Department of Planning and Environment

Our ref: SSD-7480-PA-46

Tony Dwyer
Group Manager – Approvals and Biodiversity
Vickery Coal Pty Ltd
28/259 George Street
Sydney, NSW, 2000

22/08/2023

Vickery Coal 2: Water Management Plan

Dear Mr. Dwyer

Thank you for submitting the Water Management Plan in accordance with Condition B53, Schedule 2 of the consent for the Vickery Coal 2 (SSD-7480-PA-46). I also acknowledge your response to the Department's review comments and request for additional information.

I note the Water Management Plan has been prepared in consultation with DPE Water and the EPA, and contains the information required by the conditions of approval.

Accordingly, as nominee of the Planning Secretary, I approve the Water Management Plan (Rev.2, August 2023).

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Charissa Pillay on 02 99955944.

Yours sincerely

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

WHC_PLN_VCM_WATER_MANAGEMENT_PLAN

CONTENTS

Department of Planning and Environment

NSW GOVERNMENT

Our ref: SSD-7480-PA-44

Tony Dwyer
Group Manager – Approvals and Biodiversity
Vickery Coal Pty Ltd
28/259 George Street
Sydney, NSW, 2000

06/02/2023

Vickery Coal: Appointment of the Water Management Plan (WMP) Authors

Dear Mr. Dwyer

I refer to your request in your letter, 31 January 2023, seeking for the Planning Secretary's endorsement of the Water Management Plan Authors under Schedule 2, Condition B53 of SSD-7480.

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Accordingly, the Secretary endorses the appointments of the following Environmental Consultants:

- Matthew Briody of WRM Water and Environment to prepare the surface water component of the WMP, and
- Brian Rask to prepare the groundwater component of the WMP

If you wish to discuss the matter further, please contact Charissa Pillay on 02 99955944.

Yours sincerely

Wayne Jones
Team Leader - Post Approval
Resource Assessments

As nominee of the Planning Secretary

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Edition	Rev.	Comments	Author	Authorised By	Date
1	0	Initial submission for consultation	SLR/WRM	WHC	February 2023
1	1	Review following consultation	SLR/WRM	WHC	June 2023
1	2	Updated document with DPE comments	SLR/WRM	WHC	August 2023

1 INTRODUCTION

The Vickery Coal Mine (VCM) is located within the northwest slopes and plains of New South Wales (NSW), approximately 25 kilometres (km) north of Gunnedah (Figure 1).

Development Consent (SSD-7480) was granted for the Vickery Extension Project to Vickery Coal Pty Ltd (VCPL) on the 12th of August 2020 by the NSW Independent Planning Commission as a delegate of the NSW Minister for Planning under Section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act). VCPL is a wholly owned subsidiary of Whitehaven Coal Limited [WHC]). The Development Consent allows for the development of an open cut mine and associated infrastructure with a 25 year mine life, extracting run-of-mine (ROM) coal at up to 10 million tonnes per annum (Mtpa) and processing the coal, as well as coal from WHC's Tarrawonga Mine, at an on-site coal handling and processing plant (CHPP) for offsite transport by rail.

To satisfy Conditions B53 (and B54), Schedule 2 of SSD-7480, VCPL is required to prepare (and implement) a Water Management Plan (WMP) as approved by the Planning Secretary (under the EP&A Act). The WMP (this document) has been prepared to meet the management plan requirements specified in Condition E4, Schedule 2 of SSD-7480, the commitments made in the Vickery Extension Project (VEP) Environmental Impact Statement (EIS)[1], Environmental Protection Licence (EPL) 21283 and other water licensing requirements.

On the 11th of December 2020, the Planning Secretary approved the progressive submission of environmental management plans for the Vickery Extension Project in accordance with Condition A25(a), Schedule 2 of SSD-7480.

Furthermore, the WMP has been prepared cognisant of the requirements to minimise impacts on water resources as specified in Conditions 1 to 14 of Approval Decision (EPBC 2016/7649) for the Vickery Extension Project made on the 15th of September 2021 under Sections 130(1) and 133(1) of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).

This WMP has been developed using a risk management process that follows hazard identification, impact assessment, development of management and mitigation measures and contingency planning. The WMP summarises the results of the surface water and groundwater impact assessments and outlines the control measures to be implemented as a part of the Vickery Extension Project to minimise the potential for adverse impacts on water resources for the local community and the environment. The WMP contains a monitoring program, developed to quantify impacts of the operation on water quality and quantity and to assess compliance against the relevant water criteria, and also includes the reporting and record keeping requirements to be maintained throughout the mining operations.

[1] For the purposes of this WMP, the Vickery Extension Project EIS relates to the: *Vickery Extension Project – Environmental Impact Statement* (Resource Strategies Pty Ltd, 2018); *Vickery Extension Project – Submissions Report* (VCPL, 2019a); *Vickery Extension Project Amendment Report* (VCPL, 2019b) and additional information responses dated 17 September 2019; 2, 18 & 31 October 2019; 1, 6, 12, 14 & 28 November 2019; 17 January 2020; 17 February 2020; 3, 9, 13 & 16 March 2020.

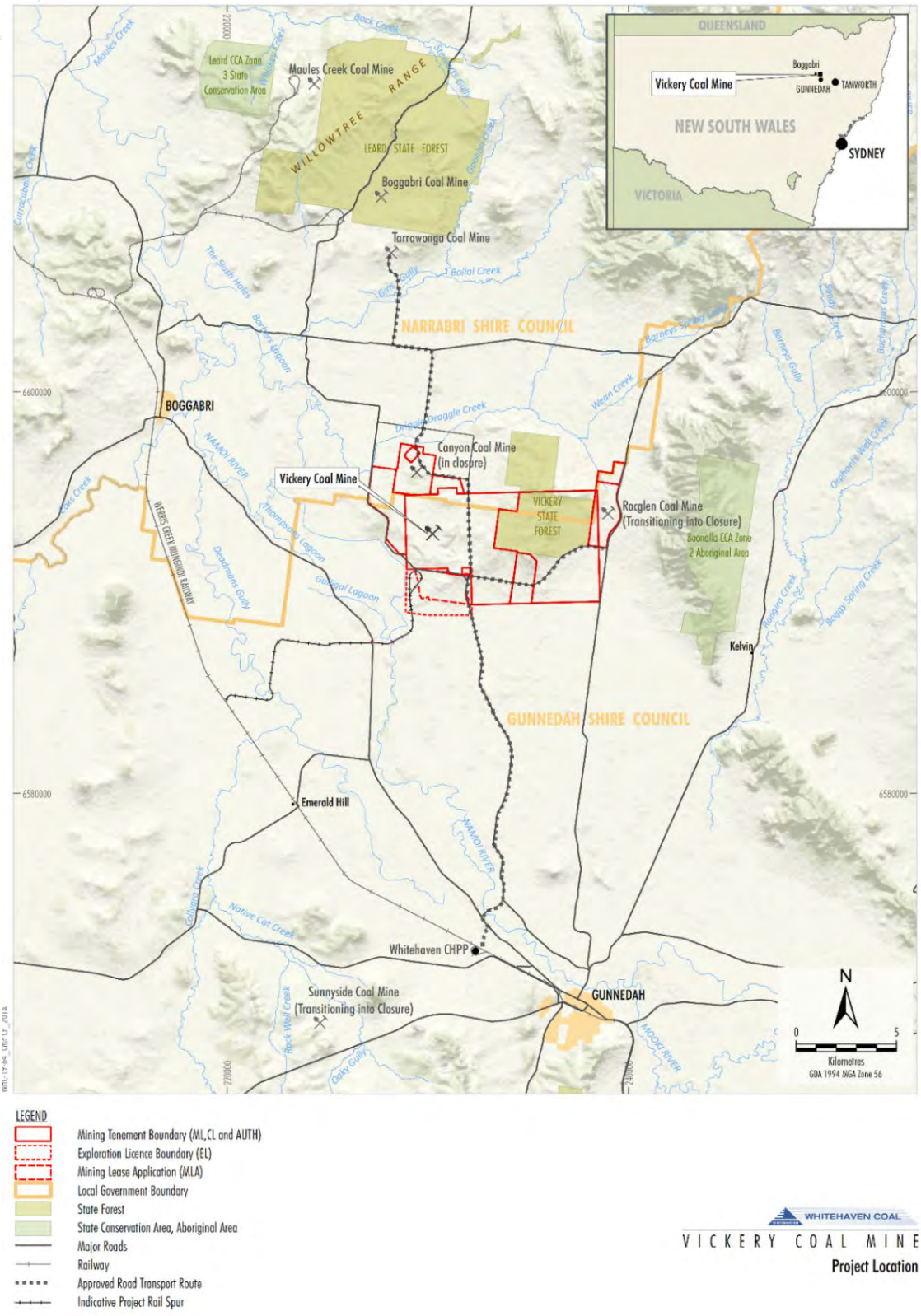


Figure 1 Locality Plan and Local Setting

The WMP was prepared by experienced and qualified water experts WRM Water & Environment (WRM) and SLR, endorsed by the Secretary of the DPIE on 6/02/2023.

This WMP will be prepared in consultation with NSW Department of Planning, Industry and Environment (DPIE), including the Environment Protection Authority (EPA) and Water Group (DPIE Water) within DPIE, and Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW).

1.1 PURPOSE AND SCOPE

This document presents the Water Management Plan (WMP) for VCM. The scope of this WMP is staged, documenting the first three (3) year period of the Vickery Extension Project, (Figures 2a to 2c) and is specifically related to the construction and initial mining activities. Future updates of the WMP will include details on the construction of the rail spur/corridor and the scaling up of the mine plan to full production.

In fulfilling the statutory obligations, and recognising the Planning Secretary has approved the progressive submission of environmental management plans, the purpose of this WMP is to:

- Consolidate information relating to baseline conditions and potential impacts from construction and initial mining activities;
- Describe the site water management system and outline measures to minimise the water related impacts from the VEP on the surrounding community and environment;
- Establish water monitoring programs to assess and report on the level of impact on water resources as required by statutory approvals; and
- To keep the local community and relevant agencies informed and to provide a mechanism to respond to water issues and complaints effectively.

1.2 STRUCTURE OF THE WATER MANAGEMENT PLAN

The structure of the following sections of the WMP has been largely guided by the statutory requirements prescribed in Condition B53, Schedule 2 of SSD-7480, as well as the general management plan requirements in Condition E4, Schedule 2 of the SSD-7480 (Section 2.1). This WMP describes:

- Statutory obligations under the Development Consent (SSD-7480), Approval Decision (EPBC 2016/7649) and other relevant legislation and guidelines (Section 2).
- Background and baseline meteorological, surface water and groundwater data, as well as spoil characterisation (Section 3).
- The site water management system including clean water management, erosion and sediment control and mine water management, as well as water licensing (Section 4).
- The site water balance and salt balance (Sections 5 and 6).
- Water impact triggers and response plans (Section 7).
- Programs for monitoring compliance with performance measures, water quality discharges, impacts on other water users, site water balance and effectiveness of measures (Section 8).

- Reporting and review procedures (Section 9).
- References (Section 10).

Enclosure 1 will be developed progressively to include details of consultation with relevant parties during the preparation of this WMP as evidence of matters resolved, endorsement and approvals received. As per PA Condition B54, the operation must implement the Water Management Plan as approved by the Planning Secretary.

Appendix A is the Groundwater Management Plan (GWMP) for VCM.

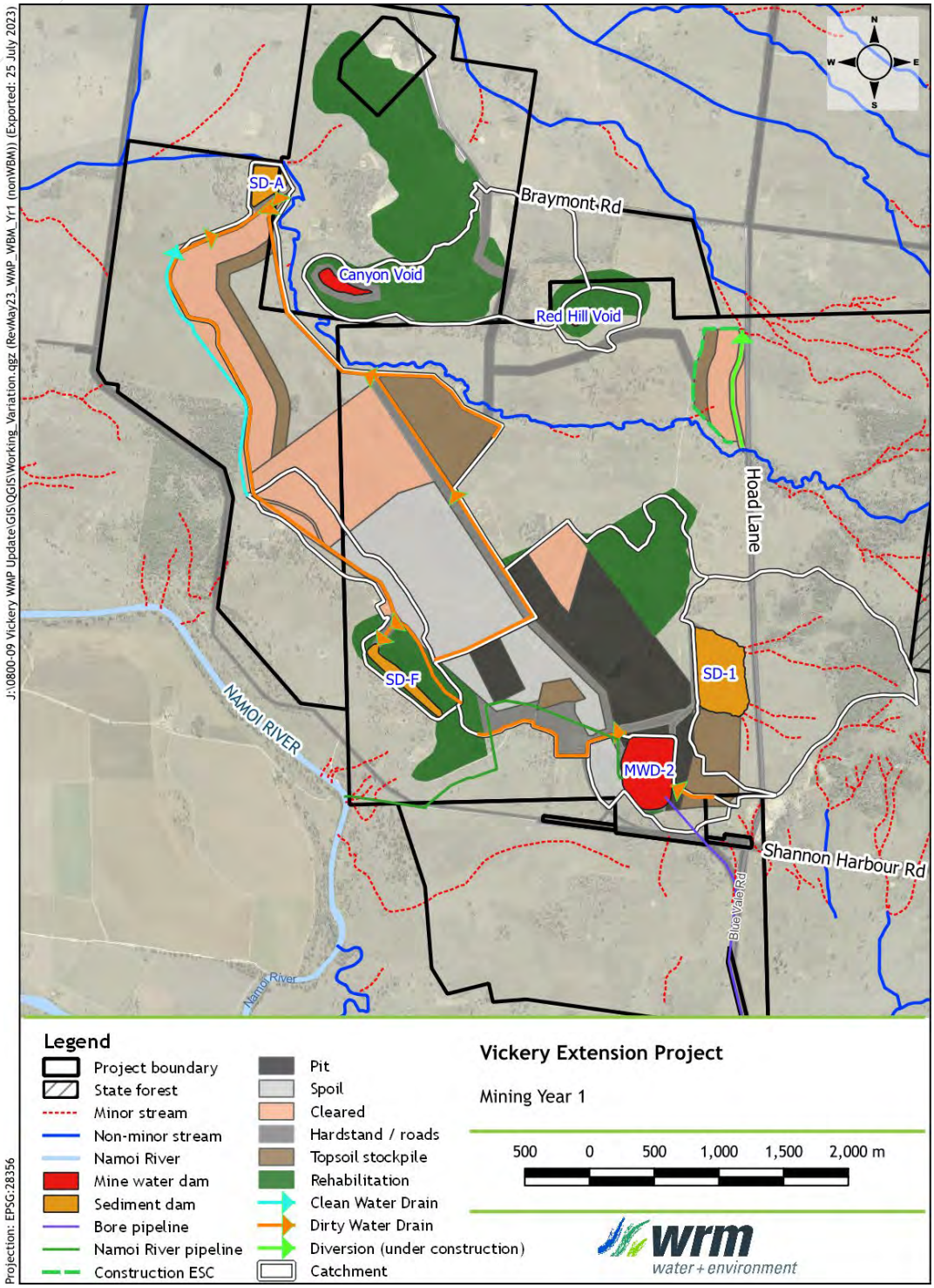


Figure 2a Layout Year 1

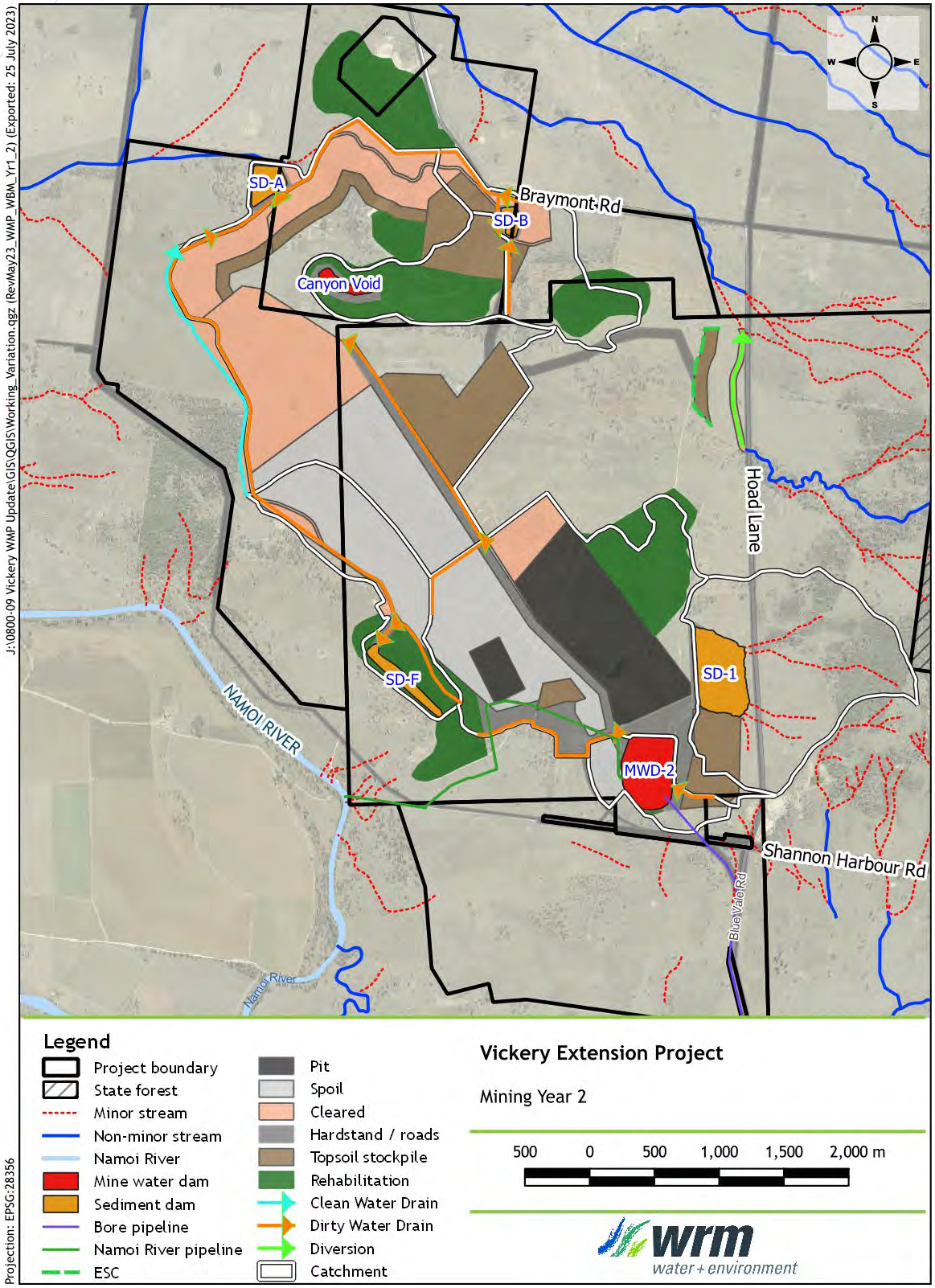


Figure 2b Layout Year 2

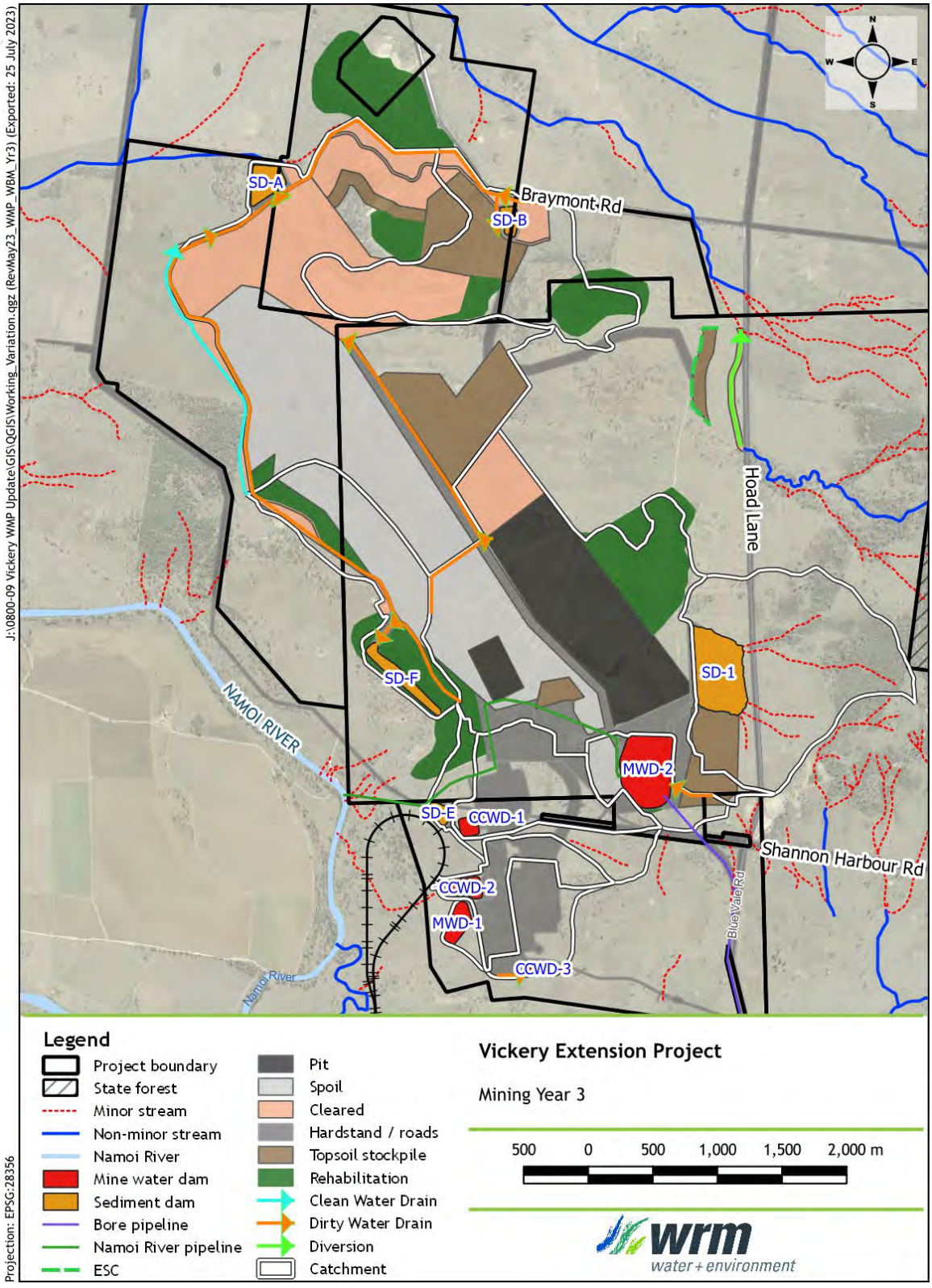


Figure 2c Layout Year 3

2 STATUTORY OBLIGATIONS

Development Consent (SSD-7480) was granted for the Vickery Extension Project by the NSW Independent Planning Commission as a delegate of the NSW Minister for Planning under Section 75J of the NSW EP&A Act on the 12th of August 2020. Conditions B39 to B54 in Schedule 2, Part B of SSD-7480 relate to 'Water' and are summarised in Table 1 along with where each requirement is addressed in this WMP, or how otherwise considered. Whilst Conditions B101 to B106 in Schedule 2, Part B of SSD-7480 relate to 'Rehabilitation', the requirements refer to water quality and water management objectives which are also explicitly referred to in Approval Decision (EPBC 2016/7649) Conditions 1, 3 and 4 for 'Water Resources' (Table 2). As stated in Approval Decision (EPBC 2016/7649) the objective of Conditions 1 to 14 is to minimise the impacts of the action on a Water Resource.

Table 1 Water Requirements from Development Consent (SSD-7480)

Water Requirements Relevant to the WMP		Section of WMP (Where Addressed or Considered)
WATER		
Water Supply		
B39.	The Applicant must (a) Ensure that it has sufficient water for all stages of the development; (b) Implement efficiency and best practice measures to minimise and conserve the use of water; and (c) If necessary, adjust the scale of the operations to match its available water supply.	Sections 4 & 5 Sections 4, 5 & 6 Sections 4.1 & 4.2
B40.	The Applicant must report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence. ***Note:*** *Under the Water Act 1912 and/or Water Management Act 2000, the Applicant is required to obtain all necessary water licences for the development, including during rehabilitation and post mine closure.*	Sections 2.5, 4.8, 5.5.1, 8.2 & 9.2.1 Section 2.5 & 4.8
Compensatory Water Supply		
B41.	The Applicant must provide a compensatory water supply to any landowner of privately-owned land whose rightful water supply is adversely and directly impacted (other than an impact that is minor or negligible) as a result of mining operations, in consultation with DPIE Water, and to the satisfaction of the Planning Secretary.	Section 7.3.1
B42.	The compensatory water supply measures must provide an alternative long term supply of water that is equivalent, in quality and volume, to the loss attributable to the development. 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.	
B43.	If the Applicant and the landowner cannot agree on whether the loss of water is 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. The burden of proof that any loss of water supply is not due to mining impacts rests with the Applicant.	
B44.	If the Applicant is unable to provide an alternative long term supply of water, then the Applicant must provide compensation, to the satisfactory of the Planning Secretary.	
B45.	However, conditions B41 to B44 do not apply if the Applicant has a compensatory water agreement with the owner/s of the land and the Applicant has advised the Department in writing of the terms of this agreement. ***Note:*** *The Water Management Plan (see condition 28* [sic]*) is required to include trigger levels for investigating potentially adverse impacts on water supplies.*	Section 7.4.1 Refer to Condition B53
Water Discharges		
B46.	The Applicant must ensure that all surface discharges from the site comply with: (a) Discharge limits (both volume and quality) set for the development in any EPL; or (b) Relevant provisions of the POEO Act.	Section 2.4

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

Water Requirements Relevant to the WMP		Section of WMP (Where Addressed or Considered)
Mine Water Storages		
B47.	The Applicant shall implement all reasonable and feasible measures to prevent migration of saline water from the mine water storages or provide suitable measures to offset the salinity impacts on the Namoi River, to the satisfaction of the EPA and the Planning Secretary.	Sections 4 & 5
Flooding		
B48.	The Applicant shall ensure that the design and construction of the project, including the Project Rail Spur and Kamilaroi Highway overpass, is consistent with the objectives of the *Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019*, to the satisfaction of the Planning Secretary.	Section 2.5.3 and Enclosure 1
B49.	The Project Rail Spur, Project Rail Spur bridges and any upgrade to the haul road must be designed and constructed to minimise flooding and scouring impacts, in consultation with BCD and consistent with the recommendations of the Department's flood peer review. The design and construction of the Project Rail Spur must provide for its complete elevation above the 1% Average Exceedance Probability flood level west of the Namoi River, generally in accordance with the EIS. Prior to construction of the Project Rail Spur or any upgrades to the haul road, the Proponent shall undertake a flood assessment of the detailed design to confirm there would be minimal impacts as predicted in the document listed in condition A2(c).	
Namoi River Pipeline		
B50.	Prior to the construction of the Namoi River pipeline and pump station, the Applicant shall: (a) Consult with DPI-NSW Fisheries regarding the general operation and design of the pump station and screens to avoid and mitigate impacts on native fish; (b) Consult with GSC regarding the design and construction of the pipeline in the Braymont Road Reserve; and (c) Implement all reasonable and feasible recommendations for DPI-NSW Fisheries and GSC in regard to the design and construction of the pipeline and pump station, to the satisfaction of the Planning Secretary.	Section 4.2
Water Management Performance Measures		
B51.	The Applicant must ensure that the development complies with the performance measures in Table 8. ***Table 8:*** *Water Management Performance Measures*	Sections 4.11 & 7

Feature	***Performance Measure***	
Water management – General	• Maintain the clean water management system separate from the dirty (i.e. sediment laden) and mine water management systems • Minimise the use of clean and potable water • Maximise water recycling, reuse and sharing opportunities • Maximise the capture and reuse of mine water and dirty water to meet operational demands for water, including dust suppression activities • Minimise the use of make-up water from licensed external sources • Design, install, operate and maintain water management infrastructure in a proper and efficient manner • Minimise risks to the receiving environment and downstream water users	Sections 2.5, 4, 5 & 8.5
Alluvial aquifers	• Negligible impacts to alluvial aquifers caused by the development beyond those predicted in the document/s listed in condition A2(c), including: - negligible impacts to water quality; - negligible change in groundwater levels; and - negligible impact to other groundwater users; • Comply with the Minimal Impact Consideration for Aquifer Interference Activities for Alluvial Water Source (highly productive groundwater sources) under the *NSW Aquifer Interference Policy* (DPI, 2012)	Sections 2.5.1, 7.2, 8.2 & 9.2

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

Water Requirements Relevant to the WMP			Section of WMP (Where Addressed or Considered)
Water Management Performance Measures (Cont.)			
Table 8 (Cont.): *Water Management Performance Measures*			
	Erosion and sediment control works	• Design, install and maintain erosion and sediment controls in accordance with the best management practice guidance series *Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008)* • Design, install and maintain any new infrastructure within 40 metres of watercourses in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012) or latest versions • Design, install and maintain any creek crossings in accordance with the Fisheries NSW Policy and Guidelines for *Fish Habitat Conservation and Management* (DPI, 2013) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries, 2003), or their latest versions	Section 4.7
	Flood protection works	• Design, install and maintain flood levees to protect mining areas from a probable maximum flood event and to ensure no increased flooding impacts on roads or privately-owned land	
	Construction and operation of linear infrastructure	• Design and construct the Project Rail Spur and Kamilaroi Highway overpass such that this infrastructure will not cause significant increased flooding, in particular increased affluxes and velocities at key locations, redistribution in and around the overpass, and flood levels at residences	Sections 2.5.3 & 8.3 and Enclosure 1
	Clean water diversions and storage infrastructure	• Design, install and maintain the clean water system to capture and convey the 100 year ARI flood event • Maximise, as far as reasonable, the diversion of clean water around disturbed areas on site, except where clean water is captured for use in site	Sections 2.5.3 & 4.3 and Figures 2a to 2c
	Sediment Dams	• Design, install and maintain sediment dams in accordance with the guidance series *Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004)* and *2E Mines and Quarries (DECC, 2008)* and the requirements under the POEO Act • Design, install and maintain sediment dams to include contingency measures to prevent the potential mobilisation of pollutants and ensure compliance with the requirements of the *Water Management Act 2000* and the EPL discharge criteria	Sections 4.7, 4.8, 7.4 & 8.6
	Mine water storages	• Design, install and maintain mine water storage infrastructure to ensure no discharge of mine water to the off-site environment • New storages designed to contain the 100 year ARI storm event and minimise permeability • Ensure adequate freeboard within all pit voids at all times to minimise the risk of discharge to surface waters and groundwater	Sections 4.5, 5 and 6.4
	In-pit emplacement of acid forming and potentially acid forming materials	• Emplacement, encapsulation and capping to prevent the migration of pollutants beyond the pit shell • Adequate freeboard within the pit void to minimise the risk of discharge to surface waters	Section 3.7
	Overburden emplacements	• Design, install and maintain emplacements to encapsulate and prevent migration of acid forming and potentially acid forming materials, and saline and sodic material • Design, install and maintain out-of-pit emplacements to prevent and/or manage long term saline seepage	Section 6
	Chemical and hydrocarbon storage	• Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards	Section 4.6

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

Water Requirements Relevant to the WMP		Section of WMP (Where Addressed or Considered)
Water Management Performance Measures (Cont.)		
	Table 8 (Cont.): *Water Management Performance Measures* Creek diversions: • Diverted creek lines are hydraulically and geomorphologically stable • Incorporate erosion control measures based on vegetation and engineering revetments • Incorporate water features such as persistent/permanent pools for aquatic habitat • Revegetate with suitable riparian vegetation Aquatic and riparian ecosystem: • Negligible environmental consequences beyond those predicted in the document/s listed in condition A2(c) • Maintain or improve baseline channel stability • Develop site-specific in-stream water quality objectives in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000) and *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006)	Section 2.3.1 Section 3
B52.	The performance measures in Table 8 do not apply to water management structures constructed under previous consents.	Section 4.2
Water Management Plan		
B53.	The Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	This WMP
	(i) be prepared by a suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;	
	(ii) be prepared in consultation with DPIE Water and the EPA;	Enclosure 1
	(iii) be submitted to the Planning Secretary for approval prior to carrying out construction under this consent;	
	(iv) describe the measures to be implemented to ensure that the Applicant:	
	(i) complies with the water management performance measures (see Table 8); and	Refer to Condition B51
	(ii) addresses the recommendations for surface and groundwater monitoring programs by the Commonwealth Independent Expert Scientific Committee on Coal Seam Gas and Large Mining Development (IESC) (IESC 2018-099: Vickery Extension Project (EPBC 2016/7649 and SSD-7480) – Expansion);	Refer to Table 4
	(v) incorporate recent meteorological and climate data and describe the periodic review of new and relevant input data, including sensitivity analysis of variations from climate projections and trends;	Sections 3.1 & 5.2
	(vi) utilise existing data from nearby mines and build on existing monitoring programs, where practicable; and	Section 3
	(vii) include a:	
	(i) **Site Water Balance** that includes details of:	Section 5
	• predicted annual inflows to and outflows from the site;	Sections 5.2 to 5.5
	• sources and security of water supply for the life of the development (including authorised entitlements and licences);	Section 2.5, 4.2.1 & 5
	• prioritisation strategy for water sources, including the strategy to maximise the reuse of mine water and dirty water for the development;	Sections 4 & 5
	• water storage capacity;	Sections 4.2 & 5
	• water use and management on the site, including any water transfers or sharing with neighbouring mines and opportunities to improve the efficiency of site water use and minimise the use of clean water on the site;	Sections 4.2, 4.2.3 & 4.3
	• licenced sources of external water supply for the development which could be utilised as a contingency measure in the event of extreme climatic conditions;	
	• licensed discharge points and limits; and	Section 2.4 & 5.5
	• reporting procedures, including the annual preparation of an updated site water balance;	Sections 5 & 9

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

Water Requirements Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Water Management Plan (Cont.)	
(ii) **Salt Balance** that includes details of: • sources of saline material on the site; • saline material and saline water management on the site; • measures to minimise discharge of saline water from the site; and • reporting procedures, including the annual preparation of an updated salt balance;	Section 6 Section 6.2 Sections 3.7 & 6.3 Section 6.3 Section 9
(iii) **Erosion and Sediment Control Plan** that: • is consistent with the best management practice requirements of *Managing Urban Stormwater: Soils and Construction - Volume 1: Blue Book* (Landcom, 2004) and *Volume 2E: Mines and Quarries* (DECC, 2008); • identifies activities that could cause soil erosion, generate sediment or affect flooding;	Section 4.4 Section 4.4.1
• includes a program to review the adequacy of flood protection works, and ensure they comply with the relevant performance measures listed in Table 8; • describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk; • describes the location, function, and capacity of erosion and sediment control structures and flood management structures; and • describes what measures would be implemented to maintain (and if necessary decommission) the structures over time;	Section 8.3 Section 4.4 Section 4.4.1 Section 4.4.1
(iv) **Surface Water Management Plan** that includes: • detailed baseline data on surface water flows and quality of watercourses and/or water bodies potentially impacted by the development, including: - stream and riparian vegetation health; - channel stability (geomorphology); and - water supply for other surface water users;	This WMP Section 3
• a detailed description of the surface water management system, including the separation of water captured on the site and uses associated with the: - clean water capture and diversion system; - dirty water system (including sediment detention basins); - mine water capture system; • detailed plans, design objectives and performance criteria for water management infrastructure, including: - any approved creek diversions or restoration works associated with the development; - water run-off diversions and catch drains; - clean water storages, mine water storages and sediment dams; - emplacement areas; - backfilled pits and any final voids for the development (see also Table 12); and - reinstated drainage networks on rehabilitated areas of the site;	Section 4 Section 4.3 Sections 4.4 & 4.7 Section 4.2 Sections 4 and 7 Refer to Condition B101 Section 4.9
• detailed performance criteria, including trigger levels for identifying and investigating any potentially adverse impacts (or trends) associated with the development, for: - downstream surface water flows and quality; - channel stability; - downstream flooding impacts; - stream and riparian vegetation heath; - water supply for other water users; and - post-mining water pollution from rehabilitated areas of the site;	Section 7.1

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

Water Requirements Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Water Management Plan (Cont.)	
• a program to monitor and evaluate: - compliance with the relevant performance measures listed in Table 8 and the performance criteria in this plan; - water quality in sediment dams prior to discharge into the environment; - controlled and uncontrolled discharges and seepage/leachate from the site;	Section 8 Refer to Condition B51 Section 8.1.2
- impacts on water supply for other water users; - surface water inflows, outflows and storage volumes, to inform the Site Water Balance; - the effectiveness of the surface water management system, including contingency measures to be implemented during a potential failure of the water management system infrastructure, and - the effectiveness of the measures in the Erosion and Sediment Control Plan; • reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results; and • a trigger action response plan to respond to any exceedances of the performance measures or performance criteria, and repair, mitigate and/or offset any adverse surface water impacts of the development;	Section 8 Sections 3, 4 & 5 Section 7 Section 9.4.2 Section 9 Section 7
(v) **Groundwater Management Plan** that includes: • detailed baseline data of groundwater levels, yield and quality for groundwater resources potentially impacted by the development, including groundwater supply for other water users; • a detailed description of the groundwater management system; • groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on: - regional and local aquifers (alluvial and hardrock); and - groundwater supply for other water users such as licensed privately-owned groundwater bores; • a program to monitor and evaluate: - compliance with the relevant performance measures listed in Table 8 and the performance criteria in this plan; - inputs and outputs from water storages (groundwater, surface water and atmospheric water), including any final void; - geochemical characteristics of groundwater flows to the open cut, to inform the progressive development of the final landform and optimise the final void dimensions, to be described in the rehabilitation strategy required by condition B104. - groundwater inflows, outflows and storage volumes, to inform the Site Water Balance; - the likelihood of any indirect impacts from the development on nearby alluvial aquifers; - the hydrogeological properties used in the groundwater modelling, including the basement volcanics; and - the effectiveness of the groundwater management system; • reporting procedures for the results of the monitoring program, including notifying other water users of any elevated results; • a trigger action response plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate and/or offset any adverse groundwater impacts of the development; and • a program to periodically validate the groundwater model for the development, including an independent review of the model every 5 years, and at least annual comparison of monitoring results with modelled predictions; and	GWMP (Appendix A)
(vi) a protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition E9.	Section 9

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

<table>
<tr><th colspan="2">Water Requirements Relevant to the WMP</th><th>Section of WMP (Where Addressed or Considered)</th></tr>
<tr><td colspan="3">Water Management Plan (Cont.)</td></tr>
<tr><td colspan="2">(viii) include a detailed performance and completion criteria for evaluating the performance of the Water Management Plan, and triggering remedial action (if necessary).</td><td>Sections 7 and 8.6</td></tr>
<tr><td>B54.</td><td>The Applicant must implement the Water Management Plan as approved by the Planning Secretary.</td><td>Enclosure 1</td></tr>
<tr><td colspan="3">REHABILITATION</td></tr>
<tr><td colspan="3">Rehabilitation Objectives</td></tr>
<tr><td>B101.</td><td>The Applicant must rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the Mining Act 1992. The rehabilitation must be generally consistent with the proposed rehabilitation objectives described in the documents listed in condition A2(c) (and shown conceptually in the figure in Appendix 6) and must comply with the objectives in Table 12.
Table 12: Rehabilitation Objectives
<table>
<tr><th>Feature</th><th>Objective</th><th></th></tr>
<tr><td>All areas of the site affected by the development</td><td>• Safe, stable and non-polluting
• Fit for the intended post-mining land use/s
• Establish the final landform and post-mining land use/s as soon as practicable after cessation of mining operations
• Minimise post-mining environmental impacts</td><td>Section 7</td></tr>
<tr><td>Areas proposed for native ecosystem re-establishment</td><td>• Establish/restore self-sustaining native open woodland ecosystems
• Establish local plant community types
• Establish:
- riparian vegetation, within any diverted and/or re-established creek lines and retained water features;
- habitat, feed and foraging resources for threatened fauna species; and
- vegetation connectivity and wildlife corridors, as far as is reasonable and feasible</td><td>Section 4.8</td></tr>
<tr><td>Areas proposed for agricultural land</td><td>• Establish/restore grassland areas to support sustainable agricultural activities
• Use species found in the local area that are suitable for pasture production
• Achieve land and soil capabilities that are equivalent or better than pre-mining
• Locate adjacent to surrounding agricultural land, where practicable</td><td>Section 4.4</td></tr>
<tr><td>Final Landform</td><td>• Stable and sustainable for the intended post-mining land use/s
• Integrated with surrounding natural landforms and other rehabilitated landforms, to the greatest extent practicable
• Incorporate macro-relief and micro-relief and drainage features that mimic natural topography and mitigate erosion, to the greatest extent practicable
• Maximum surface water drainage to the natural environment, excluding final void catchment (i.e. free draining)
• Reduce highwall slopes to a maximum of 18 degrees (excluding slopes below the post-mining sanding water level in any final void
• Minimise visual impacts, where practicable</td><td>Sections 4.4 & 4.5</td></tr>
<tr><td>Final void</td><td>• Designed as long term groundwater sink to prevent the release of polluting water into the surrounding environment, unless further mine planning and the final landform design processes identify a more suitable outcome for the final void (see condition B104)
• Optimise the size and depth of any final voids and ensure the final landform is stable and non-polluting
• Minimise to the greatest extent practicable:
- the drainage catchment of final voids;
- any highwall instability risk
- the risk of flood interaction
• Maximise potential for beneficial reuse, where practicable</td><td>Sections 2.5.3, 4.5 & 4.8</td></tr>
<tr><td>Surface infrastructure of the development</td><td>• To be decommissioned and removed, unless the Resources Regulator agrees otherwise
• Structures over the Kamilaroi Highway to be demolished and removed, unless TfNSW agrees otherwise</td><td>Refer to Condition B106</td></tr>
</table></td><td></td></tr>
</table>

Table 1 (Cont.) Water Requirements from Development Consent (SSD-7480)

<table>
<tr><th colspan="2">Water Requirements Relevant to the WMP</th><th>Section of WMP (Where Addressed or Considered)</th></tr>
<tr><td colspan="3">Rehabilitation Objectives (Cont.)</td></tr>
<tr><td colspan="2">Table 12 (Cont.): Rehabilitation Objectives
<table>
<tr><th>Feature</th><th>Objective</th></tr>
<tr><td>Rehabilitation materials</td><td>• Materials from areas disturbed under this consent (including topsoils, substrates and seeds) are to be recovered, managed and reused as rehabilitation resources, to the greatest extent practicable
• Maximise use of biosolids (or similar organic recycled material) to enhance soil quality for revegetation</td></tr>
<tr><td>Water quality</td><td>• Water retained on the site is fit for the intended post-mining land use/s
• Water discharged from the site is suitable for receiving waters and fit for aquatic ecology and riparian vegetation</td></tr>
<tr><td>Community</td><td>• Ensure public safety
• Minimise adverse socio-economic effects associated with mine closure</td></tr>
</table></td><td>Refer to Condition B106

Sections 4.9 & 4.10

Refer to Condition B106</td></tr>
<tr><td>B102.</td><td>The rehabilitation objectives in Table 12 apply to the entire site, including all landforms constructed under either this consent or previous consents. However the Applicant is not required to undertake any additional earthmoving works on landforms that have been approved and constructed under previous consents.</td><td></td></tr>
<tr><td colspan="3">Progressive Rehabilitation</td></tr>
<tr><td>B103.</td><td>The Applicant must rehabilitate the site progressively, that is, as soon as reasonably practicable following disturbance. All reasonable steps must be taken to minimise the total area exposed at any one time. Interim stabilisation and temporary vegetation strategies must be employed when areas prone to dust generation, soil erosion and weed incursion cannot be permanently rehabilitated.
Note: This condition does not prevent further disturbance at some later stage of the development of areas that have been rehabilitated.</td><td>Section 4</td></tr>
</table>

Table 2 Water Requirements from Approval Decision (EPBC 2016/7649)

<table>
<tr><th colspan="2">Water Requirements Relevant to the WMP</th><th>Section of WMP (Where Addressed or Considered)</th></tr>
<tr><td colspan="3">Water Resources</td></tr>
<tr><td>1.</td><td>For the protection of water resources, the approval holder must comply with State development consent conditions B39 to B54 and B101 to B106.</td><td>Refer to Table 1</td></tr>
<tr><td>2.</td><td>The approval holder must ensure that there is no adverse effect on the function of a water resource as a result of the action.</td><td>Sections 7 & 8</td></tr>
<tr><td>3.</td><td>The approval holder must notify the Department in writing, within 2 business days, if an application to modify State development consent conditions B39-B54 and B101-B106 is made.</td><td>Enclosure 1</td></tr>
<tr><td>4.</td><td>The approval holder must notify the Department in writing, within 10 business days, where State development consent conditions B39-B54 and B101-B106 have been modified.</td><td>Enclosure 1</td></tr>
<tr><td>5</td><td>The approval holder must include the following information in the Water Management Plan required by State development consent condition B53:
a. management and mitigation strategies to minimise potential impacts to the EPBC Act listed Murray Cod (Maccullochella peelii).
b. details of any chemical dust suppressants used. These details must include the chemicals proposed for use, typical application rates, and an assessment of the likelihood that the chemicals will enter the environment (e.g. soil, groundwater or surface water) and the potential persistence and toxicity to protected matters of these chemicals or their breakdown products. Furthermore, if data on chronic toxicity to aquatic organisms is not available in respect of any chemical proposed for use, the approval holder must include the results of direct toxicity assessments undertaken in accordance with the Australian and New Zealand guidelines for fresh and marine water quality, 2018 or any subsequent revision.</td><td>Section 4.1

Sections 2.6 & 4.6.4</td></tr>
<tr><td>6.</td><td>The approval holder must provide the Department with the final version of the Water Management Plan required by condition B53 of the State development consent within 10 business days of its approval by the NSW Planning Secretary.</td><td>Enclosure 1</td></tr>
</table>

Table 2 (Cont.) Water Requirements from Approval Decision (EPBC 2016/7649)

Water Requirements Relevant to the WMP		Section of WMP (Where Addressed or Considered)
Water Resources (Cont.)		
7.	The approval holder must notify the Department within 2 business days of any proposed changes to the final version of the Water Management Plan. If the NSW Planning Secretary approves a revised version of the Water Management Plan, the approval holder must provide the Department with the approved revised Water Management Plan within 10 business days of its approval by the NSW Planning Secretary.	Enclosure 1
8.	In addition to the Groundwater Management Plan monitoring requirements specified in condition B53 of the State development consent, the approval holder must: a. Establish and maintain a network of groundwater monitoring bores designed to detect changes in groundwater levels and include bores that are co-located or paired with surface water monitoring sites to allow monitoring and analysis of groundwater-surface water interactions. These monitoring bores must be installed prior to the commencement of mining operations. b. Monitor groundwater levels in each bore (required under condition 8a) at least once every 3 months, starting within one week of the commencement of mining operations for the life of this approval. c. Publish on the website all groundwater monitoring data from the bore network, updated at least once every 3 months to include the most recent readings available and maintain the data on the website for the life of this approval. The monitoring data must include hydrographs for the bore network and explain what the data means in relation to the groundwater performance measures specified in the State development consent.	GWMP (Appendix A)
9.	The approval holder must submit performance criteria and limits, relevant to groundwater extraction impacts for the alluvial aquifer, for the Minister's approval. The submission of the performance criteria and limits must be accompanied by evidence-based justification of how they were derived from the results of monitoring, consider groundwater-surface water connectivity, and are suitable to demonstrate condition 2 is being achieved.	GWMP (Appendix A)
10.	The approval holder must not commence groundwater extraction from the water supply borefield until the performance criteria and limits have been approved by the Minister in writing.	GWMP (Appendix A)
11.	If, at any time during the period for which this approval has effect, the approval holder detects an exceedance of any approved limit required under condition 9 the approval holder must notify the Department of the exceedance within 2 business days of detecting the exceedance.	GWMP (Appendix A)
12.	If, at any time during the period for which this approval has effect, the approval holder detects an exceedance of an approved limit required under condition 9, the approval holder must cease groundwater extraction from the water supply borefield within 2 business days.	
13.	If the approval holder has been required to cease groundwater extraction pursuant to condition 12, the approval holder must: a. provide information including monitoring data that identifies the likely cause of the exceedance of the approved limit;	
	b. consider the effect of the current condition of the water resource on the utility of the water resource for associated users; and c. if the likely cause is identified as a component of the action, propose measures to mitigate and manage any impacts to any associated users, ensuring that the utility of the water resource for associated users is not effected.	
14.	The approval holder must not recommence groundwater extraction until the information required in condition 13 has been approved by the Minister in writing. The approval holder must implement the approved mitigation and management measures.	

As stated in Condition B53(d)(ii), Schedule 2 of Development Consent (SSD-7480) (Table 1), this WMP has been prepared to consider and address the recommendations for surface and groundwater monitoring programs by the Commonwealth Independent Expert Scientific Committee on Coal Seam Gas and Large Mining Development (IESC) (IESC 2018-099: Vickery Extension Project (EPBC 2016/7649 and SSD-7480) – Expansion) (Table 3).

Table 3 Recommendations for Surface and Groundwater Monitoring Programs (EPBC 2016/7649 and SSD-7480)

Monitoring Recommendations Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Summary	
The IESC has identified areas in which additional work is required to assess the materiality of impacts, as detailed in this advice. These are summarised below. … • Monitoring of surface water quality should be improved by increasing the frequency of monitoring and the range of analytes.	Sections 3.3 & 8.1
Groundwater (Monitoring)	
2. The IESC has a number of suggested improvements for mitigation and management of potential impacts from the proposed project. These are discussed below.	
a. The proponent proposes a groundwater monitoring program using the existing monitoring network. It is unclear from the documentation provided which bores will be monitored. There is a large number of bores shown in Figure 16 (EIS, Appendix A, p. 87), and it may be unnecessary for the proponent to monitor all the bores shown. Bores which will be monitored, and the parameters to be measured, need to be clearly identified so that it can be determined that the spatial and depth coverage will be suitable. The locations for the two proposed bores to monitor for leaching from the Western Emplacement should also be clearly identified so it can be determined if these bores will be sufficient.	GWMP (Appendix A)
b. If the proposed borefield is installed, then additional monitoring bores (with monitoring at multiple screened depths) will need to be installed to monitor potential impacts in both the Upper Namoi Alluvium and the Maules Creek Formation in the vicinity of the borefield.	GWMP (Appendix A)
c. Groundwater quality monitoring is proposed; however, the parameters to be analysed are limited to several physico-chemical parameters, major ions and five metals/metalloids (aluminium, arsenic, molybdenum, selenium and iron). Hydrocarbons and additional metals should be monitored, particularly as the groundwater quality data and the geochemical analysis results (discussed further in the response to Question 2) show that concentrations of some metals could be or are already elevated (compared to ANZG 2018 guideline values for aquatic ecosystem protection). Additional parameters to be monitored should include: boron, copper, lead, antimony, tin, zinc, silver, cobalt, nickel and mercury.	GWMP (Appendix A)
d. Only pH and electrical conductivity (EC) are proposed to be monitored in groundwater twice yearly, with other parameters monitored once annually. Groundwater quality monitoring for all parameters should occur more frequently than annually (at least seasonally for all parameters and potentially continuously for EC and temperature in the water table aquifer) given the high value of the Upper Namoi Alluvial aquifer and the large number of users.	GWMP (Appendix A)
e. The groundwater monitoring plan, when developed, should include appropriate site-specific level and water quality guideline values and triggers. The plan should also include a trigger action response plan (TARP) which clearly outlines the actions and responses that will be taken, in a timely manner, when a trigger value is exceeded.	GWMP (Appendix A)
f. Groundwater ultimately discharges to local surface water systems in the project region. As such, relevant water quality objectives should include the 95% species protection guideline values for slightly to moderately disturbed aquatic ecosystems as outlined in ANZG (2018) and not only for stock and domestic, and irrigation objectives. When developing water quality objectives for groundwater for the project, these aquatic species protection guideline values need to be considered and the most conservative guideline values for each contaminant (either aquatic ecosystem, stock and domestic or irrigation) used	GWMP (Appendix A)
g. The frequency of monitoring for groundwater levels could be increased from quarterly manual observations through the use of data loggers. This could improve future groundwater models by identifying any variations in recharge assumptions, confining conditions within shallow layers and verifying specific storage values.	GWMP (Appendix A)
h. Monitoring should continue post-mining given that the extent and magnitude of groundwater drawdown will continue to increase post-mining.	GWMP (Appendix A)

Table 3 (Cont.) Recommendations for Surface and Groundwater Monitoring Programs (EPBC 2016/7649 and SSD-7480)

Monitoring Recommendations Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Surface Water (Monitoring)	
5. … Other identified potential issues are outlined below. The IESC has a number of suggested improvements for mitigation and management of potential impacts from the proposed project. These are discussed below. a. The overburden and interburden are expected to contain enriched concentrations of arsenic, silver, boron, antimony and selenium compared to average crustal abundances. Under neutral to alkaline conditions, arsenic, molybdenum and selenium will readily leach. Surface water monitoring should include these metals. b. If the overburden emplacement is constructed such that waste rock with higher sulfur content is exposed for prolonged periods to the atmosphere and moisture, acidic conditions could result. This could cause increased leaching of arsenic, cobalt, nickel, lead, selenium and zinc. The proponent proposes to blend waste rock and ensure that the surface layer ('final lift') of the waste rock emplacement does not contain any potentially-acid-forming material (EIS, Appendix M, p. 32). The IESC considers that this should be effective in mitigating the risk of acidification and associated acidic leaching. However, surface water monitoring should include sampling for arsenic, cobalt, nickel, lead, molybdenum, selenium and zinc to monitor for potential leaching. c. Coal rejects will be disposed of on-site. A small proportion of the coal or coal rejects may have a very low acid-neutralising capacity. Therefore, there is a risk that some of the reject material may be acid-forming if exposed to oxidative conditions (either aerial or through leaching). Concentrations of silver, arsenic, mercury and selenium are high in the coal material and elevated concentrations of molybdenum and selenium may also occur as these are readily soluble in the expected neutral pH conditions. Surface water monitoring should include sampling for these metals. …	Sections 3.4, 8.1 & 8.2 Sections 3.4, 8.1 & 8.2 Sections 3.4 and 8.1

2.1 NSW EP&A ACT 1979 – DEVELOPMENT CONSENT (SSD-7480)

The WMP has been prepared in accordance with the statutory requirements of Development Consent (SSD-7480). While the structure of the WMP has been largely guided by the statutory requirements prescribed in Condition B53, Schedule 2 of SSD-7480 (Table 1), the general management plan requirements in Condition E4, Schedule 2 of the SSD-7480 have also been considered. Table 4 presents these requirements and indicates where each is addressed within this WMP.

Table 4 General Management Plan Requirements from Development Consent (SSD-7480)

Management Plan Requirements Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Management Plan Requirements	
E4. Management plans required under this consent must be prepared in accordance with relevant guidelines, and include where relevant: (a) summary of relevant background or baseline data; (b) details of: (i) the relevant statutory requirements (including any relevant approval, licence or lease conditions); (ii) any relevant limits or performance measures and criteria; and (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; (c) any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	Section 2.6 Section 3 Section 2 Refer to Condition B51 (Tables 1 & 8) Section 2.1.1 and Table 3

Table 4 (Cont.) General Management Plan Requirements from Development Consent (SSD-7480)

Management Plan Requirements Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Management Plan Requirements (Cont.)	
(d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Sections 3 to 9
(e) a program to monitor and report on the: (i) impacts and environmental performance of the development; and (ii) effectiveness of the management measures set out pursuant to paragraph (d);	Sections 8 & 9
(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 7
(g) a program to investigate and implement ways to improve the environmental performance of the development over time;	Section 8
(h) a protocol for managing and reporting any: (i) incident, non-compliance or exceedance of any impact assessment criterion or performance measure; (ii) complaint; or (iii) failure to comply with other statutory requirements;	Section 9
(i) public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and	Section 10
(j) a protocol for periodic review of the plan.	Section 9.5

On the 11th of December 2020, the Planning Secretary approved the progressive submission of environmental management plans for VCM in accordance with Condition A25(a), Schedule 2 of SSD-7480. Future revisions will be made to the WMP as and when required.

2.2 COMMONWEALTH EPBC ACT 1999 – APPROVAL DECISION (EPBC 2016/7649)

The WMP has been prepared in accordance with the statutory requirements of Approval Decision (EPBC 2016/7649) for water resources (Table 2). While the structure of the WMP has been largely guided by the statutory requirements prescribed in Condition B53, Schedule 2 of SSD-7480 (Table 1), as well as the general management plan requirements in Condition E4, Schedule 2 of the SSD-7480 (Table 4), the standard administrative conditions in Part B of Approval Decision (EPBC 2016/7649) relating to submission and publication of plans (Condition 27), annual compliance reporting (Condition 28), and non-compliance and incident reporting (Conditions 29 and 30) are also considered. Table 5 presents these requirements and indicates where each is addressed within this WMP.

Table 5 Standard Administrative Requirements from Approval Decision (EPBC 2016/7649)

Standard Administrative Requirements Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Submission and Publication of Plans	
27. The approval holder must: (a) submit plans electronically to the Department; (b) unless otherwise agreed in writing by the Minister: (i) publish each plan on the website within 20 business days of the date the plan is approved by the Minister or of the date a revised action management plan is submitted to the Minister or the Department, unless otherwise agreed to in writing by the Minister; (ii) publish the Water Management Plan on the website within 20 business days of the date the plan is approved by the NSW Planning Secretary;	Section 9 and Enclosure 1

Table 5 (Cont.) Standard Administrative Requirements from Approval Decision (EPBC 2016/7649)

Standard Administrative Requirements Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Submission and Publication of Plans (Cont.)	
(iii) exclude or redact sensitive ecological data from plans that are to be published on the website or provided to a member of the public; and (iv) keep plans published on the website until the end date of this approval.	Section 9 and Enclosure 1
Annual Compliance Reporting	
28. The approval holder must prepare a compliance report addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies required under the State development consent conditions that are referred to in this approval, at the end of March every year, and covering compliance for the previous calendar year or otherwise in accordance with another annual date that has been agreed to in writing by the Minister. The approval holder must: (a) publish each compliance report on the website within 20 business days following the end of March each year; (b) notify the Department by email that a compliance report has been published on the website and provide the weblink for the compliance report within 5 business days of the date of publication; (c) keep all compliance reports publicly available on the website until this approval expires; (d) exclude or redact sensitive ecological data from compliance reports prior to publishing each compliance report on the website; and (e) where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication. Note: Compliance reports may be published on the Department's website.	Section 9.2.1
Reporting Non-Compliance	
29. The approval holder must notify the Department in writing of any: incident, or non-compliance with the conditions. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify: (a) any condition which is or may be in breach; (b) a short description of the incident and/or non-compliance; and (c) the location (including co-ordinates), date, and time of the incident and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.	Sections 9.1 & 9.4
30. The approval holder must provide to the Department the details of any incident or non-compliance with the conditions as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying: (a) any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future; (b) the potential impacts of the incident or non-compliance; and (c) the method and timing of any remedial action that will be undertaken by the approval holder.	Section 9.1 & 9.4

2.3 NSW MINING ACT 1992 – MINING TENEMENTS (CL 316, ML 1464, ML 1471, ML 1718 & ML 1838)

This WMP has been prepared cognisant of the conditions listed in each of the mining leases CL 316, ML 1464, ML 1471, ML 1718 and ML1838 including the prescribed requirements for a Mining Operations Plan / Rehabilitation Management Plan.

2.3.1 Mining Operations Plan / Rehabilitation Management Plan

A Mining Operations Plan (MOP) will be prepared as required by mining tenements held und the *Mining Act 1992* including:

- CL 316 – Condition 3;
- ML 1464 – Condition 2;
- ML 1471 – Condition 2; and
- ML 1718 – Condition 3.

As noted in Condition B106, Schedule 2 of SSD-7480 (Table 1), the Rehabilitation Management Plan may be combined with the Mining Operations Plan, or similar plan, required under the mining lease(s) granted for the development.

2.4 NSW POEO ACT 1997 – ENVIRONMENT PROTECTION LICENCE (EPL 21283)

The Vickery Coal Project at the VCM operates under EPL 21283, issued under Section 55 of the *Protection of the Environment Operations Act 1997* (POEO Act).

EPL 21283 currently authorises the carrying out of 'scheduled development work' at the premises including:

- Establishment of material stockpile areas and associated roads, including minor earthworks, erosion and sediment controls; temporary offices and amenities compounds.
- Minor adjustments to an existing power line.
- Survey works.
- Geotechnical investigations.

Table 6 summarises the monitoring, complaints handling and reporting requirements established in EPL 21283 for the scheduled development work undertaken for VCM.[2]

Table 6 Relevant Requirements from EPL 21283

Condition Requirement		Section in this WMP (Where Addressed or Considered)
P1.1	Weather Monitoring	Section 3.1
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the *Protection of the Environment Operations Act 1997*.	Section 4.4.2
M1	Monitoring Records	Section 8
M2 & M3	Recording of Pollution Complaints / Telephone Complaints Line	Section 9.3
R1	Reporting Conditions	Section 9

[2] It is recognised that the scheduled activity scale prescribed in EPL 21283 is currently limited to a maximum of 0.5 Mtpa, and in accordance with Condition A1.3 of EPL 21283 can only commence when the scheduled development work has been completed and EPL has been varied to remove reference to scheduled development work.

2.5 NSW WATER MANAGEMENT ACT 2000 – WATER ACCESS LICENCES AND ASSOCIATED WATER SUPPLY WORKS & USE APPROVALS

2.5.1 Aquifer Interference Policy and Water Sharing Plans

The NSW Aquifer Interference Policy (AIP) (NSW Government, 2012) was developed as a component of the NSW Government's Strategic Regional Land Use Policy.

The AIP states that all water taken by aquifer interference activities needs to be accounted for within the extraction limits set by the relevant Water Sharing Plan. The *Water Management Act, 2000* makes it an offence to "take" water without a water licence or in accordance with a lawful exemption. Under the *Water Management Act 2000*, the following Water Sharing Plans (WSPs) apply to the Vickery Extension Project at the VCM:

- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*;
- *Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012*;
- *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*; *and*
- *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020.*

A description of each applicable Water Sharing Plan, including existing WALs held is provided below and a collective summary including currently nominated works and use approvals provided in Section 2.5.2. Relevant groundwater sources in the vicinity of VCM are shown in Figure 3.

Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020

The open cut extent for VCM is located wholly within the Gunnedah-Oxley Basin MDB Groundwater Source under the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*.

An aquifer water access licence (WAL) for 600 Unit Shares (WAL 36576) is currently held for VCM in the Gunnedah-Oxley Basin MDB Groundwater Source.

Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012

The *Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012* applies to the unregulated water sources in the Namoi basin which comprise sources that are dependent on rainfall and natural river flows, rather than water discharged from dams, and associated alluvial groundwater systems.

The WSP provides for the sharing of water between the environment, town water supplies, basic landholder rights and commercial uses of water. The volume of water available to meet all competing environmental and extractive needs varies on a yearly and daily basis, depending on the weather, river flows and aquifer characteristics.

With regard to surface water, the Project is located wholly within the Bluevale Water Source under the *Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012*. The WSP applies

to all such water sources in the vicinity of the VCM, with the exception of the Namoi River itself which is discussed separately below.

As outlined in Sections 4.1 to 4.8, the site water management system has been designed to minimise capture of clean water in the mine water management system through the installation of clean water diversions in a staged manner.

Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016

The VCM falls within the Lower Namoi Regulated River Water Source for the purpose of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*. The Lower Namoi includes the regulated river sections downstream of Keepit Dam to the Barwon River.

The WSP provisions regulate water for the river's environmental needs, its ecological processes and direct how water available for extraction is to be shared. The WSP also sets rules for the management of WALs, water allocation accounts, the trading of or dealings in licences and water allocations, the extraction of water, the operation of dams and water flow management.

The WSP provides for domestic and stock rights and native title rights – both forms of basic landholder rights which allow some extraction of water from the river without a WAL. All other water extraction, other than for basic landholder rights, must be authorised by a WAL. Each WAL specifies a share component. The share components of specific purpose licences, such as local water utility and domestic and stock use, are expressed in ML/year. The share components of licences such as high security, general security and supplementary WALs are expressed as a number of unit shares.

This WSP is relevant to VCM with respect to licensed extraction from the Namoi River. Current water access licences (WALs) held in the Lower Namoi Regulated River Water Source are summarised in Table 7.

A subtotal of 1832 Unit Shares are currently held in the Lower Namoi Regulated River Water Source for VCM. Corresponding nominated works and use approvals are summarised in Table 7.

Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020

The VCM is located on the boundary of the Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source, defined by the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020*.

The WSP outlines the basis for groundwater sharing, including requirements for extraction under WALs, environmental water provisions, rules for managing access licences and the management of any local impacts. The latter includes consideration of the distance between any new water supply bores and neighbouring bores, property boundaries and environmental features such as rivers and wetlands.

Current aquifer water access licences (WALs) held for VCM in the Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source are summarised in Table 7.

A subtotal of 393 Unit Shares in the Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source are currently held for VCM. Corresponding nominated works and use approvals are summarised in Section 2.5.2.

2.5.2 Summary of Water Access Licences, Nominated Works and Use Approvals

A summary of Water Access Licences, Nominated Works and Use Approvals held for VCM is provided in Table 7. Several of the licenses are currently in use at the Gunnedah CHPP, however they will be transferred to VCM works approvals at the cessation of operations at the Gunnedah CHPP (when the VCM CHPP commences operation).

In addition to these licenses, VCM will actively trade water allocations each year.

Table 7 Summary of Water Access Licences, Nominated Works and Use Approvals

Water Source	WAL No.	Entitlement (Unit Shares)	Category / Nominated Works and Use
Gunnedah-Oxley Basin MDB Groundwater Source	36576	600	Aquifer "passive take" / Works 90MW933092
Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap)	12645	35	Aquifer / Works 90CA807002*
	12651	52	Aquifer / Works 90CA807002
	12653	166	
	12701	20	Aquifer "passive take" / To be assigned to 90MW833083*
	12731	3	Aquifer "passive take" / To be assigned to 90MW833083*
	12715	75	Aquifer / Works 90CA807002*
	12724	45	
Total Zone 4		**393**	
Lower Namoi Regulated River Water Source	16034	50	High Security / Works 90CA801779*
	14936	1,056	General Security / Works 90CA801779*
	2577	144	General Security / Works 90CA801779
Lower Namoi Regulated River Water Source	2682	486	General Security/ Works 90CA801779
	13051	96	General Security "passive take"/ To be assigned Works 90MW833084*
Total High and General Security		**1,832**	

* application to assign WAL to the works approval required prior to use

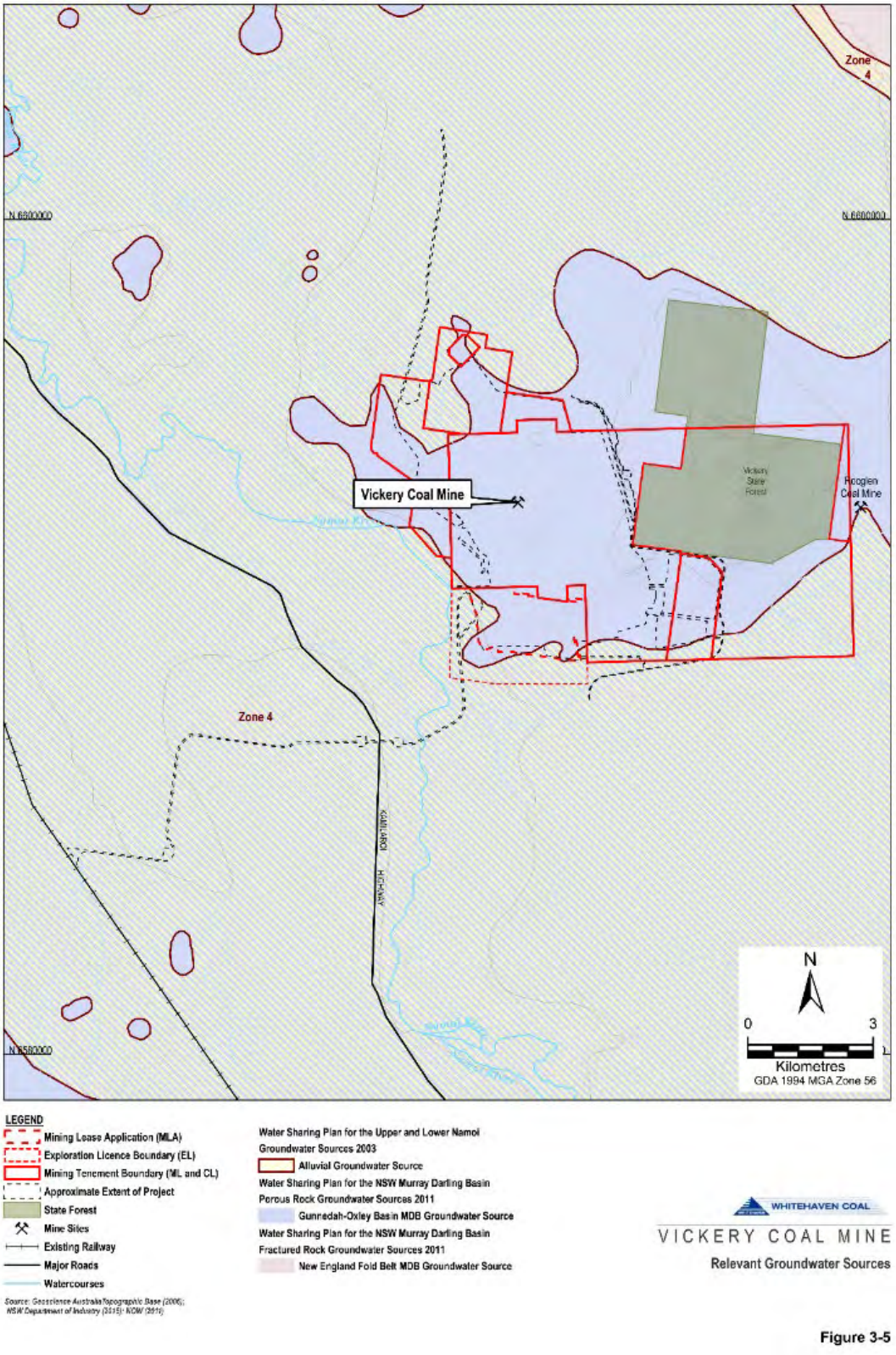


Figure 3 Relevant Groundwater Sources

2.5.3 Floodplain Management Plan

The *Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019* (FMP) was made under Section 50 of the *Water Management Act, 2000* and commenced on 7 June 2019[3]. The FMP will have effect for 10 years. The objectives of the FMP are as follows:

(a) to facilitate the orderly passage of floodwaters through the Upper Namoi Valley Floodplain;

(b) to minimise the risk to life and property from the effects of flooding;

(c) to maintain flood connectivity to wetlands, other floodplain ecosystems, and areas of groundwater recharge;

(d) to contribute to the protection of the ecological assets and values of the Upper Namoi Valley Floodplain; and

(e) to contribute to the protection of cultural, heritage and spiritual features of the Upper Namoi Valley Floodplain that are significant to Aboriginal people and other stakeholders.

The FMP defines management zones for the Upper Namoi Valley and can be viewed online as a spatial map: https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=7e127541b154435b912368704615f665

In accordance with Condition B48, Schedule 2 of SSD-7480, VCM will demonstrate to the satisfaction of the Planning Secretary that the design and construction of the Vickery Extension Project, including the Project Rail Spur and Kamilaroi Highway Overpass, is consistent with the objectives of the FMP, and minimises flooding and scouring impacts through flood assessment of the detailed design as prescribed in Condition B49, Schedule 2 of SSD-7480 (including the recommendations of the *Vickery Coal Extension Project – Further Peer Review of Flood Assessment* [WMA Water, 2020]). As defined in Table 8 of SSD-7480, the water management performance measure for the design and construction of the Project Rail Spur and Kamilaroi Highway Overpass will be such that infrastructure will not cause significant increased flooding, in particular increased affluxes and velocities at key locations, redistribution in and around the overpass, and flood levels at residences.

Flood protection levees will be designed, installed and maintained to meet the water management performance measures defined in Table 8 of SSD-7480 to protect mining areas from a probable maximum flood (PMF) event (by Namoi River inundation) and ensure no increased flooding impacts on roads or privately-owned land. As per the VEP EIS, no flood protection levees are required for the Namoi River PMF. As described in Section 4, flood protection levees will also be designed by a suitably qualified person and installed and maintained to protect the infrastructure area and south-western corner of the development affected by local flooding up to at least the 1% AEP event from Stratford Creek and South Creek. The permanent clean water diversion system will be designed, installed and maintained to capture and convey the 100 year ARI flood event (1% AEP peak discharge).

[3] The FMP replaced the *Blackville Floodplain Management Plan 2003, Caroona - Breeza Floodplain Management Plan 2006, Carroll to Boggabri Floodplain Management Plan 2006, Lower Coxs Creek Floodplain Management Plan 2013, Upper Coxs Creek Floodplain Management Plan 2005, Upper Yarraman Creek Floodplain Management Plan 2006* and the *Warrah Creek Floodplain Management Plan 2012* which were repealed under Section 45 of the *Water Management Act, 2000.*

2.6 GUIDELINES

Key guidelines which are relevant to the preparation and implementation of this WMP include:

- ANZG 2018, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian state and territory governments. Available at www.waterquality.gov.au/anz-guidelines;
- Department of Environment and Climate Change, *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries*, June 2008;
- Department of Environment and Conservation, *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW*, March 2004;
- NSW Department of Housing, *Managing Urban Stormwater: Soils and Construction – Volume 1, 4th Edition* (the "Blue Book"), 2004;
- Draft, *Water Reporting Requirements for Mines*, Major Projects Assessment Unit, Department of Water and Energy; and
- NSW Water Quality and River Flow Objectives (DEC, 2006).

3 BACKGROUND AND BASELINE DATA

3.1 METEOROLOGICAL AND CLIMATE DATA

VCPL will operate an on-site meteorological monitoring station for VCM, in accordance with Condition B38, Schedule 2 of SSD-7480 that records 15-minute averages of wind speed and direction, temperature, rainfall and relative humidity. Site recorded meteorological information will be summarised and presented in each Annual Review (Section 9.2.1).

In accordance with PA Condition B53 e) the information captured at the on-site meteorological monitoring station will be used to augment existing datasets including:

- Annual review as part of water balance model updates and reporting as part of the Annual Review;
- Periodic reviews of trends when revising the WMP;
- Reviewing and revising groundwater model validation [Appendix A]) and considered as part of sensitivity analysis of variations from climate projections and trends (Every 5 years).

Mean annual rainfall records at nearby Bureau of Meteorology (BoM) weather stations are summarised in Table 8.

Table 8 BOM Weather Stations Near the VCM

Station Number	Station Name	Start Date	End Date	Mean Annual Rainfall (mm)
54021	Barraba (Mount Lindsay)	1 Jan 1886	31 Mar 2012	979.9
54024	Barraba (Log Cabin)	1 Jan 1966	31 August 2016	667.1
55024	Gunnedah Resource Centre	1 Jan 1948	30 June 2019*	632.9
55076	Boggabri (Kanownda)	1 Jan 1899	31 December 2021*	575.5
55044	Boggabri (Retreat)	1 Mar 1899	30 October 2022*	583.4

Source: BOM (2022)
* Open

3.2 SURFACE HYDROLOGY AND DRAINAGE NETWORKS

The existing surface water and groundwater environments are described in detail in the Environmental Impact Statement (EIS) (WHC, 2018). Baseline data for surface water is presented in this section.

3.2.1 Regional Drainage Network

The Namoi River catchment is part of the Murray-Darling Basin. The Namoi River is a tributary of the Barwon River that ultimately flows to the Murray-Darling River System.

The Namoi River catchment is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north. Major tributaries of the Namoi River include Cox's Creek and the Mooki, Peel, Cockburn, Manilla and Macdonald Rivers, all of which join the Namoi River upstream of Boggabri. The catchment area of the Namoi River to Boggabri is approximately 22,600 km^2 (Advisian, 2018).

Flow in the Namoi River is regulated by three major water storages (Figure 4):

- Keepit Dam – constructed on the Namoi River upstream of the Peel River confluence in 1960 with a storage capacity of 427,000 ML.
- Chaffey Dam – constructed on the Peel River upstream of Woolomin in 1979 with a storage capacity of 62,000 ML.
- Split Rock Dam – constructed on the Manilla River in 1988 with a storage capacity of 397,000 ML.

Water is released from these major water storages for irrigation, industrial and domestic/urban requirements and as environmental flows in the Namoi River catchment.

The closest gauging station to the Vickery Extension Project at the VCM on the Namoi River is located at Boggabri (419012), just upstream of the Bollol Creek confluence with the Namoi River (Figure 4). Streamflow in the Namoi River at Boggabri is characterised by strong flow persistence with flows exceeding 1.6 ML/day on 95% of days. Zero flow is recorded on 1.4% of days. Over the full period of available data, streamflow in the Namoi River at Boggabri has a median of 403 ML/day and an average of 1,695 ML/day (Advisian, 2018).

3.2.2 Local Drainage Network

The Vickery Extension Project at the VCM is largely located within the Stratford Creek and Driggle Draggle Creek catchments, which ultimately flow into the Namoi River south of Boggabri (Figure 5). Areas to the south-west of the Vickery Extension Project drain directly to the Namoi River catchment.

The Project rail spur traverses the flatter land south-west of the Project mining area associated with the Namoi River floodplain, including Stratford Creek and Deadmans Gully (Figure 6).

Project Mining Area Sub-Catchments

The Driggle Draggle Creek sub-catchment has a catchment area of 203 km^2 and the Stratford Creek sub-catchment has a catchment area of 63 km^2. No flow gauges are located on any of the ephemeral watercourses.

Driggle Draggle Creek

Driggle Draggle Creek flows in a westerly direction to the north of the Project mining area and is an ephemeral watercourse that receives baseflow recharge in its headwaters (to the north-east of the Project).

Unnamed ephemeral drainage paths that flow through the Project mining area (referred to as the north drainage line, the north-west drainage line and west drainage line) ultimately join Driggle Draggle Creek to the north of the Project (Figure 5).

Driggle Draggle Creek enters Barbers Lagoon to the north-west of the Project, which eventually flows into the Namoi River (Figure 5).

Stratford Creek

Stratford Creek is an ephemeral watercourse that flows in a westerly direction before flowing into the Namoi River. The watercourse runs in an east-west direction parallel to the southern extent of the Project mining area (Figure 5). At the confluence with South Creek, Stratford Creek is a fourth order stream.

South Creek

South Creek is an ephemeral watercourse that drains the southern portion of the Vickery State Forest and flows in a southerly direction between the open cut extent and the secondary infrastructure area (Figure 5). South Creek joins Stratford Creek south west of the secondary infrastructure area and is a fourth order stream.

North-West Drainage Line

The north-west drainage line is an ephemeral watercourse that drains the western part of the Vickery State Forest in a north-westerly direction across the Project mining area (Figure 5). The North West drainage line receives flow from the west drainage line before joining Driggle Draggle Creek to the north-west of the Project. After the confluence with the west drainage line the watercourse becomes a fourth order stream.

West Drainage Line

The west drainage line drains from the central portion of the Project mining area in a north-westerly direction before joining the north-west drainage line (Figure 5). Immediately prior to this confluence, the west drainage line is a third order stream.

North Drainage Line

The north drainage line drains from the north eastern portion of the Project mining area in a north westerly direction (Figure 5). The north drainage line joins Driggle Draggle Creek to the north of the Project and is a third order stream.

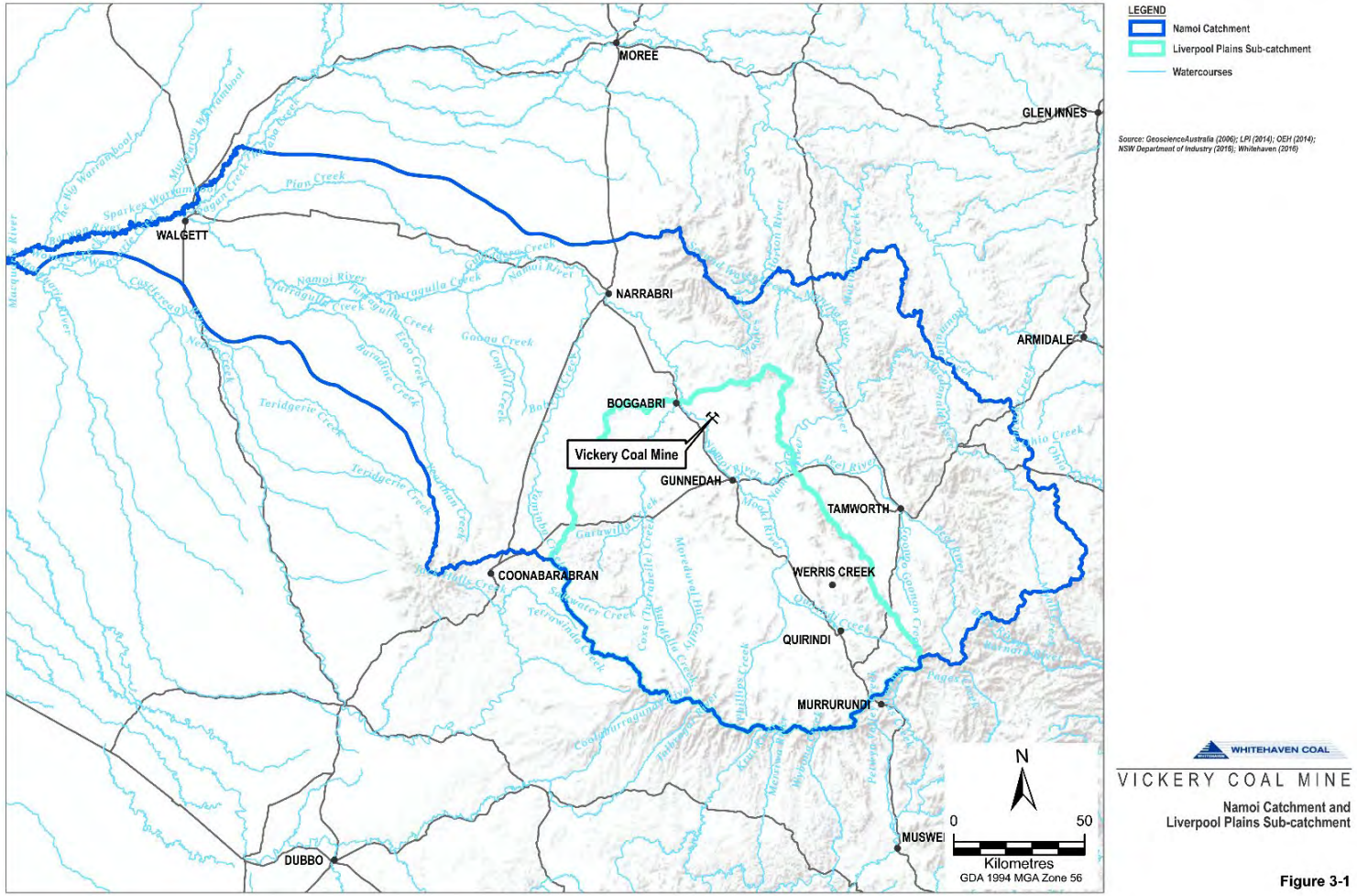


Figure 4 Namoi Catchment and Liverpool Plains Sub-Catchment

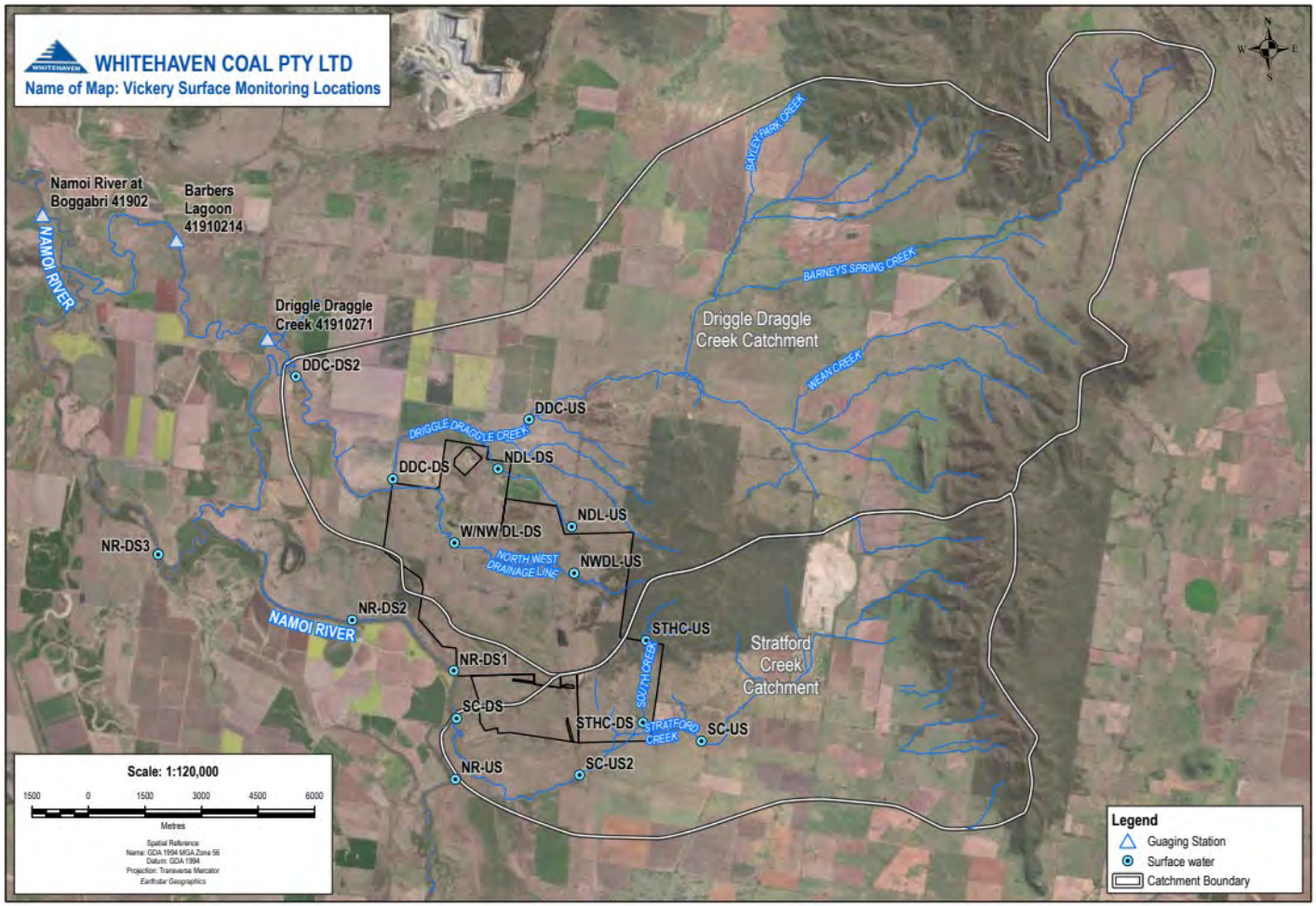


Figure 5 Regional Surface Water Sites

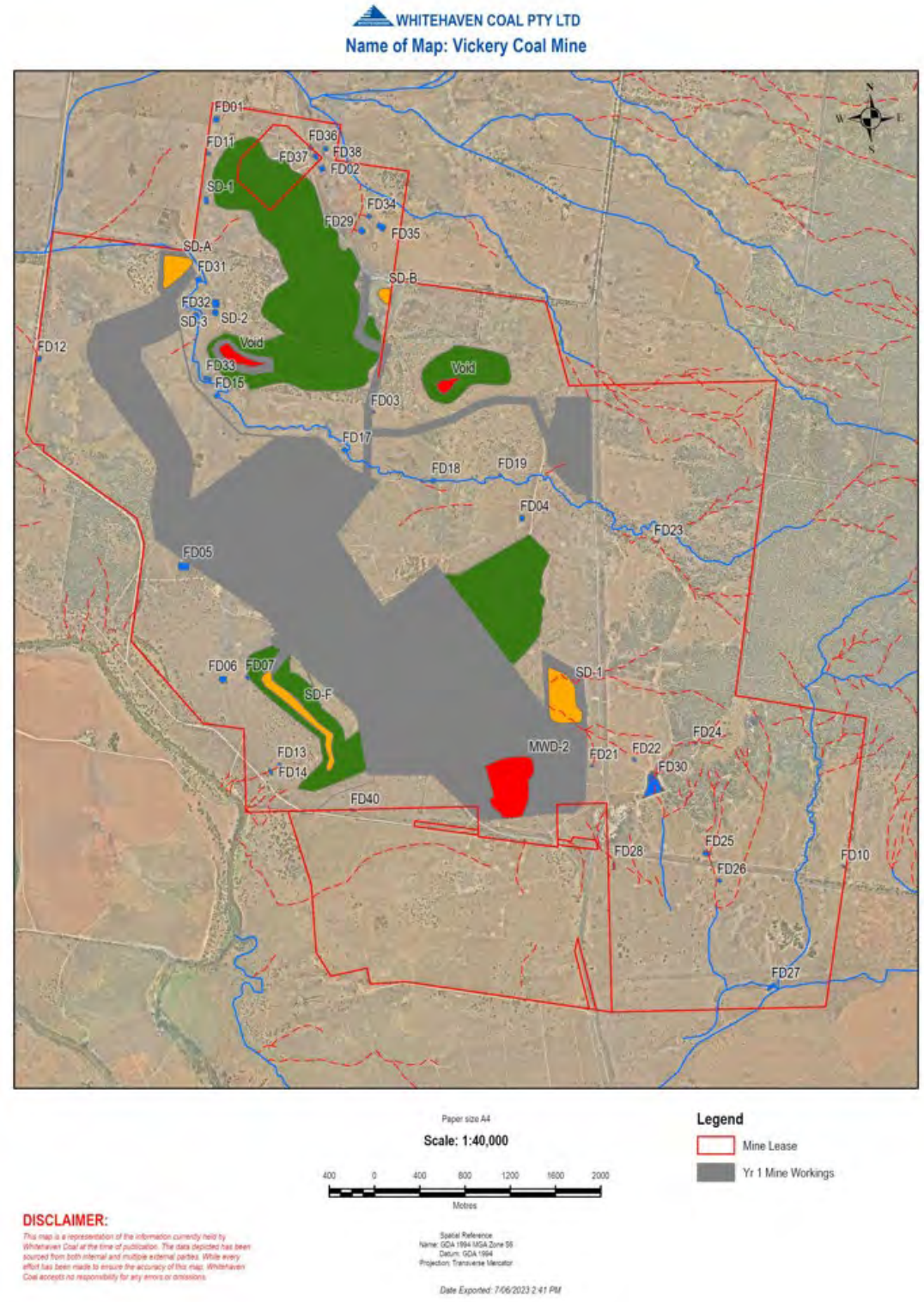


Figure 6 Local Hydrology

3.2.3 Streamflow Data

WaterNSW records streamflow at the Boggabri gauge (419012), just upstream of the Bollol Creek confluence with the Namoi River. Gauge details are provided in Table 9. VCPL do not operate any streamflow gauges for VCM.

Table 9 Available Streamflow Data on Namoi River

Stream	Gauge name	Gauge number	Catchment area (km^2)	Period of record
Namoi River	Boggabri	419012	22,600	1911 -

Figures 7 and 8 show a time series of daily flow and ranked daily flow (data taken from http://www.bom.gov.au/waterdata/) for the Boggabri gauge in the Namoi River.

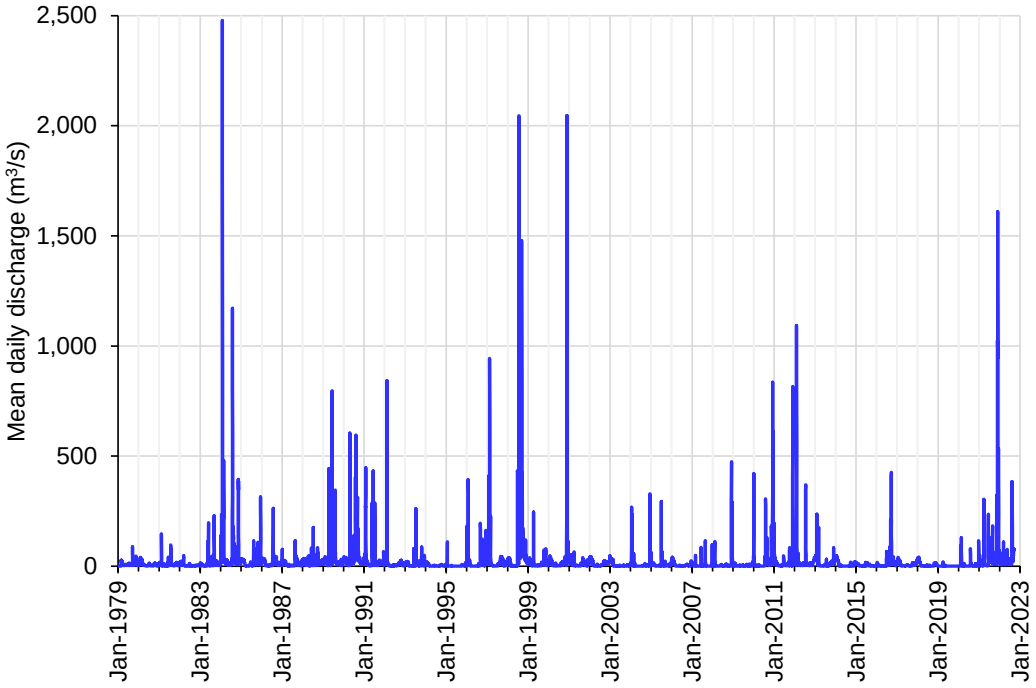


Figure 7 Daily Mean Discharge, Namoi River at Boggabri (Gauge No. 419012)

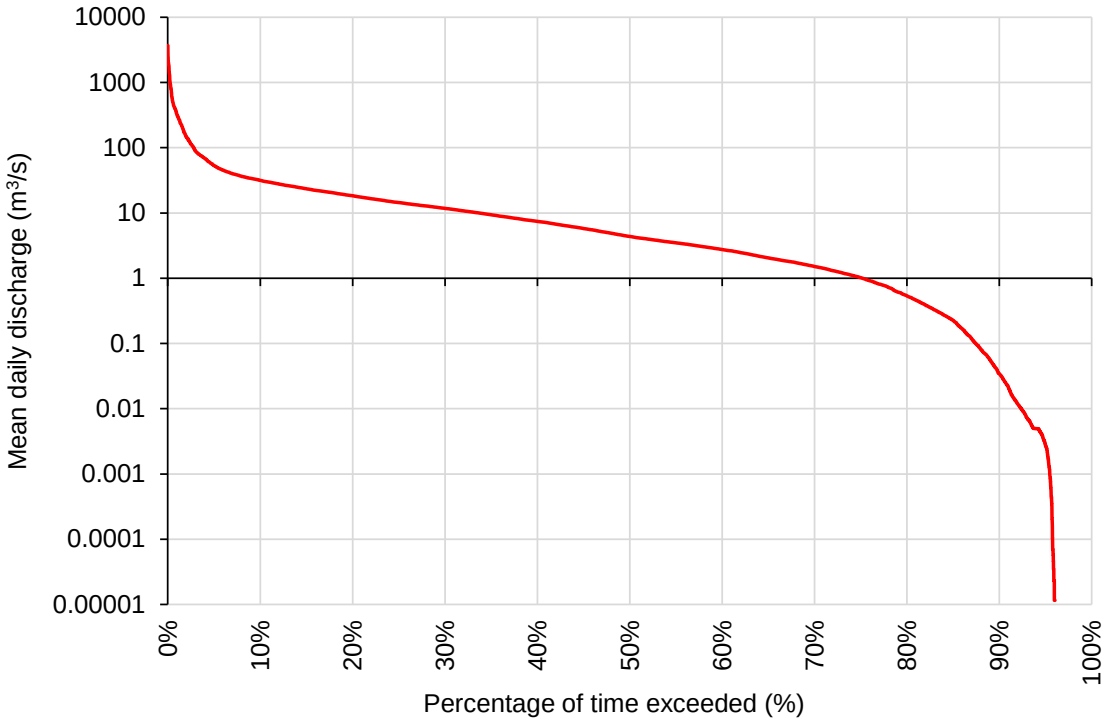


Figure 8 Ranked Flow Plot, Namoi River at Boggabri (Gauge No. 419012)

3.2.4 Riparian and Channel Condition

Eco Logical Australia (2018) conducted a riparian condition assessment using a modified version of the Riparian, Channel and Environmental (RCE) Inventory (Paterson, 1992), which was modified for Australian conditions (Chessman et al., 1997). Descriptors included width and condition of the riparian zone, surrounding land use, extent bank erosion, stream width, water depth, occurrence of pools, riffles and runs, sub-stratum type, presence of snags and woody debris, in-stream and emergent macrophytes, algae and barriers to fish passage. The total score for each site was derived by summing the score for each descriptor and calculating the result as a percentage of the highest possible score. Assessment was conducted at four locations, with scores determining that at three sites the conditions were very good, and at one site the conditions were excellent. Immediate riparian zones along the Namoi River were dominated by native vegetation consisting of mature river red gum, and had only minor impacts from human activities. Consequently, there was sufficient in-stream structure provided by snags and large woody debris.

The habitat assessment conducted at multiple locations along the Namoi River identified riparian vegetation on the western bank with woody debris, generally complex habitat, shading, bars of sand and gravel, cattle activity, occasional weeping willow and steep banks.

The stream bed generally consisted of sand, gravel or bedrock. Lateral bars occur regularly along the river, though were not present at all sites. Pools were common at most sites, and undercut banks and tree roots often made steep edges along the river during high flow.

A habitat assessment was conducted at Driggle Draggle Creek which concluded the creek bed consisted of dry or drying mud, with relatively flat bed topography. The surrounding land was highly modified with no woody vegetation growing over the main channel, limited shading and scarce debris.

3.2.5 Surface Water Users

As described in Section 2.5.1, the Project is located within the Bluevale Water Source under the WSP *for the Namoi Unregulated and Alluvial Water Sources 2012*. The Namoi River in the vicinity of the Project is located within the Lower Namoi Regulated River Water Source under the WSP *for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*.

Surface water users in the region are predominantly associated with the regulated Namoi River, and to a lesser extent, the unregulated Namoi water sources.

3.2.6 Namoi River Floodplain

The Namoi River adjacent to the Project is characterised by a 50 metre (m) to 70 m wide main channel meandering along a lower terrace floodplain approximately 500 m to 1,200 m wide. The lower terrace floodplain cuts through the greater Namoi River floodplain that varies in width from 6 km to 11 km.

The catchments of local drainages (e.g., Driggle Draggle Creek and Stratford Creek) generally flood independently of the greater Namoi River floodplain and are potentially affected by backwater from the Namoi River at their downstream ends.

Floodwater overflowing from the Namoi River onto the western floodplain drains in a westerly direction to Deadmans Gully. Deadmans Gully converges with Collygra Creek, which eventually drains to the Namoi River south of Boggabri. Floodwater overflowing onto the eastern floodplain to the south of the VCM drains in an unconfined manner until it drains into Stratford Creek.

3.2.7 Namoi River Design Flood Discharges

A flood frequency analysis was undertaken of the 130 years (1864 to 2021) of recorded and inferred stream flow data from the Namoi River stream gauge at Gunnedah (gauge number 419001) to estimate the 20%, 5% and 1% Annual Exceedance Probability (AEP) design discharges (WRM, 2023).

The estimated peak discharge for the 1955 flood event, which was one of the largest historical events on record, was included in the flood frequency analysis. While recorded stream gauge data was not available for 1955, the peak flow for the 1955 flood event was derived by WRM (2023) by converting the recorded peak water level to a stream discharge using the currently available rating curve for the gauge.

Table 10 shows the predicted peak discharges for the 20%, 5% and 1% AEP and the extreme design flood events, as well as the peak discharges for two historical flood events (1955 and 1998) as originally presented in WRM (2023). Updated Namoi River flood studies are currently in progress as part of detailed design of the Project Rail Spur (WRM, 2023).

The initial construction phase and early mining is not located within the 1% AEP flood extent of Stratford Creek or the PMF of the Namoi River. Therefore, no flood protection structures are required. The WMP will be updated to document any flood protection structures required in future stages of the mine.

3.2.8 Project Rail Spur

In accordance with PA Condition 48 and 49 The operation shall ensure that:

- the design and construction of the project, including the Project Rail Spur and Kamilaroi Highway overpass, is consistent with the objectives of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019, to the satisfaction of the Planning Secretary.
- the Project Rail Spur, Project Rail Spur bridges and any upgrade to the haul road must be designed and constructed to minimise flooding and scouring impacts, in consultation with BCD and consistent with the recommendations of the Department's flood peer review.
- Prior to construction of the Project Rail Spur or any upgrades to the haul road, the Proponent shall undertake a flood assessment of the detailed design to confirm there would be minimal impacts as predicted in the documents listed in condition A2(c).

The Flood Study Stage 1 SSD-7480-PA-48 and detailed design of the rail spur is currently under consultation with the Department and will be included in future updates of the WMP.

Table 10 Historic and Design Event Peak Flood Discharges for the Namoi River (WRM, 2023)

Event		Peak Discharge (m^3/s)
20% AEP	Design	959
1998	**Historic**	**2,633**
5% AEP	Design	2,917
1% AEP	Design	7,689
1955	**Historic**	**9,030**
Extreme (3 x 1% AEP)	Design	23,067

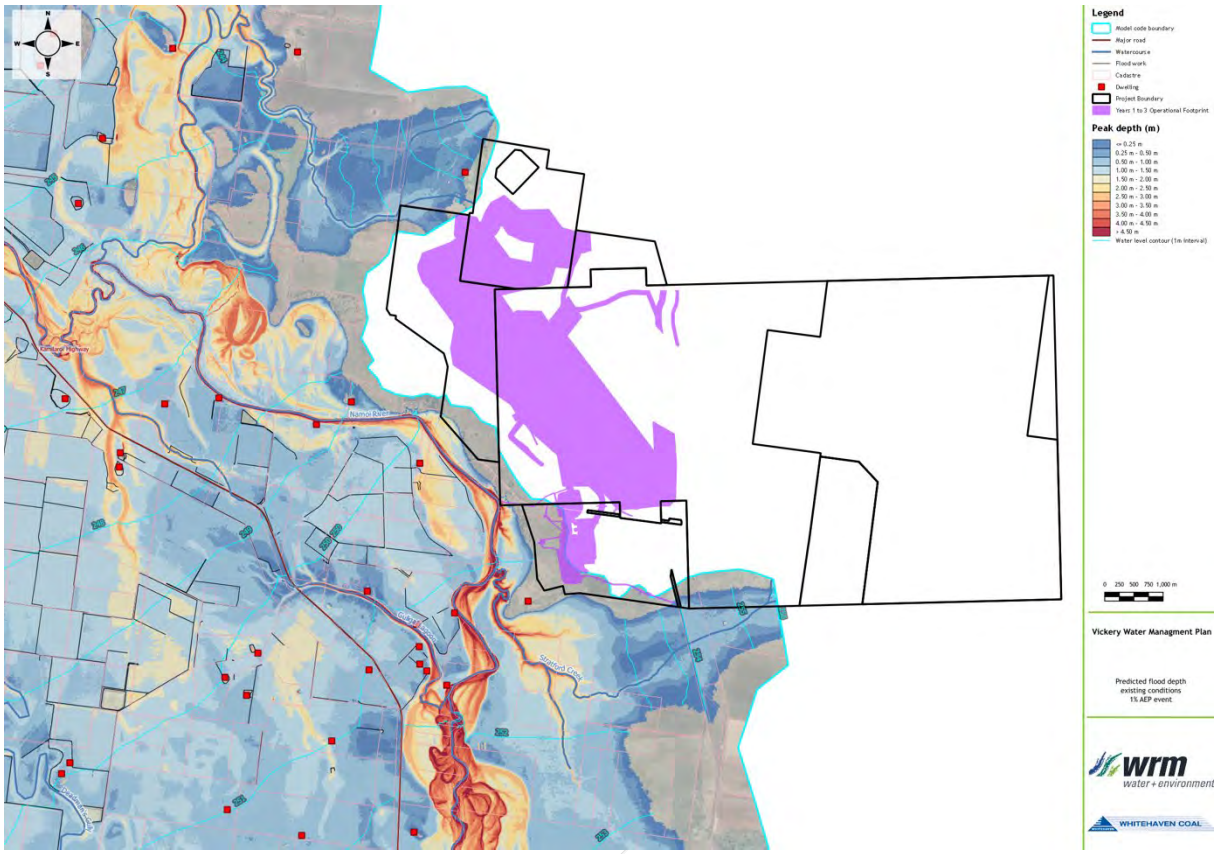


Figure 9 Namoi River Floodplain Depths and Extents for the 1% AEP Event

3.3 SURFACE WATER QUALITY

3.3.1 Regional Surface Water Resources

The Namoi River, and its associated floodplains and fringing lagoons, are the regional surface water resources of relevance to the Project.

Figure 5 shows the existing regional surface water quality monitoring sites in the vicinity of the Project.

Water quality of the Namoi River is generally characterised by moderate alkalinity and elevated electrical conductivity (EC) relative to Australian and New Zealand Environmental and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) guideline trigger values for aquatic ecosystems (Table 11).

Table 11 Summary of Regional Average Water Quality Data

Location (refer Figure 5)	Parameter^					
	pH	EC (µS/cm)	Alkalinity (mg/L)	Turbidity (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Namoi River (and Lagoons)						
Gunnedah (419001)	8.06	497	204	67.3	0.72	0.14
Barbers Lagoon (downstream of Bollol Creek) (41910214)	7.70	348	-	304	-	-
Driggle Draggle Creek at Boggabri (41910271)	6.99	117	-	-	-	-
ANZECC/ARMCANZ (2000) Guideline Trigger Values						
Aquatic Ecosystems [Default]	6.5 – 7.5	30 – 350	-	2 – 25	0.25	0.02
Primary Industries [Default]	5.0 – 9.0	-	-	-	-	-
Livestock Drinking Water [Default]	-	3,125~	-	-	-	-

NTU = nephelometric turbidity unit.
^ Sample counts for each parameter varies for each location.
~ Equivalent to 2,000 mg/L TDS with a conversion factor of 1.5625 applied.

The *Current water accounts and water quality for the Namoi River subregion (Product 1.5 for the Namoi River subregion from the Northern Inland Catchments Bioregional Assessment)* (Pena- Arancibia et al., 2016) concludes the following with respect to surface water quality in the Namoi River:

- The ANZECC/ARMCANZ default trigger value for EC for the protection of aquatic ecosystems is frequently exceeded.
- The mean daily turbidity in the Namoi River (according to NOW [NOW DI Water] gauging station records) of 141 NTU exceeds the ANZECC and ARMCANZ (2000) trigger value for aquatic ecosystems.
- There is a lack of data on the presence of heavy metals, trace elements and hydrocarbons.

EC values in the Namoi River at Gunnedah (419001) ranged between 200 micro Siemens per centimetre (µS/cm) and 900 µS/cm every year between 2001 and 2011 and there is no significant trend to the data (Schlumberger Water Services, 2011).

Average total nitrogen and total phosphorous concentrations are also elevated relative to ANZECC and ARMCANZ guideline trigger values for aquatic ecosystems. Phosphorous and nitrogen are sourced from effluent, agricultural runoff and in-stream processes (Schlumberger Water Services, 2011).

Highest turbidity values are recorded in the lower sections of the Namoi River (Schlumberger Water Services, 2011). Most sediment is derived from disturbance within catchments, stream bed and bank erosion, or direct access by livestock (Thoms et al., 1999). As stated in Schlumberger Water Services (2011):

In summary the early studies, including Nancarrow (1998), concluded that prior to 2000, the chemical water quality of the Namoi River system was generally moderate to poor, with high levels of nutrients, areas contaminated by agricultural chemicals, and areas with on-going salinity problems. While trends for parameters such as salinity, turbidity and nutrients varied in the short term, longer term trends showed little signs of a decline through time.

Surface water quality data between 2002 and 2007 has been analysed in a study carried out by the NOW (now DPI Water) in the Namoi catchment, (Mawhinney, 2011) with the following relevant conclusions:

- EC values typically exceeded default trigger levels for the protection of aquatic ecosystems but were suitable for irrigation, stock and domestic consumption;
- turbidity levels increased with distance down the catchment and are predicted to fall as beds and banks are stabilised; and
- high total phosphorous and nitrogen were detected, although there was no corresponding significant growth of blue/green algae.

3.3.2 Local Surface Water Resources

Local water quality data is available from the following sources (Table 4):

- Approved Mine and Project surface water quality monitoring conducted by WHC in the immediate vicinity of the Project (WHC, 2018);
- the original VCM EIS (Vickery Joint Venture, 1986); and
- publicly available documentation containing details of water quality monitoring conducted at nearby mine sites.

The results of 75 surface water quality samples collected by Whitehaven for the Project mining area are presented in the Vickery Extension Project Surface Water Assessment (Advisian, 2018). Opportunities to sample have been limited because the watercourses in the vicinity of the Project (with the exception of the Namoi River) are ephemeral.

Figure 5 shows existing local surface water monitoring sites and sample locations in the vicinity of the Project.

A summary of the water quality monitoring conducted for the Project, for upstream monitoring locations at other mine sites in the region, as well as the original VCM EIS (Vickery Joint Venture, 1986) is presented in Table 12.

In accordance with PA condition B52 f), VCM utilises existing data from nearby mines to build on existing monitoring programs, where practical. As shown in **Table 12**, data from the following operations has been utilised to develop local water quality data:

- Site BCU which is data collected by Tarrawonga Coal Mine;
- Site SW2 which is data collected by Boggabri Coal Mine; and
- Site WW11 which is data collected by Canyon Coal Mine.

Table 12 Summary of Local Average Water Quality Data

Location (refer Figure 5)	Parameter^		
	pH	EC (µS/cm)	TSS (mg/L)
Average of all Water Quality Monitoring Results			
Historical project monitoring sites (Local drainage)	7.0	73	42
1986 EIS monitoring sites (Namoi River, Statford Creek, Driggle Draggle Creek)	8.1	456	77
Site WW11 (Driggle Draggle Creek)	7.1	96	109
Site BCU (Back Creek near Tarrawonga Coal Mine)	7.0	169	164
Site SW2 (upstream of Boggabri Coal Mine)	7.1	98	95
ANZECC/ARMCANZ (2000) Guideline Trigger Values – Aquatic Ecosystems	6.5 – 7.5*	30 – 350	-

TSS = Total Suspended Solids

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

* Value for NSW Upland Rivers (>150 metres Australian Height Datum (m AHD).

3.4 WASTE ROCK (SPOIL) CHARACTERISATION AND MANAGEMENT OF POTENTIALLY ACID-FORMING MATERIALS

A Geochemistry Assessment was conducted by GEM (2018) for VCM and concluded:

- The majority of the overburden and interburden spoil generated would generally be expected to have a low sulfur content and be non acid forming (NAF).
- A small quantity of overburden was identified as containing increased sulfur concentrations but with low acid generating capacity. These spoil materials are anticipated to produce acid conditions only if left exposed to the atmosphere for a number of years.
- Some interburden material (typically mudstone) was identified as containing increased sulfur concentrations and higher acid generating capacity. Blending of the spoil material during excavation, transport and dumping is expected to produce an overall NAF material.
- The rejects material is typically expected to be NAF. A small proportion of the rejects are likely to have a very low acid neutralising capacity and as such there is a risk that some of these materials will be potentially acid forming. However, due to the low total sulfur content, any potentially acid forming coal rejects are expected to only have a low capacity to generate acid.
- The overburden, interburden and coal rejects material contain metal enrichment compared to average crustal abundance, with arsenic, molybdenum and selenium relatively soluble in waste rock and coal reject samples. [*Note: monitoring for these parameters is proposed as outlined in Table 3*]

Management of waste rock materials will be described in the Mining Operations Plan (Section 2.3.1) but is summarised below.

Overburden and interburden would be emplaced in the waste rock emplacement, which would be progressively rehabilitated. Water that has been in contact with the open cut or coal stockpiles would be captured in the mine water management system, contained and re-used on-site.

No reject material would be placed within 30 m of the edge of the western waste rock emplacement, and reject material would be covered with at least 5 m of inert material on the outer surfaces. Dewatered reject material would be co-disposed in locations such that any runoff or infiltration would report to the mine water management system.

Given the management of overburden, interburden, rejects and mine water proposed for the Project, the risk of contaminants in water released from sediment dams impacting downstream waters is considered to be low (Advisian, 2018).

4 WATER MANAGEMENT SYSTEM

4.1 WATER MANAGEMENT STRATEGY AND OBJECTIVES

The water management strategy for VCM is based on targeted management of water from different sources based on water quality. Water on the site is categorised as either:

- clean water – water from areas not disturbed by mining;
- dirty water – runoff from areas disturbed by stripping or placement of waste rock material (sediment laden);
- mine water – surface runoff in mining areas that is likely to have come into contact with coal or other contaminates; or
- external water – Water imported to site from licensed extraction points, either surface water or bore water

The objectives of the site water management system are to ensure:

- clean water runoff from undisturbed catchment areas is diverted away from the mining area, where possible and practical to do so;
- dirty water runoff from disturbed areas is re-used in the mine water management system or released into the receiving environment if water quality meets EPL requirements (i.e. treatment may be required);
- mine water (including water that accumulates within, or drains from, active mining areas, coal reject emplacement areas and Coal Processing Plant (CPP) infrastructure areas) and groundwater collected within open cut pits is contained and reused on-site;
- no discharge of mine water off-site; and
- on-site water demands are satisfied whilst minimising external water supply requirements.

Collectively, the water management strategy and objectives are also aimed at minimising potential impacts to the EPBC Act listed Murray Cod (*Maccullochella peelii*) in accordance with Condition 5a of Approval Decision (EPBC 2016/7649) (Table 3). The IESC advised that potential impacts to the EPBC Act listed Murray Cod (*Maccullochella peelii*) could be further reduced if construction activities (e.g. building the rail crossing) in the Namoi River are avoided or limited during higher winter/spring flows which are a cue for breeding for this species. The construction activities schedule will be confirmed during the flood assessment for the detailed design of the Project Rail Spur, Project Rail Spur Bridges and Any Upgrade to the Haul Road as prescribed in Condition B49, Schedule 2 of SSD-7480.

4.2 WATER MANAGEMENT CIRCUIT CONFIGURATION AND INFRASTRUCTURE

Based on the water categories and management objectives above, the key components of the water management system for VCM include:

- Diversion of clean water runoff around the open cut mining operations and other disturbed areas if possible and practical to do so and in compliance with the mine's Harvestable Rights allocation.

- Dirty water runoff from disturbed areas will be captured within sediment dams for treatment by settling of sediment particles. In accordance with DPIE guidelines (DECC, 2008b), treated water from sediment dams may be either:
  - reused in the water management system to reduce the reliance on external licensed water sources; or
  - discharged off site, provided that treated water meets EPL release criteria.
- Sediment dams will be sized based on design criteria in Landcom (2004) and *Volume 2E Mines and Quarries* (DECC, 2008b) for 'fine' or 'dispersive' sediments plus an additional 20% capacity in the sediment zone [or settlement volume allowance] (see Section 4.4.1 and 4.4.2).
- Other erosion and sediment controls will be designed and implemented in accordance with the WHC ESC Standard, which is based on the Landcom (2004) and DECC (2008b) guidelines. Erosion and sediment control measures are described in Section 4.4.1 of this WMP.
- Mine water will be captured in Mining Pit [Sumps] and the Mine Water Dams (MWD) which will be designed and constructed based on a 1% AEP storm event as per SSD consent condition B51. The water management system will be operated to ensure no discharge of mine water off site.
- The planning, design, construction and operation of all ESC will be conducted in accordance with the Whitehaven Erosion and Sediment Control and Mine Affected Water Standard (WHC ESC and MAW Standard)
- SD-F (BVV) will be used as a dirty water dam. The BVV may be used as a mine water surge storage (MWSS) as considered in the EIS.
- Water storages will be engineered structures. Mine water storages will be designed and constructed with low permeability materials, consistent with relevant guidelines, SSD-7480 and EPL conditions.
- Areas not required for operational purposes will be progressively rehabilitated.
- Priority usage of mine water for mine operation related purposes, such as dust suppression, which will reduce the demand from external water sources.

The water management system is designed to achieve nil discharge of mine (including coal contact) water. Mine water management is separated into two components which would operate as follows:

- Open cut catchment – water is captured in temporary sumps within the extent of the mining pit. The locations of sumps will change with pit development.
- Coal handling areas (i.e. the LOM infrastructure area) – runoff from these areas is captured in a series of coal contact water dams (CCWD).

The water management system will include permanent features that will operate throughout the life of the mine and remain post-closure (e.g. Permanent Bluevale Diversion) and temporary structures during mining operations (e.g., Drain 1).

Figure 10 shows a schematic representation of the water circuit for the mine water management system for the Vickery Coal Project at the VCM. Current and forecast site catchment areas, land use and water management infrastructure for Years 1 to 3 are shown in Figures 2a to 2c.

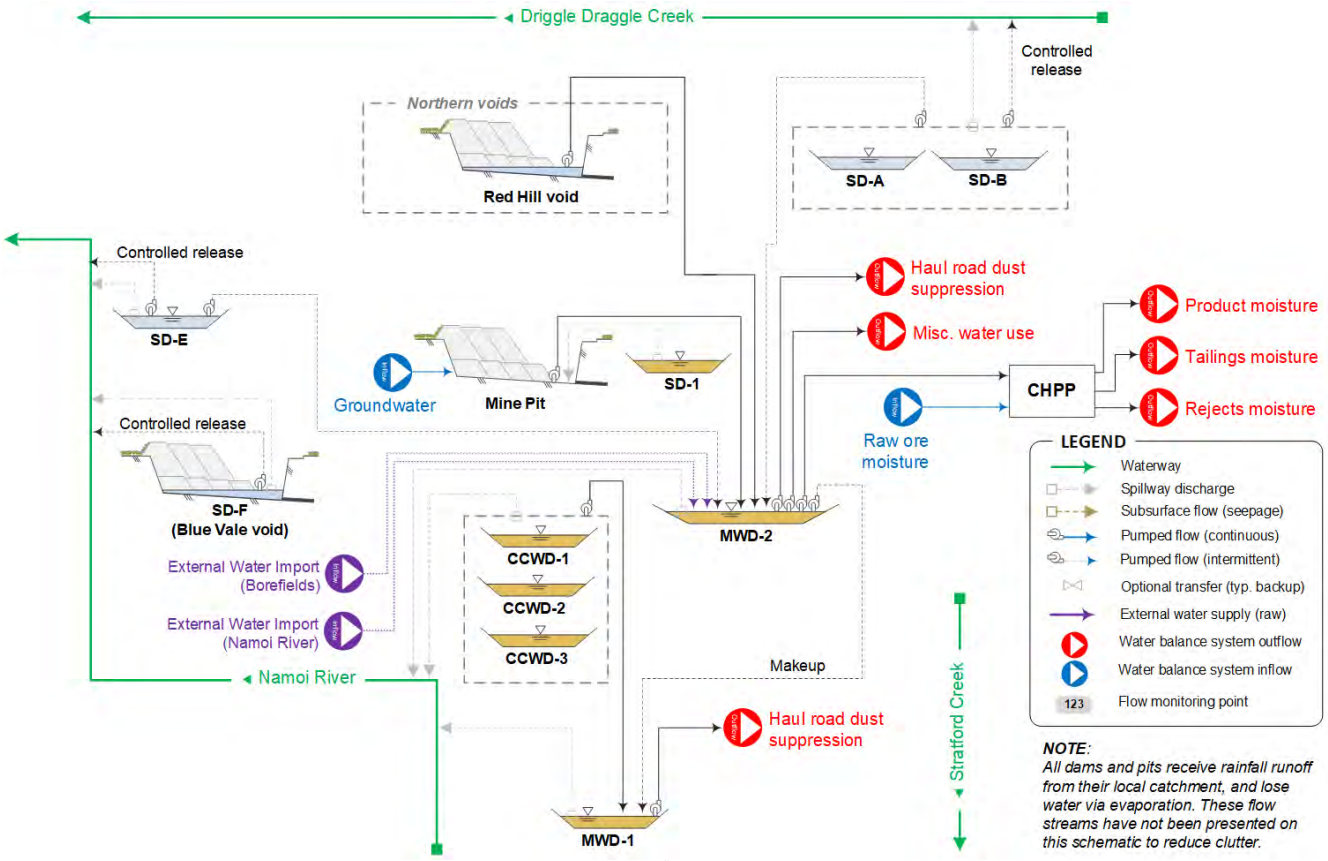


Figure 10 Schematic of Mine Water Management Circuit

4.2.1 Water Storages

The water management system includes storages for management of:

- clean water – existing legacy farm dams
- dirty water – sediment dams (SD-1, SD-A, SD-E, SD-F [BVV] and SD-B) to capture runoff from waste rock emplacements and progressive development footprint; and
- mine water – Mining Pit [Sumps], Mine Water Dams (MWD1 and MWD2) and Coal Contact Water Dams (CCWD1, CCWD2 and CCWD3) at the LOM Infrastructure Area.

Details of site storages are shown in Table 13.

The water balance simulation assumed no active (controlled) off-site releases of sediment laden (dirty) water from sediment dams. However, the model did allow overflow of sediment dams to the receiving environment to occur if rainfall exceeds the design standard, and as described in Section 4.1.

Table 13 Water Storages (On-site)

Storage	Capacity (Megalitres (ML))	Spills To	Comments	Operating rules
MWD1[a]	170	Off-site	Accepts mine water from MWD2 and CCWDs Captures runoff from the LOM infrastructure area.	Supplies water management system demands at the highest priority. Transfer to Mining Pit [Sumps] when MWD reaches maximum operating volume.
MWD2[a]	2,500	Mining Pit	Accepts mine water from the Mining Pit sumps. Captures runoff from the LOM infrastructure area.	Supplies water management system demands at the highest priority. Transfer to Mining Pit [Sumps] when MWD reaches maximum operating volume.
Mining Pit [Sumps]	3,000[b]	Mining Pit	Supplementary storage for mine affected water.	Transfers to and from MWDs to meet site demands.
SD-A	164	Off-site	Captures runoff from the waste rock emplacements.	Water released off-site if water quality meets EPL criteria[c]. Otherwise dewatered to MWD2.
SD-F (BVV)	101[d]	BVV [total capacity 1000 ML]	Captures runoff from the waste rock emplacements.	Dewatered to MWD1.
SD-B	74	Off-site	Captures runoff from the waste rock emplacements and topsoil stockpile.	Water released off-site if water quality meets EPL criteria[c]. Otherwise dewatered to MWD2.
SD-E	77	Off-site	Captures runoff from the waste rock emplacements.	Water released off-site if water quality meets EPL criteria[c]. Otherwise dewatered to MWD2.
SD-1	300	Mining Pit	Dam built by Rio Tinto in 1990s, captures runoff from hardstand areas. Storage eventually mined through.	Transfers to and from MWD to meet site demands.
CCWD1[a]	76.7	Off-site	Captures runoff from the LOM infrastructure area.	Dewatered to MWD1.
CCWD2[a]	116.1	Off-site	Captures runoff from the LOM infrastructure area.	Dewatered to MWD1.
CCWD3[a]	54.1	Off-site	Captures runoff from the LOM infrastructure area.	Dewatered to MWD1.

Storage	Capacity (Megalitres (ML))	Spills To	Comments	Operating rules
Drain 1 (temporary diversion)	N/A	Passive flow to Driggle Draggle Creek	Clean water not captured and used on-site.	Nil.
Drain 2 (Permanent Bluevale Diversion)	N/A	Passive flow to Driggle Draggle Creek	Clean water not captured and used on-site.	Nil.

[a] At LOM Infrastructure Area.
[b] The actual capacity of the Mining Pit [Sumps] varies as mining progresses.
[c] Water balance assessment assumed no off-site release.
[d] MOV displayed, the actual void capacity is surplus storage in BVV.

Drains and Pipelines

The site water management system includes the following key drains and pipelines:

- clean water diversion drains, including: Western Drain, Temporary upstream pit diversion, Drain 1 and permanent diversion Drain 2 (refer Section 4.3.4);
- dirty water drains to convey dirty water to dirty water dams (refer Figures 2a to 2c);
- Namoi River pipeline;
- bore pipeline; and
- internal water transfer pipelines (for dewatering dams and supplying water for use).

4.2.2 External Water Supply

Site water demands will be supplemented by external sources if sufficient water is not available on site to meet demands. External water sources that supplement site water supply include:

- Licensed surface water extraction from the Namoi River; and/or
- Licensed groundwater supply from an existing bore location on WHC owned land.

As shown in Section 5, the operation has modelled external water requirements under extreme climate conditions (1st percentile dry conditions, i.e. 1 in 100 year drought).

Water required from external sources will be extracted in compliance with its Water Access Licences (WALs). As outlined in Sections 2.5.1 and 2.5.2, each WAL will have a nominated water supply work and use approval within the relevant water source under the corresponding water sharing plans. For example, approval for water supply works and water use under section 92 of the *Water Management Act 2000* would be obtained from WaterNSW for the Namoi River pump station, as and when required.

In accordance with PA Condition 53 (g), during extreme climate conditions, VCPL will obtain temporary trades (through water allocation assignment trading) in addition to the WALs owned by the operation, providing a temporary allocation of unit shares in surface water and/or groundwater sources to meet any additional demand.

As a water supply contingency measure, water can also be obtained from neighbouring mines, which have in the past held excess mine water or license sources on their premises.

As prescribed in Condition B50(a), VCPL will consult with DPI-NSW Fisheries and GSC regarding the general operation and design of the pump station and screens and implement all reasonable and feasible recommendations from DPI - NSW Fisheries and GSC in regard to the design and construction of the pipeline and pump station, to avoid and mitigate impacts on native fish, which may include measures such as:

- starting the pump slowly and then gradually ramping up velocity;
- installing a suitable self-cleaning screen; and
- regular inspection of the screen.

The operation is currently consulting with GSC in accordance with Condition B50(b) to close Braymont Road Reserve, in the location of the pipeline construction, and acquire the land within the operational footprint. The pipeline will not be constructed until CSG has closed the road and the operation is authorised to operate within this area.

4.2.3 Potable Water

Potable water will be trucked to site as required (or treated to potable standards onsite) and stored in water tanks supplying the main office and workshop areas. Potable water is used for drinking and shower purposes within the main office, bathhouse and adjacent workshop areas.

The volumes of potable water used on the site are negligible compared to process water use and hence potable water use is not included in the site water balance.

4.3 CLEAN WATER MANAGEMENT

4.3.1 Overview

The key clean water management systems for the Project are:

- Diversion drain 1 to divert a non-minor stream around the mining operations. Diversion Drain 1 is temporary and will eventually be mined out. A permanent diversion drain will replace diversion drain 1 as part of the re-alignment of Blue Vale Road.
- Various temporary and permanent clean water diversion drains of minor streams around disturbed areas.

All clean water structures, capture is documented in accordance with the Whitehaven Clean Water Guideline. Details of the clean water management systems are provided in the following sub-sections.

4.3.2 Clean Water Dams

There are 39 legacy “farm dams” across the Vickery operational area. These farm dams are not part of the WMS but comply with the site harvestable rights allocation detailed in Section 4.7. VEP is not proposing to construct any additional clean water dams.

4.3.3 Clean Water Dam Decommissioning

As the mine progresses, legacy farm dams on the mine shall be decommissioned and either mined through by the open cut pit or dumped over with spoil. Only legacy dams within this approved disturbance footprint shall be decommissioned. The following process shall be undertaken for decommissioning these dams

- If the dam requires dewatering, a dam dewatering protocol will be followed which includes:
  - Engaging a suitably qualified aquatic ecologist to assess if the dam may have fauna that requires re-locating;
  - If the dam is assessed as having fauna for relocation, a suitably qualified ecologist will be present during the dewatering process to relocate fauna. The ecologist will have the appropriate permits and ethics to trap, relocate or euthanise fauna if required; and
  - DPI and NSW fisheries will be consulted on any displacement of native fish species if they are encountered in the dams.
- The dams will either be dewatered to the mines WMS, or discharged to the environment if the water quality complies with the mines EPL conditions.
- Disturbance of the dam will not occur until ESC measures are in place, if required.

4.3.4 Clean Water Diversion Drains

Runoff from clean water catchments is diverted away from disturbed areas using contour banks and diversion drains to minimise capture of clean water in the mine water management system. There are four (4) main clean water diversion drains to be constructed within the first three years, which will divert catchments where possible and practical (Figures 2a to 2c):

- **Western Drain:** separation of clean water catchment runoff to the adjacent dirty water system for the western waste rock emplacement that report to SD-A and SD-F (BVV). The clean water would drain to the 1st order drainage lines directly to to Driggle Draggle Creek.
- **Temporary upstream pit diversion:** that keeps clean water catchment runoff out of the mining pit.
- **Drain 1 (north):** Is a temporary diversion drain that diverts a non-minor stream around mining areas to Driggle Draggle Creek in the north.
- **Drain 2 (Permanent Bluevale Diversion)**: that diverts a non minor stream around mining areas and drains to tributaries of Driggle Draggle Creek in the north.

Clean water diversions would be designed and constructed in accordance with the Blue Book, with the following design standard:

- *Temporary: the 5% AEP peak discharge.*
- *Permanent: the 1% AEP peak discharge.*

4.3.5 Clean water diversions – design and performance criteria

The design of the any clean water diversion drain of non minor streams will be undertaken in accordance with the principles of the Queensland Government guideline for design of watercourse diversions[4] (Guideline). This has been adopted in the absence of an equivalent NSW guideline for watercourse diversions. Two diversions of non minor streams are planned at Vickery, including

- Temporary diversion as shown in Figure 2, which will be operational for about 5 years prior to being mined through. The temporary diversion is designed as per the target outcomes, with an emphasis on being safe and stable with sufficient stabilisation and lining.
- A permanent diversion of the same watercourse will be constructed as part of the Blue Vale Road realignment, which won't occur for at least 5 years.

The Guideline identifies five outcomes for watercourse diversions, summarised in Table 14.

Table 14 Target outcomes for reinstated drainage lines

Outcomes	
1	The watercourse diversion incorporates natural features (including geomorphic and vegetation) present in the landscape and in local watercourses.
2	The watercourse diversion maintains the existing hydrological characteristics of surface water and groundwater systems.
3	The hydraulic characteristics of the watercourse diversion are comparable with other local watercourses and are suitable for the region in which the watercourse diversion is located.
4	The watercourse diversion maintains a sediment transport regime that allows the watercourse diversion to be self-sustaining, while minimising any impacts to upstream and downstream reaches.
5	The watercourse diversion and associated structures maintain equilibrium and functionality and are appropriate for all substrate conditions they encounter.

The hydraulic characteristics of watercourse diversions are assessed using hydraulic flood modelling. Key hydraulic parameters (channel velocity, bed shear stress and channel stream power) for the diverted channel are compared with the existing channel (as well as reaches upstream and downstream of the diversion), as well as compared to Guideline threshold values. These Guideline threshold values

[4] Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000, Ref. OSW/2019/4599, Version 2.00, 05/02/2019

have been derived from an ACARP[5] study of natural watercourse and diversion in Queensland's Bowen Basin region.

A trigger action response plan (TARP) has been developed for monitoring and, if necessary, remediation of the watercourse diversion. Refer to Table 37 for details.

4.4 DIRTY WATER MANAGEMENT

Erosion and sediment control (ESC) measures to manage dirty water shall be designed, constructed and operating in accordance with the recommended best practice management requirements (Table 1) including:

- *Managing Urban Stormwater, Soils and Construction* (Landcom, 2004); and
- *Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries* (DECC, 2008).

The design of linear construction (including pipelines and roads) will be in accordance with relevant design standards including:

- *Managing Urban Stormwater, Soils and Construction, Volume 2A Installation of Services*;
- *Managing Urban Stormwater, Soils and Construction, Volume 2C Unsealed Roads; and*
- *Managing Urban Stormwater, Soils and Construction, Volume 2D Main Road Construction.*

4.4.1 Erosion and Sediment Control

General Principles

Effective erosion and sediment control is based on three key activities:

- Erosion control – prevention or minimisation of erosion caused by runoff on disturbed surfaces.
- Drainage control – a secondary erosion control, prevention or minimisation of soil erosion caused by concentrated flows. Appropriate management and separation of different water types through/around the area of concern.
- Sediment control – trapping or retention of sediment generated from either overland flow or concentrated flow.

The location of all sediment dams and drainage controls is shown in Figure 2a/b/c.

Best practice sediment control measures cannot, on their own, be relied upon to provide adequate environmental protection without implementing effective erosion and drainage controls. For such measures to be effective the following fundamentals are required:

- Integrate erosion and sediment control measures into the planning phases of construction and mine operations.
- Separate catchments by water types and control water movement through the site.

[5] Hardie, R and Lucas, R. 2002. Bowen Basin River Diversions Design and Rehabilitation Criteria. Project C9068 Report for Australian Coal Association Research Program (ACARP). Fisher Stewart Ltd, July 2002.

- Minimise the duration and extent of soil and spoil exposure where possible.
- Promptly stabilise disturbed areas where possible (to reduce the duration of disturbance).
- Maximise sediment retention on the site and maximise the volume of water that can achieve water quality compliance for EPL discharge.

The ESC will be operated to ensure they are in working order for the duration of disturbance including:

- Event based inspections prior to and post rainfall (example shown in Figure 11);
- Annual inspections by a suitably qualified person;
- Identified hazards and maintenance issues shall be reported and actioned in WHC360;
- Review of monitoring data to confirm the performance of ESC measures;
- Maintain all structures in proper working order at all times; and
- Adjust practices to maintain the required performance standard.

ESC measure shall remain operational until the disturbed area is stabilised and water quality data indicates that the runoff is of equivalent or better quality than the receiving environment. The decommissioning of ESC measure shall be documented in updates to the WMP prior to occurring.

Surface runoff water from areas that are disturbed by mining operations (including out-of-pit overburden and haul roads) is considered sediment laden (dirty) water runoff and may contain higher sediment loads than undisturbed areas.

As shown in Figure 2a/b/c, runoff from dirty water catchments is segregated from coal contact water catchments through the use of drainage controls. The drainage controls contain contaminated material or high salt concentrations within MAW catchment (including the pit), preventing impact to dirty water quality.

Activities that have the potential to cause erosion and sediment laden (dirty) runoff at the VCM include:

- vegetation clearing and topsoil stripping;
- stockpiling of topsoil;
- construction of roads and infrastructure;
- construction of waste rock emplacement areas;
- construction of contour banks and diversion drains, including re-routing existing drainages via clean water diversions; and
- other construction activities.

Potential impacts from these activities include:

- increased surface erosion from disturbed and rehabilitated areas through the removal of vegetation and stripping of topsoil;
- increased sediment and pollutant load entering the natural water system; and
- siltation or erosion of watercourses and water bodies.

The dirty water runoff potentially produced from these activities will be managed to ensure that downstream water quality is within the adopted water quality compliance criteria, through the following actions:

- dewatering dams within 5 days of rain;
- De-silting dams prior to the sediment storage zone being exceeded; and
- When required, treating water using low toxicity flocculants and pH correction prior to discharging occurring.

Flocculants utilised for dirty water treatment will be selected using a risk assessment process that considers the ecotoxicity of any potential residual flocculant in the discharge waters. This risk assessment process will be repeated for any new treatment agents used.

Topsoil stockpiles will be located within the approved development footprint and will not be located within any drainage line and be developed considering the potential for erosion and sediment issues. Further detail on the management of topsoil stockpiles is referred to separately in the Rehabilitation Management Plan (Table 1).

Sediment and erosion control measures are designed to ensure effective management and separation of clean water and dirty water runoff from mining and prestrip areas. Sediment mobilisation and erosion will be minimised by:

- protecting natural drainage lines and watercourses by the construction of erosion control devices such as diversion drains, diversion dams and sediment dams;
- installing appropriate erosion and sediment controls prior to any new disturbance associated with the activity;
- limiting the extent of the disturbance of the activity to the practical minimum;
- installing appropriate erosion and sediment controls around soil stockpiling areas; and
- progressively shaping and revegetating of waste rock emplacement areas, with adoption of the following management strategies:
  - mixing of sodic with non-sodic material during the handling of waste rock for emplacement;
  - grading of batter slopes on the waste rock emplacement areas to have an appropriate slope, consistent with the requirement to minimise the footprint of the emplacements;
  - use of contour drains on waste rock to break-up steeper slopes in order to minimise rill and gully erosion from concentrated flow;
  - design and construction of water conveyance structures to safely convey flow resulting from a 1% AEP rainfall event from the surface of the waste rock emplacement to control the volume and quality of runoff; and
  - treating areas of the final waste rock emplacement surface that exhibits erosion with gypsum;
- progressively rehabilitating disturbed land and constructing drainage controls to improve stability of rehabilitated land;
- treating rehabilitation areas to promote infiltration (i.e ripping); and

- restricting access to rehabilitated areas.

Where possible and practicable, clean water runoff from undisturbed catchments will be diverted around disturbed areas in a staged manner, as shown on Figure 2a to 2c, and described in Section 4.3 to minimise the use of clean water on the site. Any clean water capture shall comply with the WM Act.

Management and Maintenance of Erosion and Sediment Control Measures

The following management activities will apply to sediment dams:

- Following a rainfall event, the SDs will be managed to restore their design capacity (the settling zone) within five days either through pumping back to the mines WMS or through a controlled discharge in accordance with the mines EPL;
- Following a 38.4 mm or greater rainfall event over a 5 day period, all SDs and associated ESC measures will be inspected to confirm if there has been an uncontrolled discharge and what maintenance measures are required; and
- Sediment dams and associated water conveyance structures will be inspected annually by a suitably qualified persons to assess structural integrity and effectiveness.

The following maintenance measures will apply to other ESC measures:

- Following major rainfall events all diversion channels, contour drains and dirty water drains are to be inspected for damage (e.g. scour) and repaired; and
- Other erosion prevention measures, such as at stockpiles, are also to be inspected on a regular basis and repaired or reinstated where required.

Sediment fences may be utilised on an ad hoc basis to manage sediment loads in disturbance footprints, as well as in areas that cannot report to the dirty water management system such as runoff from remote facilities. Sediment fences are not the preferred form of sediment control, and as such will generally only be utilised where the other controls identified above are not practical or effective.

ESC Management during Construction of Infrastructure

The general principles and ESC measures described above also apply to areas disturbed during the construction of infrastructure (e.g. haul roads, diversion drains). Appropriate ESC measures will be developed that take into account anticipated soil, weather and construction conditions as well as the expected period of disturbance. ESC management during the construction phase will utilise catchment plans, as per the Whitehaven Coal Erosion and Sediment Control and Mine Affected Water Standard. An example of a catchment plan is shown in Figure 17.

Flooding impacts

As documented in section 3.2, all activities associated with the construction phase and early mining activities are located wholly outside of the Namoi River and Stratford Creek flood extent. Therefore, there is no potential for flood impacts from the activities documented in this water management plan.

The project rail spur is located within the Namoi River 1% AEP flood extent. As per PA Condition 48 and 49 the rail spur is designed as per the flood model currently under consultation with the Department. The construction of the Rail Spur will be documented in a future update to the WMP to document how flooding impacts will be mitigated.

4.4.2 Sediment Dams

Sediment dams will be used as settling basins for managing sediment loads within the dirty water management system. In addition, small scale sumps may be used adjacent to initial development and laydown areas as initial sediment control structures, prior to treatment in the dirty water management system.

The sizing of sediment dams is based on the following design standards and methodology:

- "Type F" sediment basins consistent with SD 6-4 (page 6-19, Landcom 2004).
- Sediment basin spillway capacity of 50 year average recurrence interval (ARI) peak discharge (to provide a high level of immunity to protect against structural damage).
- Total sediment basin volume = settling zone volume + sediment storage volume. The sediment storage volume is the portion of the basin storage volume that progressively fills with sediment until the basin is de-silted. The settling zone volume is the minimum required free storage capacity that must restored within 5 days after a runoff event.
- Sediment basin settling zone volume based on 90th percentile (wet conditions) 5-day duration rainfall (38.4 millimetre (mm)) with an adopted volumetric event runoff coefficient for disturbed catchments of 0.51 as per the EIS.
- Sediment storage volume = 50% of settling zone volume.

Sediment dam catchments and design criteria is detailed in Table 15 and is based on criteria for 'fine' or 'dispersive' sediments as per the recommended design standard s. The sediment storage allowance is 50% of the settlement volume and an additional 20% settlement volume allowance is included specifically to reduce the frequency of releases to the environment as per the project approval.

The sediment dams will be dewatered within 5 days of rain to restore the dams Settling Zone Volume. Where pollutant concentrations in sediment dams are less than the limits specified in the EPL, the dams may be dewatered to receiving waters. Where a pollutant exceeds the EPL limit, water in dams must be either:

- pumped into the mine water management system; or
- treated (i.e. flocculated to reduce TSS) to less than the EPL limit and discharged.

For rainfall events that exceed the design standard (38.4 mm in 5 days), sediment dams may discharge with TSS concentrations that exceed the water quality discharge limits of the EPL. Note however that such overflows are likely to occur during large rainfall events when background suspended solids concentrations in receiving waters are likely to be well above the water quality objective.

Table 15 Sediment Dam Catchment and Design Criteria

Sediment Dam	Catchment Area (ha)	Ultimate Catchment Area (ha)	Settlement Volume (ML)	Sediment Storage Allowance (ML)	Additional Settlement Volume Allowance (ML)	Indicative Total Capacity (ML)
			A	B	C	A+B+C
SD-A	490.9	492	96.4	48.2	19.3	163.8
SD-B	168.2	221	43.3	21.6	8.7	73.6
SD-E	43.1	230	45.0	22.5	9.0	76.6
SD-F (BVV)	109.5	303	59.3^	29.7^	11.9^	100.9^
SD-1	206.7	206.7	43	14.3	5.7	63*

^ Actual capacity of SD-F (Bluevale void) is 1,000 ML

* Actual capacity of SD-1 is 300 ML

4.4.3 Sediment Dam Discharge

Discharge water limits in EPL 21283 are not stipulated as the licence currently only allows for scheduled development works to be carried out (Section 2.4). Condition L1.1 recognises that, in relation to pollution of waters, Section 120 of the *Protection of the Environment Operations Act 1997* must be complied with.

4.5 MINE WATER MANAGEMENT

The mine water management system includes storages for managing water collected in the open cut pit, the MIA and coal stockpiles. The mine water management system must balance the potential impacts of too much water (i.e. in pit interruption to mining) and not enough water (i.e. need for external water supply sources).

Mine water is the primary water used for haul road dust suppression, coal processing and crushing, vehicle washdown and other LOM infrastructure area use, as well as construction.

4.5.1 Mine Water Management System

A dedicated system of sumps, pumps and pipelines will be established to manage mine water and maximise continuity of operations (i.e. minimise interruption) in the Mining Pit and to dewater mine water dams used for capturing runoff.

The Mine Services team will be responsible for the daily mine water management with the two most common activities including mine water pumping to the MWD and coordination of water cart dust suppression.

4.5.2 Mine Water Pumping

The water management system has been designed to minimise the potential for the discharge of mine water off-site while safely dewatering the Mining Pit (sumps) and Coal Contact Water Dams (CCWDs) by pumping to MWD1 or MWD2. All water used on site will be sourced from MWD1 or MWD2.

Operational pipelines will be located within the catchments of the mine water or dirty water catchments where possible so that any incidental leaks are contained on-site. Pipelines and valves will be located in areas outside of heavy vehicle interactions, with major pipe infrastructure protected by bunds / roadway verges. Thus, any leakage would report to either the mine water or sediment laden (dirty) water systems. Regular site operational inspections and integrity checks will be completed to identify leaks and rectify as required.

4.5.3 Mine Water Dam Storage Management

Mine dewatering requires surface storage to manage void water until it can be used for dust suppression. VCPL will use MWD1, MWD2, CCWD1, CCWD2 and CCWD3 for surface storage of mine water as outlined in Table 16.

Table 16 Mine Water Dam – Summary Details

Structure	MWD1	MWD2	CCWD1	CCWD2	CCWD3
Full Supply Volume (ML)	170	2,500	76.7	116.1	54.1
Maximum Operating Volume (ML)	144.5	2,250	15.3	23.2	10.8

4.5.4 Mine Water Usage

The primary uses of mine water is haul road dust suppression and for coal processing.

Water used for haul road dust suppression will be transferred via water carts and used to spray water to trafficable areas. Dust suppression water will also be used for vehicle washdown as well as at LOM infrastructure areas via water sprays at transfer points. Coal processing will initially consist of coal crushing prior to transport by truck to the Gunnedah CHPP, until the on site CHPP is constructed. The majority of dust suppression water usage will be applied by water carts to haul roads. The workshop utilises a small volume of water for equipment and plant washdown prior to maintenance.

Details of mine water usage for different purposes are provided in the site water balance (see Section 5.3).

4.6 CONTAMINATED WATER MANAGEMENT

The contaminated water stream includes potentially hydrocarbon contaminated water runoff from workshops, fuel farms, septic systems for treating water from ablutions and explosives mixing facility.

4.6.1 Oil/Water Treatment

Potentially hydrocarbon contaminated runoff from the concrete hardstand at workshops and fuel farms will drain to sumps and/or hydrodynamic separator systems to remove free hydrocarbons and suspended solids from stormwater. The sumps and separator systems will be serviced regularly to reduce the potential for overflow events.

4.6.2 Septic Water Treatment

During the first 3 years, septic shall be pumped off site by a licensed contractor. Prior to the construction of on site treatment, the WMP will be updated with details of the system.

4.6.3 Explosives Mixing Facility

An explosive mixing facility will be constructed in year 2 of operations. Raw products including ammonium nitrate and mineral oil used in blasting operations will be combined at the mixing facility which is located within the catchment of MWD2. To minimise the risk of contamination at the mixing facility, these products will be stored in bunded tanks, with a sump catching all runoff from the mixing facility. The sumps will be pumped out with a vac truck and disposed of through an oil water separator.

4.6.4 Chemical Dust Suppressants

In accordance with Condition 5b of Approval Decision (EPBC 2016/7649) (Table 2), details of any chemical dust suppressants (if and when used) are included below.

- Product: Hydrotac;
- Toxicity: Non-toxic at 100% for Daphnia (water flea) and Poecillia (guppy fish) and therefore not expect to have impact for local fauna;
- Usage area: the chemical dust suppressant is proposed to be used on haul roads which primarily drain into the pit catchment (only small areas of haul road are in the catchments of sediment dams); and
- Application: the chemical dust suppressant is proposed to be used during dry periods to conserve water. The chemical dust suppressant will not be used during wet times, reducing the risk of runoff containing the suppressant.

4.7 DAM COMPLIANCE

Water captured by all storages will comply with the *Water Management Act 2000* (Section 2.5) based on the location and purpose of each storage. The various categories for storages are described in Table 17.

There are numerous legacy dams across the premises and surrounds that do not form part of the water management system, including:

- Farm dams built prior to mining activities (i.e. prior to the mid 1990s)

- Dams built as part of the old mine workings for Canyon mine and the old Rio Tinto mine (mid 1990s).

The locations of all dams are shown on Figures 2a to 2c. Capacities of minor dams have been estimated from surface area and approximate depth estimates.

Details regarding the dams which fall under each of the licence categories is provided in the following sub-sections.

Table 17 License Categories for Site Water Use and Storage

Licence Category	Reference	Conditions
Water Access Licence (WAL)	*Water Management Act 2000* – Section 56	Approval for water supply works and/or water use from *WaterNSW.*
Harvestable Right	*Water Management Act 2000* – Section 53	Dam located on a minor stream[1]. Total of all harvestable rights dams not to exceed 10% of the average regional run-off calculated from landholding area multiplier.
Mixed Rights	NSW Government Gazette No. 40, Schedule 3, p1630	A dam from which water is taken as a harvestable right, as well as for other water rights. Runoff captured calculated on the average regional run-off calculation assuming 100% capture.
Excluded Work	*Water Management (General) Regulation 2018* – Schedule 1	Dam for control of erosion, flood detention or capture of drainage consistent with best management practice to prevent the contamination of a water source. Located on a minor stream[1].
Exempt	NSW Farm Dams Policy	Pre-1999, less than 7 ML.

[1] A minor stream is a first or second order stream

4.7.1 Clean water capture

VCPL compliance of clean water take is summarised in Table 18, which shows:

- The sum of the mining tenement areas to be 3,941 ha [includes MLA 578 & 579], with a specific multiplier value of 0.065, which equates to a Maximum Harvestable Rights Dam Capacity (MHRDC) of 236.3 ML.
- The total volume of Harvestable Rights Dams is currently 44.5 ML.
- The mixed rights allowance 147.5 (191.8 ML divided by 1.3).
- The annual mixed rights volume captured by mixed rights dams is 128.6 ML (Table 8).

VCPL has contiguous landholdings beyond the mining tenements which can also be relied upon for additional Harvestable Rights allowance if required.

Table 18 Clean Water Compliance Summary

Summary	
Maximum Harvestable Rights Allowance (ML):	236.3
Harvestable Rights Dam Capacity (ML):	44.5
Available Harvestable Rights Allowance (ML):	191.8
Mixed Rights Allowance (ML):	147.5
Mixed Rights Used By Site (ML):	128.6
Available Mixed Rights (ML):	19.0
Land required to meet compliance (ha):	0.0

4.7.2 Excluded Works Exemption

VCPL have a number of excluded works dams (Table 19), the Mining Pit and voids. Dams covered under the excluded works exemption have clean catchments which are neither possible nor practical to divert in accordance with best management practice.

Table 19 Excluded Works Exemption Dams – Licensing Considerations

Storage	Capacity (ML)
CCWD-1	76.7
CCWD-2	116.1
CCWD-3	54.1
MWD-1	170.0
MWD-2	2,500.0
SD-A	164.0
SD-B	74.0
SD-E	77.0
SD-F	1000.0

4.7.3 Harvestable Rights Dams

Harvestable rights dams capture clean water from overland flow and minor streams within the mining tenements. Table 20 shows the harvestable rights dams at VCM and their storage capacity.

Table 20 Harvestable Rights Dams – Licensing Considerations

Storage	Dam Capacity (ML)	Comment
FD01	1.4	Farm dam
FD02	1.4	Farm dam
FD05	3.6	Farm dam
FD06	0.7	Farm dam
FD07	0.7	Farm dam
FD09	1.1	Farm dam
FD10	0.4	Farm dam
FD11	0.5	Farm dam
FD12	1.0	Farm dam
FD13	0.5	Farm dam
FD13	0.5	Farm dam
FD14	0.8	Farm dam
FD14	0.8	Farm dam
FD16	1.0	Farm dam
FD21	0.4	Farm dam
FD22	0.5	Farm dam
FD23	0.4	Farm dam
FD24	0.4	Farm dam
FD25	1.5	Farm dam
FD26	0.6	Farm dam
FD28	0.8	Farm dam
FD29	1.7	Farm dam
FD30	16.0	Farm dam

Storage	Dam Capacity (ML)	Comment
FD34	0.9	Farm dam
FD35	2.4	Farm dam
FD36	0.7	Farm dam
FD37	1.1	Farm dam
FD38	0.8	Farm dam
FD39	1.0	Farm dam
FD40	1.0	Farm dam
Total	**44.5**	

4.7.4 Mixed Rights Dams

Table 21 summarises the mixed rights dam. Mixed rights dams have a component of their catchment which is natural and therefore captures clean water. Mixed rights dams allowance assume the dam captures 100% of annual average runoff.

Table 21 Mixed Rights Dams

Dam	Natural Catchment (ha)	Annual Runoff (ML)
SD-1	197.8	128.6
Total	**197.8**	**128.6**

4.7.5 Dams on Non-minor Streams

Table 22 summarises the dams on non-minor streams within the mining tenements:

- FD15, FD17, FD18, FD19, FD20, FD27, FD31, FD32 and FD33 are farm dams built prior to 1999. These dams are less than 7 ML and therefore exempt under the NSW Farm Dam policy. VCPL does not extract any water from these dams for the VCM.
- These dams will be progressively decommissioned and mined through in years 2 and 3 of mining.

Table 22 Dams on Non-minor Streams

Dams	Dam Capacity (ML)	Built prior to 1999	Action
FD15	1.2	Yes	None
FD17	1.1	Yes	None
FD18	0.9	Yes	None
FD19	0.5	Yes	None
FD20	1.0	Yes	None
FD27	1.5	Yes	None
FD31	1.6	Yes	None
FD32	1.4	Yes	None
FD33	1.5	Yes	None

4.8

4.9 WATER MANAGEMENT PERFORMANCE INDICATORS

Table 8 in SSD-7480 prescribes the water management performance measures for VCM which is replicated (from Table 1) in Table 23. Table 23 also lists other performance measures relevant to water management at the VCM.

VCPL will assess water management performance by using specific water management performance indicators for each performance measure. In the event that performance indicators are not met, VCPL will take action to rectify. The Water impact trigger and response plans are described separately in Section 7.which documents the actions that will be implemented when the performance measures are not met.

In accordance with Condition B53(d), the Project will implement measures to ensure compliance with the water management performance measures shown in **Table 23** (PA Table 8). Mitigation or corrective action identified during operations will be documented, actioned and tracked through the Whitehaven incident and hazard reporting system, WHC360.

Table 23 Water Management Performance Indicators

Performance Measure*	Performance Indicator	Mitigation measure
Water Management – General • Maintain the clean water management system separate from the dirty (i.e. sediment laden) and mine water management systems.	• Permanent clean diversion drains are designed by a suitably qualified person and installed and maintained to capture and convey the 100 year ARI flood event (1% AEP peak discharge) (refer Sections 4.3 and 8.5).	• Track performance of water management through the monthly report, example shown in Figure 19
• Minimise the use of clean and potable water.	• The water management systems are constructed, operated and maintained as described in Section 4.	• Annual review of clean water capture for each dam using the dam catchment plans shown in Figure 17 • Track water use through the monthly water report vs SWB forecast. Take corrective action to increase recycling/reuse and sharing when required. Identified actions documented in WHC360
• Maximise water recycling, reuse and sharing opportunities.	• Water use is consistent with the water use priority described in the Site Water Balance (Section 5) and in accordance with relevant *Water Management Act*, *2000* approvals (Section 2.5).	• Clean water capture compliant with the WHC Clean Water Guideline, which is documented in Section 4
• Maximise the capture and reuse of mine water and dirty water to meet operational demands for water, including dust suppression activities.	• Water management system configuration (as described in Section 4.2) with water transferred to MWD from Mining Pit [Sumps] and MWSS (BVV) as well as SDs (to restore capacity following rainfall events).	• Annual review of dirty water and mine water capture for each dam using the dam catchment plans shown in Figure 17. Identified actions documented in WHC360 .
• Minimise the use of make-up water from licensed external sources.	• Water transferred to MWD from Mining Pit [Sumps] and MWSS (BVV), as well as SDs (to restore capacity following rainfall events) and Clean Water Dams in preference to extraction from the Namoi River or groundwater supply borefield (Sections 4.2.1 & 5.5.1).	• Track consumption of dirty and mine water through the monthly report and ensure prioritising of dirty and mine water. Identified actions documented in WHC360
• Design, install, operate and maintain water management infrastructure in a proper and efficient manner.	• Maintain records that infrastructure is designed, constructed, operated and maintained generally in accordance with the described water management systems (refer Section 4).	• Annual audits and inspections by a suitably qualified person using the inspection template example shown in Figure 18. Identify hazards and implement actions through WHC360
• Minimise risks to the receiving environment and downstream water users.	• Water inventory is managed in accordance with the triggers detailed in the Site Water Balance (Section 5).	• Implement water treatment strategies to improve water quality from discharges as documented in Section 8

Performance Measure*	Performance Indicator	Mitigation measure
Alluvial Aquifers • Negligible impacts to alluvial aquifers caused by the development beyond those predicted in the document/s listed in condition A2(c), including: o negligible impacts to water quality; o negligible change in groundwater levels; and o negligible impact to other groundwater users; • Comply with the Minimal Impact Consideration for Aquifer Interference Activities for Alluvial Water Source (highly productive groundwater sources) under the *NSW Aquifer Interference Policy* (DPI, 2012).	• Groundwater level and quality monitoring is undertaken regularly in accordance with the groundwater monitoring program (Appendix A). Regular reporting (Section 9.2) and comparison of actual results against the predicted impacts in the EIS (Section 7.2). • Groundwater take is in accordance with the relevant WALs held in the Upper Namoi Zone 4 Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source (refer Section 2.5.1).	• Enter make good agreements with impacted other water users • Purchase additional water access licenses to account for take • Update the groundwater model • Increase groundwater monitoring in the location of the additional impact

Table 23 (Cont.) – Water Management Performance Indicators

Performance Measure*	Performance Indicator	Mitigation Measures
Erosion and Sediment Control Works • Design, install and maintain erosion and sediment controls in accordance with the best management practice guidance series *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom, 2004) and *2E Mines and Quarries* (DECC, 2008).	• Maintain records confirming that erosion and sediment controls have been designed, installed and maintained generally in accordance with the series *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom, 2004) and *2E Mines and Quarries* (DECC, 2008b) (Section 4.7)	• Annual review of dirty water and mine water capture for each dam using the dam catchment plans shown in Figure 17. Identified actions documented in WHC360 • Annual audits and inspections by a suitably qualified person using the inspection template example shown in Figure 18. Identify hazards and implement actions through WHC360
• Design, install and maintain any new infrastructure within 40 metres of watercourses in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012) or latest versions.	• Infrastructure within 40 m of watercourses is designed by a suitably qualified person and installed generally in accordance with the *Guidelines for Controlled Activities on Waterfront Land* (DPI, 2012), or its latest version (Section 4.7).	• All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • 50 m buffer zone established for non-minor streams • Buffer zone documented in the permit to clear process • All disturbance within 40m rehabilitated as soon as practical

Performance Measure*	Performance Indicator	Mitigation Measures
• Design, install and maintain any creek crossings in accordance with the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries, 2003), or their latest versions.	• Maintain records to demonstrate that creek crossings have been designed, constructed and maintained generally in accordance with *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) *and Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull, S and Witheridge, G., 2003), or their latest versions (Section 4.7).	• All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • Watercourse crossing design documented in the permit to clear process • All disturbance within 40m rehabilitated as soon as practical
Flood Protection Works • Design, install and maintain flood levees to protect mining areas from a probable maximum flood event and to ensure no increased flooding impacts on roads or privately-owned land.	• Flood protection levees are designed by a suitably qualified person and installed and maintained to protect the mining area from a probable maximum flood event (by Namoi River inundation) and to ensure no increased flooding impacts on roads or privately owned land (Section 2.5.3). • Flood protection levees are designed by a suitably qualified person and installed and maintained to protect the infrastructure area and south-western corner of the development affected by local flooding up to at least the 1% AEP event from Stratford Creek and South Creek (Section 2.5.3 and 4).	• PMF and 1% AEP extent documented through the mine planning process • All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • Updated flood modelling to assess the impact • Corrective actions Identified, documented and actioned in WHC360
Construction and Operation of Linear Infrastructure • Design the Project Rail Spur and Kamilaroi Highway overpass such that this infrastructure will not cause significant increased flooding, in particular increased affluxes and velocities at key locations, redistribution in and around the overpass, and flood levels at residences.	• The Project Rail Spur, Project Rail Spur bridges and any upgrade to the haul road will be designed by a suitably qualified person and constructed to minimise flooding and scouring impacts (and not cause significant increased flooding, in particular increased affluxes and velocities at key locations, redistribution in and around the overpass, and flood levels at residences), in consultation with the BCD of DPIE, consistent with the recommendations of the Department's flood peer review (WMA Water, 2020), and the objectives of the *Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019* (Section 2.5.3 and Enclosure 1).	• Updated flood modelling to assess the impact • All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • Provide compensation to impacted 3rd parties • Corrective actions Identified, documented and actioned in WHC360

Performance Measure*	Performance Indicator	Mitigation Measures
Clean Water Diversions and Storage Infrastructure • Design, install and maintain the clean water system to capture and convey the 100 year ARI flood event.	• Clean water diversions are designed by a suitably qualified person and constructed to capture and convey the 100 year ARI flood event (1% AEP peak discharge) (Sections 2.5.3 and 4.3).	• All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • Annual audits and inspections by a suitably qualified person using the inspection template example shown in Figure 18. Identify hazards and implement actions through WHC360
• Maximise, as far as reasonable, the diversion of clean water around disturbed areas on the site, except where clean water is captured for the use on the site.	• Clean water diversions are designed (in a staged manner) by a suitably qualified person to maximise the diversion of clean water around disturbance areas (Section 4.3 and Figures 2a to 2c). • Watercourse diversions are to be assessed in accordance with the design and performance criteria described in Section 4.3.5	• Implement treatment strategies to improve clean water diversion performance as documented in Section 8

Table 23 (Cont.) – Water Management Performance Indicators

Performance Measure*	Performance Indicator	Mitigation measures
Sediment Dams • Design, install and maintain sediment dams in accordance with the guideline series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008) and the requirements under the POEO Act.	• Sediment dams are designed by a suitably qualified person and installed and maintained generally in accordance with Managing Urban Stormwater: Soils and Construction including Volume 1 and Volume 2A – Installation of Services and 2E Mines and Quarries (DECC, 2008a;2008b).	• Dams designed as per the WHC ESC and MAW standard referred to in section 4 • All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • Annual audits and inspections by a suitably qualified person using the inspection template example shown in Figure 18. Identify hazards and implement actions through WHC360
• Design, install and maintain sediment dams to include contingency measures to prevent the potential mobilisation of pollutants and ensure compliance with the requirements of the Water Management Act 2000 and the EPL discharge criteria.	• Sediment dams are designed by a suitably qualified person and are installed, operated and maintained to include contingency measures (refer Sections 7.4 and 8.6).	

Performance Measure*	Performance Indicator	Mitigation measures
Mine Water Storages • Design, install and maintain mine water storage infrastructure to ensure no discharge of mine water to the off-site environment.	• MWDs are designed by a suitably qualified person and constructed and maintained generally in accordance with that described in the water management systems (Section 4) and site water balance (Section 5).	• Dams designed, constructed and operated as per the WHC ESC and MAW standard referred to in section 4 • All disturbance and ESC measures documented through the dam catchment plans, example plan shown in Figure 17 • Annual audits and inspections by a suitably qualified person using the inspection template example shown in Figure 18. Identify hazards and implement actions through WHC360
• New storages designed to contain the 100 year ARI storm event and minimise permeability.	• Mine water storages are designed by a suitable qualified person to contain the 1% AEP 72 hour storm event and have minimised permeability (Section 6.4).	• Track performance of water management through the monthly report, example shown in Figure 19 to ensure sufficient freeboard in storages • TARP levels are set to adjust operation of the WMS, document in Section 8
• Ensure adequate freeboard within all pit voids at all times to minimise the risk of discharge to surface waters and groundwater.	• Pit voids are designed by a qualified person to meet freeboard requirements and storage levels monitored and operated to confirm adequate performance.	
In-pit Emplacement of Acid Forming and Potentially Acid Forming Materials • Emplacement, encapsulation, treatment and/or capping to prevent the migration of pollutants beyond the pit shell.	• *Relevant performance indicators will be developed and included in a subsequent revision of this WMP.*	• Identified acid forming material will be dumped and capped in the pit • Routine water quality monitoring of storages will identity acidity issues. • pH correction used on dams which have the potential to discharge
• Adequate freeboard within the pit void to minimise the risk of discharge to surface waters.	• Pit voids are designed by a qualified person to meet freeboard requirements and storage levels monitored and operated to confirm adequate performance.	• Track performance of water management through the monthly report, example shown in Figure 19 to ensure sufficient freeboard in storages
Overburden Emplacements • Design, install and maintain emplacements to encapsulate and prevent migration of acid forming and potentially acid forming materials, and saline and sodic material.	• Overburden emplacements are designed by a suitably qualified person and constructed and maintained to prevent and/or manage long term saline seepage, and migration of potentially acid forming materials.	• All dumps and landforms designed by suitably qualified person • Ascon dump profile compared to plan and mitigation undertaken as required

Performance Measure*	Performance Indicator	Mitigation measures
• Design, install and maintain out-of-pit emplacements to prevent and/or manage long term saline seepage.	• Implementation of management measures as described in the Salt Balance (Section 6).	• Dumps located within the 1 m drawdown of the pit as shown in Figure 4-2. Saline seepage will flow towards the pit. • Routine water quality monitoring of storages will identity salinity issues. • The groundwater monitoring network described in The GWMP will identify any potential seepage • Install additional monitoring in any areas identified to be impacted • Saline water storage in MAW dams as documented in Section 4 •
Chemical and Hydrocarbon Storage • Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standards.	• Regular inspections confirm that chemical and hydrocarbon storages are stored in accordance with the relevant Australian Standards.	• Operate and maintain oil water separators as documented in Section 4. • Segregation of storages from the water management system • Maintain spill kits close to hydrocarbon storage areas to enable prompt clean up in the event of any spills. • Maintain the Pollution Incident Response management Plan to ensure that all hydrocarbon storage areas are listed in the document to enable effective management of spills.
Aquatic and Riparian Ecosystem • Negligible environmental consequences beyond those predicted in the document/s listed in condition A2(c). • Maintain or improve baseline channel stability. Develop site-specific in-stream water quality objectives in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000) and Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006).	• Photographic monitoring at ambient surface water monitoring locations to assess any changes in baseline channel stability. • Comparative assessment of stream health following inspections. In-stream water quality objectives are developed by a suitably qualified person in accordance with ANZECC (2000) and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC, 2006), or its latest version.	• Annual stream health monitoring as per Section 8 • TARPs as per Section 7 • Identify hazards and implement actions through WHC360 • Implement treatment strategies to improve stream health performance as documented in Section 7 and 8

Performance Measure*	Performance Indicator	Mitigation measures
Creek Diversions • Diverted creek lines are hydraulically and geomorphologically stable. • Incorporate erosion control measures based on vegetation and engineering revetments. • Incorporate water features such as persistent/permanent pools for aquatic habitat. • Revegetate with suitable riparian vegetation.	• Temporary clean water diversions, or diversion of minor streams are designed by a suitably qualified person and installed and maintained generally in accordance with Managing Urban Stormwater: Soils and Construction including Volume 1 and Volume 2A – Installation of Services and 2E Mines and Quarries (DECC, 2008a;2008b). • permanent diversions of non minor streams will be undertaken in accordance with the principles of the Queensland Government guideline for design of watercourse diversions	• All clean water diversions documented through the dam catchment plans, example plan shown in Figure 17 • Annual audits and inspections by a suitably qualified person using the inspection template example shown in Figure 18. Identify hazards and implement actions through WHC360 • Implement treatment strategies to improve clean water diversion performance as documented in Section 7 and 8

* Table 8 performance measures do not apply to water management structures constructed under previous consents as per condition B52, schedule 2, SSD-7480

5 SITE WATER BALANCE

5.1 OVERVIEW AND PREVIOUS MODELLING

VCPL will maintain a site water balance model using the GoldSIM modelling platform. The site water balance model will be reviewed to validate (or if necessary, re-calibrate) as required as part of the Annual Review (Sections 9.2.1 and 9.5.1) and be used to forecast the mine water management system behaviour.

Details of the site water balance model development and a summary of model outcomes are provided below and in the following sections.

A predictive model of the performance of the Vickery Extension Project at the VCM was originally developed by Advisian (2018) based on the open cut mining progression assumptions presented in the Vickery Extension Project EIS (Resource Strategies, 2018). The predictive model simulated a 26-year period (i.e. 12-month construction and initial mining phase and 25-year operations period). The water balance model considered climatic data from 1889 to 2020 which allowed for Monte-Carlo analysis of climatic sequences to determine the range of water demands that are influenced by climate. The results from all 128 modelled realisations were used to generate water storage volume estimates and other relevant site water balance statistics.

Since the EIS site water balance modelling, the mine stage design plans and water management circuit configuration for the first three years (Years 1 to 3) has been adjusted and consequently changes have been made to the clean water, dirty water, and mine water management system (Sections 4.2 to 4.5).

Catchment areas for the site water balance model have therefore been derived using the updated mine stage plans (Figures 2a to 2c) and converting runoff areas into sub-catchments based on their water types, with adjustments to dam sizing and licensing requirements as outlined in Sections 4.2.1 and 4.8.

5.2 CLIMATE DATA AND RUNOFF ESTIMATES

Long term daily rainfall and evaporation data was obtained from the SILO database (https://www.longpaddock.qld.gov.au/silo/) for the period January 1889 to December 2021 (132 years). Average monthly rainfall and evaporation are shown in Figure 11. Morton's lake evaporation was adopted to represent evaporation for the simulation of the site water balance.

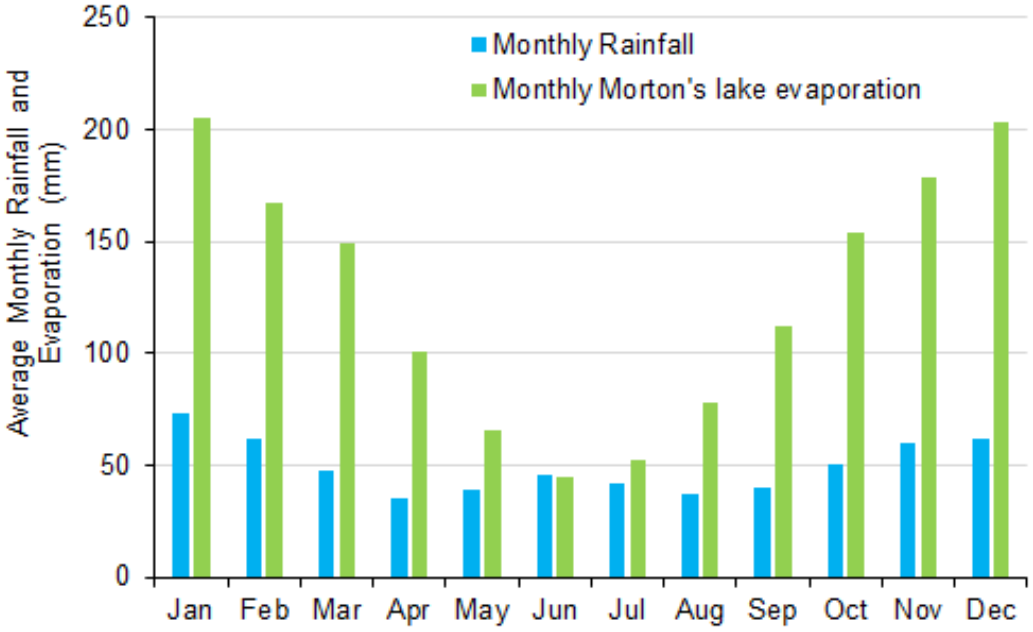


Figure 11 Average Monthly Rainfall and Evaporation from SILO Database

5.2.1 Rainfall

Rainfall inputs to the water balance have been based on data obtained from the SILO Patched Point for Boggabri (Retreat) (station number 55044).

5.2.2 Evaporation

Evaporative losses from storages within the water balance model have been estimated based on daily evaporation depths and wetted surface areas. Evaporation depths have been sourced from the SILO Patched Point service (Morton Lake Evaporation). Wetted surface areas are calculated for each storage within the GoldSIM model on a daily basis, using level-area-volume tables based on bathymetric survey or computer analysis of topographic survey data or design plans.

5.2.3 Runoff Estimates

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to estimate daily runoff from daily rainfall. The AWBM is a saturated overland flow model which allows for variable source areas of surface runoff.

The AWBM uses a group of connected conceptual storages (three surface water storages and one ground water storage) to represent a catchment. Water in the conceptual storages is replenished by rainfall and is reduced by evapotranspiration. Simulated surface runoff occurs when the storages fill and overflow. Figure 12 shows a conceptual configuration of the AWBM model.

The AWBM model uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a daily balance of soil moisture. The model has a baseflow component which

simulates the recharge and discharge of a shallow subsurface store. Runoff depth calculated by the AWBM model is converted into runoff volume by multiplying by the contributing catchment area. The model parameters define the storage depths, the proportion of the catchment draining to each of the storages, and the rate of flux between them.

Catchment runoff was modelled using the AWBM rainfall-runoff model. Catchments across the site have been characterised into the following land use types:

- Natural (undisturbed catchments, fully rehabilitated spoil and pre-strip areas).
- Compacted (haul roads, pit floor, mine infrastructure).
- Spoil (unrehabilitated overburden emplacement areas).
- Cleared (disturbed or stripped areas).
- New rehabilitation (recently rehabilitated spoil and pre-strip areas).

The adopted rainfall runoff parameters are summarised in Table 24. These parameters have been validated against observed runoff and recorded inventories at nearby sites.

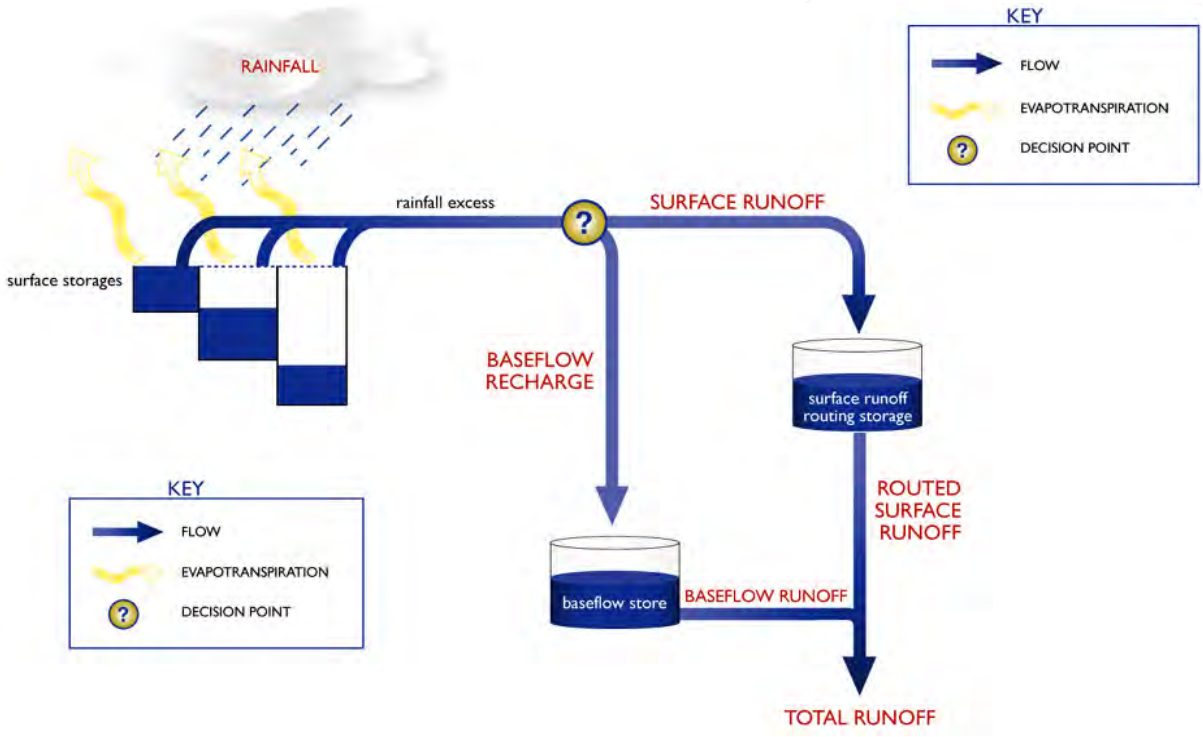


Figure 12 AWBM Model Configuration

Table 24 Adopted AWBM Parameters for the Site Water Balance

Parameter	Natural	Compacted	Spoil	Cleared	New rehabilitation
C1 (mm)	25.5	2	15	10	15
C2 (mm)	98.2	10	50	65	50
C3 (mm)	477.7	30	110	65	110
A1	0.069	0.333	0.1	0.15	0.1
A2	0.282	0.33	0.3	0.6	0.3
A3	0.649	0.337	0.6	0.25	0.6
BFI	0	0	0	0	0.2
Kbase	0	1	1	0	0.99
Ksurf	0.3	0	0	0	0
C_v	2.4%	40.8%	7.8%	12.1%	6.2%

mm = millimetres

5.3 MODELLED WATER DEMANDS

The modelled water demands from the mine water management system include:

- haul road dust suppression;
- coal processing demand, including the CHPP from year 3;
- vehicle washdown and other LOM infrastructure area use; and
- construction use.

5.3.1 Haul Road Dust Suppression

Haul road dust suppression rates have been estimated using daily rainfall and evaporation data sourced from the SILO database and the predicted haul road length. The haul road lengths have been estimated from the mine layouts (Figures 2a to 2c) and range from 15 kilometres (km) in Year 1 to 20 km by Year 3.

The following rules were used to determine the applied dust suppression rate on any given day:

- The daily evaporation rate was multiplied by a seasonal factor:
  - October to March by 0.85
  - April to September by 1.10
- For a dry day (zero rainfall), the haul road watering rate is equal to the seasonally factored daily evaporation rate.

- For a rain day when rainfall is less than the seasonally factored daily evaporation rate, the watering rate is reduced and is only required to make up the remaining depth to the seasonally factored daily evaporation rate.
- For a rain day when rainfall exceeds the seasonally factored daily evaporation rate, no haul road watering is required.
- It was assumed that 27.5 metres of the haul road width would be watered once per day; and
- If site inventory was below 1,100 ML a chemical dust suppressant was assumed to be used. A seasonal factor was applied to the wet season and dry season daily estimates to account for seasonal variation in the use of chemical dust suppressant (refer Section 4.6.4):
  - September to March application factor: 0.6
  - May to July application factor: 0.90
  - April and August application factor: 0.75

The adopted monthly consumption rates for the 3-year simulation period are summarised in Table 25.

Table 25 Adopted Monthly Haul Road Dust Suppression (Prior To Chemical Dust Suppressant)

Month	Haul Road Dust Suppression (ML/month)		
	Year 1	Year 2	Year 3
January	63	63	84
February	52	52	69
March	47	47	63
April	42	42	56
May	27	27	36
June	18	18	24
July	20	20	26
August	31	31	42
September	47	47	62
October	47	47	63
November	55	55	73
December	61	61	81
Annual	**509**	**509**	**679**

5.3.2 Coal processing demand

Coal processing will initially consist of coal crushing prior to transport by truck to the Gunnedah CHPP, until the on-site CHPP is constructed. The on-site CHPP is planned to be constructed and online by start of year 3. The on-site CHPP is estimated to use 120L/tonne.

5.3.3 Vehicle Washdown and Other LOM Infrastructure Area Use

For the purposes of the site water balance, it is assumed that approximately 1.46 ML/yr will be used nominally for vehicle washdown and other LOM infrastructure area use in years 1 and 2 and 15 ML/yr in year 3.

5.3.4 Construction Water Use

For the purposes of the site water balance, it is assumed that approximately 150 ML/yr will be used nominally for construction in years 1 and 2.

5.3.5 Total Demand Summary

Table 26 provides a summary of total demands for the water balance simulation period (Years 1 to 3).

It is noted that whilst some other water demands will need to be met as and when required (e.g. coal crushing plant), the total annual water demand for Years 1 to 3, relative to the average haul road dust suppression and vehicle washdown estimates is comparably low. Future updates to the site water balance can be made based on actual water usage (if and when required).

5.3.6 Water Efficiency

In accordance with PA Condition B39 the project will implement efficiency and best practice measures to minimise and conserve the use of water on site including;

- The use of a belt filter press in the CHPP to recover and recycle water;
- Haul road dust suppressants to reduce water use; and
- Where practical, water will primarily be stored in a single storage at MWD2, to reduce evaporation from dams.

5.3.7 Data collection

To inform future updates of the SWB, surface water inflows, outflows and storage volumes data will be monitored and recorded for the following;

- The volume of water imported to site from external water sources;
- The inventory of all storages;
- The volume discharged form dirty water dams to the receiving environment;
- The volume of water pumped between storages and the mine pit; and

- The volume of water used in the CHPP and via dust suppression.

The data will be collected from a variety of methods including flow meters, truck counts and surveyed water levels. All data will be documented and retained by the operation.

Table 26 Summary of Estimated Annual Water Demands, Years 1 to 3

Year	Haul Road Dust Suppression (ML)	CHPP Use (ML)	Vehicle Washdown and Other LOM Infrastructure Area Use (ML)	Construction Use (ML)	Total Annual Water Demand (ML)
1	509[a]	0	1	150	660
2	509[a]	0	1	150	660
3	679[a]	600	15	0	1,294

a Chemical dust suppressant use would reduce haul road dust suppression water usage

5.4 GROUNDWATER

5.4.1 Groundwater Inflows

Gross groundwater inflows to the open cut over the life of the Project are predicted to be between 0.24 ML/day (88 ML/yr) and 1.42 ML/day (518 ML/yr) (HydroSimulations, 2018). Net inflows to the pit, that enter the water management system are significantly less when evaporation and entrainment is considered.

Based on the depths to groundwater within the open cut mining footprint, net groundwater inflows to the open cut (after allowing for evaporation from seepage faces) during the initial 3 years of mining is expected to be negligible, but would nevertheless be monitored by maintaining sump volume / pumping records and calculating on an annual basis as part of the Site Water Balance updates (Section 9.5.1).

Sumps excavated in the floor of the active open cut will manage any inflows, as well as incident rainfall and runoff. Water that accumulates in the open cut sumps will be transferred to the MWD for use in the CHPP and for dust suppression.

If site water supply demands are required, and to minimise make-up water from licensed external sources, advance dewatering may also be conducted using appropriately licensed temporary (sacrificial) bores ahead of the open cut mining operation when required. Advance dewatering would generally only have the effect of bringing forward predicted groundwater inflow volumes (for water supply use), which would otherwise be realised at a future stage in the mine life as the open cut excavation advances.

5.5 CATCHMENT AREAS, LAND USE AND RELEASE ASSUMPTIONS

Table 27 lists the adopted catchment areas for the model simulation consistent with Figures 2a to 2c for Year1 to Year3 forecast (note that year 2 catchment areas were conservatively adopted for year 1).

Table 27 Adopted Catchment Areas for Model Simulation Year1 to Year3

Water Storage	Catchment (ha)		
	Year1	Year2	Year3
Mine (including Void) Water Dams			
Mining Pit	329.9	329.9	359.8
MWD1^	-[a]	-[a]	9.7
MWD2^	46.4	46.4	46.4
CCWD1^	-[a]	-[a]	79.5
CCWD2^	-[a]	-[a]	45.2
CCWD3^	-[a]	-[a]	42.2
Sediment Dams			
SD-A	490.9	490.9	490.8
SD-F (BVV)	109.5	109.5	109.5
SD-B	88.2	88.2	168.2
SD-E	-[a]	-[a]	43.1
Mixed Rights Dams			
SD-1	206.7	206.7	206.7

^ at LOM Infrastructure Area

[a] MWD1, CCWD1, CCWD2, CCWD3 and SD-E commissioned by Year3

5.5.1 Mine Water

The MWD2 will spill into the mine pit. The CCWDs are designed to contain the 1% AEP storm event. No releases of mine water were simulated as part of the SWB.

5.5.2 Dirty Water

The water balance assessment assumed no active (controlled) release of water from sediment dams. Overflow of sediment dams to the receiving environment can still occur if rainfall exceeds the design standard.

5.5.3 Clean Water Dams

Details of the clean water management strategy is provided in Section 4.3. No water is extracted from any clean water dams as part of the WMS.

5.6 WATER BALANCE MODEL SIMULATION AND RESULTS

The GoldSIM water balance model was used to undertake a 3-year forecast simulation of the site water balance for VCM under varying climatic conditions. The model simulates all major components of the water management system on a sub-daily time step. The simulated inflows and outflows included in the site water balance model are provided in Table 28.

Climatic conditions were represented by extracting 3-year periods of rainfall from the historical rainfall record which goes back to 1889. Each 3-year climate sequence represented by the model is referred to as a "realisation". The first realisation used recorded rainfall data from 1889 to 1891. The second realisation used data from 1890 to 1892, and so on. The historical rainfall record (1889 to 2021) provides 130 realisations.

Table 28 Simulated Inflows and Outflows to Mine Water Management System

Inflows	Outflows
Direct (incident) rainfall on surface of water storages	Evaporation from surface of water storages
Catchment runoff (including mine water and sediment water)	Haul road dust suppression demand
Groundwater inflows (including Mining Pit[s] and/or advance dewatering)	Vehicle washdown, construction use and other LOM Infrastructure Area use
Catchment runoff (compliant clean water only)	Uncontrolled spills from water storages
External water supply (supplementary only)	

The GoldSIM water balance model was used to assess the performance of the proposed water management system, including:

- mine water storage inventory;
- make-up water requirements from either licensed clean water capture and/or an external supply sources;
- uncontrolled spills from site water storages; and
- the overall water balance within the water management system.

Figure 10 shows the conceptualisation of the mine water management system adopted for the water balance model.

It is important to note that there is inherent uncertainty with respect to some components of the site water balance (e.g. catchment yield/rainfall runoff, groundwater inflows, etc.) but also as a consequence of the actual rate of development/mine progression. Best estimates of these parameters have been adopted and these estimates will continue to be checked and refined against on-site observations as operations progress.

In interpreting the results of a forecast simulation, it should be noted that the results provide a statistical analysis of the water management system's performance over the 3-year forecast period, based on 130 realisations with different climatic sequences.

The model results are presented as a probability of exceedance. For example, the 10th percentile represents 10% probability of exceedance and the 90th percentile results represent 90% probability of exceedance. The is an 80% chance that the result will lie between the 10th and 90th percentile traces.

Whether a percentile trace corresponds to wet or dry conditions depend upon the parameter being considered. For site water storage, where the risk is that available capacity will be exceeded, the lower percentiles correspond to wet conditions. For example, there is only a small chance that the 1 percentile storage volume will be exceeded, which would generally correspond to very wet conditions.

For external site water supply volumes (for example), where the risk is that insufficient water will be available, there is only a small chance that more than the 1 percentile water supply volume would be required. This would generally correspond to very dry climatic conditions.

It is important to note that a percentile trace shows the likelihood of a particular value on each day and does not represent continuous results from a single model realisation. For example, the 50th percentile trace does not represent the model time series for median climatic conditions.

5.6.1 Overall Water Balance

Water balance results from the 130 modelled realisations are presented in Table 29, averaged over each year. The results presented in Table 29 are the average of realisations and will include wet and dry periods distributed throughout the forecast period.

Rainfall yield for each year is affected by the variation in climatic conditions within the adopted climate sequence. It should be recognised that the following components of the water balance are subject to climatic variability:

- Rainfall runoff.
- Evaporation.
- Dust suppression water use.
- Licensed clean water use and/or external water supply requirement.
- Offsite releases/spills.

Hence, actual values of these components of the water balance will vary from year to year and may be outside the range of simulated results.

The results show that, on average:

- Combined runoff and direct rainfall contribute between 1,104 ML/year and 1,496 ML/year.
- Evaporation from water storage surfaces ranges between approximately 454 ML/year and 584 ML/year.
- The average annual external water demand supplied from licensed clean water use and/or external water supply sources ranges between approximately 137 ML/year and 326 ML/year.

- No overflows of mine water occurred in the simulation period.

Table 29 Annual Water Balance – All Realisations (Averaged)

	Annual Water Balance (ML/period)		
	Year 1	Year 2	Year 3
Water Inputs			
Direct Rainfall + Catchment Runoff	1,113	1,104	1,497
Net Groundwater Inflows	0	0	0
External Water Supply Sources	326	137	273
Total Inputs	**1,439**	**1,241**	**1,770**
Water Outputs			
Evaporation from Water Storages	454	486	585
Haul Road Dust Suppression Demand	355	390	524
Vehicle Washdown, Other LOM Infrastructure Area Use and Construction water	152	151	15
CHPP Use	0	0	600
MWD Spills	0	0	0
Sediment Dam Overflows (off-site)	32	38	49
Total Outputs	**993**	**1,065**	**1,773**
Change in Stored Volume	**+446**	**+176**	**-3**

5.6.2 Mine Site Storage Inventory

Figure 13 and Figure 14 show the predicted probability of the modelled (total) mine water inventory held in water storages over the 3-year forecast period for VCM.

A build-up of water in the active open cut generally occurs when the out of pit water storages (i.e. MWDs and CCWDs) are too full to accept additional water from the Mining Pit [sumps]. The primary out-of-pit storage is MWD2. MWD2 has a full supply capacity of 2,500 ML. The MOV of the MWD is set at 2,250 ML to prevent uncontrolled spills. When the stored volume in the MWD is below 2,250 ML, water can be pumped in from the active pit. If MWD2 stored capacity exceeds 2,250 ML, water will need to be managed within the other MWD (MWD1) and/or the pit. Pit water storage has an assumed MOV of 3,000 ML. Therefore, the combined MOV of MWD2 and Pit Water Storage is 5,250 ML.

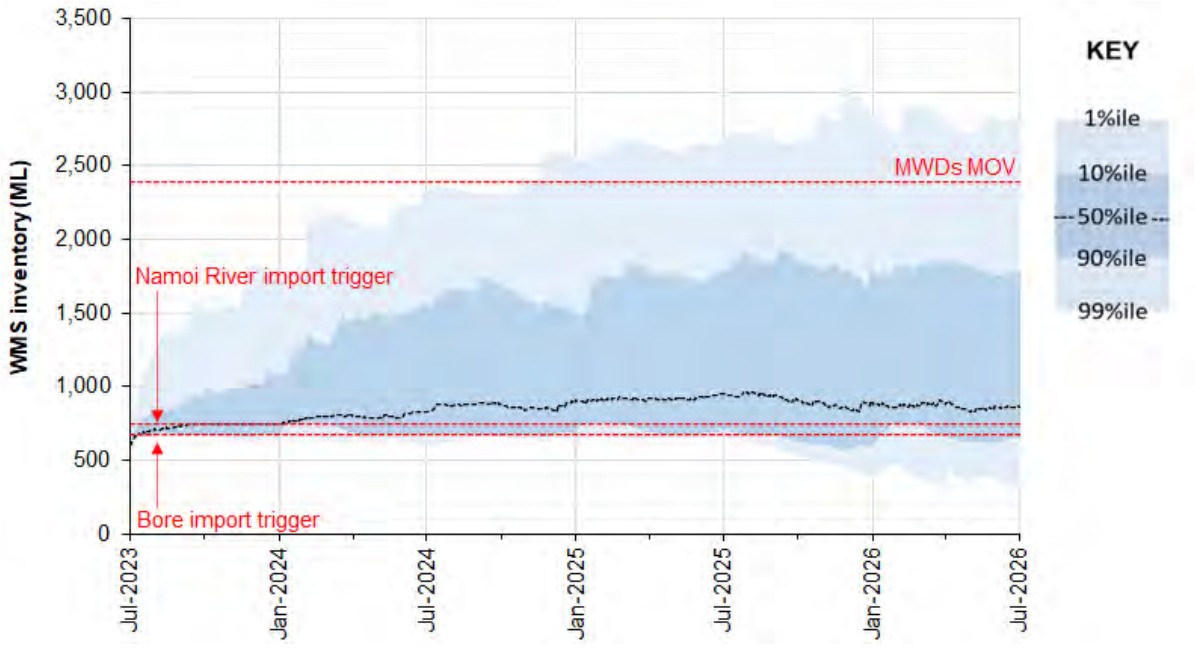


Figure 13 Forecast MWD and Pit Water Storage Combined Inventory

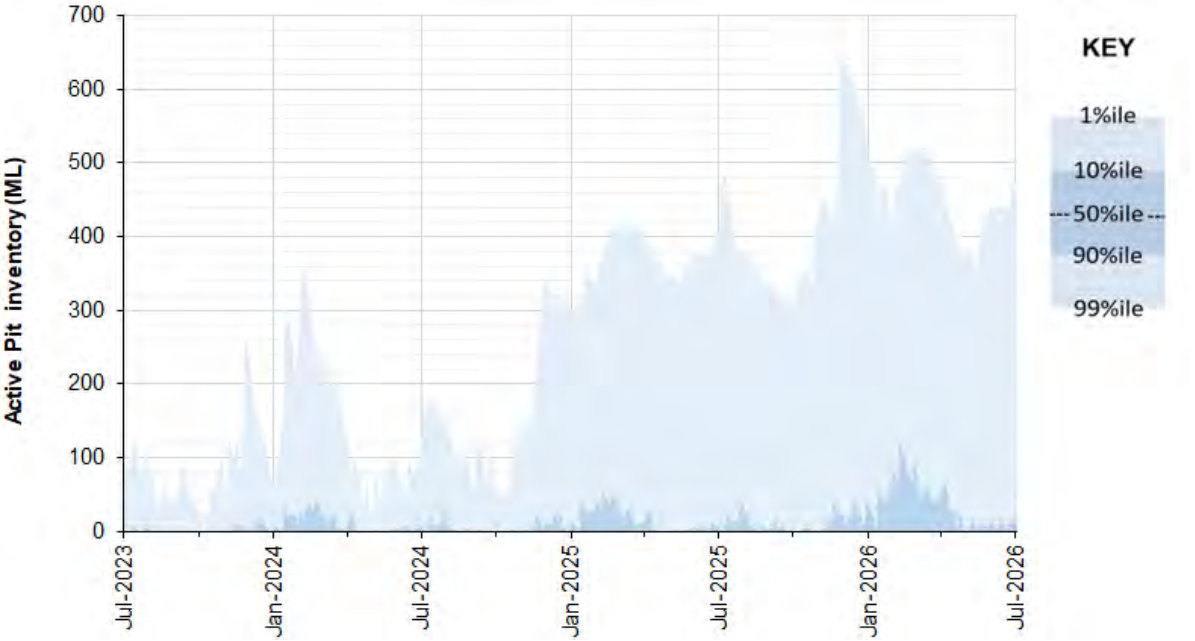


Figure 14 Forecast In-Pit Inventory

The water balance model results show that:

- There is sufficient water stored on site for the simulation period due to the external water supply.

- The 50th percentile combined MWD and Pit Water Storage volume fluctuates between 600 ML and 970 ML. This suggests that no water will be held in pit storage for median conditions, as the MWD2 MOV will not be exceeded.
- There is at least a 10% chance that:
  - the combined mine water storages will reach the MOV over the next 3 years; and
  - the pit water volume will exceed 130 ML over the next 3 years.
- There is a 1% chance that:
  - the combined mine water storages will reach MOV at some point over the next 3 years, however no mine water storage will reach their full supply volume; and
  - the pit water volume will exceed 630 ML over the next 3 years.

5.6.3 External Water Supply Requirements

When considering external water requirements, the probabilities have been inverted to indicate the risk of requiring at least the specified volume of water from an external source (including either licensed clean water dams, Namoi River water pipeline and/or groundwater supply bore). Hence, for investigation of external water supply, the 1st percentile represents very dry conditions which provide an indication of the likely upper limit of required water volumes.

Once MWD2 drops below a low trigger level, water will be demanded from external water supply sources (refer Figure 13). Figure 15 shows the potential external water supply requirements from the Namoi River pipeline and/or groundwater supply bore (combined).

The following is of note:

- For the Namoi River pipeline source:
  - there is a 90% chance that an annual volume of at least 0 ML per year of Namoi River water will be required to supply operational demands over the 3 year forecast period;
  - there is a 50% chance that an annual volume of at least between 0 and 181 ML per year of Namoi River water will be required to supply operational demands over the 3 year forecast period; and
  - there is a 10% chance that an annual volume of at least between 221 and 398 ML per year of Namoi River water will be required to supply operational demands over the 3 year forecast period.
- For the groundwater supply bore source:
  - there is a 90% chance that an annual volume of at least between 0 and 8 ML per year of bore water will be required to supply operational demands over the 3 year forecast period;
  - there is a 50% chance that an annual volume of at least between 0 and 87 ML per year of bore water will be required to supply operational demands over the 3 year forecast period; and

- there is a 10% chance that an annual volume of at least between 257 and 371 ML per year of bore water will be required to supply operational demands over the 3 year forecast period.

- External water requirements from the Namoi River and from the bore will not exceed the respective allocations and extraction limits for any of the climatic conditions assessed, therefore complying with license conditions.
- In accordance with Condition B39, the operation will ensure it has sufficient water for all stages of the development.
- In accordance with Condition B39, the operation will, if necessary, adjust the scale of the operations to match its available water supply.

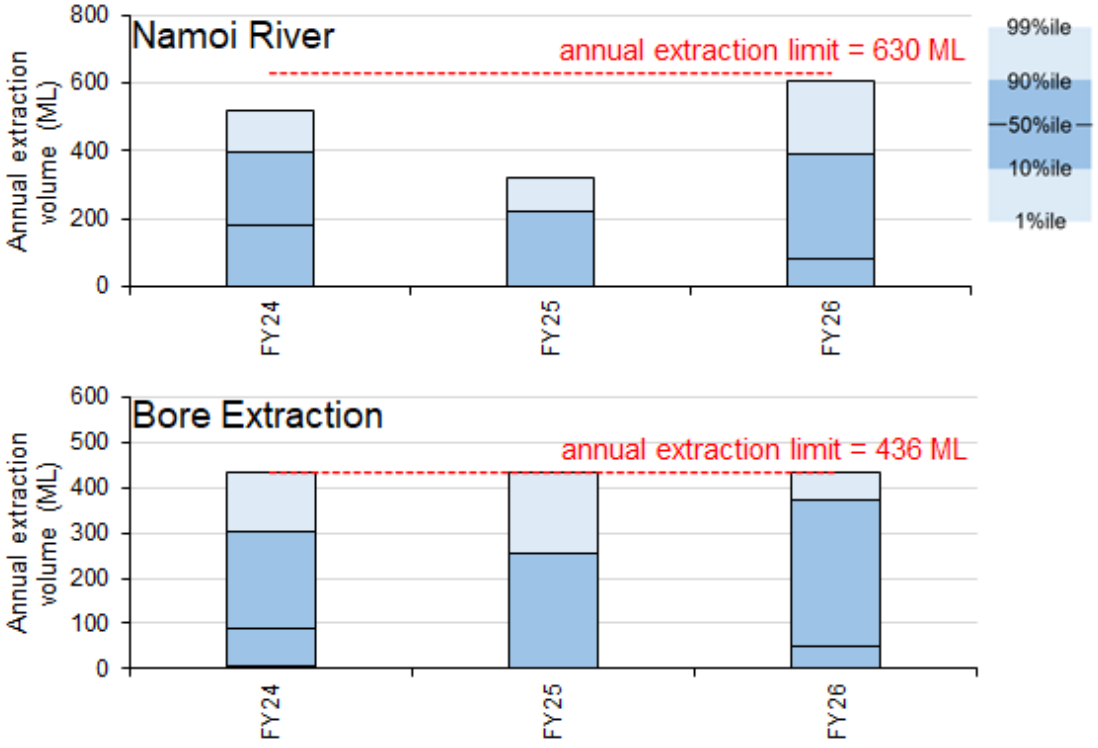


Figure 15 Forecast Total Annual External Water Supply, Namoi River and Groundwater Supply Bore

5.6.4 Uncontrolled Spills

Table 30 shows the predicted spills from key site storages over the 3 year forecast period for the median as well as the 90th (dry) and 10th (wet) percentile confidence limits. The results show:

- There are no spills from MWDs or CCWDs under all realisations (<1% spill risk).
- There is a 50% chance that there would be at least 2 spill days and 7 spill days from SD-A over the 3 year period (with an average spill volume of 0.4 ML), and 10% chance that there would be at least 25 spill days with an average spill volume of 14.4 ML.

- SD-B would spill for only 7 days during wet (10th percentile) climatic conditions, with an average spill volume of 3.9 ML.

The predicted spill frequency from sediment dams complies with the “Blue Book”, which indicates sediment dams designed to the 90th percentile 5 day rain event should spill on average (50th percentile) 2 to 4 times per year.

Table 30 Predicted Spills from Key Site Storages Over 3 Year Forecast Simulation

Dam	Probability Percentile	No. of Spill Days	Ave. Spill Volume per spill day (ML)
MWD1	10	0	0
	50	0	0
	90	0	0
MWD2	10	0	0
	50	0	0
	90	0	0
SD-A	10	25	14.4
	50	2	0.4
	90	0	0
SD-B	10	7	3.9
	50	0	0
	90	0	0
SD-E	10	0	0
	50	0	0
	90	0	0
SD-F*	10	0	0
	50	0	0
	90	0	0
CCWD1	10	0	0
	50	0	0
	90	0	0
CCWD2	10	0	0
	50	0	0
	90	0	0
CCWD3	10	0	0
	50	0	0
	90	0	0

* SD-F spills enter BVV, which has a capacity of 1,000 ML

6 SALT BALANCE

6.1 OVERVIEW

A salt balance was created to conceptualise the salt movements based on a water management system scenario assumed and adopted for the first 3 years of the Vickery Extension Project at the VCM.

The basic principle of mass conservation across a system has been applied as follows:

'Total rate of salt into a process unit' = 'Total rate of salt out of the process unit,' where

'Salt Load (t/yr) = Flow (ML/yr) x Salt concentration (mg/L)

The Salt Balance evaluates total soluble salts or mineral constituents in surface water and groundwater where salinity is defined in terms of Total Dissolved Solids (TDS). The process to evaluate the flow, concentration and subsequent loads includes:

- identification of boundaries into smaller management areas, or process units, to reflect the complexity of construction and initial mining activities;
- itemisation of saline sources and outputs for each process unit;
- quantification of water flow megalitres per year (ML/year), quality data (concentrations in milligrams/Litre) and salinity load (tonne/year) for each process unit; and
- conceptualisation of the salt balance and the various interconnections.

6.2 SALT BALANCE ASSUMPTIONS

Assumptions adopted for the salt balance model are summarised in Table 31.

Table 31 Salt Balance Assumptions

Source or Destination		Concentration (mg/L)	Reference
Incidental Groundwater Inflows to the Open Cut		2,700	HydroSimulations, 2018
Mine Water (including Coal Contact Water) Runoff		2,600	GEM, 2018
Dirty Water		1,000	Whitehaven, 2019; Advisian, 2018
Rainfall		0	-
Bore Supply (Advanced Dewatering and/or External)		3,000	HydroSimulations, 2018
Namoi River (External)		433	80th %ile at Gauge 419001
Evaporation		0	-
Overflow (assumed to be none)		0	-
Existing at Start of Year	**Volume (ML)**	**Concentration (mg/L)**	**Load (t)**
SD-A	0	-	-
SD-E	0	-	-

SD-B	0	-	-
CCWD (1,2,3)	0	-	-
Open Cut	0	-	-
SD-F (BVV)	0	-	-
SD-1	100	1,000	100
Existing voids	300	1,000	300
MWD-1	0	-	-
MWD-2	300	1,000	300

The Salt Balance schematic is presented in Figure 16. It has been developed to account for all system sources as listed in Table 28.

Losses include evaporation, reject coal entrainment and product coal (truck). Uses relate to dust suppression of construction activities, haul roads and the MIA. The balance considers geochemical, climate and hydrogeological data including direct rainfall, runoff, incidental groundwater into the open cut, Namoi River water, groundwater borefield water and evaporation volumes relative to background concentrations. Internal movement of water for the salt balance reflects those in Site Water Balance (Section 5).

6.3 SALT BALANCE RESULTS

The results of the salt balance are shown in Table 32. The time series for the salt balance includes the construction and initial mining phase, up to the end of the third year.

Salinity will progressively accumulate over time, particularly in MWD-1 and MWD-2. The SWB modelling has accounted for this salinity increase which is mainly due to groundwater inflow, surface runoff and evaporation (Advisian, 2018). Seasonal effects may affect volumes and loads.

Table 32 Salt Balance Results

	Water (ML)	Salt (t)
Starting Balance	700	700
Water Sources		
Runoff	3,127	5,192
Rainfall	609	0
Bore Supply	308	924
Incidental Groundwater into Open Cut	795	2,147
Namoi River	427	185
Total Sources	**5,266**	**8,448**
Salinity Use		
Haul Road Dust Suppression	1,269	<3,299
Vehicle Washdown and LOM Infrastructure Area Use	18	<47
CHPP Use	600	<1,560
Construction Use	300	<780
Total Use	**2,187**	**<5,686**
Losses		
Evaporation	2,321	0
Overflow	163	<163
Total Losses	**2,484**	**<163**
Closing Balance	1,295	>3,299
Change in Storage	595	>2,599
Balance	0	0

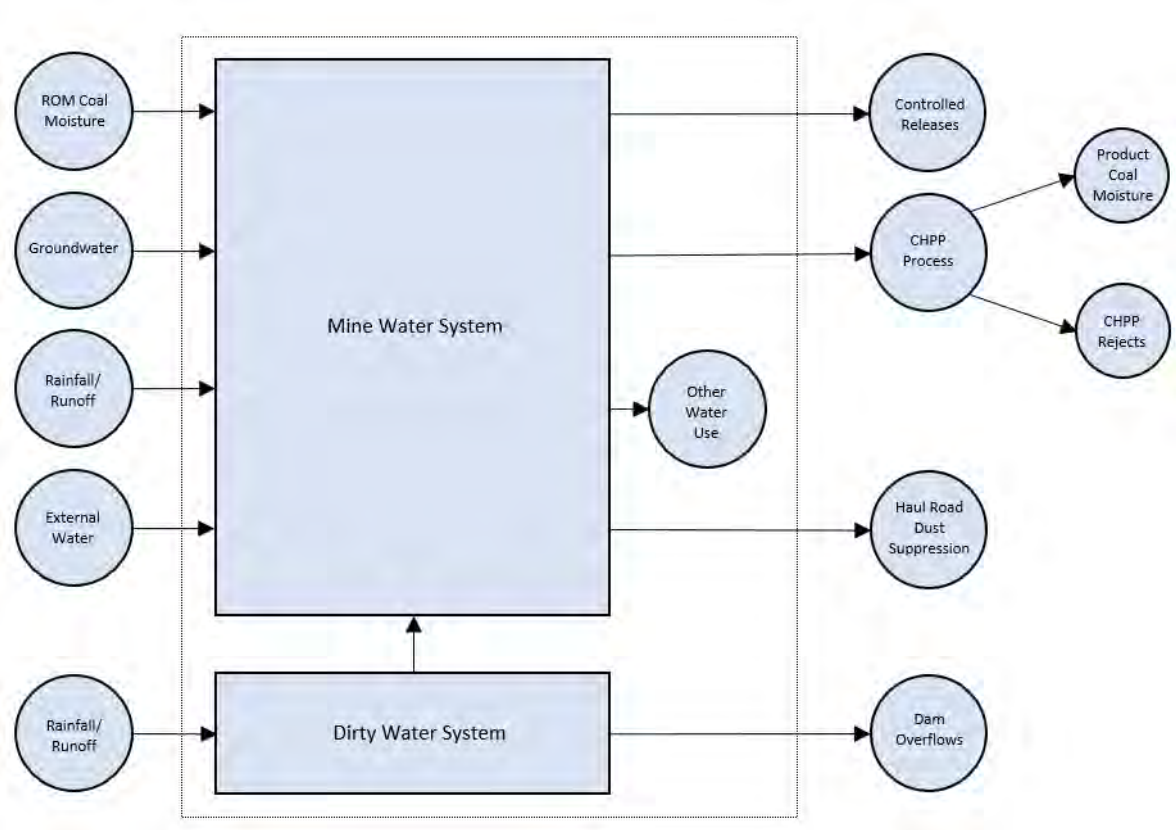


Figure 16 Salt Balance

6.4 SALINE WATER MANAGEMENT

In accordance with PA Condition B47, the operation shall implement all reasonable and feasible measures to prevent migration of saline water from the mine water storages. The water management system will be operated to prevent migration of saline water by:

- segregating runoff from coal stockpiles and contaminated catchments to MWDs (including CCWDs);
- minimising the catchment reporting to the open cut operations (including installation of a combination of permanent and temporary clean water diversions in a staged manner);
- New storages designed to contain the 100-year ARI storm event, the spill risk is assessed and documented in the SWB;
- New Mine water storages will be designed and constructed to minimise permeability consistent with relevant guidelines and the project approval including appropriate lining where required. All dams constructed will be engineered structures built in accordance with design specifications including
  - Bentonite treatment to 300 mm thick at a minimum application rate of 15 kg/m^2 and compacted to 95% MDD (maximum dry density);

  - Lining permeability of $1x10^{-9}$ m/s verified through a QA/QC process by a suitably qualified person; and
- Mine water storages within the mine pit, existing voids or the approved pit shell where seepage will migrate via groundwater drawdown to the active mine workings will not require permeability lining.
- Ensure adequate freeboard within all pit voids at all time to minimise the risk of discharge to surface waters or groundwaters
- As documented in the groundwater management plan, there is an extensive network of groundwater monitoring sites around the mine which will identify any potential migration of saline waters through groundwater so that the operation can undertake mitigation measures;
- ensuring that water management systems are managed and monitored generally in accordance with the approach describe in Sections 5 and 6; and
- regular water quality monitoring to respond as required as outlined in Sections 7 and 8.

The Project will extract salts each year from the receiving environment via the Namoi River, captured runoff and groundwater bores, which significantly exceed the salt added to the receiving environment through overflows, as shown in **Table 32**.

In the event the operation identifies saline water impacts to the Namoi River caused by the Project (As per TARP Table 37), the operation will:

- Engaged an independent suitably qualified expert to assess the extend of impact and source of salinity
- Review the annual salt balance to determine the net salt added/removed from the Namoi River for the year
- In the event the operation adds more salt than is taken, the operation will offset the salt through the following options
  - Offset net salts removed from the Namoi River by other Whitehaven Coal operations
  - Consult with the Department and EPA on salt offset opportunities, as there are currently no mechanisms available in the Namoi River catchment for salt offsetting.

7 WATER IMPACT TRIGGERS AND RESPONSE PLANS

7.1 DISCHARGE LIMITS

Discharge water quality concentration limits in EPL 21283 are listed in (Table 33). These criteria are consistent with other mines in the area. The Total Suspended Solids concentration limts specified may be exceeded for water discharged provided that:

(a) the discharge occurs solely as a result of rainfall measured at the premises that exceeds 38.4 millimetres over any consecutive 5 day period immediately prior to the discharge occurring; and

(b) all practical measures have been implemented to dewater all sediment dams within 5 days of rainfall such that they have sufficient capacity to store run off from a 38.4 millimetre, 5 day rainfall event.

Table 33 Surface Water Discharge Criteria

Parameter	100th percentile
pH	6.5 to 8.5
Total Suspended Solids (mg/L)	50
Oil and grease (mg/L)	10

7.2 TARPS

Trigger levels and contingency actions to respond to key aspects of the water management system performance are provided in Trigger Action Response Plans (TARPs) below for:

- Mine water containment (Table 34);
- Downstream flooding impacts (Table 35)
- Water supply for other water user (Table 36)
- Receiving water quality (Table 37);
- Sediment dams (Table 39);
- Watercourse diversions (Table 40); and
- Stream health (Table 41).

Table 39 shows surface water quality impact assessment criteria that will be used as trigger values for assessing the surface water impacts from the Project on receiving watercourses. Exceedance of the trigger values will initiate an investigation to assess whether the identified exceedance has potentially been caused by the Project. Where insufficient local reference data is available to determine trigger levels, Australian New Zealand Environment Conservation Council (ANZECC) eco-system trigger values have been adopted. The adopted trigger values will be refined based on ongoing sampling.

Table 34 TARP – Mine Water Containment

Level	Trigger	Action	Response
Level 1 (Normal)	MWD2 stored volume < MOV[a]	• Continue to monitor levels in accordance with monitoring plan	• No response required
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	• Ensure inter-dam transfer pumping network is operational • Review options for water transfer if required	• Post-event review to confirm event was well managed with appropriate resources in place
Level 3A (Exceedance of trigger level)	MWD2 stored volume exceeds MOV[a] with inflows still occurring	• Reduce process inflows if practical • Commence transfer from MWD2 to other mine water storages	• Post-event review to confirm suitability of water transfer infrastructure & operational rules • Update operational rules if required • Prepare recommendations and implement modifications or upgrades to water transfer infrastructure
Level 3B (Possible discharge of void water)	Total out-of pit mine water storage[b] exceeds 2,483 ML (approximately 90% capacity) with inflows still occurring	• Cease process inflows to storages with highest risk of spill • Maximise pumping capacity for transfer from mine water storages to Pit (e.g. relocate mobile pumps)	• Post-event review to confirm suitability of water transfer infrastructure & operational rules • Update operational rules if required • Implement required modifications or upgrades to water transfer infrastructure
Level 4 (Discharge of void water)	Discharge of Mine water from one or more mine Water Dams	• Complete required actions under Pollution Incident Response Management Plan • Advise DPIE of spill • Collect water quality samples of spills at dam overflow point and upstream and downstream in receiving watercourse • Remediate any environmental harm	• Initiate investigation into reasons for system failure, including assessment of environmental harm • Take actions recommended by investigation to prevent recurrence

[a] MWD2 MOV = 2,250 ML

[b] Total out-of-pit storage capacity = MWD1 + MWD2 + CCWD1 + CCWD2 + CCWD3 = 2,759 ML

Table 35 TARP – Downstream Flooding

Level	Trigger	Action	Response
Level 1 (Normal)	No site runoff	• Annual inspection of local waterways as per stream health monitoring programs	• Arrange maintenance if required to ensure culverts are clear of sediment and debris and gauges are functional.
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	• Check gauge recorders on Namoi River are reporting correctly.	• Post-event review to confirm gauges functioned correctly.
Level 3 (Flood event)	Namoi River at Gunnedah exceeds Bureau of Meteorology Minor Flood level; or Recorded site rainfall of > 50 mm per day; or	• Undertake site inspection including access road and rail spur to identify any flood damage • Make safe any areas of flood damage or major erosion on the mine site. • Prepare post-flood assessment report including: – details of recorded rainfall; – photographs of identifiable flood marks; and – photographs of identifiable changes in stream condition, such as areas of erosion or deposition.	• Post-event review to confirm gauges functioned correctly. • Review flood event trigger and revise up or down to reflect site experience.
Level 4 (Potential flood impact)	Flood event that causes identifiable damage to infrastructure or community complaint regarding flooding	• Complete actions under Level 3. • Review mining disturbance to assess whether mining operations could have contributed to flooding. • Review rainfall and flow data to assess whether mining activity is likely to have contributed to additional flooding. • Prepare a report documenting the investigation, outcomes and recommendations to prevent recurrence. • Advise complainant of outcome of assessment.	• Undertake remediation works to fix damage • Take actions recommended by investigation to prevent recurrence

Table 36 TARP – Water supply for other users

Level	Trigger	Action	Response
Level 1 (Normal)	No Impact to other water users	• None	• Continue to monitor in accordance with the WMP
Level 2 (Early water – climate related)	Water user compliant or water levels drop below baseline trigger levels	• Undertake investigation to identify if the issue is a result of climate or mining impacts • Identify if any other monitoring locations are impacted • Determine if the impact is climate or mine related	• Confirm monitoring data is accurate and not a one off • Confirm impact is from climate. • If required increase frequency of monitoring at impact location
Level 3 (short term impact – Mine related)	Water user compliant or water levels drop below baseline trigger and its attributed to the mine (monitoring data between the mine and other user also shows impact)	• Complete actions under Level 2 • Increase monitoring frequency at the impact water user to monthly • Prepare water user impact assessment report including: – details on climatic conditions and impacts – comparison of impacts to the modelled impacts assed under the project approvals – assessment of whether the impacts are short term or long term – advise DPE of the impact	• Provide short term compensatory water or other forms of compensation
Level 4 (Long term impact – mine related)	Based on level 3 investigation, the impact is attributed to the mine and will occur long term	• Complete actions under Level 3. • Identify and report source of impact • Update relevant modelling to determine if the impact is short term or long term • Increase the number of monitoring locations in the impacted area • Advise DPE of the impact	• Supply compensation water • Provide make good agreement to address impact long term which may include compensation, installation of a deeper bore, access to a new water source (i.e. replace river with bore water)

Table 37 TARP – Receiving Water Quality

Level	Trigger	Action	Response
Level 1 (Normal)	All surface water quality samples below trigger levels in Table 39.	• No action	• Continue to monitor water quality in accordance with monitoring plan
Level 2 (Early warning)	Single value at downstream sampling site exceeds trigger level in Table 39.	• Verify sample analysis to confirm result • Check upstream water quality to assess potential for impact from operations • Advise DPIE of trigger exceedance	• If upstream pollutant concentration is higher or within 5% of downstream value, then no further action required • Otherwise, assess whether operation could potentially have affected water quality and take remedial action, if appropriate
Level 3A (Potential water quality impact – no discharge)	Two or more sequential samples at a downstream sampling site exceed trigger level in Table 39.	• Check upstream water quality to assess potential for impact from operations • Report on likely causes of exceedance and all reasonable and feasible mitigation measures • Advise DPIE of trigger exceedance	• If upstream pollutant concentration is higher or within 5% of downstream values then consider need for review of trigger levels • Implement appropriate mitigation measures after considering all reasonable and feasible options
Level 3B (Potential water quality impact – sediment dam discharge)	Water quality at multiple downstream sampling sites exceeds trigger levels in Table 39. And discharge from site sediment dams has occurred.	• Check upstream water quality to assess potential for impact from operations • Report on likely causes of exceedance and all reasonable and feasible mitigation measures • Advise DPIE of trigger exceedance	• If upstream pollutant concentration is higher or within 5% of downstream values then no further action required • Implement appropriate mitigation measures after considering all reasonable and feasible options
Level 4 (Likely water quality impact –mine water dam discharge).	Single value at downstream sampling site exceeds trigger level in Table 39 and discharge from mine water dam has occurred	• Complete required actions under Pollution Incident Response Management Plan • Check upstream and downstream water qualities to confirm any impact to water quality from operations • Remediate any environmental harm • Advise DPIE of trigger exceedance	• Complete detailed incident review to identify cause of water quality exceedance • Review systems and update procedures as required to prevent recurrence • Implement any other appropriate mitigation measures after considering all reasonable and feasible options

Table 38 TARP – Post-mining water pollution from rehabilitated areas of the site

Level	Trigger	Action	Response
Level 1 (Normal)	All surface water quality samples below trigger levels in Table 39.	• No action	• Continue to monitor water quality in accordance with monitoring plan
Level 2 (Early warning)	Single value at downstream sampling site exceeds trigger level in Table 39.	• Verify sample analysis to confirm result • Check upstream water quality to assess potential for impact from operations • Advise DPIE of trigger exceedance	• If upstream pollutant concentration is higher or within 5% of downstream value, then no further action required • Otherwise, assess whether rehabilitated areas could potentially have affected water quality and take remedial action, if appropriate
Level 3A (Potential water quality impact – no discharge)	Two or more sequential samples at a downstream sampling site exceed trigger level in Table 39, but no discharge from rehabilitated sites	• Check upstream water quality to assess potential for impact from operations • Report on likely causes of exceedance and all reasonable and feasible mitigation measures • Advise DPIE of trigger exceedance	• If upstream pollutant concentration is higher or within 5% of downstream values then consider need for review of trigger levels • Implement appropriate mitigation measures to repair rehabilitation or pollution source after considering all reasonable and feasible options
Level 3B (Potential water quality impact – single event)	Two or more sequential samples at a downstream sampling site exceed trigger level in Table 39, discharge from rehabilitated sites has occurred	• Check upstream water quality to assess potential for impact from operations • Report on likely causes of exceedance and all reasonable and feasible mitigation measures • Advise DPIE of trigger exceedance	• If upstream pollutant concentration is higher or within 5% of downstream values then no further action required • Implement appropriate mitigation measures to repair rehabilitation or pollution source after considering all reasonable and feasible options
Level 4 (Potential water quality impact – multiple events).	Samples at a downstream sampling site from multiple events exceed trigger level in Table 39, discharge from rehabilitated sites has occurred	• Complete required actions under Pollution Incident Response Management Plan • Check upstream and downstream water qualities to confirm any impact to water quality from other operational or rehabilitation areas • Remediate any environmental harm • Advise DPIE of trigger exceedance	• Install ESC measures (if they are not already present) until pollution source from rehabilitation is controlled • Complete detailed incident review to identify cause of water quality exceedance • Review systems and update procedures as required to prevent recurrence • Implement any other appropriate mitigation measures after considering all reasonable and feasible options • Undertake rehabilitation improvement program

Table 39 TARP – Sediment Dams

Level	Trigger	Action	Response
Level 1 (Normal)	No site runoff	• Continue ongoing inspection and maintenance of sediment dams in accordance with monitoring plan	• No response required • De-silt sediment dam(s) if required
Level 2 (Early warning)	Current or forecast heavy rainfall (>25mm in 24 hour period).	• Ensure transfer pumping network is operational • Undertake inspection to check sediment accumulation	• Post-event review to confirm event was well managed • Check post-event sediment dam levels in sediment dams and de-silt if required
Level 3 (Sediment dam discharge)	Discharge from sediment dam within EPL limits	• Collect sample of sediment dam outflow • Confirm discharge complies with EPL water quality limits	• Post-event review to confirm rainfall exceeded design standard • Review system configuration to ensure operating as designed • Check post-event sediment levels in sediment dams and de-silt if required
Level 4 (Exceedance of water quality target)	Discharge from sediment dam exceeds EPL limits	• Complete required actions under Pollution Incident Response Management Plan • Check if event rainfall exceeds design standard • Notify DPIE if rainfall below design standard • Collect water quality samples of spills at dam overflow point and in receiving watercourse	• Check post-event sediment levels in sediment dams and de-silt if required • Initiate investigation into reasons for system failure, including assessment of environmental harm • Remediate any environmental harm • Take actions recommended by investigation to prevent recurrence

Table 40 TARP – Watercourse Diversions

Level	Trigger	Action	Response
Level 1 (Post-event inspection – no damage)	Recorded site rainfall >25mm in 24 hour period.	• Inspect diverted watercourse to check for evidence of instability such as: o bank slumping; o excessive rilling; o debris accumulation; o active areas of erosion; o excessive sediment accumulation	• Collect site photographs of diverted watercourse for comparison to future conditions.
Level 2 (Minor damage)	Post-event inspection identifies minor damage.	• Arrange maintenance if required to correct identified issues. • Implement erosion control measures to prevent recurrence.	• Undertake post-maintenance inspection approximately 1 month after works to confirm maintenance activities effective.
Level 3 (Major damage or evidence of geomorphic instability)	Post-event inspection identifies major damage.	• Undertake detailed assessment to investigate likely cause of major damage. • Obtain design advice on best actions for remediation and potential design changes to prevent recurrence. • Implement recommended works.	• Undertake post-maintenance inspection approximately 1 month after works to confirm remediation works effective

Table 41 TARP – Aquatic and Riparian Vegetation

Level	Trigger	Action	Response
Level 1 (Normal)	Taxonomic richness, SIGNAL Score, EPT Score, AND invertebrate communities at sites downstream of the mine are all similar to sites upstream of the mine	• Continue monitoring in accordance with monitoring plan	• No response needed
Level 2 (Early warning)	Some of the above ecological indices are within ranges that are similar to sites upstream of the mine	• Review existing water quality (Dissolved Oxygen, Electrical Conductivity, pH, turbidity) and flow data to see if there is a reason for loss of diversity or sensitive taxa. • Inspect sediment control devices for proper function, inspect drainage lines for signs of erosion. • Repair as needed. • Continue monitoring in accordance with plan.	• Visual inspection of sediment devices to ensure proper function. • Assess follow-up monitoring data for improved condition.
Level 3 (Exceedance of trigger level)	Taxonomic richness, SIGNAL Score, EPT Score, or invertebrate communities at sites downstream of the mine are significantly less than (or outside the rang e of one standard deviation of) those sites upstream of the mine.	• Review water quality data, flow data, and other site-specific information to see if there is a non-mining related explanation for the decline (e.g. drought, seasonal patterns). • If not, examine sediment control structures and other infrastructure that may contribute to poorer macroinvertebrate communities.	• Visual inspection of sediment devices to ensure proper function. • Assess follow-up monitoring data for improved condition.

Table 42 Receiving Water Quality Trigger Values

Parameter	Unit	ANZG Trigger Value				Recorded Baseline Data (80%ile)	Preliminary Trigger Value		Comment
		Irrigation	Livestock drinking	Eco-system[d]	Recreational	Namoi River[i]	Driggle Draggle Ck / Stratford Ck [k]	Namoi River	
pH	pH	-	-	6.5-8.5	5.0-9.0	8-8.6	-	6.5-8.6	Lower bound based on ANZG guideline for ecosystem protection, upper bound based on baseline data.
EC	µS/cm	1,000[a]	-	125-2,200	-	668	-	670	Baseline data adopted. Rounded up to nearest ten.
DO (% sat)		-	-	85-110	-	no samples	-	85-110	Lack of baseline data, adopted lowest ANZG guideline.
TDS	mg/L	-	2,000[a]	-	1000	377	-	400	Baseline data adopted. Rounded up to nearest hundred.
Turbidity	NTU	-	-	6-50	6	66	-	6-50	Lowest ANZG guideline adopted.
TSS	mg/L	-	-		-	62	-	70	Baseline data adopted. Rounded up to nearest ten.
Calcium (Ca)	mg/L	-	1,000	-	-	43	-	50	Baseline data adopted. Rounded up to nearest ten.
Sodium (Na)	mg/L	115[c]	-	-	300	53	-	60	Baseline data adopted. Rounded up to nearest ten.
Magnesium (Mg)	mg/L	-	2,000[b]	-	-	26	-	30	Baseline data adopted. Rounded up to nearest ten.
Sulphate (SO_4)	mg/L	-	1,000	-	400	49	-	50	Baseline data adopted. Rounded up to nearest ten.
Chloride (Cl)	mg/L	175[c]	-	-	400	61	-	70	Baseline data adopted. Rounded up to nearest ten.
Arsenic (As)	mg/L	0.1[f]	0.5	0.013[a.e]	0.05	0.002	-	0.013	Lowest ANZG guideline adopted.
Barium (Ba)	mg/L	-	-	-	1	0.06	-	1	Lowest ANZG guideline adopted.
Cadmium (Cd)	mg/L	0.01[f]	0.01	0.0002[e]	0.005	0.0001[j]	-	0.0002	Lowest ANZG guideline adopted.
Chromium (Cr)	mg/L	0.1[f]	1	0.001[e]	0.05	0.002	-	0.002	Baseline data adopted.
Copper (Cu)	mg/L	0.2[f]	0.4[a]	0.0014[e]	1	0.005	-	0.005	Baseline data adopted.
Iron (Fe)	mg/L	0.2[f]	-	-	0.3	1.9	-	1.9	Baseline data adopted. Rounded up to nearest tenth.
Lead (Pb)	mg/L	2[f]	0.1	0.0034[e]	0.05	0.001[j]	-	0.0034	Lowest ANZG guideline adopted.
Manganese (Mn)	mg/L	0.2	-	1.9[e]	0.1	0.1	-	0.1	Lowest ANZG guideline adopted.
Nickel (Ni)	mg/L	0.2[f]	1	0.011[e]	0.1	0.004	-	0.011	Lowest ANZG guideline adopted.
Zinc (Zn)	mg/L	2[f]	20	0.008[e]	5	0.015	-	0.02	Baseline data adopted. Rounded up to nearest 93undredth.
Mercury (Hg)	mg/L	0.002[f]	0.002	0.0006[e]	0.001	0.0001[j]	-	0.0006	Lack of baseline data, adopted lowest ANZG guideline.
Ammonia	mg/L	-	-	0.9	0.1	0.03	-	0.03	Baseline data adopted.
Total phosphorus (Total P)	mg/L	0.05[f]	-	0.025	-	0.15	-	0.2	Baseline data adopted. Rounded up to nearest tenth.
Total nitrogen (Total N)	mg/L	5	-	0.35	-	0.9	-	1	Baseline data adopted.
Nitrate as N	mg/L	-	400	0.7	10	0.2	-	0.7	Lowest ANZG guideline adopted.
Nitrite as N	mg/L	-	30	-	1	0.01	-	1	Lowest ANZG guideline adopted.

- No trigger value recommended
[a] Lowest recommended value
[b] Cattle (insufficient information on other livestock)
[c] Sensitive crops
[d] Upland River (>150 m altitude)
[e] 95% of species protected
[f] Long term trigger value
[i] Sampled downstream near Maules Creek
[j] Many samples under detection limit
[k] Local values to be derived from ongoing data collection

7.3 CONSIDERATION OF POTENTIAL SURFACE WATER IMPACTS

7.3.1 Operational Water Use

Surface water contingencies that will be considered in the event of insufficient water for site operations include:

- Modify operations to minimise dust suppression requirements;
- Bypass coal to reduce CHPP demand; and
- Use of dirty water throughout site operations.

Surface water contingencies that will be considered in the event of excess water on site include:

- Increase in pit storage of void water;
- Use of evaporators and sprays to increase evaporation;
- Increased dust suppression;
- Increased site storage capacity for void and dirty water;
- Increase offsite irrigation area and agricultural supply; and
- Increased controlled discharge volumes, managed under licence conditions.

7.3.2 Surface Water Quality Contingency

The procedure for responding to an exceedance of a water quality trigger is provided in the Receiving Water Quality TARP (Table 35).

7.3.3 Compensatory Water Supply and Compensatory Agreements

In accordance with Condition B41, Schedule 2 of SSD-7480, VCPL will provide a compensatory water supply to any landowner of privately-owned land whose rightful water supply is adversely and directly impacted (other than an impact that is minor or negligible) as a result of mining operations at the VCM, in consultation with DPIE Water, and to the satisfaction of the Planning Secretary.

Groundwater quality and groundwater levels were monitored as part of the EIS process in 2012 (Section 3.8) which will be updated prior to the commencement of mining operations associated with the Vickery Extension Project at the VCM so that it can be used as baseline information. Following a complaint from a private landowner who claims that their groundwater supply has been impacted by Vickery Extension Project at the VCM, VCPL will commence an investigation process to determine whether the loss of water supply is due to mining impacts or not. A rigorous review will be undertaken, including statistical comparison where appropriate. If the investigation concludes drawdown greater than 2 m has occurred which is attributable to the Vickery Extension Project at the VCM, VCPL will provide an alternative long-term supply of water that is equivalent, in quality and volume, to the loss attributable to the mining operation.

Any complaints relating to surface water supply (external and on-site) will be managed by ensuring external surface water take from the Namoi River (as required) is in accordance with the appropriate WALs (Section 2.5.1) and ensuring appropriate dam licensing arrangements are in place (Section 4.8).

The compensatory water supply measures will provide an alternative long-term supply of water that is equivalent, in quality and volume, to the loss attributable to the development. Equivalent water supply will be provided (at least on an interim basis) as soon as practicable after the loss is identified (following the rigorous review), unless otherwise agreed with the landowner. If VCPL and the landowner cannot agree on whether the water loss is attributable to the mining operations at the VCM 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.

If VCPL is unable to provide an alternative long-term supply of water, then WHC will provide alternative compensation (e.g. financial compensation) to the satisfaction of the Planning Secretary.

Provision of a compensatory water supply (in accordance with Conditions B41 to B44) is not applicable if VCPL has a compensatory water agreement with the owners of the affected land and VCPL has advised the Planning Secretary in writing of the terms of this agreement.

8 MONITORING

8.1 SURFACE WATER MONITORING PROGRAM

8.1.1 Overview

Monitoring of upstream, onsite and downstream water quality and quantity will assist in demonstrating that the site water management system is effective in meeting its objective of no adverse impact on receiving water quality and will allow for early detection of any impacts and appropriate corrective action.

Surface water monitoring for the Vickery Extension Project will be undertaken to:

- augment existing baseline datasets for the receiving environment;
- understand and improve the operation of the site water management system; and
- demonstrate compliance with licence conditions.

Surface water monitoring will include discharge monitoring, receiving water monitoring, and on-site water quality monitoring. The surface water monitoring locations are shown in Figure 5.

8.1.2 Discharge Water Monitoring

Offsite discharge from sediment dams may occur through controlled discharge when water quality complies with EPL criteria, or through wet weather (uncontrolled) discharge when design criteria for the sediment control system are exceeded (see Section 4.4.2).

Surface water monitoring will be undertaken at all sediment dam discharge locations during a controlled discharge or wet weather discharge from sediment dams. Discharge monitoring locations and parameters are shown in Table 43. Receiving environmental monitoring locations and parameters are shown in Table 44 The volume and frequency of water discharged from dirty water dams will be recorded and reported in the Annual Review.

Table 43 Discharge Monitoring Locations, Frequency and Parameters

Location	Frequency	Parameters
SD-A SD-B SD-E SD-F (BVV)	As soon as practicable and not more than 12 hours after discharge	Table 45 Residual flocculants if used

8.1.3 Seepage/leachate monitoring

Seepage and leachate monitoring is undertaken as part of the groundwater monitoring program documented in Appendix A. The operation has 58 groundwater monitoring location around the project

which are used to monitor changes in water level and water quality which will identify any seepage/leachate from the mine.

8.1.4 Routine Water Monitoring

A summary of the surface water quality and quantity monitoring program is provided in Table 44. Surface water sampling locations are shown in Figure 5.

Table 44 Surface Water Monitoring Summary

Monitoring location		Parameters	Frequency
On site		Rainfall	Continuous
Namoi River	NR-US Site 1 NR-DS	Table 45	Monthly if flowing, within 12 hours of a discharge
Driggle Draggle Creek	DDS-US Site 14 DDS-DS	Table 45	Monthly if flowing, within 12 hours of a discharge
North-west Drainage Line	VUS	Table 45	Monthly if flowing
Stratford Creek	SC-US Site 12 SC-DS	Table 45	Monthly if flowing, within 12 hours of a discharge
MWD2		Table 45	Quarterly
All dams		Water level	Weekly
Sediment dam overflows		See Section 8.1.2	

Table 45 Discharge and Receiving Environment Water Quality Parameters

Parameter	Units
pH (in situ and lab)	-
Turbidity (in situ and lab)	NTU
EC (in situ and lab)	µs/cm
Oil and Grease	mg/L
Total Dissolved Solids	mg/L
Iron (Fe) – Filtered and total	mg/L
Sulphate as SO_4^- - Turbidimetric	mg/L
Bicarbonate Alkalinity as $CaCO_3$	mg/L
Carbonate Alkalinity as $CaCO_3$	mg/L
Hydroxide Alkalinity as $CaCO_3$	mg/L
Total Alkalinity as $CaCO_3$	mg/L
Chloride	mg/L
Calcium	mg/L
Magnesium	mg/L
Sodium	mg/L
Potassium	mg/L
Aluminium (filtered)	mg/L
Antimony (filtered)	mg/L
Arsenic (filtered)	mg/L
Barium (filtered)	mg/L
Boron (filtered)	mg/L
Bromine (filtered)	mg/L
Cadmium (filtered)	mg/L
Copper (filtered)	mg/L
Iron (filtered)	mg/L
Lead (filtered)	mg/L
Lithium (filtered)	mg/L
Manganese (filtered)	mg/L
Mercury (filtered)	mg/L
Molybdenum (filtered)	mg/L
Nickel (filtered)	mg/L
Rubidium (filtered)	mg/L
Selenium (filtered)	mg/L
Silver (filtered)	mg/L
Strontium (filtered)	mg/L
Zinc (filtered)	mg/L
Ammonia as N	mg/L
Nitrite as N	mg/L
Nitrate as N	mg/L
Nitrite + Nitrate as N	mg/L
Total Phosphorus as P	mg/L

8.1.5 Water Sampling Methods

Trained or experienced personnel undertake environmental monitoring using industry accepted monitoring techniques with equipment calibrated to relevant Australian Standards. Analysis of all samples is completed by NATA approved laboratories.

8.1.6 Water Usage Monitoring

VCPL will maintain a network of inline flow meters, mine water dam storage level boards and water cart fill points to record the void water transfer within the water management system onsite. Each month the Environmental Officer records the flow meters and storage levels of void water dams to determine water usage onsite. These locations are subject to change in response to mining operations and are provided as a guide only. The pit dewatering pipelines are key water inputs and dust suppression are the key output from the water management system.

8.1.7 impacts on water supply for other water users

VCPL will prevent impact other water users by ensuring

- All take from license extraction sources complies with the water access licenses and water works approval.
- Groundwater drawdown and passive/indirect take is in accordance with the impacts assessed and documented in the EIS and approved by the Department.
- Undertake periodic reviews (as documented elsewhere in the WMP) and updates to the site water balance model and groundwater model to validate that the operation is compliant with its project approvals.

VCPL will monitor potential impacts at other water users including

- quarterly groundwater level and quantity monitoring if access is granted by the other water user. The location of these sites is documented in the GWMP (Appendix A)
- Development of site-specific trigger levels using baseline data collected over at least a 2-year period
- VCPL will increase the number of sites monitored if requested by other water users and access is granted.

8.2 AQUATIC AND RIPARIAN VEGETATION MONITORING

Aquatic and riparian vegetation health will be monitored against the guidelines and standards set out by the Australian River Assessment System: AusRivAS Protocols Development and Testing Report (Final Report) (Water ECOscience Pty Ltd 2002).

The Australian River Assessment System (AusRivAS, Turak et al. 2004) is a nationally standardised approach to biological assessment of stream and riparian environments. It involves a bioassessment using aquatic macroinvertebrates and a complementary physical/chemical assessment to assess the overall ecological health of streams and riparian habitats.

The AusRivAS bioassessment is underpinned by predictive modelling that predicts the aquatic macroinvertebrate fauna assemblage and abundance expected to occur at non-stressed sites. The deviation between the number of taxa expected to occur and the number of taxa that were actually observed (observed:expected ratio, or O/E) is a measure of the ecological health of a stream and riparian environment. The degree to which the number, or type, of taxa collected at a test site deviates from predicted values provides insight on how the water quality or habitat conditions are limiting the biological potential of the site. The O/E ratio ranges from 0 to > 1 and represents a continuum of ecological condition. For ease of interpretation, the continuum can be broken into condition bands that delineate an ecological condition that is impoverished, well below reference, below reference, reference, and richer than reference.

The fundamental assumption behind AusRivAS is that the physical and chemical factors measured at any site are directly related to the number and/or type of macroinvertebrates observed. For this reason, the AusRivAS assessment includes a physical, geomorphological and chemical assessment of the physical condition of the stream environment. Site parameters typically measured include a mixture of the following: geographical position, riparian vegetation, channel morphology, water chemistry, habitat composition, habitat characteristics, organic substratum, inorganic substratum and hydrology. The AusRivAS physical and chemical assessment uses software that compares site values against predicted values for reference sites. When examined alongside the results of the bioassessment, these results provide an indication of the causes of biological degradation of a stream and riparian environment.

A TARP for stream health and riparian vegetation has been developed (refer to Table 38 for details).

8.3 ADEQUACY OF FLOOD PROTECTION WORKS

Flood levees to protect mining areas will be designed by a suitably qualified person. In accordance with the performance measure (Section 4.8), a probable maximum flood event (by Namoi River inundation) will used to determine the adequacy of the design of such flood protection works.

Flood protection levees may also be installed and maintained to protect the infrastructure area and south-western corner of the development affected by local flooding up to at least the 1% AEP event from Stratford Creek and South Creek.

No flood protection levees shall be built in the first 3 years as no areas are located within the flood extents of the relevant watercourses.

Every 3 years, the adequacy of flood protection works will be reviewed by the operation, to ensure they comply with the relevant performance measures listed in table 8 of the PA. Future flood protection works required by the operation will be documented in the WMP prior to construction.

8.4 EFFECTIVENESS OF EROSION AND SEDIMENT CONTROL MEASURES

The effectiveness of the ESC measure that are constructed and operated at the Project is monitored and evaluated to show compliance with the relevant performance measures listed in **Table 23** and the performance criteria in this plan, in the following ways:

- Maintain a “ESC and MAW catchment plan” for all ESC measures once construction is complete, as per the Whitehaven Coal Erosion and Sediment Control and Mine Affected Water Standard (WHC ESC and MAW Standard), an example is shown in Figure 17, which details:
  - Catchment Risk Assessment;
  - Catchment details;
  - The adopted dam, drain and spillway design details;
  - Confirmation of the ESC measures compliance to design;
  - Supplementary ESC measures implemented in the catchment;
  - Inspection and monitoring plan;
  - TARP levels;
  - Failure Scenario;
- Undertaken event based and routine water quality monitoring to validate that water quality complies with EPL conditions and the WMP performance objectives;
- Sediment dams will be inspected for capacity, structural integrity and effectiveness. All sediment dams will have TARP markers which indicate:
  - The top of the sediment storage zone;
  - The dams MOV (settling zone);
  - The dams spillway level;
- ESC measure will be monitored on an event based and routine schedule to ensure the effectiveness of the EAS measures, including
  - **Event:** Following a 38.4 mm or greater rainfall event over a 5-day period, all SDs and associated ESC measures will be inspected, including:
    - Assess whether any discharges have occurred from sediment dams and undertake the necessary monitoring and reporting requirements;
    - all diversion channels, contour drains and dirty water drains are to be inspected for damage (e.g. scour); and
    - Other erosion prevention measures, such as at stockpiles or temporary ESC used during construction, are also to be inspected and repaired or reinstated where required.
  - **Periodic:** Sediment dams and associated water conveyance structures will be inspected annually by a suitably qualified persons to assess structural integrity and effectiveness and action necessary maintenance and repairs.
  - Figure 11 shows an example ESC monitoring and inspection form used at the operation, as per the WHC ESC and MAW Standard.
- Post rainfall, the SDs will be dewatered to restore their design capacity (the settling zone) within five days either through pumping back to the mines WMS or through a controlled discharge in accordance with the mines EPL;

- Annual water balance modelling to assess the spill risk of dams, to ensure they comply with the PA and WMP.
- Prior to the sediment storage level TARP being exceeded, clean-out will be undertaken as soon as practicable so as to reinstate the sediment storage level.

Other erosion and sediment control structures, and temporary ESC measured used during the construction phase will be inspected at regular intervals (monthly) and also following significant rainfall events (i.e. more than 20 mm in a 24 hour period) to provide for early detection of potential issues and monitor the effectiveness of the ESC measures installed.

8.5 EFFECTIVENESS OF GROUNDWATER MANAGEMENT SYSTEM

The effectiveness of the groundwater management system for VCM will be collectively determined through the groundwater monitoring, review of performance and implementation of adaptive management strategies and/or contingency measures and will be evaluated collectively as described in the GWMP (Appendix A)

8.6 EVALUATION OF THE PERFORMANCE OF THE WMP

The performance of this WMP will be evaluated via the regular reporting requirements (Section 9.2) through the implementation of monitoring programs and reviews of adequacy and effectiveness in described in Sections 8.1 to 8.5 above.

Where water impact triggers and response plans are enacted (Section 7), protocols for water management performance measure exceedances are implemented (Section 9.4.1) and/or remedial actions including adaptive management strategies (Section 9.4.2) and contingency measures are adopted (if necessary) (Section 7.3), the performance of this WMP will also be reported accordingly and be subject to reviews, revisions and audits as outlined in Section 9.5.

Tracking of key water metrics for the operation, to track the performance of the Project against the WMP is undertaking through the monthly water report, an example report is shown in Figure 19. The monthly water report is prepared by Group Water and distributed to key site personal to track performance and identify corrective actions.

ESC and MAW catchment plan			
Operation:	Vickery	**Catchment ID:**	SD-A

Catchment Risk Assessment		
Criteria	**Detail**	**Risk**
Duration of disturbance:	>3 years	High
Primary disturbance:	Spoil	High
Catchment area:	> 4 ha	High
Is there coal in the catchment:	No	Low
Is it a license discharge point:	No	Low
Catchment slope:	5% - 10%	Medium
Can the clean water catchment be diverted:	No	High
Catchment risk rating:		**High**
Catchment type:		**Dirty Water**

Catchment Details				Dam Design	
Land use	**Area (ha)**	**Cv**	**ML**	**Design Standard:**	**5-day 90% (38.4 mm)**
Spoil	114.2	0.5	21.9	Catchment (ha):	427.4
Rehabilitated	258.8	0.2	19.9	Design Storage (ML):	57.0
Hardstand/ Coal	30.7	0.9	10.6	Sediment Zone (ML)	76.8
Disturbed cleared	23.7	0.5	4.5	Total Volume (ML):	85.4
Natural	0.0	0.2	0.0	**MOV(ML):**	**173.3**
Total	**427.4**	**0.3**	**57.0**	**Additional Storage:**	**96.6**

Spillway Details		Dam Compliance Check	
Spillway Standard	2% AEP	Dam Capacity (ML)	230.3
Spillway Armour	Earth	Compliance Check	Yes
L:W Ratio	>3:1	5 day Pump Size (l/s)	131.8

Drain Details			Supplementary controls
Design Standard:	1% AEP		**List additional controls**
Drain ID	**Catchment (ha)**	**Drain Lining**	pumped to MWD
D1_SDA	157	Earth	
D2_SDA	93	Earth	

Inspection and monitoring Plan		
Type:	**Routine**	**Non Routine**
Frequency	Annually	> 38.4 mm of rain
Inspection and monitoring requirements as per the Site Dam Operatin Manual		

TARP Levels - Water and Silt					
TARP	**(ML)**	**(mAHD)**	**Trigger**	**Action**	**Response**
Green	<76.8	273.53	Do Nothing	Do nothing	Do nothing
Yellow	76.8	273.53	Sediment zone	Desilt the dam	Record volume
Orange	173.4	275.83	Settlement Zone	De-water the dam	Record volume
Red	230.3	277	Spillway	WQ sampling	As per EPL

Failure Scenario		
Event	**Action**	**Risk**
Where does the dam spill too:	Offsite	High
If the dam wall fails, where does water g	Offsite	High
If SD3 fails, where does it go:	Offsite	High
Receiving environment:	Offsite	High
Impacted 3rd party:	Environment	High

Figure 17 Example ESC Catchment Plan

ESC and MAW catchment plan - Monitoring					
Operation:	Vickery	**Catchment ID:**	SD-A		
Catchment Risk Assessment					
Criteria			**Detail**	**Risk**	
Duration of disturbance			>3 years	High	
Primary disturbance			Spoil	High	
Catchment area			> 4 ha	High	
Is there coal in the catchment			No	Low	
Is it a license discharge point			Yes	High	
Catchment slope			5% - 10%	Medium	
Can the clean water catchment be diverted			Yes	Medium	
Catchment risk rating				**High**	
Catchment type				**Dirty Water**	
Inspection Summary					
Dam TARP level at time of inspection:	Low	**Actions:**			
Inspection Type and date			Routine		
Dam Water Quality:		**EC**		**pH**	
Inspected by (Name and role):					
Dam Inspection Details					
Location	**Details of maintenance requirments**			**Risk**	**Timeline**
Dam Wall/Dam Condition				High	
				Medium	
				Low	
Dam Spillway				Low	
				Low	
				Low	
Pump/monitoring equipment				High	
				Low	
				Low	
Drain inspection details					
Location	**Details of maintenance requirments**			**Risk**	**Timeline**
Drain Embankment				Low	
				Low	
				Low	
Drain channel				Low	
				Low	
				Low	
Rock Check dams				Medium	
				Low	
				Low	
Inspection and monitoring Plan					
Type:	**Routine**			**Non Routine**	
Frequency	Annually			> 38.4 mm of rain	
TARP Levels - Water and Silt					
TARP	**(ML)**	**(mAHD)**	**Trigger**	**Action**	**Response**
Green	(ML)	(mAHD)	Do Nothing	Do nothing	Do nothing
Yellow	50	263	Sediment zone	Desilt the dam	Record volume
Orange	100	265	MOV	De-water the dam	Record volume
Red	150	266	Spillway	WQ sampling	As per EPL

Figure 18: ESC and MAW inspection and monitoring template

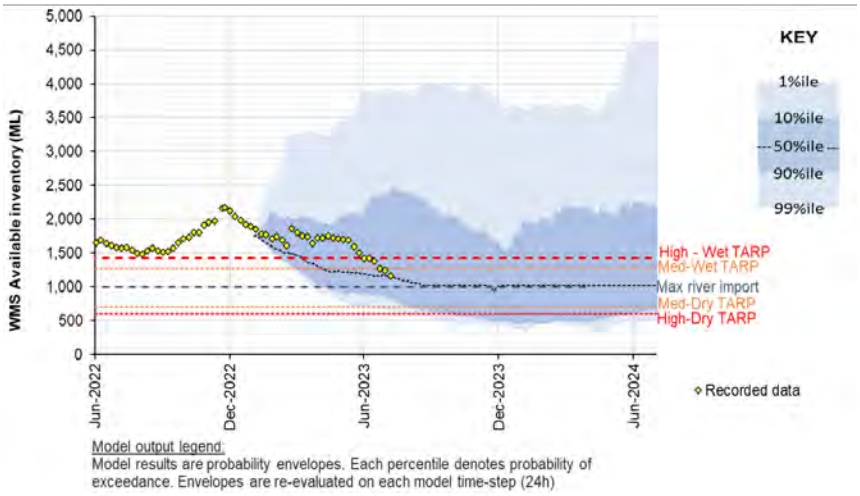
Example Site

Date:	**Completed by:**	Person Name

Site Risk Indicators

Risk	Indicator	Risk Rating
Keepit Dam	97% Inventory - 50% WALS	Low
BOM 1 Month Forecast	<35% chance of above median rain	H - Dry
BOM 3 Month Forecast	<25% chance of above median rain	H - Dry
Site Tarp Level	Site Inventory <1200 and >700 ML	Low

Site Forecast



Site Inventory - Mine Water Dams

Storage	Inventory (ML)	% MOV	TARP	Action
MAW Dams	230	82%	Low	Pump as required
Sediment Dams	65	20%	Low	NA
MWD2	1500	60%	Low	Pump to MWD
Total Site Inventory	**1795.0**	**72%**	Low	**No pumping to site**
Available Inventory	**1678.0**	**56%**	Low	**No pumping to site**

Sediment Dam TARP Levels

TARP	Number of Dams	Dams	Action
LOW	2	Dam 1, Dam 2	None
Medium			Dewater
HIGH			Priority Dewater

Site Extractions

Location	YTD (ML)	Extraction Limit (ML)	WAL (ML)	Available (ML)
Namoi River	0	600	600	600
Bore 1	0	430	430	430
Total	**0**	**1030**	**-**	**1030**

Site Actions

No External water extraction
Priority water use Mine Water

Figure 19 Example Monthly Water Report

9 REPORTING AND REVIEW

In accordance with Conditions E4(h) and Condition E4(j), Schedule 2 of SSD-7480, WHC has developed a protocol for managing and reporting the following:

- incidents;
- complaints;
- results of monitoring program;
- non-compliances with statutory requirements; and
- exceedances of any impact assessment criterion and/or performance measure.

In accordance with Condition E14(a), Schedule 2 of SSD-7480, WHC will provide regular reporting on the environmental performance of the VCM on the WHC website.

9.1 INCIDENT AND NON-COMPLIANCE REPORTING

An incident is defined 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. A non-compliance is defined as an occurrence, set of circumstances or development that is a breach of a condition of Development Consent (SSD-7480).

In the event of an incident which has caused or threatens to cause material harm to the environment, the VCM Pollution Incident Response Management Plan (PIRMP)[6] for the premises described in EPL 21283 will be implemented and relevant PIRMP notification and reporting requirements adhered to. In accordance with Condition R2.1 of EPL 21283, notifications will be made by telephoning the Environment Line service on 131 555.

Within seven (7) days of the date on which the incident occurred[7], VCM will provide the DPIE, EPA and other relevant agencies[8] with a detailed (written) incident report which will:

- Describe the date, time, duration and nature of the exceedance/incident;
- Identify the type and concentration of every pollutant discharged;
- Identify the cause (or likely cause) of the exceedance/incident;
- Name and contact details of witnesses to the event;
- Describe what action has been taken to date; and
- Describe the proposed measures to address the exceedance/incident.

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6 The PIRMP is subject to periodic testing, and based on a search of the POEO public register was last tested on 19 March 2020.

7 As prescribed in Condition R2.2. of EPL 21283.

8 Refer also to Condition 5 in CL 316 & ML 1718 (Table 7).

In the event that review of water monitoring data or trigger of performance measures indicates an incident has occurred, the incident will be reported in accordance with Condition E7, Schedule 2 of SSD-7480 and relevant conditions of EPL 21283 and relevant mining leases.

For any other incidents related to water management, VCM will notify DPIE and any other relevant agencies as soon as practicable after becoming aware of the incident.

Any further reports requested by DPIE (or the EPA) will be provided in a timely manner as agreed with the Department (or as otherwise required by Condition R3 of EPL 21283 for the EPA).

If VCM becomes aware of a breach of a condition of a WAL, the NSW Minister administering the *Water Management Act, 2000* will be notified as soon as practicable and written notice provided within seven (7) days of becoming aware of the breach by emailing: nrar.enquiries@nrar.nsw.gov.au

As required by Condition E5, Schedule 2 of SSD-7480, the suitability of this WMP (and other existing strategies, plans and programs) would be reviewed within three (3) months of submission of an incident report under Condition E7 of SSD-7480. The reviews would be undertaken to ensure this WMP is updated on a regular basis and to incorporate potential measures to improve the environmental performance of the VCM.

As noted in Condition E8, Schedule 2 of SSD-7480, a non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.

9.1.1 Notification of other water users

Other water users will be notified under the following conditions:

- Routine monitoring identifies an exceedance with trigger levels – notified within 7 days
- Updated groundwater or surface water modelling predicts potential future impacts to the water user, requiring a make good agreement – within 28 days
- In the event of an incident which has caused or threatens to cause material harm to the environment and may impact another water user, they will be notified as soon as practical, and no greater than 24 hours.

9.2 REGULAR REPORTING

VCM will provide regular reporting on the environmental performance on the Whitehaven Coal website, via Annual Reviews, Annual Compliance Reports, EPL Annual Returns, WAL logbooks (as required), and in accordance with the reporting arrangements in any plans or programs approved under the conditions of Development Consent (SSD-7480) and Approval Decision (EPBC 2016/7649).

Prior to the end of March each year, an annual review report will be submitted to DPIE reviewing the environmental performance of the development in the previous calendar year in accordance with Condition E9, Schedule 2 of Development Consent (SSD-7480). An annual compliance report will also be prepared in accordance with Approval Decision (EPBC 2016/7649).

9.2.1 Annual Review (SSD-7480) and Annual Compliance Report (EPBC 2016/7649) – End of March Each Year

In accordance with Condition E9, Schedule 2 of SSD-7480, WHC will review the environmental performance for the previous calendar year and report results within the Annual Review to the satisfaction of the NSW Planning Secretary.

In relation to water management, the Annual Review will (where relevant):

- Report on water extracted from the site each year (direct and indirect), including water taken under each WAL;
- describe the development that was carried out in the past calendar year, and the development that is proposed to be carried out over the current calendar year;
- include a comprehensive review of the monitoring results and complaints records of the development over the past year, which includes a comparison of these results against the:
    - relevant statutory requirements, limits or performance measures/criteria;
    - monitoring results of previous years; and
    - relevant predictions in the EIS;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the development;
- identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the development.

The Annual Review will be made publicly available on the WHC website in accordance with Condition E14 (a)(x), Schedule 2 of SSD-7480.

As required by Condition E5, Schedule 2 of SSD-7480, the suitability of this WMP (and other existing strategies, plans and programs) would be reviewed within three (3) months of submission of an Annual Review. The reviews would be undertaken to ensure this WMP is updated on a regular basis and to incorporate potential measures to improve the environmental performance of the VCM.

As outlined in Section 2.2, an Annual Compliance Report will be prepared addressing compliance with Approval Decision (EPBC 2016/7649) in line with the Annual Review reporting timeframe (end of March each year) including implementation of any management plans and strategies required under the conditions of SSD-7480 that are referred to Approval Decision (EPBC 2016/7649), and covering

compliance for the previous calendar year or otherwise in accordance with another annual date that has been agreed to in writing by the Commonwealth Minister.

9.2.2 Annual Environmental Management Reports / Rehabilitation Reports (CL 316; ML1464; ML 1471 & ML 1718) – Annually

In accordance with Condition 4 of CL 316, Environmental Management Reports must be lodged annually and must:

- report against compliance with the MOP (Section 2.3.1);
- report on progress in respect of rehabilitation completion criteria (Table 1);
- report on the extent of compliance with regulatory requirements (Section 9.4); and
- have regard to any relevant guidelines (Section 2.6).

Similarly, and in accordance with Condition 3 (1)-(4) of ML 1464 and ML 1471, an Annual Environmental Management Report must be lodged and must contain a review and forecast of performance for the preceding and ensuing twelve months in terms of:

- the accepted MOP (Section 2.3.1);
- development consent requirements and conditions (Table 1);
- Environmental Protection Authority and Department of Land and Water Conservation (now WaterNSW) licences and approvals (Sections 2.4 and 2.5);
- any other statutory environmental requirements (Section 2);
- details of any variation to environmental approvals applicable to the lease area; and
- where relevant, progress towards final rehabilitation objectives (Table 1).

Similarly, and in accordance with Condition 3(f) of ML 1718, a Rehabilitation Report must be lodged and must:

- provide a detailed review of the progress of rehabilitation against the performance measures and criteria established in the approved MOP;
- be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); and
- be prepared in accordance with any relevant annual reporting guidelines.

9.2.3 Annual Return (EPL 21283) – Within 60 Days from 16 May Each Year

In accordance with Condition R1.5 of EPL 21283, the Annual Return for the reporting period will be submitted to the EPA no later than 60 days after the end of each reporting period (i.e. 16 May for EPL 21283).

Condition R1.1 of EPL 21283 requires that the Annual Return include Statement(s) of Compliance as well as a Monitoring and Complaints Summary.

9.2.4 End of Water Year Logbooks (WALs) – End of June Each Year

Licensed water extraction and usage for VCM will be recorded and reported in accordance with the requirements of any WALs held (Section 2.5.1) including logbook reporting and/or metering and datalogging via DAS and iWAS were assigned to such Water Supply Works.

9.3 COMPLAINTS

VCM will maintain a Community Complaints Line and online contact via the WHC website (www.whitehavencoal.com.au) for the sole purpose of receiving community complaints, or enquiries. The Community Complaints Line number will be available on the website. The community Complaints Line will be staffed 24 hours a day, seven days a week during construction and operations. WHC will respond to callers on the next business day.

Detailed records of each complaint are kept in WHC's record management systems.

In accordance with Condition E14(a) (ix), Schedule 2 of SSD-7480, a complaints register will be made available on the WHC website during the construction and operational stages of the Vickery Extension Project at the VCM. The complaints register will include:

- the date and time of the complaint;
- the method by which engagement was made;
- any personal details provided or, if no such details were provided, a note to that effect;
- the nature of the complaint; and
- any actions (if any required) taken by WHC in relation to the complaint.

Investigations into complaints will generally commence within 24 hours of receipt, or as soon as practicable. The cause of the complaint will be analysed and actions to attempt to address the complaint taken as soon as reasonably possible. In complex cases where resolution will take more than 48 hours, WHC will commit to updating the community member.

As outlined in Section 9.2.2, Condition R1.1 of EPL 21283 requires that the Annual Return include a Complaints Summary.

9.4 REPORTING FOR NON-COMPLIANCE WITH STATUTORY REQUIREMENTS AND/OR EXCEEDANCE OF CONDITIONS AND/OR PERFORMANCE MEASURES

The results from the monitoring program will be entered into the WHC environmental database which assists in identifying any exceedances or anomalous results by comparing the monitoring results against a trigger value and highlighting when it has been exceeded. If an exceedance is verified as having occurred the protocol in Section 9.4.1 will be followed.

A protocol for managing and reporting non-compliances with statutory requirements has been developed as a component of the Vickery Extension Project Environmental Management System at the VCM and is described below.

Compliance with all approvals, plans and procedures is the responsibility of all personnel (staff and contractors) in association with the Vickery Extension Project at the VCM.

As described in Section 9.1, WHC will report incidents in accordance with Condition E7, Schedule 2 of SSD-7480 and dependent on the incident and potential environmental harm, in accordance with the protocol for industry notification of pollution incidents under Part 5.7 of the POEO Act.

WHC will notify the Planning Secretary and any other relevant agencies immediately after the authorised person becomes aware of the incident which causes or threatens to cause material harm to the environment. Within seven days (or other specified or approved time period) of the date of confirmation of the incident, WHC will provide the Planning Secretary and any other relevant agencies with a report on the incident and any subsequent information that may be requested.

A review of compliance with all conditions in the Development Consent (SSD-7480) and all other applicable approvals and licences will be included within each Annual Review (Section 9.2.1). Similarly, a review of compliance with all conditions of Approval Decision (EPBC 2016/7649) will be included in an Annual Compliance Report.

Additionally, in accordance with Condition E10, Schedule 2 of SSD-7480, an IEA (Section 9.5.1) would be conducted by a suitably qualified, experienced and independent auditor whose appointment has been endorsed by the Planning Secretary to assess compliance with the requirements SSD-7480, and any other relevant approval and tenement conditions. Further, should the Commonwealth Minister request in writing, an independent audit of compliance with Approval Decision (EPBC 2016/7649) will be conducted and published in accordance with Conditions 31 to 33.

In the event that a lease[9] or licence condition (e.g. EPL 21283, WALs, etc.) is breached or exceeded, VCM will advise the relevant regulatory agencies that breach or exceedance has occurred at the earliest opportunity. If the breach results in impacts to other water users, they will be notified at the earliest opportunity.

9.4.1 Protocol for Water Management Performance Measure Exceedance

In the event a water management performance measure for the VCM has not been met or a performance indicator is considered to have been exceeded, WHC will implement the following protocol:

[9] Refer to Conditions 4(a) and 4(b) of ML 1718 (Table 7).

- The Environmental Superintendent will report the event as an incident (Section 9.1).
- VCM will apply adaptive management strategies (Section 9.4.2).
- VCM will identify the appropriate course of action with respect to the identified impact(s), in consultation with technical specialists, the Planning Secretary and any other relevant agencies, as necessary. For example, contingency measures, such as, but not limited to, those described in Section 7.4.
- VCM will, in the event there is a dispute over the proposed remedial course of action or if the actions conflict with current approvals, submit the appropriate course of action to the Planning Secretary for approval.
- VCM will implement the appropriate course of action to the satisfaction of the Planning Secretary.

9.4.2 Adaptive Management Strategies

In accordance with Condition E3, Schedule 2 of SSD-7480, VCM will assess and manage risks to comply with the criteria and/or performance measures outlined in Schedule 2 of SSD-7480.

Where any exceedance of the criteria and/or performance measures occurs, at the earliest opportunity VCM will:

- take all reasonable and feasible steps to ensure that the exceedance ceases and does not reoccur;
- consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Planning Secretary describing those options and any preferred remediation measures or other courses of action; and
- implement remediation measures as directed by the Planning Secretary, to the satisfaction of the Secretary.

Adaptive management strategies may also include on-site water management reconfiguration to better maintain separation of clean and mine waters, adjust water storage capacities, implement additional flood protection measures or to accommodate climatic conditions and avoid discharge of mine waters. For example, when excess water is available on site, it may be possible to increase the application of water for dust suppression. These alternative management approaches could be used to reduce the risks to operations associated with climatic variability.

9.5 WMP REVIEWS, REVISIONS AND AUDITS

This WMP will be reviewed, and if necessary revised, in accordance with the requirements of Conditions E5 and E6, Schedule 2 of Development Consent (SSD-7480).

As noted in Table 26, relevant performance indicators will be developed and included in a subsequent revision of this WMP for the water management performance measures relating to:

- in-pit emplacement, encapsulation, treatment and/or capping to prevent the migration of pollutants beyond the pit shell; and
- creek diversions.

In accordance with Condition 27 of Approval Decision (EPBC 2016/7649), the WMP will be published on the WHC website and made available to the public in line with the timeframes prescribed following the WMP approval by: (i) the NSW Planning Secretary; and (ii) the Commonwealth Minister administering the EPBC Act.

9.5.1 Site Water Balance Revision

The Site water balance model (and salt balance) will be reviewed and updated:

- Annual water balance and salt as part of the Annual Review in accordance with PA Condition B53 g);
- Periodic review and revision of the SWB components of this WMP (Sections 5 and 6) will be undertaken over the life of the Project to record and document the status of inflows, storage and consumption and to optimise water management performance.

The reviews undertaken annually for the SWB and the salt balance (Section 6) will be incorporated into measures to improve the environmental performance. Monitoring will be undertaken over the life of the Project to provide data for refinement of the SWB, as well as provide opportunities to validate the calibration parameters used in the model to ensure that the latest model adequately simulates observed conditions on site by comparing simulated and recorded site water inventories over time.

The reviews would also evaluate actual external make-up water requirements, climatic conditions and long-term predictions (including consideration of Available Water Determinations [AWD] for the Lower Namoi Regulated River Water Source of the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2019* (Section 2.5.1).

9.5.2 Independent Audits

In accordance with Condition E10, Schedule 2 of SSD-7480, an independent environmental audit will be conducted within one year of the date of commencement of the Vickery Extension Project at the VCM, and every three years thereafter, to assess the environmental performance and whether it is complying with the relevant requirements of Development Consent (SSD-7480), water access licences and mining leases, including any assessment, strategy, plan or program required, and would include this WMP.

As required by Condition E5, Schedule 2 of SSD-7480, the suitability of this WMP (and other existing strategies, plans and programs) would be reviewed within three (3) months of submission of an IEA. Should the VCM response to recommendations contained in the IEA relate to this WMP, the recommendations will be implemented, as outlined in a timetable submitted together with the IEA, to the satisfaction of the Planning Secretary in accordance with Condition E11, Schedule 2 of SSD-7480.

Further, if requested by the Commonwealth Minister administering the EPBC Act under Condition 31 of Approval Decision (EPBC 2016/7649), an independent audit of compliance with the conditions of Approval Decision (EPBC 2016/7649) will be conducted and published in accordance with Conditions 32 to 33.

10 REFERENCES

Advisian, 2018	Surface Water Assessment, Vickery Extension Project Environmental Impact Statement Appendix B, prepared for Whitehaven Coal Limited.
ANZECC & ARMCANZ, 2000	Australian and New Zealand Guidelines for Fresh and Marine Water Quality – The Guidelines. National Water Quality Management Strategy. October 2000.
Boughton, 2004	'The Australian Water Balance Model, Environmental Modelling and Software', Vol. 19, pp. 943-956.
Chessman, B. C., Growns, J. E. and Kotlash. A. R., 1997	Objective derivation of macro invertebrate family sensitive grade numbers for the SIGNAL biotic index: application to the Hunter River system, New South Wales. Marine & Freshwater Research, 48(2): 159–172.
DEC, 2004	Use of Effluent by Irrigation. October 2004.
DEC, 2006	Using the ANZECC Guidelines and Water Quality Objectives in NSW.
DECC, 2008a	Managing Urban Stormwater: Soils and Construction Volume 2A – Installation of Services. January 2008.
DECC, 2008b	Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries, Department of Environment and Climate Change, June 2008.
DES, 2020	Science Notes – Land Series L137 Measuring Salinity, Queensland Government.
DFAT, 2016	Water Stewardship – Leading Practice Sustainable Development Program for the Mining Industry, Australian Government.
DNR, 2006	Carroll to Boggabri Floodplain Management Plan, NSW Government.
DPI Fisheries NSW, 2013	Policy and Guidelines for Fish Habitat Conservation and Management.
DPIE, 2020a	NSW Non-urban water metering policy, NSW Government.

DPIE, 2020b	Salinity, NSW Government. Retrieved <https://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/salinity>
Department of Water Affairs and Forestry, 2006	Water and Salt Balances – Best practice guidelines for water resource protection in the South African Mining Industry, Republic of South Africa.
Eco Logical Australia, 2018	Vickery Extension Project - Aquatic Ecology Assessment.
EPA, 2003	Guidance for the Assessment of Environmental Factors No. 54.
EPA, 2007	Sampling methods and survey considerations for subterranean fauna in Western Australia No. 54a.
Fairfull, S. and Witheridge, G., 2003	Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, January 2003.
Geo-Environmental Management, 2018	Geochemistry Assessment of Overburden, Interburden and Coal Rejects.
Hydrosimulations, 2018	Vickery Extension Project Groundwater Assessment, NPM Technical Pty Ltd trading as HydroSimulations, Report: HS2018/05g, Date: August 2018.
IESC, 2018	Advice to decision maker on coal mining project 2018:0099: Vickery Extension Project (EPBC 2016/7649 and SSD-7480) – Expansion.
Landcom, 2004	Managing Urban Stormwater, Soils and Construction Volume 1. March 2004.
Mawhinney, W. 2011	Namoi Water Quality Project 2002-2007.
Nancarrow, 1998	Central & North West regions water quality program: 1997/98 report on general water quality monitoring, Department of Land & Water Conservation, Parramatta, NSW.
NRAR, 2018	Guidelines for controlled activities on waterfront land – Riparian corridors.

Pena-Arancibia, J., Slatter, E., Northey, J. and Cassel, R., 2016	Current water accounts and water quality for the Namoi subregion (Product 1.5 for the Namoi subregion from the Northern Inland Catchments Bioregional Assessment). Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.
Peterson, R. C., 1992	The RCE: a Riparian, Channel and Environmental Inventory for small streams in the agricultural landscape. *Freshwater Biology,* 27(2):295-306.
Resource Strategies Pty Ltd, 2018	Vickery Extension Project – Environmental Impact Statement, September 2018. Prepared on behalf of Vickery Coal Pty Ltd.
Schlumberger Water Services, 2011	Namoi Catchment Water Study Phase 2 Report.
SMEC, 1999	Gunnedah and Carroll Floodplain Management Study.
SMEC, 2003	Carroll to Boggabri Flood Study.
Thoms, M., Norris, R., Harris, J., Williams D. and Cottingham, P., 1999	Environmental Scan of the Namoi River Valley.
Turak, E., Waddell, N., and Johnston, G., 2004	New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual 2004. Department of Environment and Conservation, Sydney, NSW, Australia.
VCPL, 2019a	Vickery Extension Project – Submissions Report, August 2019.
VCPL, 2019b	Vickery Extension Project Amendment Report, September 2019.
Vickery Joint Venture, 1986	Vickery Coal Mine Environmental Impact Statement.
WMA Water, 2020	Vickery Coal Extension Project – Further Peer Review of Flood Assessment.
WRM, 2023	Vickery Rail Spur Existing Conditions Flood Assessment, prepared for Whitehaven Coal Limited (WRM Ref. 0800-12-D1).

ENCLOSURE 1 EVIDENCE OF CONSULTATION, ENDORSEMENT AND APPROVAL

In accordance with Condition A24, Schedule 2 of SSD-7480, details of consultation with each relevant party identified during the preparation of this WMP is provided below. Relevant notification and plan submission requirements as required by Approval Decision (EPBC 2016/7649) are also included.

Consultee	Condition(s)	Consultation Mechanism	Status / Evidence
Development Consent (SSD-7480)			
DPIE	A25(a)	Email Approval for the Progressive Submission of Environmental Management Plans	Planning Secretary Letter (11 December 2020)
	B53(a)	Email Endorsement of Suitably Qualified and Experienced Persons	Planning Secretary Letters (21 & 29 October 2020 & 6 February 2023)
	B53(c)	Provision of the WMP for Approval by Planning Secretary	Subject to Consultation with DPIE Water and EPA
DPIE Water	B53(b)	Provision of this WMP for Consultation	Currently Subject to Consultation
EPA	B53(b)	Provision of this WMP for Consultation	Consultation provided
BCD	B49	Provision of Flood Assessment for Detailed Design of Project Rail Spur, Project Rail Spur Bridges and Any Upgrade to the Haul Road	Subject to Completion of the Flood Assessment
DPI-NSW Fisheries	B50(a)	Provision of the Design of the Pump Station and Screens for the Namoi River Pipeline and Pump Station	Subject to Completion of the Pump Station and Screens Design
GSC	B50(b)	Provision of the Design of the Pipeline in the Braymont Road Reserve for the Namoi River Pipeline and Pump Station	Subject to Completion of the Pipeline Design
Approval Decision (EPBC 2016/7649)			
DCCEEW	3	Notification of DCCEEW in Writing	Subject to Future Modification Application(s) of SSD-7480
	4	Notification of DCCEEW in Writing	Subject to Future Modification of Conditions B39 to B54 and B101 to B106, Schedule 2 of SSD-7480.
	6	Provision of the WMP (Final Version) Approved by the Planning Secretary Electronically	Subject to Approval in accordance with Condition B53(c), Schedule 2 of SSD-7480.
	7	Notification of DCCEEW and Provision of the WMP (Revised Version) Approved by the Planning Secretary Electronically	Subject to Changes Proposed to WMP (Final Version) Approved in accordance with Condition B53(c), Schedule 2 of SSD-7480.
Minister administering the EPBC Act	9 & 10	Submit Performance Criteria and Limits for Groundwater Extraction Impacts on Alluvial Aquifer for Approval to Commence Extraction	Subject to Completion of the Groundwater Supply Borefield Design

Outcomes of Consultation - *Matters Resolved & Matters Unresolved*

Appendix A Groundwater Management Plan

WHC_PLN_VCM_WATER MANAGEMENT PLAN_APPENDIX A_GROUNDWATER_ MANAGEMENT_PLAN

CONTENTS

1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document presents the Groundwater Management Plan (GWMP) for Vickery Coal Mine (VCM), also referred to as the Project. The GWMP outlines the groundwater data collection/ analysis methods, performance measures, trigger thresholds, and Trigger Action Response Plans (TARPs). The scope of the GWMP is for the initial stages of construction and early mining only.

1.2 STRUCTURE OF THE GROUNDWATER MANAGEMENT PLAN

This GWMP forms part of the Water Management Plan (WMP) for VCM. The VCM WMP comprises the following documents:

- An overarching WMP;
- GWMP (this document) (Appendix A);

The following sections of the GWMP describe:

- Section 2 - Statutory obligations under the project approval;
- Section 3 – Summary of groundwater regime;
- Section 4 – Groundwater monitoring network;
- Section 5 – Data collection methodology;
- Section 6 – Data analysis methods;
- Section 7 – Summary of baseline data;
- Section 8 – Trigger Action Response Plan (TARP);
- Section 9 – Groundwater model validation;
- Section 10 – Reporting procedures; and
- Section 11 – References.

2 STATUTORY OBLIGATIONS

The Vickery Extension Project Development Consent (SSD-7480) was granted to Vickery Coal Pty. Ltd. (VCPL) on 12 August 2020 by the NSW Independent Planning Commission as a delegate of the NSW Minister for Planning under Section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act)

Development Consent Section 4.36 of Environmental Planning and Assessment Act 1979 requires the Proponent to prepare and implement a WMP for the Project, which includes a GWMP. The requirements for the GWMP, and where each requirement is addressed in this document, are provided in **Table 2-1**. Approval Decision (EPBC 2016/7649) conditions are provided in **Table 2-2**. Conditions relevant to groundwater (Conditions 8 to 14) are to minimise the impacts of the action on a Water Resource.

Table 2-1 GWMP requirements from SSD-7480

Requirement for Groundwater Management Plan	Section of GWMP Where Addressed
Detailed baseline data of groundwater levels, yield and quality for groundwater resources potentially impacted by the development, including groundwater supply for other water users;	3, 7
A detailed description of the groundwater management system;	3
Groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on:	
• regional and local aquifers (alluvial and hard rock); and	8, Appendix A
• groundwater supply for other water users such as licensed privately-owned groundwater bores;	8, Appendix A
A program to monitor and assess:	
• compliance with the relevant performance measures listed in Table 8 (of the project approval) and the performance criteria in this plan;	8
• inputs and outputs from water storages, including any final void;	9 Final void to be updated in a future version of this GWMP
• geochemical characteristics of groundwater flows to the open cut, to inform the progressive development of the final landform and optimise the final void dimensions, to be described in the rehabilitation strategy;	5
• groundwater inflows, outflows, and storage volumes, to inform the Site Water Balance;	9
• the likelihood of any indirect impacts from the development on nearby alluvial aquifers;	8
• the hydrogeological properties used in the groundwater modelling, including the basement volcanics; and	8, 9
• the effectiveness of the groundwater management system;	8, 9

Requirement for Groundwater Management Plan	Section of GWMP Where Addressed
Reporting procedures for the results of the monitoring program, including notifying other water users of any elevated users;	10, Appendix A
A trigger action response plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate and/ or offset any adverse groundwater impacts of monitoring results with modelled predictions;	Appendix A
A program to periodically validate the groundwater model for the development, including an independent review of the model every 5 years, and at least annual comparison of monitoring results with modelled predictions.	9, 10
A protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition E9; and	10
Include detailed performance and completion criteria for evaluating the performance of the Water Management Plan and triggering remedial action (if necessary).	8, Appendix A

Table 2-2 Water Requirements from Approval Decision (EPBC 2016/7649)

Water Requirements Relevant to the GWMP		Section of GWMP (Where Addressed or Considered)
8.	In addition to the Groundwater Management Plan monitoring requirements specified in condition B53 of the State development consent, the approval holder must:	
	a. Establish and maintain a network of groundwater monitoring bores designed to detect changes in groundwater levels and include bores that are co-located or paired with surface water monitoring sites to allow monitoring and analysis of groundwater-surface water interactions. These monitoring bores must be installed prior to the commencement of mining operations.	4
	b. Monitor groundwater levels in each bore (required under condition 8a) at least once every 3 months, starting within one week of the commencement of mining operations for the life of this approval.	4, 5
	c. Publish on the website all groundwater monitoring data from the bore network, updated at least once every 3 months to include the most recent readings available and maintain the data on the website for the life of this approval. The monitoring data must include hydrographs for the bore network and explain what the data means in relation to the groundwater performance measures specified in the State development consent.	4
9.	The approval holder must submit performance criteria and limits, relevant to groundwater extraction impacts for the alluvial aquifer, for the Minister's approval. The submission of the performance criteria and limits must be accompanied by evidence-based justification of how they were derived from the results of monitoring, consider groundwater-surface water connectivity, and are suitable to demonstrate condition 2 is being achieved.	4, 8, Appendix A Performance criteria for borefield to to be updated in a future version of this GWMP
10.	The approval holder must not commence groundwater extraction from the water supply borefield until the performance criteria and limits have been approved by the Minister in writing.	4 Performance criteria for borefield to to be updated in a future version of this GWMP
11.	If, at any time during the period for which this approval has effect, the approval holder detects an exceedance of any approved limit required under condition 9 of the approval holder must notify the Department of the exceedance within 2 business days of detecting the exceedance.	4

Water Requirements Relevant to the GWMP	Section of GWMP (Where Addressed or Considered)
12. If, at any time during the period for which this approval has effect, the approval holder detects an exceedance of an approved limit required under condition 9, the approval holder must cease groundwater extraction from the water supply borefield within 2 business days.	4 Performance criteria for borefield to to be updated in a future version of this GWMP
13. If the approval holder has been required to cease groundwater extraction pursuant to condition 12, the approval holder must:	
a. provide information including monitoring data that identifies the likely cause of the exceedance of the approved limit;	4, 8, Appendix A
b. consider the effect of the current condition of the water resource on the utility of the water resource for associated users; and	4, 8, Appendix A
c. if the likely cause is identified as a component of the action, propose measures to mitigate and manage any impacts to any associated users, ensuring that the utility of the water resource for associated users is not effected.	4, 8, Appendix A
14. The approval holder must not recommence groundwater extraction until the information required in condition 13 has been approved by the Minister in writing. The approval holder must implement the approved mitigation and management measures.	4 Performance criteria for borefield to to be updated in a future version of this GWMP

This GWMP has been prepared to consider and address the recommendations for surface and groundwater monitoring programs by the Commonwealth Independent Expert Scientific Committee (IESC) on Coal Seam Gas and Large Mining Development (IESC 2018-099: Vickery Extension Project (VEP) EPBC 2016/7649 and SSD-7480 – Expansion). Recommendations from this as relevant to groundwater are shown in **Table 2-3**.

Table 2-3 Recommendations for Surface and Groundwater Monitoring Programs (EPBC 2016/7649 and SSD-7480)

Monitoring Recommendations Relevant to the WMP	Section of WMP (Where Addressed or Considered)
Groundwater (Monitoring)	
2. The IESC has a number of suggested improvements for mitigation and management of potential impacts from the proposed project. These are discussed below.	
a. The proponent proposes a groundwater monitoring program using the existing monitoring network. It is unclear from the documentation provided which bores will be monitored. There is a large number of bores shown in Figure 16 (EIS, Appendix A, p. 87), and it may be unnecessary for the proponent to monitor all the bores shown. Bores which will be monitored, and the parameters to be measured, need to be clearly identified so that it can be determined that the spatial and depth coverage will be suitable. The locations for the two proposed	4

Monitoring Recommendations Relevant to the WMP		Section of WMP (Where Addressed or Considered)
	bores to monitor for leaching from the Western Emplacement should also be clearly identified so it can be determined if these bores will be sufficient.	
b.	If the proposed borefield is installed, then additional monitoring bores (with monitoring at multiple screened depths) will need to be installed to monitor potential impacts in both the Upper Namoi Alluvium and the Maules Creek Formation in the vicinity of the borefield.	4 Bore locations and performance criteria for borefield to to be updated in a future version of this GWMP
c.	Groundwater quality monitoring is proposed; however, the parameters to be analysed are limited to several physio-chemical parameters, major ions and five metals/metalloids (aluminum, arsenic, molybdenum, selenium, and iron). Hydrocarbons and additional metals should be monitored, particularly as the groundwater quality data and the geochemical analysis results (discussed further in the response to Question 2) show that concentrations of some metals could be or are already elevated (compared to ANZG 2018 guideline values for aquatic ecosystem protection). Additional parameters to be monitored should include boron, copper, lead, antimony, tin, zinc, silver, cobalt, nickel, and mercury.	4, 6
d.	Only pH and electrical conductivity (EC) are proposed to be monitored in groundwater twice yearly, with other parameters monitored once annually. Groundwater quality monitoring for all parameters should occur more frequently than annually (at least seasonally for all parameters and potentially continuously for EC and temperature in the water table aquifer) given the high value of the Upper Namoi Alluvial aquifer and the large number of users.	4, 6
e.	The groundwater monitoring plan, when developed, should include appropriate site-specific level and water quality guideline values and triggers. The plan should also include a trigger action response plan (TARP) which clearly outlines the actions and responses that will be taken, in a timely manner, when a trigger value is exceeded.	8, Appendix A
f.	Groundwater ultimately discharges to local surface water systems in the project region. As such, relevant water quality objectives should include the 95% species protection guideline values for slightly to moderately disturbed aquatic ecosystems as outlined in ANZG (2018) and not only for stock and domestic, and irrigation objectives. When developing water quality objectives for groundwater for the project, these aquatic species protection guideline values need to be considered and the most conservative guideline values for each contaminant (either aquatic ecosystem, stock and domestic or irrigation) used.	6, 8
g.	The frequency of monitoring for groundwater levels could be increased from quarterly manual observations through the use of data loggers. This could improve future groundwater models by identifying any variations in recharge assumptions, confining conditions within shallow layers and verifying specific storage values.	4, 5
h.	Monitoring should continue post-mining given that the extent and magnitude of groundwater drawdown will continue to increase post-mining.	5.4

3 SUMMARY OF GROUNDWATER REGIME

3.1 HYDROSTRATIGRAPHIC UNITS

The Project is located in the Gunnedah Basin in the NSW Gunnedah Coalfield, which contains alluvial deposits overlying sedimentary and igneous rocks, including coal measures of Permian and Triassic age.

The two groundwater systems identified in the relevant water sharing plans, within the VCM mining area and surrounds, are:

- Alluvial groundwater system – associated with the unconsolidated alluvial sediments of the Namoi River floodplains (Upper Namoi Zone 4 Water Source).
- Porous rock groundwater system – including coal measures of the Maules Creek Formation (Gunnedah-Oxley Basin MDB Groundwater Source).

Below the Maules Creek Formation are the Goonbri and Leard Formations. The Formations are basal units of the Gunnedah Basin sedimentary sequence and unconformably overlie the Boggabri Volcanics. The Boggabri Volcanics are the basement layer of groundwater model. The Boggabri Volcanic is not a groundwater source and is not monitored.

There are two major fault structures in the region (Boggabri Thrust to the west and Mooki Thrust to the east) and eight minor fault structures across the Project area.

3.2 QUATERNARY ALLUVIUM

Alluvial sediments of the Upper Namoi Alluvium are usually subdivided into two formations, although they are not always distinguishable. The uppermost Narrabri Formation consists predominantly of clays with minor sand and gravel beds. Underlying the Narrabri Formation is the Gunnedah Formation, which consists predominantly of gravel and sand with minor clay beds. The gravel and sand layers are the productive sediments from which groundwater is extracted for irrigation to the west and south of the Project mining area.

The combined thicknesses of the Narrabri Formation and the Gunnedah Formation are typically greater than 100 m along paleochannels associated with ancient courses of the Namoi River and Coxs Creek. Elsewhere, thicknesses are typically within the 40 to 70 m range.

The higher-elevation alluvial tongues along minor drainages have limited groundwater potential with poorer water quality, although the groundwater is still suitable for some stock and domestic use.

Regionally, groundwater gradients in the alluvial aquifers indicate flow from the east in a north-westerly to westerly direction. Groundwater tends to mimic topography with groundwater in the higher elevation areas flowing towards the Namoi River in the valley.

3.3 PERMIAN POROUS ROCK

Underlying the Quaternary Alluvium there are two coal-bearing sequences in the Gunnedah Basin, namely:

- Early Permian Bellata Group (of both the Maules Creek sub-basin and Mullaley sub-basin, which are separated by the Boggabri Ridge); and
- Late Permian Black Jack Group.

The Project coal resource is located within the Maules Creek sub-basin of the Early Permian Bellata Group. The target coal seams within the Maules Creek sub-basin are contained within the Maules Creek Formation. They dip towards the east and the south.

The Maules Creek Formation is composed of interbedded sequences of sandstone, siltstone, and coal. Groundwater is encountered in both the coal seams and in the lower permeability interburden units. The coal seams within the Maules Creek Formation are typically considered the main aquifer units and may be significantly more permeable than the interburden material of interbedded mudstone, siltstone, and sandstone.

Groundwater within these coal measures is considered confined and sub-artesian. The Permian coal seams are classified as a dual-porosity, dual-permeability medium with water stored and transmitted through both the primary matrix porosity and secondary fracture porosity.

3.4 RECHARGE, DISCHARGE, AND RECEPTORS

Recharge to the groundwater systems occurs via rainfall and runoff infiltration, lateral groundwater flow, and some leakage from surface water sources. Groundwater levels are influenced by topography, geology, and surface water levels in local drainages. Groundwater tends to mound beneath hills, with ultimate discharge to adjacent drainages and loss by evapotranspiration at shallow depth. However, given the typical depth to groundwater is overall below the influence of evapotranspiration south and west of the Project mining area, evapotranspiration is unlikely to be a dominant outflow component within the Project mining area and adjacent Upper Namoi Alluvium.

During mining, drawdown created by the Project will lower the potentiometric heads in the vicinity of the Project open cut with consequent inflow of groundwater from the Maules Creek Formation. Rainfall recharge to the waste rock emplacement would cause some mounding beneath these structures.

3.5 HYDRAULIC PROPERTIES AND GROUNDWATER YIELD

Transient calibration included calibration of hydraulic properties versus time, groundwater hydrographs at the Project and other mine monitoring bores, and DPI Water observation bores in the Upper Namoi Alluvium (Hydrosimulations, 2018). The transient calibration also included rainfall recharge, historical pumping from the Upper Namoi Alluvium groundwater system, and historical mining (e.g., Rocglen Coal Mine) based on monthly stress periods from 2006 to 2011.

Table 3-1 below summarises the hydraulic properties for all hydrogeological units at the end of transient calibration. The values for horizontal hydraulic conductivity (Kx) are consistent with field estimates and with estimates from other models. Vertical hydraulic conductivity (Kz) is one order of magnitude lower than horizontal hydraulic conductivity.

Table 3-1 Calibrated Horizontal and Vertical Hydraulic Conductivities, Storage Coefficient and Specific Yield

Layer	Lithology	Kx (m/d)	Kz (m/d)	S	Sy
1	Alluvium	0.35-40	0.1-0.01	0.001	0.05
	Regolith/Weathered Permian	0.01	0.001	$1x10^{-4}$	0.01
2	Alluvium	0.35-40	0.05	0.005	0.2
	Overburden/Weathered Permian	0.01	0.001	$1x10^{-4}$	0.01
3	Overburden	$3x10^{-4}$	$3x10^{-5}$	$5x10^{-5}$	0.005
4	Braymont seam to Jeralong seam	$4x10^{-3}$	$4x10^{-5}$	$1x10^{-4}$	0.01
5	Interburden	$4x10^{-4}$	$4x10^{-5}$	$5x10^{-5}$	0.005
6	Merriown seam to Velyama seam	$4x10^{-3}$	$4x10^{-4}$	$1x10^{-4}$	0.01
7	Interburden	$4x10^{-4}$	$4x10^{-5}$	$5x10^{-5}$	0.005
8	Nagero upper seam	$3x10^{-3}$	$3x10^{-4}$	$1x10^{-4}$	0.01
9	Interburden	$3x10^{-4}$	$3x10^{-5}$	$5x10^{-5}$	0.005
10	Tralee seam to Stratford seam	$5x10^{-3}$	$5x10^{-4}$	$1x10^{-4}$	0.01
11	Interburden	$3x10^{-4}$	$3x10^{-5}$	$5x10^{-5}$	0.005
12	Bluevale to Cranleigh seam (Whitehaven seam)	$5x10^{-3}$	$5x10^{-4}$	$1x10^{-4}$	0.01
13	Underburden	$3x10^{-4}$	$3x10^{-5}$	$5x10^{-5}$	0.005
14	Volcanics	$2.5x10^{-3}$	$2.5x10^{-4}$	$1x10^{-4}$	0.01

Kx – horizontal hydraulic conductivity, Kz- vertical hydraulic conductivity, S- storage coefficient, Sy- specific yield

4 GROUNDWATER INFRASTUCTURE

4.1 MONITORING NETWORK

During construction (i.e., prior to groundwater extraction from the borefield and commencement of mining operations), baseline monitoring will continue to be undertaken from the Project groundwater monitoring network, as listed in **Table 4-1** and shown on **Figure 4-1**. The existing network consists of 47 monitoring sites. The existing monitoring network includes;

- 41 monitoring locations on Whitehaven Coal properties;
- 6 monitoring locations on 3rd party land, and

Three of the monitoring locations are operated by WaterNSW.

VCM will incorporate an additional eleven monitoring locations commensurate with commencement of mining, shown on **Figure 4-1**, including:

- Two locations (WR1 and WR2) positioned to monitor the potential for seepage from the spoil dump;
- Two locations screening the alluvium to the south east of the mine, situated outside the 1 metres predicted drawdown impact zone of the mine;
- Five locations screening the alluvium to the north of the mine in proximity of the proposed VEP bore field;
- Two locations screening the Permian aquifer to the north of the mine.

Three bores on adjacent properties will be monitored. The three bores are the closest water users to the operation, as documented in Section 7. Additional locations will be added if access is granted by other third-party water users.

In accordance Condition 8 of EPBC Approval 2016/7649, groundwater monitoring of alluvium in proximity to watercourses are co-located with surface water monitoring, including:

- Namoi River (GW02, VNW395)
- Driggle Draggle Creek (GW-4, GW-9)
- Stratford Creek (GW01, GW03, GW-16)

Data loggers will be installed at these locations within the first 12 months of mining to supplement quarterly monitoring. Sites with data loggers installed are noted in **Table 4-1** (continuous logging) and represented on **Figure 4-1**.

The groundwater monitoring network was designed commensurate of the potential receptors, including baseline aquifer conditions of both the Permian and Alluvial units, existing users and cumulative impacts. Key features of the network design can be summarised as providing;

- Sufficient spatial distribution around the mine of the two groundwater sources at Vickery (Alluvium and Permian), with multiple locations between the mine and third party water users;
- Installation of data loggers at key representative locations (aligned to potential receptors) to provide detailed insight into potential for responsive groundwater fluctuations (noted in **Table 4-1** (continuous logging) and represented on **Figure 4-1**), and

- Monitoring on third party properties to assess potential impact to other water users.

In addition to the site-specific monitoring program in the vicinity of the VEP, regional groundwater monitoring data can provide supplementary information, inclusive of monitoring sites associated with;

- Tarrawonga Coal Mine,
- Rocglen Coal Mine,
- Maules Creek Coal Mines, and
- Water NSW state observation program.

The data from these monitoring locations will be utilised during numerical model calibration and impact assessments. These sites are not actively monitored or sampled by VEP and consequently are not considered part of the baseline monitoring network. The regional network is presented on **Figure 4-2**.

Monitoring at bore locations within mine disturbance areas will be discontinued when mined by the advancing open cut. The results of groundwater monitoring will be evaluated as part of the Annual Review process to identify any potential mining related impacts.

Table 4-1 and **Table 4-2** list the proposed groundwater monitoring program for groundwater levels and groundwater quality respectively.

The majority of these locations were installed by Rio Tinto in the 1990's and therefore there are some limitations in the construction details available. VCM commits to undertake a survey of the bores in the monitoring program to validate their construction and reference locations (i.e. bore depth, screened interval, location, reduced level, casing stick-up) within 12 months of commencement of mining.

These tables specify the parameters and frequencies for the monitoring. From the commencement of mining, groundwater data shall be reported on the VCM website and updated quarterly. The government monitoring locations are also shown on **Figure 4-1**. These sites are not actively monitored by VCM but provide additional data on water levels in the vicinity of the project.

Table 4-1 VCM Groundwater Monitoring Program (Water Levels)

Bore ID	NSW Bore ID	Formation	Easting	Northing	Screen Depth (mbgl)*	Water Level Monitoring Frequency
VKY0035C	GW970195	Permian	232703.46	6593355.57	72-75	Quarterly
VKY0036C	GW970197	Permian	233121.00	6592922.00	111-114	Quarterly
VKY0042C	-	Permian	232542.46	6592597.57	-	Quarterly
VKY3033C	GW970204	Permian (1:Kurrumbede Overburden, 2:Kurrumbede Seam, 3:Kurrumbede-Shannon Harbour Interburden, 4:Shannon Harbour Interburden, 5:Stratford Upper Seam, 6:Stratford-Bluevale Interburden, 7:Bluevale-Cranleigh Interburden, 8:Cranleigh Mid Seam)	232366.46	6594261.57	1: 38 2: 51, 3: 70, 4: 90, 5: 115, 6: 140, 7: 170, 8: 190	Continuous
VKY034C	GW970196	Permian	232518.46	6593820.57	126-132	Quarterly
VKY3053C	GW970199	Permian	233097.46	6593815.57	15-18	Quarterly
VKY041C	GW970198	Permian	233397.47	6591347.57	137 - 155	Quarterly
VKY043C	GW970203	Permian	233249.47	6590531.57	234-243	Quarterly
TR26	GW970201	Permian	232437.47	6590093.57	16-19	Quarterly
TR7	GW970221	Permian	232933.47	6589764.57	12-18	Quarterly
TR18	GW970200	Permian	233429.47	6590027.57	15-18	Quarterly
TR35	GW970202	Permian	233847.47	6590277.57	19-22	Quarterly

Bore ID	NSW Bore ID	Formation	Easting	Northing	Screen Depth (mbgl)*	Water Level Monitoring Frequency
VS058	-	Alluvial	232011.47	6589197.57	-	Continuous
SB02	GW970990	Alluvial	232089.47	6588946.57	14-19.5	Quarterly
GW01	GW971000	Alluvial	232196.00	6588472.00	24-32	Quarterly/Continuous
SB15	GW970999	Alluvial	232200.47	6588448.57	26 - 31	Quarterly
SB06	GW970993	Alluvial	231497.47	6588857.57	7-19.5	Quarterly
SB11	GW970998	Alluvial	231511.47	6588651.57	22-26	Quarterly
SB05	GW970992	Alluvial	230865.47	6588831.57	7-13.5	Quarterly
SB10	GW970997	Alluvial	230849.47	6588645.57	11-17.5	Quarterly
SB01	GW970989	Alluvial	230193.47	6588776.57	12-23.5	Quarterly
SB09	GW970996	Alluvial	230301.47	6588549.57	11-20	Quarterly
SB04	GW970991	Alluvial	229585.47	6588818.57	6-14	Quarterly
SB08	GW970995	Alluvial	229605.47	6588600.57	10-17	Quarterly
SB07	GW970994	Alluvial	229011.47	6588605.57	11-17	Continuous
GW02	GW971001	Alluvial	229015.47	6588583.57	11-16.5	Quarterly/Continuous
GW03	GW971002	Alluvial	230395.47	6587751.57	36-43	Quarterly/Continuous
VS062	GW031854	Permian	229709.47	6589432.57	-	Continuous
VS059	GW971015	Permian (Volcanics)	230799.47	6589598.57	154 - 168	Continuous

Bore ID	NSW Bore ID	Formation	Easting	Northing	Screen Depth (mbgl)*	Water Level Monitoring Frequency
MD01	GW971003	Permian	230700.47	6590609.57	46 - 54	Quarterly
VS056	GW971014	Permian (Volcanics)	230699.47	6590599.57	144 - 150	Continuous
MD02	GW971004	Permian	231497.47	6590798.57	54 - 59	Quarterly
VS054	GW971006	Permian	231499.47	6590798.57	-	Quarterly
VS048	GW971005	Permian (Volcanics)	229399.47	6590998.57	-	Continuous
VNW392	-	Permian	228367.47	6591830.57	-	Quarterly
VNW391	-	Permian	228365.47	6592072.57	-	Quarterly
VNW390	-	Permian	228377.47	6592223.57	-	Quarterly
VNW395	-	Alluvial	227965.47	6592300.57	-	Quarterly/Continuous
VNW393	-	Permian	227096.46	6592855.57	-	Quarterly
GW-8	-	Permian	229644.00	6594028.00	-	Quarterly
VNW394	-	Alluvial	226098.46	6593878.57	-	Quarterly
GW-7	GW032000	Permian	227178.00	6594929.00	-	Quarterly
VNW223	GW968642	Alluvial	228894.13	6595352.80	21.2-27.2	Quarterly
GW-11	GW001602	Alluvial	228487.00	6596769.00	24-39	Quarterly
GW-9		Alluvial	229393.00	6597230.00	-	Quarterly/Continuous

Bore ID	NSW Bore ID	Formation	Easting	Northing	Screen Depth (mbgl)*	Water Level Monitoring Frequency
GW036459	GW036459	Alluvial	232848.00	6587615.00	27-33	Continuous
GW-2	GW031897	Alluvial	229297.00	6598868.00	open hole	Quarterly/Continuous
GW030052	GW030052	Alluvial	226616.00	6599386.00	19.8-21.3, and 25.9-27.4	Continuous
GW030051	GW030051	Alluvial	224986.00	6599590.00	17.7-18.6, and 55.2 - 56.7	Continuous
Proposed Monitoring Bore Locations (existing bores for inclusion)						
GW-14	GW031976	Alluvial	226187.105	6597401.977	-	Quarterly
GW-1	GW031896	Alluvial	228621.278	6599066.541	open hole	Quarterly
GW-6	GW000848	Permian	231358.584	6599289.51	-	Quarterly
GW-10	GW000815	Permian	232888.285	6596677.147	-	Quarterly
GW-12	GW003087	Permian	233300.777	6598290.057	-	Quarterly
GW-13	GW000891	Permian	231253.693	6597098.619	-	Quarterly
GW-4	GW000880	Permian	230468.123	6597633.675	-	Quarterly/Continuous
GW-15	GW021536	Alluvial	234361.125	6588823.821	27.3 - 30	Quarterly
GW-16	GW062364	Alluvial	234813.924	6589375.796	15 - 22	Quarterly/Continuous

Bore ID	NSW Bore ID	Formation	Easting	Northing	Screen Depth (mbgl)*	Water Level Monitoring Frequency
WMP Proposed New Bores						
Proposed WR1 (Installed prior to waste rock emplacement)		Alluvial	227752#	6596295#	-	Continuous (proposed)
Proposed WR2 (Installed prior to waste rock emplacement)		Alluvial	227410#	6597246#	-	Continuous (proposed)
Adjacent landowner						
GW971400	GW971400	Alluvial	225659	6590958	-	Quarterly
GW32114	GW32114	Alluvial	227502	6588105	0 - 12	Quarterly
GW971614	GW971614	Alluvial	227710	6590908	7 - 33	Quarterly

* mbgl – metres below ground level
# approximate, finalised upon installation

Table 4-2 VCM Groundwater Monitoring Program (Water Quality)

Monitoring Location	Parameter	Timing
All Permian monitoring bores (Including adjacent landowners)	Water Quality (pH, EC)	Quarterly
	Water Quality (DO, TDS, Ag, Al, As, Ba, Bo, Ca, Cd, Cl, Co, Cr, Fe, Hg, K, Pb, Mg, Mn, Mo, Na, Ni, Sb, Se, Sn, SO_4, Sr, Zn, anions, cations, ionic balance, alkalinity (all), nitrate, nitrite, ammonia, phosphorous, hydrocarbons – oil and grease)	Quarterly
All Alluvial monitoring bores (including adjacent landowners)	Water Quality (pH, EC)	Quarterly
	Water Quality (DO, TDS, Ag, Al, As, Ba, Bo, Ca, Cd, Cl, Co, Cr, Fe, Hg, K, Pb, Mg, Mn, Mo, Na, Ni, Sb, Se, Sn, SO_4, Sr, Zn, anions, cations, ionic balance, alkalinity (all), nitrate, nitrite, ammonia, phosphorous, hydrocarbons – oil and grease)	Quarterly
Mine pit sumps	Water Quality (pH, EC)	Quarterly
	Water Quality (DO, TDS, Ag, Al, As, Ba, Bo, Ca, Cd, Cl, Co, Cr, Fe, Hg, K, Pb, Mg, Mn, Mo, Na, Ni, Sb, Se, Sn, SO_4, Sr, Zn, anions, cations, ionic balance, alkalinity (all), nitrate, nitrite, ammonia, phosphorous, hydrocarbons – oil and grease)	Quarterly

4.2 WASTE EMPLACEMENT SEEPAGE MONITORING

In the long-term, once the groundwater level within the waste rock emplacement reaches an elevation above the surrounding alluvium, there is potential for some seepage to occur between the emplacement material and the surrounding alluvium embayment. As described in Section 6.1.4 of the hydrogeological investigation of the EIS, the salinity of the Alluvium is naturally relatively high, with a median TDS value of approximately 5,000 mg/L. The expected seepage concentration from the spoil emplacement is approximately 3,000 mg/L TDS, with the groundwater gradient dictating flow under the spoil in the direction of the mine pit. Consequently, any potential seepage would be unlikely to result in degradation of the baseline groundwater conditions. Maximum long-term seepage rates are predicted to range from 0.03 ML/day during initial recovery to 0.02 ML/day over the long term (HydroSimulations, 2018). This rate is in the same order of magnitude as pre-mining (i.e., existing) seepage from the Maules Creek Formation coal measures within the VCM mining area into the alluvium embayment.

In order to monitor for potential seepage from the waster rock in accordance with EPBC 2016/7649, two additional bores will be installed in to the vicinity of the waste rock emplacement where it is placed over an alluvial embayment to the north-west during the first year of operation of the VCM (see **Figure 4-2**). The planned progression of the wase emplacement will not reach the alluvium area until year three of mining, allowing 2 years of data collection prior to the spoil emplacement over the alluvium material.

Appropriate locations for the additional bores and any further groundwater monitoring requirements throughout the life of the VCM, including the final void monitoring, will be determined in consultation with a suitably qualified groundwater specialist, and will be incorporated in a subsequent revision of this GWMP.

4.3 WATER SUPPLY BORES

An existing water supply bore (90CA807002) with two water access licenses (WAL12651 and WAL12653) supply water to the VCM during construction and early mining. This bore was constructed and operating during the previous mining activities by Rio Tinto in the 1990s. Water level impacts from the use of this bore are monitored continuously at the DPE monitoring location GW036459, and quarterly at SB15 and GW01.

Ten additional water supply bores were approved in the VEP EIS, on Whitehaven-owned land along a corridor to the north of the VCM. The bores will be positioned consistent with the requirements outlined in Part 9 of the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020*. Construction and operation of this bore field will not commence until it has been approved by the Minister in writing as per EPBC 2016/7649.

The borefield will extract groundwater with appropriate licenses in the Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source of the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020* under the NSW *Water Management Act, 2000*.

The proposed borefield detailed in the VEP EIS is not proposed to be constructed within the first 3 years of mining. Baseline monitoring in the vicinity of these bores occurs at GW-2 and GW-1 and GW030052.

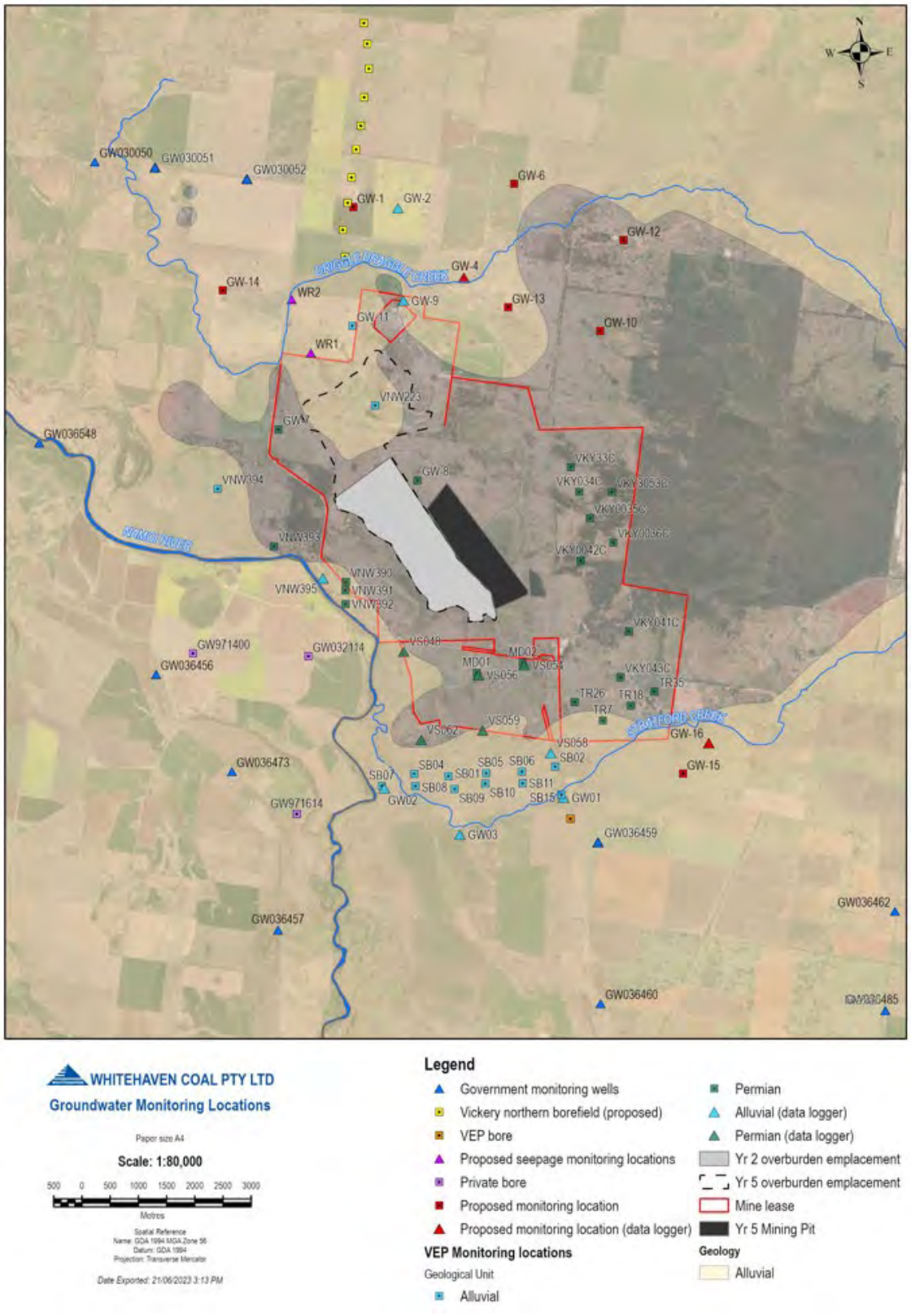


Figure 4-1 VCM Groundwater Monitoring Network

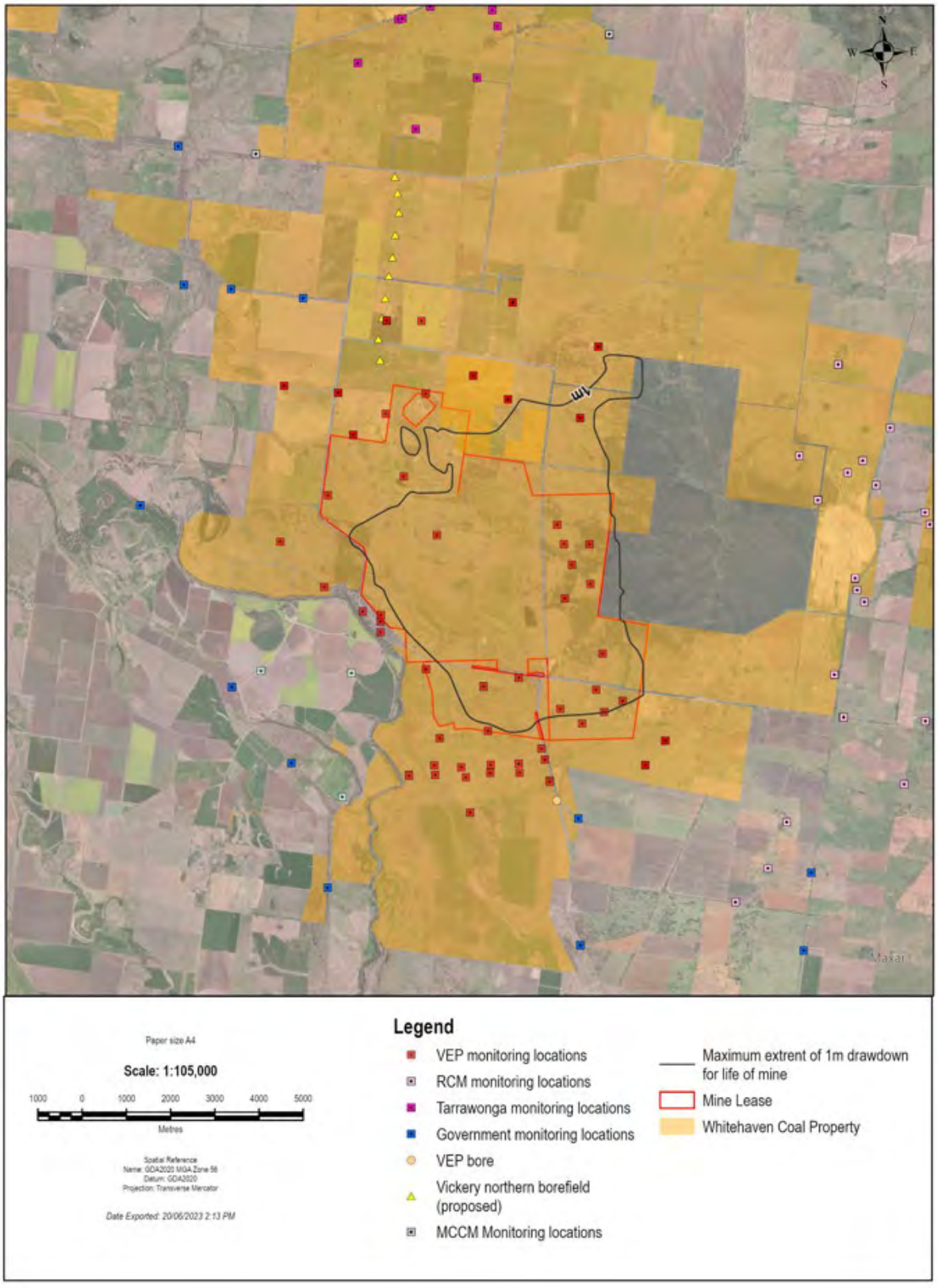


Figure 4-2 Regional Monitoring Network

5 DATA COLLECTION METHODOLOGY

Groundwater data will be collected through a monitoring program for the life of the mine. Groundwater data collection is undertaken at regular intervals by suitably qualified and experienced personnel. Water level measurements and water sample collection, as well as storage and transportation will be conducted in accordance with the Standard Operating Procedures (SOPs) included in Attachment B. The SOPs are drawn from relevant aspects of the following industry standards:

- The Australian/New Zealand Standard Water quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998); and
- The Australian/New Zealand Standard Water quality – Sampling, Part 11: Guidance on sampling of groundwaters (AS/NZS 5667.11:1998).

Groundwater data collected from each monitoring round will be collated into a database. The database will include, as a minimum requirement, the following:

- records of manual standing level water measurements and electronic pressure logger or VWP download;
- records of field water quality parameters and sampling methodologies to achieve representative samples;
- records of flow rates of water supply bores equipped with flowmeters;
- tabulated water quality laboratory results and comparison to trigger values;
- a chain of custody supplied to the laboratory of the water samples collected;
- records of original laboratory analysis certificates; and
- records of any issues encountered.

5.1 GROUNDWATER LEVELS

Natural fluctuations in groundwater levels occur in response to a range of stresses. These stresses can range from short-term events, such as rainfall recharge events, or long-term events, such as multi-year drought. To capture the range of stresses, groundwater levels/ pressures will be measured manually on a quarterly basis in open standpipe bores as well as automatically where Vibrating Wire Piezometers (VWPs) are installed. Further, continuous data loggers will be installed on monitoring locations as shown in Figure 4-1 and Table 4-1.

Figure 4-2 shows the predicted maximum extent of the 1 m drawdown on the on groundwater levels, as per the VEP EIS. The 1 m drawdown shows the project is not predicted to have any direct or indirect impacts on nearby alluvial aquifers. The monitoring program described in this plan, will validate this prediction, along with future updates on the groundwater model.

For third-party bores that are not part of the regular monitoring network, groundwater-related investigations would be triggered by receipt of a complaint. WHC will investigate and respond in accordance with the procedures described in Section 8 and Attachment A.

5.2 GROUNDWATER QUALITY

To ensure water samples collected are representative and repeatable for the screened hydrostratigrahic unit, bore purging (or equivalent suitable methodology) will be conducted prior to collection of a water sample. Field measurement/ observations of parameters, including pH, electrical conductivity, temperature, redox potential, colour, odour, and sediment load will be recorded. Collected samples will be analysed by a National Association of Testing Authorities (NATA) accredited laboratory for:

- physico-chemical parameters - pH, electrical conductivity (EC), dissolved oxygen, total dissolved solids (TDS);
- major cations - calcium, magnesium, sodium, and potassium;
- major anions - chloride and sulfate;
- alkalinity - total, carbonate, bicarbonate and hydroxide;
- nutrients – nitrite, nitrate, ammonia and phosphorous;
- hydrocarbons – oil and grease
- metals (dissolved) - aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, cobalt, iron, lead, manganese, mercury molybdenum, nickel, selenium, silver, strontium, tin, zinc; and
- ionic checks – total anions, total cations, and ionic balance.

pH and EC will be measured in the field on a quarterly basis in the alluvial and waste rock deposits (after waste rock bores installed) and on a biannual basis in the Permian geology. Groundwater samples will be collected from the standpipe bores on the same schedule for laboratory analysis. The SOP in Attachment B describes the process for collecting groundwater samples.

Samples for quality analysis should also be taken from groundwater inflow into the mine pit sumps on a regular basis (at least biannual) to characterise the geochemical characteristics of groundwater flows into the mine pit.

5.3 GEOCHEMICAL CHARACTERISTICS OF GROUNDWATER FLOWS TO THE PIT

Water quality samples from the mine pit storages/sumps will be collected quarterly, to assess the geochemical characteristics of the water collected in the pit as per Table 4-2. The geochemistry of the pit water will be compared to the geochemistry of runoff water to dams and groundwater monitoring bores, to assess the long-term water quality of the pit from the combination of runoff and groundwater inflows. The results of the monitoring will be incorporated into future final void modelling to inform final landform development.

5.4 GROUNDWATER QUANTITY

Groundwater inflows to the open cut over the life of the VCM are predicted to be between 0.24 and 1.42 ML/day during the mine life (ML/day) as per the VEP EIS (Hydrosimulations, 2018). After evaporation, it is considered unlikely that any significant groundwater would accumulate in the open cut (Advisian, 2018).

Sumps excavated in the floor of the active open cut will manage any inflows, as well as rainfall runoff. Water that accumulates in the open cut sumps will be transferred to mine water dams (MWD-1 and MWD-2) for use by the project.

Monitoring of the pit inflows and outflows to inform the site water balance model and groundwater modelling include:

- Water levels in the pit will be surveyed monthly and recorded to assess volume stored;
- Pump volumes from the pit sumps to MWD2 will be recorded and compared to estimated runoff volumes using the site water balance model, to estimate groundwater inflows;
- Estimated groundwater inflows will be compared to model predictions and any difference will be reported in the Annual Review.

Advanced dewatering may also be conducted using appropriately licensed temporary bores ahead of the open cut mining operation. No advance dewatering is planned in the first 3 years of mining.

Proponents of aquifer interference activities are required to provide predictions of the volume of water to be taken from a water source as a result of the activity. These predictions need to occur prior to approval and during operations. Water take is categorised based on the manner in which it occurs as follows:

- **Incidental take:** This is water take that is incidental to the mining activity. It includes water that is encountered within and extracted from mine pit workings. Groundwater seepage into the VCM pits is classified as incidental take.
- **Passive take:** Passive take is water losses from an adjacent groundwater system that occurs indirectly due to an adjacent activity. Passive take is predicted to occur from the Namoi Alluvium due to the VCM activities, even though the alluvial aquifer is not directly intercepted by the mining activity.
- **Consumptive use**: This category is for water that is pumped from licensed extraction bores and consumed by the mining activity as part of the proposed borefield to the adjacent north of activities at VCM. Details on the WALs used for consumptive use, and the predicted take, are located in the Water Management Plan.

The estimated volumes of water take from each category need to be measured and/ or modelled and reported in an annual review. VCM must hold a sufficient share component and water allocation to account for the take of water from the relevant water source when the take occurs. In accordance with Condition B39(a), Schedule 2 of SSD-7480, WHC will ensure it has sufficient groundwater licences for the VCM under the *Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020* and the *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*. If necessary, WHC will adjust the scale of the VCM to match its available licensed water supply or additional units will be acquired or transferred on the water market. It is recognised that water and licencing requirements may change in the future, consequently, VCM commits to making the appropriate changes to licencing prior to the additional (or variation to existing) water take occurring.

The VEP EIS (Section 6.1.5) assessed the passive and incidental take licencing requirements for each year of mining. Table 5-1 shows the water take from each water source for each year of mining. During the first five years of mining, only the Gunnedah Oxley Basin requires licensing. VCM commits to

ensuring sufficient licensing is assigned to miscellaneous works approvals (see Section 2.5.2 of the WMP) prior to the take occurring.

The VEP EIS (Section 8.1) assessed the life of mine impacts on groundwater sources for passive and incidental take. Based on the EIS (Hydrosimulations, 2018) the following life of mine (LOM) take requires licensing:

- Up to 517 megalitres per year (ML/yr) during operations (year 11) and up to 500 ML/year post mining of Gunnedah-Oxley Basin MDB (Other) Management Zone. This take will be accounted against WAL36576, which has an annual allocation of 600 ML.
- Up to 5 ML/yr during operations (year 25) and up to 9 ML/yr post mining of Upper Namoi Zone 4 Water Source. This take will be accounted against 12701, which has an annual allocation of 20 ML.
- Up to 11 ML/yr during operations (year 25) and up to 27 ML/yr post mining of Lower Namoi Regulated Water Source. This take will be accounted against WAL13051, which has an annual allocation of 96 ML.
- Licensing associated with Passive and Indirect take shall be reviewed and summarised for in the mine's Annual Review.

Table 5-1 Annual passive and incidental take for each water source (hydro simulations, 2019)

Year of mining	Incidental Take (ML)	Passive Take (ML)	
	Porous Rock	Zone 4 into porous rock	Namoi River into Zone 4
1	278.1	0.0	0.0
2	239.1	0.0	0.0
3	277.8	0.0	0.0
4	310.3	0.0	0.0
5	304.0	0.0	0.0
6	310.3	0.0	0.4
7	291.6	0.0	0.4
8	271.2	0.0	0.4
9	348.2	0.0	0.4
10	493.1	0.4	0.7

5.5 POST-MINING MONITORING AND FINAL VOIDS

The scope of the WMP is for construction and early mining. The final void modelling will be included in future versions of the WMP, incorporating monitoring data and the updated groundwater model.

VCM is approved to have a final void with a pit lake that is a groundwater sink. As documented in Section 5.3, the VCM groundwater model has assessed the maximum drawdown and water take of the post mining final void, which will be licensed in perpetuity.

The post-mining monitoring program will align with the operational monitoring program, to validate that no impacts beyond those predicted and approved as part of relinquishment occur. Given the extended temporal scale of monitoring required, the network may incur changes over time (i.e., potential bore deterioration, replacement, etc), consequently the WMP will be amended to reflect this over time to accurately portray the post-mining monitoring program.

6 DATA ANALYSIS METHODS

The methods for analysis of groundwater level, quality and quantity information are described in the sections below.

6.1 GROUNDWATER LEVEL

The methods for analysis of groundwater level data are summarised in a flowchart in **Figure 6-1**. The flowchart outlines the pre-processing steps, including quality assurance/ quality control (QA/ QC), that will be undertaken for groundwater level data analysis.

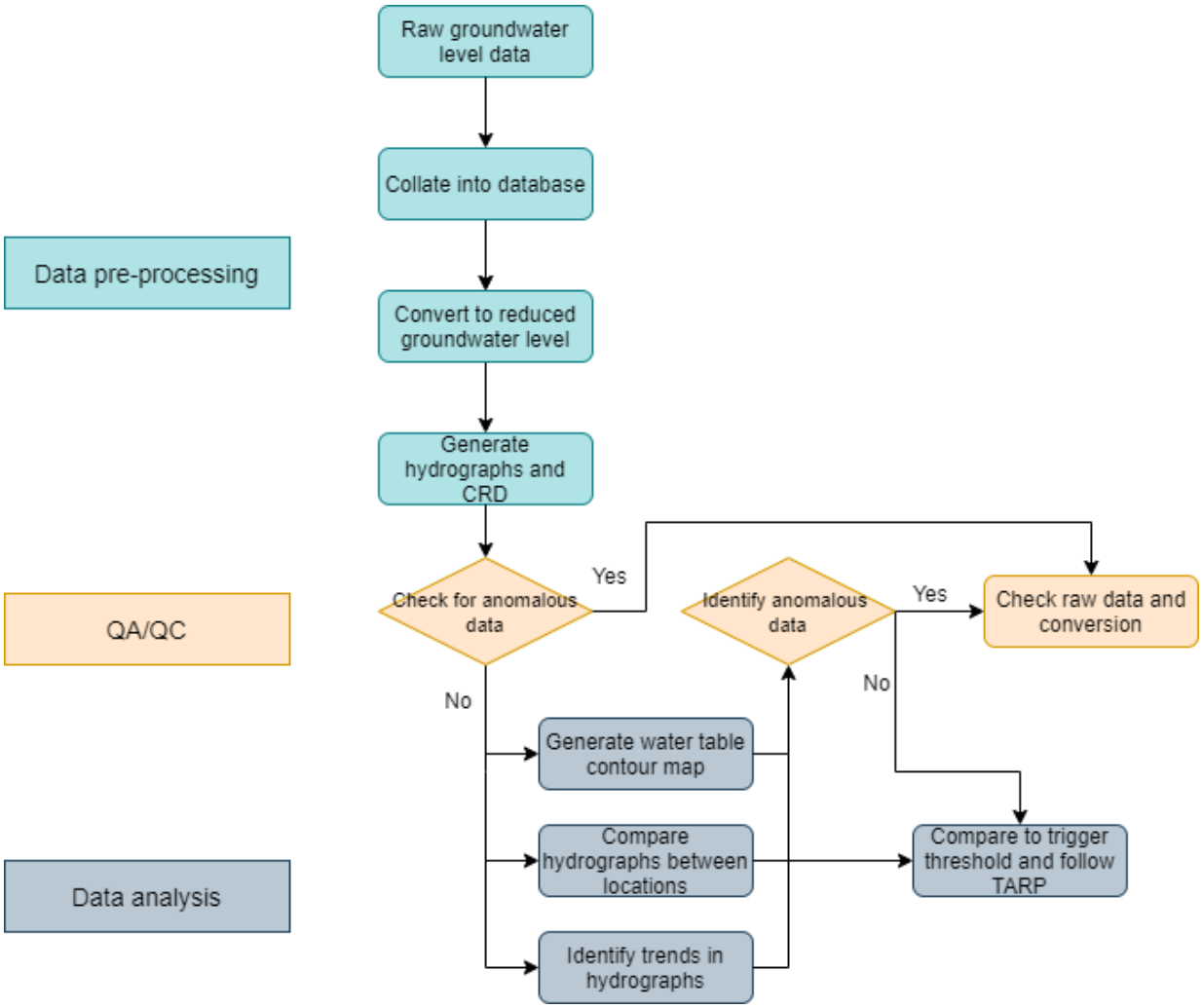


Figure 6-1 Groundwater level data pre-processing and analysis flowchart

As indicated in the flowchart, manual standing water levels, logger data and electronic pressure VWP data will be converted to a reduced water level with respect to Australian height datum (mAHD) where possible.

The reduced water level data will be visualised as time series charts (hydrographs). An example hydrograph is provided in **Figure 6-2**. Hydrographs will be utilised as a tool to identify occurrence of anomalous data points, which can form part of the QA/ QC process. Once anomalous data points are rectified or removed, the hydrographs will be used to understand the behaviour of water in the groundwater regime including:

- recharge/ discharge events as indicated by the relationship to the Cumulative Rainfall Departure from mean (CRD);
- the influence of abstraction from irrigation, stock and domestic bores;
- vertical hydraulic gradients at nested locations monitoring water levels in alluvial and Permian strata; and
- any depressurisation effects from Vickery and adjacent mining complexes.

Hydrographs will be compared between monitoring locations to reveal water level changes that could be a result of VCM activities. Where water level measurements are outside the trigger threshold the TARP process (as outlined in Section 8 and Appendix A) will be initiated.

Horizontal flow directions within key hydrostratigraphic units with sufficient spatial data will be illustrated by piezometric contour maps. These contour maps will be generated from monitoring data by connecting areas of equal groundwater elevation to create a two-dimensional representation of the piezometric surface. Comparison of contour maps with previous time periods will provide information towards changes in groundwater flow directions over time.

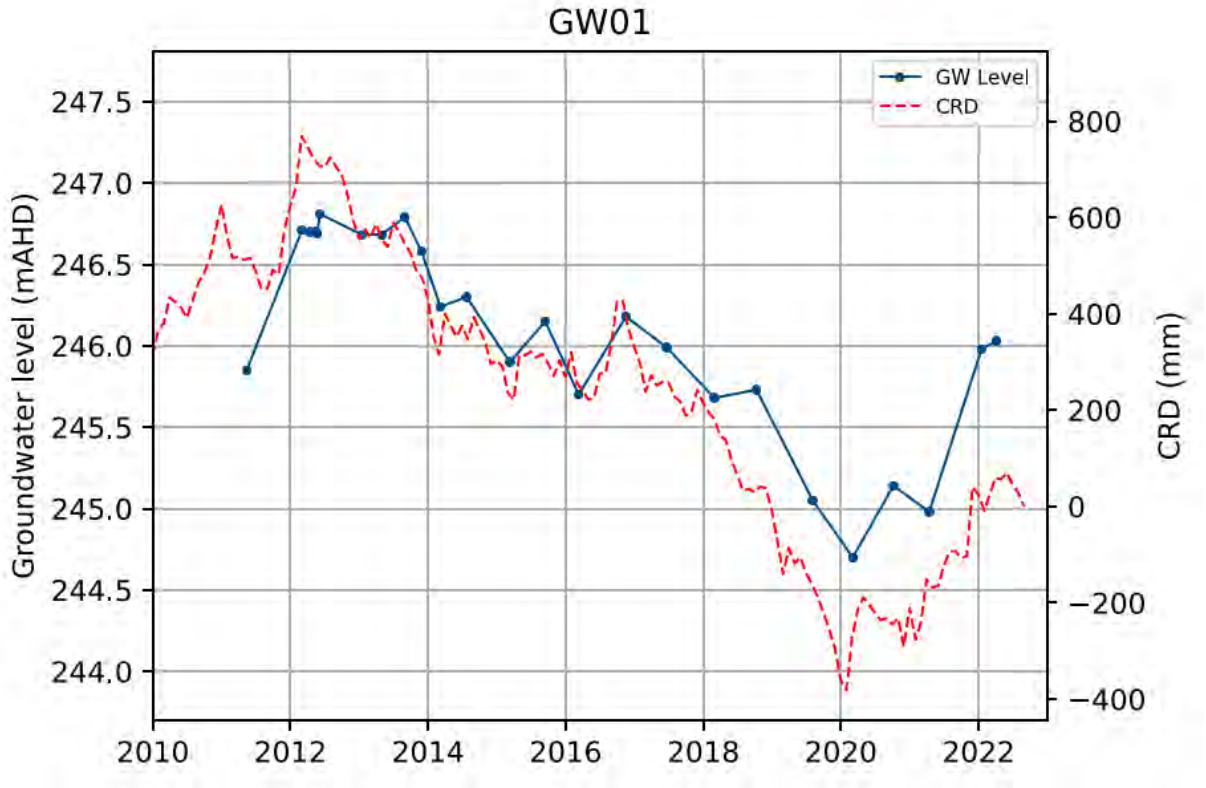


Figure 6-2 Example hydrograph (GW01) for analysis

6.2 GROUNDWATER QUALITY

Water quality analysis will occur on a quarterly basis for the alluvial bores, and a six-monthly basis for the Permian bores. The methodology for analysis of groundwater quality data is summarised in the flowchart in **Figure 6-3**. Similar to the water level flowchart in **Figure 6-1**, this flowchart outlines the pre-processing, including QA/ QC, as well as the steps that will be undertaken for groundwater quality data analysis.

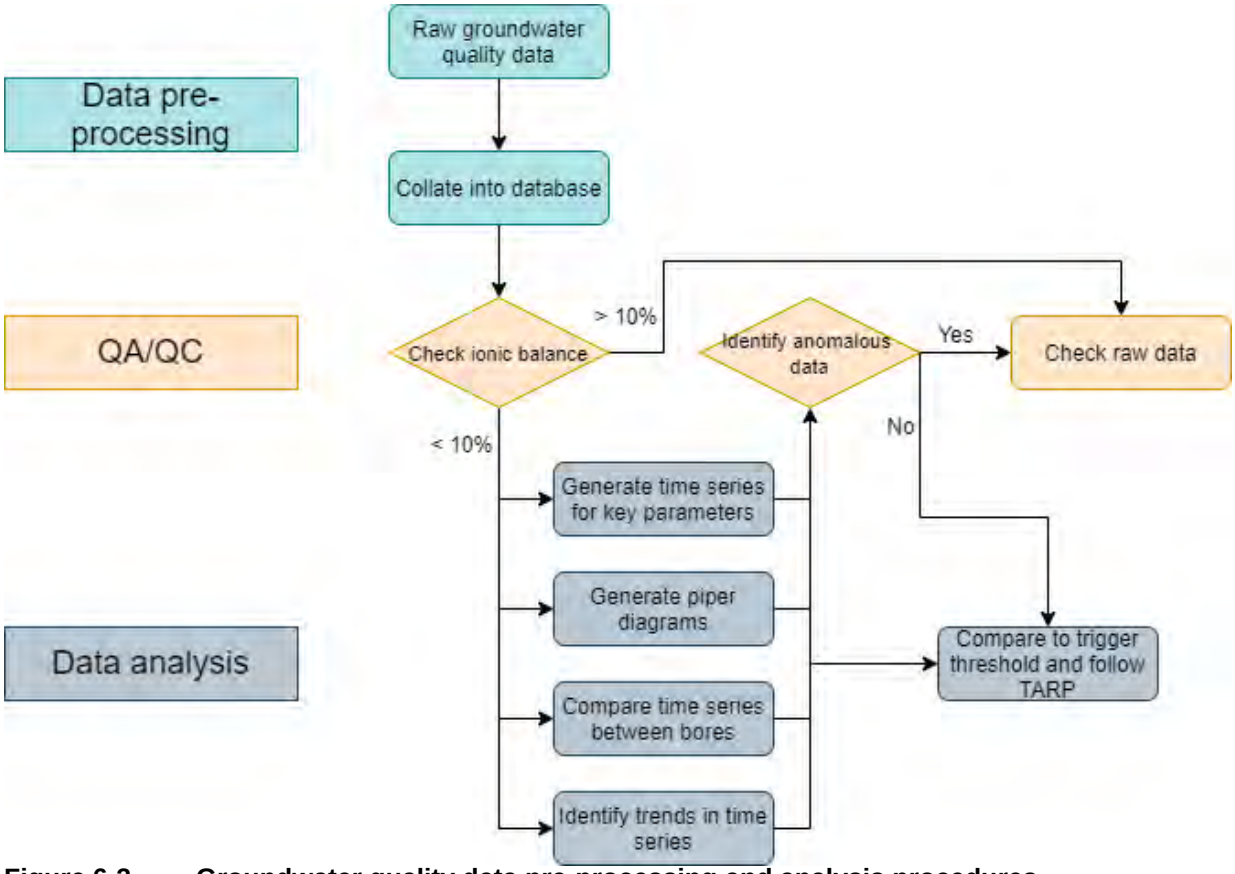


Figure 6-3 Groundwater quality data pre-processing and analysis procedures

Groundwater quality data will be pre-processed for analysis in a similar approach as the method adopted for groundwater levels. Field and laboratory results will be collated and tabulated in a single database that will identify:

- key parameters including pH, electrical conductivity, and sulfate concentrations that are either greater than the 95th percentile of baseline data or less than the 5th percentile of baseline data (latter pH only);
- ionic balance results which exceed the ± 10% margin (charge of cations should balance that of anions in natural groundwaters); and
- dissolved metal concentrations that exceed ANZECC guidelines for stock and/ or irrigation water and slightly to moderately disturbed aquatic ecosystems. Dissolved metals are used for guideline comparison because of their higher bioavailability when compared to total metals.

Groundwater samples with ionic balance beyond the ± 10% range will be identified and the cause determined. If necessary, an additional sample will be collected for laboratory analysis within seven days of the original sample. Samples that are determined not to be representative will be flagged and removed in subsequent data analysis. Records of sampling method, sample transportation and laboratory consistency of reporting limits are also factors that could influence the occurrence of nonrepresentative values.

Time series plots will be generated for water quality indicators that have trigger values based on the 5th and 95th percentile of baseline data for pH, and 95th percentile for electrical conductivity and sulfate and compared with short- and long-term water level trends. **Figure 6-4** shows an example of the stacked charts that will be generated for each monitoring bore, and the trigger thresholds based on baseline data.

In addition to the above, all field and laboratory analytes will be tabulated and compared against ANZECC guideline values for stock and/ or irrigation water as well as slightly to moderately disturbed aquatic ecosystems. Exceedances against these ANZECC guidelines will form water quality trigger thresholds for dissolved metal concentrations; and will provide information towards existing and evolving conditions of the monitored hydrostratigraphy for the parameters listed in Section 5.2.

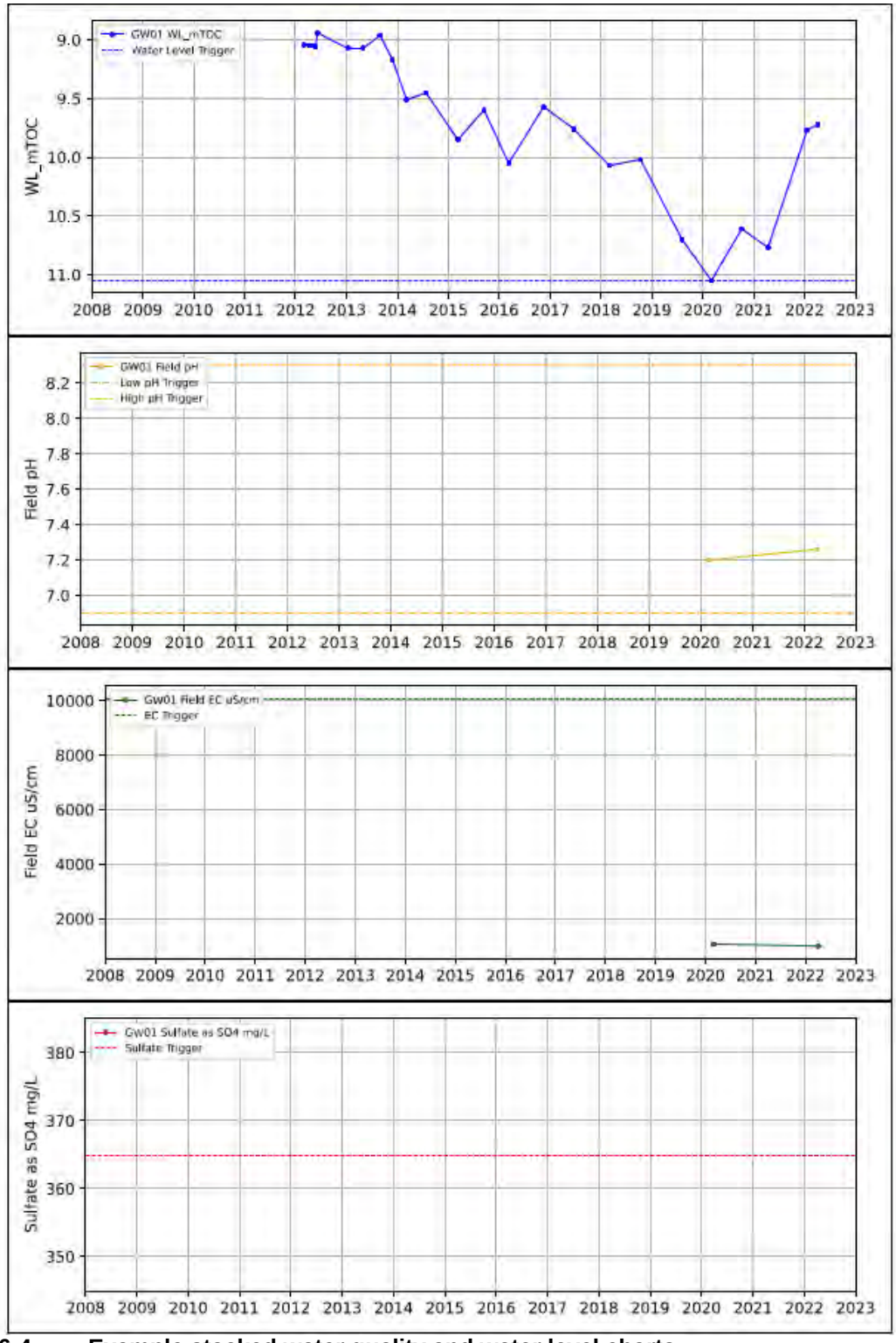


Figure 6-4 Example stacked water quality and water level charts

6.3 GROUNDWATER QUANTITY

The volume of incidental groundwater take to the mining areas will be estimated each calendar year using the site water balance model. The site water balance method compares rainfall and runoff inputs to the pits with pumping outputs and storage changes to provide an estimate of pumpable incidental groundwater take from the mining areas. The site water balance model is updated at the end of each calendar year with the results provided in the annual review (refer to separate Site Water Balance Management Plan).

The Project Approval requires *"a program to validate the groundwater model for the project, including an independent review of the model every 5 years, and comparison of monitoring results with modelled predictions".* Every five years the numerical groundwater flow model will be reviewed, validated and if necessary updated. The process will be undertaken with the input of a third-party reviewer. The numerical model simulates the subsurface flow of groundwater and provides estimates of incidental water take from the VCM pits and passive take from the surrounding alluvial aquifers. These water takes will be reviewed as part of the annual review and be used as the basis for determining entitlements required to account for groundwater taken by the mine each calendar year. This will only occur after the model has been approved for use by the DPE.

Any consumptive water take from the proposed water supply bores to the north of VCM will be monitored with flowmeters at the bore outlet and reported in the annual review.

The total volume of incidental, passive and consumptive groundwater take will be tabulated each year and compared quantitatively with the licenced entitlements in the annual review.

Different incidental take estimated by the site water balance method and groundwater modelling is not uncommon due to different underlying methodologies and assumptions. Where the water balance model and the numerical model provide differing estimates of groundwater inflow commentary on the potential cause will be provided within the annual review. A conservative approach will be undertaken utilising the highest estimates of groundwater inflow to the mining area to ensure adequate water licenses are held to account for the groundwater intercepted.

7 BASELINE DATA

7.1 SUMMARY

VCM and Canyon Mine have collected groundwater data through the existing and progressively expanding monitoring infrastructure since October 2010. Groundwater levels have fluctuated over this period due to a range of factors including climatic conditions (i.e., drought), agricultural extraction, and local mine dewatering of open pits.

Events such as the declining groundwater levels experienced during the 2017 to 2019 drought, and the subsequent recovery in early 2020 are evident.

In general, depressurisation due to mining is predicted to be limited to the Permian Coal Measures in the vicinity of VCM (Hydrosimulations, 2018), as shown by the predicted maximum 1m drawdown in Figure 4-2.

The relationship between groundwater levels, physio-chemical parameters (pH and EC) and sulfate concentrations at each location are further illustrated graphically in timeseries charts within Attachment C.

7.2 PRE MINING WATER LEVELS

Water table contours calculated from groundwater levels that are not affected by historical mining or historical pumping from the Upper Namoi Alluvium from the VEP EIS are shown in Figure 25. Groundwater level data from the EIS was analysed and the effects of mining and pumping were removed. Long-term average water levels that are based on climatic variation were then calculated and contoured. The following is of note:

- Mounding beneath the Vickery State Forest is evident.
- Groundwater flow direction is towards the west, south-west and north-west, following the topography and the Namoi River.
- The hydraulic gradient decreases appreciably to the north-west and the south west between the Project mining area and the Namoi River due to the higher hydraulic conductivity of alluvial sediments.

Water table contours calculated from groundwater levels at the time of the EIS are shown in Figure 25. Groundwater level drawdown due to mining at the Canyon and Rocglen Coal Mines is observed. Groundwater level drawdown due to pumping from the Upper Namoi Alluvium is observed compared to the water table contours in Figure 19.

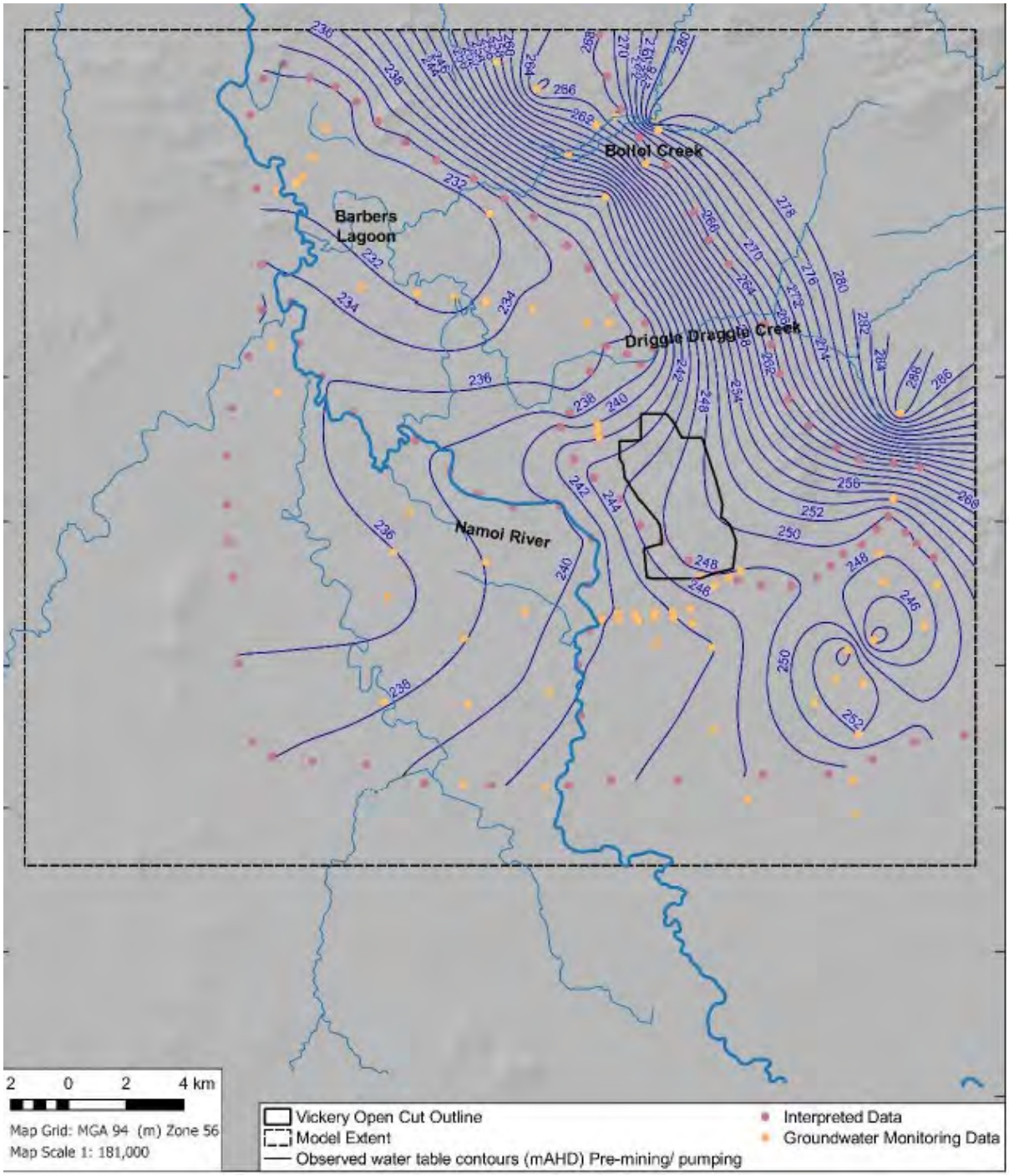


Figure 7-1 Baseline regional water table pre mining (hydrosimulations, 2018)

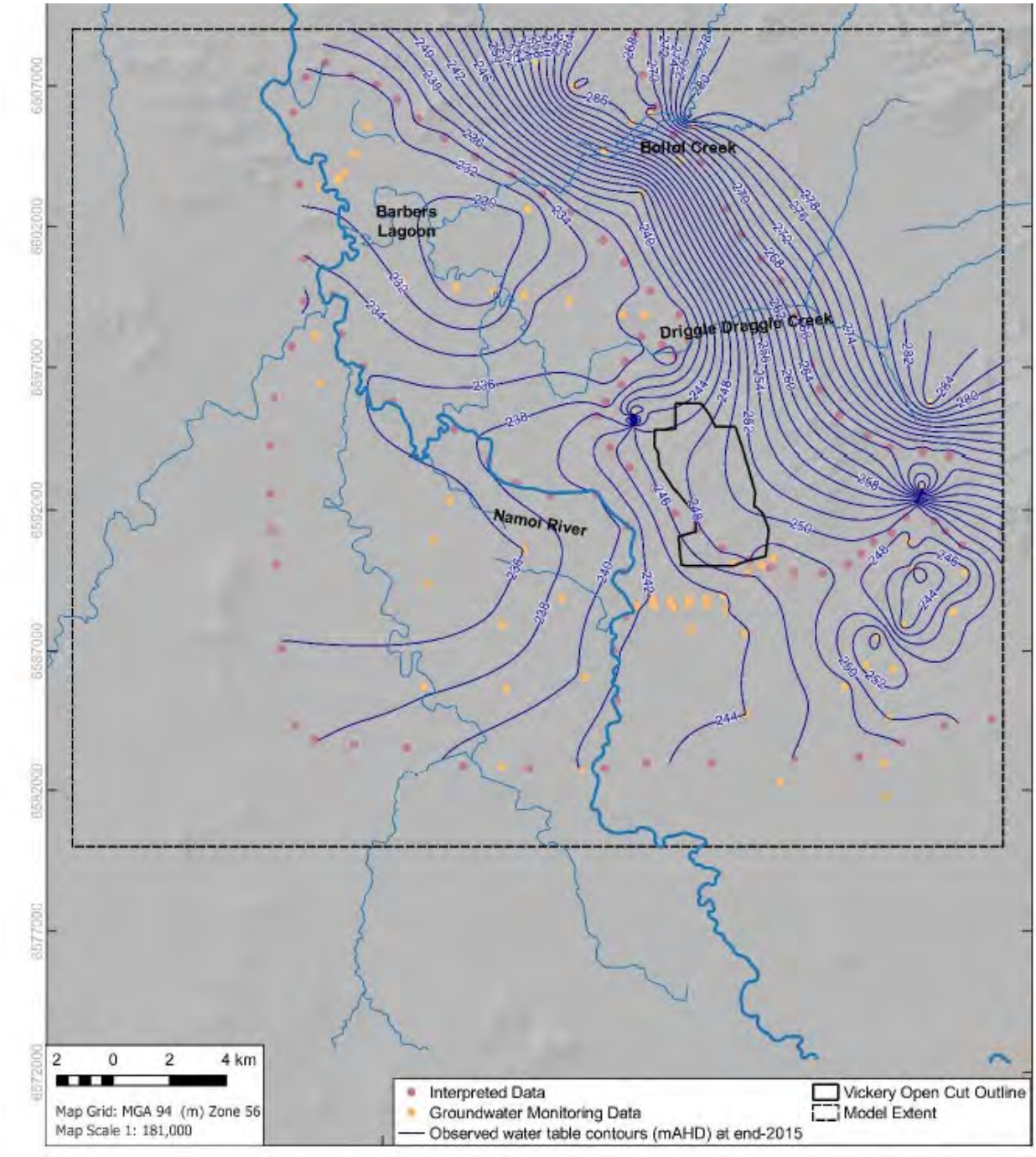


Figure 7-2 Baseline Observed water table (post Canyon and Rocglen mines) (hydrosimulations, 2018)

7.3 BASELINE WATER QUALITY

Groundwater quality within and surrounding the Project mining area is highly variable but generally poor, with most groundwater suitable only for livestock and irrigation of some salt tolerant crops. The spatial distribution of groundwater EC from data obtained during the 2012 bore census, which includes bores beyond the extent of the VCM monitoring network, is shown in Figure 27. The monitored formation is differentiated by symbol, and the magnitude of the concentration is proportional to symbol colour. Where alluvial cover is thick, the salinity is always low except for some elevated values along the downstream end of Driggle Draggle Creek.

Figure 7-3 shows the ranges in groundwater electrical conductivity (EC) in microseimens per centimetre (µS/cm) for 850 field and laboratory measurements from the VEP EIS, arranged according to aquifer type and area. EC increases in proportion to the total dissolved ions in a water sample and is a commonly used proxy for water quality. Also shown are thresholds for groundwater use categories as recommended in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). Based in the baseline data presented in the EIS, the following is of note:

- High groundwater salinity can occur in both the Permian and Alluvium, with values in excess of 15,000 µs /cm. The alluvial to the north of the mine, around Driggle Draggle Creek have the highest salinity.
- The majority of samples range from 2,000 to 8,000 µs /cm in both Alluvial and Permian.
- Groundwater quality that is suitable for drinking and irrigation is associated with the thicker alluvial deposits of the Upper Namoi Alluvium in proximity to the Namoi River and north of Driggle Draggle Creek.

Table 7-1 shows representative groundwater data from the VEP ESI, from a groundwater investigation carried out in 2016 at 6 bores located on the western boundary of the project in close proximity the mine. The results show that salinity can be elevated in close proximity to the Namoi River, with up to 5,720 µs /cm present in the alluvial.

Groundwater pH is near neutral with 90% of historical measurements at Vickery and Canyon Coal Mine area between pH 6.8 and pH 8.2

The concentrations of trace metals (median, 5th and 95th percentile) from the VEP EIS are summarised according to groundwater environment in Table 7-1. The observed historical ranges in metal concentrations are considered typical for groundwater in the area and reflect baseline conditions. Despite the wide ranges in metal concentrations, the median metal concentrations in groundwater are similar between monitored formations. Metal concentrations tend to increase with salinity (or EC) as a result of evaporative concentration of ions.

The ANZECC (2000) guidelines for fresh and marine water quality contain no specific trigger values for dissolved metals in groundwater. However, the guidelines indicate that it is appropriate to consider the environmental values of the receiving surface water systems or receptors (if and where groundwater emerges at the surface) in respect of groundwater quality. The ANZECC (2000) trigger levels for the protection of 95% of freshwater species (appropriate for moderately disturbed systems) are shown in Table 6. It is apparent that the median concentrations of Al, Cu, and Zn in groundwater samples taken prior to development are near or above the recommended trigger levels for surface water systems. This is common in natural groundwater systems of moderate to high salinity.

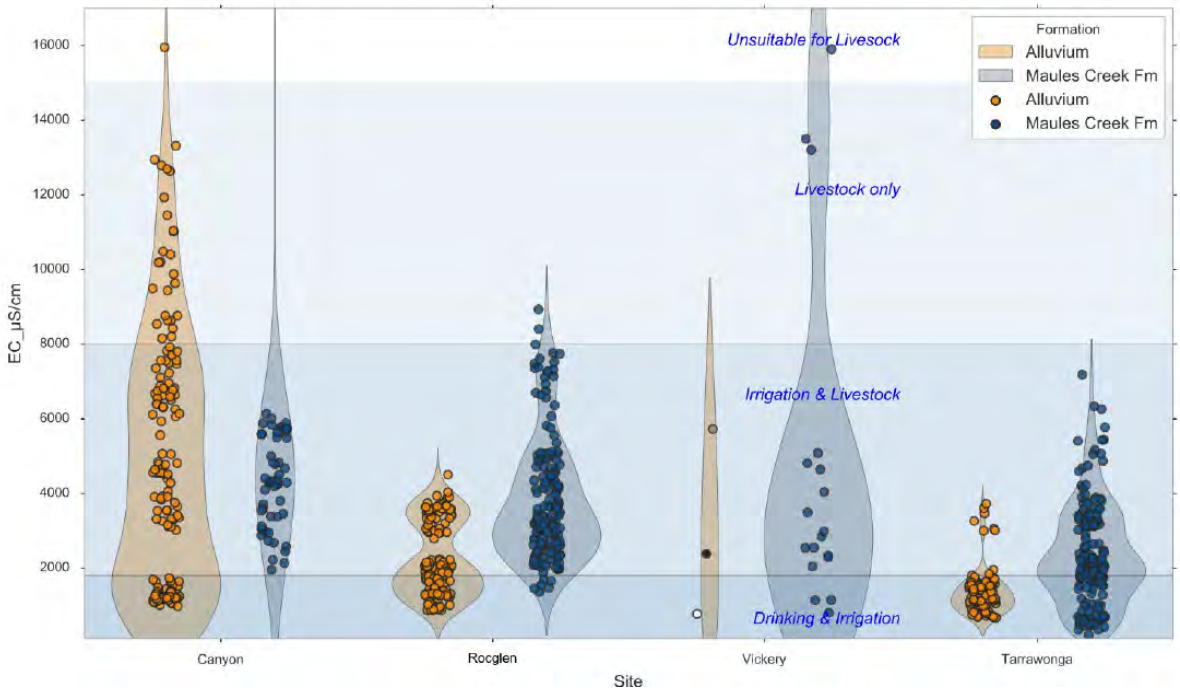


Figure 7-3 Violin Plots showing ranges in EC for Groundwater in the vicinity of Vickery and other Whitehaven mines (Hydrosimulation, 2018)

Table 7-1 Vickery Groundwater investigation along the Namoi River (hydrosimulations, 2018)

Bore (Registered Bore/Licence Number)	Lithology	Date	pH	EC	TDS	Ca	Mg	Na	K	Cl	HCO_3	SO_4
				µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
VNW392WBA	MCF	Feb 2016	7.4	3490	2210	269	98	348	20	652	737.61	311
VNW391WBB	MCF	Feb 2016	7.32	2550	1440	189	63	282	14	439	741.27	134
VNW390WBA	MCF	Feb 2016	7.3	2330	1400	178	43	268	14	386	716.88	104
VNW395WBB	UNA	Feb 2016	7.3	2380	2810	72	43	446	7	315	737.61	204
VNW393WBB	MCF	Feb 2016	8.07	2840	1660	75	29	463	12	688	179.22	197
VNW394WBB	UNA	Feb 2016	7.59	5720	3600	216	82	891	14	1190	437.69	593

Source: ERNS (2016). MCF: Maules Creek Formation. UNA: Upper Namoi Alluvium.

Note: Ca = Calcium. Mg = Magnesium. Na = Sodium. K = Potassium. Cl = Chlorine. HCO_3 = Bicarbonate. SO_4 = Sulfate.

Table 7-2 Baseline Trace Metal Concentrations in Groundwater (hydrosimulations, 2018)

Formation	%ile	Al	As	Cu	Co	Fe	Mn	Se	Zn
ANZECC (2000) Freshwater 95% protection		0.055	0.024	0.0014	ND	ND	1.9	0.011	0.008
Alluvium (n = 227)	5%	<0.01	<0.001	<0.002	<0.001	<0.05	<0.001	<0.01	0.007
	50%	**0.04**	**0.001**	**0.009**	**0.001**	**0.24**	**0.03**	**<0.01**	**0.07**
	95%	1.7	0.01	0.1	0.004	26.7	1.7	<0.01	0.9
Maules Creek Formation (n = 137)	5%	<0.01	<0.001	<0.002	<0.001	<0.05	0.003	<0.01	0.006
	50%	**0.09**	**0.001**	**0.01**	**0.001**	**0.7**	**0.11**	**<0.01**	**0.09**
	95%	6.1	0.02	0.2	0.02	25.2	2.0	0.01	1.1

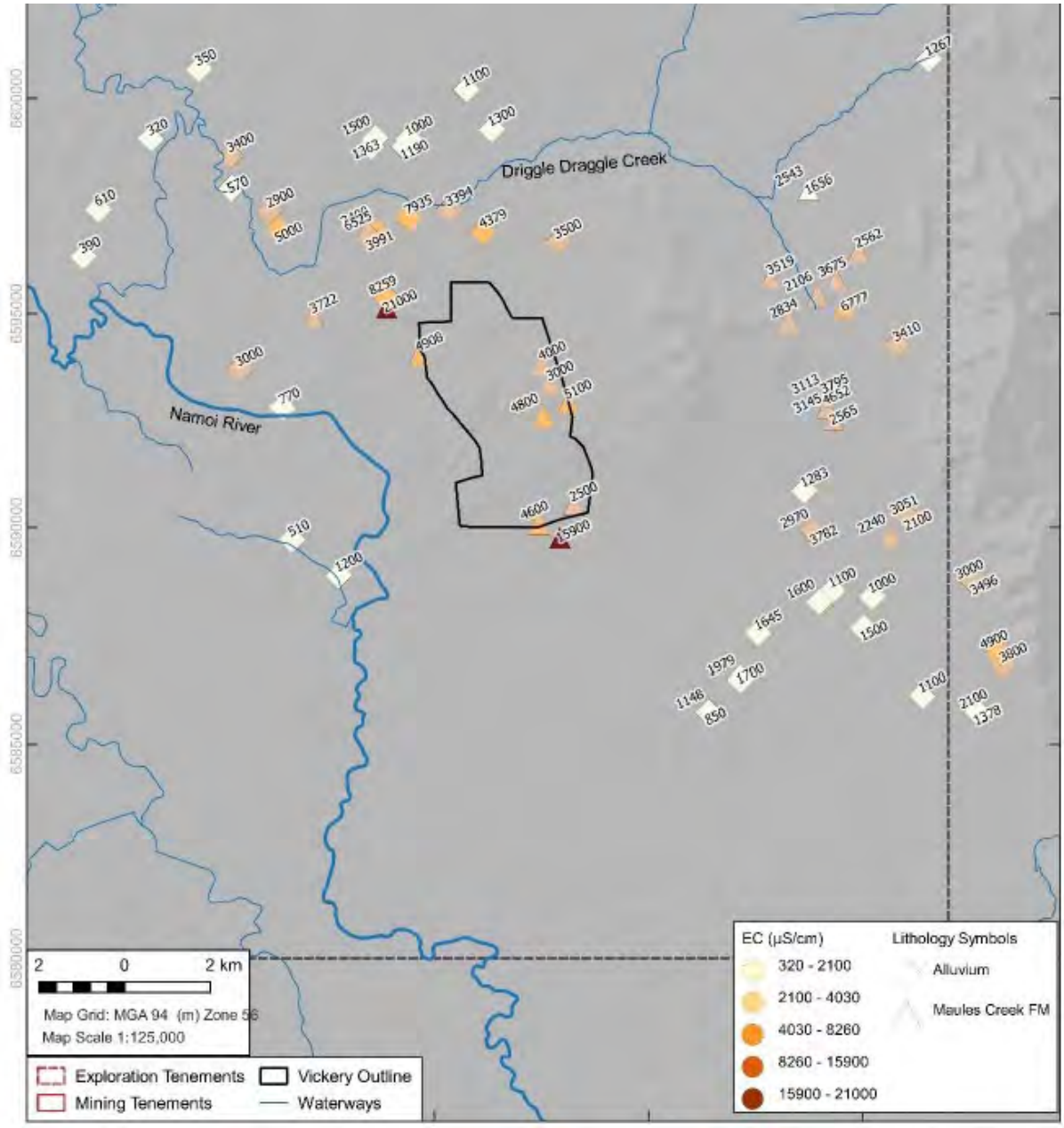


Figure 7-4 Baseline regional water EC from bore census 2012 (Hydrosimulation, 2018)

7.4 BASELINE WATER USERS

Figure 7-3 shows the distribution of groundwater extraction in the vicinity of the Project as per the VEP EIS, for bores registered for irrigation purposes. The circles indicate the relative magnitudes of the average abstraction rates from 2006 to 2010. As illustrated on the figures, activity is concentrated close to the Namoi River corridor, in particular the paleochannel to the west and north-west of the Project. The nearest active production bore is located on the western side of the Namoi River, approximately 2 km

south-west of the Project mining area. Three bores will be monitored in the vicinity of the nearest active production bore, as documented in Section 4.

The majority of irrigation water user are located at a significant distance from the operation and therefore are unlikely to be impacted, as indicated by the groundwater model.

The volume of water withdrawn annually from the 122 production bores in the model area varied from 11,300 ML in the 2009-2010 water year to about 28,800 ML in the 2006-2007 water year with an average of about 21,200 ML from 2006 to 2010.

The temporal variation in groundwater abstraction from year to year indicates

- The majority of pumping occurs over January to February; and
- Climatic conditions have a large influence on annual extractions, with higher rates of extraction in dry years such as 2006 than wetter years such as 2010.

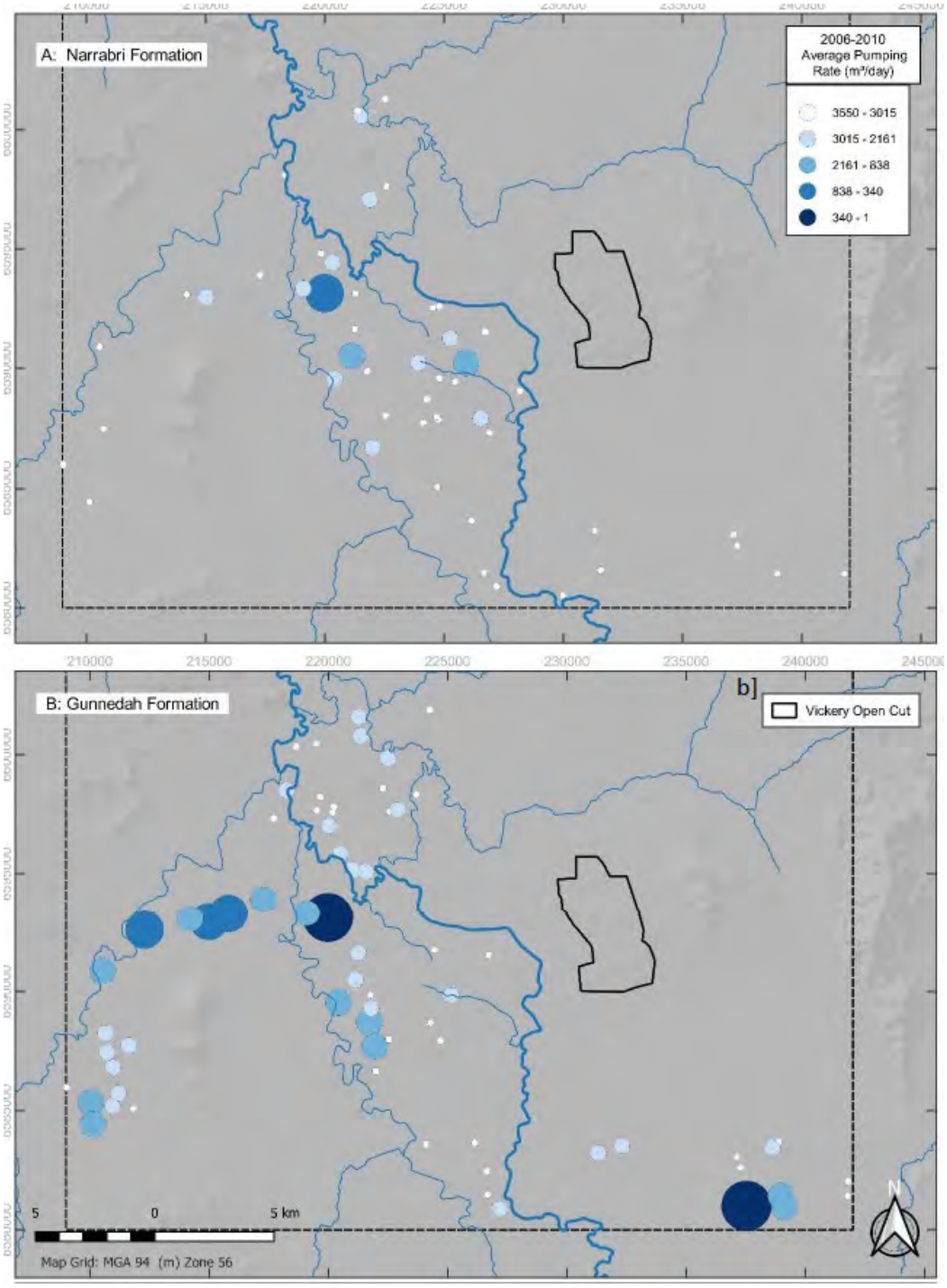


Figure 7-5 Baseline water users in the vicinity of the project (Hydrosimulation, 2018)

8 TRIGGER ACTION RESPONSE PLANS

8.1 PERFORMANCE MEASURES

Schedule B Condition 5 (g) of the SSD-7480 stipulates that the groundwater monitoring program must monitor and evaluate compliance with the relevant performance measures. Additionally, a Trigger Action Response Plan (TARP) to respond to exceedances of the groundwater performance criteria, and repair, mitigate and/or offset any adverse groundwater impacts of the development to evaluate potential changes to existing groundwater sources is to be developed.

Mining activities that intercept the water table or interfere with groundwater systems are considered aquifer interference activities under the New South Wales Aquifer Interference Policy (AIP). The minimal impact considerations described in the AIP have been adopted as the groundwater performance measures for the VCM. The minimal impact considerations in the AIP are dictated by the productivity (highly or less productive) and nature of the groundwater source (alluvial or porous/ fractured rock). These align with the Performance Measures stipulated in Schedule B Condition 51 (Table 8) of the SSD-7480, for the Alluvial Aquifers.

The Quaternary alluvial system, which is classified as a highly productive groundwater source, has some differences in performance measures compared with the Permian porous rock units of the Gunnedah Oxley Basin, which are classified as a less productive porous rock system. The performance measure will vary for each type of monitored receptor, which includes water supply works, monitoring bores in close vicinity to high-priority groundwater dependent ecosystems and regional monitoring bores. The boundaries of high-priority groundwater dependent ecosystems are defined by the WSP for the Namoi Alluvial Groundwater Sources and WSP for the NSW Murray Darling Basin (MDB) Porous Rock Groundwater.

The performance measures of each monitored groundwater system with respect to groundwater receptors and the applicable monitoring locations are presented in **Table 8-1.**

8.2 TRIGGERS AND CONTROL CHARTS

Control charting is a graphical and statistical tool to track changes in recorded data over time. The inclusion of appropriate thresholds on control charts is used to inform trigger management actions. Examples of the control charts and threshold triggers developed for the monitoring network are shown on the charts included in Attachment C.

Groundwater data, including levels and quality, have been analysed with methods described in Section 6 to establish the baseline period for each monitoring standpipe location. The baseline dataset is used to calculate the 95th percentile of measured groundwater levels as outlined in Section 6.1 for each monitoring standpipe and VWP location which is set as the trigger threshold on the control charts. Groundwater levels are expected to exceed the 95th percentile threshold on five percent of measurements given future fluctuations are representative of baseline conditions.

Table 8-1 Groundwater performance measures

Potential mining issue or impact	Receptor	Water source type	Applicable to	Performance measures	Remedial Actions
Water level changes due to water take, drawdown and aquifer interconnectivity	Alluvial aquifers	• Highly productive alluvial	All alluvial bores	Negligible impacts to alluvial aquifers caused by the development beyond those predicted.	Quantify increased impact with updated GW model If required source additional licenses
	Porous rock aquifers	• Less productive porous rock	All Permian bores	Negligible impacts to porous rock aquifers caused by the development beyond those predicted.	Quantify increased impact with updated GW model If required source additional licenses
	Water supply bores	• Highly productive alluvial • Less productive porous rock	GW032114, GW971614, GW971400(Any third party water user - Investigated upon complaint)	Negligible impacts to alluvial aquifers caused by the development beyond those predicted. No more than 2 m drawdown attributable to mining activities.	Quantify increased impact with updated GW model If required enter into make good agreement to compensate impacted party in consultation with DPIE Water to the satisfaction of the Planning Secretary
Water quality changes due to mining activities, final void, and emplacement waters	Aquifers	• Highly productive alluvial • Less productive porous rock	All alluvial and Permian bores	No change in existing beneficial use category due to mining.	Identify source of pollutant. Implement treatment plan to remove pollutant source Remediate environmental impact to the satisfaction of the Department
	Water supply bores	• Highly productive alluvial • Less productive porous rock	GW032114, GW971614, GW971400 (Any third-party water user - Investigated upon complaint)	No change in existing beneficial use category due to mining.	Identify source of pollutant. Implement treatment plan to remove pollutant source Enter into make good agreement to compensate impacted party in consultation with DPIE Water to the

Potential mining issue or impact	Receptor	Water source type	Applicable to	Performance measures	Remedial Actions
					satisfaction of the Planning Secretary

8.2.1 Standpipe and VWP Groundwater Levels

Water levels in the majority of monitoring locations are not anticipated to be affected by VCM mining are categorised to reflect baseline conditions up to 2022. Where impacts are anticipated, these have been included in the 95th percentile. VKY036c, VKY3033 (eight VWPs) and VS056 (two VWPs) and TR26 are all within the VCM open cut mining footprint, and have approved drawdowns (Hydrosimulations, 2018) of greater than 100 m. These have not been assigned trigger levels.

Trigger thresholds have not been calculated for locations that do not have sufficient data (less than four measurements). In addition, interim trigger thresholds have been calculated for locations with less than eight measurements assuming the existing data is reflective of baseline conditions. These trigger thresholds will be updated once sufficient data is acquired for these locations. Groundwater level triggers for VWPs are considered interim and will be updated with recent data in a future iteration of the GWMP, subject to a quality assurance of the recent groundwater level data (since 2012) for these bores.

Three private water supply bores are included in the regular monitoring network. Additional private water supply bores may be added in future when access is granted. No trigger levels have been developed for these bores as the water levels will need to be monitored over a longer period of time to determine the background water levels, accounting for water use and drawdown from the private water user. Groundwater-related impacts and further investigation will be triggered by receipt of a complaint.

The water level trigger thresholds for each monitoring location are summarised in **Table 8-2**.

Table 8-2 Water level trigger thresholds for monitoring bores

Monitoring location	Measurement unit	Baseline period	Rationale behind baseline period selection ^	Trigger threshold calculated from baseline data and approved impact from HS, 2018
Alluvium				
GW01	Metres below reference point#	Start (2011) - 2022	3, 7	11.05
GW02		Start (2011) - 2022	3, 7	10.55
GW03		Start (2011) - 2022	3, 4, 7	9.66

Monitoring location	Measurement unit	Baseline period	Rationale behind baseline period selection ^	Trigger threshold calculated from baseline data and approved impact from HS, 2018
GW-11	Metres above Australian Height Datum	Start (2008) - 2022	1, 3, 7	18.56
SB11		Start (2011) - 2022	3, 4, 7	11.19
TR7		Start (2012) - 2022	1, 3, 7	10.23
VNW223		Start (2006) - 2022	7	25.80
VNW392		Start (2020) - 2022	8, Interim	7.27*
VNW393		Start (2020) - 2022	8, Interim	12.51*
VNW395		Start (2020) - 2022	8, Interim	9.32*
GW030051-1		Start (1970) - 2021	3, 4, 7	223.95
GW030051-2		Start (1970) - 2021	3, 4, 7	232.38
GW030052-1		Start (1970) - 2021	3, 4, 7	232.03
GW036459		Start (1984) - 2021	3, 4, 7	243.01
VS048		2011-2012; 2021-2022	8, Interim	237.83*
VS058_1		2011-2012	8, Interim	232.91*
VS058_2		2011-2012	8, Interim	226.56*
VS058_3		2011-2012	8, Interim	233.49*
VS059_1		2011-2012	8, Interim	238.01*
VS059_2		2011-2012	8, Interim	256.07*
VS059_3		2011-2012	8, Interim	245.55*
GW-2		2006 - 2016	8, Interim	237.11
Permian				
GW-7	Metres below reference point#	Start (2005) - 2022	7	29.22 (28.68 + 0.54)
GW-9		Start (2005) - 2022	4	22.57 (21.81 + 0.76)

Monitoring location	Measurement unit	Baseline period	Rationale behind baseline period selection ^	Trigger threshold calculated from baseline data and approved impact from HS, 2018
TR18		Start (2012) - 2022	1	16.39 (13.57 + 2.82)
TR35		Start (2011) - 2022	1	33.46 (19.13 + 14.33)
VNW390		Start (2020) - 2022	8, Interim	10.93*
VS062_1	Metres above Australian Height Datum	2021-2022	8, Interim	235.32*

Notes

* = Interim water level triggers as less than eight data points; TBC = limited data points to inform on baseline;

= Bores will be surveyed to provide details for top of casing and trigger levels will subsequently be converted to metres above Australian Height Datum (mAHD).

^ = Classification of rationale behind baseline period selection for each standpipe monitoring location and includes:

1. stable trends exhibited in groundwater levels;
2. stable trends exhibited in majority of groundwater quality parameters;
3. groundwater level fluctuations reflective of climate influences;
4. groundwater level fluctuations reflective of agricultural abstractions;
5. insufficient groundwater level data to represent features of hydrostratigraphy;
6. insufficient groundwater quality data to represent features of hydrostratigraphy;
7. no predicted impacts from numerical modelling; and
8. limited data availability, chosen period of availability.

8.2.2 Groundwater Quality

As discussed in Section 8.2.1, groundwater level and quality data, including the wide range of parameters, have been analysed to identify location-specific baseline conditions/ period by the methods described in Section 6.2. Review of the baseline data have identified representative parameters to adopt for groundwater quality thresholds. 5th and 95th percentile triggers for pH, electrical conductivity (EC), and sulfate concentrations have been calculated and are presented on the control charts included in Attachment C. The trigger thresholds for each monitoring site and water quality indicator are summarised in **Table 8-3**.

Interim triggers based on the geological formation have been calculated for any bore with less than three measurements (GW01, GW-2, SB11, VNW392, VNW393, VNW395, TR18, TR35, and VNW390). These triggers will be updated in a future iteration of this GWMP, once further baseline water quality data is acquired for each bore.

Additionally, whilst interim triggers are in place, all current monitoring bores have been incorporated in the threshold table. Once adequate baseline data has been collected a selection of representative bores will be defined for which triggers will be developed and included in future iterations of this GWMP.

Table 8-3 Water quality trigger thresholds

Bore ID	Trigger threshold calculated from baseline data			
	EC (µs/cm)	pH (pH units)		SO_4 (mg/L)
	95%	5%	95%	95%
GW02	969	7.2	8.6	365*
GW03	811	6.1	8.1	365*
GW-11	4,912	7.0	9.3	365*
TR7	12,970	7.4	7.8	365*
VNW223	10,120	6.9	7.4	365*
Other Alluvium Bores	10,083*	6.9*	8.3*	365*
GW-7	5,378	7.7	8.5	86*
GW-9	12,740	6.6	8.2	86*
Other Permian Bores	12,315*	6.7*	8.4*	86*
VNW390	2330^	6.9*	8.3*	104^
VNW391	2550^	6.9*	8.3*	134^
VNW392	3490^	6.9*	8.3*	311^
VNW393	2840^	6.9*	8.3*	197^
VNW394	5720^	6.9*	8.3*	593^
VNW395	2380^	6.9*	8.3*	204^

Notes:

* = Interim water level triggers for bores not listed in this table (as insufficient data has been recorded) based on all data for that geology.

^ based on a single value from 2016 as reported in the EIS, triggers will be updated when more samples are collected

Dissolved metal concentrations will be compared to the most appropriate ANZECC guidelines depending on the environmental value of the monitored hydro stratigraphy, which generally draws water for stock, domestic, and irrigation purposes and supports slightly to moderately disturbed aquatic ecosystems.

8.2.3 Groundwater Quantity

The total volume of incidental, passive and consumptive groundwater take will be tabulated each year and reported in the annual review.

The flow and volume recorded on the flowmeters of each extraction bore will be reported in the Annual Review. Inflow into the open cut pit will be acquired from an annual water balance model.

Borefield TARPs and cease-to-pump triggers will be established in a future version of this GWMP, once locations and intended extraction volumes have been finalised. These triggers will be established prior to any extraction from these bores.

8.2.4 Groundwater Dependent Ecosystems

No high priority GDEs have been identified in the Upper Namoi Groundwater Sources or Porous Rock Groundwater Sources in the vicinity of the Project (Hydrosimulations, 2018).

No stygofauna were recorded in the eight bores sampled in August 2012; however, four stygofauna taxa were collected from three of the ten bores sampled in the Namoi River alluvial aquifer during a survey undertaken for the Project in February to March 2016 (Eco Logical Australia, 2018). The stygofauna collected during the survey were all widespread taxa and, consequently, have low conservation value. They are likely to occur throughout large sections of the Namoi River alluvial aquifer (EcoLogical Australia, 2018).

8.2.5 Summary of Triggers

The control chart triggers for groundwater levels, quality and water take are summarised in **Table 8-4**.

Table 8-4 Control chart triggers for groundwater levels, quality, and pit inflows

Component	Applicable to	Control chart triggers
Groundwater level	All standpipe monitoring bores	95% of baseline data
	All VWPs	95% of baseline data
	Private landowner bores	Complaint/95% of baseline data
Groundwater quality (pH, EC, and SO4)	All standpipe monitoring bores	5% / 95% of baseline data
	Private landowner bores	Complaint/95% of baseline data
Groundwater quality (metals)	All standpipe monitoring bores	ANZECC guidelines based on beneficial use
	Private landowner bores	Complaint/95% of baseline data
Water take	Incidental, passive, and consumptive groundwater take	> 100 % of Water Access Licenses units for each applicable water source affected by VCM

8.3 TRIGGER ACTION RESPONSE PLAN

The performance measures and control thresholds described in the previous two sections form the basis of a trigger action response plan (TARP) that outlines actions and responses in the event trigger thresholds are exceeded. The exceedance of a trigger threshold on their own occurrence does not

indicate when and what mitigation, management, or ceasing work may be an appropriate response. The groundwater level and quality TARP for the open cut activities at VCM is shown in Appendix A.

The confirmed exceedances will prompt an investigation, carried by suitably qualified personnel, to assess the reasons for trigger exceedance, which could include but not be limited to climatic conditions, agriculture abstraction, and or mining activities. In the case exceedances are attributed to mining activities, the changes in groundwater conditions, such as a decrease in water level or increase in salinity, will be compared to performance measures (discussed in Section 8.1) to evaluate the significance of any impacts manifested on the groundwater systems.

The results of the trigger investigations will be reported in each annual review. Each year if it is clear the baseline dataset is changing in response to factors not related to mining such as climate or agriculture then the trigger thresholds will be recalculated, and the control thresholds adjusted to improve the baseline statistics. When this occurs the GWMP will be updated.

8.3.1 Ameliorative Action

If the suitably qualified personnel are of the opinion that the reduction in groundwater levels and/ or quality is a consequence of mining, WHC will notify the affected landowner(s) and NRAR, and WHC will enter into negotiations with the affected landowners with the intent of formulating an agreement which provides for one or a combination of:

- Re-establishment of saturated thickness in the affected bore(s) through bore deepening;
- Establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;
- Provision of access to alternative sources of water; and/ or

Monetary compensation to reflect increased water extraction costs (if any), for example as a consequence of lowering pumps or installation of additional or alternative pumping equipment.

9 GROUNDWATER MODEL VALIDATION

Groundwater level monitoring will be conducted on a quarterly basis and the results will be used to validate modelling predictions on a five-yearly basis and inform progressive refinement of the groundwater model as the open cut mining area is developed. Revised outputs from the groundwater model will be reported in the Annual Review, as relevant over the life of the VCM and used to inform regular site water balance reviews.

Consistent with Condition B53(g)(v), Schedule 2 of SSD-7480, the VCM groundwater model (including the borefield and open cut) will be independently reviewed at least once every 5 years after the commencement of mining. The model will be updated and reviewed will be undertaken by an independent, suitably qualified person endorsed by the department.

9.1 MODEL UPDATE TRIGGERS

Circumstances which may trigger further development or refinement of the groundwater model include:

- significant changes to the mine plan;
- acquisition of new hydrogeological information including;
  - groundwater levels (elevation) which are greater than 30% different from predicted impacts and calibrated values used in the model;
  - Changes in hydraulic properties listed in **Table 3-1** by greater than an order of magnitude;
- groundwater inflows which exceed model predictions by 20% for that stage of mining.
  - As per Table 5-1, the Project has sufficient WAL allocation to account for greater than 20% increase in predicted inflows during the first 10 years of mining.

The validity of the groundwater model predictions will be reviewed every five years by a suitability qualified independent expert against water level data and estimates of water take to determine if the model is providing useful predictions. If the numerical model predictions do not compare well with the observations over the previous five-year period, then the numerical model will be updated and if necessary recalibrated. Predictions of water level changes and water take will be undertaken using the updated model.

9.2 MODEL UNCERTAINTY

The sensitivity analysis conducted for the existing groundwater model for the EIS, identified that the model is sensitive to the vertical hydraulic conductivity assigned to the model layers. A high-level assessment of model uncertainty was conducted by analysing the effect of vertical hydraulic conductivity on predicted pit inflows. Two additional transient prediction simulations were run:

- Vertical hydraulic conductivity decreased by an order of magnitude (divided by 10) for all model layers.
- Vertical hydraulic conductivity increased by an order of magnitude (multiplied by 10) for all model layers.

Changing the vertical hydraulic conductivity of all model layers by one order of magnitude results in an estimate of pit inflows of -8% to +16%. The model results presented in the EIS are therefore considered to have negligible uncertainty.

The uncertainty in predictions will also be assessed in future updates to the groundwater model using a parameter sensitivity analysis, to assess which parameters have an impact on model outputs. This assessment will identify the key parameters to further refine to reduce uncertainty.

Where changes to the nature of the predicted impacts is identified through the modelling then the suitability of the monitoring network and water supply bore monitoring will be reviewed to determine if changes are warranted.

9.3 MODEL INPUT AND OUTPUT

Model inputs and outputs for the groundwater model and the site water balance model, and how they are monitored and evaluated include:

- Surface water data including dam inventories, water usage, license extraction and discharges are as per the Site Water Balance Model documented in Section 5.3.7 of the WMP.
- Groundwater inflows to the pit are validated against pump volumes from the pit, taking into consideration rainfall and runoff into the pit catchment.
- Groundwater modelled inflows are validated by comparing the predicted groundwater drawdown levels in the model, to the actual groundwater drawdown in monitoring bores.
- Climate data is updated and validated by BOM data, and used to assess any potential climatic impacts or trends on model inputs and outputs.

10 REPORTING

10.1 ANNUAL REVIEW

The following will be reported in the Annual Review

- Groundwater monitoring data compared to triggers and predicted impacts.
- The results of any trigger exceedance investigations will also be summarised in the Annual Review.
- Any updates to the groundwater model, including changes in predicted inflows compared to licenses.

10.2 MODEL VALIDATION

The validation of the groundwater model will be reported to DPIE and in the Annual Review every five years commencing August 2025 (five years after date of approval SSD-7480).

10.3 MONITORING RESULT EXCEEDANCES

The results of any monitoring for other water users, which show elevated water quality or changes in water levels as per the TARP and bore triggers levels, will be reported to the other water users, the EPA and DPIE within 24 hours of the operation becoming aware of the exceedance

11 REFERENCES

Advisian, 2018. *Vickery Extension Project Surface Water Assessment*. Report prepared for Whitehaven Coal Limited.

Eco Logical Australia, 2018. *Vickery Extension Project Aquatic Ecology Assessment*. Report prepared for Whitehaven Coal Limited.

HydroSimulations, 2018. *Vickery Extension Project: Groundwater Assessment.* Report prepared for Whitehaven Coal Limited.

New South Wales Government (2020), "*Water Sharing Plan for the Namoi Alluvial Groundwater Sources Order 2020*", Website accessed at: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2020-0346

New South Wales Government, (2020), "*Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020"*, Website accessed at: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2020-0349

12 ATTACHMENT A – TRIGGER ACTION RESPONSE PLAN

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Negligible groundwater level impact on the Namoi Alluvium aquifer and associated surface watercourses, groundwater dependent ecosystems, and private landowner bores. Negligible groundwater level impact on the Permian bedrock and associated private landowner bores, outside that predicted by the approved groundwater impacts (Hydrosimulations, 2018). **TARP Objective** This TARP defines levels of deviation in groundwater level from 'normal' conditions and the actions to be implemented in response to each level deviation as a result of open cut mining. **Assessment Criteria** Bore specific trigger values are based on the water levels across the entire history of monitoring in each individual bore and the predicted impacts from the Hydrosimulations (2018) numerical groundwater model.	**Locations** **Open standpipes and VWPs** All monitoring locations as set out in Table 4-1 of the Groundwater Management Plan (GWMP). All monitoring locations are shown in Figure 4-1 of the GWMP. **Monitoring Frequency** **During mining** Quarterly manual measurements of water level. Continuous monitoring in bores installed with Vibrating Wire Piezometers (VWPs) and data loggers. **Post-mining** TBC	**Normal Condition**		
		• Groundwater level remains above the respective trigger limits (defined as the 95th percentile over the baseline period and detailed in Table 8-2 of the GWMP) for each individual groundwater bore.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• One quarterly monitoring result shows an exceedance of the trigger limit as detailed in Table 8-2 of the GWMP.	• *Actions as required for Normal Condition.* • Re-sample of groundwater level within seven days.	• Report declines and climate investigation outcomes in Annual Review.
		Level 2		
		• Groundwater level in a groundwater bore exceeds the respective trigger limit during three consecutive quarterly monitoring rounds. OR • Complaint received by landowners of private bores regarding groundwater level declines.	• *Actions as stated in Level 1.* For Open Standpipe Monitoring Bores, VWPs, and Private Bores: • Undertake a preliminary hydrogeological investigation as efficiently as practicable to check and validate the data and assess cause of trigger exceedances to determine if mining related as per the requirements set out in Section 8.3 of the GWMP. Review of groundwater levels to be carried out by qualified personnel. • Increase monitoring and review of data frequency for sites where Level 2 has been reached, subject to land access. For Private Bores: • Undertake investigation to demonstrate if the decline will impact the long-term viability of the affected water supply works. • Commence level monitoring of said private bore in monthly monitoring rounds, subject to negotiation and land access restrictions. The investigation will be commenced/ completed as efficiently as practicable.	• *Responses as stated in Level 1.* • Include outcomes from the preliminary investigation report in Annual Review.
		Level 3		

		• The reduction in water level is determined in the Level 2 preliminary investigation not to be controlled by climatic or external anthropogenic factors.
		OR
		• Groundwater level in a groundwater bore continues to exceed the respective trigger limit during six consecutive monitoring rounds.
			• *Actions as stated in Level 2.*
			
			For Open Standpipe Monitoring Bores, VWPs, and Private Bores:
			• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g., catchment changes, another effect unrelated to mining).
			• Review groundwater model.
			
			For Private Bores:
			• Review corrective management actions (CMAs) as specified in Section 8.3 of the GWMP considering findings from further investigations and consider additional reasonable and feasible options.
				• *Responses as stated in Level 2.*
				• Report trigger exceedance to DPE and key stakeholders. Provide the detailed investigation report to relevant agencies within a reasonable timeframe of identifying the non-compliance.
				• Report trigger exceedance and investigation outcomes in Annual Review.
				• Develop/design contingency and remedial measures based on the results of the above investigations. Contingency and remedial measures considered practical for implementation may include:
				  • Undertake landholder and government consultation;
				  • Offset groundwater leakage from the Namoi Alluvium aquifer;
				  • Review and refine the GWMP including undertaking additional specific monitoring of private landholder bores;
				  • Review Site Water Balance and predictive groundwater model; and
				  • Review mine plan impacts on alluvial groundwater source.
				
				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 per Section 8.3 of the GWMP).
				• Implement CMAs, subject to land access (finalise negotiations and implement the agreed "make-good" arrangements).
				• Monitor and report on success of CMAs in Annual Review.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Negligible quality impact on the Namoi Alluvium aquifer and associated surface watercourses and private landholder bores. Negligible quality impact on the Permian bedrock and associated private landowner bores, outside that predicted by the approved groundwater impacts (Hydrosimulations, 2018). **TARP Objective** This TARP defines levels of deviation in groundwater quality from baseline conditions and the actions to be implemented in response to each level deviation. **Assessment Criteria** Quality in each monitoring bore remains within the 5th and 95th percentile of the baseline conditions set out in Table 8-4 of the GWMP for the following parameters: • Electrical Conductivity; • pH; and • Sulfate. Other major and metal ions will be assessed against the relevant ANZECC guidelines.	**Locations** **Open standpipes** All open standpipe monitoring locations as set out in Table 4-2 of the GWMP. **Monitoring Frequency** **During mining** All monitoring sites on a quarterly basis as per Table 4-2 of the GWMP. **Post-mining** All monitoring sites on a quarterly basis as per Table 4-2 of the GWMP	**Normal Condition** • Groundwater pH remains within the baseline 5th and 95th percentile range, as specified in the GWMP. • Other groundwater quality parameters remain below the baseline 95th percentile, as specified in the GWMP.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1 • Two consecutive exceedances outside of the specified baseline range (pH) or above 95th percentile baseline (other quality parameters).	• *Actions as required for Normal Condition.* • Re-sample of groundwater quality within seven days.	• Report exceedances in Annual Review.
		Level 2 • Three consecutive exceedances (including re-samples from Level 1) outside of the specified baseline range (pH) or above 95th percentile baseline (other quality parameters). OR • Complaint received by landowners of private bores regarding groundwater quality declines.	• *Actions as stated in Level 1.* For Open Standpipe Monitoring Bores: • Undertake a preliminary hydrogeological investigation as efficiently as practicable to assess cause of quality exceedances and determine if mining related as per the requirements set out in Section 8.3 of the GWMP. Review of groundwater quality to be carried out by qualified personnel. • Increase monitoring frequency to monthly until exceedance ceases For Private Bores: • Collect quality sample from said private bore for comparison with wider aquifer data, subject to negotiation and land access restrictions. • Undertake investigation to demonstrate if quality will impact the long-term viability of the affected water supply works. The investigation will be commenced/ completed as efficiently as practicable.	• *Responses as stated in Level 1.* • Include outcomes from the preliminary investigation report in Annual Review.
		Level 3 • The water quality changes are determined from Level 2 preliminary investigation to not be controlled by climatic, local land uses, or other external anthropogenic factors. OR • Groundwater quality continues to decline with six consecutive exceedances outside of the specified baseline range (pH) or above 95th percentile baseline (other quality parameters).	• *Actions as stated in Level 2.* For Private Bores and Open Standpipe Monitoring Bores • Increase monitoring to at least monthly measurements 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., catchment changes, another effect unrelated to mining). • Review corrective management actions (CMAs) as specified in Section 8.3 of the WMP considering findings from further investigations and consider additional reasonable and feasible options.	• *Responses as stated in Level 2.* For Private Bores and Open Standpipe Monitoring Bores: • Report trigger exceedance to DPE and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. For Private Bores, if the changes have been confirmed to be related to mining effects: • Initiate negotiations with impacts landowners as soon as practicable. Consider all reasonable and feasible options for remediation as relevant (e.g., isolation, remediation, etc.). • 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 per Section 10.2.2 of the WMP). • Implement CMAs, subject to land access (finalise negotiations and implement the agreed “make-good” arrangements). • Monitor and report on success of CMAs in Annual Review.

13 ATTACHMENT B – STANDARD OPERATING PROCEDURES

Standard Operating Procedure on
Field Documentation, Groundwater Level Gauging. Groundwater Sampling and Appropriate Storage and Handling Practices

1) Purpose

These procedures describe the approach to be taken for the collection, storage/handling and documentation of representative groundwater samples.

2) Scope

These procedures apply to groundwater monitoring and sampling activities for Vickery Coal Mine. Where there is substantial variation from these procedures, a note must be made in the job briefing sheets or field notes describing the procedure that is to be used.

3) Procedures

3.1) Field equipment

All necessary equipment to conduct the groundwater sampling should be checked prior arriving on site. Field equipment required to conduct the perform the groundwater sampling include:

- Water level dipper;
- Tape measure;
- GPS unit;
- Tablet, Laptop or similar for pressure logger data download;
- Water quality meter with sensor probes for pH, electrical conductivity, temperature and redox potential, and appropriate calibration solutions;
- Appropriate personal protective equipment including long sleeve shirt and long pants, hard hat or broad brimmed hat, sun screen, gloves, protective eyewear and protective footwear;
- Water quality sample bottles;
- Filters and syringes;
- Nitrile gloves;
- Freshwater for rinsing;
- 12 fridge or cooler box and ice;
- Bailer or submersible pump; and
- Decontamination liquid to rinse reusable equipment.

3.1) Field notes

Written or digital records must be maintained for groundwater monitoring and sampling activities. These records must cover field observations and give an account of daily works and events. Paper based records must protected from the elements and all entries made in indelible ink. Field data recorded digitally in the field using a tablet, laptop or similar device must be backed up to a secondary storage device on a regular basis (e.g. daily).

Field observations collected shall include the following:

- Weather conditions;
- GPS coordinates and elevation of bore if survey has not been completed yet;
- Health and safety issues on site;
- Description of the conditions of the monitoring bore;
- Total depth of bore (where possible);
- Results of any field testing;
- Calibration results of water quality meter;
- Details of samples collected including time and date, sample, identification number and bore location, procedures used in sample collection, and instrument readings;
- Descriptions of visual and olfactory characteristics during each measurement including details such as elapsed time, volume purged, colour, turbidity, odour, sheen etc. when performing a well purge; and
- Photographs of the monitoring location visited.

Supporting information such as safety plans, site plans, and a copy of this standard operating procedures must be accessible to the field sampler when conducting monitoring and sampling.

3.2) General sampling procedures:

1. Record the condition, coordinates and elevation.
2. Record depth to standing groundwater level in the bore with a water level meter. Depth measurements should be referenced to an established datum or measuring point (e.g., top of bore casing).
3. Retrieve pressure logger (if present) within bore. Download data from pressure logger with correct cables and software with laptop.
4. Record the top of bore casing from ground level.
5. Decontaminate all reusable sampling equipment (i.e., pumps and cables) prior to use at each location.
6. Ensure that the water quality meter has been calibrated within the last 24 hours.
7. Compute water volume in the bore with standing water level, bore depth and bore diameter.
8. Lower the decontaminated pump or bailer into the bore. Ensure discharge outlet is placed at distances from bore when utilising a pump setup. Safe manual handling practices must be followed when lifting / carrying sampling equipment. Note any trip hazards prior to proceeding. If required; seek assisting when lifting heavy equipment and the position the field vehicle to minimise carry distance.

9. During purging, field water quality parameters such as pH, electrical conductivity, redox potential, temperature and sediment load should be recorded at regular intervals. Once sediment load is minimal, three bore volumes have been removed and field parameters are stable (within 10%, within 0.2°C for temperature), a groundwater sample can be collected.
10. Low yielding wells that do not yield three bore volumes in one visit should be purged dry and left to recover. Following recovery of groundwater levels, sampling can proceed as the recovered standing water should be representative of inflows from the screened hydrostratigraphic unit.
11. Scan the sample bottles with digital application provided by testing laboratory on tablet or mobile phone. If digital application is not available from testing laboratory, label sample bottles using a Xylene free permanent marker with details including bore name, sample round number, sampler name, date and time.
12. Record any other specific bottle filling instructions on the sample bottles before filling them. Note which samples need to be field filtered and/or contain preservatives such as acids.
13. Conduct filling of sample bottle with nitrile gloves.
14. For samples requiring field filtration, rinse and fill a new container with the water from the bore. Fill the syringe with water from the bore, attach the filter to the end of the syringe. Sit the filter over the sample bottle and push the water through from the syringe. Continue to do this until the sample bottle is full before screwing the cap on tightly.
15. Preserve samples in cooler boxes/eskies provided by testing laboratory that are chilled at or around 4ºC. The cooler boxes will be sealed, clearly labelled with the name and address of the testing laboratory.
16. Ensure preservation of samples in cooler boxes do not exceed the recommended sample holding times. The holding times will vary according to the NATA-certified method being used by the laboratory and should be clarified with the nominated laboratory.
17. Include chain of custody (COC) form detailing each sample sent to the laboratory. A COC form must be completed while in the field. When groundwater samples are relinquished, ensure that the receiving party have signed the form indicating the time and date. A copy of the signed form must be retained and filed as a record of samples sent and analyses requested. Where electronic COCs are used, all digital records and emails must be filed appropriately.

Care must be given to avoid loss or decay of sample labels during storage and handling. The sample label must be written on the cap of the sample bottle if the decay of sample label is unavoidable. The sample will then be sealed and recorded in a chain-of-custody form from the laboratory nominated for the analysis.

3.3) Pressure logger/VWP download procedures:

1. Connect to pressure logger/VWP sensor with appropriate cable.
2. Download data once connection is secured.
3. Check the recording interval times for synchrony for all pressure loggers/barometric loggers/VWP sensors.
4. Record the battery storage and memory of pressure logger/VWP sensors.

Standard Operating Procedure on
Quality Assurance Sampling

1) Purpose

The purpose of this procedure is to describe the approach to be taken for the collection of quality assurance samples during groundwater sampling.

2) Scope

This procedure applies when groundwater samples are collected.

3) Procedures

For the collection of the required field quality control (QC) samples refer to *SOP on Field Documentation, Groundwater Level Gauging. Groundwater Sampling and Appropriate Storage and Handling Practices*.

3.1) Quality assurance sampling

3.1.1) Field blind duplicates (Intra-laboratory duplicates)

Field blind duplicates are duplicate samples that are sent as independent samples to the same laboratory for analysis to assess the repeatability of the analytical results and the variation in analyte concentration between samples collected from the same sampling point. Field blind duplicates must be collected typically at a frequency of 1 in 20 samples (i.e., 5%).

Field blind duplicates must be taken simultaneously when the original sample is taken. Both the duplicate sample and the sample should be agitated as little as possible, preferably direct from the discharge line. The duplicates should be labelled without any indication of its original sampling point and sent for analysis as usual.

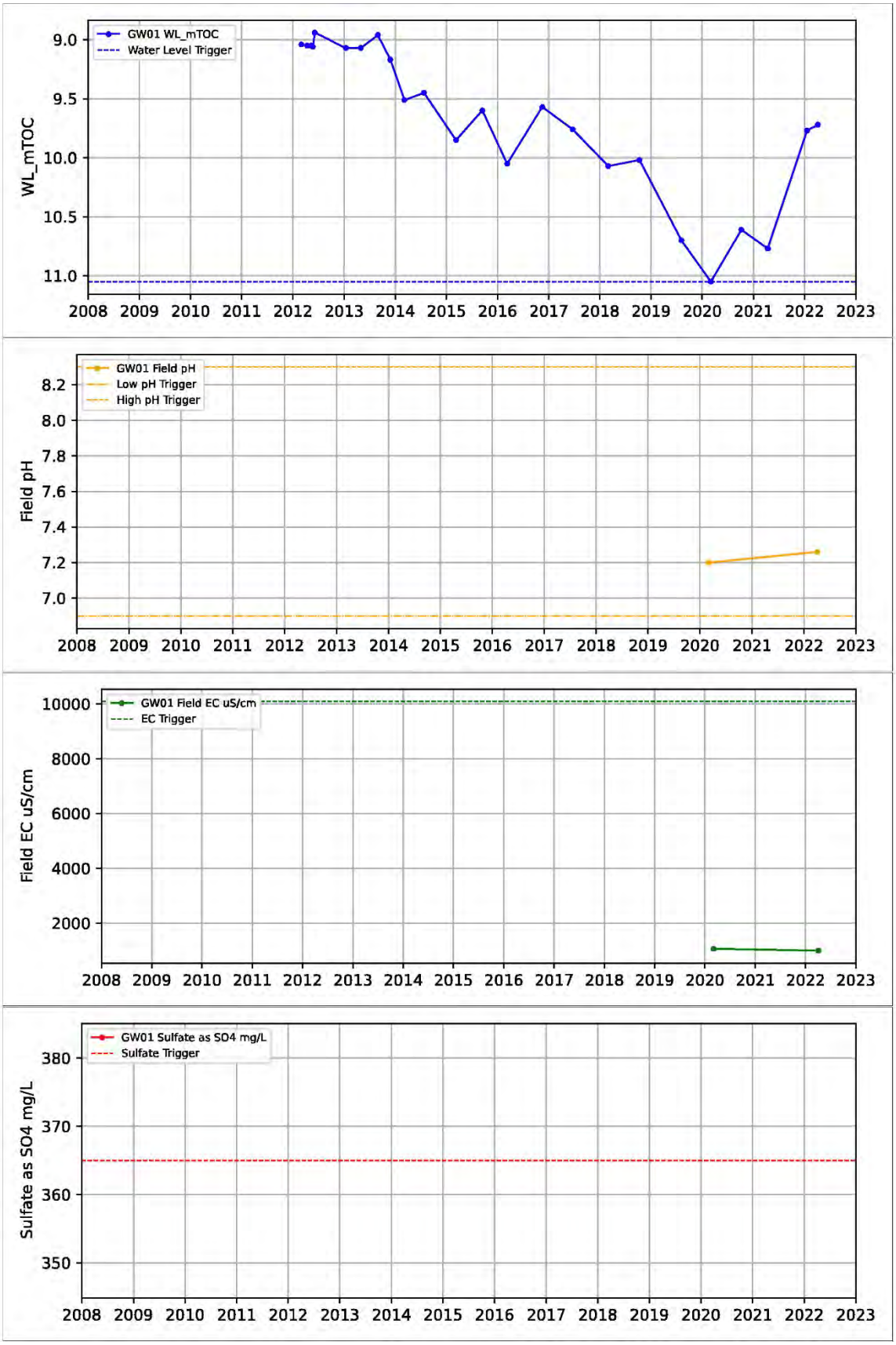
3.1.2) Field split duplicates (Inter-laboratory duplicates)

Field splits are duplicate samples that are sent to different laboratories for analysis to assess the analytical proficiency of the laboratories. Field split duplicates must be collected at a frequency of 1 in 20 samples (i.e. 5%). The combined blind and split frequency should be at least 10% of the total sample number. Field split duplicates are be collected using the same procedures as for field blind duplicates.

3.1.3) Field blanks

Field blanks monitor possible contamination that may be accidentally introduced when actually collecting the sample in the field. A sample container must be filled with deionised water in the field, sealed, labelled and sent for analysis as usual.

14 ATTACHMENT C – EXAMPLE WATER LEVEL AND WATER QUALITY TIME SERIES DATA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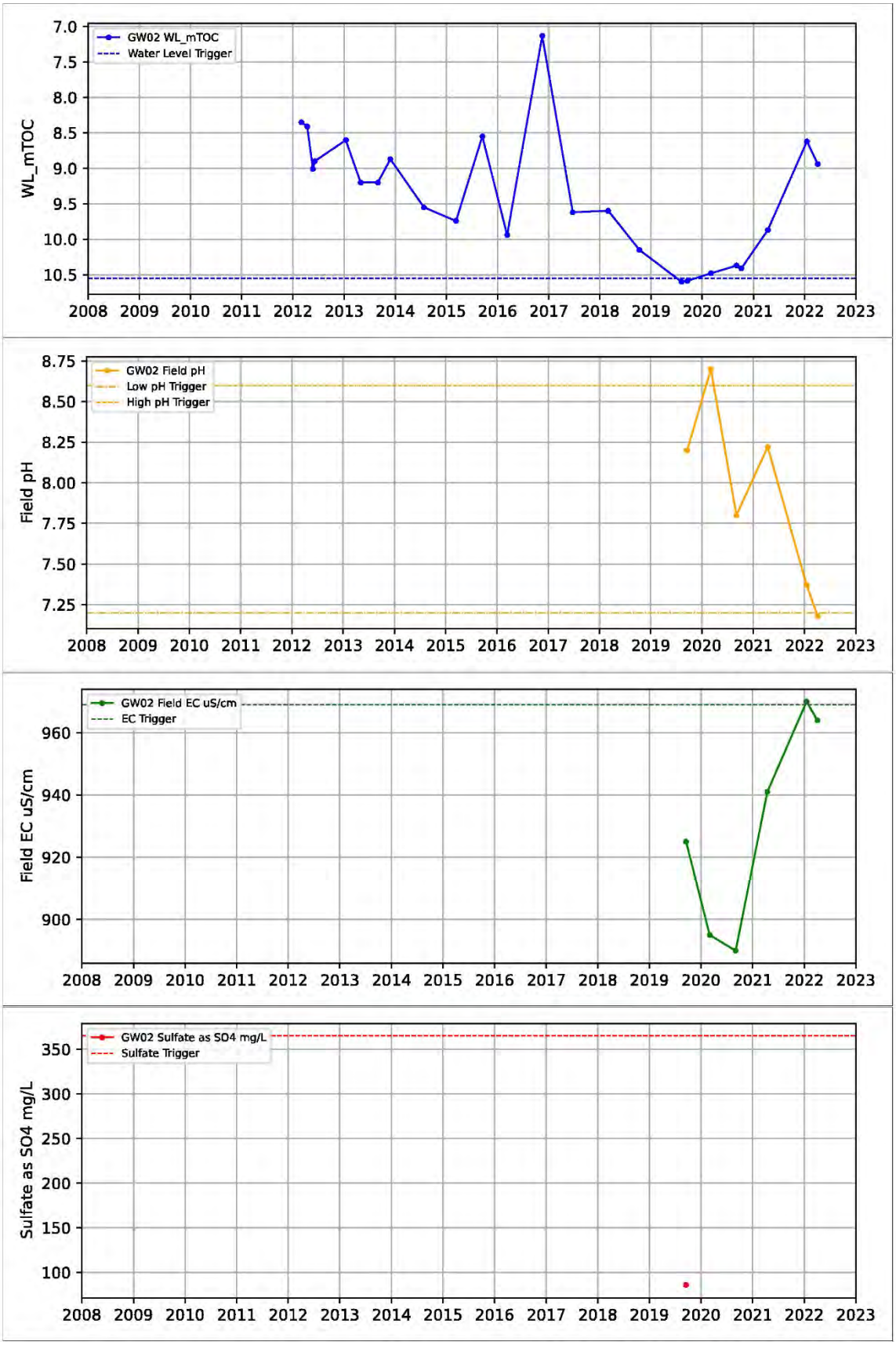
Water Level Trigger
WL_mTOC
9.0
9.5
10.0
10.5
11.0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
GW01 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.2
8.0
7.8
7.6
7.4
7.2
7.0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
GW01 Field EC uS/cm
EC Trigger
Field EC uS/cm
10000
8000
6000
4000
2000
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
GW01 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
380
370
360
350
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023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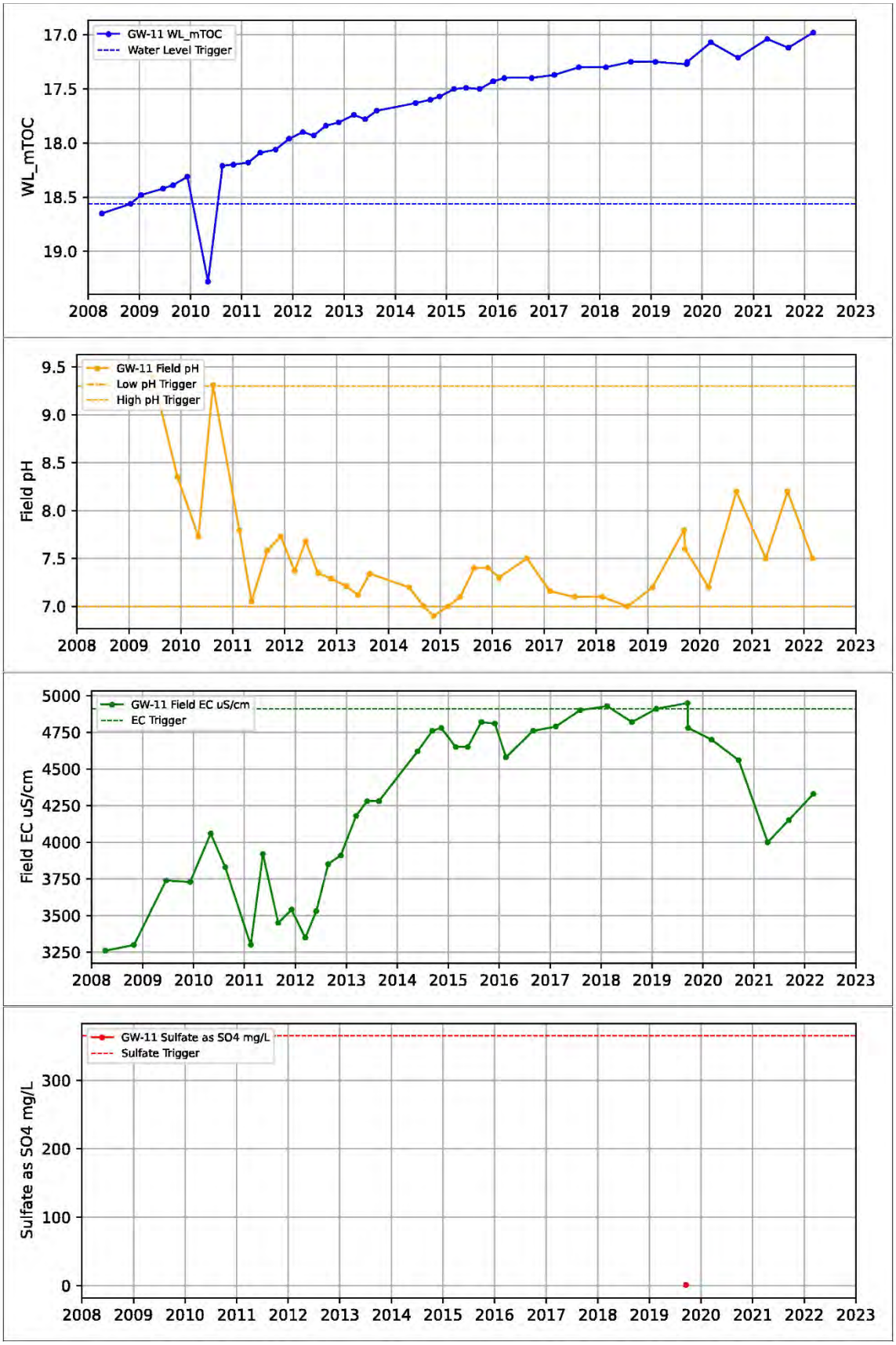
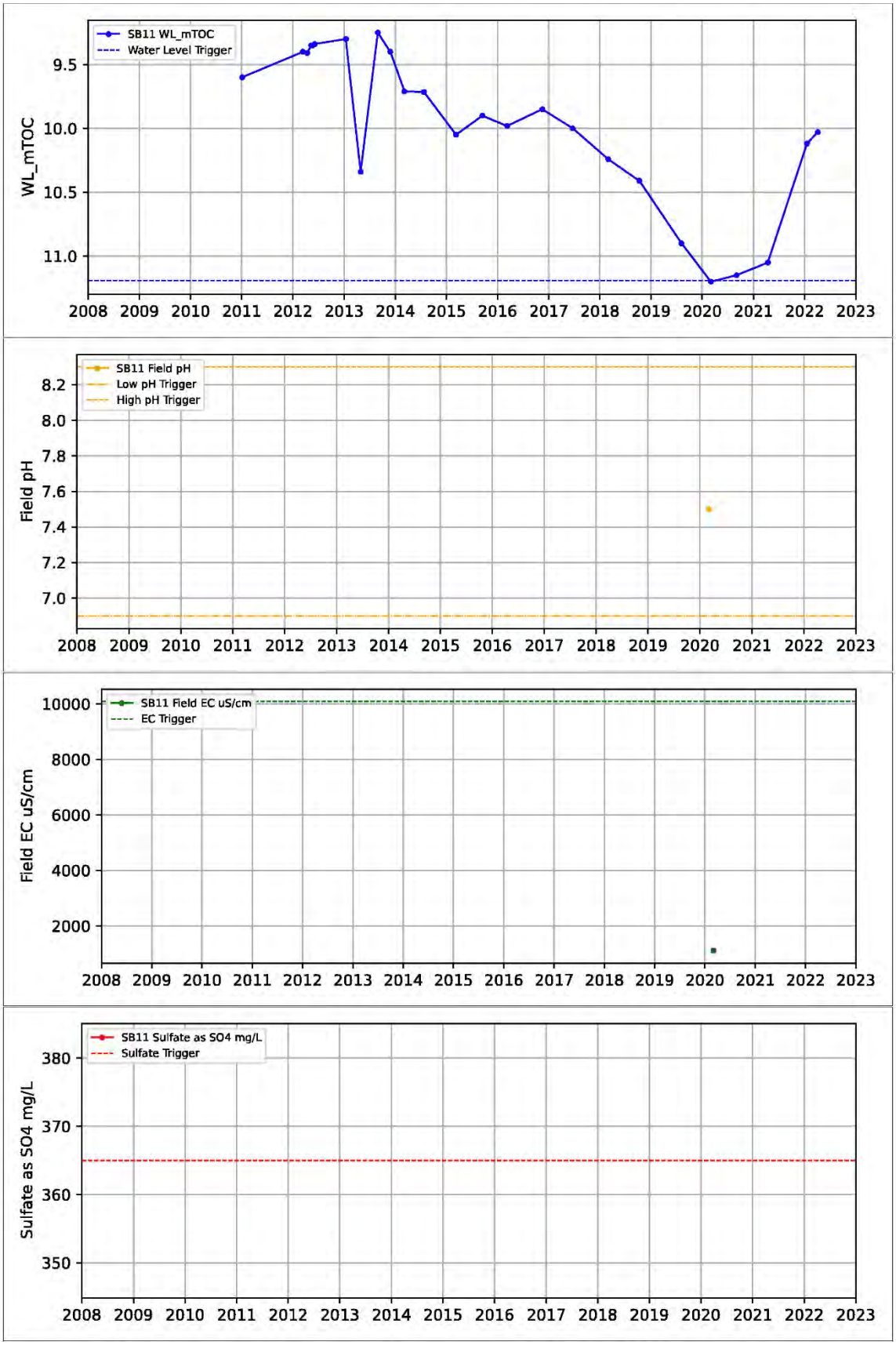
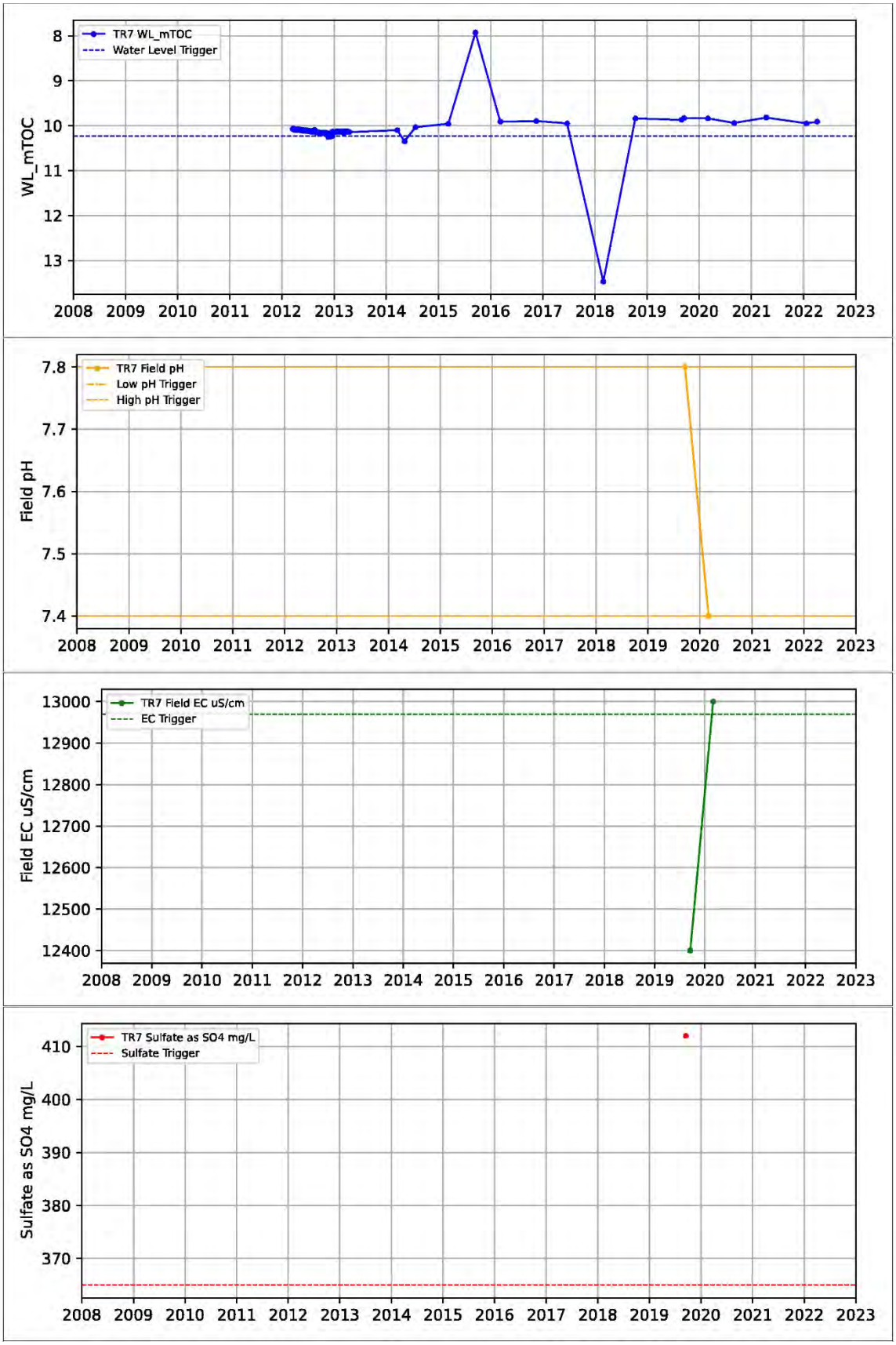
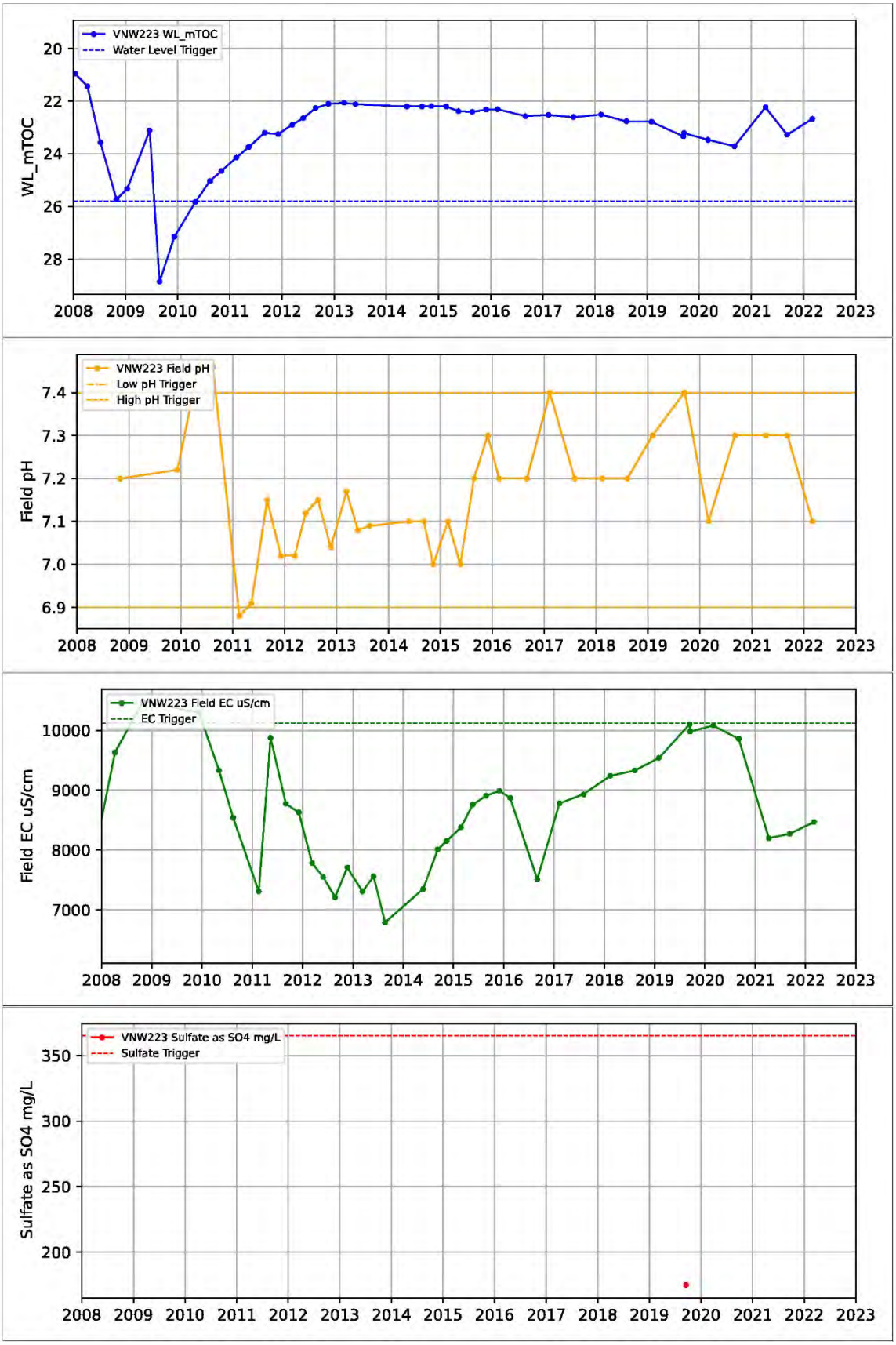
Water Level Trigger
WL_mTOC
GW02 Field pH
Low pH Trigger
High pH Trigger
Field pH
GW02 Field EC uS/cm
EC Trigger
Field EC uS/cm
GW02 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

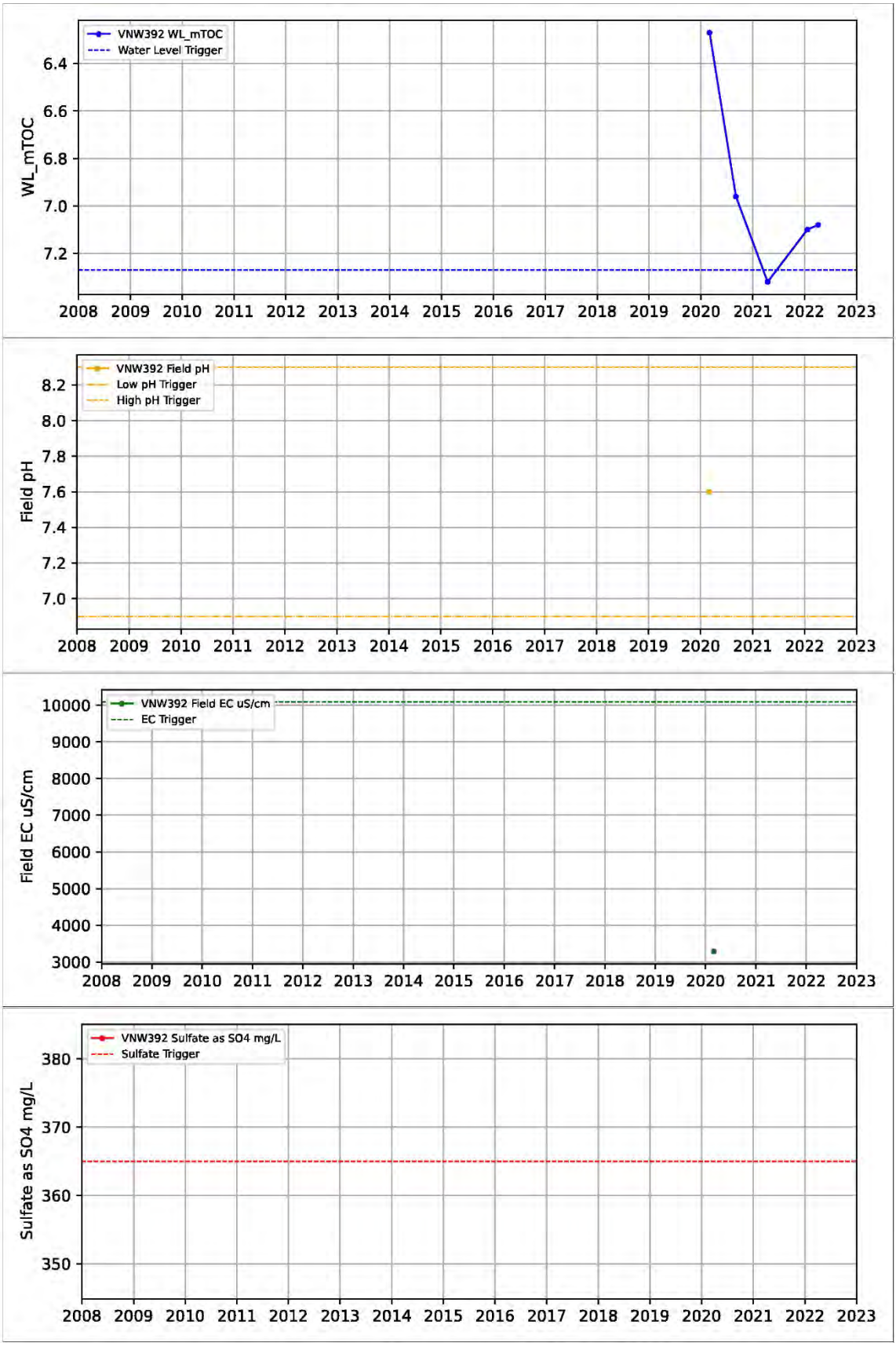

GW03 WL_mTOC
Water Level Trigger
WL_mTOC
GW03 Field pH
Low pH Trigger
High pH Trigger
Field pH
GW03 Field EC uS/cm
EC Trigger
Field EC uS/cm
GW03 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

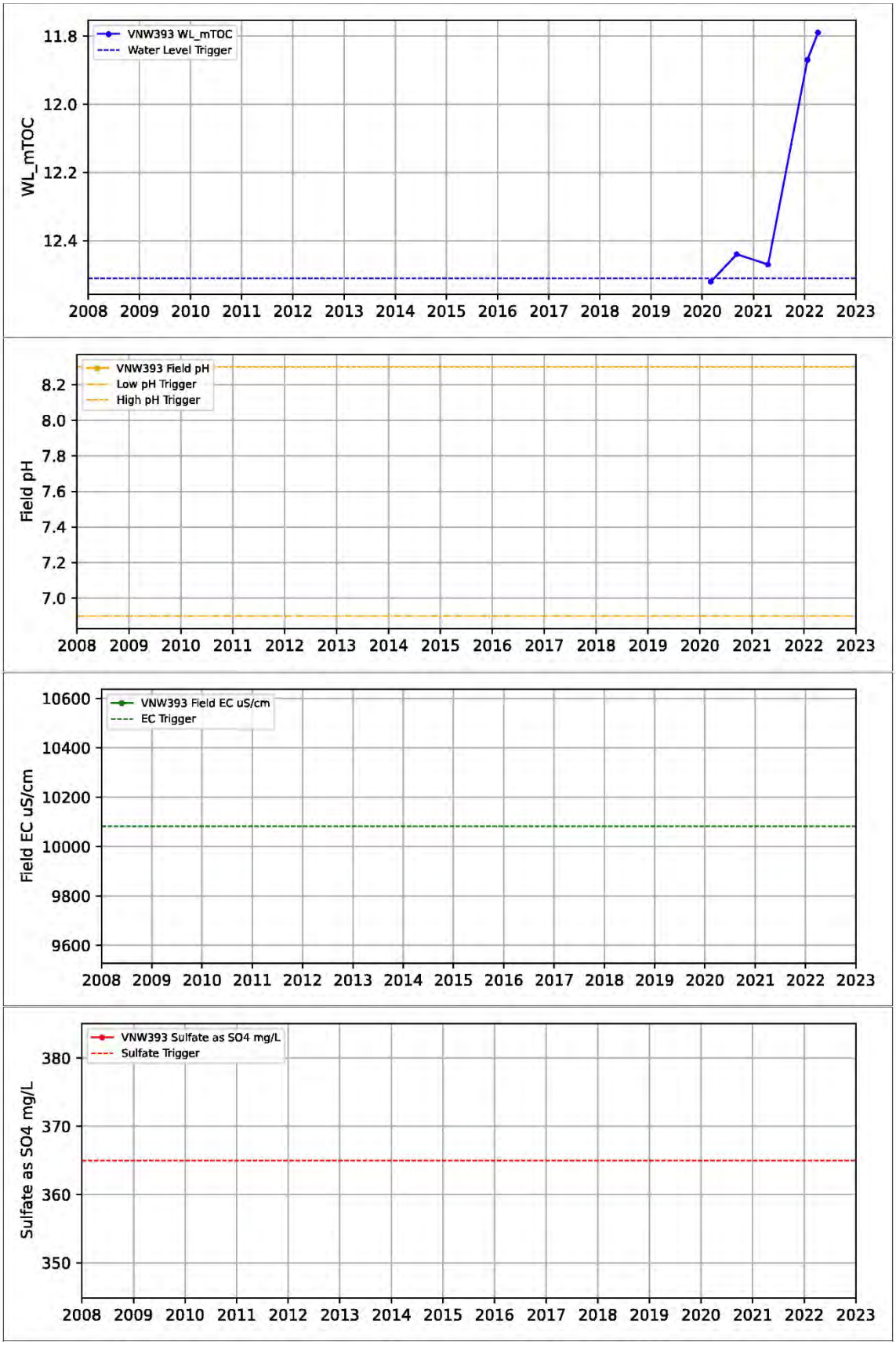

GW-11 WL_mTOC
Water Level Trigger
WL_mTOC
17.0
17.5
18.0
18.5
19.0
GW-11 Field pH
Low pH Trigger
High pH Trigger
Field pH
9.5
9.0
8.5
8.0
7.5
7.0
GW-11 Field EC uS/cm
EC Trigger
Field EC uS/cm
5000
4750
4500
4250
4000
3750
3500
3250
GW-11 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
300
200
100
0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

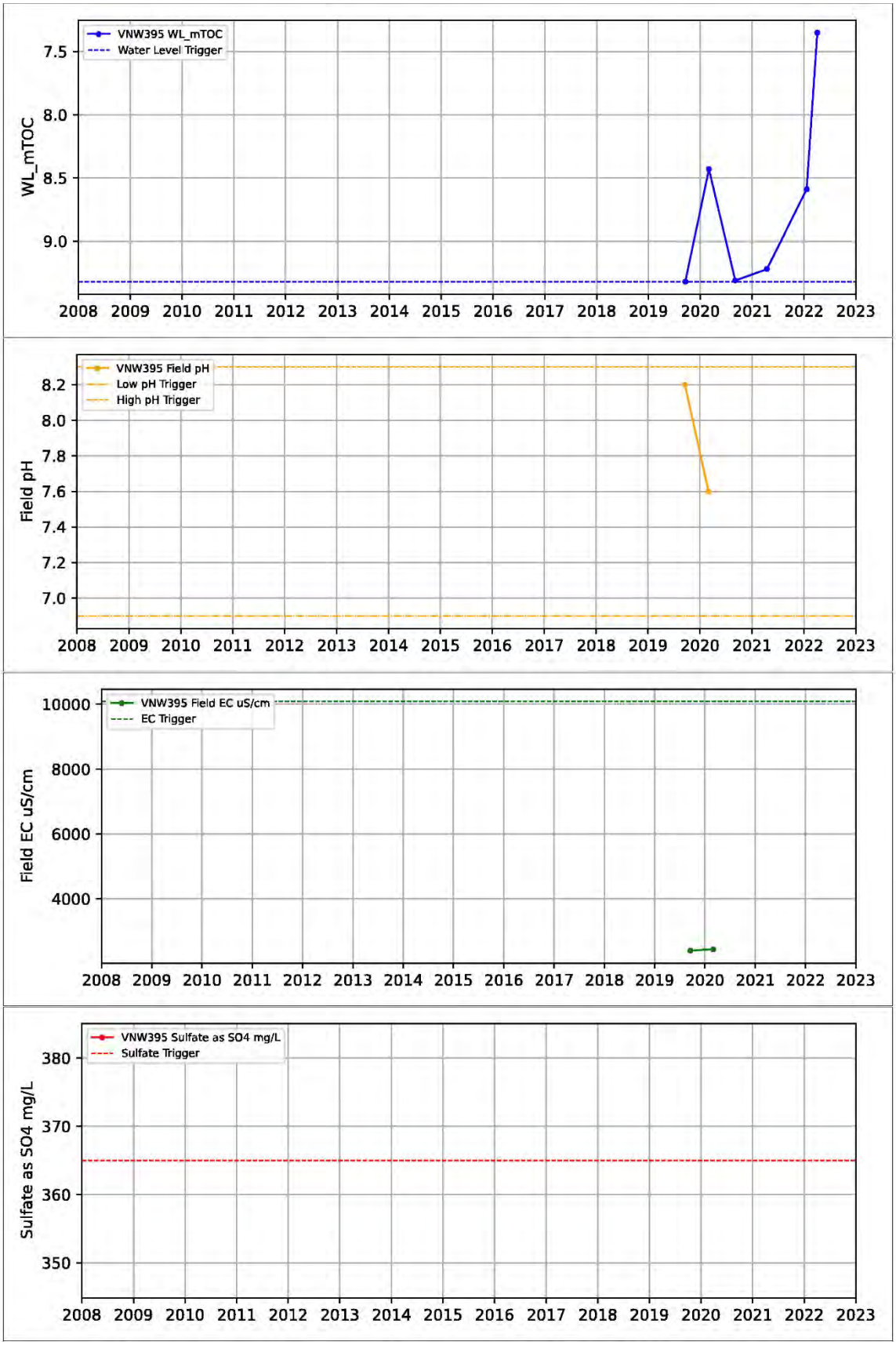

SB11 WL_mTOC
Water Level Trigger
WL_mTOC
9.5
10.0
10.5
11.0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
SB11 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.2
8.0
7.8
7.6
7.4
7.2
7.0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
SB11 Field EC uS/cm
EC Trigger
Field EC uS/cm
10000
8000
6000
4000
2000
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
SB11 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
380
370
360
350
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


TR7 WL_mTOC
Water Level Trigger
WL_mTOC
8
9
10
11
12
13
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
TR7 Field pH
Low pH Trigger
High pH Trigger
Field pH
7.8
7.7
7.6
7.5
7.4
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
TR7 Field EC uS/cm
EC Trigger
Field EC uS/cm
13000
12900
12800
12700
12600
12500
12400
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
TR7 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
410
400
390
380
370
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


VNW223 WL_mTOC
Water Level Trigger
WL_mTOC
VNW223 Field pH
Low pH Trigger
High pH Trigger
Field pH
VNW223 Field EC uS/cm
EC Trigger
Field EC uS/cm
VNW223 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


VNW392 WL_mTOC
Water Level Trigger
WL_mTOC
6.4
6.6
6.8
7.0
7.2
VNW392 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.2
8.0
7.8
7.6
7.4
7.2
7.0
VNW392 Field EC uS/cm
EC Trigger
Field EC uS/cm
10000
9000
8000
7000
6000
5000
4000
3000
VNW392 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
380
370
360
350
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


VNW393 WL_mTOC
Water Level Trigger
WL_mTOC
11.8
12.0
12.2
12.4
VNW393 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.2
8.0
7.8
7.6
7.4
7.2
7.0
VNW393 Field EC uS/cm
EC Trigger
Field EC uS/cm
10600
10400
10200
10000
9800
9600
VNW393 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
380
370
360
350
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023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Water Level Trigger
WL_mTOC
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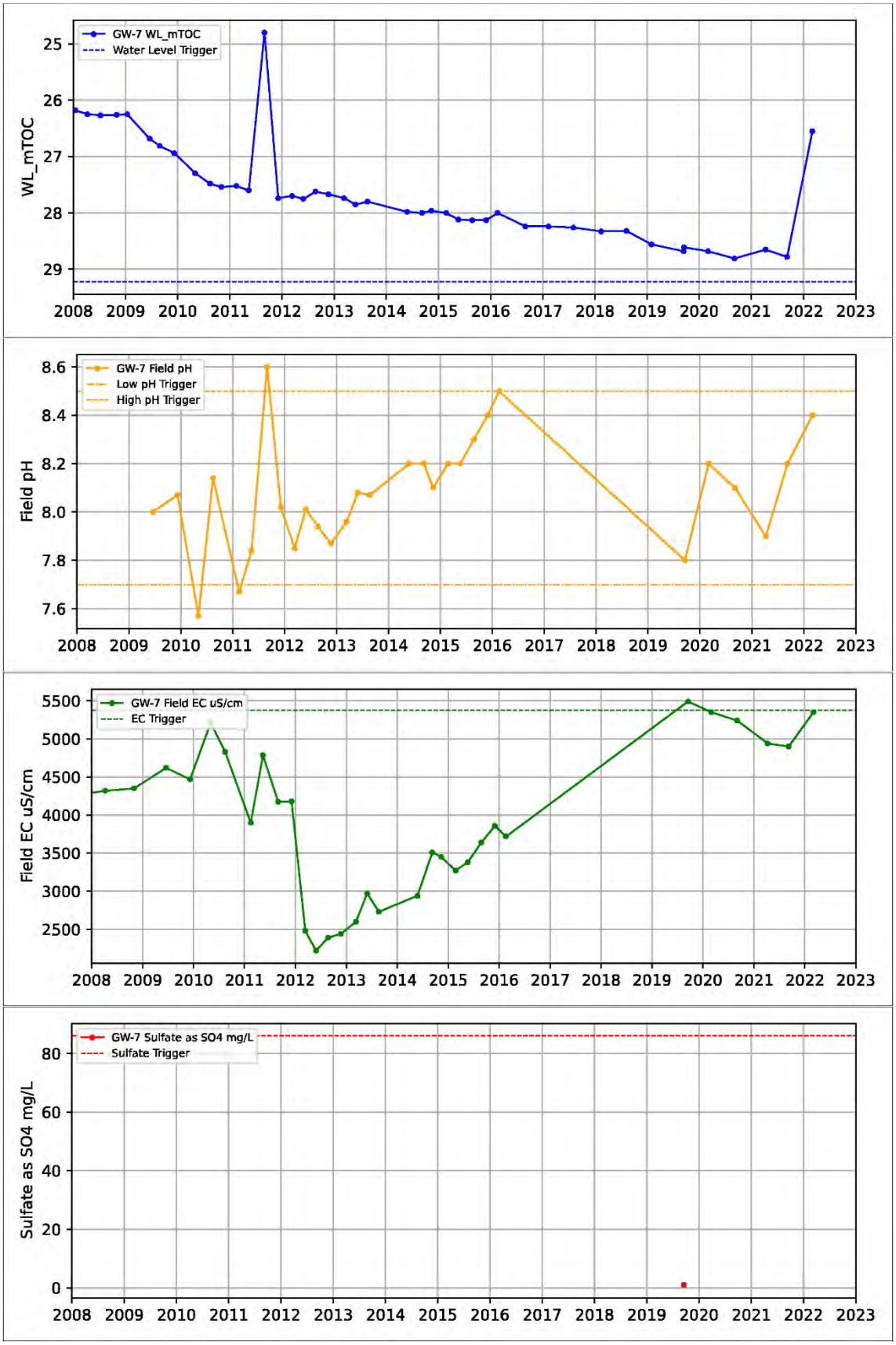
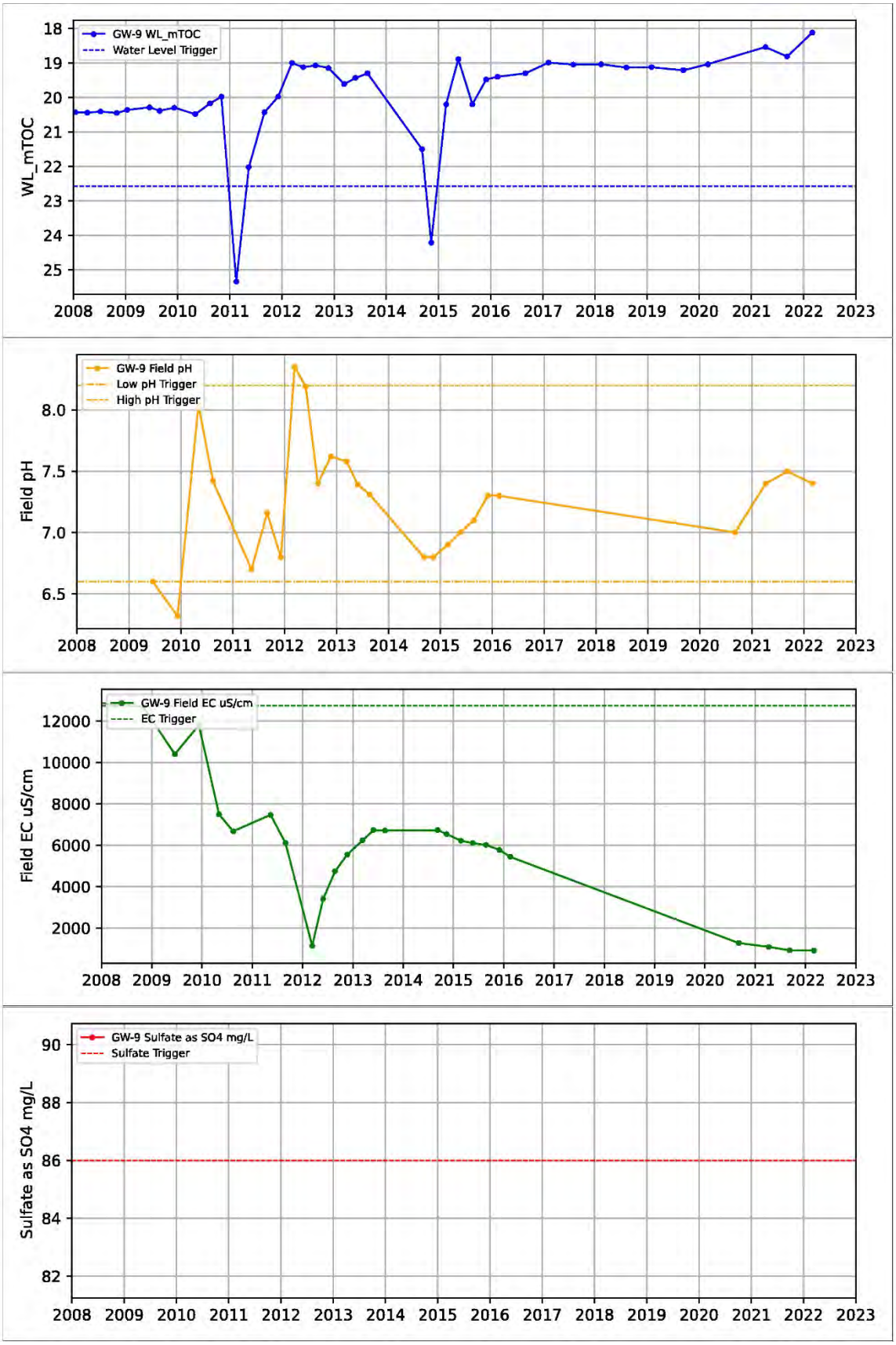
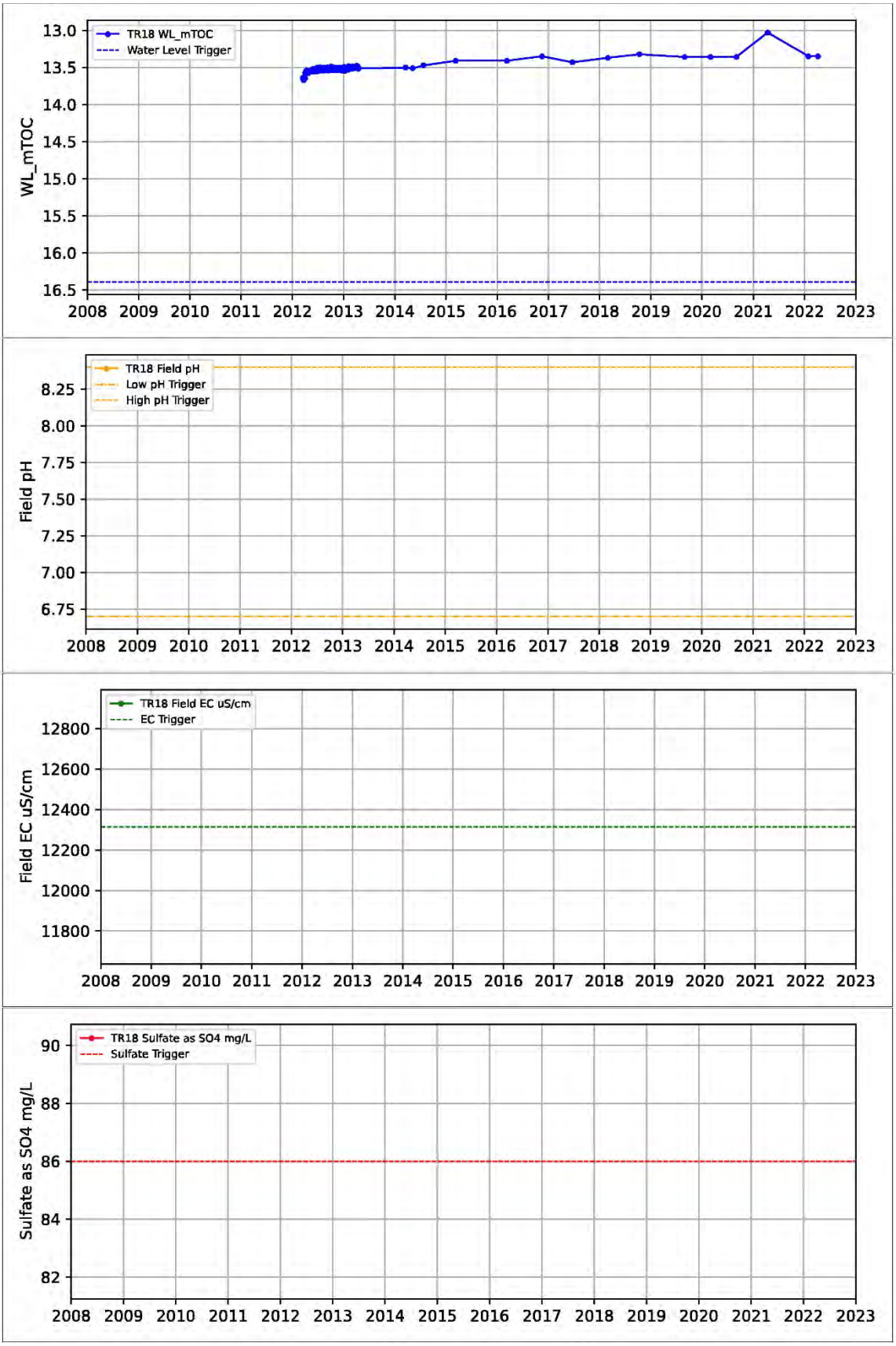
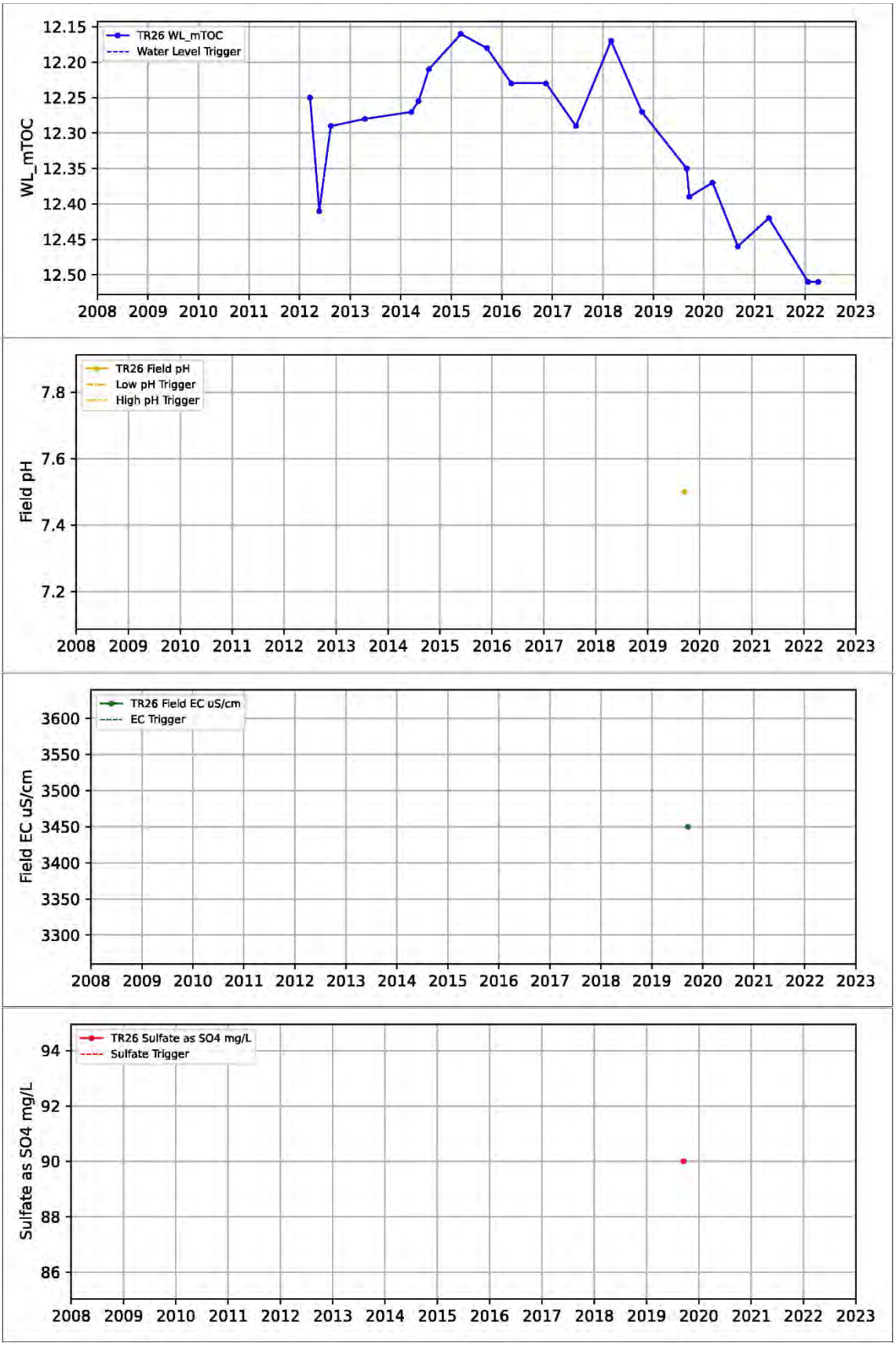
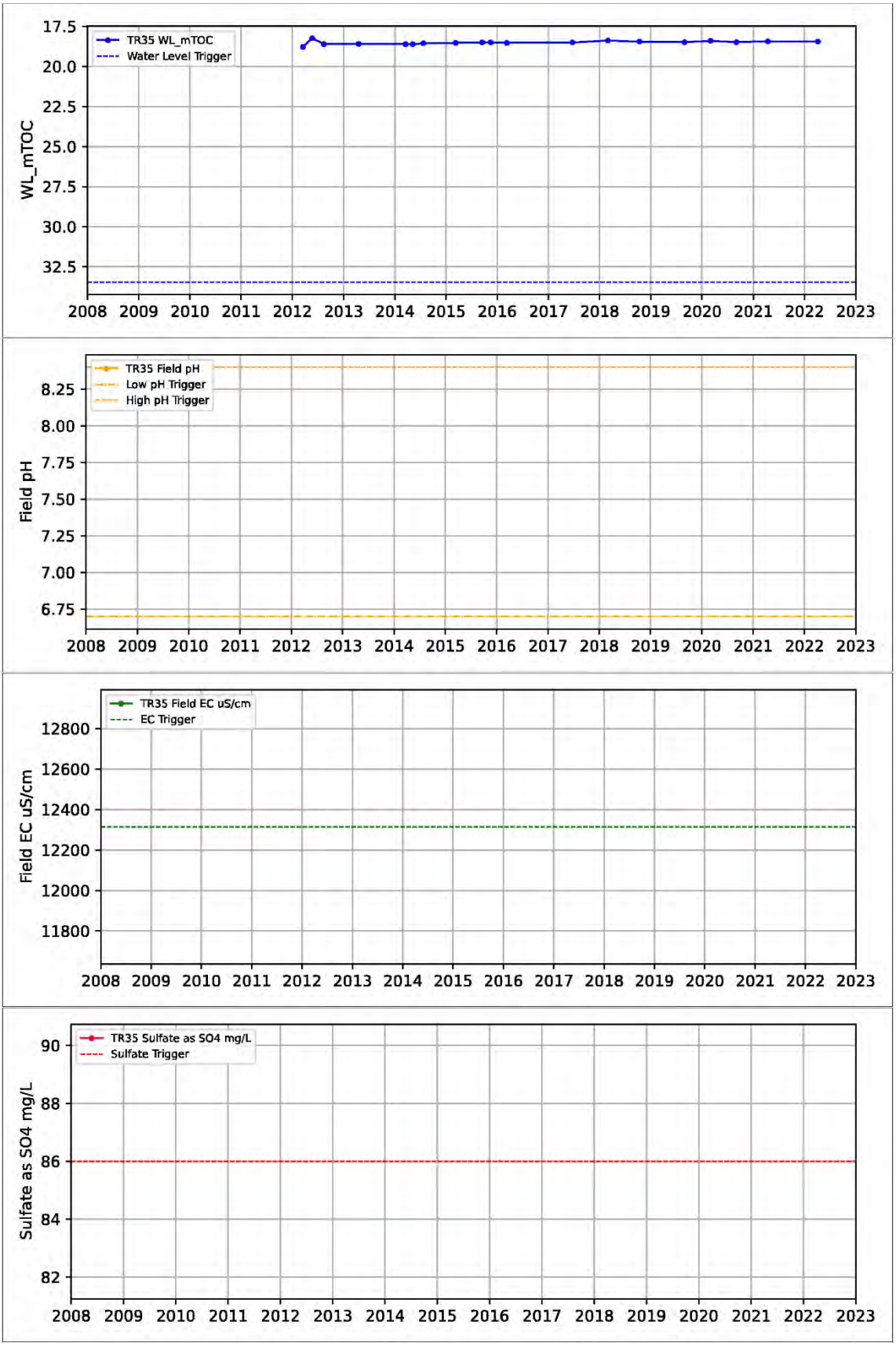
8.0
8.5
9.0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
VNW395 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.2
8.0
7.8
7.6
7.4
7.2
7.0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
VNW395 Field EC uS/cm
EC Trigger
Field EC uS/cm
10000
8000
6000
4000
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
VNW395 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
380
370
360
350
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

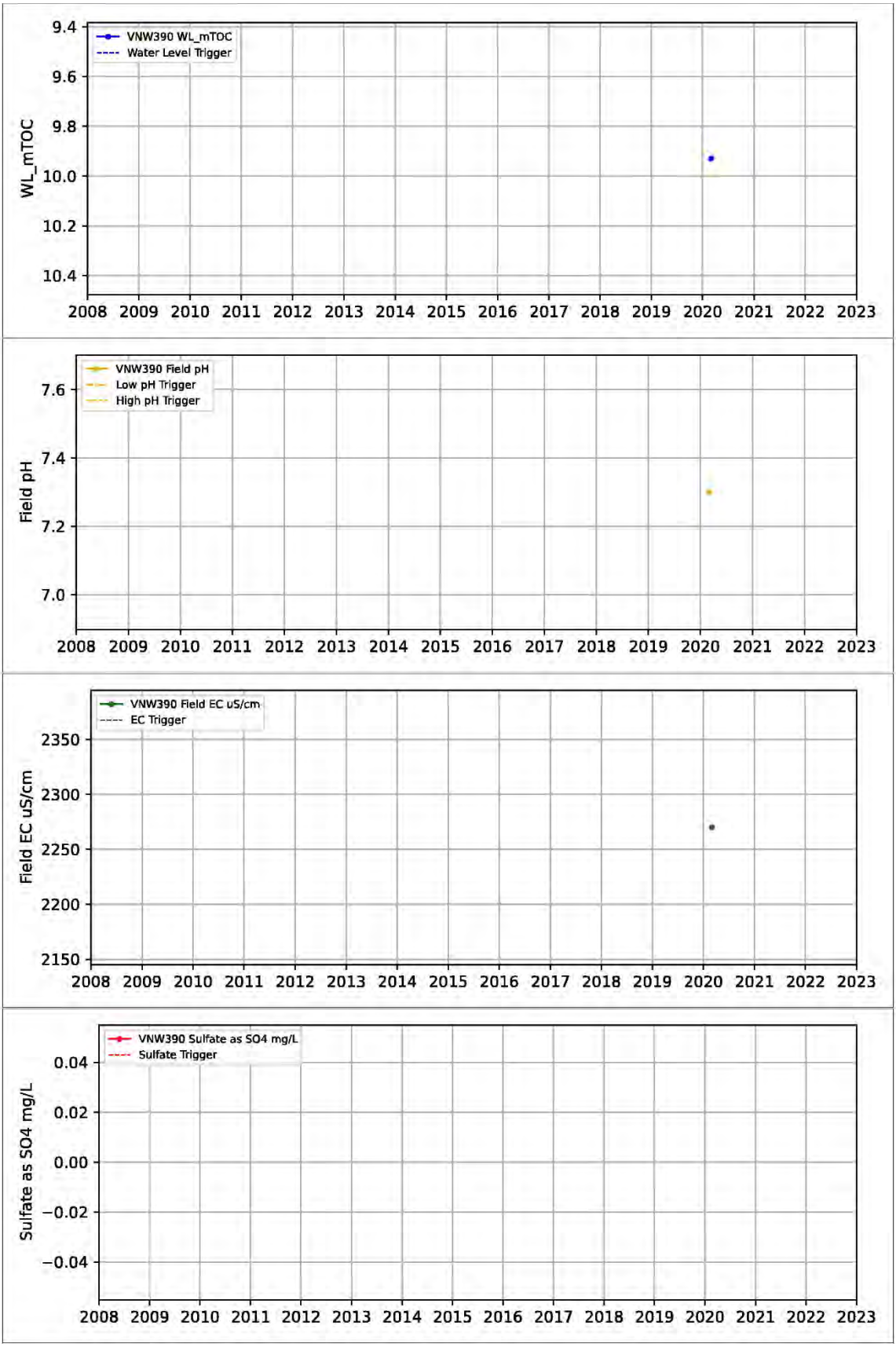

GW-7 WL_mTOC
Water Level Trigger
WL_mTOC
25
26
27
28
29
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
GW-7 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.6
8.4
8.2
8.0
7.8
7.6
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
GW-7 Field EC uS/cm
EC Trigger
Field EC uS/cm
5500
5000
4500
4000
3500
3000
2500
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
GW-7 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
80
60
40
20
0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


GW-9 WL_mTOC
Water Level Trigger
WL_mTOC
GW-9 Field pH
Low pH Trigger
High pH Trigger
Field pH
GW-9 Field EC uS/cm
EC Trigger
Field EC uS/cm
GW-9 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


TR18 WL_mTOC
Water Level Trigger
WL_mTOC
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
TR18 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.25
8.00
7.75
7.50
7.25
7.00
6.75
TR18 Field EC uS/cm
EC Trigger
Field EC uS/cm
12800
12600
12400
12200
12000
11800
TR18 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
90
88
86
84
82
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


TR26 WL_mTOC
Water Level Trigger
WL_mTOC
12.15
12.20
12.25
12.30
12.35
12.40
12.45
12.50
TR26 Field pH
Low pH Trigger
High pH Trigger
Field pH
7.8
7.6
7.4
7.2
TR26 Field EC uS/cm
EC Trigger
Field EC uS/cm
3600
3550
3500
3450
3400
3350
3300
TR26 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
94
92
90
88
86
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


TR35 WL_mTOC
Water Level Trigger
WL_mTOC
17.5
20.0
22.5
25.0
27.5
30.0
32.5
TR35 Field pH
Low pH Trigger
High pH Trigger
Field pH
8.25
8.00
7.75
7.50
7.25
7.00
6.75
TR35 Field EC uS/cm
EC Trigger
Field EC uS/cm
12800
12600
12400
12200
12000
11800
TR35 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
90
88
86
84
82
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


VNW390 WL_mTOC
Water Level Trigger
WL_mTOC
9.4
9.6
9.8
10.0
10.2
10.4
VNW390 Field pH
Low pH Trigger
High pH Trigger
Field pH
7.6
7.4
7.2
7.0
VNW390 Field EC uS/cm
EC Trigger
Field EC uS/cm
2350
2300
2250
2200
2150
VNW390 Sulfate as SO4 mg/L
Sulfate Trigger
Sulfate as SO4 mg/L
0.04
0.02
0.00
−0.02
−0.04
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023