technical report C

groundwater.



Environment Effects Statement | May 2021

western outer ring main

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APA - Western Outer Ring Main

Western Outer Ring Main Environment Effects Statement

Groundwater report

May 2021

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Executive summary

This technical report is an attachment to the Western Outer Ring Main (WORM) Project Environment Effects Statement (EES). It provides an assessment of potential groundwater impacts associated with the Project, and defines the environmental management measures necessary to meet the EES evaluation objectives.

Overview

The WORM Project (the Project) is a 600 millimetre nominal diameter high pressure gas transmission pipeline between APA's existing Plumpton Regulating Station (approximately 38 kilometres north west of Melbourne's CBD) and Wollert Compressor Station (approximately 26 kilometres north east of Melbourne's CBD), providing a high pressure connection between the eastern and western pipeline networks of the Victorian Transmission System (VTS).

The Project includes a new pipeline, three mainline valves along the pipeline alignment, and an additional compressor and regulating station at the existing Wollert Compressor Station.

APA is the proponent for the Project.

On 22 December 2019, the Minister for Planning determined that Project would require an Environment Effects Statement (EES) under the *Environment Effects Act 1978* (EE Act).

GHD was commissioned to undertake a groundwater impact assessment for the purpose of the EES.

Groundwater context

The scoping requirements for the EES issued by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs the scope of the EES technical studies. The scoping requirements relevant to the groundwater assessment are:

- **Biodiversity and habitats:** Avoid and minimise potential adverse effects on native vegetation, listed threatened and migratory species and ecological communities, and habitat for these species, as well as restore and offset residual environmental effects consistent with State and Commonwealth policies. (For this study this aspect is related to groundwater dependent ecosystems).
- **Water and catchment values:** Maintain the functions and values of groundwater, surface water and floodplain environments and minimise effects on water quality and beneficial uses

For the purposes of this EES study, potential groundwater impacts are assessed and evaluated for the Project. During construction excavations are likely to be required that are deeper than the water table and will therefore require dewatering over short periods. This may impact local groundwater levels and flow paths. During operation the pipe and the backfilled pipe trench may be below the water table which may also impact on groundwater levels and flow paths. These potential impacts on groundwater levels and flow paths may subsequently impact water availability or quality to groundwater dependent receptors, such as groundwater dependent ecosystems, surface water features receiving baseflows, groundwater users (i.e. bores), as well as activate acid sulfate soils, cause migration of any existing contaminated groundwater or cause ground subsidence. These potential impacts and the associated management measures are the focus of this report.

Existing conditions

Along the pipeline route, the water table aquifer system consists of fractured rock aquifers (i.e. siltstones, sandstone and basalts) and porous media aquifers (i.e. variable mixtures of sands, gravels, clays and silts). The fractured rock water table aquifers are present along the majority of the pipeline route, with the porous media aquifers generally present along drainage lines and waterways (such as Jacksons, Deep, Kalkallo and Merri Creek).

Regional data suggested that the depth to groundwater along the alignment varies from less than 5 m below ground level (bgl) to more than 50 m bgl. Site investigations focused on the pipeline areas where the groundwater was likely to be less than 5 m bgl and therefore where the Project is likely to interact with the water table aquifer. Based on the available information, the following areas/crossings were identified as having potential to interact with the water table aquifer:

- Area 1: Bendigo Railway and the Tame St Drain
- Area 2: Jacksons Creek
- Area 3: Deep Creek
- Area 4: Donovans Lane and the North East Rail reserve
- Area 5: Merri Creek
- Area 6 : Donnybrook Rd

These areas of direct interaction with groundwater represent approximately 5% of the entire pipeline length

The groundwater salinity from the monitoring bores near these sites was record from 910 mg/L to 7,360 mg/L Total Dissolved Solids (TDS), i.e. Segment A2 to Segment E of the State Environment Protection Policy (SEPP) (Waters). The majority of the groundwater along the alignment has been classified as Segment C. However, groundwater to the east and south east of the Hume Freeway has been classified as Segment A2, i.e. more protected beneficial uses (including potable water and irrigation).

Groundwater analysis recorded elevated concentrations of ammonia (as N), total nitrogen and total phosphorus, above relevant Australian and New Zealand Guidelines (ANZG) (2018) and/or SEPP (Waters) criteria for the protection of water dependent ecosystems. These elevated concentrations have been generally noted from near Jacksons and Deep Creeks, and from bores adjacent Gunns Gully Road. These elevated concentrations indicate that the quality may already be impacted by local background conditions and/or land uses. These elevated concentrations may preclude groundwater disposal (where required for dewatering) to the environment, e.g. waterways. In addition, the groundwater salinity in places along the alignment, may preclude groundwater disposal to land (i.e. irrigation), during construction dewatering, however this would need to be assess on a site by site basis (i.e. depending on soil and vegetation type, the duration and the availability of other water to potentially shandy with the groundwater). It is noted that the groundwater salinity in the last 10 km of the pipeline route is more likely to be suitable for direct irrigation.

Whilst a number of potentially contaminated sites, existing landfills or quarries were noted in the broader study area, dewatering is not anticipated close to these sites (i.e. >750 m). It is therefore unlikely that potential groundwater contamination associated with these sources will occur where the pipeline interacts with groundwater, although further establishment of baseline groundwater quality is required. This has been further discussed in Risk ID GW5. Hydraulic conductivity of the water table aquifer along the alignment, based on slug testing, was 0.03 m/day on average, with the maximum approximately 1 m/day and the minimum <0.01 m/day.

These values are typical for the intersected aquifers, although the basalt aquifer can be highly variable and the recorded hydraulic conductivities were in the lower end of the potential range.

Potential groundwater dependent ecosystems (GDEs), both aquatic and terrestrial, have been mapped along the alignment as shown in Figure 16, with the most relevant to potential construction dewatering impacts being at the Jacksons and Merri Creek crossings.

A database search of registered bores for the Project identified 140 bores within 1 km of the alignment. The majority of the bores are registered for stock and/ or domestic use.

Impact assessment

The impact assessment is based on regional and site specific information and the proposed construction method for the Project. The impact assessment considers all potential risks as (detailed in Table 32), in the context of the Project and associated environmental management measures (EMMs) to manage these risks and the residual impacts.

A total of eleven risk items, eight construction risks and three operation risks, were identified and assessed, as described below.

- **Construction Phase**

Risk ID GW1 - Drawdown Impact on neighbouring groundwater users (bores)

Drawdown or lowering of the groundwater level as a result of excavations requiring dewatering may impact the yield of an existing groundwater extraction bore extraction bore depending on the 'available drawdown' in the bore (i.e. the groundwater level above the pump) and other factors such as the current extraction rate of the bore.

To evaluate this risk, an estimate of the area of groundwater drawdown influence and groundwater inflow rates, was determined using analytical solutions for steady state flows. The area of drawdown influence away from a trench or bell hole was generally less than 25 m, with a maximum of 50 m predicted.

The assessment shows that drawdown interference with existing users of groundwater is not anticipated during the construction phase as the drawdown cone from dewatering activities is expected to be limited (i.e. no neighbouring bores in the predicted drawdown area).

Therefore, the risks of groundwater dewatering impacting neighbouring bores is considered to be low, and by applying the initial management measures, to minimise dewatering, the residual impact of groundwater dewatering to neighbouring bore users is considered to remain low.

Risk ID GW2 - Drawdown impacts on groundwater dependent ecosystems (GDEs) and receiving environments (i.e. river/wetland base flows)

There are a number of GDEs present along the pipeline alignment (refer Table 21). During construction dewatering, additional drawdown or lowering of the groundwater level near a GDE may cause a loss in groundwater availability that may impact the GDE health and function.

Similarly, wetlands or rivers may receive groundwater baseflow during certain times of the year which maintain surface water levels and flows. During construction dewatering, additional drawdown or lowering of the groundwater level near a wetland or river may impact the surface water levels or flows, which impacts local aquatic GDEs or downstream users /receptors.

To assess the short-term impacts that may occur during the construction phase, the predicted area of drawdown influence associated with groundwater extraction during the dewatering was overlain with the GDEs, rivers and water bodies. Drawdown was predicted to occur at the Jacksons Creek and Merri Creek crossing areas, however the impact of construction dewatering drawdown on these GDE's is considered to be minor considering:

- The drawdown extent and level is localised and minor
- The duration is short (< 4 weeks)
- Construction activities (i.e. coffer dams) through the rivers will be designed to minimise the degree of groundwater and surface water interaction (i.e. trench breakers) and therefore minimise the dewatering requirements
- Local potential terrestrial GDEs are considered unlikely to be impacted by drawdown over this short period, unless a particularly dry period/drought
- Any impact on total baseflow to these river systems are expected to be within natural climatic variations. Consequently, any impact on surface water flows would be minor and within natural flow variations and therefore impacts on potential aquatic GDEs are also considered to be insignificant to minor. In addition, Merri Creek is an ephemeral stream, and dries out regularly, therefore any fauna (i.e. fish, frogs, birds) associated with potential aquatic GDEs already require a degree of mobility under the existing conditions to survive. The potential exception may be any persistent refuge pools in the area of the Merri Creek crossing, however none have been identified in the predicted area of drawdown influence.

Therefore the risks of groundwater dewatering impacting GDE's or surface water receiving environments is considered to be low, and with application of the management measures, to minimise dewatering and optimise the timing, the residual impact of groundwater dewatering impacting GDE's or the receiving environments is considered to remain low. As a conservative measure, an additional site inspection in late summer is proposed to assess the presence of any refuge pools within 100 m of the Merri Creek crossing point. (refer EES Technical Report A Biodiversity and habitats).

Risk ID GW3 - Drawdown impacts activating acid sulfate soils

The desktop review of the regional datasets (ASRIS) indicated there is a low to extremely low probability of Acid Sulfate Soil (ASS) occurring at in the areas where construction dewatering is likely. ASS testing completed along the alignment (18 samples) identified one soil sample from a depth of 0.1 m at the net acidity EPA assessment criteria of 0.03 % S. This however was not in an area where dewatering is expected to be required.

Considering the available data, and the areas where dewatering is expected to be required during construction, it is considered that the risk of ASS activation is low. However, further assessment of PASS at the creek crossings should be completed prior to construction. With application of management measures to minimise dewatering and further assessment, the residual impacts of groundwater dewatering causing acid sulfate activation is considered to remain low.

Risk ID GW4 - Ground settlement

Lowering of the water table on the down-gradient side of the trench for the pipeline could result in desaturation of currently saturated unconsolidated sediments. This effect could result in land subsidence at the ground surface, a process that results in a reduction in ground surface elevation at affected areas. The potential for subsidence at any dewatering area will be a function of the amount of drawdown and resultant load increase on underlying soils, and the presence, thickness and compressibility of the soil strata below the water table.

The risk of damage to buildings and other infrastructure would be dependent on the amount of total and differential settlement that may occur, and the tolerance of structures to such differential movement.

The predicted drawdown and areas of influence presented in this report were reviewed and the impacts associated with settlement were assessed separately in the EES Technical Report D Land stability and ground movement (Risk ID GM3). It was concluded that considering the limited area of the drawdown influence, the soil compressibility and infrastructure present, that the risks associated with settlement were negligible. With application of management measures to minimise dewatering, and basis of design on local geotechnical conditions, the residual impacts associated with ground settlement is considered to remain negligible

Risk ID GW5 - Mobilisation of existing contaminated groundwater

Construction dewatering has the potential to cause mobilisation of existing contaminated groundwater within the drawdown cone towards the dewatering site, which may impact groundwater quality and down gradient receptors (such as users/receiving environments, GDEs/rivers). However, the six areas identified where dewatering may occur are at least 750 m from potential contaminated sites, or operational landfills/quarries. Based on the estimated dewatering drawdown influence zones (i.e. <50m), the likelihood of intersecting a significantly contaminated groundwater plume from a potential contaminated site, and migrating contaminates to the dewatering area and impacting on the existing groundwater quality and protected beneficial use around the area is considered remote.

It is however noted that groundwater quality exceeds the relevant ANZG (2018) and/or SEPP (Waters) criteria for ecosystem protection currently in many potentially dewatering areas and therefore the beneficial use of the groundwater is already impacted by local background conditions and land uses, and additional groundwater analysis should be completed at some of the dewatering areas to further assess the groundwater quality and further inform the environmental management measures and disposal options.

Disposal of groundwater from dewatering activities would be required during construction. Considering the general setting of the pipeline, disposal to waterways or land irrigation are considered the likely or favoured options for the construction contractors. However, in some locations, as noted above, there may be some limiting groundwater quality parameters for disposal to waterways, including elevated concentrations of ammonia (as N), elevated total nitrogen, phosphorus and various metals. The groundwater salinity may also preclude disposal to land (i.e. irrigation) in some areas.

The existing (and any future) groundwater quality information will need to be considered by the contractor when assessing the most appropriate disposal method at each location.

Overall the risk of mobilisation of contaminated groundwater is considered to be low, and with the application of management measures to minimise dewatering, further establishment of baseline groundwater quality, and water disposal as per regulatory requirements., the residual impacts are considered to remain low.

Risk ID GW6 - Leaks or spills or runoff impacts to groundwater quality (construction phase)

There is a possibility that spills may occur during the refuelling of vehicles, plant and machinery or the use of chemicals required as part of the construction. In addition, poor quality surface water runoff into trenches or bell holes could impact groundwater quality

With standard management procedures in place, the likelihood of these events occurring is remote, and any consequence considered moderate and therefore the risk of groundwater impacts considered low. With application of management measures to minimise chemical and fuel storage on site, and avoid or minimise spillage, the residual impacts to groundwater quality associated with potential leaks, spills or runoff are considered to remain low.

Risk ID GW7 - Drilling fluids used for HDD impacts groundwater quality

In areas where horizontal directional drilling (HDD) will occur below the water table aquifer (i.e. Deep Creek) there is potential for drilling fluids to interact with the aquifer system.

These drilling muds are designed to stabilise and seal the hole and therefore movement into the aquifer system will be very limited. In addition, the drilling muds used are generally inert and biodegradable as they are commonly used in the groundwater bore drilling industry.

After use the drilling muds are required to be disposed as per EPA regulatory requirements.

Therefore the risk of impacts associated with the drilling muds is considered negligible, and with the application of management measures to further minimise impacts, the residual impacts are considered to be negligible..

Risk ID GW8 - Disturbance and stockpiling of existing contamination spoil

There is a possibility that where potentially contaminated or acid sulfate soils are stockpiled, that contaminated runoff could recharge the water table aquifer, potentially impacting on groundwater quality and down gradient users/ receiving environments (GDEs/rivers).

The likelihood of these events occurring is remote, and any consequence considered moderate under normal management procedures, and therefore the risk of groundwater impacts considered low. With application of management measures to minimise and avoid this impact, the residual impacts to groundwater quality associated with disturbance and stockpiling of existing contamination are considered to remain low

- **Operational Phase**

Risk ID GW9 - Impacts to groundwater flow paths and levels

Alignment of the pipeline and the backfilled trench in areas of shallow groundwater may disrupt or dislocate groundwater flow paths over time. This has the potential to cause preferential flow paths within the trench or around the pipeline, which may result in localised changes in the ground water level. This may result in either mounding or drawdown of the groundwater level, up or down hydraulic gradient and subsequently has the potential to impact nearby users, GDEs, receiving waters flows/levels, or cause water logging.

The areas of potential groundwater interaction along the alignment represents approximately 5% of the entire pipeline length. The longer trenched sections below the water table have more potential for a significant impact, however there is expected to only be four of these areas, each around 0.5 km to 1 km long with the trench estimated to be 0.5 m to 1.5 m below the water table (Table 25). Considering the pipe diameter is relatively small and trench depth below the water table is relatively shallow compared to the aquifer thickness, it is expected that groundwater local flow paths will not be significantly altered or blocked. On this basis, any changes in the groundwater level close to the trench are likely to be minor and management measures would further reduce the likelihood of the alignment becoming a preferential flow path.

Therefore, the risks of impacts to groundwater flow paths and levels during the operational phase is considered to be low, and with the application of deign management measures to minimise the potential for the trench to become a preferential groundwater flow path or block groundwater flow, the residual impacts to groundwater flow paths and levels groundwater associated with the pipeline are considered to remain low.

Risk ID GW10 - Impact to Groundwater quality

This risk has the same risk pathway as Risk ID GW9, with the focus on the potential for the pipeline trench to create preferential flow paths which may result in localised changes to groundwater quality and beneficial use. As for Risk ID GW10, the potential for significant changes in groundwater levels or flow regimes is considered minor. In addition, the potential areas where the trench is expected to be below the water table are not close to any identified potentially contaminated sites which could cause additional consequences if a preferential flow pathway developed.

Therefore, this risk is considered to be low, and with the application of design management measures to minimise the potential for the trench to become a preferential flow path and subject to further baseline groundwater quality monitoring, the residual impacts to groundwater quality associated with the pipeline are considered to remain low.

Risk ID GW11 - Leaks or spills or runoff impacts to groundwater quality (operation phase)

There is a possibility that spills or leaks may occur during the operation and maintenance of the pipeline, Wollert Compressor Station and the mainline valves. This could include fuels, oils or chemicals that are used in the operation phase of the Project. The likelihood of these events occurring is considered remote, and any consequence considered moderate under normal management procedures. Therefore this risk is considered to be low, and with the application of management measures to minimise chemical and fuel storage on site, and avoid or minimise spillage, the residual impacts to groundwater quality associated with potential leaks, spills or runoff during operation are considered to remain low

Environmental management measures

Eight groundwater environmental management measures are recommended which should be included in the CEMP and OEMP. These comprise:

- Design requirements - dewatering. The Project construction phase will be designed and undertaken to minimise changes in groundwater levels, flows and quality. This includes minimising dewatering durations and utilising trench breakers
- Design requirements - operation. The pipeline design shall consider where groundwater interaction is expected to occur and incorporate trench breakers/ pipe collars or plugs, as well as suitable backfill and compaction, to prevent preferential flow paths
- Groundwater disposed in accordance with the SEPP (Waters) and as per EPA Guidelines and all relevant approval processes
- Chemicals, fuels and hazardous materials management procedures
- Spoil management procedures

Conclusion

A total of eleven impact risk items, eight construction risks and three operation risks, were identified in this report. These included construction dewatering risks, such as impacts on neighbouring groundwater bores, GDEs or groundwater receiving environments (i.e. creeks or wetlands), land settlement, acid sulfate soil activation and mobilisation of existing contaminated groundwater. Operational risks included the potential to impact on groundwater levels, flow paths and quality, as well as accidental leaks and spills.

During dewatering it was estimated that the drawdown area of influence would be localised and less than 50 m from the point of dewatering. In addition, the areas where dewatering is expected are not close to potential contaminated sites, or operational landfills/quarries.

In conclusion, the residual impact of all eleven groundwater risks were assessed as either negligible or low, with the implementation of the initial management measures, including; minimising the dewatering rates and duration in design, incorporate trench breakers/ pipe collars or plugs, and suitable compaction in the design, groundwater disposal in accordance with relevant approval processes, and adherence with hazardous/soil management procedures.

Abbreviations

Abbreviation	Definition
AASS	Actual acid sulfate soils
AHD	Australian Height Datum
AMG	Australian Map Grid
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian & New Zealand Guidelines
AS	Australian Standard
ASS	Acid Sulfate Soils
bgl	Below ground level
CEMP	Construction Environment Management Plan
COC	Chain of custody
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CUN	Clean up Notice
EE Act	*Environment Effects Act 1978*
EES	Environment Effects Statement
EMM	Environment Management Measure
EPA	Environment Protection Authority
EP	Environmental Protection
GDE	Groundwater Dependant Ecosystem
GED	General environmental duty
HDD	Horizontal directional drilling
IWMP	Industrial Waste Management Policy
IWRG	Industrial Waste Resource Guidelines
MLV	Mainline valves
mbgl	Metres below ground level
MSA	Melbourne Strategic Assessment
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
OEMP	Operation Environment Management Plan
PASS	Potential Acid Sulfate Soils
PBC	Polychlorinated Biphenyl

Abbreviation	Definition
PIW	Prescribed Industrial Waste
SEPP	State Environment Protection Policy
SPOCAS	Suspension Peroxide Oxidation Combined Acidity Sulfur
SWL	Standing water level
TDS	Total Dissolved Solids
VOC	Volatile Organic Compounds
VTS	Victorian Transmission System
WORM	Western Outer Ring Main

Glossary

Term	Definition
Acid sulfate soil and rock	Natural soils or rocks that contain iron sulphides which when exposed to oxygen can release acid that may damage or otherwise adversely impact built structures and ecosystems.
Alluvial	Pertaining to, or composed of, alluvium or other deposits from streams and rivers.
APA	APA VTS (Operations) Pty Ltd, trading as APA Group, the proponent for the Project
Basalt	A dark coloured, fine grained, mafic volcanic rock
Beneficial uses	With regards to soil and groundwater, beneficial uses are the uses that soil or groundwater could be put to if they were not contaminated and require protection under EPA Victoria's SEPPs.
Contaminant	A substance, element, or compound that has an adverse effect on the quality of soil and water.
Environmental management measure	Approaches, requirements or actions to avoid, mitigate or manage potential adverse impacts
Fill Material	A designation of waste material defined by EPA Victoria. Often referred to as 'clean fill'.
Lithology	The physical character of a rock or rock formation.
Project	The Western Outer Ring Main Project
Scoping requirements	The EES Scoping requirements for the Project issued by the Department of Environment Land, Water and Planning in August 2020.

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1. Introduction

1.1 Purpose of this report

The Western Outer Ring Main (WORM) gas pipeline project (the Project) is a proposed 600 millimetre nominal diameter high pressure gas transmission pipeline that will provide a high pressure connection between the eastern and western pipeline networks of the Victorian Transmission System (VTS).

APA is the proponent for the Project. APA is Australia's largest natural gas infrastructure business. In Victoria, the VTS is owned and maintained by APA and consists of some 2,267 kilometres of gas pipelines. The VTS serves a total consumption base of approximately two million residential consumers and approximately 60,000 industrial and commercial users throughout Victoria.

The Project has been designed to provide critical infrastructure for Victoria's gas supply, distribution, and consequent security, efficiency and affordability. The key objectives of the Project are to:

- Improve system resilience and security of gas supply
- Increase the amount of natural gas that can be stored for times of peak demand
- Improve network performance and reliability
- Address potential gas shortages as forecasted by AEMO in the March 2020 Victorian Gas Planning Report update

The Minister for Planning determined on 22 December 2019 that APA and the Western Outer Ring Main (WORM) gas pipeline project (the Project) would require an Environment Effects Statement (EES) under the *Environment Effects Act 1978* (EE Act). The EES will inform assessment of approvals required for the Project including under the *Pipelines Act 2005*, the *Aboriginal Heritage Act 2006* and *Environment Protection and Biodiversity Conservation Act 1999*.

The purpose of this report is to assess the potential groundwater impacts associated with the Project and to define the environmental management measures necessary to meet the EES evaluation objectives.

1.2 Why understanding groundwater is important

Groundwater is water located beneath the earth's surface. Groundwater is sourced from water that originates above the ground – either from rain that has infiltrated into soil or rocks, or from surface water from rivers, streams and other waterways that has seeped into the subsurface. Groundwater relies upon the connection with rainfall and surface water to be 'recharged', and as a result, it is a finite resource. Groundwater flows underground primarily laterally within soil and rock layers. There are two main types of these layers:

- **aquifers** – are geological materials such as unconsolidated sediments (gravel, sand or silt), permeable rock or fractured rock that could contain water. Groundwater generally flows within aquifers as they are typically permeable.
- **aquitards** – are soil or rock layers that could store water but are relatively impermeable, which limits the amount of groundwater flow that could occur

The upper surface of the zone of saturation within an aquifer is known as the water table. The water table could be connected with rivers, streams, lakes and wetlands; and could be relied upon for beneficial uses including maintenance of ecosystems, potable water, agriculture, parks and gardens, stock watering, contact recreation and commercial/industrial water use.

Groundwater levels in the water table fluctuate naturally depending on the recharge and discharge processes for the aquifer system, however human activities may cause direct changes to groundwater levels and quality.

With regards to this Project, during construction there is likely to be some excavations that are deeper than the water table, and will therefore require dewatering over short periods. During operation the pipe and pipe trench may be below the water table which may potentially impact on groundwater flow paths. The potential changes to groundwater levels, flow paths and possible migration of existing contaminated groundwater, have the potential to subsequently impact groundwater dependent receptors (such as groundwater dependent ecosystems, surface water and, groundwater users (i.e. bores), as well as activate acid sulfate soils or cause ground subsidence.

1.3 Limitations

This report: has been prepared by GHD for APA and *may only be used and relied on by APA for the purpose agreed between GHD and APA as set out in section 1.1 of this report.*

GHD otherwise disclaims responsibility to any person other than APA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by APA and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. EES scoping requirements

2.1 EES evaluation objectives

The scoping requirements for the EES, released by the Minister for Planning, set out the specific environmental matters to be investigated and documented in the Project's EES, and informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objectives are relevant to the groundwater assessment:

- **Biodiversity and habitats**

Avoid and minimise potential adverse effects on native vegetation, listed threatened and migratory species and ecological communities, and habitat for these species, as well as restore and offset residual environmental effects consistent with state and Commonwealth policies.

(For this study this aspect is related to groundwater dependent ecosystems).

- **Water and catchment values**

Maintain the functions and values of groundwater, surface water and floodplain environments and minimise effects on water quality and beneficial uses.

2.2 EES scoping requirements

The scoping requirements relevant to the groundwater evaluation objectives are shown in Table 1, as well as the location where these items have been addressed in this report.

Table 1 Scoping requirements relevant to Groundwater

Scoping requirement	Section addressed
Key Issues	
The potential for adverse effects on the functions, values and beneficial uses of groundwater due to the Project on groundwater dependent ecosystems (GDEs) due to changes in groundwater levels, behaviour or quality.	Section 5.6
Existing Environment	
Describe surface and groundwater conditions and their beneficial uses that could be affected from changed water quality, or water movement, due to the Project	Section 6 and 7
Identify and describe nearby wetlands/swamps and floodplains that could be affected by the Project (e.g. wetlands in Merri Creek catchment).	Section 6 and 7
Characterise the local groundwater quality and behaviour, including the protected beneficial uses and values and identifying any GDEs that might be affected by the Project	Section 6 and 7
Characterise the interaction between surface water and groundwater within the Project and broader area.	Section 6.12

Scoping requirement	Section addressed
Identify and characterise any groundwater dependant ecosystems that may be affected by the Project works. This characterisation is to be informed by data, literature and appropriate surveys.	Section 6.12 Technical Report A Biodiversity
Mitigation measures	
Identify and evaluate aspects of Project works and operations, and proposed design refinement options or measures that could avoid or minimise significant effects on water, waterway or wetland environments.	Section 10
Likely effects	
Identify and evaluate effects of the Project and alternatives on groundwater, surface water, waterways and wetlands near the Project works, including the likely extent, magnitude and duration (short and long term) of changes to water quality, water level or flow paths during construction and operation, considering appropriate climate change scenarios and possible cumulative effects resulting in combination with other existing or proposed projects of actions.	Section 9 Technical Report A Biodiversity Technical Report D Land stability and ground movement Technical Report E Contamination
Assess potential impacts on water availability and quality for farming and other land uses.	Section 9
Assess potential erosion, sedimentation and landform stability effects of the Project.	Technical Report B Surface water
Performance criteria	
Describe monitoring programs and specific monitoring activities to be implemented to ensure prompt detection of surface water and groundwater effects associated with the Project.	Section 10 Environmental Management Measures
Identify possible contingency actions to respond to foreseeable changes that may be identified through the monitoring program	

2.3 Linkages to other reports

This report relies on or informs the technical assessments as indicated in Table 2.

Table 2 Linkages to other technical reports

Specialist report	Relevance to this technical study
EES technical report E Contamination	This is relevant in regards to identifying potential contamination along the alignment and management measures for contaminated soil and groundwater
EES Technical Report A Biodiversity and habitats	This is relevant to the value of GDEs along the alignment and management
EES Technical Report B Surface water	This is relevant to the potential for changes to quality and volumes of groundwater baseflow to surface water and potential impacts on beneficial use
EES Technical Report D Land stability and ground movement	This is relevant to the potential for changes to assessment of ground settlement

3. Project description

3.1 Project overview

The Project provides a new link between APA's existing Plumpton Regulating Station (approx. 38 kilometres north west of Melbourne's CBD) and Wollert Compressor Station (approx. 26 kilometres north east of Melbourne's CBD). The Project includes the following key components:

- **A new pipeline**: The pipeline would be approximately 51 kilometres in length. The pipeline would be within a 15 metre wide permanent easement and be buried for its entire length to a minimum depth of cover of 750 millimetres.
- **Mainline valves**: Three mainline valves (MLV) would be located along the pipeline alignment. The area required for mainline valves would be subdivided and acquired by APA to provide ongoing access for any maintenance or inspection activities from the existing roads. The mainline valves would be spaced at intervals of approximately 15 kilometres, and located within the proposed easement area at approximately KP 6, KP 22 and KP 35.
- The **Wollert Compressor Station upgrade**: The installation of a new Solar Centaur 50 compressor, an end of line scraper station and a pressure regulating station within the existing APA facility at Wollert.

A schematic illustration of the Project context is shown in Figure 1.

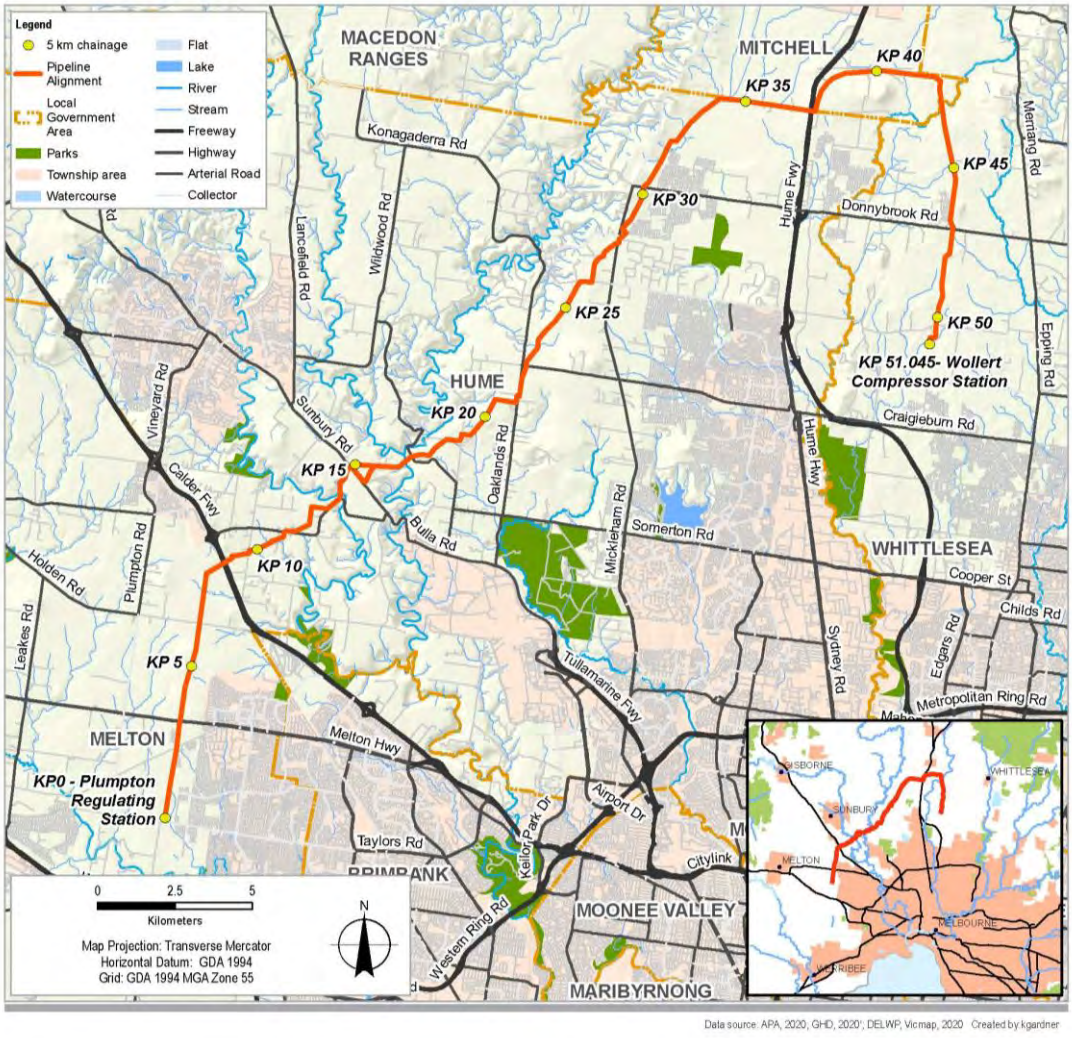


Figure 1 Western Outer Ring Main (WORM) overview

3.2 Construction

Subject to the staging of the works, construction for the entire Project is expected to take approximately nine months. Key construction activities for the Project include:

- Establishing offsite construction sites, including laydown areas
- Constructing the pipeline
- Constructing three mainline valves
- Construction of upgrades associated with the Wollert compressor station
- Rehabilitation

3.2.1 Construction sites

Two temporary laydown areas would be established for construction.

One offsite compound for pipeline works nominally 200 metres x 200 metres, including laydown and storage areas. This would be located on a site where the activity is permitted under the relevant Planning Scheme, most likely within an existing industrial area.

The second temporary laydown area and construction offices would be established for the Wollert Compressor Station construction works. The site laydown area and construction offices for the compressor station equipment would be located within the existing compressor site area at Wollert.

3.2.2 Pipeline construction area

The Project would require a construction area for the pipeline, which would typically comprise a 30 metre wide corridor along the pipeline alignment. Most construction activity would be located within this construction area. The activities and facilities within the construction corridor would include access tracks and additional work areas such as vehicle turn around points and additional work spaces for crossings, stockpiling of materials and storage of pipe. Additional work areas up to 50 m x 50 m or 50 m x 100 m (such as for vehicle turn-around points, areas to accommodate HDD) would be required in some locations.

3.2.3 Pipeline construction methodology

The techniques used to construct the underground pipeline would include various methods including open cut trench construction and alternative techniques at certain locations such as horizontal directional drilling (HDD) or horizontal boring.

Where crossing watercourses, major roads, rail line reserves or other constraints, the pipeline would be constructed using trenchless construction techniques such as HDD or shallow horizontal boring, to avoid construction disturbance within the sensitive area.

The pipeline construction sequence starts with survey works and continues with site establishment (including laydown area), clearing and grading, pipe stringing, pipe bending, welding and coating, open trench construction, lowering pipe into trench, hydrostatic testing, commissioning, and finally rehabilitation.

There would be dedicated access points into the construction corridor with vehicular movements along the Project alignment kept within the construction corridor.

3.2.4 Construction of other facilities

The construction sequence for the Wollert Compressor Station works starts with survey works and continues with site establishment (including laydown area), bulk earthworks, civil works (concrete slab and footings), mechanical works, electrical and instrumentation works, hydrostatic testing, commissioning, and site completion.

Various components of the compressor are assembled offsite. When delivered to site the various components are assembled together onsite. Cranes are used to lift the compressor into place with all connecting pipework fitted.

3.3 Operation

Following the reinstatement of land as part of the pipeline construction, the land would be generally returned to its previous use. When commissioned, the pipeline would be owned and maintained by APA. The pipeline would be contained within a 15 metre wide permanent easement corridor (within the area that formed the 30 metre construction corridor). Routine corridor inspections would be undertaken in accordance with APA procedures and AS2885 to monitor the pipeline easement for any operational or maintenance issues.

Excavating or erecting permanent structures or buildings over the underground pipeline would be prohibited in accordance with the *Pipelines Act 2005* and pursuant to easement agreements with landowners.

Maintenance and inspections of the MLVs and the Wollert Compressor Station would also be conducted periodically in accordance with APA procedures. The activities usually include vegetation management, valve and compressor operation and corrective maintenance.

The key operation and maintenance phase activities include:

- Easement maintenance (vegetation control, weed management, erosion and subsidence monitoring)
- Pipeline, MLVs and compressor station maintenance
- Specialist pigging operations
- Cathodic protection surveys for mechanical and electrical preventative and corrective maintenance
- Monitoring and routine inspections and surveillance

3.4 Activities and design considerations relevant to Groundwater

Chapter 4 Project description details the construction methodology for the pipeline, including open trench construction and also alternative techniques such as HDD or horizontal boring.

Table 4 summarises the proposed construction method for each crossing.

In regards to the Project interaction with the local groundwater systems, the following key aspects have been considered:

- **Construction:** Excavations that intersect the water table aquifer may require some level of dewatering, which will result in groundwater level changes and may subsequently impact on groundwater dependent receptors
- **Operation:** If the pipeline or trench infrastructure is permanently below the water table, then there is the potential that the pipeline or backfilled trench may impact on groundwater flow paths, impact on groundwater levels or quality and subsequently impact on groundwater dependent receptors.

The key aspects which will govern the level of interaction of the Project with groundwater are summarised below:

3.4.1 Open cut trench construction

The open trench during construction will generally be:

- Width: 1 m
- Total depth: 2 m
- Cover depth: Minimum cover depth will be 0.75 m
- Under pipe packing : 0.3 m (minimum 0.150 m)

A schematic is shown in Figure 2.

It is noted that open trench may be deeper at:

- Entry, exit points at horizontal bore locations Minor creek crossings
- Clearance of third party services
- Tie-ins
- Some railways and Road crossing: the trench may be 2.5 m to 3 m to maintain a greater pipe coverage
- Creek crossings (i.e. Jacksons and Merri Creek). A minimum cover of 2 m is required at any creek invert and therefore the trench depth at the invert will be around 2.8 m (and deeper on each side of the creek to reach this depth profile)
- Gunns Gully Rd. In this area there are two areas where future surface water channels are proposed, and therefore the pipe will be placed deeper to maintain a minimum 1.0 m cover in the future

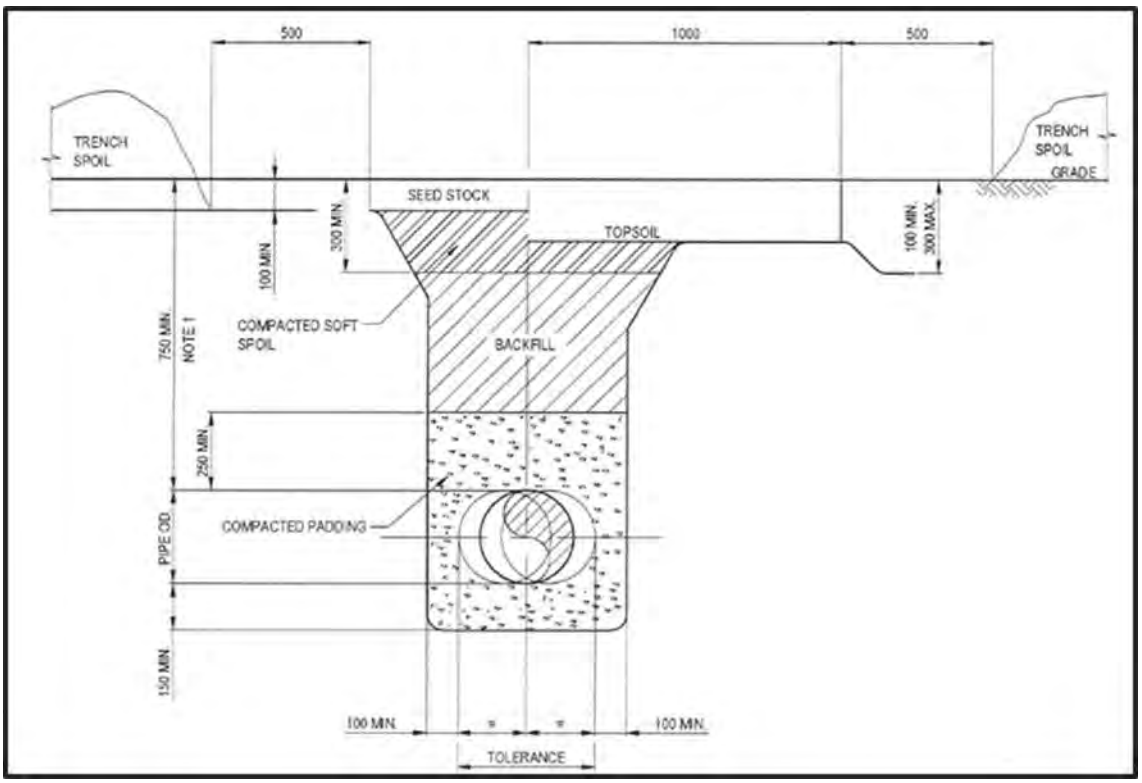


Figure 2 Open trench schematic

If the trench is excavated below the groundwater table then the following construction aspects are relevant:

- The open trench construction is planned to be up to 700 m per day. Therefore it is assumed dewatering of approximately a 700 m length of trench would be required for a period of a day using a sump pump
- Trench breakers will be used to prevent groundwater flowing from any other part of the open trench during dewatering operations (i.e. limited to the 700 m length)

3.4.2 Trenchless Methods

In some cases, due to the presence of ecologically significant areas, existing assets or other constraints, the pipeline would be constructed using trenchless construction techniques such as horizontal directional drilling (HDD) or shallow horizontal boring, to avoid surface construction disturbance within the sensitive area.

Key areas where trenchless construction techniques would be used include:

- Watercourses (i.e. Deep Creek)
- Sealed road crossings, to avoid traffic disruption.

Table 4 in the following section summarises the proposed construction method for each crossing.

Horizontal directional drilling (HDD)

The HDD construction methodology requires the excavation of entry and exit pits, typically an approximate size of three metres by three metres. The drilling would be conducted by a specific HDD rig which is operated by a specialist contractor. The size of the HDD rig and its associated footprint is based on the size of the pipe, the nature of the subsurface geology and the length of the section to be drilled.

A pilot bore is drilled, then the hole is enlarged by reaming to allow for the welded pipe string to be pulled back through the drill hole from the exit point to the entry point without damaging the coating (refer Figure 3).

Drilling muds are used while drilling the hole to stabilise the open hole and seal the hole to prevent groundwater inflow. Therefore there is no need for dewatering during the HDD process.

However, after the HDD and pipe installation is completed, bell holes would be constructed at the entry and exit points to facilitate joining of the pipe (known as tie-in). A bell hole is an enlarged hole allowing machinery to operate within it to bore under the relevant constraint. These HDD tie-in bell holes would be approximately five metres long, five metres wide and two and a half metres deep. The pipeline string is then welded to adjoining sections of the pipeline. Once the pipe string is installed and tied into the main section of the pipeline, the entry and exit points are remediated.

If the bell holes intersect the water table it is assumed they will require dewatering.

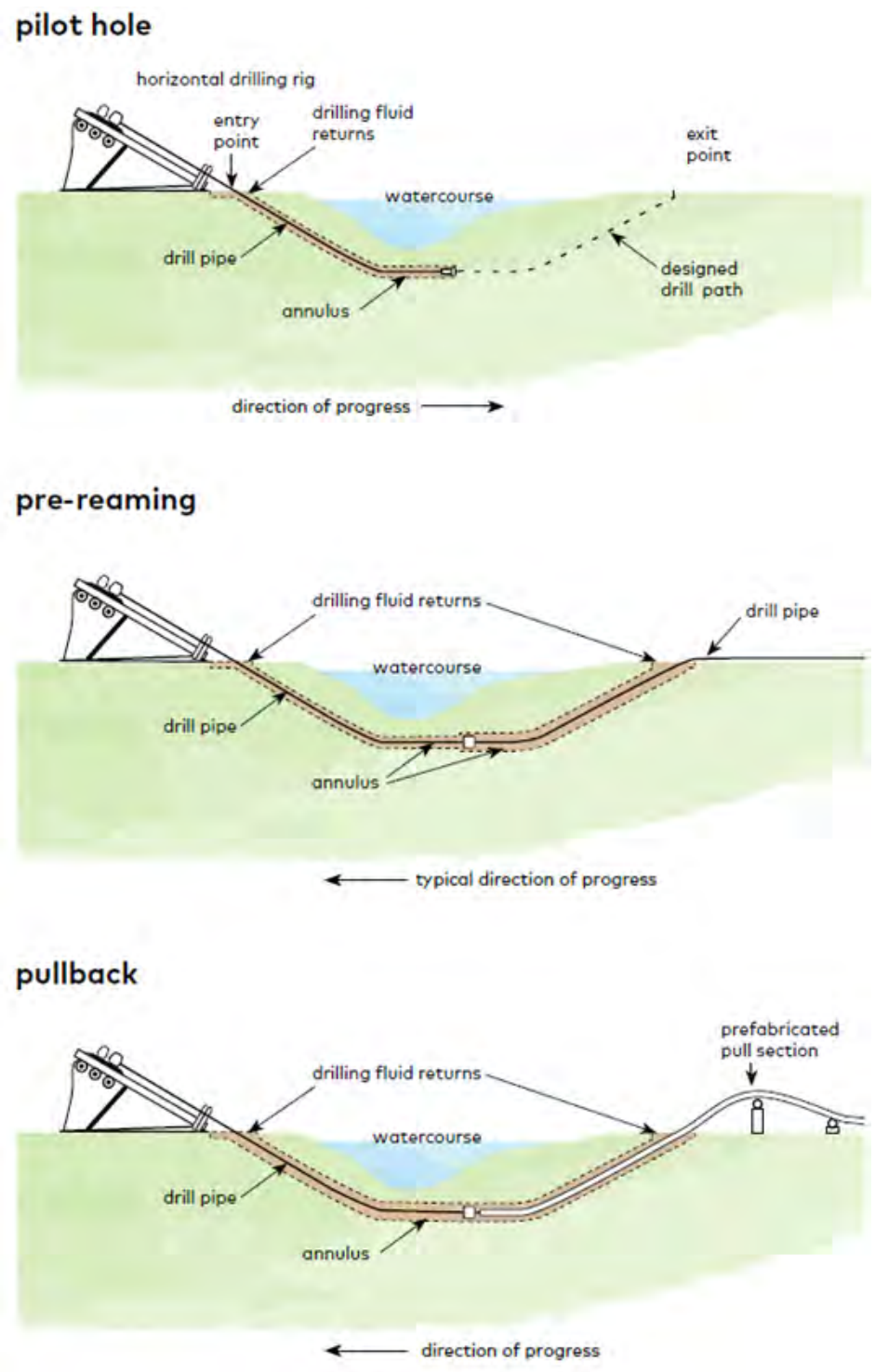


Figure 3 Typical HDD process

Shallow Horizontal Boring and Pipe Jacking

In this method, bell holes are excavated on both sides of the sensitive feature to the depth of the adjacent trench and graded to match the slope of the pipeline (refer Figure 4). A bell hole is an enlarged hole allowing a boring machine wider than the width of the trench to operate within it to tunnel under the relevant constraint. Bell holes would be approximately eight metres long and four metres wide. The depth would match the adjacent trench and graded to match the proposed slope of the pipeline. The maximum depth is 5 m.

A boring machine operates within this bell hole to tunnel under the relevant constraint. The boring machine is located within the entry pit, which uses a hydraulic ram to jack the boring pipe section, behind a cutting head, in a straight line through the ground to the receiving pit

The pipe can then be installed in the boring casing and the annulus is sealed.

If the bell holes intersect the water table it is assumed they will require dewatering during the boring operations. It is expected that there will be minimal groundwater flow into the shaft as the boring pipe will be jacked into place.

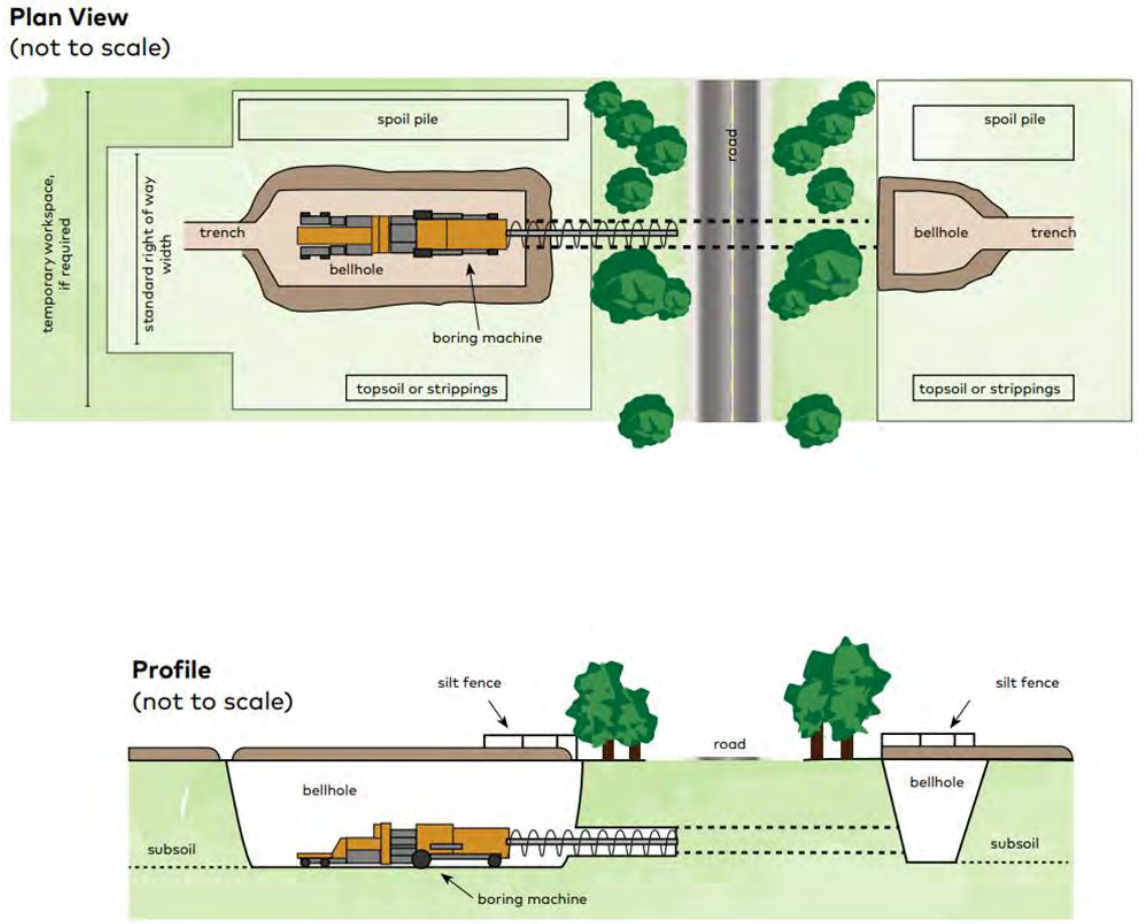


Figure 4 Typical Thrust Bore Site Set Up

3.4.3 Construction method summary and dewatering requirements

The Construction method summary and dewatering requirements have been summarised in Table 3.

Table 3 Construction method summary and dewatering requirements

Construction Method	Excavation size	Groundwater Control Requirement (if below water table)	Assumptions
Open trench	1 m wide x 2 m deep At some locations, the trench will be deeper – ie, most creek crossing, Gunns Gully Rd	Dewatering required	700 m trench per day, dewatering for 7 days. Assume sump pumps Dewatering disposal options depending on quality and location. Creek crossings that are open trench construction may require dewatering for approximately 4 weeks
Trenchless HDD	Drilled hole of various size and depth	No dewatering required for HDD	Drilling muds seal and stabilise open hole
	Bell holes 5 m x 5 m x 2.5 m deep	Dewatering required	Assume sump pumps Dewatering disposal options depending on quality and location.
Horizontal Boring and Pipe Jacking	Augered hole with bore pipe jacked in place	No dewatering	Boring pipe seals hole Pipe jacking is proposed at rail crossings
	Bell holes 8 m x 4 m x 5 m deep (max)	Dewatering required	Dewatering disposal options depending on quality and location.

3.4.4 Construction method proposed for each crossing

The construction method proposed for each crossing is summarised in Table 4.

Table 4 WORM - Foreign Crossing Drawings Listing

S/No.	Location Description	Approx. Start KP	Approx. End KP	Construction Method at Crossing
1	Beatty's Road (Melton City Council)	2.299	2.37	Bored
2	Holden Road	6.405	6.425	Bored
3	Unknown Creek	8.406	8.411	Open trench construction
4	Dillon Ct Road (Hume City Council)	8.802	8.945	Open trench construction

S/No.	Location Description	Approx. Start KP	Approx. End KP	Construction Method at Crossing
5	Duncans Lane Road (Hume City Council)	9.723	9.744	Open trench construction
6	Unknown Creek	10.668	10.68	Open trench construction
7	Morefield Ct (Hume City Council)	10.901	10.924	Bored
8	Bulla-Diggers Rest Road (Hume City Council)	11.267	11.292	Bored
9	Unknown Creek	13.986	14.14	Open trench construction
10	Wildwood Rd (Hume City Council)	17.085	17.106	Bored
11	Unnamed Road (Hume City Council)	18.414	18.44	Open trench construction
12	St Johns Rd (Hume City Council)	19.099	19.119	Bored
13	Oaklands Rd (Hume City Council)	21.665	21.705	Bored
14	Craigieburn Rd (Hume City Council)	22.737	22.758	Bored
15	Mt Ridley Rd (Hume City Council)	26.433	26.456	Bored
16	Parkland Cr (Hume City Council)	26.456	27.073	Bored/Open trench construction
17	Mickleham Rd (Hume City Council)	28.063	28.123	Bored
18	Donnybrook Rd (Hume City Council)	30.277	30.308	Bored
19	Unnamed Rd (Hume City Council)	33.802	33.826	Open trench construction
20	Gunns Gully Rd (Hume City Council -VicRoads)	36.891	36.938	Bored
21	Donnybrook Rd (Whittlesea City Council- VicRoads)	46.864	46.884	Bored
22	Summerhill Rd (Whittlesea City Council - VicRoads)	50.071	50.091	Open trench construction
23	Bendigo Rail Line reserve	8.288	8.326	Bored (Pipe jacking)
24	North Eastern Rail Line reserve	40.925	40.959	Bored (Pipe jacking)

S/No.	Location Description	Approx. Start KP	Approx. End KP	Construction Method at Crossing
25	Jacksons Creek (vicinity of creek)	13.863	13.898	Open trench construction
26	Kalkallo Basin (length of property)	33.825	35.316	Open trench construction
27	Merri Creek (vicinity of creek)	42.639	42.655	Open
28	Sunbury	14.907	14.967	Mini HDD
29	Deep Creek	16.828	16.85	HDD
30	Calder Freeway	8.677	8.802	HDD
31	Hume Freeway	36.938	37.017	HDD
32	Melton Highway	3.148	3.209	HDD
Note: Kilometre Points (KP) based on Rev 7 pipeline				

4. Legislation, policy and guidelines

4.1 Legislation, policy and guidelines

The EES is prepared under the EE Act and will inform assessment of approvals required for the Project. The legislation relevant to the principal approvals required for the Project is:

- Commonwealth approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). For the component of the Project that is located outside of the Melbourne Strategic Assessment (MSA) program area, the Project requires assessment and approval under the EPBC Act, under the assessment bilateral agreement with Victoria made under section 45 of the EPBC Act.

  The MSA program is the Victorian Government's approach to managing the impact of urban development in Melbourne's growth areas on significant vegetation communities, plants and animals. Areas within the approved MSA area occur between approximately KP 0 to KP 3.2, KP 28.16 to KP 28.57, and KP 32 to KP 51. Areas outside of the MSA occur approximately between KP 3.2 to KP 28.1, and KP 28.57 to KP 32.

- Pipeline Licence approval is required under the Pipelines Act 2005 (Vic) (Pipelines Act) for the Western Outer Ring Main Project. The Pipeline Licence application is exhibited with the EES.

  Section 49 of the Pipelines Act requires that the following matters be considered before granting a licence:

  > *(a) the potential environmental, social, economic and safety impacts of the proposed pipeline*
  >
  > *(f) the assessment of the Environment Effects Minister in relation to the proposed pipeline, if an assessment has been made*
  >
  > *(g) any written comments received from the Planning Minister or the relevant responsible authority on the effect of the proposed pipeline on the planning of the area through which it is to pass*
  >
  > *(h) any written comments received from the Water Minister and from the relevant Crown Land Minister on the impact of the proposed pipeline*

  Section 3 of the Pipelines Act state the objectives of the Act, including:

  > *(a) to facilitate the development of pipelines for the benefit of Victoria*
  >
  > *(e) to protect the public from environmental, health and safety risks resulting from the construction and operation of pipelines*
  >
  > *(f) to ensure that pipelines are constructed and operated in a way that minimises adverse environmental impacts and has regard for the need for sustainable development*

  Section 4 of the Pipelines Act sets out the principles of sustainable development to be given regard in implementing the Act including that decision-making should be guided by a careful evaluation to avoid serious or irreversible damage to the environment wherever practicable and an assessment of the risk-weighted consequences of various options.

  Section 54(c) of the Pipelines Act states that conditions on a licence may include conditions concerning the protection of the environment.

- Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act 2006* (Vic) (AH Act). Two CHMPs are currently in progress for the Project (CHMP 16593 and CHMP 16594).

A number of legislative, policy, guidance and standard documents were found to be relevant to this Groundwater impact assessment and are discussed further in this report. The key legislation, policy and guidelines that apply to the Groundwater impact assessment for the Project are summarised in Table 5. Further detail is provided in Section 4.3 to 4.5.

Table 5 Key legislation and policy applicable

Legislation/policy	Relevance to this impact assessment
Pipelines Act 2005 (Pipelines Act) *The Pipelines Act is the primary Act governing the construction and operation of pipelines in Victoria. The Pipelines Act covers 'high transmission' pipelines for the conveyance of gas, oil and other substances. DELWP and Energy Safe Victoria are responsible for administering the Pipelines Act and the Pipelines Regulations 2017.*	The Project requires a pipeline licence under the Pipelines Act for the construction and operation of the Pipeline Works. Mitigation measures to minimise impacts on groundwater for the construction of the pipeline would be included in the Pipeline Construction Environment Management Plan (CEMP)
National Environmental Protection (Assessment of Site Contamination) Measure 1999 ('ASC NEPM'), as amended in 2013	Main guidance document for the assessment of land and groundwater contamination.
Environment Protection Act 1970	Any discharge to land, waterway or groundwater; and disposal of waste (including contaminated soil and acid sulfate soil) must be in accordance with the requirements of the Environment Protection Act.
Water Act 1989 (Water Act) The Water Act provides the legal framework for the integrated management of Victoria's water resources. The main purpose of the Water Act is to promote the efficient and equitable use of water resources and ensure water resources are conserved and appropriately managed for sustainable use. The Water Act provides the framework for allocating surface water and groundwater throughout Victoria. The Water Act details the State's entitlements to water and private entitlements to water from all rivers, streams and groundwater systems in Victoria. It allows authorities and individuals to use water either through bulk entitlements, providing authorities with bulk amounts of water, or licences or sales water, which allow people to access water for mainly commercial or irrigation purposes.	Under the Water Act, the State delegates authority to government departments and water corporations (in this case Southern Rural Water – SRW) to develop and manage groundwater resources for all users and the environment. In this case SRW is responsible for issuing licences for groundwater bores (monitoring, extraction) and any groundwater extraction, e.g. during any construction dewatering. As part of the licencing process SRW may require a technical assessment to demonstrate the impact the groundwater extraction may have to the surrounding environment, including other groundwater users. SRW may also refer the application to other authorities during the assessment process, e.g. Melbourne Water.
State Environment Protection Policy (Waters)	Defines environmental quality objectives and establish beneficial uses and values of surface water and groundwater that are to be protected and would be considered for assessing the potential for contamination.

4.2 Commonwealth legislation, policy and guidelines

Commonwealth legislation relevant to the Project includes:

- *National Environmental Protection (Assessment of Site Contamination) Measure 1999* ('ASC NEPM'), as amended in 2013. Developed and issued by the National Environment Protection Council (NEPC) under the *National Environment Protection Council Act 1994*.

The ASC NEPM is the main guidance document for the assessment of land contamination in Victoria. The ASC NEPM provides a national approach to the assessment of potentially contaminated sites to ensure effective environmental management practices and provide adequate protection of human health and the environment where known contamination has occurred.

In Victoria, the ASC NEPM is mainly implemented through Victorian Government policies (subordinate legislation, such as the State Environment Protection Policies) and guidelines described below. The ASC NEPM is divided into two schedules:

- Schedule A – identifies the general process for the Assessment of Site Contamination
- Schedule B – identifies general guidelines for the Assessment of Site Contamination (soil and groundwater)

4.3 Victorian legislation, policy and guidelines

4.3.1 Existing legislation

This section provides an overview of the key legislation and policy documents which form the regulatory framework for groundwater. Groundwater in Victoria is managed primarily through the following legislation:

- *Water Act 1989*
- *Environment Protection Act 1970*

It is these two Acts which provide the principal framework for the management of groundwater. In the context of groundwater, the *Water Act 1989* principally deals with the sustainable, efficient and equitable management and allocation of the resource. It also provides a means for the protection (and enhancement) of all elements of the terrestrial phase of the water cycle.

The *Environment Protection Act 1970* empowers the Environment Protection Authority (EPA Victoria) to implement regulations and maintain the state environment policies and protect the environment from pollution and the management of wastes.

The Act regulates the discharge or emission of waste to water, land or air by a system of works approvals and licences. It has the objectives of preventing and managing pollution and environmental damage, and the setting of environmental quality goals and programs.

Groundwater disposal from dewatering will need to be managed in accordance with the Environment Protection Act 1970. There are many options available for groundwater disposal (i.e. to waterway, reinjection, irrigation, sewer) and the selected option will have different regulatory requirements (e.g. disposal to waterway or aquifer recharge would need to meet the water quality criteria and environmental requirements of the SEPP Waters).

A number of subordinate legislation and guidelines exist which further expand upon the general tenets of the *Water Act 1989* and *Environment Protection Act 1970*. State Environment Protection Policies (SEPPs) set out policies of the Victorian Government to control and reduce environmental pollution and have been formulated for discharges to atmosphere, water, land and noise emissions. They protect the environment and human activities (beneficial uses) from pollution caused by waste discharges and noise and are subordinate documents to the *Environment Protection Act 1970*.

The relevant SEPP to groundwater is:

- SEPP (Waters)

  The SEPP (Waters) has the objective to protect and improve the quality of Victoria's waters having regard to the principles of environment protection set out in the Environment Protection Act 1970.

Other relevant EPA guidelines include:

- EPA Victoria Publication 669 Groundwater sampling guidelines.
- EPA Victoria Publication 668: Hydrogeological Assessment (groundwater quality) guidelines
- EPA Publication 665.1, Acid Sulfate Soil and Rock
- Industrial Waste –Classification of drilling muds. Excess drilling muds used for HDD may need to be disposed. As a liquid waste, drilling mud is a category A prescribed industrial waste (PIW) under the Environment Protection (Industrial Waste Resource) Regulations 2009 (IWR Regulations), requiring strict management conditions. Based on risks to human health and the environment, the classification recognises drilling mud as a non-PIW, provided appropriate measures are in place to prevent pollution to the environment. EPA developed this guidance for the classification of drilling muds.

4.3.2 Environment Protection Act 2017

A review of the *Environment Protection Act 1970* has resulted in the passage of the *Environment Protection Act 2017 (EP Act 2017)* which was scheduled to come into effect in July 2020, however this has been delayed until July 2021.

The EP Act 2017 includes a new approach to environmental issues, focusing on preventing waste and pollution impacts rather than managing those impacts after they have occurred. The Act also includes the concept of general environmental duty (GED) which requires people to undertake reasonably practicable steps to eliminate, or otherwise reduce risks of harm to human health and the environment from pollution and waste. Unlike similar laws in other states and territories, a breach of the GED could lead to criminal or civil penalties, similar to those currently outlined in the *Occupational Health and Safety Act 2004*.

Under the new Act, the beneficial uses of water, as outlined in the SEPP (Waters) will be known as environmental values.

4.4 Local policy and guidelines

Southern Rural Water (SRW) is the authority delegated by the Victorian Department of Environment, Land, Water and Planning (DELWP) in southern Victoria (including the study area) to be responsible for the issuing of licenses to take and use groundwater, or for providing approval for disposal of matter underground, under the *Water Act 1989*.

It is noted that:

- A groundwater extraction licence may also be needed from SRW in the case any dewatering is required (depending on volumes/duration.)
- All observation bores/test bores will require a bore construction licence from SRW

The Port Phillip and Westernport Catchment Management Authority (PPWCMA) engages with government, water authorities, industry and the community in order to protect and enhance the natural resources within its service region.

The PPWCMA note that groundwater extraction in their service region is managed by SRW. Furthermore the PPWCMA refers to the SEPP (Groundwaters of Victoria) as a key government policy setting standards and performance objectives water quality. It is noted that the SEPP (Groundwaters of Victoria) has been replaced by the SEPP (Waters).

With regards to surface water features, e.g. waterways, the PPWCMA indicates their mission is to facilitate effective management and integration of these assets in order to protect, and where possible improve them.

4.5 Groundwater criteria

4.5.1 Groundwater segments

The SEPP (Waters) forms the primary guide to determining existing impacts and risk of impacts to groundwater quality. It provides that groundwater is categorised into segments based on the groundwater salinity (measured as mg/L Total Dissolved Solids - TDS), with each segment having particular identified beneficial uses. The segments and their beneficial uses are summarised in Table 6. Water of higher quality (lower salinity) has more beneficial uses than low quality (more saline) groundwater.

Table 6 Protected beneficial uses and groundwater segments (SEPP Waters)

Use	Segment (mg/L TDS)						
	A1	A2	B	C	D	E	F
	0 – 600	601 – 1,200	1,201 – 3,100	3,101 – 5,400	5,400 – 7,100	7,100 – 10,000	>10,001
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		

Use	Segment (mg/L TDS)						
	A1	A2	B	C	D	E	F
	0 – 600	601 – 1,200	1,201 – 3,100	3,101 – 5,400	5,400 – 7,100	7,100 – 10,000	>10,001
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Cultural and spiritual values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

Note: TDS – Total Dissolved Solids (mg/L). Source EPA 2018

EPA Victoria may determine these beneficial uses do not apply to groundwater where:

- There is insufficient yield to sustain the beneficial use
- The application of groundwater, such as for irrigation, may be a risk to beneficial uses of land or the broader environment due to the soil properties
- The beneficial use specified in the definition of water dependent ecosystems and species relates to stygofauna and troglofauna
- The background level of an environmental quality indicator would not provide for the protection of the beneficial use
- The groundwater is within a groundwater protection zone for which more stringent objectives have been developed

Notwithstanding the above conditions, the policy stipulates that the water quality is to be maintained as close as practicable to background concentrations.

Groundwater salinity is discussed in detail in Section 7.3.1, with regional data suggesting most salinity is between 1,000 mg/L and 7,000 mg/L TDS. Higher groundwater salinity, up to 35,000 mg/L has been interpreted in a limited area near the start of the alignment, i.e. towards KP1.

Site specific data collected during Project investigations record a salinity range of 910 mg/L and 7,360 mg/L TDS (refer Section 7.3.1), which is broadly consistent with the regional salinity interpretation. The site specific data places the groundwater quality within Segments A2, B, C and D of the SEPP (Waters). Broadly described, the salinity can be grouped as follows:

- Segment C groundwater from bores at Deep and Jacksons Creeks
- Segment C and D groundwater from bores installed adjacent Gunns Gully Road (higher than the regional groundwater salinity interpretation)
- Segment A2, B and C groundwater from bores installed to the east and south east of the Hume Freeway. The majority of the bores have groundwater that falls within Segment B.

The Project interaction with groundwater is expected to occur at Deep and Jacksons Creeks, and to the east and south east of the Hume Freeway as described in Section 7.2.3.

The majority of the groundwater along the alignment has been classified as Segment C. As a conservative measure, groundwater to the east and south east of the Hume Freeway has been classified as Segment A2, i.e. more protected beneficial uses (including potable water and irrigation).

As such, the range of protected beneficial uses of the groundwater for the Project have been included in Table 7. Water quality indicators for these applicable beneficial uses are described in Table 10.

Table 7 Classified Project protected beneficial uses

Use	Segment (mg/L TDS)	
	A2	C
	601 – 1,200	3,101 – 5,400
Water dependent ecosystems and species	Yes	Yes
Potable water supply (acceptable)	Yes	No
Potable mineral water supply	Yes	No
Agriculture and irrigation (irrigation)	Yes	No
Agriculture and irrigation (stock watering)	Yes	Yes
Industrial and commercial	Yes	Yes
Water-based recreation (primary contact recreation)	Yes	Yes
Traditional Owner cultural values	Yes	Yes
Cultural and spiritual values	Yes	Yes
Buildings and structures	Yes	Yes
Geothermal properties	Yes	Yes

Note: TDS – Total Dissolved Solids (mg/L). Source EPA 2018

4.5.2 Groundwater quality indicators

The SEPP (Waters) also provides groundwater quality indicators (guidelines) and objectives for each beneficial use, as identified in Table 8. These indicators have been used to determine existing groundwater conditions and potential Project impacts on groundwater beneficial use.

Table 8 Groundwater quality indicators and objectives

Beneficial use	Indicators	Objectives
Water dependent ecosystems and species	Groundwater must not cause receiving waters to be affected to the extent that the level of any environmental quality indicator is greater than the level of that indicator specified for surface waters in the SEPP (Waters) Groundwater quality must not adversely affect the maintenance of environmental values that depend on groundwater.	Water quality that is suitable to protect the integrity and biodiversity of water dependent ecosystems. This beneficial use encompasses: • protection of the integrity of riparian vegetation as it contributes to the health of water dependent ecosystems and bank stability • that groundwater quality does not adversely affect surface water ecosystems and other beneficial uses of surface environments; and • ensures that groundwater quality does not adversely affect natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis to maintain their communities of organisms, ecological processes and ecosystem services. This includes wetlands and rivers reliant on groundwater baseflow, some terrestrial vegetation and some estuarine and near-shore marine systems, cave ecosystems and subterranean fauna; maintenance of fish passage.
Potable water supply: desirable	Those specified for raw water for drinking water supply in the Australian Drinking Water Guidelines (2011), updated in 2018	Salinity shall be less than 600 mg/L TDS. The constituents of groundwater must not be affected in a manner or to an extent that leads to the aesthetic water qualities being impacted, as defined in the Australian Drinking Water Guidelines
Potable water supply: acceptable		Salinity shall be less than 1,200 mg/L TDS. Groundwater shall not be affected to the extent that the level of any water quality indicator is greater than the level of that indicator specified for raw water for drinking water supply in the Australian Water Quality Guidelines for Fresh and Marine Waters

Beneficial use	Indicators	Objectives
Potable mineral water supply	Groundwater must not be affected to the extent that the level of any environmental quality indicator is greater than the level of that indicator specified in the Australia New Zealand Food Standards Code – Standard 2.6.2 – Non-alcoholic beverages and brewed soft drinks. The constituents of groundwater must not be affected in a manner or to an extent that leads to the aesthetic water qualities being impacted, as defined in the Australian Drinking Water Guidelines.	Water quality that is suitable for use as mineral water, which in its natural state contains carbon dioxide and other soluble matter in sufficient concentration to cause effervescence or impart a distinctive taste.
Agriculture and irrigation (irrigation)	Those specified for irrigation in ANZECC (2000) for Fresh and Marine Waters	Water quality that is suitable for irrigation, such as the irrigation of domestic gardens, commercial agriculture, parks and golf courses.
Agriculture and irrigation (stock watering)	Those specified for irrigation in ANZECC (2000)) for Fresh and Marine Waters	Water quality that is suitable for stock watering.
Industrial and commercial use	Groundwater must not be affected to the extent that industrial or commercial water quality is impacted.	Water quality that is suitable for industrial and commercial use.
Water based recreation (primary contact recreation)	Groundwater must not be affected to the extent that the level of any water quality indicator is greater than the level of that indicator specified for water based recreation (primary contact recreation) for surface waters in the SEPP (Waters)	Water quality that is suitable for primary contact recreation (e.g. swimming, diving, water skiing, caving and spas), secondary contact recreation (e.g. boating and fishing) and for aesthetic enjoyment.
Traditional Owners' and Aboriginal Victorians' cultural values	No specific water quality objectives have been set. This report adopts those required to protect aquatic ecosystems.	Water quality that is suitable for traditional owner cultural needs and that will ensure that traditional owner cultural practices can continue. For example, traditional aquaculture, fishing, harvesting, cultivation of freshwater and marine foods, fish, grasses, medicines and filtration of holistic water holes/camps.

Beneficial use	Indicators	Objectives
Cultural and spiritual values	No specific water quality objectives have been set. This report adopts those required to protect aquatic ecosystems.	Water quality that is suitable for cultural and spiritual needs and that will ensure that cultural, spiritual and ceremonial practices can continue. These include the cultural values held by communities (e.g. water based festivals and celebrations).
Buildings and Structures	Introduced contaminants must not cause groundwater to become corrosive to structures or building materials; Specific indicators include: pH, sulphate, chloride, redox potential, salinity or any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures.	Groundwater quality where introduced contaminants do not cause groundwater quality to become corrosive to buildings, structures, property and materials.
Geothermal properties	No activity must affect the geothermal properties of groundwater. Specific indicators include temperature between 30 and 70 degrees Celsius.	Groundwater quality that will not affect the geothermal capacity of the groundwater.
Source: State Environment Protection Policy (Waters)		

4.6 Surface water

4.6.1 Surface water segments

The SEPP lists the beneficial uses to be protected for each segment of the water environment. Jacksons, Deep, Kalkallo and Merri Creeks (to which the groundwater may ultimately discharge) are included in the “Central Foothills and Coastal Plains” Segment.

The SEPP (Waters) indicates that the Central Foothills and Coastal Plains segment is considered to have slightly to moderately modified aquatic ecosystems. The SEPP (Waters) document the ANZECC (2000) guidelines when considering the level of ecosystem protection however these have been superseded by the ANZG (2018) guidelines. The ANZG (2018) guidelines have been accepted by the EPA and therefore adopted in this report.

The level of the ecosystem protection for the Segment is generally 95% for slightly to moderately modified aquatic ecosystems.

Other guideline values for primary industries published in the ANZECC (2000) guidelines have been retained, including water for aquaculture and the production of foods for human consumption, and water for irrigation. The SEPP (Waters) specifies physical environmental quality indicators and objectives for various nutrients and toxicants. Toxicants are specified by a percentage of T-values, which are ANZG (2018) guideline objectives. Some indicators and objectives are specified for the various segments of the environment across Victoria within the SEPP (Waters).

These are summarised in Table 9.

Table 9 SEPP (Waters) indicator criteria

Indicators		Unit	Segment
			Central Foothills and Coastal Plains
Total phosphorus	75th percentile	µg/L	≤55
Total nitrogen	75th percentile		≤1,100
Dissolved Oxygen	25th percentile	% saturation	≥75
	Maximum		130
Turbidity	75th percentile	NTU	≤ 25
Electrical Conductivity	75th percentile	µS/cm at 25^0C	≤ 250
pH	25th percentile	unit	≥ 6.7
	75th percentile		≤ 7.7
Toxicants water	% protection	-	95
Sediment toxicants	-	-	Low

Notes:
75th/25th percentiles must be calculated for a minimum of 11 data points collected from monitoring over one year
For toxicants sediment, 'low' and 'high' refer to sediment values set out in the ANZECC Guidelines
For toxicants water, '% Protection' refers to the '% Ecosystem Protection' values set out in the ANZECC Guidelines

4.7 Assessment Criteria

As described in Section 7.3.1 and above, Segment A2 and C and the associated beneficial uses have been adopted for the purposes of this assessment, based on groundwater quality measured in on the alignment where groundwater interaction with the water table is expected to occur. The water quality indicators for the applicable beneficial uses are described in Table 10. In addition, Table 10 provides details of other guidelines referred to when the primary water quality indicators do not provide a guideline value for a contaminant of concern.

In comparing the groundwater quality against the water quality objectives in the SEPP (Waters), the protection of water dependant ecosystems is considered the most sensitive beneficial use relevant to the Project and therefore the ANZG (2018) water quality guidelines and the values specified in SEPP (Waters) are appropriate as a preliminary screen.

Table 10 Discussion of Project groundwater beneficial uses and groundwater quality indicators

Beneficial Use	Segment	Existing	Water quality indicators	Discussion
Water dependant ecosystems and species	A2 C	Yes	This site is located in an area covered by the *SEPP Waters*. The SEPP lists the beneficial uses to be protected for each segment of the water environment. In accordance with Figure 1 of Schedule 1, the rivers and streams adjacent to the site (to which the groundwater ultimately discharges) are included in the "Central Foothills and Coastal Plains" Segment. The environmental quality objectives specified for this segment are those values in the ANZECC 2000 guidelines, and the level of ecosystem protection for this Segment is generally 95% for slightly to moderately modified ecosystems. The ANZECC 2000 criteria for ecosystems have been superseded by the ANZG 2018 criteria. (refer Section 4.6.1). Schedule 3, Table 1 of SEPP (Waters) 2018 also specifies also specifies environmental criteria for a number of parameters including nutrients (refer Table 9).	This is relevant to those ecosystems in down-gradient groundwater discharge areas. The groundwater flow direction relative to the site has been interpreted as towards the major drainage lines, e.g., Deep, Jacksons and Merri Creeks. These creeks have been identified within this beneficial use.
Potable water supply (acceptable)	A2	Yes	Clause 7 of Schedule 3 refers to the health-related and aesthetic guideline values specified in the *Australian Drinking Water Guidelines*. The current version of this guideline is the NHMRC, NRMMC (2011), *Australian Drinking Water Guidelines* version 3.5, Updated August 2018.	Domestic bores have been identified in the vicinity of the alignment. These may provide water for consumptive purposes.

Beneficial Use	Segment	Existing	Water quality indicators	Discussion
Potable mineral water	A2	No	Australia New Zealand Food Standards Code (2017) *Standard 2.6.2 – Non-Alcoholic Beverages and Brewed Soft Drinks*, criteria for potable mineral water supply. Aesthetic guideline values defined in the *Australian Drinking Water Guidelines.* The current version of this guideline is the NHMRC, NRMMC (2011), *Australian Drinking Water Guidelines* version 3.5, Updated August 2018.	There are two bores, located approximately 1 km north of the Donnybrook railway station, that are used for mineral water purposes. These bores are approximately 2 km west of the pipeline and well outside any potential dewatering impact zone. Whilst this beneficial use is protected , the existing (known) springs are some distance from the proposed alignment. However, it is noted that the groundwater could be developed as 'still' spring water and therefore comparison of groundwater quality to the potable guidelines is appropriate.
Agriculture and irrigation (Irrigation)	A2	Yes	ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, investigation levels for Primary Industries (Chapter 4.2 Water Quality for irrigation and general water use)	Irrigation bores have been identified along the pipeline alignment. The identified domestic bores may also support garden watering. This is considered a relevant and existing beneficial use.
Agriculture and irrigation (stock watering)	A2 C	Yes	ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, investigation levels for Primary Industries (Chapter 4.3 Livestock drinking water quality)	Stock bores have been identified along the pipeline alignment. This is a relevant and existing beneficial use.

Beneficial Use	Segment	Existing	Water quality indicators	Discussion
Water based recreation	A2 C	No	NHMRC (2008) Guidelines for Managing Risks in Recreational Water. To account for incidental ingestion during primary contact recreation activities, the NHMRC guideline values for inorganic compounds are multiple by a factor of 10 based on consideration assuming a consumption rate of 100-200 mL per day. Refer to Section 9.3 of NHMRC (2008). For the purposes of short term chemical hazard environmental quality indicators and objectives for water-based recreation – (a) waters must not be contaminated with chemicals that are either toxic or irritating to skin or mucous membrane; and (b) waters must have a pH range of – (i) 6.5–8.5; or (ii) 5–9 for recreational waters with a very low buffering capacity. For the purposes of short term aesthetic indicators and objectives for water-based recreation – (a) are assessed against single samples or observations to determine if a public warning or other communication is needed; and (b) waters are observed as being free from the following – (i) visible materials that may settle to form objectionable deposits; (ii) floating debris, oil, scum and other matter; (iii) substances producing objectionable colour, odour, taste or turbidity; (iv) substances and conditions that produce undesirable aquatic life.	While it cannot be confirmed, given the current paucity of residential development in the area it is unlikely that groundwater is currently developed for recreational purposes, e.g. swimming pool top-up water. It is noted that this may change subject to any housing development in the area.

Beneficial Use	Segment	Existing	Water quality indicators	Discussion
			Environmental quality indicator of *E. coli* is not greater than 10 *E. coli*/100 mL and when human faecal contamination sources (e.g. septic tanks) have been identified, no *E. coli* must be present. Further information is contained in Schedule 3, Part 6 (note this section applies to groundwater as well as surface water). Reference should be made to the long term and short term microbial indicators and objectives specified in Tables 13 and 14 respectively of SEPP Waters 2018.	
Industrial and commercial use	A2 C	Yes	No guideline specified, only that water quality is suitable for industrial and commercial use. ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, do not provide specific guidance for industrial water use, because industrial water requirements are so varied (both within and between industries) and sources of water for industry have other coincidental environmental values that tend to drive management of the resource.	Commercial and industrial bores have been identified along the pipeline alignment. This is considered a relevant and existing beneficial use.
Protection of Buildings and Structures	A2 C	Yes	Introduced contaminants shall not cause groundwater to be corrosive to buildings, structures property and materials. Indicators include pH, sulphate, chloride, redox potential salinity or any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures). Investigation levels are not specified in ANZECC guidelines therefore, best practice standards or guidelines are referenced, such as AS 2159-2009: Piling – Design and installation and the NEPM Management Limits that includes protection of “damage to buried infrastructure”.	Groundwater in some locations along the pipeline alignment is shallow and potentially within a range that could interact with buried services, cellars and basements of buildings. At this stage, there are few buildings located near the alignment.

Beneficial Use	Segment	Existing	Water quality indicators	Discussion
Traditional/ aboriginal cultural values	A2 C	No	Water quality that protects the cultural values of Traditional Owners. Value may include traditional aquaculture, fishing, harvesting, cultivation of freshwater and marine foods, fish, grasses, medicines and filtration of water holes. The SEPP's explanatory notes for Clause 17 states that no specific environmental quality indicators or objectives are provided for this beneficial use. However, the environmental quality objectives for beneficial uses of water dependent ecosystems and their species go some way to protecting the cultural and spiritual values. including spiritual relationships, sacred sites and customary use. Therefore, the EQIs for water-based dependent ecosystems and species and water based recreation (primary contact recreation) have been adopted in a preliminary approach in assessing this beneficial use.	The traditional landholder cultural status of the groundwater is not known. The general amenity of the major watercourses should be protected. It has been assumed that comparison of groundwater quality against the Drinking Water guidelines and the Primary Contact Recreation as a minimum would be sufficient to assess potential impacts against this beneficial use.
Geothermal	A2 C	No	Water quality that must not affect the geothermal properties of groundwater. The temperature must sit between 30 and 70° Celsius.	No geothermal bores have been identified along the alignment. The groundwater is not of elevated temperature. Accordingly, this beneficial use is unlikely to be realised.

5. Methodology

5.1 Overview of method

This section describes the method that was used to assess the potential impacts of the Project. A risk based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects. Figure 5 shows an overview of the assessment method.

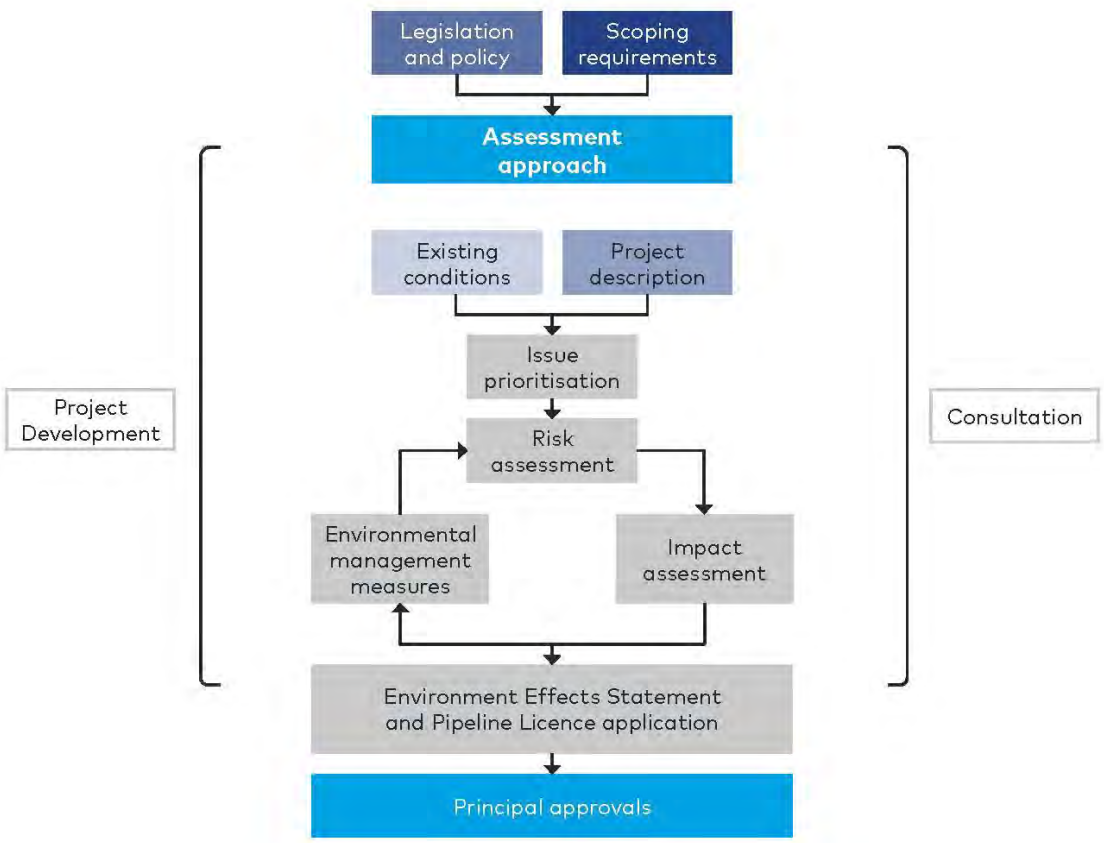
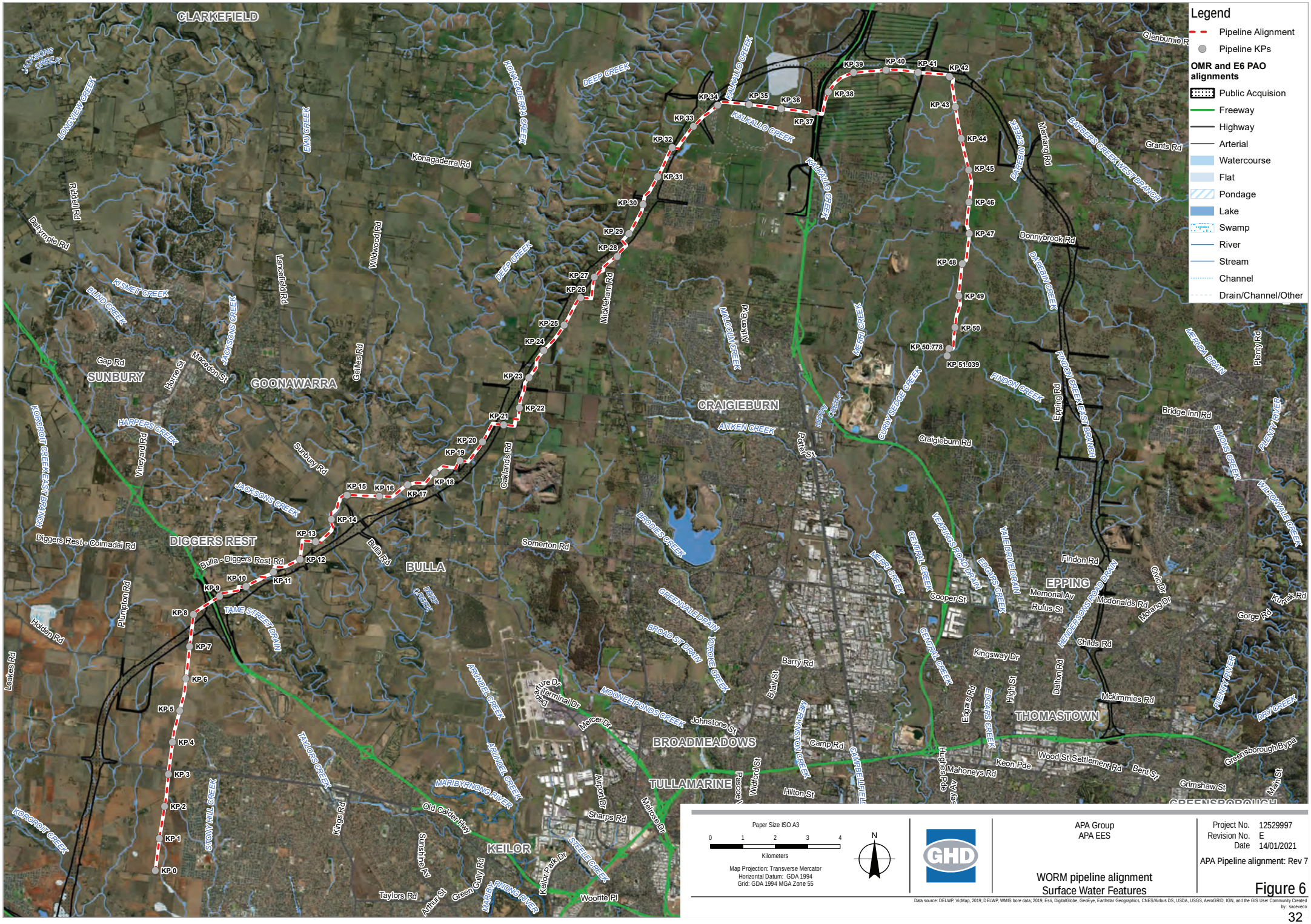


Figure 5 Overview of assessment method

5.2 Study area

The study area is along the pipeline alignment (refer Figure 6) and within the construction corridor. Whilst the construction corridor is a relatively narrow area (less than 100 metres wide), to aid the assessment regional groundwater information has been presented from within at least 3 km of the alignment.


Legend
Pipeline Alignment
Pipeline KPs
OMR and E6 PAO alignments
Public Acquision
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
GREENSBOROUGH
KP 0
KP 1
KP 2
KP 3
KP 4
KP 5
KP 6
KP 7
KP 8
KP 9
KP 10
KP 11
KP 12
KP 13
KP 14
KP 15
KP 16
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KP 36
KP 37
KP 38
KP 39
KP 40
KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
WORM pipeline alignment
Surface Water Features
Project No. 12529997
Revision No. E
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 6
Data source: DELWP, VicMap, 2019; DELWP, WMIS bore data, 2019; Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Created by: sacevedo

5.3 Data sources

The EES has relied on a number of data sources which have assumed to be accurate and up to date. These data sources have been summarised in Table 11 and referenced, where relevant, throughout the report and a complete list of references is provided in Section 12.

Table 11 Summary of data sources

Data source	Description
Publicly available	Published geological and hydrogeological mapping. Water Measurement Information System - Department of Environment, Land, Water and Planning Government produced literature including reports, zones, overlays, meteorological and topographical data. Bureau of Meteorology for Potential GDEs-
APA	Construction information pertinent to the Project GIS information for the proposed pipeline. Site geotechnical and hydrogeological information obtained through drilling, geotechnical laboratory analysis and monitoring bore installation (reports completed by Construction Science for APA) Previous Project investigation reports
GHD	Groundwater level and quality information from Project monitoring bores Aquifer hydraulic conductivity from slug testing of Project monitoring bores

5.4 Existing conditions method

The existing groundwater conditions were established through desktop and field investigations as summarised in Table 12. A description of the investigations undertaken, which were completed over a number of stages, has been in included in Section 5.4.1 to Section 5.4.6.

Table 12 Summary of desktop and field investigations

Investigation type	Investigation summary
Desktop assessment	Initial desktop hydrogeological assessment (Stage 1) Additional hydrogeological assessment following initial field investigations (Stage 3)
Field investigations	Geotechnical drilling, installation of six monitoring bores, bore development and ASS laboratory testing (Stage 2)
	Groundwater gauging, sampling and aquifer testing (completed to inform Stage 3 reporting)
	Data logger deployment in six monitoring bores (Stage 5)
	Installation of additional groundwater monitoring bores at selected locations along the pipeline alignment (generally where groundwater depth was expected to be < 5 m). (Stage 6) Development of the monitoring bores Groundwater gauging, sampling and aquifer testing

5.4.1 Stage 1: Desktop Assessment (Alluvium / Biosis 2019)

In 2019 Alluvium completed a surface water and groundwater desktop assessment for the Project (Alluvium, 2019). This initial desktop assessment was completed by Alluvium in 2019 providing a 'high level' review of the Project area and documented hydrogeological conditions based on regional information, e.g. expected geology, aquifer hydraulic conductivity and groundwater depths and salinity.

A desktop biodiversity assessment report for the Project was completed by Biosis in 2019. Biosis (2019) reported that the assessment was completed in order to inform minimising and avoidance of potential impacts to ecological values, where possible that may occur along the Project Pipeline Alignment (PPA). As part of their assessment, Biosis (2019) identified the presence and significance of Groundwater Dependant Ecosystems (GDEs) along the PPA, which is pertinent to this EES. A summary of the Biosis (2019) GDE review has been included in Section 6.12.

5.4.2 Stage 2: Initial investigation program

This stage included geotechnical drilling and initial monitoring bore installation and monitoring. All geotechnical works, monitoring bore installation (six of) and development was completed by Construction Science. The six monitoring bores were installed at the following locations:

- Jacksons Creek (one bore)
- Deep Creek (two bores)
- Adjacent Gunns Gully Road (one bore)
- Merri Creek (two bores)

Subsequent groundwater gauging, sampling and aquifer testing was completed by GHD at the completion of the drilling investigations and monitoring bore installation.

5.4.3 Stage 3: Further Hydrogeological Assessment

In August 2020 GHD (GHD) completed a Hydrogeological Assessment for the Project in order to inform detailed design and construction as well as provide hydrogeological information to inform an Environment Effects Statement (EES). The Hydrogeological Assessment (GHD, 2020) relied largely on regional data sets, which were used to identify the locations where the pipeline was likely to interact with groundwater during the construction and operation phase of the Project (refer Section 6). An initial round of monitoring was completed from the six groundwater monitoring bores installed by APA (refer Section 5.4.2) to inform the Hydrogeological Assessment.

However a number of recommendations were made to further inform potential groundwater risks for construction purposes, and to provide further groundwater level and quality information that may be required to inform the EES for the Project. These included:

- Installation of additional monitoring bores at selected locations along the alignment
- Implementation of a groundwater monitoring program in order to collect groundwater quality and groundwater level information
- Aquifer (slug) testing of the monitoring bores to determine field estimates of aquifer hydraulic conductivity

A preliminary risk assessment completed as part of the Hydrogeological Assessment concluded:

- The majority of excavations are expected to be shallow and therefore there are limited sections of the alignment where direct interaction between the Project and the groundwater environment would occur
- Trenches may require dewatering if shallow groundwater is intersected. Dewatering drawdown may impact receptors (i.e. users or GDEs) and this was considered a medium risk, albeit dependent on the aquifer hydraulic conductivity, yields and groundwater quality.
- The excavation and subsequent installation of the pipeline may disturb identified GDEs and wetlands however risks were considered low and mitigation measures were available to address such a risk
- Disturbance and oxidation of any ASS was considered a low risk
- Groundwater contamination during construction was considered a medium risk
- The pipeline alignment may impact groundwater flow patterns over the long term. This was considered a medium risk, subject to further monitoring bore installation and assessment.

5.4.4 Stage 4: Groundwater monitoring

In consultation with APA, GHD developed a groundwater monitoring program consisting of both initial groundwater monitoring requirements to inform the EES, as well as potential ongoing monitoring.

Locations for additional monitoring bores were selected along the WORM pipeline alignment based on:

- Desktop and field investigations completed through previous hydrogeological investigations (completed by GHD)
- A site inspection to ‘ground truth’ proposed locations, i.e. assess nearby sensitive environmental receptors, review site access constraints, etc.

When selecting bore locations (and depths) the following items were considered:

- Existing and available design and construction information, e.g. proposed trench and HDD depths, creek crossing methods, etc.
- Existing geotechnical drilling information
- Existing Project groundwater monitoring bore locations
- Regional groundwater depths, i.e. are the groundwater depths shallow (less than 5 m)
- Location of potential sensitive receptors, e.g. GDEs, wetlands, creeks, etc.
- The need to provide sufficient groundwater information along the pipeline alignment to complete a technically robust EES and demonstrate potential impacts (or lack thereof) to the groundwater environment

Particular areas that were considered significant in regards to potential interaction with groundwater were:

- Alignment ≈ KP30 to KP36: Shallow groundwater (<5 m) and wetlands in the alluvial or basalt aquifer system, where open cut trench construction is proposed. Aquifer yields can be variable and there is limited information, however if shallow (<2 m) and high yielding, dewatering will likely be required.

- Alignment ≈ KP38 to KP45: Shallow groundwater (<5 m) in the basalt aquifer system where open cut trench construction is proposed. In addition a number of creek crossings including Merri Creek (open trench construction crossing planned)
- Unnamed creeks or wetlands between KP40 and KP45 with shallow groundwater and proposed to be open trench construction crossings

5.4.5 Stage 5: Datalogger deployment and monitoring bore inspection

In June 2020 GHD deployed automated dataloggers (dataloggers) in the six historic Project monitoring bores (refer Section 5.4.2). The dataloggers were deployed in order to start capturing groundwater level information at regular intervals, and to allow less frequent access to private properties along the alignment. Summary results are included in Section 7.2.2.

GHD (2020a) documented a blockage in historic monitoring bore WORMBH23 and a subsequent CCTV inspection of the bore indicated a partial to compete blockage at between 15 m and 16 m depth. Bore WORMBH23 was installed by Construction Sciences (CS) during an earlier geotechnical drilling program. APA subsequently engaged CS to:

- Install a replacement monitoring bore at this location (bore WORMBH23a)
- Decommission the blocked monitoring bore

5.4.6 Stage 6: Additional site investigation program

Following the EES scoping documented above, the groundwater monitoring network was expanded in order to further inform potential groundwater risks for construction purposes, and to provide further groundwater level, yield and quality information in order to inform the EES. It is noted that the original monitoring network plan was changed slightly as there was no access to a number of proposed drilling sites. The additional investigations included:

- The installation of 11 new monitoring bores at selected locations along the alignment
- Replacement of one monitoring bore at Deep Creek (by Construction Science)
- Groundwater level and quality monitoring
- Slug testing

The field investigations have been described in Appendix B and a summary has been included in Section 7.

5.5 Risk assessment method

A risk assessment for the Project was carried out using an approach that is consistent with Australian/New Zealand Standard AS/NZS ISO 31000:2018 Risk Management Process.

This risk assessment was used to identify the issues for assessment and apply a structured approach to the level of assessment and analysis undertaken of potential environmental effects within each technical study. Applying the risk framework facilitated an approach for the EES to identify and then investigate issues with a focus proportionate to the risk, and to consider management measures focused on reducing identified risks.

The risk assessment methodology included:

- Defining the context for the risk assessment based on the existing assets, values and uses (baseline) assessments of each technical area and the proposed Project activities which interact with those existing conditions
- Identifying the risk pathways for the Project based on a specific cause and effect

- Identifying standard management/mitigation measures (including those in guidelines and standards) and whether additional mitigation measures may be required
- Analysing the consequence and likelihood of the identified risk based on a consequence guide developed for each technical area and a likelihood guide
- Defining the risk level based on the risk matrix

The identification, analysis and evaluation of risks was conducted within each technical area and across technical areas where there was input or connection across disciplines.

The consequences of a groundwater risk occurring were assigned using consequence categories from insignificant to severe developed for groundwater based on the existing conditions and values in the study area. The consequence levels and descriptors are provided in Appendix C.

A likelihood rating for each identified risk was assigned ranging from 'almost certain' where the event is expected to occur to 'rare', where the event may occur only in exceptional circumstances. The likelihood levels and descriptors are provided in Appendix A.

The risk matrix used to define each risk level is also provided in Appendix A.

The risk ratings were revisited during the impact assessment where additional environmental management measures were applied to identify the residual impacts and risks.

5.6 Impact assessment method

The methodology for the impact assessment included:

- Summarising regional groundwater conditions, including groundwater quality and depth along the alignment, based on existing published desktop information
- Identify potential receptors, risk pathways and potential key impact issues or risks of the Project construction and operation based on the regional data described in Section 5.6.1 and 5.6.2 below
- Undertaking on site hydrogeological investigations in areas where the Project was expected to interact with the groundwater system (i.e. a focus on areas of shallow groundwater). This was to confirm groundwater depth and quality, as well as aquifer permeability
- Based on the investigation results, confirm areas where the Project is likely to interact with groundwater and identify potential groundwater receptors and evaluate the potential level of impact. Analytical methods were used to estimate groundwater inflows and distance of influence during construction dewatering.
- Identification of initial mitigation measures to manage identified impacts and risks encountered or generated during Project construction and operation.
- Assessment of the significance of the potential impacts on groundwater using a risk assessment matrix (as described in Section 5.5) which ranks the likelihood and consequence of the identified risks occurring
- Where necessary, for any higher risks, identify further environmental mitigation measures, such as monitoring or contingency plans, to further reduce the risk (i.e. the residual risk)
- Where necessary propose performance criteria, to ensure effectiveness of the environmental mitigation measures

5.6.1 Construction Phase

5.6.1.1 Dewatering impacts

Dewatering trenches or bell holes during the construction phase, will result in groundwater drawdown. Groundwater drawdown may result in the following impacts:

- Interference with existing groundwater users (i.e. bores)
- Reduction in groundwater levels/flows at groundwater dependent ecosystems (GDEs) and/or receiving environments (i.e. river/wetland base flows)
- Exposure of ASS and acid generation, which may impact groundwater quality and impact down gradient users, GDEs and receiving environments
- Ground settlement
- Contamination migration which may impact groundwater quality and impact down gradient users, GDEs and receiving environments

5.6.1.2 General impacts

- Construction impacts associated with HDD drilling muds/fluids
- Construction impacts to groundwater quality associated with incidental contaminated runoff / spills and impacting on groundwater quality and downgradient users/ receiving environments (GDEs/rivers)
- Construction impacts to groundwater quality associated with activities such as ASS soil or contaminated soil stockpiling entering groundwater and impacting on groundwater quality (contamination migration) and down gradient users/ receiving environments (GDEs/rivers)
- Physical disturbance of GDE's, where an open trench may go through or directly adjacent the GDE

5.6.2 Operational Phase

5.6.2.1 Pipeline or trench is below the groundwater level

Where the pipeline and backfilled pipeline trench is located below the groundwater table during the operational period, the following impacts may occur over time:

- Alteration of local groundwater flow paths and levels. This may cause preferential flow paths, mounding /drawdown, up gradient and down gradient. This may subsequently impact users, GDEs/receiving waters, or cause water logging
- Alteration of local groundwater flow paths and levels. This may cause preferential flow paths and movement of contaminated groundwater which may subsequently impact users, GDEs/receiving waters, or cause water logging

5.6.2.2 General impacts

- Maintenance impacts to groundwater quality associated with incidental contaminated runoff / spills and impacting on groundwater quality and downgradient users/ receiving environments (GDEs/rivers)

5.7 Rationale

The level of investigation was designed to be suitable for an EES, taking into account the limitations noted in Section 5.8. Where uncertainty remains based on the limitations, the Contractor would need to address these in their proposed work plan.

5.8 Limitations, uncertainties and assumptions

Limitations are detailed in Section 1.3 of this report, in addition the following limitations apply in regards to the groundwater investigations:

- Areas where groundwater may be intersected during construction have been based on regional data and site specific data. Due to the inherent uncertainties associated with prediction of groundwater levels and flow paths between monitoring points (i.e. observation bores), these areas of potential dewatering have been interpreted and more detailed investigations maybe considered necessary by the Contractor, to further understand groundwater characteristics, as part of the construction phase.
- Inflow estimates for dewatering are based on analytical methods and limited slug testing of aquifer parameters. Due to the inherent uncertainties associated with fractured rock aquifers, localised areas of higher or lower permeability than recorded may be intersected impacting on localised groundwater inflows. Again, further detailed investigations maybe considered necessary by the Contractor to better understand the aquifer parameters as part of the construction phase.

5.9 Stakeholder engagement

Whilst stakeholder and community engagement was undertaken during the preparation of the EES, no community engagement was specifically required to inform this assessment,

EES Attachment III *Community and Stakeholder Consultation Report* provides details of the consultation activities undertaken for the Project more broadly and outcomes from those activities. There has been engagement during the EES process.

6. Existing conditions: regional context

6.1 Pipeline alignment location

The WORM pipeline alignment has been shown in Figure 1. The alignment starts in Plumpton, west of Melbourne and travels north to the Calder Freeway near Diggers Rest before heading generally north east to Mickleham. From Mickleham the alignment travels east and north east to north of Donnybrook before heading south to terminate at the existing Wollert compressor station.

As noted in Section 3.1, the pipeline alignment will have a construction corridor width of 30 m during construction. Following the completion of construction the pipeline corridor will have an easement width of 15 m. The pipeline will cross numerous roads and a number of waterways, and the method of construction is detailed in Section 3.4.

6.2 Climate

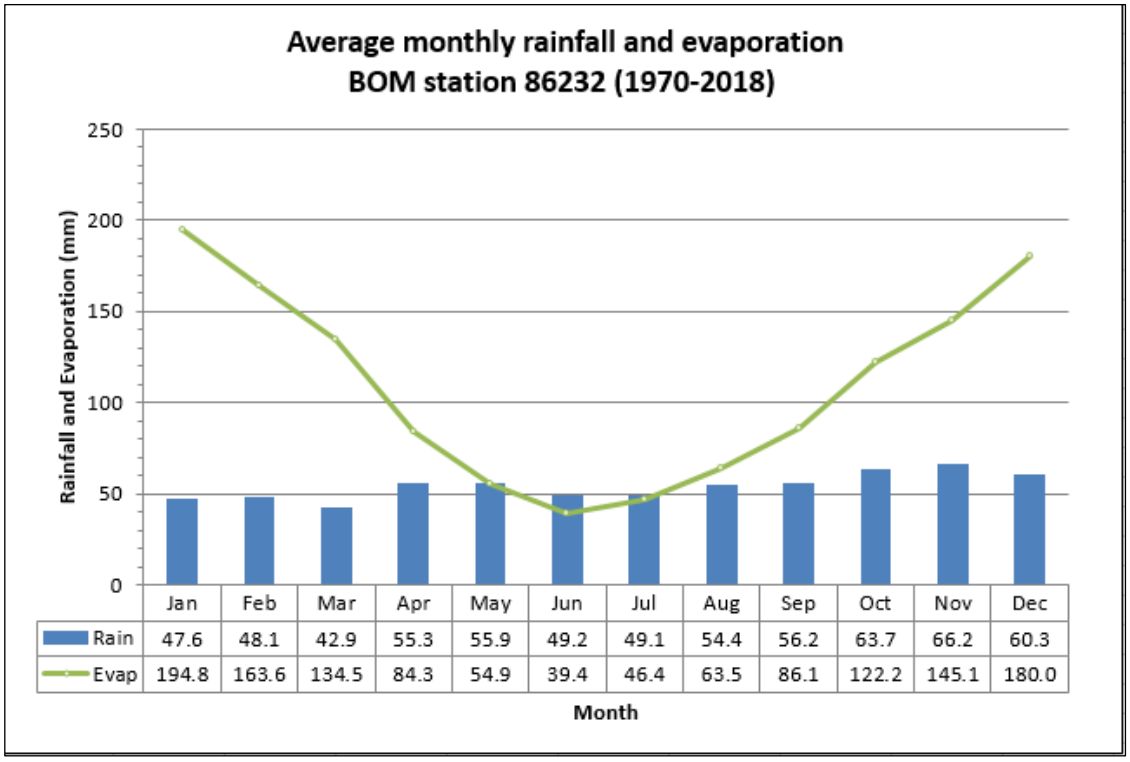
It is noted the Project site covers a large area of outer western and northern Melbourne and thus climate data was obtained from SILO (Queensland Government, 2018) for Bureau of Meteorology (BOM) station 86232, located in Melbourne, to provide a broad overview of likely climatic conditions that might be experienced.

A summary of average rainfall and evaporation is presented in Table 13 and is based on the period 1970 to 2018. The long-term mean rainfall at the site is 648.9 mm with the long term mean evaporation (1314.7 mm) approximately double that of the average rainfall.

Table 13 Summary of climate data

Month	Rainfall (mm) Average	Evaporation (mm) Average
Jan	47.6	194.8
Feb	48.1	163.6
Mar	42.9	134.5
Apr	55.3	84.3
May	55.9	54.9
Jun	49.2	39.4
Jul	49.1	46.4
Aug	54.4	63.5
Sep	56.2	86.1
Oct	63.7	122.2
Nov	66.2	145.1
Dec	60.3	180.0
Annual	**648.9**	**1314.7**

Average monthly rainfall and evaporation is shown in Figure 7. The graph shows that average evaporation is higher than rainfall in all months except for May, June and July. Annual rainfall and evaporation is shown in Figure 8.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rain	47.6	48.1	42.9	55.3	55.9	49.2	49.1	54.4	56.2	63.7	66.2	60.3
Evap	194.8	163.6	134.5	84.3	54.9	39.4	46.4	63.5	86.1	122.2	145.1	180.0

Figure 7 Average monthly rainfall and evaporation

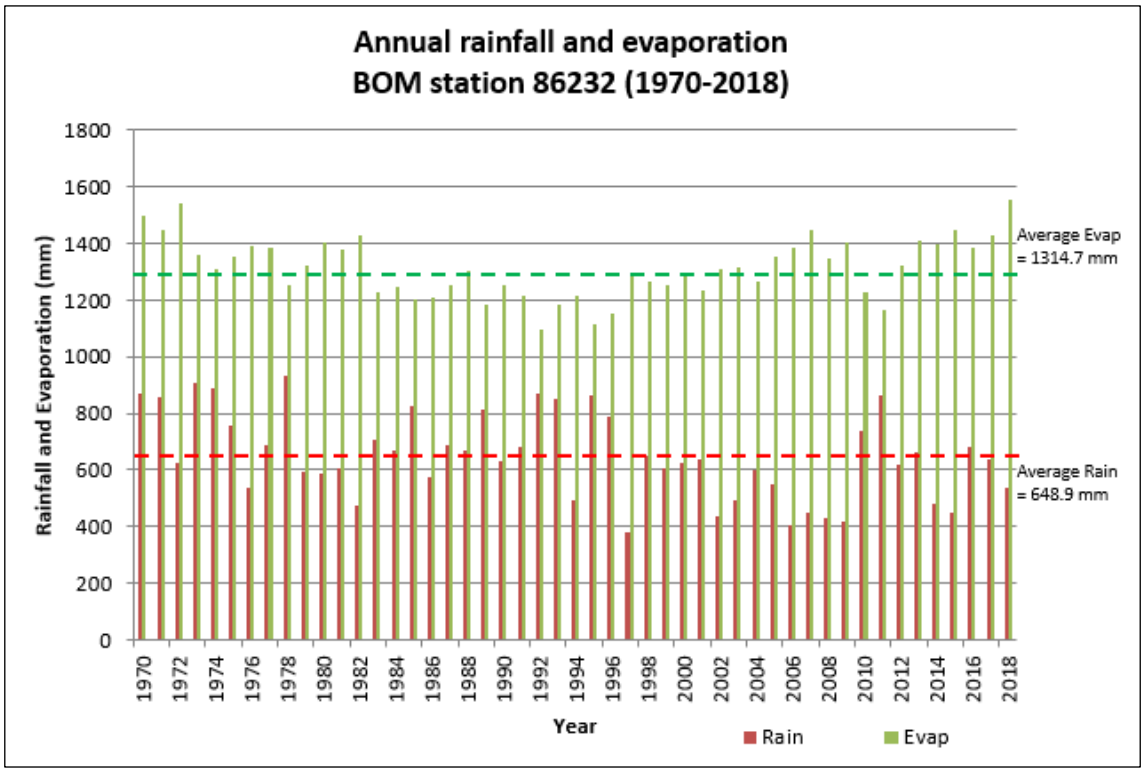


Figure 8 Annual rainfall and evaporation

6.3 Relevant surface water features – named waterways

The Project is located in the catchments of the Werribee, Maribyrnong and Yarra Rivers. The alignment crosses 22 creeks however only five of these are 'named' waterways. These five waterways are summarised in Table 14 and shown in Figure 6. A summary of the remainder of the identified waterways, and the other crossings, is shown in Table 4.

Further information on the surface water features is detailed in the EES Technical report B Surface water.

Table 14 Summary of surface water features – named waterways

Waterway	Approx. KP	Summary description
Tame Street Drain	9	Located towards the south west of the Project area. The Tame Street Drain flows broadly south east before flowing into Jacksons Creek immediately upstream of the Organ Pipes National Park
Jacksons Creek	13.6	Located towards the south west of the Project area. Jacksons Creek flows broadly south east before converging with Deep Creek to the west of Melbourne's Tullamarine airport to form the Maribyrnong River.
Deep Creek	17	Located towards the south west of the Project area. Deep Creek flows broadly south before converging with Jacksons Creek to the west of Melbourne's Tullamarine airport to form the Maribyrnong River
Kalkallo Creek	34	Located in the north of the Project area. Kalkallo Creek flows broadly south into a retarding basin immediately south of Gunns Gully Road. On exiting the retarding basin, the creek flows broadly south east before joining the Merri Creek
Merri Creek	43	Located in the north east of the Project area. Merri Creek flows broadly south before flowing into the Yarra River near the suburb of Fairfield in suburban Melbourne.
Notes: KP – Kilometre Point KPs based on Rev 7 of pipeline alignment provided by APA		

6.4 Geological setting

The geological setting for the region described below has been based on the 1:250,000 Geological Survey of Victoria map of Melbourne.

A summary of the geological setting for the Project alignment is presented in Table 15 and listed from youngest to oldest units. The surface geology is shown in Figure 9 (Geological Survey of Victoria, 2011). The Project Area is on the northern edge of Port Phillip Basin, a sedimentary basin formed during the late Cretaceous and Tertiary periods. The basin has been progressively infilled by terrestrial sediments and marine deposits. Across the western and northern sectors of the Port Phillip Basin, the Tertiary land surface has been covered by Late Tertiary to Quaternary age basalts which poured out of numerous eruption point.

The sediments in the Port Phillip Basin, overly Silurian to Devonian basement rocks consisting of siltstones, sandstone and shales. These rocks outcrop around the margin of the Port Phillip Basin and within the Project Area. These sedimentary rocks were subsequently intruded by granites during the upper Devonian and caused local contact metamorphism, and later covered extensively by the Newer Volcanics basalts in the Project Area.

A geological record from the late Devonian period through to the early Tertiary - Quaternary does not generally exist along the alignment. Faulting, uplift and erosion took place during this period with this prolonged period of erosion accompanied by deep chemical weathering, and led to the creation of a major unconformity in the stratigraphic sequence. In the Early Tertiary period, the fluvial Werribee Formation was deposited, generally to the south of the Project Area where the basin is deeper. In the Late Tertiary, the Red Bluff sands/ Bullengarook Gravels were deposited along the ancient drainage lines.

In the upper Tertiary – lower Quaternary periods, basalt lavas of the Newer Volcanics were emplaced over the landscape, with the lava flows initially filling the depressions and lows in the ancestral basement topography, before forming sheets across the landscape. This led to the displacement of streams to the margins of lava flows.

Quaternary age sediments were deposited under a range of the processes over the basalts and outcropping older rocks, typically associated with water courses, e.g. alluvial sedimentation, depressions in the landscape, e.g. swamp deposits, or gravity deposits and hillwash e.g. colluvial sediments.

Table 15 WORM summary geological setting

Period	Geological unit	Description
Quaternary	Colluvium and high level Alluvium	Alluvial, colluvial, swamp, terrace deposits, comprising sands, silts and clays, largely along drainage lines. The most significant area of Alluvium is in the north of the Project area near Gunns Gully Road
Late Tertiary – Quaternary	Newer Volcanics	A thick extrusive volcanic deposit comprising olivine basalt, scoria and tuff covering the majority of the Project area.
Late Tertiary	Red Bluff sands/ Bullengarook Gravel	Unconsolidated non-marine sediments underlying the Newer Volcanic in the western portion of the Project area. There is potential for these sediments to be exposed within major drainage lines in the area, e.g. Deep and Jacksons Creek. This formation is laterally discontinuous across the region.
Early Tertiary	Werribee Formation	Non-marine sediments, deposited in a fluvial-lacustrine environment. Only present in the south of the Project Area and thin i.e. 10 m to 20 m.
Late Devonian	Bulla Granodiorite	An igneous intrusion with limited outcrop near Deep Creek. A larger outcrop has been mapped to the east of the Bulla – Sunbury Road
Silurian to Devonian	Humevale Siltstone, Deep Creek Siltstone, Springfield Sandstone	The Deep Creek Siltstone is found in the south west of the Project where the pipeline crosses Deep Creek. This unit continues north, just to the west (but parallel with) of the pipeline. The Humevale Siltstone is found on the north west edge of the Project area. The majority of this unit has been mapped outside the study area. The Springfield Sandstone is present outside the north west edge study area and has undergone some metamorphism to hornfels.

6.5 Hydrogeological setting

6.5.1 Aquifer Systems

The outcropping geological formations detailed in Section 6.4 form the water table aquifer where they are saturated. The shallow water table aquifer is most relevant to this study considering the pipeline construction depth.

From a hydrogeological perspective, it is possible to simplify the various outcropping formations into two basic aquifer systems which are described below.

Fractured rock aquifers

Within these aquifers, groundwater is (mostly) transmitted by secondary porosity flow mechanisms in these rocks such as fractures, joints and other discontinuities within the rock mass, and therefore flow paths are often influenced by the local fracture systems. Primary porosity flow (that is, movement between grains) is mostly negligible in these materials except where the original matrix has been altered by weathering.

The fractured rock aquifers that the pipeline is anticipated to intersect include:

- Silurian – Devonian indurated sediments such as the Humevale Formation and Deep Creek Siltstone
- Late Tertiary – Quaternary Newer Volcanics basalts

The hydraulic properties of fractured rock aquifer systems can be highly variable, depending on the fracture thickness, spacing, orientation and degree of interconnectivity.

Porous media aquifers

Within porous media aquifers, groundwater is stored and transmitted by primary porosity flow (flow between the interstices and pore spaces of the sedimentary grains). The porous media formations in the study area include:

- Quaternary alluvial and colluvial sediments

Tertiary Red Bluff sands/ Bullengarook Gravel, which comprise variable mixtures of the sands, gravels, clays and silts. The alluvials are generally laterally restricted to the present day drainage lines and waterways, and in some cases can have high degree of interaction with waterways. Under these conditions, disturbance of groundwater in these sediments has potential environmental implications. The thickness of these aquifers is variable.

It is noted however that a significant area of alluvial sediments have been mapped in the north of the Project area (i.e. Kalkallo Creek area). Based on the drilling completed in the area, the thickness of these alluvial sediments is approximately 10 m.

The regional geological units have been subdivided into key aquifer systems under the Victorian Aquifer Framework (VAF). The key attributes of the aquifer systems, including their lithology, are summarised in Table 16, with the key water table aquifers relevant for this study highlighted.

The water table aquifers in the Project area have been included on Figure 10.

6.5.2 Recharge and discharge

Recharge to the water table aquifers in the Project area is expected to be predominately by rainfall across the outcrop area, with potentially some leakage from adjacent or underlying aquifers (when multiple aquifers are present). As evaporation exceeds rainfall during much of the year (refer Section 6.2) this recharge is expected to be predominantly when rainfall is higher than evaporation, i.e. winter months, and following heavy rainfall.

Groundwater discharge to some of the waterways within the study is expected, with groundwater (baseflow) components to waterways in this area contributing a proportion of the overall flow in waterways (refer Section 6.12). In some areas, along creek lines, recharge to the water table aquifer system may occur during high river flow or flood periods.

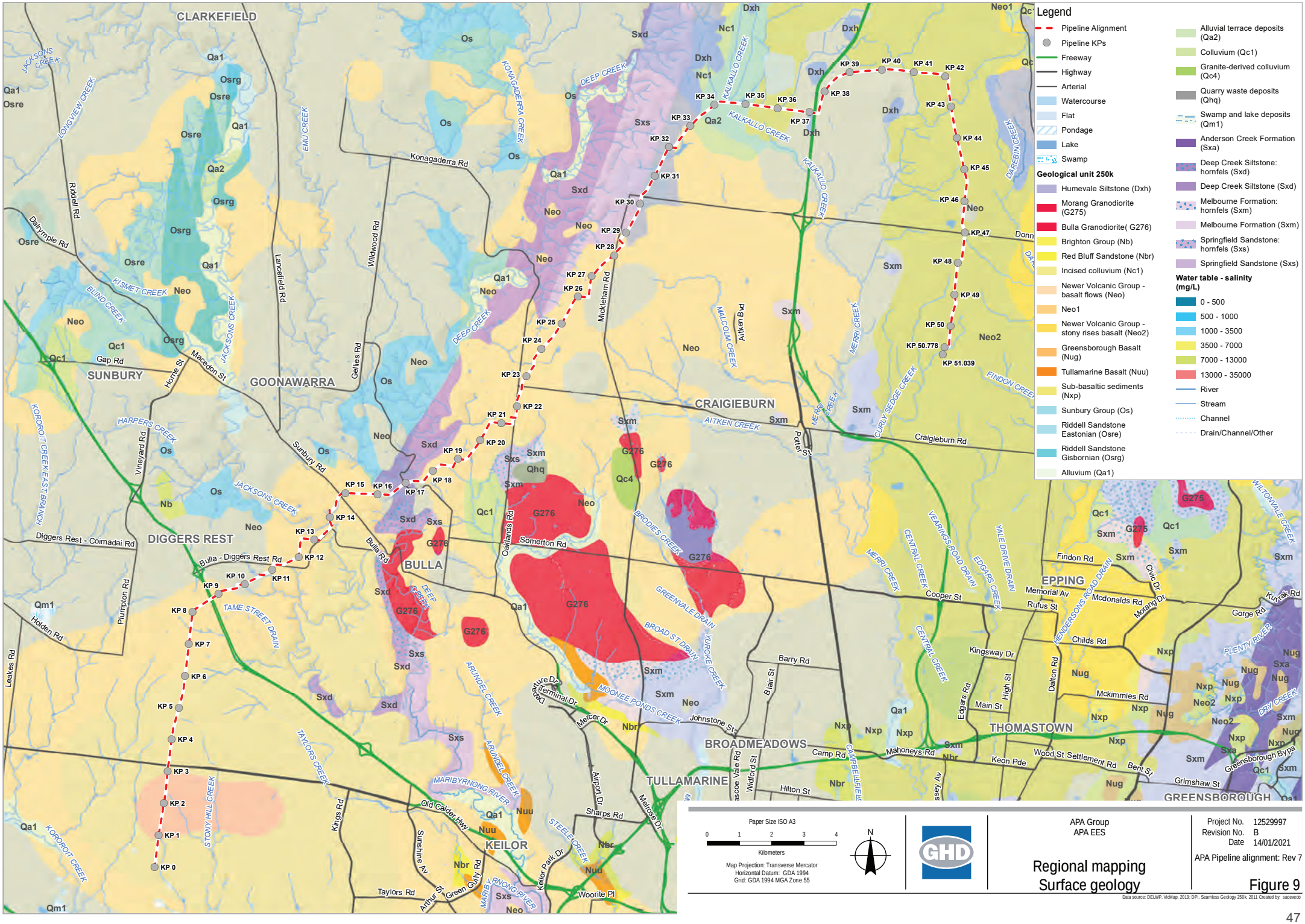
Table 16 Regional Hydrostratigraphy

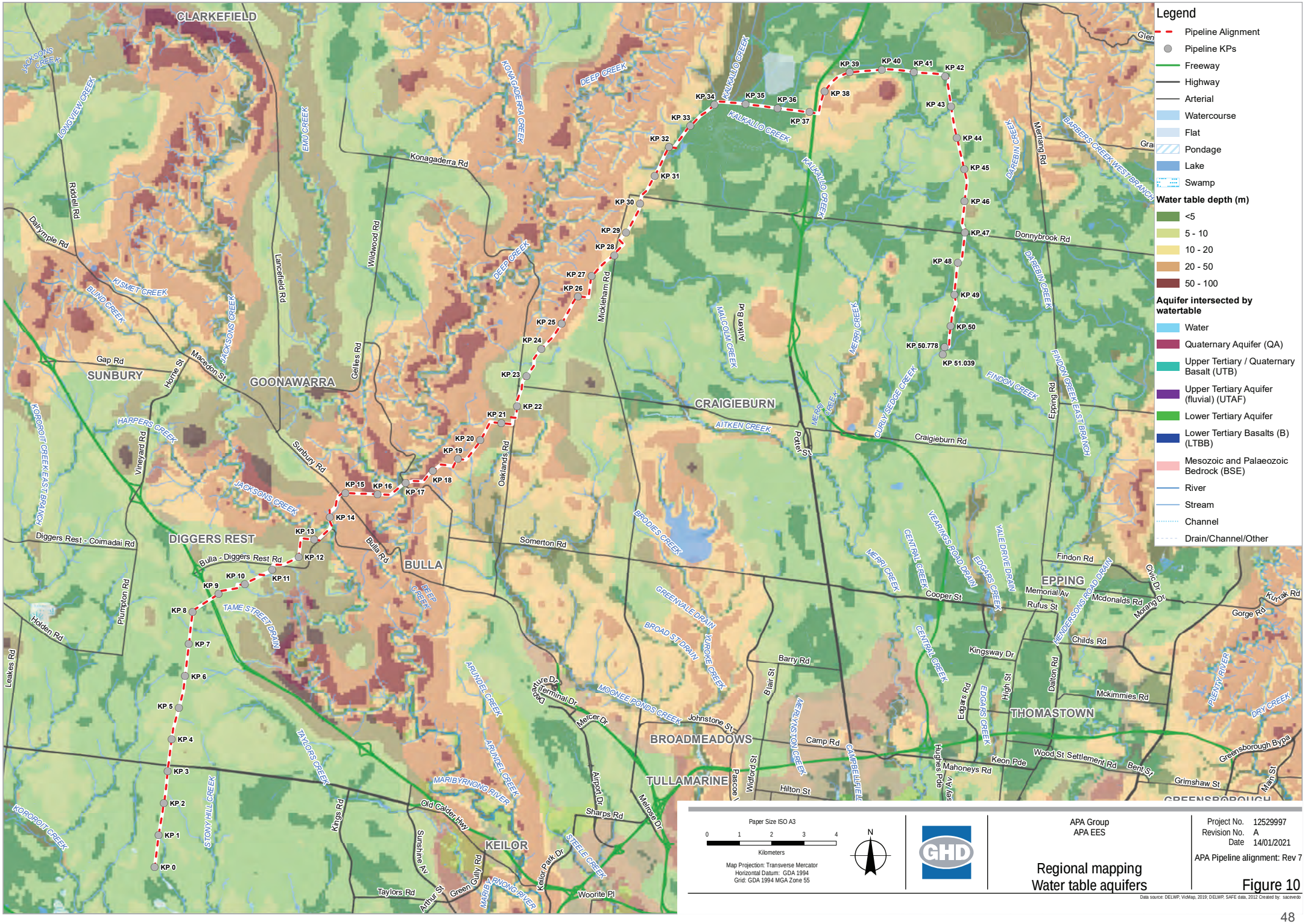
Period	Geological Formation	Hydrostratigraphic Unit(1)	Lithology	Aquifer type /condition	Salinity Range (TDS mg/L)(1)
Recent/ Quaternary	**Alluvials**	**Quaternary Aquifer (QA)**	**Silt, silty sand, sand and gravel**	**Aquifer: Sedimentary(porous): Unconfined/Semi confined**	**3,500-13,000**
Quaternary	**Newer Volcanics**	**Upper Tertiary / Quaternary Basalt Aquifer (UTB)**	**Basalt, scoria and pyroclastics**	**Aquifer: Fractured rock/ Unconfined- semiconfined**	**3,500-13,000**
Late Tertiary	Brighton Group/ Red Bluff sands/ Bullengarook Gravel	Upper Tertiary Aquifer (fluvial) (UTAF)	Sands, gravels, clays and silts	Aquifer: Sedimentary (porous): Semi-confined/unconfined	1,001-3,500
Early Tertiary	Werribee Formation	Lower Tertiary Aquifer (LTA)	Complex sequence of coal, interbedded gravel, sand, sandy and silty clay, and ligneous clay.	Aquifer: Sedimentary (porous): Confined. Only thin in Project area	1,001-3,500
Palaeozoic	**Basement Rocks**	**Basement rocks Aquifer (BSE)**	**Sedimentary and igneous rocks**	**Aquifer: Fractured rock: semi-confined, confined**	**3,500-13,000**

Notes:

(1) Victorian Aquifer Framework (VAF).

(2) Bold Aquifers form the water table aquifer in various locations in the Project Area and therefore are most relevant to this study


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Geological unit 250k
Humevale Siltstone (Dxh)
Morang Granodiorite (G275)
Bulla Granodiorite(G276)
Brighton Group (Nb)
Red Bluff Sandstone (Nbr)
Incised colluvium (Nc1)
Newer Volcanic Group - basalt flows (Neo)
Neo1
Newer Volcanic Group - stony rises basalt (Neo2)
Greensborough Basalt (Nug)
Tullamarine Basalt (Nuu)
Sub-basaltic sediments (Nxp)
Sunbury Group (Os)
Riddell Sandstone Eastonian (Osre)
Riddell Sandstone Gisbornian (Osrg)
Alluvium (Qa1)
Alluvial terrace deposits (Qa2)
Colluvium (Qc1)
Granite-derived colluvium (Qc4)
Quarry waste deposits (Qhq)
Swamp and lake deposits (Qm1)
Anderson Creek Formation (Sxa)
Deep Creek Siltstone: hornfels (Sxd)
Deep Creek Siltstone (Sxd)
Melbourne Formation: hornfels (Sxm)
Melbourne Formation (Sxm)
Springfield Sandstone: hornfels (Sxs)
Springfield Sandstone (Sxs)
Water table - salinity (mg/L)
0 - 500
500 - 1000
1000 - 3500
3500 - 7000
7000 - 13000
13000 - 35000
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
GREENSBOROUGH
KP 0
KP 1
KP 2
KP 3
KP 4
KP 5
KP 6
KP 7
KP 8
KP 9
KP 10
KP 11
KP 12
KP 13
KP 14
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KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Regional mapping
Surface geology
Project No. 12529997
Revision No. B
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 9
Data source: DELWP, VicMap, 2019; DPI, Seamless Geology 250k, 2011 Created by: sacevedo


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Water table depth (m)
<5
5 - 10
10 - 20
20 - 50
50 - 100
Aquifer intersected by watertable
Water
Quaternary Aquifer (QA)
Upper Tertiary / Quaternary Basalt (UTB)
Upper Tertiary Aquifer (fluvial) (UTAF)
Lower Tertiary Aquifer
Lower Tertiary Basalts (B) (LTBB)
Mesozoic and Palaeozoic Bedrock (BSE)
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
KP 0
KP 1
KP 2
KP 3
KP 4
KP 5
KP 6
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KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Paper Size ISO A3
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Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Regional mapping
Water table aquifers
Project No. 12529997
Revision No. A
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 10
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012 Created by: sacevedo

6.6 Neighbouring groundwater users

A search of DELWPs Water Measurement Information System (WMIS) was undertaken to identify bores within approximately 1 km of the alignment. The following comments are made regarding the WMIS data:

- Bores installed prior to the proclamation of the original Water Act (1969) may not be registered as there was no mandatory requirement to licence bores prior to this date
- The WMIS does not provide information regarding the operational status of groundwater bores
- Bores installed without a bore construction licence are unlikely to be registered on the WMIS (unless detected by later audits)
- Many bores have not been surveyed for location. Bore locations as registered were often those initially proposed on the bore construction licence application. In many instances drilling contractors could not gain access to these sites and final locations often have a positional accuracy greater than ± 250 m
- The information registered on the WMIS is subject to the accuracy of bore completion reports submitted by drilling contractors
- Information registered on the WMIS is subject to change since the completion of the bore e.g. water level information, pump setting depth, groundwater quality

Some information is not available on the WMIS e.g. pump setting depth, bore ownership

A total of 140 bores were identified within 1 km of the alignment, along the entire length. These bores have been shown in Figure 11. A summary of the bore use has been included in Table 17. A summary of the neighbouring bores has also been included in Appendix A.

Table 17 Summary of neighbouring bore use

Bore use	Number identified
Commercial	4
Domestic	7
Groundwater investigation	10
Industrial	1
Investigation	1
Irrigation	3
Miscellaneous	4
Non groundwater	15
Unknown	24
Observation	4
Stock	6
Stock and domestic	61
Total	**140**

6.7 Groundwater depths

6.7.1 Depth to water table – regional interpretation

The Secure Allocation Future Entitlements (SAFE) groundwater layers were interrogated to identify potential groundwater depths along the alignment. A regional interpretation of the groundwater depths is shown in Figure 12.

The majority of the alignment travels through areas where the depth to groundwater has been interpreted to be greater than 5 m. Shallower groundwater depths (< 5 m) however have been interpreted where the alignment crosses major waterways (refer Table 14) and a significant area in the north of the Project area near Kalkallo Creek (around eight kilometres in length from Donnybrook Rd (KP30) to the Hume Highway (KP38). Smaller areas of shallow groundwater depths have been interpreted along other parts of the alignment, at the south west end and again in the north east where a number of minor waterways have been identified.

A summary of areas where shallow (< 5 m depth) groundwater has been interpreted, based on the SAFE dataset, along or near the alignment has been included in Table 18. These areas have been the focus for further groundwater investigations to confirm the groundwater depth and quality where the pipeline may interact with the water table aquifer (refer Section 7).

Table 18 Summary of potential shallow groundwater and interpreted salinity (Regional data)

Approx. KP.	Approximate location	Interpreted groundwater salinity (mg/L TDS)	Interpreted aquifer
1	Vacant land south of Beatty's Road	3,500 – 7,000	Newer Volcanics
7	North of Holden Road	3,500 – 7,000	Newer Volcanics
8	Adjacent minor creek south of Tame Street drain Tame Street drain	3,500 – 7,000	Newer Volcanics
14	Jacksons Creek	3,500 – 7,000	Palaeozoic bedrock
17	Deep Creek	1,000 – 3,500	Palaeozoic bedrock
28	Mickleham Road	3,500 – 7,000	Palaeozoic bedrock/ Newer Volcanics (near boundary)
29 – 30	South of Donnybrook Road	3,500 – 7,000	Palaeozoic bedrock
30.5 – 37	Donnybrook Road – Kalkallo Creek – Gunns Gully Road	3,500 – 7,000 (Donnybrook Rd – Kalkallo Creek) 1,000 – 3,500 (Kalkallo Creek – Gunns Gully Road)	Paleozoic bedrock and Quaternary alluvials
39 – 43	Donovans Lane – Merri Creek	1,000 – 3,500	Newer Volcanics
43	Merri Creek	1,000 -3,500	Newer Volcanics
45	South of Merri Creek	1,000 – 3,500	Newer Volcanics
47	Donnybrook Road	1,000 – 3,500	Newer Volcanics
47 – 50	South of Donnybrook Road to Wollert Compressor Station	1,000 – 3,500	Newer Volcanics

Approx. KP.	Approximate location	Interpreted groundwater salinity (mg/L TDS)	Interpreted aquifer
Notes: "shallow" groundwater is that interpreted at less than 5 m bgl TDS – Total Dissolved Solids KP – Kilometre Point Interpreted aquifer based on regional mapping			

6.7.2 State Groundwater Observation Network water level trends

A search of the WMIS was also undertaken to identify the presence of active State Groundwater Observation Network bores (SON). The SON bores are usually the only bores with publicly available time series water level monitoring data, and at some sites, water quality monitoring data.

Six SON bores were identified at a nested site at the intersection of the Western Highway and Leakes Road in Rockbank, south west of the proposed alignment. Three SON bores were also identified at a nested site at the corner of Holden and Plumpton Roads south of Diggers Rest. Summary details for the SON bores are presented in Table 19.

The SON bores identified south of Diggers Rest are shown on Figure 11.

Table 19 Summary of SON bores

Bore ID	Bore depth (m)	Screened interval (m)	Screened geology	Status
Rockbank				
109574	37.5	N/A	N/A – inferred to be basalt based on depth	Bore destroyed. No groundwater level data
109575	37.5	N/A		
73199	37.0	19 – 33	Basalt	Bore decommissioned
73200	57.0	51 – 57	Basalt	
WRK985188	31.4	24 – 30	Basalt	Active
WRK985191	65.0	50 - 56	Basalt	
Diggers Rest				
109585	75.0	41.5 – 48.4	Basalt	Bore destroyed No groundwater level data
109586	75.0	N/A	Basalt	
77226	69.0	33 - 69	Basalt	Inactive
Note: N/A – Not Available				

Water level information is available from a number of these bores as follows:

- Rockbank
  - Bores 73199 and 73200 - monitoring record extends from 1985 to 2007
  - Bores WRK98518 and WRK985191 – monitoring record extends from 2009 to the present
- Diggers Rest
  - Bore 77226 – monitoring record extends from 1985 to 2016

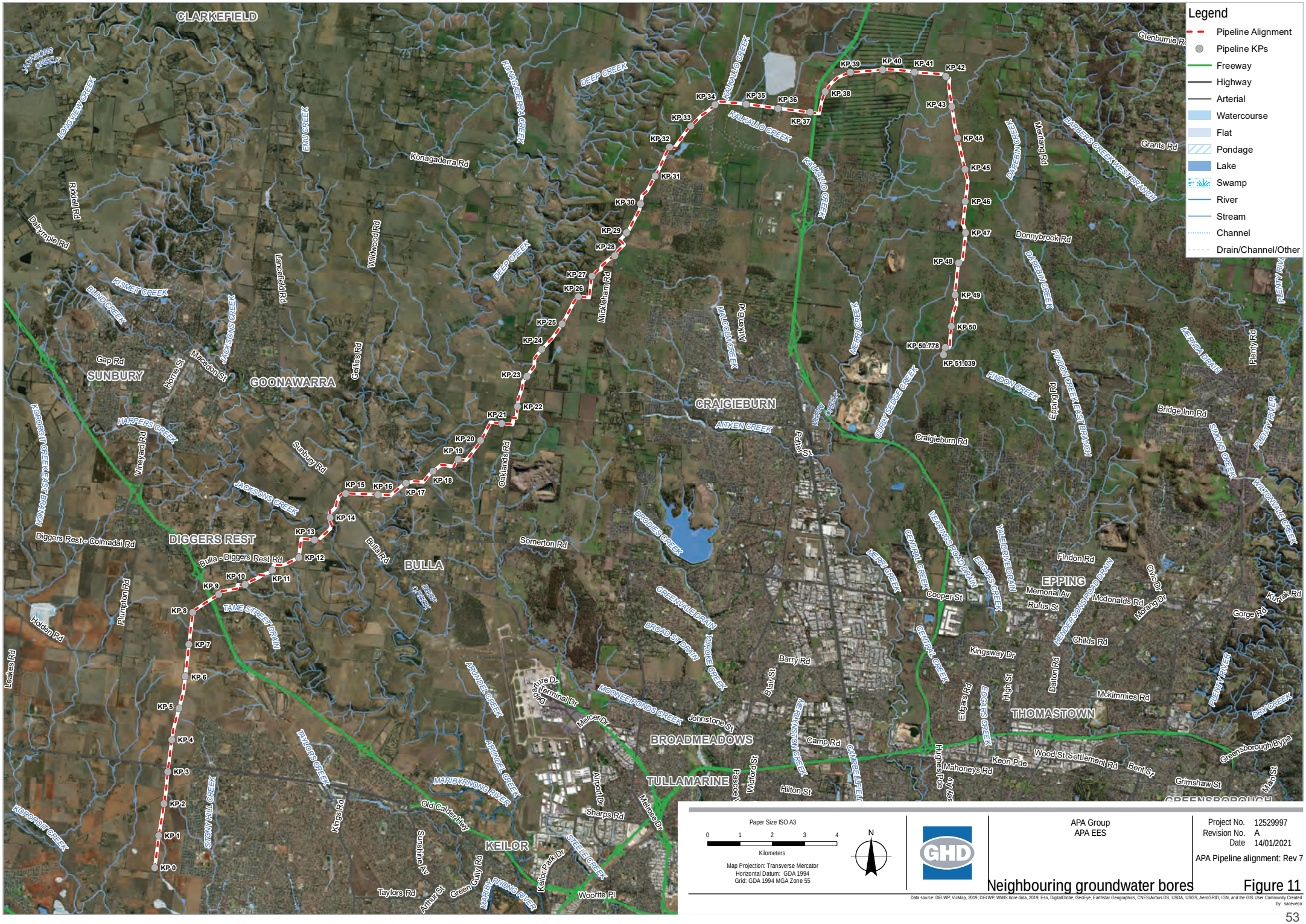
The time-series reduced water level data for these bores has been presented graphically in Figure 13 (Rockbank) and Figure 14 (Diggers Rest) to provide an understanding of long term water and seasonal water level behaviour. Table 20 summarises the water level behaviour in the bores at each location.

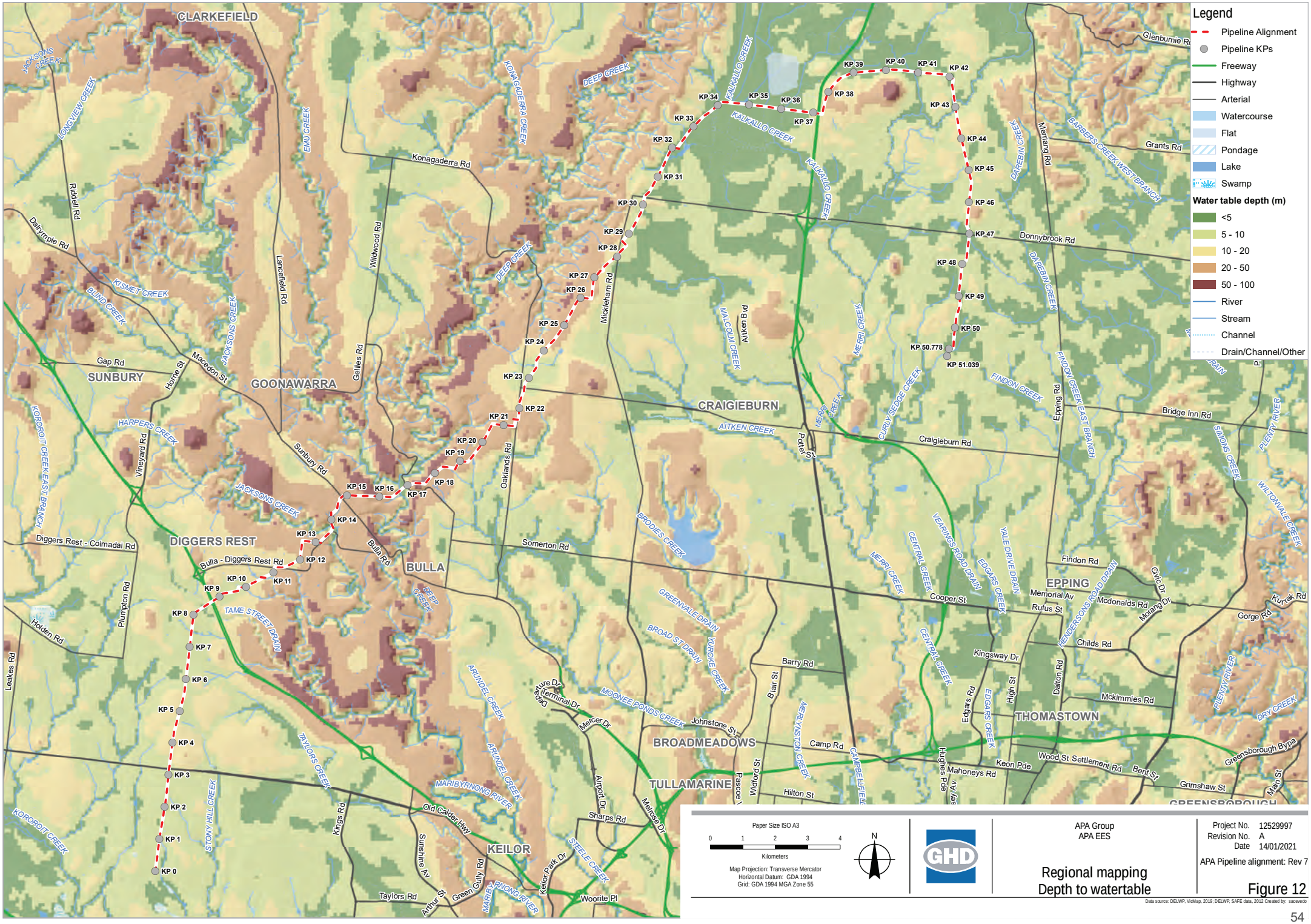
Table 20 Rockbank and Diggers Rest SON bores – summary water level behaviour

Location	Water level behaviour
Rockbank	Water levels in bores 73199 and 73200 show a long term falling trend from 1995 until records ended in late 2007 (2.5 m to 3 m water level fall). This period is consistent with drought conditions experienced across the state of Victoria at the time. Water levels in bores WRK985188 and WRK985191 initially rose, corresponding with wetter conditions following the end of the Millennium Drought. Between late 2012 and mid 2016 water levels in the bores fell, consistent with reduced rainfall during this time but have risen again slightly, by almost 1 m since mid 2016. Seasonal variations in water levels of between 0.5 m and 1 m are noted from the most recent water level data (bores WRK985188 and WRK985191). The water levels in the bores are reported at between approximately 8.5 m and 13 m bgl. This is reasonably consistent with the SAFE groundwater layers which interpret a groundwater depth of between 5 m and 10 m at this location.
Diggers Rest	Water levels in bore 77226 show a long term falling trend from approximately 1995 until late 2010 (> 3 m fall). This period is consistent with drought conditions experienced across the state of Victoria at the time. Between late 2010 and August 2012 water levels rose in the bore (> 1 m rise) prior to steadily falling again. Water levels in the bore are now lower than at the end of the Millennium Drought. Seasonal variations in water levels of up to 0.5 m are noted from this bore. The water levels in the bores are reported at between approximately 34 m and 37 m bgl. This is deeper than the SAFE groundwater layers which interpret a groundwater depth of less than 10 m at this location. Between mid-2011 and 2016 water levels in the shallow bore (bore WRK990062)

6.7.3 Other water level information

A search of WMIS was also undertake to identify if any private bores (refer Section 6.6) had water level information however no such data was identified.


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
GREENSBOROUGH
KP 0
KP 1
KP 2
KP 3
KP 4
KP 5
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KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Konagaderra Rd
Dalrymple Rd
Riddell Rd
Cap Rd
Hume St
Macedon St
Lancefield Rd
Wildwood Rd
Gellibs Rd
Mickleham Rd
Alexander Pde
Sunbury Rd
Oaklands Rd
Vineyard Rd
Diggers Rest - Coimadai Rd
Bulla - Diggers Rest Rd
Bulla Rd
Somerton Rd
Plumpton Rd
Holden Rd
Leakes Rd
Taylors Rd
Kings Rd
Old Calder Hwy
Sharps Rd
Mercer Dr
Johnstone St
Barry Rd
Camp Rd
Hilton St
Widford St
Blair St
Edgars Rd
High St
Dalton Rd
Kingsway Dr
Childs Rd
Mckimmies Rd
Wood St Settlement Rd
Mahoneys Rd
Keon Pde
Bent St
Grimshaw St
Greensborough Bypass
Main St
Findon Rd
Memorial Av
Rufus St
Cooper St
Mcdonalds Rd
Gorge Rd
Kurrak Rd
Craigieburn Rd
Bridge Inn Rd
Donnybrook Rd
Grants Rd
Merlang Rd
Glenburnie Rd
Plenty Rd
Epping Rd
Arthur St
Green Gully Rd
Keilor Park Dr
Woorite Pl
Sunshine Av
Airport Dr
Melrose Dr
Pascoe Vale Rd
Camp Pell Pde
Hughes Pde
Ashley Av
Jackson Court
Dry Creek
Jackson Creek
Longview Creek
Emu Creek
Konagaderra Creek
Deep Creek
Kalkallo Creek
Kalkallo Creek
Merri Creek
Malcolm Creek
Aitken Creek
Merri Creek
Curly Seeder Creek
Findon Creek
Findon Creek East Branch
Darebin Creek
Darebin Creek
Barbers Creek West Branch
Plenty River
Plenty River
Wernda Drain
Simons Creek
Wilsons Vale Creek
Kismet Creek
Blind Creek
Harpers Creek
Korkuroit Creek East Branch
Korkuroit Creek
Stony Hill Creek
Maribyrnong River
Maribyrnong River
Taylors Creek
Arundel Creek
Arundel Creek
Moonee Ponds Creek
Moonee Ponds Creek
Deep Creek
Jackson Creek
Tame Street Drain
Greenvale Drain
Broad St Drain
Yuroke Creek
Broadmeadows Terminal Dr
Broadmeadows Terminal Dr
Brodies Creek
Merri Creek
General Creek
General Creek
Edgars Creek
Edgars Creek
Henderson Road Drain
Veramos Road Drain
Yalebrae Drain
Sheedys Creek
Darebin
Meadow Heights
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Project No. 12529997
Revision No. A
Date 14/01/2021
APA Pipeline alignment: Rev 7
Neighbouring groundwater bores
Figure 11
Data source: DELWP, VicMap, 2019; DELWP, WMIS bore data, 2019; Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Created by: sacevedo


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Water table depth (m)
<5
5 - 10
10 - 20
20 - 50
50 - 100
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
KP 0
KP 1
KP 2
KP 3
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KP 50.778
KP 51.039
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Regional mapping
Depth to watertable
Project No. 12529997
Revision No. A
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 12
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012 Created by: sacevedo

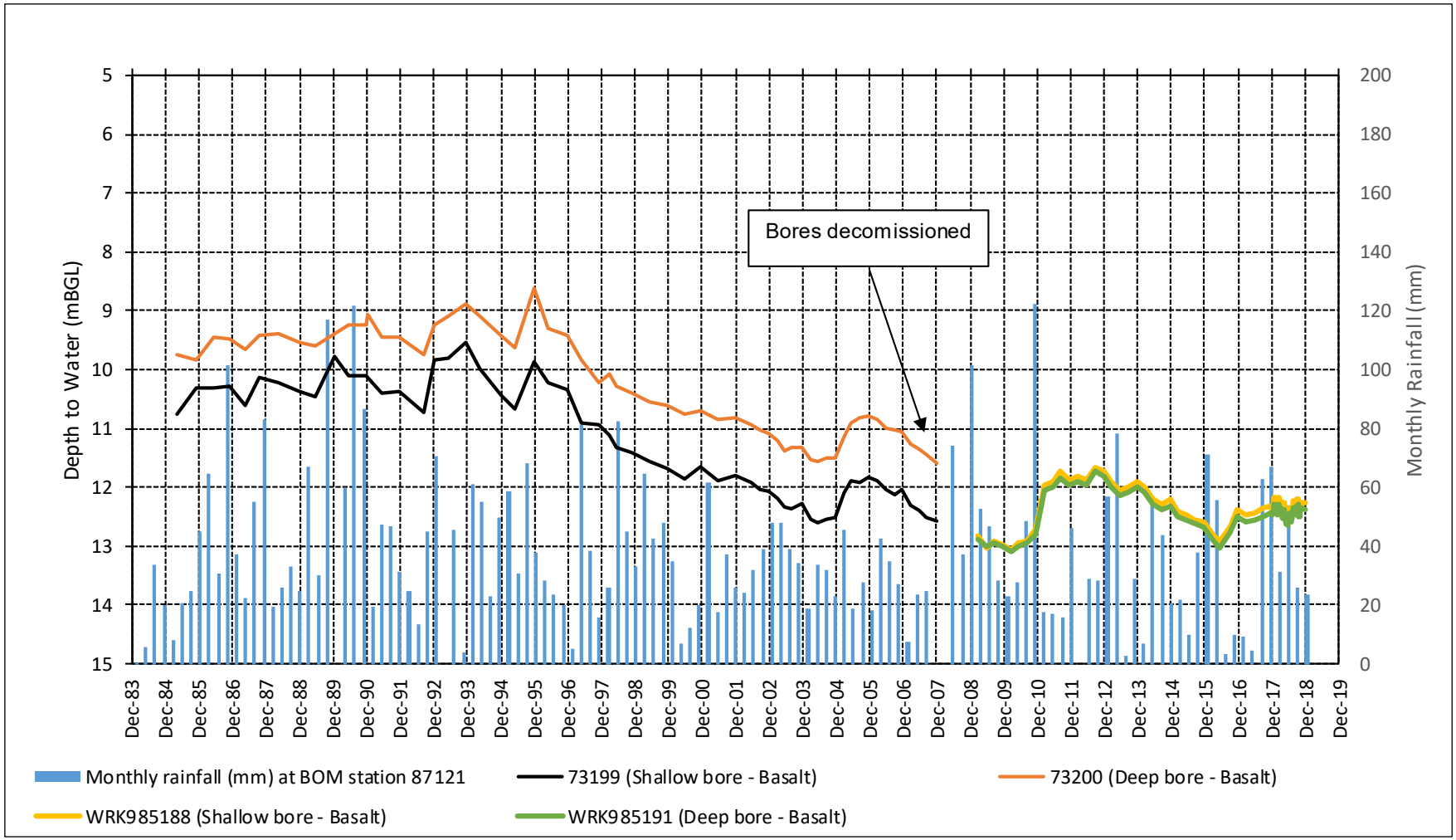


Figure 13 SON bore hydrograph – Rockbank

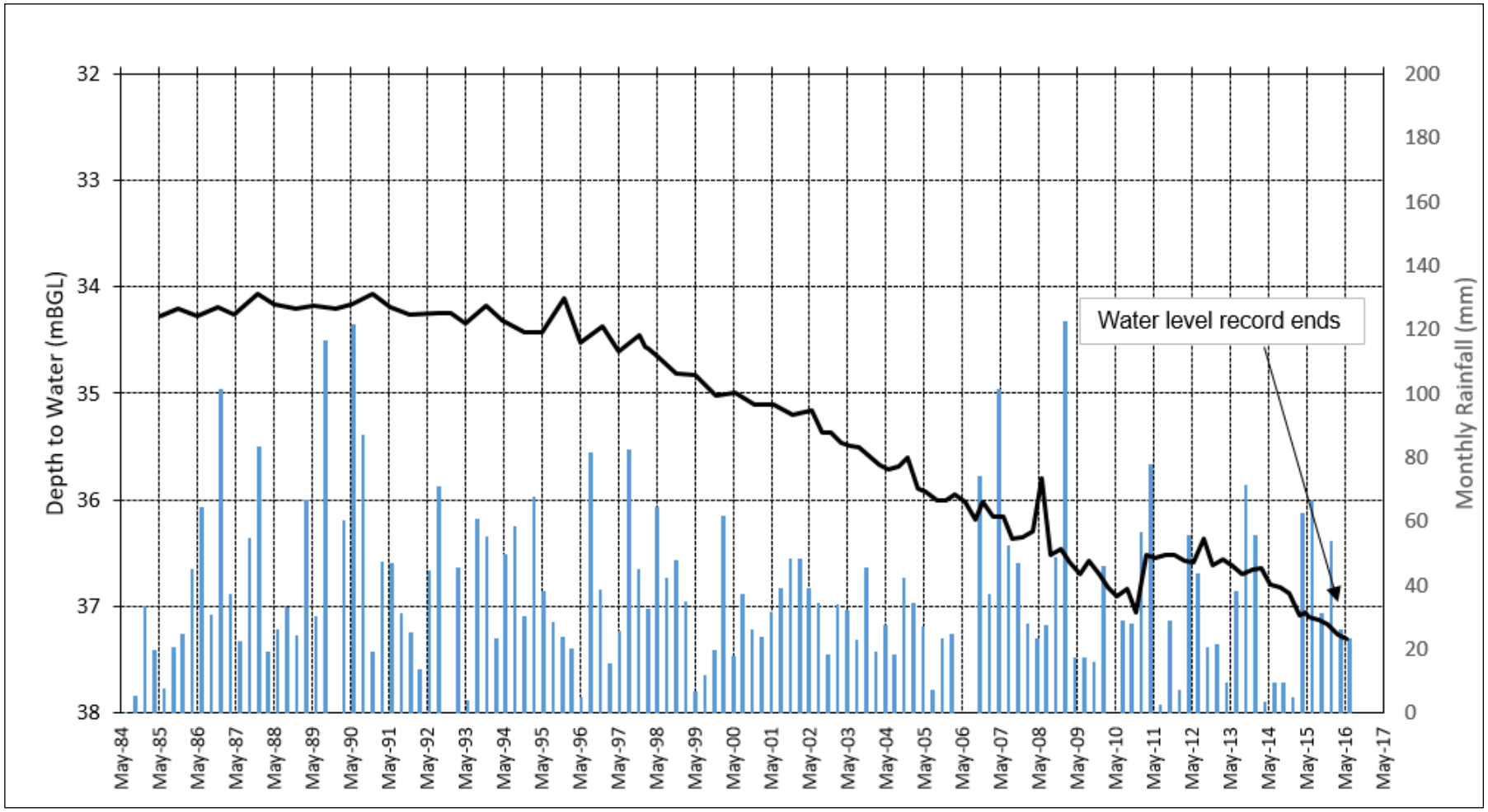


Figure 14 SON bore hydrograph – Diggers Rest

6.8 Groundwater salinity

The SAFE groundwater layers were also interrogated to identify groundwater salinity along the alignment. A regional interpretation of the groundwater salinity is shown in Figure 15.

The groundwater salinity along the majority of the alignment (i.e. 50%) has been interpreted between 3,500 mg/L and 7,000 mg/L TDS with small areas of higher salinity groundwater mapped generally in the south west of the Project area (7,000 mg/L to 35,000 mg/L TDS) between KP0 and KP5.

A significant area of fresher groundwater however has been interpreted in the north and north east of the Project area (refer Figure 15) from approximately KP35 to KP50. The groundwater salinity in this area has been interpreted at between 1,000 mg/L and 3,500 mg/L TDS.

A summary of the interpreted groundwater salinity where shallow groundwater has been identified has been included in Table 18.

Based on the regional interpreted groundwater salinity in the water table aquifer along the alignment, the following comments are made:

- The majority of the water table groundwater (between approximately KP3 and KP33) is expected to fall within Segments C and D of the SEPP (Waters) (i.e. around 60%)
- Along approximately 35% of the alignment (between approximately KP33 and KP50) the interpreted groundwater salinity of 1,000 mg/L to 3,500 mg/L TDS falls with Segments A2, B and C of the SEPP (Waters)
- Along approximately 5% of the alignment (between approximately KP1 and KP3) the interpreted higher salinity groundwater falls within Segments E and F of the SEPP (Waters)

6.9 Groundwater yields

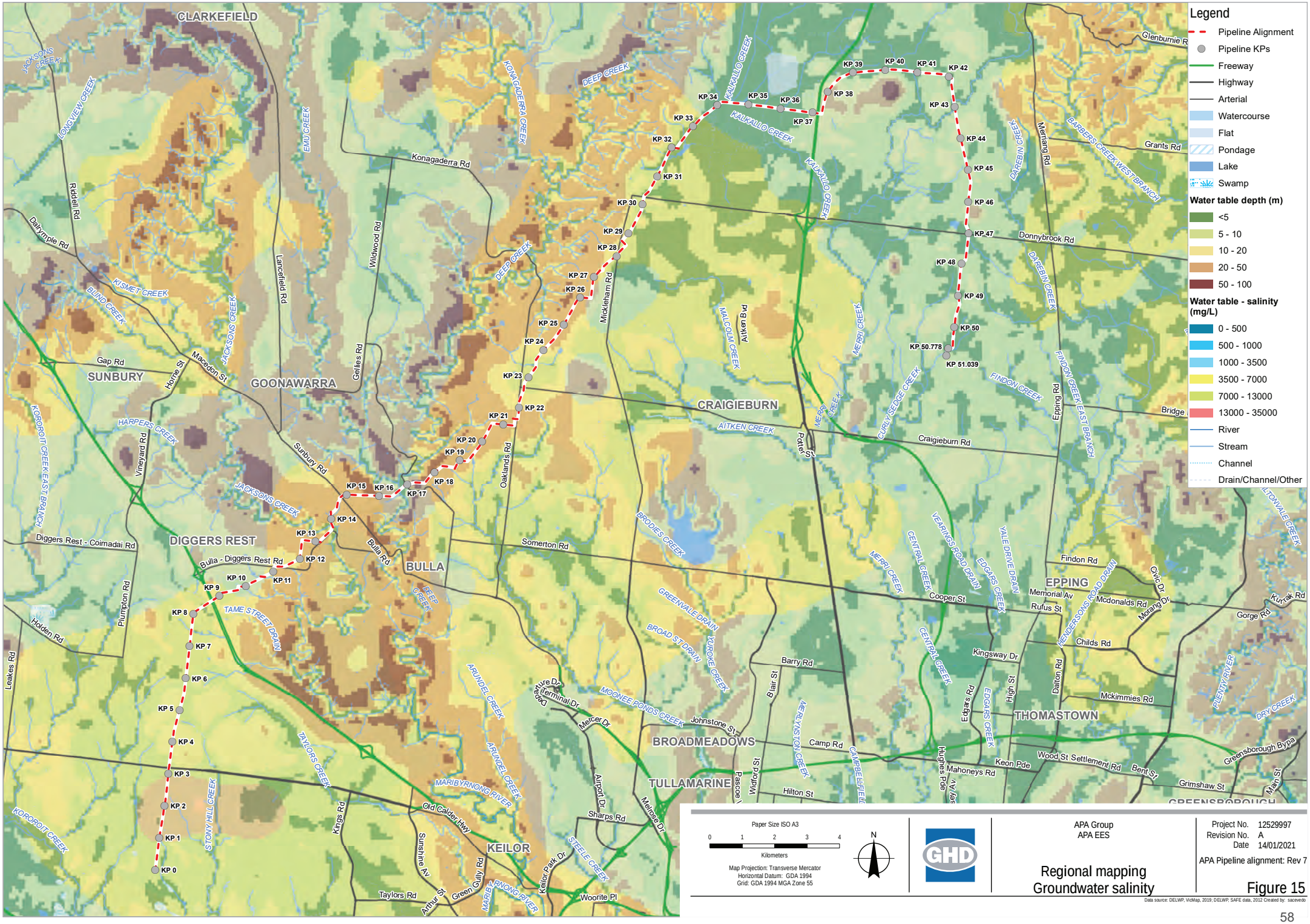
Of the 477 bores identified from the search of WMIS, 211 bores had yield information. Yields ranged from less than 0.5 L/s to 18 L/s and are shown in Figure 11. This range of yield is likely to reflect the different aquifer systems that the bores are installed in (i.e. bedrock aquifer – vs-basalt aquifer) and the variability of the fractured rock aquifer system. Based on the available data, the higher yielding bores have been installed into basalt.

6.10 Groundwater flow direction

In general, the groundwater flow direction is expected to be a subtle or subdued reflection of the local topography. As such, the groundwater flow direction is expected to be from the topographic highs towards local drainage lines and ultimately the major waterways, e.g. Deep, Jacksons and Merri Creeks. As noted previously, the aquifer fracture orientations and permeability will also have an influence on local flow directions.

6.11 Groundwater management arrangements

The alignment is not located within a Groundwater Management Area (GMA). SRW as the licencing authority however may require a technical assessment to support any required groundwater extraction licence. This may be dependent on the duration of any dewatering, volumes and groundwater quality.


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Water table depth (m)
<5
5 - 10
10 - 20
20 - 50
50 - 100
Water table - salinity (mg/L)
0 - 500
500 - 1000
1000 - 3500
3500 - 7000
7000 - 13000
13000 - 35000
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
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KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Regional mapping
Groundwater salinity
Project No. 12529997
Revision No. A
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 15
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012 Created by: sacevedo

6.12 Groundwater Dependant Ecosystems

The Bureau of Meterology's (BoMs) Groundwater Dependant Ecosystem (GDE) Atlas was interrogated to identify any potential GDEs near the pipeline alignment. Identified GDEs are shown in Figure 16.

6.12.1 Description

A groundwater dependent ecosystem (GDE) is an ecosystem which has its species composition and natural ecological processes determined by groundwater (ARMCANZ & ANZECC, 2000). That is, they are natural ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. If the availability of groundwater to GDEs is reduced, or if the quality is allowed to deteriorate, these ecosystems are impacted.

The GDEs can be broadly grouped into three categories:

- Ecosystems that depend on the surface expression of groundwater:
  - Swamps and wetlands can be sites of groundwater discharge and may represent GDEs. These sites may be permanent or ephemeral systems that receive seasonal or continuous groundwater contribution to water ponding or shallow water tables. Tidal flats and inshore waters may also be sites of groundwater discharge. Wetlands can include ecosystems on potential acid sulfate soils and, in these cases, maintenance of high water levels may be required to prevent waters from becoming acidic
  - Permanent or ephemeral stream systems may receive seasonal or continuous groundwater contribution to flow as baseflow. Interaction would depend on the nature of stream bed and underlying aquifer material and the relative water level heads in the aquifer and the stream
- Ecosystems that depend on the subsurface presence of groundwater. Terrestrial vegetation such as trees and woodlands may be supported seasonally or permanently by groundwater. These may comprise shallow or deep-rooted communities that use groundwater to meet some or all of their water requirements. Animals may depend on this vegetation and therefore indirectly depend on groundwater. Groundwater quality generally needs to be high to sustain vegetation growth
- Ecosystems that reside within a groundwater resource. These are referred to as hypogean ecosystems. Micro-organisms in groundwater systems can exert a direct influence on water quality. For example, stygofauna are typically found in karstic, fractured rock or alluvial aquifers.

It is widely acknowledged there is poor understanding of how to recognise GDEs. There is also poor understanding of the hydrogeological processes affecting GDEs, or their environmental water requirements.

6.12.2 Occurrence

Based on this assessment as well as that previous completed by Biosis (2019), Table 21 summarises the identified potential GDEs.

Table 21 Summary of identified potential GDEs

Approximate kilometre point (km)	Description	Approximate distance from alignment
KP0 – KP5	Scattered wetlands (aquatic GDEs) away from the alignment.	> 0.5 km
KP5 – KP7, KP8 – KP9	Scattered modelled GDEs (as reported in Biosis, 2019)	> 0.5 km
KP10 – KP11	Potential aquatic GDE associated with Jacksons Creek tributary and uncultivated grassland	0.3 km
KP13 – KP14	Jacksons Creek – potential terrestrial and aquatic GDEs	0 km (Jacksons Creek is the mapped GDE)
KP15 – KP 24 KP25 – KP30	Deep Creek – potential terrestrial and aquatic GDEs Potential Terrestrial GDE, will be difficult to avoid if present Along the alignment between Deep Creek and Oaklands Road and scattered potential GDEs between KP25 and KP30 Low potential aquatic GDE west of the alignment, between approximately KP25 and KP30	Most GDEs within 0.5 km of alignment
KP30 – KP31	Potential terrestrial GDE	0.1 km to 0.5 km
KP34 – KP35 KP35 – KP37	Kalkallo Creek; potential aquatic GDE A large potential GDE has been mapped immediately north of the alignment adjacent Kalkallo Creek	0 km (Kalkallo Creek is the mapped GDE) 0.3 km at closest point
KP38 – KP41	Potential terrestrial GDE	0 km to > 0.5 km
KP43	Merri Creek. Potential aquatic GDE	0 km (Merri Creek)
Note: GDEs identified in this assessment and Biosis (2019)		

Following further field investigations as part of this study (Section 7.2.4), generally groundwater levels are close to the creek bed level and are indicative that there may be groundwater discharge (i.e. baseflow) to the creeks (ie Jacksons, Merri and Deep Creek) during periods of the year.

Following field investigations as part of the Biodiversity study (EES Technical Report; Biodiversity and habitats), the following was reported in reference to GDEs:

- Alluvium (2019) states that water table depth in the Maribyrnong catchment segment of the study area exceeds 10 m, except for the Jacksons Creek & Deep Creek crossings - both of which are gaining streams. Biosis (2020) did not observe any groundwater discharge areas in the section of the Project Area within the Kororoit Creek catchment nor did they observe GDEs in that section of the Project Area, other than at the Jacksons Creek & Deep Creek crossings where Riparian Woodland was mapped.
- Alluvium (2019) acknowledged the possibility that there may be groundwater seeps in the Merri Creek catchment. Biosis (2020) did not observe any instances of salt tolerant wetland vegetation within the study area that would correspond with such seeps.

Further information on the biodiversity at the creek crossings (i.e. Merri, Jacksons and Deep Creek) is provided in Section 7.5.3 of the Biodiversity and Habitats Report.

The GDEs potentially impacted by dewatering during pipeline construction are discussed in 9.2.5 and shown in Table 34 .

6.13 Wetlands

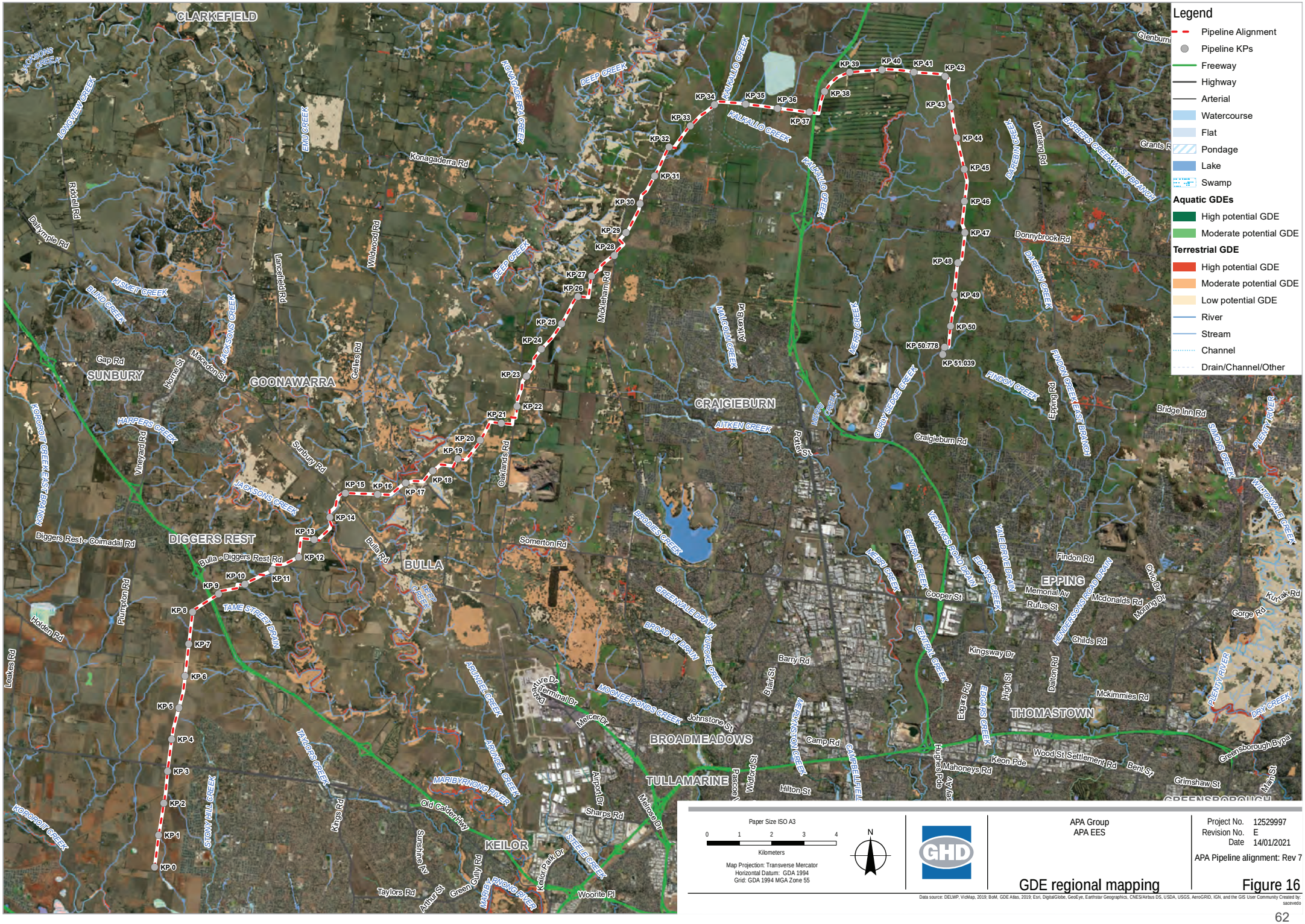
The DELWP Victorian Wetland Inventory (2017) was interrogated to identify the location of any wetlands along the alignment and these have been shown in Figure 17. Wetlands have been identified at the following locations:

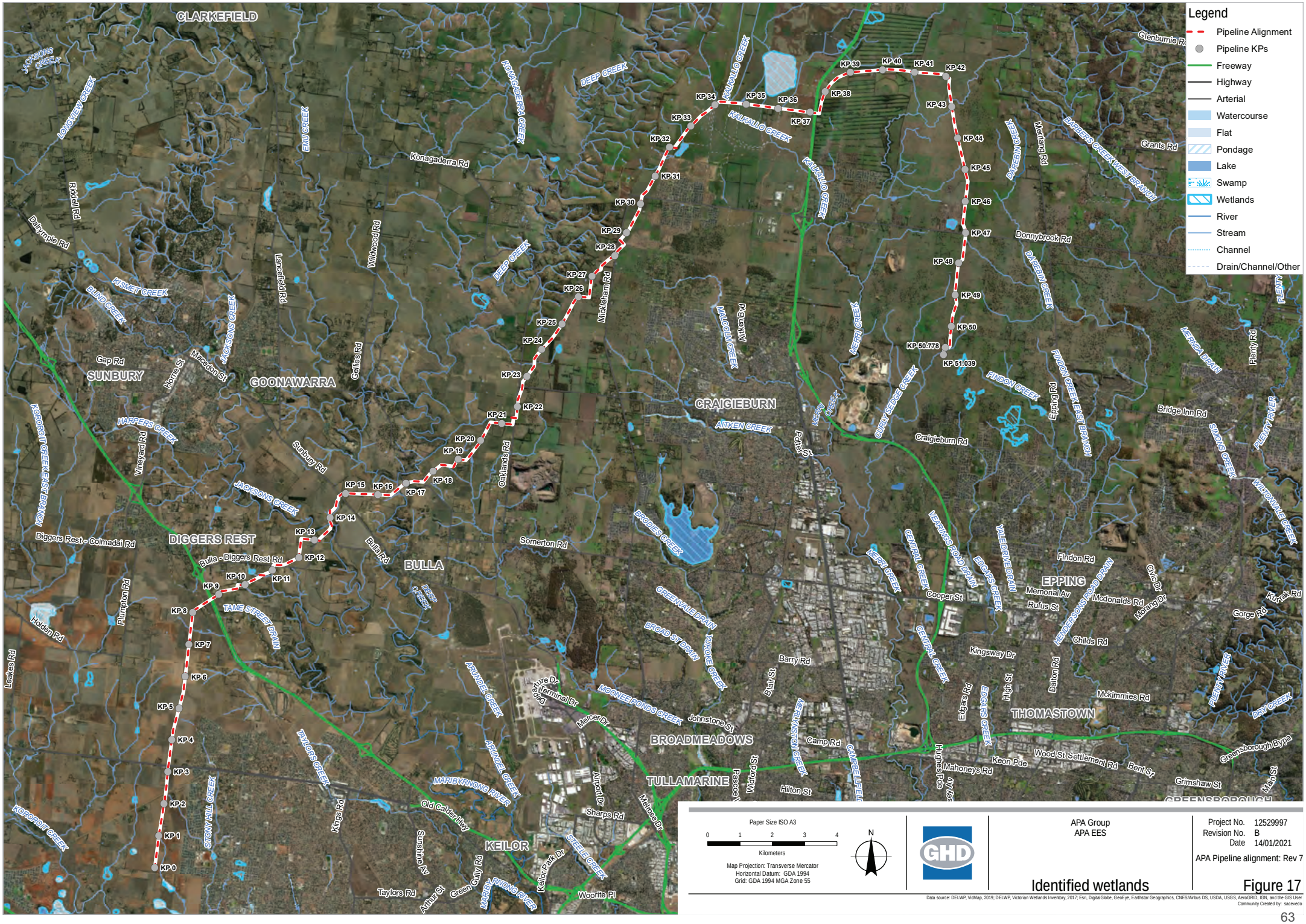
- Within the headwaters of an unnamed creek at approximately KP10. This is within approximately 0.2 km of the alignment
- Immediately south of KP25. This is within approximately 0.5 km of the alignment
- On the eastern side of the alignment between KP30 and KP32. These are within approximately 0.3 km and 0.6 km of the alignment
- Immediately north of the alignment adjacent Kalkallo Creek. This wetland corresponds with the potential GDE mapping in the area (refer Figure 16). This is within approximately 0.5 km to 1 km of the alignment
- West of the alignment, south of KP45. This is within approximately 0.5 km to 1 km of the alignment

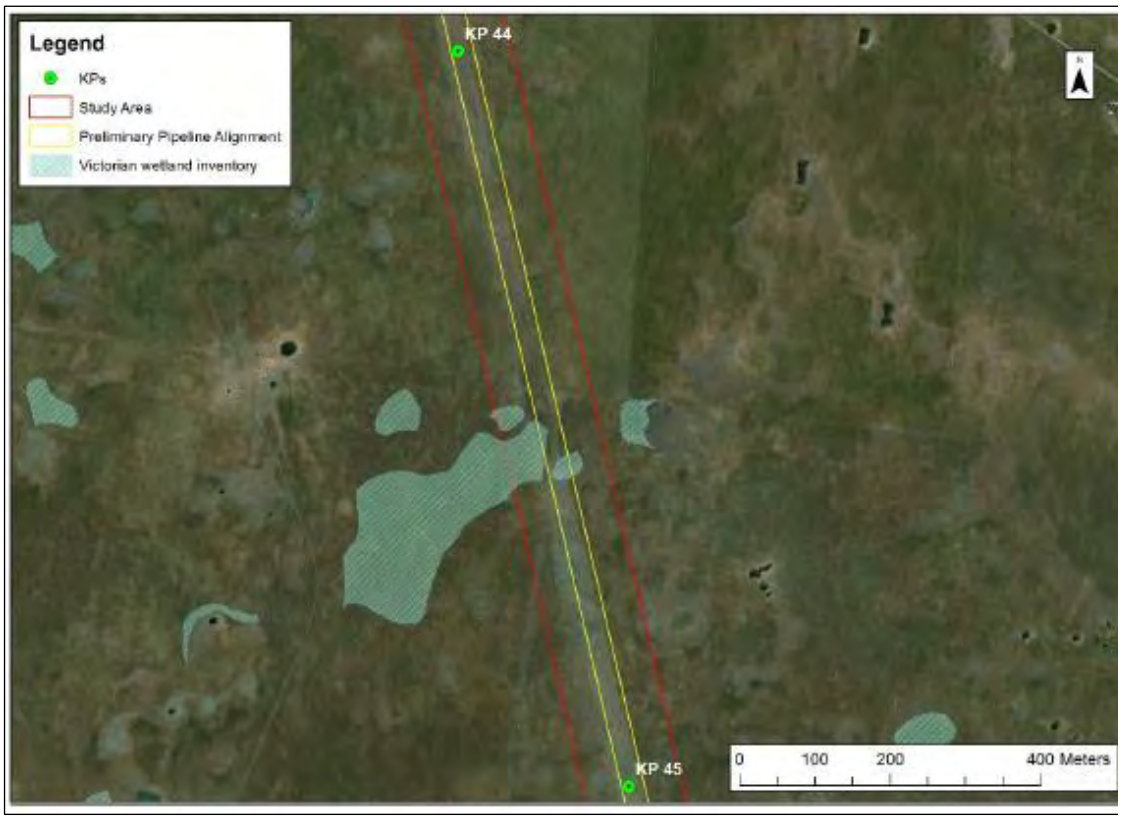
In addition, Alluvium (2019) reported three small wetlands between KP44 to KP45, two of which are partially intersected by the pipeline alignment. These wetlands, as reported in Alluvium (2019), are shown in Figure 18. EES Technical Report A Biodiversity and habitats, also reported a wetland at KP41. It is noted that they were not identified as potentials GDEs (BoM data). These wetlands are located within the existing APA easement and are discussed further in the EES Technical report A Biodiversity and habitats and EES Technical report B Surface water.

It is noted that it was proposed to install a monitoring bore close to these wetlands however poor weather at the time of the field investigations (refer Section 5.4.6) meant that the proposed site could not be accessed. Accordingly, a monitoring bore could not be installed at this location.

Subsequent interpretation of the groundwater levels between bores that were drilled, indicated that the groundwater depth was in the order of 10 m in this area (refer Section 7.2.3).


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Aquatic GDEs
High potential GDE
Moderate potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
DIGGERS REST
BULLA
CRAIGIEBURN
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
GREENSBOROUGH
KP 0
KP 1
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KP 30
KP 31
KP 32
KP 33
KP 34
KP 35
KP 36
KP 37
KP 38
KP 39
KP 40
KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Project No. 12529997
Revision No. E
Date 14/01/2021
APA Pipeline alignment: Rev 7
GDE regional mapping
Figure 16
Data source: DELWP, VicMap, 2019; BoM, GDE Atlas, 2019; Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Created by: sacevedo


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Wetlands
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
GREENSBOROUGH
KP 0
KP 1
KP 2
KP 3
KP 4
KP 5
KP 6
KP 7
KP 8
KP 9
KP 10
KP 11
KP 12
KP 13
KP 14
KP 15
KP 16
KP 17
KP 18
KP 19
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KP 22
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KP 36
KP 37
KP 38
KP 39
KP 40
KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Konagaderra Rd
Riddell Rd
Dalrymple Rd
Cap Rd
Lancefield Rd
Wildwood Rd
Mickleham Rd
Gellibs Rd
Oaklands Rd
Sunbury Rd
Vineyard Rd
Hume St
Macedon St
Diggers Rest - Coimadai Rd
Bulla - Diggers Rest Rd
Bulla Rd
Somerton Rd
Plumpton Rd
Holden Rd
Leakes Rd
Taylors Rd
Kings Rd
Old Calder Hwy
Sharps Rd
Arthur St
Green Gully Rd
Keilor Park Dr
Woorite Pl
Sunshine Av
Airport Dr
Melrose Dr
Mercer Dr
Johnstone St
Barry Rd
Camp Rd
Hilton St
Widford St
Blair St
Edgars Rd
High St
Dalton Rd
Mckimmies Rd
Kingsway Dr
Childs Rd
Gorge Rd
Kurrak Rd
Mcdonalds Rd
Memorial Av
Rufus St
Cooper St
Findon Rd
Craigieburn Rd
Bridge Inn Rd
Donnybrook Rd
Grants Rd
Glenburnie Rd
Epping Rd
Plenty Rd
Merang Rd
Keon Pde
Wood St Settlement Rd
Bent St
Grimshaw St
Greensborough Bypass
Main St
Mahoneys Rd
Hughesdale Dr
Peacock Av
Bell St
Peter St
Alexander Pde
Mickleham Rd
Paper Size ISO A3
0 1 2 3 4
Kilometers
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
GHD
APA Group
APA EES
Project No. 12529997
Revision No. B
Date 14/01/2021
APA Pipeline alignment: Rev 7
Identified wetlands
Figure 17
Data source: DELWP, VicMap, 2019; DELWP, Victorian Wetlands Inventory, 2017; Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Created by: sacevedo



Source: Alluvium (2019)

Figure 18 Wetlands between KP44 and KP45

6.14 Potential for Acid Sulfate Soils

6.14.1 Definition

Acid sulfate soils are soils, sediments, unconsolidated geological material or disturbed consolidated rock mass that contain elevated concentrations of the metal sulfide. It occurs principally in the form of pyrite (iron sulphide). These soils can be rich in organics and were formed in low oxygen or anaerobic depositional environments.

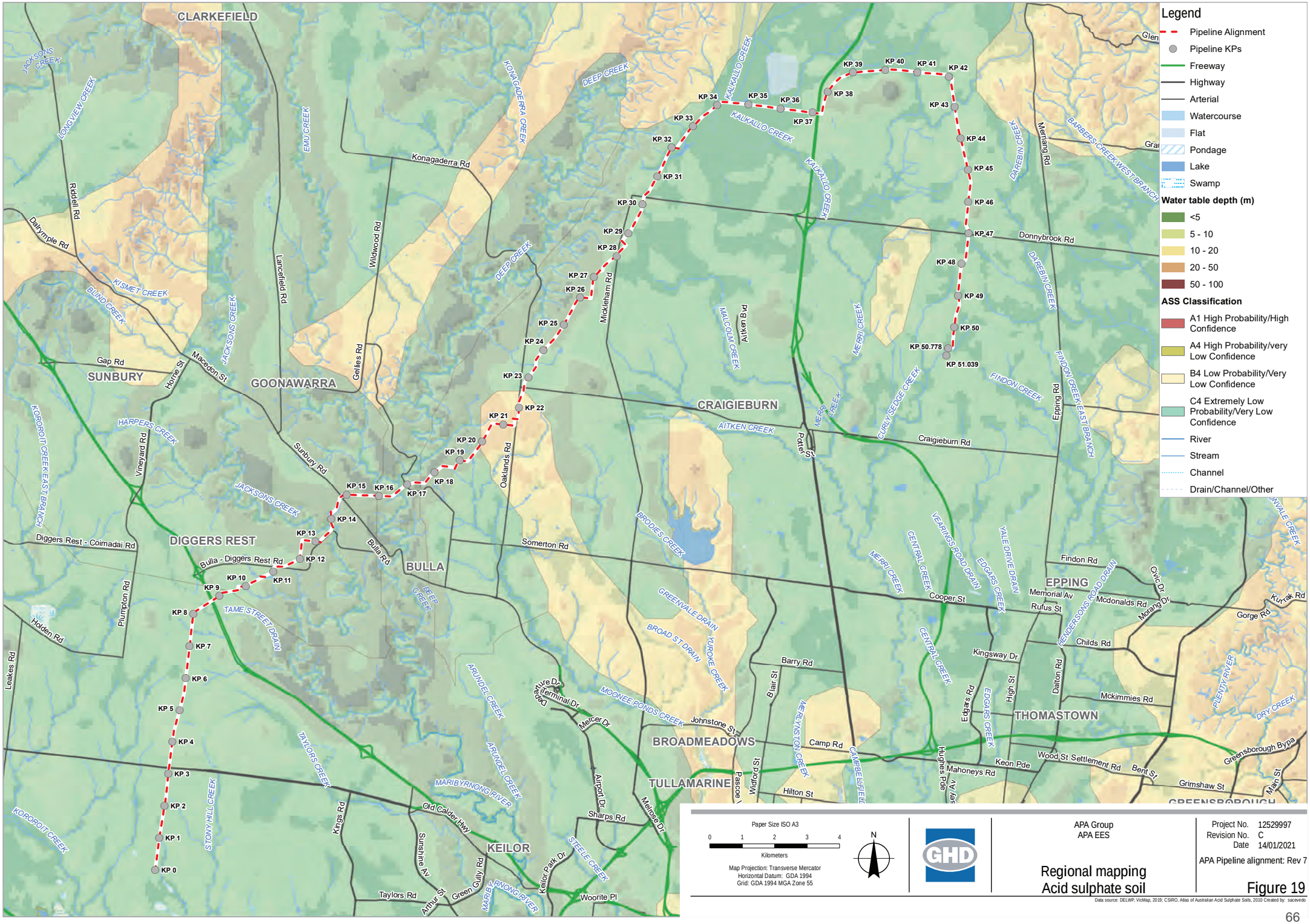
The soils are stable when undisturbed or located below the water table. However, when oxygen is introduced, the sulphides oxidise to sulphate, with resultant soils having low pH and potentially high concentrations of the heavy metals.

Groundwater levels may fall as a result of construction dewatering activities. This can result in oxidisation of materials and the mobilisation of pH and heavy metals into the environment where they can potentially impact deep-rooted vegetation, aquatic flora and fauna, and can be aggressive to reactive materials (such as concrete, steel) of foundations, underground structures (such as piles, pipes, basements) or buried services in contact with groundwater. It can also result in the discharge of acid groundwater to receiving surface water systems.

6.14.2 Identification at the site

CSIROs National Acid Sulfate Soil (ASS) Atlas indicates that there is a low to extremely low probability (with very low confidence rating) of ASS occurring at the site. We note however the mapping is based on regional data and there may be potential to intersect unidentified ASS (or acidic soil) in soils close to features with permanent or regular inundation, e.g. creeks, wetlands, GDEs.

Regional ASS mapping is presented in Figure 19. Information of site specific ASS testing is included in Section 7.5.2.


Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Water table depth (m)
<5
5 - 10
10 - 20
20 - 50
50 - 100
ASS Classification
A1 High Probability/High Confidence
A4 High Probability/very Low Confidence
B4 Low Probability/Very Low Confidence
C4 Extremely Low Probability/Very Low Confidence
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
KP 0
KP 1
KP 2
KP 3
KP 4
KP 5
KP 6
KP 7
KP 8
KP 9
KP 10
KP 11
KP 12
KP 13
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KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
Konagaderra Rd
Dalrymple Rd
Riddell Rd
Gap Rd
Macedon St
Home St
Lancefield Rd
Gellies Rd
Wildwood Rd
Mickleham Rd
Aitken Blvd
Craigieburn Rd
Porter St
Epping Rd
Merriang Rd
Donnybrook Rd
Sunbury Rd
Oaklands Rd
Vineyard Rd
Diggers Rest - Coimadai Rd
Bulla - Diggers Rest Rd
Bulla Rd
Somerton Rd
Findon Rd
Cooper St
Memorial Av
Rufus St
Mcdonalds Rd
Gorge Rd
Childs Rd
Kingsway Dr
Barry Rd
Mckimmies Rd
Dalton Rd
High St
Blair St
Johnstone St
Camp Rd
Mahoneys Rd
Keon Pde
Wood St Settlement Rd
Greensborough Bypass
Grimshaw St
Hilton St
Widford St
Airport Dr
Sharps Rd
Old Calder Hwy
Kings Rd
Taylors Rd
Green Gully Rd
Keilor Park Dr
Woorite Pl
Holden Rd
Plumpton Rd
Leakes Rd
Mercer Dr
Terminal Dr
Melrose Dr
JACKSONS CREEK
LONGVIEW CREEK
EMU CREEK
KONAGADERRA CREEK
DEEP CREEK
KALKALLO CREEK
DAREBIN CREEK
BARBERS CREEK WEST BRANCH
KISMET CREEK
BLIND CREEK
MALCOLM CREEK
MERRI CREEK
CURLY SEDGE CREEK
FINDON CREEK
FINDON CREEK EAST BRANCH
KOROROIT CREEK EAST BRANCH
HARPERS CREEK
AITKEN CREEK
BRODIES CREEK
GREENVALE DRAIN
BROAD ST DRAIN
YAROKE CREEK
VEARINGS ROAD DRAIN
CENTRAL CREEK
EDGARS CREEK
YALE DRIVE DRAIN
HENDERSONS ROAD DRAIN
TAME STREET DRAIN
DEEP CREEK
ARUNDEL CREEK
MOONEE PONDS CREEK
MERRI CREEK
CAMBELLFIELD
PLENTY RIVER
DRY CREEK
TAYLORS CREEK
MARIBYRNONG RIVER
STONY HILL CREEK
KOROROIT CREEK
STEELE CREEK
Paper Size ISO A3
0 1 2 3 4
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Regional mapping
Acid sulphate soil
Project No. 12529997
Revision No. C
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 19
Data source: DELWP, VicMap, 2019; CSIRO, Atlas of Australian Acid Sulphate Soils, 2010 Created by: sacevedo

6.15 Conceptual Hydrogeological Model

The information gathered during this assessment has been synthesised to generate a conceptual hydrogeological model (CHM) of the Project study area. Each aspect of this model is described below and depicted diagrammatically in Figure 20.

Two schematic cross sections are presented to provide an understanding of potential hydrogeological conditions along the alignment. The CHM has been developed based on available regional hydrogeological information.

One section is orientated approximately south west – north east along the alignment in the south west of the Project area. The second cross section is oriented approximately east – west in the north of the Project area. They are simplified representations of the geology and hydrogeology of the area. Subsequent field investigations have not changed the CHM understanding.

Section one (south west – north east: Approximate KP15 to KP23)

The schematic shows a simplified two aquifer system:

- The Palaeozoic basement rocks. These include sediments of the Deep Creek Siltstone.
- Late Tertiary/ Quaternary Newer Volcanics. These are mapped overlying the Palaeozoic basement either side of Deep Creek. The thickness of the basalts is unknown.

Section two (west – east: Approximate KP32 to KP37)

The schematic shows a simplified three aquifer system:

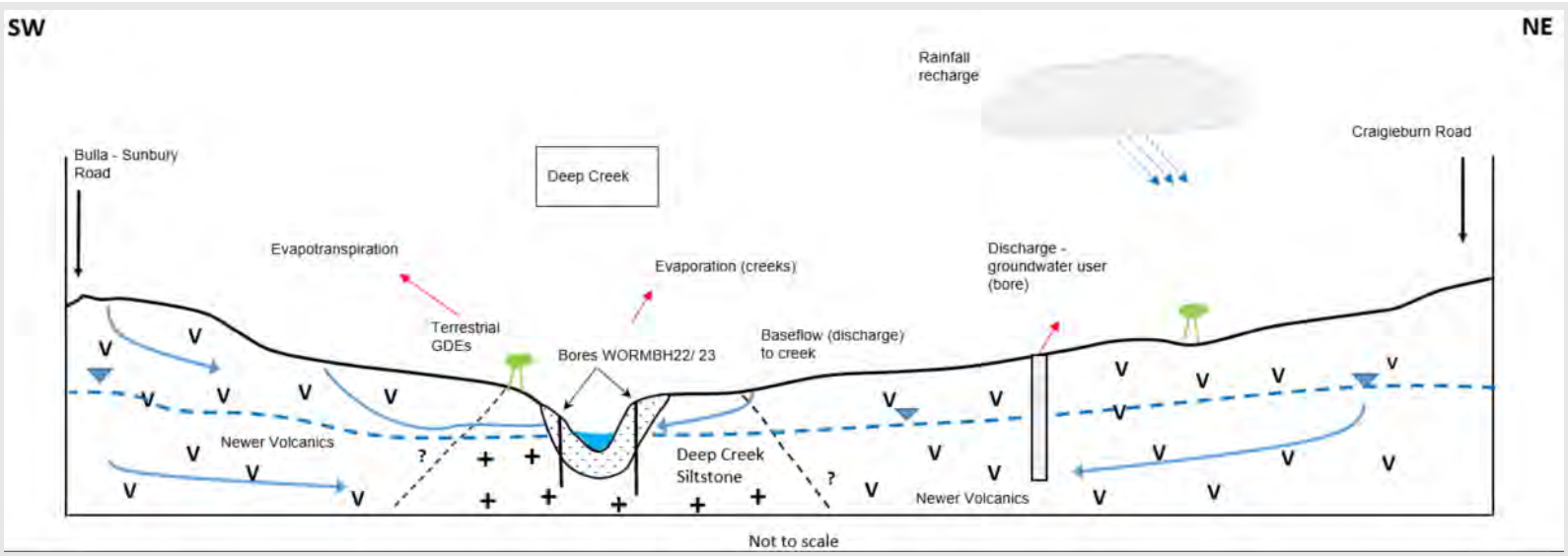
- The Palaeozoic basement rocks. These include sediments of the Humevale Siltstone at the western end of the section.
- Late Tertiary/ Quaternary Newer Volcanics. These are mapped overlying the Palaeozoic basement. The thickness of the basalts is unknown.
- Quaternary unconsolidated sediments
  These are mapped within the Kalkallo Creek floodplain. Based on the drilling completed in the area their thickness is estimated at 10 m. These sediments overly the Palaeozoic basement rock in the west and the basalt elsewhere.

The water table (unconfined/possibly semi-confined) aquifers have been shown. Regional groundwater level information indicate a depth to groundwater of in excess of 5 m however shallower groundwater depths (< 5 m) however have been interpreted where the alignment crosses major waterways. Site specific information suggests the groundwater depth in the north of the Project area near Kalkallo Creek is slightly greater than that of the regional interpretation. The fractured rock aquifers can be semi-confined at depth due to the groundwater flow through the fracture systems.

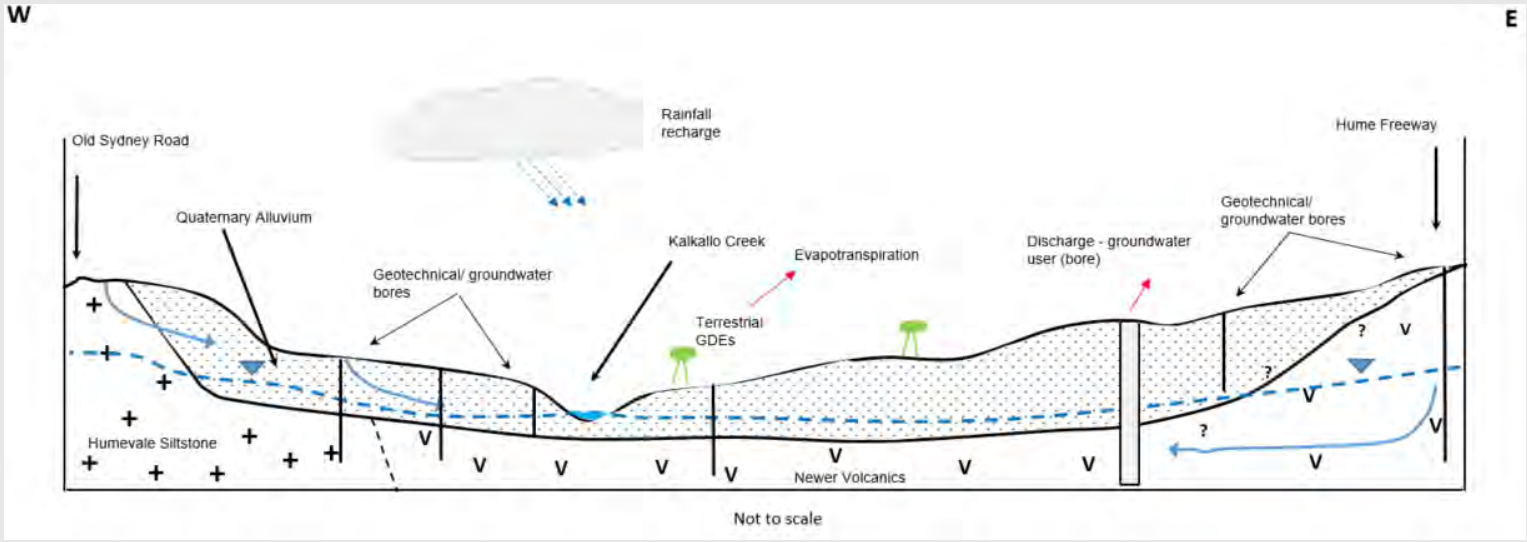
Overall groundwater flow is expected to be towards the lower lying areas, i.e. towards the existing drainage systems, with water levels being a subtle reflection of the topography.

Local flow paths are likely to be influenced by aquifer fracture orientation and the degree of weathering. Intermediate and regional flows systems have also been indicated on the schematic and as noted previously, are expected to be a subtle or subdued reflection of the local topography (i.e. flow form high to lower topography). These may also discharge into the drainage lines, mix with shallower systems or pass beneath the floodplain.

Groundwater discharge to the waterways within the study is expected, with groundwater (baseflow) components to waterways in this area contributing a proportion of the overall flow in waterways. Recharge to the aquifers is predominately by rainfall across the outcrop area. In some areas, along creek lines, recharge to the water table aquifer system may occur during high river flow or flood periods.



KP15 – KP23 (approximate only)



KP32 – KP37 (approximate only)

Figure 20 Conceptual hydrogeological sections

7. Existing site conditions

7.1 Site investigation summary

The field investigations completed to inform site conditions have been included as Appendix B. The following sections briefly summarise the field investigations completed.

7.1.1 Geotechnical Drilling

A tabulated summary of the geotechnical borehole locations, depths and summary comments, as obtained from APA, is provided in Appendix D. A copy of the geotechnical bore logs is included in Construction Science, 2020. Geotechnical drilling locations have been shown on Figure 21.

The six geotechnical bores that were converted to groundwater monitoring bores are also summarised in Appendix D. These bores are also shown in Figure 21.

Acid Sulfate Soil sampling and analysis

During the geotechnical drilling Construction Science collected soil samples from selected bores for ASS analysis. A summary of the ASS testing completed by Construction Science, including a discussion of the results has been included in Section 7.5.2.

7.1.2 Groundwater monitoring bore network

A groundwater monitoring network consisting of 18 bores was established by APA to provide information on groundwater levels, quality and estimated aquifer hydraulic conductivity. The network generally focuses on the areas where groundwater depth was expected to be less than 5 metres and therefore where there may be interaction with the pipeline.

The bores also form a groundwater monitoring network where additional groundwater level and quality information could be collected, if necessary, during future stages of the Project.

A summary of the monitoring bore installation is provided in included in Table 22 and shown in Figure 21. Monitoring bore geological and construction logs are provided in Appendix E.

Acid Sulfate Soil sampling and analysis

During this drilling further selected samples were collected for ASS analysis. A summary of the limited additional ASS testing completed as part of this investigation is also included in Section 7.5.2.

Based on the investigations completed the following is noted:

- 51 geotechnical bores were completed. This includes 50 bores by Construction Science and one bore by GHD
- 18 functional monitoring bores have been installed. This includes seven bores by Construction Science and 11 bores by GHD.

Table 22 Summary of APA monitoring bore installation

Bore ID	MGA coordinates		Elevation (m AHD)	Location description	Bore depth (m)	Screen interval (m)	Screen geology
	Easting	Northing					
Historic monitoring bores (installed 2019/2020)							
WORMBH15	303,810.977	5,833,652.464	121.446	Jacksons Creek	20.3	17.3 – 20.3	Siltstone
WORMBH22	305,819.460	5,834,711.840	102.588	Deep Creek	30.2	27.2 – 30.2	Siltstone
WORMBH23	305,954.882	5,834,829.412	101.597	Deep Creek	30	27 – 30	Mudstone
WORMBH27	323,052.000	5,846,786.180	257.600	Merri Creek	20.4	17.4 – 20.4	Basalt
WORMBH32	315,954.007	5,846,801.058	231.550	Gunns Gully Road	20	17 – 20	Siltstone/Sandstone
WORMBH49	323,040.750	5,846848.528	257.014	Merri Creek	20.5	17.52 – 20.5	Basalt
New monitoring bores (installed July – August 2020)							
WORMBH01	298476.512	5824085.564	112.738	Duha	10	7-10	Basalt
WORMBH03	302006.761	5832383.239	165.207	South of Bulla – Diggers Rest road (Prefferini).	21	15-21	Basalt
WORMBH05	309792.566	5837964.355	234.7	Craigieburn Rd (Luppino)	20	17-20	Basalt
WORMBH06	312596.541	5842025.545	267.654	Mickleham Rd (Hadshir)	12	9-12	Basalt
WORMBH07	314437.787	5845330.337	241.952	Ascotown	12	9-12	Sandy clay
WORMBH09	316615.327	5846718.973	231.759	Gunns Gully Road	12	9-12	Clay
WORMBH10	318474.624	5846478.275	242.787	Gunns Gully Road	12	9-12	Clay
WORMBH11	319872.029	5847694.546	259.303	South of Donavons Lane (Sirius)	10.1	7.1 - 10.1	Clay

Bore ID	MGA coordinates		Elevation (m AHD)	Location description	Bore depth (m)	Screen interval (m)	Screen geology
	Easting	Northing					
WORMBH12	321626.74	5847842.97	255.071	Donavons Lane	6.1	3-6	Basalt
WORMBH14	323525.919	5842612.49	233.772	Donnybrook Rd (De Angelis)	9	6-9	Basalt
WORMBH16	322804.232	5839069.687	203.843	Wollert Compressor Station	10	7-10	Basalt
WORMBH23a	305955.503	5834800.475	101.242	Deep Creek	25	22-25	Silty clay and mudstone

Notes to historic bores:

Source – APA

Screen geology as logged by Construction Science (CS)

Bore WORMBH23 blocked and since decommissioned by CS

Monitoring bore coordinates supplied by APA. Elevation in m AHD understood to represent ground level

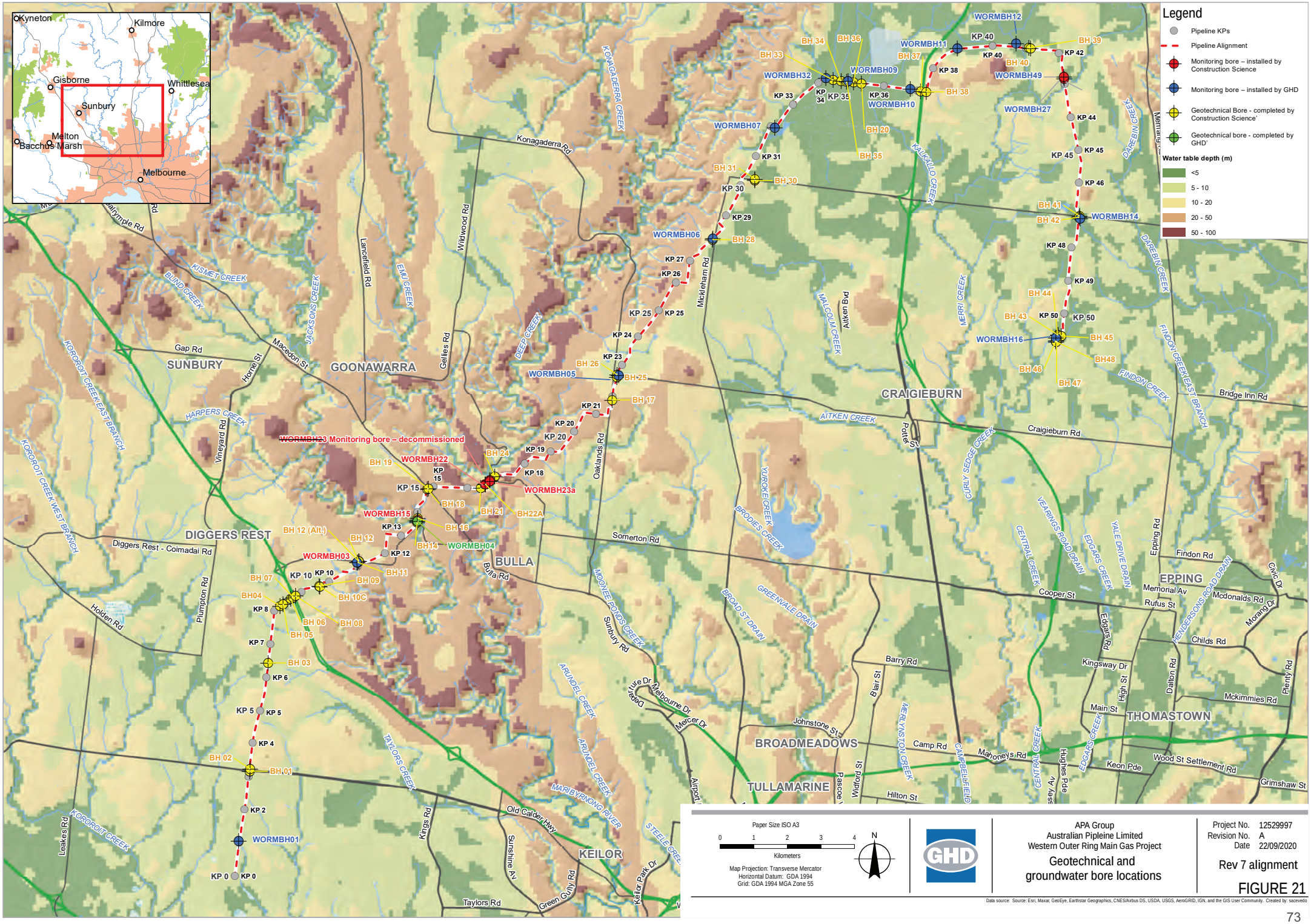
All bores comprise 50 mm diameter PVC casing

Notes to new bores:

Elevation in m AHD measured at top of PVC.

All bores comprise 50 mm diameter PVC casing

Bore WORMBH23a installed by CS


Kyneton
Kilmore
Gisborne
Whittlesea
Sunbury
Melton
Bacchus Marsh
Melbourne
Legend
Pipeline KPs
Pipeline Alignment
Monitoring bore – installed by Construction Science
Monitoring bore – installed by GHD
Geotechnical Bore - completed by Construction Science'
Geotechnical bore - completed by GHD'
Water table depth (m)
<5
5 - 10
10 - 20
20 - 50
50 - 100
WORMBH23 Monitoring bore – decommissioned
SUNBURY
GOONAWARRA
DIGGERS REST
BULLA
CRAIGIEBURN
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
Konagaderra Rd
Gap Rd
Macedon St
Horne St
Lancefield Rd
Wildwood Rd
Gellies Rd
Mickleham Rd
Oaklands Rd
Vineyard Rd
Diggers Rest - Coimadai Rd
Plumpton Rd
Holden Rd
Bulla Rd
Somerton Rd
Sunbury Rd
Barry Rd
Melbourne Dr
Mercer Dr
Johnstone St
Camp Rd
Mahoneys Rd
Hilton St
Old Calder Hwy
Kings Rd
Sunshine Av
Keilor Park Dr
Taylors Rd
Leakes Rd
Green Gully Rd
Bridge Inn Rd
Craigieburn Rd
Cooper St
Findon Rd
Epping Rd
Mcdonalds Rd
Childs Rd
Mckimmies Rd
Plenty Rd
Main St
Kingsway Dr
Keon Pde
Wood St Settlement Rd
Grimshaw St
Hughes Rde
Dalton Rd
High St
Edgars Rd
Rufus St
Memorial Av
Morang Dr
Cwic Dr
Pascoe Vale Rd
Widford St
Blair St
Merlynston Creek
Central Creek
Edgars Creek
Yale Drive Drain
Hendersons Road Drain
Findon Creek East Branch
Findon Creek
Darebin Creek
Merri Creek
Malcolm Creek
Kalkallo Creek
Konagaderra Creek
Aitken Creek
Yuroke Creek
Broadmeadows Creek
Broads St Drain
Greenvale Drain
Moonee Ponds Creek
Arundel Creek
Taylors Creek
Maribyrnong River
Steele Creek
Kororoit Creek
Kororoit Creek East Branch
Kororoit Creek West Branch
Harpers Creek
Jacksons Creek
Emu Creek
Deep Creek
Kismet Creek
Blind Creek
Yearlings Road Drain
Curly Sedge Creek
Paper Size ISO A3
0 1 2 3 4
Kilometers
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
GHD
APA Group
Australian Pipleine Limited
Western Outer Ring Main Gas Project
Geotechnical and groundwater bore locations
Project No. 12529997
Revision No. A
Date 22/09/2020
Rev 7 alignment
FIGURE 21
Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: sacevedo

7.1.3 Groundwater monitoring

As described in Appendix A, GHD completed monitoring from the monitoring bore network between March and October 2020. Table 23 provides a broad summary of the groundwater monitoring completed. Table 24 summarises the bores monitored and the adopted laboratory analytical suite.

The monitoring results have been included in Section 7.2.

It is noted that one surface water sample from each of Deep and Jacksons Creeks were collected and submitted for laboratory analysis of PFAS. The rationale, methodology and results have been reported in the Technical Assessment – Contamination.

Table 23 Summary of groundwater monitoring

Monitoring item	Relevant documentation	Appendix reference
Groundwater level gauging.	Both manual water level measurements and deployment of dataloggers to record water levels	Table 25 and Appendix J
Groundwater sampling	Groundwater purge sheets	Appendix F
Laboratory analysis	Tabulated laboratory results	Appendix G
	Certified laboratory results	Appendix H
Quality control	Field equipment calibration certificates Results of duplicate sample analysis	Appendix I
Aquifer testing (i.e. slug tests).	Slug test results	Section 7.4

Table 24 Summary of groundwater sampling and laboratory analysis

Bore ID	Number of sampling occasions	Month/s sampled	Laboratory analytical suite
WORMBH15	Two	March and October 2020	A (March) and B (October). October analysis also included PFAS
WORMBH22	Three	March, September and October 2020	A (March) and B (September). October analysis for PFAS
WORMBH23	One	March 2020	A
WORMBH27	One	March and October 2020	A (March) and B (October)
WORMBH32	Two	March and August 2020	A (March) and B (August)
WORMBH49	One	March 2020	A (March) and B (October)
WORMBH01	Not sampled – insufficient water		
WORMBH03	Not sampled – insufficient water		
WORMBH04	One	August 2020	A
WORMBH05	Not sampled – insufficient water		
WORMBH06			
WORMBH07			
WORMBH09	One	September 2020	B
WORMBH10	Not sampled – insufficient water		
WORMBH11	One	August 2020	A
WORMBH12	One	August 2020	B
WORMBH14	One	August 2020	B

Bore ID	Number of sampling occasions	Month/s sampled	Laboratory analytical suite
WORMBH16	One	August 2020	A
WORMBH23a	One	August and October 2020	B (August). October analysis for PFAS

Laboratory analytical suites:

A: Salinity (measured as mg/L TDS), pH, EC, major ions.

Ammonia (as N), nitrate (as N), Nitrate (as N), nitrite (as N), total nitrogen, Total Kjeldahl Nitrogen

Sulfate as SO4, total phosphorous, metals screen

B: As above **plus** E.Coli, Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

Oil and grease, surfactants (methylene blue active substances - MBAS), IWRG621 (TPH, OCPs, PCBs, MAH, SVOCs and VOCs, cyanide, fluoride)

7.2 Investigation Results - Groundwater Conditions along the Pipeline Alignment

7.2.1 Groundwater levels and depths

The geotechnical drilling and monitoring bore installation has provided further information on potential groundwater levels and depths along parts of the Project alignment. The following sections provide an interpretation of potential groundwater depths based on the investigations completed.

Appendix J provides a summary of groundwater observations along the alignment. The regional interpretation of groundwater depths (refer Section 6.7.1) has also been included in Appendix J. In most cases, the recorded depth to water table (metres below ground level) are reasonably consistent with the regional interpretation.

We note that the geotechnical report (Construction Science, 2020) reports groundwater from bores BH33 to BH35 at depths between 8.2 m and 9.3 m bgl. Monitoring bores WORMBH09 and WORMBH32, installed at this location, reported a groundwater depths of between approximately 7 m and 8 m bgl.

The available SON bore data (refer Section 6.7.2) indicates that seasonal variations of between 0.5 m and 1 m can occur, i.e. groundwater depths and monitoring bore water levels reported as part of this investigation may change seasonally.

7.2.2 Monitoring bore hydrographs

A monitoring bore hydrograph has been prepared for each bore where dataloggers have been deployed and shown in Appendix K. In constructing the hydrographs, the following rules were applied:

- Reduced water level trends (to metres above Australian Height Datum) and depth to water shown
- Selected bores have been presented as nested sites:
  - Bores WORMBH22, WORMBH23, WORMBH23a (Deep Creek)
  - Bores WORMBH27, WORMBH49 (Merri Creek)

The available manual water data from the bores suggests that seasonal variations of up to 1 m could be expected in groundwater levels. This is most obvious at bores near Deep, Merri and Jacksons Creeks. The deepest water levels were recorded in March 2020 with shallower water levels reported in June, August and September 2020. The further following notes are made regarding the groundwater levels:

- Groundwater levels in bore WORMBH12 (Donovans Lane) are shallow, typically between 0.3 m and 0.5 m bgl
- Groundwater levels in bore WORMBH14 are shallow, between approximately 1.2 m and 1.4 m bgl
- Groundwater levels in bore WORMBH32 have remained stable at approximately 7 m bgl
- Groundwater levels in bore WORMBH22 have varied between approximately 5.7 m and 7 m bgl
- Groundwater levels in bore WORMBH23 have varied between approximately 3 m and 3.6 m bgl
- Groundwater levels in replacement monitoring bore WORMBH23a have remained at approximately 3.3 m bgl

- Groundwater levels in bores WORMBH27 and WORMBH49 (Merri Creek) have varied between approximately 1.8 m and 3.2 m bgl

The drilling completed to date has been largely confined to major features, e.g. road, creek and rail crossings and where the regional depth to water table was < 5 m. As such, in the absence of additional site specific data, the regional interpretation of groundwater depths should be used outside these areas

7.2.3 Areas of groundwater Interaction

The recorded depth to water table minimum (shallowest) in the Project bores has been plotted on Figure 22 to Figure 30, with the regional depth to groundwater dataset for reference. In addition the groundwater level data at, and interpreted between, the monitoring bores has been presented on a series of long –sections from KP27 (WORMBH06) to the end of the alignment at KP50 (WORMBH16), where the shallower groundwater levels were encountered (refer Figure 27 to Figure 31). Groundwater level data at the creek crossings are also presented in the cross sections shown in Figure 32. Based on this data, and interpretation between groundwater monitoring points, the areas where the pipeline will interact with groundwater are highlighted on these figures, as well as summarised in Table 25. These areas of direct interaction with groundwater represent approximately 5% of the entire pipeline length.

For these areas, construction dewatering levels and lengths have been conservatively estimated based on the available information. Further detail on the river crossings is included in Section 7.2.4.

Table 25 Summary of areas of groundwater interaction along the Project alignment

Area	Approximate location	Kp From	Kp To	Distance (m)	Type	Construction Method	Bore data Depth to Groundwater [1] (mBGL) or regional	Trench Level or Bell level comment/assumption	Estimated construction drawdown required (m)	Trench length assumed [2] (m)	Interpreted aquifer
1a	Bendigo Rail	8.288	8.326	38	crossing	Bored	2 (assumed)	Bell hole 5 m maximum depth, 4 m side x 8 m long – One side only	3	5	Basalt
1b	Unknown Creek/Tame St drain	8.406	8.411	5	crossing	open trench construction	2 (assumed)	2 m below invert +2 m trench	2	10	Alluvial clay/basalt
2	Jacksons Creek	13.863	13.898	35	crossing	Open trench construction	5 - 1.68	Groundwater level on banks is approximately 1 m above creek invert. Excavation is 4 m below invert (i.e. 2 m cover + 2 m pipe trench)	5	50	Predominately Mudstone/siltstone but some clay sand/gravel
3	Deep Creek	16.828	16.85	22	crossing	HDD	3 - 5.7	HDD - 2 bell holes . 2.5 m deep. Groundwater level on banks is a minimum 3 m below surface in the winter months. No dewatering of bell holes required. HDD will be below WT	0	HDD	Mudstone
4a	Donovans Lane	40	41	1000	trench	Open trench construction	0.3	Groundwater level minimum is 0.3m.Trench excavation will be 2 m deep: conservatively assumed dewatering for full 1 km although the ground surface levels are variable	1.5	1000	Basalt

Area	Approximate location	Kp From	Kp To	Distance (m)	Type	Construction Method	Bore data Depth to Groundwater (1) (mBGL) or regional	Trench Level or Bell level comment/assumption	Estimated construction drawdown required (m)	Trench length assumed (2) (m)	Interpreted aquifer
4b	North east Rail reserve	40.925	40.959	34	Crossing	Bored	4	Groundwater level is 4 m, bell hole max. depth of 5 m. 2 bell holes x 8 m long to be dewatered	1	16	Basalt
5	Merri Creek	42.639	42.655	16	crossing	Open trench construction	2 - -2.3	Groundwater level on banks is approximately 1 m above creek invert. Excavation is 4 m below invert (i.e. 2 m cover + 2 m pipe trench)	5	50	Basalt
6	Donnybrook Rd	46.5	47.5	1000	trench	open trench construction	1.24	Groundwater level minimum is 1.2 m. Trench excavation will be 2 m deep. Conservatively assumed dewatering of 1 m for 1 km although the ground surface levels are variable	1	1000	Basalt

Notes:

(1) From local monitoring bores or interpreted between bores, (2) Length assumed for dewatering during construction

(2) GWL- Groundwater level. WT – Water table

It is again noted, that as the pipe open trench excavation was generally a total depth of 2 m, the monitoring bore network generally focused on areas where the regional data suggested the groundwater depth was < 10 m (and the creek crossings). Interpretation between monitoring bores, as shown in Figure 27 to Figure 31, were used to further assess groundwater depth in areas where groundwater may be < 5 m. In other areas where groundwater depths are > 5 m, and there was no additional Project specific groundwater data available, the SAFE regional interpretation of the groundwater depths based on all other available groundwater data, was continued to be used and it was concluded that there would be no interaction with the pipeline Project. Monitoring bores drilled in areas where groundwater was > 5 m based on the regional data (i.e. 5 m to 10 m), generally recorded groundwater levels which corelated well with the regional data or the regional data slightly underestimated the groundwater level, which provides further confidence in the regional data set (refer Appendix J).

It is noted that some original areas highlighted in Table 18 are no longer considered to be interaction zones with the pipeline. These are summarised in Table 26 and include:

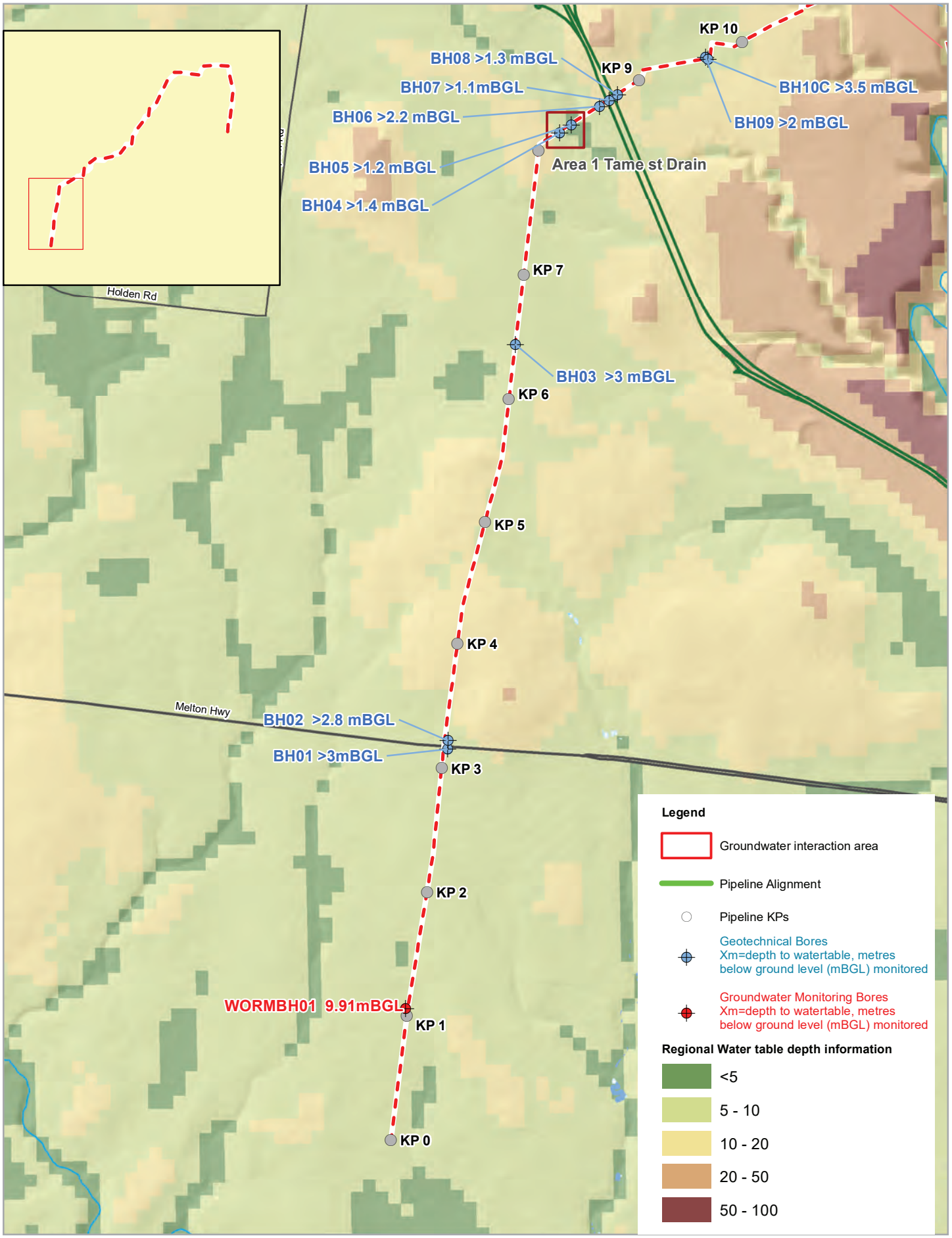
- KP1 area. The installed bore WORMBH01 confirmed a groundwater depth of 9.9 m to 10 m BGL, which is at the deepest end of the regional depth range of 5 m to 10 m. Therefore, the regional interpretation in this area is considered to be representative and the groundwater depth from KP0 to KP3 is expected to be > 5 m.
- KP6.5 - 7.5 area. Holden Road and north. There are some areas close to, but off the alignment, which the regional data indicated groundwater depth is < 5 m. Although no monitoring bores were drilled, geotechnical bore BH03 on the alignment was drilled to 3 m and did not intersect groundwater.
- KP28-KP230: Mickleham Road to Donnybrook Rd area. Monitoring bores WORMBH06 and WORMBH07 were both drilled to 12 m depth, and neither bore intersected groundwater. Geotechnical bores BH30 and BH31 did not intersect groundwater at 5.4 m and 3 m respectively. Based on these results, the groundwater depth in this area is expected to be greater than 5 m and open trench construction is not expected to intersect the water table (refer Long section 1 : Figure 27)
- KP30.5 – KP37. Donnybrook Road – Kalkallo Creek – Gunns Gully Road. Regional data suggested < 5 m across most of this pipeline length. As shown in Table 28, the groundwater depth in this area varied from 7 m to 12 m and therefore the pipe trench will not intersect the water table (refer long section 2: Figure 28). In this area, there are two 50 m sections of the pipe that requires up to 4.5 m of cover, due to proposed future drainage channels. Based on the site specific data, the pipe trench will remain around 1.5 m above the groundwater level
- KP45 - Just to the north of KP45, the regional data suggested groundwater depth may be <5 m. This was also close to a temporary wetland, which is not identified as a potential GDE. The groundwater level interpreted between bores WORMBH49 to WORMBH14 suggests the ground water depth is in the order of 10 m deep in this short section
- KP47.5 - KP50. The regional SAFE dataset suggested that there would be isolated areas where groundwater may be < 5 m along this section. However, interpreting the groundwater level between monitoring bore WORMBH16 and WORMBH14 (refer Figure 31), the groundwater depth generally exceeds 5 m , and is commonly in the order of 10 m along this section south of interaction area 6.

Finally, it is noted that in some areas of the pipeline alignment localised perched groundwater may be intersected above the regional water table due to local conditions, such as the presence of a distinct clay band at shallow depth. However, if intersected, these perched systems will generally be localised, have low storage and are unlikely to yield significant volumes of groundwater.

Table 26 Summary of groundwater depths following field investigations in shallow groundwater areas identified from regional data.

Approx. KP.	Approximate location	Regional SAFE data Depth to groundwater (m bgIL)	Interpreted groundwater depth following monitoring bore installation (m bgl)/ comment
1	Vacant land south of Beatty's Road	< 10	≈ 10 m (bore WORMBH01) Groundwater interaction not expected
7	North of Holden Road	5 - 10	Geotechnical bore BH03 drilled to 3 m depth, no groundwater intersected Groundwater interaction not expected
8	Adjacent minor creek south of Tame Street drain Tame Street drain	< 5	Regional data suggests < 5 m. 2 m assumed. Potential groundwater interaction
14	Jacksons Creek	< 5	1.68 – 5 m (monitoring bores) Potential groundwater interaction
17.5	Deep Creek	< 5	3 – 5.7m (monitoring bores Potential groundwater interaction
28	Mickleham Road	5 - 10	> 10m (bores WORMBH06, WORMBH07)
30	North of Donnybrook Road	< 5	Groundwater interaction not expected
30.5 – 37	Donnybrook Road – Kalkallo Creek – Gunns Gully Road	< 5	7 – 12m (monitoring and geotechnical bores) Groundwater interaction unlikely
39 – 43	Donovans Lane – Merri Creek	< 5 and 5 - 10	< 5 m (bore WORMBH12) Potential groundwater interaction
43	Merri Creek	< 5	< 5 m (bores WORMBH27, WORMBH49)
45	South of Merri Creek	Mostly 5 - 10	≈ 10m The groundwater level interpreted between bores WORMBH49 to WORMBH14 suggests the ground water depth is in the order of 10 m deep in this short section. Groundwater interaction not expected

Approx. KP.	Approximate location	Regional SAFE data Depth to groundwater (m bgIL)	Interpreted groundwater depth following monitoring bore installation (m bgl)/ comment
47	Donnybrook Road	< 5	< 2m (bore WORMBH14) Potential groundwater interaction
47.5 – 50	South of Donnybrook Road to Wollert Compressor Station	< 5 and 5 - 10	≈ >5m -10 m The groundwater level interpreted between bores WORMBH14 and WORMBH16 suggests the ground water depth is generally greater than 5 m in this section. Groundwater interaction not expected
Notes: KP – Kilometre Point These are the shallow groundwater areas identified in Table 18			



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Depth to groundwater and project interaction areas

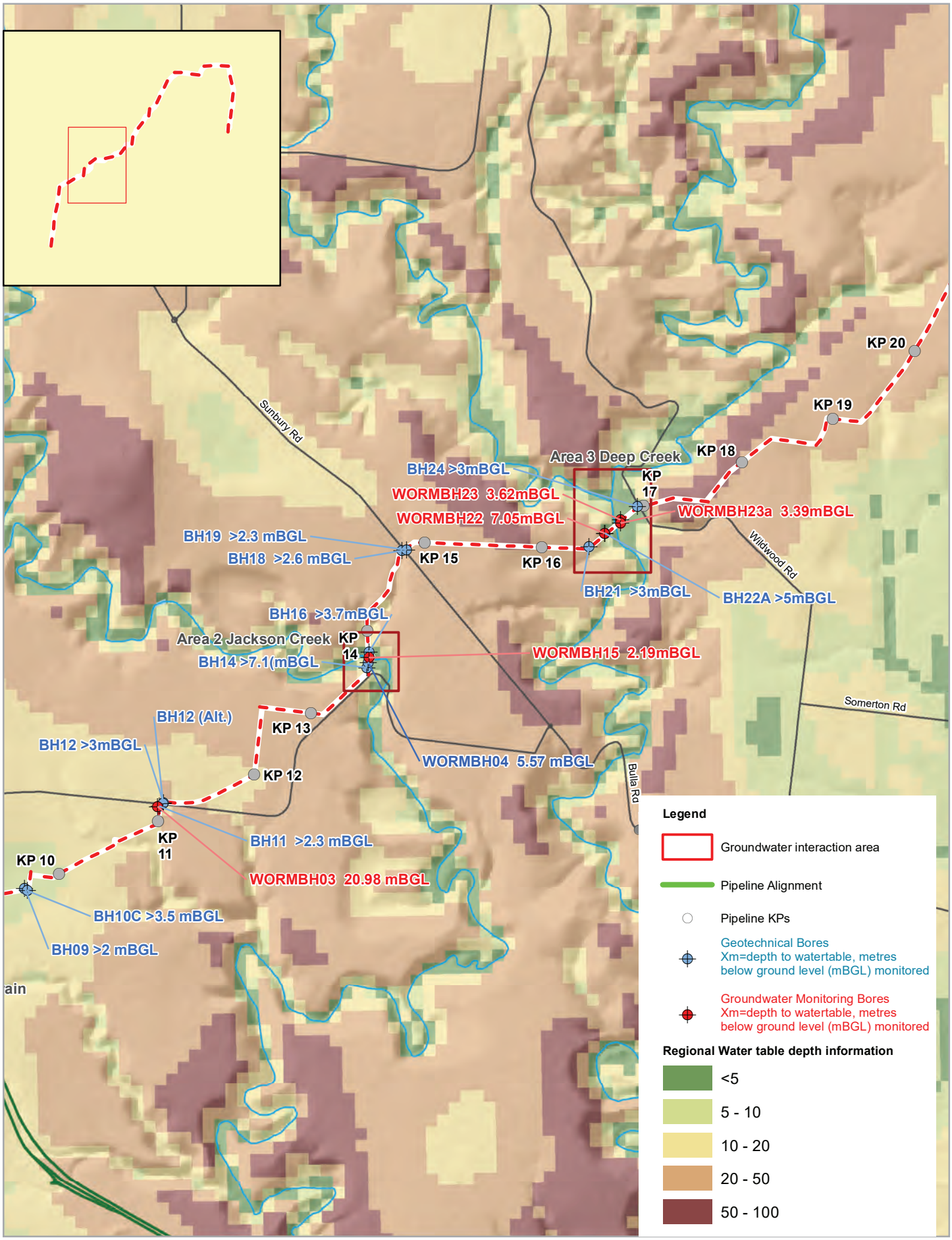
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Figure 22

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Depth to groundwater and project interaction areas

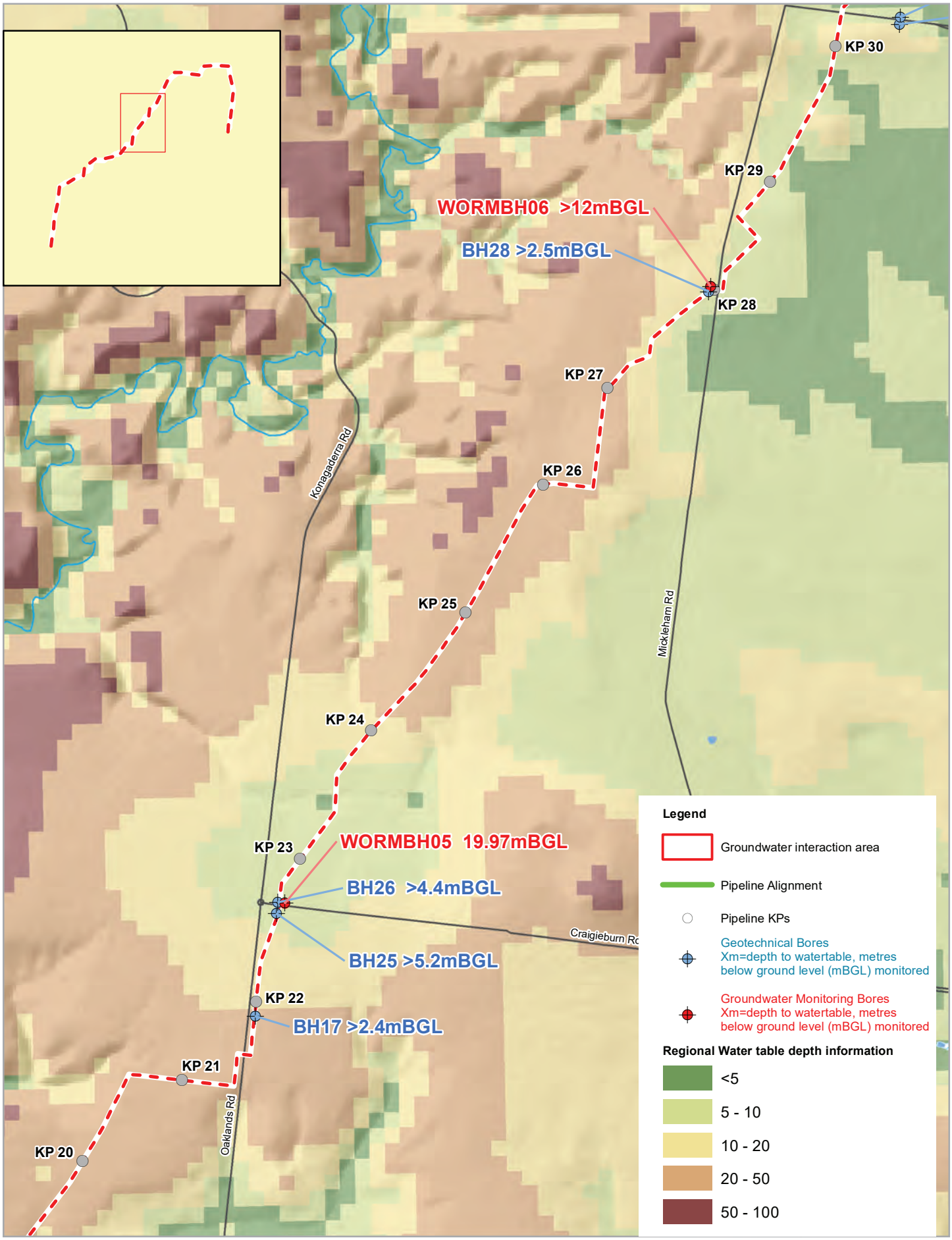
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Figure 23

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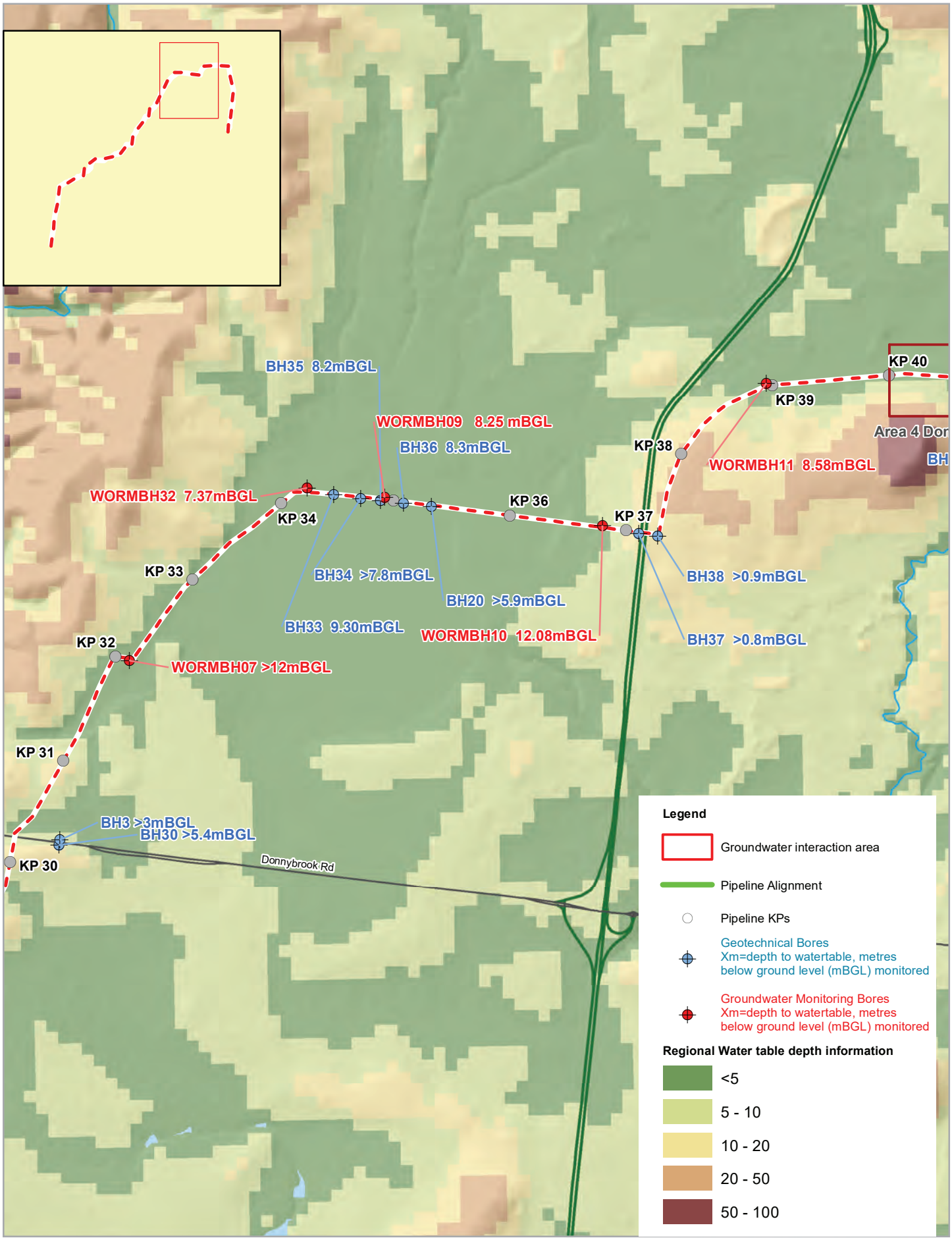
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Figure 24

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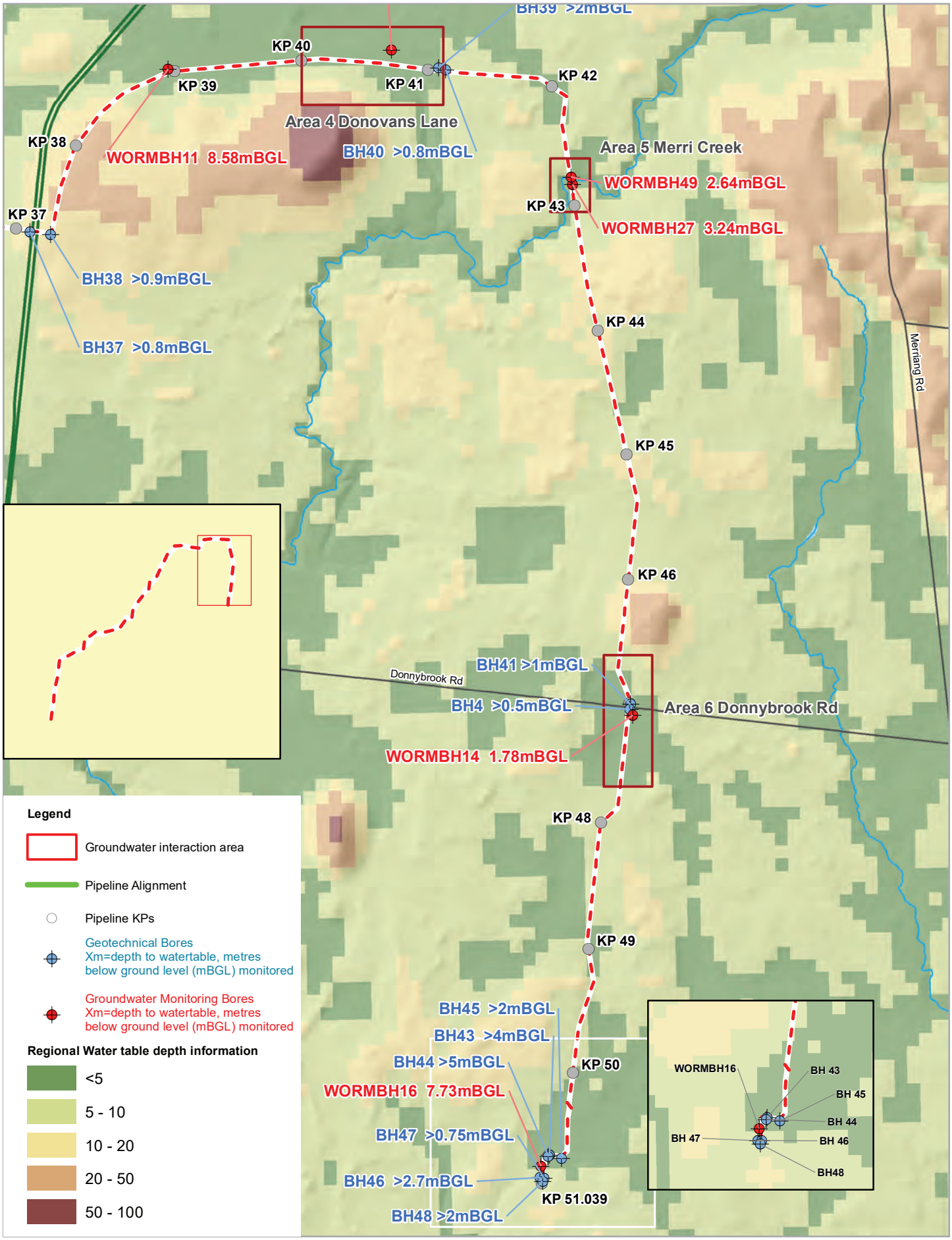
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Figure 25

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Depth to groundwater and project interaction areas

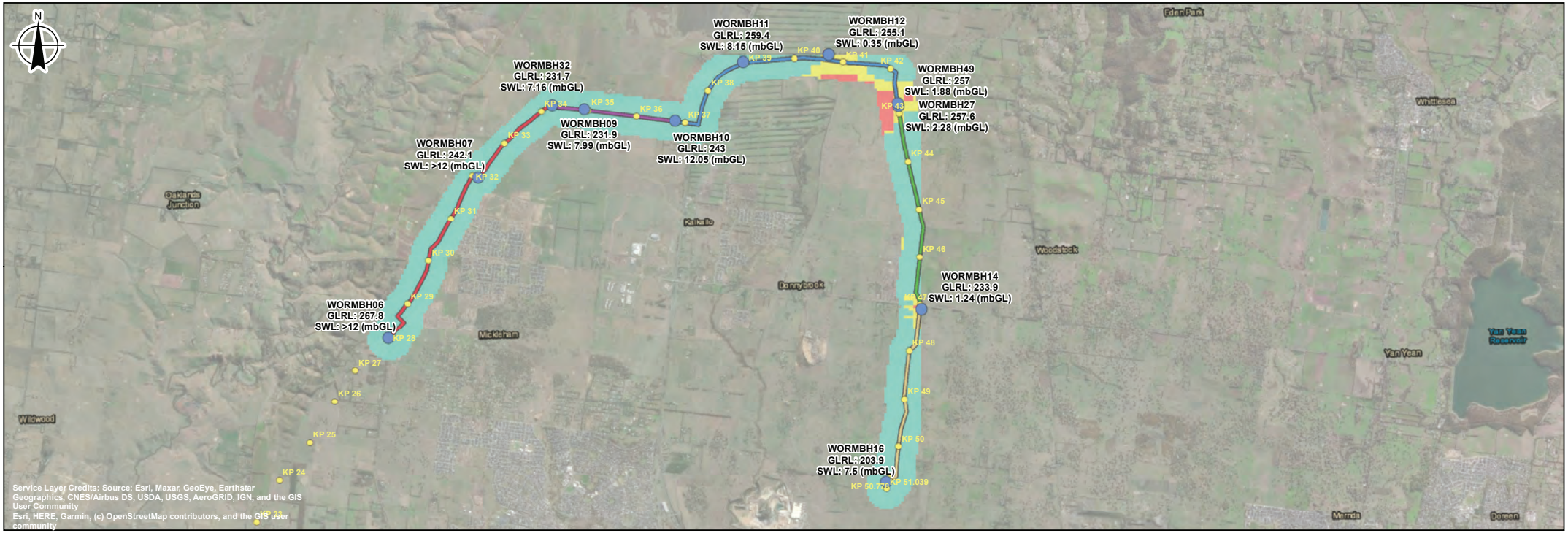
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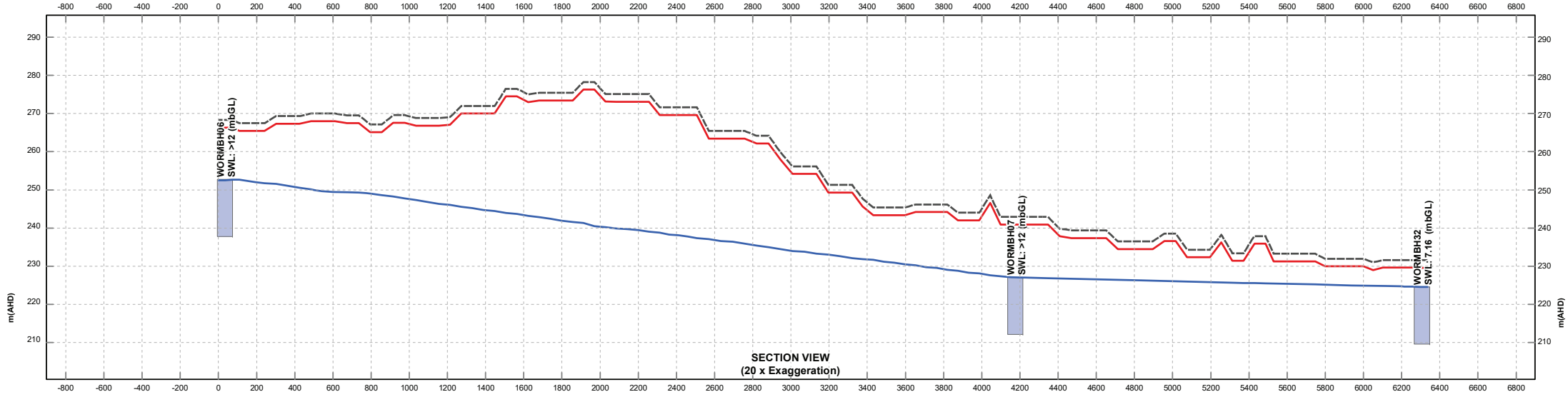
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Figure 26

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Horizontal Datum: GDA 1994, Grid: GDA 1994 VICGRID94

Legend for Plan View

- Bore locations
- Section 1
- Section 2
- Section 3
- Section 4
- Section 5

Indicative groundwater depths (based on bores shown)

- Within 2m
- 2 - 5m
- 5m or deeper

Legend for Section View

- Existing surface
- 2m below existing surface
- Top of groundwater (infered)

GL RL (mAHD) : Ground level reduced level (m Australian Height Datum)
SWL (mbGL): Standing Water Level (metres below ground level)

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Interpreted Depth to Groundwater from Observation Bore Data: Cross Section 1 - WORMBH06 to WORMBH32

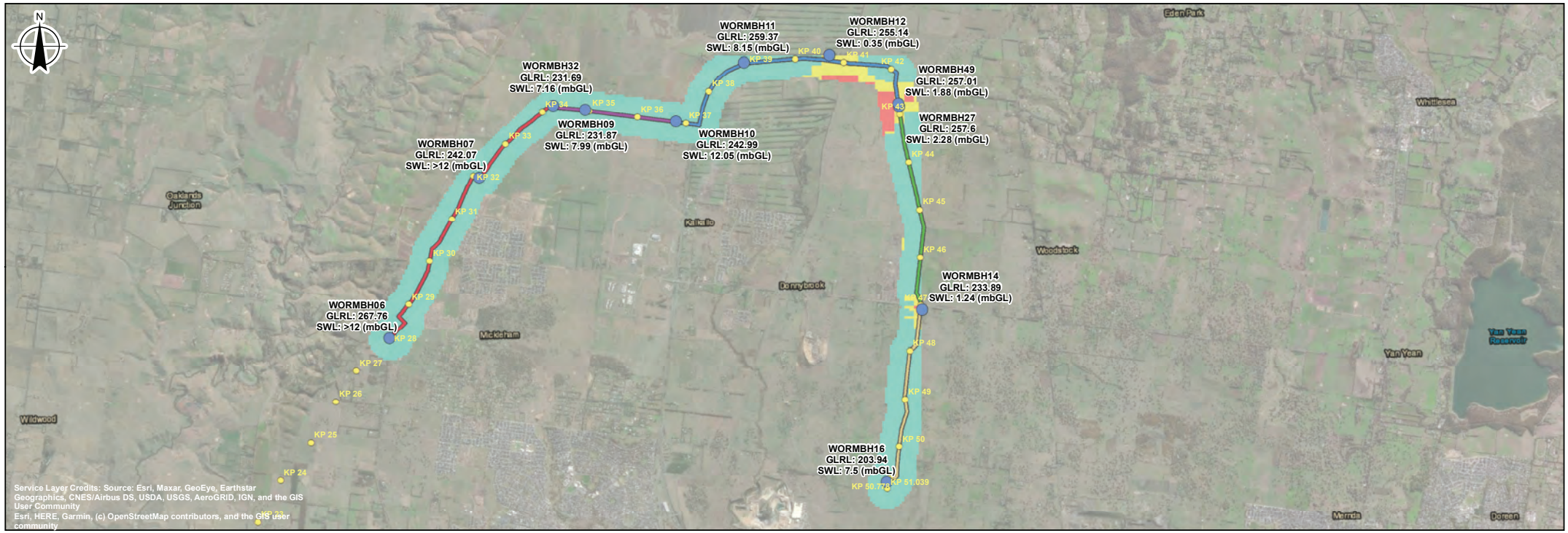
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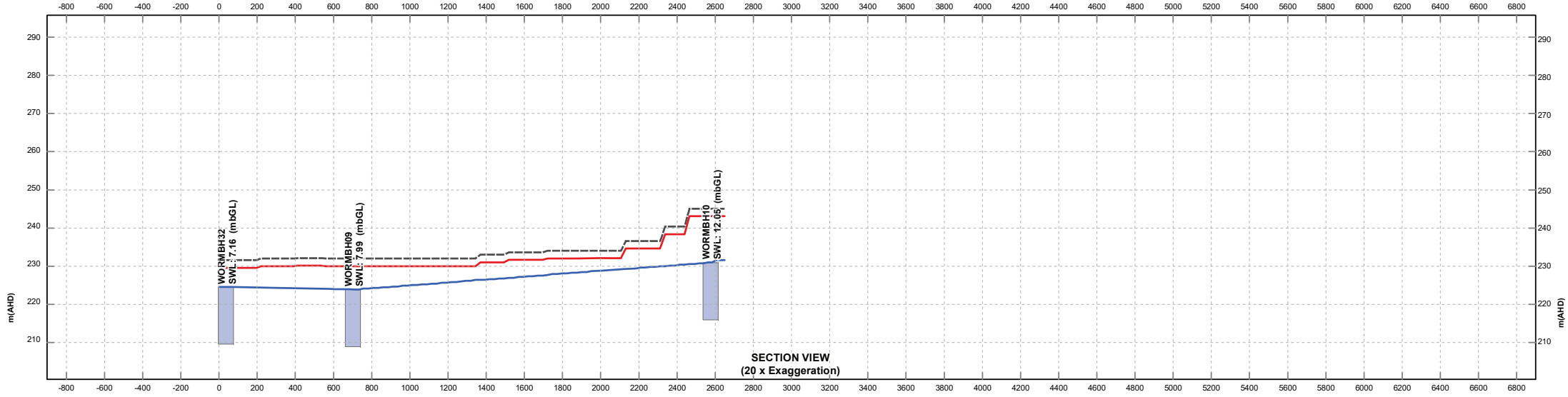
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Map Projection: Transverse Mercator
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Legend for Plan

Legend for Section View
- Existing surface
- 2m below existing surface
- Top of groundwater (infered)

GL RL (mAHD) : Ground level reduced level (m Australian Height Datum)
SWL (mbGL): Standing Water Level (metres below ground level)

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Interpreted Depth to Groundwater from Observation Bore Data: Cross Section 2 - WORMBH32 to WORMBH10

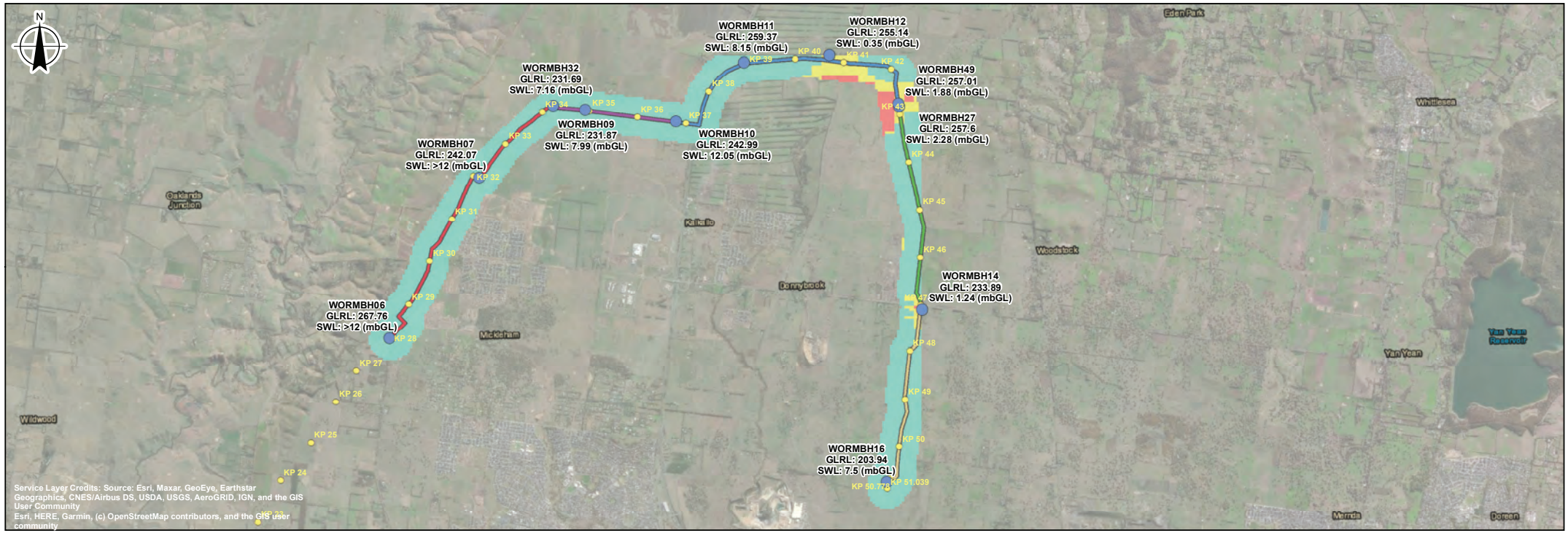
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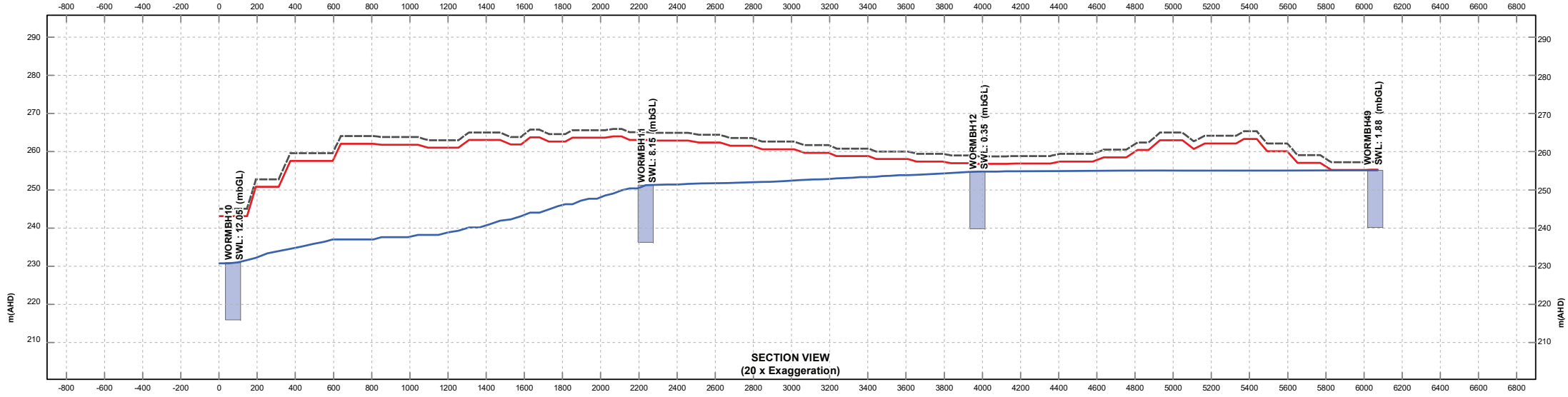
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Legend for Plan View
- Bore locations
- Section 1
- Section 2
- Section 3
- Section 4
- Section 5

Indicative groundwater depths (based on bores shown)
- Within 2m
- 2 - 5m
- 5m or deeper

Legend for Section View
- Existing surface
- 2m below existing surface
- Top of groundwater (infered)

GL RL (mAHD) : Ground level reduced level (m Australian Height Datum)
SWL (mbGL): Standing Water Level (metres below ground level)

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Interpreted Depth to Groundwater from Observation Bore Data: Cross Section 3 - WORMBH10 to WORMBH49

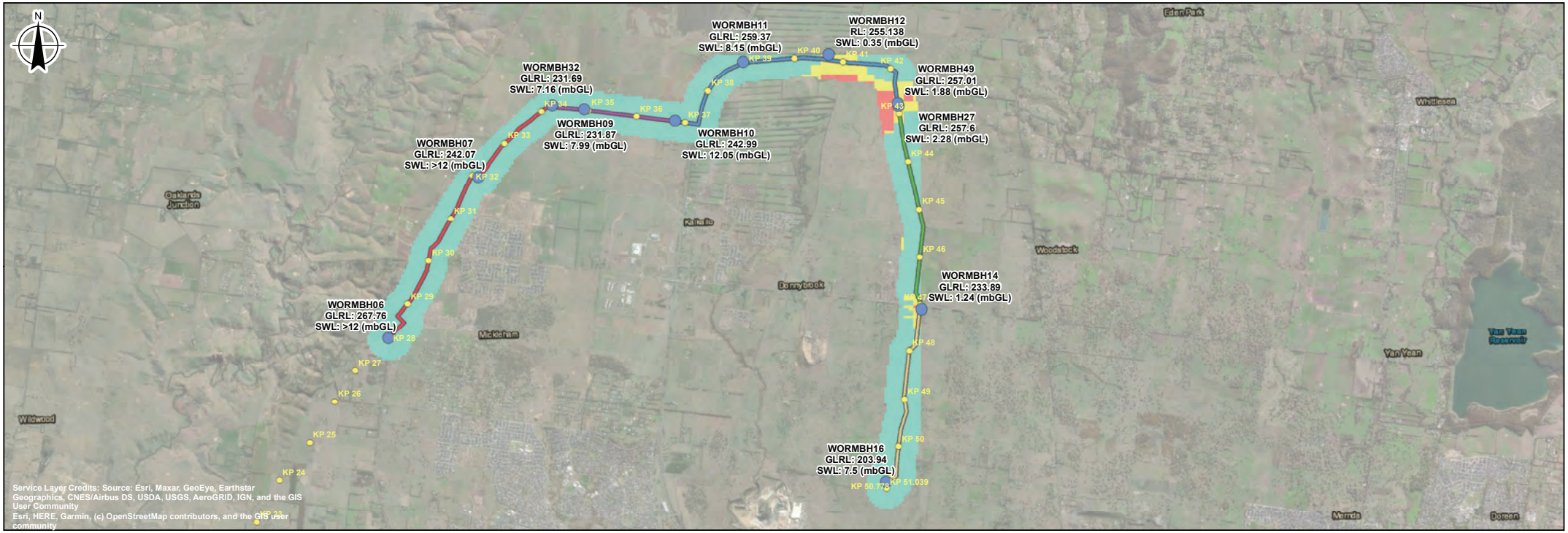
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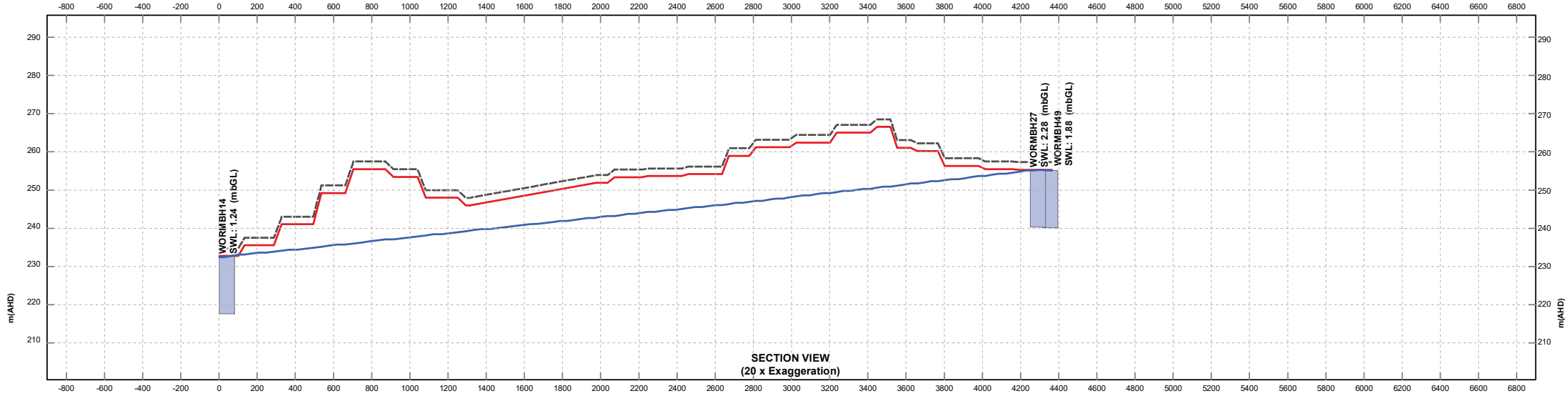
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Map Projection: Transverse Mercator
Horizontal Datum: GDA2020, Grid: GDA2020 MGA Zone 55

Legend for Plan View

- Bore locations
- Section 1
- Section 2
- Section 3
- Section 4
- Section 5

Indicative groundwater depths (based on bores shown)

- Within 2m
- 2 - 5m
- 5m or deeper

Legend for Section View

- Existing surface
- 2m below existing surface
- Top of groundwater (infered)

GL RL (mAHD) : Ground level reduced level (m Australian Height Datum)
SWL (mbGL): Standing Water Level (metres below ground level)

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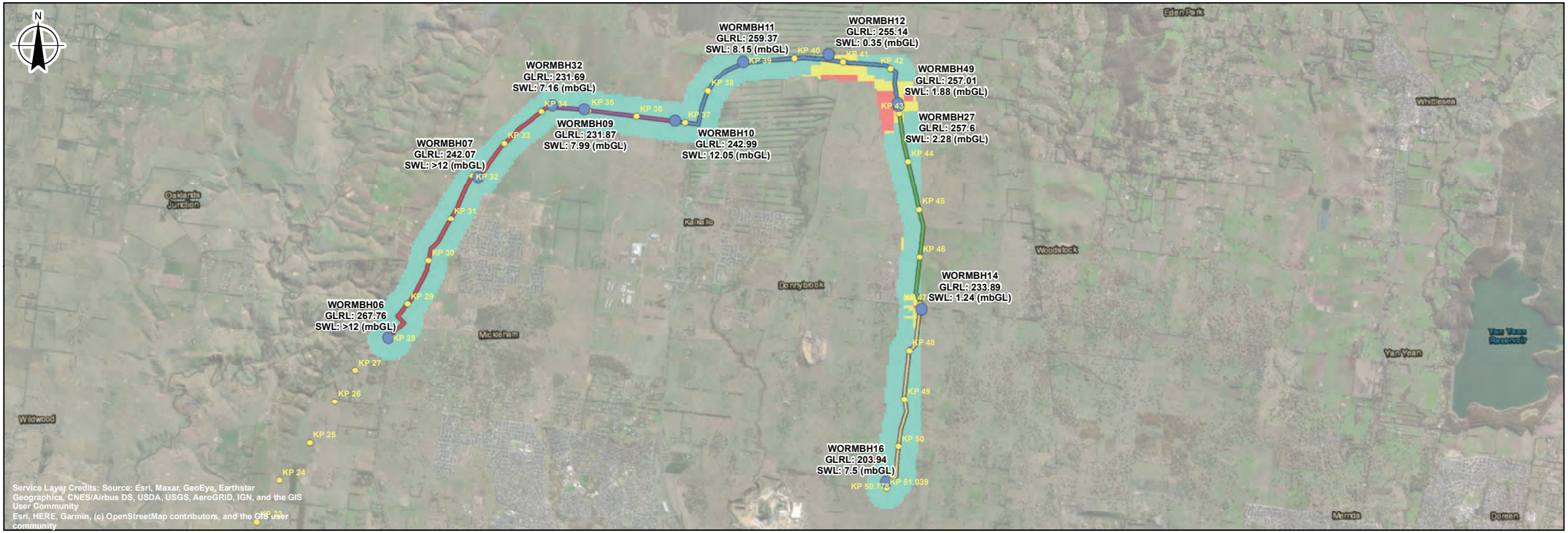
Interpreted Depth to Groundwater from Observation Bore Data: Cross Section 4 - WORMBH14 to WORMBH49

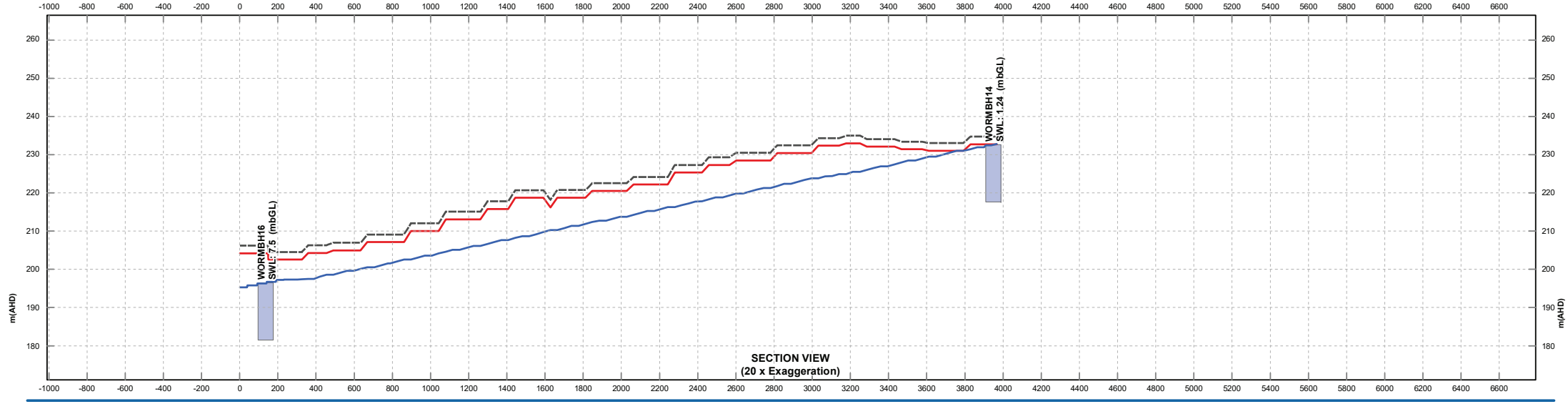
Figure 30

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Legend for Plan View
- Bore locations
- Section 1
- Section 2
- Section 3
- Section 4
- Section 5

Indicative groundwater depths (based on bores shown)
- Within 2m
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- 5m or deeper

Legend for Section View
- Existing surface
- 2m below existing surface
- Top of groundwater (infered)

GL RL (mAHD) : Ground level reduced level (m Australian Height Datum)
SWL (mbGL): Standing Water Level (metres below ground level)

APA Group
WORM EES

Job Number	12529997
Revision	A
Date	18 Jan 2021

Interpreted Depth to Groundwater from Observation Bore Data: Cross Section 5 - WORMBH16 to WORMBH14

Figure 31

\\ghdnet\ghd\AU\Melbourne\Projects\31\12529997\GIS\Maps\Deliverables\SECTION 5\12529997_XS_SECTION 5_rep.mxd

© 2021. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: DSE: Vicmap - Jan 2013, DSE: SAFE - 2012. Created by:apmiller

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7.2.4 Creek cross sections – groundwater levels

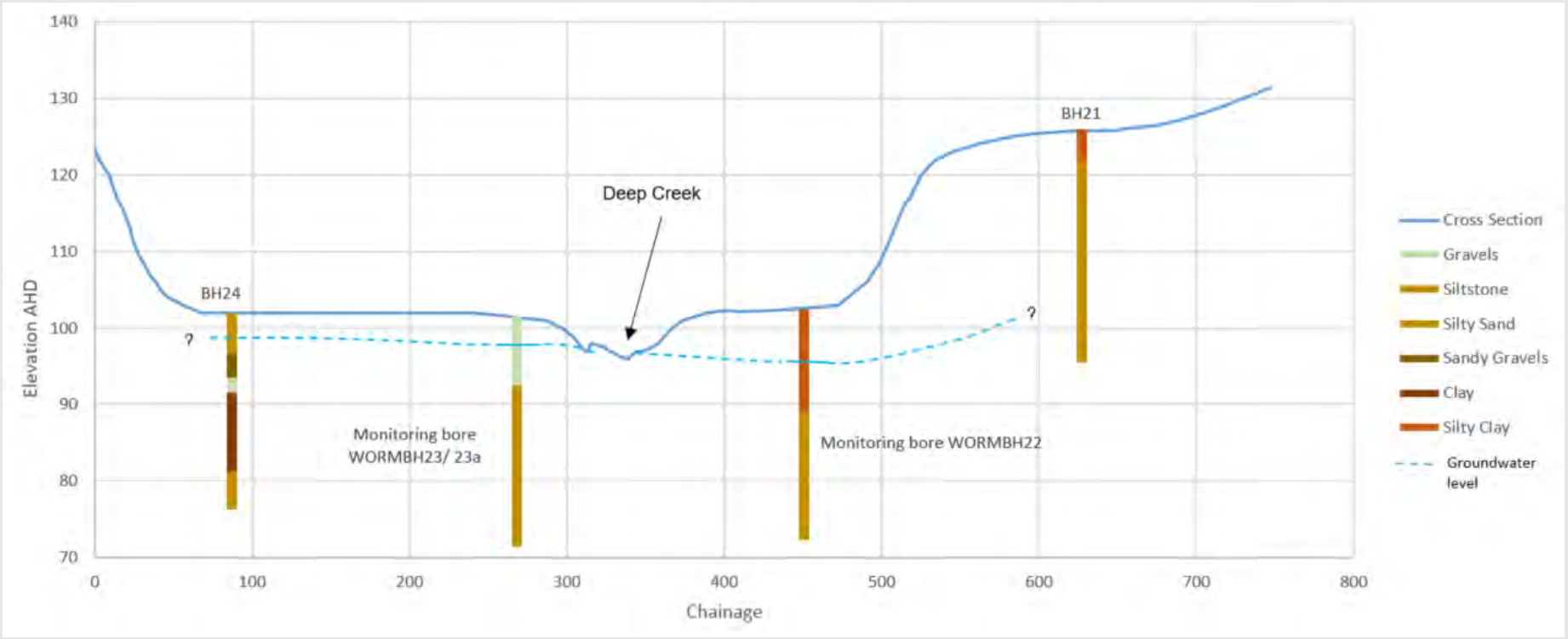
Monitoring bore installation has occurred at Deep, Jacksons and Merri Creeks with two further bores installed adjacent Gunns Gully Road. Based on the groundwater level data collected from the monitoring bores, sections from each of the locations noted above have been presented in Figure 32, along with interpreted groundwater levels.

The sections indicated that generally groundwater levels are close to the creek bed level, and are indicative that there may be groundwater discharge (i.e. baseflow) to the creeks during some periods of the year. They also indicate that the groundwater depth is shallow near the creeks. APA propose to trench across both Jacksons and Merri Creeks. Groundwater levels at these creeks are shallow and indicate that such open trench construction is likely to intersect groundwater. The level of dewatering required has been estimated, based on these sections, in Table 25.

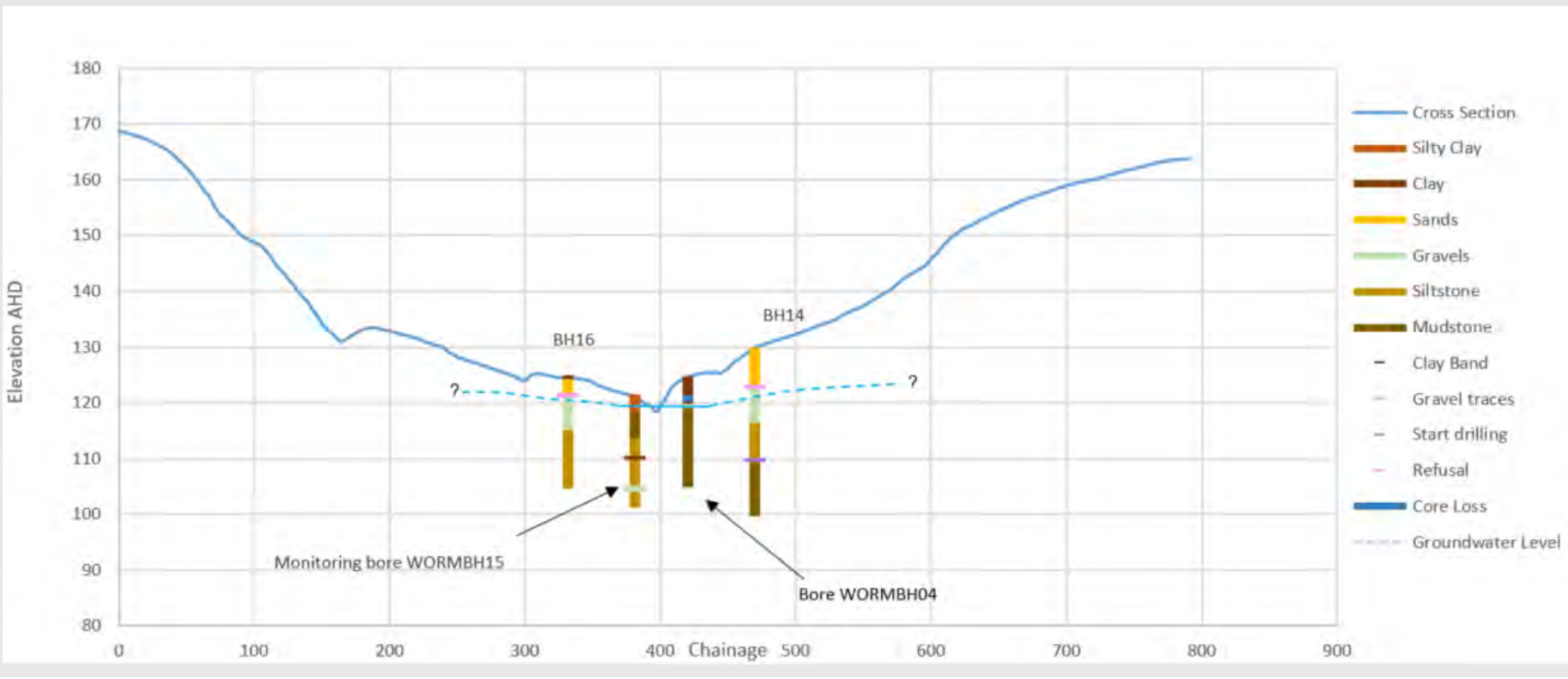
Groundwater levels are also shown for Deep Creek however it is noted that APA propose to undertake HDD under this creek rather than open trench construction through the creek. Groundwater levels observed in bores along Gunns Gully Road indicate that the depth to groundwater is between approximately 7 m and 8 m at the western end and approximately 10 m at the eastern near the Hume Freeway.

In addition, as part of the surface water studies detailed assessment of the creek conditions at the crossings were completed (EES Technical Report B Surface water), with key relevant information summarised below

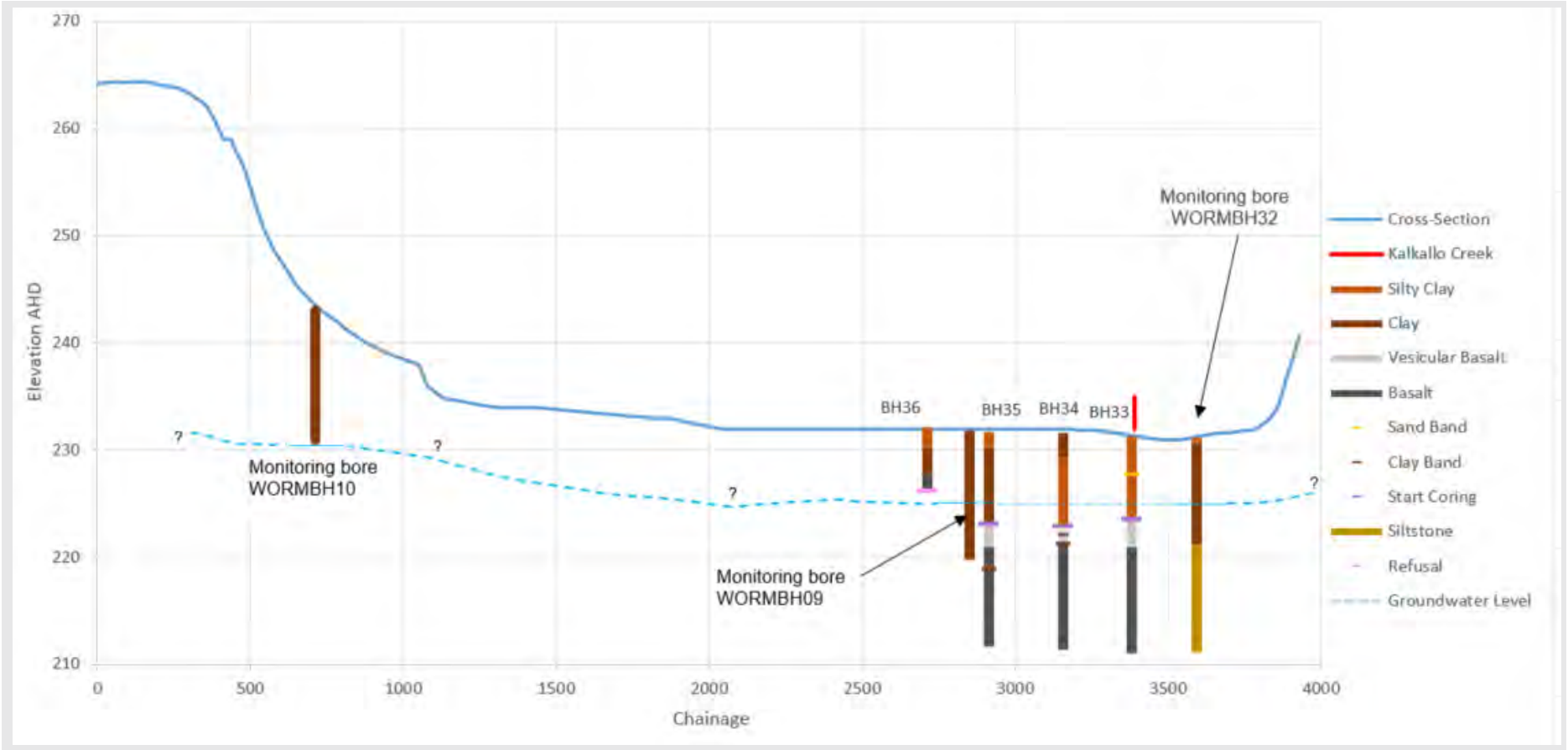
- **Merri Creek**
  - From observed conditions, Merri Creek has ephemeral flows that are generally contained within the channel. Larger rainfall events will cause flows to spread out across the northern floodplain.
  - The soil profile consists of a shallow (~2 m) layer of clay before reaching basalt which continued until the drilling was terminated
- **Jacksons Creek**
  - From observed conditions Jacksons Creek is a fast-flowing stream, with some observed bed and bank instability (i.e. presence of a graded rock structure and some local bank erosion near upstream meander)
  - Streamflow data on Jacksons Creek was obtained at Sunbury gauging station, located 12 km upstream of the site of the crossing. This indicated that the stream was perennial with mean annual flows of 100 L/sec and mean summer/ autumn flows of 60 L/sec.


140
130
120
110
100
90
80
70
Elevation AHD
0
100
200
300
400
500
600
700
800
Chainage
BH24
?
Deep Creek
Monitoring bore
WORMBH23/ 23a
Monitoring bore WORMBH22
BH21
?
Cross Section
Gravels
Siltstone
Silty Sand
Sandy Gravels
Clay
Silty Clay
Groundwater level

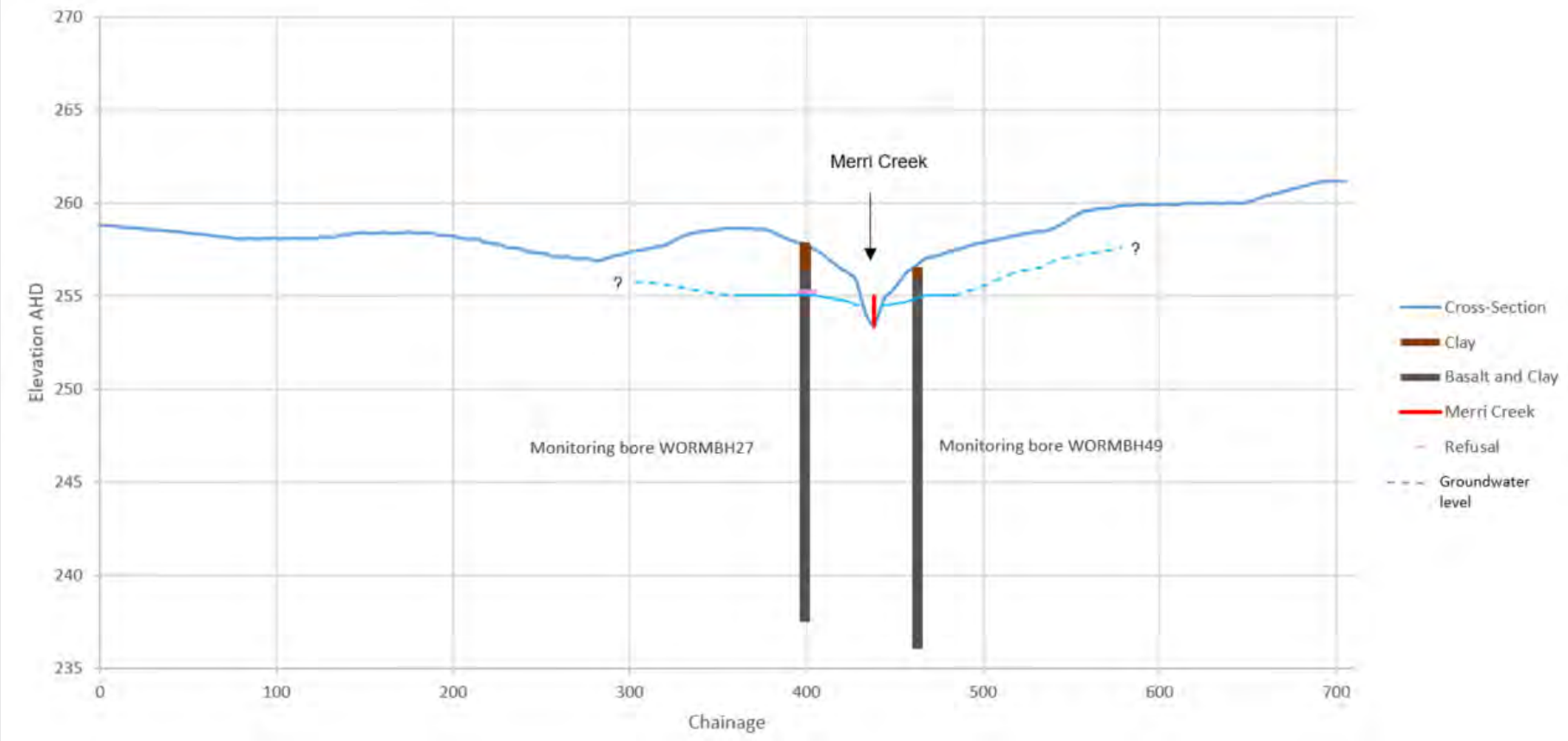
Deep Creek



Jacksons Creek



Gunns Gully Road (Kalkalo Creek)



Merri Creek

Figure 32 Cross sections – Deep, Jacksons, Kalkallo and Merri Creeks

7.3 Groundwater quality

The following sections provide a summary of the groundwater quality along the alignment, based on the sampling completed during this investigation. The reader, however, is also referred to the EES Technical Report E Contamination for a discussion on groundwater quality near identified potential sources of contamination.

7.3.1 Groundwater salinity

The groundwater salinity from the monitoring bores has been reported from 910 mg/L to 7,360 mg/L TDS, i.e. Segment A2 to Segment E of the SEPP (Waters). A summary of the groundwater salinity from the Project monitoring bores has been presented in Table 27 and Figure 33, along with the regional groundwater salinity for comparison. The monitoring bores in Table 27 have been listed geographically, i.e. from KP1 to KP50.

In most cases the groundwater salinity from the monitoring bores is consistent, or reasonably consistent, with the regional groundwater salinity interpretation. Notable exceptions include bores WORMBH09 and WORMBH32, located adjacent Gunns Gully Road. Salinity from these bores (between approximately 5,000 mg/L and 7,300 mg/L TDS) is higher than the regional groundwater salinity interpretation of 1,000 mg/L to 3,500 mg/L TDS.

As noted earlier, the drilling completed to date has been largely confined to major features, e.g. road, creek and rail crossings. As such, in the absence of additional site specific data, the regional interpretation of groundwater salinity should be used outside these areas. Where there was insufficient groundwater for sampling to occur, the regional interpretation of groundwater salinity has been included in Table 27.

In the areas of groundwater interaction (refer Section 7.3.3), the site specific salinity information indicates the groundwater falls within Segment A2, B and C. Regional salinity information from area one (refer Table 29) indicates higher salinity groundwater (Segment D) may be present.

The groundwater has been classified into Segments A2 and C for comparison against primary water quality indicators (refer Section 4.5).

7.3.2 Other analytes

A summary of the laboratory results for the remaining parameters has been included in Table 28.

The following comments are made regarding the groundwater quality:

- The salinity from the majority of the bores exceeds the ANZECC (2000) irrigation requirements (long term for moderately tolerant crops), Although it is noted that this is a guide and a number of factors need to be considered for irrigation use including the duration, crop/vegetation type and soil type
- Elevation concentrations of ammonia (as N) have been reported from bores located near Deep and Jacksons Creeks
- Elevated concentrations of total nitrogen have been reported from bores located near Deep and Jacksons Creeks, as well adjacent Gunns Gully Road
- Elevated concentrations of total phosphorus have been reported several bores along the alignment. The highest concentrations were recorded from bores located near Jacksons Creek, as well as adjacent Gunns Gully Road
- Low concentrations of arsenic were reported from all bores in March 2020. When the bores were sampled in August and September 2020, arsenic was not detected above laboratory limits of reporting

- Low concentrations of chromium, copper, nickel and zinc have been detected in all bores
- Where sampled, E.Coli has not been reported above laboratory limits of reporting
- Where sampled (refer Table 24), concentrations of TPH, OCPs, PCBs, MAH, SVOCs and VOCs were not reported above laboratory limits of reporting
- Sampling for PFAS was completed from bores WORMBH15, WORMBH22 and WORMBH23a. Concentrations of PFAS in these bores were not detected above laboratory limits of reporting

As noted above, concentrations of ammonia (as N), total nitrogen and total phosphorus, above relevant ANZG (2018) and/or SEPP (Waters) criteria may preclude groundwater disposal to the environment, e.g. waterway (if required). Additional assessment would need to be undertaken prior to any such disposal, e.g. understanding of water quality in receiving waterway, volumes to be disposed, etc.

In addition, the groundwater salinity in many bores exceeds the ANZECC (2000) criteria for long term irrigation, however the disposal of groundwater to land from dewatering during construction would need to be assessed on a site by site basis (i.e. refer Table 29, where the salinity in the last 10 km of the pipeline route is more likely to be suitable for irrigation).

7.3.3 Water quality in interaction areas

Table 29 summarises groundwater the groundwater quality in the interpreted interaction locations. Where site specific data is available from monitoring bores, this has been used in Table 29. Regional groundwater salinity information has been used in the absence of monitoring bore information.

Table 27 Summary of monitoring bore groundwater salinity

Bore ID	Bore location	Bore depth (m)	Screen interval (m)	Screen geology	Groundwater salinity (mg/L TDS)	Groundwater segment	Regional groundwater salinity (mg/L TDS)	Comment
WORMBH01	Duha	10	7-10	Basalt		-	13,000 - 35,000	Not sampled - insufficient water
WORMBH03	South of Bulla – Diggers Rest road.	21	15-21	Basalt		-	3,500 - 7,000	Not sampled - insufficient water
WORMBH04	Jacksons Creek	21	17-20	Mudstone	3,150	C	3,500 - 7,000	Salinity slightly lower than regional interpretation
WORMBH15	Jacksons Creek	20	17-20	Siltstone	4820	C	3,500 - 7,000	Salinity consistent with regional interpretation
WORMBH22	Deep Creek	30	27-30	Siltstone	3,710 and 3,960	C	1,000 - 3,500	Salinity slightly higher than regional interpretation
WORMBH23	Deep Creek	30	27-30	Mudstone	4,200	C	1,000 - 3,500	Salinity slightly higher than regional interpretation
WORMBH23a	Deep Creek	25	22-25	Silty clay and mudstone	3,560	C	1,000 - 3,500	Salinity consistent with regional interpretation
WORMBH05	Craigieburn Rd	20	17-20	Basalt	-	-	3,500 - 7,000	Not sampled - insufficient water
WORMBH06	Mickleham Rd	12	9-12	Basalt	-	-	3,500 - 7,000	Not sampled - insufficient water
WORMBH07	Ascotown	12	9-12	Sandy clay	-	-	3,500 - 7,000	Not sampled - insufficient water
WORMBH32	Gunns Gully Road	20	17-20	Siltstone/ sandstone	5,060 and 7,360	C and D	1,000 - 3,500	Salinity higher than regional interpretation
WORMBH09	Gunns Gully Road	12	9-12	Clay	5300	C	1,000 - 3,500	Salinity higher than regional interpretation
WORMBH10	Gunns Gully Road	12	9-12	Clay	-	-	1,000 - 3,500	Not sampled - insufficient water

Bore ID	Bore location	Bore depth (m)	Screen interval (m)	Screen geology	Groundwater salinity (mg/L TDS)	Groundwater segment	Regional groundwater salinity (mg/L TDS)	Comment
WORMBH11	South of Donavons Lane	10.1	7.1 - 10.1	Clay	1920	B	1,000 - 3,500	Salinity consistent with regional interpretation
WORMBH12	Donavons Lane	6.1	3-6	Basalt	3790	C	1,000 - 3,500	Salinity slightly higher than regional interpretation
WORMBH27	Merri Creek	20.4	17.4 - 20.4	Basalt	910	A2	1,000 - 3,500	Salinity consistent with regional interpretation
WORMBH49	Merri Creek	20.5	17.5 - 20.5	Basalt	1600	B	1,000 - 3,500	Salinity consistent with regional interpretation
WORMBH14	Donnybrook Rd	10	7-10	Basalt	1300	B	1,000 - 3,500	Salinity consistent with regional interpretation
WORMBH16	Wollert Compressor Station	10	7-10	Basalt	1180	A2	1,000 - 3,500	Salinity consistent with regional interpretation

Notes:

Bore WORM04 was a temporary monitoring bore

Bores WORMBH22 and WORMBH32 sampled twice during 2020. Remaining bores sampled once in 2020

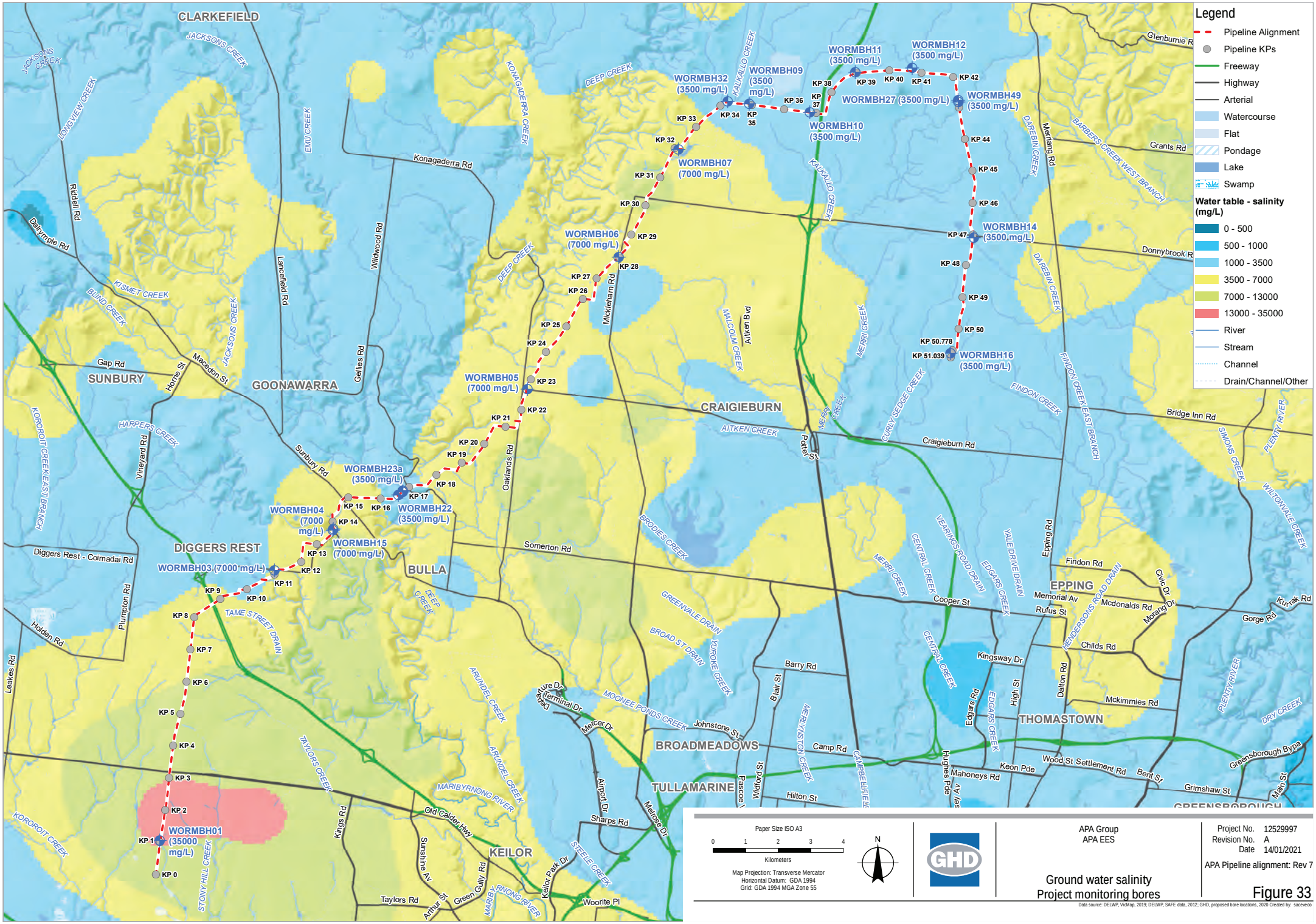

Legend
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Arterial
Watercourse
Flat
Pondage
Lake
Swamp
Water table - salinity (mg/L)
0 - 500
500 - 1000
1000 - 3500
3500 - 7000
7000 - 13000
13000 - 35000
River
Stream
Channel
Drain/Channel/Other
CLARKEFIELD
SUNBURY
GOONAWARRA
CRAIGIEBURN
DIGGERS REST
BULLA
EPPING
THOMASTOWN
BROADMEADOWS
TULLAMARINE
KEILOR
GREENSBOROUGH
WORMBH01 (35000 mg/L)
WORMBH03 (7000 mg/L)
WORMBH04 (7000 mg/L)
WORMBH05 (7000 mg/L)
WORMBH06 (7000 mg/L)
WORMBH07 (7000 mg/L)
WORMBH09 (3500 mg/L)
WORMBH10 (3500 mg/L)
WORMBH11 (3500 mg/L)
WORMBH12 (3500 mg/L)
WORMBH14 (3500 mg/L)
WORMBH15 (7000 mg/L)
WORMBH16 (3500 mg/L)
WORMBH22 (3500 mg/L)
WORMBH23a (3500 mg/L)
WORMBH27 (3500 mg/L)
WORMBH32 (3500 mg/L)
WORMBH49 (3500 mg/L)
Paper Size ISO A3
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Ground water salinity
Project monitoring bores
Project No. 12529997
Revision No. A
Date 14/01/2021
APA Pipeline alignment: Rev 7
Figure 33
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations, 2020 Created by: sacevedo

Table 28 Summary of laboratory analysis

Analyte	Concentrations	Exceedences		
		ANZG (2018)	SEPP Waters	Other
Electrical Conductivity (EC)	1,400 µS/cm to 12,500 µS/cm	-	-	Groundwater EC from the majority of the bores exceeds the ANZECC (2000) irrigation requirements (long term). Bores: WORMBH04, WORMBH09, WORMBH11 WORMBH12, WORMBH15, WORMBH22, WORMBH23, WORMBH23a and WORMBH32
Salinity (TDS)	910 mg/L to 7,360 mg/L TDS	-	-	The groundwater salinity from the majority of the bores exceeds the Australian Drinking Water Guideline limit for potable water - acceptable (600 mg/L to 1,200 mg/L TDS). Bores WORMBH09 and WORMBH32 reported groundwater salinity in excess of the ANZECC (2000) stock watering requirements
Sulfate	7 mg/L to 641 mg/L	-	-	Concentrations of sulfate in several bores exceeds the Australian Drinking Water Guideline limit for potable water - acceptable (250 mg/L). WORMBH09 (312 mg/L) WORMBH22 (446 mg/L) WORMBH23 (286 mg/L) WORMBH23a (386 mg/L) WORMBH32 (453 mg/L and 641 mg/L)

Analyte	Concentrations	Exceedences		
		ANZG (2018)	SEPP Waters	Other
Ammonia (as N)	Elevated concentration reported from bores: WORMBH04 (1.4 mg/L) WORMBH15 (1.6 mg/L) WORMBH23 (0.9 mg/L) WORMBH23 (0.41 mg/L) WORMBH32 (0.33 mg/L)	Concentrations exceed the ANZG (2018) guideline limits for 95 % protection of aquatic (freshwater) ecosystems	No SEPP guideline criteria	-
Arsenic	Arsenic was detected in all bores at low concentrations in March 2020, from 0.001 mg/L to 0.018 mg/L. Where sampled, arsenic was not detected above laboratory LOR in August and September 2020.	The concentration of 0.018 mg/L (bore WORMBH15 – Jacksons Creek) exceeded the ANZG (2018) guideline limits for 95 % protection of aquatic (freshwater) ecosystems.	The concentration of 0.018 mg/L exceeds the 95 % SEPP trigger for toxicants	-
Other metals	Low concentrations of chromium, copper, nickel and zinc have been detected in all bores.	Concentrations generally slightly exceed the ANZG (2018) guideline limits for 95 % protection of aquatic (freshwater) ecosystems.	These concentrations exceed the 95 % SEPP trigger for toxicants	-
Nitrogen – total	Elevated total nitrogen concentrations have been reported from selected bores: WORMBH23 (14.1 mg/L) WORMBH32 (15.1 mg/L) WORMBH04 (1.6 mg/L)	There is no ANZG (2018) guideline value for total nitrogen	These concentrations exceed the guideline concentration of 1,100 µg/L (1.1 mg/L)	-

Analyte	Concentrations	Exceedences		
		ANZG (2018)	SEPP Waters	Other
	WORMBH09 (1.1 mg/L) WORMBH11 (1.8 mg/L) WORMBH15 (2.2 mg/L)			
Phosphorus – total	Elevated total phosphorus concentrations have been reported from selected bores: WORMBH23 (20.6 mg/L) WORMBH32 (6.07 mg/L) in March 2020. WORMBH09 (0.39 mg/L) WORMBH12 (0.14 mg/L) WORMBH14 (0.23 mg/L) WORMBH16 (1.13 mg/L) WORMBH49 (0.25 mg/L) Bore WORMBH23 has been replaced by bore WORMBH23a and concentrations in this bore were reported at 0.02 mg/L. Concentrations in bore WORMBH32 in August 2020 were reported at 0.03 mg/L.	There is no ANZG (2018) guideline value for total phosphorus	The SEPP (Waters) specifies a guideline concentration of 55 µg/L (0.055 mg/L). These elevated concentrations exceed this guideline concentration	These concentrations exceed the ANZECC (2000) irrigation requirements.

Analyte	Concentrations	Exceedences		
		ANZG (2018)	SEPP Waters	Other
Organics	Where sampled, concentrations of TPH, OCPs, PCBs, MAH, SVOCs and VOCs were not reported above laboratory LOR	None	-	None
E. Coli	Where sampled, concentrations were not reported above laboratory LOR	-	None	-
Note: LOR – Limit of Reporting SEPP (Waters) segment: Cleared Hills and Coastal Plains				

Table 29 Summary of water quality in groundwater interaction areas

Area	Approximate location	Interpreted aquifer	Bore data Depth to Groundwater (1) (mBGL) or regional	Groundwater salinity (mg/L TDS)	Groundwater segment	Project monitoring bores	Other parameters
1a	Bendigo Rail	Basalt	2 (assumed)	3,500 – 7,000	C and D	No monitoring bores - regional groundwater information only	-
1b	Unknown Creek/Tame St drain	Alluvial clay/basalt	2 (assumed)	3,500 – 7,000	C and D		-
2	Jacksons Creek	Mudstone/siltstone	5 - 1.68	3,150 – 4,820	C	WORMBH04, WORMBH15	Elevated concentrations of ammonia (as N) and arsenic. Various metals
3	Deep Creek	Mudstone	3 - 5.7	3,710 – 4,200	C	WORMBH22, WORMBH23, WORMBH23a	Elevated concentrations of ammonia (as N) and arsenic. Trace metals Elevated total nitrogen and phosphorus. Various metals
4a	Donovans Lane	Basalt	0.3	1920 – 3790	B	WORMBH11, WORMBH12	Elevated concentrations of various metals
4b	North east Rail reserve	Basalt	4	3,790	C	WORMBH12 Salinity from site investigations is slightly higher than regional interpretation	Elevated concentrations of various metals
5	Merri Creek	Basalt	2 - -2.3	910 – 1,600	A2 and B	WORMBH27 WORMBH49	Elevated concentrations of various metals
6	Donnybrook Rd	Basalt	1.24	1,300	B	WORMBH14	Elevated concentrations of various metals
Note: WCS – Wollert Compressor Station							

7.4 Slug test results

7.4.1 Rationale

Hydraulic conductivity is a measure of how quickly groundwater can flow through the sub-surface. It is higher in a porous aquifer such as sands, and lower in fine-grained clay dominant aquifers. If conductivity is very low, the unit is often referred to as an aquitard rather than an aquifer. The hydraulic conductivity information is a key input into calculating estimates of groundwater inflows to excavations and potential distance – drawdown impacts (refer Section 9.2.2 and Appendix M).

Slug testing was therefore completed on the monitoring bores in order to provide field estimates of hydraulic conductivity along the alignment.

7.4.2 Slug test summary

The slug test data were analysed using AQTESOLV, a commercial aquifer test software package (Duffield, 2007). The slug test data was analysed using the Bower Rice and Hvorslev methods. A summary of the slug test analysis results are presented in Table 30. The average of all results is approximately 0.03 m/day, with the maximum approximately 1 m/day and the minimum <0.01 m/day.

Table 30 Slug Test Results

Bore Id	Screened geology	Average hydraulic conductivity (m/day)		
		Bouwer-RIce	Hvorslev	Both methods
Historic monitoring bores				
WORMBH15	Siltstone	0.03	0.04	0.03
WORMBH22 (GHD, 2020a)	Siltstone	<0.01	0.03	0.02
WORMBH22 (this report)		0.01	0.01	0.01
WORMBH23	Mudstone	<0.01	0.01	0.01
WORMBH27	Basalt	0.1	0.05	0.06
WORMBH32 (GHD2020a)	Siltstone/Sandstone	<0.01	0.04	0.03
WORMBH32 (this report)		0.06	0.07	0.07
WORMBH49	Basalt	<0.01	0.01	0.01
New monitoring bores				
WORMBH04	Siltstone	<0.01	0.01	<0.01
WORMBH09	Clay	0.6	0.7	0.65
WORMBH12	Basalt	1	1.1	1.1
WORMBH14	Basalt	<0.05	<0.05	<0.05
WORMBH23a	Silty clay and mudstone	<0.01	<0.01	<0.01

Bore Id	Screened geology	Average hydraulic conductivity (m/day)		
		Bouwer-RIce	Hvorslev	Both methods

Notes:

The average hydraulic conductivity is the average of all tests completed on the bore

Screened geology for historic monitoring bores and bore WORMBH23a as reported by CS

Bore WORMBH23 blocked and later decommissioned by CS. No additional slug testing on this bore. Slug testing completed on replacement bore WORMBH23a

Slug test for bore WORMBH04 completed from within temporary PVC casing

7.4.3 Hydraulic conductivity for each aquifer

A summary of the hydraulic conductivity for each aquifer has been presented in Table 31. This suggests that the bedrock aquifer has very low hydraulic conductivity, less than 0.1 m/day. Higher hydraulic conductivities, up to 1.1 m/day, have been reported from the basalt. The hydraulic conductivity for the Quaternary alluvials (bore WORMBH09, Gunns Gully Road) recorded an average of 0.6 m/day. Bore WORMBH09 was screened in clay material though it is noted that minor rock fragments were present at between approximately 9 m and 10 m depth, i.e. within the screened interval.

The field estimates of hydraulic conductivity have been compared to typical literature values, e.g. Domenic and Schwartz (1990) and the following comments are made:

- Literature values for siltstone suggest a hydraulic conductivity of less than 0.1 m/day. The hydraulic conductivity estimates for those bores screen in siltstone are consistent with this literature value.
- Literature values for basalt suggest a hydraulic conductivity of less than 0.1 m/day for an unfractured (massive) basalt. Where basalts are more permeable, e.g. through fracturing, presence of vesicles, etc., hydraulic conductivities can range from 0.1 m/day to more than 1,000 m/day. The hydraulic conductivity estimates for those bores screen in basalt fall at the lower end of these literature values.

Table 31 Summary of hydraulic conductivity by aquifer type

Aquifer/ geology	No. of bores	Hydraulic conductivity (m/ day)		
		Minimum	Maximum	Average
Basalt	Five	< 0.1	1.1	0.3
Bedrock (siltstone, sandstone, mudstone)	Six	< 0.01	0.1	0.02
Quaternary Alluvials	One	0.5	0.8	0.6

Notes:

Quaternary alluvials represented by bore WORMBH09 (screened in clay)

Bore WORMBH23a (silty clay and mudstone) included as bedrock

The hydraulic conductivity minimum, maximum and average values are for all tests completed on the bores

7.5 Summary of Acid Sulfate Soils

7.5.1 Regional interpretation

The regional ASS interpretation indicated that there is a low to extremely low probability of ASS occurring at the site (refer Section 6.14). Section 6.14 however notes that the mapping is based on regional data, i.e. there may be potential to intersect unidentified ASS (or acidic soil) in soils close to features with permanent or regular inundation, e.g. creeks, wetlands, GDEs.

7.5.2 Results of site testing

GHD (2020) reported that whilst there were field indictors of ASS identified by Construction Science, the SPOCAS testing completed in selected samples did not identify net acidity above the EPA assessment criteria of 0.03 % S.

Limited additional ASS testing as part of more recent investigations identified one soil sample from a depth of 0.1 m at the net acidity EPA assessment criteria of 0.03 % S. This sample was taken from bore WORMBH09 adjacent Gunns Gully Road. Other soils samples collected did not report any net acidity.

The Contamination Assessment completed as part of this EES indicated:

- The results to date indicate that soils would not require treatment, however it was noted that the sample locations were widely spread
- At the time of the field investigations completed by Construction Sciences, the alluvial samples were dry to moist indicating they were above the water table. It was deemed possible that sulfides present may have already oxidised
- Where alluvial material is to be disturbed during construction below the water table, such as near the three major stream crossings, this may contain PASS
- The sampling completed to date has been based on drill locations from approximately 10 m to 240 m from the actual creek beds so material directly within and under the creek beds have not been directly assessed
  - Additional sampling may be required to be completed by the Contractor before construction, to inform spoil management planning

8. Risk Assessment

A risk assessment of Project activities was performed in accordance with the methodology described in Section 5.5.

The initial risk ratings considered an initial set of mitigation measures (where relevant), which are based on compliance with legislation and standard requirements that are typically incorporated into the delivery of infrastructure projects of similar type, scale and complexity. Risk ratings were applied to each of the identified risk pathways assuming that these mitigation measures were in place.

Where the initial risk ratings were categorised as medium or higher, these risks were a focus of the impact assessment and additional management measures were considered (where possible) as part of the impact assessment.

The assessment of the potential impacts associated with the identified risks during the construction and operation of the Project is presented in the following section of this report.

The risk register showing the risk pathways and findings of the risk assessment for groundwater is attached in Appendix C.

Nine construction risks were identified and assessed and three operation risks.

A summary of the risk assessment results is presented in Table 32.

Table 32 Risk results

Risk ID	Risk description	Construction/ operation	Pipeline/ MLV/ compressor	Initial risk rating	Final risk rating
GW1	**Drawdown impacts on groundwater users (ie registered bores.)** Construction dewatering impacts to groundwater levels which impacts bore yields	Construction	Pipeline	Low	Low
GW2	**Drawdown impacts on groundwater dependent ecosystems (GDEs) and receiving environments (i.e. river/wetland base flows).** Construction Dewatering impacts to groundwater levels/Flows at GDEs or receiving environments	Construction	Pipeline	Low	Low
GW3	**Drawdown activating ASS** Drawdown impacts exposes ASS - results in acid generation and quality impact down gradient users, GDEs and receiving environments	Construction	Pipeline	Low	Low

Risk ID	Risk description	Construction/ operation	Pipeline/ MLV/ compressor	Initial risk rating	Final risk rating
GW4	**Drawdown impacts causing settlement** Construction dewatering impacts to groundwater levels and groundwater pressure reduction causes settlement of the ground and impacts buildings/infrastructure	Construction	Pipeline	Negligible	Negligible
GW5	**Mobilisation of existing contaminated groundwater** Construction dewatering impacts to groundwater quality- Construction dewatering works cause mobilisation of existing contaminated groundwater which impact groundwater quality (beneficial use) and down gradient receptors (users/receiving environments- GDEs/rivers). Contaminated groundwater requires disposal without impacting beneficial use or human health	Construction	Pipeline	Low	Low
GW6	**Leaks or spills or runoff** Construction impacts to groundwater quality Construction activities such as an oil /fuel spill or poor quality surface water entering groundwater and impacting on groundwater quality and downgradient users/ receiving environments (GDEs/rivers**)**	Construction	All	Low	Low
GW7	**Drilling fluids used for HDD impacting groundwater quality** Drilling fluids/muds used for HDD sections impacting groundwater quality and beneficial use	Construction	Pipeline	Negligible	Negligible
GW8	**Disturbance and stockpiling of existing contaminated spoil** Construction activities such ASS soil or contaminated soil stockpiling, leaching and impacting on groundwater quality (beneficial use) and downgradient receptors -users/ receiving environments (GDEs/rivers).	Construction	All	Low	Low

Risk ID	Risk description	Construction/ operation	Pipeline/ MLV/ compressor	Initial risk rating	Final risk rating
GW9	**Impact to Groundwater flow paths and levels** Alignment of the pipeline and associated infrastructure in areas of shallow groundwater may disrupt or dislocate groundwater flow paths- which may cause preferential flow paths, mounding /drawdown, up gradient and downgradient . This may impact users, GDEs/receiving waters flows/levels, or cause water logging	Operation	Pipeline	Low	Low
GW10	**Impact to Groundwater quality** Alignment of the pipeline and associated infrastructure in areas of shallow groundwater may disrupt or dislocate groundwater flow paths- which may cause preferential flow paths and movement of contaminated groundwater. This may impact users, GDEs/receiving waters.	Operation	Pipeline	Low	Low
GW11	**Leaks or spills or runoff** Operation Impact to groundwater quality Maintenance work along the pipeline and associated infrastructure in areas of shallow groundwater has the potential for fuel/oils spills or other waste which has the potential to contaminated groundwater. This may impact users, GDEs/receiving waters.	Operation	All	Low	Low

9. Impact assessment

9.1 Summary of identified potential impacts

Construction and operation of the pipeline has the potential to alter groundwater levels and /or quality within the study area. As detailed in Table 32 (above), the Project could result in the following potential impacts to groundwater:

9.1.1 Construction Phase

9.1.1.1 Dewatering impacts

Dewatering trenches or bell holes during the construction phase, will result in groundwater drawdown. Groundwater drawdown may result in the following impacts:

- Interference with existing groundwater users (i.e. bores)
- Reduction in groundwater levels/flows at groundwater dependent ecosystems (GDEs) and/or receiving environments (i.e. river/wetland base flows)
- Exposure of ASS and acid generation, which may impact groundwater quality and impact down gradient users, GDEs and receiving environments
- Ground settlement, i.e. inducement of ground settlement near an excavation due to dewatering
- Contamination migration which may impact groundwater quality and impact down gradient users, GDEs and receiving environments

9.1.1.2 General impacts

- Construction impacts to groundwater quality associated with incidental contaminated runoff / spills and impacting on groundwater quality and down gradient users/ receiving environments (GDEs/rivers)
- Construction impacts to groundwater quality associated with activities such as ASS soil or contaminated soil stockpiling entering groundwater and impacting on groundwater quality (contamination migration) and down gradient users/ receiving environments (GDEs/rivers)
- Drilling fluids used for HDD crossings below the water table impacting on groundwater quality or beneficial use
- Physical disturbance of GDE's, where an open trench may go through or directly adjacent the GDE.

It is noted that dryland salinity was not considered a risk for this Project. Dryland salinity occurs where deep-rooted vegetation is removed, generally on a large scale, and replaced by shallow-rooted vegetation, resulting in additional groundwater recharge or reduced discharge, which causes the groundwater level to rise to the surface and mobilise any existing salts in the unsaturated zone. It generally occurs where groundwater levels are shallow (ie <3m). In this case, as detailed in Section 7.2.3 there are only limited areas where the groundwater level is less than 3m depth, being along the creek lines and an estimated 1 km section along Donovans Lane and where the pipe crosses Donnybrook road. In these areas, the deep rooted trees (River Red Gum) that could be potentially removed are limited. Refer to Section 10.1.1 of Technical report A Biodiversity and habitats for further detail on potential tree removal. Due to this small number of deep-rooted trees being removed, any change to the recharge or discharge processes of the aquifer system will be minimal, and well within natural variations. Dryland salinity is a significant risk where larger areas of deep-rooted vegetation are removed from recharge or discharge areas and significantly affect the aquifer water balance to such a degree

as to cause the water table to rise permanently. It is noted in general most of the deep-rooted trees along the pipeline route and surrounds have been previously/historically cleared for agricultural or urban development (i.e. around 75% of vegetation along the route is not native) and consequently, any impacts on groundwater levels. potentially leading to increased soil salinity, may have already occurred as a consequence of this historical large scale clearing.

9.1.2 Operational Phase

9.1.2.1 Pipeline or trench is below the groundwater level

Where the pipeline infrastructure is located below the groundwater table, the following impacts may occur:

- Alteration of local groundwater flow paths and levels. This may cause preferential flow paths, mounding /drawdown, up gradient and down gradient. This may impact users, GDEs/receiving waters, or cause water logging
- Alteration of local groundwater flow paths and levels. This may cause preferential flow paths and movement of contaminated groundwater which may impact users, GDEs/receiving waters, or cause water logging

9.1.2.2 General impacts

- Maintenance impacts to groundwater quality associated with incidental contaminated runoff / spills and impacting on groundwater quality and downgradient users/ receiving environments (GDEs/rivers)

9.2 Construction impacts

This section describes the impacts that have the potential to result in impacts to groundwater assets, values and uses from the construction of the Project.

9.2.1 Basis of impact assessment

There are six areas where the pipeline construction is expected to interact with groundwater as detailed in Table 25.

Based on the construction method proposed and local hydrogeological conditions, an estimated radius of groundwater drawdown influence and groundwater inflow rates associated with dewatering during the construction phase using analytical solutions for steady state flows has been determined. The steady state analytical model is based on equivalent area analysis assuming the excavation is modelled as a trench. Sichardts and Kusakin formulas (CIRIA, 2016) were used for estimation of the distance of drawdown influence from the trench.

The analytical technique relies on simplifying the aquifer system into a single layer, flat lying model, and therefore relies upon a number of assumptions. These are summarised in Appendix L.

9.2.2 Inflow and distance of drawdown influence estimates

The analytical model relies on a number of input parameters based on the local hydrogeological conditions (i.e. aquifer hydraulic conductivity) and construction method (i.e. length and width of excavation). The input parameters used for the analysis and the results for each of these areas have also been summarised in Appendix L.

9.2.3 Summary of inflow and distance of drawdown influence estimates

A summary of the estimate distance of drawdown influence and inflows during construction dewatering for each area is shown in Table 33. Tabulated results for each area have been included in Appendix M.

It is noted that during initial excavation that higher flow rates may be encountered than predicted under steady state conditions.

Groundwater recovery following dewatering

The time for groundwater recovery to occur after dewatering ceases, would be dependent on numerous factors, such as recharge events (i.e. rainfall), depth of the water table, connection with surface water features and the duration of the pumping. However, as a general guide, the majority of groundwater level recovery should occur over a similar duration to the extraction (dewatering) period (i.e. if 7 days extraction, then the majority of recovery would occur over the subsequent 7 days).

Table 33 Summary – Estimated inflows and distance of drawdown influence during construction dewatering along the project alignment

Area	Approximate location	Kp From	Kp To	Length of crossing/trench (m)	Type	Construction Method	Estimated construction drawdown required[2] (m)	Trench or excavation length assumed for dewatering [3] (m)	Interpreted aquifer	Estimated Inflow rate (L/sec)[1]	Estimated distance of drawdown influence (m) from the excavation[1]
1a	Bendigo Rail	8.288	8.326	38	Crossing	Bored	3	8	Basalt	0.5	25
1b	Unknown Creek/Tame St drain	8.406	8.411	5	Crossing	open trench construction	2	10	Alluvial clay/basalt	0.5	20
2	Jacksons Creek	13.863	13.898	35	Crossing	Open trench construction	5	50	Mudstone/siltstone /sand	2.9	40
3	Deep Creek	16.828	16.85	22	Crossing	HDD	0	HDD	Mudstone	N/A	N/A
4a	Donovans Lane	40	41	1000	Trench	Open trench construction	1.5	1000	Basalt	60	15
4b	North east Rail reserve	40.925	40.959	34	Crossing	Bored	1	16	Basalt	1.0	10
5	Merri Creek	42.639	42.655	16	Crossing	Open trench construction	5	50	Basalt	2.9	40
6	Donnybrook Rd	46.5	47.5	1000	Trench	open trench construction	1	1000	Basalt	60	10

Area	Approximate location	Kp From	Kp To	Length of crossing/trench (m)	Type	Construction Method	Estimated construction drawdown required[2] (m)	Trench or excavation length assumed for dewatering [3] (m)	Interpreted aquifer	Estimated Inflow rate (L/sec)[1]	Estimated distance of drawdown influence (m) from the excavation[1]

Notes

1. Maximum estimated from available data and construction assumptions, full trench length open.
2. Estimated from trench/excavation depth and groundwater level information (refer Table 25)
3. Length assumed for dewatering during construction

9.2.4 Risk ID GW1 Drawdown Impact on neighbouring groundwater users (bores)

Additional drawdown or lowering of the groundwater level in an existing extraction bore may impact the yield of the bore depending on the 'available drawdown' in the bore (i.e. the groundwater level above the pump), and the other factors such as the current extraction rate of the bore.

The predicted area of drawdown influence area is less than 50 m (i.e. Table 33) around the six identified areas, associated with groundwater extraction during the dewatering, has been overlain with the known existing groundwater bores. This is shown in Figure 34 to Figure 40 The assessment shows that drawdown interference with known existing users of groundwater is not anticipated during the construction phase. Therefore, the likelihood of impact to surrounding bores is considered remote.

The distance of drawdown influence predicted is generally very localised to the pipeline alignment, as the dewatering level required is generally < 2 m, and the aquifer testing has recorded relatively low hydraulic conductivity in the basalt aquifer (i.e. generally < 1 m/day). Furthermore, given the anticipated short duration (< 4 weeks) of dewatering activities at each location, the residual impacts to a surrounding bore (if present) is considered moderate (as per the consequence descriptors in Appendix C) .

Therefore, the risks of groundwater dewatering impacting neighbouring bores is concluded to be low.

Management and Mitigation

Construction methods will be used to minimise dewatering volumes and durations, which will minimise impacts on groundwater levels and flows (EMM GW1). These may include:

- Minimising the dewatering period. The anticipated period is expected to be four weeks at the creek crossings.
- Installation of trench breakers to minimise trench inflows

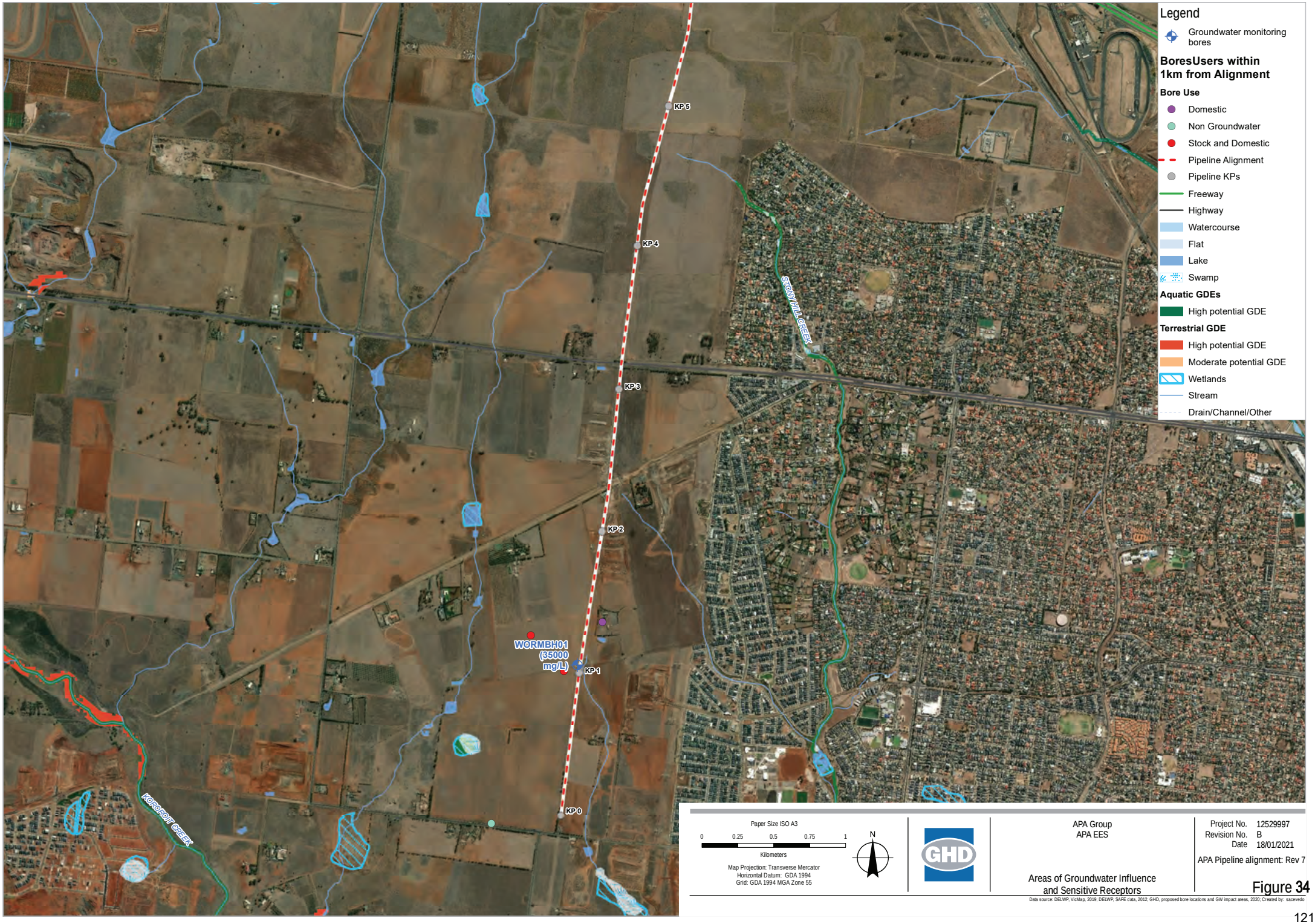
Although it is not anticipated that any neighbouring bore will be impacted by dewatering, it is possible there is unregistered bores nearby, or a slightly greater than predicted distance of drawdown influence occurs due to the variable nature of fractured rock aquifers. There is a registered bore located around 55m from an area of dewatering (at approximately KP 47.6), therefore neighbouring bores within 60 m of any area of dewatering will be identified and the following management measures (EMM GW2) will be undertaken:

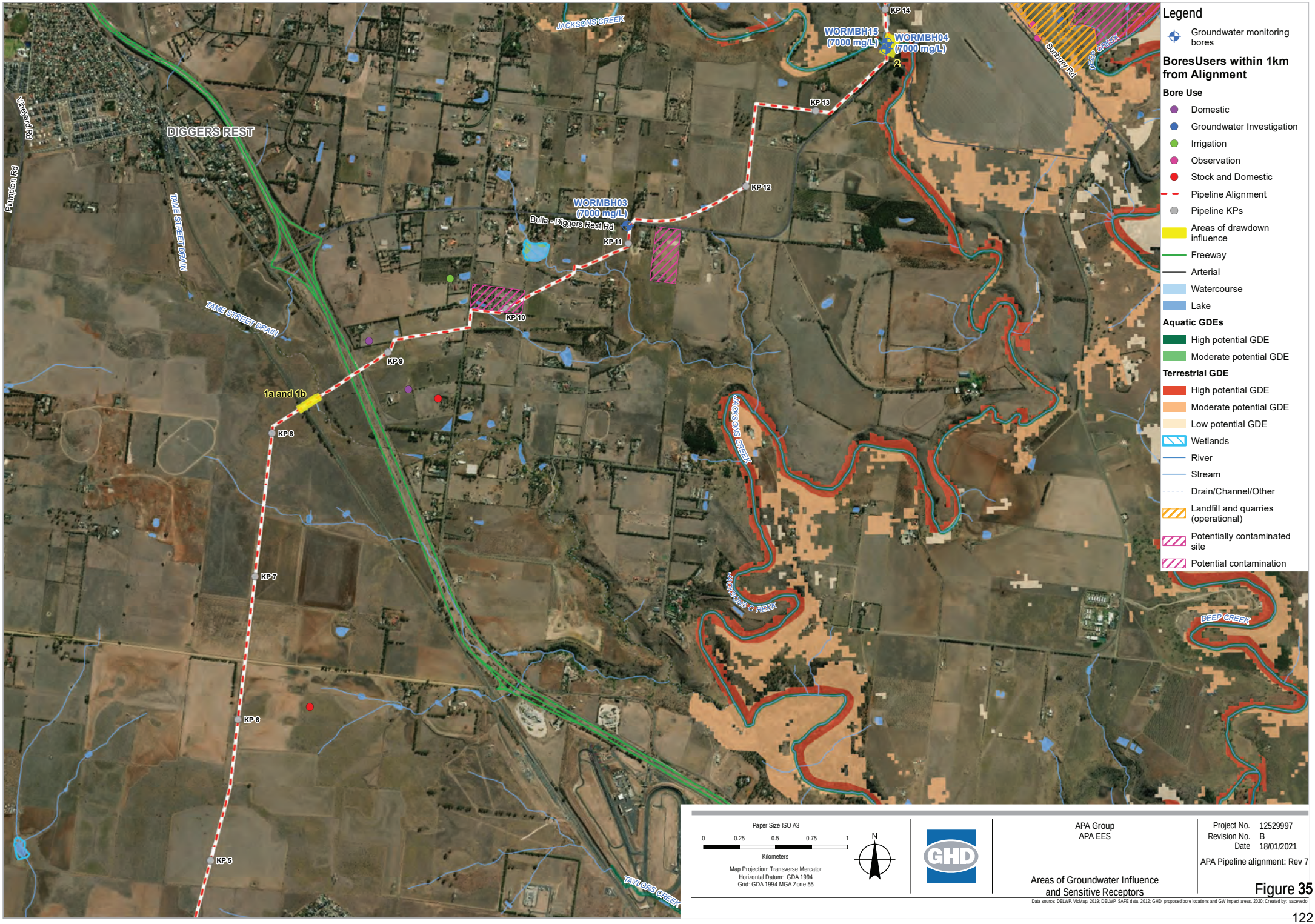
- The bore will be audited to check the current use, groundwater level, available drawdown, bore yield and quality (i.e. baseline performance)
- APA will provide alternative supply to the bore owner, if required

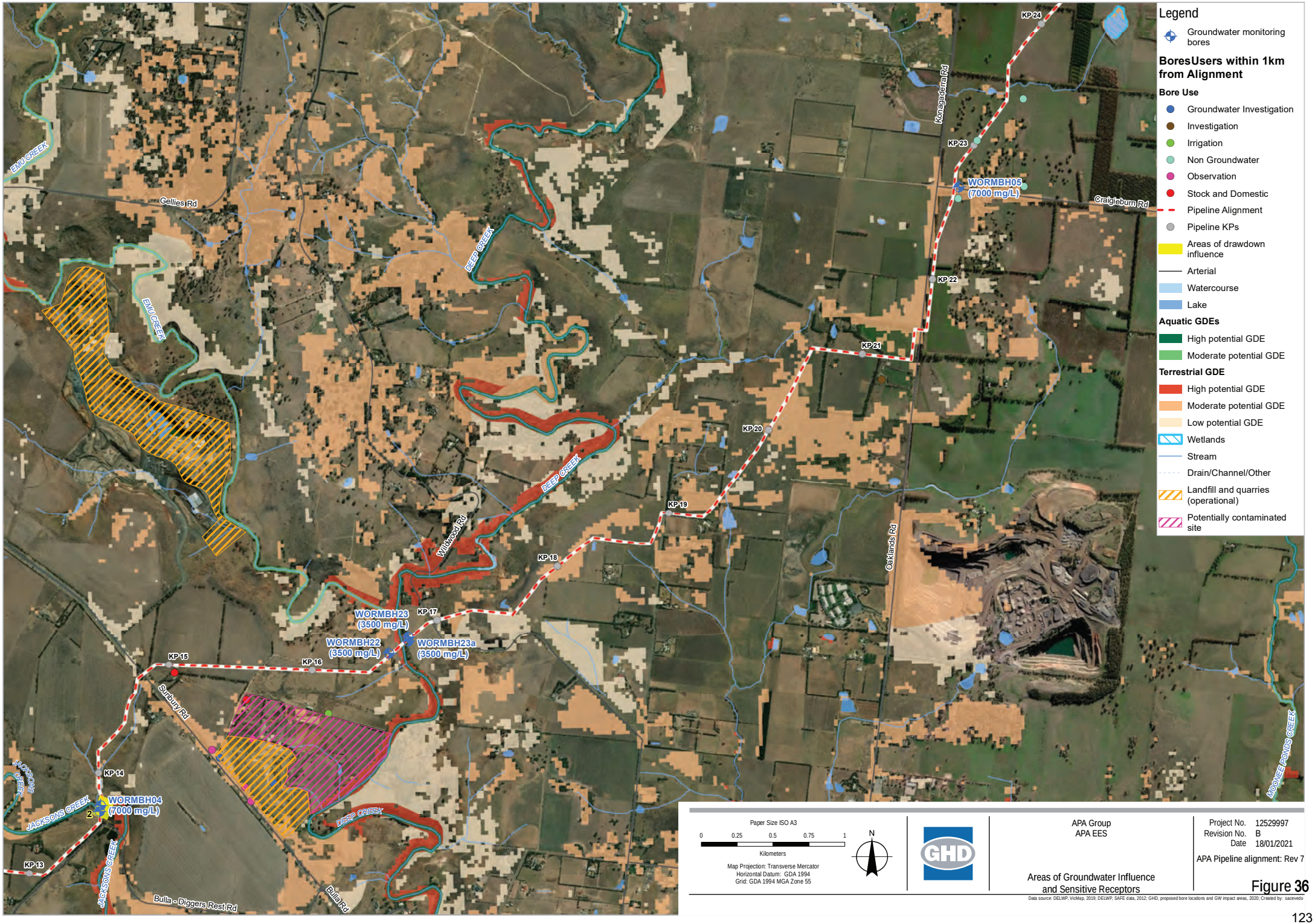
These management measures would be included within the Construction Environment Management Plan (CEMP).

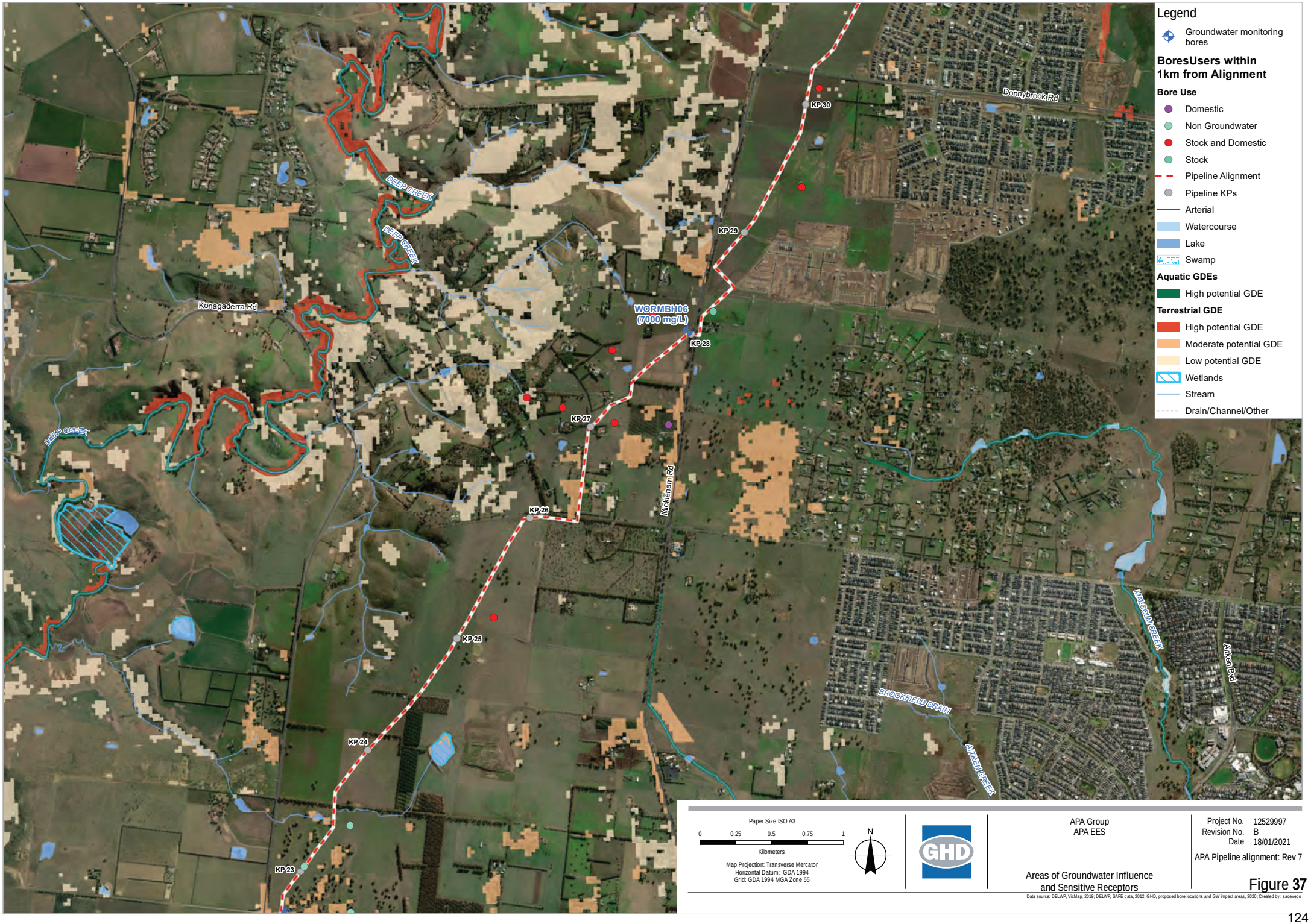
The application of the above management measures is considered to firstly achieve minimisation of the impact, followed by rehabilitation/restoration in the unlikely case any bore is impacted. Avoidance of impact is not considered to be practicably achievable for the open cut trench construction methodology which was selected based on the construction methodology development process as detailed in EES Chapter 3 Project development.

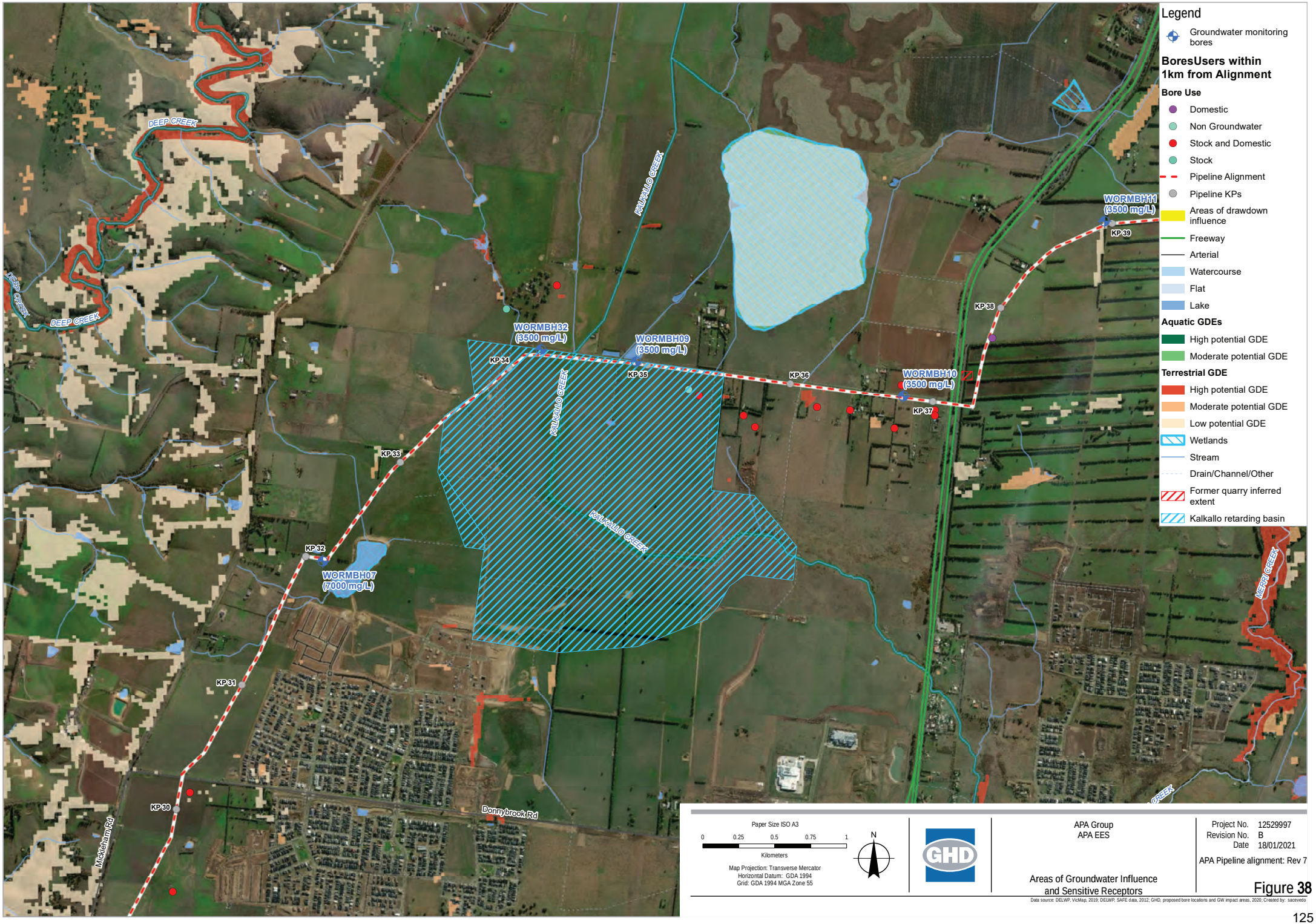
By applying the above management measures, the residual impacts of groundwater dewatering to neighbouring bore users is considered to remain low.

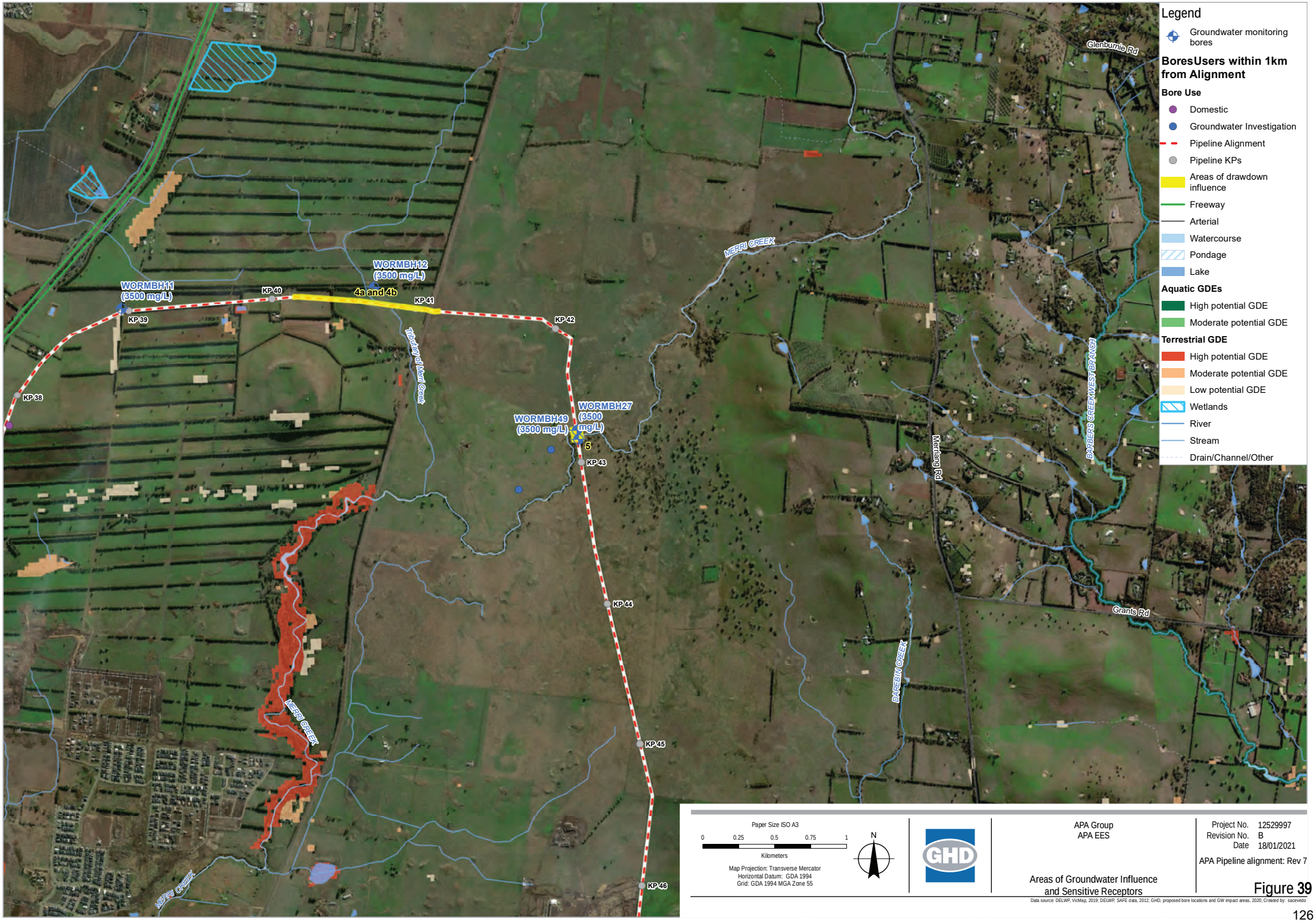

Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Domestic
Non Groundwater
Stock and Domestic
Pipeline Alignment
Pipeline KPs
Freeway
Highway
Watercourse
Flat
Lake
Swamp
Aquatic GDEs
High potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Wetlands
Stream
Drain/Channel/Other
KP 5
KP 4
KP 3
KP 2
KP 1
KP 0
STONY HILL CREEK
KOROROIT CREEK
WORMBH01 (35000 mg/L)
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
N
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 34
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo

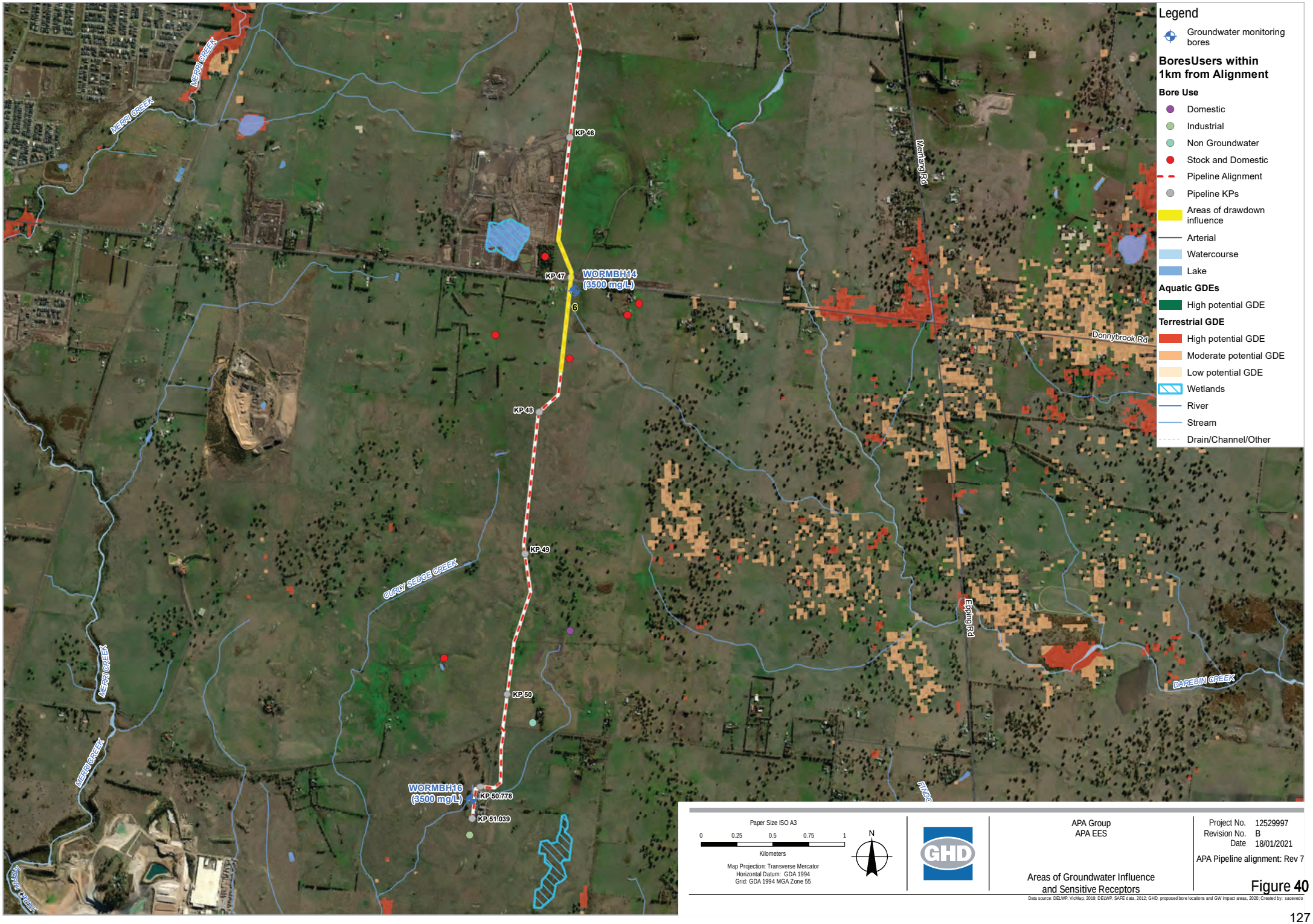

Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Domestic
Groundwater Investigation
Irrigation
Observation
Stock and Domestic
Pipeline Alignment
Pipeline KPs
Areas of drawdown influence
Freeway
Arterial
Watercourse
Lake
Aquatic GDEs
High potential GDE
Moderate potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
Wetlands
River
Stream
Drain/Channel/Other
Landfill and quarries (operational)
Potentially contaminated site
Potential contamination
DIGGERS REST
JACKSONS CREEK
TAME STREET DRAIN
Vineyard Rd
Plumpton Rd
Bulla - Diggers Rest Rd
Sunbury Rd
DEEP CREEK
TAYLORS CREEK
WORMBH15 (7000 mg/L)
WORMBH04 (7000 mg/L)
WORMBH03 (7000 mg/L)
KP 14
KP 13
KP 12
KP 11
KP 10
KP 9
KP 8
KP 7
KP 6
KP 5
1a and 1b
2
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 35
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo


Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Groundwater Investigation
Investigation
Irrigation
Non Groundwater
Observation
Stock and Domestic
Pipeline Alignment
Pipeline KPs
Areas of drawdown influence
Arterial
Watercourse
Lake
Aquatic GDEs
High potential GDE
Moderate potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
Wetlands
Stream
Drain/Channel/Other
Landfill and quarries (operational)
Potentially contaminated site
WORMBH05 (7000 mg/L)
WORMBH04 (7000 mg/L)
WORMBH23 (3500 mg/L)
WORMBH22 (3500 mg/L)
WORMBH23a (3500 mg/L)
KP 24
KP 23
KP 22
KP 21
KP 20
KP 19
KP 18
KP 17
KP 16
KP 15
KP 14
KP 13
Konagaderra Rd
Craigieburn Rd
Oaklands Rd
Wildwood Rd
Gellies Rd
Sunbury Rd
Bulla - Diggers Rest Rd
Bulla Rd
EMU CREEK
DEEP CREEK
JACKSONS CREEK
MOONEE PONDS CREEK
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 36
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo


Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Domestic
Non Groundwater
Stock and Domestic
Stock
Pipeline Alignment
Pipeline KPs
Arterial
Watercourse
Lake
Swamp
Aquatic GDEs
High potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
Wetlands
Stream
Drain/Channel/Other
Donnybrook Rd
KP 30
KP 29
KP 28
KP 27
KP 26
KP 25
KP 24
KP 23
DEEP CREEK
DEEP CREEK
DEEP CREEK
Konagaderra Rd
WORMBH06
(7000 mg/L)
Mickleham Rd
MALCOLM CREEK
Aitken Blvd
BROOKFIELD DRAIN
AITKEN CREEK
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 37
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo


Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Domestic
Non Groundwater
Stock and Domestic
Stock
Pipeline Alignment
Pipeline KPs
Areas of drawdown influence
Freeway
Arterial
Watercourse
Flat
Lake
Aquatic GDEs
High potential GDE
Moderate potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
Wetlands
Stream
Drain/Channel/Other
Former quarry inferred extent
Kalkallo retarding basin
DEEP CREEK
KALKALLO CREEK
MERRI CREEK
WORMBH32 (3500 mg/L)
WORMBH09 (3500 mg/L)
WORMBH10 (3500 mg/L)
WORMBH11 (3500 mg/L)
WORMBH07 (7000 mg/L)
KP 30
KP 31
KP 32
KP 33
KP 34
KP 35
KP 36
KP 37
KP 38
KP 39
Donnybrook Rd
Mickleham Rd
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 38
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo


Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Domestic
Groundwater Investigation
Pipeline Alignment
Pipeline KPs
Areas of drawdown influence
Freeway
Arterial
Watercourse
Pondage
Lake
Aquatic GDEs
High potential GDE
Moderate potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
Wetlands
River
Stream
Drain/Channel/Other
WORMBH11 (3500 mg/L)
WORMBH12 (3500 mg/L)
WORMBH27 (3500 mg/L)
WORMBH49 (3500 mg/L)
4a and 4b
5
KP 38
KP 39
KP 40
KP 41
KP 42
KP 43
KP 44
KP 45
KP 46
Tributary of Mud Creek
MERRI CREEK
Glenburnie Rd
Merrang Rd
BARRERS CREEK WEST BRANCH
BARRERN CREEK
Grants Rd
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 39
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo


Legend
Groundwater monitoring bores
BoresUsers within 1km from Alignment
Bore Use
Domestic
Industrial
Non Groundwater
Stock and Domestic
Pipeline Alignment
Pipeline KPs
Areas of drawdown influence
Arterial
Watercourse
Lake
Aquatic GDEs
High potential GDE
Terrestrial GDE
High potential GDE
Moderate potential GDE
Low potential GDE
Wetlands
River
Stream
Drain/Channel/Other
KP 46
KP 47
KP 48
KP 49
KP 50
KP 50.778
KP 51.039
WORMBH14 (3500 mg/L)
WORMBH16 (3500 mg/L)
MERRI CREEK
CURLY SEDGE CREEK
DAREBIN CREEK
Merlang Rd
Donnybrook Rd
Epping Rd
Paper Size ISO A3
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55
N
GHD
APA Group
APA EES
Areas of Groundwater Influence and Sensitive Receptors
Project No. 12529997
Revision No. B
Date 18/01/2021
APA Pipeline alignment: Rev 7
Figure 40
Data source: DELWP, VicMap, 2019; DELWP, SAFE data, 2012; GHD, proposed bore locations and GW impact areas, 2020; Created by: sacevedo

9.2.5 Risk ID GW2 Drawdown impacts on groundwater dependent ecosystems (GDEs) and receiving environments (i.e. river/wetland base flows)

GDEs are defined in 6.12.1 and there are a number of potential GDEs present along the pipeline alignment (refer Table 21). During construction dewatering, additional drawdown or lowering of the groundwater level near a GDE may cause a loss in groundwater availability that may impact the GDE health and function.

Similarly, wetlands or rivers may receive groundwater baseflow during certain times of the year which maintain surface water levels and flows. During construction dewatering, additional drawdown or lowering of the groundwater level near a wetland or river may impact the surface water levels or flows, which subsequently may impact local aquatic GDEs or downstream users /other receptors.

To assess the short-term impacts that may occur during the construction phase, the predicted area of drawdown influence area associated with groundwater extraction during the dewatering has been overlain with the GDEs, rivers and water bodies (refer in Figure 34 to Figure 40). As noted above, the predicted drawdown influence area is generally very localised, due to the aquifer hydraulic conductivity and the dewatering rates. The assets within the predicted area of influence are summarised in Table 34 .

The more significant assets with respect to potential groundwater impacts, are Jacksons Creek and Merri Creek, both being identified as potential aquatic GDE's and therefore expected to receive some groundwater baseflow in certain periods, which is supported by bore data.

It is noted that from observed conditions, Merri Creek at the crossing is ephemeral with no flow conditions expected during the drier periods of the year, while Jacksons Creek is a perennial system. At Merri Creek, although it is ephemeral, it is noted that in the upper reaches of Merri Creek, there is potential for the creek to contain pools that may act as drought refuges (EES Technical Report A Biodiversity and habitats). However, during the aquatic ecology field assessment there were no areas considered to contain refuge pools within the predicted area of drawdown influence (i.e. around 50 m) from the crossing, with the closest potential pool estimated to be around 100 m away.

The vegetation on the banks of Jacksons Creek is also identified as a potential terrestrial GDEs based on regional data (BOM). Site investigations recorded this vegetation to be Riparian Woodland, with the dominant species being River Red Gum.

EES Technical Report A Biodiversity and habitats (Section 9.1.7), also identifies the Riparian Woodland distributed along major waterways as potential GDEs.

Recognising the groundwater and surface water interactions in these areas, the impact of construction dewatering drawdown on these GDEs, is considered to be minor at worse considering:

- The drawdown extent and level is localised and minor
- The duration is short (< 4 weeks)
- Construction activities (i.e. coffer dams) through the rivers will be designed to minimise the degree of groundwater and surface water interaction (i.e. trench breakers) and therefore minimise the dewatering requirements

Local potential terrestrial GDEs are considered unlikely to be impacted by drawdown over this short period, unless a particularly dry period/drought, and the risks of dewatering impacting the terrestrial GDE's or the receiving environments is considered to be low. The River Red Gum of the Riparian Woodlands is sufficiently deep-rooted to withstand temporary and short-lived fluctuations in the water table. Understorey vegetation associated with Riparian Woodland consists of widespread and common species and are not considered to be groundwater dependent. Further discussion on these risks is in included in EES Technical Report A; Biodiversity and habitats, (Risk ID B10).

Any impact on total baseflow to these river systems, due to drawdown across these small stretches for the short period of time, would be difficult to detect and are expected to be within natural climatic variations. Consequently, any impact on surface water flows would be minor and within natural flow variations and therefore impacts on potential aquatic GDEs are also considered to be insignificant to minor. In addition, Merri Creek being an ephemeral system near the crossing dries out regularly, and therefore any fauna (i.e. fish, frogs, birds) associated with potential aquatic GDEs already require a degree of mobility under the existing conditions to survive in this region of the creek. The exception potentially being any persistent pool in Merri Creek that may receive groundwater baseflow to assist in maintaining the pool through the dry periods. As noted above, there has been no persistent pools identified within the predicted area of drawdown influence, so the impacts are considered insignificant to minor. However, it has been recommended (EES Technical Report A Biodiversity and habitats), as a conservative measure, to undertake a site survey during summer to further assess whether the potential refuge pool at around 100 metres away is actually persistent over the summer month or whether it dries out (which would provide further evidence that impacts will be minor).

Dewatering during the wetter months will further reduce the likelihood of impacts, however the creek crossing would likely be completed during the summer or autumn period, when surface water flows are low.

Further discussion on these risks is in included in EES Technical Report A Biodiversity report, (Risk ID B25)

Therefore the risks of groundwater dewatering impacting GDE's or the receiving environments is considered to be low.

Management and Mitigation

Construction methods will be used to minimise dewatering volumes and durations, which will minimise impacts on groundwater levels and flows. This includes minimising the connection between the surface water and groundwater systems. Trench breakers will be installed adjacent to watercourses and wetlands (EMM GW1).

In addition, where possible schedule the creek crossing works in early summer (i.e. December) or late Autumn (i.e. May) when terrestrial /aquatic GDEs are less likely to be stressed by dry conditions, recognising that the open trench construction works through the creeks would likely be completed during summer and autumn when there is low surface water flows for less disturbance in the creeks during the open trench construction works

By applying the above 'minimisation' management measures, the residual impacts of groundwater dewatering impacting GDE's or the receiving environments is considered to remain low.

Table 34 Surface water features and potential GDEs in areas of drawdown influence

Area	Approximate location	Kp From	Kp To	Estimated distance of influence (m) from the excavation(1)	Creek/River	Wetland	Potential Terrestrial GDE	Potential Aquatic GDE	Note
1a + b	Bendigo Rail Unknown Creek/Tame St drain	8.288	8.411	25	Tame St drain	None	None	None	
2	Jacksons Creek	13.863	13.898	45	Jacksons Creek	None	Yes	Jacksons Creek	Jacksons Creek assumed to receive some baseflow in some periods
3	Deep Creek	16.828	16.85	N/A	Deep Creek	N/A	N/A	N/A	HDD- no dewatering
4a +b	Donovans Lane North east Rail reserve	40	41	15	Merri Creek Tributary	None	None	None	Ephemeral
5	Merri Creek	42.639	42.655	40	Merri Creek	None	None	Merri Creek	Merri Creek assumed to receive some baseflow in some periods. Ephemeral.
6	Donnybrook Rd	46.5	47.5	10	Unnamed stream	None	None	None	Upstream end-ephemeral

9.2.6 Risk ID GW3 Drawdown impacts activating acid sulfate soils

Acid sulfate soils are defined in Section 6.14.1, and the desktop review based on regional data (ASRIS) indicated there was a low to extremely low probability of ASS occurring at the site (albeit with a very low confidence rating).

ASS testing completed along the alignment (18 samples) identified one soil sample from a depth of 0.1 m at the net acidity EPA assessment criteria of 0.03 % S. This sample was taken from bore WORMBH09 adjacent Gunns Gully Road at approximately KP35. Recorded groundwater levels indicate dewatering would not be required in this area. Other soils samples collected did not report any net acidity above EPA criteria, although it is recognised that further sampling of the saturated alluvial material near the three creek crossings may be required to assess these PASS areas.

Considering the regional and local data collected to date, and the areas where dewatering is expected to be required during construction, it is considered that the risk of acid sulfate activation is low.

The impacts associated with disturbance of potential or actual ASS are assessed separately in the EES Technical Report E Contamination.

Management and Mitigation

Construction methods will be used to minimise dewatering volumes and durations, which will minimise impacts on groundwater levels and flows (EMM GW1) and reduce the potential to activate ASS.

Other management measures associated with minimising the potential impacts associated with ASS are included in the EES Technical Report E Contamination, in particular EMM C3, which includes additional assessment of PASS at the creek crossings prior to construction.

By applying the above ‘minimisation’ management measures, the residual impacts of groundwater dewatering causing acid sulfate activation is considered to remain low.

9.2.7 Risk ID GW4 Ground Settlement

Lowering of the water table around the trench during dewatering could result in desaturation of currently saturated unconsolidated sediments. This effect could result in land subsidence at the ground surface, a process that results in a reduction in ground surface elevation at affected areas. This settlement could present a potential risk of damage to any buildings and other infrastructure in the area.

The potential for subsidence at any dewatering area will be a function of the amount of drawdown and resultant load increase on underlying soils, and the presence, thickness and compressibility of the soil strata below the water table.

The risk of damage to buildings and other infrastructure would be dependent on the amount of total and differential settlement that may occur, and the tolerance of structures to such differential movement.

The predicted drawdown and areas of influence were reviewed and the impacts/risk associated with settlement were assessed separately in the EES Technical Report D Land stability and ground movement.(Risk ID GM3) It was concluded that considering the limited area of the drawdown influence, the soil compressibility and infrastructure present, that the risks associated with settlement were negligible.

Management and Mitigation

Construction methods will be used to minimise dewatering volumes and durations, which will minimise impacts on groundwater levels and flows (EMM GW1) and reduce the potential for settlement. Other mitigation measures are presented in separately in the EES Technical Report D Land stability and ground movement include 'EMM GM1 (initial) - Third party asset management and EMM GM2 (initial) - Design and construction to be informed by geotechnical and hydrogeological conditions.

By applying the above ‘minimisation’ and ‘avoidance’ management measures, the residual impacts associated with settlement is considered to remain negligible.

9.2.8 Risk ID GW5 Mobilisation of existing contaminated groundwater

Construction dewatering works has the potential to cause mobilisation of existing contaminated groundwater within the drawdown cone towards the dewatering site, which may impact groundwater quality (beneficial use) and down gradient receptors (users/receiving environments - GDEs/rivers).

Potential existing contaminated groundwater from dewatering activities also requires disposal without impacting beneficial use or human health.

Groundwater disposal during dewatering will likely be required at the six areas identified. There are a number of short term groundwater disposal options that could be considered depending on volumes, groundwater quality and nearby infrastructure, including:

- Waterways; i.e. the nearest creek
- Land; Irrigation of private or public land
- Stock watering; i.e. storage in a dam for later use
- Sewer; if present nearby and trade waste agreement would be required
- Offsite; trucked offsite for use, treatment or disposal
- Aquifer recharge

Considering the general setting of the pipeline disposal to waterways or land irrigation are likely to be considered the favoured options for the Contractors.

As noted in Table 29, in some areas there may be some groundwater parameters of concern for disposal to waterways, including elevated concentrations of ammonia (as N), elevated total nitrogen, total phosphorus and various metals. The groundwater salinity is also likely to be too high for irrigation use in some areas, although this would need to be assess on a site by site basis (i.e. dependent on the soil and vegetation type, the duration, and the availability of other water to potentially shandy with the groundwater). The existing and future groundwater quality information will need to be considered by the Contractor when assessing the most appropriate disposal method at each location.

If discharge to waterways is considered, this is likely to require an assessment of the potential receiving environment for the groundwater and discussions with relevant regulatory authorities.

The six areas identified where dewatering may be required are > 750 m from any potential contaminated sites, or operational landfills/quarries as identified in the EES Technical Report E Contamination (and shown in in Figure 34 to Figure 40). The closest potentially contaminated site to an expected dewatering site, is the Jacksons Creek crossing which is 750 m south-west of a potentially contaminated site.

Based on the estimated dewatering drawdown influence zones (i.e. < 50 m), the likelihood of intersecting a significantly contaminated groundwater plume from a potential contaminated site, and migrating contaminates to the dewatering area, and subsequently impacting on the existing groundwater quality and protected beneficial use around the area is considered remote.

There is however, as noted above, groundwater quality in potential dewatering areas that exceed the relevant ANZG (2018) and/or SEPP (Waters) criteria for ecosystem protection currently and therefore the beneficial use of the groundwater is potentially already impacted by local background conditions and/or land use. It is also noted that additional groundwater analysis (i.e. EPA suite) should be completed at some of the dewatering areas (i.e. Jacksons Creek) to further assess the groundwater quality and further inform the environmental management measures and disposal options.

Overall the risk of mobilisation of contaminated groundwater is considered to be low, assuming standard management procedure, further establishment of baseline groundwater quality, and water disposal as per regulatory requirements.

Management and Mitigation

Construction methods will be used to minimise dewatering volumes and durations, which will minimise impacts on groundwater levels and flows (EMM GW1) and reduce the potential for mobilisation of any potentially groundwater contamination.

Extracted groundwater would be managed as follows (EMM GW3):

- Groundwater shall be disposed in accordance with the SEPP (Waters) and disposal as per EPA Guidelines and all relevant approvals process (dependent on final method/s)
- Groundwater from areas that have been identified as contaminated would not be discharged to the environment (land, waterways, sewer). However, the Contractor may engage with the local water authority to develop a trade waste agreement which would specify the levels of contamination to allow for sewer discharge
- Contaminated groundwater would either be treated onsite, depending on contaminant encountered (this may require approval from EPA Victoria) or disposed offsite to an EPA Victoria licensed facility. Alternatively, a construction approach may be adopted where contaminated groundwater is left in-situ (i.e. not abstracted or disturbed).

Baseline groundwater quality conditions should be established prior to the construction phase to allow suitable disposal options to be assessed and planned. This is underway in all expected interaction areas, except Area 1 (Bendigo Rail/Tame St Drain). Additional groundwater quality analysis should be completed in the existing bore network to confirm baseline conditions (EMM GW3). Including PFAS should be investigated at Jacksons Creek and Deep Creek so that any dewatering or HDD in those areas can be informed about the presence of PFAS to allow for appropriate disposal of the groundwater or HDD muds (EMM C4 :Contamination Report E).

Dewatering of excavated trenches/bellholes will be managed to minimise sedimentation, including the use of sediment control devices to remove suspended solids and dissipate flow . Sediment control devices would be listed in the CEMP.

By applying the above ‘avoidance’ and ‘minimisation’ management measures and undertaking some further baseline monitoring, the residual impacts of the potential mobilisation of contaminated groundwater is considered to remain low.

9.2.9 Risk ID GW6 Leaks or spills or runoff impacts to groundwater quality (construction phase)

There is a possibility that spills may occur during the refuelling of vehicles, plant and machinery or the use of chemicals required as part of the construction. In addition, poor quality surface water runoff into trenches or bell holes could impact groundwater quality

The likelihood of these events occurring is remote, and any consequence considered moderate under normal management procedures (i.e. low risk).

Management and Mitigation

The CEMP shall include requirements for management of chemicals, fuels and hazardous materials including (EMM GW4):

- Requirements as detailed in EMM C6 (Contamination Report E):
  - Minimise chemical and fuel storage on site and store hazardous materials and dangerous goods in accordance with the relevant guidelines and requirements
  - Comply with the Victorian WorkCover Authority and Australian Standard AS1940 Storage Handling of Flammable and Combustible Liquids and EPA Publication 1834 Civil construction, building and demolition guide (November 2020) and Publication 1698: Liquid storage and handling guidelines – EPA Victoria
  - Develop and implement management measures for dangerous substances, including:
    - Creating and maintaining a dangerous goods register
    - Disposing of any hazardous materials, including asbestos, in accordance with Industrial Waste Management Policies, regulation and relevant guidelines
    - Implementing requirements for the installation of bunds and precautions to reduce the risk of spills
  - Contingency and emergency response procedures to handle fuel and chemical spills, including availability of on-site hydrocarbon spill kits
  - The type and volume of liquid material (fuel, oil, lubricant) stored on-site for construction activities is to be limited to only that which is required
  - Liquid material would not be stored within 50 m of waterways
- The duration that trench sections and bell holes are open will be minimised, and surface water runoff will be diverted away from the excavations, to reduce the potential for poor quality runoff impacting groundwater

By applying the above avoidance' and 'minimisation' management measures, the residual impacts to groundwater quality associated with potential leaks, spills or runoff is considered to remain low.

9.2.10 Risk ID GW7 Drilling fluids used for HDD impacts groundwater quality

In areas where HDD will occur below the water table aquifer (i.e. Deep Creek) there is potential for the drilling fluids to interact with the aquifer system.

These drilling muds are designed to stabilise and seal the hole and therefore movement into the aquifer system will be very limited. In addition, the drilling muds used are generally inert and biodegradable as they are commonly used in the groundwater bore drilling industry.

After use the drilling muds are required to be disposed as per EPA regulatory requirements.

Therefore the risk of impacts associated with the drilling muds is considered negligible with appropriate management procedures.

Management and Mitigation

The CEMP shall include the selection of inert and biodegradable drilling fluids (EMM GW5).

Excess or recovered drilling fluids shall be disposed as per EPA regulatory requirements.

By applying the above 'minimise' management measures, the residual impacts to groundwater quality associated with drilling muds is considered to remain negligible.

9.2.11 Risk ID GW8 Disturbance and stockpiling of existing contaminated spoil

There is a possibility that where potentially contaminated or acid sulfate soils are stockpiled, that contaminated runoff could recharge the water table aquifer, potentially impacting on groundwater quality and down gradient users/ receiving environments (GDEs/rivers).

The likelihood of these events occurring is remote, and any consequence considered moderate under standard management procedures (refer below) (i.e. low risk).

Management and Mitigation

Spoil management procedures (EMM GW6) shall also be included in the CEMP including:

- Stockpile of trench spoil would be considered in accordance with EPA Publication 1834 Civil construction, building and demolition guide (November 2020).and EPA Publication 1895 Managing Stockpiles, 2020
- Where it is necessary to excavate contaminated soils, they will be stockpiled separately, with containment and treatment measures appropriate to the type of contamination present, and with measures to prevent contaminated runoff from stockpiles discharging to surface or groundwater systems
- Other spoil management procedures are detailed in EMM C1 (Contamination Report E)

By applying the above 'avoid' and 'minimise' management measures, the residual impacts to groundwater quality associated with p stockpiling of existing contaminated spoil is considered to remain low.

9.2.12 Construction physical disturbance impacts to GDEs

Physical disturbance of GDEs will occur where the pipeline is constructed via trench through the GDE. Although numerous potential terrestrial GDE's were originally identified along the pipeline alignment based on the regional BOM data, further site investigations have identified only one ecological vegetation classification (EVC), Riparian Woodland, which could be considered a terrestrial GDE.

The impact of vegetation clearing, including the Riparian Woodland, has been assessed separately in the EES Technical Report A Biodiversity and habitats, Risk ID B2, B4 and B5.

9.3 Operation impacts

This section describes the impacts that have the potential to result in impacts to groundwater assets, values and uses from the operation of the Project.

9.3.1 Risk ID GW9 Impacts to groundwater flow paths and levels

Alignment of the pipeline and the backfilled trench in areas of shallow groundwater, may disrupt or dislocate groundwater flow paths over time. This has the potential to cause preferential flow paths within the trench or around the pipeline, which may results in localised changes in the ground water level. This may result in either mounding or drawdown of the groundwater level, up or down hydraulic gradient, and subsequently has the potential to impact nearby users, GDEs/receiving waters flows/levels, or cause water logging.

The areas of potential groundwater interaction along the alignment are summarised in Table 25. As noted previously, this represents approximately 5 % of the entire pipeline length. The longer trenched sections below the water table have more potential for a significant impact, and there is expected to only be four of these areas, each around 0.5 km to 1 km long with the trench estimated to be 0.5 m to 1.5 m below the water table.

As the pipe diameter (600 mm) and trench depth below the water table is small compared to the water table aquifer thickness, it is expect groundwater local flow paths will not be significantly altered or blocked and it is considered that any changes in the groundwater level close to the trench will be minor. In addition, the water table aquifer system (i.e. basalt and mudstones), where tested, had hydraulic conductivities with an average of around 0.5 m/day with an upper limit of approximately 1 m/day. It is proposed that any backfill to the pit would have a hydraulic conductivity of a similar order (i.e. this is consistent with fine and silts sand), which further reduces the potential for significant changes in the groundwater flow regime.

Other design measures, such as the use of trench breakers/pipe breaker or plugs, will also be used to further reduce the likelihood of the alignment becoming a preferential groundwater flow path.

Therefore, the risks of impacts to groundwater flow paths and levels during the operational phase is considered to be low.

Management and Mitigation

The pipeline design shall consider where groundwater integration is expected to occur and incorporate trench breakers/ pipe collars or plugs, as well as suitable backfill compaction, to prevent preferential flow paths (EMM GW7).

By applying the above design ‘minimisation’ management measures, the residual impacts to groundwater flow paths and levels groundwater associated with the pipeline is considered to remain low.

9.3.2 Risk ID GW10 Impact to Groundwater quality

This risk has the same risk pathway as GW9, with the focus on the potential for the pipeline trench to create preferential flow paths which may result in localised changes to groundwater quality (EMM GW7).

There is potential for impact to groundwater as contaminants may be mobilised along any preferential flow paths created by the trench.

As for GW9, the potential for significant changes in the groundwater level or flow regimes is considered minor. In addition, the potential areas where the trench is expected to be below the water table are not close to any identified potentially contaminated sites (refer in Figure 34 to Figure 40 and Section 9.2.8), which could cause additional consequences if a preferential flow pathway developed.

Therefore, the risks of impacts to groundwater quality during the operational phase is considered to be low.

Management and Mitigation

The pipeline design shall consider where groundwater interaction is expected to occur and incorporate trench breakers/ pipe collars or plugs, as well as suitable backfill compaction, to prevent preferential flow paths (EMM GW7). Further establishment of baseline groundwater quality at areas where groundwater interaction is expected to occur will further inform this risk.

By applying the above design 'minimisation' management measures and subject to further baseline groundwater quality monitoring, the residual impacts to groundwater quality associated with the pipeline is considered to remain low.

9.3.3 Risk ID GW11 Leaks or spills or runoff impacts to groundwater quality

There is a possibility that spills or leaks may occur during the operation and maintenance of the pipeline, WCS and the MLVs. This could include fuels, oils or chemicals that are used in the operation phase of the Project

The likelihood of these events occurring is considered low, and any consequence considered moderate under normal management procedures.

Management and Mitigation

The OEMP shall include requirements for management of chemicals, fuels and hazardous materials as specified in EMM GW4.

By applying the above 'avoidance' and 'minimisation' management measures, the residual impacts to groundwater quality associated with potential leaks, spills or runoff during operation is considered to remain low.

9.4 Cumulative impacts

The following proposed future projects have been considered for any cumulative impact on groundwater risks:

- Outer Metropolitan Ring Transport Corridor Project (E6)
- Sunbury Road Upgrade
- Bald-Hill, Yan Yean Pipeline
- AusNet / Mondo's Western Victoria Transmission (WVTN) project

The only project which is likely to interact with groundwater, at around the same time as the WORM Project, is the Bald Hill Yan Yean pipeline. This pipeline runs on a similar alignment from approximately KP40 to KP42, including crossing under the North Eastern rail reserve. It is assumed that parts of this section of the Yan Yean pipe trench would probably also require dewatering, as expected for the WORM pipeline (i.e. Interaction area 4).

Assuming the Yan Yean pipe work is not undertaken at the same time as the WORM Project, the risks associated with construction dewatering are expected to be unchanged to those shown in Table 32. If construction of the two projects occur at the same time (i.e. dewatering at the same time in the same area), the drawdown area of influence will be greater than currently predicted (ie currently approximately 15m). The distance of drawdown influence associated with the Yan Yean pipeline would depend on the depth of the pipe and the level of dewatering required. However, assuming the distance of drawdown influence is increased to around 50m, there is still no registered groundwater users or GDE's in this area. Assuming the Yan Yean project has similar environmental management measures to this project (i.e. for groundwater disposal, etc), the cumulative risk associated with construction dewatering would again likely remain unchanged. The preference, however, would be for the work to be done at different times to minimise any potential for cumulative impacts, and the timing should be confirmed with Melbourne Water.

10. Environmental management measures

10.1 Recommended environmental management measures

Table 35 lists the recommended environmental management measures relevant to the groundwater assessment. In general, these EMMs have been developed in accordance with EPA Publication 1834 Civil construction, building and demolition guide (November 2020) and EPA Publication 1895 Managing Stockpiles, 2020. Application of the mitigation hierarchy is discussed in Section 9 as relevant to each impact assessment.

Table 35 Environmental management measures

EMM #	Environmental Management Measure	Stage
GW1	**Minimising dewatering rates and impact to groundwater levels and flows** Design and construct the Project to minimise changes in groundwater levels, flows and quality. Implement the following measures during construction to minimise groundwater impacts: • Where excavations require dewatering, adopt a construction method that minimises the dewatering period. The anticipated period is expected to be approximately four weeks at the creek crossings. • Install trench breakers adjacent to watercourses, wetlands and steep slopes as shown in the standard drawing (530-DWG-L7003) to minimise trench inflows	Construction
GW2	**Minimise impact to groundwater bore users** Although it is not anticipated that any neighbouring bore will be impacted by dewatering, it is possible there is unregistered bores nearby, or a slightly greater than predicted distance of drawdown influence may occur. If this is the case, and any neighbouring bores are considered likely to be impacted by the Project within 60 metres of an area of dewatering (including the registered bore at approximately KP 47.6), then the location, condition and functionality of the bore must be visually confirmed and make-good arrangements will be agreed in consultation with affected landholders, if required.	Construction
GW3	**Minimise impacts associated with contaminated groundwater and disposal** Establish baseline level and groundwater quality conditions prior to the construction phase to assess any existing contamination or quality issues where groundwater is likely to be intercepted during construction and dewatering is expected, and also allow suitable disposal options to be assessed and planned. • Complete additional groundwater quality analysis in the existing bore network to confirm baseline conditions • Investigate Bendigo Rail/Tame St Drain area further as regional data suggests dewatering may be necessary • Investigate PFAS at Jacksons Creek so that any dewatering in this area can be informed about the presence of PFAS to allow for appropriate management of the groundwater, and sediments. Investigations must occur prior to construction in	Construction

EMM #	Environmental Management Measure	Stage
	order to inform the CEMP and include shallow groundwater and sediment sampling. Manage extracted groundwater as follows: • Dispose groundwater in accordance with the SEPP (Waters) and EPA Guidelines and all relevant approvals processes with relevant authorities • Groundwater from areas that have been identified as contaminated must not be discharged to the environment (land, waterways). If required, engage with the local water authority to develop a trade waste agreement for sewer discharge. This agreement would specify the levels of contamination to allow for sewer discharge. • Contaminated groundwater must either be treated onsite, depending on contaminant encountered (this may require approval from the EPA Victoria) or disposed offsite to an EPA Victoria licensed facility. Alternatively, a construction approach may be adopted where contaminated groundwater is left in-situ (i.e. not abstracted or disturbed). Manage dewatering of excavated trenches/bellholes to minimise sedimentation, including the use of sediment control devices to remove suspended solids and dissipate flow. Sediment control devices must be listed in site specific environmental management plans. Minimise the duration that trench sections and bell holes are open, and divert surface water runoff away from the excavations, to reduce the potential for poor quality runoff impacting groundwater.	
GW4	**Manage chemicals, fuels and hazardous materials** Manage chemicals, fuels and hazardous materials as detailed in EMM C6.	Construction and Operation
GW5	**Drilling Fluids Requirements** Manage drilling fluids in accordance with EMM C9..	Construction
GW6	**Implement Spoil Management Procedures** Implement spoil management procedures as detailed in EMM C1.	Construction
GW7	**Design Requirements** The pipeline design shall consider where groundwater interaction is expected to occur and incorporate trench breakers or plugs, as well as suitable backfill compaction, to prevent preferential flow paths. Implement trench compaction procedure as detailed in EMM GM4 including the design of the backfill to take into account the density and permeability of the surrounding soil.	Design, Construction and Operation

Note that the groundwater management measures should be included and implemented through the CEMP and OEMP..

Other EMMs which are relevant for the groundwater risk assessment include:

- EMM C3 (Technical report E Contamination): Minimise potential impacts from disturbance of acid sulfate soils. In particular:

  - PASS may be present in saturated alluvium soils beneath and close to the creeks. Further assessment is required to confirm this in advance of construction in areas where creeks will be crossed using open trench construction or HDD excavated sediments (e.g. exit and entry pits) are present below the water table at Jacksons Creek (approx. KP13.8), and Merri Creek (approx. KP42.5).

- EMM C6 (Technical report E Contamination): Manage chemicals, fuels and hazardous materials
- EMM GM1 (Technical report D Land stability and ground movement): Third party Asset Management

  Identify and prove all third party services prior to construction and agree vertical and horizontal clearance requirements with asset owners. Liaise with asset owners for any asset within the construction easement to confirm asset clearance and other mitigation, protection, or contingency requirements, including possible settlement monitoring at the railway crossings.

  Where utility crossings occur during open trench construction, the asset protection must agreed with the provider and adhered to.

- EMM GM2 (Technical report D Land stability and ground movement): Design and construction to be informed by geotechnical and hydrogeological conditions

  Existing and planned geotechnical and hydrogeological investigations must form the basis of design and inform expected ground and water conditions during construction so that due consideration is given toward the existing ground key issues (such as those identified in Technical report D Land stability and ground movement). This information is to:

  - Provide information on the soil and rock expected to be encountered during all excavations
  - Provide information on the presence of reactive soils
  - Provide information on the presence of dispersive (“sodic”) soils
  - Provide information on the locations and extent of groundwater drawdown requirements

10.2 Recommended performance criteria and management

Although residual impacts are low during construction, it is recommended that a groundwater monitoring plan is developed as part of the CEMP using the existing bore network set up for the Project.

The objective of groundwater monitoring is to minimise the risk of impacts to groundwater during construction. Indicators include groundwater level and quality as set out in the groundwater monitoring plan in accordance with SEPP (Waters). The groundwater monitoring plan would be implemented to:

- Assess any impacts from construction activities (i.e. from drawdown during construction and recovery) which includes measuring groundwater levels and quality at key groundwater interaction areas when construction works are progressing in the immediate area (locations identified in Table 25 – Summary of areas of groundwater interaction along the Project alignment), particularly the open trench creek crossings (Jacksons and Merri Creek).

- Monitor groundwater quality during construction. This includes any dewatering to comply with the site-specific groundwater disposal management plan and SEPP (Waters) requirements. Monitoring to assess any site variability of the groundwater quality (e.g. from the baseline investigations and that there are no variations that require additional management measures such as changing pH or salinity). When dewatering occurs at locations identified in Table 25, monitoring of groundwater levels and quality would be required for the duration of dewatering works as defined in the groundwater monitoring plan. Parameters to be measured include groundwater levels, salinity, pH, EC, major ions, ammonia, nitrate, nitrite, total nitrogen and total kjeldahl nitrogen.

11. Conclusion

The purpose of this report is to provide a groundwater impact assessment to inform the preparation of the EES required for the Project.

A summary of the key assets, values or uses potentially affected by the Project, and the associated impact assessment are summarised below.

11.1 Existing conditions

A desktop assessment and field investigation program, consisting of the installation and monitoring of 17 groundwater bores, was undertaken to characterise the groundwater conditions along the pipeline route.

Along the pipeline route, the water table aquifer system consists of:

- Fractured rock aquifers, including:
  - Basement rock aquifer, consisting of siltstones and sandstone
  - Newer Volcanics basalts aquifer

These aquifer are present along the majority of the pipeline route, with the basalt aquifer being predominately present in the first and last 15 kilometres of the alignment and the bedrock aquifer in the mid 20 kilometre section.

- Porous media aquifers, including:
  - Alluvial and colluvial sediments, consisting of silt, silty sand, sand and gravel
  - Tertiary Red Bluff Sands/ Bullengarook Gravel, which comprise variable mixtures of the sands, gravels, clays and silts

These aquifers are generally restricted to the present day drainage lines and waterways (i.e. Jacksons, Deep, Kalkallo and Merri Creek).

Regional data suggested that the depth to groundwater along the alignment varies from < 5 m to > 50 m. Site investigations focused on the pipeline areas where the groundwater was likely to be < 5 m deep and therefore where the Project is likely to interact with the water table aquifer. Based on the available information, the following areas/crossings were identified:

- Area 1: Bendigo Railway and the Tame St Drain
- Area 2: Jacksons Creek
- Area 3: Deep Creek
- Area 4: Donovans Lane and the North East Rail reserve
- Area 5: Merri Creek
- Area 6 : Donnybrook Rd

These areas of direct interaction with groundwater represent approximately 5% of the entire pipeline length.

The groundwater salinity from the monitoring bores has been reported near these site between 910 mg/L to 7,360 mg/L TDS, i.e. Segment A2 to Segment E of the SEPP (Waters).The majority of the groundwater along the alignment has been classified as Segment C. However, groundwater to the east and south east of the Hume Freeway has been classified as Segment A2, i.e. more protected beneficial uses (including potable water and irrigation).

Groundwater analysis recorded elevated concentrations of ammonia (as N), total nitrogen and total phosphorus, above relevant ANZG (2018) and/or SEPP (Waters) criteria for the protection of water dependent ecosystems, indicating that the quality may already potentially be impacted by local background conditions and/or land uses. These concentrations may preclude groundwater disposal to the environment, e.g. waterway (if required).

The groundwater salinity in many bores exceeds the ANZECC (2000) criteria for long term irrigation and in places the salinity may preclude groundwater disposal to land, if required, during construction dewatering.

Potentially contaminated sites, existing landfills or quarries are not close (within 0.75 km) to the areas where the construction dewatering is likely to be required. Furthermore, the EES Technical report E Contamination, indicated that the potential to intercept groundwater contamination across the construction corridor near where potential sources of contamination had been identified was considered remote.

Hydraulic conductivity of the water table aquifer along the alignment, based on slug testing, was 0.03 m/day on average, with the maximum of approximately 1 m/day and the minimum < 0.01 m/day.

Potential GDEs, both aquatic and terrestrial, have been mapped along the alignment, with the most relevant to potential construction dewatering impacts being at the Jacksons and Merri Creek crossings.

11.2 Impact assessment

The impact assessment was based on regional and site specific information, as noted above, and the proposed construction method for the Project. The impact assessment considered a total of eleven risk items, eight construction risks and three operation risks. These included construction dewatering risks, such as impacts on neighbouring groundwater bore, GDEs or groundwater receiving environments (i.e. creeks or wetlands), land settlement, acid sulfate soil activation and mobilisation of existing contaminated groundwater. Operational risks included the potential to impact on groundwater levels, flow paths and quality, as well as accidental leaks and spills.

To evaluate the construction risks due to dewatering, an estimate of the area of groundwater drawdown influence and groundwater inflow rates, was determined using analytical solutions for steady state flows. The area of drawdown influence away from a trench or bell hole was generally less than 25m, with a maximum of 50m predicted (refer Table 33 and Figure 34 to Figure 40).

The results of the impact assessment were:

- Risk ID GW1 Drawdown Impact on neighbouring groundwater users (bores)

  Drawdown interference with existing users of groundwater is not anticipated during the construction phase as the drawdown cone from dewatering activities is expected to be limited. Therefore, the risks of groundwater dewatering impacting neighbouring bores is considered to be low. By applying the management measures, to minimise dewatering, the residual impact of groundwater dewatering to neighbouring bore users is considered to remain low

- Risk ID GW2 Drawdown impacts on groundwater dependent ecosystems (GDEs) and receiving environments (i.e. river/wetland base flows)

  Drawdown was predicted to occur at the Jacksons Creek and Merri Creek crossing areas, however the impact of construction dewatering drawdown on these GDE's is considered to be minor considering:

  – The drawdown extent and level is localised and minor
  – The duration is short (< 4 weeks)
  – Construction activities (i.e. coffer dams) through the rivers will be designed to minimise the degree of groundwater and surface water interaction (i.e. trench breakers) and therefore minimise the dewatering requirements
  – Local potential terrestrial GDEs are considered unlikely to be impacted by drawdown over this short period, unless a particularly dry period/drought
  – Any impact on total baseflow to these river systems, are expected to be within natural climatic variations. Consequently, any impact on surface water flows would be minor and within natural flow or level variations and therefore impacts on potential aquatic GDEs are also considered to be insignificant to minor. In addition, Merri Creek is an ephemeral stream, and dries out regularly, therefore any fauna associated with potential aquatic GDEs (i.e. fish, frogs, birds) already require a degree of mobility under the existing conditions to survive. The potential exception may be any persistent refuge pools in the area of the Merri Creek crossing; however none have been identified in the predicted area of drawdown influence.

  Therefore the risks of groundwater dewatering impacting GDE's or surface water receiving environments is considered to be low. As a conservative measure, an additional site inspection in late summer is proposed to assess the presence of any refuge pools within 100 m of the Merri Creek. (refer EES Technical report A Biodiversity).

  By applying the management measures, to minimise dewatering and optimise the timing, the residual impact of groundwater dewatering impacting GDE's or the receiving environments is considered to remain low.

- Risk ID GW3 Drawdown impacts activating acid sulfate soils

  The desktop review indicated there is a low to extremely low probability of Acid Sulfate Soil (ASS) occurring at the site. ASS testing completed along the alignment (18 samples) identified one soil sample from a depth of 0.1 m at the net acidity EPA assessment criteria of 0.03 % S. This however was not in an area where dewatering is expected to be required.

  Considering the available data, and the areas where dewatering is expected to be required during construction, it is considered that the risk of ASS activation is low. However, further assessment of PASS at the creek crossings should be completed prior to construction.

  With application of management measures to minimise dewatering and further assessment, the residual impacts of groundwater dewatering causing acid sulfate soil activation is considered to remain low.

- Risk ID GW4 Ground settlement

  The predicted drawdown and areas of influence presented in this report were reviewed and the impacts associated with settlement were assessed separately in the EES Technical Report D Land stability and ground movement (Risk ID GM3). It was concluded that considering the limited area of the drawdown influence, the soil compressibility and infrastructure present, that the risks associated with settlement were negligible.

With application of management measures to minimise dewatering, and basis of design on local geotechnical conditions, the residual impacts associated with ground settlement is considered to remain negligible.

- Risk ID GW5 Mobilisation of existing contaminated groundwater

  Construction dewatering has the potential to cause mobilisation of existing contaminated groundwater within the drawdown cone towards the dewatering site, which may impact groundwater quality and down gradient receptors (such as users/receiving environments, GDEs/rivers). The six areas identified where dewatering may occur are at least 750 m from potential contaminated sites, or operational landfills/quarries. Based on the estimated dewatering drawdown influence zones (i.e. < 50 m), the likelihood of intersecting a significantly contaminated groundwater plume from a potential contaminated site, and migrating contaminates to the dewatering area and impacting on the existing groundwater quality and protected beneficial use around the area is considered remote

  It is however noted that groundwater quality in some bores in the potential dewatering areas exceeds the relevant ANZG (2018) and/or SEPP (Waters) criteria for ecosystem protection currently and therefore the beneficial use of the groundwater is already impacted by local conditions and land uses, and additional groundwater analysis should be completed at the dewatering areas to further assess the groundwater quality and further inform the risk assessment

  Disposal of groundwater from dewatering activities would be required during construction at six identified areas. Considering the general setting of the pipeline, disposal to waterways or land irrigation are considered the likely or favoured options for the construction contractors. However, as noted above, in some locations there may be some groundwater parameters of concern for disposal to waterways, including elevated concentrations of ammonia (as N), elevated total nitrogen, phosphorus and various metals. The groundwater salinity may also preclude disposal to land (i.e. irrigation) in some areas.

  The existing (and any future) groundwater quality information will need to be considered by the Contractor when assessing the most appropriate disposal method at each location.

  Overall the risk of mobilisation of contaminated groundwater is considered to be low, and with the application of management measures to minimise dewatering, further establishment of baseline groundwater quality, and water disposal as per regulatory requirements., the residual impacts are considered to remain low.

- Risk ID GW6 Leaks or spills or runoff impacts to groundwater quality

  The likelihood of these events occurring is remote, and any consequence considered moderate with appropriate management procedures, and therefore the risk of groundwater impacts considered low.

  With application of management measures to minimise chemical and fuel storage on site, and avoid or minimise spillage, the residual impacts to groundwater quality associated with potential leaks, spills or runoff is considered to remain low.

- Risk ID GW7 Drilling fluids used for HDD impacts groundwater quality

  These drilling fluids are designed to stabilise and seal the hole and therefore movement into the aquifer system will be very limited. In addition, the drilling muds used are generally inert and biodegradable as they are commonly used in the groundwater bore drilling industry. After use the drilling muds are required to be disposed as per EPA regulatory requirements.

Therefore the risk of impacts associated with the drilling muds is considered negligible, and with the application of management measures to minimise impacts, the residual impacts are considered to remain negligible.

Risk ID GW8 Disturbance and stockpiling of existing contamination

The likelihood of these events occurring is remote, and any consequence considered moderate under normal management procedures, and therefore the risk of groundwater impacts considered low.

With application of management measures to minimise and avoid this impact, the residual impacts to groundwater quality associated with disturbance and stockpiling of existing contamination is considered to remain low.

- Risk ID GW9 Operation: Impacts to groundwater flow paths and levels

  The pipeline and the backfilled trench in areas of shallow groundwater may disrupt or dislocate groundwater flow paths over time and potentially cause preferential flow paths within the trench or around the pipeline, which may result in localised changes in the ground water level.

  The areas of potential groundwater interaction along the alignment represents approximately 5% of the entire pipeline length. Considering the limited extent of the pipeline below the water table, and the relatively small pipe diameter and trench depth below the water table compared to the aquifer thickness, it is expected that groundwater local flow paths will not be significantly altered or blocked. Therefore any changes in the groundwater level close to the trench are likely to be minor and management measures would further reduce the likelihood of the alignment becoming a preferential flow path.

  Therefore, the risks of impacts to groundwater flow paths and levels during the operational phase is considered to be low. and with the application of deign management measures to minimise the potential for the trench to become a preferential groundwater flow path or block groundwater flow, the residual impacts to groundwater flow paths and levels groundwater associated with the pipeline is considered to remain low.

- Risk ID GW10 Operation: Impact to groundwater quality

  This risk has the same risk pathway as Risk ID GW9, with the focus on the potential for the pipeline trench to create preferential flow paths over time, which may result in localised changes to groundwater quality and beneficial use. As for Risk ID GW10, the potential for significant changes in groundwater levels or flow regimes is considered minor. In addition, the potential areas where the trench is expected to be below the water table are not close to any identified potentially contaminated sites which could cause additional consequences if a preferential flow pathway developed. Therefore, this risk is considered to be low.

  With application of design management measures to minimise the potential for the trench to become a preferential flow path and subject to further baseline groundwater quality monitoring, the residual impacts to groundwater quality associated with the pipeline is considered to remain low.

- Risk ID GW11 Operation: Leaks or spills or runoff impacts to groundwater quality

  There is a possibility that spills or leaks may occur during the operation and maintenance of the pipeline, WCS and the MLVs. This could include fuels, oils or chemicals that are used in the operation phase of the Project. The likelihood of these events occurring is considered remote, and any consequence considered moderate under normal management procedures, and therefore the risk of groundwater impacts considered low. With application of management measures to minimise chemical and fuel storage on site, and avoid or minimise spillage, the residual impacts to groundwater quality associated with potential leaks, spills or runoff during operation is considered to remain low.

- Construction physical disturbance impacts to GDEs

  Physical disturbance of GDEs may occur if the pipeline is constructed via trench through an area of GDE. There are numerous terrestrial GDE's (i.e. classified as low to high potential GDEs) and aquatic GDE's (i.e. at major creeks) along the pipe route that will be disturbed.. The impact of vegetation clearing during construction, including the Riparian Woodland which could be considered a terrestrial GDE, has been assessed separately in the EES Technical Report A Biodiversity and habitats, Risk ID B2, B4 and B5.

In conclusion, the residual impact of all eleven groundwater risks were assessed as either negligible or low, with the implementation of the initial management measures.

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Appendices

Appendix A – Summary of neighbouring bores

Bore ID	Easting (Z55)	Northing (Z55)	Distance to alignment in km	Date completed	Bore depth (m)	Screen from (m)	Screen to (m)	Bore use
79258	312773.2	5842164.2	17	23/10/1982	58	56	58	Stock
68906	323063.2	5840074.2	25	7/09/1989	62.5	56.5	62.5	Not known
67439	300213.2	5831584.2	29	4/04/1986	61	36	50	Domestic
79167	319093.2	5846884.2	30	13/08/1982	83.8	74	83	Domestic
WRK055538	304586	5834041	34	5/05/2010	50.8	47.5	50.5	Observation
302688	309786.2	5837885.2	39	11/03/1970	35.35			Non groundwater
68947	313393.2	5843034.2	49	1/05/1991	97	73	97	Stock and domestic
68870	318693.2	5846384.2	52	21/12/1984	17	12	17	Stock and domestic
WRK972015	304325	5834579	53	17/12/2005	90			Stock and domestic
WRK972015	304325	5834579	53	17/12/2005	90			Stock and domestic
WRK990728	323490	5842140	55	15/08/2009	39			Stock and domestic
WRK056736	304827	5834391	55	5/05/2010	67			Stock and domestic
67418	302757.2	5832848.2	77	31/12/1970	0			Not known
79172	318463.2	5846554.2	87	8/04/1983	48.76	15.24	48.76	Stock and domestic
302670	309918.2	5838290.2	88	31/12/1927	47.24			Non groundwater
68850	318693.2	5846344.2	91	11/09/1982	53.3	40	50	Stock and domestic
WRK987506	320894	5847668	95		150			Not known
143266	304640.1	5833988	97	25/11/1998	57			Groundwater investigation
WRK985085	312086	5841389	102	21/02/2008	90			Stock and domestic
77210	298384.2	5824045.2	105	31/12/1906	69.18			Stock and domestic
60510	298653.2	5824384.2	107	15/09/1988	50	33	50	Domestic
WRK038874	322794.2	5838821.2	113	13/07/1979	29	17	29	Industrial
WRK986379	300393	5831706	117	2/07/2008	150			Not known
WRK976356	309904	5838118	121		150			Not known
WRK960533	323319.2	5842852.2	126	18/12/2002	11.6			Stock and domestic
68921	318103.2	5846384.2	127	22/01/1989	62	50	62	Stock and domestic
319783	316981.2	5846528.2	128	2/09/1971	21.49			Non groundwater
68859	317873.2	5846404.2	137	3/05/1983	72	53	60	Stock and domestic
67416	302446.2	5832305.2	140	31/12/1970	0			Not known
WRK054905	311242	5840030	150	16/02/2010	100			Stock and domestic
112852	317053.2	5846484.2	163	3/02/1992	20	14	20	Stock and domestic
WRK102269	309252	5836605	179	11/09/2017	13	8.5	13	Investigation
68905	323003.2	5840654.2	190	6/09/1989	62.5	56.5	62.5	Not known
115283	322861.2	5846712.2	191	28/01/1993	40	15	40	Groundwater investigation
WRK070046	304869	5834117	201	18/07/2012	56			Observation
310875	323232.2	5839605.2	202	12/06/1970	55.77			Non groundwater
68881	318413.2	5846254.2	217	15/03/1983	62.48	30.48	62.48	Stock and domestic
302671	310239.2	5838579.2	222	31/12/1927	46.93			Non groundwater
79266	311723.2	5841494.2	235	8/12/1988	93	66	93	Stock and domestic
79254	312071.2	5841897.2	252	1/12/1975	57	47	55	Stock and domestic
79263	312353.2	5842144.2	260	6/08/1982	74.67	27	74.67	Stock and domestic
WRK043241	300776	5832016	262	14/06/2003	63			Irrigation
68861	317363.2	5846344.2	262	4/05/1983	22.5	16	22.5	Stock and domestic
68946	313513.2	5843724.2	269	30/04/1991	115	79	115	Stock and domestic
67417	302502.2	5832787.2	271	31/12/1970	0			Not known
WRK087934	305397	5834280	310	26/04/2016	265.5			Irrigation
WRK087934	305397	5834280	310	26/04/2016	265.5			Irrigation
68889	317443.2	5846264.2	331	30/04/1983	50	18	50	Stock and domestic
116348	312463.2	5841374.2	333	31/08/1993	106	100	106	Domestic
58464	315714.2	5847084.2	344	28/04/1981	97.5	5.5	7	Stock
67429	300488.2	5831245.2	346	21/12/1980	52	31	52	Domestic
132509	323493.2	5840244.2	349	7/02/1998	25.5	21.5	25.5	Domestic
132509	323493.2	5840244.2	349	7/02/1998	25.5	21.5	25.5	Domestic
WRK055540	304818	5833780	359	5/06/2010	64.5	60	63	Observation
77267	298153.2	5824294.2	371	20/05/1983	61.9	1.3	61.9	Stock and domestic
68872	323893.2	5842444.2	422	5/09/1984	41	35	41	Stock and domestic
67426	300693.2	5831184.2	450	8/11/1986	45	3	45	Stock and domestic
115284	322636.2	5846436.2	456	1/02/1993	40	12	40	Groundwater investigation
67411	301203.2	5831329.2	456	31/12/1970	0			Not known
WRK055539	304859	5833686	461	5/05/2010	48	44.5	47.5	Observation
68937	322614.2	5840055.2	468	1/01/1988	0			Stock and domestic
122936	322973.2	5842304.2	477	12/12/1993	41	32	41	Stock and domestic
114870	305016.9	5833810.2	477	19/10/1992	71	53	71	Groundwater investigation

Bore ID	Easting (Z55)	Northing (Z55)	Distance to alignment Rev6 in metres	Date completed	Bore depth (m)	Screen from (m)	Screen to (m)	Bore use
79259	311473.2	5841564.2	483	24/02/1983	119	114	119	Stock and domestic
315731	297878.2	5822984.2	485	24/03/1972	98.29			Non groundwater
302669	310245.2	5837969.2	486	31/12/1927	59.43			Non groundwater
77247	299802.2	5829040.2	486	31/12/1970	36.6			Stock and domestic
WRK959979	316066	5847250	491	24/11/2002	30	20	30	Stock and domestic
68948	323973.2	5842524.2	493	7/03/1991	28	12	24	Stock and domestic
WRK983504	313914	5845394	521		150			Not known
67413	300578.2	5831057.2	526	31/12/1970	0			Not known
WRK969109	314179.2	5843284.2	528		100			Not known
WRK968901	323742.2	5841047.2	548		60			Not known
122992	322771.2	5845265.2	551	13/12/1993	36.2			Groundwater investigation
120765	312413.2	5840884.2	564	19/12/1993	118	82	94	Stock and domestic
120765	312413.2	5840884.2	564	19/12/1993	118	82	94	Stock and domestic
68904	322633.2	5840554.2	565	5/09/1989	59.7	53.7	59.7	Not known
115282	322411.2	5847086.2	566	28/01/1993	40	13	40	Groundwater investigation
68907	322513.2	5840074.2	571	8/09/1989	59.7	53	59.7	Not known
77234	299070.2	5824063.2	571	31/01/1969	0			Not known
143267	304954	5833613	574	24/11/1998	35			Groundwater investigation
WRK960845	311529.2	5841791.2	579	25/04/2003	87			Stock and domestic
67412	301495.2	5831326.2	582	31/12/1970	0			Not known
113567	323603.2	5839404.2	590	3/03/1992	49	6	49	Stock and domestic
68755	322720.2	5845299.2	593	31/12/1969	0			Not known
58465	317163.2	5847234.2	595	18/03/1982	13.5	12	13.5	Stock
122990	322603.2	5845779.2	599	13/12/1993	36.4			Groundwater investigation
68936	323613.2	5839236.2	605	1/01/1988	36.5			Stock and domestic
319778	314449.2	5843647.2	610	31/12/1965	14.02			Non groundwater
309859	301039.2	5832487.2	654	15/10/1971	66.14			Non groundwater
79251	312898.2	5843422.2	660	23/11/1971	53.34			Stock
143268	305119.6	5833610.5	684	24/11/1998	83			Groundwater investigation
79168	322453.2	5846104.2	687	4/03/1983	60	57	60	Stock and domestic
68935	323527.2	5838733.2	690	1/01/1988	19.8			Stock and domestic
315714	298959.2	5822678.2	698	31/12/1952	1.76			Non groundwater
315715	298959.2	5822678.2	698	31/12/1952	2.43			Non groundwater
315716	298959.2	5822678.2	698	31/12/1952	2.43			Non groundwater
315717	298959.2	5822678.2	698	31/12/1952	1.67			Non groundwater
315718	298959.2	5822678.2	698	31/12/1952	9.44			Non groundwater
52421	305931.2	5833878.2	745	7/10/1974	80.77			Miscellaneous
79268	312603.2	5840824.2	760	5/04/1990	96	87	93	Stock and domestic
WRK960778	309286.2	5835779.2	768	19/01/2003	63	57	63	Stock and domestic
WRK983312	315047	5844731	786		150			Not known
77213	299502.2	5825316.2	802	31/12/1906	70.4			Stock and domestic
WRK043359	308736	5835239	819		100			Not known
122937	322623.2	5842714.2	824	13/12/1993	77	47	77	Stock and domestic
115285	322237.2	5846603.2	824	1/02/1993	40	15	40	Groundwater investigation
67414	299830.2	5832310.2	825	31/12/1970	0			Not known
67423	300664.2	5830711.2	841	19/09/1975	51.5	45	51.5	Stock and domestic
WRK978542	301190	5832821	850	19/05/2007	58			Stock and domestic
WRK978542	301190	5832821	850	19/05/2007	58			Stock and domestic
52422	306198.2	5833875.2	875	11/10/1974	68.58	58.21	58.52	Miscellaneous
68940	322162.2	5839734.2	875	1/01/1988	55			Stock and domestic
52420	305713.2	5833690.2	890	15/10/1974	76.2	0	76.2	Miscellaneous
WRK991291	311036	5841558	891	4/06/2009	76			Stock and domestic
WRK991291	311036	5841558	891	4/06/2009	76			Stock and domestic
77270	299253.2	5822984.2	892	28/11/1984	41			Not known
77271	299253.2	5822984.2	892	28/11/1984	32			Not known
68883	322413.2	5842034.2	899	21/09/1982	32	26	32	Stock
302689	307704.2	5834582.2	899	18/03/1970	26.82			Non groundwater
79252	311790.2	5839472.2	902	9/02/1974	32.61	27.43	32.61	Stock
77214	297640.2	5824485.2	909	31/12/1906	52.88			Stock and domestic
WRK102725	313666	5841808	912	28/09/2017	78			Stock and domestic
WRK102725	313666	5841808	912	28/09/2017	78			Stock and domestic
WRK102725	313666	5841808	912	28/09/2017	78			Stock and domestic
79262	314263.2	5846614.2	916	22/03/1982	106.68	31	106.68	Stock and domestic
WRK963807	313113.2	5841184.2	924		100			Not known
WRK092700	301510	5830924	940		51			Stock and domestic
WRK092700	301510	5830924	940		51			Stock and domestic
WRK104977	313009	5844353	945	26/02/2018	210			Stock and domestic
WRK104977	313009	5844353	945	26/02/2018	210			Stock and domestic
WRK081992	300964	5830722	953	23/12/2014	61.5			Commercial
WRK081992	300964	5830722	953	23/12/2014	61.5			Commercial
WRK081992	300964	5830722	953	23/12/2014	61.5			Commercial
WRK966931	313823.2	5841904.2	959	20/09/2004	90.5	70	90.5	Stock and domestic
WRK962170	313777.2	5841855.2	959	14/08/2003	81			Stock and domestic
WRK043169	304431	5835595	966	1/07/1970	5			Commercial
79257	312894.2	5840868.2	991	14/09/1980	84	78	84	Stock and domestic
141698	297413.2	5823484.2	996	19/05/1998	53	46	53	Stock and domestic
52423	306465.2	5833936.2	999	9/10/1974	48.76	15.24	22.25	Miscellaneous

Appendix B – Summary of field investigations

Summary of site investigation program

1.1 Introduction

The following sections summarise the field investigations undertaken to understand existing site conditions

1.2 Geotechnical Drilling

1.2.1 Bore locations and geology logs

Geotechnical drilling was completed by Construction Science at 50 locations along the alignment. Six of the geotechnical bores were converted to groundwater monitoring bores by Construction Science during this drilling program.

1.2.2 Field and laboratory geotechnical testing and analysis

GHD understands that, during the geotechnical investigations, Construction Sciences collected soil and rock samples from the boreholes for the following tests:

- Static Load Test, dynamic Load Test
- Atterberg Limits
- Unconfined Compression Strength (UCS) Test
- Triaxial Compression Strength Test
- Permeability Test
- Compaction Test (as applicable in clayey/silty soils)
- Direct shear Test
- Consolidation Test
- Sodic Test for Dispersive Soils

A discussion of these test results has been provided under separate cover by Construction Science. Additional summary geotechnical observations were included in GHD (2020a).

1.2.3 Acid Sulfate Soil sampling and analysis

In addition to the testing documented above, Construction Science collected soil samples from selected geotechnical boreholes to test for the presence (or absence) of ASS. Soil samples were submitted to ALS Environmental Pty Ltd (ALS) for laboratory analysis. ALS is registered with the National Association of Testing Authorities (NATA) for the nominated analyses.

It is noted that APA selected the boreholes for ASS testing.

1.3 Groundwater monitoring bore network

1.3.1 Monitoring Bore Network

A groundwater monitoring network consisting of 18 bores was established by APA to provide information on groundwater levels, quality and estimated aquifer hydraulic conductivity. The network generally focuses on the areas where groundwater depth was expected to be < 5 m.

The bores also form a groundwater monitoring network where additional groundwater level and quality information could be collected during future stages of the Project.

The first six bores were installed and developed by Construction Science during the initial geotechnical drilling program. Bore WORMBH23, installed by Construction Science at Jacksons Creek, was found to be damaged and this bore was later replaced by bore WORMBH23a at the same location. The original bore WORMBH23 was decommissioned by Construction Science.

The remaining bores were installed by GHD.

Bores were constructed with 50 mm diameter PN18 uPVC threaded casing and machine slotted screens, as per the Minimum Construction Requirements for Water Bores in Australia 3rd Edition (NUDLC, 2020) and accepted industry practice.

All monitoring bores were developed prior to the completion of the drilling program. All geotechnical and groundwater monitoring bores have been surveyed.

Further bore construction details are provided in GHD, 2020b.

With regards to the monitoring network, the following should also be noted:

Bore WORMBH04 temporary PVC casing installation

A new monitoring bore could not be installed following the completion of geotechnical bore WORMBH04 on the south bank of Jacksons Creek. As such, APA agreed to install temporary PVC casing in the drilled borehole so that limited groundwater monitoring information could be collected at this location.

The 50 mm diameter temporary PVC casing was lowered to the drilled borehole depth (20 m) with the screened section set from 17 m to 20 m depth. As the casing was to be removed immediately following groundwater monitoring, no annular backfill material was used in the bore, e.g. gravel pack, bentonite seal.

A single monitoring event was completed using this temporary casing and included bore development, water level monitoring, groundwater sampling and slug testing.

Following the monitoring, the temporary casing was removed from the borehole and the borehole was backfilled and the ground surface reinstated.

1.3.2 Acid Sulfate Soil sampling and analysis

Limited additional ASS testing was recommended as part of this investigation with soil samples taken from bores WORMBH09 and WORMBH12. Soil samples were placed in laboratory supplied zip lock bags, stored in chilled eskies, or frozen if required, and submitted to a NATA accredited laboratory for analysis for the ASS ‘field screen’.

1.4 Groundwater monitoring

GHD completed the following groundwater monitoring from March to October 2020:

- Groundwater level gauging
  - This included both manual water level measurements and deployment of automated dataloggers (dataloggers) to record water levels
- Groundwater sampling and laboratory analysis
- Aquifer testing (i.e. slug tests).

These have been described in the following sections.

1.4.1 Groundwater level monitoring

Manual measurements

Based on a review of the geotechnical borehole logs we note that each borehole was initially augured generally until 'refusal' on competent rock material. The majority of the bores were then cored until the documented termination depth. A number of geotechnical bores, e.g. BH14 to BH15 were completed by washboring following auger drilling.

Whilst groundwater observations during borehole auguring are generally possible, and were made by Construction Science during coring and washboring, such observations are generally not possible as drilling fluids and/or water are added during the drilling process. Addition of these fluids and/or water typically mask the presence of any groundwater encountered during the drilling process.

Each monitoring bore was measured for depth to groundwater using an electronic water level meter prior to groundwater sampling as well as on an ad hoc basis during the field program. The depths to groundwater were referenced to the top edge of the PVC standpipe. At each bore the leading edge of the PVC standpipe was approximately 0.1 m below ground level.

Automated monitoring

Insitu branded Rugged TROLL 100's have been deployed in selected monitoring bores in order to start capturing groundwater level information at regular intervals, and to allow less frequent access to private properties along the alignment.

All dataloggers are measuring depth to water at six (6) hour intervals. As these dataloggers are non-vented (absolute), an Insitu branded Rugged BaroTROLL was also installed in bore WORMBH32, located on Gunns Gully Road. The BaroTROLL measures and logs barometric pressure and temperature to compensate for water level changes due to barometric fluctuations.

1.4.2 Groundwater sampling

Sampling methodology

Groundwater sampling from monitoring bores was completed in accordance with Victorian EPA publications 669 – Groundwater sampling guidelines (EPA, 2000) and IWRG701 – sampling and analysis of waters, waste waters, soils and wastes, and recognised industry practice. The groundwater monitoring bores were purged during which field water quality parameters and water level monitoring was undertaken. Sampling was completed following stabilisation of the field water quality parameters to limits as defined by EPA (2000).

Where sufficient water was present in the bores, sampling was completed at least once. A number of the historic bores have been sampled on two occasions as summarised in Table 1. . In addition to the monitoring sampling documented in Table 1, a groundwater sample was also collected from geotechnical bore WORM04 where temporary PVC casing was installed in the borehole.

It is noted that historic monitoring bore WORMBH23 was sampled in March 2020. This bore was purged and sampled using low flow sampling methods from above the identified blockage (GHD, 2020a).

Field parameters

The following field parameters were measured during groundwater purging and sampling:

- pH
- Oxidation – Reduction Potential (ORP)
- Dissolved Oxygen (DO)
- Electrical Conductivity (EC)
- Temperature
- Water level (during low flow purging)

In additional to monitoring of the field parameters, field staff also documented comments about the olfactory and visual observation of the purged groundwater.

Laboratory parameters

Groundwater samples were submitted by GHD to ALS Environmental Pty Ltd (ALS) for analysis. QA/QC samples were submitted to Eurofins. Both laboratories are registered NATA for the nominated analyses.

The laboratory analytical suite for the monitoring program has been included in Table 1.

Quality control procedures

GHD implemented a rigorous quality assurance/quality control (QA/QC) program as part of our field procedure, based on relevant Australian Standards and industry common practice. The QA/QC program undertaken as part of the assessment by GHD included the following:

- Implementation of GHD field procedures including sampling equipment decontamination between sampling points
- Use of dedicated sampling tubing in each bore.
- Calibration of water quality and water level equipment
- Preservation of samples with ice during transport from the field to the laboratory
- Transportation of samples with accompanying COC documentation
- Collection of blind and split duplicate samples and calculated Relative Percentage Differences (RPD)
- Comparison of field and analytical data
- Compliance with sample holding times
- Review of internal analysis of QC and laboratory duplicates
- Review of groundwater sampling and purging records

Table 1 Summary of groundwater sampling and laboratory analysis

Bore ID	Number of sampling occasions	Month/s sampled	Laboratory analytical suite
WORMBH15	Two	March and October 2020	A (March) and B (October). October analysis also included PFAS
WORMBH22	Three	March, September and October 2020	A (March) and B (September). October analysis for PFAS
WORMBH23	One	March 2020	A
WORMBH27	One	March and October 2020	A (March) and B (October)
WORMBH32	Two	March and August 2020	A (March) and B (August)
WORMBH49	One	March 2020	A (March) and B (October)
WORMBH01	Not sampled – insufficient water		
WORMBH03	Not sampled – insufficient water		
WORMBH04	One	August 2020	A
WORMBH05	Not sampled – insufficient water		
WORMBH06			
WORMBH07			
WORMBH09	One	September 2020	B
WORMBH10	Not sampled – insufficient water		
WORMBH11	One	August 2020	A
WORMBH12	One	August 2020	B
WORMBH14	One	August 2020	B

Bore ID	Number of sampling occasions	Month/s sampled	Laboratory analytical suite
WORMBH16	One	August 2020	A
WORMBH23a	One	August and October 2020	B (August). October analysis for PFAS

Laboratory analytical suites:

A: Salinity (measured as mg/L TDS), pH, EC, major ions.

Ammonia (as N), nitrate (as N), Nitrate (as N), nitrite (as N), total nitrogen, Total Kjeldahl Nitrogen

Sulfate as SO4, total phosphorous, metals screen

B: As above **plus** E.Coli, Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

Oil and grease, surfactants (methylene blue active substances - MBAS), IWRG621 (TPH, OCPs, PCBs, MAH, SVOCs and VOCs, cyanide, fluoride)

1.5 Aquifer (slug) testing

1.5.1 Methodology

Slug testing was completed on the monitoring bores in order to provide field estimates of hydraulic conductivity along the alignment.

Slug testing of the historic monitoring bores was completed as part of the earlier HA for the Project however, GHD (2020) recommended that slug testing these bores be completed again due to uncertainties in the initial results. As such, following redevelopment of these bores slug testing was undertaken again.

The testing procedure complied with Australian Standard AS2368 (1990)[1] and involved the displacement of water (i.e. creation of a slug) and the measurement of water level recovery. GHD used a Waterra slug, which was either raised or lowered within the borehole depending on whether a falling or rising head test was undertaken.

An Insitu® Leveltroll 700™ pressure transducer (30 PSI/21 m range) and datalogger was lowered to near the base of the monitoring bore being tested, below the base of the anticipated slug level. The Leveltroll 700™ was programmed to collect rapid measurements of water level changes within the first few seconds of water displacement.

The slug remained in place until water levels were considered to have equilibrated, as determined from inspection of the measured water levels. Multiple tests were undertaken on each bore to obtain a representative value of the hydraulic conductivity.

The slug test data were analysed using AQTESOLV, a commercial aquifer test software package (Duffield, 2007). The slug test data was analysed using the Bower Rice and Hvorslev methods.

1

AS2368-1990 has been withdrawn, however, in the absence of a superior alternative it is still used by GHD. GHD also relies upon the NSW Department of Industry draft pumping test guidelines (2019).

Appendix C – Risk assessment

The scoping requirements require a risk-based approach to be adopted during the design of EES studies, so that a greater level of effort is directed at investigating and managing those matters that pose relatively higher risk of adverse effects.

The risk assessment as part of the assessment framework for the EES, is described in Chapter 5 Evaluation and assessment framework.

The risk pathways define the cause and effect topics relevant to groundwater based on an understanding of the existing conditions and the Project activities. The risk pathways are provided in Table B1. Each pathway shows the initial risk rating based on standard management measures, and a residual risk rating based on additional management measures (if required) recommended through the impact assessment process.

The consequence of the risk occurring were assigned using a consequence guide specific for each technical discipline. The consequence guide is provided in Table B2.

The likelihood was assigned using a likelihood guide applied to all technical disciplines. The likelihood guide is provided in Table B3.

The risk rating was determined using the risk matrix developed for this EES. The risk matrix is shown in Table B4.

Table B1 Consequence approach

Level	Qualitative and/or quantitative description
Insignificant	Changes to groundwater levels, flows or quality have no detectable impact.
Minor	Changes to groundwater levels, flows or quality within range of typical variation and does not result in loss of one or more beneficial uses of groundwater.
Moderate	Changes to groundwater levels, flows or quality results in temporary and reversible loss of one or more beneficial uses of groundwater.
Major	Changes to groundwater levels, flows or quality results in permanent loss of one or more beneficial uses of groundwater in a local area.
Severe	Changes to groundwater levels, flows or quality results in permanent loss of one or more beneficial uses of groundwater over a widespread area.

Table B2 Likelihood approach

Level		Description
1	Rare	The event is conceivable and may occur only in exceptional circumstances
2	Remote	The event could occur but is not anticipated and may occur if certain abnormal circumstances prevail
3	Unlikely	The event is unlikely but could occur if certain circumstances prevail
4	Likely	The event will probably occur in most circumstances
5	Almost certain	The event is expected to occur in most circumstances or is planned to occur

Table B3 Risk rating approach

		Consequence rating				
		Insignificant	Minor	Moderate	Major	Severe
Likelihood rating	Almost certain	Low	Medium	High	Very high	Very high
	Likely	Low	Low	Medium	High	Very high
	Unlikely	Negligible	Low	Medium	High	High
	Remote	Negligible	Negligible	Low	Medium	High
	Rare	Negligible	Negligible	Negligible	Low	Medium

Table B4 Risk pathways

Risk No.	Works Area	Staging		Risk Pathway	Initial Environment Management Measures	Initial Risk			Additional Environmental Management Measures	Residual Risk		
	Pipeline or Compressor or MLV	Construction	Operation	Cause / effect		Consequence	Likelihood	Risk Level		Consequence	Likelihood	Risk Level
GW1	Pipeline	C		**Drawdown impacts on groundwater users (ie registered bores.)** Construction dewatering impacts to groundwater levels which impacts bore yields	**EMM GW1 (initial) -** Minimise dewatering rates and impact to groundwater levels and flows **EMM GW2 (initial) -** Minimise impact to groundwater bore users	Moderate	Remote	Low	No additional EMMs required	Moderate	Remote	Low
GW2	Pipeline	C		Drawdown impacts on groundwater dependent ecosystems (GDEs) and receiving environments (ie river/wetland base flows). Construction Dewatering impacts to groundwater levels/Flows at GDE or receiving environments	**EMM GW1 (initial) -** Minimising dewatering rates and impact to groundwater levels and flow	Minor	Likely	Low	No additional EMMs required	Minor	Likely	Low
GW3	Pipeline	C		**Drawdown activating ASS** Drawdown impacts exposes ASS - results in acid generation and quality impact down gradient users, gde and receiving environments	**EMM GW1 (initial) -** Minimising dewatering rates and impact to groundwater levels and flow **EMM C3 (Initial)** - Minimise Impacts from the disturbance of acid sulfate soils	Moderate	Remote	Low	No additional EMMs required	Moderate	Remote	Low
GW4	Pipeline	C		**Drawdown impacts causing settlement** Construction dewatering impacts to groundwater levels and groundwater pressure reduction causes settlement of the ground and impacts buildings/infrastructure	**EMM GW1 (initial) -** Minimising dewatering rates and impact to groundwater levels and flow **EMM GM01 (initial)** - Third party asset management **EMM GM02 (initial**) - Design and construction to be informed by geotechnical and hydrogeological conditions	Moderate	Rare	Negligible	No additional EMMs required	Moderate	Rare	Negligible
GW5	Pipeline	C		**Mobilisation of existing contaminated groundwater** Construction dewatering impacts to groundwater quality- Construction dewatering works cause mobilisation of existing contaminated groundwater which impact groudwater quality (beneficial use) and down gradient receptors (users/receiving environments- GDEs/rivers). Contaminated groundwater requires disposal without impacting beneficial use or human health	**EMM GW1 (initial) -** Minimising dewatering rates and impact to groundwater levels and flow - as above **EMM GW3 (initial) -** Minimise impacts associated with contaminated groundwater and disposal **EMM C4 (initial**)- Minimise risks from contaminated groundwater /trench water	Moderate	Remote	Low	No additional EMMs required	Moderate	Remote	Low
GW6	All	C		**Leaks or spills or runoff Construction impacts to groundwater quality** Construction activities such as an oil /fuel spill or por quality surface water entering groundwater and impacting on groundwater quality and downgradient users/ receiving environments (GDEs/rivers).	**EMM GW4 (initial) -** Manage chemicals, fuels and hazardous materials **EMM C6 (initial)**-Manage chemicals, fuels and hazardous materials	Moderate	Remote	Low	No additional EMMs required	Moderate	Remote	Low

Risk No.	Works Area	Staging		Risk Pathway	Initial Environment Management Measures	Initial Risk			Additional Environmental Management Measures	Residual Risk		
	Pipeline or Compressor or MLV	Construction	Operation	Cause / effect		Consequence	Likelihood	Risk Level		Consequence	Likelihood	Risk Level
GW7	All	C		**Drilling fluids used for HDD impacting groundwater quality** Drilling fluids/muds used for HDD sections impacting groundwater quality and beneficial use	**EMM GW5 (initial) -** Drilling Fluids Requirements	Minor	Remote	Negligible	No additional EMMs required	Minor	Remote	Negligible
GW8	All	C		**Disturbance and stockpiling of existing contaminated spoil** Construction activities such ASS soil or contaminated soil stockpiling, leaching and impacting on groundwater quality (benefical use) and downgradeint receptors -users/ receiving environments (GDEs/rivers).	**EMM GW6 (initial) -** Spoil Management Procedures	Moderate	Remote	Low	No additional EMMs required	Moderate	Remote	Low
GW9	All		O	**Impact to Groundwater flow paths and levels** After construction, and over time, the pipeline and the backfilled pipeline trench in areas where they intersect shallow groundwater, may disrupt or dislocate groundwater flow paths- which may cause preferential flow paths , mounding /drawdown, up gradient and downgradient . This may utlimatley impact users, GDEs/receiving waters flows/levels, or cause water logging	EMM GW7 (initial) - Design Requirements	Minor	Likely	Low	No additional EMMs required	Minor	Likely	Low
GW10	All		O	**Impact to Groundwater quality** After construction, and over time, the pipeline and the backfilled pipeline trench in areas where they intersect shallow groundwater, may disrupt or dislocate groundwater flow paths- which may cause preferential flow paths and movement of contaminated groundwater. This may impact users, GDEs/receiving waters.	EMM GW7 (initial) - Design Requirements	Minor	Unlikely	Low	No additional EMMs required	Minor	Unlikely	Low
GW11	All		O	**Leaks or spills or runoff** **Operation Impact to groundwater quality** Maintenance work along the pipeline and associated infrastructure in areas of shallow groundwater has the potential for fuel/oils spills or other waste which has the potential to contaminated groundwater. This may impact users, GDEs/receiving waters.	**EMM GW4 (initial) -** Manage chemicals, fuels and hazardous materials	Moderate	Remote	Low	No additional EMMs required	Moderate	Remote	Low

Appendix D – Geotechnical Bore Information

Geotechnical bore ID	Feature Description	Easting	Northing	RL	Bore depth (m)	Likely Construction Methodology	Depth of Auger Drilling	Core recovered from	Monitoring bore installed?	Monitoring bore depth (m)	Monitoring bore screen interval (m)
BH 01	Melton Highway Crossing	298813.290	5826160.140	139.576	15.2m	HDD	3.0m	3.0m			
BH 02	Melton Highway Crossing	298817.100	5826225.810	139.576	15.2m	HDD	2.8m	2.8m			
BH 03	MLV 1 _ Holden Road	299354.230	5829391.130	168.788	3.0m	Earthworks	3.0m	-			
BH04	Bendigo Rail Line Crossing	299706.910	5831080.690	170.143	3.4m	Horizontal Laser Bore Pipe Jacking	1.4m	1.4m			
BH 05	Bendigo Rail Line Crossing	299801.460	5831146.100	166.275	3.2m	Horizontal Laser Bore Pipe Jacking	1.2m	1.2m			
BH 06	Calder Freeway Crossing	300028.110	5831292.130	170.858	15.2m	HDD	2.2m	2.2m			
BH 07	Calder Freeway Crossing	300102.51	5831340.04	171.08	12.05	HDD	1.1	1.1			
BH 08	Calder Freeway Crossing	300170.510	5831383.090	170.952	15.2m	HDD	1.3m	1.3m			
BH 09	Duncans Lane	300872.230	5831684.480	163.403	2	N/A	2	NA			
BH 10C	Duncans Lane	300894.783	5831668.206	163.394	3.5	N/A	3.5	NA			
BH 11	Bulla - Diggers Rest Road	302022.400	5832384.640	165.257	2.3	Entry	2.3	NA			
BH 12	Bulla - Diggers Rest Road	302056.060	5832415.810	166.666	3.0 m	Exit	3.0 m	NA			
BH 12 (Alt.)	Bulla - Diggers Rest Road	302053.333	5832411.018	166.513		Exit					
BH14	Jacksons Creek Crossing	303791.109	5833565.330	129.387	30.25	HDD	7.1	20.4			
BH 15	Jacksons Creek Crossing	303810.977	5833652.464	121.446	20.3m	HDD	20	-	Yes	20.3	17.3 - 20.3
BH 16	Jacksons Creek Crossing	303809.653	5833702.122	124.903	20.3	HDD	3.7	No			
BH 18	Sunbury Road Crossing	304091.240	5834564.398	178.270	2.6	Horizontal Laser Bore Pipe Jacking	2.6	No			
BH 19	Sunbury Road Crossing	304129.515	5834573.440	180.533	2.3	Horizontal Laser Bore Pipe Jacking	2.3	No			
BH 21	Deep Creek Crossing	305685.670	5834596.670	126.700	30.5	HDD	3	3.6			
BH 22	Deep Creek Crossing	305819.460	5834711.840	102.588	5.7	HDD	5.7	NA	Yes	30.2	27.2 - 30.2
BH22A	Deep Creek Crossing	305820.874	5834713.254	102.588	30.24	HDD	18.1	18.1			
BH 23	Deep Creek Crossing	305954.882	5834829.412	101.597	30	HDD	0.8	0.8	Yes	30	27 - 30
BH 24	Deep Creek Crossing	306099.683	5834942.970	102.148	25.7	HDD	5.4	5.4			
BH 17	Proposed MLV 2 Location (TBC)	309598.48	5837221.99		4.8	Earthworks	2.4	2.4			
BH 25	Craigieburn Road Crossing	309737.000	5837897.920	234.402	5.25	Horizontal Laser Bore Pipe Jacking	5.25	NA			
BH 26	Craigieburn Road Crossing	309745.370	5837970.190	234.446	4.4	Horizontal Laser Bore Pipe Jacking	4.4	NA			
BH 28	Mickleham Road Crossing	312583.530	5841993.540	267.412	2.5	Horizontal Lase Bore Special Crossing	2.5	NA			
BH 29	Mickleham Road Crossing				2.55	Horizontal Lase Bore Special Crossing	2.55	NA			
BH 30	Donnybrook Road Crossing 1	313837.860	5843752.430	267.712	5.4	Horizontal Lase Bore Special Crossing	5.4	NA			
BH 31	Donnybrook Road Crossing 2	313843.822	5843798.620	264.843	3.0m	Horizontal Lase Bore Special Crossing	3.0m	-			
BH 32	Melbourne Retention Basin (Future Drains)	315954.007	5846801.058	231.550		HDD	10	10	Yes	20	17 - 20
BH 33	Melbourne Retention Basin (Future Drains)	316178.904	5846745.584	232.068	10.5	HDD	10.5	na			
BH 34	Melbourne Retention Basin (Future Drains)	316410.290	5846711.500	231.325	20.27	HDD	7.8	7.8			
BH 35	Melbourne Retention Basin (Future Drains)	316579.510	5846693.730	231.558	20.2	HDD	8.7	8.7			
BH 36	Melbourne Retention Basin (Future Drains)	316778.620	5846670.270	231.726	20.1	HDD	8.6	8.7			

Geotechnical bore ID	Feature Description	Easting	Northing	RL	Bore depth (m)	Likely Construction Methodology	Depth of Auger Drilling	Core recovered from	Monitoring bore installed?	Monitoring bore depth (m)	Monitoring bore screen interval (m)
BH 20	Melbourne Retention Basin (Future Drains)	317016.000	5846644.290	232.171	5.9	HDD	5.9	N			
BH 37	Hume Freeway Crossing	318785.190	5846412.100	258.975	15	HDD	0.8	0.8			
BH 38	Hume Freeway Crossing	318946.820	5846393.030	263.628	15.48m	HDD	0.9m	0.9m			
BH 39	North Eastern Rail Line Crossing	321998.440	5847705.330		3.4m	Horizontal Laser Bore Pipe Jacking	2.0m	2.0m			
BH 40	North Eastern Rail Line Crossing	322055.290	5847687.960	258.803	3.2m	Horizontal Laser Bore Pipe Jacking	0.8m	0.8m			
BH 27C	Merri Creek Crossing	323052.000	5846786.180	257.600	20.35	Open Cut	2	18.35	Yes	20.4	17.4 - 20.4
BH 41	Donnybrook Road Crossing 2	323507.352	5842698.182	235.832	2.25	Horizontal Lase Bore Special Crossing	1.05	1.2			
BH 42	Donnybrook Road Crossing 3	323501.910	5842660.410	234.994	2.6m	Horizontal Lase Bore Special Crossing	0.5m	0.5m			
BH 43	Wollert Station	322868.905	5839155.255		4.04m	Facilities Earthworks	4.04m	-			
BH 44	Wollert Station	322860.790	5839143.546		5.0m	Facilities Earthworks	5.0m	-			
BH 45	Wollert Station	322967.266	5839129.143	204.843	3.18m	Facilities Earthworks	2.0m	2.0m			
BH 46	Wollert Station	322796.892	5838977.810		4.3m	Facilities Earthworks	2.7	2.7			
BH 47	Wollert Station	322826.301	5838974.525		4.4m	Facilities Earthworks	1.5	1.5			
BH48	Wollert Station	322816.887	5838946.112		4.4m	Facilities Earthworks	2	2			
BH49	Merri Creek Crossing	323040.750	5846848.528	257.014	20.45m	Open Cut	1	19.45	Yes	20.5	17.5 - 20.5

Appendix E – Monitoring bore logs construction and geology logs

BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Beattys Road, Plumpton, Diggers Rest, Victoria

HOLE No. WORM_BH01

SHEET 1 OF 1

Position : 298476.5 E 5824085.6 N MGA 2020 Z55 **Surface RL:** 112.70m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 10/8/2020 **Date Completed :** 10/8/2020 **Logged by :** MM **Date:**

DRILLING					MATERIAL								
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	SFA Hand Auger			BH01_0.1 BH01_0.5	0.20 (112.50)		CI	Sandy CLAY; (medium plasticity), brown, sand fine grained, some rootlets, inferred reworked natural	W M	L F	trace basalt gravels		Cement-bentonite grout backfill to surface
1					1.20 (111.50)			Some large basalt boulders up to 50 mm	D				
	Air Hammer				1.60 (111.10)			BASALT; vesicular, dark grey, chips up to 3 mm, some calcite deposits	D				Bentonite seal Class 18 uPVC plain 50 mm diam. casing
2													
3													
4					4.00 (108.70)			Chips up to 9 mm diameter					
5													
6					6.50 (106.20)			Orange brown, high clay content, trace dark grey basalt gravels			extremely weathered		
7					7.50 (105.20)			Dark grey with trace orange brown, chips up to 2 mm					
8					8.00 (104.70)			Chips up to 4 mm					Gravel filter pack Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
9					9.00 (103.70)			Some iron oxide staining and calcite deposits					
10			▼		10.10 (102.60)			End of borehole at 10.1 metres.			groundwater encountered at ~9.90 m bgl		
11													
12													

Note: * indicates signatures on original issue of log or last revision of log

WELL PIEZOMETER

Gatic cover installed level with ground surface.

See standard sheets for details of abbreviations & basis of descriptions

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Job No.
31-12529997

BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited

Project : WORM - Environmental Effects Statement

Location : South of Bulla - Diggers Rest Road, Diggers Rest, Victoria

HOLE No. WORM_BH03

SHEET 1 OF 2

Position : 302006.8 E 5832383.2 N MGA 2020 Z55	**Surface RL:** 165.20m AHD	**Angle from Horiz. :** 90°	**Processed :** CM
Rig Type : Geoprobe	**Mounting:** Track	**Contractor :** Star Drilling	**Driller :** Jye	**Checked :** ADW
Date Started : 7/8/2020	**Date Completed :** 8/8/2020	**Logged by :** ADW	**Date:**

DRILLING					MATERIAL								WELL PIEZOMETER
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	HF Hand Auger			BH03_0.1 BH03_0.5 BH03_0.9			CH	CLAY; (high plasticity), dark grey and black, trace rootlets	M	VSt	Natural, no odours, etc		Gatic cover installed level with ground surface.
1					0.90 (164.30)			BASALT; dark blue - black, moderately weathered, trace vesicles	D		Basalt rock chips. Hand auger refusal @ 0.9 m Solid auger refusal @ 1.1 m		
2													
3					3.00 (162.20)			Minor red-brown staining, small vesicles present (>5%)			Driller notes soft drilling to ~5.5 m		
4													
5					5.00 (160.20)			Trace calcite					
6	Air Hammer				6.00 (159.20)			Dark blue, black, no vesicles, slightly weathered					Cement-bentonite grout backfill to surface
7													Class 18 uPVC plain 50 mm diam. casing
8					8.50 (156.70)			Trace vesicles, moderately weathered			softer drilling from ~8.5/9.0 m		
9													
10					10.00 (155.20)			BASALT; dark blue black and dark brown, moderately weathered, sigificant iron staining	M		Becoming moist ~10 m		
11					11.00 (154.20)			Trace vesicles					
12					12.00								

Note: * indicates signatures on original issue of log or last revision of log

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No.
31-12529997

BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited

Project : WORM - Environmental Effects Statement

Location : South of Bulla - Diggers Rest Road, Diggers Rest, Victoria

HOLE No. WORM_BH03

SHEET 2 OF 2

Position : 302006.8 E 5832383.2 N MGA 2020 Z55	**Surface RL:** 165.20m AHD	**Angle from Horiz. :** 90°	**Processed :** CM
Rig Type : Geoprobe	**Mounting:** Track	**Contractor :** Star Drilling	**Driller :** Jye	**Checked :** ADW
Date Started : 7/8/2020	**Date Completed :** 8/8/2020	**Logged by :** ADW	**Date:**

DRILLING					MATERIAL								WELL PIEZOMETER
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
13	Air Hammer		▼		(153.20) 13.00 (152.20)			Blue-black, moderately weathered, trace vesicles			Pause drilling at 12 m (15 mins) to see if water seeps into hole. No obvious water after 15 mins		Bentonite seal
14					14.00 (151.20)			CLAY; moderate-dark brown and red with minor extremely weathered rock fragments	M		Trace moisture		
15								BASALT; black and dark brown, heavily weathered	D				
16													
17													Gravel filter pack
18					18.00 (147.20)			Moderately weathered					Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
19					19.00 (146.20)			Blue-black, slightly weathered, massive					
20													
21					21.00 (144.20)			End of borehole at 21 metres.			Driller reports at 20.5 m rods 'fell' slightly => potential fracture. No water.		
22													
23													
24													

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Craigieburn Road (Luppino), Diggers Rest, Victoria

HOLE No. WORM_BH05

SHEET 1 OF 2

Position : 309792.6 E 5837964.3 N MGA 2020 Z55 **Surface RL:** 234.70m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 4/8/2020 **Date Completed :** 4/8/2020 **Logged by :** MM **Date:**

DRILLING					MATERIAL								Note: * indicates signatures on original issue of log or last revision of log
													WELL PIEZOMETER
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	Hand Auger		Groundwater Not Encountered During Drilling	BH05_0.1	0.10 (234.60)		CL-CI	CLAY; (low to medium plasticity), dark brown, trace fine grained sand, some rootlets	M / D	F			Gatic cover installed level with ground surface.
				BH05_0.5	0.50 (234.20)			Becoming brown		St			
1				BH05_1.0									
2				BH05_2.0	2.00 (232.70)		CI	(Medium plasticity), grey with some orange brown banding					
3	Solid Flight Auger												
4													
5					5.40 (229.30)			BASALT; vesicular, dark grey, some pale grey clay, chips up to 2 mm	D				
6													
7					7.00 (227.70)			Chips up to 4 mm					Cement-bentonite grout backfill to surface
					7.60 (227.10)			Dark grey with orange brown, becoming more weathered					
8	Air Hammer												Class 18 uPVC plain 50 mm diam. casing
9													
10					10.00 (224.70)			Becoming dark grey			Stop drilling at 10 m to see if groundwater enters hole. Waited 15 mins, no water, continue drilling		
11					11.00 (223.70)			Becoming dark grey with orange brown					
12													

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31 12529997 APA_EES WORM LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited

Project : WORM - Environmental Effects Statement

Location : Craigieburn Road (Luppino), Diggers Rest, Victoria

HOLE No. WORM_BH05

SHEET 2 OF 2

Position : 309792.6 E 5837964.3 N MGA 2020 Z55 **Surface RL:** 234.70m AHD **Angle from Horiz. :** 90° **Processed :** CM

Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW

Date Started : 4/8/2020 **Date Completed :** 4/8/2020 **Logged by :** MM **Date:**

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL							WELL PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
13	Air Hammer		Groundwater Not Encountered During Drilling		13.00 (221.70)			Becoming orange brown, some clay, becoming more weathered					
14					14.00 (220.70)			Becoming orange brown with dark grey					
15					15.00 (219.70)			Becoming dark grey					Bentonite seal
16													
17													
18					18.00 (216.70)			Becoming dark grey with orange brown, some iron oxide staining					Gravel filter pack Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
19					19.00 (215.70)			Trace calcite deposits on chips					
20					20.10 (214.60)			End of borehole at 20.1 metres.					
21													
22													
23													
24													

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Mickelham Road (Hadshir), Diggers Rest, Victoria

HOLE No. WORM_BH06

SHEET 1 OF 1

Position : 312596.5 E 5842025.5 N MGA 2020 Z55 **Surface RL:** 267.60m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 5/8/2020 **Date Completed :** 6/8/2020 **Logged by :** MM **Date:**

DRILLING					MATERIAL								WELL PIEZOMETER
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	Hand Auger			BH06_0.1	0.10 (267.50)		CI	TOPSOIL; grass	M	L			Gatic cover installed level with ground surface.
				BH06_0.5	0.50 (267.10)			CLAY; (medium plasticity), brown, some rootlets, trace sub \angular gravels, inferred natural	D-M	F			
1	Solid Flight Auger			BH06_1.0				Becoming orange brown	D	St			
2				BH06_2.0	2.00 (265.60)			Becoming pale brown					
					2.70 (264.90)			BASALT; vesicular, dark grey, trace iron oxide staining, chips up to 9 mm	D				Cement-bentonite grout backfill to surface
3													
4													Class 18 uPVC plain 50 mm diam. casing
5			Groundwater Not Encountered		5.00 (262.60)			Dark grey, chips up to 3 mm, inferred slightly weathered					
					5.50 (262.10)			Zone of reddish brown clay dust,					
					5.80 (261.80)			inferred highly weathered zone					
6													
7	Air Hammer				7.00 (260.60)			Trace calcite deposits on chips					Bentonite seal
8					8.00 (259.60)			Trace iron oxide staining					
9													
10					10.00 (257.60)			Becoming dark grey with reddish brown with some calcite deposits and iron oxide staining, inferred moderately weathered					Gravel filter pack
													Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
11													
12					12.00 (255.60)			Becoming dark grey, inferred slightly to moderately fractured					
								End of borehole at 12.1 metres.					
13													
14													

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31 12529997 APA_EES WORM LOGS.GPJ GHD GEO TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited

Project : WORM - Environmental Effects Statement

Location : Ascotown, easement immed. south of trees, Diggers Rest, Victoria

HOLE No. WORM_BH07

SHEET 1 OF 1

Position : 314438.2 E 5845331.8 N MGA 2020 Z55	**Surface RL:** 242.10m AHD	**Angle from Horiz. :** 90°	**Processed :** CM
Rig Type : Geoprobe	**Mounting:** Track	**Contractor :** Star Drilling	**Driller :** Jye	**Checked :** ADW
Date Started : 3/9/2020	**Date Completed :** 3/9/2020	**Logged by :** MM	**Date:**

DRILLING					MATERIAL								WELL PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations		WELL PIEZOMETER Log	Components
1	Hand Auger			BH07_0.1	0.50 (241.60)		CL	Sandy CLAY; (low plasticity), brown, sand, fine grained, some rootlets	D	S				Gatic cover installed level with ground surface.
				BH07_0.5			CL-CI	(Low to medium plasticity), some grey clay		F-St				
				BH07_1.0	1.00 (241.10)			Becoming brown with brown orange						
2				BH07_2.0	2.00 (240.10)			Sand, fine to medium grained, sub angular						Cement-bentonite grout backfill to surface
3					3.00 (239.10)			Orange brown						
4														Class 18 uPVC plain 50 mm diam. casing
5					5.00 (237.10)			Light orange brown						
6	Solid Flight Auger		Groundwater Not Encountered		6.00 (236.10)			Orange brown						Bentonite seal
7														
8														
9					9.00 (233.10)		CL	(Low plasticity)		St				
10					10.00 (232.10)			Becoming dark brown orange			Removed augers after 10 m and waited to see if water came into hole, then continued down to 12 m.			Gravel filter pack Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
11					11.00 (231.10)			Orange brown with some pale grey clay						
12					12.00 (230.10)			End of borehole at 12 metres.						
13														
14														

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Gunns Gully Road, Diggers Rest, Victoria

HOLE No. WORM_BH09

SHEET 1 OF 1

Position : 316615.3 E 5846719.0 N MGA 2020 Z55 **Surface RL:** 231.80m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 14/8/2020 **Date Completed :** 14/8/2020 **Logged by :** ADW **Date:**

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL							WELL PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	Hand Auger			BH09_0.1			CH	CLAY; dark grey and black, (highly plastic), rootlets present	M		No ordours/staining, etc. No obvious evidence of ASS		Gatic cover installed level with ground surface.
0.5				BH09_0.5									
1				BH09_1.0									
2				BH09_2.0	2.00 (229.80)			Moderate grey and black			Augers wet on removal / obvious soil moisture		
3					3.00 (228.80)			Grey black with minor red-brown			Firm drilling		Cement-bentonite grout backfill to surface
4				BH09_4.0 (ASS only)									Class 18 uPVC plain 50 mm diam. casing
5					5.00 (226.80)			Very firm clay, light-moderate brown with red-brown streaks		F-St			
6	Solid Flight Auger				6.00 (225.80)			Moderate grey with minor black		VSt			
7													Bentonite seal
8			▼		8.00 (223.80)			Light grey and brown sticky					
9					9.00 (222.80)			Tan brown with minor grey, trace rock fragments					
10													Gravel filter pack
10.5													Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
11					11.00 (220.80)			Moderate-dark brown and black, (plastic)					
12					12.00 (219.80)			End of borehole at 12 metres.			Auger refusal @ 12 m.		
13													
14													

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Gunns Gully Road, Diggers Rest, Victoria

HOLE No. WORM_BH10

SHEET 1 OF 1

Position : 318474.6 E 5846478.3 N MGA 2020 Z55 **Surface RL:** 242.80m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 14/8/2020 **Date Completed :** 14/8/2020 **Logged by :** ADW **Date:**

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL							WELL PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	Hand Auger			BH10_0.1 BH10_0.5			CI	CLAY; dark grey-black, (plastic), rootlets throughout	M		No odours/smells		
1				BH10_1.0 + DUP01							Duplicate soil sample taken @ 1 m		
2				BH09_2.0									
3					3.00 (239.80)			Becoming brown			'crunchy' @ 3.5 m		Cement-bentonite grout backfill to surface
4					4.00 (238.80)			Light-moderate brown with some grey, trace purple	D		Firm drilling		Class 18 uPVC plain 50 mm diam. casing
5													
6	Solid Flight Auger				6.00 (236.80)			Light brown - tan brown with some grey			No evidence of rock (basalt), auger still going down Firm drilling		
7					7.00 (235.80)			Predominately light grey with tan brown, trace purple		St			Bentonite seal
8					8.00 (234.80)			Moderate-dark brown and purple					
9					9.00 (233.80)			Dark brown and red with purple tinge					
10					10.00 (232.80)			Deep red			Firm drilling		Gravel filter pack
11					11.00 (231.80)			As above, minor grey present					Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
12			▼		12.00 (230.80)			End of borehole at 12 metres.					Finished with a 300 mm cast iron gatic
13													
14													

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

Client : Australian Pipeline Limited

Project : WORM - Environmental Effects Statement

Location : Donovans Lane (Sirius), Diggers Rest, Victoria

HOLE No. WORM_BH11

SHEET 1 OF 1

Position : 319872.0 E 5847694.5 N MGA 2020 Z55 **Surface RL:** 259.30m AHD **Angle from Horiz. :** 90° **Processed :** CM

Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW

Date Started : 13/8/2020 **Date Completed :** 13/8/2020 **Logged by :** MM **Date:**

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL								WELL PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components	
0	Hand Auger			BH11_0.1	0.20 (259.10)			TOPSOIL; grass	W	S				
							CL-CI	Sandy CLAY; (low to medium plasticity), brown, sand fine grained, some rootlets, inferred natural	M	F				
				BH11_0.5	0.50 (258.80)		CI		D					
1				BH11_1.0	1.00 (258.30)		CL	(Medium plasticity), brown with grey		St				
								(Low plasticity), pale brown with orange						
2				BH11_2.0	2.00 (257.30)			Trace gravels up to 3 mm					Cement-bentonite grout backfill to surface	
3					3.00 (256.30)		CL	Sandy gravelly CLAY; (low plasticity), pale brown, gravels sub angular and up to 4 mm, sand fine grained	D	St			Class 18 uPVC plain 50 mm diam. casing	
4														
5	Solid Flight Auger		Groundwater Not Encountered During Drilling		5.00 (254.30)			With grey and orange brown banding					Bentonite seal	
6														
7														
8					8.00 (251.30)		CL-CI	(Low to medium plasticity), brown					Gravel filter pack	
9					9.00 (250.30)			Red brown					Class 18 uPVC 0.4mm aperture slotted 50 mm diam. casing	
10					10.10 (249.20)			End of borehole at 10.1 metres.						
11														
12														

Components

Gatic cover installed level with ground surface.

See standard sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31_12529997_APA_EES_WORM_LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Donovans Lane, Diggers Rest, Victoria

HOLE No. WORM_BH12

SHEET 1 OF 1

Position : 321626.7 E 5847843.0 N MGA 2020 Z55	**Surface RL:** 255.10m AHD	**Angle from Horiz. :** 90°	**Processed :** CM
Rig Type : Geoprobe	**Mounting:** Track	**Contractor :** Star Drilling	**Driller :** Jye	**Checked :** ADW
Date Started : 3/8/2020	**Date Completed :** 3/8/2020	**Logged by :** MM	**Date:**

DRILLING					MATERIAL								WELL PIEZOMETER
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
1	Hand Auger		▼ BH12_0.1 ▽ BH12_0.5	BH12_1.0			CI	Gravelly CLAY; grey to dark grey, (medium plastricity), gravels, sub angular and up to 8 mm, trace rootlets, inferred natural	D	F			Gatic cover installed level with ground surface. Cement-bentonite grout backfill to surface
1	SFA				1.70 (253.40)				M	F-St	Groundwater at 1.4 m bgl following removal of rods, then stabilised at ~0.6 m bgl.		Class 18 uPVC plain 50 mm diam. casing Bentonite seal
2								BASALT; vesciular, dark grey, vesicles, up to 2 mm, trace iron oxide staining	M-W				
3					3.00 (252.10)				W		3.0 m, no more dust from cyclone unit, some steam blowing out		
4	Air Hammer				4.00 (251.10)			Becoming dark grey to reddish brown, iron oxide staining					Gravel filter pack Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
5													
6					6.10 (249.00)			End of borehole at 6.1 metres.					
7													
8													
9													
10													

Note: * indicates signatures on original issue of log or last revision of log

See standard sheets for details of abbreviations & basis of descriptions

GHD
Lvl 8, 180 Lonsdale Street, Melbourne VIC 3000
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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No.
31-12529997

BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31 12529997 APA_EES WORM LOGS.GPJ GHD_GEO TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Donnybrook Road, Diggers Rest, Victoria

HOLE No. WORM_BH14

SHEET 1 OF 1

Position : 323525.9 E 5842612.5 N MGA 2020 Z55 **Surface RL:** 233.90m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 6/8/2020 **Date Completed :** 7/8/2020 **Logged by :** ADW **Date:**

DRILLING					MATERIAL								WELL PIEZOMETER
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
0	Hand Auger			BH14_0.1	0.10 (233.80)		CI	TOPSOIL; brown, with grass	M	S			Gatic cover installed level with ground surface.
								Silty CLAY; (medium plasticity), dark brown, some rootlets, trace gravels, inferred reworked natural	D-M	S			
				BH14_0.5	0.50 (233.40)			Brown with grey	D	F			
1	SFA		▼	BH14_1.0	1.00 (232.90)		CH	CLAY; dark black-brown, stiff, (highly plastic)	M				Cement-bentonite grout backfill to surface
				BH14_1.5									
2				BH14_2.0	2.10 (231.80)			BASALT; dark blue-black, moderately weathered	D		Auger refusal @ 2.1 m		Class 18 uPVC plain casing
3					3.50 (230.40)			Mod-slightly weathered trace vesicles					Bentonite seal
4													
5	Air Hammer				5.00 (228.90)			Red - brown iron staining present, moisture starts / noted @ 5 m			Moist from 5 m depth to ~7 m depth		
6					6.00 (227.90)			Minor iron staining still present	M				
7					7.00 (226.90)			Dark blue black, slightly weathered	W				Gravel filter pack
8											Wet/sloppy @ 8 m		Class 18 uPVC 0.4mm aperture slotted casing
9					9.00 (224.90)			End of borehole at 9 metres.			Wet @ 9 m		
10													

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Job No.
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BOREHOLE LOG SHEET WITH WELL PIEZOMETER

GEO_BOREHOLE 31 12529997 APA_EES WORM LOGS.GPJ GHD_GEO_TEMPLATE 2.00.GDT 11/9/20

Client : Australian Pipeline Limited
Project : WORM - Environmental Effects Statement
Location : Wollert Compressor Station, Diggers Rest, Victoria

HOLE No. WORM_BH16

SHEET 1 OF 1

Position : 322804.2 E 5839069.7 N MGA 2020 Z55 **Surface RL:** 203.80m AHD **Angle from Horiz. :** 90° **Processed :** CM
Rig Type : Geoprobe **Mounting:** Track **Contractor :** Star Drilling **Driller :** Jye **Checked :** ADW
Date Started : 5/8/2020 **Date Completed :** 5/8/2020 **Logged by :** MM **Date:**

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL							WELL PIEZOMETER	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	WELL PIEZOMETER Log	Components
1	HA			BH16_0.1 BH16_0.5			CI	CLAY; dark grey, (medium plasticity), some rootlets, trace sub angular gravels, inferred reworked natural	D	F-St			Gatic cover installed level with ground surface.
					1.10 (202.70)					F			
								BASALT; vesicular, dark grey, chips up to 14 mm, inferred moderately fractured, trace iron oxide	D		Refusal with hand auger on basalt floater @ 0.9 m Refusal with solid auger @ 1.1 m		
2													Cement-bentonite grout backfill to surface
3					3.00 (200.80)			Dark grey with some orange brown staining, trace brown clay					
4					4.00 (199.80)								Class 18 uPVC plain 50 mm diam. casing
					4.20 (199.60)			Dark grey with orange brown increasing clay content					
					4.70 (199.10)			CLAY; zone of orange brown, inferred highly weathered					
5								BASALT; some iron oxide staining on chips, chips up to 9 mm					Bentonite seal
6	Air Hammer		Groundwater Not Encountered During Drilling								Drilled to 6.0 m, then took break to monitor for water. Hole still dry after 20 minutes, so continued to 10.0 m.		
7					7.00 (196.80)			Chips up to 6 mm, increasing clay content					
8					8.00 (195.80)			Becoming dark grey, chips up to 5 mm, inferred slightly to moderately weathered					Gravel filter pack Class 18 uPVC 0.4 mm aperture slotted 50 mm diam. casing
9													
10					10.10 (193.70)			End of borehole at 10.1 metres.					
11													
12													

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Job No.
31-12529997

Construction Sciences

BOREHOLE LOG SHEET

Client: APA Group
Project: 18035-PP-C-060 - WORM
Location: Deep Creek Crossing

Hole No: BH23A

Job No: P/37 **Sheet:** 1 of 6

Position: E305956.128 N5834802.029 55 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:** 101.145 m AHD

Rig Type: DB520 E-Spec **Mounting:** Track **Driller:** JK

Casing/Hole Diameter: HWT / 114/150 **Contractor:** Numac

Date Started: 30/7/20 **Date Completed:** 31/7/20 **Logged By:** JSM **Checked By:** RK

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Tes ing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
AD/T		HWT	03/08/20		101	0		CH	TOPSOIL: CLAY: high plasticity, dark brown, organic material present 0.30m			TOPSO L	
									Gravelly Sandy CLAY: medium plasticity, brown, fine to coarse grained sand, fine to coarse grained gravel, with basalt sub-rounded cobbles			ALLUVIUM	
					100	1				M (>PL)			
					99	2							
					98	3		CI					
						4				W			
					97				rock cobbles present, increased drilling instability				
					96	5				M (>PL)			

METHOD
- EX Excavator bucket
- R Ripper
- HA Hand auger
- PT Push tube
- SON Sonic drilling
- AH Air hammer
- PS Percussion sampler
- AS Short spiral auger
- AD/V Solid flight auger: V-Bit
- AD/T Solid flight auger: TC-Bit
- HFA Hollow flight auger
- WB Washbore drilling
- RR Rock roller

PENETRATION
- VE Very Easy (No Resistance)
- E Easy
- F Firm
- H Hard
- VH Very Hard (Refusal)

WATER
- Water Level on Date shown
- water inflow
- water outflow

FIELD TESTS
- SPT - Standard Penetration Test
- PP - Hand/Pocket Penetrometer
- DCP - Dynamic Cone Penetrometer
- PSP - Perth Sand Penetrometer
- MC - Moisture Content
- PBT - Plate Bearing Test
- MP - Borehole Impression Test
- P D - Photoionisation Detector
- VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
- B - Bulk disturbed sample
- D - Disturbed sample
- ES - Environmental sample
- U - Thin wall tube 'undisturbed'

MOISTURE
- D - Dry
- M - Moist
- W - Wet
- PL - Plastic limit
- LL - Liquid limit
- *w* - Moisture content

SOIL CONSISTENCY
- VS - Very Soft
- S - Soft
- F - Firm
- St - Stiff
- VSt - Very Stiff
- H - Hard

RELATIVE DENSITY
- VL - Very Loose
- L - Loose
- MD - Medium Dense
- D - Dense
- VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

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Construction Sciences

BOREHOLE LOG SHEET

Client: APA Group
Project: 18035-PP-C-060 - WORM
Location: Deep Creek Crossing

Hole No: BH23A

Job No: P/37 **Sheet:** 2 of 6

Position: E305956.128 N5834802.029 55 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:** 101.145 m AHD

Rig Type: DB520 E-Spec **Mounting:** Track **Driller:** JK

Casing/Hole Diameter: HWT / 114/150 **Contractor:** Numac

Date Started: 30/7/20 **Date Completed:** 31/7/20 **Logged By:** JSM **Checked By:** RK

Drilling: Method	Drilling: Resistance	Drilling: Casing	Drilling: Water	Sampling & Tes ing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classifica ion	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
AD/T		HWT			95	7		CI	Gravelly Sandy CLAY: medium plasticity, brown, fine to coarse grained sand, fine to coarse grained gravel, with basalt sub-rounded cobbles *(continued)*	M (>PL)		ALLUVIUM	
					94	8							
					93	9			9.00m				
					92	10			Silty CLAY: high plasticity, grey/pale grey, (Extremely Weathered siltstone)			WEATHERED ROCK	
WB					91	11		CH	decreased drilling resistance				
					90								

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
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P D - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Residual (uncorrected kPa)

SAMPLES
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D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
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H - Hard

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
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Construction Sciences

BOREHOLE LOG SHEET

Client: APA Group
Project: 18035-PP-C-060 - WORM
Location: Deep Creek Crossing

Hole No: BH23A

Job No: P/37 **Sheet:** 3 of 6

Position: E305956.128 N5834802.029 55 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:** 101.145 m AHD

Rig Type: DB520 E-Spec **Mounting:** Track **Driller:** JK

Casing/Hole Diameter: HWT / 114/150 **Contractor:** Numac

Date Started: 30/7/20 **Date Completed:** 31/7/20 **Logged By:** JSM **Checked By:** RK

Drilling			Water	Sampling & Tes ing	RL (m AHD)	Depth (m)	Material Description						Monitoring Well Details
Method	Resistance	Casing		Sample or Field Test			Graphic Log	Classifica ion	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	
WB		HWT			89			CH	Silty CLAY: high plasticity, grey/pale grey, (Extremely Weathered siltstone) *(continued)*			WEATHERED ROCK	
					88	13							
					87	14							
					86	15							
					85	16							
					84	17							

METHOD
- EX Excavator bucket
- R Ripper
- HA Hand auger
- PT Push tube
- SON Sonic drilling
- AH Air hammer
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- AD/V Solid flight auger: V-Bit
- AD/T Solid flight auger: TC-Bit
- HFA Hollow flight auger
- WB Washbore drilling
- RR Rock roller

PENETRATION
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- VH Very Hard (Refusal)

WATER
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Construction Sciences

BOREHOLE LOG SHEET

Client: APA Group
Project: 18035-PP-C-060 - WORM
Location: Deep Creek Crossing

Hole No: BH23A

Job No: P/37 **Sheet:** 4 of 6

Position: E305956.128 N5834802.029 55 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:** 101.145 m AHD

Rig Type: DB520 E-Spec **Mounting:** Track **Driller:** JK

Casing/Hole Diameter: HWT / 114/150 **Contractor:** Numac

Date Started: 30/7/20 **Date Completed:** 31/7/20 **Logged By:** JSM **Checked By:** RK

Drilling: Method	Drilling: Resistance	Drilling: Casing	Drilling: Water	Sampling & Tes ing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
WB		HWT			83	19			Silty CLAY: high plasticity, grey/pale grey, (Extremely Weathered siltstone) *(continued)*			WEATHERED ROCK	
					82	20							
					81	21		CH					
					80	22			increased drilling resistance				
					79	23			22.80m Silty CLAY: medium to high plasticity, grey mottled brown, (Extremely Weathered mudstone)				
					78			CI-CH					

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
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RR Rock roller

PENETRATION
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water inflow
water outflow

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Construction Sciences

BOREHOLE LOG SHEET

Client: APA Group
Project: 18035-PP-C-060 - WORM
Location: Deep Creek Crossing

Hole No: BH23A

Job No: P/37 **Sheet:** 5 of 6

Position: E305956.128 N5834802.029 55 GDA2020 **Angle from Horizontal:** 90° **Surface Elevation:** 101.145 m AHD

Rig Type: DB520 E-Spec **Mounting:** Track **Driller:** JK

Casing/Hole Diameter: HWT / 114/150 **Contractor:** Numac

Date Started: 30/7/20 **Date Completed:** 31/7/20 **Logged By:** JSM **Checked By:** RK

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Tes ing: Sample or Field Test	RL (m AHD)	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations	Monitoring Well Details
WB					77			CI-CH	Silty CLAY: medium to high plasticity, grey mottled brown, (Extremely Weathered mudstone) *(continued)*			WEATHERED ROCK	
									24.35m increased drilling resistance				
									Continued as Cored Drill Hole				
					76	25							
					75	26							
						27							
					74								
						28							
					73								
						29							
					72								

METHOD
- EX Excavator bucket
- R Ripper
- HA Hand auger
- PT Push tube
- SON Sonic drilling
- AH Air hammer
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RELATIVE DENSITY
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Construction Sciences

CORE LOG SHEET

Hole No: BH23A

Client: APA Group
Project: 18035-PP-C-060 - WORM
Location: Deep Creek Crossing

Job No: P/37 | Sheet: 6 of 6

Position: E305956.128 N5834802.029 55 GDA2020 | Angle from Horizontal: 90° | Surface Elevation: 101.145 m AHD

Rig Type: DB520 E-Spec | Mounting: Track | Driller: JK

Casing Diameter: HWT | Bit Type: TC | Bit Condition: | Contractor: Numac

Date Started: 30/7/20 | Date Completed: 31/7/20 | Logged By: JSM | Checked By: RK

Coring						Material Description			Defect Description			
Method	Fluid	TCR (%)	RQD (%)	RL (m AHD)	Depth (m)	Graphic Log	SOIL TYPE, plasticity or particle characteristic, colour, secondary & minor components ROCK NAME, grain size and type, colour, fabric and texture, inclusions & minor components	Weathering	Estimated Strength $Is_{(50)}$ MPa ●-Axial O-Diametral (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	Average Natural Defect Spacing (mm) (20, 60, 200, 600, 2000)	Visual	Additional Data DEFECT TYPE, orientation, shape, roughness, infilling or coating, thickness, other	Monitoring Well Details
				77			24.35m START CORING AT 24.35m						
HQ		100	15		25		MUDSTONE: fine grained, grey mottled brown 25.15m	MW				24.42 m: JT, 30°, UN, C 24.44 m: JT, 50°, UN, C 24.56 m: JT, 15°, CU, S, CN 24.59 m: JT, 10°, CU, C 24.71 m: JT, 15°, CU, S, VNR 24.72 m: JT, 15°, CU, S, CN 24.79 m: JT, 50°, CU, S, VNR 24.82 m: JT, 25°, CU, S, VNR 24.83 - 24.93 m: JT, 75°, CU, S, VNR 24.85 - 24.92 m: JT, 60°, ST, S, VNR 24.89 m: JT, 5°, UN, S, VNR 24.90 m: JT, 5°, UN, S, VNR 24.93 m: JT, 10°, CU, S, VNR 24.96 m: JT, 15°, UN, S, VNR 24.99 m: JT, 20°, UN, S, VNR 25.06 - 25.10 m: JT, 20°, ST, S, VNR 25.15 m: DB	
				76			TERMINATED AT 25.15 m Target depth						
				75	26								
				74	27								
				73	28								
				72	29								

DRILLING
- AD/V Solid flight auger: V-Bit
- AD/T Solid flight auger: TC-Bit
- HFA Hollow flight auger
- WB Washbore drilling
- RR Rock roller
- PQ Rotary core (85mm)
- HQ Rotary core (63.5mm)
- NMLC Rotary core (51.94mm)
- DT Diatube concrete coring
- PT Push tube
- PS Percussion sampling
- SON Sonic drilling
- AH Air hammer

WATER
- Water Level on date shown
- water inflow
- water outflow

ROCK QUALITY DESCRIPTIONS
- RQD Rock Quality Designation (%)
- TCR Total Core Recovery (%)

ROCK STRENGTH
- EH Extremly High
- VH Very High
- H High
- M Medium
- L Low
- VL Very Low

ROCK WEATHERING
- FR Fresh
- SW Slightly Weathered
- DW Distinctly Weathered
- MW Moderately Weathered
- HW Highly Weathered
- XW Extremly Weathered

DEFECT TYPE
- JT Joint
- SZ Sheared zone
- BP Bedding Parting
- SM Seam
- FL Foliation
- VN Vein
- CL Cleavage
- CS Crushed Seam
- FZ Fracture Zone
- DL Drift Lift
- HB Handing Break
- DB Drilling Break

PLANARITY
- CU Curved
- DIS Discontinuous
- IR Irregular
- PR Planar
- ST Stepped
- UN Undulose

ROUGHNESS
- VR Very Rough
- RF Rough
- S Smooth
- SL Slockensided
- POL Polished

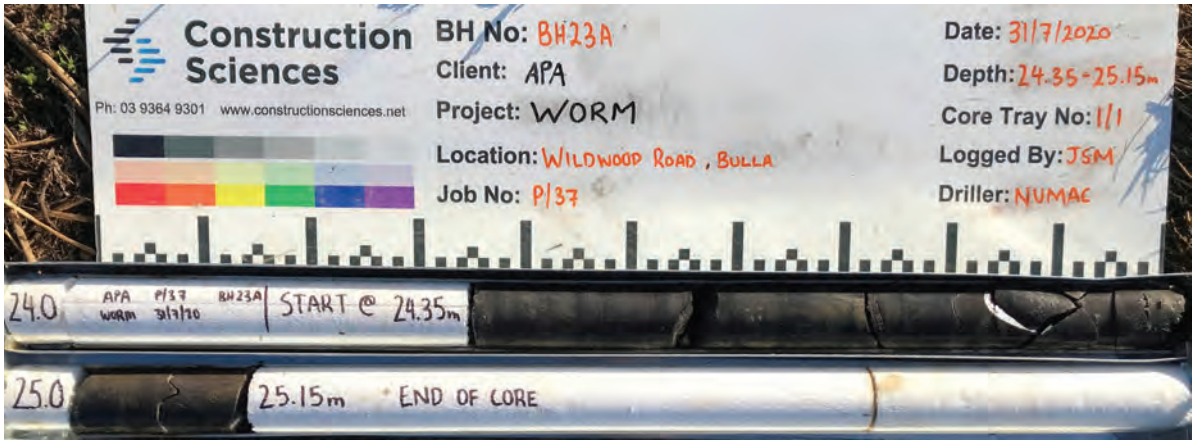
COATING
- CN Clean
- SN Stained
- VNR Veneer (thin or patchy)
- CT Coating (up to 1mm)

INFILL MATERIALS
- X Carbonaceus
- MU Unidentified minteral
- MS Secondary mineral
- KT Chlorite
- CA Calcite
- Fe Iron Oxide
- Qz Quartz

Refer to explanatory notes for details of abbreviations and basis of descriptions

CONSTRUCTION SCIENCES PTY LTD

MG CHANGES CONSTRUCTION SCIENCES HR 26.02.2020 PIEZOS 2.01.4 LIB.GLB Log CS CORED BOREHOLE P774LOGS MASTER FILE MG CHANGES 17.08.GPJ <<DrawingFile>> 18/09/2020 16:27 10.01.00.11 Datgel AGS RTA, Photo, Monitoring Tools



Construction Sciences	DRAWING TITLE: APA GROUP WORM WESTERN OUTER RING MAIN BH23A - COREBOX PHOTOS	PROJECT No: P/37	FIGURE No: 01/01
		DRAWN: [redacted]	DATE: 06/08/2020
		CHECKED: [redacted]	DATE: 06/08/2020
		SCALE: Not To Scale	A4

Construction Sciences

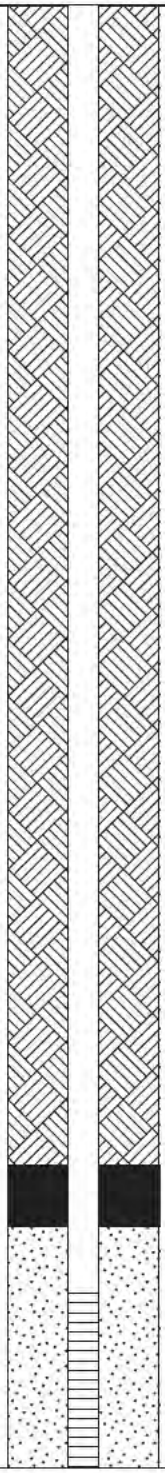
PIEZOMETER INSTALLATION LOG

Hole ID: **BH23A**

CLIENT	: APA Group	POSITION	: Deep Creek Crossing	SHEET	: 1 OF 1
CONTRACTOR	: Numac	EASTING	: 305956.1	STATUS	: 1
PROJECT	: 18035-PP-C-060 - WORM	NORTHING	: 5834802.0	LOGGED BY	: JSM
LOCATION	:	COORD. SYS.	: GDA2020 55	DRILL DATE	: 30/07/2020 - 31/07/2020
PROJECT No.	: P/37	GROUND RL	: 101.15 m AHD		

Method	Drilling Water	Depth (m)	Elevation (m AHD)	Graphic Log	Description Soil / Rock Description
AD/T		0	100		TOPSOIL: CLAY: high plasticity, dark brown, organic material present TOPSOIL
					Gravelly Sandy CLAY: medium plasticity, brown, fine to coarse grained sand, fine to coarse grained gravel, with basalt sub-rounded cobbles ALLUVIUM
		5	95		rock cobbles present, increased drilling instability
		10	90		Silty CLAY: high plasticity, grey/pale grey, (Extremely Weathered siltstone) WEATHERED ROCK decreased drilling resistance
WB		15	85		
		20	80		increased drilling resistance
					Silty CLAY: medium to high plasticity, grey mottled brown, (Extremely Weathered mudstone) WEATHERED ROCK increased drilling resistance
HQ		25			MUDSTONE: moderately weathered to moderately weathered, low strength, fine grained, grey mottled brown WEATHERED ROCK
					END OF BOREHOLE @ 25.15 m TARGET DEPTH

ID	Type	Tip Depth & RL	Installation Date	Static Water Level
SP-BH23A	Standpipe	25.15 m 76.00 m AHD	31/07/2020	



RIG	: DB520 E-Spec	CHECKED BY	: RK	REMARK
INCLINATION	: -90°	CHECKED DATE	: 18/08/2020	
AZIMUTH	:	APPROVED BY	:	
HOLE DIA.	: 150/114 mm	APPROVED DATE	:	

MG CHANGES CONSTRUCTION SCIENCES HR 26.02.2020 PIEZOS 2.01.4 LIB.GLB Log MON PIEZOMETER INSTALLATION LOG P774LOGS MASTER FILE MG CHANGES 17.08.GPJ <<DrawingFile>> 18/08/2020 16:37 10.01.00.11 Datgel AGS RTA, Photo, Monitoring Tools

Form Number: DGM03 RL0

Appendix F – Groundwater purge sheets

Groundwater Sampling Sheet

Bore ID: BH15

Client: APA	**Date:** 03.03.2020
Project: APA WORM Hydro. Study	**Time:** 9.45
Job No: 12517812	**Staff:**

Gatic Type: Flush / (Monument)
Gatic Maintanence: Y / (N) *(If Y, provide comments)*
Casing Diameter (mm): 25 / (50) / 100

Screen Interval: UNK
Filter Pack: -
Depth of Well: 20.05

Sampling Method: Low Flow
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 2.179
Depth of Pump: 17.500
Depth to Water (after pump): 1.428
Measured Depth of Well: 20.05
Any Sediment at Base of Well:

Low Flow Settings	
CPM:	4
Discharge:	3
Refill:	12
Pressure:	50 psi

Time *every 5 minutes*	Flow rate (L/min)	Depth to Water (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (ppm)	Temp. (°c)	EC (µS)	Comments (colour, turbidity, odour)
Stable after three consecutive readings		*stable*		*± 0.05*	*± 10 mV*	*± 10%*	*± 0.5°C*	*± 3%*	*e.g. ,pale grey, low, none*
9.40	0.30	1.603	0.5	9.51	83.4	4.69	17.5	2768	pale grey, low-mod., H2S
9.45	-	2.433	2.0	6.78	-53.3	1.10	17.3	4451	" "
9.50	-	2.925	3.5	6.70	-53.2	3.09	17.3	4463	pale grey, low, H2S
9.55	0.14	3.108	4.2	6.68	-54.0	4.02	17.5	4494	" "
10.00	-	3.230	4.9	6.69	-58.0	4.05	17.5	4580	" "
10.05	-	3.259	5.6	6.64	-58.4	4.41	17.5	4859	" "
10.10	-	3.269	6.3	6.60	-59.8	4.78	17.5	5145	" "

Primary sample ID: BH15-030320
Duplicate ID:
Triplicate ID:
Rinsate ID:
COC No.:

Air bubbles in vials: Y / N
Metals field filtered: (Y) / N
Equipment decontaminated: (Y) / N
Samples placed on ice: (Y) / N
No. of sample bottles collected: 3

COMMENTS:

Groundwater Sampling Sheet

Bore ID: BH23

Client: APA	**Date:** 02.03.2020
Project: APA WORM Hydro. Study	**Time:** 9:50
Job No: 12517812	**Staff:**

Gatic Type: Flush / Monument
Gatic Maintanence: (Y) / N *(If Y, provide comments)*
Casing Diameter (mm): 25 / (50) / 100

Screen Interval: 27.0 – 30.0
Filter Pack: 26.0 – 30.0
Depth of Well: 16.35 (blocked)

Sampling Method: Low Flow
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 3.514
Depth of Pump: 15.500
Depth to Water (after pump): 2.751
Measured Depth of Well: 16.350
Any Sediment at Base of Well: Y

Low Flow Settings	
CPM:	4
Discharge:	5
Refill:	10
Pressure:	45 psi

Time *every 5 minutes*	Flow rate (L/min)	Depth to Water (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (ppm)	Temp. (°c)	EC (µS)	Comments (colour, turbidity, odour)
	Stable after three consecutive readings	*stable*		*± 0.05*	*± 10 mV*	*± 10%*	*± 0.5°C*	*± 3%*	*e.g. ,pale grey, low, none*
10.00	~10	12.65	9	8.26	-201.5	–	16.1	3871	grey, high, H2S
				Dry after 18L. Switch to low-slow					
10.27	0.2	6.169	18.6	8.37	11.5	1.49	16.8	4186	grey, mod. to high, slight H2S
10.30	–	–	19.2	7.93	-153.2	11.47	16.5	4740	" "
10.33	–	–	19.8	7.81	-167.8	10.80	16.4	4674	" "
10.36	–	–	20.4	7.82	-183.4	9.79	16.8	4718	" "
10.39	–	–	21.0	7.87	-195.6	8.96	17.0	4659	" "
10.42	–	–	21.6	7.90	-200.1	8.36	16.8	4697	" "
10.45	–	–	22.2	7.90	-204.0	7.59	16.9	4686	" "
10.48	–	–	22.8	7.93	-208.1	7.09	16.9	4692	" "

Primary sample ID: BH23_020320
Duplicate ID:
Triplicate ID:
Rinsate ID:

Air bubbles in vials: Y / N
Metals field filtered: (Y) / N
Equipment decontaminated: (Y) / N
Samples placed on ice: (Y) / N

COC No.:
No. of sample bottles collected: 3

COMMENTS: Using SuperTwister, filled 9L bucket in 50 seconds
Blockage in casing ~ 16.35 m bgl

Groundwater Sampling Sheet

Bore ID: BH22

Client: APA	**Date:** 02.03.2020
Project: APA WORM Hydro. Study	**Time:** 12.40
Job No: 12517812	**Staff:**

Gatic Type: Flush / Monument
Gatic Maintanence: Y / N *(If Y, provide comments)*
Casing Diameter (mm): 25 / 50 / 100

Screen Interval: UNK
Filter Pack: -
Depth of Well: 30 m bgl

Sampling Method: Low Flow
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 6.951
Depth of Pump: 27.500
Depth to Water (after pump): 6.286
Measured Depth of Well: 30.0 m bgl
Any Sediment at Base of Well:

Low Flow Settings	
CPM:	4
Discharge:	2
Refill:	13
Pressure:	50 psi

Time *every 5 minutes*	Flow rate (L/min) *Stable after three consecutive readings*	Depth to Water (m TOC) *stable*	Cumulative Volume (L)	pH *± 0.05*	Redox (mV) *± 10 mV*	DO (ppm) *± 10%*	Temp. (°c) *± 0.5°C*	EC (µS) *± 3%*	Comments (colour, turbidity, odour) *e.g. ,pale grey, low, none*
12.55	0.4	6.740	0.5	8.70	-49.9	2.19	17.4	3818	pale grey, low-mod., none
13.00	0.3	7.505	2.5	7.53	-10.3	0.59	17.3	4339	" "
13.05	0.2	8.008	4.0	7.39	-11.2	0.96	17.3	4342	" "
13.10	-	8.478	5.0	7.35	-11.3	0.80	17.3	4337	" "
13.15	-	8.771	6.0	7.33	-10.7	0.78	17.3	4334	" "
13.20	-	8.912	7.0	7.32	-10.4	0.85	17.5	4352	" "
13.25	-	8.929	8.0	7.32	-10.1	0.88	17.4	4358	" "
13.30	-	8.932	9.0	7.33	-9.9	0.91	17.5	4361	" "

Primary sample ID: BH24_020320
Duplicate ID:
Triplicate ID:
Rinsate ID:

Air bubbles in vials: Y / N
Metals field filtered: (Y) / N
Equipment decontaminated: (Y) / N
Samples placed on ice: (Y) / N

COC No.:
No. of sample bottles collected: 3

COMMENTS:

Groundwater Sampling Sheet

Bore ID: BH27

Client: APA	**Date:** 03.03.2020
Project: APA WORM Hydro. Study	**Time:** 15.45
Job No: 12517812	**Staff:**

Gatic Type: Flush / Monument
Gatic Maintanence: Y / N *(If Y, provide comments)*
Casing Diameter (mm): 25 / 50 / 100

Screen Interval: UNK
Filter Pack: -
Depth of Well: 19.96 m bgl

Sampling Method: Low Flow
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 3.139
Depth of Pump: 17.50
Depth to Water (after pump): 2.417
Measured Depth of Well: 19.960 m bgl
Any Sediment at Base of Well:

Low Flow Settings	
CPM:	4
Discharge:	4
Refill:	4
Pressure:	50 psi

Time *every 5 minutes*	Flow rate (L/min)	Depth to Water (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (ppm)	Temp. (°c)	EC (µS)	Comments (colour, turbidity, odour)
Stable after three consecutive readings		*stable*		*± 0.05*	*± 10 mV*	*± 10%*	*± 0.5°C*	*± 3%*	*e.g. ,pale grey, low, none*
16.00	0.42	2.619	0.5	8.73	83.5	1.43	17.7	1134	pale grey, low, slight H2S
16.05	-	3.571	2.6	8.48	93.7	0.42	16.8	1074	clear, low, slight H2S
16.10	-	4.485	4.7	7.98	103.2	0.32	16.8	1076	" "
16.15	0.30	4.842	6.2	7.93	104.4	0.34	17.3	1084	" "
16.20	0.20	4.847	7.2	8.30	60.9	0.31	17.1	1060	" "
16.25	-	-	8.2	8.35	59.0	0.30	17.1	1059	" "
16.30	-	-	9.2	8.36	57.7	0.28	17.0	1057	" "

Primary sample ID: BH27_030320
Duplicate ID:
Triplicate ID:
Rinsate ID:

Air bubbles in vials: Y / N N/A
Metals field filtered: (Y) / N
Equipment decontaminated: (Y) / N
Samples placed on ice: (Y) / N

COC No.:
No. of sample bottles collected: 3

COMMENTS:

GHD Groundwater Sampling Sheet

Bore ID: BH32

Client: APA	**Date:** 02.03.2020
Project: APA WORM Hydro. Study	**Time:** 15:20
Job No: 12517812	**Staff:**

Gatic Type: Flush / Monument
Gatic Maintanence: Y / N *(If Y, provide comments)*
Casing Diameter (mm): 25 / 50 / 100

Screen Interval: UNK
Filter Pack: -
Depth of Well: 19.40 m bgl

Sampling Method: Low Flow
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 7.248
Depth of Pump: 18.000
Depth to Water (after pump): 6.930
Measured Depth of Well: 19.400
Any Sediment at Base of Well: Y

Low Flow Settings	
CPM:	4
Discharge:	1
Refill:	14
Pressure:	50 psi

Time *every 5 minutes*	Flow rate (L/min)	Depth to Water (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (ppm)	Temp. (°c)	EC (µS)	Comments (colour, turbidity, odour)
Stable after three consecutive readings		*stable*		*± 0.05*	*± 10 mV*	*± 10%*	*± 0.5°C*	*± 3%*	*e.g. ,pale grey, low, none*
15.26	0.4	7.291	0.5	10.41	82.7	9.06	19.1	1155	~~orange~~ brown, high, none
15.31	-	7.365	2.5	11.49	-41.6	8.82	18.2	2263	" "
15.42	-	7.430	4.5	10.18	16.1	7.00	18.7	5530	" "
15.47	0.3	8.180	6.0	9.31	43.8	2.76	16.5	4686	" "
15.52	0.2	8.482	7.0	9.16	52.0	2.76	16.6	4647	" "
15.57	-	-	8.0	9.12	54.0	2.67	17.1	4936	" "
16.02	-	-	9.0	9.11	54.9	2.91	17.1	5207	" "

Primary sample ID: BH32_020320
Duplicate ID:
Triplicate ID:
Rinsate ID:

Air bubbles in vials: Y / N
Metals field filtered: (Y) / N
Equipment decontaminated: (Y) / N
Samples placed on ice: (Y) / N

COC No.:
No. of sample bottles collected: 3

COMMENTS: Was this bore developed?
Sample is still very turbid and pH seems high.

Groundwater Sampling Sheet

Bore ID: BH49

Client: APA	**Date:** 03.03.2020
Project: APA WORM Hydro. Study	**Time:** 13.20
Job No: 12517812	**Staff:**

Gatic Type: Flush / Monument
Gatic Maintanence: Y / N *(If Y, provide comments)*
Casing Diameter (mm): 25 / 50 / 100

Screen Interval: UNK
Filter Pack: -
Depth of Well: 20.02 m bgl

Sampling Method: Low Flow
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 2.543
Depth of Pump: 18.000
Depth to Water (after pump): 1.802
Measured Depth of Well: 20.02 m bgl
Any Sediment at Base of Well:

Low Flow Settings	
CPM:	4, 4
Discharge:	3.5, 1.5
Refill:	11.5, 13.5
Pressure:	50 psi

Time *every 5 minutes*	Flow rate (L/min)	Depth to Water (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (ppm)	Temp. (°c)	EC (µS)	Comments (colour, turbidity, odour)
Stable after three consecutive readings		*stable*		*± 0.05*	*± 10 mV*	*± 10%*	*± 0.5°C*	*± 3%*	*e.g. ,pale grey, low, none*
13.21	0.40	1.955	0.50	8.87	48.4	1.40	17.3	1838	clear, low, slight H2S
13.26	-	2.734	2.50	8.59	51.9	0.95	16.8	1809	" "
13.31	-	3.413	4.50	8.40	55.5	0.68	16.4	1789	" "
13.36	0.15	3.966	6.50	8.38	48.8	0.51	17.0	1813	" "
13.41	-	4.091	7.25	8.40	42.0	0.53	17.2	1828	" "
13.46	-	4.111	8.00	8.40	40.3	0.53	17.2	1834	" "
13.51	-	4.119	8.75	8.40	39.9	0.52	17.1	1840	" "

Primary sample ID: BH49_030320
Duplicate ID:
Triplicate ID:
Rinsate ID:

Air bubbles in vials: Y / N
Metals field filtered: (Y) / N
Equipment decontaminated: (Y) / N
Samples placed on ice: (Y) / N

COC No.:
No. of sample bottles collected: 3

COMMENTS:

Groundwater Sampling Sheet

Bore ID: BH04

Client: APA **Date:** 13.08.2020
Project: WORM **Time:** 13:45
Job No: 12529997 **Staff:** MM

Sampling Method: Bailer
Water Quality Meter: YSI Pro Plus
Initial Depth to Water: 5.570 m bgl
Depth of Pump: N/A
Depth to Water (after pump): N/A
Measured Depth of Well:
Any Sediment at Base of Well:

Low Flow Settings	
CPM:	
Discharge:	
Refill:	
Pressure:	

Gatic Type: Flush / Monument
Gatic Maintanence: Y / N *(If Y, provide comments)*
Casing Diameter (mm): 25 / 50 / 100

Screen Interval: 17.0 - 20.0
Filter Pack: N/A
Depth of Well:

Time *every 5 minutes*	Flow rate (L/min)	Depth to Water (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (ppm)	Temp. (°c)	EC (µS)	Comments (colour, turbidity, odour)
Stable after three consecutive readings		*stable*		*± 0.05*	*± 10 mV*	*± 10%*	*± 0.5 °C*	*± 3%*	*e.g. ,pale grey, low, none*
13:59	N/A		4	8.10	17.7	6.96	16.7	3,380	pale grey, low to moderate, none

Primary sample ID: BH04
Duplicate ID:
Triplicate ID:
Rinsate ID:

Air bubbles in vials: Y / N
Metals field filtered: Y / N
Equipment decontaminated: Y / N
Samples placed on ice: Y / N

COC No.:
No. of sample bottles collected: 3

COMMENTS:

- metals bottle not filtered
- temporary PVC casing installed in borehole on 12 August 2020, screened 17 to 20 m, followed immediately by development.
- sample collected using a bailer on 13 August 2020, followed immediately by removal of casing and backfilling of borehole

CALCULATIONS

Client APA
Project WORM
Subject Groundwater Sampling Record

Job no. 12529997
Calcs by MM
Checked by

Sheet 1 of 1
Date
Date

GHD Pty Ltd ABN 39 008 488 373

Bore ID: BH09 Gatic: Flush SWL (m TOC): 8.140
Method: Low Flow Casing: 50mm ID Pump Depth: 10.00
WQM: YSI Pro Plus Screen: 9.0 - 12.0 SWL with Pump (m TOC): 8.054

Low Flow Settings: CPM 4 Discharge 2 Refill 13 Pressure 36 psi 09.09.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
10.22	0.25	8.206	0.50	7.69	84.9	5.63	14.7	6972	pale brown, low-mod., none
10.27	"	8.220	1.75	7.16	89.4	4.64	15.2	7104	" "
10.32	"	"	3.00	6.82	91.0	4.46	15.2	7104	" "
10.37	"	"	4.25	6.73	94.2	4.44	15.5	7132	" "
10.42	"	"	5.50	6.68	95.6	4.12	15.6	7120	" "
10.47	"	"	6.75	6.68	95.5	4.17	15.7	7118	" "

Sample ID: BH09, QC1, QC2

No. of Sample Bottles: 9

CALCULATIONS

Client APA Job no. 12529997 Sheet 1 of 1
Project WORM Calcs by MM Date
Subject Groundwater Sampling Record Checked by Date

Bore ID: BH11 Gatic: Flush SWL (m TOC): 8.469
Method: Bailer Casing: 50mm ID Pump Depth: N/A
WQM: YSI Pro Plus Screen: SWL with Pump (m TOC): N/A

Low Flow Settings: CPM 4 Discharge - Refill - Pressure - 26.08.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
9:30	-	DRY	7	7.83	86.9	6.39	14.6	2586	clear, low, none
									" "
									" "
									" "
									" "
									" "

Sample ID: BH11

No. of Sample Bottles: 3

GHD Pty Ltd ABN 39 008 488 373

CALCULATIONS

Client APA
Project WORM
Subject Groundwater Sampling Record

Job no. 12529997
Calcs by MM
Checked by

Sheet 1 of 1
Date
Date

Bore ID: BH12
Method: Low Flow
WQM: YSI Pro Plus

Gatic: Flush
Casing: 50mm ID
Screen: 3.0 – 6.0

SWL (m TOC): 0.283
Pump Depth: 4.5
SWL with Pump (m TOC): 0.250

Low Flow Settings: CPM 4 Discharge 1.5 Refill 13.5 Pressure 30 psi

18.08.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
15:35	0.2	0.361	0.5	7.62	54.6	2.22	13.7	2411	clear, low, none
15:40	–	0.365	1.5	7.26	53.4	1.89	13.9	2425	" " "
15:45	–	0.368	2.5	7.19	51.0	1.81	13.9	2426	" "
15:50	–	0.364	3.5	7.15	50.0	1.74	13.8	2419	" "
15:55	–	–	4.5	7.14	49.7	1.67	13.8	2419	" "
16:00	–	–	5.6	7.17	71.1	1.92	14.1	2402	" "

Sample ID: BH14

No. of Sample Bottles: 10

GHD Pty Ltd ABN 39 008 488 373

Bore ID: BH14 Gatic: Flush SWL (m TOC): 1.480
Method: Low Flow Casing: 50mm ID Pump Depth: 7.5
WQM: YSI Pro Plus Screen: 6.0 – 9.0 SWL with Pump (m TOC): 1.062

Low Flow Settings: CPM 4 Discharge 1.5 Refill 13.5 Pressure 31 psi 18.08.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
12:50	0.2	1.215	0.7	8.38	104.0	5.98	14.7	1501	pale grey, low, none
12:55	–	1.748	1.1	7.85	93.8	5.02	15.1	1514	clear, low, none
13:00	–	2.183	2.1	7.74	85.9	5.23	15.1	1516	" "
13:05	0.1	2.234	2.6	7.72	78.8	5.10	14.8	1505	" "
13:10	–	–	3.1	7.69	73.9	4.98	14.6	1501	" "
13:15	–	–	3.6	7.67	71.1	4.92	14.7	1502	" "

Sample ID: BH14
No. of Sample Bottles: 10

Client APA Job no. 12529997 Sheet 1 of 1
Project WORM Calcs by MM Date
Subject Groundwater Sampling Record Checked by Date

GHD Pty Ltd 008 488 373

CALCULATIONS

Client APA
Project WORM
Subject Groundwater Sampling Record

Job no. 12529997
Calcs by MM
Checked by

Sheet 1 of 1
Date
Date

Bore ID: BH16 Gatic: Flush SWL (m TOC): 7.642
Method: Low Flow Casing: 50mm ID Pump Depth: 9.50
WQM: YSI Pro Plus Screen: 7.1 – 10.1 SWL with Pump (m TOC): 7.540

Low Flow Settings: CPM 4 Discharge 2 Refill 13 Pressure 25 psi 26.08.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
11:13	0.10	7.810	0.5	8.15	87.6	6.03	15.7	1348	pale grey brown, low
11:18	–	–	1.0	7.30	83.6	4.32	15.8	1351	-moderate, none
11:23	–	–	1.5	7.19	74.5	4.04	16.0	1355	" "
11:28	–	7.910	2.0	7.14	70.2	3.80	16.2	1355	" "
11:33	–	8.113	2.5	7.11	68.9	4.21	16.1	1328	" "
11:38	–	8.292	3.0	7.07	69.0	4.46	16.1	1323	" "
11:43	–	8.416	3.5	7.06	68.8	4.48	16.0	1329	" "

Sample ID: BH16
No. of Sample Bottles: 3

Water level would not stabilise

GHD Pty Ltd ABN

CALCULATIONS

Sheet 1 of 1

Job no. 12529997 Date

Calcs by MM Checked by Date

Client APA

Project WORM

Subject Groundwater Sampling Record

Bore ID: BH22 Gatic: Flush SWL (m TOC) 27.085

Method: Low Flow Casing: 50mm ID Pump Depth 29.00

WQM: YSI Pro Plus Screen: SWL with Pump (m TOC): 26.189

Low Flow Settings: CPM 4 Discharge 3.5 Refill 11.5 Pressure 62 psi 02.09.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
11.05	0.25	25.888	0.50	8.11	-32.1	5.76	15.9	4948	clear, low, H2S
11.10	–	25.826	1.75	7.30	-46.2	2.26	16.3	5022	" " "
11.15	–	25.803	3.00	7.14	-53.2	2.05	16.5	5039	" "
11.20	–	[illegible]	4.25	7.11	-55.9	1.98	16.5	5043	" "
11.25	–	[illegible]	5.50	7.10	-55.2	2.05	16.5	5047	" "
11.30	–	[illegible]	6.75	7.09	-54.9	2.08	16.5	5050	" "

Sample ID: BH22

No. of Sample Bottles: 10

GHD Pty Ltd ABN 39 008 488 373

CALCULATIONS

Client APA Job no. 12529997 Sheet 1 of 1
Project WORM Calcs by MM Date
Subject Groundwater Sampling Record Checked by Date

GHD Pty Ltd ABN 39 008 488 373

Bore ID: BH22 Gatic: Flush SWL (m TOC): 5.808
Method: Low Flow Casing: 50mm ID Purge Depth: 28.00
WQM: YSI Pro Plus Screen: 27.0 - 30.0 SWL with Pump (m TOC): 4.849

Low Flow Settings: CPM 4 Discharge 3.5 Refill 11.5 Pressure 65 psi 10.09.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
12:12	0.25	5.025	0.50	7.78	82.4	3.67	17.8	5257	clear, low, none
12:17	-	5.613	1.75	7.17	130.5	3.17	17.1	5146	" "
12:22	-	6.402	3.00	6.92	159.2	3.08	17.0	5135	" "
12:27	0.15	6.898	3.75	6.86	169.0	2.92	16.9	5125	" "
12:32	-	7.014	4.50	6.85	166.4	2.88	16.9	5129	" "
12:37	0.10	7.170	5.00	6.84	168.8	2.82	16.9	5111	" "
12:42	-	7.269	5.50	6.87	167.1	2.83	16.9	5115	" "

Sample ID: BH22

No. of Sample Bottles: 10

Water level would not stabilise

Checked by Date

Sheet 1 of 1

Job no. 12529997 Date

Calcs by MM Date

Checked by

CALCULATIONS

Bore ID: BH23A Gatic: Flush SWL (m TOC): 3.360

Method: Low Flow Casing: 50mm ID Pump Depth: 23.0

WQM: YSI Pro Plus Screen: 22.0 – 25.0 SWL with Pump (m TOC): 2.521

Low Flow Settings: CPM 4 Discharge 2.5 → 1.5 Refill 12.5 → 13.5 Pressure 55 psi 19.08.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
12.54	0.2	2.682	0.5	7.73	27.7	3.09	13.7	4443	clear, low, none
12.59	–	3.264	1.5	7.04	51.3	2.36	15.4	4660	" " "
13.04	–	3.830	2.5	6.85	69.9	2.34	15.4	4669	" "
13.09	–	4.415	3.5	6.77	85.2	2.21	15.5	4676	" "
13.14	0.1	4.546	4.0	6.75	88.6	2.22	14.6	4591	" "
13.19	–	4.595	4.5	6.74	92.3	2.21	14.4	4556	" "
13.24	–	4.631	5.0	6.73	94.9	2.19	14.4	4540	" "

Sample ID: BH23A

No. of Sample Bottles: 10

Client APA

Project WORM

Subject Groundwater Sampling Record

GHD

GHD Pty Ltd ABN 39 008 488 373

Client APA
Project WORM
Subject Groundwater Sampling Record

Job no. 12529997
Calcs by MM
Checked by

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Date
Date

Bore ID: BH32 Gatic: Flush SWL (m TOC): 7.291
Method: Low Flow Casing: 50mm ID Pump Depth: 14.50
WQM: YSI Pro Plus Screen: SWL with Pump (m TOC): 6.838

Low Flow Settings: CPM 4 Discharge 1.5 Refill 13.5 Pressure 42 psi 20.08.2020

Time	Flow Rate (L/min)	SWL (m TOC)	Cumulative Volume (L)	pH	Redox (mV)	DO (mg/L)	Temp (°C)	EC (µS/cm)	Comments
9.45	0.15	7.165	0.50	7.93	53.2	3.14	15.0	8162	clear, low, none
9.50	"	7.359	1.25	7.49	51.7	2.46	15.4	8290	" " "
9.55	"	7.499	2.00	7.37	47.0	2.14	15.4	8297	" "
10.00	"	7.580	2.75	7.33	43.9	2.01	15.6	8347	" "
10.05	"	7.588	3.50	7.33	42.3	2.10	15.3	8279	" "
10.10	"	7.590	4.25	7.31	42.9	2.11	15.2	8245	" "

Sample ID: BH32
No. of Sample Bottles: 10

GHD Pty Ltd ABN 39 008 488 373

Purging and Sampling Record

Bore ID: WORMBH15

Job Information
Client: APA
Project: WORM pipeline
Proj. No.: 12529997/08
Sampler: ADW

Sampling Information
Sample Method: submersible pump
WQ Meter Type: YSI
Flow Cell: (Y) / N Pump Depth: 18 m
WLevel Meter Type: Dip/Interface/ fox
NAPL Check: Nil

Bore Information
SWL: 1.84 m Logic Check: ✓
Date: 29/10/2020 Time: 14:10
Ref.datum: PVC Stick Up: 0 m
Bore Depth: 20 m Bore Diam.: 50 mm
Screen From: 17 to 20 m Well Cap Secure? ✓

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m)	(pH/Cond..)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate purged dry?
							1.12		w/ pump in place
14:25	—	—	—	— Start purging —			—	50/15	
14:40	0.5	15.5	6.38	8684	4.43	125	1.69		clear, sed free, no odour
14:47	1	15.7	6.33	8683	2.19	115.8	1.85		
14:53	1.5	-"-	6.36	8668	0.81	115.4	2.01		
14:59	2	-"-	6.38	8669	0.61	120.3	2.12		
15:06 (1320)	2.5	15.8	6.39	8649	0.53	126.2	2.15		
15:11	3	15.8	6.40	8672	0.55	127.3	2.25		
				— Sampled —			—		
15:45							2.43		end of sampling
		flow rate stable.		~1 Lpm, i.e. v. slow.			water level		keeps falling but other parameters

Field QA Checks:
Air bubbles in vials? Y / (N) Any violent reactions? Y / (N)
Decontamination as per GHD procedure? (Y) / N
Was sampling equipment pre-cleaned? (Y) N
COC updated? (Y) / N Parameter Stabilisation(5%) (Y) N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

Purging and Sampling Record

Bore ID: BH22

Job Information
Client: APA
Project: WORM pipeline
Proj. No.: 12529997/08
Sampler: ADW

Sampling Information
Sample Method: microsurge
WQ Meter Type: YSI
Flow Cell: (Y) N Pump Depth: 28 m
WLevel Meter Type: Dip/Interface/ fox
NAPL Check: N/A

Bore Information
SWL: 5.70 m Logic Check: ✓
Date: 29/oct/2020 Time: 10:35
Ref.datum: PVC Stick Up: 0 m
Bore Depth: 30 m Bore Diam.: 50 mm
Screen From: 27 to 30 m Well Cap Secure? ✓

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (.µS.....)	Dis.Oxygen (.mg/L.)	Ox-Red Pt. (± mV)	SWL (m)	(rf/rd)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate purged dry?
							4.66		w/ pump in place
10:55	Start purging							45/102	
11:21	0.5	20.5	6.80	7884	4.17	95.3	5.23	50/15	Clear, no sed, no odour
11:26	1	20.3	6.86	7347	4.81	59.7	5.45		
11:32	~1.2	19.5	6.88	7373	5.96	-12.7	5.62	45/15	
11:36	1.5	18.6	6.86	7401	5.74	-42.1	5.82		
11:40	2	19.2	6.89	7293	5.05	-70.9	6.01		
11:46	2.5	17.6	6.86	7364	4.81	-84.1	6.23	50/15	
11:51	3	16.9	6.86	7428	4.59	-85.2	6.33		
			Sampled				6.80		@ end of sampling
	Flow rate set @ 1 LPM (v. slow) but water level keeps falling - similar to last sampling event.								

Field QA Checks:
Air bubbles in vials? Y / (N) Any violent reactions? Y / (N)
Decontamination as per GHD procedure? (Y) N
Was sampling equipment pre-cleaned? (Y) / N
COC updated? (Y) N Parameter Stabilisation(5%) Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	BioL				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Logger removed from bore during sampling

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: 120RmBH23a

Job Information
- **Client:** APA
- **Project:** WORM pipeline
- **Proj. No.:** 12529997/08
- **Sampler:** ADW

Sampling Information
- **Sample Method:** Micro.Pump.c
- **WQ Meter Type:** YSI
- **Flow Cell:** (Y) / N **Pump Depth:** 24 m
- **WLevel Meter Type:** Dip/Interface/ fox
- **NAPL Check:** N:\

Bore Information
- **SWL:** 3.39 m **Logic Check:** ✓
- **Date:** 29 Oct 2020 **Time:** 08:20
- **Ref.datum:** PVC **Stick Up:** 0 m
- **Bore Depth:** 25 m **Bore Diam.:** 50 mm
- **Screen From:** 22 to 25 m **Well Cap Secure?** ✓

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m)	(pf/ff)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate purged dry?
							2.35	~~soft~~	w/ pump in place
08:39	Start purging							54/10	
08:52	0.2	15.2	6.87	7110	8.19	-118.4	2.73	54/12	clear, sed free, mod H_2S odour
08:58	0.5	15.3	6.84	7027	8.31	-135.5	2.86		" "
09:08	1	15.7	6.82	7025	7.59	-142.7	3.11		
09:14	1.5	15.1	6.81	7038	7.07	-155.7	3.35		" " , slight H_2S odour
09:21	2	15.8	6.81	7010	6.13	-161.8	3.52		
09:27	2.5	15.2	-"-	7026	4.97	-172.7	3.78		
09:31	3	15.3	6.81	7003	4.27	-177	3.88		
09:35	3.5	15.2	6.81	7025	3.70	-179	4.04		
				Sampled			4.46		(End of sampling)
	Flow rate set at less than 1 L/min (v slow)								(but SWL keeps falling)
	other parameters stable.								

Field QA Checks:
Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? (Y) N
Was sampling equipment pre-cleaned? (Y) N
COC updated? (Y) / N Parameter Stabilisation(5%) Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc
Logger removed from bore during sampling

Was sample Field Filtered for Metals? ~~Y~~ N

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: WORMBH27

Job Information	Sampling Information	Bore Information
Client: APA	Sample Method: micropurge	SWL: 2.43 m Logic Check: ✓
Project: WORM pipeline	WQ Meter Type: YSI	Date: 28/8/2020 Time: 09:10
	Flow Cell: (Y) / N Pump Depth: 18 m	Ref.datum: PVC Stick Up: 0 m
Proj. No.: 12529997/08	WLevel Meter Type: Dip/Interface/ fox	Bore Depth: 20 m Bore Diam.: 50 mm
Sampler: AOW	NAPL Check: N.I	Screen From: 17 to 20 m Well Cap Secure? ✓

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS.....)	Dis.Oxygen (mg/L...)	Ox-Red Pt. (± mV)	SWL (m)	(pf.lpd.)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate purged dry?
@							2.0		w/ pump in place
09:24		—	Start purging			—		5/6	
09:35		No water - check pump/sample line.					All ok. kink in hose in bucket.		
09:46	0.5	14.3	9.35	2118	5.0	87.3	2.45	5/10	clear, sed free, no odour
09:54	1	14.6	8.76	2370	4.58	101.3	2.66		
09:59	1.5	14.7	8.65	2376	3.29	101.9	2.73		
10:04	2	14.6	8.64	2367	2.79	101.3	2.89		
10:09	2.5	14.5	8.61	2352	2.45	102	2.96		
10:13	3	14.7	8.58	2356	2.31	102.2	3.02		
10:18	3.5	14.6	8.56	2352	2.16	102.3	3.07	↓	
				—	Sampled		—	—	
10:50		—	End sampling			—	3.26		
		Flow rate set @ 1 L/min (v. slow)						but water levels still falling	
		Other parameters stable.							

Field QA Checks:
Air bubbles in vials? Y / (N) Any violent reactions? Y / (N)
Decontamination as per GHD procedure? (Y) N
Was sampling equipment pre-cleaned? (Y) N
COC updated? (Y) N Parameter Stabilisation(5%) (Y) / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Logger removed during sampling

Was sample Field Filtered for Metals? (Y)N

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: WormBH49

Job Information	Sampling Information	Bore Information
Client: APA	**Sample Method:** Micropurge	**SWL:** 2.17 m **Logic Check:** ✓
Project: WORM pipeline	**WQ Meter Type:** YSI	**Date:** 27/Oct/2020 **Time:** 14:50
	Flow Cell: (Y) / N **Pump Depth:** ..... m	**Ref.datum:** PVC **Stick Up:** 0 m
Proj. No.: 12529997/08	**WLevel Meter Type:** Dip/Interface/ fox	**Bore Depth:** 20 m **Bore Diam.:** 50 mm
Sampler: ADW.	**NAPL Check:** N/A	**Screen From:** 17 to 20 m **Well Cap Secure?** ✓

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (mS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m)	(L/min)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate purged dry?
	—	—			—	—	1.55	PF/PD	w/ pump in place
15:08	Start purging							2 36/6	—
15:12	0.5	14.1	7.68	2550	6.82	102	1.97	-"-	Clear, sed free
15:15	1	14.2	7.75	2543	6.84	103.7	2.20	50/6	— " — Slow purge rate
15:18	1.5	14.3	7.76	2542	6.60	104.8	2.46		Clear, sed free, no odour.
15:27	3	14.2	7.75	2538	6.40	107.9	2.83		— " —
15:32	3.5	14.1	7.77	2533	6.29	108.8	3.01		— " —
				— Sampled			—	—	
16.00	All samples collected. SWL @ end:						3.83		
			- Slow purging (1 L/min)				w/ ~~static~~ WL		Still falling, i.e. slow flow rate
			- Field parameters stabilised						

Field QA Checks:
Air bubbles in vials? Y / (N) Any violent reactions? Y / (N)
Decontamination as per GHD procedure? (Y) / N
Was sampling equipment pre-cleaned? (Y) N
COC updated? (Y) / N Parameter Stabilisation(5%) (Y) / N

Parameters / Preservatives	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
	✓	✓	✓	✓	✓	✓	✓	✓	✓				

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc
- WormBH49 (Rekool)
- Datalogger removed during sampling.

Was sample Field Filtered for Metals? (Y)/N

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Appendix G – Tabulated laboratory results (groundwater)

									Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
									Bore ID	BH04	BH09	BH11	BH12	BH14	BH15
									Sampled Date	13/08/2020	9/09/2020	26/08/2020	18/08/2020	18/08/2020	3/03/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)						
Chem_Group	**ChemName**	**output unit**	**EQL**												
Inorganics	pH (Lab)	pH units	0.01	6.5-8.5		6-9			6.7-7.7	7.86	7.12	7.54	7.64	7.76	6.85
	Electrical conductivity (lab)	µS/cm	1			2900			250	4840	10,300	3830	3900	2410	7420
	Total Dissolved Solids	mg/L	10	600	5000					-	5300	1920	3790	1300	-
	Total Dissolved Solids (est.)	mg/L	1		5000					3150	-	-	-	-	4820
	Total Suspended Solids	mg/L	5							-	-	-	15	25	-
	COD	mg/L	10							-	-	-	16	14	-
Biological	Escherichia coli (Colilert)	orgs/100mL	1							-	-	-	0	0	-
Cyanide	Cyanide (Total)	mg/L	0.004					0.007		-	-	-	-	-	-
Acidity & Alkalinity	Alkalinity (Carbonate as CaCO3)	mg/L	1							<1	<1	<1	<1	<1	<1
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1							916	478	314	357	489	1360
	Alkalinity (Hydroxide as CaCO3)	mg/L	1							<1	<1	<1	<1	<1	<1
	Alkalinity (total as CaCO3)	mg/L	1							916	478	314	357	489	1360
Major Ions	Calcium (Filtered)	mg/L	1		1000					88	87	63	71	32	187
	Magnesium (Filtered)	mg/L	1							178	413	99	195	66	290
	Potassium (Filtered)	mg/L	1							32	11	8	13	9	60
	Sodium (Filtered)	mg/L	1	180						587	1340	521	333	315	990
	Chloride	mg/L	1	250		350				1190	3440	974	1090	457	1820
	Sulfate (Filtered)	mg/L	1	250	1000					7	312	232	123	88	41
	Fluoride	mg/L	0.1		2	1	2			-	-	-	-	-	-
	Cations Total	meq/L	0.01							45.4	96.9	34.2	34.4	21	77.8
	Anions Total	meq/L	0.01							52	113	38.6	40.4	24.5	79.4
	Ionic Balance	%	0.01							6.8	7.71	6.08	8.06	7.77	1
Nutrients	Ammonia as N	mg/L	0.01					0.9		1.4	0.02	0.08	0.02	0.03	1.6
	Nitrate (as N)	mg/L	0.01		90					0.19	0.92	1.44	0.72	1.04	<0.01
	Nitrite (as N)	mg/L	0.01		9.1					<0.01	<0.01	0.02	<0.01	0.01	<0.01
	Nitrogen (Total Oxidised) (as N)	mg/L	0.01							0.19	0.92	1.46	0.72	1.05	<0.01
	Nitrogen (Total)	mg/L	0.1			5	25		1.1	1.6	1.1	1.8	0.9	1.2	2.2
	Kjeldahl Nitrogen Total	mg/L	0.1							1.4	0.2	0.3	0.2	0.2	2.2
	Phosphorus (Total)	mg/L	0.01			0.05	0.8		0.055	0.04	0.39	<0.01	0.14	0.23	0.12
Organic Indicators	BOD	mg/L	2							-	-	-	<2	<2	-
Metals	Arsenic (Filtered)	mg/L	0.001		0.5	0.1	2	0.013	0.013	0.004	<0.001	<0.001	<0.001	<0.001	0.018
	Cadmium (Filtered)	mg/L	0.0001		0.01	0.01	0.05	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium (III+VI) (Filtered)	mg/L	0.001		1	0.1	1	0.001	0.001	0.001	0.003	0.008	<0.001	0.001	<0.001
	Chromium (hexavalent) (Filtered)	mg/L	0.01					0.001	0.001	-	-	-	-	-	-
	Copper (Filtered)	mg/L	0.001	1	1	0.2	5	0.0014	0.0014	0.001	0.014	<0.001	0.012	0.016	0.019
	Lead (Filtered)	mg/L	0.001		0.1	2	5	0.0034	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
	Mercury (Filtered)	mg/L	0.0001		0.002	0.002	0.002	0.0006	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Molybdenum (Filtered)	mg/L	0.001		0.15	0.01	0.05			-	-	-	-	-	-
	Nickel (Filtered)	mg/L	0.001		1	0.2	2	0.011	0.011	0.009	0.011	<0.001	0.008	0.012	0.068
	Selenium (Filtered)	mg/L	0.01		0.02	0.02	0.05	0.011	0.011	-	-	-	-	-	-
	Silver (Filtered)	mg/L	0.001					0.00005	0.00005	-	-	-	-	-	-
	Tin (Filtered)	mg/L	0.001							-	-	-	-	-	-
	Zinc (Filtered)	mg/L	0.005	3	20	2	5	0.008	0.008	0.01	0.042	<0.005	0.041	0.078	0.074

										Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
										Bore ID	BH15	BH16	BH22	BH22	BH22	BH23
										Sampled Date	29/10/2020	26/08/2020	2/03/2020	10/09/2020	29/10/2020	2/03/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)							
Chem_Group	**ChemName**	**output unit**	**EQL**													
Inorganics	pH (Lab)	pH units	0.01	6.5-8.5		6-9			6.7-7.7	6.83	7.05	7.73	6.93	7.26	8.06
	Electrical conductivity (lab)	µS/cm	1			2900			250	8560	2000	5710	7040	7350	6460
	Total Dissolved Solids	mg/L	10	600	5000					-	1180	-	3960	-	-
	Total Dissolved Solids (est.)	mg/L	1		5000					5560	-	3710	-	4780	4200
	Total Suspended Solids	mg/L	5							5	-	-	30	-	-
	COD	mg/L	10							<20	-	-	<50	-	-
Biological	Escherichia coli (Colilert)	orgs/100mL	1							3	-	-	0	-	-
Cyanide	Cyanide (Total)	mg/L	0.004					0.007		-	-	-	-	-	-
Acidity & Alkalinity	Alkalinity (Carbonate as CaCO3)	mg/L	1							<1	<1	<1	<1	<1	<1
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1							1660	384	322	348	414	542
	Alkalinity (Hydroxide as CaCO3)	mg/L	1							<1	<1	<1	<1	<1	<1
	Alkalinity (total as CaCO3)	mg/L	1							1660	384	322	348	414	542
Major Ions	Calcium (Filtered)	mg/L	1		1000					185	92	106	124	114	136
	Magnesium (Filtered)	mg/L	1							316	77	205	253	268	236
	Potassium (Filtered)	mg/L	1							49	4	22	24	25	37
	Sodium (Filtered)	mg/L	1	180						1100	195	804	930	1040	895
	Chloride	mg/L	1	250		350				1900	354	1460	1950	1780	1730
	Sulfate (Filtered)	mg/L	1	250	1000					11	193	446	508	563	286
	Fluoride	mg/L	0.1		2	1	2			0.4	-	-	-	-	-
	Cations Total	meq/L	0.01							84.3	19.5	57.7	68.1	73.6	66.1
	Anions Total	meq/L	0.01							87	21.7	56.9	72.5	70.2	65.6
	Ionic Balance	%	0.01							1.55	5.25	0.69	3.17	2.38	0.38
Nutrients	Ammonia as N	mg/L	0.01					0.9		1.87	<0.01	0.16	0.42	-	0.41
	Nitrate (as N)	mg/L	0.01		90					<0.01	0.01	<0.01	<0.01	-	<0.01
	Nitrite (as N)	mg/L	0.01		9.1					<0.01	<0.01	<0.01	<0.01	-	<0.01
	Nitrogen (Total Oxidised) (as N)	mg/L	0.01							<0.01	0.01	<0.01	<0.01	-	<0.01
	Nitrogen (Total)	mg/L	0.1			5	25		1.1	1.9	0.2	0.3	0.4	-	14.1
	Kjeldahl Nitrogen Total	mg/L	0.1							1.9	0.2	0.3	0.4	-	14.1
	Phosphorus (Total)	mg/L	0.01			0.05	0.8		0.055	0.09	1.13	0.03	0.01	-	20.6
Organic Indicators	BOD	mg/L	2							<8	-	-	<8	-	-
Metals	Arsenic (Filtered)	mg/L	0.001		0.5	0.1	2	0.013	0.013	0.001	<0.001	0.001	<0.001	-	0.003
	Cadmium (Filtered)	mg/L	0.0001		0.01	0.01	0.05	0.0002	0.0002	0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001
	Chromium (III+VI) (Filtered)	mg/L	0.001		1	0.1	1	0.001	0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001
	Chromium (hexavalent) (Filtered)	mg/L	0.01					0.001	0.001	<0.01	-	-	-	-	-
	Copper (Filtered)	mg/L	0.001	1	1	0.2	5	0.0014	0.0014	0.018	0.015	0.011	0.02	-	0.012
	Lead (Filtered)	mg/L	0.001		0.1	2	5	0.0034	0.0034	<0.001	<0.001	<0.001	<0.001	-	<0.001
	Mercury (Filtered)	mg/L	0.0001		0.002	0.002	0.002	0.0006	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001
	Molybdenum (Filtered)	mg/L	0.001		0.15	0.01	0.05			0.002	-	-	-	-	-
	Nickel (Filtered)	mg/L	0.001		1	0.2	2	0.011	0.011	0.083	0.024	0.019	0.031	-	0.014
	Selenium (Filtered)	mg/L	0.01		0.02	0.02	0.05	0.011	0.011	<0.01	-	-	-	-	-
	Silver (Filtered)	mg/L	0.001					0.00005	0.00005	<0.001	-	-	-	-	-
	Tin (Filtered)	mg/L	0.001							0.001	-	-	-	-	-
	Zinc (Filtered)	mg/L	0.005	3	20	2	5	0.008	0.008	0.118	0.053	0.105	0.086	-	0.032

									Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
									Bore ID	BH23A	BH23A	BH27C	BH27C	BH32	BH32
									Sampled Date	4/04/1900	29/10/2020	3/03/2020	28/10/2020	2/03/2020	20/08/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)						
Chem_Group	**ChemName**	**output unit**	**EQL**												
Inorganics	pH (Lab)	pH units	0.01	6.5-8.5		6-9			6.7-7.7	7.41	7.22	8.36	8.54	8.09	7.73
	Electrical conductivity (lab)	µS/cm	1			2900			250	7190	7030	1400	2410	7780	12,500
	Total Dissolved Solids	mg/L	10	600	5000					3560	-	-	-	-	7340
	Total Dissolved Solids (est.)	mg/L	1		5000					-	4570	910	1570	5060	-
	Total Suspended Solids	mg/L	5							12	-	-	66	-	21
	COD	mg/L	10							24	-	-	<10	-	41
Biological	Escherichia coli (Colilert)	orgs/100mL	1							0	-	-	0	-	0
Cyanide	Cyanide (Total)	mg/L	0.004					0.007		-	-	-	<0.004	-	-
Acidity & Alkalinity	Alkalinity (Carbonate as CaCO3)	mg/L	1							<1	<1	3	17	<1	<1
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1							469	578	159	265	106	388
	Alkalinity (Hydroxide as CaCO3)	mg/L	1							<1	<1	<1	<1	<1	<1
	Alkalinity (total as CaCO3)	mg/L	1							469	578	162	282	106	388
Major Ions	Calcium (Filtered)	mg/L	1		1000					137	105	7	12	135	135
	Magnesium (Filtered)	mg/L	1							238	225	21	40	95	321
	Potassium (Filtered)	mg/L	1							32	31	17	28	10	15
	Sodium (Filtered)	mg/L	1	180						926	935	217	371	1200	1980
	Chloride	mg/L	1	250		350				1920	1660	385	601	2500	4090
	Sulfate (Filtered)	mg/L	1	250	1000					386	403	41	64	453	641
	Fluoride	mg/L	0.1		2	1	2			-	-	-	0.2	-	-
	Cations Total	meq/L	0.01							67.5	65.2	12	20.7	67	120
	Anions Total	meq/L	0.01							71.6	66.8	15	23.9	82.1	136
	Ionic Balance	%	0.01							2.91	1.17	11.1	7.11	10.1	6.56
Nutrients	Ammonia as N	mg/L	0.01					0.9		0.9	-	0.05	0.08	0.33	0.03
	Nitrate (as N)	mg/L	0.01		90					<0.01	-	<0.01	<0.01	<0.01	0.08
	Nitrite (as N)	mg/L	0.01		9.1					<0.01	-	<0.01	<0.01	<0.01	<0.01
	Nitrogen (Total Oxidised) (as N)	mg/L	0.01							<0.01	-	<0.01	<0.01	<0.01	0.08
	Nitrogen (Total)	mg/L	0.1			5	25		1.1	0.9	-	0.3	<0.1	15.1	<0.1
	Kjeldahl Nitrogen Total	mg/L	0.1							0.9	-	0.3	<0.1	15.1	<0.1
	Phosphorus (Total)	mg/L	0.01			0.05	0.8		0.055	0.02	-	0.29	0.31	6.07	0.03
Organic Indicators	BOD	mg/L	2							<2	-	-	<2	-	<2
Metals	Arsenic (Filtered)	mg/L	0.001		0.5	0.1	2	0.013	0.013	<0.001	-	0.003	0.002	0.002	<0.001
	Cadmium (Filtered)	mg/L	0.0001		0.01	0.01	0.05	0.0002	0.0002	<0.0001	-	<0.0001	<0.0001	<0.0001	0.0002
	Chromium (III+VI) (Filtered)	mg/L	0.001		1	0.1	1	0.001	0.001	<0.001	-	0.002	-	0.06	<0.001
	Chromium (hexavalent) (Filtered)	mg/L	0.01					0.001	0.001	-	-	-	<0.01	-	-
	Copper (Filtered)	mg/L	0.001	1	1	0.2	5	0.0014	0.0014	0.022	-	0.022	0.01	0.012	0.102
	Lead (Filtered)	mg/L	0.001		0.1	2	5	0.0034	0.0034	<0.001	-	0.001	<0.001	<0.001	0.002
	Mercury (Filtered)	mg/L	0.0001		0.002	0.002	0.002	0.0006	0.0006	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001
	Molybdenum (Filtered)	mg/L	0.001		0.15	0.01	0.05			-	-	-	0.023	-	-
	Nickel (Filtered)	mg/L	0.001		1	0.2	2	0.011	0.011	0.023	-	0.006	0.006	0.007	0.015
	Selenium (Filtered)	mg/L	0.01		0.02	0.02	0.05	0.011	0.011	-	-	-	<0.01	-	-
	Silver (Filtered)	mg/L	0.001					0.00005	0.00005	-	-	-	<0.001	-	-
	Tin (Filtered)	mg/L	0.001							-	-	-	<0.001	-	-
	Zinc (Filtered)	mg/L	0.005	3	20	2	5	0.008	0.008	0.087	-	0.048	0.012	0.036	0.129

									Site_ID	WORM	WORM	WORM	WORM
									Bore ID	BH49	BH49	Deep Creek	Jacksons Ck
									Sampled Date	3/03/2020	27/10/2020	29/10/2020	29/10/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)				
Chem_Group	**ChemName**	**output unit**	**EQL**										
Inorganics	pH (Lab)	pH units	0.01	6.5-8.5		6-9			6.7-7.7	8.3	7.97	7.75	7.54
	Electrical conductivity (lab)	µS/cm	1			2900			250	2460	2380	731	540
	Total Dissolved Solids	mg/L	10	600	5000					-	-	-	-
	Total Dissolved Solids (est.)	mg/L	1		5000					1600	1550	475	351
	Total Suspended Solids	mg/L	5							-	<5	-	-
	COD	mg/L	10							-	<10	-	-
Biological	Escherichia coli (Colilert)	orgs/100mL	1							-	0	-	-
Cyanide	Cyanide (Total)	mg/L	0.004					0.007		-	<0.004	-	-
Acidity & Alkalinity	Alkalinity (Carbonate as CaCO3)	mg/L	1							<1	<1	<1	<1
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1							232	247	107	86
	Alkalinity (Hydroxide as CaCO3)	mg/L	1							<1	<1	<1	<1
	Alkalinity (total as CaCO3)	mg/L	1							232	247	107	86
Major Ions	Calcium (Filtered)	mg/L	1		1000					18	15	13	9
	Magnesium (Filtered)	mg/L	1							64	66	25	14
	Potassium (Filtered)	mg/L	1							23	22	3	6
	Sodium (Filtered)	mg/L	1	180						345	346	76	66
	Chloride	mg/L	1	250		350				675	620	165	103
	Sulfate (Filtered)	mg/L	1	250	1000					114	78	8	22
	Fluoride	mg/L	0.1		2	1	2			-	0.1	-	-
	Cations Total	meq/L	0.01							21.8	21.8	6.09	4.62
	Anions Total	meq/L	0.01							26	24	6.96	5.08
	Ionic Balance	%	0.01							8.97	4.92	6.67	4.7
Nutrients	Ammonia as N	mg/L	0.01					0.9		0.09	0.04	0.01	0.03
	Nitrate (as N)	mg/L	0.01		90					<0.01	<0.01	0.05	0.51
	Nitrite (as N)	mg/L	0.01		9.1					<0.01	<0.01	<0.01	<0.01
	Nitrogen (Total Oxidised) (as N)	mg/L	0.01							<0.01	<0.01	0.05	0.51
	Nitrogen (Total)	mg/L	0.1			5	25		1.1	<0.1	<0.1	0.8	1.2
	Kjeldahl Nitrogen Total	mg/L	0.1							<0.1	<0.1	0.7	0.7
	Phosphorus (Total)	mg/L	0.01			0.05	0.8		0.055	0.25	0.22	0.07	0.11
Organic Indicators	BOD	mg/L	2							-	<2	-	-
Metals	Arsenic (Filtered)	mg/L	0.001		0.5	0.1	2	0.013	0.013	0.001	0.002	-	-
	Cadmium (Filtered)	mg/L	0.0001		0.01	0.01	0.05	0.0002	0.0002	<0.0001	<0.0001	-	-
	Chromium (III+VI) (Filtered)	mg/L	0.001		1	0.1	1	0.001	0.001	<0.001	-	-	-
	Chromium (hexavalent) (Filtered)	mg/L	0.01					0.001	0.001	-	<0.01	-	-
	Copper (Filtered)	mg/L	0.001	1	1	0.2	5	0.0014	0.0014	0.028	<0.001	-	-
	Lead (Filtered)	mg/L	0.001		0.1	2	5	0.0034	0.0034	<0.001	<0.001	-	-
	Mercury (Filtered)	mg/L	0.0001		0.002	0.002	0.002	0.0006	0.0006	<0.0001	<0.0001	-	-
	Molybdenum (Filtered)	mg/L	0.001		0.15	0.01	0.05			-	0.032	-	-
	Nickel (Filtered)	mg/L	0.001		1	0.2	2	0.011	0.011	0.008	0.009	-	-
	Selenium (Filtered)	mg/L	0.01		0.02	0.02	0.05	0.011	0.011	-	<0.01	-	-
	Silver (Filtered)	mg/L	0.001					0.00005	0.00005	-	<0.001	-	-
	Tin (Filtered)	mg/L	0.001							-	0.001	-	-
	Zinc (Filtered)	mg/L	0.005	3	20	2	5	0.008	0.008	0.053	0.025	-	-

										Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
										Bore ID	BH04	BH09	BH11	BH12	BH14	BH15
										Sampled Date	13/08/2020	9/09/2020	26/08/2020	18/08/2020	18/08/2020	3/03/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)								
Chem_Group	**ChemName**	**output unit**	**EQL**														
BTEXN	Benzene	µg/L	1					950		-	-	-	<1	<1	-		
	Toluene	µg/L	2	25				180		-	-	-	<2	<2	-		
	Ethylbenzene	µg/L	2	3				80		-	-	-	<2	<2	-		
	Xylene (o)	µg/L	2					350		-	-	-	<2	<2	-		
	Xylene (m & p)	µg/L	2							-	-	-	<2	<2	-		
	Xylene Total	µg/L	2	20						-	-	-	<2	<2	-		
	BTEX (Sum of Total) - Lab Calc	µg/L	1							-	-	-	<1	<1	-		
TRH - NEPM 2013	F1 (C6-C10 minus BTEX)	µg/L	20							-	-	-	<20	<20	-		
	C6-C10 Fraction	µg/L	20							-	-	-	<20	<20	-		
	F2 (>C10-C16 minus Naphthalene)	µg/L	100							-	-	-	<100	<100	-		
	>C10-C16 Fraction	µg/L	100							-	-	-	<100	<100	-		
	F3 (>C16-C34 Fraction)	µg/L	100							-	-	-	<100	<100	-		
	F4 (>C34-C40 Fraction)	µg/L	100							-	-	-	<100	<100	-		
	>C10-C40 (Sum of Total)	µg/L	100							-	-	-	<100	<100	-		
TRH - NEPM 1999	C6-C9 Fraction	µg/L	20							-	-	-	<20	<20	-		
	C10-C14 Fraction	µg/L	50							-	-	-	<50	<50	-		
	C15-C28 Fraction	µg/L	100							-	-	-	<100	<100	-		
	C29-C36 Fraction	µg/L	50							-	-	-	<50	<50	-		
	C10-C36 (Sum of Total)	µg/L	50							-	-	-	<50	<50	-		
TPH	Oil & Grease	µg/L	5000							-	-	-	<5000	<5000	-		
PAHs - standard 16	Acenaphthene	µg/L	1							-	-	-	<2	<2	-		
	Acenaphthylene	µg/L	1							-	-	-	<2	<2	-		
	Anthracene	µg/L	1					0.4		-	-	-	<2	<2	-		
	Benz(a)anthracene	µg/L	1							-	-	-	<2	<2	-		
	Benzo(a)pyrene	µg/L	0.5					0.2		-	-	-	<2	<2	-		
	Benzo[b+j]fluoranthene	µg/L	1							-	-	-	-	-	-		
	Benzo(k)fluoranthene	µg/L	1							-	-	-	-	-	-		
	Benzo(g,h,i)perylene	µg/L	1							-	-	-	<2	<2	-		
	Chrysene	µg/L	1							-	-	-	<2	<2	-		
	Dibenz(a,h)anthracene	µg/L	1							-	-	-	<2	<2	-		
	Fluoranthene	µg/L	1					1.4		-	-	-	<2	<2	-		
	Fluorene	µg/L	1							-	-	-	<2	<2	-		
	Indeno(1,2,3-c,d)pyrene	µg/L	1							-	-	-	<2	<2	-		
	Naphthalene	µg/L	1					16		-	-	-	<2	<2	-		
	Phenanthrene	µg/L	1					2		-	-	-	<2	<2	-		
	Pyrene	µg/L	1							-	-	-	<2	<2	-		
	PAHs (Sum of total) - Lab calc	µg/L	0.5							-	-	-	<2	<2	-		
	Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.5							-	-	-	<2	<2	-		
PAHs - extended	2-methylnaphthalene	µg/L	2							-	-	-	<2	<2	-		
	3-methylcholanthrene	µg/L	2							-	-	-	<2	<2	-		
	7,12-dimethylbenz(a)anthracene	µg/L	2							-	-	-	<2	<2	-		
	Benzo(b+j+k)fluoranthene	µg/L	4							-	-	-	<4	<4	-		

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				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)						
Chem_Group	**ChemName**	**output unit**	**EQL**												
Phenols - Halogenated	2-Chlorophenol	µg/L	2	0.1				490		-	-	-	<2	<2	-
	2,4-Dichlorophenol	µg/L	2	0.3				160		-	-	-	<2	<2	-
	2,4,5-Trichlorophenol	µg/L	2							-	-	-	<2	<2	-
	2,4,6-Trichlorophenol	µg/L	2	2				20		-	-	-	<2	<2	-
	2,6-Dichlorophenol	µg/L	2							-	-	-	<2	<2	-
	4-Chloro-3-methylphenol	µg/L	2							-	-	-	<2	<2	-
	Pentachlorophenol	µg/L	2					10		-	-	-	<4	<4	-
	Phenols(halogenated) - Lab Calc	µg/L	2							-	-	-	-	-	-
Phenols - Non-Halogenated	Phenol	µg/L	2					320		-	-	-	<2	<2	-
	2-Nitrophenol	µg/L	2							-	-	-	<2	<2	-
	2-Methylphenol (o-Cresol)	µg/L	2							-	-	-	<2	<2	-
	3,4-Methylphenol (m,p-cresol)	µg/L	4							-	-	-	<4	<4	-
	2,4-Dimethylphenol	µg/L	2							-	-	-	<2	<2	-
	2,4-Dinitrophenol	µg/L	100					45		-	-	-	-	-	-
	4,6-Dinitro-2-methylphenol	µg/L	50							-	-	-	-	-	-
	4,6-Dinitro-o-cyclohexyl phenol	µg/L	50							-	-	-	-	-	-
	4-Nitrophenol	µg/L	50							-	-	-	-	-	-
	Phenols (non-halogenated) EPAVic	µg/L	4							-	-	-	-	-	-
Phenols	2,3,5,6-Tetrachlorophenol	µg/L	2							-	-	-	-	-	-
	2,3,4,5 & 2,3,4,6-Tetrachlorophenol	µg/L	2							-	-	-	-	-	-
OC Pesticides	4,4'-DDE	µg/L	0.5							-	-	-	<0.5	<0.5	-
	a-BHC	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Aldrin	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Aldrin + Dieldrin	µg/L	0.5							-	-	-	<0.5	<0.5	-
	b-BHC	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Chlordane	µg/L	0.5					0.08		-	-	-	<0.5	<0.5	-
	Chlordane (cis)	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Chlordane (trans)	µg/L	0.5							-	-	-	<0.5	<0.5	-
	d-BHC	µg/L	0.5							-	-	-	<0.5	<0.5	-
	4,4 DDD	µg/L	0.5							-	-	-	<0.5	<0.5	-
	4,4 DDT	µg/L	0.5					0.01		-	-	-	<2	<2	-
	DDT+DDE+DDD - Lab Calc	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Dieldrin	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Endosulfan I (alpha)	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Endosulfan II (beta)	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Endosulfan Sulfate	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Endrin	µg/L	0.5					0.02		-	-	-	<0.5	<0.5	-
	Endrin aldehyde	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Endrin ketone	µg/L	0.5							-	-	-	<0.5	<0.5	-
	g-BHC (Lindane)	µg/L	0.5					0.2		-	-	-	<0.5	<0.5	-
	Heptachlor	µg/L	0.5					0.09		-	-	-	<0.5	<0.5	-
	Heptachlor epoxide	µg/L	0.5							-	-	-	<0.5	<0.5	-
	Hexachlorobenzene	µg/L	0.5					0.1		-	-	-	<0.5	<0.5	-
	Methoxychlor	µg/L	2							-	-	-	<2	<2	-
OP Pesticides	Chlorfenvinphos	µg/L	2							-	-	-	<2	<2	-
	Chlorpyrifos	µg/L	2					0.01		-	-	-	<2	<2	-
	Chlorpyrifos-methyl	µg/L	2							-	-	-	<2	<2	-
	Diazinon	µg/L	2					0.01		-	-	-	<2	<2	-
	Dichlorvos	µg/L	2							-	-	-	<2	<2	-
	Dimethoate	µg/L	2					0.15		-	-	-	<2	<2	-
	Ethion	µg/L	2							-	-	-	<2	<2	-

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Chem_Group	**ChemName**	**output unit**	**EQL**														
	Fenthion	µg/L	2							-	-	-	<2	<2	-
	Malathion	µg/L	2					0.05		-	-	-	<2	<2	-
	Pirimphos-ethyl	µg/L	2							-	-	-	<2	<2	-
	Prothiofos	µg/L	2							-	-	-	<2	<2	-
Chlorinated Hydrocarbons	1,1,1,2-tetrachloroethane	µg/L	5							-	-	-	<5	<5	-
	1,1,1-trichloroethane	µg/L	5					270		-	-	-	<5	<5	-
	1,1,2,2-tetrachloroethane	µg/L	5					400		-	-	-	<5	<5	-
	1,1,2-trichloroethane	µg/L	5					6500		-	-	-	<5	<5	-
	1,1-dichloroethene	µg/L	5					700		-	-	-	<5	<5	-
	1,1-dichloropropene	µg/L	5							-	-	-	<5	<5	-
	1,2,4-trichlorobenzene	µg/L	2					170		-	-	-	<2	<2	-
	1,2-dibromo-3-chloropropane	µg/L	5							-	-	-	<5	<5	-
	1,2-dichlorobenzene	µg/L	2	1				160		-	-	-	<2	<2	-
	1,2-dichloroethane	µg/L	5					1900		-	-	-	<5	<5	-
	1,2-dichloropropane	µg/L	5					900		-	-	-	<5	<5	-
	1,3-dichloropropane	µg/L	5							-	-	-	<5	<5	-
	1,4-dichlorobenzene	µg/L	2	0.3				60		-	-	-	<2	<2	-
	2,2-dichloropropane	µg/L	5							-	-	-	<5	<5	-
	2-chloronaphthalene	µg/L	2							-	-	-	<2	<2	-
	2-chlorotoluene	µg/L	5							-	-	-	<5	<5	-
	4-chlorotoluene	µg/L	5							-	-	-	<5	<5	-
	Bromobenzene	µg/L	5							-	-	-	<5	<5	-
	Carbon tetrachloride	µg/L	5					240		-	-	-	<5	<5	-
	Chlorobenzene	µg/L	5	10				55		-	-	-	<5	<5	-
	Chloroform	µg/L	5					770		-	-	-	<5	<5	-
	Chloromethane	µg/L	50							-	-	-	<50	<50	-
	cis-1,2-dichloroethene	µg/L	5							-	-	-	<5	<5	-
	Methylene chloride	µg/L	5					4000		-	-	-	-	-	-
	Hexachlorobutadiene	µg/L	2							-	-	-	<2	<2	-
	Vinyl chloride	µg/L	50					100		-	-	-	<50	<50	-
Explosives	1,3,5-Trinitrobenzene	µg/L	2							-	-	-	<2	<2	-
	2,4-Dinitrotoluene	µg/L	4					65		-	-	-	<4	<4	-
	2,6-dinitrotoluene	µg/L	4							-	-	-	<4	<4	-
	Nitrobenzene	µg/L	2					550		-	-	-	<2	<2	-
Halogenated Hydrocarbons	Bromomethane	µg/L	50							-	-	-	<50	<50	-
	Dichlorodifluoromethane	µg/L	50							-	-	-	<50	<50	-
Herbicides	Dinoseb	µg/L	50							-	-	-	-	-	-
	Pronamide	µg/L	2							-	-	-	<2	<2	-
Nitroaromatics and Keytones	2-Picoline	µg/L	2							-	-	-	<2	<2	-
	4-aminobiphenyl	µg/L	2							-	-	-	<2	<2	-
	Acetophenone	µg/L	2							-	-	-	<2	<2	-
	N-Nitrosodiphenyl & Diphenylamine	µg/L	4							-	-	-	<4	<4	-
	Pentachloronitrobenzene	µg/L	2							-	-	-	<2	<2	-
PCBs	PCBs (Total)	µg/L	1							-	-	-	<1	<1	-
Phthalates	Bis(2-ethylhexyl) phthalate	µg/L	10							-	-	-	<10	<10	-
	Butyl benzyl phthalate	µg/L	2							-	-	-	<2	<2	-
	Diethylphthalate	µg/L	2					1000		-	-	-	<2	<2	-
	Dimethyl phthalate	µg/L	2					3700		-	-	-	<2	<2	-
	Di-n-butyl phthalate	µg/L	2					26		-	-	-	<2	<2	-
	Di-n-octyl phthalate	µg/L	2							-	-	-	<2	<2	-
Surfactants	Anionic Surfactants as MBAS	µg/L	50							-	-	-	<100	<100	-

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Chem_Group	ChemName	output unit	EQL													
MAH	1,2,4-trimethylbenzene	µg/L	5							-	-	-	<5	<5	-
	1,3,5-trimethylbenzene	µg/L	5							-	-	-	<5	<5	-
	Isopropylbenzene	µg/L	5					30		-	-	-	<5	<5	-
	Styrene	µg/L	5	4						-	-	-	<5	<5	-
	n-butylbenzene	µg/L	5							-	-	-	<5	<5	-
	n-propylbenzene	µg/L	5							-	-	-	<5	<5	-
	sec-butylbenzene	µg/L	5							-	-	-	<5	<5	-
	tert-butylbenzene	µg/L	5							-	-	-	<5	<5	-
	p-isopropyltoluene	µg/L	5							-	-	-	<5	<5	-
SVOCs	1-naphthylamine	µg/L	2							-	-	-	<2	<2	-
	2-(acetylamino) fluorene	µg/L	2							-	-	-	<2	<2	-
	2-nitroaniline	µg/L	4							-	-	-	<4	<4	-
	3,3-Dichlorobenzidine	µg/L	2							-	-	-	<2	<2	-
	3-nitroaniline	µg/L	4							-	-	-	<4	<4	-
	4-(dimethylamino) azobenzene	µg/L	2							-	-	-	<2	<2	-
	4-bromophenyl phenyl ether	µg/L	2							-	-	-	<2	<2	-
	4-chloroaniline	µg/L	2							-	-	-	<2	<2	-
	4-chlorophenyl phenyl ether	µg/L	2							-	-	-	<2	<2	-
	4-nitroaniline	µg/L	2							-	-	-	<2	<2	-
	4-Nitroquinoline-N-oxide	µg/L	2							-	-	-	<2	<2	-
	5-nitro-o-toluidine	µg/L	2							-	-	-	<2	<2	-
	Aniline	µg/L	2					250		-	-	-	<2	<2	-
	Azobenzene	µg/L	2							-	-	-	<2	<2	-
	Bis(2-chloroethoxy) methane	µg/L	2							-	-	-	<2	<2	-
	Bis(2-chloroethyl)ether	µg/L	2							-	-	-	<2	<2	-
	Carbazole	µg/L	2							-	-	-	<2	<2	-
	Chlorobenzilate	µg/L	2							-	-	-	<2	<2	-
	Hexachlorocyclopentadiene	µg/L	10							-	-	-	<10	<10	-
	Hexachloroethane	µg/L	2					360		-	-	-	<2	<2	-
	Hexachloropropene	µg/L	2							-	-	-	<2	<2	-
	Isophorone	µg/L	2							-	-	-	<2	<2	-
	Methapyrilene	µg/L	2							-	-	-	<2	<2	-
	N-nitrosodiethylamine	µg/L	2							-	-	-	<2	<2	-
	N-nitrosodi-n-butylamine	µg/L	2							-	-	-	<2	<2	-
	N-nitrosodi-n-propylamine	µg/L	2							-	-	-	<2	<2	-
	N-Nitrosomethylethylamine	µg/L	2							-	-	-	<2	<2	-
	N-nitrosomorpholine	µg/L	2							-	-	-	<2	<2	-
	N-nitrosopiperidine	µg/L	2							-	-	-	<2	<2	-
	N-nitrosopyrrolidine	µg/L	4							-	-	-	<4	<4	-
	Pentachlorobenzene	µg/L	2					2		-	-	-	<2	<2	-
	Phenacetin	µg/L	2							-	-	-	<2	<2	-
VOCs	1,1-dichloroethane	µg/L	5							-	-	-	<5	<5	-
	1,2,3-trichlorobenzene	µg/L	5					10		-	-	-	<5	<5	-
	1,2,3-trichloropropane	µg/L	5							-	-	-	<5	<5	-
	1,2-dibromoethane	µg/L	5							-	-	-	<5	<5	-
	1,3-dichlorobenzene	µg/L	2	20				260		-	-	-	<2	<2	-
	2-butanone (MEK)	µg/L	50							-	-	-	<50	<50	-
	2-hexanone (MBK)	µg/L	50							-	-	-	<50	<50	-
	4-methyl-2-pentanone (MIBK)	µg/L	50							-	-	-	<50	<50	-
	Bromodichloromethane	µg/L	5							-	-	-	<5	<5	-
	Bromoform	µg/L	5							-	-	-	<5	<5	-

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Chem_Group	**ChemName**	**output unit**	**EQL**														
	Carbon disulfide	µg/L	5								-	-	-	<5	<5	-
	Chlorodibromomethane	µg/L	5								-	-	-	<5	<5	-
	Chloroethane	µg/L	50								-	-	-	<50	<50	-
	cis-1,3-dichloropropene	µg/L	5								-	-	-	<5	<5	-
	cis-1,4-Dichloro-2-butene	µg/L	5								-	-	-	<5	<5	-
	Dibromomethane	µg/L	5								-	-	-	<5	<5	-
	Iodomethane	µg/L	5								-	-	-	<5	<5	-
	Pentachloroethane	µg/L	5					80			-	-	-	<5	<5	-
	Trichloroethene	µg/L	5					330			-	-	-	<5	<5	-
	Tetrachloroethene	µg/L	5					70			-	-	-	<5	<5	-
	trans-1,3-dichloropropene	µg/L	5								-	-	-	<5	<5	-
	trans-1,2-dichloroethene	µg/L	5								-	-	-	<5	<5	-
	trans-1,4-Dichloro-2-butene	µg/L	5								-	-	-	<5	<5	-
	Trichlorofluoromethane	µg/L	50								-	-	-	<50	<50	-
	Vinyl acetate	µg/L	50								-	-	-	<50	<50	-
Dioxins & Furans	Dibenzofuran	pg/L	2000000								-	-	-	<2,000,000	<2,000,000	-
PFAS - Perfluoroalkyl Carboxylic Acids	Perfluorobutanoic acid (PFBA)	µg/L	0.01								-	-	-	-	-	-
	Perfluoropentanoic acid (PFPeA)	µg/L	0.002								-	-	-	-	-	-
	Perfluorohexanoic acid (PFHxA)	µg/L	0.002								-	-	-	-	-	-
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.002								-	-	-	-	-	-
	Perfluorooctanoic acid (PFOA)	µg/L	0.002					19 [1]			-	-	-	-	-	-
	Perfluorononanoic acid (PFNA)	µg/L	0.002								-	-	-	-	-	-
	Perfluorodecanoic acid (PFDA)	µg/L	0.002								-	-	-	-	-	-
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.002								-	-	-	-	-	-
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.002								-	-	-	-	-	-
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.002								-	-	-	-	-	-
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.005								-	-	-	-	-	-
PFAS - Perfluoroalkyl Sulfonic Acids	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.002								-	-	-	-	-	-
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.002								-	-	-	-	-	-
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.002								-	-	-	-	-	-
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.002								-	-	-	-	-	-
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.002					0.00023 [1]			-	-	-	-	-	-
	Perfluorodecanesulfonic acid (PFDS)	µg/L	0.002								-	-	-	-	-	-
PFAS - Perfluoroalkyl Sulfonamide	Perfluorooctane sulfonamide (FOSA)	µg/L	0.002								-	-	-	-	-	-
	N-Methyl perfluorooctane sulfonamide (MeFOSA)	µg/L	0.005								-	-	-	-	-	-
	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	µg/L	0.005								-	-	-	-	-	-
	N-Methyl perfluorooctane sulfonamidoacetic acid	µg/L	0.002								-	-	-	-	-	-
	N-Methyl perfluorooctane sulfonamidoethanol (M	µg/L	0.005								-	-	-	-	-	-
	N-Ethyl perfluorooctane sulfonamidoethanol (EtF(	µg/L	0.005								-	-	-	-	-	-
	N-Ethyl perfluorooctane sulfonamidoacetic acid (E	µg/L	0.002								-	-	-	-	-	-
PFAS - Fluorotelomer Sulfonic Acids	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.005								-	-	-	-	-	-
	6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.005								-	-	-	-	-	-
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.005								-	-	-	-	-	-
	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.005								-	-	-	-	-	-
PFAS - Sums	Sum of PFHxS and PFOS	µg/L	0.002								-	-	-	-	-	-
	PFAS (Sum of Total)	µg/L	0.002								-	-	-	-	-	-

										Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
										Bore ID	BH15	BH16	BH22	BH22	BH22	BH23
										Sampled Date	29/10/2020	26/08/2020	2/03/2020	10/09/2020	29/10/2020	2/03/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)								
Chem_Group	ChemName	output unit	EQL														
BTEXN	Benzene	µg/L	1					950		<1	-	-	<1	-	-
	Toluene	µg/L	2	25				180		<2	-	-	<2	-	-
	Ethylbenzene	µg/L	2	3				80		<2	-	-	<2	-	-
	Xylene (o)	µg/L	2					350		<2	-	-	<2	-	-
	Xylene (m & p)	µg/L	2							<2	-	-	<2	-	-
	Xylene Total	µg/L	2	20						<2	-	-	<2	-	-
	BTEX (Sum of Total) - Lab Calc	µg/L	1							<1	-	-	<1	-	-
TRH - NEPM 2013	F1 (C6-C10 minus BTEX)	µg/L	20							<20	-	-	<20	-	-
	C6-C10 Fraction	µg/L	20							<20	-	-	<20	-	-
	F2 (>C10-C16 minus Naphthalene)	µg/L	100							<100	-	-	<100	-	-
	>C10-C16 Fraction	µg/L	100							<100	-	-	<100	-	-
	F3 (>C16-C34 Fraction)	µg/L	100							<100	-	-	<100	-	-
	F4 (>C34-C40 Fraction)	µg/L	100							<100	-	-	<100	-	-
	>C10-C40 (Sum of Total)	µg/L	100							<100	-	-	<100	-	-
TRH - NEPM 1999	C6-C9 Fraction	µg/L	20							<20	-	-	<20	-	-
	C10-C14 Fraction	µg/L	50							<50	-	-	<50	-	-
	C15-C28 Fraction	µg/L	100							<100	-	-	<100	-	-
	C29-C36 Fraction	µg/L	50							<50	-	-	<50	-	-
	C10-C36 (Sum of Total)	µg/L	50							<50	-	-	<50	-	-
TPH	Oil & Grease	µg/L	5000							<5000	-	-	<5000	-	-
PAHs - standard 16	Acenaphthene	µg/L	1							<1	-	-	<2	-	-
	Acenaphthylene	µg/L	1							<1	-	-	<2	-	-
	Anthracene	µg/L	1					0.4		<1	-	-	<2	-	-
	Benz(a)anthracene	µg/L	1							<1	-	-	<2	-	-
	Benzo(a)pyrene	µg/L	0.5					0.2		<0.5	-	-	<2	-	-
	Benzo[b+j]fluoranthene	µg/L	1							<1	-	-	-	-	-
	Benzo(k)fluoranthene	µg/L	1							<1	-	-	-	-	-
	Benzo(g,h,i)perylene	µg/L	1							<1	-	-	<2	-	-
	Chrysene	µg/L	1							<1	-	-	<2	-	-
	Dibenz(a,h)anthracene	µg/L	1							<1	-	-	<2	-	-
	Fluoranthene	µg/L	1					1.4		<1	-	-	<2	-	-
	Fluorene	µg/L	1							<1	-	-	<2	-	-
	Indeno(1,2,3-c,d)pyrene	µg/L	1							<1	-	-	<2	-	-
	Naphthalene	µg/L	1					16		<1	-	-	<2	-	-
	Phenanthrene	µg/L	1					2		<1	-	-	<2	-	-
	Pyrene	µg/L	1							<1	-	-	<2	-	-
	PAHs (Sum of total) - Lab calc	µg/L	0.5							<0.5	-	-	<2	-	-
	Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.5							<0.5	-	-	<2	-	-
PAHs - extended	2-methylnaphthalene	µg/L	2							-	-	-	<2	-	-
	3-methylcholanthrene	µg/L	2							-	-	-	<2	-	-
	7,12-dimethylbenz(a)anthracene	µg/L	2							-	-	-	<2	-	-
	Benzo(b+j+k)fluoranthene	µg/L	4							-	-	-	<4	-	-

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Chem_Group	ChemName	output unit	EQL														
Phenols - Halogenated	2-Chlorophenol	µg/L	2	0.1				490		<2	-	-	<2	-	-
	2,4-Dichlorophenol	µg/L	2	0.3				160		<2	-	-	<2	-	-
	2,4,5-Trichlorophenol	µg/L	2							<2	-	-	<2	-	-
	2,4,6-Trichlorophenol	µg/L	2	2				20		<2	-	-	<2	-	-
	2,6-Dichlorophenol	µg/L	2							<2	-	-	<2	-	-
	4-Chloro-3-methylphenol	µg/L	2							<4	-	-	<2	-	-
	Pentachlorophenol	µg/L	2					10		<2	-	-	<4	-	-
	Phenols(halogenated) - Lab Calc	µg/L	2							<2	-	-	-	-	-
Phenols - Non-Halogenated	Phenol	µg/L	2					320		<4	-	-	<2	-	-
	2-Nitrophenol	µg/L	2							<4	-	-	<2	-	-
	2-Methylphenol (o-Cresol)	µg/L	2							<4	-	-	<2	-	-
	3,4-Methylphenol (m,p-cresol)	µg/L	4							<4	-	-	<4	-	-
	2,4-Dimethylphenol	µg/L	2							<4	-	-	<2	-	-
	2,4-Dinitrophenol	µg/L	100					45		<100	-	-	-	-	-
	4,6-Dinitro-2-methylphenol	µg/L	50							<50	-	-	-	-	-
	4,6-Dinitro-o-cyclohexyl phenol	µg/L	50							<50	-	-	-	-	-
	4-Nitrophenol	µg/L	50							<50	-	-	-	-	-
	Phenols (non-halogenated) EPAVic	µg/L	4							<4	-	-	-	-	-
Phenols	2,3,5,6-Tetrachlorophenol	µg/L	2							<2	-	-	-	-	-
	2,3,4,5 & 2,3,4,6-Tetrachlorophenol	µg/L	2							<2	-	-	-	-	-
OC Pesticides	4,4'-DDE	µg/L	0.5							<0.5	-	-	<2	-	-
	a-BHC	µg/L	0.5							<0.5	-	-	<2	-	-
	Aldrin	µg/L	0.5							<0.5	-	-	<2	-	-
	Aldrin + Dieldrin	µg/L	0.5							<0.5	-	-	<4	-	-
	b-BHC	µg/L	0.5							-	-	-	<2	-	-
	Chlordane	µg/L	0.5					0.08		-	-	-	-	-	-
	Chlordane (cis)	µg/L	0.5							<0.5	-	-	-	-	-
	Chlordane (trans)	µg/L	0.5							<0.5	-	-	-	-	-
	d-BHC	µg/L	0.5							-	-	-	<2	-	-
	4,4 DDD	µg/L	0.5							<0.5	-	-	<2	-	-
	4,4 DDT	µg/L	0.5					0.01		<0.5	-	-	<4	-	-
	DDT+DDE+DDD - Lab Calc	µg/L	0.5							-	-	-	<4	-	-
	Dieldrin	µg/L	0.5							<0.5	-	-	<2	-	-
	Endosulfan I (alpha)	µg/L	0.5							-	-	-	<2	-	-
	Endosulfan II (beta)	µg/L	0.5							-	-	-	<2	-	-
	Endosulfan Sulfate	µg/L	0.5							-	-	-	<2	-	-
	Endrin	µg/L	0.5					0.02		-	-	-	<2	-	-
	Endrin aldehyde	µg/L	0.5							-	-	-	-	-	-
	Endrin ketone	µg/L	0.5							-	-	-	-	-	-
	g-BHC (Lindane)	µg/L	0.5					0.2		-	-	-	<2	-	-
	Heptachlor	µg/L	0.5					0.09		<0.5	-	-	<2	-	-
	Heptachlor epoxide	µg/L	0.5							-	-	-	<2	-	-
	Hexachlorobenzene	µg/L	0.5					0.1		-	-	-	<4	-	-
	Methoxychlor	µg/L	2							-	-	-	-	-	-
OP Pesticides	Chlorfenvinphos	µg/L	2							-	-	-	<2	-	-
	Chlorpyrifos	µg/L	2					0.01		-	-	-	<2	-	-
	Chlorpyrifos-methyl	µg/L	2							-	-	-	<2	-	-
	Diazinon	µg/L	2					0.01		-	-	-	<2	-	-
	Dichlorvos	µg/L	2							-	-	-	<2	-	-
	Dimethoate	µg/L	2					0.15		-	-	-	<2	-	-
	Ethion	µg/L	2							-	-	-	<2	-	-

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Chem_Group	ChemName	output unit	EQL													
	Fenthion	µg/L	2							-	-	-	<2	-	-
	Malathion	µg/L	2					0.05		-	-	-	<2	-	-
	Pirimphos-ethyl	µg/L	2							-	-	-	<2	-	-
	Prothiofos	µg/L	2							-	-	-	<2	-	-
Chlorinated Hydrocarbons	1,1,1,2-tetrachloroethane	µg/L	5							<5	-	-	<5	-	-
	1,1,1-trichloroethane	µg/L	5					270		<5	-	-	<5	-	-
	1,1,2,2-tetrachloroethane	µg/L	5					400		<5	-	-	<5	-	-
	1,1,2-trichloroethane	µg/L	5					6500		<5	-	-	<5	-	-
	1,1-dichloroethene	µg/L	5					700		<5	-	-	<5	-	-
	1,1-dichloropropene	µg/L	5							-	-	-	<5	-	-
	1,2,4-trichlorobenzene	µg/L	2					170		<5	-	-	<2	-	-
	1,2-dibromo-3-chloropropane	µg/L	5							-	-	-	<5	-	-
	1,2-dichlorobenzene	µg/L	2	1				160		<5	-	-	<2	-	-
	1,2-dichloroethane	µg/L	5					1900		<5	-	-	<5	-	-
	1,2-dichloropropane	µg/L	5					900		-	-	-	<5	-	-
	1,3-dichloropropane	µg/L	5							-	-	-	<5	-	-
	1,4-dichlorobenzene	µg/L	2	0.3				60		<5	-	-	<2	-	-
	2,2-dichloropropane	µg/L	5							-	-	-	<5	-	-
	2-chloronaphthalene	µg/L	2							-	-	-	<2	-	-
	2-chlorotoluene	µg/L	5							-	-	-	<5	-	-
	4-chlorotoluene	µg/L	5							-	-	-	<5	-	-
	Bromobenzene	µg/L	5							-	-	-	<5	-	-
	Carbon tetrachloride	µg/L	5					240		<5	-	-	<5	-	-
	Chlorobenzene	µg/L	5	10				55		<5	-	-	<5	-	-
	Chloroform	µg/L	5					770		<5	-	-	<5	-	-
	Chloromethane	µg/L	50							-	-	-	<50	-	-
	cis-1,2-dichloroethene	µg/L	5							<5	-	-	<5	-	-
	Methylene chloride	µg/L	5					4000		<5	-	-	-	-	-
	Hexachlorobutadiene	µg/L	2							<5	-	-	<2	-	-
	Vinyl chloride	µg/L	50					100		<50	-	-	<50	-	-
Explosives	1,3,5-Trinitrobenzene	µg/L	2							-	-	-	<2	-	-
	2,4-Dinitrotoluene	µg/L	4					65		-	-	-	<4	-	-
	2,6-dinitrotoluene	µg/L	4							-	-	-	<4	-	-
	Nitrobenzene	µg/L	2					550		-	-	-	<2	-	-
Halogenated Hydrocarbons	Bromomethane	µg/L	50							-	-	-	<50	-	-
	Dichlorodifluoromethane	µg/L	50							-	-	-	<50	-	-
Herbicides	Dinoseb	µg/L	50							<50	-	-	-	-	-
	Pronamide	µg/L	2							-	-	-	<2	-	-
Nitroaromatics and Keytones	2-Picoline	µg/L	2							-	-	-	<2	-	-
	4-aminobiphenyl	µg/L	2							-	-	-	<2	-	-
	Acetophenone	µg/L	2							-	-	-	<2	-	-
	N-Nitrosodiphenyl & Diphenylamine	µg/L	4							-	-	-	<4	-	-
	Pentachloronitrobenzene	µg/L	2							-	-	-	<2	-	-
PCBs	PCBs (Total)	µg/L	1							<1	-	-	<1	-	-
Phthalates	Bis(2-ethylhexyl) phthalate	µg/L	10							-	-	-	<10	-	-
	Butyl benzyl phthalate	µg/L	2							-	-	-	<2	-	-
	Diethylphthalate	µg/L	2					1000		-	-	-	<2	-	-
	Dimethyl phthalate	µg/L	2					3700		-	-	-	<2	-	-
	Di-n-butyl phthalate	µg/L	2					26		-	-	-	<2	-	-
	Di-n-octyl phthalate	µg/L	2							-	-	-	<2	-	-
Surfactants	Anionic Surfactants as MBAS	µg/L	50							<50	-	-	<50	-	-

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Chem_Group	ChemName	output unit	EQL														
MAH	1,2,4-trimethylbenzene	µg/L	5							-	-	-	<5	-	-
	1,3,5-trimethylbenzene	µg/L	5							-	-	-	<5	-	-
	Isopropylbenzene	µg/L	5					30		-	-	-	<5	-	-
	Styrene	µg/L	5	4						<5	-	-	<5	-	-
	n-butylbenzene	µg/L	5							-	-	-	<5	-	-
	n-propylbenzene	µg/L	5							-	-	-	<5	-	-
	sec-butylbenzene	µg/L	5							-	-	-	<5	-	-
	tert-butylbenzene	µg/L	5							-	-	-	<5	-	-
	p-isopropyltoluene	µg/L	5							-	-	-	<5	-	-
SVOCs	1-naphthylamine	µg/L	2							-	-	-	<2	-	-
	2-(acetylamino) fluorene	µg/L	2							-	-	-	<2	-	-
	2-nitroaniline	µg/L	4							-	-	-	<4	-	-
	3,3-Dichlorobenzidine	µg/L	2							-	-	-	<2	-	-
	3-nitroaniline	µg/L	4							-	-	-	<4	-	-
	4-(dimethylamino) azobenzene	µg/L	2							-	-	-	<2	-	-
	4-bromophenyl phenyl ether	µg/L	2							-	-	-	<2	-	-
	4-chloroaniline	µg/L	2							-	-	-	<2	-	-
	4-chlorophenyl phenyl ether	µg/L	2							-	-	-	<2	-	-
	4-nitroaniline	µg/L	2							-	-	-	<2	-	-
	4-Nitroquinoline-N-oxide	µg/L	2							-	-	-	<2	-	-
	5-nitro-o-toluidine	µg/L	2							-	-	-	<2	-	-
	Aniline	µg/L	2					250		-	-	-	<2	-	-
	Azobenzene	µg/L	2							-	-	-	<2	-	-
	Bis(2-chloroethoxy) methane	µg/L	2							-	-	-	<2	-	-
	Bis(2-chloroethyl)ether	µg/L	2							-	-	-	<2	-	-
	Carbazole	µg/L	2							-	-	-	<2	-	-
	Chlorobenzilate	µg/L	2							-	-	-	<2	-	-
	Hexachlorocyclopentadiene	µg/L	10							-	-	-	<10	-	-
	Hexachloroethane	µg/L	2					360		-	-	-	<2	-	-
	Hexachloropropene	µg/L	2							-	-	-	<2	-	-
	Isophorone	µg/L	2							-	-	-	<2	-	-
	Methapyrilene	µg/L	2							-	-	-	<2	-	-
	N-nitrosodiethylamine	µg/L	2							-	-	-	<2	-	-
	N-nitrosodi-n-butylamine	µg/L	2							-	-	-	<2	-	-
	N-nitrosodi-n-propylamine	µg/L	2							-	-	-	<2	-	-
	N-Nitrosomethylethylamine	µg/L	2							-	-	-	<2	-	-
	N-nitrosomorpholine	µg/L	2							-	-	-	<2	-	-
	N-nitrosopiperidine	µg/L	2							-	-	-	<2	-	-
	N-nitrosopyrrolidine	µg/L	4							-	-	-	<4	-	-
	Pentachlorobenzene	µg/L	2					2		-	-	-	<2	-	-
	Phenacetin	µg/L	2							-	-	-	<2	-	-
VOCs	1,1-dichloroethane	µg/L	5							-	-	-	<5	-	-
	1,2,3-trichlorobenzene	µg/L	5					10		-	-	-	<5	-	-
	1,2,3-trichloropropane	µg/L	5							-	-	-	<5	-	-
	1,2-dibromoethane	µg/L	5							-	-	-	<5	-	-
	1,3-dichlorobenzene	µg/L	2	20				260		-	-	-	<2	-	-
	2-butanone (MEK)	µg/L	50							-	-	-	<50	-	-
	2-hexanone (MBK)	µg/L	50							-	-	-	<50	-	-
	4-methyl-2-pentanone (MIBK)	µg/L	50							-	-	-	<50	-	-
	Bromodichloromethane	µg/L	5							-	-	-	<5	-	-
	Bromoform	µg/L	5							-	-	-	<5	-	-

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Chem_Group	**ChemName**	**output unit**	**EQL**														
	Carbon disulfide	µg/L	5							-	-	-	<5	-	-
	Chlorodibromomethane	µg/L	5							-	-	-	<5	-	-
	Chloroethane	µg/L	50							-	-	-	<50	-	-
	cis-1,3-dichloropropene	µg/L	5							-	-	-	<5	-	-
	cis-1,4-Dichloro-2-butene	µg/L	5							-	-	-	<5	-	-
	Dibromomethane	µg/L	5							-	-	-	<5	-	-
	Iodomethane	µg/L	5							-	-	-	<5	-	-
	Pentachloroethane	µg/L	5					80		-	-	-	<5	-	-
	Trichloroethene	µg/L	5					330		<5	-	-	<5	-	-
	Tetrachloroethene	µg/L	5					70		<5	-	-	<5	-	-
	trans-1,3-dichloropropene	µg/L	5							-	-	-	<5	-	-
	trans-1,2-dichloroethene	µg/L	5							<5	-	-	<5	-	-
	trans-1,4-Dichloro-2-butene	µg/L	5							-	-	-	<5	-	-
	Trichlorofluoromethane	µg/L	50							-	-	-	<50	-	-
	Vinyl acetate	µg/L	50							-	-	-	<50	-	-
Dioxins & Furans	Dibenzofuran	pg/L	2000000							-	-	-	<2,000,000	-	-
PFAS - Perfluoroalkyl Carboxylic Acids	Perfluorobutanoic acid (PFBA)	µg/L	0.01							<0.01	-	-	-	<0.01	-
	Perfluoropentanoic acid (PFPeA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorohexanoic acid (PFHxA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorooctanoic acid (PFOA)	µg/L	0.002					19 [1]		<0.002	-	-	-	<0.002	-
	Perfluorononanoic acid (PFNA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorodecanoic acid (PFDA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.005							<0.005	-	-	-	<0.005	-
PFAS - Perfluoroalkyl Sulfonic Acids	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.002					0.00023 [1]		<0.002	-	-	-	<0.002	-
	Perfluorodecanesulfonic acid (PFDS)	µg/L	0.002							<0.002	-	-	-	<0.002	-
PFAS - Perfluoroalkyl Sulfonamide	Perfluorooctane sulfonamide (FOSA)	µg/L	0.002							<0.002	-	-	-	<0.002	-
	N-Methyl perfluorooctane sulfonamide (MeFOSA)	µg/L	0.005							<0.005	-	-	-	<0.005	-
	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	µg/L	0.005							<0.005	-	-	-	<0.005	-
	N-Methyl perfluorooctane sulfonamidoacetic acid	µg/L	0.002							<0.002	-	-	-	<0.002	-
	N-Methyl perfluorooctane sulfonamidoethanol (M	µg/L	0.005							<0.005	-	-	-	<0.005	-
	N-Ethyl perfluorooctane sulfonamidoethanol (EtF	µg/L	0.005							<0.005	-	-	-	<0.005	-
	N-Ethyl perfluorooctane sulfonamidoacetic acid (E	µg/L	0.002							<0.002	-	-	-	<0.002	-
PFAS - Fluorotelomer Sulfonic Acids	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.005							<0.005	-	-	-	<0.005	-
	6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.005							<0.005	-	-	-	<0.008	-
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.005							<0.005	-	-	-	<0.005	-
	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.005							<0.005	-	-	-	<0.005	-
PFAS - Sums	Sum of PFHxS and PFOS	µg/L	0.002							<0.002	-	-	-	<0.002	-
	PFAS (Sum of Total)	µg/L	0.002							<0.002	-	-	-	<0.002	-

										Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
										Bore ID	BH23A	BH23A	BH27C	BH27C	BH32	BH32
										Sampled Date	4/04/1900	29/10/2020	3/03/2020	28/10/2020	2/03/2020	20/08/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)								
Chem_Group	**ChemName**	**output unit**	**EQL**														
BTEXN	Benzene	µg/L	1					950		<1	-	-	<1	-	<1
	Toluene	µg/L	2	25				180		<2	-	-	<2	-	<2
	Ethylbenzene	µg/L	2	3				80		<2	-	-	<2	-	<2
	Xylene (o)	µg/L	2					350		<2	-	-	<2	-	<2
	Xylene (m & p)	µg/L	2							<2	-	-	<2	-	<2
	Xylene Total	µg/L	2	20						<2	-	-	<2	-	<2
	BTEX (Sum of Total) - Lab Calc	µg/L	1							<1	-	-	<1	-	<1
TRH - NEPM 2013	F1 (C6-C10 minus BTEX)	µg/L	20							<20	-	-	<20	-	<20
	C6-C10 Fraction	µg/L	20							<20	-	-	<20	-	<20
	F2 (>C10-C16 minus Naphthalene)	µg/L	100							<100	-	-	<100	-	<100
	>C10-C16 Fraction	µg/L	100							<100	-	-	<100	-	<100
	F3 (>C16-C34 Fraction)	µg/L	100							<100	-	-	<100	-	<100
	F4 (>C34-C40 Fraction)	µg/L	100							<100	-	-	<100	-	<100
	>C10-C40 (Sum of Total)	µg/L	100							<100	-	-	<100	-	<100
TRH - NEPM 1999	C6-C9 Fraction	µg/L	20							<20	-	-	<20	-	<20
	C10-C14 Fraction	µg/L	50							<50	-	-	<50	-	<50
	C15-C28 Fraction	µg/L	100							<100	-	-	<100	-	<100
	C29-C36 Fraction	µg/L	50							<50	-	-	<50	-	<50
	C10-C36 (Sum of Total)	µg/L	50							<50	-	-	<50	-	<50
TPH	Oil & Grease	µg/L	5000							<5000	-	-	<5000	-	<5000
PAHs - standard 16	Acenaphthene	µg/L	1							<2	-	-	<1	-	<2
	Acenaphthylene	µg/L	1							<2	-	-	<1	-	<2
	Anthracene	µg/L	1					0.4		<2	-	-	<1	-	<2
	Benz(a)anthracene	µg/L	1							<2	-	-	<1	-	<2
	Benzo(a)pyrene	µg/L	0.5					0.2		<2	-	-	<0.5	-	<2
	Benzo[b+j]fluoranthene	µg/L	1							-	-	-	<1	-	-
	Benzo(k)fluoranthene	µg/L	1							-	-	-	<1	-	-
	Benzo(g,h,i)perylene	µg/L	1							<2	-	-	<1	-	<2
	Chrysene	µg/L	1							<2	-	-	<1	-	<2
	Dibenz(a,h)anthracene	µg/L	1							<2	-	-	<1	-	<2
	Fluoranthene	µg/L	1					1.4		<2	-	-	<1	-	<2
	Fluorene	µg/L	1							<2	-	-	<1	-	<2
	Indeno(1,2,3-c,d)pyrene	µg/L	1							<2	-	-	<1	-	<2
	Naphthalene	µg/L	1					16		<2	-	-	<1	-	<2
	Phenanthrene	µg/L	1					2		<2	-	-	<1	-	<2
	Pyrene	µg/L	1							<2	-	-	<1	-	<2
	PAHs (Sum of total) - Lab calc	µg/L	0.5							<2	-	-	<0.5	-	<2
	Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.5							<2	-	-	<0.5	-	<2
PAHs - extended	2-methylnaphthalene	µg/L	2							<2	-	-	-	-	<2
	3-methylcholanthrene	µg/L	2							<2	-	-	-	-	<2
	7,12-dimethylbenz(a)anthracene	µg/L	2							<2	-	-	-	-	<2
	Benzo(b+j+k)fluoranthene	µg/L	4							<4	-	-	-	-	<4

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										Sampled Date	4/04/1900	29/10/2020	3/03/2020	28/10/2020	2/03/2020	20/08/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)								
Chem_Group	ChemName	output unit	EQL														
Phenols - Halogenated	2-Chlorophenol	µg/L	2	0.1				490		<2	-	-	<2	-	<2
	2,4-Dichlorophenol	µg/L	2	0.3				160		<2	-	-	<2	-	<2
	2,4,5-Trichlorophenol	µg/L	2							<2	-	-	<2	-	<2
	2,4,6-Trichlorophenol	µg/L	2	2				20		<2	-	-	<2	-	<2
	2,6-Dichlorophenol	µg/L	2							<2	-	-	<2	-	<2
	4-Chloro-3-methylphenol	µg/L	2							<2	-	-	<4	-	<2
	Pentachlorophenol	µg/L	2					10		<4	-	-	<2	-	<4
	Phenols(halogenated) - Lab Calc	µg/L	2							-	-	-	-	-	-
Phenols - Non-Halogenated	Phenol	µg/L	2					320		<2	-	-	<4	-	<2
	2-Nitrophenol	µg/L	2							<2	-	-	<4	-	<2
	2-Methylphenol (o-Cresol)	µg/L	2							<2	-	-	<4	-	<2
	3,4-Methylphenol (m,p-cresol)	µg/L	4							<4	-	-	<4	-	<4
	2,4-Dimethylphenol	µg/L	2							<2	-	-	<4	-	<2
	2,4-Dinitrophenol	µg/L	100					45		-	-	-	<100	-	-
	4,6-Dinitro-2-methylphenol	µg/L	50							-	-	-	<50	-	-
	4,6-Dinitro-o-cyclohexyl phenol	µg/L	50							-	-	-	<50	-	-
	4-Nitrophenol	µg/L	50							-	-	-	<50	-	-
	Phenols (non-halogenated) EPAVic	µg/L	4							-	-	-	-	-	-
Phenols	2,3,5,6-Tetrachlorophenol	µg/L	2							-	-	-	<2	-	-
	2,3,4,5 & 2,3,4,6-Tetrachlorophenol	µg/L	2							-	-	-	<2	-	-
OC Pesticides	4,4'-DDE	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	a-BHC	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	Aldrin	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	Aldrin + Dieldrin	µg/L	0.5							<0.5	-	-	-	-	<0.5
	b-BHC	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Chlordane	µg/L	0.5					0.08		<0.5	-	-	-	-	<0.5
	Chlordane (cis)	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	Chlordane (trans)	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	d-BHC	µg/L	0.5							<0.5	-	-	-	-	<0.5
	4,4 DDD	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	4,4 DDT	µg/L	0.5					0.01		<2	-	-	<0.5	-	<2
	DDT+DDE+DDD - Lab Calc	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Dieldrin	µg/L	0.5							<0.5	-	-	<0.5	-	<0.5
	Endosulfan I (alpha)	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Endosulfan II (beta)	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Endosulfan Sulfate	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Endrin	µg/L	0.5					0.02		<0.5	-	-	-	-	<0.5
	Endrin aldehyde	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Endrin ketone	µg/L	0.5							<0.5	-	-	-	-	<0.5
	g-BHC (Lindane)	µg/L	0.5					0.2		<0.5	-	-	-	-	<0.5
	Heptachlor	µg/L	0.5					0.09		<0.5	-	-	<0.5	-	<0.5
	Heptachlor epoxide	µg/L	0.5							<0.5	-	-	-	-	<0.5
	Hexachlorobenzene	µg/L	0.5					0.1		<0.5	-	-	-	-	<0.5
	Methoxychlor	µg/L	2							<2	-	-	-	-	<2
OP Pesticides	Chlorfenvinphos	µg/L	2							<2	-	-	-	-	<2
	Chlorpyrifos	µg/L	2					0.01		<2	-	-	-	-	<2
	Chlorpyrifos-methyl	µg/L	2							<2	-	-	-	-	<2
	Diazinon	µg/L	2					0.01		<2	-	-	-	-	<2
	Dichlorvos	µg/L	2							<2	-	-	-	-	<2
	Dimethoate	µg/L	2					0.15		<2	-	-	-	-	<2
	Ethion	µg/L	2							<2	-	-	-	-	<2

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										Bore ID	BH23A	BH23A	BH27C	BH27C	BH32	BH32
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				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)							
Chem_Group	ChemName	output unit	EQL													
	Fenthion	µg/L	2							<2	-	-	-	-	<2
	Malathion	µg/L	2					0.05		<2	-	-	-	-	<2
	Pirimphos-ethyl	µg/L	2							<2	-	-	-	-	<2
	Prothiofos	µg/L	2							<2	-	-	-	-	<2
Chlorinated Hydrocarbons	1,1,1,2-tetrachloroethane	µg/L	5							<5	-	-	<5	-	<5
	1,1,1-trichloroethane	µg/L	5					270		<5	-	-	<5	-	<5
	1,1,2,2-tetrachloroethane	µg/L	5					400		<5	-	-	<5	-	<5
	1,1,2-trichloroethane	µg/L	5					6500		<5	-	-	<5	-	<5
	1,1-dichloroethene	µg/L	5					700		<5	-	-	<5	-	<5
	1,1-dichloropropene	µg/L	5							<5	-	-	-	-	<5
	1,2,4-trichlorobenzene	µg/L	2					170		<2	-	-	<5	-	<2
	1,2-dibromo-3-chloropropane	µg/L	5							<5	-	-	-	-	<5
	1,2-dichlorobenzene	µg/L	2	1				160		<2	-	-	<5	-	<2
	1,2-dichloroethane	µg/L	5					1900		<5	-	-	<5	-	<5
	1,2-dichloropropane	µg/L	5					900		<5	-	-	-	-	<5
	1,3-dichloropropane	µg/L	5							<5	-	-	-	-	<5
	1,4-dichlorobenzene	µg/L	2	0.3				60		<2	-	-	<5	-	<2
	2,2-dichloropropane	µg/L	5							<5	-	-	-	-	<5
	2-chloronaphthalene	µg/L	2							<2	-	-	-	-	<2
	2-chlorotoluene	µg/L	5							<5	-	-	-	-	<5
	4-chlorotoluene	µg/L	5							<5	-	-	-	-	<5
	Bromobenzene	µg/L	5							<5	-	-	-	-	<5
	Carbon tetrachloride	µg/L	5					240		<5	-	-	<5	-	<5
	Chlorobenzene	µg/L	5	10				55		<5	-	-	<5	-	<5
	Chloroform	µg/L	5					770		<5	-	-	<5	-	<5
	Chloromethane	µg/L	50							<50	-	-	-	-	<50
	cis-1,2-dichloroethene	µg/L	5							<5	-	-	<5	-	<5
	Methylene chloride	µg/L	5					4000		-	-	-	<5	-	<5
	Hexachlorobutadiene	µg/L	2							<2	-	-	<5	-	<2
	Vinyl chloride	µg/L	50					100		<50	-	-	<50	-	<50
Explosives	1,3,5-Trinitrobenzene	µg/L	2							<2	-	-	-	-	<2
	2,4-Dinitrotoluene	µg/L	4					65		<4	-	-	-	-	<4
	2,6-dinitrotoluene	µg/L	4							<4	-	-	-	-	<4
	Nitrobenzene	µg/L	2					550		<2	-	-	-	-	<2
Halogenated Hydrocarbons	Bromomethane	µg/L	50							<50	-	-	-	-	<50
	Dichlorodifluoromethane	µg/L	50							<50	-	-	-	-	<50
Herbicides	Dinoseb	µg/L	50							-	-	-	<50	-	-
	Pronamide	µg/L	2							<2	-	-	-	-	<2
Nitroaromatics and Keytones	2-Picoline	µg/L	2							<2	-	-	-	-	<2
	4-aminobiphenyl	µg/L	2							<2	-	-	-	-	<2
	Acetophenone	µg/L	2							<2	-	-	-	-	<2
	N-Nitrosodiphenyl & Diphenylamine	µg/L	4							<4	-	-	-	-	<4
	Pentachloronitrobenzene	µg/L	2							<2	-	-	-	-	<2
PCBs	PCBs (Total)	µg/L	1							<1	-	-	<1	-	<1
Phthalates	Bis(2-ethylhexyl) phthalate	µg/L	10							<10	-	-	-	-	<10
	Butyl benzyl phthalate	µg/L	2							<2	-	-	-	-	<2
	Diethylphthalate	µg/L	2					1000		<2	-	-	-	-	<2
	Dimethyl phthalate	µg/L	2					3700		<2	-	-	-	-	<2
	Di-n-butyl phthalate	µg/L	2					26		<2	-	-	-	-	<2
	Di-n-octyl phthalate	µg/L	2							<2	-	-	-	-	<2
Surfactants	Anionic Surfactants as MBAS	µg/L	50							<100	-	-	<100	-	<50

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											Sampled Date	4/04/1900	29/10/2020	3/03/2020	28/10/2020	2/03/2020	20/08/2020
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Chem_Group	ChemName	output unit	EQL														
MAH	1,2,4-trimethylbenzene	µg/L	5								<5	-	-	-	-	<5
	1,3,5-trimethylbenzene	µg/L	5								<5	-	-	-	-	<5
	Isopropylbenzene	µg/L	5					30			<5	-	-	-	-	<5
	Styrene	µg/L	5	4							<5	-	-	<5	-	<5
	n-butylbenzene	µg/L	5								<5	-	-	-	-	<5
	n-propylbenzene	µg/L	5								<5	-	-	-	-	<5
	sec-butylbenzene	µg/L	5								<5	-	-	-	-	<5
	tert-butylbenzene	µg/L	5								<5	-	-	-	-	<5
	p-isopropyltoluene	µg/L	5								<5	-	-	-	-	<5
SVOCs	1-naphthylamine	µg/L	2								<2	-	-	-	-	<2
	2-(acetylamino) fluorene	µg/L	2								<2	-	-	-	-	<2
	2-nitroaniline	µg/L	4								<4	-	-	-	-	<4
	3,3-Dichlorobenzidine	µg/L	2								<2	-	-	-	-	<2
	3-nitroaniline	µg/L	4								<4	-	-	-	-	<4
	4-(dimethylamino) azobenzene	µg/L	2								<2	-	-	-	-	<2
	4-bromophenyl phenyl ether	µg/L	2								<2	-	-	-	-	<2
	4-chloroaniline	µg/L	2								<2	-	-	-	-	<2
	4-chlorophenyl phenyl ether	µg/L	2								<2	-	-	-	-	<2
	4-nitroaniline	µg/L	2								<2	-	-	-	-	<2
	4-Nitroquinoline-N-oxide	µg/L	2								<2	-	-	-	-	<2
	5-nitro-o-toluidine	µg/L	2								<2	-	-	-	-	<2
	Aniline	µg/L	2					250			<2	-	-	-	-	<2
	Azobenzene	µg/L	2								<2	-	-	-	-	<2
	Bis(2-chloroethoxy) methane	µg/L	2								<2	-	-	-	-	<2
	Bis(2-chloroethyl)ether	µg/L	2								<2	-	-	-	-	<2
	Carbazole	µg/L	2								<2	-	-	-	-	<2
	Chlorobenzilate	µg/L	2								<2	-	-	-	-	<2
	Hexachlorocyclopentadiene	µg/L	10								<10	-	-	-	-	<10
	Hexachloroethane	µg/L	2					360			<2	-	-	-	-	<2
	Hexachloropropene	µg/L	2								<2	-	-	-	-	<2
	Isophorone	µg/L	2								<2	-	-	-	-	<2
	Methapyrilene	µg/L	2								<2	-	-	-	-	<2
	N-nitrosodiethylamine	µg/L	2								<2	-	-	-	-	<2
	N-nitrosodi-n-butylamine	µg/L	2								<2	-	-	-	-	<2
	N-nitrosodi-n-propylamine	µg/L	2								<2	-	-	-	-	<2
	N-Nitrosomethylethylamine	µg/L	2								<2	-	-	-	-	<2
	N-nitrosomorpholine	µg/L	2								<2	-	-	-	-	<2
	N-nitrosopiperidine	µg/L	2								<2	-	-	-	-	<2
	N-nitrosopyrrolidine	µg/L	4								<4	-	-	-	-	<4
	Pentachlorobenzene	µg/L	2					2			<2	-	-	-	-	<2
	Phenacetin	µg/L	2								<2	-	-	-	-	<2
VOCs	1,1-dichloroethane	µg/L	5								<5	-	-	-	-	<5
	1,2,3-trichlorobenzene	µg/L	5					10			<5	-	-	-	-	<5
	1,2,3-trichloropropane	µg/L	5								<5	-	-	-	-	<5
	1,2-dibromoethane	µg/L	5								<5	-	-	-	-	<5
	1,3-dichlorobenzene	µg/L	2	20				260			<2	-	-	-	-	<2
	2-butanone (MEK)	µg/L	50								<50	-	-	-	-	<50
	2-hexanone (MBK)	µg/L	50								<50	-	-	-	-	<50
	4-methyl-2-pentanone (MIBK)	µg/L	50								<50	-	-	-	-	<50
	Bromodichloromethane	µg/L	5								<5	-	-	-	-	<5
	Bromoform	µg/L	5								<5	-	-	-	-	<5

										Site_ID	WORM	WORM	WORM	WORM	WORM	WORM
										Bore ID	BH23A	BH23A	BH27C	BH27C	BH32	BH32
										Sampled Date	4/04/1900	29/10/2020	3/03/2020	28/10/2020	2/03/2020	20/08/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)								
Chem_Group	ChemName	output unit	EQL														
	Carbon disulfide	µg/L	5							<5	-	-	-	-	<5
	Chlorodibromomethane	µg/L	5							<5	-	-	-	-	<5
	Chloroethane	µg/L	50							<50	-	-	-	-	<50
	cis-1,3-dichloropropene	µg/L	5							<5	-	-	-	-	<5
	cis-1,4-Dichloro-2-butene	µg/L	5							<5	-	-	-	-	<5
	Dibromomethane	µg/L	5							<5	-	-	-	-	<5
	Iodomethane	µg/L	5							<5	-	-	-	-	<5
	Pentachloroethane	µg/L	5					80		<5	-	-	-	-	<5
	Trichloroethene	µg/L	5					330		<5	-	-	<5	-	<5
	Tetrachloroethene	µg/L	5					70		<5	-	-	<5	-	<5
	trans-1,3-dichloropropene	µg/L	5							<5	-	-	-	-	<5
	trans-1,2-dichloroethene	µg/L	5							<5	-	-	<5	-	<5
	trans-1,4-Dichloro-2-butene	µg/L	5							<5	-	-	-	-	<5
	Trichlorofluoromethane	µg/L	50							<50	-	-	-	-	<50
	Vinyl acetate	µg/L	50							<50	-	-	-	-	<50
Dioxins & Furans	Dibenzofuran	pg/L	2000000							<2,000,000	-	-	-	-	<2,000,000
PFAS - Perfluoroalkyl Carboxylic Acids	Perfluorobutanoic acid (PFBA)	µg/L	0.01							-	<0.01	-	-	-	-
	Perfluoropentanoic acid (PFPeA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorohexanoic acid (PFHxA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorooctanoic acid (PFOA)	µg/L	0.002					19 [1]		-	<0.002	-	-	-	-
	Perfluorononanoic acid (PFNA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorodecanoic acid (PFDA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.005							-	<0.005	-	-	-	-
PFAS - Perfluoroalkyl Sulfonic Acids	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.002							-	<0.002	-	-	-	-
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.002					0.00023 [1]		-	<0.002	-	-	-	-
	Perfluorodecanesulfonic acid (PFDS)	µg/L	0.002							-	<0.002	-	-	-	-
PFAS - Perfluoroalkyl Sulfonamide	Perfluorooctane sulfonamide (FOSA)	µg/L	0.002							-	<0.002	-	-	-	-
	N-Methyl perfluorooctane sulfonamide (MeFOSA)	µg/L	0.005							-	<0.005	-	-	-	-
	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	µg/L	0.005							-	<0.005	-	-	-	-
	N-Methyl perfluorooctane sulfonamidoacetic acid	µg/L	0.002							-	<0.002	-	-	-	-
	N-Methyl perfluorooctane sulfonamidoethanol (M	µg/L	0.005							-	<0.005	-	-	-	-
	N-Ethyl perfluorooctane sulfonamidoethanol (EtF	µg/L	0.005							-	<0.005	-	-	-	-
	N-Ethyl perfluorooctane sulfonamidoacetic acid (E	µg/L	0.002							-	<0.002	-	-	-	-
PFAS - Fluorotelomer Sulfonic Acids	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.005							-	<0.005	-	-	-	-
	6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.005							-	<0.005	-	-	-	-
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.005							-	<0.005	-	-	-	-
	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.005							-	<0.005	-	-	-	-
PFAS - Sums	Sum of PFHxS and PFOS	µg/L	0.002							-	<0.002	-	-	-	-
	PFAS (Sum of Total)	µg/L	0.002							-	<0.002	-	-	-	-

										Site_ID	WORM	WORM	WORM	WORM
										Bore ID	BH49	BH49	Deep Creek	Jacksons Ck
										Sampled Date	3/03/2020	27/10/2020	29/10/2020	29/10/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)					
Chem_Group	ChemName	output unit	EQL											
BTEXN	Benzene	µg/L	1					950		-	<1	-	-	
	Toluene	µg/L	2	25				180		-	<2	-	-	
	Ethylbenzene	µg/L	2	3				80		-	<2	-	-	
	Xylene (o)	µg/L	2					350		-	<2	-	-	
	Xylene (m & p)	µg/L	2							-	<2	-	-	
	Xylene Total	µg/L	2	20						-	<2	-	-	
	BTEX (Sum of Total) - Lab Calc	µg/L	1							-	<1	-	-	
TRH - NEPM 2013	F1 (C6-C10 minus BTEX)	µg/L	20							-	<20	-	-	
	C6-C10 Fraction	µg/L	20							-	<20	-	-	
	F2 (>C10-C16 minus Naphthalene)	µg/L	100							-	<100	-	-	
	>C10-C16 Fraction	µg/L	100							-	<100	-	-	
	F3 (>C16-C34 Fraction)	µg/L	100							-	<100	-	-	
	F4 (>C34-C40 Fraction)	µg/L	100							-	<100	-	-	
	>C10-C40 (Sum of Total)	µg/L	100							-	<100	-	-	
TRH - NEPM 1999	C6-C9 Fraction	µg/L	20							-	<20	-	-	
	C10-C14 Fraction	µg/L	50							-	<50	-	-	
	C15-C28 Fraction	µg/L	100							-	<100	-	-	
	C29-C36 Fraction	µg/L	50							-	<50	-	-	
	C10-C36 (Sum of Total)	µg/L	50							-	<50	-	-	
TPH	Oil & Grease	µg/L	5000							-	<5000	-	-	
PAHs - standard 16	Acenaphthene	µg/L	1							-	<1	-	-	
	Acenaphthylene	µg/L	1							-	<1	-	-	
	Anthracene	µg/L	1					0.4		-	<1	-	-	
	Benz(a)anthracene	µg/L	1							-	<1	-	-	
	Benzo(a)pyrene	µg/L	0.5					0.2		-	<0.5	-	-	
	Benzo[b+j]fluoranthene	µg/L	1							-	<1	-	-	
	Benzo(k)fluoranthene	µg/L	1							-	<1	-	-	
	Benzo(g,h,i)perylene	µg/L	1							-	<1	-	-	
	Chrysene	µg/L	1							-	<1	-	-	
	Dibenz(a,h)anthracene	µg/L	1							-	<1	-	-	
	Fluoranthene	µg/L	1					1.4		-	<1	-	-	
	Fluorene	µg/L	1							-	<1	-	-	
	Indeno(1,2,3-c,d)pyrene	µg/L	1							-	<1	-	-	
	Naphthalene	µg/L	1					16		-	<1	-	-	
	Phenanthrene	µg/L	1					2		-	<1	-	-	
	Pyrene	µg/L	1							-	<1	-	-	
	PAHs (Sum of total) - Lab calc	µg/L	0.5							-	<0.5	-	-	
	Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.5							-	<0.5	-	-	
PAHs - extended	2-methylnaphthalene	µg/L	2							-	-	-	-	
	3-methylcholanthrene	µg/L	2							-	-	-	-	
	7,12-dimethylbenz(a)anthracene	µg/L	2							-	-	-	-	
	Benzo(b+j+k)fluoranthene	µg/L	4							-	-	-	-	

										Site_ID	WORM	WORM	WORM	WORM
										Bore ID	BH49	BH49	Deep Creek	Jacksons Ck
										Sampled Date	3/03/2020	27/10/2020	29/10/2020	29/10/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)					
Chem_Group	ChemName	output unit	EQL											
Phenols - Halogenated	2-Chlorophenol	µg/L	2	0.1				490		-	<2	-	-	
	2,4-Dichlorophenol	µg/L	2	0.3				160		-	<2	-	-	
	2,4,5-Trichlorophenol	µg/L	2							-	<2	-	-	
	2,4,6-Trichlorophenol	µg/L	2	2				20		-	<2	-	-	
	2,6-Dichlorophenol	µg/L	2							-	<2	-	-	
	4-Chloro-3-methylphenol	µg/L	2							-	<4	-	-	
	Pentachlorophenol	µg/L	2					10		-	<2	-	-	
	Phenols(halogenated) - Lab Calc	µg/L	2							-	-	-	-	
Phenols - Non-Halogenated	Phenol	µg/L	2					320		-	<4	-	-	
	2-Nitrophenol	µg/L	2							-	<4	-	-	
	2-Methylphenol (o-Cresol)	µg/L	2							-	<4	-	-	
	3,4-Methylphenol (m,p-cresol)	µg/L	4							-	<4	-	-	
	2,4-Dimethylphenol	µg/L	2							-	<4	-	-	
	2,4-Dinitrophenol	µg/L	100					45		-	<100	-	-	
	4,6-Dinitro-2-methylphenol	µg/L	50							-	<50	-	-	
	4,6-Dinitro-o-cyclohexyl phenol	µg/L	50							-	<50	-	-	
	4-Nitrophenol	µg/L	50							-	<50	-	-	
	Phenols (non-halogenated) EPAVic	µg/L	4							-	-	-	-	
Phenols	2,3,5,6-Tetrachlorophenol	µg/L	2							-	<2	-	-	
	2,3,4,5 & 2,3,4,6-Tetrachlorophenol	µg/L	2							-	<2	-	-	
OC Pesticides	4,4'-DDE	µg/L	0.5							-	<0.5	-	-	
	a-BHC	µg/L	0.5							-	<0.5	-	-	
	Aldrin	µg/L	0.5							-	<0.5	-	-	
	Aldrin + Dieldrin	µg/L	0.5							-	-	-	-	
	b-BHC	µg/L	0.5							-	-	-	-	
	Chlordane	µg/L	0.5					0.08		-	-	-	-	
	Chlordane (cis)	µg/L	0.5							-	<0.5	-	-	
	Chlordane (trans)	µg/L	0.5							-	<0.5	-	-	
	d-BHC	µg/L	0.5							-	-	-	-	
	4,4 DDD	µg/L	0.5							-	<0.5	-	-	
	4,4 DDT	µg/L	0.5					0.01		-	<0.5	-	-	
	DDT+DDE+DDD - Lab Calc	µg/L	0.5							-	-	-	-	
	Dieldrin	µg/L	0.5							-	<0.5	-	-	
	Endosulfan I (alpha)	µg/L	0.5							-	-	-	-	
	Endosulfan II (beta)	µg/L	0.5							-	-	-	-	
	Endosulfan Sulfate	µg/L	0.5							-	-	-	-	
	Endrin	µg/L	0.5					0.02		-	-	-	-	
	Endrin aldehyde	µg/L	0.5							-	-	-	-	
	Endrin ketone	µg/L	0.5							-	-	-	-	
	g-BHC (Lindane)	µg/L	0.5					0.2		-	-	-	-	
	Heptachlor	µg/L	0.5					0.09		-	<0.5	-	-	
	Heptachlor epoxide	µg/L	0.5							-	-	-	-	
	Hexachlorobenzene	µg/L	0.5					0.1		-	-	-	-	
	Methoxychlor	µg/L	2							-	-	-	-	
OP Pesticides	Chlorfenvinphos	µg/L	2							-	-	-	-	
	Chlorpyrifos	µg/L	2					0.01		-	-	-	-	
	Chlorpyrifos-methyl	µg/L	2							-	-	-	-	
	Diazinon	µg/L	2					0.01		-	-	-	-	
	Dichlorvos	µg/L	2							-	-	-	-	
	Dimethoate	µg/L	2					0.15		-	-	-	-	
	Ethion	µg/L	2							-	-	-	-	

										Site_ID	WORM	WORM	WORM	WORM
										Bore ID	BH49	BH49	Deep Creek	Jacksons Ck
										Sampled Date	3/03/2020	27/10/2020	29/10/2020	29/10/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)					
Chem_Group	ChemName	output unit	EQL											
	Fenthion	µg/L	2							-	-	-	-	
	Malathion	µg/L	2					0.05		-	-	-	-	
	Pirimphos-ethyl	µg/L	2							-	-	-	-	
	Prothiofos	µg/L	2							-	-	-	-	
Chlorinated Hydrocarbons	1,1,1,2-tetrachloroethane	µg/L	5							-	<5	-	-	
	1,1,1-trichloroethane	µg/L	5					270		-	<5	-	-	
	1,1,2,2-tetrachloroethane	µg/L	5					400		-	<5	-	-	
	1,1,2-trichloroethane	µg/L	5					6500		-	<5	-	-	
	1,1-dichloroethene	µg/L	5					700		-	<5	-	-	
	1,1-dichloropropene	µg/L	5							-	-	-	-	
	1,2,4-trichlorobenzene	µg/L	2					170		-	<5	-	-	
	1,2-dibromo-3-chloropropane	µg/L	5							-	-	-	-	
	1,2-dichlorobenzene	µg/L	2	1				160		-	<5	-	-	
	1,2-dichloroethane	µg/L	5					1900		-	<5	-	-	
	1,2-dichloropropane	µg/L	5					900		-	-	-	-	
	1,3-dichloropropane	µg/L	5							-	-	-	-	
	1,4-dichlorobenzene	µg/L	2	0.3				60		-	<5	-	-	
	2,2-dichloropropane	µg/L	5							-	-	-	-	
	2-chloronaphthalene	µg/L	2							-	-	-	-	
	2-chlorotoluene	µg/L	5							-	-	-	-	
	4-chlorotoluene	µg/L	5							-	-	-	-	
	Bromobenzene	µg/L	5							-	-	-	-	
	Carbon tetrachloride	µg/L	5					240		-	<5	-	-	
	Chlorobenzene	µg/L	5	10				55		-	<5	-	-	
	Chloroform	µg/L	5					770		-	<5	-	-	
	Chloromethane	µg/L	50							-	-	-	-	
	cis-1,2-dichloroethene	µg/L	5							-	<5	-	-	
	Methylene chloride	µg/L	5					4000		-	<5	-	-	
	Hexachlorobutadiene	µg/L	2							-	<5	-	-	
	Vinyl chloride	µg/L	50					100		-	<50	-	-	
Explosives	1,3,5-Trinitrobenzene	µg/L	2							-	-	-	-	
	2,4-Dinitrotoluene	µg/L	4					65		-	-	-	-	
	2,6-dinitrotoluene	µg/L	4							-	-	-	-	
	Nitrobenzene	µg/L	2					550		-	-	-	-	
Halogenated Hydrocarbons	Bromomethane	µg/L	50							-	-	-	-	
	Dichlorodifluoromethane	µg/L	50							-	-	-	-	
Herbicides	Dinoseb	µg/L	50							-	<50	-	-	
	Pronamide	µg/L	2							-	-	-	-	
Nitroaromatics and Keytones	2-Picoline	µg/L	2							-	-	-	-	
	4-aminobiphenyl	µg/L	2							-	-	-	-	
	Acetophenone	µg/L	2							-	-	-	-	
	N-Nitrosodiphenyl & Diphenylamine	µg/L	4							-	-	-	-	
	Pentachloronitrobenzene	µg/L	2							-	-	-	-	
PCBs	PCBs (Total)	µg/L	1							-	<1	-	-	
Phthalates	Bis(2-ethylhexyl) phthalate	µg/L	10							-	-	-	-	
	Butyl benzyl phthalate	µg/L	2							-	-	-	-	
	Diethylphthalate	µg/L	2					1000		-	-	-	-	
	Dimethyl phthalate	µg/L	2					3700		-	-	-	-	
	Di-n-butyl phthalate	µg/L	2					26		-	-	-	-	
	Di-n-octyl phthalate	µg/L	2							-	-	-	-	
Surfactants	Anionic Surfactants as MBAS	µg/L	50							-	<100	-	-	

										Site_ID	WORM	WORM	WORM	WORM
										Bore ID	BH49	BH49	Deep Creek	Jacksons Ck
										Sampled Date	3/03/2020	27/10/2020	29/10/2020	29/10/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)					
Chem_Group	ChemName	output unit	EQL											
MAH	1,2,4-trimethylbenzene	µg/L	5							-	-	-	-	
	1,3,5-trimethylbenzene	µg/L	5							-	-	-	-	
	Isopropylbenzene	µg/L	5					30		-	-	-	-	
	Styrene	µg/L	5	4						-	<5	-	-	
	n-butylbenzene	µg/L	5							-	-	-	-	
	n-propylbenzene	µg/L	5							-	-	-	-	
	sec-butylbenzene	µg/L	5							-	-	-	-	
	tert-butylbenzene	µg/L	5							-	-	-	-	
	p-isopropyltoluene	µg/L	5							-	-	-	-	
SVOCs	1-naphthylamine	µg/L	2							-	-	-	-	
	2-(acetylamino) fluorene	µg/L	2							-	-	-	-	
	2-nitroaniline	µg/L	4							-	-	-	-	
	3,3-Dichlorobenzidine	µg/L	2							-	-	-	-	
	3-nitroaniline	µg/L	4							-	-	-	-	
	4-(dimethylamino) azobenzene	µg/L	2							-	-	-	-	
	4-bromophenyl phenyl ether	µg/L	2							-	-	-	-	
	4-chloroaniline	µg/L	2							-	-	-	-	
	4-chlorophenyl phenyl ether	µg/L	2							-	-	-	-	
	4-nitroaniline	µg/L	2							-	-	-	-	
	4-Nitroquinoline-N-oxide	µg/L	2							-	-	-	-	
	5-nitro-o-toluidine	µg/L	2							-	-	-	-	
	Aniline	µg/L	2					250		-	-	-	-	
	Azobenzene	µg/L	2							-	-	-	-	
	Bis(2-chloroethoxy) methane	µg/L	2							-	-	-	-	
	Bis(2-chloroethyl)ether	µg/L	2							-	-	-	-	
	Carbazole	µg/L	2							-	-	-	-	
	Chlorobenzilate	µg/L	2							-	-	-	-	
	Hexachlorocyclopentadiene	µg/L	10							-	-	-	-	
	Hexachloroethane	µg/L	2					360		-	-	-	-	
	Hexachloropropene	µg/L	2							-	-	-	-	
	Isophorone	µg/L	2							-	-	-	-	
	Methapyrilene	µg/L	2							-	-	-	-	
	N-nitrosodiethylamine	µg/L	2							-	-	-	-	
	N-nitrosodi-n-butylamine	µg/L	2							-	-	-	-	
	N-nitrosodi-n-propylamine	µg/L	2							-	-	-	-	
	N-Nitrosomethylethylamine	µg/L	2							-	-	-	-	
	N-nitrosomorpholine	µg/L	2							-	-	-	-	
	N-nitrosopiperidine	µg/L	2							-	-	-	-	
	N-nitrosopyrrolidine	µg/L	4							-	-	-	-	
	Pentachlorobenzene	µg/L	2					2		-	-	-	-	
	Phenacetin	µg/L	2							-	-	-	-	
VOCs	1,1-dichloroethane	µg/L	5							-	-	-	-	
	1,2,3-trichlorobenzene	µg/L	5					10		-	-	-	-	
	1,2,3-trichloropropane	µg/L	5							-	-	-	-	
	1,2-dibromoethane	µg/L	5							-	-	-	-	
	1,3-dichlorobenzene	µg/L	2	20				260		-	-	-	-	
	2-butanone (MEK)	µg/L	50							-	-	-	-	
	2-hexanone (MBK)	µg/L	50							-	-	-	-	
	4-methyl-2-pentanone (MIBK)	µg/L	50							-	-	-	-	
	Bromodichloromethane	µg/L	5							-	-	-	-	
	Bromoform	µg/L	5							-	-	-	-	

											Site_ID	WORM	WORM	WORM	WORM
											Bore ID	BH49	BH49	Deep Creek	Jacksons Ck
											Sampled Date	3/03/2020	27/10/2020	29/10/2020	29/10/2020
				ADWG 2011 Aesthetic (v3.5 updated 2018)	ANZECC 2000 - Stock Watering	ANZECC 2000 Irrigation - Long-term Trigger Values	ANZECC 2000 Irrigation - Short-term Trigger Values	ANZG (2018) - FW - 95% species protection	SEPP Waters (2018)						
Chem_Group	**ChemName**	**output unit**	**EQL**												
	Carbon disulfide	µg/L	5								-	-	-	-	
	Chlorodibromomethane	µg/L	5								-	-	-	-	
	Chloroethane	µg/L	50								-	-	-	-	
	cis-1,3-dichloropropene	µg/L	5								-	-	-	-	
	cis-1,4-Dichloro-2-butene	µg/L	5								-	-	-	-	
	Dibromomethane	µg/L	5								-	-	-	-	
	Iodomethane	µg/L	5								-	-	-	-	
	Pentachloroethane	µg/L	5					80			-	-	-	-	
	Trichloroethene	µg/L	5					330			-	<5	-	-	
	Tetrachloroethene	µg/L	5					70			-	<5	-	-	
	trans-1,3-dichloropropene	µg/L	5								-	-	-	-	
	trans-1,2-dichloroethene	µg/L	5								-	<5	-	-	
	trans-1,4-Dichloro-2-butene	µg/L	5								-	-	-	-	
	Trichlorofluoromethane	µg/L	50								-	-	-	-	
	Vinyl acetate	µg/L	50								-	-	-	-	
Dioxins & Furans	Dibenzofuran	pg/L	2000000								-	-	-	-	
PFAS - Perfluoroalkyl Carboxylic Acids	Perfluorobutanoic acid (PFBA)	µg/L	0.01								-	-	<0.01	<0.01	
	Perfluoropentanoic acid (PFPeA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorohexanoic acid (PFHxA)	µg/L	0.002								-	-	<0.002	0.004	
	Perfluoroheptanoic acid (PFHpA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorooctanoic acid (PFOA)	µg/L	0.002					19 [1]			-	-	<0.002	0.003	
	Perfluorononanoic acid (PFNA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorodecanoic acid (PFDA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluoroundecanoic acid (PFUnDA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorododecanoic acid (PFDoDA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorotridecanoic acid (PFTrDA)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.005								-	-	<0.005	<0.005	
PFAS - Perfluoroalkyl Sulfonic Acids	Perfluorobutane sulfonic acid (PFBS)	µg/L	0.002								-	-	<0.002	0.006	
	Perfluoropentane sulfonic acid (PFPeS)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.002								-	-	<0.003	0.003	
	Perfluoroheptane sulfonic acid (PFHpS)	µg/L	0.002								-	-	<0.002	<0.002	
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.002					0.00023 [1]			-	-	<0.002	0.004	
	Perfluorodecanesulfonic acid (PFDS)	µg/L	0.002								-	-	<0.002	<0.002	
PFAS - Perfluoroalkyl Sulfonamide	Perfluorooctane sulfonamide (FOSA)	µg/L	0.002								-	-	<0.002	<0.002	
	N-Methyl perfluorooctane sulfonamide (MeFOSA)	µg/L	0.005								-	-	<0.005	<0.005	
	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	µg/L	0.005								-	-	<0.005	<0.005	
	N-Methyl perfluorooctane sulfonamidoacetic acid	µg/L	0.002								-	-	<0.002	<0.002	
	N-Methyl perfluorooctane sulfonamidoethanol (M	µg/L	0.005								-	-	<0.005	<0.005	
	N-Ethyl perfluorooctane sulfonamidoethanol (EtF	µg/L	0.005								-	-	<0.005	<0.005	
	N-Ethyl perfluorooctane sulfonamidoacetic acid (E	µg/L	0.002								-	-	<0.002	<0.002	
PFAS - Fluorotelomer Sulfonic Acids	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	0.005								-	-	<0.005	<0.005	
	6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.005								-	-	<0.005	<0.005	
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	0.005								-	-	<0.005	<0.005	
	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	0.005								-	-	<0.005	<0.005	
PFAS - Sums	Sum of PFHxS and PFOS	µg/L	0.002								-	-	<0.002	0.007	
	PFAS (Sum of Total)	µg/L	0.002								-	-	<0.002	0.02	

ActionLevelSource	ChemName	Unit	Action_Level	Action_Level_Min	Comments
ADWG 2011 Aesthetic (v3.5 updated 2018)	Zinc	mg/L	3		Natural concentrations generally <0.01 mg/L
ADWG 2011 Aesthetic (v3.5 updated 2018)	Turbidity	NTU	5		<0.2 is target for effective filtration of Cryptosporidium and Giardia, <1 is target for effective disinfection
ANZECC 2000 - Stock Watering	Nitrate (as N)	mg/L	90		400 mg/L divided by molecular weight, stock may tolerate higher nitrate concentrations if nitrate in feed are not high, water containing >1500 mg/L (as NO3) is likely to be toxic.
ANZECC 2000 - Stock Watering	Nitrite (as N)	mg/L	9.1		30 mg/L divided by molecular weight
ANZECC 2000 - Stock Watering	Copper	mg/L	1		>0.5 mg/L hazardous to sheep, >1 mg/L for cattle, >5 mg/L pigs and poulty
ANZECC 2000 - Stock Watering	Total Dissolved Solids	mg/L	5000		Loss of production expected at 5000 mg/L for beef cattle, 4000 mg/L dairy cattle, 10000 mg/L sheep, 6000 mg/L horses and pigs, 3000 mg/L poultry
ANZECC 2000 - Stock Watering	Total Dissolved Solids @ 180°C	mg/L	5000		Loss of production expected at 5000 mg/L for beef cattle, 4000 mg/L dairy cattle, 10000 mg/L sheep, 6000 mg/L horses and pigs, 3000 mg/L poultry
ANZECC 2000 - Stock Watering	Total Dissolved Solids (est.)	mg/L	5000		Loss of production expected at 5000 mg/L for beef cattle, 4000 mg/L dairy cattle, 10000 mg/L sheep, 6000 mg/L horses and pigs, 3000 mg/L poultry
ANZECC 2000 - Stock Watering	TDS (Field)	mg/L	5000		Loss of production expected at 5000 mg/L for beef cattle, 4000 mg/L dairy cattle, 10000 mg/L sheep, 6000 mg/L horses and pigs, 3000 mg/L poultry
ANZECC 2000 Irrigation - Long-term Trigger Values	Chloride	mg/L	350		Low risk of increasing crop cadmium concentrations at <350 mg/L, may cause foliar injury (table 9.2.12 and 9.2.13)
ANZECC 2000 Irrigation - Long-term Trigger Values	Lithium	mg/L	2.5		0.075 mg/L for citrus
ANZECC 2000 Irrigation - Long-term Trigger Values	Chromium (III+VI)	mg/L	0.1		Chromium VI value
ANZECC 2000 Irrigation - Long-term Trigger Values	Phosphorus (Total)	mg/L	0.05		Minimise biocloggging of irrigation equipment only
ANZECC 2000 Irrigation - Long-term Trigger Values	Electrical conductivity (field)	us/cm	2900		General guide, not intended to define suitability of irrigation water <650 uS/cm for sensitive crops, <1300 uS/cm for moderately sensitive crops, <2900 for moderately tolerant crops, <52000 for tolerant crops, <8100 for very tolerant crops.
ANZECC 2000 Irrigation - Long-term Trigger Values	Electrical conductivity (lab)	us/cm	2900		General guide, not intended to define suitability of irrigation water <650 uS/cm for sensitive crops, <1300 uS/cm for moderately sensitive crops, <2900 for moderately tolerant crops, <52000 for tolerant crops, <8100 for very tolerant crops.
ANZECC 2000 Irrigation - Long-term Trigger Values	pH (Lab)	unit	9	6	pH between 6-8.5 for groundwater and 6-9 for surface water, to limit corrosion and fouling of systems
ANZECC 2000 Irrigation - Long-term Trigger Values	Sodium Adsorption Ratio	ratio	5		5 for medium-heavy clay (clay content 55-65%) - Table 9.2.6 for more details
ANZECC 2000 Irrigation - Short-term Trigger Values	Lithium	mg/L	2.5		0.075 mg/L for citrus
ANZECC 2000 Irrigation - Short-term Trigger Values	Boron	mg/L	0.5		0.5-15 mg/L depending on crop sensitivity
ANZECC 2000 Irrigation - Short-term Trigger Values	Chromium (III+VI)	mg/L	1		Chromium VI value
ANZECC 2000 Irrigation - Short-term Trigger Values	Phosphorus (Total)	mg/L	0.8		0.8-12 mg/L - requires a site specific assessment
ANZECC 2000 Irrigation - Short-term Trigger Values	Nitrogen (Total)	mg/L	25		25-125 mg/L - requires a site specific assessment
ANZG (2018) - FW - 95% species protection (updated 15/10/2019)	Cyanide (Total)	mg/L	0.007		Cyanide as un-ionised HCN, measured as [CN]
ANZG (2018) - FW - 95% species protection (updated 15/10/2019)	Aluminium	mg/L	0.055		(pH >6.5)
ANZG (2018) - FW - 95% species protection (updated 15/10/2019)	Arsenic	mg/L	0.013		In absence of total As guideline, As (V) guideline has been adopted.
ANZG (2018) - FW - 95% species protection (updated 15/10/2019)	Chromium (III+VI)	mg/L	0.001		Guideline for Cr (VI) adopted
ANZG (2018) - FW - 95% species protection (updated 15/10/2019)	Chromium -Calculated by Hardness	mg/L	0.001		Guideline for Cr (VI) adopted
ANZG (2018) - FW - 95% species protection (updated 15/10/2019)	Ammonia as N	mg/L	0.9		Measured as NH3-N at pH 8

Appendix H – Certified laboratory results (groundwater)

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2003567**	Page	: 1 of 8
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST [redacted]	Address	: [redacted]
Telephone	: [redacted]	Telephone	: [redacted]
Project	: 12517812	Date Samples Received	: 04-Mar-2020 10:10
Order number	: ----	Date Analysis Commenced	: 04-Mar-2020
C-O-C number	: ----	Issue Date	: 11-Mar-2020 15:54
Sampler	: MM		
Site	:		
Quote number	: EN/005/19		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
[redacted]	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic Balance out of acceptable limits for sample #1 and #5 due to analytes not quantified in this report.
- EA010: Conductivity EM2003567 #7 has been confirmed by reanlaysis.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- ED041G: EM2003561 #2 Poor matrix spike recovery for Sulfate due to sample matrix. Confirmed by re-extraction and re-analysis.
- EA010-P: Electrical Conductivity @ 25°C was analysed by manual method (EA010).
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32_020320	BH24_020320	BH23_020320	BH49_030320	BH27_030320
				Client sampling date / time	02-Mar-2020 00:00	02-Mar-2020 00:00	02-Mar-2020 00:00	03-Mar-2020 00:00	03-Mar-2020 00:00
Compound	CAS Number	LOR	Unit		EM2003567-001	EM2003567-002	EM2003567-003	EM2003567-004	EM2003567-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.09	7.73	8.06	8.30	8.36
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		7780	5710	6460	2460	1400
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		5060	3710	4200	1600	910
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	3
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		106	322	542	232	159
Total Alkalinity as CaCO3	----	1	mg/L		106	322	542	232	162
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		453	446	286	114	41
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		2500	1460	1730	675	385
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		135	106	136	18	7
Magnesium	7439-95-4	1	mg/L		95	205	236	64	21
Sodium	7440-23-5	1	mg/L		1200	804	895	345	217
Potassium	7440-09-7	1	mg/L		10	22	37	23	17
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.002	0.001	0.003	0.001	0.003
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		0.060	<0.001	<0.001	<0.001	0.002
Copper	7440-50-8	0.001	mg/L		0.012	0.011	0.012	0.028	0.022
Nickel	7440-02-0	0.001	mg/L		0.007	0.019	0.014	0.008	0.006
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.001
Zinc	7440-66-6	0.005	mg/L		0.036	0.105	0.032	0.053	0.048
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.33	0.16	0.41	0.09	0.05
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32_020320	BH24_020320	BH23_020320	BH49_030320	BH27_030320
				Client sampling date / time	02-Mar-2020 00:00	02-Mar-2020 00:00	02-Mar-2020 00:00	03-Mar-2020 00:00	03-Mar-2020 00:00
Compound	CAS Number	LOR	Unit		EM2003567-001	EM2003567-002	EM2003567-003	EM2003567-004	EM2003567-005
					Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**15.1**	**0.3**	**14.1**	<0.1	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**15.1**	**0.3**	**14.1**	<0.1	**0.3**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**6.07**	**0.03**	**20.6**	**0.25**	**0.29**
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**82.1**	**56.9**	**65.6**	**26.0**	**15.0**
ø **Total Cations**	----	0.01	meq/L		**67.0**	**57.7**	**66.1**	**21.8**	**12.0**
ø **Ionic Balance**	----	0.01	%		**10.1**	**0.69**	**0.38**	**8.97**	**11.1**

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH15_030320	----	----	----	----
				Client sampling date / time	03-Mar-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2003567-006	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.85**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**7420**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		**4820**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**1360**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**1360**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**41**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**1820**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**187**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**290**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**990**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**60**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		**0.018**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.019**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.068**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		**0.001**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.074**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**1.60**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH15_030320	----	----	----	----
				Client sampling date / time	03-Mar-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2003567-006	--------	--------	--------	--------
					Result	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.2**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**2.2**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.12**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**79.4**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**77.8**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**1.00**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QC01_030320	----	----	----	----
				Client sampling date / time	03-Mar-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2003567-007	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.44**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**2**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		**1**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**3**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**3**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		<1	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		<1	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QC01_030320	----	----	----	----
				Client sampling date / time	03-Mar-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2003567-007	--------	--------	--------	--------
					Result	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**0.06**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		<0.01	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2014137**	Page	: 1 of 10
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: [redacted]	Telephone	[redacted]
Project	: 12529997	Date Samples Received	: 14-Aug-2020 09:15
Order number	: ----	Date Analysis Commenced	: 15-Aug-2020
C-O-C number	: ----	Issue Date	: 20-Aug-2020 13:51
Sampler	: MM		
Site	: ----		
Quote number	: EN/005/17 (Victoria Primary Quote)		
No. of samples received	: 7		
No. of samples analysed	: 5		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	2IC Organic Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
[redacted]	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG048G: EM2014107 #18, poor matrix spike recovery for hexavalent chromium due to sample matrix. confirmed by re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero, for 'TEQ 1/2LOR' are treated as half the reported LOR, and for 'TEQ LOR' are treated as being equal to the reported LOR. Note: TEQ 1/2LOR and TEQ LOR will calculate as 0.6mg/Kg and 1.2mg/Kg respectively for samples with non-detects for all of the eight TEQ PAHs.
- EP074-UT: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EG035T: EM2014107 #13 Poor matrix spike recovery for total mercury due to sample matrix. Confirmed by re-extraction and re-analysis.
- EG020-F : EM2013977 #1 Poor matrix spike recovery for dissolved metal due to sample matrix. Confirmed by re-digestion and re-analysis.
- Sample BH04 was filtered through a 0.45um filter prior to the dissolved metals analysis.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH01_0.1	BH01_0.5	BH11_0.1	BH11_0.5	----
			Client sampling date / time	10-Aug-2020 00:00	10-Aug-2020 00:00	13-Aug-2020 00:00	13-Aug-2020 00:00	----
Compound	CAS Number	LOR	Unit	EM2014137-001	EM2014137-002	EM2014137-003	EM2014137-004	--------
				Result	Result	Result	Result	----
EA001: pH in soil using 0.01M CaCl extract								
pH (CaCl2)	----	0.1	pH Unit	**5.2**	**7.7**	**4.6**	**5.6**	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**32.4**	**31.7**	**23.5**	**25.6**	----
EG005(ED093)T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**6**	<5	<5	<5	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Copper	7440-50-8	5	mg/kg	**14**	**10**	**15**	**23**	----
Lead	7439-92-1	5	mg/kg	**19**	**11**	**12**	**10**	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	----
Nickel	7440-02-0	2	mg/kg	**24**	**45**	**30**	**40**	----
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	----
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	----
Tin	7440-31-5	5	mg/kg	<5	<5	<5	<5	----
Zinc	7440-66-6	5	mg/kg	**21**	**17**	**13**	**19**	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	1	mg/kg	<1	<1	<1	<1	----
EK040T: Fluoride Total								
Fluoride	16984-48-8	40	mg/kg	**180**	**210**	**140**	**190**	----
EP066: Polychlorinated Biphenyls (PCB)								
Total Polychlorinated biphenyls	----	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
Styrene	100-42-5	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----
^ Sum of monocyclic aromatic hydrocarbons	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01_0.1	BH01_0.5	BH11_0.1	BH11_0.5	----
				Client sampling date / time	10-Aug-2020 00:00	10-Aug-2020 00:00	13-Aug-2020 00:00	13-Aug-2020 00:00	----
Compound	CAS Number	LOR	Unit		EM2014137-001	EM2014137-002	EM2014137-003	EM2014137-004	--------
					Result	Result	Result	Result	----
EP074H: Naphthalene									
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	----
EP074I: Volatile Halogenated Compounds									
Vinyl chloride	75-01-4	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.1-Dichloroethene	75-35-4	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Methylene chloride	75-09-2	0.4	mg/kg		<0.4	<0.4	<0.4	<0.4	----
trans-1.2-Dichloroethene	156-60-5	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
cis-1.2-Dichloroethene	156-59-2	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Chloroform	67-66-3	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.1.1-Trichloroethane	71-55-6	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
Carbon Tetrachloride	56-23-5	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
1.2-Dichloroethane	107-06-2	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
Trichloroethene	79-01-6	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.1.2-Trichloroethane	79-00-5	0.04	mg/kg		<0.04	<0.04	<0.04	<0.04	----
Tetrachloroethene	127-18-4	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.1.1.2-Tetrachloroethane	630-20-6	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
1.1.2.2-Tetrachloroethane	79-34-5	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
Hexachlorobutadiene	87-68-3	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
Chlorobenzene	108-90-7	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.4-Dichlorobenzene	106-46-7	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.2-Dichlorobenzene	95-50-1	0.02	mg/kg		<0.02	<0.02	<0.02	<0.02	----
1.2.4-Trichlorobenzene	120-82-1	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
^ Sum of volatile chlorinated hydrocarbons	----	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
^ Sum of other chlorinated hydrocarbons	----	0.01	mg/kg		<0.01	<0.01	<0.01	<0.01	----
EP075A: Phenolic Compounds (Halogenated)									
2-Chlorophenol	95-57-8	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
2.4-Dichlorophenol	120-83-2	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
2.6-Dichlorophenol	87-65-0	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
4-Chloro-3-methylphenol	59-50-7	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
2.4.5-Trichlorophenol	95-95-4	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
2.4.6-Trichlorophenol	88-06-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
2.3.5.6-Tetrachlorophenol	935-95-5	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
2.3.4.5 & 2.3.4.6-Tetrachlorophenol	4901-51-3/58-90-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
Pentachlorophenol	87-86-5	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	----
^ Sum of Phenols (halogenated)	----	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01_0.1	BH01_0.5	BH11_0.1	BH11_0.5	----
				Client sampling date / time	10-Aug-2020 00:00	10-Aug-2020 00:00	13-Aug-2020 00:00	13-Aug-2020 00:00	----
Compound	CAS Number	LOR	Unit		EM2014137-001	EM2014137-002	EM2014137-003	EM2014137-004	--------
					Result	Result	Result	Result	----
EP075A: Phenolic Compounds (Halogenated) - Continued									
EP075A: Phenolic Compounds (Non-halogenated)									
Phenol	108-95-2	1	mg/kg		<1	<1	<1	<1	----
2-Methylphenol	95-48-7	1	mg/kg		<1	<1	<1	<1	----
3- & 4-Methylphenol	1319-77-3	1	mg/kg		<1	<1	<1	<1	----
2-Nitrophenol	88-75-5	1	mg/kg		<1	<1	<1	<1	----
2.4-Dimethylphenol	105-67-9	1	mg/kg		<1	<1	<1	<1	----
2.4-Dinitrophenol	51-28-5	5	mg/kg		<5	<5	<5	<5	----
4-Nitrophenol	100-02-7	5	mg/kg		<5	<5	<5	<5	----
2-Methyl-4.6-dinitrophenol	8071-51-0	5	mg/kg		<5	<5	<5	<5	----
Dinoseb	88-85-7	5	mg/kg		<5	<5	<5	<5	----
2-Cyclohexyl-4.6-Dinitrophenol	131-89-5	5	mg/kg		<5	<5	<5	<5	----
^ Sum of Phenols (non-halogenated)	----	1	mg/kg		<1	<1	<1	<1	----
EP075B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Acenaphthene	83-32-9	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Acenaphthylene	208-96-8	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Fluorene	86-73-7	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Phenanthrene	85-01-8	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Anthracene	120-12-7	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Fluoranthene	206-44-0	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Pyrene	129-00-0	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Benz(a)anthracene	56-55-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Chrysene	218-01-9	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	1.0	mg/kg		<1.0	<1.0	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	----
^ Benzo(a)pyrene TEQ (half LOR)	----	0.5	mg/kg		**0.6**	**0.6**	**0.6**	**0.6**	----
^ Benzo(a)pyrene TEQ (LOR)	----	0.5	mg/kg		**1.2**	**1.2**	**1.2**	**1.2**	----
EP075I: Organochlorine Pesticides									

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01_0.1	BH01_0.5	BH11_0.1	BH11_0.5	----
				Client sampling date / time	10-Aug-2020 00:00	10-Aug-2020 00:00	13-Aug-2020 00:00	13-Aug-2020 00:00	----
Compound	CAS Number	LOR	Unit		EM2014137-001	EM2014137-002	EM2014137-003	EM2014137-004	--------
					Result	Result	Result	Result	----
EP075l: Organochlorine Pesticides - Continued									
alpha-BHC	319-84-6	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Hexachlorobenzene (HCB)	118-74-1	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
beta-BHC	319-85-7	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
gamma-BHC	58-89-9	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
delta-BHC	319-86-8	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Heptachlor	76-44-8	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Aldrin	309-00-2	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Heptachlor epoxide	1024-57-3	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
cis-Chlordane	5103-71-9	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
trans-Chlordane	5103-74-2	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Endosulfan 1	959-98-8	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
4.4`-DDE	72-55-9	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
Dieldrin	60-57-1	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Endrin aldehyde	7421-93-4	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Endrin	72-20-8	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
Endosulfan 2	33213-65-9	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
4.4`-DDD	72-54-8	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
Endosulfan sulfate	1031-07-8	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
4.4`-DDT	50-29-3	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
Methoxychlor	72-43-5	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
^ Sum of organochlorine pesticides	----	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	----
^ Chlordane	57-74-9	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
^ Sum of other organochlorine pesticides	----	0.03	mg/kg		<0.03	<0.03	<0.03	<0.03	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	----
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	----
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	----
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	----
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	<100	----
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01_0.1	BH01_0.5	BH11_0.1	BH11_0.5	----
				Client sampling date / time	10-Aug-2020 00:00	10-Aug-2020 00:00	13-Aug-2020 00:00	13-Aug-2020 00:00	----
Compound	CAS Number	LOR	Unit		EM2014137-001	EM2014137-002	EM2014137-003	EM2014137-004	--------
					Result	Result	Result	Result	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	<50	----
>C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	<50	<50	----
C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	----
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	0.1	%		**108**	**102**	**97.0**	**101**	----
EP074S: VOC Surrogates (Ultra-Trace)									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**78.6**	**71.6**	**81.3**	**86.8**	----
Toluene-D8	2037-26-5	0.1	%		**74.2**	**68.0**	**78.8**	**80.6**	----
4-Bromofluorobenzene	460-00-4	0.1	%		**84.5**	**79.1**	**90.6**	**95.1**	----
EP075S: Acid Extractable Surrogates (Waste Classification)									
Phenol-d6	13127-88-3	0.025	%		**95.8**	**88.5**	**96.9**	**98.2**	----
2-Chlorophenol-D4	93951-73-6	0.025	%		**88.2**	**81.8**	**88.3**	**92.9**	----
2.4.6-Tribromophenol	118-79-6	0.025	%		**97.7**	**86.9**	**98.8**	**102**	----
EP075T: Base/Neutral Extractable Surrogates (Waste Classification)									
Nitrobenzene-D5	4165-60-0	0.025	%		**89.5**	**82.8**	**92.3**	**98.1**	----
1.2-Dichlorobenzene-D4	2199-69-1	0.025	%		**86.4**	**77.4**	**87.4**	**91.0**	----
2-Fluorobiphenyl	321-60-8	0.025	%		**100**	**93.0**	**102**	**106**	----
Anthracene-d10	1719-06-8	0.025	%		**91.5**	**86.4**	**94.0**	**97.8**	----
4-Terphenyl-d14	1718-51-0	0.025	%		**88.6**	**82.1**	**89.9**	**93.8**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH04	----	----	----	----
				Client sampling date / time	13-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014137-007	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.86**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**4840**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		**3150**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**916**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**916**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**7**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**1190**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**88**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**178**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**587**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**32**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		**0.004**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.001**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.009**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.010**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**1.40**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH04	----	----	----	----
				Client sampling date / time	13-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014137-007	--------	--------	--------	--------
					Result	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.19**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.19**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.4**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.6**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	----	----	----	----
EN055: Ionic Balance									
ø **Total Anions**	----	0.01	meq/L		**52.0**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L		**45.4**	----	----	----	----
ø **Ionic Balance**	----	0.01	%		**6.80**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	CAS Number	Recovery Limits (%) Low	High
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	41	122
EP074S: VOC Surrogates (Ultra-Trace)			
1.2-Dichloroethane-D4	17060-07-0	59	119
Toluene-D8	2037-26-5	55	117
4-Bromofluorobenzene	460-00-4	59	123
EP075S: Acid Extractable Surrogates (Waste Classification)			
Phenol-d6	13127-88-3	28	134
2-Chlorophenol-D4	93951-73-6	27	123
2.4.6-Tribromophenol	118-79-6	25	149
EP075T: Base/Neutral Extractable Surrogates (Waste Classification)			
Nitrobenzene-D5	4165-60-0	29	125
1.2-Dichlorobenzene-D4	2199-69-1	31	117
2-Fluorobiphenyl	321-60-8	44	136
Anthracene-d10	1719-06-8	53	133
4-Terphenyl-d14	1718-51-0	59	141

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2014371**	Page	: 1 of 13
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: ----	Telephone	: [redacted]
Project	: 12529997/08	Date Samples Received	: 19-Aug-2020 16:00
Order number	: ----	Date Analysis Commenced	: 20-Aug-2020
C-O-C number	: ----	Issue Date	: 27-Aug-2020 16:23
Sampler	: MM		
Site	: ----		
Quote number	: ME/458/20		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
[redacted]	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
[redacted]	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	Laboratory Coordinator	WRG Subcontracting, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA005-P: EM2014450 #10 Poor duplicate precision for pH due to sample heterogeneity. Confirmed by re-preparation and re-analysis.
- EA010-P: Electrical Conductivity @ 25°C was analysed by manual method (EA010).
- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP075: Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is he sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above he LOR.
- EP074: Where reported, Total Trihalomethanes is the sum of the reported concentrations of all Trihalomethanes at or above the LOR.
- EP074: Where reported, Total Trimethylbenzenes is the sum of the reported concentrations of 1.2.3-Trimethylbenzene, 1.2.4-Trimethylbenzene and 1.3.5-Trimethylbenzene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- MBAS (EP050) is calculated as LAS, molecular weight 348 g/mol.
- EA015H: EM2014371 #2: TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- The analytical BOD run containing samples from this work order recovered the certified reference standard within acceptable criteria but the dilution water blank was elevated above 0.2 mg/L.
- EP075: Where reported, 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- E.coli & Total Coliforms by MPN (MM514) is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.76**	**7.64**	**7.41**	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**2410**	**3900**	**7190**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**1300**	**3790**	**3560**	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**25**	**15**	**12**	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**489**	**357**	**469**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**489**	**357**	**469**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**88**	**123**	**386**	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**457**	**1090**	**1920**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**32**	**71**	**137**	----	----
Magnesium	7439-95-4	1	mg/L		**66**	**195**	**238**	----	----
Sodium	7440-23-5	1	mg/L		**315**	**333**	**926**	----	----
Potassium	7440-09-7	1	mg/L		**9**	**13**	**32**	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		**0.001**	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		**0.016**	**0.012**	**0.022**	----	----
Nickel	7440-02-0	0.001	mg/L		**0.012**	**0.008**	**0.023**	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		**0.078**	**0.041**	**0.087**	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	**0.02**	**0.90**	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**1.04**	**0.72**	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**1.05**	**0.72**	<0.01	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.2**	**0.9**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.2**	**0.9**	**0.9**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.23**	**0.14**	**0.02**	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**24.5**	**40.4**	**71.6**	----	----
ø Total Cations	----	0.01	meq/L		**21.0**	**34.4**	**67.5**	----	----
ø Ionic Balance	----	0.01	%		**7.77**	**8.06**	**2.91**	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)									
Chemical Oxygen Demand	----	10	mg/L		**14**	**16**	**24**	----	----
EP030: Biochemical Oxygen Demand (BOD)									
Biochemical Oxygen Demand	----	2	mg/L		<2	<2	<2	----	----
EP050: Anionic Surfactants as MBAS									
Anionic Surfactants as MBAS	----	0.1	mg/L		<0.1	<0.1	<0.1	----	----
EP066: Polychlorinated Biphenyls (PCB)									
^ Total Polychlorinated biphenyls	----	1	µg/L		<1	<1	<1	----	----
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	----	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	----	----
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		<5	<5	<5	----	----
Isopropylbenzene	98-82-8	5	µg/L		<5	<5	<5	----	----
n-Propylbenzene	103-65-1	5	µg/L		<5	<5	<5	----	----
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	<5	<5	----	----
sec-Butylbenzene	135-98-8	5	µg/L		<5	<5	<5	----	----
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	<5	<5	----	----
tert-Butylbenzene	98-06-6	5	µg/L		<5	<5	<5	----	----
p-Isopropyltoluene	99-87-6	5	µg/L		<5	<5	<5	----	----
n-Butylbenzene	104-51-8	5	µg/L		<5	<5	<5	----	----
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	<50	<50	----	----
2-Butanone (MEK)	78-93-3	50	µg/L		<50	<50	<50	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	<50	<50	----	----
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	<50	<50	----	----
EP074C: Sulfonated Compounds									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP074C: Sulfonated Compounds - Continued									
Carbon disulfide	75-15-0	5	µg/L		<5	<5	<5	----	----
EP074D: Fumigants									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	<5	<5	----	----
1.2-Dichloropropane	78-87-5	5	µg/L		<5	<5	<5	----	----
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	<5	<5	----	----
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	<5	<5	----	----
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	<5	<5	----	----
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	<50	<50	----	----
Chloromethane	74-87-3	50	µg/L		<50	<50	<50	----	----
Vinyl chloride	75-01-4	50	µg/L		<50	<50	<50	----	----
Bromomethane	74-83-9	50	µg/L		<50	<50	<50	----	----
Chloroethane	75-00-3	50	µg/L		<50	<50	<50	----	----
Trichlorofluoromethane	75-69-4	50	µg/L		<50	<50	<50	----	----
1.1-Dichloroethene	75-35-4	5	µg/L		<5	<5	<5	----	----
Iodomethane	74-88-4	5	µg/L		<5	<5	<5	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	<5	<5	----	----
1.1-Dichloroethane	75-34-3	5	µg/L		<5	<5	<5	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	<5	<5	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	<5	<5	----	----
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	<5	<5	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	<5	<5	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	<5	<5	----	----
Trichloroethene	79-01-6	5	µg/L		<5	<5	<5	----	----
Dibromomethane	74-95-3	5	µg/L		<5	<5	<5	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	<5	<5	----	----
1.3-Dichloropropane	142-28-9	5	µg/L		<5	<5	<5	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	<5	<5	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	<5	<5	----	----
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	<5	<5	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	<5	<5	----	----
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	<5	<5	----	----
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	<5	<5	----	----
Pentachloroethane	76-01-7	5	µg/L		<5	<5	<5	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP074E: Halogenated Aliphatic Compounds - Continued									
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	<5	<5	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	<5	<5	----	----
Bromobenzene	108-86-1	5	µg/L		<5	<5	<5	----	----
2-Chlorotoluene	95-49-8	5	µg/L		<5	<5	<5	----	----
4-Chlorotoluene	106-43-4	5	µg/L		<5	<5	<5	----	----
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	<5	<5	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	<5	<5	----	----
Bromodichloromethane	75-27-4	5	µg/L		<5	<5	<5	----	----
Dibromochloromethane	124-48-1	5	µg/L		<5	<5	<5	----	----
Bromoform	75-25-2	5	µg/L		<5	<5	<5	----	----
EP075A: Phenolic Compounds									
Phenol	108-95-2	2	µg/L		<2	<2	<2	----	----
2-Chlorophenol	95-57-8	2	µg/L		<2	<2	<2	----	----
2-Methylphenol	95-48-7	2	µg/L		<2	<2	<2	----	----
3- & 4-Methylphenol	1319-77-3	4	µg/L		<4	<4	<4	----	----
2-Nitrophenol	88-75-5	2	µg/L		<2	<2	<2	----	----
2.4-Dimethylphenol	105-67-9	2	µg/L		<2	<2	<2	----	----
2.4-Dichlorophenol	120-83-2	2	µg/L		<2	<2	<2	----	----
2.6-Dichlorophenol	87-65-0	2	µg/L		<2	<2	<2	----	----
4-Chloro-3-methylphenol	59-50-7	2	µg/L		<2	<2	<2	----	----
2.4.6-Trichlorophenol	88-06-2	2	µg/L		<2	<2	<2	----	----
2.4.5-Trichlorophenol	95-95-4	2	µg/L		<2	<2	<2	----	----
Pentachlorophenol	87-86-5	4	µg/L		<4	<4	<4	----	----
EP075B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	2	µg/L		<2	<2	<2	----	----
2-Methylnaphthalene	91-57-6	2	µg/L		<2	<2	<2	----	----
2-Chloronaphthalene	91-58-7	2	µg/L		<2	<2	<2	----	----
Acenaphthylene	208-96-8	2	µg/L		<2	<2	<2	----	----
Acenaphthene	83-32-9	2	µg/L		<2	<2	<2	----	----
Fluorene	86-73-7	2	µg/L		<2	<2	<2	----	----
Phenanthrene	85-01-8	2	µg/L		<2	<2	<2	----	----
Anthracene	120-12-7	2	µg/L		<2	<2	<2	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP075B: Polynuclear Aromatic Hydrocarbons - Continued									
Fluoranthene	206-44-0	2	µg/L		<2	<2	<2	----	----
Pyrene	129-00-0	2	µg/L		<2	<2	<2	----	----
N-2-Fluorenyl Acetamide	53-96-3	2	µg/L		<2	<2	<2	----	----
Benz(a)anthracene	56-55-3	2	µg/L		<2	<2	<2	----	----
Chrysene	218-01-9	2	µg/L		<2	<2	<2	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L		<4	<4	<4	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L		<2	<2	<2	----	----
Benzo(a)pyrene	50-32-8	2	µg/L		<2	<2	<2	----	----
3-Methylcholanthrene	56-49-5	2	µg/L		<2	<2	<2	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L		<2	<2	<2	----	----
Dibenz(a.h)anthracene	53-70-3	2	µg/L		<2	<2	<2	----	----
Benzo(g.h.i)perylene	191-24-2	2	µg/L		<2	<2	<2	----	----
^ Sum of PAHs	----	2	µg/L		<2	<2	<2	----	----
^ Benzo(a)pyrene TEQ (zero)	----	2	µg/L		<2	<2	<2	----	----
EP075C: Phthalate Esters									
Dimethyl phthalate	131-11-3	2	µg/L		<2	<2	<2	----	----
Diethyl phthalate	84-66-2	2	µg/L		<2	<2	<2	----	----
Di-n-butyl phthalate	84-74-2	2	µg/L		<2	<2	<2	----	----
Butyl benzyl phthalate	85-68-7	2	µg/L		<2	<2	<2	----	----
bis(2-ethylhexyl) phthalate	117-81-7	10	µg/L		<10	<10	<10	----	----
Di-n-octylphthalate	117-84-0	2	µg/L		<2	<2	<2	----	----
EP075D: Nitrosamines									
N-Nitrosomethylethylamine	10595-95-6	2	µg/L		<2	<2	<2	----	----
N-Nitrosodiethylamine	55-18-5	2	µg/L		<2	<2	<2	----	----
N-Nitrosopyrrolidine	930-55-2	4	µg/L		<4	<4	<4	----	----
N-Nitrosomorpholine	59-89-2	2	µg/L		<2	<2	<2	----	----
N-Nitrosodi-n-propylamine	621-64-7	2	µg/L		<2	<2	<2	----	----
N-Nitrosopiperidine	100-75-4	2	µg/L		<2	<2	<2	----	----
N-Nitrosodibutylamine	924-16-3	2	µg/L		<2	<2	<2	----	----
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L		<4	<4	<4	----	----
Methapyrilene	91-80-5	2	µg/L		<2	<2	<2	----	----
EP075E: Nitroaromatics and Ketones									
2-Picoline	109-06-8	2	µg/L		<2	<2	<2	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP075E: Nitroaromatics and Ketones - Continued									
Acetophenone	98-86-2	2	µg/L		<2	<2	<2	----	----
Nitrobenzene	98-95-3	2	µg/L		<2	<2	<2	----	----
Isophorone	78-59-1	2	µg/L		<2	<2	<2	----	----
2.6-Dinitrotoluene	606-20-2	4	µg/L		<4	<4	<4	----	----
2.4-Dinitrotoluene	121-14-2	4	µg/L		<4	<4	<4	----	----
1-Naphthylamine	134-32-7	2	µg/L		<2	<2	<2	----	----
4-Nitroquinoline-N-oxide	56-57-5	2	µg/L		<2	<2	<2	----	----
5-Nitro-o-toluidine	99-55-8	2	µg/L		<2	<2	<2	----	----
Azobenzene	103-33-3	2	µg/L		<2	<2	<2	----	----
1.3.5-Trinitrobenzene	99-35-4	2	µg/L		<2	<2	<2	----	----
Phenacetin	62-44-2	2	µg/L		<2	<2	<2	----	----
4-Aminobiphenyl	92-67-1	2	µg/L		<2	<2	<2	----	----
Pentachloronitrobenzene	82-68-8	2	µg/L		<2	<2	<2	----	----
Pronamide	23950-58-5	2	µg/L		<2	<2	<2	----	----
Dimethylaminoazobenzene	60-11-7	2	µg/L		<2	<2	<2	----	----
Chlorobenzilate	510-15-6	2	µg/L		<2	<2	<2	----	----
EP075F: Haloethers									
Bis(2-chloroethyl) ether	111-44-4	2	µg/L		<2	<2	<2	----	----
Bis(2-chloroethoxy) methane	111-91-1	2	µg/L		<2	<2	<2	----	----
4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L		<2	<2	<2	----	----
4-Bromophenyl phenyl ether	101-55-3	2	µg/L		<2	<2	<2	----	----
EP075G: Chlorinated Hydrocarbons									
1.3-Dichlorobenzene	541-73-1	2	µg/L		<2	<2	<2	----	----
1.4-Dichlorobenzene	106-46-7	2	µg/L		<2	<2	<2	----	----
1.2-Dichlorobenzene	95-50-1	2	µg/L		<2	<2	<2	----	----
Hexachloroethane	67-72-1	2	µg/L		<2	<2	<2	----	----
1.2.4-Trichlorobenzene	120-82-1	2	µg/L		<2	<2	<2	----	----
Hexachloropropylene	1888-71-7	2	µg/L		<2	<2	<2	----	----
Hexachlorobutadiene	87-68-3	2	µg/L		<2	<2	<2	----	----
Hexachlorocyclopentadiene	77-47-4	10	µg/L		<10	<10	<10	----	----
Pentachlorobenzene	608-93-5	2	µg/L		<2	<2	<2	----	----
Hexachlorobenzene (HCB)	118-74-1	4	µg/L		<4	<4	<4	----	----
EP075H: Anilines and Benzidines									
Aniline	62-53-3	2	µg/L		<2	<2	<2	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP075H: Anilines and Benzidines - Continued									
4-Chloroaniline	106-47-8	2	µg/L		<2	<2	<2	----	----
2-Nitroaniline	88-74-4	4	µg/L		<4	<4	<4	----	----
3-Nitroaniline	99-09-2	4	µg/L		<4	<4	<4	----	----
Dibenzofuran	132-64-9	2	µg/L		<2	<2	<2	----	----
4-Nitroaniline	100-01-6	2	µg/L		<2	<2	<2	----	----
Carbazole	86-74-8	2	µg/L		<2	<2	<2	----	----
3.3`-Dichlorobenzidine	91-94-1	2	µg/L		<2	<2	<2	----	----
EP075I: Organochlorine Pesticides									
alpha-BHC	319-84-6	2	µg/L		<2	<2	<2	----	----
beta-BHC	319-85-7	2	µg/L		<2	<2	<2	----	----
gamma-BHC	58-89-9	2	µg/L		<2	<2	<2	----	----
delta-BHC	319-86-8	2	µg/L		<2	<2	<2	----	----
Heptachlor	76-44-8	2	µg/L		<2	<2	<2	----	----
Aldrin	309-00-2	2	µg/L		<2	<2	<2	----	----
Heptachlor epoxide	1024-57-3	2	µg/L		<2	<2	<2	----	----
alpha-Endosulfan	959-98-8	2	µg/L		<2	<2	<2	----	----
4.4`-DDE	72-55-9	2	µg/L		<2	<2	<2	----	----
Dieldrin	60-57-1	2	µg/L		<2	<2	<2	----	----
Endrin	72-20-8	2	µg/L		<2	<2	<2	----	----
beta-Endosulfan	33213-65-9	2	µg/L		<2	<2	<2	----	----
4.4`-DDD	72-54-8	2	µg/L		<2	<2	<2	----	----
Endosulfan sulfate	1031-07-8	2	µg/L		<2	<2	<2	----	----
4.4`-DDT	50-29-3	4	µg/L		<4	<4	<4	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	4	µg/L		<4	<4	<4	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-29-3	4	µg/L		<4	<4	<4	----	----
EP075J: Organophosphorus Pesticides									
Dichlorvos	62-73-7	2	µg/L		<2	<2	<2	----	----
Dimethoate	60-51-5	2	µg/L		<2	<2	<2	----	----
Diazinon	333-41-5	2	µg/L		<2	<2	<2	----	----
Chlorpyrifos-methyl	5598-13-0	2	µg/L		<2	<2	<2	----	----
Malathion	121-75-5	2	µg/L		<2	<2	<2	----	----
Fenthion	55-38-9	2	µg/L		<2	<2	<2	----	----
Chlorpyrifos	2921-88-2	2	µg/L		<2	<2	<2	----	----
Pirimphos-ethyl	23505-41-1	2	µg/L		<2	<2	<2	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP075J: Organophosphorus Pesticides - Continued									
Chlorfenvinphos	470-90-6	2	µg/L		<2	<2	<2	----	----
Prothiofos	34643-46-4	2	µg/L		<2	<2	<2	----	----
Ethion	563-12-2	2	µg/L		<2	<2	<2	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
MM514: E.coli & Total Coliforms MPN by Colilert									
Escherichia coli (Colilert)	----	1	orgs/100mL		0	0	0	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		112	113	112	----	----
Toluene-D8	2037-26-5	5	%		107	109	107	----	----
4-Bromofluorobenzene	460-00-4	5	%		109	112	113	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH14	BH12	BH23A	----	----
				Client sampling date / time	18-Aug-2020 00:00	18-Aug-2020 00:00	19-Aug-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EM2014371-001	EM2014371-002	EM2014371-003	--------	--------
					Result	Result	Result	----	----
EP075S: Acid Extractable Surrogates									
2-Fluorophenol	367-12-4	2	%		55.8	70.2	72.1	----	----
Phenol-d6	13127-88-3	2	%		27.6	35.0	34.6	----	----
2-Chlorophenol-D4	93951-73-6	2	%		62.6	74.0	76.0	----	----
2.4.6-Tribromophenol	118-79-6	2	%		53.6	63.0	61.3	----	----
EP075T: Base/Neutral Extractable Surrogates									
Nitrobenzene-D5	4165-60-0	2	%		67.5	81.2	81.6	----	----
1.2-Dichlorobenzene-D4	2199-69-1	2	%		56.0	68.0	69.2	----	----
2-Fluorobiphenyl	321-60-8	2	%		66.4	80.0	80.5	----	----
Anthracene-d10	1719-06-8	2	%		75.5	93.1	94.0	----	----
4-Terphenyl-d14	1718-51-0	2	%		68.8	86.9	89.4	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		99.7	101	100.0	----	----
Toluene-D8	2037-26-5	2	%		96.3	97.8	96.8	----	----
4-Bromofluorobenzene	460-00-4	2	%		115	110	112	----	----

Surrogate Control Limits

Sub-Matrix: **GROUNDWATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	10	75
Phenol-d6	13127-88-3	10	65
2-Chlorophenol-D4	93951-73-6	21	103
2.4.6-Tribromophenol	118-79-6	22	120
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	24	116
1.2-Dichlorobenzene-D4	2199-69-1	23	99
2-Fluorobiphenyl	321-60-8	32	114
Anthracene-d10	1719-06-8	47	119
4-Terphenyl-d14	1718-51-0	44	124
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2014440**	Page	: 1 of 13
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: ----	Telephone	: [redacted]
Project	: 12529997/08	Date Samples Received	: 20-Aug-2020 15:30
Order number	: ----	Date Analysis Commenced	: 20-Aug-2020
C-O-C number	: ----	Issue Date	: 27-Aug-2020 15:06
Sampler	: [redacted]		
Site	: ----		
Quote number	: ME/458/20		
No. of samples received	: 1		
No. of samples analysed	: 1		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
	Assistant Laboratory Manager	Melbourne Organics, Springvale, VIC
	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC
	Senior Inorganic Instrument Chemist	WRG Subcontracting, Springvale, VIC
	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK040P: EM2014512 #2 Poor matrix spike recovery for Fluoride due to sample matrix. Confirmed by re-preparation and re-analysis.
- EG050G-F: EM2014440 #1 Hexavalent chromium results may be biased high compared to Dissolved Chromium filtered as sample were not field filtered prior to sample preservation.
- EA010-P: Electrical Conductivity @ 25°C was analysed by manual method (EA010).
- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP075: Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is he sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above he LOR.
- EP074: Where reported, Total Trihalomethanes is the sum of the reported concentrations of all Trihalomethanes at or above the LOR.
- EP074: Where reported, Total Trimethylbenzenes is the sum of the reported concentrations of 1.2.3-Trimethylbenzene, 1.2.4-Trimethylbenzene and 1.3.5-Trimethylbenzene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- The analytical BOD run containing samples from this work order recovered the certified reference standard within acceptable criteria but the dilution water blank was elevated above 0.2 mg/L.
- EP075: Where reported, 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- E.coli & Total Coliforms by MPN (MM514) is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- MBAS (W-MBAS)is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.73**	----	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**12500**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**7340**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**21**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**388**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**388**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**641**	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**4090**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**135**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**321**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**1980**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**15**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		**0.0002**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.102**	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.015**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		**0.002**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.129**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.08**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.08**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	----	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**136**	----	----	----	----
ø Total Cations	----	0.01	meq/L		**120**	----	----	----	----
ø Ionic Balance	----	0.01	%		**6.56**	----	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	----	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)									
Chemical Oxygen Demand	----	10	mg/L		**41**	----	----	----	----
EP030: Biochemical Oxygen Demand (BOD)									
Biochemical Oxygen Demand	----	2	mg/L		<2	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)									
^ Total Polychlorinated biphenyls	----	1	µg/L		<1	----	----	----	----
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	----	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	----	----	----	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	----	----	----	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	----	----	----	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	----	----	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	----	----	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	----	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	----	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	----	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	----	----	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	----	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	----	----	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	----	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	----	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	----	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	----	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	----	----	----	----
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	----	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	----	----	----	----
Methoxychlor	72-43-5	2.0	µg/L		<2.0	----	----	----	----
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	----	----	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	----	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	----	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		<5	----	----	----	----
Isopropylbenzene	98-82-8	5	µg/L		<5	----	----	----	----
n-Propylbenzene	103-65-1	5	µg/L		<5	----	----	----	----
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	----	----	----	----
sec-Butylbenzene	135-98-8	5	µg/L		<5	----	----	----	----
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	----	----	----	----
tert-Butylbenzene	98-06-6	5	µg/L		<5	----	----	----	----
p-Isopropyltoluene	99-87-6	5	µg/L		<5	----	----	----	----
n-Butylbenzene	104-51-8	5	µg/L		<5	----	----	----	----
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	----	----	----	----
2-Butanone (MEK)	78-93-3	50	µg/L		<50	----	----	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	----	----	----	----
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	----	----	----	----
EP074C: Sulfonated Compounds									
Carbon disulfide	75-15-0	5	µg/L		<5	----	----	----	----
EP074D: Fumigants									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP074D: Fumigants - Continued									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	----	----	----	----
1.2-Dichloropropane	78-87-5	5	µg/L		<5	----	----	----	----
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	----	----	----	----
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	----	----	----	----
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	----	----	----	----
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	----	----	----	----
Chloromethane	74-87-3	50	µg/L		<50	----	----	----	----
Vinyl chloride	75-01-4	50	µg/L		<50	----	----	----	----
Bromomethane	74-83-9	50	µg/L		<50	----	----	----	----
Chloroethane	75-00-3	50	µg/L		<50	----	----	----	----
Trichlorofluoromethane	75-69-4	50	µg/L		<50	----	----	----	----
1.1-Dichloroethene	75-35-4	5	µg/L		<5	----	----	----	----
Iodomethane	74-88-4	5	µg/L		<5	----	----	----	----
Methylene chloride	75-09-2	5	µg/L		<5	----	----	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	----	----	----	----
1.1-Dichloroethane	75-34-3	5	µg/L		<5	----	----	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	----	----	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	----	----	----	----
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	----	----	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	----	----	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	----	----	----	----
Trichloroethene	79-01-6	5	µg/L		<5	----	----	----	----
Dibromomethane	74-95-3	5	µg/L		<5	----	----	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	----	----	----	----
1.3-Dichloropropane	142-28-9	5	µg/L		<5	----	----	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	----	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	----	----	----	----
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	----	----	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	----	----	----	----
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	----	----	----	----
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	----	----	----	----
Pentachloroethane	76-01-7	5	µg/L		<5	----	----	----	----
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	----	----	----	----
Hexachlorobutadiene	87-68-3	5	µg/L		<5	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	----	----	----	----
Bromobenzene	108-86-1	5	µg/L		<5	----	----	----	----
2-Chlorotoluene	95-49-8	5	µg/L		<5	----	----	----	----
4-Chlorotoluene	106-43-4	5	µg/L		<5	----	----	----	----
1.4-Dichlorobenzene	106-46-7	5	µg/L		<5	----	----	----	----
1.2-Dichlorobenzene	95-50-1	5	µg/L		<5	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		<5	----	----	----	----
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	----	----	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	----	----	----	----
Bromodichloromethane	75-27-4	5	µg/L		<5	----	----	----	----
Dibromochloromethane	124-48-1	5	µg/L		<5	----	----	----	----
Bromoform	75-25-2	5	µg/L		<5	----	----	----	----
EP075A: Phenolic Compounds									
Phenol	108-95-2	2	µg/L		<2	----	----	----	----
2-Chlorophenol	95-57-8	2	µg/L		<2	----	----	----	----
2-Methylphenol	95-48-7	2	µg/L		<2	----	----	----	----
3- & 4-Methylphenol	1319-77-3	4	µg/L		<4	----	----	----	----
2-Nitrophenol	88-75-5	2	µg/L		<2	----	----	----	----
2.4-Dimethylphenol	105-67-9	2	µg/L		<2	----	----	----	----
2.4-Dichlorophenol	120-83-2	2	µg/L		<2	----	----	----	----
2.6-Dichlorophenol	87-65-0	2	µg/L		<2	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	2	µg/L		<2	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	2	µg/L		<2	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	2	µg/L		<2	----	----	----	----
Pentachlorophenol	87-86-5	4	µg/L		<4	----	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	2	µg/L		<2	----	----	----	----
2-Methylnaphthalene	91-57-6	2	µg/L		<2	----	----	----	----
2-Chloronaphthalene	91-58-7	2	µg/L		<2	----	----	----	----
Acenaphthylene	208-96-8	2	µg/L		<2	----	----	----	----
Acenaphthene	83-32-9	2	µg/L		<2	----	----	----	----
Fluorene	86-73-7	2	µg/L		<2	----	----	----	----
Phenanthrene	85-01-8	2	µg/L		<2	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons - Continued									
Anthracene	120-12-7	2	µg/L		<2	----	----	----	----
Fluoranthene	206-44-0	2	µg/L		<2	----	----	----	----
Pyrene	129-00-0	2	µg/L		<2	----	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	2	µg/L		<2	----	----	----	----
Benz(a)anthracene	56-55-3	2	µg/L		<2	----	----	----	----
Chrysene	218-01-9	2	µg/L		<2	----	----	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L		<4	----	----	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L		<2	----	----	----	----
Benzo(a)pyrene	50-32-8	2	µg/L		<2	----	----	----	----
3-Methylcholanthrene	56-49-5	2	µg/L		<2	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L		<2	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	2	µg/L		<2	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	2	µg/L		<2	----	----	----	----
^ Sum of PAHs	----	2	µg/L		<2	----	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	2	µg/L		<2	----	----	----	----
EP075C: Phthalate Esters									
Dimethyl phthalate	131-11-3	2	µg/L		<2	----	----	----	----
Diethyl phthalate	84-66-2	2	µg/L		<2	----	----	----	----
Di-n-butyl phthalate	84-74-2	2	µg/L		<2	----	----	----	----
Butyl benzyl phthalate	85-68-7	2	µg/L		<2	----	----	----	----
bis(2-ethylhexyl) phthalate	117-81-7	10	µg/L		<10	----	----	----	----
Di-n-octylphthalate	117-84-0	2	µg/L		<2	----	----	----	----
EP075D: Nitrosamines									
N-Nitrosomethylethylamine	10595-95-6	2	µg/L		<2	----	----	----	----
N-Nitrosodiethylamine	55-18-5	2	µg/L		<2	----	----	----	----
N-Nitrosopyrrolidine	930-55-2	4	µg/L		<4	----	----	----	----
N-Nitrosomorpholine	59-89-2	2	µg/L		<2	----	----	----	----
N-Nitrosodi-n-propylamine	621-64-7	2	µg/L		<2	----	----	----	----
N-Nitrosopiperidine	100-75-4	2	µg/L		<2	----	----	----	----
N-Nitrosodibutylamine	924-16-3	2	µg/L		<2	----	----	----	----
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L		<4	----	----	----	----
Methapyrilene	91-80-5	2	µg/L		<2	----	----	----	----
EP075E: Nitroaromatics and Ketones									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP075E: Nitroaromatics and Ketones - Continued									
2-Picoline	109-06-8	2	µg/L		<2	----	----	----	----
Acetophenone	98-86-2	2	µg/L		<2	----	----	----	----
Nitrobenzene	98-95-3	2	µg/L		<2	----	----	----	----
Isophorone	78-59-1	2	µg/L		<2	----	----	----	----
2.6-Dinitrotoluene	606-20-2	4	µg/L		<4	----	----	----	----
2.4-Dinitrotoluene	121-14-2	4	µg/L		<4	----	----	----	----
1-Naphthylamine	134-32-7	2	µg/L		<2	----	----	----	----
4-Nitroquinoline-N-oxide	56-57-5	2	µg/L		<2	----	----	----	----
5-Nitro-o-toluidine	99-55-8	2	µg/L		<2	----	----	----	----
Azobenzene	103-33-3	2	µg/L		<2	----	----	----	----
1.3.5-Trinitrobenzene	99-35-4	2	µg/L		<2	----	----	----	----
Phenacetin	62-44-2	2	µg/L		<2	----	----	----	----
4-Aminobiphenyl	92-67-1	2	µg/L		<2	----	----	----	----
Pentachloronitrobenzene	82-68-8	2	µg/L		<2	----	----	----	----
Pronamide	23950-58-5	2	µg/L		<2	----	----	----	----
Dimethylaminoazobenzene	60-11-7	2	µg/L		<2	----	----	----	----
Chlorobenzilate	510-15-6	2	µg/L		<2	----	----	----	----
EP075F: Haloethers									
Bis(2-chloroethyl) ether	111-44-4	2	µg/L		<2	----	----	----	----
Bis(2-chloroethoxy) methane	111-91-1	2	µg/L		<2	----	----	----	----
4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L		<2	----	----	----	----
4-Bromophenyl phenyl ether	101-55-3	2	µg/L		<2	----	----	----	----
EP075G: Chlorinated Hydrocarbons									
1.3-Dichlorobenzene	541-73-1	2	µg/L		<2	----	----	----	----
1.4-Dichlorobenzene	106-46-7	2	µg/L		<2	----	----	----	----
1.2-Dichlorobenzene	95-50-1	2	µg/L		<2	----	----	----	----
Hexachloroethane	67-72-1	2	µg/L		<2	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	2	µg/L		<2	----	----	----	----
Hexachloropropylene	1888-71-7	2	µg/L		<2	----	----	----	----
Hexachlorobutadiene	87-68-3	2	µg/L		<2	----	----	----	----
Hexachlorocyclopentadiene	77-47-4	10	µg/L		<10	----	----	----	----
Pentachlorobenzene	608-93-5	2	µg/L		<2	----	----	----	----
Hexachlorobenzene (HCB)	118-74-1	4	µg/L		<4	----	----	----	----
EP075H: Anilines and Benzidines									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP075H: Anilines and Benzidines - Continued									
Aniline	62-53-3	2	µg/L		<2	----	----	----	----
4-Chloroaniline	106-47-8	2	µg/L		<2	----	----	----	----
2-Nitroaniline	88-74-4	4	µg/L		<4	----	----	----	----
3-Nitroaniline	99-09-2	4	µg/L		<4	----	----	----	----
Dibenzofuran	132-64-9	2	µg/L		<2	----	----	----	----
4-Nitroaniline	100-01-6	2	µg/L		<2	----	----	----	----
Carbazole	86-74-8	2	µg/L		<2	----	----	----	----
3.3`-Dichlorobenzidine	91-94-1	2	µg/L		<2	----	----	----	----
EP075I: Organochlorine Pesticides									
alpha-BHC	319-84-6	2	µg/L		<2	----	----	----	----
beta-BHC	319-85-7	2	µg/L		<2	----	----	----	----
gamma-BHC	58-89-9	2	µg/L		<2	----	----	----	----
delta-BHC	319-86-8	2	µg/L		<2	----	----	----	----
Heptachlor	76-44-8	2	µg/L		<2	----	----	----	----
Aldrin	309-00-2	2	µg/L		<2	----	----	----	----
Heptachlor epoxide	1024-57-3	2	µg/L		<2	----	----	----	----
alpha-Endosulfan	959-98-8	2	µg/L		<2	----	----	----	----
4.4`-DDE	72-55-9	2	µg/L		<2	----	----	----	----
Dieldrin	60-57-1	2	µg/L		<2	----	----	----	----
Endrin	72-20-8	2	µg/L		<2	----	----	----	----
beta-Endosulfan	33213-65-9	2	µg/L		<2	----	----	----	----
4.4`-DDD	72-54-8	2	µg/L		<2	----	----	----	----
Endosulfan sulfate	1031-07-8	2	µg/L		<2	----	----	----	----
4.4`-DDT	50-29-3	4	µg/L		<4	----	----	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	4	µg/L		<4	----	----	----	----
^ **Sum of DDD + DDE + DDT**	72-54-8/72-55-9/50-29-3	4	µg/L		<4	----	----	----	----
EP075J: Organophosphorus Pesticides									
Dichlorvos	62-73-7	2	µg/L		<2	----	----	----	----
Dimethoate	60-51-5	2	µg/L		<2	----	----	----	----
Diazinon	333-41-5	2	µg/L		<2	----	----	----	----
Chlorpyrifos-methyl	5598-13-0	2	µg/L		<2	----	----	----	----
Malathion	121-75-5	2	µg/L		<2	----	----	----	----
Fenthion	55-38-9	2	µg/L		<2	----	----	----	----
Chlorpyrifos	2921-88-2	2	µg/L		<2	----	----	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP075J: Organophosphorus Pesticides - Continued									
Pirimphos-ethyl	23505-41-1	2	µg/L		<2	----	----	----	----
Chlorfenvinphos	470-90-6	2	µg/L		<2	----	----	----	----
Prothiofos	34643-46-4	2	µg/L		<2	----	----	----	----
Ethion	563-12-2	2	µg/L		<2	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	----	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ Total Xylenes	----	2	µg/L		<2	----	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
MM514: E.coli & Total Coliforms MPN by Colilert									
Escherichia coli (Colilert)	----	1	orgs/100mL		0	----	----	----	----
Subcontracted Analysis: MBAS									
Anionic Surfactants as MBAS	----	0.05	mg/L		<0.05	----	----	----	----
EP066S: PCB Surrogate									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	BH32	----	----	----	----
				Client sampling date / time	20-Aug-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM2014440-001	--------	--------	--------	--------
					Result	----	----	----	----
EP066S: PCB Surrogate - Continued									
Decachlorobiphenyl	2051-24-3	1	%		59.0	----	----	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		90.4	----	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		74.0	----	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		95.0	----	----	----	----
Toluene-D8	2037-26-5	5	%		85.3	----	----	----	----
4-Bromofluorobenzene	460-00-4	5	%		96.1	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		26.9	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		56.2	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		68.6	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		64.9	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%		78.3	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		75.6	----	----	----	----
EP075S: Acid Extractable Surrogates									
2-Fluorophenol	367-12-4	2	%		37.5	----	----	----	----
Phenol-d6	13127-88-3	2	%		24.3	----	----	----	----
2-Chlorophenol-D4	93951-73-6	2	%		55.3	----	----	----	----
2.4.6-Tribromophenol	118-79-6	2	%		62.6	----	----	----	----
EP075T: Base/Neutral Extractable Surrogates									
Nitrobenzene-D5	4165-60-0	2	%		64.2	----	----	----	----
1.2-Dichlorobenzene-D4	2199-69-1	2	%		60.5	----	----	----	----
2-Fluorobiphenyl	321-60-8	2	%		70.1	----	----	----	----
Anthracene-d10	1719-06-8	2	%		81.8	----	----	----	----
4-Terphenyl-d14	1718-51-0	2	%		80.1	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		101	----	----	----	----
Toluene-D8	2037-26-5	2	%		95.1	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		114	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **GROUNDWATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	41	125
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	117
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	51	127
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	46
2-Chlorophenol-D4	93951-73-6	23	104
2.4.6-Tribromophenol	118-79-6	28	130
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	36	114
Anthracene-d10	1719-06-8	51	119
4-Terphenyl-d14	1718-51-0	49	127
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	10	75
Phenol-d6	13127-88-3	10	65
2-Chlorophenol-D4	93951-73-6	21	103
2.4.6-Tribromophenol	118-79-6	22	120
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	24	116
1.2-Dichlorobenzene-D4	2199-69-1	23	99
2-Fluorobiphenyl	321-60-8	32	114
Anthracene-d10	1719-06-8	47	119
4-Terphenyl-d14	1718-51-0	44	124
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2014726**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	[redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: [redacted]	Telephone	: [redacted]
Project	: 12529997	Date Samples Received	: 26-Aug-2020 16:15
Order number	: ----	Date Analysis Commenced	: 26-Aug-2020
C-O-C number	: ----	Issue Date	: 31-Aug-2020 11:32
Sampler	: MM		
Site	: ----		
Quote number	: ME/458/20		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
[redacted]	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	Laboratory Manager	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH11	BH16	----	----	----
				Client sampling date / time	26-Aug-2020 00:00	26-Aug-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2014726-001	EM2014726-002	--------	--------	--------
					Result	Result	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.54**	**7.05**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**3830**	**2000**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**1920**	**1180**	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**314**	**384**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**314**	**384**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**232**	**193**	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**974**	**354**	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**63**	**92**	----	----	----
Magnesium	7439-95-4	1	mg/L		**99**	**77**	----	----	----
Sodium	7440-23-5	1	mg/L		**521**	**195**	----	----	----
Potassium	7440-09-7	1	mg/L		**8**	**4**	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.008**	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	**0.015**	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	**0.024**	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.053**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.08**	<0.01	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.02**	<0.01	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH11	BH16	----	----	----
				Client sampling date / time	26-Aug-2020 00:00	26-Aug-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2014726-001	EM2014726-002	--------	--------	--------
					Result	Result	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		1.44	0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		1.46	0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.3	0.2	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		1.8	0.2	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	1.13	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		38.6	21.7	----	----	----
ø Total Cations	----	0.01	meq/L		34.2	19.5	----	----	----
ø Ionic Balance	----	0.01	%		6.08	5.25	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2015608**	Page	: 1 of 13
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: [redacted]	Telephone	: [redacted]
Project	: 12529997	Date Samples Received	: 10-Sep-2020 16:30
Order number	: ----	Date Analysis Commenced	: 10-Sep-2020
C-O-C number	: ----	Issue Date	: 16-Sep-2020 11:12
Sampler	: MM		
Site	: ----		
Quote number	: ME/458/20		
No. of samples received	: 5		
No. of samples analysed	: 5		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	Laboratory Manager - Inorganics	Sydney Inorganics, Smithfield, NSW
[redacted]	Laboratory Coordinator	WRG Subcontracting, Springvale, VIC
[redacted]	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA010-P: Electrical Conductivity @ 25°C was analysed by manual method (EA010).
- EP075: Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is he sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above he LOR.
- EP074: Where reported, Total Trihalomethanes is the sum of the reported concentrations of all Trihalomethanes at or above the LOR.
- EP074: Where reported, Total Trimethylbenzenes is the sum of the reported concentrations of 1.2.3-Trimethylbenzene, 1.2.4-Trimethylbenzene and 1.3.5-Trimethylbenzene at or above the LOR.
- EP026SP: EM2015608 #1 Sample required dilution prior to analysis of COD due to matrix interference. LOR has been raised accordingly.
- EP030: The DO depletion for EM2015608 #1 is less than 2mg/L, this indicates that the sample has been over diluted and the BOD is less than 8 mg/L. The BOD result reported was estimated from the lowest dilution
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EP075: Where reported, 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- E.coli & Total Coliforms by MPN (MM514) is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- MBAS (W-MBAS)is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.93	7.12	7.14	6.47	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		7040	10300	10300	1	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		3960	5300	5280	<10	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		30	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		348	478	480	2	----
Total Alkalinity as CaCO3	----	1	mg/L		348	478	480	2	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		508	312	310	<1	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		1950	3440	3430	<1	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		124	87	86	<1	----
Magnesium	7439-95-4	1	mg/L		253	413	406	<1	----
Sodium	7440-23-5	1	mg/L		930	1340	1320	<1	----
Potassium	7440-09-7	1	mg/L		24	11	11	<1	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	0.003	0.003	----	----
Copper	7440-50-8	0.001	mg/L		0.020	0.014	0.012	----	----
Nickel	7440-02-0	0.001	mg/L		0.031	0.011	0.009	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L		0.086	0.042	0.036	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		----	----	----	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L		----	----	----	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		----	----	----	<0.001	----
Copper	7440-50-8	0.001	mg/L		----	----	----	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Nickel	7440-02-0	0.001	mg/L		----	----	----	<0.001	----
Lead	7439-92-1	0.001	mg/L		----	----	----	<0.001	----
Zinc	7440-66-6	0.005	mg/L		----	----	----	<0.005	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	<0.0001	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.42**	**0.02**	**0.02**	<0.01	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.92**	**0.93**	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.92**	**0.93**	<0.01	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.4**	**0.2**	**0.3**	<0.1	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.4**	**1.1**	**1.2**	<0.1	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	**0.39**	**0.37**	<0.01	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**72.5**	**113**	**113**	**0.04**	----
ø Total Cations	----	0.01	meq/L		**68.1**	**96.9**	**95.4**	<0.01	----
ø Ionic Balance	----	0.01	%		**3.17**	**7.71**	**8.36**	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	----	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)									
Chemical Oxygen Demand	----	10	mg/L		<50	----	----	----	----
EP030: Biochemical Oxygen Demand (BOD)									
Biochemical Oxygen Demand	----	2	mg/L		<8	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)									
^ Total Polychlorinated biphenyls	----	1	µg/L		<1	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP074A: Monocyclic Aromatic Hydrocarbons									
Benzene	71-43-2	1	µg/L		----	----	----	----	<1
Toluene	108-88-3	2	µg/L		----	----	----	----	<2
Ethylbenzene	100-41-4	2	µg/L		----	----	----	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	----	----	----	<2
Styrene	100-42-5	5	µg/L		<5	----	----	----	<5
ortho-Xylene	95-47-6	2	µg/L		----	----	----	----	<2
Isopropylbenzene	98-82-8	5	µg/L		<5	----	----	----	<5
n-Propylbenzene	103-65-1	5	µg/L		<5	----	----	----	<5
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	----	----	----	<5
sec-Butylbenzene	135-98-8	5	µg/L		<5	----	----	----	<5
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	----	----	----	<5
tert-Butylbenzene	98-06-6	5	µg/L		<5	----	----	----	<5
p-Isopropyltoluene	99-87-6	5	µg/L		<5	----	----	----	<5
n-Butylbenzene	104-51-8	5	µg/L		<5	----	----	----	<5
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	----	----	----	<50
2-Butanone (MEK)	78-93-3	50	µg/L		<50	----	----	----	<50
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	----	----	----	<50
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	----	----	----	<50
EP074C: Sulfonated Compounds									
Carbon disulfide	75-15-0	5	µg/L		<5	----	----	----	<5
EP074D: Fumigants									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	----	----	----	<5
1.2-Dichloropropane	78-87-5	5	µg/L		<5	----	----	----	<5
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	----	----	----	<5
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	----	----	----	<5
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	----	----	----	<5
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	----	----	----	<50
Chloromethane	74-87-3	50	µg/L		<50	----	----	----	<50
Vinyl chloride	75-01-4	50	µg/L		<50	----	----	----	<50
Bromomethane	74-83-9	50	µg/L		<50	----	----	----	<50
Chloroethane	75-00-3	50	µg/L		<50	----	----	----	<50
Trichlorofluoromethane	75-69-4	50	µg/L		<50	----	----	----	<50

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP074E: Halogenated Aliphatic Compounds - Continued									
1.1-Dichloroethene	75-35-4	5	µg/L		<5	----	----	----	<5
Iodomethane	74-88-4	5	µg/L		<5	----	----	----	<5
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	----	----	----	<5
1.1-Dichloroethane	75-34-3	5	µg/L		<5	----	----	----	<5
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	----	----	----	<5
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	----	----	----	<5
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	----	----	----	<5
Carbon Tetrachloride	56-23-5	5	µg/L		<5	----	----	----	<5
1.2-Dichloroethane	107-06-2	5	µg/L		<5	----	----	----	<5
Trichloroethene	79-01-6	5	µg/L		<5	----	----	----	<5
Dibromomethane	74-95-3	5	µg/L		<5	----	----	----	<5
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	----	----	----	<5
1.3-Dichloropropane	142-28-9	5	µg/L		<5	----	----	----	<5
Tetrachloroethene	127-18-4	5	µg/L		<5	----	----	----	<5
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	----	----	----	<5
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	----	----	----	<5
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	----	----	----	<5
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	----	----	----	<5
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	----	----	----	<5
Pentachloroethane	76-01-7	5	µg/L		<5	----	----	----	<5
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	----	----	----	<5
Hexachlorobutadiene	87-68-3	5	µg/L		----	----	----	----	<5
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	----	----	----	<5
Bromobenzene	108-86-1	5	µg/L		<5	----	----	----	<5
2-Chlorotoluene	95-49-8	5	µg/L		<5	----	----	----	<5
4-Chlorotoluene	106-43-4	5	µg/L		<5	----	----	----	<5
1.3-Dichlorobenzene	541-73-1	5	µg/L		----	----	----	----	<5
1.4-Dichlorobenzene	106-46-7	5	µg/L		----	----	----	----	<5
1.2-Dichlorobenzene	95-50-1	5	µg/L		----	----	----	----	<5
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		----	----	----	----	<5
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	----	----	----	<5
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	----	----	----	<5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP074G: Trihalomethanes - Continued									
Bromodichloromethane	75-27-4	5	µg/L		<5	----	----	----	<5
Dibromochloromethane	124-48-1	5	µg/L		<5	----	----	----	<5
Bromoform	75-25-2	5	µg/L		<5	----	----	----	<5
EP074H: Naphthalene									
Naphthalene	91-20-3	5	µg/L		----	----	----	----	<5
EP075A: Phenolic Compounds									
Phenol	108-95-2	2	µg/L		<2	----	----	----	----
2-Chlorophenol	95-57-8	2	µg/L		<2	----	----	----	----
2-Methylphenol	95-48-7	2	µg/L		<2	----	----	----	----
3- & 4-Methylphenol	1319-77-3	4	µg/L		<4	----	----	----	----
2-Nitrophenol	88-75-5	2	µg/L		<2	----	----	----	----
2.4-Dimethylphenol	105-67-9	2	µg/L		<2	----	----	----	----
2.4-Dichlorophenol	120-83-2	2	µg/L		<2	----	----	----	----
2.6-Dichlorophenol	87-65-0	2	µg/L		<2	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	2	µg/L		<2	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	2	µg/L		<2	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	2	µg/L		<2	----	----	----	----
Pentachlorophenol	87-86-5	4	µg/L		<4	----	----	----	----
EP075B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	2	µg/L		<2	----	----	----	----
2-Methylnaphthalene	91-57-6	2	µg/L		<2	----	----	----	----
2-Chloronaphthalene	91-58-7	2	µg/L		<2	----	----	----	----
Acenaphthylene	208-96-8	2	µg/L		<2	----	----	----	----
Acenaphthene	83-32-9	2	µg/L		<2	----	----	----	----
Fluorene	86-73-7	2	µg/L		<2	----	----	----	----
Phenanthrene	85-01-8	2	µg/L		<2	----	----	----	----
Anthracene	120-12-7	2	µg/L		<2	----	----	----	----
Fluoranthene	206-44-0	2	µg/L		<2	----	----	----	----
Pyrene	129-00-0	2	µg/L		<2	----	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	2	µg/L		<2	----	----	----	----
Benz(a)anthracene	56-55-3	2	µg/L		<2	----	----	----	----
Chrysene	218-01-9	2	µg/L		<2	----	----	----	----
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L		<4	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP075B: Polynuclear Aromatic Hydrocarbons - Continued									
7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L		<2	----	----	----	----
Benzo(a)pyrene	50-32-8	2	µg/L		<2	----	----	----	----
3-Methylcholanthrene	56-49-5	2	µg/L		<2	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L		<2	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	2	µg/L		<2	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	2	µg/L		<2	----	----	----	----
^ Sum of PAHs	----	2	µg/L		<2	----	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	2	µg/L		<2	----	----	----	----
EP075C: Phthalate Esters									
Dimethyl phthalate	131-11-3	2	µg/L		<2	----	----	----	----
Diethyl phthalate	84-66-2	2	µg/L		<2	----	----	----	----
Di-n-butyl phthalate	84-74-2	2	µg/L		<2	----	----	----	----
Butyl benzyl phthalate	85-68-7	2	µg/L		<2	----	----	----	----
bis(2-ethylhexyl) phthalate	117-81-7	10	µg/L		<10	----	----	----	----
Di-n-octylphthalate	117-84-0	2	µg/L		<2	----	----	----	----
EP075D: Nitrosamines									
N-Nitrosomethylethylamine	10595-95-6	2	µg/L		<2	----	----	----	----
N-Nitrosodiethylamine	55-18-5	2	µg/L		<2	----	----	----	----
N-Nitrosopyrrolidine	930-55-2	4	µg/L		<4	----	----	----	----
N-Nitrosomorpholine	59-89-2	2	µg/L		<2	----	----	----	----
N-Nitrosodi-n-propylamine	621-64-7	2	µg/L		<2	----	----	----	----
N-Nitrosopiperidine	100-75-4	2	µg/L		<2	----	----	----	----
N-Nitrosodibutylamine	924-16-3	2	µg/L		<2	----	----	----	----
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L		<4	----	----	----	----
Methapyrilene	91-80-5	2	µg/L		<2	----	----	----	----
EP075E: Nitroaromatics and Ketones									
2-Picoline	109-06-8	2	µg/L		<2	----	----	----	----
Acetophenone	98-86-2	2	µg/L		<2	----	----	----	----
Nitrobenzene	98-95-3	2	µg/L		<2	----	----	----	----
Isophorone	78-59-1	2	µg/L		<2	----	----	----	----
2.6-Dinitrotoluene	606-20-2	4	µg/L		<4	----	----	----	----
2.4-Dinitrotoluene	121-14-2	4	µg/L		<4	----	----	----	----
1-Naphthylamine	134-32-7	2	µg/L		<2	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP075E: Nitroaromatics and Ketones - Continued									
4-Nitroquinoline-N-oxide	56-57-5	2	µg/L		<2	----	----	----	----
5-Nitro-o-toluidine	99-55-8	2	µg/L		<2	----	----	----	----
Azobenzene	103-33-3	2	µg/L		<2	----	----	----	----
1.3.5-Trinitrobenzene	99-35-4	2	µg/L		<2	----	----	----	----
Phenacetin	62-44-2	2	µg/L		<2	----	----	----	----
4-Aminobiphenyl	92-67-1	2	µg/L		<2	----	----	----	----
Pentachloronitrobenzene	82-68-8	2	µg/L		<2	----	----	----	----
Pronamide	23950-58-5	2	µg/L		<2	----	----	----	----
Dimethylaminoazobenzene	60-11-7	2	µg/L		<2	----	----	----	----
Chlorobenzilate	510-15-6	2	µg/L		<2	----	----	----	----
EP075F: Haloethers									
Bis(2-chloroethyl) ether	111-44-4	2	µg/L		<2	----	----	----	----
Bis(2-chloroethoxy) methane	111-91-1	2	µg/L		<2	----	----	----	----
4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L		<2	----	----	----	----
4-Bromophenyl phenyl ether	101-55-3	2	µg/L		<2	----	----	----	----
EP075G: Chlorinated Hydrocarbons									
1.3-Dichlorobenzene	541-73-1	2	µg/L		<2	----	----	----	----
1.4-Dichlorobenzene	106-46-7	2	µg/L		<2	----	----	----	----
1.2-Dichlorobenzene	95-50-1	2	µg/L		<2	----	----	----	----
Hexachloroethane	67-72-1	2	µg/L		<2	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	2	µg/L		<2	----	----	----	----
Hexachloropropylene	1888-71-7	2	µg/L		<2	----	----	----	----
Hexachlorobutadiene	87-68-3	2	µg/L		<2	----	----	----	----
Hexachlorocyclopentadiene	77-47-4	10	µg/L		<10	----	----	----	----
Pentachlorobenzene	608-93-5	2	µg/L		<2	----	----	----	----
Hexachlorobenzene (HCB)	118-74-1	4	µg/L		<4	----	----	----	----
EP075H: Anilines and Benzidines									
Aniline	62-53-3	2	µg/L		<2	----	----	----	----
4-Chloroaniline	106-47-8	2	µg/L		<2	----	----	----	----
2-Nitroaniline	88-74-4	4	µg/L		<4	----	----	----	----
3-Nitroaniline	99-09-2	4	µg/L		<4	----	----	----	----
Dibenzofuran	132-64-9	2	µg/L		<2	----	----	----	----
4-Nitroaniline	100-01-6	2	µg/L		<2	----	----	----	----
Carbazole	86-74-8	2	µg/L		<2	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP075H: Anilines and Benzidines - Continued									
3.3`-Dichlorobenzidine	91-94-1	2	µg/L		<2	----	----	----	----
EP075I: Organochlorine Pesticides									
alpha-BHC	319-84-6	2	µg/L		<2	----	----	----	----
beta-BHC	319-85-7	2	µg/L		<2	----	----	----	----
gamma-BHC	58-89-9	2	µg/L		<2	----	----	----	----
delta-BHC	319-86-8	2	µg/L		<2	----	----	----	----
Heptachlor	76-44-8	2	µg/L		<2	----	----	----	----
Aldrin	309-00-2	2	µg/L		<2	----	----	----	----
Heptachlor epoxide	1024-57-3	2	µg/L		<2	----	----	----	----
alpha-Endosulfan	959-98-8	2	µg/L		<2	----	----	----	----
4.4`-DDE	72-55-9	2	µg/L		<2	----	----	----	----
Dieldrin	60-57-1	2	µg/L		<2	----	----	----	----
Endrin	72-20-8	2	µg/L		<2	----	----	----	----
beta-Endosulfan	33213-65-9	2	µg/L		<2	----	----	----	----
4.4`-DDD	72-54-8	2	µg/L		<2	----	----	----	----
Endosulfan sulfate	1031-07-8	2	µg/L		<2	----	----	----	----
4.4`-DDT	50-29-3	4	µg/L		<4	----	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	4	µg/L		<4	----	----	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	4	µg/L		<4	----	----	----	----
EP075J: Organophosphorus Pesticides									
Dichlorvos	62-73-7	2	µg/L		<2	----	----	----	----
Dimethoate	60-51-5	2	µg/L		<2	----	----	----	----
Diazinon	333-41-5	2	µg/L		<2	----	----	----	----
Chlorpyrifos-methyl	5598-13-0	2	µg/L		<2	----	----	----	----
Malathion	121-75-5	2	µg/L		<2	----	----	----	----
Fenthion	55-38-9	2	µg/L		<2	----	----	----	----
Chlorpyrifos	2921-88-2	2	µg/L		<2	----	----	----	----
Pirimphos-ethyl	23505-41-1	2	µg/L		<2	----	----	----	----
Chlorfenvinphos	470-90-6	2	µg/L		<2	----	----	----	----
Prothiofos	34643-46-4	2	µg/L		<2	----	----	----	----
Ethion	563-12-2	2	µg/L		<2	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	----	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ Total Xylenes	----	2	µg/L		<2	----	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
MM514: E.coli & Total Coliforms MPN by Colilert									
Escherichia coli (Colilert)	----	1	orgs/100mL		**0**	----	----	----	----
Subcontracted Analysis: MBAS									
Anionic Surfactants as MBAS	----	0.05	mg/L		<0.05	----	----	----	----
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	1	%		**78.0**	----	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		**98.9**	----	----	----	**104**
Toluene-D8	2037-26-5	5	%		**96.6**	----	----	----	**99.7**
4-Bromofluorobenzene	460-00-4	5	%		**99.7**	----	----	----	**105**
EP075S: Acid Extractable Surrogates									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH22	BH09	QC01	QC03	QC04
				Client sampling date / time	10-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00	09-Sep-2020 00:00
Compound	CAS Number	LOR	Unit		EM2015608-001	EM2015608-002	EM2015608-003	EM2015608-004	EM2015608-005
					Result	Result	Result	Result	Result
EP075S: Acid Extractable Surrogates - Continued									
2-Fluorophenol	367-12-4	2	%		13.7	----	----	----	----
Phenol-d6	13127-88-3	2	%		12.1	----	----	----	----
2-Chlorophenol-D4	93951-73-6	2	%		42.0	----	----	----	----
2.4.6-Tribromophenol	118-79-6	2	%		69.5	----	----	----	----
EP075T: Base/Neutral Extractable Surrogates									
Nitrobenzene-D5	4165-60-0	2	%		80.6	----	----	----	----
1.2-Dichlorobenzene-D4	2199-69-1	2	%		61.1	----	----	----	----
2-Fluorobiphenyl	321-60-8	2	%		65.7	----	----	----	----
Anthracene-d10	1719-06-8	2	%		83.9	----	----	----	----
4-Terphenyl-d14	1718-51-0	2	%		79.8	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		98.2	----	----	----	----
Toluene-D8	2037-26-5	2	%		101	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		122	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	41	125
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075S: Acid Extractable Surrogates			
2-Fluorophenol	367-12-4	10	75
Phenol-d6	13127-88-3	10	65
2-Chlorophenol-D4	93951-73-6	21	103
2.4.6-Tribromophenol	118-79-6	22	120
EP075T: Base/Neutral Extractable Surrogates			
Nitrobenzene-D5	4165-60-0	24	116
1.2-Dichlorobenzene-D4	2199-69-1	23	99
2-Fluorobiphenyl	321-60-8	32	114
Anthracene-d10	1719-06-8	47	119
4-Terphenyl-d14	1718-51-0	44	124
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

[redacted]

[redacted]

CERTIFICATE OF ANALYSIS

Work Order	: **EM2019000**	Page	: 1 of 9
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: [redacted]	Telephone	: [redacted]
Project	: 12529997/08	Date Samples Received	: 28-Oct-2020 17:55
Order number	: 12529997/08	Date Analysis Commenced	: 28-Oct-2020
C-O-C number	: ----	Issue Date	: 04-Nov-2020 20:55
Sampler	: ADW		
Site	:		
Quote number	: EN/005/17 (Victoria Primary Quote)		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
[redacted]	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
[redacted]	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
[redacted]	Laboratory Coordinator	WRG Subcontracting, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG050G-F: EM2019000 #1 and 2 Hexavalent chromium results may be biased high compared to Dissolved Chromium filtered as sample were not field filtered prior to sample preservation.
- BOD analysis has been performed as a 6 day test. Scrutinise results accordingly.
- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above he LOR.
- EP074: Where reported, Total Trihalomethanes is the sum of the reported concentrations of all Trihalomethanes at or above the LOR.
- EP074: Where reported, Total Trimethylbenzenes is the sum of the reported concentrations of 1.2.3-Trimethylbenzene, 1.2.4-Trimethylbenzene and 1.3.5-Trimethylbenzene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- EG035F: EM2019030 #6 Poor matrix spike recovery for dissolved mercury due to sample matrix. Confirmed by re-extraction and re-analysis.
- MBAS (EP050) is calculated as LAS, molecular weight 348 g/mol.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- E.coli & Total Coliforms by MPN (MM514) is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH49	WORMBH27	-----	-----	-----
				Client sampling date / time	27-Oct-2020 00:00	28-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2019000-001	EM2019000-002	--------	--------	--------
					Result	Result	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.97**	**8.54**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**2380**	**2410**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		**1550**	**1570**	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	**66**	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	**17**	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**247**	**265**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**247**	**282**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**78**	**64**	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**620**	**601**	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**15**	**12**	----	----	----
Magnesium	7439-95-4	1	mg/L		**66**	**40**	----	----	----
Sodium	7440-23-5	1	mg/L		**346**	**371**	----	----	----
Potassium	7440-09-7	1	mg/L		**22**	**28**	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	**0.002**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	**0.010**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.032**	**0.023**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.009**	**0.006**	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Tin	7440-31-5	0.001	mg/L		**0.001**	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.025**	**0.012**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH49	WORMBH27	-----	-----	-----
				Client sampling date / time	27-Oct-2020 00:00	28-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2019000-001	EM2019000-002	--------	--------	--------
					Result	Result	----	----	----
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		<0.01	<0.01	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.2**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.08**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.22**	**0.31**	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**24.0**	**23.9**	----	----	----
ø Total Cations	----	0.01	meq/L		**21.8**	**20.7**	----	----	----
ø Ionic Balance	----	0.01	%		**4.92**	**7.11**	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)									
Chemical Oxygen Demand	----	10	mg/L		<10	<10	----	----	----
EP030: Biochemical Oxygen Demand (BOD)									
Biochemical Oxygen Demand	----	2	mg/L		<2	<2	----	----	----
EP050: Anionic Surfactants as MBAS									
Anionic Surfactants as MBAS	----	0.1	mg/L		<0.1	<0.1	----	----	----
EP066: Polychlorinated Biphenyls (PCB)									
^ Total Polychlorinated biphenyls	----	1	µg/L		<1	<1	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH49	WORMBH27	----	----	----
				Client sampling date / time	27-Oct-2020 00:00	28-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2019000-001	EM2019000-002	--------	--------	--------
					Result	Result	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		<5	<5	----	----	----
EP074E: Halogenated Aliphatic Compounds									
Vinyl chloride	75-01-4	50	µg/L		<50	<50	----	----	----
1.1-Dichloroethene	75-35-4	5	µg/L		<5	<5	----	----	----
Methylene chloride	75-09-2	5	µg/L		<5	<5	----	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	<5	----	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	<5	----	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	<5	----	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	<5	----	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	<5	----	----	----
Trichloroethene	79-01-6	5	µg/L		<5	<5	----	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	<5	----	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	<5	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	<5	----	----	----
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	<5	----	----	----
Hexachlorobutadiene	87-68-3	5	µg/L		<5	<5	----	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	<5	----	----	----
1.4-Dichlorobenzene	106-46-7	5	µg/L		<5	<5	----	----	----
1.2-Dichlorobenzene	95-50-1	5	µg/L		<5	<5	----	----	----
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		<5	<5	----	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	<5	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH49	WORMBH27	----	----	----
				Client sampling date / time	27-Oct-2020 00:00	28-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2019000-001	EM2019000-002	--------	--------	--------
					Result	Result	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	----	----	----
EP075A: Phenolic Compounds (Halogenated)									
2-Chlorophenol	95-57-8	2	µg/L		<2	<2	----	----	----
2.4-Dichlorophenol	120-83-2	2	µg/L		<2	<2	----	----	----
2.6-Dichlorophenol	87-65-0	2	µg/L		<2	<2	----	----	----
4-Chloro-3-methylphenol	59-50-7	4	µg/L		<4	<4	----	----	----
2.4.5-Trichlorophenol	95-95-4	2	µg/L		<2	<2	----	----	----
2.4.6-Trichlorophenol	88-06-2	2	µg/L		<2	<2	----	----	----
2.3.5.6-Tetrachlorophenol	935-95-5	2	µg/L		<2	<2	----	----	----
2.3.4.5 & 2.3.4.6-Tetrachlorophenol	4901-51-3/58-90-2	2	µg/L		<2	<2	----	----	----
Pentachlorophenol	87-86-5	2	µg/L		<2	<2	----	----	----
EP075A: Phenolic Compounds (Non-halogenated)									
Phenol	108-95-2	4	µg/L		<4	<4	----	----	----
2-Methylphenol	95-48-7	4	µg/L		<4	<4	----	----	----
3- & 4-Methylphenol	1319-77-3	4	µg/L		<4	<4	----	----	----
2-Nitrophenol	88-75-5	4	µg/L		<4	<4	----	----	----
2.4-Dimethylphenol	105-67-9	4	µg/L		<4	<4	----	----	----
2.4-Dinitrophenol	51-28-5	100	µg/L		<100	<100	----	----	----
4-Nitrophenol	100-02-7	50	µg/L		<50	<50	----	----	----
2-Methyl-4.6-dinitrophenol	8071-51-0	50	µg/L		<50	<50	----	----	----
Dinoseb	88-85-7	50	µg/L		<50	<50	----	----	----
2-Cyclohexyl-4.6-Dinitrophenol	131-89-5	50	µg/L		<50	<50	----	----	----
EP075I: Organochlorine Pesticides									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH49	WORMBH27	----	----	----
				Client sampling date / time	27-Oct-2020 00:00	28-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2019000-001	EM2019000-002	--------	--------	--------
					Result	Result	----	----	----
EP075l: Organochlorine Pesticides - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	0.5	µg/L		<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
MM514: E.coli & Total Coliforms MPN by Colilert									
Escherichia coli (Colilert)	----	1	orgs/100mL		0	0	----	----	----
EP066S: PCB Surrogate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH49	WORMBH27	-----	-----	-----
				Client sampling date / time	27-Oct-2020 00:00	28-Oct-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM2019000-001	EM2019000-002	--------	--------	--------
					Result	Result	----	----	----
EP066S: PCB Surrogate - Continued									
Decachlorobiphenyl	2051-24-3	1	%		77.1	80.1	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		99.8	95.8	----	----	----
Toluene-D8	2037-26-5	5	%		93.6	94.9	----	----	----
4-Bromofluorobenzene	460-00-4	5	%		102	104	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		56.8	62.2	----	----	----
Anthracene-d10	1719-06-8	1.0	%		81.2	85.3	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		75.1	78.5	----	----	----
EP075S: Acid Extractable Surrogates (Waste Classification)									
Phenol-d6	13127-88-3	0.25	%		27.4	29.7	----	----	----
2-Chlorophenol-D4	93951-73-6	0.25	%		72.3	71.7	----	----	----
2.4.6-Tribromophenol	118-79-6	0.25	%		76.2	77.6	----	----	----
EP075T: Base/Neutral Extractable Surrogates (Waste Classification)									
Nitrobenzene-D5	4165-60-0	0.25	%		85.7	87.2	----	----	----
1.2-Dichlorobenzene-D4	2199-69-1	0.25	%		90.9	89.6	----	----	----
2-Fluorobiphenyl	321-60-8	0.25	%		96.5	96.5	----	----	----
Anthracene-d10	1719-06-8	0.25	%		91.8	94.5	----	----	----
4-Terphenyl-d14	1718-51-0	0.25	%		104	108	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		98.4	94.7	----	----	----
Toluene-D8	2037-26-5	2	%		102	103	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		108	112	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	41	125
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	36	114
Anthracene-d10	1719-06-8	51	119
4-Terphenyl-d14	1718-51-0	49	127
EP075S: Acid Extractable Surrogates (Waste Classification)			
Phenol-d6	13127-88-3	13	90
2-Chlorophenol-D4	93951-73-6	42	117
2.4.6-Tribromophenol	118-79-6	52	140
EP075T: Base/Neutral Extractable Surrogates (Waste Classification)			
Nitrobenzene-D5	4165-60-0	49	136
1.2-Dichlorobenzene-D4	2199-69-1	49	128
2-Fluorobiphenyl	321-60-8	57	137
Anthracene-d10	1719-06-8	67	137
4-Terphenyl-d14	1718-51-0	66	136
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

[redacted]

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM2019188**	Page	: 1 of 13
Client	: **GHD PTY LTD**	Laboratory	: [redacted]
Contact	: [redacted]	Contact	: [redacted]
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: [redacted]
Telephone	: [redacted]	Telephone	: [redacted]
Project	: 1252999708	Date Samples Received	: 30-Oct-2020 15:40
Order number	: 1252999708	Date Analysis Commenced	: 30-Oct-2020
C-O-C number	: ----	Issue Date	: 05-Nov-2020 17:12
Sampler	: ADW		
Site	: ----		
Quote number	: EN/005/17 (Victoria Primary Quote)		
No. of samples received	: 6		
No. of samples analysed	: 6		

ilac-MRA NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
[redacted]	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
	Laboratory Coordinator	WRG Subcontracting, Springvale, VIC
	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP231X-LL: Particular sample (EM2019188-002), LOR has been raised for 6:2 FTS due to laboratory background level.
- EP231X-LL: Particular sample (EM2019188-003), LOR has been raised for PFHxS due to laboratory background level.
- EG050G-F: EM2019188 #5 Hexavalent chromium results may be biased high compared to Dissolved Chromium filtered as sample were not field filtered prior to sample preservation.
- EP026SP - EM2019188#5 ; sample required dilution prior to analyse due to matrix interfernces. LOR values have bee adjusted accoridingly.
- EA010-P: Electrical Conductivity @ 25°C was analysed by manual method (EA010).
- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP231X - Per- and Polyfluoroalkyl Substances (PFAS): Samples received in 20ml or 125ml bottles have been tested in accordance with the QSM5.3 compliant, NATA accredited method. 60mL or 250mL bottles have been tested to the legacy QSM 5.1 aligned, NATA accredited method.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above he LOR.
- EP074: Where reported, Total Trihalomethanes is the sum of the reported concentrations of all Trihalomethanes at or above the LOR.
- EP074: Where reported, Total Trimethylbenzenes is the sum of the reported concentrations of 1.2.3-Trimethylbenzene, 1.2.4-Trimethylbenzene and 1.3.5-Trimethylbenzene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- EP030: The DO depletion for EM2019188 #5 is less than 2mg/L, this indicates that the sample has been over diluted and the BOD is less than 8 mg/L. The BOD result reported was estimated from the lowest dilution.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- E.coli & Total Coliforms by MPN (MM514) is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- MBAS (W-MBAS)is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

- EP231: Stable isotope enriched internal standards are added to samples prior to extraction. Target compounds have a direct analogous internal standard with the exception of PFPeS, PFHpA, PFDS, PFTrDA and 10:2 FTS. These compounds use an internal standard that is chemically related and has a retention time close to that of the target compound. The DQO for internal standard response is 50-150% of that established at initial calibration. PFOS is quantified using a certified, traceable standard consisting of linear and branched PFOS isomers. These practices are in line with recommendations in the National Environmental Management Plan for PFAS (Australian HEPA) and also conform to QSM 5.3 (US DoD) requirements.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.22	7.26	7.75	7.54	6.83
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		7030	7350	731	540	8560
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		4570	4780	475	351	5560
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		----	----	----	----	5
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		578	414	107	86	1660
Total Alkalinity as CaCO3	----	1	mg/L		578	414	107	86	1660
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		403	563	8	22	11
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		1660	1780	165	103	1900
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		105	114	13	9	185
Magnesium	7439-95-4	1	mg/L		225	268	25	14	316
Sodium	7440-23-5	1	mg/L		935	1040	76	66	1100
Potassium	7440-09-7	1	mg/L		31	25	3	6	49
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		----	----	----	----	0.001
Cadmium	7440-43-9	0.0001	mg/L		----	----	----	----	0.0001
Chromium	7440-47-3	0.001	mg/L		----	----	----	----	<0.001
Copper	7440-50-8	0.001	mg/L		----	----	----	----	0.018
Lead	7439-92-1	0.001	mg/L		----	----	----	----	<0.001
Molybdenum	7439-98-7	0.001	mg/L		----	----	----	----	0.002
Nickel	7440-02-0	0.001	mg/L		----	----	----	----	0.083
Selenium	7782-49-2	0.01	mg/L		----	----	----	----	<0.01
Silver	7440-22-4	0.001	mg/L		----	----	----	----	<0.001
Tin	7440-31-5	0.001	mg/L		----	----	----	----	0.001
Zinc	7440-66-6	0.005	mg/L		----	----	----	----	0.118
EG035F: Dissolved Mercury by FIMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS - Continued									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		----	----	----	----	<0.01
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	----	----	----	**0.4**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	----	**0.01**	**0.03**	**1.87**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		----	----	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	----	**0.05**	**0.51**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		----	----	**0.05**	**0.51**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		----	----	**0.7**	**0.7**	**1.9**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		----	----	**0.8**	**1.2**	**1.9**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		----	----	**0.07**	**0.11**	**0.09**
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**66.8**	**70.2**	**6.96**	**5.08**	**87.0**
ø Total Cations	----	0.01	meq/L		**65.2**	**73.6**	**6.09**	**4.62**	**84.3**
ø Ionic Balance	----	0.01	%		**1.17**	**2.38**	**6.67**	**4.70**	**1.55**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		----	----	----	----	<5
EP026SP: Chemical Oxygen Demand (Spectrophotometric)									
Chemical Oxygen Demand	----	10	mg/L		----	----	----	----	<20
EP030: Biochemical Oxygen Demand (BOD)									
Biochemical Oxygen Demand	----	2	mg/L		----	----	----	----	<8
EP066: Polychlorinated Biphenyls (PCB)									
^ Total Polychlorinated biphenyls	----	1	µg/L		----	----	----	----	<1
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		----	----	----	----	<5

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
					EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EP074E: Halogenated Aliphatic Compounds									
Vinyl chloride	75-01-4	50	µg/L		----	----	----	----	<50
1.1-Dichloroethene	75-35-4	5	µg/L		----	----	----	----	<5
Methylene chloride	75-09-2	5	µg/L		----	----	----	----	<5
trans-1.2-Dichloroethene	156-60-5	5	µg/L		----	----	----	----	<5
cis-1.2-Dichloroethene	156-59-2	5	µg/L		----	----	----	----	<5
1.1.1-Trichloroethane	71-55-6	5	µg/L		----	----	----	----	<5
Carbon Tetrachloride	56-23-5	5	µg/L		----	----	----	----	<5
1.2-Dichloroethane	107-06-2	5	µg/L		----	----	----	----	<5
Trichloroethene	79-01-6	5	µg/L		----	----	----	----	<5
1.1.2-Trichloroethane	79-00-5	5	µg/L		----	----	----	----	<5
Tetrachloroethene	127-18-4	5	µg/L		----	----	----	----	<5
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		----	----	----	----	<5
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		----	----	----	----	<5
Hexachlorobutadiene	87-68-3	5	µg/L		----	----	----	----	<5
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		----	----	----	----	<5
1.4-Dichlorobenzene	106-46-7	5	µg/L		----	----	----	----	<5
1.2-Dichlorobenzene	95-50-1	5	µg/L		----	----	----	----	<5
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		----	----	----	----	<5
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		----	----	----	----	<5
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		----	----	----	----	<1.0
Acenaphthylene	208-96-8	1.0	µg/L		----	----	----	----	<1.0
Acenaphthene	83-32-9	1.0	µg/L		----	----	----	----	<1.0
Fluorene	86-73-7	1.0	µg/L		----	----	----	----	<1.0
Phenanthrene	85-01-8	1.0	µg/L		----	----	----	----	<1.0
Anthracene	120-12-7	1.0	µg/L		----	----	----	----	<1.0
Fluoranthene	206-44-0	1.0	µg/L		----	----	----	----	<1.0
Pyrene	129-00-0	1.0	µg/L		----	----	----	----	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L		----	----	----	----	<1.0
Chrysene	218-01-9	1.0	µg/L		----	----	----	----	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		----	----	----	----	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		----	----	----	----	<1.0

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Benzo(a)pyrene	50-32-8	0.5	µg/L		----	----	----	----	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		----	----	----	----	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		----	----	----	----	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		----	----	----	----	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		----	----	----	----	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		----	----	----	----	<0.5
EP075A: Phenolic Compounds (Halogenated)									
2-Chlorophenol	95-57-8	2	µg/L		----	----	----	----	<2
2.4-Dichlorophenol	120-83-2	2	µg/L		----	----	----	----	<2
2.6-Dichlorophenol	87-65-0	2	µg/L		----	----	----	----	<2
4-Chloro-3-methylphenol	59-50-7	4	µg/L		----	----	----	----	<4
2.4.5-Trichlorophenol	95-95-4	2	µg/L		----	----	----	----	<2
2.4.6-Trichlorophenol	88-06-2	2	µg/L		----	----	----	----	<2
2.3.5.6-Tetrachlorophenol	935-95-5	2	µg/L		----	----	----	----	<2
2.3.4.5 & 2.3.4.6-Tetrachlorophenol	4901-51-3/58-90-2	2	µg/L		----	----	----	----	<2
Pentachlorophenol	87-86-5	2	µg/L		----	----	----	----	<2
Sum of Phenols (halogenated)	----	2	µg/L		----	----	----	----	<2
EP075A: Phenolic Compounds (Non-halogenated)									
Phenol	108-95-2	4	µg/L		----	----	----	----	<4
2-Methylphenol	95-48-7	4	µg/L		----	----	----	----	<4
3- & 4-Methylphenol	1319-77-3	4	µg/L		----	----	----	----	<4
2-Nitrophenol	88-75-5	4	µg/L		----	----	----	----	<4
2.4-Dimethylphenol	105-67-9	4	µg/L		----	----	----	----	<4
2.4-Dinitrophenol	51-28-5	100	µg/L		----	----	----	----	<100
4-Nitrophenol	100-02-7	50	µg/L		----	----	----	----	<50
2-Methyl-4.6-dinitrophenol	8071-51-0	50	µg/L		----	----	----	----	<50
Dinoseb	88-85-7	50	µg/L		----	----	----	----	<50
2-Cyclohexyl-4.6-Dinitrophenol	131-89-5	50	µg/L		----	----	----	----	<50
Sum of Phenols (non-halogenated)	----	4	µg/L		----	----	----	----	<4
EP075I: Organochlorine Pesticides									
alpha-BHC	319-84-6	0.5	µg/L		----	----	----	----	<0.5
Heptachlor	76-44-8	0.5	µg/L		----	----	----	----	<0.5
Aldrin	309-00-2	0.5	µg/L		----	----	----	----	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EP075l: Organochlorine Pesticides - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		----	----	----	----	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L		----	----	----	----	<0.5
4.4`-DDE	72-55-9	0.5	µg/L		----	----	----	----	<0.5
Dieldrin	60-57-1	0.5	µg/L		----	----	----	----	<0.5
4.4`-DDD	72-54-8	0.5	µg/L		----	----	----	----	<0.5
4.4`-DDT	50-29-3	0.5	µg/L		----	----	----	----	<0.5
Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		----	----	----	----	<0.5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		----	----	----	----	<20
C10 - C14 Fraction	----	50	µg/L		----	----	----	----	<50
C15 - C28 Fraction	----	100	µg/L		----	----	----	----	<100
C29 - C36 Fraction	----	50	µg/L		----	----	----	----	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		----	----	----	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		----	----	----	----	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		----	----	----	----	<20
>C10 - C16 Fraction	----	100	µg/L		----	----	----	----	<100
>C16 - C34 Fraction	----	100	µg/L		----	----	----	----	<100
>C34 - C40 Fraction	----	100	µg/L		----	----	----	----	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		----	----	----	----	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		----	----	----	----	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		----	----	----	----	<1
Toluene	108-88-3	2	µg/L		----	----	----	----	<2
Ethylbenzene	100-41-4	2	µg/L		----	----	----	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	----	----	----	<2
ortho-Xylene	95-47-6	2	µg/L		----	----	----	----	<2
^ Total Xylenes	----	2	µg/L		----	----	----	----	<2
^ Sum of BTEX	----	1	µg/L		----	----	----	----	<1
Naphthalene	91-20-3	5	µg/L		----	----	----	----	<5
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.002	µg/L		<0.002	<0.002	<0.002	**0.006**	<0.002

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EP231A: Perfluoroalkyl Sulfonic Acids - Continued									
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.002	µg/L		<0.002	<0.002	<0.003	**0.003**	<0.002
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.002	µg/L		<0.002	<0.002	<0.002	**0.004**	<0.002
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.01	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorohexanoic acid (PFHxA)	307-24-4	0.002	µg/L		<0.002	<0.002	<0.002	**0.004**	<0.002
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorooctanoic acid (PFOA)	335-67-1	0.002	µg/L		<0.002	<0.002	<0.002	**0.003**	<0.002
Perfluorononanoic acid (PFNA)	375-95-1	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorodecanoic acid (PFDA)	335-76-2	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	24448-09-7	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued									
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.002	µg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.005	µg/L		<0.005	<0.008	<0.005	<0.005	<0.005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.005	µg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EP231P: PFAS Sums									
Sum of PFAS	----	0.002	µg/L		<0.002	<0.002	<0.002	**0.020**	<0.002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.002	µg/L		<0.002	<0.002	<0.002	**0.007**	<0.002
Sum of PFAS (WA DER List)	----	0.002	µg/L		<0.002	<0.002	<0.002	**0.020**	<0.002
MM514: E.coli & Total Coliforms MPN by Colilert									
Escherichia coli (Colilert)	----	1	orgs/100mL		----	----	----	----	**3**
Subcontracted Analysis: MBAS									
Anionic Surfactants as MBAS	----	0.05	mg/L		----	----	----	----	<0.05
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	1	%		----	----	----	----	**66.7**
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		----	----	----	----	**107**
Toluene-D8	2037-26-5	5	%		----	----	----	----	**98.8**
4-Bromofluorobenzene	460-00-4	5	%		----	----	----	----	**108**
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		----	----	----	----	**30.6**
2-Chlorophenol-D4	93951-73-6	1.0	%		----	----	----	----	**84.2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WORMBH23a	WORMBH22	Deep Creek	Jacksons Ck	WORMBH15
				Client sampling date / time	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00	29-Oct-2020 00:00
Compound	CAS Number	LOR	Unit		EM2019188-001	EM2019188-002	EM2019188-003	EM2019188-004	EM2019188-005
					Result	Result	Result	Result	Result
EP075(SIM)S: Phenolic Compound Surrogates - Continued									
2.4.6-Tribromophenol	118-79-6	1.0	%		----	----	----	----	98.8
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		----	----	----	----	84.8
Anthracene-d10	1719-06-8	1.0	%		----	----	----	----	92.0
4-Terphenyl-d14	1718-51-0	1.0	%		----	----	----	----	96.3
EP075S: Acid Extractable Surrogates (Waste Classification)									
Phenol-d6	13127-88-3	0.25	%		----	----	----	----	36.8
2-Chlorophenol-D4	93951-73-6	0.25	%		----	----	----	----	86.7
2.4.6-Tribromophenol	118-79-6	0.25	%		----	----	----	----	93.3
EP075T: Base/Neutral Extractable Surrogates (Waste Classification)									
Nitrobenzene-D5	4165-60-0	0.25	%		----	----	----	----	98.1
1.2-Dichlorobenzene-D4	2199-69-1	0.25	%		----	----	----	----	94.0
2-Fluorobiphenyl	321-60-8	0.25	%		----	----	----	----	103
Anthracene-d10	1719-06-8	0.25	%		----	----	----	----	102
4-Terphenyl-d14	1718-51-0	0.25	%		----	----	----	----	120
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		----	----	----	----	107
Toluene-D8	2037-26-5	2	%		----	----	----	----	95.4
4-Bromofluorobenzene	460-00-4	2	%		----	----	----	----	103
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.002	%		103	98.6	96.8	85.2	87.2
13C8-PFOA	----	0.002	%		101	95.2	102	96.6	102

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**RB01**	----	----	----	----
				Client sampling date / time	30-Oct-2020 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EM2019188-006**	--------	--------	--------	--------
					Result	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	41	125
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	46
2-Chlorophenol-D4	93951-73-6	23	104
2.4.6-Tribromophenol	118-79-6	28	130
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	36	114
Anthracene-d10	1719-06-8	51	119
4-Terphenyl-d14	1718-51-0	49	127
EP075S: Acid Extractable Surrogates (Waste Classification)			
Phenol-d6	13127-88-3	13	90
2-Chlorophenol-D4	93951-73-6	42	117
2.4.6-Tribromophenol	118-79-6	52	140
EP075T: Base/Neutral Extractable Surrogates (Waste Classification)			
Nitrobenzene-D5	4165-60-0	49	136
1.2-Dichlorobenzene-D4	2199-69-1	49	128
2-Fluorobiphenyl	321-60-8	57	137
Anthracene-d10	1719-06-8	67	137
4-Terphenyl-d14	1718-51-0	66	136
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129
EP231S: PFAS Surrogate			
13C4-PFOS	----	65	140
13C8-PFOA	----	71	133

Appendix I – Equipment calibration certificates and tabulated results of laboratory QA

Multi Parameter Water Meter

Instrument **YSI Quatro Pro Plus**
Serial No. **19D105090**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		1806267729	0 ppm
2. Conductivity		2760uS		326685	2760uS
3. pH7		pH 7.00		330737	pH 7.00
4. pH4		pH 4.00		330734	pH 4.00
5. ORP mV		233.34		334880 / 334881	233.34
6. Temp °C		20.3		163377	20.3

Calibrated by: [redacted]

Calibration date: **5-Feb-20**

Next calibration due: **3-Aug-20**

Oil / Water Interface Meter

airmet

Air-Met Scientific Pty Ltd
1300 137 067

Instrument Interface Meter (30M)
Serial No. 312504

Item	Test	Pass	Comments
Battery	Compartment	✓	
	Capacity	✓	
Probe	Cleaned/Decon.	✓	
	Operation	✓	
Connectors	Condition	✓	
		✓	
Tape Check	Cleaned	✓	
	Checked for cuts	✓	
Instrument Test	At surface level	✓	

Certificate of Calibration

This is to certify that the above instrument has been cleaned and tested.

Calibrated by: [redacted]

Calibration date: **30/07/2020**

Next calibration due: **28/09/2020**

Multi Parameter Water Meter

airmet

Air-Met Scientific Pty Ltd
1300 137 067

Instrument YSI Quatro Pro Plus
Serial No. 18J104320

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		1806267729	0 ppm
2. Conductivity		2760uS		326685	2760uS
3. pH7		pH 7.00		330737	pH 7.00
4. pH4		pH 4.00		330734	pH 4.00
5. ORP mV		240.82		334880 / 334881	240.82
6. Temp °C		16.9		163377	16.9

[redacted]

Calibrated by:

Calibration date: **30-Jul-20**

Next calibration due: **26-Jan-21**

EQUIPMENT QUALITY REPORT

Water Quality Meter:

Equipment Code: MWQ-2560 **Serial Number: 19E102560** **Description: YSI-ProPlus**

The following equipment has been issued as follows:

✓ Equipment is clean ✓ Impeller and probe check

Calibration Results							
Parameter	**Solution Description (Brand, batch # and expire date)**	**Standard**		**Error Range**	**Result**		
Temperature (°C)	-	14		-	13.7		
pH	Merck, HC90443677, Exp: Oct 22/ HC99926975, Exp: Jul 22	7.04	4.00	± 0.2	7.09	4.01	
Sp. Conductivity (µS/cm)	ACR, 354761, Exp: Nov 21	12880		± 20	12881		
DO (%)	Merck, K51377157 927, Exp: Aug 21	0	100	± 3	-0.6	100.3	
Redox (mV)	ACR, 355076, Exp: Nov 21/257174, Exp: Jan 22	253.2		± 10	252.8		

Date: 27/10/2020

Calibrated by: [redacted]

Please check that the following items are received and all items are returned. Please clean equipment before retuning. **A minimum $20 service/repair charge applies to any unclean or damaged items.**

Item	HT Id No.	Sent	Returned
Water Quality Meter	MWQ-2560	✓	
Manual	N/A	✓	
Probe Cluster	N/A	✓	
In situ monitoring cage	N/A	✓	
Storage cup	N/A	✓	
Flow through Cell	N/A	✓	
Calibration cup and lid	N/A	✓	
Spare Batteries / Screwdriver	N/A	✓	
Test and Tag	N/A	✓	

✓ Equipment voltage ✓ Pre-Delivery Calibration Confirmation Test

Date: 27/10/2020

Calibrated by: [redacted]

HT JOB NO: 17195 CLIENTS REF: P/O No: 12529997/08

RETURN DATE: / /	TIME:	CONDITION ON RETURN:

EQUIPMENT QUALITY REPORT

Interface Meter

Equipment Code: MIM-8351 Serial Number: 287419 Length: 30m

The following equipment has been issued as follows:

☑ Equipment is clean and mechanically undamaged.

Calibration Results		
Parameter	Standard	Result
Water	Intermittent beeping	✓
Oil	Consistent beep	✓
Battery	9.0V	9.5V

Date: 27/10/2020

Calibrated by: [redacted]

Please check that the following items are received and all items are returned. Please clean equipment before retuning. **A minimum $20 service/repair charge applies to any unclean or damaged items.**

Photo Ref.	Item (See photo at the back of the form)	HT Id No.	Sent	Returned
1	Carry Case	N/A	✓	
2	Interface Meter	MIM-8351	✓	
3	Tape Guide	N/A	✓	
4	Spare 9V battery. Qty 1 Voltage 9.0 v	N/A	✓	
-	Instruction leaflet	N/A	✓	

Date: 27/10/2020

Calibrated by: [redacted]

HT JOB NO: 17195 CLIENTS REF: P/O No: 12529997/08

RETURN DATE: / /	TIME:	CONDITION ON RETURN:


1
2
3
4
Solinst
Interface Meter
HydroTerra

Lab Report Number	EM2003567	EM2015608	EM2019188	EM2015608
Fie d ID	QC01_030320	QC03	RB01	QC04
Sampled_Date/ ime	3/03/2020 13:32	9/09/2020 15:00	30/10/2020 15:00	9/09/2020 15:00
Sample ype	Rinsate	Rinsate	Rinsate	rip_B

Chem_Group	ChemName	Un ts	EQL				
Acid ty & Alkalinity	Alkalinity (Carbonate as CaCO3)	mg/L	1	<1	<1		
	Alkalinity (Bicarbonate as CaCO3)	mg/L	1	**3**	**2**		
	Alkalinity (Hydrox de as CaCO3)	mg/L	1	<1	<1		
	Alkalinity (total as CaCO3)	mg/L	1	**3**	**2**		
Biological	Escher chia coli (Co ilert)	orgs/100mL	1				
BTEXN	Benzene	µg/L	1				<1
	Toluene	µg/L	2				<2
	Ethylbenzene	µg/L	2				<2
	Xylene (o)	µg/L	2				<2
	Xylene (m & p)	µg/L	2				<2
	Xylene Total	µg/L	2				
	BTEX (Sum of Total) - Lab Calc	µg/L	1				
Chlorinated Hydrocarbons	1,1,1,2-tetrach oroethane	µg/L	5				<5
	1,1,1-trichloroethane	µg/L	5				<5
	1,1,2,2-tetrachloroethane	µg/L	5				<5
	1,1,2-trichloroethane	µg/L	5				<5
	1,1-dichloroethene	µg/L	5				<5
	1,1-dichloropropene	µg/L	5				<5
	1,2, -trichlorobenzene	µg/L	2				<5
	1,2-dibromo-3-ch oropropane	µg/L	5				<5
	1,2-dichlorobenzene	µg/L	2				<5
	1,2-dichloroethane	µg/L	5				<5
	1,2-dichloropropane	µg/L	5				<5
	1,3-dichloropropane	µg/L	5				<5
	1, -dichlorobenzene	µg/L	2				<5
	2,2-dichloropropane	µg/L	5				<5
	2-chloronaphtha ene	µg/L	2				
	2-chloro oluene	µg/L	5				<5
	-chloro oluene	µg/L	5				<5
	Bromobenzene	µg/L	5				<5
	Carbon tetrachloride	µg/L	5				<5
	Ch orobenzene	µg/L	5				<5
	Ch oroform	µg/L	5				<5
	Ch oromethane	µg/L	50				<50
	cis-1,2-dichloroethene	µg/L	5				<5
	Methylene chlor de	µg/L	5				
	Hexach orobutad ene	µg/L	2				<5
	Vinyl chlor de	µg/L	50				<50
Cyanide	Cyanide (Total)	mg/L	0.00				
Explosives	1,3,5-Trin trobenzene	µg/L	2				
	2, -Dinitrotoluene	µg/L					
	2,6-din trotoluene	µg/L					
	Nitrobenzene	µg/L	2				
Ha ogenated Hydrocarbons	Bromomethane	µg/L	50				<50
	Dichlorodifluoromethane	µg/L	50				<50
Herbic des	Dinoseb	µg/L	50				
	Pronamide	µg/L	2				
Inorgan cs	pH (Lab)	pH Un ts	0.01	**6 44**	**6 47**		
	E ectrical conductiv ty (lab)	µS/cm	1	**2**	**1**		
	Total Dissolved Sol ds	mg/L	10		<10		
	Total Dissolved Sol ds (est.)	mg/L	1	**1**			
	Total Suspended So ids	mg/L	5				
	COD	mg/L	10				
MAH	1,2, -trimethylbenzene	µg/L	5				<5
	1,3,5-trimethylbenzene	µg/L	5				<5
	sopropylbenzene	µg/L	5				<5
	Styrene	µg/L	5				<5
	n-butylbenzene	µg/L	5				<5
	n-propylbenzene	µg/L	5				<5
	sec-butylbenzene	µg/L	5				<5
	tert-butylbenzene	µg/L	5				<5
	p-isopropyl oluene	µg/L	5				<5
Major Ions	Ca cium (Filtered)	mg/L	1	<1	<1		
	Magnesium (F ltered)	mg/L	1	<1	<1		
	Po assium (Fi tered)	mg/L	1	<1	<1		
	Sodium (F ltered)	mg/L	1	<1	<1		
	Ch oride	mg/L	1	<1	<1		
	Su fate (F ltered)	mg/L	1	<1	<1		
	Cat ons Total	meq/L	0.01	<0.01	<0.01		
	An ons Total	meq/L	0.01	**0 06**	**0 04**		
	Ionic Balance	%	0.01				
Meta s	Arsenic	mg/L	0.001	<0.001	<0.001		
	Arsenic (F ltered)	mg/L	0.001				
	Cadmium	mg/L	0.0001	<0.0001	<0.0001		
	Cadmium (F ltered)	mg/L	0.0001				
	Chromium (III VI)	mg/L	0.001	<0.001	<0.001		
	Chromium (III VI) (F ltered)	mg/L	0.001				
	Chromium (hexava ent) (Fi tered)	mg/L	0.01				
	Copper	mg/L	0.001	<0.001	<0.001		
	Copper (Filtered)	mg/L	0.001				
	Lead	mg/L	0.001	<0.001	<0.001		
	Lead (Fi tered)	mg/L	0.001				
	Mercury	mg/L	0.0001	<0.0001	<0.0001		
	Mercury (Filtered)	mg/L	0.0001				
	Molybdenum (Filtered)	mg/L	0.001				
	Nickel	mg/L	0.001	<0.001	<0.001		
	Nickel (Filtered)	mg/L	0.001				
	Se enium (Filtered)	mg/L	0.01				
	S lver (F ltered)	mg/L	0.001				
	Tin (Fi tered)	mg/L	0.001				
	Zinc	mg/L	0.005	<0.005	<0.005		
	Zinc (F ltered)	mg/L	0.005				
Minor Ions	Fluoride	mg/L	0.1				
N troaromat cs and Keytones	2-P coline	µg/L	2				
	-aminobiphenyl	µg/L	2				
	Acetophenone	µg/L	2				
	N-Nitrosodiphenyl & Dipheny amine	µg/L					
	Pentach oronitrobenzene	µg/L	2				
Nutrients	Ammonia as N	mg/L	0.01	<0.01	<0.01	0.01	
	Nitrate (as N)	mg/L	0.01	<0.01	<0.01		
	Nitr te (as N)	mg/L	0.01	<0.01	<0.01		
	Nitrogen (Total Oxid sed) (as N)	mg/L	0.01	<0.01	<0.01	0.01	
	Nitrogen (Tota)	mg/L	0.1	<0.1	<0.1		
	Kjeldahl N trogen Total	mg/L	0.1	<0.1	<0.1	<0.1	
	Phosphorus (Total)	mg/L	0.01	<0.01	<0.01	0.01	
OC Pest cides	, '-DDE	µg/L	0.5				
	a-BHC	µg/L	0.5				
	A drin	µg/L	0.5				
	A drin Dieldrin	µg/L	0.5				
	b-BHC	µg/L	0.5				
	Ch ordane	µg/L	0.5				
	Ch ordane (cis)	µg/L	0.5				
	Ch ordane (trans)	µg/L	0.5				
	d-BHC	µg/L	0.5				
	, DDD	µg/L	0.5				
	, DDT	µg/L	0.5				
	DDT DDE DDD - Lab Calc	µg/L	0.5				
	Dieldrin	µg/L	0.5				
	Endosu fan I (alpha)	µg/L	0.5				
	Endosu fan II (be a)	µg/L	0.5				
	Endosu fan Sulfa e	µg/L	0.5				
	Endrin	µg/L	0.5				
	Endrin a dehyde	µg/L	0.5				
	Endrin ketone	µg/L	0.5				
	g-BHC (Lindane)	µg/L	0.5				
	Heptachlor	µg/L	0.5				
	Hep achlor epox de	µg/L	0.5				
	Hexach orobenzene	µg/L	0.5				
	Methoxychlor	µg/L	2				
OP Pest cides	Ch orfenvinphos	µg/L	2				
	Ch orpyri os	µg/L	2				
	Ch orpyri os-methyl	µg/L	2				

			Lab Report Number	EM2003567	EM2015608	EM2019188	EM2015608
			Fie d ID	QC01_030320	QC03	RB01	QC04
			Sampled_Date/ ime	3/03/2020 13:32	9/09/2020 15:00	30/10/2020 15:00	9/09/2020 15:00
			Sample ype	Rinsate	Rinsate	Rinsate	rip_B
	Diazinon	µg/L	2				
	Dichlorvos	µg/L	2				
	Dimethoate	µg/L	2				
	Ethion	µg/L	2				
	Fenthion	µg/L	2				
	Malathion	µg/L	2				
	Pirimphos-ethyl	µg/L	2				
	Prothiofos	µg/L	2				
Organic Indica ors	BOD	mg/L	2				
PAHs - extended	2-methylnaphthalene	µg/L	2				
	3-methy cho anthrene	µg/L	2				
	7,12-dimethylbenz(a)anthracene	µg/L	2				
	Benzo(b j k)fluoranthene	µg/L					
PAHs - standard 16	Acenaphthene	µg/L	1				
	Acenaphthylene	µg/L	1				
	Anthracene	µg/L	1				
	Benz(a)anthracene	µg/L	1				
	Benzo(a)pyrene	µg/L	0.5				
	Benzo(b)fluoranthene	µg/L	1				
	Benzo(k fluoranthene	µg/L	1				
	Benzo(g,h,)pery ene	µg/L	1				
	Chrysene	µg/L	1				
	Dibenz(a,h)anthracene	µg/L	1				
	Fluoranthene	µg/L	1				
	Fluorene	µg/L	1				
	Indeno(1,2,3-c,d)pyrene	µg/L	1				
	Naphthalene	µg/L	1				<5
	Phenanthrene	µg/L	1				
	Pyrene	µg/L	1				
	PAHs (Sum of total) - Lab ca c	µg/L	0.5				
	Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.5				
PCBs	PCBs (Tota)	µg/L	1				
PFAS - Fluorotelomer Sulfon c Ac ds	,2 Fluorotelomer sul onic acid (2 FTS)	µg/L	0.005				
	6:2 Fluorotelomer Sulfona e (6:2 FTS)	µg/L	0.005				
	8:2 Fluorotelomer sul onic acid (8:2 FTS)	µg/L	0.005				
	10:2 Fluorotelomer su fonic ac d (10:2 FTS)	µg/L	0.005				
PFAS - Perfluoroalkyl Carboxy lc Acids	Perfluorobutanoic acid (PFBA)	µg/L	0.01				
	Perfluoropentanoic ac d (PFPeA)	µg/L	0.002				
	Perfluorohexano c ac d (PFHxA)	µg/L	0.002				
	Perfluoroheptanoic ac d (PFHpA)	µg/L	0.002				
	Perfluorooctanoic ac d (PFOA)	µg/L	0.002				
	Perfluorononanoic ac d (PFNA)	µg/L	0.002				
	Perfluorodecanoic ac d (PFDA)	µg/L	0.002				
	Perfluoroundecano c acid (PFUnDA)	µg/L	0.002				
	Perfluorododecano c acid (PFDoDA)	µg/L	0.002				
	Perfluorotridecano c acid (PFTrDA)	µg/L	0.002				
	Perfluorotetradecanoic acid (PFTeDA)	µg/L	0.005				
PFAS - Perfluoroalkyl Sulfonamide	Perfluorooctane sulfonamide (FOSA)	µg/L	0.002				
	N-Methyl perfluorooctane sul onamide (MeFOSA)	µg/L	0.005				
	N-Ethyl perfluorooctane su fonam de (EtFOSA)	µg/L	0.005				
	N-Methyl perfluorooctane sul onamidoacet c acid (MeFOSAA)	µg/L	0.002				
	N-Methyl perfluorooctane sul onamidoethanol (MEFOSE)	µg/L	0.005				
	N-Ethyl perfluorooctane su fonam doethanol (EtFOSE)	µg/L	0.005				
	N-Ethyl perfluorooctane su fonam doacetic acid (EtFOSAA)	µg/L	0.002				
PFAS - Perfluoroalkyl Sulfon c Ac ds	Perfluorobu ane sulfon c ac d (PFBS)	µg/L	0.002				
	Perfluoropentane sulfon c acid (PFPeS)	µg/L	0.002				
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.002				
	Perfluoroheptane sulfon c acid (PFHpS)	µg/L	0.002				
	Perfluorooctane sulfon c acid (PFOS)	µg/L	0.002				
	Perfluorodecanesulfon c acid (PFDS)	µg/L	0.002				
PFAS - Sums	Sum of PFHxS and PFOS	µg/L	0.002				
	PFAS (Sum of Total)	µg/L	0.002				
	PFAS (Sum of Total)(WA DER Lis)	µg/L	0.002				
Phenols	2,3,5,6-Tetrachlorophenol	µg/L	2				
	2,3, ,5 & 2 3, ,6-Tetrachlorophenol	µg/L	2				
Phenols - Halogenated	2-Ch orophenol	µg/L	2				
	2, -D ch orophenol	µg/L	2				
	2, ,5-Trichlorophenol	µg/L	2				
	2, ,6-Trichlorophenol	µg/L	2				
	2,6-D ch orophenol	µg/L	2				
	-Ch oro-3-methylphenol	µg/L	2				
	Pentach orophenol	µg/L	2				
	Phenols(halogenated) - Lab Ca c	µg/L	2				
Phenols - Non-Ha ogena ed	Phenol	µg/L	2				
	2-Nitrophenol	µg/L	2				
	2-Methylphenol (o-Creso)	µg/L	2				
	3, -Methylphenol (m p-creso)	µg/L	2				
	2, -Dimethylphenol	µg/L	2				
	2, -Dinitrophenol	µg/L	100				
	,6-Dinitro-2-methylphenol	µg/L	50				
	,6-Dinitro-o-cyc ohexyl phenol	µg/L	50				
	-N trophenol	µg/L	50				
	Phenols (non-ha ogenated) EPAVic	µg/L					
Phthalates	B s(2-ethylhexyl) phthalate	µg/L	10				
	Butyl benzyl phthalate	µg/L	2				
	Diethylphtha ate	µg/L	2				
	Dimethyl phtha ate	µg/L	2				
	Di-n-butyl phtha ate	µg/L	2				
	Di-n-octyl phtha ate	µg/L	2				
Solvents	2-hexanone (MBK)	µg/L	50				<50
	Carbon disulfide	µg/L	5				<5
	sophorone	µg/L	2				
	Vinyl aceta e	µg/L	50				<50
Surfactants	An onic Surfactants as MBAS	µg/l	50				
SVOCs	1-naphthylamine	µg/L	2				
	2-(acetylamino) fluorene	µg/L	2				
	2-nitroaniline	µg/L					
	3,3-D ch orobenzidine	µg/L	2				
	3-nitroaniline	µg/L					
	-(dimethylamino) azobenzene	µg/L	2				
	-bromophenyl phenyl ether	µg/L	2				
	-chloroani ine	µg/L	2				
	-chlorophenyl phenyl ether	µg/L	2				
	-nitroaniline	µg/L	2				
	-N troquinoline-N-oxide	µg/L	2				
	5-nitro-o-toluidine	µg/L	2				
	An line	µg/L	2				
	Azobenzene	µg/L	2				
	B s(2-ch oroethoxy) methane	µg/L	2				
	B s(2-ch oroethyl)ether	µg/L	2				
	Carbazole	µg/L	2				
	Ch orobenzila e	µg/L	2				
	Dibenzofuran	µg/L	2				
	Hexach orocyclopentadiene	µg/L	10				
	Hexach oroethane	µg/L	2				
	Hexach oropropene	µg/L	2				
	Methapyrilene	µg/L	2				
	N-nitrosod ethy amine	µg/L	2				
	N-nitrosodi-n-buty amine	µg/L	2				
	N-nitrosodi-n-propy amine	µg/L	2				
	N-Nitrosomethylethylamine	µg/L	2				
	N-nitrosomorpholine	µg/L	2				
	N-nitrosopiperidine	µg/L	2				
	N-nitrosopyrrolidine	µg/L					
	Pentach orobenzene	µg/L	2				
	Phenacetin	µg/L	2				
TPH	Oil & Grease	µg/l	5000				

			Lab Report Number	EM2003567	EM2015608	EM2019188	EM2015608
			Fie d ID	QC01_030320	QC03	RB01	QC04
			Sampled_Date/ ime	3/03/2020 13:32	9/09/2020 15:00	30/10/2020 15:00	9/09/2020 15:00
			Sample ype	Rinsate	Rinsate	Rinsate	rip_B
TRH - NEPM 1999	C6-C9 Fract on	µg/L	20				
	C10-C1 Fraction	µg/L	50				
	C15-C28 Fraction	µg/L	100				
	C29-C36 Fraction	µg/L	50				
	C10-C36 (Sum of Tota)	µg/L	50				
TRH - NEPM 2013	F1 (C6-C10 minus BTEX)	µg/L	20				
	C6-C10 Frac ion	µg/L	20				
	F2 (>C10-C16 minus Naphthalene)	µg/L	100				
	>C10-C16 Fraction	µg/L	100				
	F3 (>C16-C3 Fraction)	µg/L	100				
	F (>C3 -C 0 Fraction)	µg/L	100				
	>C10-C 0 (Sum of Tota)	µg/L	100				
VOCs	1,1-dichloroethane	µg/L	5				<5
	1,2,3-trichlorobenzene	µg/L	5				<5
	1,2,3-trichloropropane	µg/L	5				<5
	1,2-dibromoethane	µg/L	5				<5
	1,3-dichlorobenzene	µg/L	2				<5
	2-butanone (MEK)	µg/L	50				<50
	-methyl-2-pentanone (MIBK)	µg/L	50				<50
	Bromodichloromethane	µg/L	5				<5
	Bromoform	µg/L	5				<5
	Ch orodibromomethane	µg/L	5				<5
	Ch oroethane	µg/L	50				<50
	cis-1,3-dichloropropene	µg/L	5				<5
	cis-1, -D chloro-2-butene	µg/L	5				<5
	Dibromomethane	µg/L	5				<5
	odomethane	µg/L	5				<5
	Pentach oroethane	µg/L	5				<5
	Tr ch oroethene	µg/L	5				<5
	Tetrach oroethene	µg/L	5				<5
	trans-1,3-dich oropropene	µg/L	5				<5
	trans-1,2-dich oroethene	µg/L	5				<5
	trans-1, -Dichloro-2-butene	µg/L	5				<5
	Tr ch orofluoromethane	µg/L	50				<50

Appendix J – Groundwater levels – manual measurements

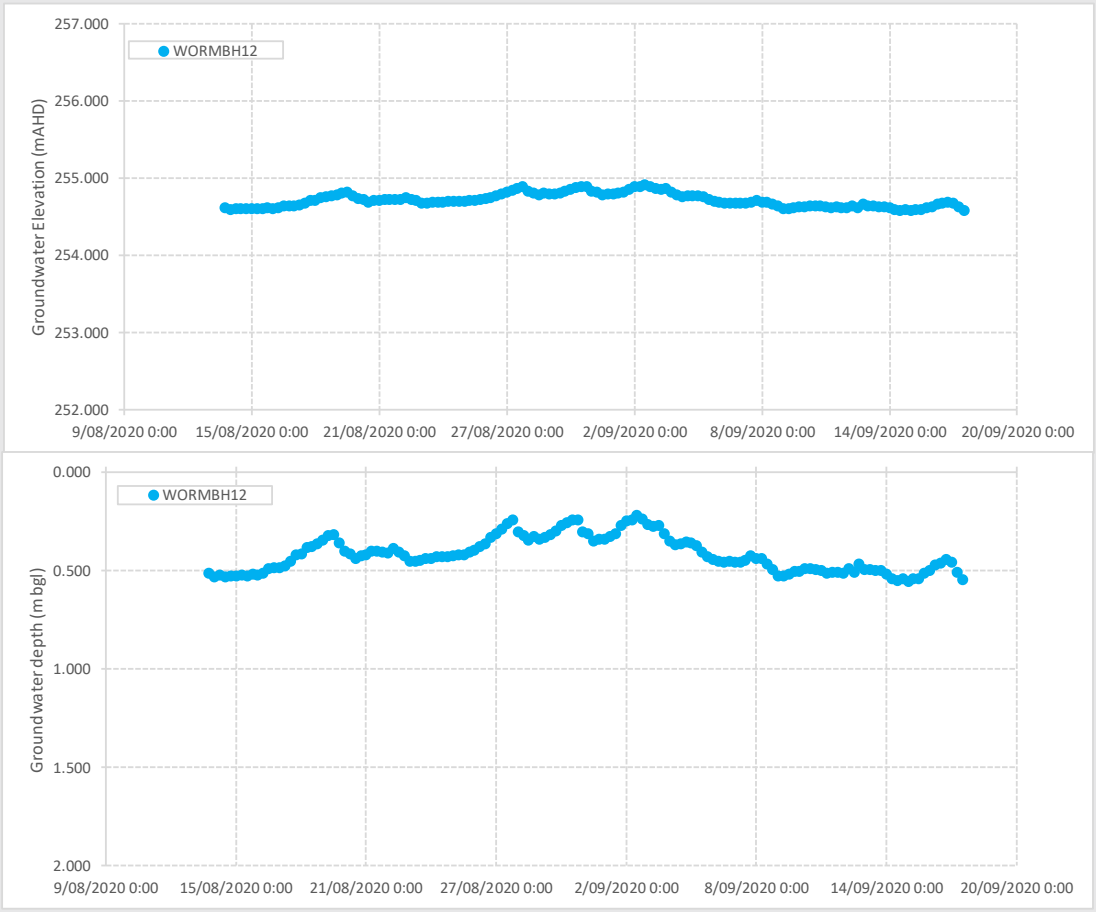
Bore ID	Investigation Type	Bore type	Easting (MGA Z55)	Northing (MGA Z55)	SWL Reading Date	SWL (mbTOC)	SWL (mbGL)	RLWL (mAHD)	Regional depth to water (m)	Gauging event/ comment
WORMBH01	Trench	Monitoring bore	298476.512	5824085.564	10/08/2020	9.900	10.027	102.838	5-10	Bore installation
Bore depth (m)	10				19/08/2020	9.779	9.906	102.959		Monitoring bore survey
Screened interval (m)	7-10									
Screened geology	Basalt									
WORMBH03	Road crossing	Monitoring bore	302006.761	5832383.239	6/07/2010	DRY	DRY		10-20	Bore installation
Bore depth (m)	21				19/08/2020	20.828	20.980	144.379		Monitoring bore survey
Screened interval (m)	15-21									
Screened geology	Basalt									
WORMBH04	Jacksons Creek	Geotechnical bore/ temporary monitoring bore	303802.810	5833611.070	13/08/2020	5.570	5.570	119.170	< 5	Groundwater level collected during sampling from temporary PVC casing in geotechnical borehole
Bore depth (m)	20									
Screened interval (m)	17-20									
Screened geology	Mudstone									
WORMBH05	Road crossing	Monitoring bore	309792.566	5837964.355	4/08/2020	19.847	19.917	214.853	5-10	Bore installation
Bore depth (m)	20				12/08/2020	19.900	19.970	214.800		Bore development
Screened interval (m)	17-20				19/08/2020	19.899	19.969	214.801		Monitoring bore survey
Screened geology	Basalt									
WORMBH06	Road crossing	Monitoring bore	312596.541	5842025.545	6/08/2020	DRY	>12		5-10 10-20	Bore installation
Bore depth (m)	12				12/08/2020	DRY	>12			Bore development
Screened interval (m)	9-12				19/08/2020	DRY	>12	<255.6		Monitoring bore survey
Screened geology	Basalt									
WORMBH07	Trench	Monitoring bore	314437.787	5845330.337	3/09/2020	DRY	>12		< 5	Bore installation
Bore depth (m)	12				9/09/2020	DRY	>12	<229.95		Monitoring bore survey
Screened interval (m)	9-12									
Screened geology	Sandy clay									
WORMBH09	Trench	Monitoring bore	316615.327	5846718.973	14/08/2020	8.000	8.106	223.759	< 5	Bore installation
Bore depth (m)	12				18/08/2020	8.072	8.178	223.687		Survey
Screened interval (m)	9-12				9/08/2020	8.130	8.236	223.629		Groundwater sampling
Screened geology	Clay				9/09/2020	8.131	8.237	223.628		Pre slug test
					9/09/2020	8.140	8.246	223.619		Groundwater sampling
					30/10/2020	7.990	7.990	223.769		Routine monitoring
WORMBH10	Trench	Monitoring bore	318474.624	5846478.275	14/08/2020	11.870	12.076	230.917	< 5 5-10	Bore installation
Bore depth (m)	12				16/07/2010					Monitoring bore survey
Screened interval (m)	9-12				18/08/2020	11.848	12.054	230.939		Survey
Screened geology	Clay				20/08/2020	11.849	12.055	230.938		Bore inspection
					30/10/2020	11.880	12.086	230.907		Routine monitoring
WORMBH11	Trench	Monitoring bore	319872.029	5847694.546	13/08/2020	DRY			< 5	Bore installation
Bore depth (m)	10.1				18/08/2020	8.519	8.583	250.784		Survey
Screened interval (m)	7.1 - 10.1				26/08/2020	8.469	8.533	250.834		Groundwater sampling
Screened geology	Clay				17/09/2020	8.082	8.146	251.221		
WORMBH12	Trench : Donovans	Monitoring bore	321626.740	5847842.970	3/08/2020	0.600	0.667	254.471	< 5	Bore installation
Bore depth (m)	6				13/08/2020	0.449	0.516	254.622		Datalogger deployment
Screened interval (m)	3-6				18/08/2020	0.281	0.348	254.790		Pre slug test
Screened geology	Basalt				18/08/2020	0.283	0.350	254.788		Groundwater sampling
					20/08/2020	0.371	0.438	254.700		Datalogger download
					9/09/2020	0.439	0.506	254.632		Datalogger download
					17/09/2020	0.468	0.535	254.603		

Bore ID	Investigation Type	Bore type	Easting (MGA Z55)	Northing (MGA Z55)	SWL Reading Date	SWL (mbTOC)	SWL (mbGL)	RLWL (mAHD)	Regional depth to water (m)	Gauging event/ comment
WORMBH14	Road crossing	Monitoring bore	323525.919	5842612.490	7/08/2020	1.660	1.775	232.112	< 5	Bore installation
Bore depth (m)	9				18/08/2020	1.210	1.325	232.562		Pre slug test
Screened interval (m)	6-9				18/08/2020	1.480	1.595	232.292		Groundwater sampling
Screened geology	Basalt				2/09/2020	1.126	1.241	232.646		Datalogger deployment
					17/09/2020	1.282	1.397	232.490		Datalogger download
					30/10/2020	1.260	1.375	232.512		Routine monitoring
WORMBH15	Jacksons Creek	Monitoring bore	303810.977	5833652.464	3/03/2020	2.179	2.189	119.257	< 5	Groundwater sampling
Bore depth (m)	20				15/06/2020	1.670	1.680	119.766		Datalogger deployment
Screened interval (m)	17-20				29/10/2020	1.840	1.850	119.596		Groundwater sampling
Screened geology	Siltstone									
WORMBH16	WCS	Monitoring bore	322804.232	5839069.687	5/08/2020	DRY			< 5 5-10	Bore installation
Bore depth (m)	10				18/08/2020	7.461	7.553	196.382		Bore development
Screened interval (m)	7-10				26/08/2020	7.636	7.728	196.207		Pre slug test
Screened geology	Basalt				26/08/2020	7.642	7.734	196.201		Groundwater sampling
					30/10/2020	7.410	7.502	196.433		Routine monitoring
WORMBH22	Deep Creek	Monitoring bore	305819.460	5834711.840	2/03/2020	6.951	7.051	95.537	< 5	Groundwater sampling
Bore depth (m)	30				16/06/2020	5.991	6.091	96.497		Datalogger deployment
Screened interval (m)	27-30				10/09/2020	5.662	5.762	96.826		Pre slug test
Screened geology	Siltstone				10/09/2020	5.808	5.908	96.680		Groundwater sampling
					29/10/2020	5.700	5.800	96.788		Groundwater sampling
WORMBH23	Deep Creek	Monitoring bore	305954.882	5834829.412	2/03/2020	3.514	3.614	97.983	< 5	Groundwater sampling
Bore depth (m)	30				15/06/2020	2.865	2.965	98.632		Datalogger deployment
Screened interval (m)	27-30				16/07/2020	2.942	3.042	98.555		Drilling inspection for BH23A
Screened geology	Mudstone				19/08/2020	3.360	3.460	98.137		
WORMBH23a	Deep Creek	Monitoring bore	305955.503	5834800.475	3/08/2020	3.300	3.390	97.942	< 5	Bore installation
Bore depth (m)	25				19/08/2020	3.212	3.302	98.030		Pre slug test
Screened interval (m)	22-25				19/08/2020	3.360	3.450	97.882		Groundwater sampling
Screened geology	Silty clay and mudstone				2/09/2020	3.194	3.284	98.048		Datalogger deployment
					10/09/2020	3.228	3.318	98.014		Datalogger download
					29/10/2020	3.390	3.480	97.852		Groundwater sampling
WORMBH32	Trench	Monitoring bore	315953.743	5846801.058	2/03/2020	7.248	7.326	224.361	< 5	Groundwater sampling
Bore depth (m)	20				15/06/2020	7.172	7.250	224.437		Datalogger deployment
Screened interval (m)	17-20				13/08/2020	7.192	7.270	224.417		Datalogger download
Screened geology	Siltstone/sandstone				20/08/2020	7.211	7.289	224.398		Pre slug test
					20/08/2020	7.291	7.369	224.318		Groundwater sampling
					9/09/2020	7.175	7.253	224.434		
					17/09/2020	7.159	7.237	224.450		Datalogger download
					30/10/2020	7.160	7.160	224.449		Routine monitoring
WORMBH27	Merri Creek	Monitoring bore	323052.000	5846786.180	3/03/2020	3.139	3.239	254.361	< 5	Groundwater sampling
Bore depth (m)	20.4				16/06/2020	2.391	2.491	255.109		Datalogger deployment
Screened interval (m)	17.4 - 20.4				26/08/2020	2.182	2.282	255.318		Datalogger download
Screened geology	Basalt				28/10/2020	2.430	2.530	255.070		Groundwater sampling

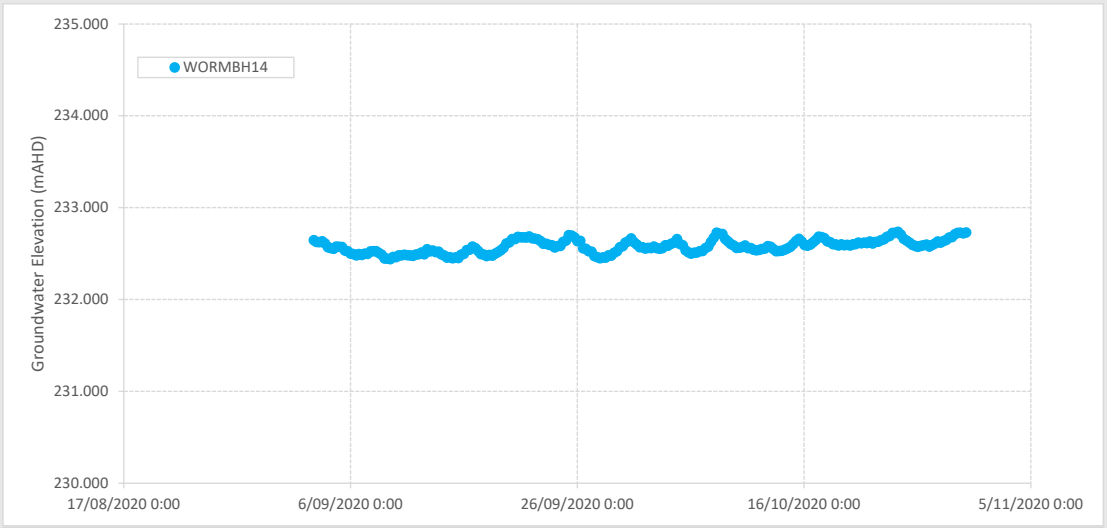
Bore ID	Investigation Type	Bore type	Easting (MGA Z55)	Northing (MGA Z55)	SWL Reading Date	SWL (mbTOC)	SWL (mbGL)	RLWL (mAHD)	Regional depth to water (m)	Gauging event/ comment
WORMBH49	Merri Creek	Monitoring bore	323040.750	5846848.528	3/03/2020	2.543	2.643	254.371	< 5	Groundwater sampling
Bore depth (m)	20.5				16/06/2020	1.900	2.000	255.014		Datalogger deployment
Screened interval (m)	17.5-20.5				17/09/2020	1.779	1.879	255.135		Datalogger download
Screened geology	Basalt				27/10/2020	2.170	2.270	254.744		Groundwater sampling
BH 01	Melton Highway Crossing	Geotechnical	298813.290	5826160.140			>3		5-10	No groundwater observed during auger drilling
BH 02	Melton Highway Crossing	Geotechnical	298817.100	5826225.810			>2.8		5-10	No groundwater observed during auger drilling
BH 03	MLV 1_ Holden Road	Geotechnical	299354.230	5829391.130			>3		5-10	No groundwater observed during auger drilling
BH04	Bendigo Rail Line Crossing	Geotechnical	299706.910	5831080.690			>1.4		5-10	No groundwater observed during auger drilling
BH 05	Bendigo Rail Line Crossing	Geotechnical	299801.460	5831146.100			>1.2		< 5	No groundwater observed during auger drilling
BH 06	Calder Freeway Crossing	Geotechnical	300028.110	5831292.130			>2_2		10-20	No groundwater observed during auger drilling
BH 07	Calder Freeway Crossing	Geotechnical	300102.510	5831340.040			>1.1		10-20	No groundwater observed during auger drilling
BH 08	Calder Freeway Crossing	Geotechnical	300170.510	5831383.090			>1.3		10-20	No groundwater observed during auger drilling
BH 09	Duncans Lane	Geotechnical	300872.230	5831684.480			>2		5-10	No groundwater observed during auger drilling
BH 10C	Duncans Lane	Geotechnical	300894.783	5831668.206			>3.5		5-10	No groundwater observed during auger drilling
BH 11	Bulla - Diggers Rest Road	Geotechnical	302022.400	5832384.640			>2.3		10-20	No groundwater observed during auger drilling
BH 12	Bulla - Diggers Rest Road	Geotechnical	302056.060	5832415.810			>3		20-50	No groundwater observed during auger drilling
BH 12 (Alt.)	Bulla - Diggers Rest Road	Geotechnical	302053.333	5832411.018						No groundwater observed during auger drilling
BH14	Jacksons Creek Crossing	Geotechnical	303791.109	5833565.330			>7.1		5-10	No groundwater observed during auger drilling
BH 16	Jacksons Creek Crossing	Geotechnical	303809.653	5833702.122			>3.7		< 5	No Groundwater observed during auger drilling
BH 18	Sunbury Road Crossing	Geotechnical	304091.240	5834564.398			>2.6		20-50	No Groundwater observed during auger drilling
BH 19	Sunbury Road Crossing	Geotechnical	304129.515	5834573.440			>2.3		20-50	No Groundwater observed during auger drilling
BH 21	Deep Creek Crossing	Geotechnical	305685.670	5834596.670			>3		< 5	No Groundwater observed during auger drilling
BH22A	Deep Creek Crossing	Geotechnical	305820.874	5834713.254			>5		< 5	No Groundwater observed during auger drilling however increasing moisture from 5 m depth
BH 24	Deep Creek Crossing	Geotechnical	306099.683	5834942.970			>3		< 5	Construction Science report groundwater from 3 m depth, borehole log indicates saturated soil conditions from 5 m depth
BH 17	Proposed MLV 2 Location	Geotechnical	309598.480	5837221.990			>2.4		20-50	No Groundwater observed during auger drilling
BH 25	Craigieburn Road Crossing	Geotechnical	309737.000	5837897.920			>5.2		5-10	No Groundwater observed during auger drilling
BH 26	Craigieburn Road Crossing	Geotechnical	309745.370	5837970.190			>4.4		5-10	No Groundwater observed during auger drilling
BH 28	Mickleham Road Crossing	Geotechnical	312583.530	5841993.540			>2.5		5-10	No Groundwater observed during auger drilling
BH 29	Mickleham Road Crossing	Geotechnical					>2.55		5-10	No Groundwater observed during auger drilling
BH 30	Donnybrook Road Crossing 1	Geotechnical	313837.860	5843752.430			>5.4		< 5	No Groundwater observed during auger drilling
BH 31	Donnybrook Road Crossing 2	Geotechnical	313843.822	5843798.620			>3		< 5	No Groundwater observed during auger drilling
BH 33	Melbourne Retention Basin	Geotechnical	316178.904	5846745.584			9.300		< 5	Groundwater observed at 9.3 m during auger drilling
BH 34	Melbourne Retention Basin	Geotechnical	316410.290	5846711.500			>7.8		< 5	No Groundwater observed during auger drilling
BH 35	Melbourne Retention Basin	Geotechnical	316579.510	5846693.730			8.200		< 5	Groundwater observed at 8.2 m during auger drilling
BH 36	Melbourne Retention Basin	Geotechnical	316778.620	5846670.270			8.300		< 5	Groundwater observed at 8.3 m during auger drilling
BH 20	Melbourne Retention Basin	Geotechnical	317016.000	5846644.290			>5.9		< 5	No Groundwater observed during auger drilling
BH 37	Hume Freeway Crossing	Geotechnical	318785.190	5846412.100			>0.8		10-20	No Groundwater observed during auger drilling
BH 38	Hume Freeway Crossing	Geotechnical	318946.820	5846393.030			>0.9		10-20	No Groundwater observed during auger drilling
BH 39	North Eastern Rail Line	Geotechnical	321998.440	5847705.330			>2		< 5	No Groundwater observed during auger drilling though increase in soil moisture noted from approx. 1 m depth
BH 40	North Eastern Rail Line	Geotechnical	322055.290	5847687.960			>0.8		5 - 10	No Groundwater observed during auger drilling
BH 41	Donnybrook Road Crossing 2	Geotechnical	323507.352	5842698.182			>1		< 5	No Groundwater observed during auger drilling
BH 42	Donnybrook Road Crossing 3	Geotechnical	323501.910	5842660.410			>0.5		< 5	No Groundwater observed during auger drilling
BH 43	Wollert Compressor Station	Geotechnical	322868.905	5839155.255			>4		< 5	No Groundwater observed during auger drilling
BH 44	Wollert Compressor Station	Geotechnical	322860.790	5839143.546			>5		< 5	No Groundwater observed during auger drilling
BH 45	Wollert Compressor Station	Geotechnical	322967.266	5839129.143			>2		< 5	No Groundwater observed during auger drilling
BH 46	Wollert Compressor Station	Geotechnical	322796.892	5838977.810			>2.7		5-10	No Groundwater observed during auger drilling
BH 47	Wollert Compressor Station	Geotechnical	322826.301	5838974.525			≈ 0.75		5-10	Groundwater observed at 0.75 m during auger drilling
BH48	Wollert Compressor Station	Geotechnical	322816.887	5838946.112			>2		5-10	No Groundwater observed during auger drilling

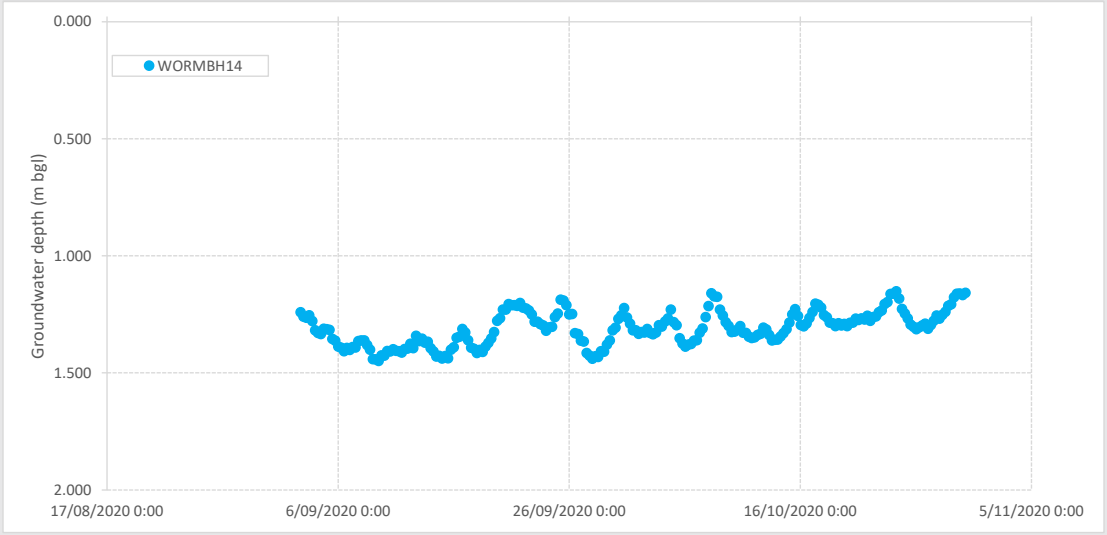
Bore ID	Investigation Type	Bore type	Easting (MGA Z55)	Northing (MGA Z55)	SWL Reading Date	SWL (mbTOC)	SWL (mbGL)	RLWL (mAHD)	Regional depth to water (m)	Gauging event/ comment
Notes: MGA - Map Grid of Australia SWL - Standing Water Level m bTOC - metres below top of collar m bGL - metres below ground level RLWL - Relative water level in Australian Height Datum										

Appendix K - Monitoring bore hydrographs

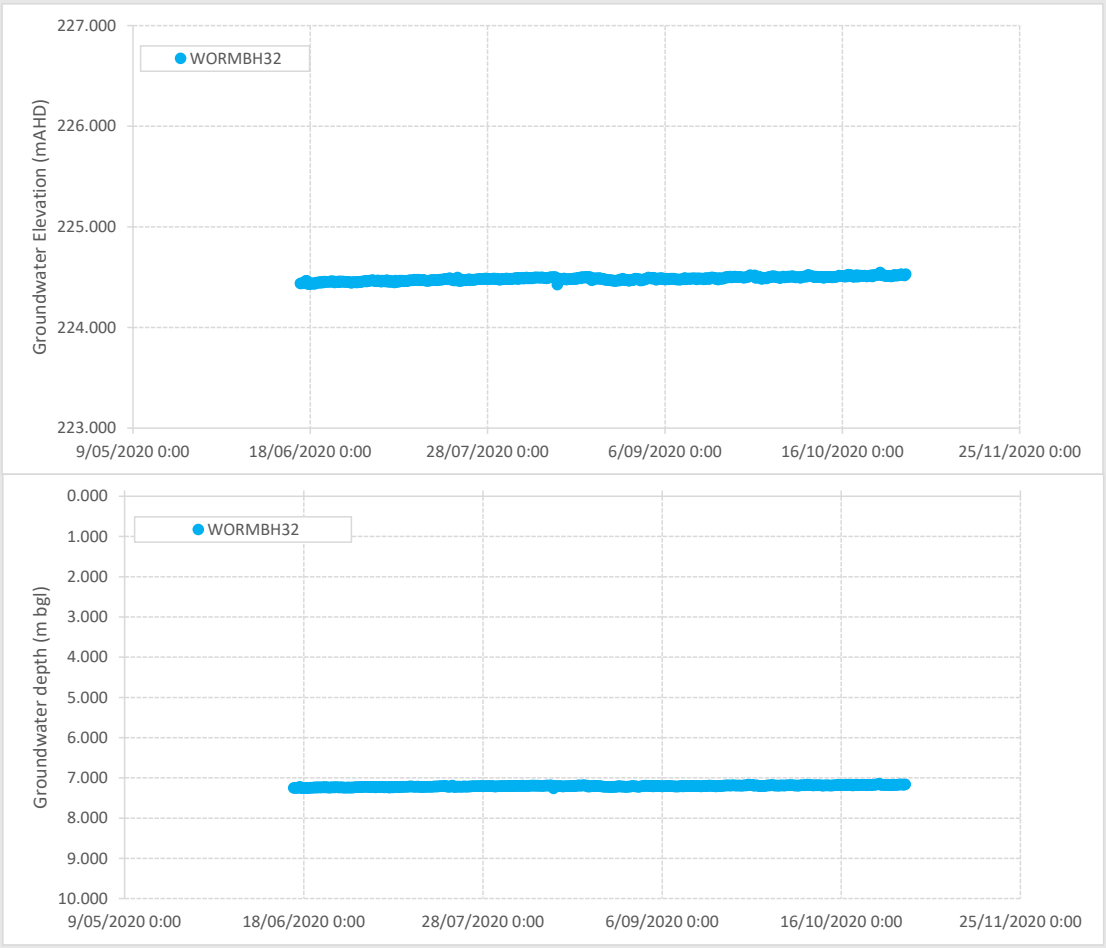


Bore WORMBH12

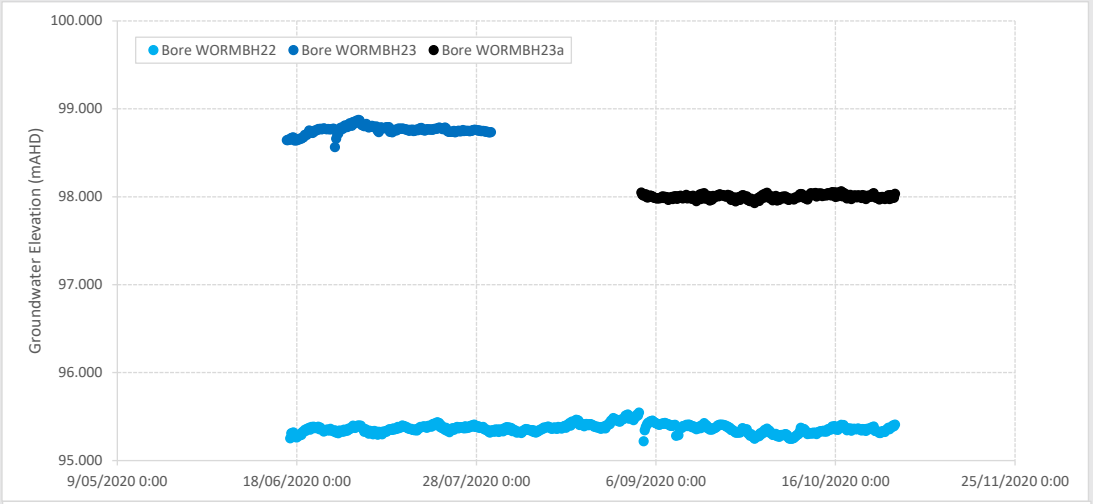


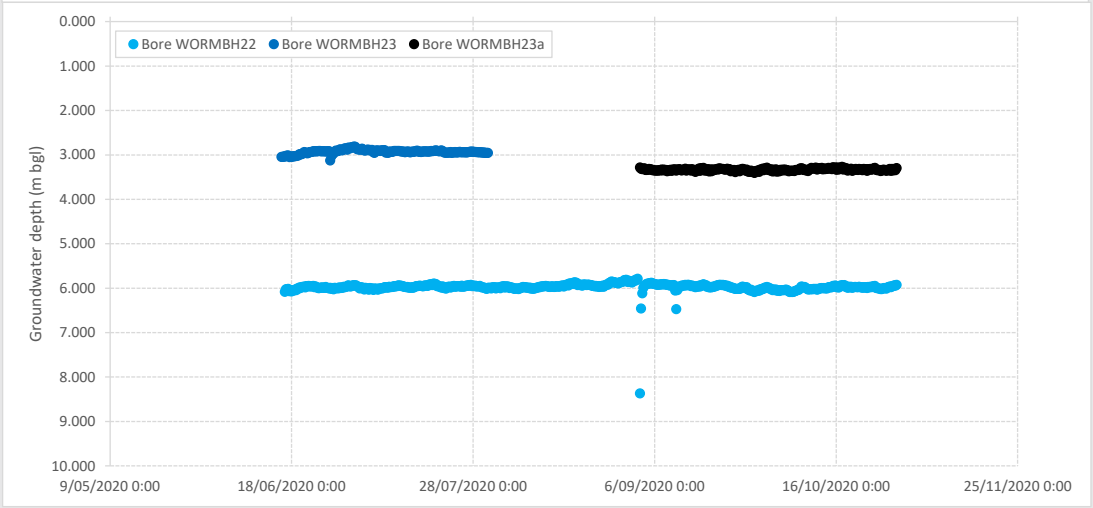


Bore WORMBH14

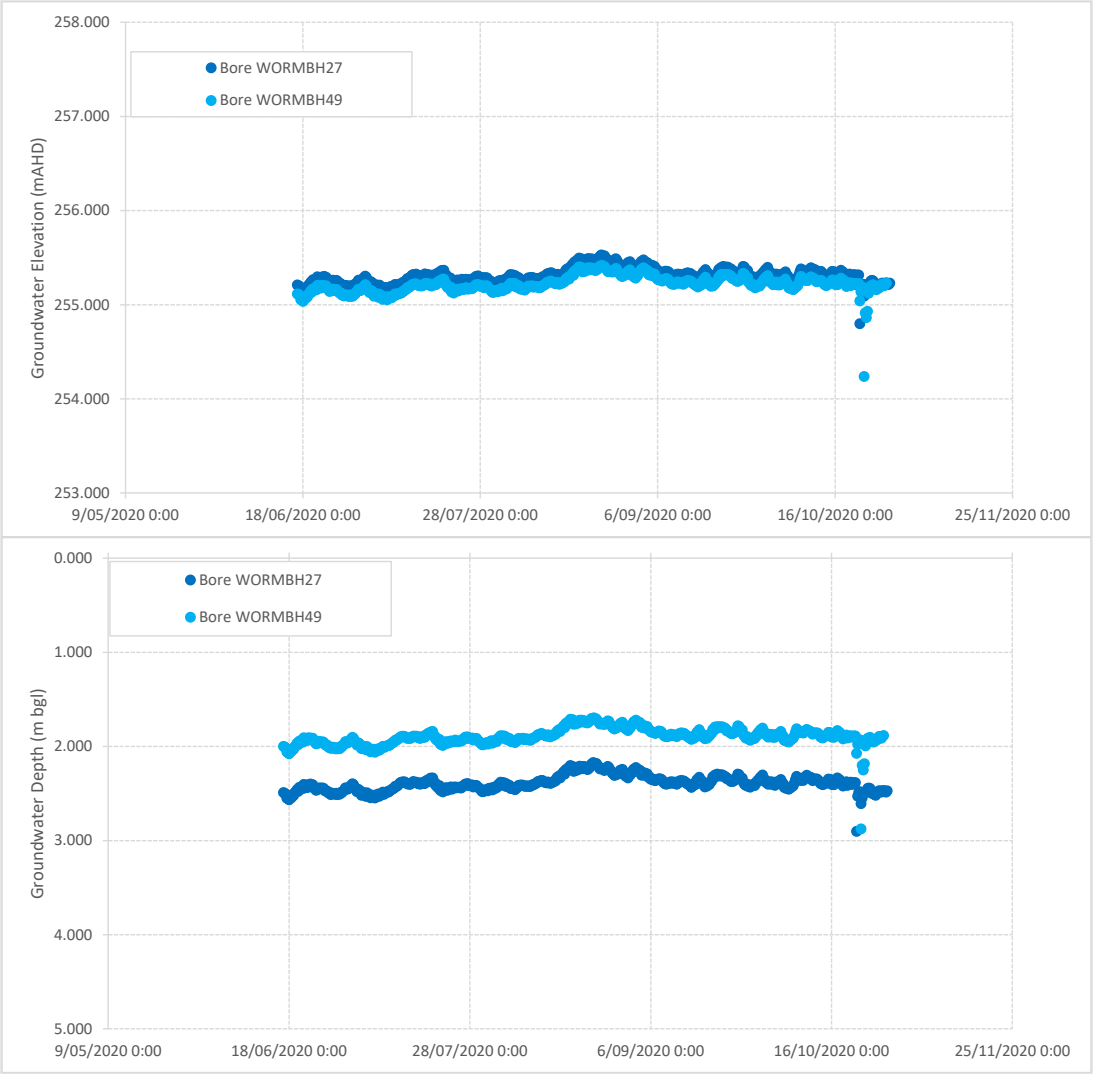

227.000
226.000
225.000
224.000
223.000
Groundwater Elevation (mAHD)
WORMBH32
9/05/2020 0:00
18/06/2020 0:00
28/07/2020 0:00
6/09/2020 0:00
16/10/2020 0:00
25/11/2020 0:00
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
9.000
10.000
Groundwater depth (m bgl)
WORMBH32
9/05/2020 0:00
18/06/2020 0:00
28/07/2020 0:00
6/09/2020 0:00
16/10/2020 0:00
25/11/2020 0:00

WORMBH32





Deep Creek (Bores WORMBH22, WORMBH23, WORMBH23a)



Merri Creek (Bores WORMBH27, WORMBH49)

Appendix L – Analytical inflow assumptions

Assumptions:

- Aquifer conditions:
  - Groundwater flow is horizontal
  - The pre-dewatering water table is horizontal
  - The trench wa excavated in unconfined conditions i.e. where the aquifer is exposed to the atmosphere
  - All recharge in the radius of influence is captured by the pit/trench
- Pit/Trench geometry and construction:
  - The excavation face was vertical
  - The excavation was established instantaneously

Appendix M – Analytical inflow inputs and results

Crossings – Open trench construction

It is noted that at the creek crossing, if the surface water body is connected to the aquifer system it may act as a recharge boundary which may impact the predicted inflow rates presented below, and restrict the extent of the drawdown cone. The level of connection will be dependent on the stream bed permeability and the coffer dam construction, which may further prevent groundwater inflows depending on the final depth.

Area 1 Tame St Drain

Area 1A: Bendigo Railway: Analytical Inputs

Input	Value	Comment
Trench length (m)	8	Bell hole x 1
Trench width (m)	4	
Dewatering Level (m)	3	
Aquifer	Basalt	
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.5 m/day	Assumed based on slug tests (rounded) and range reviewed due to variable nature of the fractured rock aquifer.
Aquifer saturated thickness	30	Based on Victorian Aquifer Framework (VAF) up to 70 m, but assumed a thinner upper aquifer zone within the total basalt thickness (i.e. clay bands)
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 1A results: Bendigo Railway: Estimated inflow rates and radius of Influence

Item	K= 0.5 (m/day)	K = 1 (m/day)
Distance of Influence (m)(1)	20	25
Estimated inflow (m^3/day) for 8 m trench(2)	29	41
Estimated Inflow (L/sec) for 8 m trench	0.3	0.5
Notes: 1. Radius is rounded to the nearest 5 m		

Area 1 Tame St Drain

Area 1B: Tame St Drain: Analytical Inputs

Input	Value	Comment
Trench length (m)	10	Assumed
Trench width (m)	2	
Dewatering Level (m)	2	
Aquifer	Basalt	
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.5 m/day	Assumed based on slug tests (rounded) and range reviewed due to variable nature of the fractured rock aquifer.
Aquifer saturated thickness	30	Based on Victorian Aquifer Framework (VAF) up to 70 m, but assumed a thinner upper aquifer zone within the total basalt thickness (i.e. clay bands)
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 1B: Tame St Drain : Estimated inflow rates and radius of Influence

Item	K= 0.5 (m/day)	K = 1 (m/day)
Distance of Influence (m)(1)	15	20
Estimated inflow (m^3/day) for 10m trench(2)	29	43
Estimated Inflow (L/sec) for 10m trench	0.3	0.5
Notes: 1. Radius is rounded to the nearest 5 m		

Area 2 Jacksons Creek

Area 2: Jacksons Creek: Analytical Inputs

Input	Value	Comment
Trench length (m)	50	Assumed
Trench width (m)	2	
Dewatering Level (m)	5	
Aquifer	Mudstone/siltstone/gravels	Thin gravel above the bedrock
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.05 m/day	Assumed based on slug tests (rounded). Max K assumes potential for gravels to be

Input	Value	Comment
		intersected. Average is for siltstone
Aquifer saturated thickness	30	Assumed main aquifer zone in top 30 m of the bedrock
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 2: Jacksons Creek: Estimated inflow rates and radius of Influence

Item	K= 0.05 (m/day	K = 1 (m/day)
Distance of Influence (m)(1)	10	40
Estimated inflow (m^3/day) for 50m trench)	57	253
Estimated Inflow (L/sec) for 50m trench	0.7	2.9
Notes: 1. Radius is rounded to the nearest 5 m		

Area 5 Merri Creek

Area 5: Merri Creek: Analytical Inputs

Input	Value	Comment
Trench length (m)	50	Assumed
Trench width (m)	2	
Dewatering Level (m)	5	
Aquifer	Basalt	Clay over basalt
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.5 m/day	Assumed based on slug tests (rounded)
Aquifer saturated thickness	30	Maximum thickness 40 m. Assumed a connected basalt aquifer zone in top 30 m.
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 5: Merri Creek: Estimated inflow rates and radius of Influence

Item	K= 0.5 (m/day)	K = 1 (m/day)
Distance of Influence (m)[1]	30	40
Estimated inflow (m^3/day) for 50 m trench	179	253
Estimated Inflow (L/sec) for 50 m trench	2.1	2.9
Notes: 1. Radius is rounded to the nearest 5 m		

Area 4b North East Rail Reserve

Area 4b: North East Rail Reserve: Analytical Inputs

Input	Value	Comment
Trench length (m)	16	2 x 8m bell holes
Trench width (m)	4	
Dewatering Level (m)	1	
Aquifer	Basalt	
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.5 m/day	Assumed based on slug tests (rounded)
Aquifer saturated thickness	30	Maximum thickness around 40 m. Assumed a connected basalt aquifer zone in top 30 m.
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 4b: North East Rail Reserve - Estimated inflow rates and radius of Influence

Item	K= 0.5 (m/day)	K = 1 (m/day)
Distance of Influence (m)[1]	5	10
Estimated inflow (m^3/day) for 32 m trench	58	84
Estimated Inflow (L/sec) for 32 m trench	0.7	1.0
Notes: 1. Radius is rounded to the nearest 5 m		

Trenched areas

Area 4a Donovan's Lane

Area 4a: Donovans Lane: Analytical Inputs

Input	Value	Comment
Trench length (m)	1000	Estimated
Trench width (m)	2	
Dewatering Level (m)	1.5	
Aquifer	Basalt	
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.5 m/day	Assumed based on slug tests (rounded)
Aquifer saturated thickness	30	Maximum thickness around 40 m. Assumed a connected basalt aquifer zone in top 30 m.
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 4a: Donovans Lane: Estimated inflow rates and radius of Influence

Item	K= 0.5 (m/day)	K = 1 (m/day)
Distance of Influence (m)(1)	10	15
Estimated inflow (m^3/day) for 1000 m trench	3,697	5,205
Estimated Inflow (L/sec) for 1000 m trench	43	60
Notes: 1. Radius is rounded to the nearest 5 m		

Area 6 Donnybrook Rd

Area 6: Donnybrook Rd: Analytical Inputs

Input	Value	Comment
Trench length (m)	1000	Estimated
Trench width (m)	2	
Dewatering Level (m)	1	
Aquifer	Basalt	
Hydraulic conductivity (m/day)	Maximum = 1 m/day Average = 0.5 m/day	Assumed based on slug tests (rounded).
Aquifer saturated thickness	30	Maximum thickness around 75 m. Assumed a connected basalt aquifer zone in top 30 m.
Analysis method	Equivalent Slot –Partially Penetrating	No inflow at end of trench assumed/ i.e. trench breaker

Area 6: Donnybrook Rd: Estimated inflow rates and radius of Influence

Item	K= 0.5 (m/day)	K = 1 (m/day)
Distance of Influence (m)[1]	5	10
Estimated inflow (m^3/day) for 1000 m trench	3,688	5,222
Estimated Inflow (L/sec) for 1000 m trench	43	60
Notes: 1. Radius is rounded to the nearest 5 m		

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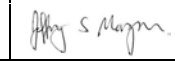
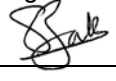
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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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