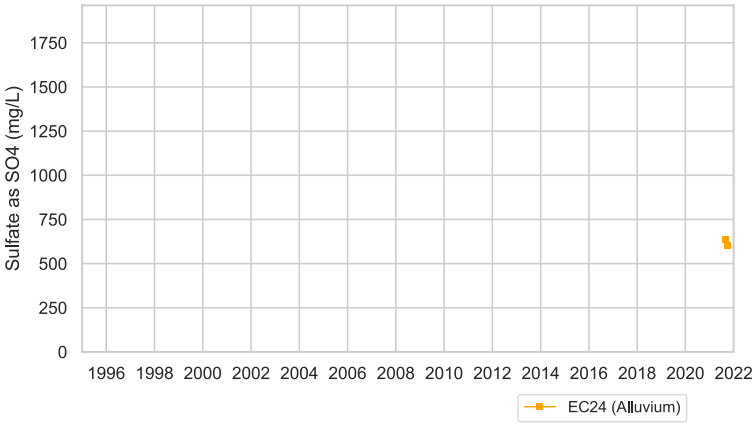

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

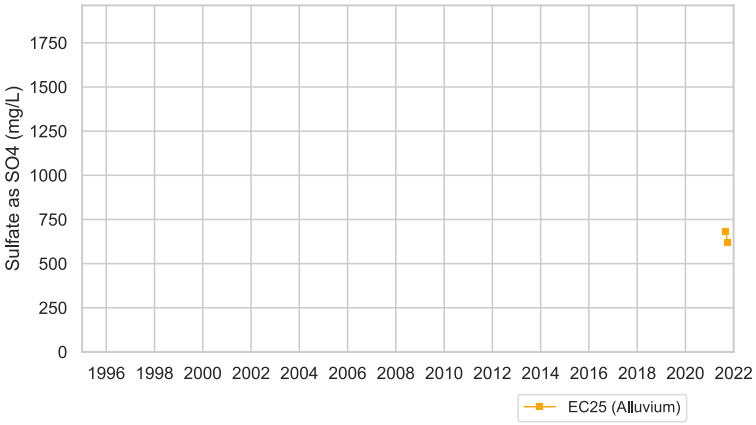

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

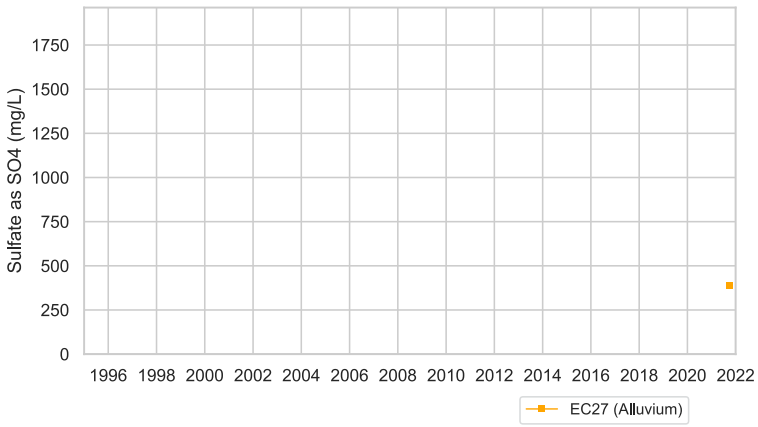

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

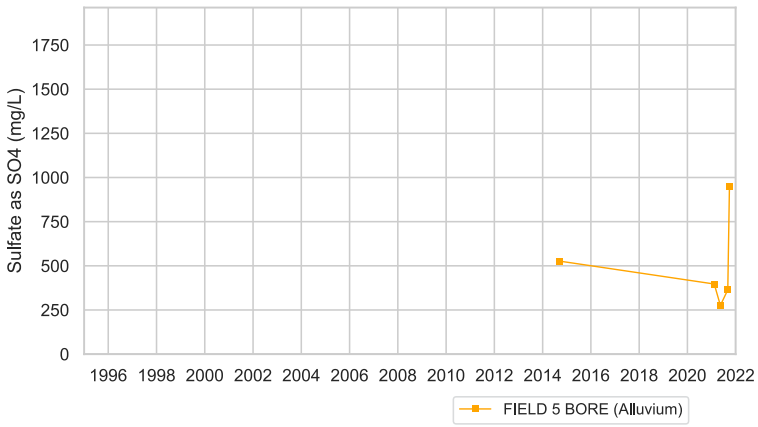

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

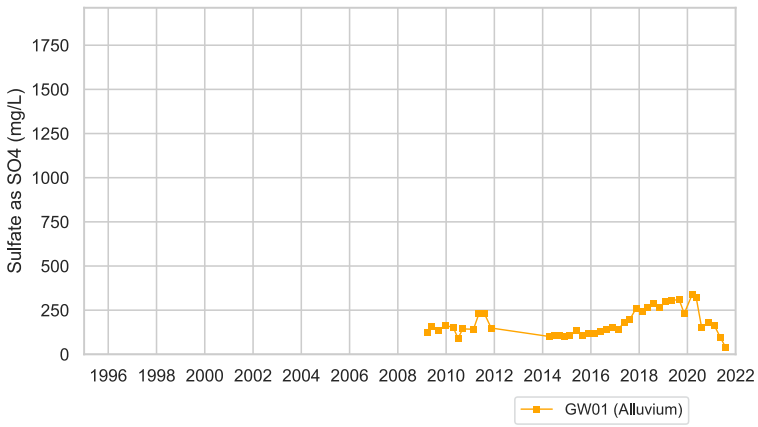

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

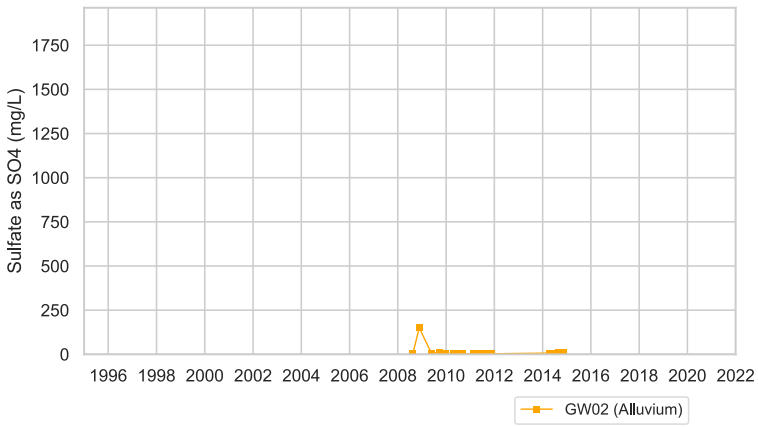

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

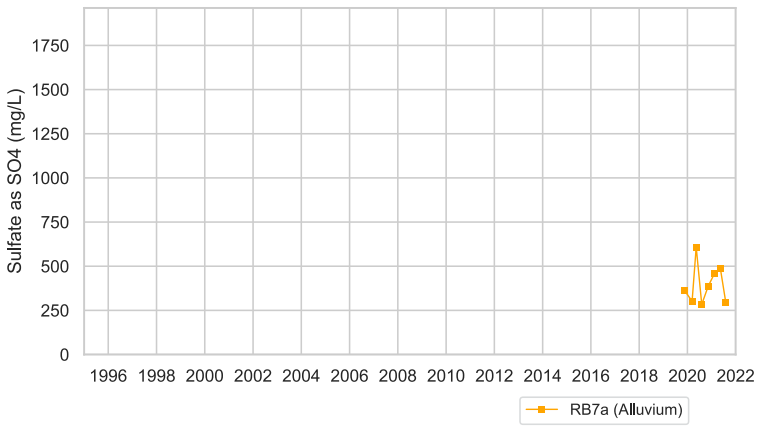

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

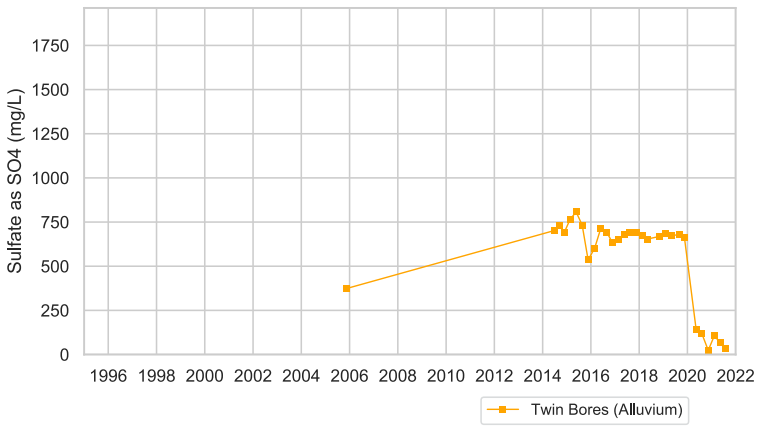

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC27 (Alluvium)

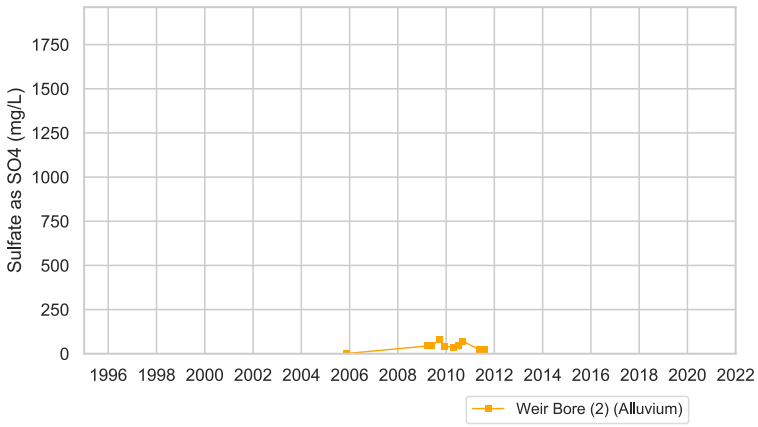

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

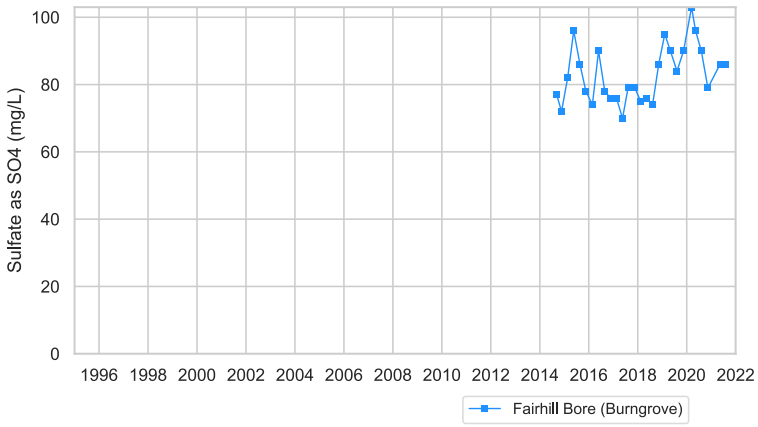

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

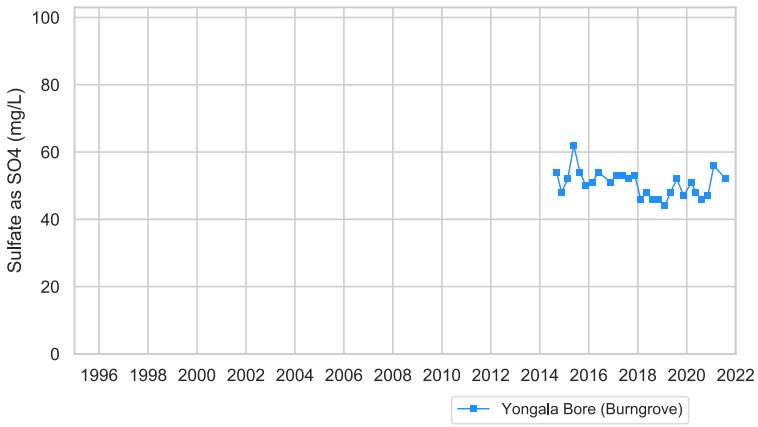

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

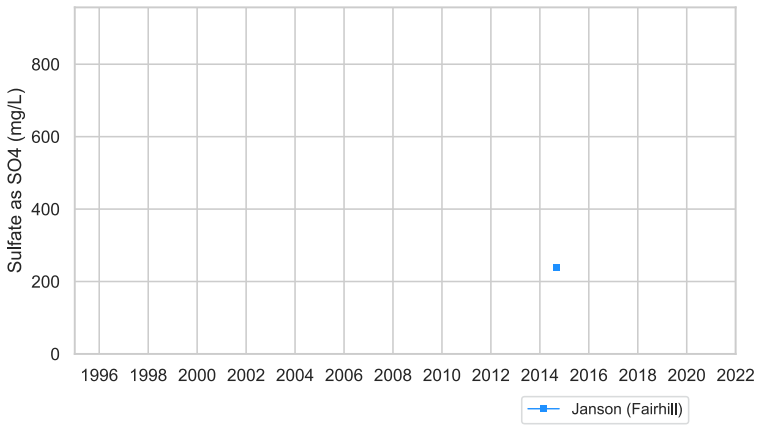

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

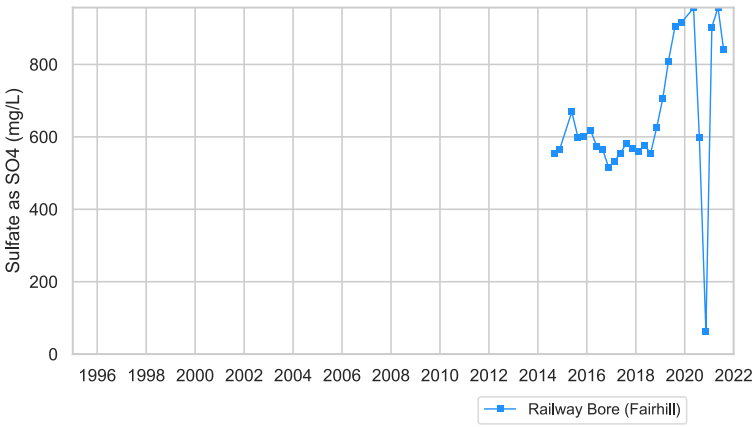

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

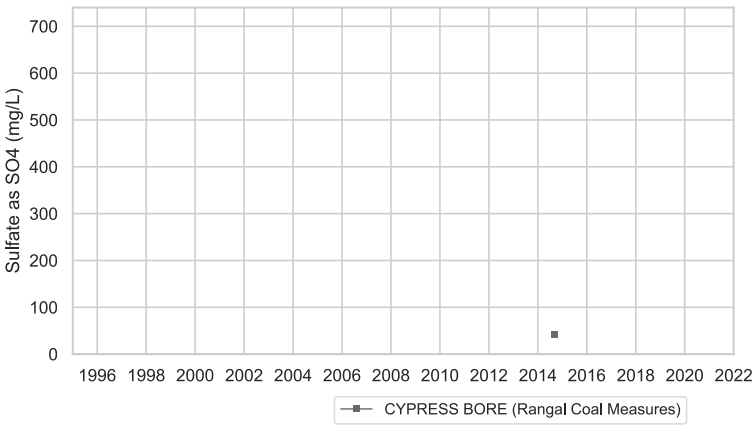

Sulfate as SO4 (mg/L)
0
250
500
750
1000
1250
1500
1750
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

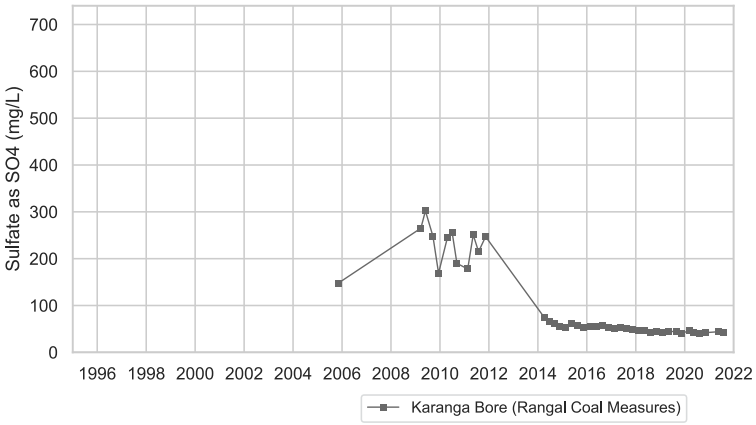

Sulfate as SO4 (mg/L)
0
20
40
60
80
100
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

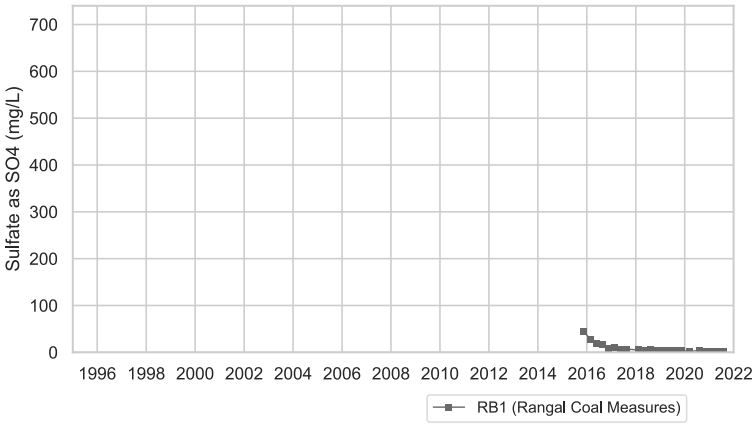

Sulfate as SO4 (mg/L)
0
20
40
60
80
100
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

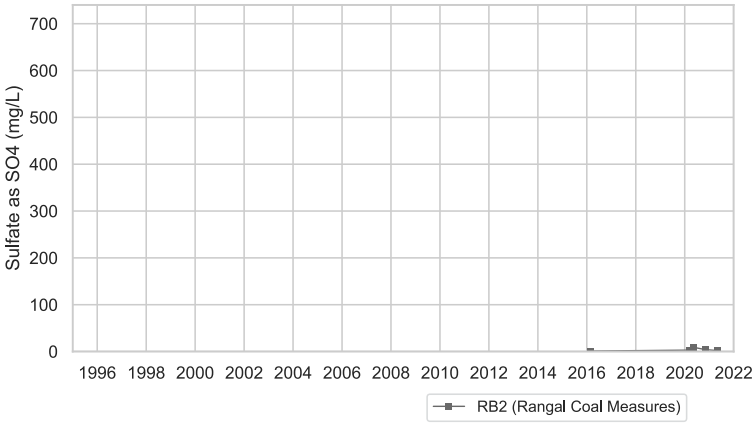

Sulfate as SO4 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

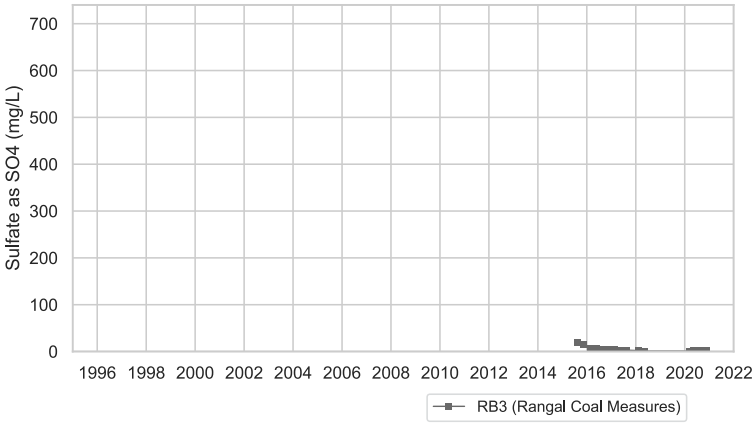

Sulfate as SO4 (mg/L)
0
200
400
600
800
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

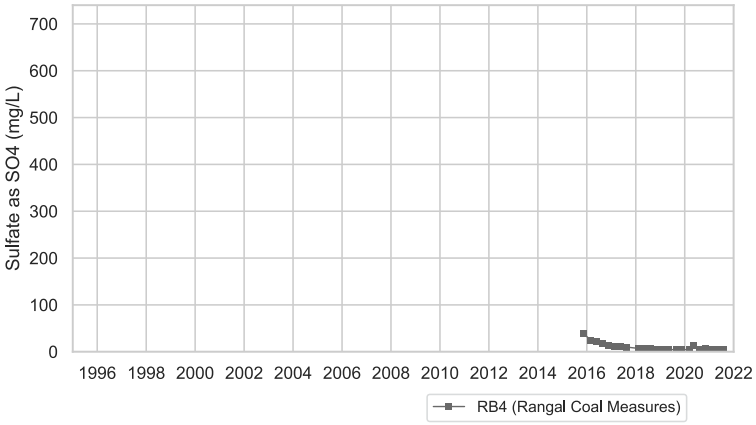

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

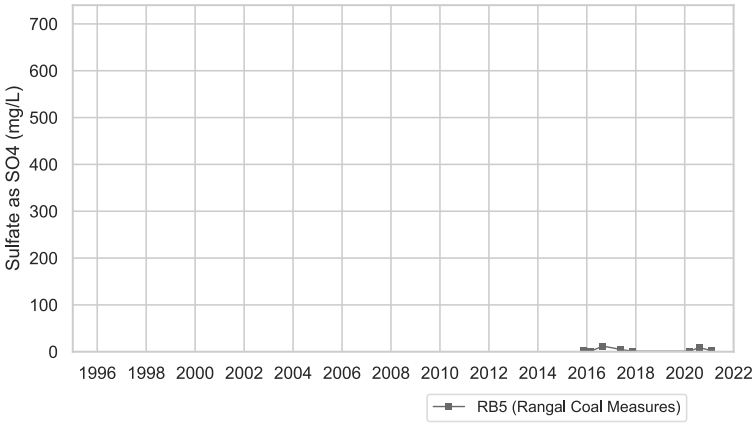

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

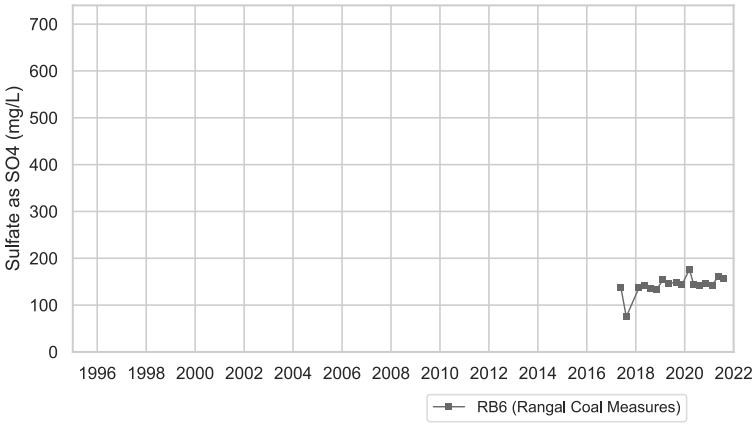

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

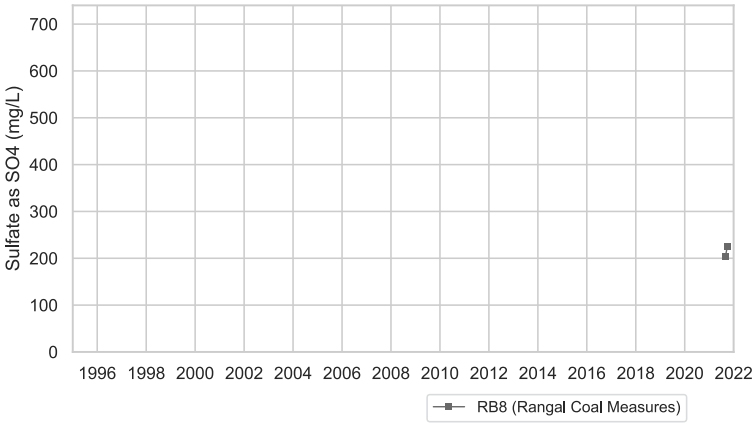

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

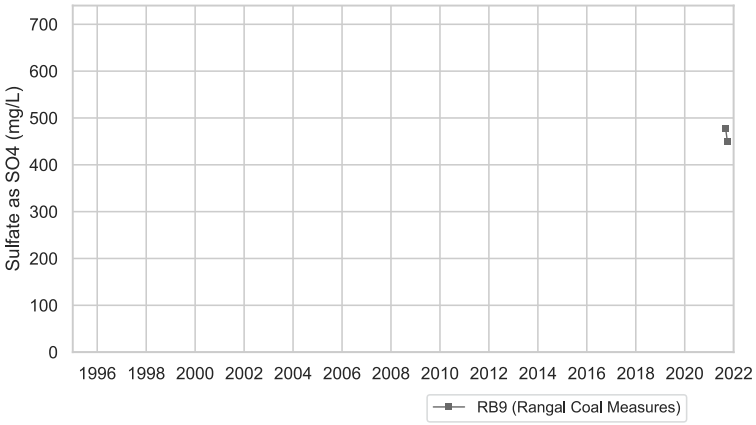

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

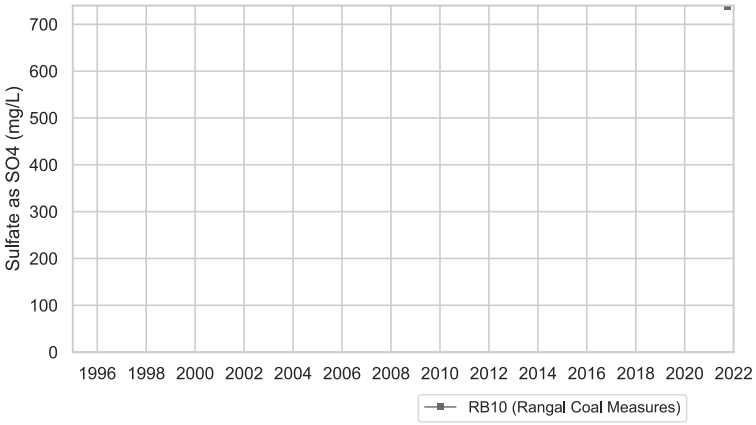

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

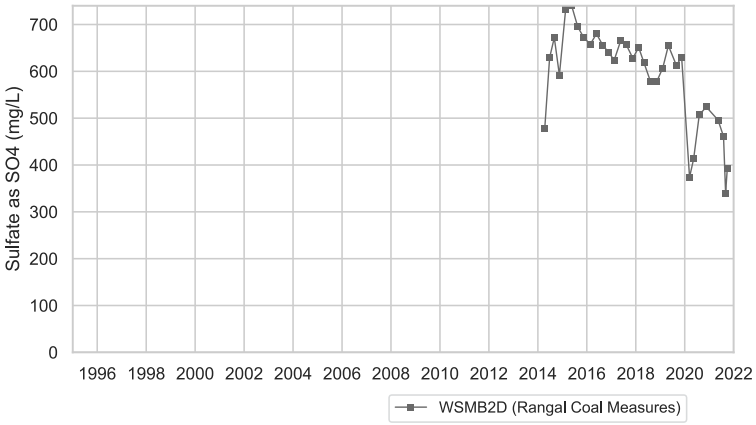

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

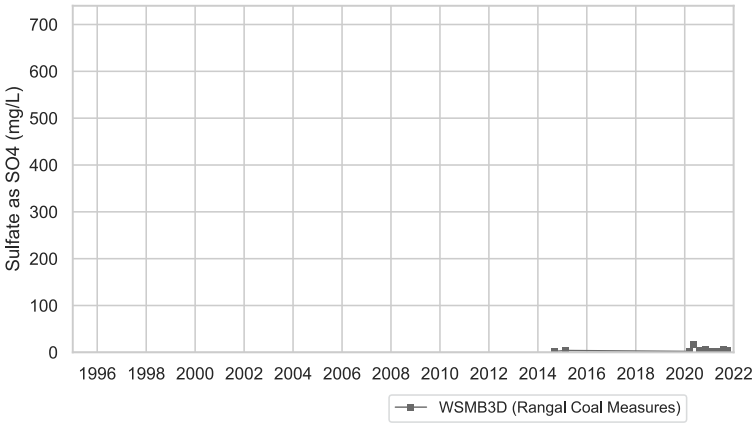

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

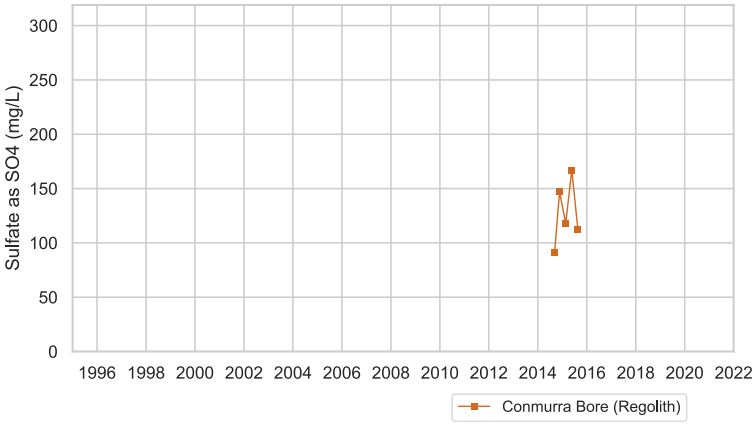

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

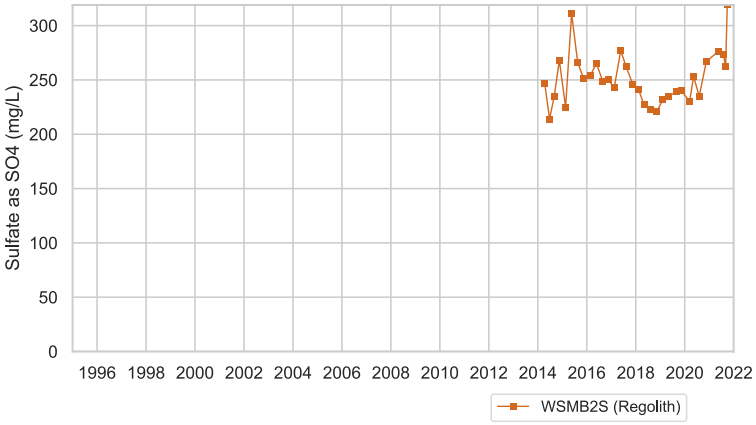

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)


Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

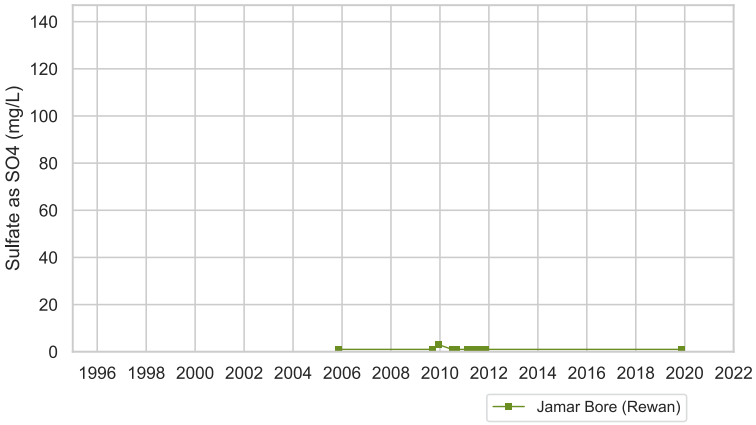

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

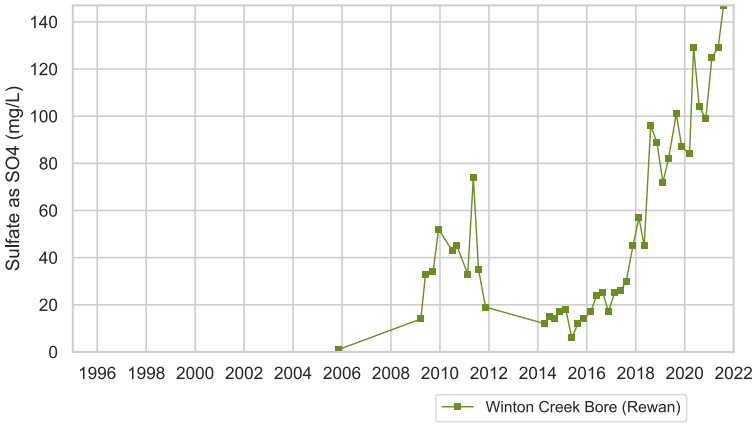

Sulfate as SO4 (mg/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

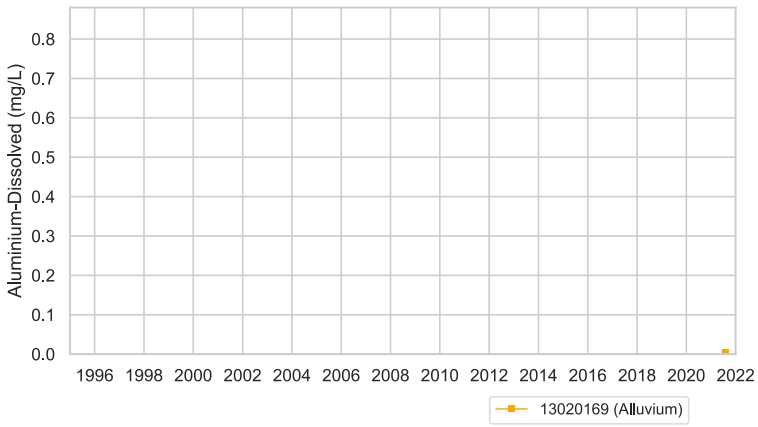

Sulfate as SO4 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

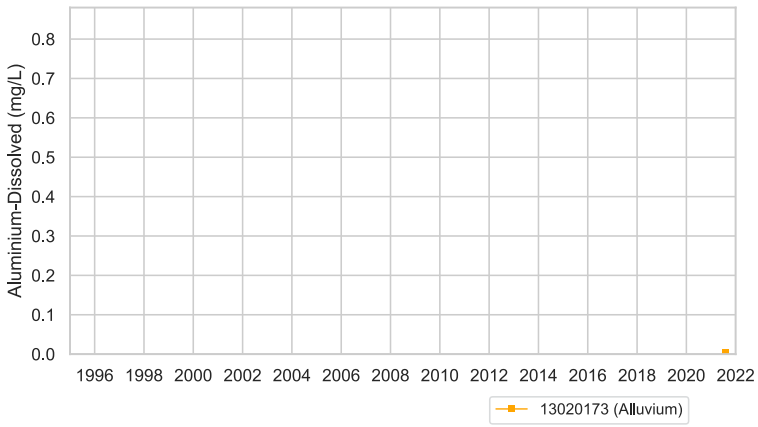

Sulfate as SO4 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

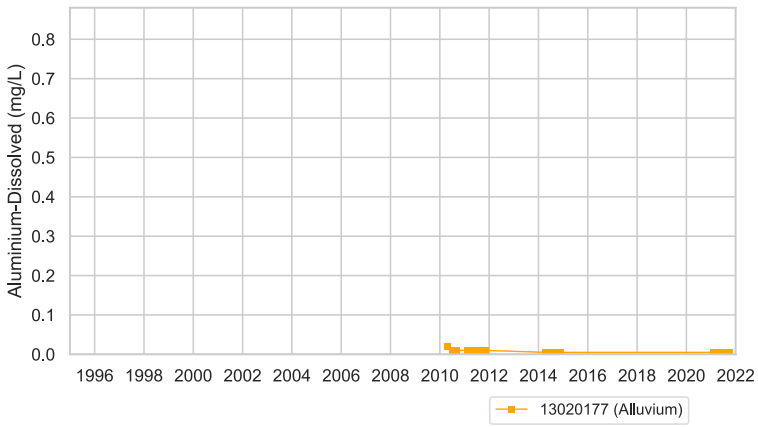
Sulfate as SO4 (mg/L)
0
50
100
150
200
250
300
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

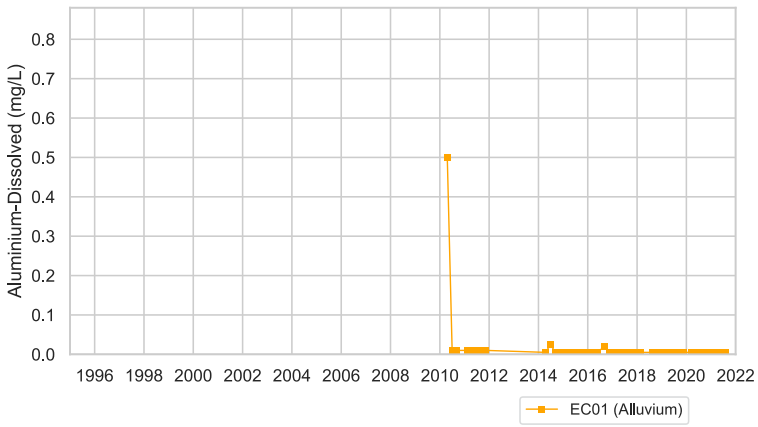

Sulfate as SO4 (mg/L)
0
20
40
60
80
100
120
140
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

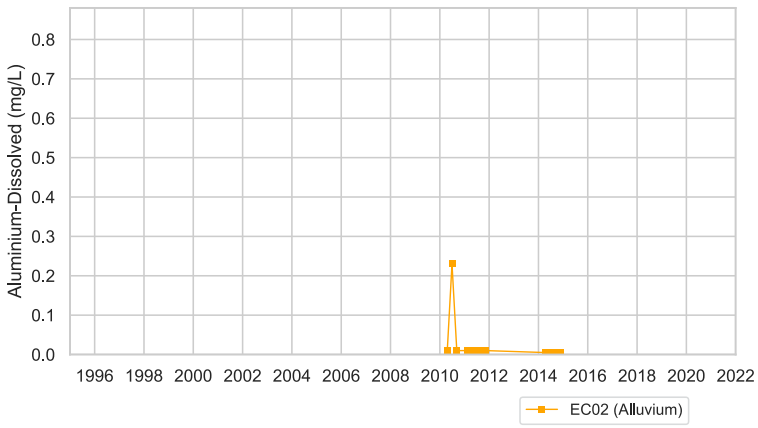

Sulfate as SO4 (mg/L)
0
20
40
60
80
100
120
140
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

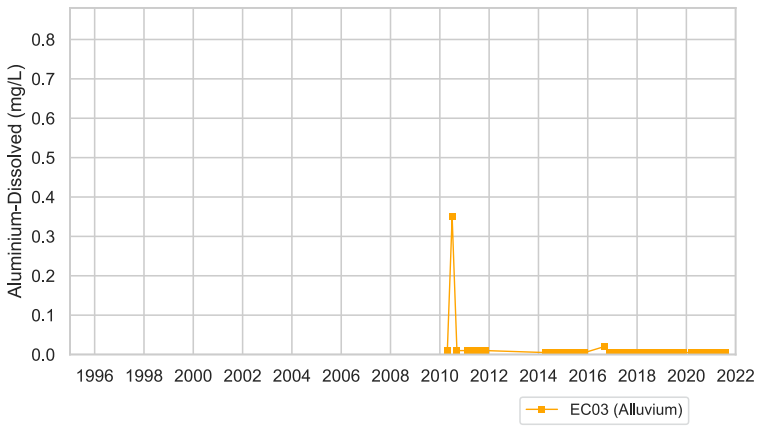

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

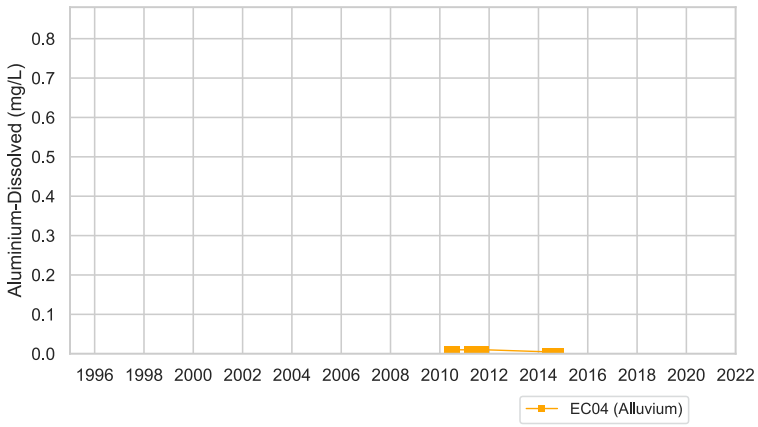

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

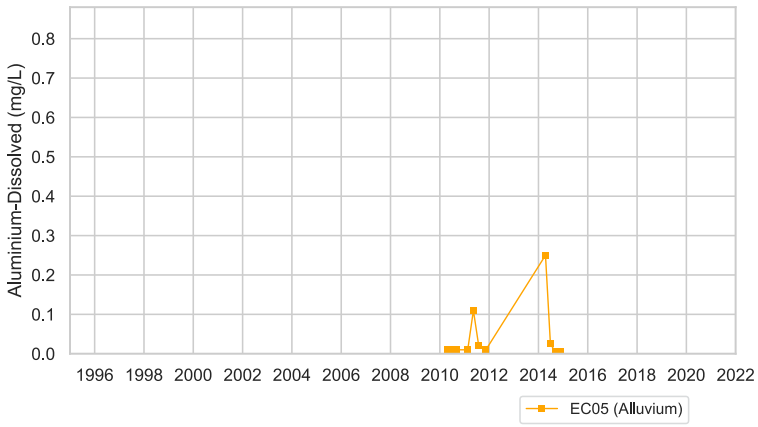

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

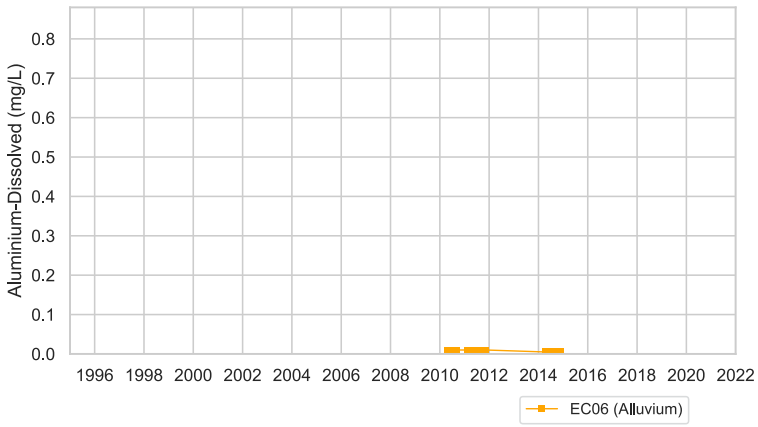

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

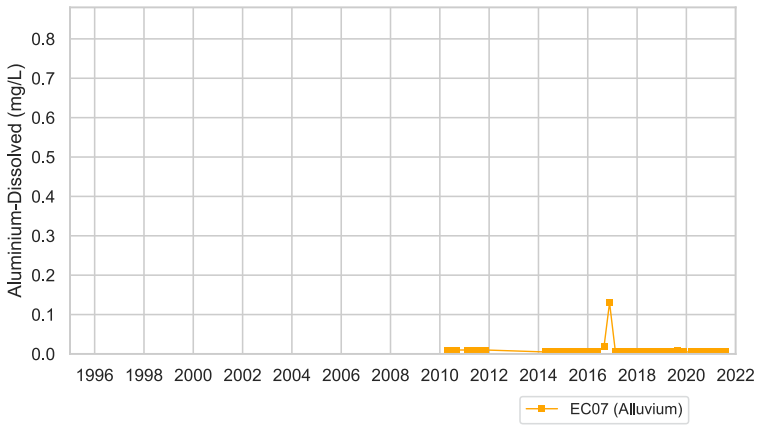

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

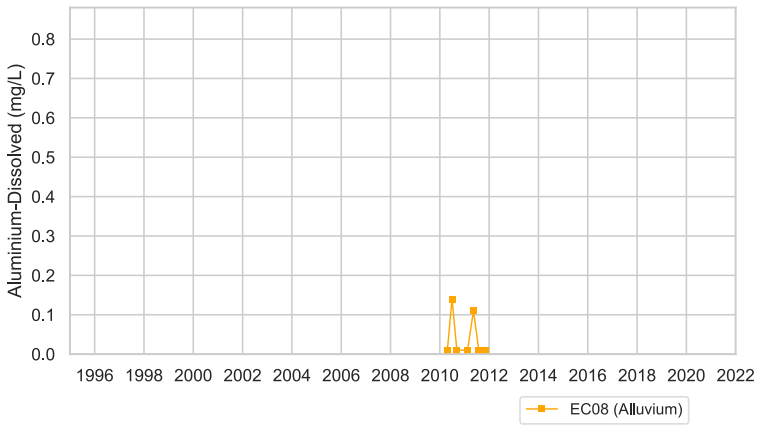

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

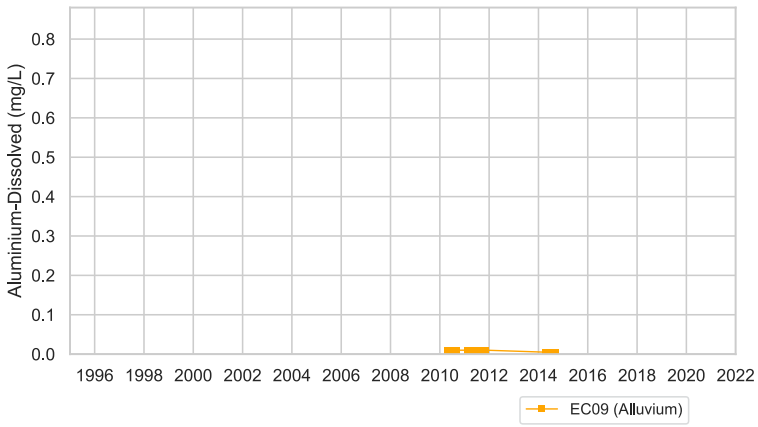

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

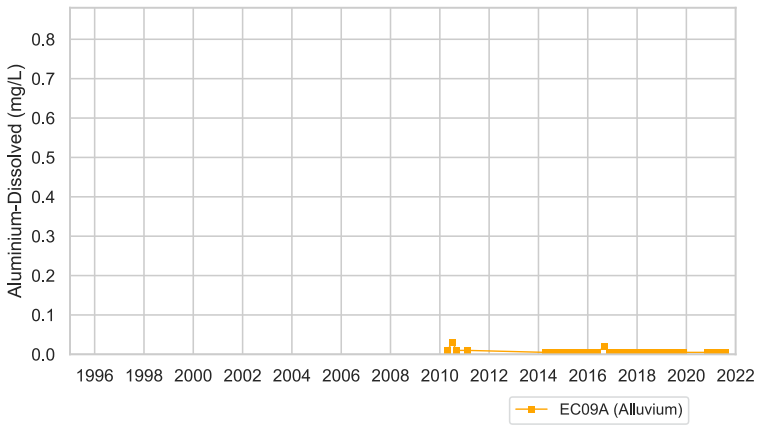

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

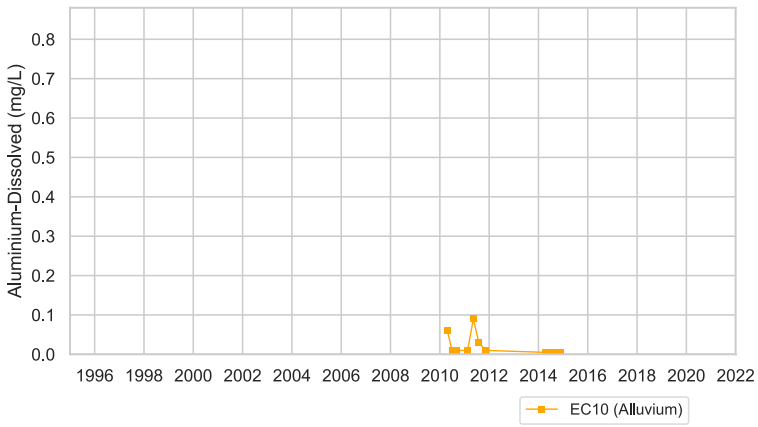

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

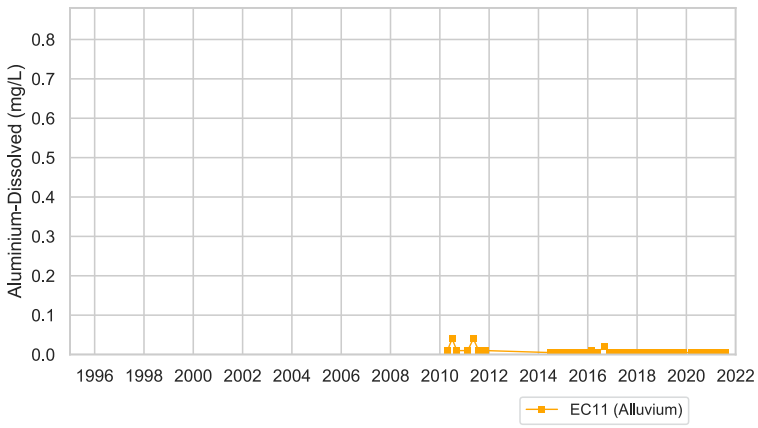

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

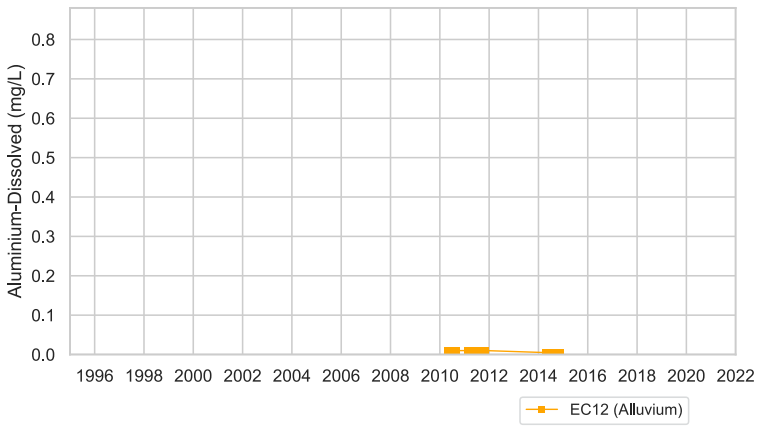

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

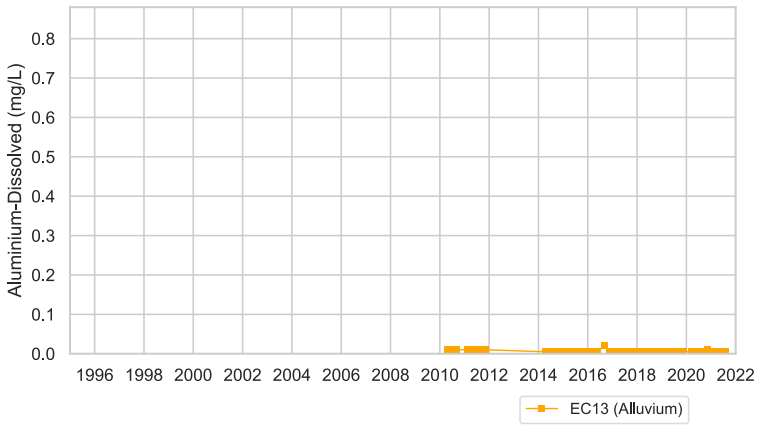

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

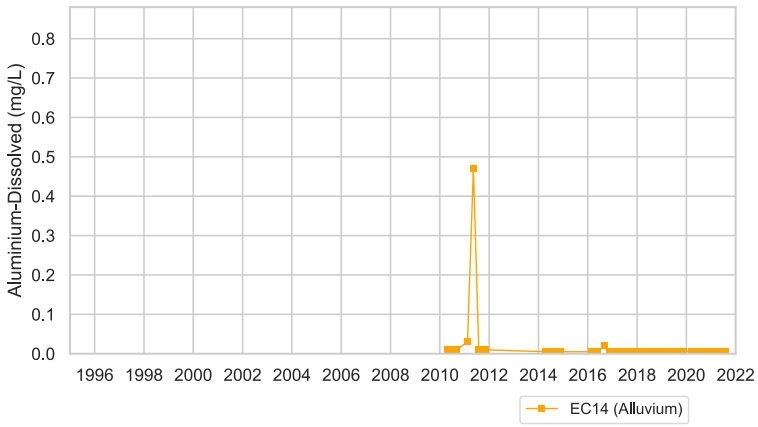

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

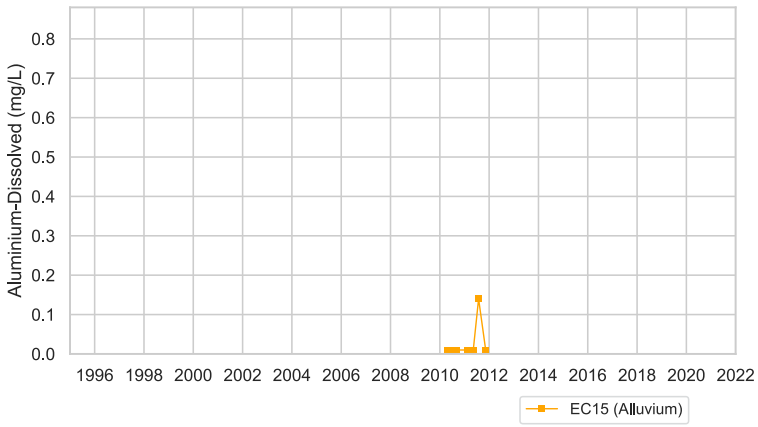

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

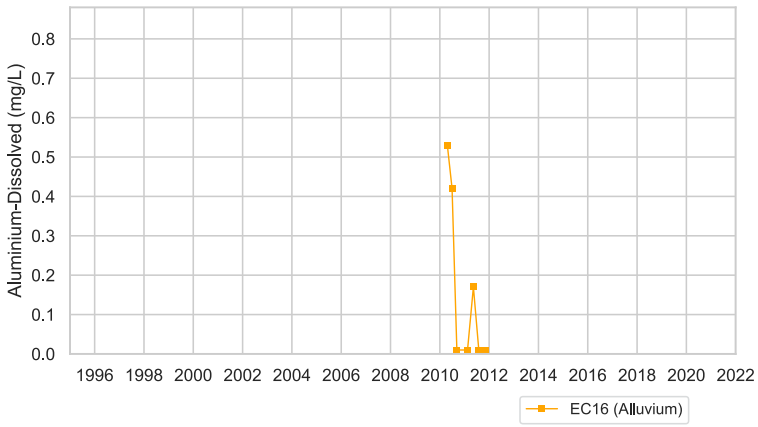

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

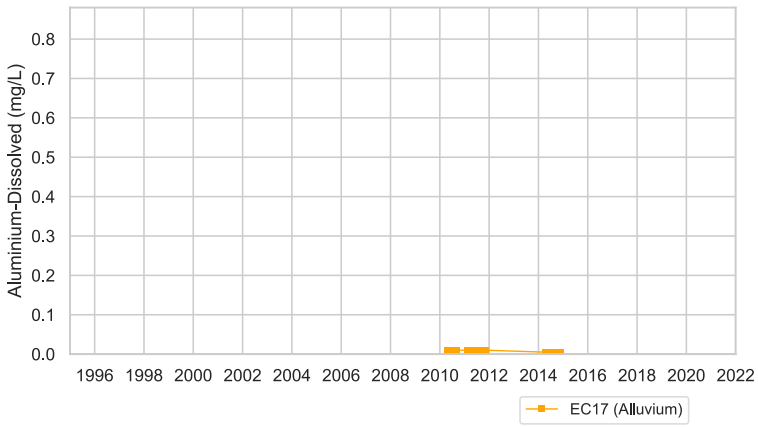

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

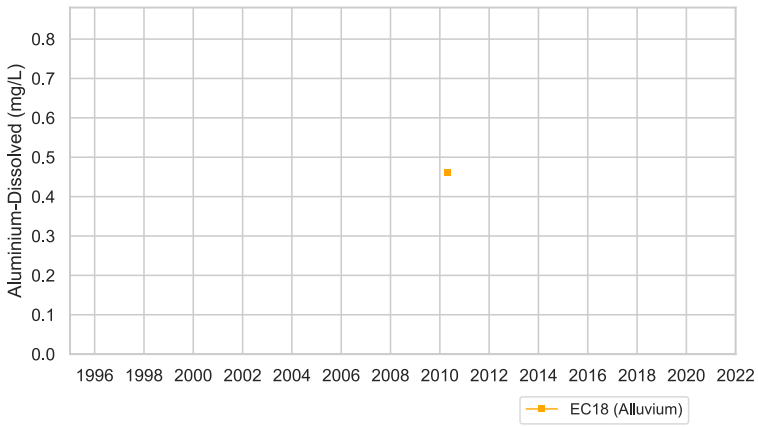

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

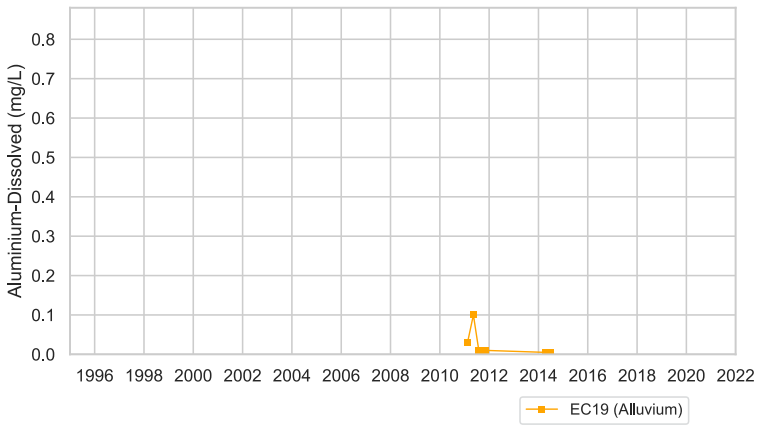

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

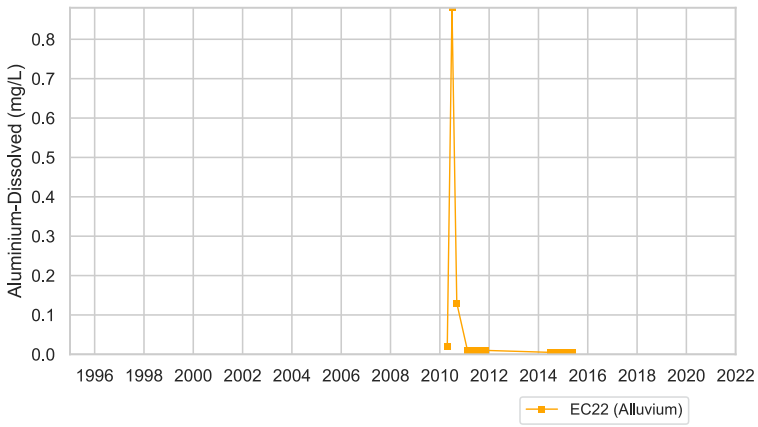

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

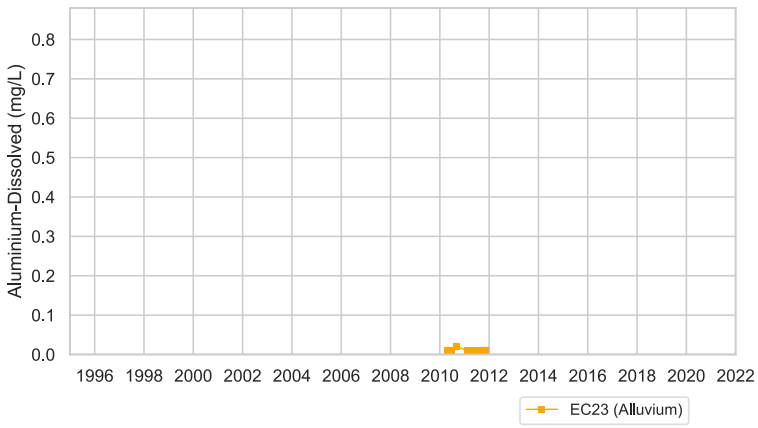

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

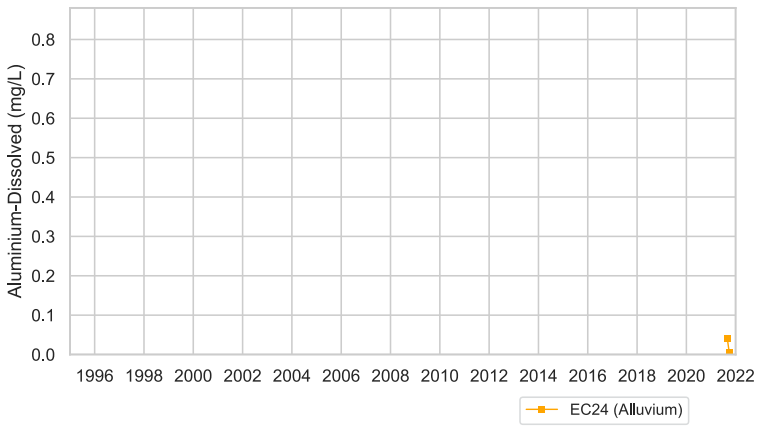

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

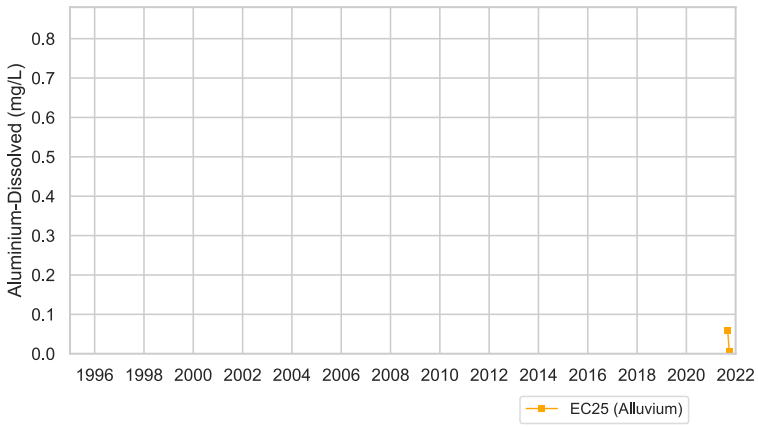

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

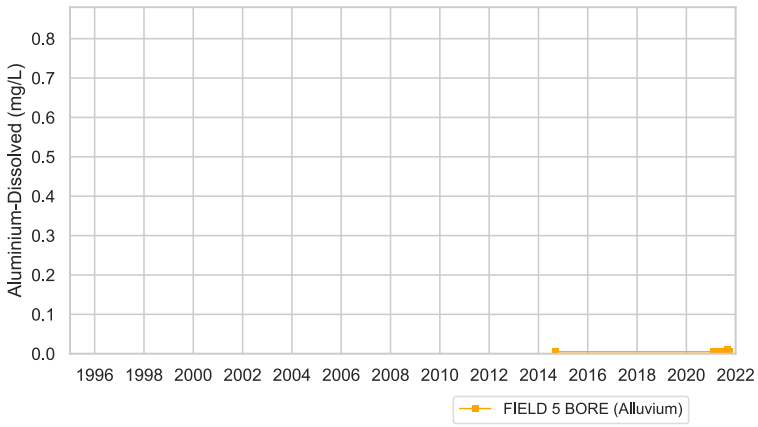

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

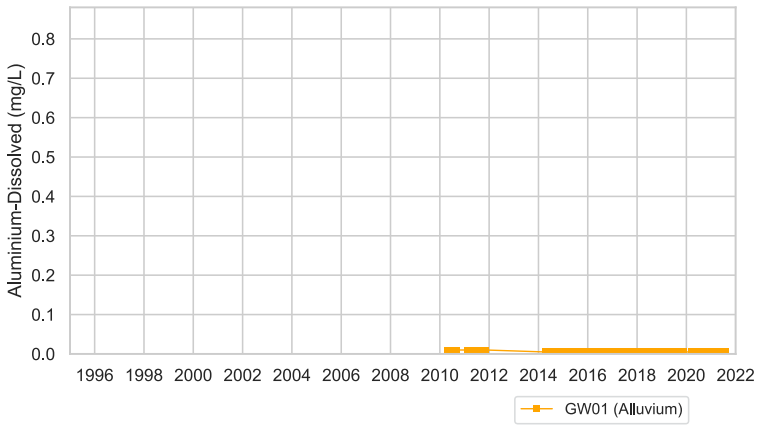

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

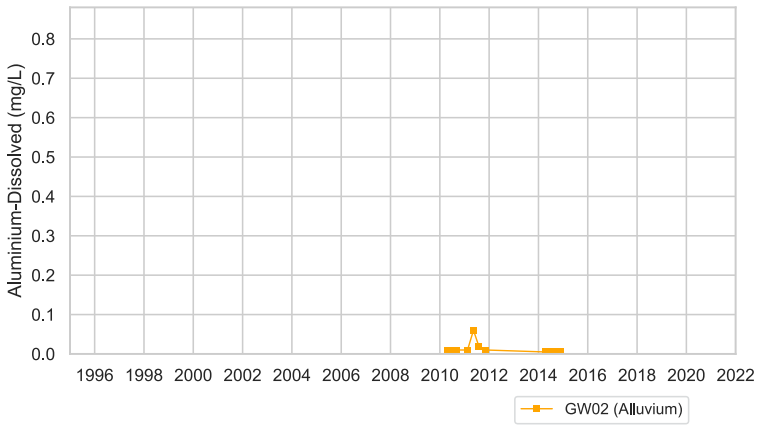

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

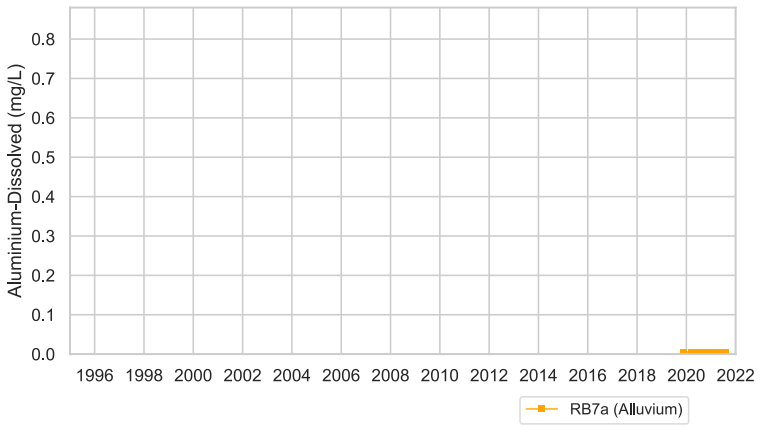

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

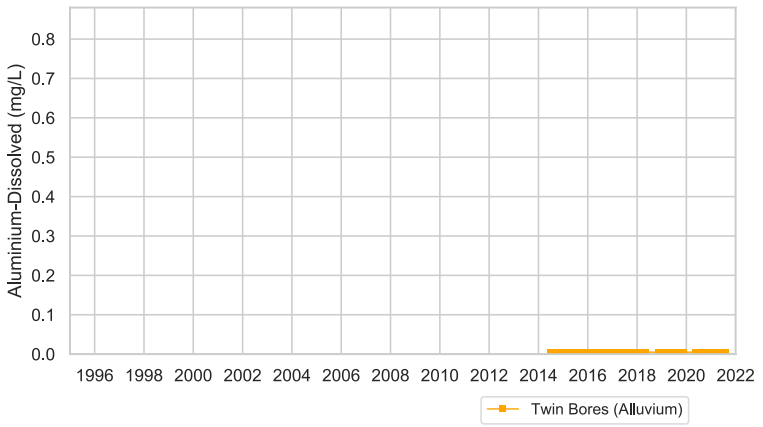

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

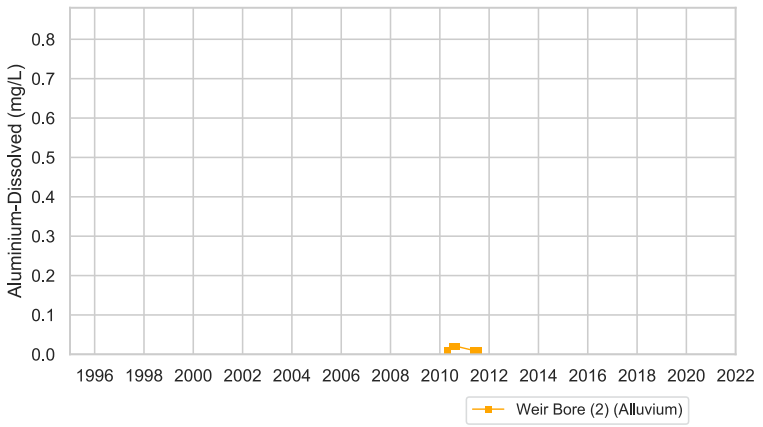

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

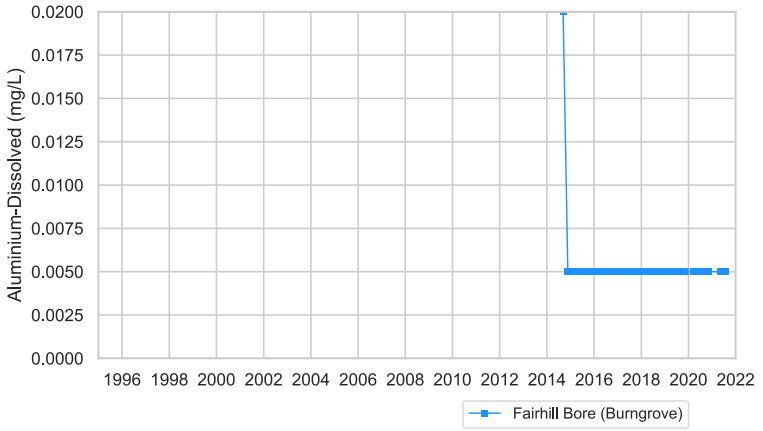

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

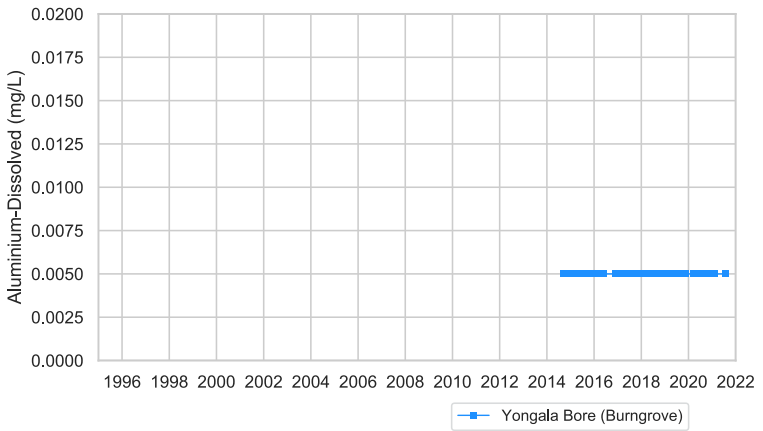

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

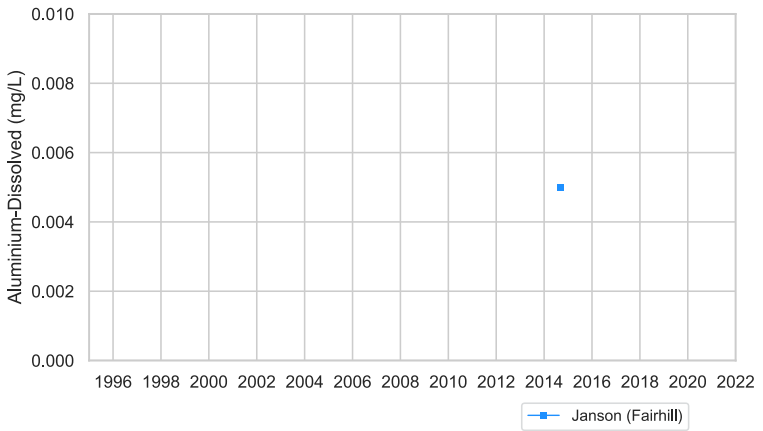

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

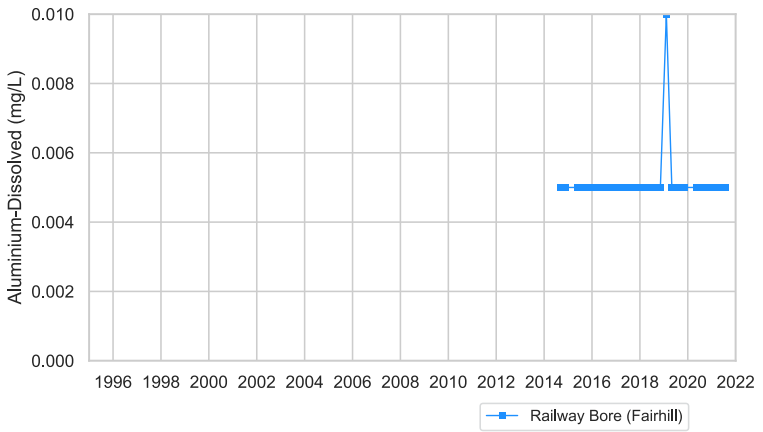

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

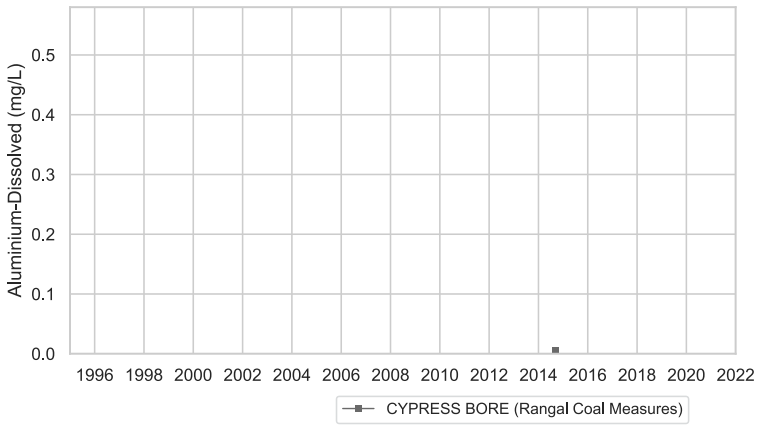

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

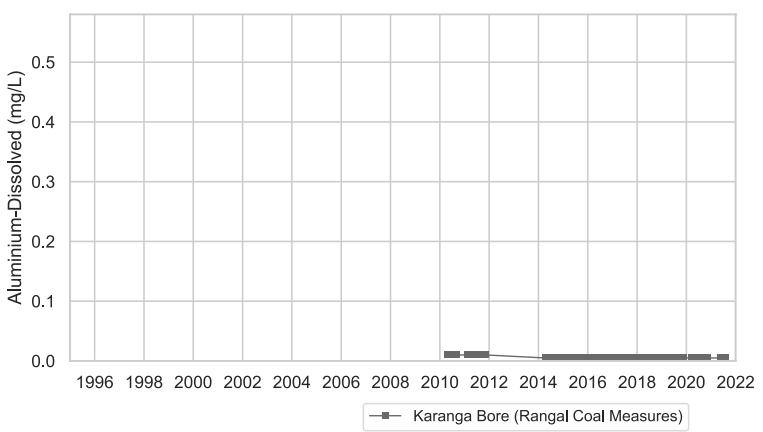

Aluminium-Dissolved (mg/L)
0.0000 0.0025 0.0050 0.0075 0.0100 0.0125 0.0150 0.0175 0.0200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

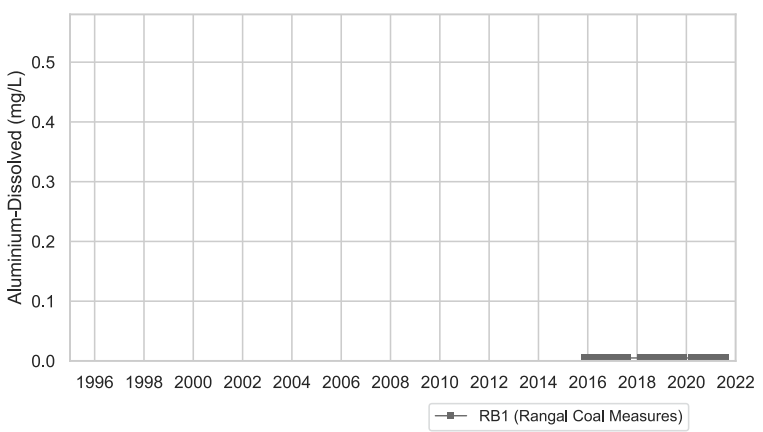

Aluminium-Dissolved (mg/L)
0.0000 0.0025 0.0050 0.0075 0.0100 0.0125 0.0150 0.0175 0.0200
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

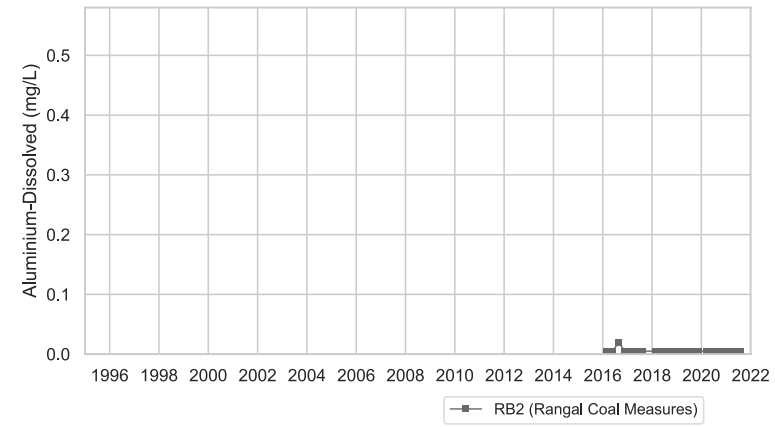

Aluminium-Dissolved (mg/L)
0.000 0.002 0.004 0.006 0.008 0.010
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

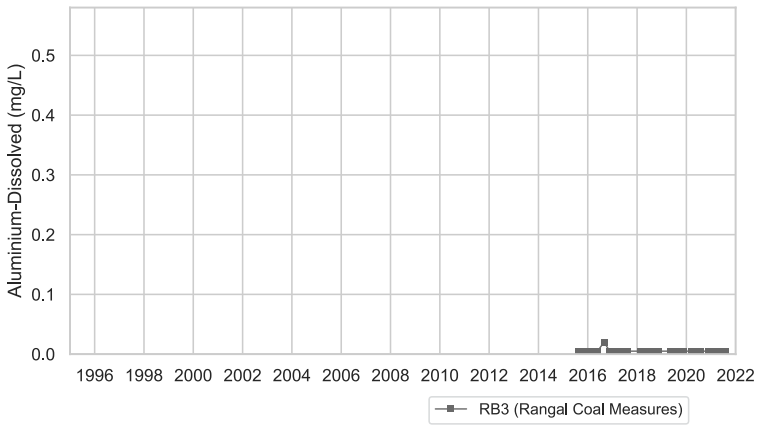

Aluminium-Dissolved (mg/L)
0.000 0.002 0.004 0.006 0.008 0.010
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

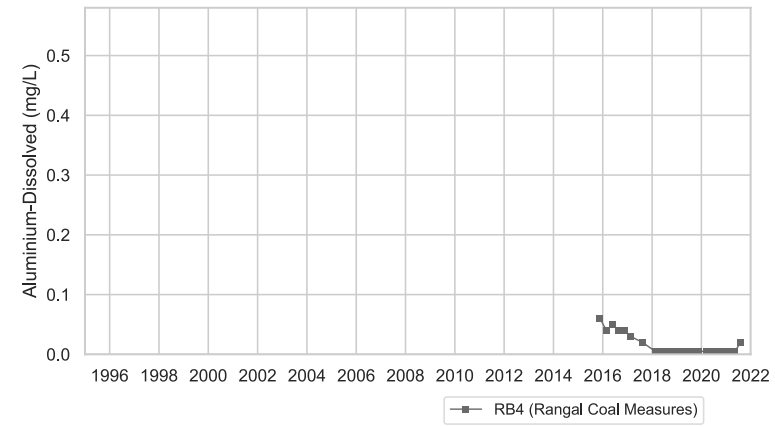

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

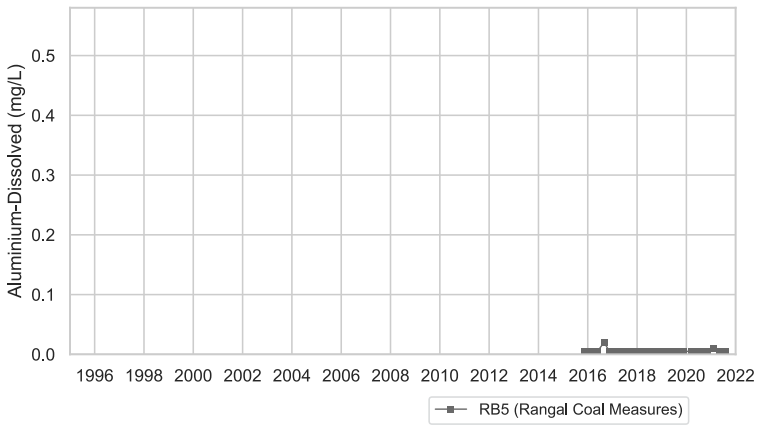

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

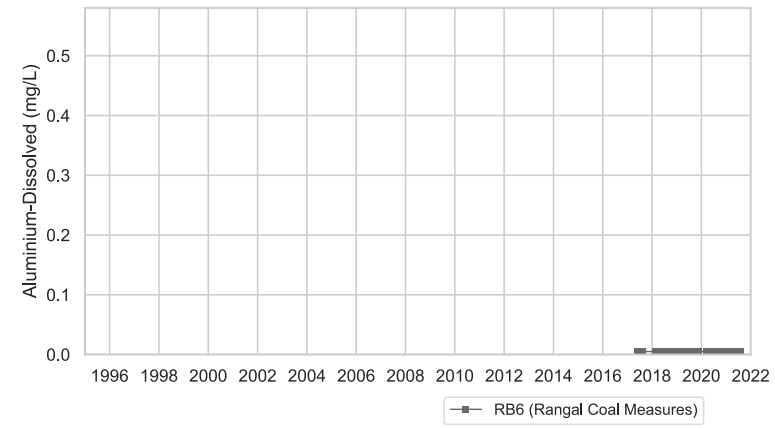

Aluminium-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

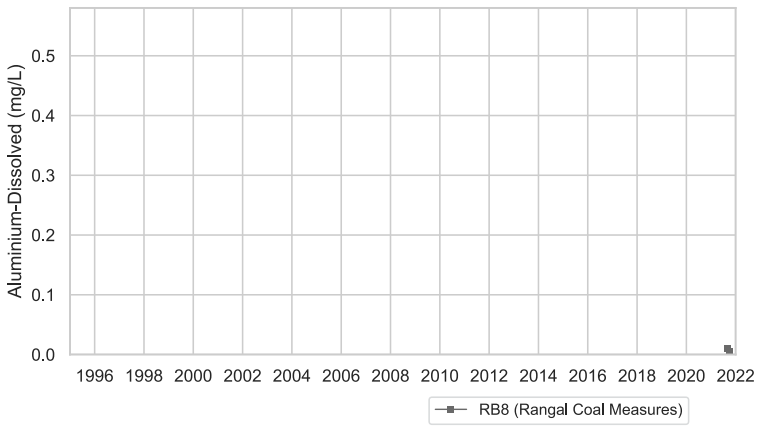

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

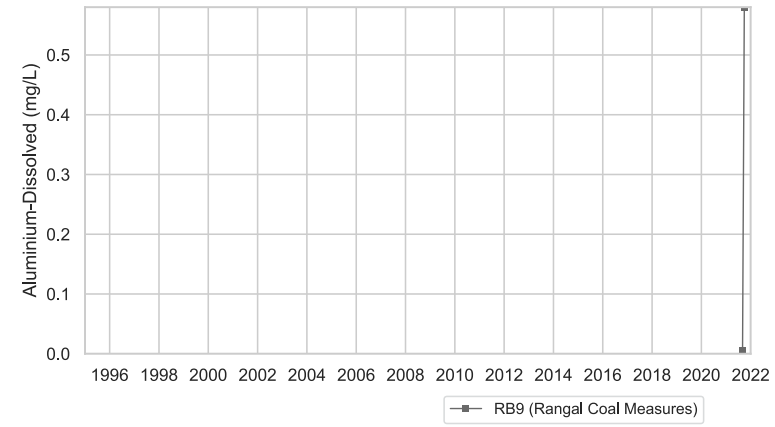

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

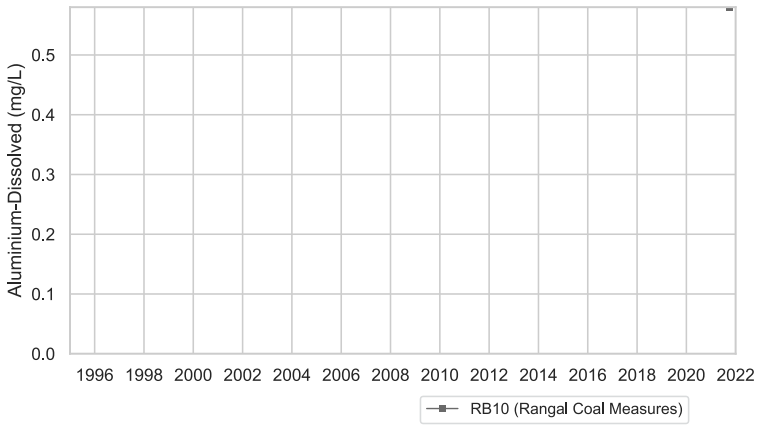

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

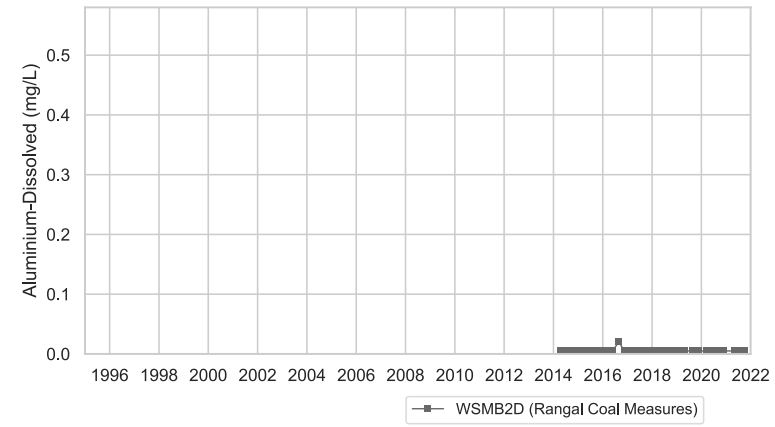

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

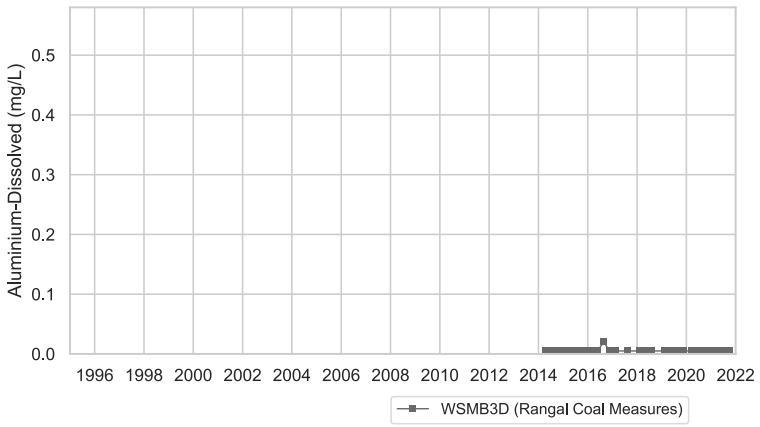

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

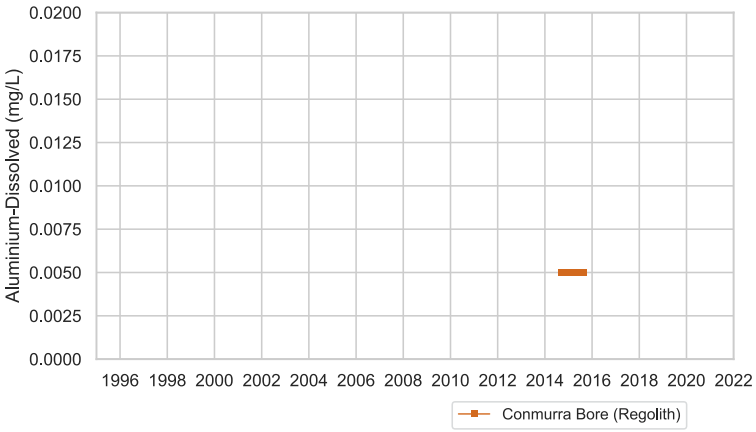

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

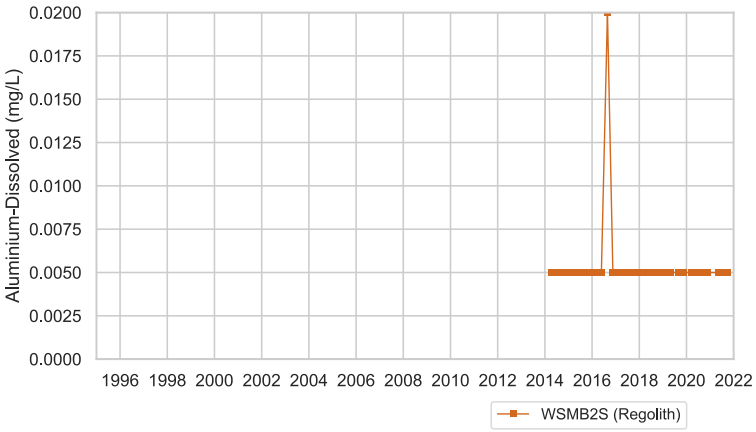

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

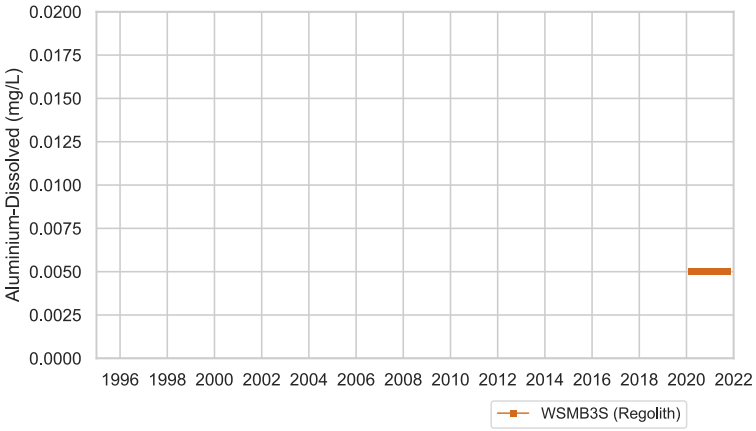

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

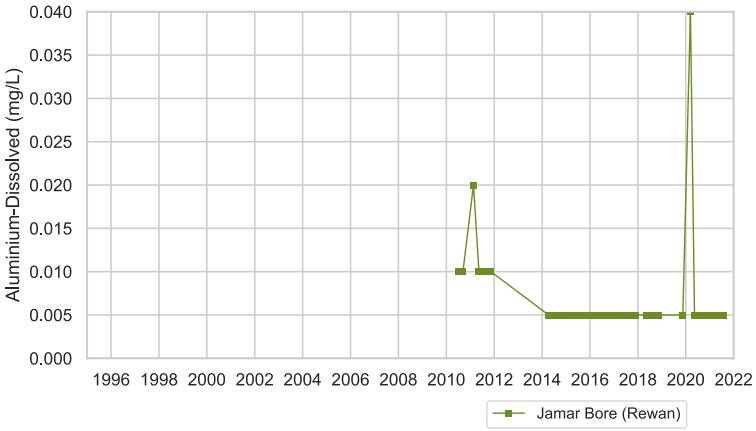

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

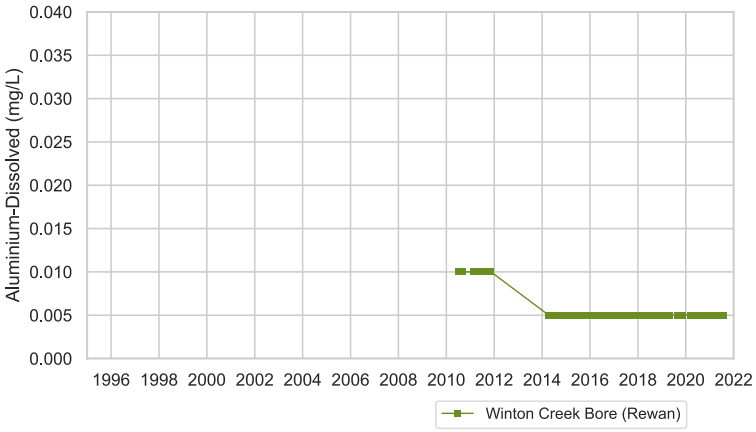

Aluminium-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

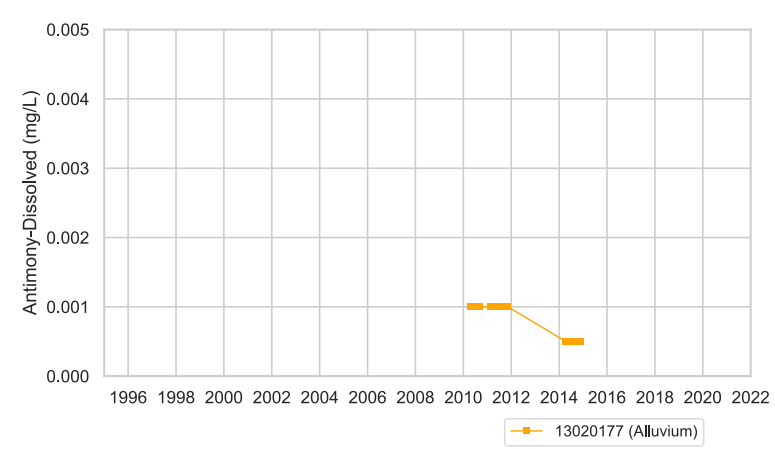

Aluminium-Dissolved (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

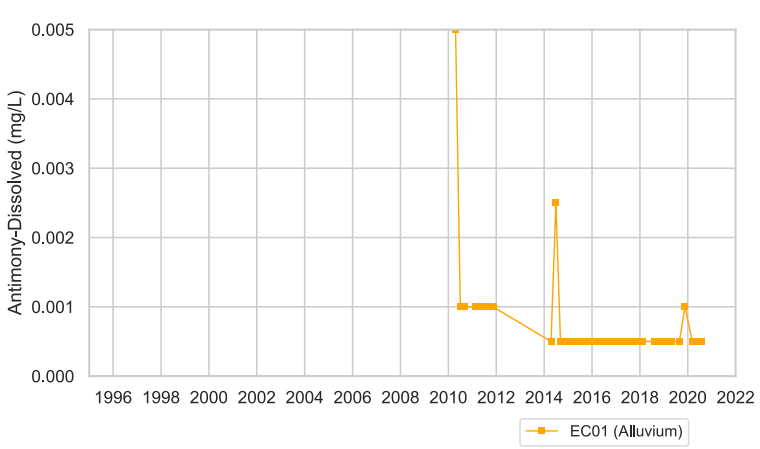

Aluminium-Dissolved (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

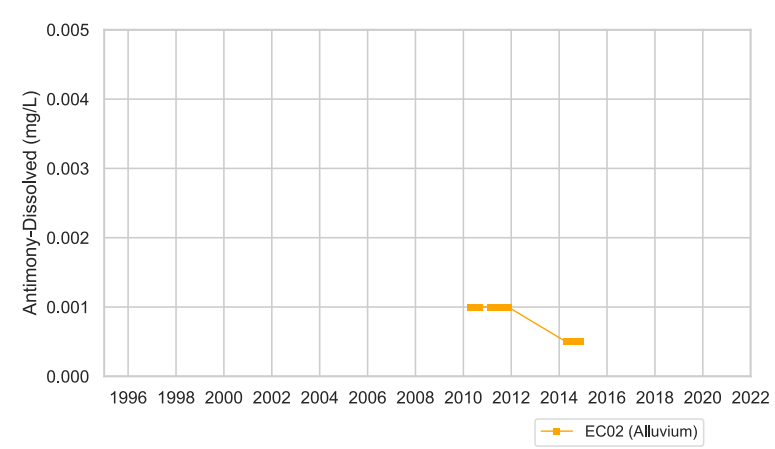

Aluminium-Dissolved (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

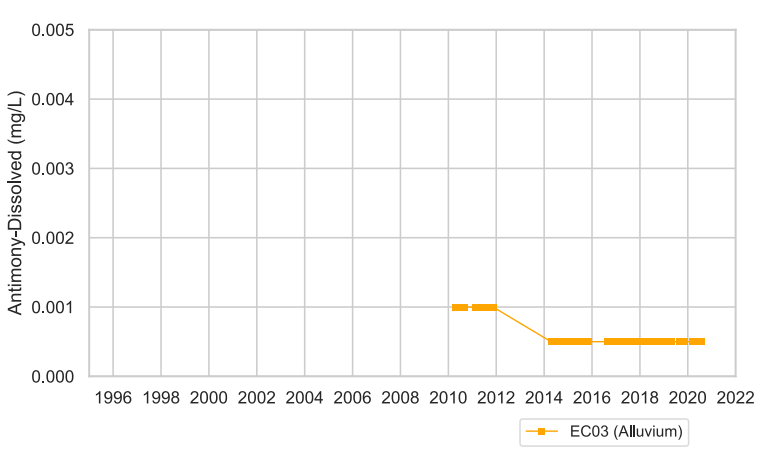

Aluminium-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

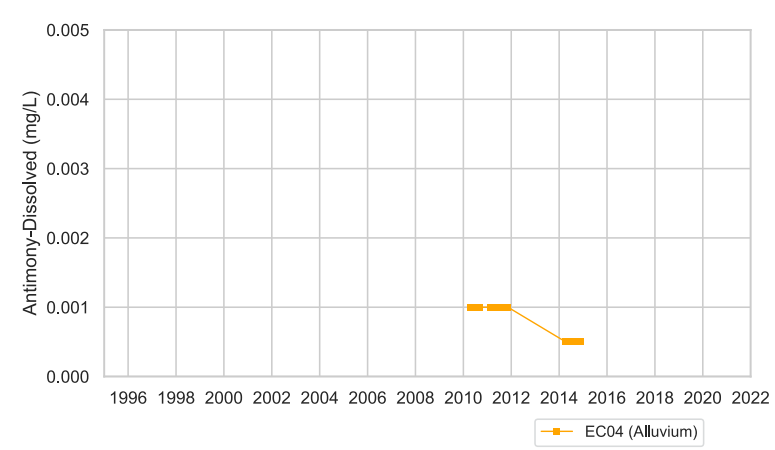

Aluminium-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

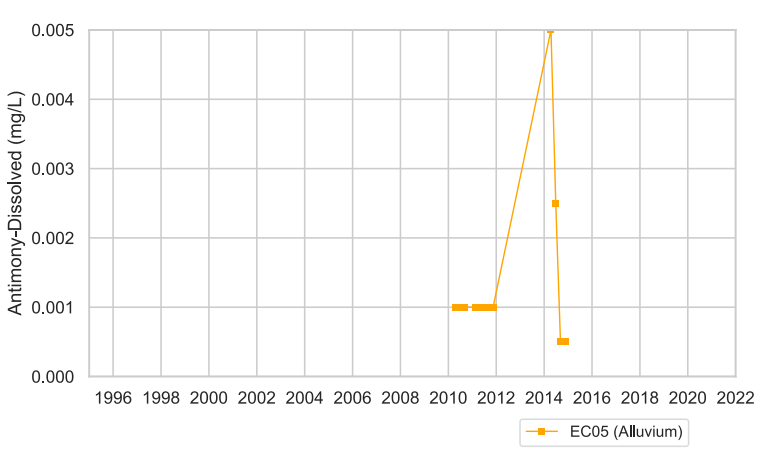

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

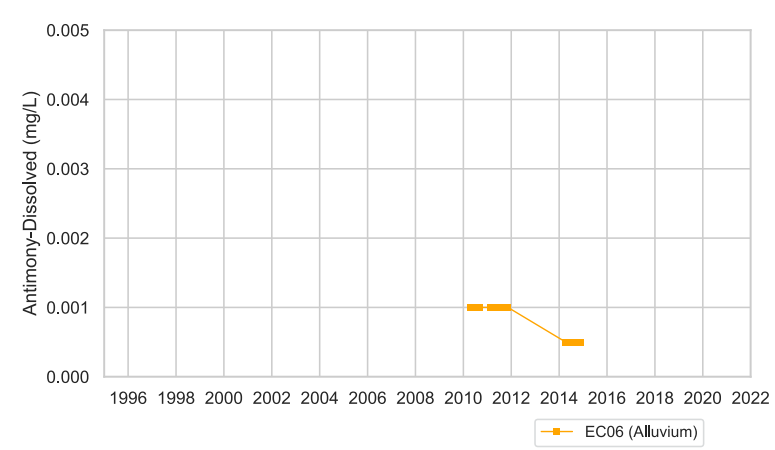

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

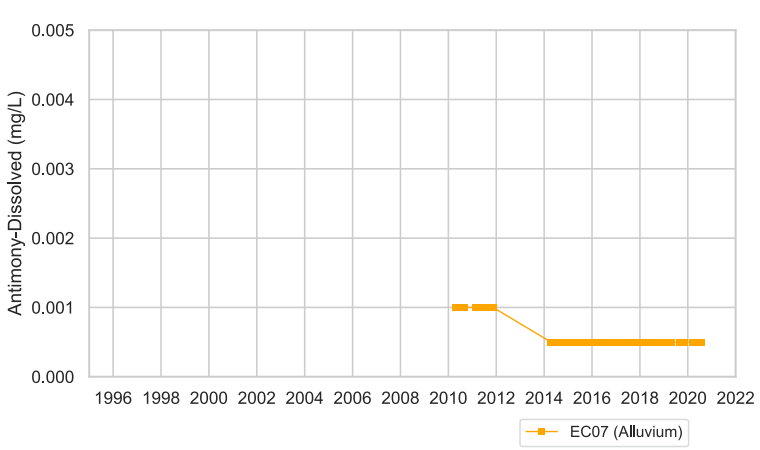

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

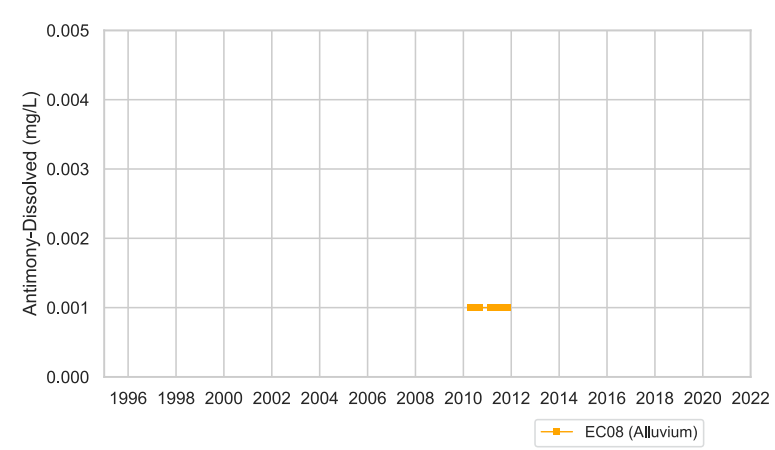

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

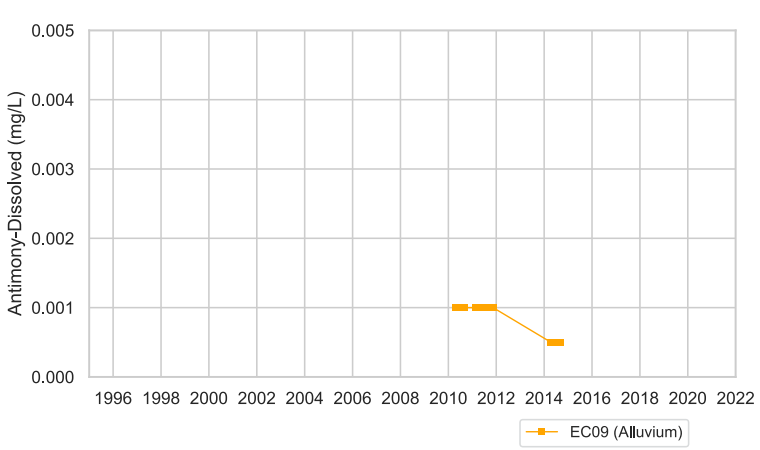

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

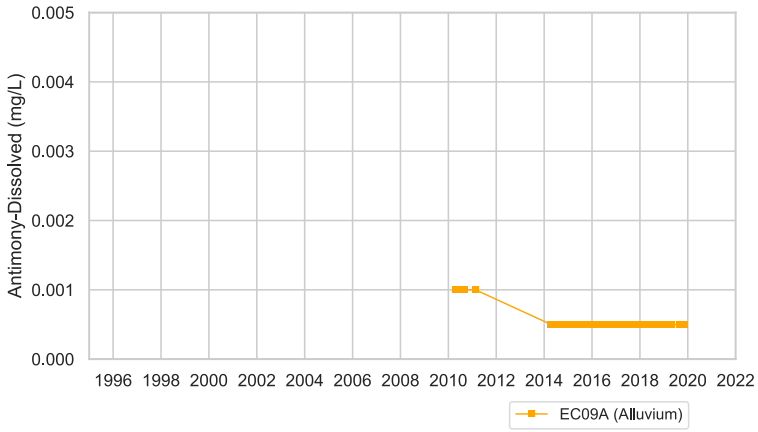

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

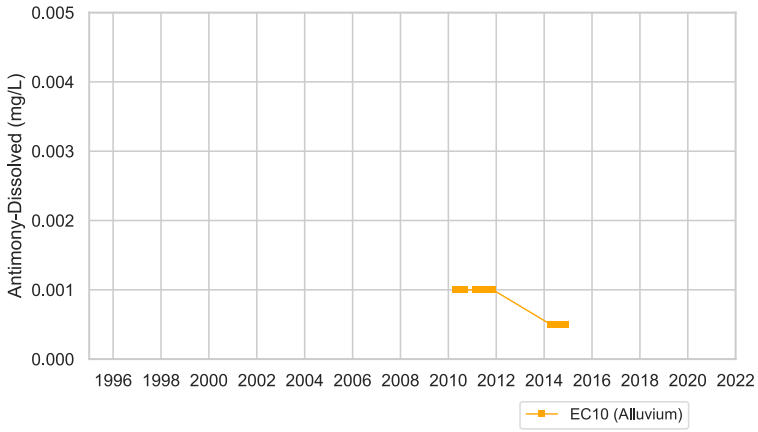

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

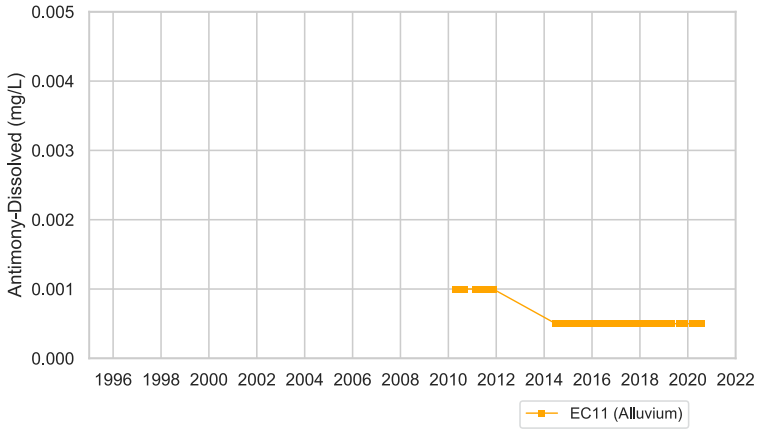

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

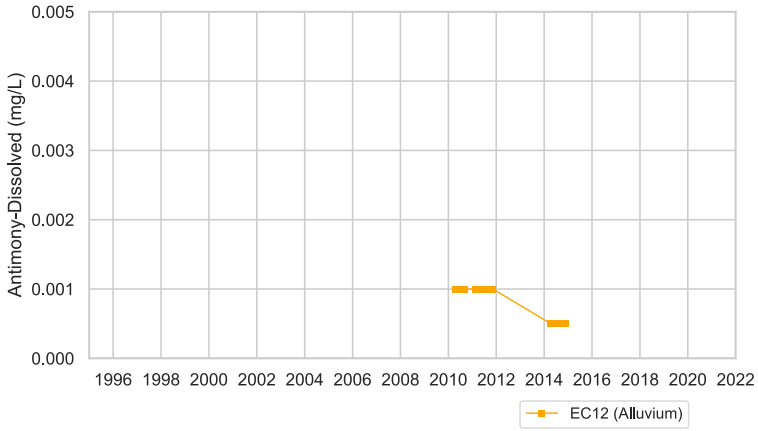

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

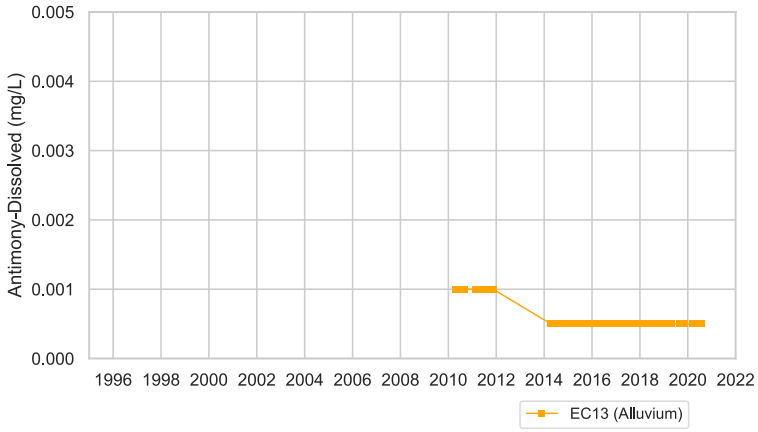

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

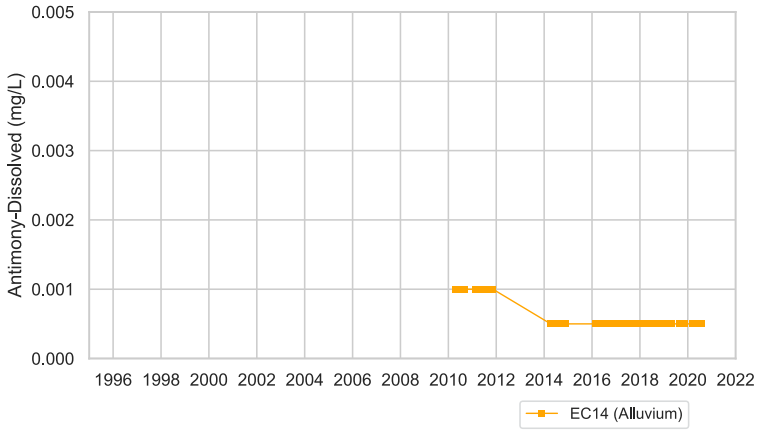

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

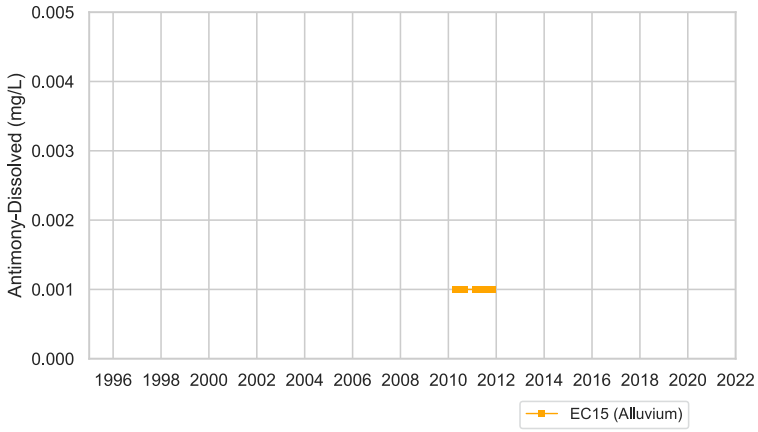

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

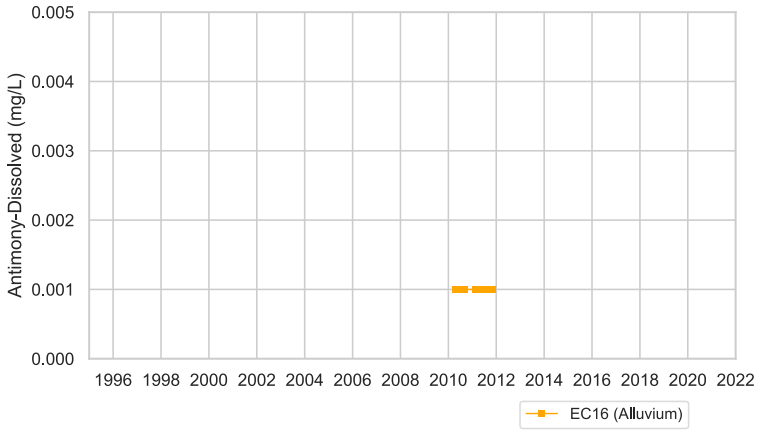

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

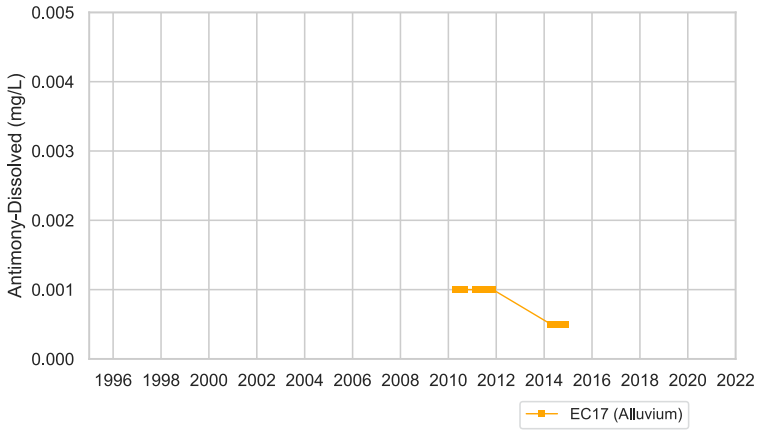

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

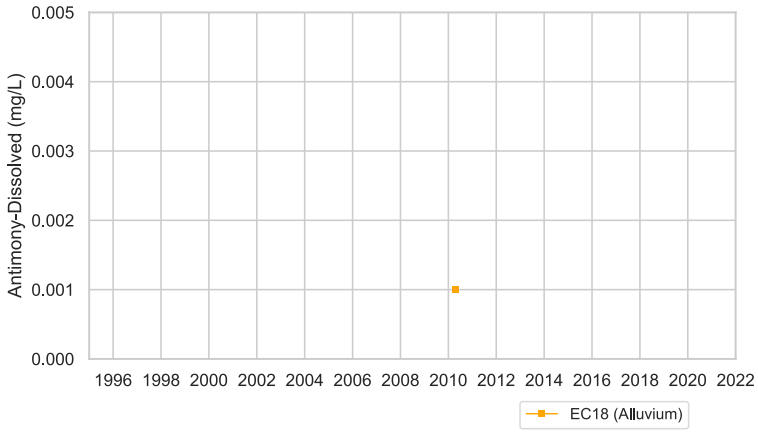

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

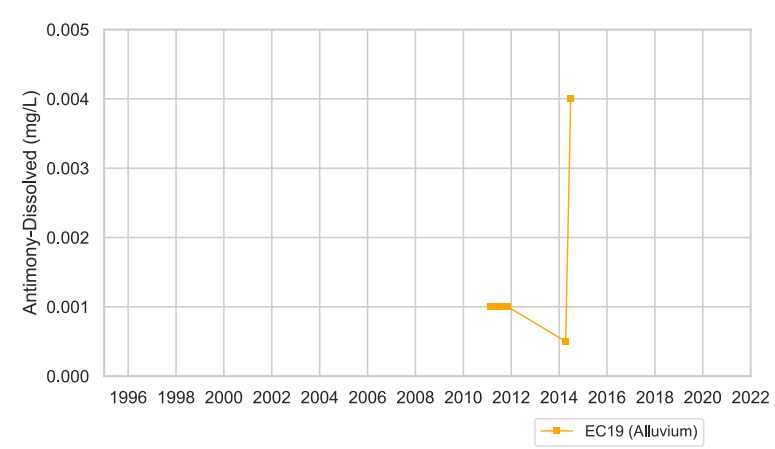

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

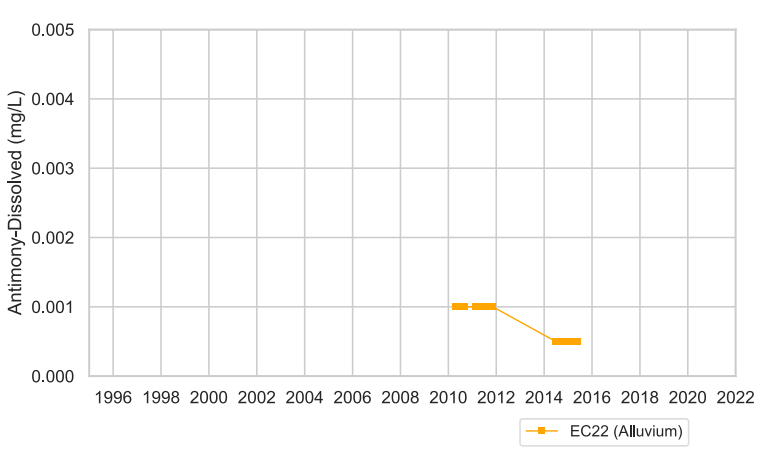

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

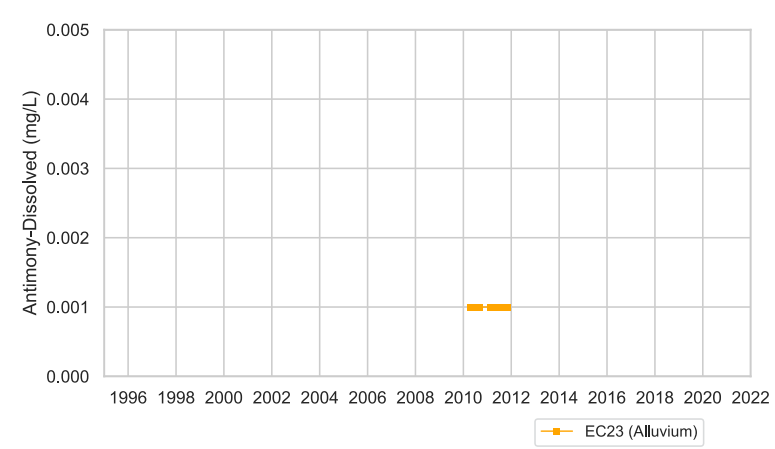

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

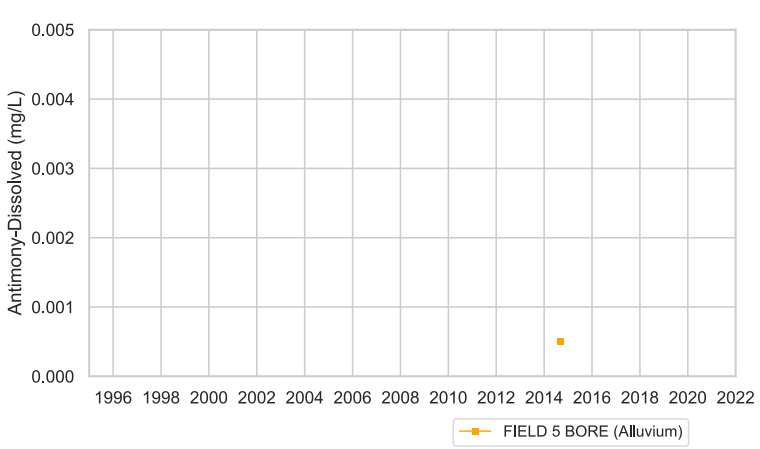

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

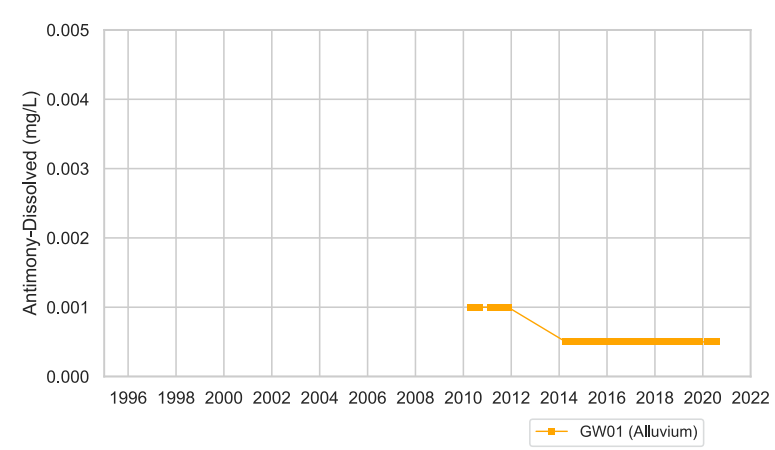

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

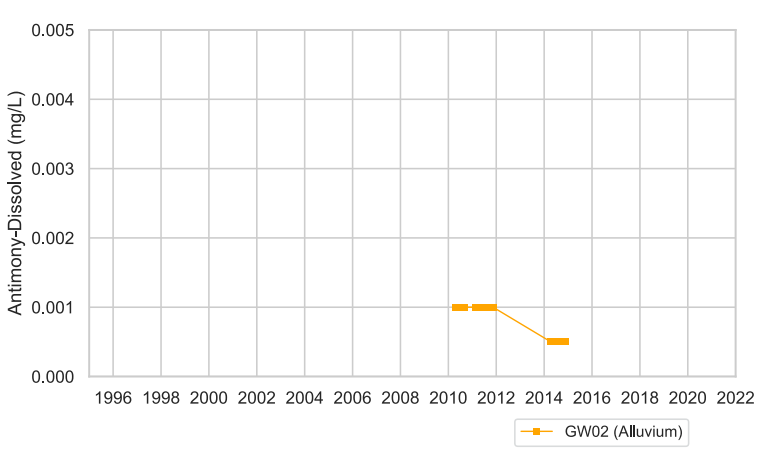

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

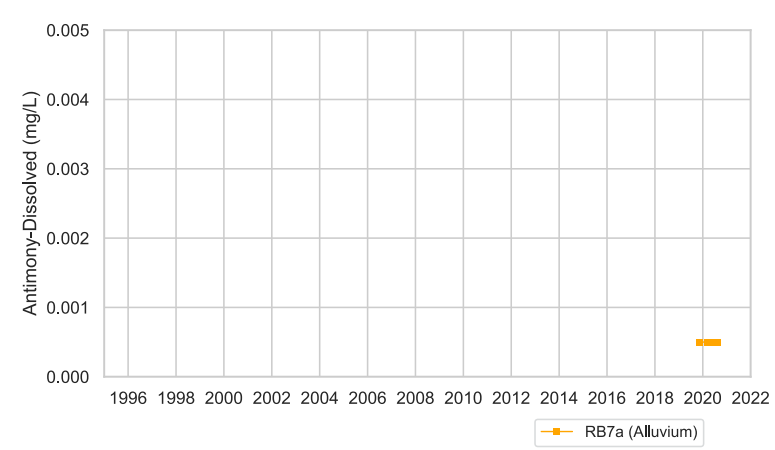

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

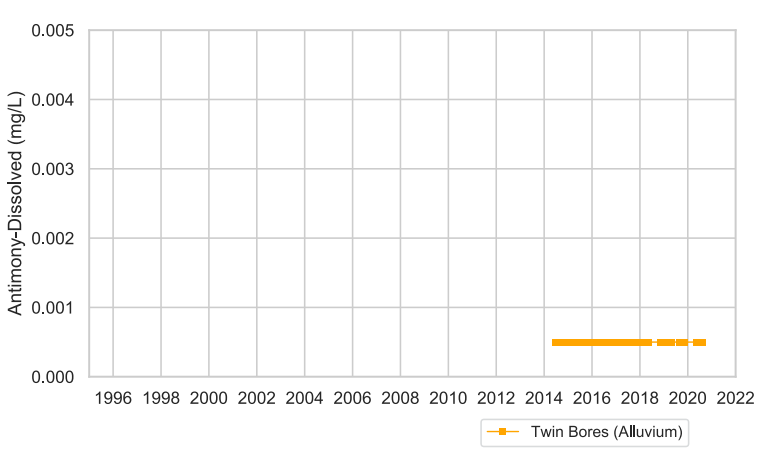

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

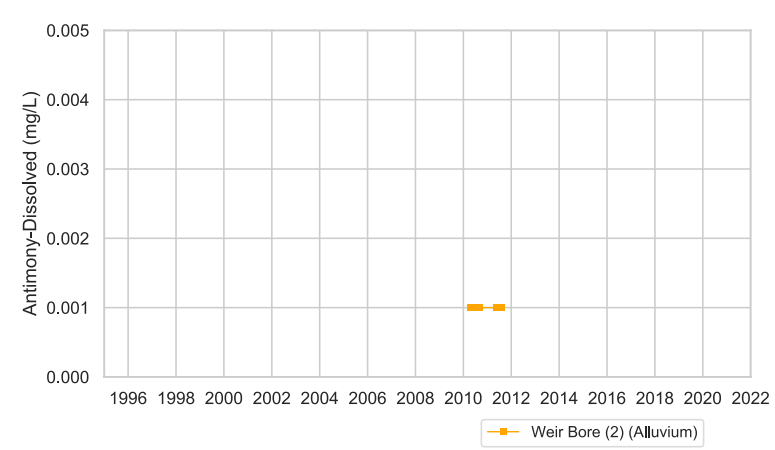

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

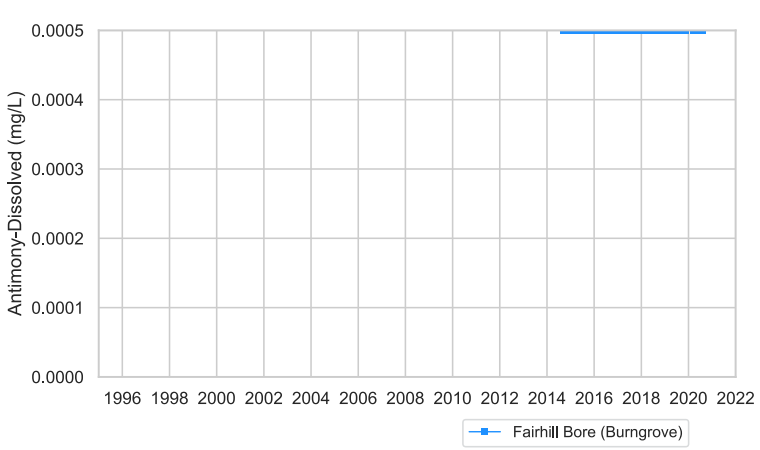

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

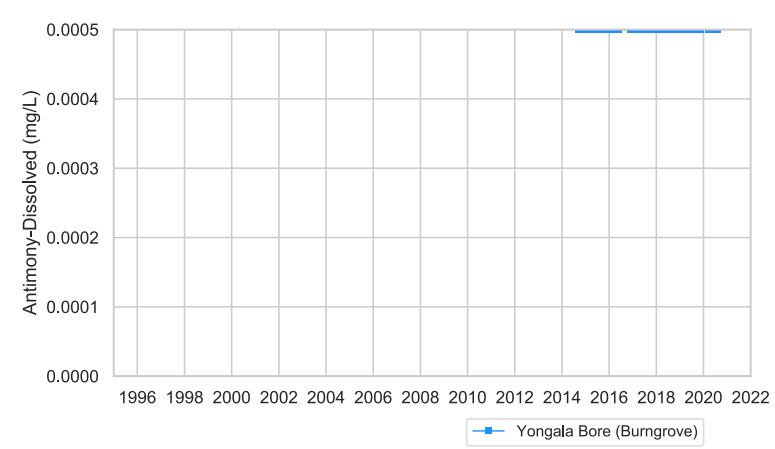

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

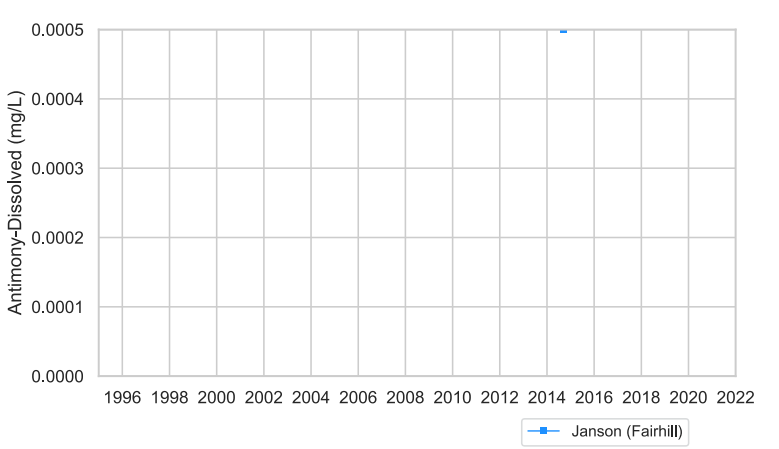

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

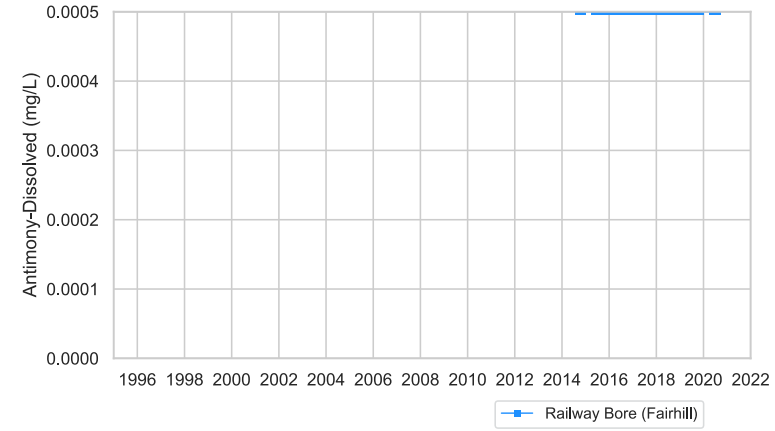

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

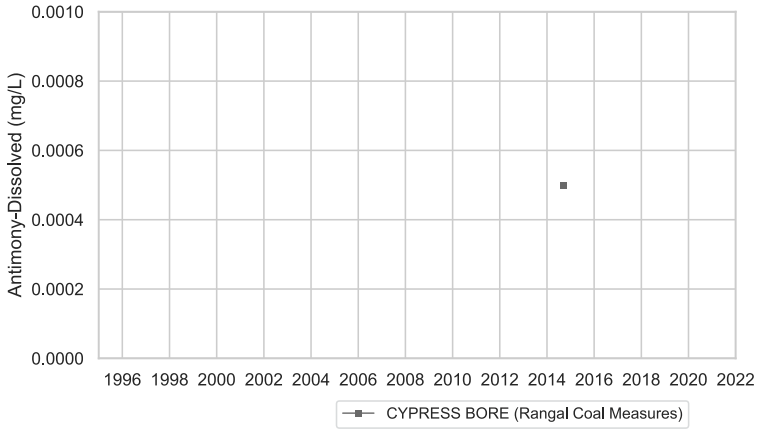

Antimony-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

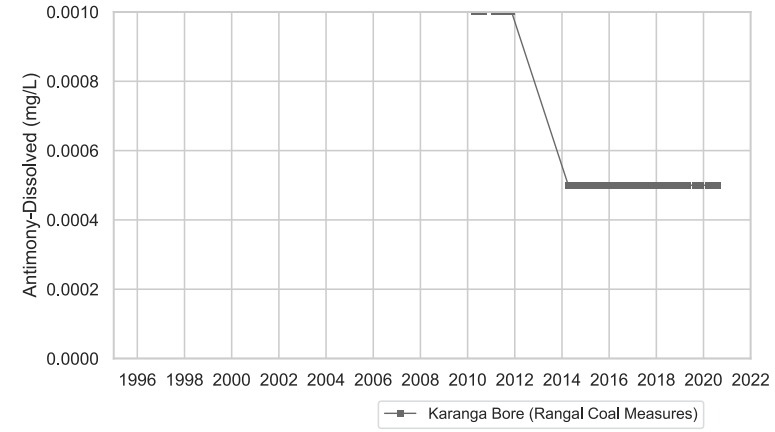

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

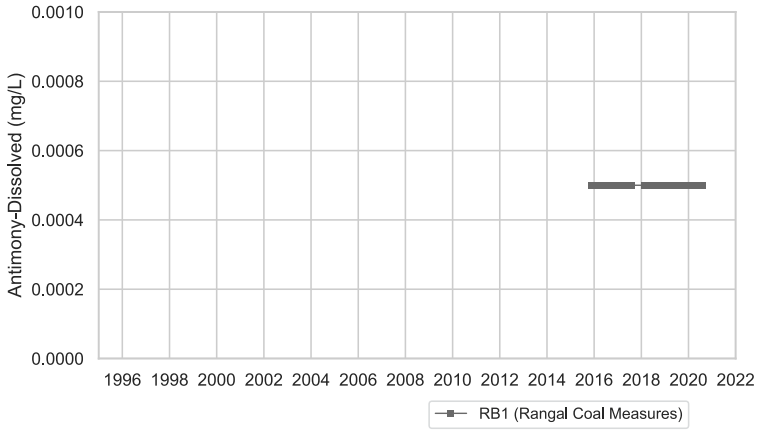

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

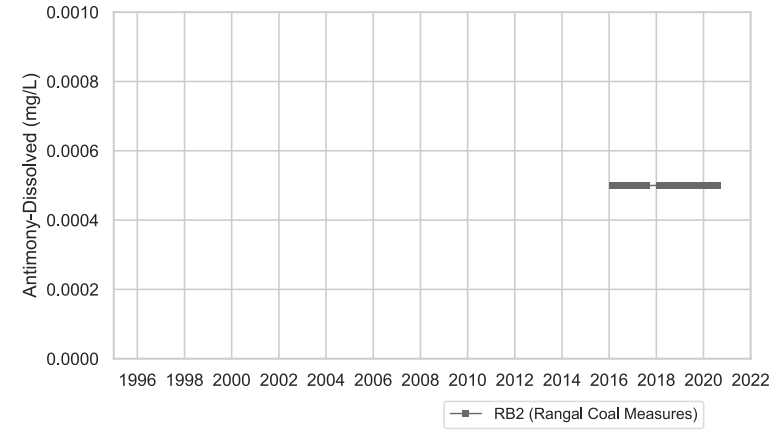

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

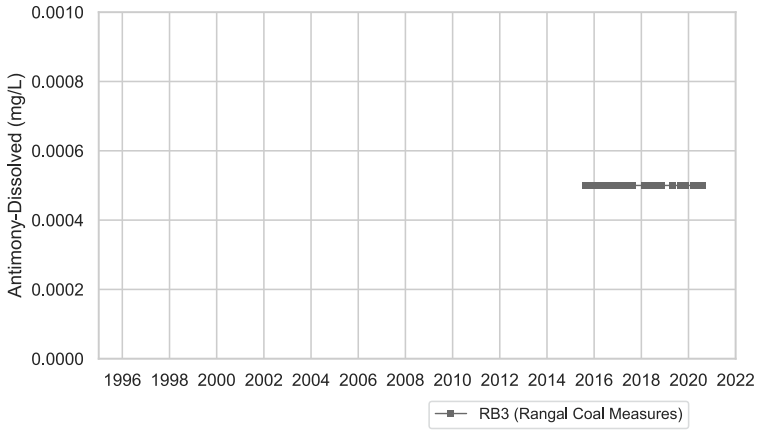

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

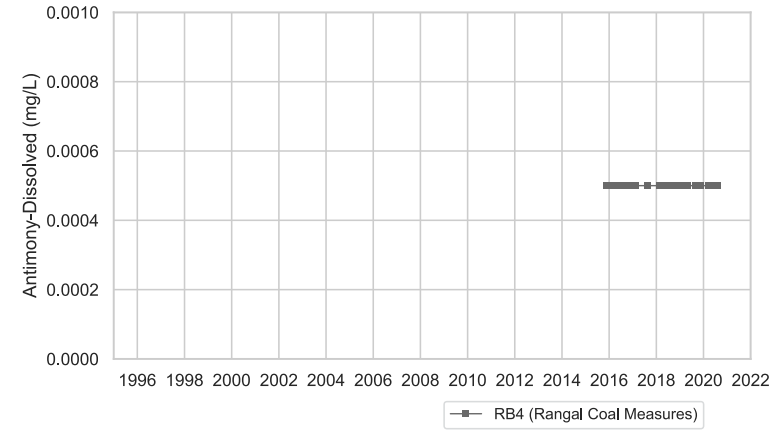

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

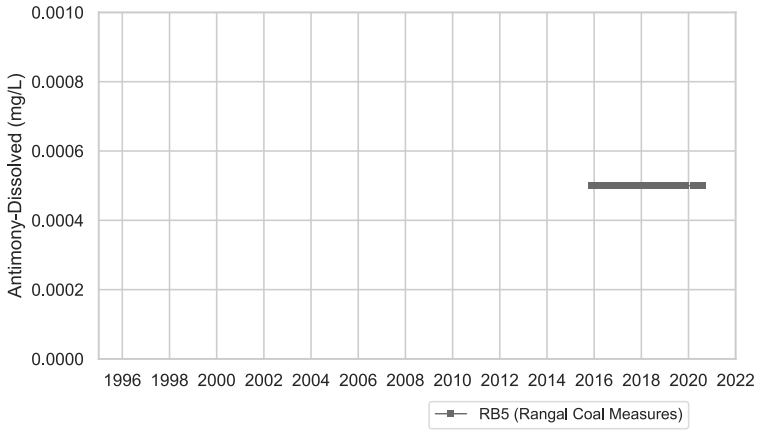

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

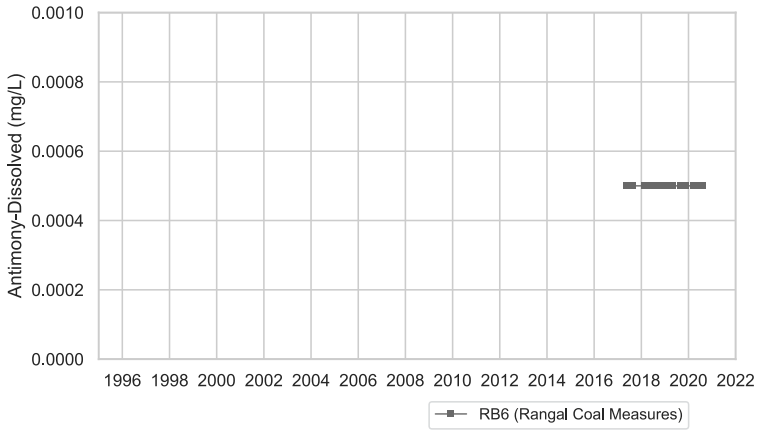

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

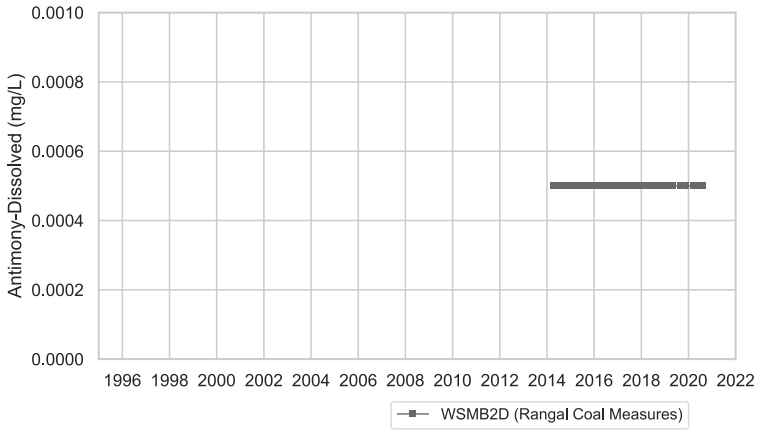

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

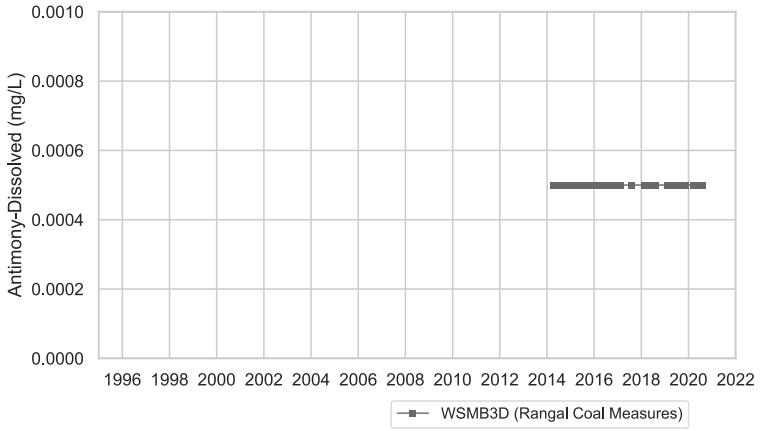

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

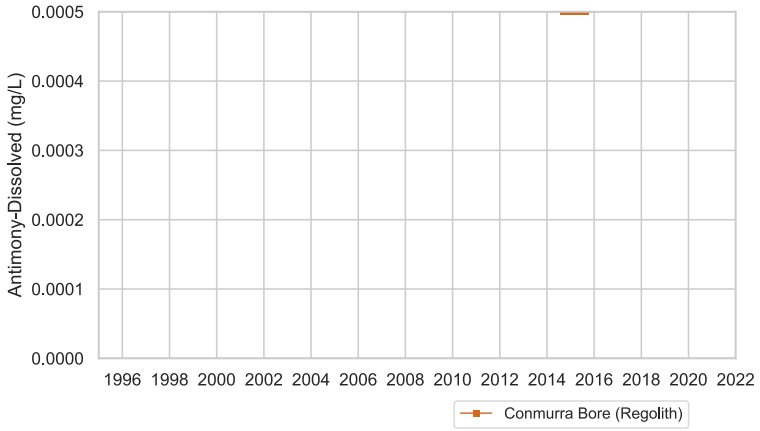

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

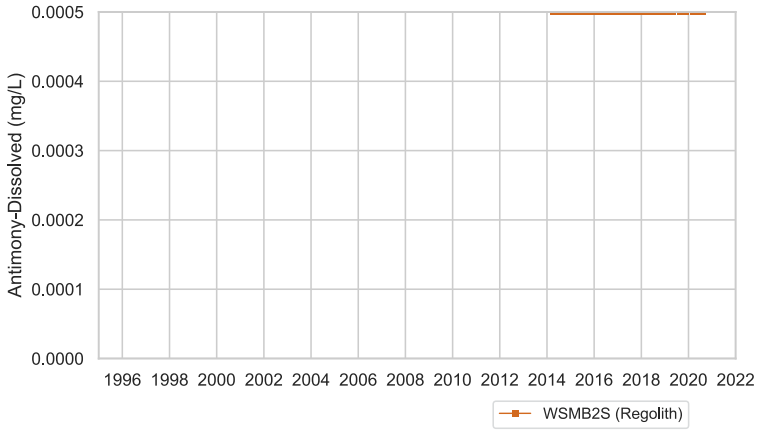

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

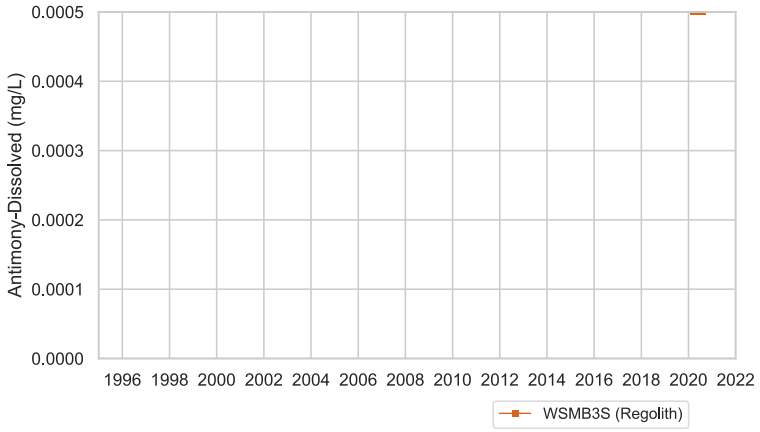

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

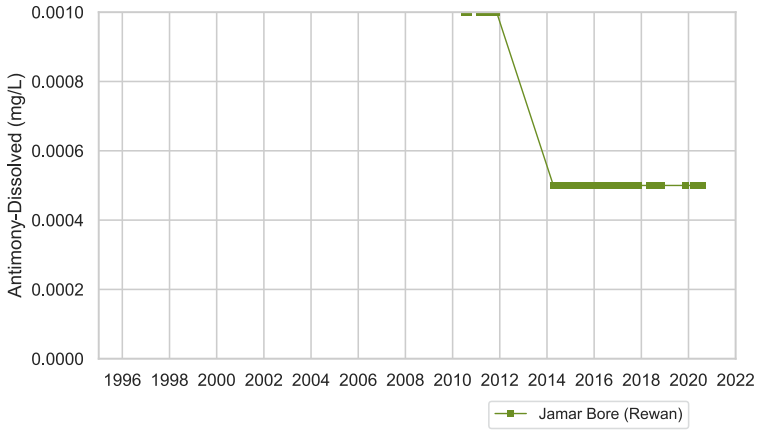

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

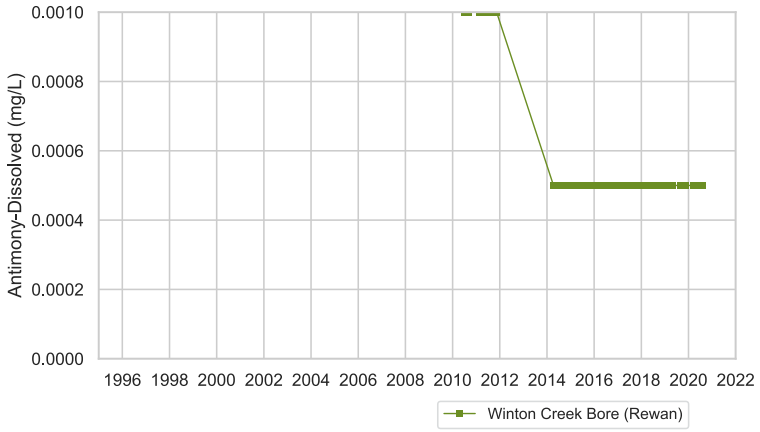

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

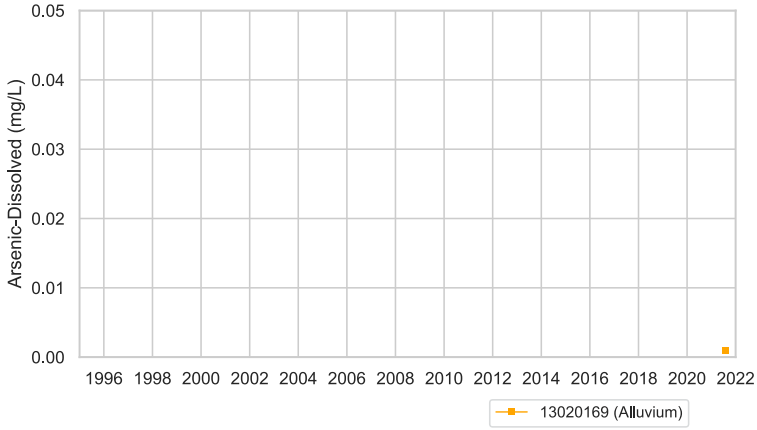

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

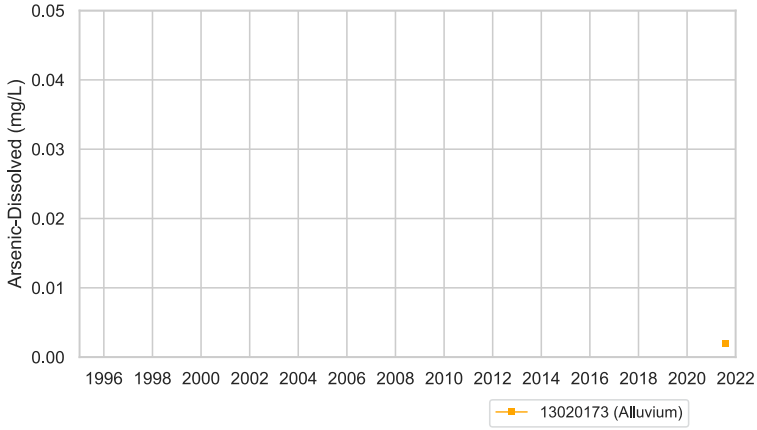

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

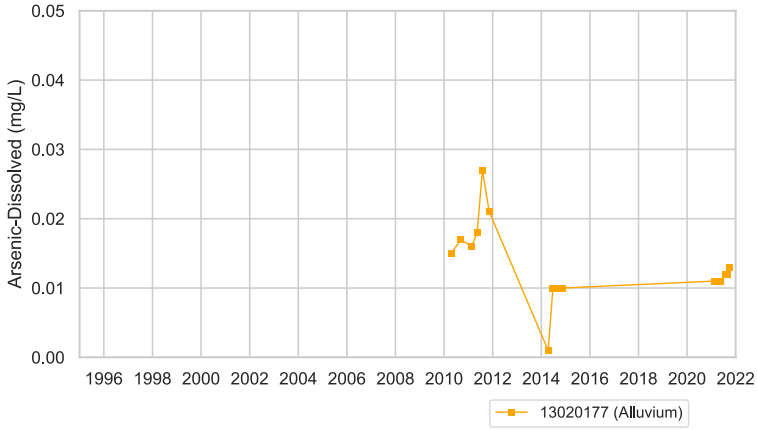

Antimony-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

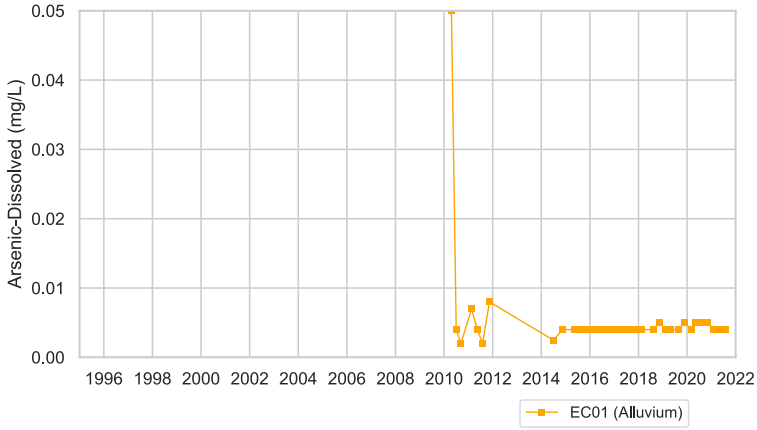

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

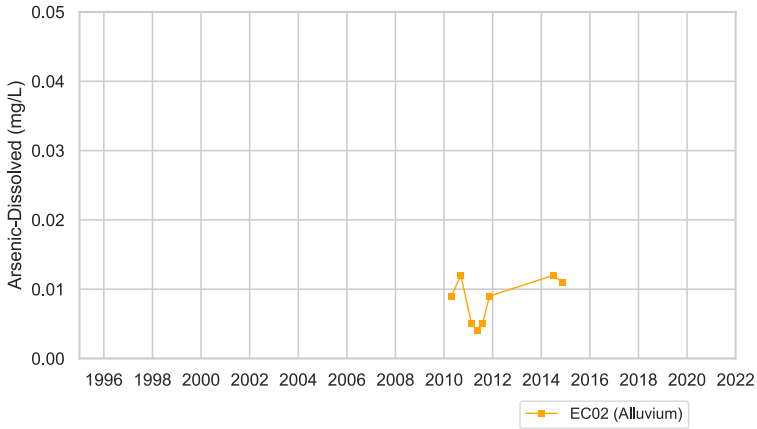

Antimony-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

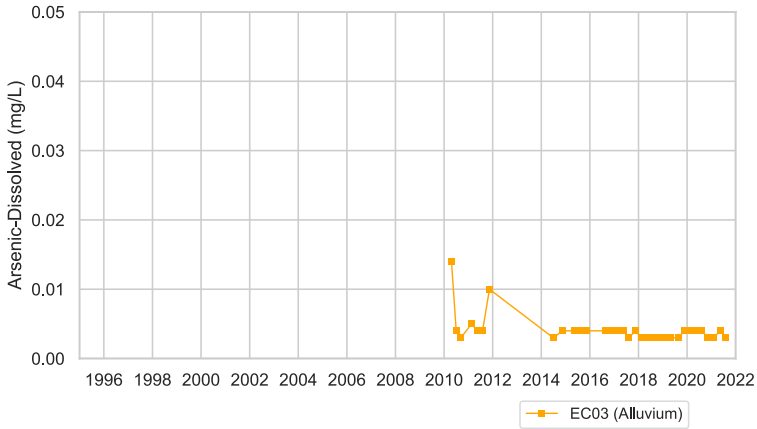

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

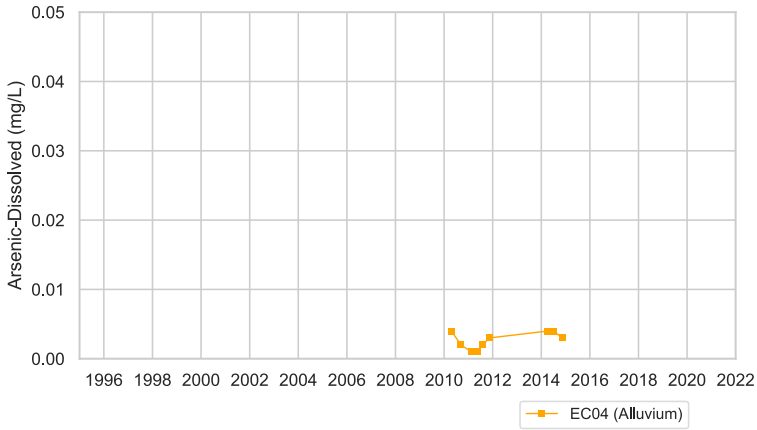

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

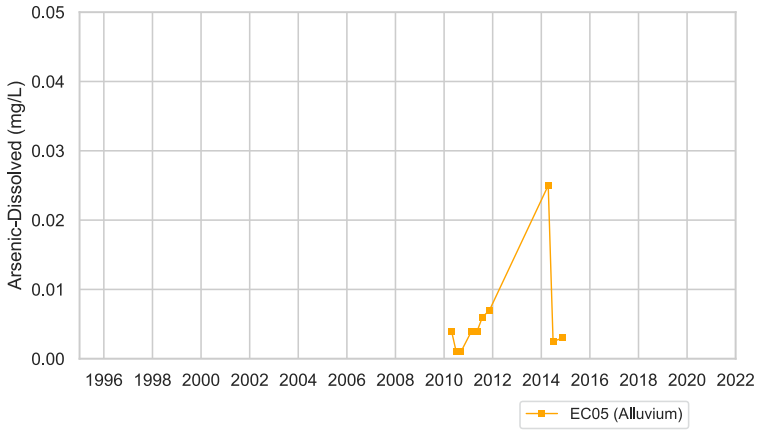

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

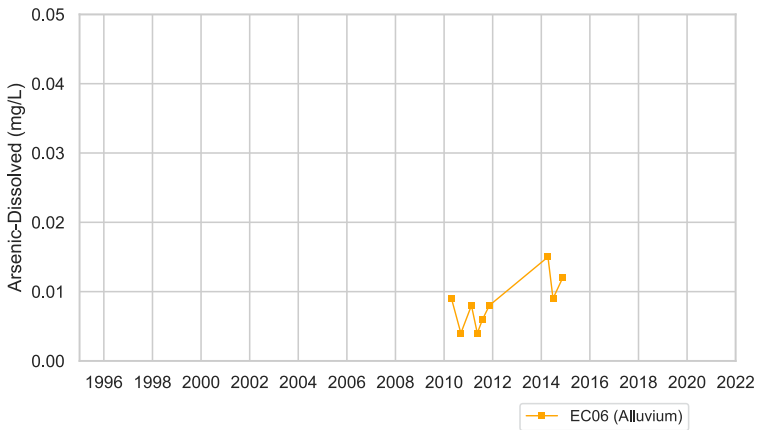

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

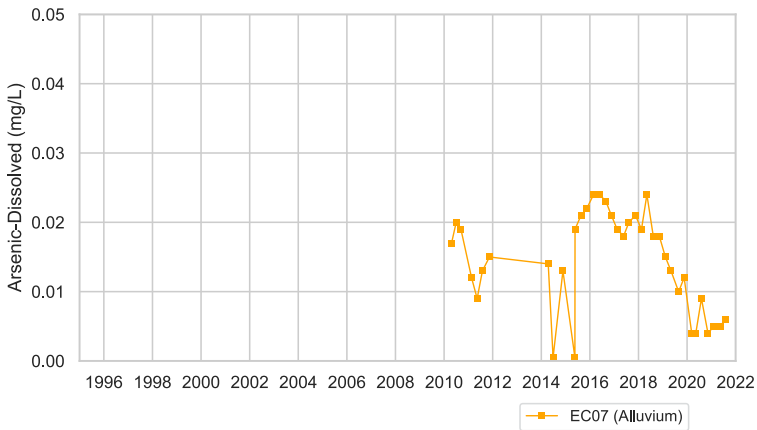

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

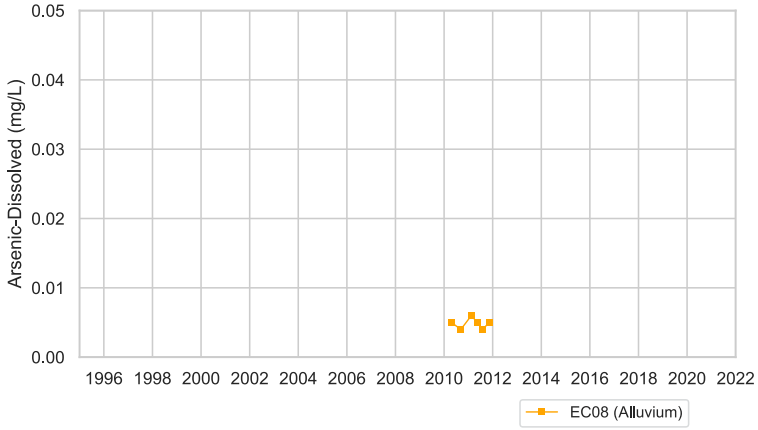

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

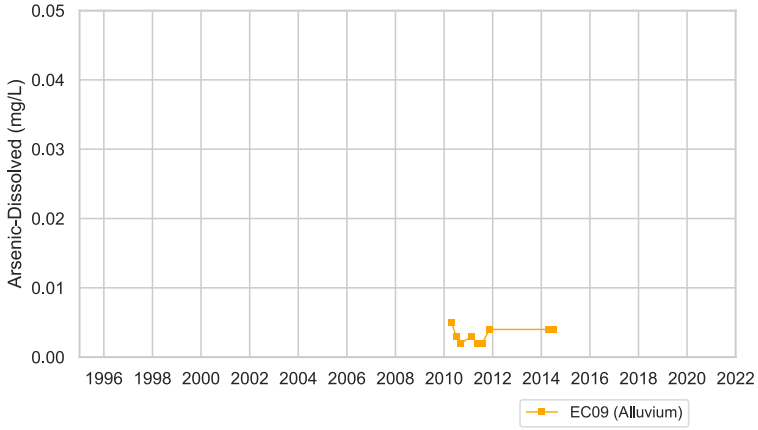

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

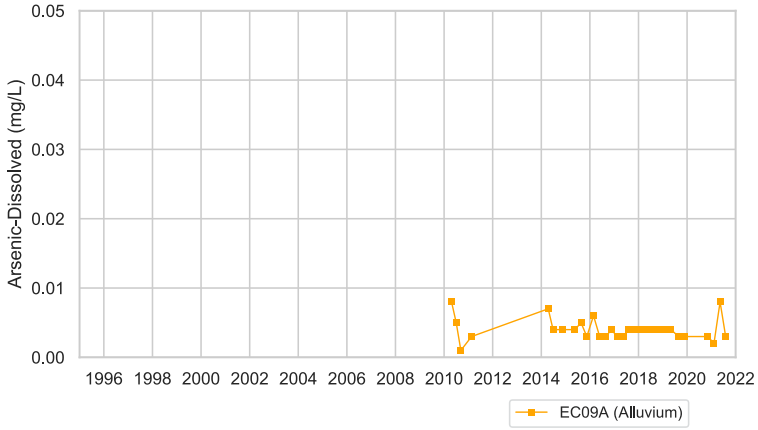

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

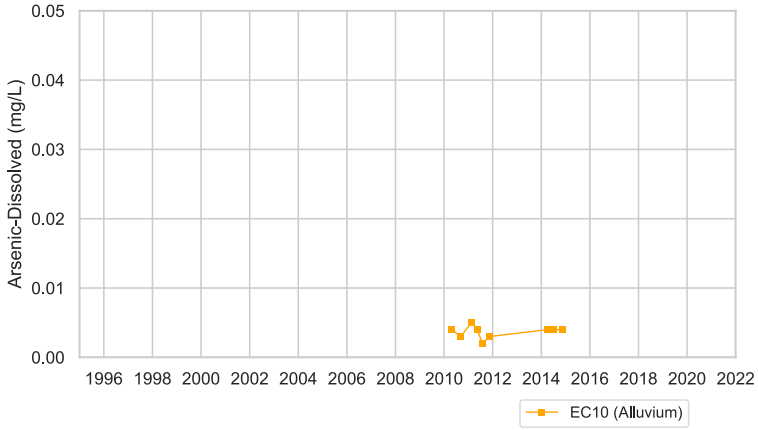

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

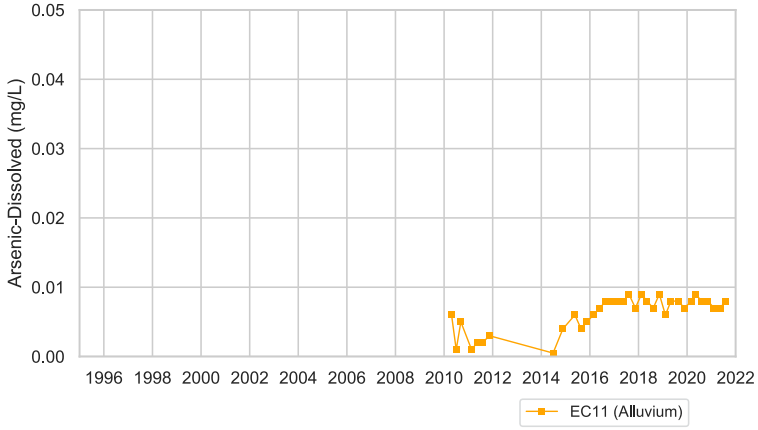

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

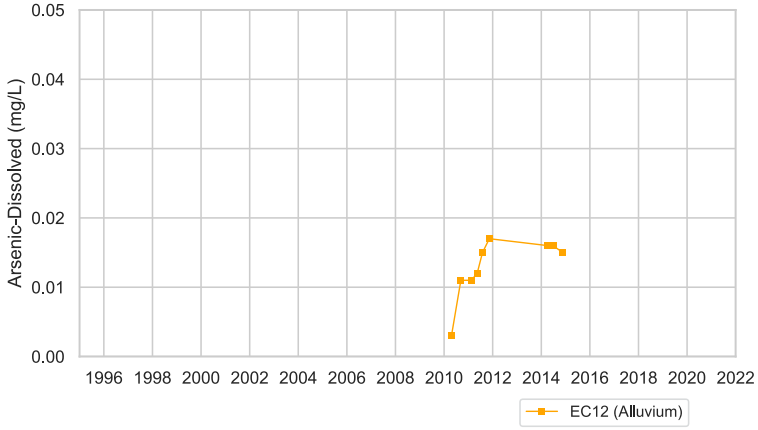

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

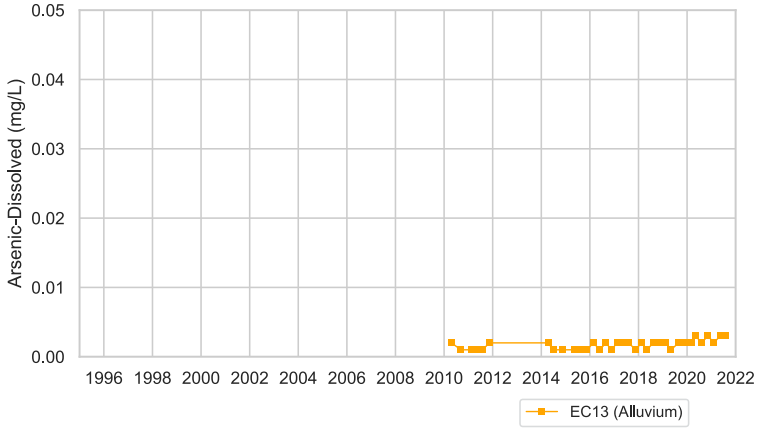

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

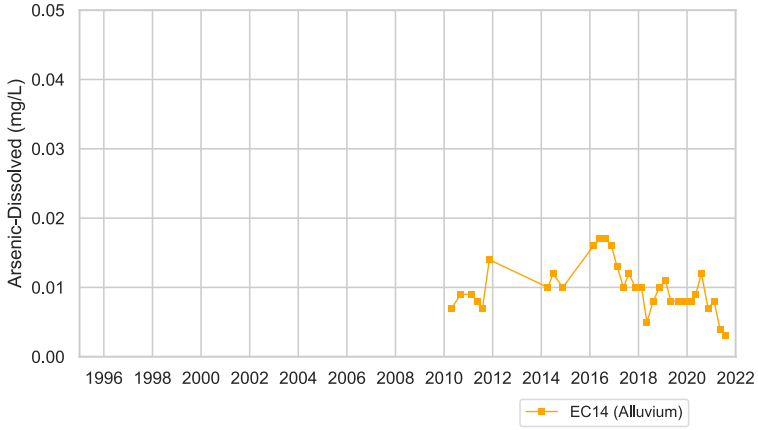

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

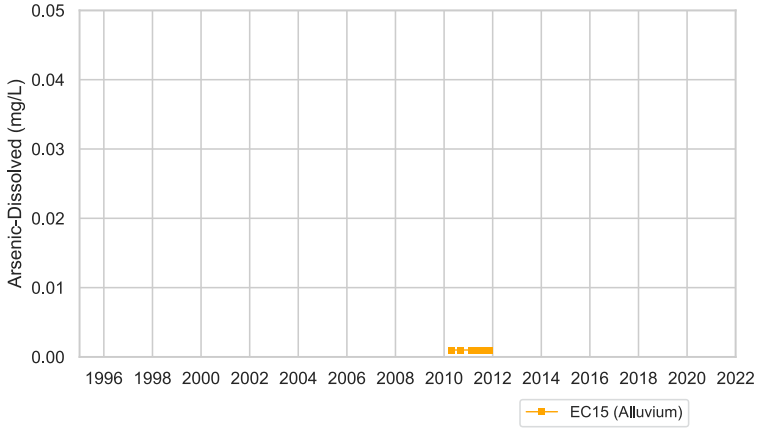

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

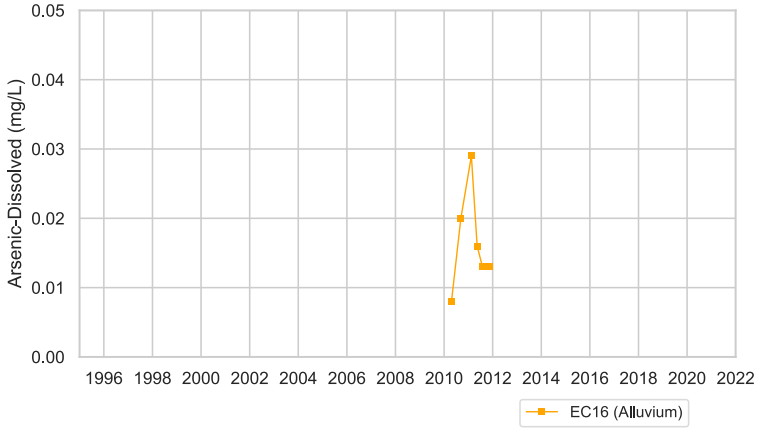

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

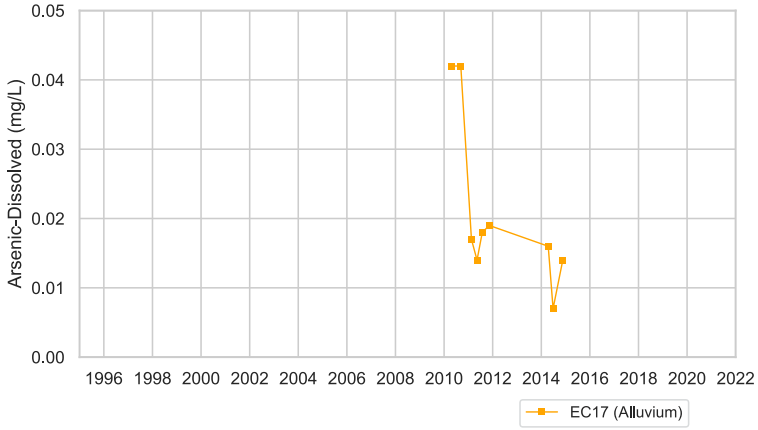

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

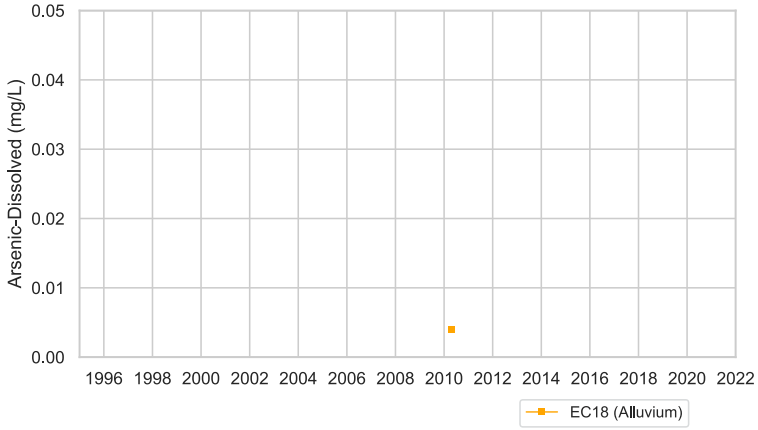

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

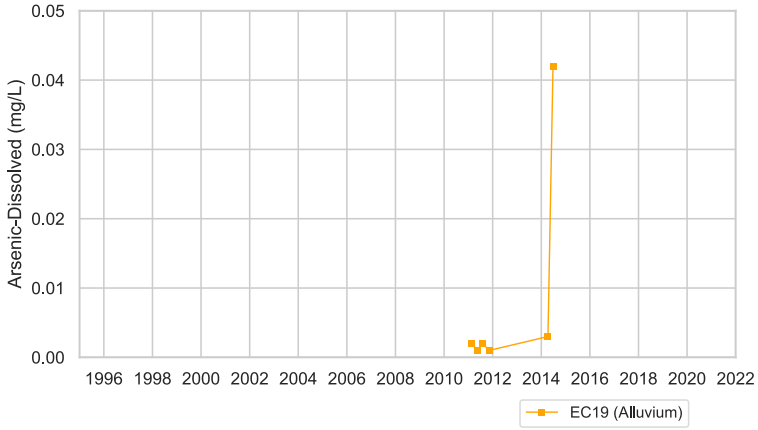

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

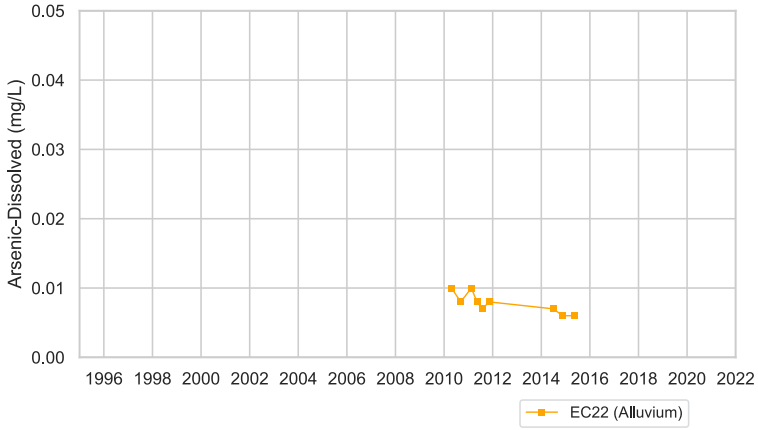

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

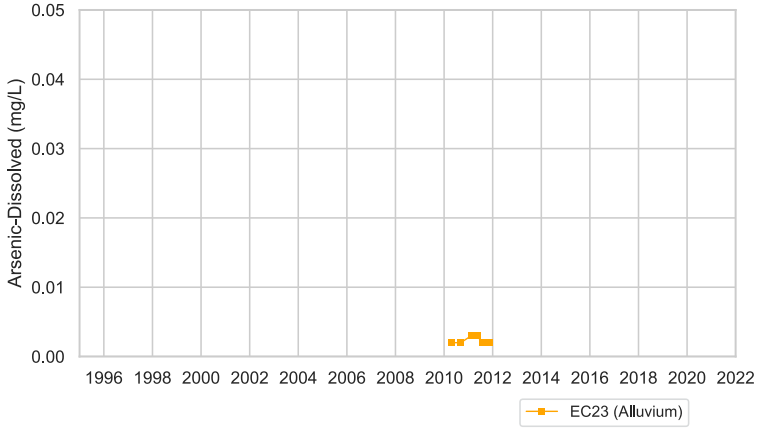

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

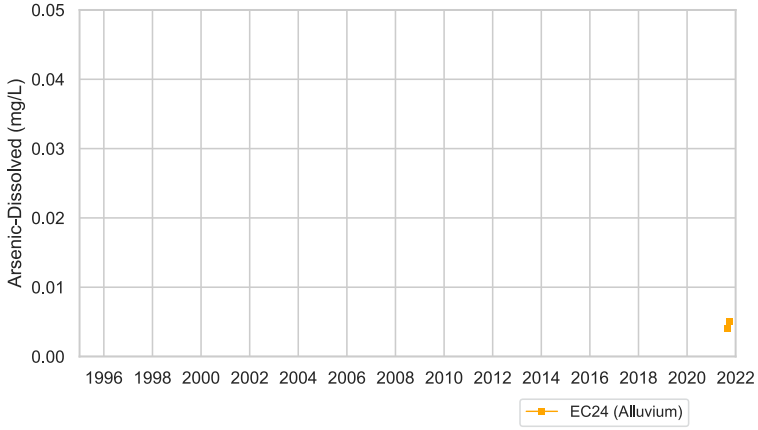

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

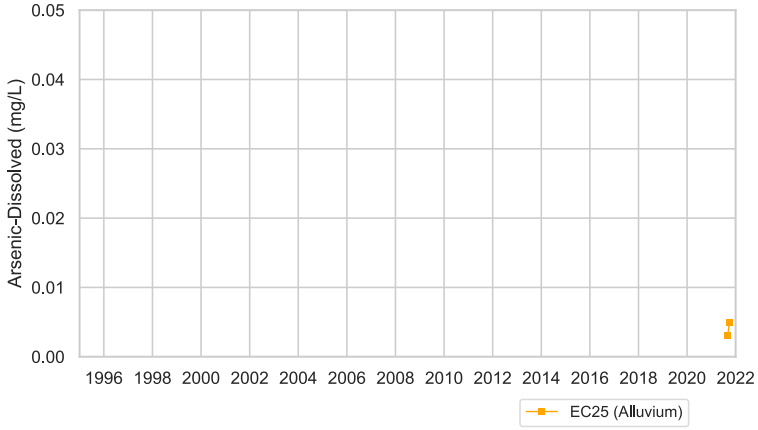

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

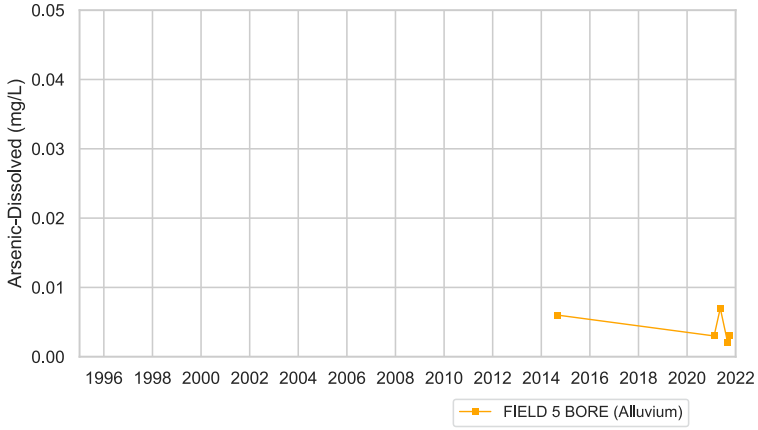

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

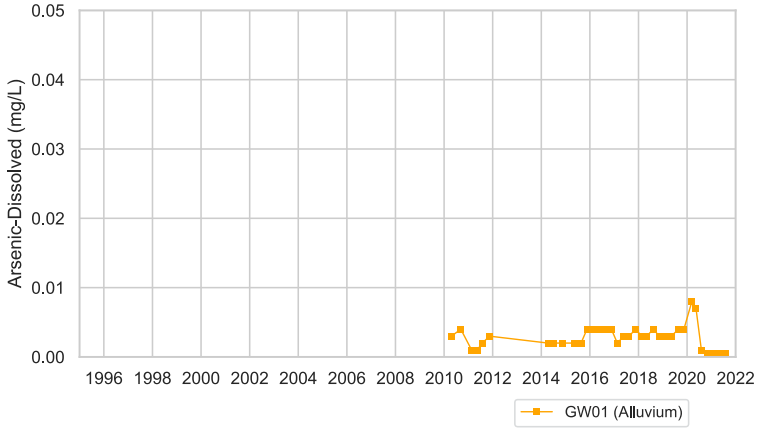

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

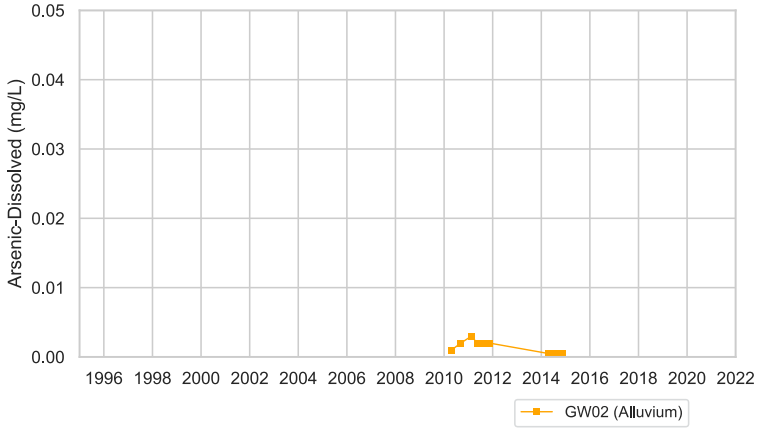

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

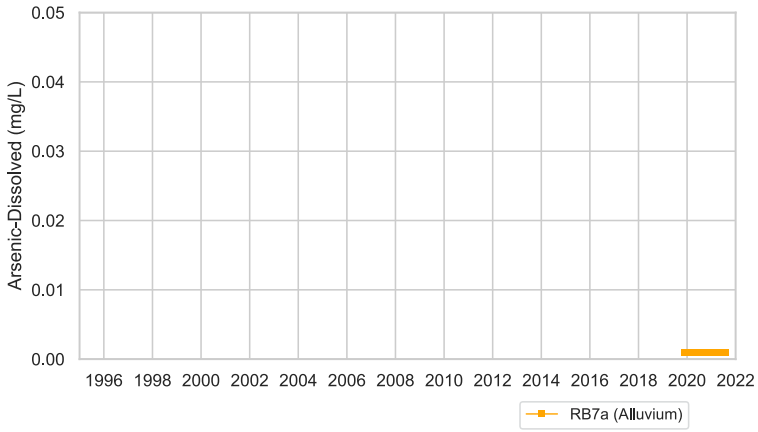

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

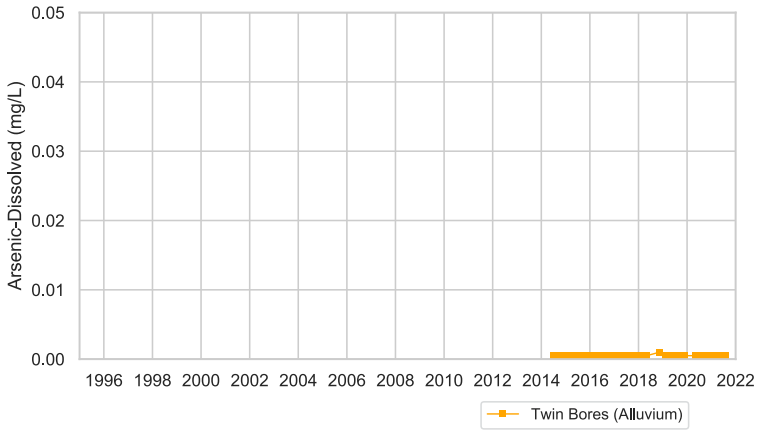

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

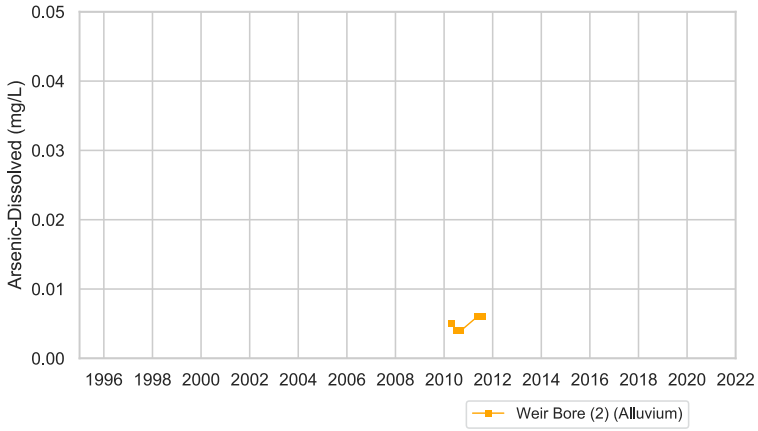

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

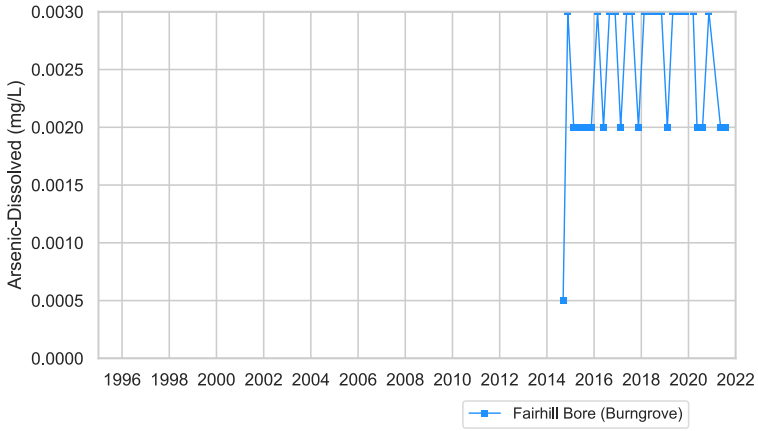

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

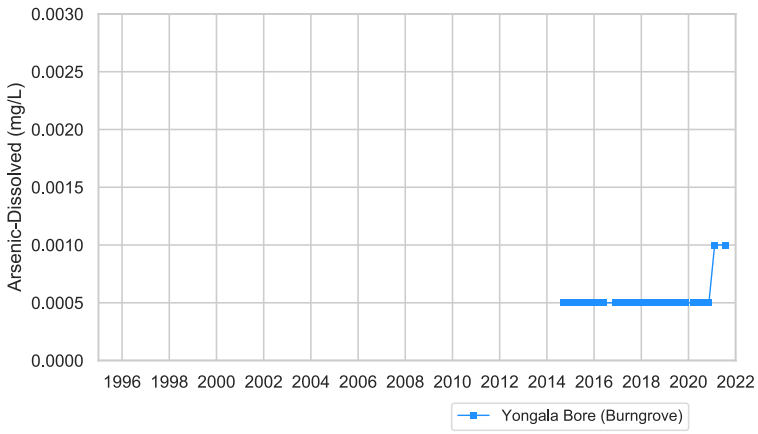

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

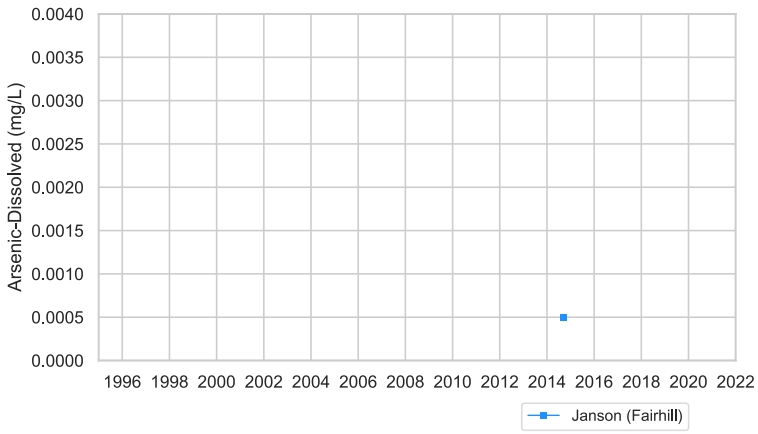

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

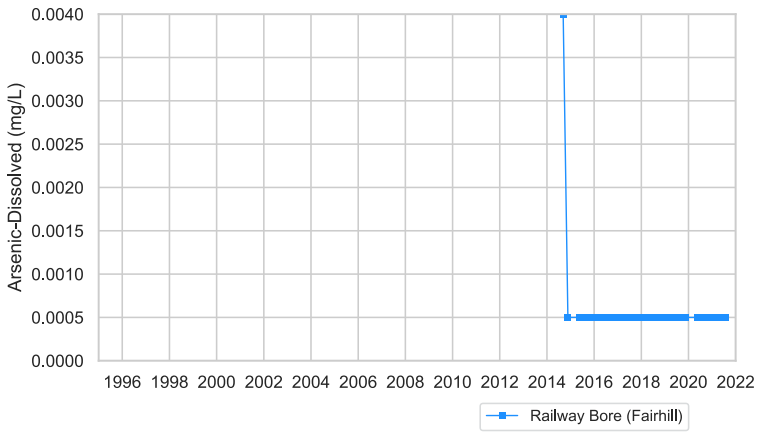

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

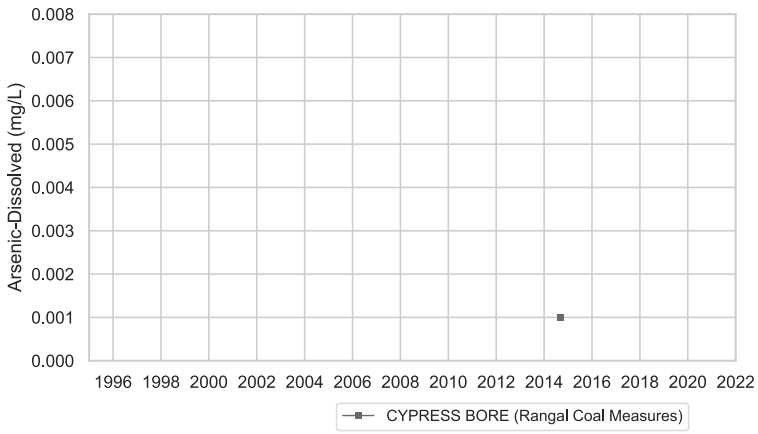

Arsenic-Dissolved (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

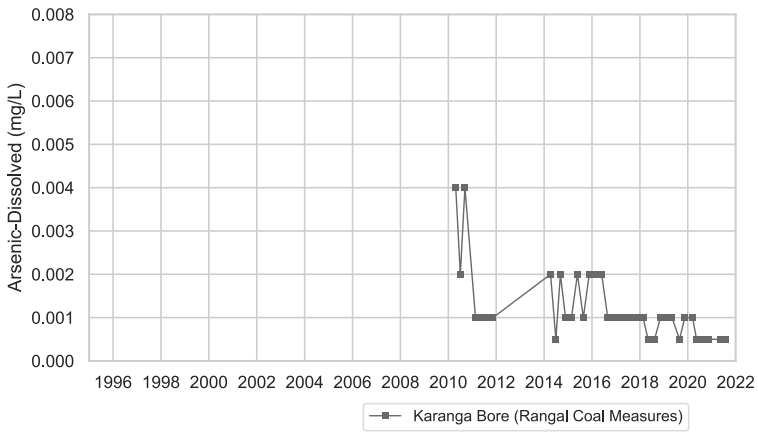

Arsenic-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

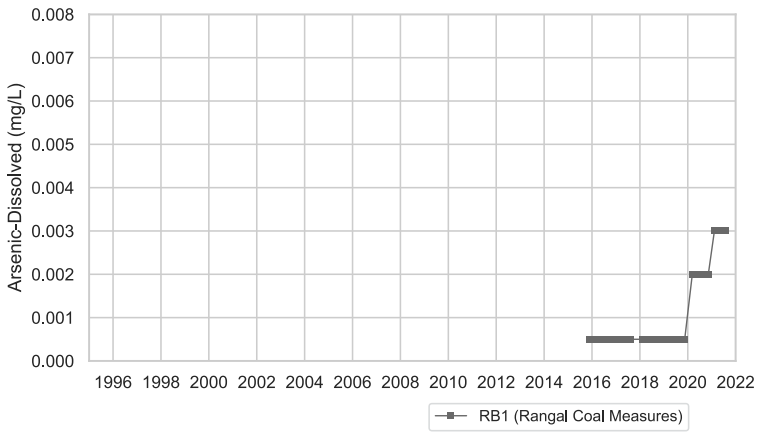

Arsenic-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

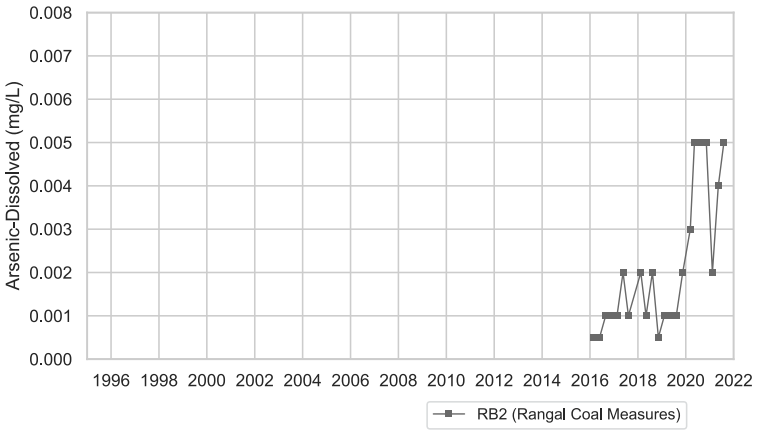

Arsenic-Dissolved (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

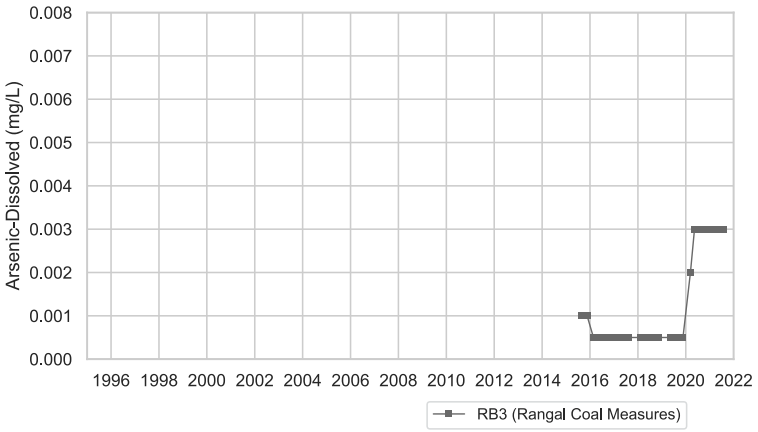

Arsenic-Dissolved (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

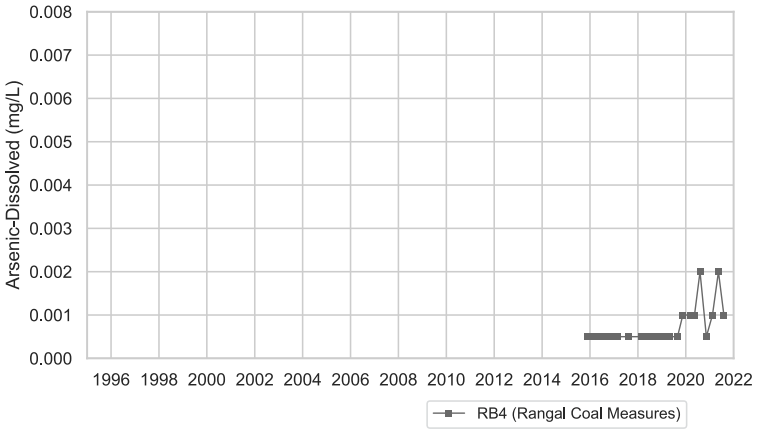

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

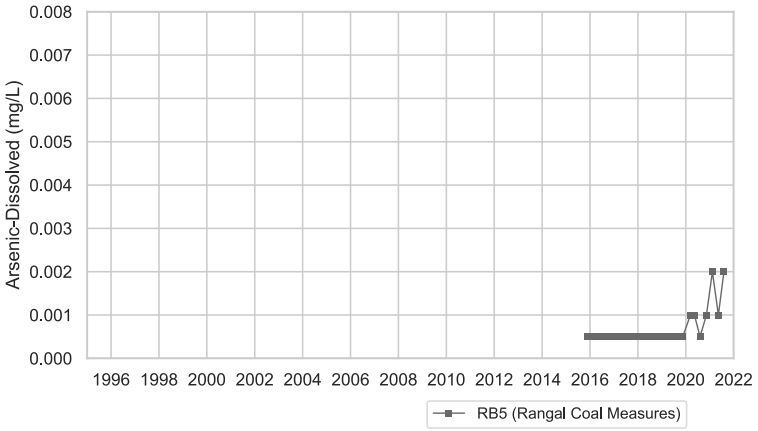

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

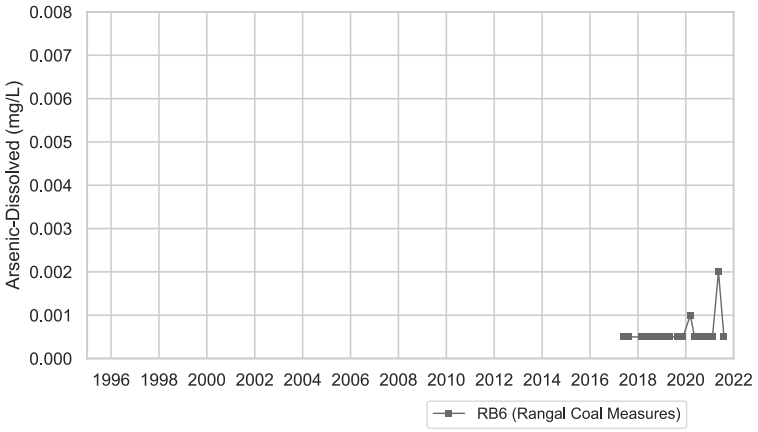

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

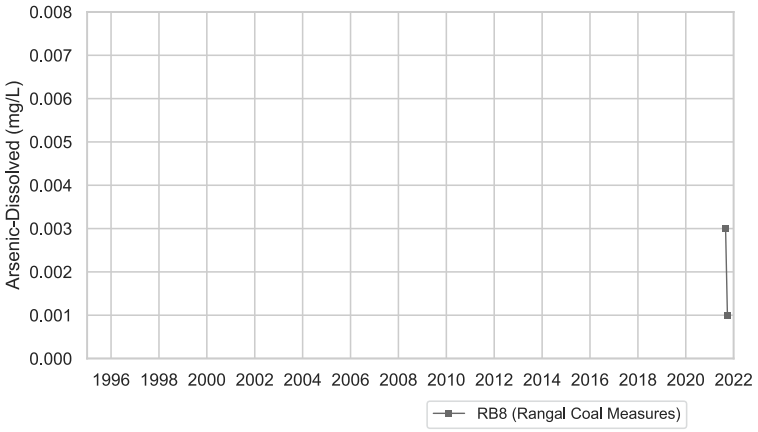

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

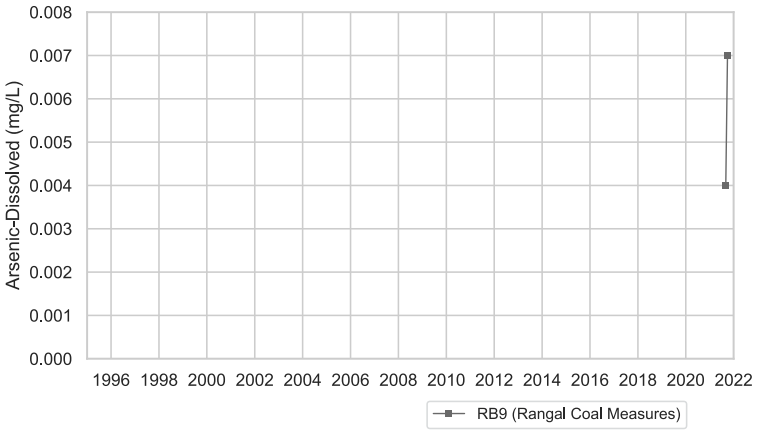

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

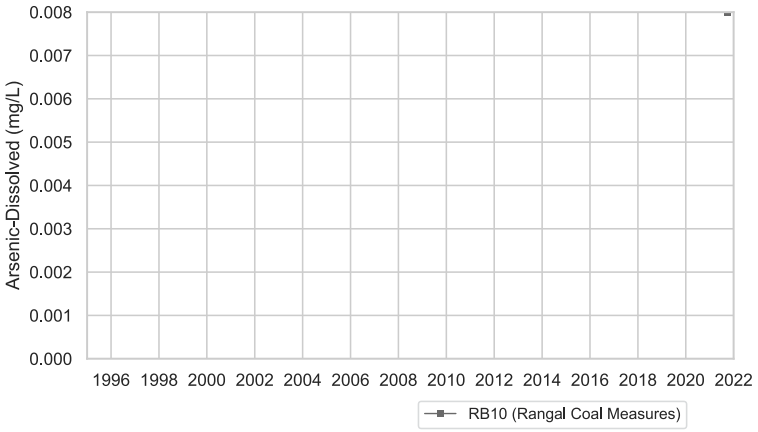

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

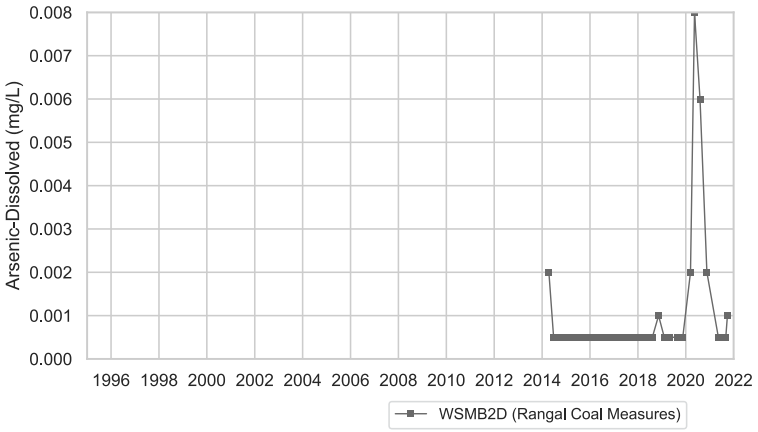

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

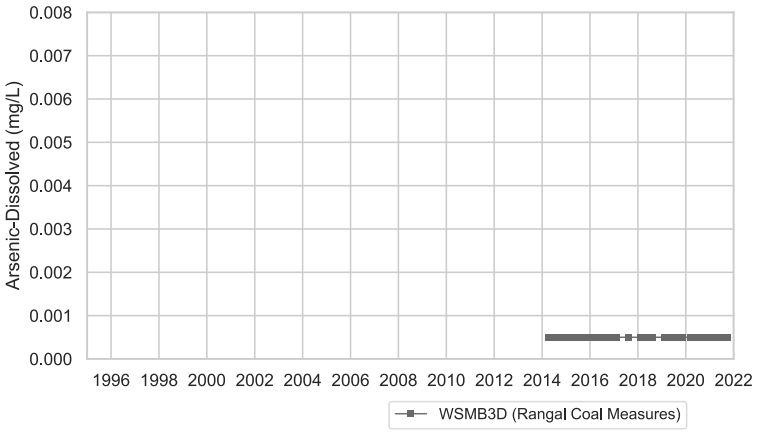

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

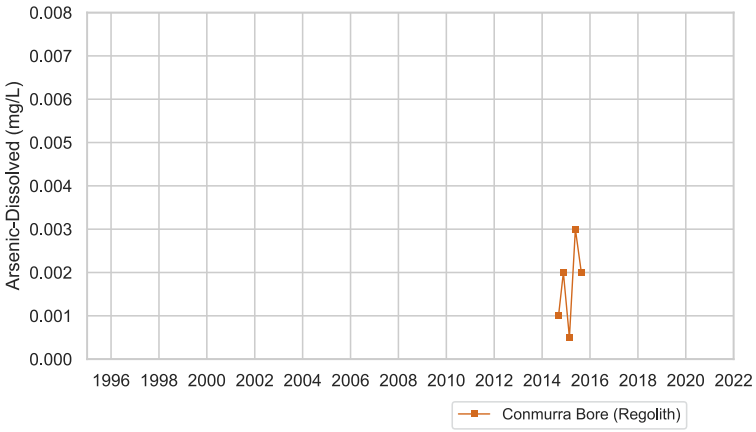

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

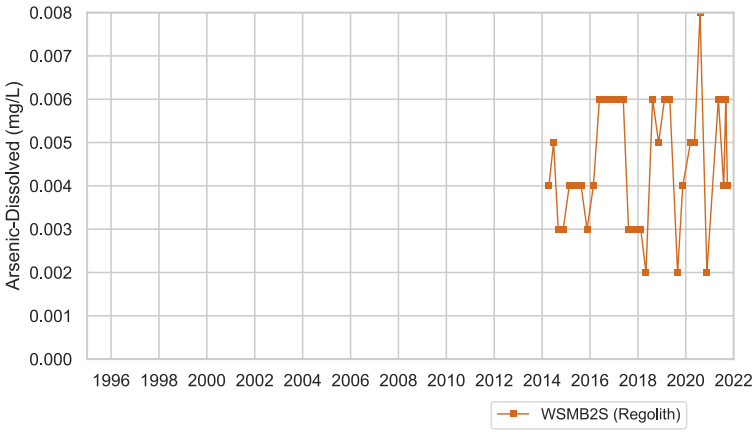

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

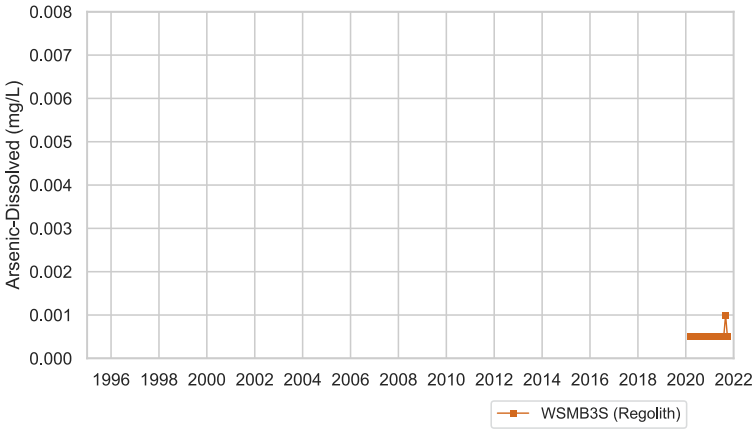

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

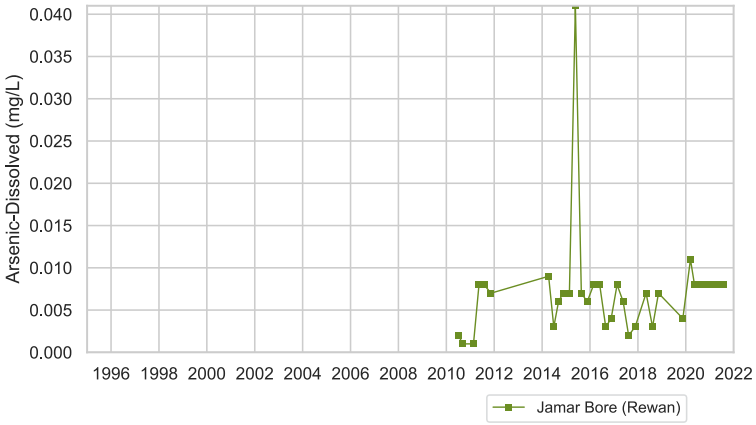

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

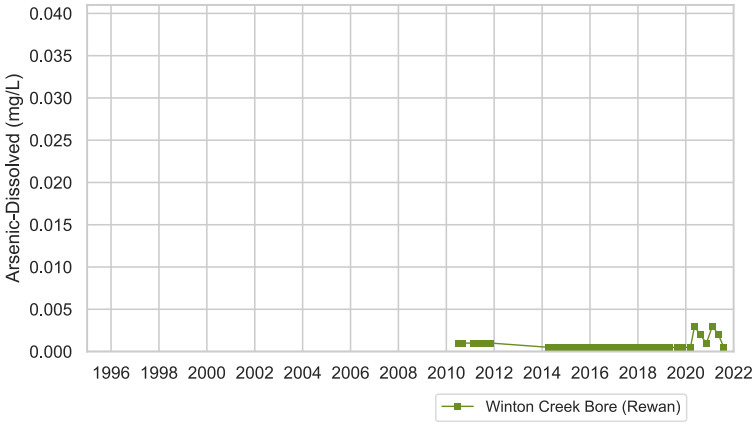

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

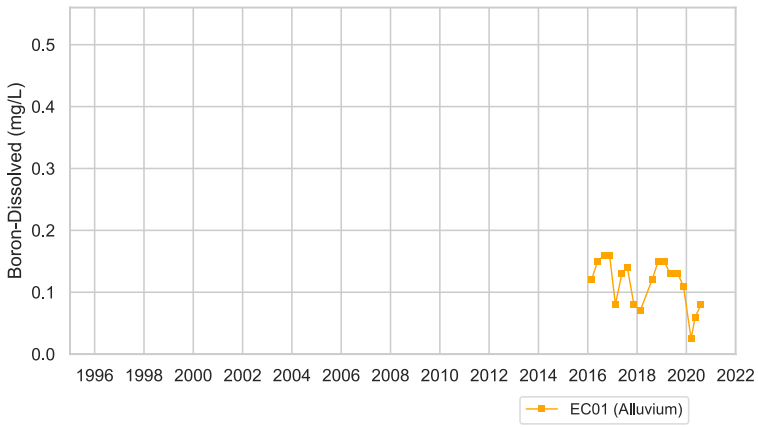

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

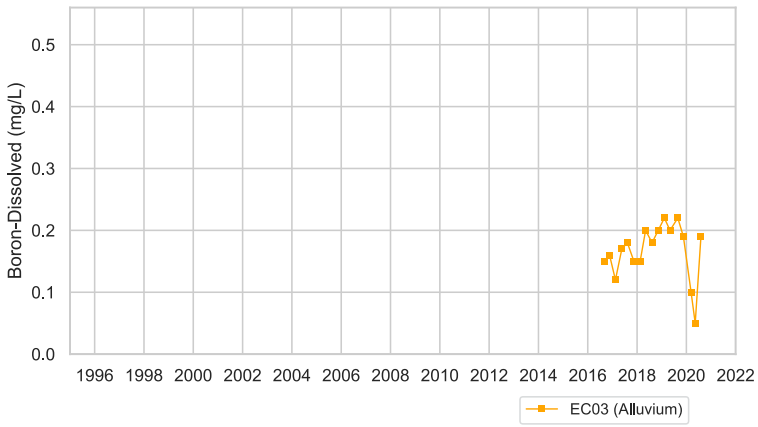

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

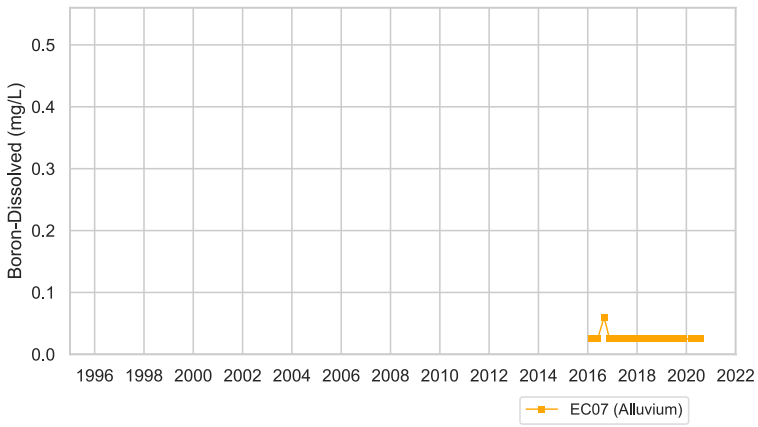

Arsenic-Dissolved (mg/L)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

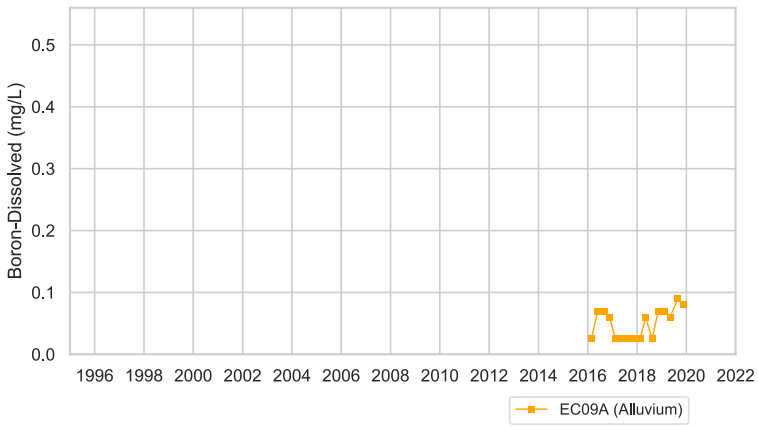

Arsenic-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

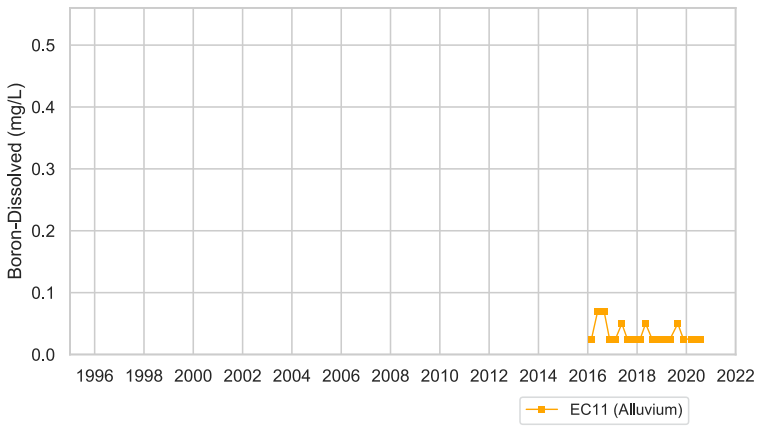

Arsenic-Dissolved (mg/L)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

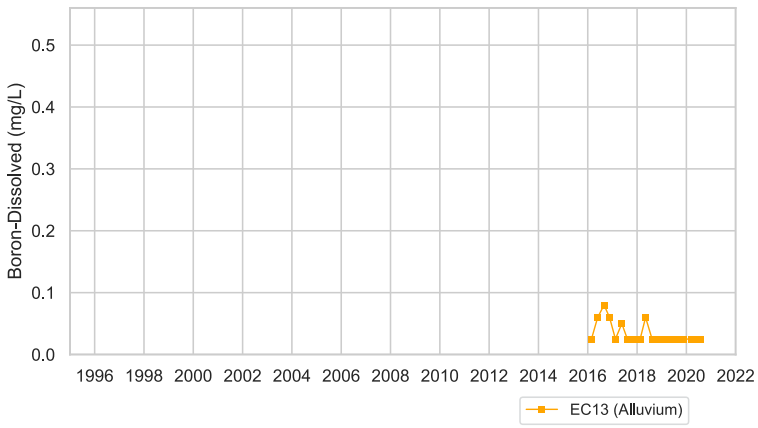

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

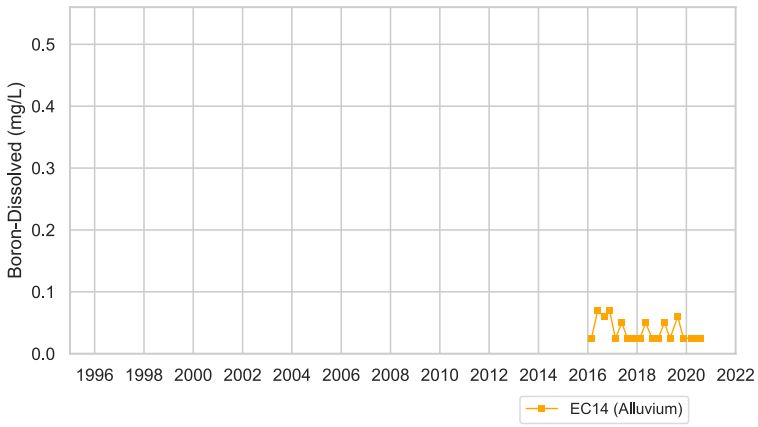

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

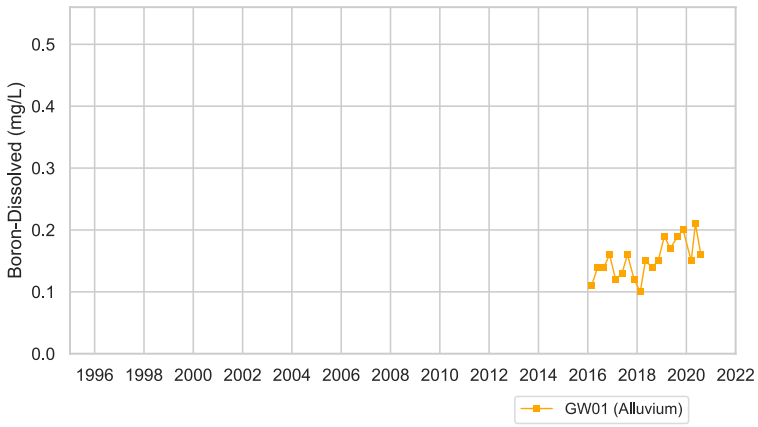

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

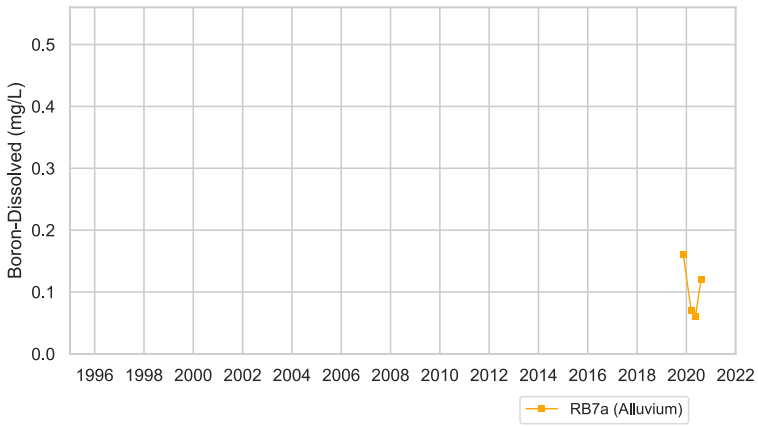

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

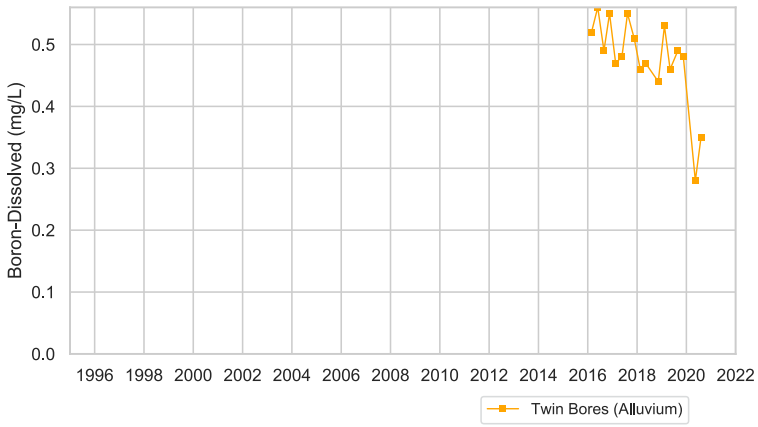

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

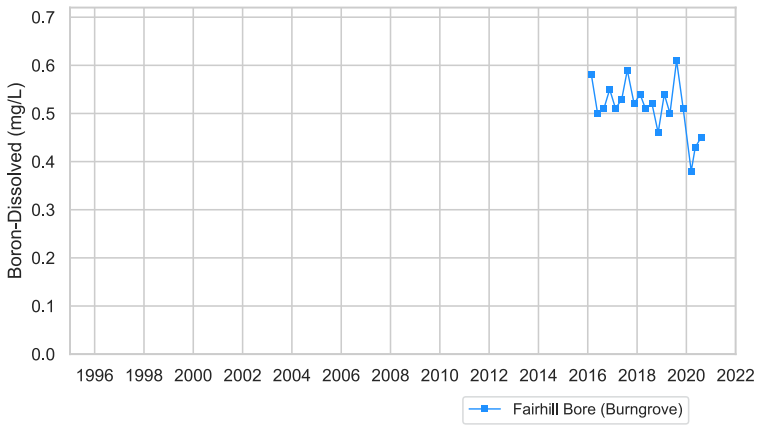

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

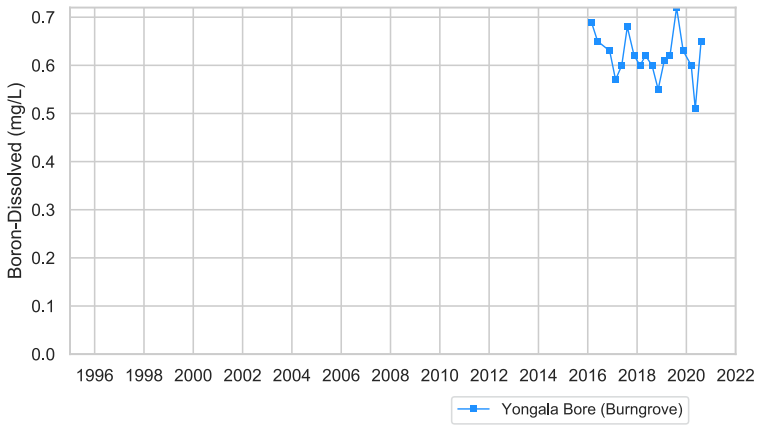

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

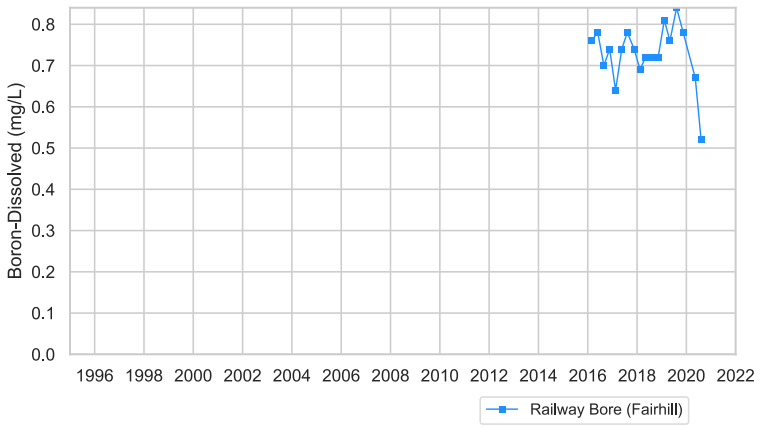

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

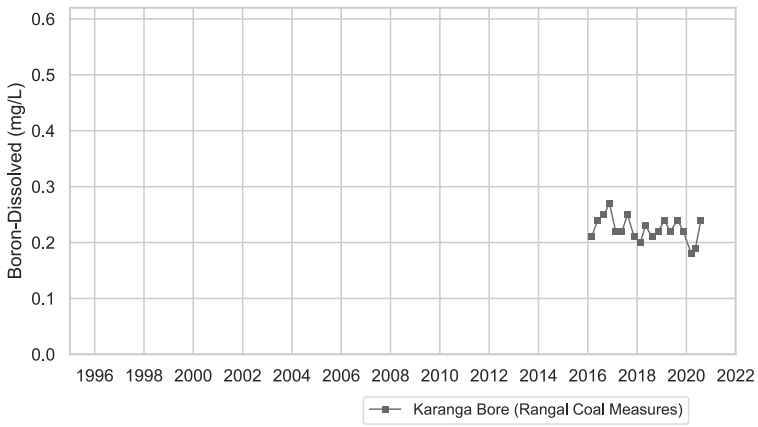

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

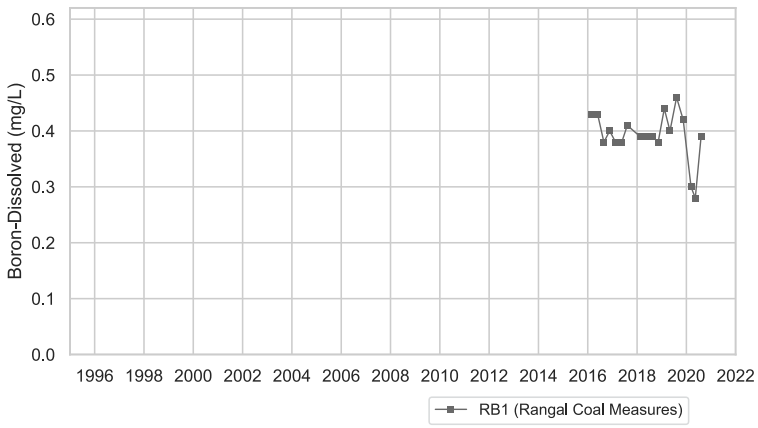

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

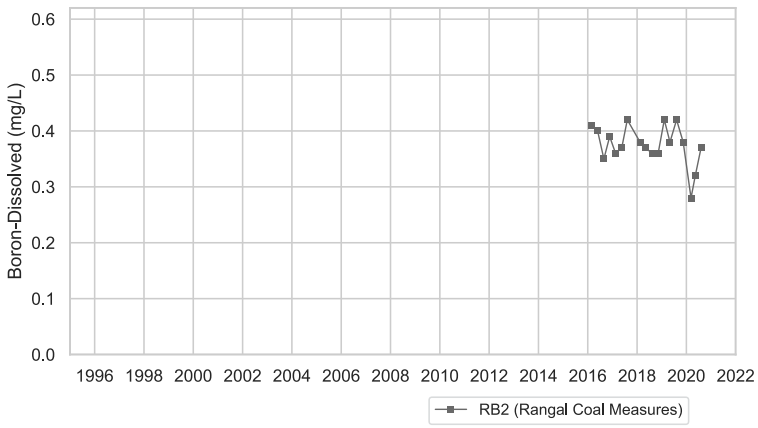

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

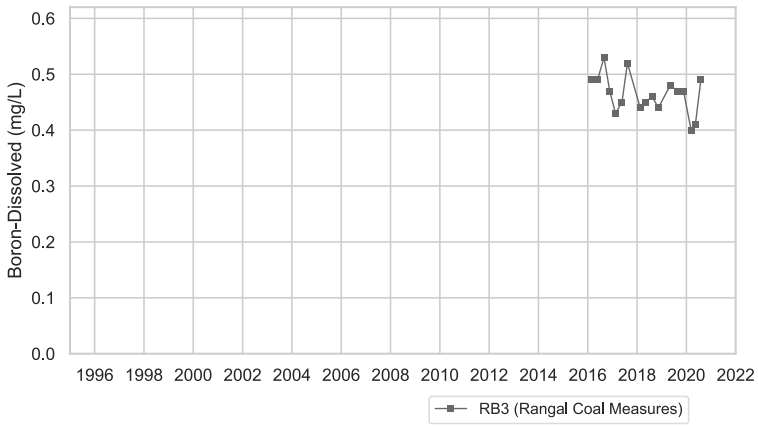

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

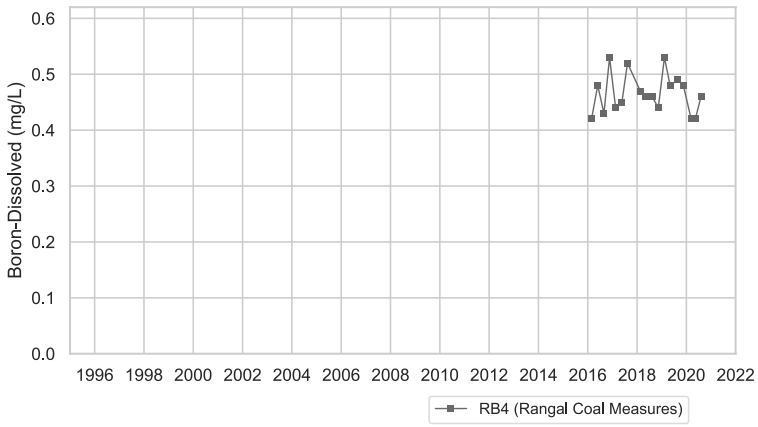

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

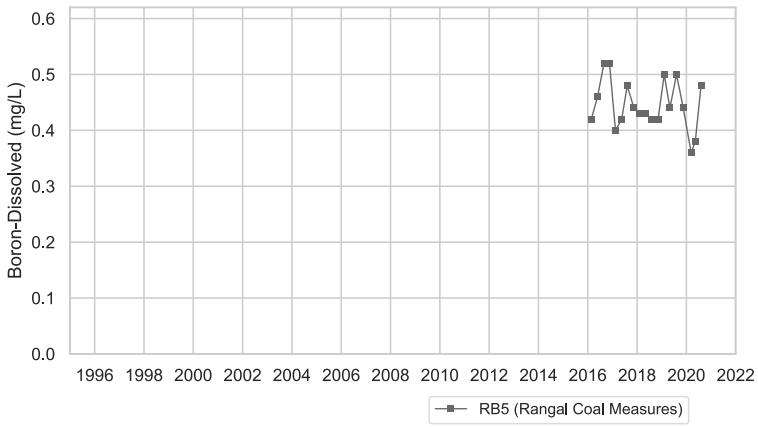

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

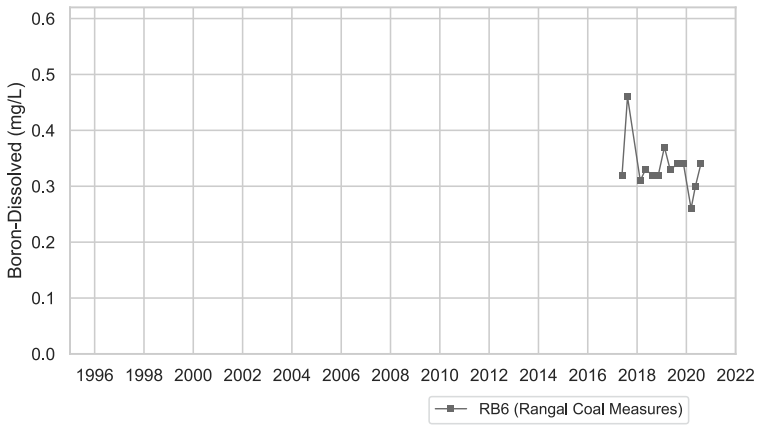

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

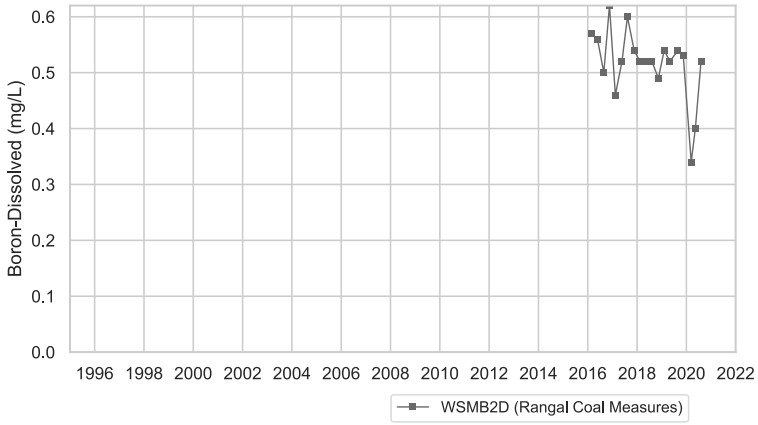

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

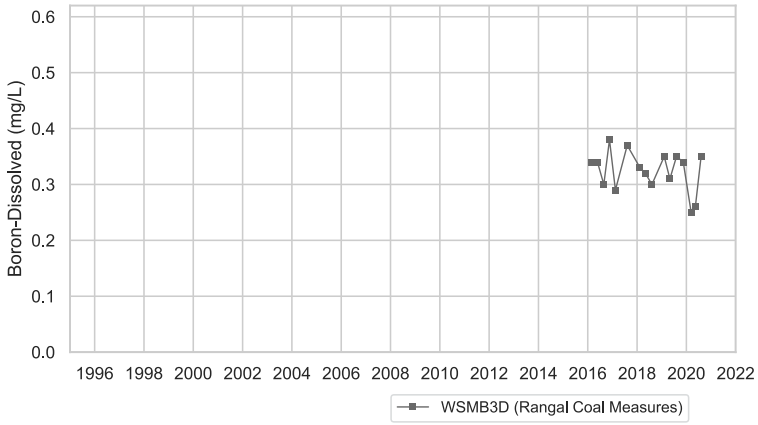

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

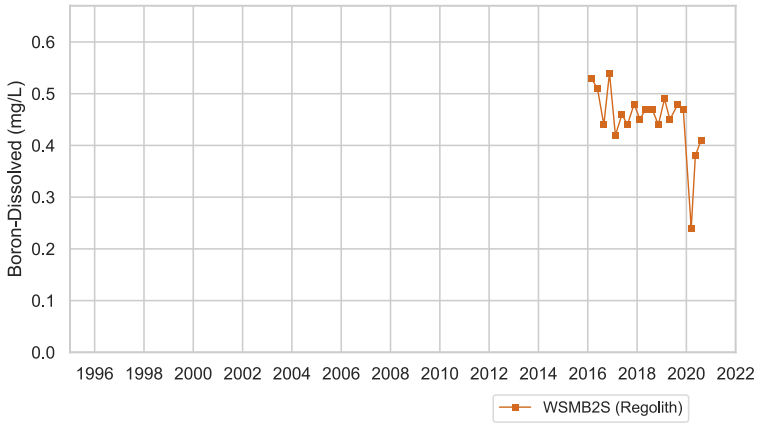

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

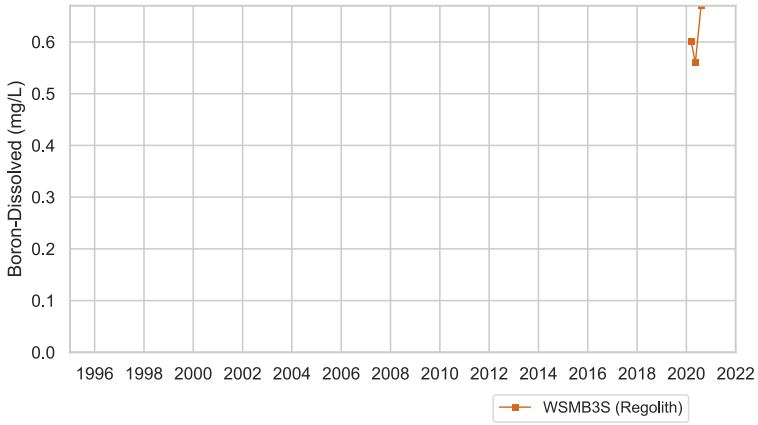

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

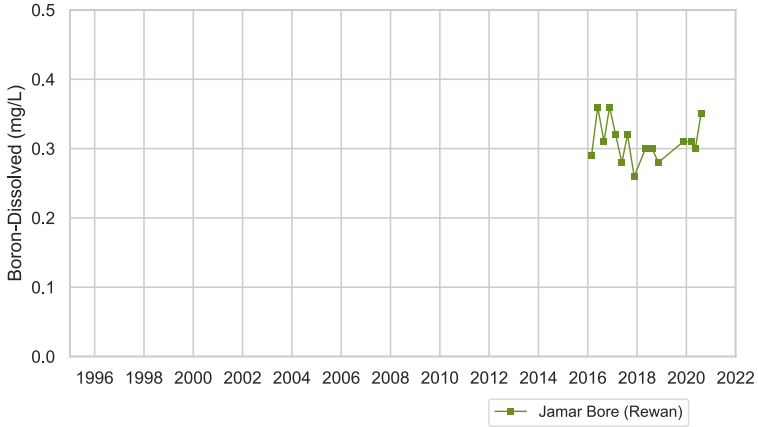

Boron-Dissolved (mg/L)
0.0 0.1 0.2 0.3 0.4 0.5 0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

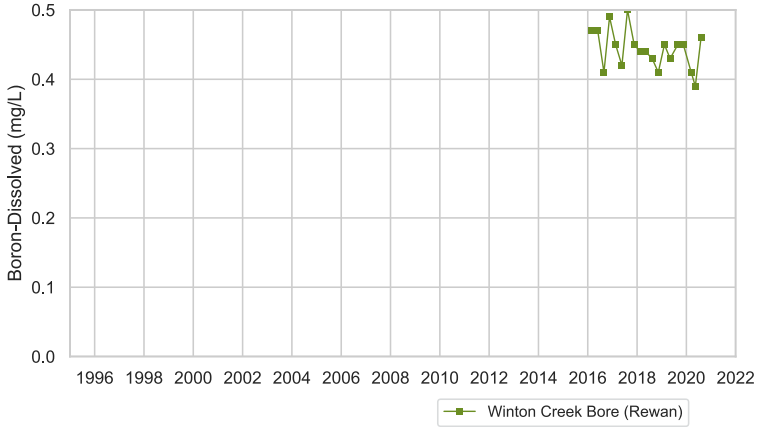

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

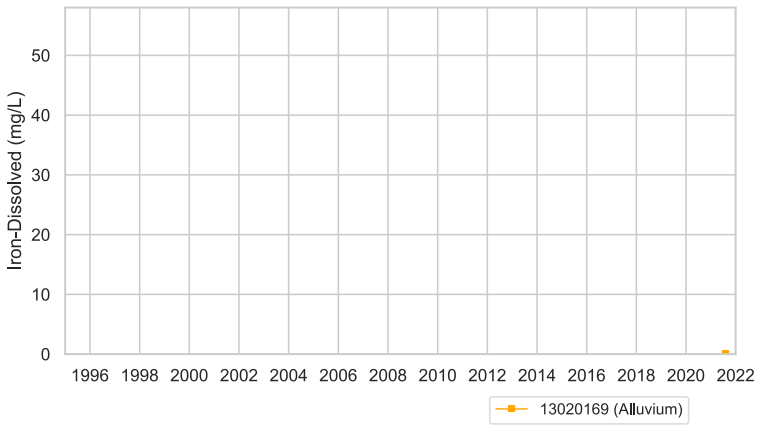

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

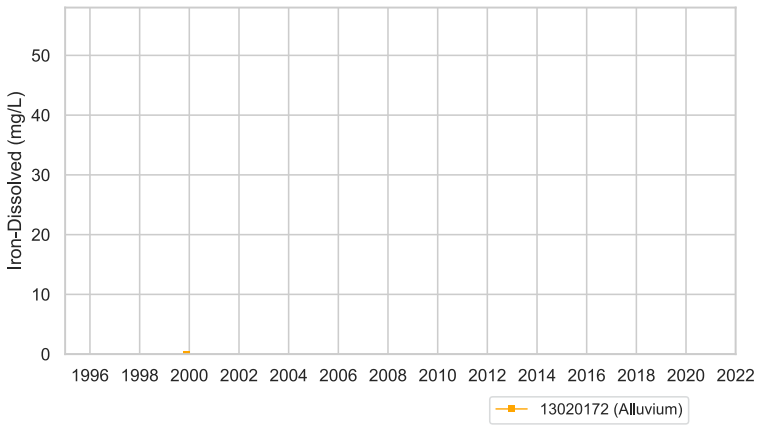

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

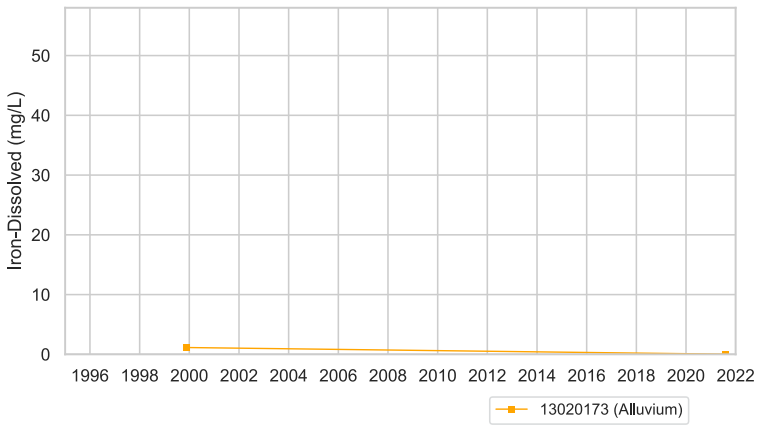

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

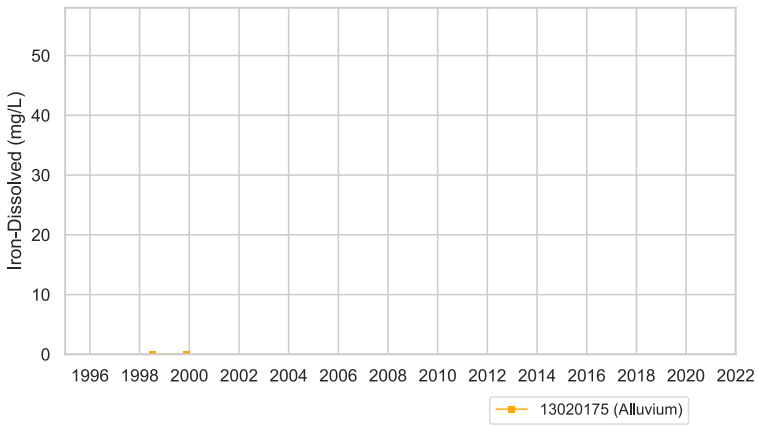

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

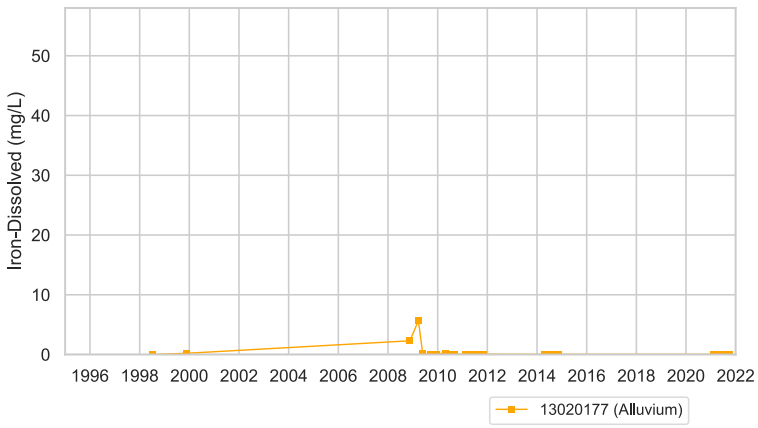

Boron-Dissolved (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

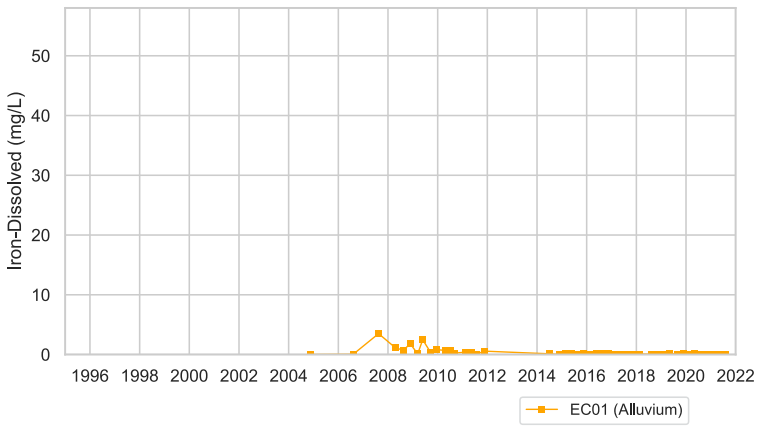

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

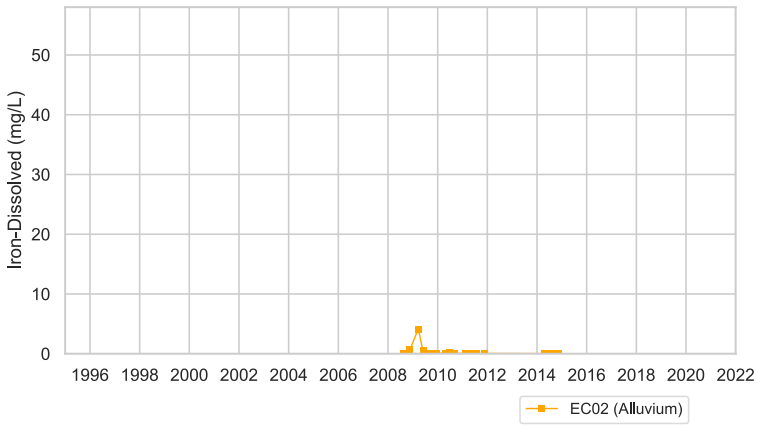

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

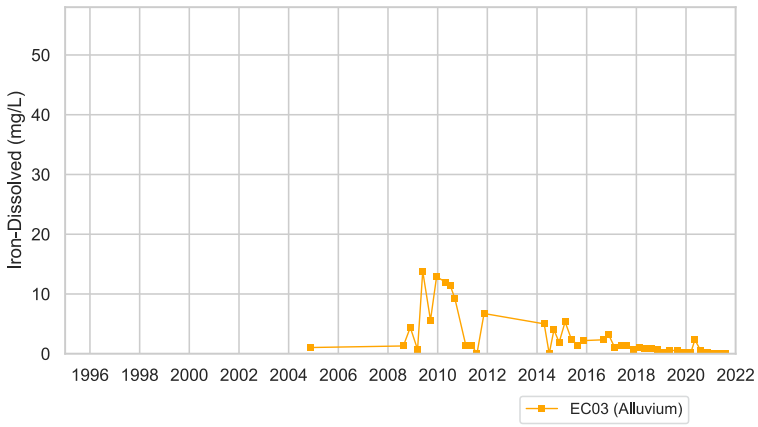

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

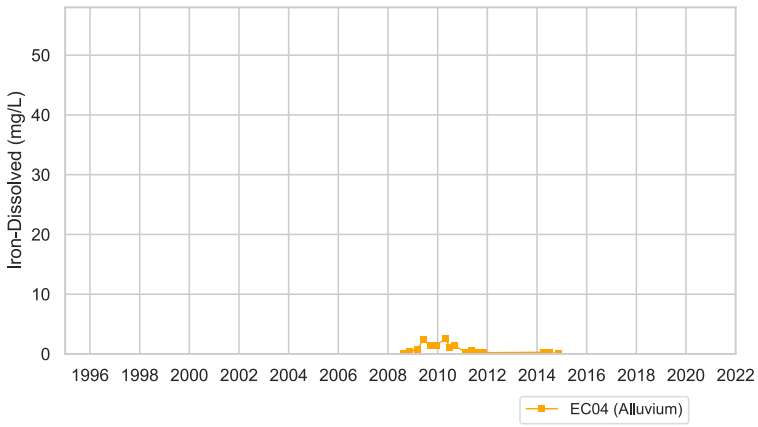

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

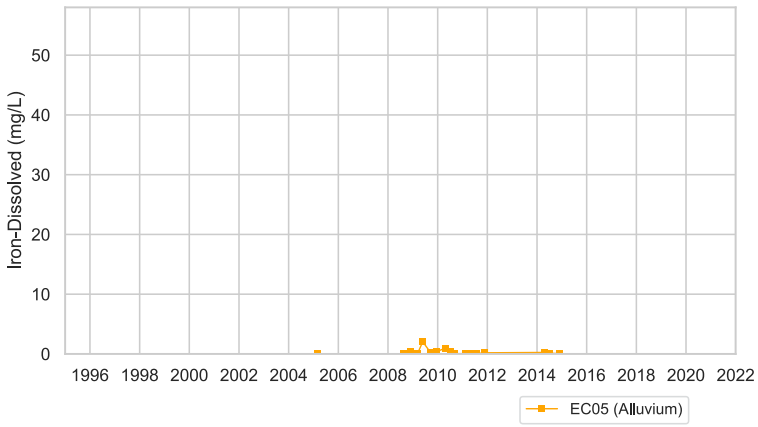

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

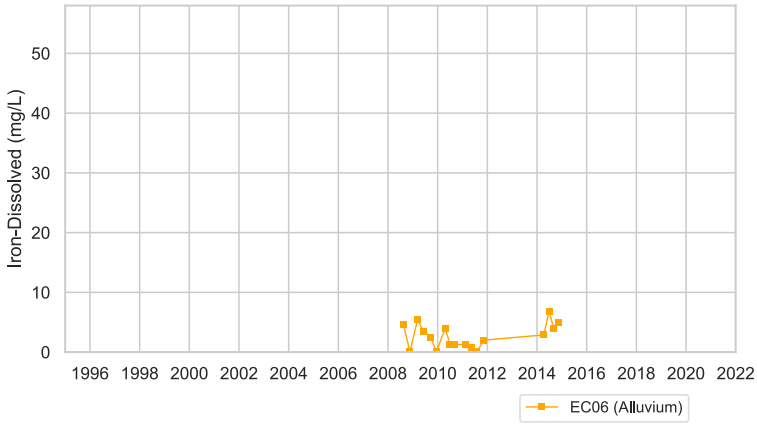

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

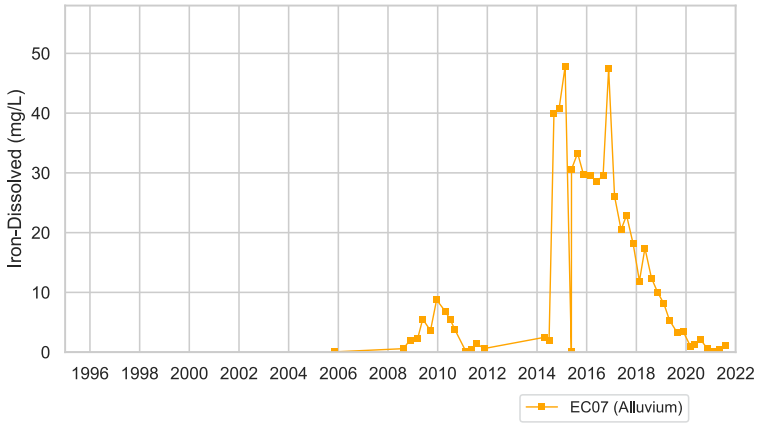

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

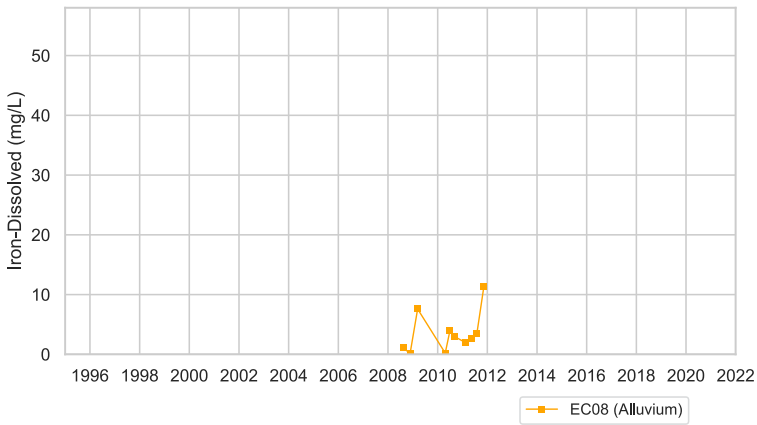

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

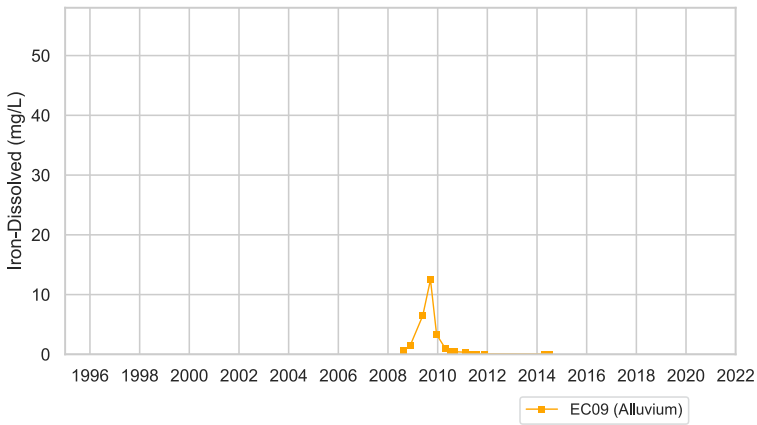

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

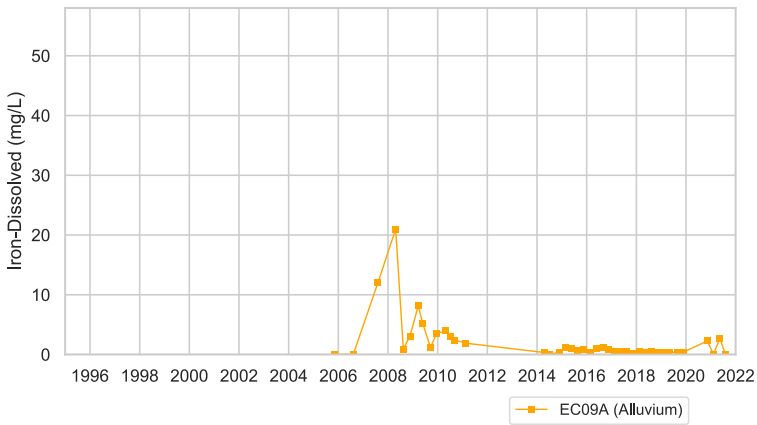

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

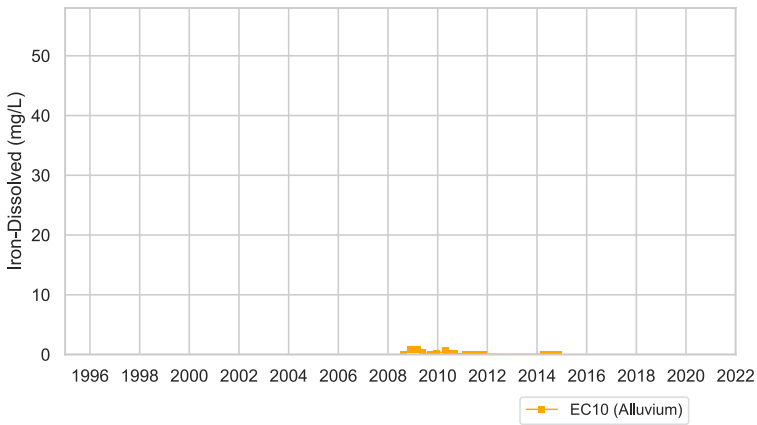

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

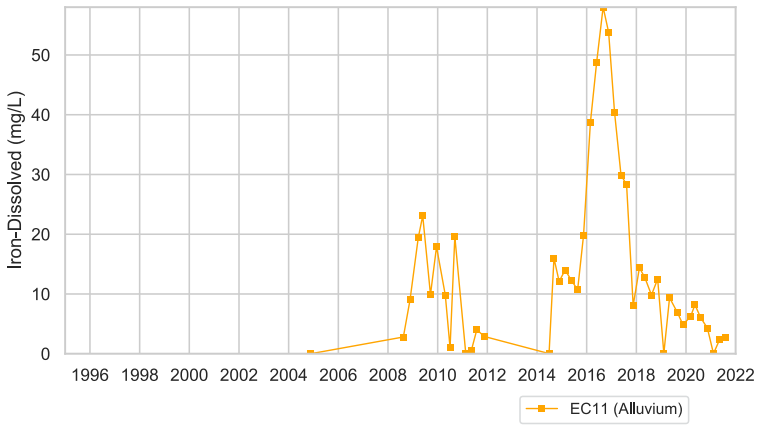

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

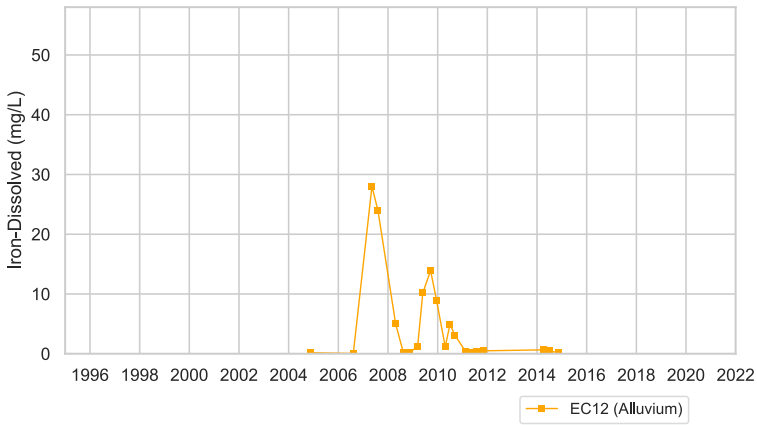

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

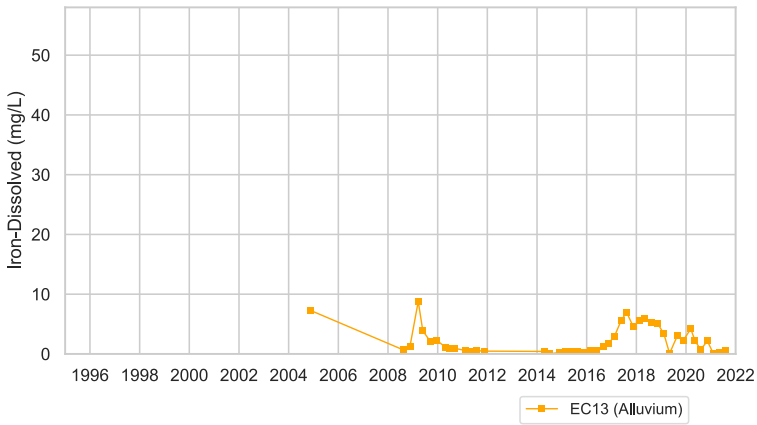

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

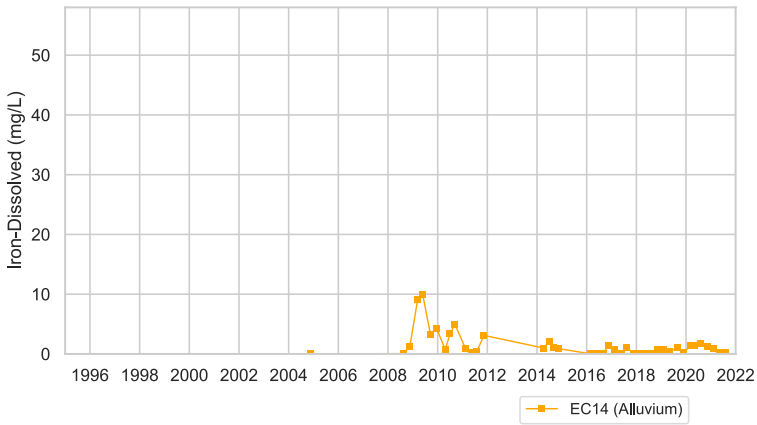

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

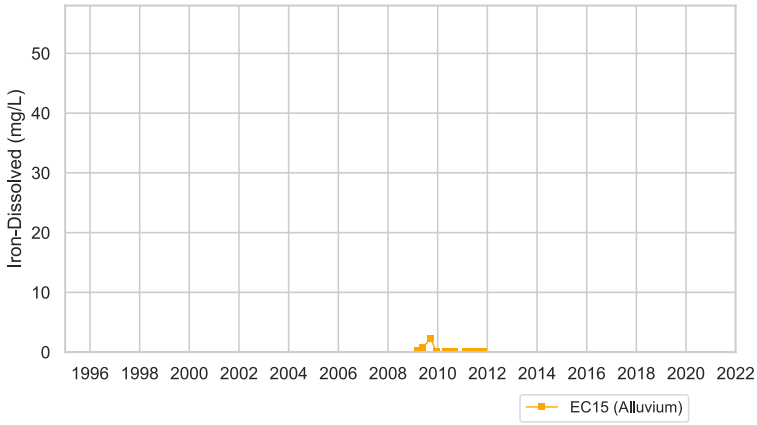

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

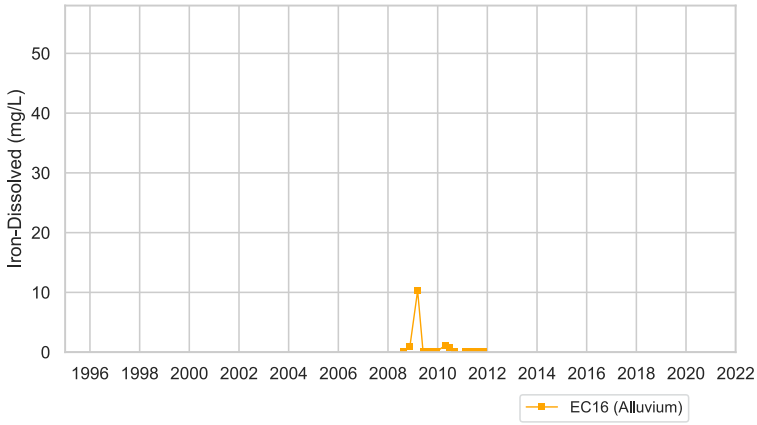

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

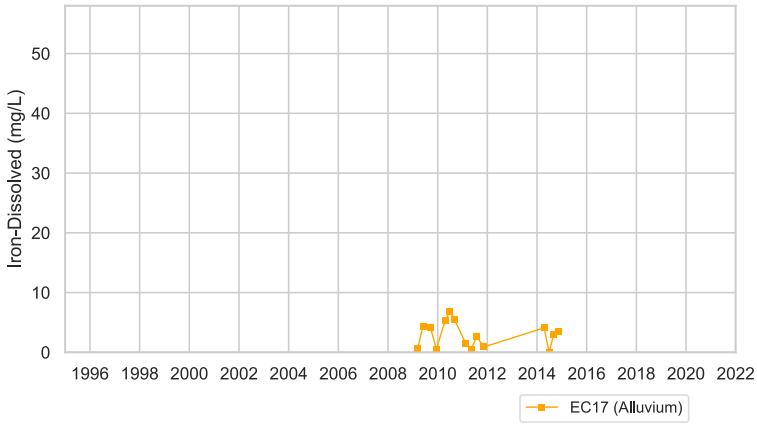

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

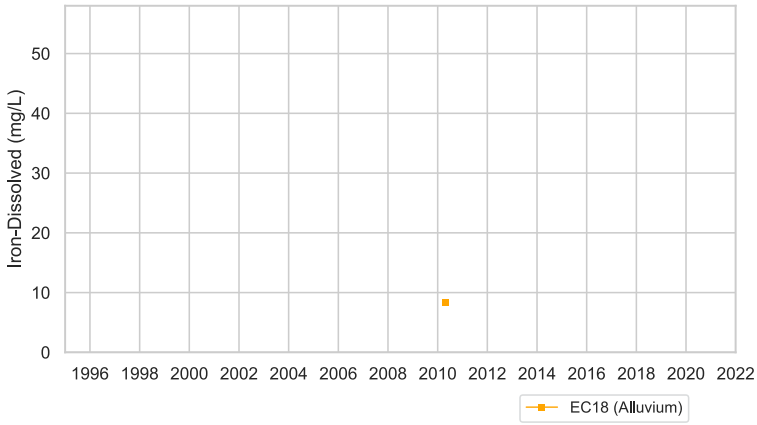

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

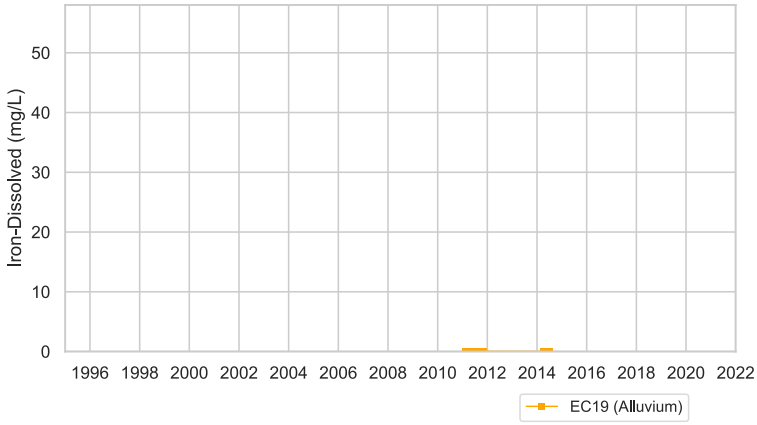

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

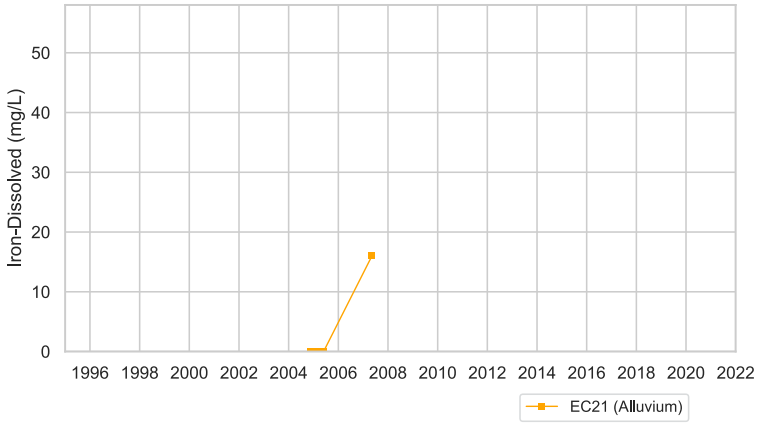

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

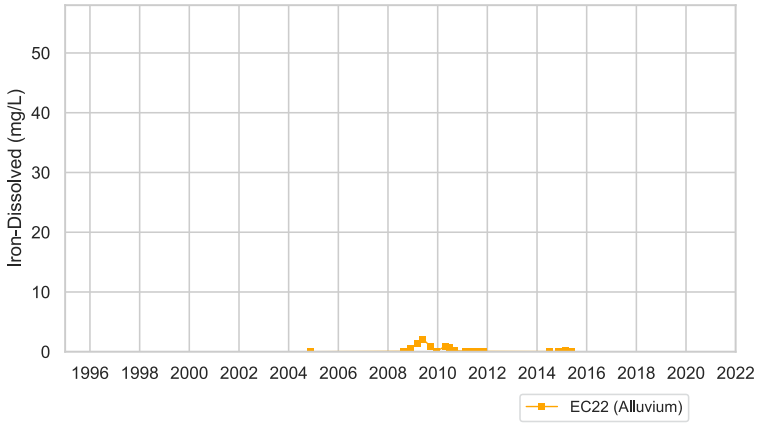

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

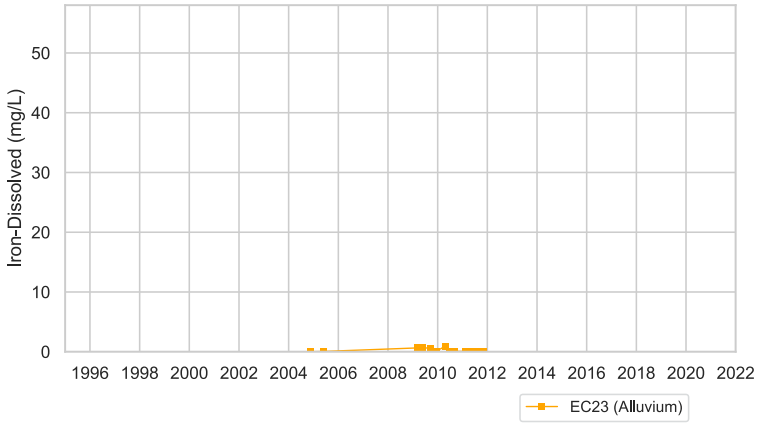

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

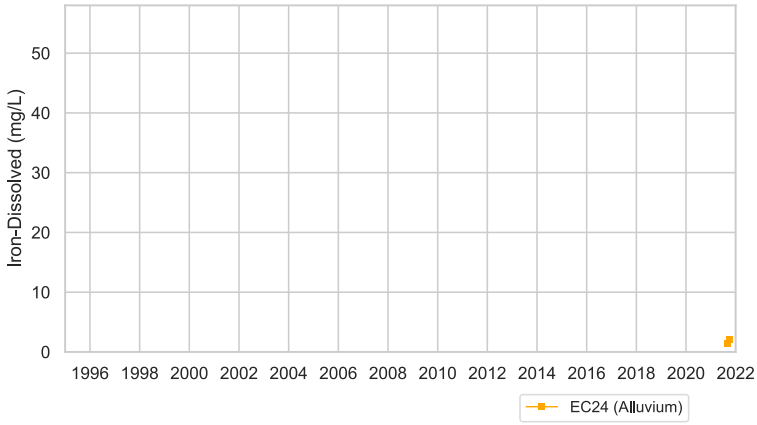

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

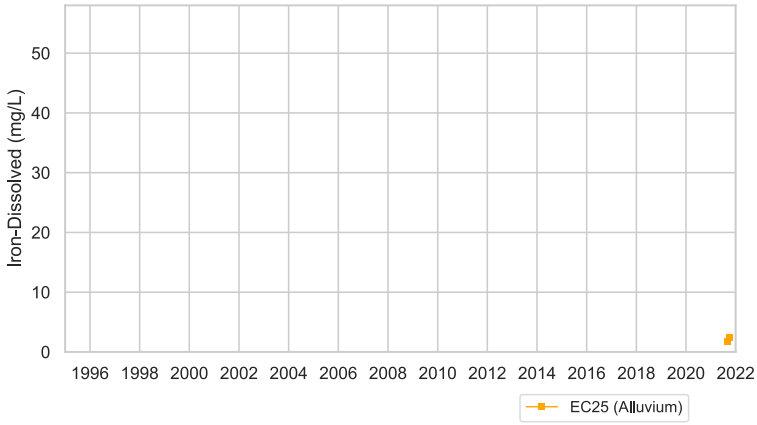

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

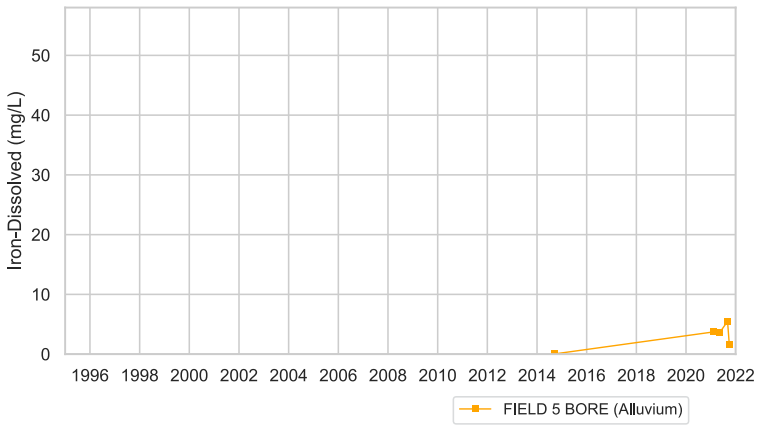

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

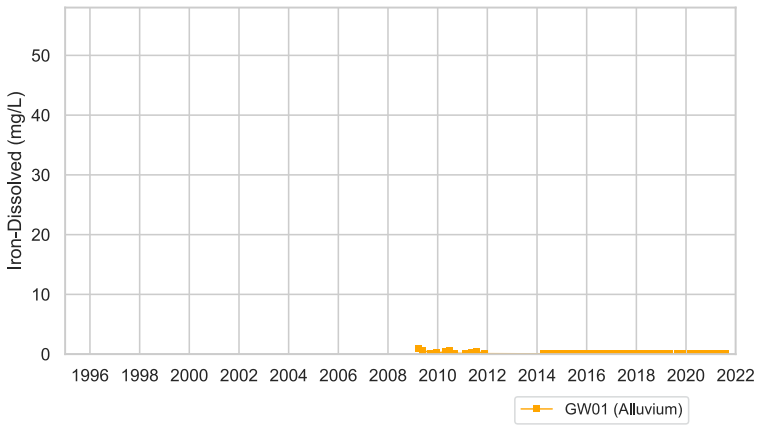

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

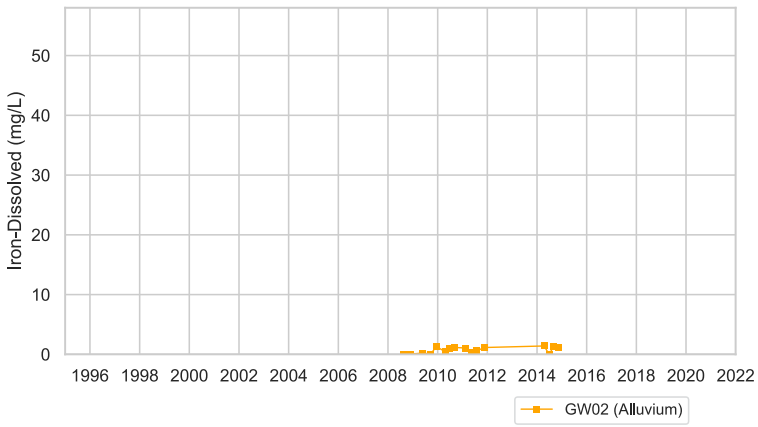

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

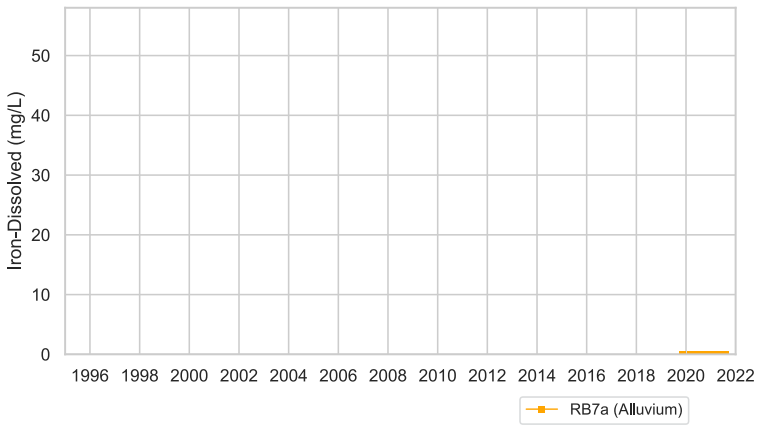

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

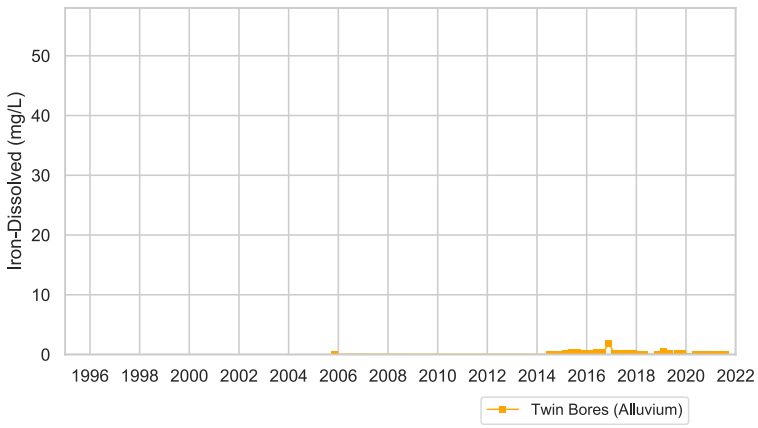

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

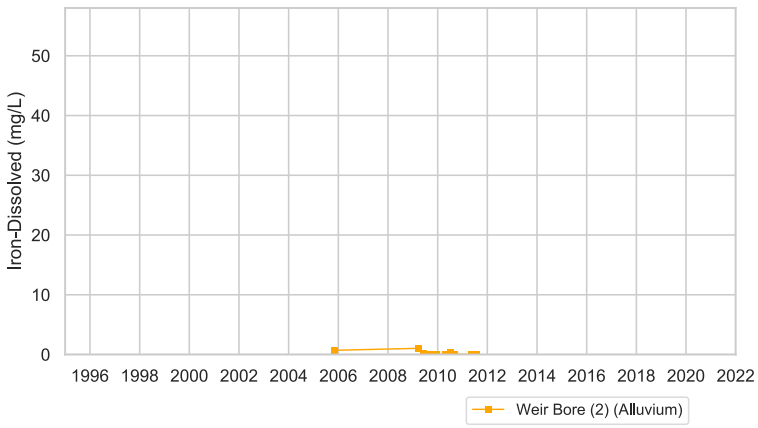

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

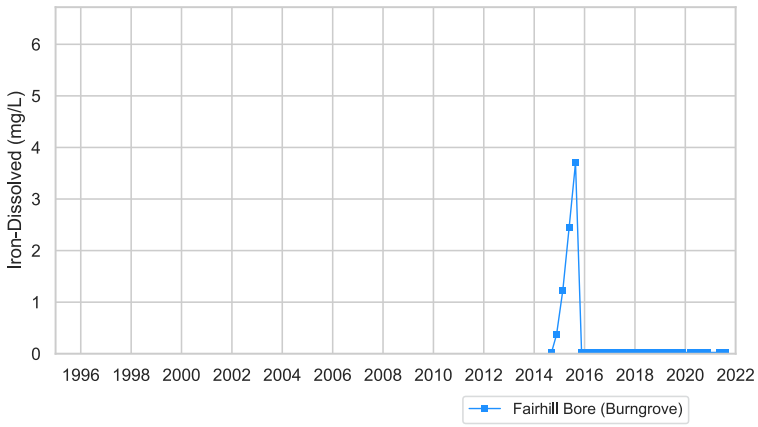

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

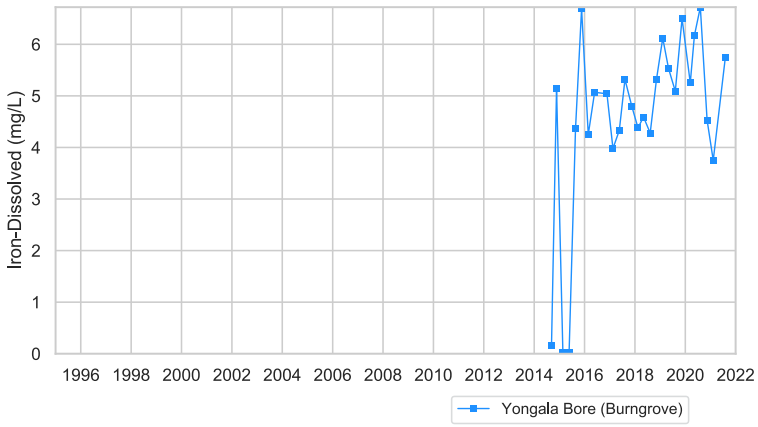

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

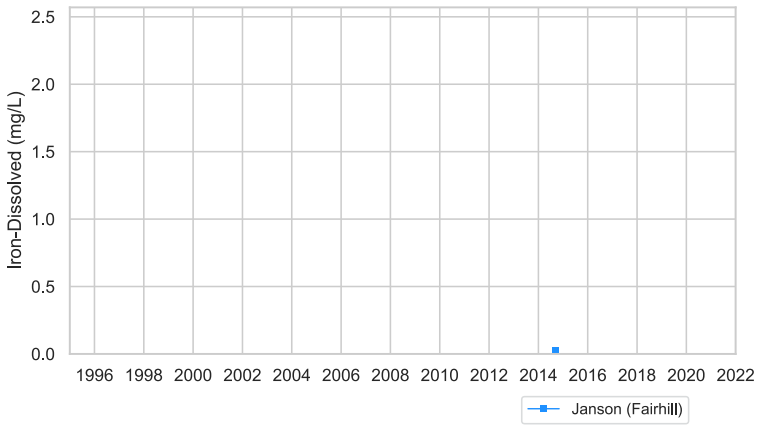

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

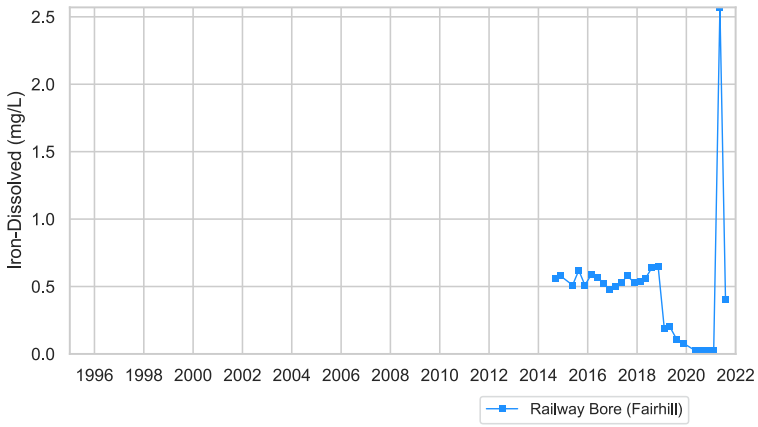

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

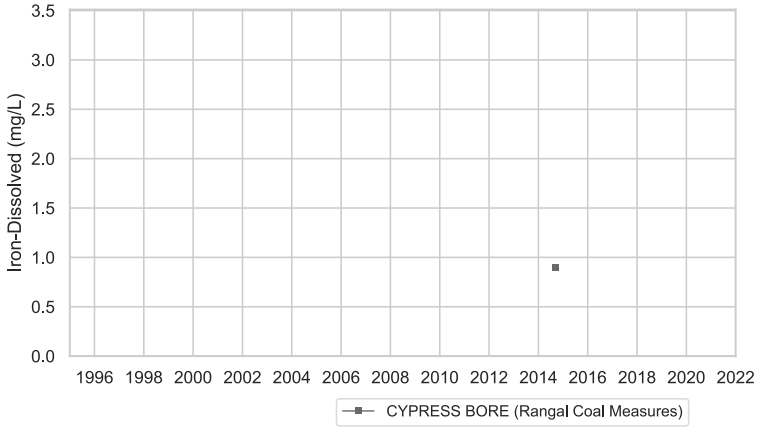

Iron-Dissolved (mg/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

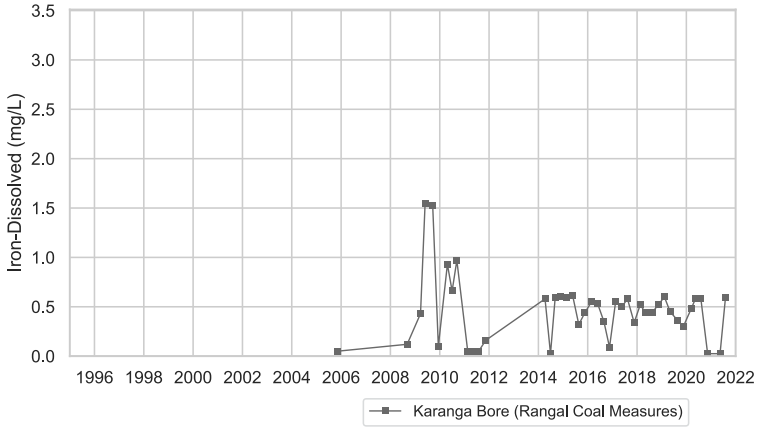

Iron-Dissolved (mg/L)
0
1
2
3
4
5
6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

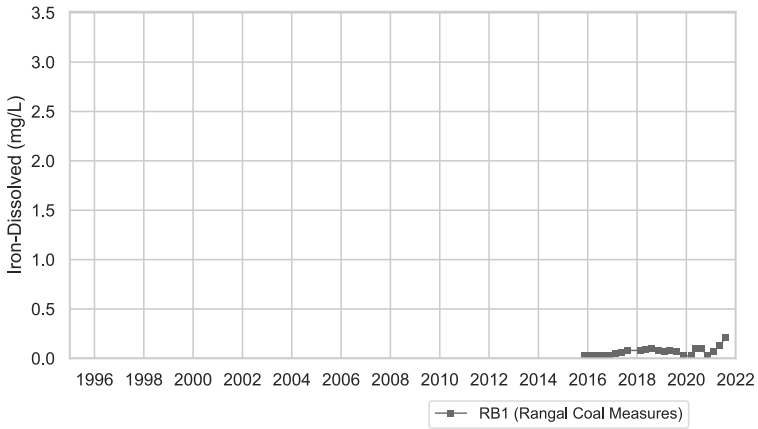

Iron-Dissolved (mg/L)
0
1
2
3
4
5
6
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

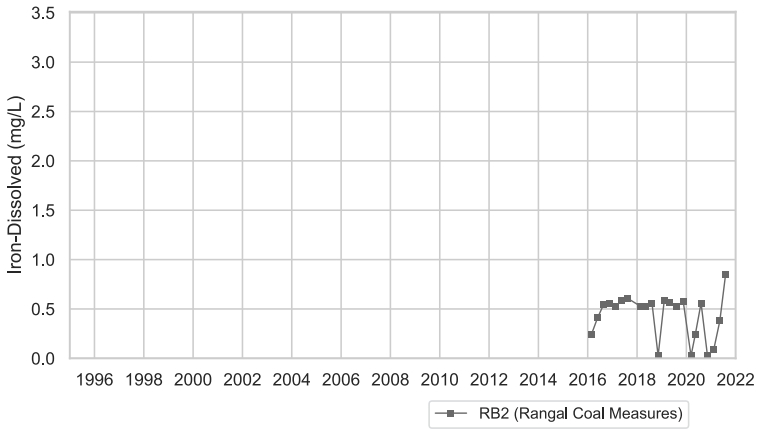

Iron-Dissolved (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

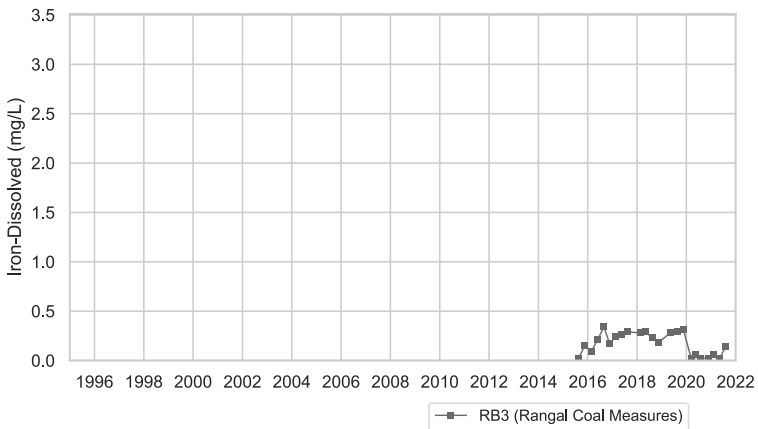

Iron-Dissolved (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

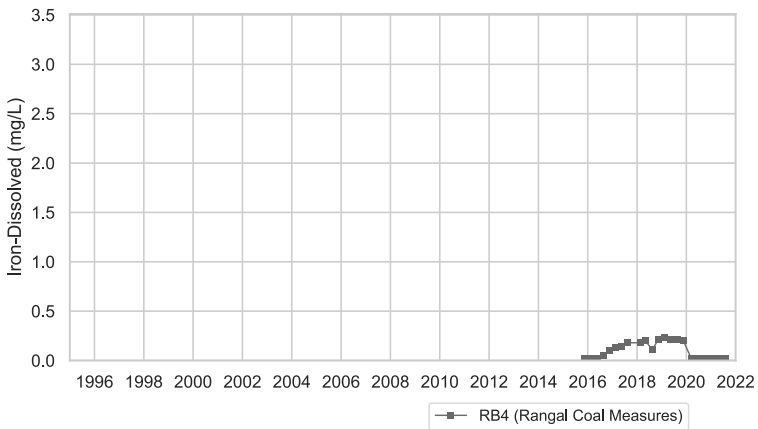

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

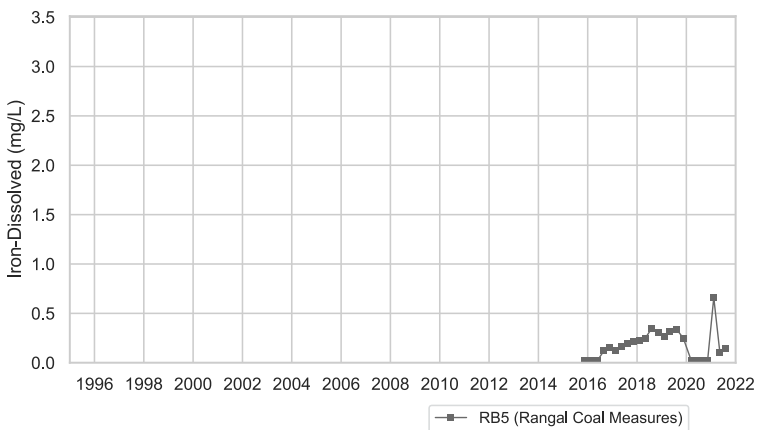

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

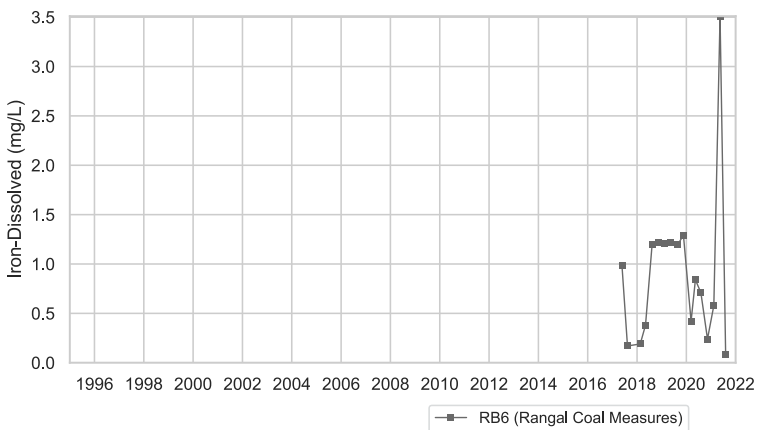

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

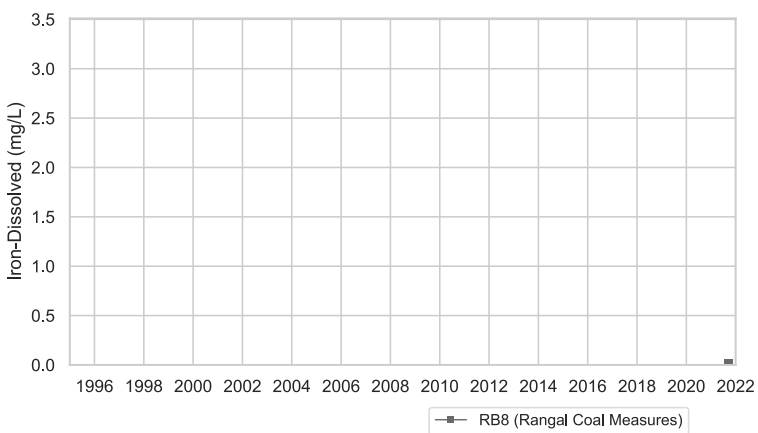

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

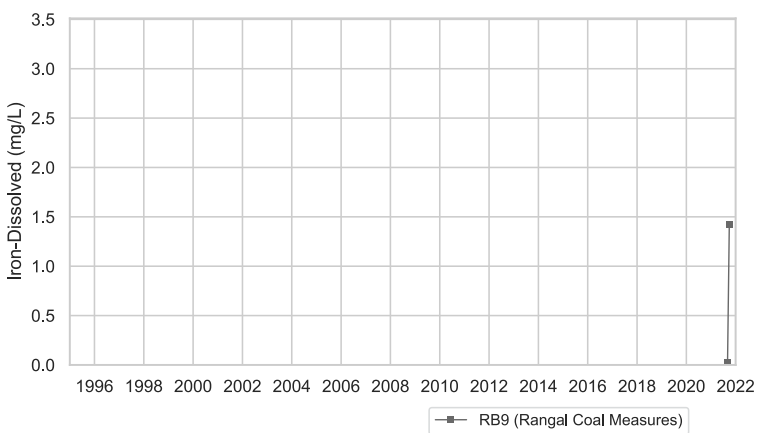

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

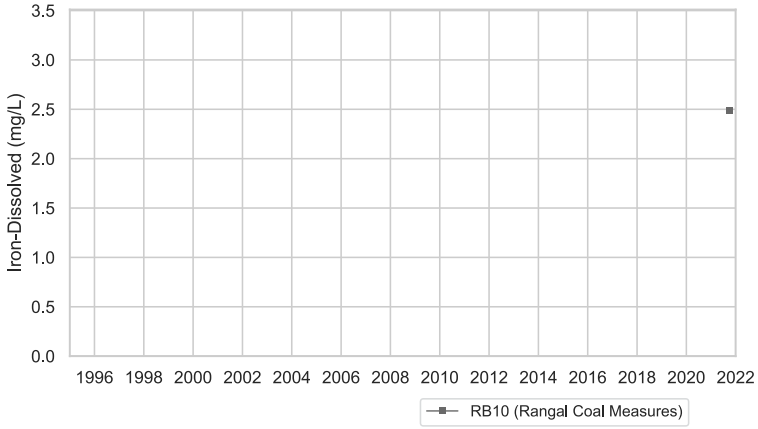

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

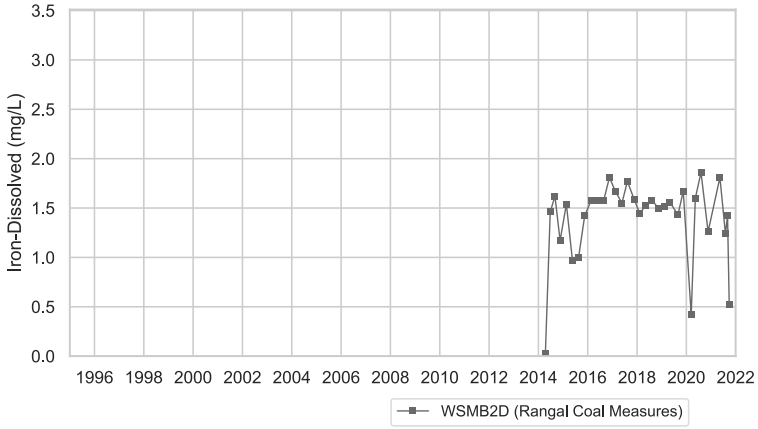

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

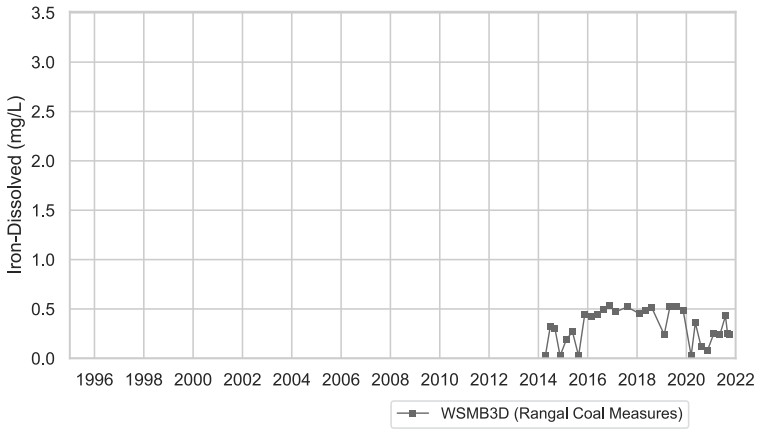

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

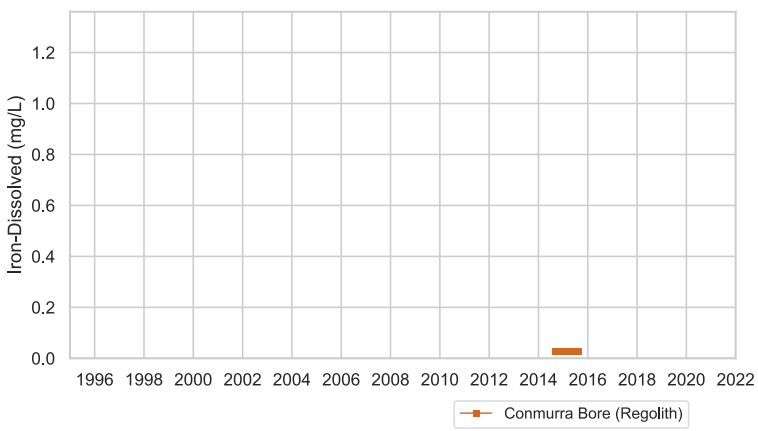

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

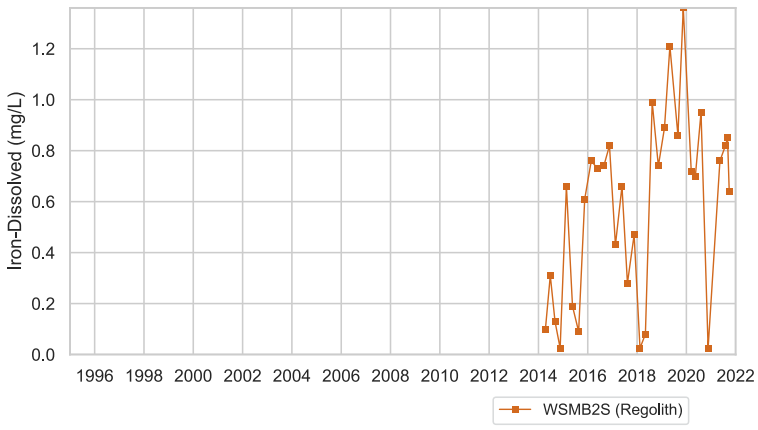

Iron-Dissolved (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)


Iron-Dissolved (mg/L)
RB10 (Rangal Coal Measures)

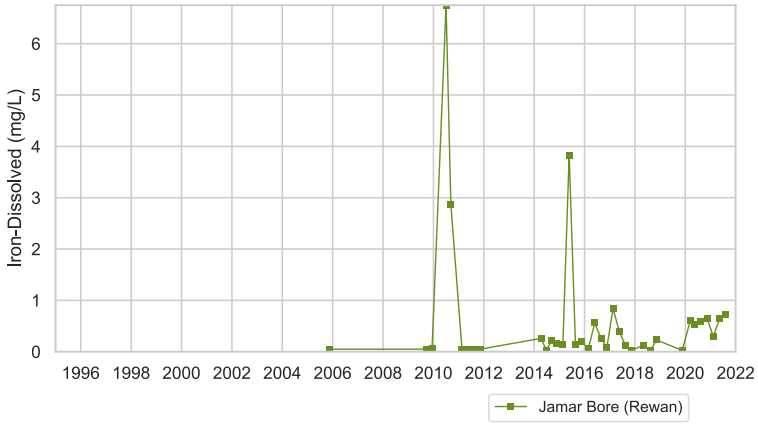

Iron-Dissolved (mg/L)
WSMB2D (Rangal Coal Measures)

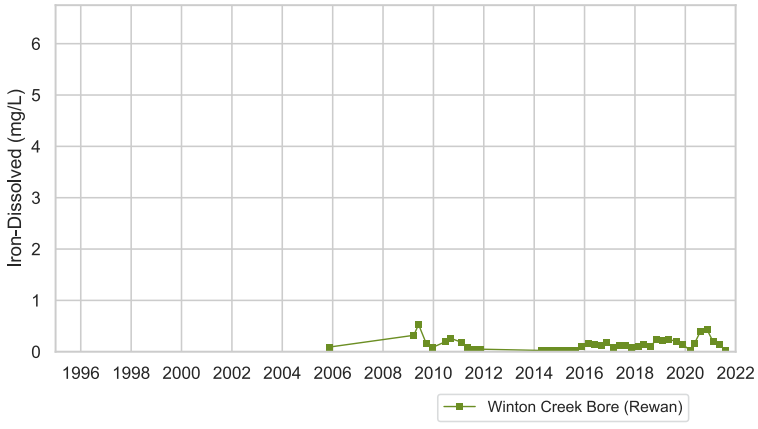

Iron-Dissolved (mg/L)
WSMB3D (Rangal Coal Measures)

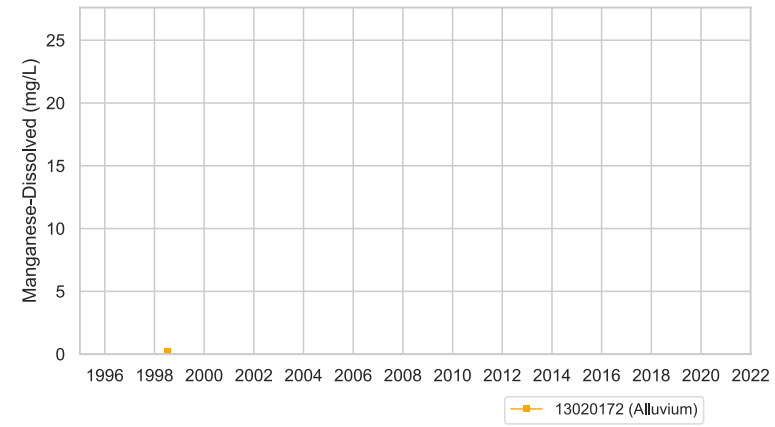

Iron-Dissolved (mg/L)
Conmurra Bore (Regolith)

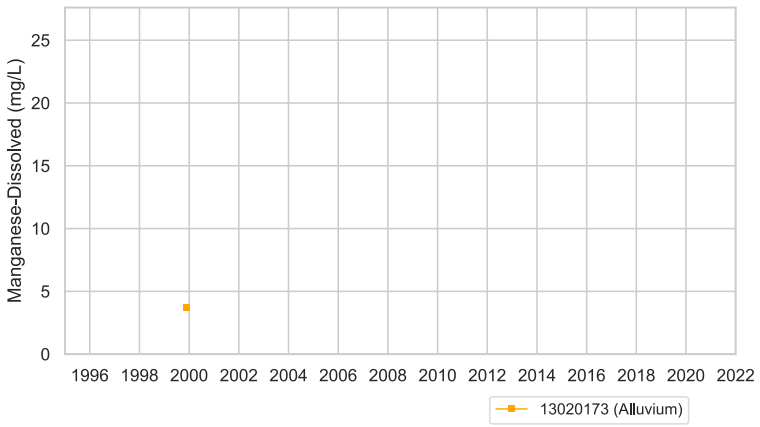

Iron-Dissolved (mg/L)
WSMB2S (Regolith)

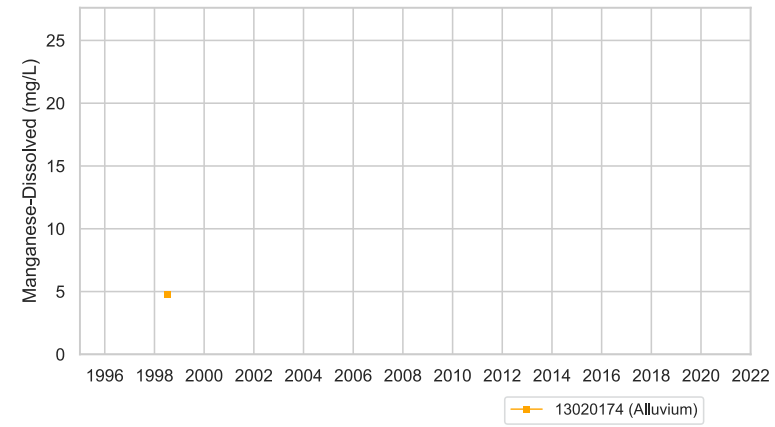
Iron-Dissolved (mg/L)
WSMB3S (Regolith)

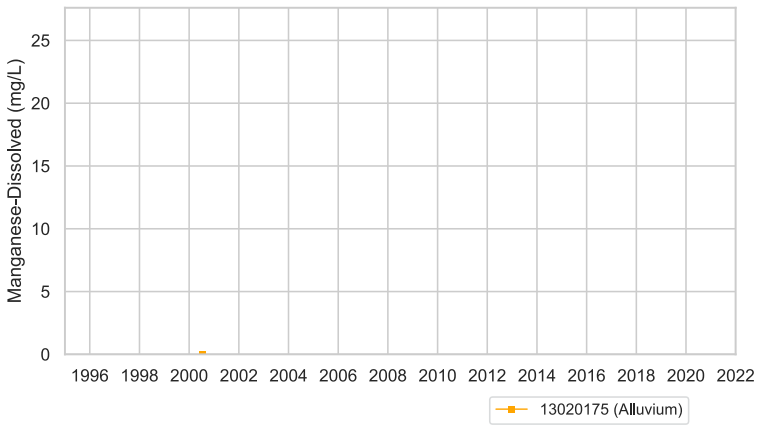

Iron-Dissolved (mg/L)
Jamar Bore (Rewan)

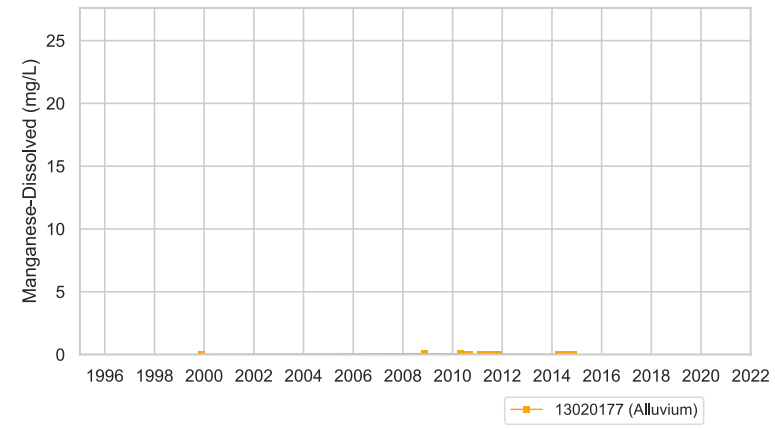

Iron-Dissolved (mg/L)
Winton Creek Bore (Rewan)

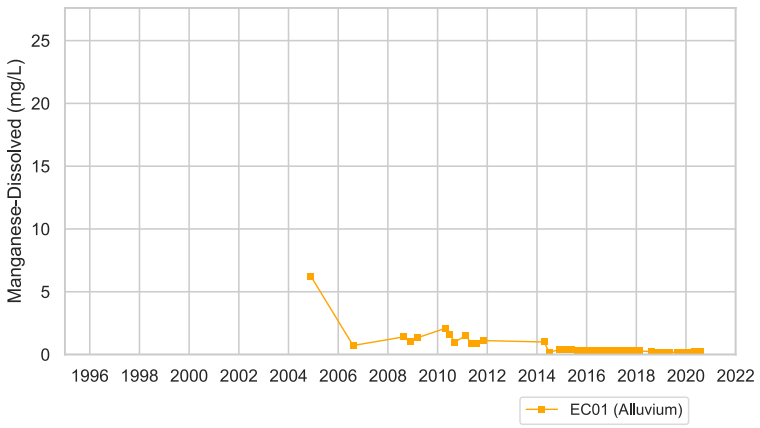

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020172 (Alluvium)

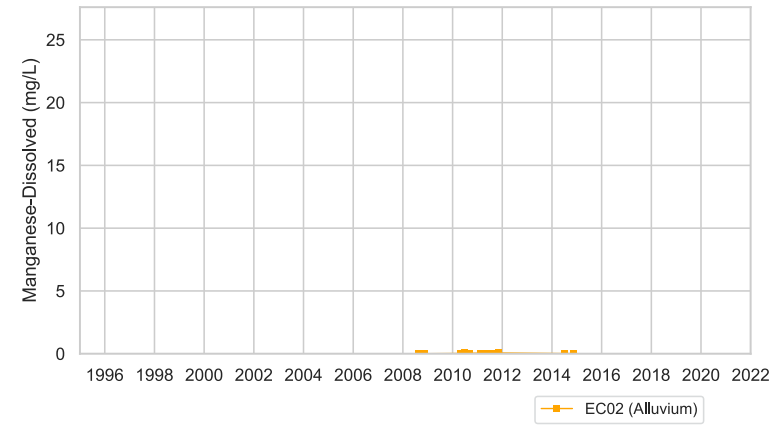

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

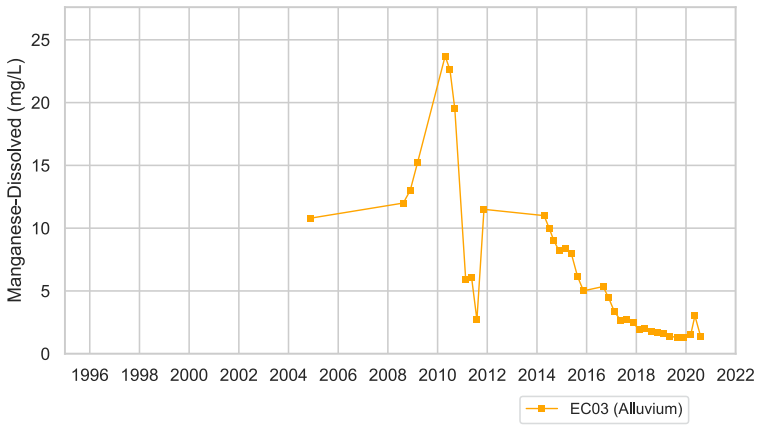

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020174 (Alluvium)

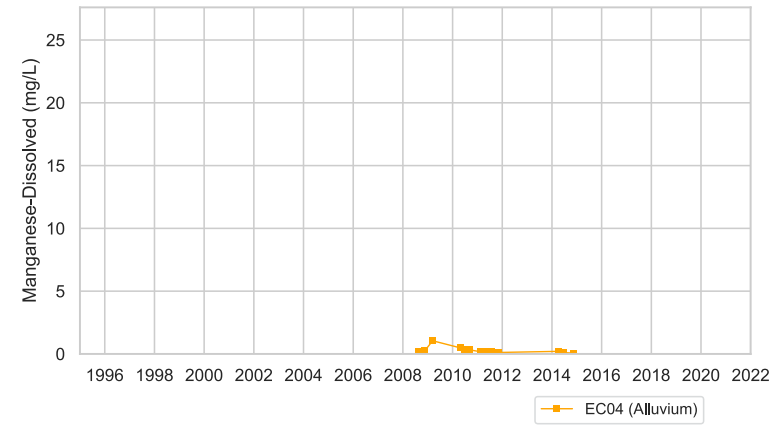

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020175 (Alluvium)

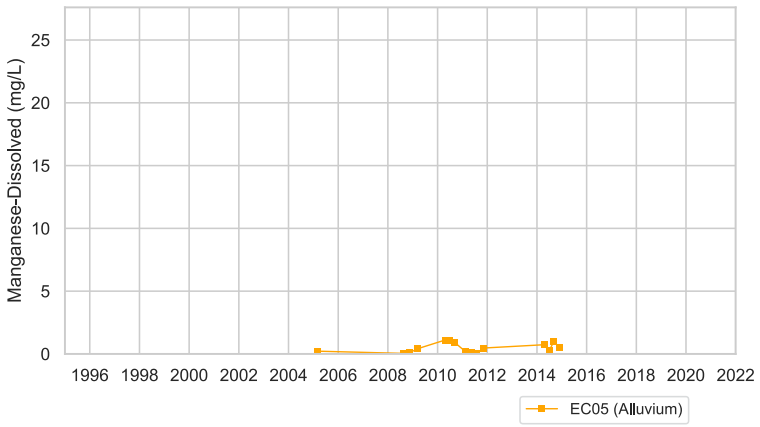

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

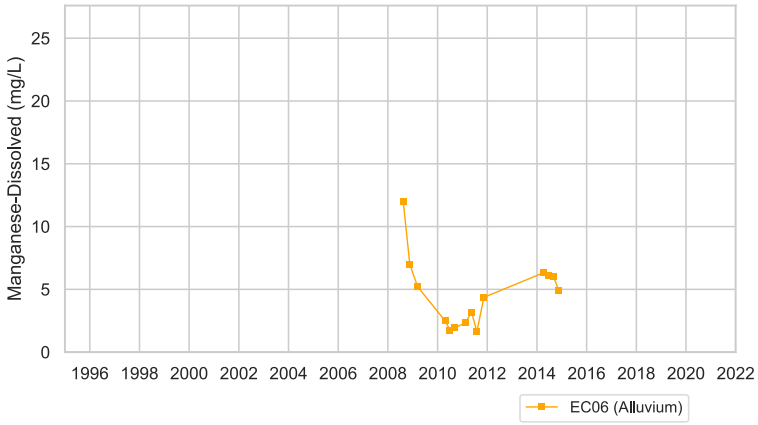

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

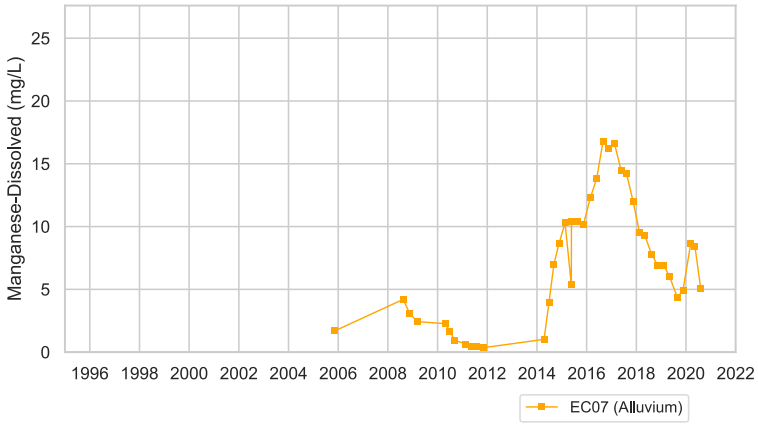

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

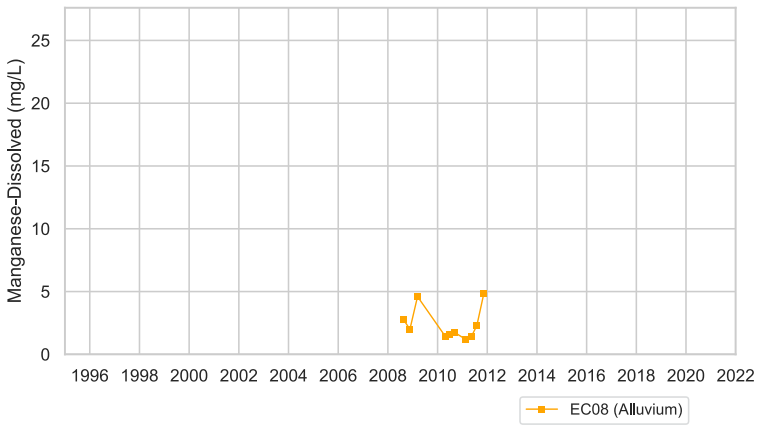

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

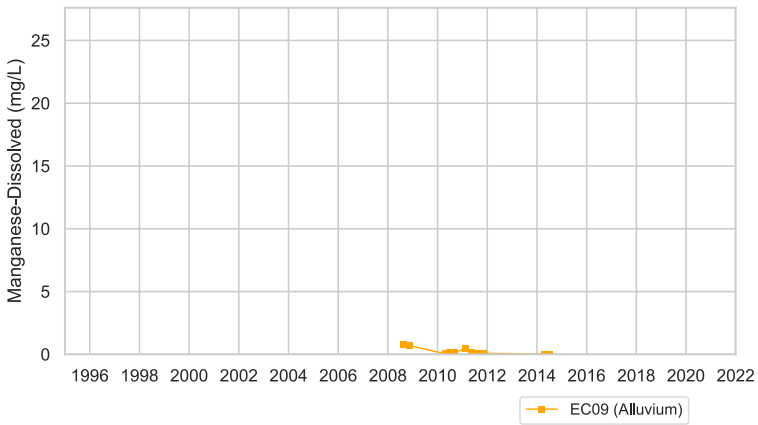

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

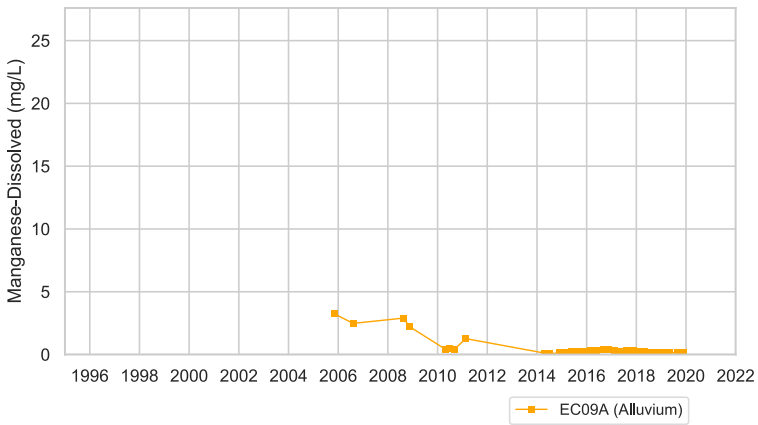

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

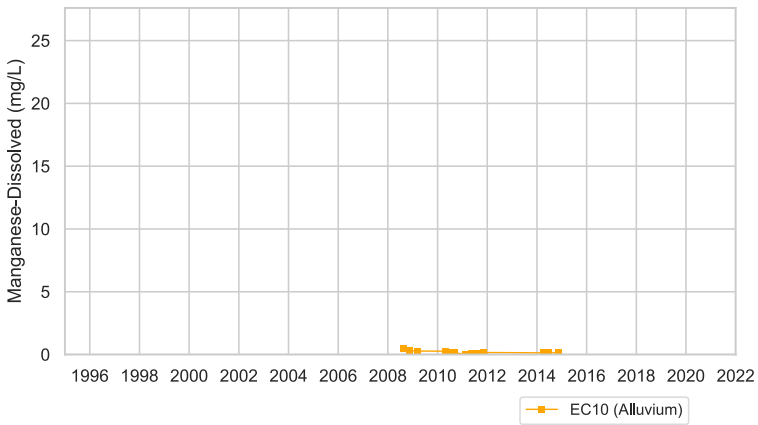

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

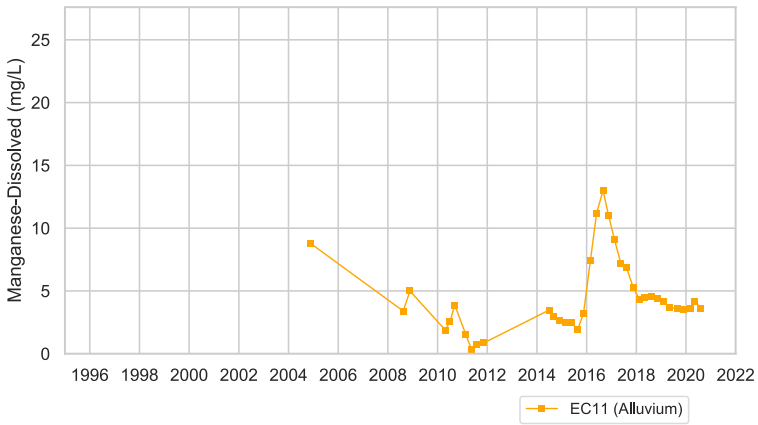

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

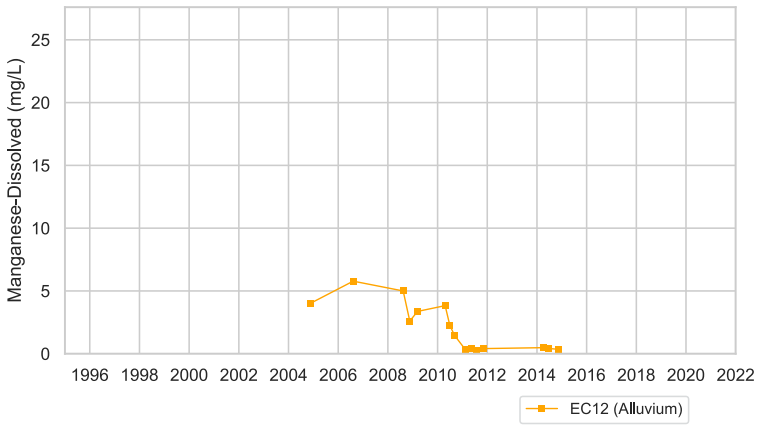

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

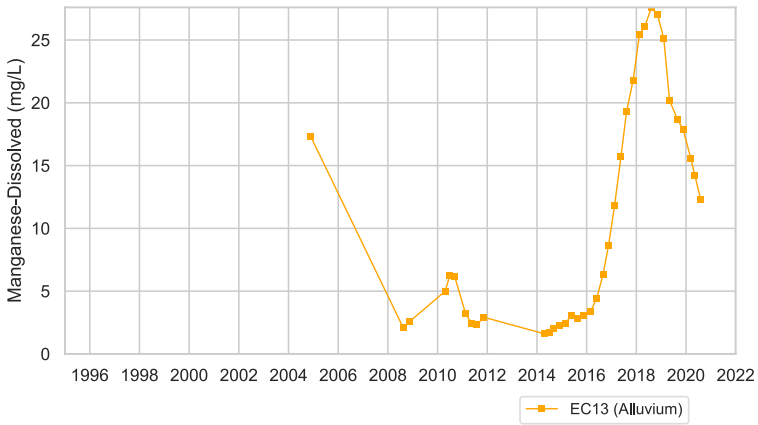

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

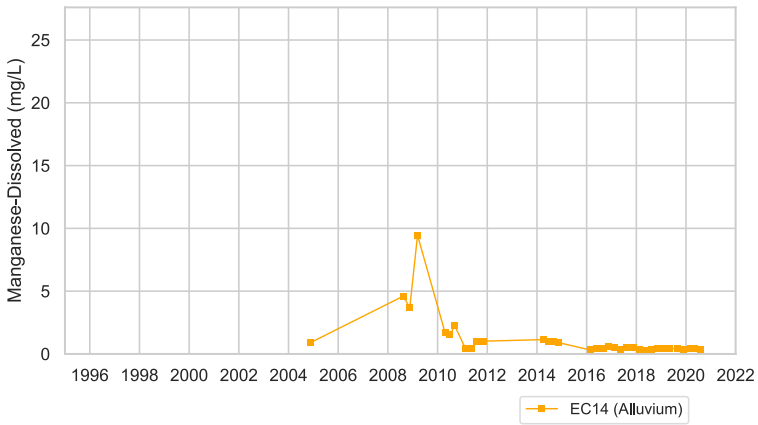

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

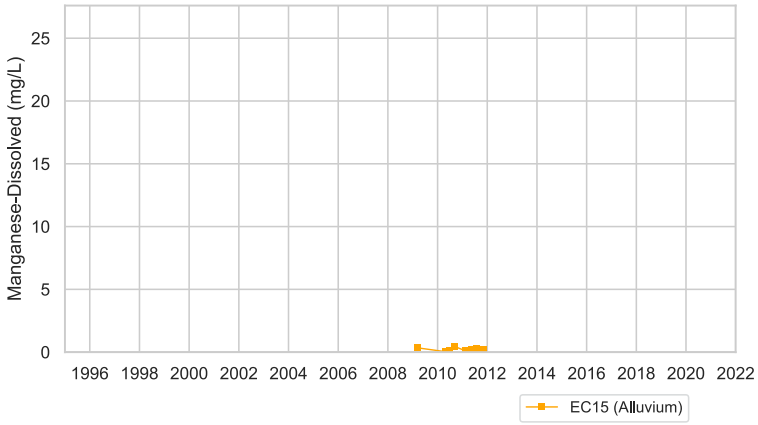

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

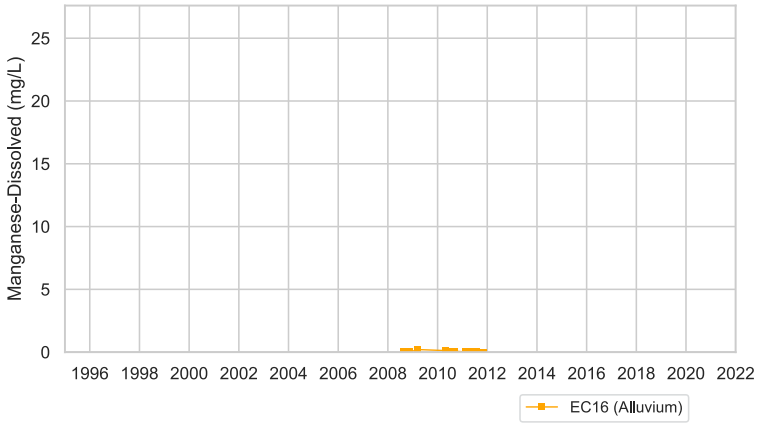

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

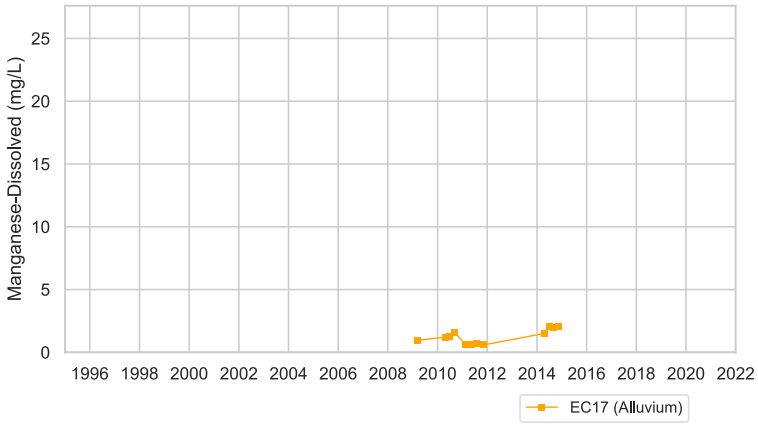

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

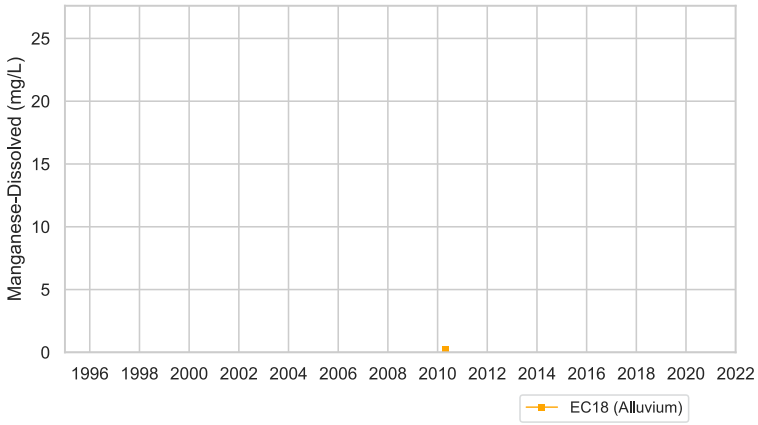

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

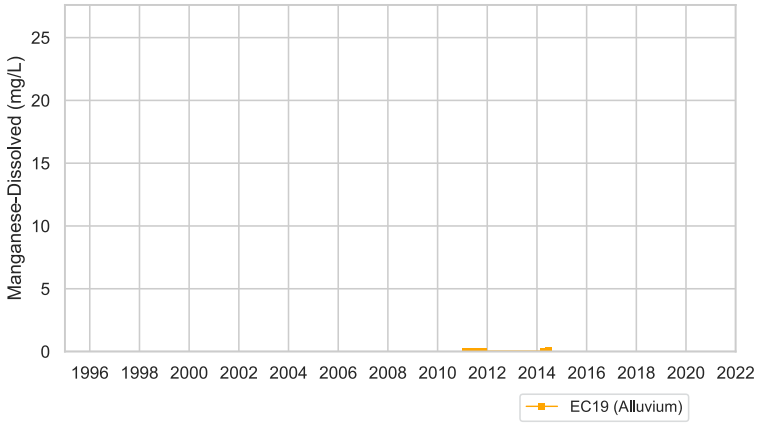

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

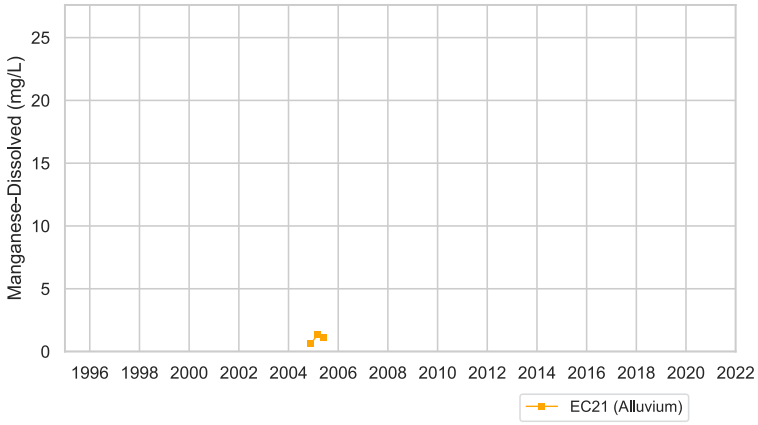

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

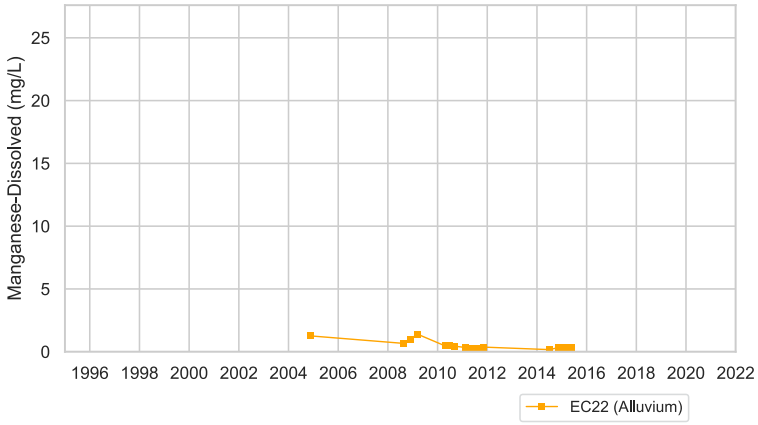

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

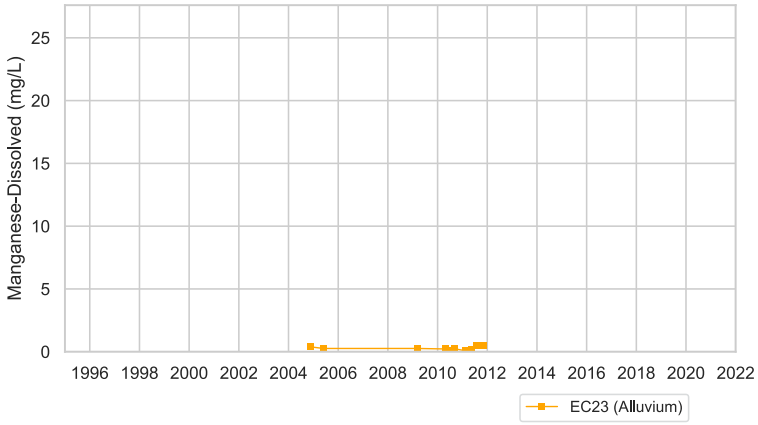

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

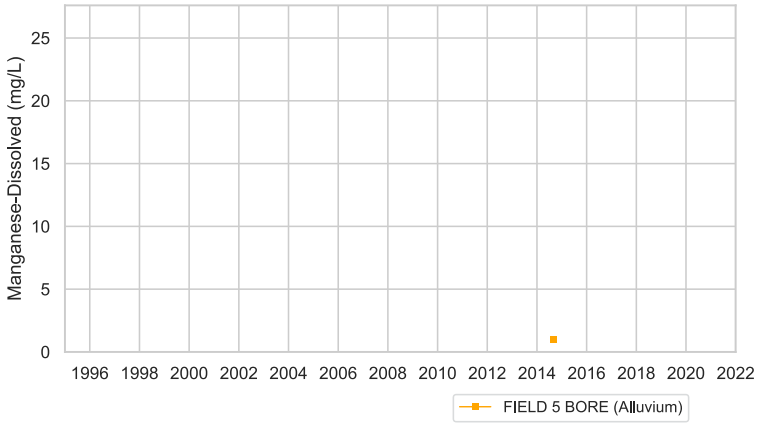

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

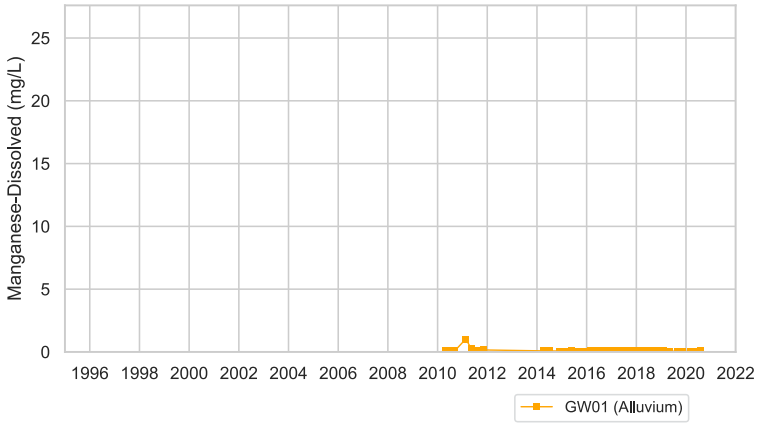

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

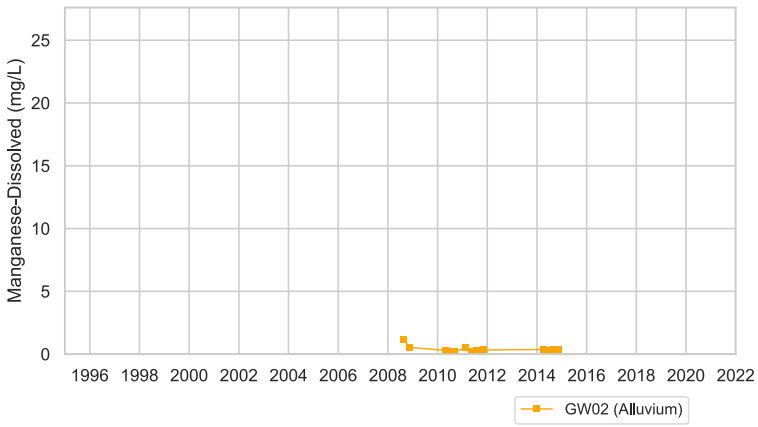

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC21 (Alluvium)

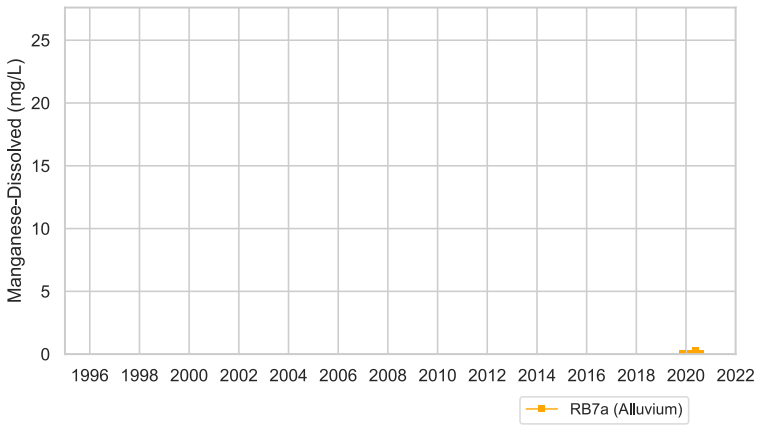

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

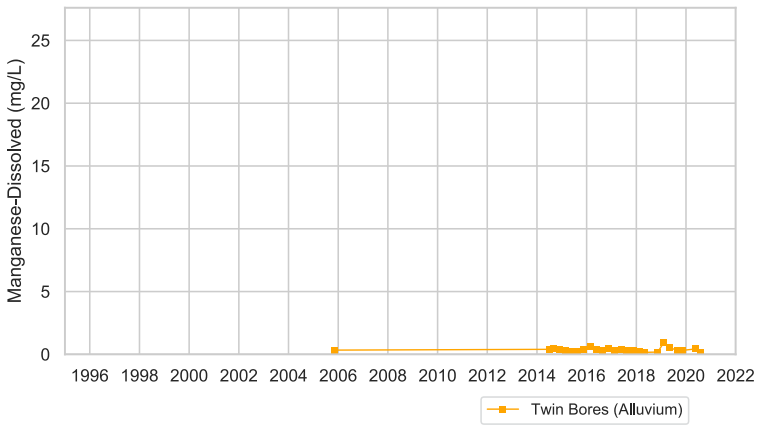

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

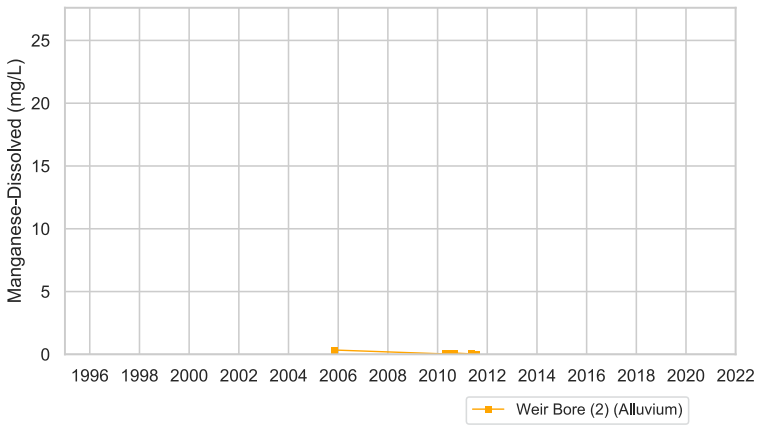

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

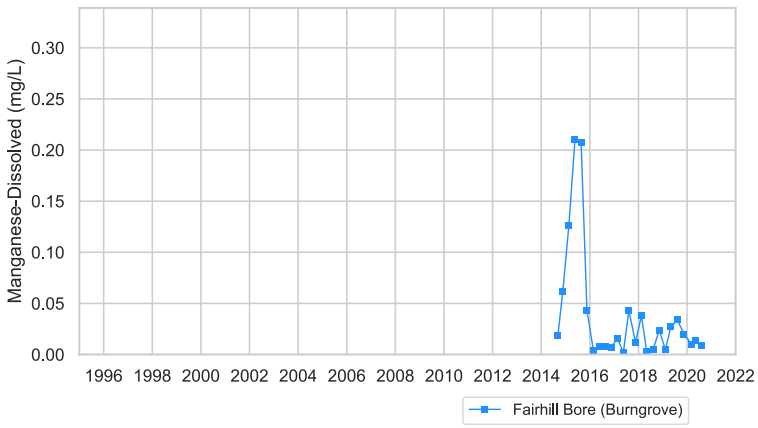

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

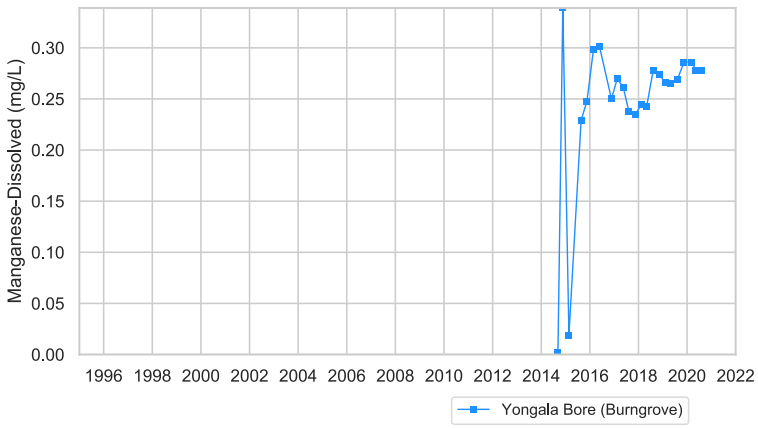

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

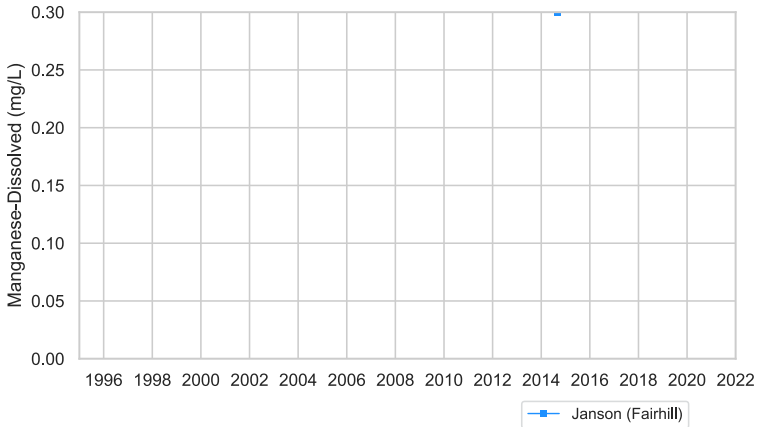

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

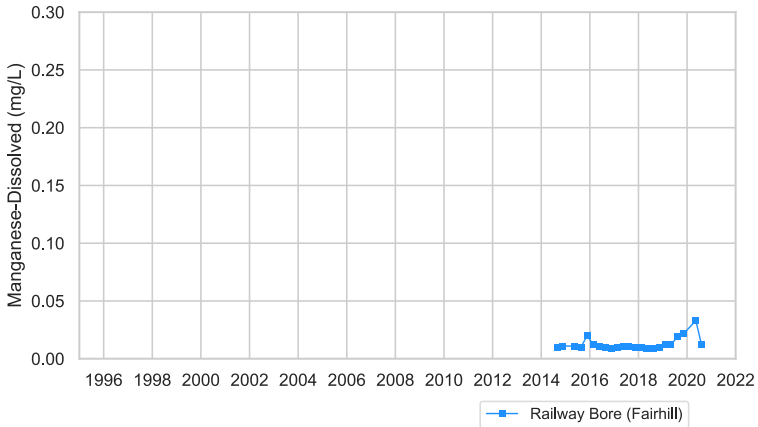

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

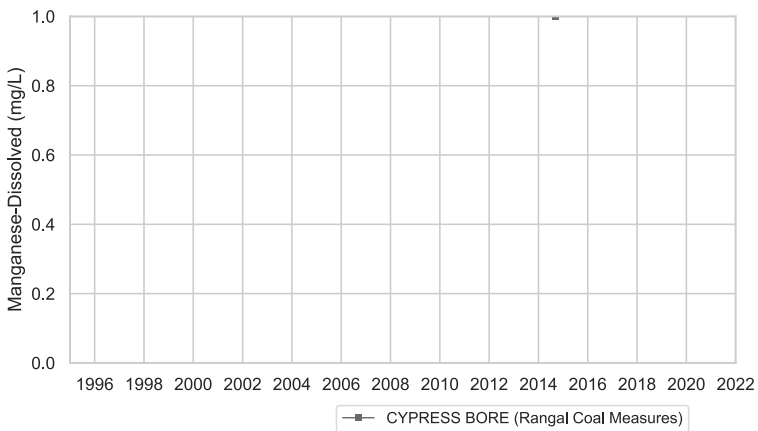

Manganese-Dissolved (mg/L)
0
5
10
15
20
25
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

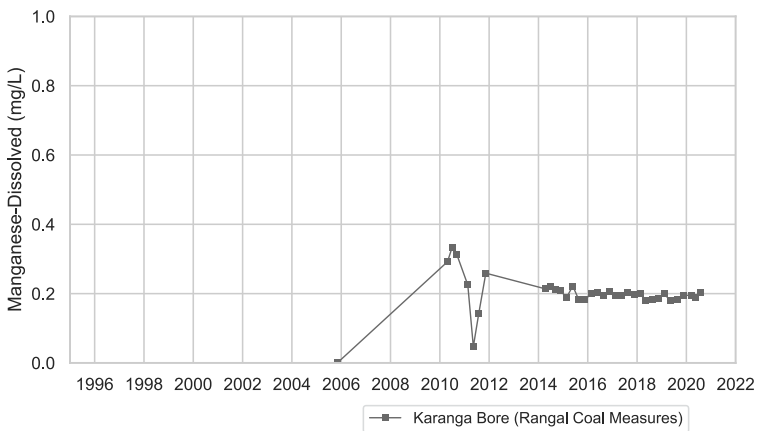

Manganese-Dissolved (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

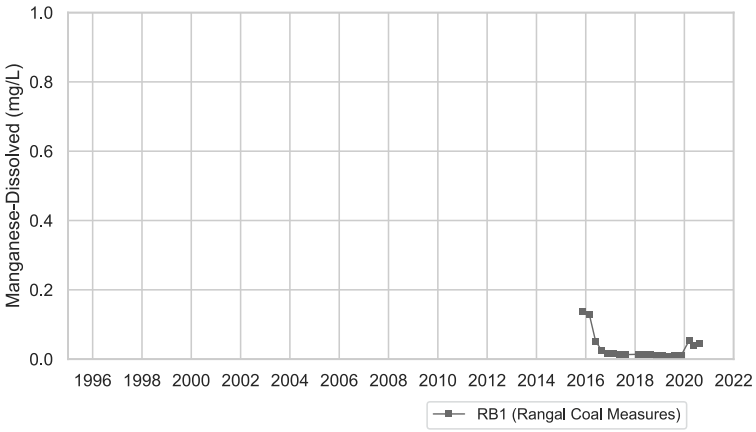

Manganese-Dissolved (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

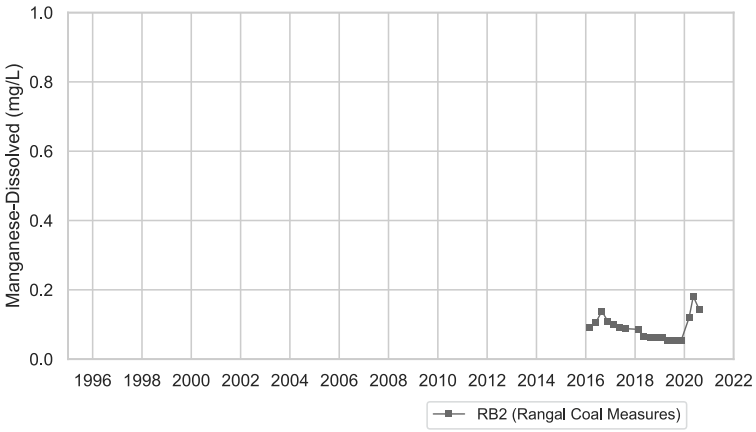

Manganese-Dissolved (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

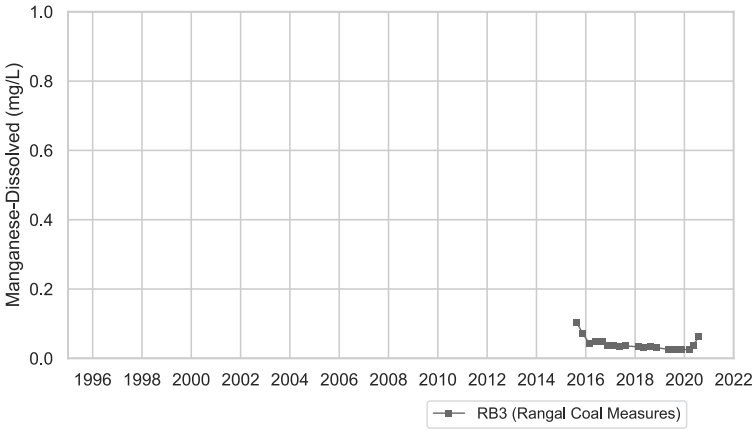

Manganese-Dissolved (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

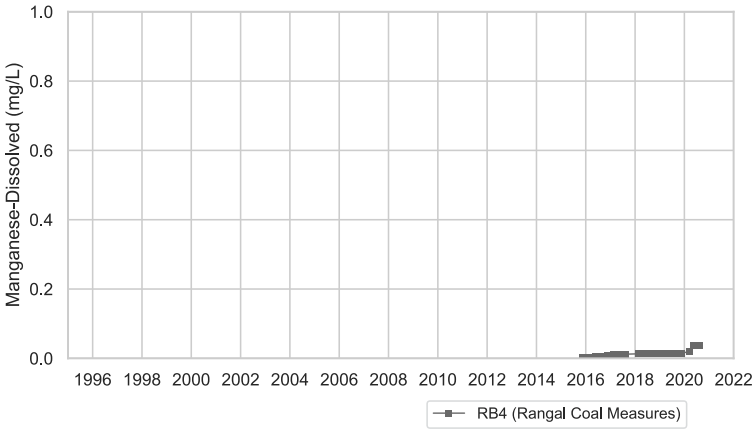

Manganese-Dissolved (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

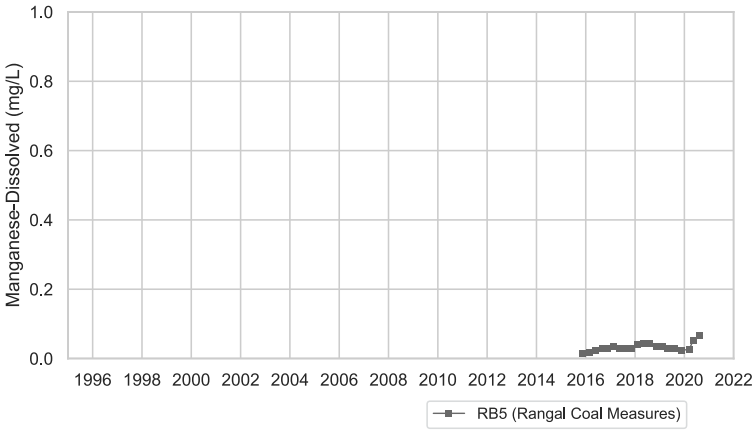

Manganese-Dissolved (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

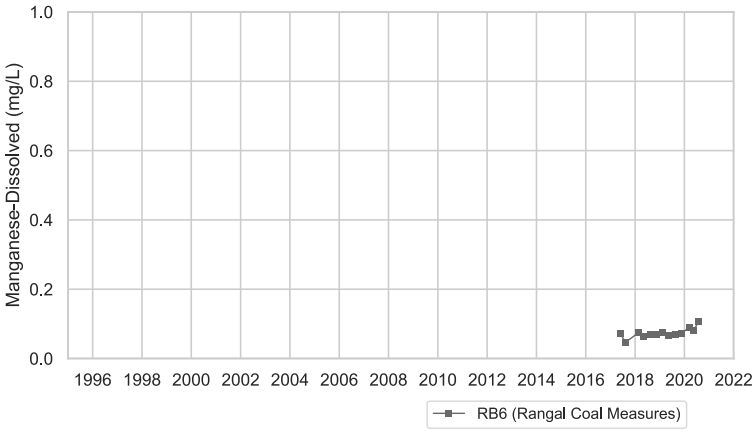

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

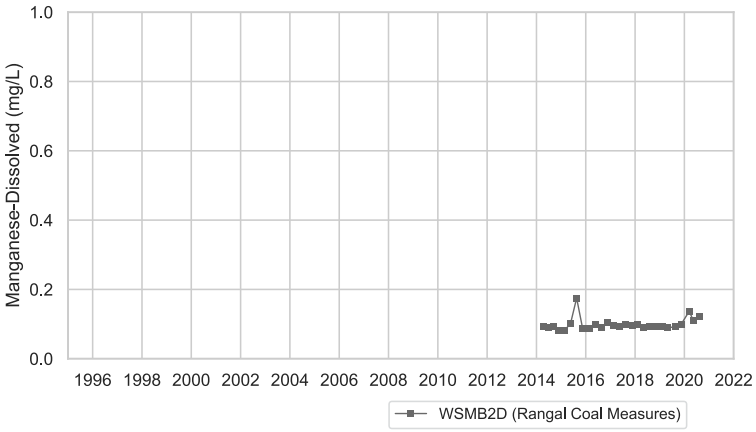

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

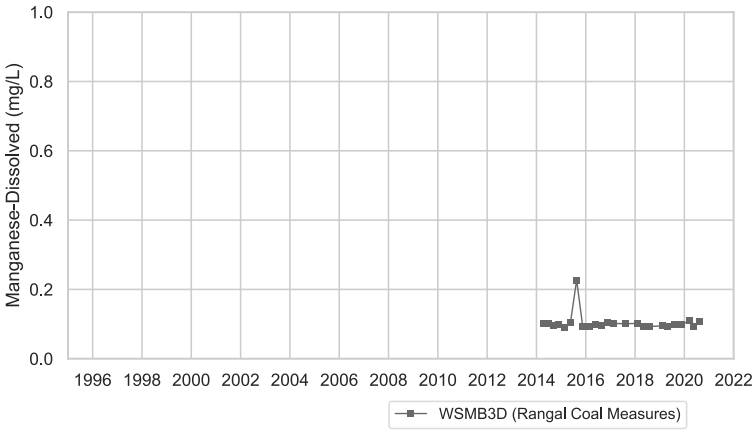

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

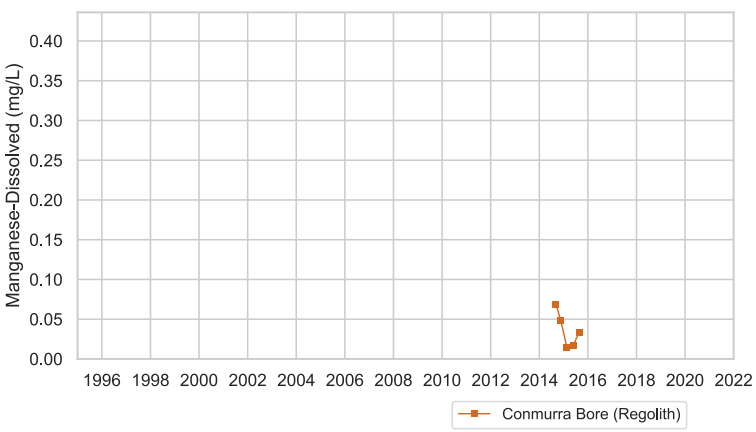

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

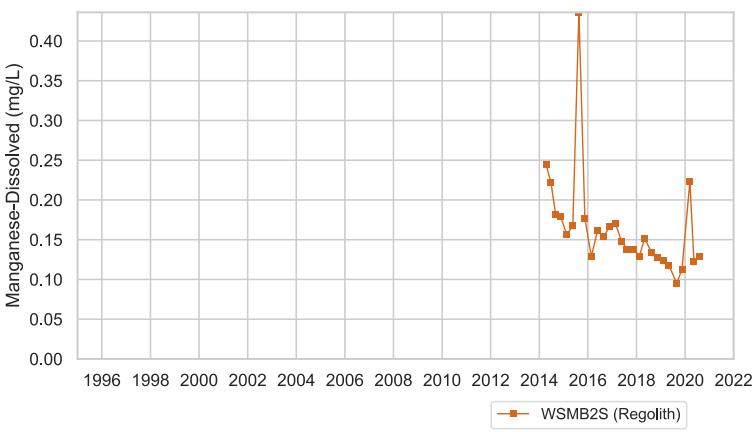

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

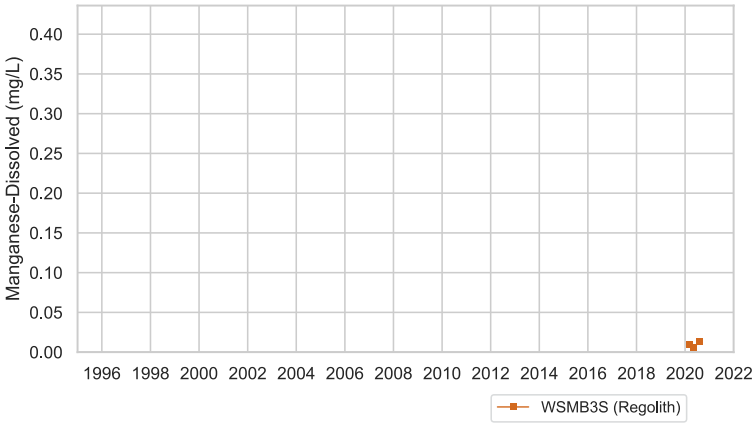

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

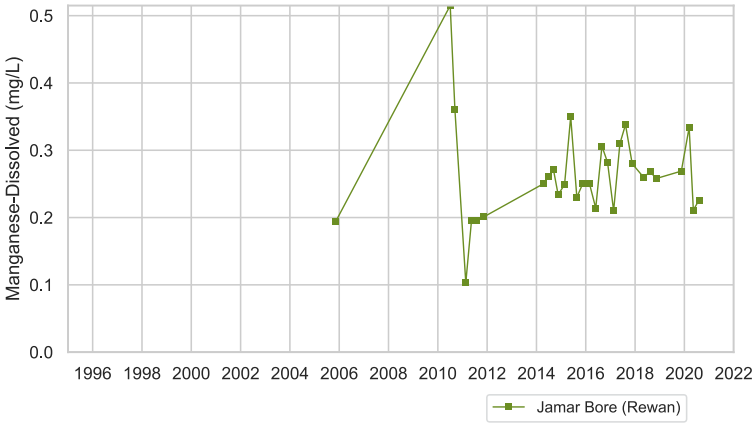

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

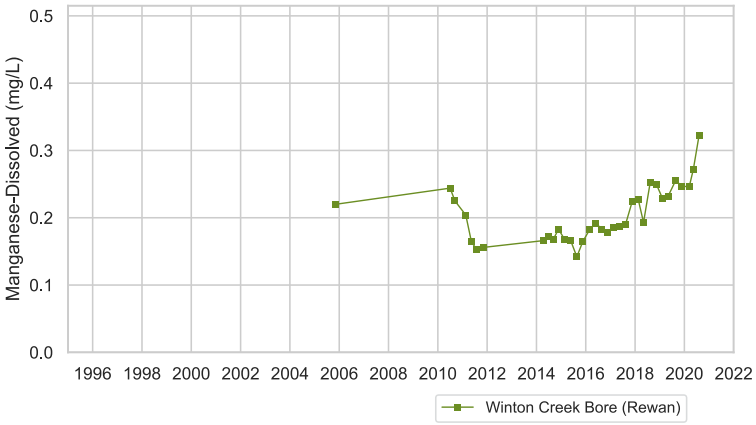

Manganese-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

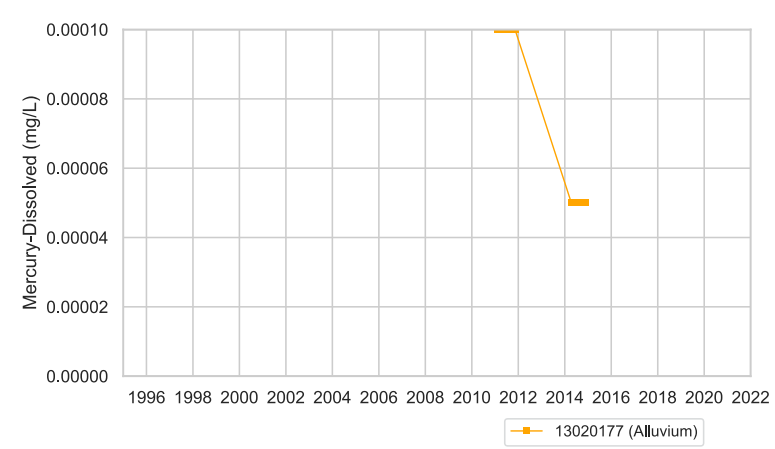

Manganese-Dissolved (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

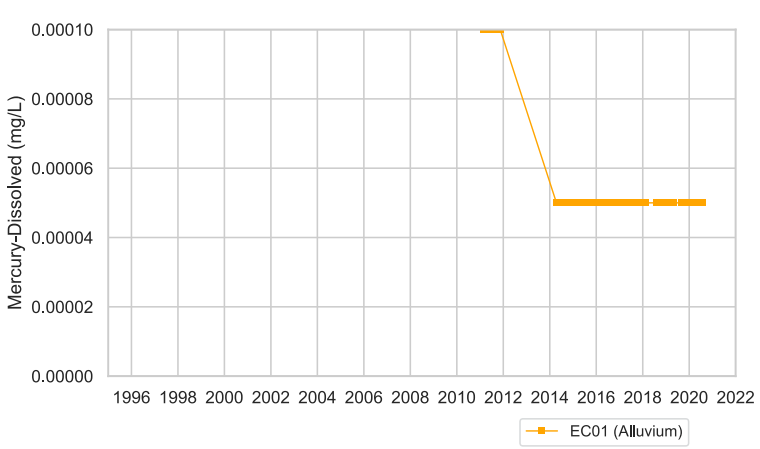

Manganese-Dissolved (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

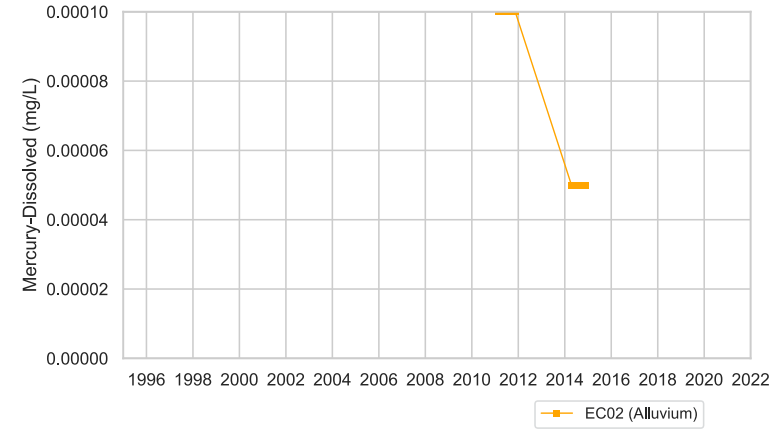

Manganese-Dissolved (mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

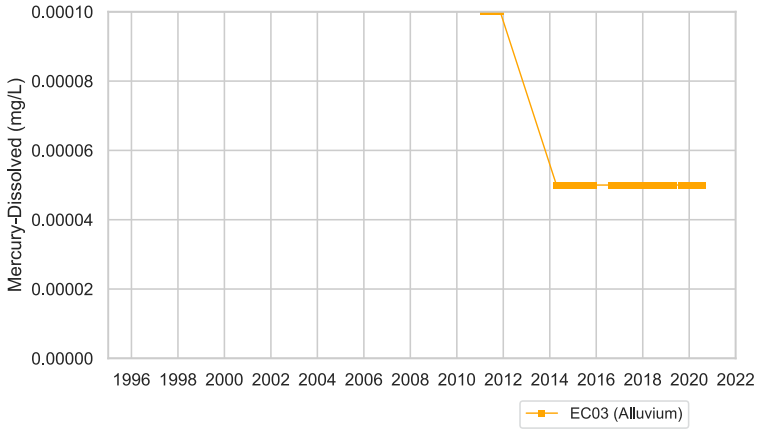

Manganese-Dissolved (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

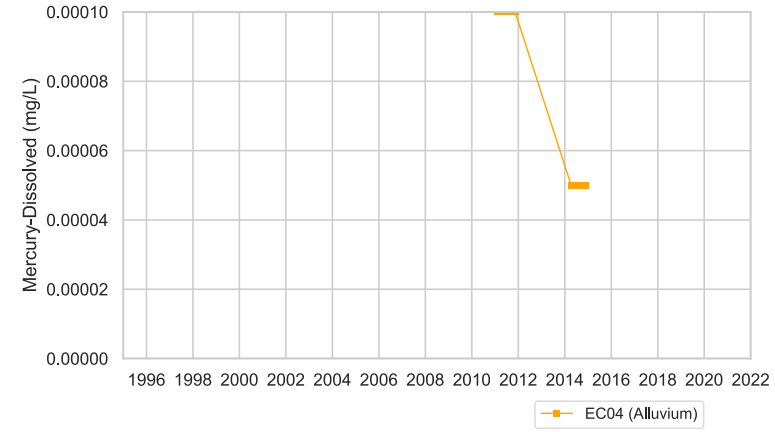

Manganese-Dissolved (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

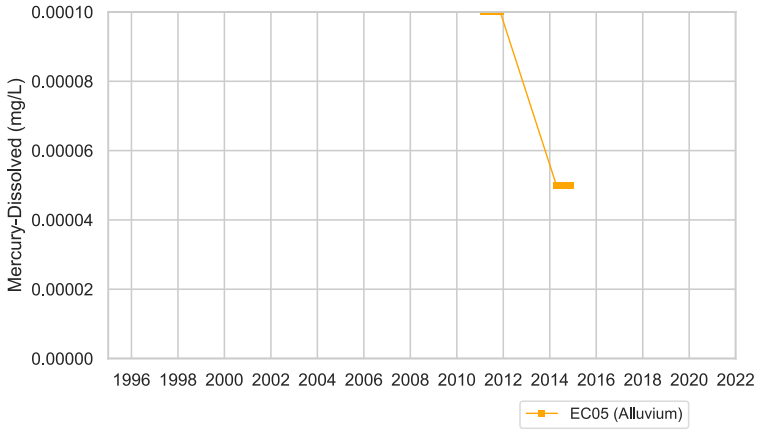

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

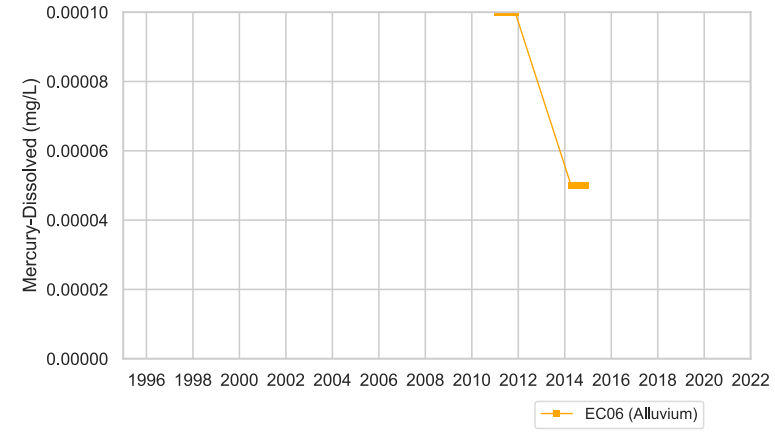

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

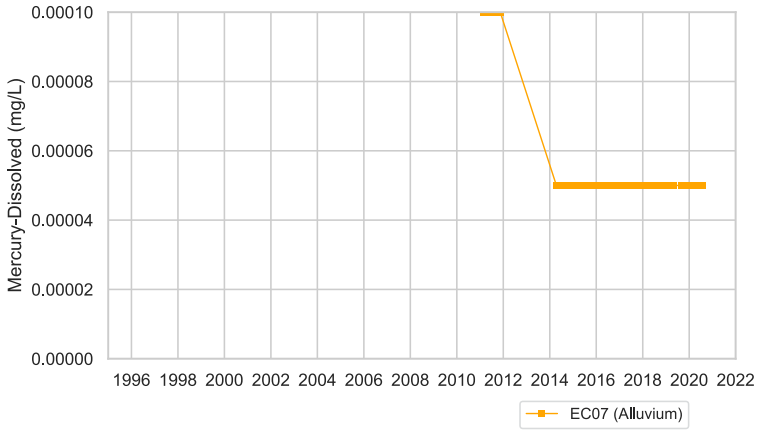

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

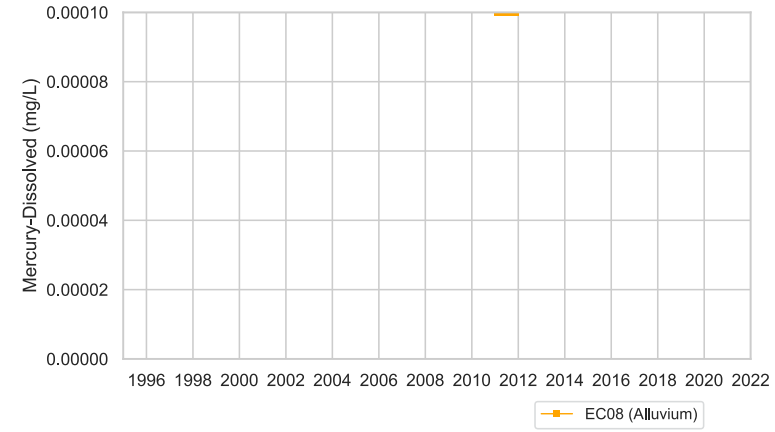

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

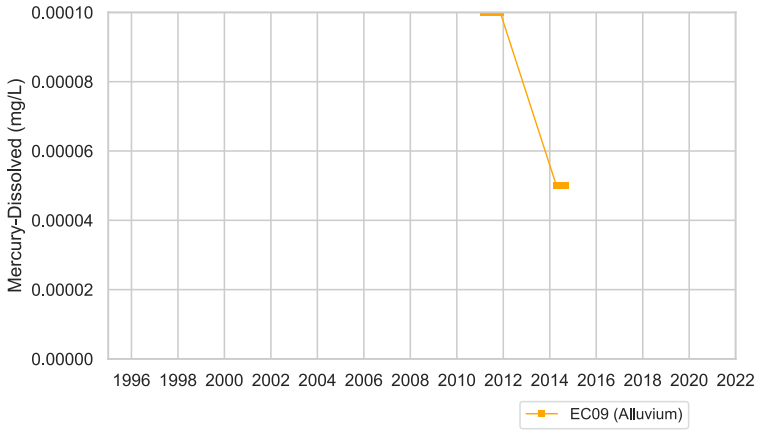

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

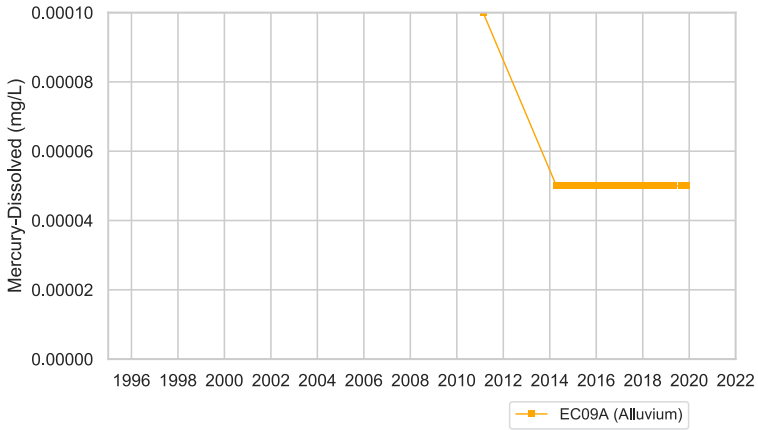

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

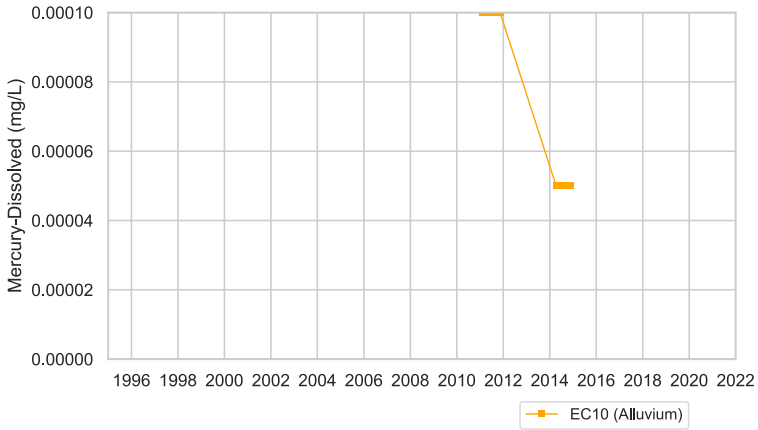

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

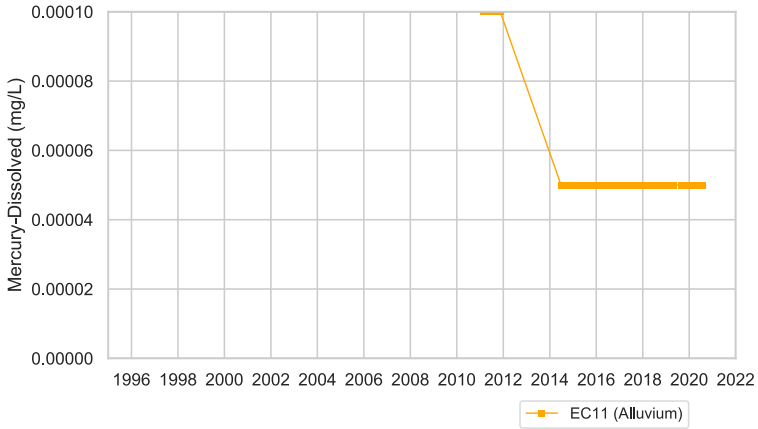

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

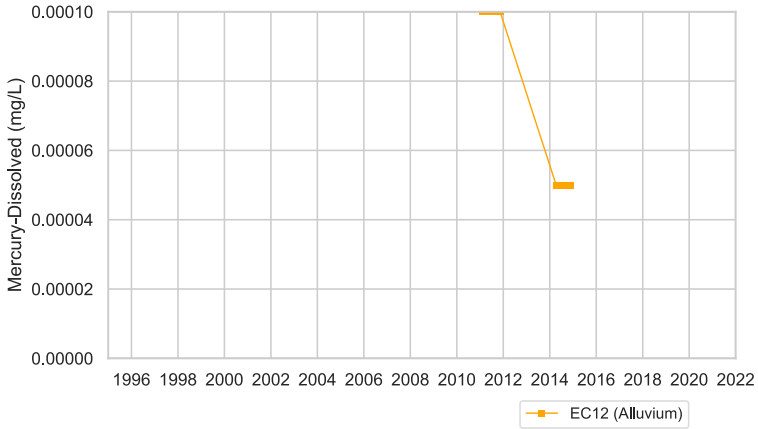

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

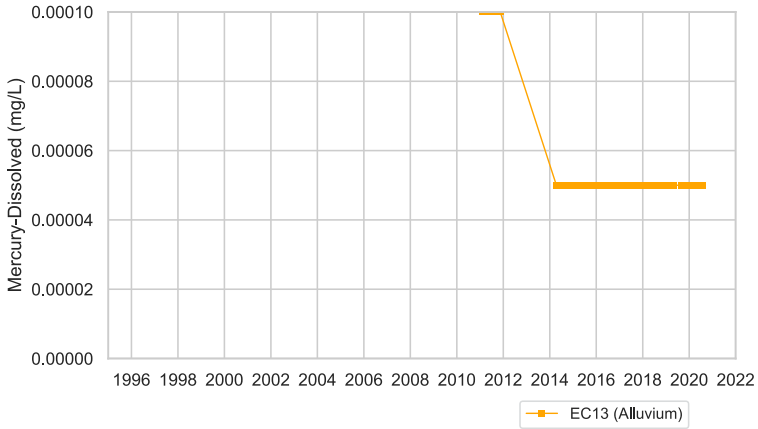

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

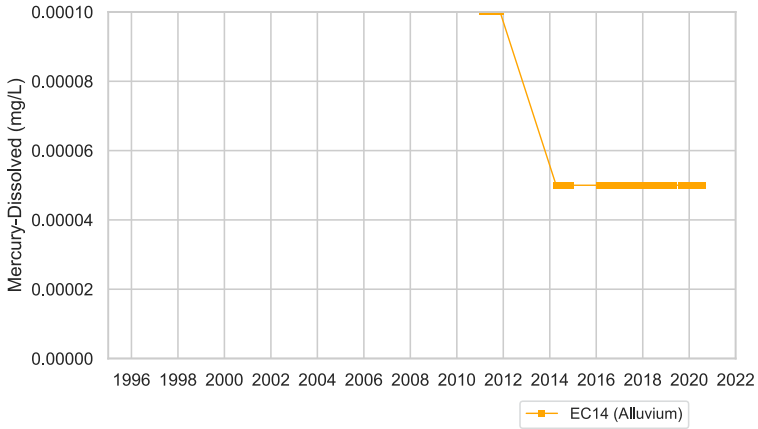

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

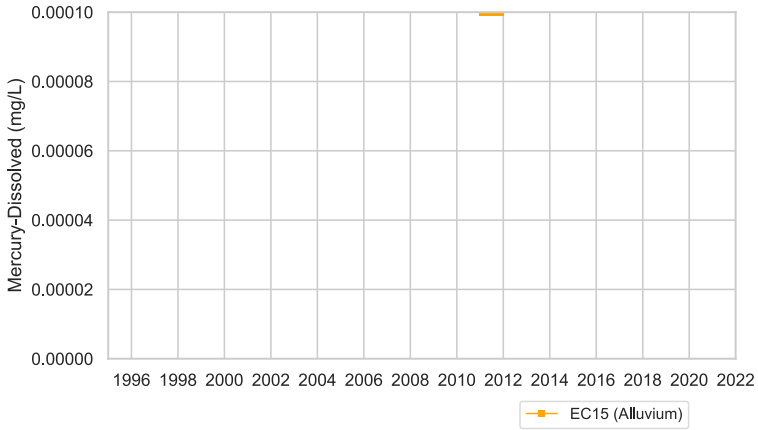

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

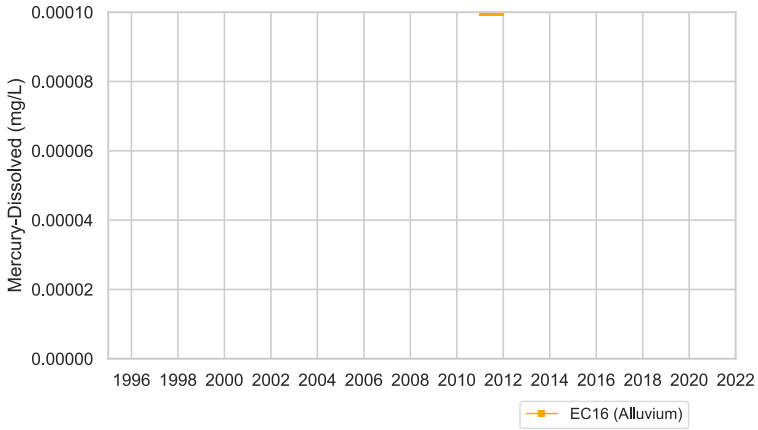

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

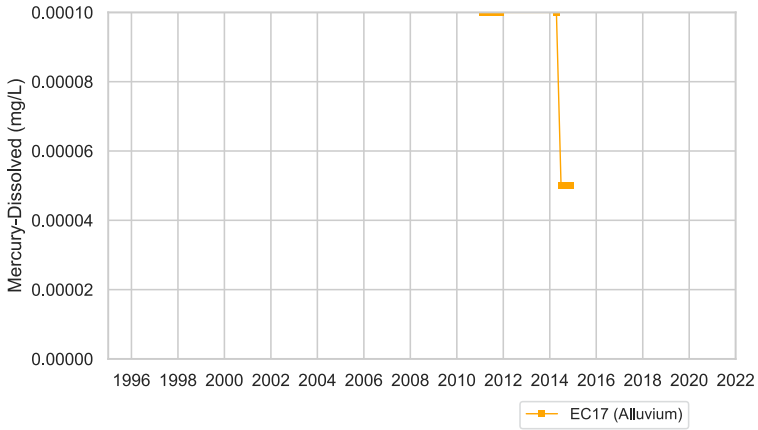

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

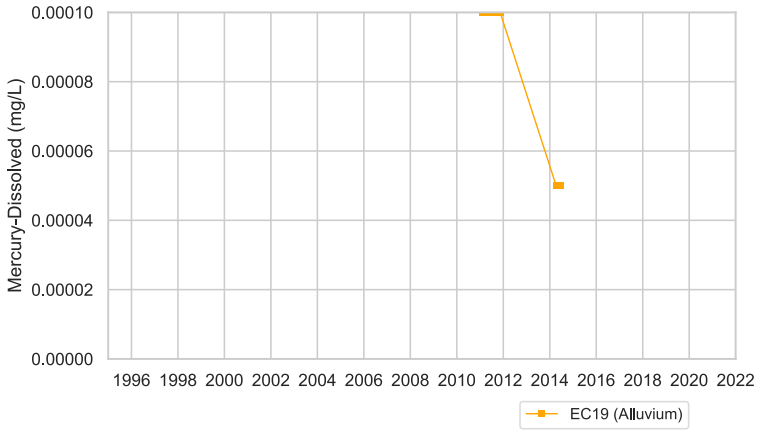

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

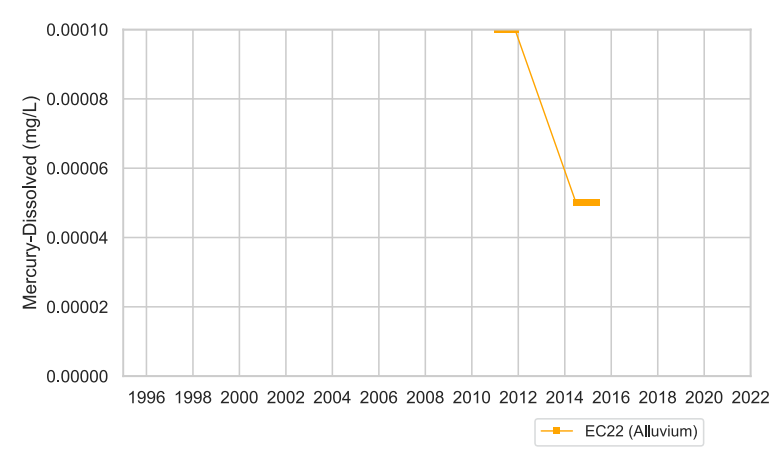

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

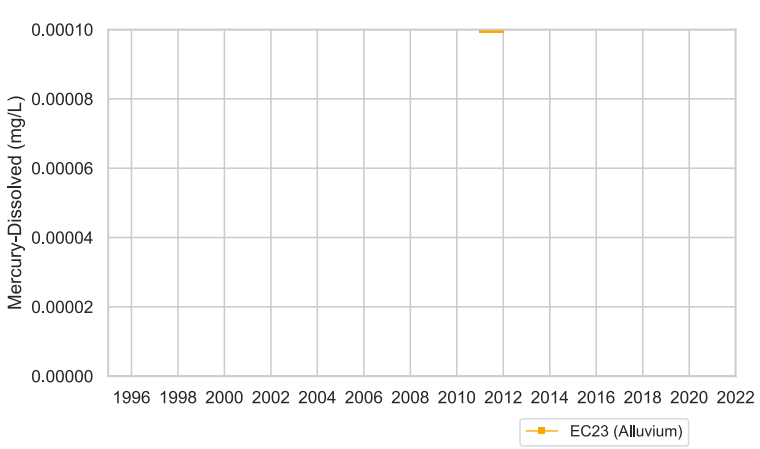

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

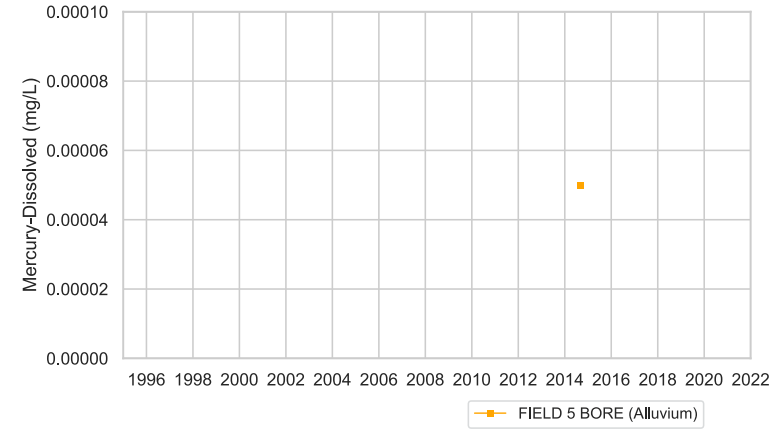

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

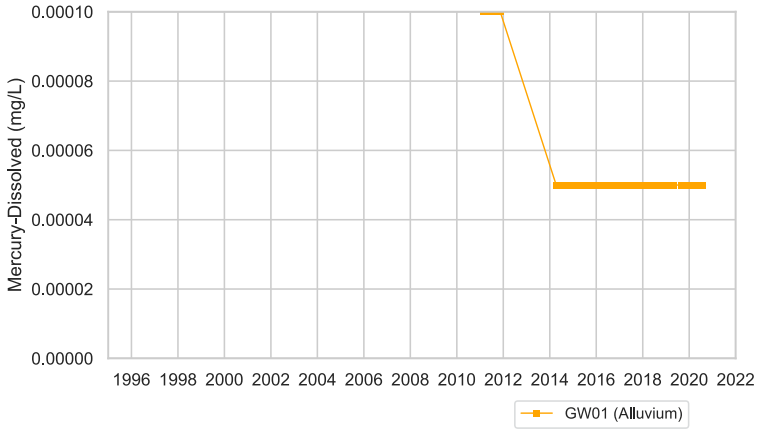

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

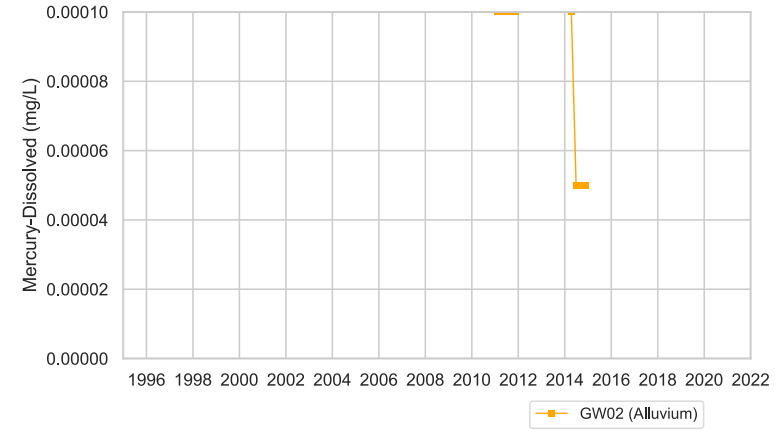

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

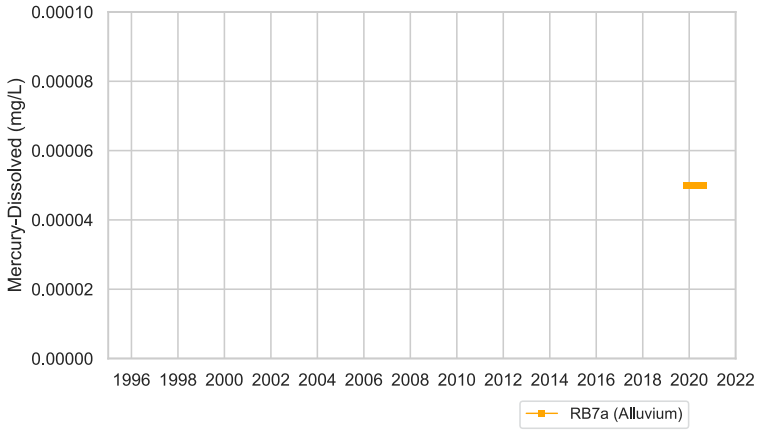

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

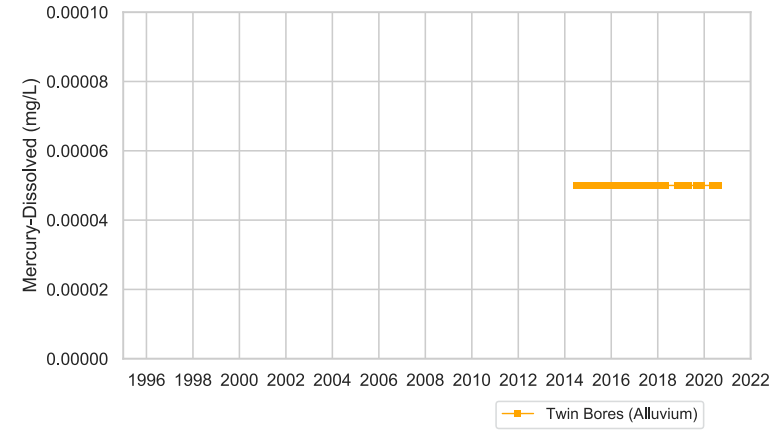

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

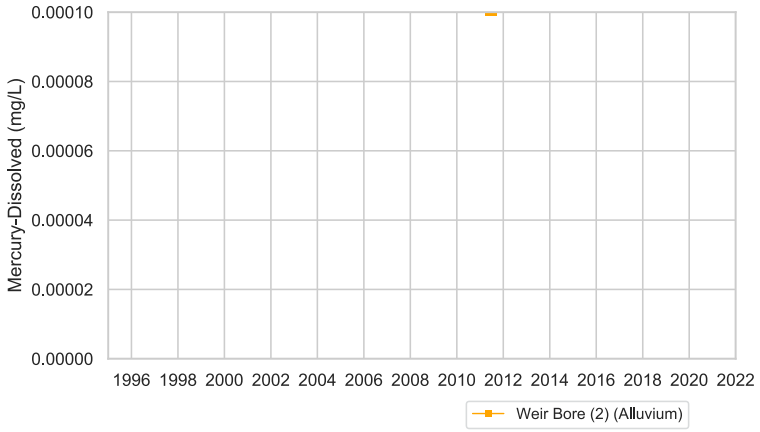

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

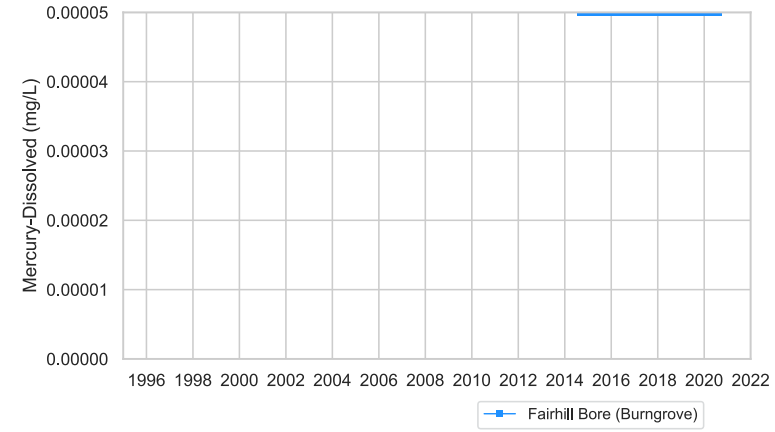

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

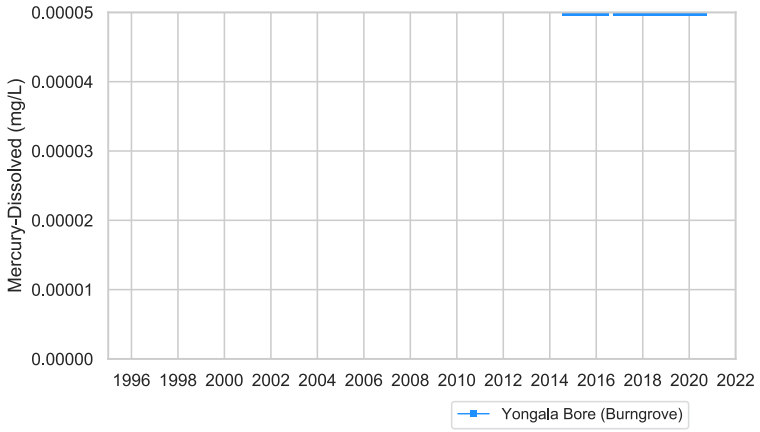

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

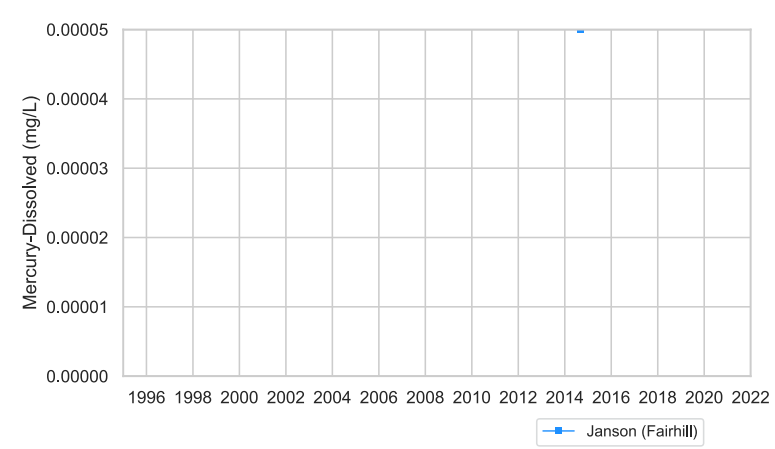

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

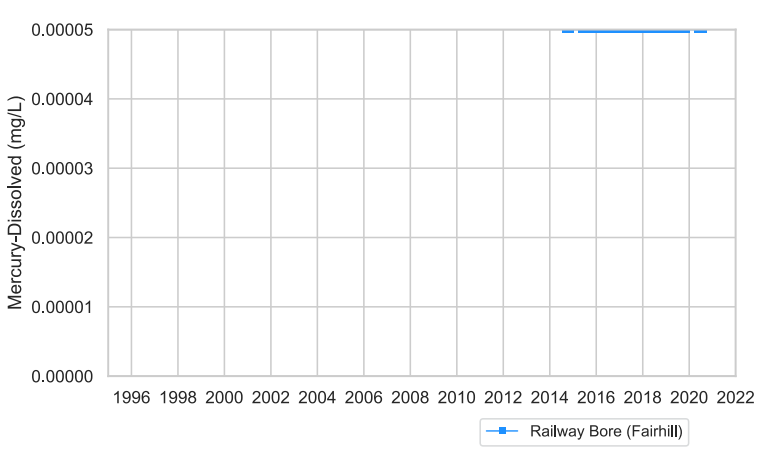

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

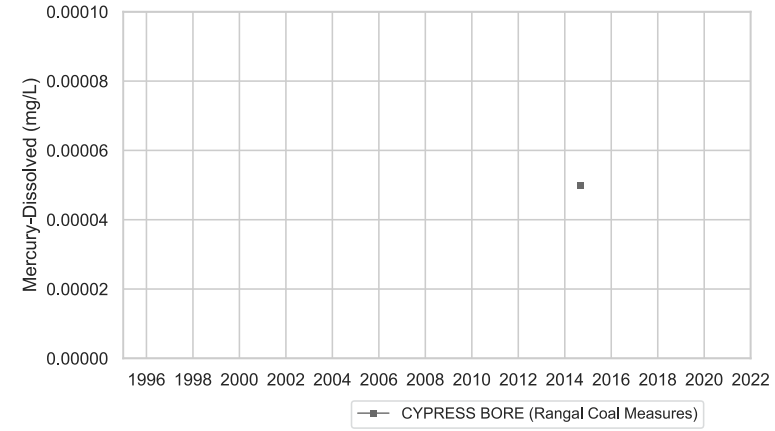

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

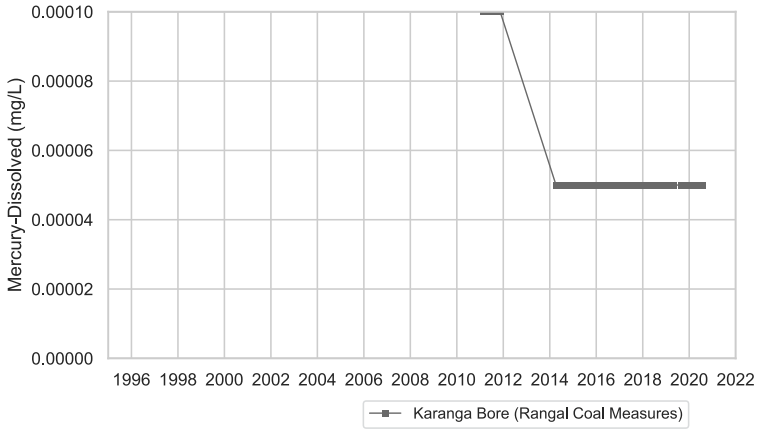

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

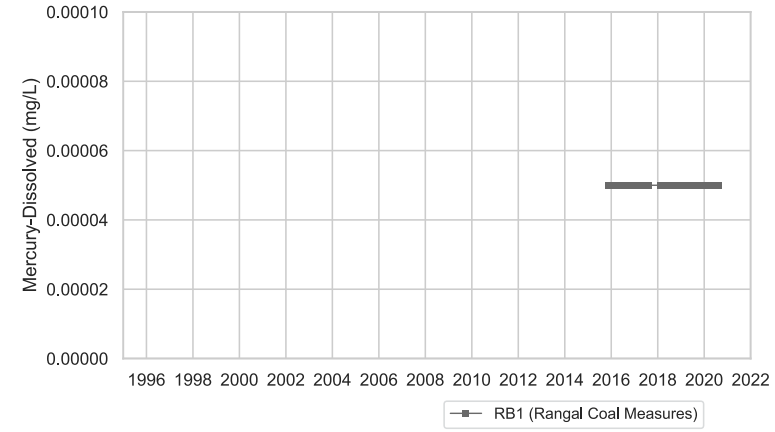

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

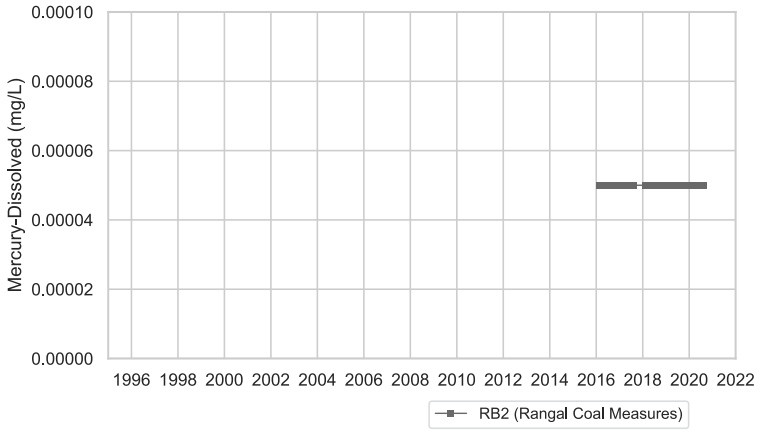

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

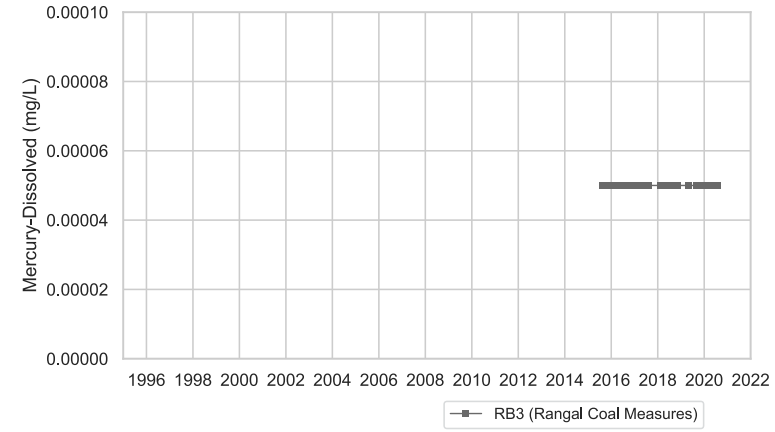

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

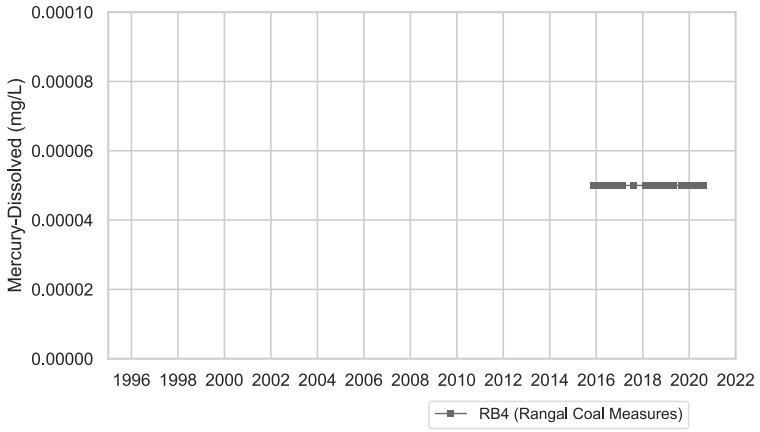

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

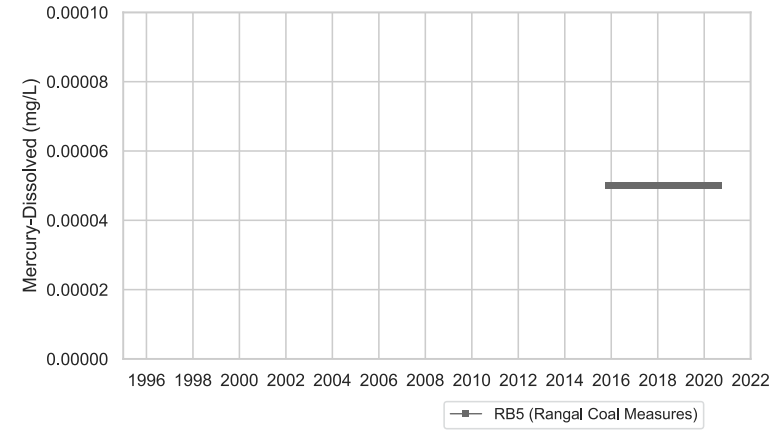

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

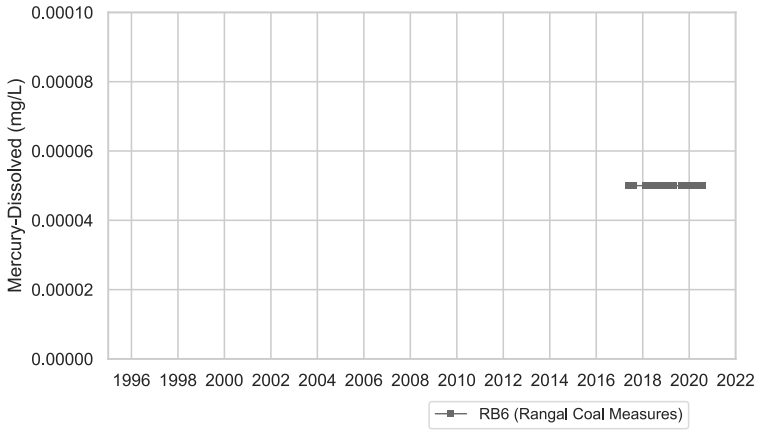

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

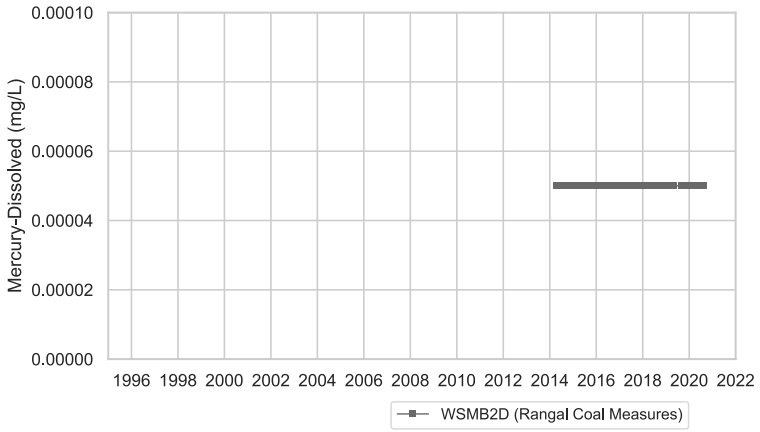

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

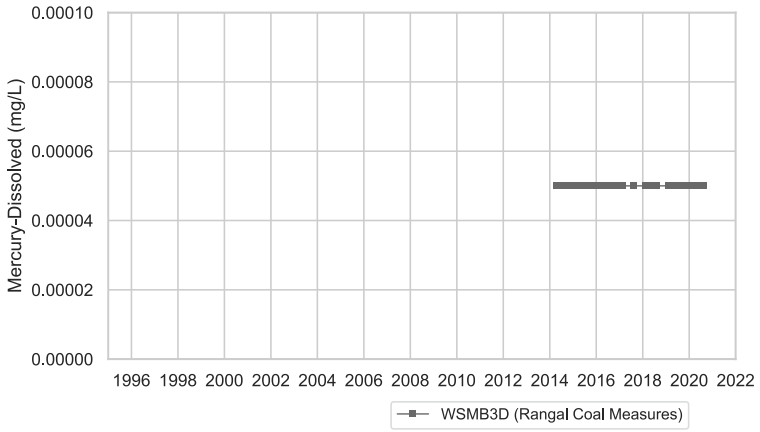

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

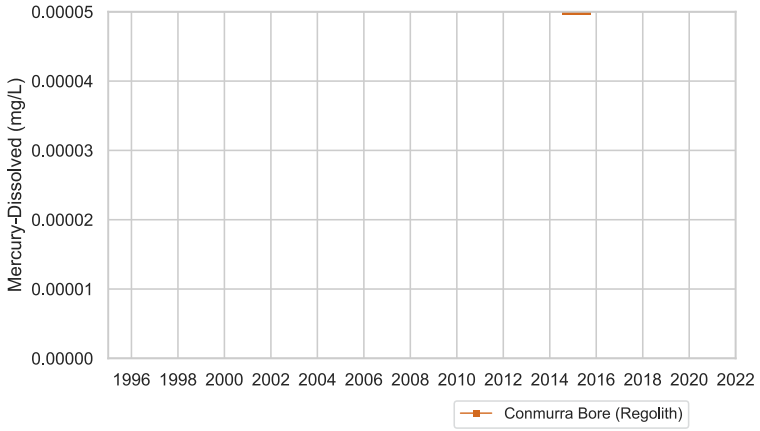

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)


Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)


Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

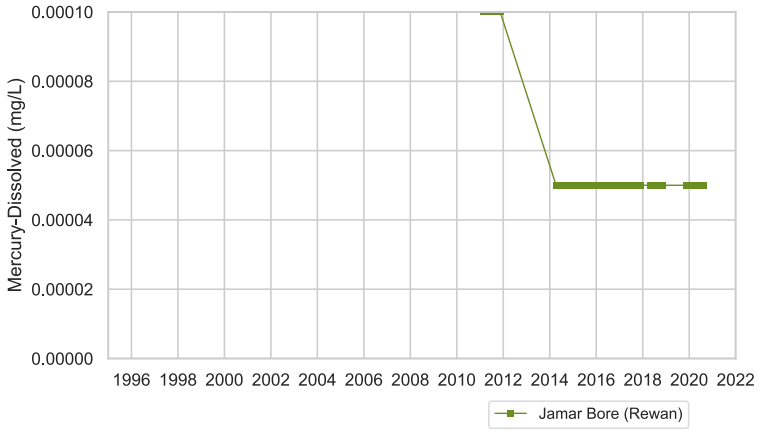

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

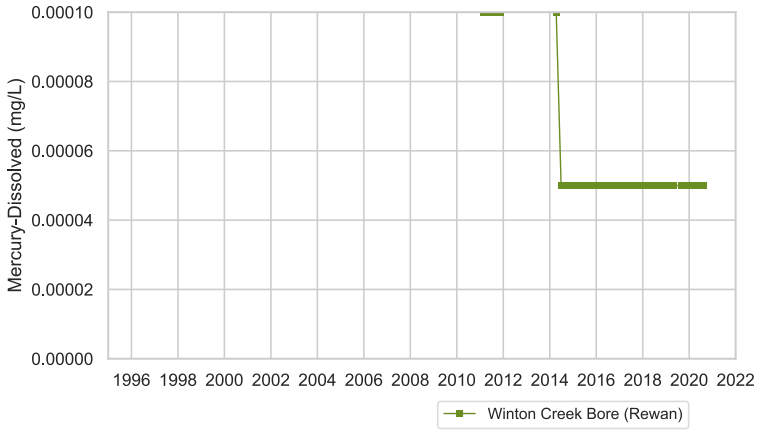

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

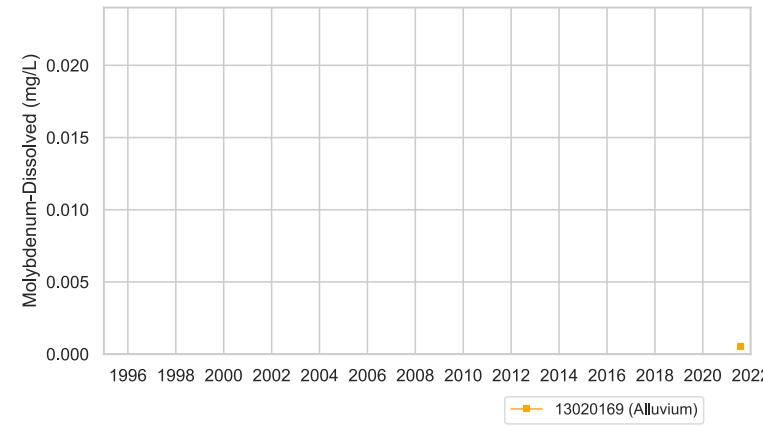

Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

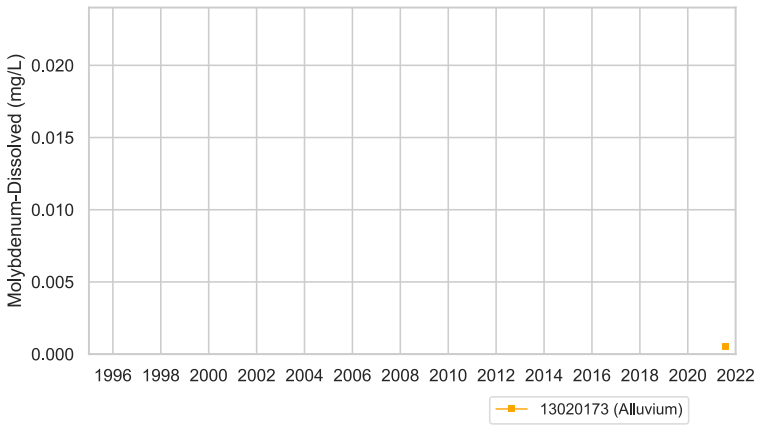
Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

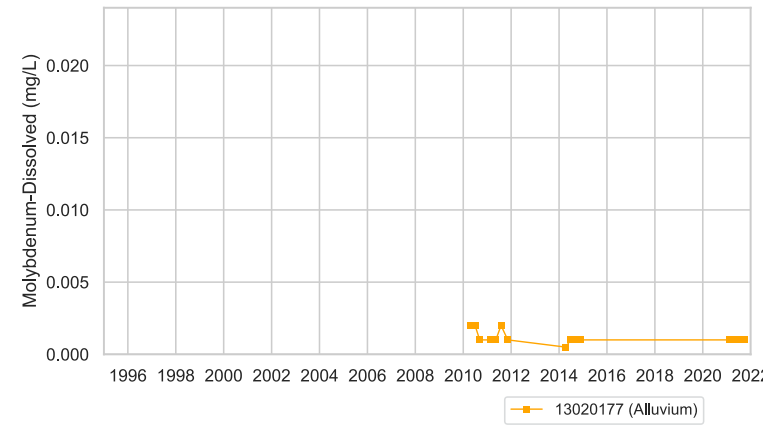
Mercury-Dissolved (mg/L)
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

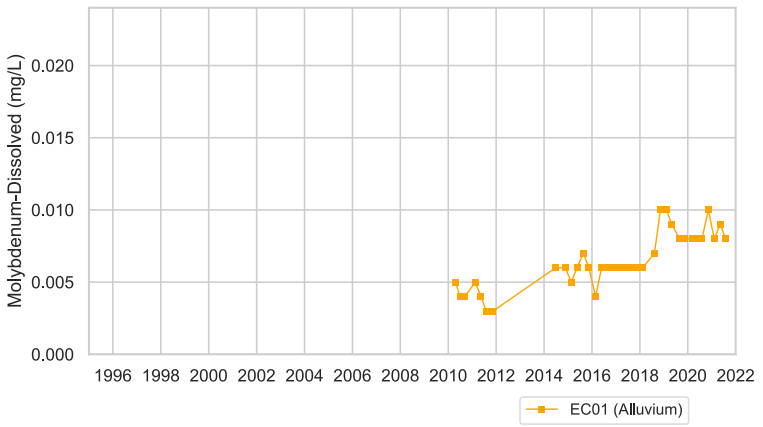

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

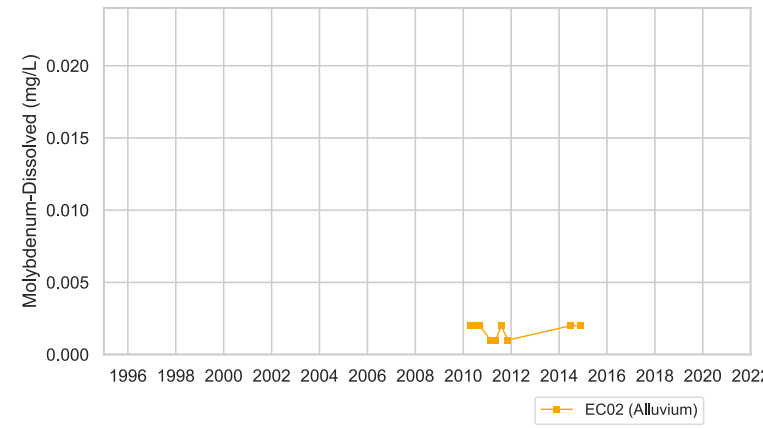

Mercury-Dissolved (mg/L)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

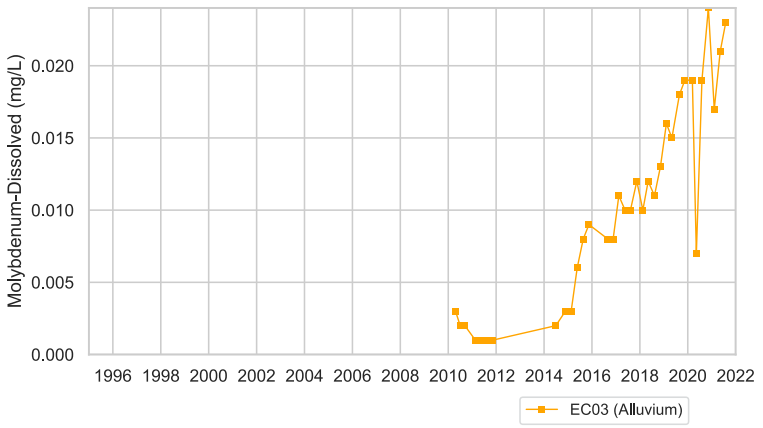

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

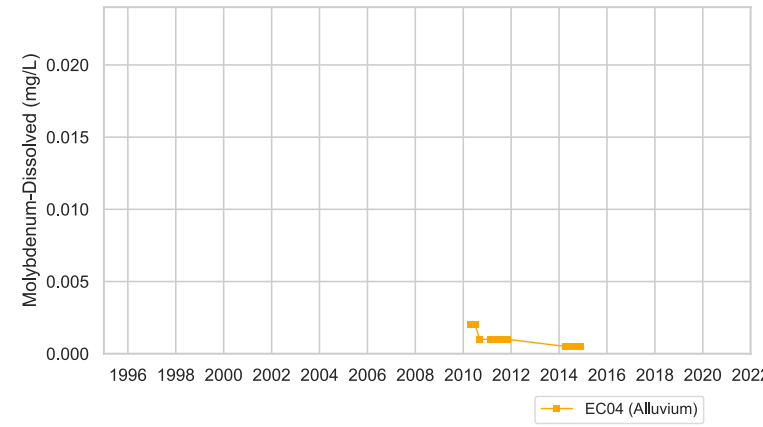

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

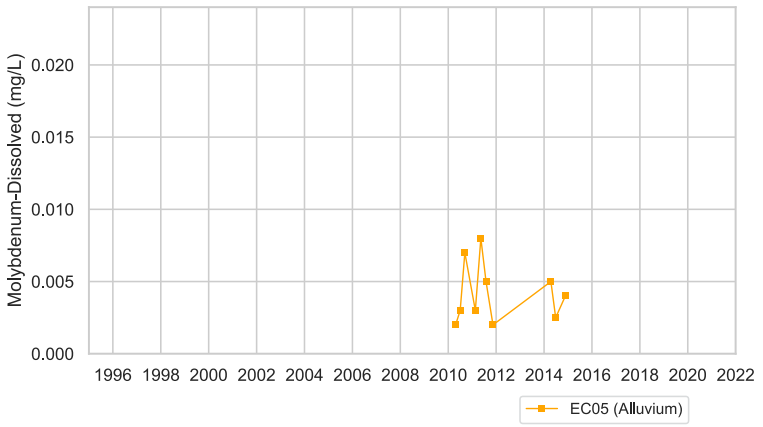

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

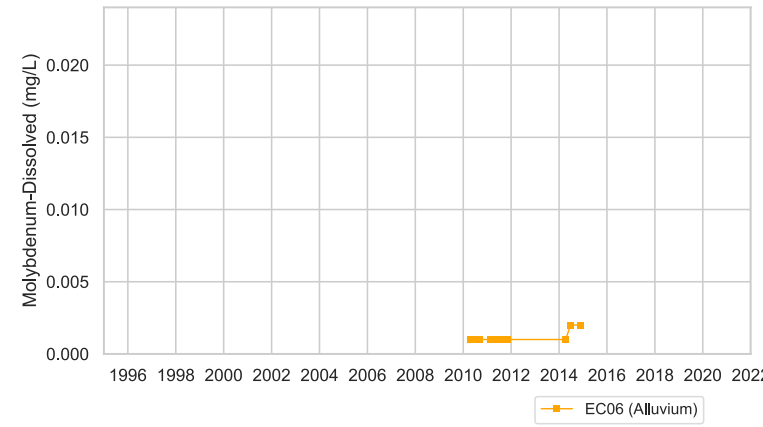

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

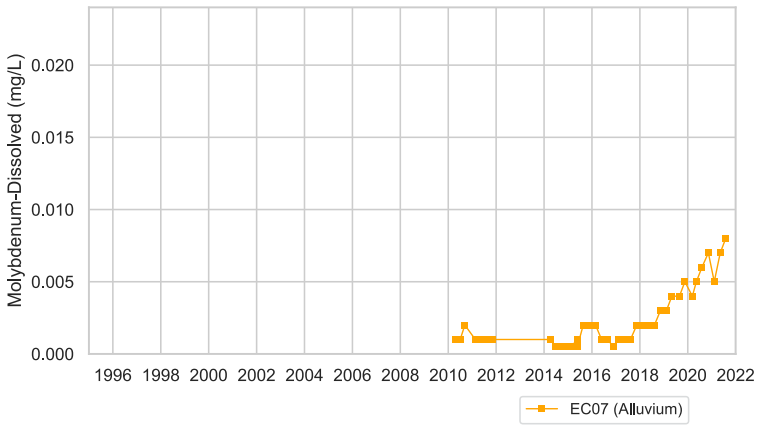

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

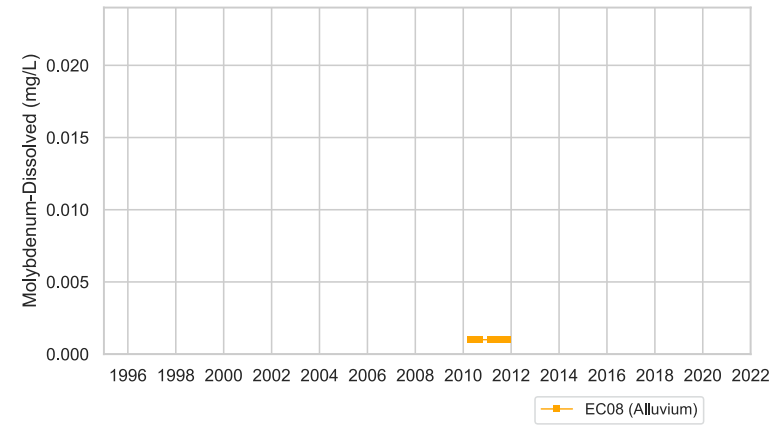

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

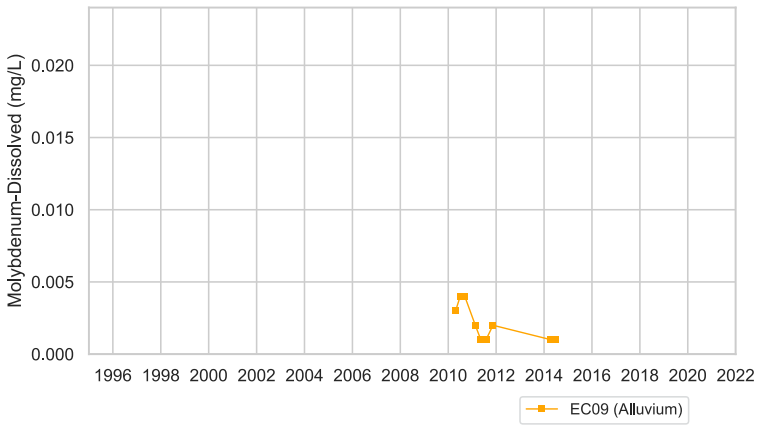

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

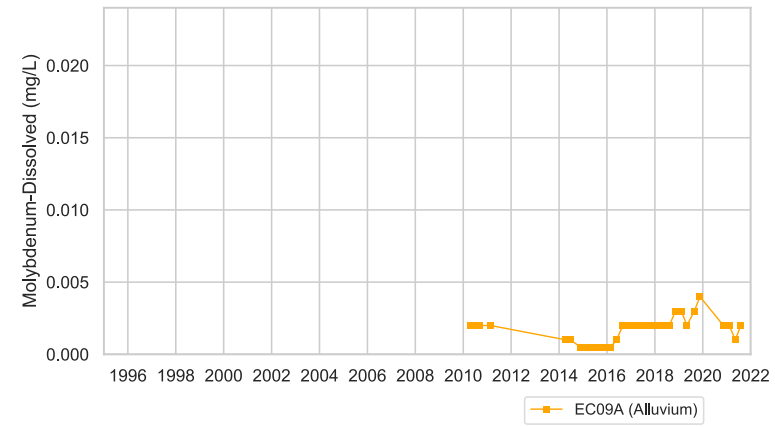

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

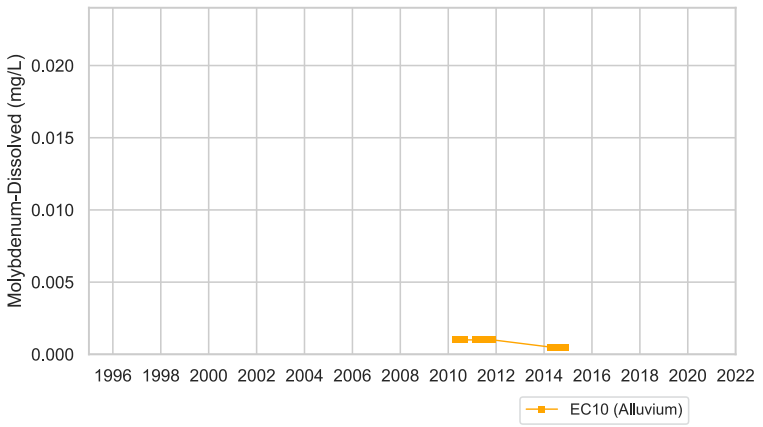

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

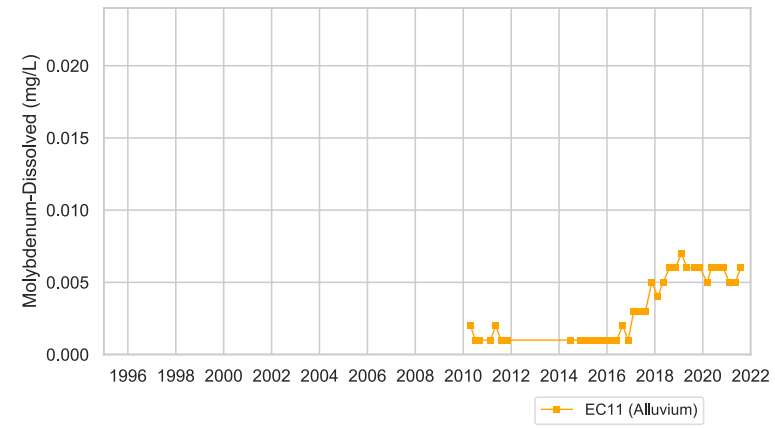

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

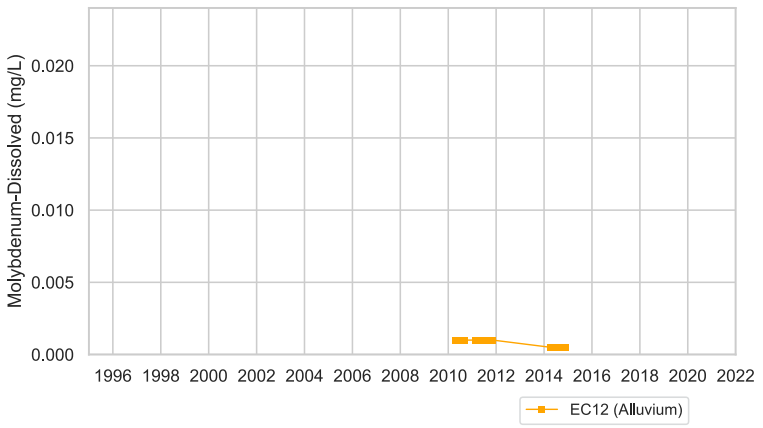

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

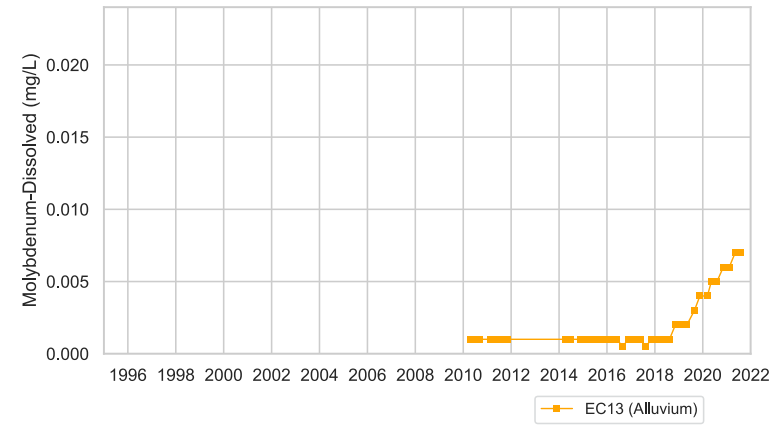

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

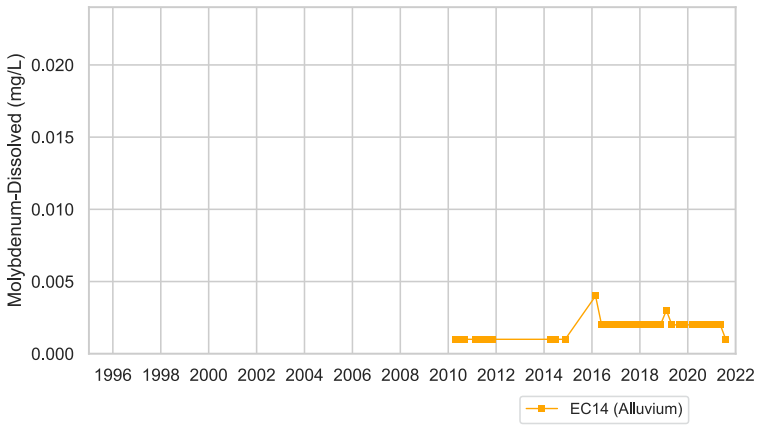

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

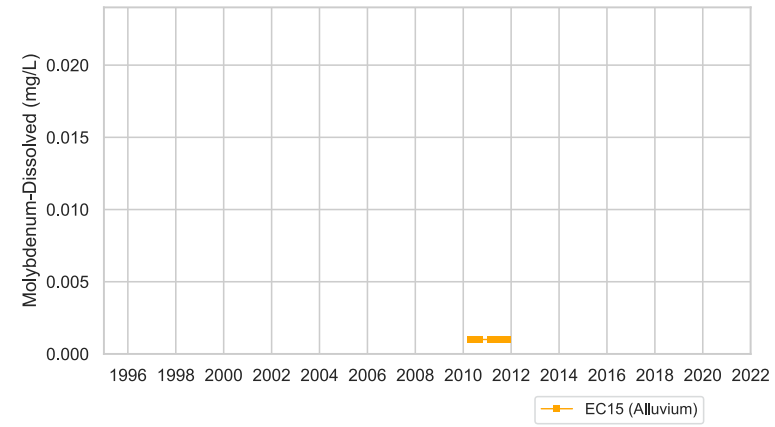

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

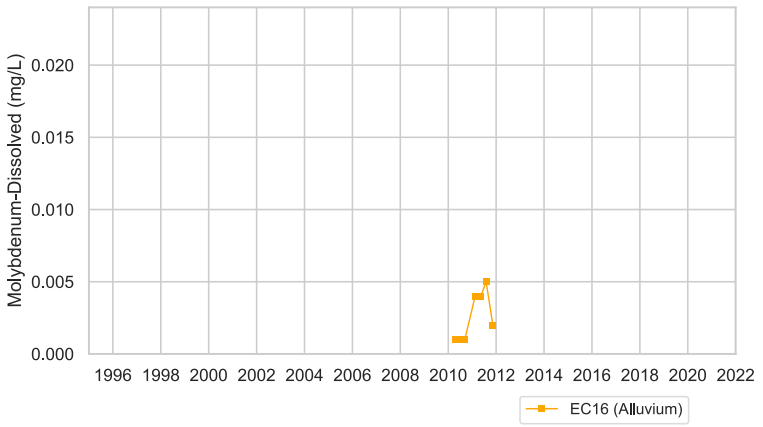

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

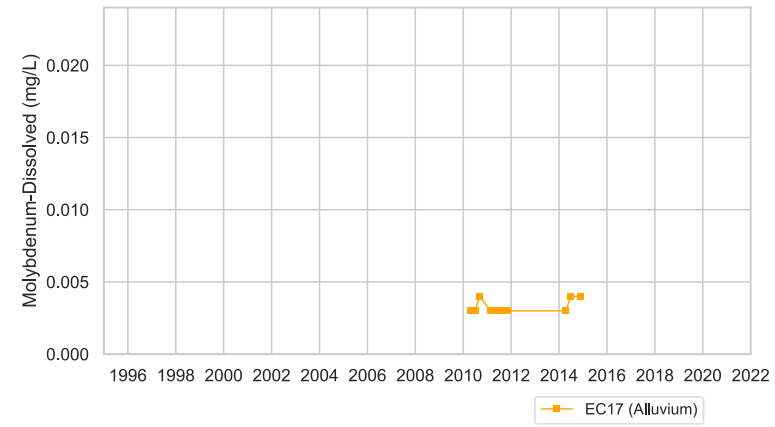

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

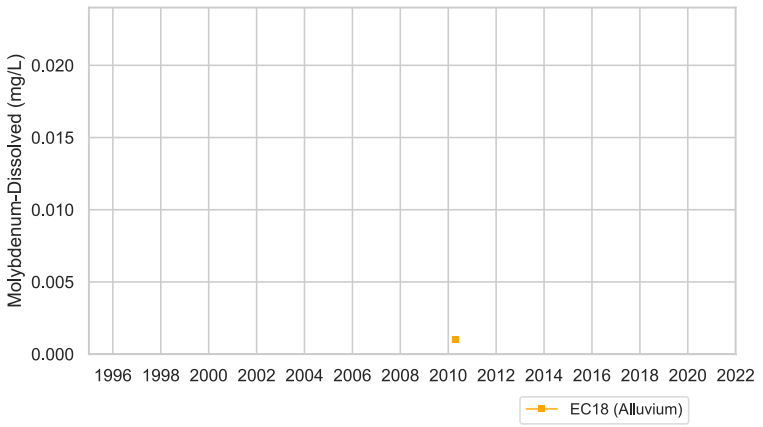

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

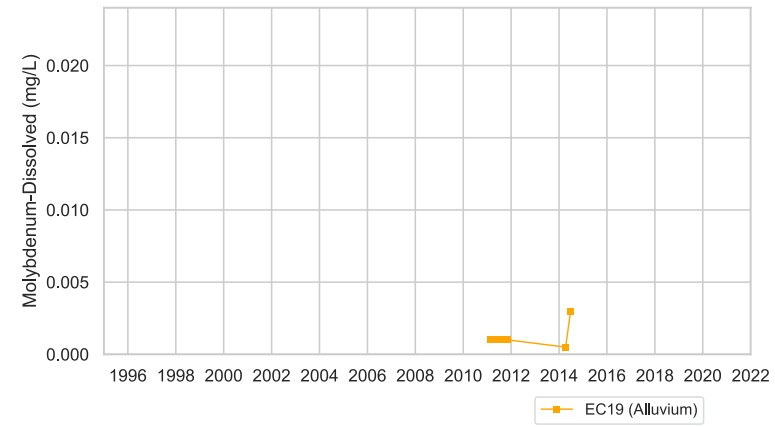

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

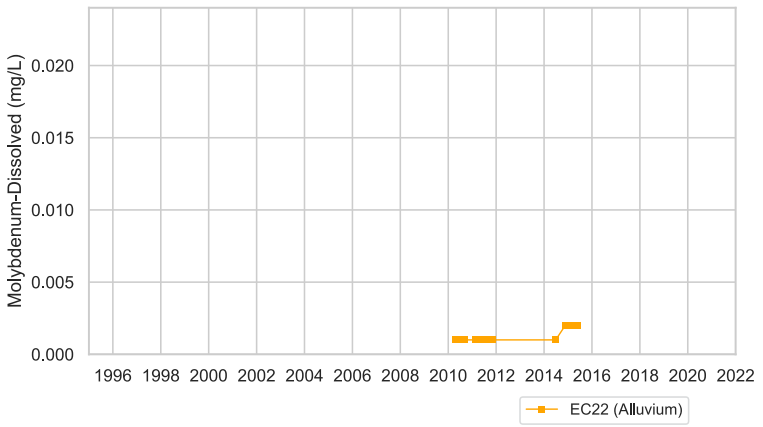

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

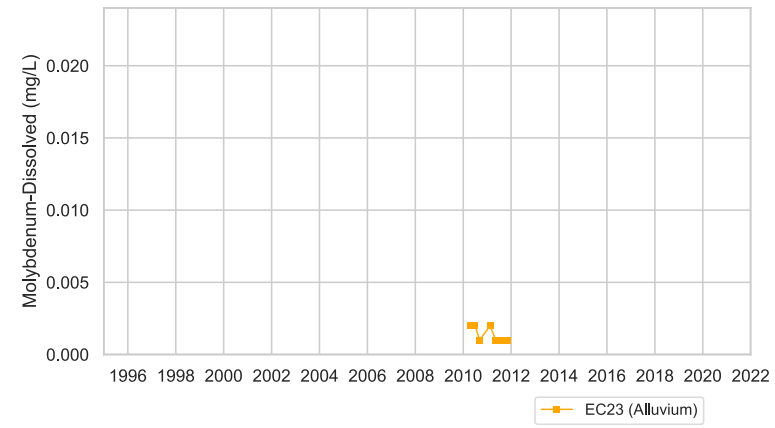

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

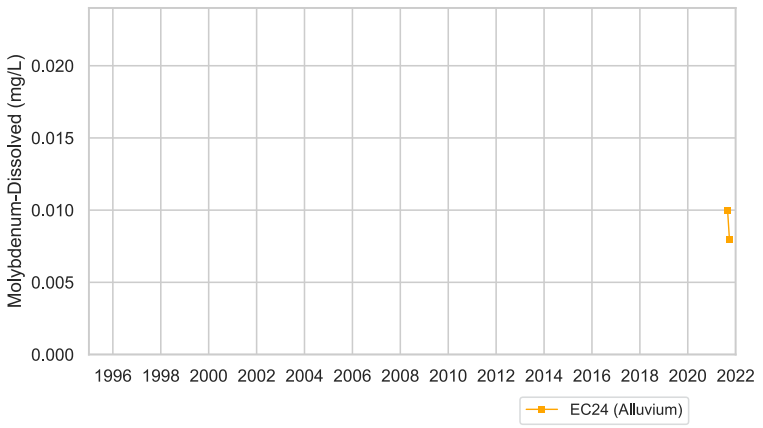

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

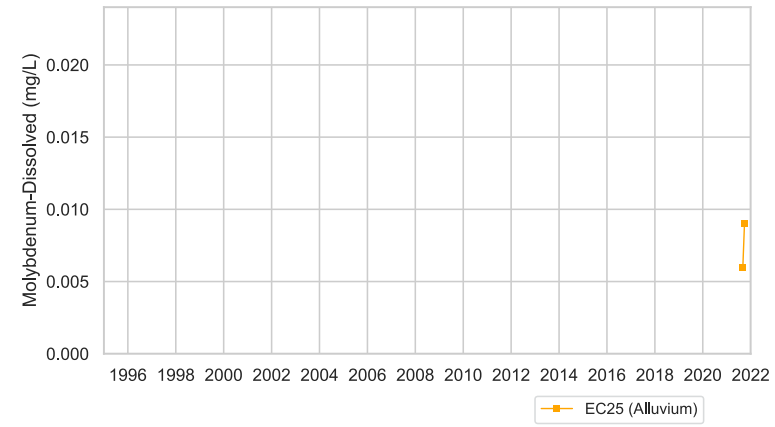

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

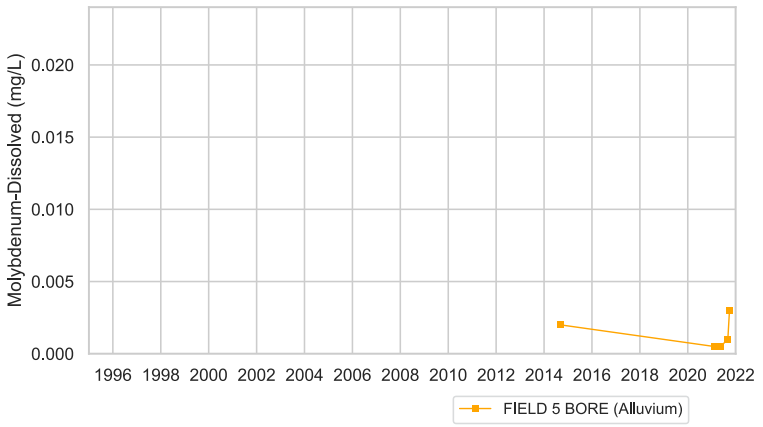

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

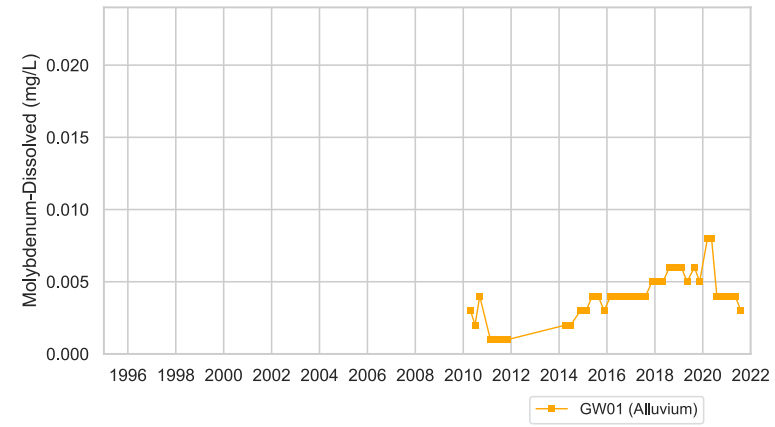

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

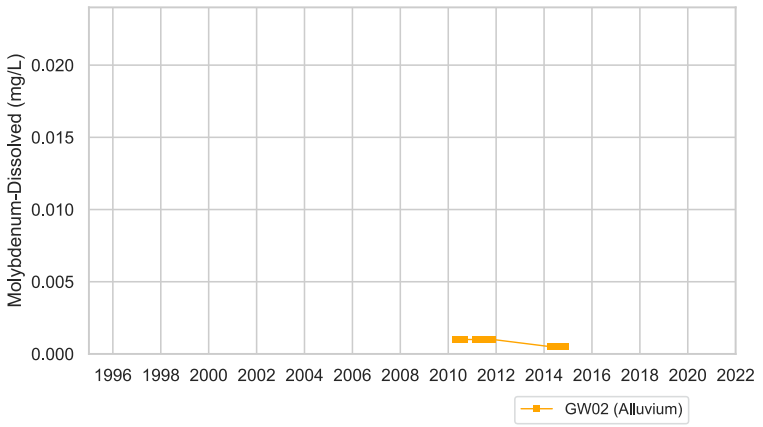

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

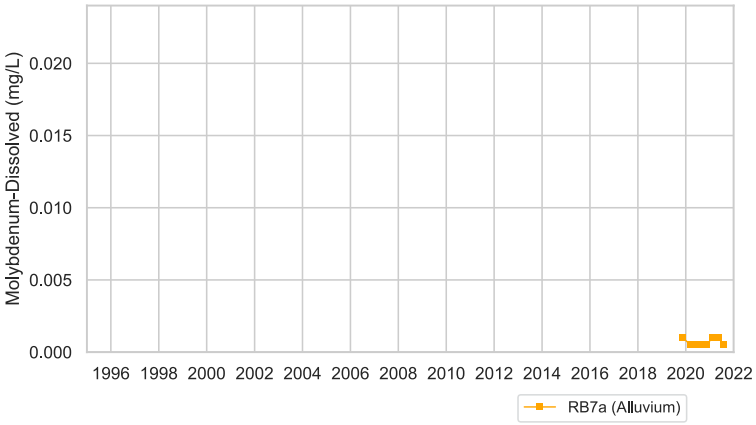

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

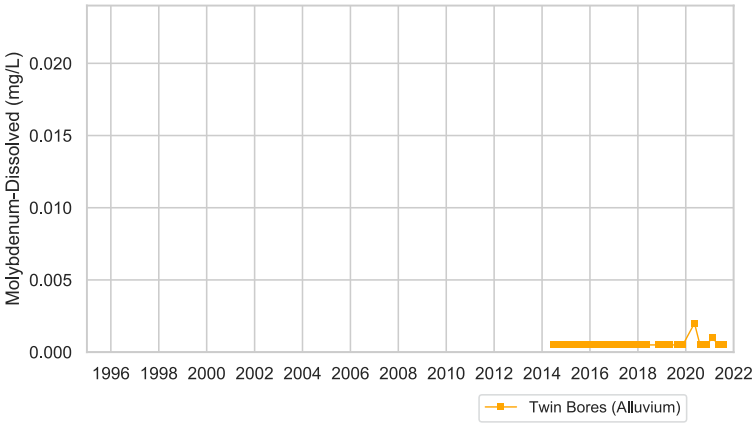

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

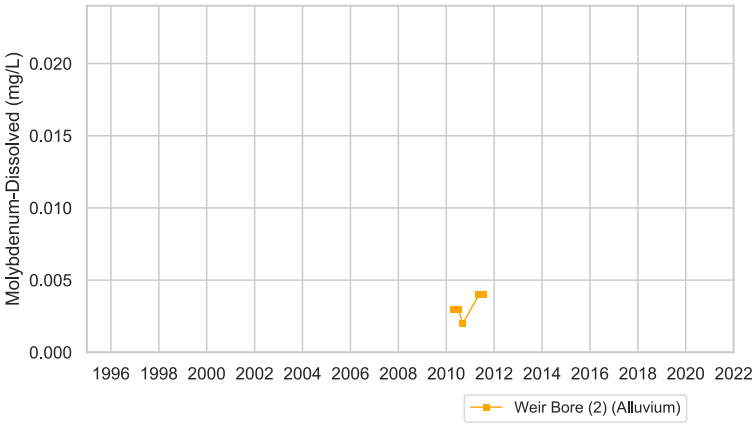

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

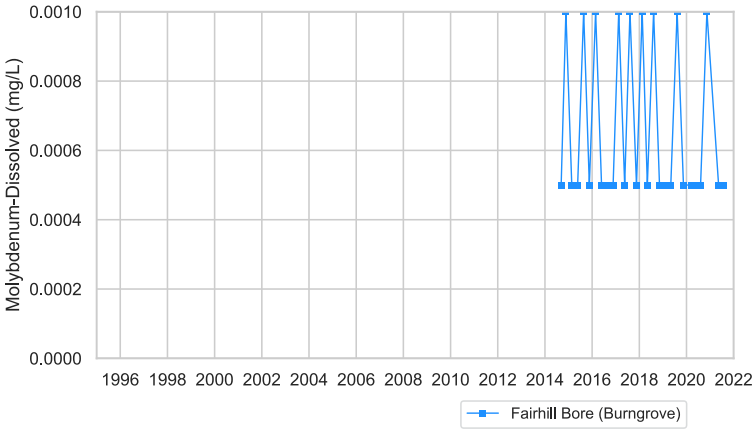

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

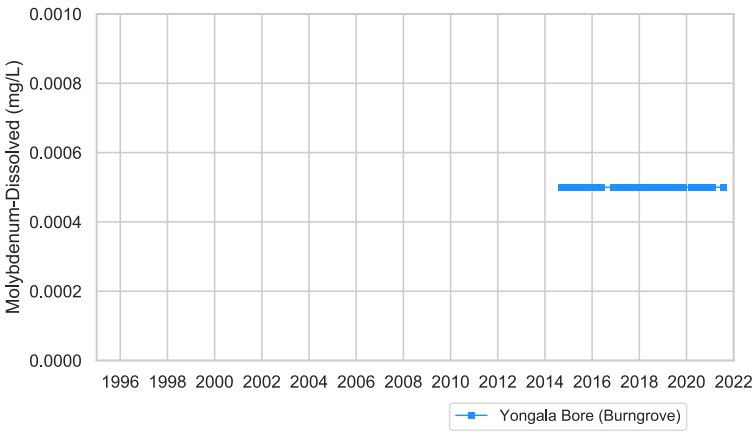

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

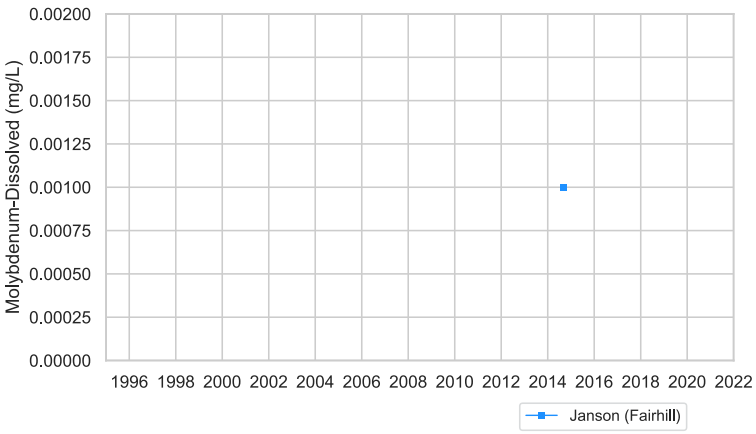

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

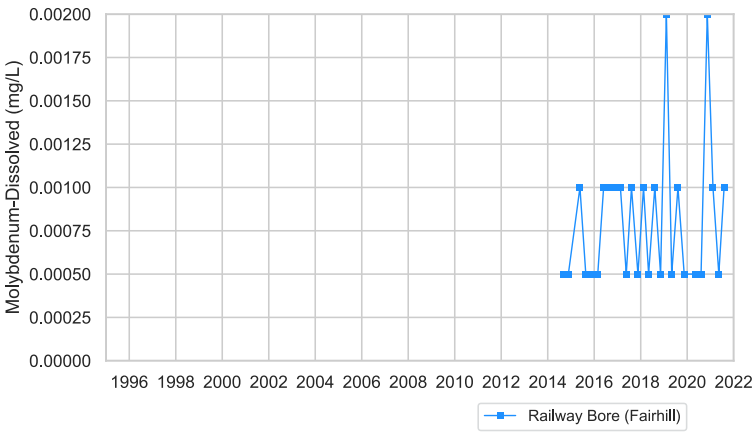

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

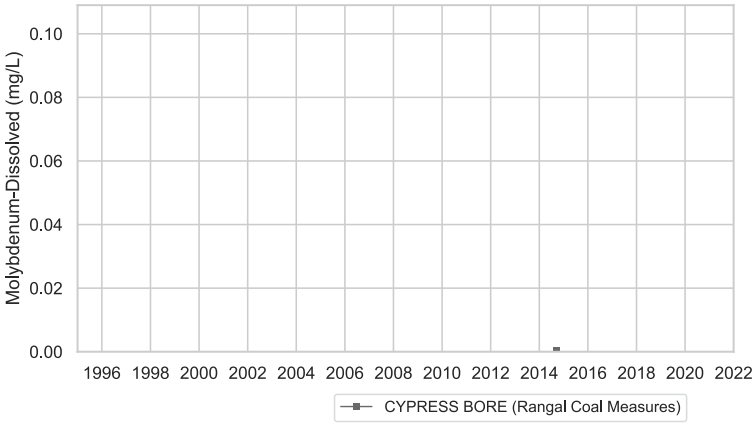

Molybdenum-Dissolved (mg/L)
0.020
0.015
0.010
0.005
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

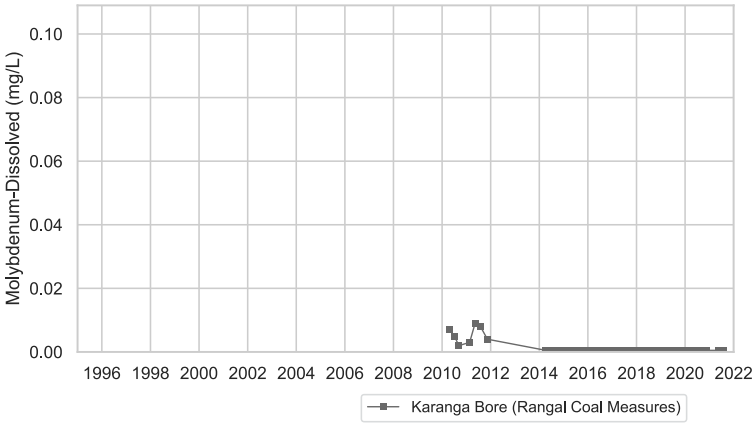

Molybdenum-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

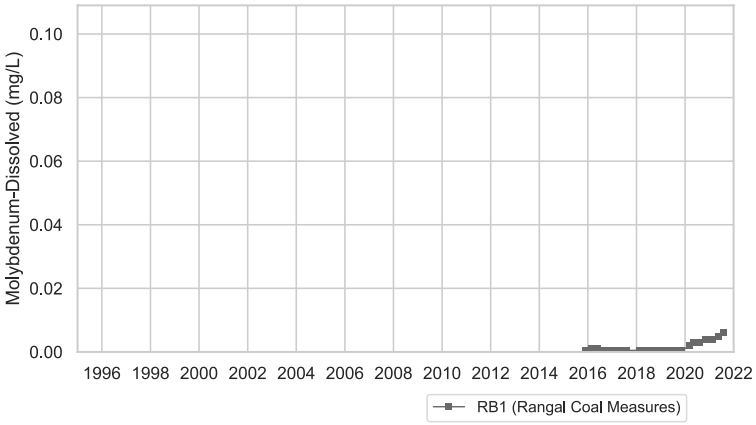

Molybdenum-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

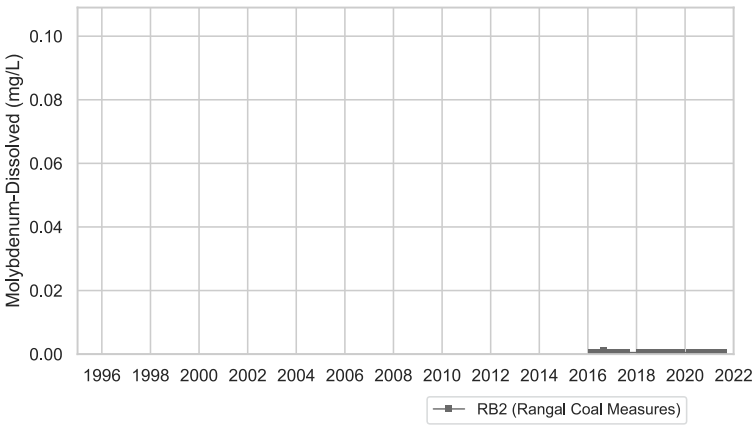

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

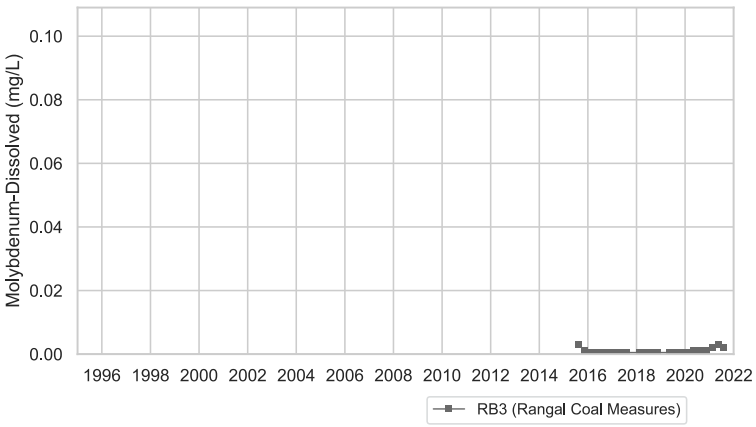

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

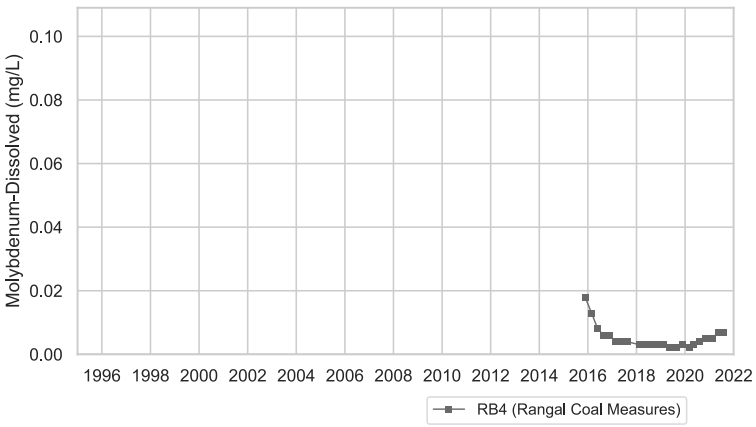

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

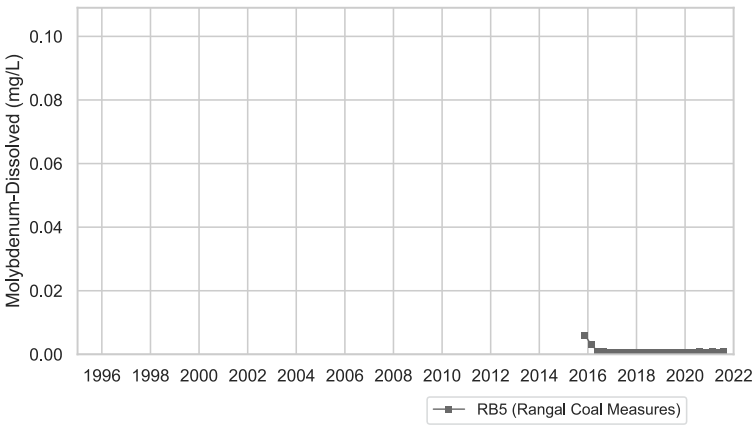

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

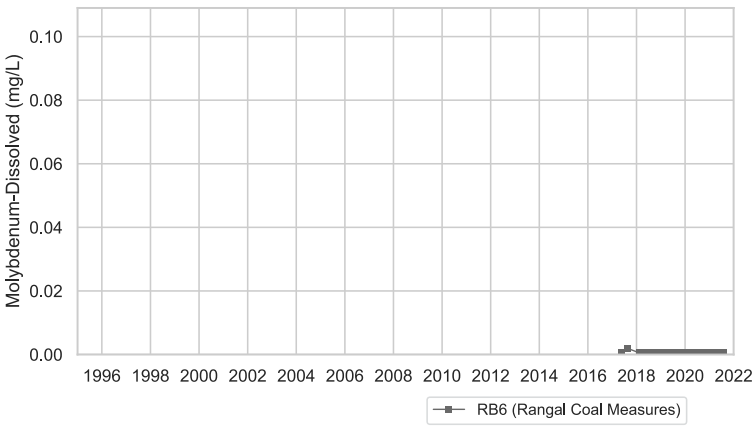

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

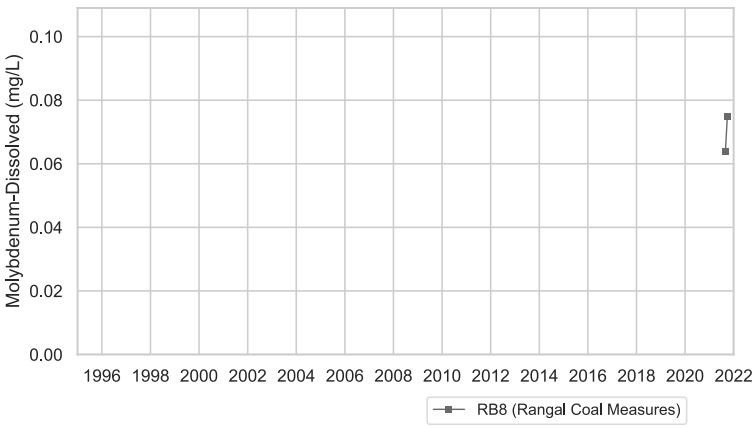

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

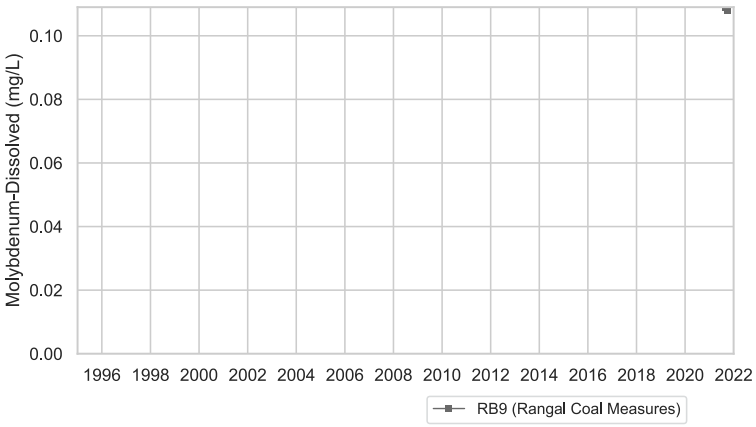

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

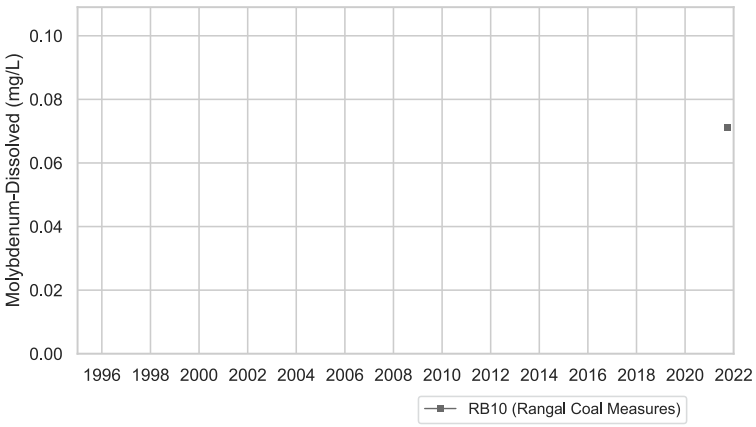

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

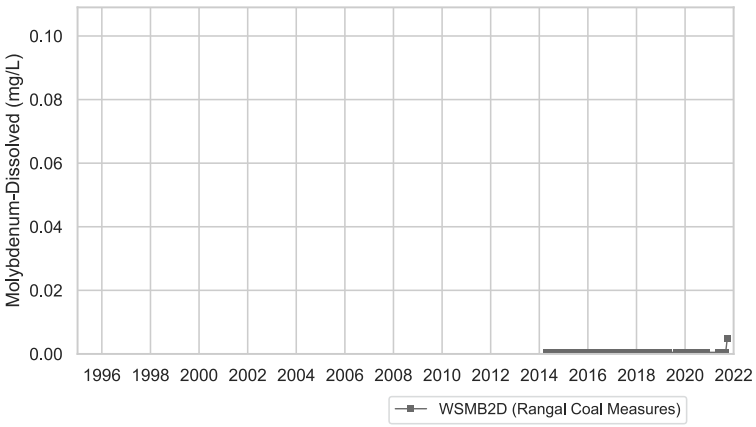

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

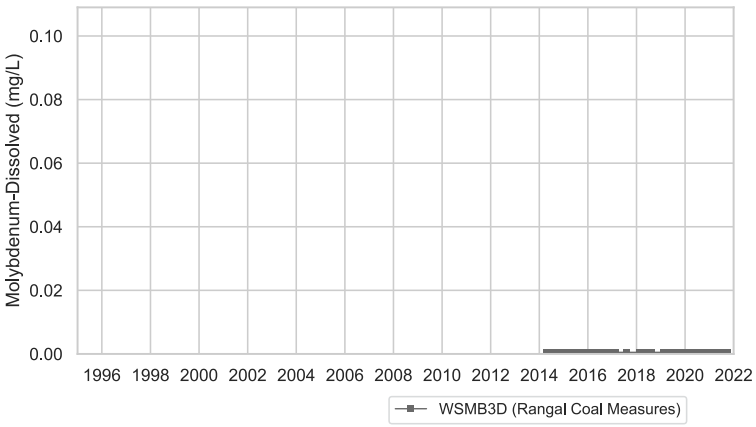

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

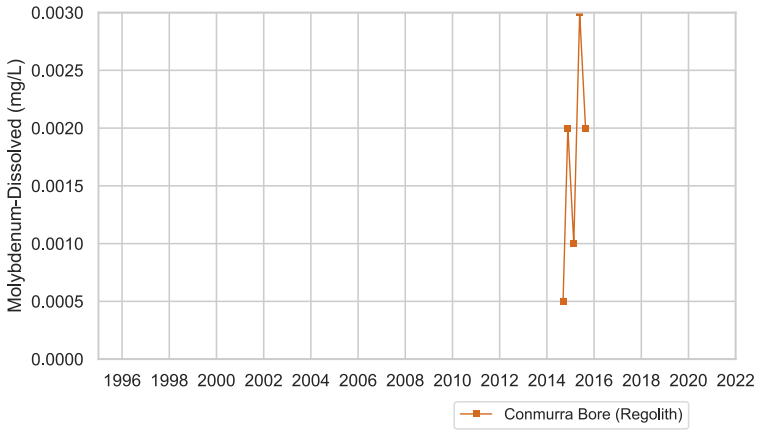

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

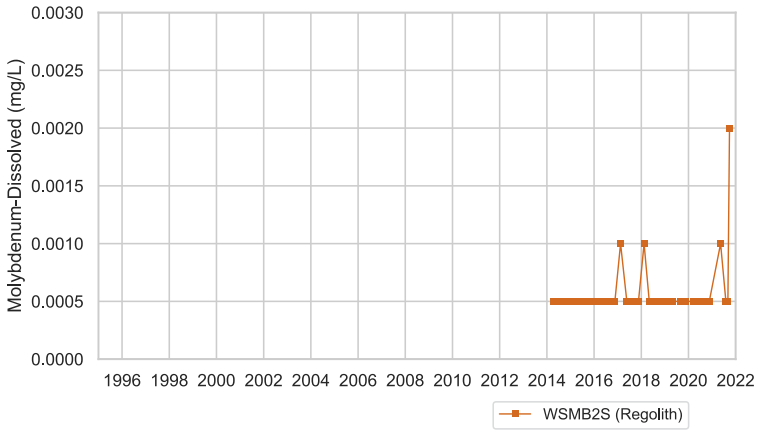

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

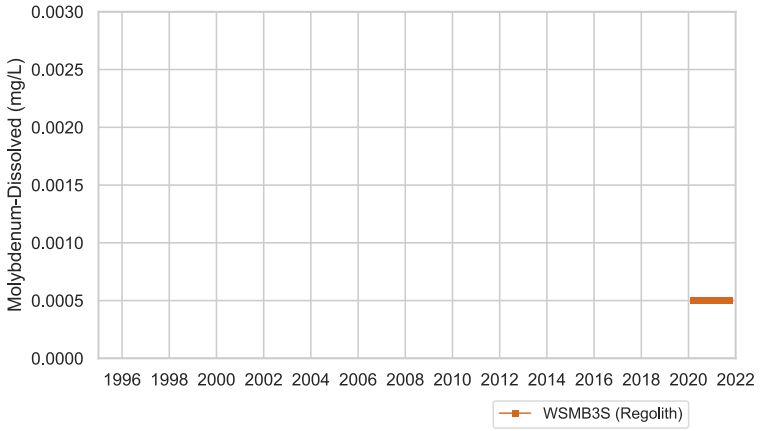

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

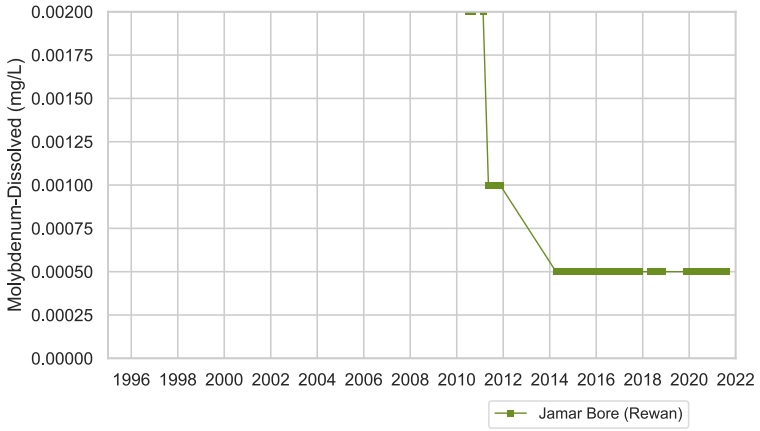

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

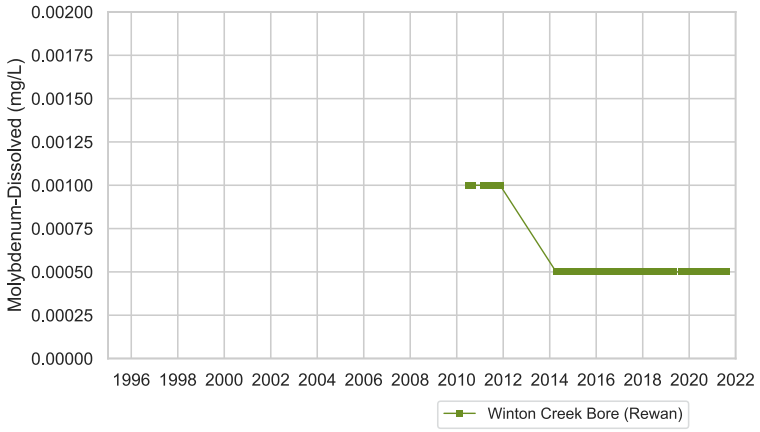

Molybdenum-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

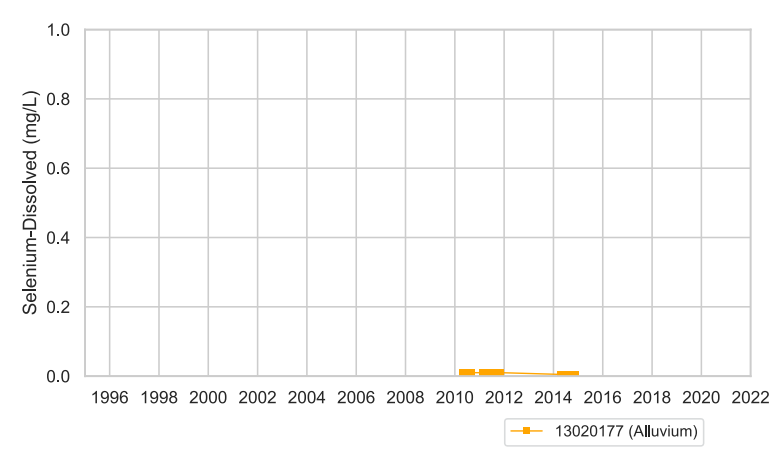

Molybdenum-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

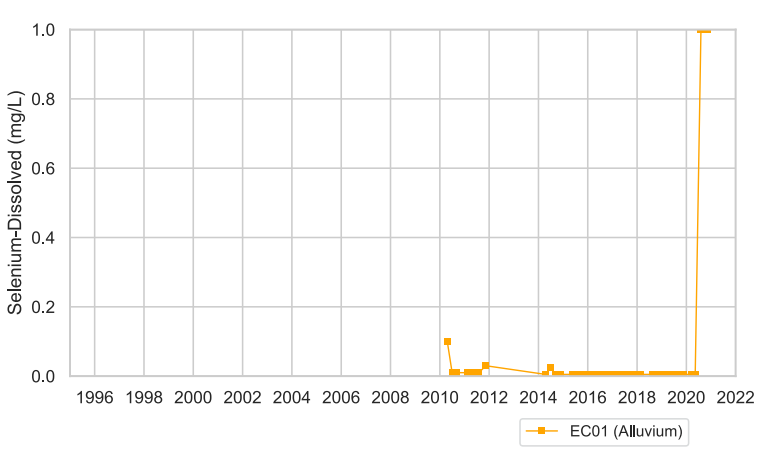

Molybdenum-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

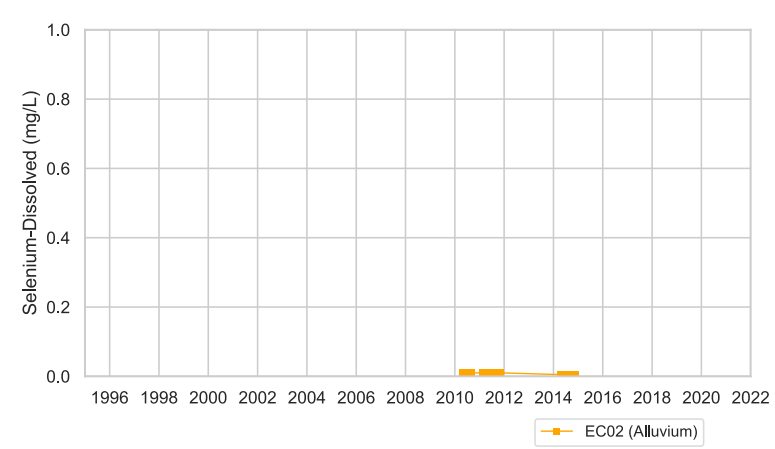

Molybdenum-Dissolved (mg/L)
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

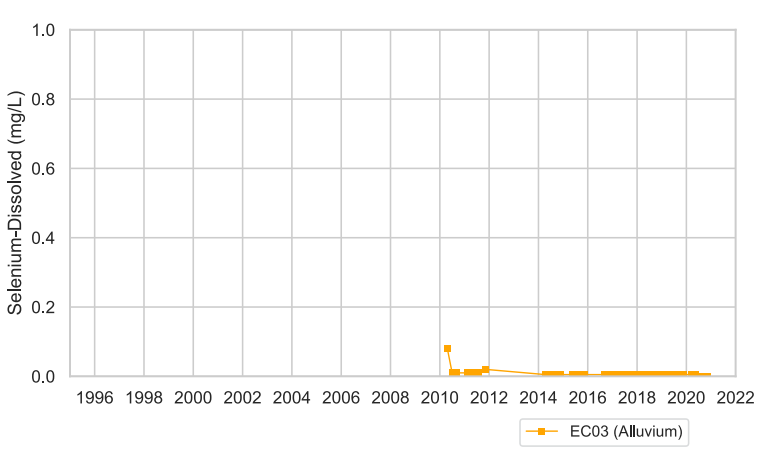

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

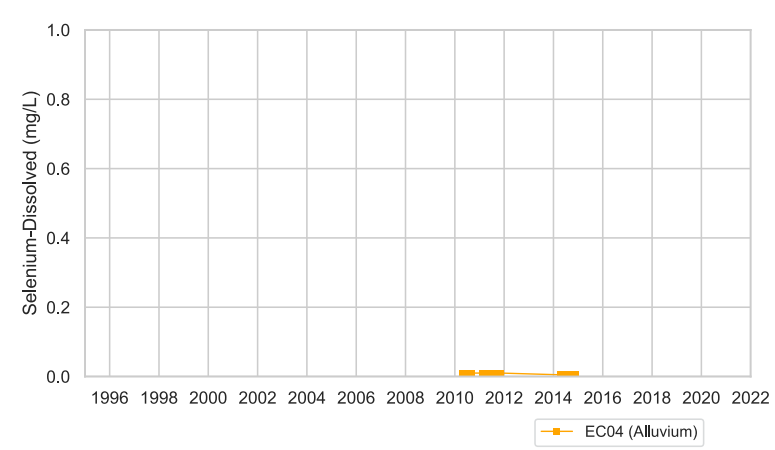

Molybdenum-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

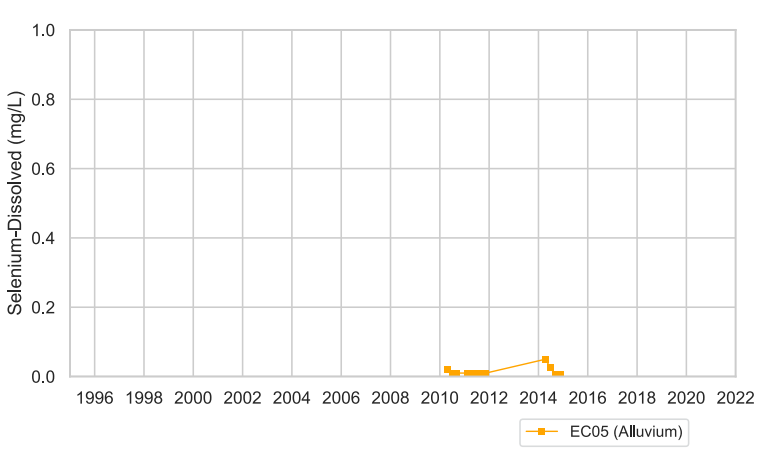

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

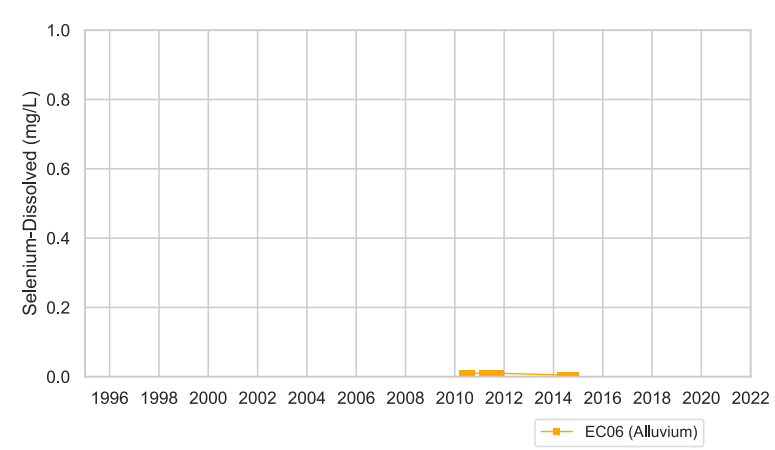

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

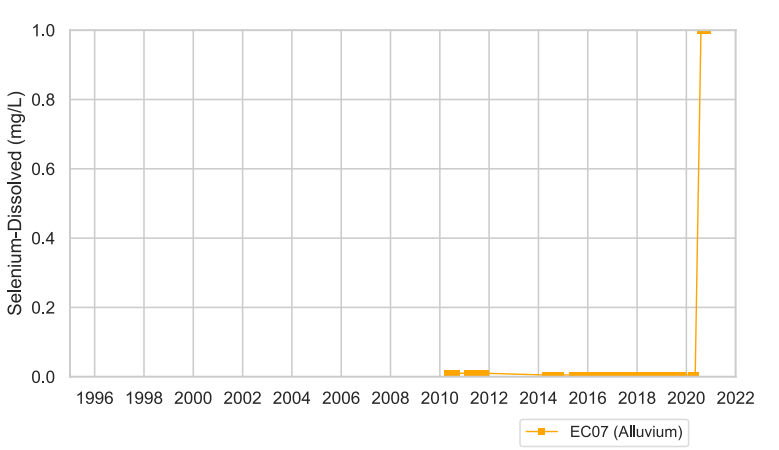

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

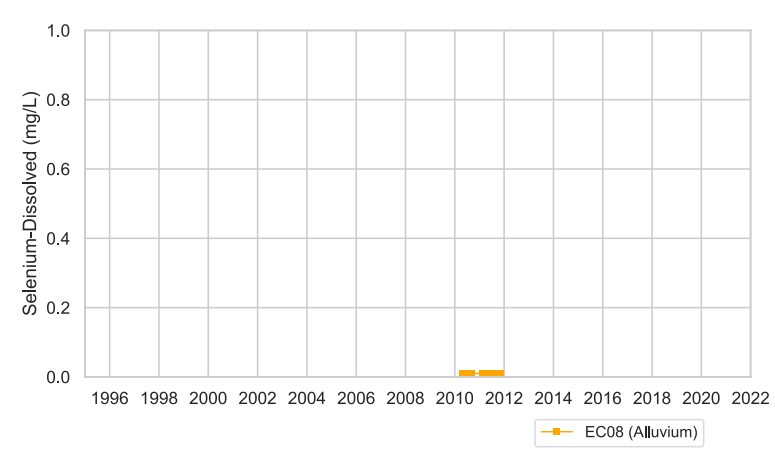

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

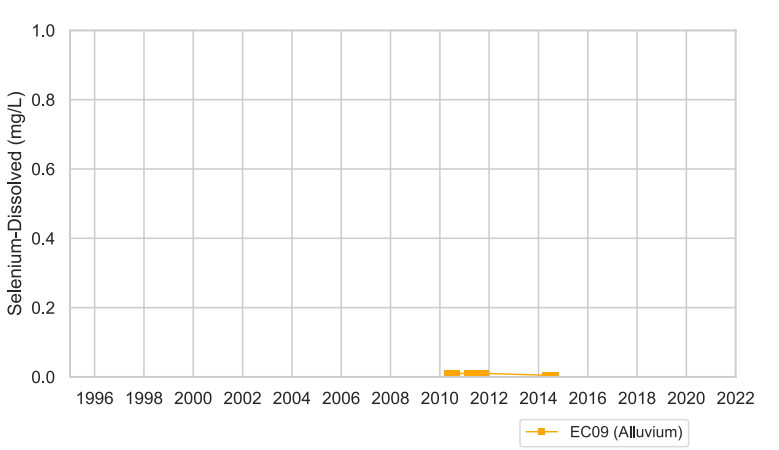

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

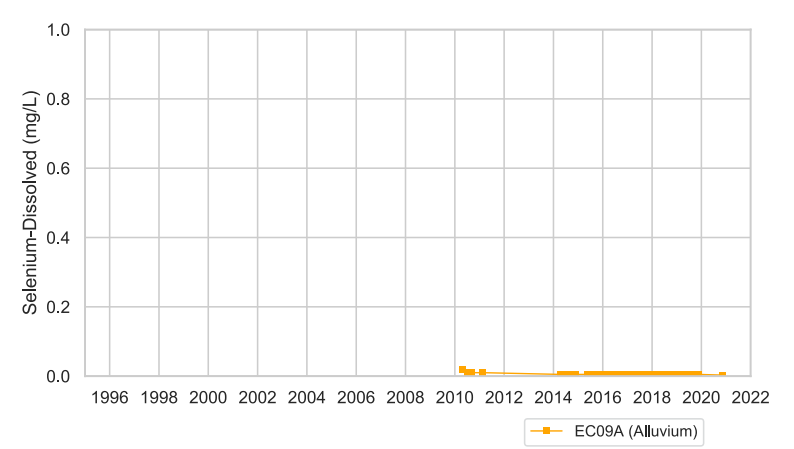

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

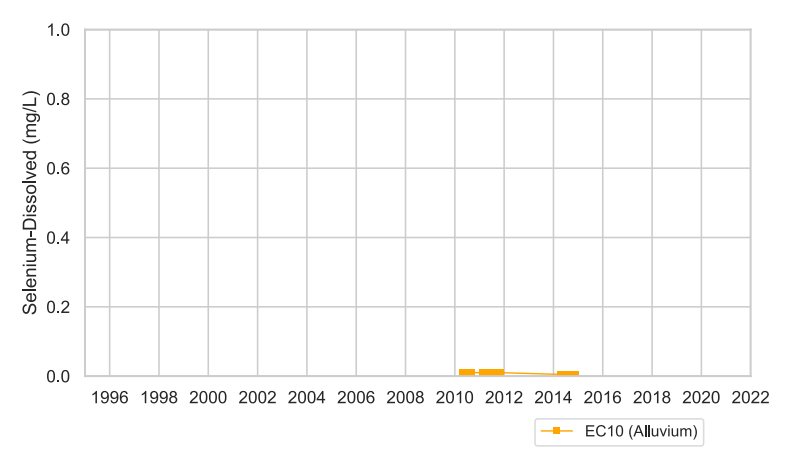

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

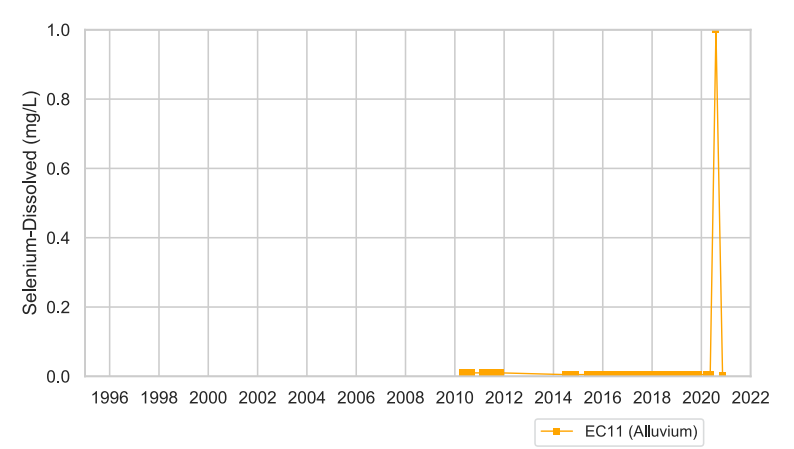

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

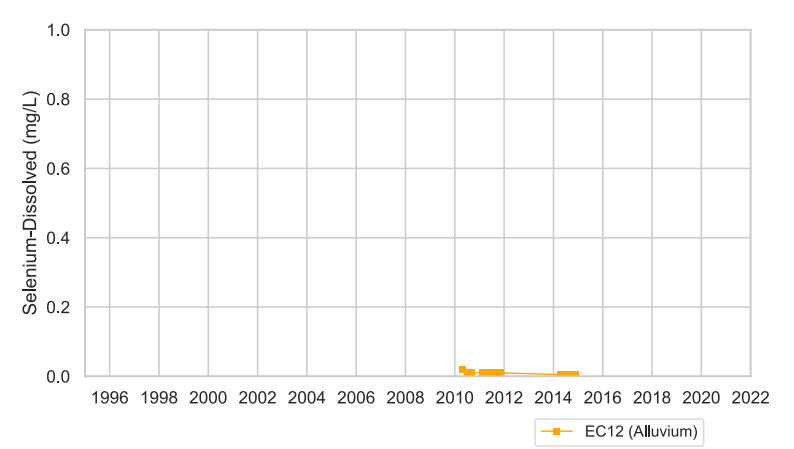

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

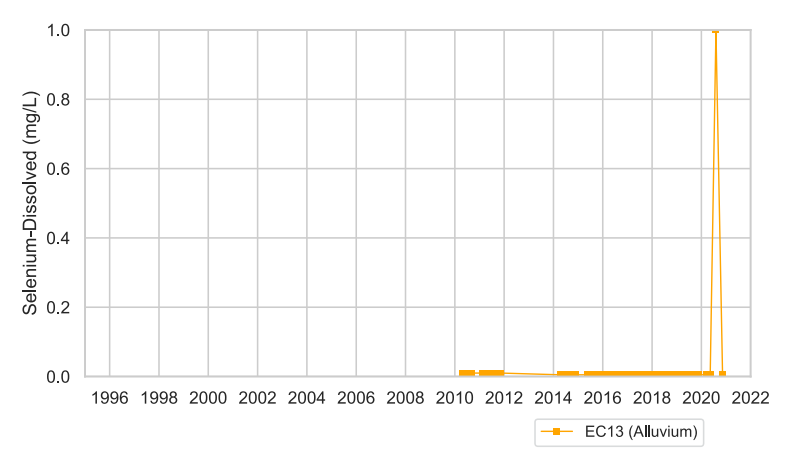

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

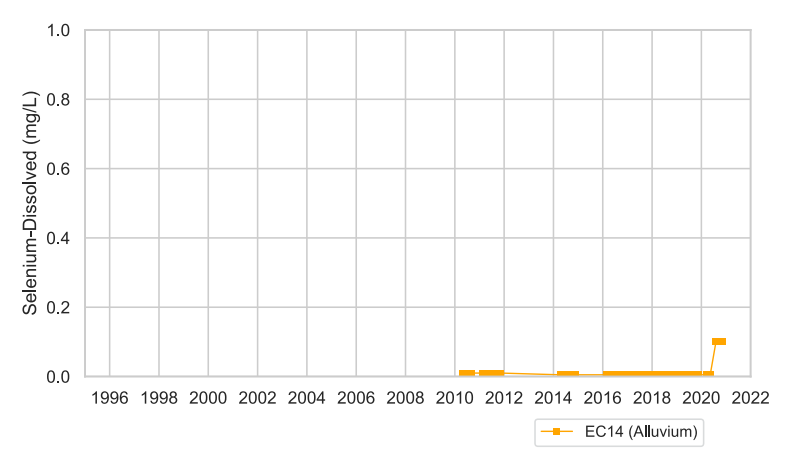

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

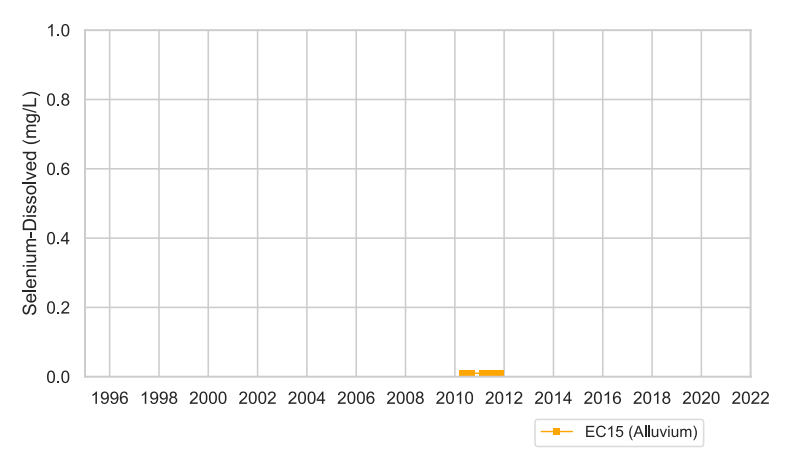

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

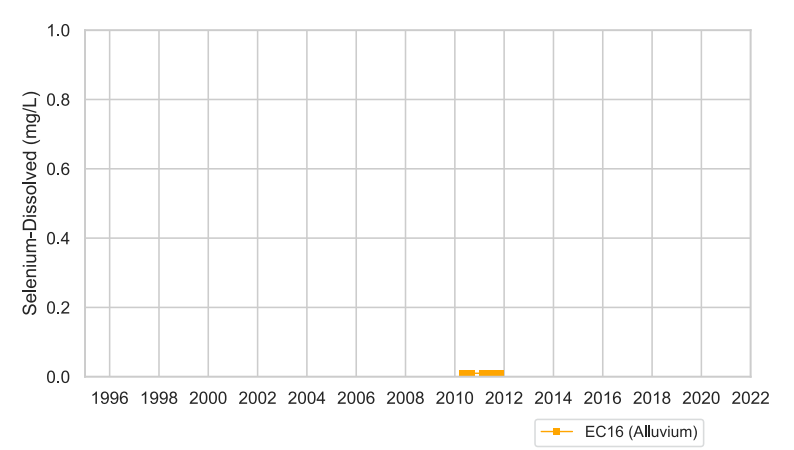

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

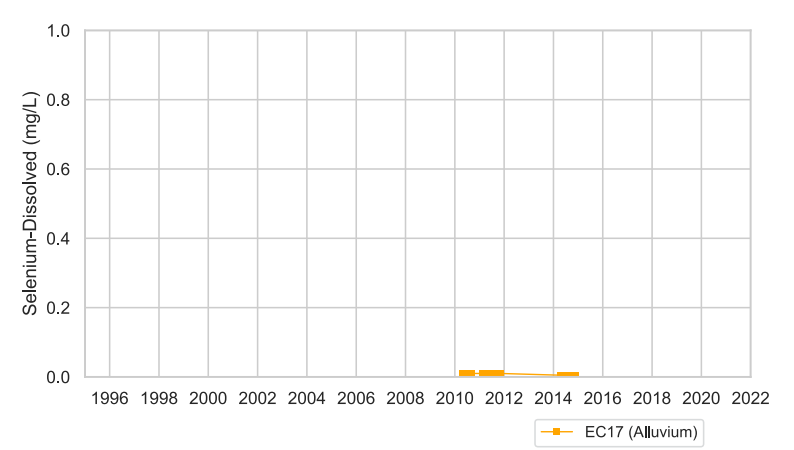

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

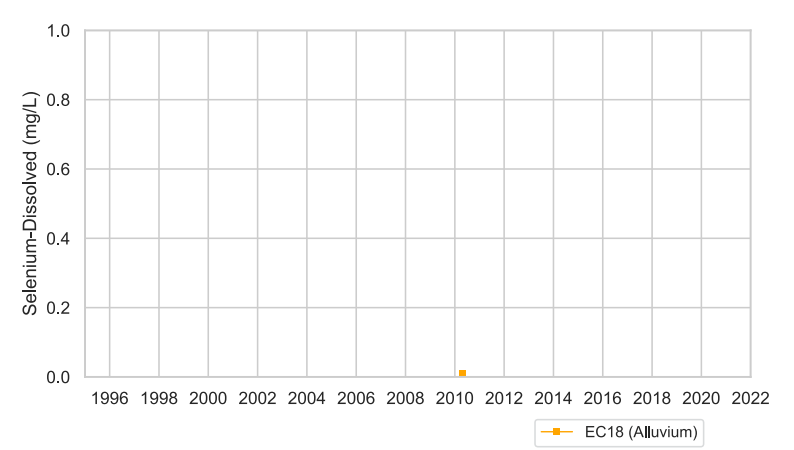

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

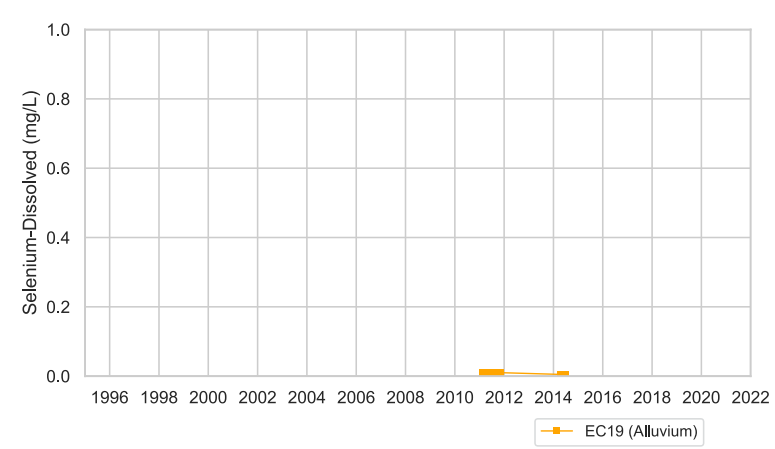

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

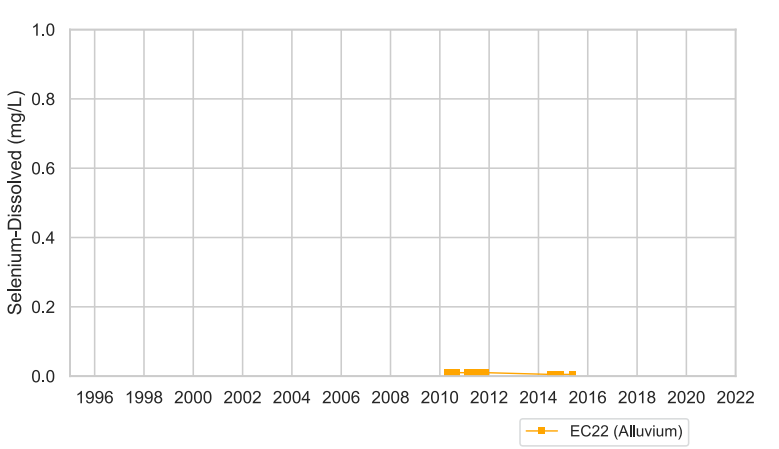

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

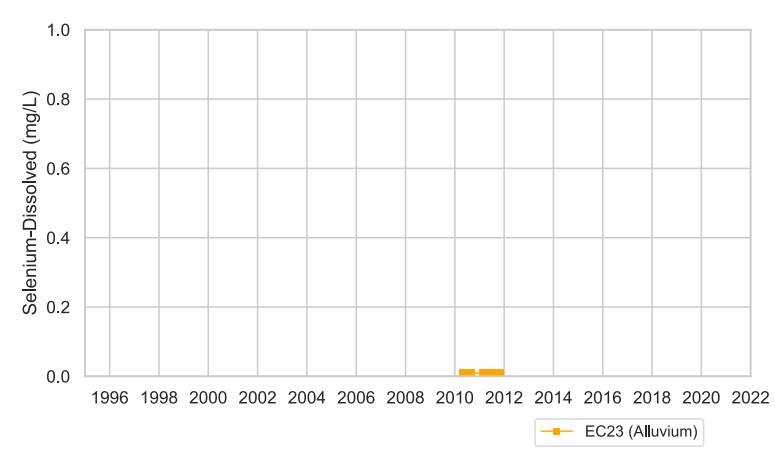

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

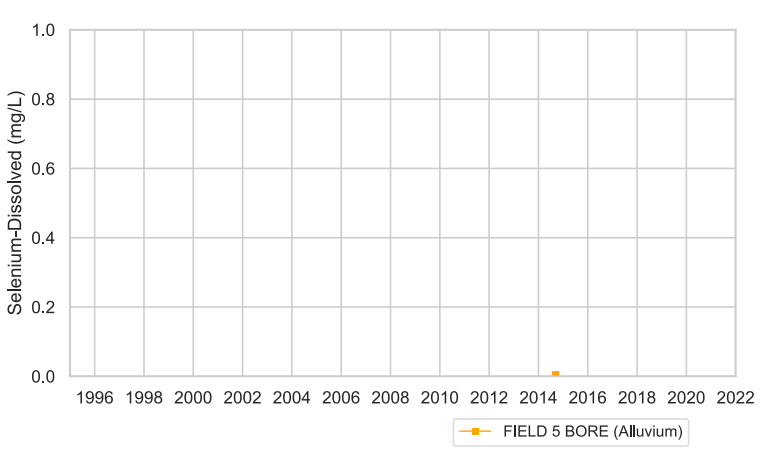

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

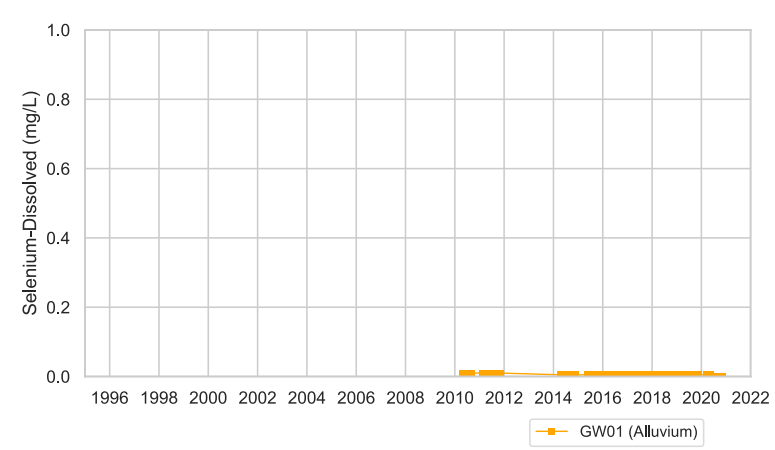

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC18 (Alluvium)

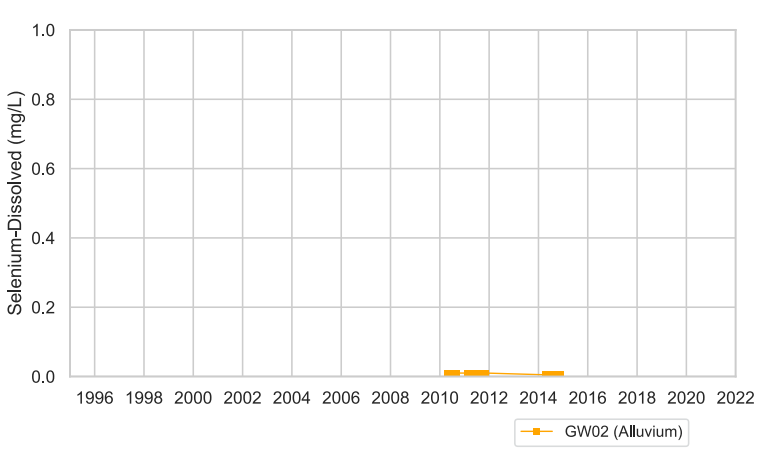

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

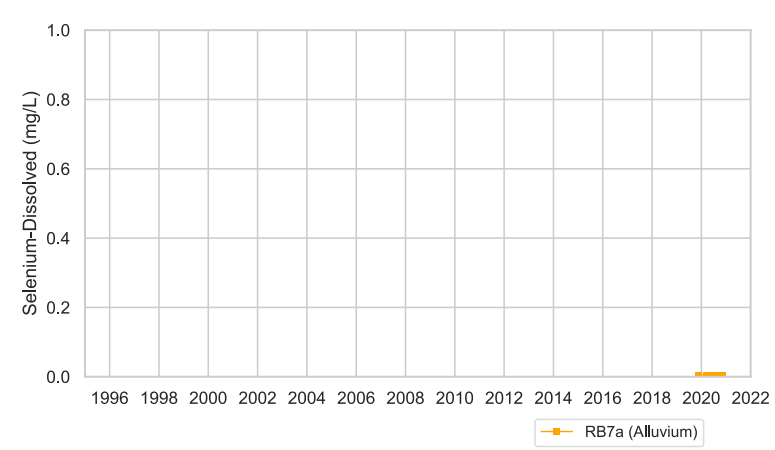

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

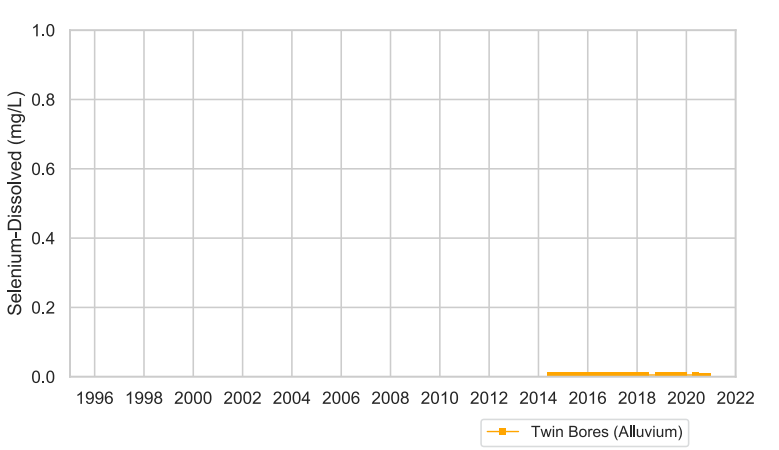

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

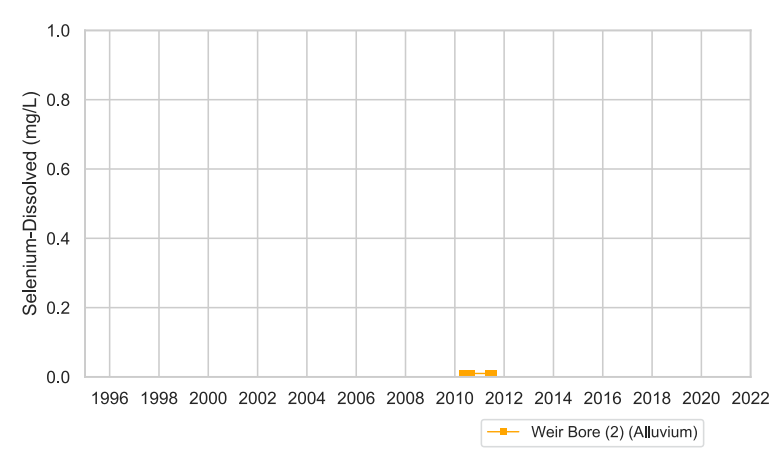

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

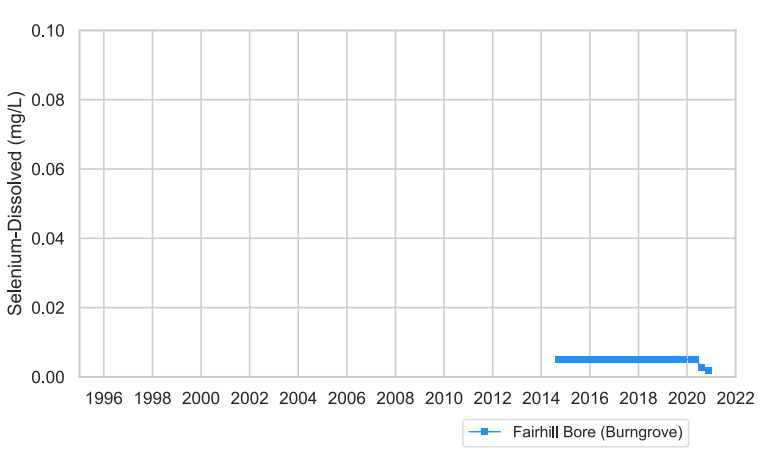

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

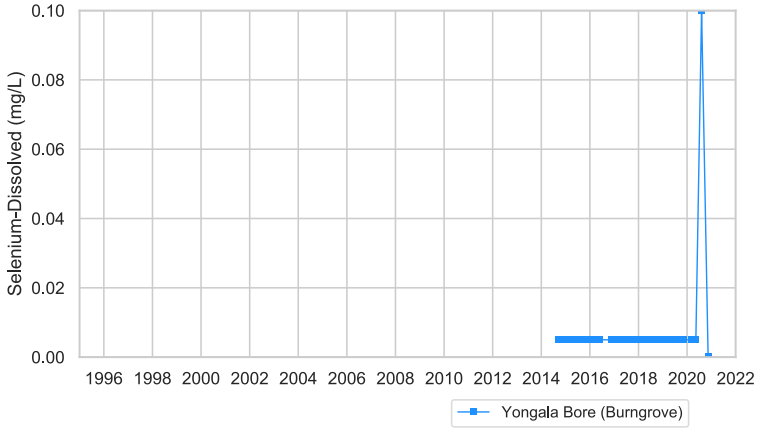

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

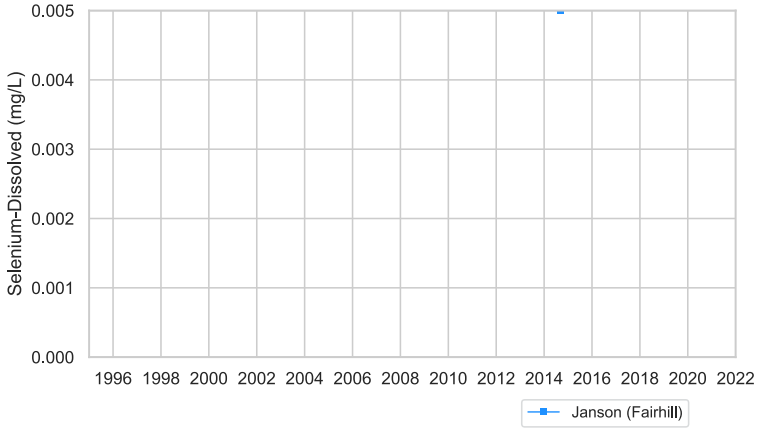

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

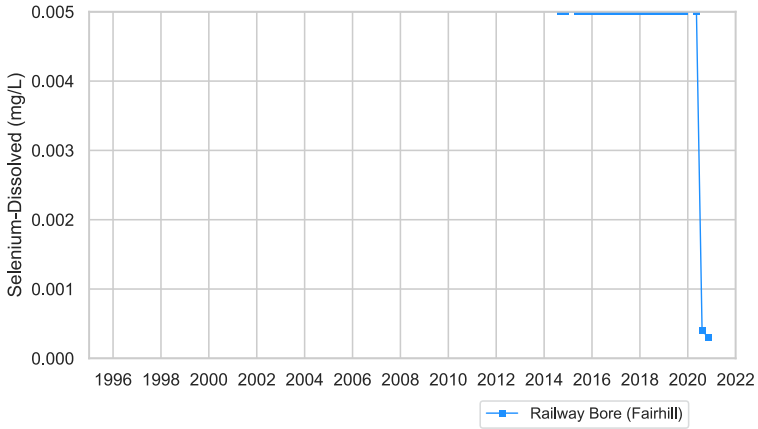

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

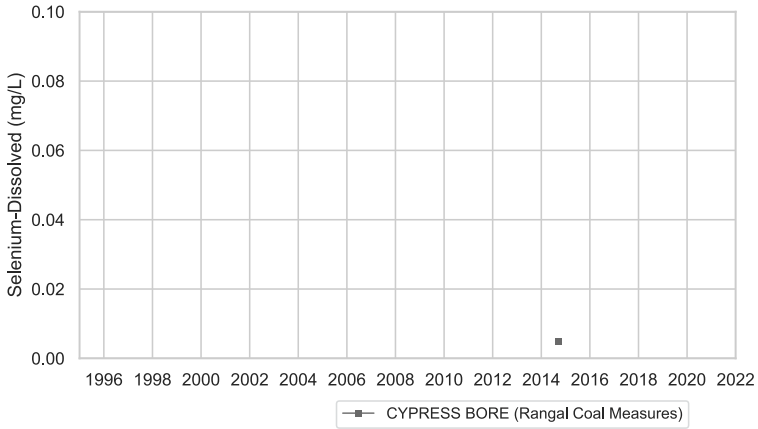

Selenium-Dissolved (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

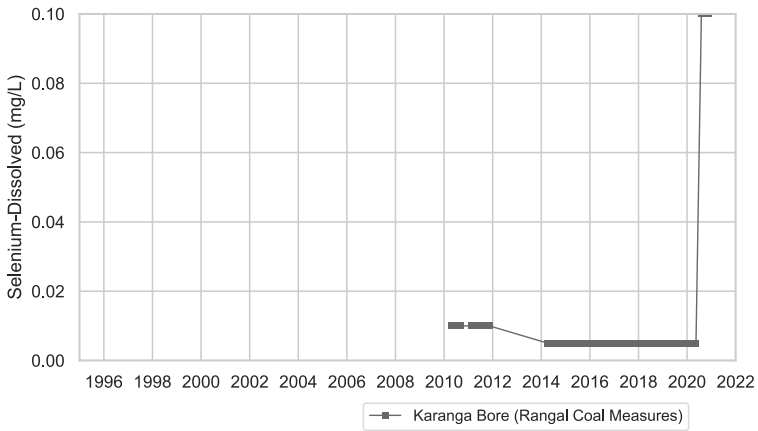

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

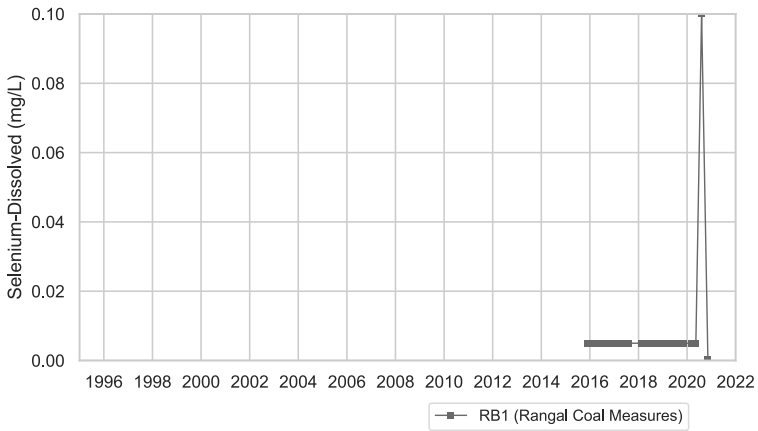

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

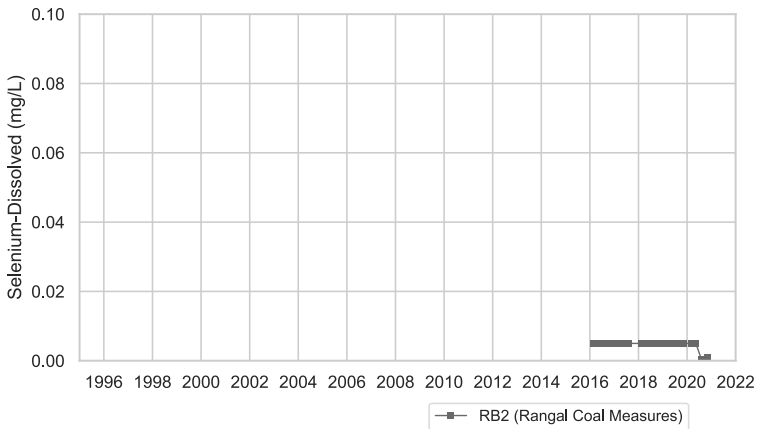

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

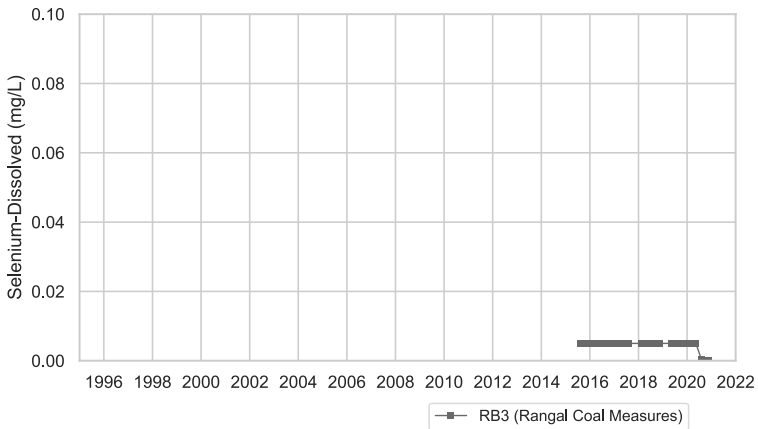

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

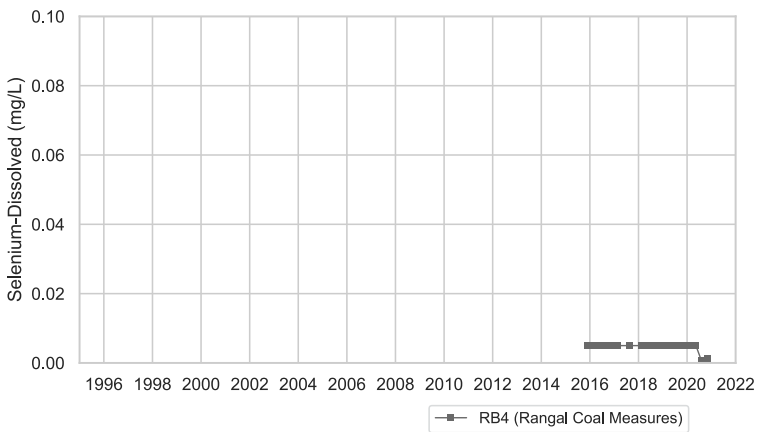

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

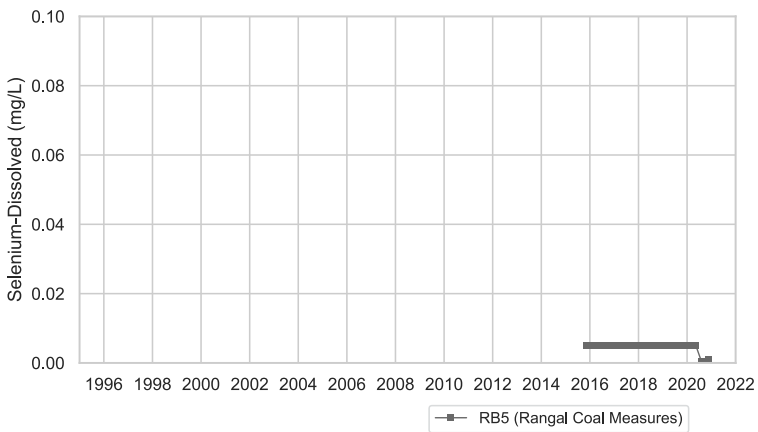

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

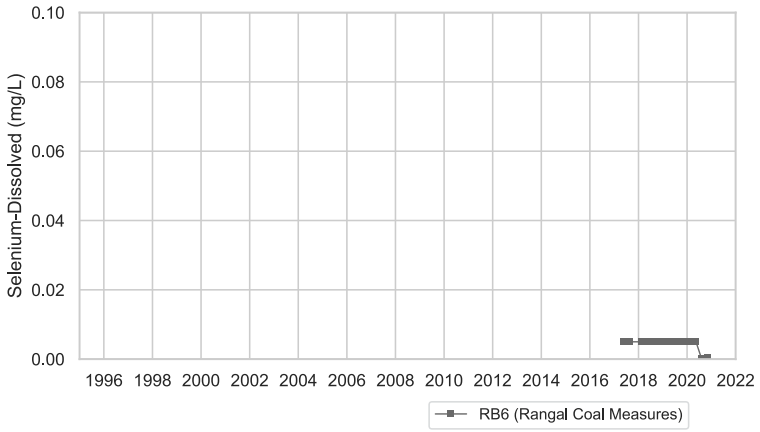

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

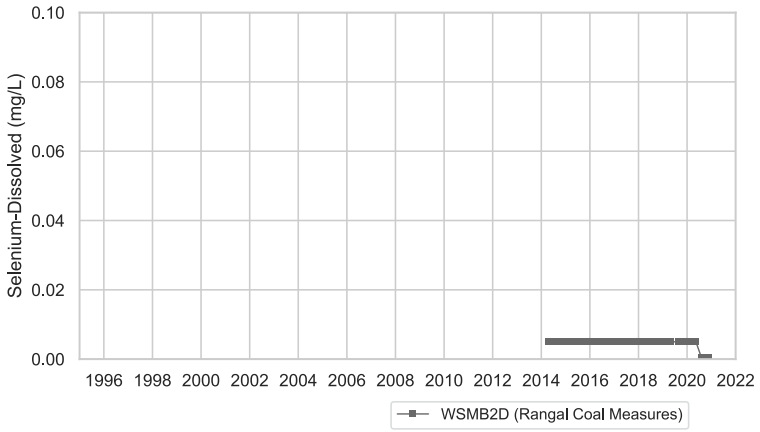

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

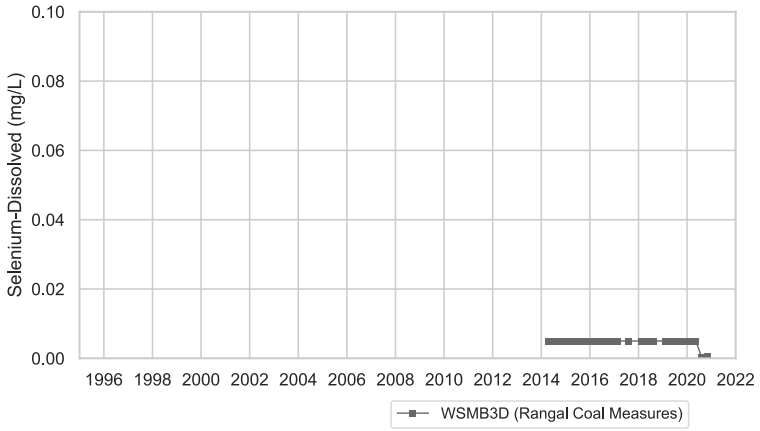

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

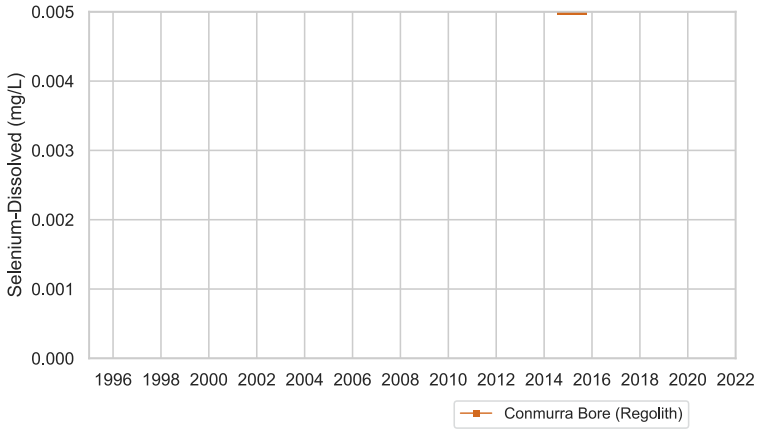

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

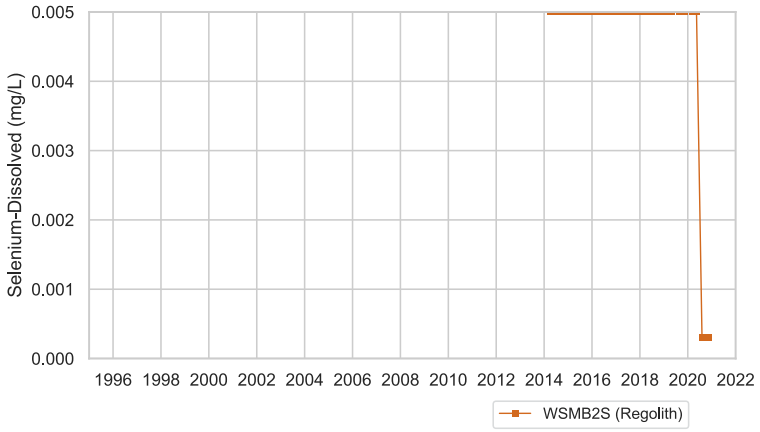

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

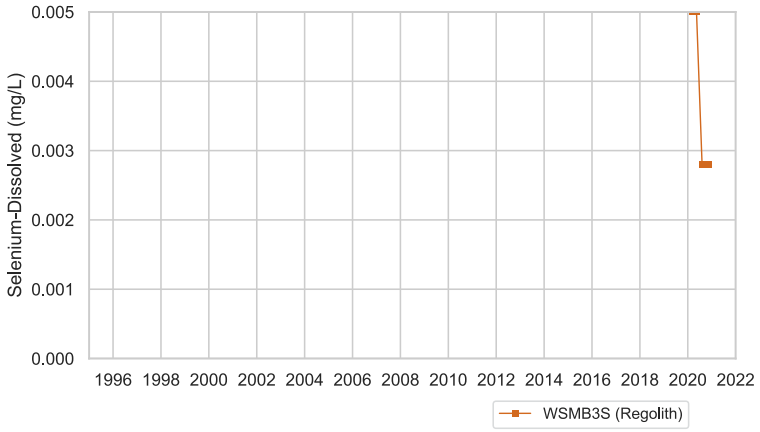

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

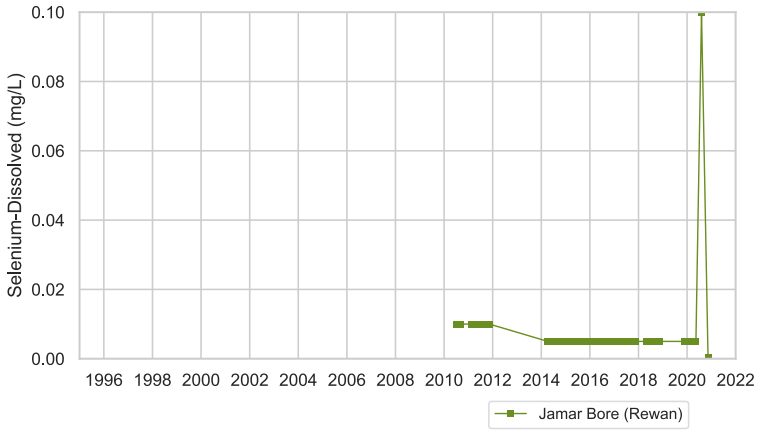

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

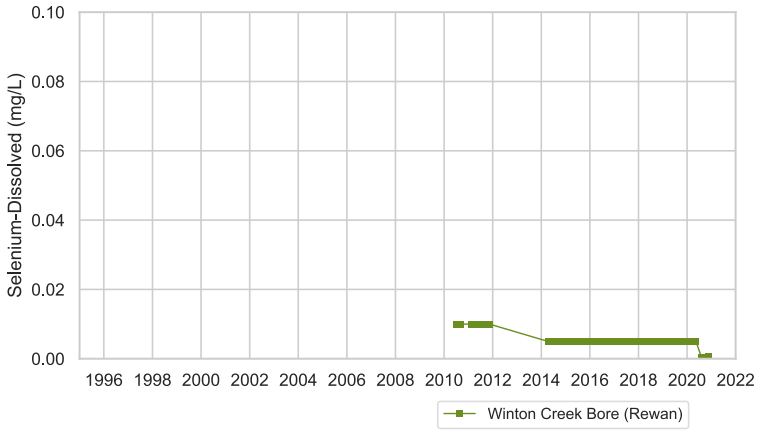

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

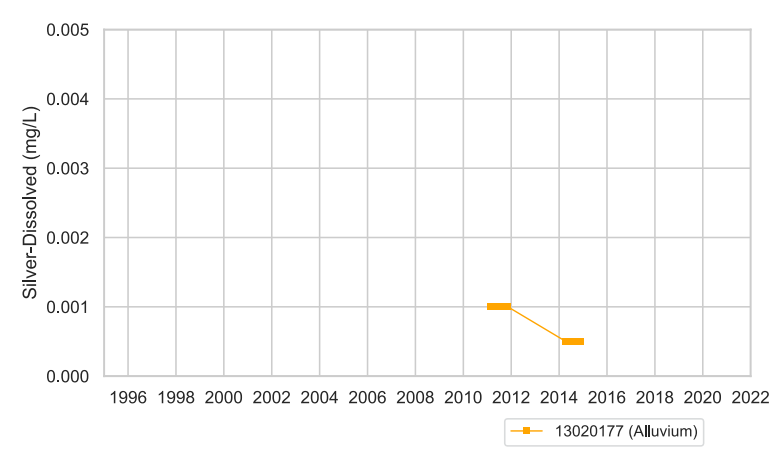

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

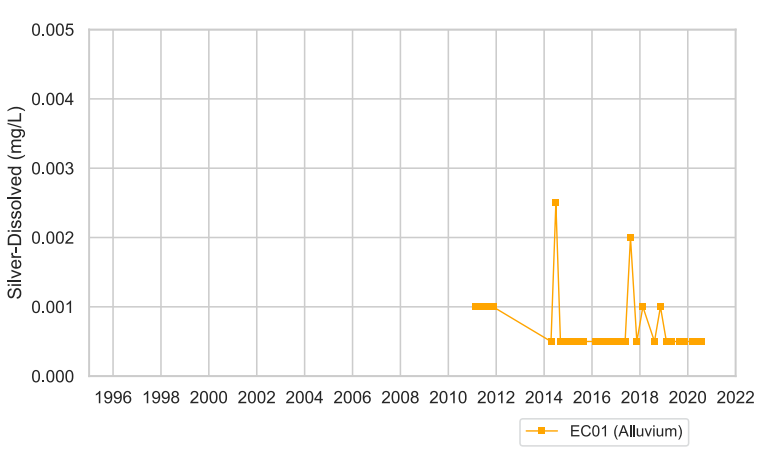

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

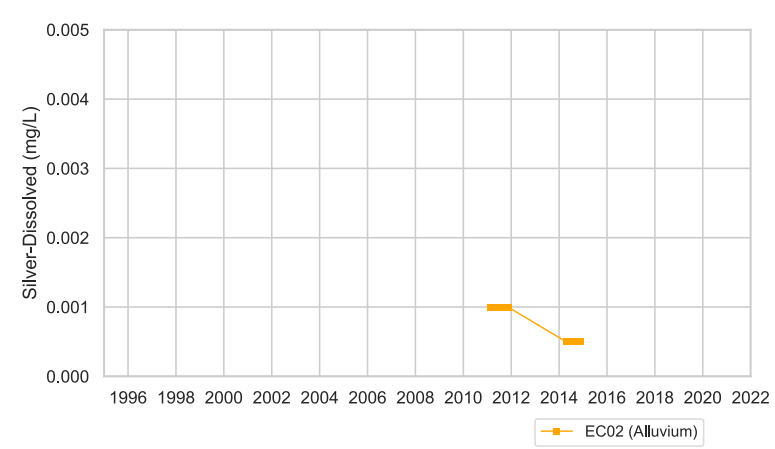

Selenium-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

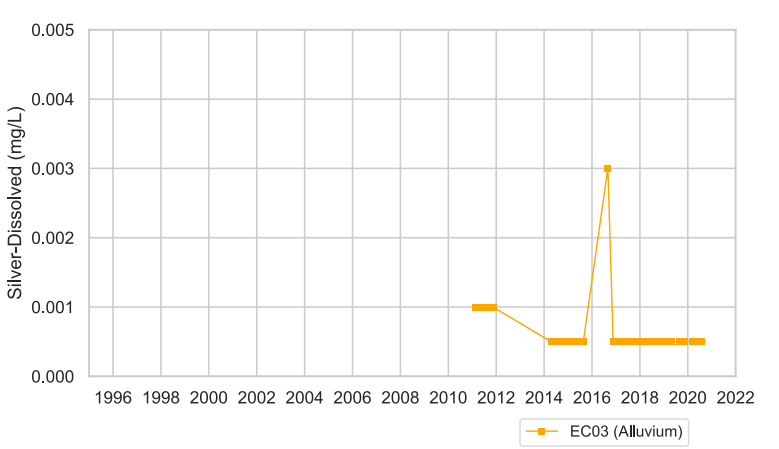

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

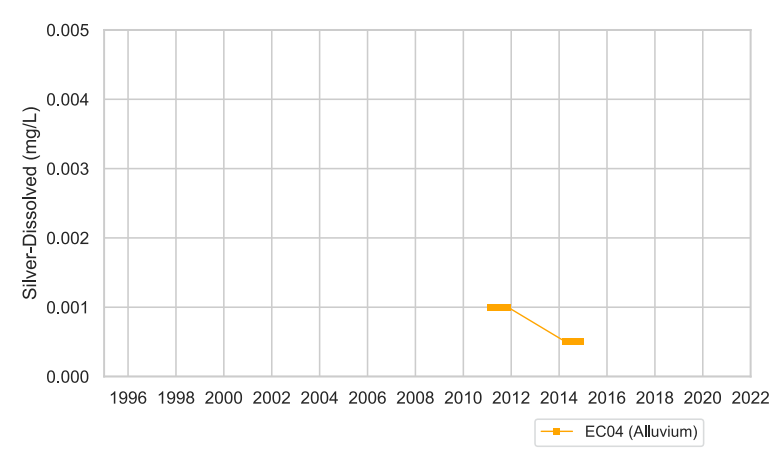

Selenium-Dissolved (mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

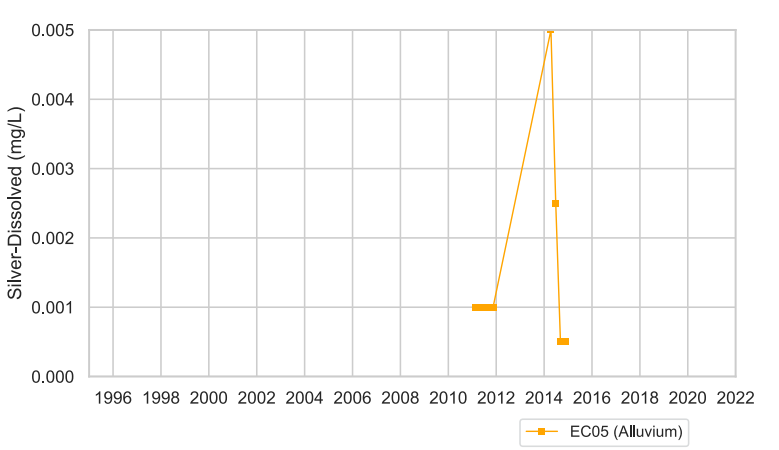

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

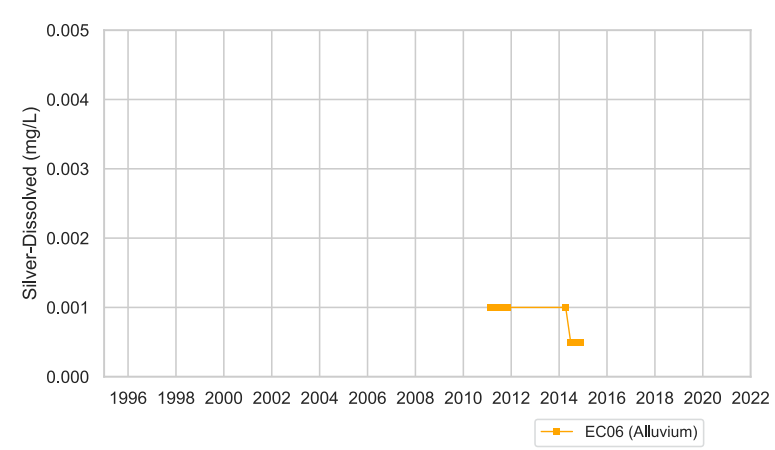

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

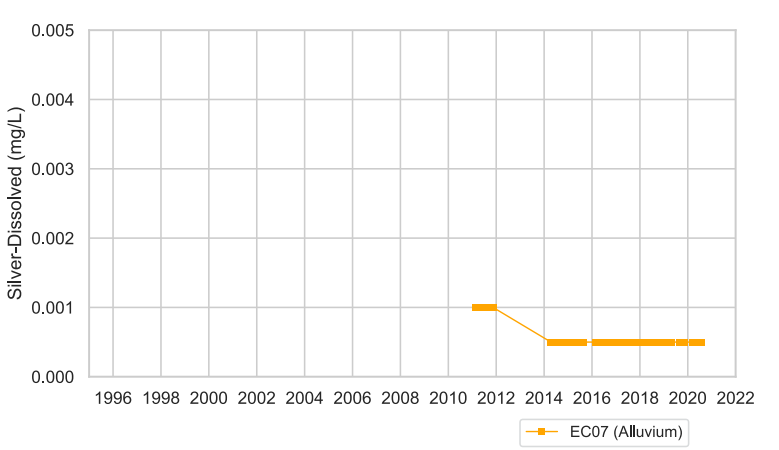

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

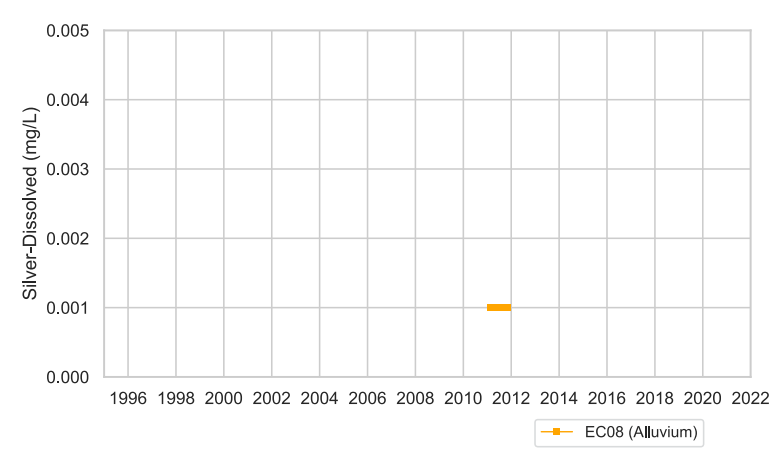

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

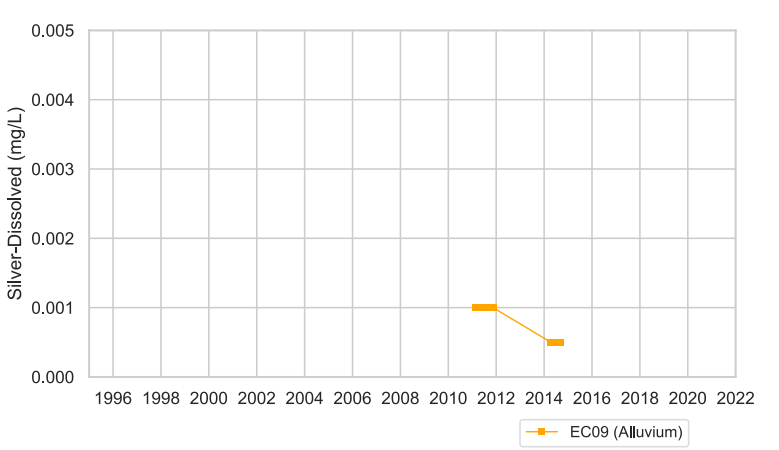

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

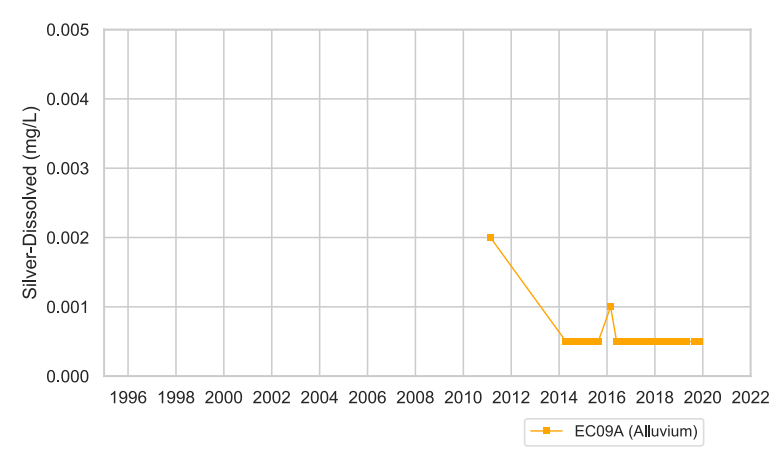

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

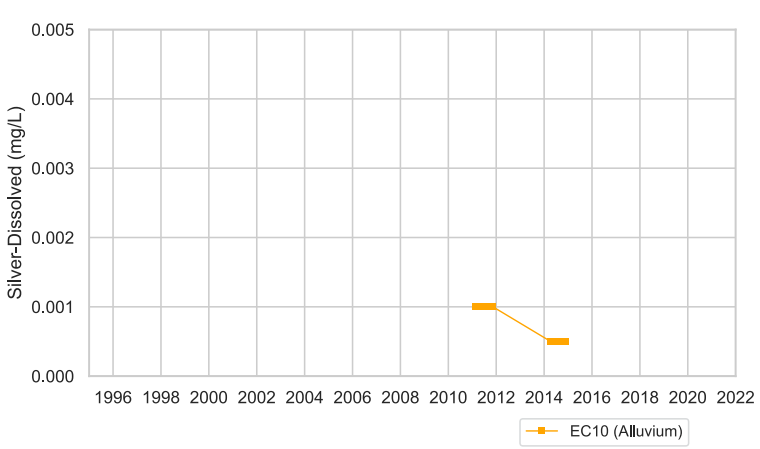

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

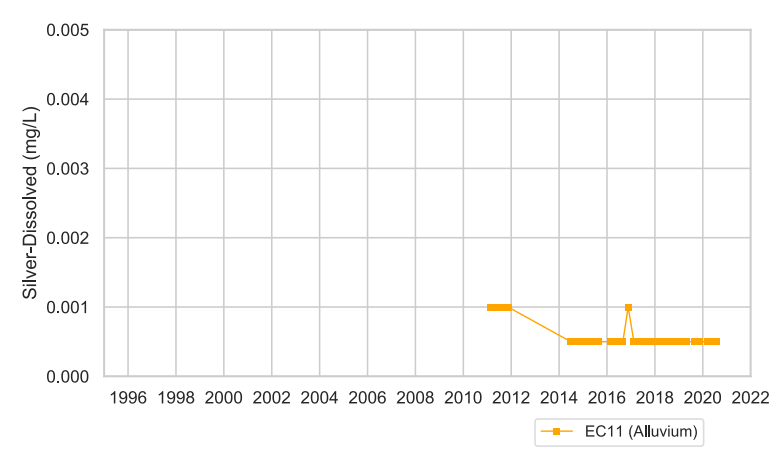

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

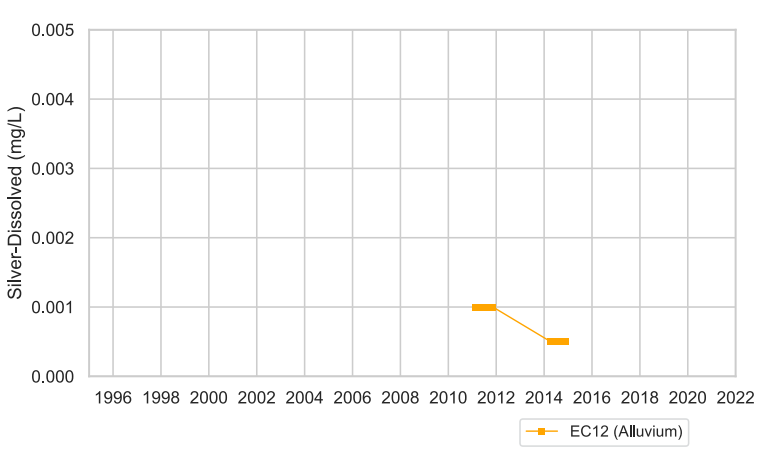

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC08 (Alluvium)

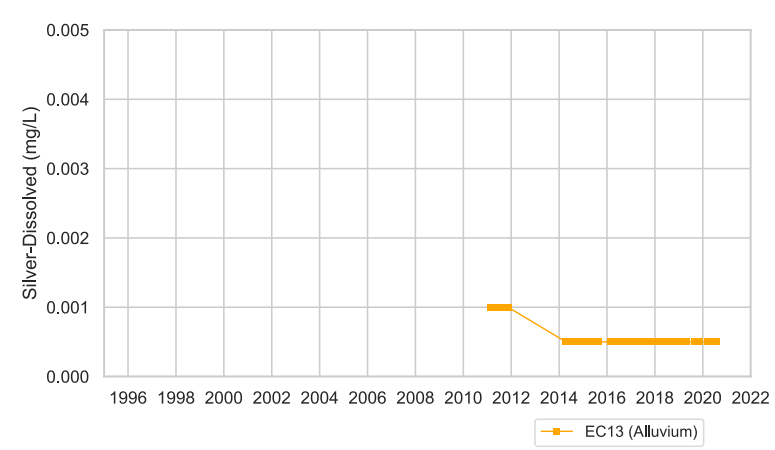

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

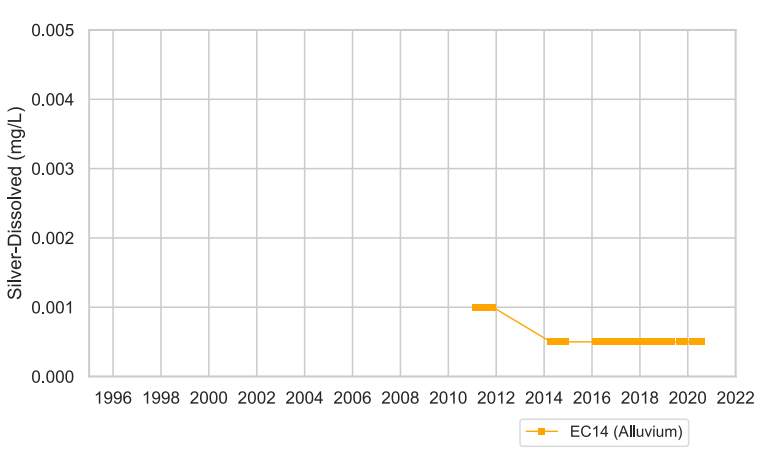

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

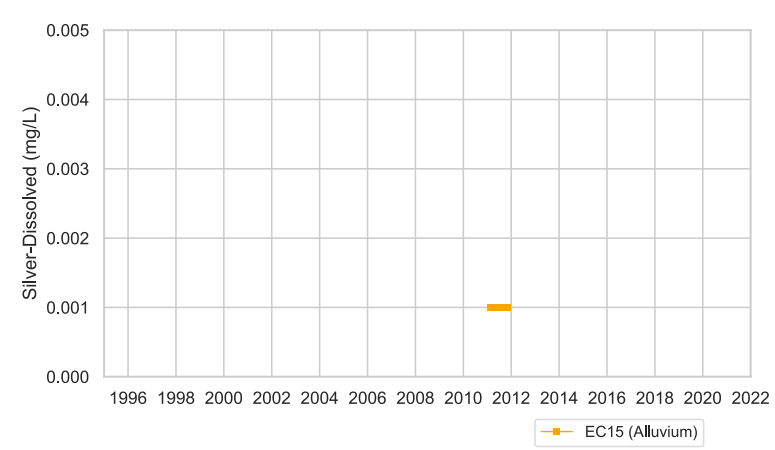

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

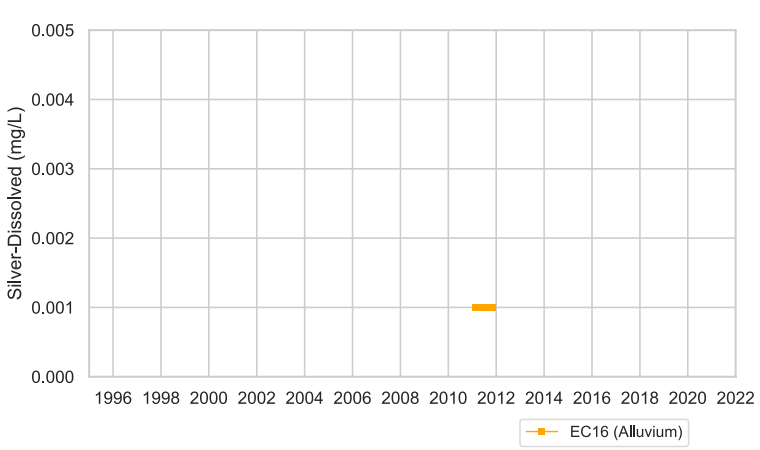

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

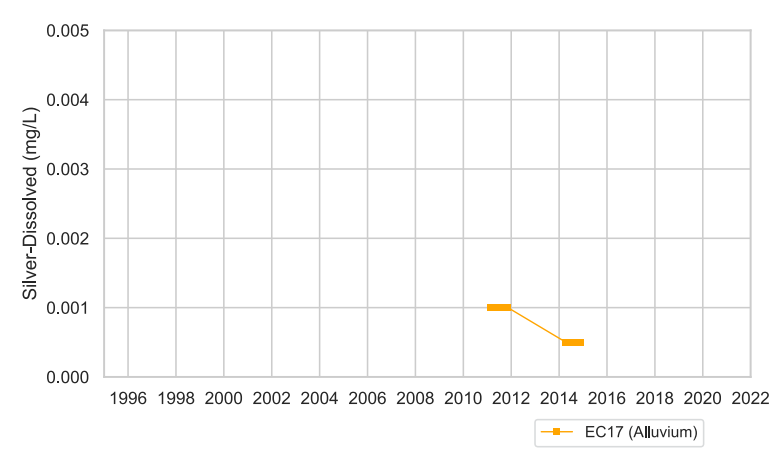

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

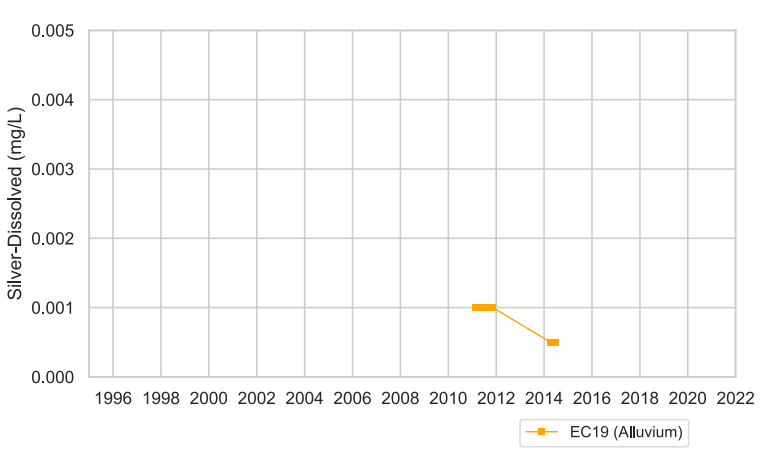

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

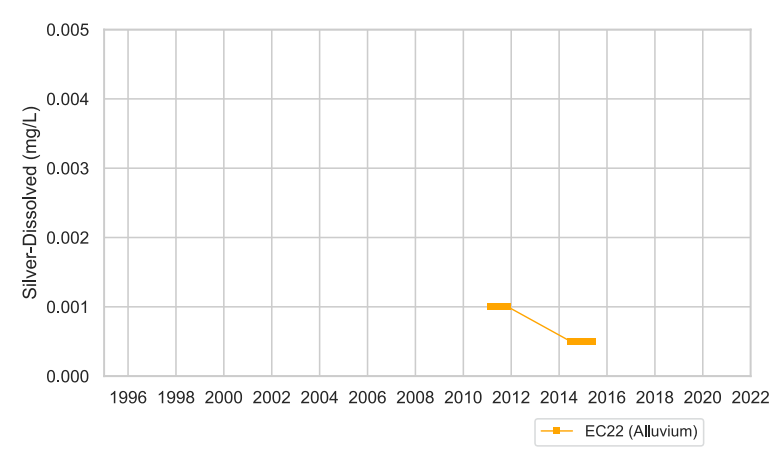

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

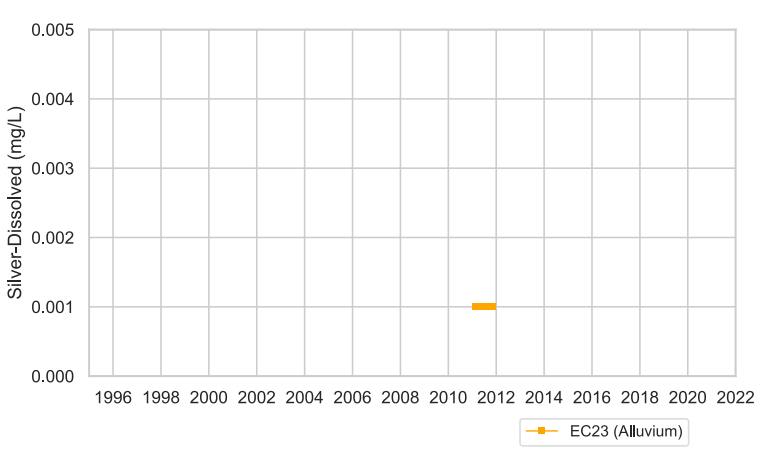

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC15 (Alluvium)

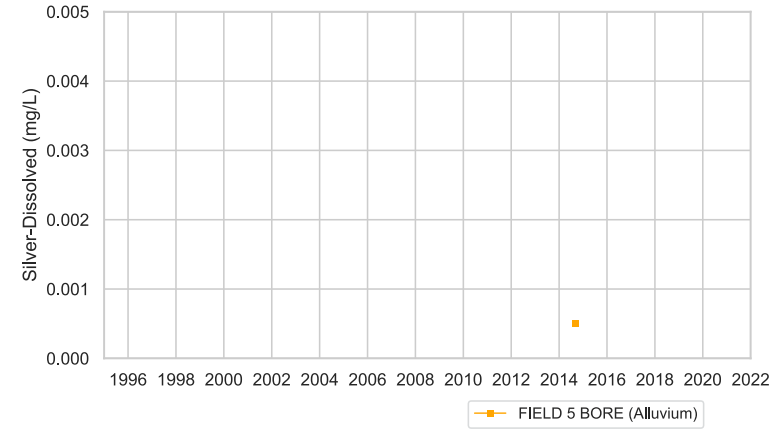

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC16 (Alluvium)

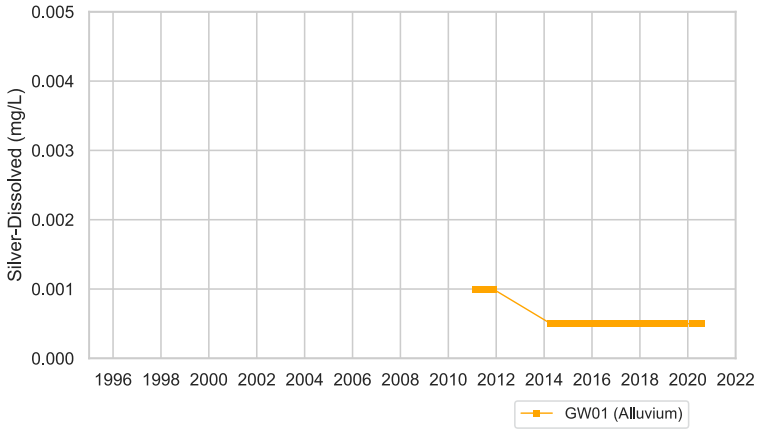

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

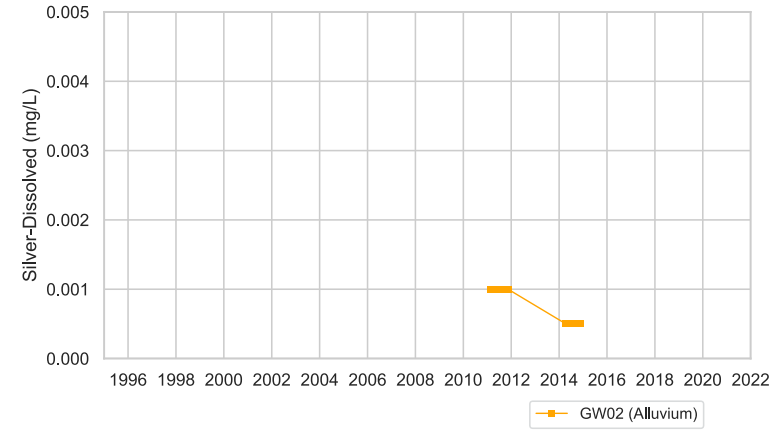

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

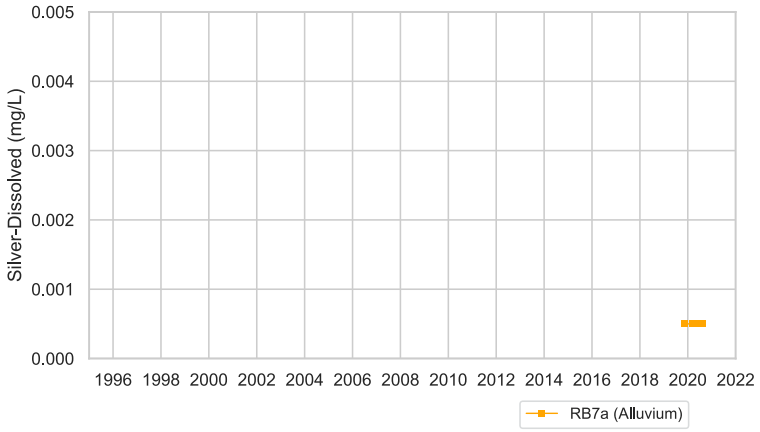

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

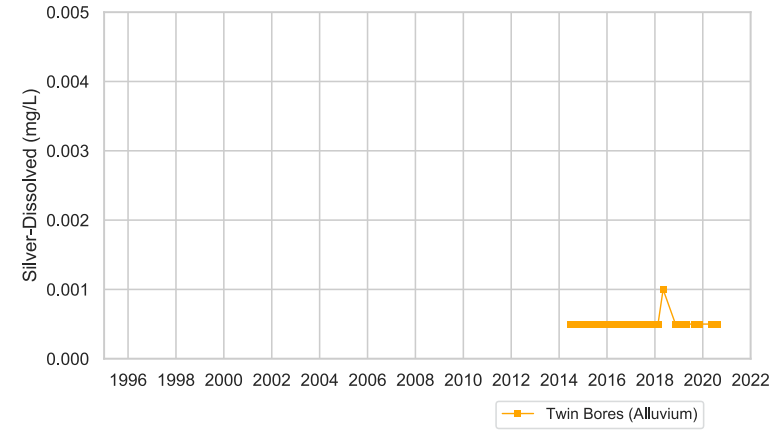

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC23 (Alluvium)

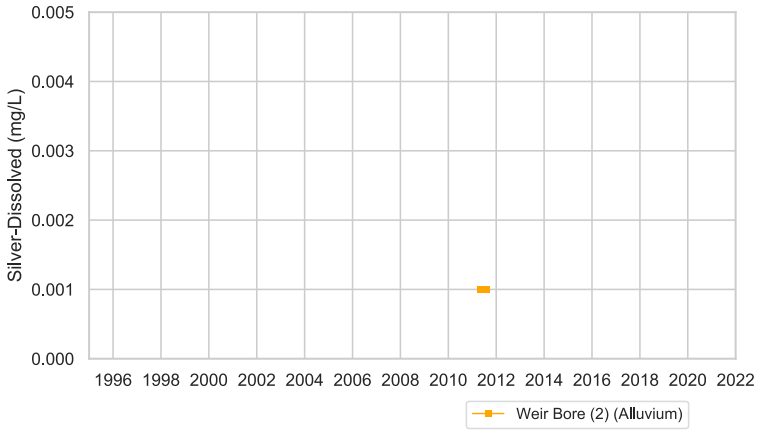

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

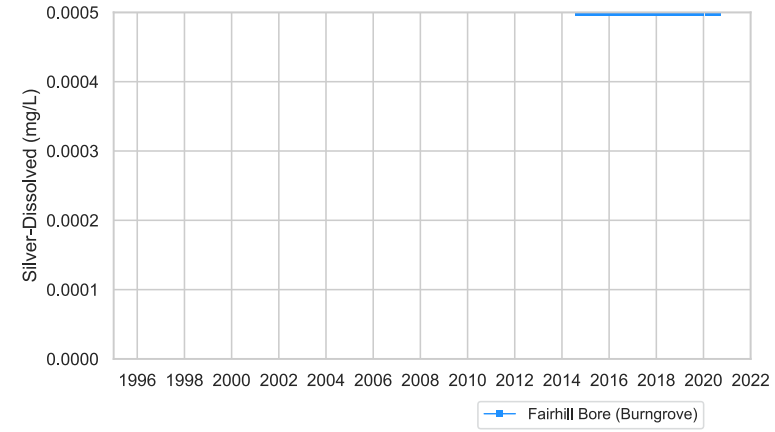

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

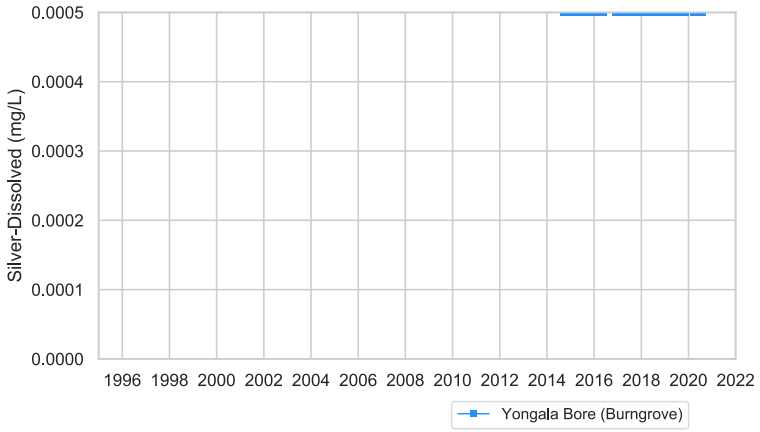

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

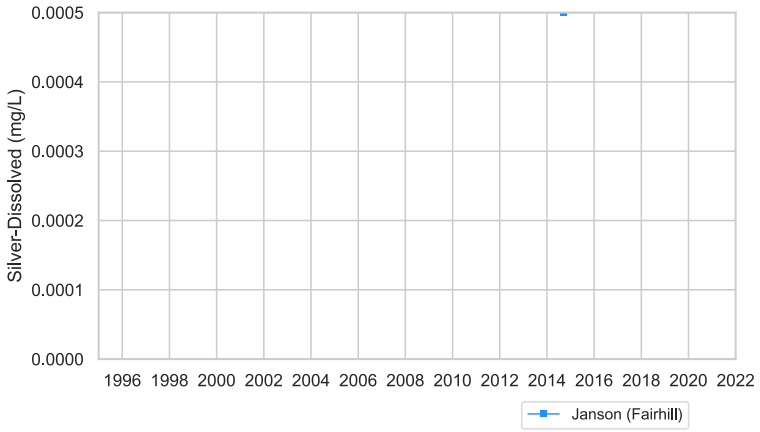

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

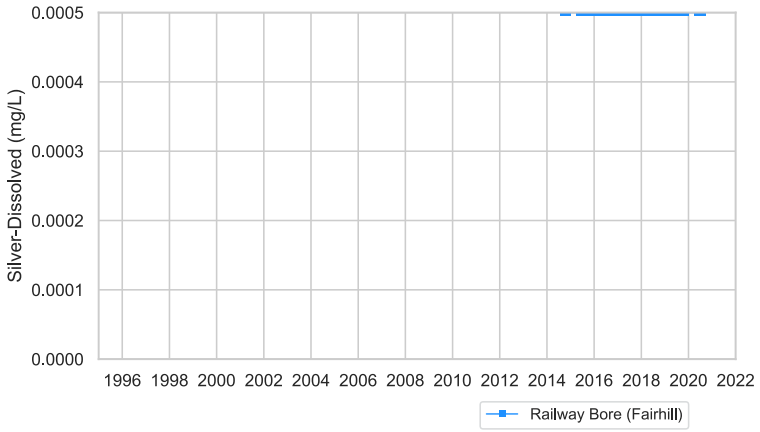

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

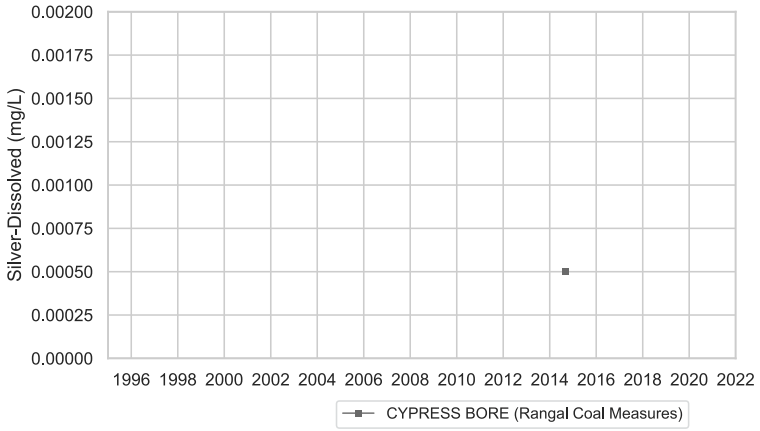

Silver-Dissolved (mg/L)
0.005
0.004
0.003
0.002
0.001
0.000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Weir Bore (2) (Alluvium)

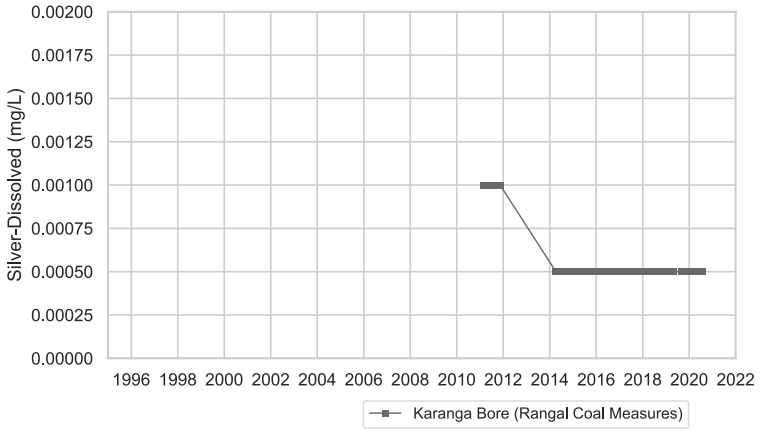

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

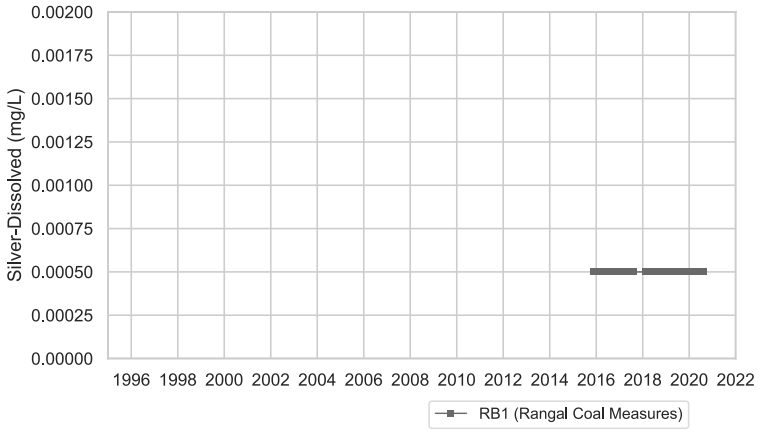

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

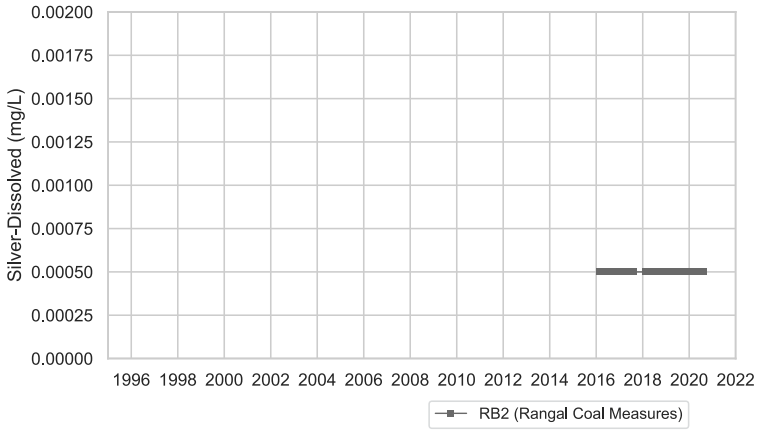

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

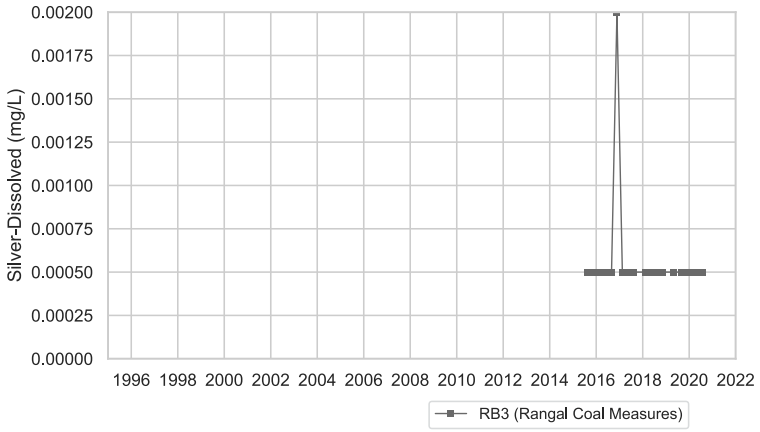

Silver-Dissolved (mg/L)
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

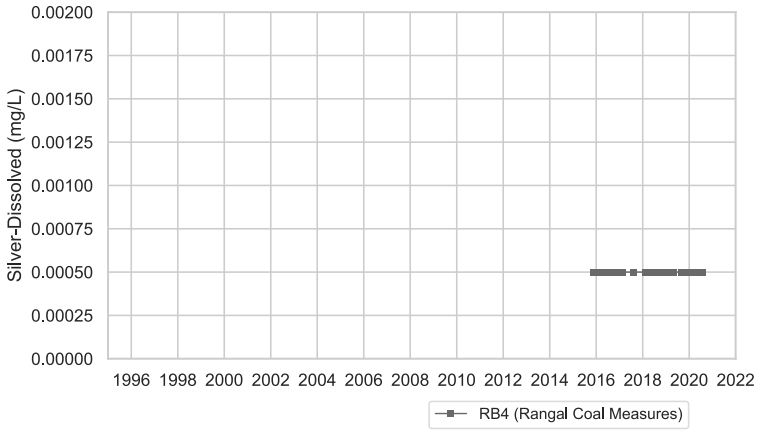

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

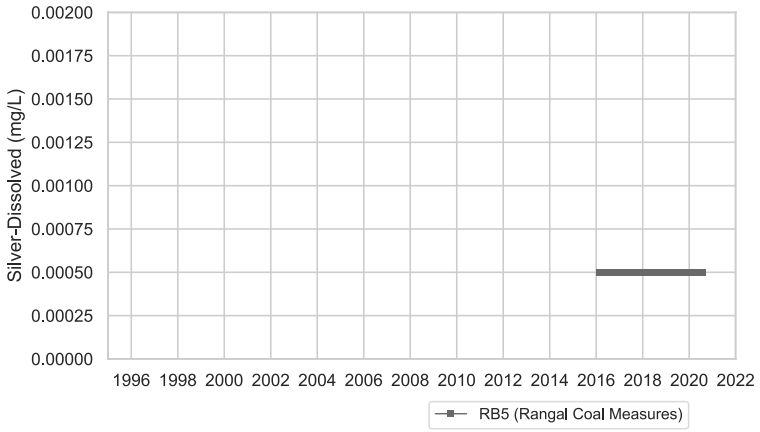

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

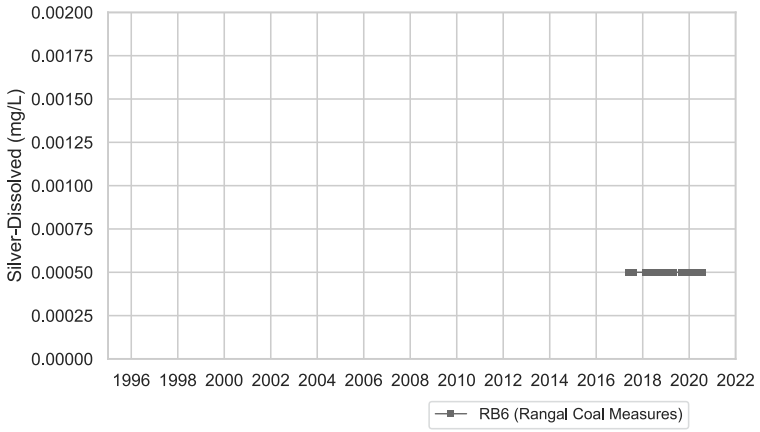

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

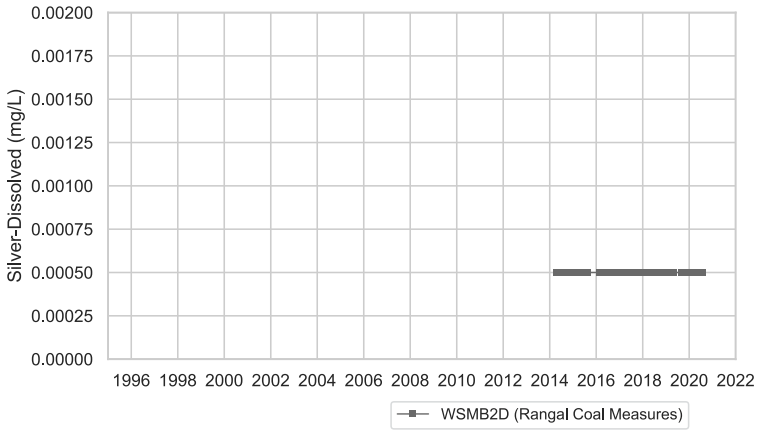

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

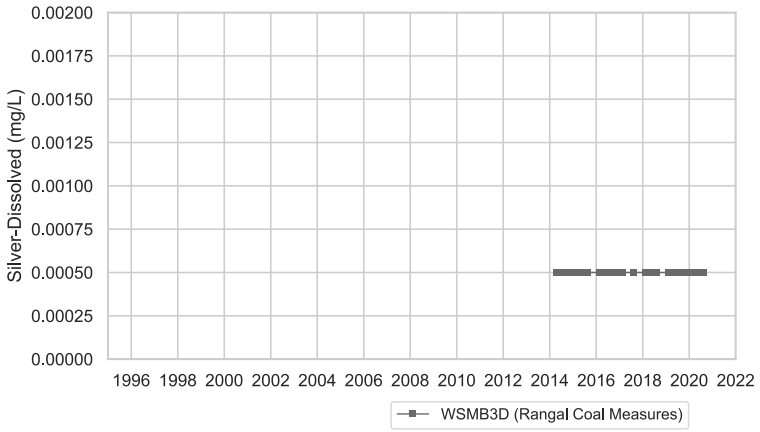

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

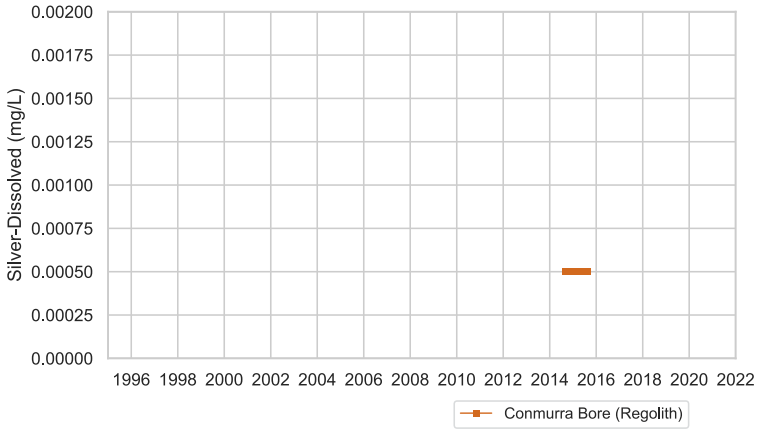

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

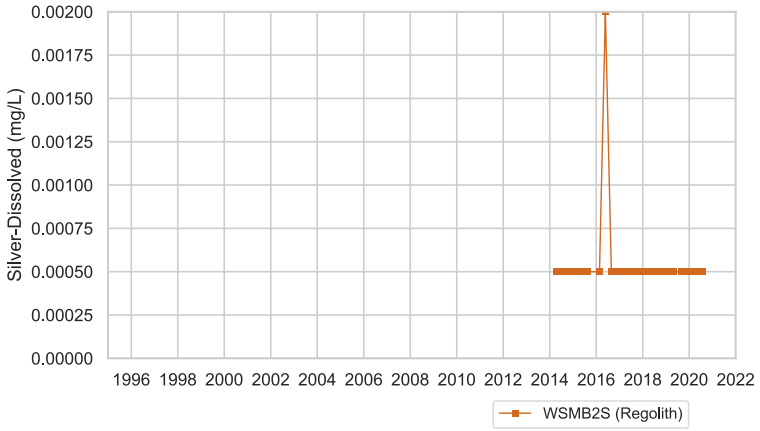

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)


Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

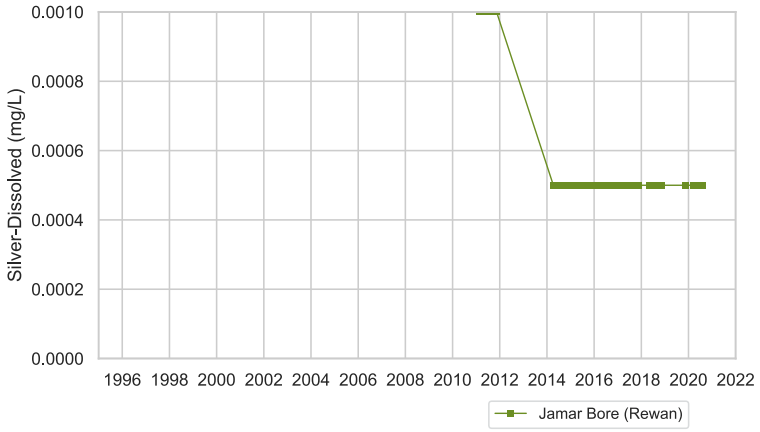

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)


Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

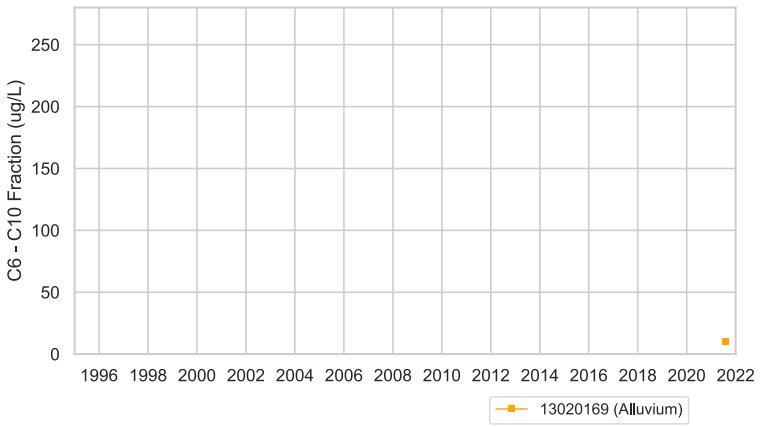

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

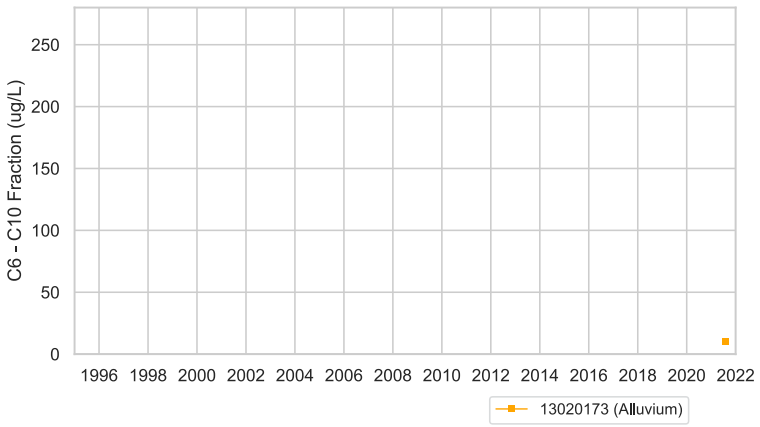

Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

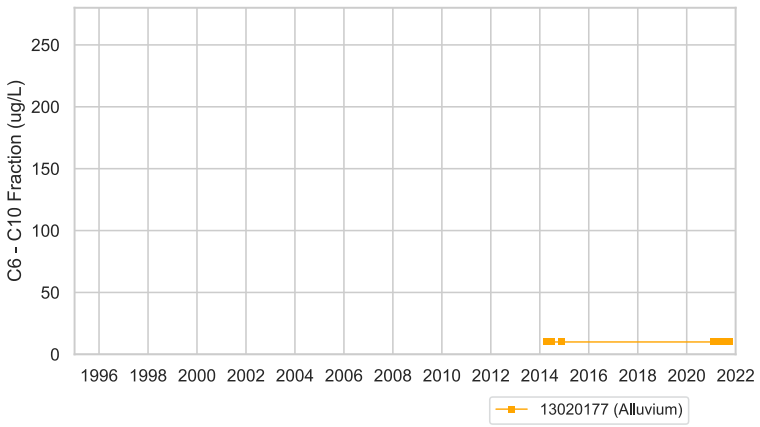
Silver-Dissolved (mg/L)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

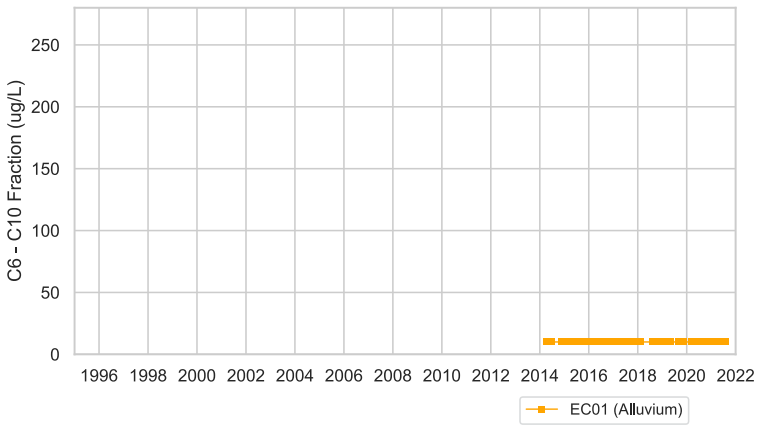

Silver-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

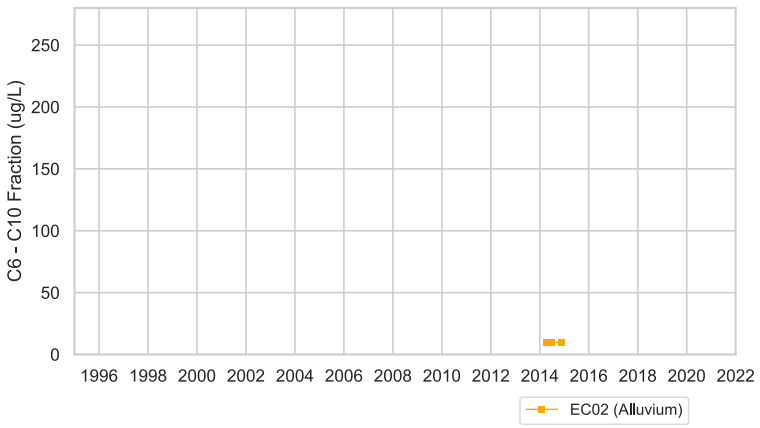
Silver-Dissolved (mg/L)
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

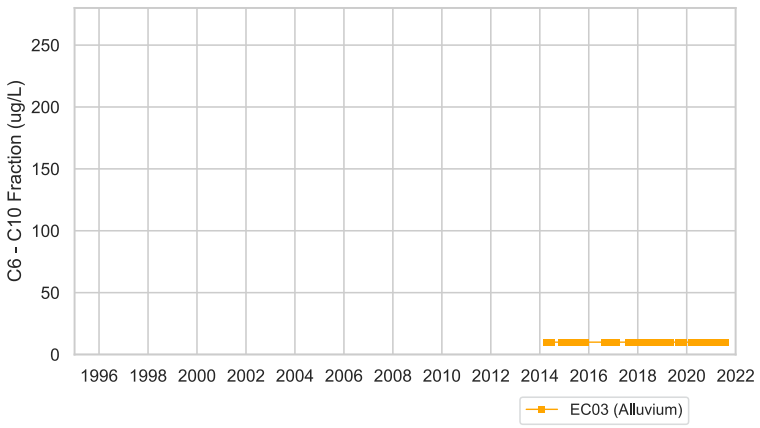

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

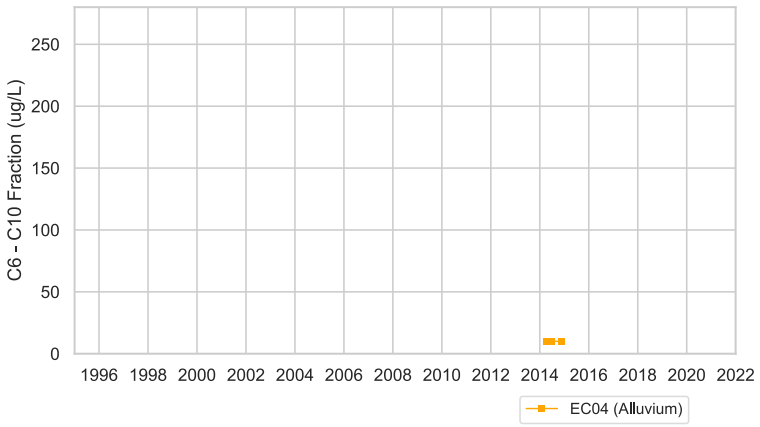

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

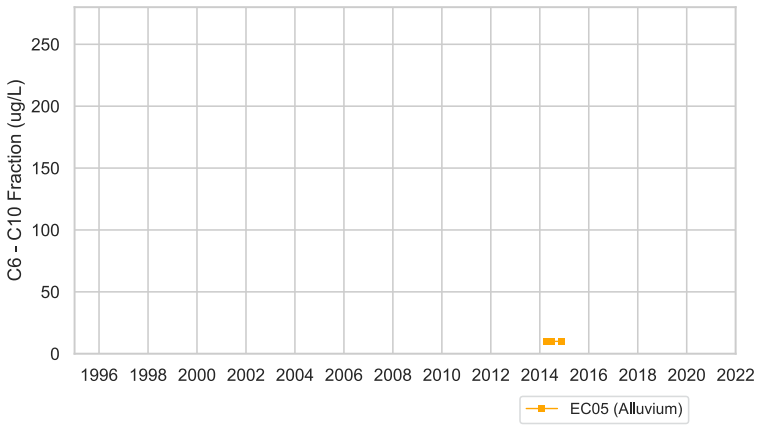

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

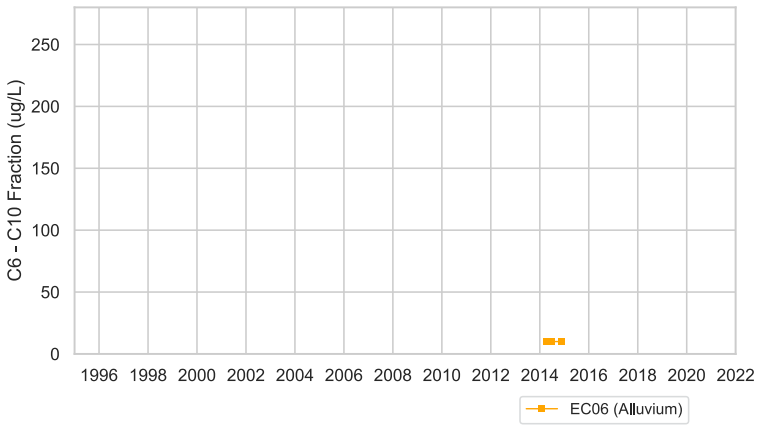

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

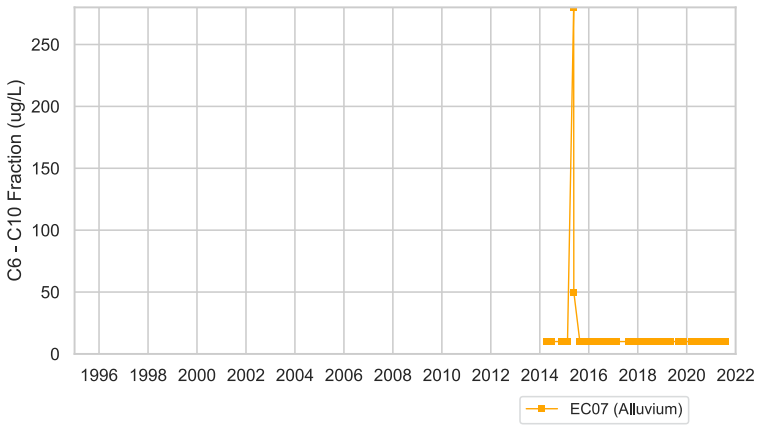

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

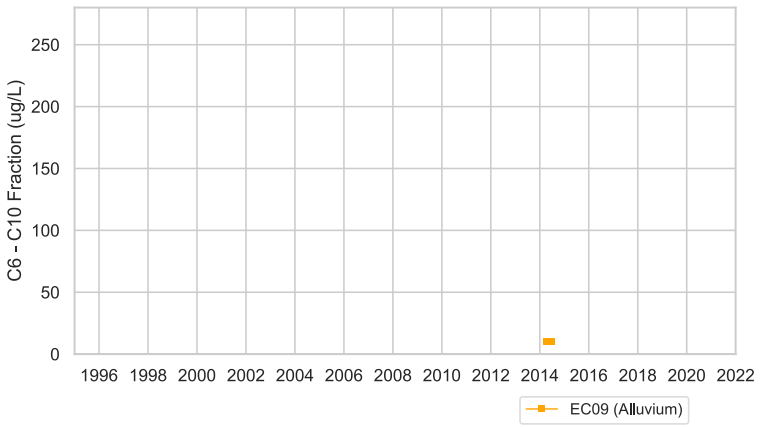

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

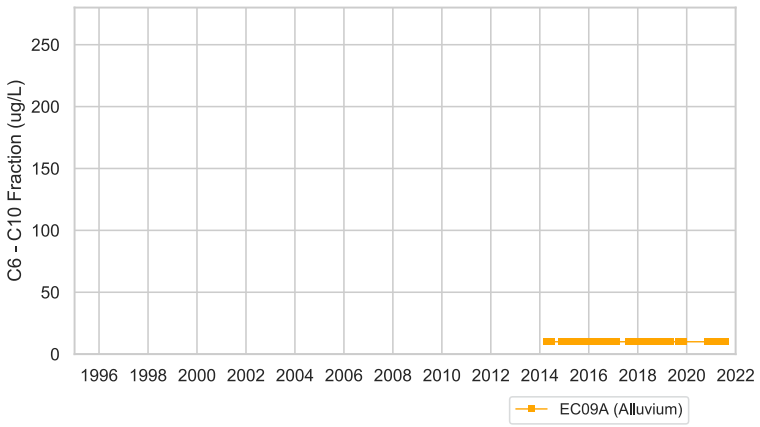

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

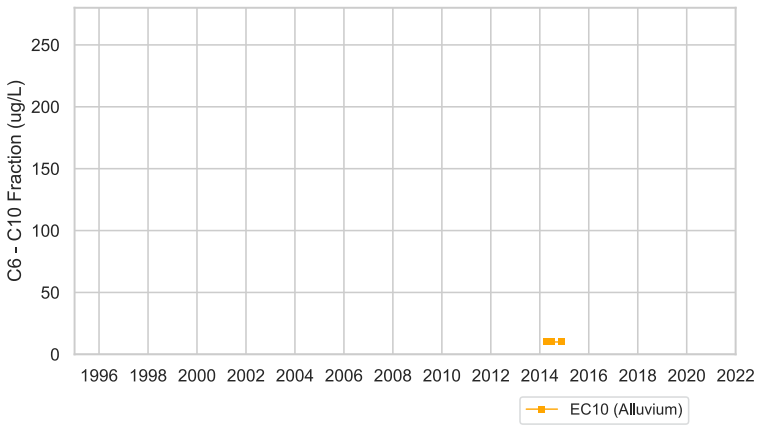

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

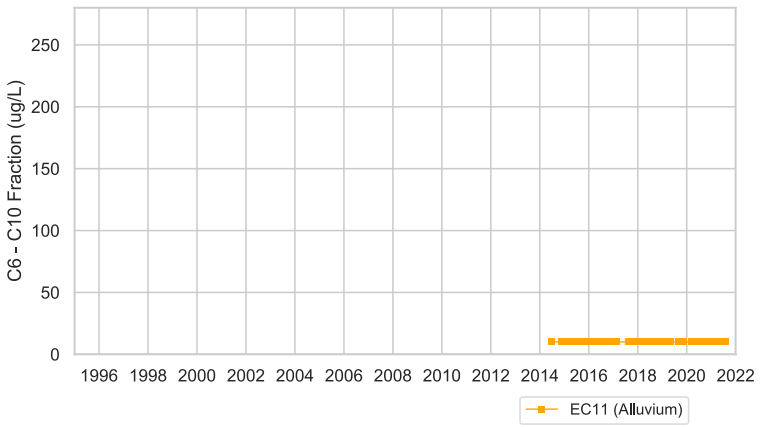

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

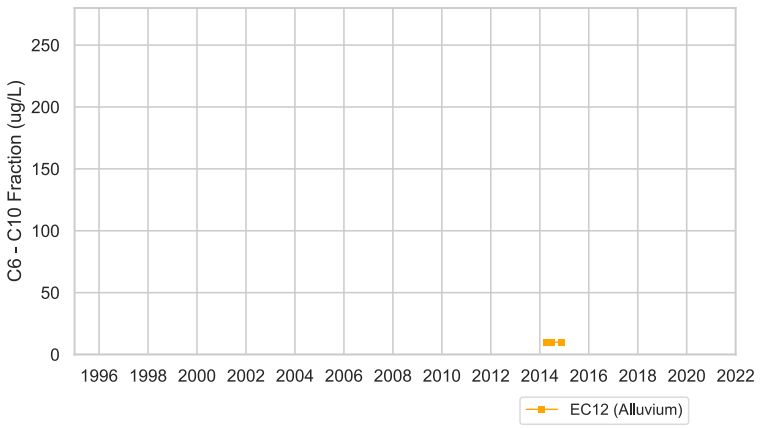

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

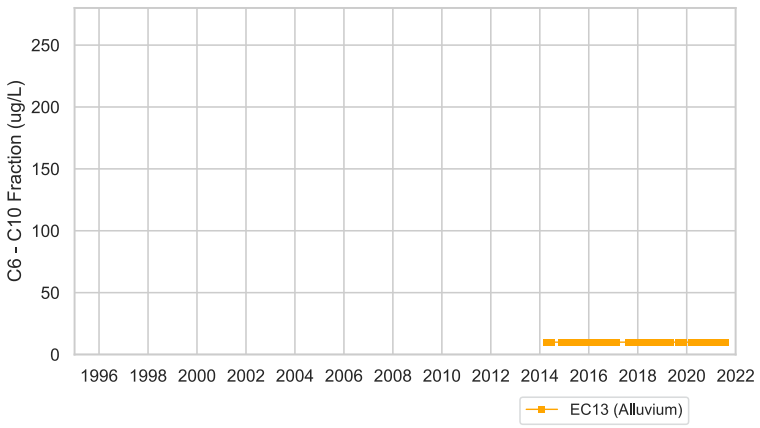

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

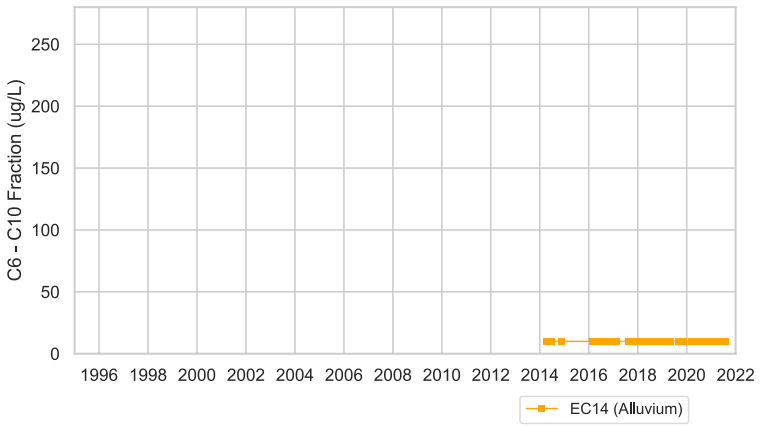

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

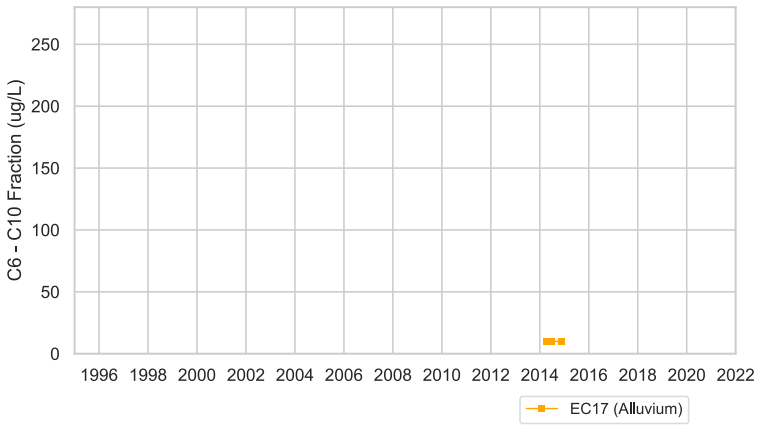

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

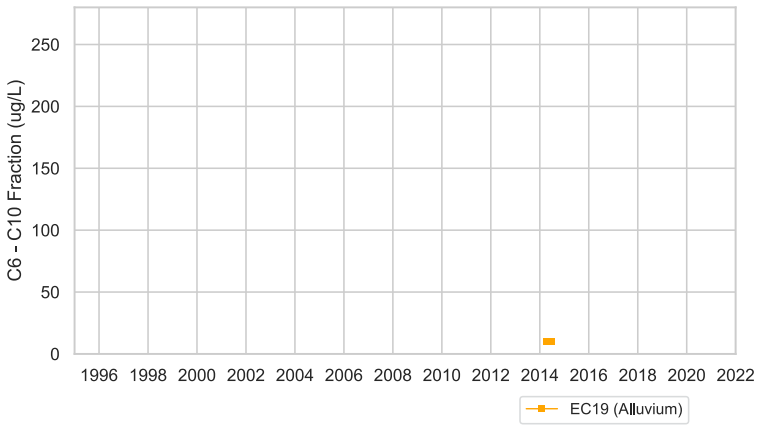

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

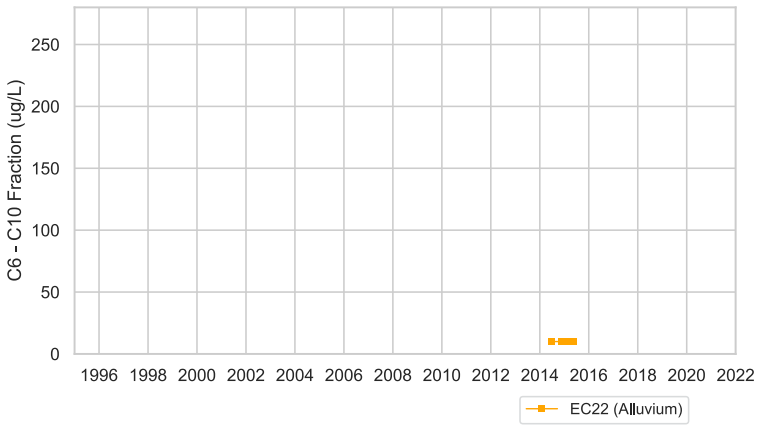

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

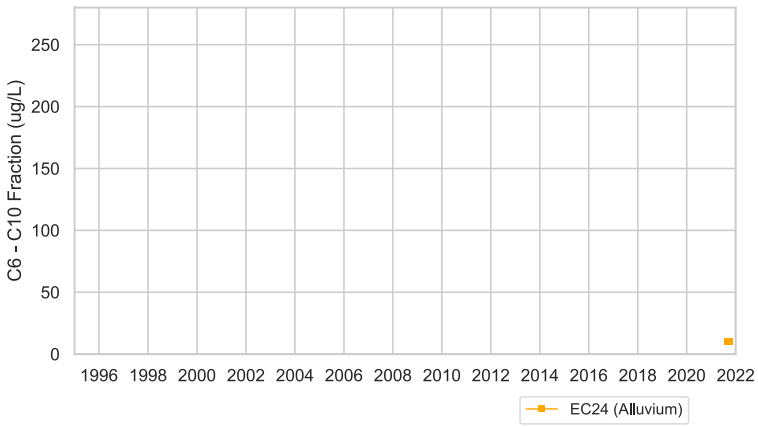

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

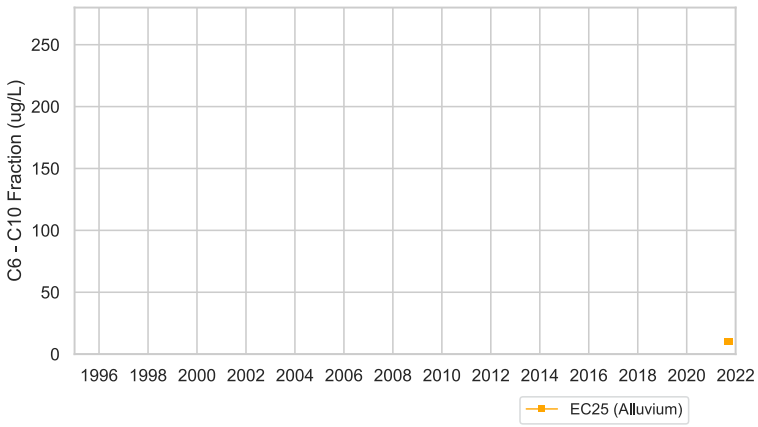

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

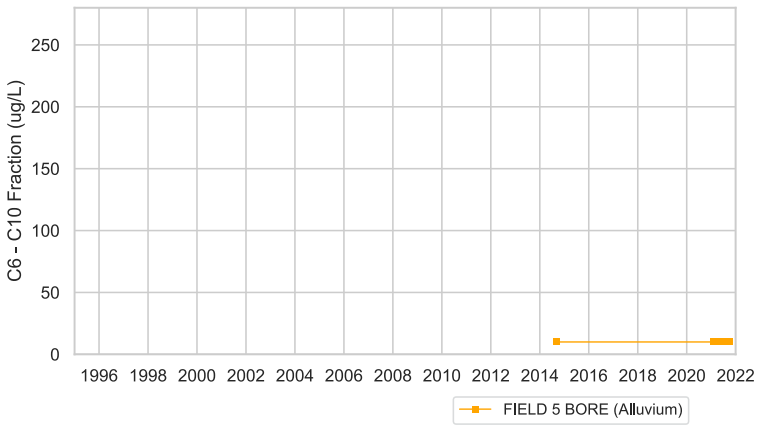

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

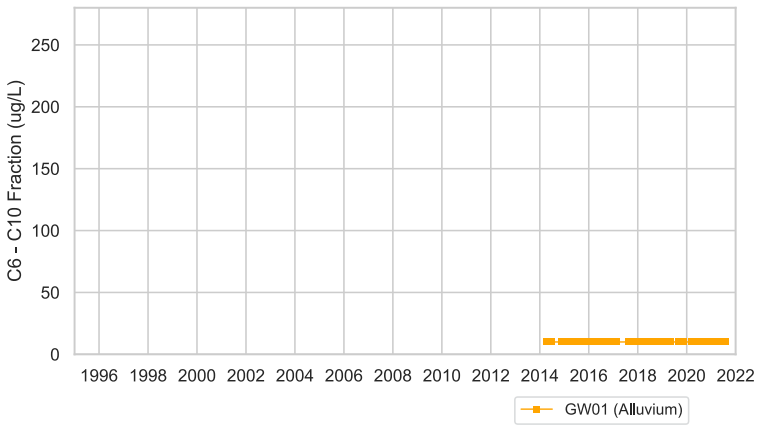

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

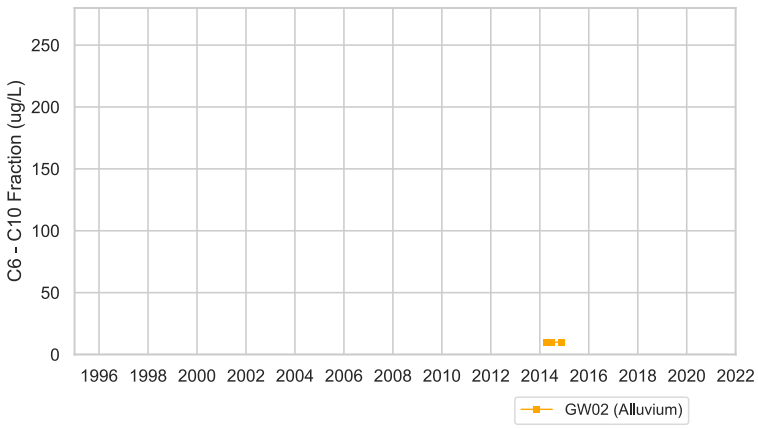

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

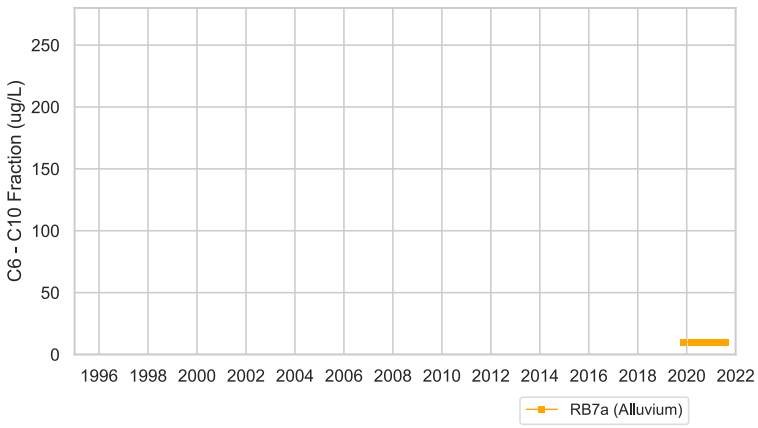

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

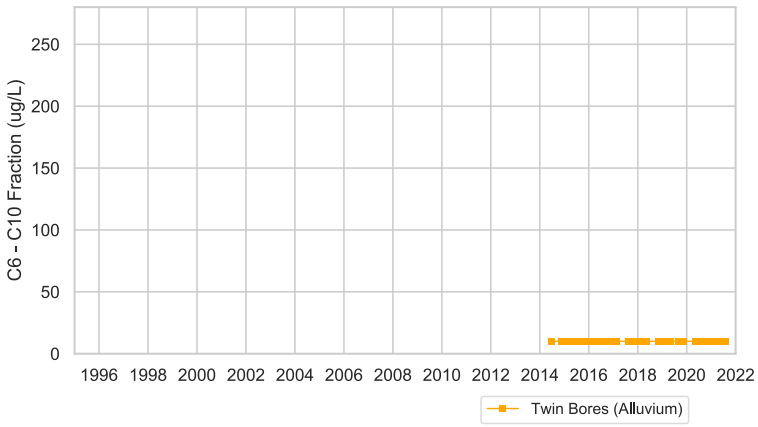

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

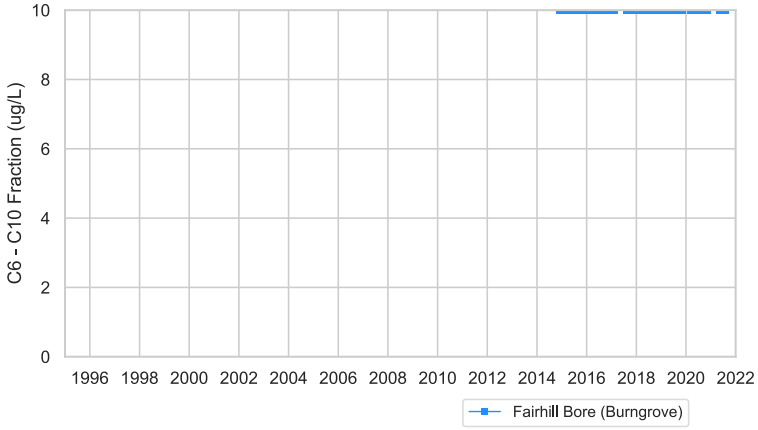

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

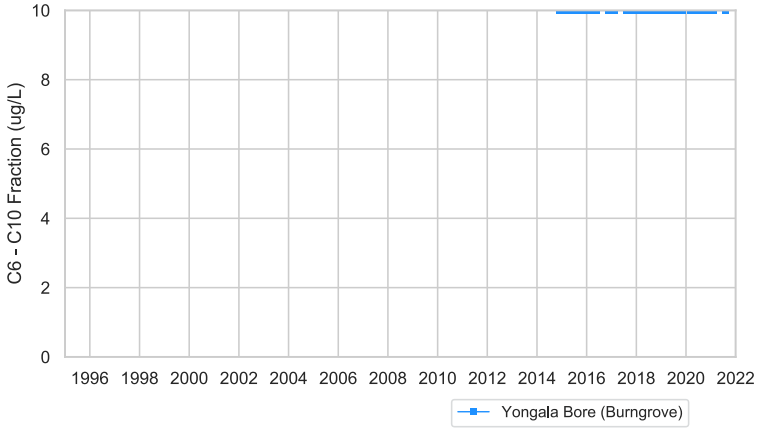

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

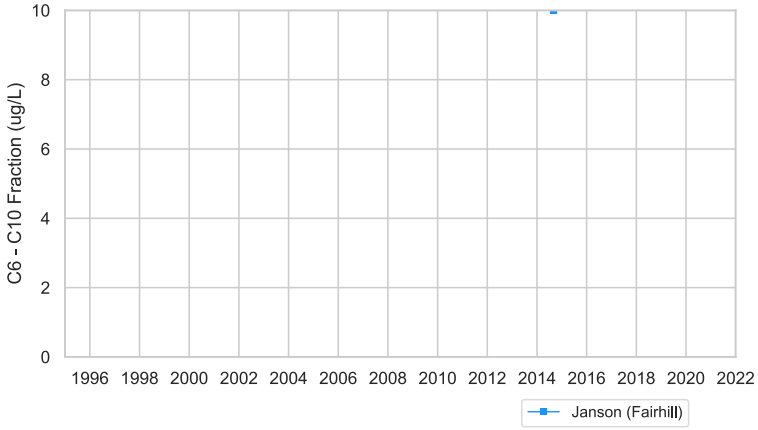

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

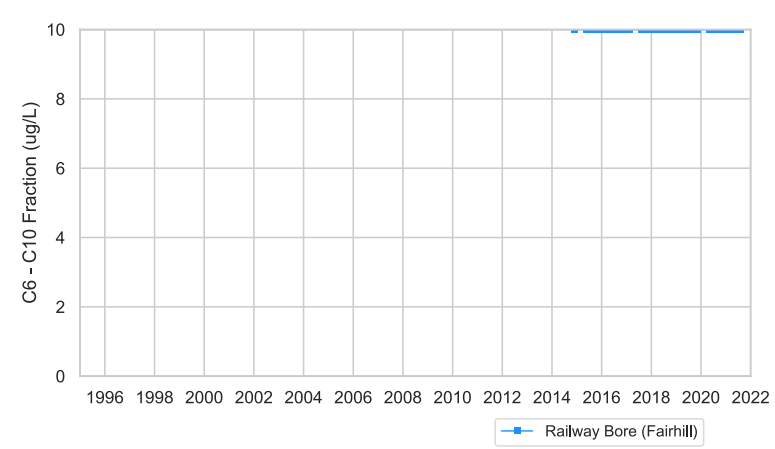

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

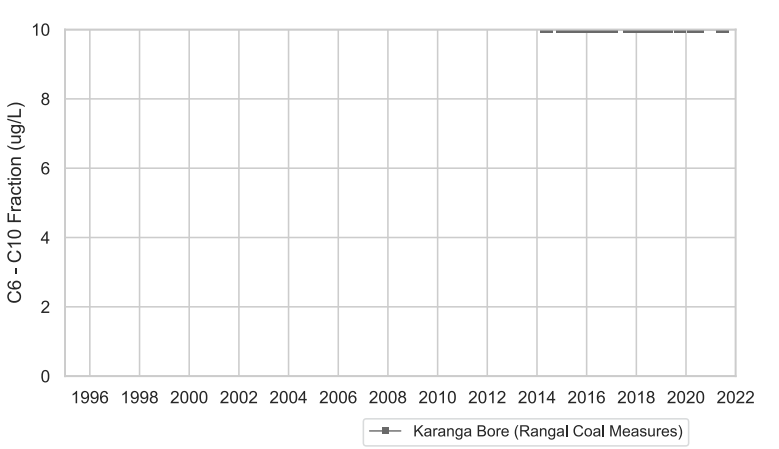

C6 - C10 Fraction (ug/L)
0
50
100
150
200
250
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

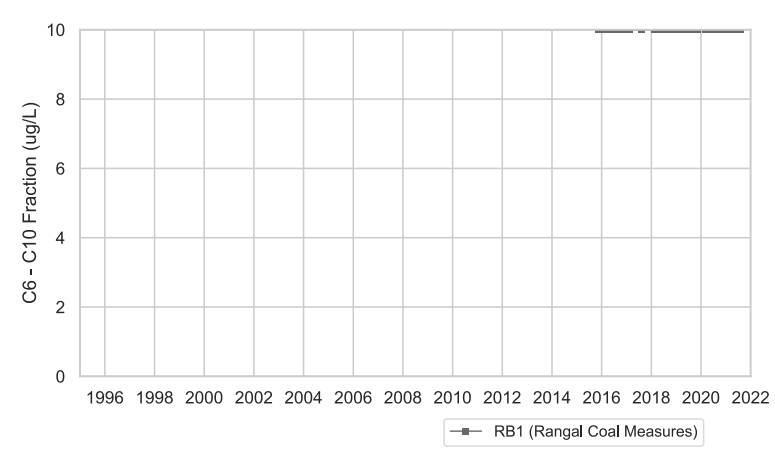

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

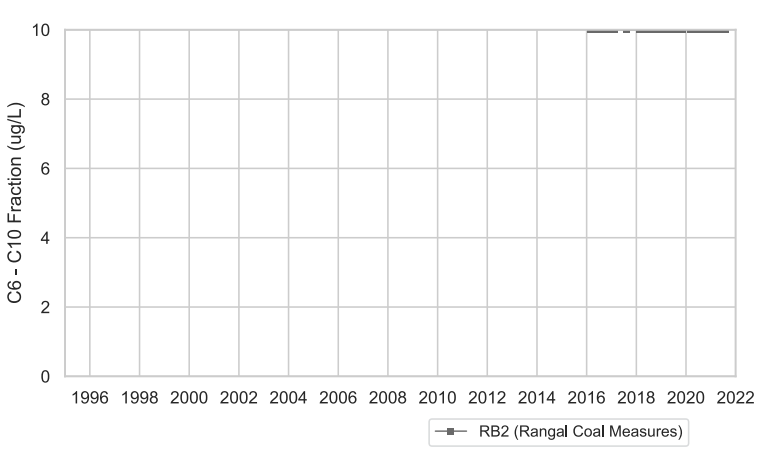

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

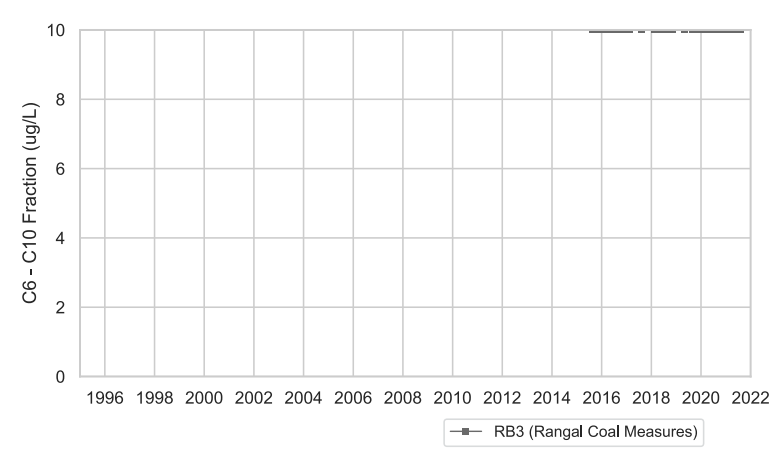

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

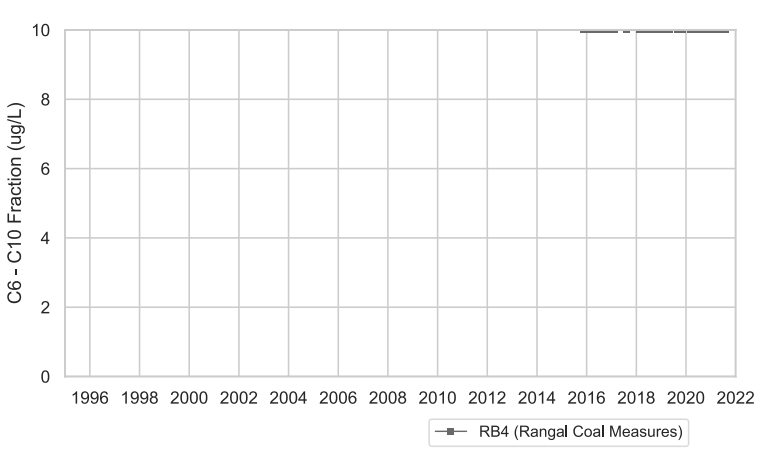

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

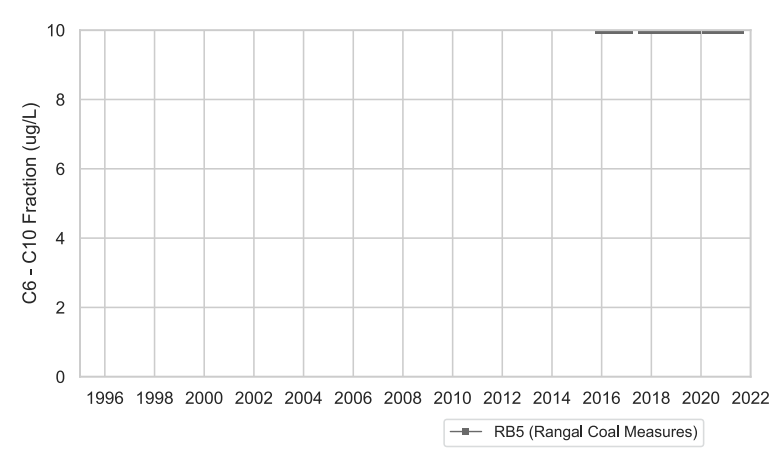

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

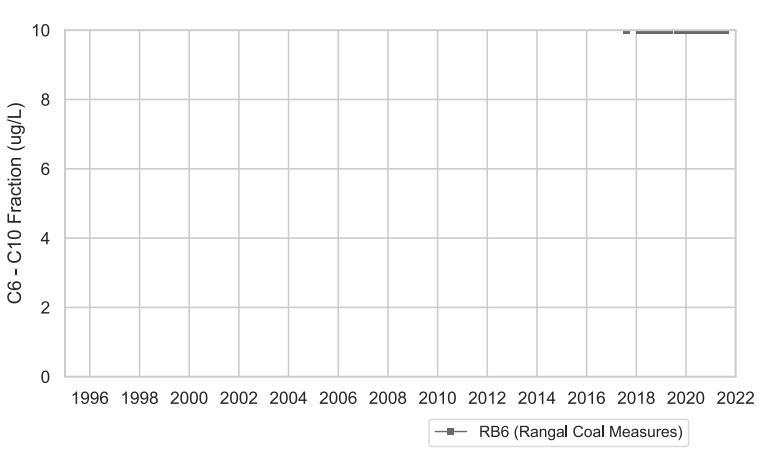

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

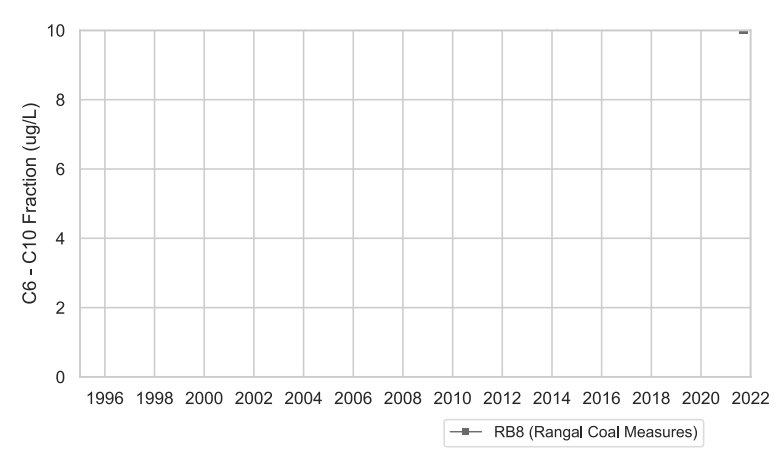

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

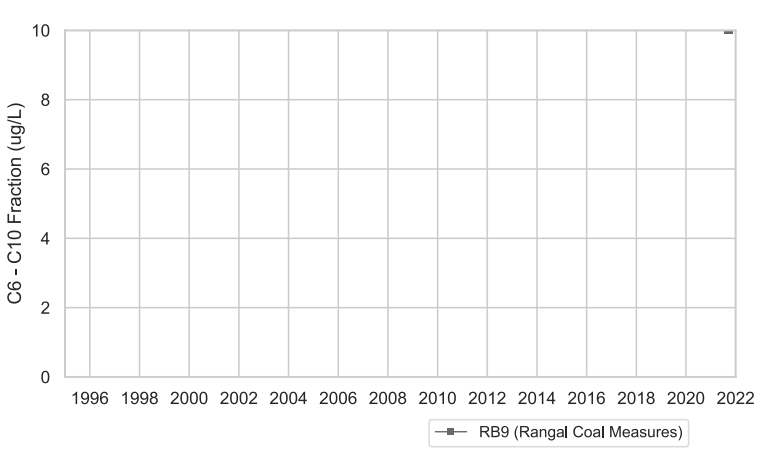

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

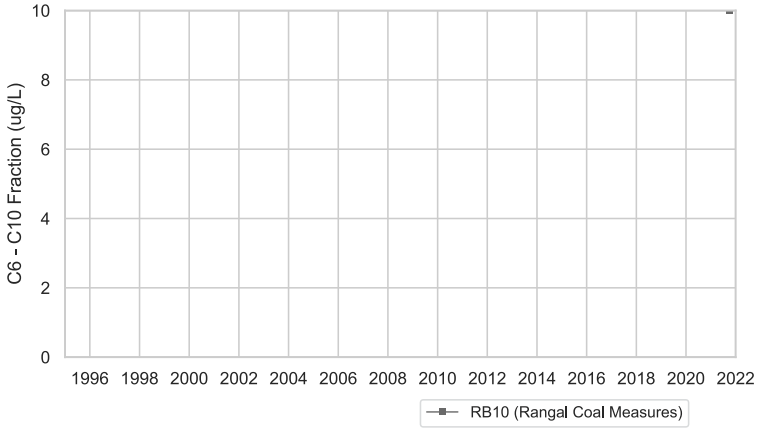

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

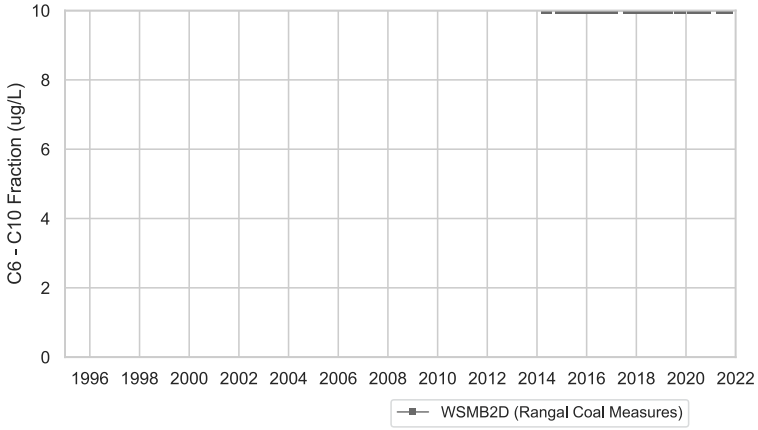

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

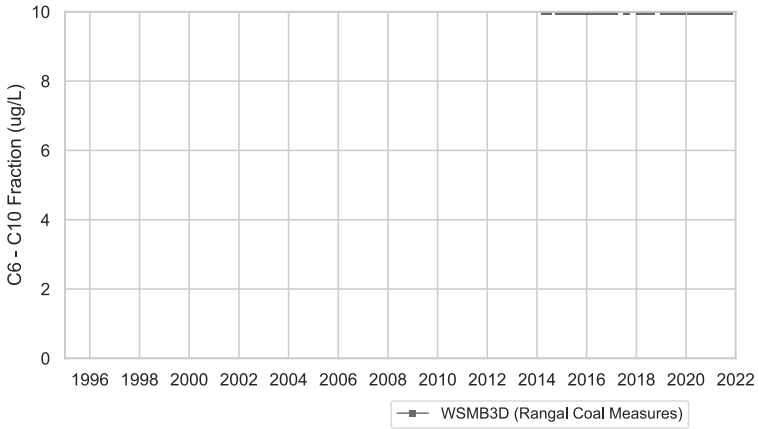

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

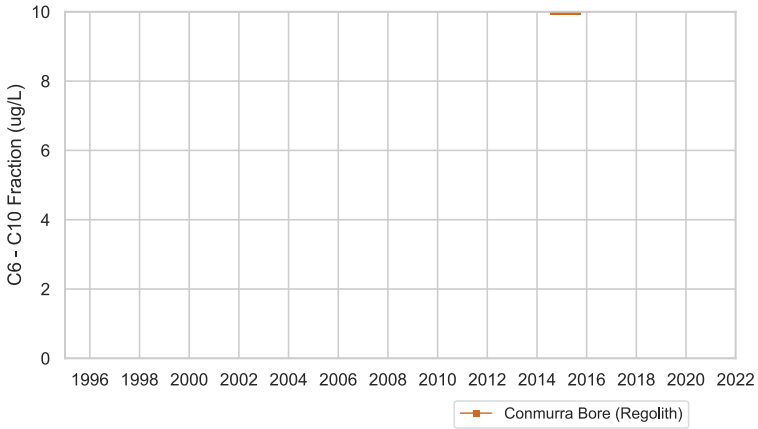

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

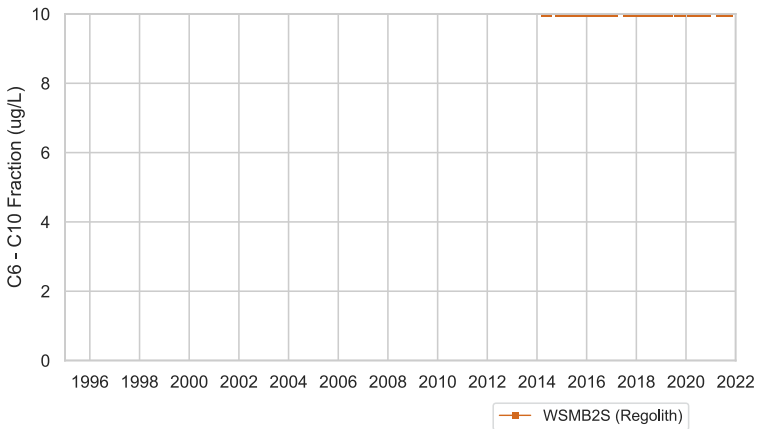

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

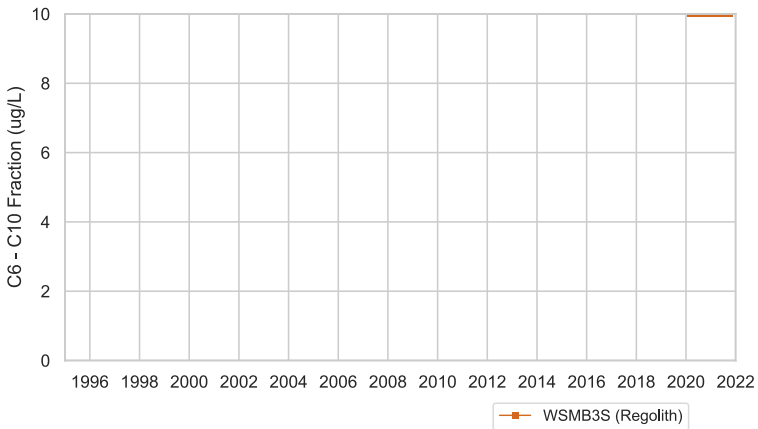

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

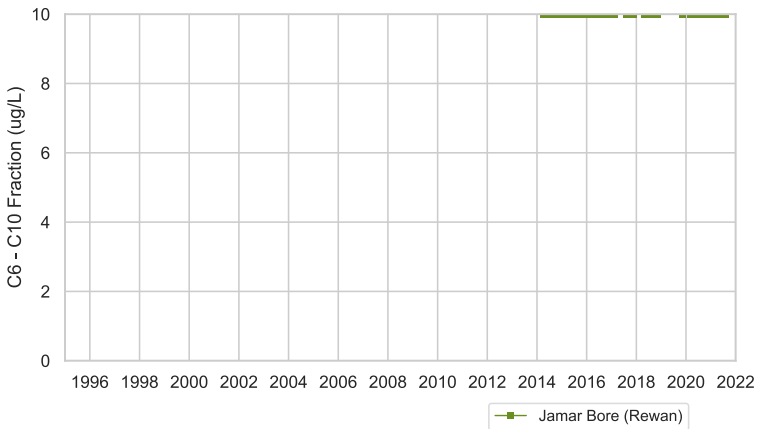

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

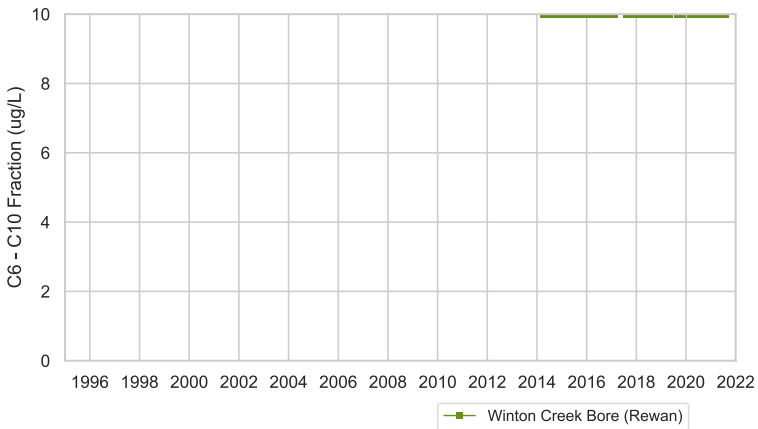

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)

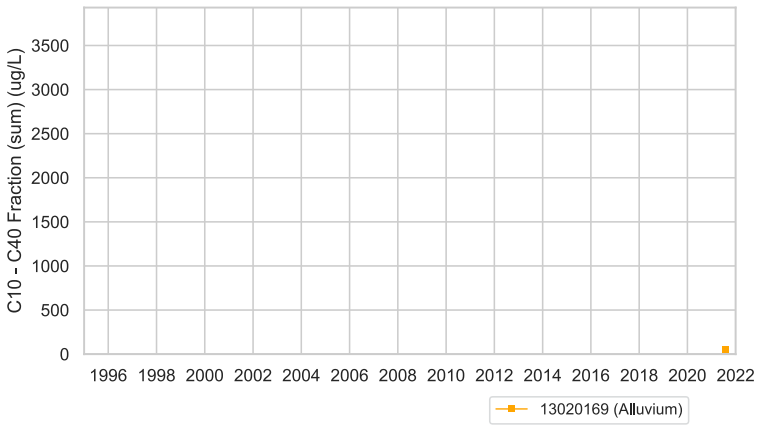

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)

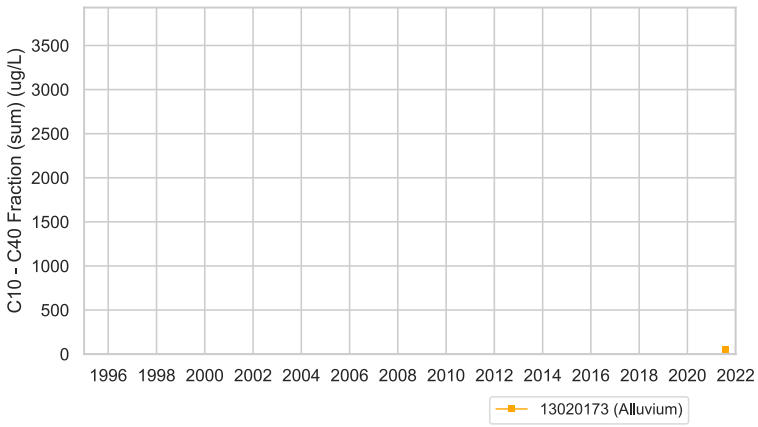

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

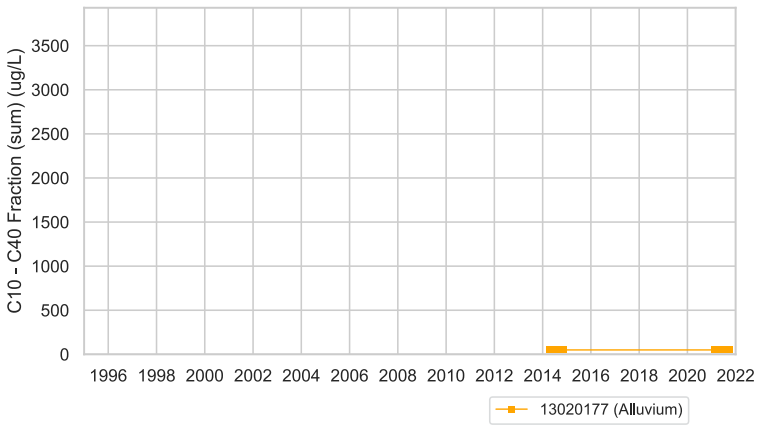

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

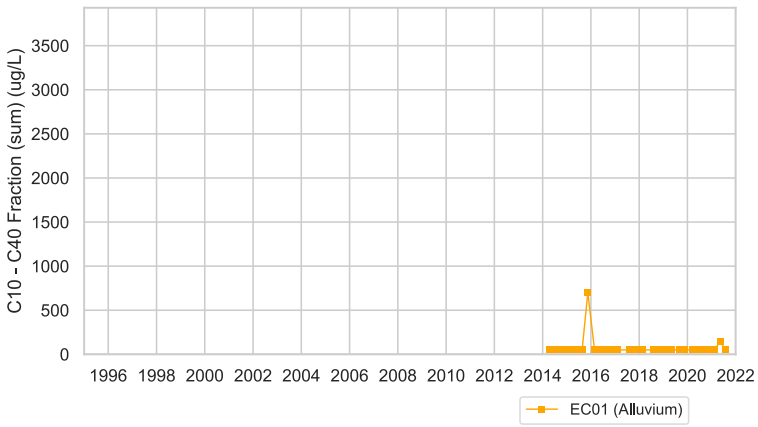

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

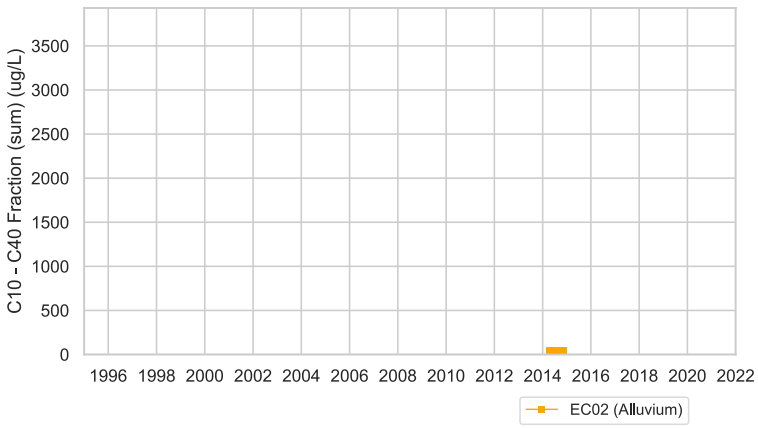

C6 - C10 Fraction (ug/L)
0
2
4
6
8
10
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

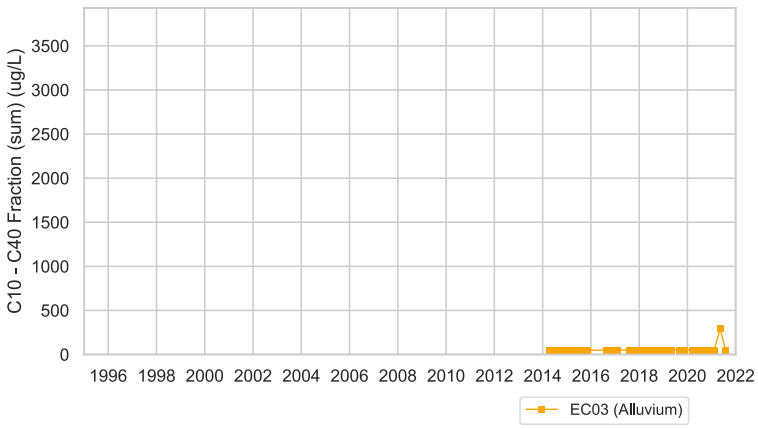

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020169 (Alluvium)

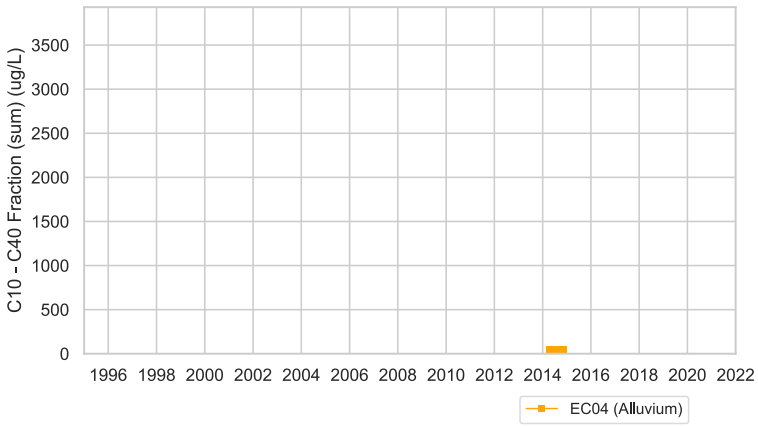

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020173 (Alluvium)

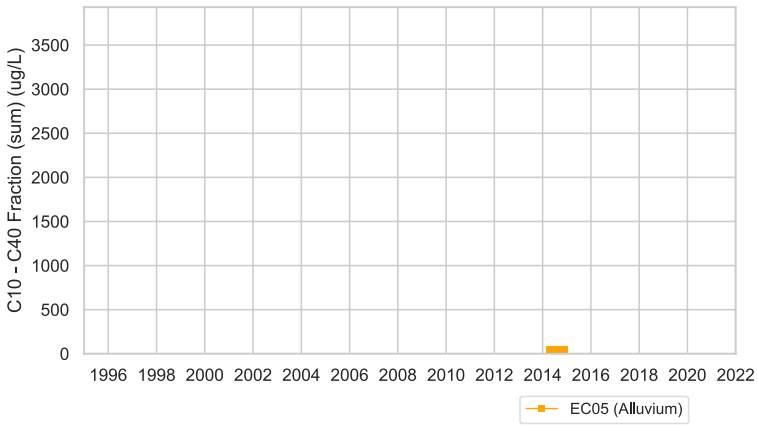

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
13020177 (Alluvium)

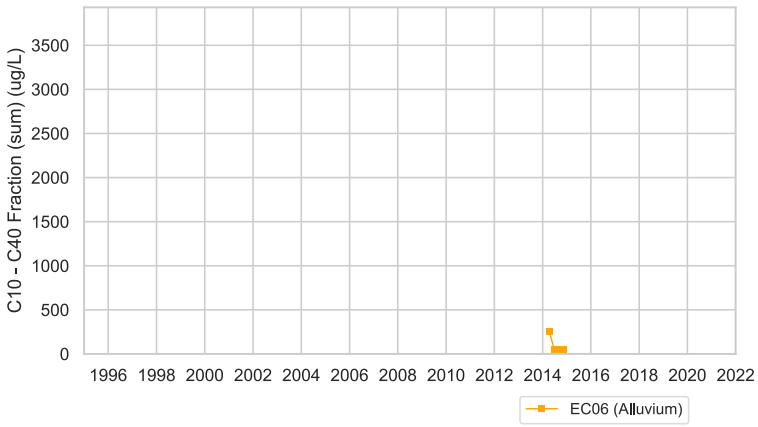

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC01 (Alluvium)

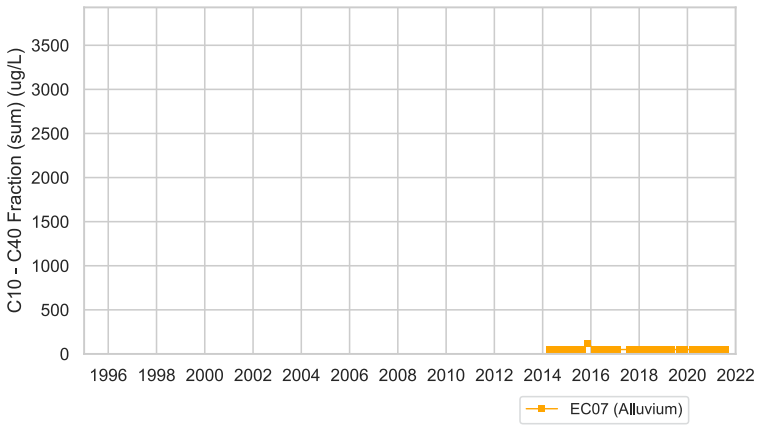

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC02 (Alluvium)

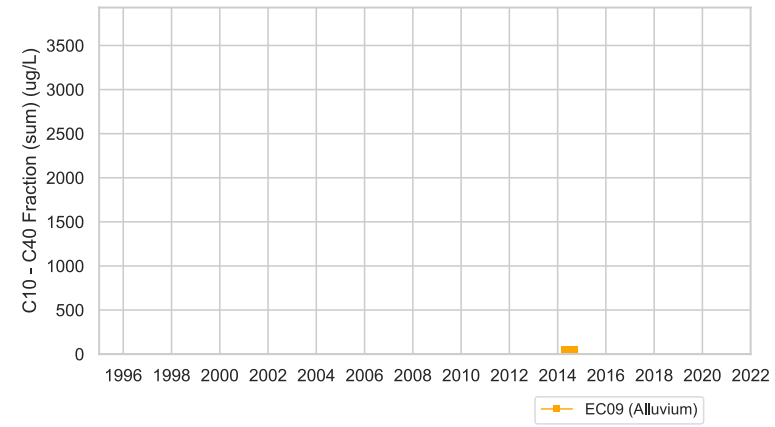

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC03 (Alluvium)

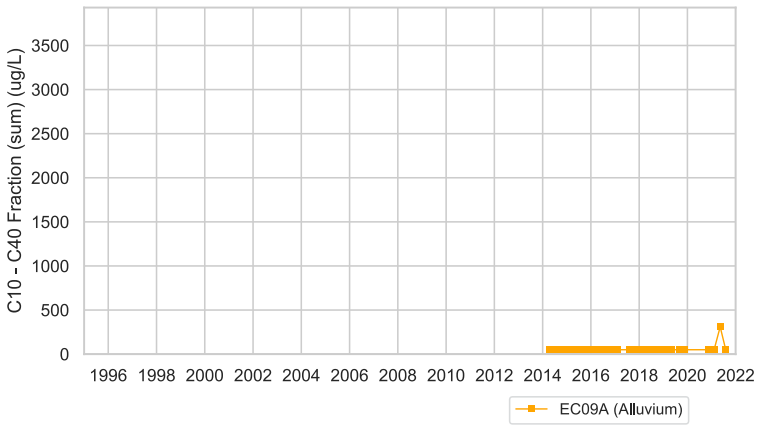

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC04 (Alluvium)

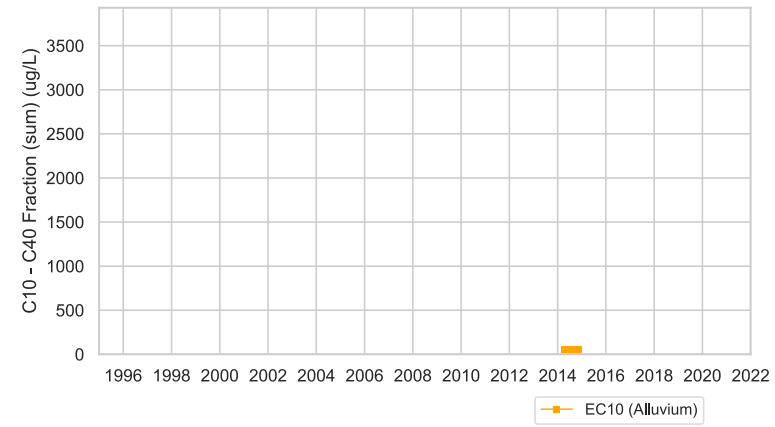

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC05 (Alluvium)

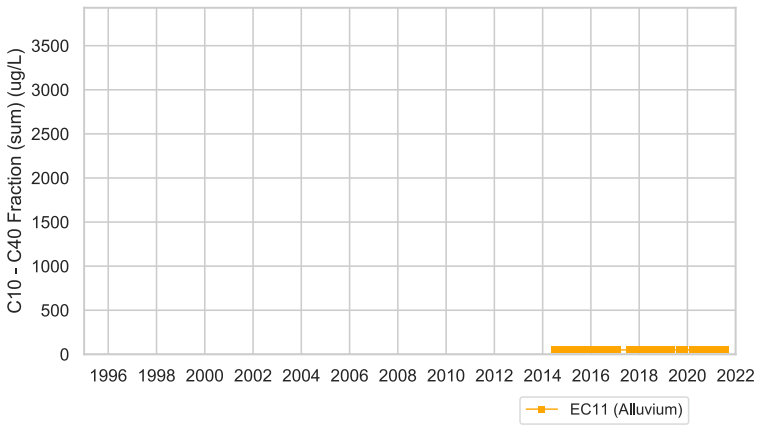

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC06 (Alluvium)

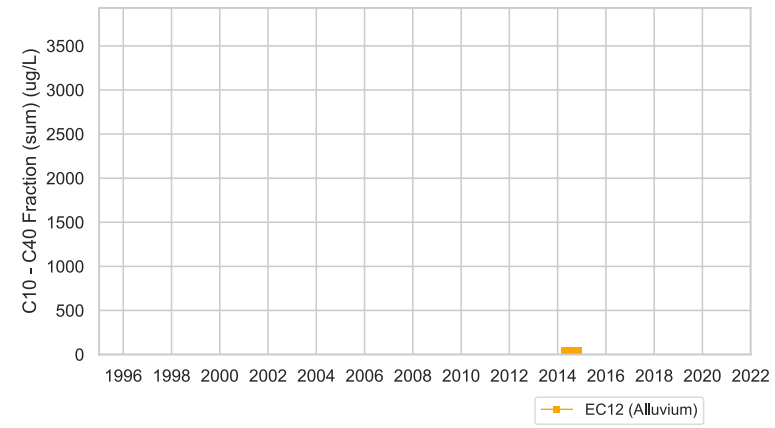

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC07 (Alluvium)

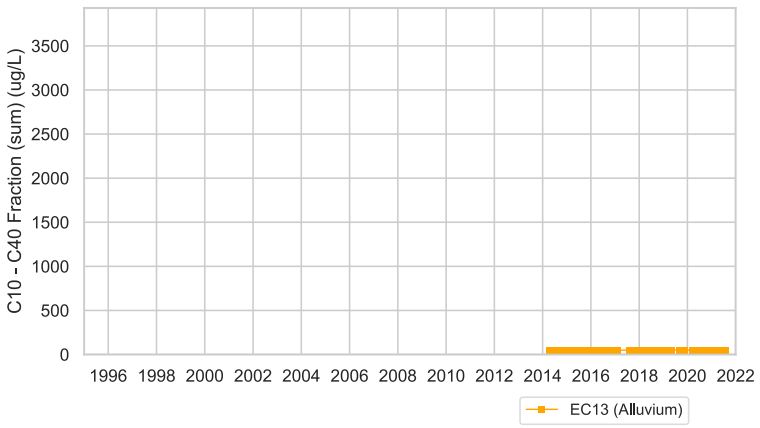

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09 (Alluvium)

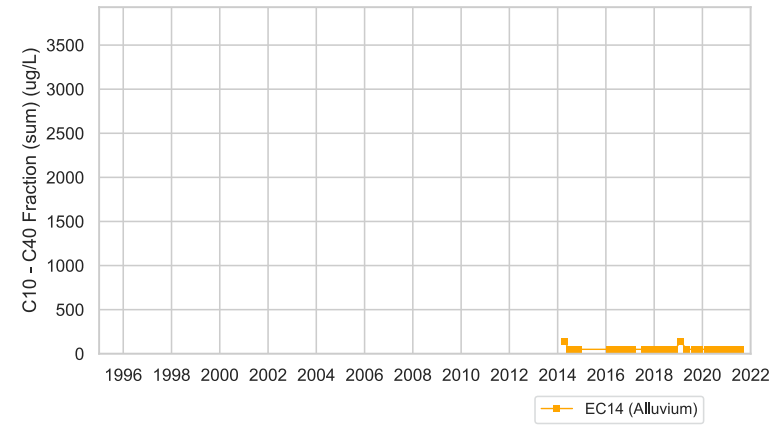

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC09A (Alluvium)

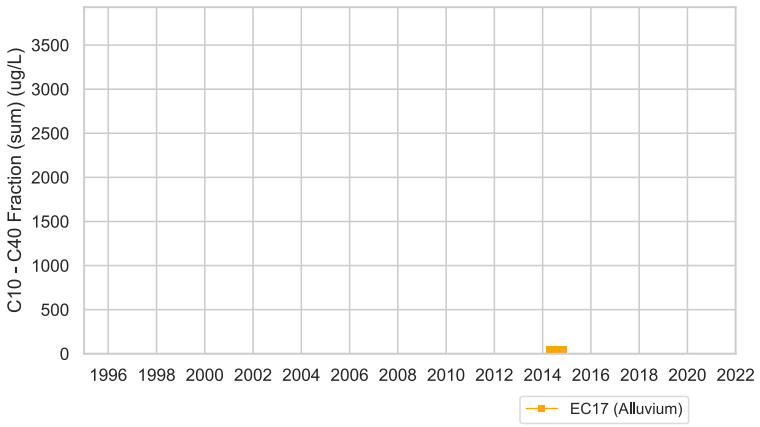

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC10 (Alluvium)

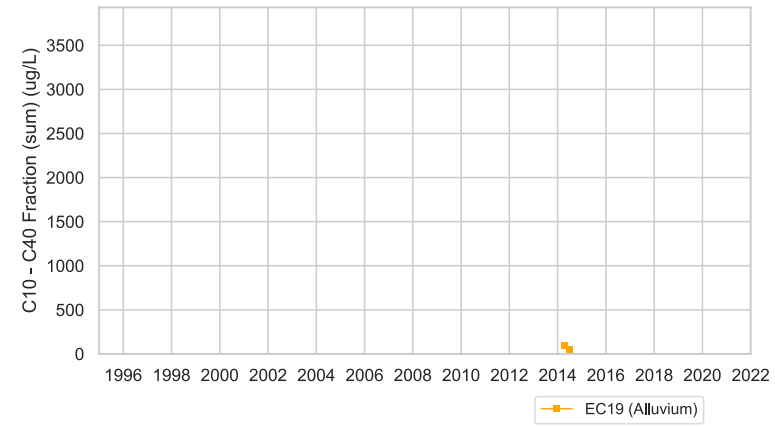

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC11 (Alluvium)

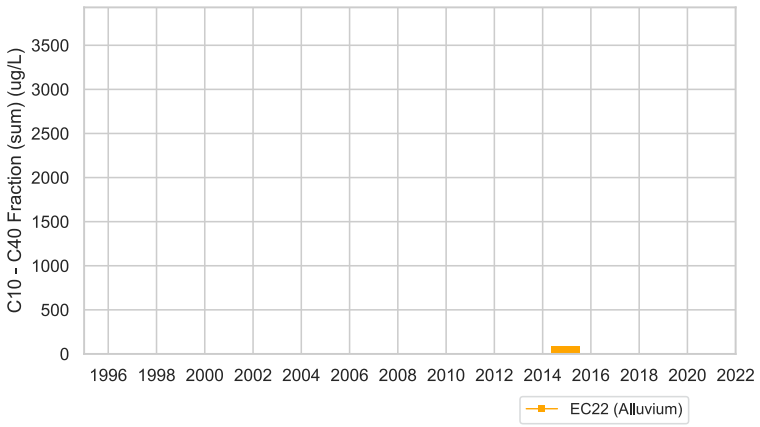

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC12 (Alluvium)

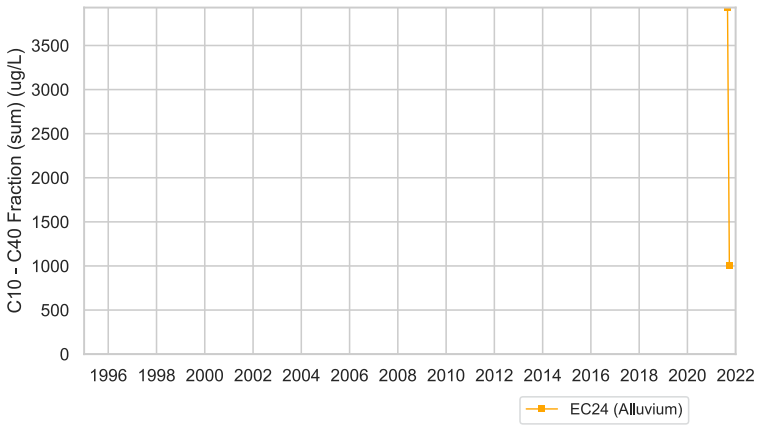

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC13 (Alluvium)

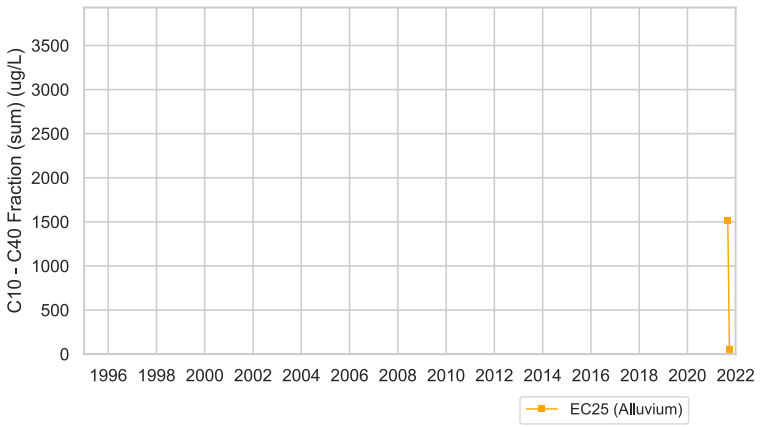

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC14 (Alluvium)

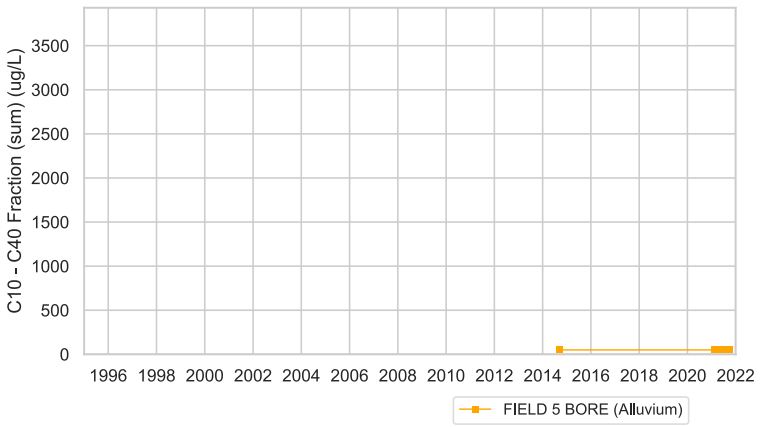

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC17 (Alluvium)

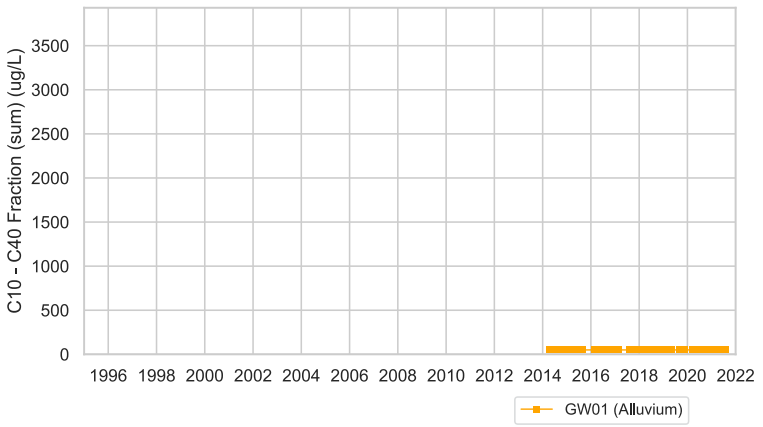

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC19 (Alluvium)

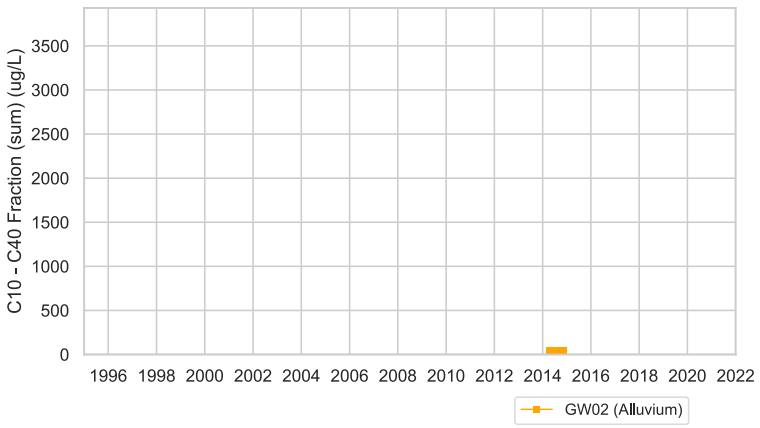

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC22 (Alluvium)

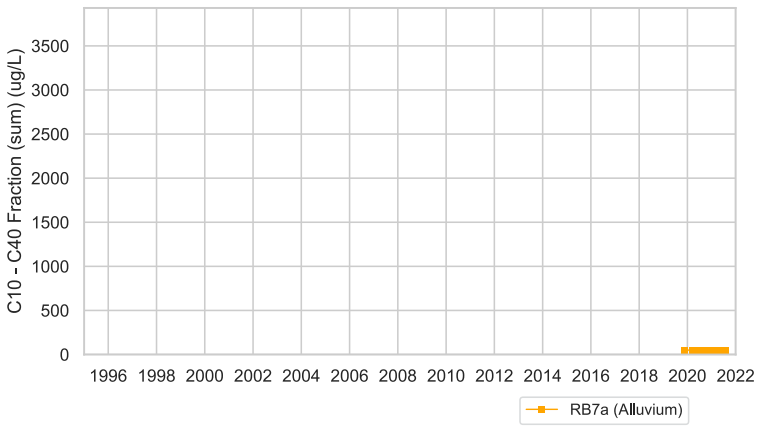

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC24 (Alluvium)

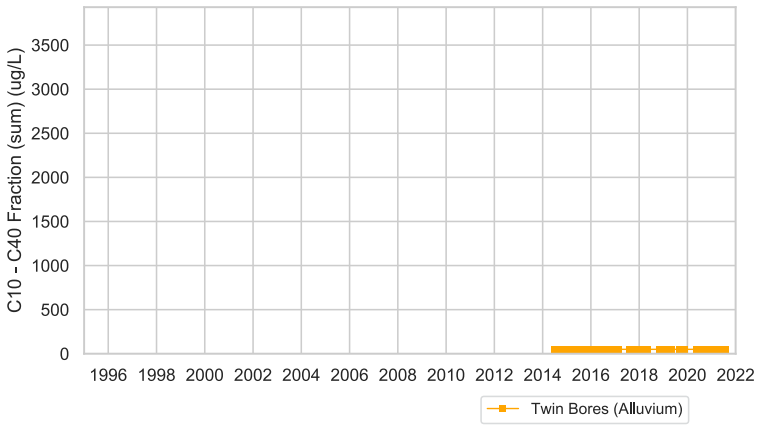

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
EC25 (Alluvium)

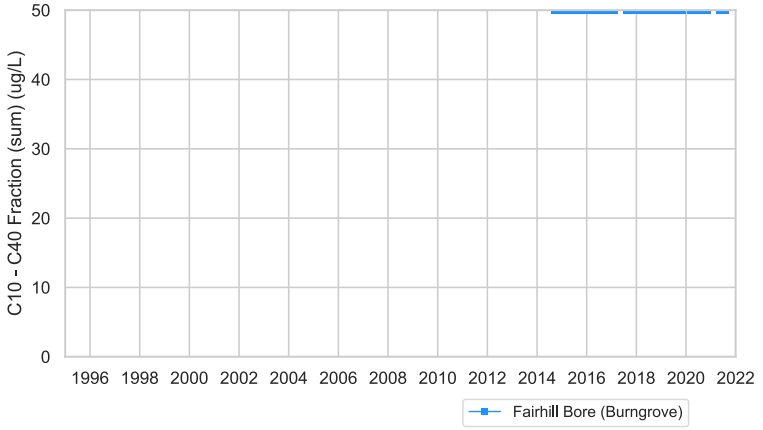

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
FIELD 5 BORE (Alluvium)

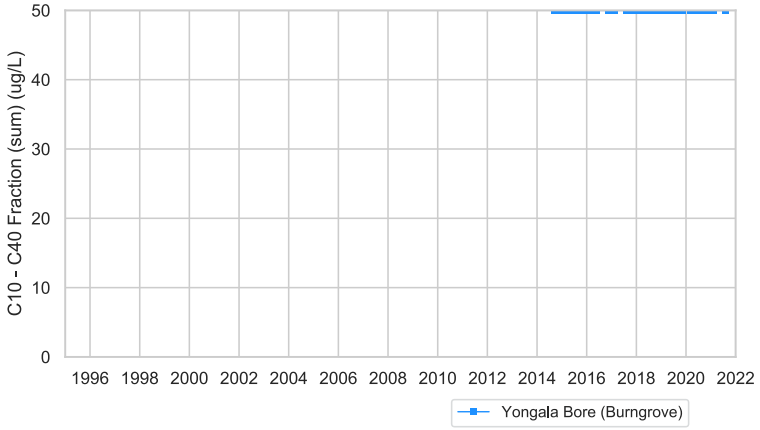

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW01 (Alluvium)

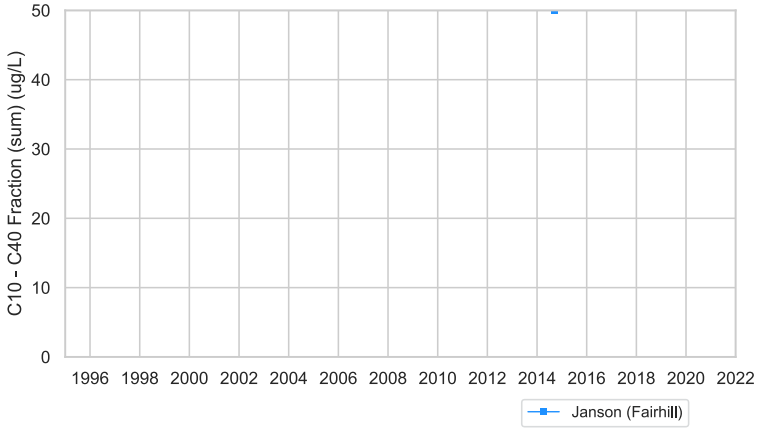

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
GW02 (Alluvium)

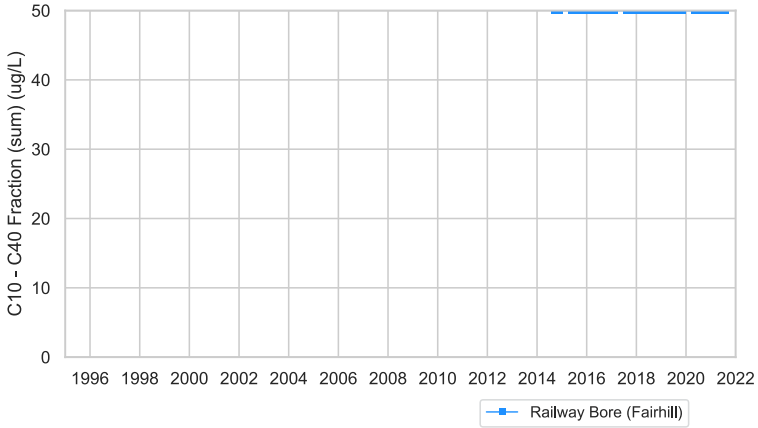

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB7a (Alluvium)

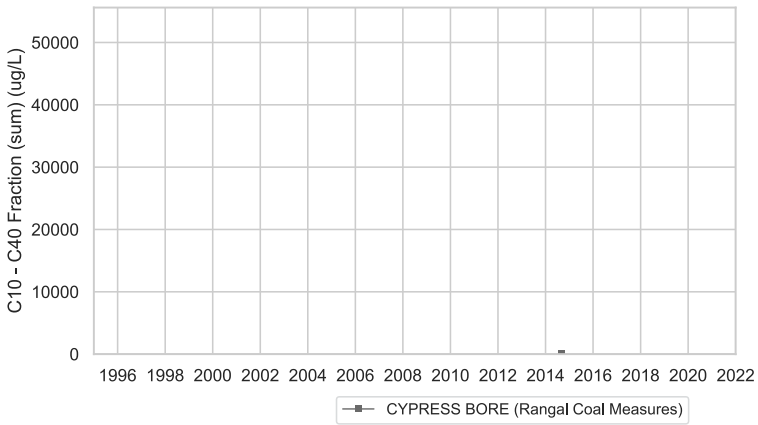

C10 - C40 Fraction (sum) (ug/L)
0
500
1000
1500
2000
2500
3000
3500
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Twin Bores (Alluvium)

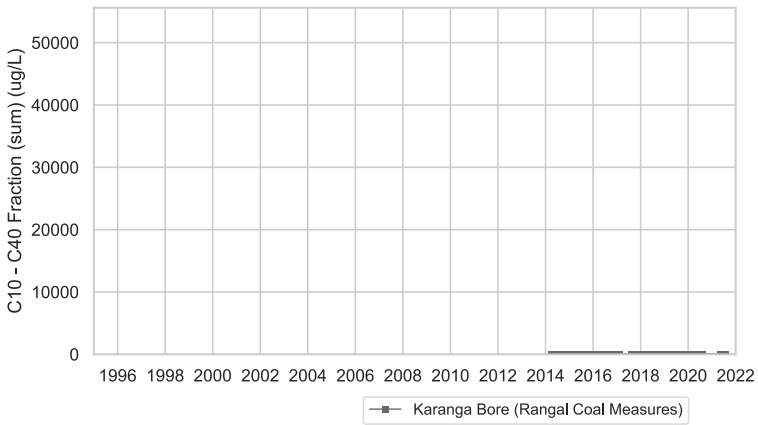

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Fairhill Bore (Burngrove)

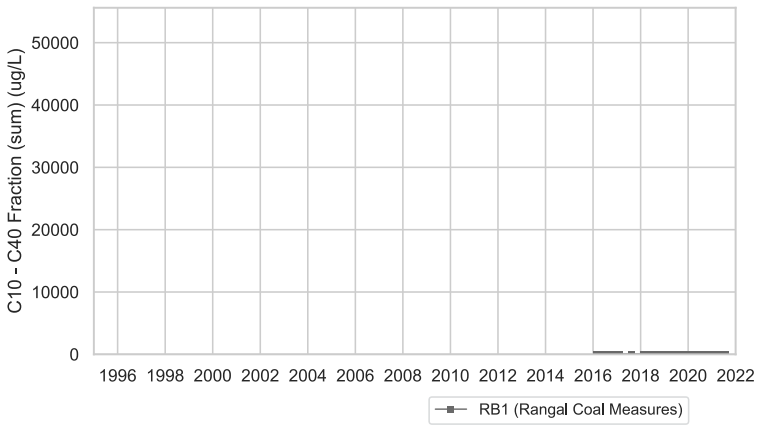

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Yongala Bore (Burngrove)

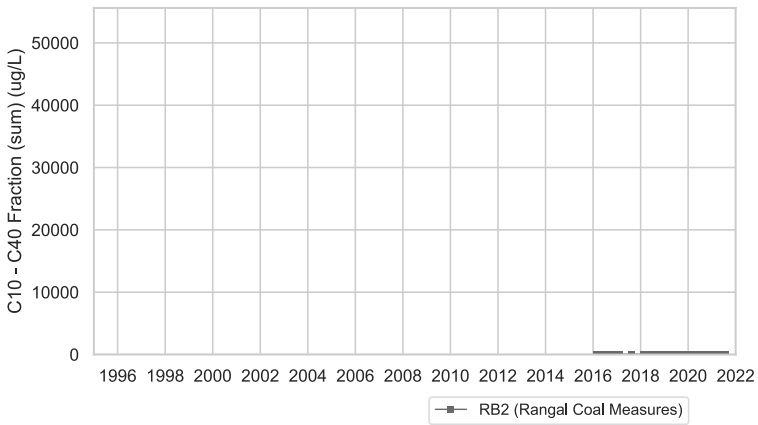

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Janson (Fairhill)

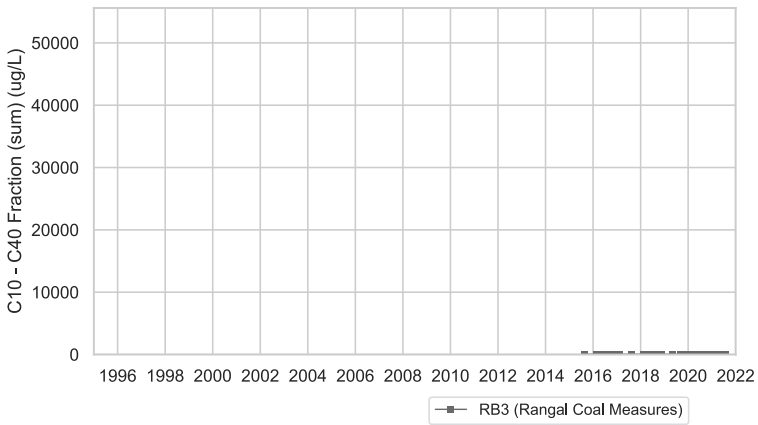

C10 - C40 Fraction (sum) (ug/L)
0
10
20
30
40
50
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Railway Bore (Fairhill)

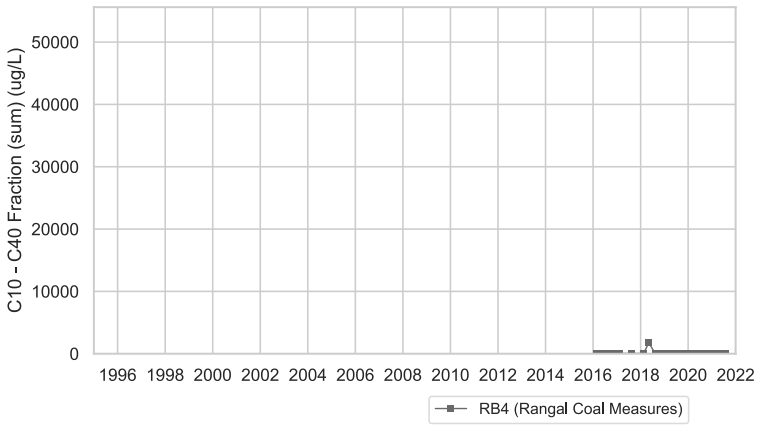

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
CYPRESS BORE (Rangal Coal Measures)

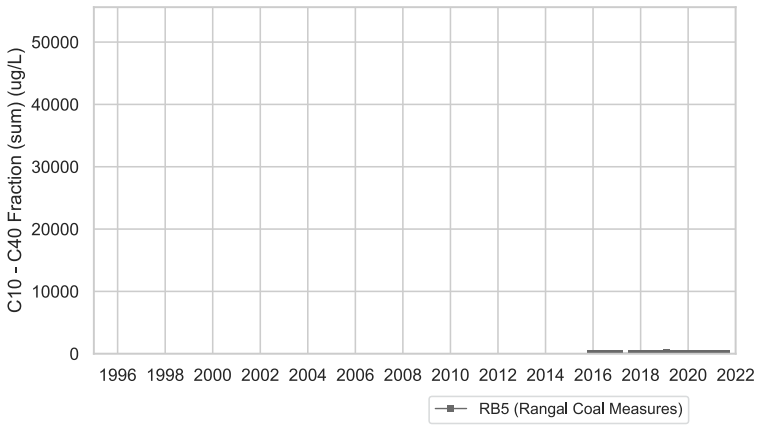

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Karanga Bore (Rangal Coal Measures)

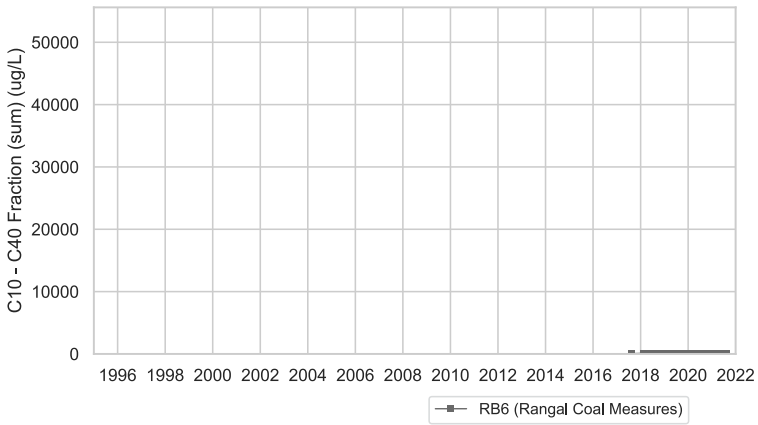

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB1 (Rangal Coal Measures)

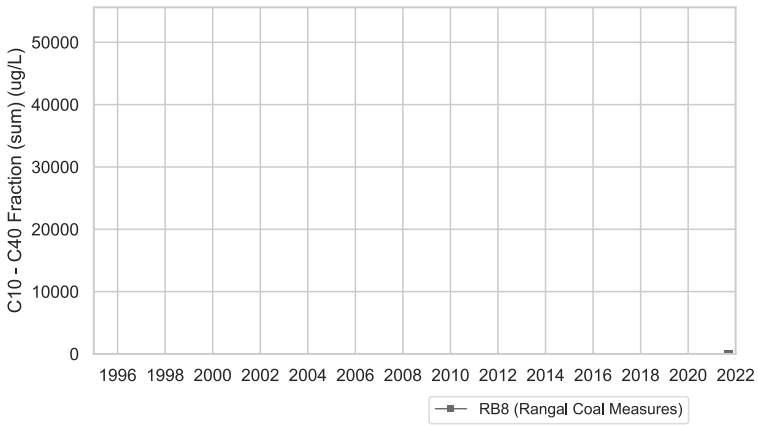

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB2 (Rangal Coal Measures)

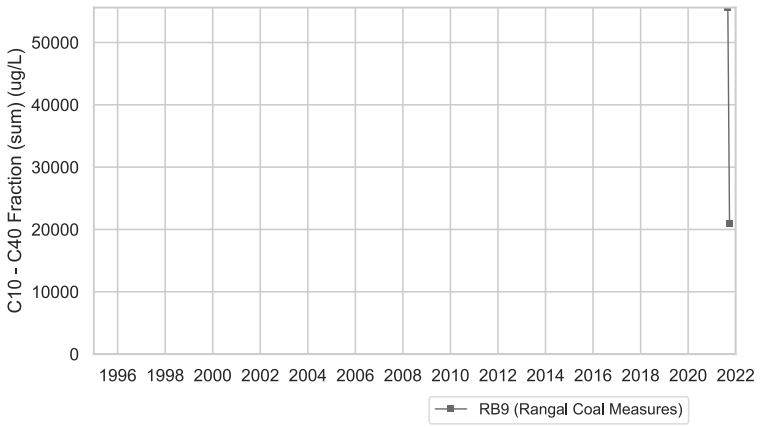

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB3 (Rangal Coal Measures)

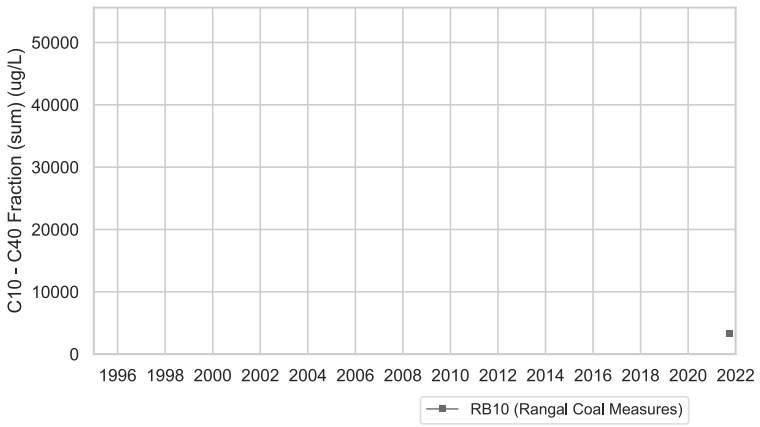

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB4 (Rangal Coal Measures)

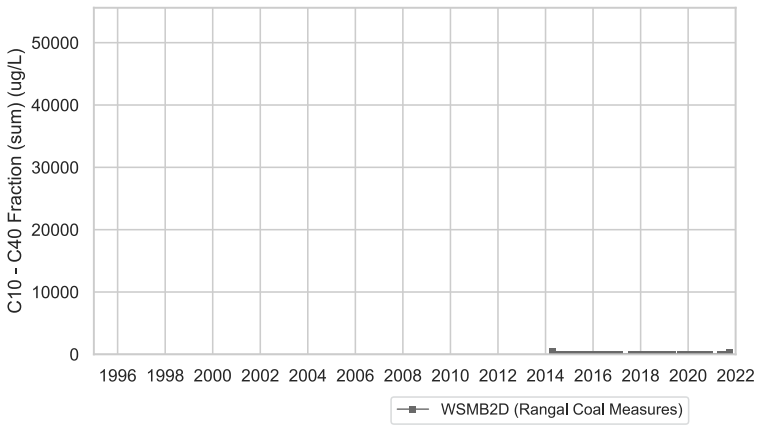

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB5 (Rangal Coal Measures)

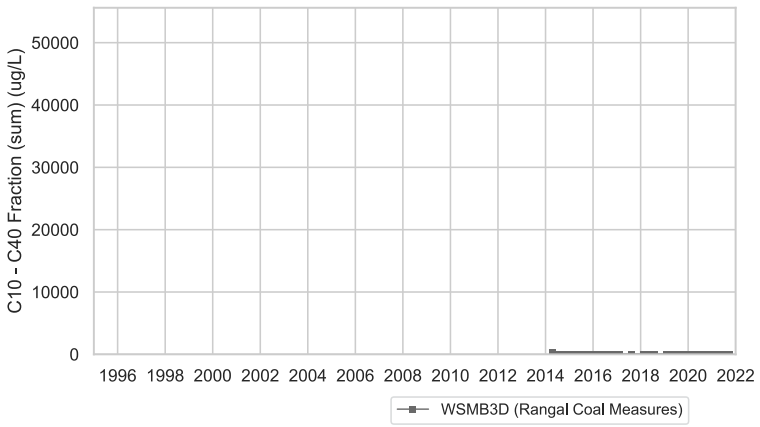

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB6 (Rangal Coal Measures)

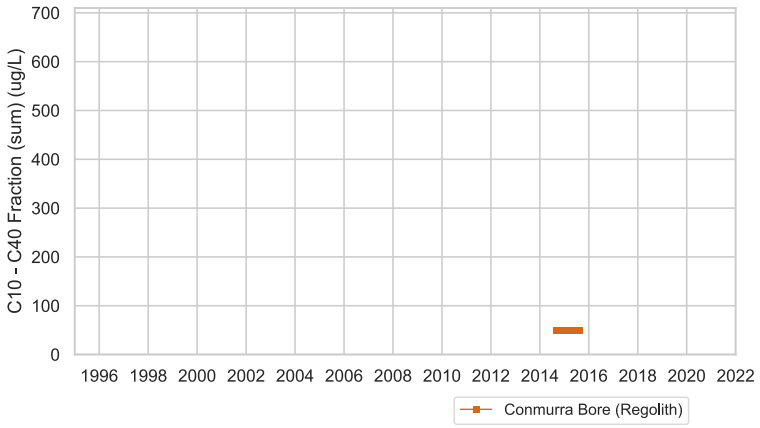

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB8 (Rangal Coal Measures)

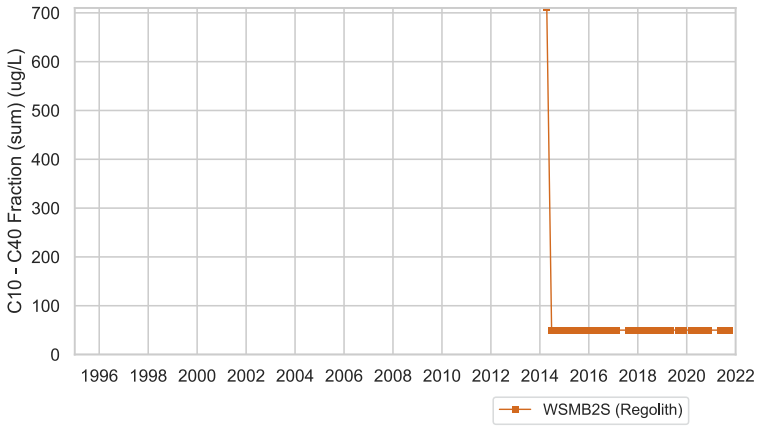

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB9 (Rangal Coal Measures)

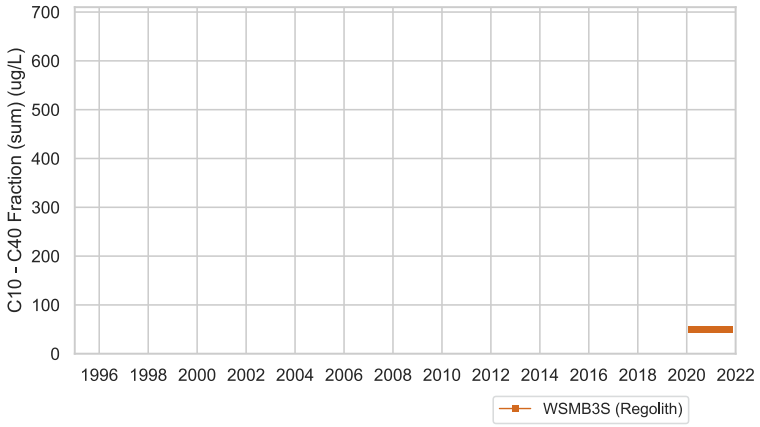

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
RB10 (Rangal Coal Measures)

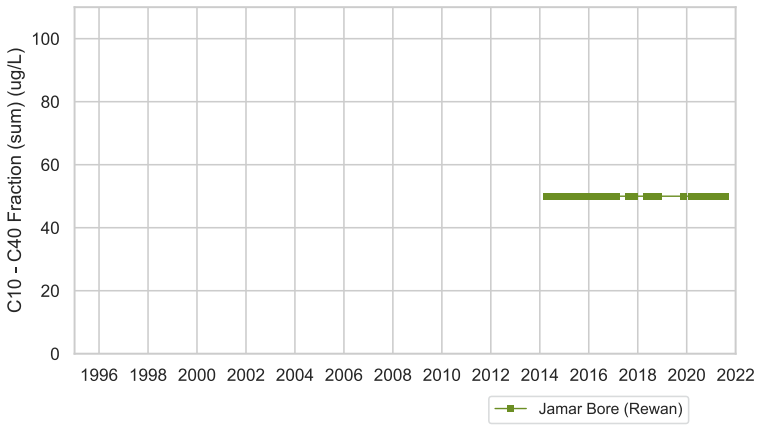

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2D (Rangal Coal Measures)

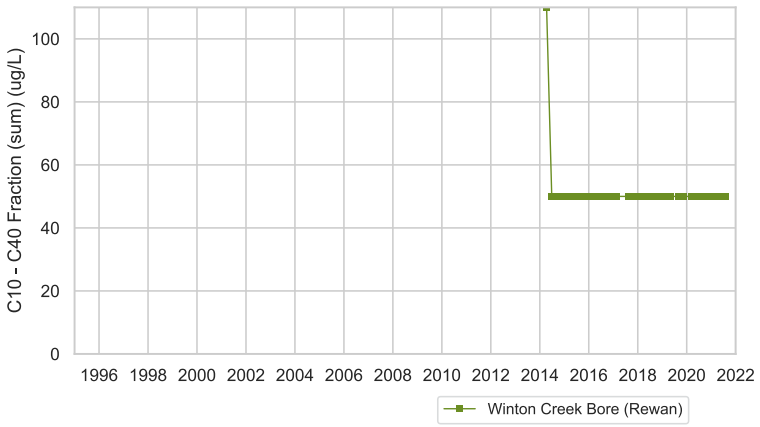

C10 - C40 Fraction (sum) (ug/L)
0
10000
20000
30000
40000
50000
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3D (Rangal Coal Measures)


C10 - C40 Fraction (sum) (ug/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Conmurra Bore (Regolith)


C10 - C40 Fraction (sum) (ug/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB2S (Regolith)

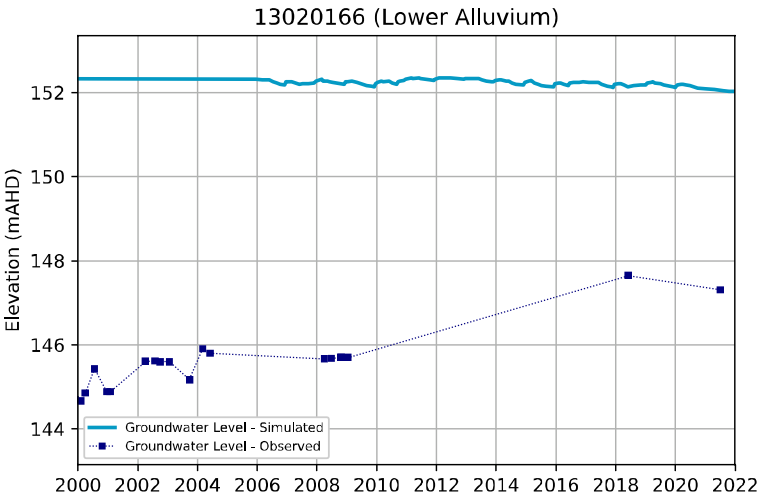

C10 - C40 Fraction (sum) (ug/L)
0
100
200
300
400
500
600
700
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
WSMB3S (Regolith)

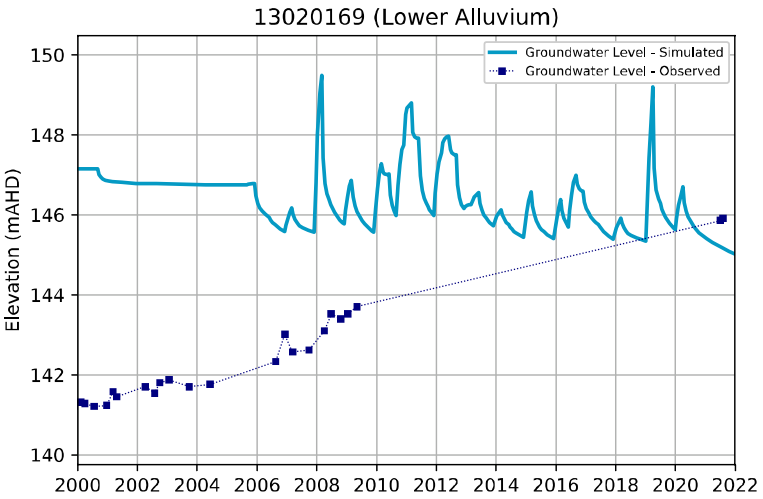

C10 - C40 Fraction (sum) (ug/L)
0
20
40
60
80
100
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Jamar Bore (Rewan)

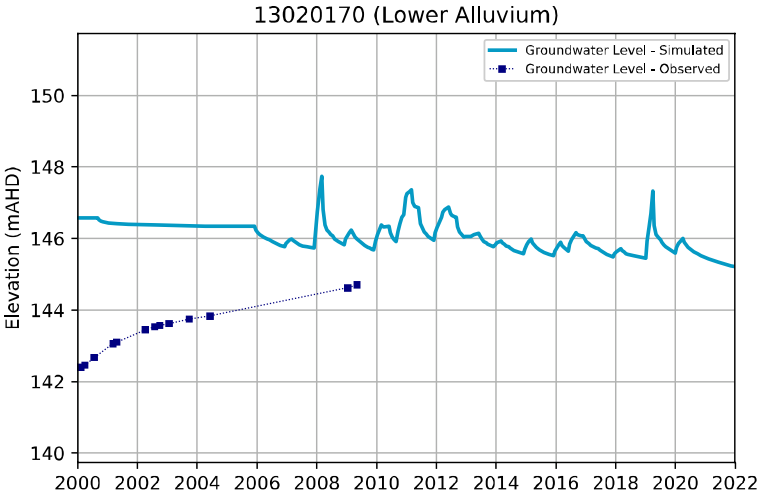

C10 - C40 Fraction (sum) (ug/L)
0
20
40
60
80
100
1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Winton Creek Bore (Rewan)

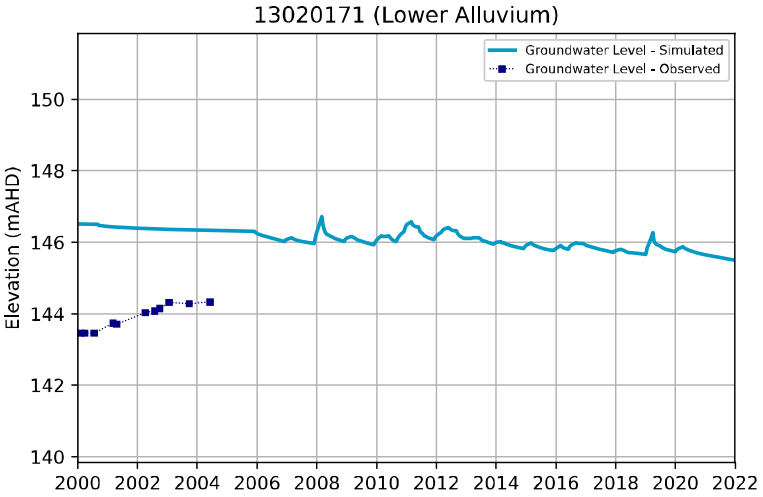
APPENDIX E

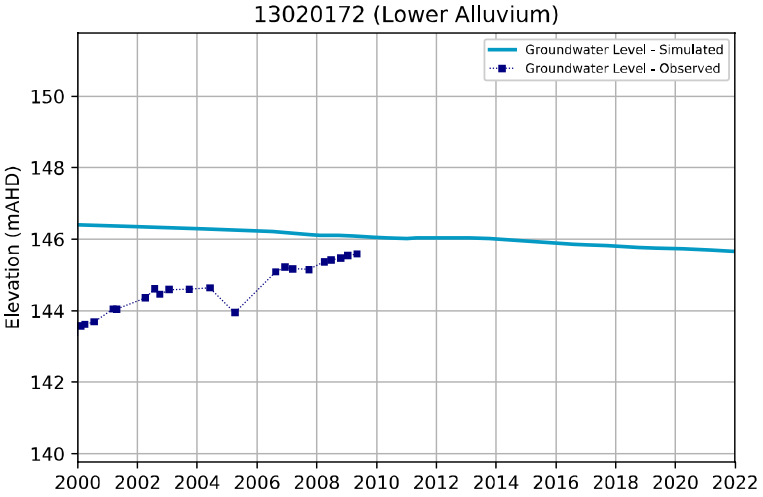
Calibration Hydrographs

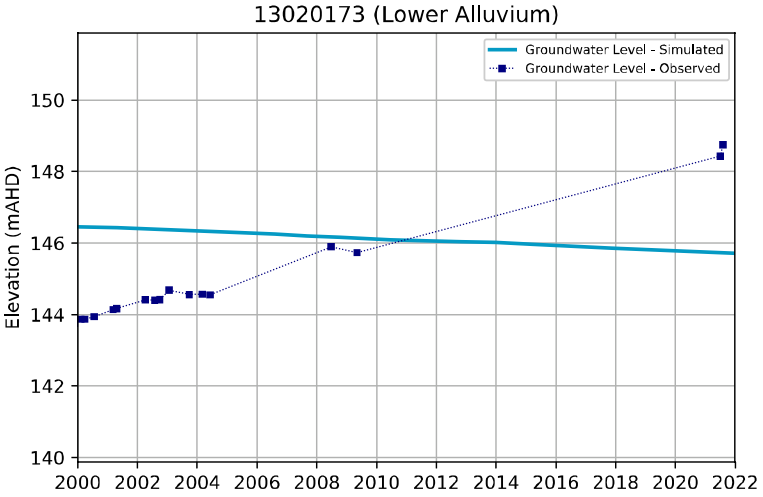

13020166 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

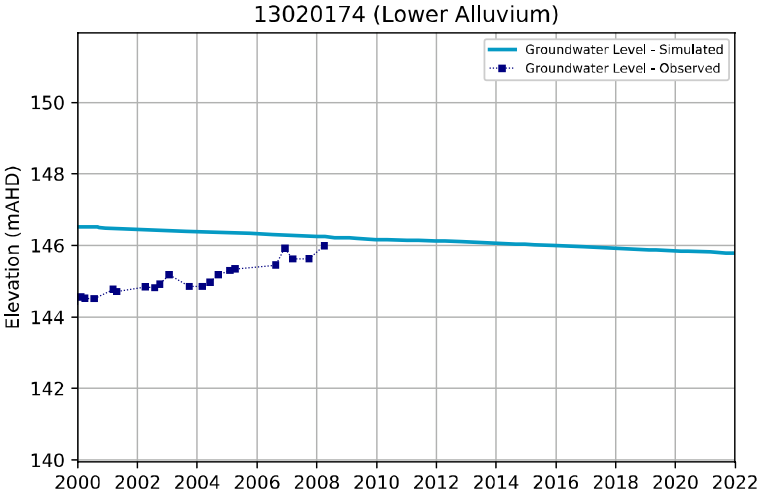

13020169 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

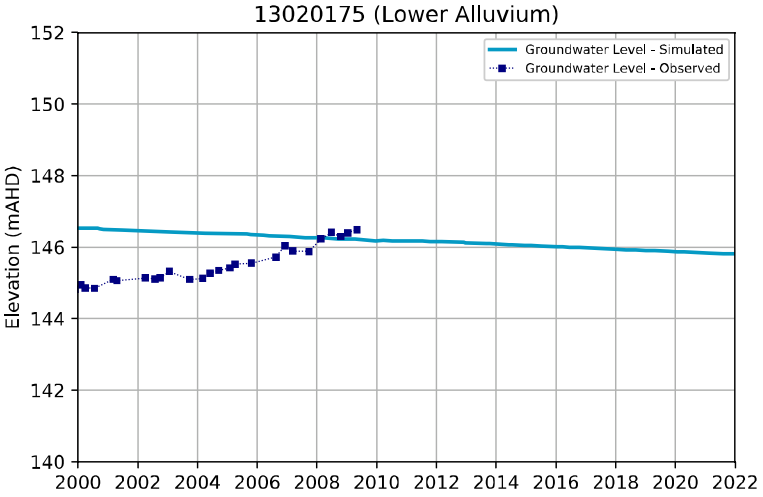

13020170 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

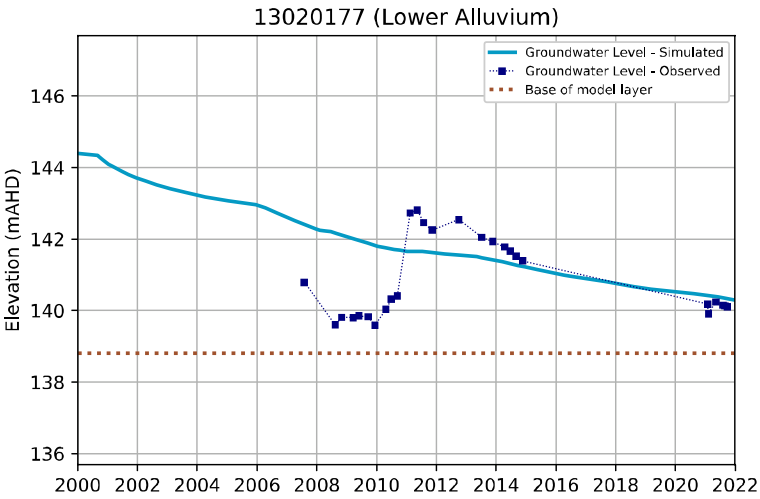

13020171 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

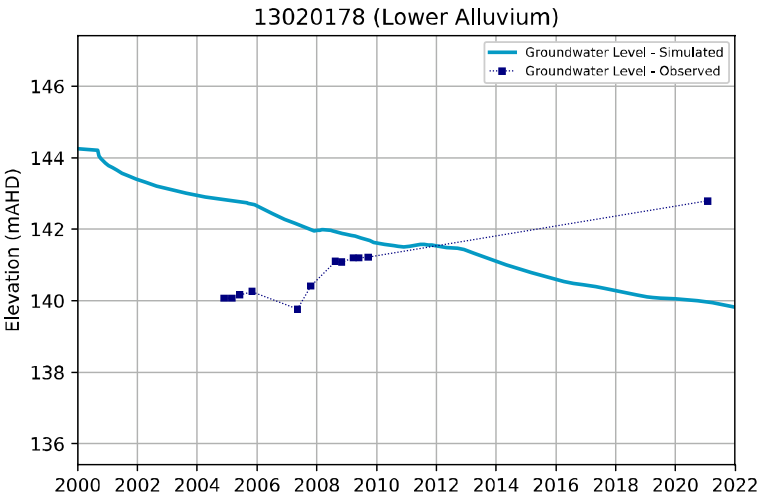

13020172 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

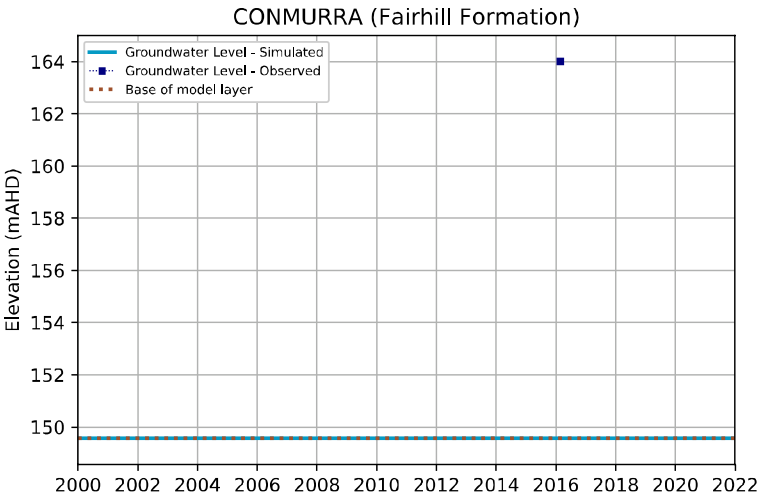

13020173 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

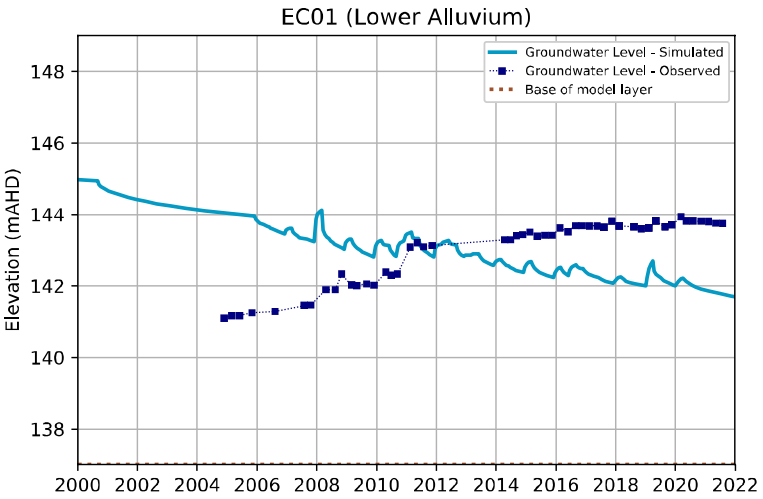

13020174 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

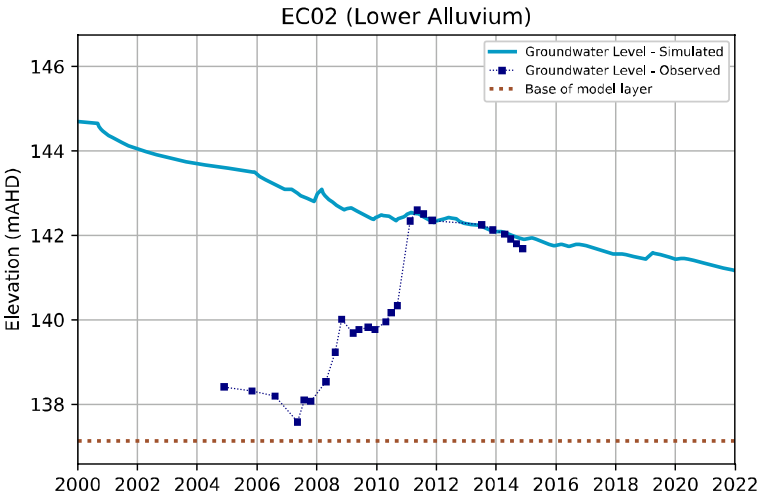

13020175 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

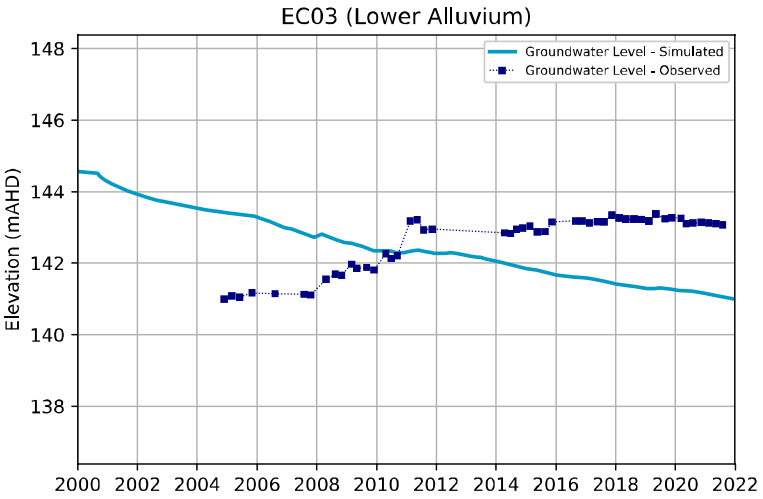

13020177 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

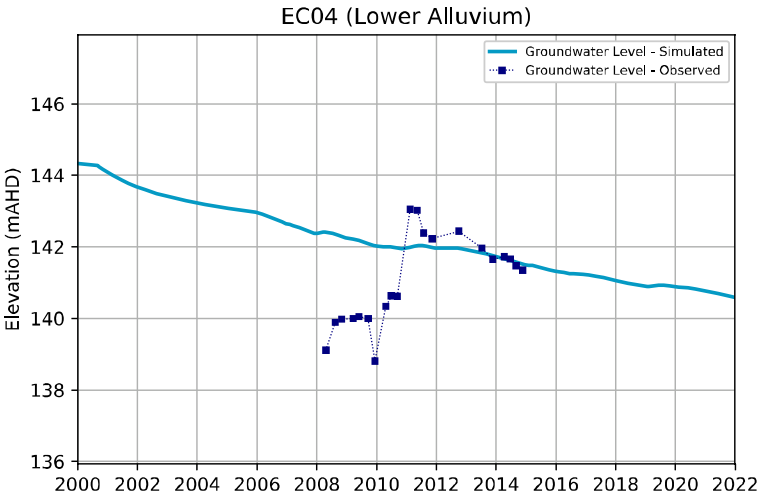

13020178 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

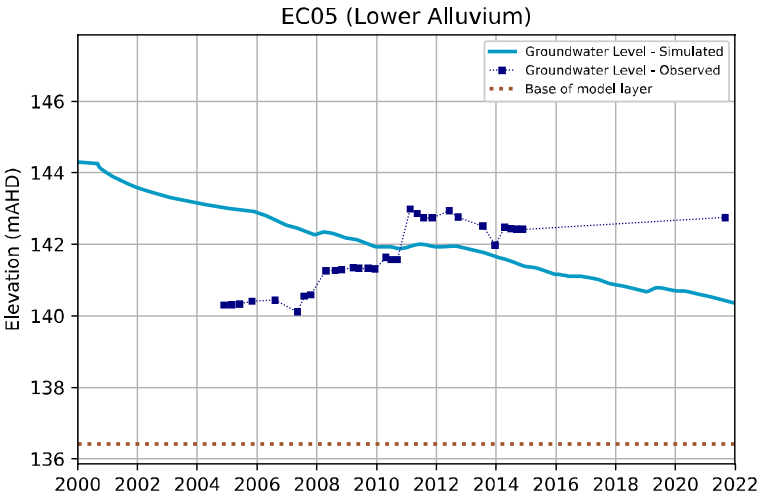

CONMURRA (Fairhill Formation)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
164
162
160
158
156
154
152
150
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

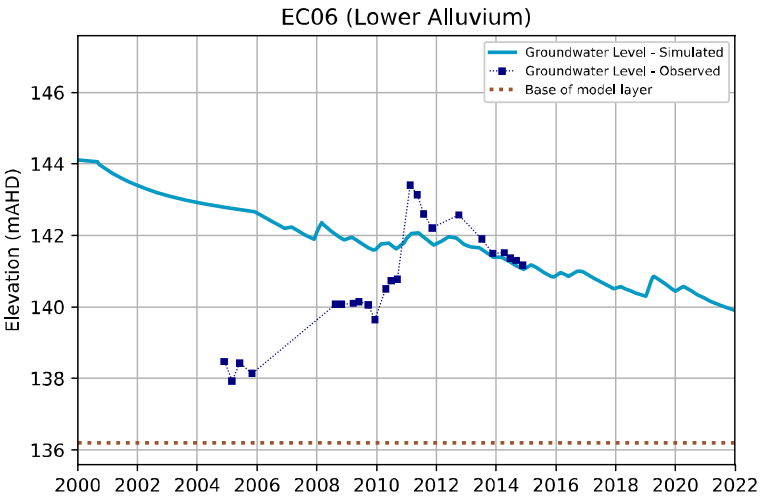

EC01 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
148
146
144
142
140
138
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

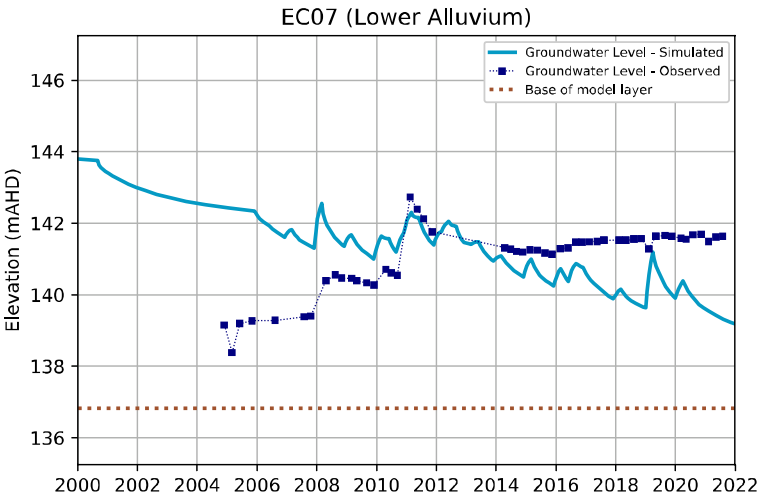

EC02 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

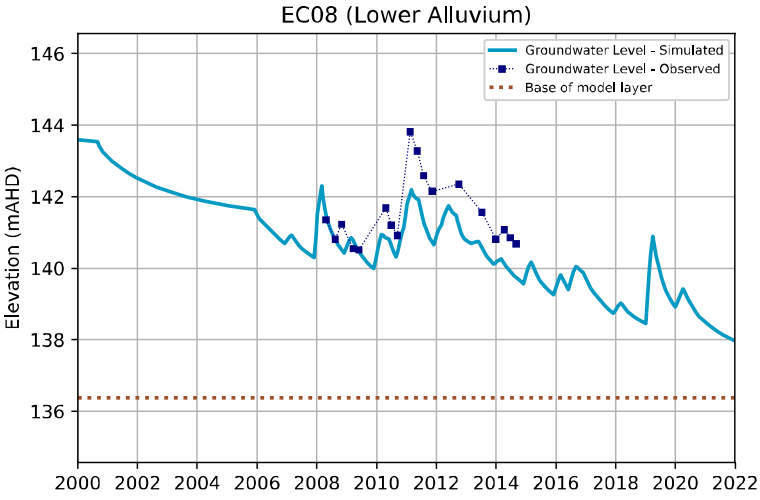

EC03 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
148
146
144
142
140
138
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

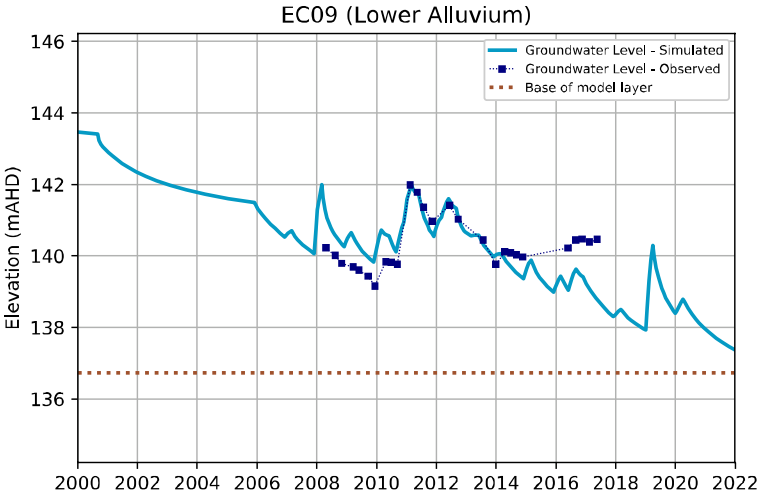

EC04 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

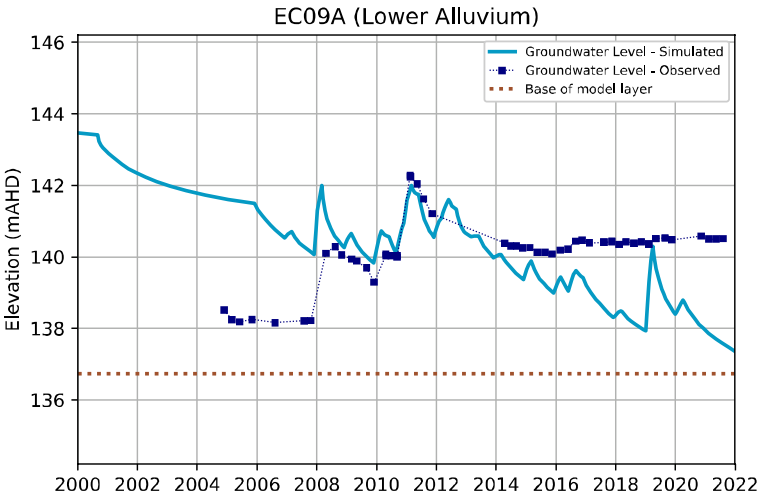

EC05 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

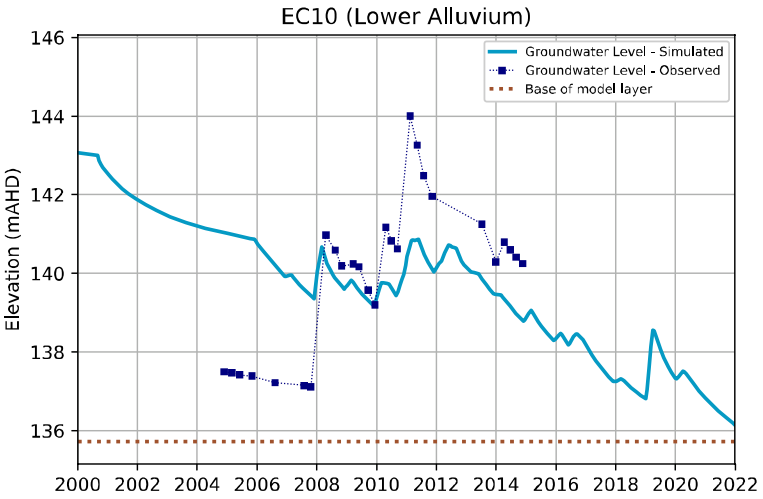

EC06 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

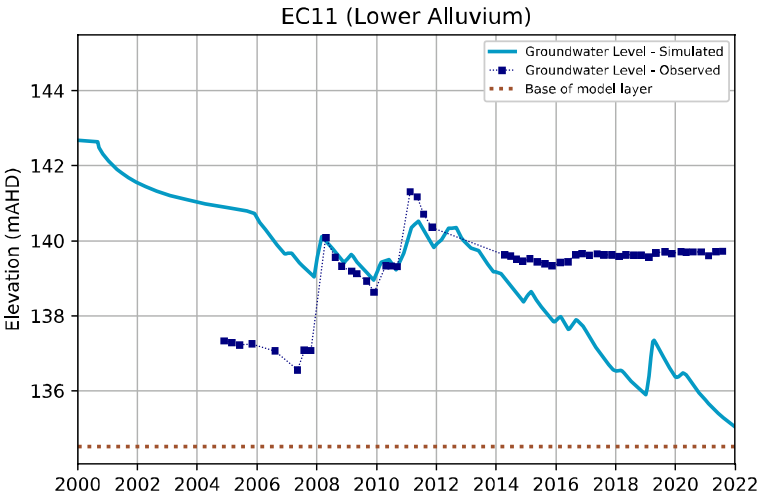

EC07 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

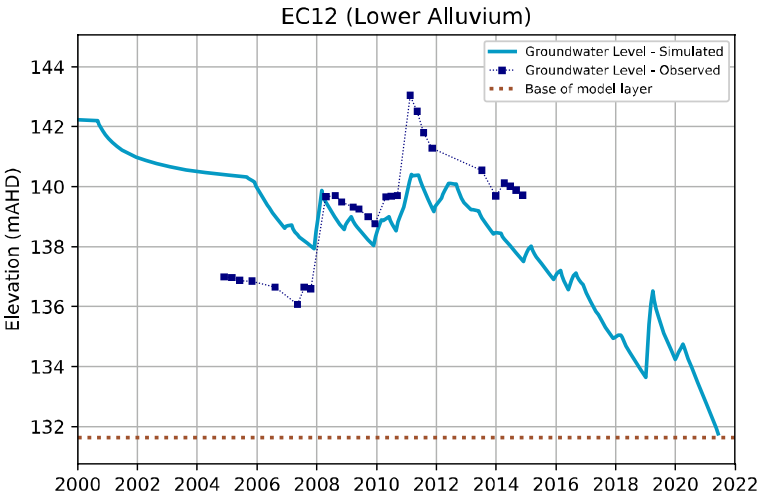

EC08 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

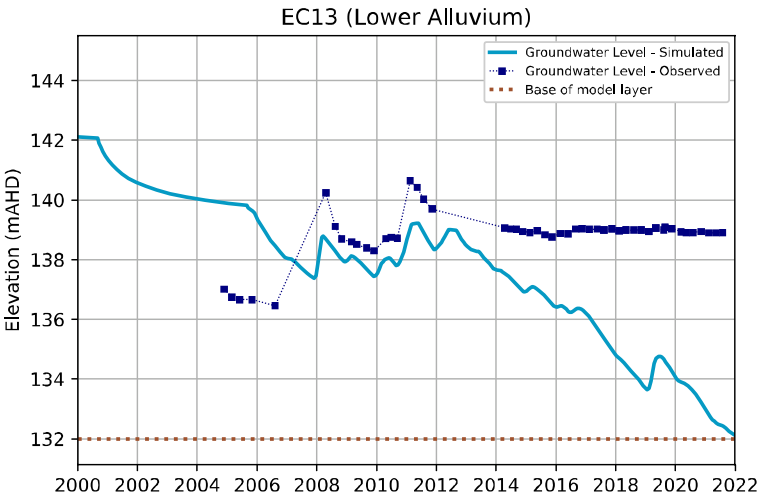

EC09 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

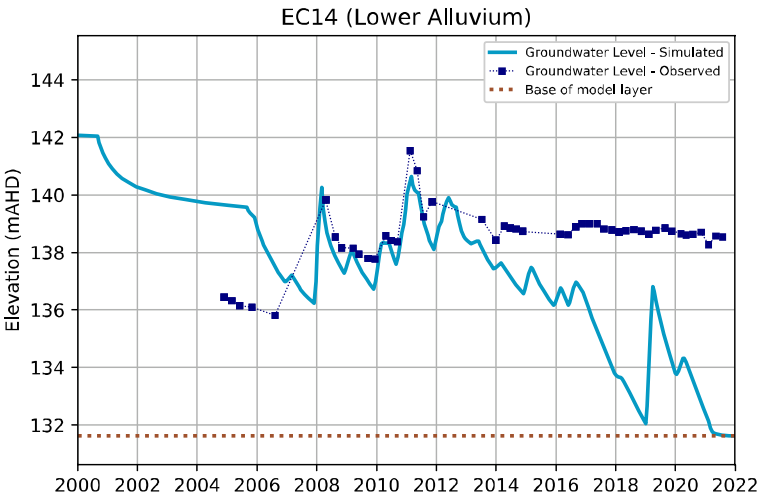

EC09A (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

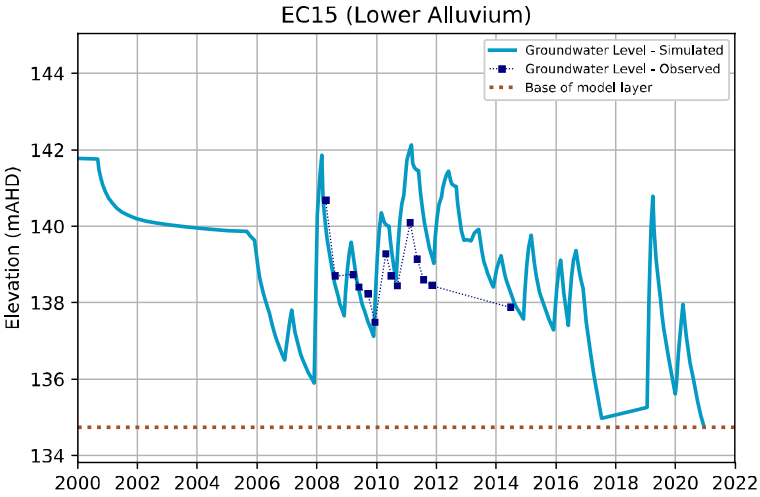

EC10 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

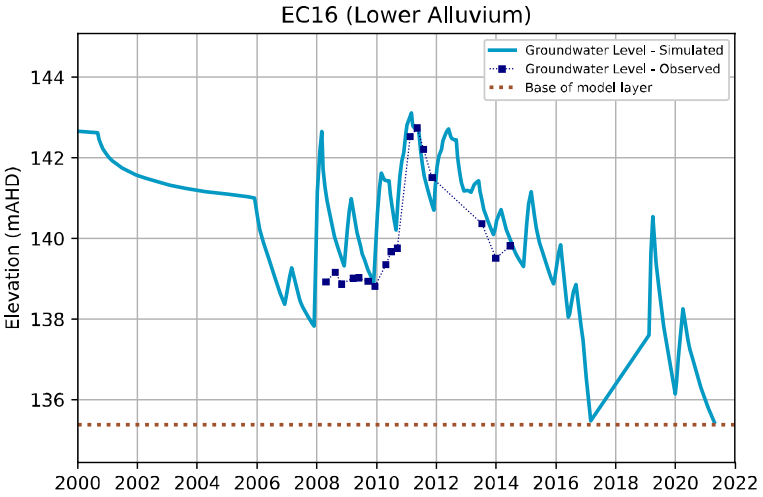

EC11 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

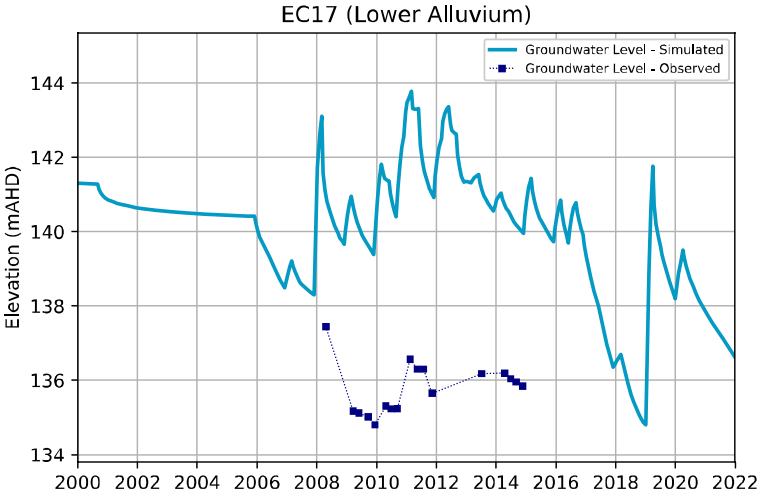

EC12 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
144
142
140
138
136
134
132
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

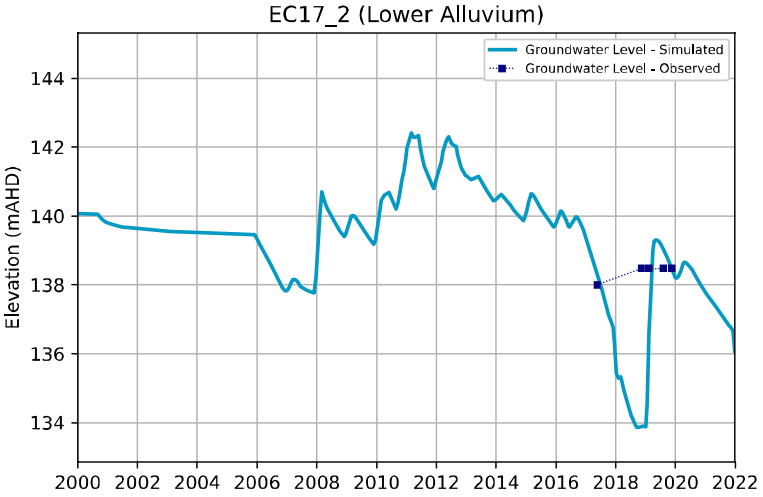

EC13 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

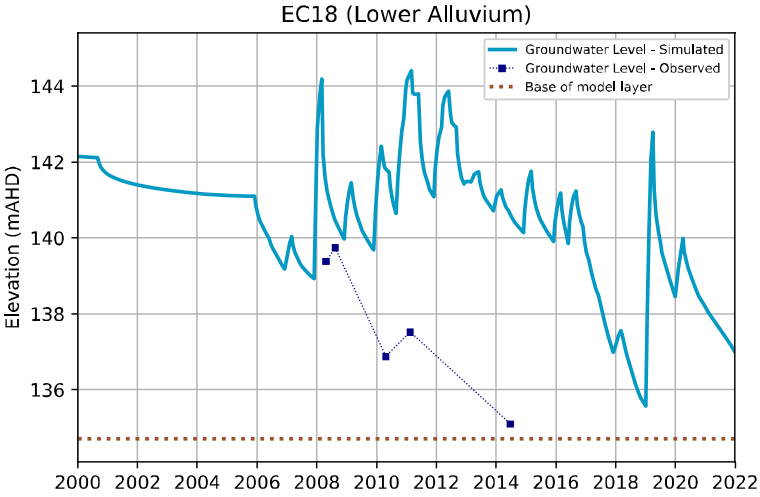

EC14 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

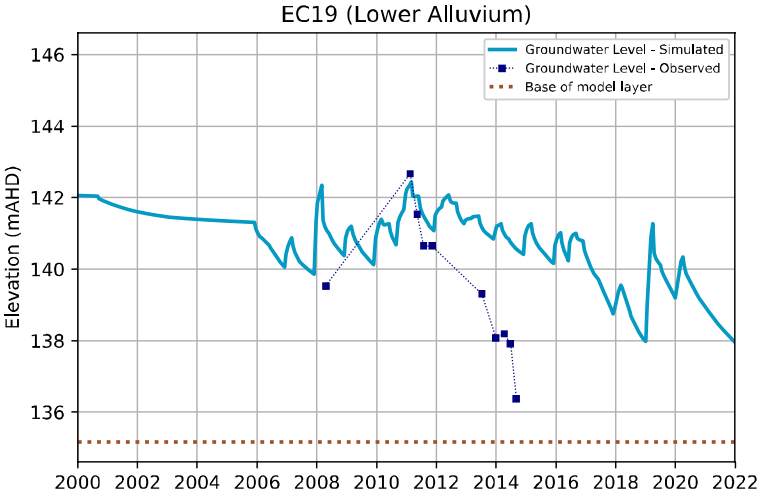

EC15 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

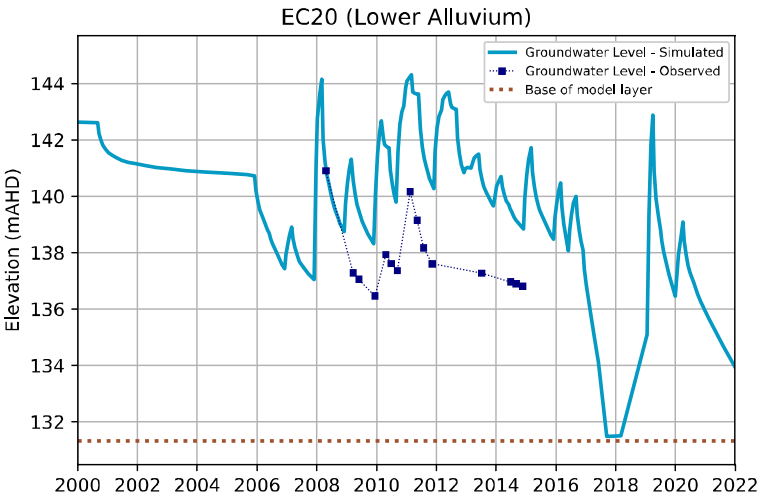

EC16 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

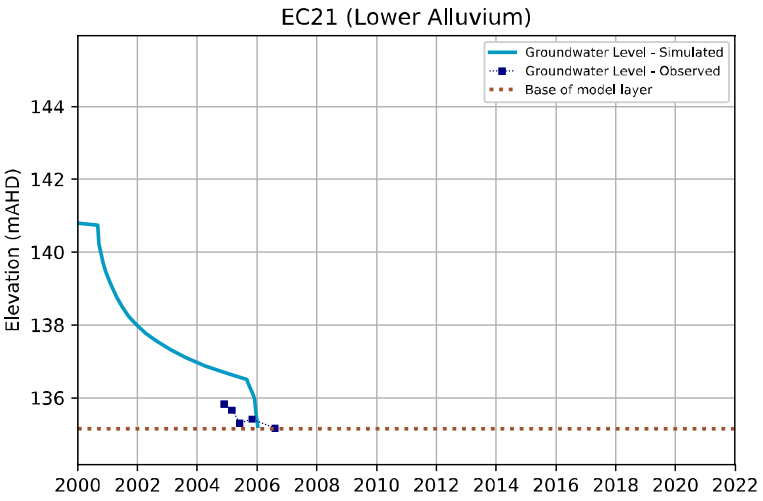

EC17 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

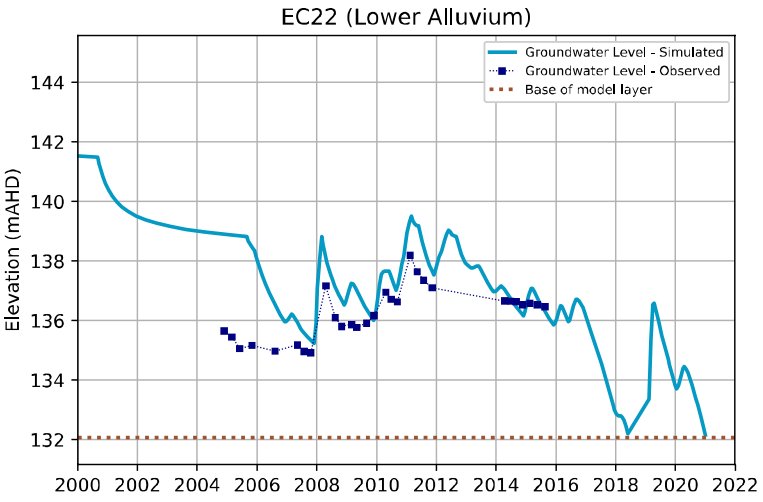

EC17_2 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

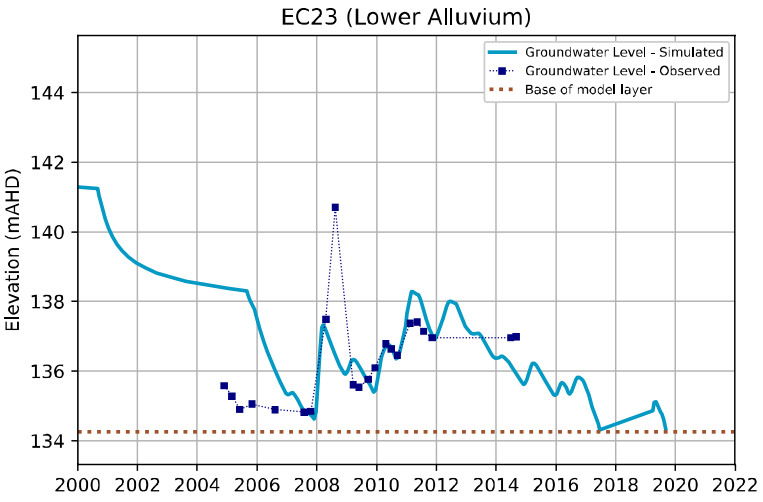

EC18 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

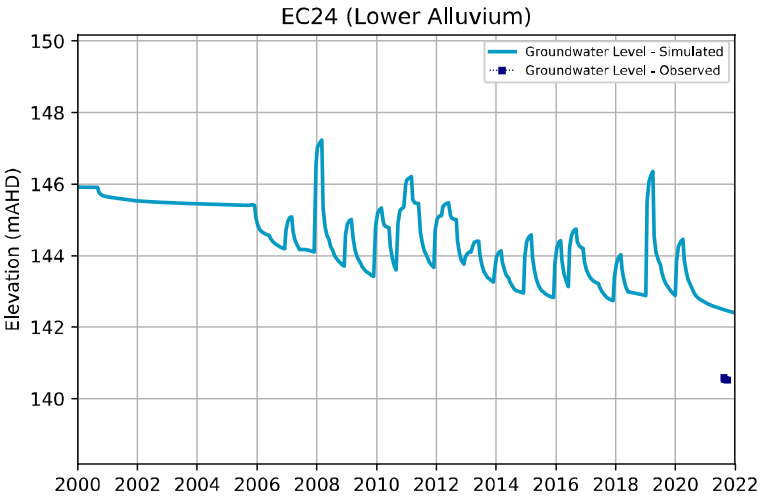

EC19 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

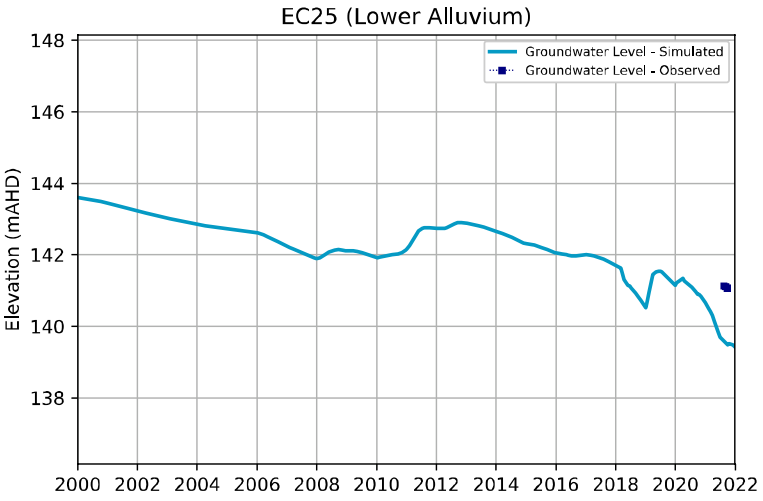

EC20 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
144
142
140
138
136
134
132
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

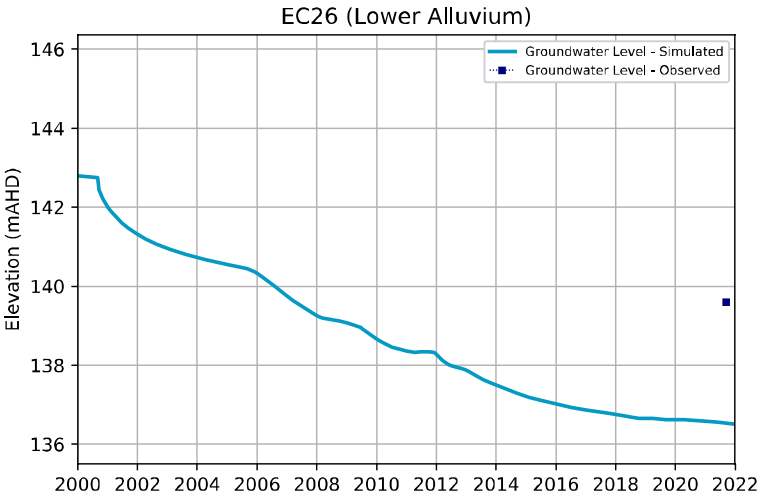

EC21 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

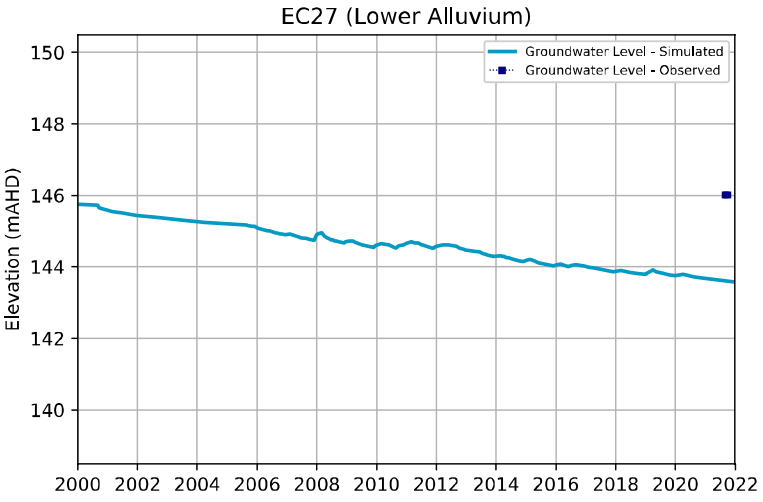

EC22 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
144
142
140
138
136
134
132
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

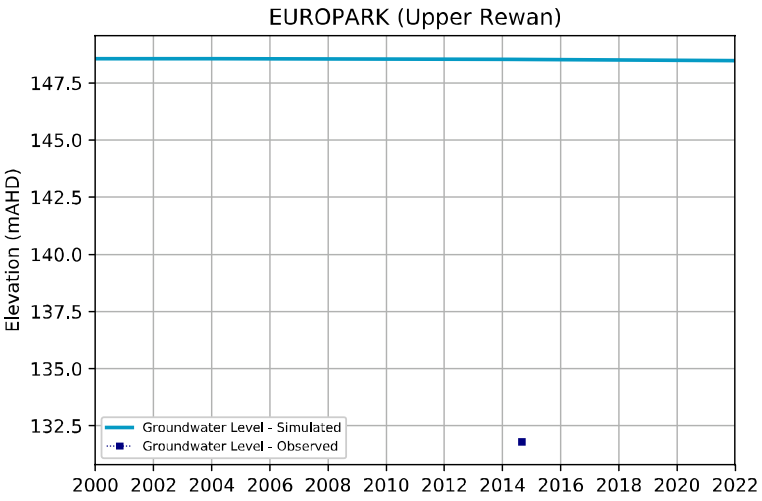

EC23 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
144
142
140
138
136
134
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

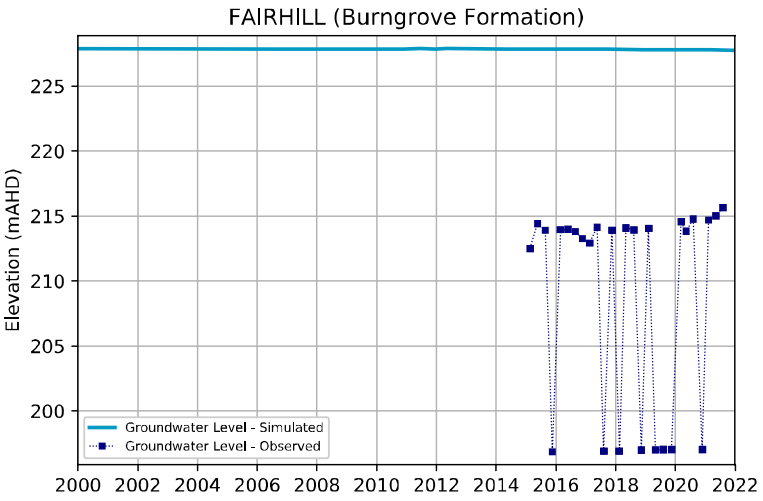

EC24 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
150
148
146
144
142
140
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

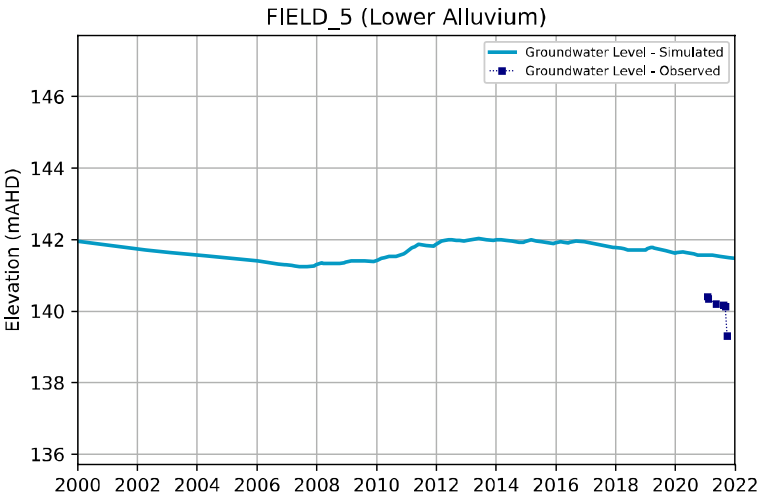

EC25 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
148
146
144
142
140
138
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

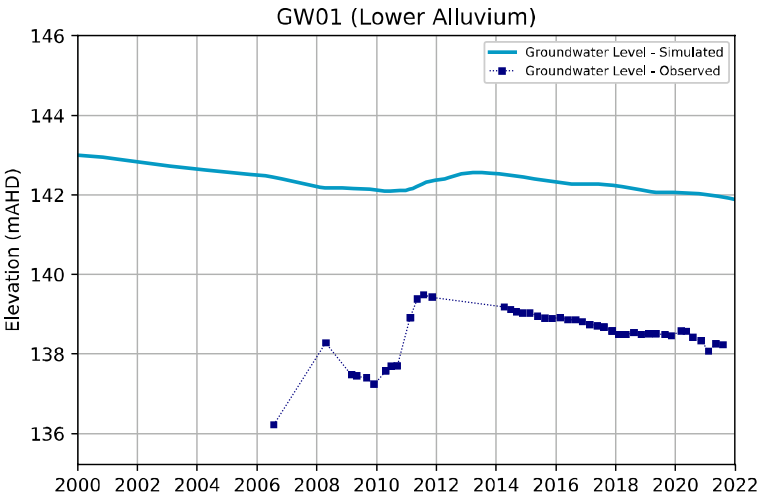

EC26 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

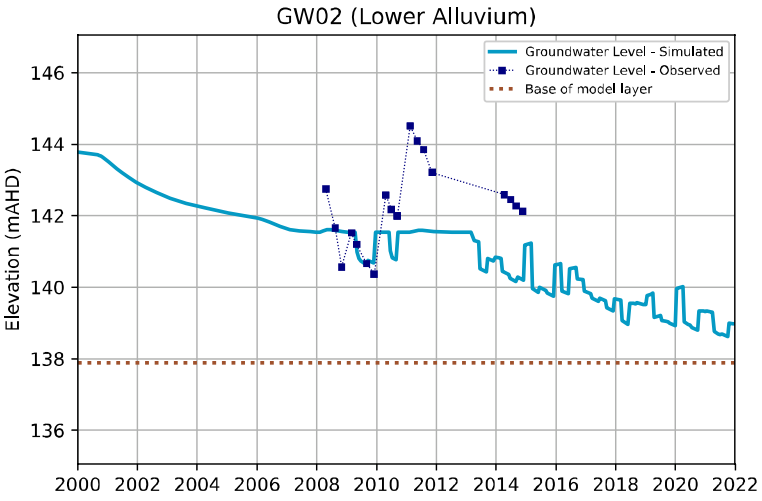

EC27 (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
150
148
146
144
142
140
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

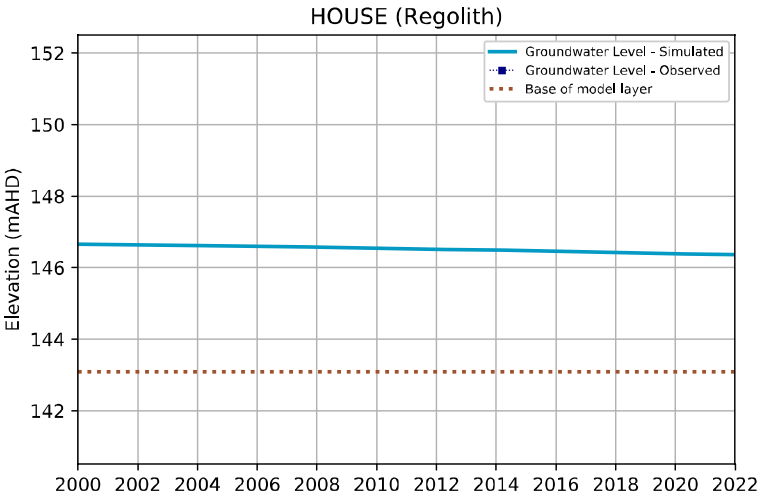

EUROPARK (Upper Rewan)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

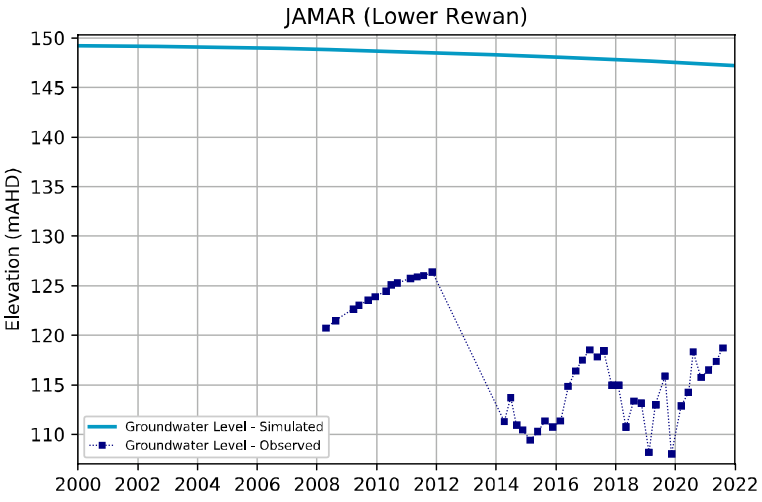

FAIRHILL (Burngrove Formation)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

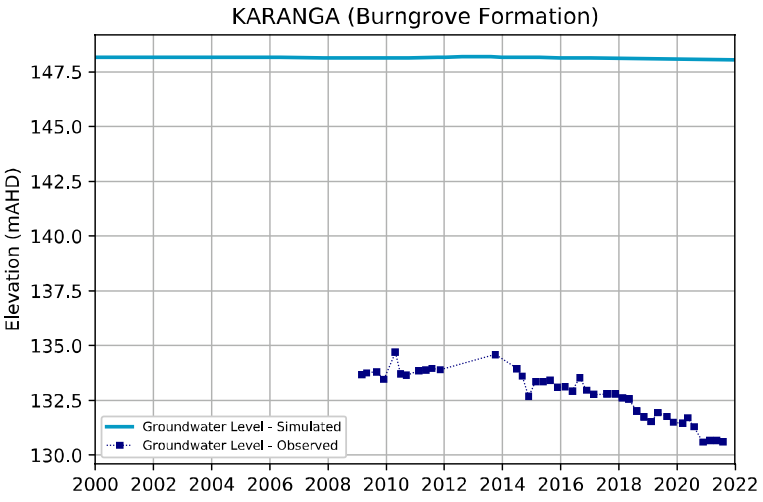

FIELD_5 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

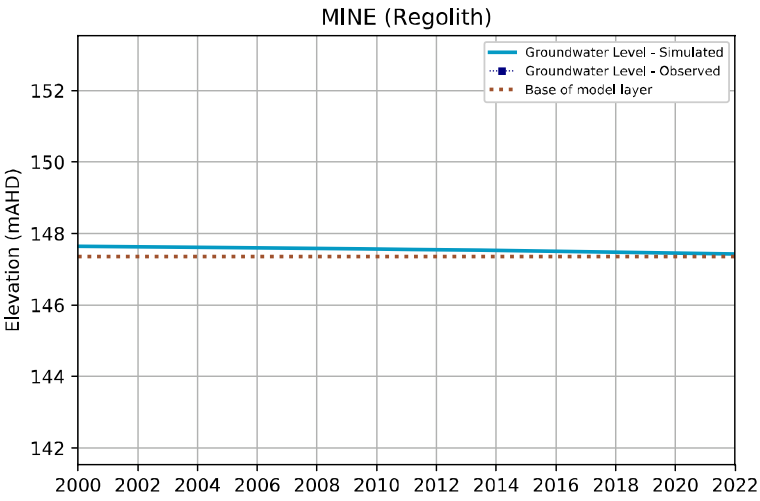

GW01 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

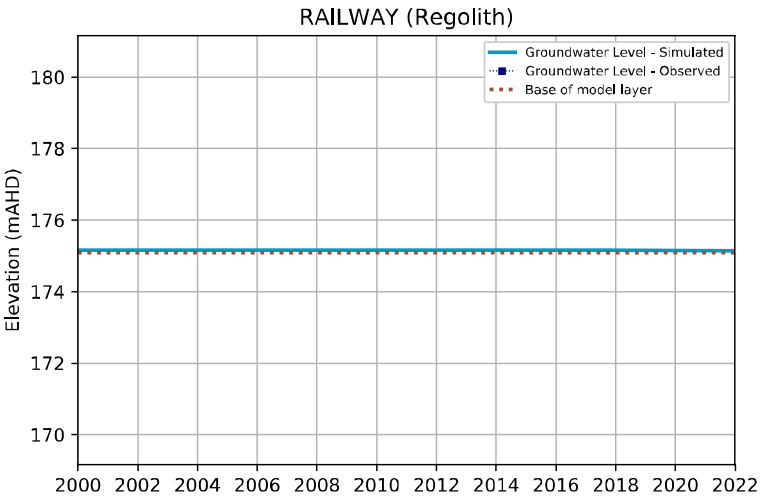

GW02 (Lower Alluvium)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer

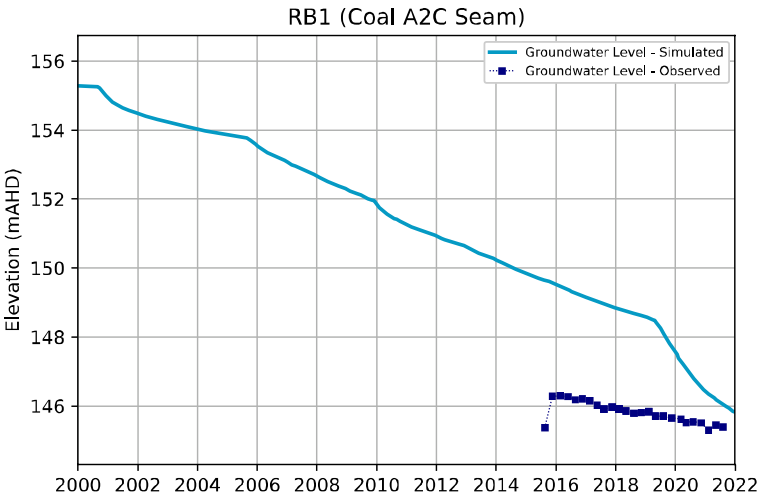

HOUSE (Regolith)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer

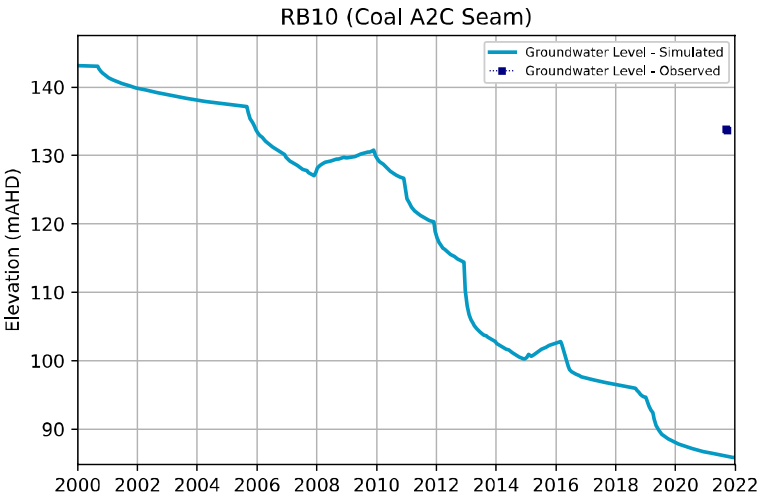

JAMAR (Lower Rewan)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

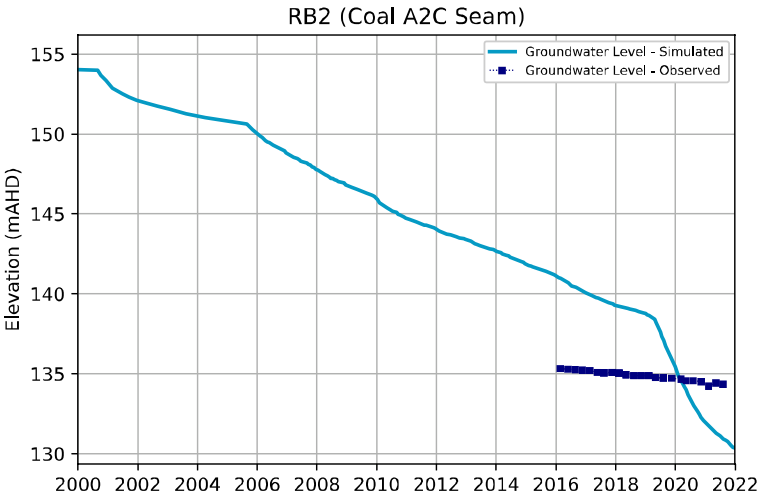

KARANGA (Burngrove Formation)
Elevation (mAHD)
Groundwater Level - Simulated
Groundwater Level - Observed

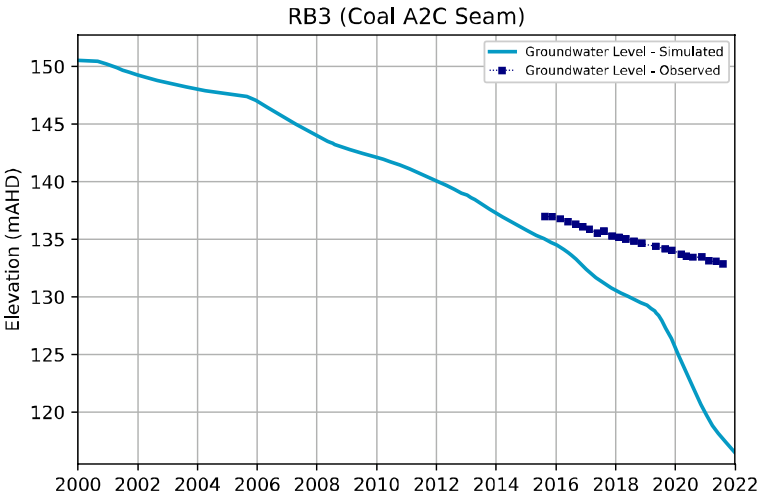

MINE (Regolith)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
152
150
148
146
144
142
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

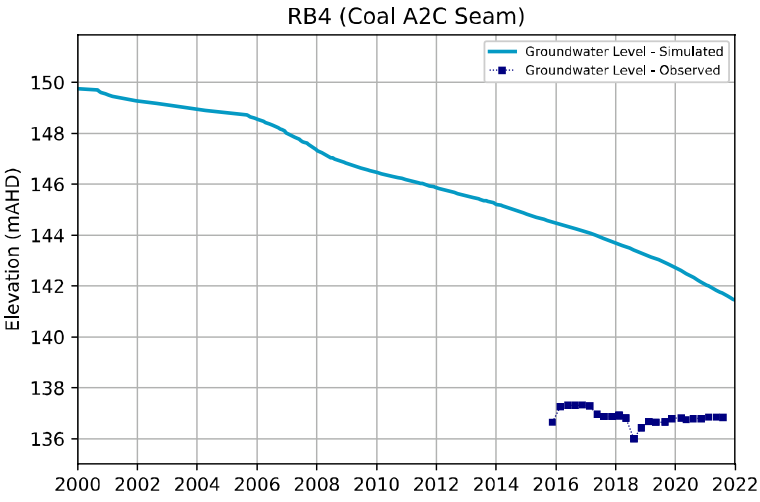

RAILWAY (Regolith)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
180
178
176
174
172
170
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

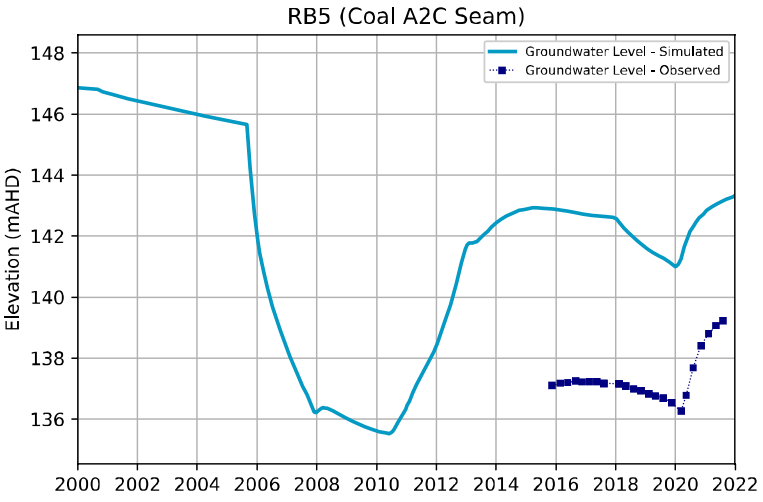

RB1 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
156
154
152
150
148
146
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

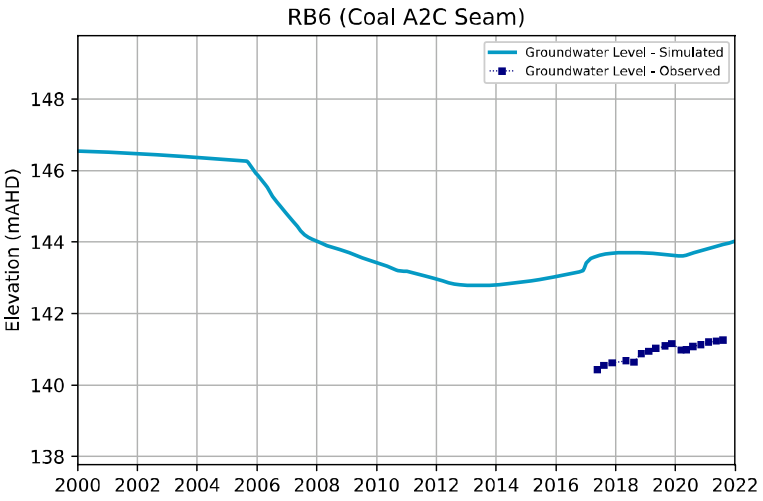

RB10 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
140
130
120
110
100
90
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

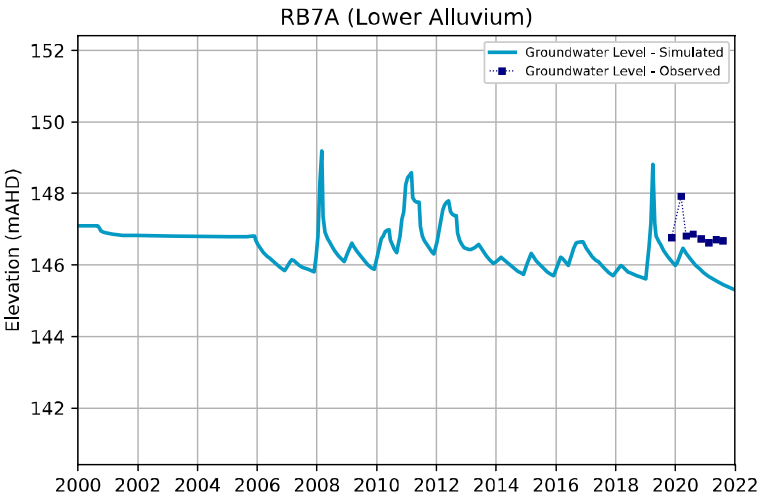

RB2 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
155
150
145
140
135
130
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

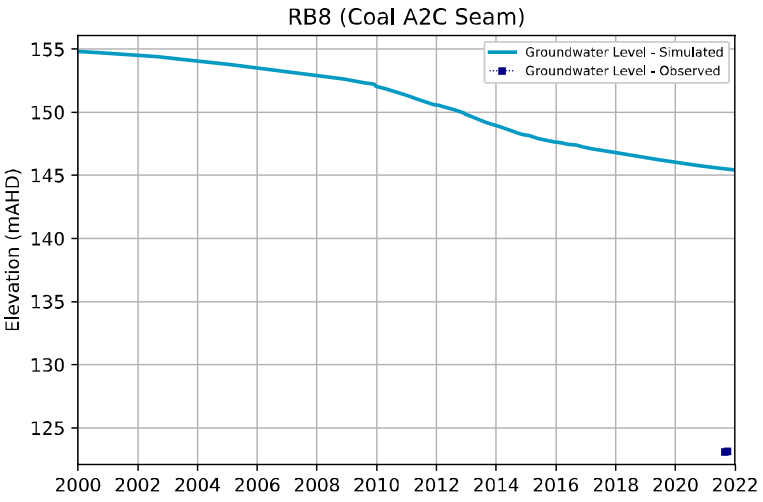

RB3 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
150
145
140
135
130
125
120
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

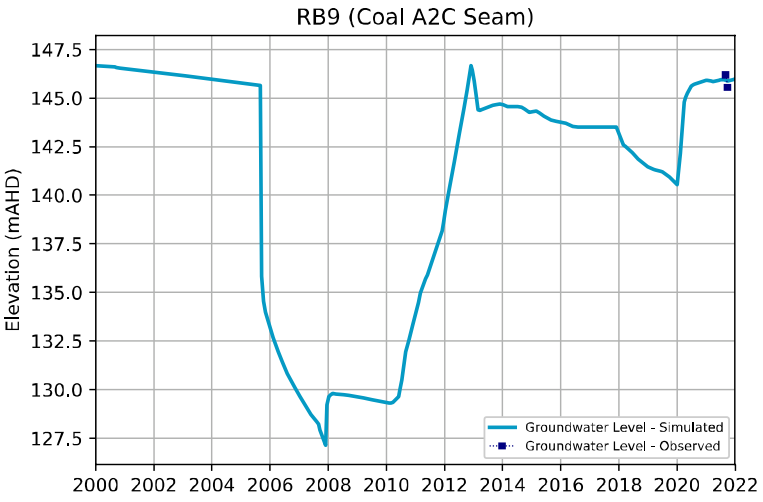

RB4 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
150
148
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

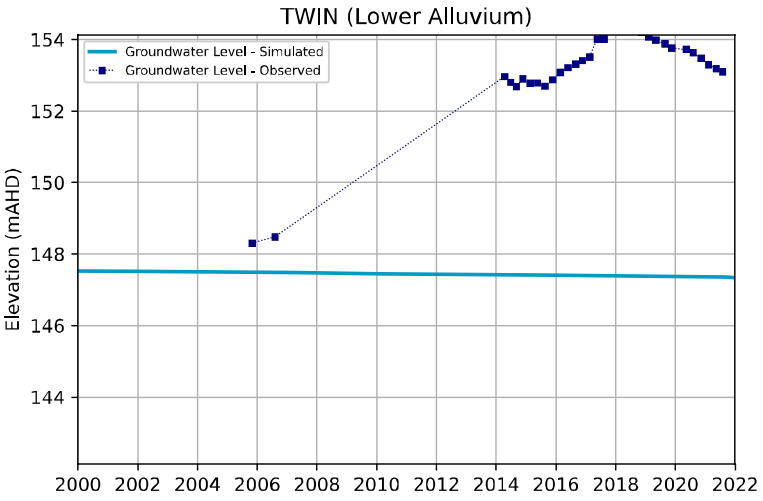

RB5 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
148
146
144
142
140
138
136
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

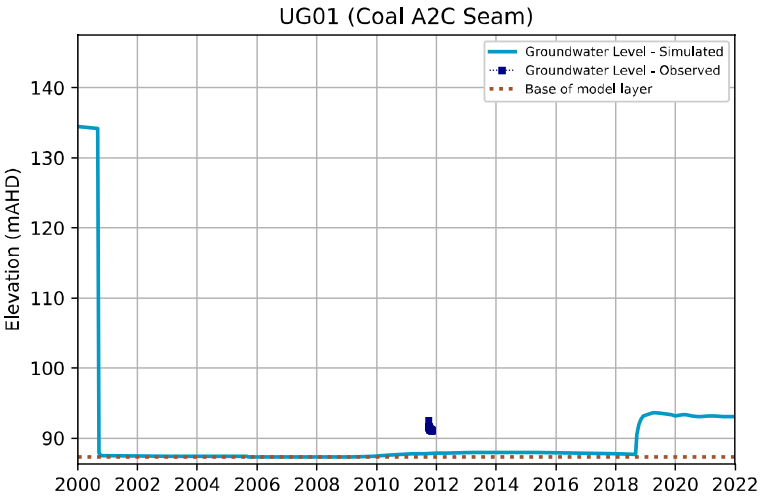

RB6 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
148
146
144
142
140
138
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

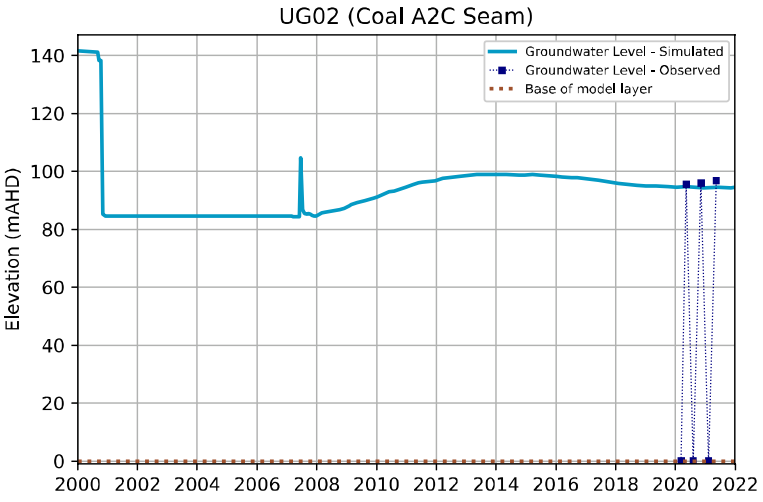

RB7A (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
152
150
148
146
144
142
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

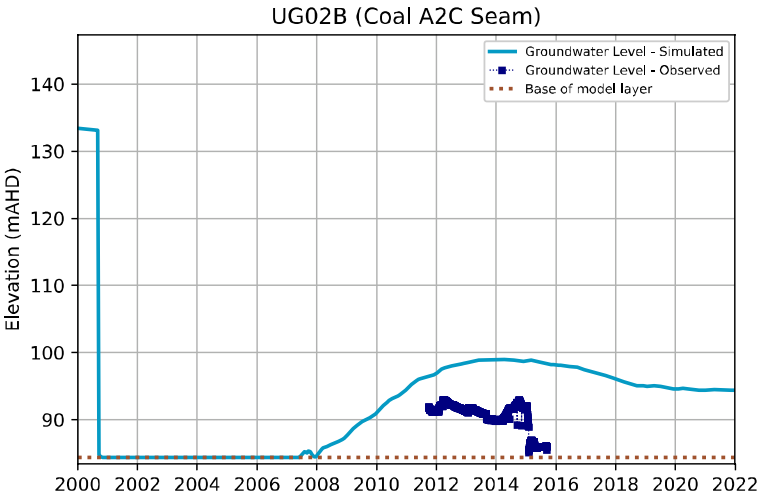

RB8 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
155
150
145
140
135
130
125
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

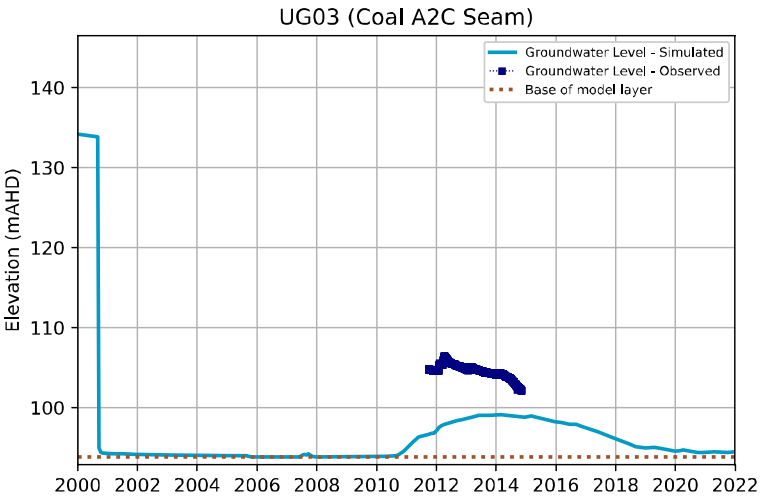

RB9 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
147.5
145.0
142.5
140.0
137.5
135.0
132.5
130.0
127.5
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

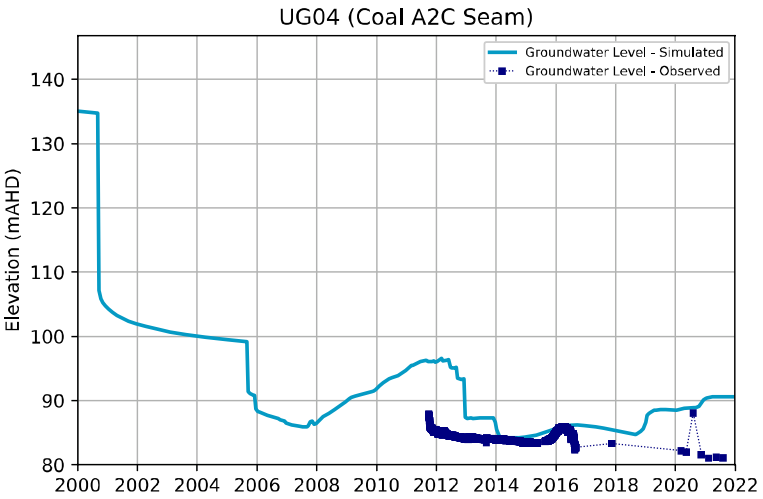

TWIN (Lower Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
154
152
150
148
146
144
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

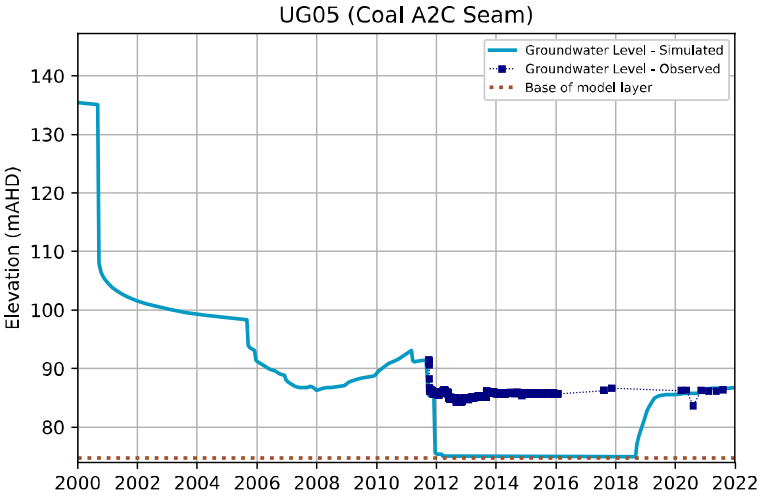

UG01 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

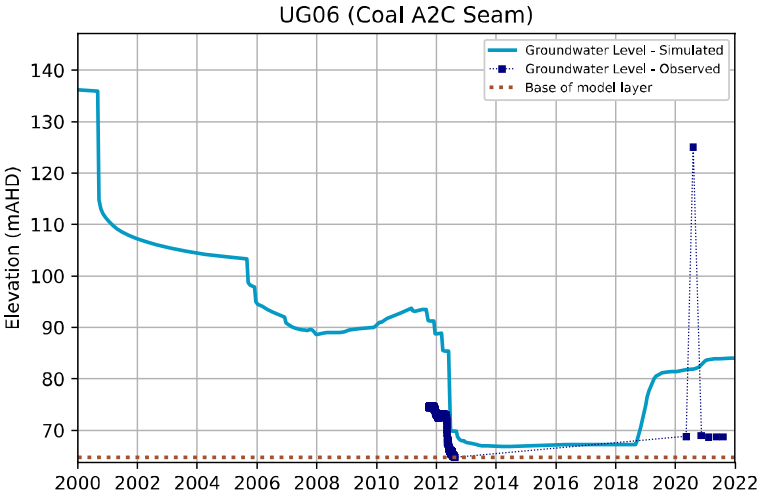

UG02 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
120
100
80
60
40
20
0
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

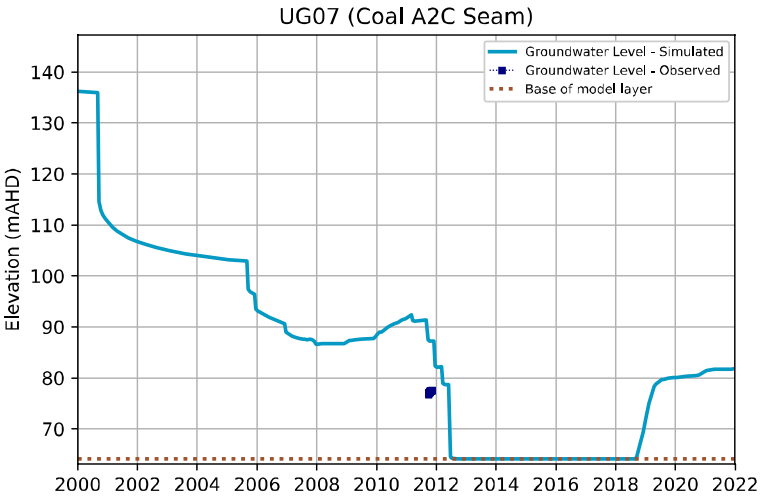

UG02B (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)
140
130
120
110
100
90
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

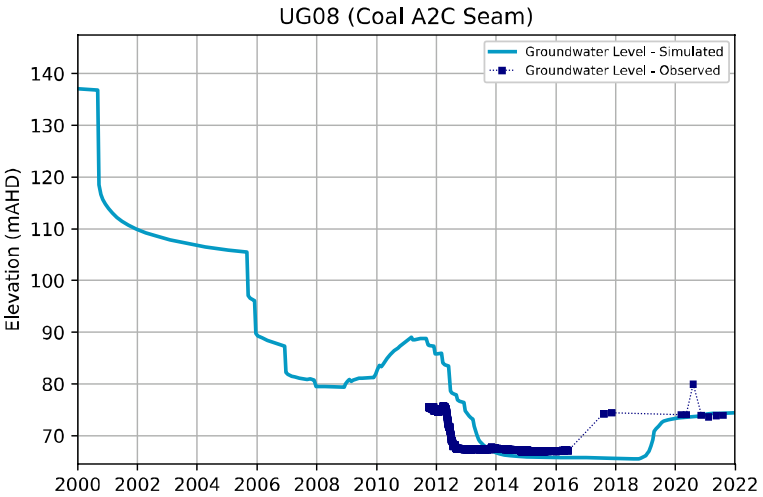

UG03 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

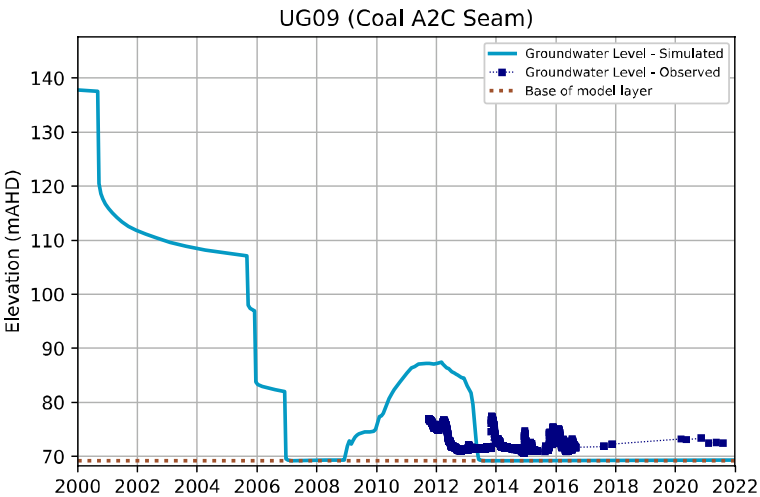

UG04 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

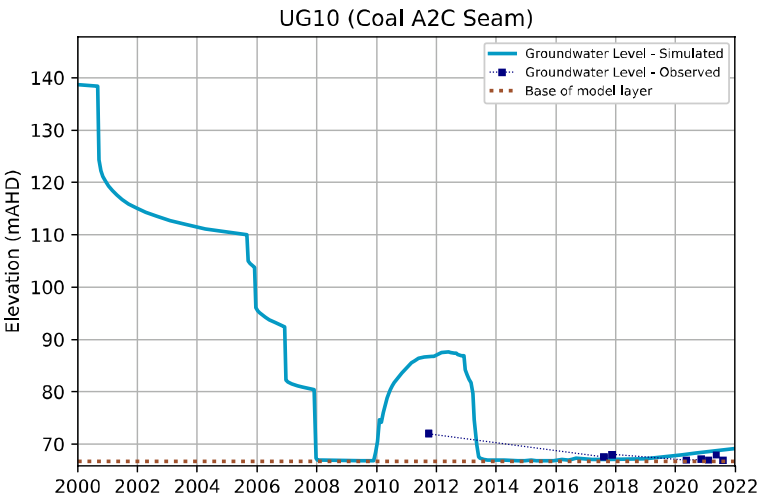

UG05 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

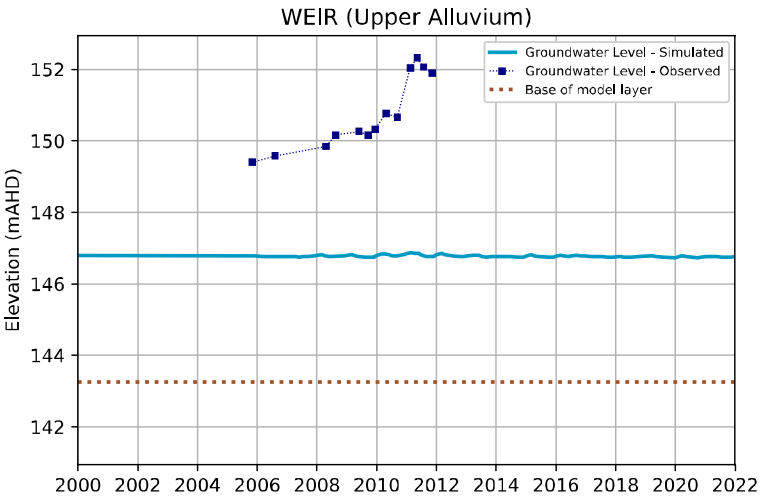

UG06 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

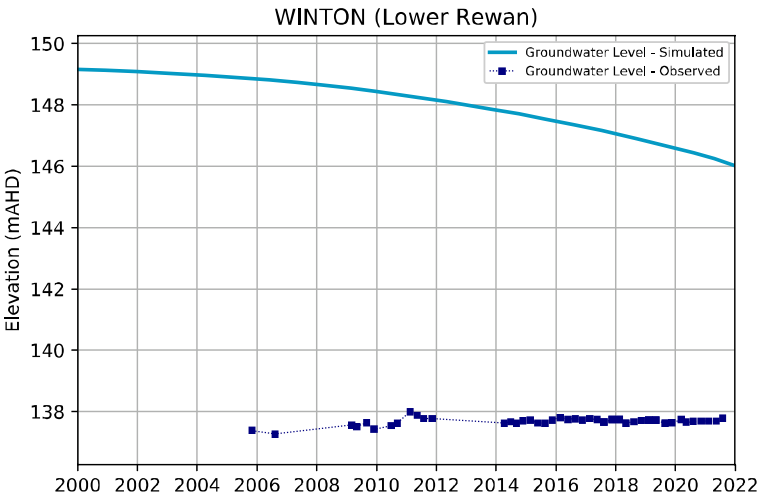

UG07 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

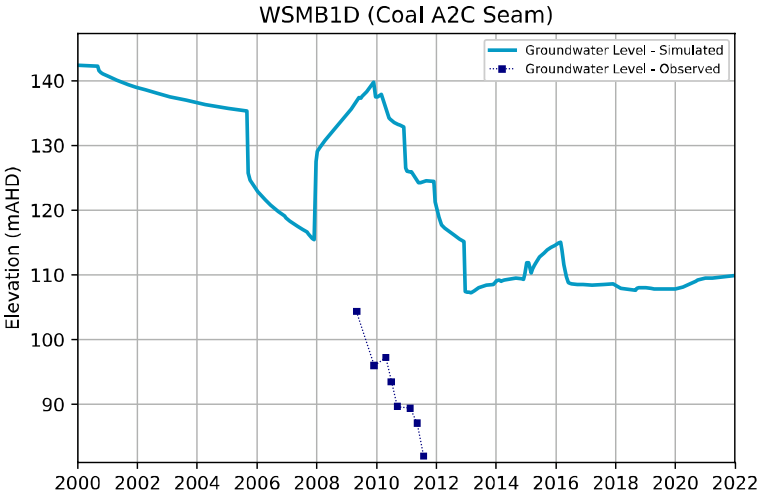

UG08 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

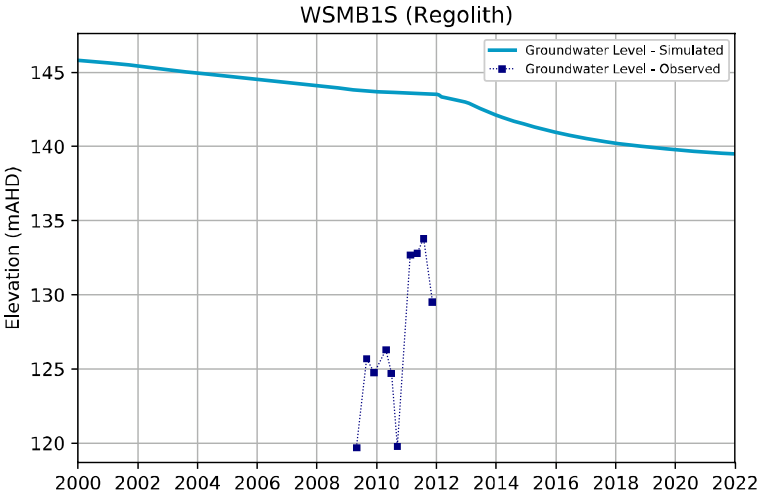

UG09 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

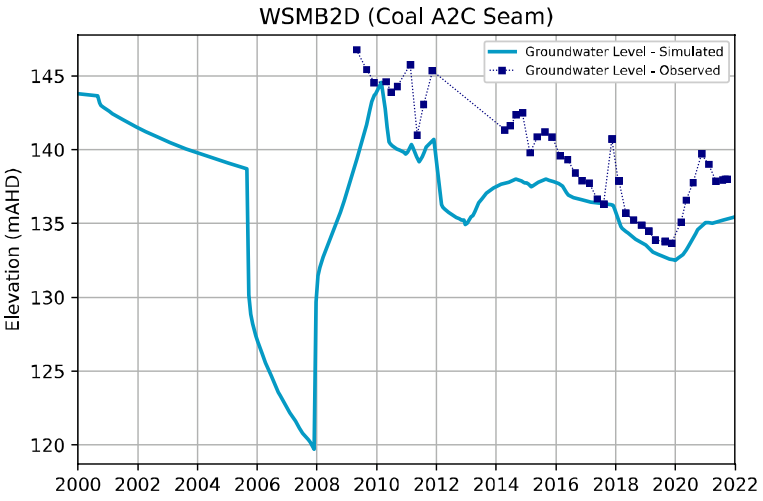

UG10 (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

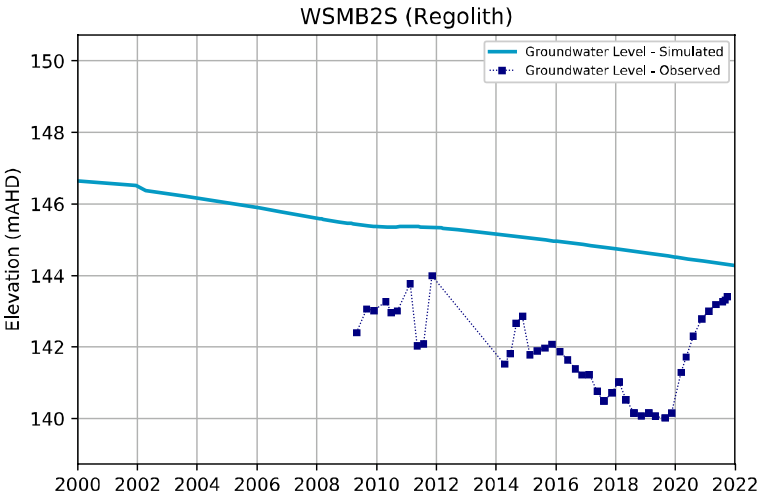

WEIR (Upper Alluvium)
Groundwater Level - Simulated
Groundwater Level - Observed
Base of model layer
Elevation (mAHD)

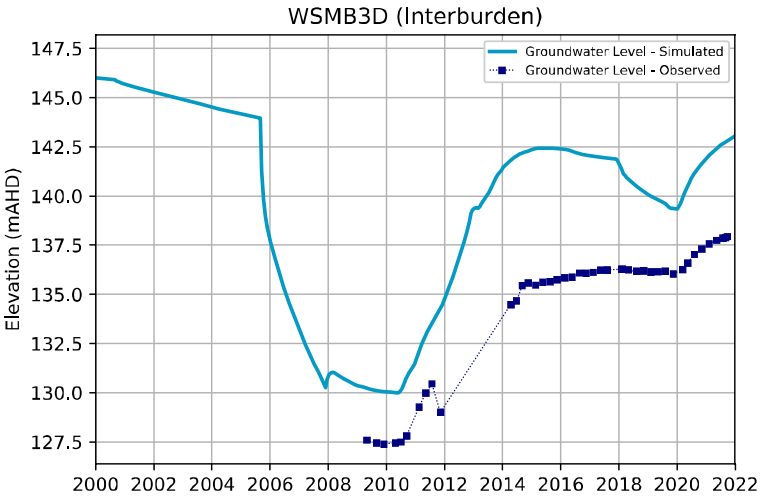

WINTON (Lower Rewan)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

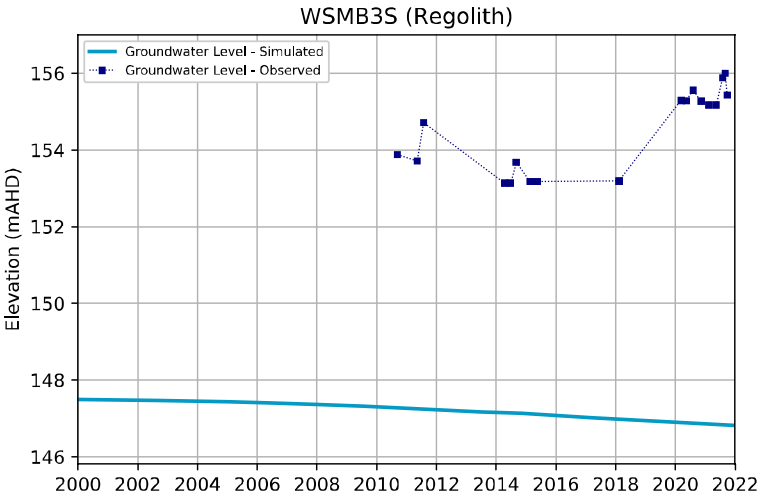

WSMB1D (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

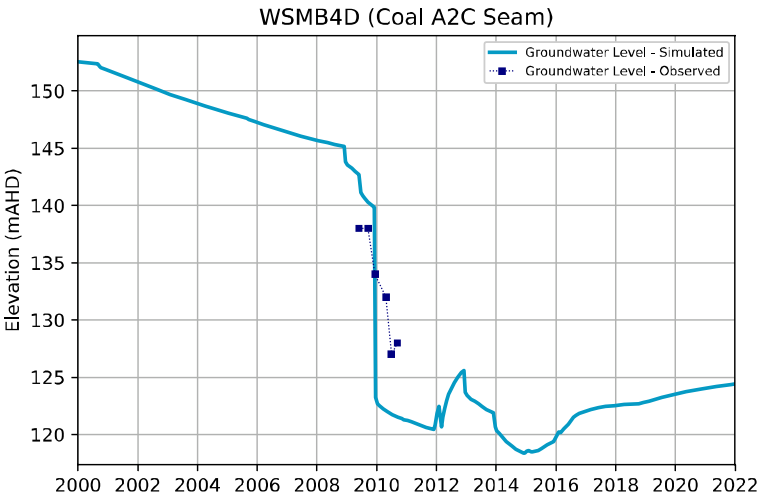

WSMB1S (Regolith)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

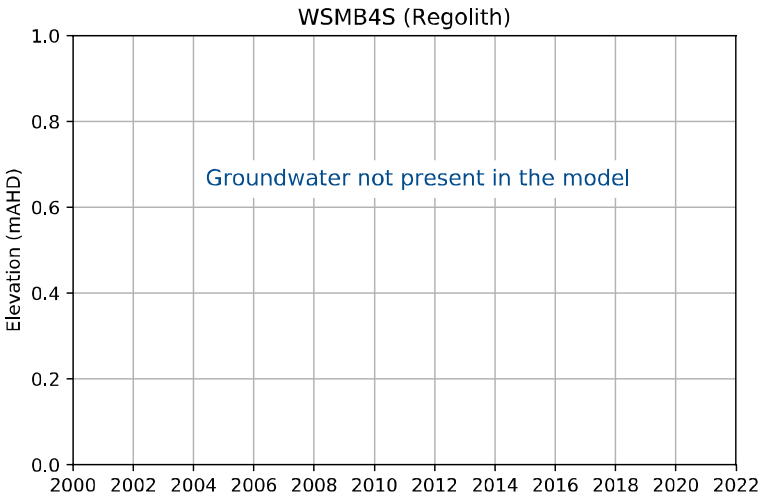

WSMB2D (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

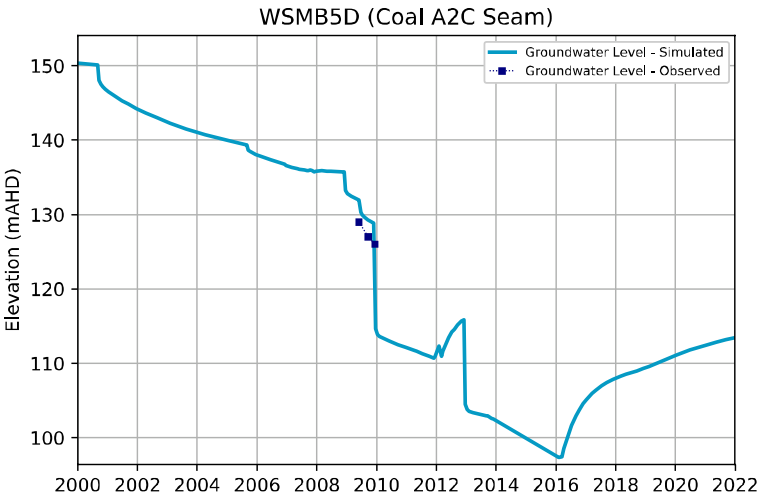

WSMB2S (Regolith)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)

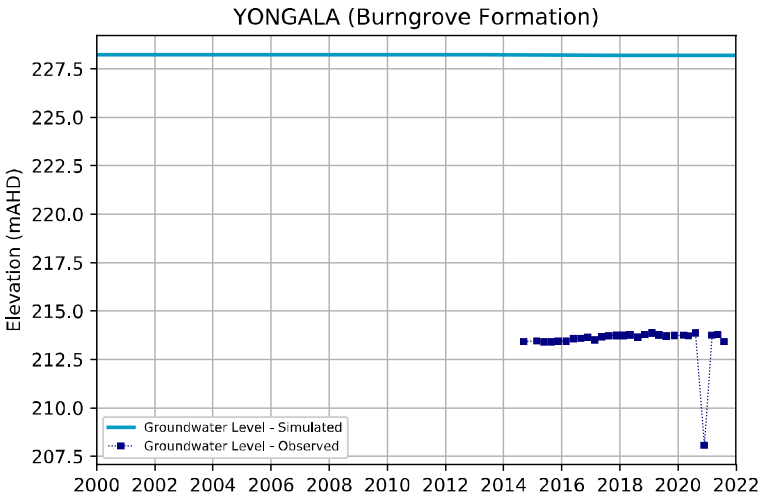

WSMB3D (Interburden)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)


WSMB3S (Regolith)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)


WSMB4D (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
150
145
140
135
130
125
120
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

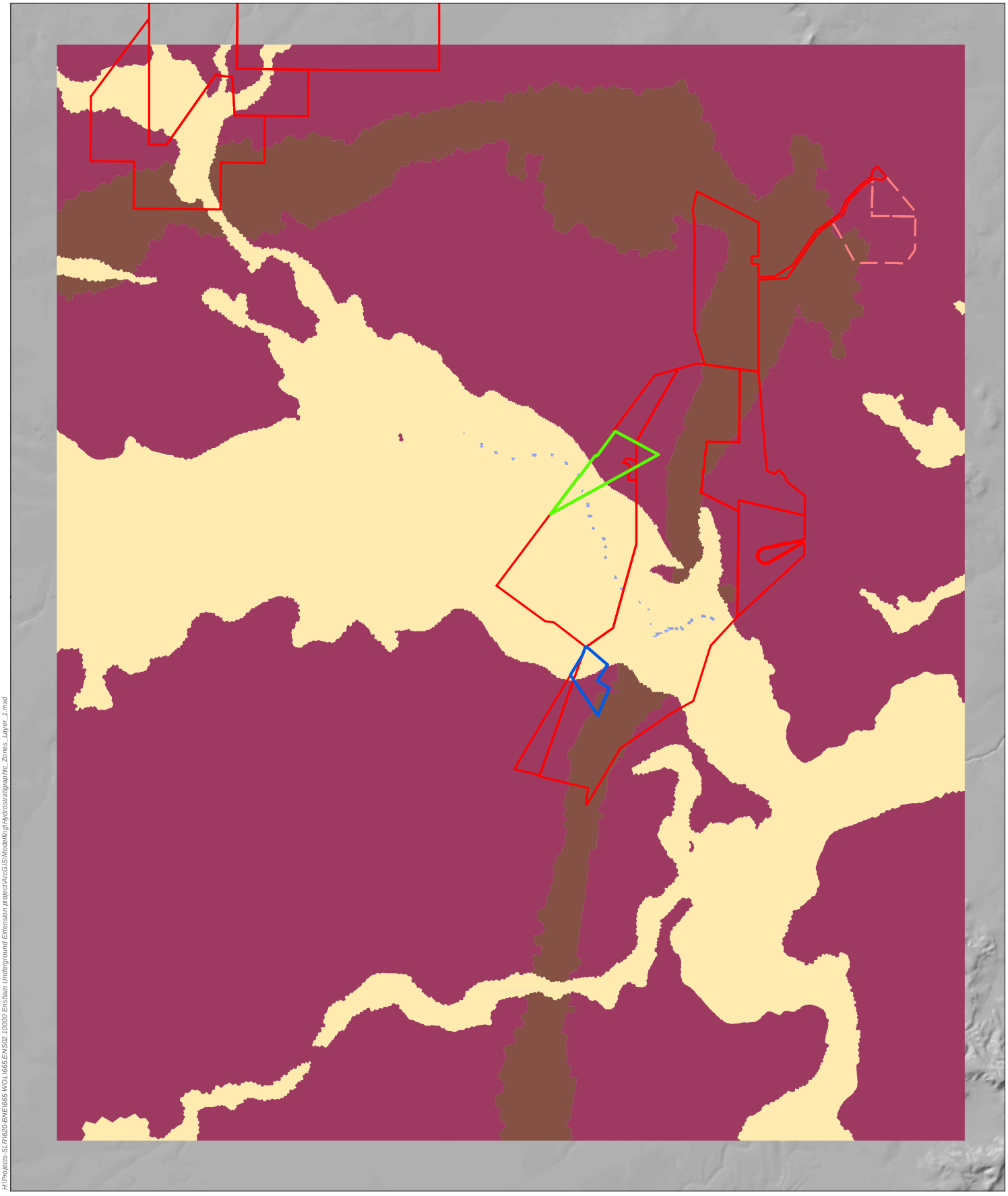

WSMB4S (Regolith)
Groundwater not present in the model
Elevation (mAHD)
1.0
0.8
0.6
0.4
0.2
0.0
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022


WSMB5D (Coal A2C Seam)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
150
140
130
120
110
100
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022


YONGALA (Burngrove Formation)
Groundwater Level - Simulated
Groundwater Level - Observed
Elevation (mAHD)
227.5
225.0
222.5
220.0
217.5
215.0
212.5
210.0
207.5
2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022

APPENDIX F

Hydraulic property zones



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_1.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L1 K Zones

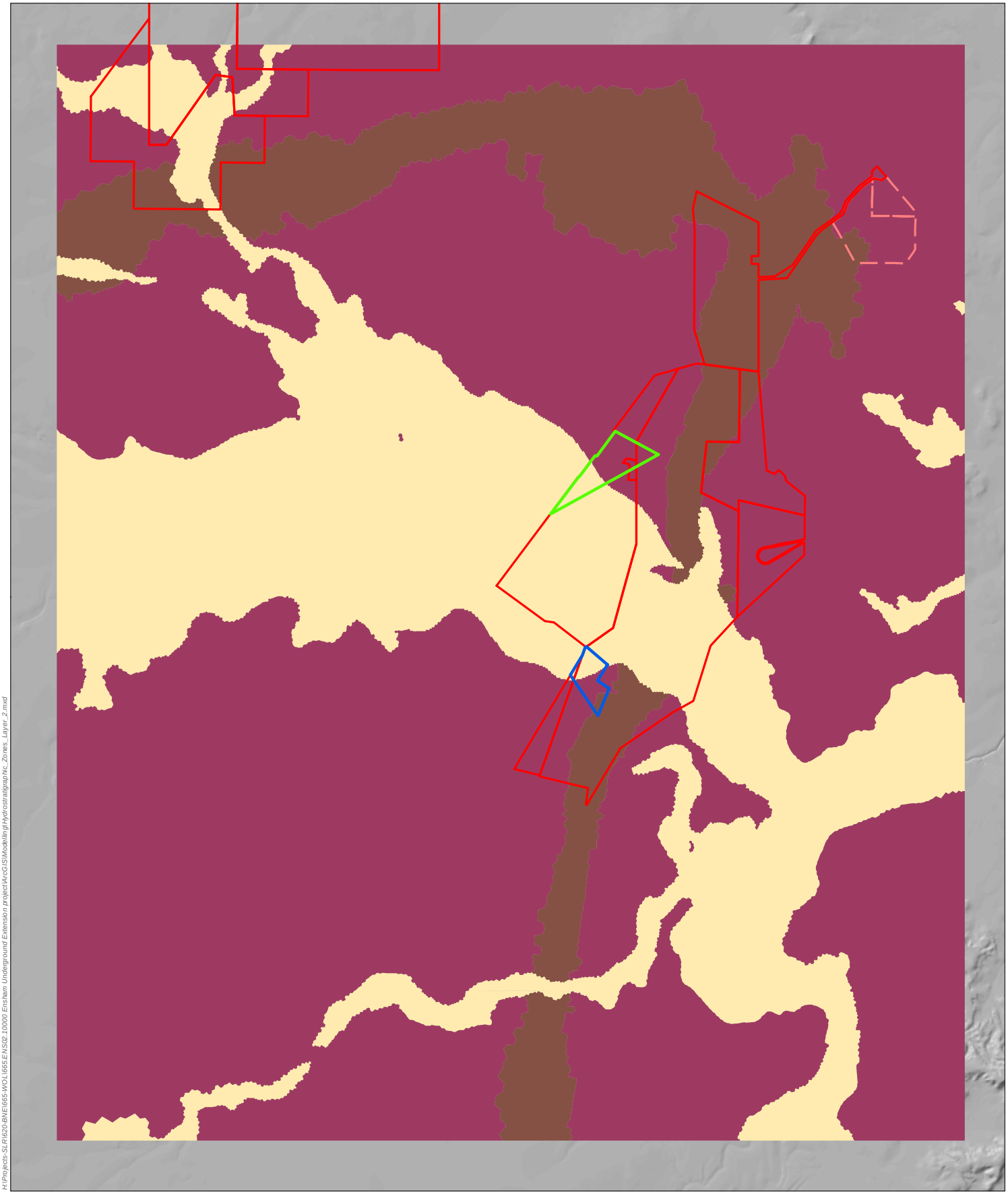
- Alluvium
- Nagoa River
- Regolith
- Shallow CM

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 1

F1-1

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_2.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L2 K Zones

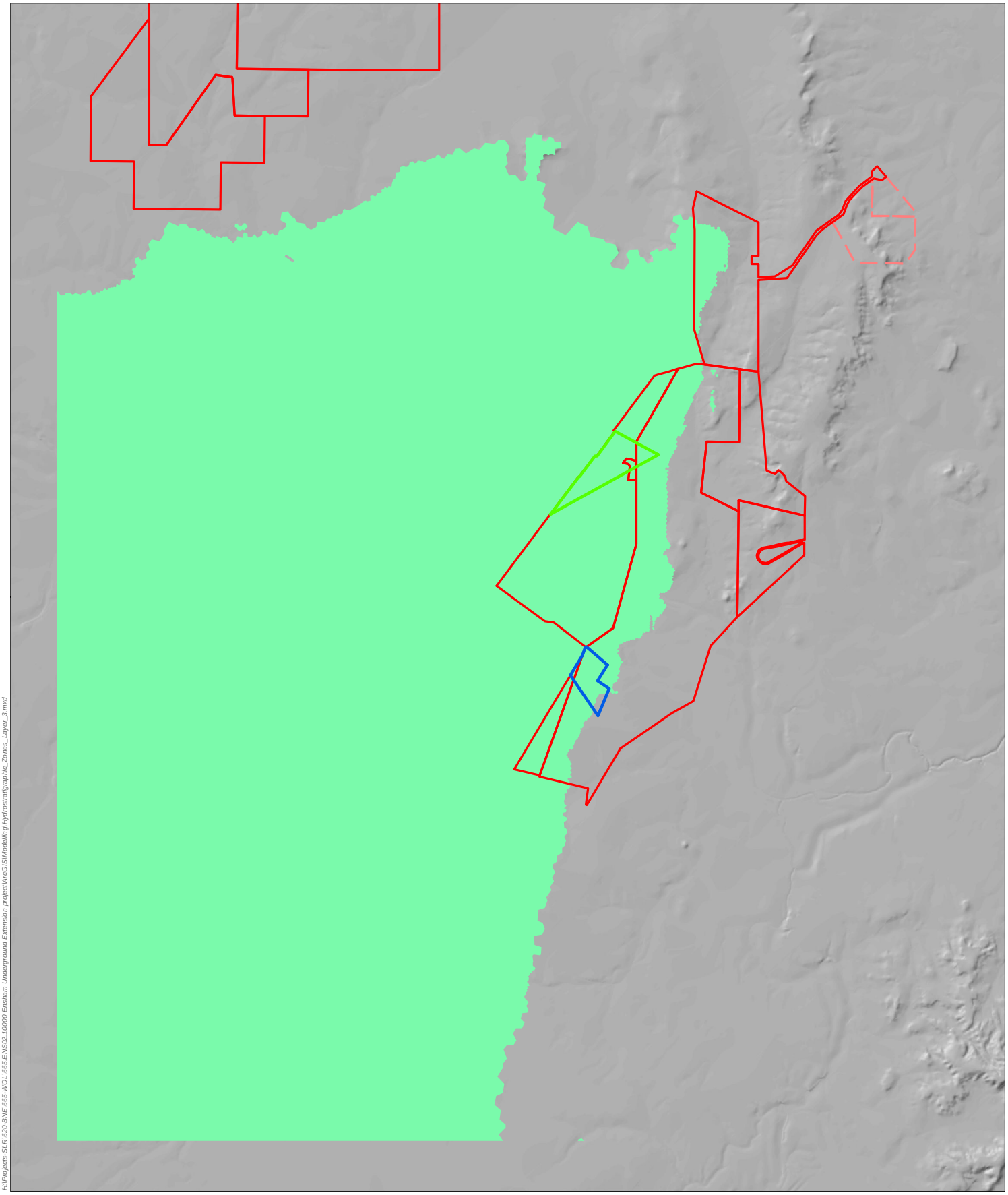
- Alluvium
- Regolith
- Shallow CM

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 2

F1-2

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_3.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L3 K Zones

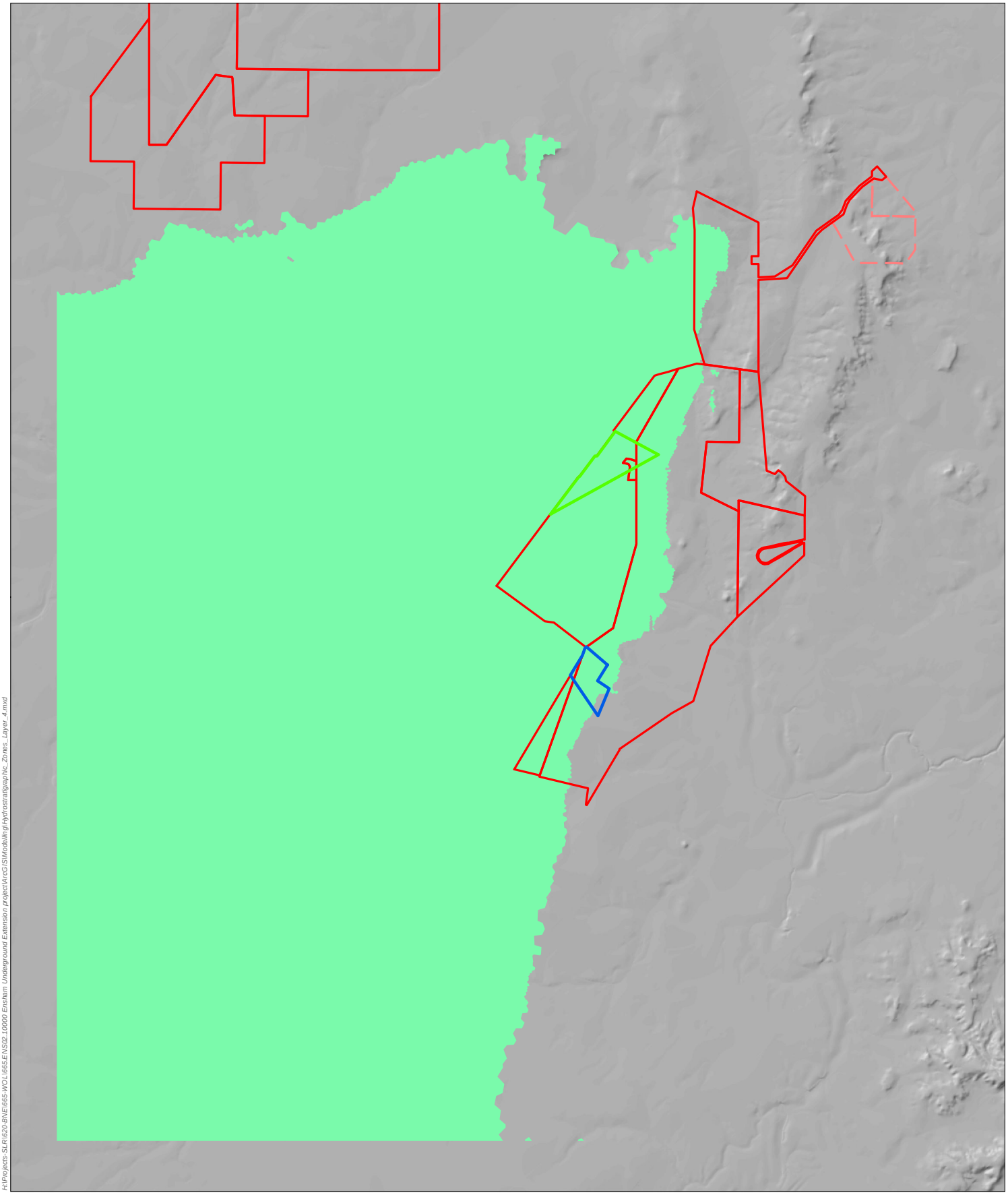
- Rewan

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 3

F1-3

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_4.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L4 K Zones

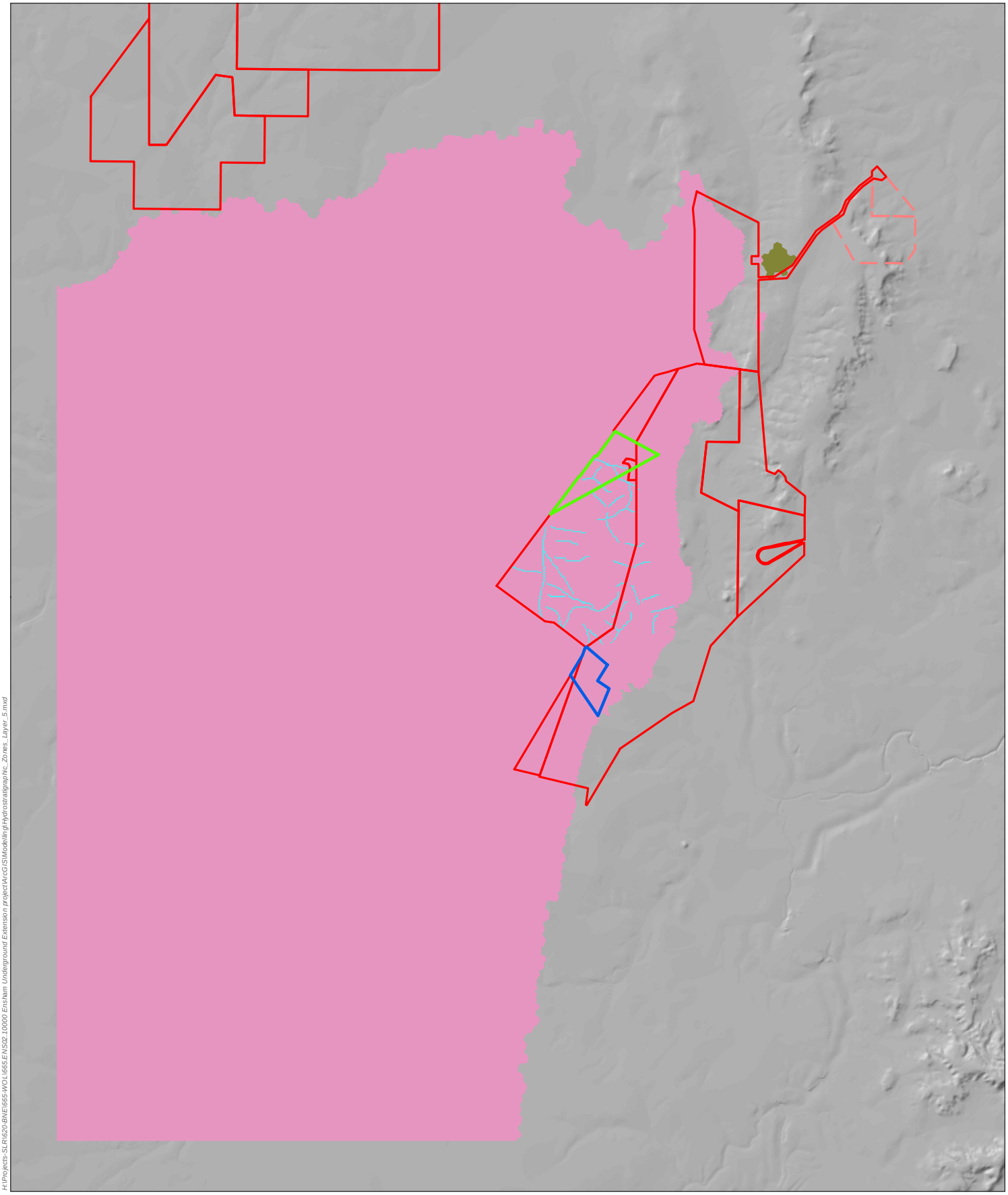
- Rewan

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 4

F1-4

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_5.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L5 K Zones

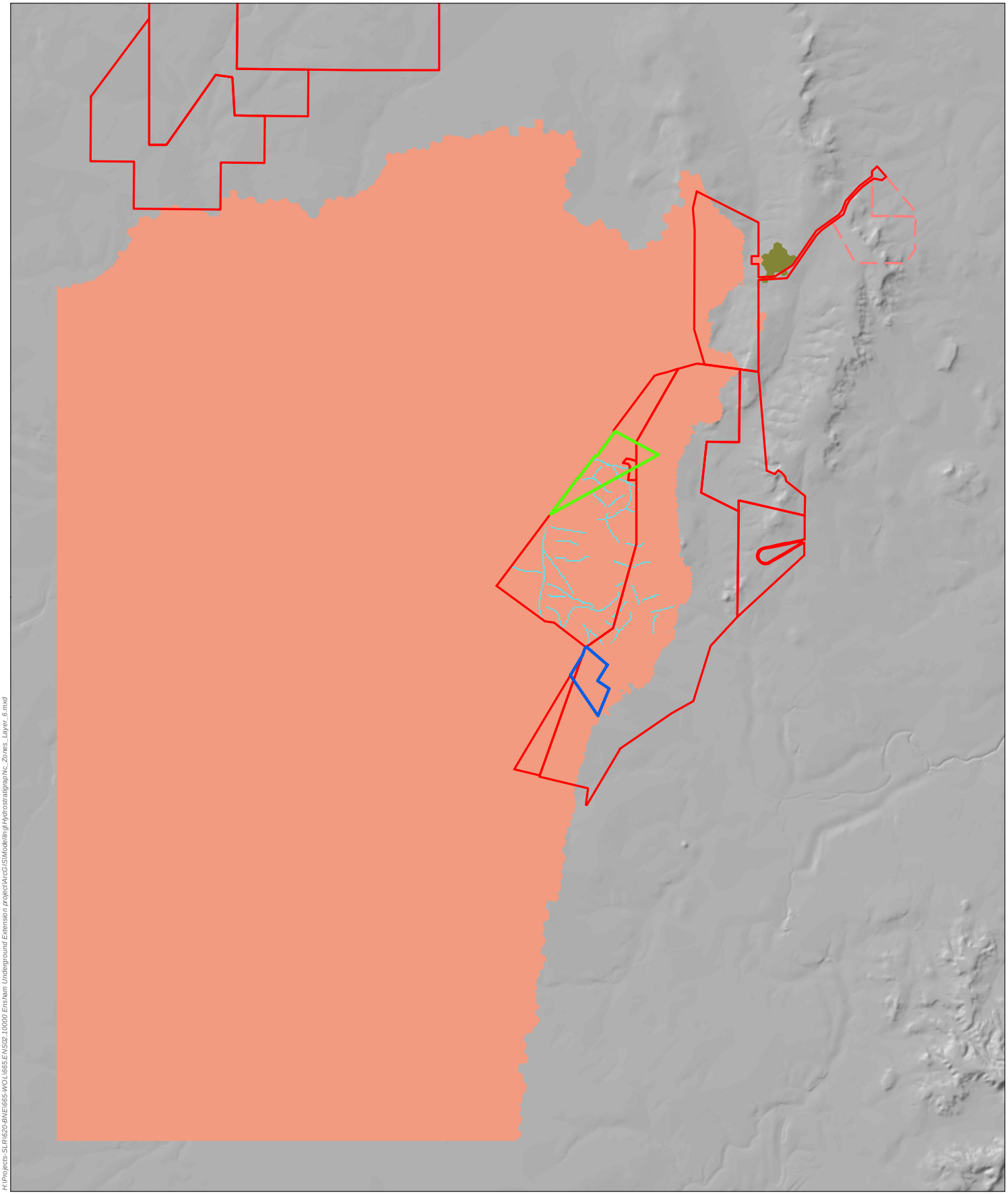
- Basement
- Fault
- Inter1

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 5

F1-5



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_6.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L6 K Zones

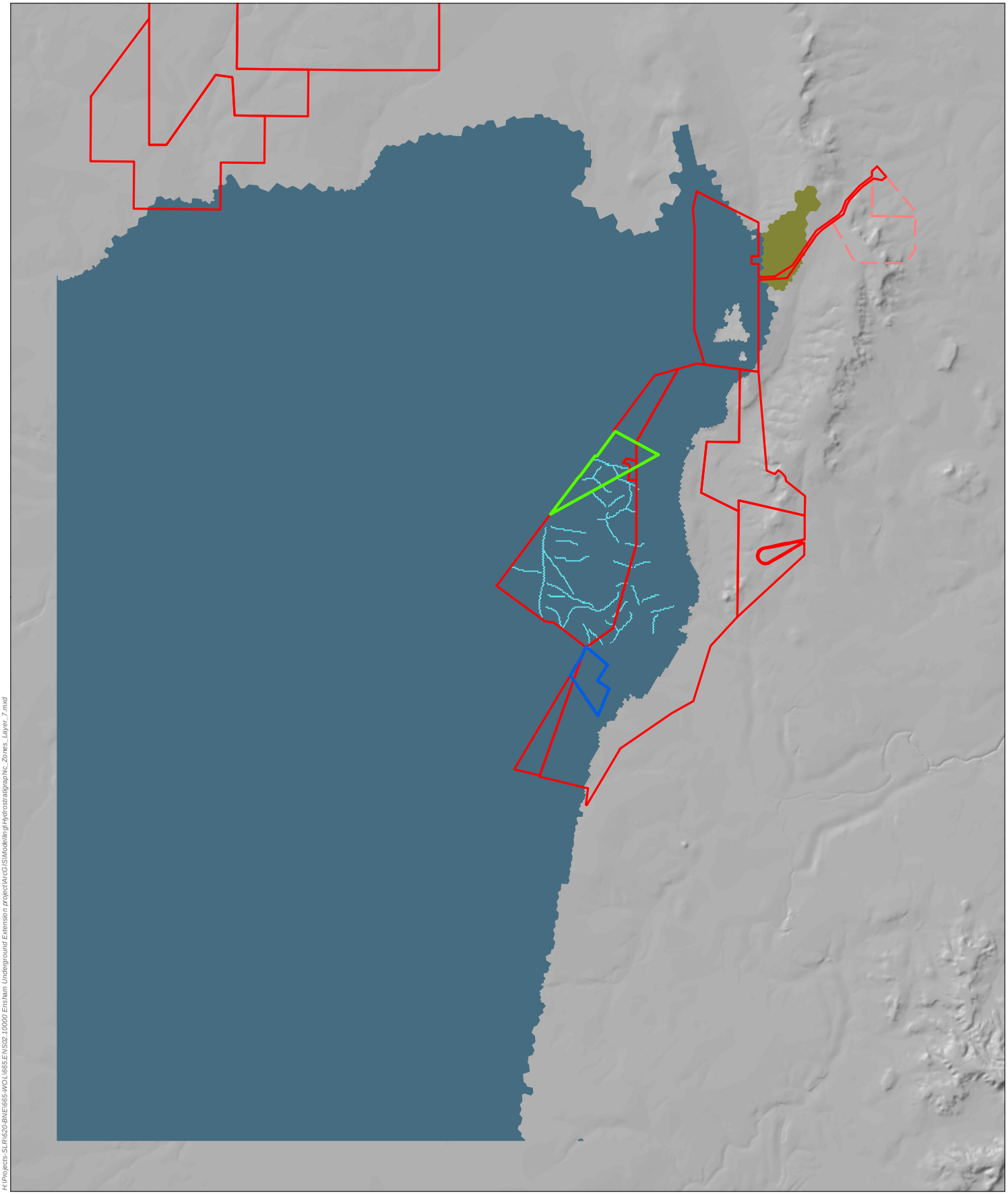
- Aries Seam
- Basement
- Fault

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 6

F1-6



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_7.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L7 K Zones

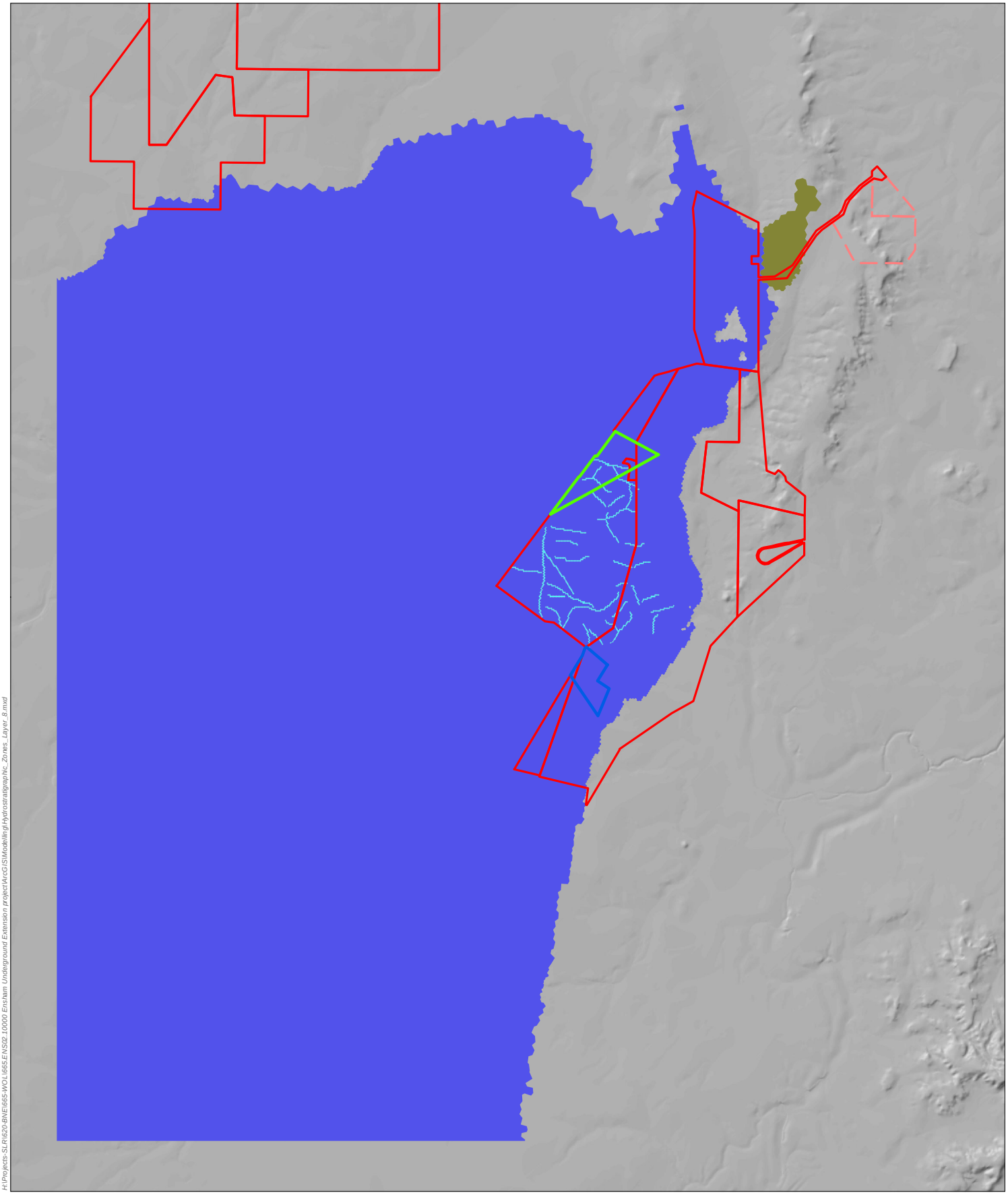
- Basement
- Fault
- Inter2

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 7

F1-7



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_8.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L8 K Zones

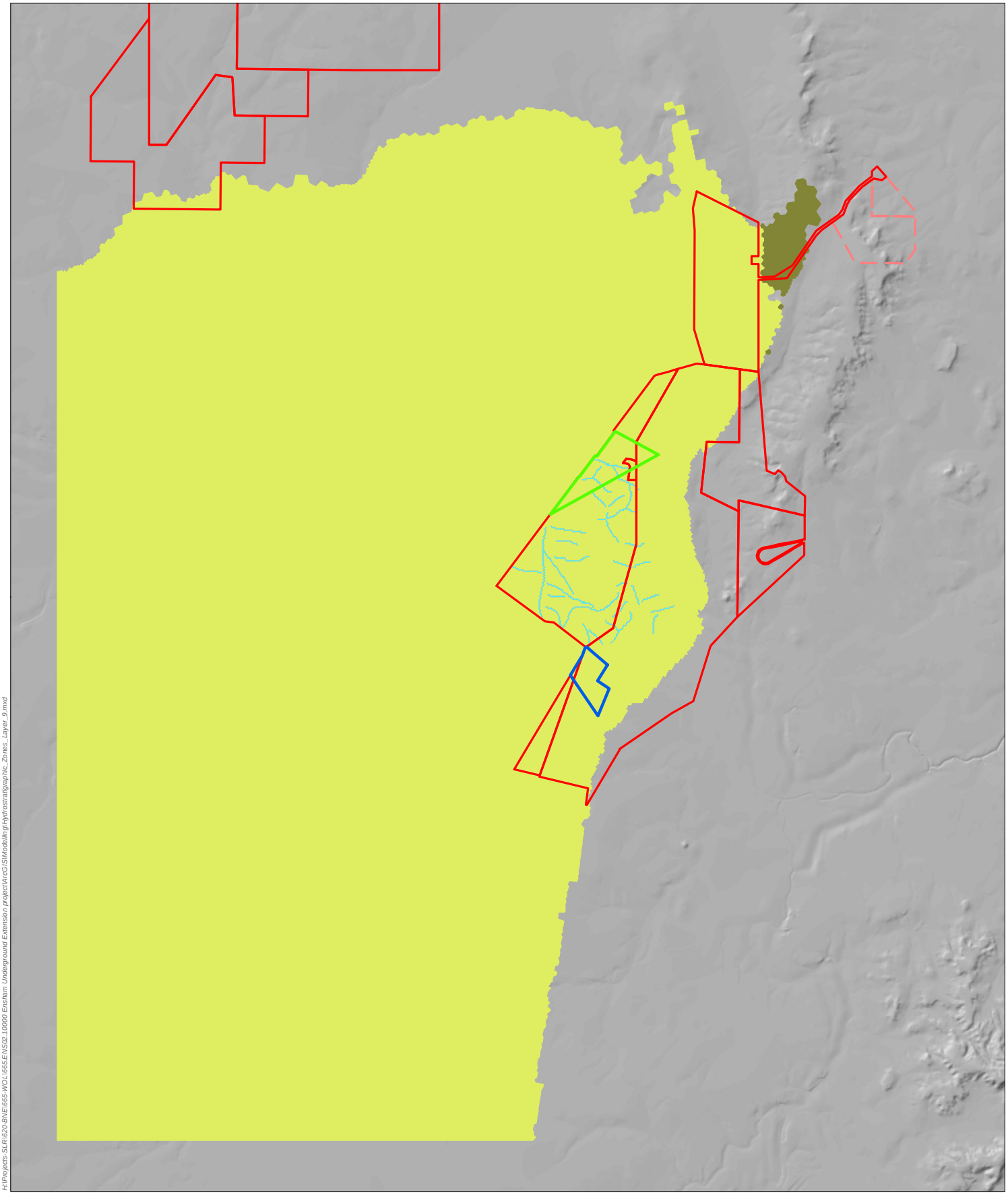
- Aries 2 and Castor
- Basement
- Fault

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 8

F1-8



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_9.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L9 K Zones

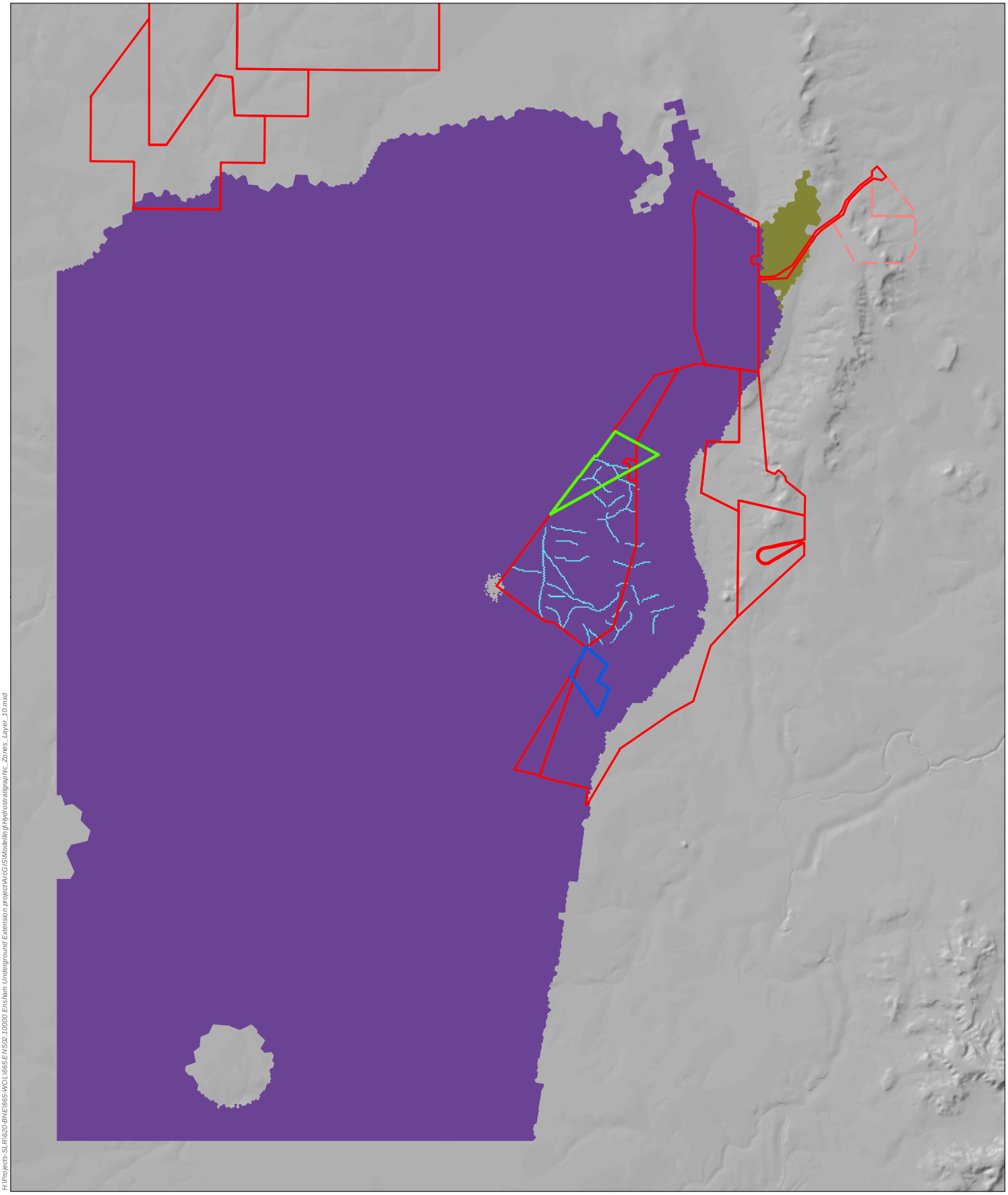
- Basement
- Fault
- Inter3

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 9

F1-9



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_10.mxd

GROUNDWATER IMPACT ASSESSMENT

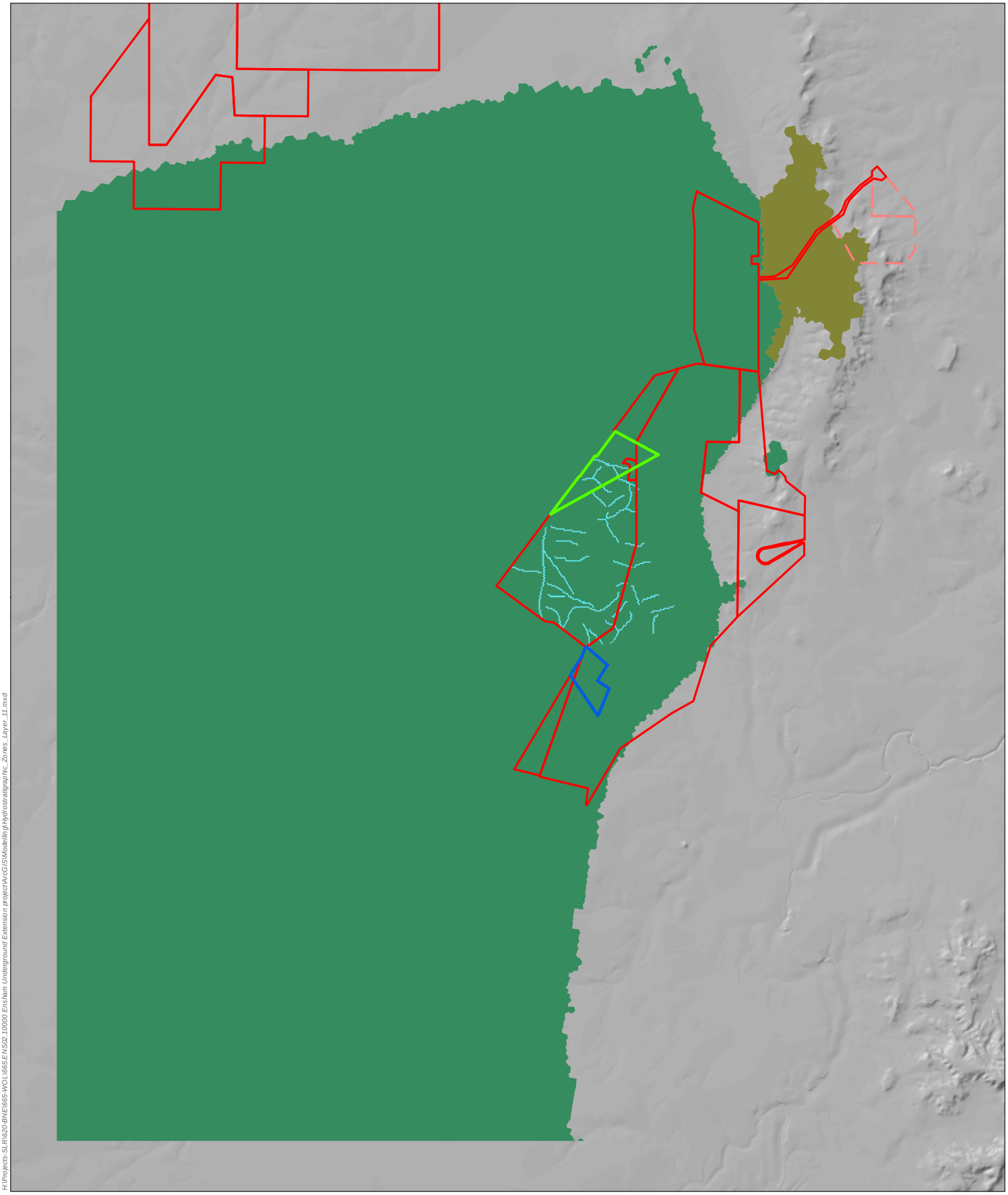
Hydrostratigraphic Zones - Layer 10

F1-10

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	03-Mar-2022
Drawn by:	PM
Sheet Size:	A4

SLR
www.slrconsulting.com



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_11.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L11 K Zones

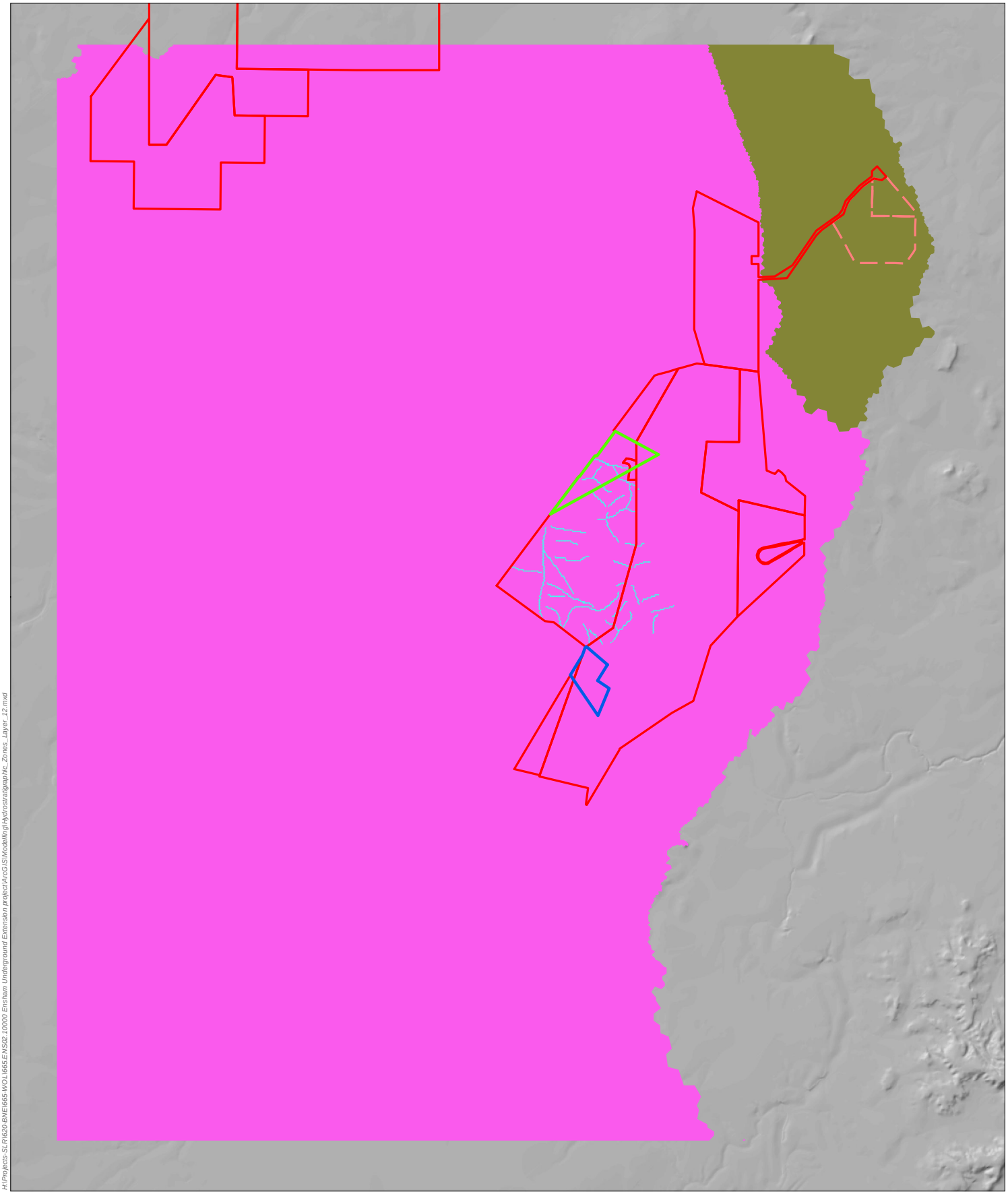
- Basement
- Fault
- Inter4

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 11

F1-11



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Hydrostratigraphic_Zones_Layer_12.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	07-Feb-2020
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

L12 K Zones

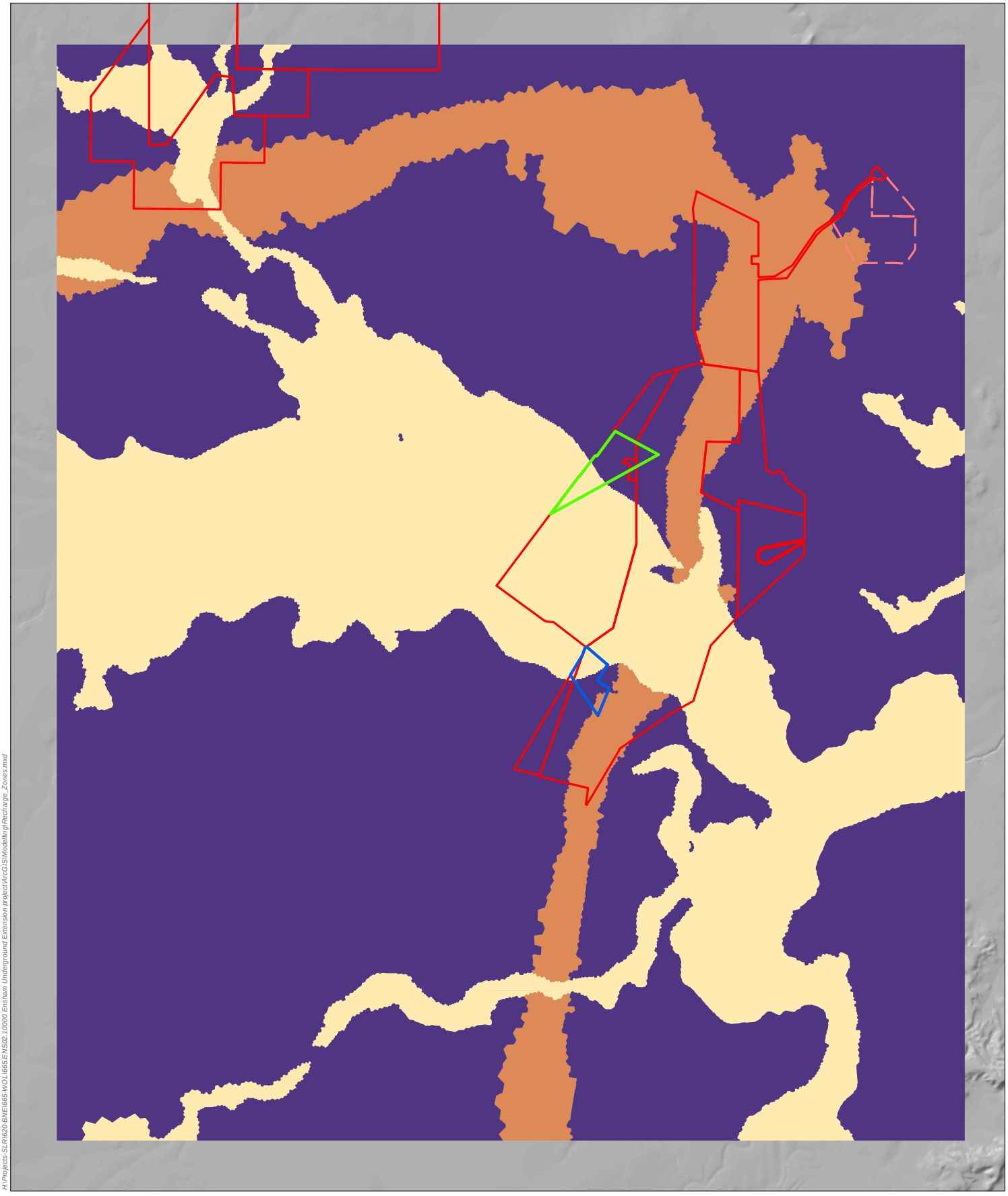
- Basement
- Burngrove
- Fault

SLR
www.slrconsulting.com

GROUNDWATER IMPACT ASSESSMENT

Hydrostratigraphic Zones - Layer 12

F1-12



H:\Projects-SLR\620-BNE\665-WOL\665.ENS02.10000 Ensham Underground Extension project\ArcGIS\Modelling\Recharge_Zones.mxd

0 2 km

Projection: GDA 1994 MGA Zone 55
Scale: 1:200,000

Project No.:	665.ENS02.10000
Date:	03-Mar-2022
Drawn by:	PM
Sheet Size:	A4

Legend

- Mining Lease (Granted)
- Mining Lease (Application)
- Zone 2
- Zone 3

RechZones

- Alluvium
- Regolith
- Shallow CM

SLR
www.slrconsulting.com

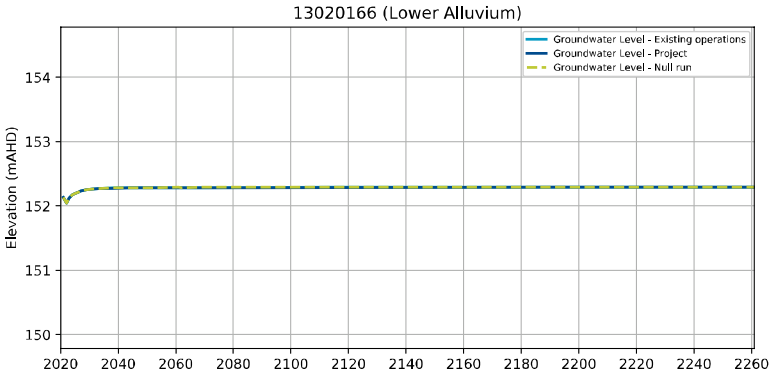
GROUNDWATER IMPACT ASSESSMENT

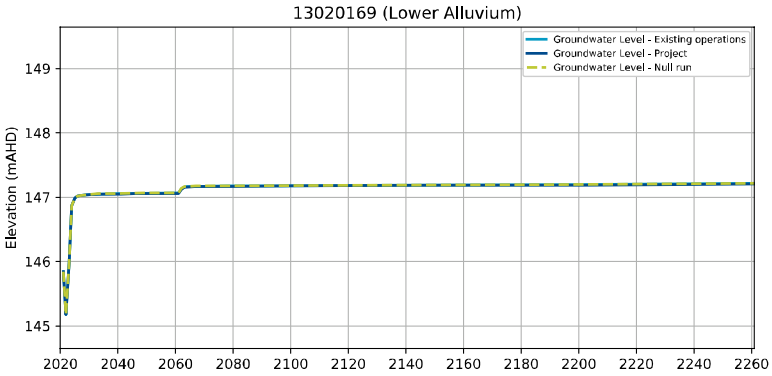
Recharge Zones

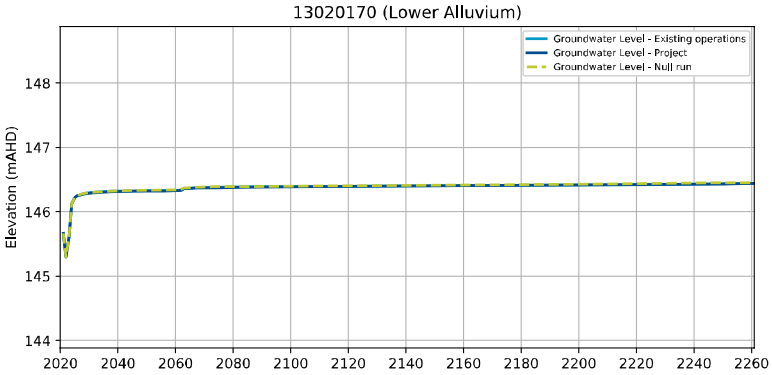
F2-1

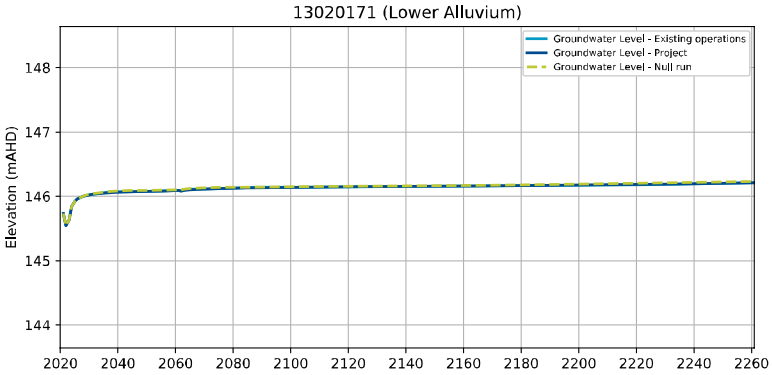
APPENDIX G

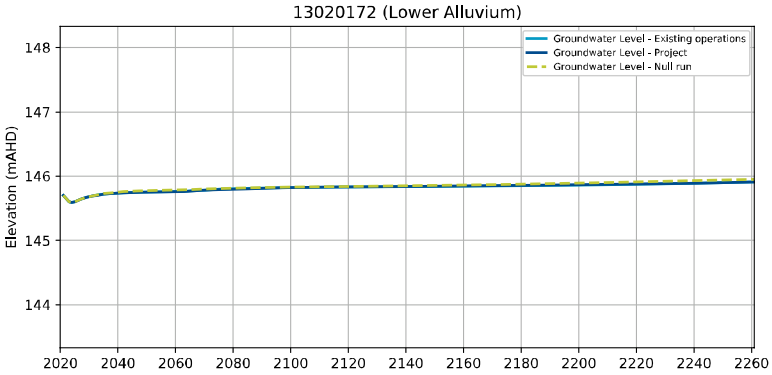
Prediction Hydrographs

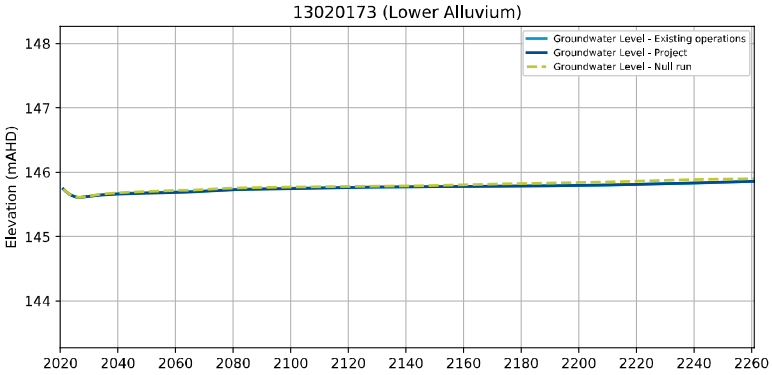

13020166 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
154
153
152
151
150
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

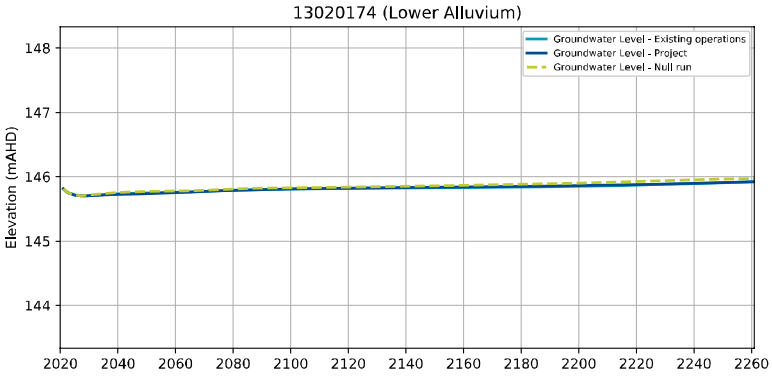

13020169 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
149
148
147
146
145
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

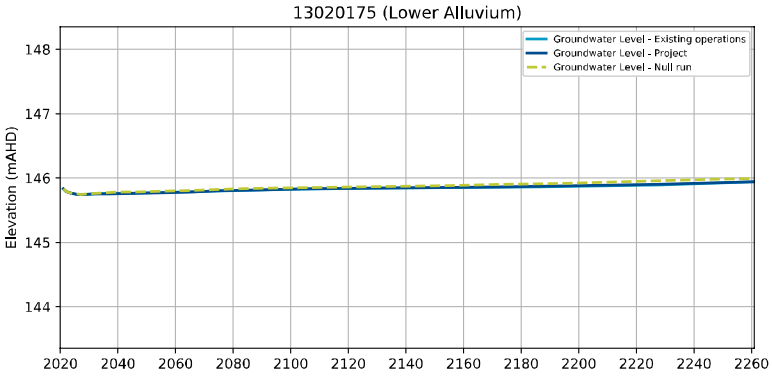

13020170 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
148
147
146
145
144
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

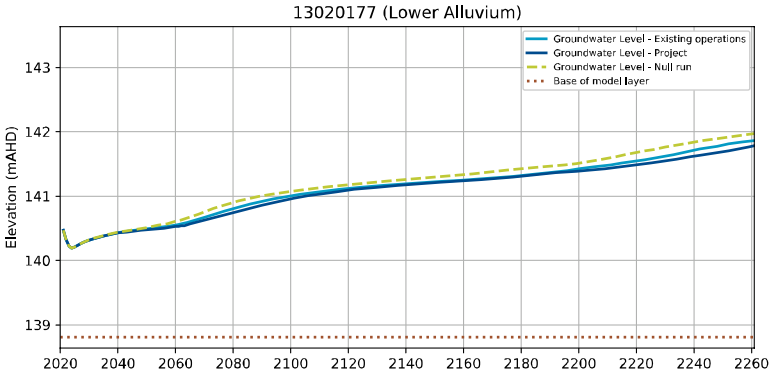

13020171 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
148
147
146
145
144
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

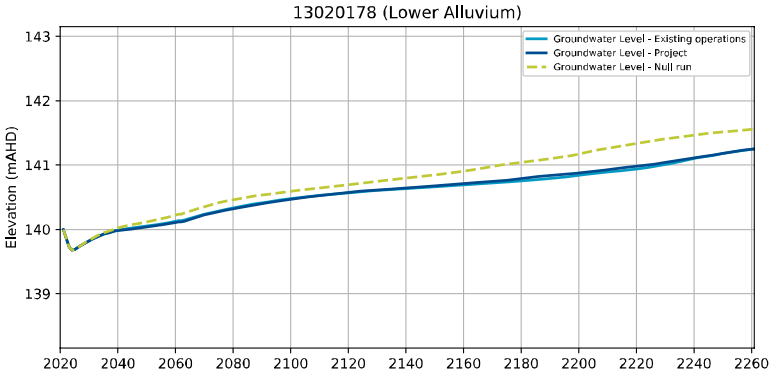

13020172 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
148
147
146
145
144
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

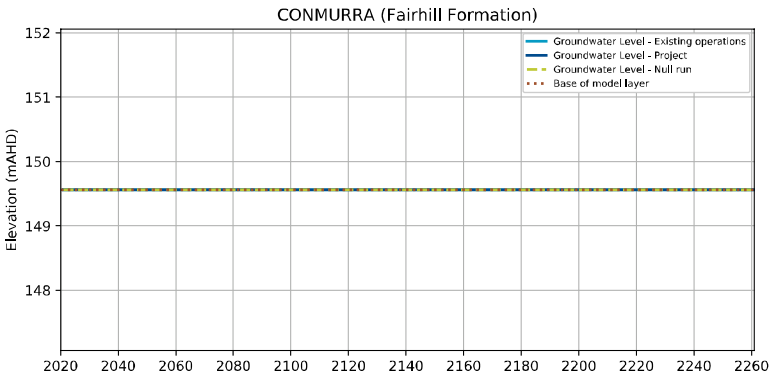

13020173 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
148
147
146
145
144
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

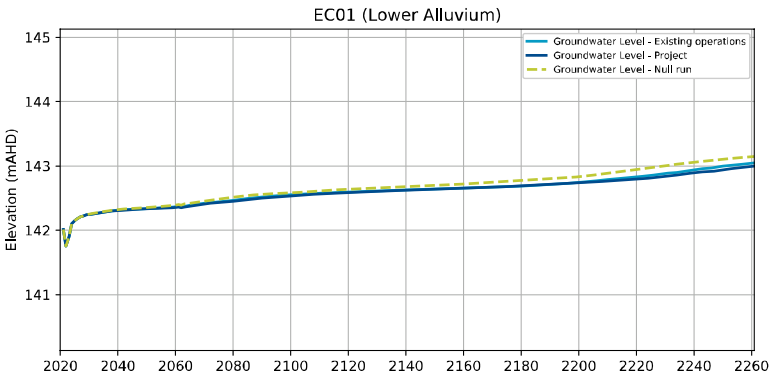

13020174 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
148
147
146
145
144
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

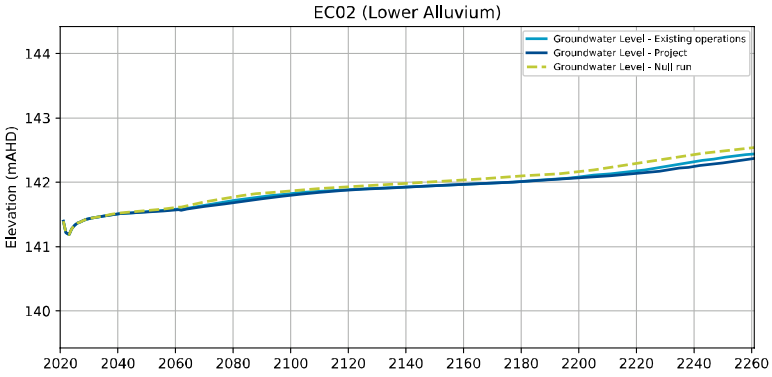

13020175 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
148
147
146
145
144
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

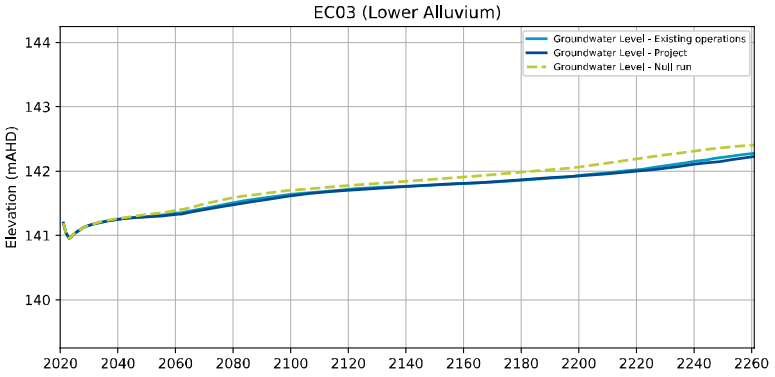

13020177 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)
143
142
141
140
139
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

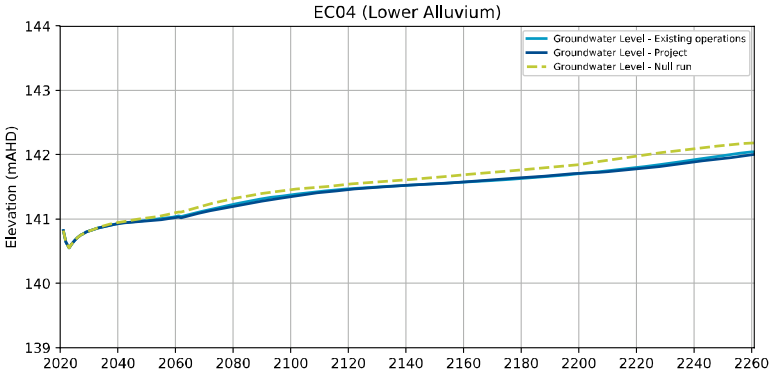

13020178 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
143
142
141
140
139
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

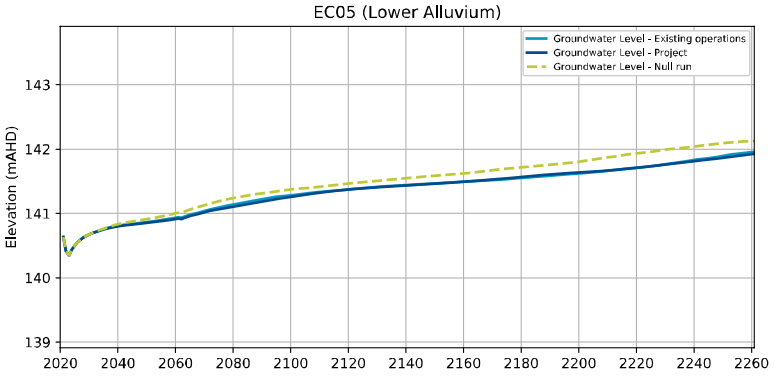

CONMURRA (Fairhill Formation)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)
152
151
150
149
148
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

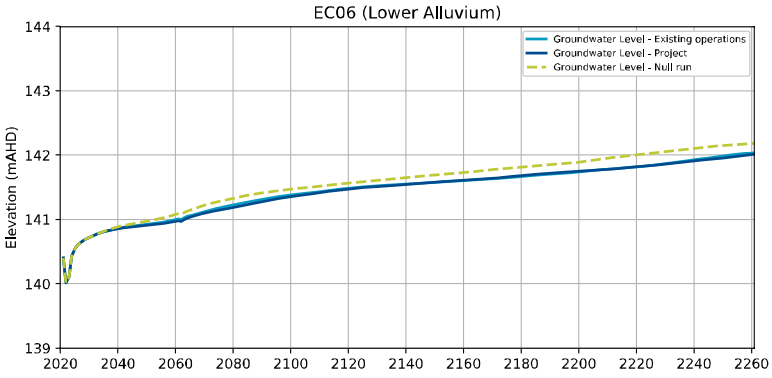

EC01 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
145
144
143
142
141
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

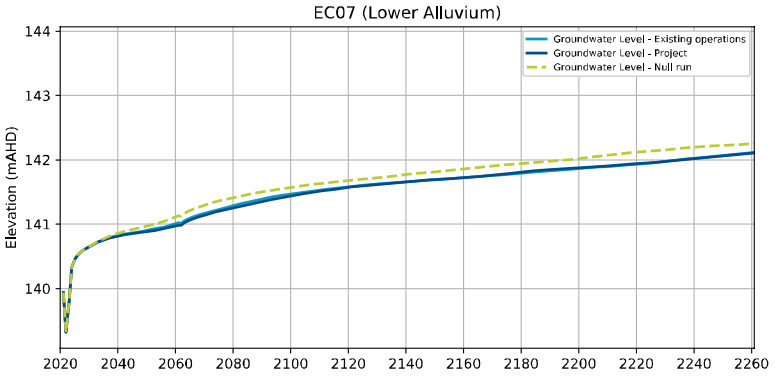

EC02 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
144
143
142
141
140
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

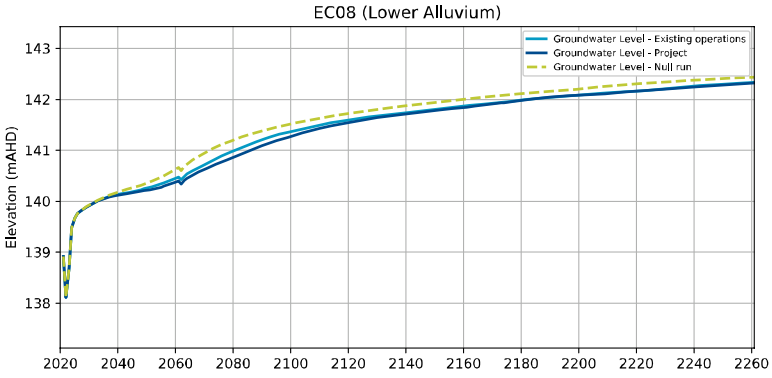

EC03 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
144
143
142
141
140
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

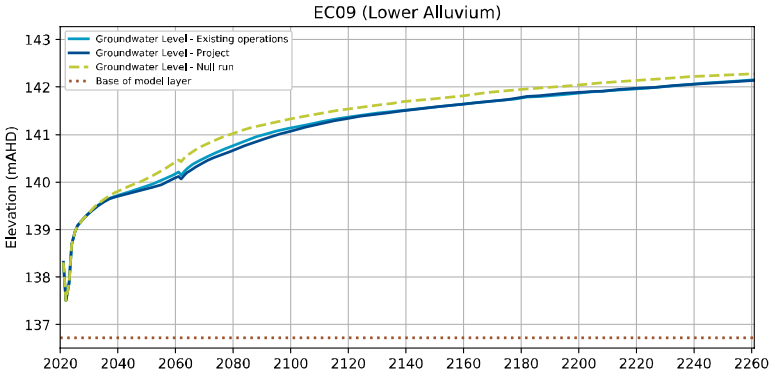

EC04 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
144
143
142
141
140
139
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

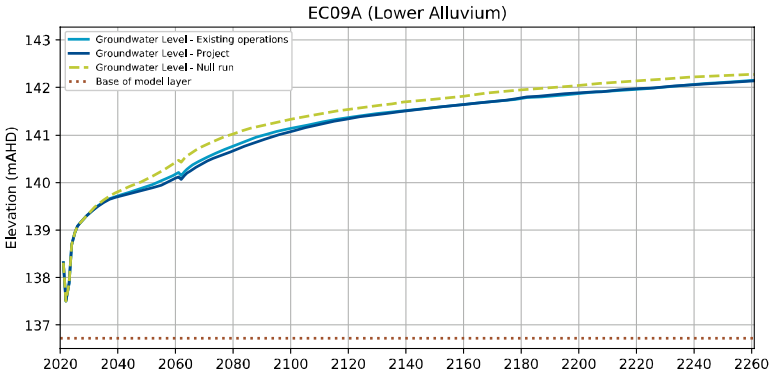

EC05 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
143
142
141
140
139
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

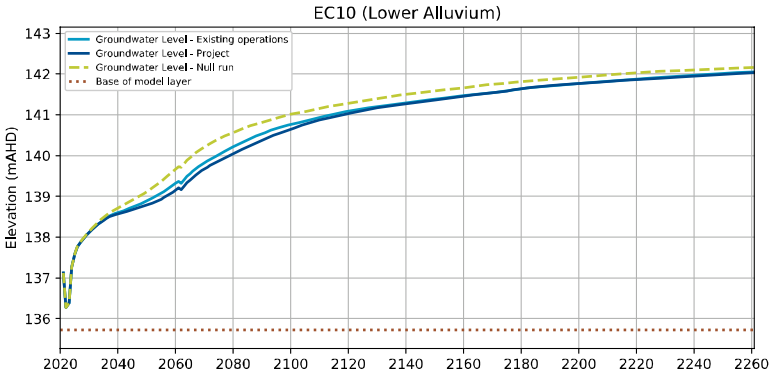

EC06 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
144
143
142
141
140
139
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

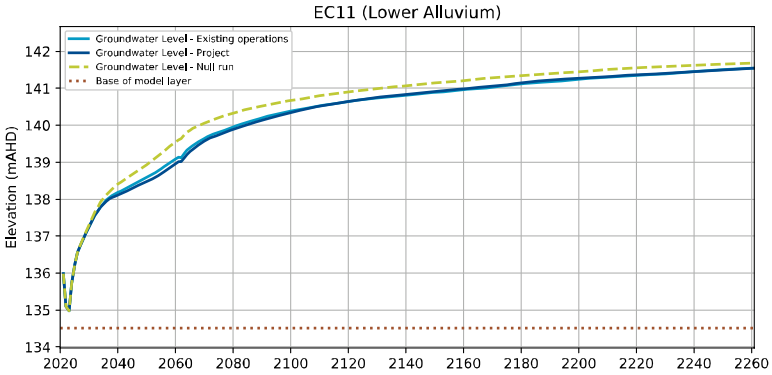

EC07 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
144
143
142
141
140
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

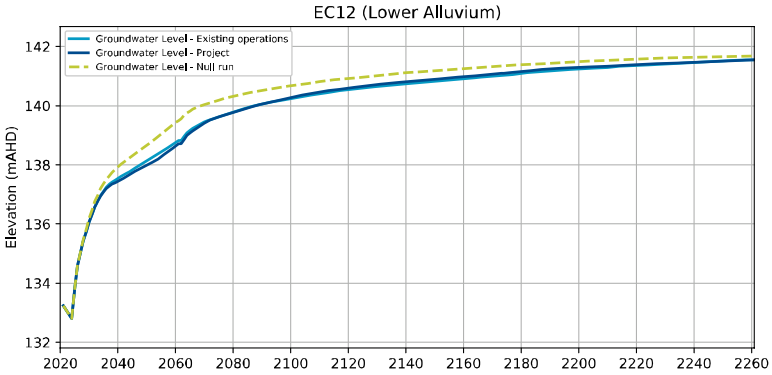

EC08 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
143
142
141
140
139
138
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

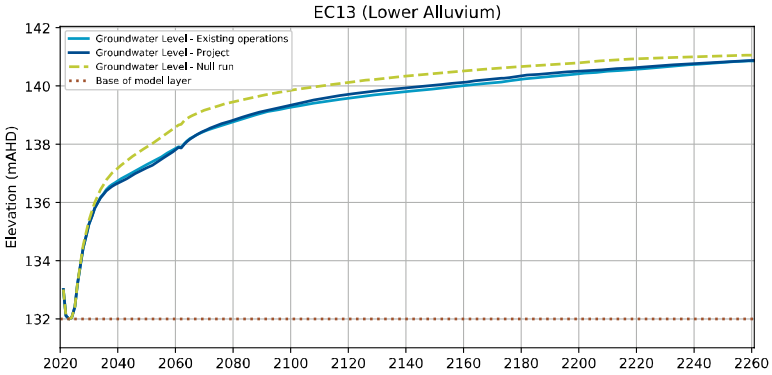

EC09 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)
143
142
141
140
139
138
137
2020 2040 2060 2080 2100 2120 2140 2160 2180 2200 2220 2240 2260

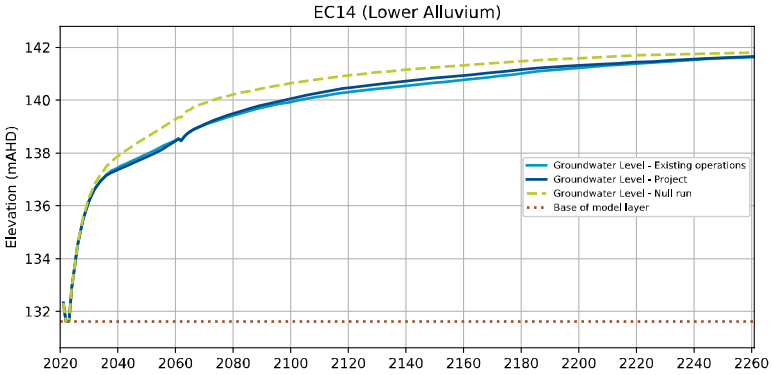

EC09A (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

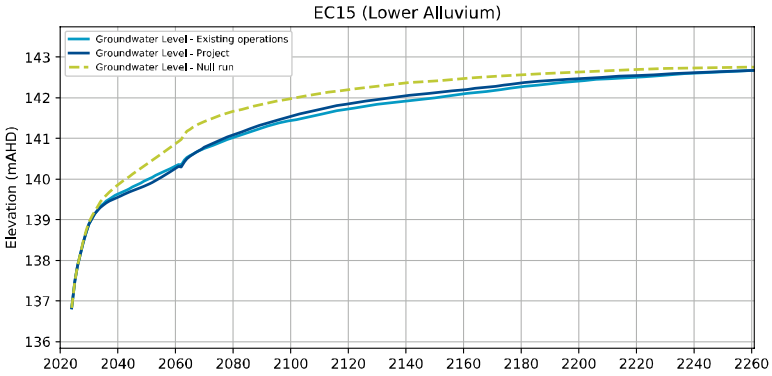

EC10 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

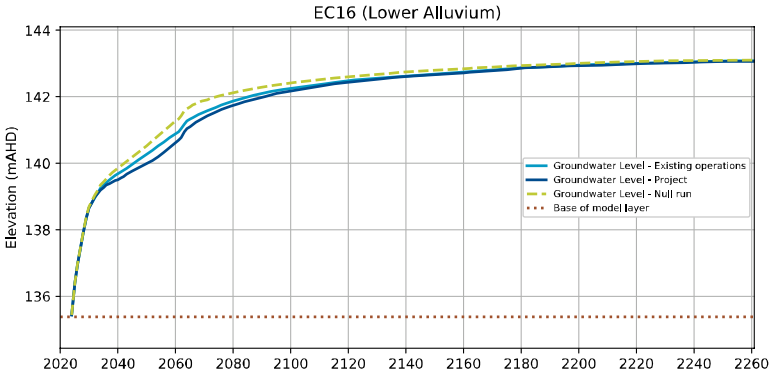

EC11 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

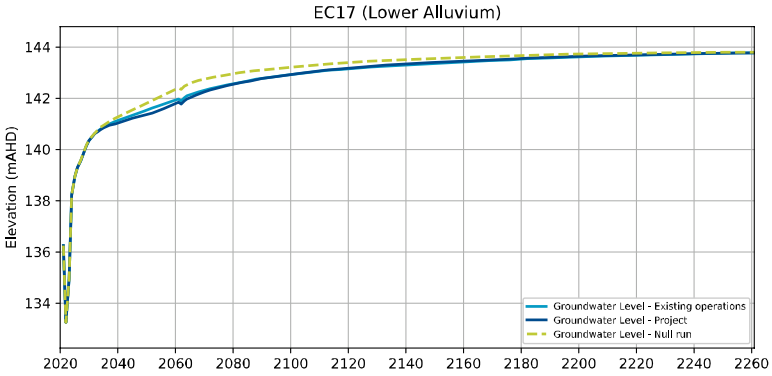

EC12 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

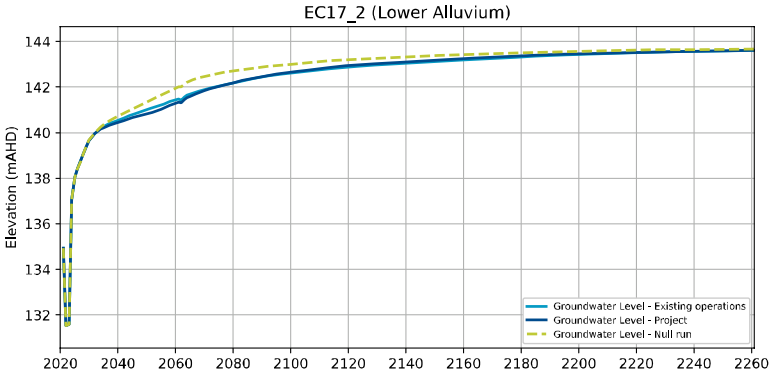

EC13 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

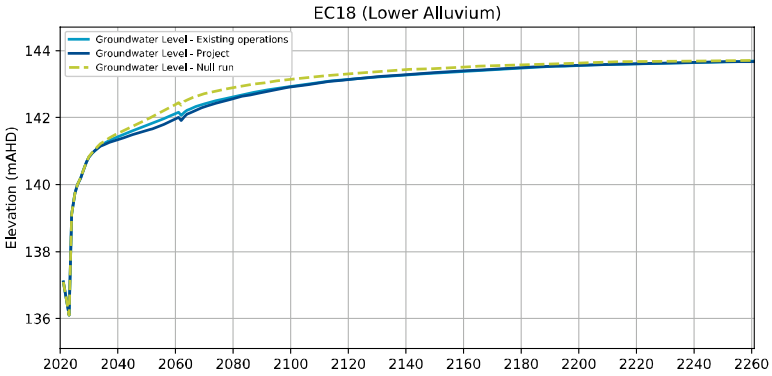

EC14 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

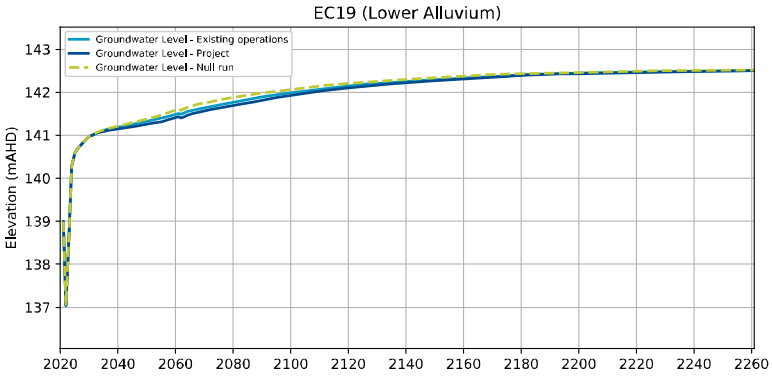

EC15 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

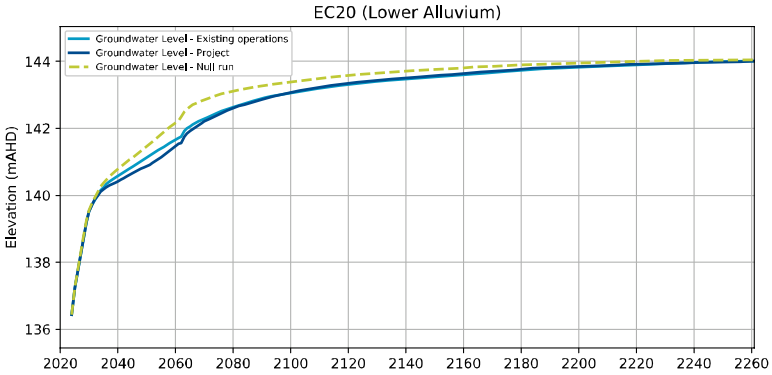

EC16 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

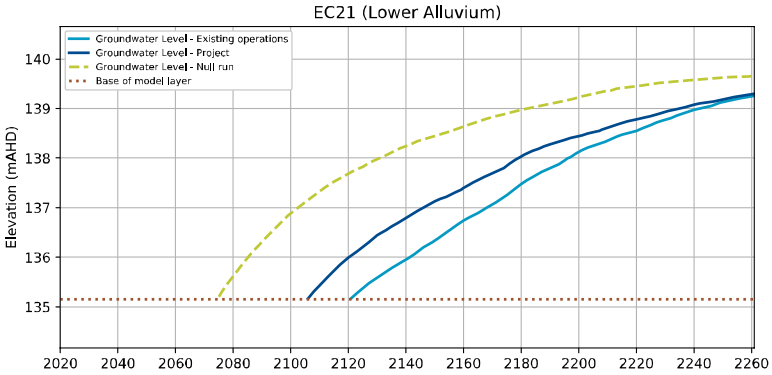

EC17 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

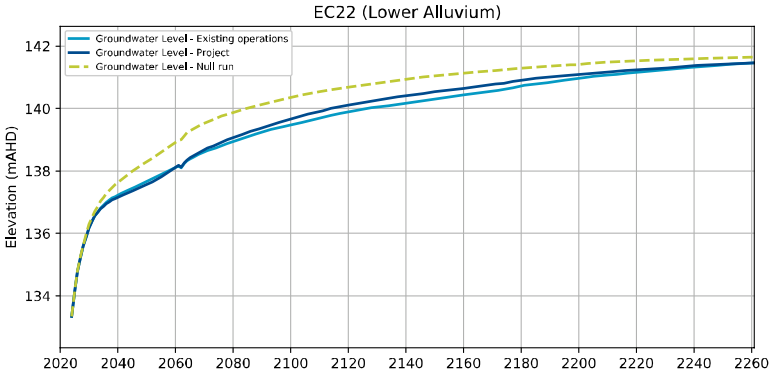

EC17_2 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

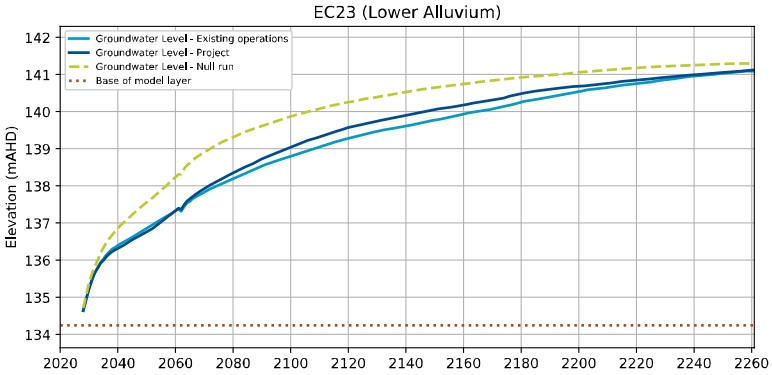

EC18 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

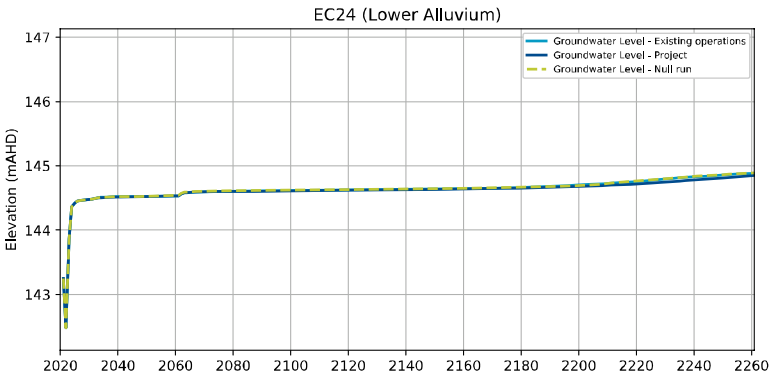

EC19 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

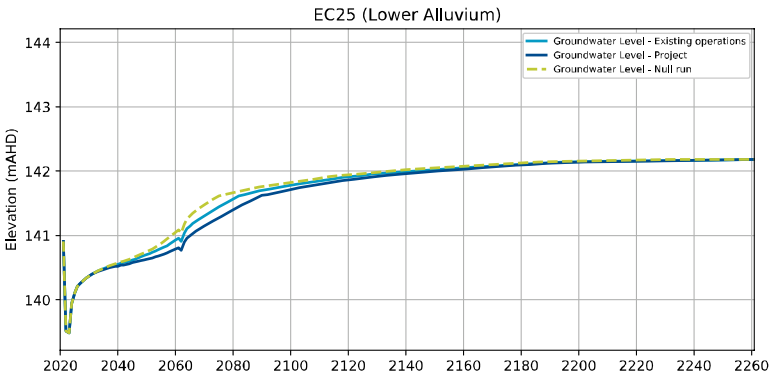

EC20 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

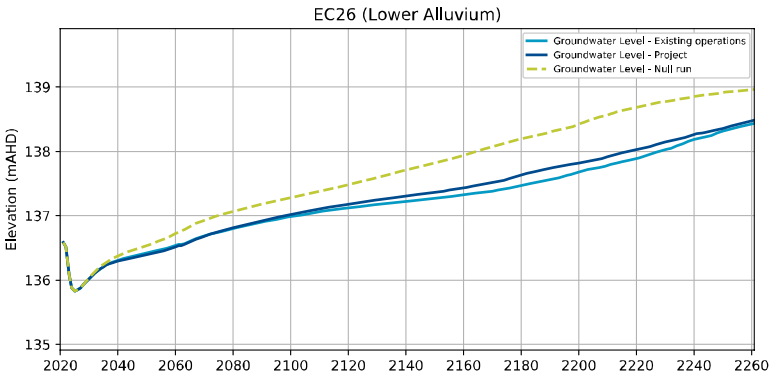

EC21 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

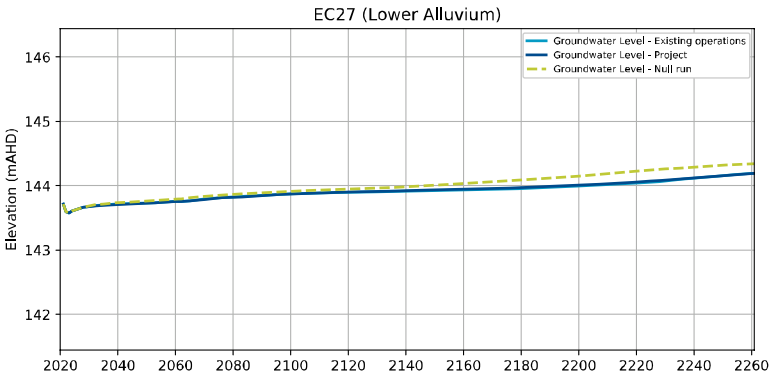

EC22 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

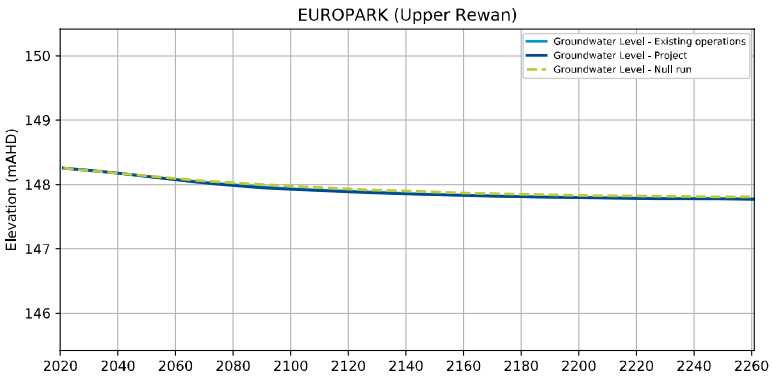

EC23 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

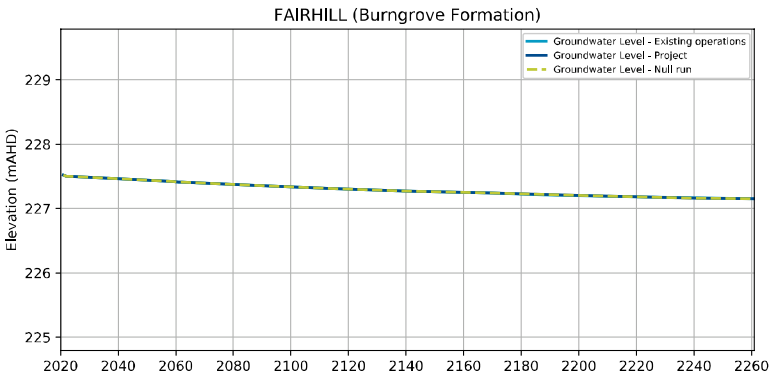

EC24 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

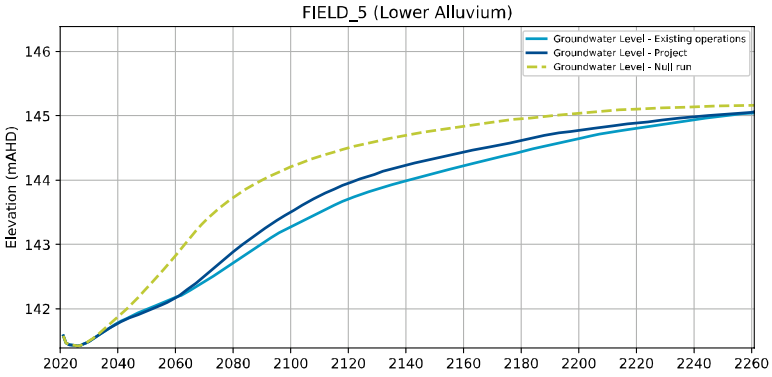

EC25 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

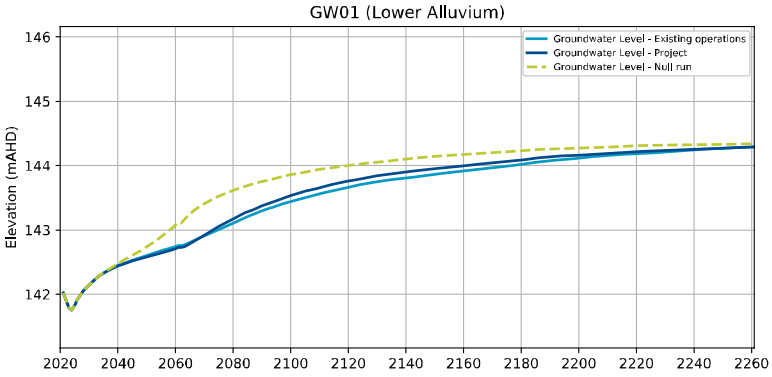

EC26 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

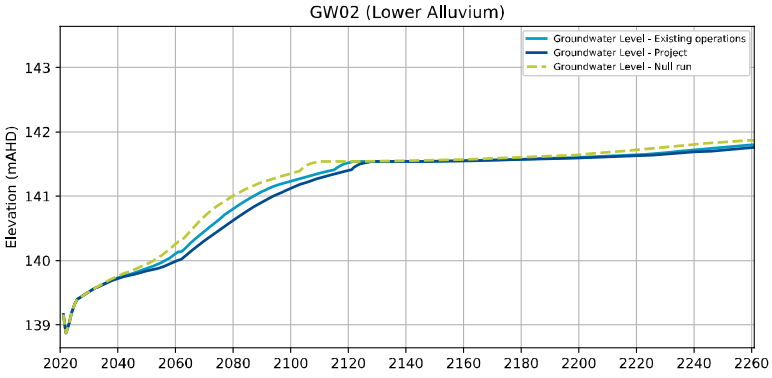

EC27 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

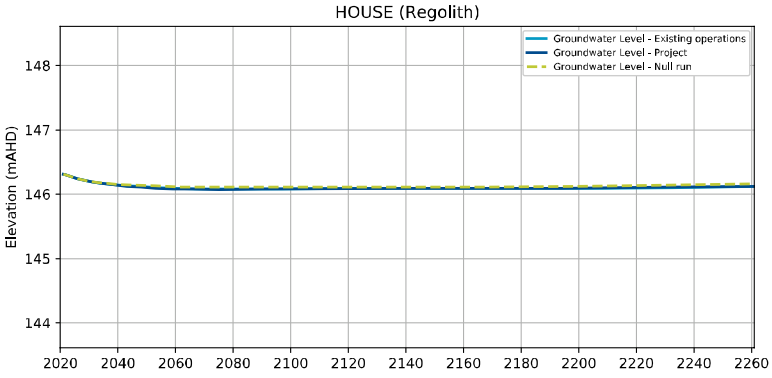

EUROPARK (Upper Rewan)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

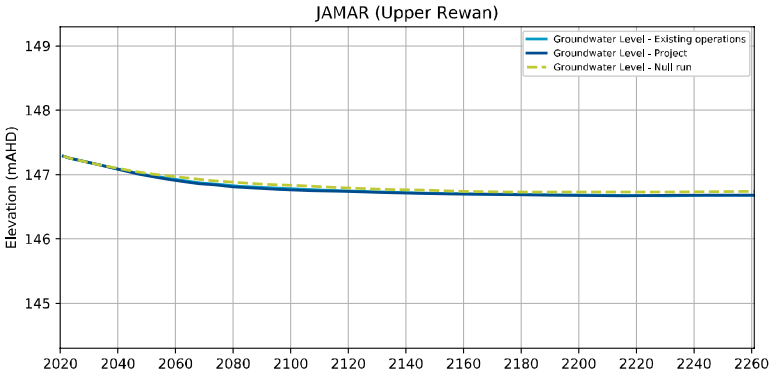

FAIRHILL (Burngrove Formation)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

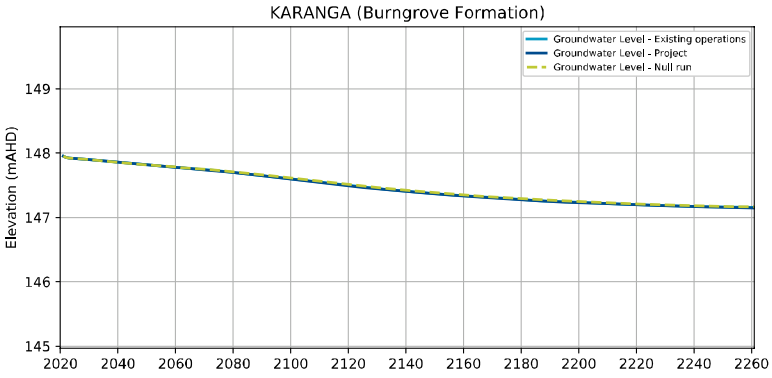

FIELD_5 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

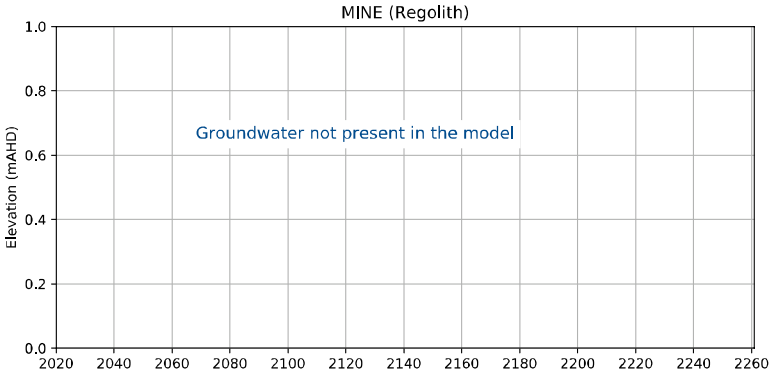

GW01 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

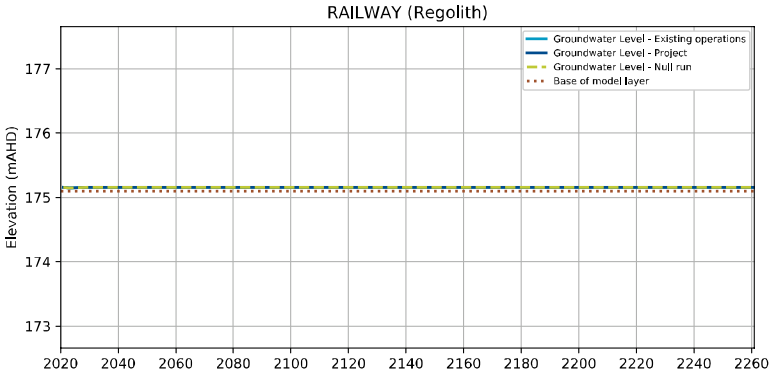

GW02 (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

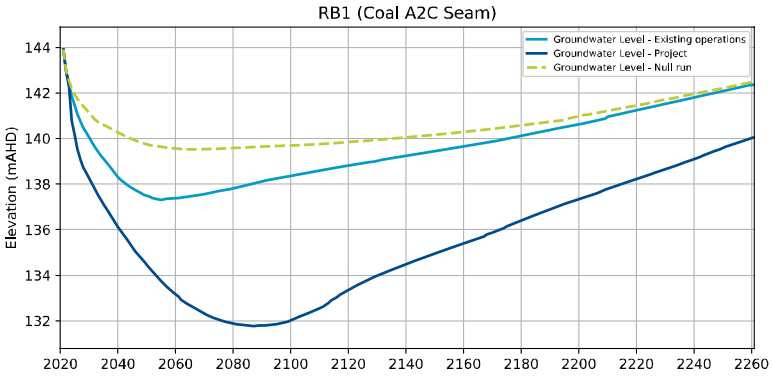

HOUSE (Regolith)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

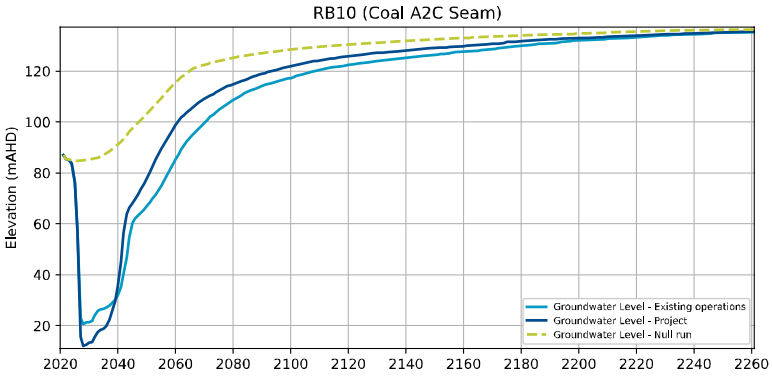

JAMAR (Upper Rewan)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

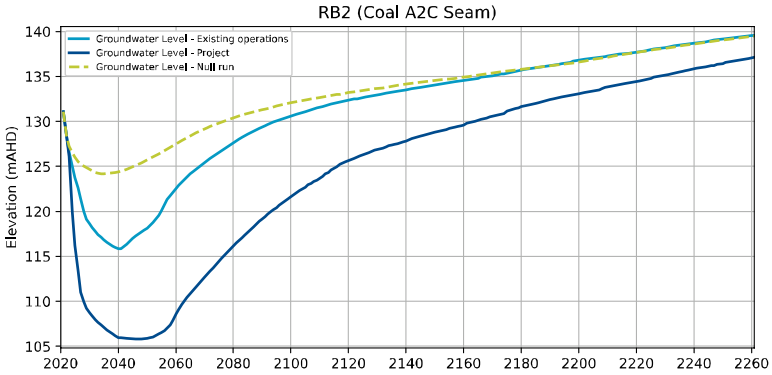

KARANGA (Burngrove Formation)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

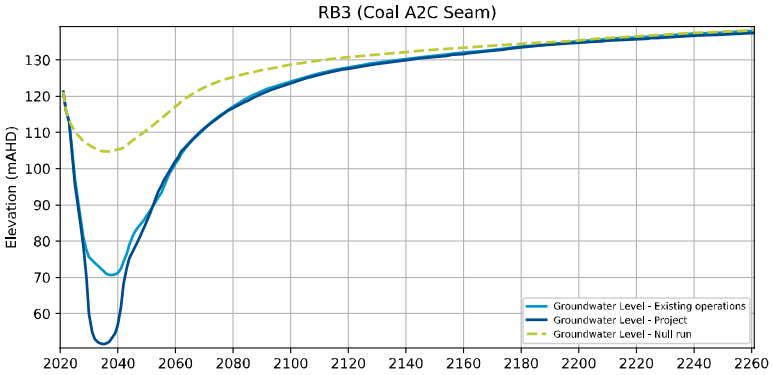

MINE (Regolith)
Groundwater not present in the model
Elevation (mAHD)

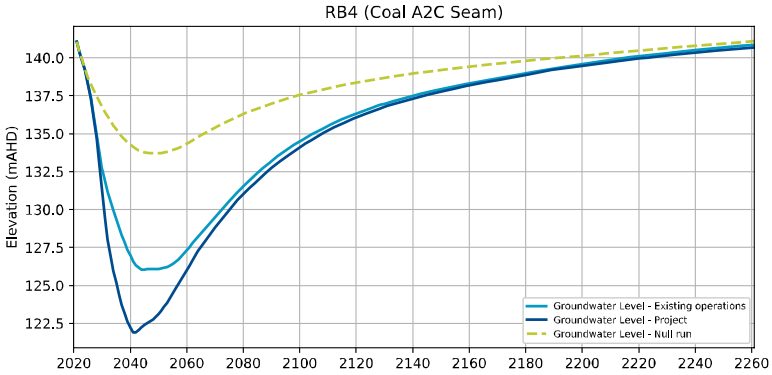

RAILWAY (Regolith)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

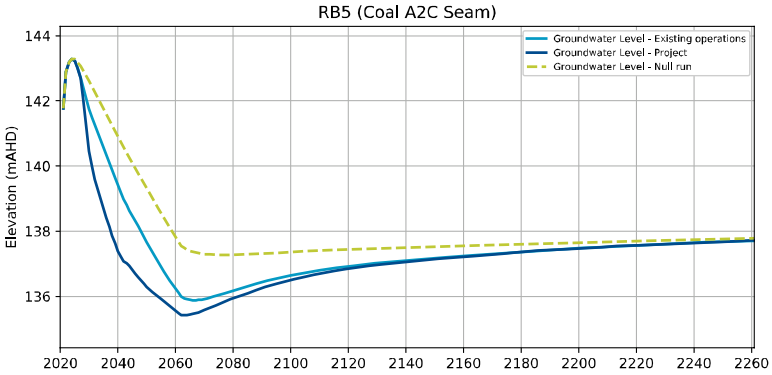

RB1 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

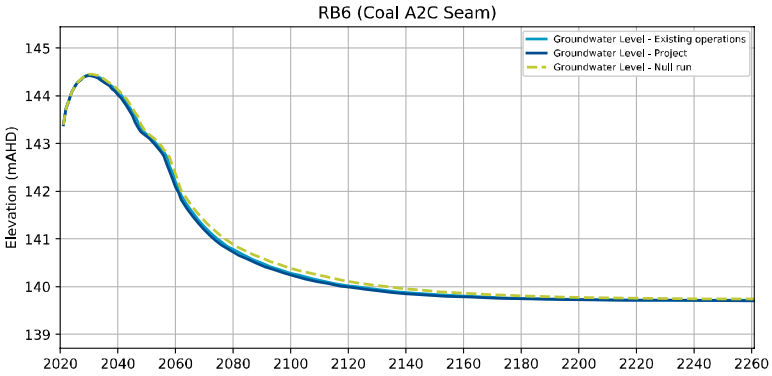

RB10 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

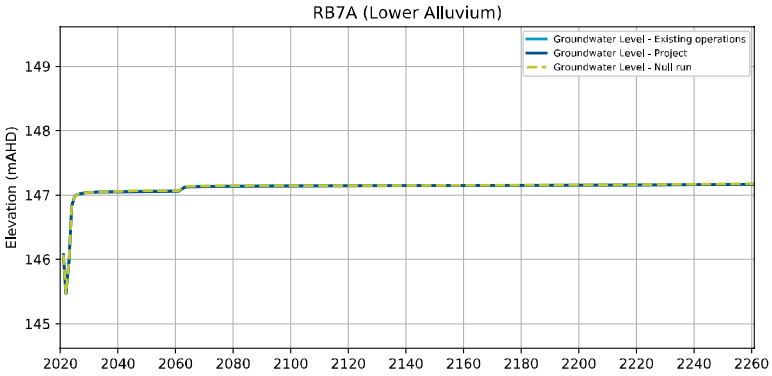

RB2 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

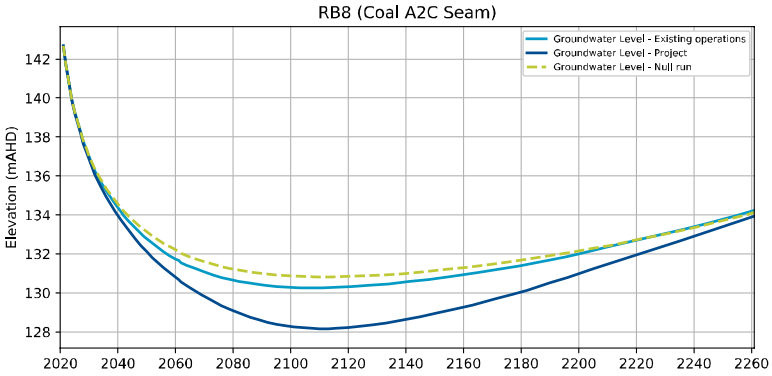

RB3 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

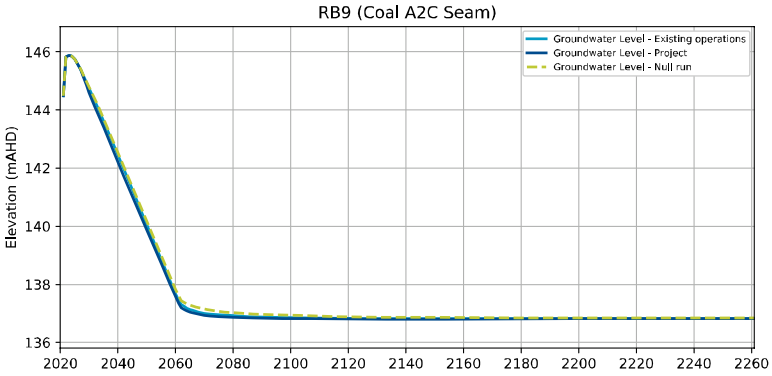

RB4 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

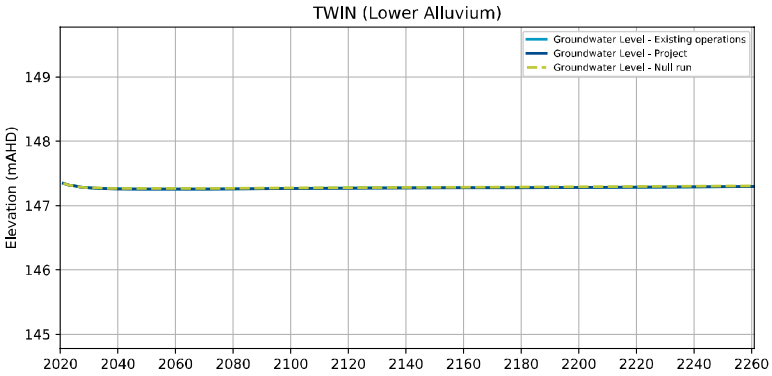

RB5 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

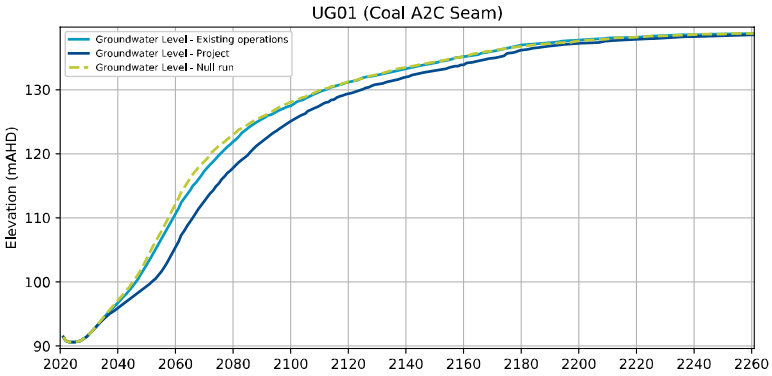

RB6 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

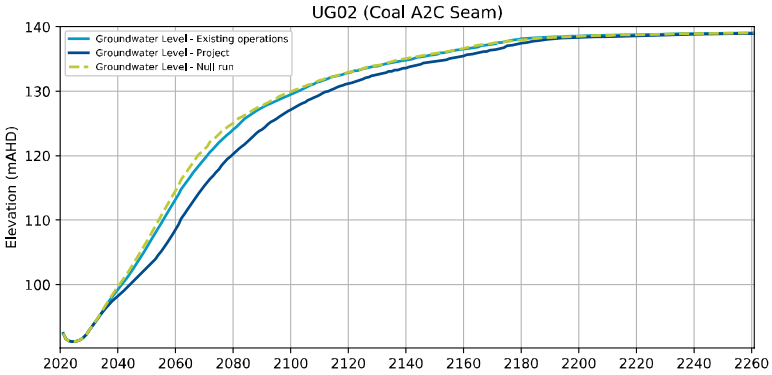

RB7A (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

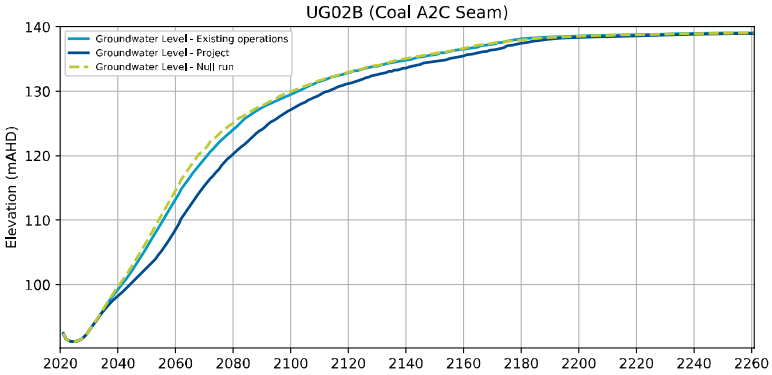

RB8 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

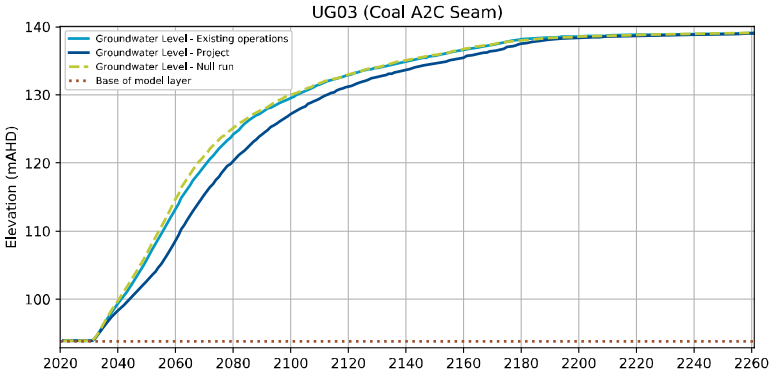

RB9 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

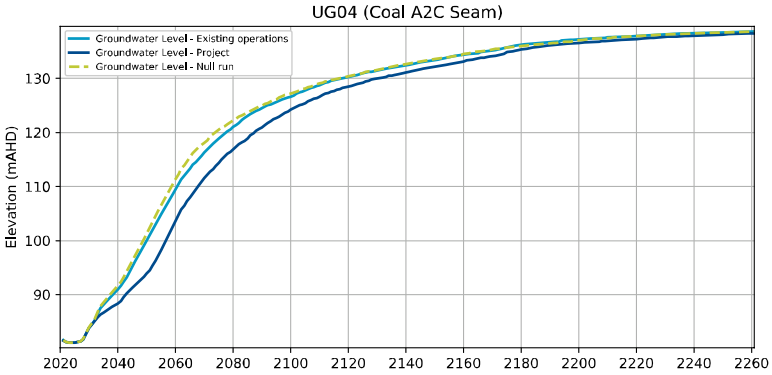

TWIN (Lower Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

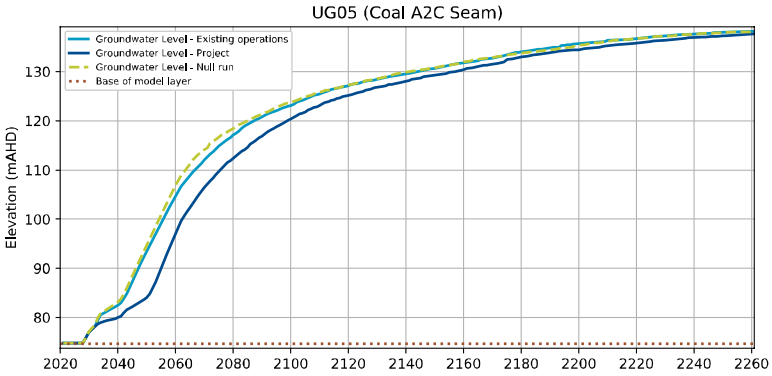

UG01 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

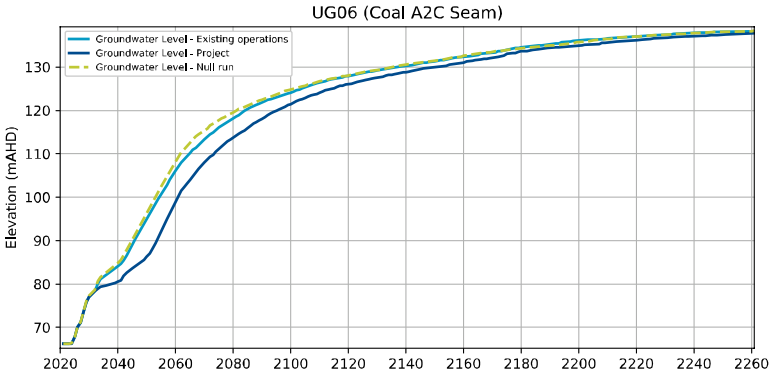

UG02 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

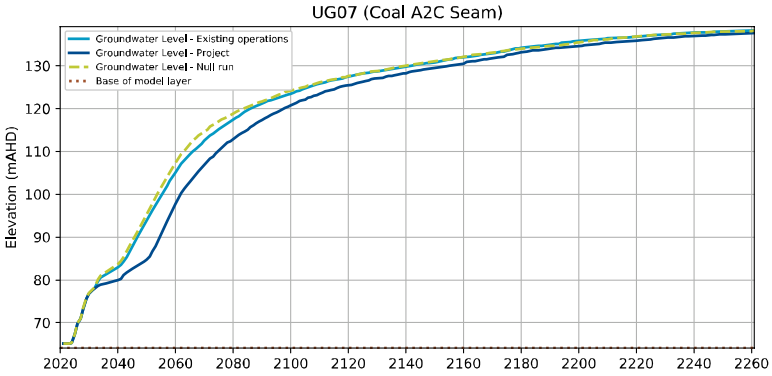

UG02B (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

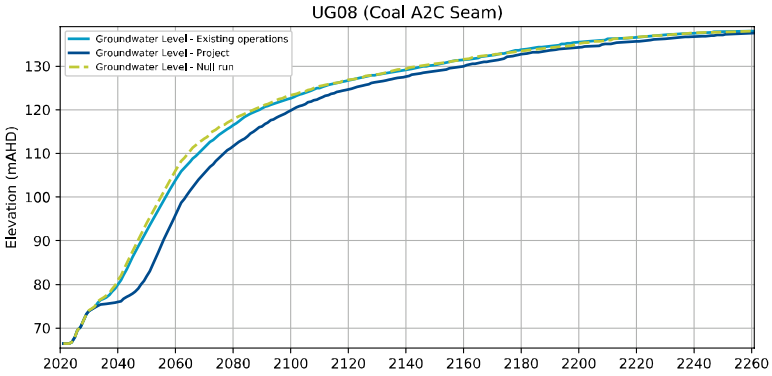

UG03 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

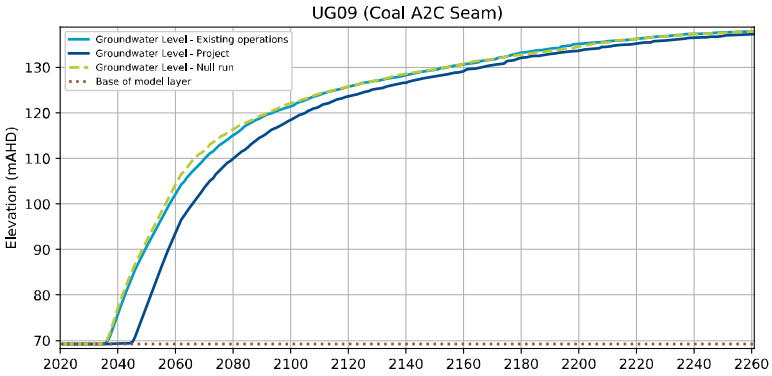

UG04 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

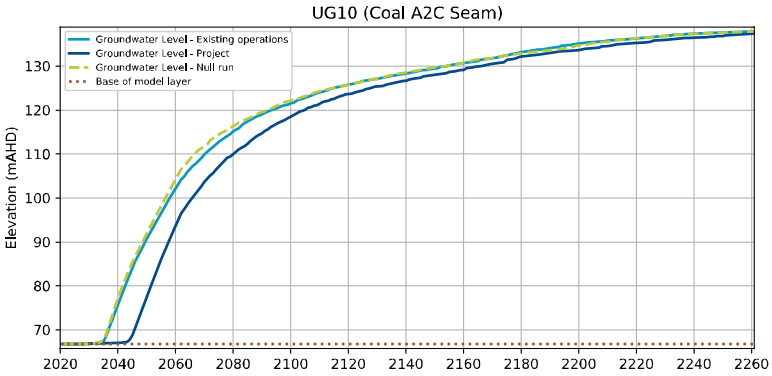

UG05 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

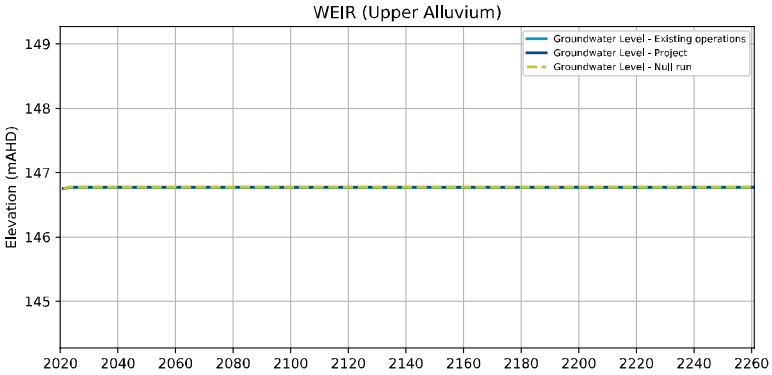

UG06 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

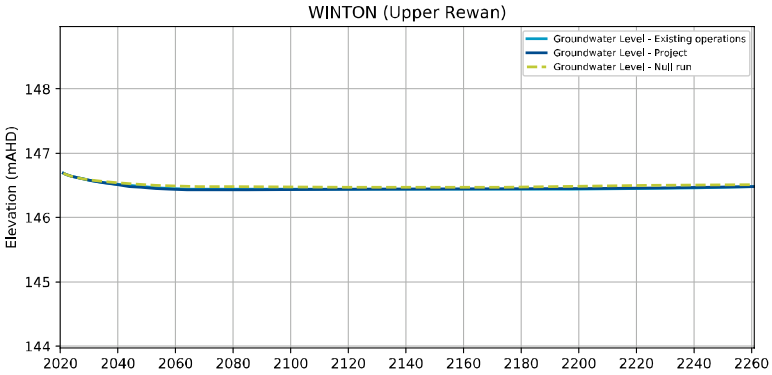

UG07 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

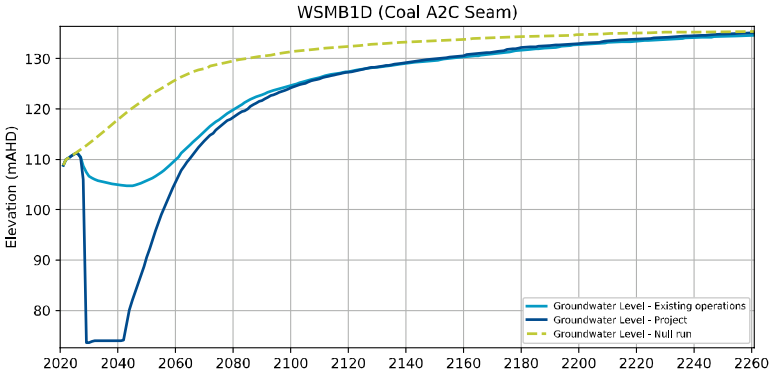

UG08 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

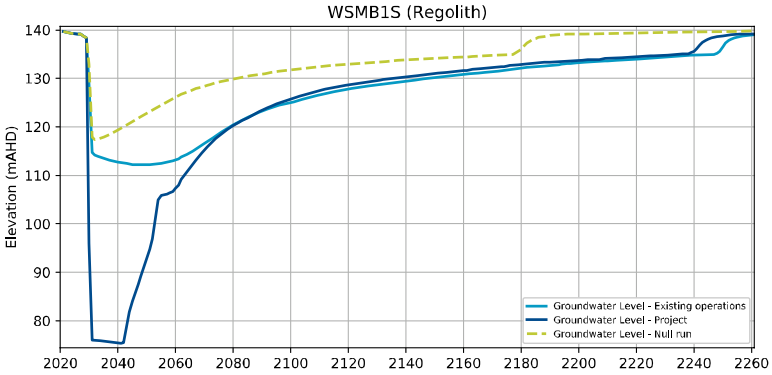

UG09 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

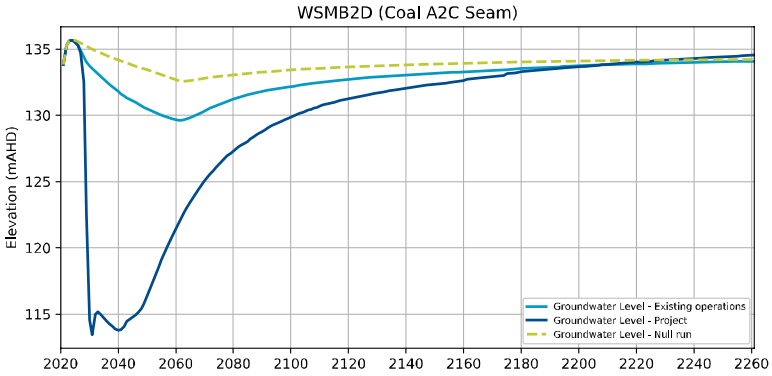

UG10 (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)

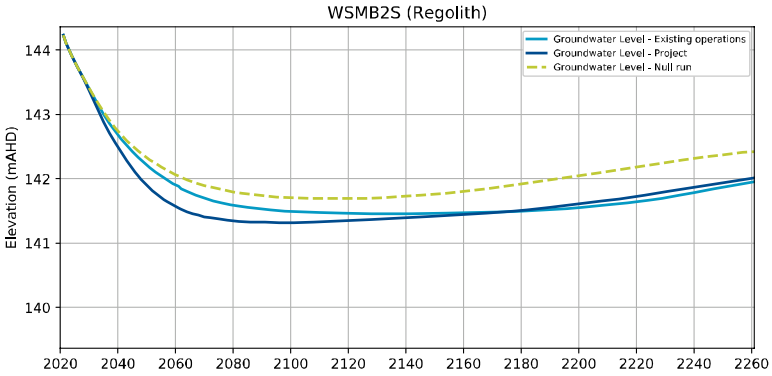

WEIR (Upper Alluvium)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

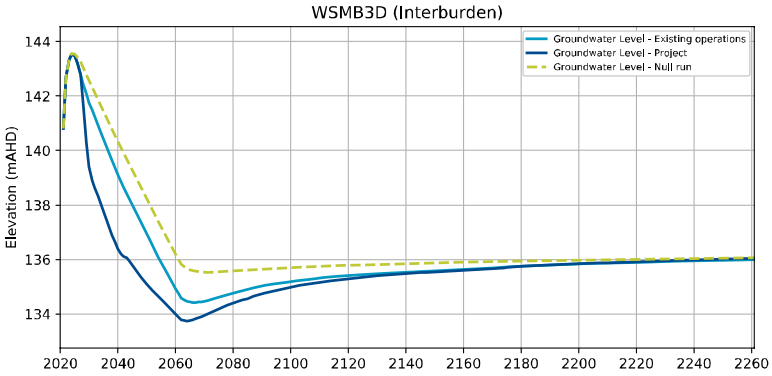

WINTON (Upper Rewan)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

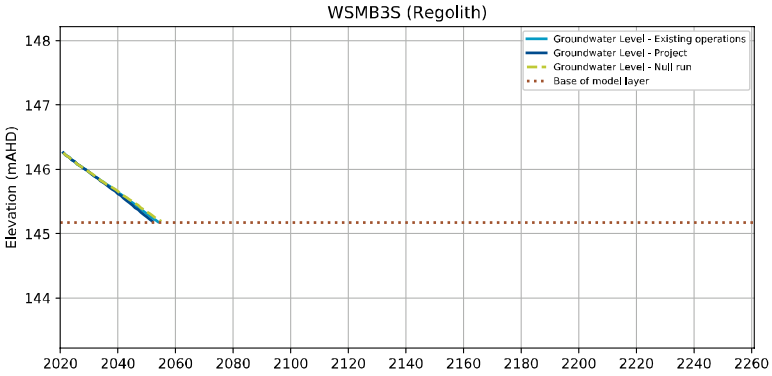

WSMB1D (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

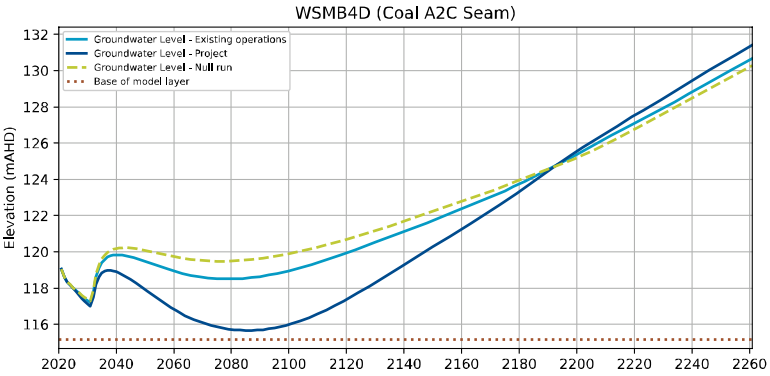

WSMB1S (Regolith)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

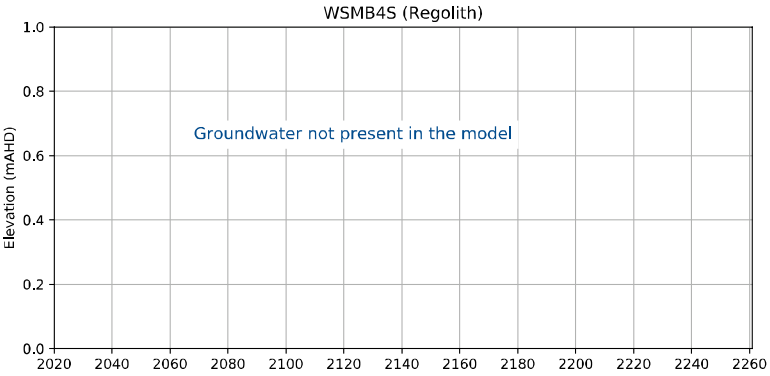

WSMB2D (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

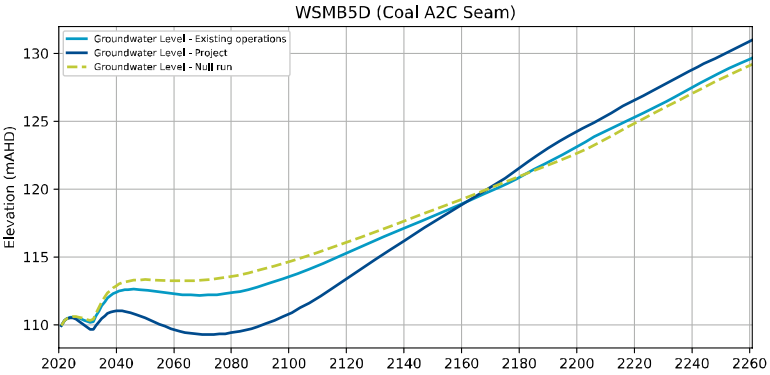

WSMB2S (Regolith)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)

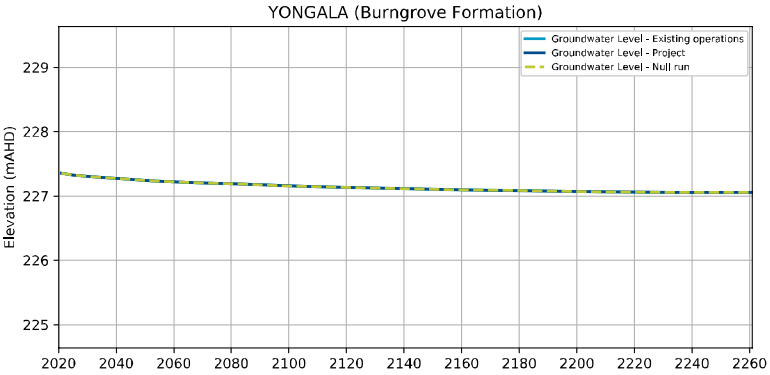

WSMB3D (Interburden)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)


WSMB3S (Regolith)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)


WSMB4D (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Base of model layer
Elevation (mAHD)
132
130
128
126
124
122
120
118
116
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260


WSMB4S (Regolith)
Groundwater not present in the model
Elevation (mAHD)
1.0
0.8
0.6
0.4
0.2
0.0
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260


WSMB5D (Coal A2C Seam)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
130
125
120
115
110
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260


YONGALA (Burngrove Formation)
Groundwater Level - Existing operations
Groundwater Level - Project
Groundwater Level - Null run
Elevation (mAHD)
229
228
227
226
225
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240
2260

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

TOWNSVILLE SOUTH
12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

Appendix D

Ensham Life of Mine Extension Project:
Flora Technical Report (AECOM, 2020)

AECOM Imagine it. Delivered.

Ensham Resources Pty Ltd
12-Aug-2020

Ensham Life of Mine Extension Project

Flora Technical Report

Ensham Life of Mine Extension Project

Flora Technical Report

Client: Ensham Resources Pty Ltd

ABN: 23 011 048 678

Prepared by

AECOM Australia Pty Ltd
Level 8, 540 Wickham Street, PO Box 1307, Fortitude Valley QLD 4006, Australia
T +61 7 3553 2000 F +61 7 3553 2050 www.aecom.com
ABN 20 093 846 925

12-Aug-2020

Job No.: 60603371

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Table of Contents

Acronyms i
Executive Summary iii
1.0 Introduction 1
1.1 Overview 1
1.2 Project Background 1
1.2.1 Project Area 1
1.2.2 Study area 2
2.0 Project description 4
2.1 Underground mining methods 4
2.2 Subsidence 4
2.3 Construction 4
3.0 Regulatory and policy framework 6
3.1 Commonwealth 6
3.1.1 Environment Protection and Biodiversity Conservation Act 1999 6
3.1.2 EPBC Act Offset Policy 6
3.1.3 Weeds of National Significance 6
3.2 Queensland legislation 7
3.2.1 Planning Act 2016 7
3.2.2 Nature Conservation Act 1992 7
3.2.3 Vegetation Management Act 1999 7
3.2.4 Environmental Protection Act 1994 8
3.2.5 Biosecurity Act 2014 9
3.2.6 Queensland Environmental Offsets Framework 9
4.0 Assessment methodology 11
4.1 Desktop assessment 11
4.2 Field survey 12
4.2.1 Vegetation community assessment 12
4.2.2 BioCondition Assessment 13
4.2.3 TEC assessments 15
4.2.4 Targeted flora searches 15
4.2.5 Survey limitations 15
4.3 Data analysis 15
4.3.1 GIS analysis 15
4.3.2 BioCondition scoring 16
4.3.3 MSES GIS analysis 17
4.3.4 Specimen ID 17
4.3.5 Nomenclature 17
4.3.6 Likelihood of occurrence assessment 17
5.0 Environmental context 19
5.1 Bioregions 19
5.2 Climate 19
5.3 Land use 20
5.4 Surface Geology 20
5.5 Watercourses 21
5.6 Connectivity 21
6.0 Desktop assessment results 22
6.1 Regulated vegetation and Regional Ecosystems 22
6.2 Threatened Ecological Communities 23
6.3 Flora of conservation significance 23
6.4 Essential habitat 24
6.5 Wetlands and waterways 24
6.6 Groundwater Dependant Ecosystems (GDEs) 24
6.7 Environmentally Sensitive Areas (ESAs) 25
6.7.1 Category A ESAs 25
6.7.2 Category B ESAs 25

6.7.3 Category C ESAs 26
6.8 Previous ecological studies 27
7.0 Field Survey results 32
7.1 Survey timing and climatic conditions 32
7.2 Survey area characteristics 33
7.3 Vegetation communities 34
7.3.1 Regulated vegetation and REs 35
7.3.2 Endangered Regional Ecosystems 35
7.4 Flora diversity 46
7.5 Exotic flora species 46
7.6 Conservation significant flora 46
7.7 Conservation significant vegetation communities 49
7.7.1 EPBC threatened ecological communities 49
7.8 Category B ESAs 50
7.9 Watercourses 50
7.10 Groundwater Dependent Ecosystems 51
7.10.1 Composition and condition 51
7.10.2 Likelihood assessment 53
8.0 Matters of State Environmental Significance 56
9.0 Potential impacts 60
9.1 Operational phase 60
10.0 Mitigation measures 61
10.1 Avoidance 61
10.2 Minimise 61
10.3 Mitigate 61
10.4 Monitoring 61
11.0 Significant residual impacts 62
11.1 Commonwealth EPBC Act significant impact assessment 62
11.2 State significant residual impact assessment 62
12.0 References 64

Appendix A
Desktop assessment results A

Appendix B
Flora species list B

Appendix C
BioCondition scores C

Appendix D
TEC Assessment Sites D

List of Figures

Figure 1 Project Area 3
Figure 2 Underground mining sequence for Ensham Mine and the Project 5
Figure 3 Project Area survey sites 14
Figure 4 Average minimum and maximum monthly temperatures from 1992 – 2019 (Bureau of Meteorology, 2019b) 19
Figure 5 Average monthly rainfall from 1992 – 2019 (Bureau of Meteorology, 2019a) 20
Figure 6 Mapped REs within the Project Area (biodiversity status) 29
Figure 7 Mapped REs within the Project Area (VM Act status) 30
Figure 8 Mapped GDE within the Project Area 31
Figure 9 Average monthly rainfall and total recorded in 2019 at Emerald Airport 33
Figure 10 Vegetation communities observed within the Project Area (VM Act status) 44
Figure 11 Vegetation communities observed within the Project Area (biodiversity status) 45
Figure 12 TEC observed within the Project Area 54
Figure 13 Environmentally Sensitive Areas and potential threatened flora habitat within the Project Area 55

Figure 14 MSES regulated vegetation within the Project Area 59

List of Tables

Table 1 Data sources and search parameters 11
Table 2 Site condition attributes for BioCondition scoring 13
Table 3 Landscape condition attributes for BioCondition scoring 15
Table 4 Final classification of BioCondition scores 17
Table 5 DNRME mapped Category B and Category C vegetation within the Project Area 22
Table 6 EPBC listed threatened ecological communities potentially occurring within the Project Area 23
Table 7 Threatened flora species potentially occurring within the Project Area 23
Table 8 Category A ESAs and Administering Legislation 25
Table 9 Category B ESAs and Administering Legislation 26
Table 10 Category C ESAs and Administering Legislation 26
Table 11 Temperature and rainfall recorded at Emerald Airport 9-14 May 2019 (Bureau of Meteorology, 2019) 32
Table 12 Temperature and rainfall recorded at Emerald Airport 17-21 October 2019 (Bureau of Meteorology, 2019) 32
Table 13 Temperatures and Rainfall Recorded at Emerald Airport 18-20 January 2020 (Bureau of Meteorology, 2019) 32
Table 14 Vegetation Communities within the Project Area 36
Table 15 Declared weed species detected within the Project Area 46
Table 16 Likelihood of occurrence assessment 48
Table 17 EPBC listed threatened ecological communities and related regional ecosystems 50
Table 18 Wetland indicator species 52
Table 19 MSES (Flora) values within the Project Area 56
Table 20 Prescribed regional ecosystem within a defined distance of a watercourse within the Project Area 58
Table 21 State significant residual impact of MSES floristic values 62
Table 22 Flora species list B-1
Table 23 BioCondition scoring for the Project Area C-1
Table 24 Brigalow TEC assessment sites D-1

Acronyms

Acronym	Description
ALA	Atlas of Living Australia
AU	Assessment Unit
BoM	Bureau of Meteorology
BPA	Biodiversity Planning Assessment
CHRC	Central Highlands Regional Council
DAWE	The Commonwealth Department of Agriculture, Water and the Environment
DBH	Diameter at Breast Height
DES	The Queensland Department of Environment and Science
DNRME	The Queensland Department of Natural Resources, Mines and Energy
EA	Environmental Authority
EIS	Environmental Impact Statement
EO Act	*Environmental Offsets Act 2014* (Qld)
EO Regulation	Environmental Offsets Regulation 2014 (Qld)
EP Act	*Environmental Protection Act 1994* (Qld)
EP Regulation	Environmental Protection Regulation 2019 (Qld)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ERA	Environmentally Relevant Activity
ESA	Environmentally Sensitive Area
EVNT	Endangered, Vulnerable or Near Threatened
FoS	Factor of Safety
GDE	Groundwater Dependent Ecosystem
HVR	High-value Regrowth
LOM	Life of Mine
MDL	Mineral Development Licence
ML	Mining Lease
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
Mtpa	Million Tonnes per Annum
NC Act	*Nature Conservation Act 1992* (Qld)
NC Regulation	Nature Conservation (Wildlife) Regulation 2006 (Qld)
Planning Act	*Planning Act 2016* (Qld)
Planning Regulation	Planning Regulation 2017 (Qld)
PMST	Protected Matters Search Tool
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database

Acronym	Description
TEC	Threatened Ecological Community
VM Act	*Vegetation Management Act 1999* (Qld)
VM status	Vegetation Management Act Status
WoNS	Weeds of National Significance

Executive Summary

AECOM Australia Pty Ltd (AECOM) was commissioned by Ensham Resources Joint Venture (Ensham JV) to assess the potential impacts of the proposed Ensham Life of Mine Extension Project (the Project) on flora values, in support of the impact assessment for the Project.

The purpose of the flora assessment is to describe the flora values of the Project Area as relevant to current Commonwealth and State legislation, assess the impacts of the proposed actions on these values and present strategies to avoid, minimise or mitigate impacts to significant flora values. Flora assessments of the Project Area and surrounding areas were completed in May 2019 (Autumn survey, Zone 1), October 2019 (Spring survey, Zone 1) and January 2020 (Summer survey, Zones 2 and 3).

The flora and vegetation values of the Project Area are considered typical for the Brigalow Belt Bioregion with large areas of land historically cleared for grazing or cropping. Areas of remnant vegetation remain, particularly along the Nogoa River and adjacent tributary watercourses. Most areas have been modified to some extent by historical and current land management practices. North of the Nogoa River, the most common modification has been cattle grazing and the removal of the shrub and ground layers. Grazing is usually in conjunction with the introduction of pasture grass species. South of the Nogoa River, native vegetation has been largely removed to be replaced with irrigated cropping or modified for grazing. The north-east portion of Zone 2 contains areas of mine rehabilitation.

The literature review identified four threatened ecological communities (TECs) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) likely to be present within the Project Area. The presence of one of these communities was confirmed within the Project Area during field surveys. This being: Brigalow (*Acacia harpophylla* dominant and co-dominant). The flora survey identified a total of eight vegetation communities, these comprise:

- *Acacia harpophylla* open forest on alluvial plains
- *Acacia harpophylla* low open forest on alluvial plains
- *Eucalyptus coolabah* woodland on alluvial plains
- *Eucalyptus camaldulensis* woodland fringing drainage lines
- *Eucalyptus theozetiana* with a midstorey of *Acacia harpophylla* on lower scarp slopes on Cainozoic lateritic duricrust
- *Acacia shirleyi* woodland on Cainozoic lateritic duricrust and scarp retreat zones
- Brigalow regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust
- Acacia regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust.

BioCondition surveys were completed at 23 locations within the Project Area. Outcomes from analysed data shows some brigalow patches of vegetation to be small and isolated with condition scoring leading them to be categorised as near dysfunctional. Vegetation communities along the Nogoa River are considered near functional due to higher connectivity and relatively large size of existing vegetation.

The literature review identified six flora species of conservation significance, with two as potentially occurring within the Project Area. Of the six species, a single species (*Cerbera dumicola*) was confirmed during field surveys. Of the 30 exotic species recorded during the vegetation surveys, six species were identified as being of management concern. These are listed as ‘restricted matters’ under the *Biosecurity Act 2014* (Qld). Four exotic species have been identified as Weeds of National Significance (WoNS).

An assessment of Groundwater Dependant Ecosystem (GDE) mapping shows that, within the Project Area, vegetation around the Nogoa River and its unnamed tributaries, Mosquito Creek and Winton Creek are all mapped as having a low confidence of being terrestrial GDE areas. Field verified RE mapping identified four vegetation communities within the terrestrial GDE mapping. Field observations including the lack of wetland flora indicator species, evidence of water stress or high availability of preferential freshwater surface flows confirmed the low likelihood of these communities to utilise and rely on groundwater. This is supported by the identified hydrogeological characteristics of the Project Area and in particular the alluvium groundwater that is accessible to deep-rooted vegetation. The higher saline content as well as thin and discontinuous saturation zones, is likely to limit vegetation use and reliance.

The *Environmental Protection Act 1994* (Qld) (EP Act) and its subordinate legislation, the Environmental Protection Regulation 2008 (Qld) (EP Regulation), place environmentally sensitive areas (ESAs) into three categories: Category A, Category B and Category C. The review of ESAs determined that no Category A or C ESAs are present within the Project Area. However, a single flora related Category B ESA is present. Desktop searches and field surveys undertaken determined the Category B ESA as an endangered regional ecosystem (RE) present within the Project Area.

A significant impact assessment in accordance with the criteria in the EPBC Act Significant Impact Guideline has been undertaken for the Project and is addressed separately in the matters of national environmental significance (MNES) report (AECOM, 2020b). After considering the significant impact assessment, the Project is considered unlikely to significantly impact on TECs.

A state significant residual impact assessment in accordance with the criteria provided in the Significant Residual Impact Guidelines (DES, 2014) has been undertaken for the Project on matters of state environmental significance (MSES) identified within the Project Area. MSES identified include Regulated Vegetation containing endangered and of concern REs and Regulated Vegetation within a defined distance of a watercourse. After consideration of the assessment, the Project will not result in a significant residual impact on MSES floristic values.

The planned development of the Project Area is to occur entirely underground with no proposed above ground clearing required and no additional surface mine infrastructure. No construction activities are proposed as part of the Project. Operational aspects of the Project will be covered by existing infrastructure and services within the approved Ensham Mine footprint. In the absence of vegetation clearing or additional road / track access requirements, or increased indirect impacts (dust, light etc), flora impacts associated with development of the Project Area are unlikely.

1.0 Introduction

1.1 Overview

AECOM Australia Pty Ltd (AECOM) was commissioned by Ensham Resources Joint Venture (Ensham JV) to assess the potential impacts of the proposed Ensham Life of Mine Extension Project (the Project) on fauna values, in support of the impact assessment for the Project.

The purpose of the flora assessment is to describe the floristic values of the Project Area as relevant to current Commonwealth and State legislation, assess the impacts of the proposed actions on these values and present strategies to avoid, minimise or mitigate impacts to significant flora values.

The scope of work for this terrestrial flora assessment included the following tasks:

- Desktop review of available literature and previous studies in the vicinity of the study area, including database searches for conservation significant vegetation communities and flora species
- Flora surveys across the study area using appropriate methodologies to:
  - identify, classify and map the extent of vegetation communities occurring within the Project Area
  - describe the condition of mapped vegetation
  - confirm the extent of Regulated Vegetation, including vegetation analogous to REs
  - identify conservation significant communities, including TECs and Category B ESAs
  - target and determine the presence of potentially occurring conservation significant flora and associated habitat, including species listed under the EPBC Act or *Nature Conservation Act 1992* (Qld) (NC Act)
  - identify potential terrestrial groundwater dependent ecosystems (GDEs) and assess condition
  - identify exotic flora species that occur within the Project Area
  - assess landscape values including corridor functions.
- Preparation of a flora assessment report that identifies the methods and results of the desktop and field studies, assesses the potential impacts of the Project, and presents mitigation measures and offset requirements.

1.2 Project Background

Ensham Mine is an existing open-cut and underground bord and pillar coal mine located approximately 35 kilometres east of Emerald in Queensland. The Project proposes to increase the life of the existing underground operations by extending the underground bord and pillar mine into an area identified as the Project Area (zones 1, 2, and 3) commencing from within Mining Lease (ML) 7459, ML70326, ML70365, and ML 70366 to an area west of ML 70365 within part of MDL 217 (see **Figure 1**). The Project will produce at up to approximately 4.5 million tonnes per annum and would extend the Ensham Life of Mine (LOM) by up to nine years to approximately 2037. The extension of the underground operation using existing infrastructure means that no surface construction or surface disturbance will be required to facilitate the Project.

1.2.1 Project Area

The Project is located in the western part of the Central Bowen Basin within the Central Highlands Regional Council (CHRC) local government area.

The Project Area spans the following land parcels:

- Lot A AP7202 (Reserve; Zone 1)
- Lot 2 CP911010 (Freehold; Zone 1)

- Lot 8 TT345 (Freehold; Zone 1)
- Lot 7 TT309 (Reserve; Zone 1)
- Lot 6 TT309 (Reserve; Zone 1)
- Lot 31 CP864573 (Freehold; Zone 2)
- Lot 32 RP908643 (Freehold; Zone 2)
- Lot 30 CP864574 (Freehold; Zone 3)
- Lot 33 RP864576 (Freehold; Zone 3).

The Project Area (zone 1, 2 and 3) covers 2,737.14 hectares (ha) of land.

1.2.2 Study area

In order to determine baseline flora and vegetation community values within the Project Area, field surveys were undertaken within the wider area to the north, west and south of the Project Area. The larger survey area enabled the wider assessment of potential direct and indirect impacts which may affect flora and vegetation community values as a result of the Project Area development. This wider field survey area is referred to as the 'study area'. The study area and the Project Area boundaries are depicted on **Figure 1**.

Land within the study area is used predominately agriculture and dry land cropping. The Nogoa river, secondary anabranch and minor tributaries traverse through the Project Area. The Nogoa River is naturally ephemeral but has continuous low flows due to the use of the river as an irrigation channel directing water releases from Fairbairn Dam for downstream users. Fairbairn Dam is approximately 60 km upstream to the south-west of the Project Area.

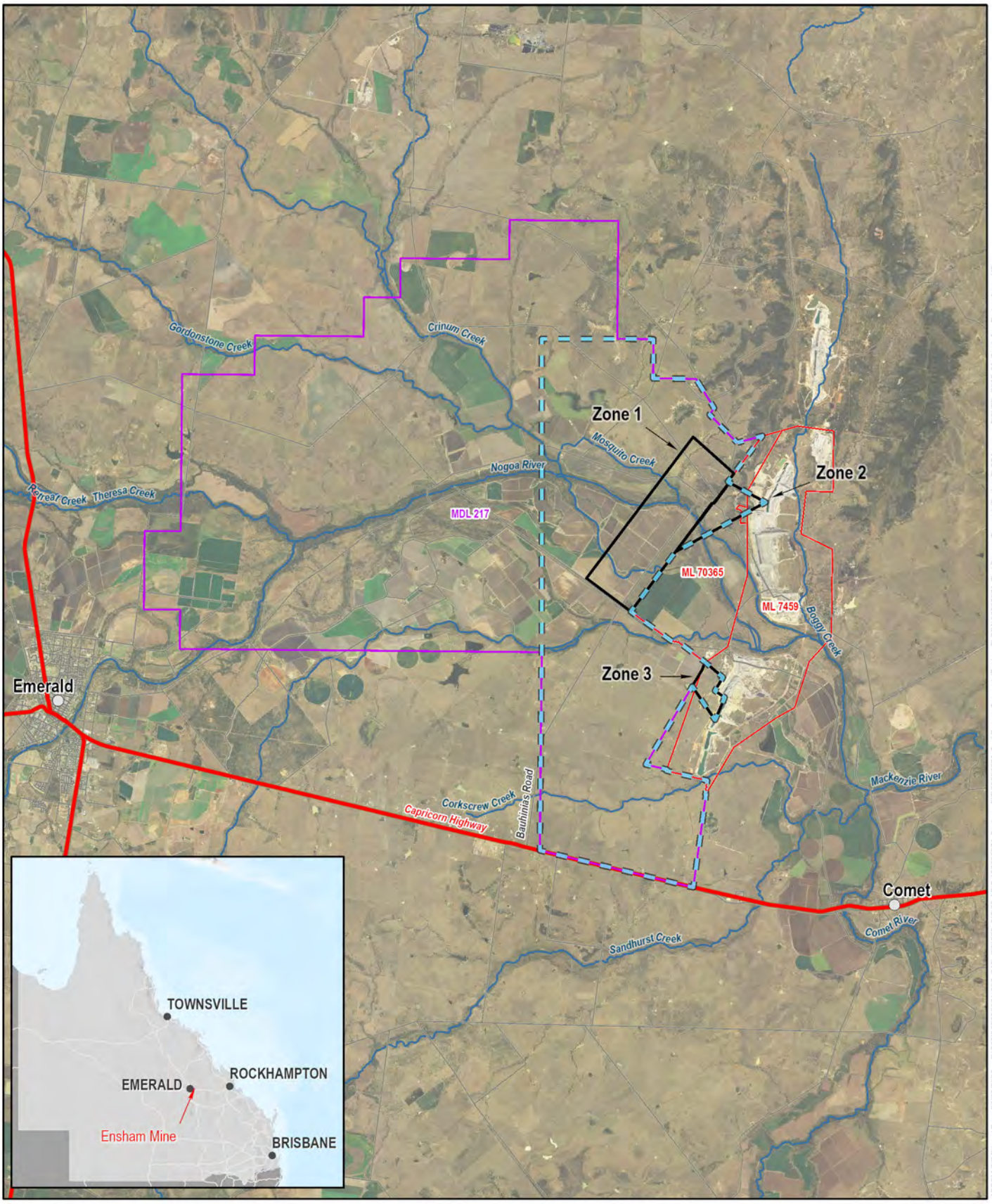


Figure 1
Project Area

Ensham RESOURCES

0 4 8 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Legend

- Project Area
- Study area
- Towns
- Watercourse
- Main road
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

Projection: GDA 1994 MGA Zone 55 Scale: 1:250,000
Source: State of Queensland, 2019. Imagery: State of Queensland, 2017.

2.0 Project description

The Project is an extension of the current underground operation. The development of access and coal extraction will advance in a southern, western and a northerly direction, with production panels and sub mains established off the main roadways.

2.1 Underground mining methods

The underground mine entries are accessed through an area of open cut workings that have come to the end of operations, providing ready access to the coal seam. The mining method is bord and pillar utilising a place change mining system with the pillars left in-situ. The pillars remain to support the roof, to minimize the risk of subsidence. Within the Project Area, all pillars are designed to exceed a FoS of 1.6 (Gordon Geotechniques, 2020). No blasting is proposed for the Project.

The underground mine services are integrated as much as possible with those of the open cut in areas such as waste management, coal transport and water management.

2.2 Subsidence

Underground mining for the proposed Project will occur at a depth of approximately 120 to 210 metres (m) below the surface, however mining under the Nogoa River will occur at depths of 120 to 190 m.

A subsidence study undertaken by Gordon Geotechniques (2020) determined that the predicted subsidence above the panel pillars following secondary coaling in the Project Area is typically less than 40 millimetres (mm). This reduces to typically less than 20 mm above the bell out pillars as they do not carry the full tributary area load on the sides of the panels. The Commonwealth Department of Agriculture, Water and the Environment (DAWE) states that seasonal variation in surface levels can be as high as 50 mm as a result of changes in moisture content meaning that the predicted subsidence is within the range of normal seasonal fluctuation (IESC, 2015). Surface cracking is not predicted above the Project Area due to the predicted low levels of maximum surface subsidence (Gordon Geotechniques, 2020).

2.3 Construction

The current underground mine workings will be extended as part of the normal operation and development of the mine. No new surface infrastructure will be required for the development of the Project Area. Accordingly, no construction activities and above surface disturbances will be required for the Project.

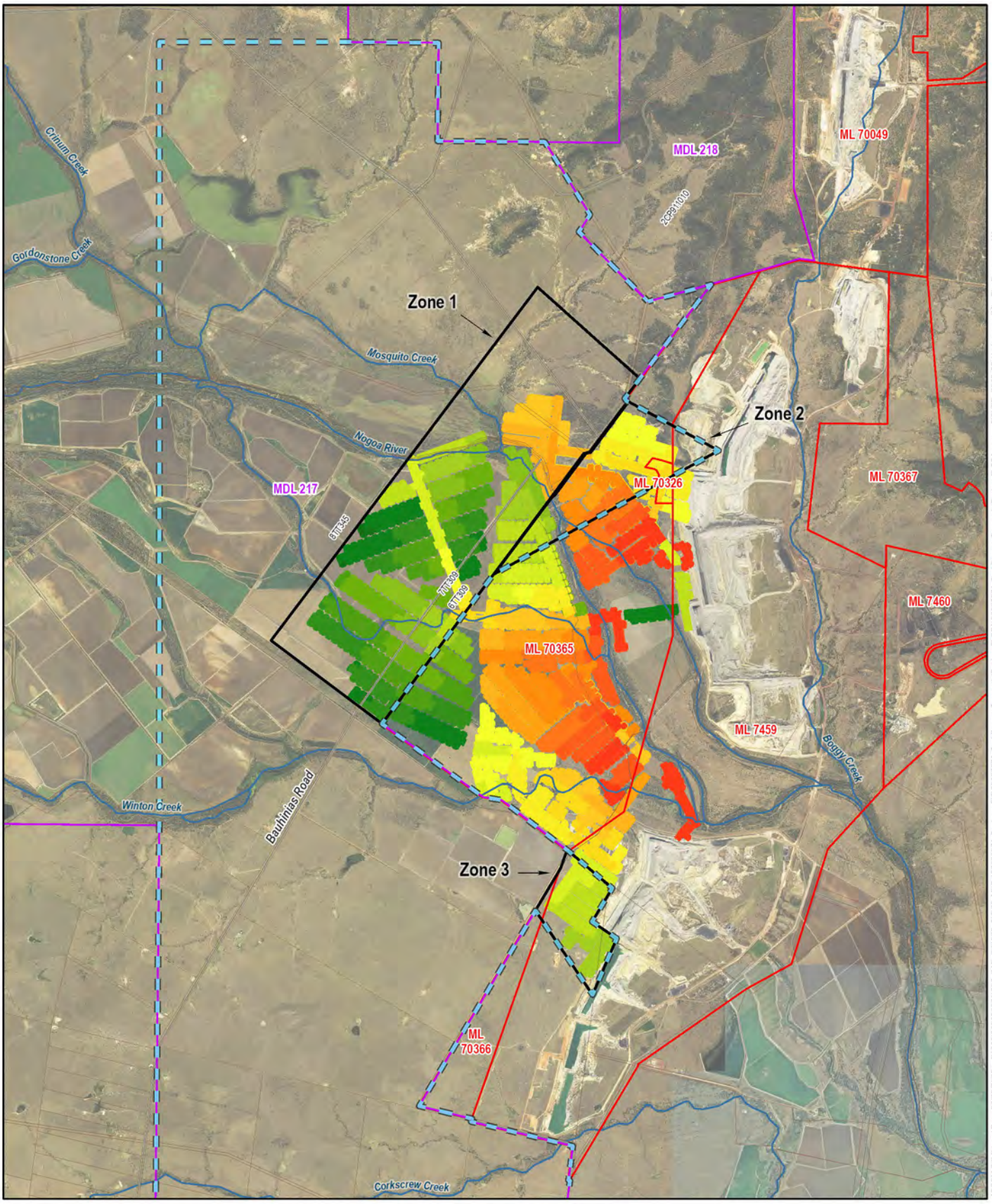


Figure 2
Underground mining sequence for Ensham Mine and the Project

Ensham RESOURCES

N

0 2 3 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Legend

- Project Area
- Study area
- Cadastral lot boundaries
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

Jan 2020 Mine Plan

- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
- 2030
- 2031
- 2032
- 2033
- 2034
- 2035
- 2036
- 2037

Projection: GDA 1994 MGA Zone 55 Scale: 1:100,000
Source: State of Queensland, 2019. Imagery: State of Queensland, 2017.
Mine plan: Indemitsu, 2019

3.0 Regulatory and policy framework

3.1 Commonwealth

3.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides the legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. These are defined under the EPBC Act as MNES. Under the provisions of the EPBC Act, an action that is likely to have a significant impact on a MNES requires the approval of the Minister for Environment and Energy. The Act identifies nine MNES:

1. world heritage properties
2. national heritage places
3. wetlands of international importance (Ramsar wetlands)
4. nationally listed threatened species and communities
5. listed migratory species
6. protection of the environment from nuclear actions
7. commonwealth marine environment
8. the Great Barrier Reef Marine Park
9. a water resource, in relation to coal seam gas development and large coal mine development.

The MNES that were considered in the terrestrial flora study focused upon listed threatened flora species and TECs. The EPBC Act lists threatened species and communities under the following categories: critically endangered, endangered and vulnerable.

3.1.2 EPBC Act Offset Policy

The conditioning of Commonwealth environmental offsets for individual projects is provisioned under Parts 8 and 9 of the EPBC Act. Part 8 outlines the assessment requirements for actions that are likely to have a significant impact on MNES and have been deemed as a controlled action. The need for offsets is decided at this assessment stage, with the requirement for offsets only conditioned (under Part 9) for actions that, following the implementation of avoidance, mitigation and management strategies, are still to result in residual impacts on MNES that are likely to be significant.

Proposed offsets for projects likely to have a significant residual impact are assessed and approved by the Commonwealth Department of Agriculture, Water and the Environment (DAWE). Approval is required prior to the action commencing and ideally conservation gains at offset sites will have commenced prior to impacts occurring. Approved offsets are required to be protected and managed in perpetuity to achieve the proposed conservation gain. This is generally taken to be the duration of the significant residual impact and until the offset has achieved the required conservation outcomes.

The MNES that were considered in the terrestrial flora study focused upon listed threatened flora species and TECs. Project impacts and mitigation measures to these MNES have also been included in the assessment. Assessment on whether these impacts are significant is outlined in the separate MNES Technical Report for the Project Area (AECOM, 2020b).

3.1.3 Weeds of National Significance

One of the objectives of the EPBC Act is to conserve Australian biodiversity which includes provisions for dealing with invasive species as threatening processes. To deal with invasive weed species, the Australian Weeds Strategy was developed by the Commonwealth in conjunction with all state and territory governments. The strategy provides a national framework for addressing weed issues and reducing weed impacts on the environment. Under the strategy, 32 of Australia's most significant weed species are listed as Weeds of National Significance (WoNS). The list was chosen based on an assessment process that prioritised weeds based on their invasiveness, potential for spread and environmental, social and economic impacts. National management strategies and manuals have been published for all WoNS. Introduced flora identified during field surveys were assessed against the WoNS list which allowed the opportunity to identify potential weed impacts to flora values during the development of the Project Area.

3.2 Queensland legislation

3.2.1 Planning Act 2016

The *Planning Act 2016* (Qld) (Planning Act) regulates development in Queensland that is made assessable under the Planning Regulation 2017 (Qld) (Planning Regulation) or the local government planning scheme and is administered by the Department of State Development, Manufacturing, Infrastructure and Planning. Development within a mining lease (or other resource tenure as stated in the Planning Regulation) is exempt from provisions of the Planning Act. If the development is not associated with the mining activity this exemption does not apply.

3.2.2 Nature Conservation Act 1992

The *Nature Conservation Act 1992* (Qld) (NC Act) prohibits the taking or destruction, without authorisation, of protected flora and fauna species in the wild. All native plants and animals in Queensland are protected under Section 71 of the NC Act. The NC Act also provides for an integrated and comprehensive approach to conserving nature. It provides a legislative basis for research, community education, dedicating, declaring and managing protected areas, and protecting native wildlife and its habitat.

The Nature Conservation (Wildlife) Regulation 2006 (Qld) (NC Regulation) lists the plants and animals considered presumed extinct in the wild, endangered, vulnerable, near threatened, least concern, international and prohibited. The NC Regulation discusses their significance and states the declared management intent and the principles to be observed in any taking and use for each group. Flora species identified during field surveys were assessed against threatened species listed in the NC Regulation. This ensured any impacts from the construction and operation of the Project could be quantified in relation to significant flora species requirements.

3.2.2.1 Protected plant framework

Contained within the NC Act, provisions exist for the regulation or restriction taking or using of protected plants. Section 89 of the NC Act states that ‘a person, other than an authorised person, must not take a protected plant that is in the wild unless the plant is taken under:

(a) a conservation plan applicable to the plant; or

(b) a licence, permit or other authority issued or given under a regulation; or

(c) an exemption under a regulation’.

Activities that affect protected plants are regulated under the subordinate NC Regulation. This regulation requires that a flora survey be carried out where areas of clearing are to occur within ‘high risk areas’ that are shown on the ‘Flora Survey Trigger Map’. High risk areas are known locations of Endangered, Vulnerable or Near Threatened (EVNT) plants that are buffered by two kilometres (km). The flora survey method and format of the associated report required under the NC Act is defined by the Flora Survey Guideline (DES, 2019c).

Where the flora survey shows that no EVNT species occur within the proposed clearing area, then the activity is exempt under section 261ZA of the NC Act, but DES must be notified by submission of a flora survey report. Where EVNT species are found to occur with the clearing area then an application for a clearing permit under the NC Act must be made, which must be accompanied by a flora survey report. To ensure any impacts from the construction and operation of the Project could be measured in relation to EVNT presence, desktop assessments and likelihood occurrence assessments were undertaken in conjunction with field surveys.

3.2.3 Vegetation Management Act 1999

The *Vegetation Management Act 1999* (Qld) (VM Act) regulates the clearing of native vegetation in Queensland and is administered by the Department of Natural Resources, Mines and Energy (DNRME). The purpose of the VM Act is to regulate the clearing of vegetation in a way that:

a. conserves remnant vegetation

b. conserves vegetation in declared areas

c. ensures that clearing does not cause land degradation

d. prevents the loss of biodiversity

e. maintains ecological processes

f. manages the environmental effects of the clearing to achieve the matters mentioned in paragraphs (a) to (e)

g. reduces greenhouse gas emissions, and

h. allows for sustainable land use (refer s3(1) of the VM Act).

The VM Act categorises and defines native vegetation as remnant (Category B), high value regrowth (HVR) (Category C), reef regrowth watercourse vegetation (Category R) and non-remnant (Category X). Remnant vegetation is further classified into a RE based on bioregion, landform and dominant canopy species. In addition, the VM Act recognises the same native vegetation categories as essential habitat for protected wildlife. Specifically, section 20AC, sub section 2 states 'Essential habitat, for protected wildlife, is a Category A area, a Category B area or Category C area shown on the regulated vegetation management map -

a. that has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; or

b. in which the protected wildlife, at any stage of its life cycle, is located'.

Under the VM Act all REs are assigned a Vegetation Management Status (VM status). This is based on the current extent remaining compared to its pre-clearing extent, as gazetted under the VM Act and listed in the Regional Ecosystem Description Database (REDD) maintained by the Queensland Herbarium, Department of Environment and Science (DES). A RE considered to have "VM status" is described as an:

- **Endangered** regional ecosystem:
  - less than 10% of its pre-clearing extent remaining, or
  - 10% to 30% of its pre-clearing extent remaining and the remnant vegetation remaining is less than 10,000 ha.
- **Of Concern** regional ecosystem:
  - 10% to 30% of its pre-clearing extent remaining, or
  - more than 30% of its pre-clearing extent remaining and the remnant vegetation remaining is less than 10,000 ha.
- **Least Concern** regional ecosystem:
  - more than 30% of its pre-clearing extent remaining and the remnant vegetation remaining is more than 10,000 ha.

The VM Act protects and regulates the clearing of native vegetation including remnant, HVR and regrowth on watercourses. The VM Act also protects and regulates the clearing of areas designated for offsets or compliance. All clearing of native vegetation within a mining tenure for mining activities is exempt from the VM Act. However, for the purpose of the flora assessment, floristic values have been classified and defined according to the REDD and status under the VM Act.

3.2.4 Environmental Protection Act 1994

Under the EP Act and the EP Regulation certain environmental features are protected within mining lease areas. These are termed ESAs and are divided into Category A, B and C. They include such features as national parks, conservation reserves, wetlands of international importance, marine plants, nature refuges state forests and heritage places. Specifically, for the Project Area, Category B ESAs include endangered regional ecosystems classified by biodiversity status. The biodiversity status is based on an assessment of the condition of remnant vegetation when:

1. less than 10% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss; or
2. 10–30% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 ha; or
3. it is a rare regional ecosystem subject to a threatening process.

The EP Act regulates Environmentally Relevant Activities (ERAs), which includes a resource activity that involves mining, geothermal, greenhouse gas storage or petroleum activities and others prescribed by the EP Regulation. Activities are classified within ERAs, based on the risk of environmental harm. DES assesses applications to undertake ERAs, and issues environmental authorities (EAs) that identify environmental conditions that must be met to prevent and / or minimise the likelihood of environmental harm caused by authorised ERAs. Applications under the EP Act for major EAs may need to be supported by an environmental impact statement (EIS), for which DES nominates the terms of reference.

3.2.5 Biosecurity Act 2014

The *Biosecurity Act 2014* (Qld) (Biosecurity Act) commenced on 1 July 2016. It ensures a consistent, risk-based approach to biosecurity in Queensland.

The Act provides biosecurity measures to safeguard Queensland's economy, agricultural and tourism industries and environment from:

- pests (e.g. wild dogs and weeds)
- diseases (e.g. foot-and-mouth disease)
- contaminants (e.g. lead on grazing land).

Under the Biosecurity Act, invasive plants and animals are categorised as either a 'prohibited matter' or a 'restricted matter'. The Biosecurity Act requires every local government in Queensland to develop a biosecurity plan for their area and also replaced the many separate pieces of legislation that were previously used to manage biosecurity. Decisions made under the Biosecurity Act will depend on the likelihood and consequences of the risk. The Biosecurity Regulation 2016 sets out how the Biosecurity Act is implemented and applied. Introduced flora identified during field surveys were assessed against the list of restricted invasive plants which allowed the opportunity to identify potential weed impacts to flora values during the operation of the Project Area.

3.2.6 Queensland Environmental Offsets Framework

The requirement to deliver State environmental offsets is provisioned under various environmental legislative acts and regulations in force in Queensland. Environmental offsets are not an assessment trigger and are only considered where an application for an approval is required, and the assessment considers the delivery of environmental offsets as a suitable and required outcome.

Upon triggering offset requirements, the conditioning and delivery of environmental offsets is directed under the Queensland offset framework consisting of the *Environmental Offsets Act 2014* (Qld) (EO Act), Environmental Offsets Regulation 2014 (Qld) (EO Regulation) and the Queensland Environmental Offset Policy 2017 (version 1.4). The EO Act provides the statutory platform that establishes the offset framework, co-ordinates the implementation of the framework in conjunction with other legislation, specifies the offset delivery and compliance process, and allows for the recognition of values that require protection through the delivery of offsets. The EO Regulation provides further details on aspects of the EO Act, including the activities and environmental matters to which the EO Act applies. Whilst the Queensland Environmental Offset Policy outlines how environmental offsets should be practically delivered to meet the requirements of the EO Act.

The environmental offset framework only applies when a prescribed activity is likely to have a significant residual impact on a prescribed environmental matter. Prescribed environmental matters include MSES, which for activities authorised under the EP Act are defined in the EO Regulation as the following:

- regulated vegetation – prescribed REs that:
  - are endangered REs
  - are of concern REs
  - intersect with an area shown as a wetland on a vegetation management wetland map
  - contain an area of essential habitat on an essential habitat map for endangered or vulnerable wildlife
  - are located within a defined distance of a relevant watercourse or drainage feature

- connectivity areas
- wetlands and watercourses
- designated precinct in a strategic environmental area
- protected wildlife habitat
- protected areas
- highly protected zones of State marine parks
- fish habitat areas
- waterway providing for fish passage
- marine plants
- legally secured offset areas.

A ‘prescribed activity’ is also defined under the EO Regulation and includes activities requiring approval under the EP Act such as mining. Significant residual impacts are determined through the application of criteria outlined in the appropriate significant residual impact guidelines. MSES relevant to the Project Area have been identified and significant residual impacts assessed.

4.0 Assessment methodology

The methodology for the flora assessment is in accordance with the recommended survey requirements to satisfy Commonwealth and State regulations.

4.1 Desktop assessment

A review of ecological data and literature was undertaken to characterise the flora values and identify the potential presence of conservation significant flora species and vegetation communities within the Project Area. Data were compiled in May 2019, October 2019 and January 2020 through a review of the following key references:

- EPBC Act Online Protected Matters Search Tool (PMST)
- Wildlife Online database (DES, 2019g)
- (DAWE, 2019)Atlas of Living Australia database (Australian Government, 2020)
- Regional Ecosystem Description Database (REDD) (Queensland Herbarium, 2019)
- Regional Ecosystem mapping (DNRME, 2019)
- Regulated Vegetation Management Map (DNRME, 2019)
- aerial imagery (Q Imagery, 2020)
- *Vegetation Management Act 1999* (Qld) (VM Act) watercourses (QSpatial, 2019)
- VM Act wetlands (QSpatial, 2019)
- Protected Plants Flora Survey Trigger Map (DES, 2019d)
- essential habitat mapping (DNRME, 2019a)
- Matters of State Environmental Significance mapping (DES, 2019b)
- Environmentally Sensitive Areas Mapping (DES, 2019c)
- map of Queensland wetland environmental values (DES, 2019e)
- Groundwater Dependant Ecosystem Atlas (BOM, 2020)
- Wetland Maps (WetlandInfo, 2020)
- current distribution texts for vascular flora (Brooker and Kleinig, 2004; Lester, 2008; Anderson, 2016)
- previous ecological assessments undertaken at Ensham Mine.

In order to identify the range of flora species potentially present within the Project Area, reviews of the above data sources were conducted for the area bound by the coordinates presented below **Table 1**.

Table 1 Data sources and search parameters

Data source	Search area	Search buffer
EPBC Act Protected Matters Search Tool	-23.419558,148.473846 -23.419558,148.474532 -23.482866,148.42475 -23.46838,148.403121 -23.406011,148.454619 -23.419558,148.473846	10 km
Wildlife Online	Latitude: 23.2727 to 23.6811 Longitude: 148.2834 to 148.5600	10 km buffer included within coordinates
Regional ecosystems	Restricted to bounds of the Project Area	0 km

4.2 Field survey

Three seasonal flora surveys were undertaken in autumn, spring and summer by two suitably qualified ecologists across the study area. The autumn survey was undertaken over five days from the 9 -14 May 2019. The spring survey was undertaken over five days between 16 – 21 October 2019. The summer survey was completed over four days between 17 – 20 January 2020.

Flora surveys consisted of validating the presence of Regulated Vegetation, REs, TECs, Category B ESAs and threatened flora habitat via three methodologies - vegetation community assessments, BioCondition assessments. TEC assessments and targeted flora searches. The methods used for each of these are described in more detail below.

4.2.1 Vegetation community assessment

The extent, classification and condition of ground-truthed vegetation communities within the Project Area was validated in accordance with the Methodology for surveying and mapping regional ecosystem and vegetation communities in Queensland (Neldner *et al.*, 2019). This included undertaking tertiary and quaternary level assessments across the Project Area.

Tertiary transects were 10 by 50 m (a total area of 500 square metres [m^2]) as per the Queensland Herbarium methodology (Neldner *et al.*, 2019). Descriptive site information recorded at Tertiary transects included location, aspect, slope, soil type, landform, disturbance, fire history, and general notes on ecological integrity. Structural analysis included recording the height class and distribution of the dominant species within each stratum present. The percentage cover of each strata was calculated along each transect, where foliage projection intersected a 50 m centre tape. Foliage projection cover (FPC) of the ground layer was determined using visual estimation of cover within five, 1 m^2 subplots spaced at 10 m intervals along each transect.

Quaternary-level sites were utilised to verify vegetation units and confirm dominant characteristic species. Structural analysis included recording the height class and life form of the dominant species within the mid and canopy strata as per (Neldner *et al.*, 2019). Evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity were compiled for each quaternary survey site. Several time encoded digital photographs were taken at each plot as a reference.

RE classification was determined based on the vegetation, soil and landform characteristics identified in the field, geological mapping for the region and the REDD. Condition status for woody vegetation was evaluated utilising the definitions of remnant vegetation under the VM Act. For the purposes of this assessment, vegetation was mapped into three categories:

- Remnant: woody vegetation that has not been cleared or vegetation that has been cleared but where the dominant canopy has greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy
- HVR: areas previously cleared or disturbed (e.g. by wildfire) over 15 years ago and containing woody vegetation floristically and structurally consistent with the RE but typically less than 70% of the height and less than 50% density of the RE
- Regrowth: areas previously cleared or disturbed (e.g. by wildfire) within the last 15 years and containing woody vegetation floristically and structurally consistent with the RE but typically less than 70% of the height and less than 50% density of the RE
- Non-remnant: areas previously cleared or otherwise significantly disturbed.

A total of 125 sites, including 10 tertiary transects and 115 quaternary sites, were undertaken within the Project Area.

4.2.2 BioCondition Assessment

Following the classification of vegetation, areas across the Project Area were delineated into assessment units and condition quantified and assessed in accordance with BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual (Eyre *et al.*, 2015). An Assessment Unit (AU) refers to vegetated areas with similar REs and vegetation status (remnant or HVR) which can be grouped together. Within each AU site condition attributes were assessed. Areas of vegetation which could not be attributed to a RE were not assessed through BioCondition assessment as a the correct comparable RE benchmark could not be determined. This included brigalow regrowth, acacia regrowth and non-remnant areas.

Site condition assessments involved the collection of 13 site-based attributes as outlined in **Table 2** within a 100 m x 50 m nested sampling plot. In total, 22 site BioCondition assessments were completed within the Project Area. The location of sampling sites is represented in **Figure 3**.

Table 2 Site condition attributes for BioCondition scoring

Attribute	Maximum attribute score
Site condition	
Recruitment of woody perennial species	5
Native plant species richness	
Trees	5
Shrubs	5
Grasses	5
Forbs	5
Tree canopy height	5
Tree canopy cover	5
Shrub canopy cover	5
Native perennial grass cover	5
Organic litter cover	5
Large trees	15
Coarse woody debris	5
Weed cover	10
Total site condition	**80**

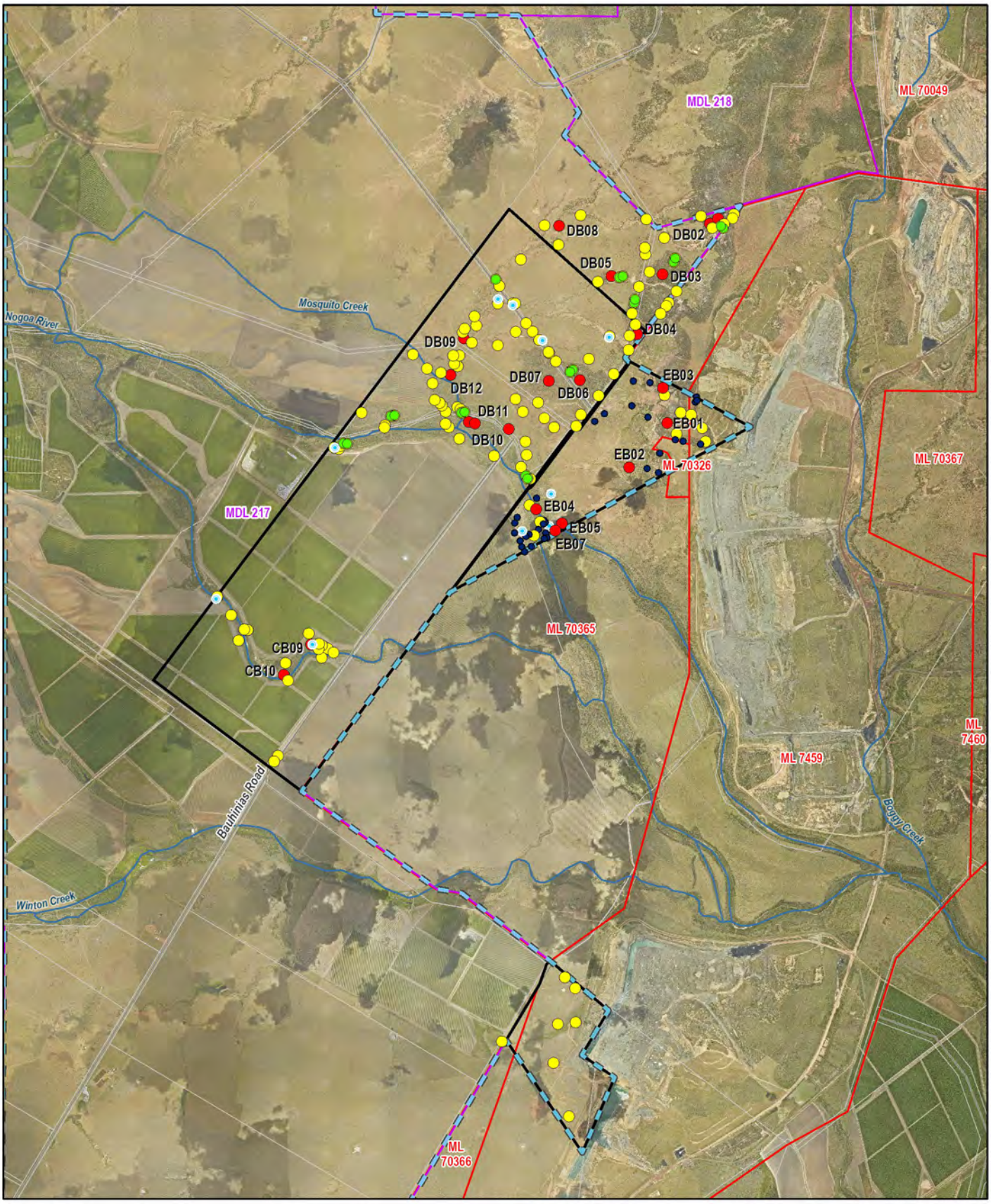


Figure 3
Project Area survey sites

Ensham RESOURCES

N

0 1 2 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Legend

- Project Area
- Study area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

Survey Sites

- BioCondition sites
- TEC vegetation assessment
- Quaternary sites
- Teritary sites
- Flora observations

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.
Survey Sites: AECOM, 2019

4.2.3 TEC assessments

TEC assessments were undertaken to confirm the presence of TECs identified during the desktop assessment, namely Brigalow (*Acacia harpophylla* dominated and co-dominated) Threatened Ecological Community (Brigalow TEC).

Brigalow TEC assessments were undertaken to identify vegetation communities meeting the key diagnostic and condition threshold criteria as described in the Commonwealth Approved Conservation Advice (Threatened Species Scientific Committee and Department of the Environment, 2013). The assessment consisted of collecting the following data at various sites within Brigalow vegetation:

- Dominance or co-dominance of Brigalow
- Brigalow listed RE
- Exotic perennial cover
- Age of community
- Patch size.

4.2.4 Targeted flora searches

Targeted searches for threatened flora species identified in the desktop assessment were undertaken in areas of potentially suitable habitat confirmed during vegetation community assessments across the Project Area.

4.2.5 Survey limitations

Data acquisition during flora surveys generally has inherent limitations associated with variability of vegetation communities across a site, and changes to the detectability and presence of species with time. A high level of confidence in comprehensiveness is implicit in this study as survey sites were strategically located to capture representative samples of all communities. Further, the seasonal conditions during which this survey was undertaken were conducive to a relatively high degree of detectable floral diversity. However, given the above, it is recognised that field studies with a temporal limitation cannot always account for 100% of potential floral diversity present within a site.

4.3 Data analysis

4.3.1 GIS analysis

Spatial data collected during the field survey were imported into ArcGIS (Version 10.2) and analysed. Where necessary, vegetation community boundaries were refined and/or verified using the collected spatial data to produce final ground-truthed mapping. TEC condition thresholds associated with patch size were also confirmed through GIS analysis of the final ground-truthed mapping. Historical aerials were also assessed to confirm regrowth areas as HVR.

Final ground-truthed mapping was then used to undertake the assessment of landscape-based attributes of the BioCondition assessment methodology. Landscape attributes assessed are outlined in **Table 3**.

Table 3 Landscape condition attributes for BioCondition scoring

Attribute	Maximum attribute score
Landscape condition	
Size of patch	10
Connectivity	5
Context	5
Total landscape condition	**20**

4.3.2 BioCondition scoring

As per the BioCondition Assessment Manual, site condition field data was compared against corresponding benchmark data (data from a representative vegetation community i.e. RE in an undisturbed state) and scored accordingly. Benchmark data was sourced from the Department of Environment and Science (2019a). Where a benchmark for a RE does not exist, a benchmark from the same broad vegetation group (BVG) is utilised to enable comparison.

The following steps were undertaken to determine the BioCondition score for each field validated assessment unit identified during field surveys.

1. Determine the BioCondition score (measured) for each sampling site using the formula:

Site condition (measured) + site context (measured) = BioCondition score (measured)

2. Determine the BioCondition score (maximum) by summing together the highest possible score attainable for each measured attribute and using the formula:

Site condition (maximum) + site context (maximum) = BioCondition score (maximum)

The maximum scores that can be obtained for each attribute are:

   a. site condition: 80

   b. site context: 20.

3. Determine the BioCondition score using the formula:

[BioCondition score (measured)/BioCondition score (maximum)] = BioCondition score

Once a BioCondition score was derived for each site, scores were averaged for each AU if more than one site was conducted. Scored AUs were then compared to the BioCondition '1234' framework (Eyre *et al.*, 2015) which categorises scores as classes from one for functional biodiversity condition) to four for dysfunctional biodiversity condition) (**Table 4**). A functional biodiversity condition represents vegetation which has the following:

- minimal disturbance (weed or anthropogenic)
- large patch size
- surrounding landscape is intact with many connections
- high species diversity in all layers from the canopy to the ground layer
- presence of fallen timber at variety of sizes
- presence of leaf litter similar to benchmark data.

A dysfunctional biodiversity condition within vegetation would be characterised by:

- high levels of disturbance
- small isolated patches with few narrow connections
- one or two canopy species with minimal cover
- few shrubs or often an overabundance of shrubs due to minimal competition from canopy species
- minimal ground covered by leaf litter
- fallen timber largely absent.

Table 4 Final classification of BioCondition scores

BioCondition class	% value	Biodiversity condition
1	>0.80	Functional
2	>0.60 – 0.80	↓
3	0.40 – 0.59	
4	<0.40	Dysfunctional

4.3.3 MSES GIS analysis

Field verified vegetation mapping derived from field surveys was utilised to describe MSES regulated vegetation values.

Identifying MSES regulated vegetation 'endangered' and 'of concern' is derived by classifying vegetation communities according to VM Act status. Only vegetation classified as 'endangered' or 'of concern' within ground truth field mapping is utilised to the extent that occurs within State mapped Category B Regulated Vegetation. Areas of vegetation with least concern status were excluded from the calculations.

To identify MSES regulated vegetation within a defined distance of a water course feature, the following process was utilised:

- identify relevant spatial data including: ground-truth field survey mapping, VM Act watercourse lines (DNRME, 2019c) and regulated vegetation mapping (DNRME, 2019)
- identify stream order (1 to 8) categories of watercourse features within the Project Area
- calculate the defined distance from a watercourse as per Queensland environmental offsets policy version 1.6 (DES, 2018).
- apply specified buffer width for non-coastal bioregion as per stream order:
  - Stream order 1-2 – 25 m buffer
  - Stream order 3-4 – 50 m buffer
  - Stream order greater than 5 – 100 m buffer.
- calculate ground-truthed remnant vegetation within the watercourse buffer and within State mapped Category B Regulated vegetation.

4.3.4 Specimen ID

Where plant species could not be identified in the field, fruiting and / or flowering specimens were taken to assist with identification. For those species not field identified during the surveys, samples were pressed and dried, and positive identifications of plant specimens were subsequently made under laboratory conditions or submitted to the Queensland Herbarium for identification.

4.3.5 Nomenclature

Taxonomic nomenclature used for the description of floral species is according to Census of the Queensland Flora 2018 (Bostock & Holland, 2018). Exotic flora species are signified in text by an asterix (*). Field references used for the identification and description of floral species include: Anderson (2016); Brooker & Kleinig (2004); Lester (2008).

4.3.6 Likelihood of occurrence assessment

A likelihood of occurrence assessment for conservation significant vegetation communities and flora identified during the desktop review was undertaken. Flora surveys were undertaken in the field to target vegetation communities and flora species considered likely or potentially occurring within the Project Area, based on the desktop sources. The methodology was applied again after field surveys to determine the likelihood of occurrence once site-based information became available.

Each species was assessed against the categories defined below:

- known: species was positively identified and recorded in the Project Area during the field surveys; or previous, reliable records occur within the Project Area
- likely: species was not recorded during the field surveys or previously, however there are known records within the nearby surrounding area and suitable habitat exists in the Project Area
- potential: species was not recorded during the field surveys or previously, however known records occur in the surrounding area and habitat in the Project Area is marginal or degraded
- unlikely: habitat in the Project Area might be suitable or marginal; however, species was not recorded during the field surveys, and no known records of the species exist within the surrounding area.

5.0 Environmental context

5.1 Bioregions

The Project Area is located within the CHRC Local Government Area. It is approximately 35 km east of Emerald and within the northern section of the Brigalow Belt Bioregion (BRB). The Project is wholly situated within the Isaac – Comet Downs subregion of the BRB. The landscape of this bioregion is predominantly undulating country within lower flats and alluvial areas common. Undulating areas are dominated by *Acacia harpophylla* (brigalow) and *Eucalyptus cambageana* (Dawson gum) communities on clay soils and *Eucalyptus crebra* (narrow-leaved ironbark) and *Eucalyptus populnea* (poplar box) open woodland communities on the shallower textured-contrast soils. *Acacia harpophylla* (brigalow) and *Eucalyptus coolabah* (coolabah) woodlands are common on alluvium, and *Acacia catenulata* (bendee) or *Acacia shirleyi* (lancewood) dominate on rocky hills and mesas (Sattler and Williams, 1999).

5.2 Climate

The climate of the region is sub-tropical with November through to February typically the warmest months, with mean maximum daily temperatures around mid-30°C, recorded during the summer months (Bureau of Meteorology, 2020a) (**Figure 4**). The mean minimum daily temperature at the monitoring station is around 10°C, recorded during winter (**Figure 4**).

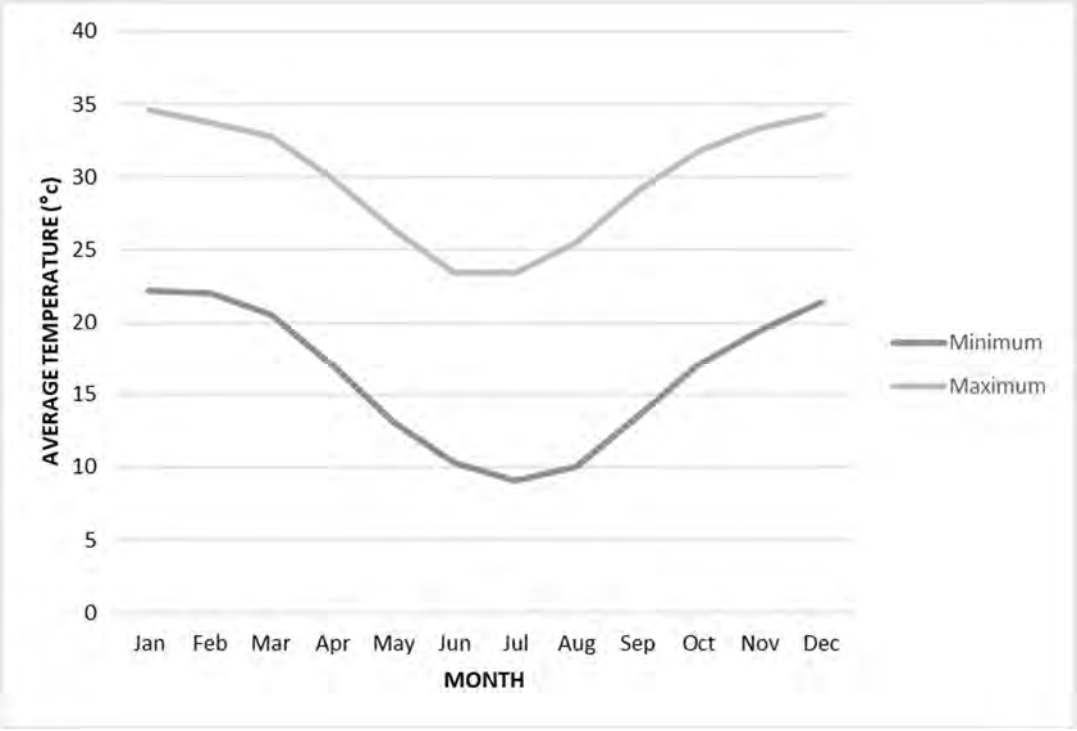


Figure 4 Average minimum and maximum monthly temperatures from 1992 – 2019 (Bureau of Meteorology, 2019b)

The annual average rainfall is 555 mm, with the wettest period occurring during the warmer months from December to February when, on average, 45% of the annual rainfall occurs (**Figure 5**).

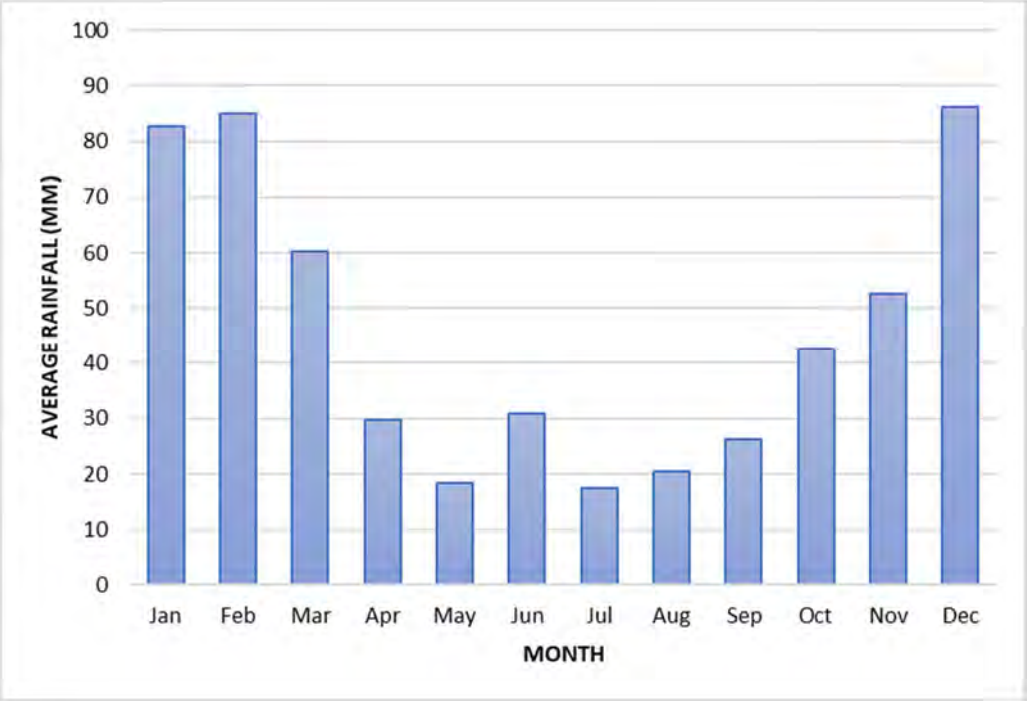


Figure 5 Average monthly rainfall from 1992 – 2019 (Bureau of Meteorology, 2019a)

5.3 Land use

The Project Area largely covers a historically cleared landscape and is surrounded by agricultural properties. The most intensive agricultural production occurs south of the Nogoa River, with a focus on irrigated cropping and irrigated modified pastures. North of the Nogoa River, agricultural production is primarily derived from grazing of native pastures with a small parcel of irrigated woody fodder plants. Most agricultural properties within the Project Area contain several isolated rural residences with associated farm infrastructure, including several irrigation pumping stations. Two areas of contoured mine rehabilitation are located within the north eastern portion of Zone 2. Evidence of grazing was noted within the southern mine rehabilitation area. Areas of mine rehabilitation are primarily grassed with few trees or shrubs persisting. Grazing is the primary land use within Zone 3 of the Project Area.

5.4 Surface Geology

The surface geology of the Project Area is described using the current Queensland Government online mapping resource GeoResGlobe, (2019).

The surface geology of the Project Area is derived from four separate geologic sources.

The southern two thirds of Zone 1, the southern half of Zone 2 and the entirety of Zone 3 are quaternary originated flood plain alluvium of clay, silt, sand and gravel. Vertosol soils are black self-mulching cracking clays closest to the Nogoa River and grey self-mulching cracking clays or brown and red self-mulching cracking clays further from the river but still within the Nogoa flood plain.

Geology of the north of Zones 1 and 2 is described as undulating elevated plains with some steep-scarped dissected margins and occasional low mesa-like residual hills derived from sedimentary rock (Emerald formation). This formation contains a variety of rock types, including deeply weathered claystone, siltstone, quartzose sandstone, pebbly sandstone, lignite oil shale and interbedded basalt. Kandosol soils described as red massive earths are often associated with the parent rock.

Located within a small section in the north-east corner of Zone 2, lithology is described as duricrusted palaeosols at the top of deeply weathering profiles, including ferricrete and silcrete.

A small portion of arenite-mudrock from the early / middle Triassic (rewan group formation) containing sandstones, mudstones, claystones and siltstones is located within the mid-section of Zones 1 and 2.

5.5 Watercourses

Watercourse features of the Project Area are described using the current Queensland Government online mapping resource (Queensland Globe, 2020).

A major watercourse feature, the Nogoa River, stream order 8, bisects the Project Area meandering west to east. Historically, the Nogoa River is partially or fully dry for part of the year (non-perennial) but is currently utilised as a canal to transport water from the upstream Fairbairn Dam. A minor tributary, Mosquito Creek, stream order 4, feeds the Nogoa River from the north. Several other small unnamed non-perennial watercourse features, stream order 1 and 2, drain to Mosquito Creek and the Nogoa River. A minor unnamed non-perennial Nogoa River tributary, stream order 7, drains the southern section of the Project Area and joins the Nogoa River south of the anabranch junction. A single minor unnamed watercourse, stream order 2, drains to the Nogoa River through Zone 3.

5.6 Connectivity

Ecological connectivity is displayed through the Biodiversity Planning Assessment (BPA), which attributes biodiversity significance on a bioregional scale. The BPA has application for identifying areas with various levels of significance solely for biodiversity reasons. Within the Project Area, state significant and regionally significant areas have been identified in relation to biodiversity and connectivity. An analysis of the BPA for the Brigalow Belt shows that 535.68 ha of state significant habitat and 164.78 ha of regionally significant habitat is present within the Project Area. No locally significant habitat has been mapped within the Project Area.

State significant areas are identified along the Nogoa River and follow the edge of the existing vegetation. The river and remaining vegetation provide the opportunity for fauna to travel and disperse within, and to other areas for survival, maintaining species diversity as well as maintaining density. The Nogoa River also provides a mechanism for waterborne seeds to be transported to downstream locations allowing for the maintenance of flora species diversity. Several minor tributaries, creek and patches of vegetation within the Project Area are important for connectivity on a regional scale. These areas often provide the linkages to allow fauna to access larger areas of suitable habitat and to move to along larger connections. North of the Nogoa River, large tracts of habitat in good condition provide for fauna and flora diversity.

6.0 Desktop assessment results

6.1 Regulated vegetation and Regional Ecosystems

DNRME regulated vegetation mapping (Version 10.0) and RE mapping (Version 11.0) was reviewed to determine the extent of Regulated Vegetation and associated REs across the Project Area. Category B Regulated Vegetation comprising nine REs are mapped as occurring within the Project Area (some in heterogenous polygons) and these are listed in **Table 5**. Based on the biodiversity status classifications, four REs are listed as endangered, three as of concern and two as no concern at present (**Figure 6**). VM Act status identifies four REs as endangered, one as of concern and four as least concern (**Figure 7**).

Category C Regulated Vegetation mapping was also consulted to determine the extent of HVR within the Project Area. HVR occurs in several small patches, which have not been cleared for over 15 years but is not yet mature enough to meet remnant status as defined under the VM Act. These are also outlined in **Table 5**.

Table 5 DNRME mapped Category B and Category C vegetation within the Project Area

Regional Ecosystem	Description[1]	Biodiversity status[2]	VM Act status[3]
Remnant			
11.3.1	*Acacia harpophylla* and / or *Casuarina cristata* open forest on alluvial plains	E	E
11.3.25e	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	OC	LC
11.4.2	*Eucalyptus spp*. and / or *Corymbia spp*. grassy or shrubby woodland on Cainozoic clay plains	OC	OC
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	E	E
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	E	E
11.4.9 (b)	*Acacia harpophylla, Eucalyptus thozetiana (*sometimes *E. cambageana)* open forest to woodland.	E	E
11.5.3	*Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	NCP	LC
11.7.1	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana or E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust	OC	LC
11.7.2	Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	NCP	LC
High Value Regrowth			
HVR 11.3.1	*Acacia harpophylla* and / or *Casuarina cristata* open forest on alluvial plains	N/A	E
HVR 11.3.2	*Eucalyptus populnea* woodland on alluvial plains	N/A	OC
HVR 11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	N/A	OC
HVR 11.3.37	Eucalyptus coolabah fringing woodland on alluvial plains	N/A	LC

1 Description of REs as contained in the REDD Version 11.1 (Queensland Herbarium, 2019)
2 Biodiversity status of the RE based on an assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of a regional ecosystem. NCP=No Concern at Present; OC=Of Concern; E=Endangered
3 Conservation status of the RE under the VM Act; LC=Least Concern; OC=Of Concern; E=Endangered.

6.2 Threatened Ecological Communities

A review of the EPBC Act PMST determined that four EPBC listed TECs are potentially occurring within the Project Area. The list of ecological communities and description is presented in **Table 6**.

Table 6 EPBC listed threatened ecological communities potentially occurring within the Project Area

Ecological community	EPBC Act status	Description
Brigalow (*Acacia harpophylla* dominant and co-dominant)	E	Characterised by the presence of brigalow (Acacia harpophylla) which is usually dominant of co-dominant in the tree layer with other species. Vegetation ranges from open forest to woodland with a prominent shrub layer (DAWE, 2013)
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	E	Grasslands typically composed of native perennial grasses on flat or undulating rises. Common on fine textured soils derived from basalt, sedimentary rock. A tree canopy is usually absent (Threatened Species Scientific Committee [TSSC], 2009)
Poplar Box Grassy Woodlands on Alluvial Plains	E	A grassy woodland with a canopy dominated by Eucalyptus populnea and understorey mostly of grasses and other herbs. This community mostly occurs on gently undulating to flat landscapes and occasionally on gentle slopes on a wide range of soil types of alluvial and depositional origin (DAWE, 2019)
Weeping Myall Woodlands	E	Open woodland to woodland where *Acacia pendula* (weeping myall) is the dominant canopy species. This vegetation community generally occurs on flat terrain, shallow depressions or gilgais on raised alluvial plains which are not active drainage channels. (TSSC, 2009)

6.3 Flora of conservation significance

Six conservation significant flora species listed under the EPBC Act and / or NC Act were identified from desktop searches as potentially occurring within the Project Area. These species and the closest known record to the Project Area is provided in **Table 7**. The full list of database search results is provided in **Appendix A**. The flora survey trigger map for clearing protected plants was utilised to determine if the Project Area falls within a protected plant trigger area. After reviewing the trigger map, it was determined that the Project Area is outside any potential protected plant trigger areas.

Table 7 Threatened flora species potentially occurring within the Project Area

Scientific name	Common name	EPBC Act status[1]	NC Act status[2]	Closest record
Acacia spania		-	NT	18 km north of Project Area
Cadellia pentastylis	Ooline	V	V	60 km south-east of the Project Area
Cerbera dumicola	Native frangipani	-	NT	Within Zone 2 of the Project Area
Dichanthium queenslandicum	King blue grass	E	V	7 km east of the Project Area
Dichanthium setosum	Blue grass	V	-	80 km south-west of the Project Area

Scientific name	Common name	EPBC Act status[1]	NC Act status[2]	Closest record
Marsdenia brevifolia		V	-	68 km south-west of the Project Area

[1] Conservation status under EPBC Act: CE (critically endangered), E (endangered), V (vulnerable), Ex (extinct)
[2] Conservation status under NC Act: PE (extinct in the wild), E (endangered), V (vulnerable), NT (near threatened), C (least concern)
[3] Source: EPBC (EPBC PMST), Wild (Wildlife online), ALA (Atlas of Living Australia)

6.4 Essential habitat

No Essential Habitat for conservation significant flora species has been mapped within the Project Area.

6.5 Wetlands and waterways

A review of wetland and waterway values determined high ecological significant wetlands, declared high ecological value waters (wetland and waterways) and VM Act wetlands are absent for the Project Area. However, VM Act watercourses are mapped across the Project Area.

6.6 Groundwater Dependant Ecosystems (GDEs)

Ecosystems that are dependent on groundwater or that may be affected by change in groundwater quality and levels are referred to as groundwater dependant ecosystems (GDEs). GDEs can be classified into three broad types:

- aquifer and cave ecosystems (subterranean GDEs)
- ecosystems dependent on the surface expression of groundwater (aquatic GDEs, including river baseflow systems, springs and swamps)
- ecosystems dependent on the subsurface presence of groundwater (terrestrial GDEs, including some riparian vegetation communities) (Doody, Hancock and Pritchard, 2019)(Bureau of Meteorology, 2020b) .

GDEs that are of relevance to the flora and vegetation values of the Project Area are the terrestrial GDEs. These GDEs are defined as ecosystems which require ground water access either on a permanent or intermittent basis allowing for all or some of the water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (WetlandInfo, 2012). Terrestrial GDE area features can include riverine or floodplain wetlands and REs. Terrestrial GDEs may be indicated by prolonged vegetation vigour during times of lower surface water availability (WetlandInfo, 2012).

Following a review of the Groundwater Dependant Ecosystem Atlas (BOM, 2020) and GDE spatial data from QSpatial (2020), there is low confidence of terrestrial GDE areas within the Project Area. Areas around the Nogoa River and unnamed tributaries, Mosquito Creek and Winton Creek are all mapped as having low confidence of terrestrial GDE areas (Figure 8).

In relation to the hydrogeological characteristics of the Project Area, including the Quaternary aged alluvium associated with the Nogoa River and tributaries, a review of the Ensham Life of Mine Extension Project – Groundwater Impact Assessment (SLR Consulting Australia, 2020) highlighted the following key points:

- alluvium consists of a discontinuous upper layer of less permeable silts and clays, which are underlain by a more permeable layer of sand and gravel
- silt and clay layers are likely to be partially isolating the alluvium layer from the Nogoa River and limiting leakage to the permeable sand and gravel
- groundwater occurrence within the alluvium appears to be variable with only thin and discontinuous saturation zones

- alluvium groundwater levels are shallow (on average 13.8 m below ground level) and within reach of deep-rooted tree species
- alluvial groundwater has a high salinity content
- Nogoa River is freshwater with a much lower salinity content, which provides further supporting evidence of the hydraulic separation between the alluvium and the instream channel and the lack of continuous recharge of the alluvium from river flows
- Recharge of the alluvium groundwater is likely associated with rainfall, localised instream flow where there is a break in the silt/clay layers and from peak flood events
- other groundwater bearing strata is associated with the Permian aged Rangal Coal Measures, which are confined, saline and is at a depth out of reach of deep-rooted tree species
- movement of groundwater within the Permian Rangal Coal Measures largely occurs within the coal seams and recharge via rainfall through the substrates; however some downward seepage from the alluvium may occur in localised areas where there is sub-cropping of coal measures and silt/clay layers are absent; and
- the drawdown influence of the Project on the alluvial aquifer extends beyond the Project Area and includes an area approximately 12 km north-west along a tributary of Crinum Creek, which is associated with coal sub-cropping at this location.

6.7 Environmentally Sensitive Areas (ESAs)

Datasets provided by DES were obtained to determine the location of ESAs in relation to the Project Area.

6.7.1 Category A ESAs

Category A ESAs, as defined by the EP Regulation, are outlined in **Table 8**. In Queensland, mining activities may not be undertaken in land comprising Category A ESAs. There are no Category A ESAs mapped within the Project Area.

Table 8 Category A ESAs and Administering Legislation

Category A Protected Areas	Administering legislation
National Park National Park (scientific) National Park (Aboriginal land) National Park (Torres Strait Islander land) National Park (Cape York Peninsula Aboriginal Land)	NC Act
Conservation Park	NC Act
Special Wildlife Reserve	NC Act
Forest Reserve	NC Act
Wet Tropics World Heritage Area	*Wet Tropics World Heritage Protection and Management Act 1993*
Great Barrier Reef Region	*Great Barrier Reef Marine Park Act 1975* (Commonwealth)
Marine Parks (other than general use zones)	*Marine Parks Act 2004*

6.7.2 Category B ESAs

Category B ESAs are defined in the EP Regulation and are presented in **Table 9**. The ESA mapping tool (DES, 2019b) shows patches of Category B ESA scattered throughout the Project Area. While there are flora relevant Category B ESA, no fauna relevant Category B ESA are present within the Project Area (AECOM, 2020a)

Table 9 Category B ESAs and Administering Legislation

Category B Protected Areas	Administering legislation
Endangered Regional Ecosystems (Biodiversity Status)	VM Act
Coordinated Conservation Areas	NC Act
Areas of Critical Habitat or Major Interest Identified under a Conservation Plan	NC Act
Areas of Interim Conservation Order	NC Act
Areas subject to the Convention on the Conservation of Migratory Species of Wild Animals	International Conventions
Areas subject to the Convention on Wetlands of International Importance, especially as Waterfowl Habitat	International Conventions
Areas subject to the Convention Concerning the Protection of the World Cultural and Natural Heritage	International Conventions
Marine Parks (within general use zones)	*Marine Parks Act 2004*
An Area to the Seaward Side of the Highest Astronomical Tide	Nil
Queensland Heritage Registered Places and Places of Cultural Heritage Significance	*Queensland Heritage Act 2004*
Aboriginal Cultural Heritage Area, other than the area known as the 'Stanbroke Pastoral Development Holding'	*Aboriginal Cultural Heritage Act 2003*
A Feature Protection Area, State Forest Park or Scientific Area	*Forestry Act 1959*
Fish Habitat Areas	*Fisheries Act 1994*
Marine Plants	*Fisheries Act 1994*

6.7.3 Category C ESAs

Category C ESAs are defined in the *Eligibility criteria and standard conditions for exploration and mineral development projects - Version 2* (Department of the Environment and Heritage Protection, 2016) (**Table 10**). In Queensland, mining activities can be undertaken in Category C ESAs. There are no Category C ESAs mapped within the Project Area.

Table 10 Category C ESAs and Administering Legislation

Category C Protected Areas	Administering Legislation
Nature Refuges and Resource Reserves	NC Act
Declared Catchment Areas; Declared Irrigation and Irrigation Project Areas; and Water Reservoirs and Drainage Areas	*Water Act 2000*
River Improvement Areas	*River Improvement Trust Act 1940*
Designated Landscape Area (e.g. Stanbroke Pastoral Holding)	*Aboriginal Cultural Heritage Act 2003*
Historic Mining Sites	Nil (Inter Departmental Notifications)
State Forests or Timber Reserves	*Forestry Act 1959*

Category C Protected Areas	Administering Legislation
DPI Research Sites	Nil (Inter Departmental Agreement)
Critical Areas and Public Purpose Reserves	*Land Act 1994*
Areas under Coastal Management Plans and Control Districts	*Coastal Protection and Management Act 1995*
An area subject to a State Planning Policy that the policy declares is in need of environmental protection	Planning Act
Areas of land occupied by the Bureau of Sugar Experiment Stations to conduct research	*Sugar Industry Act 1999*

6.8 Previous ecological studies

Three previous ecological studies have been undertaken across portions of the Project Area for other projects related to Ensham Mine. The results of these studies relevant to this flora assessment are summarised in the following sections.

Threatened Species Survey of Regrowth Vegetation at the Ensham Mine (AARC Environmental Solutions Pty Ltd)

AARC Environmental Solutions Pty Ltd (AARC) conducted a two day threatened species survey (11/03/2019 – 12/03/2019) over approximately 60 ha of non-remnant and regrowth vegetation proposed for disturbance by future mining activities east of the Project Area on ML7459 and ML70365. Three conservation significant flora species were targeted during the survey. These being *Cerbera dumicola* (native frangipani), *Dichanthium queenslandicum* (king blue-grass) and *Acacia spania*. Habitat and flora searches were conducted in accordance with the Random Meander Technique (Cropper, 1993) and the 'Flora Survey Guidelines – Protected Plants' (Department of Environment and Science, 2019b). The targeted surveys were carried out where known habitat characteristics were identified on the site.

Field surveys did not identify any threatened flora species within the target survey area. The majority of vegetation within the survey area was regrowth which intersected a small area of vegetation mapped as remnant. Remnant vegetation was highly modified by the presence of *Cenchrus ciliaris* (buffel grass). A diversity of weed species were identified to be common throughout the survey area and included *Parthenium hysterophorus* (Parthenium), *Opuntia stricta* (prickly pear), *Parkinsonia aculeata* (parkinsonia), *Bryophyllum delagoense* (mother of millions), *Sporobolus pyramidalis* (giant rat's tail grass), *Harrisia martinii* (harrisia catus) and *Vachellia farnesiana* (mimosa bush).

Stage 3 Ecological Assessment Report – Ensham Residual Void Project (Umwelt (Australia) Pty Ltd)

Umwelt (Australia) Pty Ltd (Umwelt) completed a desktop assessment for Stage 3 of the Residual Void Project, located within the existing mine operations and immediately adjacent to the Project Area. The assessment was completed in March 2019 and three preferred options were presented as part of the report and identified a number of data gaps and potential impacts of the Residual Void Project on ecological values. The report recommended that targeted ecological surveys be undertaken in potential disturbance areas for the selected option should that option result in impact beyond the existing approved mine footprint.

A summary of vegetation and flora baseline ecological conditions included:

- riparian wetlands consisting of 'Of Concern' RE 11.3.25(e) and 'Endangered' RE 11.3.3, as well as 'Endangered' RE 11.4.8
- woodland consisting of 'No Concern' RE 11.5.9, RE 11.7.2 and RE 11.7.4 and 'Of Concern' RE 11.7.1
- open forest consisting of 'Endangered' RE 11.3.1
- disturbed lands / pasture / cropping / rehabilitation

- three flora species of conservation significance, namely *Cerbera dumicola*, *Dichanthium queenslandicum* and *Acacia spania.*

Ensham Mine: BioCondition Monitoring Report 2012 – Flora (Ecological Survey and Management Pty Ltd)

Ecological Survey and Management Pty Ltd (EcoSM) completed a detailed flora and fauna biodiversity monitoring program including desktop review and targeted field survey. Field surveys were completed between 10 and 15 April 2012. The focus of the monitoring was targeted toward the riparian vegetation communities on the Nogoa River, its anabranch, associated floodplain and Winton Creek which flows south of the Project Area. Additional survey of a lateritic jump up to the north of the Nogoa River was also completed. One component of the field survey was to establish permanent BioCondition monitoring plots to quantitatively assess the structure, composition and ecological condition of vegetation communities within Ensham Mine.

A summary of results from the field survey included:

- six field validated REs within the monitoring area (one ‘endangered’, four ‘of concern’ and one ‘no concern at present’ (Biodiversity Status listing))
- eighteen BioCondition sites undertaken throughout the survey area, with often lower than average benchmark vegetation condition due to disturbance, selective timber harvesting, grazing and weed presence.

A population of *Cerbera dumicola* was recorded within the survey area. An estimated 1,000 to 2,000 specimens between 0.3 m and 2.0 m in height were reported.

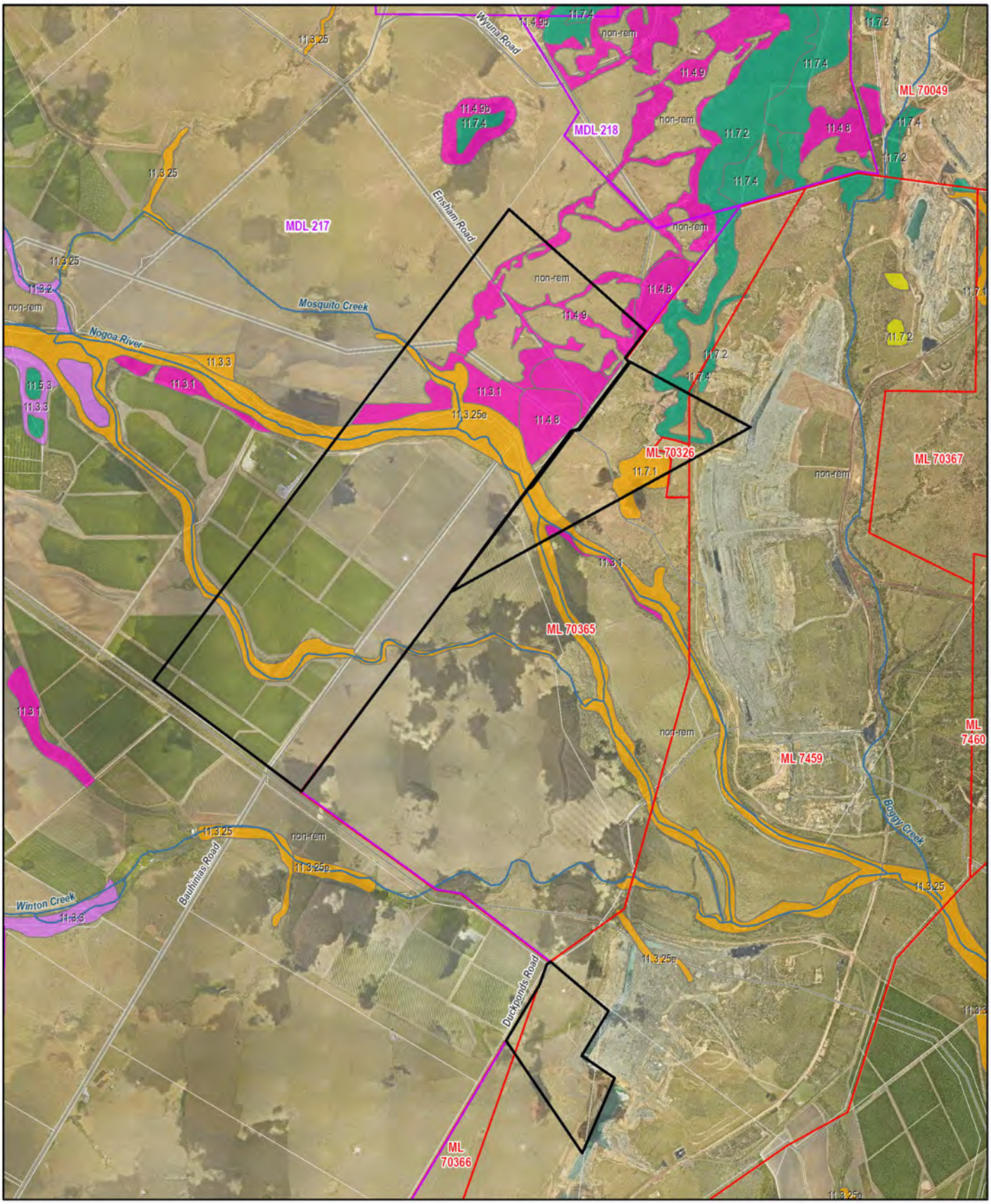


Figure 6
Mapped REs within the Project Area (Biodiversity status)

Ensham RESOURCES

N

0 1 2 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

Biodiversity status - remnant vegetation

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- No concern at present
- Non-remnant, regrowth, disturbed

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.

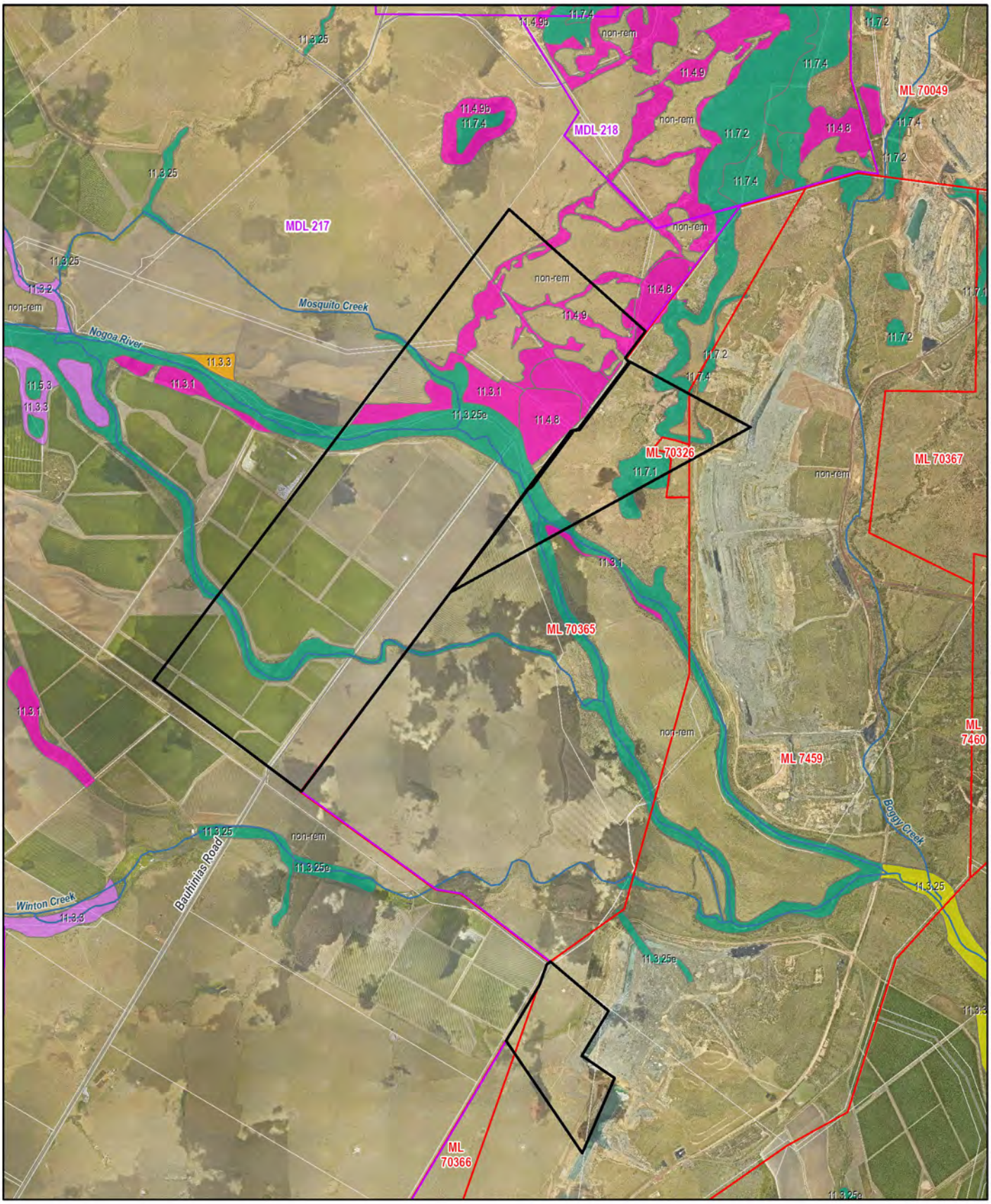


Figure 7
Mapped REs within the Project Area (VM Act status)

Ensham RESOURCES

0 1 2 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

VM Act status - remnant vegetation

- Endangered - Dominant
- Endangered - sub-dominant
- Of Concern - Dominant
- Of Concern - sub-dominant
- Least Concern
- non-remnant

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.

Figure 8
Groundwater Dependant Ecosystems within the Project Area

Ensham RESOURCES

N

0 1 2 km

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

Terrestrial GDE

- Derived GDE - low confidence

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.

7.0 Field Survey results

7.1 Survey timing and climatic conditions

Autumn field survey

Conditions experienced during the autumn flora field survey consisted of warm days and mild nights. A review of the daily weather observations sourced from the Bureau of Meteorology (BoM) Emerald Airport station (035264, approximately 25 km west of the study area), details the minimum and maximum temperature during the survey, which averaged 12.9 ºC and 25.8 ºC respectively. The BoM reports that no rainfall was recorded during the survey period, with the most recent rainfall being 1.2 mm on 4 May 2019. The minimum and maximum temperatures recorded on each day of the surveys are presented in **Table 11** and rainfall for 2019 prior to the autumn survey is shown in **Figure 9.**

Table 11 Temperature and rainfall recorded at Emerald Airport 9-14 May 2019 (Bureau of Meteorology, 2019)

Date	9 May	10 May	11 May	12 May	13 May	14 May
Minimum temperature (ºC)	12.5	18.0	9.0	8.4	14.6	14.9
Maximum temperature (ºC)	27.6	27.7	22.3	23.8	26.4	27.1
Rainfall (mm)	0.0	0.0	0.0	0.0	0.0	0.0

Spring field survey

Conditions experienced during the spring flora field survey consisted of hot days and warm nights. Daily weather observations sourced from the BoM Emerald Airport station (035264, approximately 25 km west of the study area), detailed the minimum and maximum temperature during the survey averaged 19.9 ºC and 36.6 ºC (17-21 October) and 1.2 mm of rainfall was recorded during the survey period. Prior to the October survey, the most recent rainfall recorded was 0.6 mm on 30 August 2019. The minimum and maximum temperatures recorded on each day of the surveys are presented in **Table 12** and rainfall recorded by the BoM (2019) prior to the spring survey is shown in **Figure 9** BoM (2019) .

Table 12 Temperature and rainfall recorded at Emerald Airport 17-21 October 2019 (Bureau of Meteorology, 2019)

Date	17 October	18 October	19 October	20 October	21 October
Minimum temperature (ºC)	21.7	21.0	21.1	17.6	17.7
Maximum temperature (ºC)	38.0	39.0	37.0	34.0	32.9
Rainfall (mm)	0.0	1.2	0.0	0.0	0.0

Additional Areas Survey (January 2020 – Zones 2 and 3)

Conditions at the time of the January survey were hot days and warm nights. The minimum and maximum temperatures recorded on each day of the survey are presented in **Table 13**.

Little rainfall was recorded during the survey period (0.8 mm), although 76.4 mm was recorded on the day prior to the field survey (17 January). As a result of this heavy rain, the Nogoa River, tributary creeks and the larger farm dams contained water.

Table 13 Temperatures and Rainfall Recorded at Emerald Airport 18-20 January 2020 (Bureau of Meteorology, 2019)

Date	18 Jan	19 Jan	20 Jan
Minimum Temperature (°C)	20.1	23.8	27.0
Maximum Temperature (°C)	36.9	39.0	38.5

Date	18 Jan	19 Jan	20 Jan
Rainfall (mm)	0.8	0.0	0.0

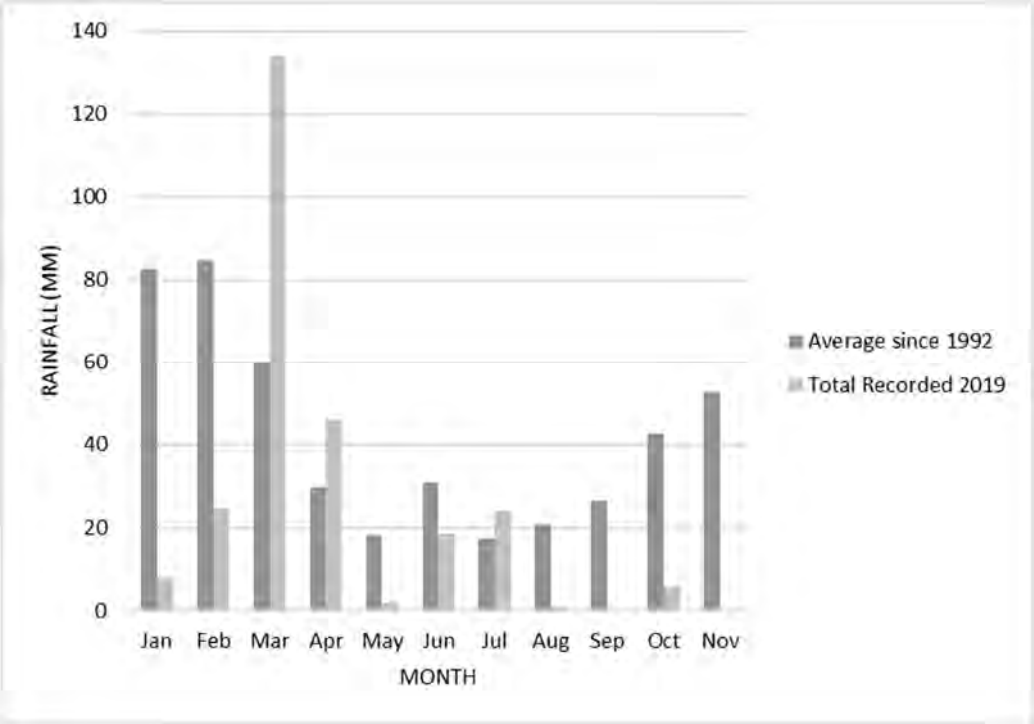


Figure 9 Average monthly rainfall and total recorded in 2019 at Emerald Airport

7.2 Survey area characteristics

Zone 1 is divided into two distinct areas based on current land use and terrain. The Nogoa River is the transition point of these two areas.

North of the Nogoa River, vegetation is dominated by remnant *Acacia* or *Eucalyptus* woodlands on hilly terrain with rocky outcrops / laterite present at higher elevation. Dominant canopy species include *Eucalyptus thozetiana, Acacia shirleyi,* and *Acacia catenulata.* The primary land use is cattle grazing which has had varying impacts to the ground and shrub layers of the vegetation communities. Impacts are predominantly dependent on accessibility of cattle influenced by terrain.

Closer and further south of the Nogoa River and within alluvial gullies and drainage lines, open forest and woodland vegetation is dominated by *Acacia harpophylla* or *Eucalyptus coolabah* with *Eucalyptus camaldulensis* fringing the river bank. Exotic shrub and groundcover species were detected during survey effort and are common throughout vegetation north of the Nogoa River. Soils are alluvial and are consistent with cracking clay soil types. Dominant land use south of the Nogoa River is centred around broad acre cropping, with the majority of the farmland channel irrigated.

Zone 2 is similar to Zone 1 in that it is divided into two distinct areas based on terrain and land use. Close to the Nogoa River, open forest and woodland vegetation is dominated by *Acacia harpophylla* or *Eucalyptus coolabah* with *Eucalyptus camaldulensis* fringing the river bank. Exotic flora species are prevalent throughout this area, particularly exotic grasses. South of the Nogoa River, the area is utilised for cattle grazing and cultivation of cattle fodder with cleared pasture and Leucaena (*Leucaena leucocephala*) the dominant vegetation. North of the Nogoa River, vegetation is dominated by remnant *Acacia* or *Eucalyptus* woodlands on hilly terrain with rocky outcrops / laterite present at higher elevation. Dominant canopy species include *Eucalyptus thozetiana* and *Acacia shirleyi.* Between areas of woodland and the Nogoa River, vegetation is heavily influenced by grazing and past land clearing. In these areas, vegetation is predominately pasture interspersed with very scattered low regrowth trees and shrubs. Mine rehabilitation occurs within the north eastern portion of Zone 2 and is dominated by pasture grass with few scattered trees and shrubs.

Zone 3 is extensively cleared with minimal regrowth trees and shrubs. The site is bisected by a single drainage feature providing areas where standing water allows growth of wetland type grasses and rushes. The eastern edge of Zone 3 borders spoil heaps from previous mining operations.

7.3 Vegetation communities

Eight vegetation communities were described and mapped in the Project Area on the basis of aerial imagery analysis and field survey results (**Figure 10**). These comprise:

- *Acacia harpophylla* open forest on alluvial plains
- *Acacia harpophylla* low open forest on alluvial plains
- *Eucalyptus coolabah* woodland on alluvial plains
- *Eucalyptus camaldulensis* woodland fringing drainage lines
- *Eucalyptus thozetiana* with a midstorey of *Acacia harpophylla* on lower scarp slopes on Cainozoic lateritic duricrust
- *Acacia shirleyi* woodland on Cainozoic lateritic duricrust and scarp retreat zones
- Brigalow regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust
- Acacia regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust.

BioCondition assessments across assessed vegetation communities found that condition was generally moderate with scores ranging from two to three out of four. This indicates that the ecological function of the communities is compromised to some degree.

The *Acacia harpophylla* open forest and low open forest on alluvial plains scored a three signifying that these vegetation communities are closer to dysfunctional than functional biodiversity condition. Vegetation representing *Eucalyptus thozetiana* woodland also score a near dysfunctional condition. A near dysfunctional condition for the vegetation communities is likely due as a result of several factors. These include:

- narrow vegetation width
- small isolated patches
- few large trees
- low tree and shrub cover and diversity
- presence of a diversity of weed species
- discontinuous connections to other vegetation.

Remaining Eucalypt dominated communities and *Acacia shirleyi* woodland scored a two indicating these areas are near functional. There are several factors which lead to an enhanced overall condition. These include:

- larger patch size
- more connections with adjacent vegetation
- a higher diversity of native trees and shrubs
- presence of a diversity of native grasses with increased groundcover
- more remnant or regrowth vegetation present within the surrounding landscape.

Complete BioCondition scoring for assessed vegetation communities is provided in **Appendix C**. **Table 14** provides a summary description of the vegetation communities. Exotic species are denoted with an asterisk (*). Regulated vegetation category classification, RE association and conservation status of the identified vegetation communities are further discussed in the following sections.

7.3.1 Regulated vegetation and REs

The majority of the Project Area (2,224.82 ha) was validated to comprise non-remnant vegetation (Category X). This is associated with either non-remnant woodland, pastures mostly dominated by *Cenchrus ciliaris* (buffel grass), agricultural cropping land, mine rehabilitation and small patches of Acacia or brigalow regrowth vegetation.

Category B Regulation Vegetation (remnant) and Category C Regulated Vegetation (HVR) was also confirmed within the Project Area and comprises a total area of 450.23 ha. This vegetation was found to be analogous to five REs. These REs mapped as per VM Act Status are displayed in **Figure 10** and show one listed as ‘endangered’, one as ‘of concern’ and three as ‘least concern’. Of the REs described as per the biodiversity status, one is listed as ‘endangered’, three as ‘of concern’ and one ‘no concern at present’ (**Figure 11**).

The flora survey displays a large difference compared with state RE mapping with several REs (11.4.2, 11.4.3, 11.4.8, 11.4.9b and 11.5.3) not identified during the field survey. Several State mapped RE polygons are heterogenous which include several REs as a percentage per polygon. This differs from the field verified mapping which consists of homogenous polygons and this accounts for the absence of many State mapped REs. A major difference was observed in Zone 1. The observation of *Eucalyptus thozetiana* (yupunyah / napunyah) on lateritic duricrust (land zone 7) differs from mapped REs which displays land zone 4 and a canopy dominated by *Eucalyptus cambageana* and *Acacia harpophylla*.

The extent, condition, dominant species and conservation significance of each RE is described below, with representative site images (**Table 14**).

7.3.2 Endangered Regional Ecosystems

A single RE with an endangered biodiversity status was identified within Project Area, namely RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains)**.** This RE occurs as both remnant and HVR. A total of 63.66 ha of RE 11.3.1 is described and mapped within the Project Area boundary (**Figure 10**). The extent of Endangered REs and HVR Endangered REs within the Project Area is listed in **Table 14**.

Table 14 Vegetation Communities within the Project Area

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Acacia harpophylla low open forest on alluvial plains.	11.3.1 HVR (DB05#, , EB07) AU1	This vegetation community occurs north and south of the Nogoa River with the majority present within gullies / drainage features to the north. It comprises a low canopy layer ranging from 6 to 7 m dominated by *Acacia harpophylla* (brigalow). The canopy often contains *Terminalia oblongata* (Yellow-wood) and *Lysiphyllum carronii* (red bauhinia). Canopy cover is sparse and averaged approximately 22 %. Dense regrowth *A. harpophylla, T. oblongata, and L. carronii* is also present as the dominant sub canopy and shrub layer. Subcanopy ranged up to 4.5 m and was sparse (11 %). The ground layer coverage is highly variable with some areas recording greater than 50 % bare ground, while others recorded a higher coverage due to the presence *Carissa ovata* (currant bush) or the exotic grass *Cenchrus ciliaris** (buffel grass). In addition to the presence of exotic weed species, other disturbances include heavy stock grazing and tree removal.	E	HVR E	0.55 (55/100)	46.74	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Acacia harpophylla open forest on alluvial plains.	11.3.1 Remnant (CB09, DB08[#]) AU2	This vegetation community occurs north and south of the Nogoa River often adjacent to other areas of remnant vegetation. Vegetation is dominated by *Acacia harpophylla* with an average canopy height of 11 m and 23 % cover. Occasional *A. harpophylla* and *Eucalyptus coolabah* form an emergent canopy up to 14 m. A lower sub canopy to 7 m is often present and is composed younger *Acacia harpophylla* with the addition of *Terminalia oblongata* and *Lysiphyllum carronii.* Brigalow is also present in the shrub layer along with a diversity of other native species including: *Geijera parviflora* (wilga), *Eremophila mitchelli* (false sandalwood), *Cassia brewsteri* (Leichhardt bean), *Alectryon diversifolia* (scrub boonaree) and *Carissa ovata* (currant bush). Shrub cover is sparse to mid-dense between approximately 28 and 35 %. The ground layer coverage is highly variable with some areas recording greater than 50% bare ground, while others recorded a higher coverage due to the presence *Carissa ovata* or the exotic grass *Cenchrus ciliaris** (buffel grass). Disturbances for this vegetation community include habitat fragmentation, weed infestation and grazing.	E	E	0.57 (57/100)	16.91	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Eucalyptus coolabah woodland on alluvial plains.	11.3.3 Remnant (DB09, DB10, DB12, CB01, CB10, EB05) AU3	The majority of this vegetation community occurs adjacent to the Nogoa River and tributary drainage features. A small portion occurs along a vegetated drainage feature surrounded by cultivation within the south of Zone 1. *Eucalyptus coolabah* (coolibah) up to 21 m in height dominates the canopy with a mid dense cover averaging 58 %. The shrub layer is generally sparse averaging 20 %, with several species present including: Acacia salicina (sally wattle), *Terminalia oblongata* (Yellow-wood), *Lysiphyllum carronii* (Queensland ebony) and *Capparis spp.* Shrub layer density is also affected by the presence or absence of the weed of national significance *Parkinsonia aculeata** (parkinsonia). The native ground layer coverage is very sparse but a diversity of native grasses occurs including: *Dichanthium sericeum* (blue grass), *Panicum decompositum* (Australian millet) and *Astrebla squarrosa* (Mitchell grass). This vegetation community often has a diversity small native herbaceous species. Disturbances include variable grazing pressure, weed invasion and historic timber harvesting.	OC	OC	0.61 (61/100)	169.43	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Eucalyptus camaldulensis woodland fringing drainage lines.	11.3.25 Remnant (DB11, CB02, EB04) AU4	This vegetation community occurs along the Nogoa River. The canopy is dominated by *Eucalyptus camaldulensis* (river red gum) with an average height of 22 m. *Casuarina cunninghamiana* (river sheoak) and occasional *Eucalyptus coolabah* (coolibah) are also present. Canopy cover averaged 65 %. The sub canopy layer is sparse, comprised of *Melaleuca trichostachya* (narrow leafed honey-myrtle), *Acacia salicina* (sally wattle), *Terminalia oblongata* (Yellow-wood) and *Ficus opposita* (sandpaper fig) in addition to juvenile canopy species. The native shrub layer is largely absent with exotic *Ricinus communis** (castor oil) and *Parkinsonia aculeata** (parkinsonia) often prevalent within the shrub layer and were seen in higher densities depending on water velocity. The mid dense ground layer is a mix of native and exotic ground covers. Native groundcover species *Ischaemum australe* (large bluegrass), *Duma florulenta* (lignum), *Chrysopogon fallax* (golden beard grass) and *Cyperus spp.*, compete with exotic species *Megathyrsus maximus** (Guinea grass), *Cynodon dactylon** (couch) and *Passiflora foetida** (stinking passion flower). Weeds, grazing and flooding play a large role is the composition and structure of this vegetation community.	OC	LC	0.79 (79/100)	52.34	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Eucalyptus thozetiana woodland with an understorey of *Acacia harpophylla* on lower scarp slopes on Cainozoic lateritic duricrust.	11.7.1 Remnant (DB03, DB04, DB06, DB07, EB02) AU5	Vegetation comprising this particular RE is located on the hills and undulating ground within the north eastern portion of Zones 1 and 2, defined by shallow gravelly soils of lateritic origin. Average canopy height is in the range of 14-17 m and is dominated by *Eucalyptus thozetiana* (yapunyah). Canopy cover ranges from 28 to 38 %. *Acacia harpophylla* (brigalow) is also occasionally present within the canopy, but often form a sub canopy layer with juvenile *E. thozetiana* to 10 m. Occasional emergent *E. thozetiana* were recorded to 25 m. The sparse shrub layer is formed from a variety of species with the most common being *Geijera parviflora* (wilga), *Erythroxylum australe* (Australian cocaine tree), *Eremophila mitchellii* (false sandalwood), *Denhamia cunninghamii* (yellow berry-bush) and *Carissa ovata* (currant bush). A sparse ground layer, predominately native grasses and herbs compete with *Harrisia martinii** (harrisia cactus) and occasional *Cenchrus ciliaris**. Other weed species are largely absent. Grazing and weed invasion are the largest contributors to disturbance within this community.	OC	LC	0.58 (58/100)	127.67	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Acacia shirleyi woodland on Cainozoic lateritic duricrust and scarp retreat zones	11.7.2 Remnant (DB01, DB02, EB01, EB02) AU6	This vegetation community occurs on scarps and slopes of plateaus and ridgelines in the north eastern section of the Project Area. *Acacia shirleyi* dominates the canopy layer at a height up to 16 m. Scattered occasional *E. thozetiana* were noted as emergents, particularly at lower elevations within this vegetation community. A sparse low shrub layer is present and characterised by species such as *Alstonia constricta*, *Capparis lasiantha* and *Cassia brewsteri*. The ground layer is extremely sparse and characterised by grasses such as *Ancistrachne uncinulata*, *Aristida sp*. and *Enneapogon sp*. Few forbs were recorded and included *Abutilon oxycarpon*, *Jasminum didymum* and *Einadia nutans*. Rare occurrences of *Cenchrus ciliaris** were noted, with other weed species absent.	NCP	LC	0.73 (73/100)	37.13	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Brigalow regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust	Regrowth	Within the central section of Zone 1 and 2 north of the Nogoa River, small isolated patches of regrowth vegetation on clay as well as shallow gravelly soils of lateritic origin were recorded. This vegetation community recorded a lower canopy height averaging 9.5 m and canopy cover of between 15 to 20 %. *Acacia harpophylla* is frequent within the canopy along with occasional *Terminalia oblongata*. The sparse shrub layer is formed from a variety of species with the most common being *Geijera parviflora* and *Carissa ovata. Cenchrus ciliaris** represents a sparse ground layer over predominately bare ground. Other weed species are largely absent. Fragmentation due to vegetation clearing is the major disturbance to this community along with stock grazing.	N/A	Non-remnant	N/A	18.53	

Vegetation community	RE (site) AU	Description	Bio-diversity status[1]	VM Act status[2]	Av. bio condition score	Area (ha)	Image
Acacia regrowth on clay plains and lower scarp slopes on Cainozoic lateritic duricrust	Regrowth	Within the northern / central section of Zone 2, small isolated patches of acacia regrowth vegetation on soils of lateritic origin were recorded. This vegetation community recorded a low sparse canopy height averaging up to 6 m. The most common canopy species was *Acacia shirleyi*, with occasional *Eucalyptus thozetiana* and a rare occurrence of *Acacia harpophylla.* The sparse shrub layer is formed from a variety of species with the most common being *Geijera parviflora* and *Carissa ovata. Cenchrus ciliaris** represents a sparse ground layer over predominately bare ground. Fragmentation due to vegetation clearing is the major disturbance to this community along with stock grazing.	N/A	Non-remnant	N/A	5.00	

1 Biodiversity status of the RE based on an assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of a regional ecosystem. NCP=No Concern at Present; OC=Of Concern; E=Endangered
2 Conservation status of the RE under the VM Act; LC=Least Concern; OC=Of Concern; E=Endangered.
located north of zone 1 but within the study area

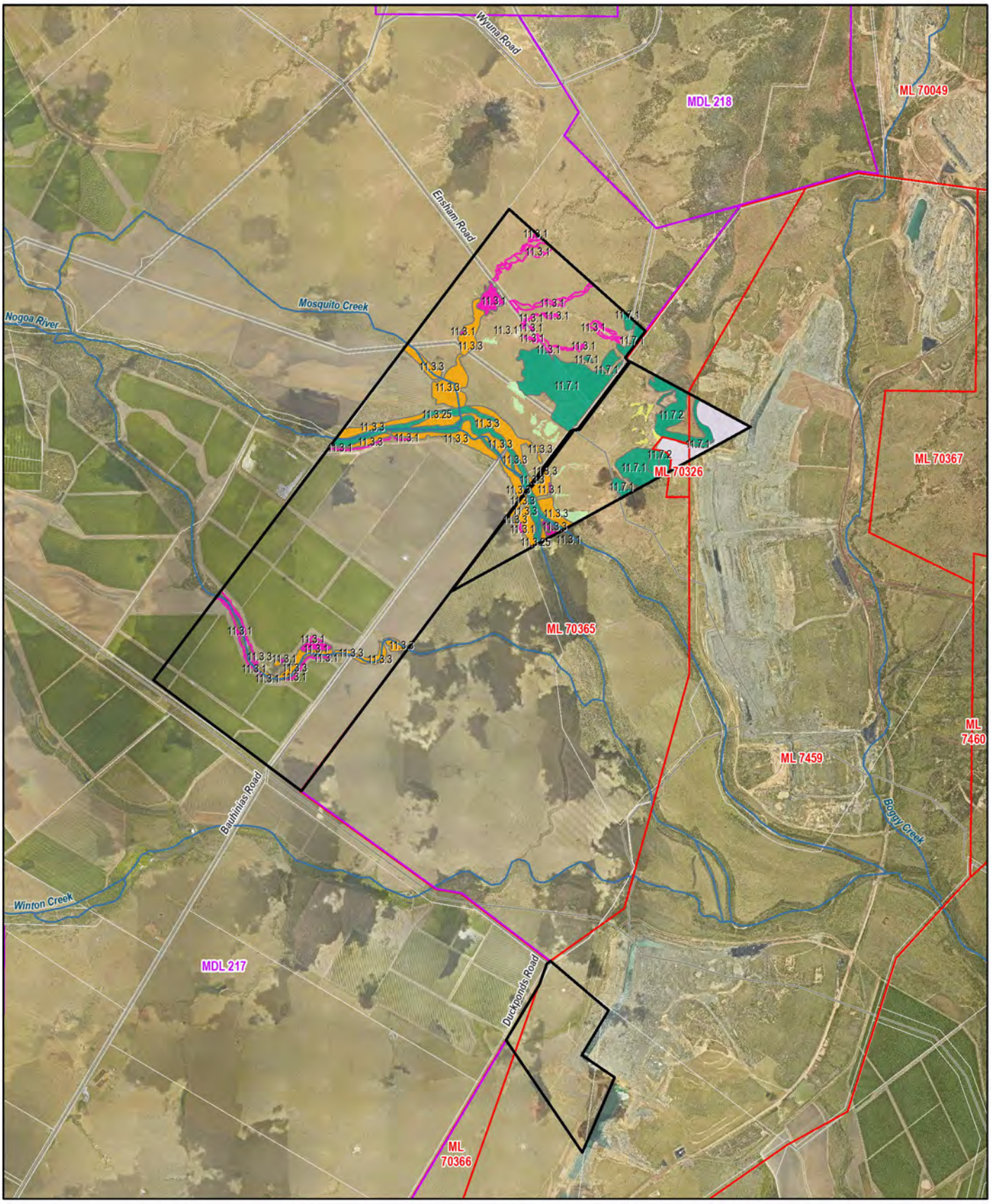


Figure 10
Vegetation communities observed within the Project Area (VM Act status)

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

VM Act status - observed regional ecosystems

- 11.3.1 Endangered, remnant *Acacia harpophylla* low open forest on alluvial plains
- 11.3.3 Of Concern, remnant *Eucalyptus coolabah* woodland on alluvial plains
- 11.3.25 Least Concern, remnant *Eucalyptus camaldulensis* woodland fringing drainage lines
- 11.7.1 Least Concern, remnant *Eucalyptus thozetiana* woodland with an understorey of *Acacia harpophylla* on lower scarp slopes on Cainozoic lateritic duricrust
- 11.7.2 Least Concern, remnant Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone
- 11.3.1 HVR *Acacia harpophylla* low open forest on alluvial plains
- cleared pasture, non-remnant, disturbed
- Brigalow Regrowth
- Acacia Regrowth
- Mine Rehabilitation

Ensham RESOURCES

0 1 2 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.
Observed REs: AECOM, 2019

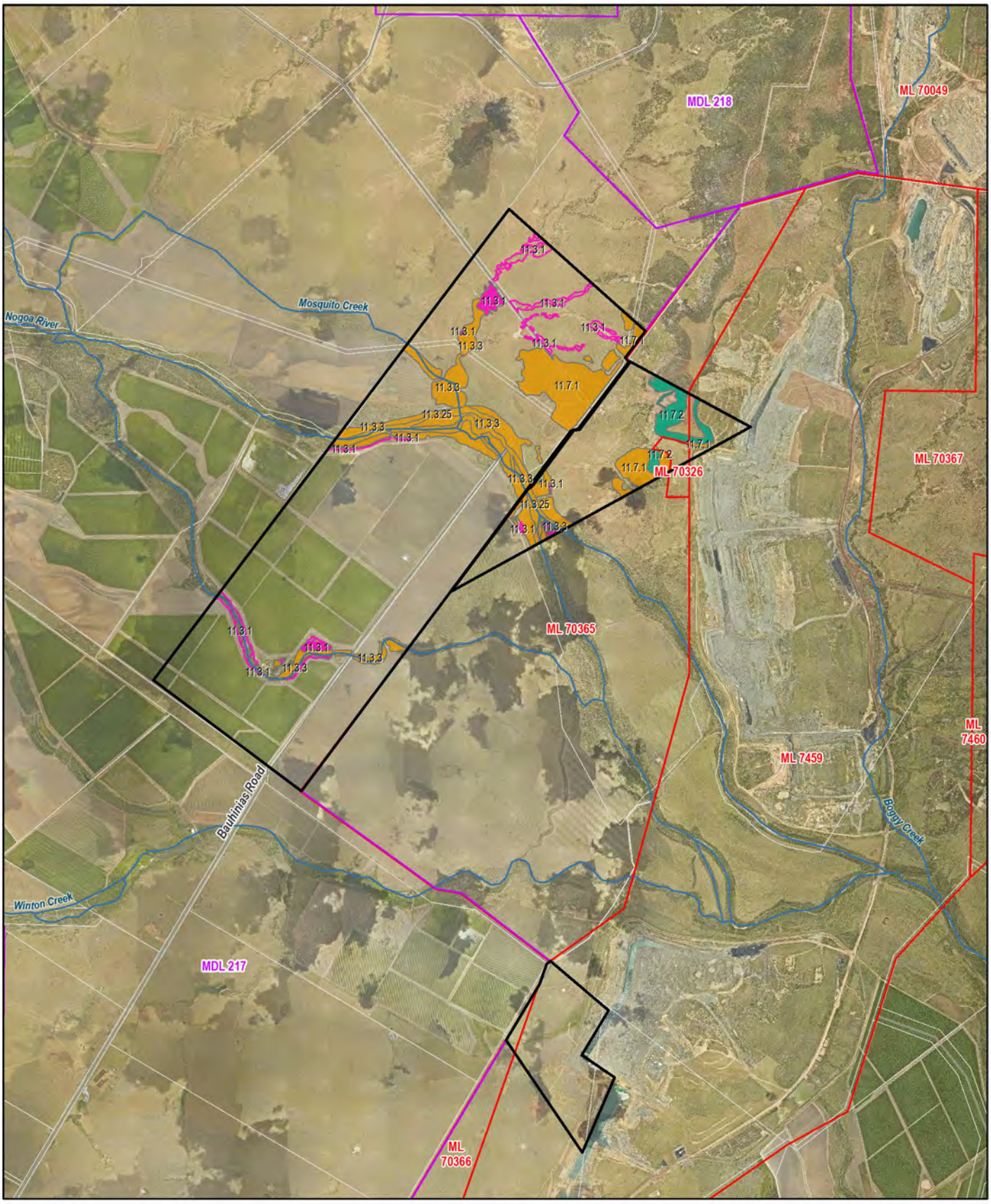


Figure 11
Vegetation communities observed within the Project Area (Biodiversity status)

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

Biodiversity status - observed regional ecosystems

- 11.3.1 Endangered, remnant *Acacia harpophylla* low open forest on alluvial plains
- 11.3.1 HVR *Acacia harpophylla* low open forest on alluvial plains
- 11.3.25 Of Concern, remnant *Eucalyptus camaldulensis* woodland fringing drainage lines
- 11.3.3 Of Concern, remnant *Eucalyptus coolabah* woodland on alluvial plains
- 11.7.1 Of Concern, remnant *Eucalyptus thozetiana* woodland with an understorey of *Acacia harpophylla* on lower scarp slopes on Cainozoic lateritic duricrust
- 11.7.2 No Concern, remnant Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone

Ensham RESOURCES

N

0 1 2 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.
Observed REs: AECOM, 2019

7.4 Flora diversity

The field surveys identified the presence of 147 taxa representing 54 families and 96 genera. Families represented by three or more genera comprised Acanthaceae (3), Apocynaceae (4), Asteraceae (5), Chenopodiaceae (6), Fabaceae (4), Malvaceae (4), Mimosaceae (3), Myrtaceae (3) Poaceae (24) and Sapindaceae (3). Genera represented by three or more species comprised *Acacia* (7 species) and *Eucalyptus* (7). *Eucalyptus coolabah* open forests tended to have the greatest diversity of flora species with a variety of native grass and forb species, while vegetation dominated by *Eucalyptus camaldulensis* along the Nogoa River had the lowest native shrub diversity.

A full flora species list including exotic species identified from each survey period is provided in **Appendix B**.

7.5 Exotic flora species

A total of 30 exotic species were recorded from the Project Area during the field surveys, including six species which are considered to be 'restricted matters' under the Biosecurity Act. Four of these species are WoNS. The Central Highlands Regional Council Biosecurity Plan 2017-2022 identifies 29 introduced flora species to be targeted for various levels of management or control within the local council area. Council management priorities range from low to high. Four of those species were identified within the Project Area. A list of these significant weed species is shown in **Table 15**. The greatest weed diversity and density was commonly associated with the presence or proximity to a water source, with the Nogoa River and tributary drainage lines often heavily weed infested. Cattle grazing areas were often dominated by *Cenchrus ciliaris**, particularly areas with minimal tree or shrub cover.

Table 15 Declared weed species detected within the Project Area

Species	Common name	Council management priority	Restricted matter	WoNS
Cardiospermum grandiflorum	Balloon vine		Yes	
Harrisia martinii	moonlight cactus	High	Yes	
Leucaena leucocephala	Leucaena	Low		
Opuntia stricta	prickly pear		Yes	Yes
Opuntia tomentosa	velvety pear		Yes	Yes
Parkinsonia aculeata	parkinsonia	Medium	Yes	Yes
Parthenium hysterophorus	parthenium	Low	Yes	Yes

7.6 Conservation significant flora

The literature review identified six species of conservation significance as potentially occurring within the Project Area and extending 10 km from the Project Area boundary (**Section 6.3**). During the January 2020 survey, *Cerbera dumicola* was identified adjacent to the northern boundary of Zone 2. The known occurrence of this species is displayed in **Figure 13**. This species occurs from the northern boundary of Zone 2, southward following the ridgeline approximately 80 to 100 m. Occurrences of this species were regularly seen along this section of ridgeline. It was noted that individuals only occurred up to two metres of elevation below the top of the ridgeline and preferred areas of deeper soil profile. Potential habitat for this species is wide ranging and includes woodland, semi-deciduous notophyll-microphyll vine forest and semi-evergreen vine thicket. This species has been found association with *Acacia shirleyi, A. catenulata*, *Eucalyptus thozetiana,* and a variety of other species. Within the Project Area, this represents areas particularly associated with RE 11.7.2 but may incorporate areas representing RE 11.7.1. Given the location of the occurrences it is also likely that the areas mapped as non-remnant along the top of ridgeline / plateau at the northern boundary of the Project Area will provide suitable habitat for this species.

Plate 1 ***Cerbera dumicola*** **identified in Zone 2**

Of the remaining species, a likelihood assessment was conducted to determine which species are possible or unlikely to occur within the Project Area. This evaluation was based on an understanding of the preferred habitats of the species, knowledge of the type and condition of habitats present at the Project Area as well as the proximity of nearby records. **Table 16** displays the likelihood of occurrence for these species.

The 'likelihood of occurrence' assessment determined that one species is considered to potentially occur within the Project Area, (**Table 16**). this being *Acacia spania*, which is listed as near threatened under the NC Act. Suitable habitat for this species was identified within the remnant areas of RE 11.7.1 and 11.7.2 across the Project Area (**Figure 13**).

The four remaining species are considered unlikely to occur within the Project Area for several reasons. *Cadellia pentastylis, Dichanthium setosum* and *Marsdenia brevifolia* have not been recorded within 50 km of the Project Area and in the case of *M. brevifolia,* this species occurs in disjunct populations the nearest of which is 68 km to the south-west. *Dichanthium queenslandicum,* while recorded to the east of the Project Area within Ensham Mine, prefers grassland conditions which do not occur within the Project Area.

Table 16 Likelihood of occurrence assessment

Scientific name	EPBC Act Status[1]	NC Act Status[2]	Habitat / distribution	Likelihood of occurrence
Acacia spania	-	NT	*Acacia spania* grows mostly on rocky sandstone ridges and hills in sandy to loamy soils in eucalypt or Acacia dominated woodland communities. The species sometimes forms relatively pure stands within these communities, and has also been recorded in vine thickets along scarp edges. Altitudinal range from 400 to 600 m. (WetlandInfo, 2019a).	**Possible** Recorded 18 km the north of the Project Area in similar vegetation and landform. Suitable habitat identified in remnant areas of 11.7.1.
Cadellia pentastylis (Ooline)	V	V	This species is found in a range of vegetation communities including dry rainforest, semi-evergreen vine thickets and sclerophyll communities. Often occurs on the edge of sandstone or basalt escarpments and prefers moderately fertile soils favoured by agriculture (WetlandInfo, 2019e).	**Unlikely** No recorded occurrences within 50 km. No suitable habitat occurs within the Project Area.
Cerbera dumicola (native frangipani)	-	NT	This species occurs across a range of habitats including woodland, semi-deciduous notophyll-microphyll vine forest and semi-evergreen vine thicket. This species has been found association with *Acacia shirleyi, A. catenulata*, *Eucalyptus thozetiana,* and a variety of other species (WetlandInfo, 2019b).	**Known** Recorded adjacent to the northern boundary of Zone 2.
Dichanthium queenslandicum (king blue grass)	E	V	A perennial grass growing to 80 cm in height. Occurs on black cracking clay in tussock grasslands. Mostly occurs in association with other blue grass species including the TEC Natural Grasslands of the Queensland Central Highlands. (WetlandInfo, 2019c).	**Unlikely** Recorded 7.5 km to the east of the Project Area. However no suitable grassland habitat occurs within the Project Area.

Scientific name	EPBC Act Status[1]	NC Act Status[2]	Habitat / distribution	Likelihood of occurrence
Dichanthium setosum (bluegrass)	V		An upright bluegrass less than one metre tall. Associated with heavy basaltic black soils and found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. (WetlandInfo, 2019d).	**Unlikely** No recorded occurrences within 50 km. No suitable grassland habitat occurs within the Project Area.
Marsdenia brevifolia	V		An erect woody shrub, sometimes weakly twinning, with disjunct distribution in north and central Queensland. Found a variety of soil types including serpentine, and occurring in woodlands to open forests (Department of the Environment Water Heritage and the Arts, 2008).	**Unlikely** No recorded occurrences within 50 km.

7.7 Conservation significant vegetation communities

7.7.1 EPBC threatened ecological communities

Database searches identified four EPBC Act TECs likely to be present (**Table 17**) on the Project Area. Of these four communities, only the Brigalow community has been confirmed within the Project Area (**Figure 12**) with 46.11 ha delineated as TEC ground-truthed vegetation.

Brigalow TEC identified within the Project Area includes both remnant (5.14 ha) and HVR (40.97 ha) areas analogous to RE 11.3.1 to the north and south of the Nogoa River. The assessment of brigalow patches followed the Conservation Advice (TSSC, 2013) and found that these areas met all key diagnostic criteria and condition thresholds for the TEC. The key diagnostic criteria are:

- the presence of brigalow as one of the most abundant tree species in the patch. Brigalow is either dominant in the tree layer, or co-dominant with other species (notably belah *Casuarina cristata*, other species of *Acacia*, or species of *Eucalyptus*).
- Within Queensland, the patch is located in one of three bioregions (Brigalow Belt Bioregion, Southeast Queensland Bioregion, Mulga Lands Bioregion):
  - within the Brigalow Belt Bioregion – consistent with RE 11.3.1, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14 or 11.12.21.
- The vegetation in the patch is brigalow regrowth with species composition and structural elements broadly typical of one of the identified REs (although species density may be reduced). This can be assumed to be the case where it has been at least 15 years since it was last comprehensively cleared (not just thinned); unless direct evidence proves otherwise.

The condition thresholds are:

- the patch is 0.5 ha or more in size; and
- exotic perennial plants comprise less than 50% of the total vegetation cover of the patch, as assessed over a minimum sample area of 0.5 ha (100 m by 50 m), that is representative of the patch.

Whilst these areas within the Project Area are analogous to RE 11.3.1 and were found to meet the key diagnostic criteria and condition thresholds for Brigalow TEC, other areas were found to be below the required condition thresholds. This is due to either patch size being less than 0.5 ha or exotic perennial grass, *Cenchrus ciliaris** comprising more than 50% of ground cover. These areas equated to 28% of the Brigalow vegetation within the Project Area.

The remaining three TECs were not identified within the Project Area due to the absence of suitable vegetation meeting key diagnostic and condition thresholds for each TEC.

Table 17 outlines the EPBC Act TECs, analogous REs and their coverage extent within the Project Area. **Table 24** (**Appendix D**) displays the results of TEC assessments completed within the Project Area and compares the field survey results with key diagnostic criteria and condition thresholds. TEC assessment survey locations are displayed in **Figure 12**.

Table 17 EPBC listed threatened ecological communities and related regional ecosystems

EPBC TEC	Analogous REs	EPBC Act status	VM Act status	Extent (ha) in Project Area
Brigalow *(Acacia harpophylla* dominant and co-dominant*)*	RE 11.3.1	Endangered	Endangered	46.12
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	-	Endangered	-	0
Poplar box grassy woodlands on alluvial plains	-	Endangered		0
Weeping myall woodlands	-	Endangered	-	0

7.8 Category B ESAs

Ground-truthing of the REs within the Project Area confirmed the presence of Category B ESAs, comprising REs with an Endangered biodiversity status (**Figure 13**), namely RE 11.3.1 – Brigalow (*Acacia harpophylla*) and / or belah (*Casuarina cristata*) open forest on alluvial plains. Field validated Category B ESAs within the Project Area encompass a total area of 16.91 ha.

7.9 Watercourses

The Project Area contains watercourse features with stream orders ranging from one to eight. The Nogoa River, stream order 8, bisects the Project Area meandering west to east. Riparian vegetation along the Nogoa River is dominated by eucalypt species particularly *Eucalyptus camaldulensis.* Other species noted within the fringing riparian canopy include *Corymbia tessellaris* (Moreton Bay ash), *Casuarina cunninghamiana* and *Eucalyptus coolabah*. A grassy understory is common along the Nogoa River and is populated by a mix of native and exotic species. Woody and perennial exotic species are also prevalent along the Nogoa River due to consistent water flow from upstream releases.

A minor unnamed non-perennial Nogoa River tributary (stream order 7)) drains the southern section of the Project Area and joins near the Nogoa River anabranch junction This unnamed tributary is bounded by irrigated farming land within the Project Area. Water was noted within this watercourse during the spring survey (October) in the absence of substantial rainfall since July. This suggests standing water may be available in several reaches of the watercourse for some time after rainfall events. This drainage feature contains section of riparian vegetation with a canopy dominated by *E. coolabah* or *Acacia harpophylla* with *E. coolabah* emergent. As with the Nogoa River the understory is heavily infested with exotic weed species.

Mosquito Creek (stream order 4) drains to the Nogoa River from the north west. Riparian vegetation along Mosquito Creek is dominated by *Eucalyptus coolabah.* Flora species diversity is low in sections due to competition from exotic flora, particularly *Parkinsonia aculeata* and *Patersonia occidentalis*. Vegetation is highly modified due to evident heavy grazing and vegetation trampling by access of stock for watering.

Within Zones 1 and 2 of the Project Area, smaller watercourse features (stream order 1 and 2) occur north and south of the Nogoa River and drain to Mosquito Creek and the Nogoa River. A single minor unnamed watercourse (stream order 2) drains to the Nogoa River through Zone 3. During the autumn and spring surveys these watercourses were isolated pools or without standing water and likely only flow after significant rainfall. On the day preceding the January 2020 survey, significant rainfall was recorded and rapid changes in flow were noted. By the end of the survey most precipitation had runoff or been absorbed leaving only isolated standing water over small areas or low flows in stream order 1 or 2 drainage features. Riparian vegetation along these smaller watercourses is dominated by *Acacia harpophylla* and occasionally *Eucalyptus coolabah*. As with Mosquito Creek these watercourses are highly impacted by grazing and extensive erosion evident in several areas in the north western section of the Project Area.

7.10 Groundwater Dependent Ecosystems

7.10.1 Composition and condition

A comparison of terrestrial GDE mapping within the Project Area overlayed with field verified RE mapping identified four vegetation communities which may have the potential to utilise groundwater to assist with vegetation water requirements. These communities include:

- RE 11.3.1 HVR *Acacia harpophylla* low open forest on alluvial plains
- RE 11.3.1 *Acacia harpophylla* open forest on alluvial plains
- RE 11.3.3 *Eucalyptus coolabah* woodland on alluvial plains
- RE 11.3.25 *Eucalyptus camaldulensis* woodland fringing drainage lines.

The majority of *Acacia harpophylla* low open forest (RE 11.3.1 HVR), which was verified as occurring within mapped potential terrestrial GDE, is located along an unnamed watercourse feature within Zone 1 of the Project Area. Small thin sections are also mapped along the Nogoa River. Vegetation comprises a low (6 m) canopy layer dominated by *Acacia harpophylla*. The canopy often contains *Terminalia oblongata* and *Lysiphyllum carronii*. Overall, the condition of this community was moderate to poor given the level of previous clearing disturbance.

Similarly, *Acacia harpophylla* open forest (RE 11.3.1), which was verified as occurring within the mapped potential terrestrial GDE, is located along the same unnamed watercourse feature within Zone 1 of the Project Area. Vegetation is dominated by sparse canopy *Acacia harpophylla* up to 7 m in height. Occasional *A. harpophylla* and *Eucalyptus coolabah* form an emergent canopy of up to 14 m. Dieback of canopy trees was noted within various patches of this community.

Potential terrestrial GDE mapping also includes *Eucalyptus coolabah* woodland on alluvial plains (RE 11.3.3) situated adjacent to the Nogoa River as well as Mosquito Creek and an unnamed watercourse to the south. A mid-dense coverage of *Eucalyptus coolabah* (coolibah) up to 21 m in height dominates the canopy. During the spring surveys (post dry season), many large canopy trees within this community appeared to be suffering from water stress, which reduced the condition of the canopy layer (**Plate 2**).

Plate 2 ***Eucalyptus coolibah*** **canopy trees with signs of water stress**

The *Eucalyptus camaldulensis* woodland (RE 11.3.25), within the potential terrestrial GDE mapping, is a fringing riparian community characterised by a mid-dense cover of *Eucalyptus camaldulensis* with an association of *Casuarina cunninghamiana. Eucalyptus coolabah* also often occurs relatively close to the riparian fringe in association with *E. camaldulensis*. Average canopy height is 22 m. The community occur on the stream banks directly adjacent to the stream channel that was often found to contain water during the field surveys. The community was observed to be in good condition and health with good vegetation growth and coverage.

Wetland indicator flora species were identified during field surveys on the premise that presence of these species shows an adaption to living in wetland areas and are dependent on them. The presence of a wetland indicator species does not confirm groundwater dependence but can be an indicator. **Table 18** displays wetland indicator species recorded within the Project Area.

Table 18 Wetland indicator species

Family	Scientific name	Common name
Casuarinaceae	*Casuarina cunninghamiana*	river she-oak
Marsileaceae	*Marsilea hirsuta*	nardoo
Myrtaceae	*Eucalyptus camaldulensis*	river red gum
	Melaleuca trichostachya	
Poaceae	*Ischaemum australe*	large bluegrass
Polygonaceae	*Duma florulenta*	lignum
Scrophulariaceae	*Eremophila bignoniiflora*	dogwood

Eucalyptus camaldulensis is the most common wetland indicator species being observed frequently along the length of the Nogoa River within the Project Area. While not as common as *E. camaldulensis*, both *Casuarina cunninghamiana* and *Melaleuca trichostachya* were also regularly recorded along the Nogoa River. The majority of wetland indicator species were recorded in vegetation characteristic of RE 11.3.25. The exception was *Duma florulenta* and *Marsilea hirsuta* which was also recorded in a portion of *Eucalyptus coolabah* woodland (RE 11.3.3). No wetland indicator flora species occur within the *Acacia harpophylla* dominated communities

Vegetation communities outside of the Project Area along the tributaries of Crinum Creek, which are also within a GDE mapped area, are likely to comprise of a similar floristic composition and condition described above for the Project Area.

7.10.2 Likelihood assessment

Vegetation communities validated to be dominated by *Acacia harpophylla* within the GDE mapping and on alluvium areas within the Project Area are considered unlikely to be terrestrial GDEs. No floristic indicators were found to be present to suggest a potential use and reliance on groundwater within the alluvium. Johnson *et al.*, 2016 describes *Acacia harpophylla* as a clonal species with stems arising from horizontal roots which draw resources from a substantial area around the plant. The concentration of the brigalow root mass in the upper soil profile allows the species to draw water from shallow, horizontal root systems, rather than from accessing groundwater with deep root systems.

is a relatively large canopy tree that can has a deeper root system. The *Eucalyptus coolabah* community within the Project Area was found to contain wetland indicator flora species. However, based on observed condition and signs of water stress within the community, particularly during the field surveys that occurred after the dry season, the community does not appear to be accessing more permanent groundwater sources. This observation is supported by identified hydrogeological characteristics of the alluvium groundwater, particularly the higher saline content as well as thin and discontinuous nature of the saturation zones. These characteristics are likely to limit the communities use and reliance regardless of the root system's ability to reach the groundwater. Based on these factors and field observations there is a low likelihood that this community is a terrestrial GDE.

The *Eucalyptus camaldulensis* woodland within the Project Area was found to be in good condition with no evidence of water stress, and dominated by wetland indicator flora species, including within the canopy layer. *Eucalyptus camaldulensis* is a common, widespread tree along watercourses over much of mainland Australia and is frequently a dominant component of riparian communities (Bolland *et al.*, 2006). This species is not physiologically adapted to either drought or salinity, although these stresses can be tolerated for short periods or at low levels (CSIRO, 2004). *Eucalyptus camaldulensis* is able to develop vertical roots to a depth greater than 10 m, which may allow some larger individuals to access potential occurrences of groundwater. As such the species is considered to be phreatophytic.

Whilst *Eucalyptus camaldulensis* woodland has the ability to utilise groundwater sources, the identified hydrogeological characteristics of the alluvium groundwater within the Project Area are not highly suitable for use by the community. Evidence of the community having access to a more permanent source of water was validated during field surveys, but this is most likely associated with permanent surface flows in the Nogoa River and tributaries. The Nogoa River is utilised in part as an irrigation channel with a largely continuous flow due to regular water releases for agriculture from Fairbairn Dam. It is also reported to have electrical conductance reflective of freshwater systems (260 µS/cm). Instream flows are also hydrologically disconnected from the alluvium (SLR Consulting Australia, 2020). This high availability of a preferential freshwater source from surface flows even during dry conditions significantly reduces the communities need and reliance on groundwater sources within the Project Area. Therefore, the likelihood of this community to be a terrestrial GDE is also considered to be low.

Vegetation communities outside of the Project Area along the tributaries of Crinum Creek are likely to comprise of a similar floristic composition and condition as the communities within the Project Area. It is also likely that they are subject to a similar hydrogeological setting and therefore have a low likelihood of being a terrestrial GDE.

Figure 12
TEC observed within the Project Area

Ensham RESOURCES

N

0 1 2 km

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

- Ground-truthed vegetation communities
- TEC assessment survey locations

Threatened ecological communities

Brigalow (*Acacia harpophylla* dominant and co-dominant)

- 11.3.1 High Value Regrowth
- 11.3.1 Remnant

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemits [2019]
Vegetation, Survey Sites, TEC: AECOM, 2019

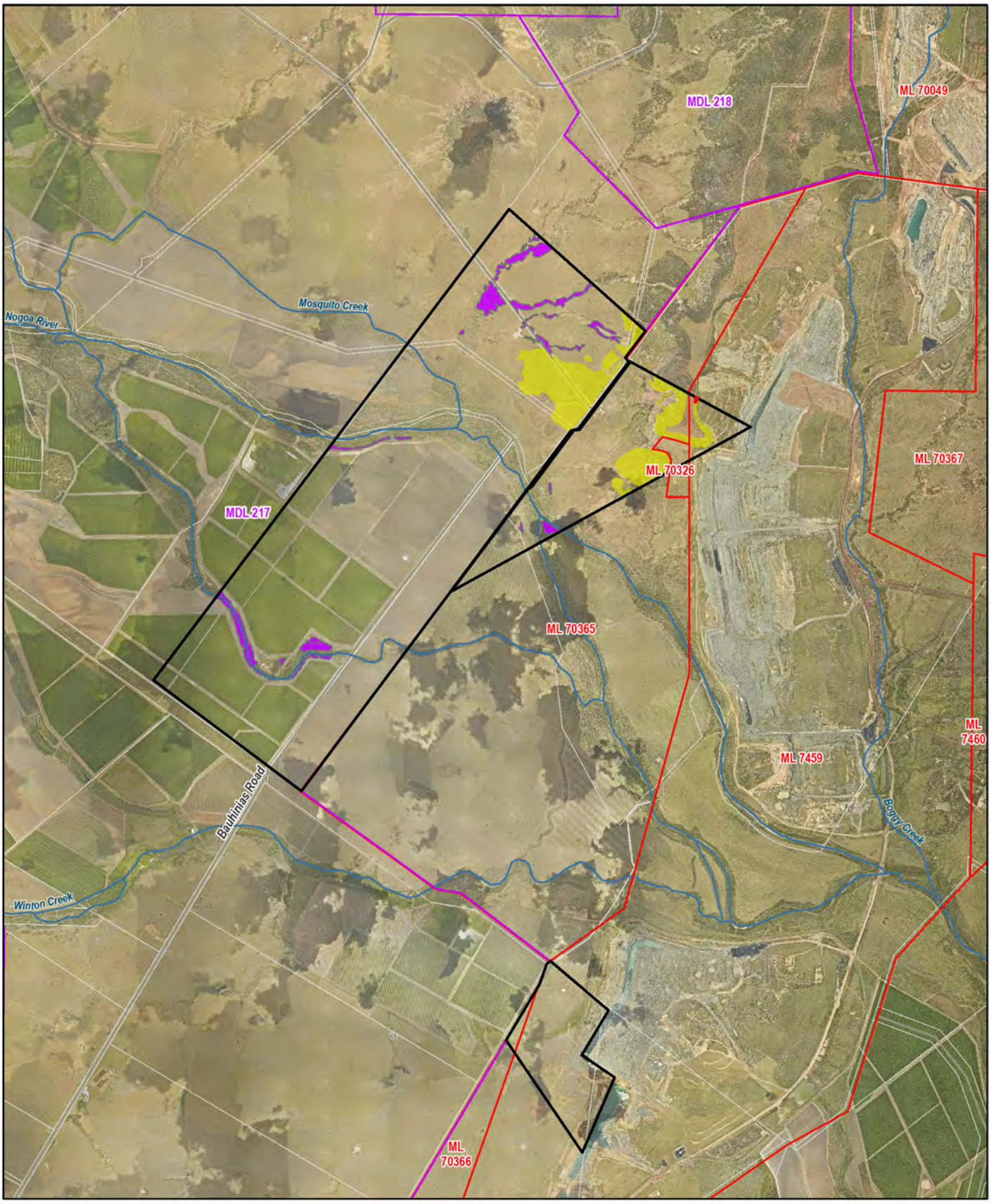


Figure 13
Environmentally Sensitive Areas and potential threatened flora habitat within the Project Area

Ensham RESOURCES

N

0 1 2 km

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

- Category B Endangered Regional Ecosystem (Biodiversity status)
- Potential threatened flora habitat *Acacia spania* and *Cerbera dumicola*
- *Cerbera dumicola* extent within Project Area

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.
REs: AECOM, 2019

8.0 Matters of State Environmental Significance

MSES include certain environmental values that are protected under Queensland legislation including:

- NC Act
- *Marine Parks Act 2004*
- *Fisheries Act 1994*
- EP Act
- *Regional Interests Planning Act 2014*
- VM Act
- EO Act.

MSES flora values affected by the Project are presented below in **Table 19**.

Table 19 MSES (Flora) values within the Project Area

Prescribed MSES	Definition	Present in the Project Area
Regulated vegetation	Prescribed regional ecosystems that are 'endangered' or 'of concern' regional ecosystems, as defined under the VM Act.	**Yes** **'endangered' and 'of concern' REs** A total of 16.43 ha of remnant 'endangered' RE 11.3.1 has been identified within and scattered across the Project Area. A total of 142.25 ha of remnant 'of concern' RE 11.3.3 has been identified within the Project Area. Areas of 'endangered and 'of concern' regulated vegetation is displayed in **Figure 14**.
	Prescribed regional ecosystem that intersects with an area shown on the vegetation management wetlands map.	**No** Regulated vegetation that intersects with an area shown on the vegetation management wetlands map are not mapped within the Project Area.
	Prescribed regional ecosystem that is located within the defined distance from the defining banks of a watercourse identified on the vegetation management watercourse map.	**Yes** Watercourse features located within the Project Area range from stream-order 1 to 8. Utilising the field verified RE mapping, four REs in remnant are located within the defined distance of each relevant watercourse. **Table 20**and **Figure 14** displays the extent of regulated vegetation within a defined distance of a watercourse or relevant drainage feature within the Project Area.
Wetlands and watercourses	Wetland in a wetland protection area as shown on the map of referrable wetlands under schedule 12, part 2 of the EP Regulation.	**No**

Prescribed MSES	Definition	Present in the Project Area
	Wetlands of high ecological significance as shown on the map of referrable wetlands under schedule 12, part 2 of the EP Regulation.	Applicable wetland and watercourse features are not mapped within the Project Area.
	Wetland or watercourse in a high ecological value waters as identified under the Environmental Protection (Water) Policy 2009, schedule 2.	
Protected wildlife habitat	An area shown as a high risk area on the flora survey trigger map and that contains plants that are endangered wildlife or vulnerable wildlife; or An area that is not shown as a high risk area on the flora survey trigger map, to the extent that the area contains plants that are endangered wildlife or vulnerable wildlife	**No** Only potential threatened flora species habitat was identified within the Project Area. *Cerbera dumicola* is located within the Project Area but is listed as Near Threatened.
Protected areas	Protected areas are declared under the NC Act for the conservation of Queensland's natural and cultural resources. They include: • national parks • national parks (Aboriginal land) • national parks (Torres Strait Islander land) • national parks (Cape York Peninsula Aboriginal land) • regional parks • nature refuges.	**No** The Project Area does not contain protected areas
Marine plants	Marine plants are part of the mosaic of fish habitats and are an integral and usually highly visible feature of the coastline. Fish habitat is defined under the *Fisheries Act 1994* and includes land, waters and plants associated with the life cycle of fish, and includes land and waters not presently occupied by fisheries resources. Marine plants are defined under the Fisheries Act and include the following: a) a plant (a tidal plant) that usually grows on, or adjacent to, tidal land, whether it is living, dead, standing or fallen; b) material of a tidal plant, or other plant material on tidal land; c) a plant, or material of a plant, prescribed under regulation or management plan to be a marine plant.	**No** The Project Area is not located in a marine environment.

Prescribed MSES	Definition	Present in the Project Area
Legally secured offset areas	Legally secured offset areas are any areas declared as an environmental offset protection area, high nature conservation value under the VM Act or another area prescribed under a regulation	**No** The Project Area does not contain legally secured offset areas

Table 20 Prescribed regional ecosystem within a defined distance of a watercourse within the Project Area

Regional Ecosystem	Relevant watercourse	Extent (ha)
RE 11.3.1 (BVG 25a)	Stream order 1,2,	4.62
RE 11.3.3 (BVG 16c)	Stream order 1,2,3,4, >5	113.48
RE 11.3.25 (BVG 16a)	Stream order 3,4, >5	51.43
RE 11.7.1 (BVG 25a)	Stream order 1,2	3.41
Total		**172.94**

Figure 14
MSES

Ensham RESOURCES

N

0 1 2 km

Legend

- Project Area
- Watercourse
- Other road

Ensham mine leases

- Mineral development licence
- Mining leases

- MSES – Regulated Vegetation within a defined distance of a watercourse
- MSES – Regulated Vegetation containing endangered and of concern REs

TERRESTRIAL ECOLOGY
Ensham Life of Mine Extension Project

Projection: GDA 1994 MGA Zone 55 Scale: 1:75,000
Source: State of Queensland, 2019. Imagery: Indemitsu, 2019.
Vegetation: AECOM, 2019

9.0 Potential impacts

Information on the potential impacts associated with the Project are outlined below. Proposed mitigation to minimise the potential impacts on flora values are outlined in **Section 10.0.**

The planned development of the Project Area is to occur entirely underground with no proposed above ground clearing required (see **Section 2.0**). No new infrastructure will be required for the development of the Project. Accordingly, no construction activities will be required for the Project. Therefore, no direct impacts or indirect impacts to TECs, threatened species and threatened species' habitats are expected to occur as a result of the Project. This is discussed and demonstrated further in the following sections.

9.1 Operational phase

Potential impacts often associated with the operational phase of underground mining projects are generally associated with indirect disturbances, including:

- subsidence
- weed incursion
- contamination from spills
- alterations to hydrological regime
- dust.

Impacts from subsidence may include soil movement, tension cracking or changes in drainage characteristics. This can impact on vegetation causing tree mortality or die back, which can alter the structural complexity of vegetation communities and the habitat that this may provide to fauna species, as well as increase the susceptibility to weed incursion.

Subsidence modelling undertaken by Gordon Geotechniques (2019) determined that the predicted subsidence above the panel pillars following secondary coal extraction in the Project Area is typically less than 40 mm. This reduces to typically less than 20 mm above the bell out pillars as they do not carry the full tributary area load on the sides of the panels. As a consequence, surface cracking is not predicted above the Project Area due to the predicted low levels of maximum surface subsidence.

Weed incursion and contamination from spills can occur during operational phases of mines through the transportation and movement of material and the storage of chemicals and hydrocarbons required for operational equipment. Weed incursion and contamination from spills can degrade and impact on vegetation communities by increasing fuel loads (with the potential to alter fire regimes), reducing floristic diversity, altering the vegetation structure, causing vegetation dieback. As all operational activities associated with the Project will be undertaken either below in the underground operational area or above ground within the existing Ensham Mine footprint, these potential impacts will be contained within the existing approved mining lease. As such the Project will not result in an increase in the extent or severity of these potential impacts. These potential indirect impacts will continue to be managed in accordance with Ensham Mine's environmental management procedures.

No works are proposed to occur within the Nogoa River and tributaries within the Project Area. All water requirements during the operational phase will be sourced from existing supplies and allocations for the Ensham Mine. Therefore, current environmental flows should not be impacted. Recharge rates into the groundwater units in the Project Area, including flux from the alluvium groundwater to underlying formations will remain unchanged following the Project. No groundwater drawdown or a reduction in groundwater quality in the alluvium is predicted within the Project Area. Only a 0.5 m drawdown is predicted in bores located outside of the Project Area. However, similar to those communities within the Project Area, vegetation communities within predicted drawdowns areas have a low likelihood of being a terrestrial GDE (SLR Consulting Australia, 2020). Therefore, the impacts to terrestrial GDEs as a result of the Project are low.

Coal mining operations can also generate substantial dust from coal stockpiles, topsoil and overburden. Whilst dust production will still occur as operations continue at Ensham Mine, the Project itself will not result in an increase of dust above the current levels. Due to the transition from open-cut operations to underground operations, it is expected that dust levels will decrease.

10.0 Mitigation measures

No direct or indirect impacts to threatened species and ecological communities, or migratory species are expected to occur as a result of the Project, as no clearing or surface infrastructure is required, and subsidence is not predicted to be material within the confines of seasonal variation in surface levels. The Project itself is not expected to increase traffic numbers, lighting or noise beyond current conditions, and therefore the impacts during the operational phase of the Project are expected to be negligible. Measures to avoid significant impacts to MNES have followed the mitigation hierarchy as set out below. Specific mitigation and monitoring measures currently employed at Ensham Mine will continue for the Project to avoid/minimise any potential indirect impacts.

10.1 Avoidance

The Project has been designed to utilise existing mining infrastructure at the Ensham Mine. Subsequently, the need for additional surface disturbance, including the clearing of vegetation within the Project Area to support the Project has been avoided.

10.2 Minimise

The development of the Project will allow for mining at Ensham Mine to transition from open-cut operations to underground operations. In doing so several current disturbances associated with open-cut mining will cease, which will result in a reduction of impact levels associated with dust, noise, erosion.

10.3 Mitigate

Ensham Mine currently complies with the existing EA (EPML00732813, dated 9 August 2018) through the adoption of established site control and monitoring measures. Consistent with current practice at Ensham Mine, the following mitigation measures are proposed to be used throughout the duration of the Project:

- maintain dust suppression in accordance with the existing dust management plans: EOP.01.00.01 Air Quality Monitoring and SOP.09.12.01 Maintaining and Watering Mine Roads
- maintain noise and ground vibration management measures in accordance with the existing management plan: E0P.04.00.01 Noise and Blast Monitoring
- continue to undertake refuelling and chemical storage in accordance with the existing management plans: SOP.09.01.04 Using Hazardous Substances, SOP.09.06.06 Servicing and Refuelling Equipment and EIMP.05.00.02 Hydrocarbons
- weed and pest management strategies to continue to be implemented for controlling the spread of weeds and pests, particularly vehicles traversing the Project Area, as per the existing management plans: EOP.06.00.03 Weed and Feral Animal Management and EIMP.06.00.01 Land.

No surface disturbance is proposed as part of Project. If any clearing activities are identified to be required to support the Project, these activities will need to be assessed to determine impacts and appropriate mitigation measures.

10.4 Monitoring

Ensham Mine currently complies with the existing EA. Monitoring measures that will be undertaken within the Project Area are consistent with current practices and monitoring plans, including:

- annual LiDAR surveys to detect signs and impacts of any subsidence.
- EOP.01.00.01 Air Quality Monitoring
- EOP.04.00.01 Noise and Blast Monitoring
- EOP.06.00.03 Weed and Feral Animal Management
- EIMP.06.00.01 Land.

11.0 Significant residual impacts

11.1 Commonwealth EPBC Act significant impact assessment

A single MNES floristic value has been identified within the Project Area. Approximately 46.11 ha of the TEC, Brigalow *(Acacia harpophylla* dominant and co-dominant), was identified in scattered patches throughout the Project Area. A significant impact assessment in accordance with the criteria in the EPBC Act Significant Impact Guideline has been undertaken for the Project and is addressed separately in the MNES report (AECOM, 2020b). After considering the significant impact assessment, the Project is considered unlikely to significantly impact the ecological community.

11.2 State significant residual impact assessment

A state significant residual impact assessment in accordance with the criteria provided in the Significant Residual Impact Guidelines (Department of the Environment and Heritage Protection, 2014) has been undertaken for the Project (**Table 21**). After considering potential impacts, mitigation measures and the state significant residual impact assessment, the Project will not have a significant residual impact on any MSES floristic values.

Table 21 State significant residual impact of MSES floristic values

Prescribed MSES	Threshold for significant residual impact	Significant residual impact expected?
Regulated vegetation (present)	For a prescribed activity to have a significant residual impact on an 'endangered' or 'of concern' RE the following must be exceeded: • for clearing for linear infrastructure: - greater than 25 m wide in a grassland (structural category) regional ecosystem; or - greater than 20 m wide in a sparse (structural category) regional ecosystem; or - greater than 10 m wide in a dense to mid-dense (structural category) regional ecosystem. • for clearing other than clearing for linear infrastructure: - area greater than 5 ha where in a grassland (structural category) regional ecosystem; or - area greater than 2 ha where in a sparse (structural category) regional ecosystem; or - area greater than 0.5 ha where in a dense to mid-dense (structural category) regional ecosystem (Department of the Environment and Heritage Protection, 2014).	Unlikely No clearing or surface works are required for the Project and therefore no impacts to Regulated Vegetation
	For a prescribed activity to have a significant residual impact on a regional ecosystem that is within the defined distance of watercourses the following must be exceeded: • clearing within 5 m of the defining bank as well as the criteria listed to have a significant residual impact on an 'endangered' or 'of concern' RE (listed above) (Department of the Environment and Heritage Protection, 2014)	Unlikely No clearing or surface works are required for the Project and therefore no impacts to Regulated Vegetation
Wetlands and watercourses (absent)	N/A	N/A
Protected wildlife habitat	N/A	N/A
Protected areas (absent)	N/A	N/A

Prescribed MSES	Threshold for significant residual impact	Significant residual impact expected?
Marine plants (absent)	N/A	N/A
Legally secured offset areas (absent)	N/A	N/A

12.0 References

AECOM (2020a) *Idemitsu - Ensham Approvals Fauna Technical Report*.

AECOM (2020b) *Matters of National Environmental Significance - Ensham Life of Mine Extension Project*.

Anderson, E. (2016) *Plants of Central Queensland, Identification and Uses of Native and Introduced Species*. CSIRO Publishing.

Australian Government (2020) *Atlas of Living Australia*, *Atlas of Living Australia*. Available at: http://www.ala.org.au/about-the-atlas/.

Bolland, D. J. *et al.* (2006) *Forest Trees of Australia*. 5th Editio. CSIRO Publishing, Collingwood, Victoria.

BOM (2020) *GDE Atlas Home: Water Information: Bureau of Meteorology*, *Bureau of Meteorology*.

Bostock, P. D. and Holland, A. E. (2018) *Introduction to the Census of the Queensland Flora 2018*. Brisbane: Queensland Department of Environment and Science.

Brooker, I. and Kleinig, D. (2004) *Field Guide to Eucalypts - Northern Australia*. 2nd Editio. Blooming Books, Melbourne.

Bureau of Meteorology (2019) *Climate Statistics for Australian Locations*. Available at: http://www.bom.gov.au/climate/data/?ref=ftr.

Bureau of Meteorology (2020a) *Average annual, seasonal and monthly rainfall*. Available at: http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp?period=an&area=qd#maps.

Bureau of Meteorology (2020b) *GDE Atlas Home: Water Information*, *Bureau of Meteorology*. Available at: http://www.bom.gov.au/water/groundwater/gde/ (Accessed: 8 October 2019).

Cropper, S. (1993) *Management of Endangered Plants*. Melbourne: CSIRO Publications.

CSIRO (2004) *Eucalyptus camaldulensis - Taxon Attribute Profile*, *Water for a Healthy Country*. Available at: https://www.anbg.gov.au/cpbr/WfHC/Eucalyptus-camaldulensis/#:~:text=Eucalyptus camaldulensis is not physiologically,and related ground water flow.

Department of Agriculture Water and the Environment (2020) *Protected Matters Search Tool*. Available at: http://www.environment.gov.au/epbc/protected-matters-search-tool.

Department of Environment and Science (2018) *Queensland Environmental Offset Policy (Version 1.6)*. Queensland Government.

Department of Environment and Science (2019a) *Environmentally Sensitive Areas Map*. Queensland Government.

Department of Environment and Science (2019b) *Flora Survey Guidelines - Protected Plants Nature Conservation Act 1992*.

Department of Environment and Science (2020a) *BioCondition Benchmarks for Regional Ecosystem Condition Assessment*.

Department of Environment and Science (2020b) *Environmental Reports - Matters of State Environmnetal Significance*. Queensland Government.

Department of Environment and Science (2020c) *Map of Queensland wetland environmental values*. Queensland Government.

Department of Environment and Science (2020d) *Protected plants flora survey trigger map*. Available at: https://environment.des.qld.gov.au/licences-permits/plants-animals/protected-plants/clearing/flora-survey-trigger-map/index.php.

Department of Environment and Science (2020e) *Wildlife Online Species List*, *Wildlife Online Dataset*.

Department of Natural Resources Mines and Energy (2019) *Watercourse lines Queensland*. Queensland Government.

Department of Natural Resources Mines and Energy (2020a) *Essential Habitat Mapping*. Department of Natural Resources, mines and Energy, Queensland Goverment.

Department of Natural Resources Mines and Energy (2020b) *Regulated vegetation managment map*. Department of Natural Resources, Mines and Energy. Queensland Government. Available at: https://www.dnrm.qld.gov.au/qld/environment/land/vegetation/vegetation-maprequest-%0Aform.

Department of the Environment (2013) *Approved Conservation Advice for the Brigalow (Acacia harpophylla dominant and co-dominant) ecological community.* jurisdiction=Commonwealth of Australia; corporateName=Department of the Environment.

Department of the Environment and Energy (2019) *Conservation Advice (including listing advice) for the Poplar Box Grassy Woodland on Alluvial Plains*. In effect under the EPBC Act from 04-Jul-2019. Available at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/141pb-conservation-advice.pdf.

Department of the Environment and Heritage Protection (2014) *Queensland Environmental Offsets Policy Significant Residual Impact Guideline*. Available at: https://www.ehp.qld.gov.au/assets/documents/pollution/management/offsets/significant-residual-impact-guide.pdf.

Department of the Environment and Heritage Protection (2016) *Eligibility criteria and standard conditions for exploration and mineral development projects - Version 2*. Available at: www.business.qld.gov.au/ea.

Department of the Environment Water Heritage and the Arts (2008) *Approved Conservation Advice for Marsdenia brevifolia*. jurisdiction=Commonwealth of Australia; corporateName=Department of the Environment. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/64585-conservation-advice.pdf. (Accessed: 24 May 2019).

Doody, T. M., Hancock, P. J. and Pritchard, J. L. (2019) *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems.* Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy.

Eyre, T. J. *et al.* (2015) *BioCondition: A condition assessment framework for terrestrial biodiversity in Queensland - biocondition-assessment-manual. Version 2.2.* Brisbane. Available at: https://www.qld.gov.au/environment/assets/documents/plants-animals/biodiversity/biocondition-assessment-manual.pdf.

GeoResGlobe (2020) *GeoResGlobe*, *Queensland Government*. Available at: https://georesglobe.information.qld.gov.au/ (Accessed: 29 November 2019).

Gordon Geotechniques (2020) *Subsidence Report for the Ensham Life of Mine Extension Project*.

Unpublished Report for Idemitsu Australia Resources Pty Ltd.

Johnson, R. *et al.* (2016) 'Changes over 46 years in plant community structure in a cleared brigalow (Acacia harpophylla) forest', *Austral Ecology*, 41(6), pp. 644–656.

Lester, N. (2008) *Woodland to Weeds : Southern Queensland brigalow belt*. 2nd Editio. Brisbane, QLD: CopyRight Pub.

Neldner, V. *et al.* (2019) *Methodology for Survey and Mapping of Vegetation Communities and Regional Ecosystems in Queensland*.

Q Imagery (2020) *QImagery - Queensland Government*. Available at: https://qimagery.information.qld.gov.au/ (Accessed: 29 November 2019).

QSpatial (2019) *Queensland Spatial Catalogue -QSpatial: Queensland Government*. Available at: http://qldspatial.information.qld.gov.au/catalogue/custom/index.page (Accessed: 3 September 2019).

QSpatial (2020) *Groundwater dependant ecosystem areas - Queensland*.

Queensland Globe (2020) *Queensland Globe*, *Queensland Government*. Available at: https://qldglobe.information.qld.gov.au/.

Queensland Herbarium (2019) *Regional Ecosystem Description Database (REDD) Version 11.1 April 2019*. Brisbane, QLD: Queensland Herbarium, State of Queensland Department of Primary Industries.

Sattler, P. and Williams, R. (1999) *The Conservation Status of Queensland's Bioregional Ecosystems*. Edited by R. Sattler, P., Williams. Brisbane: Environmental Protection Agency, Queensland Government.

SLR Consulting Australia (2020) *Enshame Life of Mine Extension project - Groundwater Impact Assessment*.

Threatened Species Scientific Committee (2009) *Commonwealth Listing Advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin*. Department of the Environment, Water, Heritage and Arts, Commonwealth of Australia.

Threatened Species Scientific Committee (2013) *Commonwealth Conservation Advice for the Brigalow (Acacia harpophylla dominant and co-dominant) ecological community*. Canberra.

Threatened Species Scientific Committee and Department of the Environment (2013) *Commonwealth Conservation Advice for the Brigalow (Acacia harpophylla dominant and co-dominant) ecological community*. Canberra.

TSSC (2009) *Commonwealth Listing Advice on Weeping Myall Woodlands.* Department of the Environment, Water, Heritage and Arts, Commonwealth of Australia.

WetlandInfo (2012) *Groundwater dependent ecosystem FAQs*, *Department of Environment and Science*.

WetlandInfo (2019a) *Acacia spania*, *Department of Environment and Science*. Available at: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?acacia-spania.

WetlandInfo (2019b) *Cerbera dumicola*. Department of Environment and Science. Available at: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?cerbera-dumicola.

WetlandInfo (2019c) *Dichanthium queenslandicum*. jurisdiction=Queensland; sector=government; corporateName=Department of Environment and Science. Available at:

https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?dichanthium-queenslandicum (Accessed: 24 May 2019).

WetlandInfo (2019d) *Dichanthium setosum*, *Department of Environment and Science*. jurisdiction=Queensland; sector=government; corporateName=Department of Environment and Science. Available at: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?dichanthium-setosum.

WetlandInfo (2019e) *Ooline – Cadellia pentastylis*. jurisdiction=Queensland; sector=government; corporateName=Department of Environment and Science. Available at: https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?cadellia-pentastylis (Accessed: 24 May 2019).

WetlandInfo (2020) *Wetland Maps*, *Department of Environment and Science*.

Appendix A

Desktop assessment results

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

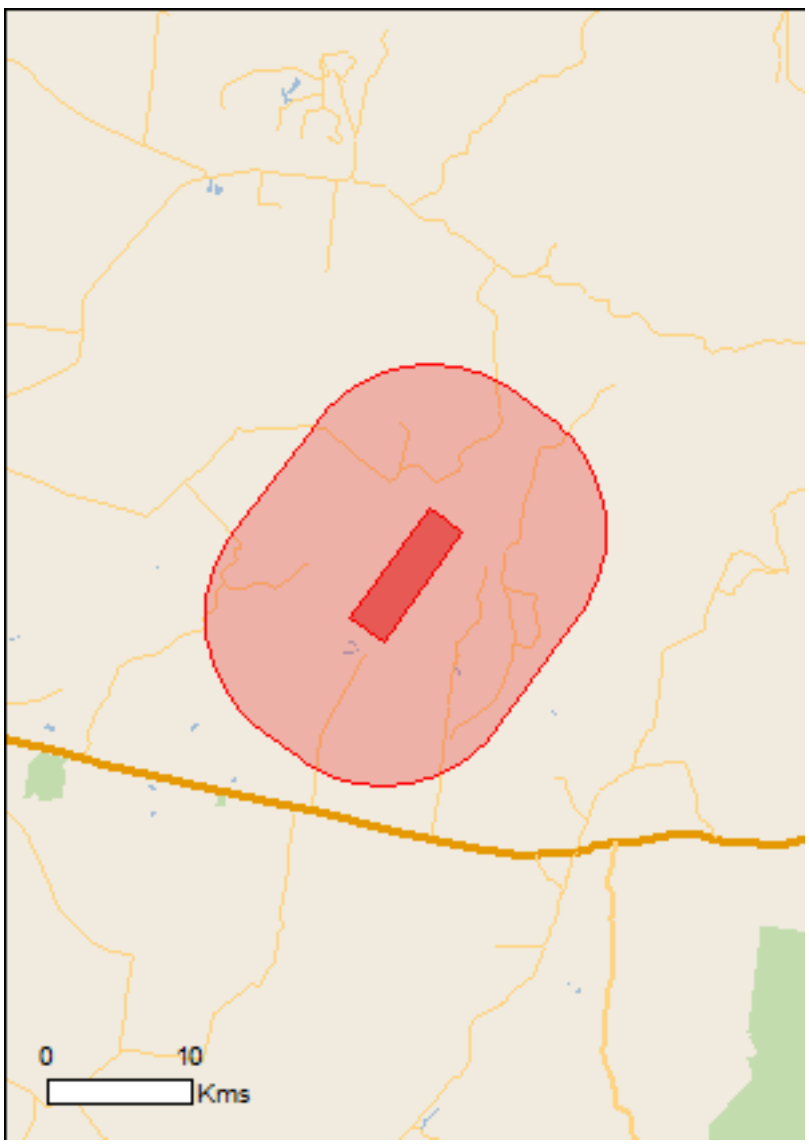
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 14/11/19 17:39:01

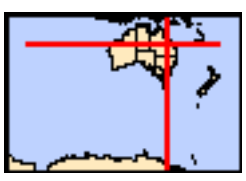
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	23
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	24
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community may occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
[Macroderma gigas](#)		
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
[Nyctophilus corbeni](#)		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
[Petauroides volans](#)		
Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
[Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)](#)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
Plants		
[Cadellia pentastylis](#)		
Ooline [9828]	Vulnerable	Species or species habitat may occur within area
[Dichanthium queenslandicum](#)		
King Blue-grass [5481]	Endangered	Species or species habitat may occur within area
[Dichanthium setosum](#)		
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
[Delma torquata](#)		
Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
[Denisonia maculata](#)		
Ornamental Snake [1193]	Vulnerable	Species or species habitat likely to occur within area
[Egernia rugosa](#)		
Yakka Skink [1420]	Vulnerable	Species or species habitat likely to occur within area
[Elseya albagula](#)		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat known to occur within area
[Furina dunmalli](#)		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
[Lerista allanae](#)		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
[Rheodytes leukops](#)		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#)		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
[Cuculus optatus](#)		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat likely to occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat may occur within area
Migratory Wetlands Species		
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area
[Anseranas semipalmata](#) Magpie Goose [978]		Species or species habitat may occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat known to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat likely to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-23.419558 148.473846,-23.419558 148.474532,-23.482866 148.42475,-23.46838 148.403121,-23.406011 148.454619,-23.419558 148.473846

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

© Commonwealth of Australia
Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Defined Area
Species: All
Type: All
Status: Rare and threatened species
Records: All
Date: All
Latitude: 23.2727 to 23.6811
Longitude: 148.2834 to 148.5600
Email: jamie.ernst@aecom.com
Date submitted: Tuesday 03 Dec 2019 19:07:44
Date extracted: Tuesday 03 Dec 2019 19:10:05

The number of records retrieved = 9

Disclaimer

As the DSITIA is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

No statements, representations or warranties are made about the accuracy or completeness of this information. The State of Queensland disclaims all responsibility for this information and all liability (including without limitation, liability in negligence) for all expenses, losses, damages and costs you may incur as a result of the information being inaccurate or incomplete in any way for any reason.

Feedback about Wildlife Online should be emailed to wildlife.online@science.dsitia.qld.gov.au

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Accipitridae	*Erythrotriorchis radiatus*	red goshawk		E	V	1/1
animals	birds	Apodidae	*Hirundapus caudacutus*	white-throated needletail		V	V	1
animals	birds	Falconidae	*Falco hypoleucos*	grey falcon		V		1/1
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	6
animals	reptiles	Chelidae	*Elseya albagula*	southern snapping turtle		E	CE	1
animals	reptiles	Chelidae	*Rheodytes leukops*	Fitzroy River turtle		V	V	4
animals	reptiles	Diplodactylidae	*Strophurus taenicauda*	golden-tailed gecko		NT		2/1
animals	reptiles	Elapidae	*Hemiaspis damelii*	grey snake		E		1
plants	land plants	Poaceae	*Dichanthium queenslandicum*			V	E	4/4

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Appendix B

Flora species list

Appendix B Flora species list

Table 22 Flora species list

Family	Species	Exotic	Common name	Status [1]
Acanthaceae	*Brunoniella australis*		blue trumpet	
Acanthaceae	*Pseuderanthemum variabile*		love flower	
Acanthaceae	*Rostellularia adscendens*		narrow leaved pink tongues	
Aizoaceae	*Tetragonia tetragonoides*		New Zealand spinach	
Aizoaceae	*Trianthema portulacastrum*	*	black pigweed	
Amaranthaceae	*Achyranthes aspera*		chaff flower	
Apocynanceae	*Alstonia constricta*		bitterbark	
Apocynanceae	*Carissa ovata*		currant bush	
Apocynanceae	*Cerbera dumicola*			NT (NC Act)
Apocynanceae	*Parsonsia lanceolata*		rough silkpod	
Asteraceae	*Bidens pilosa*	*	cobbler's pegs	
Asteraceae	*Gomphocarpus physocarpus*	*	balloon cotton bush	
Asteraceae	*Parthenium hysterophorus*	*	Parthenium	
Asteraceae	*Verbesina encelioides*	*	gold weed	
Asteraceae	*Xanthium pungens*	*	noogoora burr	
Boraginaceae	*Ehretia membranifolia*		peach bush	
Brassicaceae	*Lepidium sp.*		a peppercress	
Cactaceae	*Harrisia martinii*	*	moonlight cactus	
Cactaceae	*Opuntia stricta*	*	prickly pear	
Cactaceae	*Opuntia tomentosa*	*	velvety pear	
Caesalpinioideae	*Cassia brewsteri*		Leichhardt bean	
Caesalpinioideae	*Lysiphyllum carronii*		Queensland ebony	
Caesalpinioideae	*Lysiphyllum hookeri*		white bauhinia	
Campanulaceae	*Lobelia concurrens*		poison pratia	
Capparaceae	*Apophyllum anomalum*		broom bush	
Capparaceae	*Capparis lasiantha*		wait-a-while	
Capparaceae	*Capparis mitchellii*		wild orange	
Casuarinaceae	*Casuarina cunninghamiana*		river she-oak	
Celastraceae	*Denhamia cunninghamii*			
Chenopodiaceae	*Atriplex muelleri*		saltbush	
Chenopodiaceae	*Einadia hastata*		berry saltbush	
Chenopodiaceae	*Einadia nutans* subsp *linifolia*		native sea berry	

Family	Species	Exotic	Common name	Status [1]
Chenopodiaceae	*Enchylaena tomentosa*		ruby saltbush	
Chenopodiaceae	*Maireana microphylla*		small-leaf bluebush	
Chenopodiaceae	*Salsola australis*		prickly roly poly	
Chenopodiaceae	*Sclerolaena anisacanthoides*		yellow burr	
Chenopodiaceae	*Sclerolaena bicornis*		goat head burr	
Chenopodiaceae	*Sclerolaena birchii*		galvanised burr	
Combretaceae	*Terminalia oblongata* subsp. *oblongata*		yellow-wood	
Commelinaceae	*Commelina diffusa*		wandering dew	
Convolvulaceae	*Ipomoea plebeia*		bell vine	
Cucurbitaceae	*Cucumis sp.*			
Cyperaceae	*Cyperus gracilis*		slender flat sedge	
Cyperaceae	*Cyperus sp.*			
Erythroxylaceae	*Erythroxylum australe*		Australian cocaine tree	
Euphorbiaceae	*Euphorbia drummondi*	*	caustic weed	
Euphorbiaceae	*Euphorbia sp.*	*		
Euphorbiaceae	*Ricinus communis*	*	castor oil	
Fabaceae	*Glycine sp.*			
Fabaceae	*Leucaena leucocephala*	*	leucaena	
Fabaceae	*Parkinsonia aculeata*	*	parkinsonia	
Fabaceae	*Rhynchosia minima*		rhynchosia	
Fabaceae	*Stylosanthes sp.*	*		
Hemerocallidaceae	*Dianella caerulea*		blueberry lily	
Lomandraceae	*Lomandra longifolia*		spiny-headed mat rush	
Malvaceae	*Abutalon otocarpon*			
Malvaceae	*Abutalon oxycarpon*		small-leaved abutilon	
Malvaceae	*Hibiscus heterophyllus*		native hibiscus	
Malvaceae	*Hibiscus sturtii var. sturtii*		hill hibiscus	
Malvaceae	*Malvastrum americanum* var. *americanum*	*	spiked malvastrum	
Malvaceae	*Sida hackettiana*		spiked sida	
Malvaceae	*Sida rhombifolia*	*	flannel weed	
Marsileaceae	*Marsilea hirsuta*		nardoo	
Meliaceae	*Owenia acidula*		gooya	
Mimosaceae	*Acacia catenulata*		bendee	
Mimosaceae	*Acacia excelsa*		ironwood	

Family	Species	Exotic	Common name	Status [1]
Mimosaceae	*Acacia harpophylla*		brigalow	
Mimosaceae	*Acacia leiocalyx*		early black wattle	
Mimosaceae	*Acacia oswaldii*		miljee	
Mimosaceae	*Acacia salicina*		sally wattle	
Mimosaceae	*Acacia shirleyi*		lancewood	
Mimosaceae	*Neptunia gracilis*		native sensitive plant	
Mimosaceae	*Vachellia farnesiana*	*	mimosa bush	
Moraceae	*Ficus opposita*		sandpaper fig	
Myrtaceae	*Corymbia tessellaris*		Moreton Bay ash	
Myrtaceae	*Eucalyptus camaldulensis*		river red gum	
Myrtaceae	*Eucalyptus cambageana*		Dawson's gum	
Myrtaceae	*Eucalyptus coolabah*		coolibah	
Myrtaceae	*Eucalyptus crebra*		narrow leaf ironbark	
Myrtaceae	*Eucalyptus drepanophylla*			
Myrtaceae	*Eucalyptus populnea*		poplar box	
Myrtaceae	*Eucalyptus thozetiana*		yapunyah	
Myrtaceae	*Melaleuca trichostachya*			
Nyctaginaceae	*Boerhavia dominii*		tar vine	
Nyctaginaceae	*Boerhavia sp.*			
Oleaceae	*Jasminum didymum*		desert jasmine	
Oleaceae	*Notelaea sp.*			
Orchidaceae	*Cymbidium canaliculatum*		black orchid	
Papaveraceae	*Argemone ochroleusa* subsp. *ochroleuca*	*	Mexican poppy	
Passifloraceae	*Passiflora foetida*	*	stinking passionflower	
Phyllanthaceae	*Phyllanthus virgatus*			
Picrodendaceae	*Petalostigma pubescens*		quinine tree	
Poaceae	*Ancistrachne uncinulata*		hookey grass	
Poaceae	*Aristida caput-medusae*		many headed wire grass	
Poaceae	*Aristida latifolia*		feathertop wiregrass	
Poaceae	*Aristida sp.*			
Poaceae	*Arundinella nepalensis*		reed grass	
Poaceae	*Astrebla squarrosa*		bull Mitchell grass	
Poaceae	*Bothriochloa bladhii*		forest bluegrass	
Poaceae	*Bothriochloa pertusa*	*	Indian bluegrass	

Family	Species	Exotic	Common name	Status [1]
Poaceae	*Brachyachne convergens*		native couch	
Poaceae	*Cenchrus ciliaris*	*	buffel grass	
Poaceae	*Chloris divaricata*		slender chloris	
Poaceae	*Chrysopogon fallax*		golden beard grass	
Poaceae	*Cynodon dactalyon*	*		
Poaceae	*Dactyloctenium radulans*		button grass	
Poaceae	*Dichanthium aristatum*	*	angleton grass	
Poaceae	*Dichanthium sericeum*		Queensland bluegrass	
Poaceae	*Enteropogon ramosus*		twirly windmill grass	
Poaceae	*Entolasia stricta*		wiry panic	
Poaceae	*Eragrostis sp.*			
Poaceae	*Eriachne sp.*			
Poaceae	*Heteropogon contortus*		black spear grass	
Poaceae	*Ischaemum australe*		large bluegrass	
Poaceae	*Megathyrsus maximus*	*	Guinea grass	
Poaceae	*Melinis repens*	*	red Natal grass	
Poaceae	*Panicum decompositum*		native millet	
Poaceae	*Panicum queenslandicum*		coolabah grass	
Poaceae	*Panicum sp.*			
Poaceae	*Paspalidium distans*		spreading panic	
Poaceae	*Sporobolus caroli*		fairy grass	
Poaceae	*Sporobolus sp.*			
Poaceae	*Urochloa mosambicensis*	*	sabi grass	
Poaceae	*Urochloa subquadripara*		green summer grass	
Polygonaceae	*Duma florulenta*		lignum	
Portulacaceae	*Portulaca oleracea*		pigweed	
Portulacaceae	*Portulaca pilosa*			
Proteaceae	*Grevillea parallela*		silver oak	
Pteridaceae	*Cheilanthes sieberi subsp. sieberi*		mulga fern	
Pyllanthaceae	*Antidesma parvifolium*		currant bush	
Rhamnaceae	*Alphitonia excelsa*		soap tree	
Rubiaceae	*Psydrax oleifolia*			
Rutaceae	*Geijera parviflora*		wilga	
Santalaceae	*Santalum lanceolatum*		sandalwood	
Sapindaceae	*Alectryon diversifolius*		scrub boonaree	
Sapindaceae	*Atalaya hemiglauca*		white wood	

Family	Species	Exotic	Common name	Status [1]
Sapindaceae	*Cardiospermum sp.*	*		
Scrophulariaceae	*Eremophila bignoniiflora*		dogwood	
Scrophulariaceae	*Eremophila mitchellii*		false sandalwood	
Scrophulariaceae	*Myoporum acuminatum*		boobialla	
Solanaceae	*Physalis angulata*	*		
Solanaceae	*Solanum coactiliferum*		western nightshade	
Solanaceae	*Solanum ellipticum*		potato bush	
Sparrmanniaceae	*Grewia latifolia*		dog's balls	
Sterculiaceae	*Brachychiton rupestris*		narrow-leaved bottle tree	
Vitaceaae	*Clematicissus opaca*		pepper vine	
Zygophyllaceae	*Tribulus terrestris*	*	caltrop	

[1] Conservation status under NC Act: PE (extinct in the wild), E (endangered), V (vulnerable), NT (near threatened)

Appendix C

BioCondition scores

Appendix C BioCondition scores

Table 23 BioCondition scoring for the Project Area

Assessment Unit		AU1		AU2		AU3					
Site number		DB05	EB07	DB08	CB09	DB09	DB10	DB12	CB01	CB10	EB05
RE		11.3.1 HVR	11.3.1 HVR	11.3.1 Rem	11.3.1 Rem	11.3.3 Rem	11.3.3 Rem	11.3.3 Rem	11.3.3 Rem	11.3.3 Rem	11.3.3 Rem
Field based Attributes											
Recruitment of woody perennial species		5	3	5	5	5	0	0	0	5	5
Native plant species richness	Trees	5	5	5	5	5	5	5	5	5	2.5
	Shrubs	2.5	5	2.5	2.5	2.5	2.5	2.5	5	2.5	2.5
	Grasses	2.5	2.5	2.5	2.5	2.5	2.5	0	2.5	2.5	0
	Forbs	2.5	2.5	2.5	2.5	2.5	2.5	0	2.5	2.5	2.5
Tree canopy height		3	3	5	3	5	5	5	5	5	5
Tree canopy cover		5	5	5	5	5	3	5	3	3	3
Shrub canopy cover		3	3	3	3	5	0	0	3	3	0
Native perennial grass cover		5	0	0	3	0	1	0	1	0	1
Organic litter cover		5	5	5	5	5	3	3	3	3	3
Large trees		0	5	10	5	10	15	15	15	15	15
Coarse woody debris		2	2	2	5	5	5	5	5	2	2
Weed cover		5	3	5	5	3	3	5	10	5	3
Total field based attributes		**45.5**	**44**	**52.5**	**51.5**	**55.5**	**47.5**	**45.5**	**60**	**53.5**	**44.5**
GIS based attributes											
Patch size		2	10	5	2	2	10	2	10	2	10
Connectivity		0	4	0	2	0	4	0	4	2	2
Context		2	2	0	0	2	4	2	4	0	2

12-Aug-2020
Prepared for – Ensham Resources Pty Ltd – ABN: 23 011 048 678

Assessment Unit	AU1		AU2		AU3					
Total GIS based attributes	4	**16**	**5**	**4**	**4**	**18**	**4**	**18**	**4**	**14**
BioCondition Score	**49.5**	**60**	**57.5**	**55.5**	**59.5**	**65.5**	**49.5**	**78**	**57.5**	**58.5**
BioCondition percentage value	0.55		0.57		0.61					

Assessment Unit		AU4			AU5				
Site number		DB11	CB02	EB04	DB03	DB04	DB06	DB07	EB02
RE		11.3.25 Rem	11.3.25 Rem	11.3.25 Rem	11.7.1 Rem	11.7.1 Rem	11.7.1 Rem	11.7.1 Rem	11.7.1 Rem
Field based Attributes									
Recruitment of woody perennial species		0	5	5	5	5	5	5	0
Native plant species richness	Trees	5	5	5	5	5	2.5	5	2.5
	Shrubs	5	5	2.5	2.5	2.5	2.5	2.5	2.5
	Grasses	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0
	Forbs	2.5	2.5	5	2.5	2.5	2.5	0	2.5
Tree canopy height		5	5	5	5	5	5	5	5
Tree canopy cover		3	3	3	5	5	5	5	5
Shrub canopy cover		0	5	5	3	3	3	5	3
Native perennial grass cover		5	5	3	0	0	0	1	0
Organic litter cover		3	3	3	5	3	3	5	5
Large trees		15	15	15	5	5	10	10	10
Coarse woody debris		5	5	2	5	5	5	2	5
Weed cover		10	3	3	5	5	5	3	3
Total field based attributes		**61**	**64**	**61**	**50.5**	**48.5**	**51**	**51**	**43.5**
GIS based attributes									
Patch size		10	10	10	5	2	5	5	5
Connectivity		4	4	5	2	2	2	0	0
Context		4	2	2	4	4	4	4	2
Total GIS based attributes		**18**	**16**	**17**	**11**	**8**	**11**	**9**	**0**

Assessment Unit	AU4			AU5				
BioCondition Score	**79**	**80**	**78**	**61.5**	**56.5**	**62**	**60**	**7**
BioCondition percentage value	0.79			0.58				

Assessment Unit		AU6			
Site number		DB01	DB02	EB01	EB03
RE		11.7.2 Rem	11.7.2 Rem	11.7.2 Rem	11.7.2 Rem
Field based Attributes					
Recruitment of woody perennial species		5	5	3	5
Native plant species richness	Trees	5	5	5	2.5
	Shrubs	5	5	5	2.5
	Grasses	2.5	2.5	2.5	0
	Forbs	5	5	0	0
Tree canopy height		5	5	5	3
Tree canopy cover		5	5	2	2
Shrub canopy cover		3	5	3	5
Native perennial grass cover		0	0	1	3
Organic litter cover		3	3	5	5
Large trees		15	15	5	0
Coarse woody debris		2	5	2	5
Weed cover		10	10	10	10
Total field based attributes		**65.5**	**70.5**	**48.5**	**43**
GIS based attributes					
Patch size		10	10	10	10
Connectivity		5	5	2	2
Context		4	4	2	2
Total GIS based attributes		0	0	0	0
BioCondition Score		**19**	**19**	**14**	**14**
BioCondition percentage value		0.73			

Appendix D

TEC Assessment Sites

Appendix D TEC Assessment Sites

Table 24 Brigalow TEC assessment sites

Site No.	Diagnostic Criteria			Condition Thresholds	
	Presence of Brigalow as dominant or co-dominant	Located within Bioregion 6, 11 or 12	Species composition and structural elements present	Patch size > 0.5 ha	Exotic perennials < 50% cover
1	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	×
5	✓	✓	✓	✓	✓
6	✓	✓	✓	✓	✓
7	✓	✓	✓	✓	✓
8	✓	✓	✓	✓	×
9	✓	✓	✓	×	✓
10	✓	✓	✓	×	✓

About Us

WSP is one of the world's leading engineering professional services consulting firms, bringing together approximately 65,000+ talented people around the globe. We are technical experts who design and provide strategic advice on sustainable solutions and engineer Future ReadyTM projects that will help societies grow for lifetimes to come. wsp.com