GROUNDWATER MANAGEMENT PLAN

Tahmoor Coal Pty Ltd

Contents

1 Introduction

1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an existing underground coal mine located approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of New South Wales (NSW). Tahmoor Mine surface facilities are situated between the towns of Tahmoor and Bargo within the Wollondilly Local Government Area (LGA). The mine has previously extracted longwalls to the north and west of the surface facilities and has been operating continuously since 1979 when coal was first mined using bord and pillar mining methods, followed by longwall mining methods since 1987. Underground workings extend north under the town of Tahmoor and Picton with two ventilation shafts being located on the outskirts of town. The location of Tahmoor Mine in the regional context is shown in Figure 1.

Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Extracted coal is processed on site at the coal handling and preparation plant (CHPP) and coal clearance facilities prior to transportation via rail to Port Kembla and Newcastle for Australian domestic and export customers.

Tahmoor Mine surface facilities are situated in between the townships of Tahmoor and Bargo, and adjacent to Remembrance Drive on land owned by Tahmoor Coal with mining conducted under both crown and freehold property (see Figure 1). Surface facilities at Tahmoor Mine include administration buildings and offices, a materials store, diesel tanks, electrical workshop, mechanical workshop, bathhouse, water storage tanks, ventilation fan, CHPP, storage areas, run of mine (RoM) stockpile and product stockpiles. A third party owned power station is also located on-site and utilises methane from the mines' gas drainage system to produce electricity.

An Environmental Impact Statement (EIS) was exhibited in early 2019 to gain approval for the Tahmoor South Coal Project (the Project), which involves use of the existing surface infrastructure and the expansion of underground longwall mining to the south of the existing workings (referred to as the Tahmoor South Domain). Tahmoor Coal subsequently revised the proposed mine design and submitted amended development applications on two occasions (in February and August 2020). In April 2021, Tahmoor Coal received Development Application Approval (SSD 8445) for the extraction of up to 4 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, with a total of up to around 33 Mt of ROM coal proposed to be extracted over a 10-year period.

Modification 1 to SSD 8445 (MOD 1), approved in July 2022, sought to extend the commissioning date of the Water Treatment Plant. Modification 2 to SSD 8445 (MOD 2), approved in June 2023, proposed the underground storage of brine in the historical Tahmoor North Western Domain mining area and the temporary storage of excess mine water in the historical Tahmoor North mining area.

1.2 Purpose

The purpose of this Groundwater Management Plan is to provide a framework for Tahmoor Coal personnel to ensure that compliance is achieved with relevant internal and external regulatory requirements related to groundwater management at Tahmoor Coal. The plan ensures that impacts on the community are minimised and managed within a structured framework.

This plan is to ensure compliance with Development Consent (SDD 8445) (the Consent) **Condition B34**, **Schedule 2.**

1.3 Scope

This Groundwater Management Plan includes management measures and monitoring requirements relating to:

a) **Planning;**
b) **Stakeholder Consultation;**
c) **Environmental Management and Monitoring;**
d) **Implementation and Reporting;**
e) **Review and Improvement;**
f) **Document Information; and**
g) **Change Information.**

The Groundwater Management Plan applies to all activities associated with Tahmoor Coal and forms part of the Environmental Management System (EMS).

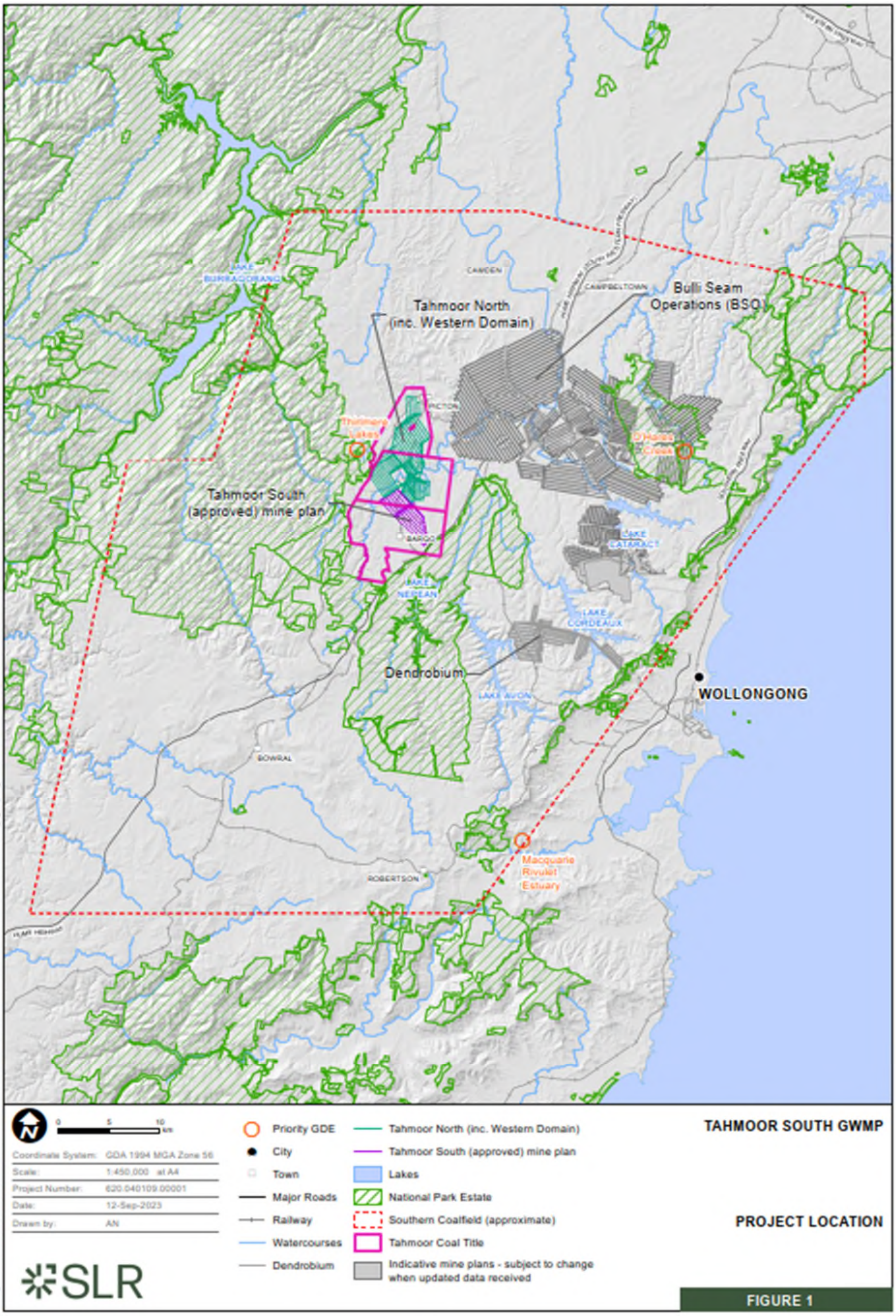

Figure 1 Tahmoor Coal Site Location

2 Planning

2.1 Statutory Requirements and Legislation

2.1.1 Relevant Legislation and Policy

2.1.1.1 Water Management Act 2000

The *Water Management Act 2000* is the regulatory framework for the management and control of water use within NSW. In conjunction with the *Water Act 1912*, it governs the licensing of water to users. In addition, the *Water Management Act 2000* allows for the development and implementation of Water Sharing Plans (WSPs). WSPs regulate the trade and sharing of surface and groundwaters between competing needs and users throughout NSW.

2.1.1.1.1 RELEVANT WATER SHARING PLANS AND GROUNDWATER MANAGEMENT AREAS

Tahmoor Mine currently extracts groundwater that drains into underground mine workings and pumps this water to the surface via three dewatering lines before treating the water and discharging it off site.

Tahmoor Mine falls within the '*Greater Metropolitan Region Groundwater Sources*' WSP (NOW, 2011b), which commenced in 2011. **Figure 2** indicates the extent of this WSP, along with the various groundwater sources in this region that are regulated by the WSP. A WSP is used to manage the average long-term annual volume of water extracted from a given groundwater source. The relevant Groundwater Source for the Tahmoor Mine is:

- Sydney Basin Nepean Sandstone.

Other relevant Groundwater Sources include:

- Sydney Basin – Central, located 10 km to the east and north-east.
- Sydney Basin – South, located 15-20 km east and south-east; and
- Goulburn GMA - located over 25 km to the west and south.

The Sydney Basin – Nepean Sandstone Groundwater Source is further subdivided into Management Zones (MZ), as shown using hatching on **Figure 2**.Figure 2The Tahmoor South domain (CCL 747) is located within the ***Nepean Management Zone 2***, while Zone 1 covers the southern 'third' of the Groundwater Source as well as a smaller area to the west of Camden – these are both at least 10 km from the Tahmoor South Domain.

The Nepean Sandstone Groundwater Source has an annual limit on entitlement (LTAAEL) of 99,568 ML (NOW, 2011a), while current entitlement is 31,346 ML (based on the WaterNSW Water Register 2020-2021 water year).

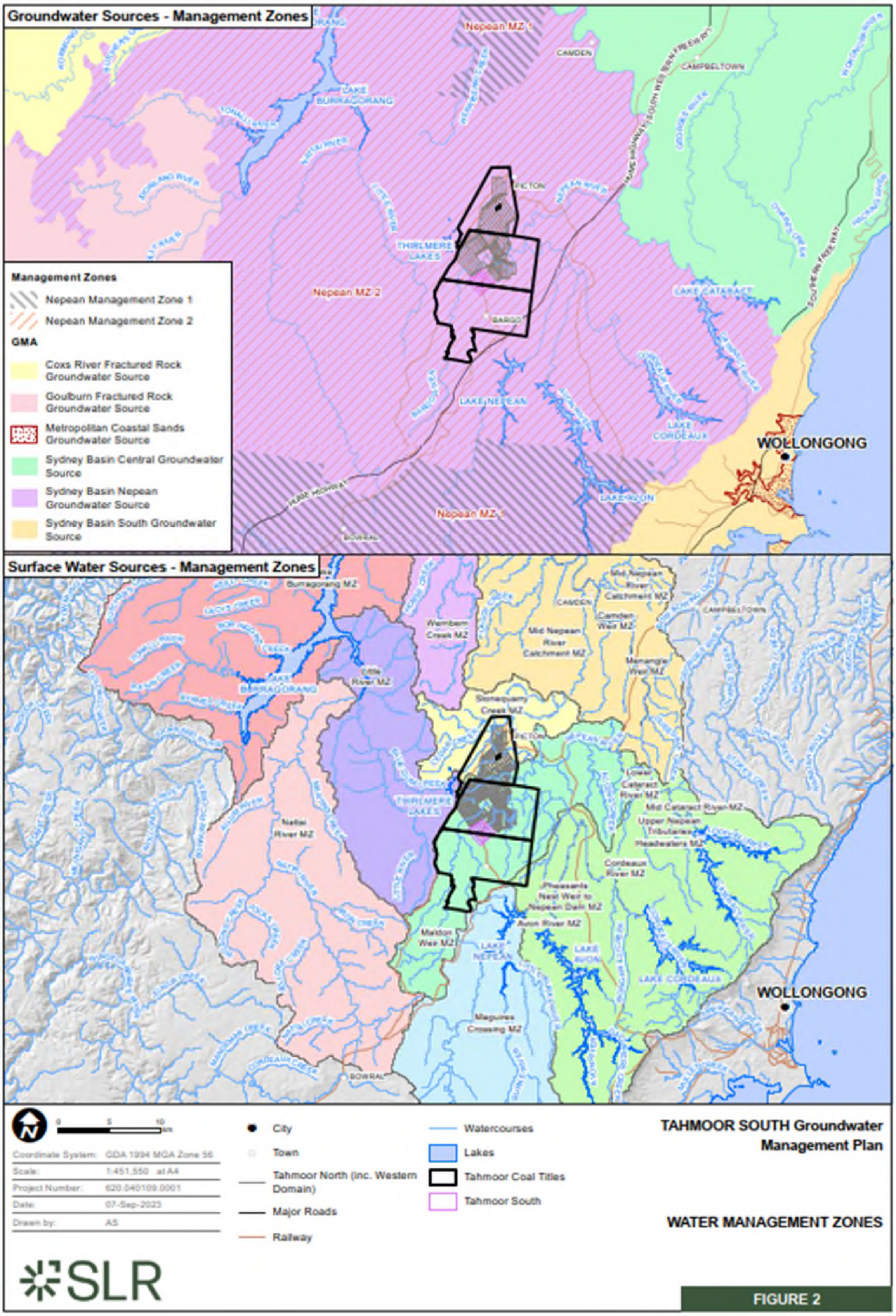

Figure 2 Relevant WSPs and Groundwater Management Areas

2.1.1.2 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) was developed to provide a framework to guide the assessment of impacts that may result following the ‘take’ of water from an aquifer. It outlines the requirements for obtaining licences for approved aquifer interference activities, as well as considerations for the assessment of impacts (NSW Government, 2012).

Underground mining generally requires the dewatering of the geological strata. In accordance with the AIP, such activity is classified as an ‘Aquifer Interference’. In order to meet the requirements of the ‘minimal impact considerations’ of the AIP, a groundwater assessment is conducted.

The AIP requires an estimation of "all quantities of water that are likely to be taken from any water source during and following cessation of the activity and all predicted impacts associated with that activity". Water take and impact estimation is to be based on a "complex modelling platform" for any mining activity not subject to the Gateway process, where the model makes use of the "available baseline data that has been collected at an appropriate frequency and scale and over a sufficient period of time to incorporate typical temporal variations".

The AIP specifies ‘minimal harm considerations’ for highly and less productive aquifers, while also defining thresholds for water table and groundwater pressure drawdown, and changes in groundwater and surface water quality. There are separate minimal impact considerations for:

- “Highly productive” groundwater;
- “Less productive” groundwater;
- “Water supply” works;
- “High Priority” Groundwater Dependent Ecosystems (GDEs); and
- “High Priority” Culturally significant sites.

The AIP categorises groundwater source productivity (‘highly productive’ or ‘less productive’) based on characteristics of salinity and aquifer yield. Tahmoor Mine is located within the ‘Highly Productive’ Hawkesbury Sandstone aquifer. The Hawkesbury Sandstone aquifer is the most utilised aquifer in this region. Water sourced from the underlying Narrabeen Group and Permian Coal Measures comprises the remaining portion of water sourced around Tahmoor Mine (HydroSimulations, 2018).

It should be noted that the categorisation of groundwater source productivity does not make any vertical distinction of aquifer productivity. This is relevant as the higher yielding Hawkesbury Sandstone aquifer overlies the lower-yielding Narrabeen Group/Permian Coal Measures groundwater systems which are at greater depths.

2.1.2 Development Consent Conditions

The requirement for this groundwater management plan is established by Condition B34 (v) under Schedule 1 of the Consent. **Table 1** outlines the requirements under this condition and identifies where these requirements have been addressed.

Table 1 Development Consent Conditions

Condition Reference	Condition	Where Addressed
B34	Prior to the commencement of construction activities, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must: Groundwater Management Plan that includes:	
	• detailed baseline data regarding groundwater levels, yield and quality for privately-owned groundwater bores (as required under condition B25(a)) and the condition of GDEs (including Thirlmere Lakes) potentially impacted by the development;	**Section 4.1**
	• a program to periodically review and update data regarding groundwater levels, yield and quality at privately-owned groundwater bores in the vicinity of the development, including any bores potentially impacted by cumulative groundwater drawdown;	**Section 4.3.2**
	• a detailed description of the groundwater management system, including commitments to: o install an additional monitoring bore in the footprint of Tahmoor North to monitor post-mining groundwater level and quality; o install additional monitoring bores (minimum of four) at or near the Thirlmere Lakes; o install bores above the initial longwalls to define profile fracturing and depressurisation in the Hawkesbury Sandstone and Bulgo Sandstone; o monitor shallow groundwater within the Hawkesbury Sandstone;	**Section 4.3 and Appendix B**
	o monitor volumetric take (mine inflow), including inflows to the underground mine; and	**Section 4.3.3**
	o regularly review the monitoring program to ensure robust and reliable monitoring is undertaken, including reviewing the performance of vibrating wire piezometers;	**Section 4.3.5**
	• groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts (or trends) associated with the development, on: o regional and local aquifers (alluvial and hard rock); and o groundwater supply for other users such as licensed privately-owned groundwater bores;	**Section 4.4.1, Appendix G**
	• uncertainty analysis of the potential impacts of mining the proposed longwalls on the water levels in Thirlmere Lakes, based upon results from the current Thirlmere Lakes Research Program and other ongoing monitoring and investigations;	**Section 4.2 and Appendix E, Appendix G**
	• a program to monitor and evaluate:	

	o compliance with the relevant performance measures listed in Table 4 (of the commitments) and the performance criteria of this plan; o water loss/seepage from water storages into the groundwater system; o groundwater inflows, outflows and storage volumes, to inform the Site Water Balance; o impacts on water supply for other water users; o impacts on GDEs (including Thirlmere Lakes); o the hydrogeological setting of any nearby alluvial aquifers and the likelihood of any indirect impacts from the development; and o the effectiveness of the groundwater management system; • reporting procedures for the results of the monitoring program, including notifying other water users, the NSW Office of Environment and Heritage and Thirlmere Lakes Research Program of any elevated results; • a trigger action response plan to respond to any exceedances of the relevant performance measures and groundwater performance criteria, and repair, mitigate and/or offset any adverse groundwater impacts of the development, including impacts on Thirlmere Lakes; • a Groundwater Modelling Plan that: o provides details for the future groundwater model re-build and recalibration which must be completed within 2 years of the commencement of development under this consent; o is independently third-party reviewed; o provides for the incorporation of the outcomes of the findings of the Thirlmere Lakes Research Program and other relevant research on the Thirlmere Lakes; o considers field data and the outcomes of subsidence monitoring; o provides for periodic validation and where necessary recalibration, of the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and • a plan to respond to any exceedances of the performance measures in Table 4.	**Section 4.4.1** **Section 4.1.9 and Appendix D** **Appendix B and Appendix G** **Section 4.2** **Section 4.4.1 and Section 4.4.2** **Section 4.4.1 and Appendix G** **Section 4.2, Appendix E and Appendix F** **Section 4.4.1 and Appendix D**

2.1.3 Management Plan Requirements

Consent Condition E5 outlines the general requirements for all management plans. **Table 2** outlines the requirements under this condition and identifies where these requirements have been addressed.

Table 2 Management Plan Requirements

Condition Reference	Condition	Where Addressed
E5	Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:	**NA**
(a)	a summary of relevant background or baseline data;	**Section 4.1**
(b)	details of:	**NA**
(b) (i)	the relevant statutory requirements (including any relevant approval, licence or lease conditions);	**Section 2.1**
(b) (ii)	any relevant limits or performance measures and criteria; and	**Section 4.4**
(b) (iii)	the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	**Section 4.4**
(c)	any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	**Section 2.1.2**
(d)	a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	**Section 4.2**
(e)	a program to monitor and report on the:	**NA**
(e) (i)	impacts and environmental performance of the development; and	**Section 4.3**
(e) (ii)	effectiveness of the management measures set out pursuant to condition E5(d);	**Section 4.2.1**
(f)	a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	**Section 4.4**
(g)	a program to investigate and implement ways to improve the environmental performance of the development over time;	**Sections 4.5 and 6**
(h)	a protocol for managing and reporting any:	**NA**
(h) (i)	incident, non-compliance or exceedance of any impact assessment criterion or performance criterion;	**Sections 5.3, 5.4 and 5.5**
(h) (ii)	complaint; or	**Section 5.6**
(h) (iii)	failure to comply with other statutory requirements;	**Covered collectively within Sections 5.3, 5.4 and 5.5**
(i)	public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and	**Section 7.1**
(j)	a protocol for periodic review of the plan.	**Section 6**

2.2 EIS Commitments

Condition A2 (g) of the Consent states that the development may only be carried out generally in accordance with the EIS. The relevant EIS documents include:

a) Tahmoor South Project Environmental Impact Statement, Volumes 1 and 7, dated January 2019;
b) Tahmoor South Project Amendment Report, including Appendices A to R and response to submissions, dated February 2020;
c) Tahmoor South Project Second Amendment Report, Appendices A to O and response to submissions, dated August 2020; and
d) Additional information responses dated 14 September 2020 (including Appendices A to L), 23 October 2020 and 4 November 2020.

EIS commitments relevant to this management plan are outlined in **Table 3**.

Table 3 EIS Commitments

EIS Reference	Commitment		Where Addressed
HR-9	Potential impact: Variation in salinity or contaminants of concern in the REA runoff Management and mitigation: Conduct surface water and groundwater monitoring during active placement of coal handling and preparation plant rejects.		**Section 4.3.1.1, Appendix B and Appendix D**
GW-6	Groundwater The mitigation measures outlined in Section 11.3.5 and Appendix I of the EIS prepared for the Project remain applicable to the Amended Project. Although, the revised Groundwater Assessment provides further detail regarding monitoring of groundwater during operation of the project, such that monitoring would include: - A condition assessment of bores and monitoring equipment (VWPs) of new bores around Tahmoor South, with a specific update of the GWMP; - Re-install at least one bore in the footprint of a Tahmoor North longwall (eg at TNC029) to monitor post-mining groundwater level and groundwater quality; and - Monitoring in longwall centre-lines of pre- and post-mining conditions Tahmoor South. This would be undertaken for the longwall (LW101A), and then every two or three after that. Packer testing would also be undertaken, followed by installing VMPs at four elevations in the Hawkesbury Sandstone and then two in the Bulgo Sandstone to assist in defining a profile of fracturing and depressurisation above longwalls.		**4.1.5.1, Appendix B** **4.3.1, Appendix B** **4.3.1, Appendix B**
PAR	Groundwater In addition to these measures, since exhibition of the EIS, Tahmoor Coal has installed a number of piezometers in and around Longwalls 31-32 and the Western Domain longwalls (in Tahmoor North) at the northern edge of the mine. These have already, and will in future, provide useful information for conceptualisation and model calibration/verification.		**4.3.1, Appendix B, Appendix E and Appendix F**

2.3 Other Leases and Licences

All development consents, leases, licences, and other relevant approvals are stored in the Cority Compliance Management database, which is administered by both site and Liberty GFG Corporate. A summary of the relevant mining leases is provided in **Table 4**. A summary of other approvals and licences is provided in **Table 5**.

Table 4 Mining Lease

Lease	Title	Granted	Expires
CCL 716	Original Tahmoor Leases	15/06/1990	13/03/2042
CCL 747	Bargo Mining Lease	23/05/1990	06/11/2025
ML 1376	Tahmoor North Lease	28/08/1995	28/08/2043
ML 1308	Small Western lease to west of CCL716	02/03/1993	02/03/2035
ML1642	Pit-top and REA surface Mining Lease	27/08/2010	27/08/2031
ML 1539	Tahmoor North Extensions Lease	16/06/2003	16/06/2024

Table 5 Approvals/Licences

Approval Title / Description	Date Granted	Expiry Date
Environmental Protection Licence 1389	01/05/2012	No Expiry
WAL36442	6/12/2013	No Expiry
WAL25777	27/10/2014	No Expiry
WAL 43572	07/05/2021	No Expiry
WAL43656	01/08/2022	No Expiry
SWC839757	10/07/2023	No Expiry

3 Stakeholder Consultation

3.1 Internal Stakeholder Communication

Internal stakeholders include employees, contractors and visitors of Tahmoor Coal. *TAH-HSEC-00119- Communication and Engagement Procedure* has been developed to include the following:

a) Methods of communication between internal stakeholders;

b) Types of information that is communicated between internal stakeholders;

c) Responsibilities for communication of information to internal stakeholders; and

d) Review of communication methods, including the consideration of feedback to / from internal stakeholders.

3.2 External Stakeholder Communication

External stakeholders include neighbours and the local / regional community, local council, state and federal government agencies and regulators, and press / media. Any external communications relating to groundwater will be conducted in accordance with Tahmoor Coal's standard communications procedures. External stakeholders are identified within the following documents:

- *TAH-HSEC-00031- Community Development Plan; and*
- *TAH-HSEC-00039 – Stakeholder Engagement Plan*.

External stakeholder communication is undertaken in accordance with:

- *TAH-HSEC-00039– Stakeholder Engagement Plan*; and
- *TAH-HSEC-00119- Communication and Engagement Procedure*.

These documents include information on the following topics:

a) Methods of communication to external stakeholders.

b) Types of information that is communicated between external stakeholders.

c) Responsibilities for communication of information to external stakeholders.

d) Review of communication methods, including the consideration of feedback to / from external stakeholders.

A key objective of *TAH-HSEC-00119 - Communication and Engagement Procedure* is to maintain positive relationships established with the local community and other external stakeholders.

3.3 Consultation to Date

A draft version of this management plan was distributed to the following stakeholders for review and feedback:

a) Natural Resource Access Regulator (NRAR)
b) Department of Planning, Infrastructure and Environment (DPIE) Water
c) EPA

The feedback provided by stakeholders is summarised within **Table 6** below.

Table 6 Consultation to Date

Consulted Parties	Consultation Conducted	Outcomes of Consultation
EPA	Draft plan provided for comment on 16/11/2021. Feedback on draft plan received on 29/11/2021.	Comments reviewed and addressed in Appendix E.
DPIE Water	Draft plan provided for comment on 16/11/2021. No comments on the plan have been received as of 25/03/2022. Feedback provided by DPIE Water via email on 03/04/2022 stated that DPIE Water would prefer to review the plan once it is in final draft form, with all required elements and supporting work and documents (including modelling) complete and available.	No comments required to be addressed.
NRAR	Draft plan provided for comment on 16/11/2021. No feedback received as of 25/03/2022.	No comments required to be addressed.

4 Environmental Management and Monitoring

4.1 Baseline Data

4.1.1 Geology

The geology around Tahmoor Mine comprises interbedded sandstones, siltstones, shales of the Triassic Wianamatta Group, Hawkesbury Sandstone and Narrabeen Group, and the interbedded sandstones, siltstones, and coal seams of the Permian Illawarra Coal Measures, and the Shoalhaven Group. Sill and dyke intrusions have been identified from surface mapping and drilling records.

4.1.2 Hydrogeological Units

The major hydrostratigraphic units that characterise the area around Tahmoor Mine are the Sydney Basin Triassic and Permian rock units, with the Hawkesbury Sandstone being the primary aquifer. These aquifers fall within the *Nepean Sandstone Groundwater Source* and have been classified as being 'Highly Productive' by the NSW Government based on considerations of bore yield and groundwater quality. The Bulgo Sandstone of the Narrabeen Group and the underlying Illawarra Coal Measures supply additional water to this system; however, contributions are substantially lower.

The extent of surficial units around Tahmoor Mine are presented in **Figure 3**. Generally, there is limited extent of alluvium in this region. Surficial exposure is dominated by the Hawkesbury Sandstone, with some capping via overlying Wianamatta Formation. The major units are described in the following sub-sections.

Alluvium

The alluvium is composed of two main units – the Thirlmere Lakes alluvium and the Quaternary to modern alluvium (**Figure 3**):

- The Thirlmere Lakes alluvium is Cretaceous in age and are positioned within a thin valley that forms the upper reaches of Blue Gum Creek to the west of Tahmoor Mine. It has been described as 'laterised alluvium' (Moffit, 1999) and is characterised by clayey sands and sandy clays with maximum thicknesses of 40 m to 60 m.
- The modern to Quaternary aged alluvium typically exists within watercourses in the northern regions of the mine lease. The main body of alluvium is located near the Western Domain i.e. along Stonequarry Creek downstream (east) of the Western Domain, extending downgradient to Picton.

Groundwater conditions are likely to be unconfined. Recharge to the alluvium is expected to be predominantly from rainfall, rainfall runoff and peak streamflow events (SLR, 2021).

There is no mapped alluvium adjacent to or above the Tahmoor South mine footprint.

Wianamatta Formation

Shale formations that have been largely eroded and are present as hill cappings overlying the Hawkesbury Sandstone. The shales have poor permeability and water quality, however, can lead to the development of springs in areas in contact with the Hawkesbury Sandstone (HydroSimulations, 2018).

Hawkesbury Sandstone

This unit forms a porous rock aquifer of moderate resource potential, tending to higher resource potential in areas where secondary porosity (jointing and fracturing) is more developed, such as in structural zones like the Lapstone Monocline/Nepean Fault zones (HS/SLR, 2020).

In the area of Tahmoor Mine, groundwater in this aquifer generally flows in a south to north-easterly direction, although there is evidence of a weak groundwater divide roughly in line with the western edge of the mine lease. This runs from around Mittagong in the south, through the Thirlmere Lakes area and to the north-west of Tahmoor North. From this divide groundwater flows either to the east and north-east, generally towards the Nepean River, or to the west draining to the Blue Gum Creek/Little River/Nattai River catchment (HS/SLR, 2020).

Hawkesbury Sandstone exhibits a range of salinities (fresh to saline) with a median value of approximately 500 mg/L (GeoTerra, 2013). Publicly available data from AGL's Camden Gas Project indicated an average total dissolved solid (TDS) of about 380 mg/L for Hawkesbury Sandstone groundwater (Parsons Brinckerhoff, 2013). These values are supported by the data collected in the previous bore census for the Western Domain (GeoTerra, 2019), where three of the four samples of groundwater electrical conductivity (EC, which is a measure of salinity) were <1,700 µS/cm (approx. 1,000 mg/L).

Following the significant rainfall events in Feb-March 2021, there was a gradual decline in water quality (fresher groundwater) within the Hawkesbury Sandstone across the Western Domain with EC ranging from 255 µS/cm to 70 µS/cm (SLR, 2021). Some significant freshening in groundwater (from 1500 µS/cm to approximately 100 µS/cm) occurred locally around the Western Domain due to rainfall recharge. The private bores show a stable salinity in 2021 with a slight freshening at GW105228 from 1270 µS/cm in late October 2020 to 1000 µS/cm in July 2021. The latest records in EC at other private bores are within baseline levels (SLR, 2021).

Illawarra Coal Measures

The Illawarra Coal Measures includes the Bulli Coal and Wongawilli Coal seams, which are the major economic coal seams in the Southern Coalfield (HS/SLR, 2020). Tahmoor Mine, including the Tahmoor South workings, targets the Bulli Coal seam. The Bulli Coal seam is typically 375 – 410 metres deep at Tahmoor South.

Groundwater levels in the Illawarra Coal Measures follows a regional south-to-north gradient. However, as this aquifer is targeted for coal extraction at Tahmoor and several other nearby coal mines this gradient is reversed in some areas indicating flow towards the relevant mine workings.

The radius of influence around the mine workings, in the Bulli seam, appears to be around 600-1,000 m. SCT (2013) also analysed groundwater pressures and observed pressure reduction at 700-1,200 m from the nearest longwall.

This aquifer is not targeted for use as the water quality is poor (HS/SLR, 2020). The Illawarra Coal Measures have an average TDS of 11,000 mg/L and a range 3,200-27,500 mg/L was reported for groundwater from the Illawarra Coal Measures.

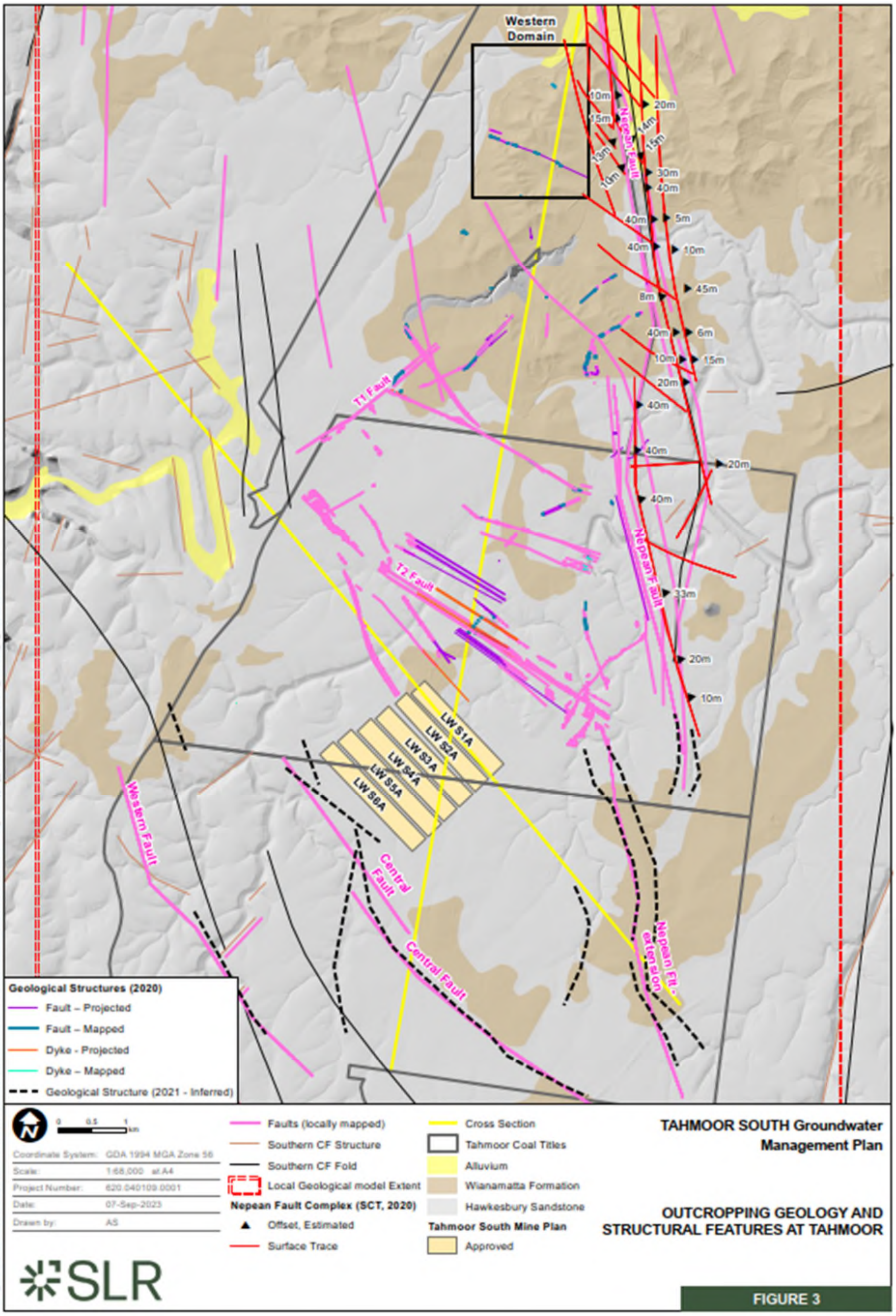

Figure 3 Surficial Geological Outcrop and major faults

4.1.3 Geological Structure

There are a number of geological structures mapped in the vicinity of Tahmoor Mine. The main ones are described as follows and shown on **Figure 3**. It is expected that as development occurs in the Tahmoor South area, additional structures will be identified and characterised.

4.1.3.1 Nepean Fault

The largest of these geological structures are the Nepean Fault (trending north-south) and several NW-SE trending features (faults and monoclines) near parts of the existing Tahmoor Mine and east of the Project. The Nepean Fault is known to have different properties to the host geological units. It could be either a hydraulic barrier or a conductive fault, as it is observed that there are large hydraulic gradients across the fault. Tahmoor Coal has observed water inflows to the mine to be higher than typical at a point where the mine workings intersected the fault zone, which indicates that the Nepean Fault is generally more permeable than the surrounding geology.

Further discussion of increased inflows during the intersection of Longwall 16 is presented in **Section 4.1.3.4**

4.1.3.2 T1 and T2 Faults

The ‘T1’ and ‘T2’ faults which are present at the western edge of the previously extracted Tahmoor longwalls between the mine and the Thirlmere Lakes. These faults lie essentially to the north of (and are not intersected by) the proposed Tahmoor South longwalls.

4.1.3.3 Other Structures

Other features of note are:

- the Camden Syncline, which plunges from south to north, and is located about 3.3 km east of the eastern-most Tahmoor South longwall panels, and more or less coincident with the Nepean River at this point;
- Bargo Fault, heading more or less west, which diverges from the Nepean Fault and crosses the mined area of Tahmoor North;
- the Central and Western Faults, which trend NW-SE, just outside the proposed southern limit of the Tahmoor South longwalls. The alignment of the Central Fault is essentially congruent with the course of Hornes Creek , suggesting that the creek might exist at this location due to the influence of this structural feature;
- Victoria Park Fault, lying near to the west of the Tahmoor North longwalls 26-31, and distant from Tahmoor South;
- There are other smaller faults mapped within the extent of the historical Tahmoor workings.

4.1.3.4 Water make associated with structures

As noted above, the Nepean Fault zone has been associated with greater water makes (inflow) than is typical. The intersection of other faults, such as the Bargo Fault and Victoria Park Faults, by mining has not produced notable additional water inflows. Investigative drilling into fault zones has also proved difficult. For this reason, it is believed that most of the faults in the area act as barriers to flow, possibly because of the presence of fines or mineralisation within the fault zone.

4.1.4 Historic Groundwater Inflow

Groundwater pumped from all sumps in the mine workings is currently, and will continue to be, monitored by means of flow meters fitted to pipelines recording pumping times and rates. This water reporting to the underground workings and sumps may include groundwater seepage inflows, supply inflows (potable supply and for operations), and some re-circulation.

Operational water balance reviews will continue to be performed monthly collating groundwater extractions, as well as imported water to inform on-site water management. Such a system has been in operation at Tahmoor since 2009 (14 years) and will continue for the life of Tahmoor South. Advice from SIMEC is that it is not possible to separately meter the volumes that enter the mine workings in the 'Drift' and in the workings (at seam level). The volumetric flux monitoring will therefore provide data on the total groundwater inflow to all workings, where dewatering of Tahmoor North/Western Domain workings will cease soon after LW W4 is completed (in 2022). This will mean that inflow to Tahmoor South workings will be the primary component of groundwater inflow.

Since 2009, inflows to the Tahmoor Mine have been within the range of 2 Megalitres per day (ML/d) to 6 ML/d. **Figure 4** presents a history of the calculated inflows ('water make') at Tahmoor Mine between 2015 and 2021. The average inflow to the mine for current water year (July-2022 to May - 2023) is 2.9 ML/d. It was 4.4 ML/d for the previous water year (July 2021 to June 2022) and was 4.5 ML/d for the water year 2020-21 (SLR, 2021). It is noted, that pumping may cease for short periods (i.e. due to equipment failure and other reasons), the water balance may estimate zero inflow for short periods (i.e. an underestimate of true inflow). Conversely, if pumping is required to be increased to make up for earlier shortfalls in pumping, the water balance may estimate higher inflow for short periods (i.e. overestimate the true inflow). As a result, longer-term averages are more reliable than the short-term inflow estimates.

The period between mid-2020 shows an increase in inflows to greater than 5 ML/day at the end of July 2020 likely due to the extraction of LW W1. Inflows declined in late 2020, before rising in February 2021 (early in LW W2), with the peak at just over 6 ML/d in March and April 2021. Inflows to the Western Domain are not metered in isolation from other parts of Tahmoor North (they are metered along with all other pump-out) but are estimated to be greater than 2.5 ML/d at analysis between Feb – April 2021. Other than the minor fault observed in the southern 'half' of LW W1 and LW W2, no other obvious geological structures have been noted as intersecting current workings.

Inflows predicted by the rebuilt numerical groundwater model (SLR, 2022) for the Tahmoor South workings are shown on **Figure 5**.

Inflows to the underground operations are predicted to increase over the first half of the operational life of LW S1A-S6A, reaching a maximum peak of approximately 2.5 ML/day at the beginning of 2025. Inflow rates decline gradually from 2025 until the cessation of mining in 2026, where inflows to LW S1A-S6A reach a steady rate of approximately 0.12 ML/day. The average inflow rate over the total duration of mining at LW S1A-S6A is calculated at 0.8 ML/day.

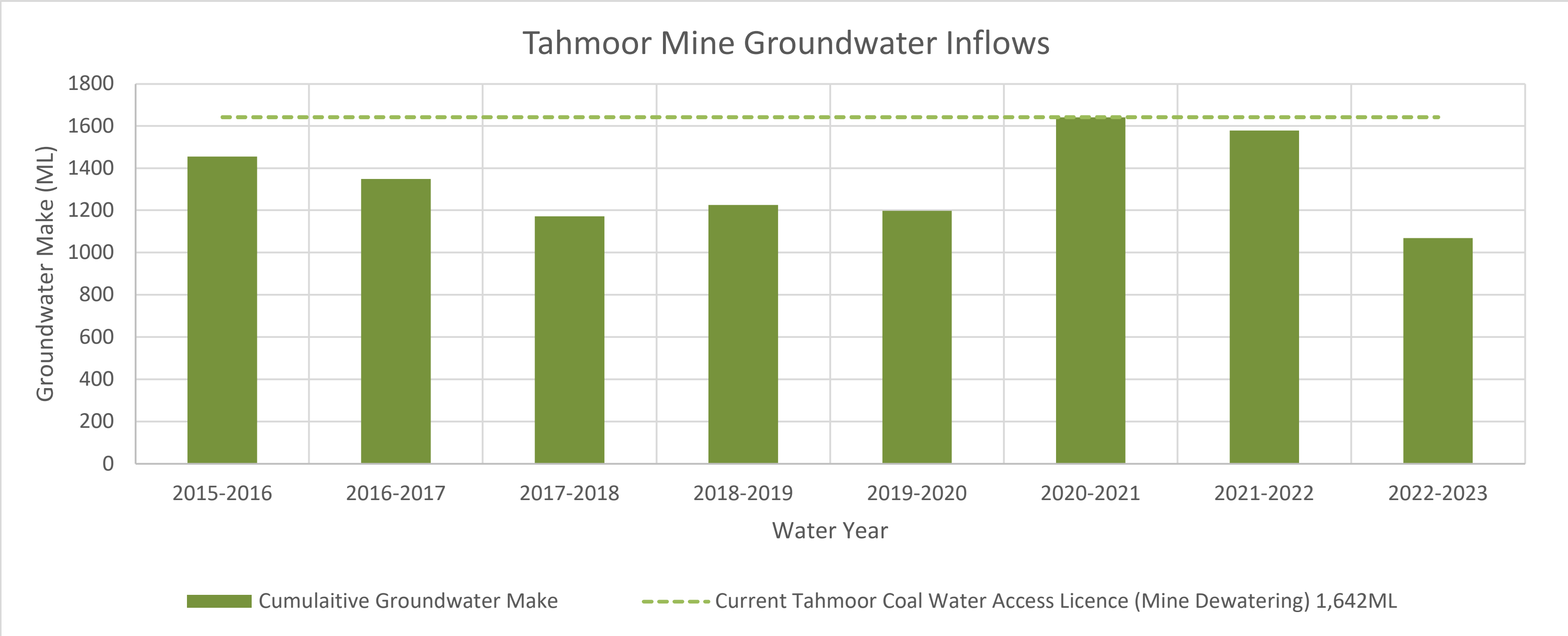

Figure 4 Historic Groundwater Inflow [Measured] for the period between 2015 – 2023

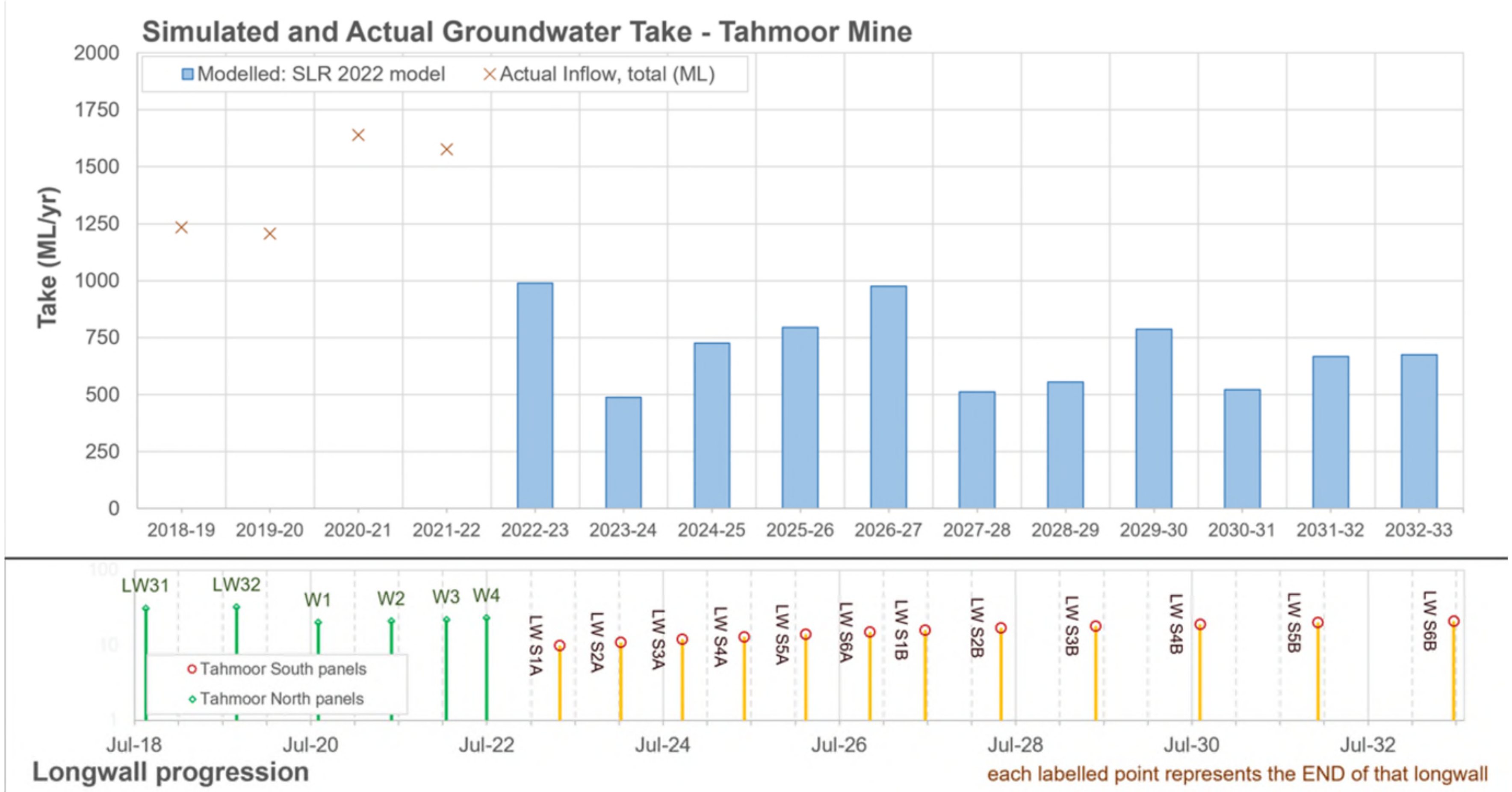

Figure 5 Simulated Groundwater Take

4.1.5 Groundwater Levels

4.1.5.1 Tahmoor South Monitoring Bores

Historically, thirteen bores exist that are equipped with Vibrating Wire Piezometers (VWPs) in the Tahmoor South monitoring network, and these are described in **Table 7** and shown on **Figure 6**. Works are underway to repair and re-instate sensors that are inactive. Telemetry has been installed providing continuous access to data.

In accordance with recommendations via approved Development Consent SSD 8445 MOD2 (determination date 13 June 2023), a selection of current monitoring points associated with the historical working, namely the Western Domain, will be incorporated into the Tahmoor South ongoing monitoring regime. The VWPs selected for ongoing monitoring include WD02, TNC036 and TNC040, included in Table 7.

Table 7 Summary of existing VWPs in Tahmoor South

Bore ID	Easting	Northing	Status	Targeted Aquifer*	Type	Sensor Depths (m bns)
TBC009	278511	6202058	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	30, 75, 140, 182, 192, 322, 343, 357, 381, 391, 397m
TBC018	279645	6204509	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	70 (inactive, 11, 164, 179, 198, 282, 366, 377, 404, 426, 432m
TBC020	280909	6204059	Inactive	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	70, 105, 141, 194, 211, 293, 375, 397, 401, 434, 439m
TBC024	274763	6204163	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	117, 139, 168, 185, 240, 295, 350, 371, 384, 391m
TBC026	281603	6207068	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, LRSS, WWCO	VWP	95, 135, 176, 191, 211, 278, 344, 409, 432, 440, 460m
TBC027	275708	6202210	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	95, 132, 169, 181, 198, 253, 306, 362, 384, 396, 400m
TBC032	277244	6204725	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	95, 131, 168, 181, 200, 237, 294, 371, 397, 437m
TBC034	272956	6205076	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	65 (inactive), 113 (inactive), 161(inactive), 176, 196, 245, 294, 343, 364, 382m
WD02	278245.5	6215178.3	Existing	HBSS, BACS, BGSS	VWP	130, 200, 240, 280, 305, 330, 355, 410m
TNC036	277268.6	6215382.0	Existing	HBSS, BGSS,BUCO	VWP	65, 97, 169, 214, 298, 412, 463m
TNC040	279003.6	6214520.9	Existing	WMFM, HBSS, BGSS,BUCO	VWP	27, 65, 131, 225, 252, 352, 452, 501m

** WNFM – Wianamatta Group, HBSS – Hawkesbury Sandstone, BHCS – Bald Hill Claystone, BGSS – Bulgo Sandstone, SPCS – Stanwell Park Claystone, SCSS – Scarborough Sandstone, WBCS - Wombarra Claystone, CCSS – Coal Cliff Sandstone, BUCO– Bulli Coal Seam, WWCO – Wongawilli Coal Seam*

To compliment this VWP Network, an additional 14 open standpipes have been constructed for ongoing water level and quality monitoring. As per the additional VWPs incorporated from the historical workings monitoring network, P14 and P16 open standpipes have been included in the Tahmoor South monitoring network. The construction details and initial water levels are provided in **Table 8**.

Table 8 Summary of existing Open Standpipes in Tahmoor South

Bore ID	Easting	Northing	Target Aquifer	Depth (m)	Monitoring Regime
P50 a, b, c (Thirlmere1)	273900	6208500	HBSS	Approx. 20, 35, 65	monthly
P51a	275623.00	6206431.71	HBSS	19.96	15 minute intervals
P51b	275620.60	6206419.68	HBSS	35.38	15 minute intervals
P57 a, b (Hornes1)	275500	6204600	HBSS	Approx. 20, 35	monthly
P52a	277649.84	6206848.30	HBSS	41.17	15 minute intervals
P53 a	277649.91	6206496.48	HBSS	41	15 minute intervals
P53b	277658.61	6206492.50	HBSS	60.55	15 minute intervals
P53c	277665.80	6206489.23	HBSS	80.78	15 minute intervals
P54a	277809.68	6205951.98	HBSS	25	monthly
P54b	277806.92	6205944.68	HBSS	35.99	monthly
P55a	277297.77	6205283.12	HBSS	41.05	15 minute intervals
P55b	277303.32	6205270.96	HBSS	59.36	15 minute intervals
P55c	277296.45	6205262.51	HBSS	81.90	15 minute intervals
P56 a	276645.55	6206175.36	HBSS	20.9	15 minute intervals
P65b	276639.18	6206166.92	HBSS	45.56	15 minute intervals
P56c	276637.06	6206154.37	HBSS	80.4	15 minute intervals
P14A	278398.4	6216535.9	Alluvium/colluvium	6	15 minute intervals
P14B	278392.6	6216534.3	HBSS	16.6	15 minute intervals
P14C	278397.2	6216541.8	HBSS	31.6	15 minute intervals
P14D	278391.4	6216540.0	HBSS	61.6	15 minute intervals
P16A	277350.5	6215146.7	HBSS	27.5	15 minute intervals
P16B	277349.9	6215140.4	HBSS	45.5	15 minute intervals
P16C	277347.3	6215135.3	HBSS	75.5	15 minute intervals

In addition to the VWPs and new OSPs, there are three bores located on pit-top and seven bores located within the Reject Emplacement Area (REA), as described in **Table 9** shown on **Figure 8.** The REA and pit-top piezometers have data loggers installed recording water levels every 12 hours, with data downloaded on a quarterly basis. Water pressure in the VWPs (when operational) is recorded every 12 hours with data downloaded on a quarterly basis. Figures depicting hydrographs for these bores are provided in Appendix B of the Tahmoor South Groundwater Monitoring Plan (**Appendix B**).

Table 9 Reject Emplacement Area (REA) Piezometers

Bore ID	Easting	Northing	Status	Targeted Aquifer	Type	Depth (metres)
REA1	278362.3	6207826.8	Active	REA	OSP	54.8
REA2	278441.2	6206332.2	Active	REA	OSP	58
REA3	277820.7	6206453.4	Active	REA	OSP	41
REA4	277650.8	6206835.2	Active	REA	OSP	57.5
REA5	277424.2	6206769.0	Active	REA	OSP	7.2
REA6	278643.3	6207214.8	Active	REA	OSP	46.3

Bore ID	Easting	Northing	Status	Targeted Aquifer	Type	Depth (metres)
REA7	278035.1	6207307.3	Active	REA	OSP	43
PitTop1	277357.6	6207494.9	Active	pit-top	OSP	55.04
PitTop2	277396.0	6207663.2	Active	pit-top	OSP	6.85
PitTop4	276872.2	6207331.6	Active	pit-top	OSP	33.7

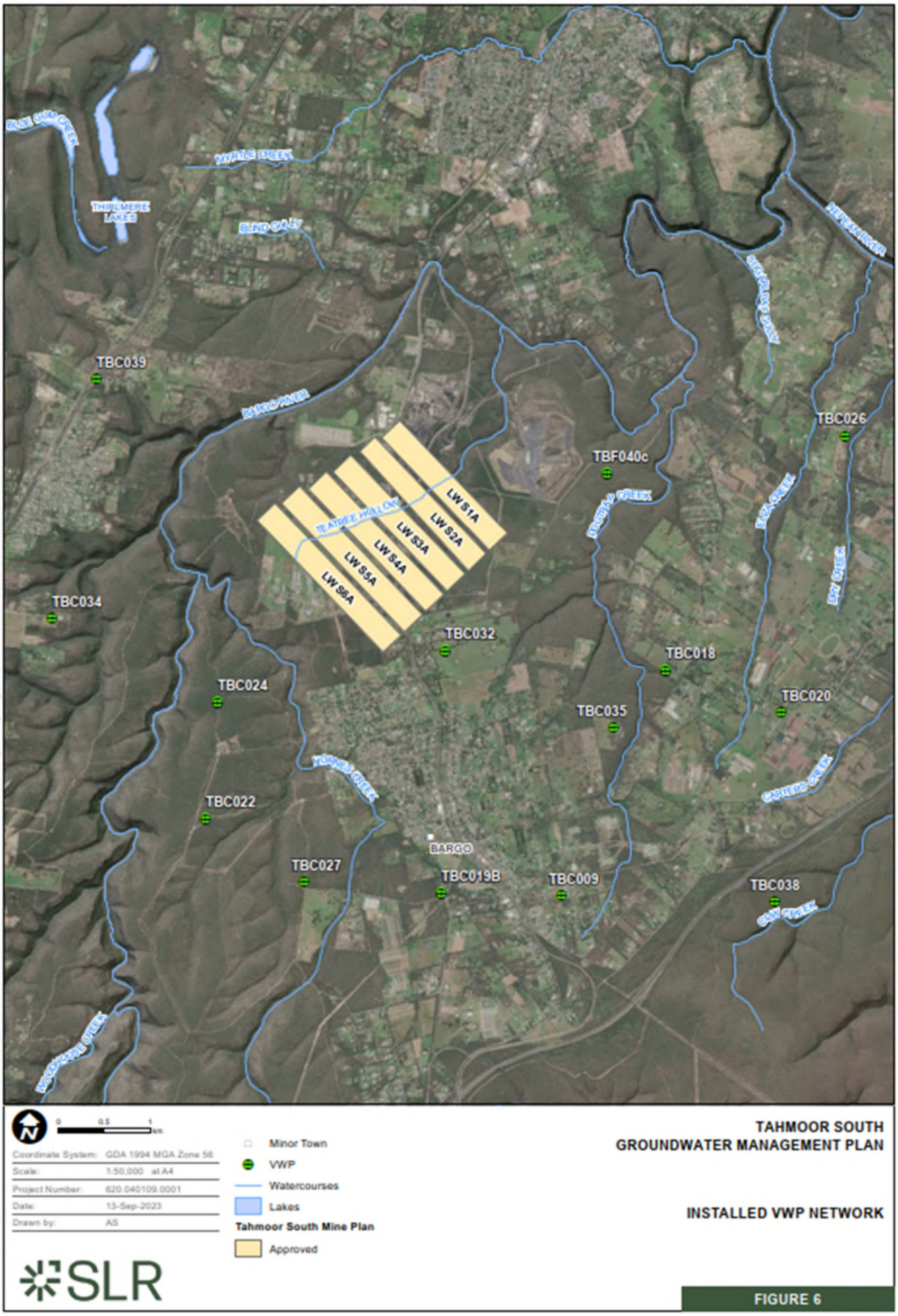

Figure 6 Vibrating Wire Piezometers

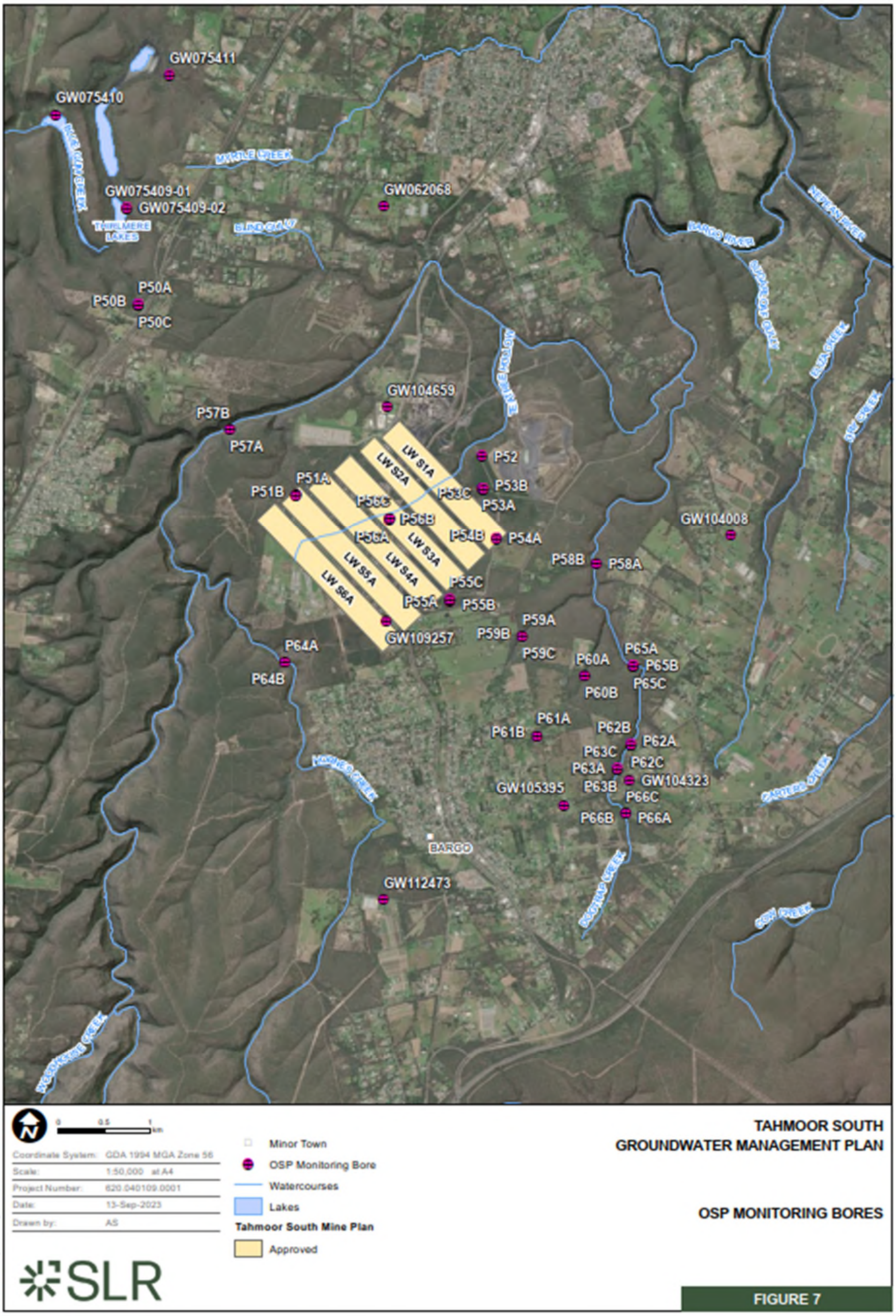

Figure 7 OSP Monitoring Bores

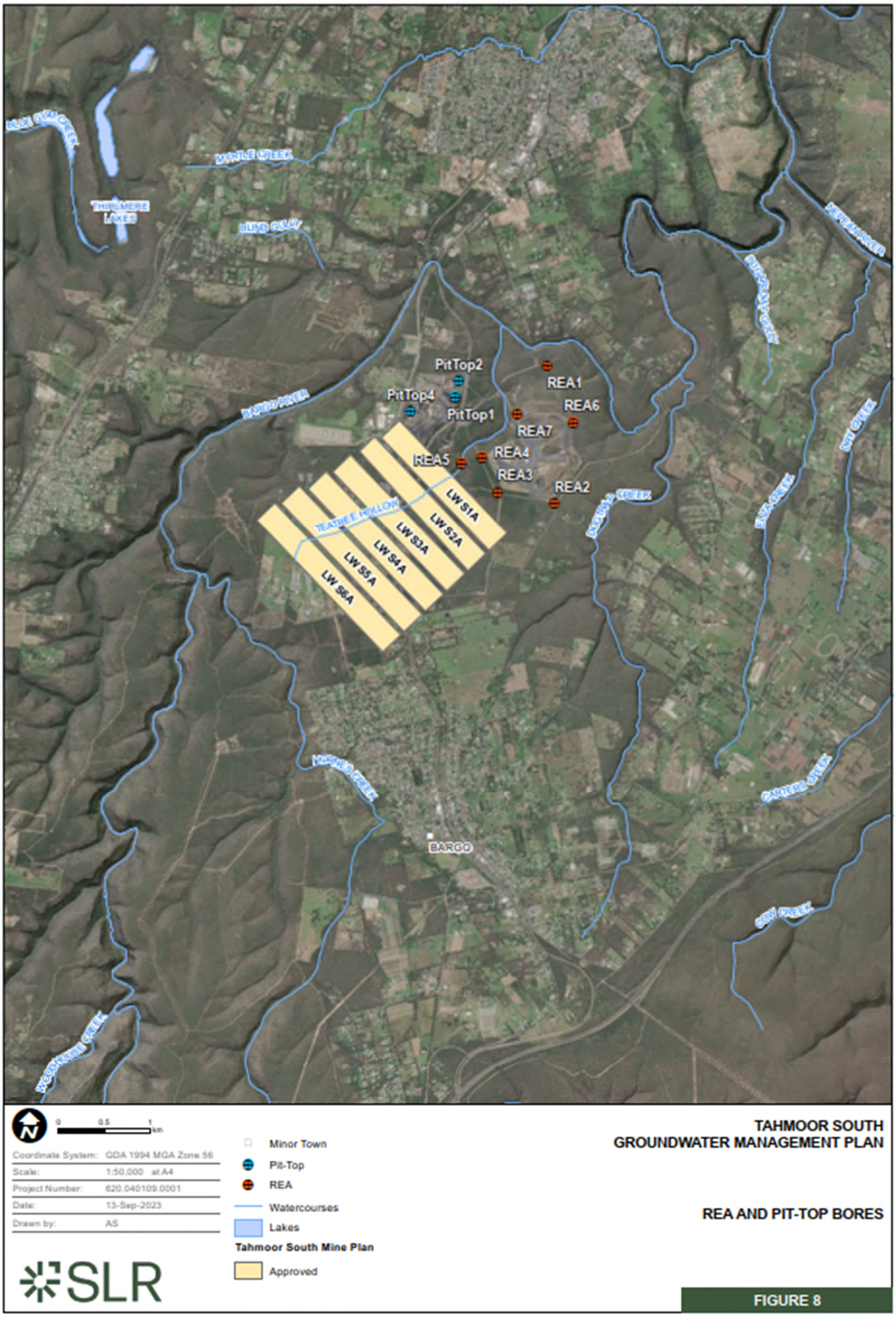

Figure 8 REA and Pit-top Piezometers

4.1.5.2 Private Bores

The pre-mining private landholder bore survey commenced in January 2022 and was concluded by 15th March 2022, surveying a total of 40 bores. Water level data was captured for all bores where possible and summarised in **Table 10**. Six bores have been incorporated into the routine monitoring regime, with water levels manually recorded monthly.

Table 10 Groundwater Levels in Private Bores

Bore	Ongoing Monitoring	Current Use and Frequency	Aquifer	Bore Depth (m)	Groundwater Depth (metres below ground)
10CA119328	no	Irrigation, daily (when onsite dam is low)	HBSS	NR	54.4
115NTG	no	Not currently used, pump to be installed next month	HBSS	~160 - 170 m	41.67
GW032443	no	Not currently used	HBSS	10.71 (measured, likely blocked)	0.71
GW059618	no	No one onsite for comment, likely not in use as no infrastructure connected	HBSS	122.71	19.96
GW062068	yes	Not used due to "part cave-in" 11 years ago	HBSS	>100	21.93
GW102452	no	Formerly used for aquaculture (~50,000L/day)	HBSS	71.41	36.41
GW103023	no	No current use. Formerly used for water extraction to supply aquaculture enterprise	HBSS	51.43	17.68
GW103036	no	Daily, irrigation	HBSS	127.42	68.49
GW103615	no	Not currently used	HBSS	73.1	65.36
GW104008	yes	When required to fill the dam and irrigate lawns	HBSS	>100	46.84
GW104323	yes	Daily use (on timer) for crop irrigation	HBSS	79.8	68.6
GW104659	yes	To replenish adjacent dam, regulated by timer	HBSS	50.08	43.8
GW105395	yes	Not currently used	HBSS	53.1	0.5
GW105803	no	Not currently used	HBSS	80 (anecdotal, not measured)	17.05
GW106546	no	Once per week for stock watering	HBSS	63.63 (likely blockage as installed to 116 metres)	41.67
GW109257	yes	Not used for two years, previously used to fill site dam	HBSS	NR	37.06
GW111518	no	Frequent use when required, for crop irrigation	HBSS	28.3 (owner described depth of 28.3 so potential obstruction)	19.24
GW111828	no	Not currently used, previously used intermittently when water not available from GW115773 as irrigation back-up	HBSS	60.7 (likely blocked as install depth recorded as 205 m)	Dry or blocked

GW111842	no	Not currently used	HBSS	69.4 (likely blocked as install depth recorded as 240 m)	Dry or blocked
GW112415	no	Daily use to fill dam and irrigate lawn	HBSS	96.96	42.86
GW112473	yes	Daily use to fill dam	HBSS	NR	32.95
GW115773	no	Daily use for irrigation	HBSS	81.87	75.85
GW116897	no	Not currently used, waiting for pump install for future crop use	HBSS	51.2 (potential blockage as install recorded to 160m)	19.9
GW45404	no	Not used in years	HBSS	72.73 (could be blocked)	Dry
Heritage Well	no	Unused	HBSS	3.12	1.15

4.1.6 Hydraulic Conductivity

For the purpose of describing or quantifying how water flows through a porous or fractured medium, the term 'permeability' is used interchangeably with 'hydraulic conductivity' in this document. Data has been sourced from packer testing with some available from core testing, conducted at Tahmoor, Appin and Dendrobium Mines. Packer testing primarily tests horizontal hydraulic conductivity (Kh), but can also be useful in characterising the likely vertical hydraulic conductivity (Kv) in sedimentary units. Data indicated that there is large range of values among formations, however it should be noted that there is limited core testing data (Kv), particularly outside of the Hawkesbury Sandstone (HBSS).

Data suggests a decreasing permeability with depth of the rock mass as a whole; however, that trend is mainly evident for the non-coal units while the coal seams are key exceptions to this general trend:

- Decreasing from the Hawkesbury Sandstone down to the Wombarra Claystone, then a step up at the Bulli Coal seam due to the higher permeability of the coal material; and
- A further decreasing trend in the sandstone and siltstone units below the Bulli Coal Seam.
- Like the Bulli Coal, the Wongawilli Coal seam is more permeable than the surrounding sandstone and siltstone units.
- There is a weak trend of decreasing matrix permeability with depth observed in the core data (SLR, 2021).

The installation of three further Height-of-Fracturing (HoF) holes are proposed for investigating fracturing conditions, as per the Groundwater Monitoring Plan (SLR, 2021b), one more in the A-block, and two in the B-block. This follows the ongoing investigation in the Western Domain at bores WD01-WD02.

4.1.7 Groundwater Quality

Monitoring Bores

Water quality samplings is currently conducted at monitoring bores located across the Tahmooor South domain, inclusive of the Pit-top area (Pit Top 1, 2, 4) and the Reject Emplacement Area (REA1-7), dedicated nested open standpipes and seven private bores. The bores included in the ongoing monitoring regime are presented in **Table 11**. This includes the 7 open standpipes incorporated from the historical working areas to meet the requirements of the Mod 2 approval. Tahmoor Coal conducts full laboratory water quality analysis at these bores, inclusive of the following parameters:

- Electrical conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO);
- Nutrients (Total N, Total P);
- Major Ions (Ca, Cl, K, Na, SO4, HCO3, F);

- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity; and
- Total (Fe, Mn) and dissolved metals (Fe, Mn, Cu, Pb, Zn, Ni, Al, As, Se, Li, Sr, Co).
- EC is recorded at NSW government monitoring bores at Thirlmere Lakes since 2012.

Table 11 Groundwater Quality Monitoring Network

Bore	Easting	Northing	Bore Depth (m)	Monitoring Regime
REA1	278362.3	6207826.8	54.8	quarterly
REA2	278441.2	6206332.2	58	quarterly
REA3	277820.7	6206453.4	41	quarterly
REA4	277650.8	6206835.2	57.5	monthly
REA5	277424.2	6206769	7.2	quarterly
REA6	278643.3	6207214.8	46.3	quarterly
REA7	278035.1	6207307.3	43	quarterly
PitTop1	277357.6	6207494.9	55.04	quarterly
PitTop2	277396	6207663.2	6.85	quarterly
PitTop4	276872.2	6207331.6	33.7	quarterly
P51a	275623.00	6206431.71	19.96	monthly
P51b	275620.60	6206419.68	35.38	monthly
P52a	277649.84	6206848.30	41.17	monthly
P53 a	277649.91	6206496.48	41	monthly
P53b	277658.61	6206492.50	60.55	monthly
P53c	277665.80	6206489.23	80.78	monthly
P54a	277809.68	6205951.98	25	monthly
P54b	277806.92	6205944.68	35.99	monthly
P55a	277297.77	6205283.12	41.05	monthly
P55b	277303.32	6205270.96	59.36	monthly
P55c	277296.45	6205262.51	81.90	monthly
P56 a	276645.55	6206175.36	20.9	monthly
P65b	276639.18	6206166.92	45.56	monthly
GW109257	276603.8	6205057	120	monthly
GW104008	280359	6205978	140	monthly
GW112473	276586	6202000	138	monthly
GW104659	276616	6207392	132	monthly
GW105395	278546.8	6203033	90	monthly
GW104323	276242	6206412	79.8	monthly
P14A	278398.4	6216535.9	6	monthly (then quarterly)
P14B	278392.6	6216534.3	16.6	monthly (then quarterly)
P14C	278397.2	6216541.8	31.6	monthly (then quarterly)
P14D	278391.4	6216540.0	61.6	monthly (then quarterly)
P16A	277350.5	6215146.7	27.5	monthly (then quarterly)

P16B	277349.9	6215140.4	45.5	monthly (then quarterly)
P16C	277347.3	6215135.3	75.5	monthly (then quarterly)

Field water quality has been undertaken for EC and pH on a monthly basis since August 2019. **Appendix C** presents the baseline data (EC and pH) for the Pit Top and REA bores, with the rainfall residual mass included for comparison to climatic trends.

Private Bores

Historical groundwater quality data for the Study Area, in the form of EC, are summarised in **Figure 9**. These data were sourced from publicly available data from the NSW government Groundwater Works/Pinneena database, and from the bore census conducted by Geoterra (2013a). The information in the Groundwater Works database is a mix of qualitative (e.g. 'fresh', 'brackish') and quantitative (e.g. '500 ppm'). In order to convert or standardise these qualitative entries to an approximate quantitative measure some assumptions have been made. The resultant quantitative salinities were classified as shown on **Figure 9**, as well as assigning the various bores to layers using the geological model built for this study.

The data indicate that:

- Groundwater in the Alluvium and Wianamatta Formation are of mixed quality. It is likely that evaporative concentration of salts could occur in alluvial aquifers, especially in clayey facies. The marine origin and low permeability of the Wianamatta Shales tends to lead to higher salinities in this unit.
- There is little data for the Narrabeen Group or Illawarra Coal Measures. Older units such as the Shoalhaven Group exhibit a range of salinities from fresh to saline.

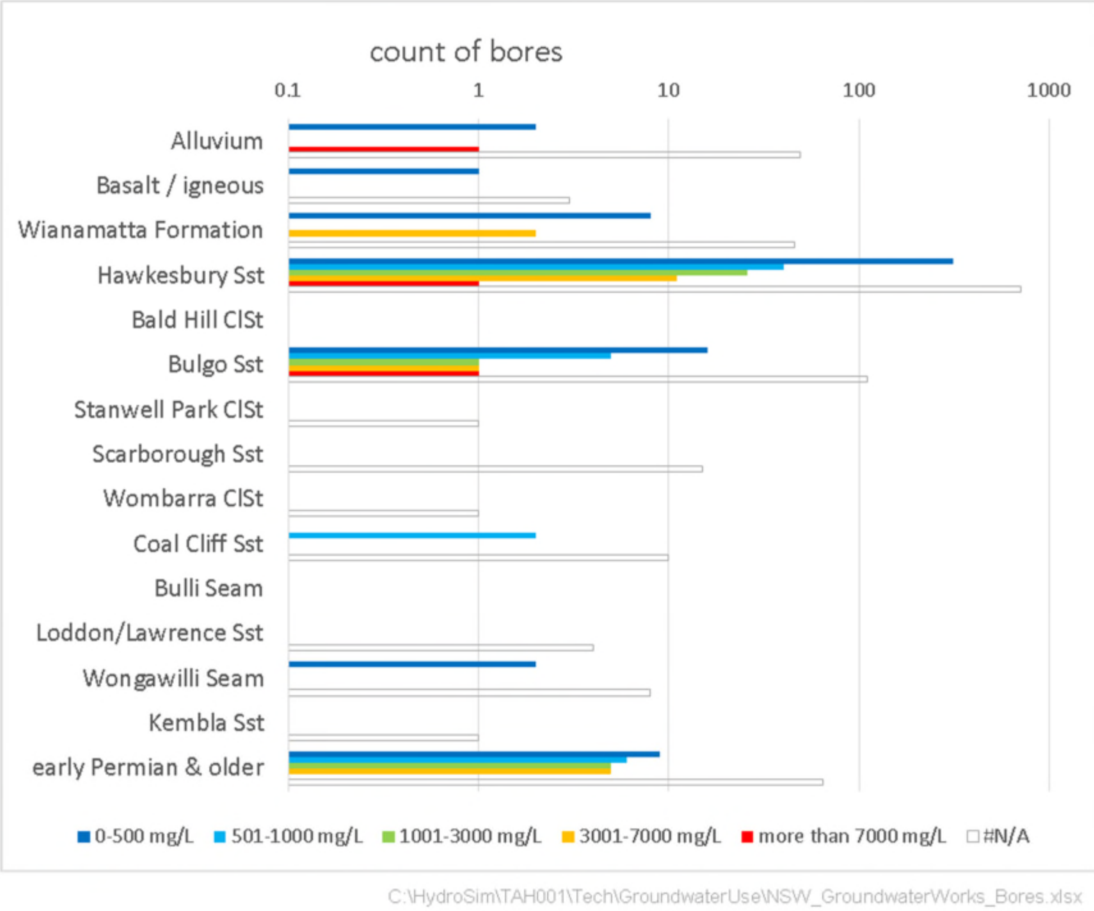

Figure 9 Summary of groundwater salinity data

In addition, Table 12 presents the salinity (as EC) recorded during the 2022 Private Bore Survey (SLR, 2022c). The median groundwater salinity is 810 µS/cm, with a minimum of 165 µS/cm and a maximum of 3,378 µS/cm. There are no apparent trends with groundwater salinity and bore depth or location.

Table 12 Private Bore Survey Salinity Data

Bore	Ongoing Monitoring	Aquifer	Bore Depth (m)	Groundwater Salinity EC (µS/cm)
10CA119328	No	HBSS	NR	1472
115NTG	No	HBSS	~160 - 170 m	689
GW032443	No	HBSS	10.71 (measured, likely blocked)	226
GW059618	No	HBSS	122.71	2396
GW062068	Yes	HBSS	>100	165
GW070245	No	HBSS	NR	949
GW102179	No	HBSS	NR	1849
GW102344	No	HBSS	NR	801
GW102452	No	HBSS	71.41	371
GW103023	No	HBSS	51.43	3378
GW103036	No	HBSS	127.42	371
GW103559	No	HBSS	NR	487

GW104008	Yes	HBSS	>100	1323
GW104323	yes	HBSS	79.8	1025
GW104659	Yes	HBSS	50.08	539
GW105262	No	HBSS	NR	1828
GW105395	No	HBSS	53.1	3341
GW105803	No	HBSS	80 (anecdotal, not measured)	1108
GW105883	No	HBSS	NR	1686
GW110669	No	HBSS	NR, 111 metres install depth noted on bore	677
GW111518	No	HBSS	28.3	277
GW111669	No	HBSS	NR	481
GW111810	No	HBSS	NR	2058
GW112415	No	HBSS	96.96	1059
GW112473	Yes	HBSS	NR	515
GW115773	No	HBSS	81.87	820
GW116897	No	HBSS	51.2 (potential blockage as install recorded to 160m)	776
Heritage Well	No	HBSS	3.12	684
GW106590	No	HBSS	150 (Installed depth)	842

4.1.8 Groundwater Use

4.1.8.1 Groundwater Dependent Ecosystems

The Thirlmere Lakes are the closest 'High Priority' Groundwater Dependent Ecosystem to Tahmoor Mine, being 650-700 m from historical Tahmoor longwalls at their closest points, but at least 3,500 m from Tahmoor South longwalls.

Thirlmere Lakes are of high conservation importance, gazetted as a National Park in 1972, and providing habitat for dependent aquatic species (Schädler & Kingsford, 2016). The Lakes are a group of waterbodies in the Greater Blue Mountains World Heritage Area that includes Lake Gandangarra, Lake Werri Berri, Lake Couridjah, Lake Baraba and Lake Nerrigorang.

The water in Thirlmere Lakes is predominantly derived via rainfall. The Thirlmere Lakes Inquiry concluded that the Lakes appear to act as naturally losing system under both dry and wet conditions (Heritage Computing, 2012b; Schädler & Kingsford, 2016).

Preliminary findings by the NSW government Thirlmere Lakes Research Program (TLRP) indicate that historical effects of Tahmoor Mine on Thirlmere Lakes hydrology have likely been very small compared to climatic effects. The TLRP released the major findings report from the study, '*Thirlmere Lakes – A Synthesis of Current Research*', on the 24th March 2022 (DPE, 2022). The field and modelling results suggest that the recent water level declines are primarily associated with climate variability versus the nearby longwall mining. However, this conclusion does not preclude the influence of the ongoing longwall mining and bore extraction in the future, and ongoing monitoring was recommended. The findings of this report are aligned with existing conceptualisation of the Lakes and are supported by the proposed monitoring program and groundwater modelling.

Regional mapping of groundwater dependence of terrestrial ecology is shown on **Figure 10** (DPIE, 2018). Key areas as identified via this mapping include the Thirlmere Lakes and reaches of Dog Trap Creek and Teatree Hollow. This indicates a high probability of interaction of groundwater and surface water at these locations, in the form of riparian vegetation.

4.1.8.2 Springs

Literature indicates that it is likely that the Hawkesbury Sandstone may contain springs that have developed in saturated and perched aquifers within the unit (HydroSimulations, 2018). However, no significant springs or soaks have been mapped or located in the vicinity of the Project. Field investigations carried out by Brienen Environment & Safety (2022) supported this finding. A further hydrogeological desktop study reviewing recent water levels, topography and state GDE mapping supported the conclusion that the presence of springs is unlikely (SLR, 2023).

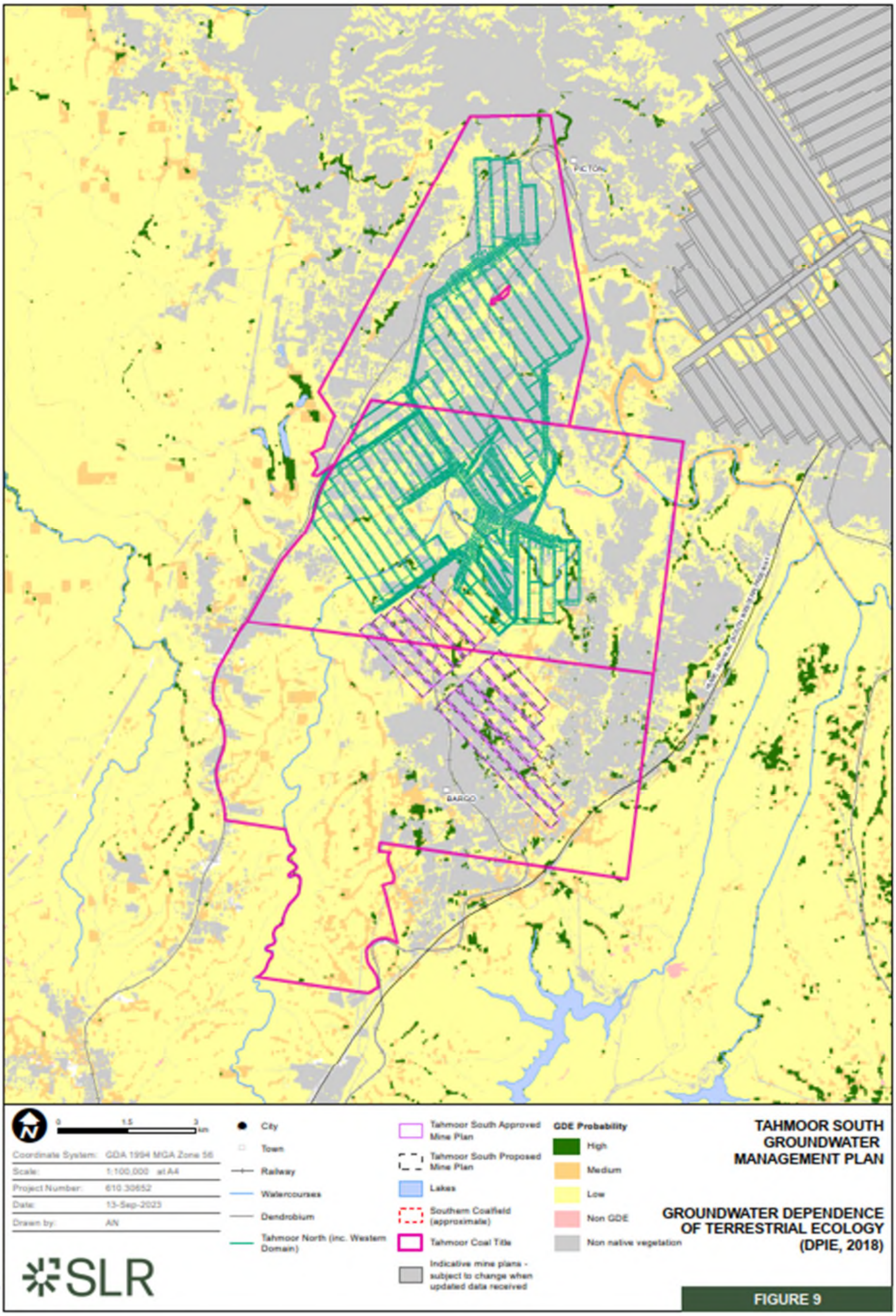

Figure 10 Groundwater Dependence of Terrestrial Ecology (DPIE, 2018)

4.1.8.3 Anthropogenic Use

The Hawkesbury Sandstone is a productive aquifer (**Section 4.1.2**) utilised by landholders for subsidiary water supply. Modelling for the Tahmoor South EIS indicated approximately 52 bores owned and operated by private landholders may be impacted (drawdown exceeding 2 metres, as per the AIP) as a result of the Tahmoor South extraction. Utilising the rebuilt Numerical Groundwater Model, completed for the LW S1A – LWS6A Extraction Plan, a summary of predicted drawdown resulting from this extraction is provided in **Table 13**.

The field survey was conducted to establish baseline conditions of as many bores as possible, with seven selected for ongoing monitoring.

Table 13 Private Groundwater Users potentially impacted by Tahmoor South operations

Work Number	Easting	Northing	Bore Depth (m)	LW S1A-S6A Potential Impact (m)	Cumulative Mining Impact (m)
GW104659	276617	6207391	132	1	14.4
GW105847	277020	6204404	NA	1.1	3.9
GW111810	277034	6204407	142	1.1	3.9
GW105883	277040	6204629	NA	1.4	4.5
GW014262	276764	6204587	48.8	1.6	4.6
GW111669	276232	6206450	120	2.2	10.8
GW109257	276603	6205052	120	2.2	6
GW032443	276415	6206336	130.1	2.4	10.2
GW102452	277234	6200992	120.5	<1	<1
GW103023	277261	6200993	165	<1	<1
GW103036	276840	6200964	132.5	<1	<1
GW103559	276504	6201854	190	<1	<1
GW105262	278609	6200731	104	<1	<1
GW111357	277051	6200982	144	<1	<1
GW111518	276882	6200987	150	<1	<1
GW112415	277479	6200865	139	<1	<1
GW112473	276577	6202010	138	<1	<1
GW116897	281442	6203190	160	<1	<1
GW108538	281155	6205941	66	<1	12.5
GW110669	274565	6207896	132	<1	12.1
GW062068	276581	6209579	150	<1	8.9
GW106590	280442	6206344	150	<1	4.7
GW111047	280015	6206037	120	<1	4.6
GW031294	279732	6205706	90.2	<1	4.2
GW007445	277454	6204323	134.1	<1	3.6
GW104008	280368	6205982	140	<1	3.5
GW105577	280728	6207041	162	<1	3.5
GW070245	280090	6205714	97.5	<1	3.3
GW053449	280369	6205813	105	<1	3.1

GW057969	281350	6206116	108	<1	2.5
GW100455	281877	6207020	96	<1	2.5
GW103615	279720	6204034	103	<1	2.5
GW054146	279886	6204676	104	<1	2.4
GW045404	282217	6206689	53.3	<1	2.2
GW051877	281673	6205875	92	<1	2.2
GW058634	279479	6203419	122	<1	2.2
GW104090	278208	6215913	150.5	<1	2.1
GW104323	279259	6203318	109	<1	2.1
GW105395	278543	6203037	90	<1	2
GW053450	282303	6205837	120	<1	1.8
GW107470	282069	6208057	132	<1	1.7
GW115773	282232	6205725	81.87	<1	1.7
GW062661	282609	6207469	126.5	<1	1.6
GW104860	282745	6206178	204.3	<1	1.6
GW106546	282785	6206765	116	<1	1.6
GW111828	282391	6205638	205	<1	1.6
GW100433	278540	6202588	126	<1	1.5
GW104454	281410	6204568	66	<1	1.5
GW052016	280259	6203604	110	<1	1.4
GW111842	282654	6205664	240	<1	1.4
GW102179	280953	6203826	153	<1	1.3
GW059618	281587	6204277	117	<1	1.2
GW102045	281266	6203733	120	<1	1.1
GW105803	282278	6204644	140	<1	1.1
GW101936	280604	6202851	126	<1	1
GW108842	282500	6204716	174	<1	1

4.1.9 On-site Water Storage

There are 20 earthen water storages and two water storage tanks across the Tahmoor Coal surficial workings area. Two investigations into the potential for seepage from these storages to groundwater have been completed including:

- Tahmoor South Surface Water Investigation, SLR 2022, which included a visual inspection and assessment, and
- Preliminary Surface Water and Groundwater Quality Investigation, SLR, 2022.

Both reports are included in Appendix D. Findings of both reports concluded minimal likelihood of any connectivity between surface water storages and groundwater systems. The need for ongoing monitoring specific to leakage is considered unnecessary based on these findings.

4.2 Management Measures

Ongoing management measures include development and implementation of the Groundwater Modelling Plan (SLR, 2021). The Modelling Plan is provided in **Appendix E**. Please note that is Modelling Plan is currently referencing historic longwall names, as this was completed prior to finalising the nomenclature. According to the Consent Conditions, the plan should;

- provide details for the future groundwater model re-build and recalibration which must be completed within 2 years of the commencement of development under this consent;
- include planning for an independent third-party review;
- provide for the incorporation of the outcomes of the findings of the Thirlmere Lakes Research Program and other relevant research on the Thirlmere Lakes;
- consider field data and the outcomes of subsidence monitoring; and
- provide for periodic validation and where necessary recalibration, of the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions.

The Groundwater Modelling Plan (SLR, 2021f) has undergone independent third-party review, endorsed by the independent reviewer on the 23rd December 2021 (**Appendix F**). The Groundwater Modelling Plan follows the modelling process presented in the Australian Groundwater Modelling Guidelines (Barnett et al, 2012) and addresses the modelling objectives, conceptualisation, model design, calibration approach and set up, the predictive modelling approach, the sensitivity and uncertainty analysis, and the outputs and reporting.

The Groundwater Model has undergone complete rebuild, with the modelling report appended to the Groundwater Technical Report supporting the LW S1A-S6A Extraction Plan.

4.2.1 Management Measure Effectiveness

The groundwater model will be validated periodically via comparison of monitoring results with modelled predictions. Re-calibration will occur as necessary, and an independent review of the model will occur every three years. Groundwater monitoring results will be compared to groundwater model predictions on an annual basis to assess actual versus predicted groundwater levels and/or drawdown (i.e. height of depressurisation), and groundwater inflows to the mine. This analysis will be incorporated in regular groundwater compliance reporting, such as the Annual Review and/or Six-monthly Review

Aligned with completion of model re-calibration the trigger levels dependent on modelling outputs will be reviewed and updated as necessary.

4.3 Monitoring

Groundwater monitoring will be undertaken in accordance with the relevant Australian Standards legislation and EPA approved methods for sampling, including (but not limited to):

- NSW DECC (2004) Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales.
- AS/NZS 5667.1:1998 Water Quality – Sampling – Guidance on the Design of Sampling Programs, Sampling Techniques, and the Preservation and Handling of Samples.
- AS/NZS 5667.11:1998 Water Quality - Sampling - Guidance on Sampling of Groundwaters.

Groundwater monitoring has commenced across all Tahmoor South monitoring sites for both groundwater levels and groundwater quality.

4.3.1 Tahmoor South Monitoring Network

The Tahmoor South Monitoring Network currently consists of a series of multi-level Vibrating Wire Piezometers (VWPs), Open standpipes (OSPs) and private bores.

The standpipe piezometers can be used for monitoring water levels manually or with an automated datalogger (installed in 10 sites to date), as well as for collection of water samples for groundwater quality monitoring purposes. The VWPs are grouted and therefore can only be used for monitoring groundwater pressures, but do allow for multiple instruments to be installed at different depths within a single borehole.

The network answers to the requirement of the Consent Conditions and EIS Commitments in addition to the key receptors identified, as detailed in the Groundwater Monitoring Plan provided in **Appendix B** (SLR, 2021h). The Groundwater Monitoring Plan is an active document, updated as implementation occurs.

In addition to the proposed 'Tahmoor South' network, monitoring results associated with Tahmoor North and the Western Domain have been incorporated into the numerical groundwater modelling, and where purposeful, into the Tahmoor South network (i.e. in the footprint of a Tahmoor North longwall). Additionally, monitoring in longwall centrelines of pre- and post-mining conditions at Tahmoor South will be undertaken for the longwall (LW101A), and then every two or three after that. Packer testing would also be undertaken, followed by installing VMPs at four elevations in the Hawkesbury Sandstone and then two in the Bulgo Sandstone to assist in defining a profile of fracturing and depressurisation above longwalls.

Please note, the Monitoring Plan currently references historic longwall names, which will be updated in subsequent versions.

4.3.1.1 Groundwater Monitoring Regime

Pre-extraction monitoring regimes for both groundwater level and quality are described below. The frequency of monitoring and the parameters to be monitored may be varied in consultation with regulators, during extraction as per adaptive management strategies. It is proposed that quarterly sampling may be suitable post-establishment of baseline conditions (24 months or more, at most sites, but 12 months of sampling at some sites near to LW 101A), with adjustments in frequency made as extraction progresses and based on proximity to the position of the active longwall.

4.3.1.1.1 GROUNDWATER LEVEL MONITORING

Prior to commencement of extraction groundwater level data have been collected on a monthly basis, or where loggers are installed, downloaded monthly. This is suitable to determine baseline aquifer conditions.

This monthly monitoring regime is continuing throughout extraction. However, during extraction in previous mining areas, Tahmoor Coal has demonstrated responsiveness to variability in groundwater levels that may be resultant of mining, via adaptive management practices. Consequently, the frequency of monitoring may be varied in consultation with DPE or advisory panels (or similar) as required.

Post-mining monitoring will continue with continuous recording for loggers and quarterly manual measurements of water level for 12 months following completion of the longwalls or as required in accordance with the Rehabilitation Plan.

4.3.1.1.2 GROUNDWATER QUALITY MONITORING

Monthly sampling was undertaken prior to longwall extraction occurring near to the monitoring points,. Ongoing monthly quality monitoring is currently underway. Frequency of monitoring may be reduced at some sites post collection of 24 baseline data points, dependent on intent and location (i.e. those more pertinent to the B-block, and not intended to be mined before 2024 may only require quarterly sampling).

Collection of field parameters will occur monthly, inclusive of:

- pH;
- Electrical Conductivity – EC (µS/cm);
- Total Dissolved Solids – TDS (mg/L).

A full suite of groundwater chemistry will be sampled monthly, inclusive of:

- Major ions: Ca, K, Na, Mg, F, Cl, SO4;
- Total phosphorus and total nitrogen;
- Total alkalinity as CaCO3, HCO3, CO3, DOC; and
- Total and dissolved metals: (Fe, Mn, Cu, Pb, Zn, Ni, Al, As, Se, Li, Sr, Co, Ba).

4.3.2 Private Bore Monitoring

The private landholder bores census was concluded in March 2022. The Tahmoor Coal Community Liaison Specialist attempted to contact all pertinent landholders, with a total of forty bores surveyed. Where possible, the following information was collected;

- Current bore status (operational, destroyed, etc);
- Bore location and top of casing (surveyed);
- Bore equipment;
- Current use regime;
- Groundwater level;
- Groundwater quality (as per the regime described above);
- Land access agreements and suitability for routine monitoring.

The OSP monitoring network was developed to capture suitable spatial representation of the Hawkesbury Sandstone to capture potential impact to private bores. Additionally, six bores have been selected for inclusion into the ongoing monitoring regime. This selection was made on the suitability of the bores, land access agreements and spatial distribution.

4.3.3 Groundwater Extraction Monitoring

Groundwater pumped from all sumps in the mine workings is currently, and will continue to be, monitored by means of flow meters fitted to pipelines recording pumping times and rates. This water reporting to the underground workings and sumps may include groundwater seepage inflows, supply inflows (potable supply and for operations), and some re-circulation.

Operational water balance reviews will continue to be performed monthly collating groundwater extractions, as well as imported water to inform on-site water management. The 'groundwater inflow' calculated from the water balance is a licensable 'groundwater take' as per the AIP and *Water Management Act 2000*.

4.3.4 Post-mining groundwater Levels and Quality

The Tahmoor Commitments request to "re-install at least one bore in the footprint of a Tahmoor North longwall (e.g. at TNC029) to monitor post-mining groundwater level and groundwater quality". It is recommended that monitoring of WD02 for post-mining water levels and P14P116 for water quality are a suitable to meet the post-mining monitoring requirements. **Figure 11** shows the location of these bores, with their proximity to the proposed site (previously TNC029). Re-instating this specific bore is not seen to add value to the network beyond the existing bores that can provide the required post-mining information.

4.3.5 Monitoring Equipment Effectiveness

Annual reviews of the monitoring network will be undertaken to assess the condition of the monitoring bores and associated equipment. Monitoring will be undertaken as per the standards described above, with equipment maintained to meet these standard requirements.

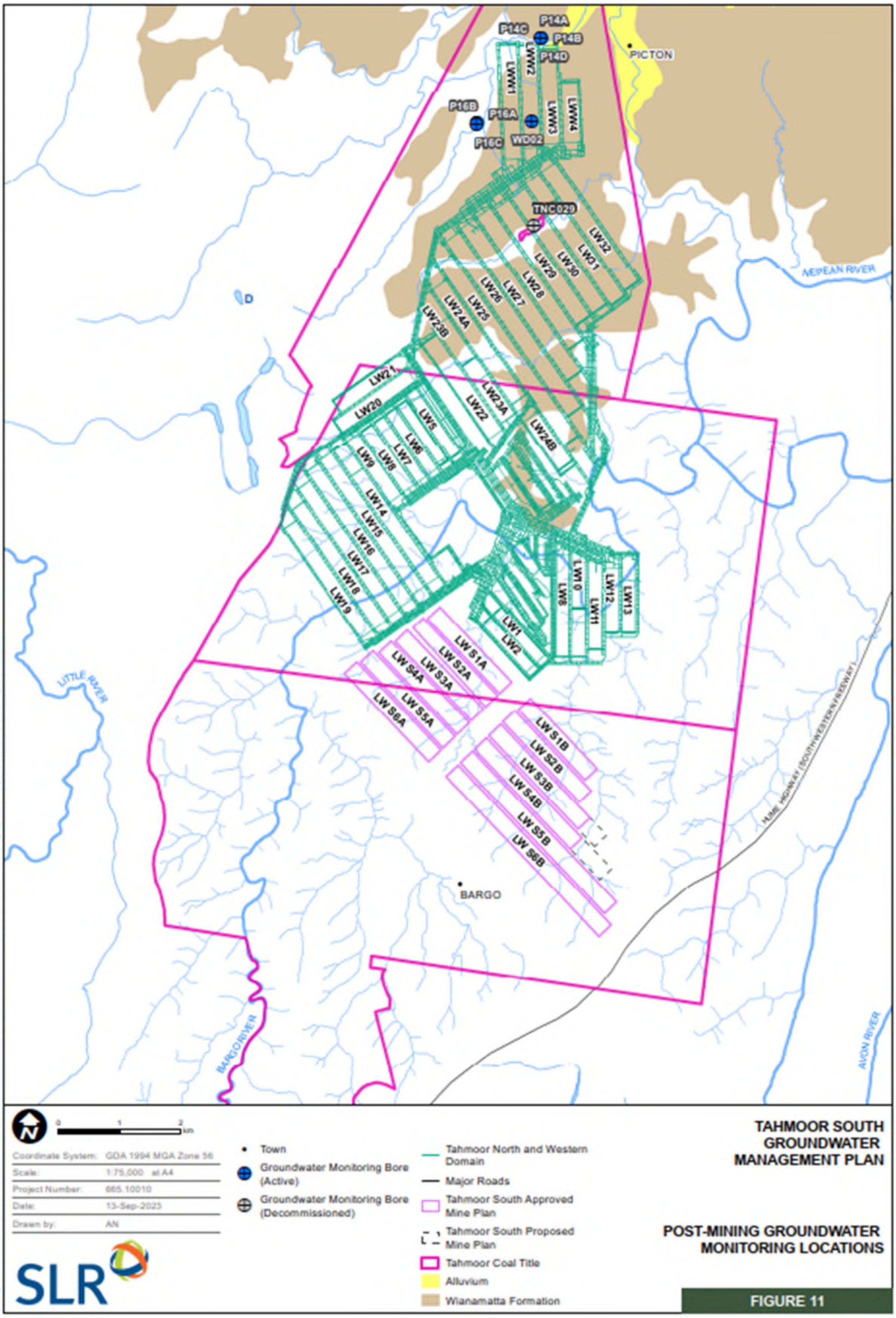

Figure 11: Post-mining groundwater monitoring locations

4.4 Contingency Plan

4.4.1 Trigger Action Response Plans

In accordance with Condition E5 (f) of the Consent, in the event that performance measures (in the form of pre-defined tiggers) are considered to have been exceeded or are likely to be exceeded, a response will be undertaken in accordance with the Trigger Action Response Plans (TARP) provided in **Appendix G**.

The primary actions of the TARP are to:

- Define appropriate trigger levels for 'shallow' and 'deep' groundwater levels, groundwater quality (pH, EC and metals) at monitoring bores and private bores;
- Develop specific actions to respond to high risk of exceedance of any performance measure to ensure that the measure is not exceeded; and
- Present a plan in the event a performance measures are exceeded or are likely to be exceeded and describe the management / corrective actions to be implemented (i.e. notifications to relevant agencies, groundwater monthly/quarterly reviews, revision in any Corrective Action Management Plan and/or Annual Reviews).

It is important to note that the Conditions refer to compliance with the "relevant performance measures listed in Table 4 (of the commitments)", however Table 4 is only pertinent to Surface Water and not groundwater. The only exclusion to this is the Performance Measure referring to Groundwater Dependent Ecosystems (GDEs) including Thirlmere Lakes, for which the performance measure states;

- Negligible impacts including;
  - Negligible change in groundwater levels; and
  - Negligible change in groundwater quality.

This performance measure applies to the TARP titled "WMP13 - Groundwater Bores Monitoring for Thirlmere Lakes.

Each TARP has four levels of triggers – "Normal Conditions" - being where the environment is behaving or performing within normal or expected levels, through to Level 3 (L3) each with escalating risk to the environment via deviation from baseline or expected conditions.

The success of remediation measures that have been implemented for any TARP exceedance would be reviewed as part of any Corrective Action Management Plan and Six-monthly reporting, the latter which would provide an opportunity to review and update existing triggers if deemed necessary.

A total of six TARPS (TARP WMP8 to WMP13) are required to address various components of the groundwater system, including:

- WMP8 – Shallow Groundwater Levels (Open standpipes and private bores);
- WMP9 – Shallow Groundwater Pressures (VWP Sensors < 200 m depth);
- WMP10 – Groundwater Level / Pressure Deep VWPs (> 200 m depth excluding monitoring the Bulli Coal Seam);
- WMP11 – Groundwater Quality (Open standpipes and private bores);
- WMP12 – Groundwater – Surface-water interaction; and
- WMP13 – Groundwater Bores Monitoring for Thirlmere Lakes.

The TARPS are provided to work in conjunction with not only each other, but also other TARPS within the overarching Water Management Plan to provide a holistic approach to the overall management of the water system.

4.4.1.1 Methodology for Derivation of Triggers

Trigger levels have been developed utilising baseline data in conjunction with modelled drawdown predictions and climate data.

Historical data indicates that significant mining-related drawdown or depressurisation (tens to hundreds of metres) is typical in strata deeper than 200 metres below ground (mBG), and drawdown or depressurisation is less severe and less persistent in strata shallower than 200 mBG. Consequently, trigger levels have been set independently for these depth profiles.

4.4.1.1.1 GROUNDWATER LEVELS

<u>Shallow monitoring (<200 metres)</u>

In the Western Domain, climatic variations have not caused reductions in groundwater levels at shallow open-standpipe bores in excess of 2 m (SLR,2021). Differences at VWPs observed due to climatic variation, however, were observed to cause reductions in water levels of up to 5 m. Therefore, a water level reduction of greater than 2 m for shallow standpipe bores and 5 m for shallow VWP loggers for a period beyond 6 months was considered to be a possible indicator of greater than predicted impacts to groundwater (even if greater drawdown was predicted, the concept is to use this magnitude of drawdown as an early warning).

Shallow OSPs

The TARP Significance Levels (1, 2 and 3) will be assigned a trigger corresponding to a calculated groundwater elevation for each groundwater monitoring bores. For monitoring sites with short baseline periods (<6 months), the maximum groundwater level observed during pre-mining has been used as reference levels in the TARP level calculations. For bores with a longer baseline, the reference level has been defined following a review of the baseline data. **Table 14**.

Table 14 Shallow Monitoring Bore Trigger Levels

Bore ID	Groundwater Levels (mAHD)		
	TARP Level 2	TARP Level 3	TARP Level 4
Shallow OSP			
P51A	296.3	292.4	288.5
P51B	297.5	293.6	289.7
P52	246.7	244.6	242.5
P53A	255.8	253.7	251.6
P53B	255.8	253.7	251.6
P53C	253.6	251.4	249.1
P54A	260.7	259	257.4
P54B	259.9	258.2	256.6
P55A	271.1	269.7	268.2
P55B	266	264.4	262.9
P55C	259.7	258.2	256.6
P56A	288.2	284.8	281.4
P56B	278.9	275.5	272.1
P56C	257.4	254.1	250.7
REA4	248.3	246.2	244.1
Private Bores			

GW104008	234.7	234	233.2
GW104323	256.9	256.8	256.8
GW104659	249.8	243.6	237.4
GW105395	322.1	modelled DDN is equal to 2m	modelled DDN is equal to 2m
GW109257	280.9	278.9	276.9
GW112473	317.1	modelled DDN less than 1m	modelled DDN less than 1m

Shallow VPS

Regionally, climatic variations have been observed to cause reductions in water levels of up to 5 m in shallow (< 200 m depth) VWPs. Therefore, a water level reduction of greater 5 m for shallow VWP loggers for a period beyond 6 months is considered to be a possible indicator of greater than predicted impacts to groundwater (even if greater drawdown was predicted, the concept is to use this magnitude of drawdown as an early warning).

A reference level has been generated for each VWP sensor, based on the average groundwater level observed prior to commencement of extraction.

At most sites the average groundwater levels sits at levels observed prior to the 2017-2019 NSW drought and in some cases to levels observed during the wetter conditions in 2021. This makes the groundwater level average a conservative reference level.

TARP Level 1 (L1) was then calculated as Reference level (mAHD) minus 5 m which is consistent with approaches adopted elsewhere at Tahmoor Mine (i.e. for the Western Domain).

Elsewhere at Tahmoor Mine, TARP Level 3 (L3) has been based on the maximum modelled drawdown and calculated as Reference Level minus maximum modelled drawdown. The maximum modelled drawdown at the reference sites ranges from 0 m to 3.3 m which is smaller than the adopted 5 m natural fluctuations to derive TARP L1. This results in some cases in the TARP L3 being higher than TARP L1.

Therefore, instead of calculating TARP L3 as "Reference Level minus maximum modelled drawdown", TARP L3 is calculated as "TARP L1 minus the maximum modelled drawdown". TARP L3 now lies below TARP L1.

TARP Level 2 (L2) is calculated as the average of L1 and L3.

Some VWP sensor are assigned model Layer 1 (i.e. TBC024 HBSS-117m; TBC027-HBSS-95m, TBC034-HBSS-65m). No drawdown is simulated in Layer 1 at those sites hence no TARP Level 2 and 3 can be derived here.

Trigger levels for the shallow VWP sensors are provided in **Table 15**

Table 15 Shallow VWP Trigger Levels

Bore	Groundwater Trigger Level (mAHD)			Model Layer
	TARP Level 1	TARP Level 2	TARP Level 3	
TBC024 - HBSS 117m	282.6	-	-	1
TBC024 - HBSS 139m	282.0	281.5	281.0	5
TBC024 - BHCSS 168m	284.5	283.6	282.8	6
TBC024 - BGSS 185m	284.3	282.3	280.3	8
TBC027 - HBSS-95m	315.1	-	-	1

TBC027 - HBSS-132m	307.8	307.6	307.3	5
TBC027 - HBSS-169m	307.2	307.0	306.8	5
TBC027 - BHCS-181m	305.7	305.5	305.3	16
TBC027 - BGSS-198m	305.3	305.1	304.9	8
TBC034 - HBSS-65m	366.8	-	-	1
TBC034 - HBSS-113m	363.0	362.7	362.3	4
TBC034 - HBSS-161m	353.4	353.1	352.8	4
TBC034 - BHCS-176m	349.9	349.4	348.9	16
TBC034 - BGSS-196m	353.3	352.1	350.9	8
TBC038 – XXX*	tbc	tbc	tbc	
TBC09-HBSS-30m	tbc	tbc	tbc	1
TBC09-HBSS-75m	304.4	304.2	304.1	2
TBC09-BHCS-182m	288.0	287.4	286.8	15
TBC09-BGSS-192m	285.4	285.2	285.0	8
TBC018 - WWFM/HBSS-70m	tbc	tbc	tbc	1
TBC018 - WWFM/HBSS-117m	246.9	246.6	246.2	1
TBC018 - HBSS (lower)-164m	245.7	245.4	245.1	5
TBC018 - BHCS-179m	243.5	243.1	242.8	3
TBC018 - BGSS-198m	239.7	237.8	236.0	8
TBC032 - HBSS-95m	257.3	256.7	256.2	4
TBC032 - HBSS-131m	250.0	249.3	248.6	5
TBC032 - HBSS-168m^	261.9	261.1	260.4	5
TBC032 - BHCS-181m	237.8	228.7	219.5	6
TBC032 - BGSS-200m	238.8	208.7	178.7	8
TBC033 - HBSS-65m	279.9	279.2	278.6	3
TBC033 - WWFM/HBSS-113m	273.3	272.7	272.0	1
TBC033 - HBSS (lower)-161m	263.6	262.9	262.2	5
TBC033 - BHCS-173m^	235.4	213.8	192.3	16
TBC033 - BGSS-190m	230.2	217.7	205.2	8

* Data unavailable (tbc) = to be confirmed, ^potential issues with VWP stability but trigger levels still reported

Deep monitoring (> 200 metres)

For bores that monitor depths greater than 200 m groundwater level monitoring results will be compared to groundwater model predictions on an annual basis comparing actual groundwater levels with predictions. In the event that monitoring data suggests divergence from the predicted trends (i.e. from numerical groundwater modelling predictions), the TARP would be enacted.

Each trigger level is associated with level of deviation from modelled predicted drawdown and period of time for which this deviation is experienced:

- Normal Conditions – Observed drawdown does not exceed modelled impacts predicted drawdown by greater than 30 metres. Observed drawdown exceeds the modelled predicted drawdown by greater than 30 metres for less than three consecutive months;

- Level 1 (L1) – Observed drawdown exceeds the modelled predicted drawdown, by greater than 30 metres for greater than three consecutive months;
- Level 2 (L2) – Observed drawdown exceeds modelled predicted drawdown by more than 30 metres for a greater than 6 consecutive months; and
- Level 3 (L3) – Observed drawdown exceeds modelled predicted drawdown for 12 consecutive months or more.

Bores encompassed within this TARP, including the associated model layer, are provided in **Table 16**, with associated predicted drawdown hydrographs provided in the LW S1A – S6A Extraction Plan, Groundwater Technical Report.

Table 16 Deep VWP Sensors and associated model layers

Bore	Model Layer	Model Geology
TBC09_322	8	BUSS Mid
TBC09_343	8	BUSS Mid
TBC09_357	12	SBSS Lower
TBC09_381	10	SPCS
TBC09_391	15	Bulli Seam
TBC09_397	17	Wongawilli
TBC18_282	8	BUSS Mid
TBC18_366	8	BUSS Mid
TBC18_377	13	WBCS
TBC18_404	15	Bulli Seam
TBC18_426	17	Wongawilli
TBC18_432	17	Wongawilli
TBC20_211	8	BUSS Mid
TBC20_293	8	BUSS Mid
TBC20_375	8	BUSS Mid
TBC20_397	13	WBCS
TBC20_411	7	BUSS Upper
TBC20_434	17	Wongawilli
TBC20_439	4	HBSS Mid
TBC26_211	8	BUSS Mid
TBC26_278	8	BUSS Mid
TBC26_344	8	BUSS Mid
TBC26_409	13	WBCS
TBC26_432	15	Bulli Seam
TBC26_440	16	Eckersley
TBC26_460	16	Eckersley
TBC32_200	8	BUSS Mid
TBC32_237	8	BUSS Mid
TBC32_257	8	BUSS Mid

TBC32_294	8	BUSS Mid
TBC32_314	8	BUSS Mid
TBC33_247	8	BUSS Mid
TBC33_306	8	BUSS Mid
TBC33_363	11	SBSS Upper
TBC33_384	16	Eckersley
TBC33_408	16	Eckersley
TBC39_243	8	BUSS Mid
TBC39_299	8	BUSS Mid
TBC39_354	11	SBSS Upper
TBC39_375	16	Eckersley
TBC39_402	16	Eckersley

Bulli Coal Seam

It is expected that the TARP will exclude loggers located in the Bulli Coal Seam on the basis that as this is the target coal seam, significant depressurisation effects are expected due to dewatering of mine workings. Additionally, there are no other groundwater users of this aquifer (environmental or anthropogenic), other than mines, that warrant the need to investigate head changes in this unit. However, monitoring will be undertaken and undergo review alongside the loggers included in the TARP.

4.4.1.1.2 GROUNDWATER QUALITY

The proposed methodology for calculating trigger values for EC, pH and metals at Tahmoor South monitoring bores and private bores is presented here. The proposed TARP is provided in **Appendix G**.

EC

Electrical conductivity (EC) is a measure of salinity and is used for monitoring of changes to groundwater salinity. Baseline data has undergone review and data cleansing prior to derivation of triggers. A single trigger level will be established for each bore, as the maximum observed EC in the pre-mining/early mining record plus ten per cent of that value.

pH

Each bore has been assigned a lower and upper trigger level, to represent the natural fluctuations in pH and enable capture of groundwater changes to more basic or acidic conditions. Baseline data (pre-mining and early-mining) has undergone review and data cleansing. Triggers are based on the minimum and maximum pH values recorded in the available dataset minus/plus 1 pH unit if the max/min pH are within four pH units (otherwise, just max/min are utilised). Again, regional data will be taken into consideration.

Dissolved Metals

A single trigger level concentration for metals has been assigned to the Tahmoor South monitoring bores and the private bores. Triggers have been derived for dissolved metals and total iron (Fe).

The trigger has been set at the 95th percentile value of all available baseline data to date.

4.4.1.2 Adaptive Management via TARPs

Adaptive Management is the implementation of management strategies as required dependent on ongoing outcomes and impacts of mining. For example, if surface water losses are identified, additional management will be implemented to review this from a groundwater perspective (i.e. groundwater–surface water interaction study). Hence, adaptive management is responding to changing requirements for management based on ongoing review of data. Consequently, the two TARPs presented here have strong links to other primary TARPs and utilise the same network.

Groundwater – Surface Water Interaction

The Tahmoor South monitoring network has been developed to provide pertinent information on baseflow relationships with nested surface water and groundwater monitoring sites. Groundwater data would be reviewed alongside complementary monitoring.

This TARP defines levels of deviation in surface water - groundwater interactions from 'normal' conditions and the actions to be implemented in response to each level deviation. The instigation of this TARP will be dictated by triggers exceedances in pertinent groundwater or surface water sites requiring further investigation of groundwater – surface water interactions.

This TARP references Biodiversity Management Plan TARP – Riparian Vegetation (BMP3), which specifically defines levels of deviation in riparian vegetation condition from normal conditions and the actions required to be implemented in response to each level of deviation. The riparian vegetation can be considered a GDE with relevant Performance Measure, managed under the Riparian Vegetation TARP, supported by this TARP. TARP BMP3 will be enacted via this TARP as well as via its own specific criteria, to support investigations providing a holistic review of groundwater and surface water in relation to GDEs.

Groundwater Bores Monitoring for Thirlmere Lakes

The Thirlmere Lakes have a specific series of bores aimed at monitoring potential impacts on the Lakes resulting from longwall extraction. The network is designed to provide an early warning system of changes in groundwater conditions that may indicate a potential impact to Thirlmere Lakes, via a cross section of data between mine operations and the Lake, including the following sites:

- "Early warning" bores: GW062068, GW104659, TBC039 (sensor at 65 metres in Hawkesbury Sandstone (HBSS))
- "Thirlmere Lakes" bores: GW075409–1, GW075409–2, GW075410, GW075411 (paired with gauging station 212066) and proposed sites: P50a, P50b, P50c

Trigger levels are linked to the shallow water level and water quality triggers defined in their specific TARPs. Given the Thirlmere Lakes are considered GDEs, the relevant Performance Measure is incorporated, being;

- GDE Performance Measure: Negligible impacts including:
- Negligible changes in groundwater levels; and
- Negligible changes in groundwater quality.

4.4.2 Potential Ameliorative Actions – Private Bores

The monitoring network described above, provides water level and quality data at an adequate spatial and temporal scale to undertake investigations into potential impacts to existing groundwater users.

In accordance with Condition B26 – B29 of the Tahmoor South Domain Consent (SSD 8445), where a mining related impact has occurred at a private bore, Tahmoor Coal will implement a make good process.

Tahmoor Coal has been implementing this process during the life of Tahmoor/Tahmoor North. The process allows for bore owners to apply to Tahmoor Coal if they believe their bore's level or water quality has declined triggering an assessment into the potential cause (i.e. mining related). If it is deemed that the mine is responsible, then remedial action would be implemented, potentially deepening and/or replacing bores and wells, and/or providing an alternative water source to affected users.

The make good process would be staged by Tahmoor Coal in accordance with the proposed mining schedule and the results of predictive groundwater modelling. Contact has been made with landholders whose registered bores are predicted to incur a drawdown of greater than 2 m, as per the NSW Aquifer Interference Policy (AIP) criterion, or whose bores are at risk of subsidence related impacts. Following this initial contact with landholders, where access was granted a baseline field survey has been completed to verify bore details – location, depth, condition of bore and pump, standing water levels, groundwater quality and usage (where possible). Survey findings have been provided to the landholder so that they have the same baseline information as Tahmoor Coal. This information has provided both parties with a thorough understanding of the current bore condition and a reference point for comparison with subsequent bore assessments as mining progresses. The verified bore data has also been included in the recent update of the groundwater model.

In the event that a mining-related impact to a private bore has been confirmed and any further potential impacts are understood (based on groundwater modelling), the landholder and Tahmoor Coal would negotiate a make good agreement. This agreement would include specific make good mitigation measures and outline a potential timeframe for undertaking these measures, if required. The make good agreement would include and consider the conditions of any development consents, the provisions of the AIP and the NSW Coal Mine Subsidence Compensation Act 2017.

There are a number of make good options that may be adopted, based on the details and characteristics of an individual bore and the extent of mining-induced impacts. These mitigation measure options include:

- Bore maintenance where physical adjustments and regular maintenance of the bore(s) are required to return them to pre-mining conditions. This could include re-establishment of saturated thickness in the affected bore(s) through extending the depth of the pump, or deepening of the bore(s) to return yield to pre-mining conditions;
- Replacement of bore(s) to provide a yield at least equivalent to the yield of the affected bore prior to mining. This may be required where deepening of an existing bore is not possible (e.g. the bore has partially collapsed or the bore hole is not straight or vertical);
- Provision of access to an alternative source of water or compensatory water supply. This option may be offered while other measures are being undertaken and could include connection to the town water supply or the provision of on-site storage (e.g. dam or water tanks); or
- Compensation to reflect increased water extraction costs (e.g. due to lowering pumps or installation of additional or alternative pumping equipment).

Equivalent water supply should be provided (at least on an interim basis) as soon as practicable after the loss is identified, unless otherwise agreed with the landowner. The burden of proof that any loss of water supply is not due to mining impacts rests with Tahmoor Coal, in accordance with Condition B27 of SSD 8445.

If there is a dispute as to whether the loss of water is to be attributed to the development or the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Planning Secretary for resolution, in accordance with Condition B28 of SSD 8445. If Tahmoor Coal is unable to provide an alternative long-term supply of water, compensation will be provided to the affected landowner, to the satisfaction of the Planning Secretary.

4.5 Adaptive Management/Continuous Improvement

In accordance with Condition E4 of the Consent, where any exceedance of the criteria or performance measures outlined within this document has occurred, Tahmoor Colliery will:

a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;

b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action;
c) within 14 days of the exceedance occurring (or other timeframe agreed by the Planning Secretary), submit a report to the Planning Secretary describing these remediation options and any preferred remediation measures or other course of action; and
d) implement reasonable remediation measures as directed by the Planning Secretary

Tahmoor Coal have adopted the "Plan-Do-Check-Act" model as shown in **Figure 12**. This model will be applied to all aspects of Tahmoor Coal's environmental management and is utilised to embed the continuous improvement process in all system documents.

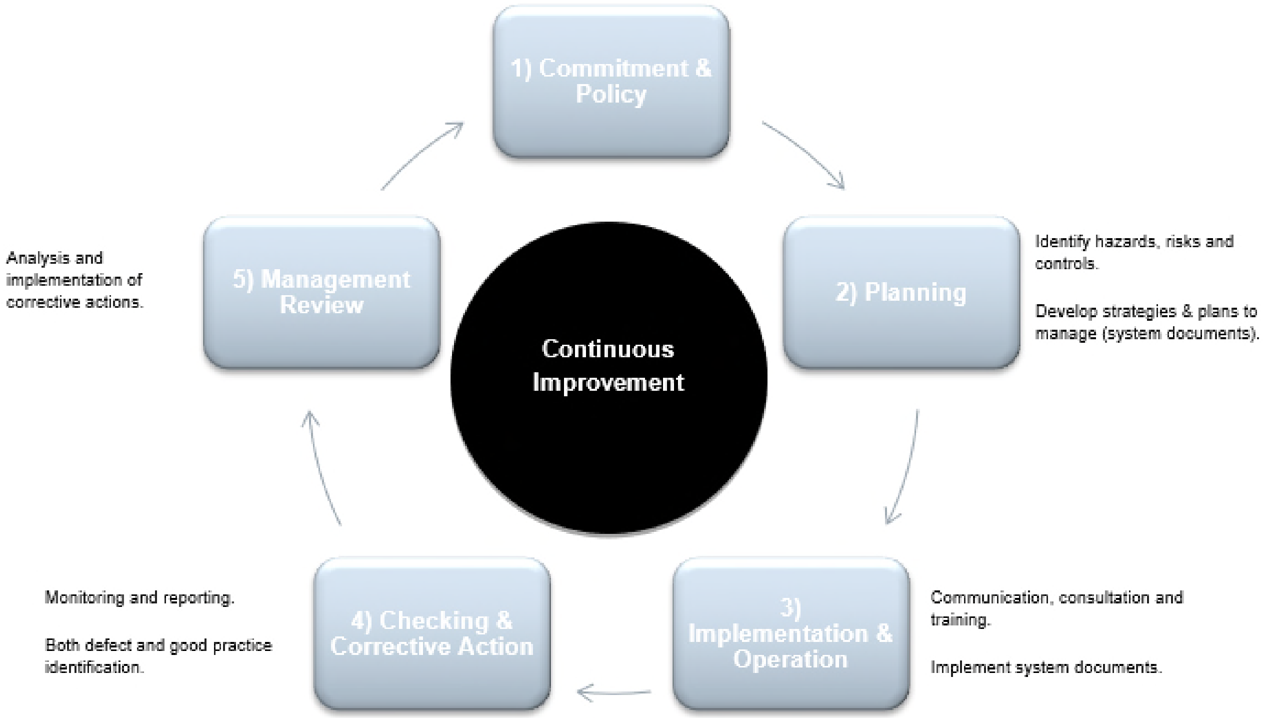

Figure 12: Continuous Improvement Model

5 Implementation and Reporting

5.1 Tahmoor Environmental Management System (EMS) Framework

The Tahmoor Environmental Management System (EMS) Framework provides the strategic context for the environmental management of Tahmoor Coal and forms part of the broader Health, Safety, Environment and Community (HSEC) management systems at Tahmoor Coal. The EMS outlines how Tahmoor Coal manages environment and community (E&C) aspects, impacts and performance. It provides a framework for the standards, plans and procedures implemented to ensure operations are managed in accordance with the ISO:14001 principles.

The objectives of the EMS are:

a) To provide an overall framework for environmental management at Tahmoor utilising the principles of ISO:14001;

b) To ensure compliance with all development consent, licences and approvals at Tahmoor Coal;

c) To detail the relationship and interactions between various operational and environmental components at Tahmoor Coal;

d) To provide effective mechanisms for external communications, maintaining a relationship with the local community; and

e) To assist Tahmoor Coal employees and contractors in administering their responsibilities regarding environmental management.

This plan will be implemented in conjunction with the EMS framework.

5.2 General Reporting

General reporting requirements in accordance with Consent Condition E13 and E14, including submitting an Annual Review by the end of March each year (or other timeframe agreed by the Planning Secretary). The Annual Review will:

a) describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;
b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the:
   i. relevant statutory requirements, limits or performance measures/criteria;
   ii. requirements of any plan or program required under this consent;
   iii. monitoring results of previous years; and
   iv. relevant predictions in the EIS (or updated and contemporary modelling, as required by agencies).
c) identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;
d) evaluate and report on:
   i. the effectiveness of the noise and air quality management systems; and
   ii. compliance with the performance measures, criteria and operating conditions of this consent;
e) identify any trends in the monitoring data over the life of the development and provide any raw monitoring data as requested by the Planning Secretary;
f) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
g) describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.

Copies of the Annual Review must be submitted to Council and relevant agencies and made available to the CCC and any interested person upon request.

5.3 Incidents

The Consent defines an incident as '*an occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance*'.

Material Harm is defined within the Consent as "harm to the environment that:

- involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or results in actual or potential loss or property damage of an amount, or
- amounts in aggregate, exceeding $10,000, (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)".

This definition excludes "harm" that is authorised under either this consent or any other statutory approval.'

Tahmoor Coal manages and responds to incidents in accordance with the following plans:

a) Emergency and Incident Manual (TAH-HSEC-232).
b) Pollution Incident Response Management Plan (TAH-HSEC-00155).
c) Notification of Environmental Pollution Incidents (TAH-HSEC-00224).

These plans have been developed to manage preparation, incident response and reporting requirements under the Protection of the Environment Operations Act 1997 (NSW).

The management plans provide roles and responsibilities, management strategies, action and response plans and record management protocols for incidents and emergencies.

A Written Incident Notification will be submitted to the Planning Secretary via the Major Projects website within seven days after Tahmoor Coal becomes aware of an incident.

Written Incident Notifications will include:

a) the development and application number;
b) details of the incident (date, time, location, a brief description of what occurred and why it is classified as an incident);
c) how the incident was detected;
d) when Tahmoor Coal became aware of the incident;
e) any actual or potential non-compliance with conditions of consent;
f) describe what immediate steps were taken in relation to the incident;
g) identify further action(s) that will be taken in relation to the incident; and
h) identify a project contact for further communication regarding the incident.

Within 30 days of the date on which the incident occurred or as otherwise agreed to by the Planning Secretary, Tahmoor Coal will provide the Planning Secretary and any relevant public authorities (as determined by the Planning Secretary) with a Detailed Incident Report.

Detailed Incident Reports will include:

a) a summary of the incident;
b) outcomes of an incident investigation, including identification of the cause of the incident;
c) details of the corrective and preventative actions that have been, or will be, implemented to address the incident and prevent recurrence; and
d) details of any communication with other stakeholders regarding the incident.

5.4 Non-Compliances

The Consent defines a non-compliance as 'an occurrence, set of circumstances or development that is in breach of the consent'.

Non-compliances or system defects detected during monitoring, inspections and audits will be managed in accordance with the Tahmoor Coal Environmental Management Framework Document (TAH-HSEC-00173), with corrective action plans developed and implemented to rectify any issues.

The Planning Secretary will be notified in writing via the Major Projects website within seven days after Tahmoor Colliery becomes aware of any non-compliance.

If a non-compliance is detected, the following steps will be followed:

a) Identify and confirm the non-compliance (i.e. review against approval criteria or condition and confirm that a non-compliance has occurred);
b) Complete internal environmental incident reporting documentation including an investigation to capture all relevant information;
c) In accordance with the relevant approval, determine what action (i.e. external reporting) is required. Specifically, determine if immediate reporting is required and to which stakeholders, or ensure that the event is captured for future reporting;
d) Following the incident investigation, develop a corrective action plan aimed at preventing future re-occurrence; and
e) Complete all required reporting and consult with relevant agencies on the corrective action plan to be implemented.

A non-compliance notification will identify the following:

a) the development and the application number,
b) the condition of consent that the development is non-compliant with
c) the way in which it does not comply and the reasons for the non-compliance (if known); and
d) any actions which have been, or will be, undertaken to address the non-compliance.

A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.

5.5 Exceedances

For the purposes of this plan, an exceedance is defined 'any instance where monitoring results show an exceedance of criterion outlined within the Consent or other regulatory instrument'.

Exceedances will be managed by Tahmoor Coal through the Contingency Plan and TARP process as outlined in **Section 4.4** and **Appendix G**.

Exceedance reporting will occur as per the response in the Trigger Actions Response Plans, with reporting to DPIE (and other relevant agencies) within 7 days of investigation completion where a TARP Level 4 has occurred.

5.6 Complaints and Disputes

Community Complaints at Tahmoor Coal are managed in accordance with *TAH-HSEC-00119-Communication and Engagement* and *TAH-HSEC-00120- Community Complaints & Enquiry Procedure*. Tahmoor Coal operates a 24-hour complaints line (1800 154 415) for receiving community complaints and other stakeholder communications. The general process detailed in *TAH-HSEC-00120- Community Complaints & Enquiry Procedure* for responding to complaints is:

a) Acknowledging all complaints and responding to the complainant within 24 hours where practicable;
b) Registering all complaint details in Cority;

c) Investigating complaints impartially considering the facts and the circumstances prevailing at the time;
d) Implementing corrective actions if required; and
e) Reporting to relevant stakeholders of investigation outcomes and corrective actions taken.

A record of all community complaints in relation to activities undertaken by the licensee must be kept in a legible form and be in accordance to Tahmoor Coal's Environmental Protection Licence (EPL) 1389.

The following information will also be kept in the event of a community complaint, as required by Section M4 in Tahmoor Coal's EPL 1389:

a) The date and time of the complaint;
b) The method by which the complaint was made;
c) Any personal details of the complainant which were provided by the complainant or a note to that effect;
d) The nature of the complaint;
e) The action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
f) If no action was taken by the licensee, the reasons why no action was taken.

These records must be kept for at least 4 years after the complaint was made and be able to be produced to any authorised officer who asks to see them.

In the event of a dispute or conflict between Tahmoor Coal personnel and a member of the community, the Tahmoor Coal E&C Manager will facilitate communication between both parties to reach a resolution, which may include a meeting with the complainant to discuss the issue.

Where relevant, negotiations will be initiated in accordance with any relevant Consent conditions. This general process is documented *in TAH-HSEC-00119- Communication and Engagement*. If a dispute cannot be resolved, the matter will be escalated to involve the site Operations Manager or General Manager as required and may involve consultation with the relevant government agency to assist in reaching a determination on the matter

5.7 Risk and Change Management

Aspects and impacts at Tahmoor Coal are considered for operational activities, legislative requirements and internal and external stakeholder views. Key environmental aspects and impacts are identified during the annual review of the Tahmoor Coal Environment and Community (E&C) Broad Brush Risk Assessment (BBRA) and the operational Life of Mine (LOM) Risk Assessment and Site Wide Broad-Brush Risk Assessment (Mine BBRA).

The purpose of the E&C BBRA is to identify significant E&C aspects and impacts across the site, the risk they pose and the controls necessary to effectively manage them. Management of potential impacts is prioritised according to the level of risk each aspect is assigned. Once all identified aspects, impacts, risks and management controls have been identified within the Annual E&C Risk Assessment, associated plans are updated accordingly.

The purposed of the Mine BBRA is to identify significant aspects and impacts of operations at a site level. Existing or proposed management controls are identified to reduce the risk of impacts on the E&C. The need for any new (or modifications to existing) approvals is also identified during this process.

The LOM Risk Assessment considers aspects and impacts of business activities at a strategic level. These risk assessments cover the life of mine risks associated with each operation. The outcomes of the LOM Risk Assessment are used in conjunction with the Tahmoor Coal E&C BBRA and Mine BBRA to develop the annual capital and operational budget and the associated work schedule.

In accordance with Tahmoor Coal's Health & Safety Management System, project and activity specific risk assessments are completed as required and include assessment of E&C risks.

5.8 Roles & Responsibilities

E&C management is regarded as part of the responsibilities of all employees and contractors at Tahmoor Coal. Specific information pertaining to the role, responsibility, authority and accountability of key personnel involved in environmental management at Tahmoor Coal is provided in **Table 17** below.

Table 17 Accountabilities

Role	Accountabilities for this document
Operations Manager	Provide adequate environmental personnel/resources for implementation of this plan and associated plans.
Environment & Community Manager	Facilitate a process of managing overall compliance with regulatory requirements and undertake external reporting for legislative non-compliances as required. Determine adequate resources and funds are available to ensure the effectiveness of this procedure; and certify compliance and adherence to this plan. Develop, implement and maintain this plan. Liaise with relevant government authorities in relation to regulatory conditions and compliance issue. Liaise with the community as required and as per the Stakeholder Engagement Strategy, including facilitation of Community Consultative Committee meetings.
All Managers	Activities under their control are to be undertaken in accordance with this plan and associated management plans and site procedures. Manage environmental controls within their jurisdiction are operated and maintained in a proper and efficient manner. Report all environmental incidents and complaints in a timely manner.

Role	Accountabilities for this document
Environmental Specialist	Responsible for coordinating environmental compliance on-site including timely completion of monitoring and reporting in accordance with internal and external requirements. Sign off on the accuracy of reports and the suitability of recommendations. Develop, implement, review and maintain this plan and system documents. Implement process for self-assessment audits. Assign persons responsible for completion of audit actions and set a due by date. Monitor that planned actions arising out of audits are implemented. Ensure all community complaints are addressed, investigated and appropriately managed as per site procedures, and reported internally as per internal requirements.
All Coordinators	Activities under their control are to be undertaken in accordance with this plan and associated management plans and site procedures. Manage environmental controls within their jurisdiction are operated and maintained in a proper and efficient manner. Report all environmental incidents and complaints in a timely manner.
All Persons	Activities under their control are to be undertaken in accordance with this plan and associated management plans and site procedures. Manage environmental controls within their jurisdiction are operated and maintained in a proper and efficient manner. Report all environmental incidents and complaints in a timely manner.

5.9 Internal Audits & Reviews

In accordance with internal company requirements, Tahmoor Coal has implemented a system for the monitoring and review of E&C performance at the site. Tahmoor Coal is to provide ongoing monitoring and regular management review of E&C performance to:

a) Confirm the adequacy and effectiveness of management plans, procedures and standards;

b) Address any identified weaknesses;

c) Share good performance and lessons learnt with other sites; and

d) Ensure ongoing compliance with all leases, licences and approvals.

Process or area specific internal audits are also conducted periodically, generally administered by the General Manager E&C, focussing on the following areas:

a) Air quality;

b) Water management;

c) Erosion and sediment control; and

d) Statutory approvals.

These audits may be conducted by consultants on behalf of Tahmoor Coal, by Liberty GFG employees or may be self-assessments conducted by Tahmoor Coal personnel. Audit results and corrective actions are recorded in Cority and assigned to responsible personnel for completion within appropriate timeframes.

5.10 Independent Environmental Audit

In accordance with Conditions E15 – E20 of the Consent, Tahmoor Coal will complete Independent Environmental Audits of the development at the frequencies determined within DPE’s Independent Audit Post Approval Requirements (2020), and outlined below in **Table 18**.

Table 18 Independent Audit Frequencies

Phase	Initial Independent Audit	Ongoing Independent Audit Intervals
Construction	Within 12 weeks of the commencement of construction	At intervals, no greater than 26 weeks from the date of the initial Independent Audit or as otherwise agreed by the Secretary.
Operation	Within 26 weeks of the commencement of operation	At intervals, no greater than 3 years or as otherwise agreed by the Secretary.
Closure /Rehabilitation	Within 52 weeks from notifying of suspension/ceasing of operations	At intervals no greater than 1 year or as otherwise agreed by the Secretary.

The audits will assess:

a) Environmental performance of the Mine;

b) Compliance with the requirements of all relevant:

   i. Development consents;

   ii. Mining leases;

   iii. Exploration Authorisations; and

   iv. Site environmental protection licence

The audit will also assess:

a) Environmental assessments; and

b) Plans and programs required by above approvals.

The audit will review the adequacy of the following requirements under the abovementioned approvals:

a) Strategies;

b) Plans; and

c) Programs

The audit will recommend appropriate measures and corrective actions to improve environmental performance at Tahmoor Coal. Audit results and corrective actions are recorded in Cority and assigned to responsible personnel for completion within appropriate timeframes.

5.11 Employee & Contractor Training

Environmental training for Tahmoor Coal employees and contractors is conducted in accordance with the Environment & Community Training Needs Analysis, which Tahmoor Coal manages through the Scenario Training Database. General environmental awareness training is provided to all employees and contractors annually through a generic visitor induction and the SafeCoal training session scheduled by the Tahmoor Coal Health, Safety & Training Department.

6 Review and Improvement

6.1 Plan Audit

Audits of the Groundwater Management Plan are to be conducted in consultation with the Plan owner and nominated individuals and shall focus on the content and implementation.

Audits on the content shall consist of a determination of understanding of the Groundwater Management Plan by the individual's allocated responsibility under this plan.

Audits on the implementation shall consist of reviews of the safe working procedures and risk assessments developed to ensure safe operation of this Groundwater Management Plan, they may also involve discussions with personnel involved in the management plan to determine understanding and compliance.

Should an audit of this Groundwater Management Plan determine that a deficiency is evident in the content or implementation; a corrective action must be developed and implemented. Actions will be assigned to a nominated individual and tracked in Cority.

Tahmoor Coal is responsible to verify that the nominated corrective action has been implemented by way of a follow up audit.

Any changes to the Groundwater Management Plan are to be managed and communicated to all personnel in line with the Change Management Process.

6.2 Plan Review

This ***Groundwater Management Plan*** will be reviewed:

Event based: in accordance with Condition E7 (a) of the Consent, a review will be required within 3 months of any incident, event or finding that identifies an inadequacy in the Groundwater Management Plan risk assessment or associated documents to continue to effectively manage the identified hazard; a change to the workplace itself or any aspect of the work environment, a change to a system of work, a process or a procedure; or

Time based: in the absence of regular event-based reviews and in accordance with Condition E7 (b-e) of the Consent, this plan will be reviewed within three months of:

b) the submission of an Annual Review under Condition E13;
c) the submission of an Independent Environmental Audit under Condition E15;
d) (the approval of any modification of the conditions of this consent (unless the conditions require otherwise); or
e) notification of a change in development phase under Condition A19;

If deemed appropriate, external service providers may be included in the review process. All reviews are to be documented.

7 Document Information

Relevant legislation, standards and other reference information will be regularly reviewed and monitored for updates and will be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

7.1 Access to Information

Information pertaining to Tahmoor Coal's general environmental performance against internal targets and external approvals criteria is reported to the community via the mine website and Tahmoor Coal's Community Consultative Committee (TCCCC). Examples of reports to government agencies include:

a) Environmental Protection Licence Annual Return (submitted to Environment Protection Authority);

b) Annual Review (submitted to Department of Planning & Infrastructure, Council, TCCCC etc.); and

c) Independent Environmental Audit (submitted to Department of Planning & Infrastructure).

These reports are prepared in accordance with relevant guidelines and *TAH-HSEC-00119- Communication and Engagement* and are published on Tahmoor Coal's website in accordance with *TAH-HSEC-00221- Website Management Procedure.*

7.2 Related Documents

Related documents, listed in the below table, are internal documents directly related to or referenced from this document.

Table 19 Related Documents

Number	Title
TAH-HSEC-00375	Tahmoor Coal Environmental Management Strategy
TAH-HSEC-00119	Communication and Engagement
TAH-HSEC-00120	Community Complaints & Enquiry Procedure
TAH-HSEC-00221	Website Management Procedure
TAH-HSEC-00031	Community Development Plan
TAH-HSEC-00381	Social Impact Management Plan
TAH-HSEC-00039	Stakeholder Engagement Plan
TAH-HSEC-00232	Emergency and Incident Manual

7.3 Reference Information

Reference information, listed in the below table, is information that is directly related to the development of this document or referenced from within this document.

Table 20 Reference Information

Title
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SLR, 2021f, Groundwater Modelling Plan, prepared for Tahmoor Coal, September 2021.

SLR, 2021h, Tahmoor South, Groundwater Monitoring Plan, prepared for Tahmoor Coal, October 2021

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Thomann, J.A., Werner, A. D., Irvine, D.J, and Currell, M. J., 2020, Adaptive management in groundwater planning and development: A review of theory and applications, Journal of Hydrology, Vol. 586, July 2020

8 Change Information

Table 21 Full details of the document history are recorded in the document control register, by version

Version	Date Reviewed	Review team (Consultation)	Change Summary
1.0	02/11/2021	Michelle Grierson, Natalie Brumby, Thomas O'Brien, April Hudson	New Document
2.0	17/06/2022	Natalie Brumby	Reviewed in accordance with Condition E7(b) of SSD 8445 following submission of the 2021 Annual Review to DPE. Reviewed in accordance with condition E7(e) of SSD 8445 following change in development phase under condition A9 (construction commencement on 16th May 2022).
3.0	18/10/2022	Sharron Hulbert (SLR Consulting), Natalie Brumby	Reviewed in accordance with Condition E7(c), (d) and (e) following an Independent Environmental Audit (10th August 2022), following the approval of any modification (Mod 1 approved 19th July 2022) and following the commencement of first and second workings (18th Oct 2022) of the Consent SSD 8445.
4.0	30/06/2023	Sharron Hulbert (SLR Consulting), Natalie Brumby	Reviewed in accordance with Condition E7(b) following the submission of an Annual Review (31st March 2023) and Condition E7(c) following the submission of an Independent Environmental Audit (2nd June 2023).
5.0	13/09/2023	Sharron Hulbert (SLR Consulting), Natalie Brumby	Reviewed in accordance with Condition E7(d) following the approval of any modification (MOD 2 - 13th June 2023) of the Consent SSD 8445 and to incorporate recommendations from approved MOD 2 Development Consent. Section 4, Figures 6, 7 and 11, Tables 5, 7, 8, 11 and 14 updated.

APPENDIX A – Experts Endorsement

Planning, Industry & Environment

Ms Zina Ainsworth
Manager Environment and Community
SIMEC Mining
2975 Remembrance Drive
Tahmoor NSW 2573

16/08/2021

Dear Ms. Ainsworth

Tahmoor South Coal (SSD-8445)
Management Plan Experts Endorsement

I refer to your request (SSD-8445-PA-2) for the Secretary's approval of suitably qualified persons to prepare the Management Plans for the Tahmoor South Coal (SSD-8445).

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Consequently, I can advise that the Secretary approves the appointment of the following experts to prepare the following Management Plans:

Management Plan	Suitably Qualified Person
Noise Management Plan	Michelle Grierson – Senior Environmental Scientist Umwelt Australia Pty Ltd Katie Teyhan (Technical Reviewer) - Associate Acoustics Manager Newcastle EMM
Spontaneous Combustion Management Plan	Michelle Grierson – Senior Environmental Scientist Umwelt Australia Pty Ltd
Water Management Plan	Camilla West - Senior Water Resources Scientist Tony Marszalek - Director and Principal Water Resources Engineer Hydro Engineering & Consulting Pty Ltd
Groundwater Management Plan	Will Minchin – Hydrogeologist Maxime Philibert - Hydrogeologist SLR Consulting
Biodiversity Management Plan	Luke Baker - Team Leader Ecology Niche Environment and Heritage
Rehabilitation Strategy	Michelle Grierson – Senior Environmental Scientist Umwelt Australia Pty Ltd
Traffic Management Plan	Michelle Grierson – Senior Environmental Scientist Umwelt Australia Pty Ltd
Social Impact Management Plan	Amanda Bateman – Community Liaison Specialist Tahmoor Coal Pty Ltd

It is noted that it was proposed that Michelle Grierson – Senior Environmental Scientist Umwelt Australia Pty Ltd was proposed to prepare the Air Quality and Greenhouse Gas Management Plan. Given the significance of the technical aspects associated with air quality and greenhouse gas emissions at the project, the Department requests that a technical specialist be proposed to work with Ms Grierson to prepare this Air Quality and Greenhouse Gas Management Plan. Please provide further details of the proposed air quality expert by lodging further details via the portal.

If you wish to discuss the matter further, please contact Wayne Jones on (02) 6575 3406.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Secretary

APPENDIX B – Tahmoor South Groundwater Monitoring Plan

TAHMOOR SOUTH

Groundwater Monitoring Plan

Prepared for:

Tahmoor Coal
2975 Remembrance Driveway
Tahmoor
NSW 2574

SLR Ref: 665.10010.00407-R01
Version No: -v3.0
November 2021

SLR

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@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 Tahmoor Coal (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
665.10010.00407-R01-v3.0	16 November 2021	Sharon Hulbert	Will Minchin	Ines Epari
665.10010.00407-R01-v2.1	16 November 2021	Sharon Hulbert	Will Minchin	Ines Epari
665.10010.00407-R01-v2.0	22 October 2021	Sharon Hulbert	Will Minchin	Ines Epari
665.10010.00407-R01-v1.1-v1.0	21 October 20218	Sharon Hulbert	Will Minchin	Ines Epari

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DOCUMENT REFERENCES

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1 Introduction

A broad network of groundwater monitoring bores has been installed across the Tahmoor Coal project domain including Tahmoor Western Domain, Tahmoor, Tahmoor North and the recently approved Tahmoor South area. The intent of this plan is to optimise monitoring and water management for the Tahmoor South project.

The groundwater monitoring program has been developed with consideration of the outlined consent conditions in Schedule 2 of SSD 8445 and the Tahmoor Commitments as they pertain to groundwater. Additionally, consideration of existing users, both environmental (i.e. GDEs) and anthropogenic (existing users) has been made.

2 Commitment and Policy

2.1 Background

The Groundwater Monitoring Plan (GWMP) is a component of the overarching Groundwater Management Plan that informs the Water Management plan for the Tahmoor South Operations. The Water Management Plan is one of a series of Environmental Management plans that together for the Environmental Management Framework for Tahmoor South.

2.1.1 Historical mining operations at Tahmoor

Figure 1 shows the location of the historical and proposed operations, located approximately 3 km south of Tahmoor and approximately 80 km south-west of Sydney, New South Wales.

The Tahmoor Mine is located in the central region of the Southern Coalfield, which has numerous historical and operational underground coal mines. These include the Bulli Seam Operations [‘BSO’] (historical Appin and West Cliff mines), Tower Mine, Russell Vale Mine, and Cordeaux Mine. Within the footprint of the Tahmoor Mine the Bulli Coal seam is around 375-500 metres (m) deep, consistent with majority of other mines in the Southern Coalfield.

Tahmoor and Tahmoor North

Mining of the Bulli Coal seam at Tahmoor Mine began in 1979, with bord and pillar mining to 1986 in three areas. From 1987, 31 longwalls have been completed in the areas designated ‘Tahmoor’ and ‘Tahmoor North’. Longwall 31 was completed on 17/08/2018.

Tahmoor Western Domain

Mining of the Bulli Seam in the Tahmoor Western Domain via four longwalls. Longwall W1 extraction commenced on 15 November 2019 and was completed on 6 November 2020 and LW W2 extraction commenced on 7 December 2020 and was completed on 17th June 2021. The total length of longwall extracted at LW W1 was 1,869 m and at LW W2 was 1,685 m. Longwall W3 extraction commenced on the 12th September 2021. Extraction of Longwall W4 is set to commence in early 2022.

2.1.2 Proposed Tahmoor South operations

The Project is an underground coal project targeting the Bulli Coal seam coal resource within CCL 716 and CCL 747. It is an extension to the existing Tahmoor Mine operations as described above (2.1.1).

Mining will occur via the longwall method, similar to that in previous Tahmoor mining domains, with an expected maximum output of 4 million tonne per annum (MtPA) per annum (PA) run-of-mine (ROM) coal and an operational life of approximately 13 years (to approximately 2035).

The Project consists of 12 longwalls, separated into the ‘A’ and ‘B’ blocks. The panels are numbered 101A – 106A and 101B – 106B, as shown in Figure 2.

2.1.3 Existing Conditions

Characterisation of the existing conditions is provided in previous assessment documents (i.e. HydroSimulations, 2020; EMM, 2020), including;

- Topography;
- Climatic condition (rainfall, evaporation)
- Surface drainage (i.e. lakes and reservoirs, rivers and creeks)
- Designated areas (e.g. National Parks, declared Water Supply Catchments);
- Geology; and
- Hydrogeological conceptualisation (i.e. aquifers, groundwater flow, recharge/discharge processes).

A discussion of potential receptors is provided here to present how monitoring is designed to support the recognition of potential impact via extraction operations. However, detailed review of the groundwater interaction with each is not provided in this report and can be found in the existing aforementioned documents.

2.2 Objectives of the GMP

The objectives of the GMP are to:

- Outline the existing monitoring network;
- Provide details of the historical baseline monitoring data;
- Establish a monitoring network suitable for capturing the required baseline (pre-mining), operational and post-mining groundwater data;
- Detail the integrated groundwater monitoring strategy.

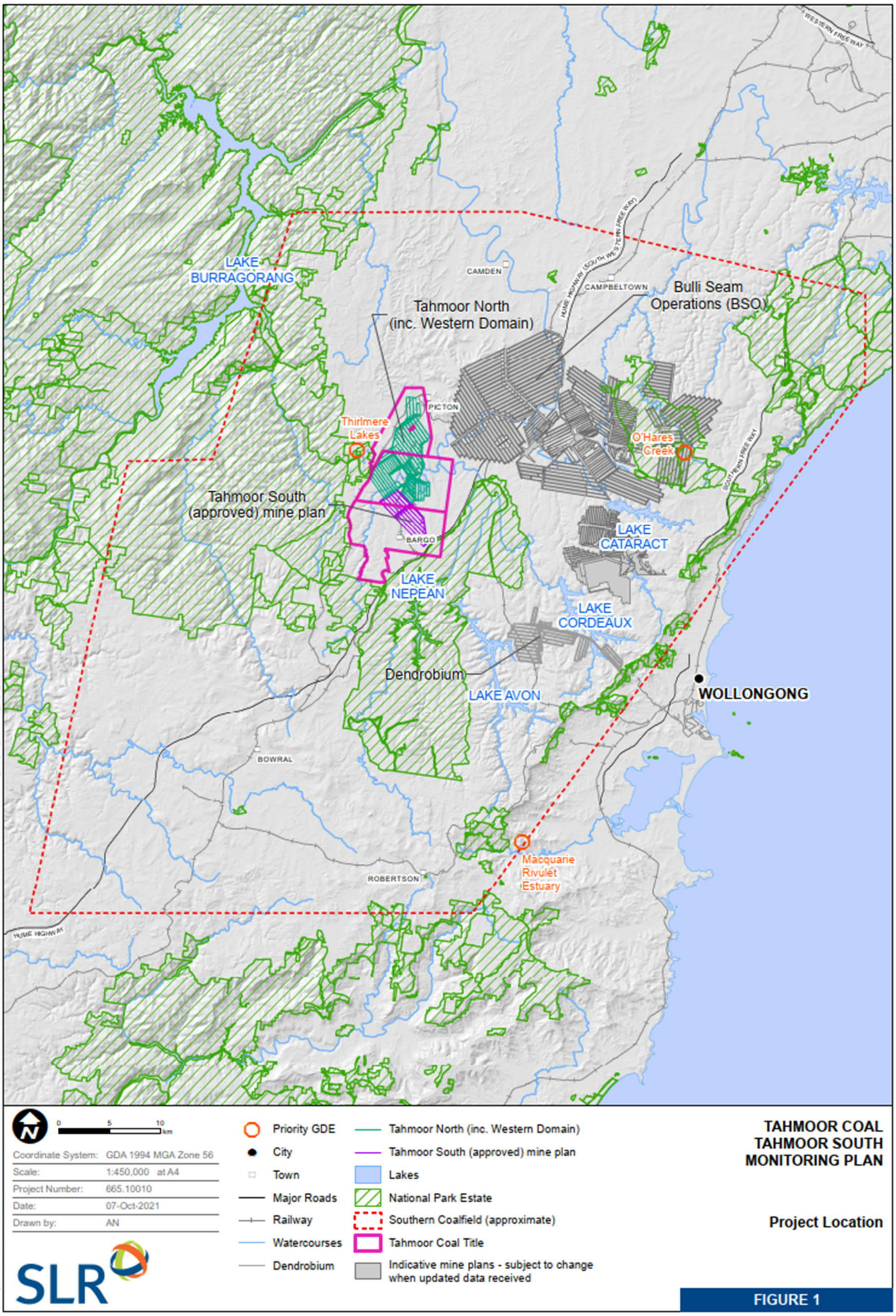


Figure 1 Regional Locality Map

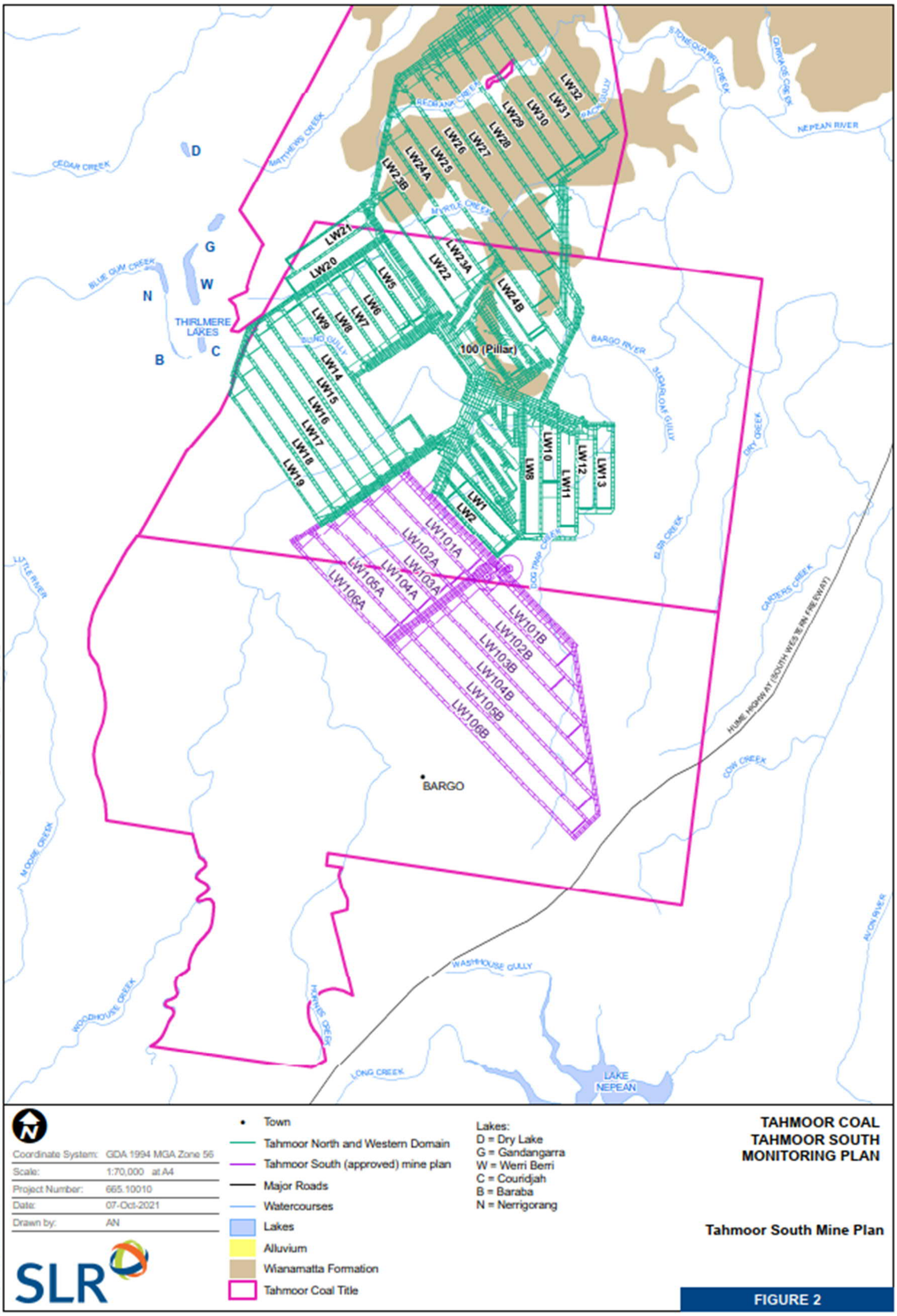


Figure 2 Proposed Tahmoor South extraction footprint

3 Proposed Monitoring Regime

The proposed regime includes monitoring of the following elements:

- Groundwater levels and aquifer depressurisation;
- Groundwater quality;
- Impacts on surface water features;
- Impacts on groundwater dependent ecosystems; and
- Potential effects on private bores.

The following sections outline the basis for the proposed monitoring program (Section 3.2), a summary of the sites that could be used as 'Reference Sites' to provide a baseline comparison to understand future groundwater behaviour in relation to Tahmoor South operations (Section 3.3), and an overview of the program (sites, parameters, timing) is provided in Section 3.3.

3.1 Auxiliary monitoring network

To support the interpretation of groundwater monitoring data it is often considered in relation to other monitoring data. This network, although not directly part of the groundwater monitoring program, is critical to the ongoing review and understanding of the hydrogeological regime. Additional monitoring networks that support the groundwater monitoring program include:

- Surface water monitoring; and
- Climatic monitoring.

A brief description of each has been provided her for completeness.

3.1.1 Surface Water Monitoring

The surface water monitoring plan is currently being developed by hydrological consultants HEC. The existing and proposed monitoring surface water monitoring network for Tahmoor South is provided in Figure 3. A total of 34 surface water monitoring sites currently exist, with an additional 26 proposed.

Groundwater – surface water connectivity refers to the direction and magnitude of flow between the water resources located above and below ground. These interactions can have significant implications for both water quantity and quality and changes in either component can directly or indirectly impact the other. Assessing groundwater-surface water interactions is often complex and difficult. Commonly, groundwater level measurements compared to watercourse stage height are used to define the hydraulic gradient and the direction of flow:

- a 'gaining' watercourse is one that is receiving flow ('baseflow') from the underlying groundwater system; and
- a 'losing' watercourse is one where water is moving from the stream into the underlying groundwater system.

Flow measurements at various points along the stream can be used to estimate the magnitude of gains or losses with the underlying aquifer. Consequently, understanding and monitoring the baseline regimes, and any potential changes, is critical to management of the hydrological cycle as a whole.

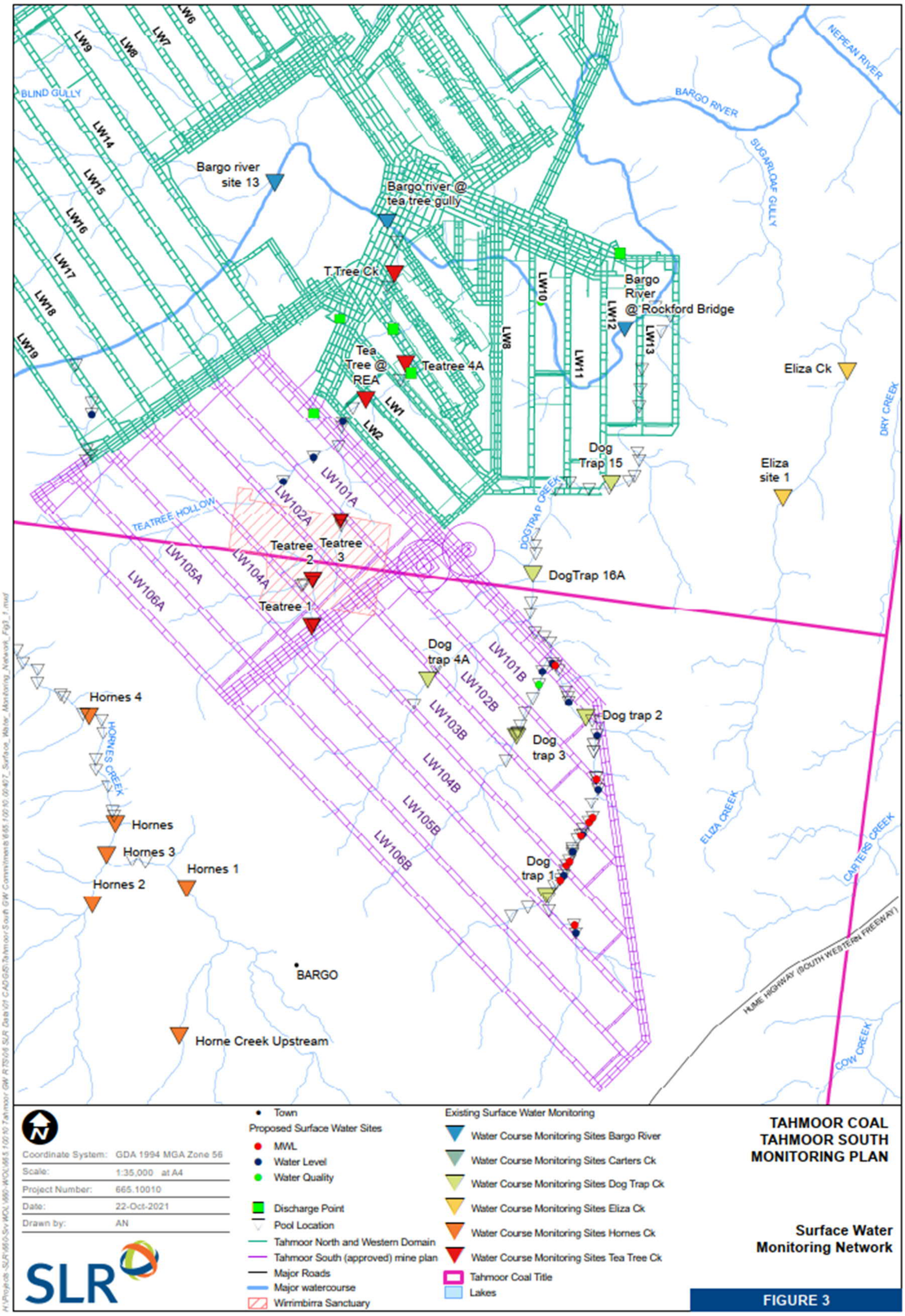


Figure 3 Proposed surface water monitoring regime

3.1.2 Climatic Monitoring

The recorded rainfall is considered critical to the monitoring regime, as the data is used to differentiate between natural groundwater level fluctuations resulting from rainfall induced recharge and discharge and minimum (or other abstraction related) induced variations.

For the shallow unconfined aquifers there is typically a direct and often immediate relationship between rainfall and groundwater level. For the deeper aquifers, this relationship may still hold, with temporal delays due to lagging response.

Rainfall trends, plotted as cumulative residual deviation (CRD), are plotted with groundwater data to inform cause-and-effect analysis of groundwater fluctuations.

Tahmoor Coal installed a Rainfall Station on site in 2019 to provide local data. The closest Bureau of Meteorology (BoM) weather station is located at Picton (Station ID: 068052), to the north-east of the Project. SILO Grid point data at latitude: -34.15, longitude: 150.60 is typically used to assess long-term climate trends in the vicinity of the Project. This dataset is interpolated from quality checked observational timeseries data collected at nearby stations by the BoM.

3.2 Basis for Monitoring

The groundwater monitoring program has been developed considering the approved Tahmoor South mine plan in relation to key receptors in the area, and the conceptual and numerical modelling of how longwall extraction at Tahmoor South could affect these receptors. The key receptors identified are surface watercourses that may have a component of baseflow dependency, potential groundwater dependent ecosystems (inclusive of Thirlmere Lakes), anthropogenic users (bores and the Special Areas) as well as there being a need to monitoring the baseline hydrogeological conditions.

Surface water monitoring for levels, flow and water quality occur as part of the surface water monitoring regime. An integrated monitoring network is desired to establish and monitor groundwater – surface water connectivity and potential impacts of groundwater responses to mining on surface water. The proposed surface water monitoring sites are also presented on Figure 3. With respect to watercourses, Tahmoor South will mine under Teatree Hollow and Dogtrap Creek, and longwalls would be approximately 600-1000 m from sections of Bargo River, Hornes Creek, Eliza Creek, Cow Creek and Carters Creek.

SLR have obtained recent mapping of groundwater dependence of terrestrial ecology (DPIE, 2018) and used this to assist in targeting groundwater monitoring for areas identified as having a higher likelihood of groundwater dependency than others (Figure 4). We have also considered existing structural mapping by government and by SIMEC, as well as the available preliminary findings from the Thirlmere Lakes Research Program.

Existing users have been identified and considered when defining the monitoring regime. Figure 5 presents the location of private bores in relation to the Tahmoor South proposed operations. Although a selection of the private bores themselves will be monitored for baseline condition prior to extraction, additional and dedicated monitoring bores will supplement this data to provide a relevant spatial distribution of baseline hydrogeological conditions.

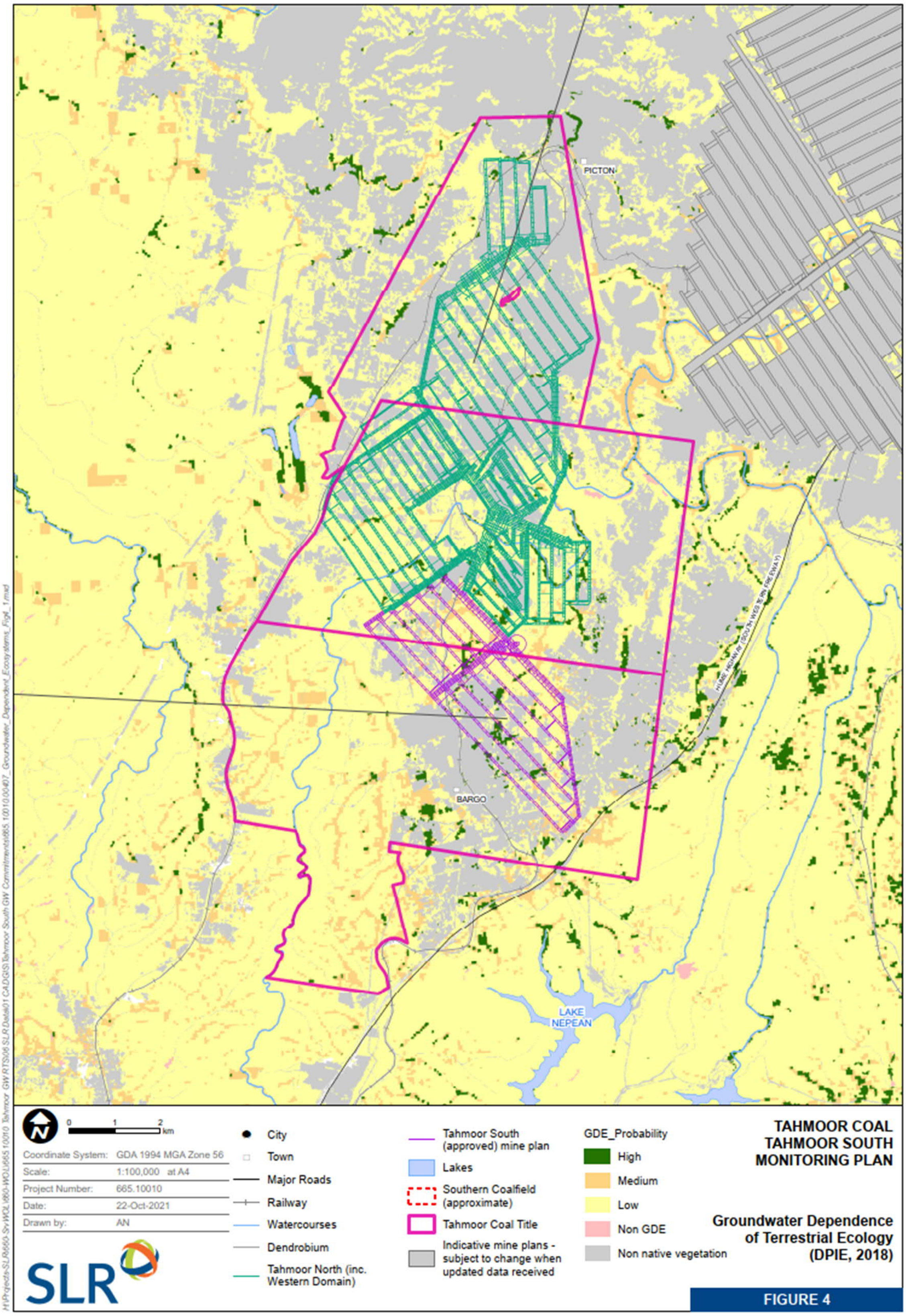


Figure 4 Groundwater Dependence of Terrestrial Ecology (DPIE, 2018)

These key receptors are listed in Table 1 with a summary of the parameters to be sampled and the sites for sampling in order to monitor for potential effects or impacts. The justification for site selection at or near these receptors is described in the following paragraphs. Proposed sites have been given a preliminary identifier or name for the purpose of planning – these names will be replaced in future once confirmed and installed.

Table 1 Key receptors near Tahmoor South and relevant groundwater monitoring

Receptor / Aspect	Parameter	Data Collection Frequency	Bore IDs
Teatree Hollow	Water Quality (field parameters)	Monthly	TBC032. Proposed sites: Teatree1, Teatree2, Teatree4, Teatree6, Teatree7
	Water Quality (speciation)	Quarterly	
	Water levels	Monthly (for manual dips and data downloads where loggers installed)	
Dogtrap Creek	Water Quality (field parameters)	Monthly	TBC018. Proposed sites: Dogtrap1, Dogtrap2, Dogtrap3, Dogtrap4, Dogtrap5, Dogtrap6, Dogtrap7, Dogtrap8, Dogtrap9, Dogtrap10, Dogtrap11, Dogtrap12
	Water Quality (speciation)	Quarterly	
	Water levels	Monthly (for manual dips and data downloads where loggers installed)	
Other watercourses	Water Quality (field parameters)	Monthly	TBC026, TBC027, TBC033, TBC038. Proposed sites: Bargo1, BargoTrib1, BargoTrib2, Hornes1.
	Water Quality (speciation)	Quarterly	
	Water levels	Monthly (for manual dips and data downloads where loggers installed)	
Existing Users (bores)	Water levels / pressures	Monthly (for manual dips and data downloads where loggers installed)	TBC009, TBC018, TBC019B, TBC020, TBC027, TBC032, TBC039, Proposed sites: Teatree7, Dogtrap8
	Water Quality (field parameters)	Quarterly	
	Water Quality (speciation)	Monthly/quarterly (adaptive monitoring based on current longwall mining extent – quarterly for background, and monthly when longwall mining in within 1.5km).	
Wirrimbirra Sanctuary (on Teatree Hollow)	Water Quality (field parameters)	Monthly	Existing heritage site: BRE_600_pa19 Proposed sites: Teatree4, Teatree5, Teatree6,
	Water Quality (speciation)	Quarterly	
	Water levels	Monthly (for manual dips and data downloads where loggers installed)	
Thirlmere Lakes	Water levels / pressures	Monthly (for manual dips and data downloads where loggers installed)	NSW govt: GW075409-1 & -2, GW075410, GW075411.
	Water levels / pressures	Monthly (for manual dips and data downloads where loggers installed)	TBC039.

Receptor / Aspect	Parameter	Data Collection Frequency	Bore IDs
	Water levels / pressures Water Quality (field parameters)	Monthly	Proposed: Thirlmere1, Bargo1.
Special Areas	Water levels / pressures	Monthly (for manual dips and data downloads where loggers installed)	TBC038, TBC039, GW075409-02.
	Water Quality (field parameters) Water Quality (speciation)	Monthly (for manual dips and data downloads where loggers installed)	Proposed: Cow1
Cumulative effects (re: Bulli Seam Operations mine)	Water levels / pressures	Monthly (for manual dips and data downloads where loggers installed)	TBC026

A summary of the basis for the proposed sites and how they relate to each receptor is described in greater detail in the following sections and in Appendix A.

3.2.1 Watercourses above longwalls – Teatree Hollow and Dogtrap Creek

- As at Tahmoor North, a series of shallow piezometers are proposed to monitor groundwater levels and identify potential drawdown in the near surface along watercourses (or as close as possible).
- In general, shallow groundwater monitoring sites are proposed to be co-located with a subset of the surface water monitoring sites proposed by HEC (Tahmoor's consultant hydrologists).
- Additional focus has been placed on sites where mapping (DPIE, 2018, as per Figure 4) suggests greater potential for groundwater dependence.

3.2.2 Watercourses outside longwall footprint

- As at Tahmoor North, shallow piezometers are proposed to monitor groundwater levels and identify potential drawdown in the near surface along watercourses (or as close as possible). However, given the distance to longwalls, and location of existing monitoring sites, existing sites will be predominantly used to monitor groundwater levels around these watercourses.
- In some instances, additional shallow groundwater monitoring sites will be located near to surface water monitoring sites, to provide information on possible groundwater-surface water interaction.

3.2.3 Groundwater Users (bores)

A series of private groundwater users have been identified within the potential impact zone of Tahmoor South. Section provides further detail on the individual bores, with their locations presented on Figure 5.

- Groundwater monitoring sites have been selected to monitor the area near or between clusters of registered bores, focussing on bores where drawdown is predicted to be greatest (HydroSimulations; 2020a, 2020b), and noting that the Hawkesbury Sandstone aquifer is by far the predominant source of groundwater in this region.
- Where monitoring exists, this has been identified to be part of the long-term monitoring program, but some additional sites are recommended to improve spatial coverage.

- In addition, bore TBC026, which is located approximately halfway between Tahmoor South and the BSO Mine will be used to monitor for the possible cumulative effects of Tahmoor and BSO mines on groundwater pressures in this area, where there is a cluster of private bores.

3.2.4 Thirlmere Lakes (High Priority GDE/World Heritage Site)

Thirlmere Lakes is a group of waterbodies in the Greater Blue Mountains World Heritage Area that includes Lake Gandangarra, Lake Werri Berri, Lake Couridjah, Lake Baraba and Lake Nerrigorang.

- Based on discussion with agencies regarding the Thirlmere Lakes Research Program (TLRP), due for completion in late 2021, no new groundwater monitoring sites were installed for that program. We propose then to continue to obtain and assess data from the existing NSW government monitoring bores at the lakes (4 bores).
- Given the TLRP's preliminary findings that historical effects of Tahmoor Mine on Thirlmere Lakes hydrology have likely been very small compared to climate effects, we do not consider that monitoring network requires a significant extension to focus on potential effects from Tahmoor South (given the distance to those longwalls). We do suggest that a new site ("Thirlmere1") be drilled with three open standpipe piezometers near to the lakes, and another approximately halfway between there and the longwalls ("Bargo1").

3.2.5 Wirrimbirra Sanctuary

The Wirrimbirra Sanctuary was established in 1963 as a memorial to the biologist and naturalist David Stead through the efforts of his wife, Dr Thistle Stead, conservationist and writer, and their friends. Wirrimbirra is Wildlife Refuge No 163, declared in 1967 under section 68 of the repealed NSW National Parks and Wildlife Act 1967. It currently operates as a conservation area and learning centre under the name "Australian Wildlife Sanctuary". Figure 6 depicts the property boundary for Wirrimbirra Sanctuary in relation to longwalls.

The *Statement of Heritage Impact* (SoHI) of the Wirrimbirra Sanctuary was undertaken by EMM (2020) and identified a large earthen "well" (BRE_600_pa19) located in the west of the Lot on the edge of the train line, excavated directly into the ground through the shale bedrock (Figure 7). Measuring approximately 4 m (north/south) by 3 m (east/west) with depth estimated to be over 2 m. Reporting postulates that it is likely that the feature fills via groundwater and/or rain but the lack of lining within the feature suggests it is unlikely to have functioned as a well. It is more likely a waterhole for stock or a form of water storage from the construction or early period of the railway. The SoHI did not recommend broad groundwater monitoring but did recommend monitoring of the well (BRE_600_pa19) (EMM, 2020 & SIMEC, 2020).

- Groundwater monitoring is proposed to be located near Wirrimbirra Sanctuary on Teatree Hollow and located above LW103A and, primarily, LW104A to provide local baseline groundwater data and monitor for potential impact to the Sanctuary and Teatree Hollow.
- Additionally, the well (Bre_600_pa19) will be reviewed for suitability for inclusion into the monitoring program.

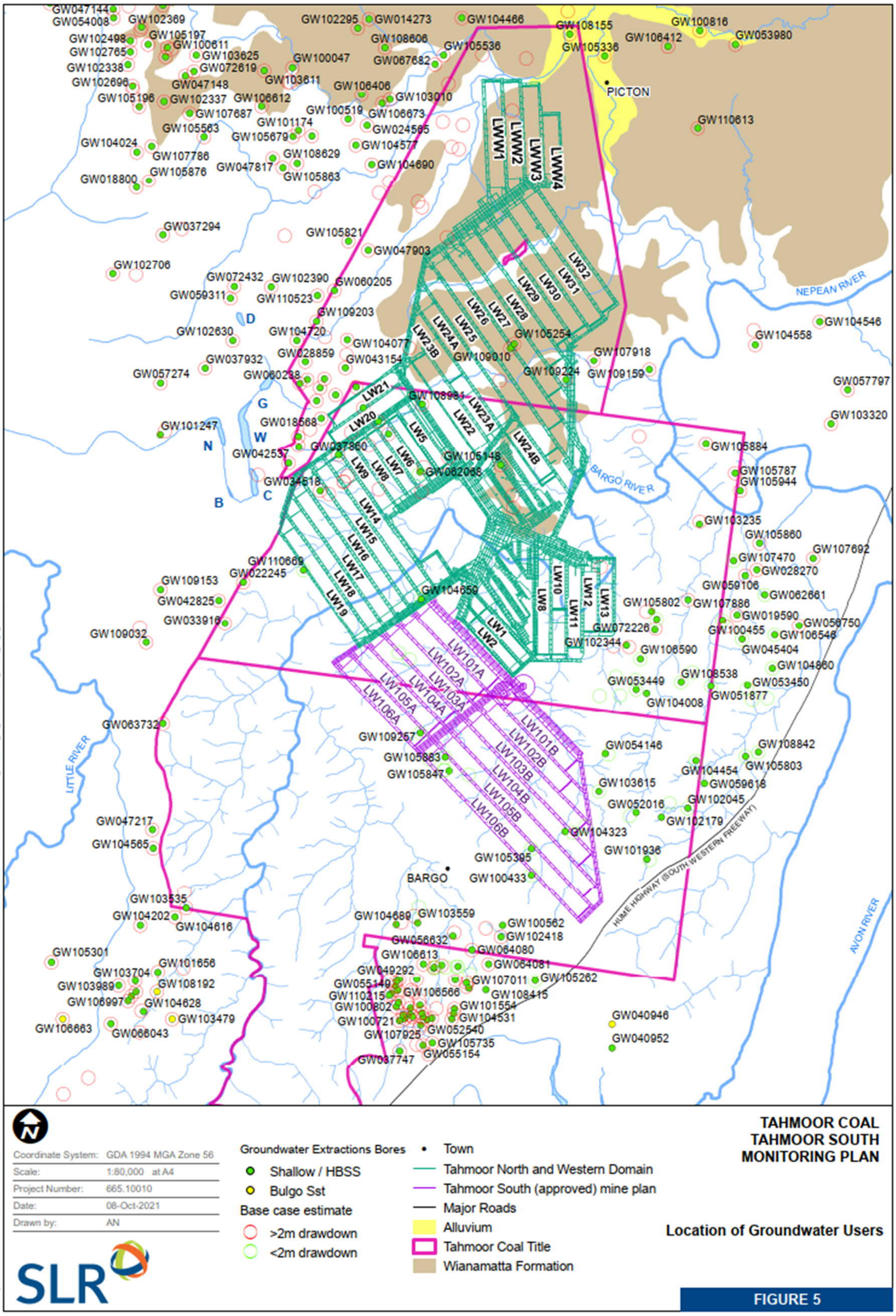


Figure 5 Private Users

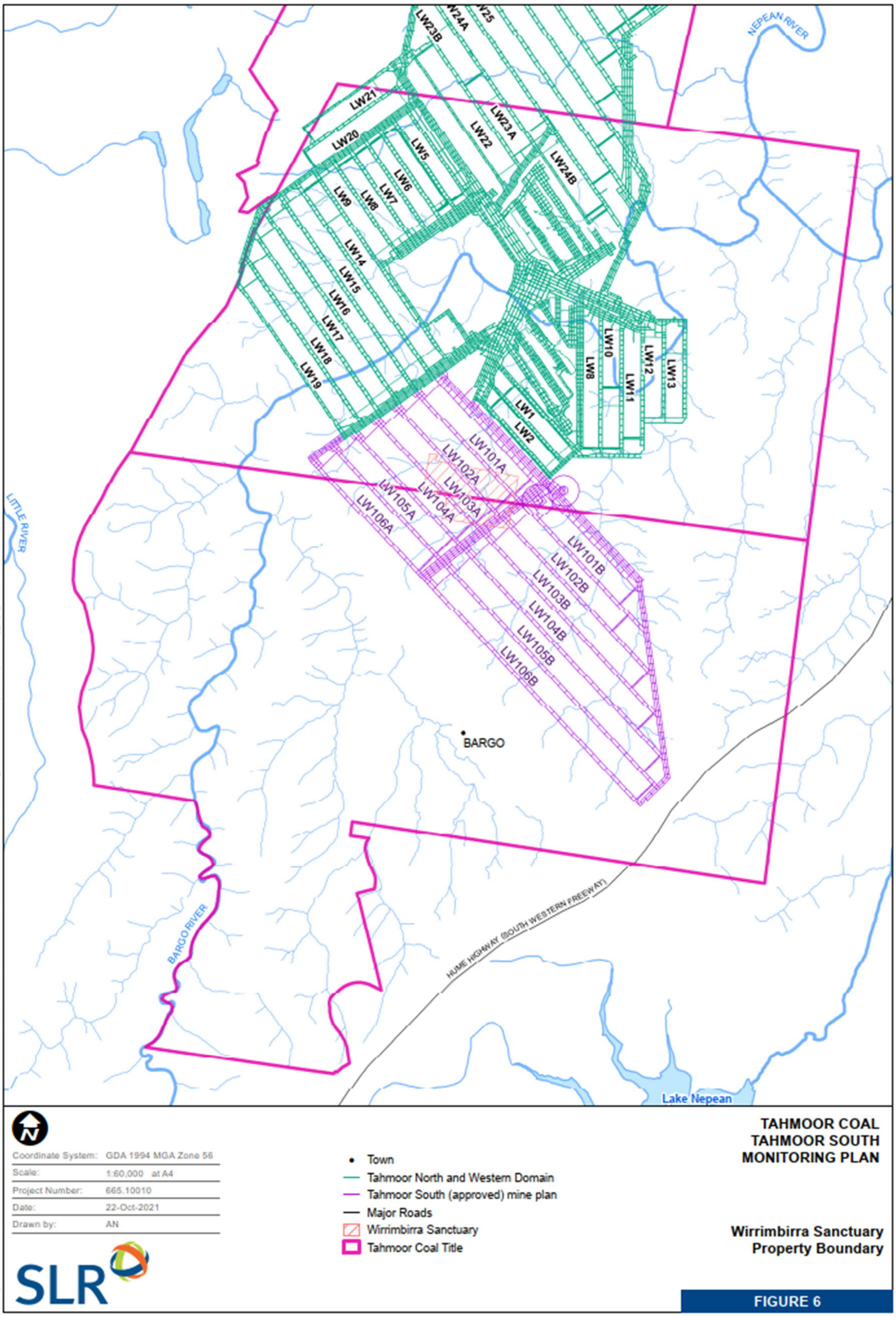


Figure 6 Wirrimbirra Sanctuary property boundary

Figure 7 Well feature identified as BRE_600_pa19 (EMM, 2020)

3.2.6 Special Areas (WaterNSW water supply catchments)

WaterNSW has responsibility for the quality of water in Greater Sydney's drinking water catchment areas. Special Areas are lands that surround water supply storages with the aim of protecting water supply and are declared under the Water NSW Act 2014 (WNSW Act). The Metropolitan Special Area is located to the east of Tahmoor South (protecting the Upper Nepean water supply scheme), while the Warragamba Special Area is located to the west of historical Tahmoor/Tahmoor North mining areas (around Lake Burragorang) (shown on Figure 1)

For the most part, existing bores will be used to monitor for changes in groundwater levels or pressures that might be attributed to mining. COVID lockdown is currently preventing access to repair one of these sites. Additional sites will also be installed to improve this monitoring.

These bores are located in areas near to where Tahmoor South longwalls are in close proximity to the Metropolitan Special Area (to east of the mine) and in areas where the Warragamba Special Area (to the west of the mine) is nearest Tahmoor South longwalls.

3.2.7 Post-mining Groundwater Levels and Quality

The Tahmoor Commitments state that "Re-install at least one bore in the footprint of a Tahmoor North longwall (e.g. at TNC029) to monitor post-mining groundwater level and groundwater quality". It is recommended that monitoring of WD02 for post-mining water levels and P9d/P10c/GW104090 for water quality are a suitable to meet the post-mining monitoring requirements.

3.3 Proposed Monitoring Network

The existing network includes both standpipe bores and multi-level VWP bores and cover major hydrogeological units and are broadly distributed across the project area (Figure 8). To supplement this network, an additional series of open standpipes (OSP) have been proposed to monitor potential receptors as described above. The overall proposed network is a combination of the existing network and proposed new sites and is summarised in Table 3 and shown on Figure 8.

The standpipe piezometers can be used for monitoring water levels manually or with an automated datalogger, as well as for collection of water sampled for groundwater quality monitoring purposes. The VWPs are grouted and therefore can only be used for monitoring groundwater pressures, but do allow for multiple instruments to be installed at different depths within a single borehole.

3.3.1 Piezometer Status Review

A number of existing sites in Table 3 have been identified as requiring some review and action (e.g. replacement of loggers, improving housing to prevent water ingress into the logger). This process is underway, but not yet complete. In the event that key piezometers/loggers at sites cannot be repaired (or they fail in future), the need for a replacement will be assessed and a recommendation made. This will be presented to agencies.

3.3.2 Reference Sites

In order to carry out Before-After-Comparison-Impact (BACI) analysis, appropriate Reference Sites should be included in a monitoring program. SLR has identified four possible sites which will be reviewed for suitability post completion of the piezometer status review (Table 2). Other sites not listed below may be used as Reference sites for specific analytical tasks, depending on their proximity to mining or other features at the time of analysis, but in general those identified below will be used.

Table 2 Tahmoor South Groundwater Reference Sites

Parameter	Site	Justification
Groundwater level/pressure	TBC024	1,700 m south of LW106A
Groundwater level/pressure	TBC027	2,400 m southwest of LW106B
Groundwater level/pressure	TBC034	2,500 m southwest of LW106A
Groundwater level/pressure	TBC038	1,200 m east of LW105B, but 5 km southeast of A-longwalls.

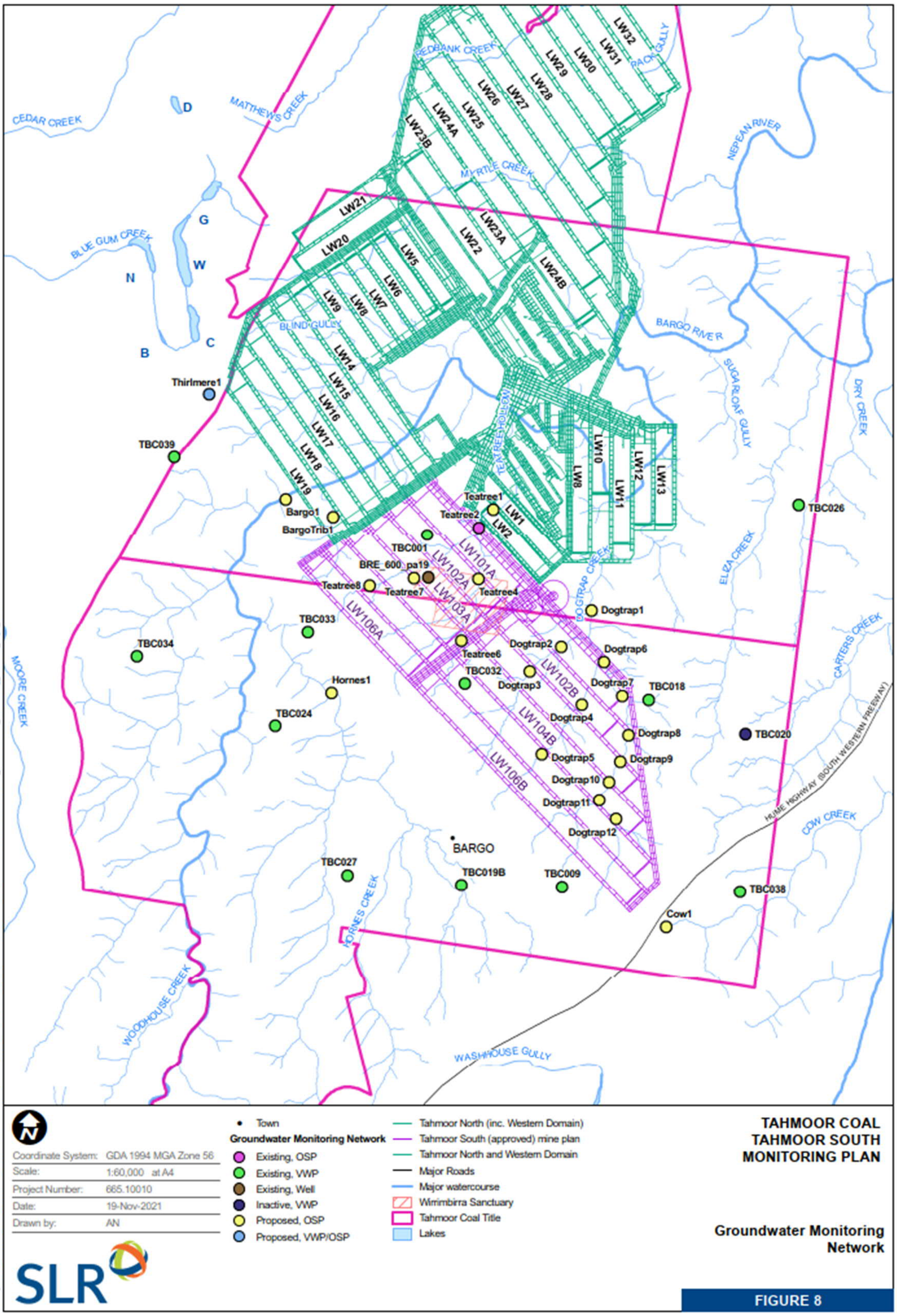


Figure 8 Groundwater Monitoring Network

Table 3 Proposed Groundwater Monitoring Network

Bore ID	Easting	Northing	Status	Targeted Aquifer*	Type#	Depth
TBC001	276749	6206665	Inactive	BUCO, WWCO	VWP	VWPs: 398, 429 m
TBC009	278511	6202058	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 30, 75, 140, 182, 192, 322, 343, 357, 381, 391, 397m
TBC018	279645	6204509	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 70 (inactive), 11, 164, 179, 198, 282, 366, 377, 404, 426, 432m
TBC020	280909	6204059	Inactive	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 70, 105, 141, 194, 211, 293, 375, 397, 401, 434, 439m
TBC019B	277200	6202080	Planned	HBSS, BGSS?	VWP	to be drilled to mid-Bulgo (~250m)
TBC024	274763	6204163	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 117, 139, 168, 185, 240, 295, 350, 371, 384, 391m
TBC026	281603	6207068	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, LRSS, WWCO	VWP	VWPs: 95, 135, 176, 191, 211, 278, 344, 409, 432, 440, 460m
TBC027	275708	6202210	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 95, 132, 169, 181, 198, 253, 306, 362, 384, 396, 400m
TBC032	277244	6204725	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 95, 131, 168, 181, 200, 237, 294, 371, 397, 437m
TBC033	275194	6205395	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 65, 113, 161, 173, 190, 247, 305, 363, 384, 408m
TBC034	272956	6205076	Existing	HBSS, BHCS, BGSS, WBCS, BUCO, WWCO	VWP	VWPs: 65 (inactive), 113 (inactive), 161(inactive), 176, 196, 245, 294, 343, 364, 382m
TBC038	280838	6201995	Inactive	HBSS, BHCS, BGSS, BUCO, WWCO	VWP	VWPs: 95, 129, 163, 175, 192, 249, 306, 364, 385, 408m
TBC039	273445	6207688	Existing	HBSS, BACS, BGSS	VWP	VWPs: 65 (inactive), 106, 147, 172, 188, 243, 299, 354, 375, 402m
Thirlmere1	273900	6208500	Proposed	HBSS x2, BGSS x 1	VWP/OSP	Approx. 20, 35, 65 metres
Bargo1	274900	6207140	Proposed	HBSS x2, BGSS x1	OSP	Approx. 20, 35, 65 metres
BargoTrib1	275520	6206910	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Cow1	279875	6201540	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Hornes1	275500	6204600	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Teatree1	277615	6207010	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Teatree2	277424	6206769	Existing	HBSS	OSP	Approx. 20, 35, 65 metres
Teatree4	277420	6206090	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Teatree6	277200	6205280	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Teatree7	276580	6206100	Proposed	HBSS	OSP	Approx. 20, 35 metres, + 80m
Teatree8	276000	6206000	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Dogtrap1	278900	6205680	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Dogtrap2	278500	6205200	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Dogtrap3	278090	6204880	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap4	278770	6204450	Proposed	HBSS	OSP	Approx. 20, 35 metres.

Bore ID	Easting	Northing	Status	Targeted Aquifer*	Type#	Depth
Dogtrap5	278250	6203800	Proposed	HBSS	OSP	Approx. 20, 35 metres.
Dogtrap6	279060	6205000	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap7	279300	6204560	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap8	279380	6204040	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap9	279275	6203700	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap10	279125	6203440	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap11	279000	6203200	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
Dogtrap12	279220	6202950	Proposed	HBSS	OSP	Approx. 20, 35, 65 metres
BRE_600_pa19	276764	6206108	Existing	HBSS	Well	<2m

** WNFM – Wianamatta Group, HBSS – Hawkesbury Sandstone, BHCS – Bald Hill Claystone, BGSS – Bulgo Sandstone, SPCS – Stanwell Park Claystone, SCSS – Scarborough Sandstone, WBCS - Wombarra Claystone, CCSS – Coal Cliff Sandstone, BUCO– Bulli Coal Seam, WWCO – Wongawilli Coal Seam*

 # VWP – Vibrating Wire Piezometer, OSP – Open Stand-pipe

In addition to the monitoring bores described above are a series of piezometers at the pit-top and near the Reject Emplacement Area (REA). These are relatively close to the Tahmoor South domain. These are described in Table 4 and presented on Figure 9. The piezometers are not associated with the regional aquifers (i.e. Hawkesbury sandstone) but rather constructed in shallow sediments and the REA and serve the following purposes:

- Pit Top piezometers are utilised to determine if the storage dams are leaking.
- REA piezometers are utilised to determine if there is any Acid Mine Drainage leaching the dumps

The current network is considered adequate monitor these entities and consequently no additional monitoring bores are proposed here.

Table 4 Reject Emplacement Area (REA) Piezometers

Bore ID	Easting	Northing	Status	Targeted Aquifer	Type	Depth
REA1	278362.3	6207826.8	Active	REA	OSP	54.8
REA2	278441.2	6206332.2	Active	REA	OSP	58
REA3	277820.7	6206453.4	Active	REA	OSP	41
REA4	277650.8	6206835.2	Active	REA	OSP	57.5
REA5	277424.2	6206769.0	Active	REA	OSP	7.2
REA6	278643.3	6207214.8	Active	REA	OSP	46.3
REA7	278035.1	6207307.3	Active	REA	OSP	43
PitTop1	277357.6	6207494.9	Active	pit-top	OSP	55.04
PitTop2	277396.0	6207663.2	Active	pit-top	OSP	6.85
PitTop4	276872.2	6207331.6	Active	pit-top	OSP	33.7

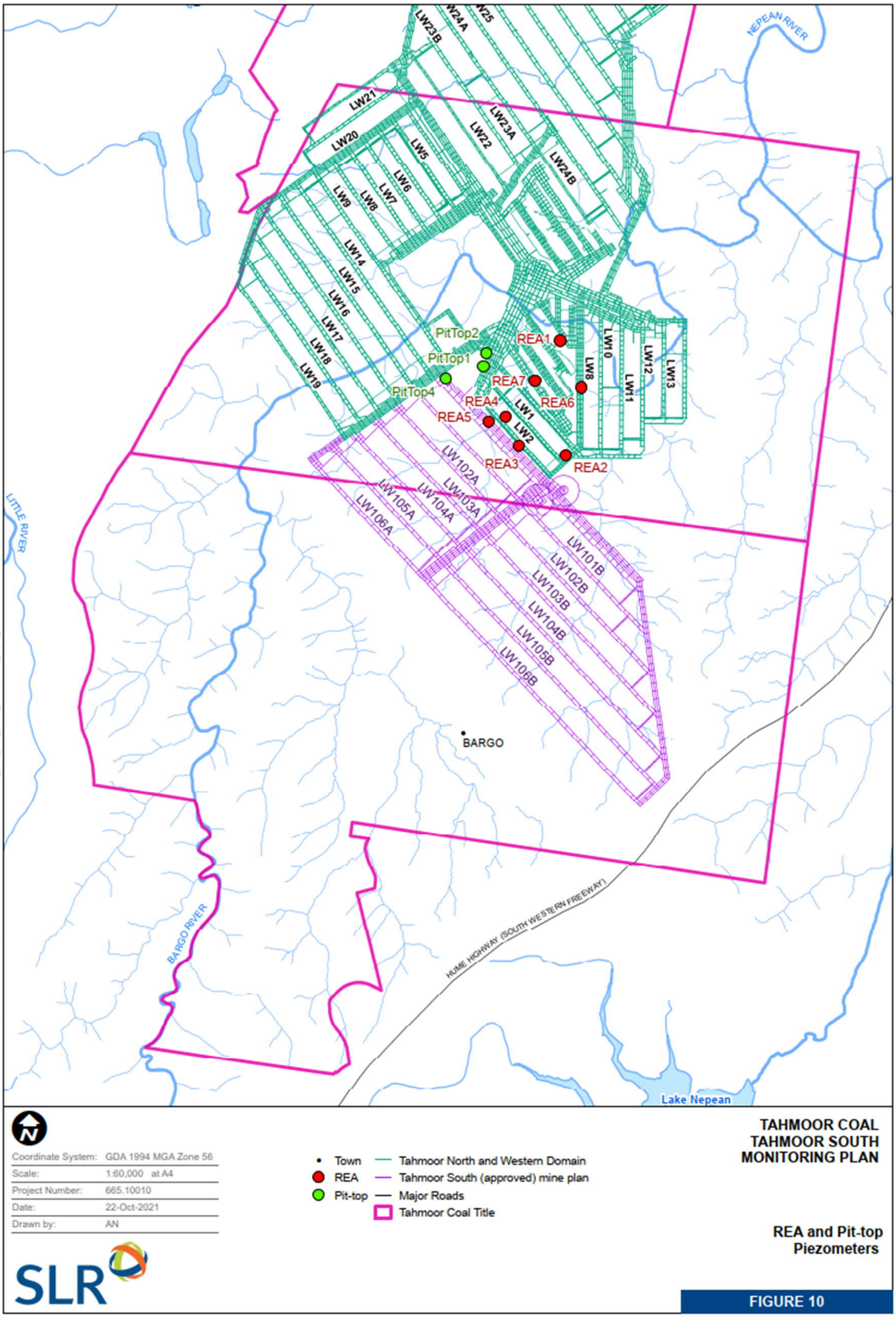


Figure 9 REA Piezometers

3.3.3 Groundwater Level/Pressure Monitoring

For most monitoring sites, 24 months or more of baseline data will be obtained (as per the AIP), however there are some, i.e. those near to LW 101A (the Teatree bore series), where mining will likely occur prior to 24 months of data being obtained. In this case, monthly data will be collected to maximise the baseline record.

Groundwater level data should be collected on a monthly basis, or where loggers are installed, downloaded monthly. Prior to commencement of extraction monthly data collation is suitable to determine baseline aquifer conditions.

During extraction, Tahmoor Coal has demonstrated responsiveness to variability in groundwater levels, that may be resultant of mining, via adaptive management practices. The frequency of monitoring may be varied in consultation with DPIE or advisory panels (or similar) as required. Post-mining monitoring will be undertaken at a frequency to be assessed once mining is complete.

The existing bores, when operational, have been routinely monitored for water pressure. Tahmoor Coal is currently in the process of reinstating the network to full operational capacity and will continue to monitor.

The REA and pit-top piezometers have data loggers installed recording water levels every 12 hours, with data downloaded on a quarterly basis. Water pressure in the VWPs (when operational) is recorded every 12 hours with data downloaded on a quarterly basis.

Hydrographs available to date are provided in Appendix B, shown with cumulative rainfall deficit (CRD). Hydrographs for the shallow pit-top and REA piezometers indicate a strong correlation with rainfall trends. Pressures from VWPs typically are not responsive to rainfall, although subdued trends are observed in the shallower sensors in TBC032 and fluctuation in pressure levels are also observed in TBC027.

3.3.4 Groundwater Quality

Establishing baseline groundwater quality data prior to commencement of extraction will occur via routine groundwater sampling for field and laboratory analysis. In order to maximise baseline data, monthly sampling will be undertaken to establish a strong baseline and understanding of potential seasonal variations for the first 12 months with a reassessment of frequency at the end of this period. It is proposed that total and dissolved metals are analysed for a period of 6 months of baseline collection to inform a review and final decision regarding suitability of the metal suite going forward (i.e. continue with total and dissolved, a combination, etc). Frequency of monitoring may be reduced at some sites post this period, dependent on intent and location (i.e. those more pertinent to the B-block, and not intended to be mined before 2024 may only require quarterly sampling).

Collection of field parameters will occur monthly, inclusive of;

- pH;
- Electrical Conductivity – EC (µS/cm);
- Total Dissolved Solids – TDS (mg/L).

A full suite of groundwater chemistry will be sampled monthly, inclusive of:

- Major ions: Ca, K, Na, Mg, F, Cl, SO_4;
- Total phosphorus and total nitrogen;

- Total alkalinity as $CaCO_3$, HCO_3, CO_3, DOC; and
- Total and dissolved metals: (Fe, Mn, Cu, Pb, Zn, Ni, Al, As, Se, Li, Sr, Co, Ba).

Sampling will be undertaken in accordance with the standards as outlined in Section 3.3.5, typically, each piezometer / bore will be purged prior to sampling until pH and salinity measurements stabilise, which usually involves removal of at least three bore volumes of water. Samples will be collected, appropriately preserved, kept on ice and transported under chain of custody documentation to arrive at the laboratory within appropriate holding times.

As with monitoring of water levels/pressures, the frequency of monitoring and the parameters to be monitored may be varied in consultation with regulators, during extraction as per adaptive management strategies. It is proposed that quarterly sampling may be suitable post-establishment of baseline conditions (24 months or more, at most sites, but 12 months of sampling at some sites near to LW 101A), with adjustments in frequency made as extraction progresses.

The frequency of post mining monitoring will be reassessed after mining is complete as it may be possible, depending on results, to lengthen the intervals.

3.3.5 Monitoring Standards

Groundwater monitoring will be undertaken in accordance with the relevant Australian Standards legislation and EPA approved methods for sampling, including (but not limited to);

- NSW DECC (2004) *Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales*.
- AS/NZS 5667.1:1998 *Water Quality – Sampling – Guidance on the Design of Sampling Programs, Sampling Techniques, and the Preservation and Handling of Samples*.
- AS/NZS 5667.11:1998 *Water Quality - Sampling - Guidance on Sampling of Groundwaters*.

3.4 Groundwater Extraction Monitoring

Groundwater pumped from all sumps in the mine workings is currently, and will continue to be, monitored by means of flow meters fitted to pipelines recording pumping times and rates. This water reporting to the underground workings and sumps may include groundwater seepage inflows, supply inflows (potable supply and for operations), and some re-circulation.

Operational water balance reviews will continue to be performed monthly collating groundwater extractions, as well as imported water to inform on-site water management. Such a system has been in operation at Tahmoor since 2009 (13 years) and will continue for the life of Tahmoor South. Advice from SIMEC is that the volume of groundwater extracted from Tahmoor South is monitored via "shaft 3". The total volumetric flux monitoring provides data on the total groundwater inflow to all workings, where dewatering of Tahmoor North/Western Domain workings will cease soon after LW W4 is complete (in 2022). This will mean that inflow to Tahmoor South workings will be the primary component of all the groundwater inflow.

3.5 Longwall fracturing investigations

Pre-mining and post-mining investigation boreholes, which facilitate acquisition of geotechnical and groundwater-related data are proposed for the middle of LW101A and one other location above the A-longwalls (likely to be LW104A, but dependent on land access), as well as LW101B and one other location above the B-longwalls. At each installation, the hole will be packer tested, run geophysical and downhole camera and have VWPs installed (proposed three sensors in the HBSS and three in the BGSS).

Co-ordinates have not been proposed for these sites here, rather just the general location (i.e. first hole to be central of LW101A) as land access constraints are unknown and are to be investigated by Tahmoor Coal.

The installation of the first Height of Fracturing (HoF) hole is to occur at least 4 months prior to commencement of extraction of LW101A to obtain baseline data. However, SLR recommend that for the LW104A HOF hole, the pre-mining hole be installed prior to the preceding longwall (e.g. installed during LW102A for the purpose of understanding pre-mining conditions at LW104A).

4 Private Bores

A number of private bores have been identified within the potential impact zone of Tahmoor South (Figure 5). Groundwater modelling indicates 52 bores that may experience a potential impact, in the form of groundwater level drawdown exceeding 2 metres, resultant from extraction operations. A detailed survey of these private bores will be undertaken to ascertain details on the current bore condition (i.e. operational, not in use, destroyed, decommissioned, etc), and groundwater conditions (water levels and quality). The preliminary bore survey will aim to capture baseline data and can be completed in stages dependent on the proximity to the longwalls and commensurate with the extraction plan (i.e. A-block extracted first).

A summary of all the identified private bores is provided in Appendix C. Where possible, ongoing monitoring of private bores will be undertaken on a quarterly basis, inclusive of water levels and the full hydrogeochemical suite as described in Section 3.3.4. The frequency of monitoring can be modified depending on the proximity to the active longwall. However, it should be noted, that landowners pumping their own bores, as well as the interference effects from other landholder groundwater use, can significantly affect standing water levels in a bore without any influence from mining or subsidence. Whilst all efforts will be made to monitor private bores, the monitoring network has been developed to capture regional groundwater conditions that can act as a proxy for landholder bores to infer level of impact (Section 3.2.3).

5 Tahmoor South Commitments

The Tahmoor South Commitments are issued by the regulators providing a list of site-specific requirements to be met by Tahmoor Coal. A detailed review of the Commitments Conditions (the Conditions) was undertaken, and all aspects pertaining to groundwater monitoring are summarised in Appendix D, with a comment stating how they are being addressed in the proposed monitoring program.

6 Summary

This Groundwater Monitoring Plan has been developed to provide a monitoring network sufficient to:

- Identify potential receptors (e.g. private groundwater users/bores, watercourses, GDEs, drinking water catchments) and provide suitable placement and construction of groundwater bores, both VWPs and OSPs, to allow identification of variations in groundwater conditions to:
  - Establish baseline groundwater conditions prior to commencement of extraction;
  - Monitor for variation in groundwater conditions that could be the result of longwall extraction and that may impact said receptors.
- Understand private groundwater users and allow for assessment of potential impacts to inform make-good strategies (to be developed in the Groundwater Management Plan, informed by the monitoring network).
- Augment the surface water monitoring network near to watercourses in order to understand potential groundwater-surface water interaction, and monitor for mining-related effects on this.
- Address the requirements of the Tahmoor South Commitments issued by regulators.

A total of 40 groundwater monitoring sites are proposed comprising both VWP and OSPs to monitor both water level/pressure and water quality.

7 Forward Works Plan

The installation of the network is designed commensurate to data requirements and panned extraction. It is understood the extraction will commence with the A-series, incorporating six longwalls.

Table 5 provides a summary of the priority of the proposed network for installation, in order to assist Tahmoor Coal with developing the forward works plan. Given the A-block is to undergo mining prior to commencing the B-block, the installation works could be divided into programs, considerate of the timing of commencement of each block and the desire to obtain 24 months of baseline data where possible.

Table 5 Potential timing of proposed network installation

Site ID	Priority	Proposed Timing
Thirlmere1	3	A-block
Bargo1	2	A-block
BargoTrib1	2	ASAP
Cow1	2	pre B-block (2 years prior)
Hornes1	3	A-block
Teatree1	1	ASAP
Teatree2	1	ASAP
Teatree4	1	ASAP
Teatree6	1	ASAP
Teatree7	1	ASAP
Teatree8	2	ASAP
Dogtrap1	2	pre B-block (2 years prior)
Dogtrap2	2	pre B-block (2 years prior)
Dogtrap3	1	pre B-block (2 years prior)
Dogtrap4	1	pre B-block (2 years prior)
Dogtrap5	2	pre B-block (2 years prior)
Dogtrap6	1	pre B-block (2 years prior)
Dogtrap7	1	pre B-block (2 years prior)
Dogtrap8	1	pre B-block (2 years prior)
Dogtrap9	1	pre B-block (2 years prior)
Dogtrap10	1	pre B-block (2 years prior)
Dogtrap11	1	pre B-block (2 years prior)
Dogtrap12	1	pre B-block (2 years prior)
TNC029	1	ASAP

Each of the required HoF holes should be installed a minimum of 6 months prior to extraction of the underlying longwall. The exception to this is the HOF bore for LW104A should be installed during LW102A, to monitor for conditions prior to the adjacent longwall being extracted).

8 References

Department of Planning, Industry and Environment (DPIE), 2018. Spatial Layer of HEVAE Vegetation Groundwater Dependent Ecosystems Value in NSW. https://datasets.seed.nsw.gov.au/dataset/hevae-vegetation-groundwater-dependent-ecosystems-in-nsw

EMM 2020, Tahmoor South Project: Wirrimbirra Sanctuary – Statement of Heritage Impact, prepared for Tahmoor Coal Pty Ltd by EMM Consulting Pty Ltd.

HydroSimulations/SLR, 2020a. Tahmoor South - Amended Project Report: Groundwater Assessment. Report HS2019/42 (v4), August 2020.

HydroSimulations/SLR, 2020b. Tahmoor South Project - Second Amendment Report: Groundwater Assessment. Report 665.10010.00005, 28 July 2020.

SIMEC, 020, Tahmoor South Project: Response to agency feedback on Second Project Amendment Report, letter addressing NSW Department of Planning, Industry and Environment, dated 14 September 2020.

APPENDIX A

Summary of Proposed Monitoring Sites

Table A-1 Proposed sites commentary

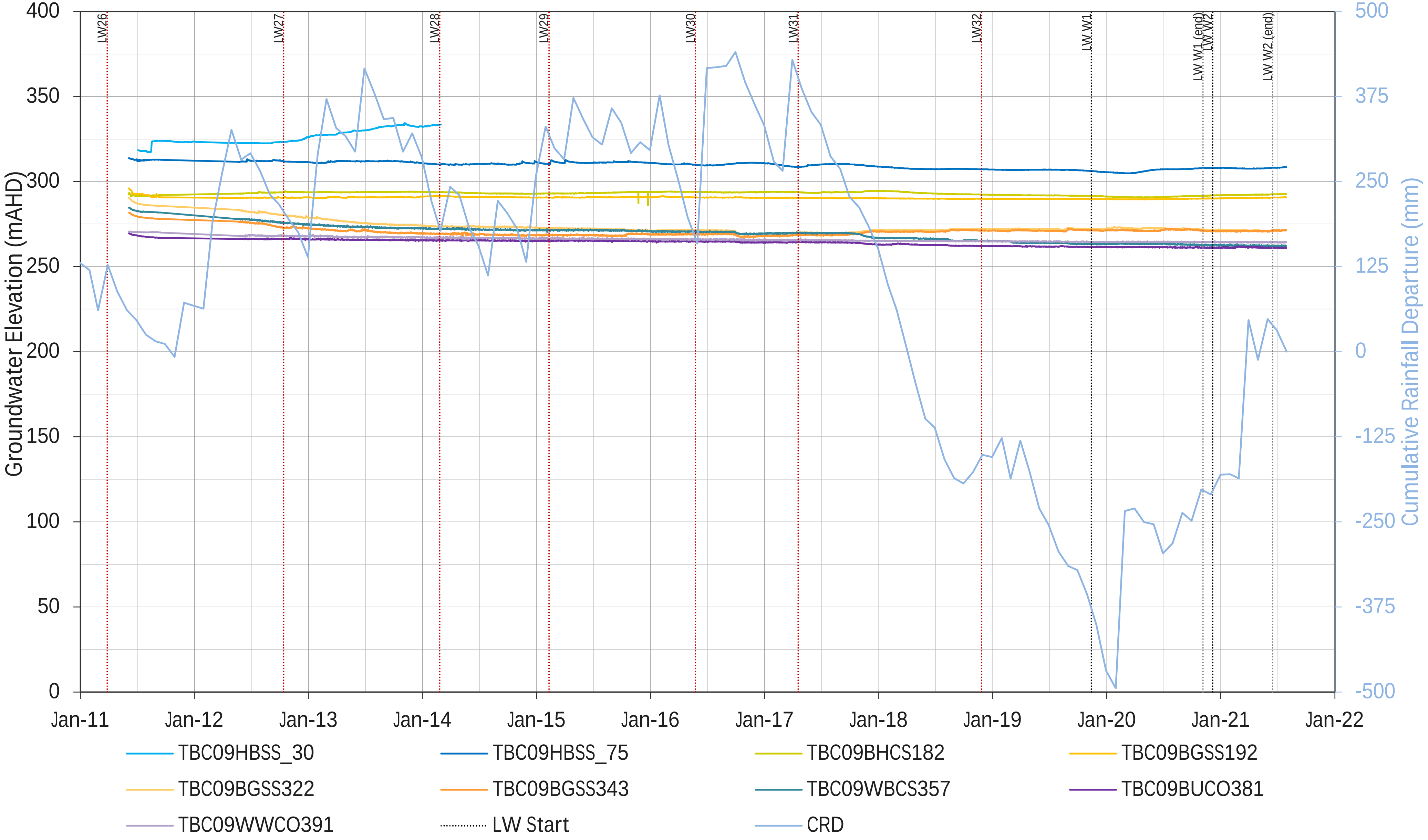
Site ID	Type	Comment
Thirlmere1	OSP	TLRP has not progressed with new monitoring, therefore install OSPs. Given all reporting to date implies negligible impact, not considered critical but it responsive to the Commitments.
Bargo1	OSP	3 OSPs in HBSS near to Bargo River. Could be anywhere from here to about 700m upstream.
BargoTrib1	OSP	2 OSPs, pair with PROPOSED SW site-BR4-Qla
Cow1	OSP	2 OSPs, check if HEC proposing SW site on Cow Creek. If so, 15-20m deep piezo.
Hornes1	OSP	2 OSPs, option to monitor GWs paired with SW site on Hornes. TBC033 is good for GWIs near Hornes, but cannot be paired w/ a SW site.
Teatree1	OSP	2 OSPs. pair with EXISTING SW site-3000089
Teatree2	OSP	3 OSPs. pair with PROPOSED SW site-TT4-Qla
Teatree4	OSP	2 OSPs. pair with EXISTING SW site-3000134
Teatree6	OSP	3 OSPs. pair with EXISTING SW site-3000132
Teatree7	OSP	2 OSPs. Western edge of Wirrimbirra, and near to registered bores. Install deeper one to 80m, similar depth to nearby registered bores.
Teatree8	OSP	2 OSPs. No pools (or SW sites) in this area. So need to place with nearby drainage line elevation surveyed.
Dogtrap1	OSP	2 OSPs. pair with EXISTING SW site-3000064
Dogtrap2	OSP	2 OSPs. in high GW dependent area along main Dogtrap trib. Could be anywhere 200m upstream or downstream from this point
Dogtrap3	OSP	3 OSPs. pair with EXISTING SW site-3000131
Dogtrap4	OSP	2 OSPs. pair with EXISTING SW site-3000130
Dogtrap5	OSP	2 OSPs. in high GW dependent area along Dogtrap trib. Could be anywhere 100m upstream or downstream from this point
Dogtrap6	OSP	3 OSPs. pair with PROPOSED SW site-DTC-P36 or DTC37-Qla
Dogtrap7	OSP	3 OSPs. pair with EXISTING SW site-3000130
Dogtrap8	OSP	3 OSPs. in high GW dependent area along Dogtrap Ck. pair with PROPOSED SW site-DTC21-Qla
Dogtrap9	OSP	3 OSPs. pair with PROPOSED SW site-DT7-La
Dogtrap10	OSP	3 OSPs. pair with PROPOSED SW site-DTC16-Qla and DTC-P09
Dogtrap11	OSP	3 OSPs. pair with EXISTING SW site-3000128
Dogtrap12	OSP	3 OSPs. pair with PROPOSED SW site-DT1-QLa
HOF1	VWP	Height of fracture investigation hole - LW101A

Site ID	Type	Comment
HOF2	VWP	Height of fracture investigation hole - LW104A. Perhaps locate at TBC016.
HOF3	VWP	Height of fracture investigation hole - LW101B
HOF4	VWP	Height of fracture investigation hole - LW103B or LW104B.
TNC-29	OSP	To fulfil commitments, post-mining monitoring of water levels and quality.

APPENDIX B

Hydrographs for Existing Monitoring Bores

TBC09


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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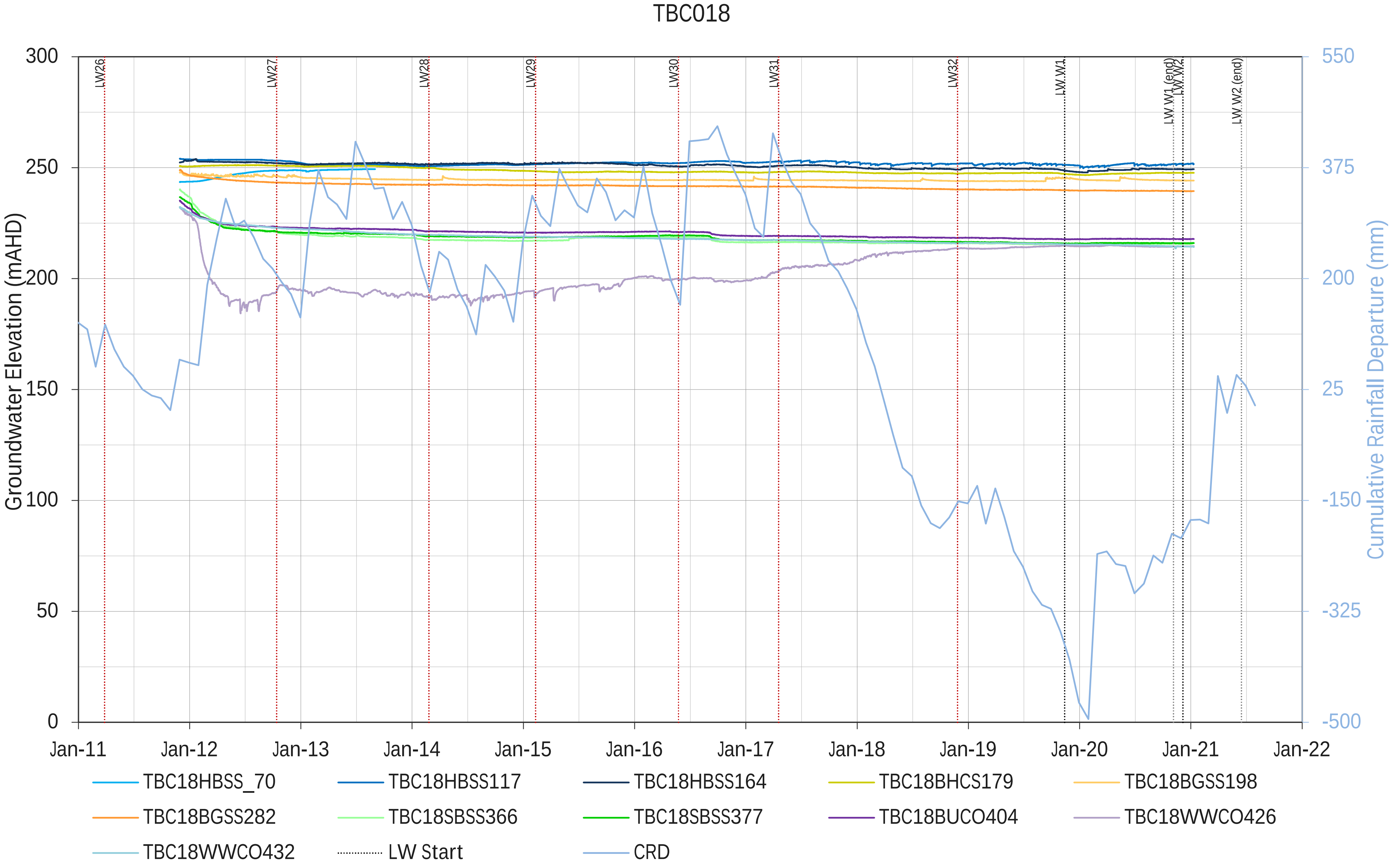
350
300
250
200
150
100
50
0
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC09HBSS_30
TBC09HBSS_75
TBC09BHCS182
TBC09BGSS192
TBC09BGSS322
TBC09BGSS343
TBC09WBCS357
TBC09BUCO381
TBC09WWCO391
LW Start
CRD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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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100
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0
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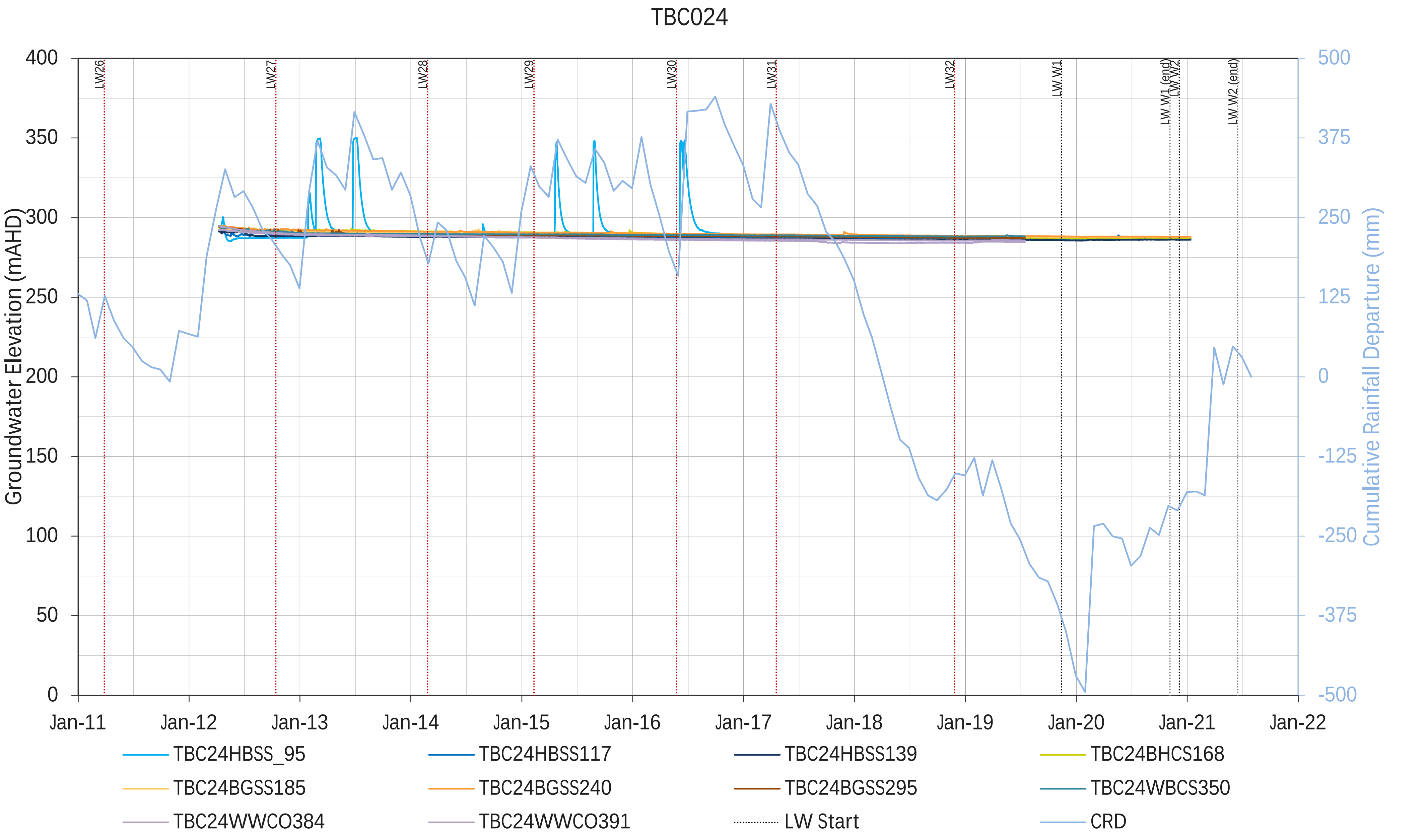
200
25
-150
-325
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
TBC18HBSS_70
TBC18HBSS117
TBC18HBSS164
TBC18BHCS179
TBC18BGSS198
TBC18BGSS282
TBC18SBSS366
TBC18SBSS377
TBC18BUCO404
TBC18WWCO426
TBC18WWCO432
LW Start
CRD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Cumulative Rainfall Departure (mm)
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100
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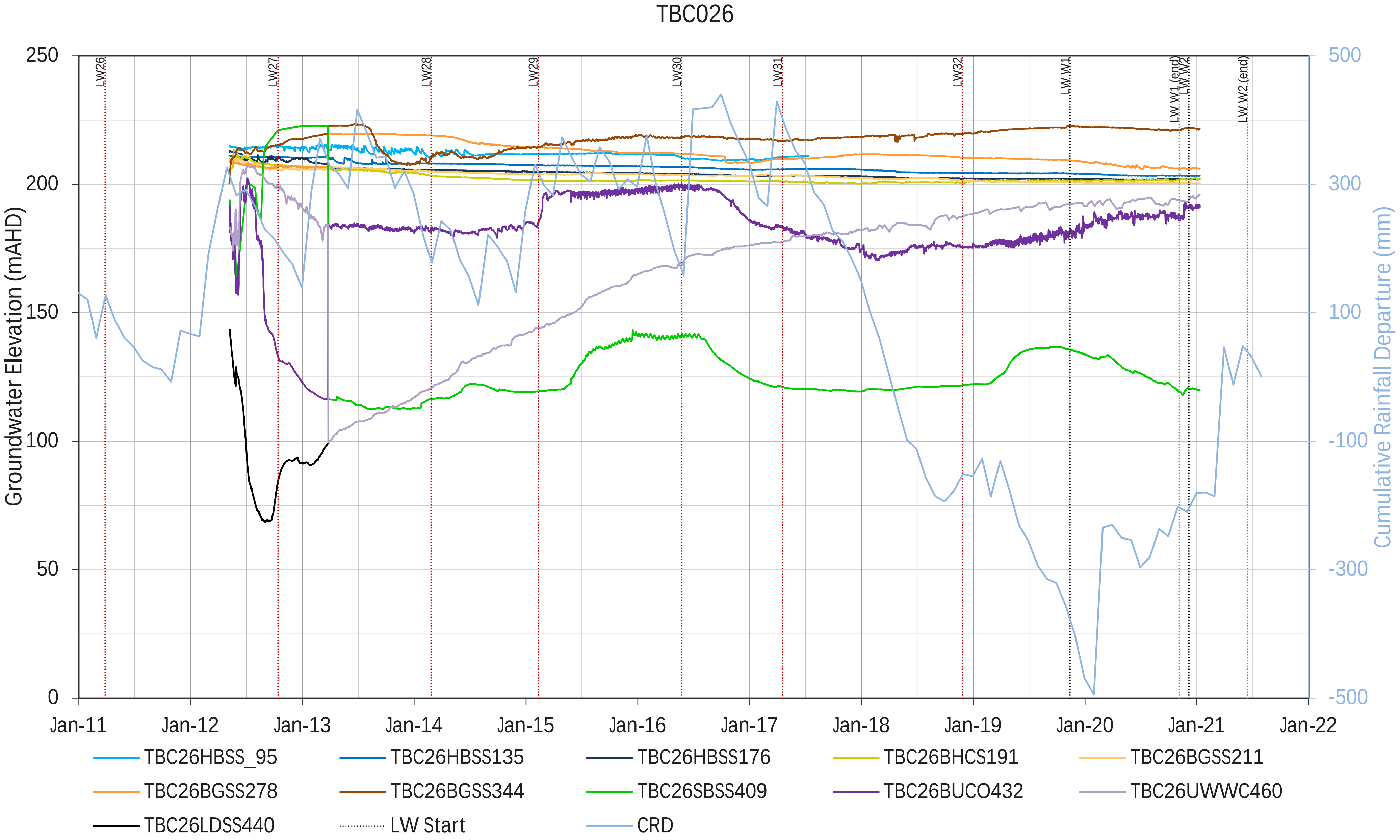
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC24HBSS_95
TBC24HBSS117
TBC24HBSS139
TBC24BHCS168
TBC24BGSS185
TBC24BGSS240
TBC24BGSS295
TBC24WBCS350
TBC24WWCO384
TBC24WWCO391
LW Start
CRD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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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200
150
100
50
0
500
300
100
-100
-300
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
TBC26HBSS_95
TBC26HBSS135
TBC26HBSS176
TBC26BHCS191
TBC26BGSS211
TBC26BGSS278
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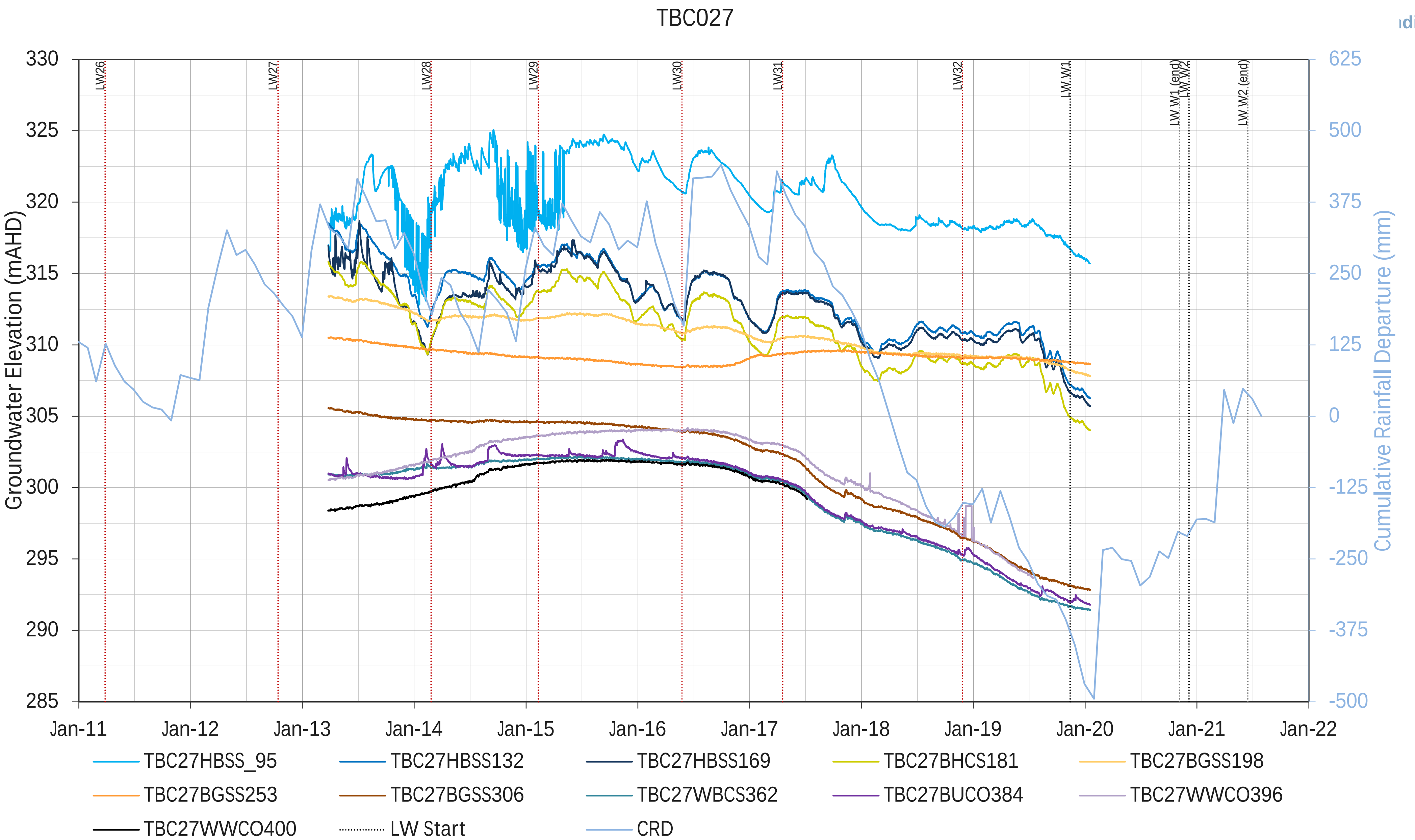
TBC26SBSS409
TBC26BUCO432
TBC26UWWC460
TBC26LDSS440
LW Start
CRD

TBC027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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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315
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305
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500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
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LW W2
LW W2 (end)
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TBC27BHCS181
TBC27BGSS198
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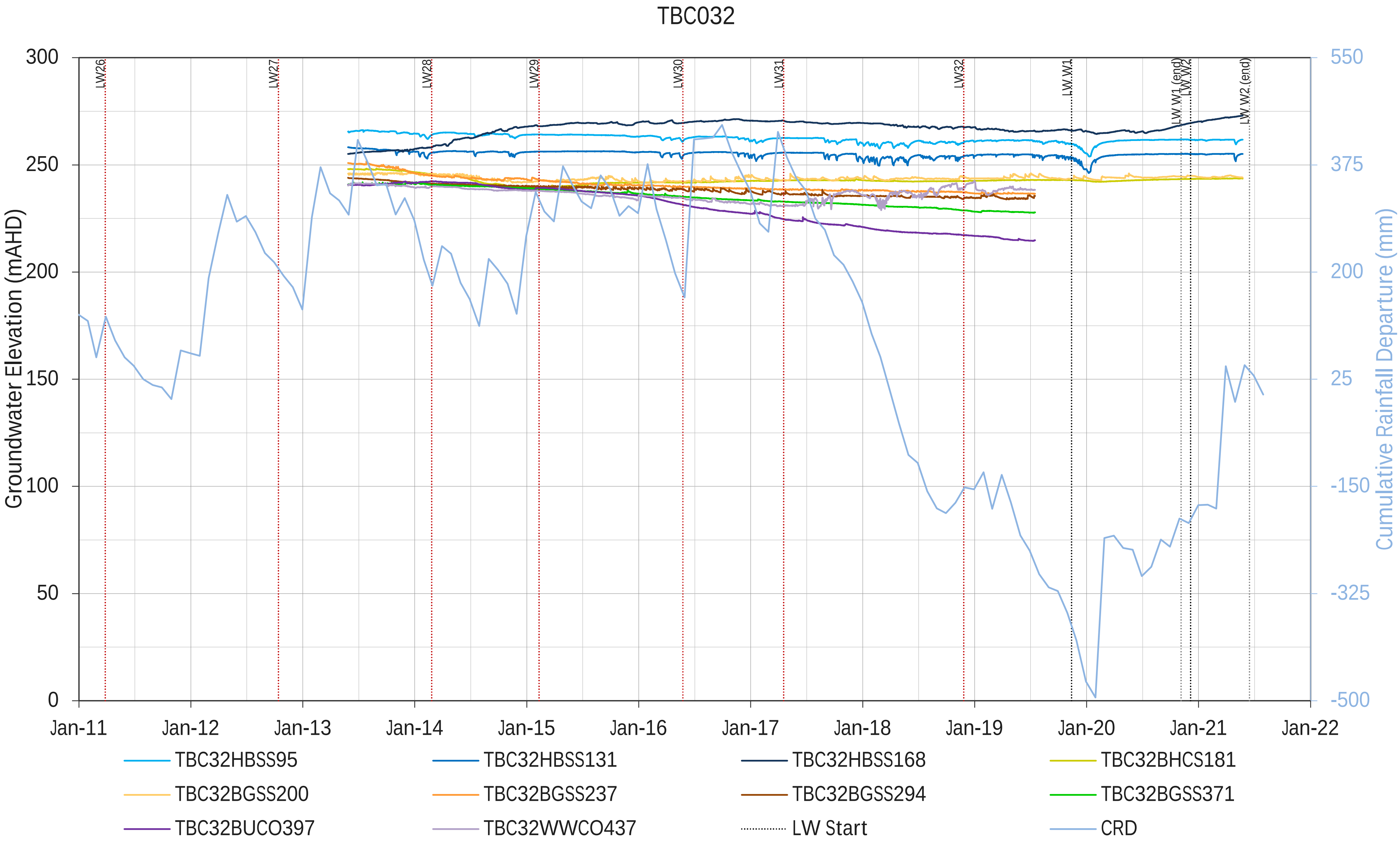
TBC27WBCS362
TBC27BUCO384
TBC27WWCO396
TBC27WWCO400
LW Start
CRD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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC32HBSS95
TBC32HBSS131
TBC32HBSS168
TBC32BHCS181
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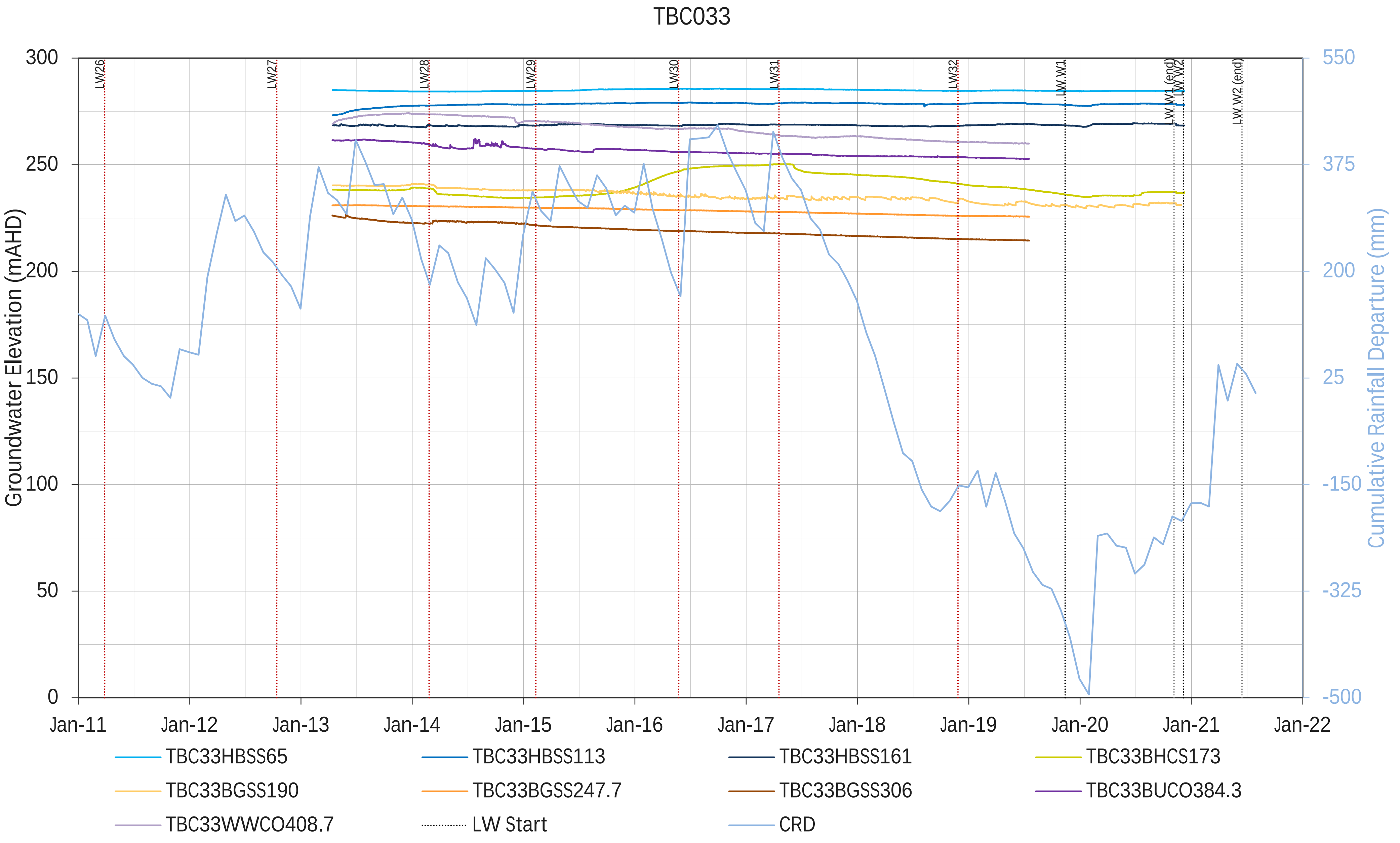
TBC32BGSS371
TBC32BUCO397
TBC32WWCO437
LW Start
CRD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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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200
150
100
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550
375
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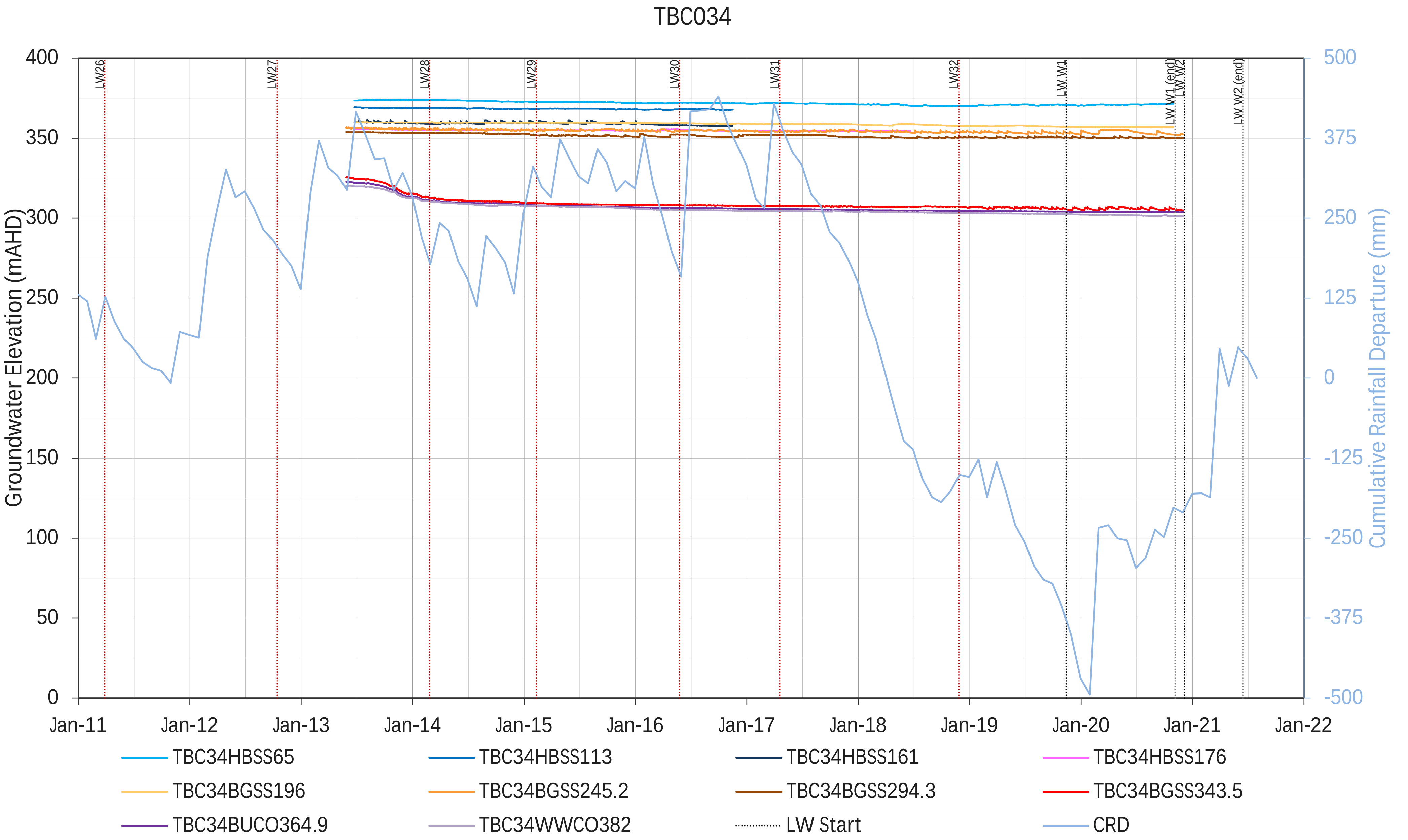
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC33HBSS65
TBC33HBSS113
TBC33HBSS161
TBC33BHCS173
TBC33BGSS190
TBC33BGSS247.7
TBC33BGSS306
TBC33BUCO384.3
TBC33WWCO408.7
LW Start
CRD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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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150
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Jan-13
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Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
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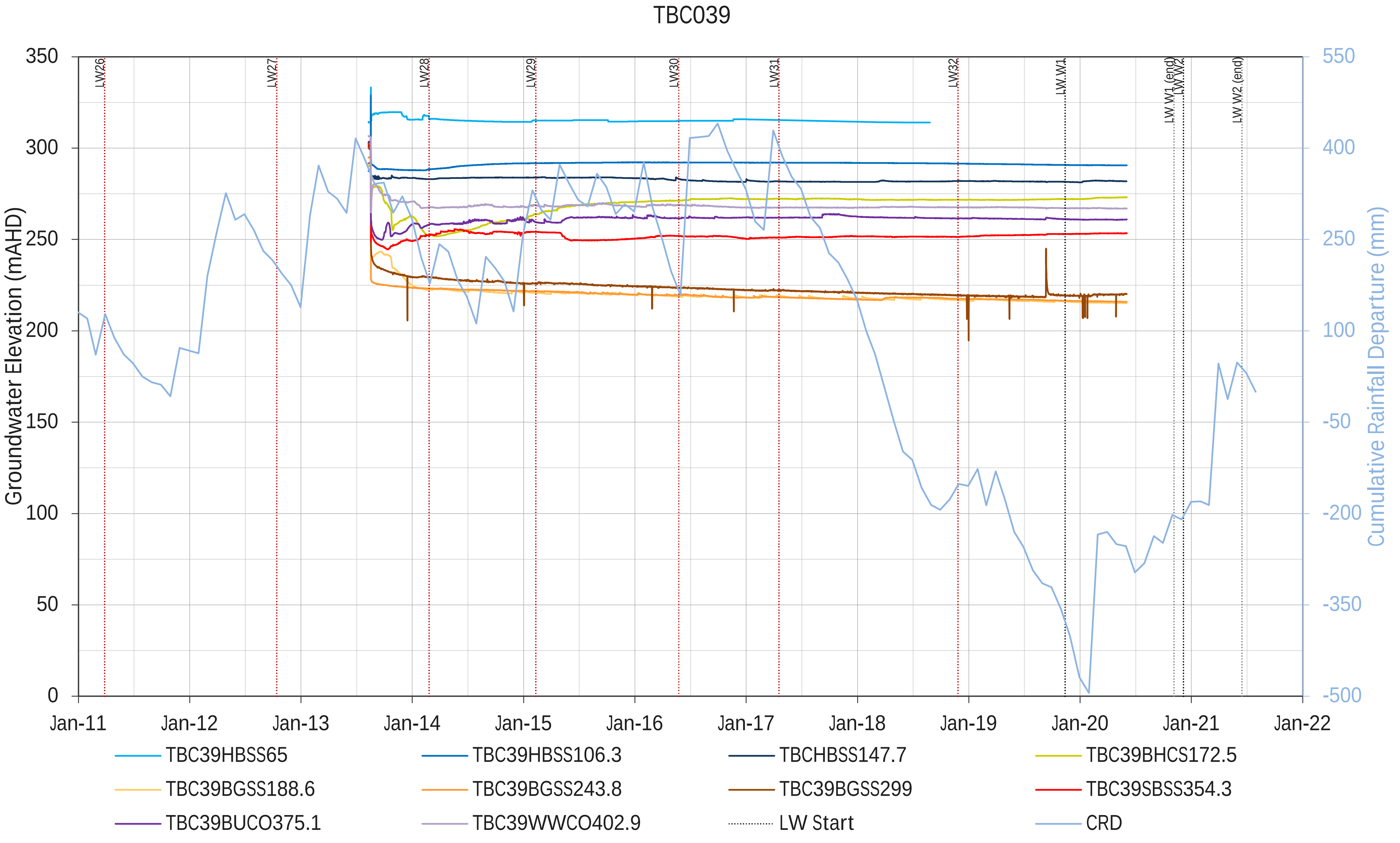
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC34HBSS65
TBC34HBSS113
TBC34HBSS161
TBC34HBSS176
TBC34BGSS196
TBC34BGSS245.2
TBC34BGSS294.3
TBC34BGSS343.5
TBC34BUCO364.9
TBC34WWCO382
LW Start
CRD


TBC039
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
350
300
250
200
150
100
50
0
550
400
250
100
-50
-200
-350
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC39HBSS65
TBC39HBSS106.3
TBCHBSS147.7
TBC39BHCS172.5
TBC39BGSS188.6
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TBC39SBSS354.3
TBC39BUCO375.1
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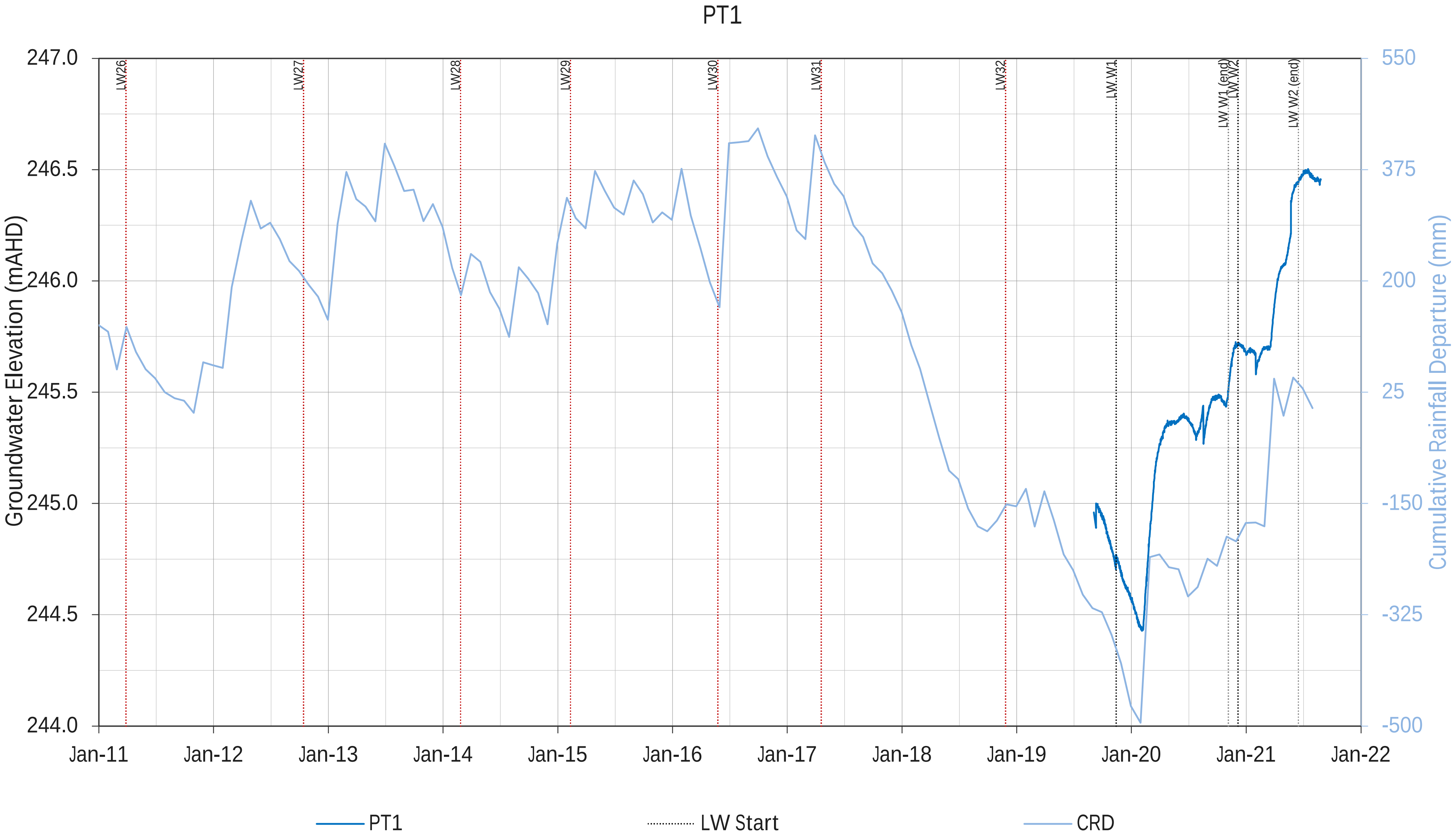
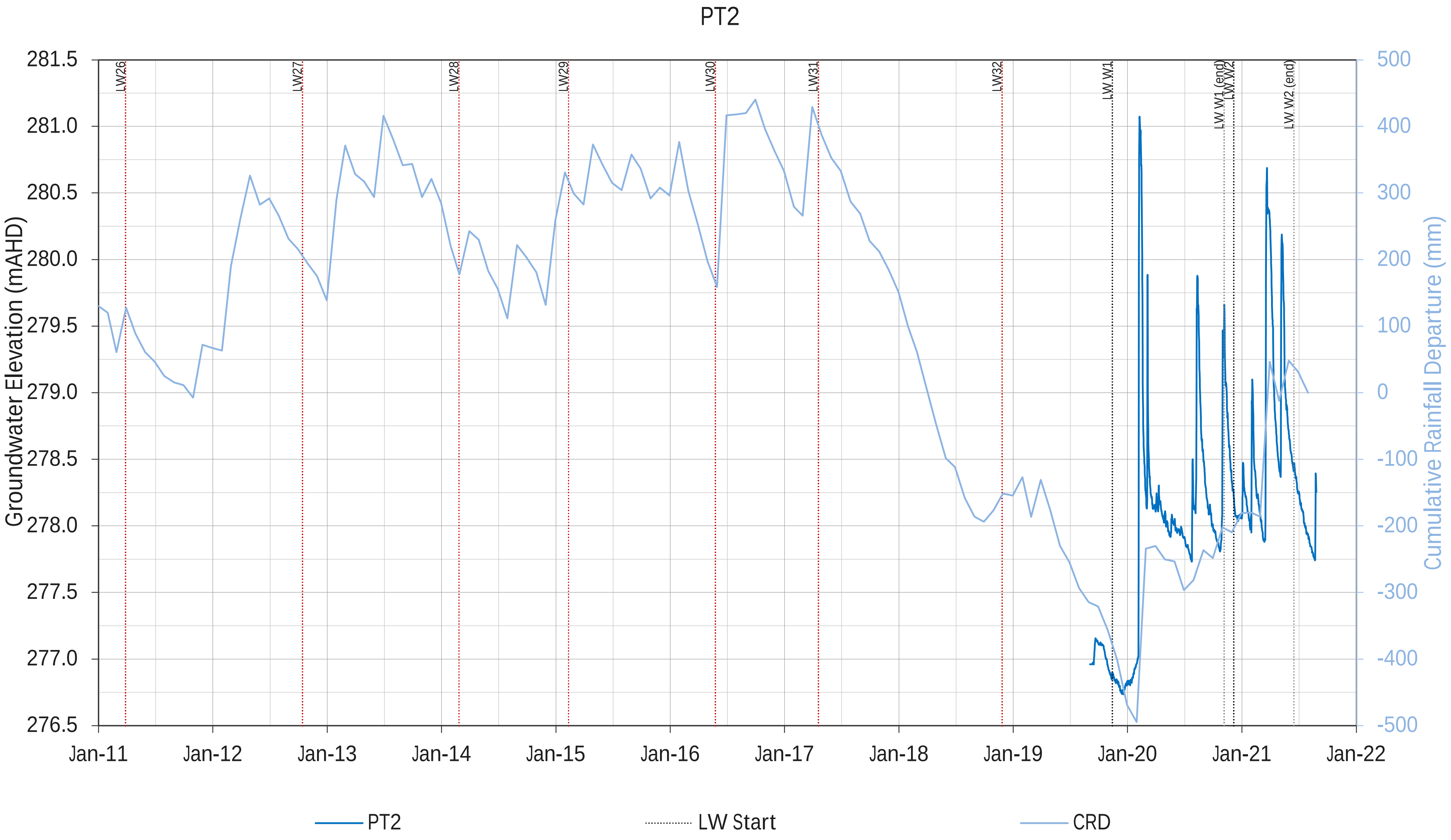
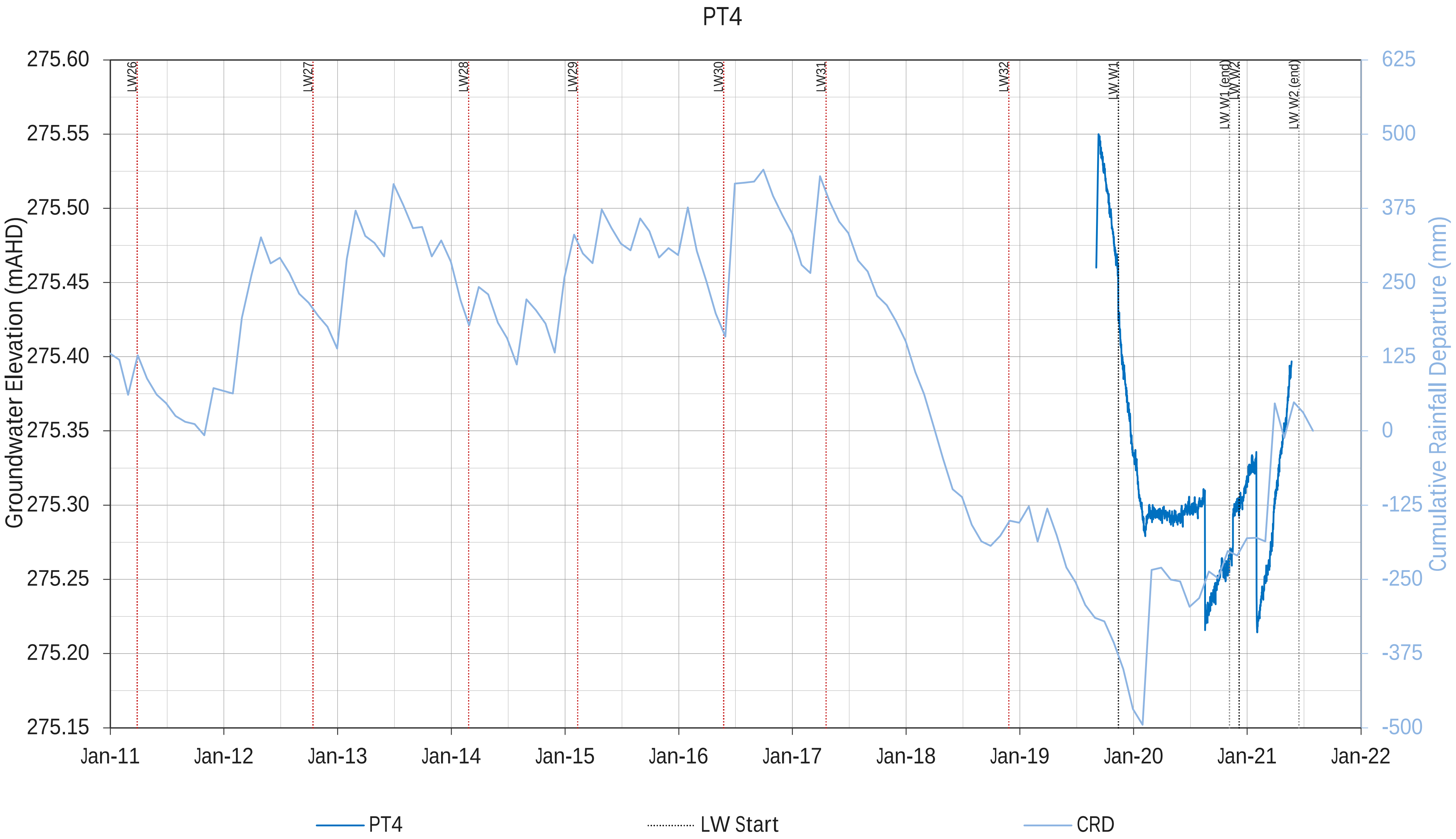
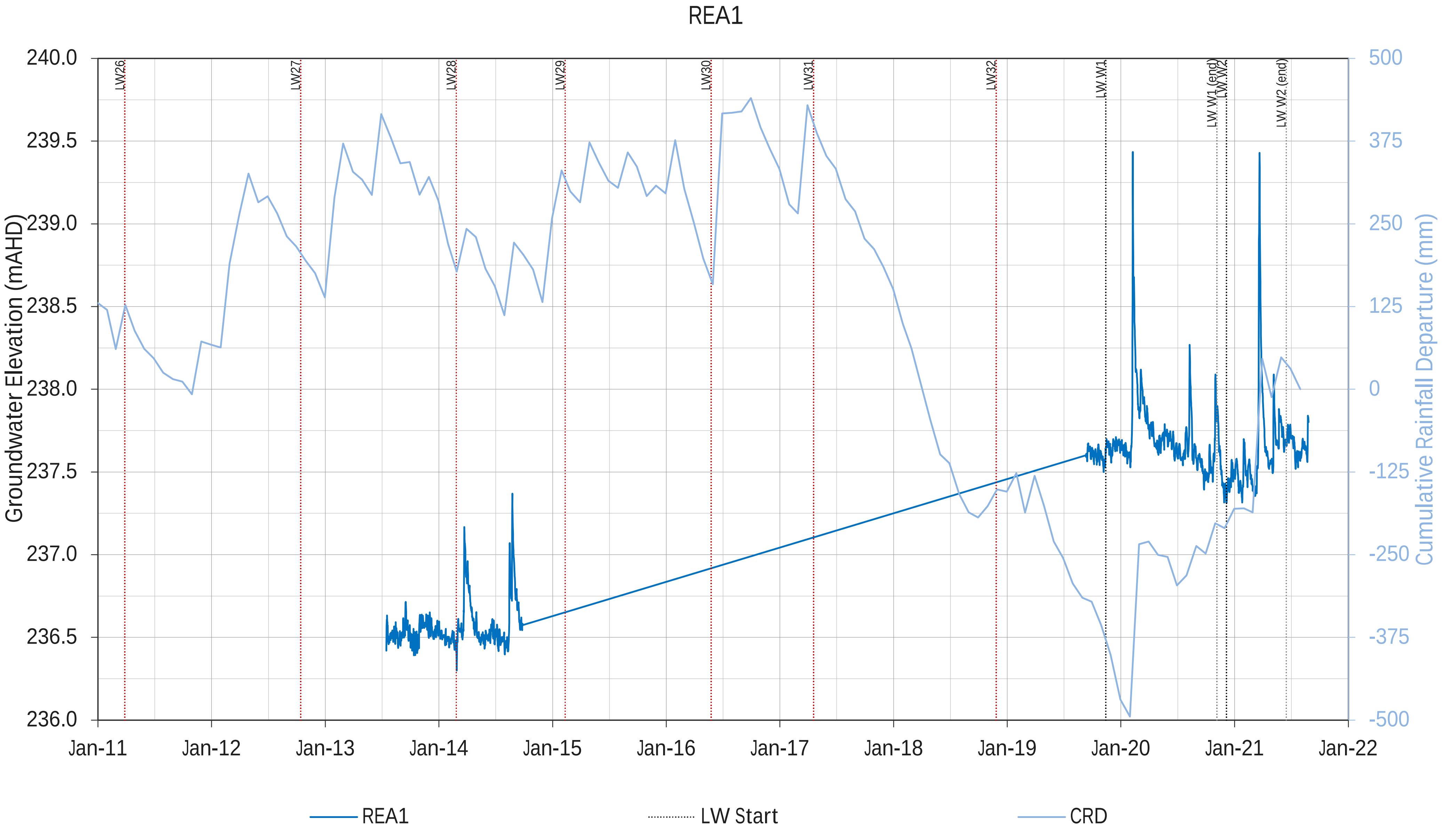
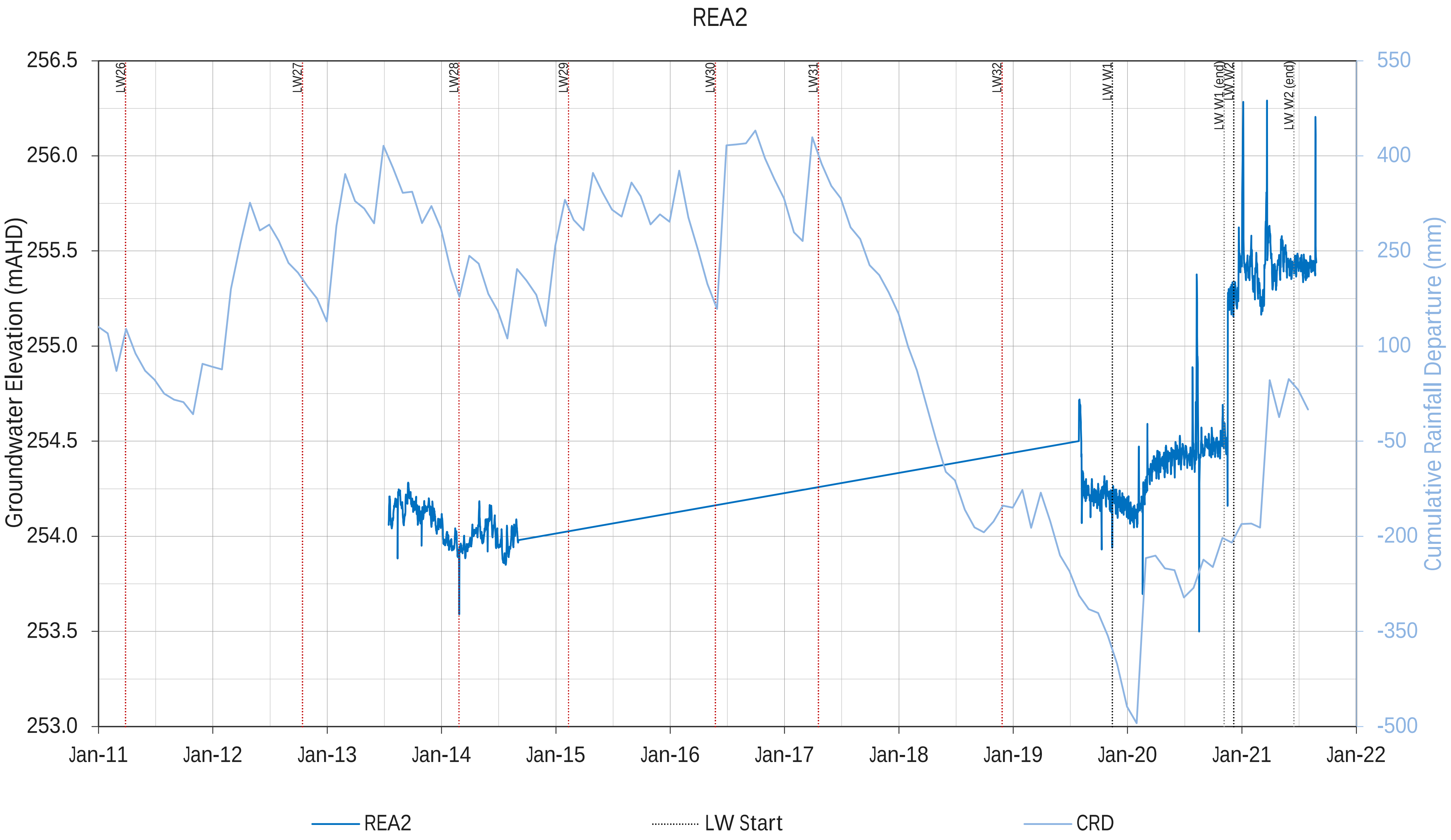
LW Start
CRD

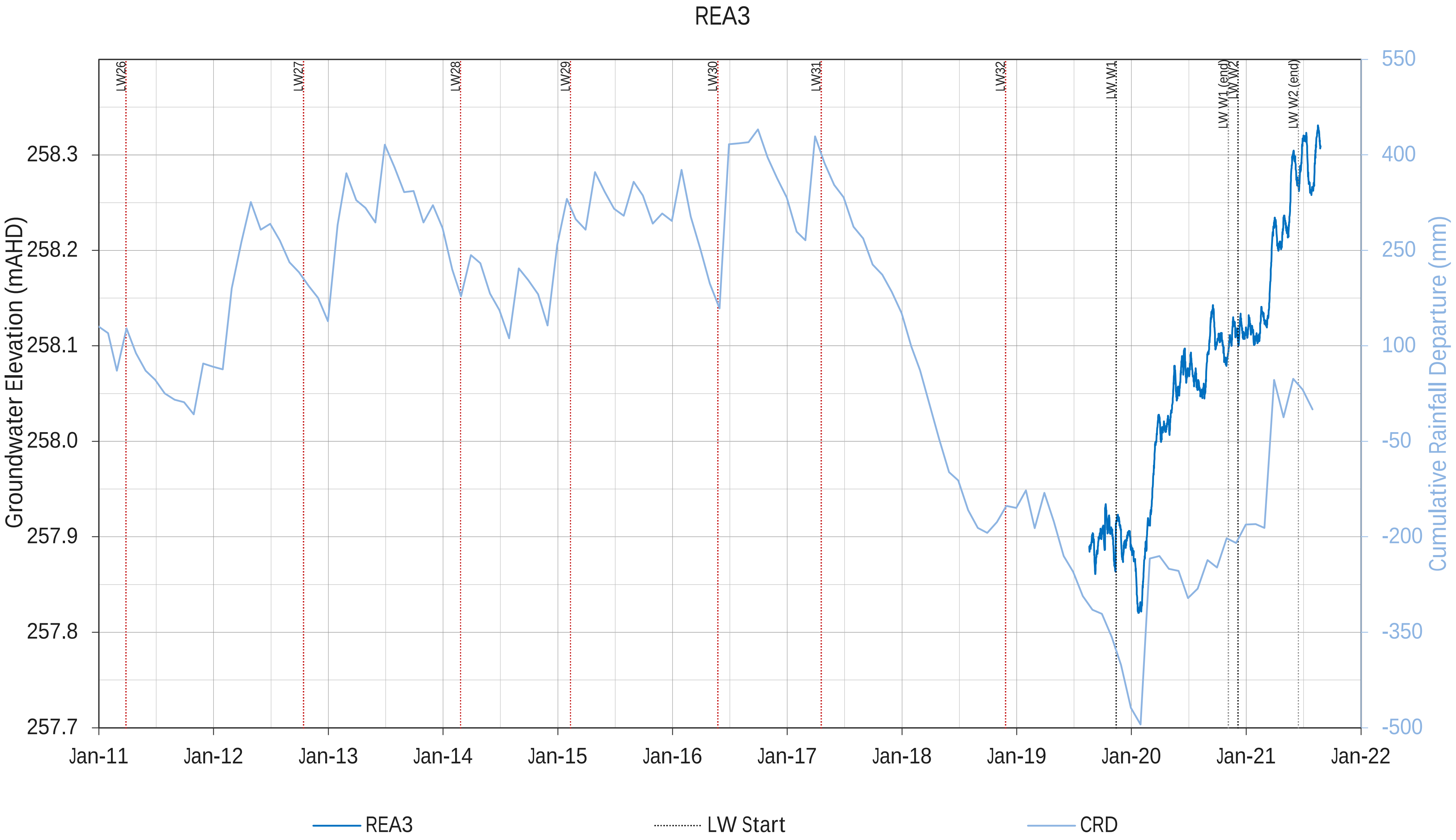

PT1
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
247.0
246.5
246.0
245.5
245.0
244.5
244.0
550
375
200
25
-150
-325
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
PT1
LW Start
CRD


PT2
281.5
281.0
280.5
280.0
279.5
279.0
278.5
278.0
277.5
277.0
276.5
Groundwater Elevation (mAHD)
500
400
300
200
100
0
-100
-200
-300
-400
-500
Cumulative Rainfall Departure (mm)
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
PT2
LW Start
CRD

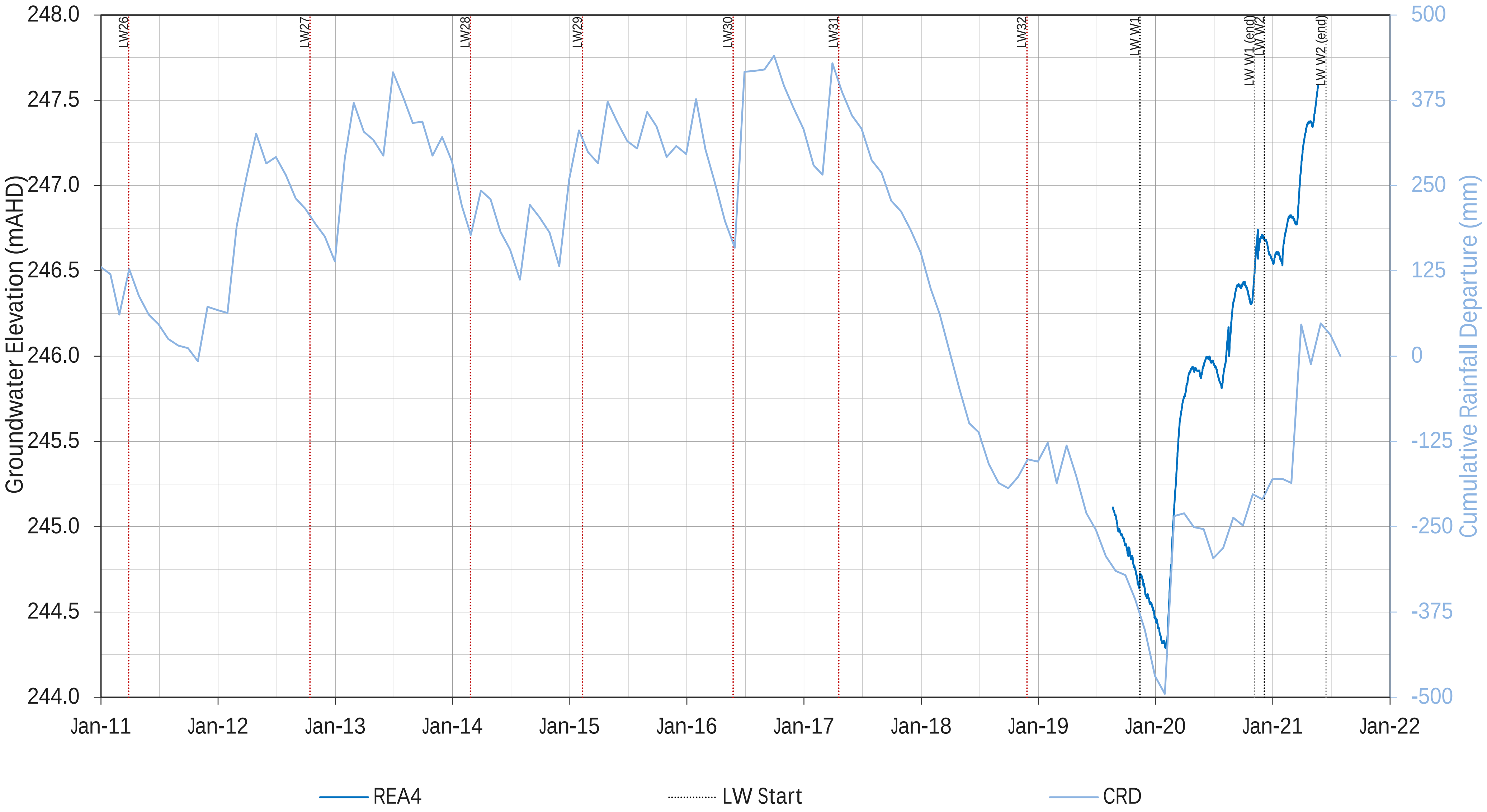

PT4
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
275.60
275.55
275.50
275.45
275.40
275.35
275.30
275.25
275.20
275.15
625
500
375
250
125
0
-125
-250
-375
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
PT4
LW Start
CRD

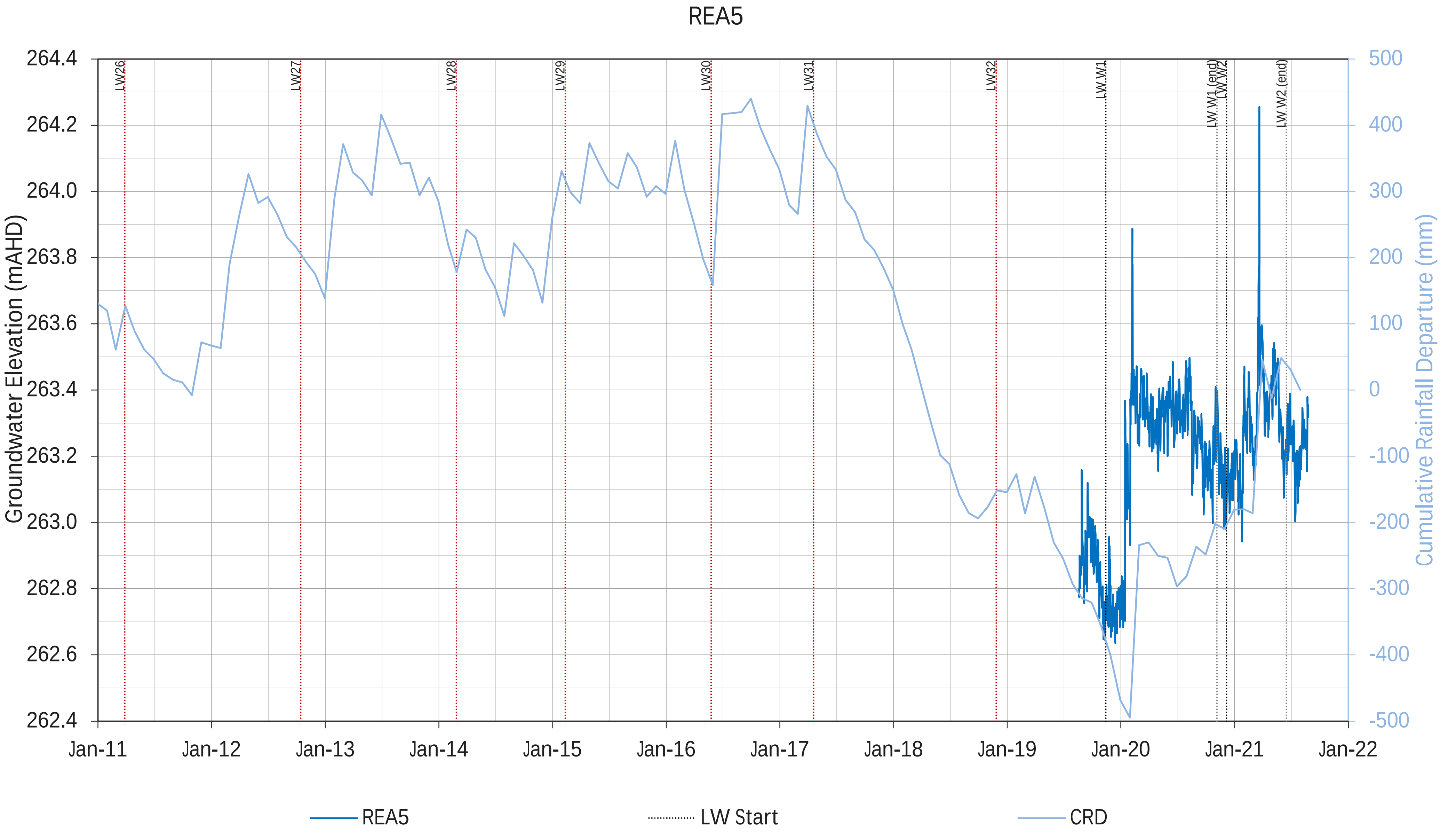

REA1
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
240.0
239.5
239.0
238.5
238.0
237.5
237.0
236.5
236.0
500
375
250
125
0
-125
-250
-375
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
REA1
LW Start
CRD

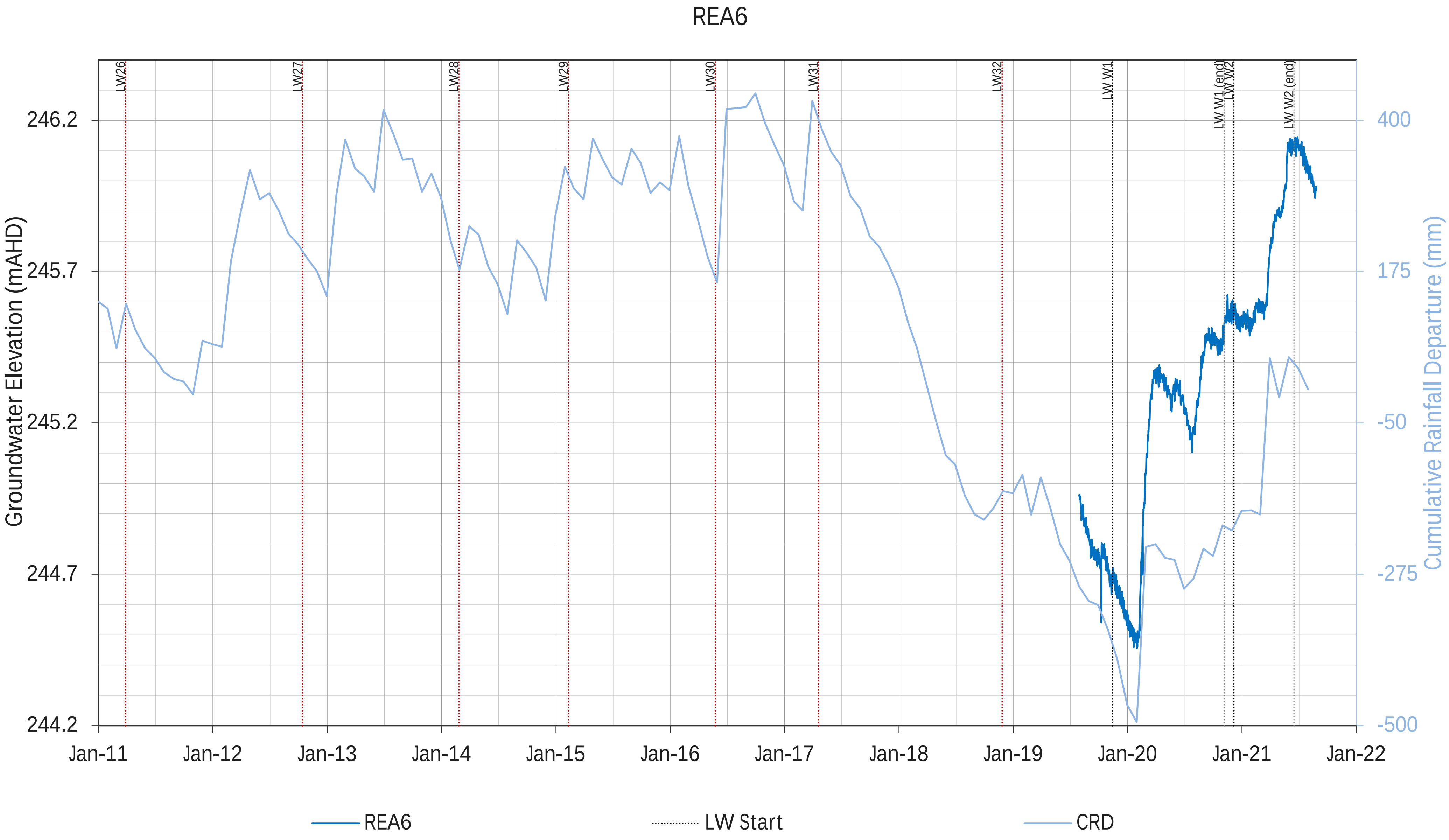

REA2
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
256.5
256.0
255.5
255.0
254.5
254.0
253.5
253.0
550
400
250
100
-50
-200
-350
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
REA2
LW Start
CRD

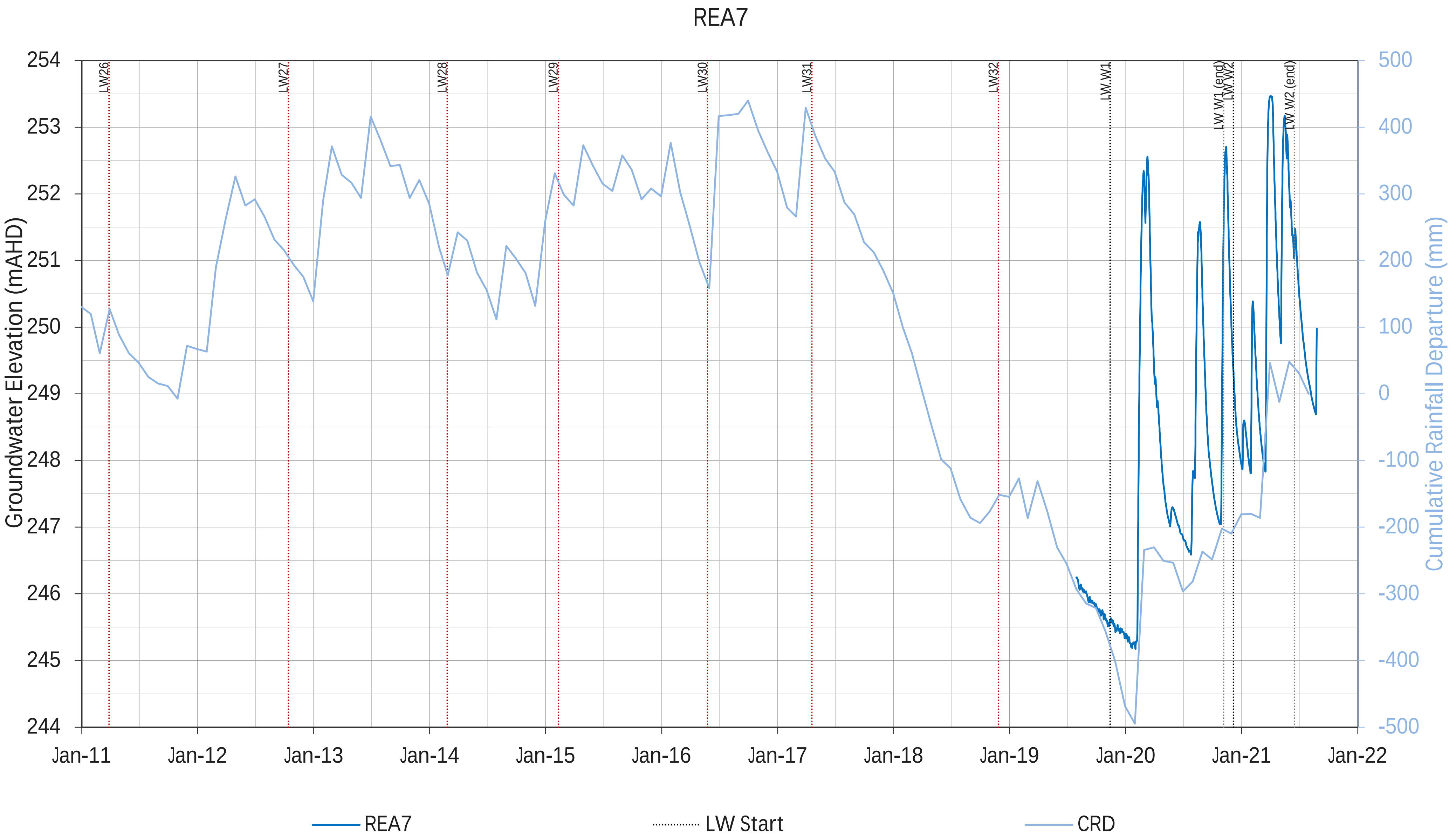

REA3
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
258.3
258.2
258.1
258.0
257.9
257.8
257.7
550
400
250
100
-50
-200
-350
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA3
LW Start
CRD

REA4


248.0
247.5
247.0
246.5
246.0
245.5
245.0
244.5
244.0
Groundwater Elevation (mAHD)
500
375
250
125
0
-125
-250
-375
-500
Cumulative Rainfall Departure (mm)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA4
LW Start
CRD


REA5
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
264.4
264.2
264.0
263.8
263.6
263.4
263.2
263.0
262.8
262.6
262.4
500
400
300
200
100
0
-100
-200
-300
-400
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
REA5
LW Start
CRD


REA6
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
246.2
245.7
245.2
244.7
244.2
400
175
-50
-275
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA6
LW Start
CRD


REA7
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
254
253
252
251
250
249
248
247
246
245
244
500
400
300
200
100
0
-100
-200
-300
-400
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA7
LW Start
CRD

APPENDIX C

Private Bore Summary

Table C-1 Private Bore Details

Work Number	Easting	Northing	Purpose	Aquifer
GW007445	277454	6204323	Irrigation	HBSS
GW014262	276764	6204587	Livestock	HBSS
GW031294	279732	6205706	Irrigation	HBSS
GW102179	280953	6203826	Irrigation	HBSS
GW102452	277234	6200992	Livestock	HBSS
GW103036	276840	6200964	Domestic	HBSS
GW103023	277261	6200993	Livestock	HBSS
GW104008	280368	6205982	Domestic	HBSS
GW103615	279720	6204034	Domestic	HBSS
GW104323	279259	6203318	Domestic	HBSS
GW104454	281410	6204568	Domestic	HBSS
GW070245	280090	6205714	Domestic	HBSS
GW100433	278540	6202588	Domestic	HBSS
GW100455	281877	6207020	Livestock	HBSS
GW102045	281266	6203733	Domestic	HBSS
GW101936	280604	6202851	Domestic	HBSS
GW108842	282500	6204716	Irrigation	HBSS
GW108538	281155	6205941	Domestic	HBSS
GW109257	276603	6205052	Domestic	HBSS
GW111357	277051	6200982	Recreation/cult.	HBSS
GW111047	280015	6206037	Domestic	HBSS
GW111810	277034	6204407	Domestic	HBSS
GW111828	282391	6205638	Irrigation	HBSS
GW111518	276882	6200987	Domestic	HBSS
GW112473	276577	6202010	Irrigation	HBSS
GW112415	277479	6200865	Domestic	HBSS
GW111842	282654	6205664	Irrigation	BGSS
GW104860	282745	6206178	Commerc./Indust.	HBSS
GW105262	278609	6200731	Domestic	HBSS
GW105395	278543	6203037	Domestic	HBSS
GW105847	277020	6204404	Unknown	HBSS
GW105803	282278	6204644	Domestic	HBSS
GW105883	277040	6204629	Unknown	HBSS
GW106546	282785	6206765	Domestic	HBSS
GW045404	282217	6206689	Water supply	HBSS
GW052016	280259	6203604	Livestock	HBSS
GW051877	281673	6205875	Livestock	HBSS
GW054146	279886	6204676	Domestic	HBSS

Work Number	Easting	Northing	Purpose	Aquifer
GW053450	282303	6205837	Irrigation	HBSS
GW053449	280369	6205813	Irrigation	HBSS
GW057969	281350	6206116	Irrigation	HBSS
GW058634	279479	6203419	Domestic	HBSS
GW059618	281587	6204277	Domestic	HBSS
GW062661	282609	6207469	Domestic	HBSS
GW032443	276415	6206336	Irrigation	HBSS
GW107470	282069	6208057	Domestic	HBSS
GW111669	276232	6206450	Domestic	HBSS
GW062068	276581	6209579	Domestic	HBSS
GW106590	280442	6206344	Domestic	HBSS
GW104659	276617	6207391	Irrigation	HBSS
GW105577	280728	6207041	Irrigation	HBSS
GW110669	274565	6207896	Domestic	HBSS

APPENDIX D

Tahmoor South Commitments - monitoring

Table D-1 Summary of Tahmoor South Commitments pertaining to monitoring

Condition ID	Condition	Method to address
B25	Compensatory Water Supply Prior to the commencement of second workings under this consent, the Applicant must complete a bore census for all licensed privately-owned groundwater bores that are predicted to have a drawdown of greater than 2 metres as a result of the development providing: (a) notification of bore owners, including an indication of the level of risk of impact to their water supply; (b) ongoing engagement and consultation with bore owners in accordance with the Make Good Strategy contained in the EIS; (c) detailed baseline data regarding groundwater levels, yield and quality for privately-owned groundwater bores; and (d) a condition assessment of existing groundwater bores and monitoring equipment; to the satisfaction of the Planning Secretary.	Baseline survey (Section 4)
B34	(v) Groundwater Management Plan that includes: A detailed baseline data regarding groundwater levels, yield and quality for privately-owned groundwater bores (as required under condition B25(a)) and the condition of GDEs (including Thirlmere Lakes) potentially impacted by the development	Baseline survey (Section 4) Review of Thirlmere Lakes Research Program (TLRP) data and installation of additional monitoring to establish baseline prior to extraction (Section 3.2.4)
	a detailed description of the groundwater management system, including commitments to: - install an additional monitoring bore in the footprint of Tahmoor North to monitor post-mining groundwater level and quality;	Section 3.2.7
	- install additional monitoring bores (minimum of four) at or near the Thirlmere Lakes;	Installation of an additional nested site with three open standpipes at "Thirlmere 1", and another site with three open standpipes approximately halfway between there and the longwalls ("Bargo1"). (Section 3.2.4)
	- install bores above the initial longwalls to define profile fracturing and depressurisation in the Hawkesbury Sandstone and Bulgo Sandstone;	Installation of HoF holes (Section 3.5)
	- monitor shallow groundwater within the Hawkesbury Sandstone;	Section 3.3
	- monitor volumetric take (mine inflow), including inflows to the underground mine; and	Section 3.4

Condition ID	Condition	Method to address
Schedule 2, Part C, C1	Subsidence The Applicant must ensure that the development does not cause any exceedances of the performance measures in Table 7. Table 7: Subsidence impact performance measures - natural and heritage features etc Features and Performance Measures: Feature (Water Resources) & Performance Measures All watercourses within the Subsidence Area: - No greater subsidence impact or environmental consequences to water quality, water flows (including baseflow) or stream health (including riparian vegetation), than predicted in the EIS Other watercourses: - Negligible environmental consequences including beyond those predicted in the EIS, including: - negligible division of flows or changes in the natural drainage behaviour of pools; - negligible decline in baseline channel stability; - negligible gas releases and iron staining; and - negligible increase in water turbidity GDEs including Thirlmere Lakes: - Negligible impacts including: - negligible change in groundwater levels; and - negligible change in groundwater quality.	Section 3.3
C8	detailed baseline data on: - surface water flows, quality and geomorphic conditions of watercourses and/or water bodies that could be affected by subsidence; and - groundwater levels, yield and quality in the region, including for privately-owned licensed bores;	Section 3.3 and Section 4
	- background changes in groundwater yield/quality against mine-induced changes, in particular, on privately-owned groundwater bores in the vicinity of the site;	Section 3.3 and Section 4
	- permeability, hydraulic gradient, flow direction and connectivity of the deep and shallow groundwater aquifers; and	Section 3.3 (overarching monitoring regime to provide valuable conceptualisation information)
	- impacts of the development on GDEs (including Thirlmere Lakes);	Section 3.2.4

Condition ID	Condition	Method to address
C8	Extraction Plan The Applicant must prepare an Extraction Plan for all second workings on the site of the development to the satisfaction of the Planning Secretary. Each Extraction Plan must: (i) include a program to collect sufficient baseline data for future Extraction Plans.	
GW-3	Groundwater Potential impact: Impacts to groundwater as a result of mining induced subsidence Management and mitigation measures: Update and maintain regional groundwater monitoring network, with monitoring results reported annually within the Annual Review. This would include replacement of failed bores around Tahmoor North and Tahmoor South, as well as establishing new bores. Monitoring of groundwater levels would include:	Section 3.3 (installation of additional monitoring network and review of current netrok status underway)
	- A condition assessment of bores and monitoring equipment (VMPs) of new bores around Tahmoor South, with a specific update of the GWMP.	Section 3.3.1
	- Geophysical logging of boreholes that allow changes in groundwater storage and fracture apertures to be quantified and depth of rock deformation to be identified (i.e. observations of non-deformed ground which could be at least 10- 30 m below surface).	Installation of HoF holes (Section 3.5)
	- Re-install at least one bore in the footprint of a Tahmoor North longwall (e.g. at TNC029) to monitor post-mining groundwater level and groundwater quality.	Section 3.2.7
	- Monitoring in longwall centre-lines of pre- and post-mining conditions Tahmoor South. This is would be undertaken for the longwall (101A), and then every two or three after that. Packer testing would also be undertaken, followed by installing VMPs at four elevations in the Hawkesbury Sandstone and then two in the Bulgo Sandstone to assist in defining a profile of fracturing and depressurisation above longwalls. Results from monitoring would be compared to those from groundwater monitoring of reference sites including upstream and outside the predicted subsidence impact zone where relevant	Installation of HoF holes (Section 3.5)
GW-6	Groundwater Potential impact: Impacts to groundwater as a result of mining-induced subsidence Management and mitigation measure:	
	- Improvements would be made to the measurement of the volumetric take (total mine inflow) to better understand inflow to different parts of Tahmoor North/Western Domain and then in the Tahmoor South ‘A’ and ‘B’ blocks.	Section 3.4
PAR	Groundwater	

Condition ID	Condition	Method to address
	The mitigation measures outlined in Section 11.3.5 and Appendix I of the EIS prepared for the Project remain applicable to the Amended Project. Although, the revised Groundwater Assessment provides further detail regarding monitoring of groundwater during operation of the project, such that monitoring would include: - A condition assessment of bores and monitoring equipment (VWPs) of new bores around Tahmoor South, with a specific update of the GWMP;	Section 3.3.1
	- Re-install at least one bore in the footprint of a Tahmoor North longwall (eg at TNC029) to monitor post-mining groundwater level and groundwater quality; and	Section 3.2.7
	- Monitoring in longwall centre-lines of pre- and post-mining conditions Tahmoor South. This would be undertaken for the longwall (LW101A), and then every two or three after that. Packer testing would also be undertaken, followed by installing VMPs at four elevations in the Hawkesbury Sandstone and then two in the Bulgo Sandstone to assist in defining a profile of fracturing and depressurisation above longwalls.	Installation of HoF holes (Section 3.5)
RD -2	Rejects disposal Potential impact: Impacts associated with improper management of the REA Management and mitigation measures: Update the Water Management Plan to include specific monitoring of Acid and Metalliferous Drainage and contaminants of concerns from the REA material and leachate specifying contingency measures if monitoring parameters are exceeded, and how impacts to the environment surrounding the REA will be monitored. It would also include monitoring of groundwater for water quality parameters and contaminant compounds including an ongoing monitoring plan for the site and contingencies if parameters are exceeded	Section 3.3
HR-9	Hazard and risk Potential impact: Variation in salinity or contaminants of concern in the REA runoff Management and mitigation: Conduct surface water and groundwater monitoring during active placement of coal handling and preparation plant rejects.	Section 3.3

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

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
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Grd Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

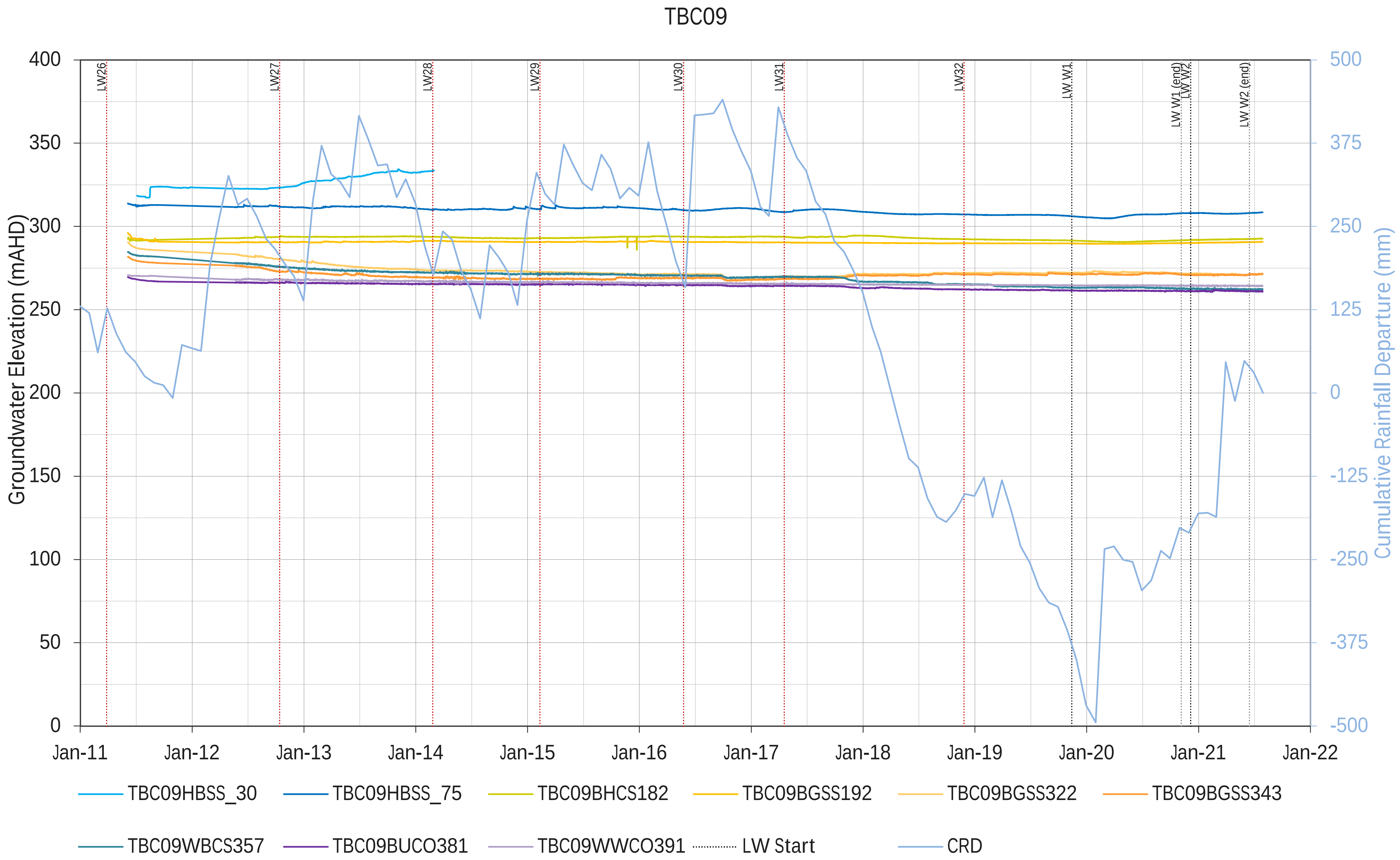
AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

APPENDIX C – Baseline data for the REA and Pit-top Bores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Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
400
350
300
250
200
150
100
50
0
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250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC09HBSS_30
TBC09HBSS_75
TBC09BHCS182
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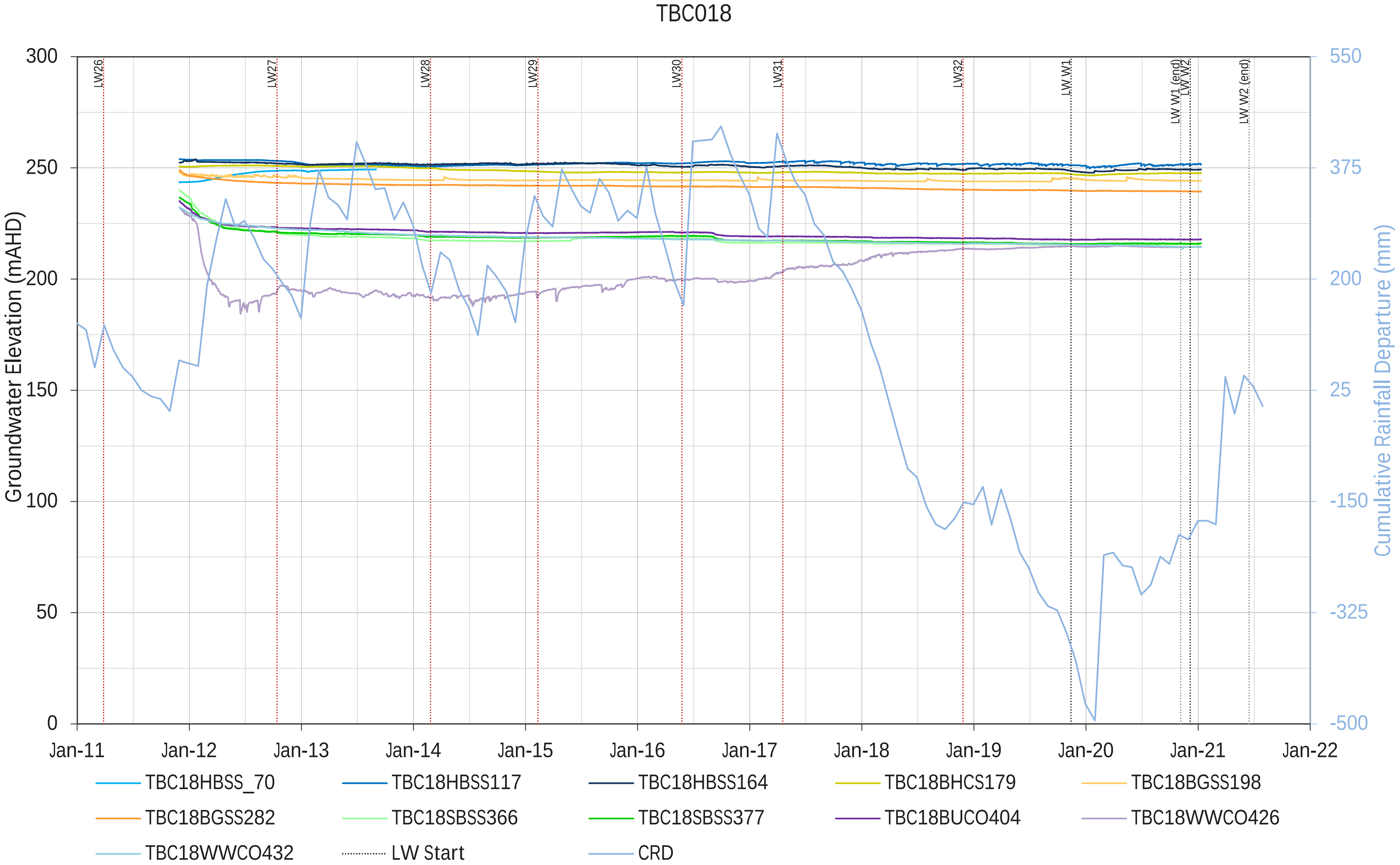
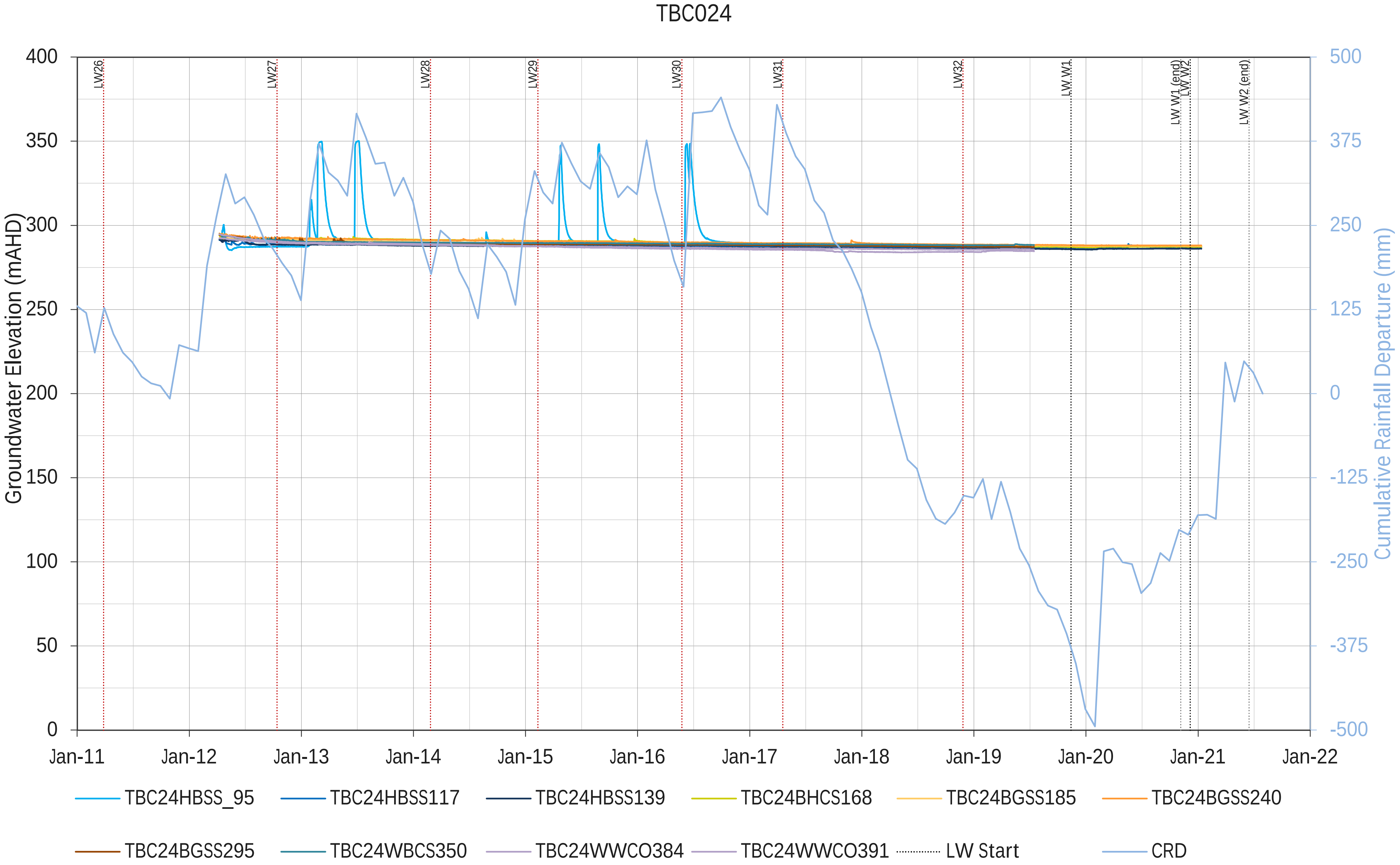
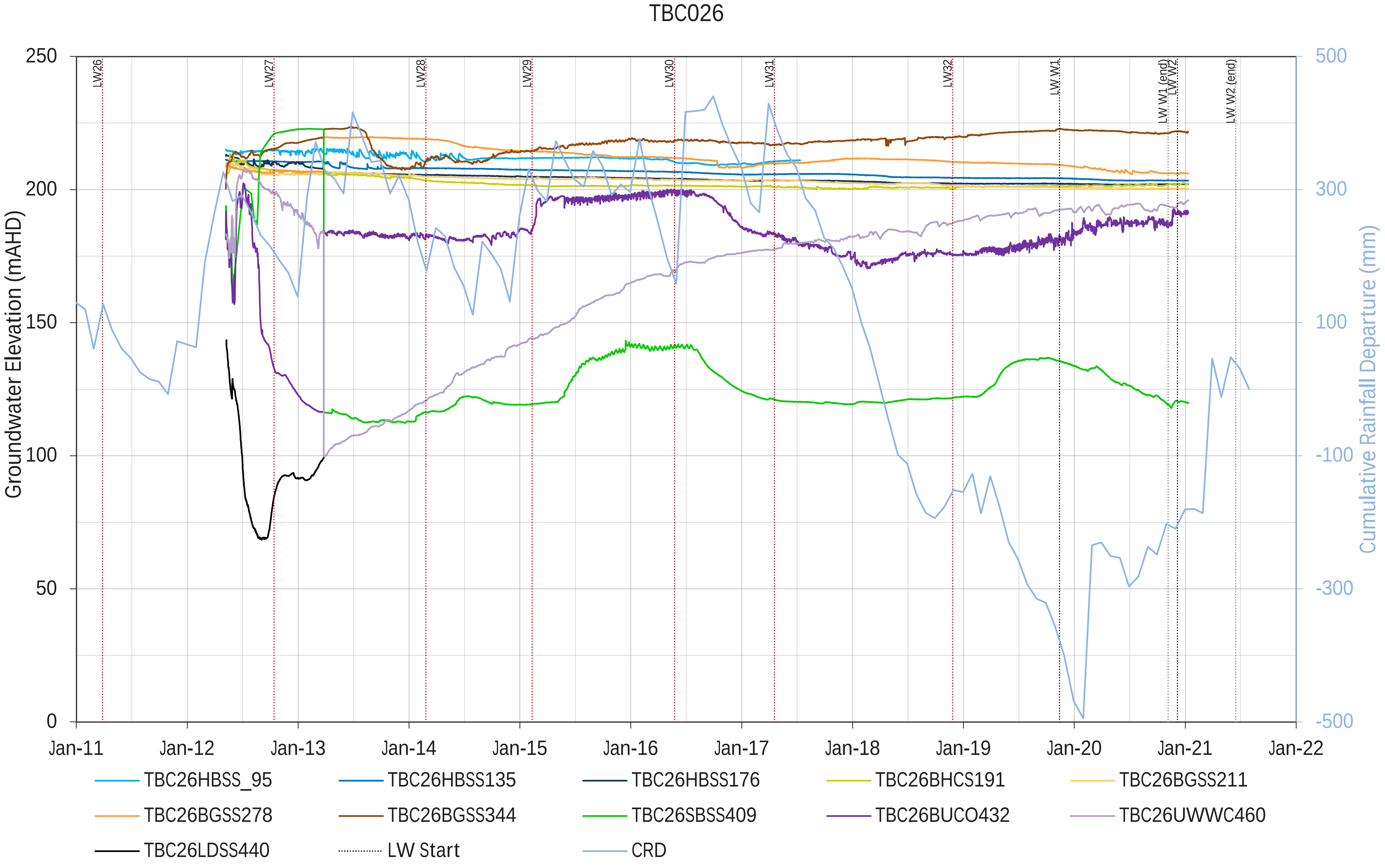
TBC09WBCS357
TBC09BUCO381
TBC09WWCO391
LW Start
CRD

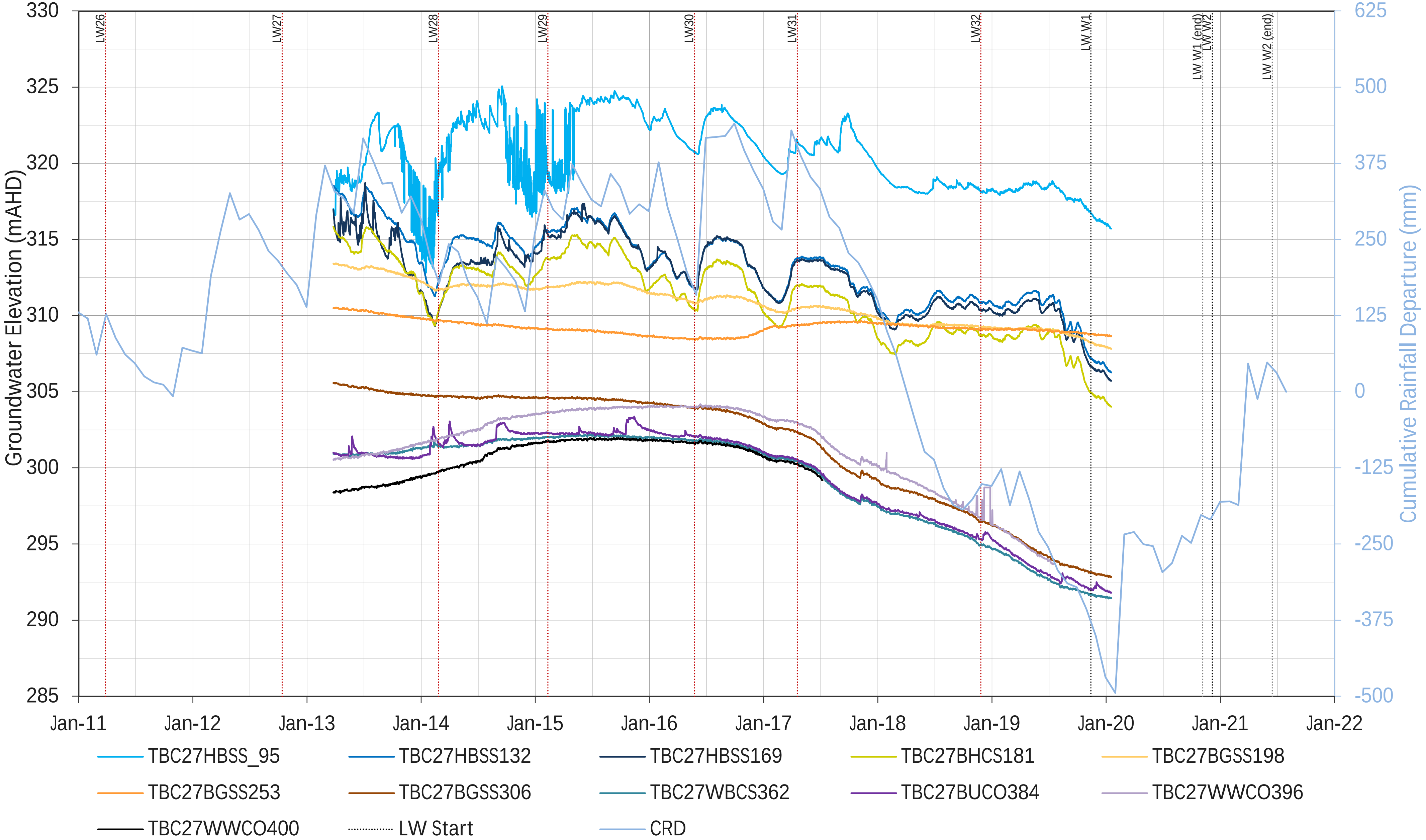

TBC018
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
300
250
200
150
100
50
0
550
375
200
25
-150
-325
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
TBC18HBSS_70
TBC18HBSS117
TBC18HBSS164
TBC18BHCS179
TBC18BGSS198
TBC18BGSS282
TBC18SBSS366
TBC18SBSS377
TBC18BUCO404
TBC18WWCO426
TBC18WWCO432
LW Start
CRD

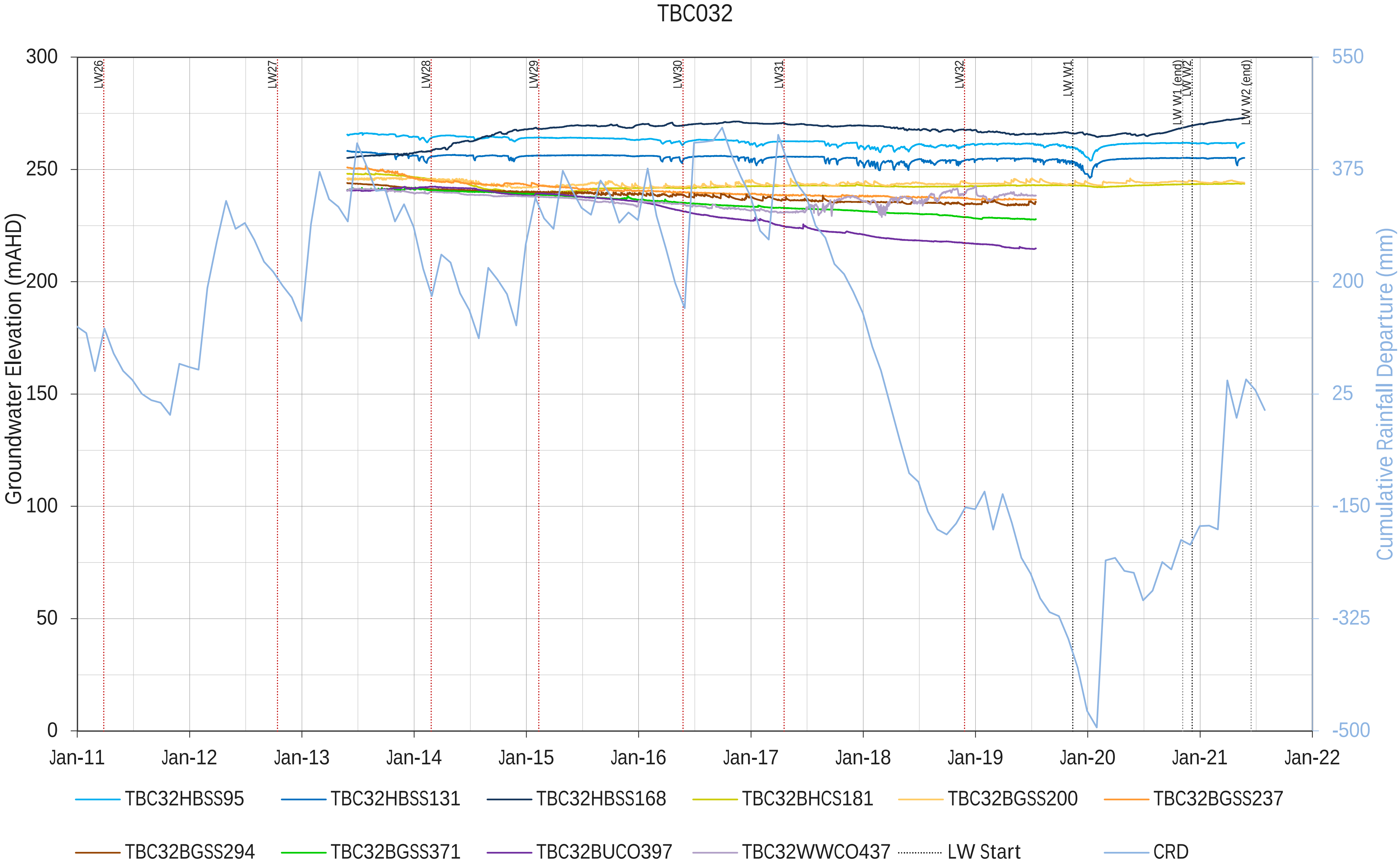


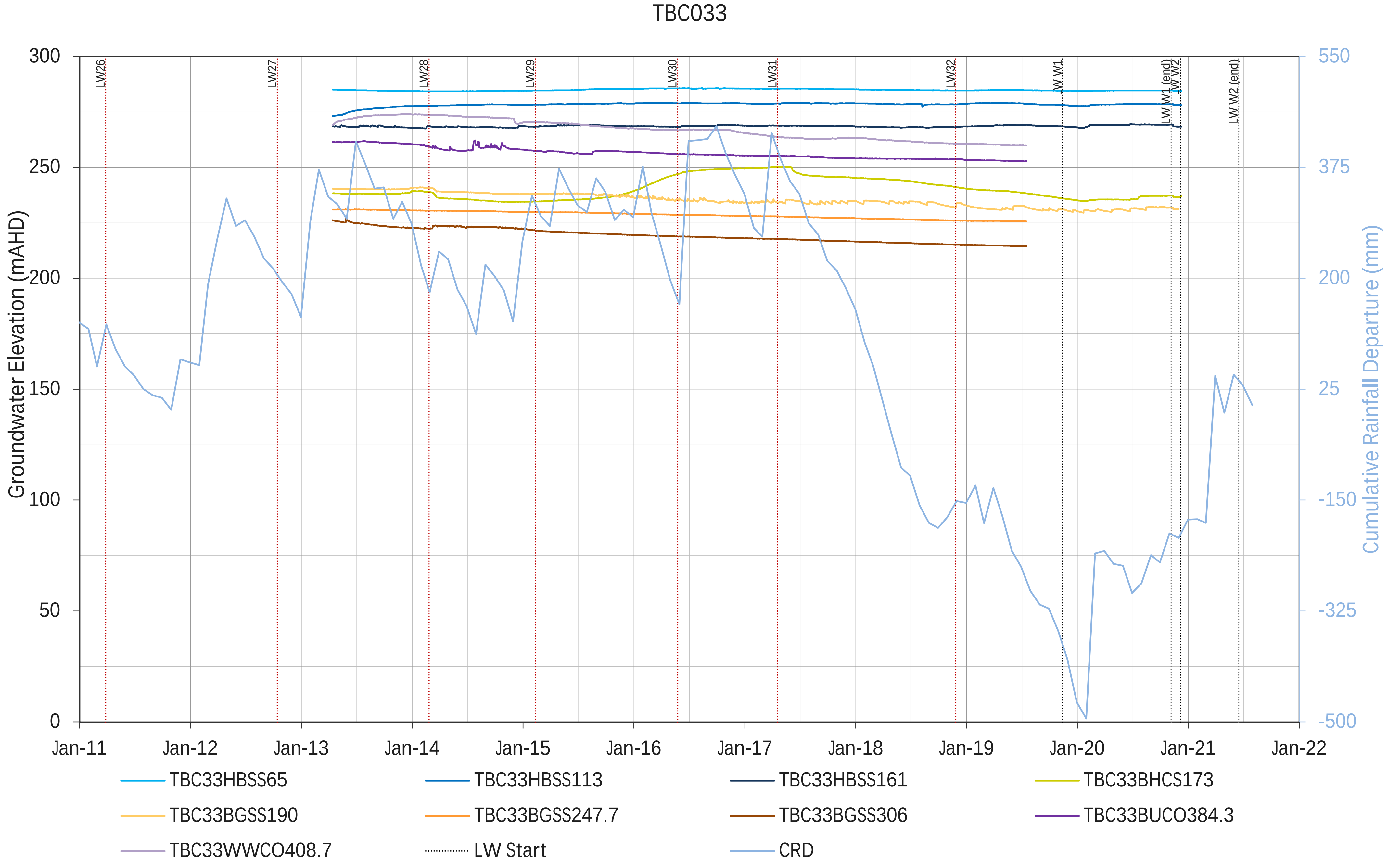
TBC024
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
400
350
300
250
200
150
100
50
0
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC24HBSS_95
TBC24HBSS117
TBC24HBSS139
TBC24BHCS168
TBC24BGSS185
TBC24BGSS240
TBC24BGSS295
TBC24WBCS350
TBC24WWCO384
TBC24WWCO391
LW Start
CRD


TBC026
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
250
200
150
100
50
0
500
300
100
-100
-300
-500
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
TBC26HBSS_95
TBC26HBSS135
TBC26HBSS176
TBC26BHCS191
TBC26BGSS211
TBC26BGSS278
TBC26BGSS344
TBC26SBSS409
TBC26BUCO432
TBC26UWWC460
TBC26LDSS440
LW Start
CRD

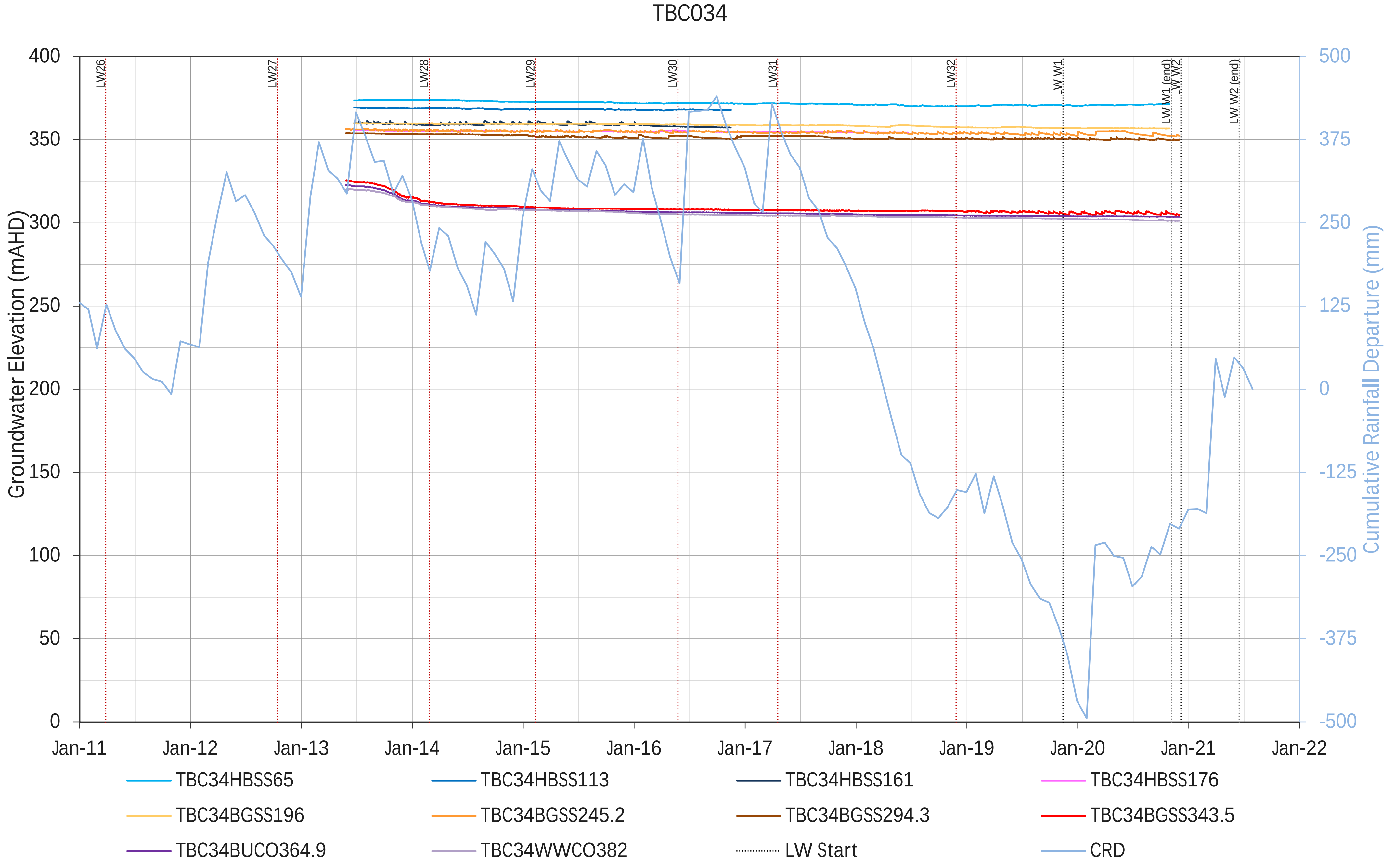
TBC027

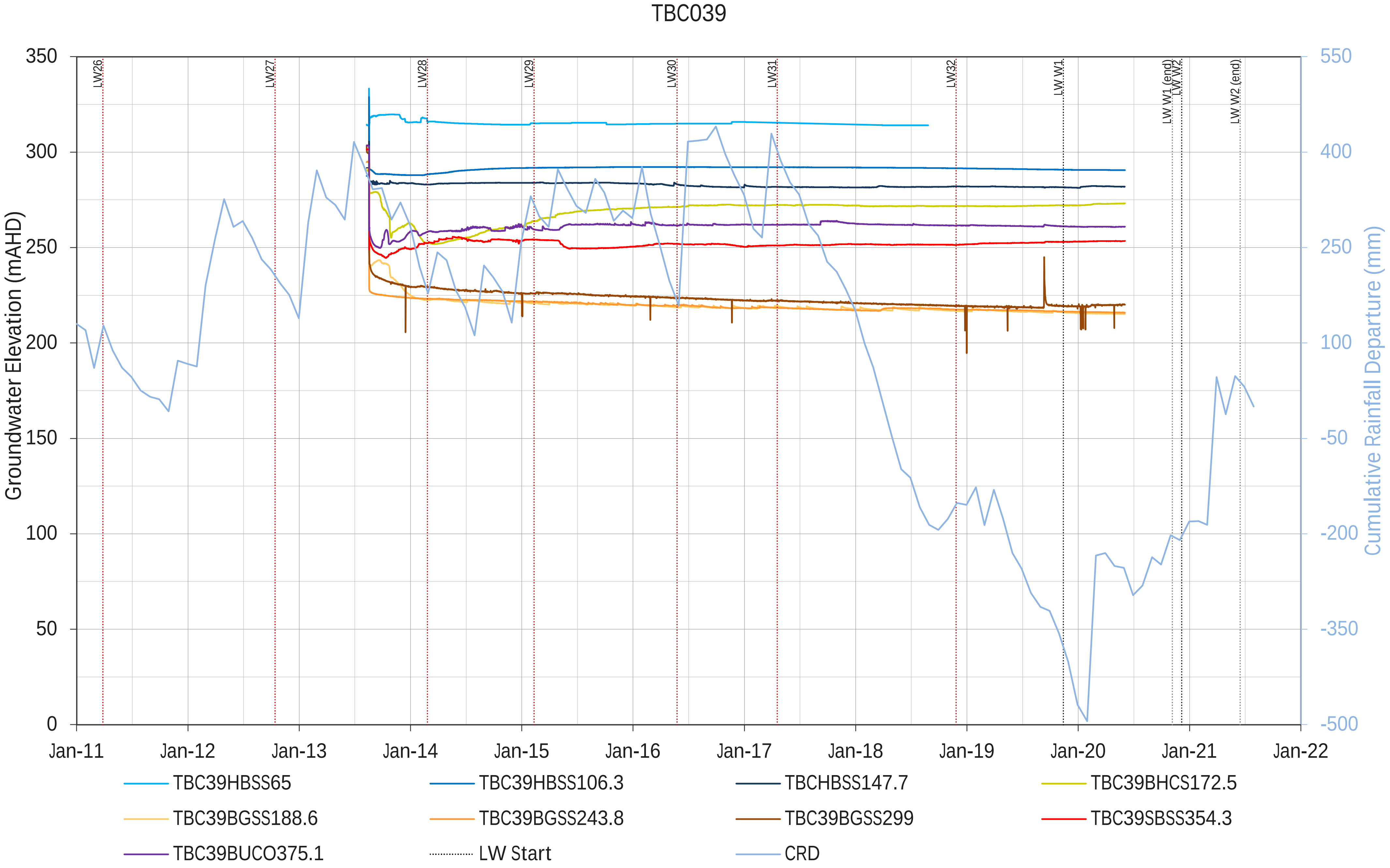

LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
330
325
320
315
310
305
300
295
290
285
625
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
TBC27HBSS_95
TBC27HBSS132
TBC27HBSS169
TBC27BHCS181
TBC27BGSS198
TBC27BGSS253
TBC27BGSS306
TBC27WBCS362
TBC27BUCO384
TBC27WWCO396
TBC27WWCO400
LW Start
CRD

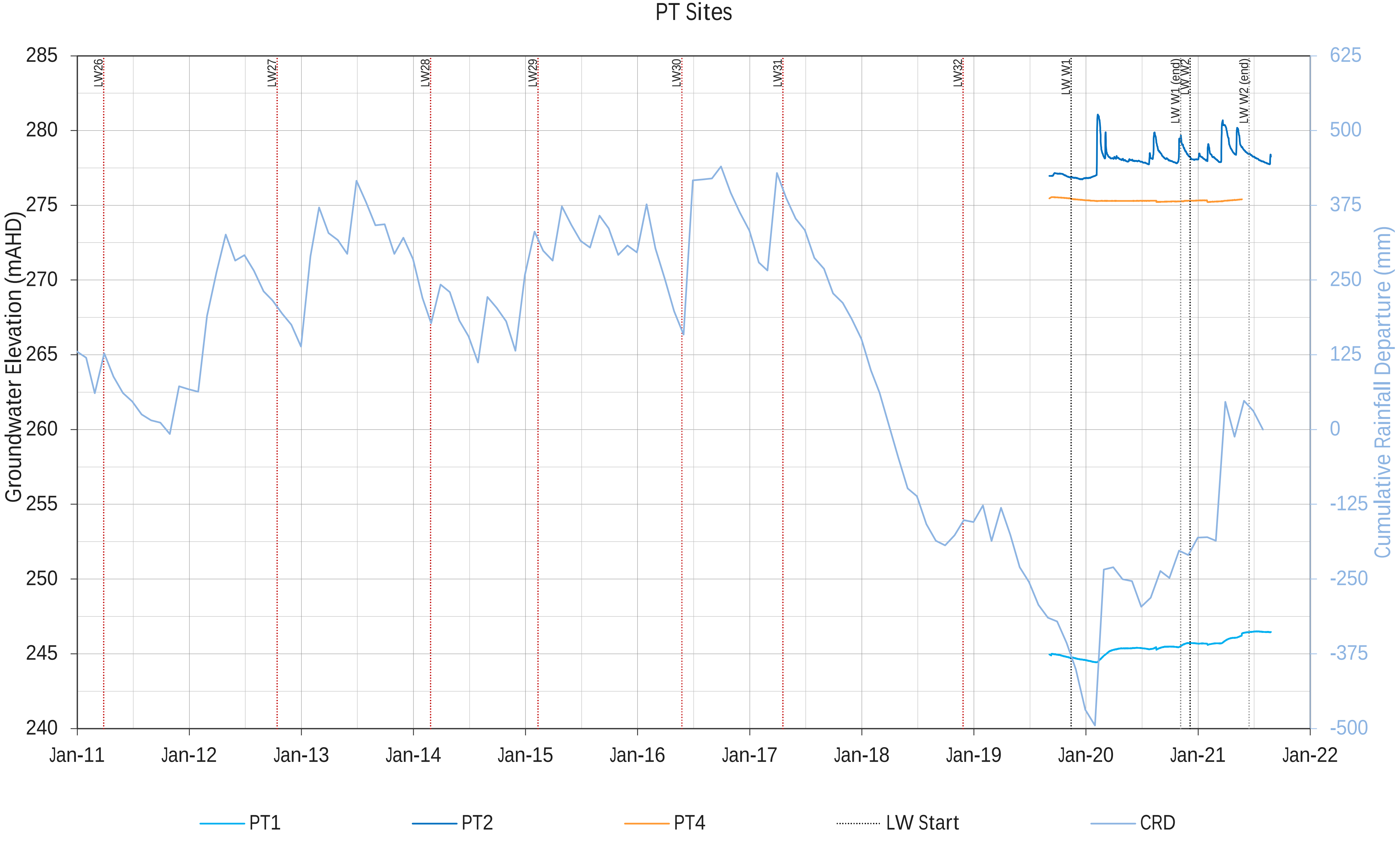

TBC032
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
300
250
200
150
100
50
0
550
375
200
25
-150
-325
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC32HBSS95
TBC32HBSS131
TBC32HBSS168
TBC32BHCS181
TBC32BGSS200
TBC32BGSS237
TBC32BGSS294
TBC32BGSS371
TBC32BUCO397
TBC32WWCO437
LW Start
CRD

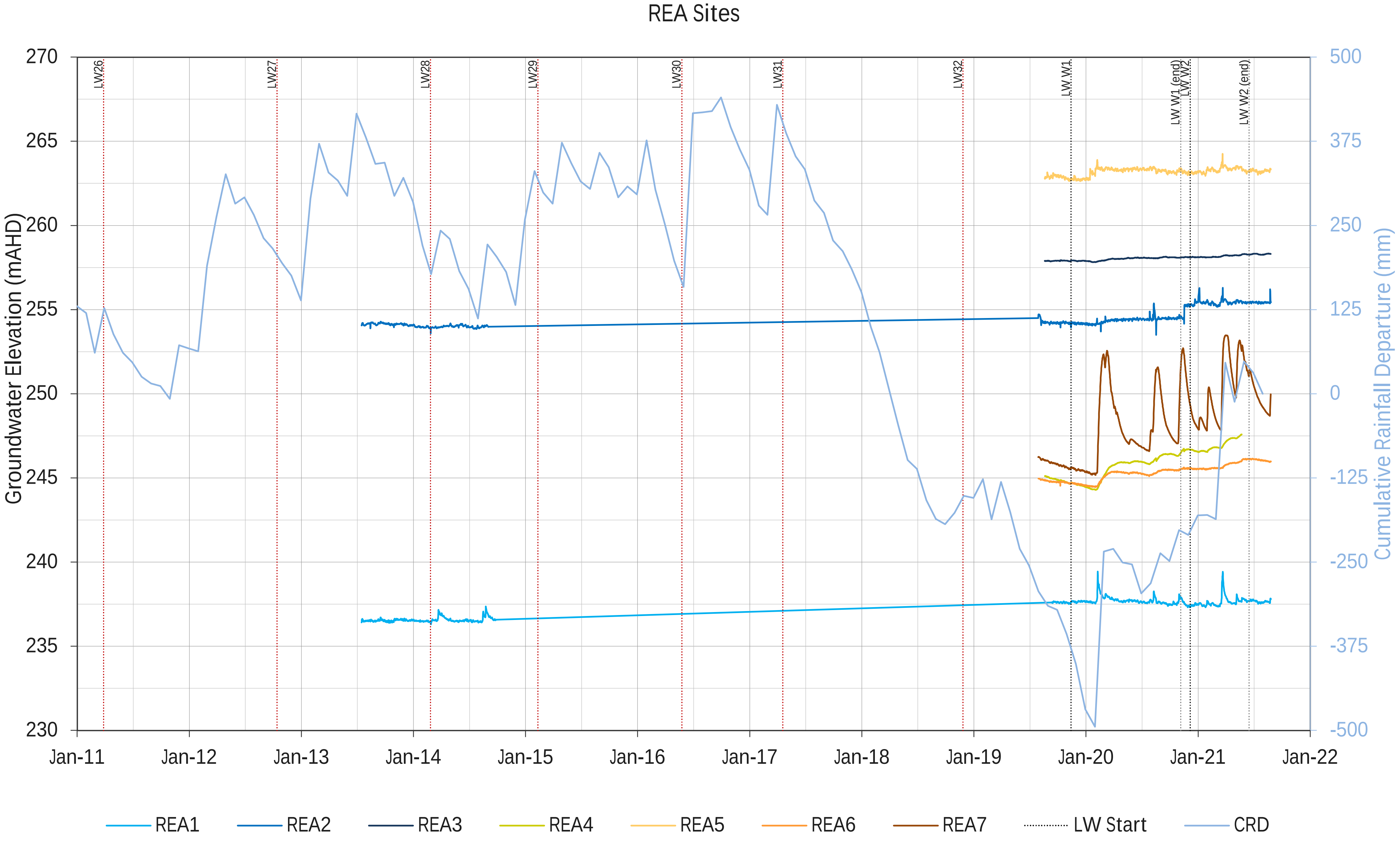


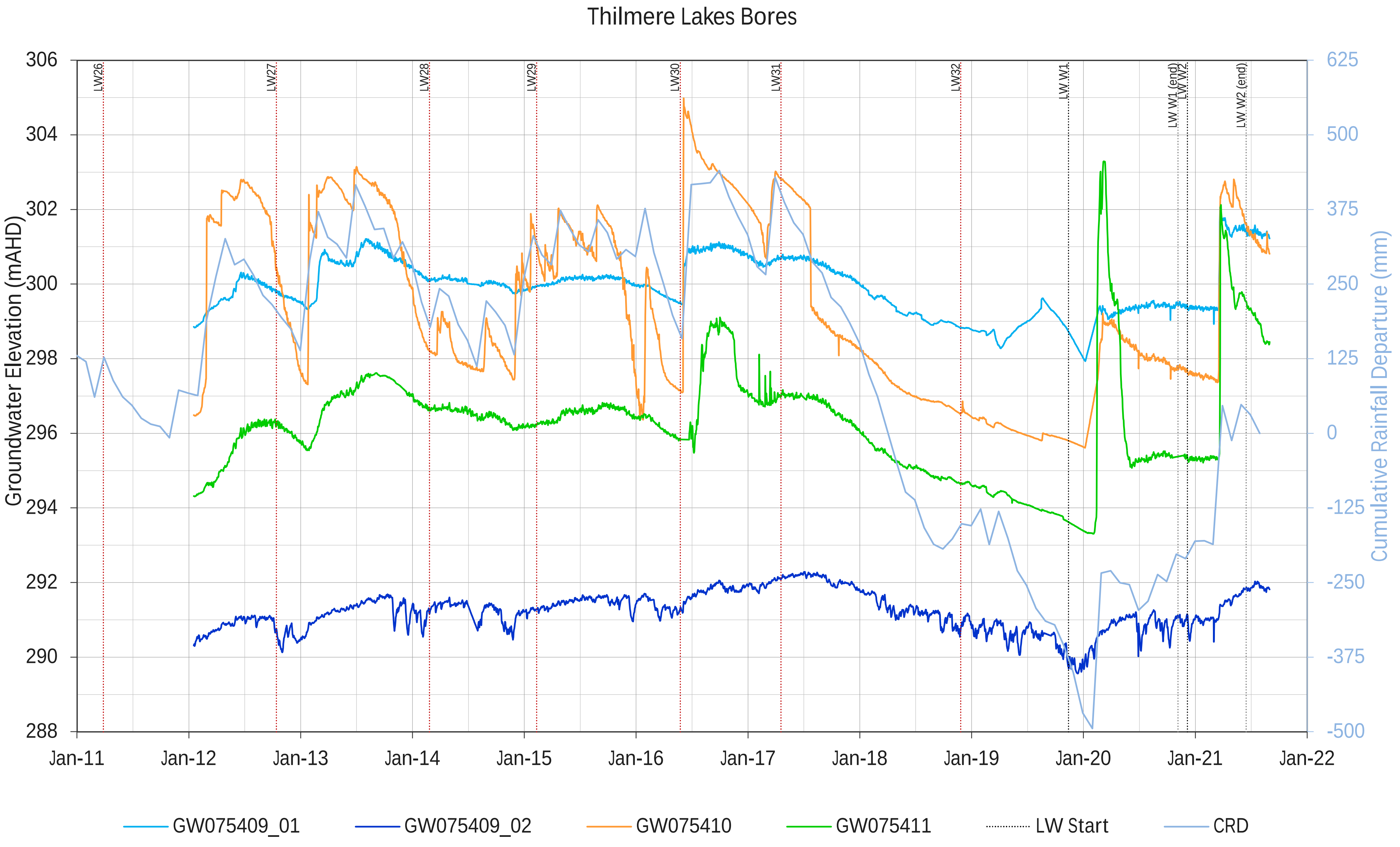
TBC033
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
300
250
200
150
100
50
0
550
375
200
25
-150
-325
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC33HBSS65
TBC33HBSS113
TBC33HBSS161
TBC33BHCS173
TBC33BGSS190
TBC33BGSS247.7
TBC33BGSS306
TBC33BUCO384.3
TBC33WWCO408.7
LW Start
CRD


TBC034
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
400
350
300
250
200
150
100
50
0
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC34HBSS65
TBC34HBSS113
TBC34HBSS161
TBC34HBSS176
TBC34BGSS196
TBC34BGSS245.2
TBC34BGSS294.3
TBC34BGSS343.5
TBC34BUCO364.9
TBC34WWCO382
LW Start
CRD

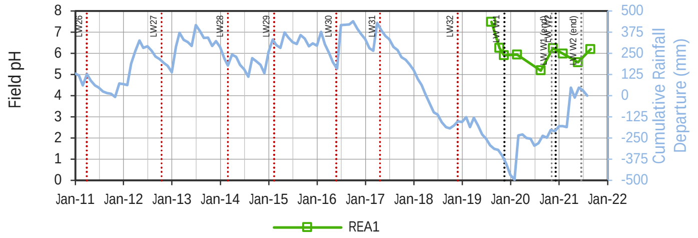

TBC039
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
350
300
250
200
150
100
50
0
550
400
250
100
-50
-200
-350
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
TBC39HBSS65
TBC39HBSS106.3
TBCHBSS147.7
TBC39BHCS172.5
TBC39BGSS188.6
TBC39BGSS243.8
TBC39BGSS299
TBC39SBSS354.3
TBC39BUCO375.1
LW Start
CRD

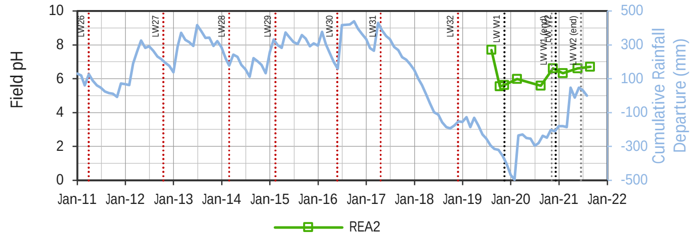

PT Sites
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
285
280
275
270
265
260
255
250
245
240
625
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
PT1
PT2
PT4
LW Start
CRD

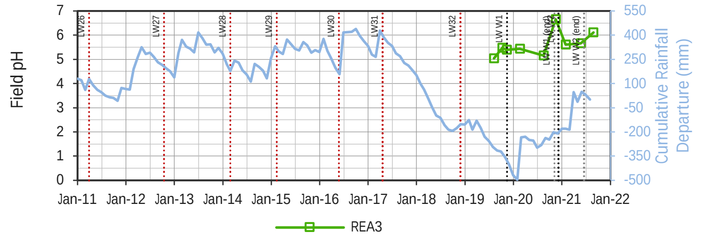

REA Sites
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
270
265
260
255
250
245
240
235
230
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA1
REA2
REA3
REA4
REA5
REA6
REA7
LW Start
CRD

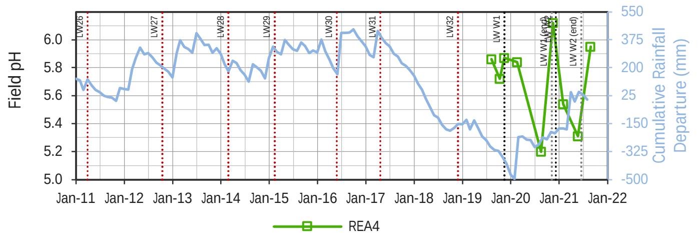


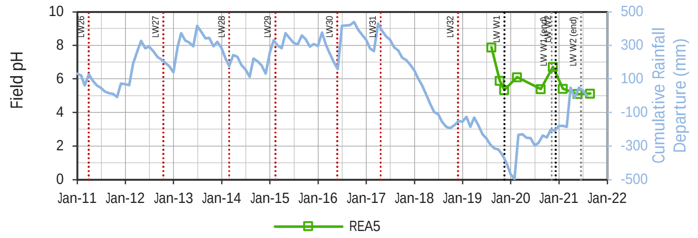
Thilmere Lakes Bores
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
306
304
302
300
298
296
294
292
290
288
625
500
375
250
125
0
-125
-250
-375
-500
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
GW075409_01
GW075409_02
GW075410
GW075411
LW Start
CRD

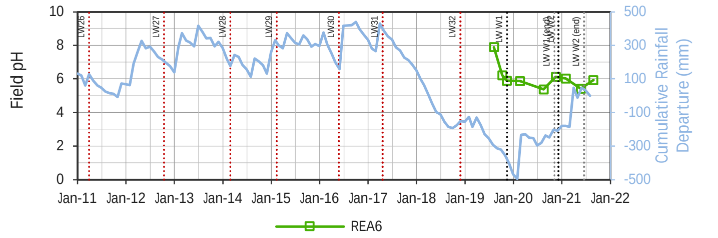

Field pH
Cumulative Rainfall Departure (mm)
REA1

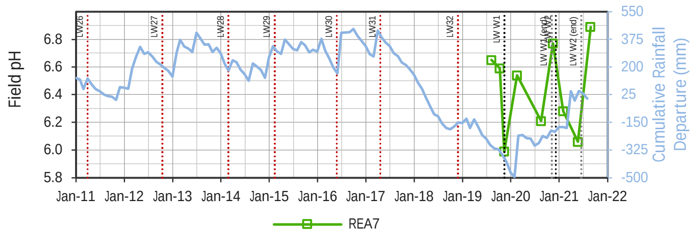

Field pH
Cumulative Rainfall Departure (mm)
REA2

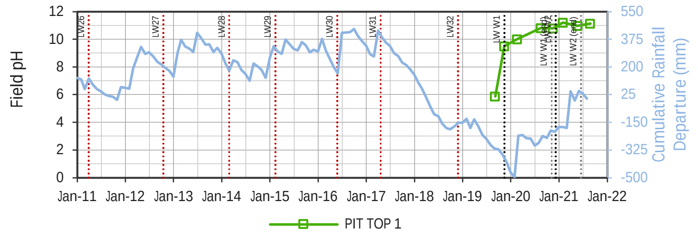

Field pH
Cumulative Rainfall Departure (mm)
REA3

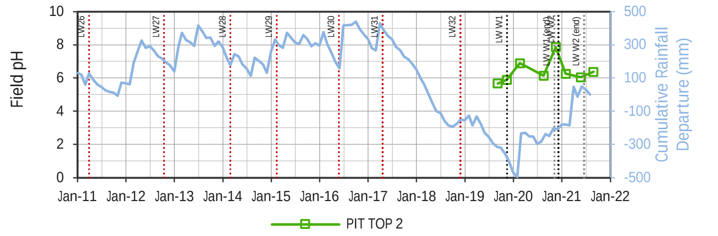

Field pH
Cumulative Rainfall Departure (mm)
REA4

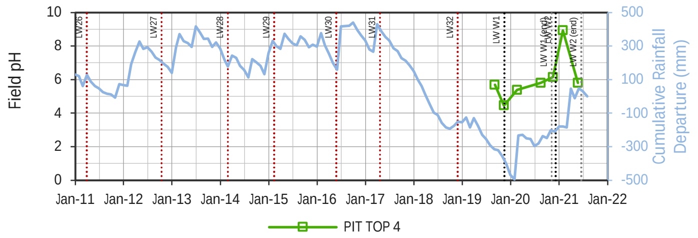

Field pH
Cumulative Rainfall Departure (mm)
REA5

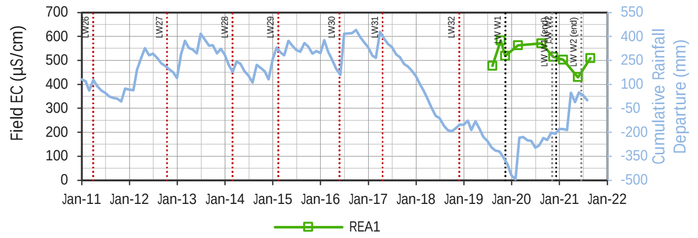

Field pH
Cumulative Rainfall Departure (mm)
REA6

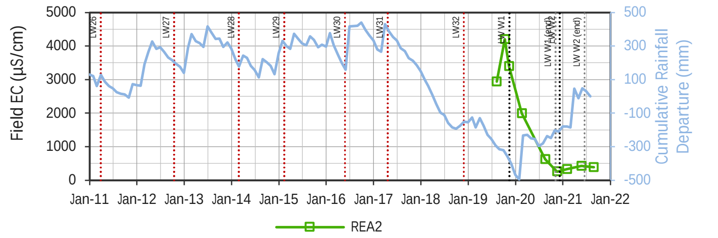

Field pH
Cumulative Rainfall Departure (mm)
REA7

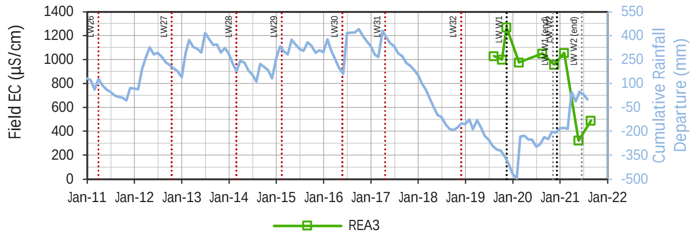

Field pH
Cumulative Rainfall Departure (mm)
PIT TOP 1

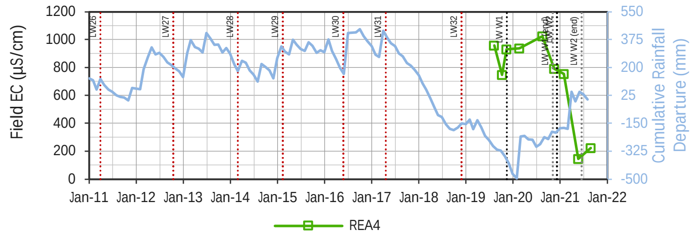

Field pH
Cumulative Rainfall Departure (mm)
PIT TOP 2

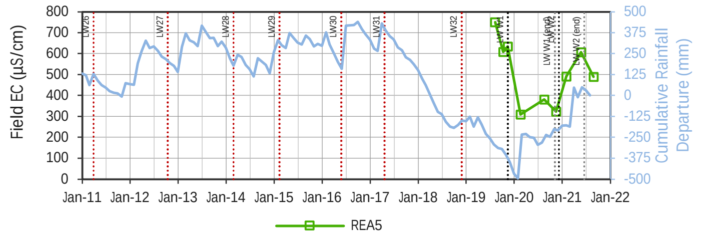

Field pH
Cumulative Rainfall Departure (mm)
PIT TOP 4

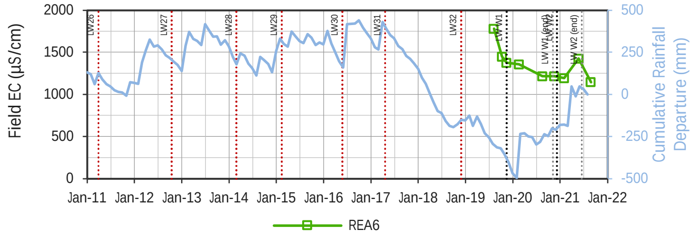

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA1

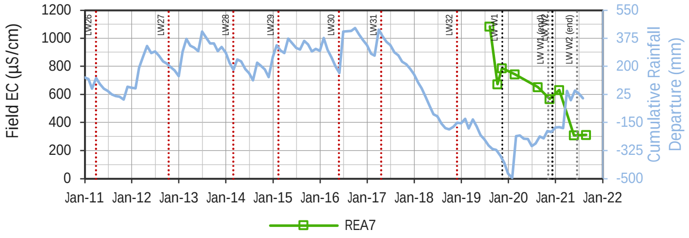

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA2

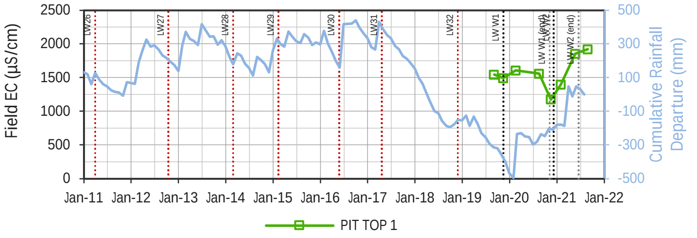

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA3

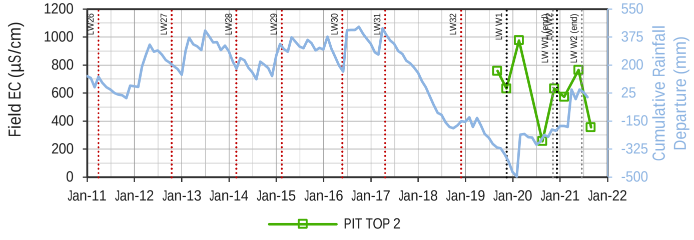

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA4

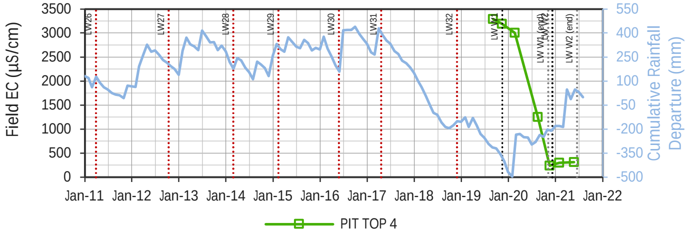

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA5

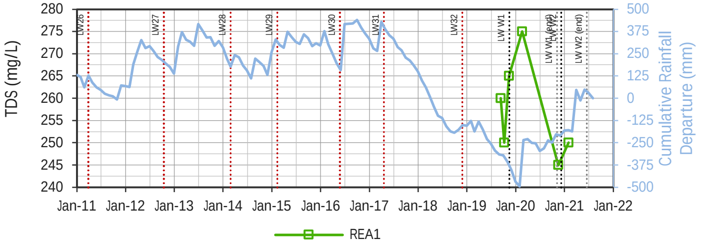

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA6

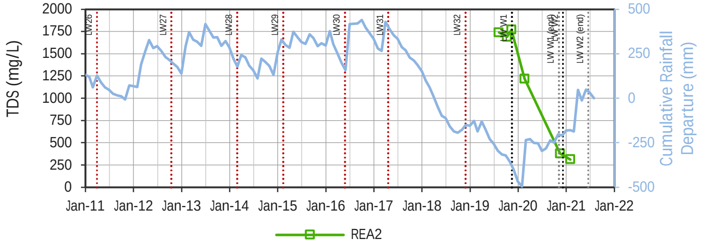

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
REA7

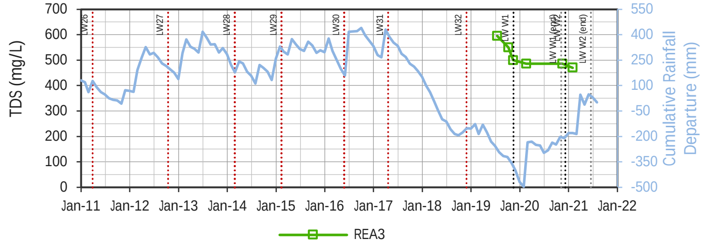

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
PIT TOP 1

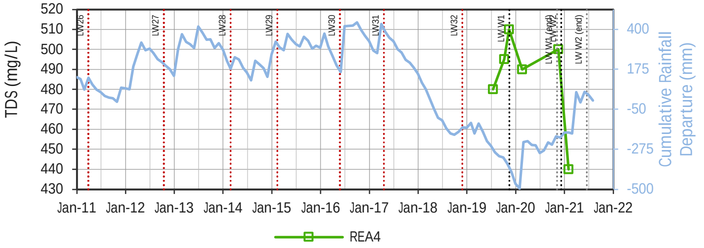

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
PIT TOP 2

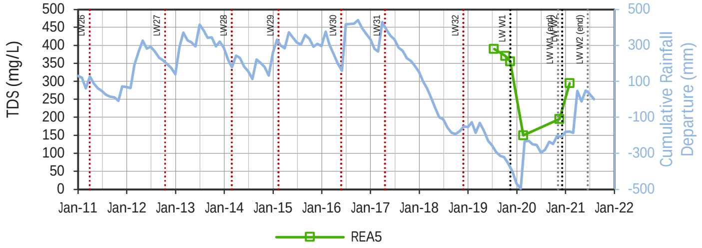

Field EC (µS/cm)
Cumulative Rainfall Departure (mm)
PIT TOP 4

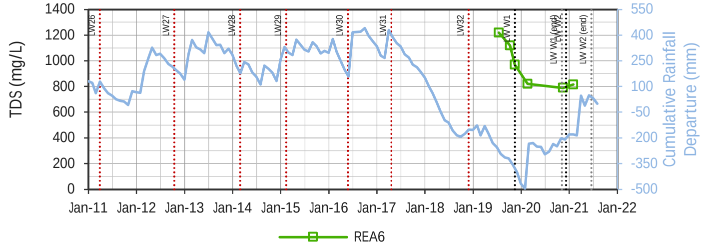

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA1

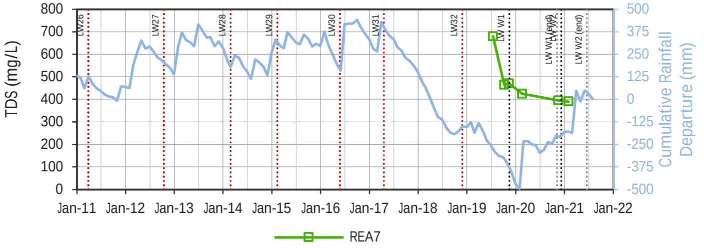

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA2

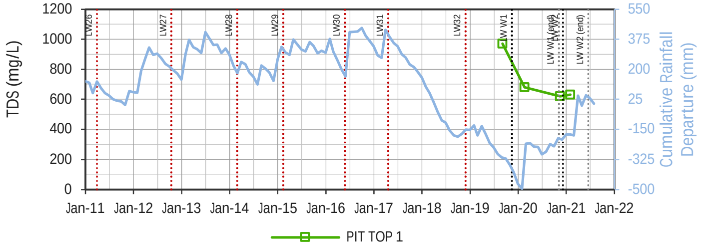

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA3

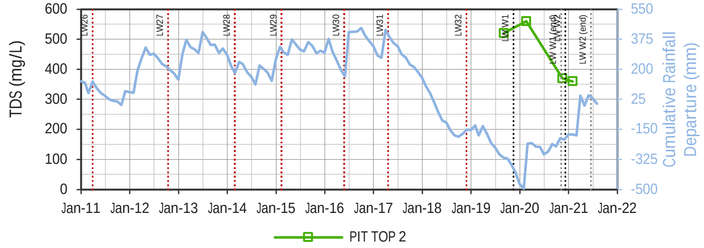

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA4

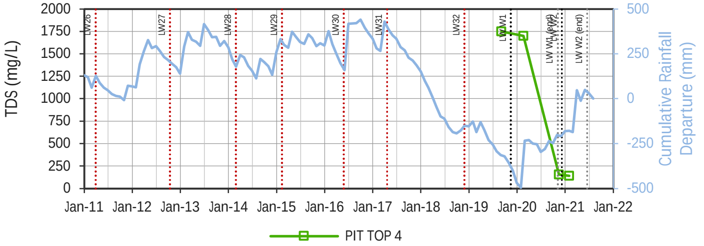

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA5

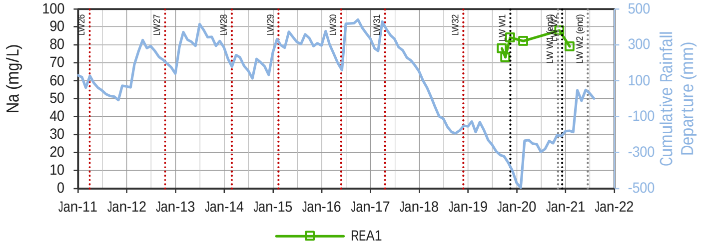

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA6

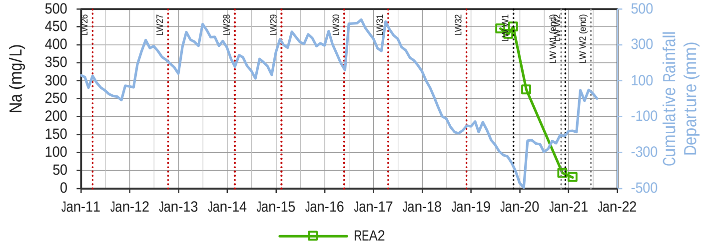

TDS (mg/L)
Cumulative Rainfall Departure (mm)
REA7

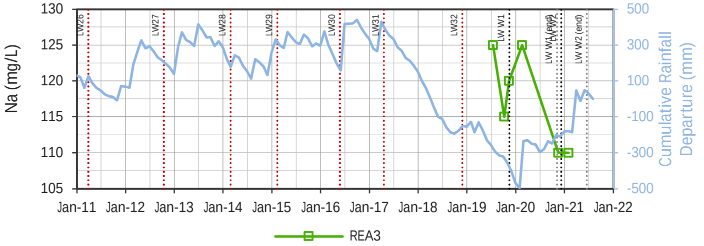

TDS (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

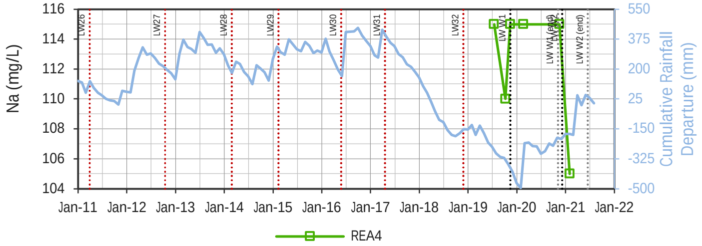

TDS (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

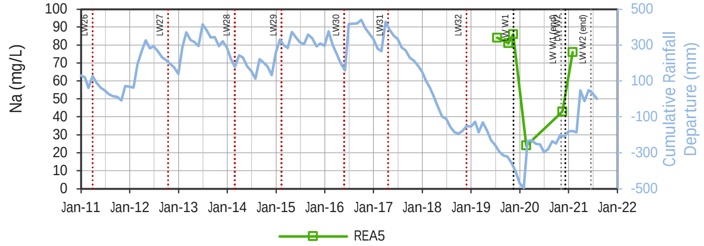

TDS (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

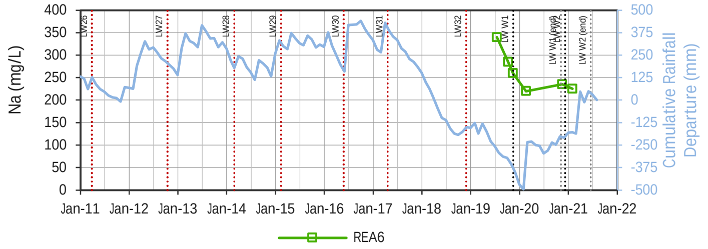

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA1

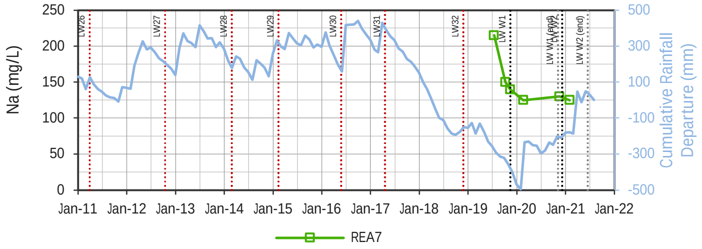

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA2

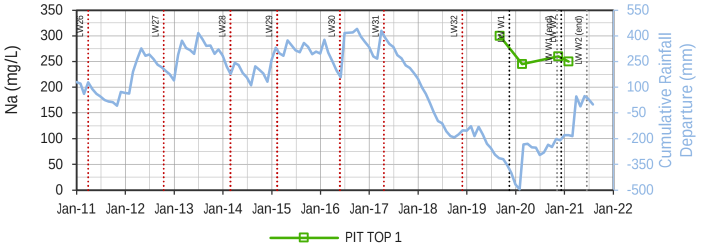

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA3

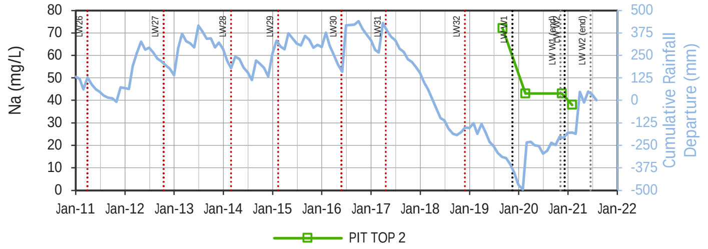

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA4

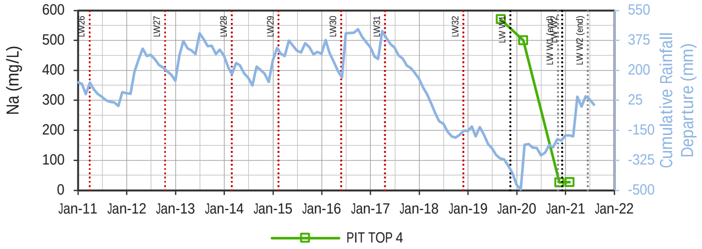

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA5

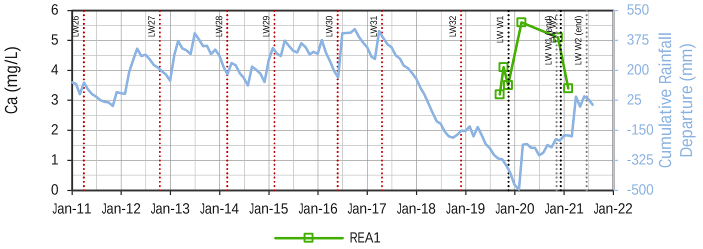

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA6

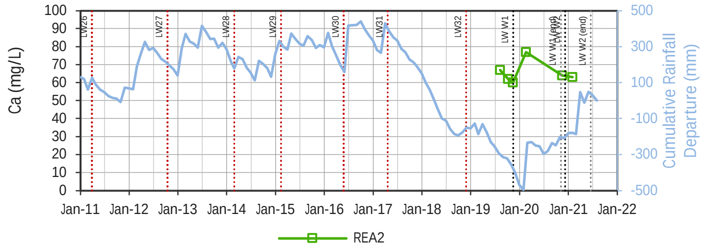

Na (mg/L)
Cumulative Rainfall Departure (mm)
REA7

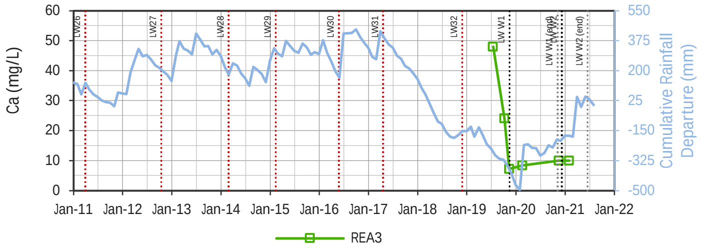

Na (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

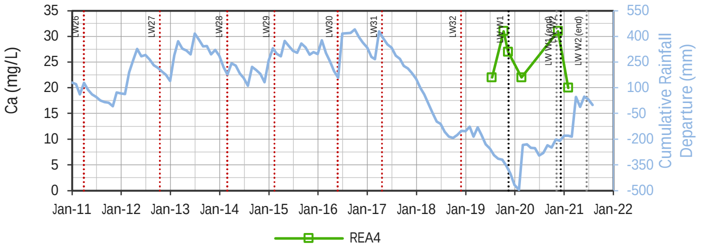

Na (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

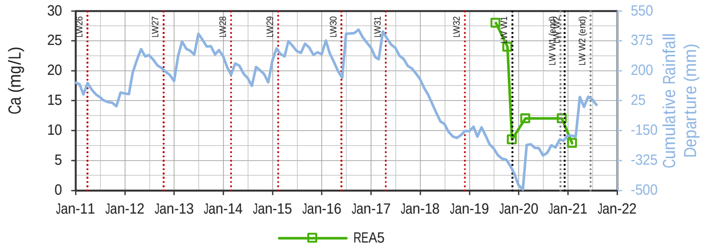

Na (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

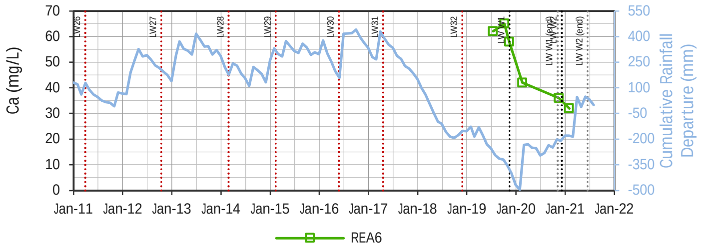

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA1

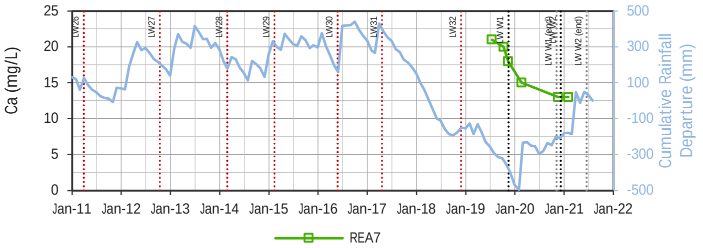

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA2

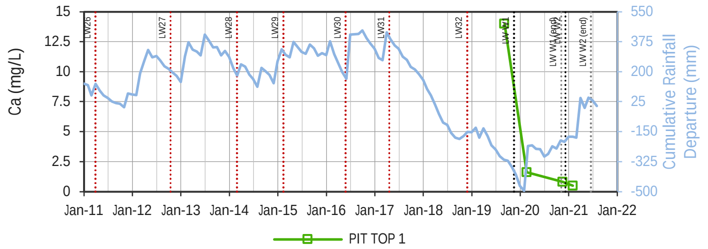

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA3

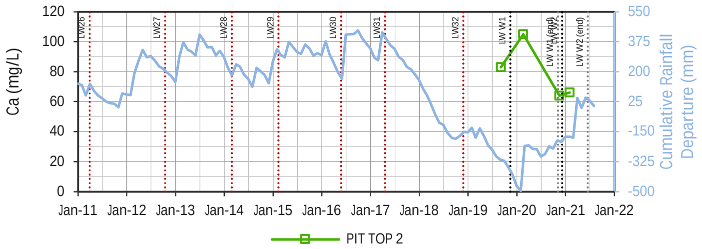

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA4

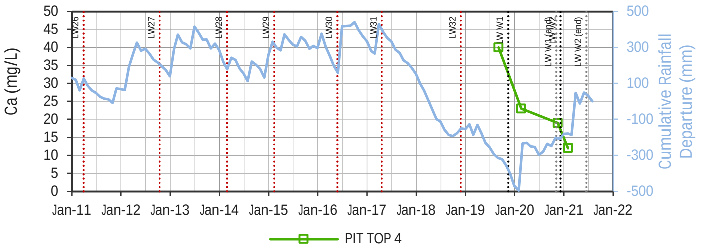

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA5

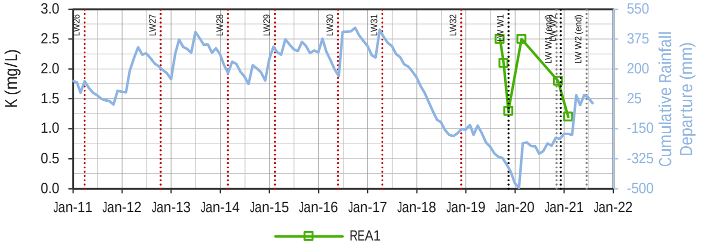

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA6

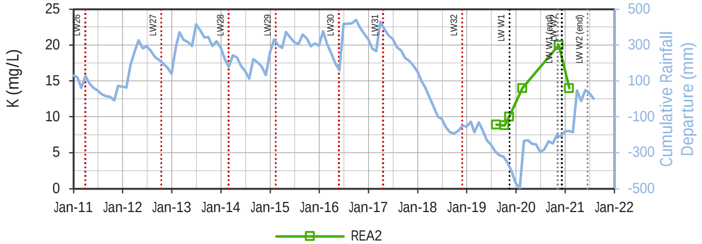

Ca (mg/L)
Cumulative Rainfall Departure (mm)
REA7

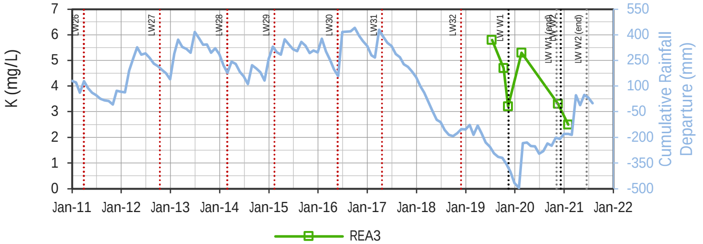

Ca (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

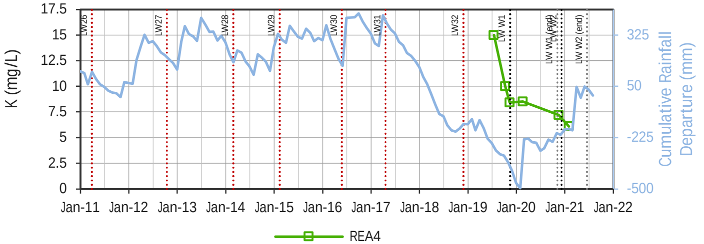

Ca (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

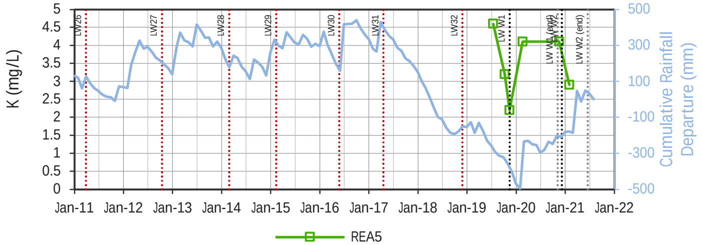

Ca (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

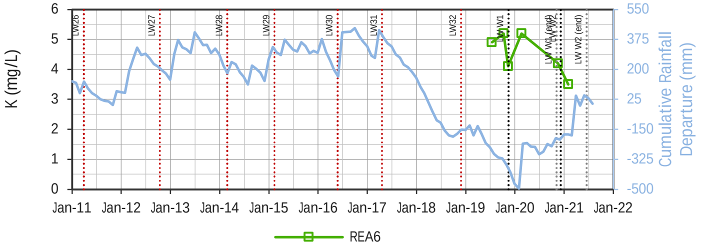

K (mg/L)
Cumulative Rainfall Departure (mm)
REA1

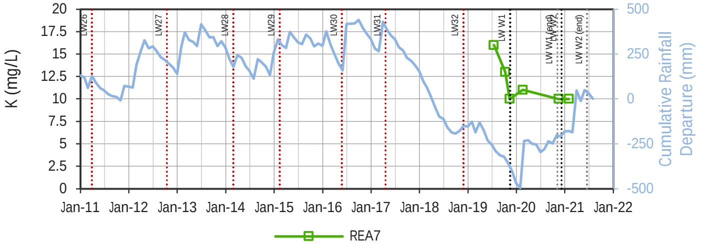

K (mg/L)
Cumulative Rainfall Departure (mm)
REA2

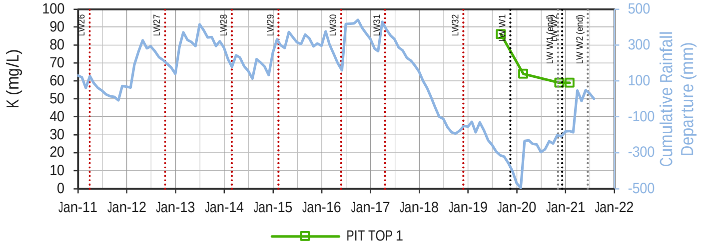

K (mg/L)
Cumulative Rainfall Departure (mm)
REA3

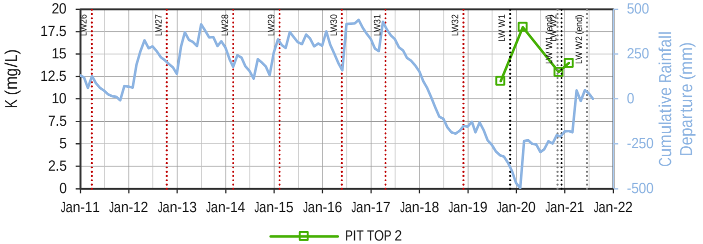

K (mg/L)
Cumulative Rainfall Departure (mm)
REA4

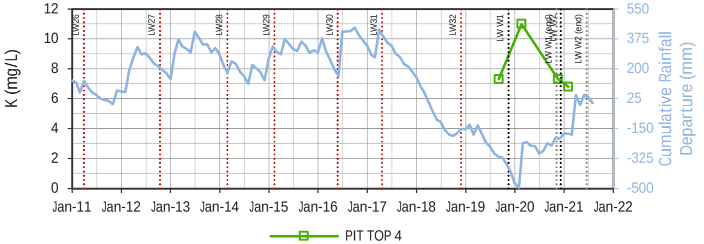

K (mg/L)
Cumulative Rainfall Departure (mm)
REA5

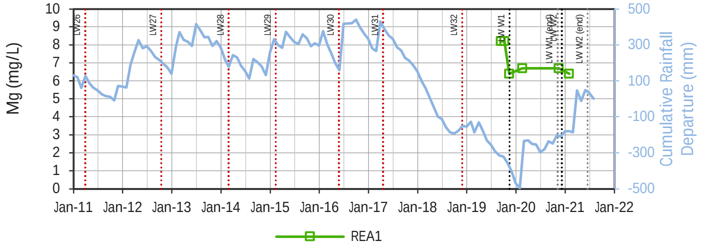

K (mg/L)
Cumulative Rainfall Departure (mm)
REA6

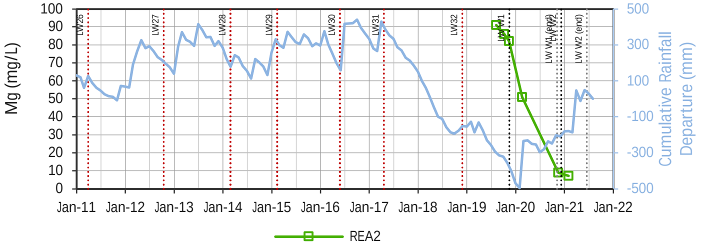

K (mg/L)
Cumulative Rainfall Departure (mm)
REA7

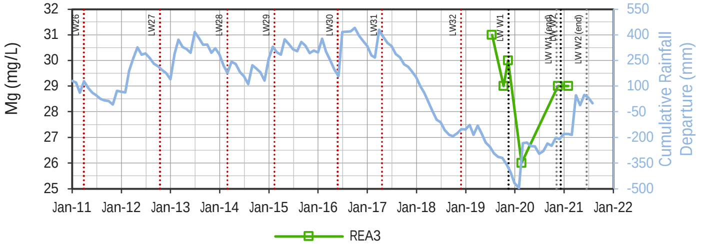

K (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

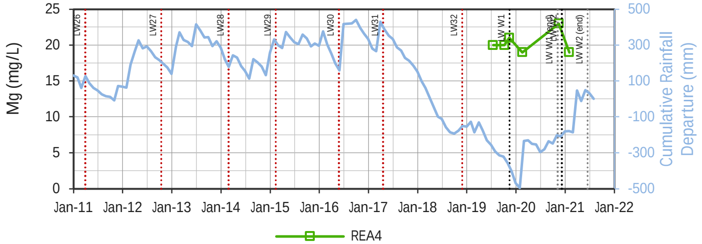

K (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

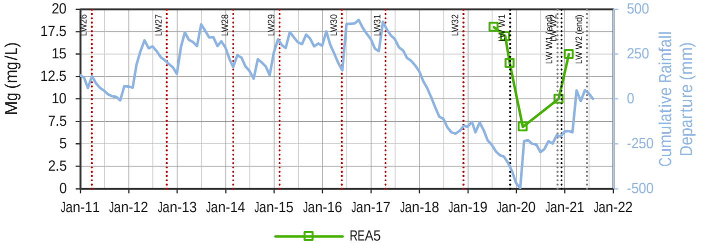

K (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

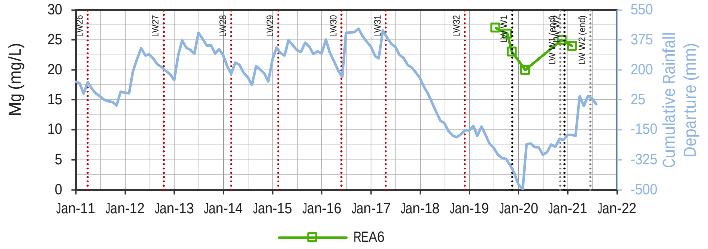

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA1

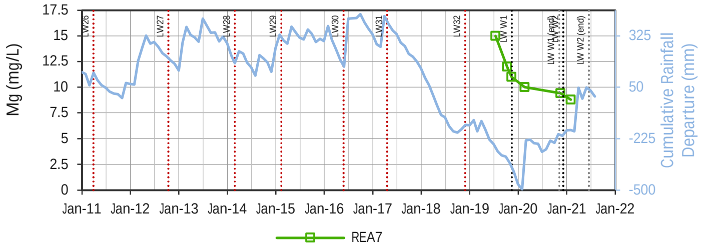

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA2

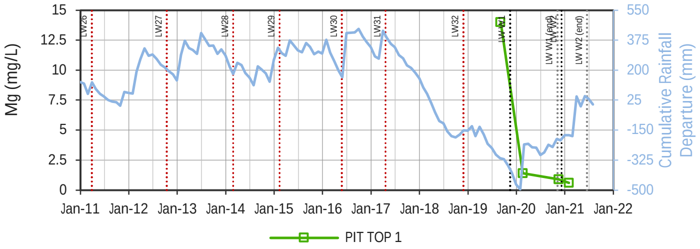

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA3

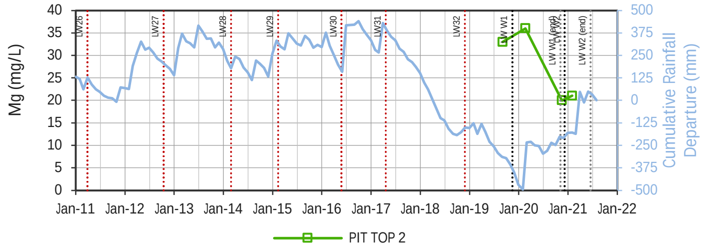

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA4

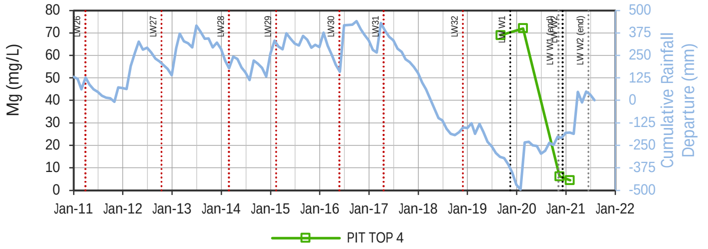

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA5

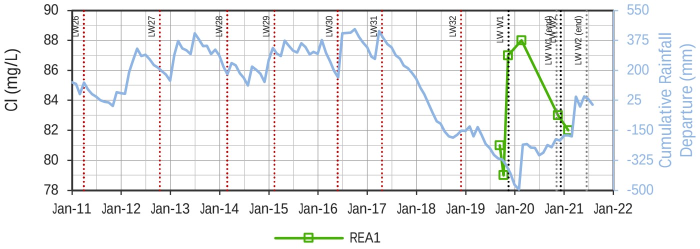

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA6

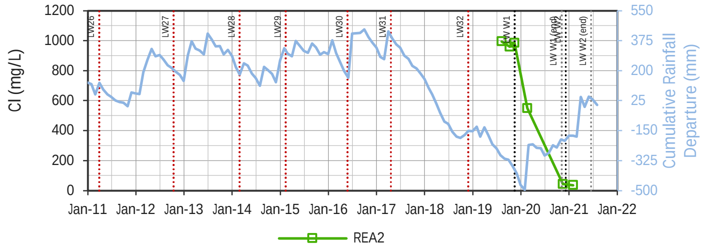

Mg (mg/L)
Cumulative Rainfall Departure (mm)
REA7

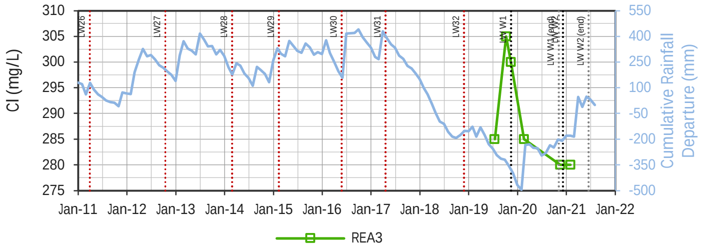

Mg (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

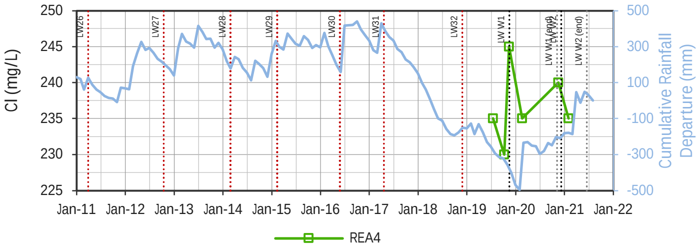

Mg (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

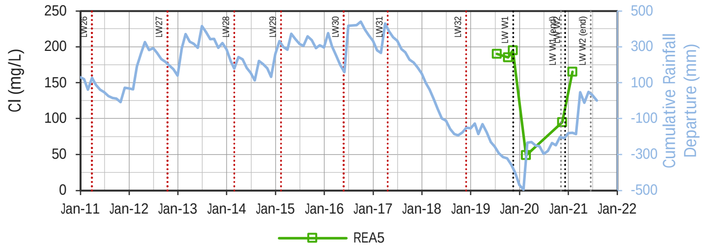

Mg (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

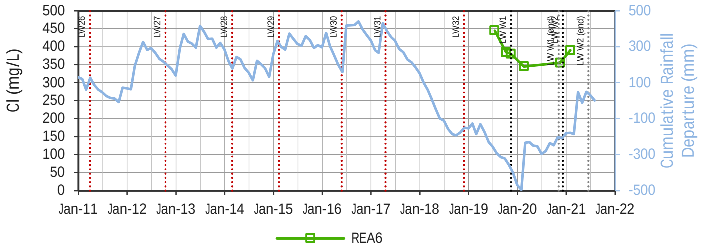

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA1

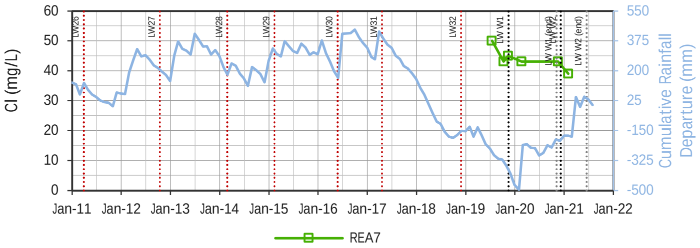

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA2

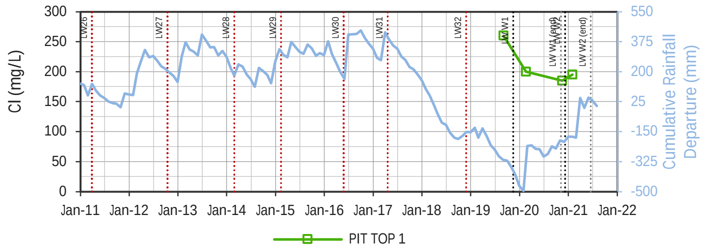

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA3

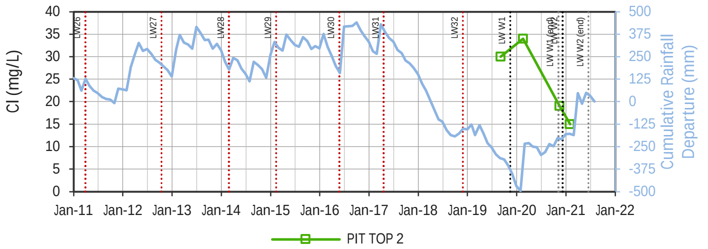

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA4

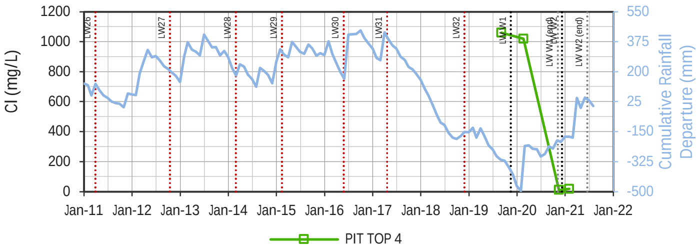

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA5

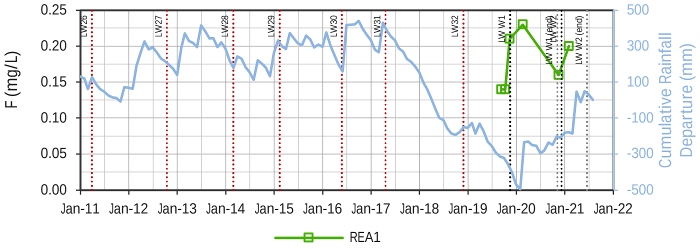

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA6

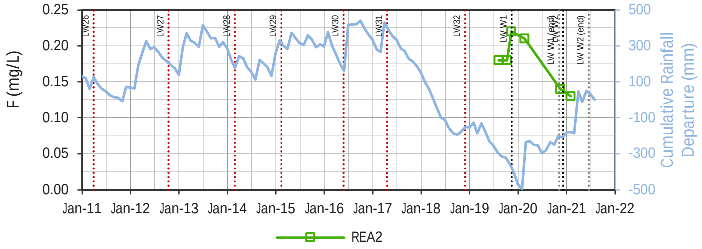

Cl (mg/L)
Cumulative Rainfall Departure (mm)
REA7

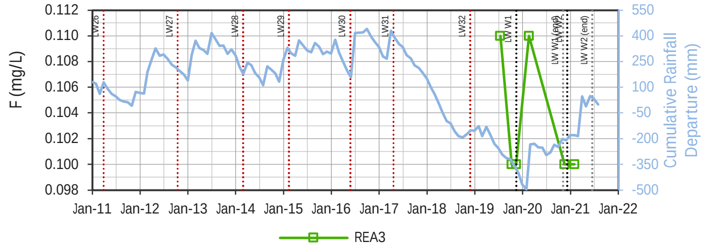

Cl (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

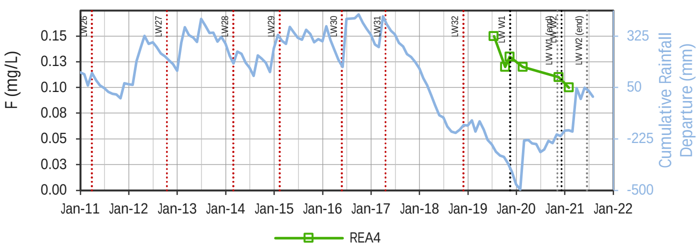

Cl (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

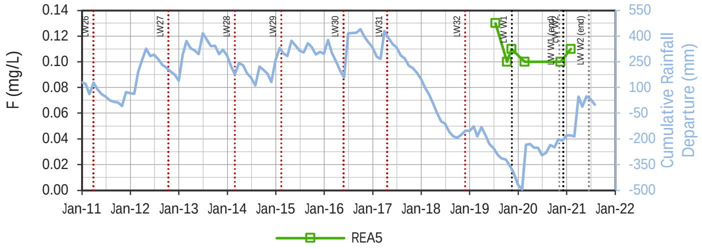

Cl (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

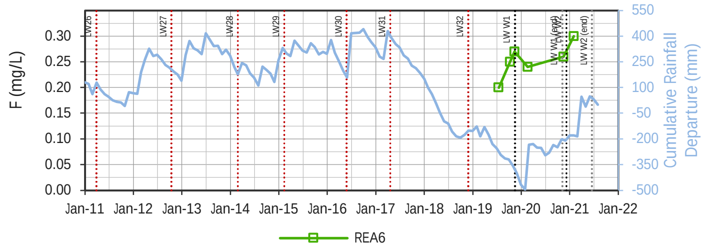

F (mg/L)
Cumulative Rainfall Departure (mm)
REA1

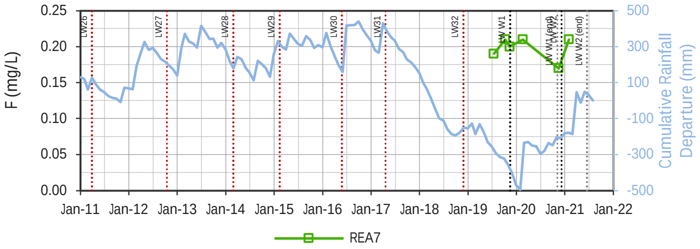

F (mg/L)
Cumulative Rainfall Departure (mm)
REA2

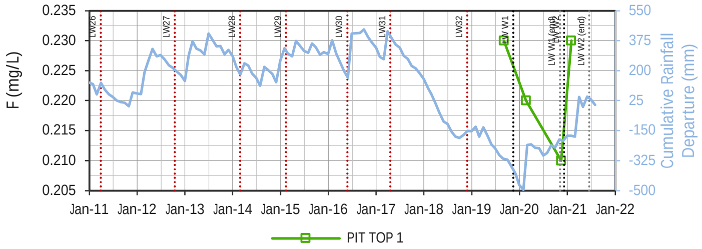

F (mg/L)
Cumulative Rainfall Departure (mm)
REA3

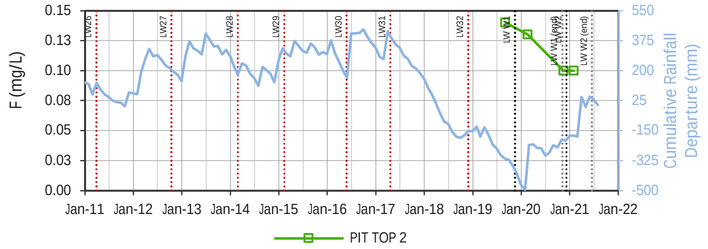

F (mg/L)
Cumulative Rainfall Departure (mm)
REA4

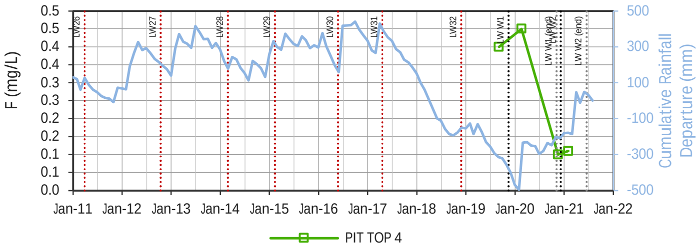

F (mg/L)
Cumulative Rainfall Departure (mm)
REA5

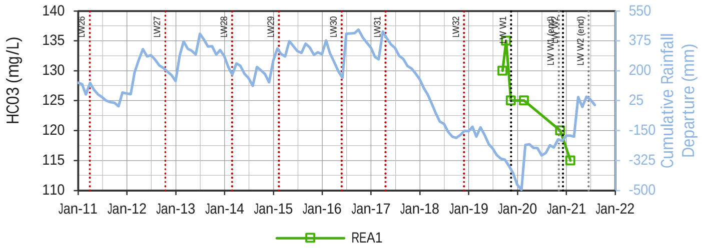

F (mg/L)
Cumulative Rainfall Departure (mm)
REA6

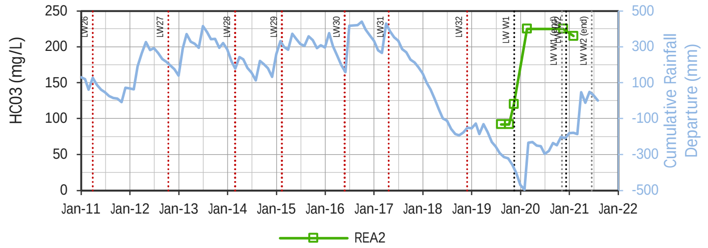

F (mg/L)
Cumulative Rainfall Departure (mm)
REA7

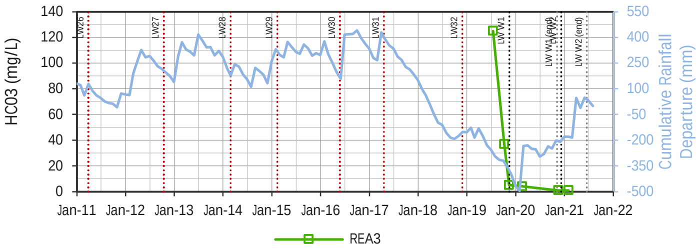

F (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

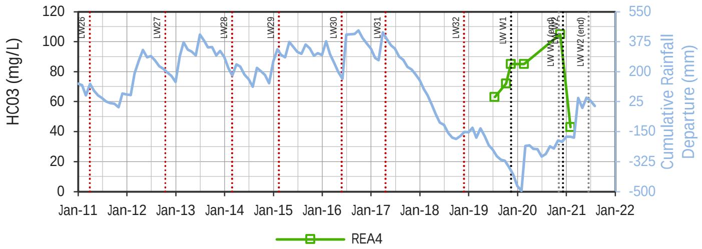

F (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

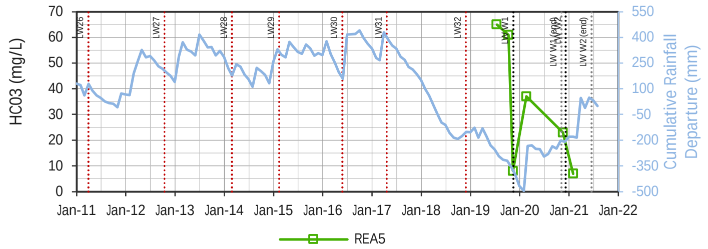

F (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

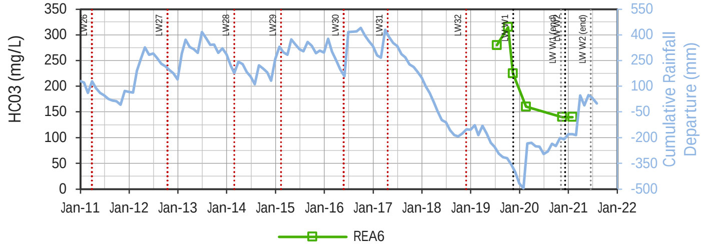

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA1

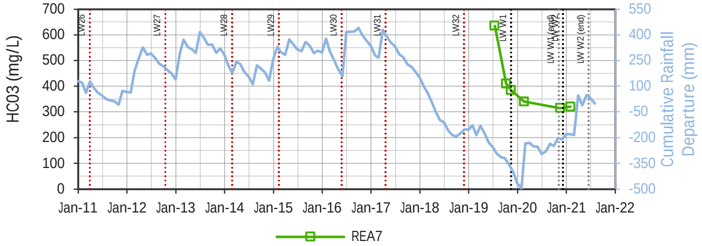

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA2

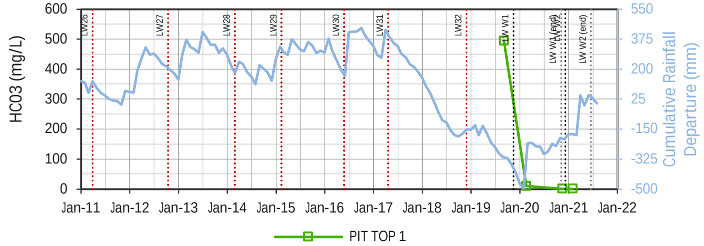

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA3

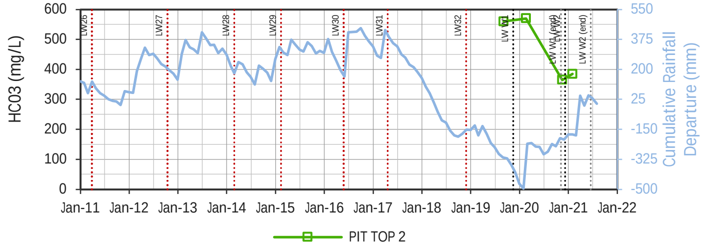

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA4

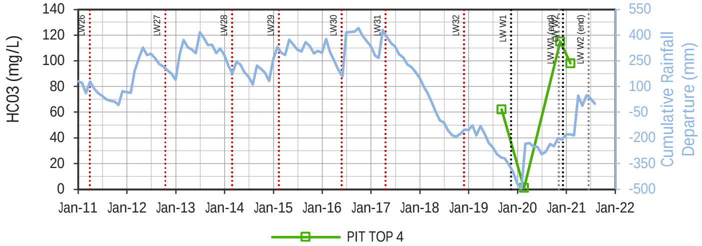

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA5

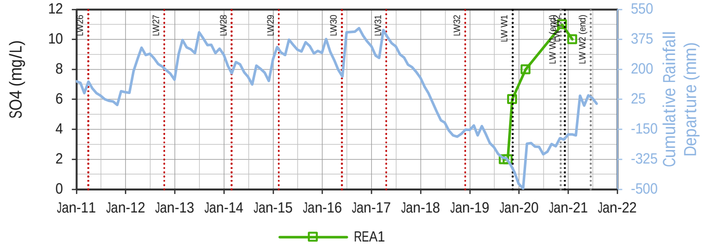

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA6

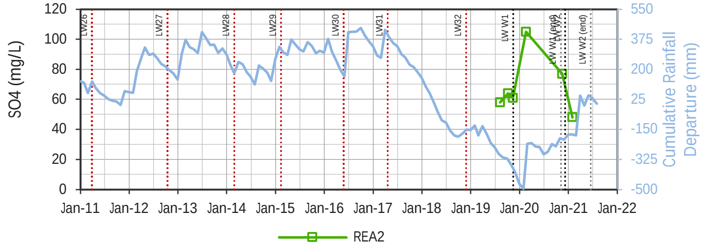

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
REA7

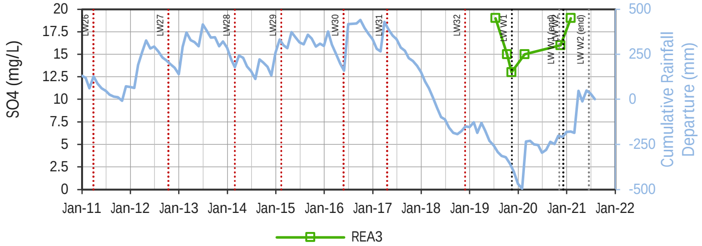

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

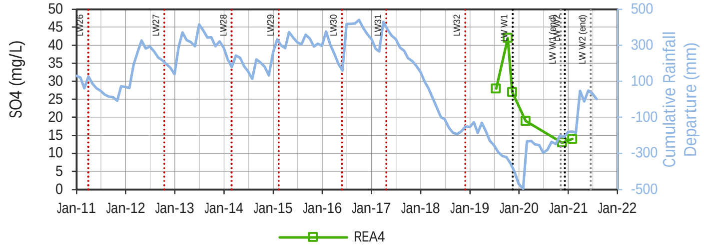

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

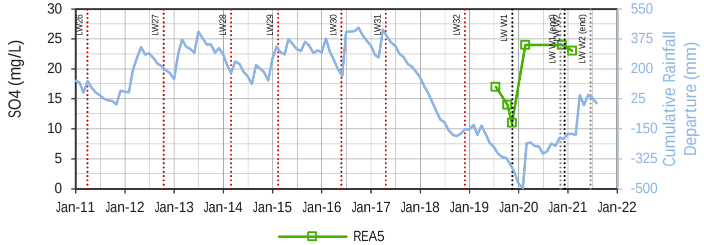

HC03 (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

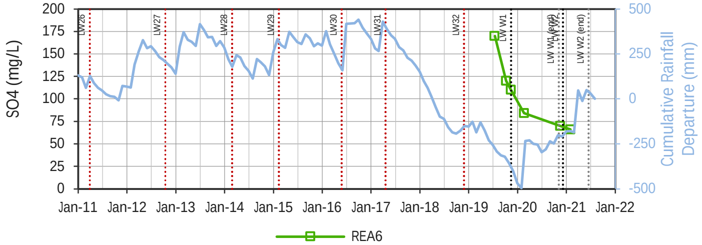

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA1

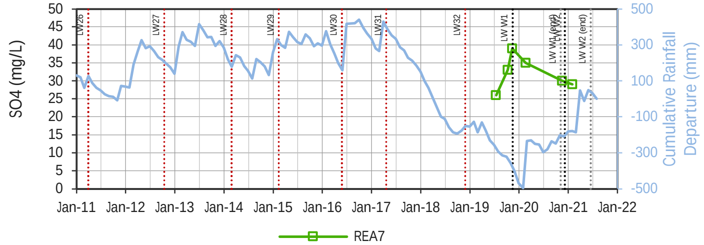

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA2

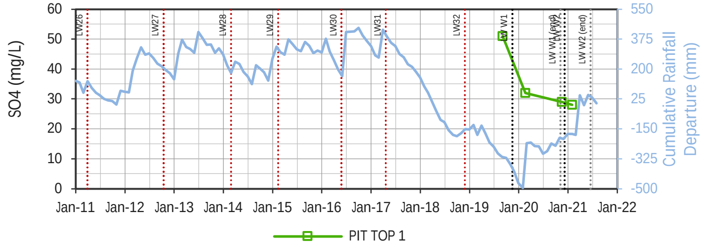

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA3

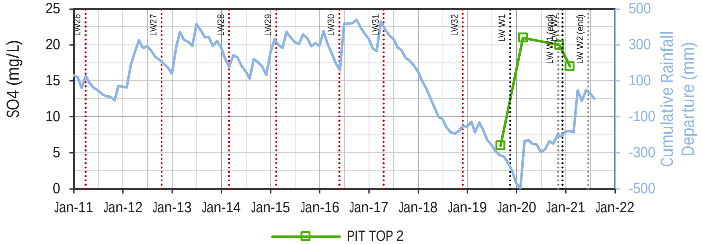

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA4

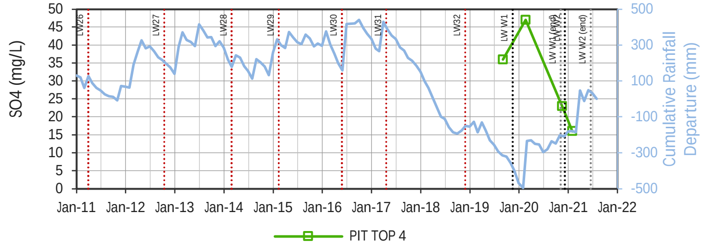

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA5

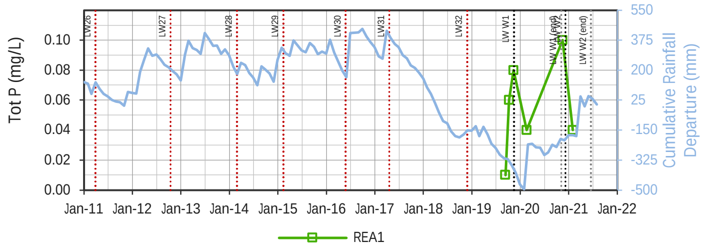

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA6

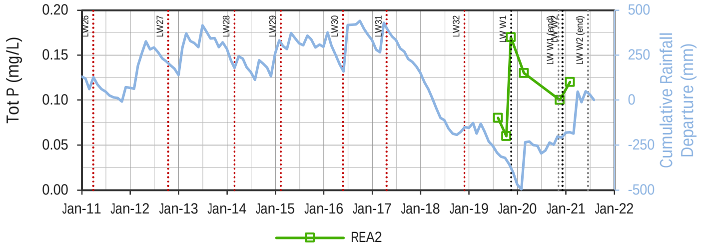

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
REA7

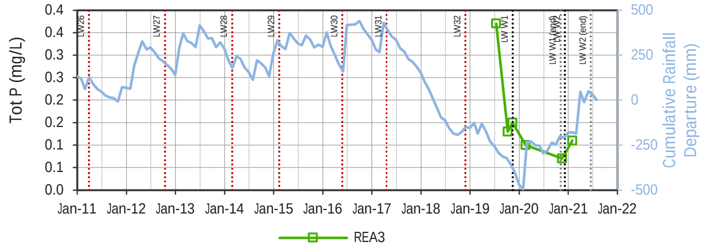

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

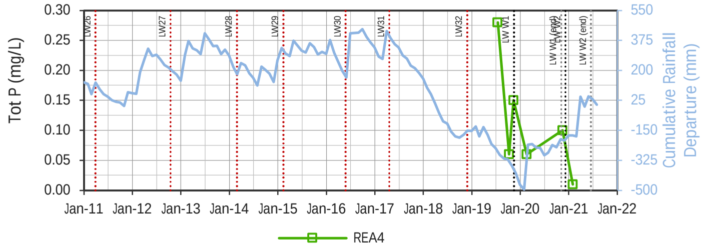

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

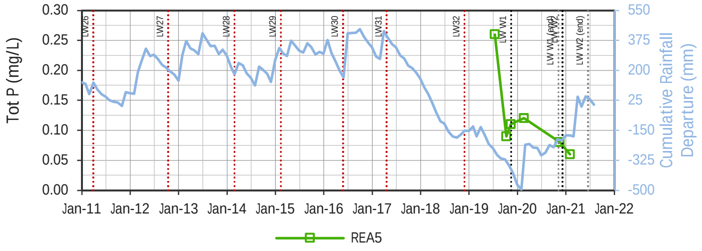

SO4 (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

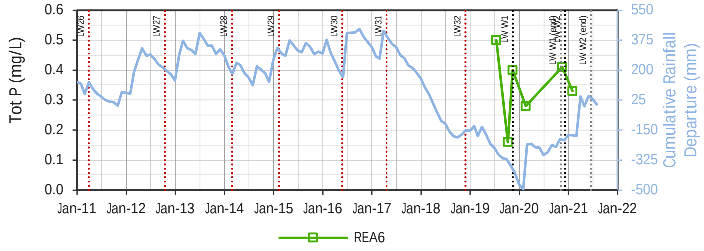

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA1

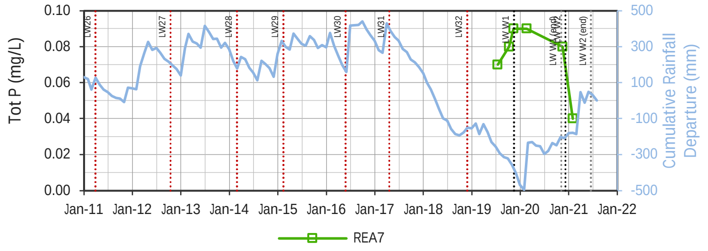

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA2

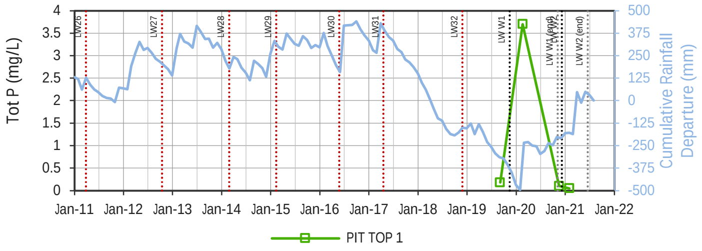

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA3

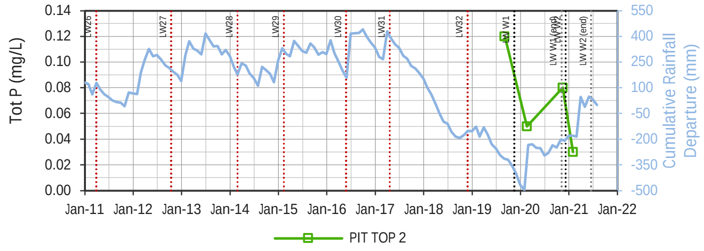

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA4

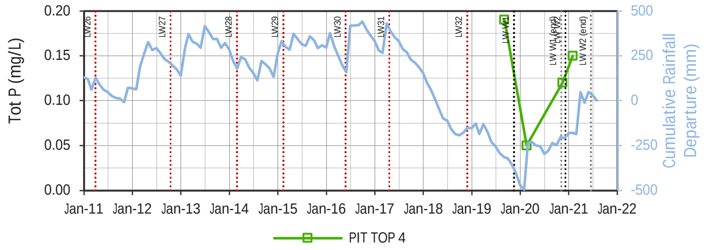

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA5

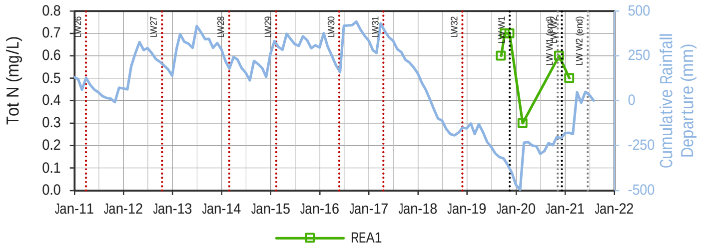

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA6

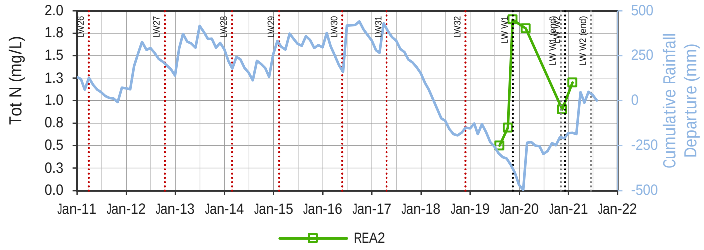

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
REA7

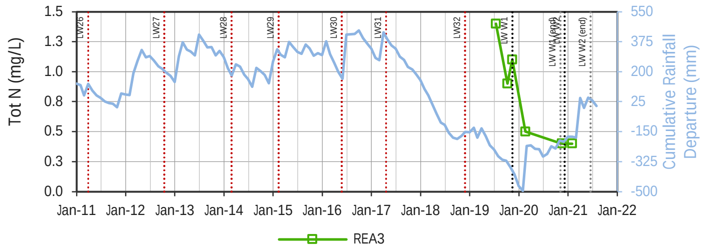

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

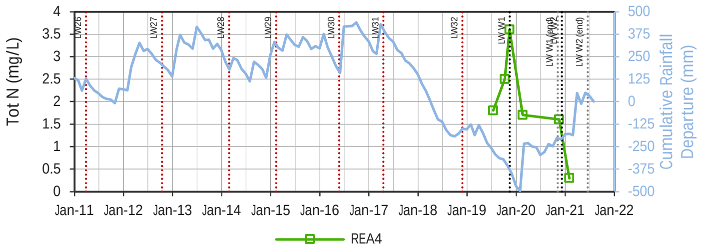

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

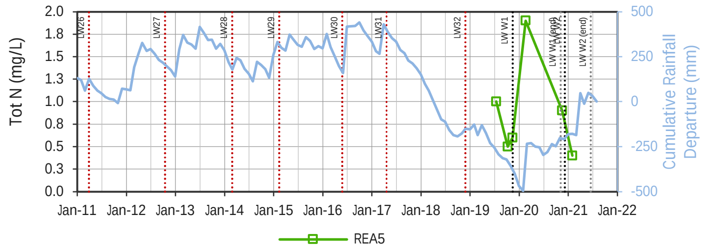

Tot P (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

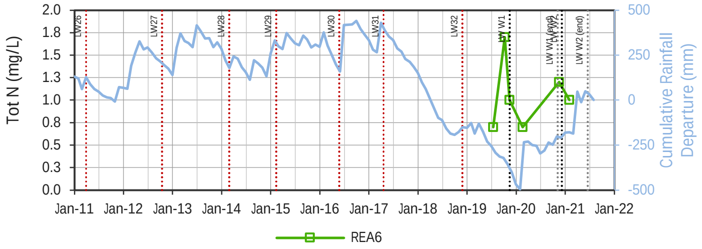

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA1

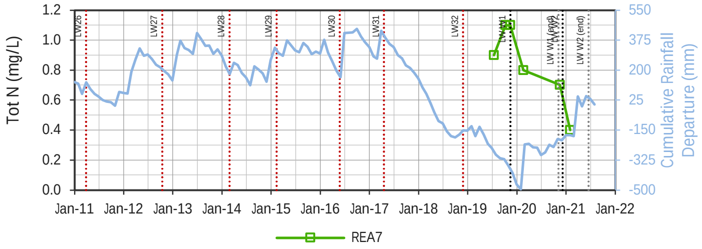

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA2

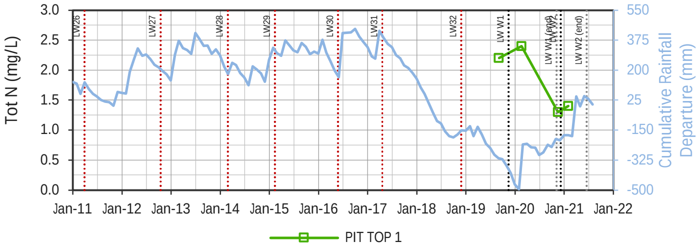

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA3

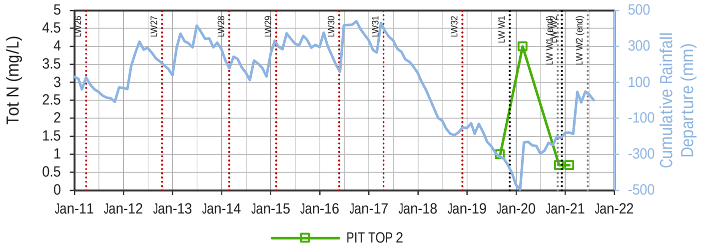

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA4

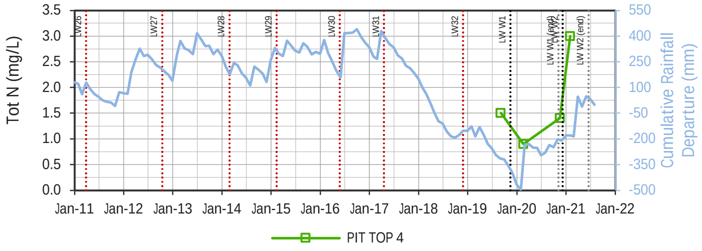

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA5

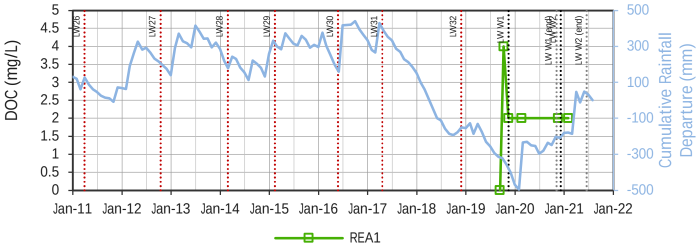

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA6

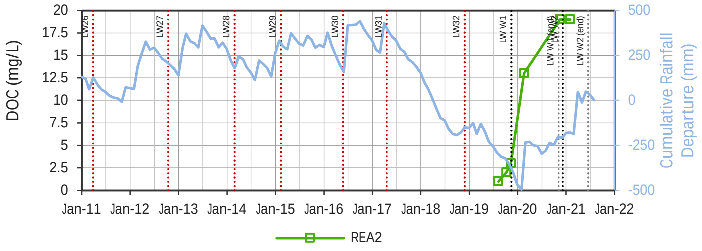

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
REA7

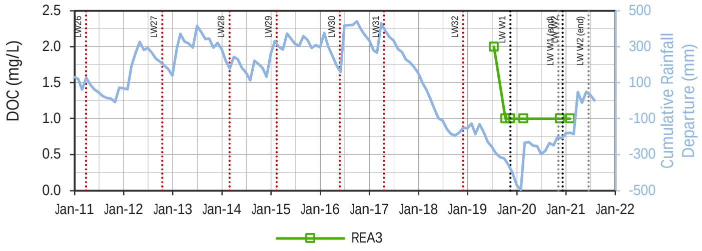

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1

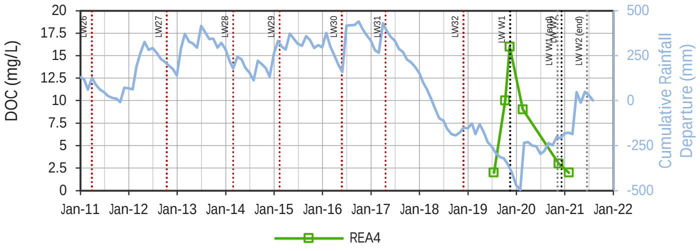

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2

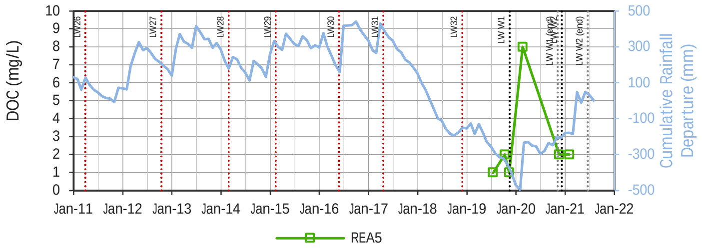

Tot N (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

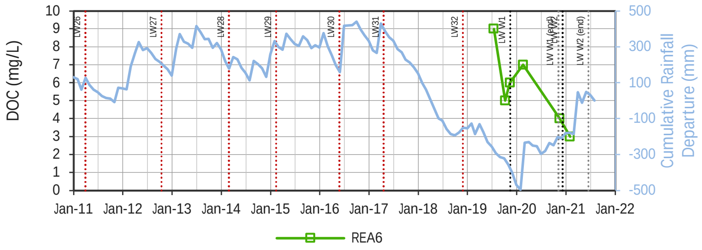

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA1

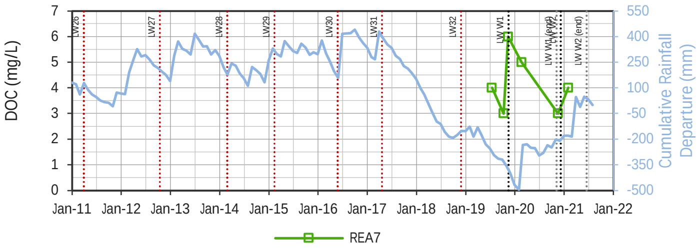

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA2

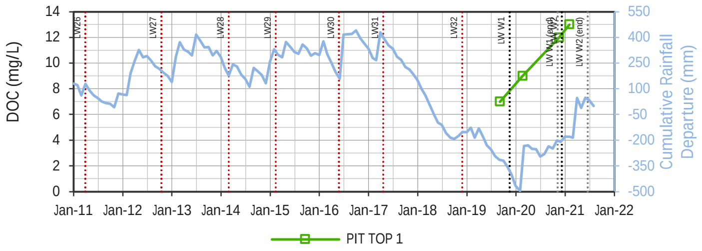

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA3

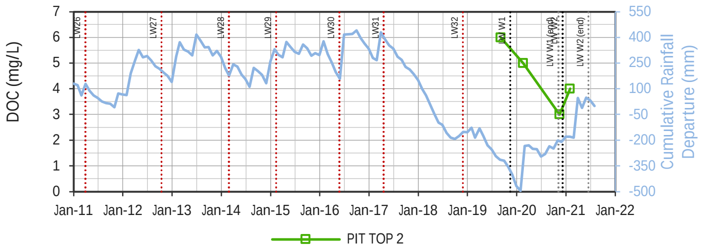

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA4

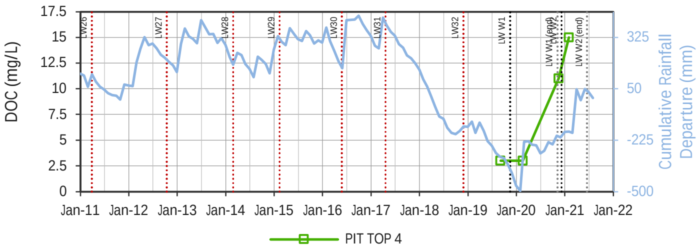

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA5

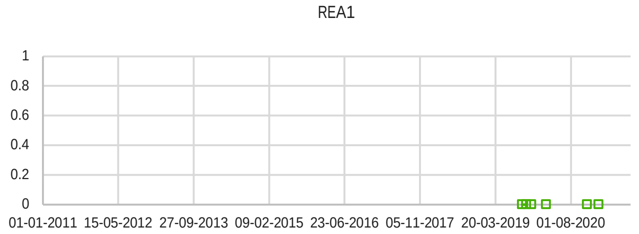

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA6

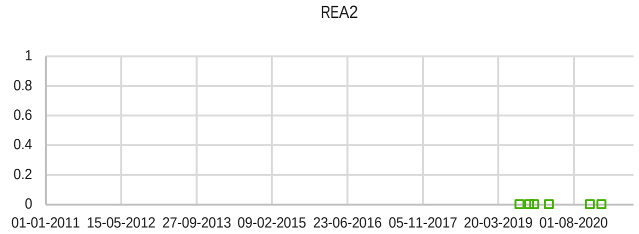

DOC (mg/L)
Cumulative Rainfall Departure (mm)
REA7

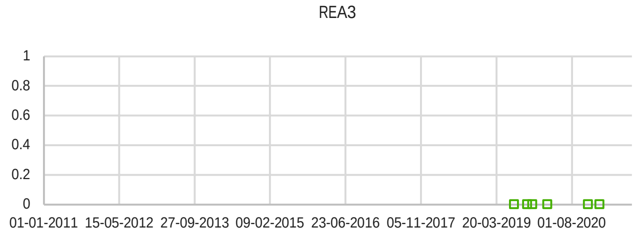

DOC (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1


DOC (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2


DOC (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4


REA1


REA2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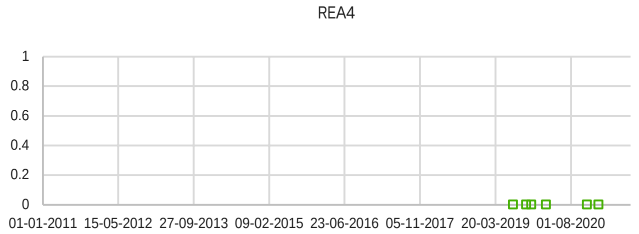
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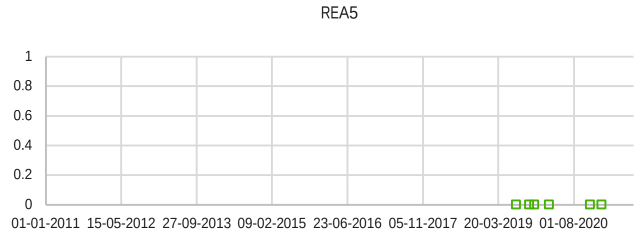
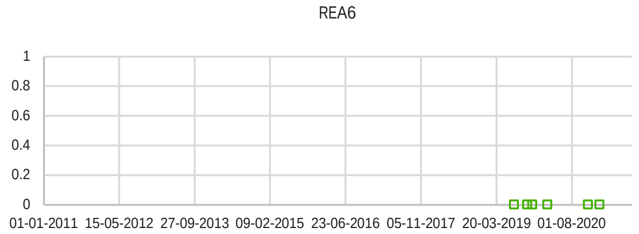
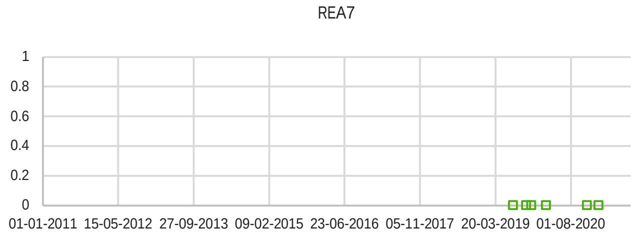

REA5


REA6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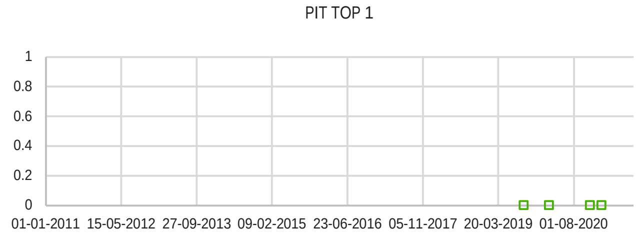
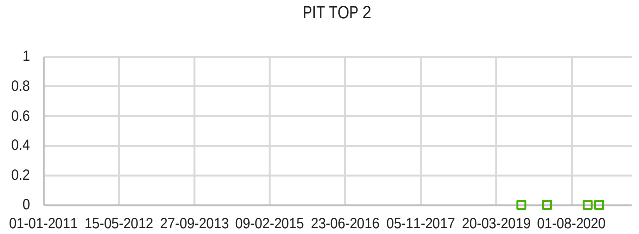

PIT TOP 1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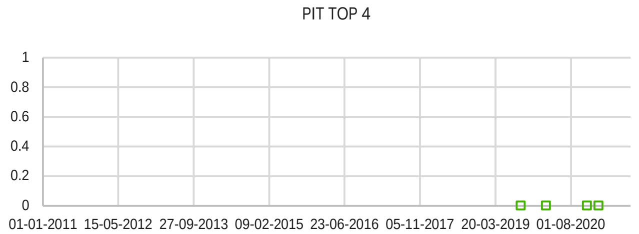
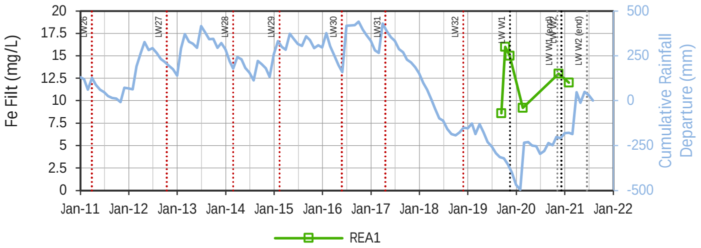
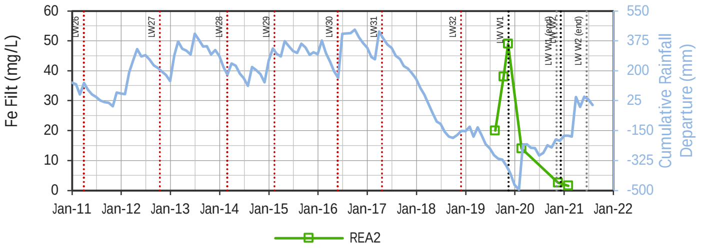
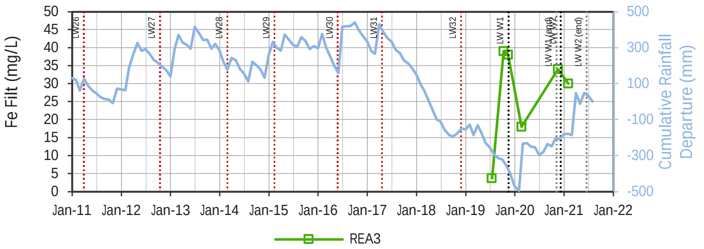
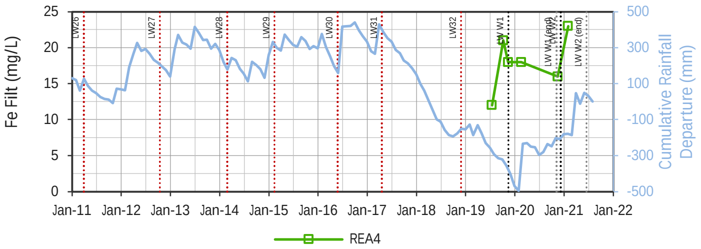
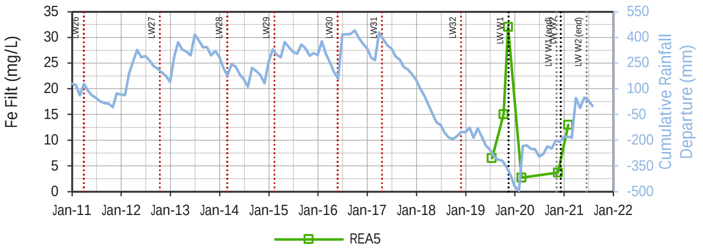

PIT TOP 4

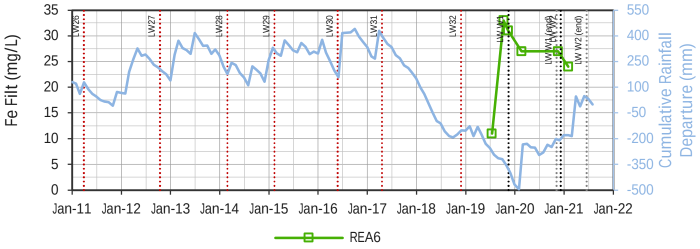

Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA1

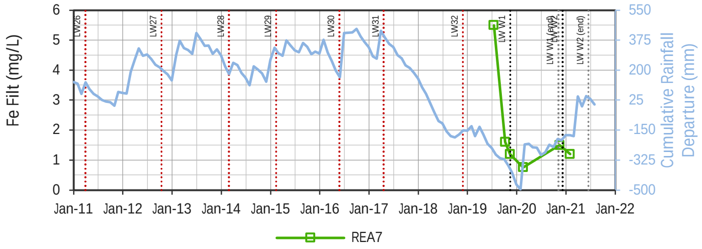

Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA2

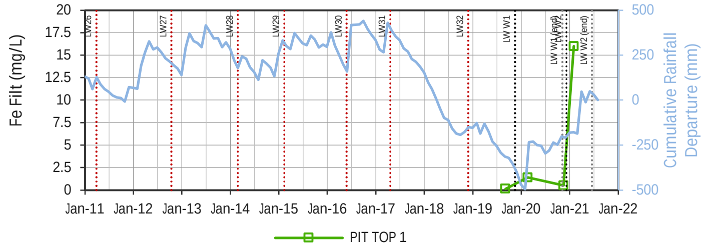

Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA3

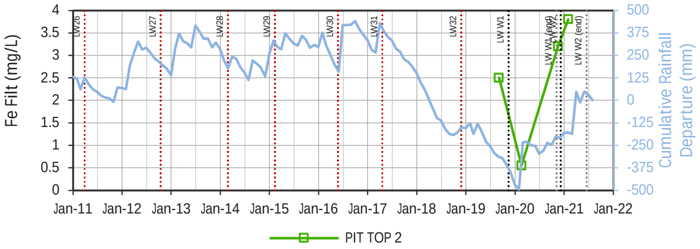

Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA4

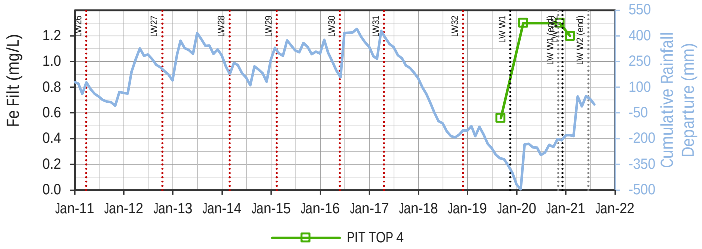

Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA5


Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA6


Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
REA7


Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
PIT TOP 1


Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
LW26
LW27
LW28
LW29
LW30
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
PIT TOP 2


Fe Filt (mg/L)
Cumulative Rainfall Departure (mm)
LW26
LW27
LW28
LW29
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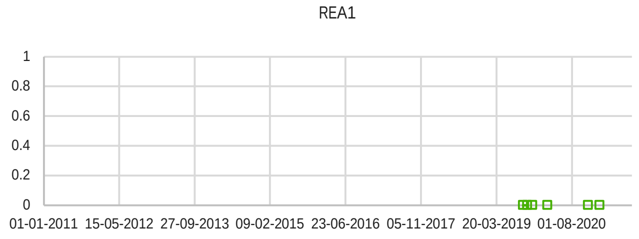
LW31
LW32
LW W1
LW W1 (end)
LW W2
LW W2 (end)
PIT TOP 4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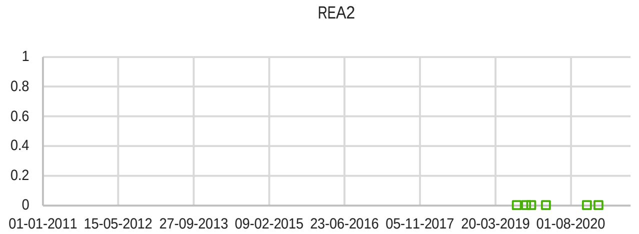
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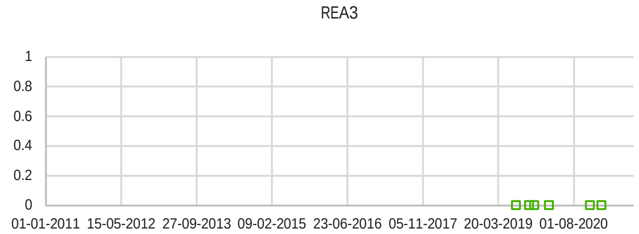
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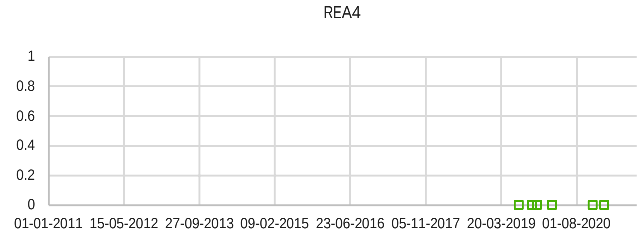
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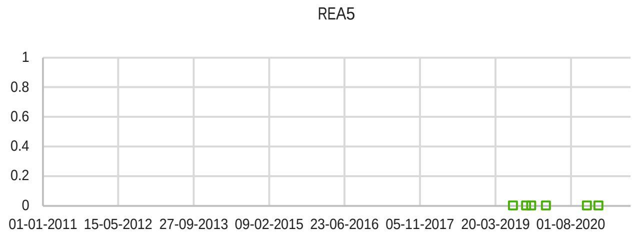
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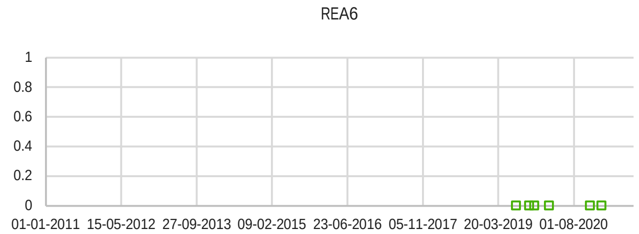
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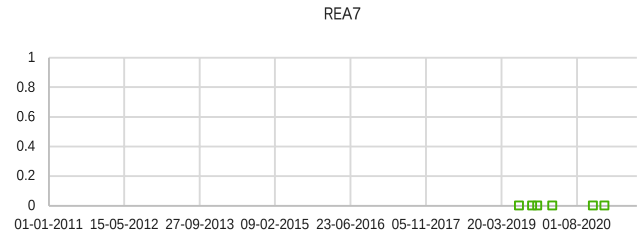
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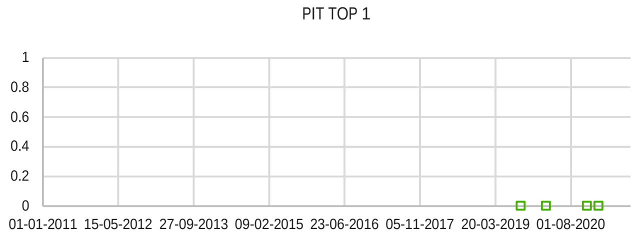
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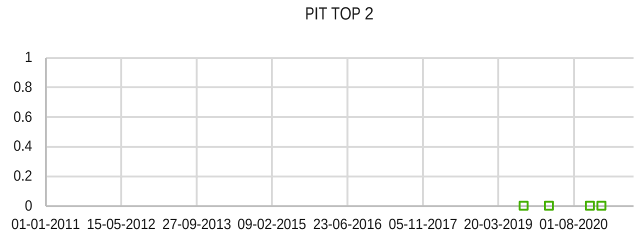
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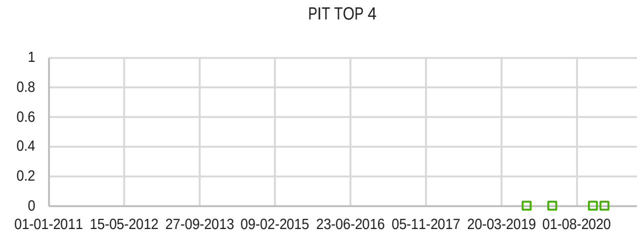
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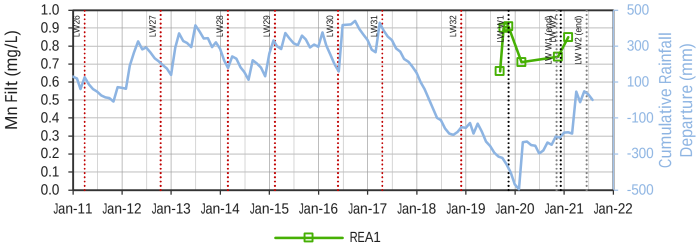
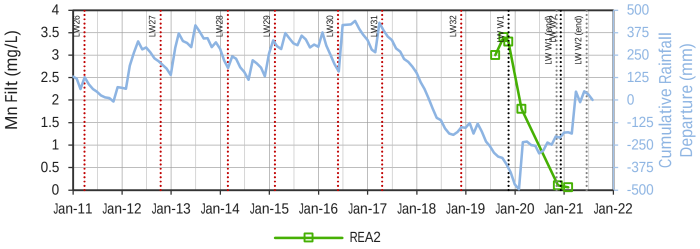

Mn Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA1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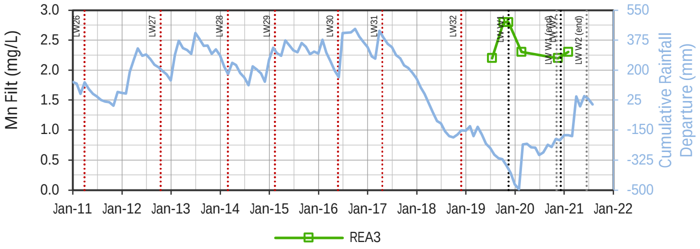
Cumulative Rainfall Departure (mm)
REA2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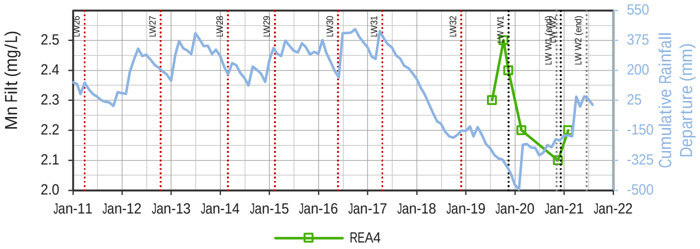
Cumulative Rainfall Departure (mm)
REA3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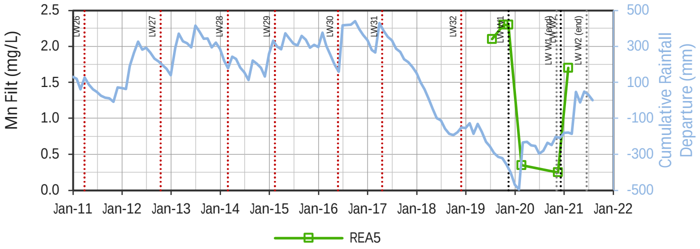
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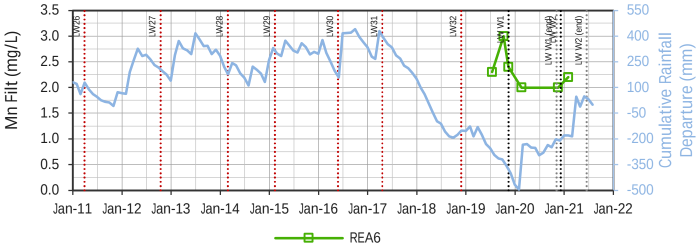
REA5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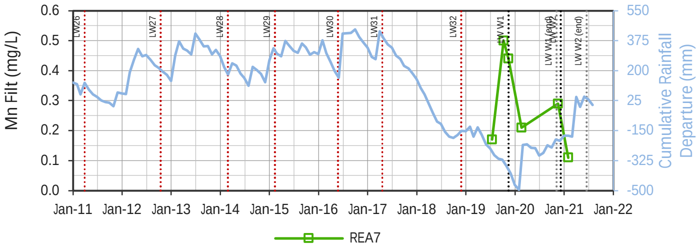
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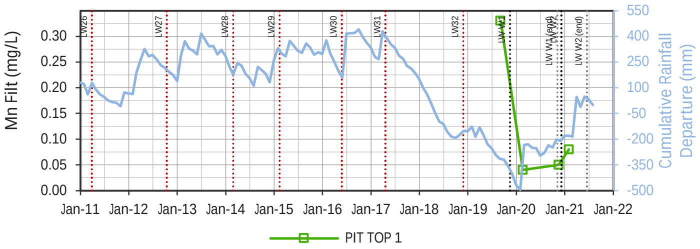
Cumulative Rainfall Departure (mm)
REA7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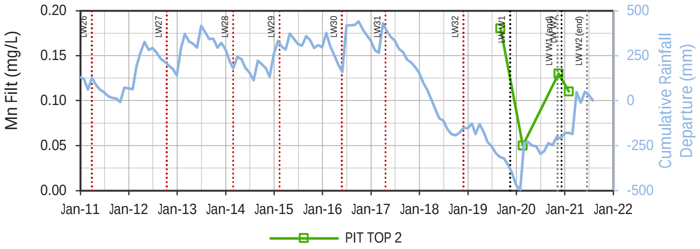
PIT TOP 1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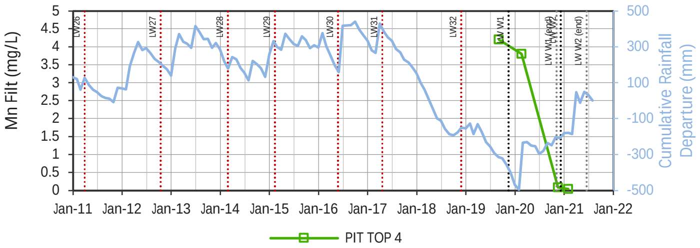
Cumulative Rainfall Departure (mm)
PIT TOP 2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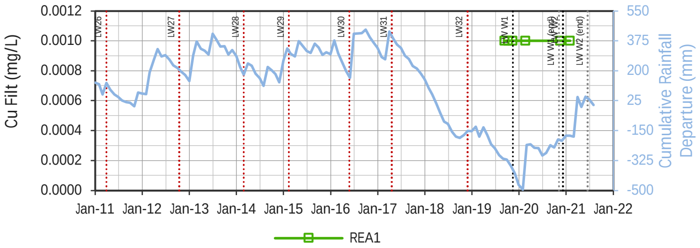
Cumulative Rainfall Departure (mm)
PIT TOP 4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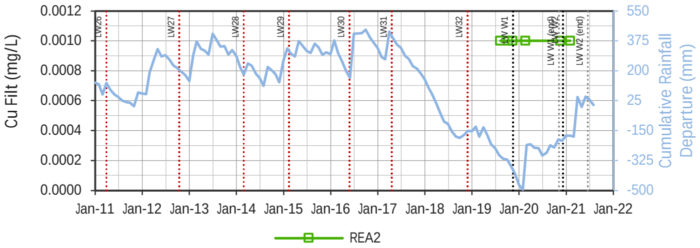
REA1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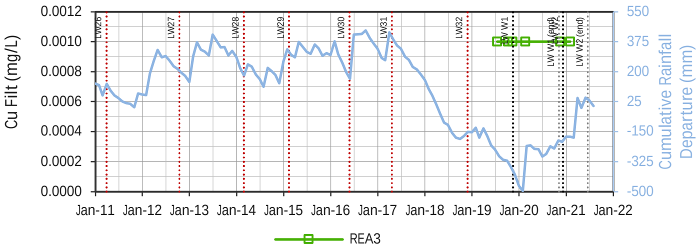
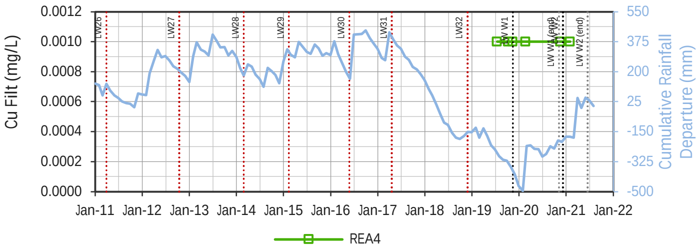
Cumulative Rainfall Departure (mm)
REA2


Cu Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA3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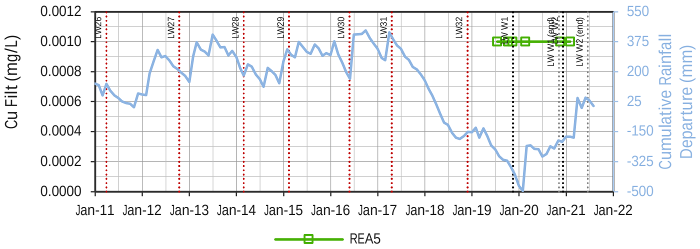
Cumulative Rainfall Departure (mm)
REA4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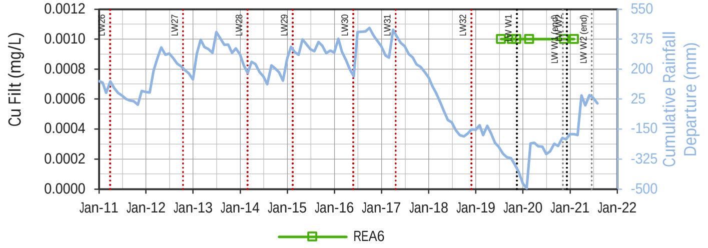
Cumulative Rainfall Departure (mm)
REA5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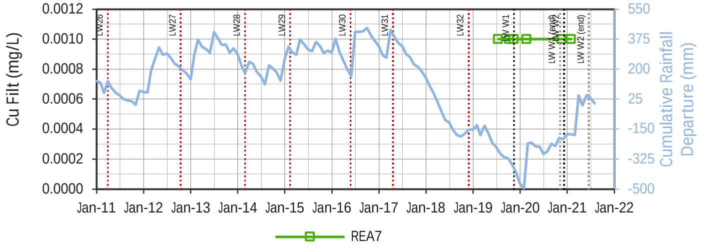
REA6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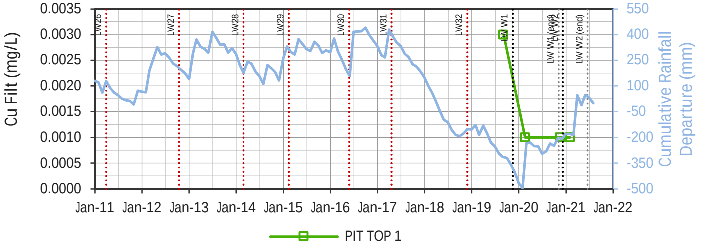
REA7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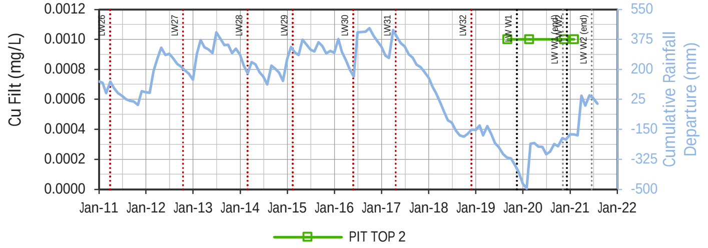
PIT TOP 1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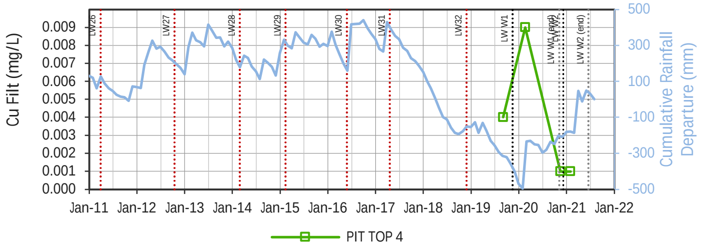
Cumulative Rainfall Departure (mm)
PIT TOP 2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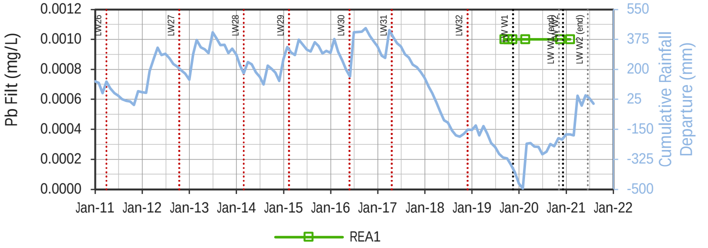
Cumulative Rainfall Departure (mm)
PIT TOP 4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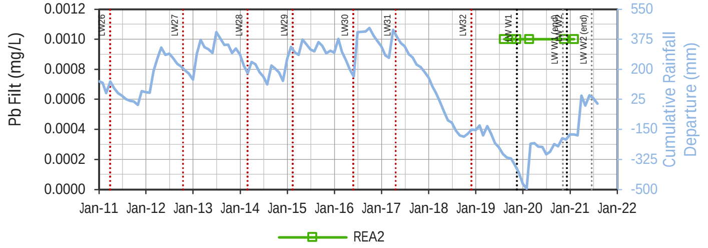
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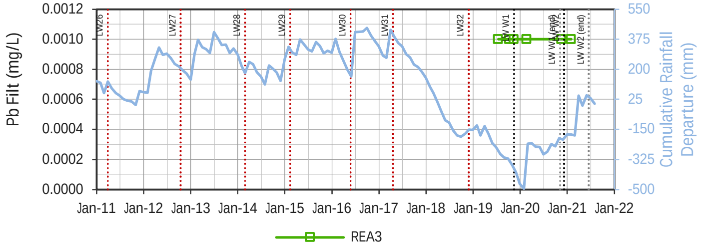
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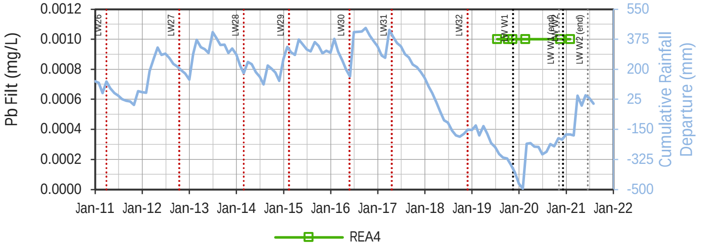
REA3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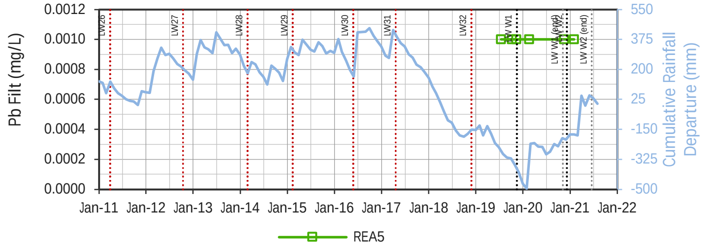
REA4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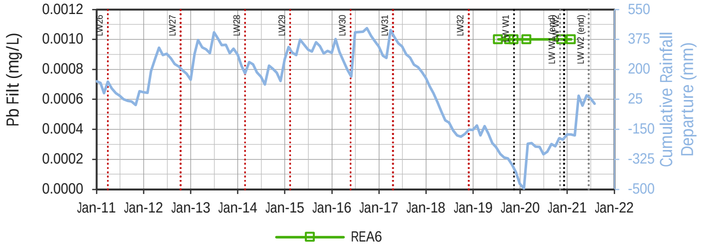
REA5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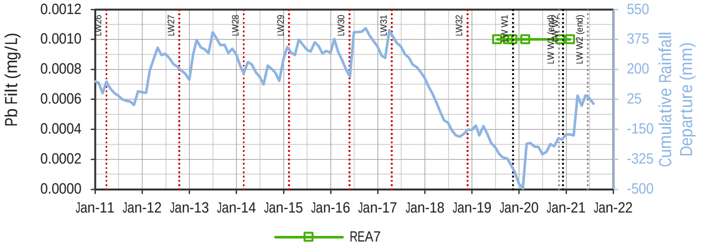
REA6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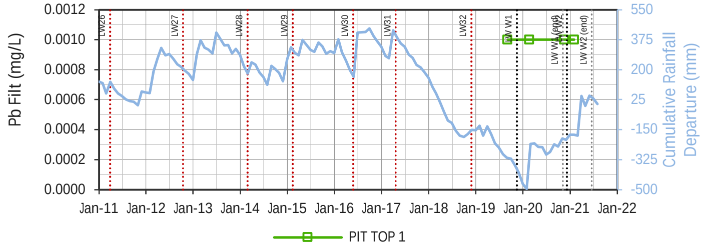
Cumulative Rainfall Departure (mm)
REA7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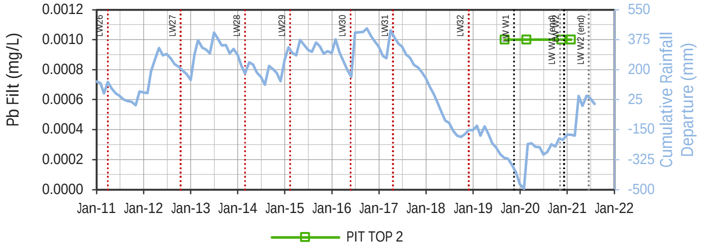
Cumulative Rainfall Departure (mm)
PIT TOP 1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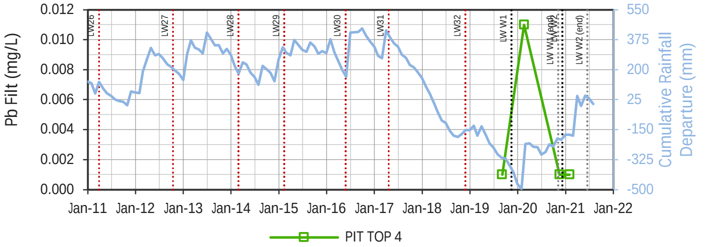
PIT TOP 2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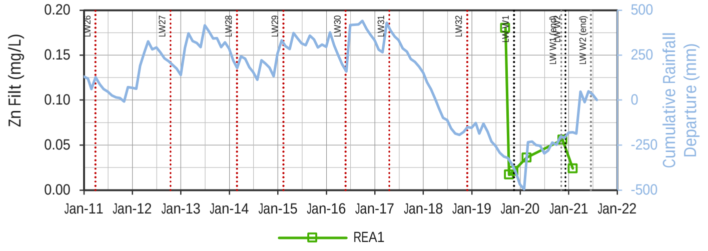
Cumulative Rainfall Departure (mm)
PIT TOP 4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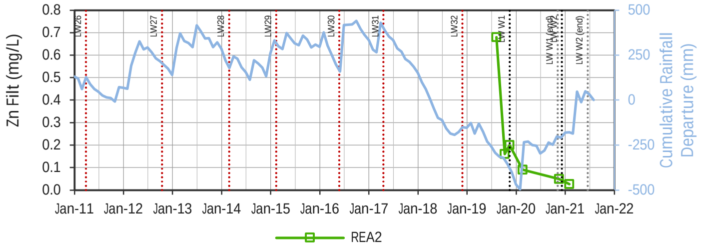
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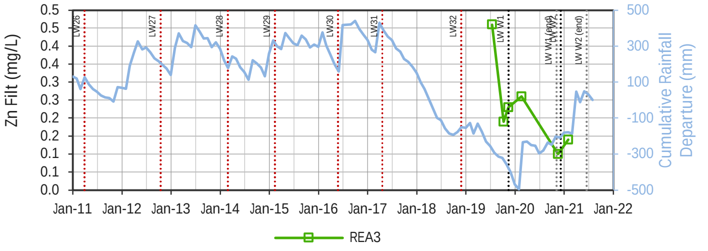
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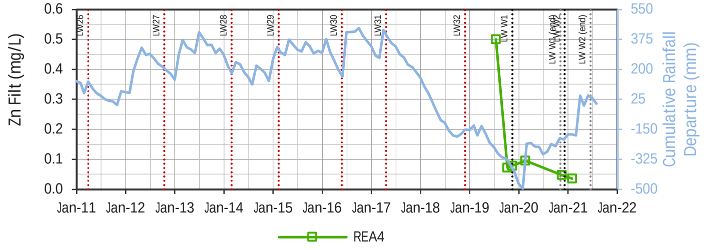
Cumulative Rainfall Departure (mm)
REA3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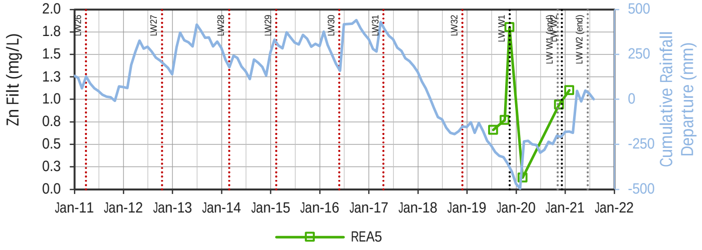
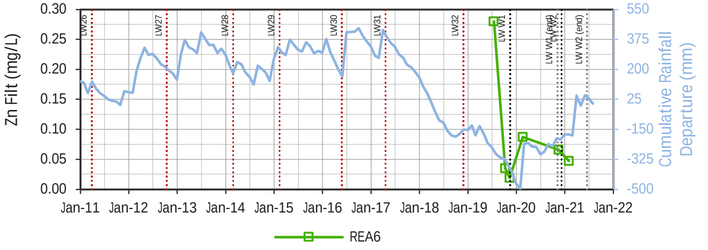
Cumulative Rainfall Departure (mm)
REA4


Zn Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA5


Zn Filt (mg/L)
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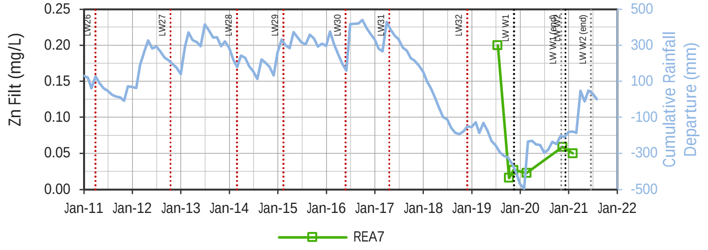
REA6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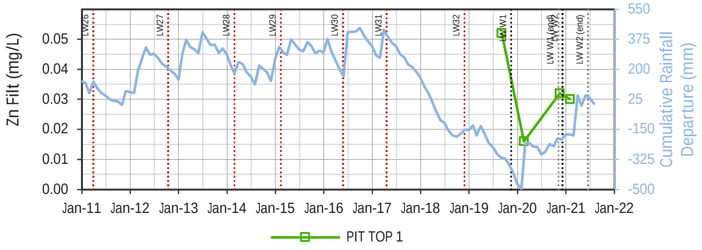
Cumulative Rainfall Departure (mm)
REA7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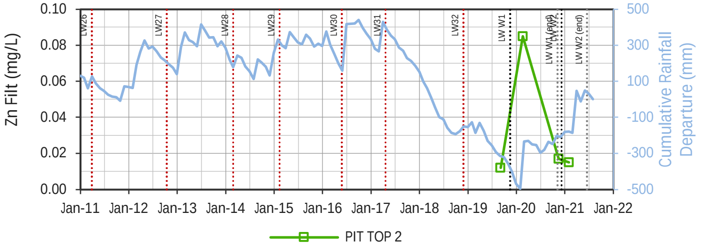
Cumulative Rainfall Departure (mm)
PIT TOP 1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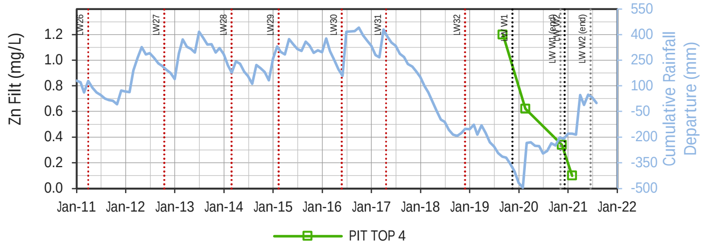
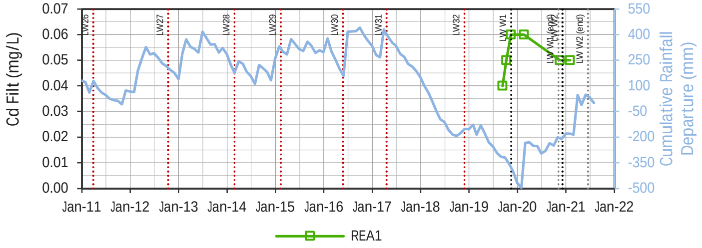
Cumulative Rainfall Departure (mm)
PIT TOP 2


Zn Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4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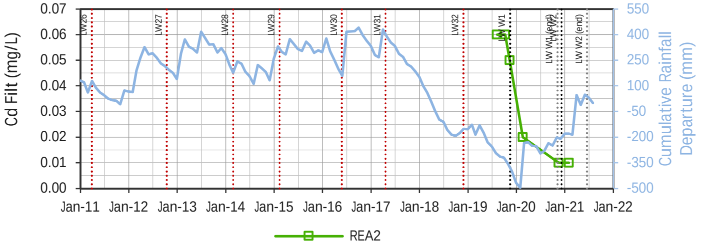
REA1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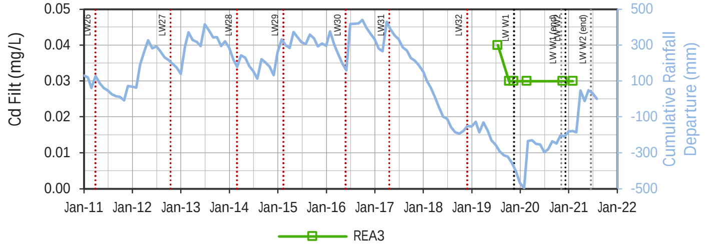
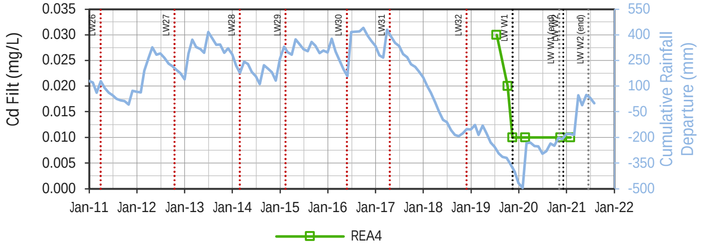
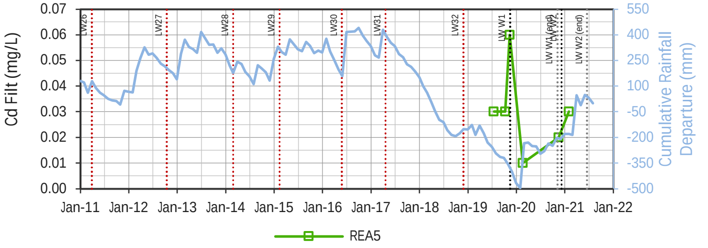
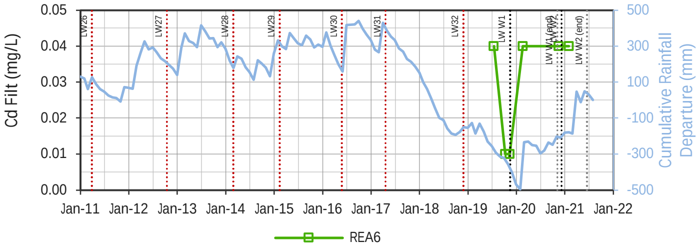
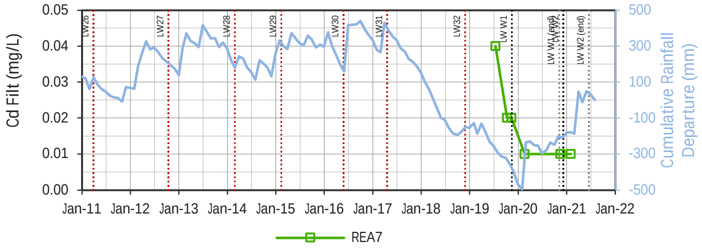
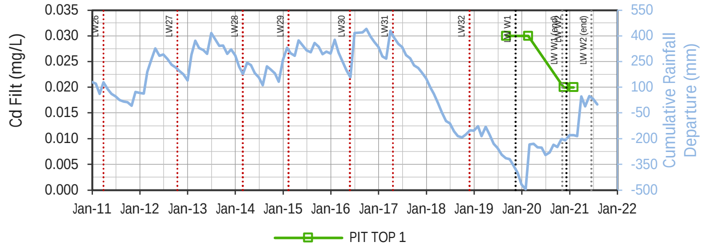

Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA3

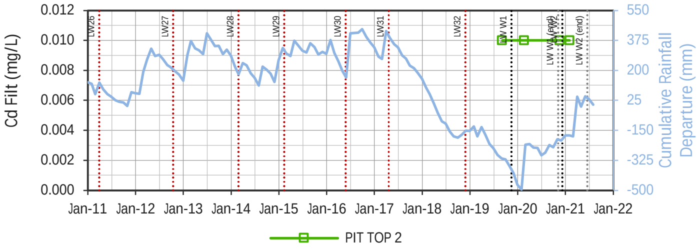

Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA4

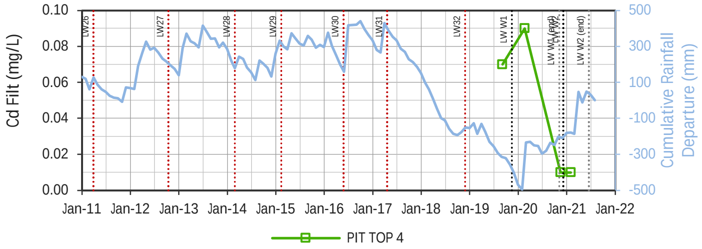

Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA5

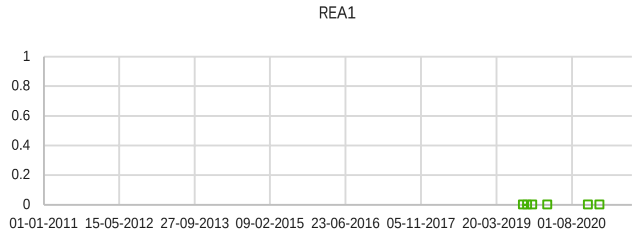

Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA6


Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA7


Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1


Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 2


Cd Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4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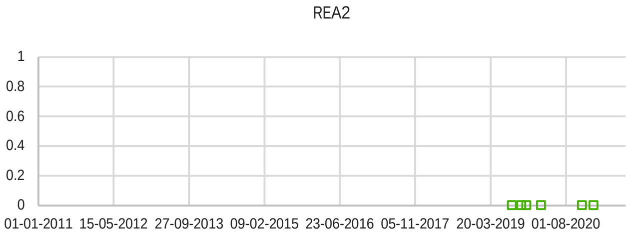
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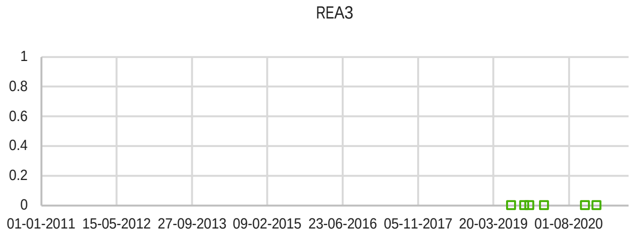
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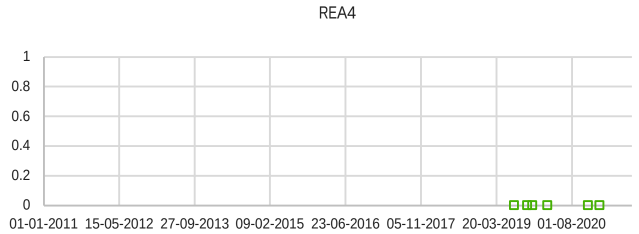
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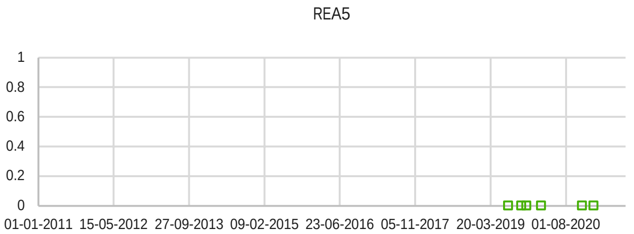
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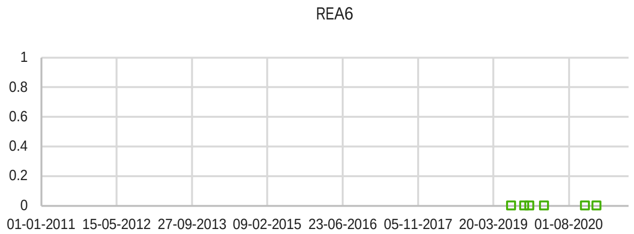
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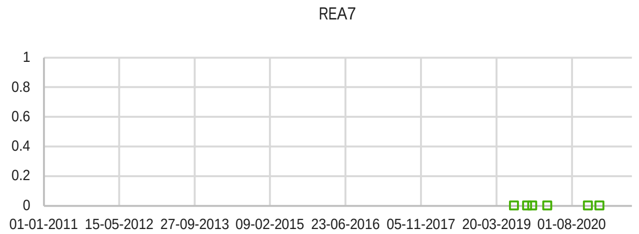
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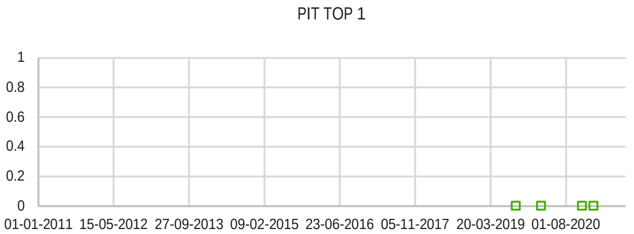
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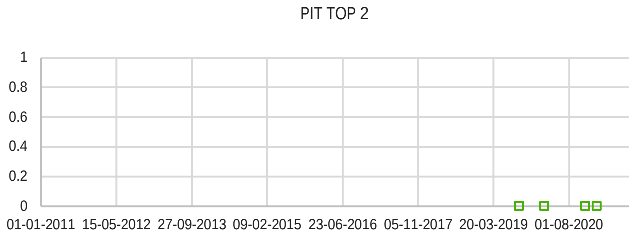
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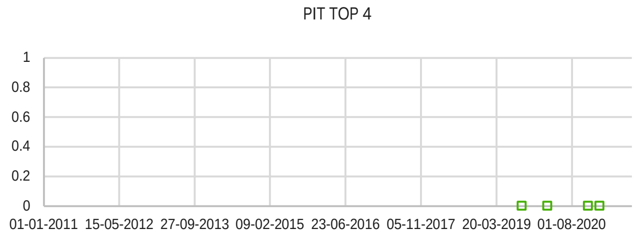
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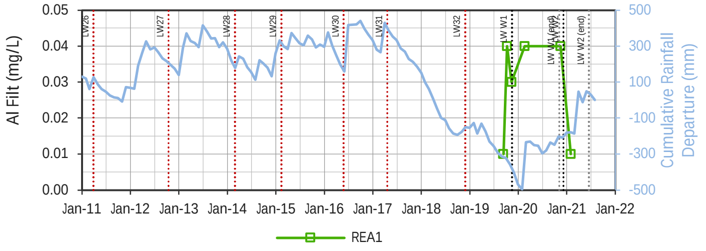
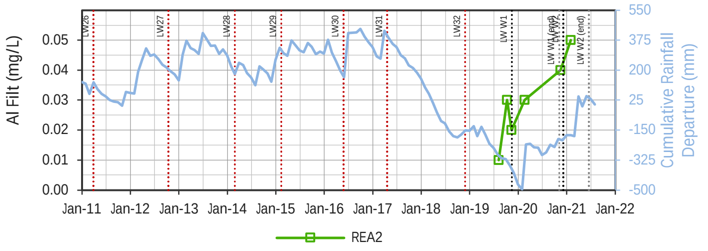

Al Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA1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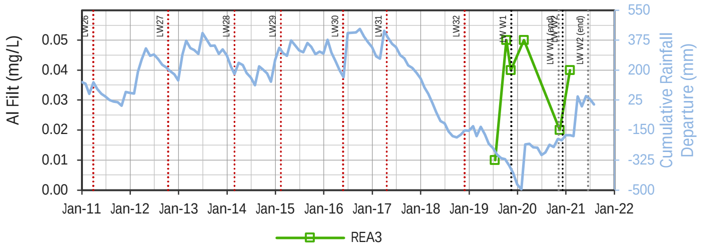
REA2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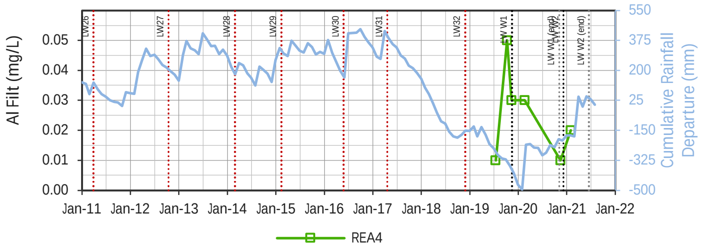
Cumulative Rainfall Departure (mm)
REA3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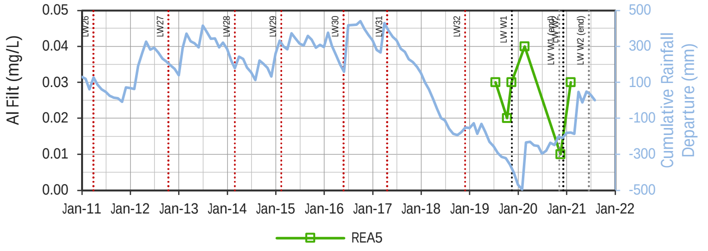
Cumulative Rainfall Departure (mm)
REA4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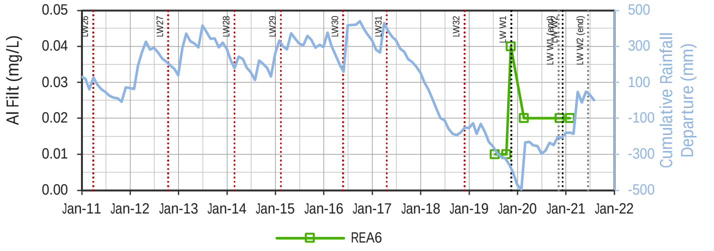
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Cumulative Rainfall Departure (mm)
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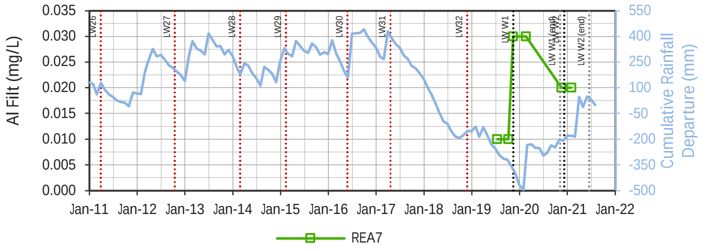
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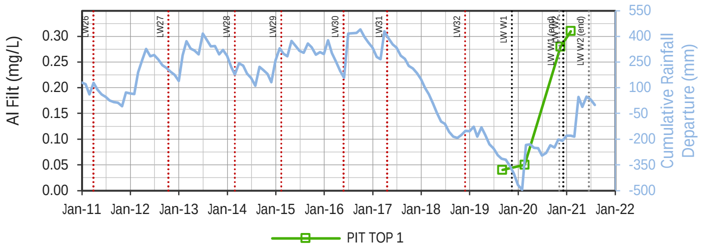
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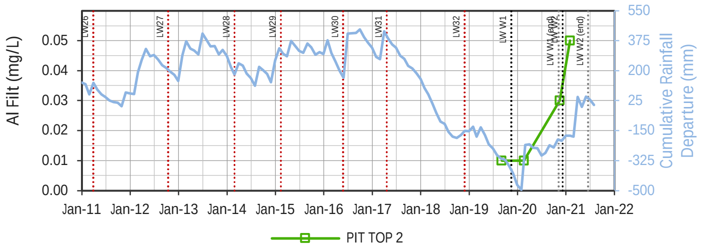
PIT TOP 1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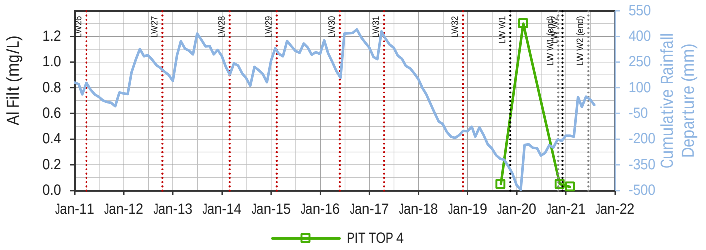
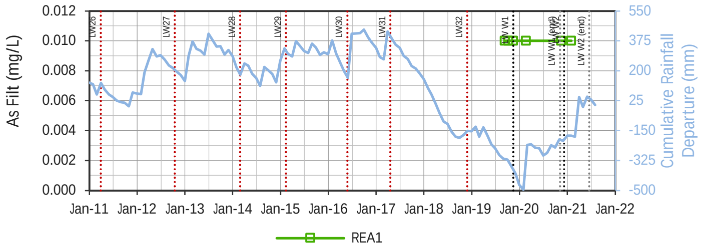
Cumulative Rainfall Departure (mm)
PIT TOP 2


Al Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4


As Filt (mg/L)
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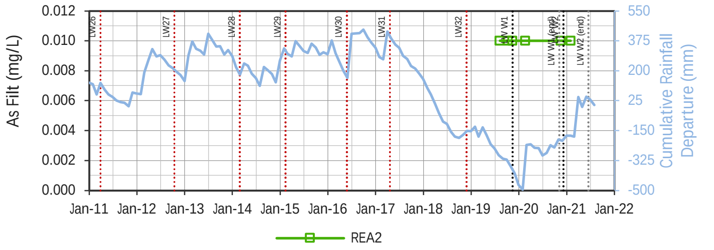
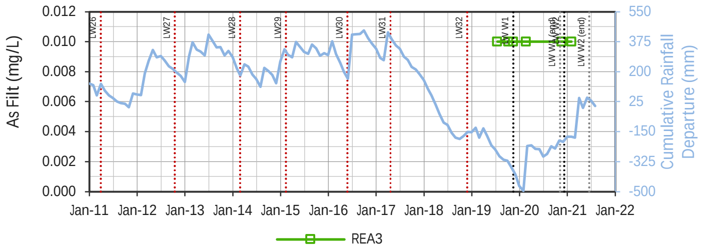
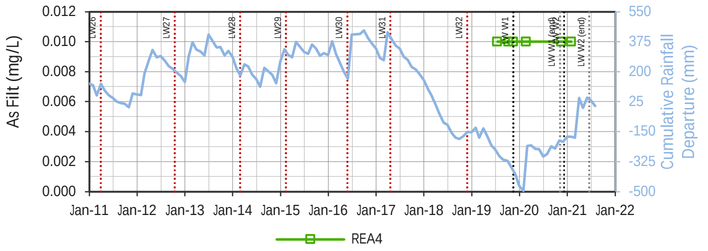
REA1


As Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA2


As Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA3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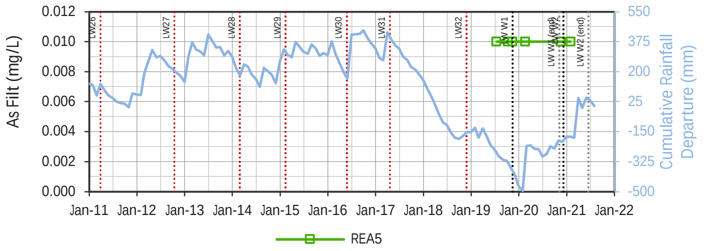
REA4


As Filt (mg/L)
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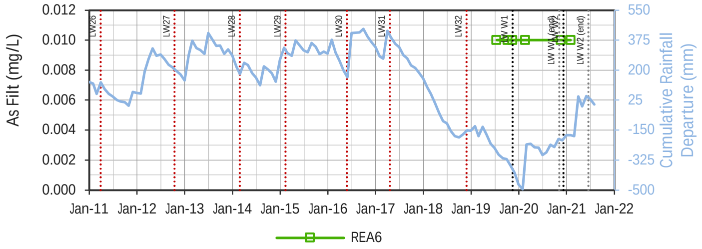
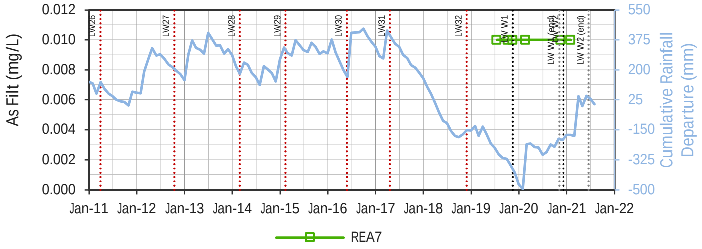
REA5


As Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA6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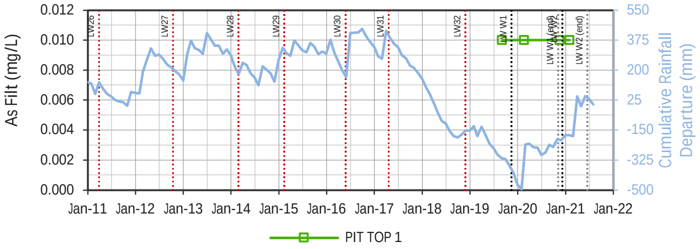
REA7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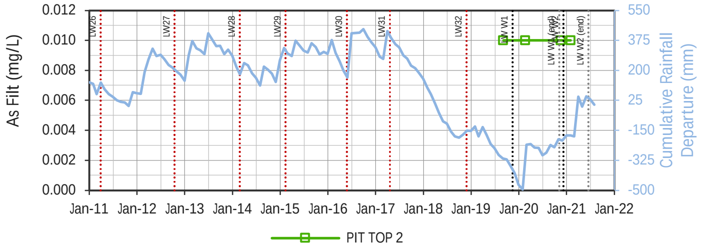
PIT TOP 1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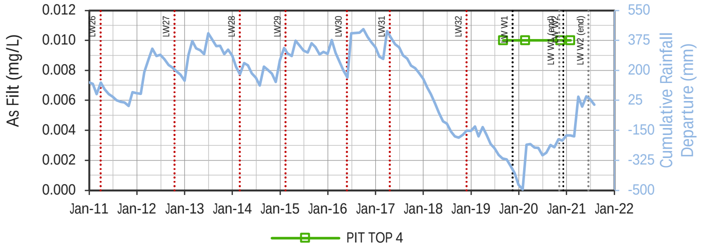
PIT TOP 2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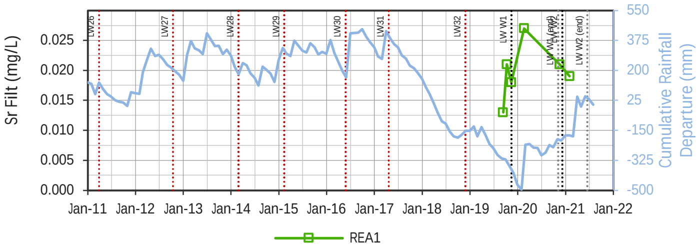
PIT TOP 4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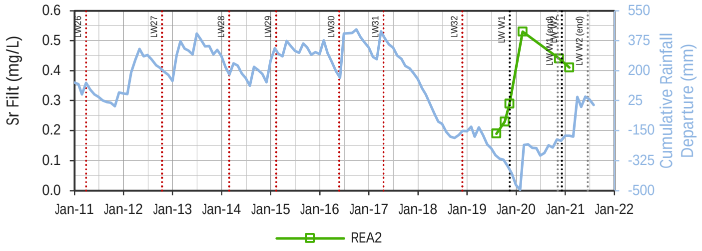
REA1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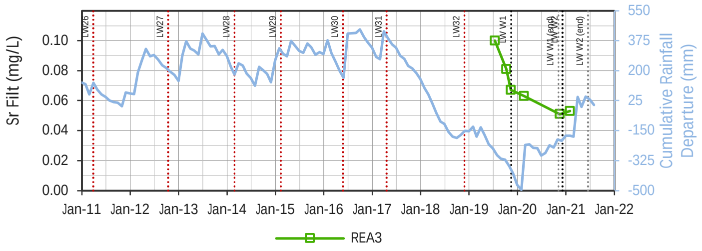
Sr Filt (mg/L)
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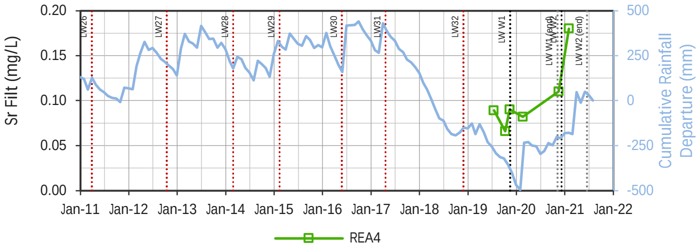
REA3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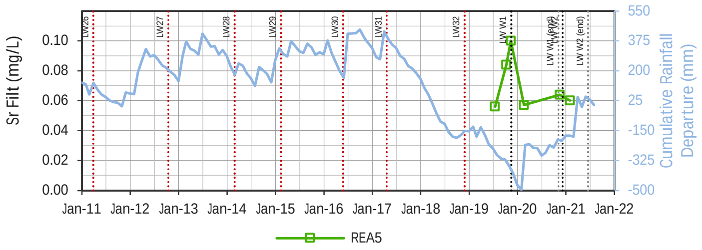
REA4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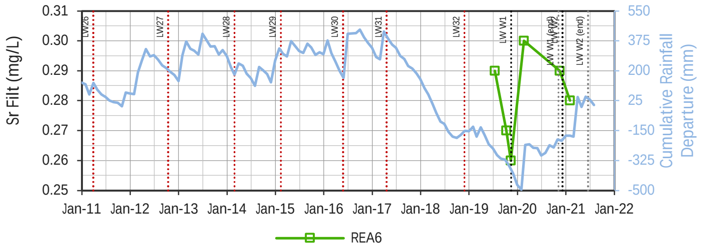
REA5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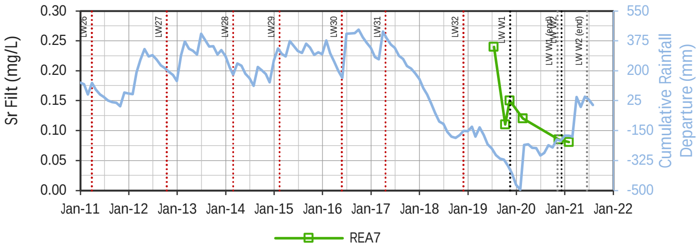
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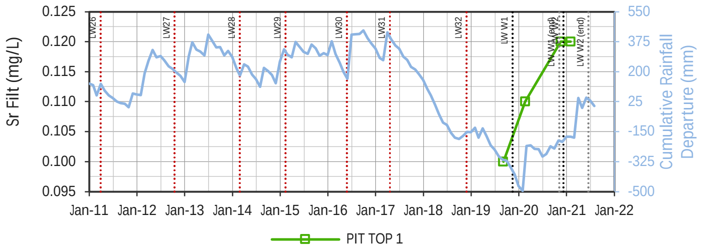
REA7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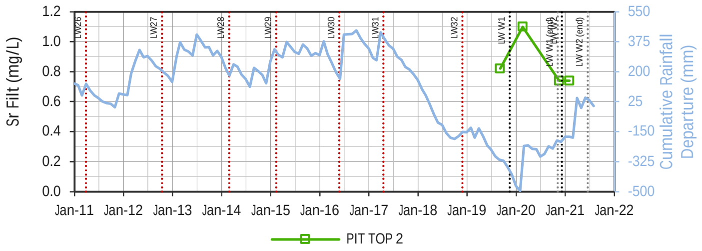
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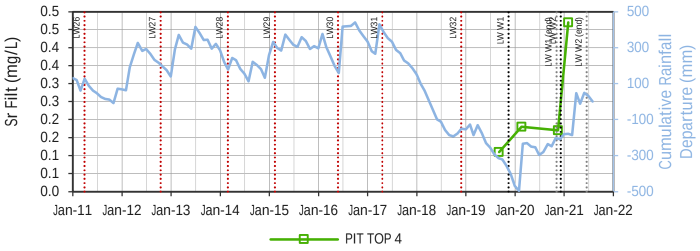
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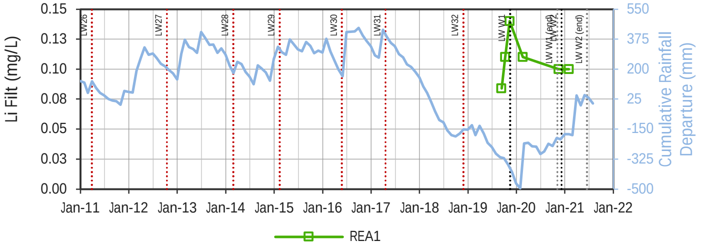
Cumulative Rainfall Departure (mm)
PIT TOP 4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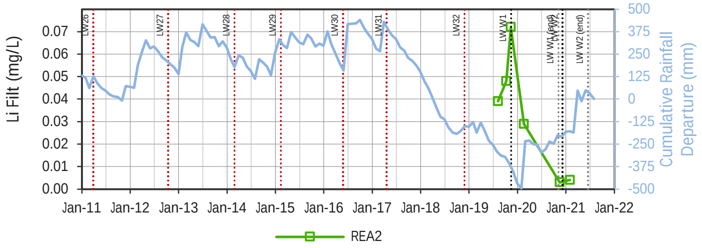
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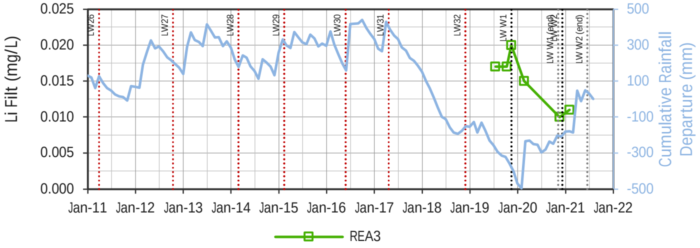
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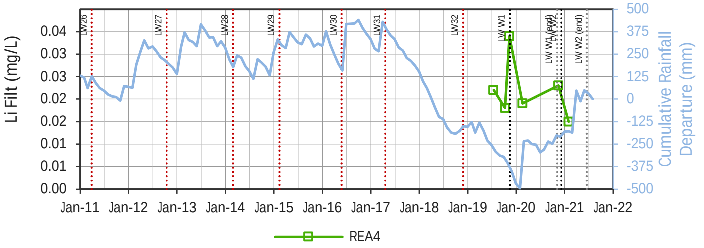
Cumulative Rainfall Departure (mm)
REA3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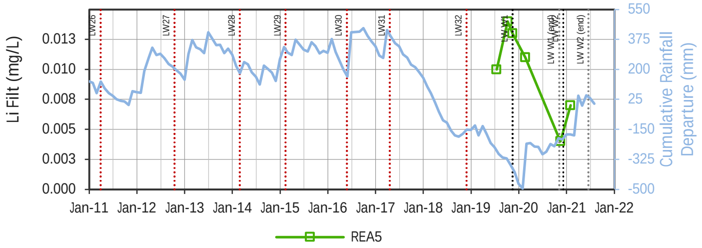
Cumulative Rainfall Departure (mm)
REA4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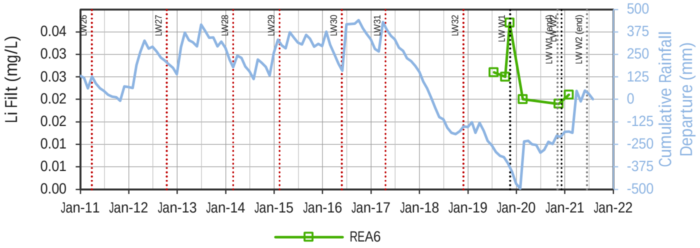
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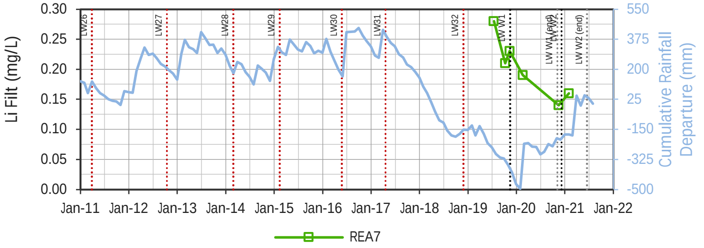
REA6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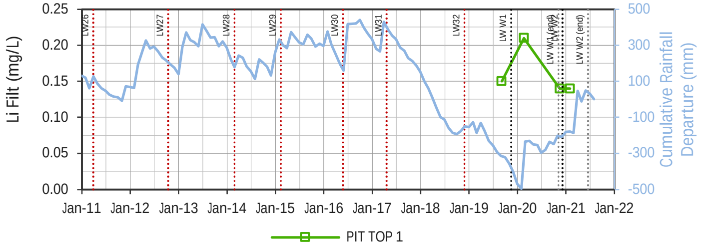
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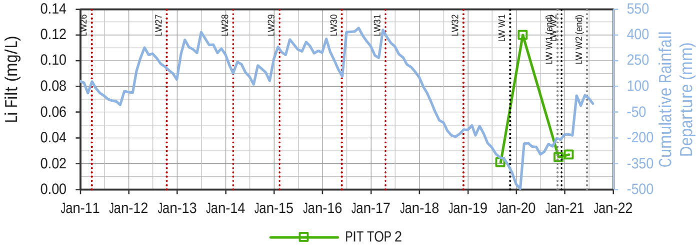
Cumulative Rainfall Departure (mm)
PIT TOP 1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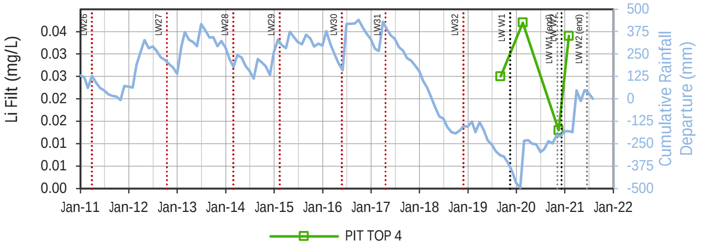
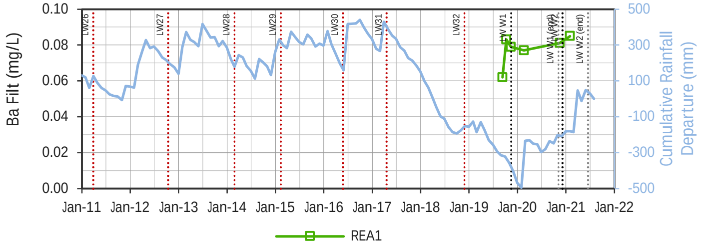
Cumulative Rainfall Departure (mm)
PIT TOP 2


Li Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4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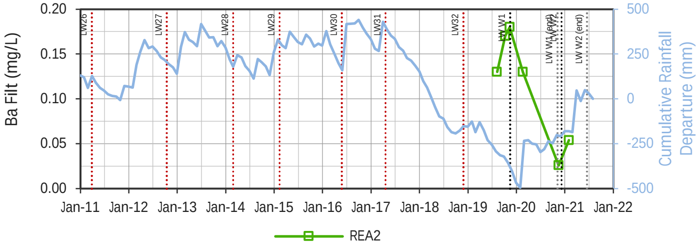
Cumulative Rainfall Departure (mm)
REA1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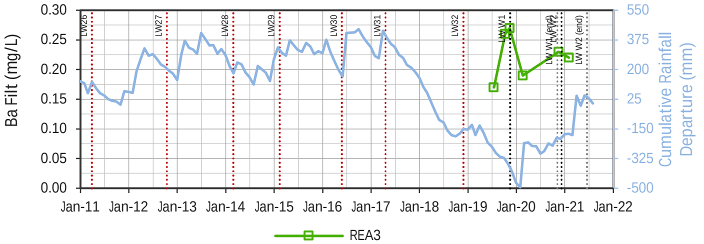
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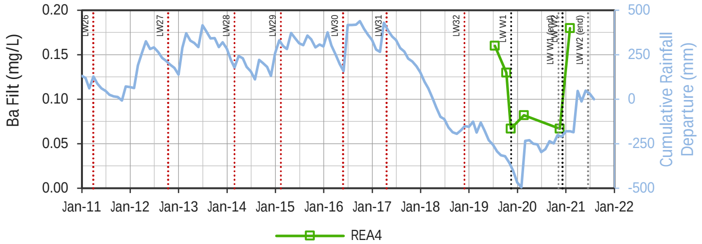
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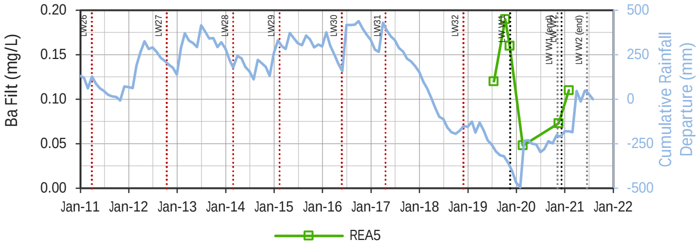
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Cumulative Rainfall Departure (mm)
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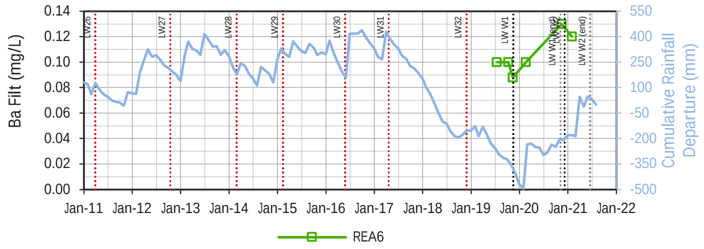
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Cumulative Rainfall Departure (mm)
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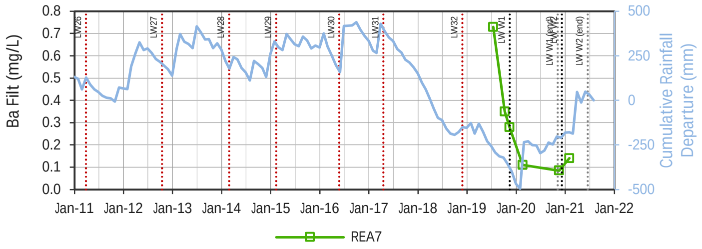
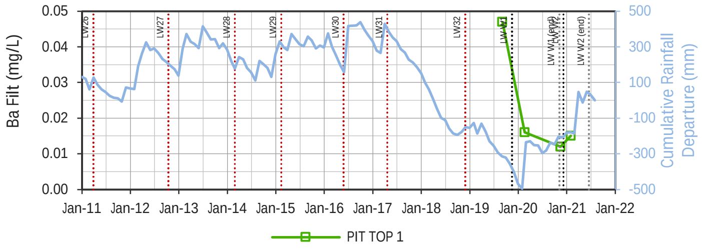
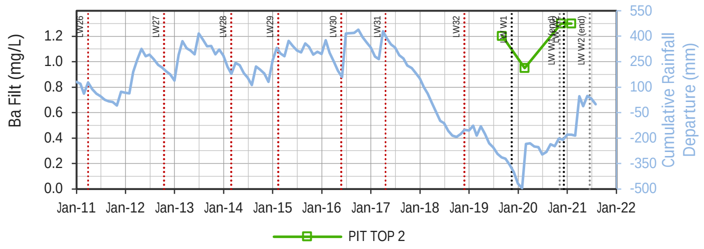

Ba Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA7


Ba Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 1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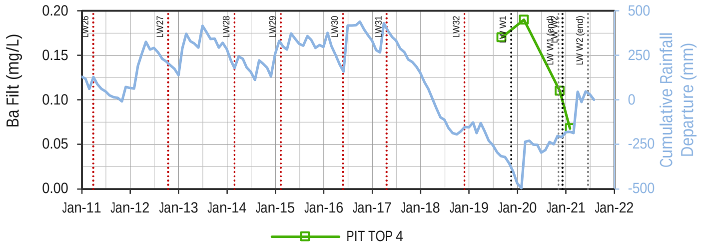
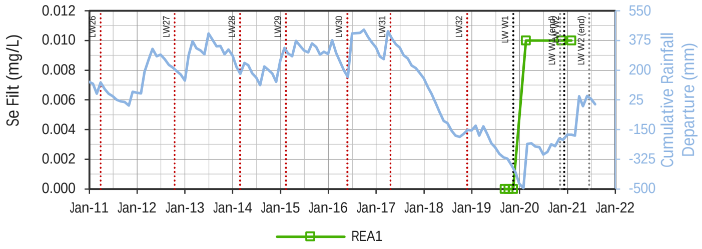
Cumulative Rainfall Departure (mm)
PIT TOP 2


Ba Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4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Cumulative Rainfall Departure (mm)
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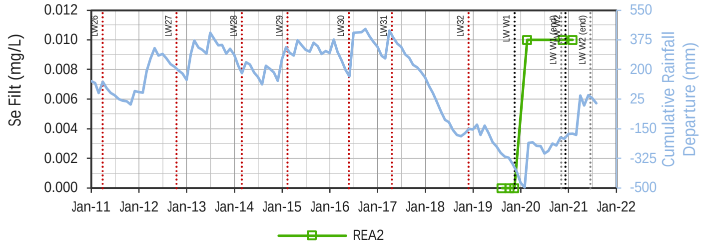
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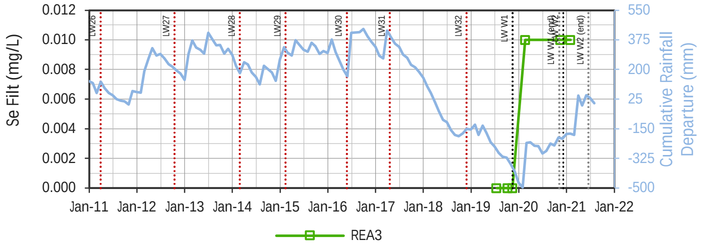
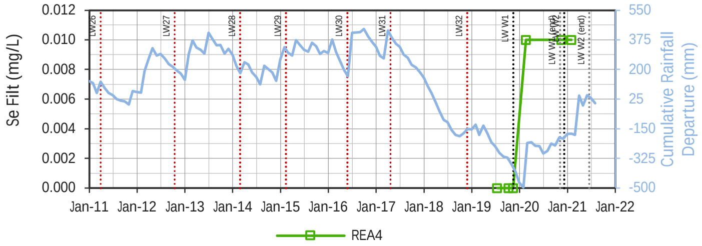
Cumulative Rainfall Departure (mm)
REA2


Se Filt (mg/L)
Cumulative Rainfall Departure (mm)
REA3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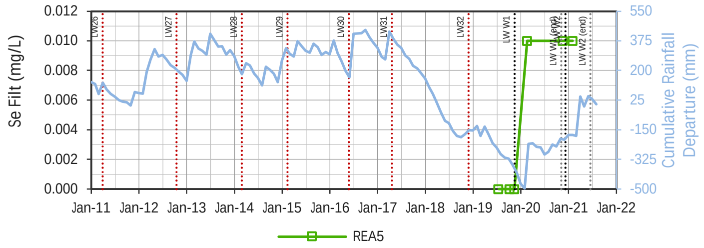
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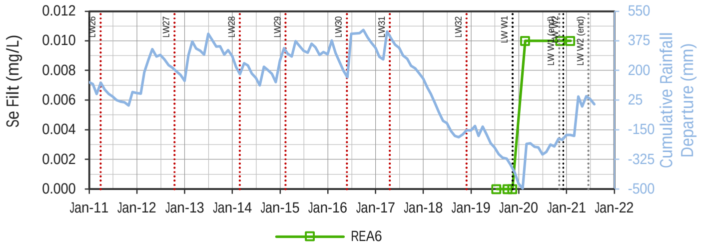
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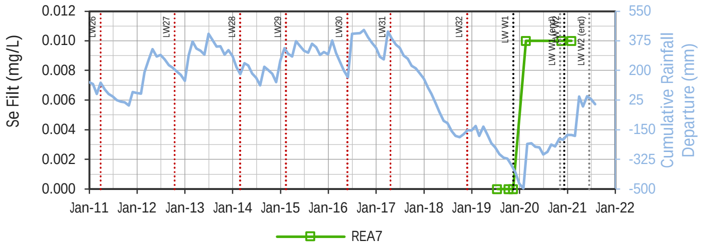
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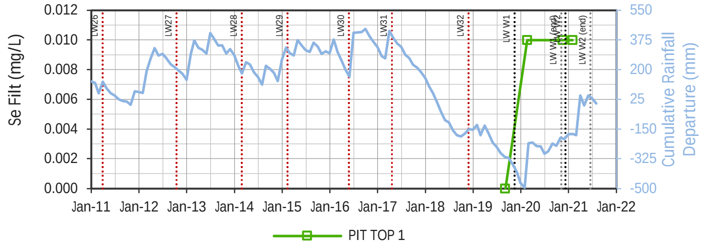
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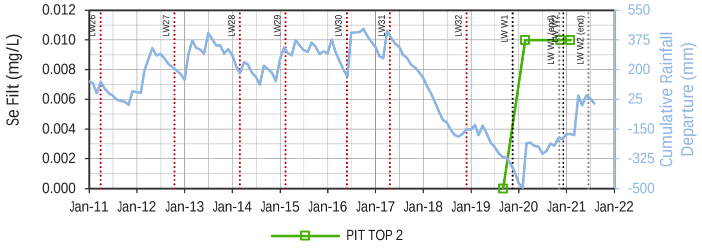
PIT TOP 1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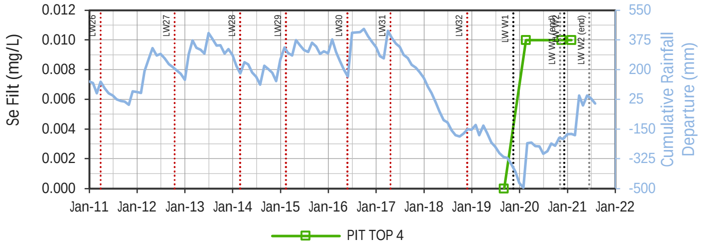
PIT TOP 2


Se Filt (mg/L)
Cumulative Rainfall Departure (mm)
PIT TOP 4

APPENDIX D – On-site Storages – Groundwater Interaction Studies

TAHMOOR SOUTH SURFACE WATER STORAGE INVESTIGATION

Prepared for:

Tahmoor Coal
2975 Remembrance Driveway
Bargo, NSW, 2574

SLR Ref: 660.30163.00000-R01
Version No: -v2.0
March 2022

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 1, The Central Building, UoW Innovation Campus
North Wollongong NSW 2500 Australia

T: +61 2 4249 1000
E: wollongong@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 Tahmoor Coal (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
660.30163.00000-R01-v1.1	24 March 2022	Ben Tarrant	Danielle O'Toole	Danielle O'Toole
660.30163.00000-R01-v1.1	1 March 2022	Ben Tarrant	Danielle O'Toole	Ines Epari
660.30163.00000-R01-v1.1	21 January 2021	Ben Tarrant	Danielle O'Toole	Sharon Hulbert

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DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

Tahmoor Coal (TC) has engaged SLR Consulting Australia (SLR) to undertake an assessment of all stored water bodies across TC's Tahmoor Colliery site. These services have been undertaken in general accordance with our proposal (A00.07077.PROMO-P01-v1.0-20211119, dated 19 November 2021) and Tahmoor Coal Purchase Order 7100117010.

2 Background

Tahmoor Colliery is an underground metallurgical coal mine operated by SIMEC Mining. Located in Tahmoor within the Southern Highlands Region of NSW, it is approximately 80km South-West of Sydney.

TC has identified approximately 20 earthen water storage structures and 2 concrete water storage tanks with an estimated combined storage capacity of 149 ML across the Tahmoor Colliery site. These storages require assessment of the potential linkage to groundwater in accordance with Tahmoor South Development Consent (Application No. 8445[1]):

> *Condition B34 e) (v) 6th dot point: a program to monitor and evaluate:*
> - *Water loss / seepage from water storages into the groundwater system*

The colliery surface operations can be broadly defined into three areas with the associated water storage types defined by the area it is located in:

- 'Pit Top Area' which generally encompasses TC operations located to the west of the railway siding. Water storages in this area comprise of washery settling ponds, sewerage treatment ponds, potable water tanks, remnant tailings dams and water treatment ponds
- 'Rejects Emplacement Area (REA)' located to the east of the railway siding encompasses run-off sediment basins from the rejects emplacement area
- 'Shaft Site Area' located approximately 1.6km north-east of the REA area off Rockford Road, the shaft water storages comprise of two sediment dams

Location of each water storage is provided in Figure 1. Nomenclature, location, and type is provided in Table 1.

3 Scope of Services

Based on the understanding of the Development Consent Condition (DCC), SLR has undertaken a two phased assessment of the storage structures comprising:

- visual site walkover of all surface water storages by an experience Geotechnical Engineer
- high level, comparative assessment of storage water and groundwater chemistry signature
- provided a report (this report), outlining the findings of our observations and assessment, including:

[1] NSW Government - Independent Planning Commission of NSW, Development Consent Section 4.36 of the Environmental Planning and Assessment Act 1979, *Tahmoor South Project SSD8445*, 2020, Sydney

- assessment of all stored water bodies and associated infrastructure and documentation of their condition noting any seepage or leakage and downstream groundwater receptors
- assessment of geomorphological features surrounding surface water infrastructure and potential impacts to groundwater

Details of the site inspections of the following structures (identified by TC) are summarised in Table 1. Upstream and downstream flows have been derived from TC monitoring and site observations. Figure 1 shows the water storage locations and Figure 2 shows the site balance between surface water storage. Note Surface water storages S4a and S6a were discovered during site walkover and are not included in the water balance figure.

Table 1 TC Surface Water Storages

Storage Facility	Type	Capacity (ML)	Inputs	Comments
Tahmoor Colliery Pit Top				
M1	Settling Pond	1.8ML	STP-2, Pit Top Storage Yard run-off, Washery Water (incl. M4), Mine water	M1 to M4 act together to treat mine water pumped from underground and stormwater. Discharged via LDP1 (To Teatree Hollow Creek)
M2	Settling Pond	0.5ML	M1, pit top storage yard run-off	
M3	Water Treatment Pond	9.0ML	S4, M2, minor road run-off	
M4	Water Treatment Pond	8.0ML	M3	Water recycled for use in CHPP and used for dust suppressant activities on sire. Discharged via LDP1.
M5	Retention Basin	1.0ML	Run-off from up shaft area	Bargo River downstream. Appears to have some natural groundwater charge. Overflow to M6
M6	Retention Basin	0.5ML	M5	Appears to be naturally charged from groundwater. Overflow to Bargo River via LOP6.
S2/S3	Sediment Basin and Settling Pond	8.3ML	Stockpile run-off	Stockpile dams are discharged to S4.
STP 1	Treatment Pond	0.59ML	Sewerage Treatment Plant	Overflows to M1
STP 2	Treatment Pond	0.59ML	STP 1 and yard run-off	
T1	Tailings Storage Facility	0.5ML*	Run-off	Regularly cleaned out. TC no longer produces slurry tailings. Belt-press dry stacking used. Fines are combined with reject and sent to REA for disposal.
T2	Tailings Storage Facility	0.6ML*	Run-off	
Tank No. 1	Water Supply	0.25ML	Shaft 3 groundwater supply	Underground water supply
Tank No. 2	Water Supply	0.25ML		
Gas Plant Pool	Retention Drain	0.005ML	Gas Plant embankment run-off	Retention drain with weir structure to capture and control run-off flows from Gas Plant embankment to the west
Tahmoor Colliery Rejects Emplacement Area (REA)				
S4	Retention Basin	36.9ML	S2/S3, S9	Pumped to M3. Acts as a retention basin with controlled outlet. Discharge to overflow Point 4 (LOP4).

Storage Facility	Type	Capacity (ML)	Inputs	Comments
S4a	Silt Trap	~0.2ML*	Rejects processing yard run-off	Sediment trap to capture southerly run-off from rejects process yard.
S5	Silt Trap	0.5ML	Rejects processing yard run-off	Silt trap to capture northerly run-off via spoon drain from rejects processing yard.
S6	Retention Basin	1.5ML	S5	Retention basin with controlled outlet (glory hole) to S9. Overflow to S6a via vegetated channel
S6a	Retention Basin	~0.8ML*	S6 overflow	Earthen embankment retention basin within natural gully. Overflow to S9.
S7	Retention Basin	41.5ML	REA Run-off, 7a and 7b	Main catchment for run-off from REA. Retention basin during peak rainfall events. All water pumped to S9
S7a	Retention Basin	12ML	REA Run-off	Retention basin with controlled outlet to S7 Dam.
S7b	Retention Basin	1.0ML	S7a and S7	
S8	Retention Basin	4.5ML	S7b	Pumped to S9. Overflow to LOP5, discharge to Teatree Hollow Creek.
S9	Retention Basin	0.4ML	S6, S7, S8 and haul road run-off	Wet well pumps to S4. Discharge by LOP3 to Teatree Hollow Creek.
S10	Sediment Basin	~0.1ML*	Haul Road run-off	Evaporative sediment basin

Notes: [*] = Capacity not previously measured. Identified during site inspection. Estimated based on-site observation
LDP = License discharge point, LOP = license overflow point

SLR CONSULTING PTY LTD
UOW INNOVATION CAMPUS
SQUIRES WAY
WOLLONGONG, NSW
P: 02 4249 1000
www.slrconsulting.com

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Title:	TAHMOOR COLLIERY WATER STORAGE FACILITIES	Drawn:	BT
Client:	TAHMOOR COAL	Reviewed:	DT
Project:	SURFACE WATER STORAGE ASSESSMENT	Size:	A3
Project No.:	660.30052.0000	Datum:	None
Status:	ASSESSMENT	Version:	0.1
Date:	09/12/2021		

SIMEC

FIGURE # 1

Figure 2 Water Balance

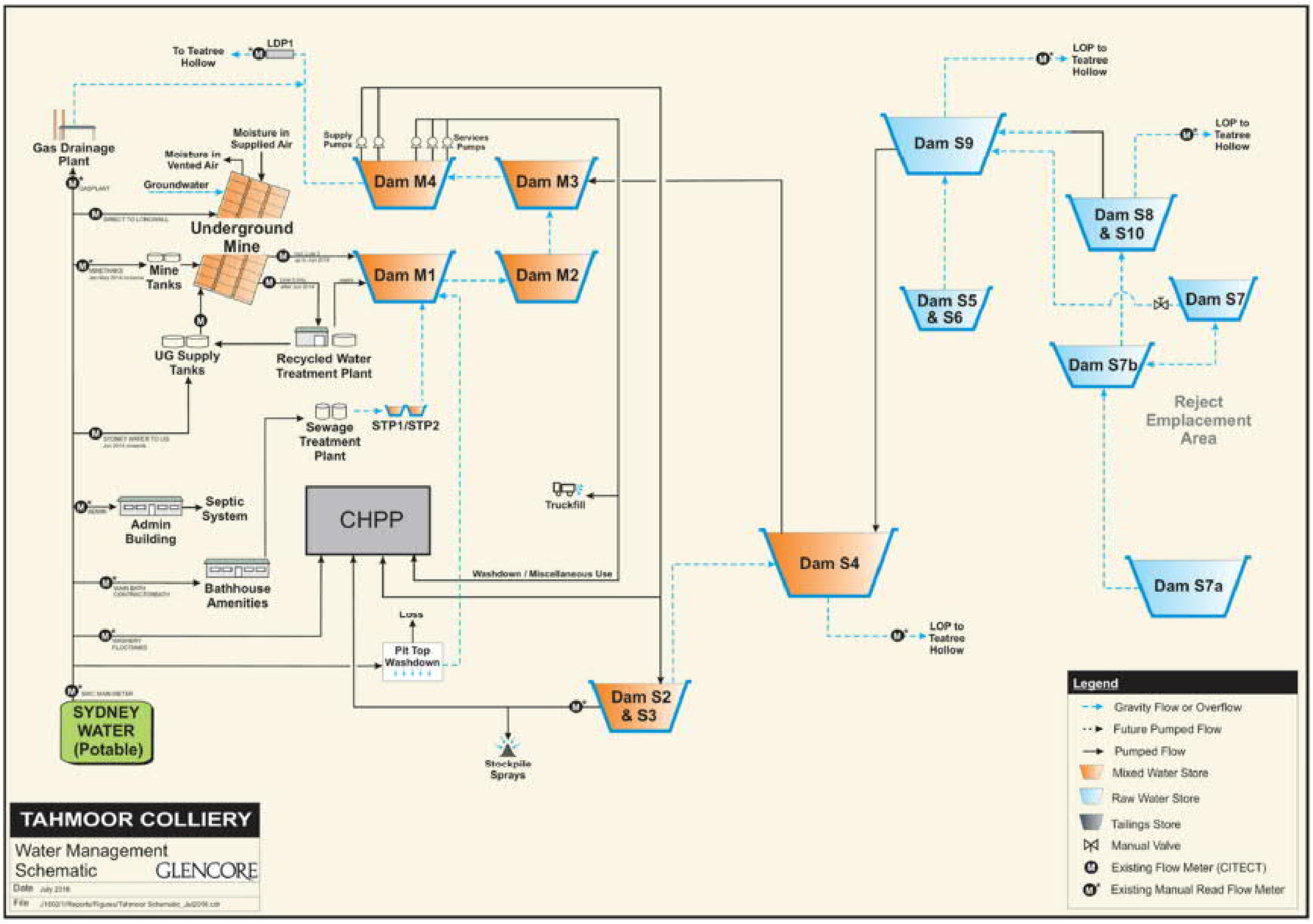

Image extracted from *Tahmoor Coal, Tahmoor Coal Annual Review, AEMR and Rehabilitation Report, March 2021, http://www.simec.com/media/7157/tahmoor-coal-2020-annual-review-and-appendices-1-13_17_final.pdf*

4 Site Description

Three areas and the surface water structures contained within were investigated:

Tahmoor Colliery Pit Top

- Located to the west of the Southern Highlands Rail line, Tahmoor Colliery Pit Top consists of administration building, workshop, machinery and equipment storage areas, people and materials access to the underground workings via roadway and shaft facilities, sewerage treatment plant, remnant tailings ponds, sedimentations pond, Coal Handling Processing Plant (CHPP), product stockpiles, Pit Top water treatment plant and railway siding.

Reject Emplacement Area (REA)

- Located to the east of the Southern Highlands Rail line, the Reject Emplacement Area (REA) comprises multiple reject stockpiles, some in a state of rehabilitation and surface water management structures.

Shaft Site

- The shaft site is located approximately 2.5km and 1.6km north-east of the Pit Top and REA respectively. The site provides access to the underground working which were mined using the bord and pillar method. The shaft opening has been secured with a steel plate and a perimeter security fence installed

Extracted from TC management plans and the *2020 Annual Review, AEMR and Rehabilitation Report (March 2021*), the following provides some context on Tahmoor Collieries surface and mine water activities.

"The surface water / runoff generated from the mines pit top facilities, stockpile and reject emplacement areas is managed via a connected network of drainage lines, dams etc, with all the surface water reporting to licenced discharge point 1. (Dam M4)."

"Tahmoor Coal has previously mined 33 longwalls to the north and west of the Tahmoor Mine's current Pit Top location. Tahmoor Coal is currently mining Longwall West 3 (LW W3) in accordance with Development Consents and Extraction Plan Approval."

"Longwalls are extracted within Tahmoor North at a depth of approximately 450 m in the Bulli Seam. Water from sedimentary layers above the mine workings seep into the mine at a rate of approximately 2.9 ML/day. This water is pumped to the surface and directed to the mine's Pit Top treatment dams. Water quality and flow is monitored under the conditions of Tahmoor Coal's EPL 1389 and Water Licence 36442."

"Groundwater bores at Tahmoor Coal Pit Top and REA are monitored quarterly for Water quality and water levels. These levels have remained relatively stable through out the reporting period."

"Tahmoor Coal is licensed to discharge water from one (1) licenced discharge location and overflow from three (3) Licenced Overflow Points (LOPs) during periods of wet weather (as per EPL 1389) which refers to more than 10 mm of rainfall within a 24 hour period at the premises."

"Sydney potable water is utilised across Tahmoor Coal with applications in amenities across Pit Top facilities and sent underground for Longwall applications. Emphasis is placed on utilising Recycled water and seeking to reduce Sydney Water potable water use on site where possible. The average monthly potable water usage was 33 ML/month."

"Tahmoor Coal continues to recycle mine water from the sealed longwall goafs to the south of the No.3 Shaft for reuse in the mine operations underground and various surface facilities."

"Mine water and storm water is discharged into Tea Tree Hollow which flows into the Bargo River. Water samples from the Bargo River are also taken monthly, upstream and downstream of the confluence of Tea Tree Hollow."

5 Site Observations

An Associate Geotechnical Engineer (Ben Tarrant) from the SLR Geotechnics and Mine Waste Engineering team visited the TC sites to inspect all water storage bodies and associated infrastructure identified by TC and presented in Appendix 6 of the *2020 Annual Review, AEMR and Rehabilitation Report* (March 2021). An additional three sites were also inspected, identified in the field investigation.

The following criteria were considered as part of the visual assessment:

- Storage key metrics, including storage capacity, spillway condition and geometry, likely construction method, inflow and outflow;
- Embankment condition, seepage and condition of associated infrastructure;
- Surrounding topography and geology.

A total of 26 stored water structures and associated infrastructure were observed during the site visits as well as the license discharge point (LDP). A full summary of site observations is included in Appendix A. A summary of key observations is included in the following sections. A selection of key site photographs included in the Appendix B.

The following definition of connectivity has been proposed as a basis for discussion between jurisdictions:

- High connection for systems where the conductance is high and there can be an expectation that surface water impact on groundwater will have an influence within a specified timeframe which is short. In these types of systems, it might be expected that more than 70% of the volume of the surface storage water flows to groundwater;
- Moderate connection for systems where both the conductance and hydraulic gradients are moderate. In these types of systems, it might be expected that between 10% and 70% of the volume of surface water storage flows to groundwater;
- Poor connection for systems where the conductance is low. In these types of systems, it might be expected that less than 10% of the volume of surface water storage flows onto groundwater;
- Unconnected systems where the arrangement of aquifer, stream and intervening materials means there is no physical means by which measurable quantities of water can be exchanged between surface water and ground water.

Table 2 Surface Water – Groundwater Connectivity Assessment

Name	Storage	Likely pathway(s) to groundwater	Estimated Connectivity to Groundwater	Basis of Assumption Regarding Degree of Connectivity
M1	Pit Top sediment pond.	Seepage via basin	Unconnected/Poor	Unlined. Likely thick bed of low permeability flocculated coal fines in base of pond. Founded on bedrock of thin horizontally bedded sandstone and shale and residual soil. No observed subsidence cracking. No observed natural jointing or faults. No observed downstream seepage. No local Groundwater Dependent (GWD) ecosystems. Overtops into M2. No connection to downstream river/creek systems.
M2	Pit Top second settlement pond	Seepage via basin	Poor	Unlined. Likely thick bed of low permeability flocculated coal fines in base of pond. No observed subsidence cracking. No observed significant natural jointing or faults. Thin horizontally bedded sandstone and shale. No observed downstream seepage. No local GWD ecosystems. Overtops into M3. Not connection to downstream river/creek systems. Large casuarina trees on pond bank may offer deeply penetrating root systems.
M3	First Water Treatment Plant Pond	Seepage via basin	Poor	Unlined. Likely bed of low permeability settled coal fines in base of pond. Founded in bedrock/residual soil. No observed subsidence cracking. No observed downstream seepage. No local GWD ecosystems. Flow to M4. Large casuarina trees on pond bank may offer deeply penetrating root systems.
M4	Second Water Treatment Plant Pond	Seepage via basin and spillway	Poor/Moderate	Unlined, founded in natural bedrock and clayey residual soils with downstream fill embankment. No seepage observed downstream of embankments. No local GWD ecosystems. Potential connectivity via LDP1 to Teatree Hollow Creek, connectivity depended on creek connectivity to groundwater. Assumed creek has moderate connectivity. Highly diluted if connected.
M5	Upshaft First Sediment Pond	Seepage via basin and Embankment	Poor	Unlined, founded in natural bedrock and clayey residual soils with downstream fill embankment. Seepage observed downstream of embankment - seepage flows to M6. No local GWD ecosystems. No evidence of subsidence. No evidence of natural faults or cracking.
M6	Upshaft Second Sediment Pond	Seepage via basin and Embankment	Poor/moderate	Unlined, founded in natural bedrock and clayey residual soils with downstream fill embankment. Low flow seepage observed downstream of embankment – potential flows to Bargo River (230m to west). No evidence of subsidence. No evidence of natural faults or cracking. Spillway overflow (LOP6) to Bargo River. Groundwater inflow naturally recharges pond.

Name	Storage	Likely pathway(s) to groundwater	Estimated Connectivity to Groundwater	Basis of Assumption Regarding Degree of Connectivity
T1 + T2	Remnant Tailings Storage Facilities	Seepage via basin	Unconnected	Unlined. Founded on residual soils/bedrock. Thick layer of very low permeability tailings in base. Only captures local run-off subject to evaporation. Small storage volume. No seepage downstream of embankments.
STP1 & STP2	Sewerage Water Treatment Ponds	Seepage via basin	Unconnected/Poor	Unlined. Cut into in natural bedrock and clayey residual soils. Connectivity, if any, likely via natural jointing within rock mass. No evidence of subsidence or major faults.
S2 & S3	Stockpile run-off sediment ponds	Seepage via basin	Unconnected/Poor	Unlined. Cut into natural bedrock and clayey residual soils. Likely thick bed of low permeability coal fines in base of pond. Embankments constructed of coal wash rejects. Kept full. No evidence of subsidence. Connectivity, if any, likely via natural jointing within rock mass. No evidence of natural faults or cracking. Downstream gully has groundwater seepage on side walls. Colouration not indicative of connection to surface storage.
S4	Retention Pond	Seepage via basin and embankment	Poor/moderate	Unlined. Cut into natural bedrock and clayey residual soils with natural fill embankments. No evidence of large faults or subsidence. Thin layer of low permeability washed in coal fines. Very minor seepage noted at downstream toe of embankment. Seepage noted to have iron oxide staining and bacteria presence, maybe indicative of mine impacted waters seeping out of sandstone strata. Seepage unlikely to continue to local river system before evaporation or significant dilution.
S4a	Sediment Basin	Seepage via basin	Unconnected	Unlined. Founded on residual sandy clay soils. Only hold water during periods of rainfall. No signs of faults or subsidence. Any seepage would flow into S4.
S5	Sediment Basin	Seepage via basin	Unconnected	Unlined, founded on residual soils. No evidence of faulting or subsidence cracking. No seepage observed downstream. Empty during dry periods. No evidence of water dependant vegetation downstream or surrounding.

Name	Storage	Likely pathway(s) to groundwater	Estimated Connectivity to Groundwater	Basis of Assumption Regarding Degree of Connectivity
S6	Sediment Basin	Seepage via basin and spillway	Poor	Unlined, founded on alluvium and residual soils. Layer of low permeability coal fines noted downstream. No evidence of faulting or subsidence cracking. No seepage observed downstream. Hold water year-round. Undulating, waterlogged ground downstream of spillway with high water demand vegetation. Ponding noted at time of walkover. Spillway would be regularly used in intense rainfall events due to under capacity glory hole drainage. Large trees within upstream embankment may act as conduits to deeper layers.
S6a	Retention Pond	Seepage via basin and embankment	Poor	Unlined, founded on residual soils of clayey gravelly sand. Heavily vegetated basin of reeds with medium sized trees within upstream embankment which may act as conduits to deeper stratum. Steady seepage noted downstream of north-easterly embankment which flows into Teatree Hollow Creek. Seepage outlet shows iron oxide staining and algae matting. No freeboard at time of investigation, spillway flows direct to Teatree Hollow Creek.
S7	Retention Pond	Seepage via basin	Unconnected/Poor	Unlined, founded on residual soils of clayey gravelly sand and outcropping bedrock. Embankments constructed of coarse coal wash rejects. No seepage observed downstream of embankment toe. Seepage observed approx. 100m below toe within sandstone outcrops within remnant water course. Seepage very slight potential linkage to S7 upslope.
S7a	Retention Pond	Seepage via Basin	Poor/Moderate	Unlined, founded on residual soils of clayey gravelly sand and outcropping bedrock. Infilled remnant water course. Dead trees present in basin – root systems may act as conduits to deeper layers. Embankments constructed of coarse coal wash rejects. Some scour damage observed on face and loss of inlet culvert headwall. No seepage observed downstream of embankment toe. Seepage observed approx. 100m below toe within sandstone outcrops within remnant water course. Seepage water similar to S7a storage water - potential linkage. Unfavourable jointing (i.e. orientated below surface) observed within downstream outcropping sandstone.
S7b	Retention Pond	Seepage via basin	Unconnected/Poor	Unlined, founded on residual soils and horizontally bedded sandstone. Thick layer of low permeability coal fines in base. No seepage observed downstream. Medium sized trees within upstream batter faces.

Name	Storage	Likely pathway(s) to groundwater	Estimated Connectivity to Groundwater	Basis of Assumption Regarding Degree of Connectivity
S8	Retention Pond	Seepage via Basin and spillway	Unconnected/Poor	Unlined, founded on residual soils and horizontally bedded sandstone. No signs of significant faulting or subsidence. Portion of embankment abuts natural sandstone. Very minor seepage observed in downstream embankment face. Downstream of spillway, water dependent reeds present, potential combination of downstream seepage and spillway flows. Spillway flows into Teatree Hollow Creek.
S9	Retention Pond	Seepage via basin	Unconnected/Poor	Unlined, founded on residual soils and horizontally bedded sandstone. No signs of fracture zones, faults, or subsidence cracking. Embankment of site won fill materials of sandy clays. Pond directly upstream of Teatree Hollow Creek.
S10	Sediment Basin	Seepage via basin	Unconnected	Unlined, founded on residual soils. Shallow. No evidence of fractured zones, subsidence, or downstream seepage. Ephemeral – only filled during periods of high rain. Basin layered with low permeability silt from road run-off.
GPD	Retention Basin	Seepage via basin	Unconnected	Unlined, founded on residual soils, shallow. Stagnant water, thick algae and water dependant vegetation indicates minimal loss of water.
Tank 1 & Tank 2	Underground Potable Water Tank	Seepage via cracking	Unconnected.	Very slight seepage. Any seepage subject to evaporation. Founded on engineered, compacted foundation.

6 Piezometer and Rainfall

Figure 3 and Figure 4 show recorded rainfall against the measured piezometer groundwater levels. Locations of the piezometers are shown in Appendix B.

The data indicates correlation between rainfall and groundwater measured in REA7, REA1 and REA2. Pit Top 2 piezometers do show some variation, however the correlation to rainfall appears to be poor.

The results below are not an indication of linkage between the Tahmoor surface water structures and groundwater, but rather an identification of groundwater sources sensitive to surface water variation within the catchment area. The information may be used as basis of further investigation to confirm linkages.

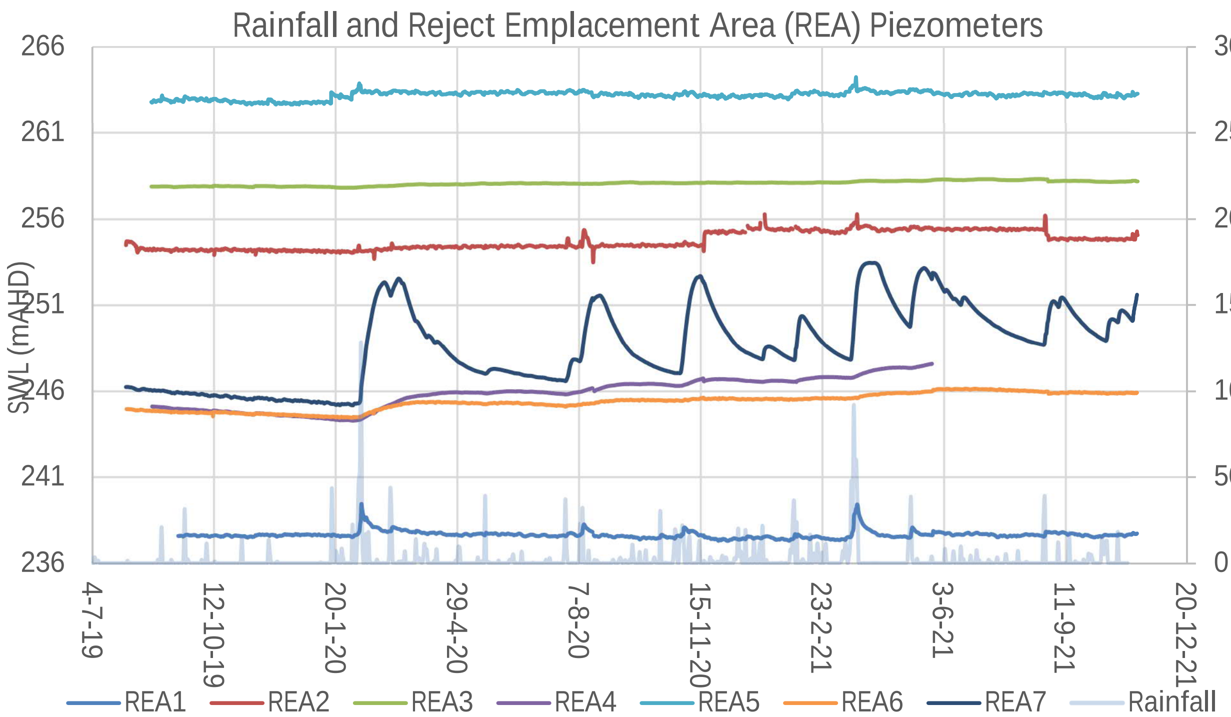

Figure 3 Reject Emplacement Area Rainfall and Groundwater Level (as measured by piezometers)

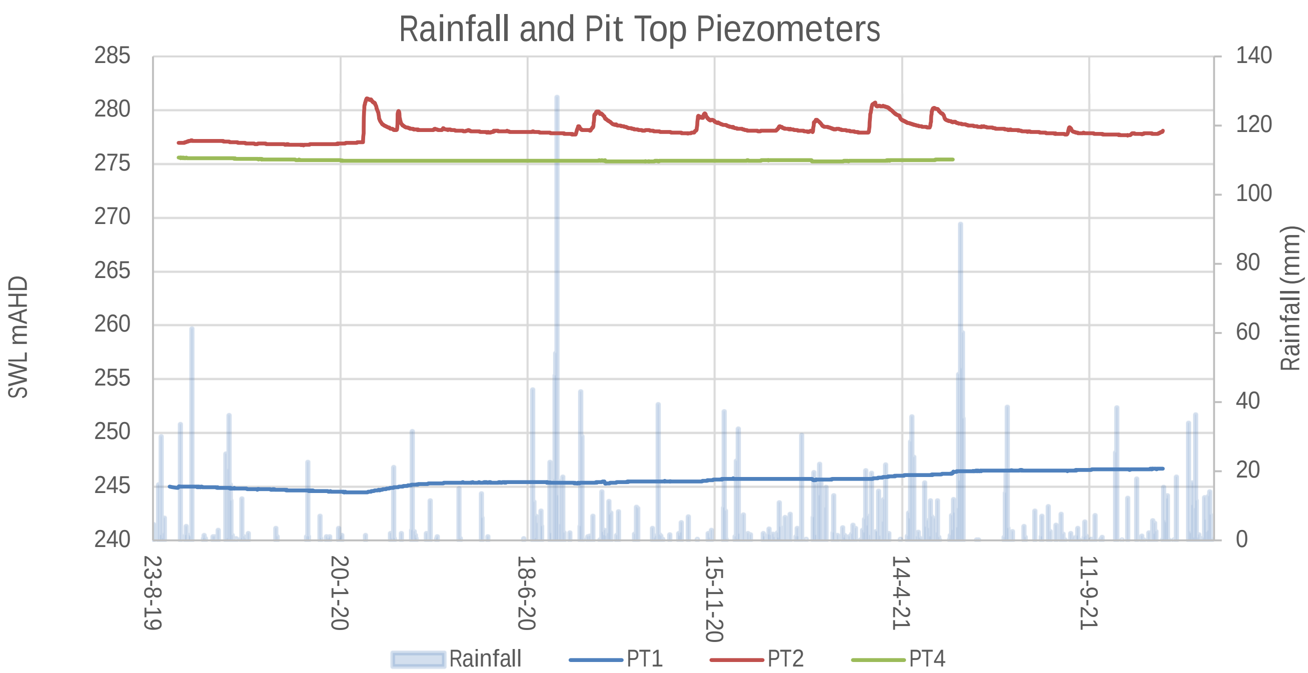

Figure 4 Pit Top Area Rainfall and Groundwater Level (as measured by piezometers)

Rainfall data from combination of site (up to 14/2/2020) recording and data from BOM, Buxton Station No. 68166 (15/2/2020 to end).

7 Chemical Analysis

Comparison of surface water chemical assessment and historical groundwater chemical assessment is provided in Figure 5 to Figure 9 . For display purposes, only pH and Electric Conductivity are shown to illustrate potential correlation. Only one surface water data point was available at the time of assessment (12 Oct 2021).

For the Pit Top area, the surface water location of License Discharge Point 1 (LDP1) has the closest proximity and is downstream of all Pit Top surface water storages.

With only one surface water pH and EC data point, it is difficult to assess connectivity. Leachate from Southern Coalfields coal will typically have alkaline pHs (pH>7) due to the carbonate content and low sulphur content. All groundwater except Pit Top 1 displays pH content below what would be expected from coal impacted water. This is emphasised in the surface storage water pHs which tend to have pH>7, reflective of runoff from coal and coalwash stockpiles. From the pH data, groundwater intercepted by Pit Top 1 maybe impacted by surface water, however, further assessment would be required as this groundwater maybe naturally alkaline as it does exceed measured storage surface water pH. Electric conductivity for both groundwater and surface storage water ranges within similar values, with the groundwater EC typical of the Southern Coalfields region.

Assessment of groundwater and surface water heavy metal leachate ranges using box and whisker plots is presented in Figure 9Error! Reference source not found.. The last 4 points in each plot are a single data set of the surface storage water results. The surface water results generally plotted within ranges similar to groundwater. Barium did show higher results for S4, S8 and S9 dams which falls within historical ranges of Pit Top 2 Piezometer, however the dams are downstream of Pit Top and not likely to be connected. Similarly, to the pH and EC data, it is difficult to draw conclusion from limited data, however there appears to be low connectivity.

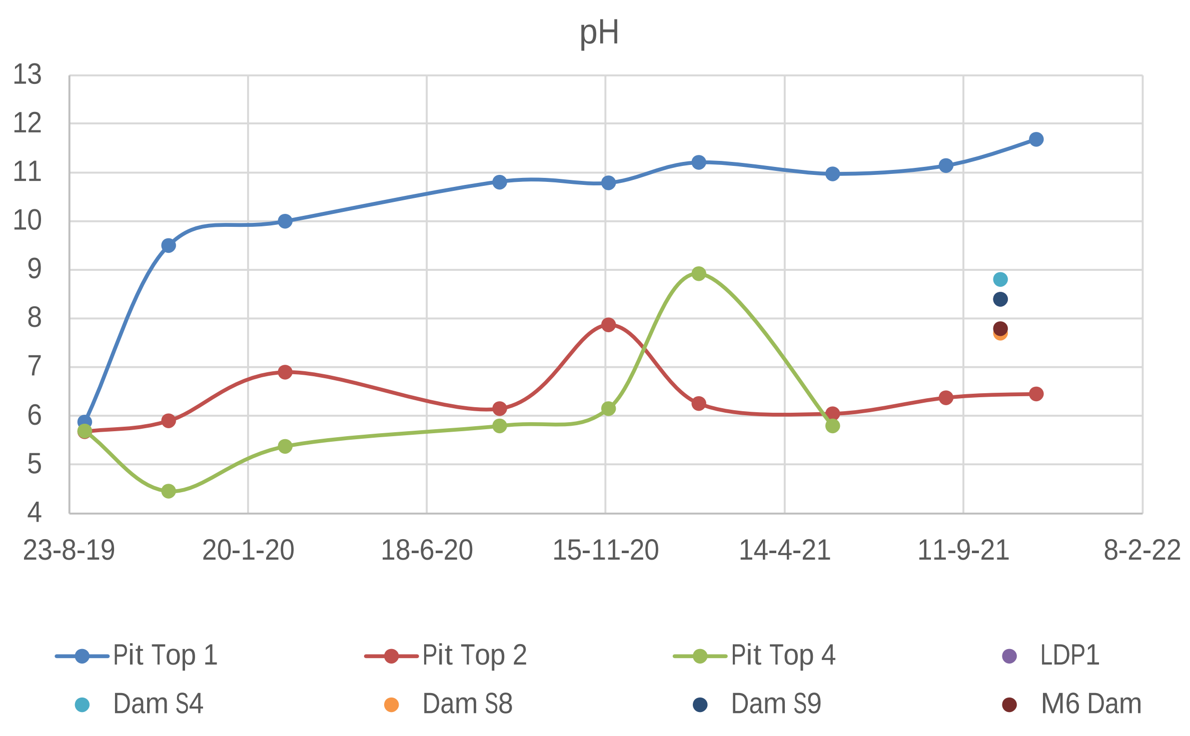

Figure 5 Pit Top Piezometers and Surface Water pH

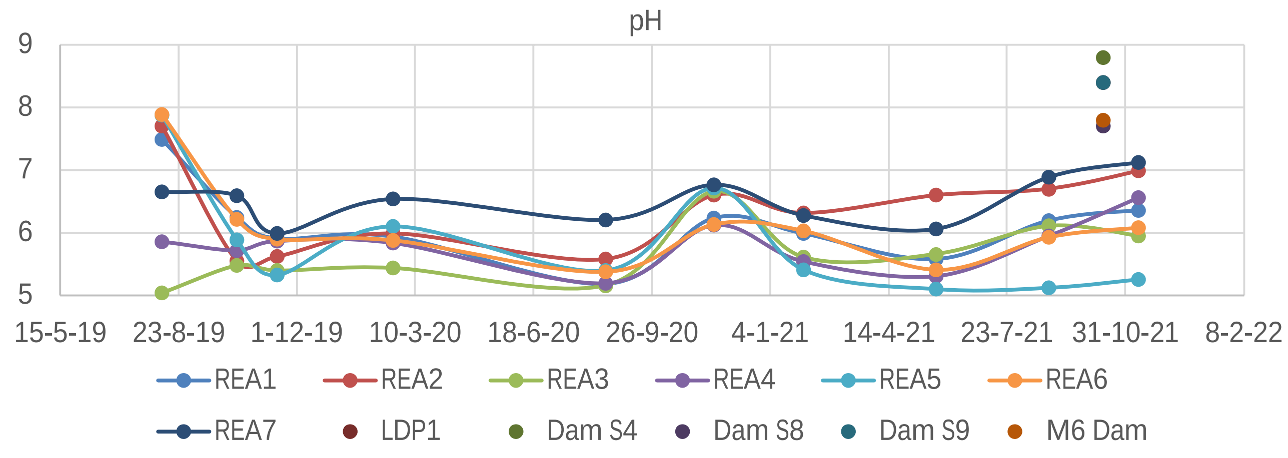

Figure 6 REA Piezometers and Surface Water pH

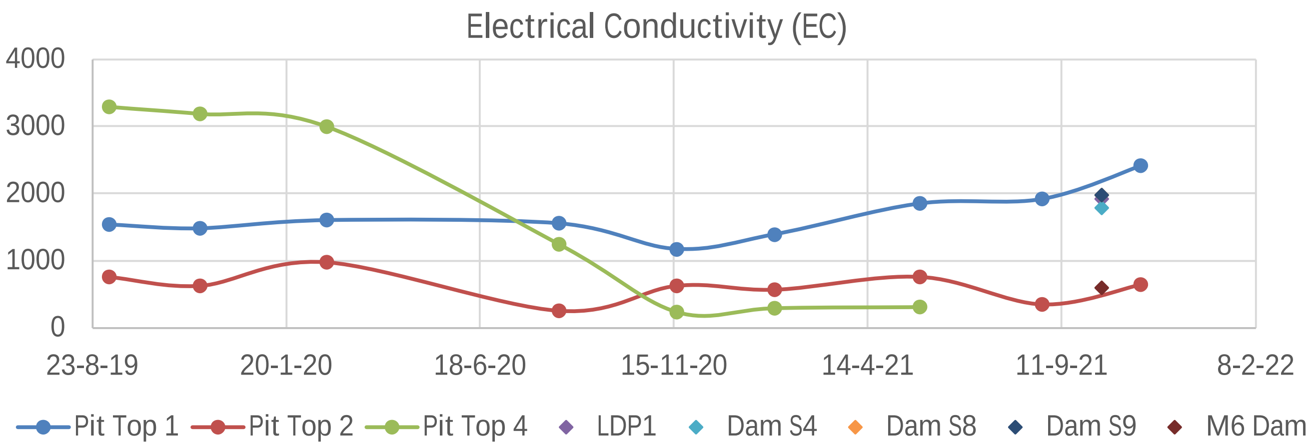

Figure 7 Pit Top Electric Conductivity and Surface Water Conductivity

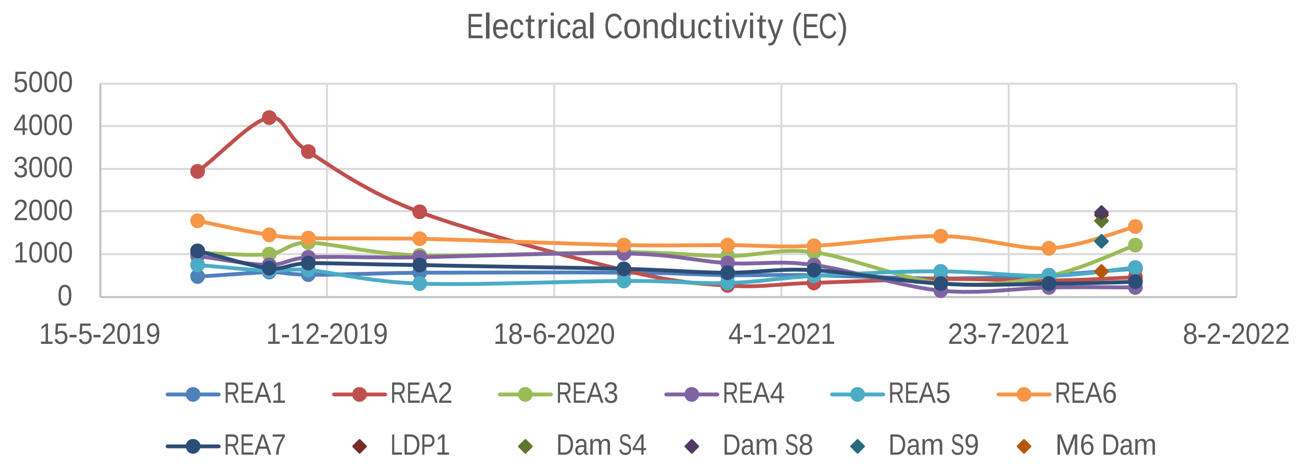

Figure 8 REA Electric Conductivity and Surface Water Electric Conductivity

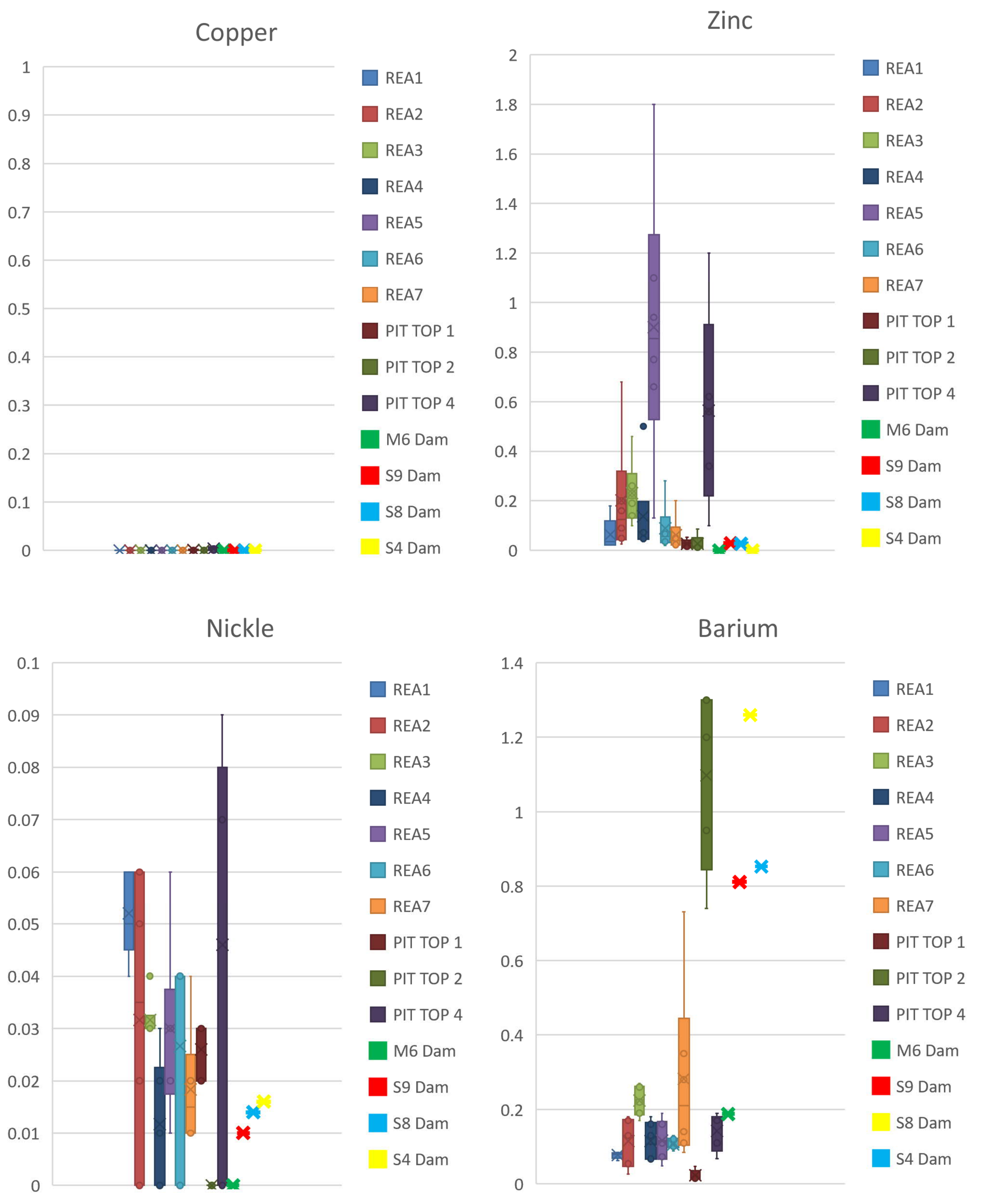

Figure 9 Heavy Metal Leachate Piezometers and Surface Water

8 Data Gaps and Limitations

The Basis of Assumption presented in Table 2 presents the information gaps that could shed further light on the connectivity of the surface water storage features to groundwater.

Based on review of the Pit Top piezometers and chemistry data it is difficult to discern the connectivity of surface water to groundwater, however based on the available data, the connectivity appears to be limited.

8.1 Recommendations

A number of potential further exploratory options exist that may assist in providing a greater level of confidence for the preliminary findings presented here, including;

1) Define the water quality signature for the groundwater and surface water features, by determining the chemical characterisation, to allow for comparison. This would involve sampling the water features for physiochemical parameters (salinity, pH, metals, etc). Ideally this would occur over multiple sampling events (at a minimum dry and wet conditions). It is recommended to include basic isotopes (carbon).

2) Dye tracing has been used his historically to identify relationships between surface water and groundwater. However, given the spatial distribution os surface water storages and piezometers, this method may not be viable for this site.

3) Completion of a site water balance may assist in identifying relationships between the surface water and groundwater features, however, data is unlikely to be sufficient to perform such an exercise.

It is recommended that, if Tahmoor Coal deems is necessary to undertake additional scope of works, option 1 presented above is the most suitable for this site.

9 Conclusion

Based on surface observations, the surface storage water structures were generally found to have limited connectivity to groundwater outside of the structure themselves. The unlined nature of all the water storages (with exception to the potable water tanks) offers the most likely path of connectivity to groundwater. The surrounding geology indicates all storages are founded on residual soils or bedrock with favourable jointing and bedding. There was no observed evidence of geological features that may act as conduits for surface water/groundwater connectivity, however underlying subsidence and cracking maybe evident in the base of storage structures that cannot be observed.

Assessment of rainfall to groundwater levels did indicate some sensitivity in groundwater to rainfall variation as measured at piezometers REA1, REA2 and REA7.

Comparison of surface and groundwater chemistry was difficult to discern any meaningful relationship due to limited surface water data sets, however, from the information, connectivity between surface water and groundwater appeared to be limited. Pit Top 1 did show a high pH (pH~11), however it was notably higher than measured surface water and likely to be upstream of Pit Top workings.

Recommendations are provided as a means of firming up assumptions in connectivity.

APPENDIX A

Summary of Observations

Table A1 Observation Summary, Pit Top Water Storage Facilities

Name	Storage	Observation	Comment
M1	Pit Top sediment pond. Receives first round of water from washery and yard run-off. Also receives treated sewerage water. Flocculant and coagulant applied at inlet to assist in settlement.	Narrow rectangular in shape. Approximately 110m long and 25m wide. Outlet at opposite ends of longitudinal axis to flocculant. Cut into natural ground. Unlined. Washery pipeline inlet located near outlet. Headwall cracked. Inlet from STP 2 overgrown with reeds. Silt sock at culvert outlet to M2. Site bunds constructed of pond fines.	Exposed shale and sandstone of narrow spaced horizontal bedding observed in side walls. Natural soils/rock stained black. Pond kept full to manage settlement. Depth unknown. Base condition unknown. Fines cleaned out periodically and used as side bunding. No soft spots observed within perimeter roadways. Reeds encroaching on culvert outlet to M2, low impact on flow. No evidence of nearby subsidence, however much of area has been developed and asphalted.
M2	Pit Top second settlement pond	Input from M1. Heavily vegetated on eastern bank with small to medium casuarina trees. Medium density reeds vegetated along toe of banks. Cut into natural ground. Unlined. South bank at toe of T2 TSF. Side bunds constructed of pond fines. Outflow to M3 via drop pit in SW corner Near kept full to promote flow to M3.	Exposed shale and sandstone of narrow spaced horizontal bedding observed in side walls. Natural soils/rock stained black. Pond kept full to manage settlement. Depth unknown. Condition of base unknown. Fines cleaned out periodically and used as side bunding. No soft spots observed within perimeter roadways. No sign of tilting in trees. No evidence of nearby subsidence, however much of area has been developed and asphalted.

Name	Storage	Observation	Comment
M3	First Water Treatment Plant Pond	Input from S4 and M2 at southern end. Heavily vegetated along banks of pond with reeds and medium sized casuarina trees. Cut into natural in the south and fill embankments in the north. Unlined. Kept full with ≤0.50m freeboard. Inlet regularly cleaned. No seepage observed in downstream gullies or within adjacent rail siding cut. Separated from M4 by ~4.0m wide natural divide. Primary silt sock across width of pond approximately 20m from inlet. Outlet to M4 via dual pipe culvert with silt sock.	Large quantity of coal fines located along the banks upstream of outlet silt sock resultant of regular clean-out. Embankments constructed of local residual soils and crushed bedrock. Likely overburden. In good condition with little to no scour observed. No evidence of seepage in perimeter roadway and toe of embankment. Low velocity water flow. No seepage in lower roadway, downstream of pond observed. Inlet and outlet culvert in good condition. Not able to observe base. Depth unknown. No evidence of nearby subsidence, however much of area has been developed and asphalted.
M4	Second Water Treatment Plant Pond	Input from M3. Cut into natural in the south and contained by fill embankment on northern and eastern edges. Unlined. Banks heavily vegetated with casuarina trees and reeds. Concrete lined spillway located in north-east corner embedded cobble flow dissipators. Output to LDP1 and recycled back to washery. Good clarity over spillway.	No evidence of cracking or seepage within dividing embankment. Similarly pipeline infrastructure and trees show no sign of movement. Fill embankment constructed of locally sourced residual soils and sandstone gravels. No signs of seepage along downstream toe of embankment. Spillway in good condition. No evidence of nearby subsidence, however much of area has been developed and asphalted.
M5	Upshaft First Sediment Pond	Cut into natural with fill embankment on the north, east and south sides with 3.50m wide crest. Unlined. Heavily vegetated and grassed with moderate reed growth within basin. Run-off from upshaft area. Formalised concrete spillway in NW corner.	Embankment constructed of coal wash rejects. Reed growth suggest good retainment of water. No observed scour at spillway of downstream. No observed seepage at toe of embankment. No evidence of nearby subsidence, however loose surface materials likely infill any cracking.

Name	Storage	Observation	Comment
M6	Upshaft Second Sediment Pond	Cut into natural with fill embankment on the north, east and south sides with 3.00m wide crest. Unlined. Heavily vegetated and grassed with moderate reed growth within basin. Seepage observed downstream of embankment within exposed rock, seepage has iron oxide staining.	Embankment constructed of coal washery rejects and locally won residual soil and rock materials. Appears to be naturally recharged. Groundwater seepage observed in north-west corner from exposed rock formation. Soft wet areas downstream of eastern downstream embankment. Seepage observed in localised areas. No evidence of nearby subsidence, however loose surface materials likely infill any cracking.
LDP1	License Discharge Point 1	Inflow from M4 via channel that runs adjacent to rail corridor. Channel is cut into natural material. Water velocity in channel has moderate speed. Small retainment pond cut into natural soil. Steep, sub-vertical banks. Heavily grassed on banks with reeds. Adjacent to rail siding corridor. Natural water colouration. Square notch weir outlet.	Between railway embankment and banks of LDP1, thick reeds and tall grass, suggestive of overflow into the area. Minor scour on banks.
T1 + T2	Remnant Tailings Storage Facilities	Embankments constructed of compacted coal washery rejects and naturally won materials. No external feed. All water from pond catchment. Earthen embankment separates T1 and T2. Grassed embankments. Embankments approx. 2H:1V	Disposal of slurry tailings no longer conducted at TC. Facility now used to temporarily store belt press fines. No signs of slumping or instability in embankments. No signs of seepage on downstream toes. Some minor scour evident at emergency spillway.
STP1 & STP2	Sewerage Water Treatment Ponds	Cut into natural subgrade with steep batters. Unlined. Subgrade clayey gravels/sands. Gravel component weathered sandstone. Small 80mm pipe allows flow downstream from STP1 to STP2. STP2 receives Pit Top storage yard run-off	Recent removal of small to medium casuarina trees may facilitate minor slumping of the embankment as the root ball deteriorates. Concrete slab foundation to the east of STP2 shows no signs of movement (cracking, undermining etc).

Name	Storage	Observation	Comment
S2 & S3	Stockpile run-off sediment ponds	Combination of cut into natural with earthen/CWR embankments for increased capacity. Dense reeds populate the inlet with occasional casuarinas on the banks. Earthen embankment constructed of CWR separates S2 and S3. Fines build up evident in inlet channel.	The eastern fringe sits on the crest of a natural gully. Likely majority of eastern embankment is constructed of coarse CWR rejects. No seepage was observed within the downstream toe. Not able to observe base of pond due to poor water clarity. Seepage observed in the downstream gully, approx. 15m below S2 and S3. Difficult to discern origins. Seepage exit point noted to have iron oxide staining, microbial colouration, and low flow. Ponds are cleaned out on regular basis. No subsidence observed within proximal areas including downstream creek.
S4	Retention Pond	Cut into natural and complimented with earthen perimeter embankments to increase capacity. Sandstone outcrops noted on shorelines. Coal intermixed with natural noted on shoreline. Northern embankment built up with sandstone boulders and coarse CWR to facilitate roadway. Southern embankment constructed of locally sourced earthen materials. Appears southern embankment abutted into natural sandstone outcrop in south-eastern corner. Inflow from S9, S2 and S3. Outflow to M3 water treatment pond.	Largest of all the on-site water storages. One seepage point noted along the downstream toe of the southern embankment. Difficult to discern origins. Seepage exit point noted to have iron oxide staining, microbial colouration, and low flow. Vegetation around seepage path suggests ephemeral. No significant scour or erosion.
S4a	Sediment Basin	Cut into natural. Captures south-westerly run-off from REA Processing Area. No spillway or outlet.	Appears to be a natural depression that has become a sediment basin due to the construction of the perimeter embankment around S4 and roadway. Evaporative.
S5	Sediment Basin	Cut into natural with the western and northern embankments constructed of coal washery rejects and natural clayey sand materials. 2H:1V batters, approximately 2.0m to 2.50m high. Unlined. Captures north-easterly run-off from REA Processing Area. Embankments well grassed. Turbid water. Spillway to S6.	Well vegetated area. No seepage observed in downstream toes. No scour observed in embankments. Spoon drain directs flows to S6 on the however no formalised spillway evident.

Name	Storage	Observation	Comment
S6	Sediment Basin	Inflow from S5 via spoon drain. Constructed from combination of cut (basin) and fill (embankment). Constructed from coal washery rejects and earthen material embankments (likely won from basin). Unlined. Embankment sparsely vegetated. Approx. 3.0m wide with 1H:2H. Shoreline subgrade comprised of natural clayey sand material and coal fines. Embankments combines of sandstone cobbles/boulders and sandy/clay and clayey/sand. Overflow pipe, approx. 200mm diameter - directs flows to S9. Turbid water with build up of reject fines along banks.	Overflow pipe's capacity would be easily exceeded in most low to high inflow events. Spillway in south-west corner much lower than surrounding embankment crest. Combined with overflow pipes low capacity, spillway likely overtopped frequently. Downstream of spillway hummocky and wet in places with some localised small pools. Downstream ponding likely resultant of recent rainfall pooling in depressions rather than seepage. Natural muddy water colouration. No evidence of scour. No evidence of proximal subsidence, however surrounding area vegetate with topsoil, likely any cracking infilled. Base of pond unable to be observed due to poor water clarity.
S6a	Retention Pond	Inflow from S6 spillway. Near full capacity. Outlet via spillway in north-west corner to Teatree Hollow Creek. Heavy reed growth and well vegetated banks. Constructed by damming natural confluence zone. Eastern bank created by haul road. Northern embankment constructed of clayey sand and cobbles. Approx. 2.50m wide, steep batters.	Seepage observed downstream of northern embankment. Iron oxide staining and bacterial matting evident Appears naturally recharging from the confluence channel. Historical imagery suggests constant water storage. Established, large trees within embankment suggests construction at least 20 years ago. No evidence of proximal subsidence, however surrounding area vegetate with topsoil, likely any cracking infilled.

Name	Storage	Observation	Comment
S7	Retention Pond	Cut into natural subgrade. Founded on residual soil and weathered sandstone/shale bedrock. Unlined. Formed by road embankment constructed of CWR that is capped to the west and reject stockpiles on the remaining sides. Southern stockpile capped with sparse vegetation. Haul trucks frequent haul road. Uncapped CWR shows minor scour gullies. Captures all run-off from REA stockpiles and S7b. Level in S7 can rise above S7b, in which case flow is also to S7b. Pipe culvert between S7 and S7b clear. Outlet to S9 via glory hole. Poor water clarity in pond. Clear water clarity for S7b inflow.	Scour slump evident on road embankment at road run-off exit point near north-west corner. If left unchecked, may induce minor loss in road. No seepage evident on downstream side of road embankment. No evidence of embankment instability. Approx. 1/3rd of base - visible shows no signs of cracking or subsidence, however soil deposits likely infill any cracking. Embankments made up of combination of coarse CWR and fines.
S7a	Retention Pond	Similar to S7, formed by road embankment on western side constructed of coal washery rejects. Remaining sides formed by reject stockpiles. Road embankment upstream slope 1V:2H to 3H, downstream slope 1V:4H to 5H. Medium trees populate upstream slope of road embankment. Founded on natural subgrade of residual clayey soil and sandstone bedrock. Dead medium to large trees within basin. Turbid water clarity Under haul road culvert that directs water from western REA to S7a clear, some minor scour noted at outlet. Culvert diverting northern catchment flows in S7a compromised at outlet. Headwall as well as final concrete pipe section detached.	Downstream of road embankment remnant gully and water course. Alignment of gully suggests dam and road embankment dissects old gully. Groundwater seepage noted downstream of S7 within old water course via natural fractures in sandstone bedrock. Water clarity slightly less turbid than water observed in S7a, however similar in colour, potential linkage. Low flow seepage with minor ponding around seepage points. Subsidence cracking not observed in natural surrounding subgrade. Some natural jointing orientated unfavourably (below surface).
S7b	Retention Pond	Constructed from fill embankments made of coal washery rejects and natural materials. Founded on residual soils and sandstone bedrock. Basin floor comprise of silt and coal reject fines. Embankment 3.0m wide with 1V:3H slopes. Inflow from S7 pipe and S7b spillway. Outlet spillway cut into natural subgrade comprises reno mattress and concrete channel at outlet. Minor scour evident. Sparsely vegetated on slopes with medium sized trees.	No signs of seepage downstream of embankment. No signs of embankment instability. Outlet and inlet in good conditions. Outlet spillway sufficient size to prevent overtopping. Downstream of outlet channel to S8 armoured with sandstone boulders. Minimal evidence of coal fines in outlet channel. Approx. 1.7m freeboard.

Name	Storage	Observation	Comment
S8	Retention Pond	Constructed from fill embankments of coal washery rejects that have been capped with natural local materials. Abutted into natural outcropping sandstone. Founded on sandstone. 3.0m wide embankment. Formalised spillway via v-notch weir. Spillway feeds into a natural low area which continues into Teatree Hollow Creek. Clear water with low content of coal fines in basin. Banks well grassed with large trees on natural banks and medium tress on fill embankments. Reeds evident in basin. Water pumped to S9.	No evidence of subsidence or induced cracking within surrounding bedrock. Only natural fractures observed. Spillway armoured with sandstone boulders. Some minor scour evident near outlet. Slight seepage noted in downstream embankment. Seepage above water level, likely percolating water from recent rain event seeping out of soil.
S9	Retention Pond	Combination of cut (southern side) and fill on northern embankment. Fill embankment constructed of naturally sourced materials comprising sandy clay/clayey sand and gravels. Founded on sandstone bedrock. Unlined. Embankment 4.1m wide. Approx. 1V:2.6 to 3.0H slope batters. Input from S6, S7, S8 and road run-off. Glory hole drainage to wet well which pumps to dosing plant then S4.	Embankment conducted without engineering specification. Likely end tipped and pushed out with nominal compaction from machinery. Embankment in good condition. No cracking or evidence of movement observed. No seepage observed at downstream toe of embankment. Dam is located just above Teatree Hollow creek. Creek's outcropping sandstone showing no signs of subsidence cracking. Natural fractures evident.
S10	Sediment Basin	Created by fill embankments of coal washery rejects. 1.50m crest width. Founded on residual soils/bedrock. Inflow from road run-off. Turbid water clarity No outlet. Evaporative.	Embankment in good condition. Small capacity of dam, likely to be overtopped regularly. Well vegetated embankment with no scour evident.
GPD	Retention Basin	Cut into natural subgrade to capture confluence of run-off flow. Unlined. Retention basin with square notch weir and drop pit. Heavily vegetated. Algae bloom, no clarity in water. Inflow from upstream gas plant containment embankment run-off Outflow to LDP1.	Stagnant water. Water quality not impacted by mine operations. Vegetation and algae suggest rarely dry. No signs of seepage in surrounding banks.

Name	Storage	Observation	Comment
Tank 1 & Tank 2	Underground Potable Water Tank	Cement steel reinforced circular water tanks. Founded on natural residual soil and bedrock.	Seepages evident in hairline cracks. Moss and calcium staining evident around some cracks suggestive of long-term seepage. Seepage very slight, most likely to evaporate.

APPENDIX B

Site Photos


M3 Looking North


M3 Looking South West


M3 looking North West


M3 Looking North


M3 Foundation Conditions


M3 Looking NW


M3 SW Bank


M3 Outlet / M4 Inlet

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M4 Looking North West


M4 Looking South West


M4 Spillway NW corner


M4 Looking South


M4 Embankment Conditions


M4 WTP Feed


M4 Downstream Spillway Runoff


M4 WTP Pontoon

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M5 Looking West

M5 Looking East

M5 Looking West

M5 Looking North East

M5 Foundation Conditions

M5 Spillway

M5 Looking North

M5 Upstream Inlet Channel

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M6 Looking East

M6 Looking West

M6 Looking North

M6 Looking East

M6 Foundation Conditions

M6 Downstream Seepage

M6 Upstream Seepage Water

M6 License Discharge Point 6

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S2 Looking East

S3 Looking East

S2 Looking North

S2 Foreground, S3 Background

S2 & S3 Embankment + Foundation Conditions

S3 Looking South East

S2 to S3 Causeway

Inflow from Product Stockpile to S2

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S4 North West Bank

S4 South West Corner

S4 Northern Bank Looking North West

S4 Looking South East

S4 Embankment + Foundation Conditions

S4 Downstream Pooling

S4 Downstream Seepage

S4 Spillway

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S4a South West Bank


S4a Looking North West


S4a Looking South East


S4a Looking North West


S4a Looking South East


S4a Northern Bank Looking West


S4a Looking South East


S4a Northern Bank Looking East

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S5 Looking South West

S5 Southern Bank

S5 Eastern Embankment Looking North

S5 Looking North East

S5 Northern Embankment Crest

S5 Downstream NE Embankment

S5 Looking North East

S5 Looking South

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S6 Western Bank Looking North

S6 East Bank Looking South West

S6 South West Spillway Looking North East

S6 Looking North East

S6 Old Inundated Glory Hole (concrete) and New Glory Hole (PVC)

S6 Western Embankment Looking South West

S6 Looking North East, Downstream Western Embankment

S6 Downstream spillway ponded water

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S6a Northern Bank Looking East

S6a Western Bank Looking South East

S6a Western Bank Looking East

S6a Looking South East

S6a Northern Embankment Downstream

S6a Downstream Seepage of Northern Embankment

S6a Inflow Channel (South West corner)

S6a Downstream seepage

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S7 Looking East

S7 Looking North East

S7 Southern Embankment Looking North West

S7 Looking South

S7 Foundation Conditions

S7 Western Embankment Crest

S7 Scour from Road Run-off on Western Embankment

Inlet from S7b

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S7a Looking East

S7a Western Embankment Looking

S7a Southern Embankment Looking North West

S7a Looking North

S7a Western Embankment Downstream

S7a Inlet from REA run-off

Remnant Gully downstream of S7a Western Embankment

S7a scoured out inlet pipe SW corner

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Project:	Surface Water Storage Assessment	Size:	A3	Version:	0.1
Project No.:	660.30163.00000	Datum:	None		
Status:	Inspection				
Date:	December 2021				

SIMEC


S7b Eastern Bank Looking North West


S7b Looking North West


S7b Northern Embankment Looking South East


S7b Looking South at channel inlet from S7


S7b Downstream Sandstone Outcrop


S7b Western Embankment


S7b downstream of channel to S8


S7b Spillway outlet

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\

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NSW, 2500
AUSTRALIA
T: 61 2 9428 8100
F: 61 2 9428 8100
www.slrconsulting.com

Title:	S7b Surface Water Storage	Drawn:	BT		
Client:	SIMEC Mining	Reviewed:	DT/ SH		
Project:	Surface Water Storage Assessment	Size:	A3	Version:	0.1
Project No.:	660.30163.00000	Datum:	None		
Status:	Inspection				
Date:	December 2021				


S8 Eastern Bank Looking North


S8 East Bank Looking West at Spillway


S8 Northern Embankment Looking South


S8 Looking North


S8 Downstream Old Pond


S8 Downstream of Spillway


S8 Spillway SW Corner


S8 Channel Inlet

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F: 61 2 9428 8100
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Title:	S8 Surface Water Storage	Drawn:	BT		
Client:	SIMEC Mining	Reviewed:	DT/ SH		
Project:	Surface Water Storage Assessment	Size:	A3	Version:	0.1
Project No.:	660.30163.00000	Datum:	None		
Status:	Inspection				
Date:	December 2021				

S9 Eastern Bank Looking South

S9 East Bank Looking North

S9 East Embankment Looking West

S9 Looking East

S9 Downstream Eastern Bank

S9 Southern Embankment Looking East

S9 Spillway NW Corner

S9 Southern Embankment

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\

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SLR
T: 61 2 9428 8100
F: 61 2 9428 8100
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Title:	S9 Surface Water Storage	Drawn:	BT		
Client:	SIMEC Mining	Reviewed:	DT/ SH		
Project:	Surface Water Storage Assessment	Size:	A3	Version:	0.1
Project No.:	660.30163.00000	Datum:	None		
Status:	Inspection				
Date:	December 2021				

SIMEC

S10 Looking North

S10 East Bank Looking South West

S10 Looking North East

S10 Looking South

S10 Eastern Road Embankment

S10 Western Embankment

S10 Downstream Embankment

S10 Downstream River

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AUSTRALIA
T: 61 2 9428 8100
F: 61 2 9428 8100
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Title:	S10 Surface Water Storage	Drawn:	BT		
Client:	SIMEC Mining	Reviewed:	DT/ SH		
Project:	Surface Water Storage Assessment	Size:	A3	Version:	0.1
Project No.:	660.30163.00000	Datum:	None		
Status:	Inspection				
Date:	December 2021				

SIMEC


STP1 Looking North


STP2 Looking North East


STP2 Looking South


STP1 & STP2 Looking West


STP Foundation Conditions


STP1 South East Corner


Embankment Between STP1 and SPT2


STP2 Outlet to M1

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\

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AUSTRALIA
T: 61 2 9428 8100
F: 61 2 9428 8100
www.slrconsulting.com

SLR

Title:	STP1 & SPT2 Surface Water Storage	Drawn:	BT		
Client:	SIMEC Mining	Reviewed:	DT/ SH		
Project:	Surface Water Storage Assessment	Size:	A3	Version:	0.1
Project No.:	660.30163.00000	Datum:	None		
Status:	Inspection				
Date:	December 2021				

SIMEC


Tank 2 Seepage


Tank 1 Seepage


Tank 1


Tank 1 and Tank 2


Tank 1 and Tank 2


Tank 2

File Location: \\AU.SLR.Local\Corporate\Projects-SLR\

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INNOVATION CAMPUS
NSW, 2500
AUSTRALIA
T: 61 2 9428 8100
F: 61 2 9428 8100
www.slrconsulting.com

Title:	Tank 1 & Tank 2 Surface Water Storage	Drawn:	BT
Client:	SIMEC Mining	Reviewed:	DT/ SH
Project:	Surface Water Storage Assessment	Size:	A3 Version: 0.1
Project No.:	660.30163.00000	Datum:	None
Status:	Inspection		
Date:	December 2021		

5 August 2022

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Tahmoor Coal
2975 Remembrance Driveway
Bargo, NSW 2574

Attention: April Hudson

Dear April

Preliminary Surface Water and Groundwater Quality Investigation

1 Introduction

Tahmoor Coal (TC, "the client") engaged SLR Consulting Australia ("SLR") to undertake a preliminary assessment of groundwater interaction from all the stored water bodies across the Tahmoor Colliery Site ("the site") located in Tahmoor within the Southern Highlands of NSW, approximately 70 km south-west of Sydney.

Tahmoor Colliery is an underground metallurgical coal mine operated by SIMEC Mining. The client has identified approximately 20 earthen water storage structures and 2 water storage tanks with an estimated combined storage capacity of 149 ML across the site. These storages require assessment of the potential linkage to groundwater in accordance with Tahmoor South Development Consent (Application No. 8445[1]):

Condition B34 e) (v) 6th dot point: a program to monitor and evaluate:

- *Water loss / seepage from water storages into the groundwater system*

1.1 Purpose and Objectives

The purpose is to evaluate water quality within the surface water and groundwater across the site, to inform assessment of potential seepage from the 20 earthen water storages and 2 water storage tanks into the groundwater. The specific objectives are to:

- Identify contaminants of concern within the surface water storages to cause potential contamination of groundwater at the site.
- Assess any impacts on the environmental value of the groundwater due to potential contamination.
- Take into consideration the conceptual hydrogeological model prepared by SLR (SLR, 2020), to evaluate trends of groundwater and surface water to identify any relationships.
- Review water chemistry and water level data, provided by the client, of surface water and groundwater, to identify any similarities which may indicate seepage of water into groundwater.
- Identify data gaps and further steps to address identified gaps.

[1] NSW Government - Independent Planning Commission of NSW, Development Consent Section 4.36 of the Environmental Planning and Assessment Act 1979, *Tahmoor South Project SSD8445*, 2020, Sydney

2 Site Information

Tahmoor Mine surface facilities are located between the townships of Tahmoor and Bargo. The site layout is shown in Figure 1, Appendix A . The surface operations can be broadly defined into three areas with the associated water storage types defined by the area it is located in:

- 'Pit Top Area' which generally encompasses TC operations west of the railway siding. Water storages in this area comprise washery settling ponds, sewerage treatment ponds, potable water tanks, remnant tailings dams and water treatment ponds.
- 'Rejects Emplacement Area (REA)' located east of the railway siding encompasses run-off sediment basins from the REA.
- 'Shaft Site Area' located approximately 1.6 km north-east of the REA area off Rockford Road. The shaft water storages comprise two sediment dams with a licensed discharge point (LDP6 from M6 Dam).

Groundwater is understood to seep into the mine at approximately 4.4 ML/day in 2021 (SIMEC 2022), and is pumped to the surface, within the Pit Top Area (see Figure 1, Appendix A), and distributed to mine treatment dams before being discharged at a licensed discharge point (LDP1). Monitoring at LDP1 of pH, electrical conductivity, turbidity, total suspended solids, arsenic, nickel, zinc, copper, total nitrogen have historically reported below the established levels under the Tahmoor Coal's Environmental Protection Licence (EPL) 1389 and Water Licence 36442.

Rejects from the Coal Handling Preparation Plant (CHHP) include dewatered fines and coarse rejects which are mixed and transported via conveyor to a bin and loading area prior to placement in the REA. The REA stormwater management system comprises a network of collection drains, sediment dams and run off collection water storages which are connected to the licenced discharge points (Dam S4, S8 and S9) which eventually flow into Teatree Hollow.

Figure 1 below shows the schematic details of the main water sources, flow paths across the mine site and discharge points.

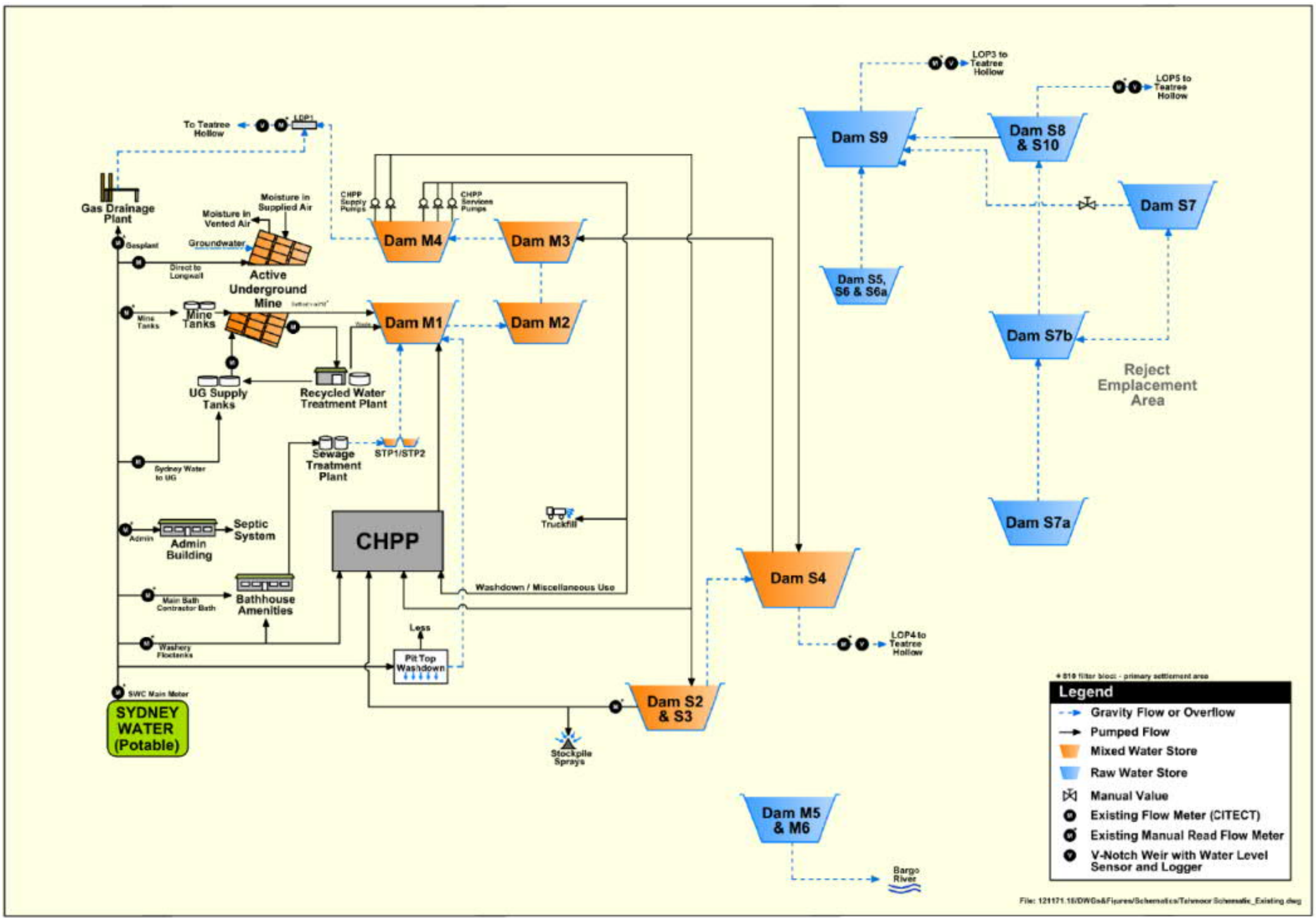

Figure 1 Schematic representation of existing water management system

3 Hydrogeological Setting Overview

This section summarises the site hydrogeological setting relevant from SLR (2020). Further detail of the conceptual hydrogeological model and the hydrogeological setting is in SLR (2020).

3.1 Geology

The fluvially-deposited Triassic Hawkesbury Sandstone is the dominant outcropping stratigraphic unit in this region and has a thickness of up to 300 m. The Wianamatta Formation, composed of soft shales, overlies the Hawkesbury Sandstone and is present to the north of the mine. Due to high silica content of Hawkesbury Sandstone, it exhibits higher resistance to erosion than the Wianamatta Formation. As such, soil production on the Hawkesbury Sandstone is low and the sandstone is the common bed material for the watercourses in the region, with the Wianamatta Formation typically appearing as capping at higher elevations.

3.2 Main Aquifer

The Hawkesbury sandstone is the primary aquifer in the area. This aquifer falls within the Sydney Basin Nepean Sandstone Groundwater Source and has been classified as 'Highly Productive' by the NSW Government on considerations of bore yield and groundwater quality.

3.3 Groundwater Flow Direction

Overall groundwater flow in this unit is in an east to north-easterly direction, and is closer to the ground surface in lower lying areas associated with surface water drainage lines.

3.4 Groundwater Salinity

The Hawkesbury Sandstone exhibits a range of salinities (fresh to saline) with a median value of approximately 500 mg/L TDS (GeoTerra, 2013). Publicly available data from AGL's Camden Gas Project indicated an average of about 380 mg/L TDS for Hawkesbury Sandstone groundwater (Parsons Brinckerhoff, 2013).

Groundwater TDS data from monitoring bores at the site, discussed below in Section 4, show a range of 76 mg/L (REA4) to 1770 mg/L (REA2).

4 Limited Water Quality Assessment

4.1 Groundwater Data

The following limited water quality assessment has been undertaken using data provided by the client and provides a preliminary comparison of surface water and groundwater chemistry.

The Tahmoor South Groundwater Management Plan (Tahmoor Coal, 2021) indicates that groundwater water quality testing is undertaken on a quarterly basis and the results for the following parameters are presented:

- Electrical conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO)
- Nutrients (Total N, Total P)
- Major Ions (Ca, Cl, K, NA, SO_4, HCO_3, F)
- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity and;
- Total and dissolved metals (Fe, Mn, Cu, Pb, Zn, Ni, Al, As, Se, Li, Sr, Co)

Field measurements for pH and EC have also been undertaken monthly since August 2019.

SLR was provided with groundwater quality data between July 2019 and February 2022.

The groundwater monitoring network at the site, as provided by the client, is summarised in Table 1. Figure 1, Appendix A shows the location of the groundwater bores. Based on the groundwater elevation and inferred flow direction (Figure 2, Appendix A), there is no monitoring bore that monitors groundwater upgradient of the site.

Table 1 Summary of monitoring network at the site

Bore ID	Coordinates (MGA 94)		Installation Date	TOC (m AHD)	Depth (m BGL)	Screened Depth (m BGL)	Aquifer	Comment
	Eastings	Northings						
Tahmoor Colliery Rejects Emplacement Area (REA)								
REA1	278362.3	6207826.8	17-07-2013	277.61	54.8	51-54	Shallow	originally called TGW4. downgradient REA
REA2	278441.2	6206332.2	17-07-2013	285.79	58	53-58	Shallow	originally drilled as TGW5, redrilled as REA2
REA3	277820.7	6206453.4	31-07-2019	289.87	41	38-41	Shallow	upgradient REA
REA4	277650.8	6206835.2	24-07-2019	283.62	57.5	54.5-57.5	Shallow	upgradient REA
REA5	277424.2	6206769.0	17-07-2019	264.91	7.2	4.2-7.2	Shallow	upgradient REA
REA6	278643.3	6207214.8	24-07-2019	284.23	46.3	43.3-46.3	Shallow	downgradient (east) of REA
REA7	278035.1	6207307.3	17-07-2019	275.64	43	40-43	Shallow	downgradient (west) of REA
Tahmoor Colliery Pit Top								
Pit Top 1	277357.6	6207494.9	05-09-2019	286.77	55.04	52-55	Shallow	d/s of sediment dam M3
Pit Top 2	277396.0	6207663.2	05-09-2019	281.3	6.85	5.8-6.8	Shallow	north of sediment dams
Pit Top 4	276872.2	6207331.6	05-09-2019	295.95	33.7	31.5-33.5	Shallow	u/s of sediment dams near helicopter pad

4.2 Surface Water Data

The Tahmoor South Surface Water Management Plan (Tahmoor Coal, 2022) indicates that the surface water quality testing is undertaken on a monthly basis and the results for the following parameters are presented:

- Selected dissolved and total metals
- Physicochemical parameters
- Nutrients
- Oil and grease
- Escherichia coli and flagellates

Surface water storages within the site, potential contaminants of concern related to the inputs and activities/infrastructures within the vicinity of the surface water location, and current monitoring are summarised in Table 2 and presented in Figure 1, Appendix A.

As the depth of the water storages is not available, to assess the relative potential of each storage for interaction with groundwater, SLR has estimated the depth of water in each storage using the reported storage volume, and the water surface area estimated from Nearmap.

SLR was provided with surface water quality data between December 2020 and February 2022.

4.3 Potential Contaminants of Concern

The potential contaminants of concern, which if also detected in groundwater, could act as an indicator of surface water and groundwater connectivity within the area. Table 2 outlines the likely contaminants of concern considered associated with the surrounding activities and infrastructure in each area. In summary the contaminants of concern for each area are:

- Pit Top Area: TDS, pH, heavy metals, nutrients, total recoverable hydrocarbons and e-coli
- REA: TDS, pH and heavy metals including nickel and zinc
- Shaft Site Area: TDS, heavy metals and total recoverable hydrocarbons

Table 2 Summary of surface water storages and potential contaminants of concern

Storage Facility	Type	Capacity (ML[2])	Surface Area[3] (m^2)	Estimated Depth (m)	Inputs[3]	Comments[3]	Current Monitoring	Associated contaminants of concern related to the activities/infrastructure within the vicinity
Tahmoor Colliery Pit Top								
M1	Settling Pond	1.8	2382	0.8	STP-2, Pit Top Storage Yard run-off, Washery Water (incl. M4), Mine water	M1 to M4 act together to treat mine water pumped from underground and stormwater. Discharged via LDP1 (To Teatree Hollow Creek)	None undertaken	TDS, pH, heavy metals (in particular nickel and zinc), sulphur, nutrients, and total recoverable hydrocarbons
M2	Settling Pond	0.5	926	0.5	M1, pit top storage yard run-off		None undertaken	
M3	Water Treatment Pond	9.0	3586	2.5	S4, M2, minor road run-off		Monthly monitoring	
M4	Water Treatment Pond	8.0	3879	2.1	M3	Water recycled back to washery.	None undertaken	
S2/S3	Sediment Basin and Settling Pond	8.3	3708	2.2	Stockpile run-off	Dams are kept full and are used to supply water for dust suppression. Discharge to S4.	None undertaken	TDS, pH, heavy metals, nitrate, sulfate and total recoverable hydrocarbons
STP 1	Treatment Pond	0.59	482	1.2	Sewerage Treatment Plant	Overflows to M1	None undertaken	Nutrients and e-coli
STP 2	Treatment Pond	0.59	390	1.5	STP 1 and yard run-off			
T1	Tailings Storage Facility	0.5*	2687	0.2	Run-off	Regularly cleaned out. TC no longer produces slurry tailings. Belt-press dry stacking used.	None undertaken	Heavy metals such as lead, arsenic and mercury.
T2	Tailings Storage Facility	0.6*	1785	0.3	Run-off		None undertaken	
Tank No. 1	Potable Water Supply	0.25	130	1.9	Mains supply	Potable water supply	None undertaken	NA

[2] Data obtained from Tahmoor Surface Water Storage Investigation Report (SLR 2021).
[3] Measured from Nearmap Aerial Image dated 3 May 2022

Storage Facility	Type	Capacity (ML[2])	Surface Area[3] (m^2)	Estimated Depth (m)	Inputs[3]	Comments[3]	Current Monitoring	Associated contaminants of concern related to the activities/infrastructure within the vicinity
Tank No. 2	Potable Water Supply	0.25	130	1.9			None undertaken	
Gas Plant Pool	Retention Drain	0.005	60	0.1	Gas Plant embankment run-off	Retention drains with weir to capture and control run-off from the Gas Plant embankment to the west	None undertaken	Heavy metals, nitrate, and sulfate
Tahmoor Colliery Rejects Emplacement Area (REA)								
S4	Retention Basin	36.9	13115	2.8	S2/S3, S9	Pumped to M3. Acts as a retention basin with controlled outlet. Discharge to overflow Point 4 (LOP4).	Monthly monitoring	TDS, pH, and heavy metals, in particular nickel and zinc
S4a	Silt Trap	~0.2*	553	0.4	Rejects processing yard run-off	Sediment trap to capture southerly run-off from rejects process yard.	None undertaken	Heavy metals, in particular nickel and zinc
S5	Silt Trap	0.5	142	3.5	Rejects processing yard run-off	Silt trap to capture northerly run-off via spoon drain from rejects processing yard.	None undertaken	Heavy metals, in particular nickel and zinc
S6	Retention Basin	1.5	974	1.5	S5	Retention basin with controlled outlet to S9. Overflow to S6a via vegetated channel	None undertaken	Heavy metals, in particular nickel and zinc
S6a	Retention Basin	~0.8*	718	1.1	S6 overflow	Earthen embankment retention basin within natural gully. Overflow to S9.	None undertaken	Heavy metals, in particular nickel and zinc
S7	Retention Basin	41.5	5935	7.0	REA Run-off, 7a and 7b	Main catchment for run-off from REA. Retention basin during peak rainfall events. All water pumped to S9	None undertaken	Heavy metals, in particular nickel and zinc
S7a	Retention Basin	12	8052	1.5	REA Run-off	Retention basin with controlled outlet to S7 Dam.	None undertaken	Heavy metals, in particular nickel and zinc
S7b	Retention Basin	1.0	242	4.1	S7a and S7			

Storage Facility	Type	Capacity (ML^2)	Surface Area[3] (m^2)	Estimated Depth (m)	Inputs[3]	Comments[3]	Current Monitoring	Associated contaminants of concern related to the activities/infrastructure within the vicinity
S8	Retention Basin	4.5	392	11.5	S7b	Pumped to S9. Overflow to LOP5, discharge to Teatree Hollow Creek.	Monthly monitoring	Heavy metals, in particular nickel and zinc
S9	Retention Basin	0.4	329	1.2	S6, S7, S8 and haul road run-off	Wet well pumps to S4. Discharge by LOP3 to Teatree Hollow Creek.	Monthly monitoring	Heavy metals, in particular nickel and zinc
S10	Sediment Basin	~0.1*	118	0.8	Haul Road run-off	Evaporative sediment basin	None undertaken	Heavy metals, in particular nickel and zinc
Shaft Site Area								
M5	Retention Basin	1.0	352	2.8	Run-off from up shaft area	Appears to be naturally charged from groundwater. Overflow to M6	None undertaken	TDS, heavy metals and total recoverable hydrocarbons
M6	Retention Basin	0.5	1198	0.4	M5	Appears to be naturally charged from groundwater. Overflow to Bargo River via LDP6.	Monthly monitoring	

Notes (*) = Capacity not previously measured - estimated during the site inspection by SLR in December 2021

4.4 Adopted Guidelines

The 2007 Department of Environmental and Conservation (DEC 2007 *Guidelines for the Assessment and Management of Groundwater Contamination*) provides a best-practice framework for assessing and managing groundwater in NSW. The guideline identifies environmental values which will require assessment of potential risks from contaminated groundwater with consideration of the relevance of the environmental value from the contaminated groundwater.

For the purpose of this assessment of potential impact of surface water on groundwater, the guidelines relevant to groundwater are here considered relevant to the water in the surface water storages on site. Table 3 outlines the groundwater environmental values and relevant guidelines used as part of this assessment.

Table 3 Groundwater environmental value and relevant guideline

Environmental value	Realisation	Guidelines
Aquatic ecosystem protection	DEC (2007) recommends assuming that aquatic ecosystem protection is an applicable environmental value of groundwater when conducting a preliminary assessment of groundwater. For the purposes of this assessment a 95% species protection level is adopted as the ecosystem is considered slightly to moderately disturbed system.	ANZG (2018) Australian & New Zealand Guidelines for Fresh and Marine Water Quality
Drinking Water	DEC (2007) considers aquifers with a TDS concentration of less than 2000 mg/L I suitable for drinking water purposes and hence this environmental value is realised.	NHMRC (2011) Drinking Water Guidelines
Agriculture and irrigation (irrigation)	Four irrigation bores (GW031294.1.1, GW032443.1.1, GW104659.1.1 and GW013282.1.1) within the Australian Groundwater Explorer map were identified within a 2 km radius of the site and hence, is considered a likely realised environmental value.	ANZG (2018) "Primary Industries" guidelines for agricultural drinking water quality
Agriculture and irrigation (stock watering)	Stock watering groundwater bores were not identified within a 2 km radius and hence is not considered a realised environmental value.	NA
Water-based recreation (primary contact recreation)	As a preliminary assessment, it is assumed that groundwater will ultimately discharge into surface water therefore, this environmental value will be realised.	NHMRC (2008) Guidelines for managing risks in recreational water
Cultural and Spiritual Values	Aboriginal heritage site is a number of locations within the catchment area was identified, therefore, this environmental value will be realised assuming that groundwater will discharge into surface water.	NHMRC (2008) Guidelines for managing risks in recreational water

Water discharge limits for LDP1, as specified in EPL 1389, are listed in Table 4 (Tahmoor Coal, 2022). Contaminant concentrations of LDP1 have been generally reported below the discharge limits outlined in EPL 1389 (Tahmoor Coal, 2021).

Table 4 EPL 1389 Licenced Discharge Point 1 Water Quality Limits

Contaminant	Discharge Limit
Aluminium	0.11 mg/L
Arsenic	0.2 mg/L
Barium	6.44 mg/L

Contaminant	Discharge Limit
Copper	0.005 mg/L
Nickel	0.2 mg/L
Zinc	0.3 mg/L
Electrical Conductivity	2,600 µS/cm
Enterococci	1,700 (colony forming units per 100mL)
Total Nitrogen	8 mg/L
pH	6.5 to 9 pH Units
Total suspended solids	30 mg/L
Turbidity (NTU)	150

4.5 Results and Discussion

4.5.1 Groundwater level

Table 2 presents the depth to groundwater of the piezometers relevant to the site from data collected between September 2019 and November 2021. The standing water level data is presented in Appendix B. Depth to groundwater is shallowest within Pit Top 2 and REA 5, both are shallow bores, indicating greater potential for impact of seepage on groundwater at those locations.

Table 5 Summary of depth to water and groundwater elevation from data collected between September and November 2021

Location ID	Depth to water (m TOC)		Depth to water (m TOC) 9 November 2021	Groundwater Elevation (m AHD)		Groundwater Elevation (m AHD) 9 November 2021
	Maximum	Minimum		Maximum	Minimum	
Pit Top 1	42.34	40.12	40.12	246.65	244.43	246.65
Pit Top 2	4.56	0.23	3.23	281.07	276.74	278.07
Pit Top 4[4]	20.74	20.40	inaccessible	275.55	275.21	inaccessible
REA 1	40.30	38.18	39.89	239.43	237.31	237.72
REA 2	32.29	29.50	30.49	256.29	253.50	255.30
REA 3	32.05	31.54	31.67	258.33	257.82	258.20
REA 4[5]	39.33	37.03	inaccessible	247.59	244.29	inaccessible
REA 5	2.27	0.65	1.62	264.26	262.64	263.29
REA 6	39.77	38.08	38.30	246.15	244.46	245.93
REA 7	30.47	22.17	24.02	253.47	245.17	251.62

[4] No readings after 27 May 2021 as plate was under water.
[5] No readings were provided after 24 May 2021.

4.5.2 Groundwater Occurrence and Flow

Groundwater elevation, contours and inferred groundwater flow direction for November 2021 monitoring event is shown in Figure 2, Appendix A. Standing water level of Pit Top 2 was not included in the preparation of groundwater elevation contours and further assessment will be required to represent local groundwater including perched water table within the area. The groundwater flow direction is inferred to the north-east and is consistent with the regional groundwater flow direction quoted by in the conceptual hydrogeological model for Tahmoor Mine (SLR, 2020). Survey of surface water storage elevation would assist with assessment of interaction of surface water and groundwater.

4.6 Analytical Results

Table 1, Appendix B lists the analytical results of the groundwater samples compared with the adopted criteria. Analytes which exceed the adopted criteria for each area in surface water and groundwater are presented in Table 6.

Table 6 Summary of locations exceeding adopted guideline values

Analyte	Domain	Drinking Water	Agriculture and Irrigation	Primary Contact and Recreation & Cultural Values	Aquatic Ecosystems
Arsenic	Surface Water	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2	-
	Groundwater	No exceedance	No exceedance	No exceedance	-
Barium	Surface Water	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2	-	No exceedance	-
	Groundwater	No exceedance	-	No exceedance	-
Copper	Surface Water	-	-	-	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam
	Groundwater	-	-	-	Pit Top 4
Aluminium	Surface Water	-	No exceedance	-	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, S4 Dam
	Groundwater	-	No exceedance	-	Pit Top 1, Pit Top 4
Iron	Surface Water	Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, M6 Dam	Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, S8 Dam, M6 Dam	Mine Dewatering Line 1	-

Analyte	Domain	Drinking Water	Agriculture and Irrigation	Primary Contact and Recreation & Cultural Values	Aquatic Ecosystems
	Groundwater	Pit Top 1, Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 1, Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 1, Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	-
Lead	Surface Water	Not analysed[6]	Not analysed[7]	Not analysed[7]	Not analysed[7]
	Groundwater	Pit Top 4	No exceedance	No exceedance	REA5
Manganese	Surface Water	Not analysed[7]	Not analysed[7]	Not analysed[7]	Not analysed[7]
	Groundwater	Pit Top 1, Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 1, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 4, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 4, REA2, REA3, REA4, REA5, REA6, REA7
Nickel	Surface Water	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2	No exceedance	No exceedance	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, S4 Dam, S8 Dam
	Groundwater	Pit Top 1, Pit Top 2, REA1, REA2, REA3, REA4, REA5, REA6, REA7	No exceedance	No exceedance	Pit Top 1, Pit Top 2, REA1, REA2, REA3, REA4, REA5, REA6, REA7
Selenium	Surface Water	Not analysed[7]	Not analysed[7]	Not analysed[7]	Not analysed[7]
	Groundwater	Pit Top 1	Pit Top 1	Pit Top 1	Pit Top 1
Zinc	Surface Water	No exceedance	No exceedance	No exceedance	LDP1, Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, S8 Dam, S4 Dam, M6 Dam
	Groundwater	No exceedance	No exceedance	No exceedance	Pit Top 1, Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7
pH	Surface Water	LDP1, M3 Exit, S4 Dam	LDP1, M3 Exit, S4 Dam	LDP1, M3 Exit, S4 Dam	-
	Groundwater	Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	-
Phosphorus	Surface Water	-	Not analysed	-	-

[6] LDP1, S9 Dam, S8 Dam and M6 Dam were analysed for lead, manganese and selenium on 19 April 2021 and were below adopted criteria.

Analyte	Domain	Drinking Water	Agriculture and Irrigation	Primary Contact and Recreation & Cultural Values	Aquatic Ecosystems
	Groundwater	-	Pit Top1, Pit Top 2, Pit Top 4, REA1, REA2, REA3, REA4, REA5, REA6, REA7	-	-
Total Nitrogen	Surface Water	-	S9 Dam, S4 Dam, S8 Dam	-	-
	Groundwater	-	Pit Top 2	-	-
TDS	Surface Water	LDP1, M3 Entry, M3 Exit, Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, S4 Dam, S8 Dam,	-	-	-
	Groundwater	Pit Top 1, Pit Top 4, REA2, REA6, REA7	-	-	-
Ammonia as N	Surface Water[7]	-	-	-	LDP1
	Groundwater	-	-	-	Not Analysed
Nitrate as N	Surface Water[8]	No exceedance	-	No exceedance	LDP1, S4 Dam, S8 Dam
	Groundwater	No exceedance	-	No exceedance	Not Analysed
Sodium	Surface Water	LDP1, Mine Dewatering Line 1, mine Dewatering Line 2, S9 Dam, S4 Dam, S8 Dam	-	No exceedance	-
	Groundwater	Pit Top 1, Pit Top 4, REA2, REA6	-	No exceedance	-
Chloride	Surface Water	No exceedance	-	No exceedance	-
	Groundwater	Pit Top 1, Pit Top 4, REA2, REA3, REA6	-	No exceedance	-
Turbidity	Surface Water	LDP1, M3 Exit, M3 Entry, Mine Dewatering Line 1, Mine Dewatering Line 2, S9 Dam, S4 Dam, S8 Dam, M6 Dam	-	-	-
	Groundwater	Not analysed	-	-	-

Note (-): No adopted criteria

[7] LDP1, S9 Dam, S8 Dam and M6 Dam were analysed on 19 April 2021 only.

4.7 Trend Analysis

The concentration trends of contaminants which exceeded the adopted criteria in surface water and nearby groundwater were assessed by plotting concentration over time. Parameters not analysed in surface water but exceeded criteria in groundwater were also assessed for concentration trend in groundwater. The plots are in Appendix C.

4.7.1 Pit Top Area

Analytical data for surface water LDP1, mine dewatering line 1 and 2, M3 Entry and M3 Exit, and groundwater Pit Top 1, Pit Top 2 and Pit Top 4 were available. Concentration trends of iron, nickel, zinc, TDS, pH, copper, aluminium, sodium, ammonia as N, lead, manganese, selenium, phosphorus, total nitrogen and chloride are presented in Appendix C.

The following are observations on the concentration trends:

- Iron concentrations within the surface water locations (LOR to 3.5 mg/L and average concentration of 1 mg/L) were an order of magnitude lower than groundwater (0.62 mg/L to 190 mg/L and average concentration of 15 mg/L).
- Nickel concentrations within the surface water locations i.e., mine dewatering lines 1 and 2 and LDP1, indicate a decreasing trend from December 2020 to February 2022. Nickel concentration trend with the groundwater also indicate a decreasing trend.
- Zinc concentrations within the surface water locations i.e., Mine Dewatering lines 1 and 2 and LDP1, indicate an increasing trend from December 2020 to February 2022. An increasing trend is not indicated in groundwater.
- TDS concentrations within the surface water locations i.e., Mine Dewatering lines 1 and 2, M3 Entry, M3 Exit and LDP1, were generally higher than the groundwater sample locations. An increasing trend is not identified in groundwater.
- pH of surface water sample locations i.e., LDP1, M3 Entry, M3 Exit, were consistently reported between 8 to 9 pH units between 2020 and February 2022. The pH at Pit Top Bore 1 and Pit Top Bore 4 appear to increase from approximately pH 6 in 2019 to pH 11 in February 2022. The increase of pH in the groundwater does not appear to be correlated with the changes in surface water pH.
- Concentrations of copper within the groundwater were mostly reported below the laboratory limit of reporting after October 2020. The concentration at surface water storages has ranged between below the laboratory limit of reporting to 0.005 mg/L.
- Aluminium concentration trends within the surface water storages have decreased and is generally consistent to or below the concentrations in the groundwater, whilst the concentration in groundwater, Pit Top 1 and Pit Top 4, is increasing .
- Sodium concentrations within the surface water storages are higher than groundwater. There is no observed trend in groundwater.
- There is insufficient concentration data for lead, manganese, chloride and selenium in the surface water to determine trends. Lead concentration in groundwater does not indicate a trend.
- Nitrogen (total) concentration in groundwater, Pit Top 4, similar concentration to LDP1 since late-2020, although no trend apparent over recent data.
- There is insufficient concentration data for ammonia as N in groundwater and surface water to determine trends.

4.7.1.1 Summary

The above qualitative assessment of trends in concentration for the tested analytes does not indicate impact from surface water on groundwater quality in the area.

4.7.2 Rejects Emplacement Area (REA)

Analytical data for S9 Dam, S4 Dam and S8 Dam and groundwater REA1, REA2, REA3, REA4, REA5, REA6 and REA7 were available. Concentration trends of iron, sodium, E.coli, TDS, pH, zinc, and phosphorus each surface water and groundwater location were produced and presented in Appendix C.

The following are observations on the concentration trends:

- Concentrations of iron within the surface water sample locations were reported lower than in groundwater, and no concentration trend in groundwater.
- Concentrations of sodium within the surface water samples were reported higher than in groundwater, and no concentration trend in groundwater.
- There is insufficient concentration data for *E.coli* in surface water and in groundwater to determine trends.
- TDS concentrations of surface water were consistently higher than groundwater and no concentration trend in groundwater.
- pH levels in surface water is greater than in groundwater. There has been a slight increase in field pH in groundwater at REA1, REA2 and REA7 and surface water S4 since September 2021, however insufficient data at time of reporting to confirm a trend.
- Concentrations of zinc within the surface water sample locations, are consistently lower than in groundwater and no trends are apparent.

4.7.2.1 Summary

The above qualitative assessment of trends in concentration for the tested analytes does not indicate impact from surface water on groundwater quality in the area.

4.8 Data Gaps

The main data gaps in relation to the above assessment and potential actions to address the gaps and support future assessments are summarised in Table 7.

Table 7 Main Data Gaps and Potential Actions

Main Data Gap	Potential Action
The surface water elevation and depth of the water storages is not available.	Survey the surface elevation and depth of the main water storages
Concentrations of contaminants were not available for all sample locations.	Include a one-off analysis of surface water and groundwater samples for heavy metals, nutrients, total recoverable hydrocarbons, TDS, pH, and *E.-Coli*.

5 Summary

The above assessment of water quality of surface water and groundwater to assess potential impacts on groundwater from surface water, based on limited data, indicates:

- Depth to groundwater within the Pit Top Area is between 0.23 m TOC to 42.34 m TOC and depth to groundwater within the Reject Emplacement Area is between 0.65 m BGL and 40.30 m BGL. Depth to groundwater is shallowest in Pit Top Bore 2 and REA 5, both of which are close to a surface water body.
- Depth of each surface water body was estimated to be between 0.5 m BGL (M2 Dam) and 2.5 m BGL (M3 Dam) within the Pit Top Area, between 0.4 m BGL (S4a Dam) and 11.5 m BGL (S8 Dam) within the Reject Emplacement Area, and between 0.4 m BGL to 2.8 m BGL within the Shaft Site Area.
- Groundwater flow direction is towards the north-east, which is consistent with the groundwater flow direction outlined in the Groundwater Modelling Plan (SLR 2020).
- The groundwater environmental values in the area are drinking water, primary contact and recreation, agriculture and irrigation, cultural values and water dependent ecosystems.
- The potential contaminants of concern are TDS, pH, heavy metals, nutrients, total recoverable hydrocarbons and E. Coli and were reported above one or more adopted criteria.
- On the available data, a qualitative assessment of trends in concentration for the tested analytes in the Pit Top Area and REA does not indicate impact from surface water on groundwater quality in those areas.

Potential actions to address identified data gaps and support future assessments are summarised in Table 7.

6 Closure

We trust this letter meets your requirements; however, should you have any queries, please do not hesitate to contact the undersigned.

Yours sincerely

SNEHA BHATTACHAN
Senior Project Engineer

Checked/
Authorised by: JB

7 References

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NHMRC (2008) Guidelines for Managing Risks in Recreational Water, National Health and Medical Research Council, February 2008

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SLR (2021) Tahmoor Surface Water Storage Investigation – Tahmoor Coal, SLR Consulting Australia Pty Ltd, 21 January 2021, Ref: 660.30163.00000-R01-v1.1

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Tahmoor Coal (2021) 2020 Annual Review, AEMR and Rehabilitation Report – Tahmoor Coal, 31 March 2021

Tahmoor Coal (2022) Tahmoor South – Surface Water Management Plan – Tahmoor Coal, 18 March 2022

Appendix A

Figures

Scale: 1:9,750 at A4
Coordinate System: GDA 1994 MGA Zone 56

Date Drawn: 26-Jul-2022
Project Number: 660.30163

SLR

Data Source:
Nearmap Imagery March 2022

SITE PLAN
TAHMOOR COLLIERY WATER STORAGE FACILITIES

FIGURE 1

H:\Projects-SLR\660-SrvWOL\660-WOL\660.30163.00000 Tahmoor South On site Water Storage Inve\06 SLR Data\01 CADGIS\GIS\SLR66030163_Site_Plan_01.mxd

Scale: 1:9,750 at A4
Coordinate System: GDA 1994 MGA Zone 56

Date Drawn: 20-Jul-2022
Project Number: 660.30163

SLR

Data Source:
Nearmap Imagery March 2022

Note: SWL from Pit Top 2 was not included in preparation of this groundwater contour plot.

GROUNDWATER ELEVATION
9 NOVEMBER 2021

FIGURE 2

H:\Projects-SLR\660-SrvWOL\660-WOL\660.30163.00000 Tahmoor South On site Water Storage Inve\06 SLR Data\01 CADGIS\GIS\SLR66030163_Groundwater_Contour_Plot_01.mxd

Appendix B

Tables

Table 1: Surface Water and Groundwater Analytical Results

SLR

						Metals																						TPH	Inorganics																
						Lithium	Strontium	Arsenic	Barium	Boron	Cadmium	Chromium (III+VI)	Chromium (hexavalent)	Cobalt	Copper	Chromium (Trivalent)	Silver	Aluminium	Iron	Iron (Filtered)	Lead	Manganese	Manganese (Filtered)	Mercury	Nickel	Selenium	Zinc	Oil and Grease	Alkalinity (Bicarbonate)	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	pH (Field)	Alkalinity (Carbonate)	Carbonate Alkalinity as CaCO3_	Phosphorus	Alkalinity (total) as CaCO3	Nitrogen (Total)	TDS	TDS (Calculated) [#1]	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Kjeldahl Nitrogen Total
						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	pH_Unit	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic															1				0.3	0.3		0.1	0.1				3					6-8.5						600	600		11.3	9		
ADWG 2018 Health								0.01	2	4	0.002		0.05		2		0.1				0.01	0.5	0.5	0.001	0.02	0.01																		
ANZECC 2000 Irrigation Long Term Trigger Values						**2.5[#4]**		**0.1**		**0.5**	**0.01**	**0.1**		**0.05**	**0.2**			**5**	**0.2**	**0.2**	**2**	**0.2**	**0.2**	**0.002**	**0.2**	**0.02**	**2**					**6-8.5[#5]**			**50[#6]**		**5**							
ANZECC 2000 Irrigation Short Term Trigger Values						**2.5[#4]**		**2**			**0.05**	**1**		**0.1**	**5**			**20**	**10**	**10**	**5**	**10**	**10**	**0.002**	**2**	**0.05**	**5**										**25**							
ANZG (2018) Freshwater 95% toxicant DGVs										0.37[#8]	0.0002[#9]		0.0004[#8]		0.0014[#9]		0.00005[#10]	0.055[#11]			0.0034[#11]	1.9[#12]	1.9[#12]	0.0006[#10]	0.011[#10]	0.011[#10]	0.008[#13]													0.74	0.16			
NHMRC Guidelines for Managing Risks in Recreational Water 2008								*0.1*	*20*	*40*	*0.02*		*0.5*		*10*		*1*		*3*	*3*	*0.1*	*1*	*1*	*0.01*	*0.2*	*0.1*	*30*					*6.5-8.5*									*113*	*9*		
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**																																							
Pit Top Area	LDP 1	08-Dec-2020	LDP 1 (Main mine discharge)	normal	EW2005557	-	-	0.105	3.11	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	0.074	-	0.049	<5	-	-	-	8.6	-	-	-	-	-	-	1528	-	-	-	-	-
		07-Jan-2021	LDP 1 (Main mine discharge)	normal	EW2100074	-	-	0.058	2.94	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	0.067	-	0.044	<5	-	-	-	8.6	-	-	-	-	-	-	1274	-	-	-	-	-
		09-Feb-2021	LDP 1 (Main mine discharge)	normal	EW2100587	-	-	0.097	2.02	-	-	-	-	-	0.002	-	-	0.25	-	-	-	-	-	-	0.063	-	0.066	-	-	1070	<1	8.7	64.8[#1]	108	-	1180	3.9	-	1378	-	-	-	-	-
		11-Mar-2021	LDP 1 (Main mine discharge)	normal	EW2101104	-	-	0.091	2.12	-	-	-	-	-	<0.001	-	-	0.03	-	-	-	-	-	-	0.046	-	0.087	-	-	880	<1	8.5	51.6[#1]	86	-	966	3.4	-	1242	-	-	-	-	-
		19-Apr-2021	LDP 1 (Main mine discharge)	normal	EW2101726	-	-	0.077	2.4	0.07	<0.0001	<0.001	<0.01	0.014	<0.001	<0.01	<0.001	0.02	-	-	0.003	-	0.099	<0.0001	0.039	<0.01	0.105	<5	-	1060	<1	8.5	54.6[#1]	91	-	1150	2.6	-	1385	1.02	1.14	0.04	1.18	1.4
		13-May-2021	LDP 1 (Main mine discharge)	normal	EW2102105	-	-	0.058	2.53	-	-	-	-	-	0.001	-	-	0.03	-	-	-	-	-	-	0.043	-	0.082	-	-	1000	<1	8.6	15.6[#1]	26	-	1030	2.8	-	1255	-	-	-	-	-
		11-Jun-2021	LDP 1 (Main mine discharge)	normal	EW2102597	-	-	0.032	3.49	-	-	-	-	-	0.001	-	-	0.02	-	-	-	-	-	-	0.047	-	0.09	-	-	900	<1	8.5	32.4[#1]	54	-	953	2.7	-	1190	-	-	-	-	-
		09-Jul-2021	LDP 1 (Main mine discharge)	normal	EW2102976	-	-	0.03	4	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.048	-	0.107	-	-	1020	<1	8.4	0.6[#1]	<1	-	1020	2.9	-	1333	-	-	-	-	-
		09-Aug-2021	LDP 1 (Main mine discharge)	normal	EW2103386	-	-	0.077	3.21	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.044	-	0.066	-	-	1180	<1	8.5	1.8[#1]	3	-	1190	2.6	-	1391	-	-	-	-	-
		09-Sep-2021	LDP 1 (Main mine discharge)	normal	EW2103811	-	-	0.056	1.59	-	-	-	-	-	0.001	-	-	0.03	-	-	-	-	-	-	0.03	-	0.071	-	-	870	<1	8.5	53.4[#1]	89	-	959	2.3	-	1255	-	-	-	-	-
		12-Oct-2021	LDP 1 (Main mine discharge)	normal	EW2104254	-	-	0.072	1.94	-	-	-	-	-	0.002	-	-	0.04	-	-	-	-	-	-	0.04	-	0.078	-	-	884	<1	8.4	66.6[#1]	111	-	995	2.4	-	1248	-	-	-	-	-
		12-Nov-2021	LDP 1 (Main mine discharge)	normal	EW2104783	-	-	0.037	1.28	-	-	-	-	-	0.002	-	-	0.01	-	-	-	-	-	-	0.017	-	0.084	-	-	536	<1	8.5	15.6[#1]	26	-	562	1.4	-	761	-	-	-	-	-
		14-Dec-2021	LDP 1 (Main mine discharge)	normal	EW2105347	-	-	0.024	2.29	-	-	-	-	-	0.001	-	-	0.02	-	-	-	-	-	-	0.036	-	0.04	-	-	681	<1	8.6	36[#1]	60	-	740	3.1	-	1196	-	-	-	-	-
		14-Jan-2022	LDP 1 (Main mine discharge)	normal	EW2200095	-	-	0.039	1.92	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.024	-	0.092	-	-	723	<1	8.5	21.6[#1]	36	-	760	2.2	-	1235	-	-	-	-	-
		11-Feb-2022	LDP 1 (Main mine discharge)	normal	EW2200530	-	-	0.08	2.23	-	-	-	-	-	0.001	-	-	0.02	-	-	-	-	-	-	0.044	-	0.138	-	-	874	<1	8.5	57.6[#1]	96	-	970	3.1	-	1320	-	-	-	-	-
	M3 Entry	08-Dec-2020	M3 Entry	normal	EW2005557	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1508	-	-	-	-	-
		07-Jan-2021	M3 Entry	normal	EW2100074	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1437	-	-	-	-	-
		09-Feb-2021	M3 Entry	normal	EW2100587	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1573	-	-	-	-	-
		11-Mar-2021	M3 Entry	normal	EW2101104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1242	-	-	-	-	-
		19-Apr-2021	M3 Entry	normal	EW2101726	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	-	-	-	-	-	-	1456	-	-	-	-	-
		13-May-2021	M3 Entry	normal	EW2102105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	-	-	-	-	-	-	1346	-	-	-	-	-
		11-Jun-2021	M3 Entry	normal	EW2102597	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	-	-	-	-	-	-	1203	-	-	-	-	-
		09-Jul-2021	M3 Entry	normal	EW2102976	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.1	-	-	-	-	-	-	1560	-	-	-	-	-
		09-Aug-2021	M3 Entry	normal	EW2103386	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.7	-	-	-	-	-	-	845	-	-	-	-	-
		09-Sep-2021	M3 Entry	normal	EW2103811	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1300	-	-	-	-	-
		12-Oct-2021	M3 Entry	normal	EW2104254	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1229	-	-	-	-	-
		12-Nov-2021	M3 Entry	normal	EW2104783	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1027	-	-	-	-	-
		14-Dec-2021	M3 Entry	normal	EW2105347	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1216	-	-	-	-	-
		14-Jan-2022	M3 Entry	normal	EW2200095	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	-	-	-	-	-	-	1294	-	-	-	-	-
		11-Feb-2022	M3 Entry	normal	EW2200530	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1287	-	-	-	-	-
	M3 Exit	08-Dec-2020	M3 Exit	normal	EW2005557	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1580	-	-	-	-	-
		07-Jan-2021	M3 Exit	normal	EW2100074	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1450	-	-	-	-	-
		09-Feb-2021	M3 Exit	normal	EW2100587	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.6	-	-	-	-	-	-	1469	-	-	-	-	-
		11-Mar-2021	M3 Exit	normal	EW2101104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1261	-	-	-	-	-
		19-Apr-2021	M3 EXit	normal	EW2101726	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1430	-	-	-	-	-
		13-May-2021	M3 Exit	normal	EW2102105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	-	-	-	-	-	-	1313	-	-	-	-	-
		11-Jun-2021	M3 Exit	normal	EW2102597	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1183	-	-	-	-	-
		09-Jul-2021	M3 Exit	normal	EW2102976	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.1	-	-	-	-	-	-	1482	-	-	-	-	-
		09-Aug-2021	M3 Exit	normal	EW2103386	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.6	-	-	-	-	-	-	1307	-	-	-	-	-
		09-Sep-2021	M3 Exit	normal	EW2103811	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1268	-	-	-	-	-
		12-Oct-2021	M3 Exit	normal	EW2104254	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.6	-	-	-	-	-	-	1300	-	-	-	-	-
		12-Nov-2021	M3 Exit	normal	EW2104783	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	-	-	-	-	-	-	982	-	-	-	-	-
		14-Dec-2021	M3 Exit	normal	EW2105347	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1222	-	-	-	-	-
		14-Jan-2022	M3 Exit	normal	EW2200095	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-	-	-	-	-	1359	-	-	-	-	-
		11-Feb-2022	M3 Exit	normal	EW2200530	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	-	-	-	-	1287	-	-	-	-	-
	Mine DW - Line 1	08-Dec-2020	Mine Dewatering - Line 1	normal	EW2005557	-	-	0.096	2.47	-	-	-	-	-	-	-	-	-	3.04	-	-	-	-	-	0.054	-	0.062	-	-	-	-	7.9	-	-	-	-	-	-	1125	-	-	-	-	-
		07-Jan-2021	Mine Dewatering - Line 1	normal	EW2100074	-	-	0.213	4.89	-	-	-	-	-	-	-	-	-	1.39	-	-	-	-	-	0.113	-	0.116	-	-	-	-	7.7	-	-	-	-	-	-	1931	-	-	-	-	-
		09-Feb-2021	Mine Dewatering - Line 1	normal	EW2100587	-	-	0.117	2.02	-	-	-	-	-	0.003	-	-	0.39	-	-	-	-	-	-	0.066	-	0.17	-	-	894	<1	8.2	28.2[#1]	47	-	942	-	-	1235	-	-	-	-	-
		11-Mar-2021	Mine Dewatering - Line 1	normal	EW2101104	-	-	0.228	3.31	-	-	-	-	-	0.002	-	-	0.02	-	-	-	-	-	-	0.088	-	0.192	-	-	1370	<1	8.1	96[#1]	160	-	1530	-	-	1866	-	-	-	-	-
		19-Apr-2021	Mine Dewatering - Line 1	normal	EW2101726	-	-	0.1	1.76	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.036	-	0.242	-	-	856	<1	7.9	23.4[#1]	39	-	895	-	-	1203	-	-	-	-	-
		13-May-2021	Mine Dewatering - Line 1	normal	EW2102105	-	-	0.134	1.98	-	-	-	-	-	0.002	-	-	0.01	-	-	-	-	-	-	0.035	-	0.376	-	-	951	<1	8.1	0.6[#1]	<1	-	952	-	-	1320	-	-	-	-	-
		11-Jun-2021	Mine Dewatering - Line 1	normal	EW2102597	-	-	0.045	3.61	-	-	-	-	-	<0.001	-	-	0.03	-	-	-	-	-	-	0.041	-	0.188	-	-	794	<1	7.7	6.6[#1]	11	-	805	-	-	1222	-	-	-	-	-
		09-Jul-2021	Mine Dewatering - Line 1	normal	EW2102976	-	-	0.128	4.35	-	-	-	-	-	0.004	-	-	<0.01	-	-	-	-	-	-	0.058	-	0.141	-	-	1290	<1	7.7	0.6[#1]	<1	-	1290	-	-	1716	-	-	-	-	-
		09-Aug-2021	Mine Dewatering - Line 1	normal	EW2103386	-	-	0.197	4.05	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.062	-	0.176	-	-	1690	<1	7.7	0.6[#1]	<1	-	1690	-	-	1872	-	-	-	-	-
		09-Sep-2021	Mine Dewatering - Line 1	normal	EW2103811	-	-	0.174	2.24	-	-	-	-	-	0.002	-	-	<0.01	-	-	-	-	-	-	0.042	-	0.273	-	-	1010	<1	7.7	32.4[#1]	54	-	1070	-	-	1547	-	-	-	-	-
		12-Oct-2021	Mine Dewatering - Line 1	normal	EW2104254	-	-	0.135	1.61	-	-	-	-	-	<0.001	-	-	0.02	-	-	-	-	-	-	0.044	-	0.133	-	-	763	<1	7.9	0.6[#1]	<1	-	763	-	-	1151	-	-	-	-	-
		12-Nov-2021	Mine Dewatering - Line 1	normal	EW2104783	-	-	0.148	2.78	-	-	-	-	-	0.004	-	-	0.01	-	-	-	-	-	-	0.049	-	0.305	-	-	1300	<1	8.2	0.6[#1]	<1	-	1300	-	-	1606	-	-	-	-	-
		14-Jan-2022	Mine Dewatering - Line 1	normal	EW2200095	-	-	0.197	3.54	-	-	-	-	-	0.001	-	-	<0.01	-	-	-	-	-	-	0.061	-	0.35	-	-	1440	<1	7.5	0.6[#1]	<1	-	1440	-	-	1755	-	-	-	-	-
		11-Feb-2022	Mine Dewatering - Line 1	normal	EW2200530	-	-	0.178	1.56	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.037	-	0.254	-	-	894	<1	8	21.6[#1]	36	-	930	-	-	1307	-	-	-	-	-

Table 1: Surface Water and Groundwater Analytical Results

SLR

Monitoring Area	Location Code	Sampled Date	Field ID	Sample Type	Lab Report No.	Metals: Lithium	Strontium	Arsenic	Barium	Boron	Cadmium	Chromium (III+VI)	Chromium (hexavalent)	Cobalt	Copper	Chromium (Trivalent)	Silver	Aluminium	Iron	Iron (Filtered)	Lead	Manganese	Manganese (Filtered)	Mercury	Nickel	Selenium	Zinc
						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
ADWG 2018 Aesthetic															1				0.3	0.3		0.1	0.1				3
ADWG 2018 Health								0.01	2	4	0.002		0.05		2		0.1				0.01	0.5	0.5	0.001	0.02	0.01	
ANZECC 2000 Irrigation Long Term Trigger Values						**2.5[#4]**		**0.1**		**0.5**	**0.01**	**0.1**		**0.05**	**0.2**			**5**	**0.2**	**0.2**	**2**	**0.2**	**0.2**	**0.002**	**0.2**	**0.02**	**2**
ANZECC 2000 Irrigation Short Term Trigger Values						**2.5[#4]**		**2**			**0.05**	**1**		**0.1**	**5**			**20**	**10**	**10**	**5**	**10**	**10**	**0.002**	**2**	**0.05**	**5**
ANZG (2018) Freshwater 95% toxicant DGVs										0.37[#8]	0.0002[#9]		0.0004[#8]		0.0014[#9]		0.00005[#10]	0.055[#11]			0.0034[#11]	1.9[#12]	1.9[#12]	0.0006[#10]	0.011[#10]	0.011[#10]	0.008[#13]
NHMRC Guidelines for Managing Risks in Recreational Water 2008								*0.1*	*20*	*40*	*0.02*		*0.5*		*10*		*1*		*3*	*3*	*0.1*	*1*	*1*	*0.01*	*0.2*	*0.1*	*30*
Pit Top Area	Mine DW - Line 2	08-Dec-2020	Mine Dewatering - Line 2	normal	EW2005557	-	-	***0.245***	5.2	-	-	-	-	-	-	-	-	-	**0.91**	-	-	-	-	-	0.118	-	0.091
		07-Jan-2021	Mine Dewatering - Line 2	normal	EW2100074	-	-	***0.222***	4.85	-	-	-	-	-	-	-	-	-	**1.27**	-	-	-	-	-	0.118	-	0.109
		09-Feb-2021	Mine Dewatering - Line 2	normal	EW2100587	-	-	***0.145***	2.46	-	-	-	-	-	0.005	-	-	0.74	-	-	-	-	-	-	0.082	-	0.284
		11-Mar-2021	Mine Dewatering - Line 2	normal	EW2101104	-	-	***0.239***	3.47	-	-	-	-	-	0.001	-	-	0.02	-	-	-	-	-	-	0.089	-	0.188
		19-Apr-2021	Mine Dewatering - Line 2	normal	EW2101726	-	-	***0.178***	2.62	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.047	-	0.29
		13-May-2021	Mine Dewatering - Line 2	normal	EW2102105	-	-	***0.169***	2.93	-	-	-	-	-	0.002	-	-	0.02	-	-	-	-	-	-	0.05	-	0.427
		11-Jun-2021	Mine Dewatering - Line 2	normal	EW2102597	-	-	0.094	4.97	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.06	-	0.195
		09-Jul-2021	Mine Dewatering - Line 2	normal	EW2102976	-	-	***0.136***	4.48	-	-	-	-	-	0.004	-	-	<0.01	-	-	-	-	-	-	0.055	-	0.152
		12-Nov-2021	Mine Dewatering - Line 2	normal	EW2104783	-	-	***0.138***	3.08	-	-	-	-	-	0.004	-	-	0.01	-	-	-	-	-	-	0.046	-	0.332
		14-Jan-2022	Mine Dewatering - Line 2	normal	EW2200095	-	-	***0.203***	3.65	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.06	-	0.352
		11-Feb-2022	Mine Dewatering - Line 2	normal	EW2200530	-	-	***0.268***	2	-	-	-	-	-	0.001	-	-	0.02	-	-	-	-	-	-	0.049	-	0.353
	PIT TOP 1	05-Sep-2019	PIT TOP 1	Normal		0.15	0.1	<0.01	0.047	-	<0.01	-	-	-	0.003	-	-	0.04	***4.6***	0.14	<0.001	<0.36	**0.33**	-	0.03	-	0.052
		14-Nov-2019	PIT TOP1	Normal		0.22	0.14	<0.01	0.023	-	<0.01	-	-	-	0.001	-	-	0.05	**1**	**0.95**	<0.001	<0.05	0.031	-	0.03	***140***	0.006
		20-Feb-2020	PIT TOP 1	Normal		0.21	<0.11	<0.01	0.016	-	<0.01	-	-	-	<0.001	-	-	0.05	**1.5**	<1.4	<0.001	<0.06	0.04	-	0.03	<0.01	0.016
		17-Nov-2020	PIT TOP 1	Normal		0.14	<0.12	<0.01	0.012	-	<0.01	-	-	-	<0.001	-	-	0.28	***4.7***	<0.52	<0.001	<0.06	0.05	-	0.02	<0.01	0.032
		20-Feb-2021	PIT TOP 1	Normal		0.14	<0.12	<0.01	0.015	-	<0.01	-	-	-	<0.001	-	-	0.31	***190***	<16	<0.001	<0.1	0.08	-	0.02	<0.01	0.03
		24-May-2021	PIT TOP 1	Normal		0.13	<0.12	<0.01	0.016	-	<0.0002	-	-	-	<0.001	-	-	0.32	**2.2**	<0.47	<0.001	<0.03	0.02	-	0.02	<0.01	0.017
		27-Aug-2021	PIT TOP 1	Normal		0.01	<0.13	<0.01	0.1	-	<0.0002	-	-	-	<0.001	-	-	0.36	***8.1***	<1.7	<0.001	<0.12	0.09	-	0.02	<0.01	0.025
		21-Feb-2022	PIT TOP 1	Normal		0.017	<0.12	<0.01	0.11	-	<0.0002	-	-	-	<0.001	-	-	0.47	**0.62**	<0.43	<0.001	<0.13	0.1	-	0.02	<0.01	0.016
	PIT TOP 2	05-Sep-2019	PIT TOP 2	Normal		0.021	0.82	<0.01	1.2	-	<0.01	-	-	-	0.001	-	-	<0.01	***8.1***	**2.5**	<0.001	<0.23	0.18	-	<0.01	-	<0.012
		14-Nov-2019	PIT TOP2	Normal		0.013	0.6	<0.01	0.74	-	<0.01	-	-	-	<0.001	-	-	0.03	***110***	<8.5	<0.001	<0.46	0.14	-	<0.01	-	0.008
		20-Feb-2020	PIT TOP 2	Normal		0.12	<1.1	<0.01	0.95	-	<0.01	-	-	-	<0.001	-	-	0.01	**1.2**	<0.55	<0.001	<0.08	0.05	-	<0.01	<0.01	0.085
		17-Nov-2020	PIT TOP 2	Normal		0.025	<0.74	<0.01	1.3	-	<0.01	-	-	-	<0.001	-	-	0.03	***10***	<3.2	<0.001	<0.13	0.13	-	<0.01	<0.01	0.017
		20-Feb-2021	PIT TOP 2	Normal		0.027	<0.74	<0.01	1.3	-	<0.01	-	-	-	<0.001	-	-	0.05	***5.1***	<3.8	<0.001	<0.14	0.11	-	<0.01	<0.01	0.015
		24-May-2021	PIT TOP 2	Normal		0.059	<0.98	<0.01	1.3	-	<0.0002	-	-	-	<0.001	-	-	0.03	***7***	<5.3	<0.001	<0.12	0.1	-	<0.01	<0.01	0.01
		27-Aug-2021	PIT TOP 2	Normal		0.66	<0.015	<0.01	0.36	-	<0.0002	-	-	-	<0.001	-	-	0.02	***12***	<5.3	<0.001	<0.13	0.09	-	<0.01	<0.01	0.016
		11-Nov-2021	PIT TOP 2	Normal		0.82	<0.012	<0.01	0.45	-	<0.0002	-	-	-	<0.001	-	-	0.02	**0.66**	<0.49	<0.001	<0.07	0.06	-	<0.01	<0.01	0.022
		21-Feb-2022	PIT TOP 2	Normal		0.69	<0.033	<0.01	0.37	-	<0.0002	-	-	-	<0.001	-	-	0.04	**2**	<1.2	<0.001	<0.02	0.01	-	<0.01	<0.01	0.017
	PIT TOP 4	05-Sep-2019	PIT TOP 4	Normal		0.025	0.11	<0.01	0.17	-	<0.01	-	-	-	0.004	-	-	0.05	***3.4***	**0.56**	<0.001	<4.3	***4.2***	-	0.07	-	1.2
		14-Nov-2019	PIT TOP4	Normal		0.046	0.14	<0.01	0.17	-	<0.01	-	-	-	0.005	-	-	0.11	***5.4***	**1.8**	0.003	***4.4***	***4.3***	-	0.07	-	0.56
		20-Feb-2020	PIT TOP 4	Normal		0.037	<0.18	<0.01	0.19	-	<0.01	-	-	-	0.009	-	-	1.3	**1.7**	**1.3**	0.011	***3.8***	***3.8***	-	0.09	<0.01	0.62
		17-Nov-2020	PIT TOP 4	Normal		0.013	<0.17	<0.01	0.11	-	<0.01	-	-	-	<0.001	-	-	0.05	**1.6**	<1.3	<0.001	<0.09	0.08	-	<0.01	<0.01	0.34
		20-Feb-2021	PIT TOP 4	Normal		0.034	<0.47	<0.01	0.068	-	<0.01	-	-	-	<0.001	-	-	0.03	***3.1***	<1.2	<0.001	<0.06	0.04	-	<0.01	<0.01	0.1
		24-May-2021	PIT TOP 4	Normal		0.019	<0.36	<0.01	0.092	-	<0.0002	-	-	-	<0.001	-	-	0.05	**1.7**	<0.72	<0.001	<0.05	0.05	-	<0.01	<0.01	0.062
		11-Nov-2021	PIT TOP 4	Normal		0.032	<0.12	<0.01	0.12	-	<0.0002	-	-	-	<0.001	-	-	0.05	**1.5**	<1.4	<0.001	<0.26	**0.23**	-	<0.01	<0.01	0.006
		21-Feb-2022	PIT TOP 4	Normal		0.085	<0.069	<0.01	0.59	-	<0.0002	-	-	-	<0.001	-	-	1.1	**1.5**	<0.35	<0.001	<0.02	0.02	-	<0.01	<0.01	0.01

Location Code	Sampled Date	TPH: Oil and Grease	Inorganics: Alkalinity (Bicarbonate)	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	pH (Field)	Alkalinity (Carbonate)	Carbonate Alkalinity as CaCO3_	Phosphorus	Alkalinity (total) as CaCO3	Nitrogen (Total)	TDS	TDS (Calculated)[#1]	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Kjeldahl Nitrogen Total
		mg/L	mg/L	mg/L	mg/L	pH_Unit	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic						6-8.5						600	600		11.3	9		
ADWG 2018 Health																		
ANZECC 2000 Irrigation Long Term Trigger Values						**6-8.5[#5]**			**50[#6]**		**5**							
ANZECC 2000 Irrigation Short Term Trigger Values											**25**							
ANZG (2018) Freshwater 95% toxicant DGVs														0.74	0.16			
NHMRC Guidelines for Managing Risks in Recreational Water 2008						*6.5-8.5*									*113*	*9*		
Mine DW - Line 2	08-Dec-2020	-	-	-	-	8	-	-	-	-	-	-	2126	-	-	-	-	-
	07-Jan-2021	-	-	-	-	7.8	-	-	-	-	-	-	1976	-	-	-	-	-
	09-Feb-2021	-	-	1010	<1	8.1	43.2[#1]	72	-	1080	-	-	1476	-	-	-	-	-
	11-Mar-2021	-	-	1640	<1	8	68.4[#1]	114	-	1760	-	-	1944	-	-	-	-	-
	19-Apr-2021	-	-	1410	<1	7.9	43.8[#1]	73	-	1480	-	-	1716	-	-	-	-	-
	13-May-2021	-	-	1310	<1	7.9	0.6[#1]	<1	-	1310	-	-	1541	-	-	-	-	-
	11-Jun-2021	-	-	1290	<1	7.6	0.6[#1]	<1	-	1290	-	-	1554	-	-	-	-	-
	09-Jul-2021	-	-	1300	<1	7.7	0.6[#1]	<1	-	1300	-	-	1710	-	-	-	-	-
	12-Nov-2021	-	-	1250	<1	8.2	0.6[#1]	<1	-	1250	-	-	1573	-	-	-	-	-
	14-Jan-2022	-	-	1300	<1	7.6	0.6[#1]	<1	-	1300	-	-	1788	-	-	-	-	-
	11-Feb-2022	-	-	1270	<1	8	0.6[#1]	<1	-	1270	-	-	1528	-	-	-	-	-
PIT TOP 1	05-Sep-2019	-	495	-	-	-	-	-	**180**	-	2.2	970	-	-	-	-	-	-
	14-Nov-2019	-	165	-	-	-	-	-	**80**	-	1.8	800	-	-	-	-	-	-
	20-Feb-2020	-	10	-	-	-	-	-	**3700**	-	2.4	680	-	-	-	-	-	-
	17-Nov-2020	-	<1	-	-	-	-	-	**100**	-	1.3	620	-	-	-	-	-	-
	20-Feb-2021	-	<1	-	-	-	-	-	50	-	1.4	630	-	-	-	-	-	-
	24-May-2021	-	<1	-	-	-	-	-	50	-	1.2	620	-	-	-	-	-	-
	27-Aug-2021	-	<1	-	-	-	-	-	**170**	-	2.3	605	-	-	-	-	-	-
	21-Feb-2022	-	<1	-	-	-	-	-	**200**	-	1.9	595	-	-	-	-	-	-
PIT TOP 2	05-Sep-2019	-	560	-	-	-	-	-	**120**	-	1	520	-	-	-	-	-	-
	14-Nov-2019	-	385	-	-	-	-	-	**5500**	-	**6**	425	-	-	-	-	-	-
	20-Feb-2020	-	570	-	-	-	-	-	50	-	4	560	-	-	-	-	-	-
	17-Nov-2020	-	365	-	-	-	-	-	**80**	-	0.7	370	-	-	-	-	-	-
	20-Feb-2021	-	385	-	-	-	-	-	30	-	0.7	360	-	-	-	-	-	-
	24-May-2021	-	635	-	-	-	-	-	**70**	-	0.5	580	-	-	-	-	-	-
	27-Aug-2021	-	200	-	-	-	-	-	30	-	0.6	225	-	-	-	-	-	-
	11-Nov-2021	-	260	-	-	-	-	-	30	-	0.6	260	-	-	-	-	-	-
	21-Feb-2022	-	205	-	-	-	-	-	**240**	-	0.7	210	-	-	-	-	-	-
PIT TOP 4	05-Sep-2019	-	62	-	-	-	-	-	**190**	-	1.5	1750	-	-	-	-	-	-
	14-Nov-2019	-	<1	-	-	-	-	-	**110**	-	1.7	1710	-	-	-	-	-	-
	20-Feb-2020	-	<1	-	-	-	-	-	50	-	0.9	1700	-	-	-	-	-	-
	17-Nov-2020	-	115	-	-	-	-	-	**120**	-	1.4	155	-	-	-	-	-	-
	20-Feb-2021	-	98	-	-	-	-	-	**150**	-	3	140	-	-	-	-	-	-
	24-May-2021	-	155	-	-	-	-	-	**70**	-	1.4	185	-	-	-	-	-	-
	11-Nov-2021	-	<1	-	-	-	-	-	**70**	-	2.8	600	-	-	-	-	-	-
	21-Feb-2022	-	<1	-	-	-	-	-	10	-	2.7	155	-	-	-	-	-	-

Table 1: Surface Water and Groundwater Analytical Results

SLR

Monitoring Area	Location Code	Sampled Date	Field ID	Sample Type	Lab Report No.	Lithium	Strontium	Arsenic	Barium	Boron	Cadmium	Chromium (III+VI)	Chromium (hexavalent)	Cobalt	Copper	Chromium (Trivalent)	Silver	Aluminium	Iron	Iron (Filtered)	Lead	Manganese	Manganese (Filtered)	Mercury	Nickel	Selenium	Zinc	Oil and Grease	Alkalinity (Bicarbonate)	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	pH (Field)	Alkalinity (Carbonate)	Carbonate Alkalinity as CaCO3_	Phosphorus	Alkalinity (total) as CaCO3	Nitrogen (Total)	TDS	TDS (Calculated) [#1]	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Kjeldahl Nitrogen Total
						Metals																						TPH	Inorganics															
						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	pH_Unit	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic															1				0.3	0.3		0.1	0.1				3					6-8.5						600	600		11.3	9		
ADWG 2018 Health								0.01	2	4	0.002		0.05		2		0.1				0.01	0.5	0.5	0.001	0.02	0.01																		
ANZECC 2000 Irrigation Long Term Trigger Values						**2.5[#4]**		**0.1**		**0.5**	**0.01**	**0.1**		**0.05**	**0.2**			**5**	**0.2**	**0.2**	**2**	**0.2**	**0.2**	**0.002**	**0.2**	**0.02**	**2**					**6-8.5[#5]**			**50[#6]**		**5**							
ANZECC 2000 Irrigation Short Term Trigger Values						**2.5[#4]**		**2**			**0.05**	**1**		**0.1**	**5**			**20**	**10**	**10**	**5**	**10**	**10**	**0.002**	**2**	**0.05**	**5**										**25**							
ANZG (2018) Freshwater 95% toxicant DGVs										0.37[#8]	0.0002[#9]		0.0004[#8]		0.0014[#9]		0.00005[#10]	0.055[#11]			0.0034[#11]	1.9[#12]	1.9[#12]	0.0006[#10]	0.011[#10]	0.011[#10]	0.008[#13]													0.74	0.16			
NHMRC Guidelines for Managing Risks in Recreational Water 2008								*0.1*	*20*	*40*	*0.02*		*0.5*		*10*		*1*		*3*	*3*	*0.1*	*1*	*1*	*0.01*	*0.2*	*0.1*	*30*					*6.5-8.5*									*113*	*9*		
Reject Emplacement Area (REA)	Dam S9 (LDP 3)	08-Dec-2020	S9 Dam (LDP 3)	normal	EW2005557	-	-	<0.001	0.672	-	-	-	-	-	-	-	-	-	0.12	-	-	-	-	-	0.015	-	<0.005	<5	-	-	-	8.2	-	-	-	-	-	-	1092	-	-	-	-	-
		07-Jan-2021	S9 Dam (LDP 3)	normal	EW2100074	-	-	0.003	0.595	-	-	-	-	-	-	-	-	-	0.63	-	-	-	-	-	0.013	-	0.008	<5	-	-	-	8.4	-	-	-	-	-	-	780	-	-	-	-	-
		09-Feb-2021	S9 Dam (LDP 3)	normal	EW2100587	-	-	<0.001	0.708	-	-	-	-	-	<0.001	-	-	0.2	-	-	-	-	-	-	0.014	-	<0.005	-	-	991	<1	8.1	0.6[#1]	<1	-	991	3.5	-	1151	-	-	-	-	-
		11-Mar-2021	S9 Dam (LDP 3)	normal	EW2101104	-	-	<0.001	1.25	-	-	-	-	-	<0.001	-	-	0.02	-	-	-	-	-	-	0.016	-	0.025	-	-	1190	<1	8.4	78.6[#1]	131	-	1320	11.5	-	1469	-	-	-	-	-
		19-Apr-2021	S9 Dam (LDP 3)	normal	EW2101726	-	-	<0.001	0.547	0.07	<0.0001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.001	<0.01	-	-	0.001	-	0.016	<0.0001	0.01	<0.01	<0.005	<5	-	941	<1	8.3	25.2[#1]	42	-	984	0.1	-	1164	0.08	0.12	<0.01	0.12	<0.1
		13-May-2021	S9 Dam (LDP 3)	normal	EW2102105	-	-	<0.001	0.742	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.011	-	0.041	-	-	986	<1	8.2	0.6[#1]	<1	-	986	5.2	-	1164	-	-	-	-	-
		11-Jun-2021	S9 Dam (LDP 3)	normal	EW2102597	-	-	<0.001	1.29	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.012	-	<0.005	-	-	955	<1	8.3	12[#1]	20	-	976	3.1	-	1183	-	-	-	-	-
		09-Jul-2021	S9 Dam (LDP 3)	normal	EW2102976	-	-	<0.001	1.23	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.014	-	0.008	-	-	961	<1	8.1	0.6[#1]	<1	-	961	2.7	-	1216	-	-	-	-	-
		09-Aug-2021	S9 Dam (LDP 3)	normal	EW2103386	-	-	<0.001	1.46	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.014	-	<0.005	-	-	1140	<1	8.3	3[#1]	5	-	1140	3	-	1248	-	-	-	-	-
		09-Sep-2021	S9 Dam (LDP 3)	normal	EW2103811	-	-	<0.001	1.19	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.012	-	<0.005	-	-	971	<1	8.4	51[#1]	85	-	1060	3.9	-	1183	-	-	-	-	-
		12-Oct-2021	S9 Dam (LDP 3)	normal	EW2104254	-	-	0.001	0.812	-	-	-	-	-	0.002	-	-	0.02	-	-	-	-	-	-	0.01	-	0.029	-	-	664	<1	8.4	41.4[#1]	69	-	733	3.6	-	845	-	-	-	-	-
		12-Nov-2021	S9 Dam (LDP 3)	normal	EW2104783	-	-	<0.001	0.456	-	-	-	-	-	0.001	-	-	0.02	-	-	-	-	-	-	0.006	-	0.017	-	-	485	<1	8	0.6[#1]	<1	-	485	1	-	586	-	-	-	-	-
		14-Dec-2021	S9 Dam (LDP 3)	normal	EW2105347	-	-	<0.001	0.687	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.012	-	0.018	-	-	764	<1	8.1	0.6[#1]	<1	-	764	0.1	-	1099	-	-	-	-	-
		14-Jan-2022	S9 Dam (LDP 3)	normal	EW2200095	-	-	<0.001	0.611	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.01	-	0.016	-	-	998	<1	7.9	0.6[#1]	<1	-	998	2.1	-	1170	-	-	-	-	-
		11-Feb-2022	S9 Dam (LDP 3)	normal	EW2200530	-	-	0.001	0.538	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.01	-	0.018	-	-	602	<1	8.2	0.6[#1]	<1	-	602	2.8	-	884	-	-	-	-	-
	Dam S4 (LDP 4)	08-Dec-2020	Dam S4 (LDP 4)	normal	EW2005557	-	-	0.002	1.06	-	-	-	-	-	-	-	-	-	<0.05	-	-	-	-	-	0.013	-	<0.005	<5	-	-	-	8.9	-	-	-	-	-	-	1326	-	-	-	-	-
		07-Jan-2021	Dam S4 (LDP 4)	normal	EW2100074	-	-	0.003	1.27	-	-	-	-	-	-	-	-	-	0.13	-	-	-	-	-	0.013	-	<0.005	<5	-	-	-	8.9	-	-	-	-	-	-	1209	-	-	-	-	-
		09-Feb-2021	Dam S4 (LDP 4)	normal	EW2100587	-	-	0.005	1.15	-	-	-	-	-	0.001	-	-	0.5	-	-	-	-	-	-	0.015	-	<0.005	-	-	907	<1	9	89.4[#1]	149	-	1060	11.7	-	1190	-	-	-	-	-
		11-Mar-2021	Dam S4 (LDP 4)	normal	EW2101104	-	-	0.002	1.04	-	-	-	-	-	<0.001	-	-	0.1	-	-	-	-	-	-	0.014	-	<0.005	-	-	1080	<1	8.9	138.6[#1]	231	-	1310	14.1	-	1456	-	-	-	-	-
		19-Apr-2021	Dam S4 (LDP 4)	normal	EW2101726	-	-	0.001	0.898	<0.05	<0.0001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.001	0.05	-	-	<0.001	-	<0.001	<0.0001	0.008	<0.01	<0.005	<5	-	701	<1	8.7	61.2[#1]	102	-	803	6.4	-	1118	0.01	5.78	0.03	5.81	0.6
		13-May-2021	Dam S4 (LDP 4)	normal	EW2102105	-	-	0.004	1.03	-	-	-	-	-	<0.001	-	-	0.12	-	-	-	-	-	-	0.01	-	0.022	-	-	814	<1	8.8	30.6[#1]	51	-	865	5.4	-	982	-	-	-	-	-
		11-Jun-2021	Dam S4 (LDP 4)	normal	EW2102597	-	-	0.001	1.24	-	-	-	-	-	<0.001	-	-	0.06	-	-	-	-	-	-	0.01	-	<0.005	-	-	884	<1	8.9	68.4[#1]	114	-	998	5.7	-	1183	-	-	-	-	-
		09-Jul-2021	Dam S4 (LDP 4)	normal	EW2102976	-	-	0.006	1.32	-	-	-	-	-	<0.001	-	-	0.1	-	-	-	-	-	-	0.018	-	0.028	-	-	993	<1	8.9	0.6[#1]	<1	-	993	4.7	-	1229	-	-	-	-	-
		09-Aug-2021	Dam S4 (LDP 4)	normal	EW2103386	-	-	0.005	1.12	-	-	-	-	-	<0.001	-	-	0.17	-	-	-	-	-	-	0.019	-	<0.005	-	-	958	<1	9	55.8[#1]	93	-	1050	3.5	-	1229	-	-	-	-	-
		09-Sep-2021	Dam S4 (LDP 4)	normal	EW2103811	-	-	0.006	0.963	-	-	-	-	-	<0.001	-	-	0.07	-	-	-	-	-	-	0.016	-	<0.005	-	-	765	<1	8.8	88.8[#1]	148	-	914	3.4	-	1112	-	-	-	-	-
		12-Oct-2021	Dam S4 (LDP 4)	normal	EW2104254	-	-	0.004	0.853	-	-	-	-	-	<0.001	-	-	0.1	-	-	-	-	-	-	0.016	-	<0.005	-	-	838	<1	8.8	103.2[#1]	172	-	1010	3.4	-	1164	-	-	-	-	-
		12-Nov-2021	Dam S4 (LDP 4)	normal	EW2104783	-	-	0.006	1.02	-	-	-	-	-	0.001	-	-	0.03	-	-	-	-	-	-	0.012	-	0.009	-	-	754	<1	8.8	49.8[#1]	83	-	837	5.2	-	1034	-	-	-	-	-
		14-Dec-2021	Dam S4 (LDP 4)	normal	EW2105347	-	-	0.002	1.25	-	-	-	-	-	<0.001	-	-	0.03	-	-	-	-	-	-	0.011	-	0.006	-	-	737	<1	8.8	63[#1]	105	-	842	6.7	-	1222	-	-	-	-	-
		14-Jan-2022	Dam S4 (LDP 4)	normal	EW2200095	-	-	0.002	0.972	-	-	-	-	-	<0.001	-	-	0.03	-	-	-	-	-	-	0.01	-	0.013	-	-	780	<1	8.7	48.6[#1]	81	-	861	5.2	-	1047	-	-	-	-	-
		11-Feb-2022	Dam S4 (LDP 4)	normal	EW2200530	-	-	0.003	1.04	-	-	-	-	-	<0.001	-	-	0.05	-	-	-	-	-	-	0.01	-	0.01	-	-	732	<1	8.9	79.2[#1]	132	-	864	4	-	1209	-	-	-	-	-
	S8 Dam (LDP 5)	08-Dec-2020	S8 Dam (LDP 5)	normal	EW2005557	-	-	<0.001	0.755	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	-	0.015	-	<0.005	<5	-	-	-	7.1	-	-	-	-	-	-	1112	-	-	-	-	-
		07-Jan-2021	S8 Dam (LDP 5)	normal	EW2100074	-	-	<0.001	0.739	-	-	-	-	-	-	-	-	-	0.26	-	-	-	-	-	0.016	-	<0.005	<5	-	-	-	7.2	-	-	-	-	-	-	1047	-	-	-	-	-
		09-Feb-2021	S8 Dam (LDP 5)	normal	EW2100587	-	-	<0.001	0.741	-	-	-	-	-	<0.001	-	-	0.03	-	-	-	-	-	-	0.015	-	<0.005	-	-	1090	<1	7.1	0.6[#1]	<1	-	1090	4.5	-	1203	-	-	-	-	-
		11-Mar-2021	S8 Dam (LDP 5)	normal	EW2101104	-	-	<0.001	1.45	-	-	-	-	-	<0.001	-	-	0.02	-	-	-	-	-	-	0.015	-	<0.005	-	-	1240	<1	7.5	37.8[#1]	63	-	1300	12.9	-	1515	-	-	-	-	-
		19-Apr-2021	S8 Dam (LDP 5)	normal	EW2101726	-	-	<0.001	0.56	0.07	<0.0001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.001	<0.01	-	-	<0.001	-	0.049	<0.0001	0.01	<0.01	<0.005	<5	-	1080	<1	7.1	0.6[#1]	<1	-	1080	0.2	-	1209	0.02	0.2	<0.01	0.2	<0.1
		13-May-2021	S8 Dam (LDP 5)	normal	EW2102105	-	-	<0.001	0.759	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.012	-	0.052	-	-	932	<1	7	0.6[#1]	<1	-	932	9.3	-	1203	-	-	-	-	-
		11-Jun-2021	S8 Dam (LDP 5)	normal	EW2102597	-	-	<0.001	1.26	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.012	-	<0.005	-	-	1060	<1	7.6	0.6[#1]	<1	-	1060	2.9	-	1209	-	-	-	-	-
		09-Jul-2021	S8 Dam (LDP 5)	normal	EW2102976	-	-	<0.001	1.35	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.013	-	0.014	-	-	1020	<1	7.6	0.6[#1]	<1	-	1020	3.2	-	1229	-	-	-	-	-
		09-Aug-2021	S8 Dam (LDP 5)	normal	EW2103386	-	-	<0.001	1.53	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.016	-	0.012	-	-	1080	<1	7.5	0.6[#1]	<1	-	1080	3.1	-	1281	-	-	-	-	-
		09-Sep-2021	S8 Dam (LDP 5)	normal	EW2103811	-	-	<0.001	1.25	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.014	-	<0.005	-	-	953	<1	7.5	0.6[#1]	<1	-	953	3.6	-	1242	-	-	-	-	-
		12-Oct-2021	S8 Dam (LDP 5)	normal	EW2104254	-	-	<0.001	1.26	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.014	-	0.027	-	-	1180	<1	7.7	0.6[#1]	<1	-	1180	4	-	1287	-	-	-	-	-
		12-Nov-2021	S8 Dam (LDP 5)	normal	EW2104783	-	-	<0.001	0.611	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.01	-	0.019	-	-	753	<1	7.2	0.6[#1]	<1	-	753	0.6	-	787	-	-	-	-	-
		14-Dec-2021	S8 Dam (LDP 5)	normal	EW2105347	-	-	<0.001	0.717	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.013	-	0.045	-	-	842	<1	7	0.6[#1]	<1	-	842	0.1	-	1164	-	-	-	-	-
		14-Jan-2022	S8 Dam (LDP 5)	normal	EW2200095	-	-	<0.001	0.63	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.011	-	0.025	-	-	960	<1	6.9	0.6[#1]	<1	-	960	2.2	-	1196	-	-	-	-	-
		11-Feb-2022	S8 Dam (LDP 5)	normal	EW2200530	-	-	<0.001	0.64	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.012	-	0.014	-	-	782	<1	7.1	0.6[#1]	<1	-	782	0.2	-	1125	-	-	-	-	-

Table 1: Surface Water and Groundwater Analytical Results

SLR

						Metals																						TPH	Inorganics															
						Lithium	Strontium	Arsenic	Barium	Boron	Cadmium	Chromium (III+VI)	Chromium (hexavalent)	Cobalt	Copper	Chromium (Trivalent)	Silver	Aluminium	Iron	Iron (Filtered)	Lead	Manganese	Manganese (Filtered)	Mercury	Nickel	Selenium	Zinc	Oil and Grease	Alkalinity (Bicarbonate)	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	pH (Field)	Alkalinity (Carbonate)	Carbonate Alkalinity as CaCO3_	Phosphorus	Alkalinity (total) as CaCO3	Nitrogen (Total)	TDS	TDS (Calculated) [#1]	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Kjeldahl Nitrogen Total
						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	pH_Unit	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic															1				0.3	0.3		0.1	0.1				3					6-8.5						600	600		11.3	9		
ADWG 2018 Health								0.01	2	4	0.002		0.05		2		0.1				0.01	0.5	0.5	0.001	0.02	0.01																		
ANZECC 2000 Irrigation Long Term Trigger Values						**2.5[#4]**		**0.1**		**0.5**	**0.01**	**0.1**		**0.05**	**0.2**			**5**	**0.2**	**0.2**	**2**	**0.2**	**0.2**	**0.002**	**0.2**	**0.02**	**2**					**6-8.5[#5]**			**50[#6]**		**5**							
ANZECC 2000 Irrigation Short Term Trigger Values						**2.5[#4]**		**2**			**0.05**	**1**		**0.1**	**5**			**20**	**10**	**10**	**5**	**10**	**10**	**0.002**	**2**	**0.05**	**5**										**25**							
ANZG (2018) Freshwater 95% toxicant DGVs										0.37[#8]	0.0002[#9]		0.0004[#8]		0.0014[#9]		0.00005[#10]	0.055[#11]			0.0034[#11]	1.9[#12]	1.9[#12]	0.0006[#10]	0.011[#10]	0.011[#10]	0.008[#13]													0.74	0.16			
NHMRC Guidelines for Managing Risks in Recreational Water 2008								*0.1*	*20*	*40*	*0.02*		*0.5*		*10*		*1*		*3*	*3*	*0.1*	*1*	*1*	*0.01*	*0.2*	*0.1*	*30*					*6.5-8.5*									*113*	*9*		
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**																																							
Reject Emplacement Area (REA)	REA1	12-Sep-2019	REA1	Normal		0.084	0.013	<0.01	0.062	-	<0.01	-	-	-	<0.001	-	-	<0.01	9.5	<8.6	<0.001	<0.71	0.66	-	0.04	-	<0.18	-	130	-	-	-	-	-	<10	-	0.6	260	-	-	-	-	-	-
		10-Oct-2019	REA1	Normal		0.11	0.021	<0.01	0.083	-	<0.01	-	-	-	<0.001	-	-	0.04	16	<16	<0.001	<0.95	0.9	-	0.05	-	0.017	-	135	-	-	-	-	-	60	-	0.7	250	-	-	-	-	-	-
		14-Nov-2019	REA1	Normal		0.14	0.018	<0.01	0.079	-	<0.01	-	-	-	<0.001	-	-	0.03	15	<15	<0.001	<1	0.91	-	0.06	-	0.021	-	125	-	-	-	-	-	80	-	0.7	265	-	-	-	-	-	-
		20-Feb-2020	REA1	Normal		0.11	<0.027	<0.01	0.077	-	<0.01	-	-	-	<0.001	-	-	0.04	11	<9.2	<0.001	<0.72	0.71	-	0.06	<0.01	0.036	-	125	-	-	-	-	-	40	-	0.3	275	-	-	-	-	-	-
		17-Nov-2020	REA1	Normal		0.1	<0.021	<0.01	0.081	-	<0.01	-	-	-	<0.001	-	-	0.04	19	<13	<0.001	<0.85	0.74	-	0.05	<0.01	0.056	-	120	-	-	-	-	-	100	-	0.6	245	-	-	-	-	-	-
		20-Feb-2021	REA1	Normal		0.1	<0.019	<0.01	0.085	-	<0.01	-	-	-	<0.001	-	-	0.01	12	<12	<0.001	<0.9	0.85	-	0.05	<0.01	0.024	-	115	-	-	-	-	-	40	-	0.5	250	-	-	-	-	-	-
		24-May-2021	REA1	Normal		0.1	<0.018	<0.01	0.082	-	<0.0002	-	-	-	<0.001	-	-	0.02	13	<11	<0.001	<0.88	0.82	-	0.05	<0.01	0.03	-	120	-	-	-	-	-	30	-	0.3	0	-	-	-	-	-	-
		27-Aug-2021	REA1	Normal		<0.074	<0.1	<0.01	0.016	-	<0.0002	-	-	-	<0.002	-	-	<0.01	22	12	<0.001	<0.93	0.85	-	0.06	<0.01	<0.053	-	125	-	-	-	-	-	250	-	1.4	265	-	-	-	-	-	-
		11-Nov-2021	REA1	Normal		<0.079	<0.1	<0.01	0.015	-	<0.0002	-	-	-	<0.001	-	-	0.01	12	<12	<0.001	<0.84	0.79	-	0.05	<0.01	0.019	-	125	-	-	-	-	-	90	-	0.5	275	-	-	-	-	-	-
		21-Feb-2022	REA1	Normal		0.091	<0.1	<0.01	0.036	-	<0.0002	-	-	-	<0.001	-	-	0.04	15	<11	<0.001	<0.72	0.67	-	0.06	<0.01	0.016	-	120	-	-	-	-	-	<10	-	0.7	260	-	-	-	-	-	-
	REA2	09-Aug-2019	REA2	Normal		0.039	0.19	<0.01	0.13	-	<0.01	-	-	-	<0.001	-	-	<0.01	27	<20	<0.001	<3.2	3	-	0.06	-	<0.68	-	92	-	-	-	-	-	80	-	0.5	1740	-	-	-	-	-	-
		10-Oct-2019	REA2	Normal		0.048	0.23	<0.01	0.17	-	<0.01	-	-	-	<0.001	-	-	0.03	41	<38	<0.001	<3.4	3.4	-	0.06	-	0.16	-	92	-	-	-	-	-	60	-	0.7	1690	-	-	-	-	-	-
		14-Nov-2019	REA2	Normal		0.072	0.29	<0.01	0.18	-	<0.01	-	-	-	<0.001	-	-	0.02	52	<49	<0.001	<3.5	3.3	-	0.05	-	0.2	-	120	-	-	-	-	-	170	-	1.9	1770	-	-	-	-	-	-
		20-Feb-2020	REA2	Normal		0.029	<0.53	<0.01	0.13	-	<0.01	-	-	-	<0.001	-	-	0.03	18	<14	<0.001	<2.2	1.8	-	0.02	<0.01	0.09	-	225	-	-	-	-	-	130	-	1.8	1220	-	-	-	-	-	-
		17-Nov-2020	REA2	Normal		0.003	<0.44	<0.01	0.026	-	<0.01	-	-	-	<0.001	-	-	0.04	3.6	<2.6	<0.001	<0.1	0.1	-	<0.01	<0.01	0.049	-	225	-	-	-	-	-	100	-	0.9	380	-	-	-	-	-	-
		20-Feb-2021	REA2	Normal		0.004	<0.41	<0.01	0.054	-	<0.01	-	-	-	<0.001	-	-	0.05	3.1	<1.6	<0.001	<0.07	0.06	-	<0.01	<0.01	0.026	-	215	-	-	-	-	-	120	-	1.2	315	-	-	-	-	-	-
		24-May-2021	REA2	Normal		0.006	<0.26	<0.01	0.037	-	<0.0002	-	-	-	<0.004	-	-	0.05	2.3	1.4	<0.002	0.06	0.06	-	<0.01	<0.01	0.11	-	180	-	-	-	-	-	80	-	1	250	-	-	-	-	-	-
		27-Aug-2021	REA2	Normal		0.037	<0.004	<0.01	0.26	-	<0.0002	-	-	-	<0.002	-	-	0.05	10	4.6	<0.001	<0.24	0.23	-	<0.01	<0.01	0.049	-	180	-	-	-	-	-	190	-	2	235	-	-	-	-	-	-
		11-Nov-2021	REA2	Normal		0.037	<0.002	<0.01	0.26	-	<0.0002	-	-	-	<0.001	-	-	0.04	1.9	<1.6	<0.001	<0.08	0.07	-	<0.01	<0.01	0.03	-	195	-	-	-	-	-	40	-	0.7	230	-	-	-	-	-	-
		21-Feb-2022	REA2	Normal		0.05	<0.007	<0.01	0.26	-	<0.0002	-	-	-	<0.001	-	-	0.05	1.2	<1	<0.001	<0.05	0.03	-	<0.01	<0.01	0.047	-	200	-	-	-	-	-	<10	-	0.7	235	-	-	-	-	-	-
	REA3	16-Jul-2019	REA3	Normal		0.017	0.1	<0.01	0.17	-	<0.01	-	-	-	<0.001	-	-	0.01	8.6	<3.7	<0.001	<2.5	2.2	-	0.04	-	0.46	-	125	-	-	-	-	-	370	-	1.4	595	-	-	-	-	-	-
		10-Oct-2019	REA3	Normal		<0.017	0.081	<0.01	0.26	-	<0.01	-	-	-	<0.001	-	-	0.05	40	<39	<0.001	<2.8	2.8	-	0.03	-	0.19	-	37	-	-	-	-	-	130	-	0.9	550	-	-	-	-	-	-
		14-Nov-2019	REA3	Normal		<0.02	0.067	<0.01	0.27	-	<0.01	-	-	-	<0.001	-	-	0.04	39	<38	<0.001	<2.8	2.8	-	0.03	-	0.23	-	5	-	-	-	-	-	150	-	1.1	500	-	-	-	-	-	-
		20-Feb-2020	REA3	Normal		0.015	<0.063	<0.01	0.19	-	<0.01	-	-	-	<0.001	-	-	0.05	23	<18	<0.001	<2.3	2.3	-	0.03	<0.01	0.26	-	4	-	-	-	-	-	100	-	0.5	485	-	-	-	-	-	-
		17-Nov-2020	REA3	Normal		<0.01	<0.051	<0.01	0.23	-	<0.01	-	-	-	<0.001	-	-	0.02	39	<34	<0.001	<2.6	2.2	-	0.03	<0.01	0.1	-	<1	-	-	-	-	-	70	-	0.4	485	-	-	-	-	-	-
		20-Feb-2021	REA3	Normal		0.011	<0.053	<0.01	0.22	-	<0.01	-	-	-	<0.001	-	-	0.04	33	<30	<0.001	<2.9	2.3	-	0.03	<0.01	0.14	-	<1	-	-	-	-	-	110	-	0.4	470	-	-	-	-	-	-
		24-May-2021	REA3	Normal		0.014	<0.12	<0.01	0.035	-	<0.0002	-	-	-	<0.006	-	-	0.04	12	4.2	0.003	0.22	0.15	-	0.01	<0.01	0.93	-	135	-	-	-	-	-	140	-	1.4	175	-	-	-	-	-	-
		27-Aug-2021	REA3	Normal		<0.1	<0.012	<0.01	0.11	-	<0.0002	-	-	-	<0.001	-	-	0.02	17	<9.3	<0.001	<1.4	1.1	-	0.02	<0.01	0.48	-	82	-	-	-	-	-	90	-	0.6	320	-	-	-	-	-	-
		11-Nov-2021	REA3	Normal		<0.21	<0.008	<0.01	0.076	-	<0.0002	-	-	-	<0.001	-	-	0.03	26	<19	<0.001	<2.4	2.3	-	0.03	<0.01	0.17	-	2	-	-	-	-	-	80	-	0.2	475	-	-	-	-	-	-
		21-Feb-2022	REA3	Normal		<0.22	<0.012	<0.01	0.066	-	<0.0002	-	-	-	<0.001	-	-	0.03	2	<1.9	<0.001	<2.3	2	-	0.03	<0.01	0.12	-	11	-	-	-	-	-	150	-	0.5	460	-	-	-	-	-	-
	REA4	16-Jul-2019	REA4	Normal		0.022	0.089	<0.01	0.16	-	<0.01	-	-	-	<0.001	-	-	<0.01	19	<12	<0.001	<2.4	2.3	-	0.03	-	<0.5	-	63	-	-	-	-	-	280	-	1.8	480	-	-	-	-	-	-
		10-Oct-2019	REA4	Normal		0.018	0.066	<0.01	0.13	-	<0.01	-	-	-	<0.001	-	-	0.05	21	<21	<0.001	<2.5	2.5	-	0.02	-	0.072	-	72	-	-	-	-	-	60	-	2.5	495	-	-	-	-	-	-
		14-Nov-2019	REA4	Normal		0.034	0.09	<0.01	0.067	-	<0.01	-	-	-	<0.001	-	-	0.03	21	<18	<0.001	<2.6	2.4	-	0.01	-	0.078	-	85	-	-	-	-	-	150	-	3.6	510	-	-	-	-	-	-
		20-Feb-2020	REA4	Normal		0.019	<0.082	<0.01	0.082	-	<0.01	-	-	-	<0.001	-	-	0.03	20	<18	<0.001	<2.3	2.2	-	0.01	<0.01	0.095	-	85	-	-	-	-	-	60	-	1.7	490	-	-	-	-	-	-
		17-Nov-2020	REA4	Normal		0.023	<0.11	<0.01	0.067	-	<0.01	-	-	-	<0.001	-	-	0.01	18	<16	<0.001	<2.4	2.1	-	<0.01	<0.01	0.047	-	105	-	-	-	-	-	100	-	1.6	500	-	-	-	-	-	-
		20-Feb-2021	REA4	Normal		0.015	<0.18	<0.01	0.18	-	<0.01	-	-	-	<0.001	-	-	0.02	30	<23	<0.001	<2.5	2.2	-	<0.01	<0.01	0.036	-	43	-	-	-	-	-	<10	-	0.3	440	-	-	-	-	-	-
		24-May-2021	REA4	Normal		0.008	<0.069	<0.01	0.031	-	<0.0002	-	-	-	<0.002	-	-	0.05	2.2	0.28	<0.002	0.03	0.03	-	<0.01	<0.01	0.24	-	41	-	-	-	-	-	60	-	0.5	76	-	-	-	-	-	-
		27-Aug-2021	REA4	Normal		0.047	<0.005	<0.01	0.081	-	<0.0002	-	-	-	<0.001	-	-	0.02	1.8	0.61	<0.001	<0.15	0.15	-	<0.01	<0.01	0.21	-	55	-	-	-	-	-	<10	-	0.8	82	-	-	-	-	-	-
		11-Nov-2021	REA4	Normal		0.05	<0.003	<0.01	0.091	-	<0.0002	-	-	-	<0.001	-	-	0.03	3.9	<3.5	<0.001	<0.19	0.17	-	<0.01	<0.01	0.061	-	59	-	-	-	-	-	30	-	0.5	91	-	-	-	-	-	-
		21-Feb-2022	REA4	Normal		0.059	<0.024	<0.01	0.077	-	<0.0002	-	-	-	<0.001	-	-	0.02	2.5	<1	<0.001	<0.25	0.2	-	<0.01	<0.01	0.056	-	115	-	-	-	-	-	110	-	0.9	145	-	-	-	-	-	-
	REA5	16-Jul-2019	REA5	Normal		<0.01	0.056	<0.01	0.12	-	<0.01	-	-	-	<0.001	-	-	0.03	20	<6.5	<0.001	<2.1	2.1	-	0.03	-	0.66	-	65	-	-	-	-	-	260	-	1	390	-	-	-	-	-	-
		10-Oct-2019	REA5	Normal		0.014	0.084	<0.01	0.19	-	<0.01	-	-	-	<0.001	-	-	0.02	17	<15	<0.001	<2.3	2.3	-	0.03	-	0.77	-	61	-	-	-	-	-	90	-	0.5	370	-	-	-	-	-	-
		14-Nov-2019	REA5	Normal		0.013	0.1	<0.01	0.16	-	<0.01	-	-	-	<0.001	-	-	0.03	33	<32	<0.001	<2.3	2.3	-	0.06	-	1.8	-	8	-	-	-	-	-	110	-	0.6	355	-	-	-	-	-	-
		20-Feb-2020	REA5	Normal		0.011	<0.057	<0.01	0.048	-	<0.01	-	-	-	<0.001	-	-	0.04	3.4	<2.7	<0.001	<0.35	0.35	-	0.01	<0.01	0.13	-	37	-	-	-	-	-	120	-	1.9	150	-	-	-	-	-	-
		17-Nov-2020	REA5	Normal		0.004	<0.064	<0.01	0.073	-	<0.01	-	-	-	<0.001	-	-	<0.01	4	<3.7	<0.001	<0.28	0.25	-	0.02	<0.01	<0.94	-	23	-	-	-	-	-	80	-	0.9	195	-	-	-	-	-	-
		20-Feb-2021	REA5	Normal		0.007	<0.06	<0.01	0.11	-	<0.01	-	-	-	<0.001	-	-	0.03	15	<13	<0.001	<1.9	1.7	-	0.03	<0.01	1.1	-	7	-	-	-	-	-	60	-	0.4	295	-	-	-	-	-	-
		24-May-2021	REA5	Normal		0.007	<0.045	<0.01	0.11	-	<0.0002	-	-	-	<0.003	-	-	0.03	26	25	0.004	2	1.6	-	0.02	<0.01	0.82	-	8	-	-	-	-	-	50	-	0.2	285	-	-	-	-	-	-
		27-Aug-2021	REA5	Normal		<0.13	<0.008	<0.01	0.026	-	<0.0002	-	-	-	<0.002	-	-	0.04	20	17	0.001	2.3	2.1	-	0.03	<0.01	1.1	-	8	-	-	-	-	-	40	-	0.3	325	-	-	-	-	-	-
		11-Nov-2021	REA5	Normal		<0.13	<0.01	<0.01	0.027	-	<0.0002	-	-	-	<0.003	-	-	0.01	5.2	4.6	<0.001	<2.2	2.2	-	0.04	<0.01	0.89	-	5	-	-	-	-	-	30	-	0.4	315	-	-	-	-	-	-
		21-Feb-2022	REA5	Normal		<0.16	<0.01	<0.01	0.17	-	<0.0002	-	-	-	<0.001	-	-	0.04	1.5	<0.76	<0.001	<2.1	1.9	-	0.02	<0.01	0.95	-	6	-	-	-	-	-	90	-	0.8	320	-	-	-	-	-	-
	REA6	16-Jul-2019	REA6	Normal		0.026	0.29	<0.01	0.1	-	<0.01	-	-	-	<0.001	-	-	0.01	43	<11	<0.001	<2.5	2.3	-	0.04	-	0.28	-	280	-	-	-	-	-	500	-	0.7	1220	-	-	-	-	-	-
		10-Oct-2019	REA6	Normal		0.025	0.27	<0.01	0.1	-	<0.01	-	-	-	<0.001	-	-	0.01	65	<33	<0.001	<3.3	3	-	<0.01	-	0.035	-	315	-	-	-	-	-	160	-	1.7	1120	-	-	-	-	-	-
		14-Nov-2019	REA6	Normal		0.037	0.26	<0.01	0.088	-	<0.01	-	-	-	<0.001	-	-	0.04	42	<31	<0.001	<2.7	2.4	-	<0.01	-	0.019	-	225	-	-	-	-	-	400	-	1	970	-	-	-	-	-	-
		20-Feb-2020	REA6	Normal		0.02	<0.3	<0.01	0.1	-	<0.01	-	-	-	<0.001	-	-	0.02	31	<27	<0.001	<2.1	2	-	0.04	<0.01	0.087	-	160	-	-	-	-	-	280	-	0.7	820	-	-	-	-	-	-
		17-Nov-2020	REA6	Normal		0.019	<0.29	<0.01	0.13	-	<0.01	-	-	-	<0.001	-	-	0.02	60	<27	<0.001	<2.3	2	-	0.04	<0.01	0.066	-	140	-	-	-	-	-	410	-	1.2	790	-	-	-	-	-	-
		20-Feb-2021	REA6	Normal		0.021	<0.28	<0.01	0.12	-	<0.01	-	-	-	<0.001	-	-	0.02	53	<24	<0.001	<2.4	2.2	-	0.04	<0.01	0.047	-	140	-	-	-	-	-	330	-	1	815	-	-	-	-	-	-
		24-May-2021	REA6	Normal		0.018	<0.29	<0.01	0.1	-	<0.0002	-	-	-	<0.001	-	-	0.03	39	28	<0.001	<1.9	1.9	-	0.05	<0.01	0.16	-	100	-	-	-	-	-	310	-	1.2	770	-	-	-	-	-	-
		27-Aug-2021	REA6	Normal		<0.082	<0.021	<0.01	0.37	-	<0.0002	-	-	-	<0.001	-	-	0.01	36	<30	<0.001	<2.3	2.2	-	0.04	<0.01	0.062	-	97	-	-	-	-	-	140	-	0.3	780	-	-	-	-	-	-
		11-Nov-2021	REA6	Normal		<0.081	<0.017	<0.01	0.33	-	<0.0002	-	-	-	<0.001	-	-	0.02	27	<23	<0.001	<2.2	2.1	-	0.03	<0.01	0.047	-	91	-	-	-	-	-	130	-	0.3	715	-	-	-	-	-	-
		21-Feb-2022	REA6	Normal		0.1	<0.021	<0.01	0.35	-	<0.0002	-	-	-	<0.001	-	-	0.04	20	<15	<0.001	<2.2	2	-	0.03	<0.01	0.081	-	100	-	-	-	-	-	50	-	0.6	765	-	-	-	-	-	-
	REA7	16-Jul-2019	REA7	Normal		0.28	0.24	<0.01	0.73	-	<0.01	-	-	-	<0.001	-	-	0.01	6.5	<5.5	<0.001	<0.22	0.17	-	0.04	-	0.2	-	635	-	-	-	-	-	70	-	0.9	680	-	-	-	-	-	-
		10-Oct-2019	REA7	Normal		0.21	0.11	<0.01	0.35	-	<0.01	-	-	-	<0.001	-	-	<0.01	3	<1.6	<0.001	<0.5	0.5	-	0.02	-	<0.016	-	410	-	-	-	-	-	80	-	1.1	465	-	-	-	-	-	-
		14-Nov-2019	REA7	Normal		0.23	0.15	<0.01	0.28	-	<0.01	-	-	-	<0.001	-	-	0.03	3.4	<1.2	<0.001	<0.48	0.44	-	0.02	-	0.027	-	385	-	-	-	-	-	90	-	1.1	470	-	-	-	-	-	-
		20-Feb-2020	REA7	Normal		0.19	<0.12	<0.01	0.11	-	<0.01	-	-	-	<0.001	-	-	0.03	0.8	<0.76	<0.001	<0.23	0.21	-	0.01	<0.01	0.023	-	340	-	-	-	-	-	90	-	0.8	425	-	-	-	-	-	-
		17-Nov-2020	REA7	Normal		0.14	<0.085	<0.01	0.085	-	<0.01	-	-	-	<0.001	-	-	0.02	4.9	<1.5	<0.001	<0.31	0.29	-	0.01	<0.01	0.059	-	315	-	-	-	-	-	80	-	0.7	395	-	-	-	-	-	-
		20-Feb-2021	REA7	Normal		0.16	<0.081	<0.01	0.14	-	<0.01	-	-	-	<0.001	-	-	0.02	1.4	<1.2	<0.001	<0.15	0.11	-	0.01	<0.01	0.05	-	320	-	-	-	-	-	40	-	0.4	390	-	-	-	-	-	-
		24-May-2021	REA7	Normal		0.015	<0.043	<0.01	0.025	-	<0.0002	-	-	-	<0.001	-	-	0.05	1.6	<0.72	<0.001	<0.09	0.07	-	<0.01	<0.01	0.057	-	105	-	-	-	-	-	50	-	0.2	165	-	-	-	-	-	-
		27-Aug-2021	REA7	Normal		0.031	<0.018	<0.01	0.047	-	<0.0002	-	-	-	<0.001	-	-	0.03	2	<1.2	<0.001	<0.11	0.1	-	<0.01	<0.01	0.019	-	110	-	-	-	-	-	40	-	0.6	160	-	-	-	-	-	-
		11-Nov-2021	REA7	Normal		<0.078	<0.018	<0.01	0.064	-	<0.0002	-	-	-	<0.001	-	-	<0.01	2.2	<1.7	<0.001	<0.16	0.13	-	<0.01	<0.01	<0.032	-	120	-	-	-	-	-	60	-	0.6	170	-	-	-	-	-	-
		21-Feb-2022	REA7	Normal		0.049	<0.032	<0.01	0.073	-	<0.0002	-	-	-	<0.001	-	-	0.05	0.86	<0.77	<0.001	<0.08	0.07	-	<0.01	<0.01	0.007	-	170	-	-	-	-	-	20	-	1.1	230	-	-	-	-	-	-

Table 1: Surface Water and Groundwater Analytical Results

SLR

Metals

Monitoring Area	Location Code	Sampled Date	Field ID	Sample Type	Lab Report No.	Lithium	Strontium	Arsenic	Barium	Boron	Cadmium	Chromium (III+VI)	Chromium (hexavalent)	Cobalt	Copper	Chromium (Trivalent)	Silver	Aluminium	Iron	Iron (Filtered)	Lead	Manganese	Manganese (Filtered)	Mercury	Nickel	Selenium	Zinc
						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
ADWG 2018 Aesthetic															1				0.3	0.3		0.1	0.1				3
ADWG 2018 Health								0.01	2	4	0.002		0.05		2		0.1				0.01	0.5	0.5	0.001	0.02	0.01	
ANZECC 2000 Irrigation Long Term Trigger Values						**2.5#4**		**0.1**		**0.5**	**0.01**	**0.1**		**0.05**	**0.2**			**5**	**0.2**	**0.2**	**2**	**0.2**	**0.2**	**0.002**	**0.2**	**0.02**	**2**
ANZECC 2000 Irrigation Short Term Trigger Values						**2.5#4**		**2**			**0.05**	**1**		**0.1**	**5**			**20**	**10**	**10**	**5**	**10**	**10**	**0.002**	**2**	**0.05**	**5**
ANZG (2018) Freshwater 95% toxicant DGVs										0.37#8	0.0002#9		0.0004#8		0.0014#9		0.00005#10	0.055#11			0.0034#11	1.9#12	1.9#12	0.0006#10	0.011#10	0.011#10	0.008#13
NHMRC Guidelines for Managing Risks in Recreational Water 2008								*0.1*	*20*	*40*	*0.02*		*0.5*		*10*		*1*		*3*	*3*	*0.1*	*1*	*1*	*0.01*	*0.2*	*0.1*	*30*
Shaft Site Area	M6 Dam (LDP 6)	08-Dec-2020	M6 Dam (LDP 6)	normal	EW2005557	-	-	<0.001	0.228	-	-	-	-	-	-	-	-	-	**0.87**	-	-	-	-	-	<0.001	-	<0.005
		07-Jan-2021	M6 Dam (LDP 6)	normal	EW2100074	-	-	<0.001	0.234	-	-	-	-	-	-	-	-	-	**0.39**	-	-	-	-	-	0.001	-	<0.005
		09-Feb-2021	M6 Dam (LDP 6)	normal	EW2100587	-	-	<0.001	0.233	-	-	-	-	-	<0.001	-	-	0.01	-	-	-	-	-	-	0.001	-	<0.005
		11-Mar-2021	M6 Dam (LDP 6)	normal	EW2101104	-	-	<0.001	0.21	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.002	-	<0.005
		19-Apr-2021	M6 Dam (LDP 6)	normal	EW2101726	-	-	<0.001	0.134	<0.05	<0.0001	<0.001	<0.01	<0.001	<0.001	<0.01	<0.001	<0.01	-	-	<0.001	-	0.018	<0.0001	<0.001	<0.01	<0.005
		13-May-2021	M6 Dam (LDP 6)	normal	EW2102105	-	-	<0.001	0.136	-	-	-	-	-	<0.001	-	-	0.02	-	-	-	-	-	-	<0.001	-	<0.005
		11-Jun-2021	M6 Dam (LDP 6)	normal	EW2102597	-	-	<0.001	0.129	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	<0.005
		09-Jul-2021	M6 Dam (LDP 6)	normal	EW2102976	-	-	<0.001	0.14	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	<0.005
		09-Aug-2021	M6 Dam (LDP 6)	normal	EW2103386	-	-	<0.001	0.16	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	<0.005
		09-Sep-2021	M6 Dam (LDP 6)	normal	EW2103811	-	-	<0.001	0.172	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	<0.005
		12-Oct-2021	M6 Dam (LDP 6)	normal	EW2104254	-	-	<0.001	0.188	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	<0.005
		12-Nov-2021	M6 Dam (LDP 6)	normal	EW2104783	-	-	<0.001	0.228	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	0.024
		14-Dec-2021	M6 Dam (LDP 6)	normal	EW2105347	-	-	<0.001	0.252	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.001	-	0.022
		14-Jan-2022	M6 Dam (LDP 6)	normal	EW2200095	-	-	<0.001	0.233	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	<0.001	-	0.031
		11-Feb-2022	M6 Dam (LDP 6)	normal	EW2200530	-	-	<0.001	0.236	-	-	-	-	-	<0.001	-	-	<0.01	-	-	-	-	-	-	0.001	-	<0.005

TPH / Inorganics

Sampled Date	Lab Report No.	Oil and Grease (TPH)	Alkalinity (Bicarbonate)	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	pH (Field)	Alkalinity (Carbonate)	Carbonate Alkalinity as CaCO3_	Phosphorus	Alkalinity (total) as CaCO3	Nitrogen (Total)	TDS	TDS (Calculated) #1	Ammonia as N	Nitrate (as N)	Nitrite (as N)	Nitrite + Nitrate as N	Kjeldahl Nitrogen Total
		mg/L	mg/L	mg/L	mg/L	pH_Unit	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic						6-8.5						600	600		11.3	9		
ADWG 2018 Health																		
ANZECC 2000 Irrigation Long Term Trigger Values						**6-8.5#5**			**50#6**		**5**							
ANZECC 2000 Irrigation Short Term Trigger Values											**25**							
ANZG (2018) Freshwater 95% toxicant DGVs														0.74	0.16			
NHMRC Guidelines for Managing Risks in Recreational Water 2008						*6.5-8.5*									*113*	*9*		
08-Dec-2020	EW2005557	<5	-	-	-	7.7	-	-	-	-	-	-	332	-	-	-	-	-
07-Jan-2021	EW2100074	<5	-	-	-	7.8	-	-	-	-	-	-	354	-	-	-	-	-
09-Feb-2021	EW2100587	-	-	128	<1	7.7	0.6#1	<1	-	128	0.4	-	405	-	-	-	-	-
11-Mar-2021	EW2101104	-	-	138	<1	7.8	0.6#1	<1	-	138	0.3	-	437	-	-	-	-	-
19-Apr-2021	EW2101726	<5	-	76	<1	7.4	0.6#1	<1	-	76	0.3	-	235	<0.01	<0.01	<0.01	<0.01	0.3
13-May-2021	EW2102105	-	-	71	<1	7.5	0.6#1	<1	-	71	0.3	-	229	-	-	-	-	-
11-Jun-2021	EW2102597	-	-	68	<1	8.5	0.6#1	<1	-	68	0.2	-	258	-	-	-	-	-
09-Jul-2021	EW2102976	-	-	66	<1	8.1	0.6#1	<1	-	66	0.2	-	297	-	-	-	-	-
09-Aug-2021	EW2103386	-	-	81	<1	8	0.6#1	<1	-	81	0.1	-	338	-	-	-	-	-
09-Sep-2021	EW2103811	-	-	85	<1	7.8	0.6#1	<1	-	85	0.1	-	360	-	-	-	-	-
12-Oct-2021	EW2104254	-	-	98	<1	7.8	0.6#1	<1	-	98	0.3	-	387	-	-	-	-	-
12-Nov-2021	EW2104783	-	-	82	<1	7.6	0.6#1	<1	-	82	0.3	-	350	-	-	-	-	-
14-Dec-2021	EW2105347	-	-	85	<1	7.8	0.6#1	<1	-	85	0.3	-	365	-	-	-	-	-
14-Jan-2022	EW2200095	-	-	100	<1	7.4	0.6#1	<1	-	100	0.4	-	327	-	-	-	-	-
11-Feb-2022	EW2200530	-	-	103	<1	7.5	0.6#1	<1	-	103	0.4	-	359	-	-	-	-	-

Env Stds Comments

#1:Insufficient data to set a guideline value based on health considerations
#2:Not necessary
#3:Escherichia coli should not be detected in any 100 mL sample of drinking water. If detected in drinking water, immediate action should be taken including investigation of potential sources of faecal contamination.
#4:(0.075 Citrus crops)
#5:for groundwater systems
#6:To minimise bioclogging of irrigation equipment
#7:Requires site-specific assessment
#8:High reliability. DGV may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species). Check toxicant DGV technical brief for spread of data and its significance.
#9:Very high reliability
#10:Low reliability
#11:Moderate reliability
#12:Moderate reliability. DGV may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species). Check toxicant DGV technical brief for spread of data and its significance.
#13:High reliability
#14:High reliability. Ammonia as total ammonia, measured as [NH3-N] at pH 8. DGV may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species).

Data Comments

#1 ESDAT Calculated

Table 1: Surface Water and Groundwater Analytical Results

						Major/minor ions							Biological		NA	Field		Organic
						Calcium	Magnesium	Potassium	Sulphate	Sodium	Chloride	Fluoride	Enterococci	E. Coli	Suspended Solids	EC (field)	Turbidity	Dissolved Organic Carbon
						mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	org/100ml	cfu/100 ml	mg/L	µS/cm	NTU	mg/L
ADWG 2018 Aesthetic									250	180	250						5	
ADWG 2018 Health												1.5		0#3				
ANZECC 2000 Irrigation Long Term Trigger Values												**1**						
ANZECC 2000 Irrigation Short Term Trigger Values												**2**						
ANZG (2018) Freshwater 95% toxicant DGVs																		
NHMRC Guidelines for Managing Risks in Recreational Water 2008									*2500*	*1800*	*2500*							
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**													
Pit Top Area	LDP 1	08-Dec-2020	LDP 1 (Main mine discharge)	normal	EW2005557	18	14	25	-	527	82	-	-	-	<5	2350	3.9	-
		07-Jan-2021	LDP 1 (Main mine discharge)	normal	EW2100074	14	10	25	-	464	101	-	-	-	<5	1960	6.9	-
		09-Feb-2021	LDP 1 (Main mine discharge)	normal	EW2100587	-	-	-	-	-	-	-	50	-	13	2120	18	-
		11-Mar-2021	LDP 1 (Main mine discharge)	normal	EW2101104	-	-	-	-	-	-	-	19	-	9	1910	7.1	-
		19-Apr-2021	LDP 1 (Main mine discharge)	normal	EW2101726	22	12	20	-	464	92	-	7	-	11	2130	4	-
		13-May-2021	LDP 1 (Main mine discharge)	normal	EW2102105	-	-	-	-	-	-	-	100	-	8	1930	8.5	-
		11-Jun-2021	LDP 1 (Main mine discharge)	normal	EW2102597	-	-	-	-	-	-	-	12	-	16	1830	19.1	-
		09-Jul-2021	LDP 1 (Main mine discharge)	normal	EW2102976	-	-	-	-	-	-	-	4	-	<5	2050	2.3	-
		09-Aug-2021	LDP 1 (Main mine discharge)	normal	EW2103386	-	-	-	-	-	-	-	12	-	6	2140	1.5	-
		09-Sep-2021	LDP 1 (Main mine discharge)	normal	EW2103811	-	-	-	-	-	-	-	16	-	10	1930	12.4	-
		12-Oct-2021	LDP 1 (Main mine discharge)	normal	EW2104254	-	-	-	-	-	-	-	33	-	24	1920	12.4	-
		12-Nov-2021	LDP 1 (Main mine discharge)	normal	EW2104783	-	-	-	-	-	-	-	800	-	22	1170	38.7	-
		14-Dec-2021	LDP 1 (Main mine discharge)	normal	EW2105347	-	-	-	-	-	-	-	9	-	<5	1840	6.2	-
		14-Jan-2022	LDP 1 (Main mine discharge)	normal	EW2200095	-	-	-	-	-	-	-	410	-	15	1900	9.2	-
		11-Feb-2022	LDP 1 (Main mine discharge)	normal	EW2200530	-	-	-	-	-	-	-	330	-	28	2030	54.3	-
	M3 Entry	08-Dec-2020	M3 Entry	normal	EW2005557	-	-	-	-	-	-	-	-	-	12	2320	10	-
		07-Jan-2021	M3 Entry	normal	EW2100074	-	-	-	-	-	-	-	-	-	21	2210	27.5	-
		09-Feb-2021	M3 Entry	normal	EW2100587	-	-	-	-	-	-	-	-	-	31	2420	28.5	-
		11-Mar-2021	M3 Entry	normal	EW2101104	-	-	-	-	-	-	-	-	-	38	1910	45.4	-
		19-Apr-2021	M3 Entry	normal	EW2101726	-	-	-	-	-	-	-	-	-	21	2240	25.6	-
		13-May-2021	M3 Entry	normal	EW2102105	-	-	-	-	-	-	-	-	-	92	2070	85.4	-
		11-Jun-2021	M3 Entry	normal	EW2102597	-	-	-	-	-	-	-	-	-	38	1850	30.2	-
		09-Jul-2021	M3 Entry	normal	EW2102976	-	-	-	-	-	-	-	-	-	22	2400	7.1	-
		09-Aug-2021	M3 Entry	normal	EW2103386	-	-	-	-	-	-	-	-	-	<5	1300	0.9	-
		09-Sep-2021	M3 Entry	normal	EW2103811	-	-	-	-	-	-	-	-	-	14	2000	13.7	-
		12-Oct-2021	M3 Entry	normal	EW2104254	-	-	-	-	-	-	-	-	-	595	1890	222	-
		12-Nov-2021	M3 Entry	normal	EW2104783	-	-	-	-	-	-	-	-	-	55	1580	81.2	-
		14-Dec-2021	M3 Entry	normal	EW2105347	-	-	-	-	-	-	-	-	-	47	1870	29.6	-
		14-Jan-2022	M3 Entry	normal	EW2200095	-	-	-	-	-	-	-	-	-	100	1990	52.4	-
		11-Feb-2022	M3 Entry	normal	EW2200530	-	-	-	-	-	-	-	-	-	70	1980	52.4	-
	M3 Exit	08-Dec-2020	M3 Exit	normal	EW2005557	-	-	-	-	-	-	-	-	-	<5	2430	4.8	-
		07-Jan-2021	M3 Exit	normal	EW2100074	-	-	-	-	-	-	-	-	-	8	2230	12.1	-
		09-Feb-2021	M3 Exit	normal	EW2100587	-	-	-	-	-	-	-	-	-	15	2260	21.7	-
		11-Mar-2021	M3 Exit	normal	EW2101104	-	-	-	-	-	-	-	-	-	29	1940	36.3	-
		19-Apr-2021	M3 EXit	normal	EW2101726	-	-	-	-	-	-	-	-	-	17	2200	23.4	-
		13-May-2021	M3 Exit	normal	EW2102105	-	-	-	-	-	-	-	-	-	7	2020	16.1	-
		11-Jun-2021	M3 Exit	normal	EW2102597	-	-	-	-	-	-	-	-	-	24	1820	28.4	-
		09-Jul-2021	M3 Exit	normal	EW2102976	-	-	-	-	-	-	-	-	-	<5	2280	2.9	-
		09-Aug-2021	M3 Exit	normal	EW2103386	-	-	-	-	-	-	-	-	-	<5	2010	1.7	-
		09-Sep-2021	M3 Exit	normal	EW2103811	-	-	-	-	-	-	-	-	-	12	1950	14.3	-
		12-Oct-2021	M3 Exit	normal	EW2104254	-	-	-	-	-	-	-	-	-	28	2000	18.3	-
		12-Nov-2021	M3 Exit	normal	EW2104783	-	-	-	-	-	-	-	-	-	32	1510	67.9	-
		14-Dec-2021	M3 Exit	normal	EW2105347	-	-	-	-	-	-	-	-	-	25	1880	19.3	-
		14-Jan-2022	M3 Exit	normal	EW2200095	-	-	-	-	-	-	-	-	-	18	2090	24	-
		11-Feb-2022	M3 Exit	normal	EW2200530	-	-	-	-	-	-	-	-	-	34	1980	46.1	-
	Mine DW - Line 1	08-Dec-2020	Mine Dewatering - Line 1	normal	EW2005557	17	14	18	-	364	127	-	-	-	-	1730	-	-
		07-Jan-2021	Mine Dewatering - Line 1	normal	EW2100074	21	12	32	-	651	88	-	-	-	-	2970	-	-
		09-Feb-2021	Mine Dewatering - Line 1	normal	EW2100587	-	-	-	-	-	-	-	-	-	178	1900	200	-
		11-Mar-2021	Mine Dewatering - Line 1	normal	EW2101104	-	-	-	-	-	-	-	-	-	534	2870	476	-
		19-Apr-2021	Mine Dewatering - Line 1	normal	EW2101726	18	10	14	-	388	110	-	-	-	-	1850	-	-
		13-May-2021	Mine Dewatering - Line 1	normal	EW2102105	-	-	-	-	-	-	-	-	-	161	2030	285	-
		11-Jun-2021	Mine Dewatering - Line 1	normal	EW2102597	-	-	-	-	-	-	-	-	-	68	1880	45.3	-
		09-Jul-2021	Mine Dewatering - Line 1	normal	EW2102976	-	-	-	-	-	-	-	-	-	88	2640	124	-
		09-Aug-2021	Mine Dewatering - Line 1	normal	EW2103386	-	-	-	-	-	-	-	-	-	193	2880	255	-
		09-Sep-2021	Mine Dewatering - Line 1	normal	EW2103811	-	-	-	-	-	-	-	-	-	286	2380	433	-
		12-Oct-2021	Mine Dewatering - Line 1	normal	EW2104254	-	-	-	-	-	-	-	-	-	478	1770	312	-
		12-Nov-2021	Mine Dewatering - Line 1	normal	EW2104783	-	-	-	-	-	-	-	-	-	546	2470	796	-
		14-Jan-2022	Mine Dewatering - Line 1	normal	EW2200095	-	-	-	-	-	-	-	-	-	192	2700	253	-
		11-Feb-2022	Mine Dewatering - Line 1	normal	EW2200530	-	-	-	-	-	-	-	-	-	116	2010	221	-

Table 1: Surface Water and Groundwater Analytical Results

						Major/minor ions							Biological		NA	Field		Organic
						Calcium	Magnesium	Potassium	Sulphate	Sodium	Chloride	Fluoride	Enterococci	E. Coli	Suspended Solids	EC (field)	Turbidity	Dissolved Organic Carbon
						mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	org/100ml	cfu/100 ml	mg/L	µS/cm	NTU	mg/L
ADWG 2018 Aesthetic									250	180	250						5	
ADWG 2018 Health												1.5		0[#3]				
ANZECC 2000 Irrigation Long Term Trigger Values												**1**						
ANZECC 2000 Irrigation Short Term Trigger Values												**2**						
ANZG (2018) Freshwater 95% toxicant DGVs																		
NHMRC Guidelines for Managing Risks in Recreational Water 2008									*2500*	*1800*	*2500*							
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**													
Pit Top Area	Mine DW - Line 2	08-Dec-2020	Mine Dewatering - Line 2	normal	EW2005557	29	15	32	-	725	80	-	-	-	-	3270	-	-
		07-Jan-2021	Mine Dewatering - Line 2	normal	EW2100074	22	12	32	-	667	102	-	-	-	-	3040	-	-
		09-Feb-2021	Mine Dewatering - Line 2	normal	EW2100587	-	-	-	-	-	-	-	-	-	510	2270	495	-
		11-Mar-2021	Mine Dewatering - Line 2	normal	EW2101104	-	-	-	-	-	-	-	-	-	538	2990	463	-
		19-Apr-2021	Mine Dewatering - Line 2	normal	EW2101726	24	9	21	-	586	86	-	-	-	-	2640	-	-
		13-May-2021	Mine Dewatering - Line 2	normal	EW2102105	-	-	-	-	-	-	-	-	-	161	2370	260	-
		11-Jun-2021	Mine Dewatering - Line 2	normal	EW2102597	-	-	-	-	-	-	-	-	-	61	2390	27.5	-
		09-Jul-2021	Mine Dewatering - Line 2	normal	EW2102976	-	-	-	-	-	-	-	-	-	92	2630	114	-
		12-Nov-2021	Mine Dewatering - Line 2	normal	EW2104783	-	-	-	-	-	-	-	-	-	594	2420	751	-
		14-Jan-2022	Mine Dewatering - Line 2	normal	EW2200095	-	-	-	-	-	-	-	-	-	195	2750	257	-
		11-Feb-2022	Mine Dewatering - Line 2	normal	EW2200530	-	-	-	-	-	-	-	-	-	205	2350	270	-
	PIT TOP 1	05-Sep-2019	PIT TOP 1	Normal		14	14	86	51	300	260	0.23	-	-	-	-	-	7
		14-Nov-2019	PIT TOP1	Normal		8.2	7.5	66	37	265	230	0.25	-	-	-	-	-	11
		20-Feb-2020	PIT TOP 1	Normal		1.6	1.4	64	32	245	200	0.22	-	-	-	-	-	9
		17-Nov-2020	PIT TOP 1	Normal		0.8	<0.9	59	29	260	185	0.21	-	-	-	-	-	12
		20-Feb-2021	PIT TOP 1	Normal		0.5	<0.6	59	28	250	195	0.23	-	-	-	-	-	13
		24-May-2021	PIT TOP 1	Normal		0.7	<0.5	63	29	245	190	0.22	-	-	-	-	-	14
		27-Aug-2021	PIT TOP 1	Normal		0.8	<0.4	56	27	260	190	0.19	-	-	-	-	-	16
		21-Feb-2022	PIT TOP 1	Normal		0.5	<0.2	58	27	255	190	0.18	-	-	-	-	-	13
	PIT TOP 2	05-Sep-2019	PIT TOP 2	Normal		83	33	12	6	72	30	0.14	-	-	-	-	-	6
		14-Nov-2019	PIT TOP2	Normal		43	21	9.5	20	76	34	0.11	-	-	-	-	-	4
		20-Feb-2020	PIT TOP 2	Normal		105	36	18	21	43	34	0.13	-	-	-	-	-	5
		17-Nov-2020	PIT TOP 2	Normal		64	20	<13	20	43	19	<0.1	-	-	-	-	-	3
		20-Feb-2021	PIT TOP 2	Normal		66	21	<14	17	38	15	<0.1	-	-	-	-	-	4
		24-May-2021	PIT TOP 2	Normal		98	39	<15	15	61	20	<0.1	-	-	-	-	-	3
		27-Aug-2021	PIT TOP 2	Normal		39	10	<9.6	12	24	17	<0.1	-	-	-	-	-	1
		11-Nov-2021	PIT TOP 2	Normal		44	11	<10	7	32	15	<0.1	-	-	-	-	-	3
		21-Feb-2022	PIT TOP 2	Normal		36	9.3	<11	8	23	10	<0.1	-	-	-	-	-	2
	PIT TOP 4	05-Sep-2019	PIT TOP 4	Normal		40	69	7.3	36	570	1060	0.4	-	-	-	-	-	3
		14-Nov-2019	PIT TOP4	Normal		29	<70	5.7	42	530	1020	0.51	-	-	-	-	-	4
		20-Feb-2020	PIT TOP 4	Normal		23	<72	11	47	500	1020	0.45	-	-	-	-	-	3
		17-Nov-2020	PIT TOP 4	Normal		19	6.1	<7.3	23	26	11	<0.1	-	-	-	-	-	11
		20-Feb-2021	PIT TOP 4	Normal		12	4.5	6.8	16	27	17	0.11	-	-	-	-	-	15
		24-May-2021	PIT TOP 4	Normal		19	5.7	13	14	39	18	0.11	-	-	-	-	-	15
		11-Nov-2021	PIT TOP 4	Normal		0.6	<0.5	52	25	260	185	0.18	-	-	-	-	-	15
		21-Feb-2022	PIT TOP 4	Normal		3.6	<0.5	<42	16	44	10	<0.1	-	-	-	-	-	13

Table 1: Surface Water and Groundwater Analytical Results

SLR

						Major/minor ions							Biological		NA	Field		Organic
						Calcium	Magnesium	Potassium	Sulphate	Sodium	Chloride	Fluoride	Enterococci	E. Coli	Suspended Solids	EC (field)	Turbidity	Dissolved Organic Carbon
						mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	org/100ml	cfu/100 ml	mg/L	µS/cm	NTU	mg/L
ADWG 2018 Aesthetic									250	180	250						5	
ADWG 2018 Health												1.5		0[#3]				
ANZECC 2000 Irrigation Long Term Trigger Values												**1**						
ANZECC 2000 Irrigation Short Term Trigger Values												**2**						
ANZG (2018) Freshwater 95% toxicant DGVs																		
NHMRC Guidelines for Managing Risks in Recreational Water 2008									*2500*	*1800*	*2500*							
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**													
Reject Emplacement Area (REA)	Dam S9 (LDP 3)	08-Dec-2020	S9 Dam (LDP 3)	normal	EW2005557	32	31	23	-	328	12	-	-	-	8	1680	7.3	-
		07-Jan-2021	S9 Dam (LDP 3)	normal	EW2100074	34	22	18	-	214	17	-	-	280	22	1200	81.4	-
		09-Feb-2021	S9 Dam (LDP 3)	normal	EW2100587	-	-	-	-	-	-	-	100	-	9	1770	4.1	-
		11-Mar-2021	S9 Dam (LDP 3)	normal	EW2101104	-	-	-	-	-	-	-	210	-	27	2260	56.3	-
		19-Apr-2021	S9 Dam (LDP 3)	normal	EW2101726	46	28	20	-	282	10	-	110	-	<5	1790	1.6	-
		13-May-2021	S9 Dam (LDP 3)	normal	EW2102105	-	-	-	-	-	-	-	51	-	<5	1790	3.2	-
		11-Jun-2021	S9 Dam (LDP 3)	normal	EW2102597	-	-	-	-	-	-	-	160	-	26	1820	24.6	-
		09-Jul-2021	S9 Dam (LDP 3)	normal	EW2102976	-	-	-	-	-	-	-	5	-	<5	1870	2.4	-
		09-Aug-2021	S9 Dam (LDP 3)	normal	EW2103386	-	-	-	-	-	-	-	29	-	8	1920	4.7	-
		09-Sep-2021	S9 Dam (LDP 3)	normal	EW2103811	-	-	-	-	-	-	-	58	-	11	1820	33.7	-
		12-Oct-2021	S9 Dam (LDP 3)	normal	EW2104254	-	-	-	-	-	-	-	840	-	454	1300	279	-
		12-Nov-2021	S9 Dam (LDP 3)	normal	EW2104783	-	-	-	-	-	-	-	220	-	120	902	210	-
		14-Dec-2021	S9 Dam (LDP 3)	normal	EW2105347	-	-	-	-	-	-	-	32	-	15	1690	8.7	-
		14-Jan-2022	S9 Dam (LDP 3)	normal	EW2200095	-	-	-	-	-	-	-	48	-	44	1800	27.7	-
		11-Feb-2022	S9 Dam (LDP 3)	normal	EW2200530	-	-	-	-	-	-	-	740	-	50	1360	132	-
	Dam S4 (LDP 4)	08-Dec-2020	Dam S4 (LDP 4)	normal	EW2005557	10	18	21	-	444	36	-	-	42	<5	2040	3.2	-
		07-Jan-2021	Dam S4 (LDP 4)	normal	EW2100074	8	15	22	-	429	34	-	-	530	8	1860	18.4	-
		09-Feb-2021	Dam S4 (LDP 4)	normal	EW2100587	-	-	-	-	-	-	-	16	-	18	1830	34.6	-
		11-Mar-2021	Dam S4 (LDP 4)	normal	EW2101104	-	-	-	-	-	-	-	16	-	10	2240	3.7	-
		19-Apr-2021	Dam S4 (LDP 4)	normal	EW2101726	13	16	16	-	313	21	-	8	22	7	1720	4.2	-
		13-May-2021	Dam S4 (LDP 4)	normal	EW2102105	-	-	-	-	-	-	-	80	-	24	1510	88.8	-
		11-Jun-2021	Dam S4 (LDP 4)	normal	EW2102597	-	-	-	-	-	-	-	29	-	10	1820	2.6	-
		09-Jul-2021	Dam S4 (LDP 4)	normal	EW2102976	-	-	-	-	-	-	-	3	-	<5	1890	1	-
		09-Aug-2021	Dam S4 (LDP 4)	normal	EW2103386	-	-	-	-	-	-	-	25	-	13	1890	1.5	-
		09-Sep-2021	Dam S4 (LDP 4)	normal	EW2103811	-	-	-	-	-	-	-	15	-	<5	1710	3.9	-
		12-Oct-2021	Dam S4 (LDP 4)	normal	EW2104254	-	-	-	-	-	-	-	560	-	12	1790	19.7	-
		12-Nov-2021	Dam S4 (LDP 4)	normal	EW2104783	-	-	-	-	-	-	-	570	-	50	1590	148	-
		14-Dec-2021	Dam S4 (LDP 4)	normal	EW2105347	-	-	-	-	-	-	-	62	-	11	1880	4.7	-
		14-Jan-2022	Dam S4 (LDP 4)	normal	EW2200095	-	-	-	-	-	-	-	120	-	19	1610	28	-
		11-Feb-2022	Dam S4 (LDP 4)	normal	EW2200530	-	-	-	-	-	-	-	190	-	<5	1860	6.6	-
	S8 Dam (LDP 5)	08-Dec-2020	S8 Dam (LDP 5)	normal	EW2005557	56	32	23	-	324	12	-	-	33	6	1710	1.9	-
		07-Jan-2021	S8 Dam (LDP 5)	normal	EW2100074	56	33	25	-	286	12	-	-	-	<5	1610	7.3	-
		09-Feb-2021	S8 Dam (LDP 5)	normal	EW2100587	-	-	-	-	-	-	-	100	-	<5	1850	0.8	-
		11-Mar-2021	S8 Dam (LDP 5)	normal	EW2101104	-	-	-	-	-	-	-	120	-	7	2330	6.1	-
		19-Apr-2021	S8 Dam (LDP 5)	normal	EW2101726	57	31	24	-	323	10	-	4	-	7	1860	1.5	-
		13-May-2021	S8 Dam (LDP 5)	normal	EW2102105	-	-	-	-	-	-	-	65	-	<5	1850	1.5	-
		11-Jun-2021	S8 Dam (LDP 5)	normal	EW2102597	-	-	-	-	-	-	-	170	-	8	1860	10.6	-
		09-Jul-2021	S8 Dam (LDP 5)	normal	EW2102976	-	-	-	-	-	-	-	8	-	<5	1890	2	-
		09-Aug-2021	S8 Dam (LDP 5)	normal	EW2103386	-	-	-	-	-	-	-	28	-	5	1970	3.6	-
		09-Sep-2021	S8 Dam (LDP 5)	normal	EW2103811	-	-	-	-	-	-	-	21	-	<5	1910	7.2	-
		12-Oct-2021	S8 Dam (LDP 5)	normal	EW2104254	-	-	-	-	-	-	-	300	-	40	1980	42.9	-
		12-Nov-2021	S8 Dam (LDP 5)	normal	EW2104783	-	-	-	-	-	-	-	130	-	13	1210	28	-
		14-Dec-2021	S8 Dam (LDP 5)	normal	EW2105347	-	-	-	-	-	-	-	29	-	<5	1790	2.2	-
		14-Jan-2022	S8 Dam (LDP 5)	normal	EW2200095	-	-	-	-	-	-	-	47	-	11	1840	0.6	-
		11-Feb-2022	S8 Dam (LDP 5)	normal	EW2200530	-	-	-	-	-	-	-	500	-	7	1730	6.8	-

Table 1: Surface Water and Groundwater Analytical Results

SLR

						Major/minor ions							Biological		NA	Field		Organic
						Calcium	Magnesium	Potassium	Sulphate	Sodium	Chloride	Fluoride	Enterococci	E. Coli	Suspended Solids	EC (field)	Turbidity	Dissolved Organic Carbon
						mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	org/100ml	cfu/100 ml	mg/L	µS/cm	NTU	mg/L
ADWG 2018 Aesthetic									250	180	250						5	
ADWG 2018 Health												1.5		0[#3]				
ANZECC 2000 Irrigation Long Term Trigger Values												**1**						
ANZECC 2000 Irrigation Short Term Trigger Values												**2**						
ANZG (2018) Freshwater 95% toxicant DGVs																		
NHMRC Guidelines for Managing Risks in Recreational Water 2008									*2500*	*1800*	*2500*							
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**													
Reject Emplacement Area (REA)	REA1	12-Sep-2019	REA1	Normal		3.2	8.2	2.5	2	78	81	<0.14	-	-	-	-	-	-
		10-Oct-2019	REA1	Normal		4.1	8.2	2.1	2	73	79	0.14	-	-	-	-	-	4
		14-Nov-2019	REA1	Normal		3.5	6.4	1.3	6	84	87	0.21	-	-	-	-	-	2
		20-Feb-2020	REA1	Normal		5.6	6.7	2.5	8	82	88	0.23	-	-	-	-	-	2
		17-Nov-2020	REA1	Normal		5.1	6.7	1.8	11	88	83	0.16	-	-	-	-	-	2
		20-Feb-2021	REA1	Normal		3.4	6.4	1.2	10	79	82	0.2	-	-	-	-	-	2
		24-May-2021	REA1	Normal		5.1	7.7	1.9	11	88	88	0.16	-	-	-	-	-	2
		27-Aug-2021	REA1	Normal		5.8	7.2	2.2	11	84	88	0.17	-	-	-	-	-	<1
		11-Nov-2021	REA1	Normal		7.9	6.4	3.5	11	81	91	0.15	-	-	-	-	-	<1
		21-Feb-2022	REA1	Normal		8.2	7.1	2.1	11	83	85	<0.16	-	-	-	-	-	1
	REA2	09-Aug-2019	REA2	Normal		67	91	8.9	58	445	995	0.18	-	-	-	-	-	1
		10-Oct-2019	REA2	Normal		62	86	8.8	64	430	960	0.18	-	-	-	-	-	2
		14-Nov-2019	REA2	Normal		60	82	10	61	450	985	0.22	-	-	-	-	-	3
		20-Feb-2020	REA2	Normal		77	51	14	105	275	550	0.21	-	-	-	-	-	13
		17-Nov-2020	REA2	Normal		64	9	20	77	43	43	0.14	-	-	-	-	-	19
		20-Feb-2021	REA2	Normal		63	7.2	14	48	31	36	0.13	-	-	-	-	-	19
		24-May-2021	REA2	Normal		58	5.5	8.3	39	19	20	0.1	-	-	-	-	-	15
		27-Aug-2021	REA2	Normal		55	4.5	10	33	18	20	0.13	-	-	-	-	-	14
		11-Nov-2021	REA2	Normal		55	4.6	11	24	17	19	0.1	-	-	-	-	-	14
		21-Feb-2022	REA2	Normal		55	4.9	12	18	17	19	<0.11	-	-	-	-	-	14
	REA3	16-Jul-2019	REA3	Normal		48	31	5.8	19	125	285	0.11	-	-	-	-	-	2
		10-Oct-2019	REA3	Normal		24	29	<4.7	15	115	305	<0.1	-	-	-	-	-	<1
		14-Nov-2019	REA3	Normal		7.2	30	<3.2	13	120	300	<0.1	-	-	-	-	-	<1
		20-Feb-2020	REA3	Normal		8.4	26	5.3	15	125	285	0.11	-	-	-	-	-	1
		17-Nov-2020	REA3	Normal		10	<29	<3.3	16	110	280	<0.1	-	-	-	-	-	<1
		20-Feb-2021	REA3	Normal		10	<29	<2.5	19	110	280	<0.1	-	-	-	-	-	1
		24-May-2021	REA3	Normal		26	3.1	<6.2	16	27	17	<0.1	-	-	-	-	-	5
		27-Aug-2021	REA3	Normal		32	12	<8.2	18	67	145	<0.1	-	-	-	-	-	<1
		11-Nov-2021	REA3	Normal		20	25	<5.4	19	110	280	<0.1	-	-	-	-	-	<1
		21-Feb-2022	REA3	Normal		14	28	<6.1	16	115	265	<0.1	-	-	-	-	-	<1
	REA4	16-Jul-2019	REA4	Normal		22	20	15	28	115	235	0.15	-	-	-	-	-	2
		10-Oct-2019	REA4	Normal		31	20	10	42	110	230	0.12	-	-	-	-	-	10
		14-Nov-2019	REA4	Normal		27	21	8.4	27	115	245	0.13	-	-	-	-	-	16
		20-Feb-2020	REA4	Normal		22	19	8.5	19	115	235	0.12	-	-	-	-	-	9
		17-Nov-2020	REA4	Normal		31	23	7.2	13	115	240	0.11	-	-	-	-	-	3
		20-Feb-2021	REA4	Normal		20	19	<6.1	14	105	235	<0.1	-	-	-	-	-	2
		24-May-2021	REA4	Normal		10	1.9	<3.4	13	13	11	<0.1	-	-	-	-	-	4
		27-Aug-2021	REA4	Normal		12	2	<4.8	12	13	11	<0.1	-	-	-	-	-	3
		11-Nov-2021	REA4	Normal		11	3.1	<5.9	13	15	12	<0.1	-	-	-	-	-	3
		21-Feb-2022	REA4	Normal		19	2.7	<5.3	14	25	12	<0.1	-	-	-	-	-	4
	REA5	16-Jul-2019	REA5	Normal		28	18	4.6	17	84	190	0.13	-	-	-	-	-	<1
		10-Oct-2019	REA5	Normal		24	17	<3.2	14	81	185	<0.1	-	-	-	-	-	2
		14-Nov-2019	REA5	Normal		8.5	14	2.2	11	86	195	0.11	-	-	-	-	-	1
		20-Feb-2020	REA5	Normal		12	6.9	<4.1	24	24	49	<0.1	-	-	-	-	-	8
		17-Nov-2020	REA5	Normal		12	10	<4.1	24	43	95	<0.1	-	-	-	-	-	2
		20-Feb-2021	REA5	Normal		7.9	15	2.9	23	76	165	0.11	-	-	-	-	-	2
		24-May-2021	REA5	Normal		4.1	11	2.2	21	90	160	0.11	-	-	-	-	-	1
		27-Aug-2021	REA5	Normal		19	12	<3.9	19	71	175	<0.1	-	-	-	-	-	<1
		11-Nov-2021	REA5	Normal		12	14	<2.8	15	81	180	<0.1	-	-	-	-	-	<1
		21-Feb-2022	REA5	Normal		16	14	<2.7	16	80	180	<0.1	-	-	-	-	-	<1
	REA6	16-Jul-2019	REA6	Normal		62	27	4.9	170	340	445	0.2	-	-	-	-	-	9
		10-Oct-2019	REA6	Normal		65	26	5.2	120	285	385	0.25	-	-	-	-	-	5
		14-Nov-2019	REA6	Normal		58	23	4.1	110	260	380	0.27	-	-	-	-	-	6
		20-Feb-2020	REA6	Normal		42	20	5.2	84	220	345	0.24	-	-	-	-	-	7
		17-Nov-2020	REA6	Normal		36	25	4.2	70	235	355	0.26	-	-	-	-	-	4
		20-Feb-2021	REA6	Normal		32	24	3.5	66	225	390	0.3	-	-	-	-	-	3
		24-May-2021	REA6	Normal		24	26	4.5	62	240	370	0.26	-	-	-	-	-	3
		27-Aug-2021	REA6	Normal		22	24	4.2	54	225	375	0.27	-	-	-	-	-	<1
		11-Nov-2021	REA6	Normal		19	22	3.5	51	210	345	0.22	-	-	-	-	-	<1
		21-Feb-2022	REA6	Normal		20	23	4.1	50	245	375	0.25	-	-	-	-	-	1
	REA7	16-Jul-2019	REA7	Normal		21	15	16	26	215	50	0.19	-	-	-	-	-	4
		10-Oct-2019	REA7	Normal		20	12	13	33	150	43	0.21	-	-	-	-	-	3
		14-Nov-2019	REA7	Normal		18	11	10	39	140	45	0.2	-	-	-	-	-	6
		20-Feb-2020	REA7	Normal		15	10	11	35	125	43	0.21	-	-	-	-	-	5
		17-Nov-2020	REA7	Normal		13	9.4	10	30	130	43	0.17	-	-	-	-	-	3
		20-Feb-2021	REA7	Normal		13	8.8	10	29	125	39	0.21	-	-	-	-	-	4
		24-May-2021	REA7	Normal		3.6	2.4	<16	25	47	15	<0.1	-	-	-	-	-	2
		27-Aug-2021	REA7	Normal		5.5	1.7	<21	21	37	17	<0.1	-	-	-	-	-	1
		11-Nov-2021	REA7	Normal		5.1	1.8	<26	19	40	19	<0.1	-	-	-	-	-	<1
		21-Feb-2022	REA7	Normal		6.4	1.5	35	23	53	19	0.11	-	-	-	-	-	2

Table 1: Surface Water and Groundwater Analytical Results

SLR

						Major/minor ions							Biological		NA	Field		Organic
						Calcium	Magnesium	Potassium	Sulphate	Sodium	Chloride	Fluoride	Enterococci	E. Coli	Suspended Solids	EC (field)	Turbidity	Dissolved Organic Carbon
						mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	org/100ml	cfu/100 ml	mg/L	µS/cm	NTU	mg/L
ADWG 2018 Aesthetic									250	180	250						5	
ADWG 2018 Health												1.5		0#3				
ANZECC 2000 Irrigation Long Term Trigger Values												**1**						
ANZECC 2000 Irrigation Short Term Trigger Values												**2**						
ANZG (2018) Freshwater 95% toxicant DGVs																		
NHMRC Guidelines for Managing Risks in Recreational Water 2008									*2500*	*1800*	*2500*							
Monitoring Area	**Location Code**	**Sampled Date**	**Field ID**	**Sample Type**	**Lab Report No.**													
Shaft Site Area	M6 Dam (LDP 6)	08-Dec-2020	M6 Dam (LDP 6)	normal	EW2005557	30	14	6	-	44	73	-	-	14	<5	511	3.4	-
		07-Jan-2021	M6 Dam (LDP 6)	normal	EW2100074	30	15	5	-	54	113	-	-	42	<5	545	3.4	-
		09-Feb-2021	M6 Dam (LDP 6)	normal	EW2100587	-	-	-	-	-	-	-	<1	-	<5	623	1.3	-
		11-Mar-2021	M6 Dam (LDP 6)	normal	EW2101104	-	-	-	-	-	-	-	2	-	<5	672	0.8	-
		19-Apr-2021	M6 Dam (LDP 6)	normal	EW2101726	16	9	4	-	34	67	-	38	35	<5	362	1	-
		13-May-2021	M6 Dam (LDP 6)	normal	EW2102105	-	-	-	-	-	-	-	19	-	<5	352	1.4	-
		11-Jun-2021	M6 Dam (LDP 6)	normal	EW2102597	-	-	-	-	-	-	-	<1	-	<5	397	0.6	-
		09-Jul-2021	M6 Dam (LDP 6)	normal	EW2102976	-	-	-	-	-	-	-	<1	-	<5	457	0.3	-
		09-Aug-2021	M6 Dam (LDP 6)	normal	EW2103386	-	-	-	-	-	-	-	1	-	<5	520	0.4	-
		09-Sep-2021	M6 Dam (LDP 6)	normal	EW2103811	-	-	-	-	-	-	-	<1	-	<5	554	0.4	-
		12-Oct-2021	M6 Dam (LDP 6)	normal	EW2104254	-	-	-	-	-	-	-	1	-	6	596	0.8	-
		12-Nov-2021	M6 Dam (LDP 6)	normal	EW2104783	-	-	-	-	-	-	-	130	-	<5	538	7	-
		14-Dec-2021	M6 Dam (LDP 6)	normal	EW2105347	-	-	-	-	-	-	-	<1	-	<5	562	1.4	-
		14-Jan-2022	M6 Dam (LDP 6)	normal	EW2200095	-	-	-	-	-	-	-	9	-	5	503	3.5	-
		11-Feb-2022	M6 Dam (LDP 6)	normal	EW2200530	-	-	-	-	-	-	-	75	-	<5	552	4.3	-

Env Stds Comments

#1:Insufficient data to set a guideline value based on health considerations
#2:Not necessary
#3:Escherichia coli should not be detected in any 100 mL sample of drinking water. If detected in drinking water, immediate action should be taken including investigation of potential sources of faecal contamination.
#4:(0.075 Citrus crops)
#5:for groundwater systems
#6:To minimise bioclogging of irrigation equipment
#7:Requires site-specific assessment
#8:High reliability. DGV may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species). Check toxicant DGV technical brief for spread of data and its significance.
#9:Very high reliability
#10:Low reliability
#11:Moderate reliability
#12:Moderate reliability. DGV may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species). Check toxicant DGV technical brief for spread of data and its significance.
#13:High reliability
#14:High reliability. Ammonia as total ammonia, measured as [NH3-N] at pH 8. DGV may not protect key test species from chronic toxicity (this refers to experimental chronic values or geometric mean for species).

Data Comments

#1 ESDAT Calculated

Appendix C

Trends

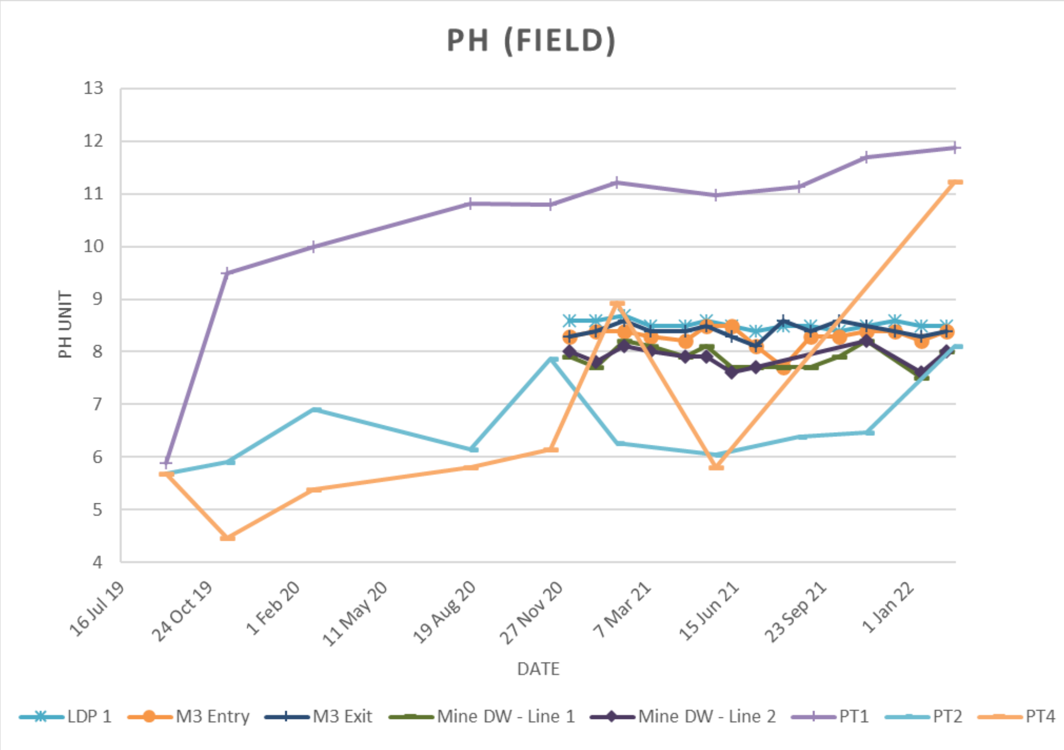

Figure 1 pH Concentrations Over Time - Pit Top Area

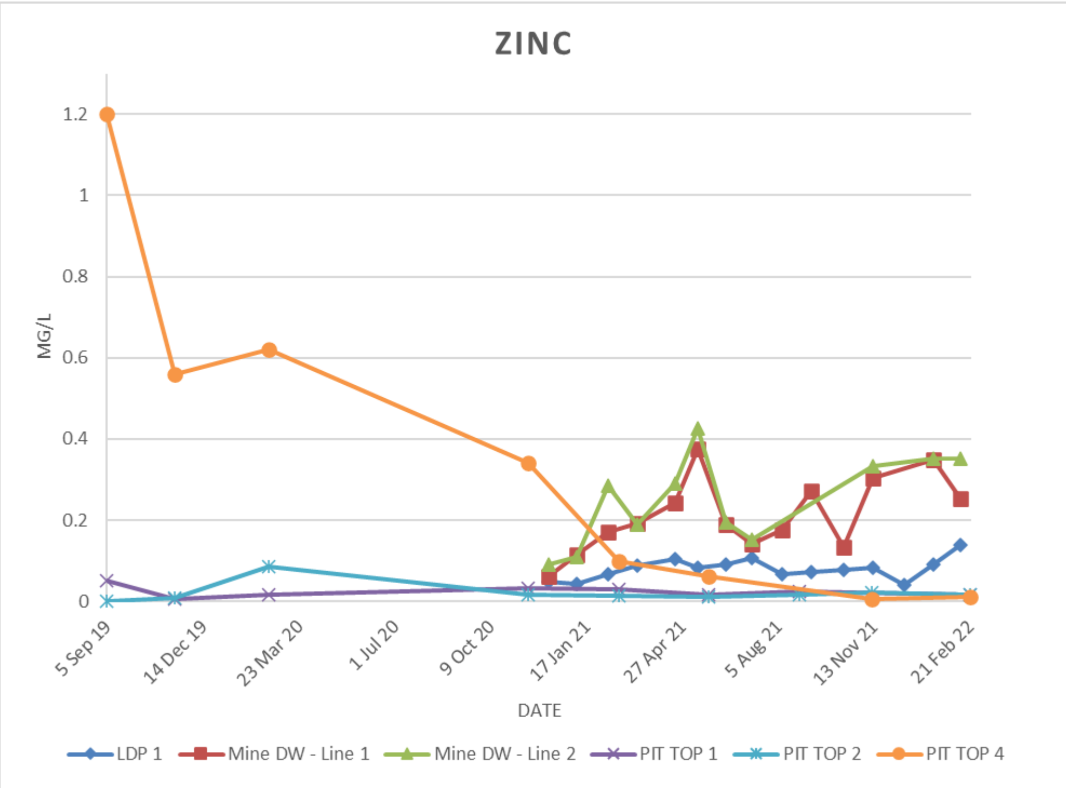

Figure 2 Zinc Concentrations Over Time – Pit Top Area

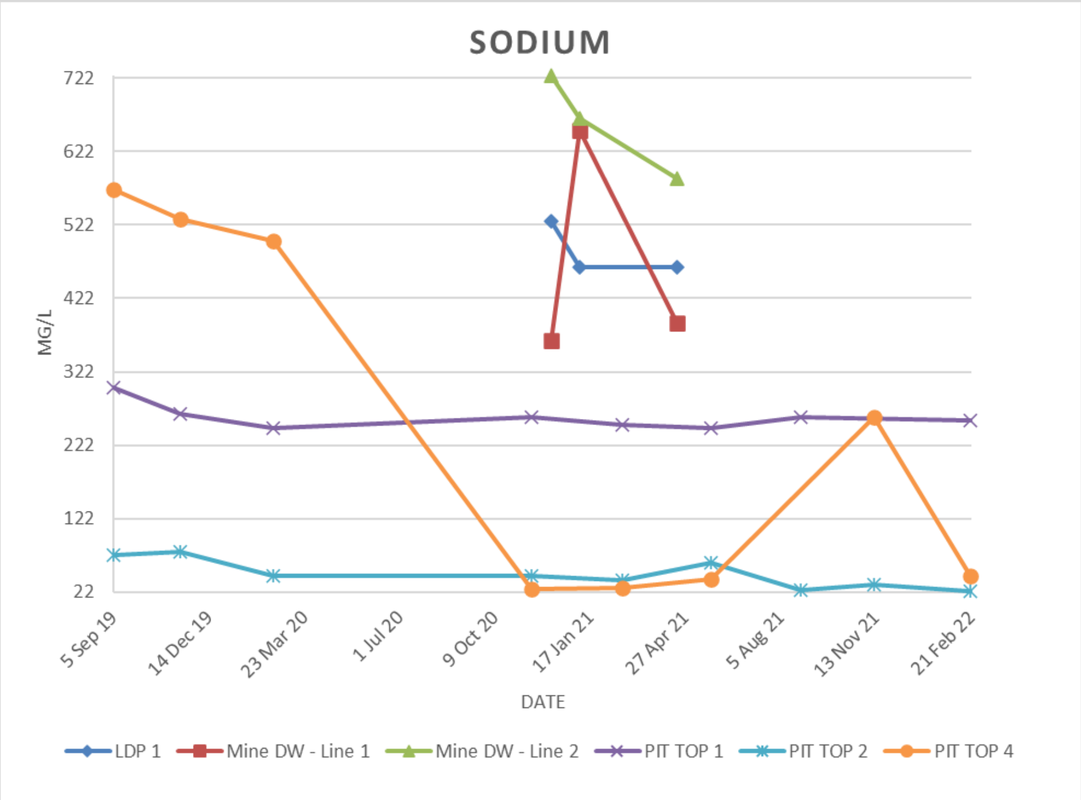

Figure 3 Sodium Concentrations Over Time – Pit Top Area

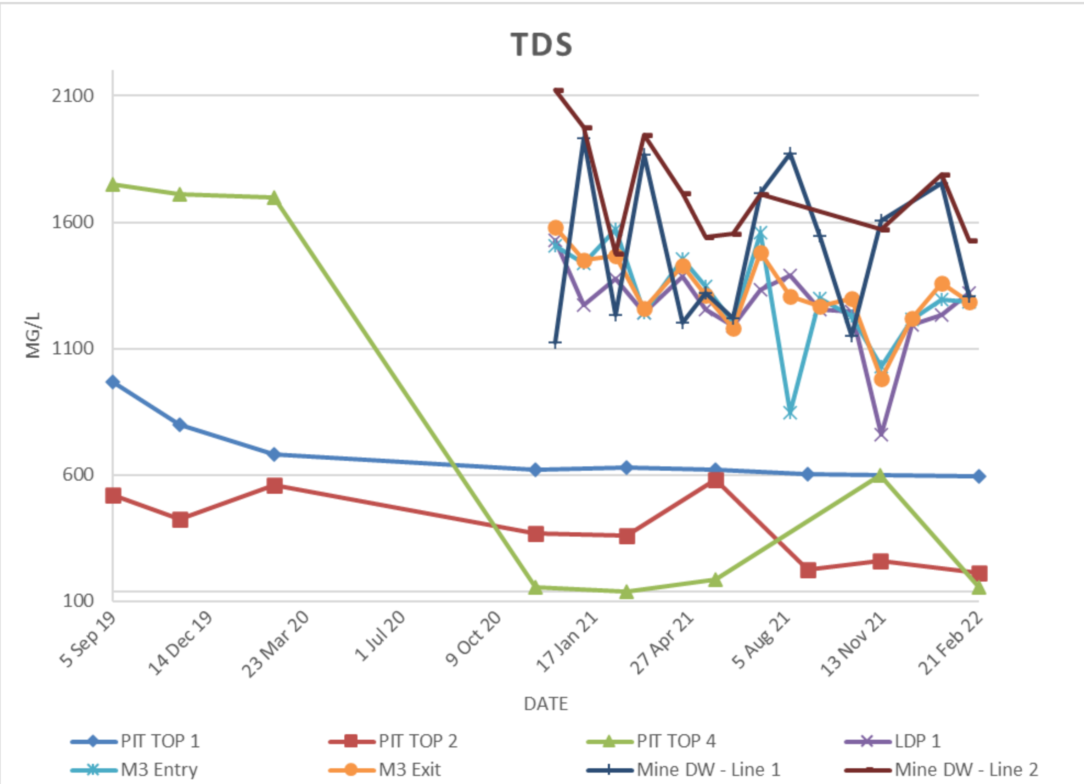

Figure 4 TDS Concentrations Over Time – Pit Top Area

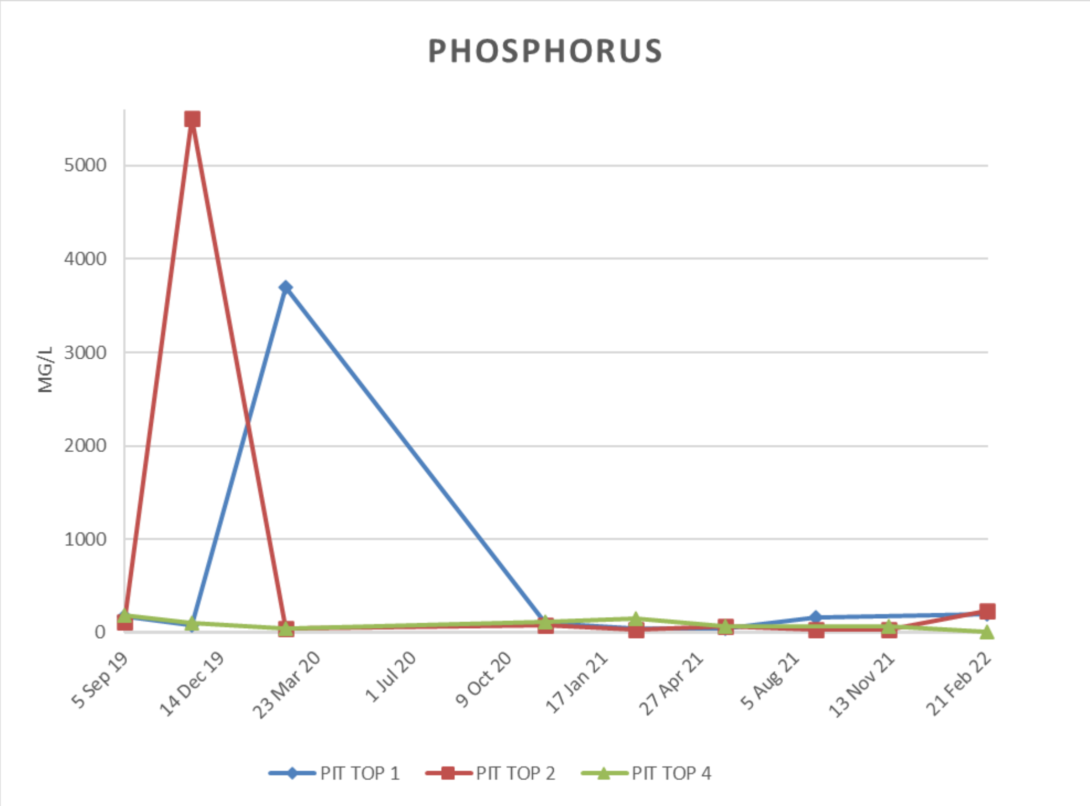

Figure 5 Phosphorus Concentrations Over Time – Pit Top Area

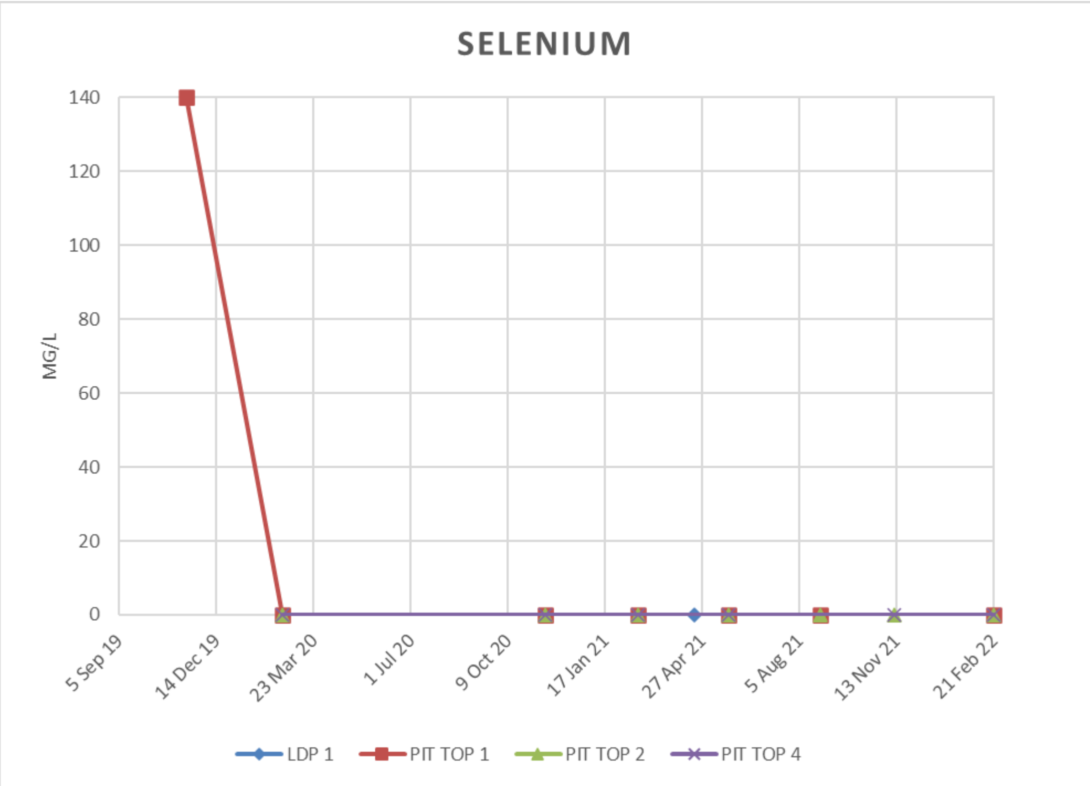

Figure 6 Selenium Concentrations Over Time – Pit Top Area

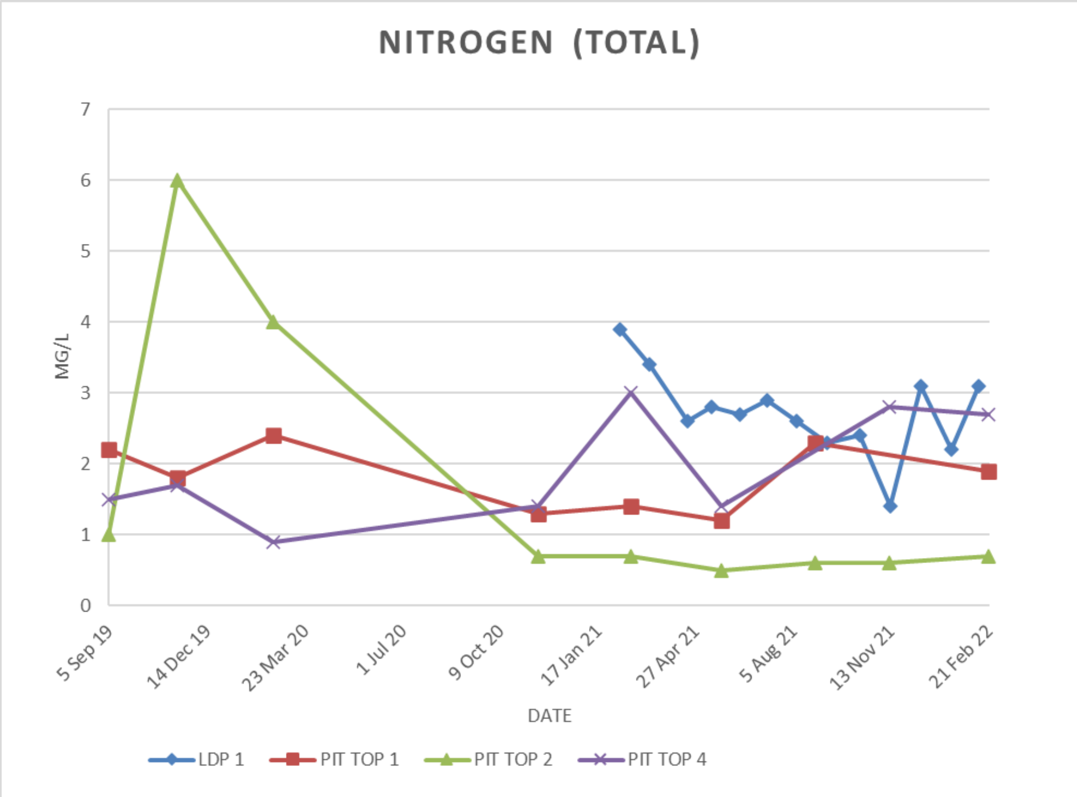

Figure 7 Total Nitrogen Concentrations Over Time – Pit Top Area

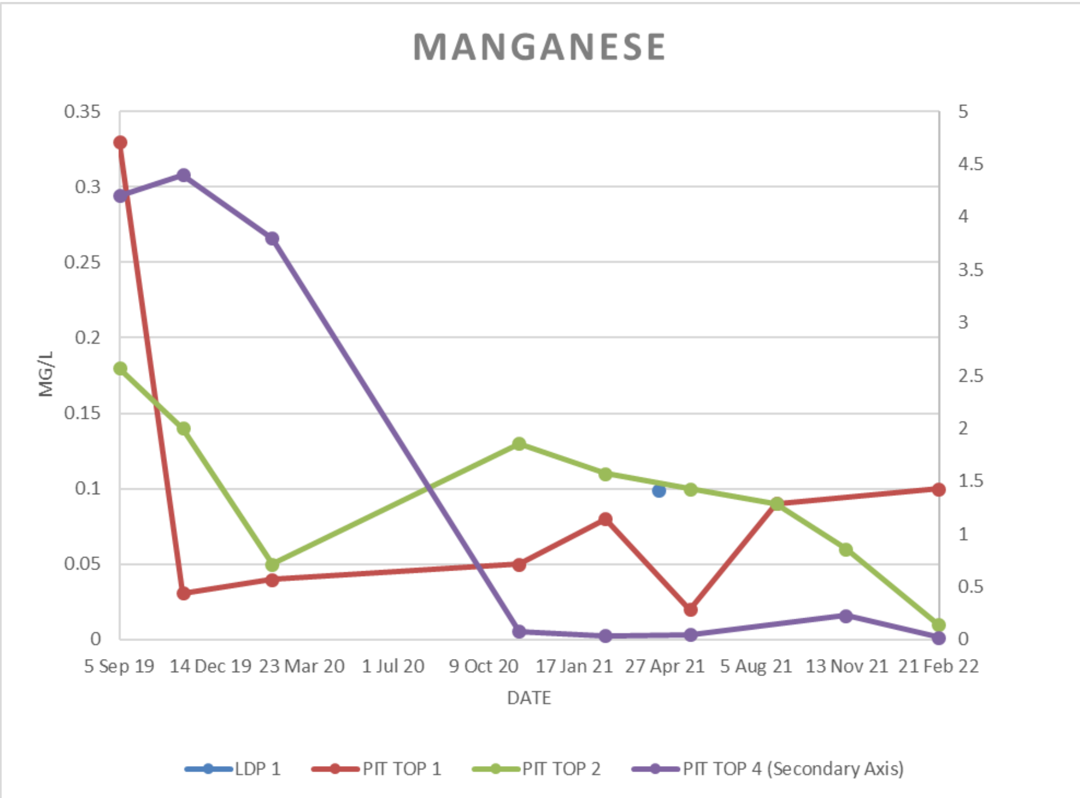

Figure 8 Manganese Concentrations Over Time – Pit Top Area

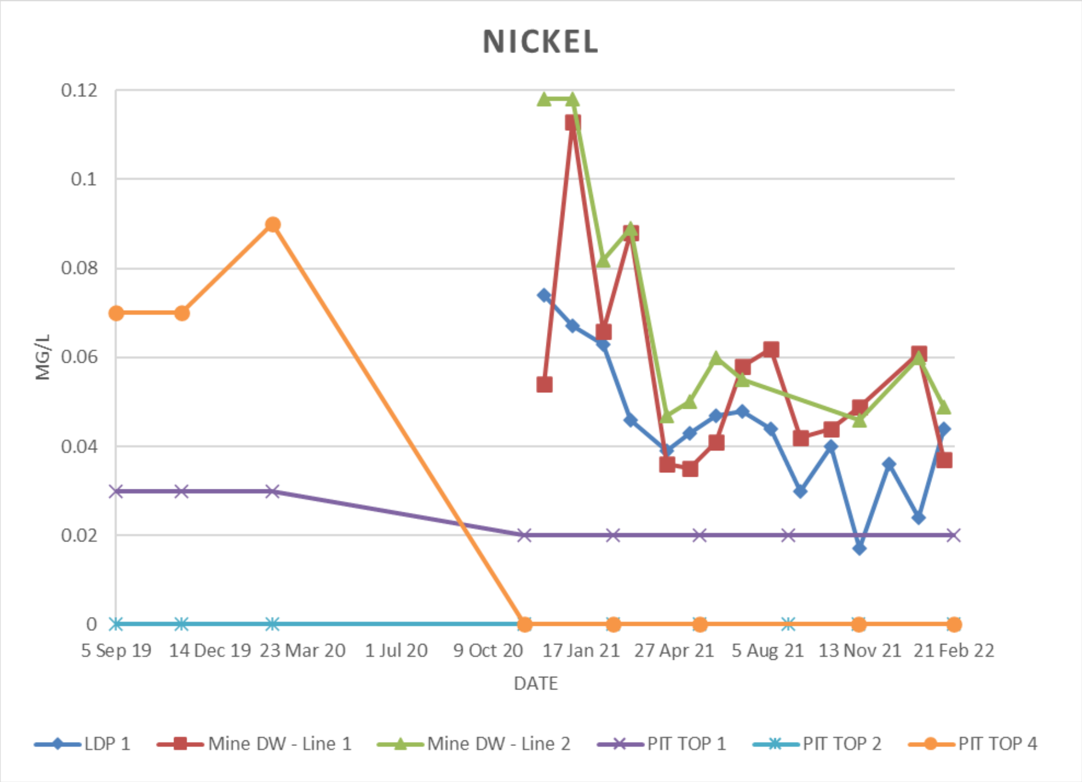

Figure 9 Nickel Concentrations Over Time – Pit Top Area

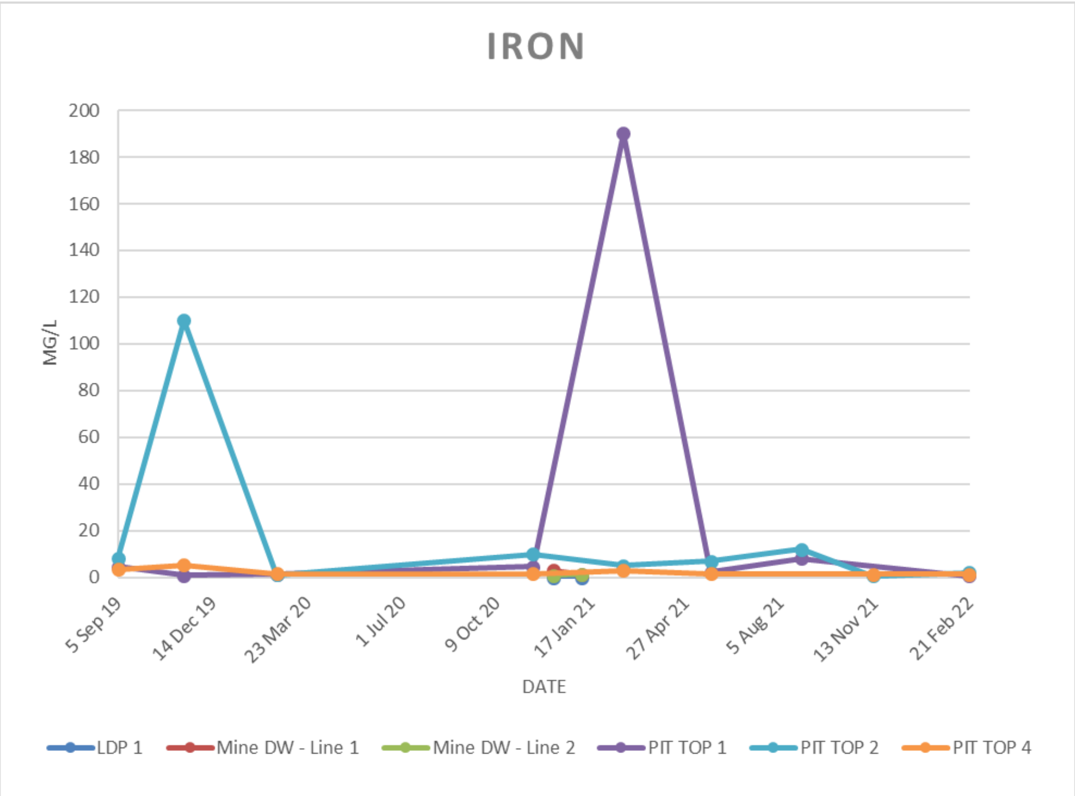

Figure 10 Iron Concentrations Over Time – Pit Top Area

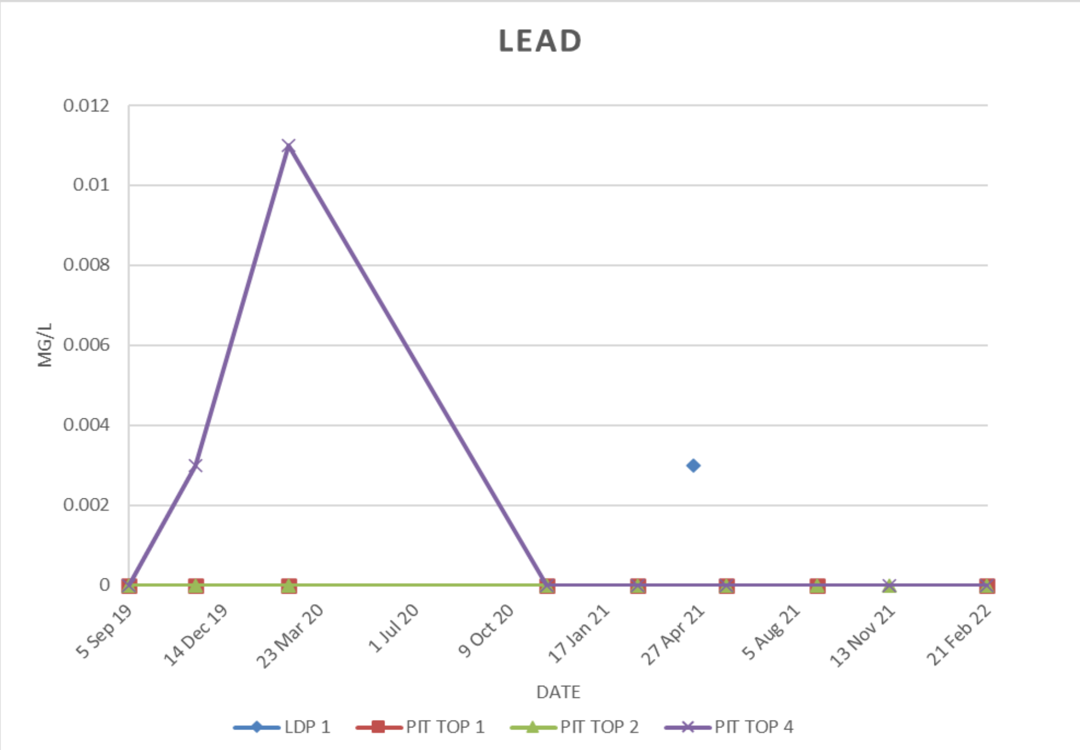

Figure 11 Lead Concentration Over Time – Pit Top Area

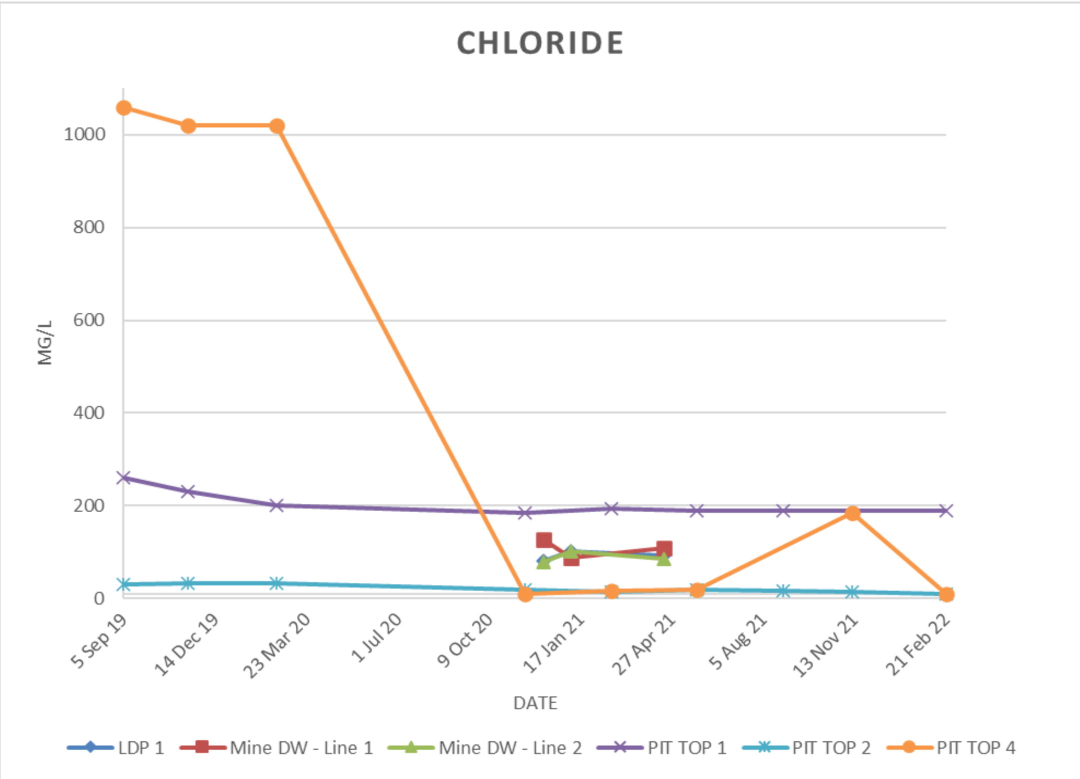

Figure 12 Chloride Concentrations Over Time – Pit Top Area

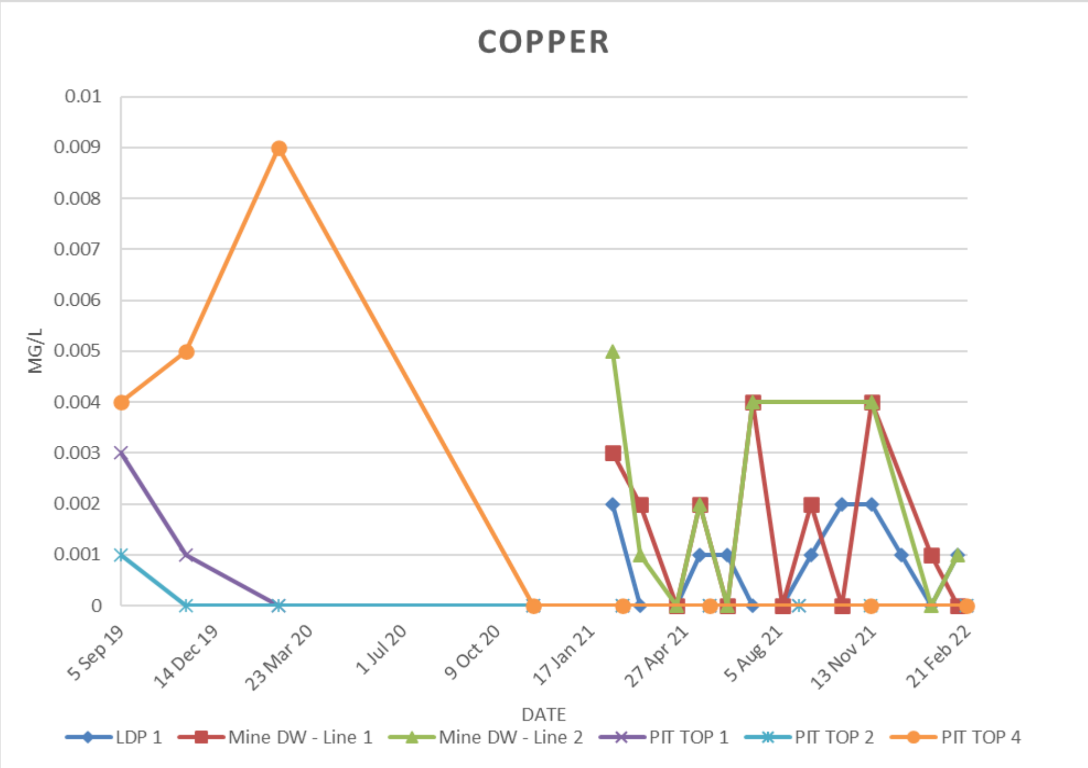

Figure 13 Copper Concentrations Over Time – Pit Top Area

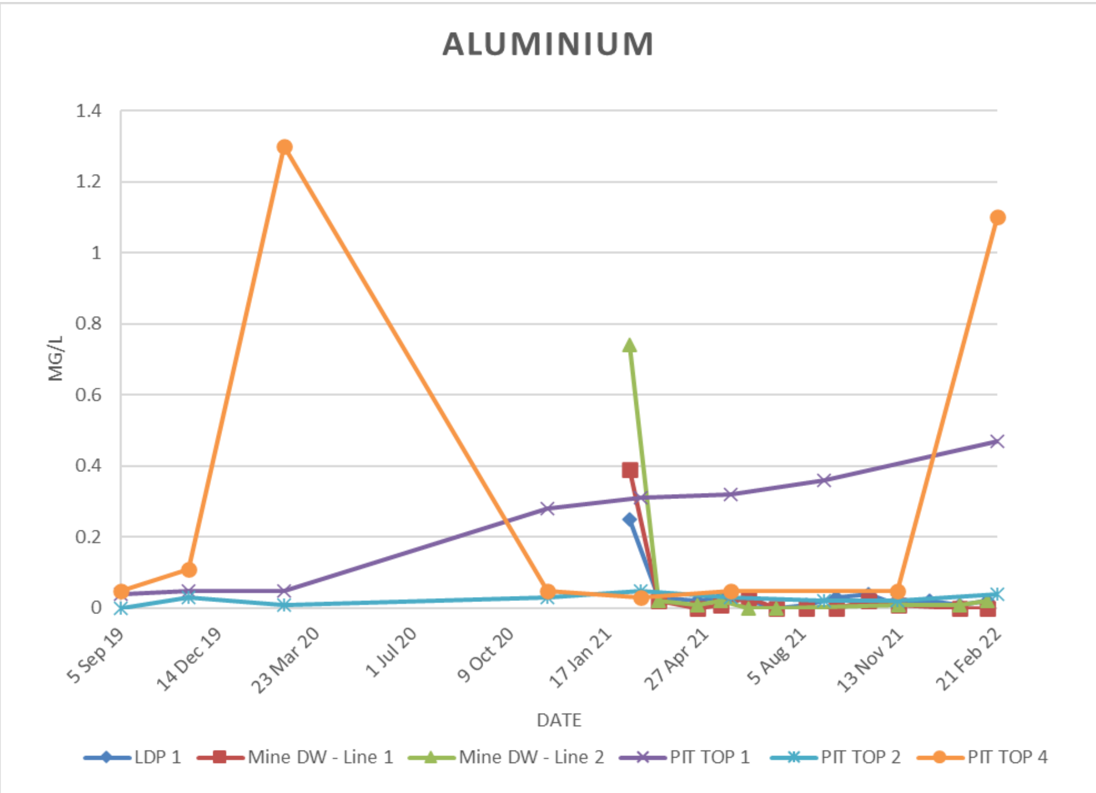

Figure 14 Aluminium Concentrations Over Time – Pit Top Area

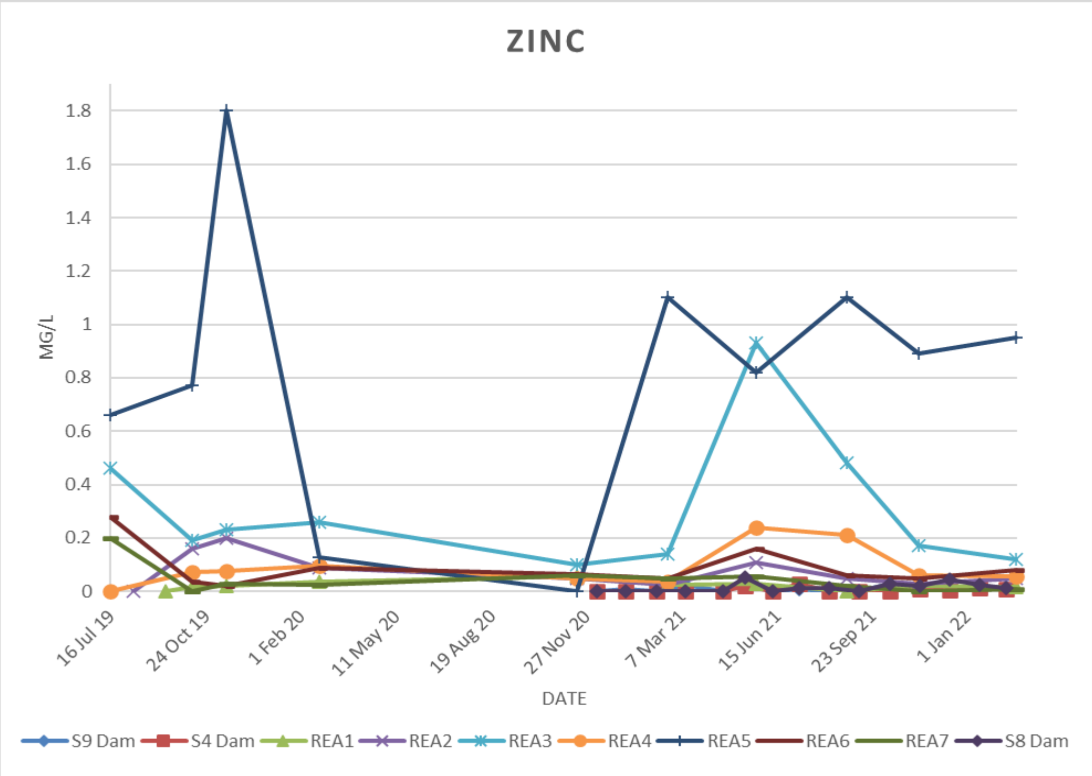

Figure 15 Zinc Concentrations Over Time – Rejects Emplacement Area

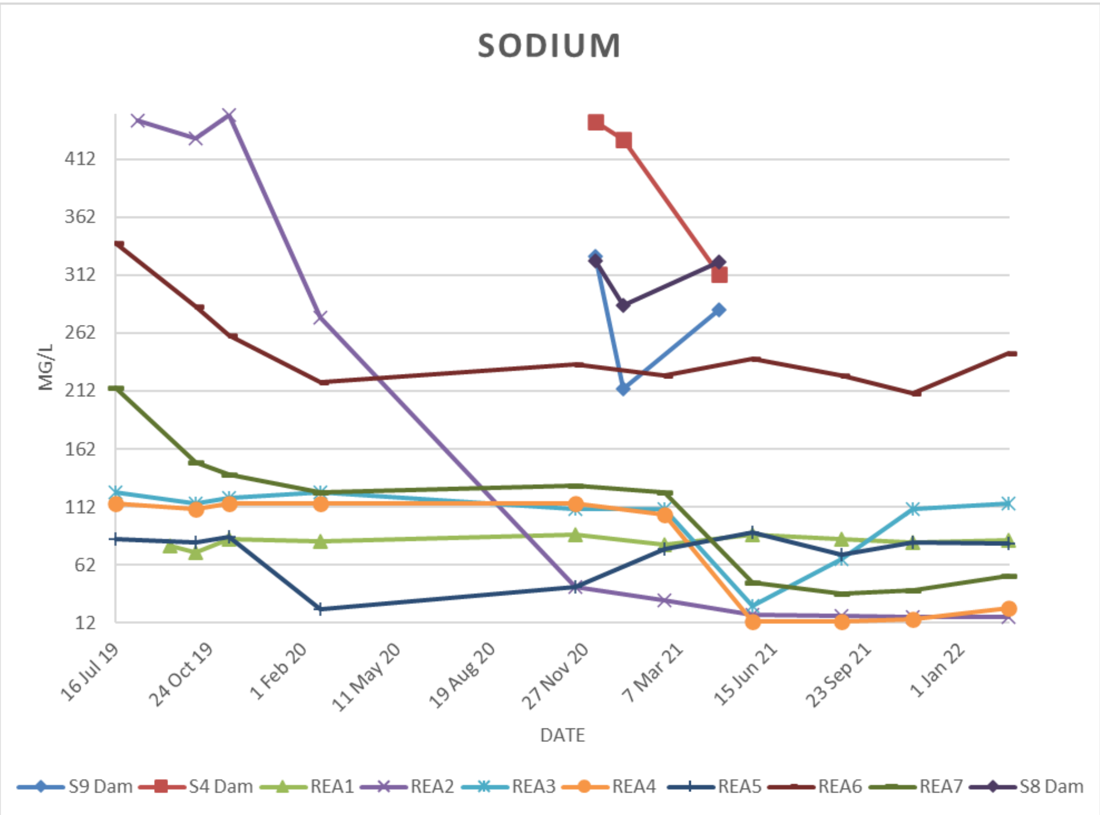

Figure 16 Sodium Concentrations Over Time – Rejects Emplacement Area

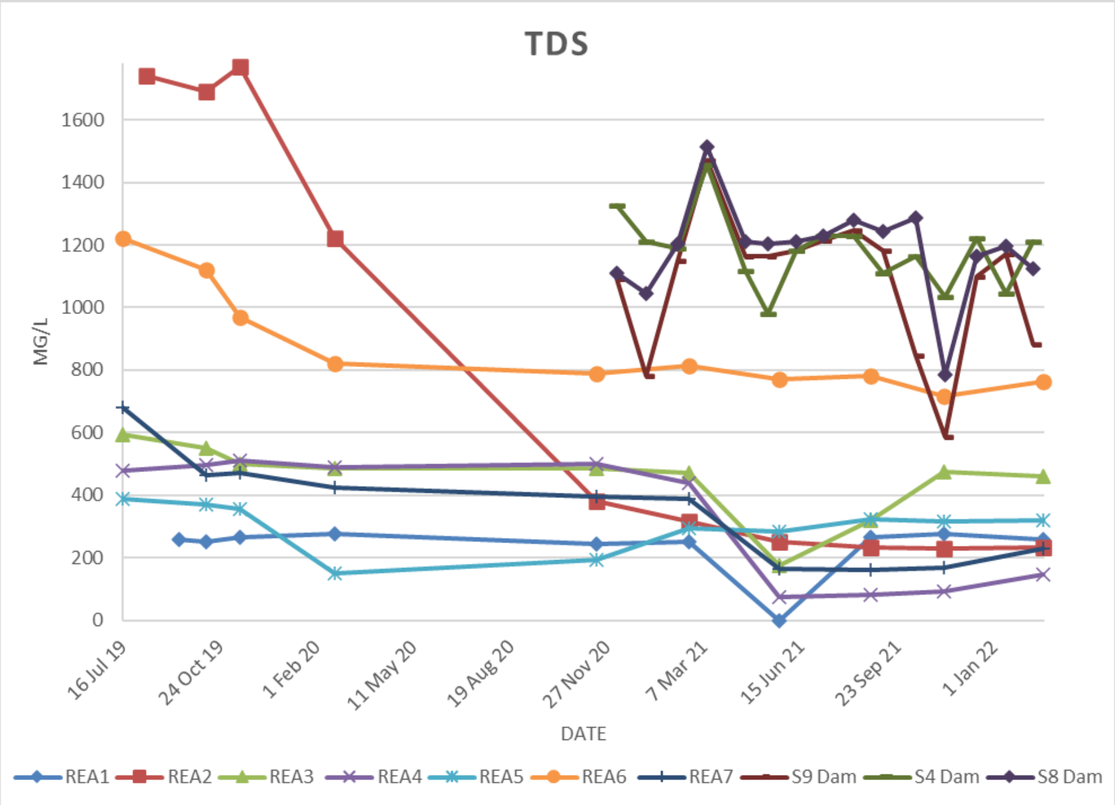

Figure 17 TDS Concentrations Over Time – Rejects Emplacement Area

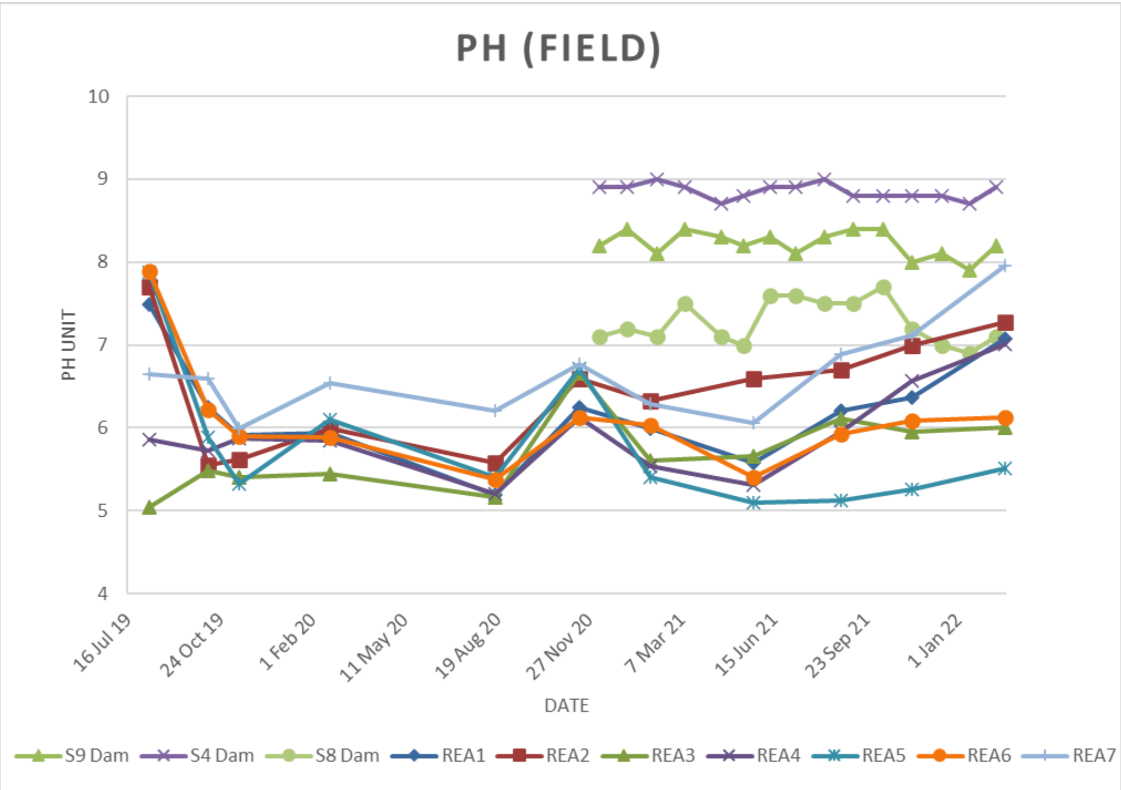

Figure 18 pH levels Over Time – Rejects Emplacement Area

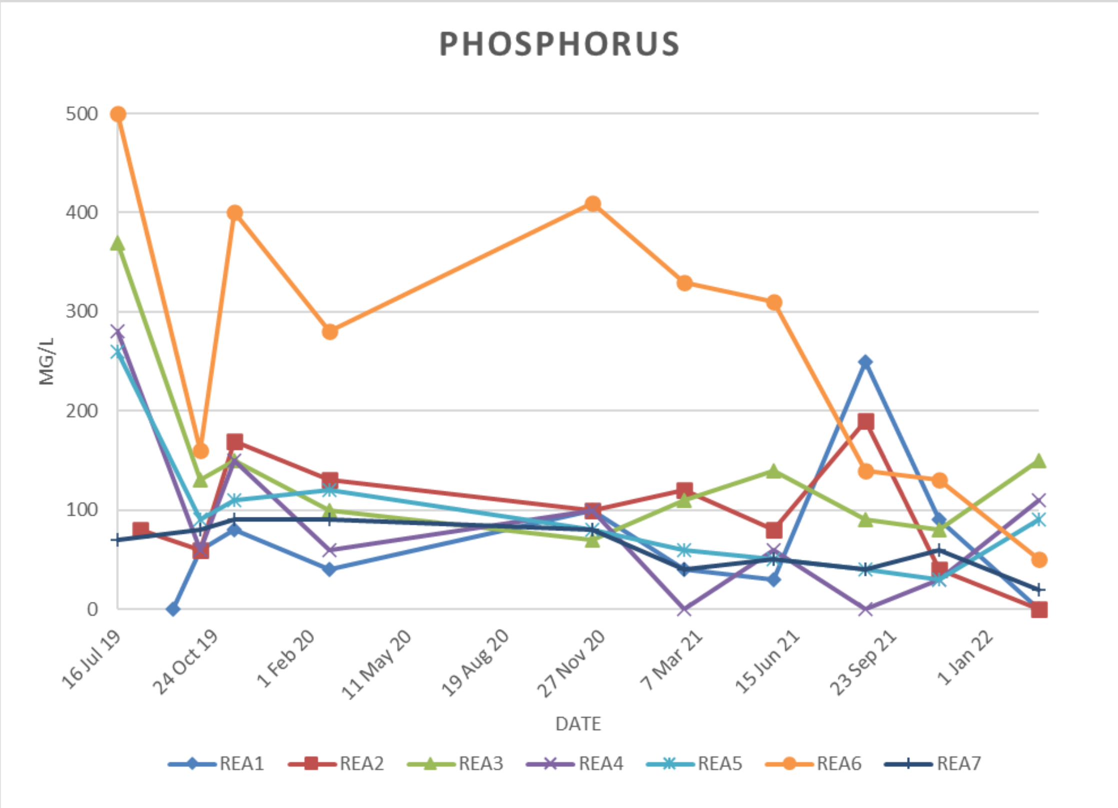

Figure 19 Phosphorus Concentrations Over Time – Rejects Emplacement Area

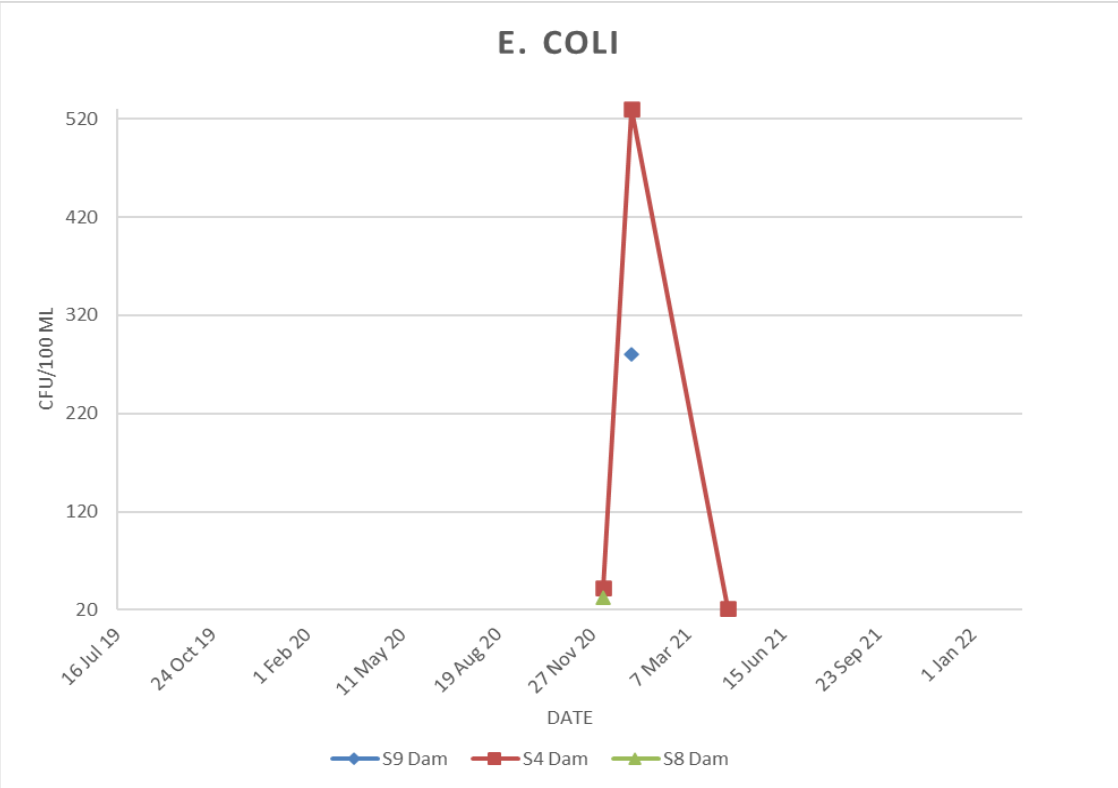

Figure 20 E.Coli levels Over Time – Rejects Emplacement Area

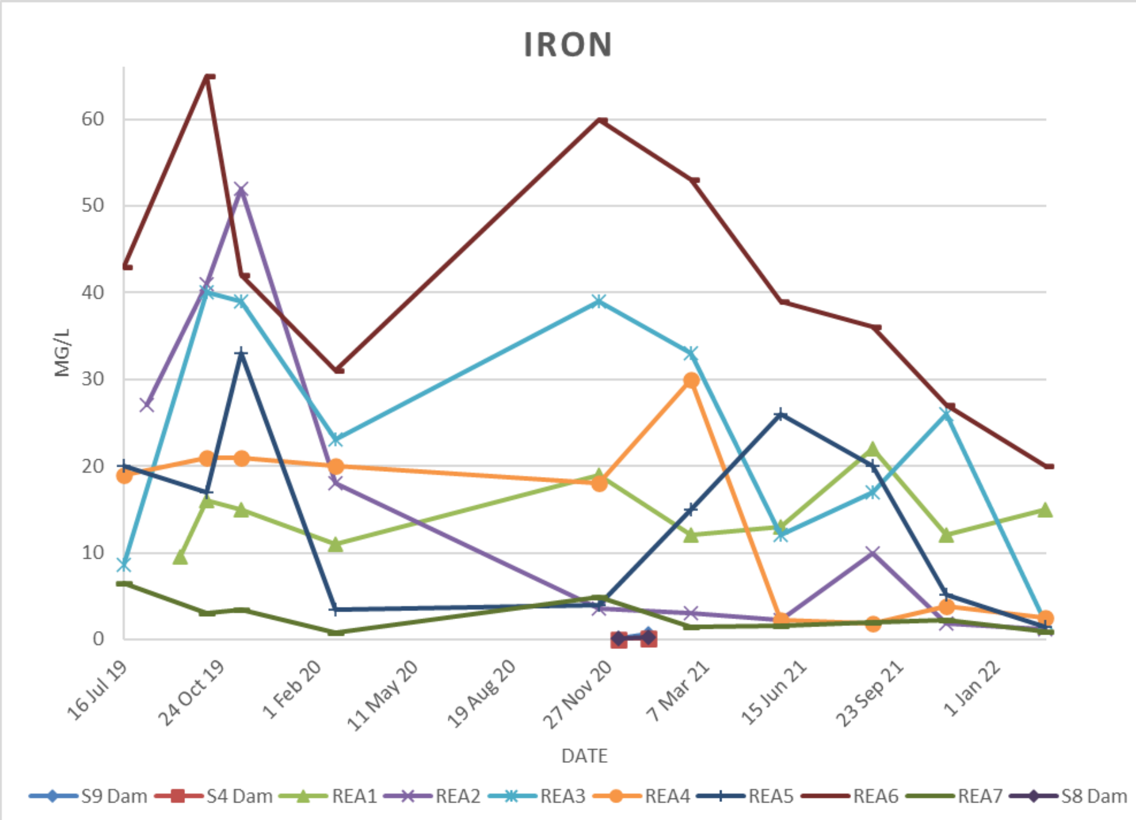

Figure 21 Iron Concentrations Over Time – Rejects Emplacement Area

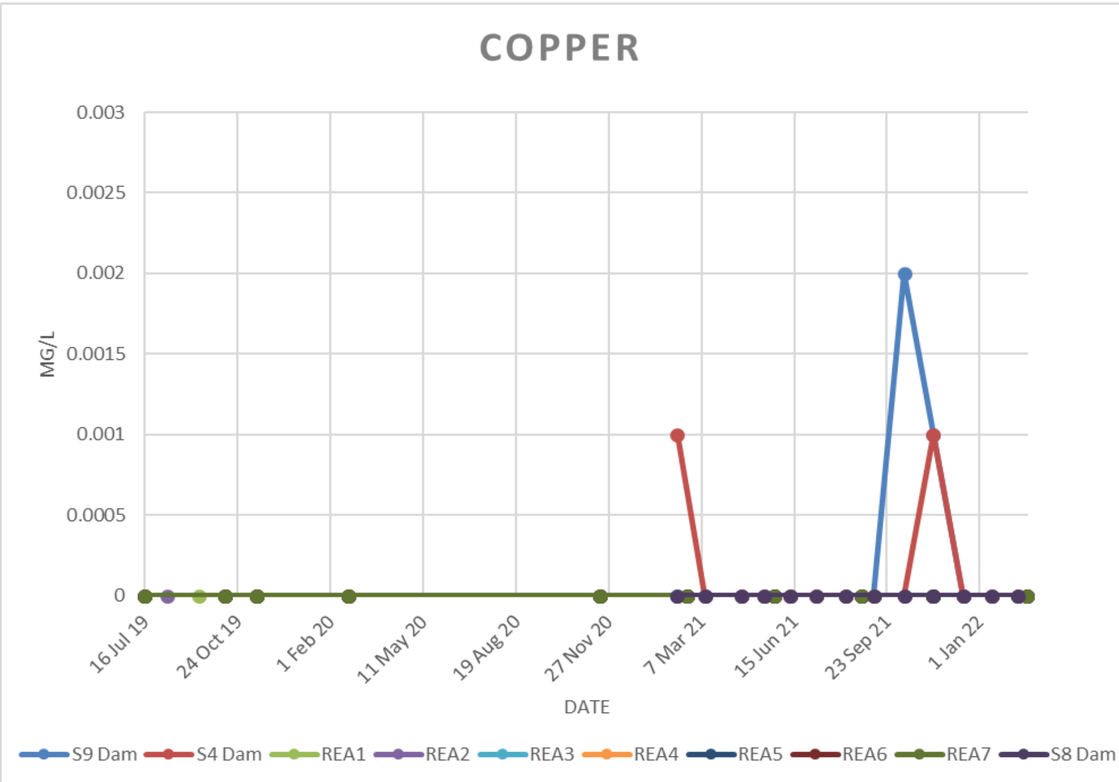

Figure 22 Copper Concentrations Over Time – Rejects Emplacement Area

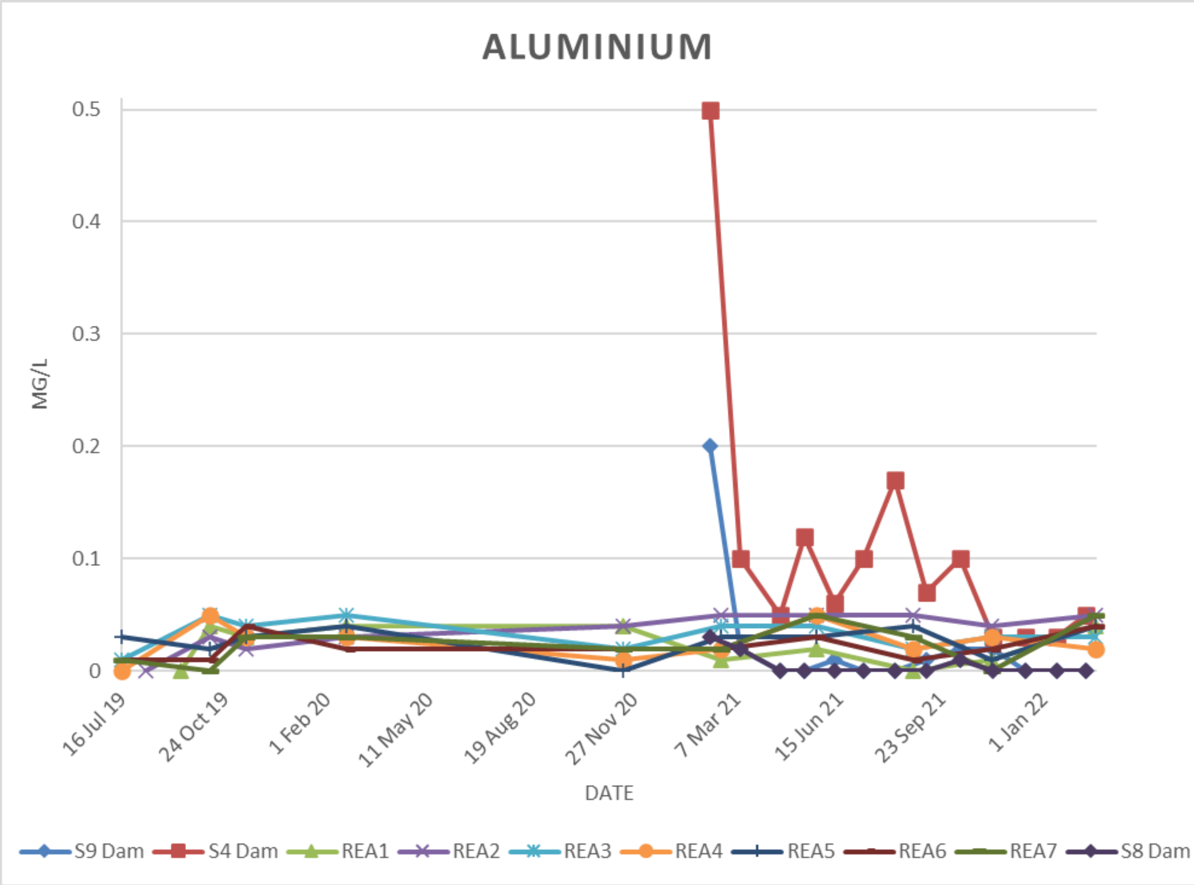

Figure 23 Aluminium Concentrations Over Time – Rejects Emplacement Area

APPENDIX C

Piezometer Locations

SLR CONSULTING PTY LTD
UOW INNOVATION CAMPUS
SQUIRES WAY
WOLLONGONG, NSW
P: 02 4249 1000
www.slrconsulting.com

Title:	TAHMOOR COLLIERY GROUNDWATER PIEZOMETER LOCATIONS	Drawn:	BT
Client:	TAHMOOR COAL	Reviewed:	SH
Project:	SURFACE WATER STORAGE ASSESSMENT	Size:	A3
Project No.:	660.30052.0000	Datum:	None
Status:	ASSESSMENT	Version:	1.0
Date:	09/12/2021		

SIMEC

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CAIRNS
Level 1 Suite 1.06
Boland's Centre
14 Spence Street
Cairns QLD 4870
Australia
T: +61 7 4722 8090

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
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Grd Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

APPENDIX E – Groundwater Modelling Plan

GROUNDWATER MODELLING PLAN

Prepared for:

Tahmoor Coal
2975 Remembrance Driveway
Tahmoor NSW 2573

SLR Ref: 665.10010.00407-R02
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PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com   www.slrconsulting.com

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APPENDIX

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) was engaged to develop a Groundwater Modelling Plan for the Tahmoor Coal Mine.

The Tahmoor South Project (the Project) is an underground coal development project targeting the Bulli Coal seam coal resource within Consolidated Coal Leases (CCL) 716 and 747 in the Southern Coalfield, 80 km southwest of Sydney (see Figure 1).

A Development Consent was issued by the Independent Planning Commission of NSW following the approval of the development application (Tahmoor South Project) referred to in Schedule 1, subject to the conditions in Schedule 2. As per the Tahmoor South Coal Project Development Consent Condition B34 (v) and recommendations made in the EIS Groundwater Assessment (HS/SLR, 2020), a Groundwater Modelling Plan is to be developed and incorporated in the Tahmoor South Groundwater Management Plan (GMP) currently in preparation by SLR.

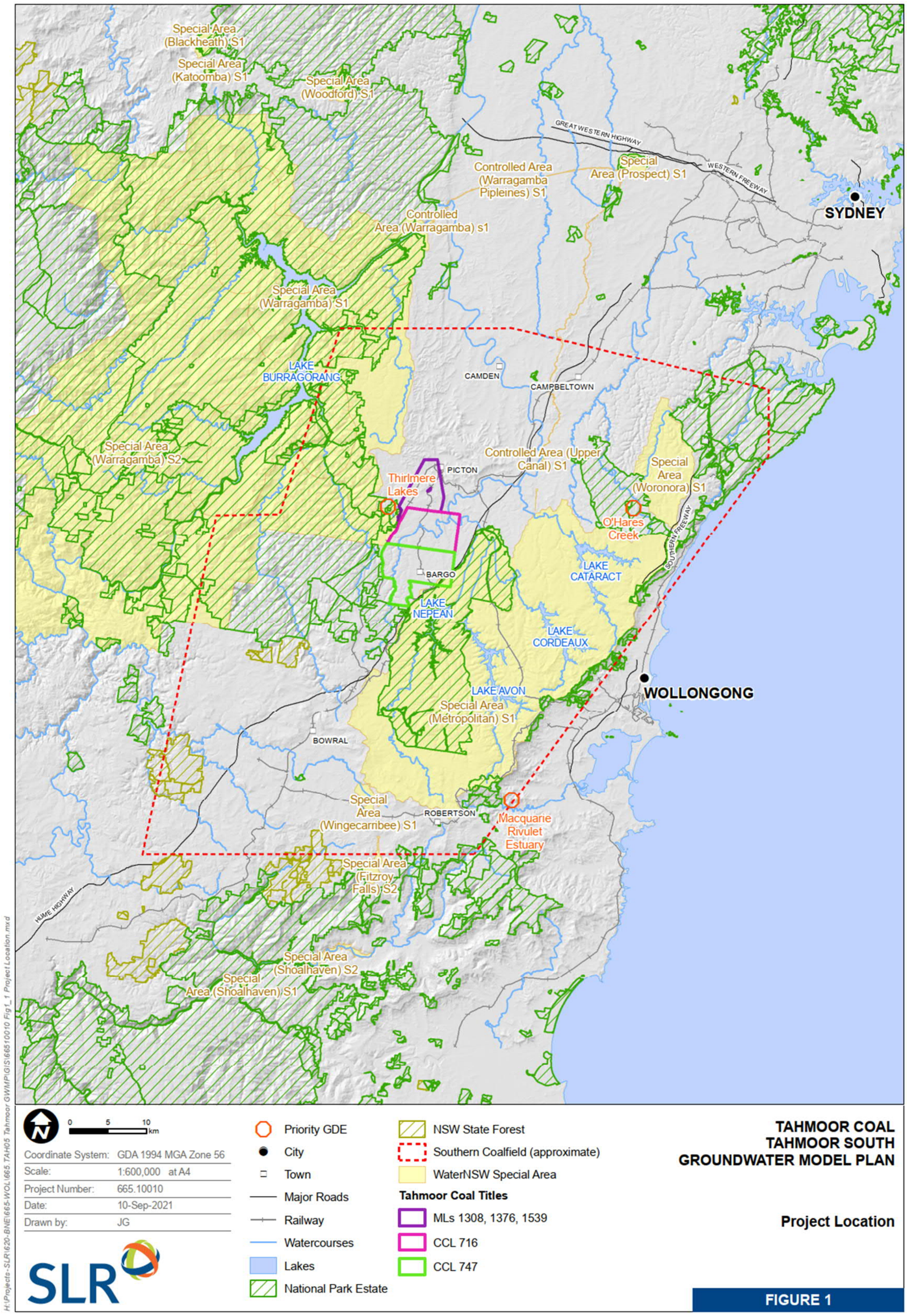

Figure 1 Project Location

1.1 Scope and Objectives

The objective of this report is to present the Groundwater Modelling Plan (GMP) for the revision and rebuild of the groundwater model used for informing Tahmoor Coal's operations and approvals. The GMP presented in this report outlines the modelling process that will be implemented to conduct the groundwater model re-build, which will be used to inform future potential environmental impacts of the Project.

A GMP was previously developed for the Project (SLR, 2020). However, in the letter dated 14 September 2020, NSW Department of Primary Industries and Environment- Water (DPIE-W) recommended the 2020 GMP to be revised (Attachment A DPIE-W, 2020), provided in Appendix A. The content of the GMP (SLR, 2020) which were considered still valid and appropriate are used to develop the GMP in this report.

Section 2 of this report reviews the existing groundwater model for the Tahmoor Mine, including Tahmoor South and the historical operations at Tahmoor North and the current operations in the Western Domain. This model was last updated in 2020 (HS/SLR, 2020), with some minor modifications in 2021 for the Western Domain Extraction Plan. This review of the existing model includes the following:

- Suitability of the model packages currently incorporated (including recharge, rivers, drains, etc);
- Data availability and current status of calibration (water levels, mine inflows etc);
- Scheduling/timing of mine progression against latest mine plan; and
- The extent to which agency comments and requirements received during the Tahmoor South EIS process are addressed within the model, and the suitability of the model to address outstanding comments and inform ongoing requirements.

Section 3 includes a summary of the gaps and areas for improvement in the existing groundwater model and data as well as considerations for the update of the model.

Section 4 of this report outlines the GMP and covers the following items identified in the groundwater Commitments:

- provides details for the future groundwater model re-build and recalibration which must be completed within 2 years of the commencement of development under this consent (i.e. approximately March 2024);
- is independently third-party peer reviewed;
- provides for the incorporation of the outcomes of the findings of the Thirlmere Lakes Research Program (TLRP) and other relevant research on the Thirlmere Lakes;
- considers field data and the outcomes of subsidence monitoring;
- provides for periodic validation, and where necessary recalibration, of the groundwater model, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions;

Section 5 presents a summary of the GMP and the forward work plan, highlighting the existence of data gaps that will further support the model development.

2 Review of Existing Model Status

The existing groundwater model for Tahmoor South was last updated in 2019, with some minor modifications in 2021 for the Western Domain Extraction Plan. The objectives of the existing groundwater model (SLR, 2021) are to understand the effects on the hydrogeological system during and after mining operations as follows:

- Inflow of water to the underground mine and the management of that mine water;
- Impacts on groundwater levels during and after operational mining, both within the Permo-Triassic strata and the alluvium associated with Thirlmere Lakes; and
- Impacts on baseflow and stream leakage to and from the Bargo and Nepean Rivers and their tributaries during and after operational mining. This could also impact upon groundwater quality around streams;

The groundwater assessment and modelling report conducted for the Tahmoor South Amended Project (HS/SLR, 2020) were peer reviewed by Hugh Middlemis (HydroGeoLogic, 2020).

The following presents a summary of the existing model.

2.1 Design

The software used to undertake the numerical model is MODFLOW-USG Transport. The groundwater model domain represents an area 3,237 km^2 to carry out an assessment of the cumulative impacts of Tahmoor and neighbouring mines. The model grid is a rectilinear structured grid composed of 612 rows, 529 columns with uniform cell size (100m x 100m) across 16 model layers. Minimal refinement has been applied to the Thirlmere Lakes and upper Blue Gum Creek, with cell sizes of 25m x 25m. There are a total of 2,877,930 active model cells.

2.2 Calibration

A steady state and transient calibration was carried out for the period 1980-2019 to simulate mine workings at Tahmoor/ Tahmoor North, neighbouring mines and the transient climate sequence. A combination of PEST (automated) and manual calibration techniques were used to calibrate the model to mine inflows, groundwater levels and baseflow. An iterative process was established to calibrate the steady state and transient models.

The model was calibrated by varying the following parameters:

- Hydraulic Conductivity (Kx and Kz);
- Storage (Sy, SS);
- Recharge; and
- Drain Conductance for development headings (manual calibration).

The model takes about 12 hours to run the historical calibration period. The calibration statistics for the calibrated transient model range from 2.8% (HS/SLR, 2019) to 2.9% (SLR, 2021) with a mass balance error of 0.02%. The statistics indicate that the model is an acceptable match to historical data based on AGMG (2012).

Key elements of the performance of the existing calibrated groundwater model are:

- Good match in observed groundwater levels in the stratigraphic layers especially in the upper layers representing the shallow aquifers (Hawkesbury Sandstone) with most of the private bores screened in the HBSS (HS/SLR, 2020; SLR, 2021);
- Good match in the vertical head profile in the Hawkesbury Sandstone and Bulgo Sandstone (HS/SLR, 2020);
- Simulated groundwater flow system contours are consistent with measured levels (Middlemis, 2020);
- Good match in the magnitude of mine inflow (HS/SLR, 2020; SLR, 2021);
- Good match in the modelled baseflow and observed flow (HS/SLR, 2020).

Limitations of the calibrated model are discussed in HS/SLR (2020) (refer to Section 4) and are briefly outlined below:

- Imperfect simulation of mining operations (i.e. roadway development);
- Structural errors including vertical and horizontal discretization of the model (i.e. lumped units and model cell size);
- Structural errors due to discretization of time in the model (i.e. stress period lengths);
- Imperfect representation of the hydraulic properties and recharge (i.e. coarse zones for defining hydraulic properties, 'average' value of permeability, single property zone across a modelled stratigraphic layer).

Further limitations of the existing model covering the calibration stage are discussed in Section 3 and are accompanied with potential remedial actions.

2.3 Predictions

The prediction period runs for the proposed active mine life of Tahmoor South, followed by post-mining recovery to year 2500. The lengths of the modelled stress periods are matched to longwall panel durations at Tahmoor and neighbouring mines and were recently updated as part of the LW W3-W4 Extraction Plan (SLR, 2021). For the post-mining period, the recovery period was subdivided into 23 stress periods progressing out from around 6-months - 1 year to 100 years in lengths.

Potential impacts of the development were assessed by making comparisons between five (5) development scenarios presented in HS/SLR (2020) (refer to Section 5.2.1). Figure 2 presents examples of predictive outputs (maximum drawdown in shallow aquifers and at groundwater users) from the existing model (HS/SLR, 2020).

A selection of seven (7) deterministic uncertainty scenario runs were carried out to test the impact of various hydrogeological features and behaviours presented in HS/SLR (2020) (refer to Section 5.2.1).

Additional deterministic uncertainty scenarios were developed in SLR (2021) to account for the uncertainty in the properties of the Nepean Fault Complex near to the Western Domain.

The prediction model implemented:

- Underground mining and dewatering activity (using Drains cells);
- The change in hydraulic parameters with time in the goaf and overlying fractures zones directly after mining of each panel (TVM package and stacked drains (SLR, 2021)).

The following outputs results of the predicted model were considered:

- Transient model water balance to the end of Tahmoor South (2019-2035) and for the recovery period (2036-2500);
- Predicted mine inflows for each deterministic scenario (i.e. time series forecast, average, peak);
- Predicted groundwater levels (i.e. bore hydrographs inside/outside footprint of Tahmoor South proposed longwalls) during prediction and recovery periods.
- Predicted drawdown near the significant GDE's (the Thirlmere Lakes), including incremental drawdown due to the Project, of alluvial groundwater beneath the Thirlmere Lakes;
- Predicted drawdown in the water table and lower Hawkesbury Sandstone;
- Predicted baseflow capture for local watercourses (19) due to Tahmoor South and cumulative mining;
- Predicted change in Lake-Aquifer interaction at Thirlmere Lakes (i.e. modelled leakage and lake level);
- Salt Balance for mine inflow;

The groundwater assessment focused on the criteria specified by the minimal impact considerations of the Aquifer Interference Policy:

- Licensable takes of water
- Water table drawdown
- Pressure head drawdown
- Groundwater quality impacts

Potential impacts due to both Tahmoor South and cumulative mining were highlighted in (SLR/HS) 2020 by considering the:

- Groundwater drawdown and baseflow capture at priority GDE's and local watercourses
- Simulated impacts on groundwater levels (i.e maximum modelled drawdown and water level recovery in different stratigraphic units);
- Maximum simulated drawdown on existing groundwater users (i.e private bores)
- Impact on groundwater quality (i.e change in groundwater salinity)

The complexity and confidence of the numerical groundwater model developed for the Tahmoor South Amended Project (HS/SLR, 2020) was adequate and fell within a Class 2-3 model confidence (HS/SLR, 2020). Further details on the complexity and confidence are presented in the peer review by Hugh Middlemis (HydroGeoLogic, 2020).

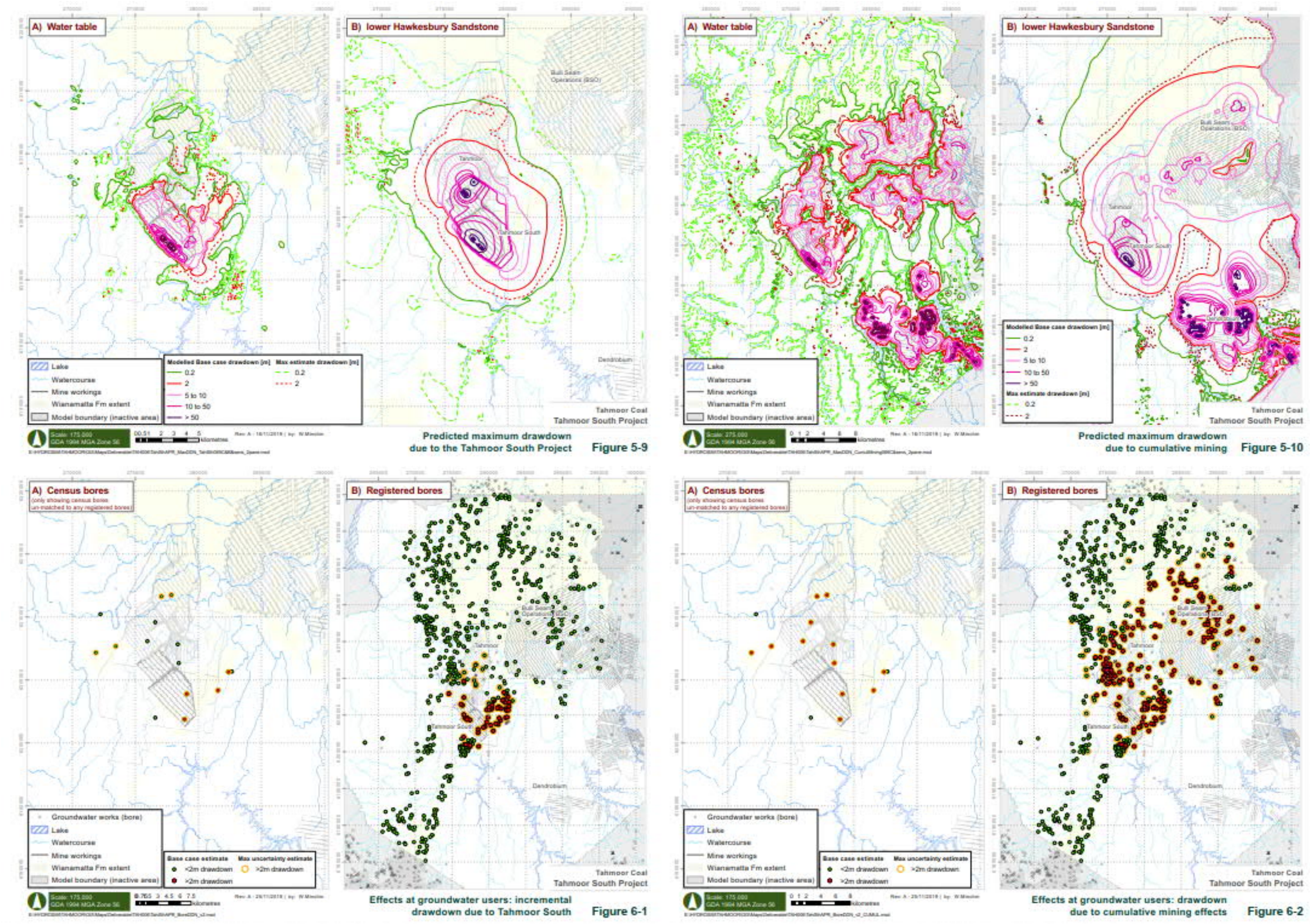

Figure 2 Predicted maximum drawdown and effect at groundwater users due to Tahmoor South and cumulative mining (HS/SLR, 2020)

3 Gap Analysis

The IESC *Uncertainty analysis – Guidance for groundwater modelling within a risk management framework* (2018) 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 with regards key aspects of the conceptualisation required to be incorporated into the HydroSimulations/SLR (2020) model in order to be fit for purpose for Tahmoor South Project. The review is presented in Table 1 and includes actions to verify if additional data is available, as well as considerations for the update of the model.

Table 1 Groundwater Model and Data Limitations

Type	Part	Status	Comment
Structural/ Conceptual	Grid and Model Extent	To be updated	The model has a structured grid that includes detailed cell refinement around the Thirlmere Lakes and upper reach of Blue Gum Creek. The model has over 2 million cells, is large and has a long run-time (Middlemis, 2020; HS/SLR, 2020). Optimise model cells (reduce to about 15% of the current count) to improve run times. . Minimal change to the model extent.
		To be updated	The model layers are fully extensive. Use of the MODFLOW-USG 'pinch-out' functionality may be employed to reduce overall cell count. This process allows to remove the need to have a minimum thickness and layer continuity where a stratigraphic unit is absent.
	Layers / geometry	To be updated	Top of layer 1 may require update based on site LiDAR data.
		To be updated	Geological model is mainly based on 2013/2014 with slight revision. Limited representation of the Wianamatta Formation grouped with other lithologies. Use existing geological model and data and incorporate latest geological findings
		To be updated	Thirlmere Lakes geometry - Use existing geological model and data. Incorporate latest findings from TLRP in conceptual/numerical model (as yet unavailable)
		To be updated	Model layer elevations - Geological model is mainly based on 2013/2014 with slight revision. Use existing geological model and data. Update on layering based on latest Tahmoor site geological model, Tahmoor site-specific geological studies and site geological drill holes.
	Conceptualisation – Geological Structure	To be maintained, unless new information is provided that changes conceptualisation.	Review of future geological investigations should be conducted across Tahmoor South, with new potential causal pathways implemented in the conceptual model, if any identified. Improve representation of all zones of fracturing (especially disconnected/dilated zone).

Type	Part	Status	Comment
	Conceptualisation – GDEs	To be verified	Review of the NSW government TLRP.
	Conceptualisation – Surface Water Groundwater Interactions	To be updated – with focus on grid resolution/layers and calibration history matching	Confirm and improve the understanding of interaction between surface and groundwater (i.e. along Bargo River, Dog Trap Creek). Improve coverage of data for the surface water and groundwater (shallow) monitoring network.
	Conceptualisation – Saturated Extent of Alluvium and Regolith/Hawkesbury Sandstone	To be updated – with focus on grid resolution/layers and calibration history matching	Use existing groundwater monitoring data and future groundwater monitoring sites. Limited groundwater levels/quality data for the shallow groundwater monitoring network across Tahmoor South. Improve coverage of data around the Thirlmere Lakes (i.e new monitoring sites to be installed). Data collected at the future groundwater monitoring bores within the shallow aquifers of Tahmoor South will inform the conceptual model.
Parameter-isation	Hydraulic Conductivity – Depth Dependence	To be based on regional data, but can be updated if additional site data available	Use existing hydraulic conductivity database – Include new field testing of hydraulic conductivity (horizontal and to a lesser extent vertical). Confirm the general decline in hydraulic conductivity with depth that is replicated in the model.
	Hydraulic Conductivity - Heterogeneity	To be updated	The model has a single value of hydraulic properties for each model layer (assumed homogeneous). Use zones to delineate hydraulic properties (K and S) and depth dependence function for coal and interburden.
	Goaf Effects	To be updated in the model	Use existing hydraulic conductivity database - Site specific data is available but remains limited on the change in properties with longwall mining at Tahmoor (e.g. site TBF040c). Consider geotechnical and hydrogeological data from WD02 (post-mining hole) in the Western Domain and future investigation above LW W101A to investigate pre/post mining hydraulic properties at Tahmoor South.

Type	Part	Status	Comment
	Lakes and Water Reservoirs	To be maintained in model and updated if additional data is available	Minor to no changes for the water storage, Lake Burragorang, Lake Nepean, Lake Avon, Lake Cordeaux, Lake Cataract using a boundary condition (RIV package). These features will be maintained in the model, and where new information on fill levels will be considered and updated. RIV model package to be updated for the Thirlmere Lakes. Incorporate recent water levels at Thirlmere Lakes (2019-2021).
	Rivers	To be maintained in model and updated if additional data is available	Representation of rivers to be improved in the model. Update RIV package (river stage heights) with recent water levels. Consider new surface water monitoring site to calculate modelled river stage. Incorporate latest surface elevation (i.e LiDAR data) and update the modelled river-bed elevation if required. Revise estimates of bed-conductance and hydraulic properties if necessary, using latest study available (i.e findings on the surface cracking zone across Tahmoor/Tahmoor North).
	Recharge	To be maintained in model and updated if additional data is available	Recharge zonation is based on mapped surface geology and recharge rates calibrated against independent estimates derived from chloride mass balance (Crosbie, 2015). Soil mapping and site water quality data could be further utilised to base recharge rates. A map showing the distribution of the recharge in the steady state and average values in the transient model will be included in reporting.
	Evapotranspiration	To be maintained in model and updated if additional data is available	Simulated as a constant potential ET rate from groundwater. Potential ET from groundwater to be simulated considering historical variation in this parameter OR keep as a constant rate but included in sensitivity analysis. If using the transient method, this should be estimated using a water/energy balance model that considers historical rainfall/ET patterns and is calibrated to infiltration recharge (see previous). Rooting or extinctions depths will be based on review of relevant literature (e.g. Canadell, 1996; Zolfhagar, 2013), and any information from the TLRP). A map showing the distribution of the evapotranspiration in the steady state and average values in the transient model will be included in reporting.

Type	Part	Status	Comment
	Drains (mine dewatering)	To be updated in the model	Drain conductance estimated from simulated hydraulic conductivities. Drain conductance will be allowed to vary (as a calibration parameter) from initial estimates.
	Drains (mine operations)	To be updated in the model	Historical and approved mine plan data to be sought by Tahmoor Coal (with assistance from agencies) in order to simulate up-to-date mine plans. For Tahmoor, the simulation of up-to-date plans for the neighbouring BSO Mine is most important.
	Groundwater pumping	To be maintained in model and updated if additional data is available	Groundwater pumping by third party bores users is highly uncertain (in terms of rates). As such, bore use was only considered as a deterministic scenario. If more reliable data is available from WaterNSW/DPIE-Water (although review of the Water Register suggests that it is not), groundwater pumping via MODFLOW Wells should be included in calibration and prediction.
Data Sources	Observation Data Quality	To be updated	Observation data ends in late 2019. Recent groundwater observations will be incorporated for the observation bore file prior to calibration. This includes observation data across the Western Domain, Tahmoor North, and Tahmoor South but could also include new monitoring sites installed during the model re-build as part of the Groundwater Monitoring Plan.
	Landholder Bore Data Quality	To be maintained, but potentially review in future.	Impacts on registered landholder bores are influenced by the assumptions of the bore design, target geology and use. A rigorous bore census is to be conducted as part of the Groundwater Monitoring Plan. Verification of landholder bore details in the model will be undertaken.
	Temporal spread	To be updated	Timeseries water level data from the site as well as the neighbouring mines are available for the shallow and deep aquifers. SLR have all data for Tahmoor up to late 2020-early 2021 but need to update to mid-2021. Additional data for BSO will be requested.

Type	Part	Status	Comment
Mass balance Error	Settings	To be updated	The model has 'solver' settings where the head close (HCLOSE) criteria is currently set to 0.04 m. Reduce the HCLOSE toward 0.01 m to improve model mass balance. Model stability should be emphasised during the attempt to reduce the HCLOSE criteria.
Scenario Uncertainties Future stresses/ conditions	Calibration	Have most data but require confirmation of historical mine data	Steady state (pre-1980) and transient (1980 to 2019) calibration model set up in existing model. Calibration model timing ends in late 2019 and should be extended to mid-2021. The calibration can be improved by updating the hydraulic conductivity depth-dependence (pilot point calibration to represent heterogeneity), improved representation of the stratigraphic units (elevation and thickness) especially the alluvium (Thirlmere Lakes), Wianamatta formation, Hawkesbury Sandstone, and Bulli Seam, evapotranspiration rate and possibly groundwater pumping. Limited verification against baseflow estimates along local watercourses, this needs to be improved if sufficient data is available. Model not calibrated to groundwater drawdown. Limited reporting on steady state and calibration data.
	Predictive	To be updated	Out-dated mines plans for approved BSO and Dendrobium Mine domains.
	Sensitivity and uncertainty	To be updated and be maintained.	A Linear analysis method was used to conduct the Uncertainty Analysis. Limited capability to conduct uncertainty analysis. The run time of the existing model prevented a Type 3 Uncertainty Analysis being carried out.

4 Groundwater Model Plan (GMP)

As per the Development Consent (SSD 8445), as part of the Groundwater management Plan, Tahmoor Coal is to provide a GMP that provides the details for the future groundwater model re-build and recalibration which must be completed within two years of the commencement of development under the Consent. The new groundwater model will be used as part of the approval process during the preparation and development of Extraction Plan.

The GMP follows the modelling process presented in the Australian Groundwater Modelling Guidelines (AGMG, 2012) and addresses the modelling objectives, conceptualisation, model design, calibration approach and set up, the predictive modelling approach, the sensitivity and uncertainty analysis, and the outputs and reporting. The modelling will adhere to the AGMG and in particular to the guiding principles outlined in that document. The GMP is developed in consideration of the IESC Uncertainty Analysis Guidelines that identify four main sources of uncertainty in groundwater modelling; structural/conceptual, parameterisation, measurement error and scenario uncertainties as shown in Table 1. In line with the risk assessment approach outlined within IESC Uncertainty analysis – Guidance for groundwater modelling within a risk management framework released in 2018, the MIP provides an opportunity for early identification of potential impacts and discussion on ways to manage these.

4.1 Modelling Objectives

The Tahmoor Mine groundwater model is being updated to address components presented in the gap analysis (Section 3) and to improve the incorporations of the four sources of uncertainty presented earlier.

The groundwater model is intended to inform the potential risk of environmental impacts associated with the historical, present, and future mining operations and meet Development Consent (SSD 8445) obligations as outlined in the B34 (v) and discussed in Section 1.2. The objectives of the groundwater model are to estimate:

- Mine inflows to the underground mine workings;
- Change in groundwater levels during and after operational mining, both within the Permo-Triassic strata and the alluvium associated with Thirlmere Lakes;
    - Impacts on water supply for water users (i.e. private bores);
    - Impacts on GDE's including the Thirlmere Lakes.
- Change on baseflow and stream leakage to and from the Bargo and Nepean Rivers and their tributaries during and after mining;
- Estimate the storage capacity and groundwater recovery at Tahmoor Mine during and after the cessation of mining; and
- Inform possible changes in groundwater quality due to operations at Tahmoor Mine;

The predictions are required for mining at Tahmoor South Project, to inform post-mining management and licensing across the Tahmoor Mine domain, and also for cumulative impacts from the Project and approved and foreseeable mines in the area.

The groundwater model will assist with decision-making and planning on the following components:

- Management of mine water (i.e incorporate predicted mine inflows in the Site Water Balance);

- Licensable takes of water (i.e groundwater and surface water licensing); and
- Quantify the level risk of risk associated with management options (i.e Adaptive Management options)

The model will be used as a decision-making tool that can be used for future studies and to inform the Long-term Water Management Strategy for the Tahmoor mining complex.

4.2 Progressive Review

A peer reviewer is required as part of the Consent and consequently has been engaged in the process. SLR is in favour of progressive review and proposes a hold point on completion of each stage of work, it will be reported and presented to peer reviewer and stakeholders to allow feedbacks to be considered and implemented in the model.

Two primary key stakeholders have been identified, namely Department of Primary Industries – Water (DPI-Water) and the Environmental Protection Agency (EPA). A copy of the peer reviewed document from each Hold Point will be provided via email to the identified contact from each regulatory body. A schematic showing the project flow assumed in the scope of works is presented in Figure 3. The process is considered to have internal feedback loops, as independent reviews and stakeholder consultation is undertaken.

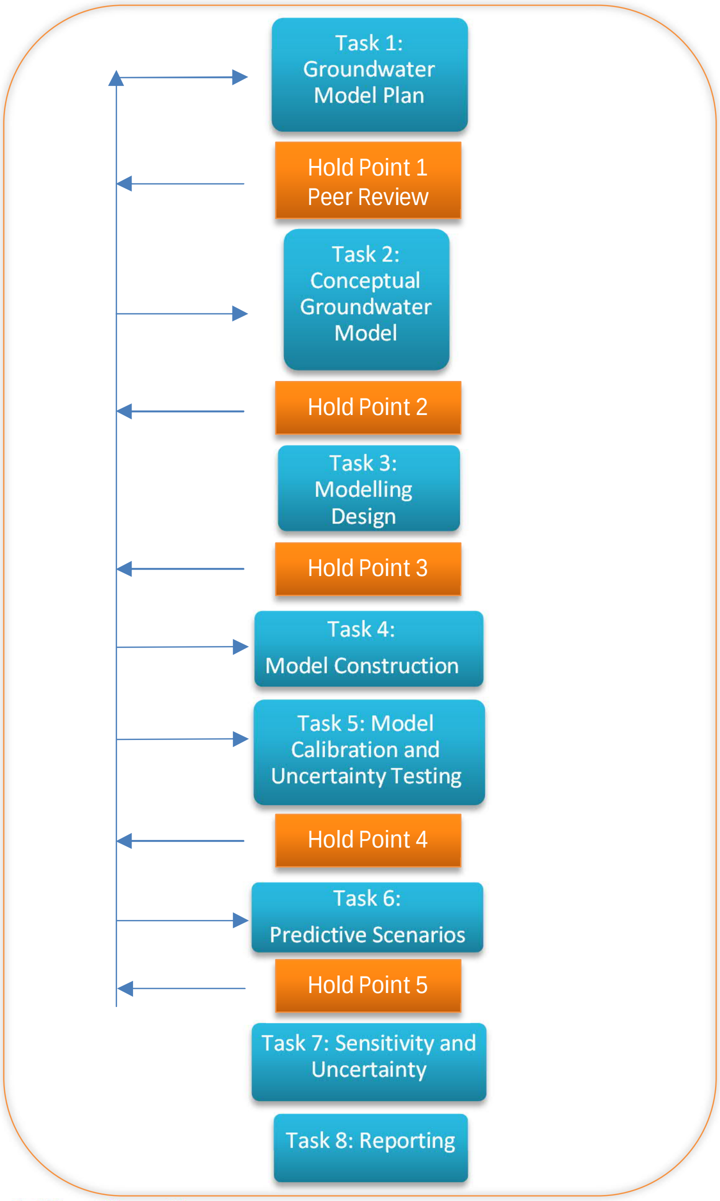

Figure 3 Indicative Modelling Flow Chart

It is worth noting that the limitations of the model inherently exist. These are often linked to the quality and nature of the incoming data (i.e. mine footprint data for nearby mines, extent and nature of specific mapped fractures, etc).

Table 2 presents aspects of the operations that will be not included in the model and the associated aspects of hydrogeology that will not be simulated. Additional model limitations specific to this model will be described in the Modelling Design report.

Table 2 Model Limitations

Limitations/Exclusions (not simulated in the groundwater model)	
Operations	Hydrogeology
Injection and storage of brine and mine water in historical underground mine workings and/or goaf areas.	Simulation of solute/mass transport. The solute movement through the groundwater system in response to the mine water and brine injections into the underground workings.
Post-mining	Post-mining recovery (i.e. groundwater levels recovery and groundwater quality changes following the completion of mining).

4.3 Conceptualisation

The objective of the Conceptualisation Stage is to develop and describe a qualitative model of the hydrogeological regime of the site and how that regime may change as a result of the project. It is important as the model design must attempt to replicate key components of the conceptual model in a numerical simulation framework.

Since 2013, the development of the hydrogeological conceptualisation for the Tahmoor Coal Mine was based on leading practices and considered field data, investigations, expert advice, scientific literature and other appropriate information. The hydrogeological representation presented in the Tahmoor South Amended Project (HS/SLR, 2020) will remain the basis of the conceptualisation to progress with the groundwater model re-build.

The current conceptual model of Tahmoor Coal Mine was recently revised to incorporate field investigations findings (i.e. Nepean Fault, role of structures around the Western Domain, fracturing above longwalls), which are discussed in Section 3.4 and Section 3.5 of the Groundwater Technical Report (SLR, 2021).

To provide the latest scientific basis to rebuild the numerical model, a process of verification of the existing conceptual model is to be conducted. It will follow the four following steps:

1. Review the existing hydrogeological conceptualisation;
2. Review and interpret recent field data, investigations and research findings;
3. Identify relevant information and update key elements of the hydrogeological representation; and
4. Identify the areas of uncertainty.

The following sections briefly discusses this process of verification.

4.3.1 Existing Environment

The following key elements of the conceptual model presented and discussed in (HS/SLR, 2020) and (SLR, 2021) will be reviewed and used as part of the groundwater model re-build:

- Surface drainage:
    - Watercourses;
    - Lakes, including Thirlmere Lakes.
- Geology:
    - Stratigraphic units or layers;
    - Geological Structure;
    - Coal Resources;
    - Hydraulic properties.
- Groundwater:
    - Aquifers;
    - Surface Water – Groundwater interaction;
    - Groundwater Users.

- Subsidence effects of longwall mining on strata.

Table 3 provides a brief discussion of the key environmental assets relevant to the Tahmoor South Project (location shown on Figure 4). Further details on the key environmental assets, if considered relevant to the Tahmoor South Project, will be provided in the conceptualisation stage to highlight their risk to be impacted from the mine. Any additional discussion on key environmental assets will depend upon the availability of new data/information provided prior/during the conceptualisation stage.

Table 3 Key Environmental Assets

River	Characteristics
Nepean River	Perennial and flows from the south through Lake Nepean, across the study area and just east of the Tahmoor South Project. Flows in a northerly direction, with flow of around 310 ML/day (Maldon Weir).
Bargo River	Nepean River tributary. Flows through the middle of the Tahmoor mine leases, before flowing into the Nepean River on the eastern side. Incised in the Hawkesbury Sandstone. Flows in an easterly direction towards Nepean River. Upper Bargo inferred to be gaining, but losing condition prevails with water flowing into the underlying Hawkesbury Sandstone. Losses could be due to earlier mining or natural.
Dog Trap Ck	Flows through the southern part of Tahmoor South. Incised in the Hawkesbury Sandstone. Flows in a northerly direction. Similar flow condition as the “upper Bargo” but losing conditions are inferred to be prevailing. Losses could be due to earlier mining or natural.
Teatree Hollow,	Flows across the northern part of Tahmoor South and across the northern part of Wirrimbirra Sanctuary toward the Bargo River. Surface water monitoring started in 2012.
Hornes Creek	Flows from the south toward the Bargo River. Flows approximately 800m from Tahmoor South Project. Incised in the Hawkesbury Sandstone. Surface water monitoring started in 2012. Potentially a baseflow fed stream.
Eliza Creek, Dry Creek, Carters Creek	Easterly creeks flow from the south toward the Nepean River. Mostly incised in the Hawkesbury Sandstone. Low flow condition and small surface water catchment. Minor contribution from baseflow but no evidence for complete disconnection between streams and groundwater.
Designated Areas	
Water NSWs ‘Special Areas’	National Parks, State Forest and ‘drinking water catchments’. All present on land adjacent to Tahmoor Mine Leases areas.
GDEs	**Characteristics**
Thirlmere Lakes	High Priority GDE in the Water Sharing Plan. Series of shallow freshwater bodies located along a horshoe bend in Blue Gum Ck (inc. Werri Berri, Gandangarra, Couridjah, Baraba, Nerrigorang). Located 650-700 from the nearest Tahmoor North longwalls (LW17-18) and some 3,500m from Tahmoor South panels.
O’Hares Creek and Macquarie Rivulet	O’Hares Creek (>20km) and Macquarie Rivulet (25km). Far field effect from mining at Tahmoor are not anticipated to reach these GDE’s due to their distance to the approved Tahmoor South Project.
High Priority Endangered Ecological Vegetation Communities	Temperate Highland Swamps on Sandstone are in the Southern Highlands about 20-25 km south of Tahmoor South longwalls. Cumberland Plain Woodland. More diffuse and located in the northern half of the study area and further north. Habitat located on soilds developed on the sahles of the Wianamatta Formation. Not solely reliant on groundwater.

River	Characteristics
Wirrimbirray Sanctuary	Property situated on Tea Tree Hollow and one of its main tributary and within the foot print of Tahmoor South longwalls S1A/S4A.
Reservoirs	
Lake Burragorang	18 km northwest of Tahmoor South; storage level ~116.7 mAHD; surface area 72 km^2
Lake Nepean	3 km south of Tahmoor South; storage level ~317.2 mAHD; surface area 3 km^2
Lake Avon	6 km south-southeast of Tahmoor South; storage level ~320.2 mAHD; surface area 9.5 km^2
Lake Cordeaux	14 km east-southeast of Tahmoor South; storage level ~303.9 mAHD; surface area 7.5 km^2
Lake Cataract	18 km east of Tahmoor South; storage level ~289.9 mAHD; surface area 8.5 km^2
Aquifers	
Hawkesbury Sandstone	Primary aquifer. Porous rock aquifer of moderate resource potential. Higher resource potential in areas where secondary porosity is more developed (Nepean Fault). Due to the stratification of the sandstone sequences, groundwater flow is primarily horizontal, with minor vertical leakage. Groundwater is controlled by the topography with flows towards major rives that are deeply incised into the sandstone (i.e. Nepean River).
Narrabeen Group	Sequence of interbedded sandstone, claystone, and siltstone present across Tahmoor Mine. The major unit is the Bulgo Sandstone which has a poor groundwater quality due to the higher salinity than the Hawkesbury Sandstone.
Illawarra Coal Measures	The Illawarra Coal Measures are the primary economic sequence of interest in the Sydney Basin, and consist of interbedded sandstones, shale and coal seams with a thickness of approximately 200 m to 300 m. The two main coal seams mined in the Southern Coalfield are the uppermost Bulli Seam and the Wongawilli Seam (Holla and Barclay, 2000)
Alluvial Aquifer	Minor hydrostratigraphic unit. Thirlmere Lakes Alluvium associated with Blue Gum Ck. Comprises clayey sands and sandy clays. Maximum thickness 40-60 m within a thin valley, few hundred metres wide.
Wianamatta Formation	Minor hydrostratigraphic unit. Poorly permeable, with typically poor water quality. Groundwater in the Wianamatta Group is associated with perched water table zones with limited vertical flow. Springs can develop within the Wianamatta Formation and contact with the Hawkesbury Sandstone.
Private Usage	
Private Bores	Licensed groundwater entitlement of approximately 4,060 ML/year for private or small-scale government use. There is approximately 1,000 ML/year of unlicensed groundwater use for stock and domestic purposes, which is based on the assumption that use for these purposes is 1-2 ML/year. Most of the groundwater usage in the area is from the Hawkesbury Sandstone or from surficial alluvium and basalt aquifers (about 89% of the total), with about 10% from the Bulgo Sandstone.

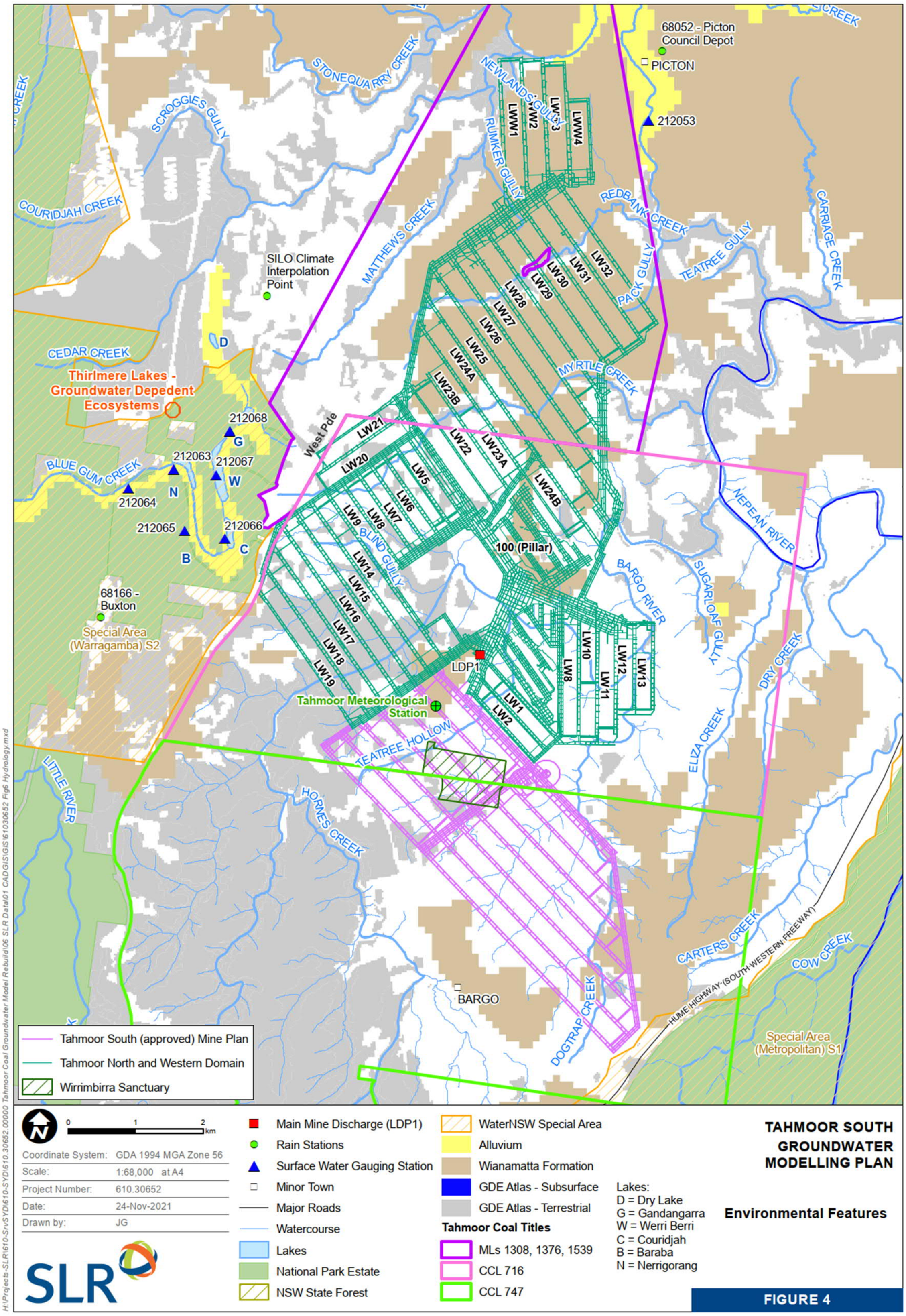

Figure 4 Environmental features

4.3.2 Data Collection and Interpretation

An on-going process of refinement and feedback will be established between the conceptualisation, design, and calibration (AGMG, 2012) via a progressive review. Data that was collected to develop the previous conceptual models (HS/SLR, 2020; SLR, 2021) will be used in the new conceptual model.

SLR currently coordinates the Monitoring Plan Strategy of Tahmoor Coal for the Tahmoor South Project which aims to upgrade the monitoring network by re-installing bores and recommending new monitoring location (for 'shallow' and 'deep' groundwater).

To meet the requirements of the Condition B34 (iv), Tahmoor Coal is in the planning stage to upgrade the surface water monitoring network. The upgrade will be conducted by the surface water consultant, ACT Williams.

The upgrade in the water monitoring network has the objective to better understand the hydrogeological condition prior, during and following the cessation of mining operations at Tahmoor South and will provide insightful information for the hydrogeological conceptual model.

The following briefly presents data that will be collected as part of field programs, investigations and research findings and that will be interpreted to revise key elements of the conceptual model:

4.3.2.1 Surface Drainage

- Time series of watercourses stages, flow and water quality;
- Lake water levels; and
- Findings of the TLRP.

4.3.2.2 Geology

- Hydraulic properties (Kh, Kv and S values) via packer tests and core tests.
- Bore log geological data; and
- Latest geological model (i.e. surface elevations and geological structures).

4.3.2.3 Groundwater

- Time series of groundwater levels/pressure and groundwater quality;

4.3.2.4 Stressors

- Effects of longwall mining on strata (i.e. subsidence and fracturing);
- Water makes in the underground mine;
- Possible discharge of wastewater to groundwater systems; and
- Groundwater use (i.e. records in recent abstraction rate if any available).

As part of the iteration process, preliminary model simulations in the prediction stage will be conducted to test elements of the conceptualisation and highlight additional data that may be required. The conceptual model plan will also incorporate uncertainty early in the model stage development.

The conceptual hydrogeological model for the Tahmoor Coal Mine and surrounds will be updated using information derived from geological and topographical maps, seismic and airborne electromagnetic surveys, bore log geological data, packer testing, other regional hydrogeology reports, and data from the groundwater monitoring network. The following sections present the process of verification of the key components of the conceptual groundwater model.

The key components of the conceptual groundwater model will be verified using new data from the:

- Latest geological model (i.e. surface elevations and geological structures);
- Detailed topographic maps (i.e. LiDAR data);
- Existing and future groundwater monitoring bores (i.e. groundwater levels/pressures, bore logs geological data);
- Permeability investigations (i.e. pre- and post-mining packer testing, core testing);
- Management of mine inflows (i.e. water make in the underground mine).

4.3.3 Hydraulic conductivity

The existing conceptual model (SLR, 2021) has recently been revised and updated to incorporate new hydraulic properties measured across the Western Domain as part of the Extraction Plan for LW W3-W4 and more recently to inform the effect of higher hydraulic property zones north to the Western Domain (SLR, 2021).

The 'Tahmoor Mine hydraulic properties database' is constantly revised and updated as new information (i.e. packer test results) become available, and is augmented by data shared with neighbouring mining operations. Appendix A of the Groundwater Technical Report (SLR, 2021) presents the latest major update of the database prior to the revision of the groundwater numerical model. The methodology to incorporate new hydraulic properties in the numerical model will be discussed in Section 4.4 of this GMP.

SLR currently coordinates the Monitoring Plan Strategy of Tahmoor Coal for the Tahmoor South Project which aims to upgrade the monitoring network by re-installing bores and recommending new monitoring location (for 'shallow' and 'deep' groundwater) to better characterise the groundwater regime.

Packer testing to characterise horizontal hydraulic conductivity (Kh), as well as core testing to characterise the lower bounds on Kv, will be conducted at some new monitoring sites. It is expected that the packer testing will be conducted during the groundwater model re-build process, prior the commencement of mining at Tahmoor South. A process of validation will be conducted in which the 'Tahmoor Mine hydraulic properties database' will be updated as new information become available.

The incorporation of the outcomes of the findings of the TLRP and other relevant research on the Thirlmere Lakes will be incorporated in the groundwater conceptual model. At this time of writing the GMP (SLR, 2021), only preliminary results are available, and these have been considered in previous documentation. Final interpretation and data are not yet available ,but will be incorporated in the conceptual model.

Recommendations will be provided in the Monitoring Plan Strategy to possibly install additional monitoring bores near the Thirlmere Lakes, if required.

Available bore logs data from the Thirlmere Lakes will be reviewed and used to inform the revision of the aquifer geometry and alluvium extent.

The updated hydraulic properties database will be interpreted, and any anomalies will be investigated. Depending on the outcomes of the TLRP and where possible, the following verification could be envisaged for the Thirlmere Lakes conceptual model:

- Aquifer geometry (i.e. alluvium extent and thickness, depth to bedrock);
- Hydraulic conductivity of alluvial material and bedrock beneath the Thirlmere Lakes;
- Geological structure (i.e faults);

4.3.4 Subsidence and deformation

Following an extensive review of literature and regional and site data the representation of subsidence and deformation in site conceptual and numerical model has been defined by several conceptual zones. These conceptual zones will remain the basis of the new conceptual model with data from field programs to be utilised to simulate the changes that occur to the geological strata around the Tahmoor Mine. The conceptual zones are (HS/SLR, 2020):

- the caved zone (including the extracted panel of coal);
- the fractured zone, consisting of:
    - a lower zone of vertically connected cracking;
    - an upper zone of disconnected-cracking, but where horizontal conductivity and porosity is enhanced;
    - the constrained zone;
    - the surface cracking zone; and
- ‘floor’ strata deformation, beneath the extracted panel.

4.3.4.1 Zone of Vertically Connective Cracking

The rocks in the connective-cracking part of the fractured zone will have a substantially higher vertical conductivity than the undisturbed host rocks, encouraging groundwater to move out of rock storage downwards towards the goaf. The representation and parameterisation of the connective-cracking part of the fractured zone will be revised and updated, if necessary, in the conceptual model.

The existing and proposed bores with multiple vibrating wire piezometers (VWP’s) in hydrostratigraphic units of various depths from the Bulli Seam to the Hawkesbury Sandstone within/near the Tahmoor South footprint will allow to identify any changes in the hydraulic gradient. These observations will provide information on the extent and depth of the lower zone of vertically connected cracking.

The permeability results from field investigation will inform both the height above the panel and magnitude of the vertical enhancement of the hydraulic properties.

4.3.4.2 Upper Zone of Disconnected-Cracking

Depending on longwall geometry and the presence of low permeability lithologies, there can be a zone of ‘disconnected’ fracturing (or a ‘constrained zone’) in the overburden that acts to mitigate the upward migration of depressurisation. In this zone, rock layers are likely to sag without breaking, and bedding planes are likely to open. As a result, some increase in horizontal conductivity could still be expected, but the less frequent vertical fracturing will lead to disconnection in that direction, meaning there is little change in vertical conductivity. In the zone of disconnected fracturing the vertical movement of groundwater will be enhanced slightly but not be significantly greater than under natural conditions.

The existing shallow nested piezometers which monitor the Hawkesbury Sandstone (upper, mid, lower) at various depth such as P12-P17 and WD01 across the Western Domain are good examples of sites that provide information on the potential occurrence of the upper zone of disconnected fracturing. Groundwater observations in the Hawkesbury Sandstone can be coupled with bores equipped with VWPs in deeper strata to delineate the depth of the zone of disconnected fractures. Pre- and post-mining permeability test results at existing and new monitoring sites at Tahmoor Mine will be used to provide information on the possible depth of the vertically connected fracturing and the zone of disconnected fracturing above that.

The height of connected and disconnected fracturing will be updated based on the width of the longwall panels, cutting height and the depth of mining, and considering the guidance in IEPMC (2019a). Again, observations in groundwater levels and hydraulic test results especially the Hawkesbury Sandstone will be presented and discussed in the conceptual model to provide information on any potential changes in rock properties.

4.3.4.3 Surface Cracking Zone

In the surface zone, near-surface fracturing can occur due to horizontal tension at the edges of a subsidence trough. Cracking at the surface will typically be 20 to 30 m deep. McNally and Evans (2007) stated this is usually but not always transitory, due to increased porosity that may not be connected below or beyond the area of disturbance. The upgrade in the shallow groundwater monitoring network across the Tahmoor South will help to identify near-surface fracturing. Field investigations (i.e. packer tests) during pre and post mining across Tahmoor South and as previously conducted along Redbank and Myrtle Creek (Tahmoor North) will help to assess changes in permeability (magnitude and depth) due to near-surface cracking, and the persistence of effects on shallow groundwater and surface water. Existing groundwater levels trends for the baseline period will be presented, including at proposed monitoring location as they become available.

To verify these conceptual zones, groundwater levels and pressures within and outside the Tahmoor South footprint will be assessed using hydrographs to identify changes in hydraulic gradient between aquifers due to mining. The existing flow direction in the relevant stratigraphic units will be presented by developing groundwater contour maps and hydrographs and compared water level predictions from during and after mining, to identify any change in flow direction.

Outside the footprint of longwalls, advice from geotechnical engineers will be required to better understand (and possibly simulate) the potential role of basal shears and valley closure at Tahmoor Mine. Such effects may not be included in the groundwater modelling, given the difficult in predicting their occurrence, and representing these in the model given the physical scale of the effect(s).

4.3.5 Height of Connected Fracturing

As discussed above, the height of connected fracture is estimated based on the width of the longwall panels, cutting height and the depth of mining. The deformation of and vertical drainage of water through the fractured zone will result in areas of the fractured zone to have groundwater pressures reduced towards atmospheric pressure (i.e. zero pressure head). This does not mean that these areas are dry, simply that there is free drainage through the cracks and fractures, and that recharge from above is insufficient to match downward drainage. Empirical models can be used to estimate the vertical height to which this occurs.

At this mine, the empirical models referred to as the Ditton Geology Model (Ditton and Merrick, 2014) and Tammetta model (2013) appear suitable. The estimates from both will be considered during conceptualisation.

Analysis of geotechnical and hydrogeological data from WD01 (pre-mining hole) and WD02 (post-mining hole), and the earlier HOF hole (TBC040c), will be considered alongside the estimates from the Ditton model "A-zone" and "B-zone" and the results of the Tammetta (2013) ("H"). This analysis will inform the conceptualisation and selection of an appropriate empirical model (or some alternative method, if neither of these is suitable), which will then inform design and parametrisation of the height of fracturing in the numerical model prior to calibration.

Estimates of the height of fracturing above the Tahmoor South longwalls will be re-calculated using the latest Tahmoor South mine plan and geological model, although should not change significantly from the estimates presented in the EIS.

As mining progresses at Tahmoor South, it is recommended to conduct the development of Height of Fracturing (HoF) holes above the Tahmoor South longwalls. Subsequent packer testing (pre-/post-mining) and defect logging of the HoF holes and monitoring of groundwater pressure would inform the conceptual model (i.e. identify zero pressure head, change in permeability with depth). This would increase the confidence of the representation of the conceptual zones in the conceptual model and numerical model.

4.3.6 Surface Water Systems

The surface cracking zone will be incorporated in the new conceptual model, as previously done in HS/SLR (2020). Mining induced deformation of the surface cracking zone may result in reduced baseflow to watercourses and increased leakage of surface water into near surface strata.

To assess future impacts of subsidence, monitoring and analysis of both ground and surface water quality is essential to determine whether subsidence has occurred. Further bore installations will be conducted along local watercourses at Tahmoor South in conjunction with the installation of various surface water monitoring sites to monitor flow and stage height.

The upgrade in the water network will improve the understanding of the interactions between surface water and groundwater (i.e. gaining or losing system) before, during and following mining at Tahmoor South and be incorporated in the conceptual model. An extensive water monitoring network will help to target areas where water lost from surface features (i.e. surface cracking zone above longwalls or defects outside the footprint of longwalls) is likely to occur or has occurred. A review of the existing and future groundwater and surface water quality data will also provide information on the location of re-emergent water due to the surface cracking zone. Packer testing at existing and proposed shallow bores before and following mining will provide additional information on surface cracking effects (i.e depth, change in hydraulic property, flow pathways).

4.3.7 Concepts and uncertainty

At the end of the conceptualisation stage, there will be an opportunity to consider the source of uncertainty of the new conceptual model by conducting a qualitative uncertainty analysis.

This analysis has for objectives to understand uncertainty at an early stage, its effect on the project objectives, identify any remedial actions to reduce it and verify the uncertainty methodology proposed in this GMP. This will be presented as a summary table or flow chart at the end of the conceptualisation report and be discussed with Tahmoor Coal and relevant agencies.

HOLD POINT 2- Conceptualisation report and presentation

4.4 Model Design

Based on the conceptual groundwater model a numerical groundwater model will be developed.

The model will be constructed to be suitable for predicting groundwater responses to changes in applied stress or hydrological conditions and the evaluation and management of potentially high-risk impacts. The model will also be developed in line with understanding of IESC expectations.

The existing Tahmoor groundwater model lastly updated by SLR (2021) will be used as a foundation to build the Tahmoor South model. As outlined in Section 3, a range of updates are required to develop a model that is fit for purpose for the ongoing requirements of Tahmoor Mine and agencies. The updates to the model design include:

- Model extent and grid – revise grid extent and refinement of the mesh to focus on areas or features of importance and put less focus on more distant areas or features.
- Model layers –verify model layers match the Tahmoor Coal geological model surfaces and LiDAR data, and update layers where necessary. Consider stratification of alluvium at Thirlmere Lakes .
- Timing – update calibration model and extend to mid-2021 and improve stress period timing to capture seasonality and mine progression changes.
- Boundary Conditions – update model boundary conditions with revised grid extent.
- Stresses –updates pumping and mining stresses from up-to-date and site-specific data

Further details on the proposed updates are included in Section 4.4.1 to 4.4.7 below.

4.4.1 Model Target Confidence Level Classification

The groundwater modelling will be conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett *et al.* 2012), the MDBC Groundwater Flow Modelling Guideline (MDBC 2001) and the released IESC Explanatory Note for Uncertainty Analysis (IESC, 2018). These are mostly generic guides and do not include specific guidelines on special applications, such as underground coal mine modelling.

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.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

Table 4 (based on Table 2.1, Barnett *et al.* 2012) summarises the classification criteria and shows a scoring system allowing model classification.

Based on Table 4, the groundwater model developed for this Groundwater Assessment may be classified as primarily Class 2 (effectively “medium confidence”) with some items meeting Class 3 criteria, which is considered an appropriate level for this Project context. Criteria that will need to be considered and incorporated in the revised model are also indicated by the symbol ‘*’; these will allow to improve the confidence level.

Table 4 Groundwater Model Classification Table (modified from HydroGeoLogic, 2020)

Class	Data		Calibration		Prediction		Indicators	TOTAL
	No much / Sparse coverage		Not possible		Timeframe >> Calibration		Predictive Timeframe > 10x Calibration	
	No metered usage	*	Large error statistic		Large stresses/periods		Predictive Stresses > 5x Calib'n	
1	Low resolution topo DEM	✓	Inadequate data spread		Poor/no validation		Mass Balance > 1% (or one off <5%)	1
	Poor aquifer geometry		Targets incompatible with model purpose		Transient prediction but steady-state calibration		Properties <> field values	
	Basic/Initial conceptualisation						Poor performance stats / no review	
	Some data / OK coverage	*	Weak seasonal match	*	Predictive Timeframe > Calib'n		Predictive Timeframe = 3-10x Calib'n	
	Some usage data	*	Some long-term trends wrong		Different stresses &/or periods		Predictive Stresses = 2-5x Calib'n	
2	Some Baseflow estimates, Some K & S measurements	✓	Partial performance (e.g. some stats / part record / model-measure offsets).	✓	No validation but key simulations constrained by data (maybe not all)	✓	Mass Balance (1% (all periods)	7
	Some high res. Topo DEM and adequate aquifer geometry	✓	Head & Flux targets constrain calibration	✓	Calib. & prediction consistent (transient or steady state)		Some properties maybe <> field values, but review by Hydrogeologist	
	Sound conceptualisation, reviewed & stress-tested	✓	Non-uniqueness, sensitivity and qualitative uncertainty addressed	✓*	Magnitude & type of stresses outside range of calib'n stresses		Some poor performance or coarse discretisation in key areas/times	
3	Plenty data, good coverage	*	Good performance statistics	*	Timeframe ~ Calibration	✓	Predictive Timeframe <3x Calib'n	9

SLR

Class	Data		Calibration		Prediction		Indicators	TOTAL
	Good metered volumes (all user)		Most long-term trends matched	*	Similar stresses &/ or periods.	✓	Predictive Stresses <2x Calib'n	
	Local climate data & baseflows		Most seasonal matches OK.	*	Good validation (or all simulations constrained by data)	✓	Mass balance <0.5% (all periods)	
	Kh, Kv & Sy measurements from range of tests.	✓	Calibration to present day ahead and flux targets	✓	Steady state prediction only when calibration in steady state	✓	Properties ~ field measurements.	
	Hig res topo DEM all areas & good aquifer geometry.		Non-uniqueness minimised &/or parameter identifiability &/or minimum variance or RCS assessed	✓	Suitable computational methods applied & parameters are consistent with conceptualisation	✓	No coarse discretisation in key areas (grid or time).	
	Mature conceptualisation		Sensitivity &/or Qualitative Uncertainty	*	Quantitative uncertainty analysis	✓*	Review by experienced Hydro/Modeller	

* To be finalised

Sourced from HydroGeoLogic (2020) - After Table 2-1 of AGMG (Barnett et al. 2012) and Figure 5 of IESC uncertainty guidance (Middlemis & Peeters 2018))

4.4.2 Model Code

Consistent with the existing model, the numerical modelling will be undertaken using Geographic Information Systems (GIS) in conjunction with MODFLOW-USG-Transport (currently v1.8.0; Panday, 2021). MODFLOW-USG is a relatively new version of the popular MODFLOW code (McDonald and Harbaugh, 1988) developed by the United States Geological Survey (USGS). MODFLOW has been the most widely used code for groundwater modelling in the past and has long been considered an industry standard.

4.4.3 Model Extent and Mesh Design

Minimal changes to the model extent will be conducted. The new model will be large enough to incorporate surrounding mines and to prevent boundary influence on model predictions. The model outputs (i.e. extent of the predicted maximum drawdown) from the Tahmoor existing model (SLR, 2021) will be used to define the model extent.

The proposed horizontal and vertical extent of the numerical model will likely be similar to the existing model (approximately 60 km N-S and 50 km W-E). The model domain is designed large enough to allow the adjacent mines/projects (primarily BSO/Appin and Dendrobium Mines, but others if necessary)) to be assessed for potential cumulative impacts related to Tahmoor Mine.

To allow stable numerical modelling of the large spatial area of the model domain, an unstructured grid with varying Voronoi cell sizes will be designed using Algomesh (HydroAlgorithmics, 2014). Varying Voronoi cell sizes allows refinement around areas of interest (e.g. watercourses, mine areas, significant geological features) while a coarser resolution elsewhere reduces the total cell count to a manageable size. In addition, pinch-out option of MODFLOW-USG will be used, which means model layering does not need to be continuous over the model domain, and layers can stop where geological units pinch out or outcrop. This is also particularly useful when simulating thin, discontinuous hydrostratigraphic units and faults.

The model domain will be vertically discretised based on the conceptual model (current estimate is 18 layers). Single hydrogeological units will be represented by one and/or up to three model layers while aquitards will be represented as an individual model layer. The total number of cells in the model is expected to be considerably reduced compared to the existing model, especially after pinching out parts of the upper layers where stratigraphic units may be absent or eroded away. The reduction of the number of model cells and the use of pinch-outs will improve the speed of the simulation.

Grid refinement will be considered to represent the following features:

- Regular (aligned) square grids of cells (100 m spacing) enforced in the Tahmoor North, Tahmoor South and Western Domain and rotated in line with the longwalls, and in those of neighbouring mines (approximately 150 m spacing).
- Drainage within the model domain, represented by cell size constraints of 25 to 120 m Voronoi cells. Higher refinement is associated with proximity to enforce finer Voronoi cell resolution along the mapped extents of the Nepean River, Bargo River, Stonequarry Creek, Cedar Creek, Carters Creek, Eliza Creek, Dry Creek, Dogtrap Creek, Teatree Hollow, Hornes Creek, Cow Creek and the Thirlmere Lakes (25 m) including the upper reach of Blue Gum Creek.
- The mapped alluvial boundaries present across the model extent will be used to enforce finer cell resolution in a range of 200 m and 400 m cell size (i.e. Thirlmere Lakes, Upland Swamps).

- Regular hexagonal grid of cells will be used to refine the mesh across the reservoirs (e.g. Nepean, Avon Reservoirs) with maximum cell size of 200 m.
- The faults by 150 m by 150 m hexagonal Voronoi cells (i.e. Nepean Fault Complex, Bargo Fault, Victoria Park Fault, Central Fault, Western Fault) with greater details possible along faults close to Tahmoor Mine.

4.4.4 Layers and Features

It is proposed that the model be developed with approximately 18 layers to represent the regional stratigraphy, capture key coal seams mined at site and surrounding operations and allow the model to simulate vertical variation in drawdown above and adjacent to Tahmoor longwalls. The proposed layers for the new model are presented in Table 5 (subject to further analysis and conceptualisation).

As shown Table 5, most of the proposed layers for the Tahmoor South model are currently in the existing model. Where a layer exists in the 2020 model, the layer information will be directly incorporated into the new model. Additional layers will be added to the existing 16 model layers. Firstly, if findings from future geological investigations and the TLRP suggest substantial differences to current conceptualisation. This may include a new layer used to represent alluvial deposits at Thirlmere Lakes. Secondly, there should be a clearer distinction between the units currently simulated in Layer 1, meaning that the representation of the Wianamatta Formation in a single layer instead of being grouped with other lithologies. Upon completion of transferring the layer elevations from the existing model to the updated model, they will be compared against the site geology model and available bore logs to ensure accuracy. Average thickness shown in Table 5 are calculated from the existing model and will be adjusted if comparison against the geology model warrants it.

The extent of the fault from the SLR (2021) model will be compared against the site geology model and any recent field investigations and then updated if required in the new model. The faults will be simulated as a different hydraulic property zone (K only, not S parameters).

The dykes and sills including the large 'Yerrinbool Igneous Complex' present in the coal measures and other units were not present in the SLR (2021) model and are unlikely to be incorporated in the new model due to the effects being at local scale (HS, 2019).

Table 5 Proposed Model Layers (subject to revision)

Model Layer	Model Lithology / Stratigraphy	Mean Thickness (m)
1	Regolith, alluvium and basalt	30
2	Wianamatta Formation	
3	Hawkesbury Sandstone Upper	40
4	Hawkesbury Sandstone	
5	Hawkesbury Sandstone Lower	55
6	Bald Hill Claystone	20
7	Bulgo Sandstone Upper	55
8	Bulgo Sandstone Lower	55
9	Stanwell Park Claystone	13
10	Scarborough Sandstone	12
11	Scarborough Sandstone	12
12	Wombarra Claystone	19

Model Layer	Model Lithology / Stratigraphy	Mean Thickness (m)
13	Coal Cliff Sandstone	absent at Tahmoor otherwise approx. 20 m
14	Bulli Seam	2.2
15	Eckersley Formation (e.g. Loddon / Lawrence Sandstones)	40
16	Wongawilli Coal Seam	5
17	Kembla Sandstone	10
18	Older units (lower Permian Coal Measures and Shoalhaven Group)	100
1-14	Conductive zone/fault (e.g. Nepean Fault, Eastern Fault, zone north of Western Domain	NA
1-14	Barrier Fault (mostfaults)	NA

4.4.5 Timing

A combined steady-state and transient calibration model will be developed. The stress period lengths are likely to be consistent with the existing groundwater model, as follows:

- A steady state model for pre-mining condition;
- Transient warm up model (i.e. 1969 to 2009)
- Transient model calibration will be based on historical mine scheduling based on longwall start/completion from January 2009 to December-2021;
- Predictive model based on longwall start/completion will be used to simulate effects on the groundwater regime over the life of approved the Tahmoor Mine, including Tahmoor South (late-2021 to 2035); and
- Post-mining or Recovery period will simulate post-mining conditions for a period of several hundred years after completion of approved mining at Tahmoor.

During steady state calibration, initial water levels will be set at the Top of Layer 1 and modelled heads from subsequent calibration runs will then be used. The steady state model will be set up as the first stress period of the new transient model.

Steady state water levels will be checked, where possible, against suitable “pre-mining” heads, however given the long history of mining at Tahmoor, such data is sparse.

4.4.6 Boundary Conditions

The indicative model boundary conditions and model extent are presented in Figure 5. The model perimeter is set as a 'no-flow' boundary by default in MODFLOW-USG.

For the rest of the model boundaries, general head boundary (GHB) boundary conditions are likely to be used to represent the regional flow into and out of the model area. Groundwater will enter the model where the head set in the GHB is higher than the modelled head in the adjacent cell and leave the model when the water level is lower in the GHB. Where possible, GHB heads will be assigned based on recorded water levels at monitoring and/or registered bores. GHB conductance is calculated using the estimated modelled hydraulic conductivity of the layer in which the GHB is assigned multiplied by the cell area and is therefore variable in this model due to variable cell-size.

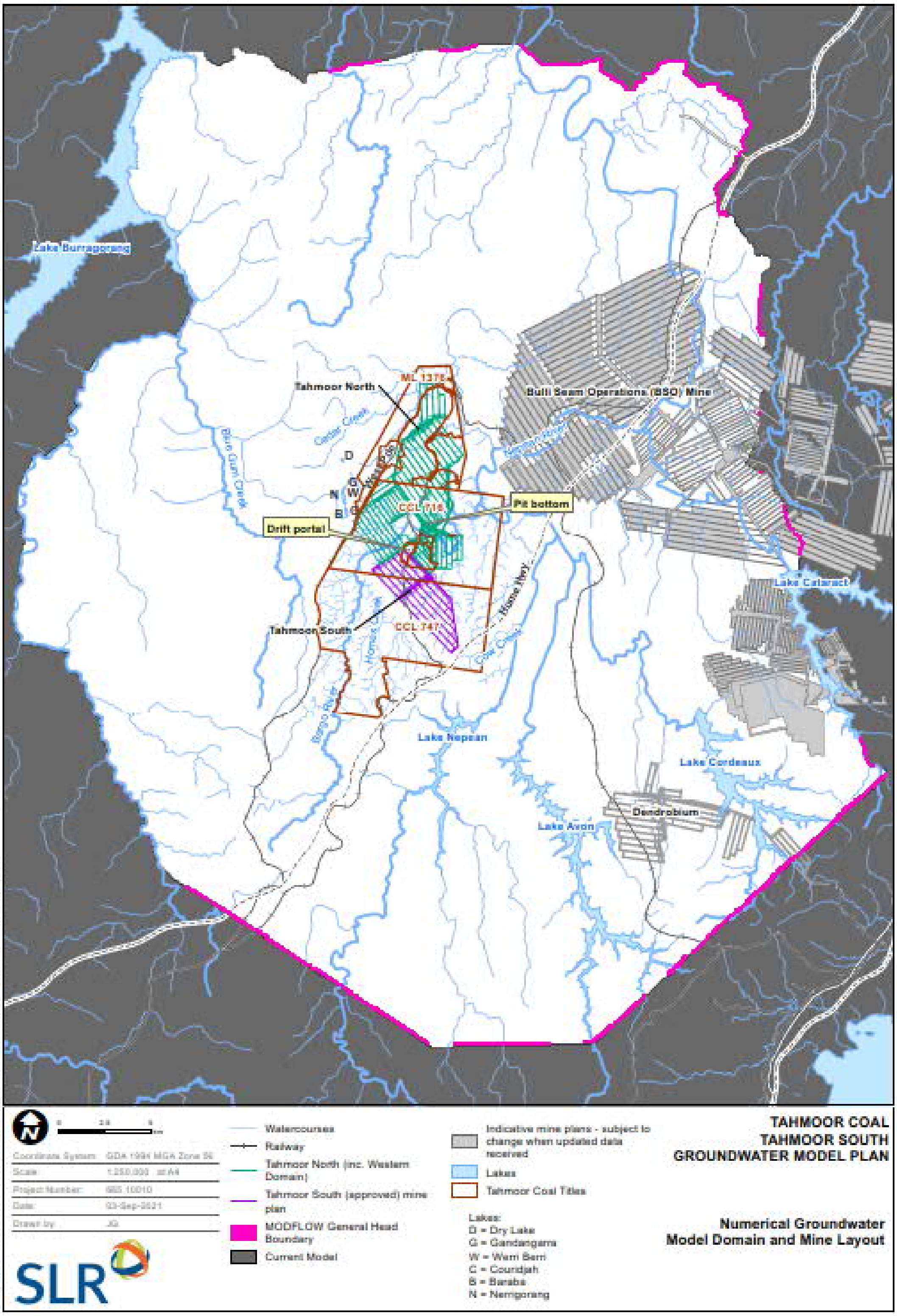

Figure 5 Numerical Model Domain

4.4.7 Stresses

4.4.7.1 Surface Drainage

Major rivers and streams (Stream Order 4 and 5) as well as minor creeks (Stream Order 3) will be represented in the model. The major watercourse include the Bargo River, Nepean River, Avon River, Stonequarry Creek, as well as the more minor Cedar Creek, Dogtrap Creek, Teatree Hollow, Eliza Creek, and Cow Creek. Creeks and rivers throughout the model domain will be simulated using MODFLOW's River (RIV) package. RIV is a form of the head dependent boundary condition which is appropriate for a stream that partially penetrates a layer and can receive water from an aquifer (gaining stream) or pass water to an aquifer (losing stream).

The watercourses likely to be included in the model RIV package are presented in Table 6. River and creek widths and conductance will be adopted from the existing groundwater model and the river surface based will be updated using the latest LiDAR surveys provided by Tahmoor Coal or taken from the Elvis web-portal[1]. Watercourses widths will be estimated from available data and imagery. The initial river conductance for model calibration and prediction will be calculated using river width, river length, riverbed thickness (which will be assumed), and the vertical hydraulic conductivity of riverbed material. River-bed conductance will be set up to vary during the calibration stage (Section 4.5)

The river stage elevations will be estimated using the recorded stage heights from the government gauging stations (Stonequarry Creek - 212053) and an appropriate multiplier based on watercourse order or size. For the transient simulation, river stage levels will be updated with recent surface water observations and using the same methodology as developed in the existing model (HS/SLR, 2020 – refer to Section 4.4.2). Transient river stages will be estimated from observed data from the NSW Government monitoring station on Stonequarry Creek (212053) and data collected by Tahmoor Mine at several monitoring locations along Redbank Creek, Cedar, Matthews and Stonequarry Creeks, and then for watercourses around Tahmoor South (e.g. Dogtrap Creek).

Table 6 provides details on the design of surface drainage in the model but any updates in the conceptualisation will be accounted for the parametrisation of surface drainage (i.e recent water levels, new monitoring sites). As described in Table 6, average stage heights for each model stress period will be calculated using the monthly data available at Stonequarry Creek (station 212053) and will be used in the calibration model. The monitoring data collected by Tahmoor Coal are used to estimate an appropriate multiplier of the Stonequarry Creek data for the other watercourses, classed according to their size (catchment area). Data at future monitoring stations, if available, can be used to update and refine the river stage heights. For the predictive period, the recent surface water level data will be incorporated in the calculations of the river stage heights used in the existing model.

The minor tributaries or drainage lines would be represented by Voronoi cells up to 1 km^2 in area of lower grid refinement. The river stage height in the minor tributaries or drainage lines that do not have a reach number (i.e. of lesser interest) will be set up to 0 m. This would follow the same procedure as in the existing model. Therefore, the minor tributaries or drainage lines will only act as drains to the groundwater system and will not result in any leakage or recharge (i.e. stage set to 0 m).

[1] https://elevation.fsdf.org.au/

Table 6 River and Surface Water Features in the Tahmoor South Model

Boundary	Water depth (m)
Nepean River	- SS simulation - Long-term Median - Calibration simulation - Historical Monthly Average - Prediction simulation- Transient Stage Height- Long Term Monthly Average
Bargo River, Avon River, Cordeaux river	- SS simulation - Long-term Median - Calibration simulation - Historical Monthly Average - Prediction simulation- Transient Stage Height- Long Term Monthly Average
Stonequarry Crk	- SS simulation - Long-term Median - Calibration simulation - Historical Monthly Average - Prediction simulation- Transient Stage Height- Long Term Monthly Average
Cedar Ck, Redbank Ck, Matthews Ck, Myrtle Crk, Eliza Crk, Dogtrap Ck, Cow Crk, Hornes Crk, Teatree Hollow, Carters Crk, Dry Crk	- SS simulation - Long-term Median - Calibration simulation - Historical Monthly Average - Prediction simulation- Transient Stage Height- Long Term Monthly Average
Rumker Gully, Newlands Gully	- SS simulation - Long-term Median - Calibration simulation - Historical Monthly Average - Prediction simulation - Transient Stage Height- Long Term Monthly Average
Other Minor Creeks	- SS simulation - Long-term Median - Calibration simulation - Fixed Stage - Prediction simulation - Fixed Stage

4.4.7.2 Water Storages and Lakes

The Thirlmere Lakes and man-made reservoirs (i.e Lake Nepean, Lake Avon, Lake Cordeaux, Lake Cataract, Lake Burragorang) will be represented in the new model using the MODFLOW River Package. The same methodology as in the HS/SLR (2020) model will be applied to simulate these two simple classes of waterbody in the new model. Further details on the methodology are provided in HS/SLR (2020) (refer to Section 4.4.5).

The results of the TLRP will be used to update the representation of the Thirlmere Lakes, and the associated alluvium, in the new model. It is expected to update the RIV package but will not be limited to the following depending on the results:

- recent Thirlmere Lakes water levels;
- refinement on the Thirlmere Lakes extent; and
- bed conductance (i.e. widths, thickness of bed, vertical hydraulic conductivity)

The groundwater model will be not fully coupled with the surface water model and the groundwater model will be used to inform surface water impact assessment and any surface water modelling.

4.4.7.3 Recharge and Evapotranspiration

Recharge zones will be revised in the new model, based on recent land use and geological mapping. Initial recharge rates will be estimated on a regional basis, considering literature (e.g. Crosbie, 2015; EMM, 2015), field data, and BoM's AWRA-L modelling. The recharge rates will be adjusted during the calibration stage.

Potential ET from groundwater will be simulated using the MODFLOW Evapotranspiration (EVT) package. Evapotranspiration zones will be set based on land use mapping (vegetation type). The extinction depth will be set-up in a similar way as in the existing model (HS/SLR, 2020 – refer to Section 4.4.5), considering literature.

The model design and calibration report will present maps of the recharge and evapotranspiration zones that will be represented in both the new steady and transient models.

4.4.7.4 Mining

Underground mining will be represented to assess impacts of the Tahmoor Mine and cumulative effects with neighbouring mines. The MODFLOW Drain (DRN) package will be used to simulate mine dewatering in the model for the historical and approved mining including for the surrounding mines. Drain boundary conditions allow a one-way flow of water out of the simulated groundwater system.

In both the calibration and prediction model, the DRN package from the existing model will be utilised and updated with the latest mine plans available for:

- Tahmoor South
- Tahmoor and Tahmoor North
- BSO/Appin Mine (approved and updating if required historical mining at West Cliff and Tower)
- Dendrobium Mine (historical and approved domains)
- other mine areas as required by the conceptual model.

The Drains will be activated on the basis of roadway and longwall schedules in the various mine areas to match the stress period timing.

Underground mining will also be represented with the TVM (time varying materials) model package to represent subsidence and fracturing effects above longwalls. The modelled hydraulic properties will be changed with time in the goaf and overlying fractured zone above each longwall panel.

As described previously (Section 4.3.5), the empirical models Tammetta (2013) and Ditton Geology Model (Ditton and Merrick, 2014) will be assessed in conjunction with the data from monitoring sites and targeted investigations and this will inform the parametrisation of the height of fracturing in the numerical model prior to and during calibration.

Prior to the calibration stage, it is suggested to conduct preliminary runs involving a combination of the two empirical models (e.g. Concept 1 and Concept 2, or another, as described below) to test the sensitivity of the height of fracture estimates on mine inflows and drawdown.

- Concept 1: Ditton A-zone (connected fracture) and Ditton B-zone (disconnected fracture).
- Concept 2: Tammetta H (connected fracturing) and Ditton B (disconnected).
- Based on data analysis from investigations (Section 4.3.5), alternative models might be developed.

To determine the most appropriate "Concept", geotechnical and hydrogeological observations from WD02 (post-mining hole) in the Western Domain and future investigation above LW W101A to investigate pre/post mining hydraulic properties at Tahmoor South are intended to be used to provide a more accurate representation of the fracturing. In case, site data is not available by the time of constructing the model, then regional data on fracture height will be used to choose the best approach in simulating mining. There will be opportunity as part of statutory requirements (i.e Extraction Plan) to allow for regular verification of the conceptual model/ updating of the model (i.e fracture height) based on data that become available.

To date, site specific data is available but remains limited on the change in properties with longwall mining at Tahmoor (e.g. site TBF040c).

The findings on the conceptualisation and the model sensitivity to Concept 1 and Concept 2 (or others) will inform the methodology to set up the model packages (i.e. TVM) for the calibration stage.

Further details are provided in HS/SLR (2020) (refer to Section 4.4.9 and Section 4.6.1) for the implementation of the DRN package and enhanced permeability zone.

HOLD POINT 3: Model design report and presentation

4.5 Model Calibration Plan

Automated parameterisation software (PEST++; Doherty 2019) will be used for the model calibration. PEST++ undertakes non-intrusive, highly parameterized inversion of an environmental model. PEST++ includes significant functionality that is absent from PEST including more efficient calibration algorithms that can accommodate large, highly parameterized groundwater models. PEST++ can conduct model runs in serial or in parallel.

A combined steady-state and transient calibration will likely be adopted. The groundwater model calibration will cover a pre-mining steady state run, and a transient run using available groundwater level data, groundwater drawdown and documented mine inflows and measured baseflow.

The reliability of the existing groundwater model will be verified by comparing drawdown predictions (i.e drawdown extent and magnitude including predicted impacts to registered bores) with drawdown observed during recent mining operations.

4.5.1 Calibration Data Set

The calibration data-set, updated during conceptualisation and model development, will include the latest groundwater level, mine inflow and river baseflow measurements collected by the groundwater monitoring instruments operated by Tahmoor Mine and by other parties, including the TLRP, government monitoring sites and data shared with nearby mining operations (e.g. Appin Mine, Dendrobium).

The following data sets will guide the model calibration:

- Tahmoor bores: model calibration will include up to 4,000 groundwater level observations derived from daily or sub-daily data. Approximately 253 sites will have target model layers adjusted/refined from those used in the 2020 groundwater model based on field verification of actual bore depths (where possible) and groundwater monitoring network upgrades;
- Tahmoor bores: The conceptual report lists 115 bores including 40 bores equipped with one or more VWPs. The data set for these bores and new bores will be added to the new model calibration data set;
- Appin/BSO bores: the calibration data set will be updated with the recent data and will be utilized in model calibration;
- Underground mine inflows to Tahmoor North, Western Domain and Tahmoor South. There is on-going discussion to isolate inflow to Tahmoor South from the inflow entering the existing mine areas in Tahmoor North and the Western domain. This would improve the verification of the model to estimate inflow to Tahmoor South in the future.
- Baseflow estimates: Previous work has been conducted to estimate baseflow in HS/SLR (2020) and SLR (2021) along local watercourses (i.e. upper Bargo, Dog Trap Creek, Cedar Creek). Further work will be conducted on baseflow estimates in the conceptual stage (in collaboration with hydrological consultants, HEC) and incorporated in the calibration stage.
- Calibration to observed drawdown in the Hawkesbury Sandstone and other stratigraphic units will be considered. This should improve the model calibration to this important behaviour.

4.5.2 Calibration Parameter Set

To produce the best match between the observed and simulated water levels, flows and drawdowns, the model will be calibrated via the PEST suite of software by adjusting the following:

- Aquifer parameters including horizontal and vertical hydraulic conductivity, specific storage and specific yield;
- Stresses including recharge rates; and
- Boundary conditions including General Head Boundary (GHB), River (RIV) bed conductance for watercourses and for Thirlmere Lakes), and drain conductance applied in the MODFLOW Drain (DRN) package (for mine dewatering).

The following issues will be considered:

- Starting hydraulic properties and recharge for calibration will be set based on data analysis and conceptualisation;
- The use of pilot points for hydraulic properties and recharge to allow a better representation of the natural heterogeneity of aquifer properties; and
- The use of depth-dependent functions for hydraulic parameters will be considered where appropriate;

Following calibration, a composite sensitivity analysis and an identifiability analysis will be conducted using PEST++. This is an output of the identifiability analysis assesses the most sensitive properties of the model from a sensitivity (Jacobean) matrix. This analysis provides a ranked list of the model properties that should be explored for sensitivity during the prediction phase of modelling.

The model parameters and model boundaries incorporated in the calibration parameter set above will be included in the composite sensitivity analysis. The additional model packages and parameters will be also be considered :

- Hydraulic properties (e.g Nepean Fault Complex, Southern Faults, T1-T2 Faults and new geological structures that are included in the calibrated model);
- Fracture zone properties; and
- Model Boundaries (e.g evapotranspiration, recharge, drain etc).

HOLD POINT 4: Model calibration results report and presentation

4.6 Predictive Model Plan

Following of the model calibration, the predictive model will be set up. Transient predictive models will be developed for three model scenarios:

- Null run – no mining within region.
- Base case – all approved and foreseeable mining in region (including Tahmoor North), no proposed mining at Tahmoor South.
- Full development – all approved and foreseeable mining in region plus proposed mining at Tahmoor South.

The Basecase model and Full development model will enable quantification of groundwater take and impacts due to the proposed operations at the Tahmoor South. The Null run will enable assessment of cumulative impacts. The objectives of the predictive modelling will be to:

- Predict groundwater levels (and drawdown) during and at the end of mining;
- Predict the extent of maximum groundwater drawdown/depressurisation due to mining operations, and cumulative impacts, and present in maps for the key stratigraphic units or aquifers;
- Predict the mining induced changes in groundwater fluxes to and from alluvial sediments and other important aquifers (i.e Hawkesbury Sandstone aquifer) that are present in the model domain (e.g via the use of Zone Budgets)
- Predicts the average water balance for all the predictive scenarios (e.g. via the use of Zone Budgets or similar software).
- Predict drawdown at specific environmental features, e.g. within the Thirlmere Lakes alluvium, at other identified GDEs or nominated sites (e.g. Wirrimbirra Sanctuary).
- Predict groundwater fluxes, flow paths and gradient between hydrogeological units to predict the potential changes in groundwater quality. This will allow to identify and advise on the mitigation and management measures required.
- Predict mine inflow to all domains at Tahmoor Mine as a function of time.
- Capture of surface flow, via the reduction in baseflow to or induced leakage from watercourses. This includes losses from surface cracking effects (usually above or adjacent to longwall areas) and losses due to groundwater drawdown.
- Quantify potential induced losses from reservoirs, of which Lake Nepean is the closest.
- Predict the change in groundwater levels at identified groundwater users (i.e. registered bores, landholder bores, third party bores and GDEs) due to the Tahmoor South operations and cumulative impacts.
- The change in simulated ET will be extracted from the model (e.g via the use of Zone Budgets) and discussed in the report.
- Quantify the available storage capacity in the underground mine workings of Tahmoor North during and after the cessation of mining at Tahmoor South and
- Predict the recovery time of groundwater levels following mining at Tahmoor South with a particular interest in the Tahmoor North area;
- Areas of potential risk where groundwater impact mitigation/control measures may be required; and

- Comparison of the project impacts to consent conditions and regulatory requirements.

An additional modelling option is the use of particle tracking (MODPATH). MODPATH is a particle tracking code compatible that is used in conjunction with MODFLOW-USG. After running a MODFLOW simulation, the user can designate the location of a set of particles. The particles are then tracked through time assuming they are transported by advection using the flow field computed by MODFLOW. The output is particularly useful to predict groundwater flow during and post-mining.

HOLD POINT 5: Model predictions report and presentation

4.7 Sensitivity Analysis Plan

4.7.1 Prediction Identifiability

Prediction identifiability analysis will be carried out. Prediction identifiability describes parameters capability on impacting the model predictions. To calculate the prediction identifiability the groundwater model is run once per each parameter. The predictions included in the analysis will be:

- Project mine inflows;
- Maximum cumulative drawdown;
- Alluvium direct and indirect take at Thirlmere Lakes;
- Change in Lake-Aquifer interaction at Thirlmere Lakes; and
- Baseflow loss along watercourses and water levels of Thirlmere Lakes.

The Murray Darling Basin Modelling Guidelines (MDBC, 2000) recommends classifying sensitivity by the resultant changes (or contribution) to the model calibration and predictions. According to this process models can be classified as one of the four main types:

- Type I: Insignificant changes to calibration (low identifiability) and prediction (low uncertainty contribution);
- Type II: Significant changes to calibration (high identifiability) – insignificant changes to predictions (low uncertainty contribution);
- Type III: Significant changes to calibration (high identifiability) –significant changes to predictions (high uncertainty contribution); and
- Type IV: Insignificant changes to calibration (low identifiability) –significant changes to predictions (high uncertainty contribution).

Types I-III are of less concern, as these Types have an insignificant impact on model predictions or constrained by calibration. Type IV is classed as 'a cause for concern' as non-uniqueness in a model input might allow a range of valid calibrations but the choice of value impacts significantly on a prediction (MDBC, 2000).

To classify the sensitivity contribution to the model calibration and predictions for each model parameter, the calibration and prediction identifiability are then compared against each other for each parameter.

The Automated parameterisation software (PEST++; Doherty 2019) will be used for the identifiability assessment. The prediction identifiability will be guided by the outcomes of the sensitivity analysis following the calibration stage. The ranked list of the model properties and model boundaries identified in the identifiability assessment as 'high identifiability' will help guide the uncertainty analysis.

4.8 Uncertainty Analysis

In accordance with the IESC Information Guidelines: *Uncertainty analysis – Guidance for groundwater modelling within a risk management framework* released in December 2018, uncertainty analysis is required to help demonstrate the numerical model is fit for purpose and provides information about uncertainty in a way that allows decision-makers to understand the effects of model uncertainty on the project objectives and impact predictions.

IESC (2018b) describes three approaches to uncertainty analysis with respect to groundwater modelling and these, in order of increasing complexity and computational resource requirements, are: (1) scenario analysis with subjective probability, (2) deterministic modelling with linear probability quantification and (3) stochastic modelling with Bayesian probability. A Type 3 uncertainty analysis will be conducted.

A Type 3 uncertainty analysis is required for the Project to comply with Groundwater Commitments stated in Development Consent following post-determination.

Type 3 uncertainty analysis will be guided by the results of this composite sensitivity analysis and calibration and prediction identifiability to explore more extreme values within the constraints of the model calibration statistics.

A targeted uncertainty analysis can be performed using an adapted Monte Carlo method with modern software packages, focusing on model factors that influence predictions of potential "significant risk", notably the potential risk to Thirlmere Lakes. Other receptors identified during the conceptual model review and workshops with relevant regulatory agencies, such as the Wirrimbirra Sanctuary and relevant local watercourses, would be considered in the uncertainty analysis. The uncertainty analysis will be conducted consistent with the IESC 2018 guidance.

Instead of simple random sampling, the Latin Hypercube Sampling (LHS) method is suggested to be used to create random realisations from parameter distribution. LHS aims to spread the sample points evenly across all possible values. In doing so, it divides parameter space into N intervals of equal probability and chooses one sample from each interval. A large set of parameter realisations is created and the calibrated model is run once for each realisation. The realizations that meet the convergence criteria will then be post processed to achieve the following outcomes:

- Uncertainty of the Project underground mine inflows;
- Uncertainty of maximum drawdown extent;
- Uncertainty of alluvium direct and indirect take at Thirlmere Lakes; and
- Uncertainty of change in Lake-Aquifer interaction at Thirlmere Lakes
- Uncertainty of change in water levels at Thirlmere Lakes.

HOLD POINT 6: OPTIONAL

4.9 Reporting

Five reports will be prepared during the model re-build and will be peer reviewed at the hold points highlighted in this GMP. If required, specific items identified by the peer reviewer that need to be revised will be addressed in order to move forward to the next stage.

It is suggested to prepare the following report as part of the progressive review:

- Conceptualisation Report
- Model Design Report
- Calibration Report
- Prediction Report
- Sensitivity and Uncertainty Analysis Report (optional)

A presentation will accompany each report and will highlight relevant findings/results to be discussed with relevant agencies during hold point stage.

At the end of the model rebuild the five reports will be incorporated in a main report "Tahmoor Mine Groundwater Model Update.

5 Forward Works Plan

In preparing this GMP, SLR reviewed the existing conceptual and groundwater model reported by SLR/HS (2020).

This report presents a summary of the gaps in the existing model and suggest a range of updates in the rebuild of the Tahmoor South Groundwater model proposed to ensure the model is fit for purpose. The updates include:

- Model grid;
- Model layers;
- Timing – update calibration model to extend to mid-2021 to include recent mining and update predictive models to capture the mining progression as accurately as possible;
- Boundary Conditions – update model boundary conditions with revised grid extent and regional flows;
- Stresses – Maintain inputs, but with updates from more recent and site-specific data for mine progression, lakes and watercourses and recharge.

As well as updates to the calibration process to incorporate additional observation data and observation points and refine the depth dependence function. As well as constrain the calibration process to fit within the timeframe and utilise calibration and uncertainty analysis already completed on the HS/SLR (2020) and SLR (2021) model.

It has also been identified that some data gaps exist and that addressing these data issues will further support the model development, this includes:

- Site specific data on hydraulic conductivity and storage parameters (if available), including results from current and future planned programs (i.e packer test or cores testing across Tahmoor South);
- The latest geological model for Tahmoor South;
- The latest geological structure mapping and (if available) data from Tahmoor South, especially around LW 101A, LW 102A. We recommend that geological investigations be carried out as early as possible to facilitate this modelling work but also the Extraction Plans that will be required prior to final approval.;
- Confirmation of the underground mine progression (i.e. timing and cutting height) to incorporate into the predictive model scenarios;
- Latest dewatering/pumping volumes at Tahmoor/Tahmoor North and Western Domain;
- The latest historical mine plan and future plan for Appin Mine and Dendrobium Mine including mine progression and longwalls and roadway timing;
- Site surface water discharge information (if available);
- Any available data on the latest LiDAR survey from Tahmoor Coal (in particular surveyed elevations along watercourses);
- Latest groundwater levels and quality across Tahmoor/Tahmoor North, Western Domain and Tahmoor South;
- Latest surface water levels and quality across Tahmoor/Tahmoor North, Western Domain and Tahmoor South.

The proposed forward work plan is summarised below up to the end of the Conceptualisation stage:

- GMP to be peer-reviewed with subsequent comments addressed by SLR, before submitting to DPIE-W;
- Collect the remaining data described above including geological model, exploration bore details and mine plan. Process the data and use in the new conceptual model;
- Progress with the conceptual model verification process in parallel with the Groundwater Monitoring Plan development. An iterative process between these two processes is developed;
- Prepare the Conceptualisation Report;
- Peer review of the Conceptualisation Report and address comments;
- Move to next stage of the model re-build – Model Design.

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APPENDIX A

DPIE-Water (2020)

OUT20/9373

Andrew Rode
Planning & Assessment
NSW Department of Planning, Industry and Environment

andrew.rode@planning.nsw.gov.au

Dear Mr Rode

**Tahmoor South Coal Project (SSD-8445) –
Second Amendment Report**

I refer to your email of 4 August 2020 to the Department of Planning, Industry and Environment (DPIE) – Water and the Natural Resources Access Regulator (NRAR) about the above matter.

DPIE Water acknowledges that the revised design will lessen impacts to water licensing, groundwater and surface water but notes that this will only be to a very minor degree. The project modifications and revised risk assessment do not alleviate the issues described in our previous advice regarding the Response to Submissions (RTS) (OUT20/2603) of 4 June 2020, and the majority of our earlier recommendations still apply.

With regard to the groundwater model, the proponent has satisfactorily updated the Groundwater Assessment (Appendix C) consistent with our recommendation relating to the RTS. However, the Groundwater Modelling Plan requires review.

Further detailed comments regarding the Groundwater Impact Assessment, the Groundwater Modelling Plan and recommendations in Table 1 are provided in **Attachment A**.

Any further referrals to DPIE - Water and NRAR regarding this matter can be sent by email to: landuse.enquiries@dpi.nsw.gov.au.

Yours sincerely

Mitchell Isaacs
Director, Office of the Deputy and Strategic Relations
Department of Planning, Industry and Environment: Water
14 September 2020

ATTACHMENT A

DPIE – Water and NRAR detailed comment and recommendations

Second Amendment Report for the Tahmoor South Coal Project (SSD 8445)

1. Groundwater

DPIE – Water acknowledges the information in the revised Groundwater Assessment (Appendix C) - dated August 2020 indicate that there will be reduced groundwater impacts but only to a very minor degree.

As such, the project modifications and revised risk assessment do not alleviate the issues described in our previous advice (RTS submission - dated 4 June 2020, OUT20/2603).

Therefore the majority of the recommendations provided by DPIE – Water in our 4 June advice remain current. Please note Table 1 for a list of all relevant recommendations that we now recommend.

With regard to the groundwater model, the proponent has satisfactorily updated the Groundwater Assessment (Appendix C). However, the Groundwater Modelling Plan (GMP; Appendix M) prepared by SLR Consulting Australia Pty Ltd on behalf of SIMEC GFG in response to the DPIE-Water recommendation 2.2 (OUT20/2603) requires revision. Please note further explanatory comments are provided below in point 1.2.

1.1 Groundwater Impact Assessment

Water take

The proposed further project modifications will result in a modest, incremental decrease on the groundwater impacts of the project. The exclusion of the two south-western most longwalls from the mine plan will shorten the mine life by three years bringing a conclusion to mining in 2032 instead of 2035. The shortening of the mine life has the most material positive effect on groundwater impacts by reducing total groundwater take during the active mine life by an estimated 4,100 to 6,400 ML. Peak inflows however are not likely to change in any observable way.

Groundwater drawdown and bore impacts

The proponent presents an argument that the mine amendments will result in very small reductions in previous model predicted drawdown effects overall. This assertion is reasonable. Further, the proponent argues that the risk of drawdown impacts on bore users would be slightly lower with the recent amendments. Again, this is a reasonable assertion, but the degree of change is so small that there is likely to be no material difference from previous model predictions.

In the previous project configuration and groundwater impact assessment, the proponent identified groundwater users and bores potentially affected (incrementally) by the Tahmoor South proposal itself, and total cumulative impacts due to all mining in the area (largely Bulli Seams Operations). The potential impacts were considerable with multiple bores predicted to exceed the Level 2 minimal impact (2 m decline) consideration classification under the Aquifer Interference Policy (AIP) as follows:

Based on the proponent selected impact scenario:

- 52 bores > 2 m – Tahmoor South-only impact
- 228 bores > 2 m – all cumulative impact

Accounting for further model uncertainty:

- 73 bores > 2 m – Tahmoor South-only impact
- 264 bores > 2 m – all cumulative impact

In the Second Project Amendment Report, the revised groundwater risk assessment introduces a new concept to identify bore impact risks. Instead of the > 2 m Category 2 drawdown impact definition provided by the Aquifer Interference Policy, the proponent has devised a risk rating defined by the likelihood of a bore experiencing drawdown that would result in a "make good" claim by a bore user. The description of the risk assessment method is reproduced from the Second Amendment Report below:

Table 6.6 Risk of bore requiring 'make good'

Risk rating	Criteria	Justification
High	Above longwalls and pillars	Groundwater drawdo (strata deformation) effects on a bore abo required 'make' good
Moderate	Model predicts a maximum drawdown greater than 10 m and within 1 km of a panel	A drawdown of great 30 per cent of availab Historical effects on a North have required is deliberately conser
Moderate-low	Model predicts a maximum drawdown	Drawdown due to mi

This results in a predicted risk rating and count of bores likely to require "make good" tabulated below, again reproduced from the report. The second project amendment (second column) shows a marginal improvement in bore impact risk rating.

Table 6.7 Bores likely to require make good

Risk rating	Number of bores, PAR (AECOM 2020b)	Num
High	11	
Moderate	6	
Moderate-low	3	
Low	32	

This risk assessment framework is reliant on the experience of the operation of the nearby Tahmoor North coal mine where predicted wide-scale drawdown impacts of greater than 2 m on 75 bores has resulted in only two "make good" claims to date. The proponent argues that because most bores in the area are quite deep (> 50 m) and have large available drawdowns, 2 m, "or even 10 m" drawdowns would largely go unnoticed by bore users. The essence of the revised risk assessment is that a drawdown of 10 m, in the view of the proponent, is a more suitable impact threshold than the 2 m benchmark of the AIP.

This risk assessment put forward by the proponent still means that there is considerable risk of bores requiring make good. It highlights the importance of the proponent putting in place an adequate bore census, trigger action response plan and make good program.

We agree that the second project amendment will likely lessen the groundwater impacts of the project, but to a very minor degree. The project modifications and revised risk assessment do not alleviate the issues described in the previous advice provided by DPIE - Water, and the previous recommendations remain current.

1.2 Groundwater Modelling Plan

Pre-approval Recommendation

The Groundwater Modelling Plan (GMP) (Appendix M) prepared by SLR Consulting Australia Pty Ltd on behalf of SIMEC GFG in response to DPIE-Water's recommendation in the RTS contains useful information but overall requires revision. We recommend that the proponent revise the GMP according to the recommendations explained below. This includes the provision of an independent third-party review.

In summary, the GMP should be revised to:

1. show purposeful adherence of the overall modelling process and all its elements to best practice guidelines (currently Australian Groundwater Modelling Guidelines (AGMG) 2012 and subsequent explanatory notes).
2. reflect understanding of basic requirements in groundwater models. This can be achieved through provisions to ensure compliance of the new model with the requirements outlined in the AGMG 2012 model review checklists (Tables 9-1 and 9-2; pp 119–124).
3. follow the general workflow recommended in the AGMG 2012 (Figure 1-2, p 13) or similar, including frequent checks, modifications and feedback loops to earlier stages as may be required.
4. include provisions for progressive independent third-party reviews.
5. involve consultation with key stakeholders and reviewers throughout all stages, including the model planning stage.
6. clarify the model's:
    a. intended use
    b. objectives (can have main and sub-objectives)
    c. target confidence level attributes and class according to AGMG 2012 recommendations
    d. intended scale
    e. intended exclusions, and
    f. expected limitations.
7. clarify the intended inclusion of surface water in the model, specifically whether the groundwater model will be directly or indirectly coupled with a surface water model and whether the groundwater model will be used for surface water flow predictions.
8. include verification of the current model to identify areas of strength and areas of weakness in it. This is an essential step in the new model design. DPIE - Water notes that the proponent noted in reports and presentations that the model overestimates drawdowns, which in the proponent's opinion makes the model conservative. DPIE - Water seeks a more realistic model to enable well-informed decision making.
9. clarify intended method/s for checking the conceptual model. The AGMG 2012 regards conceptualisation to be an ongoing process.
10. stipulate a practical staged reporting strategy. As a minimum, reports are required following the conceptualisation and design stage, after the calibration stage, and after predictive modelling and uncertainty analysis as recommended in the AGMG 2012.
11. be considered as the first report on the model that is required within two years of the project determination.

12. allow for regular updating of the model and/or updating based on modelling results, data availability, changes in the project or statutory requirements.

Explanation

In our response to the RTS (OUT20/2603), DPIE - Water requested 'a clear plan for a groundwater model re-build and calibration' prior to determination on the project. This is to enhance the possibility of transparent, inclusive, trustworthy, robust, fit-for-purpose modelling and regular model updates throughout the project's life.

DPIE – Water's advice included detailed recommendations for model improvements which have not been addressed in the GMP provided in the Second Amendment Report. The GMP should consider the recommendations made by DPIE - Water, other submitters, the revised report, and the latest independent review. Most importantly, the GMP must demonstrate the intention and ability to produce an updated model within two years from determination through a systematic process following established best practice, specifically, the Australian Groundwater Modelling Guidelines (2012) (AGMG 2012) and subsequent explanatory notes. The need for further updating will be determined following consideration of the results of the first model update, new data, and changes to the project.

The reviewed GMP provides useful thoughts that can be considered during the model update. However, it falls short of DPIE - Water's expectations. The purpose of the GMP must be to outline the modelling process rather than designing the updated model. The proponent's understanding of DPIE - Water requirements of the GMP presented in Section 2 requires revision. Within this context, the geology and hydrogeology information presented in Sections 4 and 5 is deemed unnecessary. The maps provided in Figures 1 and 2 and the potential changes in the model layers presented in Table 2 are also considered redundant.

Section 6 states that it '*discuss*[s] *the key components of the conceptual groundwater model.*' As noted above, the GMP is not required to present a conceptual model or report on planned changes in the current model. It is simply required to clarify the process of verification of the existing model including updating it with new data or as may be found necessary from other stages of the model being updated. DPIE - Water agrees that the conceptual model elements listed in Section 6.5 require review and believes that all aspects of the conceptual model require substantiation, including peripheral boundaries and effects from neighbouring operations.

Section 7 presents the numerical model implementation approach under three headings: (1) model development, (2) calibration, and (3) forecasting. The tasks under these headings correspond to Stages 3–7 in the groundwater modelling process described in the AGMG 2012. However, they are incomplete and lack looping between stages. The detailed information and discussion in Sections 7.1 will be useful during the actual model implementation but they should not be considered inclusive and should not prejudice the future model design. Section 7.7.1 notes that '*The conductivity and role of geological structures (i.e. faults) has been discussed in Section 6.1.*' However, Section 6.1 does not discuss the planned representation of structures like faults and dykes in the numerical model. It is noted that important aspects in the numerical model design and implementation have not been covered, including initial conditions.

Section 7.2 notes that parametric sensitivity will be checked for bed conductance parameters, e.g. for river, lake, and drain model cells. DPIE - Water clarifies that comprehensive sensitivity analysis including composite parametric sensitivity or parameter identifiability is required to enable focusing the model calibration efforts on the parameters for which the model is sensitive. The sensitivity analysis must include all aquifer property parameters (e.g. hydraulic conductivity and storativity parameters), boundary conditions (e.g. recharge), and peripheral boundary conditions (e.g. General Head Boundary conductance). The GMP must clarify intentions with regards to steady-state and transient model calibration, the calibration methods (manual and/or automated), the weighting (QA/QC) system for observed datasets, how the results of each calibrated model will be used to inform subsequent modelling stages and the project decision making.

Section 7.3 outlines the planned model predictions and uncertainty analysis, referencing appropriate best practice guidelines. It lists planned predictions and notes that there may be more. However, it does not comment on possible use of particle tracking and zone budget calculations to determine the extent and magnitude of effects. The GMP does not allow for revisiting previous tasks/stages (looping) like the model conceptualisation or numerical implementation to enhance the model calibration if necessary.

Section 8 misinterprets DPIE - Water requirements and contradicts Section 7.3. It contemplates that the model development will end by recalibrating the model and reporting on it, i.e. no predictions. It seems to suggest that predictions will be carried out only when a requirement is identified. DPIE - Water clarifies that model predictions of fluxes, groundwater levels and changes in both are requested as part of the model update.

In conclusion, the current version of the GMP contains useful information, but it must be revised and subjected to independent third-party review before resubmitting to DPIE for review. This memo must be provided to the independent reviewer to clarify to them DPIE - Water expectations. The independent review should be included with the revised GMP. This request is in line with the AGMG 2012, which recommends progressive review and staged reporting. Planning constitutes the first modelling stage as stipulated by the guidelines. Consequently, the modelling plan represents the first report for the required updated model.

2.1 Recommendations

Table 1 – DPIE Water recommendations in response to the 2nd Amendment Report

Number	Recommendation	Reference
Prior to determination		
1	Groundwater drawdown, water user impacts – bore census, make good provisions, mitigation strategy and Trigger Action Response Plan as described in recommendation 2.1 of the DPIE Water RTS advice (OUT20/2603)	RTS, OUT20/2603, recommendation 2.1
2	That the proponent revise the Groundwater Modelling Plan according to the recommendations described in s1.2 of this advice.	This replaces recommendation 2.2, RTS, OUT20/2603
Post determination		
3	The project must obtain adequate Water Access Licences to account for both Surface and Groundwater take, prior to the take of any additional unlicensed water; and provide evidence of the additional Water Access Licence shares obtained (in accordance with the predicted water) to the Natural Resources Access Regulator	RTS, OUT20/2603, recommendation 1.1
4	The detailed design of the cores census is to be developed in consultation with DPIE Water and to the satisfaction of the DPIE Secretary	RTS, OUT20/2603, recommendation 2.3
5	The proponent should rebuild the groundwater model within two years of project determination in accordance with the model rebuild plan.	RTS, OUT20/2603, recommendation 2.4
6	The proponent should develop its Water Monitoring Plan in consultation with DPIE Water and to the satisfaction of the DPIE Secretary	RTS, OUT20/2603, recommendation 2.5

7	The proponent should undertake a geomorphology survey (baseline and post mining) of waterways overlying and within the 20mm line of subsidence for each longwall to complement monitoring of subsidence at each longwall, in consultation with DPIE Water	RTS, OUT20/2603, recommendation 3.1
8	Surface water Trigger Action Response Plans are to be developed in consultation with DPIE Water as described in recommendation 3.2 in our RTS advice (OUT20/2603)	RTS, OUT20/2603, recommendation 3.2
9	Surface water monitoring to be undertaken as described in recommendation 3.3 in our RTS advice (OUT20/2603)	RTS, OUT20/2603, recommendation 3.3

END ATTACHMENT A

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

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
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Grd Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

APPENDIX F – Groundwater Modelling Plan – Reviewer Endorsement

Jacobs

Memorandum

Floor 11, 452 Flinders Street
Melbourne VIC 3000
PO Box 312, Flinders Lane
Melbourne VIC 8009 Australia
T +61 3 8668 3000
F +61 3 8668 3001
www.jacobs.com

Subject	**Review**	**Project Name**	Tahmoor Coal Groundwater Model Plan
Attention	April Hudson	**Project No.**	IA267800
From	Brian Barnett		
Date	23 December, 2021		
Copies to	Sharon Hulbert		

1. Introduction

This document provides peer review comments on the Groundwater Modelling Plan for Tahmoor Coal, prepared by SLR Consulting Pty, Ltd. (the Report) of December, 2021. I was also provided a copy of a letter from New South Wales Department of Planning, Industry and Environment (DPIE) to Tahmoor Coal that includes review comments from DPIE to an earlier version of the Groundwater Modelling Plan (Groundwater Assessment, Appendix C, dated August 2020) (the DPIE Review).

I am a hydrogeologist and groundwater modeller with more than forty years of consulting industry experience. My qualifications and experience are summarised in Appendix A: Curriculum Vitae.

I believe I am suitably independent as I:

- Have no pecuniary interest in the project.
- Have never worked for the proponent either as an employee or consultant.
- Have never worked or collaborated with the proponent's specialists (SLR Consulting), other than in a peer review capacity.
- Have never worked on another nearby project that may have material cumulative impacts with the Tahmoor Coal Mine, other than in a peer review capacity.

My review is aimed at assessing whether the groundwater modelling plan provides a rational basis for the development and use of numerical groundwater models of the Tahmoor Coal Mine. I have noted DPIE suggestions that the model plan should adhere to the Australian Groundwater Modelling Guidelines[1] (AGMG). Accordingly, I have focussed on those aspects of the guidelines that are relevant to the proposed modelling plan.

[1] Barnett B, Townley LR, Post V, Evans RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A and Boronkay A. 2012, *Australian Groundwater Modelling Guidelines.* Waterlines Report #82. National Water Commission, Canberra.

As a result of my review of earlier versions of the Report I provided a number of comments and suggestions on how the document could be improved. My comments pertained to the following:

- Adding context as to why the model is being updated and how it will be used.
- Adding a map of the mine showing the key environmental assets and a summary of the environmental features at risk of impact from future mining.
- The proposed approach to determine an appropriate size of the model domain.
- The proposed approach to defining model layers.
- The proposed approach to implementing the fracturing expected to occur above the longwall panels.
- The use of Zone Budgets approach to quantify changes in groundwater exchange fluxes with individual river reaches and alluvial aquifers.
- Clarification of how the model will be used to assess potential groundwater quality impacts.
- The use of groundwater evapotranspiration as an indicator of impacts on GDE's.
- The inclusion of a verification of the existing model predictions.
- Inclusion of stakeholder consultation in the progressive reporting and review process.
- Adding model limitations and exclusions.
- Whether the plan has adequately addressed the DPIE review comments.
- Whether the model plan adheres to the AGMG.

2. Peer Review Findings

My review comments have been addressed by SLR Consulting through a number of report revisions. The current version of the report dated 23rd December, 2021 (665.10010.00407-R02-v3.1-20121223.docx) includes the revisions that have been made in response to my review comments. I consider this document to provide a sound plan for the modelling programme for the coming months. It appears to be aligned with relevant Guiding Principles defined in the AGMG and with recommendations on uncertainty analysis included in Middlemis and Peeters, 2018[2].

The model is primarily being used to assess potential environmental impacts that may arise during and after future mining. Accordingly, my reviews have and will focus on ensuring that the model is designed, constructed and used to obtain confident estimates of future impacts to environmental assets including existing groundwater users and potential diversion of groundwater from shallow aquifers that are accessed by other users including GDE's.

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[2] Middlemis, H and Peeters, LJM, 2018. *Uncertainty Analysis – Guidance for groundwater modelling within a risk management framework*. A report prepared by 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.

Appendix A: Curriculum Vitae

Brian Barnett

Qualifications:

Bachelor of Engineering (Civil), University of Auckland, 1980

Relevant Experience:

Jacobs Group (Australia) Pty Ltd. (Prior to December 2013 SINCLAIR KNIGHT MERZ, AUSTRALIA)

May 2000 to present

Senior Hydrogeologist and Geothermal Reservoir Engineer SKM, Melbourne, Australia.

Responsible for groundwater modelling and geothermal studies. Major projects include:

- ***Australian Groundwater Modelling Guidelines. National Water Commission.*** Project manager and principal contributor to an Australian Groundwater Modelling Guideline that is planned to supersede the current Murray Darling Basin Commission guidelines. The project was completed in March 2012 and the document was published in June 2012.
- ***Frieda River Mine Dewatering Investigations. Xstrata Copper.*** Groundwater modelling of a proposed copper mine in Papua New Guinea. Groundwater models were used to estimate the dewatering pumping requirement for the mine and to provide an assessment of the environmental impacts that may accompany mine dewatering.
- ***New Acland Coal Mine*. *New Hope Group.*** Developed a groundwater model of the New Acland Coal Mine to assist with gaining environmental and industry approvals for expanding coal mining operations. The model was used to predict the likely future inflows to the mining pits and to assess potential impacts that may arise from the inflows and associated drawdown in groundwater

heads. The work has included expert witness appearance in recent Queensland Land Court proceedings.

- ***Wards Well Coal Mine. BMA***. Supervising the modelling of an underground coal mine in Queensland. The model includes time varying material properties that represent deformation of formations above long wall mine panels.
- ***Kulwin Mineral Sands Mine Dewatering Investigations. Iluka Resources Ltd.*** Detailed numerical groundwater models were developed to help design the mine dewatering system. Investigations were aimed at depressuring the local groundwater system to expose the mineral sand deposits to allow dry mining of the resource. The models paid particular attention to vertical flow processes in and around the deposit and hence incorporated multiple (27 layers in total) horizontal layers.
- ***Pardoo Iron Ore Mine Dewatering Investigations. Atlas Iron.*** Groundwater models were developed in the FEFLOW numerical modelling code to estimate the mine dewatering requirements of an iron ore mine in the Pilbara region of Western Australia.
- ***Northern Murray Basin Environmental Effects Statement. Iluka Resources Ltd.*** Preparation of a water management report that formed part of the EES for the Kulwin and WRP deposits in the Northern Murray Basin Project. Work included the development of regional groundwater flow models to assess environmental impacts of dewatering and water disposal.
- ***Mine dewatering for Murray Basin Titanium Ltd for the Wemen Mineral Sand Mine.*** Numerical groundwater models were formulated and calibrated in order to help optimise a dewatering plan for a mineral sand deposit in Northern Victoria. The models were also used to assess the likely impacts of dewatering and associated water disposal on the Murray River.
- ***Mine water management consultant for Murray Basin Titanium Ltd for the Prungle Mineral Sand Mine.*** Responsibilities included the development of numerical groundwater models to assist in designing a groundwater supply scheme to provide water for a dredge mining operation in Northern Victoria. Investigations also included the assessment of groundwater extraction and disposal on local and regional surface water and groundwater resources.
- ***Murray Darling Basin Sustainable Yields Project. CSIRO.*** Groundwater modelling team leader for a major project covering groundwater resources in Queensland, New South Wales, Victoria and South Australia. SKM was contracted by CSIRO in 2007 to undertake the groundwater resource assessment for the entire Murray Darling Basin. The project involved the numerical modelling of all major fresh water aquifers in the basin. Twelve finite difference numerical models were run for the study. Results were used to quantify the available groundwater resources of the basin and to assess the impacts of future climate change and impacts of groundwater development on river flows.
- ***Northern Sewer Project, Groundwater Models.*** Groundwater flow models were developed for the NSP1 and NSP2 sewer tunnels in north Melbourne. The models were used to assess inflows into the tunnels and to determine the likely impacts of groundwater drawdown on the aquifer and on

the associated loss of base flow to local streams and rivers. Models were constructed to assess both the construction and operational phases.

- ***Lindsay River Groundwater Modelling. DNRE Victoria.*** Development of a three dimensional finite element groundwater model of the aquifers within the Lindsay River Anabranch of the Murray River. The model was developed in the FEFLOW modelling code and is being used to design a salt interception scheme.
- ***Numerical Water Trade Models. Mallee CMA Victoria.*** Project manager and leader of modelling team to develop, calibrate and run predictive scenario models for the Nangiloc Colignan and Wemen irrigation areas in northern Victoria. Models were aimed at quantifying the impact on salinity in the River Murray associated with the trading of irrigation water.
- ***South East Queensland Effluent Reuse Study – Darling Downs.*** Brisbane City Council. The impacts associated with future use of treated effluent for irrigation in the Darling Downs was investigated through the development and calibration of large scale three dimensional groundwater flow and solute transport models. Impacts under investigation included changes in groundwater head, changes in the groundwater interaction with rivers and streams and the water quality changes in the aquifer.
- ***Lake Toolibin Groundwater Modelling. CALM WA.*** A three dimensional finite difference groundwater model was formulated to assess the dewatering performance of a network of pumping bores designed to reduce groundwater heads beneath Lake Toolibin. The project is aimed at minimising salinisation of the lake by reducing groundwater discharge through the lake bed.
- ***Barwon Downs Groundwater Modelling. Barwon Water, VIC.*** This project involved the development and calibration of a large three dimensional finite difference groundwater flow model to assess the safe long term yield from the Barwon Downs borefield. Models were calibrated over a thirty year period of observation and were run in predictive mode for 100 years.

KINGSTON MORRISON LIMITED, AUCKLAND

1997 to May 2000

In July 1999, Kingston Morrison Ltd joined the Sinclair Knight Merz Group.

- **Senior Geothermal Reservoir Engineer.** Responsible for all aspects of geothermal reservoir assessment and well testing. Also responsible for all hydrogeological investigations and groundwater modelling.

SUMIKO CONSULTANTS COMPANY LIMITED, TOKYO, JAPAN

1991 to 1997:

Geothermal Reservoir Engineering Manager. Responsible for the enhancement of geothermal reservoir engineering and mineral resource evaluation capabilities in Sumiko Consultants through the acquisition of reservoir and well bore simulation codes and the application of geostatistical methods and software.

GEOTHERMAL ENERGY NEW ZEALAND LIMITED (GENZL), AUCKLAND

1981 to 1991:

Reservoir Engineer. Responsible for all geothermal reservoir engineering studies including extended assignments in Indonesia, Kenya and Japan.

HAWKES BAY REGIONAL WATER BOARD

1979 to 1981:

Groundwater Engineer. Duties included the investigation of hydraulic and chemical characteristics of aquifers in the Hawkes Bay region and the preparation of resource management plans.

APPENDIX G –Trigger Action Response Plans (TARP)

WMP8 Shallow Groundwater Levels (Open standpipes and private bores)

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature No performance measure relevant. TARP Objective This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation. This TARP supports TARP WMP13, where groundwater levels as they pertain to groundwater dependent ecosystems (GDEs) (Thirlmere Lakes) are covered. Assessment Criteria Bore specific trigger values based on baselines data for each reporting level.	Locations Open standpipes Existing sites: P51a, P51b, P52, REA4, P53a, P53b, P53c, P54a, P54b, P54c, P55a, P55b, P55c, P56a, P56b, P56c Proposed sites: P50a, P50b, P50c, P57a, P57b Private bores GW109257, GW104008, GW112473, GW104659, GW062068, GW105395, GW104323 All monitoring locations are shown in Figure 23 of the Water Management Plan. Monitoring Frequency Pre-mining Monthly manual measurements of water level. During Mining Monthly manual measurements of water level. Post-mining Quarterly manual measurements of water level for 12 months following the completion of LW S6A, or as required in accordance with a Rehabilitation Management Plan.	**Normal Condition**		
		• Groundwater level remains consistent with baseline variability and pre-mining trends with reductions in groundwater level less than two meters.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Greater than 2 m water level reduction[1] for a period of 6 months following the commencement of extraction.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as required for Normal Condition.* • Undertake an investigation to assess cause and determine if mining related. • Undertake investigation to demonstrate if the decline will impact the long-term viability of the affected water supply works. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results). The investigation will be commenced/completed as efficiently as practicable. If the changes have been confirmed to be related to mining effects: For Private Bores: • Initiate negotiations with impacts landowners as soon as practicable. Consider all reasonable and feasible options for remediation as relevant (e.g. extending the depth of the bore, establishment of additional bores, etc - as per Section 6.2.1.4 of the Water Management Plan. " For Open Standpipe Monitoring Bores • For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.	For Private Bores and Open Standpipe Monitoring Bores • Report trigger exceedance to DPE and key stakeholders. • Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review. If the changes have been confirmed to be related to mining effects: For Private Bores: • Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan). • Implement CMAs, subject to land access (finalise negotiations and implement the agreed "make-good" arrangements) • Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review.
		Level 2		
		• Water level declines below the average between the 'maximum modelled drawdown' (Level 3 trigger) and the '2 m drawdown' (Level 1 trigger)[1] for a period of greater than 6 months following the commencement of extraction. AND • The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as stated in Level 1.* • Consider increasing monitoring and review of data at sites where Level 2 has been reached, subject to land access. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change). • Compare against base case and deterministic model scenarios[2]. • Review Water Management Plan and modify if necessary. For Private Bores: • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.	For Private Bores and Open Standpipe Monitoring Bores • *Responses as stated in Level 1.* • Advise DPE and key stakeholders of any required amendments to Water Management Plan. For Private Bores: • Provide findings of CMA review to DPE and key stakeholders for consultation. • Implement additional CMAs, subject to land access.
		Level 3		
		• Water level reduction greater than the maximum modelled drawdown[1] for a period of 6 months following the commencement of extraction. AND • The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as stated in Level 2.* • Increase monitoring and review of data frequency for sites where Level 3 has been reached, subject to land access. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate).	For Private Bores and Open Standpipe Monitoring Bores • *Responses as stated in Level 2.* For Private Bores: • Develop a Rehabilitation Management Plan in consultation with DPE and key stakeholders. • Implement Rehabilitation Management Plan, subject to land access.

Notes:
[1] Level 1, 2 and 3 triggers for water level reduction is provided in Table 6-3 in Appendix E of the Water Management Plan.
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.

WMP9 Shallow Groundwater Pressures (VWP sensors < 200 m)

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management – Trigger	Management – Action	Management – Response
Performance Measure Feature No performance measure relevant. TARP Objective This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation. Assessment Criteria Bore specific trigger values based on baselines data for each reporting level.	Locations TBC032, TBC033, TBC009, TBC018, TBC0039 Monitoring of all VWP < 200 m depth intakes. Reference Sites: TBC024, TBC027, TBC034, TBC038 All monitoring locations are shown in Figure 23 of the Water Management Plan. Monitoring Frequency Pre-mining VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time. During Mining VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time. Post-mining Monitoring of data (streamed continuously) for 12 months following the completion of LW S6A.	**Normal Condition**		
		• No observable mining induced change at VWP intakes. • Greater than 5 m water level reduction in VWP intakes[1] following the commencement of extraction for a period of less than six months	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Greater than 5 m water level reduction in VWP intakes[1] following the commencement of extraction for a period of greater than six months	• *Actions as required for Normal Condition.* • Undertake an investigation to assess cause and determine if mining related, commence/complete as soon as practicable. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).	• Report trigger exceedance to DPE and key stakeholders. • Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.
		Level 2		
		• Water level declines below the calculated Level 2 trigger – being the average of Level 1 (the '5 m drawdown'[1]) and Level 3 (the 'maximum modelled drawdown') – following the commencement of extraction for a period of greater than six months. AND • The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	• *Actions as stated in Level 1.* • Review deeper VWP data at monitored sites. Determine whether additional review of data is required. Determine if review of additional existing VWP sites is required. Reasons for not increasing frequency of data review could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change). • Compare against base case and deterministic model scenarios[2]. • Review Water Management Plan and modify if necessary.	• *Responses as stated in Level 1.* • Advise DPE and key stakeholders of any required amendments to Water Management Plan.
		Level 3		
		• Water level reduction greater than the maximum modelled drawdown[1] following the commencement of extraction for a period of greater than six months. AND • The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	• *Actions as stated in Level 2.* • Increase review of data frequency for sites where Level 3 has been reached. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). Commence/complete as soon as practicable • Undertake investigative to review model results in conjunction with field data.	• *Responses as stated in Level 2.*

Notes:
[1] Level 1, 2 and 3 triggers for water level reduction is provided in Table 6-4 in Appendix E of the Water Management Plan).
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.

WMP10 Groundwater level/pressure Deep VWPs (> 200 m)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
No performance measure relevant.

<u>TARP Objective</u>
This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation.

<u>Assessment Criteria</u>
Bore specific trigger values based on modelled data for each reporting level.
Model layers utilised to define predicted drawdown for each VWP logger provided in Table below.</td><td rowspan="8"><u>Locations</u>
TBC009, TBC0018, TBC020, TBC026, TBC032, TBC033, TBC039

Reference sites: TBC024, TBC027, TBC034, TBC038

Monitoring of all VWP > 200 m depth intakes excluding those monitoring the Bulli Coal Seam.

All monitoring locations are shown in Figure 23 of the Water Management Plan.

<u>Monitoring Frequency</u>
Pre-mining
VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time.

During Mining
VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time.

Post-mining
Monitoring of data (streamed continuously) for 12 months following the completion of LW S6A.</td><td colspan="3">Normal Condition</td></tr>
<tr><td>• Observed data does not exceed modelled impacts predicted drawdown by greater than 30 metres[1].
• Observed drawdown exceeds the modelled predicted drawdown[1], by greater than 30 metres for of less than three consecutive months</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Observed drawdown exceeds the modelled predicted drawdown[1], by greater than 30 metres for greater than three consecutive months.</td><td>• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related, to be commenced/completed as soon as practicable.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).</td><td>• Report trigger exceedance to DPE and key stakeholders.
• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Observed drawdown is exceeds modelled predicted drawdown[1], by more than 30 metres greater than 6 consecutive months.
•</td><td>• Actions as stated in Level 1.
• Determine suitability of increasing frequency of data review at sites where Level 2 has been reached. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).
• Review data in conjunction with VWP data from additional existing VWP sites.
• Compare against base case and deterministic model scenarios[2].
• Review Water Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
• Inclusion of more regional VWPs into data review to determine likely extent and depth of depressurisation.
• Advise DPE and key stakeholders of any required amendments to Water Management Plan.</td></tr>
<tr><td colspan="3">Level 3</td></tr>
<tr><td>• Observed drawdown exceeds modelled predicted drawdown[1] by 30 m, for 12 consecutive months or more.</td><td>• Actions as stated in Level 2.
• Increase review of data frequency for sites where Level 3 has been reached.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). To be commenced/completed as soon as practicable.
• Review base case and deterministic model scenarios[2] in conjunction with water pressure data and report findings.</td><td>• Responses as stated in Level 2.</td></tr>
<tr><td colspan="5">Notes:
[1] Predicted drawdown refers to the drawdown as generated by the groundwater model and varies over time as extraction progresses. Observed drawdown will be plotted on a monthly basis against the predicted drawdown to determine if a trigger has occurred. Therefore, as the predicted drawdown will be constantly changing according to extraction progression, it is not possible to set a specific trigger limit.
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.</td></tr>
</table>

Sensor	Model Layer	Model Geology
TBC09_322	8	BUSS Mid
TBC09_343	8	BUSS Mid
TBC09_357	12	SBSS Lower
TBC09_381	10	SPCS
TBC09_391	15	Bulli Seam
TBC09_397	17	Wongawilli
TBC18_282	8	BUSS Mid
TBC18_366	8	BUSS Mid
TBC18_377	13	WBCS
TBC18_404	15	Bulli Seam
TBC18_426	17	Wongawilli
TBC18_432	17	Wongawilli
TBC20_211	8	BUSS Mid

Sensor	Model Layer	Model Geology
TBC26_344	8	BUSS Mid
TBC26_409	13	WBCS
TBC26_432	15	Bulli Seam
TBC26_440	16	Eckersley
TBC26_460	16	Eckersley
TBC32_200	8	BUSS Mid
TBC32_237	8	BUSS Mid
TBC32_257	8	BUSS Mid
TBC32_294	8	BUSS Mid
TBC32_314	8	BUSS Mid
TBC33_247	8	BUSS Mid
TBC33_306	8	BUSS Mid
TBC33_363	11	SBSS Upper

TBC20_293	8	BUSS Mid		TBC33_384	16	Eckersley
TBC20_375	8	BUSS Mid		TBC33_408	16	Eckersley
TBC20_397	13	WBCS		TBC39_243	8	BUSS Mid
TBC20_411	7	BUSS Upper		TBC39_299	8	BUSS Mid
TBC20_434	17	Wongawilli		TBC39_354	11	SBSS Upper
TBC20_439	4	HBSS Mid		TBC39_375	16	Eckersley
TBC26_211	8	BUSS Mid		TBC39_402	16	Eckersley
TBC26_278	8	BUSS Mid				

WMP11 Groundwater Quality (open standpipes and private bores)

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management – Trigger	Management – Action	Management – Response
Performance Measure Feature No performance measure relevant. TARP Objective This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation. This TARP supports TARP WMP13, where groundwater quality as it pertains to groundwater dependent ecosystems (GDEs) (Thirlmere Lakes) is covered. Assessment Criteria Bore specific trigger values based on baselines data for each reporting level.	Locations Open standpipes Existing sites: P51a, P51b, P52, REA4, P53a, P53b, P53c, P54a, P54b, P55a, P55b, P55c, P56a, P56b, P56c Proposed sites: P50a, P50b, P50c, P57a, P57b Private bores GW109257, GW104008, GW112473, GW104659, GW062068, GW105395, GW104323 All monitoring locations are shown in Figure 23 of the Water Management Plan. Monitoring Frequency Pre-mining Monthly water quality sampling. During Mining Monthly water quality sampling Post-mining Quarterly water quality sampling. Water Quality sample parameters: **Field Parameters** PH EC TDS DO **Laboratory Analysis** Total alkalinity as CaCO3, HCO3, CO3, DOC Dissolved Major Cations (Ca, K, Na, Mg, F, Cl, SO4) Dissolved Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe) Total Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe) Total Nitrogen Total Phosphorus Ionic Balance (Total Anions and Total Cations)	**Normal Condition**		
		• No observable changes in salinity, pH or metals outside of the baseline variability.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Observed salinity and/or metals or pH outside of defined trigger levels[1] for 3 consecutive months or more. The effect *does not persist* after a significant rainfall recharge event. AND • A similar trend or response is noted at other monitored bores or private groundwater bores.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as required for Normal Condition.* • Undertake an investigation to assess cause and determine if mining related. • Undertake investigation to demonstrate if the change in quality will impact the long-term viability of the affected water supply works. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results). If the changes have been confirmed to be related to mining effects: For Private Bores: • Initiate negotiations with impacted landholders as soon as practicable. Consider all reasonable and feasible options for remediation as relevant. This could include potential for implementation of make-good provisions as per Section 6.2.1.4 of the Water Management Plan for affected private bore owners (e.g. provision of access to an alternative source of water). For Open Standpipe Monitoring Bores • For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.	For Private Bores and Open Standpipe Monitoring Bores • Report trigger exceedance to DPE and key stakeholders. • Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review. If the changes have been confirmed to be related to mining effects: For Private Bores: • Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. provision of access to an alternative source of water as detailed in Section 6.2.1.4 of the Water Management Plan). • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review.
		Level 2		
		• Observed salinity and/or metals or pH outside of defined trigger levels[1], for 3 consecutive months or more. The effect *persists* after a significant rainfall recharge event. AND • The change in water quality is determined not to be controlled by climatic or external anthropogenic factors.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as stated in Level 1.* • Consider increasing monitoring and review of data at sites where Level 2 has been reached, subject to land access. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water quality change). • Review Water Management Plan and modify if necessary. For Private Bores: • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.	For Private Bores and Open Standpipe Monitoring Bores • *Responses as stated in Level 1.* • Advise DPE and key stakeholders of any required amendments to Water Management Plan. For Private Bores: • Provide findings of CMA review to DPE and key stakeholders for consultation. • Implement additional CMAs, subject to land access.
		Level 3		
		• Observed salinity and/or metals or pH outside of defined trigger levels[1], for greater than 6 consecutive months. AND • The change in water quality is determined not to be controlled by climatic or external anthropogenic factors.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as stated in Level 2.* • Increase monitoring and review of data frequency for sites where Level 3 has been reached, subject to land access. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). • Undertake investigative report to demonstrate if the water quality change will impact the long-term viability of any affected water supply works.	Private Bores and Open Standpipe Monitoring Bores • *Responses as stated in Level 2.* For Private Bores: If ascertained impact is due to mining activities and has potential to impact long-term viability of supply for private groundwater bores: • Develop a Rehabilitation Management Plan in consultation with DPE and landowner. • Implement Rehabilitation Management Plan, subject to land access.

Notes:
[1] Defined trigger levels for groundwater quality are listed in Table 6-5 of Appendix E of the Water Management Plan.

WMP12 Groundwater – surface water Interaction

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
No performance measure relevant.

<u>TARP Objective</u>
This TARP defines levels of deviation in surface water - groundwater interactions from ‘normal’ conditions and the actions to be implemented in response to each level deviation.
The instigation of this TARP will be dictated by triggers exceedances in pertinent groundwater or surface water sites requiring further investigation of groundwater – surface water interactions.

Where groundwater – surface water connectivity indicates in a gaining stream, there is potential for groundwater supporting riparian vegetation. Consequently, Riparian vegetation in these situations could be a Groundwater Dependent Ecosystem (GDE), and the pertinent Performance Measure applicable:
Negligible impacts including:
• Negligible change in groundwater levels; and
• Negligible change in groundwater quality.

Riparian GDEs are addressed through the Riparian Vegetation TARP (BMP3). Consultation through the ERG will link this TARP (WMP12) to BMP3 via actions in BMP3 to consider groundwater – surface water relationships when pertinent.

<u>Assessment Criteria</u>
Bore specific trigger values based on baselines data for each reporting level. For this TARP, the aligned groundwater and surface water sites would be considered collectively to interpret potential changes/impacts to groundwater – surface water interaction.</td>
<td rowspan="8"><u>Locations</u>
Open standpipes
P51a, P51b, P52, REA4, P53a, P53b, P53c
P54a, P54b, P54c, P55a, P55b, P55c

The aligned surface water and groundwater sites are as follows:
• P51a, P51b with surface water site BR2-Qla
• P52, REA4 with surface water site-TT14-QLa
• P53a, P53b, P53c with surface water site-TT14-Qla
• P54a, P54b, P54c with surface water site TT3-QLa
• P55a, P55b, P55c with surface water site TT1-QRLa

All monitoring locations are shown in Figure 23 of the Water Management Plan.

<u>Monitoring Frequency</u>
Pre-mining
Monthly manual measurements of water level and water quality.

During Mining
Monthly manual measurements of water level and water quality.

Post-mining
Quarterly manual measurements of water level for 12 months following the completion of LW S6A, or as required in accordance with a Rehabilitation Management Plan.</td>
<td colspan="3">Normal Condition</td></tr>
<tr><td>• Observed (or inferred where not immediately neighbouring a surface water site) groundwater and surface water interaction remains consistent with baseline variability and/pre-mining trends, and decrease in groundwater inflow not persisting after significant rainfall recharge events.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Observed (or inferred where not immediately neighbouring a surface water site) groundwater levels at surface water monitoring site decline below Level 1 (in TARP WMP8) following the commencement of extraction.</td><td>• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).</td><td>• Report trigger exceedance to DPE and key stakeholders.
• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.
If the changes have been confirmed to be related to mining effects:
• Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Observed (or inferred where not immediately neighbouring a surface water site) groundwater levels at aligned surface water monitoring site decline below Level 2 (in TARP WMP8) following the commencement of extraction.
AND
• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factor.</td><td>• Actions as stated in Level 1.
• Increase frequency of data review to fortnightly at sites where Level 2 has been reached, subject to land access. Reasons for not increasing frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).
• Compare against base case and deterministic model scenarios[1].
• Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline.
• Review surface water data to assess for surface water level decline at relevant site.
• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.
• Review Water Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
• Provide findings of CMA review to DPE and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.
• Advise DPE and key stakeholders of any required amendments to Water Management Plan, including reporting on relationship of observations to baseline and deterministic model scenarios, as necessary.</td></tr>
<tr><td colspan="3">Level 3</td></tr>
<tr><td>• Inferred groundwater levels at surface water monitoring site decline below Level 3 (in TARP WMP8) following the commencement of extraction.
AND
• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factor.</td><td>• Actions as stated in Level 2.
• Increase frequency of data review for sites where Level 3 has been reached, subject to land access.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). Report to be commenced and completed as soon as practicable.</td><td>• Responses as stated in Level 2.
• Develop a Rehabilitation Management Plan in consultation with DPE and key stakeholders.
• Implement Rehabilitation Management Plan, subject to land access.</td></tr>
<tr><td colspan="5">Notes:
[1] “Deterministic” model scenario refers to the predictive scenario modelling utilised to determine the trigger level.</td></tr>
</table>

APPENDIX H – Response from Agencies

Agency	Date Response Received	Comments	Response
EPA	29-11-2021	The EPA has reviewed the plan and notes that the groundwater monitoring sub-plan (Appendix C) has not been attached to the main document.	Appendix C appended
		The EPA recommends that a map showing the locations of the groundwater monitoring bores around the pit top and Reject emplacement Area be included in section 4.1.5.1.	Additional figure (Figure 8) included in Section 4.1.5.1, showing locations of REA and pit-top piezometers.