Bayswater Water and Other Associated Operational Works Project

Appendix D – Surface Water, Groundwater and Flooding Technical Paper

Water and Other Associated Operational Works (WOAOW) Project

AGL Macquarie

Surface Water, Groundwater and Flooding Technical Paper

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Water and Other Associated Operational Works (WOAOW) Project

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Contents

Glossary of terms and abbreviations

Term/Acronym	Meaning
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AIP	Aquifer Interference Policy
ASRIS	Australian Soil Resource Information System
ASS	Acid Sulfate Soils
BGL	Below Ground Level
BH	Borehole
BOM	Bureau of Meteorology
BTEXN	Benzene Toluene Ethylbenzene Xylenes and Naphthalene
BWAD	Bayswater Ash Dam
CEMP	Construction Environmental Management Plan
CRD	Cumulative rainfall deviation
DPIE	Department of Planning, Industry and Environment
EC	Electrical conductivity
EIS	Environmental Impact Statement
ESCP	Erosion and sediment control plan
GDE	Groundwater dependent ecosystem
HP	High pressure
HRSTS	Hunter River Salinity Trading Scheme
LSP	Lime Softening Plant
LTAAEL	Long-term average annual extraction limit
LTV	Long-term trigger value
NWQMS	National Water Quality Management Strategy
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PMF	Probable Maximum Flood
RL	Reduced Level
SCP	Seepage Collection Pond
SEARs	Secretary's Environmental Assessment Requirements
SILO	Scientific Information for Land Owners
SRE	Sensitive receiving environment
STV	Short-term trigger value

Term/Acronym	Meaning
TDS	Total dissolved solids
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids
WAL	Water access license
WM Act	Water Management Act 2000 (NSW)
WM Reg	Water Management Regulation 2018 (NSW)
WQO	Water Quality Objective
WSP	Water Sharing Plan

Executive Summary

Project background

AGL Macquarie owns and operates Bayswater Power Station (**Bayswater**), located approximately 16 kilometres south-east of Muswellbrook, NSW. Bayswater was commissioned in 1985 to utility standards of the time and has a current technical life up to 2035. Prior to its retirement, water and wastewater infrastructure and site upgrades (the '**Project**)' are required to ensure its continued operational and environmental performance.

Jacobs, on behalf of AGL Macquarie, has been commissioned to prepare an Environmental Impact Statement (**EIS**) for the assessment of infrastructure and water upgrade works, in accordance with Division 4.7 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Purpose of this report

This report presents the results of a surface water (including flooding) and groundwater assessment for the Project. The report has been prepared to support the EIS for the Project, which has been prepared to address the Secretary's Environmental Assessment Requirements (**SEARs**) for the Project.

Approach to assessment

The surface water and groundwater assessment was undertaken by considering the following:

- The existing environment, including the local hydrological and hydrogeological setting;
- Legislation and policy relevant to surface water and groundwater;
- Project characteristics that are relevant to surface water and groundwater;
- Potential surface water and groundwater related impacts which may arise due to the Project; and
- Appropriate monitoring and mitigation measures to ensure potential impacts are addressed.

Overview of Project improvements to water quality

The Project's upgrades are anticipated to improve water quality and quantity as follows:

- Upgrades to the coal handling plant (CHP) are expected to reduce stormwater flows, increase re-use of water within the coal plant and reduce the quantity of discharge water from Coal Settling Basin (CSB).
- Upgrades to the existing seepage collection dams located downslope of the Bayswater Ash Dam (BWAD), which currently collect water that seeps through the BAWD wall, are expected to improve seepage collection effectiveness.

Overview of potential impacts and proposed mitigation and monitoring measures

Surface water

The following surface water risks have been identified:

- Potential impacts to surface water during construction may arise as a result of removal of vegetation, stripping of topsoil, excavation, stockpiling, concreting, instream works, transportation of cut and fill and accidental spills and leaks.
- The subsequent impact to water quality could be increased turbidity, suspended solids, nutrients and contaminants from mobilisation of soils, which in turn could lead to increased weed growth and algal

blooms and smothering of aquatic organisms. Oily films, increased alkalinity and pH, and elevated concentrations of toxicants from concreting works and accidental leaks and spills could result in reduced health of aquatic organisms.

- Waterways at greatest risk are those directly impacted (instream works) or located in close proximity to construction works and include Wisemans Creek, Pikes Creek, Saltwater Creek, Bayswater Creek and Chilcotts Creek.
- During operation, there is the potential for increased seepage from augmentation of Ash Dam, uncontrolled stormwater runoff and contaminant leachate from the salt cake facility and erosion and sedimentation from the operation of the borrow pits, all of which have the potential to impact on surface water quality of downstream waterways.
- If the proposed ash line leaks, the ash/water mix could ultimately migrate to nearby creeks and streams, in particular, Lake Liddell, Chillcotts Gully, Pikes Creek and Bayswater Creek.

The following surface water monitoring and mitigation measures are proposed:

- A Construction Soil and Water Management Plan will be developed and will include measures to minimise and manage erosion and sediment transport, measures to manage stockpiles, accidental spills and potential saline soils. The plan will also document measures to manage dewatering from site and sediment basins and provide recommended discharge criteria.
- Stockpiles will be located away from waterways and appropriately bunded to reduce the risk to water quality.
- Design and implementation of drainage features will be in accordance with relevant guidelines.
- A water quality monitoring plan will be developed for implementation during construction and operation to monitor water quality and confirm that controls implemented are working effectively.

Groundwater

The following groundwater risks have been identified:

- If the landfill's leachate collection liner leaks, it is possible that saline or briny water could migrate from the area of the landfill and move towards sensitive receptors. Potential sensitive receptors include vegetation surrounding the proposed landfill and ephemeral drainage lines and water bodies down-gradient of the proposed landfill.
- If borrow pit excavations intersect the water table, drawdown to groundwater levels could occur, and intercepted groundwater volumes may require discharge.
- Increasing the ash dam wall level with addition of a concrete parapet could lead to increased seepage flows through the existing dam wall due to the potential for increases in ash dam water head. Some of this seepage could migrate to underlying groundwater systems.
- During construction and operation, groundwater could be contaminated if spills or leaks of hazardous materials occur. Such spills/leaks may include, but not be limited to, oils, lubricants and fuels used by construction plant.
- If underbore excavations for underground lengths of the ash line intercept groundwater, the excavations could depressurise groundwater systems and lead to groundwater level drawdown.
- If underbore drilling for underground lengths of the ash line intercepts groundwater, drilling fluids could contaminate groundwater systems.
- If the proposed ash line leaks, the ash/water mix could ultimately migrate to groundwater systems.

The following groundwater monitoring and mitigation measures are proposed:

- A groundwater monitoring plan has been prepared, including groundwater monitoring in the area of the proposed salt cake landfill and borrow pit areas, plus monitoring of seepage through the ash dam wall.
- If groundwater is unexpectantly intersected during borrow pit excavations, excavations should cease in that area and the date, location, level and depth of groundwater interception should be documented by the contractor and conveyed to a hydrogeologist. The hydrogeologist is to then determine an appropriate course of action depending on the specifics of the situation. Such a course of action may include re-location of excavations to higher areas of elevation where groundwater would likely be deeper and establishment of routine monitoring of the monitoring bores in the vicinity of the borrow pits.
- If monitoring indicates that after implementation of the proposed upgrades to the seepage collection dams, that the dams are not effectively collecting seepage, then additional seepage collection dam upgrades should be made, or alternatively, the seepage collection system be re-designed and re-constructed.
- The salt cake landfill liner should be designed to ensure leachate and salt cakes will not geochemically compromise the elected liner type due to reactions.
- If underbores are drilled for the Ravensworth Ash Line, and drilling fluids are required, where possible, freshwater should be used. Where this is not possible, environmentally friendly biodegradable drilling fluid should be used.
- The above-ground sections of the Ravensworth Ash Line should be routinely daily for leaks at least annually. Observed leaks should be rectified.
- Impacts of potential spills/leaks of hazardous materials should be mitigated through regular plant maintenance and checks. Onsite spill kits will be provided. There should be an established spill clean-up procedure and where appropriate, remediation of potential contamination sources after a spill, including removal of the contamination source where required (e.g. through offsite removal and disposal to an appropriately licensed waste facility or disposed of onsite in line with the Environment Protection License).

Flooding

Construction of the Project elements has the potential to cause adverse impacts on flooding if management measures are not implemented, monitored and maintained throughout the construction phase. The following construction activities have the potential to impact on flooding:

- Removal of vegetation, general earthworks, including stripping of topsoil and excavation.
- Stockpiling of topsoil, vegetation and construction materials.
- Temporary works (e.g. waterway crossings, embankments, outlet works, diversion of waterways etc).

Potential operational impacts of the Project on flooding include the following:

- Any failure of the augmented BWAD would result in similar, however slightly enlarged inundation area than the existing BWAD. Being a Significant Consequence Category Dam, the augmented BWAD needs to satisfy the current regulatory requirements.
- The salt cake landfill facility may encroach on the floodway for the 1% AEP event and may have adverse impacts on flooding.
- The borrow pits have the potential to divert and re-distribute flood flows which may result in adverse impacts on scouring and bank erosion.
- The Ravensworth ash line could be damaged or destroyed by flooding and the pipeline could have adverse impacts on flooding.
- The flooding assessment for the CHP water and wastewater infrastructure upgrade options needs to be updated to confirm impacts.

The following mitigation measures are proposed to address flooding risks:

- Temporary works will consider flood impacts during construction. Should construction staging require a temporary departure from the design (e.g. higher embankments for preloading, temporary diversions or temporary crossings of waterways), flood impacts will be assessed before finalising the approach.
- Where stockpiles are to be located in the floodplain, they will be located and sized to ensure no adverse impacts on flood behaviour.
- A flood management plan will be prepared for the construction stage. The plan will consider likelihood of flooding, flood evacuation routes, warning times and potential impacts from flooding from the Project elements.
- Temporary crossings on water courses will be designed with consideration of flooding during construction and removal and rehabilitation following completion of construction.
- Dam break inundation maps will be prepared utilising a two-dimensional hydraulic modelling software (eg. TUFLOW or equivalent) based on the current relevant guidelines.
- A detailed assessment of the flood handling capacity for the dam will be undertaken for each of the augmentation stages based on the current relevant guidelines and regulatory requirements. The consequence categories for each of the augmentation stages will be reassessed and inundation maps will be prepared to inform the Dam Safety Emergency Plan.
- A detailed flood study will be undertaken at the detailed design stage to confirm that the salt cake landfill facility will not encroach the floodway in the 1% AEP event.

Conclusion

Based on a review of surface water and groundwater data, along with an analysis of the existing environmental setting and an assessment of the Project’s characteristics, with adoption of mitigation measures, the Project is expected to generate acceptable impacts to surface water and groundwater systems.

Important note about your report

The sole purpose of this report is to present the findings of a surface water and groundwater impact assessment, in connection with proposed updates to Bayswater Power Station (Bayswater), to enable key information to be drawn into the Project's Environmental Impact Statement (EIS). The report was commissioned by AGL Macquarie ('the Client') and is limited to the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

The findings presented in this report are professional opinions based upon public domain information sources, site data collected by Jacobs and information and data provided or made available by the Client.

Jacobs has relied upon and presumed that the information provided by the Client and from the public domain is accurate and Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete, or if conditions change, then it is possible that any conclusions as expressed in this report may change. For the reasons outlined above, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report.

Reports and conclusions that deal with sub-surface conditions and more generally, environmental data, are typically based on interpretation and judgement and as a result have uncertainty attached to them. This report contains interpretations and conclusions which are uncertain, due to the nature of the investigations. No study can investigate every risk, and even a rigorous assessment and/or sampling program may not characterise all areas of a site.

This report is based on assumptions that the site conditions as revealed through sampling are indicative of conditions throughout the site. The findings are the result of standard assessment techniques used in accordance with normal practices and standards, and (to the best of Jacobs knowledge) they represent a reasonable interpretation of the current conditions on the site. Sampling techniques, by definition, cannot determine the conditions between the sample points and so this report cannot be taken to be a full representation of the sub-surface conditions. This report only provides an indication of the likely sub surface conditions.

Conditions encountered during construction/operation of Project elements may be different from those inferred in this report, for the reasons explained in this limitation statement. If site conditions encountered are different from those encountered during the Jacobs and others' site investigations, Jacobs reserves the right to revise any of the findings, observations and conclusions expressed in this report.

The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the Project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

Except as specifically stated in this report, Jacobs makes no statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

1. Introduction

AGL Macquarie owns and operates Bayswater, located approximately 16 kilometres south-east of Muswellbrook, NSW. Bayswater was commissioned in 1985 to utility standards of the time and has a current technical life up to 2035. Prior to its retirement, water and wastewater infrastructure and site improvements are required to ensure its continued operational and environmental performance.

The proposed Water and Other Associated Operational Works (**WOAOW**) Project (**Project**) at Bayswater would ensure the continued safe, efficient and reliable operation of the Power Station until its retirement. This Project provides the opportunity for improvements based on post-installation advances in water and wastewater management.

Jacobs, on behalf of AGL Macquarie has been commissioned to prepare an EIS for the assessment of infrastructure and water upgrade works, in accordance with Division 4.7 of the EP&A Act.

1.1 Description of the Project

The purpose of the Project is to improve the management of ancillary processes over the remaining operating life of Bayswater. The Project would include:

- Augmentation of the existing Bayswater ash dam (**BWAD**) to provide additional ash storage capacity;
- Improvements to water management structures and systems to ensure continued collection and reuse of process water and return waters from the BWAD;
- Improvements to the management of water and waste materials within the CHP sediment basin and associated drainage system;
- Increasing coal ash recycling activities to produce up to 1,000,000 tonnes per annum of ash derived product material and reuse of coal ash;
- Upgrades to existing fly ash harvesting infrastructure including the installation of weighbridges, construction of a new 240 tonne silo, tanker wash facility and additional truck parking;
- Construction and operation of a new coal ash pipeline to Ravensworth Void No. 5 for ash emplacement;
- Construction and operation of a salt cake landfill facility to dispose of salt cake waste; and
- Construction and operation of up to four borrow pits to facilitate the improvements proposed for the Project and other works on AGL Macquarie land.

In addition, the Project would include ancillary works such as repositioning underground pipelines above ground, routine clearing of vegetation along the alignments of the Lime Softening Plant (LSP) Sludge Line and High Pressure (HP) Pipeline to provide ongoing access for maintenance and management within the disturbance footprint.

1.1.1 Proposed water management description

AGL Macquarie have indicated that there will be no change to existing water supply arrangements/licensing due to the Project.

1.1.1.1 Coal handling plant

Discharges (overflows) to Tinkers Creek currently occur on a daily basis from the CHP sediment basin. CHP water and wastewater infrastructure upgrades are proposed as part of an Environmental Improvement Program at Bayswater to improve the quality of discharges from the sediment basin and associated systems. Upgrades to be undertaken as part of the Project may include implementing operational reuse of the coal plant water system through alterations/upgrades to the CHP such as belt cleaners, scrapers, trays and controls systems, and the construction of clean water diversions to reduce stormwater inflows to the CHP sediment basin. Water management systems, including the monitoring of the volume and quality of discharges to Tinkers Creek, would be continued.

1.1.1.2 Ash dam augmentation

The BWAD operates as a closed loop water system, with slurry water from the ash dam being transferred via return water pipelines around the northern perimeter to the return water tanks, located at the western ridgeline for reuse. The return water pipelines are connected to the return water pumps in the pumping station at the toe of the main embankment. The existing process for the management of water from within the ash dam would be continued. Water levels within the ash dam would be maintained at an appropriate level to ensure an adequate environmental freeboard is maintained and to avoid overtopping the spillway.

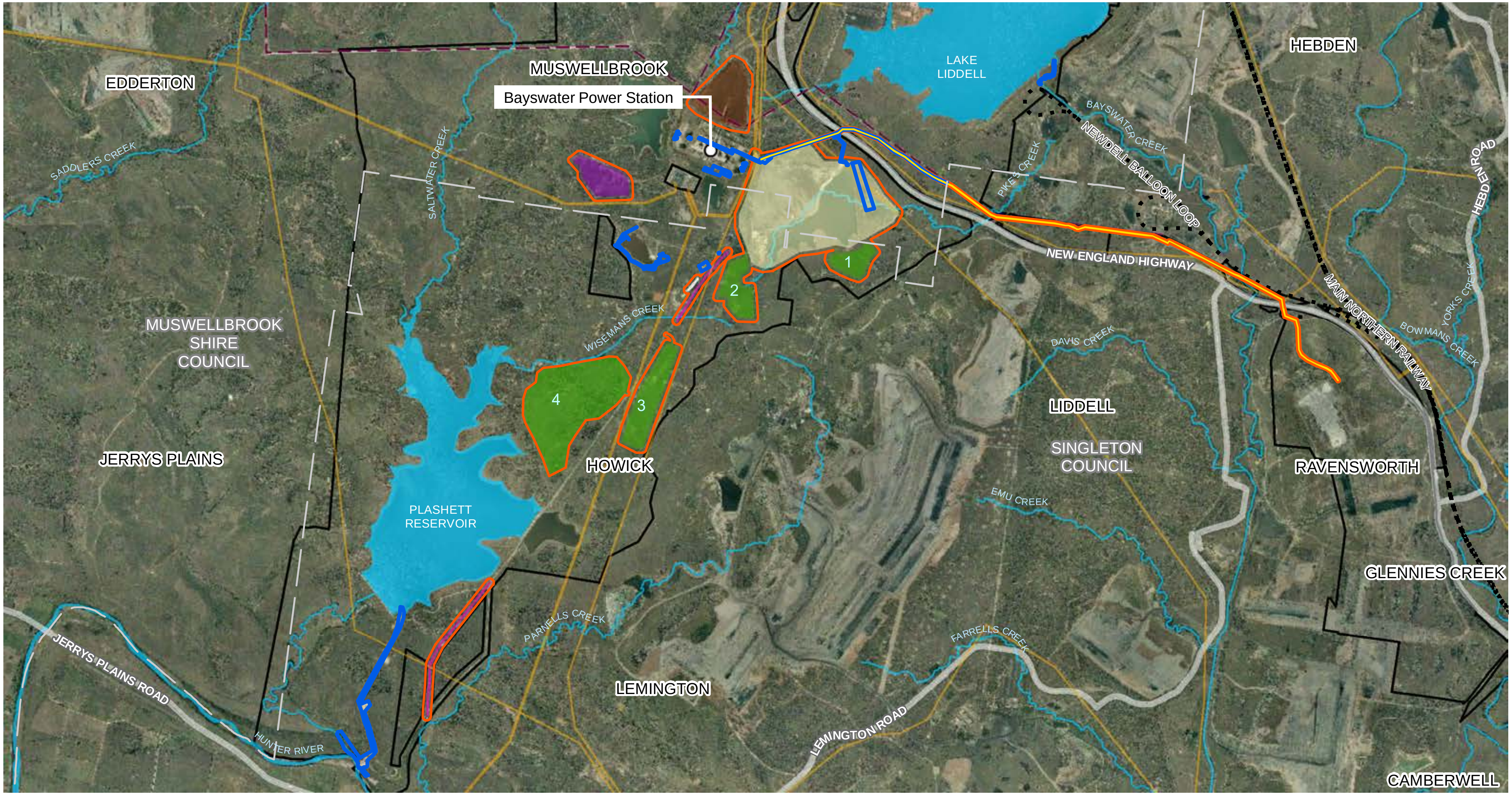
Seepage from the BWAD currently flows to the two seepage collection ponds at the toe of the main embankment, where it is pumped back to the BWAD (AGL Macquarie, January 2018). Works proposed as part of the BWAD augmentation include water management improvement works associated with the main and saddle dam walls including diversion of clean runoff around the site and installation of new, and upgraded, seepage capture and return infrastructure. The upgrade of the existing pumps is included in the scope of the Project and would be undertaken to achieve higher pumping rates to manage additional seepage.

Seepage flow rates would continue to be monitored and reported a part of the dam monitoring and surveillance reporting required by the Dam Safety Committee approvals.

Water requirements associated with other elements of the Project, for example for the upgraded Ash recycling facilities, would be sourced from existing onsite utilities. Water would be managed in accordance with AGL Macquarie’s existing water management systems.

1.2 Location and context

Bayswater (Figure 1.1) is located on the New England Highway, approximately 6 kilometres west of the locality of Liddell and approximately 16 kilometres south east of the township of Muswellbrook in the Upper Hunter Valley of New South Wales. Bayswater lies within the Local Government Areas of Muswellbrook and Singleton. The Project is predominately located on land owned by AGL Macquarie, although some Project infrastructure also crosses road reserves owned by Roads and Maritime and Singleton Council, and small areas of Crown land.



Study area
Local Government Area boundary
Footprints of approvals to be surrendered
AGL owned land
Railway
Electricity transmission line
Coal supply conveyor

Project elements:

Ash Dam Augmentation, Ash Harvesting and Water Management Works
Ravensworth Ash Line
Coal Handling Plant Water and Wastewater Infrastructure Upgrades
HP Pipe Clearing
LSP Sludge Line Clearing
Clay Borrow Pits
Salt Cake Landfill

Data sources
Jacobs 2019
AGL 2019
NSW Spatial Services 2019

GDA94 MGA56

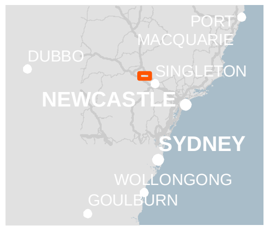


Figure 1 - 1 AGL Site Plan and Project Elements

1.3 Scope and purpose of this report

This report presents the results of a surface water (including flooding) and groundwater assessment for the Project. The report has been prepared to support the EIS for the Project, which has been prepared to address the SEARs for the Project.

The scope of this report is limited to surface water (including flooding) and groundwater. Primary objectives are to:

- Summarise proposed development details that are relevant to surface water and groundwater;
- Describe the proposed water management system;
- Summarise key legislation and policy relevant to surface water and groundwater;
- Summarise the existing environment, including the local hydrological and hydrogeological setting;
- Outline and assess potential surface water and groundwater related impacts which may arise due to the Project;
- Where required, outline measures to mitigate potential surface water and groundwater related impacts which may arise due to the Project; and
- Outline a brief surface water (including flooding) and groundwater monitoring program for the Project.

The report is structured as follows:

Section 1 – introduces the report and describes the proposed water management system;

Section 2 – provides an overview of legislation, policies and guidelines applicable to this assessment;

Section 3 – describes the methodology and approach for the assessment;

Section 4 – describes the existing environment with respect to the physical characteristics of the landscape and catchments, and existing water quality of the stream within the Project site. Groundwater data is also summarised;

Section 5 – provides an assessment of the impacts to surface water, groundwater and flooding during construction;

Section 6 – provides an assessment of the impacts to surface water, groundwater and flooding during operation;

Section 7 – summarises water balance of the Project;

Section 8 – provides recommended mitigation measures; and

Section 9 – concludes the key findings and recommendations from the investigation.

1.4 Secretary’s Environmental Assessment Requirements (SEARs)

The SEARs for the Project were issued on 30 November 2018. This report has been prepared in accordance with the SEARs. Table 1-1 below summarises the SEARs and outlines the relevant sections of this report where they have been addressed.

Table 1-1 Compliance with the water components of the SEARs

SEARs	Addressed in this report
The EIS must address the following specific matters:	
1) an assessment of the likely impacts of the development (including flooding) on the quantity and quality of the region’s surface and groundwater resources, related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts	Section 5, Section 6 and Section 7.
2) details of water requirements and supply arrangements for construction and operation;	Section 7, with additional detail provided in the EIS’s accompanying stand-alone water balance modelling report (Jacobs, 2019). AGL Macquarie have indicated that there will be no change to existing water supply arrangements/licensing due to the Project.
3) a description of the proposed water management system, water monitoring program and all other proposed measures to mitigate surface water and groundwater impacts; and	Section 1.1.1, Section 7 and Section 8
4) a description of the erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with *Managing Urban Stormwater: Soils & Construction – Volume 1* (Landcom 2004);	Section 8.1

2. Legislation and policy framework

The following section provides consideration of the legislative and policy framework for the surface water, groundwater and flooding assessment.

2.1 Surface Water

2.1.1 NSW Legislation

Environment Planning and Assessment Act (EP&A Act) 1979

The EP&A Act and the Environmental Planning and Assessment Regulation 2000 (**Regulation**) provides the framework for development assessment in NSW. The EP&A Act and the Regulation include provisions to ensure that the potential environmental impacts of a development are considered in the decision-making process prior to proceeding to construction.

The Project has been declared to be SSD and accordingly requires assessment in accordance with Division 4.7 of the EP&A Act. This EIS has been prepared to address the specific SEARs issued for the Project. The Minister for Planning and Public Spaces (formally the Minister for Planning) is the consent authority for SSD under the EP&A Act.

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (NSW) (**POEO Act**) is administered by the Environmental Protection Authority (EPA). The POEO Act regulates air and water pollution, noise control and waste management. Schedule 1 of the POEO Act list the activities that are “scheduled activities” for the purposes of the Act and Part 1, clause 17 includes electricity generation.

Bayswater operates under Environmental Protection License (**EPL**) No. 779. The power station is classed as a generating plant capable of producing greater than 4,000 GWh electricity per annum. The EPL sets emission and operational limits and includes monitoring requirements for the power station for a range of sites, parameters and concentration limits.

Monitoring is undertaken by AGL at a number of locations within the Bayswater and Liddell Power Stations water network and Lake Liddell in accordance with EPL 779. Locations are detailed in Table 2-1.

Table 2-1 Bayswater Power Station EPA water quality monitoring locations (EPL 779)

EPA Reference	AGL Reference	Description
EPA 01	LDP01 (EPL 1)	Discharge from main station oil separator holding basin to Tinkers Creek.
EPA 07	LDP07 (EPL 7)	Discharge from cooling towers to Tinkers Creek.
EPA 08	LDP08 (EPL 8)	Discharge pipe from Lake Liddell dam wall.
EPA 17	LDP17 (EPL 17)	Inlet point located on the Void 4 pontoon pump system.
EPA 18	LDP18 (EPL 18)	Discharge from Bayswater Ash Dam unlined flood spillway located near left abutment.

The EPL monitoring sites relevant to this impact assessment are as follows:

- EPA 01 (LDP01) – Secondary discharge to Tinkers Creek downstream of EPA 07;
- EPA 07 (LPD07) – Primary discharge to Tinkers Creek;
- EPA 08 (LDP08) – Lake Liddell ambient background; and,
- EPA 18 (LDP18) – Discharge from Bayswater Ash Dam unlined flood spillway located near left abutment.

The monitoring requirements and concentration limits at three of the four sites, as stipulated by EPL 779, are outlined in Table 2-2.

Table 2-2 Water quality monitoring requirements and concentration limits (EPL 779)

Site	Parameter	Units of Measure	Maximum concentration limit
EPA 01	Oil and Grease	Milligrams per litre	10
	Total suspended solids	Milligrams per litre	20
EPA 07	Conductivity	Micro-siemens per centimetre	4500
	pH	pH	6.5-8.5
EPA 08	pH	pH	6.5-8.5
	Total suspended solids	Milligrams per litre	30

Under the POEO Act, there is a legal responsibility to ensure that runoff leaving a site meets an agreed water quality standard, including water being discharged from sedimentation ponds after storm events.

Protection of the Environment Administration Act 1991

The NSW *Protection of the Environment Administration Act 1991* (**POEA Act**) establishes the EPA, Board of the EPA, and community consultation forums. The objectives of the POEA Act are to protect, restore and enhance the quality of the environment and to reduce risks to human health. It sets out obligations and responsibilities for managing activities that may cause environmental harm. The POEA Act allows the Board to determine whether the EPA should institute proceedings for serious environmental protection offences and advises the Minister on any matter relating to the protection of the environment. Under the POEA Act, AGL Macquarie should ensure that any discharges into water of substances likely to cause harm to the environment must be reduced to harmless levels.

Water Act 1912, Water Management Act 2000 and Water Management (General) Regulation 2011

The *Water Act 1912* (NSW) and the *Water Management Act 2000* (NSW) (**WM Act**) are the two key pieces of legislation for the management of water in NSW and contain provisions for the licensing of water access and use. The *Water Act 1912* (NSW) is being progressively phased out and replaced by the WM Act.

The aims of the WM Act are to provide for the sustainable and integrated management of the State's water sources for the benefit of both present and future generations. The WM Act implicitly recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing license holders with more secure access to water and greater opportunities to trade water through the separation of water licenses from land. The WM Act enables the State's water resources to be managed under water sharing plans, which establish the rules for the sharing of water in a particular water source between water users and the environment, and rules for the trading of water in a particular water source.

Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002

Salt occurs naturally in the rock and soil types throughout the Hunter Valley which is leached into the groundwater and rivers of the Hunter River catchment. Additionally, anthropogenic activities have the potential to cause increased saline waters, for example salty water that is produced as a result of power station operations.

The need to have controlled discharges of saline water into the Hunter River to allow mining and electricity generation to continue whilst protecting irrigation activities and the environment has long been recognised. The Hunter River Salinity Trading Scheme (HRSTS) has been in operation since January 1995 for this purpose. The HRSTS provides scheme participants in the scheme, a flexible economic tool for the protection of waterways. The scheme allows agriculture, mining and power stations to make controlled releases of excess saline water into the Hunter River at times of high flood flows.

Under the Scheme, discharges of saline water are controlled so they do not cause river levels to exceed 600 electrical conductivity units (EC) at Denman and 900 EC at Singleton. This is achieved through:

- Discharge scheduling at times when the rivers flow and salinity allow salt to be discharged without breaching the salinity limits; and
- Sharing the allowable discharge according to discharges holdings of tradeable salinity credits.

A regulatory review of the scheme in 2001 (EPA, 2001) concluded that the scheme has protected the environment and reduced the frequency of the exceedance of the salinity target at Singleton. Exceedances were reported to be reduced from 33% of the time down to only 4% of the time and none of the exceedances related to licensed discharges. It also concluded that alternatives to the scheme would “deliver either poorer environmental outcomes or similar outcomes at a much greater cost.”

Lake Liddell and Bayswater Creek drain to the middle sector of the Hunter River between Denman and Singleton which has the flow categories and discharge limits listed in Table 2-3.

Table 2-3 Flow categories and discharge limits under the HRSTS

Flow Category		Discharge Limits	Salinity target
Low Flow	River flow less than 1800 ML/day	No discharge	900 µS/cm
High Flow	River flow between 1800-6000 ML/day	Limited discharge with credits	900 µS/cm
Flood Flow	River flows above 6000 ML/day	Unrestricted discharge	900 µS/cm

AGL Macquarie is a scheme participant and currently holds 222 credits for Bayswater (EPA, 2018) (1000 credits are active at any one time under the scheme).

NSW Fisheries Management Act 1994

The *Fisheries Management Act 1994* (NSW) (FM Act) provides for the protection of threatened fish and marine vegetation and is administered by the Department of Primary Industries. The FM Act, in conjunction with the *Biodiversity Conservation Act 2016,* aims to conserve, develop and share fishery resources and conserve marine species, habitats and diversity.

Waterways within the footprint area have been categorised with regard to DPI key fish habitat mapping and the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013). Refer to Section 4.9.3 for details.

2.1.2 Policy and Guidelines

Australian Water Quality Guidelines (ANZG, 2018)

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)* (**ANZG**) provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters and list a range of environmental values assigned to that waterbody. The ANZG (2018) recommended guideline values have been considered when describing the existing water quality of the receiving environments. Water quality has been compared against default guideline values for 99%, 95%, 90% and 80% species protection in aquatic ecosystems.

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000)

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000) produced by the Australian New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (**ANZECC/ARMCANZ**), have been applied with guidance from the *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DECC, 2006) booklet to understand the current health of the waterways in the vicinity of the Project and the ability to support nominated environmental values, particularly the protection of aquatic ecosystems. The ANZECC/ARMCANZ Water Quality Guidelines (2000) provide recommended trigger values for various levels of protection which have been considered when describing the existing water quality and key indicators of concern. These guidelines will be applied for the indicators not yet available in the ANZG (2018).

Whilst the existing environment of the receiving waterways within the Project study area are known to be highly disturbed ecosystems, this assessment has adopted a conservative approach when assessing ambient water quality and applied default trigger values for protection of slightly to moderately disturbed ecosystems for physical and chemical stressors.

NSW Water Quality and River Flow Objectives (DECC, 2006)

The NSW Water Quality Objectives (WQOs) are the agreed environmental values and long-term goals for NSW's surface water (DECCW, 2006). They set out:

- The community's values and uses (ie healthy aquatic ecosystem, water suitable for recreation or drinking water etc) for our waterways (rivers, creeks, lakes and estuaries); and
- A range of water quality indicators to assess whether the current condition of the waterway supports these values and uses.

Areas within a catchment are categorised by their environmental values or uses of the environment that are important for a healthy ecosystem or for public benefit or health. These are values that require protection from the effects of pollution and waste discharges and provide goals that help in the selection of the most appropriate management options (ANZECC/ARMCANZ, 2000).

Waterways within the footprint area have been classified as "uncontrolled streams" by the Environment, Energy and Science Group of the Department of Planning, Industry and Environment (**EESG**) (formerly known as NSW Office of Environment and Heritage). Uncontrolled streams and waterbodies are those that are not in estuaries or other categories. The flow pattern in these streams may have been altered in some way through land-use change and extraction. Many of these streams flow into the regulated river sections, and so changes to their flow regime will affect downstream flows.

EESG have nominated a number of environmental values for uncontrolled streams. The nominated water quality objectives/environmental values for the waterways and reservoirs within the footprint area include:

- **Protection of aquatic ecosystems:** Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have historically been impacted upon by multiple pressures including changes in flow regime, modification and destruction of key habitats, development and poor water quality. There are a number of naturally occurring physical and chemical stressors that can cause degradation of aquatic ecosystems. These parameters include, nutrients, dissolved oxygen, pH, salinity and turbidity (suspended solids). The EESG objectives for aquatic ecosystems are consistent with the agreed national framework for assessing water quality set out in the ANZECC/ARMCANZ (2000) and ANZG (2018) guidelines. The ANZECC/ARMCANZ (2000) Guidelines provide the technical guidance to assess the water quality needed to protect aquatic ecosystems;
- **Visual amenity:** The aesthetic appearance of a waterbody is an important aspect with respect to visitation and recreation. The water should be free from noticeable pollution, floating debris, oil, scum and other matter. Substances that produce objectionable colour, odour, taste or turbidity and substances and conditions that produce undesirable aquatic life should not be apparent (NHMRC, 2008). The key aesthetic indicators are transparency, odour and colour;
- **Secondary contact recreation:** Secondary contact recreation implies some direct contact with the water would be made but ingestion is unlikely in activities such as boating, fishing and wading. Bacteriological indicators are used to assess the suitability of water for recreation;
- **Primary contact recreation:** Primary contact recreation implies some direct contact with the water would be made during activities such as swimming in which there is a high probability of water being swallowed. Bacteriological indicators, nuisance organisms, algal blooms, pH, temperature, chemical contaminants, surface films, visual clarity and colour are used to assess the suitability of water for recreation;
- **Livestock water supply:** The purpose of the livestock water supply objective is to protect water quality to maximise the production of healthy livestock. Indicators monitored for this objective include algae and blue-green algae, salinity, faecal coliforms and chemical contaminants; and
- **Irrigation water supply:** The purpose of the irrigation water supply objective is to protect quality of waters applied to crops and pasture. Indicators monitored for this objective include algae and blue-green algae, salinity, faecal coliforms and heavy metals.

Additionally, the objectives of Homestead water supply, Drinking water at point of supply – Disinfection only, Drinking water at point of supply – Clarification and disinfection, Drinking water at point of Supply – Groundwater and Aquatic foods (cooked) have also been nominated for streams within the catchment, however do not apply to streams within the footprint or immediately downstream (within the potential zone of impact) as the area is not included in the drinking water catchment and fishing is prohibited.

The environmental values have been considered in the assessment of existing water quality and potential impacts as a result of the Project.

Key water quality indicators and related numerical criteria have been nominated for each environmental value using the ANZECC Water Quality Guidelines. These values and indicators are provided in Table 2-4.

Table 2-4 Key water quality indicators and related numerical criteria for environmental values using the ANZG (2018) and ANZECC Water Quality Guidelines (ANZECC/ARMCANZ, 2000)

Environmental value	Indicator	Guideline value
Aquatic ecosystems – maintaining or improving the ecological condition of waterbodies and riparian zones over the long term	Total phosphorus	25µg/L
	Total nitrogen	350µg/L
	Chlorophyll-a	3µg/L
	Turbidity	6-50NTU

	Salinity (electrical conductivity)	125-2200µS/cm
	Dissolved oxygen	85-110% saturation
	pH	6.5-8.5
	Toxicants	As per ANZG (2018) toxicant default guideline values (95% level of protection for slightly to moderately disturbed ecosystems and 99% level of protection for toxicants that bioaccumulate. Given the highly disturbed nature of the project area, 90% and 80% specie protection DGVs will also be discussed).
Visual amenity – aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter n/a (no quantitative value specified)
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts n/a (no quantitative value specified)
Secondary contact recreation – maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	As per the NHMRC 2008 Guidelines for managing risks in recreational water
	Nuisance organisms	As per the visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable of recreation. Toxic substances should not exceed values in Table 9.3 of NHMRC (2008) guidelines.
	Visual clarity and colour	As per the visual amenity guidelines.
	Surface films	As per the visual amenity guidelines.
Primary contact recreation – maintaining or improving water quality for activities such as swimming where	Faecal coliforms, enterococci, algae and blue-green algae	As per the NHMRC 2008 Guidelines for managing risks in recreational water
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water.

there is a high probability of water being swallowed	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed values in table 9.3 of the NHMRC (2008) guidelines.
	Visual clarity and colour	As per the visual amenity guidelines.
	Temperature	15°-35°C for prolonged exposure.
Irrigation water supply – protecting the quality of waters applied to crops and pastures	Algae and blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, a number of interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscapes and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in table 4.2.2 of the ANZECC Guidelines.
	Heavy metals and metalloids	Long term trigger values (**LTV**) and short-term trigger values (**STV**) for heavy metals and metalloids in irrigation water are presented in table 4.2.10 of the ANZECC 2000 guidelines.
Livestock water supply – protecting water quality to maximise production of healthy livestock.	Algae & blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents.
	Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in table 4.3.1 (ANZECC 2000 Guidelines).
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value).
	Chemical contaminants	Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2011) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.

Often in modified environments there is the potential for the current water quality to not meet the existing guidelines and trigger values for protecting nominated environmental values. Irrespective of the current condition of waterways, the proposal should not further degrade water quality. As such the key objective of the proposal is to minimise the potential impacts on downstream receiving waters, so that the proposal changes the existing water regime by the smallest amount practicable.

Managing Urban Stormwater - Soils and Construction

Managing Urban Stormwater, Soils and Construction, Volume 1 (Landcom, 2004), commonly referred to as the 'Blue Book', outlines the basic principles for stormwater management during construction. It provides guidance on design and construction of sediment and erosion control measures to protect downstream water quality, thereby improving the health, ecology and amenity of rivers and streams.

Guidelines for Managing Risks in Recreational Waters

The *Guidelines for Managing Risks in Recreational Water* (NHRMC, 2008) aim to protect the health of humans from threats posed by the recreational use of coastal, estuarine and fresh waters.

The guidelines provide recommended values for indicators that may pose a risk to human health. These indicators are relevant for waterways that are being used for recreation but have the potential to be polluted.

2.2 Groundwater

2.2.1 Water Sharing Plan

The main tool under the WM Act for managing NSW water resources are the water sharing plans (**WSPs**). Numerous WSPs are established throughout NSW for groundwater (and surface water). The purpose of a WSP is to provide water users with a clear picture of when and how water will be available for extraction, protect the fundamental environmental health of the water source and ensure the water source is sustainable long-term. WSPs are sometimes subdivided into subset areas based on groundwater system characteristics and are referred to as 'sources'. Sources are rarely further divided into 'management zones'. Multiple WSPs and sources can occur vertically on top of one another due to different hydrogeological systems.

The whole Project area and surrounds is mapped (NSW Government, 2009 and 2016) to be occupied by the following management zones, sources and WSPs, which are listed from shallowest to deepest:

- Jerrys Management Zone, of the Jerrys Water Source, of the WSP for the Hunter Unregulated and Alluvial Water Sources 2009 (NSW Government, 2009); and
- Sydney Basin – North Coast Water Source, of the WSP for the North Coast Fractured and Porous Rock Groundwater Sources (NSW Government, 2016).

The boundary between alluvium and underlying residual soil or rock defines the interface between the two WSPs. If the Project extracts groundwater from alluvial material, the upper WSP (Jerrys Water Source) is applicable. Conversely, if the Project extracts groundwater from residual material or rock which underlies the alluvium, then the lower WSP (North Coast Water Source) is applicable.

The geology mapping shows (Section 4.4.3) that alluvium material is limited to the vicinity of major creeks. With the exception of the Ravensworth Ash Line, the Project elements do not occupy areas of mapped alluvial material. The Ravensworth Ash Line crosses mapped alluvium (Figure 4.2) at Bayswater Creek (Figure 1.1) for a distance of approximately 500m. Remaining areas of the ash line do not cross mapped alluvial material. Therefore, with the exception of the 500m length of the Ravensworth Ash Line that crosses Bayswater Creek, the applicable WSP for the Project is anticipated to be the North Coast Fractured and Porous Rock Groundwater Sources (NSW Government, 2016). It is noted that areas of alluvial material could exist beyond the mapped areas, and the WSP for the Hunter Unregulated and Alluvial Water Sources 2009 (NSW Government, 2009) would apply for such areas.

It is not readily apparent what the long-term average annual extraction limit (**LTAAEL**) is for the Jerrys Water Source from the WSP (NSW Government, 2009). The NSW Water Register (WaterNSW, 2019b) shows that within the Jerrys Water Source, as of October 2019, there are 10 ‘Aquifer’ WALs totaling 1,246 megalitres, four ‘Domestic and Stock’ WALs totaling 10 megalitres and one ‘Major Utility’ WAL totaling 7,700 megalitres.

The LTAAEL for the Sydney Basin – North Coast WSP (NSW Government, 2016), as of October 2019, is 90,000 megalitres per year. The NSW Water Register (WaterNSW, 2019b) shows that there are currently 174 WALs with a total license volume of 68,106 megalitres per year. As such, there is currently up to 21,894 megalitres per year of unassigned groundwater.

No groundwater extraction is anticipated to occur due to the Project. Therefore, a groundwater WAL is not required for the Project.

2.2.2 NSW Aquifer Interference Policy (2012)

The NSW Aquifer Interference Policy (**AIP**) (DPI NOW, 2012) outlines minimal impact considerations for water table and groundwater pressure drawdown for high priority groundwater dependent ecosystems (**GDEs**), as identified in the WSP, high priority culturally significant sites (as identified in the WSP) and existing groundwater supply bores. Water quality impact considerations are also outlined.

In accordance with the AIP, the Project is situated within a ‘less productive groundwater source’ on the basis of expected yields of less than 5 L/second and monitoring data (Section 4.8.3) indicating total dissolved solid (TDS) concentrations of greater than 1,500 mg/L. As such, the following minimal impact considerations apply:

- A maximum cumulative pressure head or water table decline of two metres at any water supply work. If this condition cannot be met, then appropriate studies will need to demonstrate to the Minister’s satisfaction, that decline in head will not prevent the long-term viability of the affected water supply works unless make good provisions apply; and
- Any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. Additionally, for alluvial sources only, there should be no increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. If the beneficial use condition cannot be met, then appropriate studies will need to demonstrate to the Minister’s satisfaction, that the change in groundwater quality will not affect the long-term viability of the dependent ecosystem. If the salinity condition cannot be met, then appropriate studies are required to demonstrate to the Minister’s satisfaction, that the River Condition Index category of the highly connected surface water source will not be reduced at the nearest point to the activity.

The term ‘beneficial use category’ is synonymous with the term ‘environmental value’, which is defined as values or uses of the groundwater that support aquatic ecosystems, primary industries, recreation and aesthetics, drinking water, industrial water, and cultural and spiritual values (ANZECC/ARMCANZ, 2000).

Impact limits to high priority GDEs and culturally significant sites as outlined in the AIP are not applicable for the Project, as no high priority GDEs and culturally significant sites are mapped (NSW Government, 2009 and NSW Government, 2016) within 10 kilometres of the Project.

2.2.3 **Groundwater Dependent Ecosystem Policy**

The NSW State Groundwater Dependent Ecosystems Policy (Department of Land and Water Conservation, 2002) implements the WM Act by providing guidance on the protection and management of GDEs. It sets out management objectives and principles to:

- Ensure that the most vulnerable and valuable ecosystems are protected;

- Manage groundwater extraction within defined limits thereby providing flow sufficient to sustain ecological processes and maintain biodiversity;
- Ensure that sufficient groundwater of suitable quality is available to ecosystems when needed;
- Ensure that the precautionary principle is applied to protect GDEs, particularly the dynamics of flow and availability and the species reliant on these attributes; and
- Ensure that land use activities aim to minimise adverse impacts on GDEs.

2.2.4 **National Water Quality Management Strategy**

The National Water Quality Management Strategy (**NWQMS**) is the adopted national approach to protecting and improving water quality in Australia. It consists of a number of guideline documents, of which certain documents relate to protection of surface water resources while others relate to the protection of groundwater resources.

The primary document relevant to the assessment of groundwater risks for the Project is the Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013). This document sets out a high-level risk-based approach to protecting or improving groundwater quality for a range of groundwater beneficial uses (called 'environmental values'), including aquatic ecosystems, primary industries (including irrigation and general water users, stock drinking water, aquaculture and human consumption of aquatic foods), recreational and aesthetic values (e.g. swimming, boating and aesthetic appeal of water bodies), drinking water, industrial water and cultural values.

For the purpose of this assessment, 'environmental values' pertaining to aquatic ecosystems, primary industries and industrial water are considered potentially applicable. Although not observed onsite, it is possible that groundwater may at times discharge to surface water bodies in the form of 'baseflow', albeit at very low flow rates. Therefore, as a conservative approach, environmental values pertaining to aquatic ecosystems were considered potentially applicable. Environmental values pertaining to primary industries and industrial water were considered potentially applicable as existing bores in the region of the Project included purposes listed as 'manufacturing and industry' and 'drainage of groundwater'. Environmental values pertaining to drinking water are not considered applicable due to poor groundwater quality, such as high TDS concentrations (Section 4.8.3). Values pertaining to recreational and aesthetic values are considered not applicable as the creeks/drainage lines in the Project's vicinity, which may be fed by groundwater baseflow at times (albeit at very low rates), are not used for these purposes in the area of the Project. Cultural groundwater values in connection with groundwater baseflow to creeks/drainage lines are considered not applicable as potential baseflow contributions from groundwater systems, whilst possibly present, would represent a negligible contribution to the cultural value.

2.3 Flooding

Dams Safety Act 2015

Safety of dams has been administered under the Dams Safety Act 1978 (**1978 Act**) for the last forty years. In the absence of regulations, the Dams Safety Committee administered the 1978 Act by publishing guidance material for dam owners. The 1978 Act also had very limited penalty provisions.

In 2015, the Dams Safety Act 2015 (**2015 Act**) replaced the 1978 Act. The 2015 Act requires a dams safety regulation to be enacted for dam owners to follow. An Interim Dams Safety Advisory Committee was established to identify criteria for declaring dams and to develop dams safety policy and standards.

The 2015 Act and Dams Safety Regulation 2019 (**DS Reg)** commenced on 1 November 2019. The 2015 Act and DS Reg include provisions to ensure that any risks to public safety, environment and assets relating to dams are of a level that is acceptable to the community. The DS Reg identifies that a dam or proposed dam that is a prescribed dam within the meaning of the 1978 Act immediately before the repeal of that Act is a declared dam. BWAD is a prescribed dam (Aurecon, 2016) under the 1978 Act and hence BWAD is a declared dam under the 2015 Act.

Under the DS Reg, declared dams that do not have operation and maintenance or emergency plans will have six months to establish these plans. Declared dam owners will have a two-year transition period to make the required changes, from commencement of the 2015 Act and the DS Reg. During the two-year transition period, Dams Safety NSW will conduct site visits and trial audits to help declared dam owners progress the development of their systems and processes to meet the requirements of the DS Reg and standards.

According to the 2015 Act, dam safety will be based on dam owners' implementation of management systems. Dams Safety NSW will not need to provide a technical determination on their evaluations. Dam owners will make risk decisions based on a new approach that requires dam owners to reduce dam safety risks 'so far as reasonably practicable'.

Environmental Guidelines Solid Waste Landfills (EPA, 2016)

The principal legislation governing waste management and landfill disposal of waste in NSW is the POEO Act. Most new landfills receiving waste from off-site must hold an environment protection license issued by the EPA under the POEO Act.

The EPA has prepared guidelines to provide guidance for the environmental management of landfills by specifying a series of 'Minimum Standards' involving a mix of design and construction techniques, effective site operations, monitoring and reporting protocols, and post-closure management. The guidelines identify the following restrictions relating to siting of landfills in the vicinity of waterways:

- In or within 40 metres of a permanent or intermittent water body or in an area overlying an aquifer that contains drinking water quality groundwater that is vulnerable to pollution; and
- Within a floodway that may be subject to washout during a major flood event (similar to a 1 in100 annual exceedance probability event).

NSW FRM Policy and Guidelines

The primary objective of the NSW Flood Risk Management (**FRM**) framework, as expressed within the NSW Flood Prone Land Policy (Floodplain Development Manual (**FDM**) DIPNR, 2005), is as follows:

"*To reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible."*

Within the scope of this technical paper, the relevance of the above objective is primarily to ensure that the Project does not lead to increased flood risk to property and persons, and that appropriate controls are proposed to achieve this outcome.

The NSW Flood Prone Land Policy, as identified within Section 1.1 of the FDM, places the primary responsibility for flood risk management on local councils. This provides the opportunity for flood risk management to be integrated within council's normal planning processes. As the Project is located across the boundary of the Singleton and Muswellbrook Local Government Areas, both Singleton Council and Muswellbrook Shire Council are responsible for managing flood risk to an acceptable level.

The NSW Flood Prone Land Policy and the FDM provide a platform for the management of floodplains following a risk management approach. The FDM provides guidance on how to implement the NSW Flood Prone Land Policy. The FDM requires the level of flood risk acceptable to the community to be determined through a process overseen by a committee comprised of local elected representatives, community members and state and local Government officials (including the SES).

The ultimate outcome is the preparation of a Floodplain Risk Management Plan (**FRMP**), which is a plan formally adopted by a local council in accordance with the NSW Flood Prone Land Policy. FRMPs should have an integrated mix of management measures that address existing, future and continuing risk. Typically, FRMPs have been prepared by local councils for urban floodplains. A FRMP is yet to be prepared by Singleton Council and/or Muswellbrook Shire Council covering the Project area.

Local Environment Plan and Development Control Plan

The Project is located across the boundary of the Singleton and Muswellbrook Local Government Areas and as such two Local Environmental Plans (**LEP**) apply to the Project. Under the Singleton LEP 2013, the Project is zoned RU1 Primary Production and under the Muswellbrook LEP 2009, the Project is zoned SP2 infrastructure.

The Muswellbrook Development Control Plan (**DCP**) 2009 applies to all land within the Muswellbrook Shire local government area and is used to assist proponents of development in achieving development outcomes, consistent with the provisions of the Muswellbrook LEP 2009. Section 25 of the DCP identifies the following objectives on flooding and runoff regimes to ensure that:

- post development runoff reflects pre-development conditions; and
- development does not result in environmental damage within existing drainage courses and receiving waters.

The Singleton Development Control Plan 2014 (**SDCP 2014**) applies to the Singleton local government area. It is a statutory plan that supplements LEP requirements. The DCP is used by Council in the assessment of Development Applications. When designing development proposals, applicants need to address the relevant requirements of any DCPs which apply to the proposal.

3. Methodology

3.1.1 Study area

The study area for the surface water quality assessment is the area directly affected by the Project and any additional areas likely to be affected by the Project either directly or indirectly. The study area generally comprises the construction and operational footprints and a 500 metre buffer around the Project.

The groundwater study area is presented in Figure 3.1 and is approximately 12km long (north – south) by 14km wide (east – west). The study area was chosen to encapsulate the Project elements and provide broader hydrogeological context, especially with regards to surrounding licensed bores.

3.2 Surface Water Quality

3.2.1 Desktop assessment

The desktop assessment involved a review of the existing surface water conditions across the study area to assess the likely and potential impacts of the Project on surface water quality during construction and operation. The review of information included:

- Available literature, water quality data and background information on catchment history and land use to aid in interpreting the existing conditions. Literature sources included:
  - AECOM (2017), Water Balance Assessment – Bayswater and Liddell Ash Dams, AGL Macquarie Pty Ltd, June 2016;
  - Aurecon (2013), *Ravensworth Void 4 Discharge Investigation*, Macquarie Generation, October 2013;
  - Australian Government – Bioregional Assessments (2019), *Water Storage in the Hunter river basin*;
  - Australian Government – Bioregional Assessments (2019a) Impact and risk analysis for the Hunter subregion - Potential Impacts on Water Quality;
  - Department of Infrastructure, Planning and Natural Resources (2004) *A guide to the Water Sharing Plan for the Hunter Regulated River Water Source*, September 2004;
  - Department of Environment and Conservation NSW (2006), Hunter River Salinity Trading Scheme – Working together to protect river quality and sustain economic development, June 2006;
  - Niche Environmental and Heritage, (2015) *Aquatic Impact Assessment Report – Culvert and Channel Maintenance of Tinkers Creek*, Niche Environmental and Heritage 2014; and
  - Water quality data collected by AGL Macquarie. Required under EPL 779.
- Assessment of the impact of construction and operation activities on water quality and hydrology with reference to the ANZG (2018) and ANZECC/ARMCANZ (2000) water quality guidelines with regard to the relevant environmental values of aquatic ecosystems, visual amenity, primary and secondary contact recreation, and irrigation supplies (as mentioned, other environmental values mentioned in Section 2.1.2 do not apply to waterways within the footprint).
- Identification of water quality and hydrology treatment measures to mitigate the impact of construction on water quality, following the principles of *Managing Urban Stormwater–Soils and Construction Volume 1* (Landcom, 2004) and *Managing Urban Stormwater–Soils and Construction Volume 2D* (DECC, 2008), collectively referred to as the Blue Book.
- Consideration and recommendation of run-off protection measures for changes during the operation of the Project.

3.2.2 Discharge criteria

To ensure that the project is constructed and operated to protect the NSW water quality objectives (or work towards achieving them), any controlled discharges will be managed in accordance with the ANZG (2018) water quality guidelines and any requirements of an Environment Protection license. Due to the anthropogenic activities that are undertaken in the Project area, waterways within the study area have been classified as highly disturbed ecosystems.

3.2.3 Sensitive receiving environments

Sensitive receiving environments (**SREs**) are environments that have a high conservation or community value or support ecosystems/human uses of water that are particularly sensitive to pollution or degradation of water quality. SREs were classified based on the following considerations:

- Key fish habitat field assessment in accordance with (DPI, 2013);
- Key fish habitat mapping (DPI, 2018);
- Threatened aquatic species under FM Act, BC Act and EPBC Act;
- Groundwater and surface water dependent vegetation and fauna communities listed under the BC Act and EPBC Act;
- Proximity to a drinking water catchment; and
- Areas that contribute to aquaculture and commercial fishing.

No waterways within the footprint area were identified as SREs. Further detail is provided in Section 4.9.

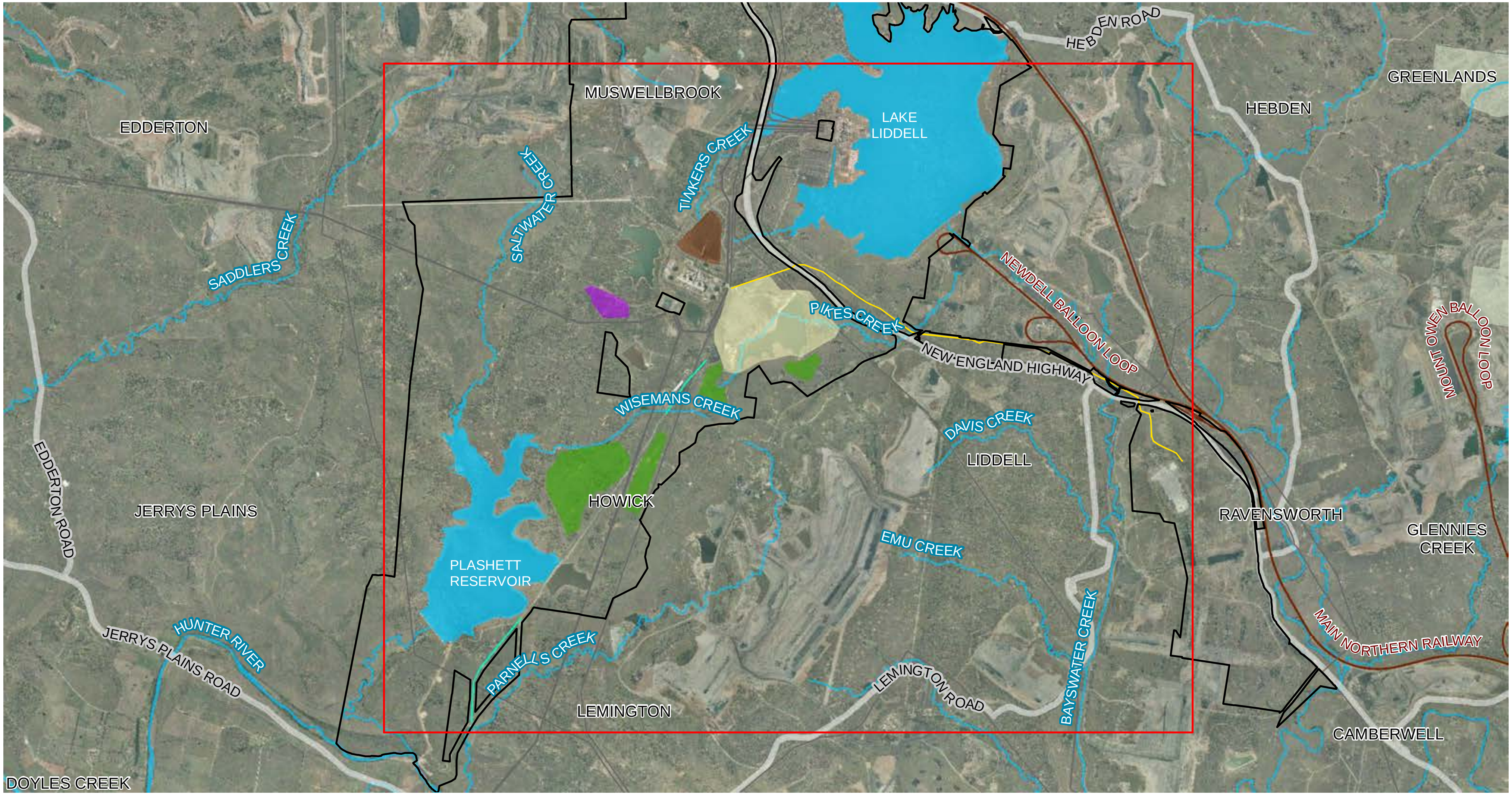
3.3 Groundwater

3.3.1 Overview

Assessment of potential Project related groundwater impacts was completed by undertaking the following:

- Characterisation of the existing environment, including climate, topography, hydrology, geology/soils, and groundwater occurrence, quality and use, including GDEs;
- Collation of data from previously completed drilling and monitoring programs;
- Dedicated field investigations, including drilling, groundwater monitoring bore installation and groundwater level monitoring, to confirm hydrogeological conditions in the area of the potential borrow pits;
- Development of conceptual groundwater model(s);
- Identification of potential groundwater related impacts that could arise due to the Project;
- Qualitative assessment of potential groundwater related impacts that could arise due to the Project;
- Implementation of the conceptual groundwater model in a finite element cross section groundwater model, to qualitatively assess potential salt migration from the proposed salt cake landfill facility;
- Assessment of potential groundwater related impacts against the minimal impact considerations of the AIP (DPI NOW, 2012); and
- Recommendation for monitoring and management of identified potential impacts and risks, including mitigation measures as appropriate.

The specific methodologies used for these components of the methodology are described in the following sections.



Groundwater Impact Assessment Study Area (approximately 14km x 12km)
AGL owned land

Project elements:
- Ash Dam Augmentation, Ash Harvesting and Water Management Works
- Salt Cake Landfill
- Coal Handling Plant Water and Wastewater Infrastructure Upgrades
- HP Pipe Clearing
- LSP Sludge Line Clearing
- Clay Borrow Pits
- Ravensworth Ash Line

0 1 2 km
1:100,000 at A4

Data sources
Jacobs 2019, AGL 2019
NSW Spatial Services 2019

GDA94 MGA56

Figure 3.1 Groundwater Impact Assessment Study Area

3.3.2 Groundwater assessment dataset

3.3.2.1 Public domain data

Public domain data was used to characterise existing groundwater conditions in the study area. Sources included:

- Bore data obtained from WaterNSW (2019a) was used to review registered groundwater bores and associated groundwater level records;
- The Bureau of Meteorology's (BOM, 2019a) online Australian Groundwater Insight mapping portal was interrogated to determine the WSPs (Section 2.2.1) (NSW Government, 2009 and 2016) in the groundwater study area;
- GDE maps for the applicable WSPs (Section 2.2.1) (NSW Government, 2009 and 2016) were reviewed to determine the presence of mapped high priority GDEs. Additionally, the BOM's Groundwater Dependent Ecosystem (GDE) Atlas (BoM, 2019b) was reviewed to investigate the potential presence of GDEs within the study area;
- Rainfall data from gauging stations in/around the groundwater study area, from the BOM (BoM, 2019c) and Scientific Information for Land Owners (SILO) database (Queensland Government, 2019);
- The Water Register (WaterNSW, 2019b) was reviewed to investigate data on existing groundwater users, including Water Access Licence (WAL) holders and stock and domestic users; and
- Publicly available maps were also used, including geological maps, topography and drainage maps and soil maps.

3.3.2.2 Key project data extracted from existing AGL Macquarie data

A large dataset provided by AGL Macquarie was used to select key groundwater monitoring bores and boreholes for inclusion into the Project's groundwater assessment dataset. Bores were selected based on their relative proximity to each of the Project elements, and all available data for these bores was used.

These data included the following:

- 27 groundwater monitoring bores across four key Project elements, including the ash dam augmentation, salt cake landfill, periphery of the north eastern potential borrow pit area and the Ravensworth Ash Line;
- One soil bore in the vicinity of the Ravensworth Ash Line;
- Between three to eleven records of manual groundwater level measurements from November 2016 to April 2019; and
- Groundwater quality analytical records from November 2016 to April 2019. Analytes tested included:
  - Heavy metals;
  - Total recoverable hydrocarbons (TRH);
  - Benzene toluene ethylbenzene xylenes and naphthalene (BTEXN);
  - Polycyclic aromatic hydrocarbons (PAHs);
  - Polychlorinated biphenyls (PCBs);
  - Ammonia;
  - Nutrients;
  - Major anions and cations; and

- Field parameters: pH, EC, Total Dissolved Solids (TDS), Dissolved Oxygen (DO) and Redox potential.

The key existing groundwater monitoring bores and boreholes are summarised in Table 3.1, Table 3.2 and shown in Figure 3.2.

Table 3.1 Summarised key existing project groundwater monitoring bores and boreholes

Bore/borehole ID	Start of monitoring (dd/mm/yyyy)	End of monitoring (dd/mm/yyyy)	Count of records (rounds)	Number of analytes tested
BA_EW_MW01	1/12/2016	28/03/2019	10	79
BA_MW01	30/11/2016	28/03/2019	10	79
BA_MW03	23/11/2016	28/03/2019	10	79
BB_MW01	18/04/2018	17/04/2019	5	79
BB_MW02	18/04/2018	17/04/2019	5	79
BB_MW05	17/04/2018	17/04/2019	5	79
BQEW_MW01	29/11/2016	26/03/2019	10	79
BQEW_MW02	29/11/2016	26/03/2019	10	79
BQEW_MW03	30/11/2016	26/03/2019	10	79
BQ_MW02	24/11/2016	27/03/2019	11	79
BQ_MW03	24/11/2016	27/03/2019	10	79
BQ_MW04	29/11/2016	28/03/2019	10	79
BQ_MW05	25/11/2016	25/11/2016	1	79
BQ_MW07	25/11/2016	22/03/2019	8	79
BQ_MW08	25/11/2016	27/03/2019	10	79
BQ_MW10	24/11/2016	26/03/2019	8	79
BQ_MW11	25/11/2016	26/03/2019	10	79
BQ_MW13	24/11/2016	27/03/2019	10	79
MW-A01	7/08/2018	15/11/2018	4	32
MW-A02	21/09/2018	16/11/2018	3	32

MW-A03D	19/09/2018	14/11/2018	3	32
MW-A03S	19/09/2018	14/11/2018	3	32
MW-A04	6/08/2018	15/11/2018	4	32
MW-A05	19/09/2018	14/11/2018	3	32
MW-A06	19/09/2018	14/11/2018	3	32
MW-A07	21/09/2018	16/11/2018	3	32
BR_MW01	MW [1]	MW [1]	MW [1]	MW [1]
BY_MW20	SB [2]	SB [2]	SB [2]	SB [2]

Notes: [1] Routine groundwater monitoring bore data not available. However, information on the monitoring well log (lithology moisture and water strike depth), and a 'final water level' measurement after drilling have been used for assessment purposes. Soil bore and not sampled for groundwater depths nor quality. However, information on the borehole log (lithology moisture and water strike depth) have been used for assessment purposes.

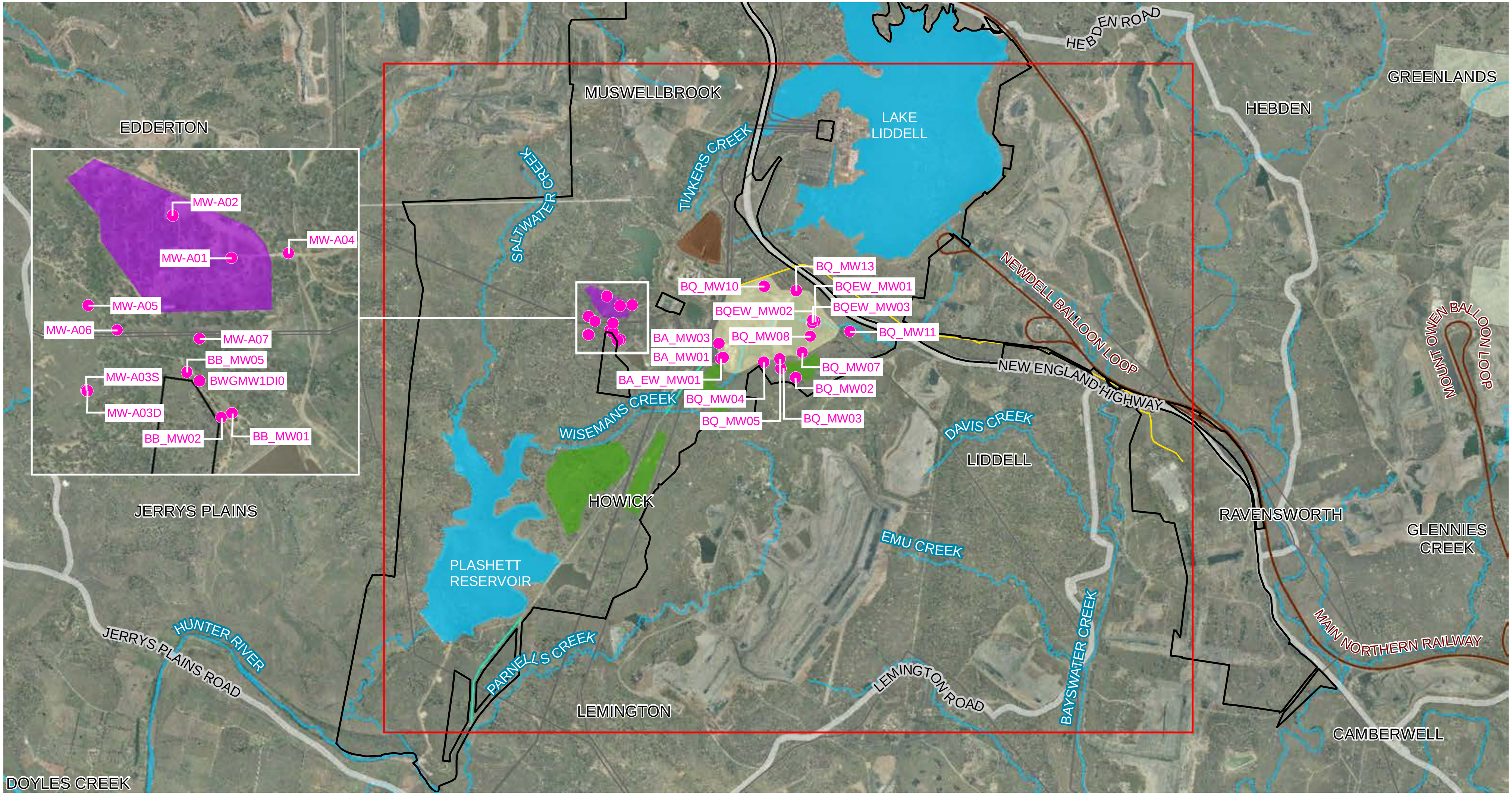
Table 3.2: Summerised key existing project monitoring bore and borehole details

Bore ID	Key area	Easting (m)	Northing (m)	Elevation (mAHD)	Screen depth (mBGL)	Screened lithology
BA_EW_MW01	Ash dam augmentation zone	307605	6412529	182.69[a]	-	-
BA_MW01	Ash dam augmentation zone	307644	6412540	182.30[b]	5.5 - 8.5	Clay
BA_MW03	Ash dam augmentation zone	307569	6412789	174.29[b]	2.0 - 5.0	Shale, generally completely weathered, wet from 3.0 m below ground level (mBGL)
BB_MW01	Salt cake landfill zone	305818	6412858	170.74[b]	1.7 - 4.7	Silty clay, sandy clay, gravelly sandy clay
BB_MW02	Salt cake landfill zone	305777	6412843	172.85[b]	6.2 - 9.2	Sandstone, Sandy Clay

Bore ID	Key area	Easting (m)	Northing (m)	Elevation (mAHD)	Screen depth (mBGL)	Screened lithology
BB_MW05	Salt cake landfill zone	305644	6413018	164.43[b]	1.0 - 3.0	Sandy Clay
BQEW_MW01	Ash dam augmentation zone	309280	6413180	134.22[a]	-	-
BQEW_MW02	Ash dam augmentation zone	309227	6413155	135.16[a]	-	-
BQEW_MW03	Ash dam augmentation zone	309235	6413201	134.65[a]	-	-
BQ_MW02	NE borrow pit	308930	6412190	148.55[b]	2.7 - 5.7	Clay
BQ_MW03	NE borrow pit	308672	6412351	158.11[b]	2.7 - 5.7	Clay
BQ_MW04	Ash dam augmentation zone	308369	6412458	178.75[b]	7.0 - 10.0	Siltstone
BQ_MW05	Ash dam augmentation zone	308651	6412519	174.74[b]	4.5 - 7.5	Shale, Sandy Clay
BQ_MW07	Ash dam augmentation zone	309050	6412628	177.00[b]	7.0 - 10.0	Shale, Sandy Clay
BQ_MW08	Ash dam augmentation zone	309200	6412915	151.80[b]	3.5 - 6.5	Sandy Clay
BQ_MW10	Ash dam augmentation zone	308378	6413806	156.31[b]	3.5 - 5.3	Gravel
BQ_MW11	Ash dam augmentation zone	309896	6412999	127.92[b]	2.0 - 5.0	Clay
BQ_MW13	Ash dam augmentation zone	308942	6413730	173.51[b]	2.8 - 5.8	Silty Clay
MW-A01	Salt cake landfill zone	305817	6413459	186.71[a]	8.0 - 14.0	Silty clay (possibly weathered

Bore ID	Key area	Easting (m)	Northing (m)	Elevation (mAHD)	Screen depth (mBGL)	Screened lithology
						siltstone) and siltstone
MW-A02	Salt cake landfill zone	305588	6413623	192.04[a]	16.0 - 19.0	Siltstone
MW-A03S	Salt cake landfill zone	305258	6412945	161.29[a]	11.0 - 14.0	Silty Clay, Clayey Gravel
MW-A03D	Salt cake landfill zone	305254	6412947	161.26[a]	3.0 - 6.0	Siltstone
MW-A04	Salt cake landfill zone	306038	6413477	192.06[a]	12.0 - 15.0	Siltstone
MW-A05	Salt cake landfill zone	305262	6413275	168.99[a]	9.0 - 12.0	Siltstone
MW-A06	Salt cake landfill zone	305375	6413180	168.74[a]	11.0 - 17.0	Siltstone
MW-A07	Salt cake landfill zone	305692	6413147	174.99[a]	19.0 - 25.0	Siltstone
BR_MW01	Ravensworth ash line	315228	6411564	104.96	49.0 – 52.0	Sandstone
BY_MW20	Ravensworth ash line	308873	6414115	149 [a]	NA – soil bore	NA – soil bore. Borehole drilled to 10 mBGL through sandy silt, sandy clay, shale and siltstone. All material dry

Notes: [-] No data available. [a] bore elevation was extracted from a digital elevation model (DEM). [b] bore elevation was GPS surveyed.



Groundwater Impact Assessment Study Area (approximately 14km x 12km)

AGL owned land

Project elements:

- Ash Dam Augmentation, Ash Harvesting and Water Management Works
- Salt Cake Landfill
- Coal Handling Plant Water and Wastewater Infrastructure Upgrades
- HP Pipe Clearing
- LSP Sludge Line Clearing
- Clay Borrow Pits
- Ravensworth Ash Line

0 1 2 km

1:100,000 at A4

N

Data sources

Jacobs 2019, AGL 2019
NSW Spatial Services 2019

GDA94 MGA56

Figure 3.2 Key site groundwater monitoring bores used for impact assessment

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Created by : XX | QA by : XX

3.3.2.2.1 Project borrow pit field assessment

No existing borehole or groundwater monitoring bore data were available within the proposed potential borrow pit areas. A drilling programme was undertaken to facilitate data collection as part of this assessment. 15 shallow boreholes were drilled in September and October 2019, with nine of the 15 boreholes completed as groundwater monitoring bores. The data from these bores was used to update the groundwater system conceptualisation in the proposed potential borrow pit areas. The borrow pit borehole and groundwater monitoring bore locations and logs are provided in Figure 3.3 and Appendix A, respectively. Key details of the Project's borrow pit boreholes and groundwater monitoring wells are summarised in Table 3.3. The borrow pit boreholes/groundwater monitoring bores were assigned identification codes beginning with 'JBP'.

Each of the nine monitoring bores were equipped with a data logger to monitor groundwater levels at six hourly intervals. The data logger was deployed upon completion of bore construction between 30 September 2019 and 3 October 2019 and the data collected on 29 October 2019. A groundwater level monitoring period of approximately one month was used for this assessment. This is a relatively short monitoring period, but is considered appropriate since AGL Macquarie has committed to not penetrating the water table for the borrow pit excavations, and because the data collected indicates that the regional water table in the area of the borrow pits is situated in bedrock or limited to areas of relative low elevation in the area of drainage lines. AGL Macquarie advised that potential borrow pit excavations will not extend into bedrock and will extract clay only (or extremely weathered rock). Groundwater quality was not tested from the borrow pit investigation groundwater monitoring bores. This was not considered necessary given the existing Project background data elsewhere on site, and because the potential borrow pits are not proposed to intersect the regional water table.

Table 3.3: Key borrow pit borehole and groundwater MW details

Borehole or MW ID[1]	Easting[2]	Northing[2]	Ground level (mAHD)[2]	Top of casing (mAGL)[3]	Total borehole depth (mBGL)	Screened interval (mBGL)	Sand filter pack (mBGL)	Bentonite (mBGL)
JBP_BH101	308943	6412254	157.65	NA [4]	2.50	NA [4]	NA [4]	NA [4]
JBP_BH102	308949	6412386	176.02	NA [4]	1.95	NA [4]	NA [4]	NA [4]
JBP_BH103	309214	6412348	161.42	NA [4]	0.70	NA [4]	NA [4]	NA [4]
JBP_BH104	307396	6412329	196.48	NA [4]	1.65	NA [4]	NA [4]	NA [4]
JBP_BH105	307454	6412252	209.97	NA [4]	1.10	NA [4]	NA [4]	NA [4]
JBP_BH106	305876	6410608	162.52	NA [4]	4.25	NA [4]	NA [4]	NA [4]
JBP_MW101	309297	6412323	154.22	0.95	1.91	1.50 – 1.91	0.60 – 1.91	0.20 – 0.60
JBP_MW102	307358	6412360	186.65	1.01	4.95	1.37 – 4.37	0.85 – 4.37	0.60 – 0.85
JBP_MW103	306208	6410685	153.64	0.95	4.95	1.30 – 4.30	0.60 – 4.30	0.30 – 0.60
JBP_MW104	306369	6410794	155.69	1.02	6.40	2.91 – 5.91	2.41 – 5.91	2.11 – 2.41
JBP_MW105	306462	6410777	162.27	0.92	4.63	1.20 – 4.20	0.60 – 4.20	0.40 – 0.60
JBP_MW106	305477	6410960	140.95	1.01	6.25	3.94 – 5.94	2.30 – 5.94	2.10 – 2.30
JBP_MW107	305282	6410670	145.69	0.94	2.45	1.00 – 2.00	0.40 – 2.00	0.20 – 0.40
JBP_MW108	304815	6410729	133.08	0.93	4.60	1.10 – 4.10	0.60 – 4.10	0.40 – 0.60
JBP_MW109	305226	6410581	140.29	0.94	8.20	4.80 – 7.75	4.30 – 7.75	4.00 – 4.30

Notes: [1] BH suffix denotes borehole with no groundwater monitoring well. MW suffix denotes borehole completed as a groundwater monitoring well. [2] From survey (VRS differential GPS from a CORS base station) by a registered surveyor. [3] Calculated by subtracting surveyed ground level from surveyed top of pipe level (both surveyed via VRS differential GPS from a CORS base station by a registered surveyor). [4] NA – not applicable as no groundwater MW present.

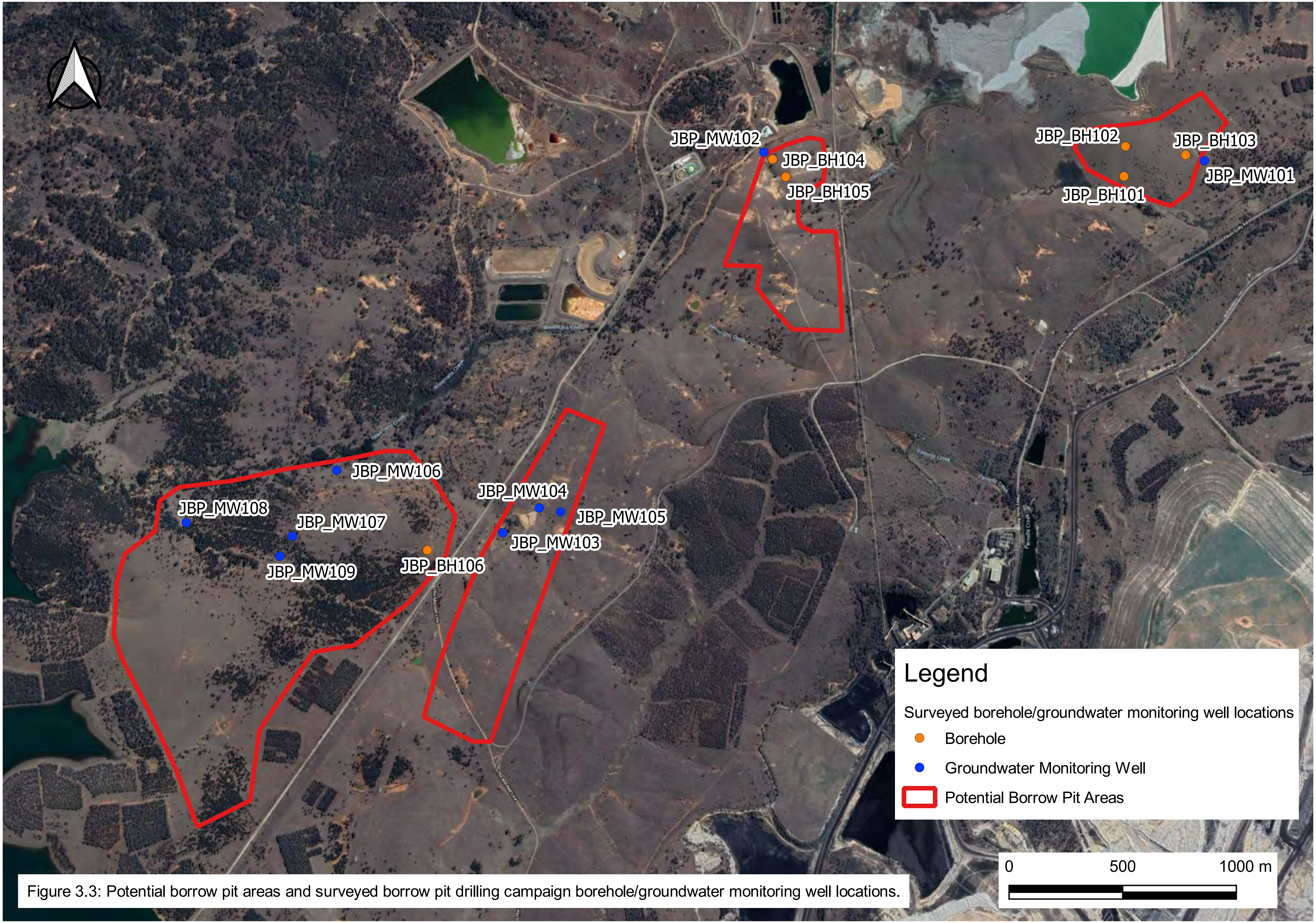


Figure 3.3: Potential borrow pit areas and surveyed borrow pit drilling campaign borehole/groundwater monitoring well locations.

3.3.3 Conceptual groundwater model and identification of potential impacts

Potential Project related groundwater impacts were identified and the Project elements were assessed to determine their likelihood of causing potential impacts to groundwater. A conceptual groundwater model was developed for Project elements, which prior to the borrow pit drilling program, showed a relatively higher likelihood of potentially impacting groundwater systems. This included the salt cake landfill facility and the potential borrow pit areas.

3.3.4 Groundwater impact assessment

The groundwater level and quality impacts for each Project element were assessed qualitatively based on Project element characteristics, the Project groundwater data set and the conceptual ground model(s).

The salt cake land fill facility was assessed quantitatively using a finite element two dimensional cross section flow model, SEEP/W, coupled to C/TRAN, a solute transport model. The model was established to determine potential salt migration in the case of the proposed landfill's liner leaking. The model details are outlined in the following section.

3.3.5 SEEP/W and C/TRAN two dimensional cross section groundwater flow and transport model

Salt cakes placed in the landfill facility will be a potential source of salt created by the interaction with rainfall creating saline or briny water. The maximum possible TDS concentration of brine water is approximately 260,000 mg/L, which is about seven times more saline than seawater (seawater TDS is approximately 35,000 mg/L). If the landfill's leachate collection liner leaks, it is possible that saline or briny water could migrate from the area of the landfill and move towards sensitive receptors. Potential sensitive receptors surrounding the landfill include vegetation, including the following Endangered Ecological Communities (**EECs**) and Critically Endangered Ecological Communities (**CEECs**) mapped by the Project ecologist, Kleinfelder (2019):

- Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC.
- Central Hunter Valley eucalypt forest and woodland CEEC.

The above vegetation communities exist in the general area immediately adjacent the proposed landfill area.

An unnamed ephemeral drainage line extends from downslope of the proposed landfill, before its confluence with Saltwater Creek about 2.1 kilometres north of Plashett Reservoir; from there, Saltwater Creek flows into Plashett Reservoir. Plashett Reservoir is located approximately 4.9 kilometres from the landfill via this route. The unnamed ephemeral drainage line and water bodies are also considered potential sensitive receptors for discharge of saline or briny water from the landfill.

The area of the proposed landfill is elevated and has minimal upslope catchment. Once in the groundwater, saline or brine migration is inferred to ultimately be towards the south and then along the directional surface water flow path to Plashett Reservoir.

3.3.5.1 Modelling approach

Two models were developed, an existing conditions steady state model and a transient (time varying) landfill simulation model. The purpose of the existing conditions model was to provide a basis to determine the steady state recharge rate that results in good calibration to inferred water table levels for the area of the model. The same recharge rate was applied to the landfill simulation model, outside of the landfill footprint. The recharge rate was reduced in the landfill simulation model within the landfill footprint to simultaneously simulate reduced recharge due to the landfill liner and leakage through the liner.

The modelling approach aligns with the principle of simplicity advocated by the Australian groundwater modelling guidelines (Barnett *et.al*, 2012). Therefore, the landfill geometry (specific cells, leachate collection system, liner and capping) was not included in the model, as this is considered superfluous complexity and its omission creates a conservative approach. The modelling approach is also based on recharge flux through the liner, with the flux value derived based on literature; hence, the physical process of recharge moving from the surface, through the capping, cell material, leachate collection gravel and finally liner, did not need to be included in the model.

3.3.5.2 Model Geometry

A cross section as per the salt cake landfill conceptual groundwater model was developed. This section location was chosen because of the landfill's proximity to adjacent EECs and CEECs, and the unnamed drainage line at this location. The section was derived using a Geographic Information System (**GIS**) profile tool applied to two metre digital elevation model (**DEM**) data obtained through ELVIS (ICSM, 2019), a Federal Government online portal capable of outputting elevation data. The section begins at the eastern extent of the landfill area and extends to the drainage depression located approximately 100 m west of the landfill. Groundwater flow paths are conceptualised to converge at the drainage line, which is why the model was terminated at the drainage line.

The model was assigned a uniform base elevation of 154 metres Australian Height Datum (**mAHD**), equivalent to 20 mBGL at the western extent of the section. This base level was considered sufficient to allow for modelling of shallow flow, given the groundwater level at the western extent of the model was conceptualised to be approximately 5 mBGL based on nearby groundwater bore data. Groundwater bore data indicates the groundwater level increases towards the east with increasing distance away from the drainage line.

Model geometry is shown in Figure 3.4**Error! Reference source not found.**.

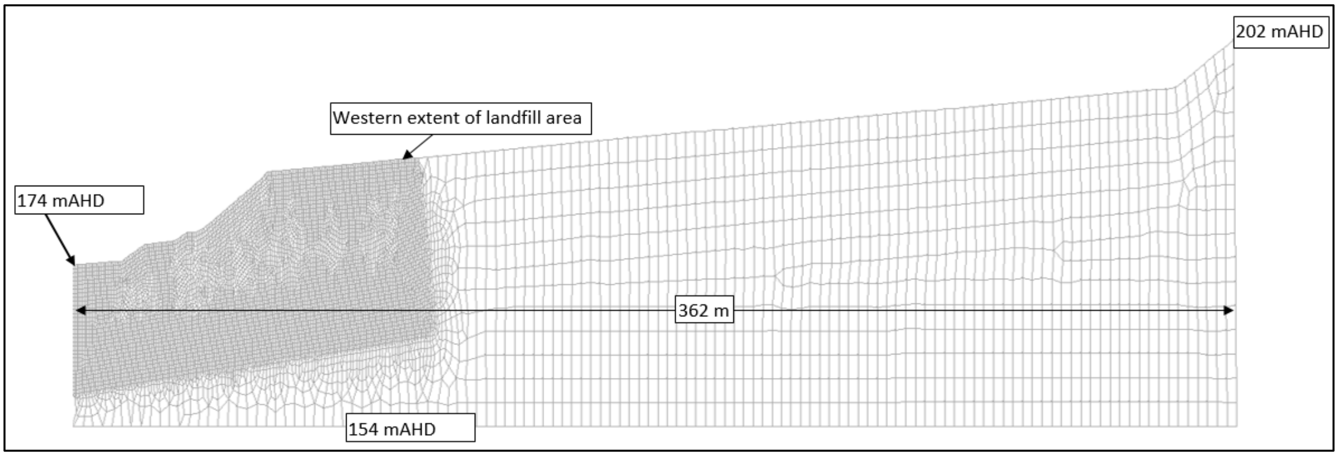


Figure 3.4: Model geometry

3.3.5.2.1 Material properties and water density function

The entire model domain was simulated with the material properties of siltstone, due to the water table in the proposed landfill area being exclusively situated within siltstone, except for a very small area at the western extremity of the model (refer conceptual site model).

Unsaturated/saturated flow was simulated using a saturated hydraulic conductivity (k) of 0.01 m/d. This value represents the horizontal hydraulic conductivity (kH) applied to represent the weathered overburden in a calibrated groundwater model (AGE, 2013) associated with nearby Mount Arthur Coal Mine. Vertical hydraulic conductivity (kV) was assigned a value of 0.001 m/d as a standard and conservative ratio of 1:10 kV:kH. This ratio represents preferential horizontal flow due to horizontal bedding. The volumetric water content and hydraulic conductivity functions applied in the model are provided in Figure 3.5 and Figure 3.6 respectively.

A conservative coefficient of volume compressibility (*mv*) value of 1.02 x 10^{-6} kPa^{-1} was assigned and calculated based on an assumed specific storage value for the siltstone of 0.00001 m^{-1}. The applied *mv* value is within the range of literature values for sound and jointed rocks (Bell, 2000).

Density dependent flow is applicable in this case and was modelled, as salt water has a higher density compared to freshwater. The density function used in the transient simulation model is shown in Figure 3.7.

Dispersion is flow length scale dependent and for modelling is typically a calibration parameter, or if no data is available, is based on the length from the contaminant source to the contaminant sink, which in this case is approximately 100 m. Based on this distance and a dispersion and scale scatter plot in Lovanh *et.al* (2000), a longitudinal dispersivity value of 10 m was applied. For transverse dispersivity, a value of 0.05 m was applied, which is commensurate and in the same order of magnitude as a reduction from longitudinal dispersivity to vertical dispersivity as assumed by Environment Agency (2006).

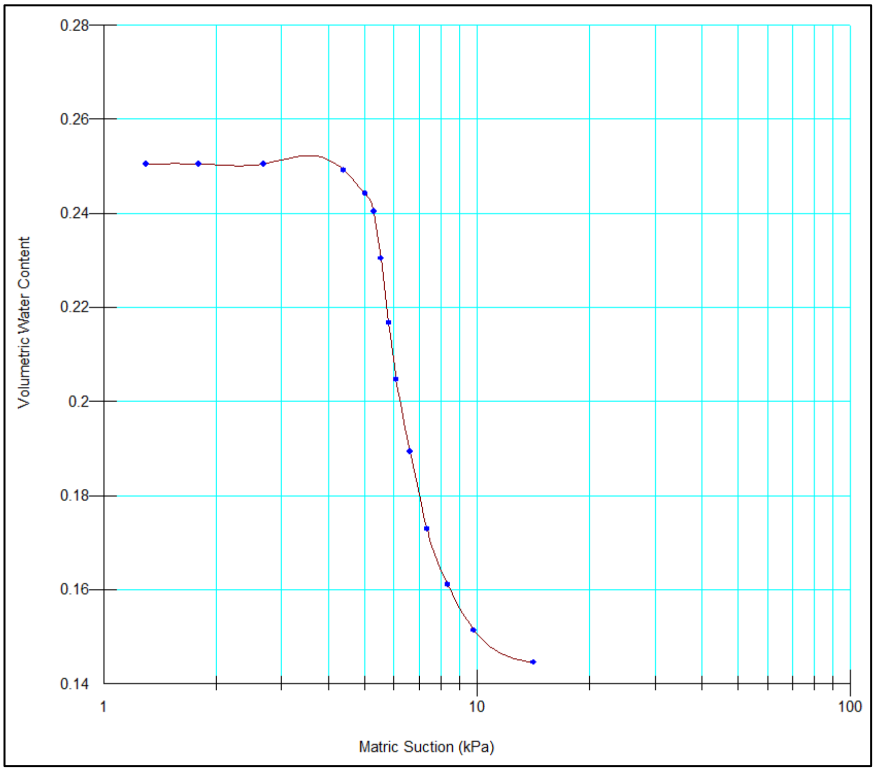


Figure 3.5: Volumetric water content function used for siltstone

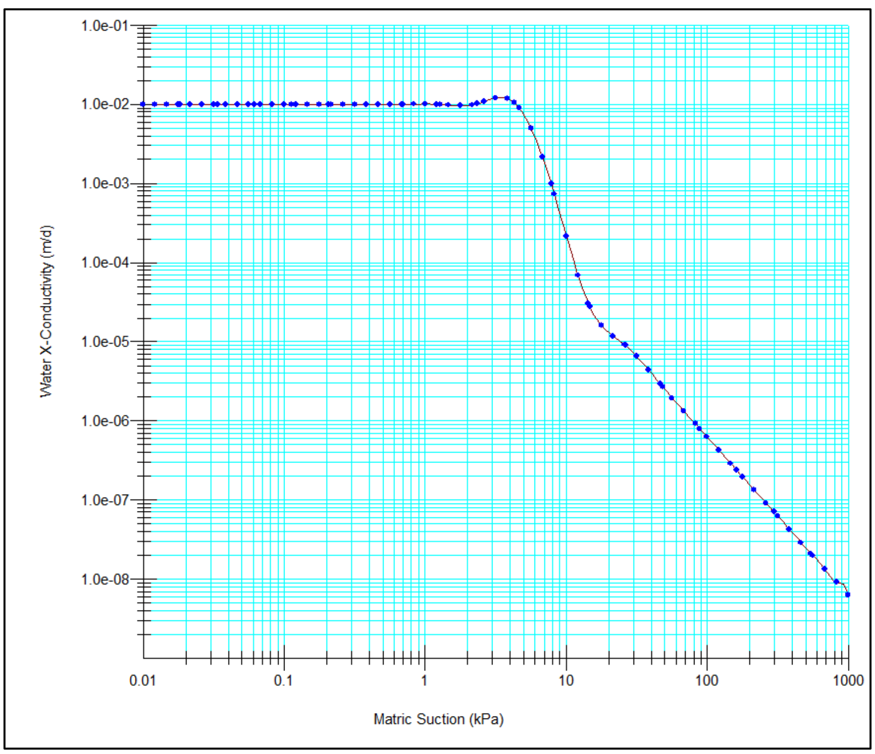


Figure 3.6: Hydraulic conductivity function for siltstone

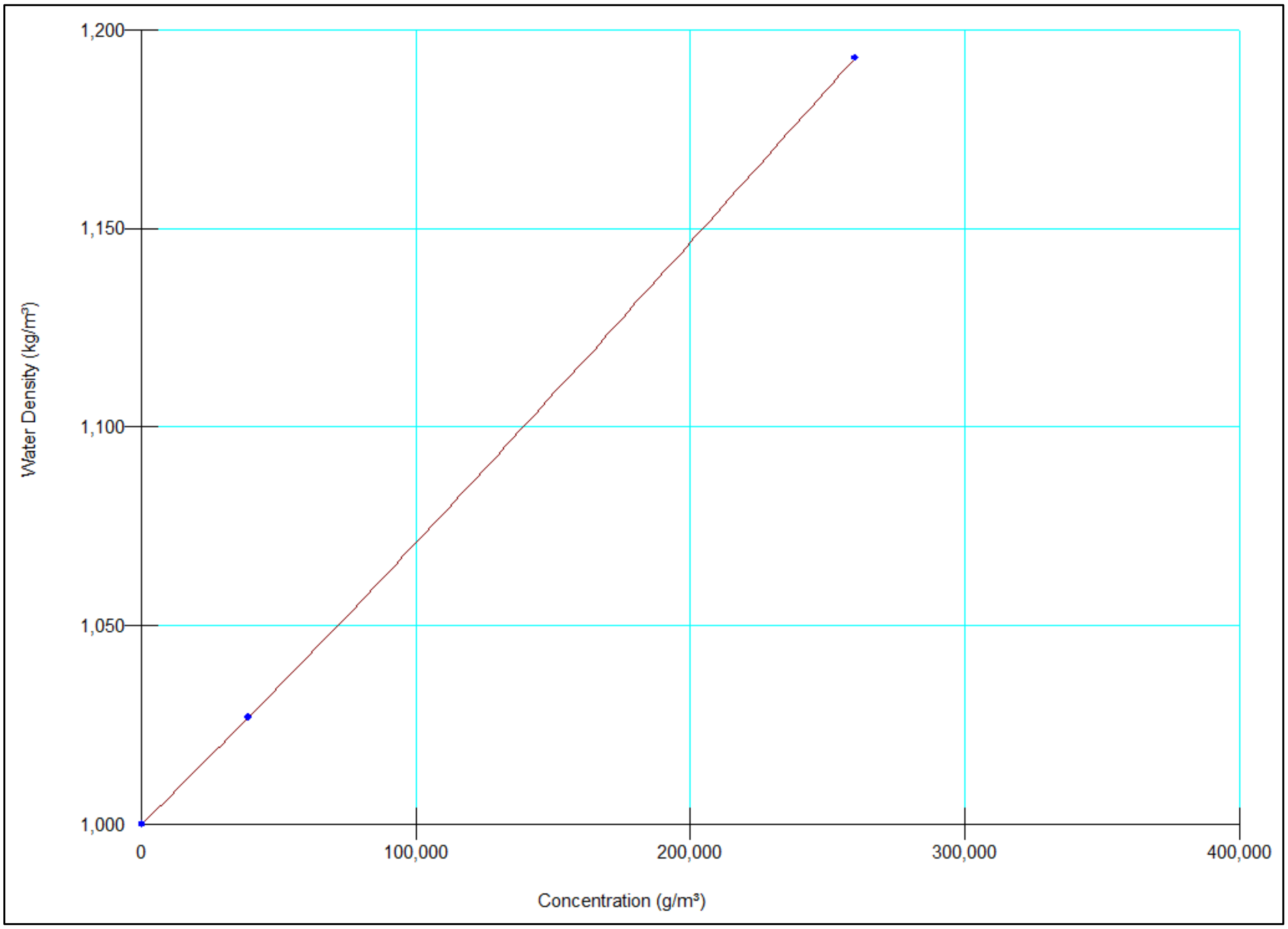


Figure 3.7: Water density function

3.3.5.2.2 Boundary conditions

The boundary conditions applied in the model are shown in Figure 3.8 and summarised below:

- A constant head of 169 mAHD (5 mBGL) was applied at the western model boundary to allow the model to discharge. The level for the boundary condition was applied based on the mean monitored groundwater depth at nearby groundwater monitoring bore MW-A05 of 6.44 m BGL, but with a groundwater depth decrease applied due to the model's western boundary being upgradient from bore MW-A05.
- The existing conditions recharge rate and recharge rate outside of the landfill footprint in the landfill simulation model was 16 mm/year and was determined through trial and error calibration in the existing conditions model. The objective of the applied recharge rate was to determine a water table depth of approximately 11.5 mBGL in the approximate location of bore MW-A02 after being transposed onto the section (bore is off the cross section and was transposed onto cross section at a similar surface level elevation).
- A constant recharge rate of 10 mm/year was applied to the landfill simulation model to simultaneously simulate reduced recharge due to the landfill liner and leakage through the liner. This rate was adopted based on a comprehensive peer reviewed landfill leakage rate study (Moo-Young *et.al*, 2003). This study analysed leakage rates through landfill liners measured by leakage detection systems for 259 landfill cells, mostly located in the United States of America. Of the 259 cells, 140 cells (54%) were associated with a

geomembrane (typically HDPE) and compacted clay liner (CCL). The 90th percentile operational leakage rate for such a system was approximately 10 mm/year. For a geomembrane with geosynthetic clay liner (GCL), the 90th percentile leakage rate was significantly less, approximately 0.55 mm/yr, which is approximately 5.5% of the 90th percentile geomembrane with CCL rate. The study data indicated post closure leakage rates are significantly less than operational rates. The flux rate to simulate leakage through the liner of 10 mm/year is considered conservative for impact assessment modelling purposes.

- The flux through the liner was assigned a constant TDS concentration of 260,000 mg/L, the upper limit for brine water.
- The recharge flux outside of the landfill footprint was assigned a TDS concentration of 7,000 mg/L, which is based on the mean and median monitored concentrations from groundwater monitoring bores near the proposed landfill of 7,277 mg/L and 7,753 mg/L, respectively.
- A solute free exit mass flux boundary was applied to the western model boundary to allow salt to freely exit the model based on advection (driven by the constant head boundary) and dispersion.

3.3.5.3 Mesh discretisation

The areas west of the proposed landfill was assigned an element length of 0.5 m, whereas the remaining model area was assigned an element length of 3 m. The mesh is shown in Figure 3.8 and resulted in a Peclet Number generally less than 2, which is considered acceptable (Geo-slope, 2012) for minimising potential numerical dispersion and oscillation in the model.

3.3.5.4 Time discretisation

The transient landfill simulation model started with the head output from the existing conditions model and a uniform TDS concentration of 7,000 mg/L throughout the model. The simulation model was then run for 1,000 years, subdivided in to 7,300 linear time steps of 50 days. The time step duration was adopted after trial and error assessment to ensure the Courant Number was generally less than 1, which is considered acceptable (Geo-slope, 2012) for minimising potential numerical dispersion and oscillation in the model. The total simulation time of 1,000 years was adopted as this is considered an appropriate planning horizon for assessment, given the landfill will only operate for approximately 15 years (Bayswater is planned to close in 2035).

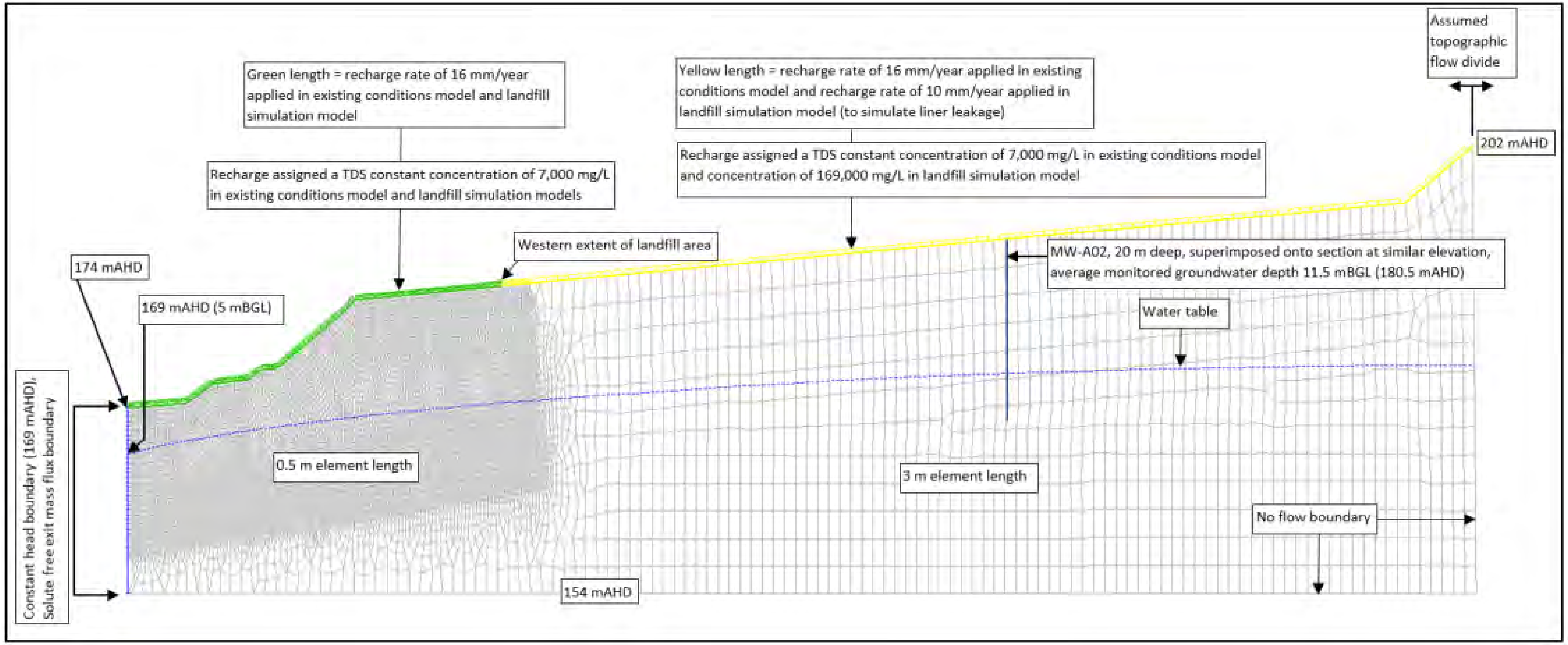


Figure 3.8: Model boundary conditions, geometry and mesh

3.4 Flooding

3.4.1 Study area

The Project elements are generally located within the catchment areas of Lake Liddell and Lake Plashett. In particular, the Project elements relating to the augmentation of BWAD, salt cake landfill facility, borrow pits, ash pipeline from Bayswater to Ravensworth Void No. 5 and CHP water and wastewater infrastructure upgrades have the potential to impact on flood behaviour within the catchment areas of both lakes. The Project elements relating to additional coal ash recycling and fly ash harvesting upgrades, and ancillary works involving routine clearing of vegetation along the alignments of LSP Sludge Line and HP Pipeline would have almost negligible impacts on flooding.

3.4.2 Desktop assessment

The flooding assessment involved a review of the existing hydrological regime for the Project elements to assess their likely and potential impacts on flooding during construction, operation and decommissioning. Information on the existing hydrological regime has been sourced from a review of available literature, background information on catchment history and land use to aid in interpreting the existing conditions. Literature sources included:

- Aurecon (2019), *Bayswater Ash Dam Augmentation – Design Report*, AGL Macquarie Pty Ltd, March 2016;
- Aurecon (2016), *Bayswater Ash Dam – Ash Management Plan*, AGL Macquarie Pty Ltd, May 2016;
- AECOM (2017), *Water Balance Assessment – Bayswater and Liddell Ash Dams*, AGL Macquarie Pty Ltd, June 2016;
- AECOM (2016b), *Water Management Investigation - Bayswater Ash Dam, Bayswater and Liddell PRP*, AGL Macquarie Pty Ltd, June 2016;
- AECOM (2016c), *Assessment of Hydraulic Parameters in Tinkers Creek in the vicinity of the Ash Settling Pond required for a controlled activity approval*, AGL Macquarie Pty Ltd, March 2016;
- AECOM (2015), *Tinkers Creek, Options Analysis – Hydraulics Report*, AGL Macquarie Pty Ltd, September 2015;
- Aurecon (2013), *Ravensworth Void 4 Discharge Investigation*, Macquarie Generation, October 2013;and
- Department of Infrastructure, Planning and Natural Resources (2005) *Floodplain Development Manual, the management of flood liable land,* April 2005.

4. Existing Environment

4.1 Site Description

Bayswater is a coal-fired power station located in the Upper Hunter region of NSW, between Singleton and Muswellbrook. Bayswater was commissioned in 1985 and has been owned and operated by AGL Macquarie Pty Limited (AGL) since 2 September 2014.

Bayswater receives fresh water supply for the cooling water system from two artificial waterbodies, Plashett Reservoir and Lake Liddell. Bayswater draws cooling tower make up water from Plashett Reservoir or as make-up from Lake Liddell for condenser cooling which passes through the water treatment plant before entering the station cooling tower system, where it absorbs waste heat from the steam cycle.

In order to manage salinity in the cooling towers, water is periodically blown down into Lake Liddell (Aurecon, 2013). This water is discharged from the power station site from a number of licenced discharge points that drain to a small, intermittent stream known as Tinkers Creek which subsequently flows downstream into Lake Liddell. Flows from Lake Liddell are intermittently released to Bayswater Creek from a discharge point at the dam wall. Bayswater Creek acts as a transfer channel from Lake Liddell to the Hunter River and is regulated by the Hunter River Salinity Trading Scheme (**HRSTS**) (See Section 2.1.1).

4.2 Catchments and sub-catchments

4.2.1 Hunter River catchment

Bayswater is situated in the central region of the Hunter River catchment area which spans approximately 22,000 km^2 (EPA, 2013). The Hunter River rises in the Mount Royal Range north east of Scone and travels approximately 450 kilometres to the sea at Newcastle (DIPNR, 2004). The Hunter region supports a range of agricultural activities including wineries, dairying, vegetables, fodder, beef and horse breeding as well as over 20 of the largest coal mines in Australia and two operational coal-fired power stations. Redbank Power Station, which is currently not in operation, is also located within the Hunter River catchment. The river is regulated from Glenbawn Dam to Maitland, spanning a distance of approximately 250 kilometres.

A significant management issue in the Hunter River catchment area is high salinity. Sources of salt within waterways in the catchment include rainfall and weathering products which enter streams via surface runoff pathways and groundwater sources, particularly from the underground geology of the Permian coal measures. Coal mining and power generation are also expected to contribute to sources of salinity in streams however lack of long-term monitoring data and a highly variable climate make this difficult to confirm. Of the surface water salinity observations from across the Hunter region, median electrical conductivities exceed 5500 µS/cm in water sources for Singleton, Jerrys Plains, Muswellbrook and Wybong. Streams with identified groundwater interactions are also often found to have high salinities (Bioregional Assessments, 2019).

In response to this, in 1994, the NSW government implemented the HRSTS which enabled the regulation of salty water discharge into the Hunter River (DEC, 2006). As previously discussed in Section 2.1.1, the central idea of the scheme is to discharge water with high salinity during times of high flows of fresh water with low salinity. This is when the river can best handle salt discharges as the large volume of fresh water dilutes the saltier discharge and mixing the discharge with river flow can ensure water can be kept fresh to meet water quality standards.

4.2.2 Bayswater Creek and Saltwater Creek sub-catchments

Lake Liddell and Plashett Reservoir are linked to the “Middle Sector” of the Hunter River. Flows from Lake Liddell are transported to the Hunter River via Bayswater Creek (DEC, 2006), and Plashett Reservoir is linked to the Hunter River by a canal that connects into a High Pressure Pump Station on the Hunter River.

Bayswater Creek has a total catchment area of approximately 96 kilometres squared and has been substantially disturbed by mining activities. A dam wall was constructed across Bayswater Creek in the 1960s to create Lake Liddell, a large cooling water pond for the Liddell and Bayswater . Below Lake Liddell, the waterway has been heavily modified to accommodate discharges from the lake, where it flows in a south easterly direction into the Hunter River approximately 15 kilometres downstream. While discharges from Lake Liddell are the primary source of flow into Bayswater Creek, a number of other tributaries flow into Bayswater Creek below the dam including Davis Creek, Emu Creek, and Chain of Ponds Creek. Furthermore, due to expansion of coal operations in the catchment in the early 1990’s, the lower 5 kilometres of Bayswater Creek has been diverted around the Narama Mine. The diversion channel is located just downstream of the confluence of Davis Creek to 100 metres upstream of the confluence with the Hunter River. The diversion channel is devoid of meanders and has shortened the length of the original creek, requiring a drop structure where Bayswater Creek meets the Hunter River (Aurecon, 2013).

Saltwater Creek sub-catchment area is comprised of two major drainage lines, Salt Water Creek running north-south and Noname Creek (Saltwater Creek Tributary) running east-west, which joins Saltwater Creek in the south before draining into Plashett Reservoir. The catchment has been found to be releasing approximately 230 tonnes/km^2/year of salt, which is thought to be a result of groundwater-surface water connections due to the saltwater thrust which traverses Saltwater Creek (EPA, 2013).

4.3 Climate

4.3.1 Rainfall

Daily rainfall data from the AGL Macquarie rain gauge, located on site, is available from 2005 to 2018. Long-term rainfall data is available from the BOM’s (2019c) Doyles Creek (Wood Park, Station Number 061130) rainfall station, located approximately 10 km to the south west of the site, and is available from 1920 to present, with a data gap between 1963 to 1971. The Doyles Creek rainfall data was downloaded from SILO (Queensland Government, 2019) database and the missing data has been automatically interpolated. Mean monthly rainfall is summarised in Table 4-1.

The average long-term annual rainfall for the AGL Bayswater rain gauge of 699mm is comparable to the Doyles Creek mean annual rainfall of 641mm. Rainfall is generally greater in the late spring/summer months from November to February. Within the winter months, rainfall is relatively high in June.

Table 4-1 Mean monthly rainfall for AGL and Doyles Creek stations

Station	Mean monthly rainfall total (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Doyles Creek (1)	74	77	56	45	38	51	41	36	42	54	63	63
AGL (2)	61	78	89	45	46	78	27	37	43	44	91	61

Notes. (1) Mean for data from 1920 to 2019.
(2) Mean for data from 2005 to 2018.

4.3.2 Evaporation

Doyles Creek (BOM, 2019c) (Wood Park, Station Number 061130) indicated an average Class A pan evaporation of 1,514mm/year from 1920 to present. Table 4-2 presents mean daily Class A pan evaporation for each month at Doyles Creek Station.

Table 4-2: Mean daily Class A pan evaporation at Doyles Creek Station

Average daily pan evaporation (mm/day)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6.60	5.71	4.59	3.35	2.20	1.64	1.89	2.66	3.77	4.86	5.84	6.69

Areal actual evapotranspiration (**AAET**) is normally used to represent evaporation from soils. AAET is the average of the evapotranspiration that actually takes place under prevailing soil moisture conditions.

AAET data for the site was estimated from data available on BOM (2019c). This source has national coverage GIS layers for average long-term average monthly AAET data from 1961. Average daily AAET rates calculated from the monthly data obtained from BOM maps is provided in Table 4-3.

Table 4-3 Estimated areal actual evapotranspiration for the site

	Areal actual evapotranspiration for the site (mm/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
mm/d	2.97	2.36	2.19	1.3	1	0.9	0.81	0.87	1.37	1.97	2.5	2.45
mm/month	92	66	68	39	31	27	25	27	41	61	75	76

4.3.3 Rainfall surplus

Rainfall surplus (Table 4-4) is defined as rainfall – evapotranspiration. A positive rainfall surplus indicates a water surplus, which may manifest itself in increased potential for groundwater recharge. Conversely, a negative rainfall surplus indicates a water deficit and therefore is associated with reduced potential for groundwater recharge. Based on the Doyles Creek rainfall and the BOM AAET (BOM, 2019c), there is a rainfall surplus in February and from April to September. Remaining months have a rainfall deficit.

Table 4-4 Mean monthly rainfall surplus

Station	Mean monthly rainfall surplus (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Doyles Creek rainfall [(1)]	74	77	56	45	38	51	41	36	42	54	63	63
AAET	92	66	68	39	31	27	25	27	41	61	75	76
Rainfall surplus [(2)]	-18	11	-12	6	7	24	16	9	1	-7	-12	-13

Notes. [(1)] Mean for data from 1920 to 2019.
[(2)] Monthly rainfall surplus = monthly rainfall – monthly AAET.

4.4 Soils, geology and landform

4.4.1 Topography

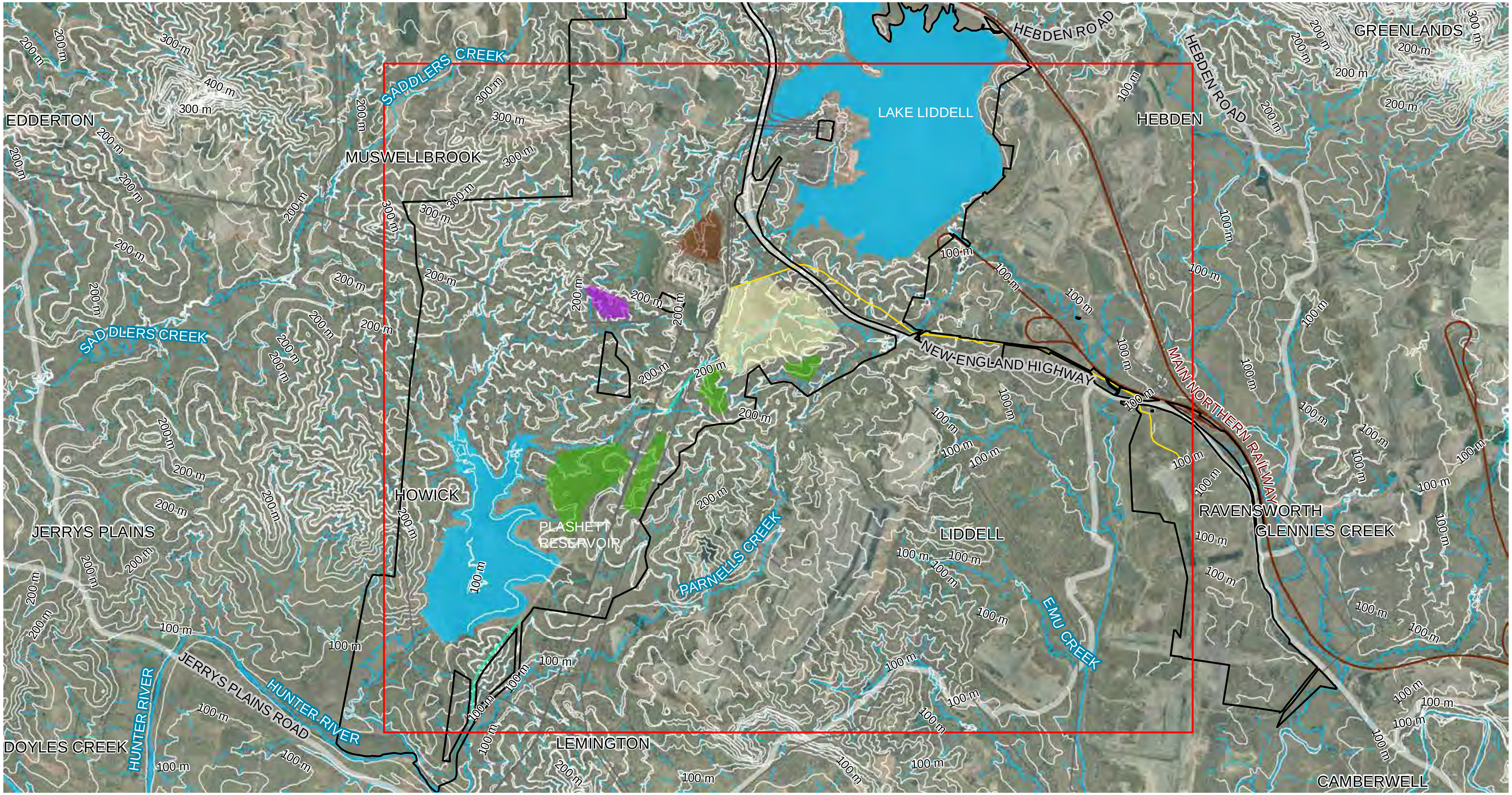
The local topography is shown in Figure 4.1. The area of the Project elements is generally characterised by low hills with elevations ranging from 100 mAHD to 220 mAHD. The majority of the Project elements are situated between two large water bodies, Lake Liddell in the north east and Plashett Reservoir to the south west, both with an elevation of approximately 125 to 130 mAHD. Maximum slopes of natural land in the vicinity of Project elements are approximately 25% to 30% (14 to 17 degrees).

4.4.2 Geology

The 1:100,000 Hunter Coalfield Regional Geology map (Department of Mineral Resources, 1993) indicates that surface geology in the vicinity of the Project elements comprises sedimentary rock, with some limited areas mapped as Quaternary Alluvium. Geological mapping in the area of the Project elements is summarised in Table 4.6 and shown in Figure 4.2.

Table 4.5: Geological mapping summary

Project element	Geology mapping (Department of Mineral Resources, 1993) summary
Ash dam augmentation	The western two-thirds is mapped as Mulbring Siltstone of the Maitland Group comprising siltstone, claystone and minor fine grained sandstone. The remaining eastern third is mapped as the Saltwater Creek Formation of the Wittingham Coal Measures comprising sandstone, siltstone and minor coaly bands. The Saltwater Creek Formation is younger than the Mulbring Siltstone. Both the formations are mapped as dipping to the east or south east at between 4 to 10 degrees. Regionally, the area's surface geology generally consists of sedimentary rock formations, with some Quaternary Alluvium deposits. The closest mapped alluvium deposit to the ash dam augmentation area is approximately 2.9 kilometres to the east south east.
Salt cake landfill	The area of the proposed salt cake landfill is mapped as the Branxton Formation comprising conglomerate, sandstone and siltstone. There is no mapped alluvial immediately adjacent to the landfill with the nearest mapped alluvial material approximately 2.4 kilometres to the south west.
HP pipe clearing	This Project element occupies two separate areas, a northern area and southern area. The northern area is mapped to comprise Mulbring Siltstone with the nearest Quarternary Aluvium deposit approximately 2 kilometres to the south. The southern area of pipe clearing is mapped to comprise Mulbring Siltstone and various Wittingham Coal Measure subgroups. For the southern area of pipe clearing, Quarternary Alluvial is mapped to the east at distances varying from approximately 10 metres to 800 metres.
LSP sludge line clearing	This Project element is mapped to comprise Mulbring Siltstone. The nearest mapped Quaternary Alluvium is located approximately 2.5 kilometres to the south.
Clay borrow pits	Borrow Pit 1 is mapped as Saltwater Creek Formation of the Wittingham Coal Measures. Borrow Pits 2 and 3 are mapped as Mulbring Siltstone of the Maitland Group. Borrow Pit 4 is predominantly mapped Mulbring Siltstone with the exception of the area 100 metres to 200 metres to the north western of the borrow pit, which is mapped as the Branxton Formation. The nearest mapped Quaternary Alluvium to any of the potential borrow pits is located approximately 400 metres west of Borrow Pit 4.
Ravensworth ash line	The ash line passes through geology mapped as Mulbring Siltstone, Vane Subgroup and Jerry Plains Subgroup of the Wittingham Coal Measures and Quaternary Alluvium associated with Bayswater Creek. There are potential underground sections of the proposed pipe in all of the above mapped units.



Groundwater Impact Assessment Study Area (approximately 14km x 12km)
AGL owned land

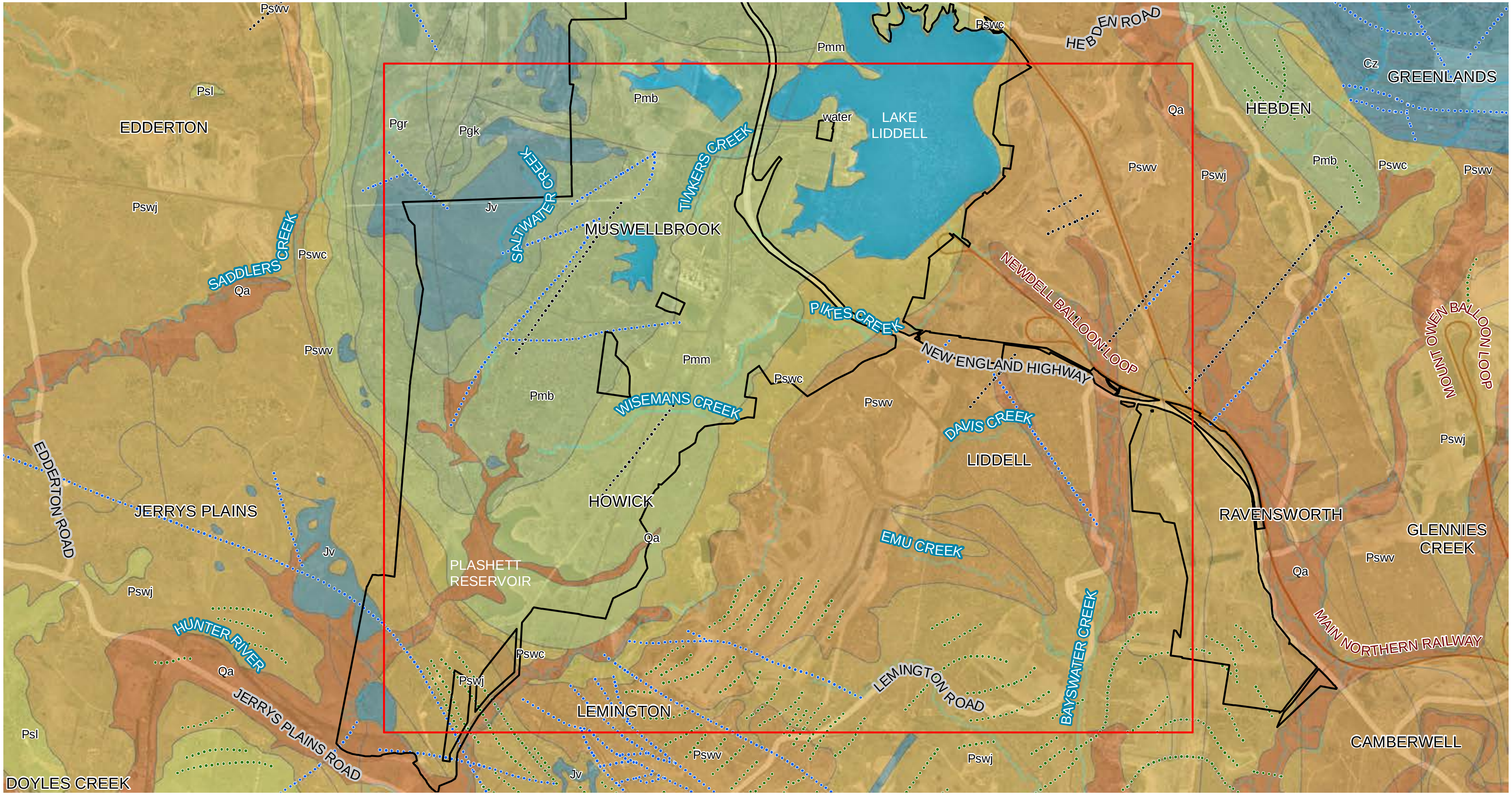
Project elements:
- Ash Dam Augmentation, Ash Harvesting and Water Management Works
- Salt Cake Landfill
- Coal Handling Plant Water and Wastewater Infrastructure Upgrades
- HP Pipe Clearing
- LSP Sludge Line Clearing
- Clay Borrow Pits
- Ravensworth Ash Line

0 1 2 km
1:100,000 at A4

Data sources
Jacobs 2019, AGL 2019
NSW Spatial Services 2019

GDA94 MGA56

Figure 4.1 Topography



Groundwater Impact Assessment Study Area (approximately 14km x 12km)
AGL owned land

Structure
Fault
Dyke

Cz
Jv
Pgk
Pgr
Pmb
Pmm

Psl
Pswc
Pswj
Pswv
Qa
water

0 1 2 km
1:100,000 at A4

Data sources
Jacobs 2019, AGL 2019, NSW Spatial Services 2019, DIRE

GDA94 MGA56

Figure 4.2 Geology

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4.4.3 Hydrology

Existing catchment hydrology for the Project elements have been defined based on the available data and are presented in Table 4.5.

Table 4.6: Catchment hydrology for the Project elements

Project element	Catchment Hydrology
Ash dam augmentation	The BWAD is located on the upper catchment area of Pikes Gully and has a catchment area of 232 hectares (AECOM, 2017). The 39 metre high zoned embankment dam has a 6 metre wide crest located at RL 174 metre and the downstream face incorporates a 4 metre wide berm at RL 150 metre. The 780 metre long saddle dam located at the north western corner of the storage (capacity 22,000 megalitres at full supply level) has a maximum height of 15 metres and a 6 metre wide crest at RL 172.8 metre. (Aurecon, 2019). The decant pond has a storage capacity of 3,300 megalitres at FSL. Discharge from the BWAD is via four submerged outlet towers which are connected by an outlet pipe situated upstream of the main embankment. Three towers are currently blocked off due to ash deposit encroached on the outlet pipe. A 300 metre long outlet pipeline joins the outlet towers to the valve pit downstream of the dam. The flood spillway consists of a 15 metre wide open unlined channel excavated through a saddle near the left abutment of the main dam wall. A 6 metre wide concrete sill with an invert level at RL 172 metre is located at the upstream end of the channel. The approach channel upstream of the sill is lined with rip-rap over a distance of 5 metre. The spillway discharges into Chilcotts Creek which eventually flows into Lake Liddell. A detailed flood study was carried out in 1998 to assess the flood handling capacity for the dam utilising probable maximum precipitation data provided by the Bureau of Meteorology in 1993. The available flood storage in the storage was based on the "end-of-life" ash storage contours to estimate peak flood level in the storage. The 1998 study determined that the saddle dam would be overtopped during extreme rainfall events with an annual exceedance probability (AEP) of less than 1:20,000.
Salt cake landfill	The salt cake landfill is proposed at the former contractor's compound which is located approximately 250 metre south of the Freshwater Dam. The northern edge of the site generally runs along a ridge line defining the catchment divide between the Freshwater Dam and Noname Creek. The southern boundary of the site has a steep bank. The landfill site has a 4% slope towards the southern boundary and covers an area of approximately 27 hectares. The site drains into Noname Creek which discharges into Saltwater Creek.
Borrow pits	Borrow Pit 1 covers an area of approximately 18 hectares located within the catchment area of Bayswater Creek. Borrow Pit 2 covers an area of approximately 26 hectares located at the upper catchment areas of Pikes Gully, Bayswater Creek and Wisemans Creek. Borrow Pit 3 covers an area of approximately 42 hectares generally located within the catchment area of Wisemans Creek. Borrow Pit 4 is the largest of the four pits and covers an area of approximately 140 hectares draining into Wisemans Creek and Plashett Reservoir.
Ash pipeline from Bayswater to Ravensworth	The Project element involves construction of an additional pipeline for the transfer and disposal of ash from the Ravensworth Fly Ash Plant (Bayswater) to Ravensworth Void No. 5. The majority of the pipeline would be located above ground. The proposed pipeline would be located underground at New England Highway, roadways, Pikes Creek, Liddell Station Road and other infrastructure corridors. The pipeline would be raised above ground for crossing Bayswater Creek and Chilcotts Creek.
Coal handling plant water and wastewater infrastructure upgrades	The sediment basin of the CHP currently overflows daily to Tinkers Creek and hence additional water and wastewater management infrastructure works are proposed to manage overflows to Tinkers Creek. For the

Project element	Catchment Hydrology
	purposes of this application, it is assumed that the volume and frequency of discharges to Tinkers Creek would not be altered as a result of the project.
HP pipe clearing	This is an existing pipeline. AGL would be clearing vegetation along this pipeline so as to access it for maintenance and repairs. Works associated with vegetation clearing are not anticipated to impact on flooding along the HP pipe.
LSP sludge line clearing	This is an existing pipeline. AGL would be clearing vegetation along this pipeline so as to access it for maintenance and repairs. Works associated with vegetation clearing are not anticipated to impact on flooding along the LSP sludge line.

4.4.4 Soil Landscapes

A review of NSW eSPADE (NSW Government Environment and Heritage, October, 2019) soil profile data indicated soils in the area of the Project elements generally compromise silty clay loams, clay loams and silty loams underlain by silty clays, medium clays, heavy clays.

Soil depth for the existing Project bores ranges from less than 1 m to approximately 11 m.

Soil depth for the borrow pit drilling programme boreholes and groundwater monitoring bores ranges from approximately 0.7 m to 8 m, as inferred based on standard penetration test (**SPT**) refusal or low SPT advancement, observed rock cuttings, or auger refusal. These boreholes encountered clayey soils.

4.4.5 Soil salinity

The NSW Government Environment and Heritage (October, 2019) online eSPADE mapping portal indicates that the Project area has modelled soil EC as follows:

- 0 – 0.3 mBGL: generally 0.05 to 0.10 DS/m
- 0.3 – 1 mBGL: generally 0.05 to 0.20 DS/m

These soil EC values are considered 'non saline' as per soil salinity class ranges provided by Agriculture Victoria (October, 2019). However, eSPADE (NSW Government Environment and Heritage (October, 2019) profile data in the broad vicinity of the Project elements indicates tested ECe (soil EC) values ranging from 0.9 DS/m to 15 DS/m, with a median value of 0.7 DS/m. The minimum, median and maximum of these soil salinity values are considered as 'non saline', 'moderately saline' and 'highly saline' as per the soil salinity class ranges provided by Agriculture Victoria (October, 2019).

4.4.6 Acid sulfate soil and rock

Acid Sulfate Soils (**ASS**) is the common name for naturally occurring sediments and soils containing iron sulphides. The exposure of these soils to oxygen by drainage or excavation, oxidises the iron sulphides and generates sulfuric acid. The sulfuric acid can be readily released into the environment, with potential adverse effects on the natural and built environments. The majority of ASS are formed when available sulfate (which occurs widely in seawater, marine sediment, or saturated decaying organic material) reacts with dissolved iron and iron minerals forming iron sulfide minerals, the most common being pyrite. This generally limits their occurrence to deeper marine sediments and low lying sections of coastal floodplains, rivers and creeks where surface elevations are less than approximately 5 mAHD.

No ASS mapping data was available within eSPADE (NSW Government Environment and Heritage, October 2019).

The Australian Soil Resource Information System (**ASRIS**) (CSIRO, October 2019) indicates the major water bodies in the vicinity of the Project (i.e. Lake Liddell, the Ash Dam, Plashett Reservoir and the large freshwater dam west of the CHP) to have 'high probability of occurrence' for ASS, with a 'very low' level of confidence. Whereas, the Project element areas are mapped as a 'low probability of occurrence' for ASS, with a 'very low' level of confidence. Also, as the site has elevations ranging from approximately 100 mAHD to 220 mAHD, ASS is not anticipated.

4.5 Watercourses

Watercourses within the Project area have been classified according to the Strahler stream classification system and the Framework for Biodiversity Assessment (**FBA**) where waterways are given an order according to the number of additional tributaries associated with each waterway (Strahler, 1952 and OEH, 2014). A first order stream, otherwise known as headwater stream, begins at the top of a catchment. They are generally the smaller tributaries that carry water from the upper reaches of the catchment to the main channel of the river and are rarely named. Where two first order streams join, the section downstream of the junction is referred to as a second order stream. Additionally, where two second order streams join, the waterway downstream is classified third order and so on. Where a lower order stream (eg first) joins a higher order stream (eg third) the area downstream of the junction retains the higher order. These key watercourses are shown on Figure 4-3.

4.5.1 Tinkers Creek

Tinkers Creek is an intermittent, first order stream which has been described as being 'highly modified' and in a degraded state (Niche, 2015). Tinkers Creek is located approximately north-west of Bayswater CHP and receives discharge from Bayswater at two discharge points. Tinkers Creek additionally receives flow from a modified drainage line that links the Freshwater Dam (located to the south-west) to Tinkers Creek. Available water quality data for Tinkers Creek has been summarised in Section 4.7.1.

4.5.2 Lake Liddell

Lake Liddell, with a capacity of 150 gigalitres, is an artificial lake constructed to supply cooling water to Bayswater and Liddell power stations by damming Bayswater Creek. The lake collects runoff from the upper portion of the Bayswater Creek catchment, including Maidswater Creek and a number of other unnamed tributaries (Bioregional Assessments, 2019). Lake Liddell additionally receives flow from licensed discharges of Bayswater and Liddell Power Stations. Discharges from Bayswater are released into the lake via Tinkers Creek and Chilcotts Creek, and discharges from Liddell Power Station are released directly into the lake. Water discharges released from Lake Liddell to Bayswater Creek are monitored at licensed discharge point "LDP08". The quality of water released into Bayswater Creek is subject to regulation by the HRSTS and water quality parameter limits implemented under AGL Macquarie's EPLs 779 (Bayswater) and 2122 (Liddell Power Station). Additionally, Lake Liddell was previously open for public recreational use however had to be permanently closed in March 2016 due to public safety concerns regarding the discovery of the amoeba *Naegleria fowleri* in the lake (AGL, 2016). Despite this, the Lake Liddell Recreational Area which resides adjacent to the waterbody is still available for public use. Available water quality data for Lake Liddell has been summarised in Section 4.7.2.

4.5.3 Bayswater Creek

Bayswater Creek is a fifth order waterway which has been dammed to create the Lake Liddell reservoir and heavily modified below the dam wall to accommodate discharges downstream into the Hunter River. The creek acts as a transfer channel between Lake Liddell and the Hunter River with discharges to Hunter River regulated by the HRSTS. The transfer channel has significantly altered the aquatic and riparian habitat in the creek, and there is little opportunity for a natural flora and fauna community to establish (Aurecon, 2013). There are two major tributaries and a number of minor tributaries also flowing into Bayswater Creek downstream of the AGL Macquarie power station facilities, these include Davis Creek, Emu Creek and Chain of Ponds Creek. Available water quality data for Bayswater Creek has been summarised in Section 4.7.3.

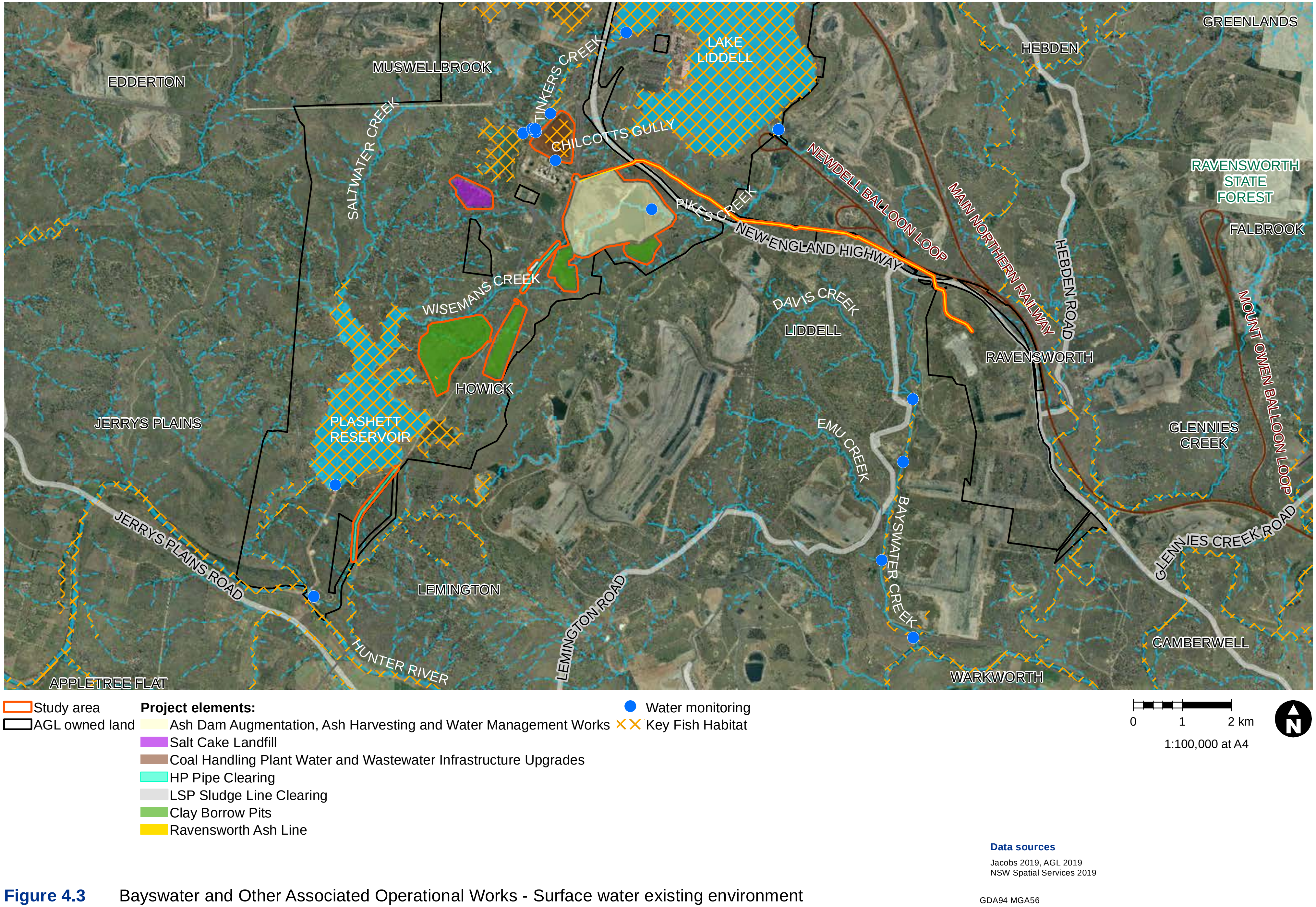

Figure 4.3 Bayswater and Other Associated Operational Works - Surface water existing environment

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4.5.5 Hunter River

The Hunter River, the ultimate receiving environment of the Project, is the major ninth order waterway within the Hunter River Catchment area. The Hunter river rises in the Liverpool Range and flows generally south and then east, reaching the Tasman Sea at Newcastle. The volume and pattern of flows in the Hunter River system have been significantly altered by the construction and operation of Glenbawn and Glennies Creek Dams. Significant volumes of water are also taken and stored for power station use at Bayswater and Liddell Power Stations in Plashett Reservoir and Lake Liddell. Water quality data for Hunter river upstream of the AGL landholdings has been summarised in Section 4.7.4.

4.5.6 Plashett Reservoir

Plashett Reservoir (also known as Lake Plashett), with a capacity of 67 gigalitres, is an artificial storage reservoir for Bayswater (Bioregional Assessments, 2019). The reservoir collects run off from sub-catchments in the northern extent of the reservoir, Saltwater Creek, Saltwater Creek Tributary and Wisemans Creek, as well as from a number of small, unnamed perennial streams in proximity to the reservoir. Additionally, water is pumped from the Hunter River into Lake Plashett, with the river located approximately 2 kilometres south of the Plashett Reservoir at its closest point. Water quality data for Plashett Reservoir has been summarised in Section 4.7.5.

4.5.7 Pikes Creek (Pikes Gully)

Pikes Creek is a third order stream that flows in a north-easterly direction through the BWAD and under the New England Highway. Approximately 190 litres/minute of seepage discharge seeps through the foundation of BWAD Dam Wall, into the main dam Seepage Collection Pond (**SCP**) at the toe of the dam on the right abutment (AECOM, 2017). A second SCP was constructed downstream of SCP 1 in the 1990’s in response to an increase in seepage causing discharges to by-pass the subsurface drains and collection pond and therefore be released into Pikes Creek. Additionally, during wet periods, SCP 2 is used to collect overflow flows (Pacific Power Services, 1993). Pikes Creek also receives flow from a number of small tributaries downstream of the ash dam. Water quality data for Pikes Creek has been summarised in Section 4.7.6.

4.5.8 Saltwater Creek

Saltwater Creek is a fourth order waterway which flows in a southerly direction toward Plashett Reservoir. A major unnamed tributary of Saltwater Creek (known as Noname Creek) joins the waterway approximately 1 kilometre upstream of the confluence of Saltwater Creek and Plashett Reservoir. Noname Creek is a third order Strahler stream. Saltwater Creek also receives flow from a number of smaller tributaries located along the length of the waterway. Noname Creek is situated within proximity of the proposed ‘Salt Cake landfill site’. No water quality data is available for Saltwater Creek or Noname Creek.

4.5.9 Chilcotts Creek

Chilcotts Creek is an ephemeral, first order stream located on the north-eastern side of Bayswater CHP and north of the BWAD. The creek flows approximately 1 kilometre in a north-easterly direction toward Lake Liddell and crosses under the New England Highway. Two small drainage lines flow into the creek however the creek receives the majority of its flow from direct seepage from the BWAD - Saddle Dam wall and from runoff during wet periods. There is currently no formal collection point for this seepage volume and no available water quality data for this creek.

4.5.10 Wisemans Creek

Wisemans Creek is a fourth order stream which flows in a south-westerly direction toward Plashett Reservoir. The creek receives flow from a number of small tributaries located along its length. Wisemans Creek is situated directly adjacent to the proposed Borrow Pit 1 site and within proximity of Borrow Pit 2 and Borrow Pit 3 sites. There is no available water quality data for Wisemans Creek.

4.6 Flooding

Existing flood behaviour for the Project elements have been defined based on the available data and are discussed below.

4.6.1 The BWAD

Existing flooding behaviour in the BWAD in the context of both Pikes Creek and Chilcotts Creek is discussed below.

Pikes Creek (Pikes Gully)

The PMF level for the BWAD is estimated at RL 173.3 metres which is 0.7 metres below the main embankment crest (Aurecon, 2016) located across Pikes Gully. This means that flood behaviour in Pikes Gully downstream of the BWAD is not influenced by the BWAD. The seepage discharge that seeps through the foundation of the main embankment of the BWAD into Seepage Collection Ponds is too small to have any discernible impact on flood behaviour in Pikes Gully.

A large-scale breach from the main embankment of the BWAD would inundate the downstream area along Pikes Creek and could overtop the bridge where the New England Highway crosses Pikes Creek approximately 1.75 kilometres downstream. It is also possible that the Liddell Station Road could be subject to inundation further downstream.

Chilcotts Creek

Water levels in the BWAD have historically been controlled by the level of the outlet tower, with the decant pond level maintained at or below the full supply level (**FSL**) RL 171.5 metres. Whilst the system was originally designed to achieve zero discharge, the available storage volume in the decant pond is expected to decrease over time due to the progressive filling with ash material. (AECOM, 2016b).

Water levels within the BWAD are monitored and managed by AGLMacquarie and can be balanced with volumes stored within the Ravensworth Void. However, under some conditions, when water level in the decant pond exceeds the FSL, overflows occur via the spillway discharge via Chillcotts Creek to Lake Liddell. (AECOM, 2016b).

Should a large-scale breach occur in the saddle dam wall, the inundation area would follow the natural creek line to the north, reaching the culvert at the New England Highway approximately 550 metres downstream. It is likely that ash and water would partially divert to the east and cross the highway and discharge into the Liddell Main Cooling Water Dam.

4.6.2 Salt cake landfill

Ground levels within the former contractor's compound vary between RL 197 metres and RL 175 metres. A gully runs along the south western boundary of the site. The gully drains a catchment area of approximately 50 hectares and discharges into Noname Creek. Noname Creek drains a catchment area of approximately 160 hectares before the gully discharges into the creek.

The site is located approximately 4 metres above the bed of the unnamed gully at the north-western corner where the catchment area draining into the gully is approximately 9 hectares and the site is located approximately 8 metres above the bed of Nonanme Creek in the vicinity of the north-eastern boundary of the site where the catchment area draining into Noname Creek is approximately 65 hectares.

The site being located on high ground and the catchment area of the gully being small, the site is not subject to frequent flooding from the gully and the site is not considered a floodway. The site is located, at least, 8 metres above the bed of Noname Creek and is not expected to be subject to flooding from Noname Creek during major flood events.

4.6.3 Borrow pits

Borrow Pit 1 is located within the catchment area of Bayswater Creek and the area of the pit is 18ha. The western half of the pit area drains south into the main channel of Bayswater Creek and the eastern half drains into two gullies which join Bayswater Creek farther downstream. Ground levels within the pit area vary between RL 187m and RL 145m.

Borrow Pit 2 covers an area of approximately 26 hectares located on the upper catchment areas of Pikes Gully, Bayswater Creek and Wisemans Creek. Approximately 50% of the pit area drains into Pikes Gully and remaining area of the pit drains into both Bayswater Creek and Wisemans Creek. Ground levels within the pit area vary between RL 225 metres and RL 183 metres.

Borrow Pit 3 covers an area of approximately 42 hectares generally located within the catchment area of Wisemans Creek. The pit area is drained by several gullies which drain into Wisemans Creek. Ground levels within the pit area vary between RL 195 metre and RL 152 metres.

Borrow Pit 4 covers an area of approximately 140 hectares draining into Wisemans Creek and Plashett Reservoir. Almost two-thirds of the pit area drains into Wisemans Creek and the remaining area drains into Plashett Reservoir. Ground levels within the pit area vary between RL 170 metres and RL 130 metres.

4.7 Surface water quality

This section discusses the existing surface water quality at the main waterways within the Project area. Available water quality data was limited, however monitoring records for Lake Liddell, Plashett Reservoir, Bayswater Creek, Tinkers Creek, Pikes Gully and Hunter River have been collected from various sources and analysed for the purposes of this assessment. It should be noted that for some watercourses, data presented has been derived from grab samples only and therefore is solely reflective of water quality at the time of collection and should not be interpreted as long-term water quality trends. Table 4-7 and Figure 4-3 provide further information about available data and monitoring timeframes.

Table 4-7 Water quality monitoring sites used for this assessment

Site name	Project Site code*	Waterway	Data source	Monitoring timeframe/period	Description and relevance
Hunter River Low Pressure Pumping Station	**HR1**	Hunter River	Ravensworth Void 4 Discharge Investigation (Aurecon, 2013)	2005 – 2013	Water quality data collected by Macquarie Generation for the Hunter River (at the low-pressure pumping station). Approximately 170 metres downstream of the confluence of Saltwater Creek and Hunter River.
Plashett Reservoir Monitoring Site	**PR1**	Plashett Reservoir	Monitoring data acquired from AGL Macquarie (2019)	2015 – 2019	Monitoring site located at Plashett Reservoir dam wall. Indicative water quality within in Plashett Reservoir.

Site name	Project Site code*	Waterway	Data source	Monitoring timeframe/period	Description and relevance
Bayswater Creek Sampling Site 1	**BC1**	Bayswater Creek	Ravensworth Void 4 Discharge Investigation (Aurecon, 2013)	December 2010	Aurecon (2013) monitoring site within Bayswater Creek approximately 300 metres upstream of the confluence of Bayswater Creek and Hunter River.
Bayswater Creek Sampling Site 2	**BC2**	Bayswater Creek	Ravensworth Void 4 Discharge Investigation (Aurecon, 2013)	December 2010	Aurecon (2013) monitoring site within Bayswater Creek approximately 900 metres downstream of the confluence of Bayswater Creek and Emu Creek.
Bayswater Creek Sampling Site 3	**BC3**	Bayswater Creek	Ravensworth Void 4 Discharge Investigation (Aurecon, 2013)	December 2010	Aurecon (2013) monitoring site within Bayswater Creek approximately 250 metres downstream of the confluence of Davis Creek.
Bayswater Creek Sampling Site 4	**BC4**	Bayswater Creek	Ravensworth Void 4 Discharge Investigation (Aurecon, 2013)	December 2010	Aurecon (2013) monitoring site within Bayswater Creek approximately kilometres downstream of the confluence of Davis Creek.
Discharge Point 07 (EPL 7)	**LDP07**	Tinkers Creek	Monitoring data required under EPL 779 (AGL Macquarie, 2019)	2015 – 2019	Monitoring site located at the licensed discharge point from cooling towers to Tinkers Creek via an under-over weir.
Discharge Point 08 (EPL 8)	**LDP08**	Lake Liddell	Monitoring data required under EPL 779 (AGL Macquarie, 2019)	2015 – 2019	Monitoring site located at the discharge pipe from Lake Liddell dam wall. Indicative water quality in Lake Liddell.
Coal Handling Plant 03	**CHP03**	Tinkers Creek	Bayswater Coal Handling Plant Sediment Basin – Assessment of Water Quality and Water Management (AECOM, 2017)	November 2016 – January 2017	Monitoring site located within the upstream tributary of Tinkers Creek that is influenced by the fresh water dam, which is located within an external catchment.
Coal Handling Plant 04	**CHP04**	Tinkers Creek	Bayswater Coal Handling Plant Sediment Basin – Assessment of Water Quality and Water Management (AECOM, 2017)	November 2016 – January 2017	Monitoring site located at the confluence of external catchment areas and Tinkers Creek, upstream of LDP07.
Coal Handling Plant 05	**CHP05**	Tinkers Creek	Bayswater Coal Handling Plant Sediment Basin – Assessment of Water Quality and Water Management (AECOM, 2017)	November 2016 – January 2017	Monitoring site located downstream of the confluence of LDP07 and Tinkers Creek.

Site name	Project Site code*	Waterway	Data source	Monitoring timeframe/period	Description and relevance
Coal Handling Plant 09	**CHP09**	Tinkers Creek	Bayswater Coal Handling Plant Sediment Basin – Assessment of Water Quality and Water Management (AECOM, 2017)	November 2016 – January 2017	Monitoring site located at the overflow outlet weir that discharges into Tinkers Creek.
Coal Handling Plant 10	**CHP10**	Tinkers Creek	Bayswater Coal Handling Plant Sediment Basin – Assessment of Water Quality and Water Management (AECOM, 2017)	November 2016 – January 2017	Monitoring site located downstream of the confluence of discharge points into Tinkers Creek.
Coal Handling Plant 11	**CHP11**	Tinkers Creek	Bayswater Coal Handling Plant Sediment Basin – Assessment of Water Quality and Water Management (AECOM, 2017)	November 2016 – January 2017	Monitoring site located at the confluence of Tinkers Creek and Lake Liddell.
MGW10	**PC1**	Pikes Creek (Pikes Gully)	Monitoring data acquired from AGL Macquarie (2019)	2005 – 2011	Monitoring site at BWAD spill way.

** The Project site codes will here-in be used to describe results of analysis*

4.7.1 Tinkers Creek

Discharge water quality of pH and electrical conductivity at LDP07 between 2015 and 2019 was compared against the EPL 779 discharge criteria and the recommended ANZECC/ARMCANZ (2000) guidelines for protection of aquatic ecosystems. It should be noted that hourly pH monitoring data from 2017 to 2019 was averaged over a 24-hour period to indicate mean daily pH concentration and therefore does not reflect the number of exceedances reported to the EPA during the reporting period. For the purpose of this assessment, daily average pH concentration is considered adequate.

There was no available long-term toxicant concentration data for Tinkers Creek, however data collected over three rounds of monthly sampling from November 2016 to January 2017 was extracted from AECOM (2017), analysed and compared to the recommended ANZG (2018) guidelines for either the protection of aquatic ecosystems or primary industry (irrigation and general water use and livestock drinking water). Limited monitoring data retrieved from AECOM (2017) (CHP09) was also used to indicate general pH and electrical conductivity entering Tinkers Creek.

pH and Electrical Conductivity

LDP07

The pH of the discharge over the monitoring period remained within the pH range specified in EPL779 and the ANZECC/ARMCANZ (2000) criteria (6.5 to 8.5) on all sampling occasions except two, where the upper limit of 8.5 was exceeded. The pH did not fall below the lower limit of 6.5 at any time. There was no noticeable variation in the pH with a median pH of 8.11 over the entire period (Table 4-8).

The electrical conductivity of discharge was recorded below the upper limit specified for electrical conductivity in EPL779 (4500µS/cm) at all times, with a maximum conductivity of 3960µS/cm recorded. Electrical conductivity was outside the ANZECC/ARMCANZ (2000) recommended range of 125 – 2250µS/cm on most occasions, however, as discussed in Section 4.2.1, median electrical conductivities is suggested to exceed 5500 µS/cm in water sources within the Hunter River Catchment. Therefore, these values are low in comparison. The median, 80^{th} and 20^{th} percentile electrical conductivity is provided in Table 4-8.

Table 4-8 Summary statistics at site EPL 7 (Source: AGL Macquarie, 2019)

Indicator	Minimum	20^{th} percentile	Median	80^{th} percentile	Maximum
pH	7.05	7.99	8.11	8.29	**10.49**
Electrical conductivity (µS/cm)	1027	**2553**	**3050**	**3490**	**3960**

CHP09

Based on a small monitoring program of six sampling occasions (AECOM, 2017), the average pH of discharge at CHP09 was 7.8. pH values remained within the range specified in EPL779 and the ANZECC/ARMCANZ (2000) criteria (6.5 to 8.5) at all times.

Electrical conductivity of the discharge at CHP09 was well below the EPL779 limit of 4500µS/cm and within the ANZECC/ARMCANZ (2000) recommended guidelines at all times. Summary statistics are provided in Table 4-9.

Table 4-9 Summary statistics at site EPL 1 downstream of EPL 7 (Source: AGL Macquarie, 2019)

Indicator	Minimum	20^{th} percentile	Average	80^{th} percentile	Maximum
pH	7.6	7.6	7.8	7.9	7.9
Electrical conductivity (µS/cm)	668	955	1152	1550	**2670**

Toxicant concentrations

The results for toxicants extracted from AECOM (2017) report are provided in Table 4-10. Based on available data, the majority of the trace metals and ions had concentrations below detection limits or below ANZG (2018) guidelines for either the protection aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water). The exceptions were boron, chloride, chromium, copper, fluoride, lead, sodium and zinc which were above the guideline level at a minimum of one sampling site. Results outside the recommended guidelines are shown in bold.

Table 4-10 Toxicant data at sampling sites along Tinkers Creek. (Source: AECOM, 2017)

Parameter		ANZG (2018) guideline level of protection				CHP03[4]	CHP04[5]	CHP05[4]	CHP10[6]	CHP11[4]
		99%	95%[1]	90%	85%					
Barium (mg/L)	(Ba)	No guideline				0.051	0.069	0.136333	0.02833	0.09833
Arsenic (mg/L)	(As)	0.001	0.024	0.094	0.36	<0.001	0.002	0.002	<0.001	<0.001
Beryllium (mg/L)	(Be)	0.1[2]				<0.001	<0.001	<0.001	<0.001	<0.001
Boron (mg/L)	(B)	0.09	0.37	0.68	1.3	0.17	0.17	0.203	0.065	**0.72**
Cadmium (mg/L)	(Cd)	0.00006	0.0002	0.0004	0.0008	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Calcium (mg/L)	(Ca)	1,000[3]				118	10	31.833	29.5	152
Chloride (mg/L)	(Cl)	350[2]				151.667	25	126.5	127	**390**
Chromium (mg/L)	(Cr)	0.00001	0.001	0.006	0.04	<0.001	**0.029**	<0.001	<0.001	<0.001
Cobalt (mg/L)	(Co)	0.05[2]				<0.001	0.008	<0.001	<0.001	<0.001
Copper (mg/L)	(Cu)	0.001	0.0014	0.0018	0.0025	<0.001	0.009	**0.1157**	0.001	<0.001
Fluoride (mg/L)	(F)	2[2]				1.4333	0.6	0.9666	0.2667	1.2333
Lead (mg/L)	(Pb)	0.001	0.0034	0.0056	0.0094	<0.001	**0.026**	<0.001	<0.001	<0.001
Magnesium (mg/L)	(Mg)	No guideline				65.6667	6	152.333	28.8333	103
Manganese (mg/L)	(Mn)	1.2	1.9	2.5	3.6	0.06867	0.205	0.008	0.0075	0.03533
Mercury (mg/L)	(Hg)	0.00006	0.00006	0.0019	0.0054	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Nickel (mg/L)	(Ni)	0.008	0.011	0.013	0.017	0.001	**0.011**	**0.043**	0.0018	**0.018**
Potassium (mg/L)	(K)	No guideline				7.6667	3	18	4.1667	15
Selenium (mg/L)	(Se)	0.005	0.011	0.018	0.034	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (mg/L)	(Na)	230[2]				138	23	**297.333**	76.333	**262**
Vanadium (mg/L)	(V)	0.1[1]				<0.01	0.05	<0.01	<0.01	<0.01
Zinc (mg/L)	(Zn)	0.0024	0.008	0.015	0.031	<0.005	0.03	0.01133	0.01	0.013

[1] – Trigger values for slightly-moderately disturbed ecosystems in south-east Australia (Lowland river)

[2] – Trigger values for primary industry (irrigation and general water use – long term use)

[3] – Trigger values for primary industry (livestock drinking water)

[4] – Average of three sampling events.

[5] – Only one sampling event due to sampling location being dry on two of the three sampling dates.

[6] – Average of five sampling events.

4.7.2 Lake Liddell

As discussed in Section 4.5.2, Lake Liddell is an artificial waterbody that was constructed in the 1960’s for use of supplying cooling water to Bayswater and Liddell power stations by damming Bayswater Creek. The water quality of the lake is influenced by a number of sources as it collects runoff from the upper portion of the Bayswater Creek catchment (Bioregional Assessments, 2019), as well as from licensed discharges released from Bayswater and Liddell Power Stations at Tinkers Creek, Chilcotts Creek and directly into the lake. The water quality of Lake Liddell is monitored at LDP08, which is located at the pipe at the dam wall used to release water to Bayswater Creek.

Water quality monitoring data was collected between July 2015 and July 2019.

pH and Electrical Conductivity

LDP08

The pH values complied with the requirements specified in EPL779 for LDP08 (EPA 8) monitoring site at all times (6.5-8.5), however median pH was outside the ANZECC/ARMCANZ (2000) recommended pH range of 6.5 – 8.0 for lakes and reservoirs (Table 4-11). Electrical conductivity concentrations were compliant with the licensed LDP08 (EPA 8) limit of 4500 µS/cm at all times.

Table 4-11 Summary statistics at site EPL 8, within Lake Liddell (Source: AGL Macquarie, 2019)

Indicator	Minimum	20^{th} percentile	Median	80^{th} percentile	Maximum
pH	7.7	7.9	8.2	8.4	8.5
Electrical conductivity (µS/cm)	**2160**	**2246**	**2310**	**2614**	**2860**

Toxicant concentrations

Based on the median (n=48) values for all toxicants provided in Table 4-12, a large portion of the trace metals and ions had concentrations below detection limits or below ANZG (2018) guidelines for either the protection of aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water). The exceptions were boron, cadmium, chloride, copper, fluoride and molybdenum. Results outside the recommended guidelines are shown in bold.

Table 4-12 Toxicant and ion concentration data at EPL 8 (Source AGL Macquarie, 2019)

Parameter		ANZG (2018) Guideline level of protection				Lake Liddell Dam Wall (LDP08)
		99%	95%[1]	90%	80%	
Aluminum (mg/L)	(Al)	0.027[4]	0.055[4]	0.08[4]	0.15[4]	0.0235[5]
Antimony (mg/L)	(Sn)	0.009				0.006
Arsenic (mg/L)	(Ar)	0.001	0.024	0.094	0.36	0.005
Beryllium (mg/L)	(Be)	0.1[2]				<0.001
Boron (mg/L)	(B)	0.09	0.37	0.68	1.3	1.185
Cadmium (mg/L)	(Cd)	0.00006	0.0002	0.0004	0.0008	0.0005[5]
Calcium (mg/L)	(Ca)	1,000[3]				139
Chloride (mg/L)	(Cl)	350[2]				**437**[5]
Chromium (VI) (mg/L)	(Cr)	0.00001	0.001	0.006	0.04	0.0005
Copper (mg/L)	(Cu)	0.001	0.0014	0.0018	0.0025	**0.003**[5]
Fluoride (mg/L)	(F)	2[2]				1.8
Iron (mg/L)	(Fe)	0.2[2]				0.04[5]
Lead (mg/L)	(Pb)	0.001	0.0034	0.0056	0.0094	<0.001
Magnesium (mg/L)	(Mg)	No guideline				81.8
Manganese (mg/L)	(Mn)	1.2	1.9	2.5	3.6	0.0155

Parameter		ANZG (2018) Guideline level of protection				Lake Liddell Dam Wall (LDP08)
		99%	95%[1]	90%	80%	
Mercury (mg/L)	(Hg)	0.00006	0.00006	0.0019	0.0054	<0.0001
Molybdenum (mg/L)	(Mo)	0.01[2] 0.034[6]				**0.101**
Nickel (mg/L)	(No)	0.008	0.011	0.013	0.017	0.004
Potassium (mg/L)	(K)	No guideline				18.25
Selenium (mg/L)	(Se)	0.005	0.011	0.018	0.034	<0.01
Silver (mg/L)	(Ag)	0.00002	0.00005	0.0001	0.0002	<0.001
Sodium (mg/L)	(Na)	230[2]				315.5
Vanadium (mg/L)	(V)	0.1[1]				0.0091
Zinc (mg/L)	(Zn)	0.0024	0.008	0.015	0.031	0.0025[5]

[1] – Trigger values for slightly-moderately disturbed ecosystems in south-east Australia (Lowland river)
[2] – Trigger values for primary industry (irrigation and general water use – long term use)
[3] – Trigger values for primary industry (livestock drinking water)
[4] – for pH > 6.5
[5] – For the purpose of estimating medians, when concentrations were below the detection limit (DL), a value of half the DL was used.
[6] – Trigger values for freshwater (Unknown)

4.7.3 Bayswater Creek

As discussed in Section 4.2.1, salinity of water courses within the Hunter River catchment are naturally elevated, with sources of salt related heavily to rainfall and weathering products which enter streams via surface runoff pathways and groundwater sources, particularly from the underground geology of the Permian coal measures. Of the surface water salinity observations from across the Hunter region (including Bayswater Creek), median electrical conductivities exceeded 5500 µS/cm for areas in proximity to the AGL Macquarie power station facilities (Bioregional Assessments, 2019). Bayswater Creek is the main transfer channel linking Lake Liddell and the Hunter River, with Lake Liddell being the artificial waterbody utilised to capture runoff from the upper portion of the Bayswater Creek catchment and discharge from the AGL Macquarie power station facilities. Discharges to Hunter River via Bayswater Creek are regulated by the HRSTS.

There was no contemporary water quality data for pH, electrical conductivity, or toxicant indicators for Bayswater Creek, however water sampling at locations along Bayswater Creek was undertaken by Aurecon (2013) in December 2010. Results were extracted from Aurecon (2013), analysed and compared to the ANZECC/ARMCANZ (2000) guidelines for the protection of lowland river aquatic ecosystems, or ANZG (2018) guidelines for either the protection of aquatic ecosystems or primary industry (irrigation and general water use and livestock drinking water).

<u>pH and electrical conductivity</u>

The quality of water within Bayswater Creek at the time of sampling was characterised by high electrical conductivity, with all samples above the ANZECC/ARMCANZ (2000) guidelines, however all samples were below the stated median EC value for water courses in the area (5500 µS/cm) (Bioregional Assessments, 2019). pH levels remained within the ANZECC/ARMCANZ (2000) guidelines values on all four sampling occasions. Summary data is provided in Table 4-13.

Table 4-13 Bayswater Creek water quality data at sampling points downstream of the dam wall (Source: Aurecon, 2013)

Parameter		ANZG (2018) Guidelines	BC 1	BC 2	BC 3	BC 4
Electrical conductivity	(EC)	125 – 2,200	**2,864**	**3,452**	**3,130**	**2,907**
pH	(pH)	6.5 – 8.5	8.13	7.82	8.12	7.91

Toxicant concentrations

Based on data for toxicant concentrations, a large portion of the analysed trace metals and ions had concentrations below detection limits or below recommended upper limits stated in the ANZG (2018) guidelines for either the protection of aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water). The exceptions were aluminum, chloride, chromium, copper, fluoride, iron, sodium and zinc which were above the guideline level at a minimum of one sampling site. Results are provided in Table 4-14. Results outside the recommended guidelines are shown in bold.

Table 4-14 Bayswater Creek trace metal and ion concentration data at sampling points downstream of the dam wall (Source: Aurecon, 2013)

Parameter		ANZG (2018) Guideline level of protection				BC 1	BC 2	BC 3	BC 4
		99%	95%[1]	90%	80%				
Aluminum (mg/L)	(Al)	0.027	0.055[4]	0.08	0.15	<0.1	**0.2**	<0.1	<0.1
Barium (mg/L)	(Ba)	No guideline				0.1	0.07	0.09	0.09
Arsenic (III) (mg/L)	(As)	0.001	0.024	0.094	0.36	0.002	0.002	0.002	0.002
Beryllium (mg/L)	(Be)	0.1[2]				<0.01	<0.01	<0.01	<0.01
Boron (mg/L)	(B)	0.09	0.37	0.68	1.3	<1	<1	<1	<1
Cadmium (mg/L)	(Cd)	0.00006	0.0002	0.0004	0.0008	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (mg/L)	(Ca)	1,000[3]				140	94	150	150
Chloride (mg/L)	(Cl)	350[2]				**510**	**620**	**540**	**510**
Chromium (VI) (mg/L)	(Cr)	0.00001	0.001	0.006	0.04	<0.001	0.002	0.005	0.002
Cobalt (mg/L)	(Co)	0.05[2]				<0.01	<0.01	<0.01	<0.01
Copper (mg/L)	(Cu)	0.001	0.0014	0.0018	0.0025	0.002	0.001	<0.001	<0.001
Fluoride (mg/L)	(F)	2[2]				**2**	1	**2**	1
Iron (mg/L)	(Fe)	0.2[2]				<0.001	0.002	0.005	0.002
Lead (mg/L)	(Pb)	0.001	0.0034	0.0056	0.0094	<0.001	<0.001	<0.001	<0.001
Magnesium (mg/L)	(Mg)	No guideline				110	80	120	110
Manganese (mg/L)	(Mn)	1.2	1.9	2.5	3.6	<0.01	0.02	0.06	0.03
Mercury (mg/L)	(Hg)	0.00006	0.00006	0.0019	0.0054	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum (mg/L)	(Mo)	0.01[2] 0.034[1]				<0.1	<0.1	<0.1	<0.1
Nickel (mg/L)	(Ni)	0.008	0.011[6]	0.013	0.017	0.002	0.004	0.008	0.004

Potassium (mg/L)	(K)	No guideline				18	14	17	16
Selenium (mg/L)	(Se)	0.005	0.011	0.018	0.034	0.002	0.005	0.002	<0.002
Silver (mg/L)	(Ag)	0.00002	0.00005	0.0001	0.0002	<0.001	<0.001	<0.001	<0.001
Sodium (mg/L)	(Na)	230[2]				**440**	**650**	**480**	**430**
Strontium (mg/L)	(Sr)	No guideline				2.4	1.9	2.6	2.5
Titanium (mg/L)	(Ti)	No guideline				<0.01	<0.01	<0.01	<0.01
Vanadium (mg/L)	(V)	0.1[1]				<0.01	<0.01	<0.01	<0.01
Zinc (mg/L)	(Zn)	0.0024	0.008	0.015	0.031	<0.01	**0.06**	<0.01	<0.01

[1] – Trigger values for slightly-moderately disturbed ecosystems in south-east Australia (Lowland river)

[2] – Trigger values for primary industry (irrigation and general water use – long term use)

[3] – Trigger values for primary industry (livestock drinking water)

[4] – for pH > 6.5

4.7.4 Hunter River

No contemporary data water quality data for pH, electrical conductivity, or toxicant concentrations was available for Hunter River in the vicinity of the Project, however monitoring undertaken between 2005 and 2013 at the Low Pressure Pumping Station, located along Hunter River upstream of AGL landholdings, was extracted from Aurecon (2013). Results were analysed and compared to the ANZECC/ARMCANZ (2000) guidelines for the protection of lowland river aquatic ecosystems, or ANZG (2018) guidelines for either the protection of aquatic ecosystems or primary industry (irrigation and general water use and livestock drinking water).

pH and electrical conductivity

The median pH value of the Hunter River was within the ANZECC/ARMCANZ (2000) recommended pH range of 6.5 - 8.5 for the protection of lowland river aquatic ecosystems (Table 4-15). Electrical conductivity concentrations also remained within the ANZECC/ARMCANZ (2000) recommended range of 125 – 2,200 µS/cm at all times. Further, median value for EC was found to be below the required upper limit of 900 µS/cm for the corresponding section of Hunter River as specified in the HRSTS.

Table 4-15 Summary statistics at site HR1, Hunter River upstream of AGL Operations (Source: Aurecon, 2013)

Indicator	Minimum	20^{th} percentile	Median	80^{th} percentile	Maximum
pH	7.25	7.83	8.2	8.35	8.68
Electrical conductivity (µS/cm)	333	580	827.55	944.92	1258

Toxicant concentrations

No contemporary or long-term toxicant data was available for the Hunter River, therefore a single grab sample taken at the Hunter River Low Pressure Pumping Station on the 9^{th} March 2011, extracted from Aurecon (2013), has been used to infer potential water quality. Data is provided in Table 4-16. The majority of indicators were not detected or were detected in concentrations below ANZG (2018) recommended guidelines for either the protection of aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water). The exceptions were aluminum, copper and iron. Results outside the recommended guidelines are shown in bold.

Table 4-16 Hunter River water quality data, upstream of AGL Operations (Source: Aurecon, 2013)

Parameter		ANZG (2018) Guideline level of protection				Hunter River, Low Pressure Pumping Station (H0)
		99%	95%[1]	90%	80%	
Aluminum (mg/L)	(Al)	0.027	0.055[4]	0.08	0.15	**0.82**
Arsenic (mg/L)	(As)	0.001	0.024	0.094	0.36	<0.001
Beryllium (mg/L)	(Be)	0.1[2]				<0.01
Cadmium (mg/L)	(Cd)	0.00006	0.0002	0.0004	0.0008	<0.0002
Chromium (VI) (mg/L)	(Cr)	0.00001	0.001	0.006	0.04	<0.001
Copper (mg/L)	(Cu)	0.001	0.0014	0.0018	0.0025	**0.003**
Iron (mg/L)	(Fe)	0.2[2]				0.46
Lead (mg/L)	(Pb)	0.001	0.0034	0.0056	0.0094	<0.001
Magnesium (mg/L)	(Mg)	No guideline				46
Manganese (mg/L)	(Mn)	1.2	1.9	2.5	3.6	0.1
Mercury (mg/L)	(Hg)	0.00006	0.00006	0.0019	0.0054	<0.00005
Molybdenum (mg/L)	(Mo)	0.01[2] 0.034[1]				<0.01
Nickel (mg/L)	(Ni)	0.008	0.011	0.013	0.017	0.002
Selenium (mg/L)	(Se)	0.005	0.011	0.018	0.034	<0.001
Silver (mg/L)	(Ag)	0.00002	0.00005	0.0001	0.0002	<0.001
Vanadium (mg/L)	(V)	0.006[1]				<0.01
Zinc (mg/L)	(Zn)	0.0024	0.008	0.015	0.031	<0.01

[1] – Trigger values for slightly-moderately disturbed ecosystems in south-east Australia (Lowland river)

[2] – Trigger values for primary industry (irrigation and general water use – long term use)

[3] – Trigger values for primary industry (livestock drinking water)

[4] – for pH > 6.5

4.7.5 Plashett Reservoir

Water quality of Plashett Reservoir is monitored at PMB-009 (referred to as PR1 in this assessment). The water quality of this site is reflective of water quality supplied from the Hunter River to Plashett Reservoir via a canal that is connected to a Low-Pressure Pumping Station on the Hunter River. Water from the Plashett Reservoir is subsequently transported to and utilised by the Bayswater facilities. Based on available data, water quality monitoring for pH and electrical conductivity was collected between July 2015 and July 2019, and toxicant indicators were sampled in the months of March, May and June of 2015.

pH and electrical conductivity

Monitoring data from the Plashett Reservoir revealed the median pH value was outside the ANZECC/ARMCANZ (2000) recommended pH range of 6.5 – 8.0 for lakes and reservoirs at all times (Table 4-17). Electrical conductivity concentrations also outside the recommended range of 20 – 30 µS/cm for lakes and reservoirs at all times.

Table 4-17 Summary statistics from data collected in Plashett Reservoir (Source: AGL Macquarie, 2019)

Indicator	Minimum	20th percentile	Median	80th percentile	Maximum
pH	8.2	8.5	**8.6**	**8.7**	**8.9**
Electrical conductivity (µS/cm)	513	585.6	669	693.8	745

Trace metals and ion concentration

Based on available data, only a limited number of indicators were monitored within Plashett Reservoir at PR1 (see Table 4-18). Five of the six toxicants had average (n=4) concentrations below detection limits or below ANZG (2018) guidelines for either the protection of aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water). The exception was aluminium which did not meet any level of protection. Results outside the recommended guidelines are shown in bold.

Table 4-18 Plashett Reservoir trace metal data (Source AGL Macquarie, 2019)

Parameter		ANZG (2018) Guideline level of protection				Plashett Reservoir (PR1)
		99%	95%[1]	90%	80%	
Aluminum (mg/L)	(Al)	0.027	0.055[4]	0.08	0.15	**0.18**
Chloride (mg/L)	(Cl)	350[2]				87
Copper (mg/L)	(Cu)	0.001	0.0014	0.0018	0.0025	0.0014
Iron (mg/L)	(Fe)	0.2[2]				0.15
Selenium (mg/L)	(Se)	0.005	0.011	0.018	0.034	<0.01
Sodium (mg/L)	(Na)	230[2]				54.2

[1] – Trigger values for slightly-moderately disturbed ecosystems in south-east Australia (Lowland river)

[2] – Trigger values for primary industry (irrigation and general water use)

[3] – Trigger values for primary industry (livestock drinking water)

[4] – for pH > 6.5

4.7.6 Pikes Creek (Pikes Gully)

No contemporary data water quality data for pH, electrical conductivity, or toxicant concentrations was available for Pikes Creek, however data was available from monitoring that was undertaken by Macquarie Generation between 2005 and 2010, assumed to be downstream of the BADW. Results were analysed and compared to the ANZECC/ARMCANZ (2000) guidelines for the protection of lowland river aquatic ecosystems, or ANZG (2018) guidelines for either the protection of aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water).

pH and electrical conductivity

Monitoring data from Pikes Creek revealed that the median pH value was within the ANZECC/ARMCANZ (2000) recommended pH range of 6.5 – 8.5 for the protection of lowland river aquatic ecosystems (Table 4-19).

Electrical conductivity was above the ANZECC/ARMCANZ (2000) guidelines of 125 – 2,200 µS/cm at all times, however were below the stated median EC value for water courses in the area (5500 µS/cm) (Bioregional Assessments, 2019).

Table 4-19 Summary statistics of data collected at the Bayswater Ash Dam Wall (AGL Macquarie, 2019)

Indicator	Minimum	20th percentile	Median	80th percentile	Maximum
pH	7.9	8.1	8.3	8.5	**8.7**
Electrical conductivity (µS/cm)	**4460**	**5010.6**	**5322**	**5438.2**	**5490**

Toxicant concentration

Limited data was available for toxicant indicators for water in Pikes Gully, with the majority of the toxicants only sampled once on 24 November 2010. Concentrations of the remaining indicators are based on median values of 28 sampling events between 2005 and 2011. Results are provided in Table 4-20. Some of the toxicants had median concentrations that were above the ANZG (2018) recommended guidelines for either the protection of aquatic ecosystems (greater than 80% species protection) or primary industry (irrigation and general water use and livestock drinking water). These included aluminum, boron, cadmium, chloride, chromium, copper, fluoride, molybdenum, nickel, selenium, sodium and zinc. Results outside the recommended guidelines are shown in bold.

Table 4-20 Trace metals and ions data collected from upstream of the ash dam wall (AGL Macquarie, 2019)

Parameter		ANZG (2018) Guideline level of protection				Pikes Gully (MGW10)
		99%	95%[1]	90%	80%	
Aluminum (mg/L)	(Al)	0.027	0.055[4]	0.08	0.15	**0.2**[6]
Antimony (mg/L)	(Sb)	0.009				0.008[7]
Arsenic (mg/L)	(As)	0.001	0.024	0.094	0.36	0.015[7]
Barium (mg/L)	(Ba)	No guideline				0.09[7]
Boron (mg/L)	(B)	0.09	0.37	0.68	1.3	**310**
Cadmium (mg/L)	(Cd)	0.00006	0.0002	0.0004	0.0008	<0.01[7]
Chloride (mg/L)	(Cl)	350[2]				**785**[6]
Chromium (VI) (mg/L)	(Cr)	0.00001	0.001	0.006	0.04	<0.01[10]
Copper (mg/L)	(Cu)	0.001	0.0014	0.0018	0.0025	**0.005**[9]
Fluoride (mg/L)	(F)	1[2]				**3.7**[7]
Iron (mg/L)	(Fe)	0.2[2]				0.0656
Lead (mg/L)	(Pb)	0.0034[6]				0.01[7]
Lithium (mg/L)	(Li)	No guideline				0.69[7]
Manganese (mg/L)	(Mn)	1.2	1.9	2.5	3.6	0.06[7]
Mercury (mg/L)	(Hg)	0.00006	0.00006	0.0019	0.0054	0.00005[7]
Molybdenum (mg/L)	(Mo)	0.01[2] 0.034[5]				0.3[7]
Nickel (mg/L)	(Ni)	0.008	0.011	0.013	0.017	**0.**49[7]
Potassium (mg/L)	(K)	No guideline				31[7]
Selenium (mg/L)	(Se)	0.005	0.011	0.018	0.034	**0.019**[7]
Silver (mg/L)	(Ag)	0.00002	0.00005[6]	0.0001	0.0002	<0.001[7]

Sodium (mg/L)	(Na)	230[2]				**789**[6]
Strontium (mg/L)	(Sr)	No guideline				3[7]
Vanadium (mg/L)	(V)	0.006[1]				0.04[7]
Zinc (mg/L)	(Zn)	0.0024	0.008	0.015	0.031	**0.01**[7]

[1] – Trigger values for slightly-moderately disturbed ecosystems in south-east Australia (Lowland river)

[2] – Trigger values for primary industry (irrigation and general water use – long term use)

[3] – Trigger values for primary industry (livestock drinking water)

[4] – for pH > 6.5

[5] – Trigger value for freshwater (Unknown)

[6] – For the purpose of estimating medians (n=28), when concentrations were below the detection limit (DL), a value of half the DL was used.

[7] – Only 1 sampling event undertaken on 24/11/2010

4.8 Hydrogeology

4.8.1 Existing key Project groundwater level data

Monitored groundwater depths and levels for existing key Project groundwater monitoring bores (excluding the bores completed in the borrow pit drilling program – these are covered in Section 4.8.2) are summarised in Table 4.21 and groundwater depths are plotted in hydrographs in Figure 4.4 through to Figure 4.6. The bore locations are shown in Figure 3.2. Cumulative rainfall deviation (**CRD**) from mean rainfall is also plotted on the hydrographs to show rainfall trend. The data indicates that average groundwater depths ranged from 0.4 mBGL (excluding a few bores which had artesian pressures due to being downslope of embankments) to 11.5 mBGL, with average groundwater elevation varying from 126.9 mAHD to 186.2 mAHD. It must be noted that the relatively shallow groundwater depths are a result of the bores being located in relatively low lying land. There are Project elements situated in areas of relatively high elevation, such as significant portions of the proposed two northern borrow pit areas. For these elevated areas, the depth to groundwater is anticipated to be significantly deeper than the depths to groundwater outlined in Table 4.21, as shown in Sections 4.8.2 and 4.8.6

Groundwater level trends of bores with 10 or more records are summarised as follows:

- The hydrographs of BA_EW_MW01 and BA_MW01 displayed declining trends from early 2017 until late 2018 when an increasing trend is observed;
- BQ_MW03 displayed a declining trend, with an approximate 5 m decline from late 2016 to mid-2019.; and
- BA_MW03, BQEW_MW01, BQEW_MW02, BQEW_MW03, BQ_MW02, BQ_MW04, BQ_MW08, BQ_MW11 and BQ_MW13 displayed generally stable trends from late 2016 to mid-2019.

Although not tabulated in Table 4.21 due to differing data types, groundwater level data derived from monitoring well/borehole logs for BR_MW01 and BY_MW20, Ravensworth Ash Line assessment bores, is summarised as follows:

- BR_MW01 – water strike 50 mBGL, final water level after drilling of 29 mBGL, material logged as moist to dry to 22 mBGL (material moisture beyond this depth is not summarised as not relevant to ash line assessment).); and
- BY_MW20 (soil bore) – no water strikes, material logged as ‘dry’ to borehole termination depth of 10 m.

Table 4.21: Monitored groundwater depths and levels for existing key project groundwater monitoring bores

Bore ID	Minimum depth to water (mBGL)	Maximum depth to water (mBGL)	Average depth to water (mBGL)	Minimum elevation (mAHD)	Maximum elevation (mAHD)	Average elevation (mAHD)
BA_EW_MW01	2.36[a]	6.28[a]	4.03[a]	177.16[a]	181.08[a]	179.41[a]
BA_MW01	4.06	8.67	6.00	174.56	179.17	177.23
BA_MW03	-0.83	0.46	-0.26	174.66	175.95	175.38
BB_MW01	1.59	2.24	1.93	169.22	169.87	169.53
BB_MW02	3.88	4.44	4.13	169.13	169.69	169.44
BB_MW05	1.06	1.41	1.19	163.66	164.01	163.88
BQEW_MW01	1.00[a]	1.13[a]	1.09[a]	133.84[a]	133.97[a]	133.88[a]
BQEW_MW02	-0.16[a]	0.08[a]	-0.02[a]	135.83[a]	136.07[a]	135.93[a]
BQEW_MW03	0.24[a]	0.49[a]	0.38[a]	134.91[a]	135.16[a]	135.03[a]
BQ_MW02	3.27	4.29	3.71	144.26	145.28	144.84
BQ_MW03	0.42	5.36	2.32	153.46	158.40	156.50
BQ_MW04	8.04	9.20	8.58	170.11	171.27	170.73
BQ_MW05	7.42	7.42	7.42	168.07	168.07	168.07
BQ_MW07	8.52	10.21	9.58	167.53	169.22	168.16
BQ_MW08	3.09	4.35	3.66	148.01	149.27	148.70
BQ_MW10	-0.51[^]	-0.51[^]	-0.51[^]	157.33	157.33	157.33
BQ_MW11	1.20	2.16	1.70	126.48	127.44	126.94
BQ_MW13	3.70	5.74	4.61	168.69	170.73	169.82

Bore ID	Minimum depth to water (mBGL)	Maximum depth to water (mBGL)	Average depth to water (mBGL)	Minimum elevation (mAHD)	Maximum elevation (mAHD)	Average elevation (mAHD)
MW-A01	10.74	12.06	11.46	175.58	176.90	176.18
MW-A02	11.10	11.64	11.36	181.19	181.73	181.48
MW-A03D	1.62	1.84	1.72	159.94	160.16	160.07
MW-A03S	2.30	2.49	2.43	159.17	159.36	159.23
MW-A04	1.79	10.08	6.58	182.70	190.99	186.21
MW-A05	6.40	6.52	6.46	163.15	163.27	163.21
MW-A06	6.17	6.26	6.22	163.24	163.33	163.28
MW-A07	3.25	4.60	4.01	171.11	172.46	171.71

Notes: [a] Stick up data was unavailable and therefore assumed to be 0.75m above ground level for converting depth to water measurements to mBGL and mAHD. ^ minimum, maximum and average water depth are above ground level.

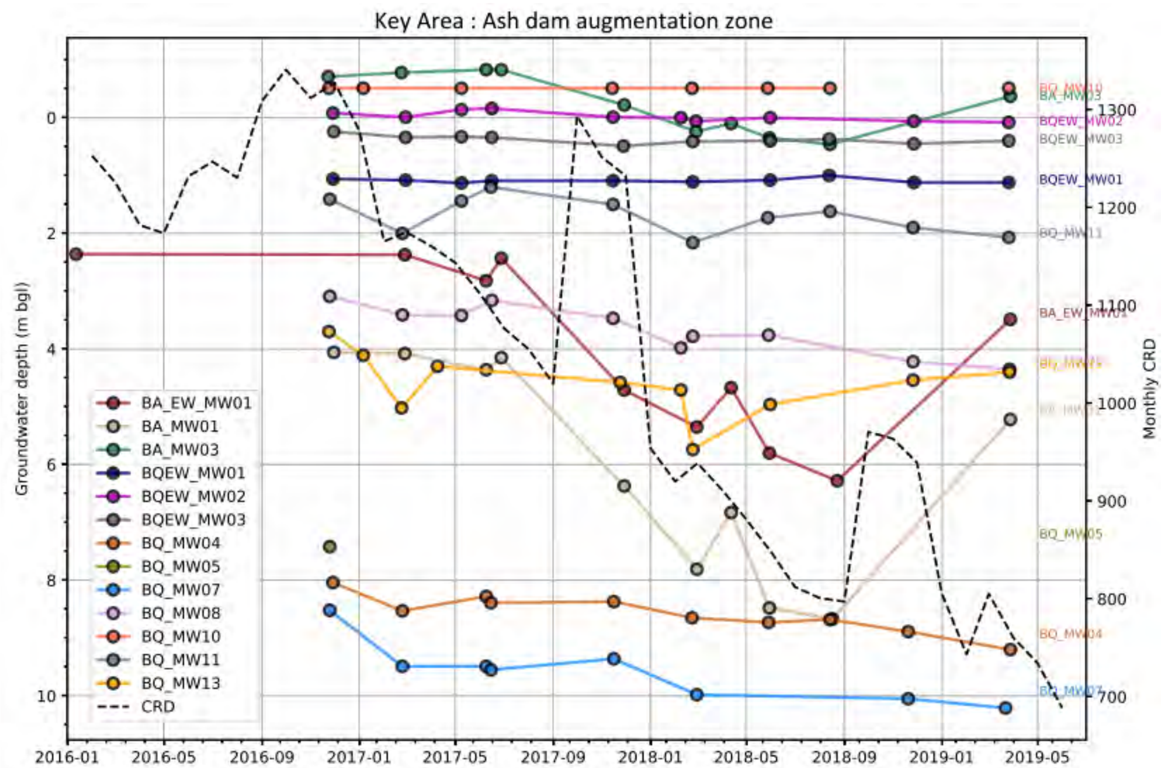


Figure 4.4: Hydrographs for ash dam augmentation zone bores

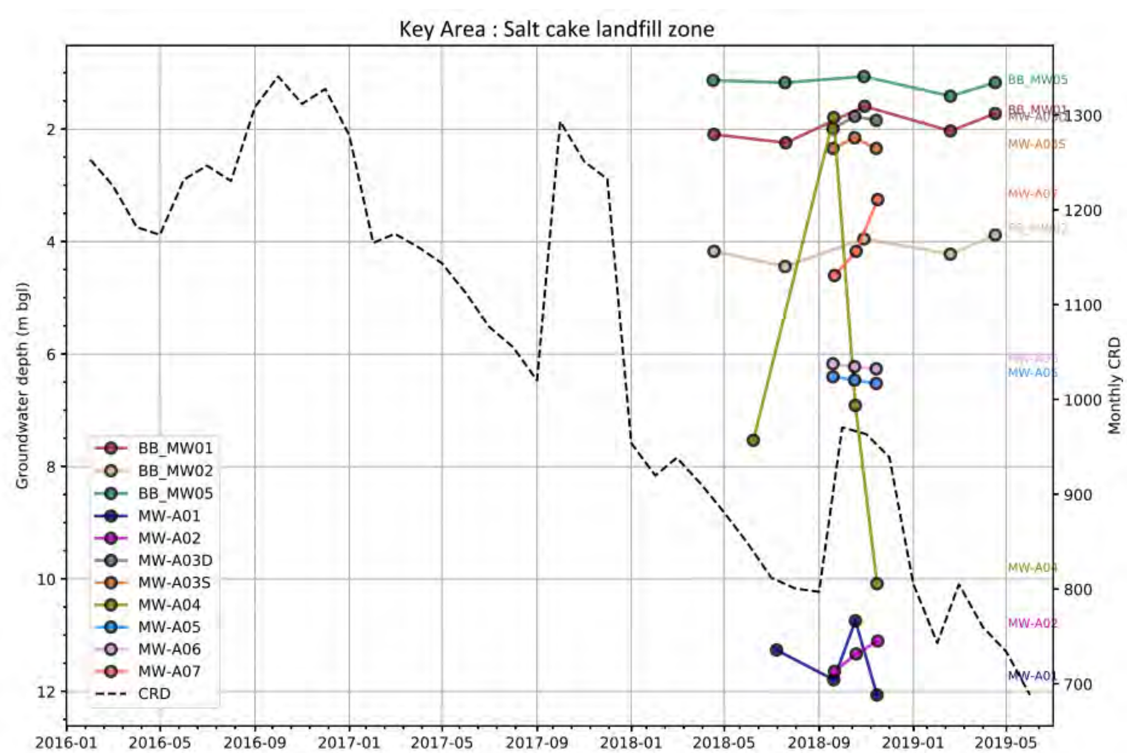


Figure 4.5: Hydrographs for salt cake landfill zone bores

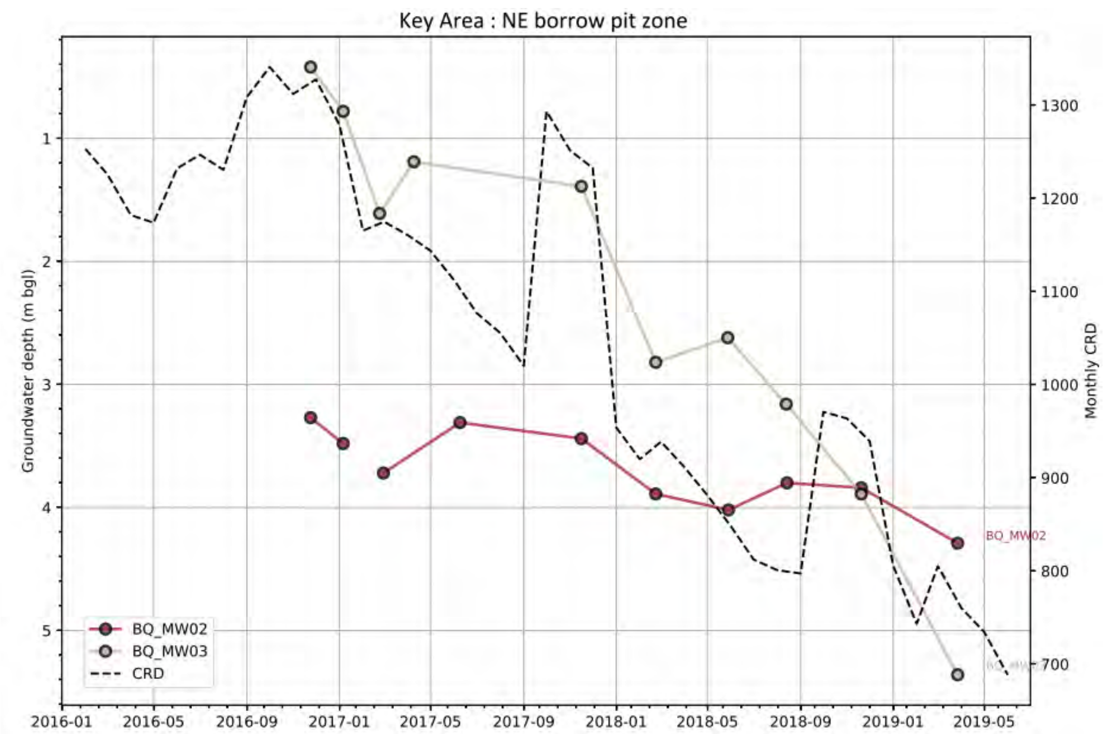


Figure 4.6: Hydrographs for bores on periphery of Borrow Pit 1

4.8.2 Borrow Pit Drilling programme groundwater level data

Groundwater was observed at four of the 15 locations, JBP_MW102, JBP_MW104, JBP_MW106 and JBP_MW109 (Figure 3.3). Observed groundwater levels and depths on the final day of the monitoring period are summarised in Table 4.22 whilst hydrographs showing groundwater level (mAHD), depth (mBGL) and rainfall over the borrow pit groundwater level monitoring period are provided in Figure 4.7, Figure 4.8, Figure 4.9 and Figure 4.10.

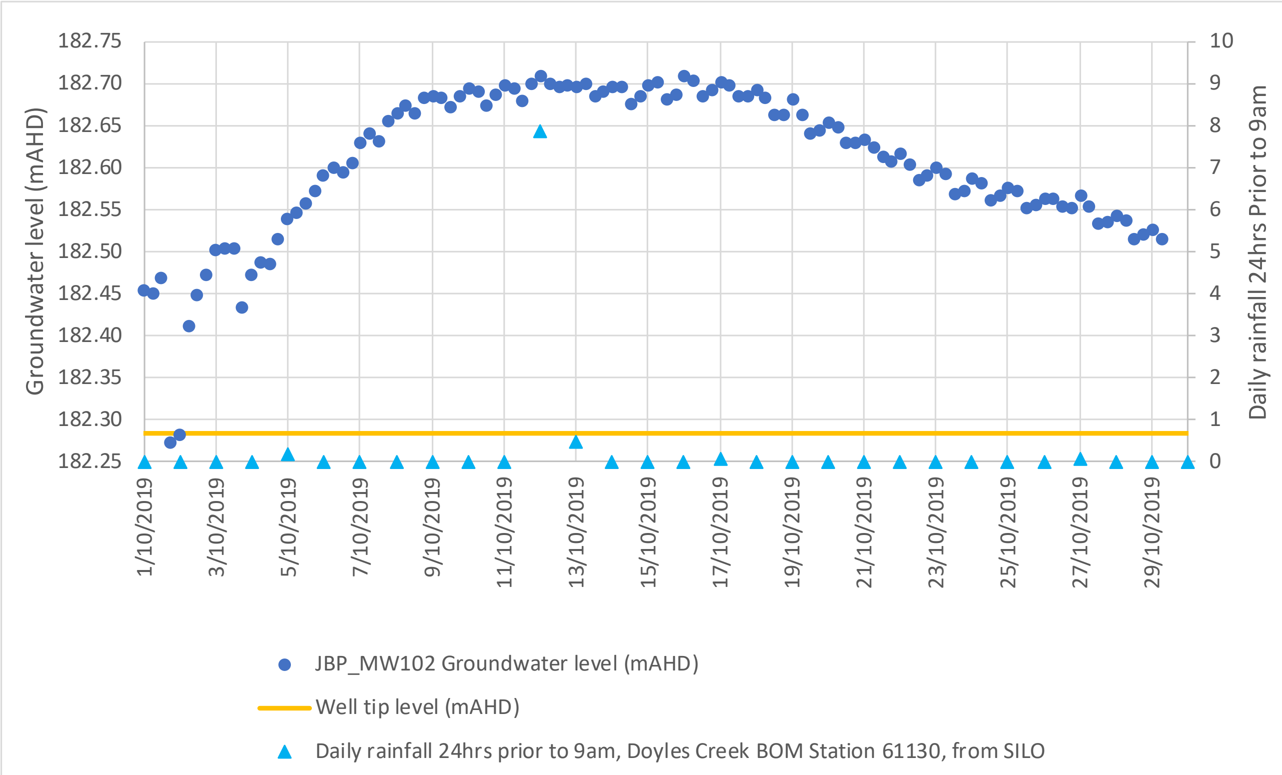
Table 4.22: Borehole and groundwater MW groundwater level observations on 29/10/2019

Borehole or MW ID [1]	Ground level (mAHD) [2]	Groundwater level (mAHD) on 29/10/2019 [3]	Groundwater depth (mBGL) on 29/10/2019 [3]
JBP_MW102	186.65	182.52	4.13
JBP_MW104	155.69	152.44	3.25
JBP_MW106	140.95	136.61	4.34
JBP_MW109	140.29	133.78	6.51

Notes: [1] MW suffix denotes borehole completed as a groundwater monitoring well. [2] From survey (VRS differential GPS from a CORS base station) by a registered surveyor. [3] Measured by dip meter.

The following is noted:

- Except for JBP_MW104, groundwater levels reached equilibrium in the monitoring period. JBP_MW104 is interpreted to have almost reached equilibrium by the end of the monitoring period.
- Rainfall over the monitoring period was negligible.
- Hydrogeological conceptualisation of the borrow pit areas is covered in Section 4.8.6 and includes hydrogeological cross sections showing inferred groundwater levels.



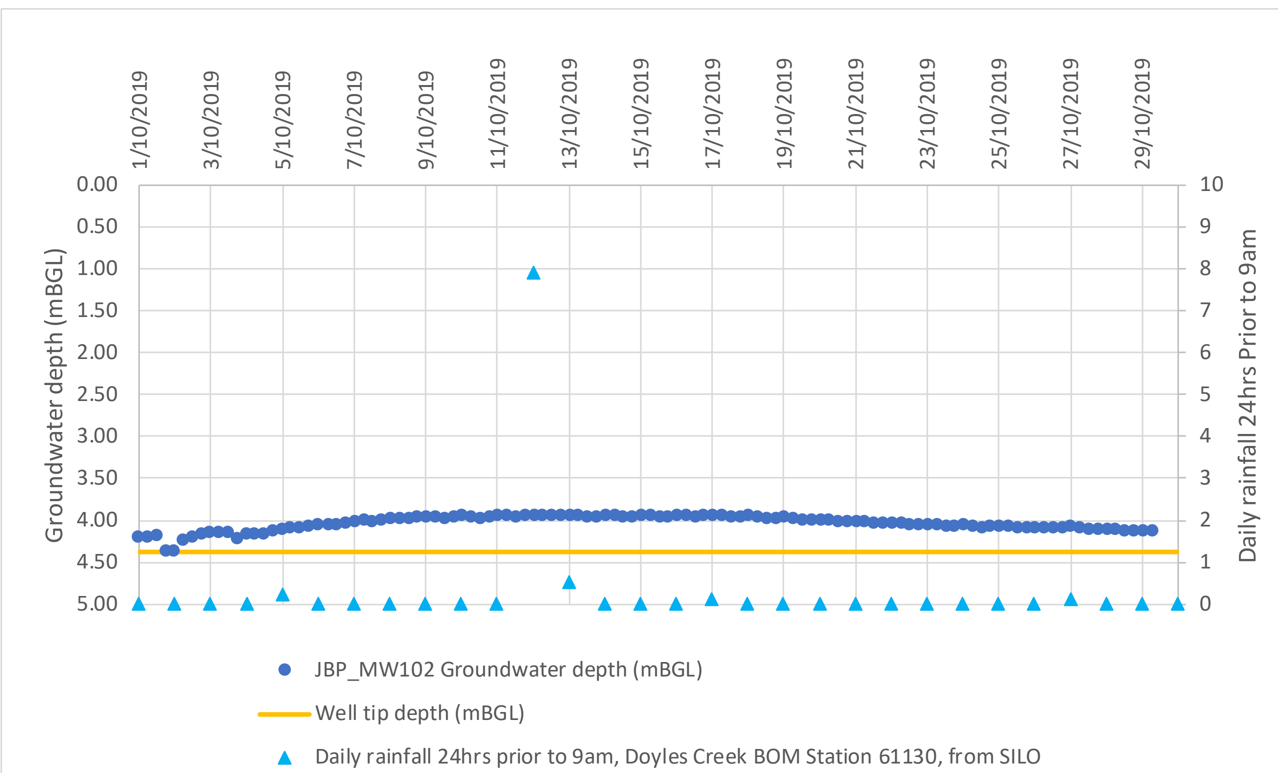
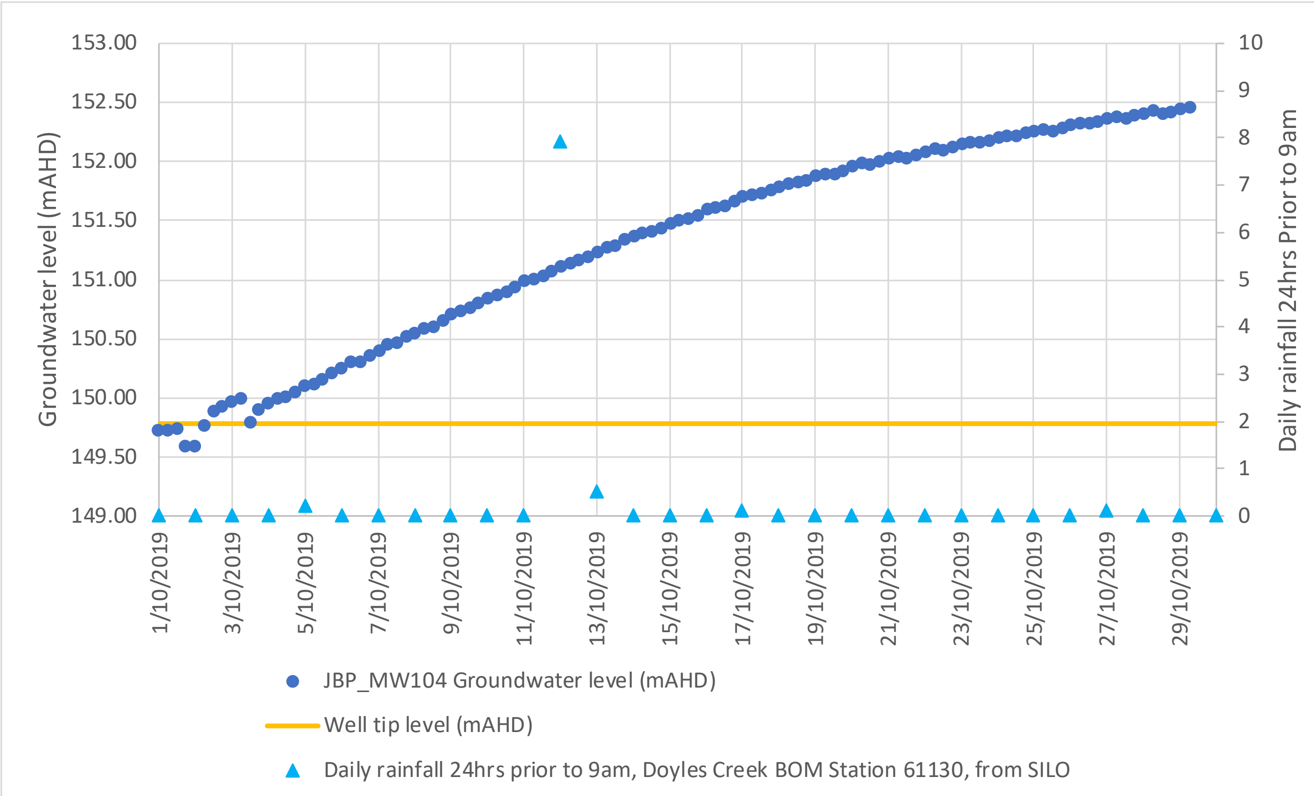


Figure 4.7: JBP_MW102 groundwater level/depth and rainfall



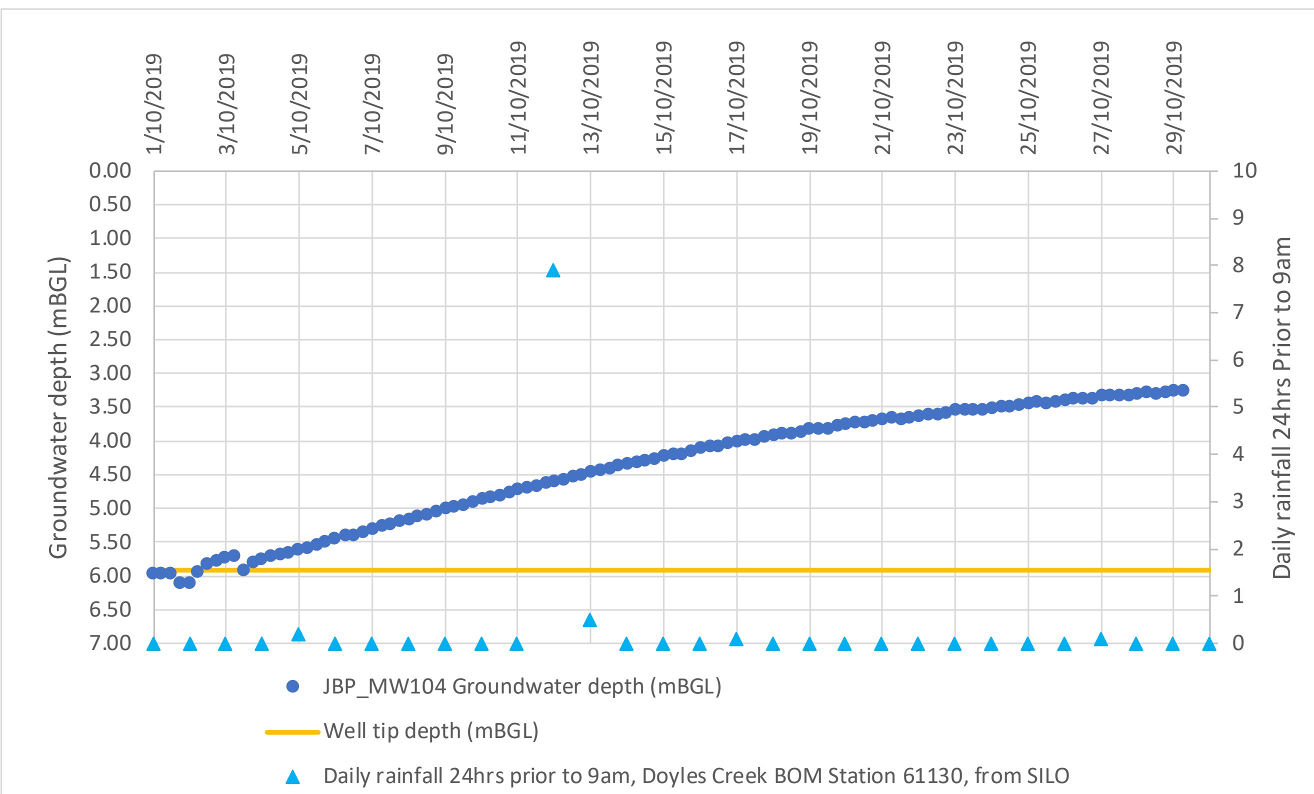
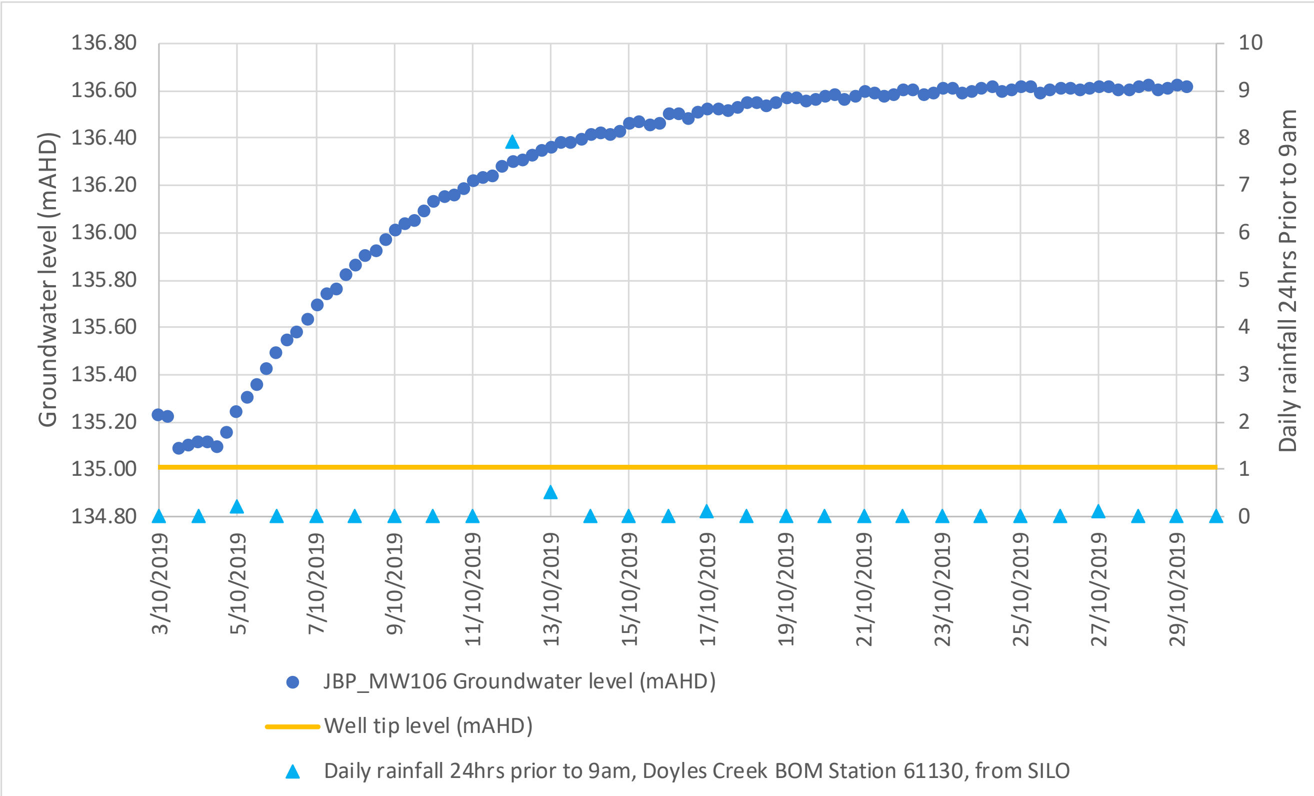


Figure 4.8: JBP_MW104 groundwater level/depth and rainfall



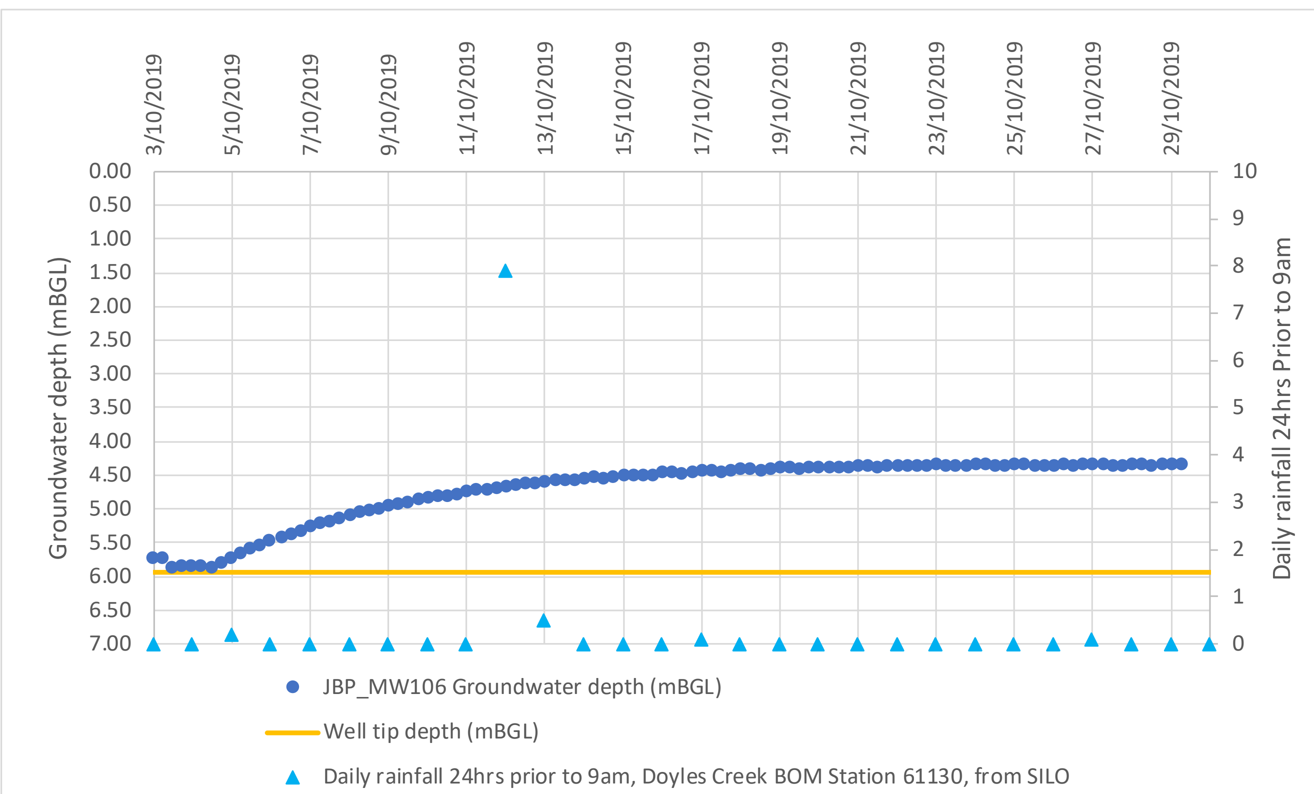
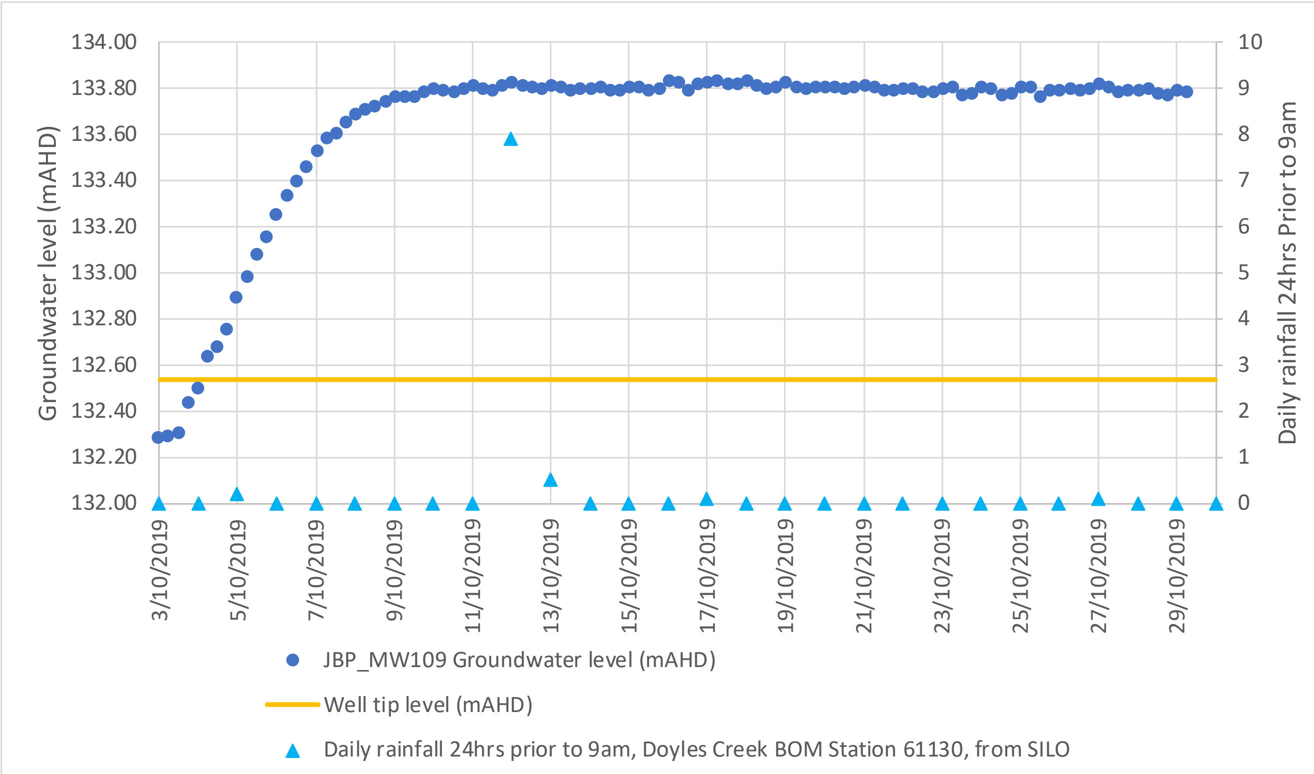


Figure 4.9: JBP_MW106 groundwater level/depth and rainfall



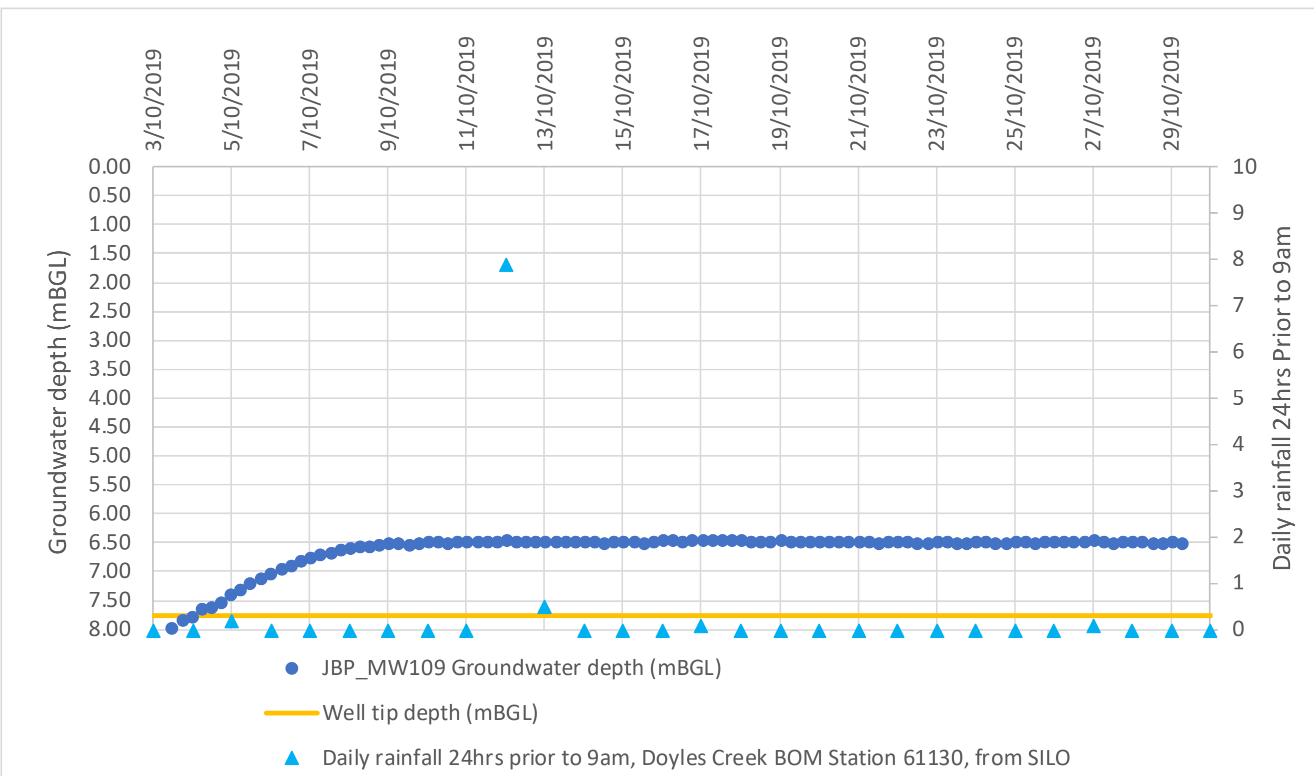


Figure 4.10: JBP_MW109 groundwater level/depth and rainfall

4.8.3 Groundwater quality

Existing groundwater quality data is available for Project assessment groundwater monitoring bores. The bores were sampled during multiple rounds and field tested (field parameters only) and laboratory tested for the range of analytes outlined in 3.2.3.2.

Groundwater quality results are tabulated and compared to ANZECC 2000 freshwater 95% level of protection, ANZECC 2000 trigger values for lowland rivers, and ANZECC 2000 freshwater 99% level of protection (used only for bioaccumulate Mercury and Selenium) and presented in Appendix B. The following general keys points are noted:

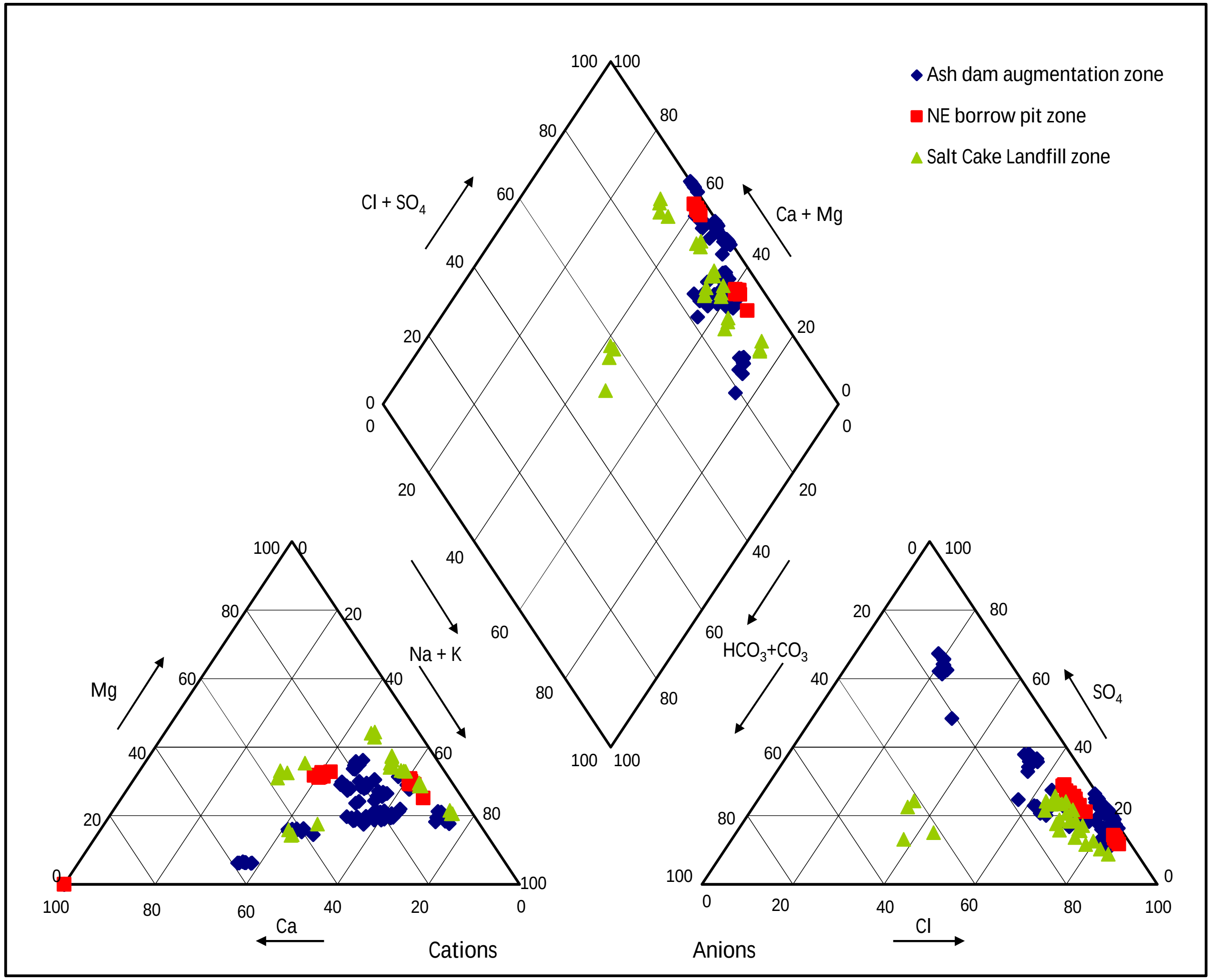
- Aluminium, Boron, Copper, Cadmium, Manganese, Nickel and Zinc concentrations were frequently above ANZECC 2000 GW 95% guideline levels
- Reactive phosphorous and total nitrogen were at times above the ANZECC 2000 guideline levels for lowland rivers
- The pH values at BA_MW01, BA_MW03 BQ_MW04 and BA_ BQ_MW10 were above the ANZECC 2000 guideline levels for lowland rivers
- TRH, BTEXN, PAHs and PCBs concentrations were all below the laboratory detection limits.

Groundwater quality statistics for the ash dam augmentation zone bores, salt cake landfill bores and bores on the periphery of Borrow Pit 1 are summarised in tables within Appendix C.

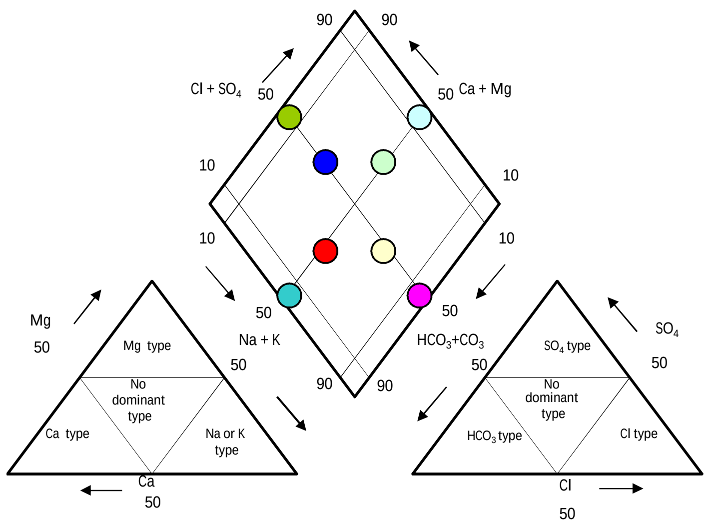
In order to characterise the existing groundwater quality, the major and minor ions are presented in a piper plot in Figure 4.11.

The piper plot indicates the groundwater of the Project monitoring bores is generally split between sodium chloride and calcium chloride water types. MW_A04 (middle samples in diamond portion of plot) associated with the Salt cake landfill, has a distinct groundwater quality signature compared to other Project bores (refer Figure 4.11). This location is characterised by no dominant water type.

The average TDS concentration, excluding MW_A04, was 11,556 mg/L, with a maximum concentration of 20,600 mg/L, which is considered saline (Freeze and Cherry, 1979). The mean and median monitored TDS concentrations for the salt cake landfill bores is 7,277 mg/L and 7,753 mg/L, respectively, which corresponds to ‘brackish’ water (Freeze and Cherry, 1979).



WATER TYPE CATEGORISATION



WATER TYPE SUB-FIELDS

- Ca + Mg, Na + K type
- Ca + Mg type
- HCO_3, Cl + SO_4 type
- HCO_3 + CO_3 type
- Na + K, Ca + Mg type
- Na + K type
- Cl + SO_4, HCO_3 type
- Cl + SO_4 type

Figure 4.11: Piper plot of major cations and anions

4.8.4 Registered groundwater bores

Bore data provided by WaterNSW (2019a) was reviewed to investigate registered groundwater bores and associated groundwater level records in the groundwater study area. The review identified 35 registered groundwater bores within the study area. Licensed groundwater bore locations are shown in Figure 4.12 and summarised in Table 4.23.

The purpose of the 35 bores is summarised as follows:

- Water supply for manufacturing and industry (i.e. Commercial/industrial) – 2 bores
- Dewatering – 2 bores
- Monitoring – 29 bores
- Unknown – 2 bores

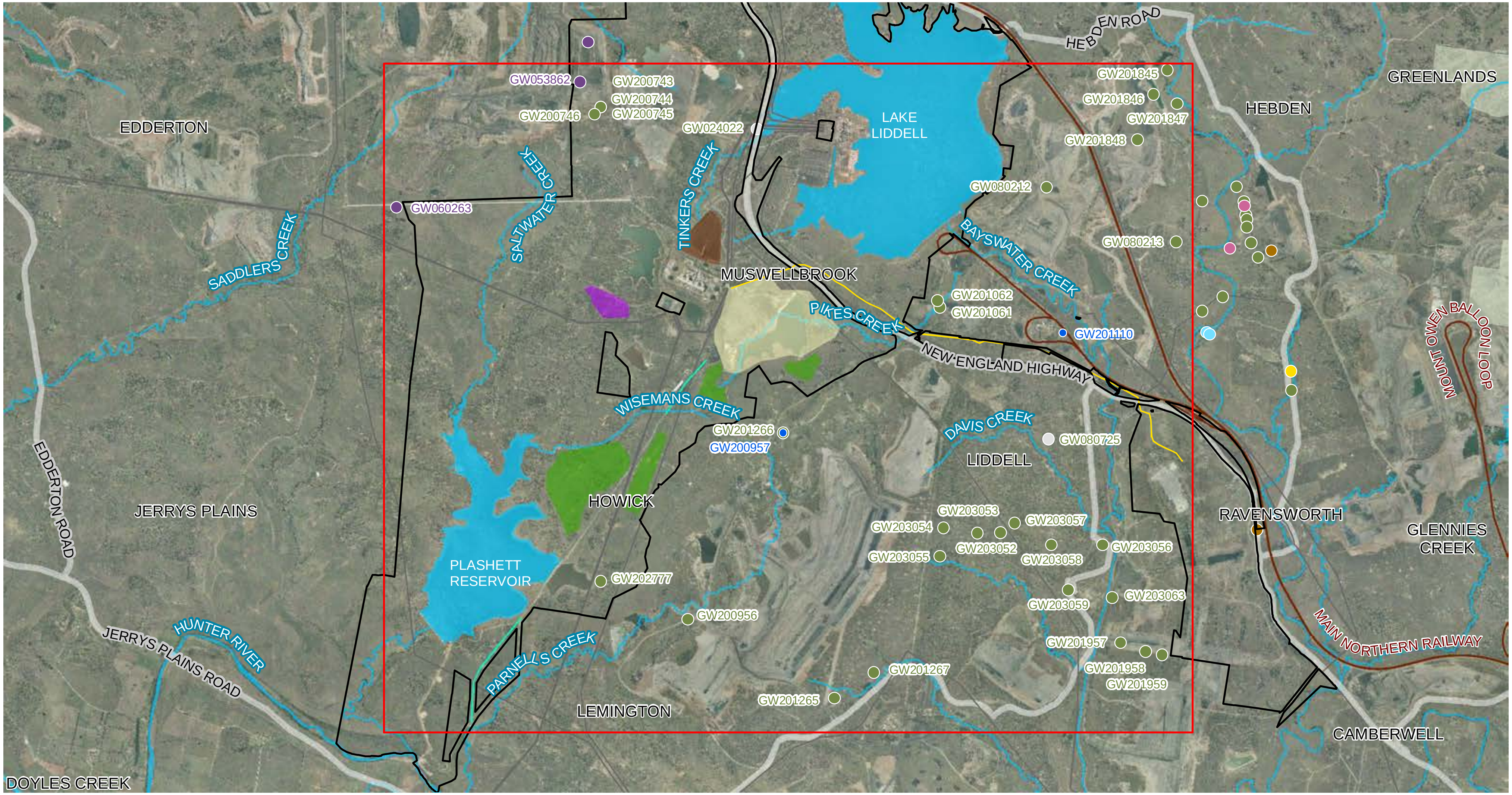
The two commercial/industrial bores, GW053862 and GW060263, are both located approximately 3.6 km north-west of their closest Project elements (salt cake landfill and coal handling plant). The closest dewatering bore to the Project elements, GW20110, is located approximately 450 m north of the closest Project element (Ravensworth Ash Line). The closest monitoring bore to the Project elements, GW201061, is located approximately 500 m north of the closest Project element (Ravensworth Ash Line).

Standing water levels for the bores ranged from 3 to 43 mBGL (16 mAHD to 182 mAHD).

Table 4.23: Licensed bore summary information

Bore ID	Easting (m)	Northing (m)	Purpose	Approximate ground elevation (mAHD)	Drilled Depth (mBGL)	Standing Water level (mBGL)
GW024022	308245	6416589	Unknown	139.66	3	NULL
GW053862	305106	6417425	Manufacturing and industry	196.15	99	NULL
GW060263	301855	6415205	Manufacturing and industry	260.38	61	NULL
GW080212	313389	6415560	Monitoring	119.05	0	NULL
GW080213	315687	6414594	Monitoring	110.88	0	NULL
GW080725	313424	6411091	Unknown	89.9	130	43
GW200743	305476	6416977	Monitoring	194.16	114	NULL
GW200744	305476	6416977	Monitoring	194.16	196	14
GW200745	305476	6416977	Monitoring	194.16	119	9
GW200746	305371	6416853	Monitoring	203.5	133	28
GW200956	307024	6407896	Monitoring	142.75	97	NULL
GW200957	308715	6411207	Drainage of groundwater	191.6	60	NULL

Bore ID	Easting (m)	Northing (m)	Purpose	Approximate ground elevation (mAHD)	Drilled Depth (mBGL)	Standing Water level (mBGL)
GW201061	311490	6413430	Monitoring	111.79	15	NULL
GW201062	311451	6413551	Monitoring	109.76	17	NULL
GW201110	313676	6412975	Drainage of groundwater	92.67	48	NULL
GW201265	309624	6406493	Monitoring	117.04	74	NULL
GW201266	308715	6411207	Monitoring	160.47	60	NULL
GW201267	310326	6406955	Monitoring	113.58	43	NULL
GW201845	315528	6417638	Monitoring	0	22	3.1
GW201846	315281	6417210	Monitoring	0	23	NULL
GW201847	315703	6417043	Monitoring	0	21	4.8
GW201848	314994	6416402	Monitoring	0	22	4.56
GW201957	314700	6407480	Monitoring	0	78	NULL
GW201958	315140	6407325	Monitoring	0	71	NULL
GW201959	315440	6407265	Monitoring	0	69	NULL
GW202777	305476	6408573	Monitoring	0	854	NULL
GW203052	312568	6409432	Monitoring	0	202	NULL
GW203053	312157	6409431	Monitoring	0	200	NULL
GW203054	311561	6409524	Monitoring	0	200	NULL
GW203055	311490	6409008	Monitoring	0	200	NULL
GW203056	314380	6409215	Monitoring	0	262	NULL
GW203057	312820	6409605	Monitoring	0	248	NULL
GW203058	313476	6409215	Monitoring	0	251	NULL
GW203059	313768	6408418	Monitoring	0	248	NULL
GW203063	314548	6408282	Monitoring	0	300	NULL



Groundwater Impact Assessment Study Area (approximately 14km x 12km)

AGL owned land

Project elements:

- Ash Dam Augmentation, Ash Harvesting and Water Management Works
- Salt Cake Landfill
- Coal Handling Plant Water and Wastewater Infrastructure Upgrades
- HP Pipe Clearing
- LSP Sludge Line Clearing
- Clay Borrow Pits
- Ravensworth Ash Line

Borehole purpose

- Commercial and industrial
- Drainage of groundwater
- Exploration or research
- Household
- Irrigated agriculture
- Manufacturing and industry
- Monitoring
- Unknown

0 1 2 km

1:100,000 at A4

N

Data sources

Jacobs 2019, AGL 2019
NSW Spatial Services 2019

GDA94 MGA56

Figure 4.12 Licensed surrounding groundwater bores

Date: 14/10/2019 Path: J:\IE\Projects\04_Eastern\IA215400\22_Spatial\GIS\Directory\Templates\Figures\Groundwater\IA215400_GIS_GRW_F004_r1v2_Groundwater_bores.mxd
Created by : XX | QA by : XX

4.8.5 Groundwater dependent ecosystems

Review of the WSP GDE maps for the North Coast Fractured and Porous Rock Groundwater Sources (NSW Government 2016) and the Hunter Unregulated and Alluvial Water Sources (NSW Government 2009) identified no high priority GDEs within the groundwater assessment study area boundary. The BOM's GDE Atlas (BOM, 2019b) was reviewed for potential GDEs within the study area. The atlas mapping is shown in Figure 4.13 and summarised as follows:

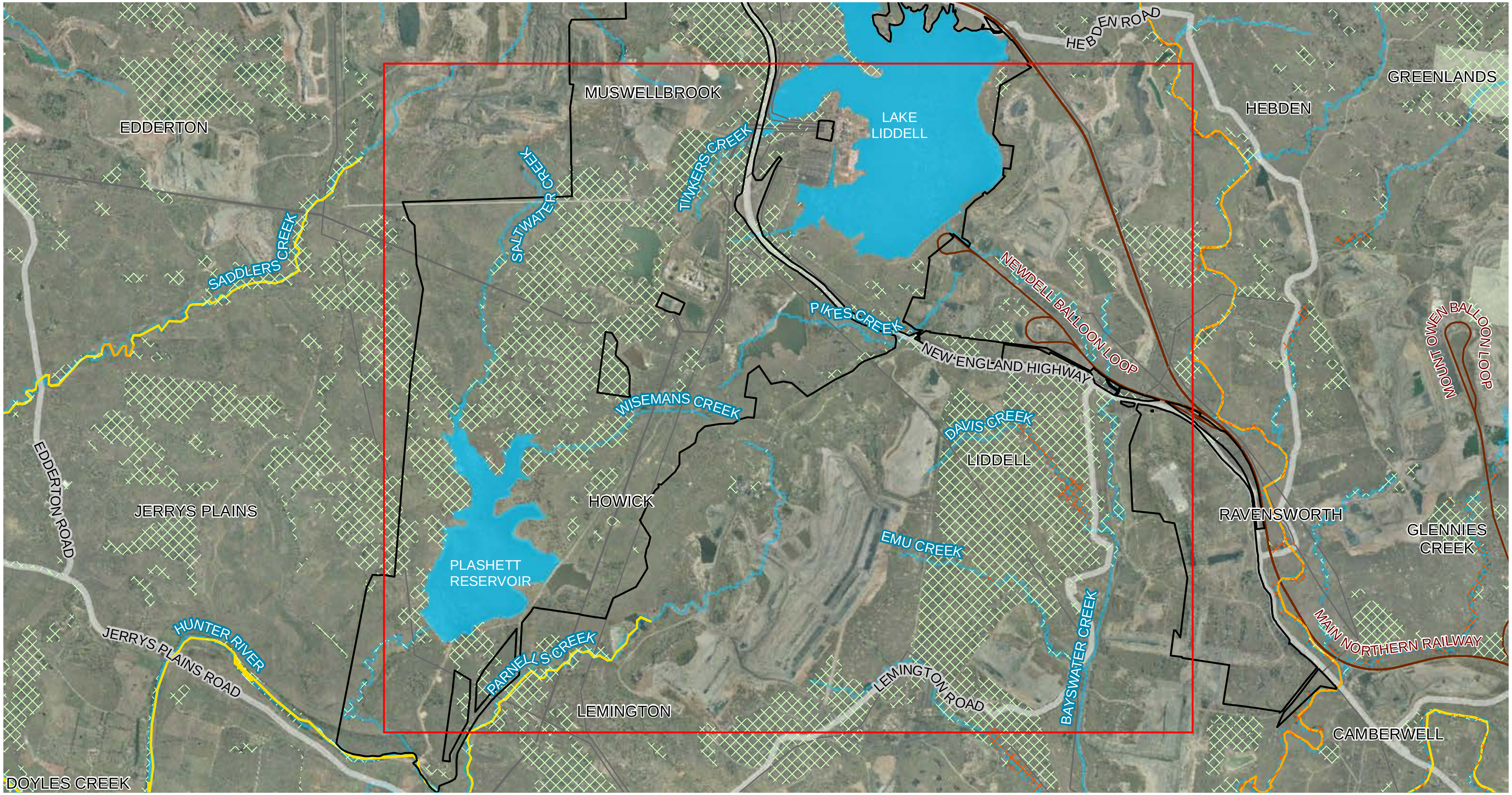
- 'Low potential terrestrial GDEs – from regional studies' are mapped over vast portions of the groundwater study area, most notably in the north western and south eastern portion of the study area;
- 'High potential terrestrial GDEs – from regional studies' are mapped over a narrow strip approximately 2 km long surrounding Davis Creek in the east of the groundwater study area. This same mapping category also occupies the southern boundary of the groundwater study area for a distance of approximately 200 m and surrounds an unnamed creek;
- 'Moderate potential aquatic GDE – from national assessment' is mapped in the very north eastern corner of the groundwater study area over a creek reach of approximately 1 km; and
- 'High potential aquatic GDE – from national assessment' is mapped in the south east of the groundwater study area over a reach of Parnells Creek which is approximately 4 km long.

4.8.6 Conceptual groundwater model

The conceptual hydrogeological model is based on the data documented in this report. The conceptual hydrogeological model is summarised as follows:

- Shallow groundwater flow direction is similar to the broad topography trend, with discharge towards major surface water drainage features;
- Hydraulic gradients are anticipated to be low to moderate in areas with relatively high slopes, and low in the vicinity of drainage lines;
- Unconfined to semi-confined groundwater flow conditions, with isolated artesian pressures in some location downslope and in close proximity to embankments;
- Local water tables are inferred to be situated in either residual soil (typically clayey), alluvial soil (also typically clayey) and sedimentary rock (typically siltstone). All of these units are anticipated to have low bulk hydraulic conductivity. Alluvial deposits in the vicinity of the Project elements, if present, are inferred to be thin and not productive and are not considered to host 'Aquifers';
- Low recharge rate by rainfall across the groundwater study area;
- Groundwater is of limited use as water supply source due to low yields and high TDS;
- Groundwater is generally brackish to saline;
- Groundwater occurs at relatively shallow depths in the vicinity of low lying drainage depressions, and occurs at deeper depths in elevated areas; and
- Baseflow to creeks and surface water features is inferred to be very low due to low hydraulic conductivity and gradients, and also due to very low upgradient recharge.

Graphical representations of conceptual groundwater models for the salt cake landfill facility and area of proposed borrow pits are provided as cross sections in Figure 4.14 and Figure 4.15 through to Figure 4.21, respectively (Figure 4.15 and Figure 4.16 show borrow pit cross section locations). A conceptual hydrogeological cross section was developed for the salt cake landfill facility because it is considered to have a relatively high potential to cause groundwater impacts if mitigation measures are not implemented. The conceptual hydrogeological cross sections for the borrow pits were developed to synthesise the borrow pit drilling program data and provide a basis to assess the likelihood of the proposed borrow pits intersecting the water table.



Groundwater Impact Assessment Study Area (approximately 14km x 12km)

AGL owned land

Groundwater Dependent Ecosystem - Terrestrial

High potential GDE - from regional studies

Low potential GDE - from regional studies

Groundwater Dependent Ecosystem - Aquatic

High potential GDE - from national assessment

Moderate potential GDE - from national assessment

Data sources

Jacobs 2019, AGL 2019
NSW Spatial Services 2019

Figure 4.13 Groundwater Dependent Ecosystem Mapping

GDA94 MGA56

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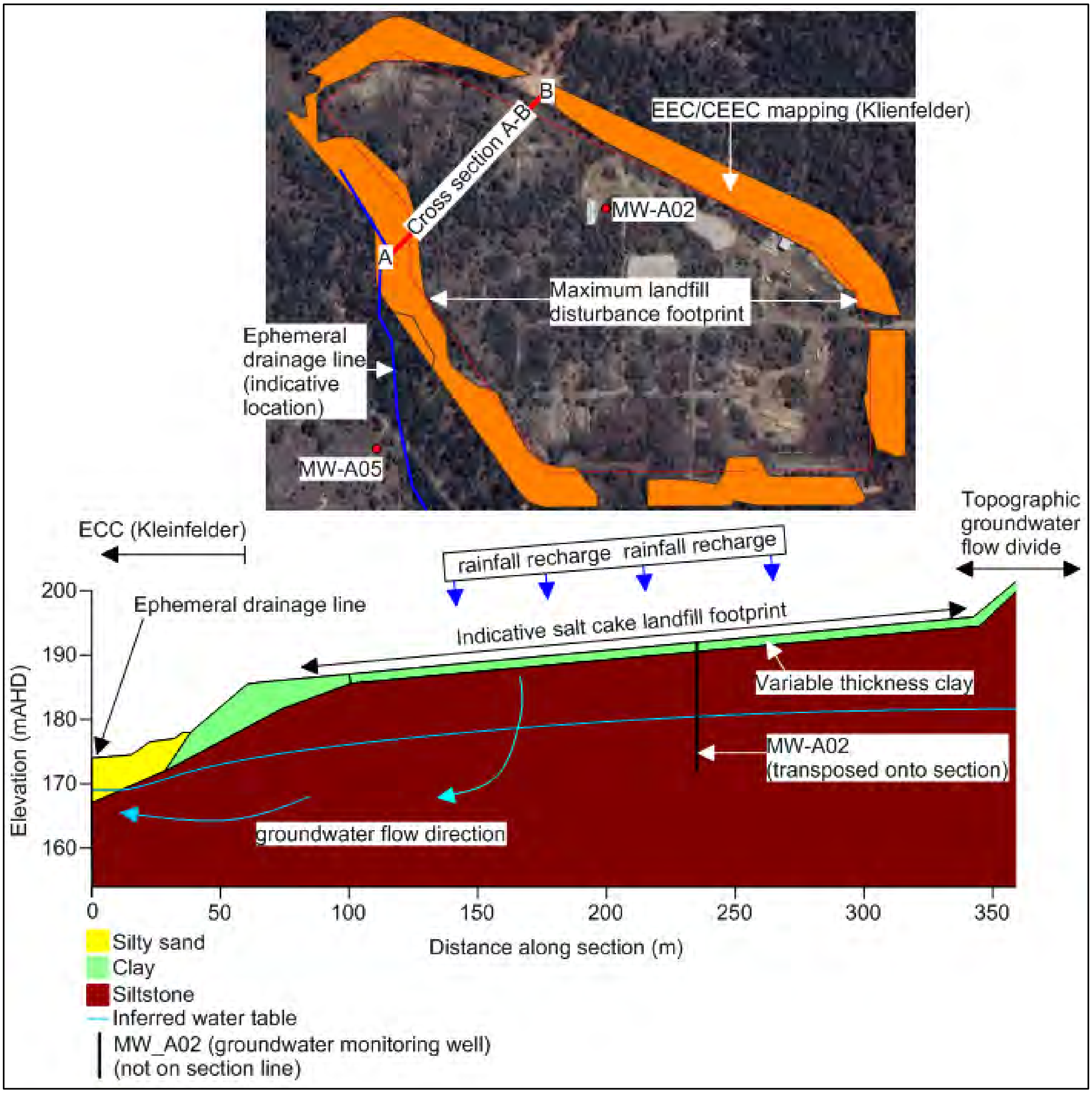


Figure 4.14: Salt cake landfill conceptual hydrogeological cross section

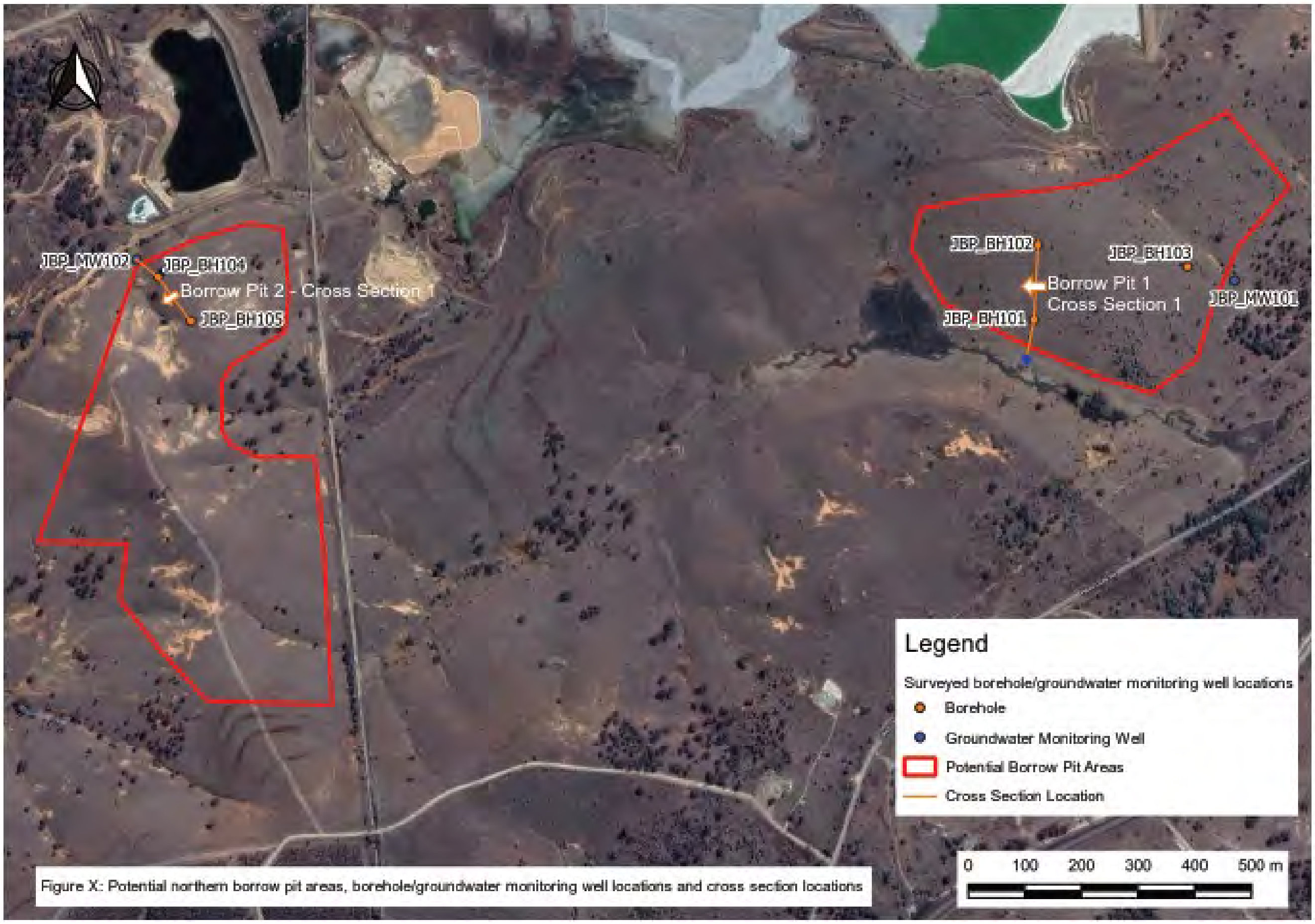


Figure 4.15: Replace at pdf stg with full pg pdf

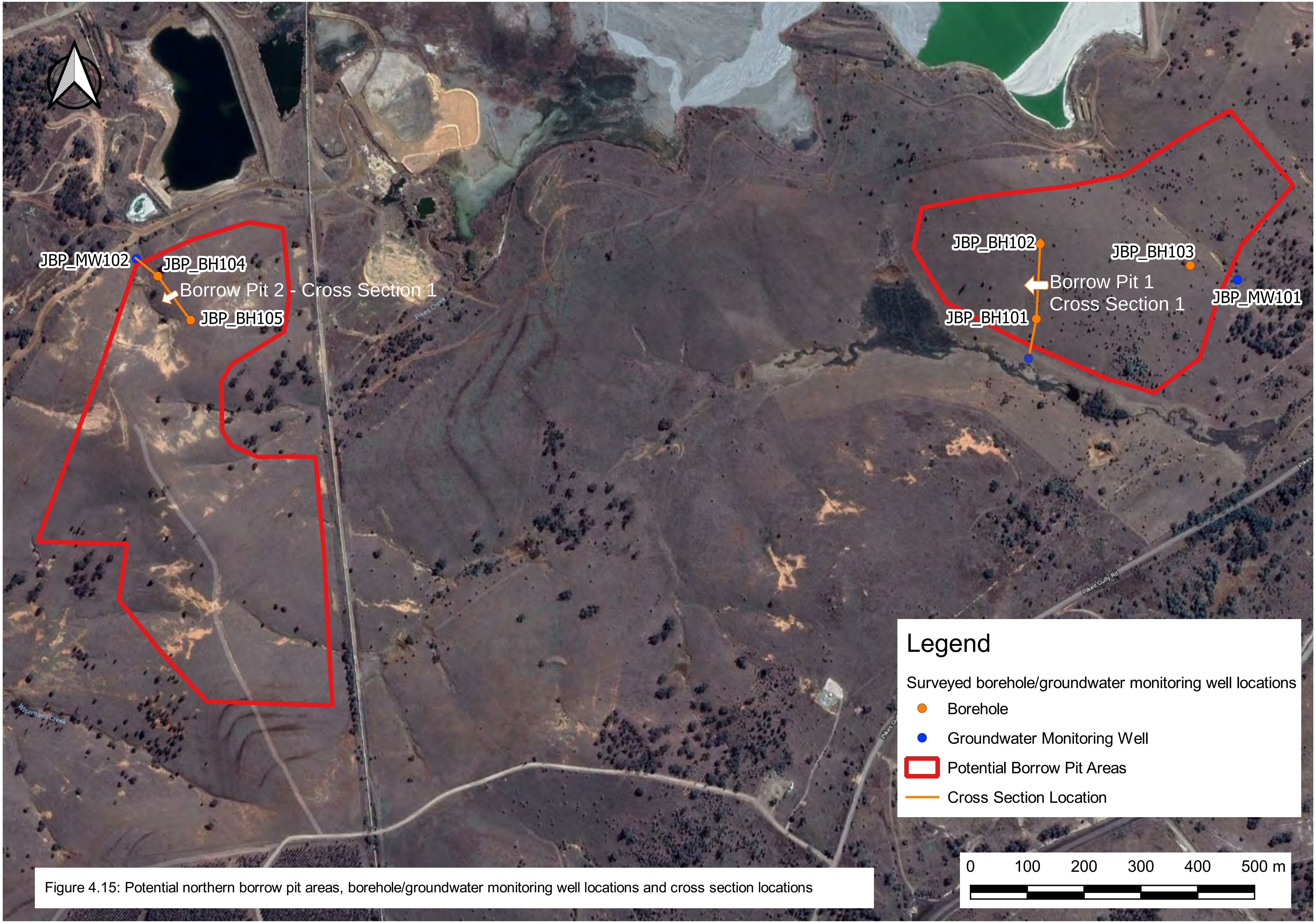


Figure 4.15: Potential northern borrow pit areas, borehole/groundwater monitoring well locations and cross section locations

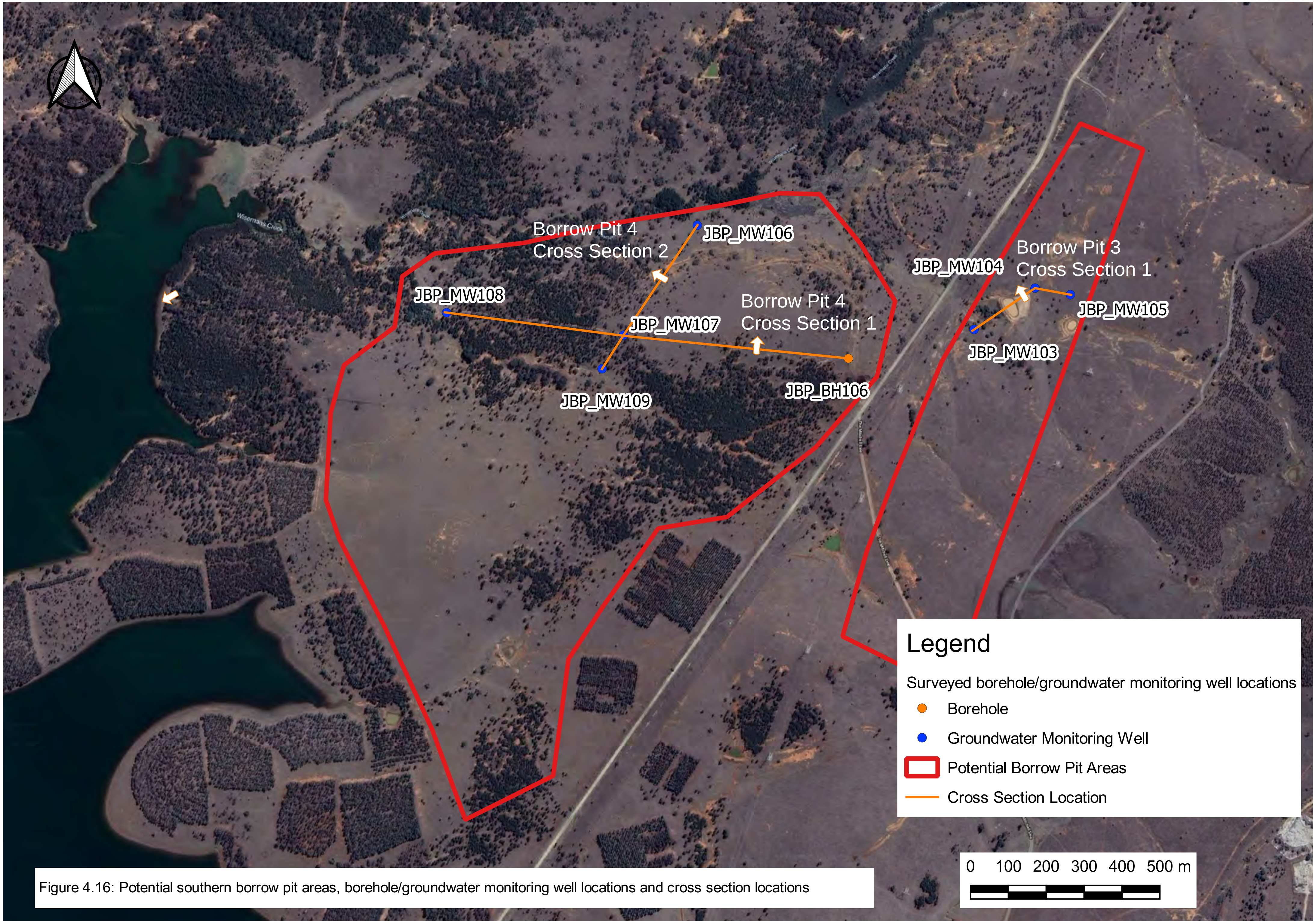


Figure 4.16: Potential southern borrow pit areas, borehole/groundwater monitoring well locations and cross section locations

Figure 4.17: Borrow Pit 1 - Cross Section 1

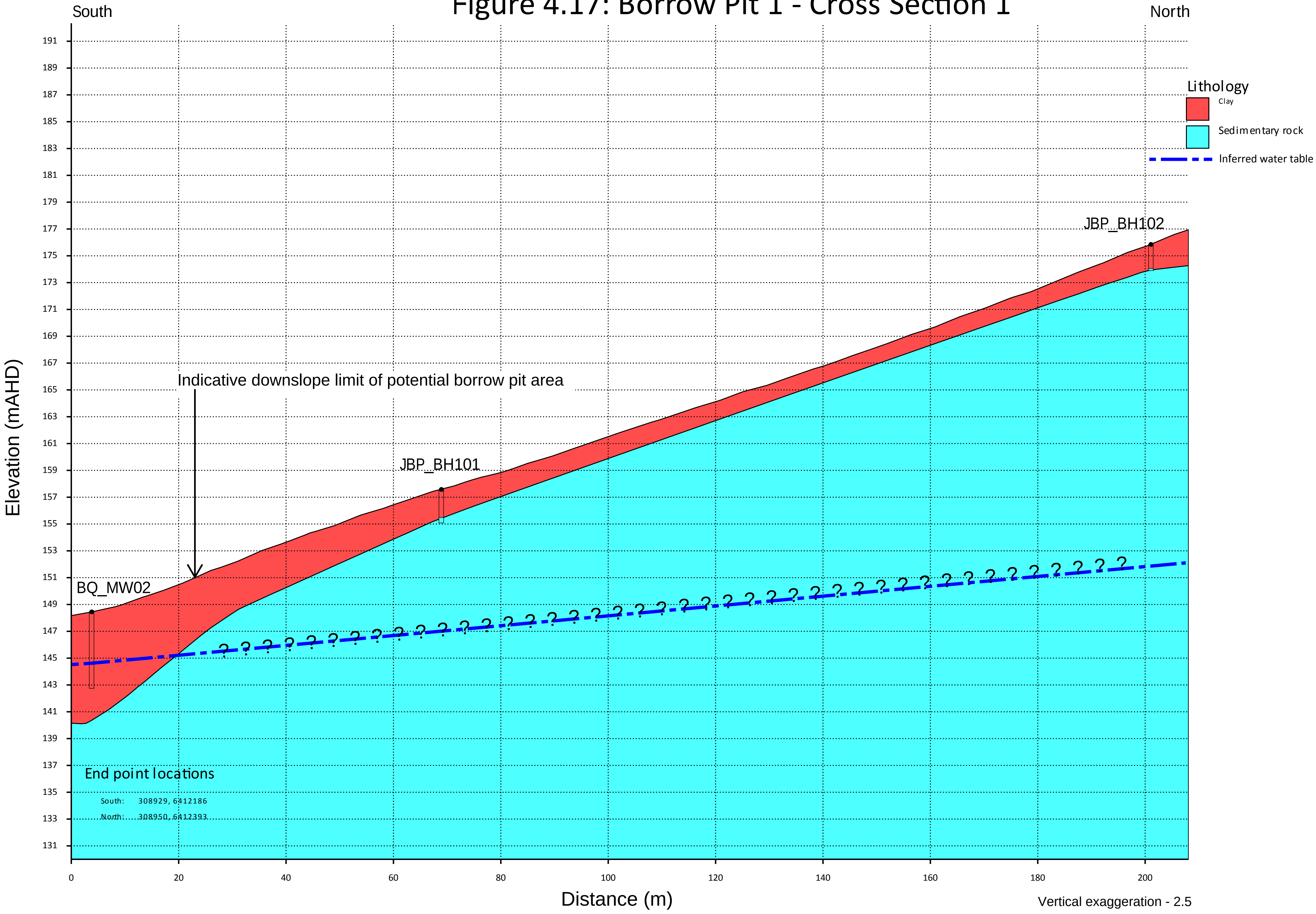


Figure 4.18: Borrow Pit 2 - Cross Section 1

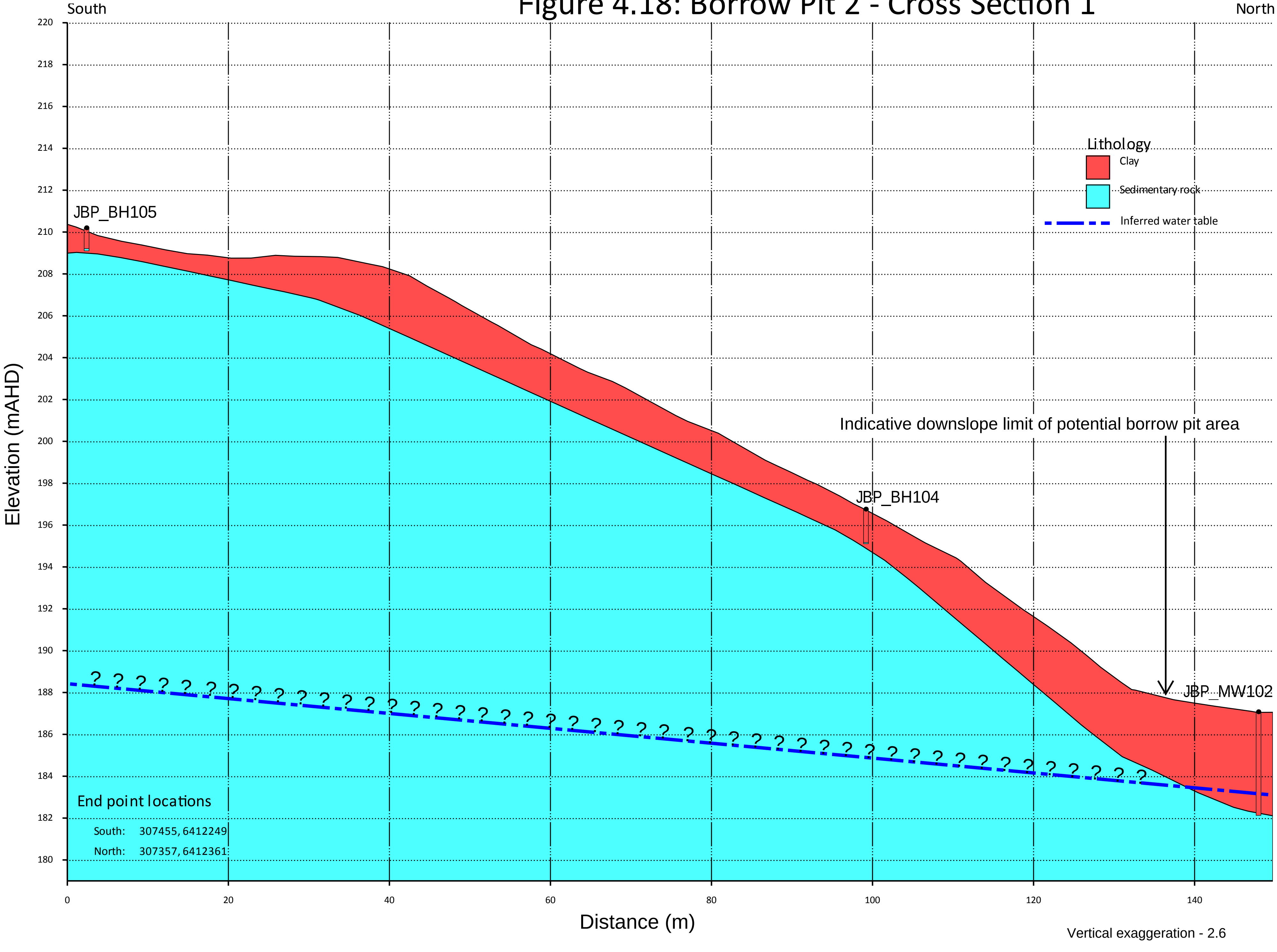


Figure 4.19: Borrow Pit 3 - Cross Section 1

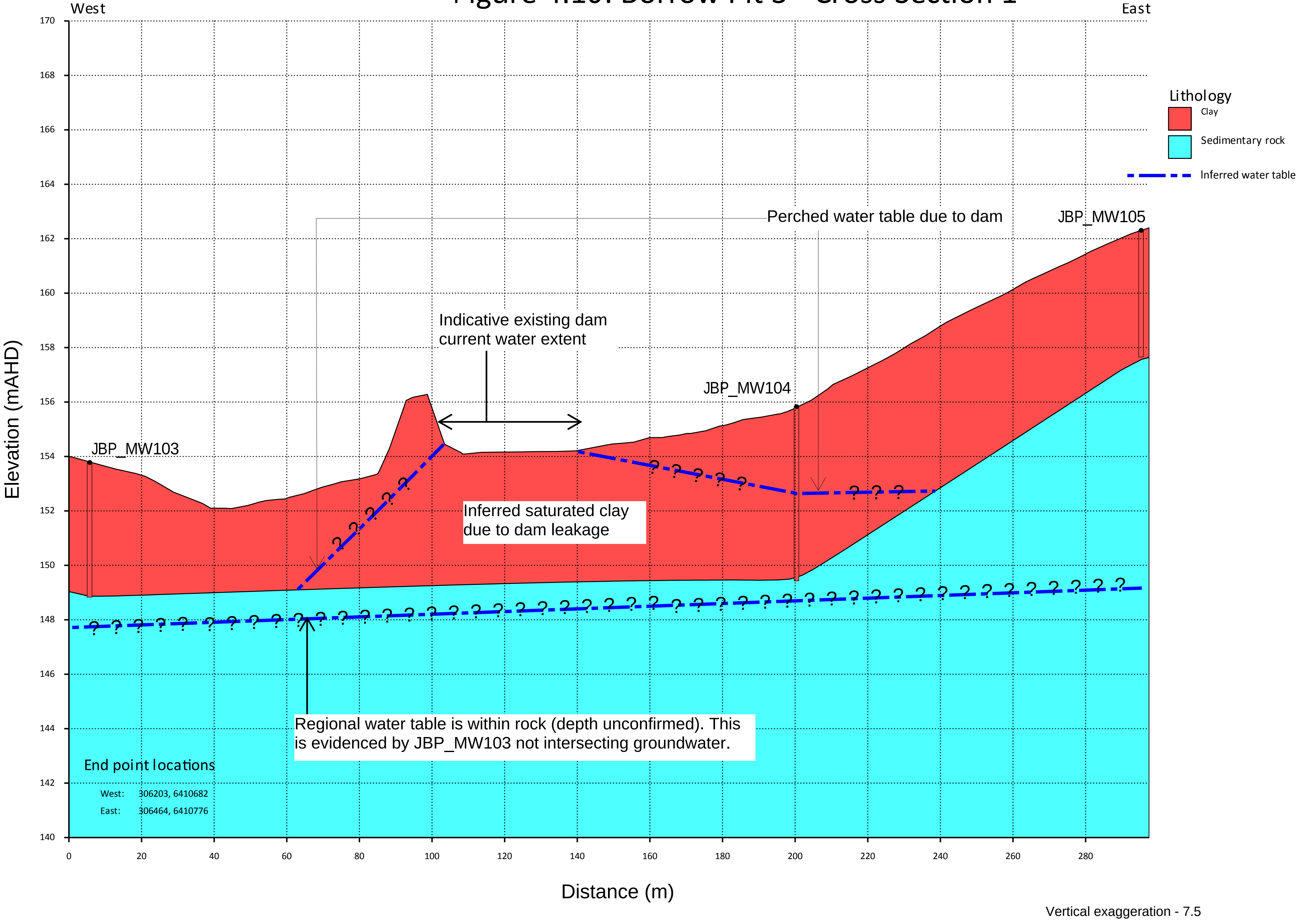


Figure 4.20: Borrow Pit 4 - Cross Section 1

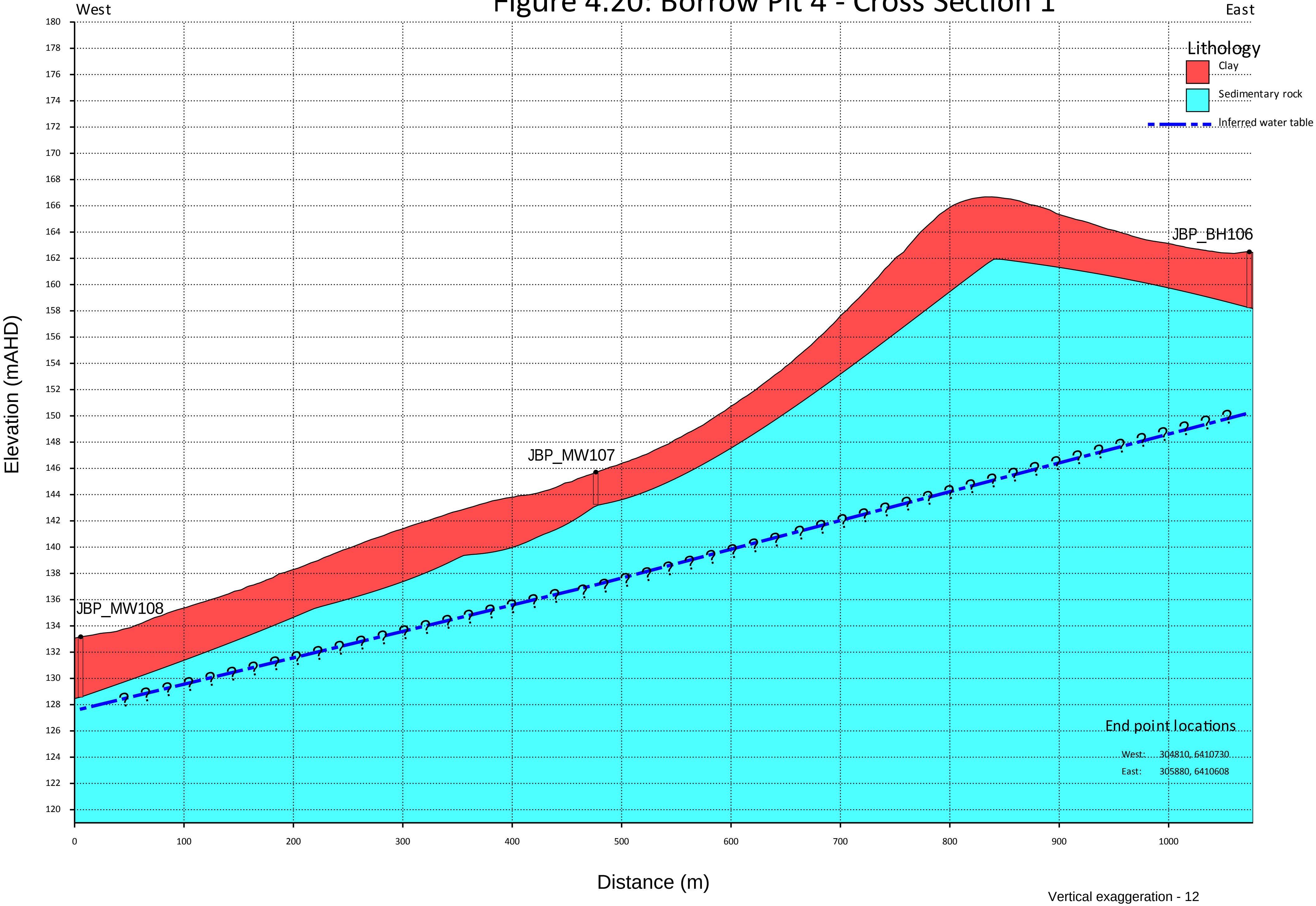
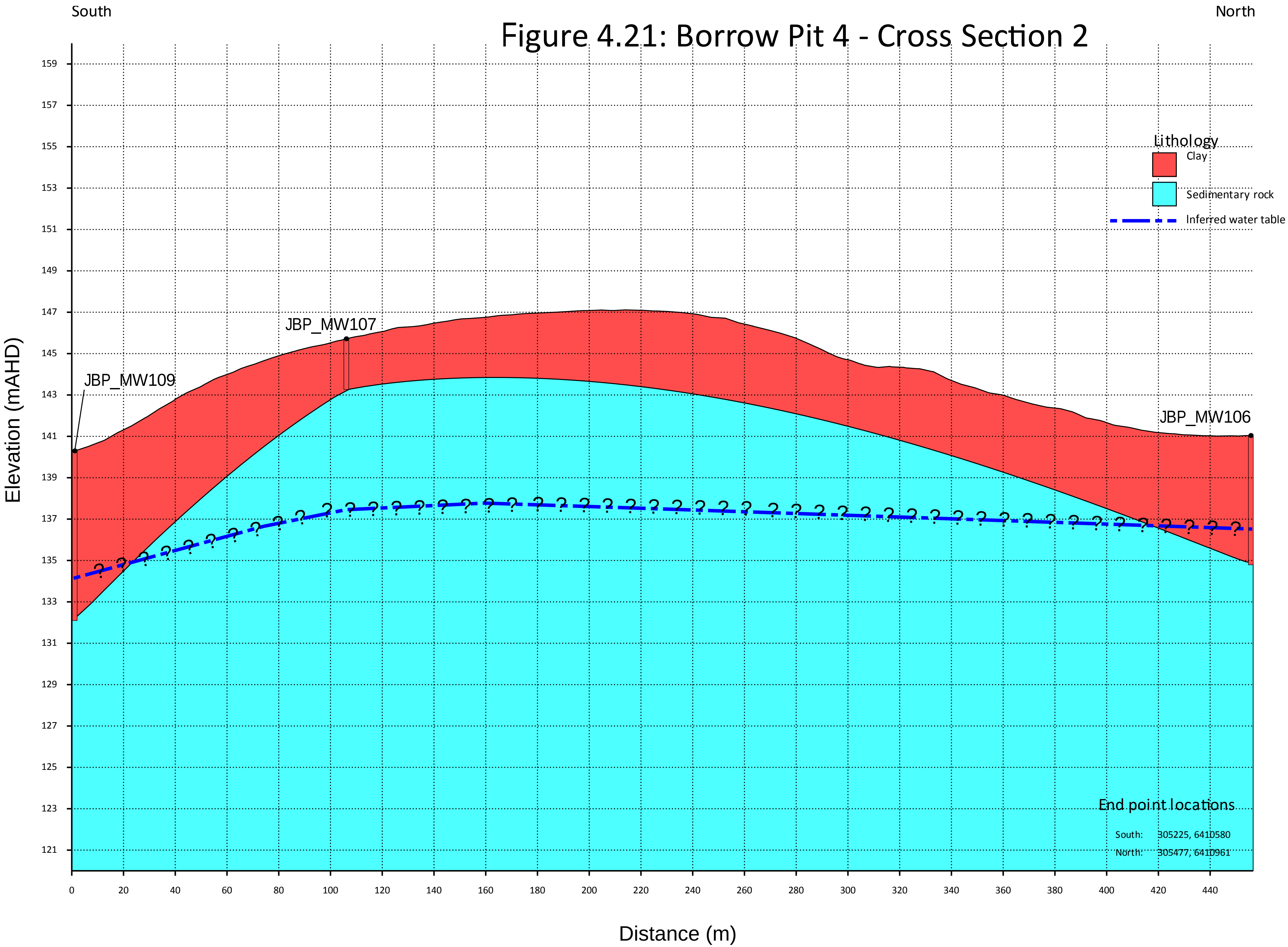


Figure 4.21: Borrow Pit 4 - Cross Section 2



Vertical exaggeration - 8

4.9 Sensitive receiving environments

No waterways within the Project footprint area have been classified as sensitive receiving environments. This conclusion has been made based on the following considerations:

4.9.1 Drinking water catchment

No waterways within the footprint area are part of the drinking water catchments for any of the surrounding townships.

4.9.2 Areas that contribute to aquaculture and commercial fishing

Commercial fishing is prohibited in waterways within the footprint area, and no waterways are classified as aquaculture areas.

4.9.3 Threatened aquatic species

Assessment of fish habitat values of waterways within the proposal area has been based on review of existing literature, desk-top searches and aerial photograph interpretation. The assessment has considered the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) as well as current indicative distribution of the threatened species in NSW, modelled from past catchment data and environmental conditions as provided by the Department of Primary Industries (2018) and the Commonwealth EPBC Act Protected Matters Search Tool.

According to the Protected Matters Search Tool and the DPI NSW threatened species distribution maps (2018), no threatened fish listed under the EPBC Act or FM Act are likely to be present in any of the waterways located within the Project footprint area.

Lake Liddell, Plashett Reservoir and Bayswater Creek have been mapped as Key Fish Habitat (**KFH**) (DPI, 2018), however, no threatened species are predicted to occur and only minimal suitable aquatic habitat features appear to be present along the banks of the waterways. Considering this, all three waterways have been classified as Type 3 minimal key fish habitat (DPI, 2013). Furthermore, Bayswater Creek has been highly modified downstream including the construction of a diversion channel which has resulted in significantly altered aquatic and riparian habitat. In particular, the construction of a drop structure near the confluence of Bayswater Creek and the Hunter River prevents the migration of fish upstream.

No other waterways within the Project footprint have been mapped as KFH.

5. Assessment of potential construction impacts

Construction of the various Project elements would involve a range of activities that present a potential risk to surface water, groundwater and flooding if management measures are not implemented, monitored and maintained throughout the construction phase. Further details, including construction information, is provided in Chapter 2 of the EIS, however, a summary of construction activities associated with the Project is provided in Table 5-1.

Table 5-1 Construction activities associated with the Project elements

Project Element	Summary of Component	Construction activities
Ash management works	Ash Dam augmentation	• Establishment of appropriate environmental controls including water diversions and protection of existing waterbodies in the vicinity of works, and erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and construction - Volume 1* (the Blue Book) • Clearing works, including the removal and relocation of infrastructure within the ash emplacement footprint; • Construction of foundations at the base of the levee embankments; • Earthworks and construction of levee embankments and internal cell walls; • Construction of a concrete parapet wall; • Earthworks and minor civil works associated with the establishment of the additional southern saddle dams; • Connection of extensions to the existing ash and water management infrastructure.
Ash management works	Installation of additional coal ash recycling facilities and fly ash harvesting upgrades	• It is expected the majority of materials would be supplied to site as pre-fabricated materials with only minor assembly and installation works expected to be undertaken on site. • Formalised gravel access roads would be provided to allow for additional vehicles entering and exiting the coal ash recycling and fly ash harvesting facilities.
Ash management works	Installation of ash pipeline from Bayswater to Ravensworth Void No. 3	• Vegetation clearance along the pipeline alignments. It has been assumed that all vegetation would be cleared • Laying above ground pipelines onto plinths • Trenching or underboring below ground sections of the pipelines. Depending on the trench depths, shoring or benching the trench may be required; and • Removal of any disused pipelines as required.
Salt cake landfill facility	Construction of the salt cake landfill facility	• Site clearing, including the removal of contractor facilities and materials. It is assumed that these materials would be relocated to other areas of AGL Macquarie land or disposed of in appropriately licensed landfills, as required; • Establishment of clean water diversions; • Establishment of erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and construction - Volume 1* (the Blue Book)

		• Excavation and minor earthworks to create landfill cells, including installation of appropriate lining, and surface water diversion structures, where required.
Borrow pits	Accessing borrow pits consecutively as the need for material arises and commencing from those closest to the Ash Dam	• Site clearance, including vegetation removal where necessary. • Establishment of clean water diversions; • Establishment of erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and construction - Volume 1* (the Blue Book) • Clearing vegetation and either mulching for onsite reuse or used to created habitat piles; and • Stripping and stockpiling of topsoil for later use in rehabilitation.
Coal handling plant water and waste water infrastructure upgrades	Minor civil works and plant modifications related to water management improvement works.	• Minor civil works and plant modification activities limited to the existing operational areas of the coal handling plant. • Excavation and minor earthworks for the construction of the clean water diversions • Establishment of erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and construction - Volume 1* (the Blue Book)
Ancillary works	Vegetation clearing along alignments of the LSP Sludge Line and HP.	• Routine clearance of vegetation along alignment where necessary.

5.1 Surface Water Quality

Construction of the Proposal presents a risk to degradation of downstream surface water quality if management measures are not implemented, monitored and maintained throughout the construction phase.

Potential impacts to water quality would occur through the following construction activities:

- Removal of vegetation, general earthworks, including stripping of topsoil and excavation;
- Stockpiling of topsoil and vegetation;
- Transportation of cut and/or fill materials and the movement of heavy vehicles across exposed earth;
- Potential for spills and leaks;
- Concreting; and
- Instream works.

Potential impacts to water quality associated with construction activities of the Project elements are discussed below.

5.1.1 Removal of vegetation and general earthworks

Removal of vegetation and general earthworks can impact on water quality during the construction phase if runoff is allowed to mobilise exposed soils. This can result in increased erosion and sedimentation. Augmentation of the ash dam and installation of the pipeline, infrastructure upgrades to the coal handling plant, ancillary facilities and establishment/construction of salt cake facility and borrow pits would all require removal of vegetation, stripping of topsoil and excavation or earthworks thereby disturbing and exposing soils.

The impact of these works on water quality could include increased turbidity, suspended solids, nutrients and contaminants from mobilisation of soils.

The excavation of the borrow pits presents the greatest risk to the water quality of Wisemans Creek and Pikes Creek which are located downstream of these areas. Pikes creek is also downstream of the Ash Dam and therefore earthworks associated with the augmentation of this and the pipeline have the potential to impact on Pikes Creek. Given the proximity of proposed works to these waterways, erosion and sediment control measures will be required in the CEMP to ensure no impacts to downstream water quality occur.'

5.1.2 Stockpiling of topsoil and vegetation

Stockpiles of raw materials or spoil would be located as close as practical to the work area with implementation of appropriate environmental protection measures to minimise impacts on receiving waters from erosion and sedimentation.

5.1.3 Transportation of cut and/or fill materials and the movement of heavy vehicles across exposed earth

The earthworks and movement of construction vehicles within the Project areas could increase erosion and sediment deposition in waterways. Construction activities adjacent to waterways could introduce contaminants such as oil and greases or disturb contaminated sediments, potentially having an adverse impact on water quality. All waterways within the Project area are at risk of being impacted, however the waterways most at risk of being impacted are Wisemans Creek, Pikes Creek, Saltwater Creek and Bayswater Creek due to their proximity to the proposed works associated with construction of the Ash pipeline and borrow pits.

5.1.4 Potential for spills/leaks

The release of potentially harmful chemicals and other substances in the environment may occur accidentally during construction due to leakage or spills of petroleum, oils and other toxicants from construction machinery, plant equipment, refueling and vehicles travelling to and from site. Spills and leakages could potentially be transported to downstream waterways. This can result in oily films on surface water reducing the visual amenity and a decrease in biodiversity, loss of habitat and fish kills from elevated concentrations of toxicants.

5.1.5 Concreting

Concrete works are required for the Ash Dam augmentation and for the installation of the ash transfer pipeline. Concrete works can result in concrete dust, concrete slurries or washout water entering downstream waterways which can increase the alkalinity and pH of downstream waterways which can be harmful to aquatic life. Additionally, water contaminated with chromium can accumulate in the gills of fish affecting the health of aquatic animals. Chilcotts Creek, which is downstream of the Ash Dam, is at greatest risk of being impacted.

5.1.6 Instream works

There is potential for soil and bank erosion, as well as mobilisation of sediments into receiving waterways including Chilcotts Creek, Pikes Creek and Bayswater Creek during direct disturbance of waterway bed and banks as a result of earthworks and construction of the Ash Pipeline and Borrow Pits. This can result in increased turbidity, decreased dissolved oxygen, increased nutrients and toxicants which can cause increased weed growth and algal blooms.

5.1.7 In-direct impacts

The aforementioned activities would result in in-direct water quality impacts to the operating water bodies of Lake Liddell and Plashett Reservoir if poor quality is allowed to mobilise to these waterbodies via tributaries. In particular, Salt Creek, Wisemans Creek.

5.2 Groundwater

5.2.1 Identification and qualitative assessment of potential groundwater impacts during construction

Identified potential groundwater impacts during construction are outlined and qualitatively assessed in Table 5.2. With the exception of the salt cake landfill, which is assessed to represent a medium risk, potential impacts are assessed as very low or low risk.

Table 5.2: Identified potential groundwater impacts during construction

Project element	Potential impacts to groundwater during construction	Comment	Likelihood, consequence, risk
Salt cake landfill	Potential Impact A (**PIA**) – contamination of groundwater due to spills/leaks. Groundwater could be contaminated if spills or leaks of hazardous materials occur during construction and migrate to the water table. Such spills/leaks may include, but not be limited to oils, lubricants and fuels used by construction plant.	The contaminate source would be on the surface (unless subsequently buried) and may be able to be identified. This would lead to the source being contained and remediated. Therefore, potential contaminant sources would be temporary. Additionally, a leachate collection system liner will underlie the landfill area and will therefore collect potential unidentified contamination. In the event a typical sized fuel/oil spill, surrounding sensitive receptors are not anticipated to be impacted.	Unlikely likelihood, minor consequence, low risk
	Potential Impact B (**PIB**) – salinisation of groundwater from salt cake landfill leachate. If the landfill's leachate collection liner leaks, it is possible that saline or briny water could migrate from the area of the landfill and move towards sensitive receptors. Potential sensitive receptors include EEC and CEEC vegetation surrounding the proposed landfill and ephemeral drainage lines and water bodies down-gradient of the proposed landfill. As cells will be progressively constructed throughout the life of the landfill, this risk is applicable during construction and operation.	The proposed landfill would be constructed in accordance with NSW EPA (2016) guidelines for solid waste landfills and therefore would have a leachate barrier system, including a liner (either compacted clay liner or geosynthetic clay liner), overlying geomembrane liner (HDPE) and 300mm gravel leachate collection layer with associated pipework sloping to a sump. During operation, cells that will not receive lifts for some time will be capped with an intermediate cover in accordance with NSW EPA (2016) guidelines. A final capping layer, including a low permeability layer, will complete each land fill cell. These design features would help to mitigate offsite migration of saline/briny water. However, if the liner leaks, offsite migration could occur. If a leak does occur, potential applicable surrounding sensitive receptors include the EEC and CEEC vegetation (if these vegetation communities take up saline water from the saturated or unsaturated zone) and down-gradient ephemeral drainage lines and creeks. It is noted that due to the saline/briny water being relatively denser, a freshwater lens will lie over the saline/briny water downslope of the salt source.	Possible likelihood, minor consequence, medium risk

Project element	Potential impacts to groundwater during construction	Comment	Likelihood, consequence, risk
		This potential impact is difficult to assess qualitatively, which is why it was assessed quantitatively (Section 6.2.2).	
Borrow pits	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
	Potential Impact C (**PIC**) – groundwater drawdown and possible need to discharge groundwater due to borrow pits intercepting groundwater. If borrow pit excavations intersect the water table, drawdown to groundwater levels could occur, and intercepted groundwater volumes may require discharge.	The proponent does not propose to extract material from below the water table or the soil/rock interface. Based on the borrow pit drilling program data, including groundwater level monitoring data, and the conceptual groundwater model for the area of the proposed borrow pits, the risk of the borrow pits intercepting groundwater resulting in interception of groundwater and subsequent groundwater level drawdown and the need to potentially discharge intercepted groundwater is very low, especially with adoption of mitigation measures (Section 8).	Rare likelihood, minor consequence, very low risk
Ravensworth Ash Line	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
	Potential Impact D (**PID**) – groundwater drawdown due to underbore excavations. If underbore excavations intercept groundwater for underground lengths of the ash line, the excavations could depressurise groundwater systems and lead to groundwater level drawdown.	If an underbore is drilled beneath the water table, groundwater leakage to the underbore would likely be minimal and only occur temporary. After drilling, the void would fill with groundwater and leakage into the void would be negligible. Short-term drawdown would be negligible and no long-term drawdown is anticipated.	Unlikely likelihood, minor consequence, low risk
	Potential Impact E (**PIE**) – contamination of groundwater due to drilling muds. If underbore excavations intercept groundwater for underground lengths of the ash line, drilling fluids could contaminate groundwater systems.	Drilling fluids would have a low pressure (as the underbore would not be deep) and can be selected to be contaminant free and bio-degradable.	Rare likelihood, minor consequence, very low risk
Ash dam augmentation	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
	Potential Impact F (**PIF**) – seepage through ash dam wall migrating to groundwater systems. Seepage is	The existing ash dam wall is currently leaking. Increasing the height of the dam wall (via a concrete	Likely likelihood, insignificant

Project element	Potential impacts to groundwater during construction	Comment	Likelihood, consequence, risk
	currently migrating through the existing ash dam wall. Increasing the ash dam wall level will result in a higher maximum potential head. The increase in head could lead to increased seepage flows through the dam wall. Some of this seepage could migrate to underlying groundwater systems.	parapet) will increase the hydraulic head potential and may increase seepage flows beyond that which are currently occurring. Collection dams are currently operating and collecting this seepage. However, some seepage is not being collected. Seepage collection dams would be modified to improve seepage collection efficiency. Such improvements may include, but not be limited to, diversions to the dams, lining the dams, enlarging the dams and upgrading pumps. There are no potential sensitive groundwater receptors until approximately 1.4 kilometres downgradient (measured straight line distance) from the current ash dam wall, where low potential GDEs are mapped. The surface water assessment concluded that Pikes Creek was not a sensitive receiving environment.	consequence, low risk
CHP water and wastewater infrastructure upgrades	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
HP pipe clearing	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
LSP sludge line clearing	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk

5.2.2 Assessment of potential groundwater impacts in accordance with NSW AIP (2012)

Assessment of potential groundwater impacts (both construction and operational) in accordance with the NSW AIP (2012) is covered in Section 6.2.3.

5.3 Flooding

Construction of the Project elements have the potential to cause adverse impacts on flooding if management measures are not implemented, monitored and maintained throughout the construction phase.

Potential impacts to flooding would occur through the following construction activities:

- Removal of vegetation, general earthworks, including stripping of topsoil and excavation;
- Stockpiling of topsoil, vegetation and construction materials; and
- Temporary works

Potential impacts to flooding associated with construction activities of the Project elements are discussed below.

5.3.1 Removal of vegetation and general earthworks

Removal of vegetation and general earthworks can impact on flooding during the construction phase if runoff is allowed to mobilise exposed soils. This can result in increased erosion and sedimentation. Augmentation of the BWAD and installation of the pipeline, infrastructure upgrades to the coal handling plant, ancillary facilities and establishment/construction of salt cake facility and borrow pits would all require removal of vegetation, stripping of topsoil and excavation or earthworks thereby disturbing and exposing soils.

5.3.2 Stockpiling of topsoil, vegetation and construction materials

Stockpiles of raw materials or spoil would be located as close as practical to the work area with implementation of appropriate environmental protection measures to minimize adverse impacts on existing flood behaviour.

5.3.3 Temporary works

All temporary works (e.g. waterway crossings, embankments, outlet works, diversion of waterways etc.) would be designed and constructed to minimize impacts on flooding during the construction period.

6. Assessment of potential operational impacts

During the operational phase of the Project, all construction access roads for the various Project elements would be maintained and cleared areas would be stabilised as required. Water quality risks during operation would instead be associated with runoff or seepage of pollutants from the newly constructed or upgraded Project sites, in particular runoff from the salt cake landfill site, seepage from the increased ash dam and water drainage associated with the use of the borrow pits. Run-off from the borrow pits, however, would be managed in accordance with the Blue Book and where possible, water would be used for operational purposes such as dust suppression. The management of borrow pit water will be covered by a Water Management Plan and Construction and Environmental Management Plan that will be developed for the Project. Further operational details are provided in Chapter 2 of the EIS, however, a summary of operational activities associated with the Project is provided in Table 6-1.

Table 6-1 Operational activities associated with the Project elements

Project Element	Summary of Component	Operational activities
Ash management works	Ash Dam augmentation	The continued operation of the Ash Dam would remain generally unchanged. Water levels within the Ash Dam would be maintained at an appropriate level to ensure an adequate freeboard is maintained as required under the 2015 Act noting that discharge from the spillway is licensed under EPL 779.
Ash management works	Installation of additional coal ash recycling facilities and fly ash harvesting upgrades	Operation of the coal ash recycling facilities would occur over the remaining operational life of Bayswater. The operation of the fly ash harvesting infrastructure would continue to be managed in accordance with existing environmental management systems upscaled inline with the increased harvesting volumes.
Ash management works	Installation of ash pipeline from Bayswater to Ravensworth Void No. 3	The operation of the new pipes would be as per the existing pipeline.
Salt cake landfill facility	Construction of the salt cake landfill facilities	The salt cake would be delivered to the cells via existing internal access roads. Transfer and placement would occur as required. *EPA Environmental Guidelines* (2016) would be adhered to throughout operation of the salt cake landfill facility, which would include provision of appropriate coverage of each active landfill cell to minimise dust and rainwater infiltration.
Borrow pits	Accessing borrow pits consecutively as the need for material arises and commencing from those closest to the Ash Dam	The borrow pits operational stage would comprise: • Excavation of clay material using benching techniques; • Transport of material to point of use using existing internal access tracks; and • Progressive rehabilitation, or soil binding, of exposed areas to manage dust and sediment runoff. During operation, surface water ponding within the borrow pits would be appropriately managed in accordance with the Blue Book, with suitable retention times and treatment provided before being discharged or re-used in operations. It is assumed that after material from the borrow pits has been utilised and the pits are stabilised, the final design of the borrow pits would be self-draining so to avoid the borrow pits becoming permanent waterbodies. Excavation within the

		borrow pits would not intercept with groundwater table, and no dewatering works would be required except following rainfall events. Existing internal access tracks would be maintained as required throughout operation, and in accordance with existing environmental management procedures.
CHP water and waste water infrastructure upgrades	Minor civil works and plant modifications related to water management improvement works.	• Minor civil works and plant modification activities limited to the existing operational areas of the coal handling plant. • Excavation and minor earthworks for the construction of structures such as clean water diversions • Establishment of erosion and sediment controls in accordance with *Managing Urban Stormwater: Soils and construction – Volume 1* (the Blue Book)
Ancillary works	Vegetation clearing along alignments of the LSP Sludge Line and HP.	• Routine clearance of vegetation along alignment where necessary.

6.1 Surface Water Quality

The potential impacts to water quality associated with operational activities of the Project elements are as follows:

6.1.1 Ash management

Increasing the size of Bayswater Ash Dam may result in an increased volume of dam seepage to the SCPs located to the north-west of the dam wall. SCP1 is located directly adjacent to the dam wall and SCP2 is approximately 500 metres (on-the-fly) downstream. Further downstream of SCP2 is Pikes Creek.

Whilst it proposed to modify the two seepage dams through lining of the dam and drainage structures for better seepage management, there is still the potential that augmentation of the Ash Dam could result in increased seepage volumes beyond the capacity of the collection ponds. This could result in increased runoff to Pikes Creek and potentially impact the water quality.

6.1.2 Salt cake landfill facility

The key risks to surface water quality from the operation of the landfill facility are related to contaminated leachate from the landfill site or by uncontrolled stormwater flows containing sediments and contaminants entering downstream waterways. Additionally, the storage and transport of the wastes to the facility presents a risk to water quality.

To reduce the risk of leachate and waste entering the surrounding environment, the landfill facility would be designed in accordance with EPA (2016) requirements which would include a liner system (whereby compacted clay or a geosynthetic liner is laid within the cell) to contain the waste within the system.

Without appropriate erosion/sediment controls and stormwater diversions, uncontrolled stormwater flows along drainage lines, through disturbed areas and soil stockpiles could transport sediments and contaminants to downstream waterways.

The storage and transport of wastes to the landfill facility presents a risk to water quality if the waste is not appropriately covered during transportation or due to accidental spills from incidents.

6.1.3 Borrow pits

Poor design of excavations from borrow pits may lead to ponding of water, scouring and bank erosion which could impact on downstream water quality. The key risks to surface water quality from the operation of the borrow pits relates to the excavation and transport of the materials, and erosion and sedimentation from exposed areas being transported to downstream waterways from wind and rain.

Whilst the design of the borrow pits will be so that runoff is diverted away from the site, there is the risk of rainwater falling directly into the pit and ponding. Water that is collected in the borrow pits will be managed appropriately in accordance with the Blue Book and/or reused for operational purposes.. Once borrow pits are stabilised, the final landform will be designed to be free draining so that they do not form permanent water bodies.

6.1.4 Coal handling plant water and wastewater infrastructure upgrades

The upgrades to the CHP water and wastewater infrastructure, whilst presenting a risk to water quality during the construction of the upgrade, will likely result in better water quality of Tinkers Creek and Lake Liddell during operation, by reducing stormwater inflows into Tinkers Creek and increasing the re-use of water within the coal plant system. Additionally, upgrading the water infrastructure in the coal handling plant to enable more water to be diverted for re-use in the plant would allow for increased operating capacity of the Coal Settling Basin (**CSB**) as the volume of process water entering the existing CBS would be decreased, allowing for more water retention time before being discharged into Tinkers Creek.

Modifications such as enlargement of the CSB if deemed practical will result in better treatment of water prior to discharge due to increased storage volume and detention time.

6.2 Groundwater

6.2.1 Identification and qualitative assessment of potential groundwater impacts during operation

Identified potential groundwater impacts during operation are outlined and qualitatively assessed in Table 6.2. With the exception of the salt cake landfill, which is assessed to represent a medium risk, potential impacts were assessed as very low or low risk.

Table 6.2: Identified potential groundwater impacts during operation

Project element	Potential impacts to groundwater during operation	Comment	Likelihood, consequence, risk
Salt cake landfill	Potential Impact A (PIA) – contamination of groundwater due to spills/leaks. Groundwater could be contaminated if spills or leaks of hazardous materials occur during construction and migrate to the water table. Such spills/leaks may include, but not be limited to, oils, lubricants and fuels used by construction plant.	The contaminate source would be on the surface (unless subsequently buried) and may be able to be identified. This would lead to the source being contained and remediated. Therefore, potential contaminant sources would be temporary. Additionally, a leachate collection system liner will underlie the landfill area and will therefore collect potential unidentified contamination. In the event a typical sized fuel/oil spill, surrounding	Unlikely likelihood, minor consequence, low risk

Project element	Potential impacts to groundwater during operation	Comment	Likelihood, consequence, risk
		sensitive receptors are not anticipated to be impacted.	
	<u>Potential Impact B (PIB) – depressurize of groundwater from salt cake landfill leachate.</u> If the landfill's leachate collection liner leaks, it is possible that saline or briny water could migrate from the area of the landfill and move towards sensitive receptors. Potential sensitive receptors include EEC and CEEC vegetation surrounding the proposed landfill and ephemeral drainage lines and water bodies down-gradient of the proposed landfill. As cells will be progressively constructed throughout the life of the landfill, this risk is applicable during construction and operation.	The proposed landfill would be constructed in accordance with NSW EPA (2016) guidelines for solid waste landfills and therefore would have a leachate barrier system, including a liner (either compacted clay liner or geosynthetic clay liner), overlying geomembrane liner (HDPE) and 300mm gravel leachate collection layer with associated pipework sloping to a sump. During operation, cells that will not receive lifts for some time will be capped with an intermediate cover in accordance with NSW EPA (2016) guidelines. A final capping layer, including a low permeability layer, will complete each land fill cell. These design features would help to mitigate offsite migration of saline/briny water. However, if the liner leaks, offsite migration could occur. If a leak does occur, potential applicable surrounding sensitive receptors include the EEC and CEEC vegetation (if these vegetation communities take up saline water from the saturated or unsaturated zone) and down-gradient ephemeral drainage lines and creeks. It is noted that due to the saline/briny water being relatively denser, a freshwater lens will lie overlie the saline/briny water downslope of the salt source. This potential impact is difficult to assess qualitatively, which is why it was assessed quantitatively (Section 6.2.2).	Possible likelihood, minor consequence, medium risk
Borrow pits	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
	<u>Potential Impact C (PIC) – groundwater drawdown and possible</u>	The proponent does not propose to extract material from below the water	Rare likelihood, minor consequence, very low risk

Project element	Potential impacts to groundwater during operation	Comment	Likelihood, consequence, risk
	need to discharge groundwater due to borrow pits intercepting groundwater. If borrow pit excavations intersect the water table, drawdown to groundwater levels could occur, and intercepted groundwater volumes may require discharge.	table or the soil/rock interface. Based on the borrow pit drilling programme data, including groundwater level monitoring data, and the conceptual groundwater model for the area of the proposed borrow pits, the risk of the borrow pits intercepting groundwater resulting in interception of groundwater and subsequent groundwater level drawdown and the need to potentially discharge intercepted groundwater is very low, especially with adoption of mitigation measures (Section 8).	
Ravensworth Ash Line	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
	Potential Impact D (PID) – groundwater drawdown due to underbore excavations. If underbore excavations for underground lengths of the ash line intercept groundwater, the excavations could depressurize groundwater systems and lead to groundwater level drawdown.	If an underbore is drilled beneath the water table, groundwater leakage to the underbore would likely be minimal and only occur temporary. After drilling, the void would fill with groundwater and leakage into the void would be negligible. Short-term drawdown would be negligible and no long-term drawdown is anticipated.	Unlikely likelihood, minor consequence, low risk
	Potential Impact G (PIG) – ash line leakage. After construction, if the ash line leaks, the ash/water mix could ultimately migrate to groundwater systems.	Most of the ash line length is above-ground, therefore if leaks occur, they will be able to be detected (through routine inspections) and fixed. If underground sections of the ash line were to leak, potential sensitive receptors in the areas of underground pipe lengths are limited to low potential GDEs at creek crossings. Good workmanship would limit the likelihood of leaks and potential leakage is only applicable during the life of ash transport. After ash transport stops, there would no leakage.	Unlikely likelihood, minor consequence, low risk
Ash dam augmentation	PIA Potential Impact F (PIF) – seepage through ash dam wall migrating to	The existing ash dam wall is currently leaking. Increasing the height of the dam wall will increase the hydraulic	Likely likelihood, insignificant consequence, low risk

Project element	Potential impacts to groundwater during operation	Comment	Likelihood, consequence, risk
	groundwater systems. Seepage is currently migrating through the existing ash dam wall. Increasing the ash dam wall level will result in a higher maximum potential head. The increase in head could lead to increased seepage flows through the dam wall. Some of this seepage could migrate to underlying groundwater systems	head and may increase seepage flows beyond that which are currently occurring. Collection dams are currently operating and collecting this seepage. However, some seepage is not being collected. The proponent proposes to continue using these seepage collection dams but modify the dams to improve seepage collection efficiency. The proponent has advised that such improvements may include, but not be limited to, diversions to the dams, lining the dams, enlarging the dams and upgrading pumps. There are no potential sensitive groundwater receptors until approximately 1.4km downgradient (measured straight line distance) from the current ash dam wall, where low potential GDEs are mapped. The surface water assessment concluded that Pikes Creek was not a sensitive receiving environment.	
Coal handling plant water and wastewater infrastructure upgrades	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
HP pipe clearing	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk
LSP sludge line clearing	PIA	The risk of this potential impact affecting groundwater systems is low for the same reasons outlined for the salt cake landfill (except landfill liner).	Unlikely likelihood, minor consequence, low risk

6.2.2 Quantitative groundwater impact assessment

Zoomed in outputs from the SEEP/W and CTRAN/W salt migration model for the area west of the proposed landfill are provided in Figure 6.1 to Figure 6.4 for model output times of 13.7 years, 110 years, 520 years and 1,000 years (the adopted planning horizon), respectively. Annotation is provided on the 1,000 year output (Figure 6.4). A wide angle view showing the entire model area for the output time of 1,000 years is provided in Figure 6.5. The contours in the figures are TDS concentrations at 20,000 mg/L intervals, with the 10,000 mg/L contour representing the minimum contoured value. A minimum contour value of 10,000 mg/L was adopted for the outputs to enable ease of contouring the results and is appropriate given the existing salt cake landfill area bores have an existing mean, median and maximum TDS concentration of 7,277 mg/L, 7,783 mg/L and 13,760 mg/L. The blue dashed line is the modelled water table.

The results are summarised as:

- The 10,000 mg/L contour beneath the proposed landfill is slightly deeper than the water table at 13.7 years, the first model output period.
- Although not shown in the figures, the 10,000 mg/L contour reaches the western model boundary at approximately 95 years.
- At 1,000 years, the 10,000 mg/L contour is situated approximately at the water table for the portion of model between approximately 60 m west of the western landfill extent to the western model boundary. Closer to the salt source, the 10,000 mg/L contour is above the water table and in the unsaturated zone.
- At the eastern EEC/CEEC extent, the closest the EECs/CEECs are to the salt source, the 10,000 mg/L contour is located at a depth of approximately 10 mBGL.

The Project ecologist, Kleinfelder, indicated that the EEC/CEEC vegetation surrounding the Salt Cake Landfill is unlikely to be a GDE but could be a facultative phreatophyte (opportunistically groundwater dependent) in areas where sandy soils are present and the water table is relatively shallow. At the eastern extent of the EECs/CEECs, located to the west of the proposed landfill, the 10,000 mg/L salt contour is located at a depth of approximately 10 mBGL and would be situated within siltstone, beyond the expected root extent. In the area of the model where the water table is relatively shallow, such as 4 mBGL to 5 mBGL, as shown in Figure 6.4, the modelled salt concentration at the water table is similar to background salt concentrations. Based on the model results and the advice provided by the Project ecologist, Kleinfelder, the EECs/CEECs immediately surrounding the proposed landfill are unlikely to be impacted by potential saline leachate migrating from the salt cake landfill in the event that the liner fails.

Outside and downgradient of the modelled area, the groundwater depths may be shallower than those at the western model boundary; that is in the general vicinity of the unnamed ephemeral drainage line that extends from downslope of the proposed landfill before connecting to Saltwater Creek. In these areas, there is a risk that EECs/CEECs present could be impacted by salt. However, as the hydraulic gradient would likely be lower due to very low topographic relief, flow velocity would likely be lower, and potential impact would not likely eventuate for an extended period of time. Additionally, EECs/CEECs are also unlikely to be impacted as the saline/briny water would need to discharge from the siltstone into overlying soil. The conceptual model considers that the alluvium or residual soil overlying the siltstone has very low conductivity and therefore the rate of groundwater discharging from the siltstone to overlying alluvial material or residual soil is anticipated to be very low and constrain solute transport. Also, a freshwater lens is anticipated to overlie saline/briny water, which would mitigate potential impacts to EECs/CEECs.

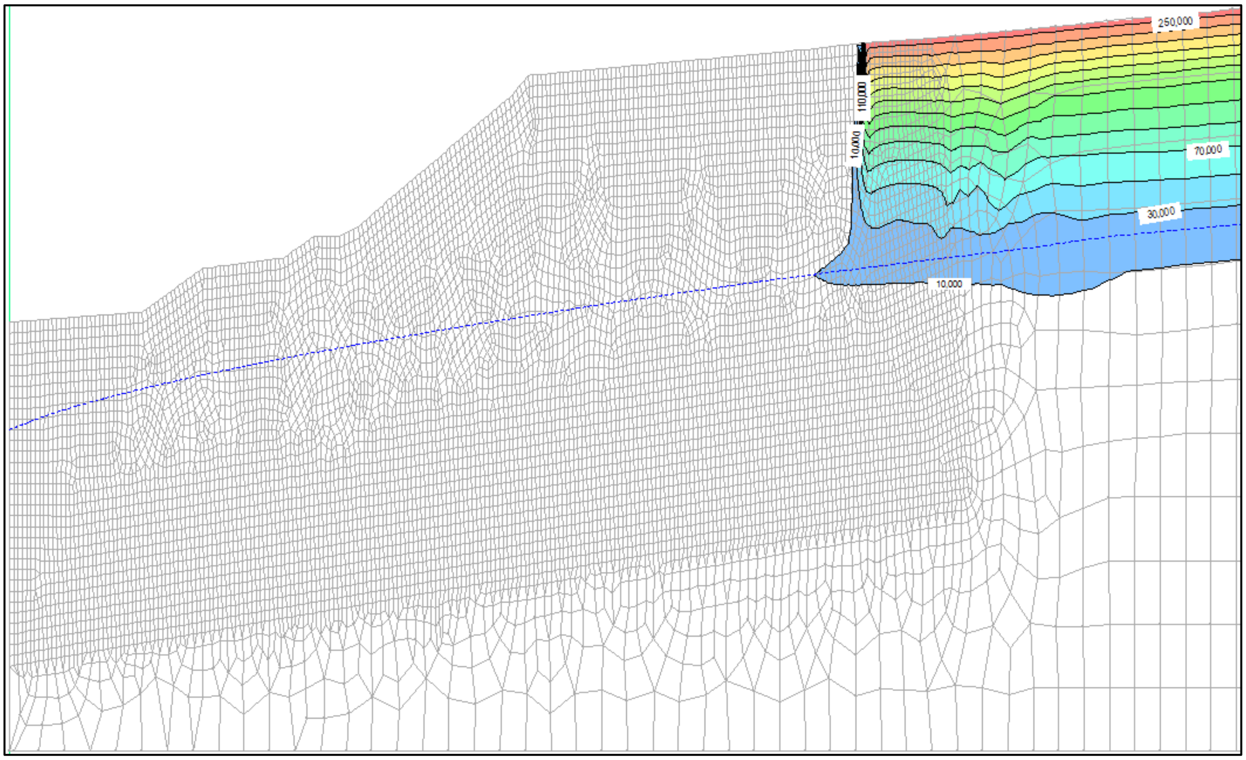


Figure 6.1: Salt model output (13.7 years).

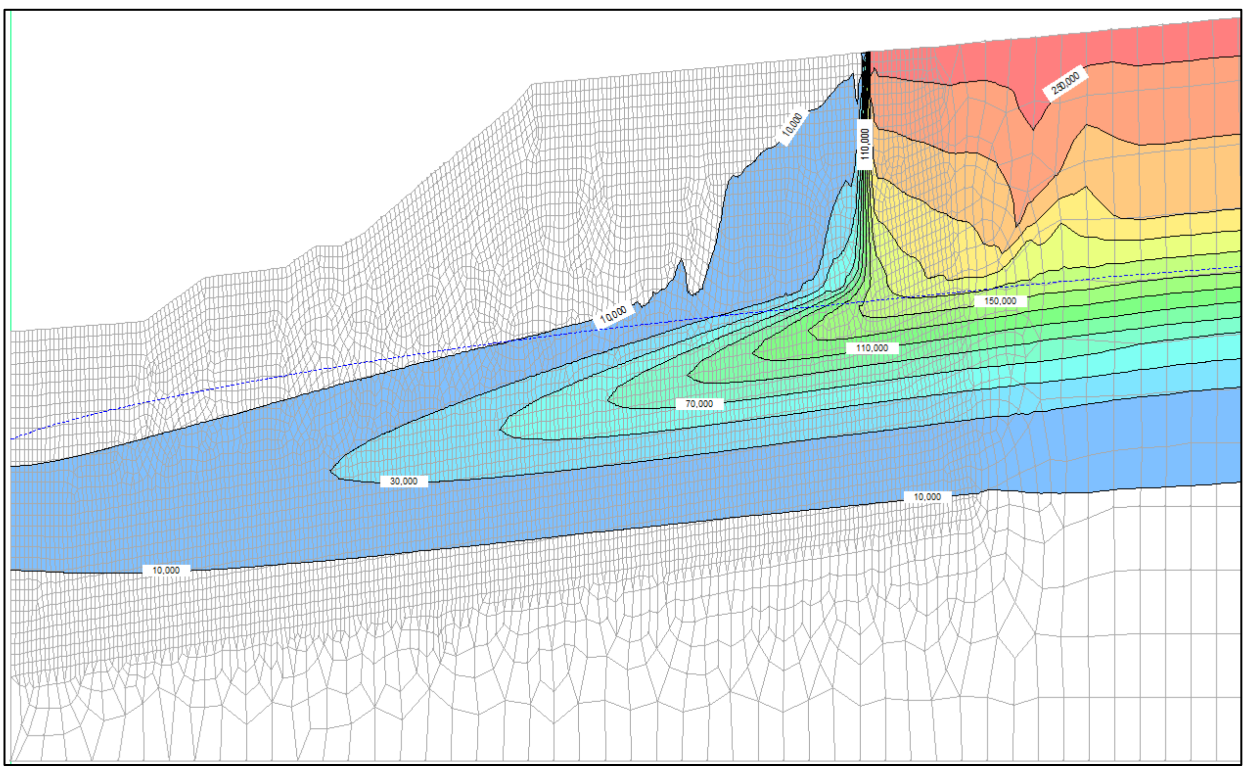


Figure 6.2: Salt model output (110 years).

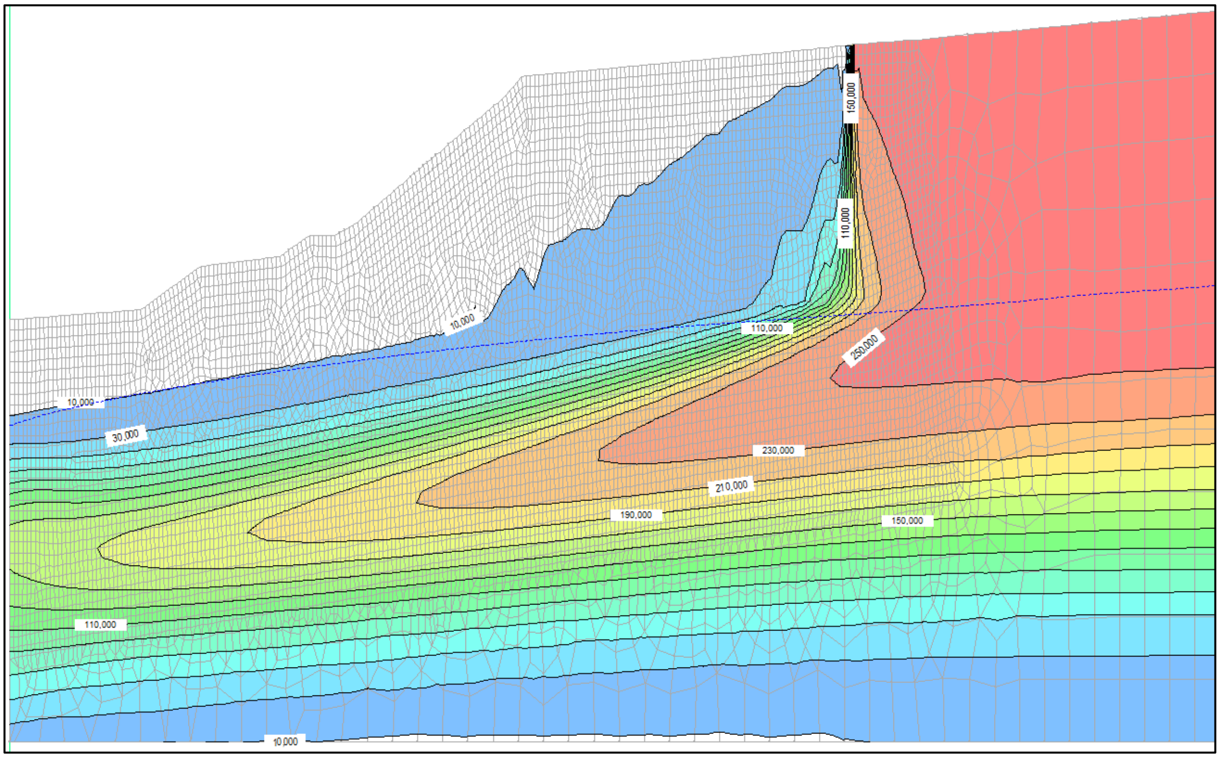


Figure 6.3: Salt model output (520 years).

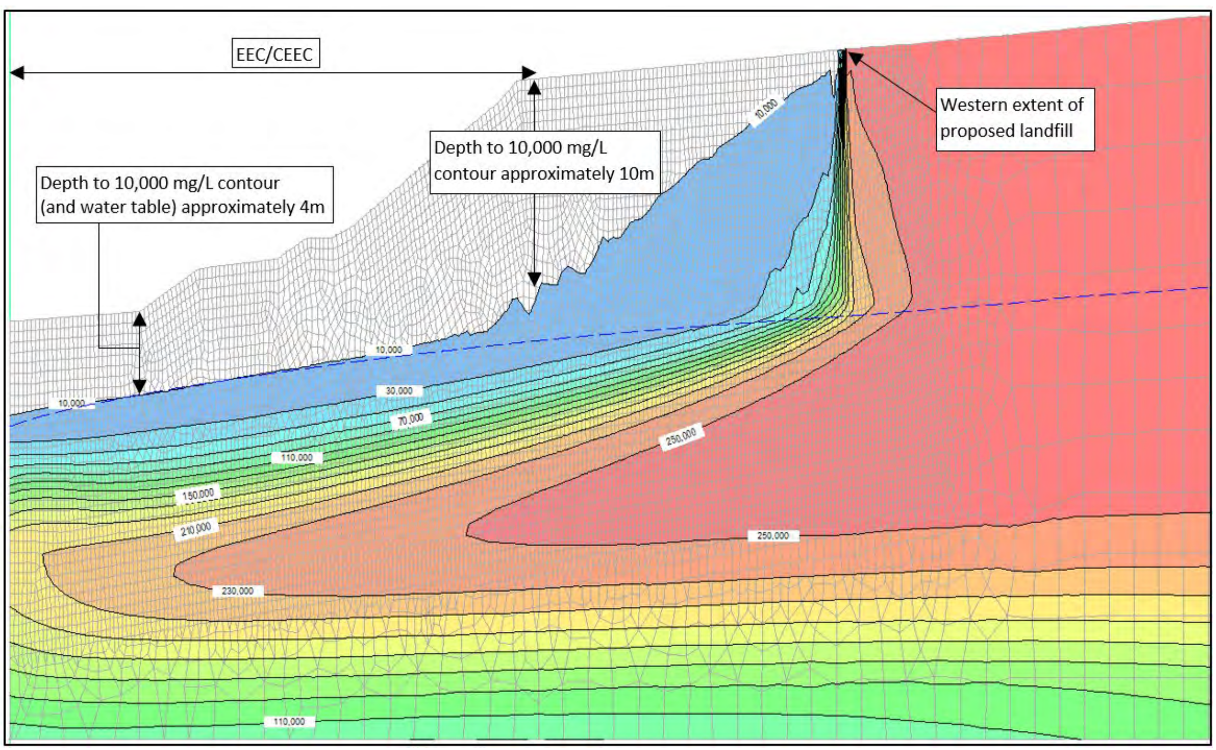


Figure 6.4: Salt model output (1000 years).

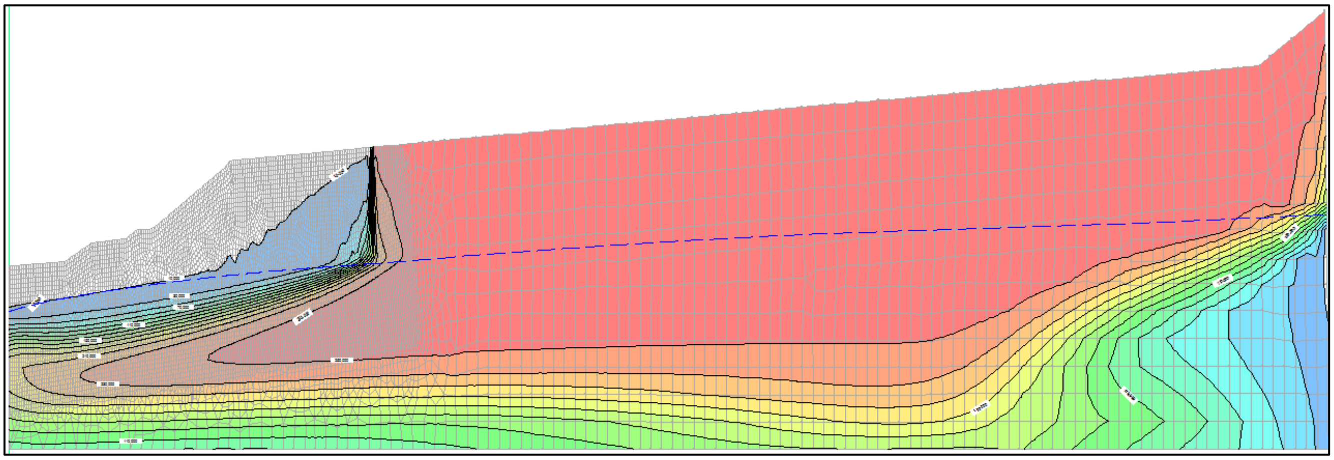


Figure 6.5: Salt model output (1000 years), wide angle view showing entire model.

6.2.3 Assessment of potential groundwater impacts in accordance with NSW AIP (2012)

No long-term water table drawdown or groundwater pressure head reduction is anticipated to occur as a result of the Project. Therefore, the Project is considered to meet the AIP (DPI NOW, 2012) minimal impact consideration with regards to water table drawdown or groundwater pressure head reduction. High priority GDEs are not mapped near the site and are therefore not relevant.

In the event of a liner failure, saline/briny water was modelled to migrate from the landfill beyond a distance of 40m. The concentrations associated with the saline/briny water are such that the beneficial use category of the groundwater source may be lowered. Therefore, the Project is assessed to not meet the AIP (DPI NOW, 2012) minimal impact consideration with regards to groundwater quality. However, the potential change to groundwater salinity is not anticipated to affect the long-term viability of the dependent ecosystem (EECs and CEECs).

6.3 Flooding

6.3.1 Augmentation of the BWAD

The augmentation work would cut the ash dam off from virtually all natural catchment reporting to the dam, with flood inflows as a result of direct rainfall on the ash surfaces. Over the remaining life of the dam, the decant water pond would be operated to hold up to 3,300 megalitres of water over the next few years of operations, however, this could rise to 3,785 megalitres when attenuating large floods (Aurecon, 2019). Any failure of the augmented BWAD would result in similar, however slightly enlarged inundation area than the existing BWAD.

There is no identifiable permanent population at risk (**PAR**) downstream of the BWAD. An itinerant PAR of 6 has been estimated along the New England Highway (Aurecon, 2019). Sunny day failure would impact an estimated area of less than 5 square kilometres and the duration of the impact is likely to be less than one year as the majority of the area affected is the land for the power station. Damage to infrastructure is estimated at approximately $10 million. Hence, the augmented BWAD would remain a Significant Consequence Category Dam under both sunny day and flood conditions. Being a Significant Consequence Category Dam, the augmented BWADs need to satisfy the following regulatory requirements:

- Allow for sufficient 'environmental freeboard' to detain the 1 in 10 AEP, 72 hour storm without discharging over the spillway; and
- Allow sufficient total freeboard to safely discharge the 1 in 10,000 AEP deign flood through the spillway without allowing the dam to overtop.

A hydrological assessment on the Acceptable Flood Capacity for the augmented BWAD will be undertaken at the detailed design stage based on the current guidelines presented in Australian Rainfall and Runoff and other regulatory requirements. The Acceptable Flood Capacity will be defined for each stages of upgrade.

A dam break assessment will be undertaken using a two-dimensional hydraulic modelling software (TUFLOW or equivalent) for each stages of upgrade both for the main dam and the saddle dams. Consequence category will be defined for each stages of upgrade and dam break flood mapping will be prepared to inform Dam Safety Emergency Plan for each stages of upgrade. Stability analysis for the augmented dam for each stages of upgrade will also be updated at detailed design stage.

6.3.2 Salt cake landfill facility

The salt cake landfill facility would include approximately 10 cells which would be constructed progressively. As most of the proposed cells would be of turkey's nest style construction, no natural stormwater runoff would enter these cells except for direct rainfall. If necessary, diversion structures would be constructed to prevent stormwater entering the cells. The landfill facility being free from external flooding during major storm events, no adverse impacts on flood flows, flow velocities and scouring resulting from encroachment of the floodplain are expected.

A detailed flooding assessment will be undertaken at the detailed design stage based on current guidelines from the Australian Rainfall and Runoff and using a two-dimensional hydraulic modelling software (TUFLOW or equivalent) to demonstrate that the salt cake landfill facility would have no adverse impacts on flood behaviour up to and including the 1% AEP event.

6.3.3 Borrow pits

For the purpose of this assessment it is assumed that the borrow pits will be left as voids. Potential impacts on flooding for the operation phase include re-distribution of flood flows due to diversion and which may impact on scouring and bank erosion. An assessment will be undertaken at the detailed design stage to assess potential impacts of the Borrow Pits on re-distribution of peak flood flows on scouring and bank erosion. Mitigation measures will be identified and included in the design to address adverse impacts on scouring and bank erosion.

6.3.4 Ravensworth Ash Line

The majority of the pipeline would be located above ground. The pipeline would be raised above ground for crossing Bayswater Creek and Chilcotts Creek. A flooding assessment will be undertaken at detailed design stage to confirm that the pipeline would have no adverse impacts on flood behaviour and the pipeline will not be damaged or destroyed due to flooding. The current guidelines from Australian Rainfall and Runoff will be used to estimate catchment runoff and a two-dimensional hydraulic model (TUFLOW or equivalent) will be developed to route the catchment runoff to estimate flood depths, velocities and flood hazards.

6.3.5 Coal handling plant water and wastewater infrastructure upgrades

The upgrades to the CHP water and wastewater infrastructure, whilst presenting a risk to water quality during the construction of the upgrade, will likely result in better water quality of Tinkers Creek and Lake Liddell during operation, by reducing stormwater inflows into Tinkers Creek and increasing the re-use of water within the coal plant system. The enlargement of the CHP sediment basin will result in better treatment of water prior to discharge due to increased storage volume and detention time.

It is to be noted that the catchment hydrology adopted in the options analysis for Tinkers Creek (AECOM, 2015) is based on the guidelines presented in Australian Rainfall and Runoff 1987. Hence it would be necessary to update the options analysis for Tinkers Creek based on guidelines presented in the current version of Australian Rainfall and Runoff.

7. Project water balance

7.1 Overview

The SEARs for the Project required a 'detailed and consolidated site water balance' be prepared. A daily site water balance model was prepared by Jacobs using GoldSim a probabilistic simulation computer program. A summary and conclusions drawn from the water balance model is provided in Section 7.2 below. For additional detail, refer to the stand-alone water balance modelling report (Jacobs, 2019) appended to the Project's EIS.

7.2 Summary and conclusions

The water balance model predicts no overflows via the spillway from the BWAD for both existing and post-BWAD augmentation conditions for average rainfall conditions. However, for extreme wet conditions, that are likely to occur less than 5 % of the time, the water balance model predicts that overflow from the BWAD water storage pond may occur via the spillway.

As a mitigation measure to avoid spills over the BWAD spillway, AGL Macquarie has committed to ensuring that adequate environmental freeboard is maintained throughout the life of the dam by setting operational target levels for the BWAD. AGL Macquarie will ensure that the operational target levels are not exceeded to avoid spills over the spillway for rainfall events up to the 1 in 10-year, 72-hour storm. To achieve these operational target levels, water will need to be progressively removed from the ash cycle to manage this natural rise. Given the proposed mitigation measures, the potential surface water impacts due to increasing volume and frequency of overflows from the BWAD due the proposed BWAD augmentation are likely to range from minor to negligible. Options understood to be available for progressively removing water from the ash cycle include the following:

- Using the transfer point to send water directly to Void 4. Surplus BWAD water may be sent through this transfer out to Ravensworth Void 4 for eventual use in the flyash cycle and/or discharged from Void 4 under the HRSTS were appropriate; and
- Alternatively, excess water can be transferred to the BCP and treated for use in the cooling water system.

The water balance modelling results indicate that daily seepage flows from the BWAD bypassing the BWAD seepage collection system (Seepage Collection Pond 1 and Seepage Collection Pond 2) are similar for existing and post-BWAD augmentation conditions for varying rainfall scenarios. Modelled seepage losses range from 8.7 ML/day to 9.2 ML/day. It is likely that a significant portion of the BWAD seepage flows bypassing the BWAD seepage collection system discharges to Pikes Creek.

AGL Macquarie has committed to upgrading the BWAD seepage collection system to maximise the volume of BWAD seepage loss flows that are captured by the seepage pond collection and pumped back to BWAD. Therefore, the proposed upgrades to the seepage collection are expected to result in a reduction of the volume of the potentially impacted BWAD seepage that is discharged to the receiving environment. This is likely to have a positive impact on the water quality of Pikes Creek and other downstream receiving water bodies.

The results of the predictive water balance modelling assessment indicate that the CHP sediment basin will continue to overflow daily to Tinkers Creek for both the existing and post-upgrade conditions. The water balance model predicts that daily overflow volume is expected to range from approximately 1.6 to 4.2 ML/day with an average of 2.3 ML/day over the next 15 years. The water balance assessment also indicates that process water inflows constitute approximately 60% of the inflows to the CHP sediment basin for average rainfall conditions. The aim of the proposed upgrades to the CHP water and wastewater infrastructure is to improve the water quality of the discharges to Tinkers Creek. However, the proposed changes are not expected to have a significant impact on the volume and frequency of water discharged from the CHP Basin to Tinkers Creek.

The water balance modelling indicates that the likely impacts of the final free-draining borrow pit landforms on daily stormwater runoff volumes are minor to negligible.

The following proposed features of the salt cake landfill facility design will minimise the discharge of briny leachate from the salt cake landfill facility. The change in stormwater runoff discharge due to construction and operation of the salt cake landfill facility is likely to be minor to negligible due to the following mitigation measures:

- The active cell is likely to occupy approximately 10% of the total proposed salt cake landfill facility area at any time during the operation phase. Therefore, the impact of operating the active cell on the total stormwater runoff and peak flow within Noname surface water catchment is likely to be negligible;
- The final capped and rehabilitated surface of the salt cake landfill facility will be designed to ensure that the surface water runoff characteristics of the rehabilitated surface and the existing surface area are similar; and
- The cooling water management system will not be affected by the proposed water infrastructure projects at the Bayswater.

8. Proposed mitigation measures

8.1 Surface water, groundwater and flooding mitigation measures

The key water quality objective for the Project is to ensure downstream waterways are protected against the potential impacts from construction and operation of the Project. Measures to avoid, minimise or manage surface water and hydrology impacts as a result of the Project, as well as groundwater impact mitigation measures are detailed in Table 8-1. These measures include preparation of a soil and water management plan, erosion and sediment control plan, an emergency spill response procedure and a water quality monitoring program to monitor the performance of these measures, plus additional mitigation measures. The environmental management measures include a surface water quality monitoring program which will include the collection of baseline data for comparison to construction and operational monitoring data where applicable.

Table 8-1 Proposed mitigation measures

Impact	Reference	Environmental management measure	Responsibility	Timing
Surface water				
General	SW01	A Construction Soil and Water Management Plan (CSWMP) will be prepared for the Project. The plan will outline measures to manage soil and water impacts associated with the construction works. The CSWMP will provide: • Measures to minimise/manage erosion and sediment transport both within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans (ESCP) for all progressive stages of construction; • Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation; • Measures to manage groundwater dewatering and impacts; • Processes for dewatering of water that has accumulated on site and from sediment basins, including relevant discharge criteria; • Measures to manage accidental spills including the requirement to maintain materials such as spill kits; • Measures to manage potential saline soils; • Details of surface water and groundwater quality monitoring to be undertaken prior to, throughout, and following construction; • Controls for receiving environments may include but not be limited to: – Designation of ‘no go’ zones for construction plant and equipment; – Creation of catch/diversion drains and sediment fences at the downstream boundary of construction activities where practicable to ensure containment of sediment-laden runoff	Contractor	Prior to construction

		and diversion toward sediment sump treatment areas (not sediment basins) to prevent flow of runoff to nearby waterways; and • Erosion and sediment control measures will be implemented and maintained at all work sites in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the "Blue Book". Additionally, any water collected from worksites would be treated and discharged to avoid any potential contamination or local storm water impacts. Measures would be designed in accordance with the relevant guideline where appropriate.		
	SW02	A suitably qualified erosion and sediment control specialist will be engaged where deemed appropriate for the construction of the Project to provide advice on the planning and implementation of erosion and sediment control including review of ESCPs.	Contractor	Prior to construction and during construction
	SW03	The current water reuse strategy will be amended for both construction and operational phases of the Project to reduce reliance on potable water where possible noting that AGL Macquarie obtains the majority of its water from the Hunter River. This strategy will be updated during the detailed design stage and implemented throughout the Project and will outline the construction and operational water requirements. Alternative water supply options to potable water will be investigated, with the aim of reusing water using recycled water where feasible. No additional water is required for the Project outside of AGL Macquarie's Water License Package.	Contractor	Detailed design, prior to construction, and throughout construction and operation
Impacts of stockpiles	SW04	Stockpiles will be managed to minimise the potential for mobilisation and transport of dust, sediment and leachate in runoff. This will include: • Minimising the number of stockpiles, area used for stockpiles, and time that they are left exposed; • Locating stockpiles away from drainage lines, waterways and areas where they may be susceptible to wind erosion; and • Stabilising stockpiles, establishing appropriate sediment controls and suppressing dust as required.	Contractor	Construction
Surface water quality impacts	SW05	A construction water quality monitoring program will be developed where appropriate and included in the CSWMP for the Project to, observe any changes in surface water and groundwater during construction, and inform appropriate management responses.	Contractor	Prior to construction, and during construction and operation

		The program will be based on the water quality monitoring methodology, water quality indicators and the monitoring locations outlined in the CSWMP. Sampling locations and monitoring methodology to be undertaken during construction will be further developed in detailed design in accordance with the 'ANZECC water quality guidelines' (ANZECC/ARMCANZ (2000). It will include collection of samples for analysis from sedimentation basin discharge points, visual monitoring of other points of release of construction waters and monitoring of downstream waterways where appropriate. The monitoring frequency during construction will be confirmed during detailed design however will include at least monthly construction monitoring at all monitoring sites which will preferentially monitor following wet weather events. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, additional mitigation measures will be identified and implemented as required.		
	SW06	An operational water quality monitoring program will be developed and implemented following the completion of construction to observe any changes in surface water and groundwater following construction and inform appropriate management responses. The program will be based on the water quality monitoring methodology, water quality indicators, and the monitoring locations presented outlined in the SWMP. The monitoring program will be undertaken monthly initially and will preferentially monitor following wet weather events when rainfall results in discharge from control sites or is greater than a nominated rainfall threshold which will be identified in detailed design. Monitoring will be undertaken for a minimum of 12 months following the completion of construction, or until the affected waterways are certified by a suitably qualified and experienced independent expert as being rehabilitated to an acceptable condition and/or the permanent water quality structures are deemed to be operating satisfactorily. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, additional mitigation measures will be identified and implemented as required.	Contractor	Prior to operation and during operation
	SW07	The performance water quality controls will be verified as the detailed design develops for the Project to ensure the objectives of the Project are achieved. In the instance that during detailed design it cannot be demonstrated that the water quality controls would be	Contractor	Detailed design

		effective in mitigating potential impacts, additional mitigation measures would be identified and implemented.		
Impacts on water bodies	SW08	The following measures will be undertaken to manage activities in proximity to waterways: • Works within waterfront land would be managed in accordance with the relevant guideline as deemed appropriate; • Implementing practices to minimise disturbance of banks and undertaken bank stabilization; and • Appropriate drainage features will be incorporated into the design of the Project elements by a suitably qualified and experienced professional. All Project elements will be designed and constructed in accordance with relevant guidelines.	Contractor	Prior to construction and during construction
Borrow Pits	SW09	Borrow Pits to comply with design specifications to minimise interference and disruption of natural surface water flows and water quality, particularly impacts on turbidity.	Contractor	Detailed design/Construction/Operation
Groundwater				
Impacts on groundwater quality and levels due to salt cake landfill and borrow pits, plus seepage through ash dam wall	GW01	Groundwater monitoring and monitoring of seepage through the ash dam wall should be undertaken as per the groundwater monitoring plan (Section 8.2).	As per groundwater monitoring plan (Section 8.2)	As per groundwater monitoring plan (Section 8.2)
Groundwater impacted due to borrow pits unexpectantly intercepting water table	GW02a	Design borrow pit areas to avoid areas with shallow groundwater	Contractor	Detailed design
	GW02b	If groundwater is unexpectantly intersected during borrow pit excavations, excavations should cease in that area and the date, location, level and depth of groundwater interception should be documented by the contractor and conveyed to a hydrogeologist. The hydrogeologist is to then determine an appropriate course of action depending on the specifics of the situation. Such a course of action may include re-location of excavations to higher areas of elevation where groundwater would likely be deeper and establishment of routine monitoring of the monitoring bores in the vicinity of the borrow pits.	Contractor	Construction
Landfill liner durability compromised	GW03	During detailed design, salt cake landfill design should ensure leachate and salt cakes will not geochemically compromise the elected liner type due to reactions. Since the salt is reported by the proponent to predominantly comprise gypsum, there may be a risk that this material (and leachate) could interact with clay liners and result in compromised liner integrity.	Contractor	Detailed design

Underbore drilling fluids	GW04	If underbores are drilled for the Ravensworth Ash Line, if drilling fluids are required, where possible, freshwater should be used. Where this is not possible, environmentally friendly biodegradable drilling fluid should be used.	Contractor	Construction
Ash line leakage	GW05	The above-ground sections of the Ravensworth Ash Line should be routinely checked for leaks at least daily. Observed leaks should be rectified.	Contractor (during construction) AGL Macquarie (during operation)	Construction and operation

Spills/leaks of hazardous materials, such as, but not limited to, fuels, lubricants and oils, contaminating groundwater systems	GW06	• Regular plant maintenance and checks.
		• Onsite spill kits and established spill clean-up procedures, which would include:
		  • Having adequate spill prevention and absorbent materials (including absorbent pads, absorbent booms, granular absorbent and disposal bags) onsite to manage spills and leaks of potential pollutants;
		  • Provision of appropriate equipment and materials to capture any drips and spills which occur during the transfer of potential pollutants, and when carrying out maintenance of hydrocarbon filled plant and equipment;
		  • Procedures which ensure that spills of potential pollutants are contained and cleaned up immediately. Such spillage must not be cleaned up by hosing, sweeping, or otherwise releasing contaminants to any watercourse, waterway or groundwater; and
		  • Routine tool box talks and safe work method statements (SWMSs) which cover spill management protocols.
		• Remediation of potential contamination sources and where possible removal of the contamination source (e.g. through offsite removal and disposal to an appropriately licensed waste facility).
			Contractor (during construction)
			AGL Macquarie (during operation)
				Construction and operation

Ash dam seepage through dam wall impacting groundwater systems	GW07	The ash dam seepage flow rate should be monitored during construction and operation, as well as the effectiveness of the two ash dam seepage collection dams. If monitoring indicates that after implementation of the proposed upgrades to the seepage collection dams, that the dams are not effectively collecting seepage, then additional seepage collection dam upgrades should be made, or alternatively, the seepage collection system be re-designed and re-constructed.	Contractor (during construction) AGL Macquarie (during operation)	Construction and operation

Flooding				
Impacts on flood behaviour during construction	F01	Temporary works will consider flood impacts during construction. Should construction staging require a temporary departure from the design (e.g. higher embankments for preloading, temporary diversions or temporary crossings of waterways), flood impacts will be assessed before finalising the approach.	Contractor	Construction
	F02	Where stockpiles are to be located in the floodplain, they will be located and sized to ensure no adverse impacts on flood behaviour.	Contractor	Construction
Impact of flooding on construction activities	F03	A flood management plan will be prepared. The plan will consider likelihood of flooding, flood evacuation routes, warning times and potential impacts from flooding from the Project. It will include, but not limited to: • Any monitoring requirements to provide advance notice of a flood event; • Procedures (e.g. dam safety emergency plan) to be implemented in the event of a flood; and • Required training and staff inductions.	Contractor	Construction
Bed and bank stability during construction	F04	Temporary crossings on water courses will be designed with consideration of flooding during construction and removal and rehabilitation following completion of construction.	Contractor	Construction
Augmentation of Ash Dam	F05	Dam break inundation maps will be prepared based on two-dimensional hydraulic modelling software (eg. TUFLOW or equivalent) based on the current relevant guidelines presented in Australian Rainfall and Runoff, ANCOLD and guidelines acceptable to Dams Safety NSW. The inundation maps will be utilised to confirm the consequence category for the dam.	Contractor	Detailed design
	F06	A detailed assessment of the flood handling capacity for the dam will be undertaken for each of the augmentation stages based on the current guidelines presented in Australian Rainfall and Runoff. The consequence categories for each of the augmentation stages will be reassessed and inundation maps will be prepared to inform the Dam Safety Emergency Plan.	Contractor	Detailed design
Salt cake landfill facility	F07	A detailed flood study will be undertaken using a two-dimensional hydraulic modelling software (eg. TUFLOW or equivalent) and current guidelines presented in Australian Rainfall and Runoff to confirm that the landfill facility will not encroach the floodway in the 1% AEP event.	Contractor	Detailed design
Ash pipeline from Bayswater to Ravensworth	F08	A detailed flood study will be undertaken using a two-dimensional hydraulic modelling software (eg. TUFLOW or equivalent) and the current guidelines presented in Australian Rainfall and Runoff to confirm that the new ash pipeline will not have any adverse impacts on flood	Contractor	Detailed design

		behaviour during construction or operation stages of the Project and the pipeline will not be damaged or destroyed by flood force.		

8.2 Groundwater monitoring plan

A groundwater monitoring plan is considered necessary for the salt cake landfill and potential borrow pit areas. A groundwater monitoring program is already in place for the BWAD (AECOM, 2016a) . This program will be reviewed and amended as required for the project. A groundwater monitoring plan is not considered necessary for other Project elements due to their limited potential to impact groundwater systems. Details for the groundwater monitoring plan are summarised in the following sections.

8.2.1 Salt Cake Landfill

The existing groundwater bores in the general area of the proposed salt cake landfill should be monitored to enable identification of potential salt migration. The monitoring bores, analytes and monitoring frequency is outlined in Table 8.2. The monitoring data should be reported annually and compared to data obtained prior to the construction of the landfill. The monitoring and reporting frequency prescribed is adequate given solute transport will occur very slowly.

It is noted that bores MW-A01 and MW-A02 are located within the proposed landfill footprint and will likely need decommissioning prior to completion of the landfill life cycle. These bores should be retained as long as possible and decommissioned as late as possible in the life of the landfill. Similar bores should be installed outside and as close as feasible to the landfill footprint. To achieve the longest bore life within the landfill, cells should be constructed around the monitoring bores, or if constructed in the area of the bores, such cells should be constructed as late as possible in the life of the landfill.

Table 8.2: Salt cake landfill groundwater monitoring

Groundwater monitoring bore	Monitoring analytes	Monitoring frequency
MW-A01	Field parameters (pH, electrical conductivity, temperature, dissolved oxygen, redox, turbidity), TDS, major ions, major anions, groundwater level	All analytes except groundwater level – annual (if anomalous results observed then increase monitoring frequency to quarterly) Groundwater level – at least quarterly
MW-A02		
MW-A03S		
MW-A03D		
MW-A04		
MW-A05		
MW-A06		
MW-A07		
MW-A08		
BB_MW01		
BB_MW02		
BB_MW05		
BWGMW1DI0		

8.2.2 Borrow pits

If groundwater is unexpectantly intersected during borrow pit excavations, excavations should cease in that area and the date, location, level and depth of groundwater interception should be documented by the contractor and conveyed to a suitably qualified hydrogeologist. The hydrogeologist must then determine an appropriate course of action depending on the specifics of the situation. Such a course of action may include re-location of excavations to elevated areas, where groundwater is likely to be deeper and establishment of routine of groundwater monitoring via bores in the vicinity of the borrow pits.

This degree of proposed monitoring is commensurate with the low risk of the borrow pits intercepting the water table.

8.2.3 Ash dam seepage collection dams

Although not groundwater, the ash dam seepage flow rate should be monitored during construction and operation, as well as the effectiveness of the two ash dam seepage collection dams. If monitoring indicates that after implementation of the proposed upgrades to the seepage collection dams, that the dams are not effectively collecting seepage, then additional seepage collection dam upgrades should be made, or alternatively, the seepage collection system be re-designed and re-constructed.

9. Conclusion

9.1 Surface water quality

The project lies within the central regions of the Hunter River catchment and more specifically the Bayswater Creek and Saltwater Creek subcatchments. Waterways with the potential to be impacted include Tinkers Creek, Bayswater Creek, Satlwater Creek, Chilcotts Creek, Wisemans Creek, Pikes Creek, Hunter River, Lake Liddell and Plashett Reservoir.

The assessment of existing water quality looked at key indicators of pH, electrical conductivity, trace metals and chloride. Generally, pH and many trace metals were below recommended guideline values for protection of aquatic ecosystems and other nominated environmental values. There were however some trace metals that were above recommended ANZG (2018) water quality guidelines at numerous sites and included chloride, copper, fluoride nickel, sodium, zinc. Molybdenum, aluminium, chromium, lead, and selenium were also detected in elevated concentrations on occasion. Electrical conductivity was often elevated across the different waterways and above the ANZG (2018) water quality guidelines.

The construction and operation of the Project has the potential to impact these waterways. Potential impact to surface water could result from:

- Erosion of soils and sedimentation of waterways;
- Reduced water quality from elevated turbidity, increased nutrients and other contaminants;
- Smothering of aquatic organisms from increased sediments and associated low dissolved oxygen levels;
- Potential growth of weeds and algal blooms associated with reduced water quality; and
- Accidental leaks or spoil of chemical and fuels.

To minimise impacts to surface water quality a range of measures would be implemented during the detailed design, construction and operational phases of the Project including:

- A detailed Construction Soil and Water Management Plan (SWMP) would be prepared to manage soil and water impacts associated with the construction works;
- Management of stockpiles;
- Spill response procedures;
- Water quality monitoring; and
- Water quality controls and drainage infrastructure.

Overall, with the implementation of the proposal mitigation measures, the Project is expected to have minimal impacts on existing water quality during the construction phase. Whilst some potential impacts to water quality have been identified during the operational phase, there will also be an improvement to water quality associated with the upgrade of the coal handling plant and seepage management measures associated with BWAD.

9.2 Groundwater

With the exception of potential salinisation associated with the proposed salt cake landfill, the Project is expected to generate negligible impacts to groundwater and risks to groundwater are assessed as low. This conclusion is based on a detailed review of background groundwater level and quality data, along with an analysis of the existing environmental setting and an assessment of the Project elements. Saline/briny water may migrate to underlying and surrounding groundwater systems, if the salt cake landfill liner were to leak.

A cross sectional groundwater flow and solute transport finite element model was developed to model potential salt migration from the proposed salt cake landfill. Groundwater level and saturated/unsaturated zone TDS concentrations from the worst case model output time (1,000 years) were reviewed by the Project ecologist, Kleinfelder, and assessed as unlikely to impact surrounding EEC/CEEC vegetation.

There is a very low risk that the presence of shallower groundwater depths downgradient of the modelled section could cause an impact to EECs/CEECs, where present, due to migration of the saline/briny water. This will likely be mitigated by the natural development of a freshwater lens on top of saline water. The ultimate potential sink for the saline/briny water would be Plashett Reservoir, which is wholly within the boundary of AGL owned land. The groundwater flow path to this ultimate sink is conceptualised to be along the ephemeral drainage line that extends from downslope of the proposed landfill before connecting to Saltwater Creek, which flows to Plashett Reservoir. Groundwater discharge rates into Plashett Reservoir would be negligible relative to surface water inflows. Therefore, saline/briny water migrating to Plashett Reservoir would be readily diluted by surface water flows.

No long-term water table drawdown or groundwater pressure head reduction is anticipated to occur due to the Project. Therefore, the Project is considered to meet the AIP (DPI NOW, 2012) minimal impact consideration with regards to water table drawdown or groundwater pressure head reduction. High priority GDEs are not mapped near the site and are therefore not relevant.

The Project is considered to <u>not</u> meet the AIP (DPI NOW, 2012) minimal impact consideration with regards to groundwater quality, as in the event of a landfill liner failure, the concentrations associated with the saline/briny water are such that the beneficial use category of the groundwater source may be lowered beyond 40m of the landfill. However, the potential change to groundwater salinity is not anticipated to affect the long-term viability of dependent ecosystems (EECs and CEECs) within the adopted planning horizon period (1,000 years).

Risks associated with accidental spills or leakages of hazardous materials (such as fuels, lubricants and hydraulic oils) during the construction and operational phases of the Project elements will be mitigated through appropriate management measures.

9.3 Flooding

The construction and the operation of the Project has the potential to impact on flooding on a number waterways which discharge into Lake Liddell and Lake Plashett. Potential impacts to flooding could result during construction and operation of the Project.

The following construction activities have the potential to impact on flooding:

- Removal of vegetation, general earthworks, including stripping of topsoil and excavation;
- Stockpiling of topsoil, vegetation and construction materials; and
- Temporary works (e.g. waterway crossings, embankments, outlet works, diversion of waterways etc).

Potential operational impacts of the Project on flooding include the following:

- Potential failure of the augmented BWAD may result in enlarged inundation area than the existing BWAD;
- The salt cake facility may encroach the floodway for the 1% AEP event and may have adverse impacts on flooding;
- The borrow pits have the potential to divert and re-distribute flood flows which may result in adverse impacts on scouring and bank erosion;
- The Ravensworth ash line could be damaged or destroyed by flooding and the pipeline could have adverse impacts on flooding; and

- Outcomes from flooding assessment for the CHP water and wastewater infrastructure upgrade options may be different with the current guidelines presented in Australian Rainfall and Runoff.

To minimise impacts to flooding a range of measures would be implemented during the detailed design, construction and operational phases of the Project including:

- Temporary works will consider flood impacts during construction. Should construction staging require a temporary departure from the design (e.g. higher embankments for preloading, temporary diversions or temporary crossings of waterways), flood impacts will be assessed before finalising the approach;
- Where stockpiles are to be located in the floodplain, they will be located and sized to ensure no adverse impacts on flood behaviour;
- A flood management plan will be prepared for the construction stage;
- Temporary crossings on water courses will be designed with consideration of flooding during construction and removal and rehabilitation following completion of construction;
- A detailed assessment of the flood handling capacity for the BWAD will be undertaken for each of the augmentation stages based on the current relevant guidelines and regulatory requirements. The consequence categories for each of the augmentation stages will be reassessed and inundation maps will be prepared to inform the Dam Safety Emergency Plan;
- A detailed flood study will be undertaken at the detailed design stage to confirm that the salt cake landfill facility will not encroach the floodway in the 1% AEP event; and
- A detailed flood study will be undertaken to confirm that the new ash pipeline will not have any adverse impacts on flood behaviour during construction or operation stages of the Project and the pipeline will not be damaged or destroyed by flood force.

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Appendix A. Borrow pit drilling programme borehole and groundwater monitoring bore logs

JACOBS Engineering Log - Borehole

JBP_BH101

Project:	Bayswater Burrow Pits	**Page:**	1 of 1
Client:	AGL Macquarie	**Location:** Borrow Pit 1	**Project No:** IA215400

Contractor:	Terratest	**Easting:**	308942.7	**Elevation:**	157.65	**Started:**	30/09/2019
Plant:	Geoprobe	**Northing:**	6412254.1	**Datum:**	AHD	**Finished:**	30/09/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/T		Not Observed	U				CL	CLAY: low plasticity, brown, trace fine to coarse grained sand, trace fine grained, subangular gravel, trace rootlets			TOPSOIL
			SPT 3, 5, 6 N=11	157			CI-CH	CLAY: medium to high plasticity, brown	D	St	RESIDUAL SOIL
			D		1						
			D				CI	CLAY: medium plasticity, orange-brown banded grey, trace fine grained sand, relict rock fabric		VSt	EXTREMELY WEATHERED MATERIAL
			SPT 8, 12, 14 N=26	156	2						
			SPT 22, 25/140mm N=25					SILTSTONE: orange-brown banded grey, highly weathered, very low strength			BEDROCK
				155				Hole Terminated at 2.50 m Refusal			
				154	3						
				153	4						
				152	5						
				151	6						
				150	7						

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HWSPT penetration by hammer weight; RWSPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value)		
VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}		
VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_BH102

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 1	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	308949.4	**Elevation:**	176.02	**Started:**	01/10/2019
Plant:	Geoprobe	**Northing:**	6412386.1	**Datum:**	AHD	**Finished:**	01/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description** SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		Not Observed	U D				CL	CLAY: low plasticity, brown, trace fine to coarse grained sand, trace fine grained, subangular gravel, trace rootlets	D		TOPSOIL
			SPT 4, 5, 8 N = 13				CI-CH	CLAY: medium to high plasticity, red-brown spotted dark grey, trace rootlets		St	RESIDUAL SOIL 0.30: HP Samp >600 kPa 0.70: HP Samp >600 kPa
AD/T			SPT 9,11,12 N = 23	175	1		CL-CI	CLAY: low to medium plasticity, orange-brown, mottled grey, with lenses of highly weathered, very low to low strength sandstone		VSt	0.80: V-bit refusal EXTREMELY WEATHERED MATERIAL
			D SPT 6, 15, 30/130mm N = R, HB				CL	CLAY: low plasticity, orange banded grey, trace highly weathered, very low to low strength sandstone inclusions		H	1.60: HP Samp >600 kPa
								SANDSTONE: fine grained, grey, highly weathered, very low to low strength			BEDROCK
				174	2			Hole Terminated at 1.95 m Refusal			
				173	3						
				172	4						
				171	5						
				170	6						
				169	7						

METHOD & SUPPORT	PENETRATION	GROUNDWATER	SAMPLES & FIELD TESTS	MOISTURE	DENSITY (N-value)	CONSISTENCY (Su) {N-value}
HA Hand Auger AS Auger ADV Auger - V-bit ADT Auger - TC-bit WB Washbore RR Rock Roller AH Air Hammer VC Vibro core C Casing	No resistance ranging to refusal	= Water level (static) = Water level (during drilling) = Water inflow = Water outflow	D Disturbed Sample B Bulk Sample SPT SPT Sample U Undisturbed Sample ES Enviro Sample W Water Sample N SPT blows per 300mm HW SPT penetration by hammer weight RW SPT penetration by rod weight HP Hand Penetrometer HV Hand Vane Shear (P: Peak Su R: Residual Su)	D = Dry M = Moist W = Wet Wp = Plastic Limit Wl = Liquid Limit	VL Very Loose 0 - 4 L Loose 4 - 10 MD Medium Dense 10 - 30 D Dense 30 - 50 VD Very Dense 50 - 100	VS Very Soft < 12 kPa {0-2} S Soft 12 - 25 {2-4} F Firm 25 - 50 {4-8} St Stiff 50 - 100 {8-15} VSt Very Stiff 100 - 200 {15-30} H Hard > 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_BH103

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 1	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	309213.7	**Elevation:**	161.42	**Started:**	30/09/2019
Plant:	Geoprobe	**Northing:**	6412348.1	**Datum:**	AHD	**Finished:**	30/09/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION / MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/T		Not Observed	U				CL	CLAY: low plasticity, dark brown, with fine to medium grained sand, with rootlets	D	F	TOPSOIL
			SPT 4,7,7 N = 14	161			CI-CH	CLAY: medium to high plasticity, orange-brown spotted dark grey and grey, trace fine to medium grained, subrounded gravel	w <PL	St / VSt	RESIDUAL SOIL 0.30: HP Samp >600 kPa
			D								
								Hole Terminated at 0.70 m Refusal			0.70: V-bit refusal. Hole was respositioned and again refused at 0.70m, assumed bedrock.

RL scale: 161, 160, 159, 158, 157, 156, 155, 154. Depth scale: 1, 2, 3, 4, 5, 6, 7.

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value)		
VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}		
VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_BH104

Project: Bayswater Burrow Pits			**Page:** 1 of 1
Client: AGL Macquarie	**Location:** Borrow Pit 2		**Project No:** IA215400

Contractor: Terratest	**Easting:** 307395.8	**Elevation:** 196.48	**Started:** 01/10/2019
Plant: Geoprobe	**Northing:** 6412329.3	**Datum:** AHD	**Finished:** 01/10/2019
Logged by: GC **Checked by:** MF	**Grid:** MGA94 Zone 56	**Inclination:** -90°	**Orientation:**

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description** SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		Not Observed	D U				CL	CLAY: low plasticity, brown, trace fine to coarse grained sand, trace fine grained, subangular gravel, trace rootlets	D	F	RESIDUAL SOIL
			SPT 1,5,5 N = 10 D	196	1		CI	CLAY: medium plasticity, brown mottled grey, with fine to medium grained, subangular gravel, trace fine to coarse grained sand		St	0.40: HP Samp >600 kPa
			SPT 6,11,13 N = 24	195			CI	CLAY: medium plasticity, orange-brown banded dark grey, with highly weathered, very low strength siltstone bands		VSt / H	1.20: V-bit refusal EXTREMELY WEATHERED MATERIAL 1.55: HP Samp >600 kPa
								SILTSTONE: orange-brown banded dark grey, highly weathered, very low strength			BEDROCK
				194	2			Hole Terminated at 1.65 m Refusal			
				193	3						
				192	4						
				191	5						
				190	6						
				189	7						

METHOD & SUPPORT
HA Hand Auger
AS Auger
ADV Auger - V-bit
ADT Auger - TC-bit
WB Washbore
RR Rock Roller
AH Air Hammer
VC Vibro core
C Casing

PENETRATION
No resistance ranging to refusal

GROUNDWATER
= Water level (static)
= Water level (during drilling)
= Water inflow
= Water outflow

SAMPLES & FIELD TESTS
D Disturbed Sample
B Bulk Sample
SPT SPT Sample
U Undisturbed Sample
ES Enviro Sample
W Water Sample
N SPT blows per 300mm
HW SPT penetration by hammer weight
RW SPT penetration by rod weight
HP Hand Penetrometer
HV Hand Vane Shear
(P: Peak Su R: Residual Su)

MOISTURE
D = Dry
M = Moist
W = Wet
Wp = Plastic Limit
Wl = Liquid Limit

DENSITY (N-value)

VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}

VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_BH105

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 2	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	307453.8	**Elevation:**	209.97	**Started:**	01/10/2019
Plant:	Geoprobe	**Northing:**	6412251.8	**Datum:**	AHD	**Finished:**	01/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description** SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		Not Observed	D U				CL	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace fine to coarse grained sand, trace rootlets	D	F	TOPSOIL
			D SPT 2,4,7 N = 11				CI	CLAY: medium plasticity, brown mottled grey, with fine to medium grained, subangular gravel, trace rootlets		St	RESIDUAL SOIL 0.30: HP Samp >600 kPa
			SPT 8,9,13 N = 22	209	1		CI	CLAY: medium plasticity, brown mottled grey, with fine to medium grained, subangular gravel, relict rock fabric		VSt	EXTREMELY WEATHERED MATERIAL
								SILTSTONE: dark grey banded orange-brown, highly weathered, very low to low strength			BEDROCK
								Hole Terminated at 1.10 m Refusal			
				208	2						
				207	3						
				206	4						
				205	5						
				204	6						
				203	7						
				202							

METHOD & SUPPORT
- HA Hand Auger
- AS Auger
- ADV Auger - V-bit
- ADT Auger - TC-bit
- WB Washbore
- RR Rock Roller
- AH Air Hammer
- VC Vibro core
- C Casing

PENETRATION
No resistance ranging to refusal

GROUNDWATER
- = Water level (static)
- = Water level (during drilling)
- = Water inflow
- = Water outflow

SAMPLES & FIELD TESTS
- D Disturbed Sample
- B Bulk Sample
- SPT SPT Sample
- U Undisturbed Sample
- ES Enviro Sample
- W Water Sample
- N SPT blows per 300mm
- HW SPT penetration by hammer weight
- RW SPT penetration by rod weight
- HP Hand Penetrometer
- HV Hand Vane Shear
- (P: Peak Su R: Residual Su)

MOISTURE
- D = Dry
- M = Moist
- W = Wet
- Wp = Plastic Limit
- Wl = Liquid Limit

DENSITY (N-value)

VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}

VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_BH106

Project: Bayswater Burrow Pits
Client: AGL Macquarie
Location: Borrow Pit 4

Project No: IA215400

Contractor:	Terratest	**Easting:**	305876.2	**Elevation:**	162.52
Plant:	Geoprobe	**Northing:**	6410608.4	**Datum:**	AHD
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°

Started: 03/10/2019
Finished: 03/10/2019
Orientation:

DRILLING INFORMATION / MATERIAL SUBSTANCE

Method & Support	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V	Not Observed	U; SPT 4, 5, 5 N=10		0	CL	CLAY: low plasticity, brown, trace fine grained sand, trace rootlets	D	F	TOPSOIL
		D; U	162		CH	CLAY: high plasticity, orange-brown mottled brown, red-brown and grey, trace fine grained, subrounded-subangular gravel, trace rootlets		St	RESIDUAL SOIL
				1		... becoming grey mottled red-brown			
		D; SPT 7, 16, 21 N=37	161		CI-CH	CLAY: medium to high plasticity, grey mottled red-brown and orange-brown		H	1.50: SPT appears wet as drillers poured water into hole to recover cuttings
			160	2	CI	CLAY: medium plasticity, red-brown mottled grey and yellow, trace fine grained sand	w <PL	St / VSt	
		D; SPT 5, 8, 8 N=16; D	159	3		... becoming grey mottled yellow			
		SPT 8, 14, 28 N=42		4	CL-CI	CLAY: low to medium plasticity, grey mottled red-brown, relict rock fabric		H	EXTREMELY WEATHERED MATERIAL
			158			Hole Terminated at 4.25 m Refusal			
			157	5					
			156	6					
			155	7					

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value): VL Very Loose 0 - 4; L Loose 4 - 10; MD Medium Dense 10 - 30; D Dense 30 - 50; VD Very Dense 50 - 100

CONSISTENCY (Su) {N-value}: VS Very Soft < 12 kPa {0-2}; S Soft 12 - 25 {2-4}; F Firm 25 - 50 {4-8}; St Stiff 50 - 100 {8-15}; VSt Very Stiff 100 - 200 {15-30}; H Hard > 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_MW101

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 1	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	309296.7	**Elevation:**	154.22	**Started:**	30/09/2019
Plant:	Geoprobe	**Northing:**	6412322.9	**Datum:**	AHD	**Finished:**	30/09/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description** SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/T		Not Observed	D U	154			CL	CLAY: low plasticity, dark brown, trace fine to coarse grained sand, trace rootlets	D	F	TOPSOIL
			SPT 4,5,7 N = 12				CI	CLAY: medium plasticity, orange-brown mottled grey, trace fine grained sand, trace rootlets, trace red-brown ironstone fine grained, subangular gravel		St	RESIDUAL SOIL 0.35: HP Samp >600 kPa
			D	153	1			... boulder encountered at 1.0-1.2m, fine grained, orange-brown sandstone		VSt / H	
			SPT 9,25/80mm N = R D SPT 3/0mm N = R, HB					SANDSTONE: fine grained, orange-brown banded grey, highly weathered, very low to low strength			BEDROCK
				152	2			Hole Terminated at 1.91 m Refusal			1.90: No sample recovered (hammer bouncing)
				151	3						
				150	4						
				149	5						
				148	6						
				147	7						

METHOD & SUPPORT	PENETRATION	GROUNDWATER	SAMPLES & FIELD TESTS	MOISTURE	DENSITY (N-value)	CONSISTENCY (Su) {N-value}
HA Hand Auger AS Auger ADV Auger - V-bit ADT Auger - TC-bit WB Washbore RR Rock Roller AH Air Hammer VC Vibro core C Casing	No resistance ranging to refusal	= Water level (static) = Water level (during drilling) = Water inflow = Water outflow	D Disturbed Sample B Bulk Sample SPT SPT Sample U Undisturbed Sample ES Enviro Sample W Water Sample N SPT blows per 300mm HW SPT penetration by hammer weight RW SPT penetration by rod weight HP Hand Penetrometer HV Hand Vane Shear (P: Peak Su R: Residual Su)	D = Dry M = Moist W = Wet Wp = Plastic Limit Wl = Liquid Limit	VL Very Loose 0 - 4 L Loose 4 - 10 MD Medium Dense 10 - 30 D Dense 30 - 50 VD Very Dense 50 - 100	VS Very Soft < 12 kPa {0-2} S Soft 12 - 25 {2-4} F Firm 25 - 50 {4-8} St Stiff 50 - 100 {8-15} VSt Very Stiff 100 - 200 {15-30} H Hard > 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_MW102

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 2	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	307358.0	**Elevation:**	186.65	**Started:**	01/10/2019
Plant:	Geoprobe	**Northing:**	6412360.0	**Datum:**	AHD	**Finished:**	01/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V	D		0.00	CL	CLAY: low plasticity, brown, trace fine grained, subangular to subrounded gravel, trace fine to coarse grained sand, trace rootlets	D	F	TOPSOIL
AD/V	SPT 4,5,6 N = 11; D	186	0.20–1.50	CI-CH	CLAY: medium to high plasticity, orange-brown, trace rootlets	D	St	RESIDUAL SOIL 0.30: HP Samp >600 kPa
AD/V	SPT 4,9,10 N = 19	185	1.50–2.00	CI	CLAY: medium plasticity, brown spotted grey, red and orange, trace fine to coarse grained sand, trace fine to medium grained, subangular to subrounded gravel	D	VSt	1.60: HP Samp >600 kPa
AD/T	D U; SPT 7,10,13 N = 23; D; SPT 1,10,15 N = 25	184, 183, 182	2.00–4.95	CL-CI	CLAY: low to medium plasticity, orange-brown banded dark grey and grey, relict rock fabric	D	VSt / H	2.00: V-bit refusal EXTREMELY WEATHERED MATERIAL 3.10: HP Samp >600 kPa 4.60: HP Samp >600 kPa
		181, 180, 179	4.95		Hole Terminated at 4.95 m Refusal			

Groundwater: ▽ 29/10/19 (approx. 4.2 m)

METHOD & SUPPORT	PENETRATION	GROUNDWATER	SAMPLES & FIELD TESTS	MOISTURE	DENSITY (N-value)	CONSISTENCY (Su) {N-value}
HA Hand Auger AS Auger ADV Auger - V-bit ADT Auger - TC-bit WB Washbore RR Rock Roller AH Air Hammer VC Vibro core C Casing	No resistance ranging to refusal	▼ = Water level (static) ▽ = Water level (during drilling) ► = Water inflow ◄ = Water outflow	D Disturbed Sample B Bulk Sample SPT SPT Sample U Undisturbed Sample ES Enviro Sample W Water Sample N SPT blows per 300mm HW SPT penetration by hammer weight RW SPT penetration by rod weight HP Hand Penetrometer HV Hand Vane Shear (P: Peak Su R: Residual Su)	D = Dry M = Moist W = Wet Wp = Plastic Limit Wl = Liquid Limit	VL Very Loose 0 - 4 L Loose 4 - 10 MD Medium Dense 10 - 30 D Dense 30 - 50 VD Very Dense 50 - 100	VS Very Soft < 12 kPa {0-2} S Soft 12 - 25 {2-4} F Firm 25 - 50 {4-8} St Stiff 50 - 100 {8-15} VSt Very Stiff 100 - 200 {15-30} H Hard > 200 kPa {>30}

Engineering Log - Borehole

JBP_MW103

Project: Bayswater Burrow Pits		**Page:** 1 of 1	
Client: AGL Macquarie	**Location:** Borrow Pit 3	**Project No:** IA215400	

Contractor:	Terratest	**Easting:**	306207.8	**Elevation:**	153.64	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410685.0	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		Not Observed	D			CL-CI	CLAY: low to medium plasticity, brown, trace fine grained sand, trace fine to medium grained, subangular and on surface gravel, trace rootlets	D	F	TOPSOIL
			SPT 3,4,6 N = 10	153		CI-CH	CLAY: medium to high plasticity, brown spotted orange brown and red, trace fine to medium grained, subangular gravel ... becoming dark brown ... becoming orange-brown mottled grey and brown		St	0.35: HP Samp >600 kPa
			U		1					
			SPT 3,7,11 N = 18	152					VSt	1.60: HP Samp >600 kPa
			D		2	CI	CLAY: medium plasticity, orange-brown mottled grey and orange-brown, trace fine to medium grained, subangular to angular siltstone gravel, very faint relict rock fabric			RESIDUAL SOIL
			D	151		CI	CLAY: medium plasticity, orange-brown mottled grey and red-brown, thin bands of highly weathered, very low strength siltstone, relict rock fabric ... trace white quartz crystals up to 4mm	w <PL	VSt / H	EXTREMELY WEATHERED MATERIAL
			SPT 5,10,17 N = 27		3					3.25: HP Samp >600 kPa
				150	4					3.70: driller poured water down to remove cuttings
			SPT 7,16,23 N = 39	149						4.70: HP Samp >600 kPa
					5		Hole Terminated at 4.95 m Refusal			
				148	6					
				147	7					
				146						

Legend

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value)		
VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}		
VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_MW104

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 3	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	306368.9	**Elevation:**	155.69	**Started:**	01/10/2019
Plant:	Geoprobe	**Northing:**	6410794.2	**Datum:**	AHD	**Finished:**	01/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION / MATERIAL SUBSTANCE

Method & Support	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description (SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		D		0.0	CL	CLAY: low plasticity, brown, trace fine to coarse grained sand, trace fine grained, subangular gravel, trace rootlets	D		TOPSOIL
		SPT 2, 2, 4 N=6	155		CI	CLAY: medium plasticity, brown, trace fine grained, subrounded gravel, trace rootlets ... becoming orange-brown ... becoming orange-brown mottled grey and dark grey		F	RESIDUAL SOIL 0.30: HP Samp = 440 - >660 kPa
		D		1					
		SPT 3, 4, 6 N=10	154	2	CI-CH	CLAY: medium to high plasticity, orange-brown spotted red-brown, dark grey and grey, trace fine to medium grained, subangular gravel, trace fine to medium grained sand		St	1.70: HP Samp = 250 - 440 kPa
	29/10/19	U SPT 3, 5, 10 N=15	153	3	CI	CLAY: medium plasticity, grey mottled orange-brown and red-brown, trace fine to medium grained, subangular gravel, very faint relict rock fabric	w <PL	St / VSt	EXTREMELY WEATHERED MATERIAL 3.00: HP Samp = 410 - >600 kPa 3.20: HP Samp = 500 - >600 kPa
		D SPT 4, 11, 14 N=25 D	152 151 150	4 5	CI	CLAY: medium plasticity, dark grey banded orange-brown, relict rock fabric ... white crystals (calcitic or quartz?)		VSt	4.70: HP Samp >600 kPa
		SPT 8, 23, 25/100mm N=R		6				H	6.10: HP Samp >600 kPa
			149 148	7		Hole Terminated at 6.40 m Refusal			

METHOD & SUPPORT
HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION
No resistance ranging to refusal

GROUNDWATER
= Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS
D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample
N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE
D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value)

VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}

VS	Very Soft	< 12 kPa	{0-2}
S	Soft	12 - 25	{2-4}
F	Firm	25 - 50	{4-8}
St	Stiff	50 - 100	{8-15}
VSt	Very Stiff	100 - 200	{15-30}
H	Hard	> 200 kPa	{>30}

JACOBS 3.01.3.GLB Log JACOBS AU BOREHOLE LOG IA215400.GPJ <<DrawingFile>> 12/11/2019 16:38 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

JACOBS Engineering Log - Borehole

JBP_MW105

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 3	**Project No:**	IA215400

Contractor: Terratest		**Easting:**	306462.2	**Elevation:**	162.27	**Started:**	02/10/2019
Plant: Geoprobe		**Northing:**	6410776.9	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by: GC	**Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description** SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		Not Observed	D				CL-CI	CLAY: low to medium plasticity, brown, trace fine grained sand, trace rootlets	D	F	TOPSOIL
			SPT 4, 5, 5 N=10	162			CI-CH	CLAY: medium to high plasticity, brown mottled grey, trace fine grained, subrounded gravel		St	RESIDUAL SOIL 0.40: HP Samp >600 kPa
			D	161	1		CH	CLAY: high plasticity, red-brown mottled grey and orange-brown			
			SPT 4, 6, 8 N=14								1.70: HP Samp >600 kPa
			D	160	2						
			U				CI	CLAY: medium plasticity, orange-brown mottled grey and red-brown, trace fine to medium grained, subrounded to subangular gravel, trace fine to coarse grained sand	w <PL	St / VSt	2.70: HP Samp >600 kPa
			SPT 3, 6, 9 N=15	159	3						3.00: HP Samp = 370 - 480 kPa
			D								
			SPT 6, 19, 25/130mm N=R	158	4		CI-CH	CLAY: medium to high plasticity, orange-brown mottled red-brown and grey, with fine to medium grained, tabular gravel, relict rock fabric		H	EXTREMELY WEATHERED MATERIAL 4.40: HP Samp >600 kPa
				157, 156, 155	5, 6, 7			Hole Terminated at 4.63 m Refusal			4.63: V-bit refusal

METHOD & SUPPORT	PENETRATION	GROUNDWATER	SAMPLES & FIELD TESTS		MOISTURE	DENSITY (N-value)			CONSISTENCY (Su) {N-value}		
HA Hand Auger	No resistance ranging to refusal	= Water level (static)	D Disturbed Sample	N SPT blows per 300mm	D = Dry	VL	Very Loose	0 - 4	VS Very Soft	< 12 kPa	{0-2}
AS Auger		= Water level (during drilling)	B Bulk Sample	HW SPT penetration by hammer weight	M = Moist	L	Loose	4 - 10	S Soft	12 - 25	{2-4}
ADV Auger - V-bit		= Water inflow	SPT SPT Sample	RW SPT penetration by rod weight	W = Wet	MD	Medium Dense	10 - 30	F Firm	25 - 50	{4-8}
ADT Auger - TC-bit		= Water outflow	U Undisturbed Sample	HP Hand Penetrometer	Wp = Plastic Limit	D	Dense	30 - 50	St Stiff	50 - 100	{8-15}
WB Washbore			ES Enviro Sample	HV Hand Vane Shear	Wl = Liquid Limit	VD	Very Dense	50 - 100	VSt Very Stiff	100 - 200	{15-30}
RR Rock Roller			W Water Sample	(P: Peak Su R: Residual Su)					H Hard	> 200 kPa	{>30}
AH Air Hammer											
VC Vibro core											
C Casing											

JACOBS Engineering Log - Borehole

JBP_MW106

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 4	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	305476.8	**Elevation:**	140.95	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410960.1	**Datum:**	AHD	**Finished:**	03/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION / MATERIAL SUBSTANCE

Method & Support	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		SPT 3, 4, 5 N = 9			CL	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace fine grained sand, trace rootlets	D	F	TOPSOIL
					CI-CH	CLAY: medium to high plasticity, brown, trace fine grained, subangular gravel, trace rootlets			RESIDUAL SOIL
		D	140	1		... becoming orange-brown, trace fine grained sand			
		D				... becoming orange-brown mottled grey	w <PL		
		U							
			139	2				St	
		D				... becoming orange-brown mottled grey spotted dark grey, trace fine grained, subrounded to subangular gravel			
		SPT 2, 3, 5 N = 8	138	3					
		D	137	4	CI	CLAY: medium plasticity, orange-brown mottled grey and dark grey red-brown, trace fine grained sand, trace fine grained, subangular to subrounded gravel	w ~PL	F / St	
	29/10/19 (water level)	SPT 2, 3, 5 N=8							
		D	136	5					
		SPT 15, 30/100mm N = R, HB	135	6	CL-CI	CLAY: low to medium plasticity, orange-brown mottled grey, relict rock fabric	w <PL	H	EXTREMELY WEATHERED MATERIAL
						Hole Terminated at 6.25 m Refusal			
			134	7					
			133						

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value): VL Very Loose 0 - 4; L Loose 4 - 10; MD Medium Dense 10 - 30; D Dense 30 - 50; VD Very Dense 50 - 100

CONSISTENCY (Su) {N-value}: VS Very Soft < 12 kPa {0-2}; S Soft 12 - 25 {2-4}; F Firm 25 - 50 {4-8}; St Stiff 50 - 100 {8-15}; VSt Very Stiff 100 - 200 {15-30}; H Hard > 200 kPa {>30}

JACOBS — Engineering Log - Borehole

JBP_MW107

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 4	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	305282.0	**Elevation:**	145.69	**Started:**	03/10/2019
Plant:	Geoprobe	**Northing:**	6410669.8	**Datum:**	AHD	**Finished:**	03/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description** SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/V		Not Observed	SPT 3, 6, 6 N=12				CL	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace rootlets	D	F	TOPSOIL
			D	145	1		CI-CH	CLAY: medium to high plasticity, brown mottled orange-brown, red-brown and dark grey, trace fine grained, subrounded gravel, trace rootlets		St	RESIDUAL SOIL
			D; D SPT 6, 11, 16 N=27	144			CI	CLAY: medium plasticity, orange-brown mottled grey, trace fine grained, subangular gravel, relict rock fabric	w <PL	VSt / H	EXTREMELY WEATHERED MATERIAL
			SPT 11, 19, 23 N=42		2		CL-CI	CLAY: low to medium plasticity, grey mottled orange-brown, dark grey and red-brown, trace thin bands of highly weathered, very low to low strength siltstone, relict rock fabric		H	
				143				Hole Terminated at 2.45 m Refusal			
				142, 141, 140, 139, 138	3, 4, 5, 6, 7						

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value):

VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}:

VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

Engineering Log - Borehole

JBP_MW108

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 4	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	304815.0	**Elevation:**	133.08	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410729.4	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description (SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/T	Not Observed	SPT 2, 4, 7 N = 11	133		CL	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace rootlets	D	F	TOPSOIL
		D			CI-CH	CLAY: medium to high plasticity, orange-brown, trace fine grained, subangular gravel, trace rootlets		St	RESIDUAL SOIL
		U	132	1		... becoming orange-brown spotted dark grey			
		SPT 5, 5, 7 N = 12	131	2					
		D			CI	CLAY: medium plasticity, orange-brown banded grey mottled red-brown, 70mm thick beds of gravelly clay, gravel is fine to coarse grained, subangular, very faint relict rock fabric	w <PL	VSt / H	EXTREMELY WEATHERED MATERIAL
		SPT 6, 12, 13 N = 25	130	3					
		D							3.60: driller poured water down to recover cuttings
		SPT 17, 29, 27/100mm N = R	129	4	CL-CI	CLAY: low to medium plasticity, grey mottled orange-brown, trace fine grained sand, relict rock fabric		H	
						Hole Terminated at 4.60 m Refusal			
			128	5					
			127	6					
			126	7					

METHOD & SUPPORT	PENETRATION	GROUNDWATER	SAMPLES & FIELD TESTS	MOISTURE	DENSITY (N-value)	CONSISTENCY (Su) {N-value}
HA Hand Auger AS Auger AD/V Auger - V-bit AD/T Auger - TC-bit WB Washbore RR Rock Roller AH Air Hammer VC Vibro core C Casing	No resistance ranging to refusal	= Water level (static) = Water level (during drilling) = Water inflow = Water outflow	D Disturbed Sample B Bulk Sample SPT SPT Sample U Undisturbed Sample ES Enviro Sample W Water Sample N SPT blows per 300mm HW SPT penetration by hammer weight RW SPT penetration by rod weight HP Hand Penetrometer HV Hand Vane Shear (P: Peak Su R: Residual Su)	D = Dry M = Moist W = Wet Wp = Plastic Limit Wl = Liquid Limit	VL Very Loose 0 - 4 L Loose 4 - 10 MD Medium Dense 10 - 30 D Dense 30 - 50 VD Very Dense 50 - 100	VS Very Soft < 12 kPa {0-2} S Soft 12 - 25 {2-4} F Firm 25 - 50 {4-8} St Stiff 50 - 100 {8-15} VSt Very Stiff 100 - 200 {15-30} H Hard > 200 kPa {>30}

JACOBS 3.01.3.GLB Log JACOBS AU BOREHOLE LOG IA215400.GPJ <<DrawingFile>> 12/11/2019 16:38 8.30.003 Datgel Lab and In Situ Tool - DGD | Lib: Jacobs 3.01.2 2017-03-09 Prj: Jacobs 3.00.0 2016-07-17

Project: Bayswater Burrow Pits **Page:** 1 of 2
Client: AGL Macquarie **Location:** Borrow Pit 4 **Project No:** IA215400

Contractor:	Terratest	**Easting:**	305225.6	**Elevation:**	140.29	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410581.2	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION / MATERIAL SUBSTANCE

Method & Support	Samples & SPT Data	RL (m)	Depth (m)	Classification Symbol	Material Description (SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/T	SPT 1,1,2 N = 3	140		CL-CI	CLAY: low to medium plasticity, brown, trace fine grained, subangular gravel, trace fine to medium grained sand, trace rootlets	D	S / F	TOPSOIL
	D			CI-CH	CLAY: medium to high plasticity, brown spotted dark grey, trace fine grained, subangular gravel, trace rootlets		F	RESIDUAL SOIL
	U	139	1		... becoming grey mottled orange-brown and red-brown	w <PL		
	SPT 7,9,11 N = 20; D	138	2	CH	CLAY: high plasticity, grey mottled orange-brown, trace fine grained, subangular gravel		VSt	
	D; SPT 3,6,7 N = 13; D; SPT 4,5,8 N = 13	137, 136, 135	3, 4, 5	CH	CLAY: high plasticity, grey mottled orange, trace fine to medium grained, subangular ironstone gravel, trace fine grained sand	w ~PL	St	2.70: ... increasing in moisture 3.05: HP Samp =300 kPa 3.15: HP Samp =360 kPa
	D; SPT 2,3,4 N = 7; D; U	134, 133	6, 7	CI-CH	CLAY: medium to high plasticity, orange-brown mottled grey, trace fine grained sand, trace fine grained, subangular gravel		F / St	6.10: HP Samp =160 kPa 6.20: HP Samp =160 kPa 6.30: HP Samp =170 kPa
	SPT 7,20,21 N = 41			CI	CLAY: medium plasticity, dark grey mottled orange-brown, relict rock fabric	w <PL	H	EXTREMELY WEATHERED MATERIAL

Groundwater: water level (during drilling) 29/10/19, approx. 6.4 m.

METHOD & SUPPORT: HA Hand Auger; AS Auger; ADV Auger - V-bit; ADT Auger - TC-bit; WB Washbore; RR Rock Roller; AH Air Hammer; VC Vibro core; C Casing

PENETRATION: No resistance ranging to refusal

GROUNDWATER: = Water level (static); = Water level (during drilling); = Water inflow; = Water outflow

SAMPLES & FIELD TESTS: D Disturbed Sample; B Bulk Sample; SPT SPT Sample; U Undisturbed Sample; ES Enviro Sample; W Water Sample; N SPT blows per 300mm; HW SPT penetration by hammer weight; RW SPT penetration by rod weight; HP Hand Penetrometer; HV Hand Vane Shear (P: Peak Su R: Residual Su)

MOISTURE: D = Dry; M = Moist; W = Wet; Wp = Plastic Limit; Wl = Liquid Limit

DENSITY (N-value)		
VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}		
VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

JACOBS Engineering Log - Borehole

JBP_MW109

Project:	Bayswater Burrow Pits	**Page:**	2 of 2
Client:	AGL Macquarie	**Location:**	Borrow Pit 4
Project No:	IA215400		

Contractor:	Terratest	**Easting:**	305225.6	**Elevation:**	140.29	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410581.2	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING INFORMATION | MATERIAL SUBSTANCE

Method & Support	Penetration	Groundwater Levels	Samples & SPT Data	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL TYPE: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture	Consistency Relative Density	Field Test Data & Other Observations
AD/T			D				CI		w <PL	H	
				132				Hole Terminated at 8.20 m Refusal			
					9						
				131							
					10						
				130							
					11						
				129							
					12						
				128							
					13						
				127							
					14						
				126							
					15						
				125							

METHOD & SUPPORT
HA Hand Auger
AS Auger
ADV Auger - V-bit
ADT Auger - TC-bit
WB Washbore
RR Rock Roller
AH Air Hammer
VC Vibro core
C Casing

PENETRATION
No resistance ranging to refusal

GROUNDWATER
= Water level (static)
= Water level (during drilling)
= Water inflow
= Water outflow

SAMPLES & FIELD TESTS
D Disturbed Sample
B Bulk Sample
SPT SPT Sample
U Undisturbed Sample
ES Enviro Sample
W Water Sample
N SPT blows per 300mm
HW SPT penetration by hammer weight
RW SPT penetration by rod weight
HP Hand Penetrometer
HV Hand Vane Shear
(P: Peak Su R: Residual Su)

MOISTURE
D = Dry
M = Moist
W = Wet
Wp = Plastic Limit
Wl = Liquid Limit

DENSITY (N-value)		
VL	Very Loose	0 - 4
L	Loose	4 - 10
MD	Medium Dense	10 - 30
D	Dense	30 - 50
VD	Very Dense	50 - 100

CONSISTENCY (Su) {N-value}		
VS	Very Soft	< 12 kPa {0-2}
S	Soft	12 - 25 {2-4}
F	Firm	25 - 50 {4-8}
St	Stiff	50 - 100 {8-15}
VSt	Very Stiff	100 - 200 {15-30}
H	Hard	> 200 kPa {>30}

Piezometer Installation Details

JACOBS

JBP_MW101

Project:	Bayswater Burrow Pits	**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 1
Project No:	IA215400		

Contractor:	Terratest	**Easting:**	309296.7	**Elevation:**	154.22	**Started:**	30/09/2019
Plant:	Geoprobe	**Northing:**	6412322.9	**Datum:**	AHD	**Finished:**	30/09/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING / MATERIAL SUBSTANCE

Method & Support: AD/T (to 1.91 m)
Water: Not Observed

Description of Strata

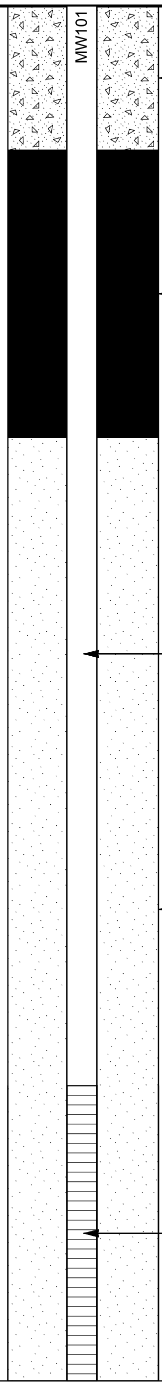
ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type)

RL (m)	Depth (m)	Description of Strata
154.2	0.0	CLAY: low plasticity, dark brown, trace fine to coarse grained sand, trace rootlets; dry, firm
154.0	0.2	CLAY: medium plasticity, orange-brown mottled grey, trace fine grained sand, trace rootlets, trace red-brown ironstone fine grained, subangular gravel; dry, stiff to hard
153.2	1.0	... boulder encountered at 1.0-1.2m, fine grained, orange-brown sandstone
	1.5	SANDSTONE: fine grained, orange-brown banded grey, highly weathered, very low to low strength
	1.91	Hole Terminated at 1.91 m Refusal

RL scale: 154.2, 154.0, 153.8, 153.6, 153.4, 153.2, 153.0, 152.8, 152.6, 152.4, 152.2
Depth scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0

INSTALLATION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL
MW101	Standpipe Piezometer	0.95 m 155.17 m	1.91 m 152.31 m



DRILLING

NMLC	NMLC Coring	HQ	HQ Coring	TCR	% core run recovered
NQ	NQ Coring	PQ	PQ Coring	RQD	% core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling)

JACOBS — Piezometer Installation Details — JBP_MW102

Project: Bayswater Burrow Pits		**Page:**	1 of 1
Client: AGL Macquarie	**Location:** Borrow Pit 2	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	307358.0	**Elevation:**	186.65	**Started:**	01/10/2019
Plant:	Geoprobe	**Northing:**	6412360.0	**Datum:**	AHD	**Finished:**	01/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING / MATERIAL SUBSTANCE

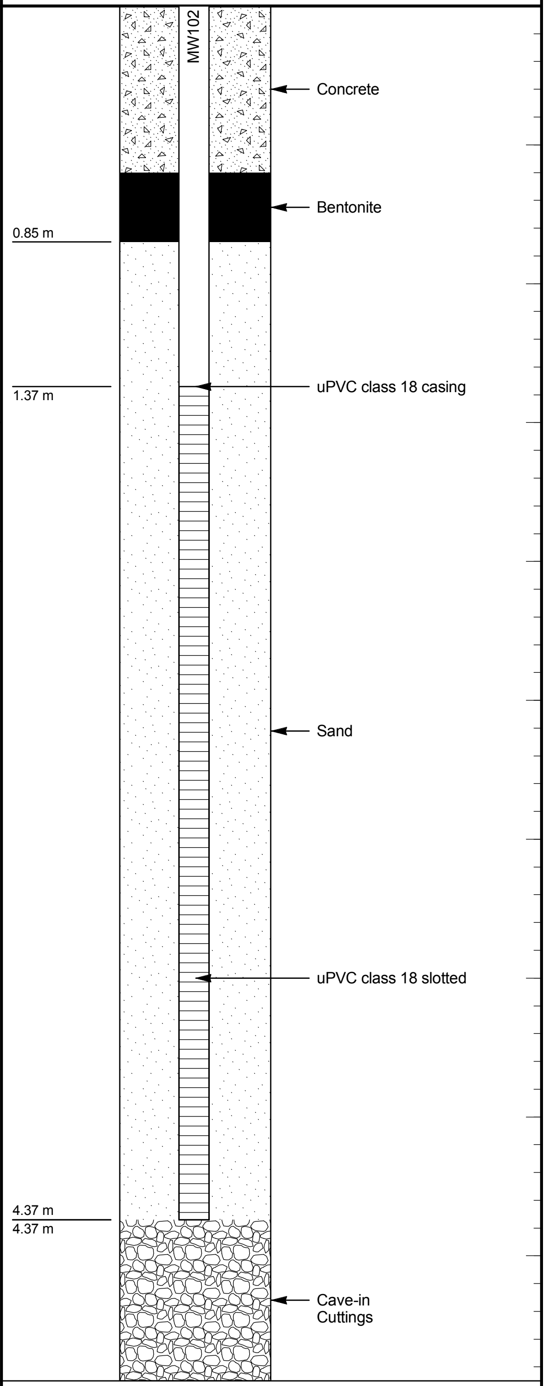
Description of Strata: ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type)

Method & Support	Depth (m)	Description of Strata
AD/V	0.0	CLAY: low plasticity, brown, trace fine grained, subangular to subrounded gravel, trace fine to coarse grained sand, trace rootlets; dry, firm
AD/V	~0.2	CLAY: medium to high plasticity, orange-brown, trace rootlets; dry, stiff
AD/V	~1.5	CLAY: medium plasticity, brown spotted grey, red and orange, trace fine to coarse grained sand, trace fine to medium grained, subangular to subrounded gravel; dry, very stiff
AD/T	2.0	CLAY: low to medium plasticity, orange-brown banded dark grey and grey, relict rock fabric; dry, very stiff / hard
	4.95	Hole Terminated at 4.95 m Refusal

Water: 29/10/19 (approx. 4.2 m, RL ~182.5)

INSTALLATION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL
MW102	Standpipe Piezometer	1.00 m 187.65 m	4.37 m 182.28 m



DRILLING

NMLC NMLC Coring
NQ NQ Coring
HQ HQ Coring
PQ PQ Coring
TCR % core run recovered
RQD % core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static)
▽ = Water level (approx. 1 month after drilling)

Piezometer Installation Details

JBP_MW103

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 3	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	306207.8	**Elevation:**	153.64	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410685.0	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING | MATERIAL SUBSTANCE | INSTALLATION DETAILS

Method & Support: AD/V
Water: Not Observed

RL (m): 153.5, 153.0, 152.5, 152.0, 151.5, 151.0, 150.5, 150.0, 149.5, 149.0, 148.5
Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0

Description of Strata

ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type)

CLAY: low to medium plasticity, brown, trace fine grained sand, trace fine to medium grained, subangular and on surface gravel, trace rootlets; dry, firm

CLAY: medium to high plasticity, brown spotted orange brown and red, trace fine to medium grained, subangular gravel; moist, dry of plastic limit, stiff to very stiff

... becoming dark brown

... becoming orange-brown mottled grey and brown

CLAY: medium plasticity, orange-brown mottled grey and orange-brown, trace fine to medium grained, subangular to angular siltstone gravel, very faint relict rock fabric; moist, dry of plastic limit, very stiff

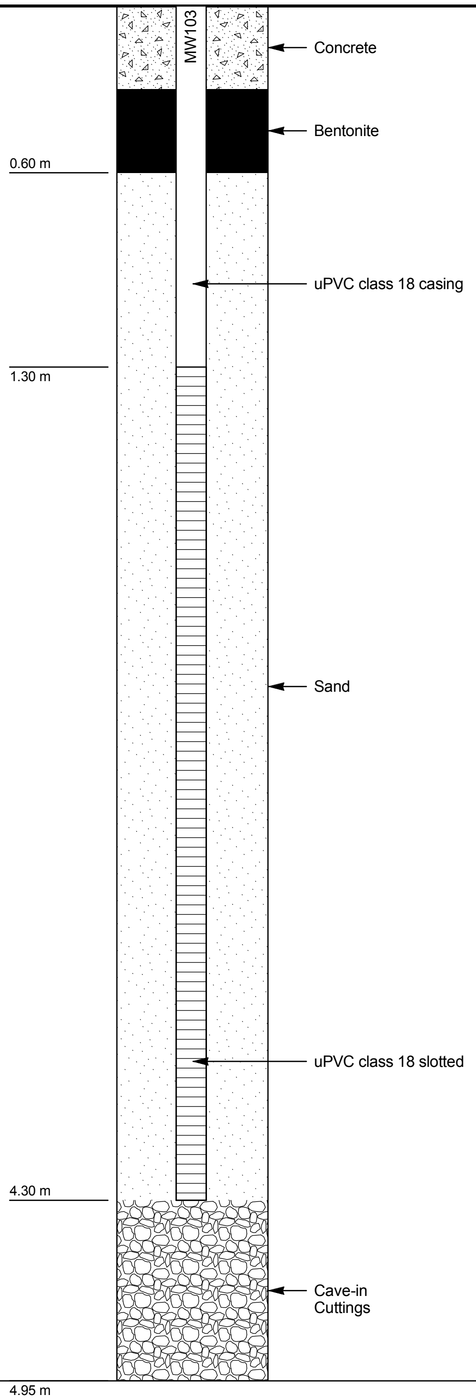
CLAY: medium plasticity, orange-brown mottled grey and red-brown, thin bands of highly weathered, very low strength siltstone, relict rock fabric; moist, dry of plastic limit, very stiff / hard

... trace white quartz crystals up to 4mm

Hole Terminated at 4.95 m
Refusal

Installation details

ID	Type	Stick Up & RL	Tip Depth & RL
MW103	Standpipe Piezometer	0.95 m 154.59 m	4.30 m 149.34 m



DRILLING

NMLC NMLC Coring
NQ NQ Coring
HQ HQ Coring
PQ PQ Coring
TCR % core run recovered
RQD % core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static)
▽ = Water level (during drilling)

JACOBS Piezometer Installation Details

JBP_MW104

Project: Bayswater Burrow Pits
Client: AGL Macquarie
Location: Borrow Pit 3
Page: 1 of 1
Project No: IA215400

Contractor:	Terratest	**Easting:**	306368.9	**Elevation:**	155.69	**Started:**	01/10/2019
Plant:	Geoprobe	**Northing:**	6410794.2	**Datum:**	AHD	**Finished:**	01/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

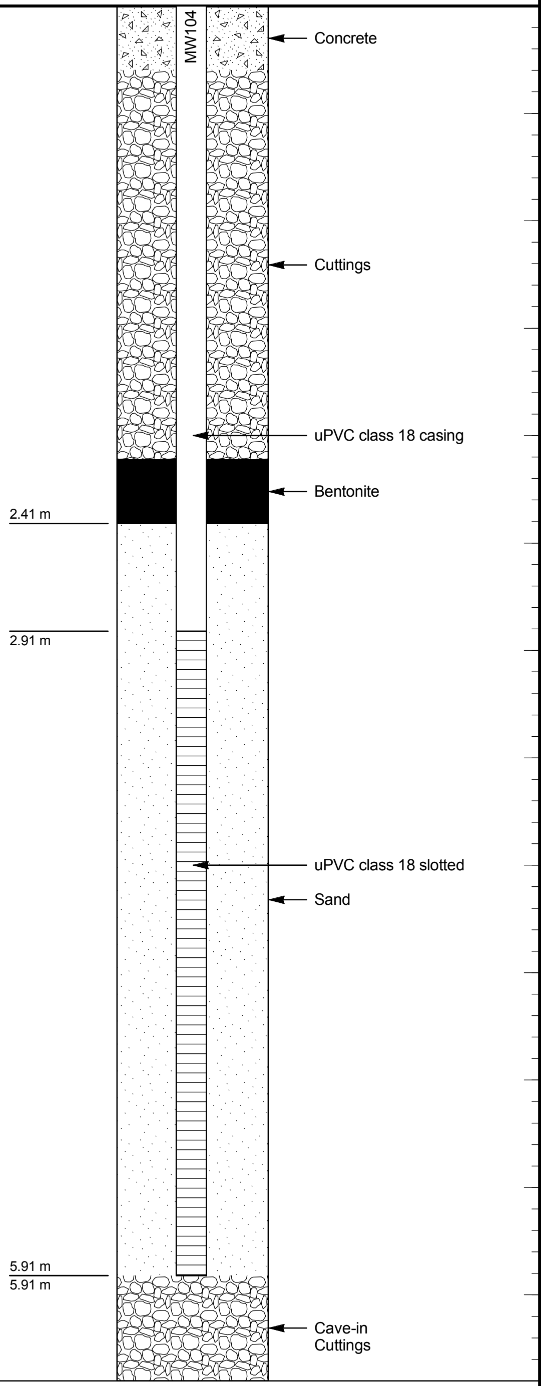
DRILLING / MATERIAL SUBSTANCE

Method & Support: AD/V (0.00–6.40 m)
Water: 29/10/19 (water level approx. 1 month after drilling, at about 3.2 m)

RL (m)	Depth (m)	Description of Strata (ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type))
155.69 – 155.5	0.0 – 0.2	CLAY: low plasticity, brown, trace fine to coarse grained sand, trace fine grained, subangular gravel, trace rootlets; dry, firm
155.5 – 154.5	0.2 – 1.2	CLAY: medium plasticity, brown, trace fine grained, subrounded gravel, trace rootlets; moist, dry of plastic limit, firm ... becoming orange-brown ... becoming orange-brown mottled grey and dark grey
154.5 – 153.2	1.2 – 2.5	CLAY: medium to high plasticity, orange-brown spotted red-brown, dark grey and grey, trace fine to medium grained, subangular gravel, trace fine to medium grained sand; moist, dry of plastic limit, stiff
153.2 – 151.9	2.5 – 3.8	CLAY: medium plasticity, grey mottled orange-brown and red-brown, trace fine to medium grained, subangular gravel, very faint relict rock fabric; moist, dry of plastic limit, stiff / very stiff
151.9 – 149.3	3.8 – 6.4	CLAY: medium plasticity, dark grey banded orange-brown, relict rock fabric; moist, dry of plastic limit, very stiff to hard ... white crystals (calcitic or quartz?)
	6.40	Hole Terminated at 6.40 m Refusal

INSTALLATION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL
MW104	Standpipe Piezometer	1.03 m 156.72 m	5.91 m 149.78 m



DRILLING

NMLC NMLC Coring
NQ NQ Coring
HQ HQ Coring
PQ PQ Coring
TCR % core run recovered
RQD % core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static)
▽ = Water level (approx. 1 month after drilling)

JACOBS — Piezometer Installation Details

JBP_MW105

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 3	**Project No:**	IA215400

Contractor:	Terratest	**Easting:**	306462.2	**Elevation:**	162.27	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410776.9	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

INSTALLATION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL
MW105	Standpipe Piezometer	0.92 m 163.19 m	4.20 m 158.07 m

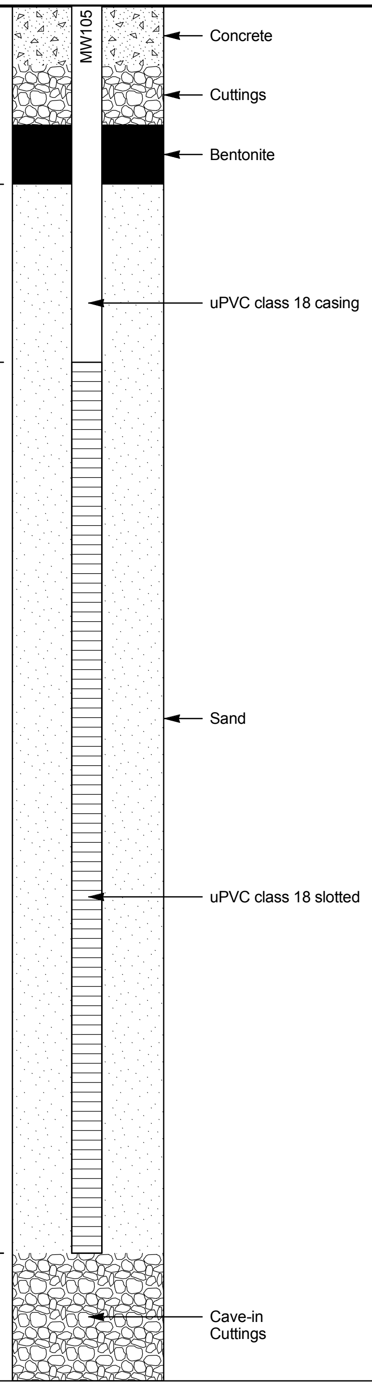
DRILLING / MATERIAL SUBSTANCE

Method & Support: AD/V (0.00 – 4.63 m)
Water: Not Observed

Description of Strata
ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type)

Depth (m)	RL (m)	Description of Strata
0.00 – 0.20	162.27 – 162.07	CLAY: low to medium plasticity, brown, trace fine grained sand, trace rootlets; dry, firm
0.20 – 1.20	162.07 – 161.07	CLAY: medium to high plasticity, brown mottled grey, trace fine grained, subrounded gravel; moist, dry of plastic limit, stiff
1.20 – 2.40	161.07 – 159.87	CLAY: high plasticity, red-brown mottled grey and orange-brown; moist, dry of plastic limit, stiff / very stiff
2.40 – 3.80	159.87 – 158.47	CLAY: medium plasticity, orange-brown mottled grey and red-brown, trace fine to medium grained, subrounded to subangular gravel, trace fine to coarse grained sand; moist, dry of plastic limit, stiff to very stiff
3.80 – 4.63	158.47 – 157.64	CLAY: medium to high plasticity, orange-brown mottled red-brown and grey, with fine to medium grained, tabular gravel, relict rock fabric; moist, dry of plastic limit, hard
4.63		Hole Terminated at 4.63 m Refusal

Installation depths: 0.60 m; 1.20 m; 4.20 m; 4.20 m



DRILLING

NMLC	NMLC Coring	HQ	HQ Coring	TCR	% core run recovered
NQ	NQ Coring	PQ	PQ Coring	RQD	% core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling)

Piezometer Installation Details

JBP_MW106

Project: Bayswater Burrow Pits
Client: AGL Macquarie
Location: Borrow Pit 4

Project No: IA215400

Contractor:	Terratest	**Easting:**	305476.8	**Elevation:**	140.95	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410960.1	**Datum:**	AHD	**Finished:**	03/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

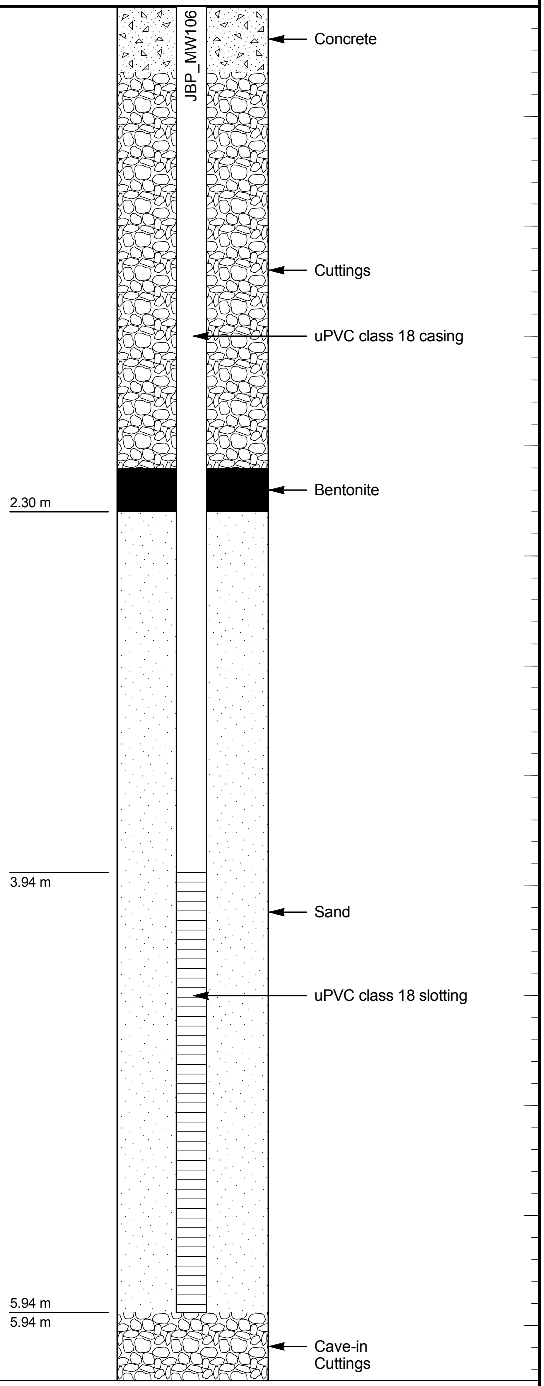
DRILLING / MATERIAL SUBSTANCE

Method & Support: AD/V (0 – 6.25 m)
Water: 29/10/19 (approx. 4.35 m)

RL (m)	Depth (m)	Description of Strata (ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type))
	0.0	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace fine grained sand, trace rootlets; dry, firm
		CLAY: medium to high plasticity, brown, trace fine grained, subangular gravel, trace rootlets; moist, dry of plastic limit to moist, near plastic limit, stiff
		... becoming orange-brown, trace fine grained sand
140	1	... becoming orange-brown mottled grey
139	2	
		... becoming orange-brown mottled grey spotted dark grey, trace fine grained, subrounded to subangular gravel
138	3	
137	4	CLAY: medium plasticity, orange-brown mottled grey and dark grey red-brown, trace fine grained sand, trace fine grained, subangular to subrounded gravel; moist, near plastic limit, firm / stiff
136	5	
135	6	CLAY: low to medium plasticity, orange-brown mottled grey, relict rock fabric; moist, dry of plastic limit, hard
		Hole Terminated at 6.25 m Refusal

INSTALLATION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL
JBP_MW106	Standpipe Piezometer	1.01 m 141.96 m	5.94 m 135.01 m



DRILLING

NMLC NMLC Coring
NQ NQ Coring
HQ HQ Coring
PQ PQ Coring
TCR % core run recovered
RQD % core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static)
▽ = Water level (approx. 1 month after drilling)

Piezometer Installation Details

JBP_MW107

Project:	Bayswater Burrow Pits			**Page:**	1 of 1
Client:	AGL Macquarie	**Location:**	Borrow Pit 4	**Project No:**	IA215400

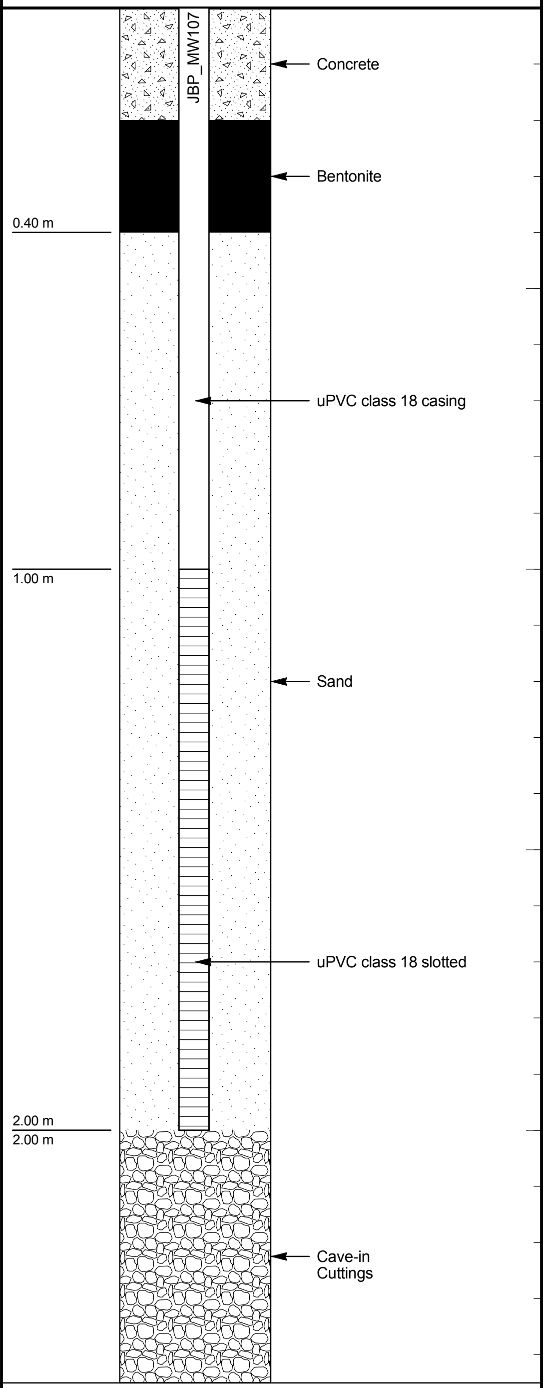
Contractor:	Terratest	**Easting:**	305282.0	**Elevation:**	145.69	**Started:**	03/10/2019
Plant:	Geoprobe	**Northing:**	6410669.8	**Datum:**	AHD	**Finished:**	03/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING | MATERIAL SUBSTANCE | INSTALLATION DETAILS

Method & Support	Water	RL (m)	Depth (m)	Description of Strata ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type)
AD/V	Not Observed	145.69	0.00	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace rootlets; dry, firm
			0.10	CLAY: medium to high plasticity, brown mottled orange-brown, red-brown and dark grey, trace fine grained, subrounded gravel, trace rootlets; moist, dry of plastic limit, stiff
			1.10	CLAY: medium plasticity, orange-brown mottled grey, trace fine grained, subangular gravel, relict rock fabric; moist, dry of plastic limit, very stiff / hard
			2.00	CLAY: low to medium plasticity, grey mottled orange-brown, dark grey and red-brown, trace thin bands of highly weathered, very low to low strength siltstone, relict rock fabric; moist, dry of plastic limit, hard
			2.45	Hole Terminated at 2.45 m Refusal

RL scale (m): 145.6, 145.4, 145.2, 145.0, 144.8, 144.6, 144.4, 144.2, 144.0, 143.8, 143.6, 143.4, 143.2
Depth scale (m): 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6

ID	Type	Stick Up & RL	Tip Depth & RL
JBP_MW107	Standpipe Piezometer	0.94 m 146.63 m	2.00 m 143.69 m



DRILLING

NMLC	NMLC Coring	HQ	HQ Coring	TCR	% core run recovered
NQ	NQ Coring	PQ	PQ Coring	RQD	% core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static) ▽ = Water level (during drilling)

Piezometer Installation Details

JBP_MW108

Project: Bayswater Burrow Pits
Client: AGL Macquarie
Location: Borrow Pit 4

Project No: IA215400

Contractor:	Terratest	**Easting:**	304815.0	**Elevation:**	133.08	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410729.4	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING / MATERIAL SUBSTANCE

Method & Support: AD/T (0.0 – 4.60 m)
Water: Not Observed

Description of Strata

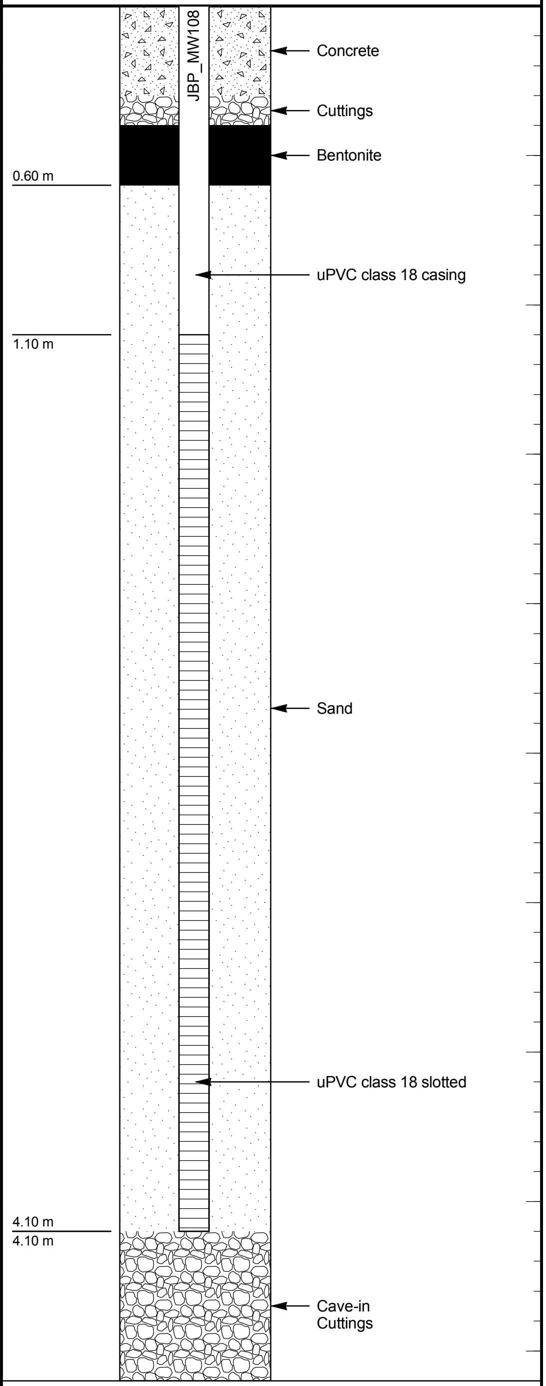
ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type)

Depth (m)	RL (m)	Description of Strata
0.00 – 0.20	133.08 – 132.88	CLAY: low plasticity, brown, trace fine grained, subangular gravel, trace rootlets; dry, firm
0.20 – 2.50	132.88 – 130.58	CLAY: medium to high plasticity, orange-brown, trace fine grained, subangular gravel, trace rootlets; dry, stiff ... becoming orange-brown spotted dark grey
2.50 – 4.00	130.58 – 129.08	CLAY: medium plasticity, orange-brown banded grey mottled red-brown, 70mm thick beds of gravelly clay, gravel is fine to coarse grained, subangular, very faint relict rock fabric; moist, dry of plastic limit, very stiff / hard
4.00 – 4.60	129.08 – 128.48	CLAY: low to medium plasticity, grey mottled orange-brown, trace fine grained sand, relict rock fabric; moist, dry of plastic limit, hard

Hole Terminated at 4.60 m
Refusal

INSTALLATION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL
JBP_MW108	Standpipe Piezometer	0.93 m 134.01 m	4.10 m 128.98 m



DRILLING

NMLC	NMLC Coring	HQ	HQ Coring	TCR	% core run recovered
NQ	NQ Coring	PQ	PQ Coring	RQD	% core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static)   ▽ = Water level (during drilling)

JACOBS Piezometer Installation Details

JBP_MW109

Project: Bayswater Burrow Pits
Client: AGL Macquarie
Location: Borrow Pit 4

Project No: IA215400

Contractor:	Terratest	**Easting:**	305225.6	**Elevation:**	140.29	**Started:**	02/10/2019
Plant:	Geoprobe	**Northing:**	6410581.2	**Datum:**	AHD	**Finished:**	02/10/2019
Logged by:	GC **Checked by:** MF	**Grid:**	MGA94 Zone 56	**Inclination:**	-90°	**Orientation:**	

DRILLING / MATERIAL SUBSTANCE / INSTALLATION DETAILS

Columns: Method & Support | Water | RL (m) | Depth (m) | Graphic Log | Description of Strata (ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, major defect type))

Method & Support: AD/T (0 to 8.20 m)

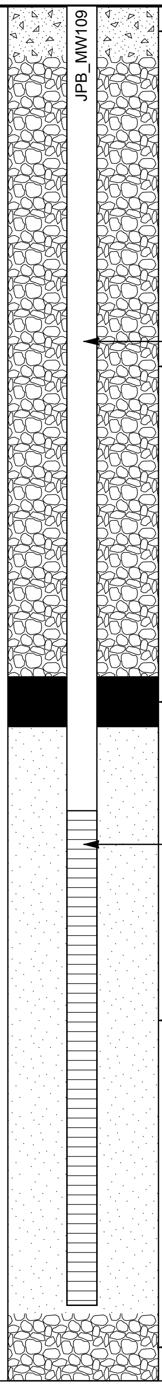
Water: 29/10/19 (approx. 6.3 m)

Depth (m)	Description of Strata
0.00	CLAY: low to medium plasticity, brown, trace fine grained, subangular gravel, trace fine to medium grained sand, trace rootlets; dry, soft / firm
~0.15	CLAY: medium to high plasticity, brown spotted dark grey, trace fine grained, subangular gravel, trace rootlets; moist, dry of plastic limit, firm to very stiff
~1.4	... becoming grey mottled orange-brown and red-brown
~1.65	CLAY: high plasticity, grey mottled orange-brown, trace fine grained, subangular gravel; moist, dry of plastic limit, very stiff
~2.7	CLAY: high plasticity, grey mottled orange, trace fine to medium grained, subangular ironstone gravel, trace fine grained sand; moist, near plastic limit, stiff
~5.7	CLAY: medium to high plasticity, orange-brown mottled grey, trace fine grained sand, trace fine grained, subangular gravel; moist, near plastic limit, firm / stiff
~7.3	CLAY: medium plasticity, dark grey mottled orange-brown, relict rock fabric; moist, dry of plastic limit, hard
8.20	Hole Terminated at 8.20 m Refusal

RL (m): 140, 139, 138, 137, 136, 135, 134, 133, 132

Installation Details

ID	Type	Stick Up & RL	Tip Depth & RL
JPB_MW109	Standpipe Piezometer	0.94 m 141.23 m	7.75 m 132.54 m



DRILLING

NMLC	NMLC Coring	HQ	HQ Coring	TCR	% core run recovered
NQ	NQ Coring	PQ	PQ Coring	RQD	% core run > 100mm long (rock fraction only measured)

GROUNDWATER SYMBOLS

▼ = Water level (static)
▽ = Water level (approx. 1 month after drilling)

Appendix B. Summerised groundwater quality data

JACOBS

			Metals																																													
			Aluminium	Aluminium (Filtered)	Antimony	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (hexavalent)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Lithium	Magnesium	Magnesium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Silver	Thallium	Tin	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)	Carbonate Alkalinity as CaCO3	Soluble Bicarb as CaCO3*	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 2000 FW 95%			55	55								370	370	0.2	0.2	1					1.4	1.4			3.4	3.4				1900	1900	0.6	0.6			11	11	11	11	0.05					8	8				
ANZECC(2000) trigger values for lowland rivers																																																		
Location_Code	Key Area	Sampled_Date_Time																																																
BA_EW_MW01	Ash dam augmer	1/12/2016	90	80	-	3	1	34	31	<1	<1	2530	2290	0.6	0.1	-	<1	<1	9	9	<1	<1	<50	<0.05	<1	<1	-	302	-	1940	1730	<0.1	<0.1	2	2	49	49	<10	<10	-	-	-	<10	<10	15	15	-	-	<1	84
BA_EW_MW01	Ash dam augmer	27/02/2017	260	80	-	2	2	29	31	2	<1	3040	3020	0.2	0.1	-	<1	<1	7	7	<1	<1	120	<0.05	<1	<1	-	396	-	1920	1790	<0.1	<0.1	2	<1	45	44	<10	<10	-	-	-	<10	<10	21	14	-	-	<1	87
BA_EW_MW01	Ash dam augmer	28/06/2017	100	100	-	2	<1	19	18	<1	<1	2950	2970	0.2	<0.1	-	<1	<1	8	8	<1	<1	<50	<0.05	<1	<1	-	466	-	1950	2130	<0.1	<0.1	2	2	39	34	<10	<10	-	-	-	<10	<10	16	13	-	-	<1	61
BA_EW_MW01	Ash dam augmer	6/09/2017	160	60	-	1	<1	18	16	<1	<1	2700	2490	0.1	<0.1	-	<1	<1	11	9	<1	<1	100	<0.05	<1	<1	-	406	-	2370	2210	<0.1	<0.1	<1	<1	35	33	<10	<10	-	-	-	<10	<10	12	8	-	-	<1	66
BA_EW_MW01	Ash dam augmer	29/11/2017	30	<10	-	1	<1	14	15	<1	<1	2940	2830	<0.1	0.1	-	<1	<1	8	8	<1	<1	50	<0.05	<1	<1	-	383	-	2850	2810	<0.1	<0.1	<1	<1	27	27	<10	<10	-	-	-	<10	<10	7	<5	-	-	<1	69
BA_EW_MW01	Ash dam augmer	28/02/2018	70	<10	-	1	<1	17	14	<1	<1	3100	2830	0.2	0.1	-	1	<1	9	13	<1	<1	110	0.22	<1	<1	-	350	-	3240	2850	<0.1	<0.1	1	2	33	31	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	84
BA_EW_MW01	Ash dam augmer	30/05/2018	80	<10	-	1	<1	14	15	<1	<1	3060	2600	0.2	0.2	-	<1	<1	6	5	<1	<1	160	0.11	<1	<1	-	392	-	2230	2200	<0.1	<0.1	2	1	32	34	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	93
BA_EW_MW01	Ash dam augmer	23/08/2018	40	<10	-	1	<1	14	13	<1	<1	3380	2900	0.5	0.3	-	<1	<1	4	4	<1	<1	<50	<0.05	<1	<1	-	411	-	2200	2020	<0.1	<0.1	1	<1	33	30	<10	<10	-	-	-	<10	<10	8	<5	-	-	<1	101
BA_EW_MW01	Ash dam augmer	4/12/2018	40	<10	-	1	1	18	17	<1	<1	3210	3160	0.8	0.8	-	<1	<1	3	3	<1	<1	<50	<0.05	<1	<1	-	387	-	1950	1850	<0.1	<0.1	1	2	37	36	<10	<10	-	-	-	<10	<10	7	6	-	-	<1	100
BA_EW_MW01	Ash dam augmer	28/03/2019	20	<10	-	1	<1	27	25	<1	<1	3630	3220	0.4	0.5	-	<1	<1	4	4	1	<1	<50	<0.05	<1	<1	-	490	-	769	719	<0.1	<0.1	<1	<1	47	50	<10	<10	-	-	-	<10	<10	8	8	-	-	<1	89
BA_MW01	Ash dam augmer	30/11/2016	130	120	-	<1	1	7	7	<1	<1	2300	2360	2	2	-	<1	<1	23	24	<1	<1	130	<0.05	<1	<1	-	547	-	3070	3180	<0.1	<0.1	<1	<1	138	138	<10	<10	-	-	-	<10	<10	44	46	-	-	<1	35
BA_MW01	Ash dam augmer	27/02/2017	130	110	-	<1	1	8	7	<1	<1	2340	2360	2.1	2	-	<1	<1	24	24	<1	<1	<50	<0.05	2	<1	-	601	-	3180	3200	<0.1	<0.1	5	<1	126	130	<10	<10	-	-	-	<10	<10	49	45	-	-	<1	33
BA_MW01	Ash dam augmer	28/06/2017	120	100	-	<1	<1	7	6	<1	<1	2380	2330	1.8	1.8	-	<1	<1	22	22	<1	<1	<50	<0.05	<1	<1	-	674	-	3030	3090	<0.1	<0.1	<1	<1	130	118	<10	<10	-	-	-	<10	<10	47	40	-	-	<1	30
BA_MW01	Ash dam augmer	6/09/2017	250	80	-	<1	<1	8	7	<1	<1	2400	2250	1.9	1.6	-	<1	<1	24	22	<1	<1	290	<0.05	<1	<1	-	516	-	3370	2630	<0.1	<0.1	<1	<1	129	119	<10	<10	-	-	-	<10	<10	48	39	-	-	<1	29
BA_MW01	Ash dam augmer	29/11/2017	440	90	-	<1	<1	9	7	<1	<1	2280	2230	1.8	1.9	-	<1	<1	20	22	1	<1	480	<0.05	<1	<1	-	554	-	2960	2920	<0.1	<0.1	<1	<1	111	119	<10	<10	-	-	-	<10	<10	48	42	-	-	<1	42
BA_MW01	Ash dam augmer	28/02/2018	190	90	-	<1	<1	8	6	<1	<1	2440	2430	1.9	1.8	-	<1	<1	25	23	<1	<1	170	<0.05	<1	<1	-	503	-	3330	2990	<0.1	<0.1	<1	<1	133	119	<10	<10	-	-	-	<10	<10	46	41	-	-	<1	33
BA_MW01	Ash dam augmer	30/05/2018	100	80	-	<1	<1	7	7	<1	<1	2260	1950	1.7	1.8	-	<1	<1	26	25	<1	<1	<50	<0.05	<1	<1	-	571	-	3220	3270	<0.1	<0.1	<1	<1	126	126	<10	<10	-	-	-	<10	<10	45	42	-	-	<1	41
BA_MW01	Ash dam augmer	17/08/2018	100	60	-	<1	<1	7	6	<1	<1	2030	2040	1.6	1.4	-	<1	<1	23	20	<1	<1	60	<0.05	<1	<1	-	519	-	3080	2900	<0.1	<0.1	<1	<1	116	110	<10	<10	-	-	-	<10	<10	41	35	-	-	<1	39
BA_MW01	Ash dam augmer	4/12/2018	80	70	-	<1	<1	8	6	<1	<1	2440	2450	1.8	1.7	-	<1	<1	26	23	<1	<1	<50	<0.05	<1	<1	-	560	-	3400	3150	<0.1	<0.1	<1	<1	137	120	<10	<10	-	-	-	<10	<10	48	41	-	-	<1	46
BA_MW01	Ash dam augmer	28/03/2019	70	60	-	<1	<1	7	6	<1	<1	2230	1920	2	1.8	-	<1	<1	22	22	<1	<1	<50	<0.05	<1	<1	-	610	-	3210	2920	<0.1	<0.1	<1	<1	120	121	<10	<10	-	-	-	<10	<10	42	39	-	-	<1	36
BA_MW03	Ash dam augmer	23/11/2016	320	280	-	1	<1	14	11	<1	<1	1340	1130	3	2.8	-	<1	<1	97	92	<1	<1	<50	<0.05	<1	<1	-	504	-	3630	3330	<0.1	<0.1	<1	<1	288	283	<10	<10	-	-	-	<10	<10	116	114	-	-	<1	37
BA_MW03	Ash dam augmer	23/02/2017	390	290	-	<1	<1	14	13	<1	<1	1440	1350	3	2.6	-	<1	<1	106	98	<1	<1	230	<0.05	<1	<1	-	551	-	3670	3500	<0.1	<0.1	<1	<1	294	274	<10	<10	-	-	-	<10	<10	122	108	-	-	<1	37
BA_MW03	Ash dam augmer	28/06/2017	310	340	-	<1	3	15	13	<1	<1	1600	1600	2.6	2.4	-	<1	<1	95	98	<1	<1	<50	<0.05	<1	<1	-	586	-	3380	3700	<0.1	<0.1	<1	<1	297	270	<10	<10	-	-	-	<10	<10	121	114	-	-	<1	33
BA_MW03	Ash dam augmer	6/09/2017	440	300	-	<1	<1	14	11	<1	<1	1730	1570	2.4	2.2	-	<1	<1	102	96	<1	<1	180	<0.05	<1	<1	-	454	-	3970	3090	<0.1	<0.1	<1	<1	281	275	<10	<10	-	-	-	<10	<10	118	113	-	-	<1	34
BA_MW03	Ash dam augmer	29/11/2017	350	340	-	<1	<1	13	12	<1	<1	1790	1660	2.6	2.3	-	<1	<1	101	99	<1	<1	80	<0.05	<1	<1	-	455	-	3660	3540	<0.1	<0.1	<1	<1	270	274	<10	<10	-	-	-	<10	<10	111	112	-	-	<1	33
BA_MW03	Ash dam augmer	27/02/2018	330	330	-	<1	<1	14	12	<1	<1	1860	1870	2.6	2.2	-	<1	<1	104	89	<1	<1	60	<0.05	<1	<1	-	403	-	3910	3300	<0.1	<0.1	<1	<1	297	242	<10	<10	-	-	-	<10	<10	116	99	-	-	<1	32
BA_MW03	Ash dam augmer	30/05/2018	270	250	-	<1	<1	14	13	<1	<1	1680	1530	2.4	2.2	-	<1	<1	94	89	74	<1	70	<0.05	3	<1	-	439	-	3780	3710	<0.1	<0.1	<1	<1	265	254	<10	<10	-	-	-	<10	<10	155	95	-	-	<1	36
BA_MW03	Ash dam augmer	14/08/2018	270	280	-	<1	<1	13	13	<1	<1	1370	1540	2.3	2.4	-	<1	<1	89	90	<1	<1	50	<0.05	<1	<1	-	452	-	3630	3840	<0.1	<0.1	<1	<1	256	270	<10	<10	-	-	-	<10	<10	103	103	-	-	<1	32
BA_MW03	Ash dam augmer	4/12/2018	320	310	-	<1	<1	12	12	<1	<1	1610	1580	2.7	2.6	-	<1	<1	100	92	<1	<1	<50	<0.05	<1	<1	-	432	-	3550	3500	<0.1	<0.1	<1	<1	298	284	<10	<10	-	-	-	<10	<10	118	112	-	-	<1	35
BA_MW03	Ash dam augmer	28/03/2019	290	270	-	<1	<1	13	12	<1	<1	1520	1300	2.7	2.5	-	<1	<1	94	90	<1	<1	<50	<0.05	<1	<1	-	451	-	3490	3240	<0.1	<0.1	<1	<1	285	274	<10	<10	-	-	-	<10	<10	109	108	-	-	<1	33
BQ_MW04	Ash dam augmer	29/11/2016	90	<10	-	<1	<1	28	32	<1	<1	180	200	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	130	<0.05	3	3	-	298	-	12	12	<0.1	<0.1	3	3	4	4	<10	<10	-	-	-	<10	<10	<5	6	-	-	<1	811
BQ_MW04	Ash dam augmer	24/02/2017	60	<10	-	<1	<1	33	34	<1	<1	200	220	<0.1	0.1	-	<1	<1	<1	2	<1	<1	80	<0.05	2	<1	-	418	-	23	207	<0.1	<0.1	2	2	3	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	820
BQ_MW04	Ash dam augmer	15/06/2017	40	<10	-	<1	<1	34	33	<1	<1	170	170	<0.1	<0.1	-	<1	<1	<1	<1	1	<1	160	0.08	1	<1	-	314	-	46	45	<0.1	<0.1	4	3	4	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	829
BQ_MW04	Ash dam augmer	6/09/2017	1740	<10	-	<1	<1	44	23	<1	<1	210	190	<0.1	<0.1	-	4	<1	1	<1	5	<1	2960	<0.05	7	<1	-	309	-	70	15	<0.1	<0.1	3	2	6	3	<10	<10	-	-	-	<10	<10	8	<5	-	-	<1	921
BQ_MW04	Ash dam augmer	16/11/2017	1000	<10	-	<1	<1	33	24	<1	<1	350	370	<0.1	0.4	-	2	<1	<1	<1	<1	<1	1370	<0.05	2	<1	-	334	-	28	3	<0.1	<0.1	3	3	3	3	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	908
BQ_MW04	Ash dam augmer	22/02/2018	110	<10	-	<1	<1	27	24	<1	<1	310	320	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	160	<0.05	<1	<1	-	304	-	6	3	<0.1	<0.1	3	2	3	3	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	921
BQ_MW04	Ash dam augmer	29/05/2018	<10	<10	-	<1	<1	23	22	<1	<1	190	190	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	<50	<0.05	<1	<1	-	249	-	2	3	<0.1	<0.1	2	2	5	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	933
BQ_MW04	Ash dam augmer	14/08/2018	170	<10	-	<1	<1	32	35	<1	<1	220	250	<0.1	<0.1	-	<1	<1	<1	6	<1	<1	100	<0.05	<1	<1	-	376	-	90	514	<0.1	<0.1	3	2	4	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	873
BQ_MW04	Ash dam augmer	20/11/2018	500	<10	-	<1	<1	30	24	<1	<1	290	300	<0.1	<0.1	-	<1	<1	<1	<1	1	<1	720	<0.05	1	<1	-	219	-	48	30	<0.1	<0.1	2	2	6	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	867
BQ_MW04	Ash dam augmer	28/03/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW05	Ash dam augmer	25/11/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	25/11/2016	60	<10	-	<1	<1	6	6	<1	<1	1250	1090	<0.1	0.2	-	5	3	<1	<1	<1	<1	70	<0.05	<1	<1	-	330	-	11	12	<0.1	<0.1	<1	2	9	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	243
BQ_MW07	Ash dam augmer	24/02/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	15/06/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	6/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	16/11/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	28/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	20/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	22/03/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW08	Ash dam augmer	25/11/2016	510	<10	-	<1	<1	8	5	<1	<1	3480	3100	<0.1	<0.1	-	2	<1	<1	<1	<1	<1	790	<0.05	<1	<1	-	134	-	125	108	<0.1	<0.1	<1	1	6	7	<10	<10	-	-	-	<10	<10	6	<5	-	-	<1	138
BQ_MW08	Ash dam augmer	24/02/2017	10	<10	-	<1	<1	5	6	<1	<1	3380	3100	<0.1	<0.1	-	<1	<1	<1	<1	2	3	<50	<0.05	<1	<1	-	122	-	144	139	<0.1	<0.1	<1	<1	8	7	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	140
BQ_MW08	Ash dam augmer	16/06/2017	1540	<10	-	<1	<1	14	6	<1	<1	3070	3590	<0.1	<0.1	-	2	<1	<1	<1	3	<1	2660	<0.05	<1	<1	-	132	-	177	138	<0.1	<0.1	<1	<1	9	8	<10	<10	-	-	-	<10	<10	7	<5	-	-	<1	138
BQ_MW08	Ash dam augmer	5/09/2017	5490	<10	-	3	<1	44	5	<1	<1	3540	3330	<0.1	<0.1	-	6	<1	2	<1	11	<1	9420	<0.05	2	<1	-	131	-	283	99	<0.1	<0.1	1	<1	13	7	<10	<10	-	-	-	10	<10	21	<5	-	-	<1	155
BQ_MW08	Ash dam augmer	15/11/2017	320	<10	-	<1	<1	7	6	<1	<1	3530	3590	<0.1	0.1	-	<1	1	<1	<1	<1	<1	400	<0.05	<1	<1	-	153	-	130	133	<0.1	<0.1	<1	<1	9	9	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	150
BQ_MW08	Ash dam augmer	23/02/2018	260	<10	-	<1	<1	8	5	<1	<1	3400	3250	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	420	<0.05	<1	<1	-	120	-	138	126	<0.1	<0.1	<1	<1	7	7	<10	<10	-	-	-	<10	<10	8	<5	-	-	<1	152
BQ_MW08	Ash dam augmer	29/05/2018	4740	<10	-	2	<1	34	6	<1	<1	3140	3730	0.2	<0.1	-	4	<1	2	<1	9	12	7240	<0.05	3	<1	-	126	-	267	134	<0.1	<0.1	1	<1	13	9	<10	<10	-	-	-	10	<10	16	<5	-	-	<1	146
BQ_MW08	Ash dam augmer	2/08/2018	40	<10	-	<1	<1	7	5	<1	<1	2950	3460	<0.1	0.1	-	<1	<1	<1	<1	<1	<1	60	<0.05	<1	<1	-	126	-	135	129	<0.1	<0.1	<1	<1	9	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	135
BQ_MW08	Ash dam augmer	26/11/2018	40	<10	-	2	<1	6	6	<1	<1	3720	3580	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	50	<0.05	<1	<1	-	131	-	140	145	<0.1	<0.1	3	<1	8	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	144

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

JACOBS

Location_Code	Key Area	Sampled_Date_Time	Aluminium	Aluminium (Filtered)	Antimony	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (hexavalent)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)
			Metals																			
			μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
ANZECC 2000 FW 95%			55	55								370	370	0.2	0.2	1					1.4	1.4
ANZECC(2000) trigger values for lowland rivers																						
BQ_MW08	Ash dam augmer	27/03/2019	240	<10	-	<1	<1	8	5	<1	<1	3700	3380	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW10	Ash dam augmer	24/11/2016	7420	6370	-	<1	<1	8	6	4	3	3900	3650	0.5	0.4	-	<1	<1	105	97	2	<1
BQ_MW10	Ash dam augmer	1/06/2017	5860	4800	-	<1	<1	6	6	2	2	2580	2720	0.4	0.4	-	<1	<1	80	74	3	2
BQ_MW10	Ash dam augmer	5/09/2017	7430	7150	-	<1	<1	13	9	3	4	3780	3510	0.2	0.3	-	5	<1	101	96	3	3
BQ_MW10	Ash dam augmer	14/11/2017	7320	7050	-	<1	<1	7	8	3	3	3660	3510	0.6	0.5	-	<1	<1	103	96	3	2
BQ_MW10	Ash dam augmer	22/02/2018	6910	6900	-	<1	<1	7	7	3	3	3870	3780	0.5	0.5	-	<1	<1	97	95	3	3
BQ_MW10	Ash dam augmer	28/05/2018	8460	6830	-	<1	<1	10	8	4	3	4620	3380	0.6	0.5	-	<1	<1	120	90	5	3
BQ_MW10	Ash dam augmer	14/08/2018	7360	6810	-	<1	<1	8	7	3	3	3380	3480	0.4	0.5	-	<1	<1	100	92	3	3
BQ_MW10	Ash dam augmer	27/11/2018	7540	7180	-	<1	<1	8	7	4	4	3760	3470	0.5	0.5	-	<1	<1	103	96	4	3
BQ_MW10	Ash dam augmer	26/03/2019	7060	6820	-	<1	<1	8	7	4	4	3540	3380	0.4	0.5	-	<1	<1	98	85	3	3
BQ_MW11	Ash dam augmer	25/11/2016	1200	<10	-	<1	<1	13	7	<1	<1	510	360	<0.1	0.2	-	2	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	24/02/2017	1790	<10	-	1	<1	17	9	<1	<1	540	520	<0.1	<0.1	-	2	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	15/06/2017	770	<10	-	<1	<1	12	10	<1	<1	410	450	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	5/09/2017	270	<10	-	<1	<1	10	6	<1	<1	420	350	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	15/11/2017	660	<10	-	<1	<1	11	7	<1	<1	460	380	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	23/02/2018	80	<10	-	<1	<1	10	8	<1	<1	560	690	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	28/05/2018	470	<10	-	<1	<1	15	9	<1	<1	820	450	<0.1	<0.1	-	<1	<1	4	<1	<1	<1
BQ_MW11	Ash dam augmer	14/08/2018	120	10	-	<1	<1	9	8	<1	<1	420	400	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	26/11/2018	10	<10	-	2	<1	8	8	<1	<1	490	430	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW11	Ash dam augmer	26/03/2019	<10	<10	-	<1	<1	9	9	<1	<1	410	400	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW13	Ash dam augmer	24/11/2016	1180	<10	-	1	<1	39	24	<1	<1	2510	2450	<0.1	<0.1	-	2	<1	1	<1	<1	<1
BQ_MW13	Ash dam augmer	23/02/2017	80	<10	-	<1	<1	30	29	<1	<1	2280	2170	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW13	Ash dam augmer	1/06/2017	40	<10	-	<1	<1	25	22	<1	<1	1740	1820	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW13	Ash dam augmer	4/09/2017	160	<10	-	<1	<1	32	28	<1	<1	2370	1910	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW13	Ash dam augmer	24/11/2017	90	<10	-	<1	<1	31	30	<1	<1	2310	1800	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQ_MW13	Ash dam augmer	23/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW13	Ash dam augmer	31/05/2018	160	<10	-	<1	<1	33	32	<1	<1	2320	2160	<0.1	<0.1	-	<1	<1	<1	<1	1	1
BQ_MW13	Ash dam augmer	2/08/2018	110	<10	-	<1	<1	40	34	<1	<1	2310	2340	<0.1	<0.1	-	<1	<1	<1	<1	<1	1
BQ_MW13	Ash dam augmer	26/11/2018	1100	<10	-	2	<1	41	34	<1	<1	2270	2110	<0.1	<0.1	-	1	<1	<1	<1	2	<1
BQ_MW13	Ash dam augmer	27/03/2019	260	<10	-	<1	<1	34	29	<1	<1	2290	2150	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	29/11/2016	10	<10	-	<1	<1	10	11	<1	<1	1800	1920	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	28/02/2017	10	<10	-	<1	<1	11	11	<1	<1	2020	2060	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	16/06/2017	130	<10	-	<1	<1	10	11	<1	<1	1980	2190	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	5/09/2017	100	<10	-	<1	<1	10	9	<1	<1	2280	2130	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	15/11/2017	30	<10	-	<1	<1	12	9	<1	<1	2160	1730	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	23/02/2018	20	<10	-	<1	<1	14	13	<1	<1	2050	1980	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	31/05/2018	<10	<10	-	<1	<1	15	14	<1	<1	2250	2040	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	13/08/2018	10	<10	-	<1	<1	15	13	<1	<1	2100	1980	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	27/11/2018	30	<10	-	<1	<1	11	10	<1	<1	2230	2200	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW01	Ash dam augmer	26/03/2019	<10	<10	-	<1	<1	11	11	<1	<1	2200	2040	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW02	Ash dam augmer	29/11/2016	660	<10	-	<1	<1	18	12	<1	<1	2740	2990	<0.1	<0.1	-	<1	<1	1	<1	1	<1
BQEW_MW02	Ash dam augmer	28/02/2017	40	<10	-	<1	<1	12	11	<1	<1	3380	3310	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW02	Ash dam augmer	16/06/2017	<10	<10	-	<1	<1	11	12	<1	<1	3000	3320	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW02	Ash dam augmer	5/09/2017	20	<10	-	<1	<1	11	10	<1	<1	3430	3200	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW02	Ash dam augmer	15/11/2017	20	70	-	<1	<1	13	9	<1	<1	3210	2760	<0.1	<0.1	-	<1	<1	<1	<1	1	1
BQEW_MW02	Ash dam augmer	27/02/2018	260	<10	-	<1	<1	14	10	<1	<1	3540	3190	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW02	Ash dam augmer	31/05/2018	10	<10	-	<1	<1	12	12	<1	<1	3440	3220	<0.1	<0.1	-	<1	<1	<1	<1	1	<1
BQEW_MW02	Ash dam augmer	2/08/2018	<10	<10	-	<1	<1	15	11	<1	<1	3850	3240	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW02	Ash dam augmer	27/11/2018	<10	<10	-	<1	<1	14	11	<1	<1	4270	3270	<0.1	<0.1	-	<1	<1	<1	<1	1	<1
BQEW_MW02	Ash dam augmer	26/03/2019	<10	<10	-	<1	<1	12	11	<1	<1	3440	3280	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1
BQEW_MW03	Ash dam augmer	30/11/2016	6740	<10	-	5	4	73	33	<1	<1	310	310	<0.1	<0.1	-	8	<1	6	3	9	<1
BQEW_MW03	Ash dam augmer	28/02/2017	1060	<10	-	4	4	41	33	<1	<1	600	530	<0.1	<0.1	-	1	<1	5	4	6	<1
BQEW_MW03	Ash dam augmer	16/06/2017	1480	<10	-	2	3	46	37	<1	<1	320	330	<0.1	<0.1	-	2	<1	4	4	2	<1
BQEW_MW03	Ash dam augmer	5/09/2017	880	<10	-	1	<1	32	24	<1	<1	410	250	<0.1	<0.1	-	1	<1	1	<1	1	<1
BQEW_MW03	Ash dam augmer	28/11/2017	54,700	<10	-	25	2	357	29	5	<1	440	360	0.4	<0.1	-	67	<1	24	4	103	<1
BQEW_MW03	Ash dam augmer	23/02/2018	1160	<10	-	3	1	32	25	<1	<1	580	550	<0.1	<0.1	-	1	<1	3	3	1	<1
BQEW_MW03	Ash dam augmer	31/05/2018	160	<10	-	<1	<1	23	24	<1	<1	450	380	<0.1	<0.1	-	<1	<1	<1	<1	1	<1
BQEW_MW03	Ash dam augmer	13/08/2018	310	<10	-	<1	<1	24	20	<1	<1	340	360	<0.1	<0.1	-	<1	<1	<1	<1	3	<1

Location_Code	Sampled_Date_Time	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Lithium	Magnesium	Magnesium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Silver	Thallium	Tin	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)	Carbonate Alkalinity as CaCO3	Soluble Bicarb as CaCO3*	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3
		Metals																											
		μg/L	mg/L	μg/L	μg/L	μg/L	mg/L	mg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 2000 FW 95%				3.4	3.4				1900	1900	0.6	0.6			11	11	11	11	0.05					8	8				
ANZECC(2000) trigger values for lowland rivers																													
BQ_MW08	27/03/2019	260	<0.05	<1	<1	-	125	-	135	132	<0.1	<0.1	<1	<1	8	9	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	123
BQ_MW10	24/11/2016	300	0.23	<1	<1	-	39	-	680	586	<0.1	<0.1	<1	<1	203	196	<10	10	-	-	-	<10	<10	292	259	-	-	<1	<1
BQ_MW10	1/06/2017	290	0.18	<1	<1	-	38	-	821	528	<0.1	<0.1	<1	<1	150	149	<10	<10	-	-	-	<10	<10	199	192	-	-	<1	<1
BQ_MW10	5/09/2017	320	0.25	<1	<1	-	38	-	666	645	<0.1	<0.1	<1	2	192	179	<10	<10	-	-	-	<10	<10	274	266	-	-	<1	<1
BQ_MW10	14/11/2017	380	0.26	<1	<1	-	41	-	690	689	<0.1	<0.1	<1	<1	205	180	<10	<10	-	-	-	<10	<10	275	262	-	-	<1	<1
BQ_MW10	22/02/2018	270	0.24	<1	<1	-	38	-	628	637	<0.1	<0.1	<1	<1	181	183	<10	<10	-	-	-	<10	<10	260	255	-	-	<1	<1
BQ_MW10	28/05/2018	490	0.26	<1	<1	-	39	-	800	646	<0.1	<0.1	<1	<1	256	181	10	10	-	-	-	<10	<10	329	266	-	-	<1	<1
BQ_MW10	14/08/2018	280	0.25	<1	<1	-	38	-	666	606	<0.1	<0.1	<1	<1	195	182	<10	<10	-	-	-	<10	<10	281	259	-	-	<1	<1
BQ_MW10	27/11/2018	300	0.25	<1	<1	-	39	-	692	662	<0.1	<0.1	<1	<1	196	182	<10	<10	-	-	-	<10	<10	282	252	-	-	<1	<1
BQ_MW10	26/03/2019	280	0.26	<1	<1	-	40	-	668	646	<0.1	<0.1	<1	<1	194	185	<10	<10	-	-	-	<10	<10	286	268	-	-	<1	<1
BQ_MW11	25/11/2016	1630	<0.05	<1	<1	-	449	-	36	14	<0.1	<0.1	2	2	4	4	<10	<10	-	-	-	<10	<10	6	<5	-	-	<1	444
BQ_MW11	24/02/2017	2280	<0.05	<1	<1	-	532	-	140	88	<0.1	<0.1	2	2	6	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	465
BQ_MW11	15/06/2017	970	<0.05	<1	<1	-	482	-	54	40	<0.1	<0.1	3	3	5	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	452
BQ_MW11	5/09/2017	380	<0.05	<1	<1	-	479	-	53	41	<0.1	<0.1	2	2	4	3	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	500
BQ_MW11	15/11/2017	750	<0.05	<1	<1	-	439	-	62	35	<0.1	<0.1	2	2	5	3	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	511
BQ_MW11	23/02/2018	80	<0.05	<1	<1	-	467	-	60	38	<0.1	<0.1	2	1	4	3	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	505
BQ_MW11	28/05/2018	360	<0.05	<1	<1	-	426	-	120	65	<0.1	<0.1	3	2	13	4	<10	<10	-	-	-	<10	<10	11	<5	-	-	<1	498
BQ_MW11	14/08/2018	110	<0.05	<1	<1	-	402	-	23	15	<0.1	<0.1	2	1	5	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	437
BQ_MW11	26/11/2018	<50	<0.05	1	<1	-	461	-	43	41	<0.1	<0.1	3	2	4	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	464
BQ_MW11	26/03/2019	<50	<0.05	<1	<1	-	429	-	37	34	<0.1	<0.1	2	2	3	4	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	425
BQ_MW13	24/11/2016	1630	<0.05	2	<1	-	134	-	104	77	<0.1	<0.1	<1	<1	10	8	<10	<10	-	-	-	<10	<10	5	<5	-	-	<1	446
BQ_MW13	23/02/2017	110	<0.05	<1	<1	-	161	-	111	111	<0.1	<0.1	<1	<1	6	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	516
BQ_MW13	1/06/2017	70	<0.05	<1	<1	-	125	-	137	82	<0.1	<0.1	<1	<1	5	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	500
BQ_MW13	4/09/2017	200	<0.05	<1	<1	-	144	-	99	99	<0.1	<0.1	<1	<1	8	7	<10	<10	-	-	-	<10	<10	15	<5	-	-	<1	482
BQ_MW13	24/11/2017	120	<0.05	<1	<1	-	146	-	125	122	<0.1	<0.1	<1	<1	8	7	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	542
BQ_MW13	23/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW13	31/05/2018	200	<0.05	<1	<1	-	138	-	85	80	<0.1	<0.1	<1	<1	8	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	553
BQ_MW13	2/08/2018	160	<0.05	<1	<1	-	149	-	133	120	<0.1	<0.1	1	<1	8	8	<10	<10	-	-	-	<10	<10	6	<5	-	-	<1	489
BQ_MW13	26/11/2018	1560	<0.05	1	<1	-	159	-	139	138	<0.1	<0.1	2	<1	7	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	497
BQ_MW13	27/03/2019	350	<0.05	<1	<1	-	149	-	131	128	<0.1	<0.1	<1	<1	6	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	423
BQEW_MW01	29/11/2016	70	<0.05	<1	<1	-	250	-	86	88	<0.1	<0.1	4	4	13	13	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	312
BQEW_MW01	28/02/2017	110	0.07	<1	<1	-	294	-	107	105	<0.1	<0.1	4	2	14	14	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	336
BQEW_MW01	16/06/2017	280	<0.05	<1	<1	-	265	-	65	67	<0.1	<0.1	4	4	13	12	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	302
BQEW_MW01	5/09/2017	150	<0.05	<1	<1	-	281	-	69	51	<0.1	<0.1	4	3	14	12	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	334
BQEW_MW01	15/11/2017	100	0.07	<1	<1	-	252	-	104	89	<0.1	<0.1	4	3	14	12	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	344
BQEW_MW01	23/02/2018	160	<0.05	<1	<1	-	287	-	84	74	<0.1	<0.1	3	3	12	12	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	360
BQEW_MW01	31/05/2018	350	<0.05	<1	<1	-	268	-	114	58	<0.1	<0.1	3	2	12	13	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	360
BQEW_MW01	13/08/2018	160	<0.05	<1	<1	-	251	-	108	74	<0.1	<0.1	3	3	13	11	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	314
BQEW_MW01	27/11/2018	130	0.07	<1	<1	-	267	-	110	95	<0.1	<0.1	3	3	13	13	<10	<10	-	-	-	<10	<10	<5	38	-	-	<1	289
BQEW_MW01	26/03/2019	70	0.06	<1	<1	-	284	-	109	102	<0.1	<0.1	4	3	14	13	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	300
BQEW_MW02	29/11/2016	900	<0.05	<1	<1	-	144	-	47	26	<0.1	<0.1	19	14	10	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	258
BQEW_MW02	28/02/2017	<50	<0.05	<1	<1	-	164	-	17	19	<0.1	<0.1	18	13	14	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	279
BQEW_MW02	16/06/2017	<50	<0.05	<1	<1	-	153	-	16	15	<0.1	<0.1	17	17	9	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	266
BQEW_MW02	5/09/2017	<50	<0.05	<1	<1	-	177	-	16	12	<0.1	<0.1	16	15	10	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	300
BQEW_MW02	15/11/2017	<50	<0.05	<1	<1	-	153	-	20	17	<0.1	<0.1	16	13	10	8	<10	<10	-	-	-	<10	<10	7	<5	-	-	<1	300
BQEW_MW02	27/02/2018	380	<0.05	<1	<1	-	161	-	21	16	<0.1	<0.1	19	13	12	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	307
BQEW_MW02	31/05/2018	<50	<0.05	<1	<1	-	169	-	14	14	<0.1	<0.1	20	12	11	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	297
BQEW_MW02	2/08/2018	<50	<0.05	<1	<1	-	164	-	23	16	<0.1	<0.1	27	22	13	9	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	277
BQEW_MW02	27/11/2018	<50	<0.05	<1	<1	-	167	-	22	17	<0.1	0.1	23	17	13	10	<10	<10	-	-	-	<10	<10	<5	6	-	-	<1	265
BQEW_MW02	26/03/2019	60	<0.05	<1	<1	-	173	-	43	41	<0.1	<0.1	19	16	10	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	253
BQEW_MW03	30/11/2016	11,400	3.66	4	<1	-	266	-	232	214	<0.1	<0.1	8	5	18	10	<10	<10	-	-	-	20	<10	18	<5	-	-	<1	518
BQEW_MW03	28/02/2017	3930	2.68	<1	<1	-	385	-	265	254	<0.1	<0.1	6	4	22	15	<10	<10	-	-	-	<10	<10	10	<5	-	-	<1	733
BQEW_MW03	16/06/2017	3870	1.83	<1	<1	-	246	-	197	203	<0.1	<0.1	5	5	15	14	<10	<10	-	-	-	<10	<10	7	<5	-	-	<1	604
BQEW_MW03	5/09/2017	1520	0.21	<1	<1	-	280	-	122	81	<0.1	<0.1	3	3	16	13	<10	<10	-	-	-	<10	<10	6	<5	-	-	<1	749
BQEW_MW03	28/11/2017	71,200	0.73	61	<1	-	441	-	379	231	<0.1	<0.1	5	4	71	16	<10	<10	-	-	-	200	<10	177	<5	-	-	<1	669
BQEW_MW03	23/02/2018	2920	1.23	<1	<1	-	408	-	195	193	<0.1	<0.1	3	2	14	11	<10	<10	-	-	-	<10	<10	9	<5	-	-	<1	750
BQEW_MW03	31/05/2018	270	0.1	<1	<1	-	301	-	44	45	<0.1	<0.1	3	2	14	15	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	736
BQEW_MW03	13/08/2018	500	0.06	<1	<1	-	302	-	24	22	<0.1	<0.1	3	2	15	14	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	677

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

Metals

			Aluminium	Aluminium (Filtered)	Antimony	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (hexavalent)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Lithium	Magnesium	Magnesium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Silver	Thallium	Tin	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)	Carbonate Alkalinity as CaCO3	Soluble Bicarb as CaCO3*	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 2000 FW 95%			55	55								370	370	0.2	0.2	1					1.4	1.4			3.4	3.4				1900	1900	0.6	0.6			11	11	11	11	0.05					8	8				
ANZECC(2000) trigger values for lowland rivers																																																		
Location_Code	Key Area	Sampled_Date_Time																																																
BQEW_MW03	Ash dam augmer	27/11/2018	2500	<10	-	1	<1	38	22	<1	<1	440	350	<0.1	<0.1	-	3	<1	1	<1	5	<1	3290	0.36	2	<1	-	345	-	33	36	<0.1	<0.1	3	3	16	13	<10	<10	-	-	-	<10	<10	10	<5	-	-	<1	662
BQEW_MW03	Ash dam augmer	26/03/2019	510	<10	-	2	<1	25	21	<1	<1	400	390	<0.1	<0.1	-	<1	<1	2	2	1	<1	1500	0.19	<1	<1	-	330	-	133	125	<0.1	<0.1	3	3	14	14	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	626
BQ_MW02	NE borrow pit zo	24/11/2016	140	<10	-	1	<1	14	9	<1	<1	260	220	0.1	<0.1	-	8	<1	<1	<1	<1	<1	170	<0.05	<1	<1	-	1080	-	649	643	<0.1	<0.1	2	1	17	14	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	866
BQ_MW02	NE borrow pit zo	23/02/2017	30	<10	-	<1	<1	11	11	<1	<1	250	220	0.7	0.5	-	<1	<1	<1	<1	1	2	50	<0.05	<1	<1	-	904	-	746	689	<0.1	<0.1	3	2	11	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	926
BQ_MW02	NE borrow pit zo	28/02/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW02	NE borrow pit zo	1/06/2017	110	<10	-	<1	<1	8	6	<1	<1	190	220	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	200	<0.05	<1	<1	-	1000	-	928	574	<0.1	<0.1	2	<1	8	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	938
BQ_MW02	NE borrow pit zo	6/09/2017	40	<10	-	<1	<1	10	8	<1	<1	280	270	0.3	0.2	-	<1	<1	<1	<1	<1	<1	70	<0.05	<1	<1	-	978	-	676	502	<0.1	<0.1	2	2	10	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	1000
BQ_MW02	NE borrow pit zo	16/11/2017	10	<10	-	6	<1	9	9	<1	<1	270	280	0.3	0.2	-	<1	<1	<1	<1	<1	<1	<50	<0.05	<1	<1	-	1150	-	649	664	<0.1	<0.1	2	2	10	11	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	976
BQ_MW02	NE borrow pit zo	22/02/2018	100	<10	-	1	<1	13	12	<1	<1	230	290	0.3	0.2	-	<1	<1	<1	<1	<1	<1	120	<0.05	<1	<1	-	1090	-	561	524	<0.1	<0.1	2	2	9	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	987
BQ_MW02	NE borrow pit zo	29/05/2018	20	10	-	<1	1	10	10	<1	<1	240	320	0.3	0.4	-	<1	<1	<1	<1	<1	2	<50	<0.05	<1	3	-	994	-	709	711	<0.1	<0.1	3	2	9	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	974
BQ_MW02	NE borrow pit zo	14/08/2018	10	<10	-	<1	<1	8	8	<1	<1	240	240	0.2	0.3	-	<1	<1	<1	<1	<1	<1	<50	<0.05	<1	<1	-	941	-	677	622	<0.1	<0.1	2	2	10	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	880
BQ_MW02	NE borrow pit zo	20/11/2018	<10	<10	-	<1	<1	8	8	<1	<1	250	240	0.2	0.2	-	<1	<1	<1	<1	<1	<1	<50	<0.05	<1	<1	-	987	-	631	636	<0.1	<0.1	2	2	10	10	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	916
BQ_MW02	NE borrow pit zo	27/03/2019	<10	<10	-	<1	<1	8	7	<1	<1	260	250	0.3	0.3	-	<1	<1	<1	<1	<1	1	<50	<0.05	<1	<1	-	958	-	736	708	<0.1	<0.1	2	2	12	11	<10	<10	-	-	-	<10	<10	8	<5	-	-	<1	814
BQ_MW03	NE borrow pit zo	24/11/2016	720	<10	-	<1	<1	15	8	<1	<1	2190	2030	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	950	<0.05	<1	<1	-	334	-	86	72	<0.1	<0.1	<1	<1	9	8	<10	<10	-	-	-	<10	<10	5	<5	-	-	<1	132
BQ_MW03	NE borrow pit zo	23/02/2017	180	<10	-	<1	<1	11	10	<1	<1	2140	1920	<0.1	<0.1	-	<1	<1	4	3	<1	<1	620	0.34	<1	<1	-	371	-	253	192	<0.1	<0.1	<1	<1	9	9	<10	<10	-	-	-	<10	<10	6	<5	-	-	<1	137
BQ_MW03	NE borrow pit zo	1/06/2017	<10	<10	-	<1	<1	8	7	<1	<1	1580	1580	<0.1	<0.1	-	<1	<1	1	1	<1	<1	210	0.13	<1	<1	-	320	-	165	107	<0.1	<0.1	<1	<1	7	6	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	137
BQ_MW03	NE borrow pit zo	4/09/2017	20	<10	-	<1	<1	10	8	<1	<1	2450	1650	<0.1	<0.1	-	<1	<1	1	<1	2	<1	150	0.12	<1	<1	-	309	-	111	110	<0.1	<0.1	<1	<1	7	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	126
BQ_MW03	NE borrow pit zo	16/11/2017	<10	<10	-	<1	<1	9	8	<1	<1	2350	2230	<0.1	<0.1	-	<1	<1	<1	1	<1	<1	130	0.09	<1	<1	-	362	-	106	104	<0.1	<0.1	<1	<1	8	7	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	144
BQ_MW03	NE borrow pit zo	22/02/2018	<10	<10	-	<1	<1	10	9	<1	<1	2130	2020	<0.1	<0.1	-	<1	<1	1	1	<1	<1	140	0.1	<1	<1	-	347	-	112	113	<0.1	<0.1	<1	<1	6	9	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	146
BQ_MW03	NE borrow pit zo	28/05/2018	10	<10	-	<1	<1	13	10	<1	<1	2620	1960	<0.1	<0.1	-	<1	<1	3	2	<1	<1	620	0.3	<1	<1	-	309	-	310	217	<0.1	<0.1	<1	<1	11	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	141
BQ_MW03	NE borrow pit zo	13/08/2018	30	<10	-	<1	<1	10	9	<1	<1	1970	2040	<0.1	<0.1	-	<1	<1	1	1	<1	<1	180	0.12	<1	<1	-	312	-	108	103	<0.1	<0.1	<1	<1	8	8	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	126
BQ_MW03	NE borrow pit zo	20/11/2018	20	<10	-	<1	<1	9	8	<1	<1	2230	2230	<0.1	<0.1	-	<1	<1	<1	1	1	<1	70	0.06	<1	<1	-	316	-	122	123	<0.1	<0.1	<1	<1	10	9	<10	<10	-	-	-	<10	<10	<5	<5	-	-	<1	123
BQ_MW03	NE borrow pit zo	27/03/2019	70	<10	-	<1	<1	13	9	<1	<1	2220	2100	0.1	0.1	-	<1	<1	2	2	<1	<1	180	0.13	<1	<1	-	314	-	134	124	<0.1	<0.1	<1	<1	10	9	<10	<10	-	-	-	<10	<10	5	<5	-	-	<1	126
BB_MW01	Salt cake landfill	18/04/2018	212	-	<1	8.6	-	-	-	-	-	216	-	1.33	-	<10	6.2	-	90.6	-	12.7	-	193	-	1.7	-	1430	-	-	28,300	-	<0.04	-	3.9	-	1170	-	12.6	-	<0.2	1.64	<10.5	8.4	-	<10	-	-	-	-	-
BB_MW01	Salt cake landfill	20/07/2018	174	-	<1	9.2	-	-	-	-	-	238	-	0.81	-	<10	1.8	-	93.3	-	10.5	-	213	-	1.6	-	2280	-	-	30,600	-	<0.1	-	2.7	-	1170	-	14.3	-	<0.2	1.72	<10.5	6.1	-	<10	-	-	-	-	-
BB_MW01	Salt cake landfill	30/10/2018	71	-	<1	9.1	-	-	-	-	-	<210	-	1.89	-	<1	<1	-	120	-	13.1	-	77	-	1.4	-	2940	-	-	41,000	-	<0.1	-	3	-	1540	-	21.2	-	0.8	2.01	<10.5	2.8	-	12	-	-	-	-	-
BB_MW01	Salt cake landfill	18/02/2019	23	-	<1	7.5	-	-	-	-	-	213	-	1.66	-	<1	<1	-	71.2	-	12	-	24	-	<0.4	-	2420	-	-	19,200	-	<0.1	-	2.4	-	1110	-	13	-	<0.2	1.58	<10.5	14.7	-	<10	-	-	-	-	-
BB_MW01	Salt cake landfill	17/04/2019	109	-	<1	9.2	-	-	-	-	-	255	-	2.44	-	<10	<1	-	110	-	13.8	-	88	-	2.8	-	2830	-	-	43,800	-	<0.1	-	2.8	-	1430	-	16.1	-	<0.2	2.1	23.1	11.4	-	<10	-	-	-	-	-
BB_MW02	Salt cake landfill	18/04/2018	263	-	<1	10.7	-	-	-	-	-	<210	-	<0.42	-	<10	4.8	-	33.2	-	<2.1	-	420	-	1.8	-	1070	-	-	21,500	-	<0.04	-	2.7	-	1020	-	15.7	-	0.9	9.07	<10.5	8.6	-	16	-	-	-	-	-
BB_MW02	Salt cake landfill	19/07/2018	19	-	<1	11.4	-	-	-	-	-	<210	-	<0.42	-	<10	<1	-	34	-	<2.1	-	191	-	1.8	-	1450	-	-	24,600	-	<0.1	-	2.8	-	1050	-	19.3	-	<0.2	8.99	<10.5	5.2	-	16	-	-	-	-	-
BB_MW02	Salt cake landfill	29/10/2018	<10	-	<1	11.9	-	-	-	-	-	<210	-	<0.42	-	1	<1	-	43.1	-	<2.1	-	201	-	1.4	-	1840	-	-	25,000	-	<0.1	-	2.5	-	1360	-	27.4	-	0.2	11.1	<10.5	2.1	-	18	-	-	-	-	-
BB_MW02	Salt cake landfill	18/02/2019	<10	-	<1	9.5	-	-	-	-	-	<210	-	<0.42	-	<1	<1	-	36.8	-	<2.1	-	200	-	<0.4	-	1590	-	-	23,100	-	<0.1	-	2.8	-	980	-	14.8	-	<0.2	8.54	<10.5	12.6	-	13	-	-	-	-	-
BB_MW02	Salt cake landfill	17/04/2019	14	-	<1	12.1	-	-	-	-	-	246	-	<0.42	-	<10	<1	-	43	-	<2.1	-	238	-	4.4	-	1740	-	-	29,300	-	<0.1	-	3	-	1240	-	20.4	-	<0.2	10.6	20.4	7.5	-	12	-	-	-	-	-
BB_MW05	Salt cake landfill	17/04/2018	50	-	<0.2	1.2	-	-	-	-	-	123	-	<0.05	-	<10	0.6	-	10.7	-	0.8	-	193	-	0.1	-	119	-	-	4150	-	<0.04	-	3.8	-	170	-	0.9	-	<0.1	0.17	<0.2	1	-	2	-	-	-	-	-
BB_MW05	Salt cake landfill	19/07/2018	8	-	<0.2	0.8	-	-	-	-	-	141	-	<0.05	-	<10	0.4	-	5.9	-	<0.5	-	97	-	<0.1	-	128	-	-	2880	-	<0.1	-	4	-	130	-	0.9	-	<0.1	0.11	<0.2	1.2	-	2	-	-	-	-	-
BB_MW05	Salt cake landfill	29/10/2018	<5	-	<0.2	1.1	-	-	-	-	-	116	-	<0.05	-	<1	13.1	-	7	-	<0.5	-	200	-	<0.1	-	112	-	-	2570	-	<0.1	-	5.7	-	107	-	1	-	<0.1	0.1	0.2	0.6	-	1	-	-	-	-	-
BB_MW05	Salt cake landfill	18/02/2019	<5	-	<0.2	0.8	-	-	-	-	-	144	-	<0.05	-	<1	1.4	-	6.7	-	<0.5	-	127	-	<0.1	-	110	-	-	2720	-	<0.1	-	4.7	-	114	-	0.7	-	<0.1	0.15	<0.2	0.5	-	<1	-	-	-	-	-
BB_MW05	Salt cake landfill	17/04/2019	<5	-	<0.2	0.8	-	-	-	-	-	119	-	<0.05	-	<10	<0.2	-	5.6	-	<0.5	-	218	-	<0.1	-	95.1	-	-	3110	-	<0.1	-	4.1	-	107	-	0.6	-	0.2	0.12	<0.2	0.5	-	1	-	-	-	-	-
MW-A01	Salt cake landfill	7/08/2018	-	-	-	<1	<1	16	15	<1	<1	190	200	<0.1	<0.1	-	3	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	356	78	68	<0.1	<0.1	-	-	14	12	<10	<10	-	-	-	<10	<10	<5	<5	<1	634	<1	634
MW-A01	Salt cake landfill	20/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	331	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	456	<1	456
MW-A01	Salt cake landfill	18/10/2018	-	-	-	<1	<1	13	11	<1	<1	190	160	<0.1	<0.1	-	2	<1	<1	<1	1	<1	-	-	<1	<1	-	-	288	114	102	<0.1	<0.1	-	-	12	9	<10	<10	-	-	-	<10	<10	<5	<5	<1	515	<1	515
MW-A01	Salt cake landfill	15/11/2018	-	-	-	<1	<1	20	17	<1	<1	230	200	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	472	232	210	<0.1	<0.1	-	-	21	17	<10	<10	-	-	-	<10	<10	<5	<5	<1	634	<1	634
MW-A02	Salt cake landfill	21/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	715	<1	715
MW-A02	Salt cake landfill	19/10/2018	-	-	-	2	2	17	10	<1	<1	230	180	<0.1	<0.1	-	2	<1	10	8	1	<1	-	-	<1	<1	-	-	899	288	247	<0.1	<0.1	-	-	17	14	<10	<10	-	-	-	<10	<10	17	12	<1	792	<1	792
MW-A02	Salt cake landfill	16/11/2018	-	-	-	5	4	21	15	<1	<1	360	270	<0.1	<0.1	-	1	<1	30	22	<1	1	-	-	<1	<1	-	-	1100	897	657	<0.1	<0.1	-	-	62	43	<10	<10	-	-	-	<10	<10	22	16	<1	858	<1	858
MW-A03D	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	532	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	1000	<1	1000
MW-A03D	Salt cake landfill	17/10/2018	-	-	-	2	2	10	8	<1	<1	210	200	<0.1	<0.1	-	1	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	560	128	112	<0.1	<0.1	-	-	2	2	<10	<10	-	-	-	<10	<10	<5	<5	<1	1190	<1	1190
MW-A03D	Salt cake landfill	14/11/2018	-	-	-	2	2	10	10	<1	<1	260	250	<0.1	<0.1	-	2	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	554	138	134	<0.1	<0.1	-	-	3	3	<10	<10	-	-	-	<10	<10	<5	<5	<1	1220	<1	1220
MW-A03S	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	872	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	1090	<1	1090
MW-A03S	Salt cake landfill	17/10/2018	-	-	-	<1	<1	20	16	<1	<1	150	80	<0.1	<0.1	-	<1	<1	4	4	<1	<1	-	-	<1	<1	-	-	818	503	408	<0.1	<0.1	-	-	13	10	<10	<10	-	-	-	<10	<10	<5	<5	<1	1240	<1	1240
MW-A03S	Salt cake landfill	14/11/2018	-	-	-	<1	1	23	20	<1	<1	210	180	<0.1	<0.1	-	<1	<1	4	5	<1	2	-	-	<1	<1	-	-	913	627	596	<0.1	<0.1	-	-	15	15	<10	<10	-	-	-	<10	<10	<5	<5	<1	1340	<1	1340
MW-A04	Salt cake landfill	6/08/2018	-	-	-	<1	<1	6	6	<1	<1	<50	<50	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	11	8	6	<0.1	<0.1	-	-	2	<1	<10	<10	-	-	-	<10	<10	<5	<5	<1	145	<1	145
MW-A04	Salt cake landfill	20/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	110	<1	110
MW-A04	Salt cake landfill	18/10/2018	-	-	-	<1	<1	7	6	<1	<1	<50	<50	<0.1	<0.1	-	2	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	10	3	2	<0.1	<0.1	-	-	2	<1	<10	<10	-	-	-	<10	<10	<5	<5	<1	123	<1	123
MW-A04	Salt cake landfill	15/11/2018	-	-	-	<1	<1	9	8	<1	<1	<50	<50	<0.1	<0.1	-	<1	<1	<1	<1	1	1	-	-	<1	<1	-	-	13	3	3	<0.1	<0.1	-	-	<1	<1	<10	<10	-	-	-	<10	<10	<5	<5	<1	138	<1	138
MW-A05	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	903	<1	903
MW-A05	Salt cake landfill	17/10/2018	-	-	-	<1	<1	20	20	<1	<1	130	170	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	663	34	32	<0.1	<0.1	-	-	5	4	<10	<10	-	-	-	<10	<10	6	<5	<1	1150	<1	1150
MW-A05	Salt cake landfill	14/11/2018	-	-	-	<1	<1	23	20	<1	<1	190	160	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	613	42	39	<0.1	<0.1	-	-	5	4	<10	<10	-	-	-	<10	<10	<5	<5	<1	1160	<1	1160

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

JACOBS

			Metals																																														
			Aluminium	Aluminium (Filtered)	Antimony	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (hexavalent)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Lithium	Magnesium	Magnesium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Silver	Thallium	Tin	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)	Carbonate Alkalinity as CaCO3	Soluble Bicarb as CaCO3*	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3
			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 2000 FW 95%			55	55								370	370	0.2	0.2	1					1.4	1.4			3.4	3.4				1900	1900	0.6	0.6			11	11	11	11	0.05					8	8				
ANZECC(2000) trigger values for lowland rivers																																																		
Location_Code	Key Area	Sampled_Date_Time																																																
MW-A06	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	730	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	770	<1	770
MW-A06	Salt cake landfill	17/10/2018	-	-	-	5	4	9	7	<1	<1	180	180	<0.1	<0.1	-	<1	<1	1	<1	<1	<1	-	-	<1	<1	-	-	737	88	77	<0.1	<0.1	-	-	10	9	<10	<10	-	-	-	<10	<10	<5	<5	<1	885	<1	885
MW-A06	Salt cake landfill	14/11/2018	-	-	-	5	5	9	8	<1	<1	250	230	<0.1	<0.1	-	<1	<1	<1	<1	<1	<1	-	-	<1	<1	-	-	765	96	90	<0.1	<0.1	-	-	11	11	<10	<10	-	-	-	<10	<10	<5	<5	<1	942	<1	942
MW-A07	Salt cake landfill	21/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	669	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	1260	<1	1260
MW-A07	Salt cake landfill	19/10/2018	-	-	-	<1	<1	8	6	<1	<1	370	320	<0.1	<0.1	-	10	2	3	2	15	<1	-	-	<1	<1	-	-	668	33	24	<0.1	<0.1	-	-	18	5	<10	<10	-	-	-	<10	<10	8	<5	<1	1440	<1	1440
MW-A07	Salt cake landfill	16/11/2018	-	-	-	<1	<1	10	7	<1	<1	460	410	<0.1	<0.1	-	10	2	4	3	<1	2	-	-	<1	<1	-	-	712	35	30	<0.1	<0.1	-	-	10	6	<10	<10	-	-	-	<10	<10	8	6	<1	1540	<1	1540

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

			Inorganics																					Field Parameters				
			Ammonia as N	Anions Total	Bicarbonate	Calcium	Calcium (Filtered)	Carbonate	Cations Total	Chloride	Fluoride	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Potassium	Reactive Phosphorus as P	Sodium	Sulfate as SO4 - Turbidimetric	Hardness as CaCO3	TSS	Dissolved Oxygen	EC (field)	pH (Field)	Redox (Field)	Total Dissolved Solids
			mg/L	meq/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L	%	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	pH Units	mV	mg/L
ANZECC 2000 FW 95%														0.1581														
ANZECC(2000) trigger values for lowland rivers																	0.5		0.02							6.5 - 8		
Location_Code	Key Area	Sampled_Date_Time																										
BA_EW_MW01	Ash dam augmer	1/12/2016	0.17	-	84	510	-	<1	-	1390	2.2	-	0.3	0.04	<10	0.04	0.3	34	0.05	1240	3360	2520	-	0.82	8330	6.3	-206	8100
BA_EW_MW01	Ash dam augmer	27/02/2017	0.09	-	87	476	-	<1	-	1240	2.3	-	0.4	0.08	<10	0.08	0.5	32	0.1	1330	3020	2820	-	1.66	8540	6.5	-262	7870
BA_EW_MW01	Ash dam augmer	28/06/2017	0.12	-	61	516	-	<1	-	1320	2.1	-	0.3	0.02	<10	0.02	0.3	31	0.05	1440	3200	3210	-	3.09	8490	6.5	-178	7560
BA_EW_MW01	Ash dam augmer	6/09/2017	0.08	-	66	566	-	<1	-	1250	2.8	-	0.1	0.05	<10	0.05	0.2	38	0.06	1280	2900	3080	-	0.83	8950	6.5	128	7520
BA_EW_MW01	Ash dam augmer	29/11/2017	0.13	-	69	520	-	<1	-	1410	1.7	-	0.2	<0.01	<10	<0.01	0.2	38	0.06	1180	3080	2880	-	1.61	8580	6.5	131	7630
BA_EW_MW01	Ash dam augmer	28/02/2018	0.18	-	84	508	-	<1	-	1360	1.9	-	0.2	0.06	<10	0.06	0.3	38	0.02	1150	3380	2710	-	2.83	9280	6.6	-248	7520
BA_EW_MW01	Ash dam augmer	30/05/2018	0.16	-	93	538	-	<1	-	1340	2	-	0.2	0.02	<10	0.02	0.2	34	0.06	1280	3770	2960	-	2.82	9680	6.4	-90	5600
BA_EW_MW01	Ash dam augmer	23/08/2018	0.2	-	101	582	-	<1	-	1390	1.8	-	0.3	<0.01	<10	<0.01	0.3	36	0.08	1310	3560	3140	-	2.71	9450	6.6	-40	5940
BA_EW_MW01	Ash dam augmer	4/12/2018	0.04	-	100	543	-	<1	-	1470	1.9	-	0.7	0.83	<10	0.83	1.5	40	0.05	1140	3380	2950	-	1.05	8920	6.6	182	7060
BA_EW_MW01	Ash dam augmer	28/03/2019	0.02	-	89	650	-	<1	-	1910	1.8	-	0.3	0.46	50	0.51	0.8	47	0.04	1400	4620	3640	-	2.17	10,440	6.7	171	7320
BA_MW01	Ash dam augmer	30/11/2016	0.04	-	35	522	-	<1	-	1750	0.5	-	0.2	0.02	<10	0.02	0.2	29	0.18	1430	3870	3560	-	0.74	10,100	5.5	193	9950
BA_MW01	Ash dam augmer	27/02/2017	0.25	-	33	506	-	<1	-	1500	0.6	-	0.3	0.04	<10	0.04	0.3	28	0.21	1530	3710	3740	-	1.19	10,040	5.6	187	9500
BA_MW01	Ash dam augmer	28/06/2017	0.02	-	30	501	-	<1	-	1490	0.6	-	<0.2	0.02	<10	0.02	<0.2	26	0.19	1660	4110	4030	-	3.01	9940	5.7	274	9370
BA_MW01	Ash dam augmer	6/09/2017	<0.01	-	29	487	-	<1	-	1340	0.8	-	<0.2	0.03	<10	0.03	<0.2	27	0.2	1350	3910	3340	-	0.63	10,390	5.6	221	9100
BA_MW01	Ash dam augmer	29/11/2017	0.02	-	42	493	-	<1	-	1530	0.5	-	0.3	<0.01	<10	<0.01	0.3	28	0.17	1400	3720	3510	-	1.11	9950	5.6	194	8610
BA_MW01	Ash dam augmer	28/02/2018	0.03	-	33	485	-	<1	-	1470	0.6	-	0.1	0.04	<10	0.04	0.1	28	0.19	1300	4000	3280	-	1.06	10,600	5.6	216	8930
BA_MW01	Ash dam augmer	30/05/2018	0.03	-	41	515	-	<1	-	1400	0.8	-	0.2	0.04	<10	0.04	0.2	29	0.16	1430	4630	3640	-	0.86	10,530	5.5	196	8400
BA_MW01	Ash dam augmer	17/08/2018	0.03	-	39	442	-	<1	-	1400	0.7	-	<0.2	<0.01	<10	<0.01	<0.2	27	0.17	1280	4300	3240	-	3.16	10,610	5.8	203	6000
BA_MW01	Ash dam augmer	4/12/2018	0.04	-	46	474	-	<1	-	1530	0.8	-	0.2	0.2	<10	0.2	0.4	26	0.17	1360	4310	3490	-	1.06	10,220	5.6	218	9430
BA_MW01	Ash dam augmer	28/03/2019	0.03	-	36	507	-	<1	-	1440	0.5	-	0.1	<0.01	<10	<0.01	0.1	30	0.18	1470	5000	3780	-	1.81	10,700	5.7	196	7790
BA_MW03	Ash dam augmer	23/11/2016	0.12	-	37	531	-	<1	-	1790	0.9	-	0.3	0.02	<10	0.02	0.3	46	0.06	1640	4560	3400	-	1.9	11,380	5.5	260	9760
BA_MW03	Ash dam augmer	23/02/2017	0.16	-	37	493	-	<1	-	1800	1.2	-	<0.2	0.07	<10	0.07	<0.2	36	0.04	1780	3670	3500	-	1.15	10,900	5.4	173	9550
BA_MW03	Ash dam augmer	28/06/2017	0.06	-	33	524	-	<1	-	1620	1.3	-	<0.1	0.02	<10	0.02	<0.1	45	0.06	1900	3800	3720	-	3.03	10,260	5.6	258	9240
BA_MW03	Ash dam augmer	6/09/2017	0.06	-	34	503	-	<1	-	1390	1.7	-	<0.2	0.05	<10	0.05	<0.2	45	0.06	1520	3710	3120	-	0.75	10,560	5.6	188	8980
BA_MW03	Ash dam augmer	29/11/2017	0.07	-	33	499	-	<1	-	1640	1.3	-	0.2	<0.01	<10	<0.01	0.2	46	0.05	1520	3540	3120	-	0.8	10,140	5.5	222	9260
BA_MW03	Ash dam augmer	27/02/2018	0.07	-	32	481	-	<1	-	1450	1.2	-	0.1	0.04	<10	0.04	0.1	46	0.02	1390	4080	2860	-	0.92	10,650	5.5	177	8750
BA_MW03	Ash dam augmer	30/05/2018	0.08	-	36	499	-	<1	-	1430	1.3	-	0.1	0.02	<10	0.02	0.1	47	0.05	1510	4040	3050	-	0.73	10,730	5.5	131	6140
BA_MW03	Ash dam augmer	14/08/2018	0.08	-	32	525	-	<1	-	1480	1.4	-	0.1	<0.01	<10	<0.01	0.1	47	0.05	1540	4030	3170	-	1.14	9110	5.5	219	7610
BA_MW03	Ash dam augmer	4/12/2018	0.08	-	35	498	-	<1	-	1500	1.6	-	<0.1	<0.01	<10	<0.01	<0.1	44	0.07	1440	3960	3020	-	0.49	10,010	5.4	209	8820
BA_MW03	Ash dam augmer	28/03/2019	0.1	-	33	498	-	<1	-	1310	1.2	-	<0.1	<0.01	<10	<0.01	<0.1	47	0.07	1530	4930	3100	-	1.73	10,350	5.6	217	6430
BQ_MW04	Ash dam augmer	29/11/2016	0.04	-	811	251	-	<1	-	3600	<0.1	-	<0.2	0.02	<10	0.02	<0.2	27	0.03	2220	824	1850	-	4.86	12,060	6.8	223	7910
BQ_MW04	Ash dam augmer	24/02/2017	0.05	-	820	217	-	<1	-	3700	0.1	-	<0.5	0.09	<10	0.09	<0.5	20	<0.01	2700	843	2260	-	7.56	12,080	7.2	167	8660
BQ_MW04	Ash dam augmer	15/06/2017	0.08	-	829	226	-	<1	-	3710	0.1	-	<0.2	<0.01	<10	<0.01	<0.2	25	<0.01	2190	745	1860	-	5.32	12,790	7	245	7880
BQ_MW04	Ash dam augmer	6/09/2017	<0.01	-	921	182	-	<1	-	3260	0.2	-	0.3	0.05	<10	0.05	0.4	22	<0.01	2140	813	1730	-	5.15	12,100	7	235	7620
BQ_MW04	Ash dam augmer	16/11/2017	0.02	-	908	203	-	<1	-	3750	0.1	-	<0.5	0.03	<10	0.03	<0.5	25	<0.01	2320	898	1880	-	5.98	12,160	6.9	156	8060
BQ_MW04	Ash dam augmer	22/02/2018	0.02	-	921	185	-	<1	-	3790	0.1	-	<0.2	0.03	<10	0.03	<0.2	21	<0.01	2140	926	1710	-	6.05	13,090	7	239	7630
BQ_MW04	Ash dam augmer	29/05/2018	<0.01	-	933	158	-	<1	-	3310	0.2	-	0.3	0.01	<10	0.01	0.3	20	0.01	1890	880	1420	-	8.4	11,920	7.2	230	7400
BQ_MW04	Ash dam augmer	14/08/2018	0.03	-	873	213	-	<1	-	3510	0.2	-	<0.5	0.04	<10	0.04	<0.5	24	<0.01	2380	934	2080	-	7.8	10,600	7.3	248	6450
BQ_MW04	Ash dam augmer	20/11/2018	<0.01	-	867	135	-	<1	-	1920	0.2	-	<0.1	0.04	<10	0.04	<0.1	19	<0.01	1760	900	1240	-	7.86	10,030	7.3	273	6370
BQ_MW04	Ash dam augmer	28/03/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW05	Ash dam augmer	25/11/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	25/11/2016	0.05	-	243	521	-	<1	-	973	0.2	-	<0.1	0.2	<10	0.2	0.2	27	0.05	1340	3830	2660	-	3.01	8830	6.7	190	8240
BQ_MW07	Ash dam augmer	24/02/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.51	12,230	6.6	186	-
BQ_MW07	Ash dam augmer	15/06/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.43	9520	6.9	292	-
BQ_MW07	Ash dam augmer	6/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.55	8820	7	196	-
BQ_MW07	Ash dam augmer	16/11/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.61	8280	7	176	-
BQ_MW07	Ash dam augmer	28/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9810	7	220	-
BQ_MW07	Ash dam augmer	20/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	22/03/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW08	Ash dam augmer	25/11/2016	0.1	-	138	570	-	<1	-	623	0.6	-	<0.1	0.02	<10	0.02	<0.1	16	<0.01	680	2460	1980	-	1.04	5410	6.6	165	4780
BQ_MW08	Ash dam augmer	24/02/2017	0.17	-	140	528	-	<1	-	564	0.6	-	0.2	0.08	<10	0.08	0.3	12	0.01	749	1910	1820	-	0.53	5180	6.6	125	4780
BQ_MW08	Ash dam augmer	16/06/2017	0.09	-	138	550	-	<1	-	601	0.7	-	<0.1	<0.01	<10	<0.01	<0.1	16	<0.01	655	2160	1920	-	0.74	5460	6.7	217	4390
BQ_MW08	Ash dam augmer	5/09/2017	0.06	-	155	521	-	<1	-	562	0.8	-	0.1	0.03	<10	0.03	0.1	14	<0.01	667	2070	1840	-	0.62	5440	6.7	187	4520
BQ_MW08	Ash dam augmer	15/11/2017	0.08	-	150	657	-	<1	-	604	0.8	-	<0.1	<0.01	<10	<0.01	<0.1	17	<0.01	747	2260	2270	-	2.51	5240	6.8	216	3760
BQ_MW08	Ash dam augmer	23/02/2018	0.18	-	152	521	-	<1	-	647	0.6	-	<0.2	0.01	<10	0.01	<0.2	14	<0.01	653	2370	1800	-	1.12	5480	6.7	168	3570
BQ_MW08	Ash dam augmer	29/05/2018	0.09	-	146	577	-	<1	-	635	0.7	-	0.3	<0.01	<10	<0.01	0.3	14	0.01	631	2360	1960	-	0.71	5430	6.7	212	2850
BQ_MW08	Ash dam augmer	2/08/2018	0.1	-	135	551	-	<1	-	642	0.7	-	0.2	<0.01	<10	<0.01	0.2	15	<0.01	625	2350	1890	-	2.83	5200	6.8	205	4040
BQ_MW08	Ash dam augmer	26/11/2018	0.11	-	144	579	-	<1	-	655	0.7	-	<0.1	<0.01	<10	<0.01	<0.1	15	<0.01	628	1960	1980	-	2.01	5390	6.8	224	3960

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

JACOBS

			Inorganics																					Field Parameters				
			Ammonia as N	Anions Total	Bicarbonate	Calcium	Calcium (Filtered)	Carbonate	Cations Total	Chloride	Fluoride	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Potassium	Reactive Phosphorus as P	Sodium	Sulfate as SO4 - Turbidimetric	Hardness as CaCO3	TSS	Dissolved Oxygen	EC (field)	pH (Field)	Redox (Field)	Total Dissolved Solids
			mg/L	meq/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L	%	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	pH Units	mV	mg/L
ANZECC 2000 FW 95%														0.1581														
ANZECC(2000) trigger values for lowland rivers																	0.5		0.02							6.5 - 8		
Location_Code	Key Area	Sampled_Date_Time																										
BQ_MW08	Ash dam augmer	27/03/2019	0.11	-	123	526	-	<1	-	641	0.6	-	<0.1	<0.01	<10	<0.01	<0.1	15	<0.01	625	2310	1830	-	2.17	5460	6.8	156	2980
BQ_MW10	Ash dam augmer	24/11/2016	0.54	-	<1	582	-	<1	-	594	0.2	-	0.7	<0.01	<10	<0.01	0.7	19	<0.01	420	1660	1610	-	2.79	4440	4	404	3800
BQ_MW10	Ash dam augmer	1/06/2017	0.49	-	<1	562	-	<1	-	574	0.3	-	0.6	<0.01	<10	<0.01	0.6	19	<0.01	430	1730	1560	-	2.81	4470	4	310	3210
BQ_MW10	Ash dam augmer	5/09/2017	0.45	-	<1	570	-	<1	-	573	0.2	-	0.6	0.03	<10	0.03	0.6	19	<0.01	411	1630	1580	-	3.4	4540	4	307	2980
BQ_MW10	Ash dam augmer	14/11/2017	0.62	-	<1	595	-	<1	-	602	0.2	-	0.6	<0.01	<10	<0.01	0.6	20	<0.01	415	1600	1650	-	3.02	4510	3.9	353	3880
BQ_MW10	Ash dam augmer	22/02/2018	0.58	-	<1	573	-	<1	-	667	0.2	-	0.4	<0.01	<10	<0.01	0.4	19	<0.01	436	1820	1590	-	4.05	4560	3.9	312	3310
BQ_MW10	Ash dam augmer	28/05/2018	0.59	-	<1	611	-	<1	-	640	1.2	-	0.6	<0.01	<10	<0.01	0.6	18	<0.01	406	1800	1690	-	3.19	4590	4	273	4000
BQ_MW10	Ash dam augmer	14/08/2018	0.58	-	<1	572	-	<1	-	645	1	-	0.7	<0.01	<10	<0.01	0.7	19	<0.01	407	1740	1580	-	2.13	4280	3.9	379	3010
BQ_MW10	Ash dam augmer	27/11/2018	0.58	-	<1	609	-	<1	-	589	1.2	-	0.6	<0.01	<10	<0.01	0.6	20	0.02	410	1860	1680	-	2.33	4560	4.1	406	2820
BQ_MW10	Ash dam augmer	26/03/2019	0.63	-	<1	587	-	<1	-	604	0.7	-	0.6	<0.01	<10	<0.01	0.6	21	<0.01	418	1780	1630	-	2.52	4660	4.1	379	3530
BQ_MW11	Ash dam augmer	25/11/2016	0.05	-	444	275	-	<1	-	936	1.4	-	<0.1	0.04	<10	0.04	<0.1	9	<0.01	1890	4300	2540	-	1.42	10,500	7.1	199	9440
BQ_MW11	Ash dam augmer	24/02/2017	0.18	-	465	265	-	<1	-	856	1.6	-	0.2	0.08	<10	0.08	0.3	8	0.02	2130	4380	2850	-	2.05	10,110	7.2	78	9090
BQ_MW11	Ash dam augmer	15/06/2017	0.19	-	452	277	-	<1	-	860	2.1	-	0.2	<0.01	<10	<0.01	0.2	9	<0.01	1670	4600	2680	-	2.03	10,170	7.2	243	8700
BQ_MW11	Ash dam augmer	5/09/2017	0.02	-	500	245	-	<1	-	822	2	-	<0.2	0.07	<10	0.07	<0.2	8	0.02	1970	4460	2580	-	0.57	10,300	7.3	170	8850
BQ_MW11	Ash dam augmer	15/11/2017	0.08	-	511	255	-	<1	-	882	1.4	-	0.2	<0.01	<10	<0.01	0.2	8	0.02	1810	4770	2440	-	3.37	9930	7.3	168	8130
BQ_MW11	Ash dam augmer	23/02/2018	0.04	-	505	245	-	<1	-	920	1.4	-	<0.2	0.04	<10	0.04	<0.2	8	0.01	1830	4650	2530	-	2.96	10,270	7.3	237	9240
BQ_MW11	Ash dam augmer	28/05/2018	0.05	-	498	248	-	<1	-	925	1.9	-	<0.1	0.03	<10	0.03	<0.1	8	0.04	1740	4380	2370	-	1.27	10,200	7.2	36	7550
BQ_MW11	Ash dam augmer	14/08/2018	0.01	-	437	228	-	<1	-	856	1.7	-	<0.5	0.02	<10	0.02	<0.5	7	<0.01	1640	4470	2220	-	1.67	9200	7.2	192	6130
BQ_MW11	Ash dam augmer	26/11/2018	0.09	-	464	269	-	<1	-	877	1.7	-	<0.1	0.01	<10	0.01	<0.1	8	0.01	1820	4380	2570	-	2.43	10,010	7.3	37	8510
BQ_MW11	Ash dam augmer	26/03/2019	0.01	-	425	266	-	<1	-	775	1.6	-	<0.1	<0.01	<10	<0.01	<0.1	9	<0.01	1800	4590	2430	-	2.01	10,220	7.3	157	8910
BQ_MW13	Ash dam augmer	24/11/2016	0.08	-	446	324	-	<1	-	709	1.8	-	0.2	0.02	<10	0.02	0.2	4	0.01	737	1500	1360	-	3.23	4910	6.8	103	4130
BQ_MW13	Ash dam augmer	23/02/2017	0.12	-	516	320	-	<1	-	675	1.9	-	<0.2	0.08	<10	0.08	<0.2	4	<0.01	865	1150	1460	-	3.72	5000	6.7	84	3780
BQ_MW13	Ash dam augmer	1/06/2017	0.06	-	500	300	-	<1	-	668	2	-	<0.1	0.06	<10	0.06	<0.1	4	0.03	765	1610	1260	-	1.42	5060	6.8	115	3880
BQ_MW13	Ash dam augmer	4/09/2017	0.05	-	482	312	-	<1	-	700	1.9	-	0.1	<0.01	<10	<0.01	0.1	4	0.02	752	1410	1370	-	1.07	5410	6.8	126	3980
BQ_MW13	Ash dam augmer	24/11/2017	0.08	-	542	332	-	<1	-	748	1.8	-	<0.1	0.03	<10	0.03	<0.1	4	0.01	781	1640	1430	-	3.88	5010	7	142	3590
BQ_MW13	Ash dam augmer	23/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW13	Ash dam augmer	31/05/2018	0.07	-	553	327	-	<1	-	714	1.9	-	<0.1	0.4	<10	0.4	0.4	4	0.02	758	1630	1380	-	1.09	5450	6.8	107	3910
BQ_MW13	Ash dam augmer	2/08/2018	0.07	-	489	352	-	<1	-	740	1.8	-	0.2	0.03	<10	0.03	0.2	4	0.02	814	1660	1490	-	0.72	5230	6.8	117	3700
BQ_MW13	Ash dam augmer	26/11/2018	0.07	-	497	374	-	<1	-	702	2	-	<0.1	0.03	<10	0.03	<0.1	4	0.12	794	1390	1590	-	2.17	5540	6.9	168	4000
BQ_MW13	Ash dam augmer	27/03/2019	0.1	-	423	344	-	<1	-	624	1.7	-	0.2	0.01	<10	0.01	0.2	4	0.01	773	1980	1470	-	3.2	5570	7	146	3590
BQEW_MW01	Ash dam augmer	29/11/2016	0.03	-	312	333	-	<1	-	1020	1.4	-	<0.1	<0.01	<10	<0.01	<0.1	12	0.03	1080	2990	1860	-	0.54	7150	7	62	5580
BQEW_MW01	Ash dam augmer	28/02/2017	0.04	-	336	298	-	<1	-	886	1.5	-	<0.1	0.03	<10	0.03	<0.1	11	0.02	1200	2350	1950	-	1.03	7060	7.2	57	6210
BQEW_MW01	Ash dam augmer	16/06/2017	0.03	-	302	282	-	<1	-	851	1.9	-	<0.1	<0.01	<10	<0.01	<0.1	11	0.02	1020	2550	1800	-	1.03	7040	7.1	188	5490
BQEW_MW01	Ash dam augmer	5/09/2017	0.01	-	334	278	-	<1	-	818	2	-	<0.1	0.02	<10	0.02	<0.1	10	0.01	1150	2360	1850	-	0.94	7100	7.2	157	5580
BQEW_MW01	Ash dam augmer	15/11/2017	0.02	-	344	272	-	<1	-	922	1.3	-	<0.1	<0.01	<10	<0.01	<0.1	10	<0.01	1040	2540	1720	-	1.22	6970	7.2	117	4760
BQEW_MW01	Ash dam augmer	23/02/2018	0.01	-	360	293	-	<1	-	1070	1.2	-	0.1	0.01	10	0.01	0.1	10	0.01	1140	2660	1910	-	1.28	7580	7.1	165	6250
BQEW_MW01	Ash dam augmer	31/05/2018	0.03	-	360	300	-	<1	-	900	1.6	-	<0.1	0.06	<10	0.06	<0.1	11	0.01	1120	2700	1850	-	1.79	7360	7.2	163	3820
BQEW_MW01	Ash dam augmer	13/08/2018	<0.01	-	314	270	-	<1	-	1010	1.6	-	<0.1	<0.01	<10	<0.01	<0.1	9	0.01	1010	2510	1710	-	1	6700	7.2	127	5390
BQEW_MW01	Ash dam augmer	27/11/2018	0.04	-	289	317	-	<1	-	871	2	-	<0.1	<0.01	<10	<0.01	<0.1	11	0.01	1090	2660	1890	-	2.72	7270	7.3	98	5680
BQEW_MW01	Ash dam augmer	26/03/2019	0.03	-	300	317	-	<1	-	999	1.5	-	<0.1	<0.01	<10	<0.01	<0.1	12	0.01	1160	2670	1960	-	1.89	7820	7.2	44	6150
BQEW_MW02	Ash dam augmer	29/11/2016	0.12	-	258	295	-	<1	-	734	1.4	-	0.1	<0.01	<10	<0.01	0.1	13	0.01	799	2120	1330	-	0.76	5540	7.1	28	3580
BQEW_MW02	Ash dam augmer	28/02/2017	0.26	-	279	264	-	<1	-	690	1.5	-	<0.5	0.05	<10	0.05	<0.5	12	0.01	883	1520	1330	-	1.92	5320	7.3	100	4360
BQEW_MW02	Ash dam augmer	16/06/2017	0.09	-	266	266	-	<1	-	732	1.9	-	<0.1	0.04	<10	0.04	<0.1	12	0.02	861	1740	1290	-	0.66	5600	7.3	157	4120
BQEW_MW02	Ash dam augmer	5/09/2017	0.08	-	300	258	-	<1	-	698	2	-	<0.1	0.03	<10	0.03	<0.1	10	<0.01	924	1630	1370	-	1.36	5670	7.4	118	4140
BQEW_MW02	Ash dam augmer	15/11/2017	0.16	-	300	253	-	<1	-	769	1.3	-	<0.5	<0.01	<10	<0.01	<0.5	10	<0.01	807	1800	1260	-	1.31	5460	7.3	138	3640
BQEW_MW02	Ash dam augmer	27/02/2018	0.17	-	307	255	-	<1	-	798	1.3	-	<0.2	0.02	<10	0.02	<0.2	12	<0.01	804	1760	1300	-	1.31	5770	7.4	126	4130
BQEW_MW02	Ash dam augmer	31/05/2018	0.15	-	297	273	-	<1	-	789	1.7	-	0.3	0.07	<10	0.07	0.4	12	0.02	888	1740	1380	-	1.07	5770	7.3	120	2880
BQEW_MW02	Ash dam augmer	2/08/2018	0.14	-	277	258	-	<1	-	824	1.4	-	0.9	0.01	<10	0.01	0.9	12	0.01	885	1810	1320	-	0.7	5480	7.3	134	3290
BQEW_MW02	Ash dam augmer	27/11/2018	0.17	-	265	292	-	<1	-	755	1.7	-	<0.1	<0.01	<10	<0.01	<0.1	12	0.01	870	1920	1420	-	2.22	5830	7.4	131	4350
BQEW_MW02	Ash dam augmer	26/03/2019	0.18	-	253	284	-	<1	-	778	1.4	-	0.2	<0.01	<10	<0.01	0.2	12	0.01	881	1860	1420	-	1.9	6010	7.4	50	4450
BQEW_MW03	Ash dam augmer	30/11/2016	0.03	-	518	417	-	<1	-	1890	0.9	-	0.2	<0.01	<10	<0.01	0.2	12	<0.01	1400	2100	2140	-	0.92	8500	6.8	-133	6290
BQEW_MW03	Ash dam augmer	28/02/2017	0.02	-	733	550	-	<1	-	2590	1	-	<0.1	0.04	<10	0.04	<0.1	16	<0.01	2170	2620	2960	-	1.71	11,870	6.8	-40	10,000
BQEW_MW03	Ash dam augmer	16/06/2017	<0.01	-	604	492	-	<1	-	1770	1	-	<0.1	<0.01	<10	<0.01	<0.1	13	<0.01	1340	2080	2240	-	1.27	9440	6.7	44	6760
BQEW_MW03	Ash dam augmer	5/09/2017	<0.01	-	749	554	-	<1	-	1970	1.1	-	<0.2	0.02	<10	0.02	<0.2	11	<0.01	1650	2440	2540	-	0.84	11,370	6.7	117	8390
BQEW_MW03	Ash dam augmer	28/11/2017	0.09	-	669	540	-	<1	-	2900	1	-	1.7	0.04	<10	0.04	1.7	15	<0.01	2450	3230	3160	-	1.41	11,620	6.7	173	10,600
BQEW_MW03	Ash dam augmer	23/02/2018	0.04	-	750	469	-	<1	-	2980	1	-	<0.2	<0.01	<10	<0.01	<0.2	14	<0.01	2200	3080	2850	-	1.27	13,130	6.8	32	10,200
BQEW_MW03	Ash dam augmer	31/05/2018	0.01	-	736	555	-	<1	-	2480	1	-	<0.2	0.08	<10	0.08	<0.2	14	<0.01	1820	2760	2620	-	0.71	11,380	6.7	91	5780
BQEW_MW03	Ash dam augmer	13/08/2018	0.02	-	677	531	-	<1	-	2620	0.9	-	<0.5	0.01	<10	0.01	<0.5	12	<0.01	1820	2680	2570	-	1.1	10,310	6.7	136	7890

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

JACOBS

			Inorganics																						Field Parameters				
			Ammonia as N	Anions Total	Bicarbonate	Calcium	Calcium (Filtered)	Carbonate	Cations Total	Chloride	Fluoride	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Potassium	Reactive Phosphorus as P	Sodium	Sulfate as SO4 - Turbidimetric	Hardness as CaCO3	TSS	Dissolved Oxygen	EC (field)	pH (Field)	Redox (Field)	Total Dissolved Solids
			mg/L	meq/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L	%	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	pH Units	mV	mg/L
ANZECC 2000 FW 95%														0.1581														
ANZECC(2000) trigger values for lowland rivers																	0.5		0.02							6.5 - 8		
Location_Code	Key Area	Sampled_Date_Time																										
BQEW_MW03	Ash dam augmer	27/11/2018	0.02	-	662	546	-	<1	-	1850	1.2	-	<0.1	0.01	<10	0.01	<0.1	14	<0.01	2080	3140	2780	-	2.61	12,680	6.8	108	9520
BQEW_MW03	Ash dam augmer	26/03/2019	0.05	-	626	499	-	<1	-	2540	1	-	<0.2	0.02	<10	0.02	<0.2	15	<0.01	1980	2930	2600	-	2.73	12,840	6.9	46	8950
BQ_MW02	NE borrow pit zo	24/11/2016	0.62	-	866	520	-	<1	-	3750	0.7	-	0.7	0.04	<10	0.04	0.7	25	0.01	4140	7730	5740	-	2.53	18,770	6.8	117	19,000
BQ_MW02	NE borrow pit zo	23/02/2017	0.72	-	926	510	-	<1	-	3810	1	-	<1	0.14	<10	0.14	<1	22	<0.01	4500	6820	6220	-	-	-	-	-	19,800
BQ_MW02	NE borrow pit zo	28/02/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.58	20,500	6.7	138	-
BQ_MW02	NE borrow pit zo	1/06/2017	0.63	-	938	483	-	<1	-	3710	1	-	0.7	0.02	<10	0.02	0.7	25	0.01	4030	8500	5320	-	1.67	19,900	6.6	166	13,700
BQ_MW02	NE borrow pit zo	6/09/2017	0.19	-	1000	500	-	<1	-	3420	1.2	-	<0.5	0.38	<10	0.38	<0.5	24	<0.01	3820	7590	5280	-	2.75	21,100	6.7	199	18,600
BQ_MW02	NE borrow pit zo	16/11/2017	0.14	-	976	532	-	<1	-	3630	0.9	-	<0.5	0.43	<10	0.43	<0.5	27	<0.01	4270	8030	6060	-	4.44	20,400	6.6	149	20,600
BQ_MW02	NE borrow pit zo	22/02/2018	0.2	-	987	499	-	<1	-	4330	0.9	-	<0.5	0.3	<10	0.3	<0.5	25	0.01	4030	8070	5730	-	4.67	22,100	6.8	227	19,100
BQ_MW02	NE borrow pit zo	29/05/2018	<0.1	-	974	535	-	<1	-	4200	1.2	-	0.2	0.35	20	0.37	0.6	26	0.01	3880	6990	5430	-	3.52	21,300	6.8	176	18,000
BQ_MW02	NE borrow pit zo	14/08/2018	0.11	-	880	505	-	<1	-	4010	1.1	-	<0.2	0.41	<10	0.41	0.4	25	<0.01	3720	7930	5140	-	3.94	19,700	6.7	213	19,300
BQ_MW02	NE borrow pit zo	20/11/2018	0.1	-	916	514	-	<1	-	3620	1.3	-	<0.5	0.44	<10	0.44	<0.5	26	<0.01	3920	9310	5350	-	5.3	21,200	6.8	233	19,000
BQ_MW02	NE borrow pit zo	27/03/2019	0.42	-	814	481	-	<1	-	3860	0.9	-	<0.5	0.35	<10	0.35	<0.5	26	<0.01	3760	6370	5150	-	2.98	21,200	6.7	168	18,900
BQ_MW03	NE borrow pit zo	24/11/2016	0.12	-	132	476	-	<1	-	641	0.4	-	<0.1	<0.01	<10	<0.01	<0.1	10	0.07	793	2970	2560	-	2.85	6030	6.3	221	5980
BQ_MW03	NE borrow pit zo	23/02/2017	0.37	-	137	469	-	<1	-	618	0.5	-	0.4	0.08	<10	0.08	0.5	9	0.07	897	3020	2700	-	2.6	6250	6.3	-160	4460
BQ_MW03	NE borrow pit zo	1/06/2017	0.29	-	137	458	-	<1	-	600	0.6	-	<0.5	0.02	<10	0.02	<0.5	11	0.07	788	3230	2460	-	2.01	6260	6.4	-13	4290
BQ_MW03	NE borrow pit zo	4/09/2017	0.06	-	126	453	-	<1	-	630	0.5	-	0.1	<0.01	<10	<0.01	0.1	11	0.06	739	2880	2400	-	1.24	6570	6.3	26	5780
BQ_MW03	NE borrow pit zo	16/11/2017	0.1	-	144	496	-	<1	-	672	0.4	-	<0.2	0.03	<10	0.03	<0.2	12	0.07	836	3400	2730	-	2.3	6390	6.4	106	6220
BQ_MW03	NE borrow pit zo	22/02/2018	0.17	-	146	474	-	<1	-	687	0.5	-	<0.5	0.03	<10	0.03	<0.5	11	0.07	816	3180	2610	-	1.32	6590	6.4	120	5880
BQ_MW03	NE borrow pit zo	28/05/2018	0.13	-	141	458	-	<1	-	652	0.6	-	0.2	0.13	10	0.14	0.3	10	0.12	751	3180	2420	-	0.78	6610	6.3	92	5720
BQ_MW03	NE borrow pit zo	13/08/2018	0.05	-	126	472	-	<1	-	658	0.6	-	<0.5	0.02	<10	0.02	<0.5	10	0.06	758	3080	2460	-	2.72	5910	6.3	173	5520
BQ_MW03	NE borrow pit zo	20/11/2018	0.05	-	123	480	-	<1	-	653	0.7	-	<0.1	<0.01	<10	<0.01	<0.1	12	0.05	728	2930	2500	-	2.42	6540	6.5	165	5300
BQ_MW03	NE borrow pit zo	27/03/2019	0.06	-	126	473	-	<1	-	698	0.6	-	<0.2	<0.01	<10	<0.01	<0.2	13	0.04	724	3000	2470	-	4.41	6560	6.6	56	4560
BB_MW01	Salt cake landfill	18/04/2018	-	-	-	-	-	-	-	43,900	2.82	-	-	-	-	-	-	-	-	-	-	-	74	-	107,500	6.6	-	-
BB_MW01	Salt cake landfill	20/07/2018	-	-	-	-	-	-	-	44,600	14.7	-	-	-	-	-	-	-	-	-	-	-	6	-	108,800	6.5	-	-
BB_MW01	Salt cake landfill	30/10/2018	-	-	-	-	-	-	-	45,800	<0.5	-	-	-	-	-	-	-	-	-	-	-	<5	-	111,400	6.6	-	-
BB_MW01	Salt cake landfill	18/02/2019	-	-	-	-	-	-	-	44,200	2.28	-	-	-	-	-	-	-	-	-	-	-	13	-	106,100	6.6	-	-
BB_MW01	Salt cake landfill	17/04/2019	-	-	-	-	-	-	-	43,500	1.07	-	-	-	-	-	-	-	-	-	-	-	44	-	114,100	6.5	-	-
BB_MW02	Salt cake landfill	18/04/2018	-	-	-	-	-	-	-	48,800	3.35	-	-	-	-	-	-	-	-	-	-	-	93	-	112,700	6.6	-	-
BB_MW02	Salt cake landfill	19/07/2018	-	-	-	-	-	-	-	51,800	9.37	-	-	-	-	-	-	-	-	-	-	-	10	-	113,200	6.4	-	-
BB_MW02	Salt cake landfill	29/10/2018	-	-	-	-	-	-	-	47,900	<0.5	-	-	-	-	-	-	-	-	-	-	-	<5	-	112,800	6.5	-	-
BB_MW02	Salt cake landfill	18/02/2019	-	-	-	-	-	-	-	46,300	3.81	-	-	-	-	-	-	-	-	-	-	-	25	-	112,900	6.6	-	-
BB_MW02	Salt cake landfill	17/04/2019	-	-	-	-	-	-	-	45,800	4.2	-	-	-	-	-	-	-	-	-	-	-	12	-	116,500	6.6	-	-
BB_MW05	Salt cake landfill	17/04/2018	-	-	-	-	-	-	-	5130	1.08	-	-	-	-	-	-	-	-	-	-	-	9	-	20,000	7	-	-
BB_MW05	Salt cake landfill	19/07/2018	-	-	-	-	-	-	-	5190	3.15	-	-	-	-	-	-	-	-	-	-	-	<5	-	17,800	7.2	-	-
BB_MW05	Salt cake landfill	29/10/2018	-	-	-	-	-	-	-	3540	0.7	-	-	-	-	-	-	-	-	-	-	-	<5	-	15,350	7.2	-	-
BB_MW05	Salt cake landfill	18/02/2019	-	-	-	-	-	-	-	3390	<1	-	-	-	-	-	-	-	-	-	-	-	9	-	15,190	7.2	-	-
BB_MW05	Salt cake landfill	17/04/2019	-	-	-	-	-	-	-	3280	0.82	-	-	-	-	-	-	-	-	-	-	-	<5	-	15,410	7.1	-	-
MW-A01	Salt cake landfill	7/08/2018	-	95.7	-	-	629	-	90.3	736	0.4	2.9	-	-	-	-	-	38	-	658	2990	-	-	1.48	6830	6.8	217	4371
MW-A01	Salt cake landfill	20/09/2018	-	85.5	-	-	595	-	82.4	744	0.3	1.8	-	-	-	-	-	32	-	568	2660	-	-	1.73	6350	6.7	170	4064
MW-A01	Salt cake landfill	18/10/2018	-	86.2	-	-	579	-	76.6	574	0.4	5.9	-	-	-	-	-	35	-	532	2870	-	-	1.3	5380	6.8	179	5380
MW-A01	Salt cake landfill	15/11/2018	-	111	-	-	650	-	110	1110	0.3	0.25	-	-	-	-	-	43	-	866	3200	-	-	1.36	8390	6.7	132	5370
MW-A02	Salt cake landfill	21/09/2018	-	181	-	-	322	-	167	939	0.1	3.98	-	-	-	-	-	48	-	1740	6730	-	-	4.61	11680	6.7	239	7475
MW-A02	Salt cake landfill	19/10/2018	-	175	-	-	359	-	172	1050	0.2	0.82	-	-	-	-	-	56	-	1820	6240	-	-	3.29	12530	6.7	162	8019
MW-A02	Salt cake landfill	16/11/2018	-	184	-	-	437	-	206	1330	0.2	5.5	-	-	-	-	-	58	-	2110	6220	-	-	4.9	14400	6.6	166	9216
MW-A03D	Salt cake landfill	19/09/2018	-	156	-	-	217	-	148	1910	0.6	2.48	-	-	-	-	-	25	-	2140	3940	-	-	1.91	12220	6.9	-79	7821
MW-A03D	Salt cake landfill	17/10/2018	-	177	-	-	248	-	161	2240	0.8	4.82	-	-	-	-	-	30	-	2340	4340	-	-	1.54	13130	6.9	-43	8403
MW-A03D	Salt cake landfill	14/11/2018	-	158	-	-	233	-	159	1800	0.7	0.33	-	-	-	-	-	28	-	2330	3990	-	-	1.4	13100	6.8	-132	8384
MW-A03S	Salt cake landfill	19/09/2018	-	246	-	-	410	-	217	3140	0.4	6.42	-	-	-	-	-	33	-	2840	6530	-	-	3.31	15800	7.1	173	10112
MW-A03S	Salt cake landfill	17/10/2018	-	239	-	-	365	-	204	3210	0.6	8.03	-	-	-	-	-	33	-	2700	5960	-	-	3.14	17390	7.1	191	11130
MW-A03S	Salt cake landfill	14/11/2018	-	241	-	-	393	-	228	3000	0.6	2.71	-	-	-	-	-	37	-	3050	6230	-	-	2.08	17450	7	59	11168
MW-A04	Salt cake landfill	6/08/2018	-	5.58	-	-	37	-	5.18	37	0.6	3.79	-	-	-	-	-	3	-	54	79	-	-	3.15	531	7.7	159	340
MW-A04	Salt cake landfill	20/09/2018	-	5.3	-	-	50	-	5.79	62	0.6	4.39	-	-	-	-	-	3	-	55	65	-	-	4.16	628	7.8	245	402
MW-A04	Salt cake landfill	18/10/2018	-	5.59	-	-	49	-	5.72	61	0.6	1.11	-	-	-	-	-	4	-	54	68	-	-	4.21	563	7.9	214	360
MW-A04	Salt cake landfill	15/11/2018	-	6.23	-	-	58	-	6.76	48	0.6	4.06	-	-	-	-	-	4	-	62	102	-	-	3.02	687	7.8	187	440
MW-A05	Salt cake landfill	19/09/2018	-	132	-	-	290	-	135	1340	0.5	1.22	-	-	-	-	-	27	-	1660	3650	-	-	1.66	10420	6.9	144	6669
MW-A05	Salt cake landfill	17/10/2018	-	152	-	-	367	-	160	1460	0.7	2.65	-	-	-	-	-	34	-	1990	4220	-	-	1.66	11290	6.9	127	7226
MW-A05	Salt cake landfill	14/11/2018	-	148	-	-	313	-	146	1280	0.7	0.59	-	-	-	-	-	31	-	1820	4250	-	-	1.04	11240	6.8	124	7194

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

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			Inorganics																					Field Parameters				
			Ammonia as N	Anions Total	Bicarbonate	Calcium	Calcium (Filtered)	Carbonate	Cations Total	Chloride	Fluoride	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Potassium	Reactive Phosphorus as P	Sodium	Sulfate as SO4 - Turbidimetric	Hardness as CaCO3	TSS	Dissolved Oxygen	EC (field)	pH (Field)	Redox (Field)	Total Dissolved Solids
			mg/L	meq/L	mg/L	mg/L	mg/L	mg/L	meq/L	mg/L	mg/L	%	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	uS/cm	pH Units	mV	mg/L
ANZECC 2000 FW 95%														0.1581														
ANZECC(2000) trigger values for lowland rivers																	0.5		0.02							6.5 - 8		
Location_Code	Key Area	Sampled_Date_Time																										
MW-A06	Salt cake landfill	19/09/2018	-	169	-	-	302	-	161	1600	0.3	2.46	-	-	-	-	-	27	-	1950	5200	-	-	1.89	12100	6.8	42	7744
MW-A06	Salt cake landfill	17/10/2018	-	178	-	-	333	-	168	1810	0.5	3	-	-	-	-	-	31	-	2060	5250	-	-	1.14	13160	6.8	37	8422
MW-A06	Salt cake landfill	14/11/2018	-	174	-	-	321	-	169	1550	0.4	1.33	-	-	-	-	-	30	-	2060	5350	-	-	0.98	13130	6.7	-10	8403
MW-A07	Salt cake landfill	21/09/2018	-	292	-	-	235	-	256	3410	0.3	6.46	-	-	-	-	-	45	-	4330	8180	-	-	2.21	20300	6.7	82	13760
MW-A07	Salt cake landfill	19/10/2018	-	280	-	-	254	-	268	3470	0.4	2.25	-	-	-	-	-	50	-	4580	7390	-	-	1.64	21400	6.8	100	13696
MW-A07	Salt cake landfill	16/11/2018	-	287	-	-	254	-	285	3200	0.3	0.4	-	-	-	-	-	52	-	4880	7980	-	-	1.62	21300	6.7	110	13632

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

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			TRH - NEPM 2013 Fractions								TPH - NEPM 1999 Fractions					BTEXN								PAHs																
			TRH >C10-C16 (F2)	TRH >C6 - C10	TRH >C10 - C16	TRH >C16 - C34	TRH >C34 - C40	TRH >C10 - C40 (Sum of total)	TRH >C6 - C10 less BTEX (F1)	TRH >C10 - C16 less Naphthalene (F2)	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C36 (Sum of total)	Benzene	Ethylbenzene	Naphthalene	Toluene	Total BTEX	Xylene (m & p)	Xylene (o)	Xylene Total	Benzo[b+j]fluoranthene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene TEQ (zero)	Benzo(a) pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Phenanthrene	Pyrene	PAHs (Sum of total)
			mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC 2000 FW 95%																950		16				350																		
ANZECC(2000) trigger values for lowland rivers																																								
Location_Code	Key Area	Sampled_Date_Time																																						
BA_EW_MW01	Ash dam augmer	1/12/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	27/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	28/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	6/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	29/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	28/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	30/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	23/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	4/12/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_EW_MW01	Ash dam augmer	28/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	30/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	27/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	28/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	6/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	29/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	28/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	30/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	17/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	4/12/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW01	Ash dam augmer	28/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	23/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	23/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	28/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	6/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	29/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	27/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	30/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	14/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	4/12/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BA_MW03	Ash dam augmer	28/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	29/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	24/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	15/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	6/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	16/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	22/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	29/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	14/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	20/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW04	Ash dam augmer	28/03/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW05	Ash dam augmer	25/11/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	25/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW07	Ash dam augmer	24/02/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	15/06/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	6/09/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	16/11/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	28/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	20/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW07	Ash dam augmer	22/03/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW08	Ash dam augmer	25/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	24/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	16/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	5/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	15/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	23/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	29/05/2018	<100	<20,000	-	<100,000	<100,000	<100,000	<20	<100	<20,000	<50,000	<100,000	<50,000	<50,000	<1000	<2000	<1	<2000	<1	<2000	<2000	<2000	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	2/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW08	Ash dam augmer	26/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5

- = Not analysed for

Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

JACOBS

			TRH - NEPM 2013 Fractions								TPH - NEPM 1999 Fractions					BTEXN								PAHs																
			TRH >C10-C16 (F2)	TRH >C6 - C10	TRH >C10 - C16	TRH >C16 - C34	TRH >C34 - C40	TRH >C10 - C40 (Sum of total)	TRH >C6 - C10 less BTEX (F1)	TRH >C10 - C16 less Naphthalene (F2)	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C36 (Sum of total)	Benzene	Ethylbenzene	Naphthalene	Toluene	Total BTEX	Xylene (m & p)	Xylene (o)	Xylene Total	Benzo[b+j]fluoranthene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene TEQ (zero)	Benzo(a) pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Phenanthrene	Pyrene	PAHs (Sum of total)
			mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC 2000 FW 95%																950		16				350																		
ANZECC(2000) trigger values for lowland rivers																																								
Location_Code	Key Area	Sampled_Date_Time																																						
BQ_MW08	Ash dam augmer	27/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	24/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	1/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	5/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	14/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	22/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	28/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	14/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	27/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW10	Ash dam augmer	26/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	25/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	24/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	15/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	5/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	15/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	23/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	28/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	14/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	26/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW11	Ash dam augmer	26/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	24/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	23/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	1/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	4/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	24/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	23/02/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW13	Ash dam augmer	31/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	2/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	26/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW13	Ash dam augmer	27/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	29/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	28/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	16/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	5/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	15/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	23/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	31/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	13/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	27/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW01	Ash dam augmer	26/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	29/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	28/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	16/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	5/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	15/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	27/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	31/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	2/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	27/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW02	Ash dam augmer	26/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	30/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	28/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	16/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	5/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	28/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	23/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	31/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	13/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

JACOBS

			TRH - NEPM 2013 Fractions								TPH - NEPM 1999 Fractions					BTEXN								PAHs																
			TRH >C10-C16 (F2)	TRH >C6 - C10	TRH >C10 - C16	TRH >C16 - C34	TRH >C34 - C40	TRH >C10 - C40 (Sum of total)	TRH >C6 - C10 less BTEX (F1)	TRH >C10 - C16 less Naphthalene (F2)	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C36 (Sum of total)	Benzene	Ethylbenzene	Naphthalene	Toluene	Total BTEX	Xylene (m & p)	Xylene (o)	Xylene Total	Benzo[b+j]fluoranthene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene TEQ (zero)	Benzo(a) pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Phenanthrene	Pyrene	PAHs (Sum of total)
			mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC 2000 FW 95%																950		16				350																		
ANZECC(2000) trigger values for lowland rivers																																								
Location_Code	Key Area	Sampled_Date_Time																																						
BQEW_MW03	Ash dam augmer	27/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQEW_MW03	Ash dam augmer	26/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	24/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	23/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	28/02/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BQ_MW02	NE borrow pit zo	1/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	6/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	16/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	22/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	29/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	14/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	20/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW02	NE borrow pit zo	27/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	24/11/2016	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	23/02/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	1/06/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	4/09/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	16/11/2017	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	22/02/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	28/05/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	13/08/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	20/11/2018	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BQ_MW03	NE borrow pit zo	27/03/2019	<0.1	<20	-	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<1	<2	<0.001	<2	<2	<2	<0.001	<1	<1	<1	<1	<0.5	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.5
BB_MW01	Salt cake landfill	18/04/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW01	Salt cake landfill	20/07/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW01	Salt cake landfill	30/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW01	Salt cake landfill	18/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW01	Salt cake landfill	17/04/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW02	Salt cake landfill	18/04/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW02	Salt cake landfill	19/07/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW02	Salt cake landfill	29/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW02	Salt cake landfill	18/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW02	Salt cake landfill	17/04/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW05	Salt cake landfill	17/04/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW05	Salt cake landfill	19/07/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW05	Salt cake landfill	29/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW05	Salt cake landfill	18/02/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB_MW05	Salt cake landfill	17/04/2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A01	Salt cake landfill	7/08/2018	-	<20	<100	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<5	<2	<0.001	<2	<2	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A01	Salt cake landfill	20/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A01	Salt cake landfill	18/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A01	Salt cake landfill	15/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A02	Salt cake landfill	21/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A02	Salt cake landfill	19/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A02	Salt cake landfill	16/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A03D	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A03D	Salt cake landfill	17/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A03D	Salt cake landfill	14/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A03S	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A03S	Salt cake landfill	17/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A03S	Salt cake landfill	14/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A04	Salt cake landfill	6/08/2018	-	<20	<100	<100	<100	<100	<0.02	<0.1	<20	<50	<100	<50	<50	<1	<2	<5	<2	<0.001	<2	<2	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A04	Salt cake landfill	20/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A04	Salt cake landfill	18/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A04	Salt cake landfill	15/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A05	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A05	Salt cake landfill	17/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A05	Salt cake landfill	14/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

JACOBS

			TRH - NEPM 2013 Fractions								TPH - NEPM 1999 Fractions					BTEXN								PAHs																
			TRH >C10-C16 (F2)	TRH >C6 - C10	TRH >C10 - C16	TRH >C16 - C34	TRH >C34 - C40	TRH >C10 - C40 (Sum of total)	TRH >C6 - C10 less BTEX (F1)	TRH >C10 - C16 less Naphthalene (F2)	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C36 (Sum of total)	Benzene	Ethylbenzene	Naphthalene	Toluene	Total BTEX	Xylene (m & p)	Xylene (o)	Xylene Total	Benzo[b+j]fluoranthene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene TEQ (zero)	Benzo(a) pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Phenanthrene	Pyrene	PAHs (Sum of total)
			mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
ANZECC 2000 FW 95%																950		16				350																		
ANZECC(2000) trigger values for lowland rivers																																								
Location_Code	Key Area	Sampled_Date_Time																																						
MW-A06	Salt cake landfill	19/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A06	Salt cake landfill	17/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A06	Salt cake landfill	14/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A07	Salt cake landfill	21/09/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A07	Salt cake landfill	19/10/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW-A07	Salt cake landfill	16/11/2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

JACOBS

			Polychlorinated Biphenyls
			PCBs (Sum of total)
			µg/L
ANZECC 2000 FW 95%			
ANZECC(2000) trigger values for lowland rivers			
Location_Code	Key Area	Sampled_Date_Time	
BA_EW_MW01	Ash dam augmer	1/12/2016	<1
BA_EW_MW01	Ash dam augmer	27/02/2017	<1
BA_EW_MW01	Ash dam augmer	28/06/2017	<1
BA_EW_MW01	Ash dam augmer	6/09/2017	<1
BA_EW_MW01	Ash dam augmer	29/11/2017	<1
BA_EW_MW01	Ash dam augmer	28/02/2018	<1
BA_EW_MW01	Ash dam augmer	30/05/2018	<1
BA_EW_MW01	Ash dam augmer	23/08/2018	<1
BA_EW_MW01	Ash dam augmer	4/12/2018	<1
BA_EW_MW01	Ash dam augmer	28/03/2019	<1
BA_MW01	Ash dam augmer	30/11/2016	<1
BA_MW01	Ash dam augmer	27/02/2017	<1
BA_MW01	Ash dam augmer	28/06/2017	<1
BA_MW01	Ash dam augmer	6/09/2017	<1
BA_MW01	Ash dam augmer	29/11/2017	<1
BA_MW01	Ash dam augmer	28/02/2018	<1
BA_MW01	Ash dam augmer	30/05/2018	<1
BA_MW01	Ash dam augmer	17/08/2018	<1
BA_MW01	Ash dam augmer	4/12/2018	<1
BA_MW01	Ash dam augmer	28/03/2019	<1
BA_MW03	Ash dam augmer	23/11/2016	<1
BA_MW03	Ash dam augmer	23/02/2017	<1
BA_MW03	Ash dam augmer	28/06/2017	<1
BA_MW03	Ash dam augmer	6/09/2017	<1
BA_MW03	Ash dam augmer	29/11/2017	<1
BA_MW03	Ash dam augmer	27/02/2018	<1
BA_MW03	Ash dam augmer	30/05/2018	<1
BA_MW03	Ash dam augmer	14/08/2018	<1
BA_MW03	Ash dam augmer	4/12/2018	<1
BA_MW03	Ash dam augmer	28/03/2019	<1
BQ_MW04	Ash dam augmer	29/11/2016	<1
BQ_MW04	Ash dam augmer	24/02/2017	<1
BQ_MW04	Ash dam augmer	15/06/2017	<1
BQ_MW04	Ash dam augmer	6/09/2017	<1
BQ_MW04	Ash dam augmer	16/11/2017	<1
BQ_MW04	Ash dam augmer	22/02/2018	<1
BQ_MW04	Ash dam augmer	29/05/2018	<1
BQ_MW04	Ash dam augmer	14/08/2018	<1
BQ_MW04	Ash dam augmer	20/11/2018	<1
BQ_MW04	Ash dam augmer	28/03/2019	-
BQ_MW05	Ash dam augmer	25/11/2016	-
BQ_MW07	Ash dam augmer	25/11/2016	<1
BQ_MW07	Ash dam augmer	24/02/2017	-
BQ_MW07	Ash dam augmer	15/06/2017	-
BQ_MW07	Ash dam augmer	6/09/2017	-
BQ_MW07	Ash dam augmer	16/11/2017	-
BQ_MW07	Ash dam augmer	28/02/2018	-
BQ_MW07	Ash dam augmer	20/11/2018	-
BQ_MW07	Ash dam augmer	22/03/2019	-
BQ_MW08	Ash dam augmer	25/11/2016	<1
BQ_MW08	Ash dam augmer	24/02/2017	<1
BQ_MW08	Ash dam augmer	16/06/2017	<1
BQ_MW08	Ash dam augmer	5/09/2017	<1
BQ_MW08	Ash dam augmer	15/11/2017	<1
BQ_MW08	Ash dam augmer	23/02/2018	<1
BQ_MW08	Ash dam augmer	29/05/2018	<1
BQ_MW08	Ash dam augmer	2/08/2018	<1
BQ_MW08	Ash dam augmer	26/11/2018	<1

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

			Polychlorinated Biphenyls
			PCBs (Sum of total)
			µg/L
ANZECC 2000 FW 95%			
ANZECC(2000) trigger values for lowland rivers			

Location_Code	Key Area	Sampled_Date_Time	
BQ_MW08	Ash dam augmer	27/03/2019	<1
BQ_MW10	Ash dam augmer	24/11/2016	<1
BQ_MW10	Ash dam augmer	1/06/2017	<1
BQ_MW10	Ash dam augmer	5/09/2017	<1
BQ_MW10	Ash dam augmer	14/11/2017	<1
BQ_MW10	Ash dam augmer	22/02/2018	<1
BQ_MW10	Ash dam augmer	28/05/2018	<1
BQ_MW10	Ash dam augmer	14/08/2018	<1
BQ_MW10	Ash dam augmer	27/11/2018	<1
BQ_MW10	Ash dam augmer	26/03/2019	<1
BQ_MW11	Ash dam augmer	25/11/2016	<1
BQ_MW11	Ash dam augmer	24/02/2017	<1
BQ_MW11	Ash dam augmer	15/06/2017	<1
BQ_MW11	Ash dam augmer	5/09/2017	<1
BQ_MW11	Ash dam augmer	15/11/2017	<1
BQ_MW11	Ash dam augmer	23/02/2018	<1
BQ_MW11	Ash dam augmer	28/05/2018	<1
BQ_MW11	Ash dam augmer	14/08/2018	<1
BQ_MW11	Ash dam augmer	26/11/2018	<1
BQ_MW11	Ash dam augmer	26/03/2019	<1
BQ_MW13	Ash dam augmer	24/11/2016	<1
BQ_MW13	Ash dam augmer	23/02/2017	<1
BQ_MW13	Ash dam augmer	1/06/2017	<1
BQ_MW13	Ash dam augmer	4/09/2017	<1
BQ_MW13	Ash dam augmer	24/11/2017	<1
BQ_MW13	Ash dam augmer	23/02/2018	-
BQ_MW13	Ash dam augmer	31/05/2018	<1
BQ_MW13	Ash dam augmer	2/08/2018	<1
BQ_MW13	Ash dam augmer	26/11/2018	<1
BQ_MW13	Ash dam augmer	27/03/2019	<1
BQEW_MW01	Ash dam augmer	29/11/2016	<1
BQEW_MW01	Ash dam augmer	28/02/2017	<1
BQEW_MW01	Ash dam augmer	16/06/2017	<1
BQEW_MW01	Ash dam augmer	5/09/2017	<1
BQEW_MW01	Ash dam augmer	15/11/2017	<1
BQEW_MW01	Ash dam augmer	23/02/2018	<1
BQEW_MW01	Ash dam augmer	31/05/2018	<1
BQEW_MW01	Ash dam augmer	13/08/2018	<1
BQEW_MW01	Ash dam augmer	27/11/2018	<1
BQEW_MW01	Ash dam augmer	26/03/2019	<1
BQEW_MW02	Ash dam augmer	29/11/2016	<1
BQEW_MW02	Ash dam augmer	28/02/2017	<1
BQEW_MW02	Ash dam augmer	16/06/2017	<1
BQEW_MW02	Ash dam augmer	5/09/2017	<1
BQEW_MW02	Ash dam augmer	15/11/2017	<1
BQEW_MW02	Ash dam augmer	27/02/2018	<1
BQEW_MW02	Ash dam augmer	31/05/2018	<1
BQEW_MW02	Ash dam augmer	2/08/2018	<1
BQEW_MW02	Ash dam augmer	27/11/2018	<1
BQEW_MW02	Ash dam augmer	26/03/2019	<1
BQEW_MW03	Ash dam augmer	30/11/2016	<1
BQEW_MW03	Ash dam augmer	28/02/2017	<1
BQEW_MW03	Ash dam augmer	16/06/2017	<1
BQEW_MW03	Ash dam augmer	5/09/2017	<1
BQEW_MW03	Ash dam augmer	28/11/2017	<1
BQEW_MW03	Ash dam augmer	23/02/2018	<1
BQEW_MW03	Ash dam augmer	31/05/2018	<1
BQEW_MW03	Ash dam augmer	13/08/2018	<1

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09/09/2019
Reviewed : BR

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			Polychlorinated Biphenyls
			PCBs (Sum of total)
			µg/L
ANZECC 2000 FW 95%			
ANZECC(2000) trigger values for lowland rivers			

Location_Code	Key Area	Sampled_Date_Time	
BQEW_MW03	Ash dam augmer	27/11/2018	<1
BQEW_MW03	Ash dam augmer	26/03/2019	<1
BQ_MW02	NE borrow pit zo	24/11/2016	<1
BQ_MW02	NE borrow pit zo	23/02/2017	<1
BQ_MW02	NE borrow pit zo	28/02/2017	-
BQ_MW02	NE borrow pit zo	1/06/2017	<1
BQ_MW02	NE borrow pit zo	6/09/2017	<1
BQ_MW02	NE borrow pit zo	16/11/2017	<1
BQ_MW02	NE borrow pit zo	22/02/2018	<1
BQ_MW02	NE borrow pit zo	29/05/2018	<1
BQ_MW02	NE borrow pit zo	14/08/2018	<1
BQ_MW02	NE borrow pit zo	20/11/2018	<1
BQ_MW02	NE borrow pit zo	27/03/2019	<1
BQ_MW03	NE borrow pit zo	24/11/2016	<1
BQ_MW03	NE borrow pit zo	23/02/2017	<1
BQ_MW03	NE borrow pit zo	1/06/2017	<1
BQ_MW03	NE borrow pit zo	4/09/2017	<1
BQ_MW03	NE borrow pit zo	16/11/2017	<1
BQ_MW03	NE borrow pit zo	22/02/2018	<1
BQ_MW03	NE borrow pit zo	28/05/2018	<1
BQ_MW03	NE borrow pit zo	13/08/2018	<1
BQ_MW03	NE borrow pit zo	20/11/2018	<1
BQ_MW03	NE borrow pit zo	27/03/2019	<1
BB_MW01	Salt cake landfill	18/04/2018	-
BB_MW01	Salt cake landfill	20/07/2018	-
BB_MW01	Salt cake landfill	30/10/2018	-
BB_MW01	Salt cake landfill	18/02/2019	-
BB_MW01	Salt cake landfill	17/04/2019	-
BB_MW02	Salt cake landfill	18/04/2018	-
BB_MW02	Salt cake landfill	19/07/2018	-
BB_MW02	Salt cake landfill	29/10/2018	-
BB_MW02	Salt cake landfill	18/02/2019	-
BB_MW02	Salt cake landfill	17/04/2019	-
BB_MW05	Salt cake landfill	17/04/2018	-
BB_MW05	Salt cake landfill	19/07/2018	-
BB_MW05	Salt cake landfill	29/10/2018	-
BB_MW05	Salt cake landfill	18/02/2019	-
BB_MW05	Salt cake landfill	17/04/2019	-
MW-A01	Salt cake landfill	7/08/2018	-
MW-A01	Salt cake landfill	20/09/2018	-
MW-A01	Salt cake landfill	18/10/2018	-
MW-A01	Salt cake landfill	15/11/2018	-
MW-A02	Salt cake landfill	21/09/2018	-
MW-A02	Salt cake landfill	19/10/2018	-
MW-A02	Salt cake landfill	16/11/2018	-
MW-A03D	Salt cake landfill	19/09/2018	-
MW-A03D	Salt cake landfill	17/10/2018	-
MW-A03D	Salt cake landfill	14/11/2018	-
MW-A03S	Salt cake landfill	19/09/2018	-
MW-A03S	Salt cake landfill	17/10/2018	-
MW-A03S	Salt cake landfill	14/11/2018	-
MW-A04	Salt cake landfill	6/08/2018	-
MW-A04	Salt cake landfill	20/09/2018	-
MW-A04	Salt cake landfill	18/10/2018	-
MW-A04	Salt cake landfill	15/11/2018	-
MW-A05	Salt cake landfill	19/09/2018	-
MW-A05	Salt cake landfill	17/10/2018	-
MW-A05	Salt cake landfill	14/11/2018	-

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

JACOBS

			Polychlorinated Biphenyls
			PCBs (Sum of total)
			µg/L
ANZECC 2000 FW 95%			
ANZECC(2000) trigger values for lowland rivers			

Location_Code	Key Area	Sampled_Date_Time	
MW-A06	Salt cake landfill	19/09/2018	-
MW-A06	Salt cake landfill	17/10/2018	-
MW-A06	Salt cake landfill	14/11/2018	-
MW-A07	Salt cake landfill	21/09/2018	-
MW-A07	Salt cake landfill	19/10/2018	-
MW-A07	Salt cake landfill	16/11/2018	-

- = Not analysed for
Bold = exceedance of ANZECC 2000 FW 99% guideline (only applied to bioaccumulatants, i.e. Mercury and Selenium)

09/09/2019
Reviewed : BR

Appendix C. Summerised groundwater quality data by Project element areas

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	Aluminium	Aluminium (Filtered)	Antimony	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Chromium (hexavalent)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron_Tot (Filtered)	Lead	Lead (Filtered)	Lithium	Magnesium	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)
Ash dam augmentation zone																														
Mean concentration	1675.1	1833.1	-	2.7	2.1	21.1	14.7	3.4	3.2	2083.8	1974.5	1.3	1.1	-	6.1	2.0	42.5	44.2	7.9	3.1	1766.0	0.5	6.1	3.0	-	302.5	951.6	896.8	-	0.1
Standard deviation	5789.3	2903.0	-	4.7	1.2	34.8	9.3	0.9	0.7	1227.0	1163.0	1.0	0.9	-	14.5	1.4	43.9	40.8	20.6	2.8	7943.0	0.9	14.7	-	-	162.8	1345.7	1279.8	-	-
Median	255.0	270.0	-	2.0	2.0	14.0	11.0	3.0	3.0	2275.0	2120.0	1.2	0.5	-	2.0	2.0	23.0	23.0	3.0	3.0	270.0	0.2	2.0	3.0	-	299.5	135.0	128.5	-	0.1
Minimum concentration	10.0	10.0	-	1.0	1.0	5.0	5.0	2.0	2.0	170.0	170.0	0.1	0.1	-	1.0	1.0	1.0	2.0	1.0	1.0	50.0	0.1	1.0	3.0	-	38.0	2.0	3.0	-	0.1
Maximum Concentration	54700.0	7180.0	-	25.0	4.0	357.0	37.0	5.0	4.0	4620.0	3780.0	3.0	2.8	-	67.0	3.0	120.0	99.0	103.0	12.0	71200.0	3.7	61.0	3.0	-	674.0	3970.0	3840.0	-	0.1
Count of detects	100.0	35.0	-	26.0	11.0	108.0	108.0	11.0	9.0	108.0	108.0	40.0	43.0	-	20.0	2.0	53.0	47.0	35.0	13.0	83.0	26.0	16.0	1.0	-	108.0	108.0	108.0	-	1.0
Salt Cake landfill																														
Mean concentration	94.3	-	-	5.9	2.9	13.9	11.7	-	-	216.8	212.7	1.6	-	1.0	3.8	2.0	34.9	7.3	8.1	1.5	178.7	-	1.9	-	1343.6	568.3	9247.8	157.6	-	-
Standard deviation	91.9	-	-	4.2	1.5	6.0	5.2	-	-	82.8	77.5	0.6	-	-	3.9	-	38.0	7.5	6.3	0.6	91.9	-	1.2	-	1032.5	306.8	13714.1	199.3	-	-
Median	60.5	-	-	5.0	2.0	11.5	10.0	-	-	210.0	200.0	1.7	-	1.0	2.0	2.0	20.4	4.5	11.3	1.5	193.0	-	1.7	-	1450.0	638.0	627.0	83.5	-	-
Minimum concentration	8.0	-	-	0.8	1.0	6.0	6.0	-	-	116.0	80.0	0.8	-	1.0	0.4	2.0	1.0	2.0	0.8	1.0	24.0	-	0.1	-	95.1	10.0	3.0	2.0	-	-
Maximum Concentration	263.0	-	-	12.1	5.0	23.0	20.0	-	-	460.0	410.0	2.4	-	1.0	13.1	2.0	120.0	22.0	15.0	2.0	420.0	-	4.4	-	2940.0	1100.0	43800.0	657.0	-	-
Count of detects	10.0	-	-	21.0	7.0	18.0	18.0	-	-	25.0	15.0	5.0	-	1.0	16.0	2.0	22.0	6.0	10.0	4.0	15.0	-	9.0	-	15.0	26.0	33.0	18.0	-	-
NE borrow pit																														
Mean concentration	100.7	10.0	-	2.7	1.0	10.4	8.7	-	-	1217.5	1115.5	0.3	0.3	-	8.0	-	1.9	1.5	1.3	1.7	257.3	0.2	-	3.0	-	668.8	423.5	376.9	-	-
Standard deviation	179.3	-	-	2.9	-	2.2	1.4	-	-	1014.4	895.6	0.2	0.1	-	-	-	1.2	0.8	0.6	0.6	259.3	0.1	-	-	-	352.4	292.2	263.5	-	-
Median	30.0	10.0	-	1.0	1.0	10.0	8.5	-	-	930.0	950.0	0.3	0.2	-	8.0	-	1.0	1.0	1.0	2.0	170.0	0.1	-	3.0	-	637.5	435.5	359.5	-	-
Minimum concentration	10.0	10.0	-	1.0	1.0	8.0	6.0	-	-	190.0	220.0	0.1	0.1	-	8.0	-	1.0	1.0	1.0	1.0	50.0	0.1	-	3.0	-	309.0	86.0	72.0	-	-
Maximum Concentration	720.0	10.0	-	6.0	1.0	15.0	12.0	-	-	2620.0	2230.0	0.7	0.5	-	8.0	-	4.0	3.0	2.0	2.0	950.0	0.3	-	3.0	-	1150.0	928.0	711.0	-	-
Count of detects	15.0	1.0	-	3.0	1.0	20.0	20.0	-	-	20.0	20.0	10.0	9.0	-	1.0	-	7.0	8.0	3.0	3.0	15.0	9.0	-	1.0	-	20.0	20.0	20.0	-	-

- = Count of records is 0 or count of of records is 1 meaning standard deviation cannot be calculated.

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Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Selenium	Selenium (Filtered)	Silver	Thallium	Tin	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)	Carbonate Alkalinity as CaCO3	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Ammonia as N	Anions Total	Bicarbonate	Calcium	Cations Total	Chloride	Fluoride	Ionic Balance	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Potassium	Reactive Phosphorus as P	Sodium	Sulfate as SO4 - Turbidimetric
5.5	4.7	64.5	60.1	10.0	10.0	-	-	-	60.0	-	81.6	102.1	-	-	333.5	0.1	-	333.5	415.7	-	1324.2	1.2	-	0.3	0.1	30.0	0.1	0.4	19.7	0.1	1278.6	2735.9
6.4	5.1	91.6	86.6	#DIV/0!	0.0	-	-	-	93.5	-	97.0	93.1	-	-	269.7	0.1	-	269.7	138.6	-	839.9	0.6	-	0.3	0.1	28.3	0.1	0.3	12.3	0.1	551.7	1173.7
3.0	3.0	13.5	12.0	10.0	10.0	-	-	-	15.0	-	43.0	70.5	-	-	300.0	0.1	-	300.0	483.0	-	954.5	1.3	-	0.2	0.0	30.0	0.0	0.3	15.0	0.0	1280.0	2545.0
1.0	1.0	3.0	3.0	10.0	10.0	-	-	-	10.0	-	5.0	6.0	-	-	29.0	0.0	-	29.0	135.0	-	562.0	0.1	-	0.1	0.0	10.0	0.0	0.1	4.0	0.0	406.0	745.0
27.0	22.0	298.0	284.0	10.0	10.0	-	-	-	200.0	-	329.0	268.0	-	-	933.0	0.6	-	933.0	657.0	-	3790.0	2.8	-	1.7	0.8	50.0	0.8	1.7	47.0	0.2	2700.0	5000.0
62.0	57.0	108.0	108.0	1.0	2.0	-	-	-	4.0	-	56.0	38.0	-	-	99.0	101.0	-	99.0	108.0	-	108.0	107.0	-	51.0	67.0	2.0	67.0	53.0	108.0	66.0	108.0	108.0
3.4	-	403.8	10.9	11.9	-	0.5	3.9	14.6	5.5	-	10.3	11.3	-	-	855.8	-	152.7	-	319.2	145.9	12786.4	1.6	3.1	-	-	-	-	-	32.2	-	1894.2	4372.5
0.9	-	560.8	10.0	8.9	-	0.4	4.3	12.5	4.8	-	6.9	5.0	-	-	418.7	-	85.5	-	169.2	80.0	19326.4	2.8	2.2	-	-	-	-	-	15.5	-	1346.2	2410.3
3.0	-	41.5	9.0	14.3	-	0.5	1.7	20.4	5.2	-	12.0	12.0	-	-	894.0	-	163.5	-	317.0	160.5	3000.0	0.6	2.7	-	-	-	-	-	32.5	-	1970.0	4295.0
2.4	-	2.0	2.0	0.6	-	0.2	0.1	0.2	0.5	-	1.0	6.0	-	-	110.0	-	5.3	-	37.0	5.2	37.0	0.1	0.3	-	-	-	-	-	3.0	-	54.0	65.0
5.7	-	1540.0	43.0	27.4	-	0.9	11.1	23.1	14.7	-	22.0	16.0	-	-	1540.0	-	292.0	-	650.0	285.0	51800.0	14.7	8.0	-	-	-	-	-	58.0	-	4880.0	8180.0
15.0	-	32.0	15.0	15.0	-	4.0	15.0	3.0	15.0	-	15.0	3.0	-	-	26.0	-	26.0	-	26.0	26.0	41.0	38.0	26.0	-	-	-	-	-	26.0	-	26.0	26.0
2.2	1.9	9.6	9.3	-	-	-	-	-	-	-	6.0	-	-	-	530.8	0.2	-	530.8	489.4	-	2242.5	0.8	-	0.4	0.2	15.0	0.2	0.5	18.0	0.1	2395.0	5410.5
0.4	0.3	2.3	1.7	-	-	-	-	-	-	-	1.4	-	-	-	409.4	0.2	-	409.4	24.3	-	1644.2	0.3	-	0.3	0.2	7.1	0.2	0.2	7.4	0.0	1662.8	2457.9
2.0	2.0	9.5	9.0	-	-	-	-	-	-	-	5.5	-	-	-	480.0	0.1	-	480.0	482.0	-	2059.0	0.7	-	0.3	0.1	15.0	0.1	0.5	17.5	0.1	2308.5	4885.0
2.0	1.0	6.0	6.0	-	-	-	-	-	-	-	5.0	-	-	-	123.0	0.1	-	123.0	453.0	-	600.0	0.4	-	0.1	0.0	10.0	0.0	0.1	9.0	0.0	724.0	2880.0
3.0	2.0	17.0	14.0	-	-	-	-	-	-	-	8.0	-	-	-	1000.0	0.7	-	1000.0	535.0	-	4330.0	1.3	-	0.7	0.4	20.0	0.4	0.7	27.0	0.1	4500.0	9310.0
10.0	9.0	20.0	20.0	-	-	-	-	-	-	-	4.0	-	-	-	20.0	19.0	-	20.0	20.0	-	20.0	20.0	-	6.0	16.0	2.0	16.0	7.0	20.0	14.0	20.0	20.0

- = Count of records is 0 or count of of records is 1 meaning standard deviation cannot be calculated.

09/09/2019
Reviewed : BR

Hardness as CaCO3	TSS	Dissolved Oxygen	EC (field)	pH (Field)	Redox (Field)	Total Dissolved Solids
2282.7	-	2.2	8373.3	6.5	154.8	6365.5
755.0	-	1.6	2618.8	0.9	116.2	2281.9
2030.0	-	1.7	8920.0	6.8	168.0	6270.0
1240.0	-	0.5	4280.0	3.9	-262.0	2820.0
4030.0	-	8.4	13130.0	7.4	406.0	10600.0
108.0	-	112.0	113.0	113.0	113.0	108.0
-	29.5	2.3	36369.5	6.9	115.2	7277.0
-	30.9	1.2	43601.2	0.4	97.4	3939.2
-	12.5	1.8	15190.0	6.8	138.0	7782.5
-	6.0	1.0	531.0	6.4	-132.0	340.0
-	93.0	4.9	116500.0	7.9	245.0	13760.0
-	10.0	26.0	41.0	41.0	26.0	26.0
4036.5	-	3.0	13494.0	6.6	128.6	11985.5
1568.4	-	1.3	7340.3	0.2	95.0	6921.8
3935.0	-	2.7	12690.0	6.6	157.0	9960.0
2400.0	-	0.8	5910.0	6.3	-160.0	4290.0
6220.0	-	5.3	22100.0	6.8	233.0	20600.0
20.0	-	20.0	20.0	20.0	20.0	20.0

- = Count of records is 0 or count of of records is 1 meaning standard deviation cannot be calculated.