Surface Water and Groundwater Assessment

Montrose Quarry

Boral Resources (Vic) Pty Limited

21 August 2025

→ **The Power of Commitment**

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Executive Summary

Boral are proposing to expand their Montrose quarry and numerical groundwater modelling was commissioned to quantify the potential impacts of the expansion on groundwater and the flow regimes in nearby Bungalook Creek, and the water level recovery during rehabilitation. The quarry has been actively mining for over 50 years, holds a groundwater licence entitlement, and disposes of seepage inflows to Bungalook Creek under an EPA discharge licence.

Setting

The quarry is sited upon the Mount Dandenong Volcanic Complex. These rhyodacites form a low permeability, low yielding fractured rock aquifer system and have intruded Silurian age mudstones and siltstones. A drilling and monitoring bore construction program was commissioned in the early 2000s to better characterise the hydrogeological setting of the quarry.

The groundwater is typically fresh and although groundwater use occurs in the region, bore densities are not great and the area is considered to be Unincorporated from a groundwater management perspective. Most bores are registered for stock and domestic purposes; however, industrial uses have been identified. The licensing status of such bores is not known.

The depth to groundwater is variable across the site, owing to the steep topography. In the southern and eastern parts of the Work Plan area, groundwater levels can be over 50 m below surface, however, closer to Bungalook Creek, groundwater can be within 5 m of the ground surface.

Bungalook Creek is the nearest waterway to the quarry, and it drains the northern slopes of Mount Dandenong, and lies on the southern boundary of the Work Plan area. The creek commences further northeast of the quarry, flows west and southwest towards the quarry, before it ultimately joins Dandenong Creek, approximately 7 km further to the west – southwest. Its catchment includes urbanised and peri-urban areas. The dominant land use within the catchment is urban, but some areas are used for grazing and industrial land uses. The Bungalook Creek flow records indicates typical daily flow rates ranging from around 0.1 ML/day to 30 ML/day.

Numerical modelling

The numerical groundwater modelling has shown:

- There is an existing level of disturbance to the groundwater environment caused by the historical and current quarry operations
- Streamflow in Bungalook Creek is likely to recharge the water table, via leakage from the stream bed. Historical extraction at the quarry is likely to have resulted in some drawdown towards Bungalook Creek, albeit temporary and limited to periods of low flow when there is insufficient leakage to top up the water table
- Further expansion has the potential to cause local disconnection between the streambed and underlying groundwater which can increase streamflow leakage. When stream flows are less than 10 L/s, potential exists for all streamflow to be lost via leakage
- Water table drawdown, notably along Bungalook Creek is sensitive to prevailing climate. Greater drawdowns occur during drier climate periods, as there is insufficient streamflow to supply recharge to the water table. For most periods, modelling predicts 5 m to 15 m of drawdown along Bungalook Creek, however, it could be 15 m to 27 m during dry periods
- Climate change modelling indicates that the uncertainty in future climate has a similar (if not, bigger) contribution to the uncertainty in modelled water table drawdown compared to that arising from the uncertainty in model parameters

Impacts of quarry expansion

In terms of impacts to groundwater and surface water resources:

- The quarry setting and low yield nature of the regional aquifers, would suggest limited likelihood for a significant increase in the local use of the groundwater resource. As the quarry expands, Boral will have to apply for an increased annual entitlement, which would be subject to *Water Act* (1989) approvals
- Drawdowns will extend from the expanded quarry and there are existing groundwater users within the estimated zone of dewatering. For the most part, most users are stock and domestic and estimated as having less than 5 m loss in available drawdown. A registered industrial bore (WRK056003) on Fussell Road is estimated to have upwards of 15 m loss in available drawdown. A range of mitigation measures are available if these potential interference impacts eventuate
- Groundwater seepage into the quarry is currently returned by Boral to Bungalook Creek under an EPA discharge licence, and this should continue into the future. Returning the volume of groundwater captured at the quarry to Bungalook Creek could maintain the streamflow and locally offset drawdown via leakage. A large portion of this flow may be lost downstream as the rate of leakage would be expected to be lower than the rate in which the flow is routed downstream. Direct recharge of this water via a series of injection bores is likely to be more effective in returning groundwater back into the aquifer (from where it is originally derived) and maintain the water table along the creek
- Drawdowns are predicted beneath Bungalook Creek and terrestrial vegetated land, i.e., Dr Ken Leversha Reserve. Ecological assessment has been completed by EMM (2025) which indicated that there were "*not any GDEs in the project area with the risk of terrestrial GDE occurrence in the project area deemed to be low to negligible"*
- A stable long term pit water level of ~139 to 142 m AHD is predicted post closure, well below the top of pit level of around 150 m AHD

Recommendations

- Boral implement a surface water and groundwater management plan (refer Appendix M) to establish baseline conditions prior to the quarry expansion. This adaptive management plan would also include monitoring triggers for Boral to implement additional actions depending upon the groundwater level response to the quarrying

This report is subject to, and must be read in conjunction with, the limitations set out in section 1 and the assumptions and qualifications contained throughout the Report.

Glossary of acronyms

Acronym	Definition
AASS	Actual Acid Sulfate Soil
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
ANZG	Australian and New Zealand Guidelines
ARI	Annual Recurrence Interval
AS	Australian Standard
BOM	Bureau of Meteorology
CMA	Catchment Management Authority
CEMP	Construction Environment Management Plan
DCI	Directly Connected Imperviousness
DEECA	Department of Energy, Environment and Climate Action
DRN	Drain (Modflow package)
EC	Electrical Conductivity
EES	Environmental Effects Statement
EPA	Environment Protection Authority
EPBC	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
EPR	Environment Protection Regulations
ERS	Environment Reference Standard
EVT	Evapotranspiration (Modflow package)
FO	Flood overlay
FFG	Flora and Fauna Guarantee (Act)
GDE	Groundwater Dependent Ecosystem
GED	General environmental duty
GEDIS	Geological, Exploration and Development Information System
GHB	General Head Boundary (Modflow package)
GIS	Geographic Information System
GMA	Groundwater Management Area
GQRUZ	Groundwater Quality Restricted Use Zones
ISC	Index of stream condition
LSIO	Land subject to inundation overlay
MNES	Matters of national environmental significance
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
NEPM	National Environment Protection Measures
NZS	New Zealand Standard
O&M	Operation and Maintenance
PASS	Potential Acid Sulfate Soil
PCV	Permissible Consumptive Volume

Acronym	Definition
PFAS	Per- and poly-fluoroalkyl substances
RAMSAR	Convention on Wetlands of International Importance Especially as Waterfowl Habitat
RCP	Representative Concentration Pathway
RCH	Recharge (Modflow package)
RLWT	Reduced Level Water Table
SDS	Safety Data Sheets
SFR	Streamflow Routing (Modflow package)
SON	State Observation Network
SWL	Standing Water Level
TDS	Total Dissolved Solids
VAF	Victorian Aquifer Framework
WMIS	Water Measurement Information System
WSPA	Water Supply Protection Area
WWTP	Wastewater Treatment Plant

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1. Introduction

GHD Pty Ltd (GHD) was engaged by Boral Resources Australia Ltd (Boral) to undertake a surface and groundwater assessment of the proposed expansion of its Montrose Quarry. Established in the early 1950s, the site operates under Work Authority 100 and Boral is seeking to expand the quarry.

1.1 Purpose of this report

The objective of the assessment is to support the planning approvals for a Work Authority and Work Plan Variation for the extended quarry operations. In addition, the assessment also considers the impacts of the expansion and approvals required under the Water Act (1989), as well as the potential for increased discharges and requirements for amending the waste discharge licence under the Environmental Protection Act (2017).

1.2 Limitations

This report: has been prepared by GHD for Boral Resources (Vic) Pty Limited and may only be used and relied on by Boral Resources (Vic) Pty Limited for the purpose agreed between GHD and Boral Resources (Vic) Pty Limited as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Boral Resources (Vic) Pty Limited 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 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

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.

GHD has prepared a Numerical Groundwater Model ("Model") for, and for the benefit and sole use of, Boral Resources (Vic) Pty Limited to support the estimation of water level changes during the quarry expansion, and post quarrying activities and must not be used for any other purpose or by any other person.

The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the Boral Resources (Vic) Pty Limited, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs becomes available.

The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.

The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.

GHD has prepared this report on the basis of information provided by Boral Resources (Vic) Pty Limited 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.

1.3 Assumptions

GHD has relied upon information regarding the quarry and its operations as provided by Boral. This information has included:

- Quarry plans and survey information
- Historical aerial imagery
- Previous geotechnical studies

Hydrogeological investigations were undertaken by Golder in the early 2000s and this included the installation of a monitoring bore network, and the development of a numerical groundwater model. This modelling was undertaken to support a southwards expansion of the quarry.

Since these investigations in the early 2000s, there has been little further groundwater studies completed at the quarry. Therefore, information from the Golder (2006) technical studies has been used to characterise the background conditions at the quarry.

GHD has also relied on a GDE assessment, completed by EMM Consulting (EMM) in 2025 and supplied to GHD by Boral. GHD has used this GDE assessment ‘as is’, i.e. it was beyond the scope of GHDs assessment to independently verify the accuracy of the EMM GDE assessment.

It has been assumed that the EMM GDE assessment was completed in accordance with relevant industry standards and guidelines, and the results of the assessment are correct.

1.4 Scope of works

The scope of works for the surface and groundwater assessment were documented in GHD’s proposal data 20 April 2022. An outline scope of works is summarised below:

- Desktop review of existing conditions and site visitation
- Field investigations including geological mapping and sump pumping test investigations
- Surface water assessment including:
  - Development of a site water balance
  - Review of the operating site water balance
  - Review of the pit water lake recovery
- Development of a numerical groundwater model
  - Assessment of changes to Bungalook Creek baseflow
  - Assessment of climate change impacts
- Water risk assessment
- Assessment of impacts of quarry expansion
- Preparation of a monitoring plan

2. Relevant legislation

2.1 Relevant legislation

A summary of the State legislation relevant to the water aspects of the project is provided in Table 1.

Table 1 Summary of State legislation

Act	Description	Relevance to the project
Water Act 1989	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 Water Act is the primary legislation for the resourcing and use of water in Victoria.	Under the Act approvals are required for: – Construction of bores for monitoring, dewatering, or aquifer recharge – Extraction of groundwater, or aquifer reinjection/recharge Construction works on a waterway
Environment Protection Act 2017	The Environment Protection Act 2017 (as amended by the Environment Protection Amendment Act 2018) and its subordinate legislation came into effect on 1 July 2021, transforming Victoria's environment protection laws and the Environment Protection Authority Victoria (EPA). It replaces the original EPA Act (1970). The Act introduces a General Environmental Duty (GED) which requires all Victorians to take reasonable and practicable steps to reduce the human and environmental risks of their activities. 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. The EP Act is supported by subordinate legislation, including regulations and the Environment Reference Standard (ERS).	The ERS: – identifies environmental values that the Victorian community want to achieve and maintain – provides a way to assess those environmental values in locations across Victoria – has indicators and objectives to measure people's actions against these values The indicators and objectives set out in the ERS will be used as a standard to measure any potential impacts of the project on environmental values. Other guidelines documents provide guidance on how the project can comply with the GED, including: – About Stormwater (EPA Victoria 2020a) – Civil construction, building and demolition guide. (EPA Victoria 2020b) – Managing soil disturbance. (EPA Victoria 2020c) – Managing stockpiles. (EPA Victoria 2020d) – Working within or adjacent to waterways. (EPA Victoria 2020e) Managing truck and other vehicle movement (EPA Victoria 2020f)
Environmental Effects Act 1978 (EE Act) (Victoria)	The *Environment Effects Act 1978* provides for assessment of proposed projects that are capable of having a significant effect on the environment. The Act enables statutory decision-makers (Ministers, local government and statutory authorities) to make decisions about whether a project with potentially significant environmental effects should proceed. The Act enables the Minister administering the *Environment Effects Act* to decide that an Environment Effects Statement (EES) should be prepared.	At the time of preparation of this report it is understood that the project has not been submitted for EES referral.

Act	Description	Relevance to the project
	The EES process involves: – Referral to the Minister for Planning – The Minister's decision on the need for an EES – Preparation of scoping requirements for the EES studies and reporting – Preparation of the EES report – Public review (exhibition and lodgement of submissions) – Ministerial assessment of environmental effects Consideration of the assessment	
National Environment Protection Council Act 1994 (NEPC Act) (Federal)	The NEPC Act resulted in the establishment of the National Environment Protection Council (NEPC) and National Environment Protection Measures (NEPMs). NEPMs are a set of national objectives designed to assist in protecting or managing particularly aspects of the environment. A NEPM was established for the Assessment of Site Contamination (ASC) (NEPC 1999) which was amended in 2013. The NEPM (ASC) provides a national approach to provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination. No approvals are required under the NEPM Act.	This is considered a relevant guideline where contaminated groundwater (and water, land, air) may be encountered by the project.

2.2 Relevant guidelines

2.2.1 National guidelines and policies

A number of national guidelines are relevant to groundwater and these are summarised in Table 2.

Table 2 Summary of National guidelines

Policy/Guideline	Description
Minimum Construction Requirements for Water Bores in Australia 2020	The guidelines outline the minimum requirements for constructing, maintaining, rehabilitating, and decommissioning water bores in Australia. They are used extensively by regulators and the drilling industry and provides a consistent standard reference across Australia for the licensing of bores and drillers. Geotechnical investigations undertaken to characterise the groundwater environment of the project have adopted these guidelines.
NHMRC, NRMMC 2011 Australian Drinking Water Guidelines 6	The guidelines are intended to provide a framework for good management of drinking water supplies that, if implemented, will assure safety at point of use. The ADWG have been developed after consideration of the best available scientific evidence. These guidelines have been applied to assess groundwater quality.
ANZECC, ARMCANZ 2000 Australian and New Zealand Guidelines for fresh and marine water quality.	The guidelines outline the management framework recommended for applying the water quality guidelines to the natural and semi-natural marine and fresh water resources in Australia and New Zealand. The guidelines provide a summary of the water quality objectives proposed to protect and manage the environmental values supported by the water resources, and advice on designing and implementing water quality monitoring and assessment programs. These guidelines have been updated in 2018 and applied to assess groundwater quality.

Policy/Guideline	Description
NHMRC 2008 Guidelines for Managing Risks in Recreational Waters	The primary aim of these guidelines is to protect the health of humans from threats posed by the recreational use of coastal, estuarine and fresh waters. Threats may include natural hazards such as surf, rip currents and aquatic organisms, and those with an artificial aspect, such as discharges of wastewater. These guidelines have been applied to assess groundwater quality.
NRMMC, EPHC, NHMRC 2009 Australian Guidelines for Water Recycling: Managed Aquifer Recharge'	These guidelines provide a sound and consistent basis for protecting human health and the environment at managed aquifer recharge operations in all of Australia's states and territories. These guidelines are appropriate in circumstances where Boral wish to the recharge water back into the groundwater system (rather than discharging seepage inflows into the Bungalook Creek directly).
HEPA PFAS National Environnemental Management Plan 2018	The plan has provided guidance to environmental regulators regarding the regulation of PFAS contaminated sites and materials.

2.2.2 State guidelines and policies

A number of Victoria guidelines are relevant to surface water and groundwater and these are summarised in Table 3.

Table 3 Summary of Victorian guidelines and policies

Policy/Guideline	Description
Environment Reference Standard (ERS) (2021)	This is a tool introduced under the EPA Act (2017) and replaces the former State Environment Protection Policies (SEPPs). The ERS: – Identifies environmental values that the Victoria want to achieve and maintain. – Provides a way to assess those environmental values in locations across Victoria
Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems 2015	These guidelines are a supplement to a section of the *Water Act 1989* where a groundwater Take and Use application is made. It requires applications to undergo a risk assessment and referral process.
Environment Protection (Industrial Waste Resource) Regulations 2009	These regulations (under the *Environment Protection Act 1970*) categorise industrial wastes (including groundwater) by risk profile to ensure that each is appropriately handled, stored, treated, transported and disposed of. This regulation sets a hierarchy of preference for waste management.
Water (Trade Waste) Regulations 2014	These regulations (under the *Water Act 1989*) set out various trade waste policies and guidelines for Victoria's Water Authorities, including the condition for the receipt and disposal of trade wastes.
EPA Victoria 2022 Groundwater Sampling Guidelines (669.1)	The key objective of this document is to foster practices that will assist with accurate and consistent determination of chemical and biological indicators of groundwater. Such practices will ensure that groundwater samples are representative of groundwater in the aquifer and will remain representative until analytical determinations or measurements are made.
EPA Victoria 2022 Guidelines for Hydrogeological Assessments (Water Quality) (668.1)	These guidelines describe the basics of groundwater contamination: how a site conceptual model is developed; the process of a hydrogeological assessment; the collection of groundwater data; and what an hydrogeological assessment report should contain.
EPA Victoria 2014 The clean-up and management of polluted groundwater.	These guidelines provide details of EPA Victoria requirements and expectations for developing and implementing the clean-up and management of polluted groundwater, to ensure the protection of human health and the environment.
EPA Victoria Publication 1834: Civil construction, building and demolition guideline (2020).	This guide supports the civil construction, building and demolition industries to eliminate or reduce the risk of harm to human health and the environment through good environmental practice. This guideline supersedes early EPA publications (1991 and 1996)

Policy/Guideline	Description
EPA Victoria Publication 1287 2009 Guidelines for risk assessment of wastewater discharges to waterways.	These guidelines outline what is expected from practitioners proposing to discharge wastewater to waterways and how this is to be assessed. A risk assessment framework and guidance on its application is provided.
EPA Victoria 347.1 (2015)	To protect the environment by providing a secondary containment system, for liquids, which if spilt are likely to cause pollution or pose an environmental hazard.
Healthy Waterway Strategy, Melbourne Water (2018)	The Healthy Waterway Strategy has been developed by Melbourne Water and EPA. It provides a consistent framework, whereby the targets within the HWS and the Urban Stormwater Management Guidance are aligned and reflect current scientific and industry knowledge.
Clause 53.18-5 Stormwater management objectives for buildings and works	Provides guidance and encouragement to implement stormwater management that aims to reduce the impact of stormwater from the surrounding infrastructure and maximises the retention and reuse of stormwater.

2.3 Approach to application of the guidelines and policies

2.3.1 Surface water

In terms of seeking a works approval variation for the proposed expansion of the hornfels quarry in this region, the relevant government department, Earth Resources (which will become part of the new Department of Energy, Environment and Climate Action (DEECA), may seek approval from the following referral authorities:

- Melbourne Water – Responsible for management of floodplains and waterway within the catchment and administering “licence for works” under Section 67 of the *Water Act* (1989)
- Southern Rural Water (SRW) – Water Authority responsible for the licencing of water use and discharge

The *Water Act* (1989) was amended by the Water (Irrigation Farm Dams) Act (2002) to require licensing of all irrigation and commercial water use that interferes with, or takes from, waterways, springs, soaks and dams.

Under section 67 of the *Water Act* (1989), a licence is required to construct, alter, operate, remove or decommission works on a waterway. Works include reservoirs, dams, bores, channels, sewers, drains, pipes, conduits, machinery, equipment and apparatus, whether on, above or under land. Also included are any works that may result in the drainage of any land; or the collection, storage, taking, use or distribution of any water; or the obstruction or deflection of the flow of any water.

The construction of new works on a waterway requires a works licence. Licensing is a Ministerial responsibility under the *Water Act* (1989) that has been delegated to SRW. SRW applies the waterway determination guidelines to assess whether a particular site is a waterway as defined by the *Water Act* (1989).

Extractive activities affecting water quality include:

- Alteration of sediment transfer initiating bed and bank instabilities
- Soil erosion
- Loss/Disturbance of vegetation and habitat
- Potential to initiate an avulsion (i.e., change in watercourse)
- Nutrient and sediment discharge into waterways

The following fundamental principles and are cited in reference to extractive industries within the guideline document:

- Extractive industries must not contribute to sediment entering waterways and threaten waterway health
- Extraction on a floodplain shall not threaten floodplain stability
- Discharge of process solutions or quarry waste must not enter waterways
- All discharge from the site must meet the standards of the EPA
- To be located greater than 100 metres from waterways

There are several floodplain management principles that need to be considered when assessing proposed works or development in the floodplain. Whilst the majority of the floodplain principals relate directly to implications on flooding there is the following principle articulated for the environmental protection:

Protection of environmental values and water quality - The environmental values of floodplains, waterways, wetlands, and riparian environs must be protected or enhanced. Developments and uses must not unduly compromise water quality in receiving waterways and wetlands.

2.3.2 Groundwater

2.3.2.1 Groundwater resource

Background to resource management

DEECA has recognised areas of intensive groundwater use throughout Victoria. The principal management unit for groundwater resources in Victoria is the Groundwater Management Unit or GMU. A GMU may be a Groundwater Management Area (GMA), a Water Supply Protection Area (WSPA) or an Unincorporated Area. An Unincorporated Area is a region falling outside of a GMA or WSPA.

Under the *Water Act* (1989), the Minister for Water may declare the total volume of groundwater (and/or surface water) which may be taken in an area. This is termed the Permissible Consumptive Volume (PCV). The total volume of water allocated under the PCV became a trigger for declaration of a GMA (or WSPA).

The *Water Act* (1989) requires that all persons who wish to extract groundwater (except domestic and stock users) apply for a groundwater licence. Groundwater licences are issued to protect the rights of licence holders, ensure that water is shared amongst users, and to ensure that environmental requirements are protected. The Victorian Water Register was established as a public register of all water-related entitlements.

Within WSPAs, caps or moratoriums on the issue of additional extraction licenses are often present. Owing to the implications on groundwater development, Ministerial approval, including the development of management plans, were required to convert a GMA to a WSPA. In the late 1990s approximately 50 GMAs were established across the State.

DEECA delegates the management of the *Water Act* (1989) to Southern Rural Water (SRW) in this region, i.e., SRW is the licensing authority responsible for allocation of the groundwater (and surface water) resources. There has been continued water resource reform, and with this reform, SRW has been releasing Local Management Plans (LMPs).

LMPs are incorporating smaller GMUs into larger groundwater catchments for management purposes, but local rules have been retained to address specific issues and water trading arrangements. LMPs are considered to be more responsive than statutory management plans as they can be revised and updated with changing (local) groundwater conditions.

Relevant groundwater management area

The quarry falls within the service area of Southern Rural Water, a rural water authority delegated by DEECA.

The quarry does not fall within a recognised GMA. There are no moratoriums on the issue of new groundwater entitlements, however, groundwater licence applications would be subject to technical assessment and Southern Rural Water determinations under the *Water Act* (1989).

To assess impacts for groundwater licensing determination, Southern Rural Water typically require a technical hydrogeological assessment. The requirements of a technical hydrogeological assessment can vary, but general guidelines have been attached as Appendix A.

2.3.2.2 Groundwater quality

Classification of groundwater

The *Environment Protection Act 2017* specifies new objectives of the EPA and consequential amendments to the former *Environment Protection Act 1970*. The Act changes Victoria’s focus to a prevention based approach, rather than preventing waste and pollution impacts and managing these after they have occurred. Central to the Act is the general environmental duty (GED), which requires Victorians to reduce the risk of their activities potentially harming the environment or human health through waste and pollution.

The Act introduces two subordinate instruments:

- Environment Protection Regulations (EPR)
- Environment Reference Standard (ERS)

Under section 93 of the new *Environment Protection Act 2017*, an Environmental Reference Standard (ERS is used to assess and report on the environmental conditions throughout Victoria. The ERS:

- Identifies environmental values (human health and the environment) to be achieved or maintained in Victoria
- Specifies indicators and objectives used to measure, determine or assess whether those environmental values are being achieved, maintained, or threatened

The ERS is not intended to represent a compliance standard but rather has a primary function to provide an environmental assessment and reporting benchmark. The ERS contains environmental values for each element of the environment in separate parts, i.e., air, land, water (surface and groundwater), however, the different elements of the environment can impact each other and the interactions between them need to be considered.

The ERS (2020) provides that groundwater is categorised into segments, with each segment having particular identified values. The segments and their environmental values are summarised in Table 4.

Table 4 Protected environmental values and groundwater segments

Environmental value	**Segment (TDS mg/l)**						
	A1 (0-600)	**A2 (601-1,200)**	**B (1,201-3,100)**	**C (3,101-5,400)**	**D (5,401-7,100)**	**E (7,101-10,000)**	**F (>10,000)**
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	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

Note: TDS – Total Dissolved Solids (mg/L). Source ERS (2020).

The environmental values may not apply to groundwater if:

- There is insufficient aquifer yield to sustain the environmental value, having regard to variations within the aquifer and reasonable bore development techniques to improve yield; or
- The application of that groundwater, such as for irrigation, may be a risk to the environmental values of land or the broader environment due to the soil properties; or
- The background water quality level exceeds (or is less than, in the case of indicators such as pH, dissolved oxygen and many biological indicators) the relevant objective specified in the ERS and as a result the environmental value cannot be achieved

Background groundwater quality

No groundwater quality monitoring was undertaken as part of the current scope of works; however, it is understood that Boral propose to implement a monitoring program for the quarry.

Golder (2006) document an average salinity from selected site monitoring bores, and groundwater seepage into the quarry as 1,630 mg/L TDS.

There is no site specific groundwater quality information and in the absence of such information, background salinity can be interpreted from regional mapping and neighbouring bores. These sources tend to support a high or fresh groundwater quality, with salinities less than 1,000 mg/L TDS. On the assumption that regional salinity mapping is reliable, the groundwater falls within segments A to B (refer section 2.3.2).

Protected environmental values

Based upon the available data, groundwater typically falls within Segments A and B based upon the ERS classifications documented in Table 4. The ERS considers groundwater falling within the Segment A to be the most sensitive. A discussion of the environmental values, and their relevance to the quarry is provided in Table 5.

Table 5 Relevance of Segment A environmental values

Environmental value	Existing in work plan area	Neighbouring areas	Discussion
Water dependent ecosystems and species	Possibly	✓	**Relevant** Groundwater quality must be maintained to protect aquatic ecosystems at the point of groundwater discharge. The study area falls within the Central Foothills and Coastal Plains segment which are considered to be a slightly to moderately modified water dependent ecosystem.
Potable water supply (desirable)	✗	No	**Potentially relevant** Such low salinity groundwater has been identified regionally, but not local to the quarry itself. Groundwater is not used on site for such purposes. Stock and domestic bores have been identified in the broader area, however, the likelihood of use for potable supply is considered limited given the relatively low yields of bores, but also the availability of reticulated mains water throughout the region.
Potable water supply (acceptable)	✗	No Urban bores ✓ Domestic	
Potable mineral water supply	✗	No	**Not relevant** The groundwater is not within a recognised mineral water province and there are no identified mineralised bores close to the site. There is a limited likelihood of groundwater being used for this purpose.

Environmental value	Existing in work plan area	Neighbouring areas	Discussion
Agriculture and irrigation (irrigation)	N/A	✓	**Relevant** One bore (WRK983171) at the Mooroolbark bowls club with an irrigation use has been identified. Bore yields in the MDVC aquifer system are not likely to be capable of supporting large scale commercial irrigation enterprises.
Agriculture and irrigation (stock watering)	N/A	✓	**Relevant** Nearby stock bores have been identified. The groundwater salinity is suitable for a wide range of livestock types. The urbanised land development within the study area is not conducive to livestock, e.g., agriculture/farming land which would suggest that such an environmental value is unlikely to be realised in the future.
Industrial and commercial use	Seepage used by quarry	No	**Potentially relevant** There are no existing bores within a commercial or industrial use type, however, this environmental value could be realised in the future. Bore yields in the MDVC aquifer system are not likely to be capable of supporting large scale commercial enterprises.
Water-based recreation (primary contact recreation)	N/A	✓	**Relevant** Bunglaook Creek borders the quarry and groundwater is expected to discharge to waterways. It is noted that based upon the site inspection, there are limited deep pools or access to the creek for bathing purposes.
Traditional Owner cultural values	N/A	✓	**Relevant** No specific engagement with the local traditional owners has been undertaken as part of this work. In the absence of such engagement, it has been assumed that protection of groundwater that discharges into nearby waterways is required to maintain traditional owner cultural values.
Buildings and structures	N/A	✓	**Possibly** There are some buildings, including residential properties, located within the study area, however, these are assumed to have shallow foundations. The estimated deep water levels are likely to limit the interaction between groundwater.
Geothermal properties	N/A	N/A	**Not relevant** The groundwater is too shallow to have an elevated temperature and therefore this value is not considered relevant to this assessment.

The likelihood of some of these environmental values of groundwater being realised at or near the quarry site is questionable, however, this would form an objective of future revisions of the SW-GWMP when the groundwater quality has been confirmed.

2.3.3 A18 permit

With the issue of the new EPA Act (2017), the EPA has introduced additional tools to supplement the EPA licencing system that is currently in place. Through the EPAs Permissions Scheme Policy (Publication 1799), additional tiers of controls, i.e., permits and registrations, are established that reinforce the GED, and who can undertake prescribed activities.

The new policy sets out rules for:

- Licences (pilot project, development, and operating)

  These are applied to complex activities that require the highest level of regulatory control due to the significant risk of harm to human health and the environment, or a high potential for mismanagement. The application process may require detailed assessment
- Permits

  These apply to activities that are of moderate or high risk with low complexity. Applications are assessed by the EPA and may contain conditions that are largely standard across an industry
- Regulations

  These are suited to activities that pose moderate to low risks, and are automatically granted upon application

It is understood that the EPA has raised concerns with the Earth Resource Regulator regarding quarries (resource recovery operation) and in-pit sumps and the potential requirement for an A18 permit ‘Discharge or deposit of waste to aquifer permission). Further clarification is required from the EPA to understand that rationale supporting the need for such. The following, however, is noted:

- The Quarry sump at Montrose principally stores stormwater run-off from the quarrying activities and collects groundwater seepage. When fully dewatered, the sump would principally contain groundwater, with some stormwater run-off
- The water stored in the sump contributes to the site water balance and thus a vital component of site operations. There is no deliberate intent to ‘dispose’ of water to the aquifer. Water from this sump is typically transferred to another storage for use around the site, i.e. dust suppression and plant washing
- Quarry sumps may leak and therefore form a component of groundwater recharge to the aquifer. However, at Montrose, it is below the water table and receives groundwater inflow
- The introduction of other contaminants e.g. organics, heavy metals, is considered to present a low risk. Contaminants could be introduced through plant maintenance e.g. hydraulic leaks, or refuelling, however, there are standard environmental procedures site environmental management procedures to mitigate this risk. This is assessed further in this report

3. Water approvals and licencing

3.1 EPA

EPA has issued Licence 17685 to Boral for the discharge of treated wastewater to surface water. A copy of the licence has been attached as Appendix B.

The general conditions attached to the licence have been summarised in Table 6.

Table 6 EPA licence 17685 conditions: General

Condition	Description
LI_G1	You must ensure that waste is not discharged, emitted or deposited beyond the boundaries of the premises except in accordance with this licence or under the Act.
LI_G2	You must immediately notify EPA of non-compliance with any condition of this licence by calling 1300 EPA VIC (1300 372 842), sending an email to contact@epa.vic.gov.au, or using the EPA Interaction Portal.
LI_G3	By 30 September each year you must submit an annual performance statement to EPA for the previous financial year in accordance with the Annual Performance Statement Guidelines (EPA Publication 1320.3, released June 2011).
LI_G4	Documents and monitoring records used for preparation of the annual performance statement must be retained at the premises for five years from the date of each statement and be able to be immediately produced upon request by an officer of the Authority.
LI_G5	You must establish and implement a risk based monitoring program that enables you and EPA to determine compliance with each condition of this licence. The monitoring program must comply with the requirements.

In relation to the water and land environment, there are additional conditions as summarised in Table 7. The discharge limits stipulated on the licence are summarised in Table 8.

Table 7 EPA licence 17685 conditions: Water and Land

Condition	Description
LI_DW1	You must ensure that surface water discharged from the premises is not contaminated with waste.
LI_DW2	Discharge of waste to surface waters must be in accordance with the 'Discharge to Water' table.
LI_DL1	You must not contaminate land or groundwater.

Table 8 Discharge limits

Discharge point no.	Description of discharge point	Indicator	Limit type	Unit	Discharge limit
DPB	DPB as shown in Schedule 1B	Flow rate	Max daily flow	ML/d	0.86
		Electrical conductivity	Annual median	µS/cm	1,600
		Electrical conductivity	Maximum	µS/cm	2,000
		Turbidity	Annual median	NTU	25
		Turbidity	Maximum	NTU	40
		pH	Maximum	pH	9
		pH	Minimum	pH	6

3.2 Groundwater extraction

Golder (2006) reported that Boral held a groundwater extraction licence for 23 ML/year. Subsequent to that period, the entitlement volume was updated to 120 ML (BEE027293).

A copy of the take and use licence has been attached as Appendix C. The extraction point information is described as follows:

- Volume 5793 Folio 414, CA 38B Parish of Mooroolbark
- 353,560 mE and 5,813,000 mN

Conditions attached to the licence include:

- The volume of water taken under this licence in any twelve-month period from 1 July to 30 June must not exceed the licence volume, less any volume that has been temporarily transferred to another person or location
- The maximum volume that may be taken under this licence in any one day is 0.60 ML per day
- The Authority may determine water allocations at 1 July or during the course of the subsequent 12-month period that are less than 100% of the licence volume, in which case the licence volume is correspondingly reduced for that 12-month period
- Unless otherwise directed by the Authority, water may be taken at any time between 1 July and 30 June

4. Study methodology

4.1 Overview

This section describes the method that is common to each of the surface water and groundwater assessments. The approach used in the assessment has been guided by an evaluation framework that is broadly consistent with what would be required under an Environmental Effects Statement (EES), although the expansion of the quarry does not require an EES. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects (refer Figure 1).

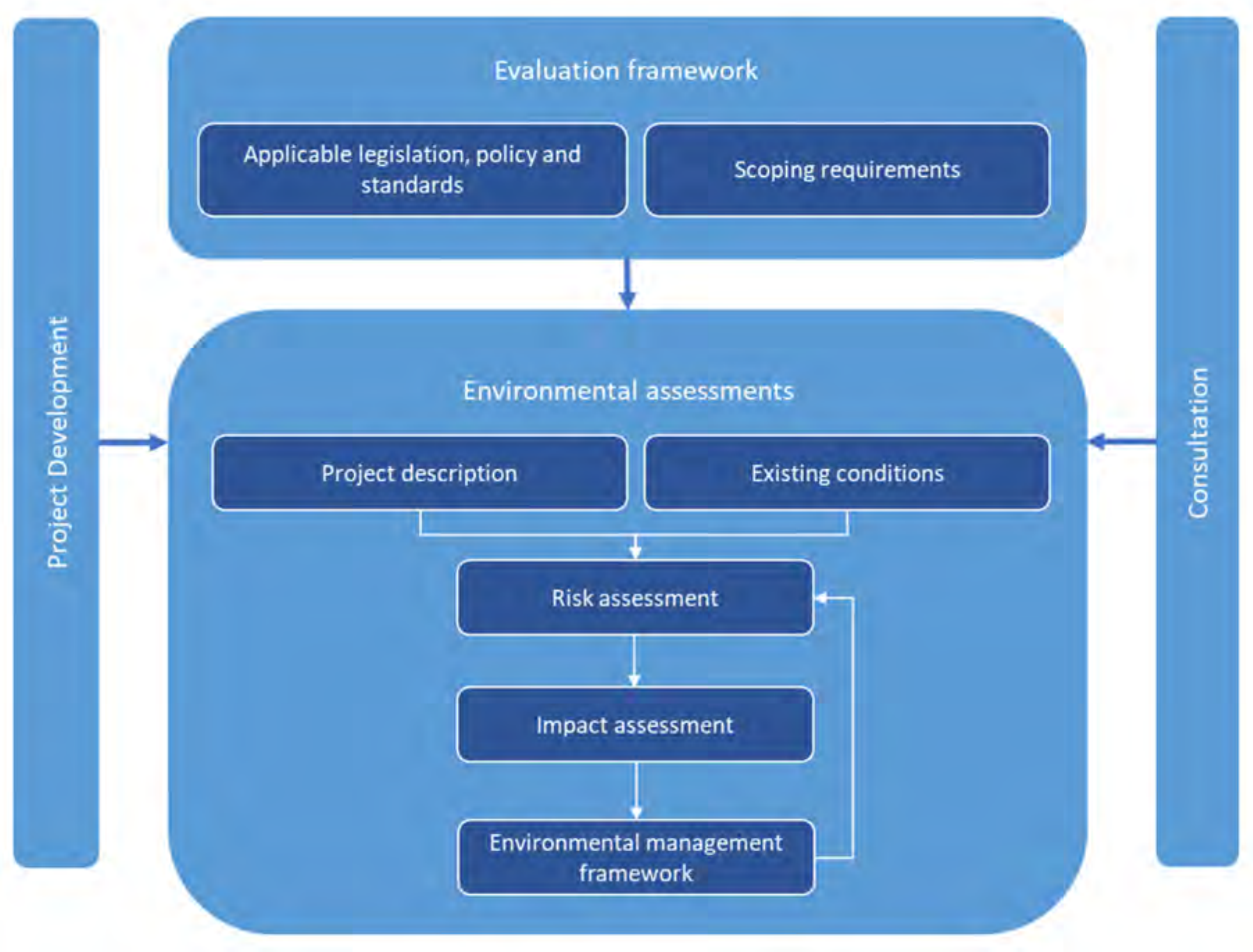

Figure 1 Overview of EES assessment framework

An effective impact assessment should:

- Be consistent with the principles of a systems and risk-based approach
- Put forward a sound rationale for the level of assessment and analysis undertaken for any environmental effect or combination of environment effects arising from all components and stages of the project

The surface water and groundwater assessment undertaken encompasses consideration of physical systems, ecological systems, human communities, land use effects and economic effects as relevant to the project. It has been undertaken using a precautionary approach according to the following steps:

- Characterisation of the existing environmental conditions
- Review of the Project design and the proposed expansion and operation activities in the context of the existing conditions to determine the location, type, timing, intensity, duration and spatial distribution of Project components and activities in relation to sensitive receptors
- An initial risk assessment to evaluate the likelihood and consequence of the proposed Project activities in the context of the initial mitigation measures to determine the relative importance of environmental risks associated with the Project
- Assessment of potential direct and indirect environmental impacts to analyse the spatial and temporal extent, magnitude and nature of the potential impacts giving consideration to the sensitivity and significance of affected receptors
- Evaluation of the predicted outcomes against applicable legislation, policy and standards
- Evaluation of the potential for cumulative impacts caused by impacts of the Project in combination with impacts of other projects that are taking place or are proposed nearby
- Identify mitigation measures where necessary, to address potentially significant environmental effects
- Identification and evaluation of the residual environmental effects including magnitude, duration and extent, taking into account the proposed mitigation measures and their likely effectiveness

Based on the findings of the surface and groundwater assessment, mitigation measures may have to be established to monitor and evaluate environmental management and contingency measures in relation to the residual environmental effects. These are described in section 13.

4.2 Study area

At a minimum, the study area encompasses the entire site boundary of the quarry. However, groundwater processes occur over a range of scales such as local and regional flow regimes. It is therefore necessary to extend the study area for the groundwater impact assessment beyond the quarry footprint to capture these broader processes. The approximate study area is shown in Figure 1.

Project boundary definition

The proposed project boundary (Work Plan area) established for the project defines the area in which the project elements and expansion would be contained. It encompasses all areas that would be used for quarry and include buffer zones.

Study area – whole project

The term study area for the surface water and groundwater impact assessment refers to a broader region surrounding the project boundary. The study area includes all land within approximately 3 km to 5 km of the project boundary. This description covers a much broader area than the expected zone of impact, and the additional information captured has been used to provide context for regional groundwater flow processes. This broader study area was mostly assessed by desktop research.

5. Site setting

5.1 Site location

5.1.1 Land parcels

The quarry address is described as 56 Canterbury Road Montrose and it is located at the intersection of Canterbury and Fussell Roads, Montrose. The site is shown in Figure 2. A summary of results from the DEECA planning report have been provided in Table 9.

Table 9 DEECA planning report

Item	Description
Address	56 – 72 Canterbury Road
Land parcels	32 Lot 3 LP28407 3\LP28407 Lot 4 LP28407 4\LP28407 Lot 5 LP28407 5\LP28407 Lot 6 LP28407 6\LP28407 Lot 2 LP33736 2\LP33736 Lot 4 LP33736 4\LP33736 Lot 5 LP33736 5\LP33736 Lot 6 LP33736 6\LP33736 Lot 7 LP33736 7\LP33736 Lot 1 LP33792 1\LP33792 Lot 1 TP186055 1\TP186055 Lot 1 TP186056 1\TP186056 Lot 1 TP237908 1\TP237908 Lot 1 TP240397 1\TP240397 Lot 1 TP244371 1\TP244371 Lot 1 TP247561 1\TP247561 Lot 1 TP320315 1\TP320315 Lot 1 TP339840 1\TP339840 Lot 1 TP386740 1\TP386740 Lot 1 TP557828 1\TP557828 Lot 1 TP585781 1\TP585781 Lot 1 TP631632 1\TP631632 Lot 1 TP840679 1\TP840679 Lot 1 TP876683 1\TP876683 Lot 2 TP876683 2\TP876683 Lot 3 TP876683 3\TP876683 Lot 4 TP876683 4\TP876683 Lot 5 TP876683 5\TP876683 Lot 6 TP876683 6\TP876683 Lot 1 TP885943 1\TP885943 Lot 1 TP898839 1\TP898839 PARISH OF MOOROOLBARK Allot. 38B 38B\PP3176
Local Government Area	Shire of Yarra Ranges
Council Property No.	158003
Perimeter	4009 m (approximate)
Area	781033 m^2 (approximate)

5.1.2 Topography

The quarry has been established on the northwestern foothills of Mount Dandenong. The northwestern corner of the site lies at an elevation of around 135 m AHD, and the southern batters have been excavated into a local topographical high. The southern parts of the site, which constitute the proposed expansion area for the quarry rise to over 200 m AHD.

Bungalook Creek drains the northern slopes of Mount Dandenong and lies on the southern boundary of the Work Plan area.

Paper Size ISO A4

0 0.1 0.2 0.3 0.4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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GHD

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MONTROSE QUARRY

Site Location Plan

Project No.	31-1270927
Revision No.	A
Date	21/04/2023

FIGURE **2**

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Print date: 26 Apr 2023 - 17:09

Data source: VicMap Data, DELWP Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: lgomez

5.1.3 Neighbouring land use

The neighbouring land use is summarised as follows:

North

Canterbury Road forms the northern boundary of the existing Work Plan area. Land on the northern side of Canterbury Road is used for commercial and light industrial purposes. Land uses include:

- Garden supplies and building materials
- Montrose transfer station
- Generator hire, sales and service
- Commercial premises selling car parts, kitchen cabinetry, building trusses etc

Residential housing commences on Canterbury Road near the north eastern corner of the Work Plan area.

West

The western boundary of the Work Plan area is adjacent to Fussell Road. At the time of reporting, the vacant land near the intersection of Canterbury and Fussell Roads was being redeveloped, with earthworks underway. Further southwards the land uses are commercial/light industrial and include a wide variety of businesses including:

- Car parts
- Garden supplies
- Reinforcing company

Close to the southern edge of the existing quarry area, access to Fussell Road is controlled by a locked gate. This gate provides access to the rear of the quarry (and the proposed expansion area), as well as a Melbourne Water water storage.

East

Land uses along the eastern boundary can be divided into two basic types. Residential housing is present along the northern half, which is accessed via Ash Grove. There is a short buffer distance (approximately 50 m) filled with vegetation separating the rear of these residences from the working area of the site. Horse agistment occurs in small paddocks at the southern end of Ash Grove.

The southern half of the eastern boundary is vegetated and abuts the Dr Ken Leversha Reserve.

South

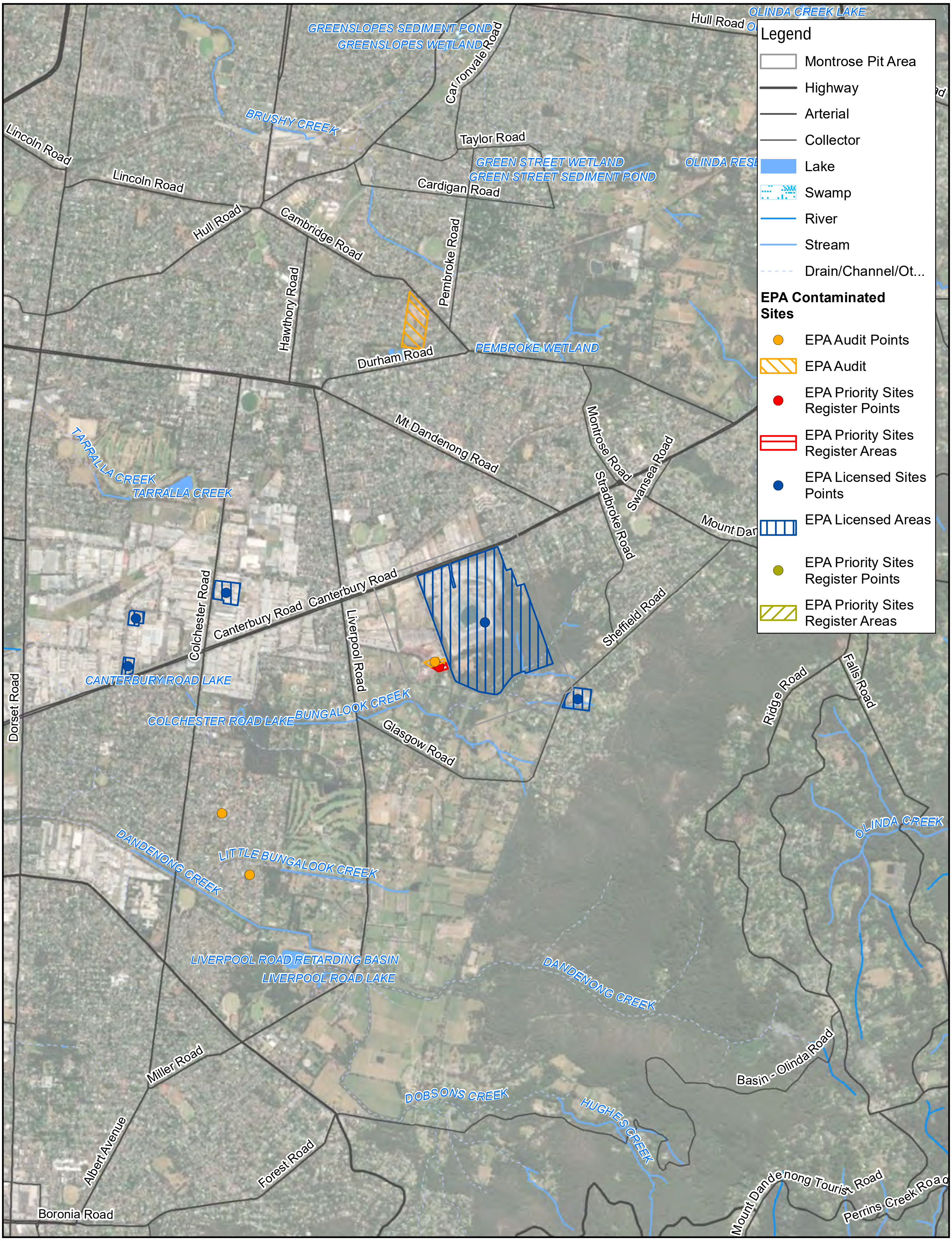
The southern parts of the Work Plan area are vegetated, and the forested area continues to the southern banks of Bungalook Creek. The land uses on the southern side of Bungalook Creek include residential premises (on larger sized allotments) and small paddocks, presumably used for livestock grazing (horse agistment).

5.1.4 Potentially contaminated sites

A review of DEECA’s Victoria Unearthed GIS mapping tool was undertaken to identify any EPA registered sites. The results of the search have been summarised in Table 10.

Table 10 Summary of neighbouring registered sites

Location description	Category	Description	Risk
270 Sheffield Road Approx. 0.5 km to southeast of Work Plan areas	Licensed premises	Billanook Primary School The school has a sewage treatment plant and the licence allows discharge of treated sewage to waterways (Sheffield Road Drain). This drain terminates into Bungalook Creek.	This is considered to pose a low to negligible risk to operations on the Boral site.
Lot 2 76 Fussell Road Adjacent western boundary of Work Plan area	EPA priority sites register	This is currently an auto parts recovery store. Listed as requiring assessment and/or cleanup.	Unknown – potential for contaminated groundwater plume
Lot 1 76 Fussell Road Adjacent western boundary of Work Plan area	53X statement	Site underwent an environmental audit (EES 2014). The groundwater underlying the site was impacted by chlorinated hydrocarbons (and heavy metals in soils). The reporting documented conditions in Lot 1 and Lot 2. The site was considered to have a perched groundwater system in fill materials; however, bores were installed in both the perched, and underlying regional aquifer. Perched groundwater occurred at 1 m to 3 m bgl, and ~13 m bgl in the regional aquifer. Flow was expected to be towards the northeast. The auditor considered the site presented a low risk of on-going impact because: – No chlorinated hydrocarbon NAPL was identified – Source had been removed – Evidence of chlorinated hydrocarbon natural attenuation Practicability of groundwater clean-up needs to be periodically assessed.	There is potential for dewatering activities undertaken by Boral to enhance the migration of the contaminated groundwater plume.
215 Colchester Road Approx. 1.5 km to the west of the Work Plan area	Licensed premises	Site is currently occupied by RLA Polymers. RLA make a range of adhesives and construction productions.	Unknown – potential for contaminated groundwater plume
150 Cambridge Road, Kilsyth Approx. 2 km due north of the Work Plan area	53X statement	Former Yarra Hills Secondary College The Audit did not identify any significant soil or groundwater contamination. Groundwater monitoring bores were installed which indicated the groundwater level to be 15 m bgl to > 25 m bgl.	This is considered to pose a low to negligible risk to operations on the Boral site.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Project No.	31-1270927
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Neighbouring contaminated sites

FIGURE 3

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Data source: VicMap Data, DELWP Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: lgomez

5.2 Climate

Climate data for the groundwater and surface water assessment was obtained from the SILO point database (**https://longpaddock.qld.gov.au/silo/point-data/**), which comprises infilled daily data for climate stations around Australia from 1889 to yesterday. The mean monthly rainfall and evaporation data for the years since 1990 is summarised in Table 11 for the representative stations. Climate data is presented for Montrose (86076), Dorset (86234) and Mount Dandenong (86243).

The Croydon (86234 – Dorset Golf) climate station was applied in the numerical groundwater modelling studies completed by GHD (2023). The two climate stations have broadly similar data.

The Mount Dandenong GTV (86243) climate station has been used as a measure of flow in Bungalook Creek as it provides a better representation of the higher rainfall that occurs in the upper Bungalook Creek catchment, which drains the northern slopes of Mount Dandenong.

Table 11 Summary of climate

Month	Montrose (86076)		Dorset (86234)		Mount Dandenong (86243)	
	Monthly rainfall (mm)	Monthly Evaporation (mm)	Monthly rainfall (mm)	Monthly Evaporation (mm)	Monthly rainfall (mm)	Monthly Evaporation (mm)
January	57.9	173.1	53.2	178.0	66.2	167.4
February	57.1	140.6	50.9	144.7	67.5	134.6
March	57.8	117.5	48.4	121.5	71.2	112.1
April	78.7	70.4	71.4	73.6	91.2	65.3
May	84.7	45.4	70.8	47.9	93.0	40.8
June	97.1	33.0	79.5	35.2	116.9	28.6
July	86.4	38.5	70.8	40.9	98.4	34.3
August	100.7	53.8	80.9	56.6	133.6	49.1
September	93.8	74.0	79.7	77.0	116.0	69.2
October	85.6	103.05	80.2	109.05	108.8	99.3
November	88.7	126.9	81.5	131.2	110.6	120.1
December	79.7	158.4	74.0	164	91.8	151.5
Annual	**963.1**	**1126.1**	**841.4**	**1179.7**	**1165.2**	**1072.2**

Note:
1. Site elevation: Montrose: 170 m, Croydon (Dorset Golf): 114 m, Mt Dandenong: 600 m
2. Station location: Montrose -37.8021 E, 145.3679 N, Croydon -37.8054 E, 145.2987 N, Mt Dandenong -37.83 E 145.35 N
3. Based upon data from 1990 to 2022

5.3 Geology

5.3.1 Regional setting

A simplified stratigraphy has been summarised in Table 12. The oldest rocks in the region are lower Silurian age to lower Devonian age turbiditic sediments. These rocks are differentiated as the Melbourne Formation and comprise thinly to massively bedded mudstones, siltstones, sandstones and shales. The Melbourne Formation is mapped both to the east and west of the quarry. These indurated sediments are kilometres in thickness and form the geological basement.

Following their deposition, tectonic activity resulted in the folding of these sediments, which culminated in a period of igneous activity in the upper Devonian. During this period, a thick sequence of acid volcanics were extruded, and a variety of acidic rocks intruded. This igneous activity resulted in the contact metamorphism to the adjacent Silurian – Devonian sediments.

Table 12 *Stratigraphic summary*

Period	Stage	Representative formation	Lithological description	Comment
Quaternary			Undifferentiated alluvials, swamp, and colluvial deposits.	Alluvials mapped in present day drainage lines
	L	Newer Volcanics	Olivine basalts	Not present near quarry
Tertiary	U			
		Brighton Group	Sands, clays, silts	
	M	Newport Fm	Glauconitic and carbonaceous silts, clays, shelly sands and marls	
	L	Older Volcanics	Olivine basalts	
		Werribee Fm	Sands, silts, clays	
Unconformity				
Devonian	U	Mount Dandenong Volcanics Group	Acid extrusives and intrusives	Mount Evelyn Rhyodacite and Coldstream Rhyolite are mapped in the quarry
		Unconformity		
	L	Lilydale Lmst	Limestone, well bedded	Not present near quarry
		Humevale Fm	Massive to thinly bedded siltstones and greywackes	Mapped to the west of the quarry in the Bayswater and Croydon areas
Silurian	U	Melbourne Fm/Dargile Fm	Sandstones and interbedded siltstones and shales	Mapped in the Heathmont/Ringwood area, a few kilometres to the west of the quarry
	M to L	Anderson Creek Fm	Siltstones and interbedded sandstones (and metamorphics)	

Notes: U – Upper, M – Middle, L – Lower, Fm - Formation

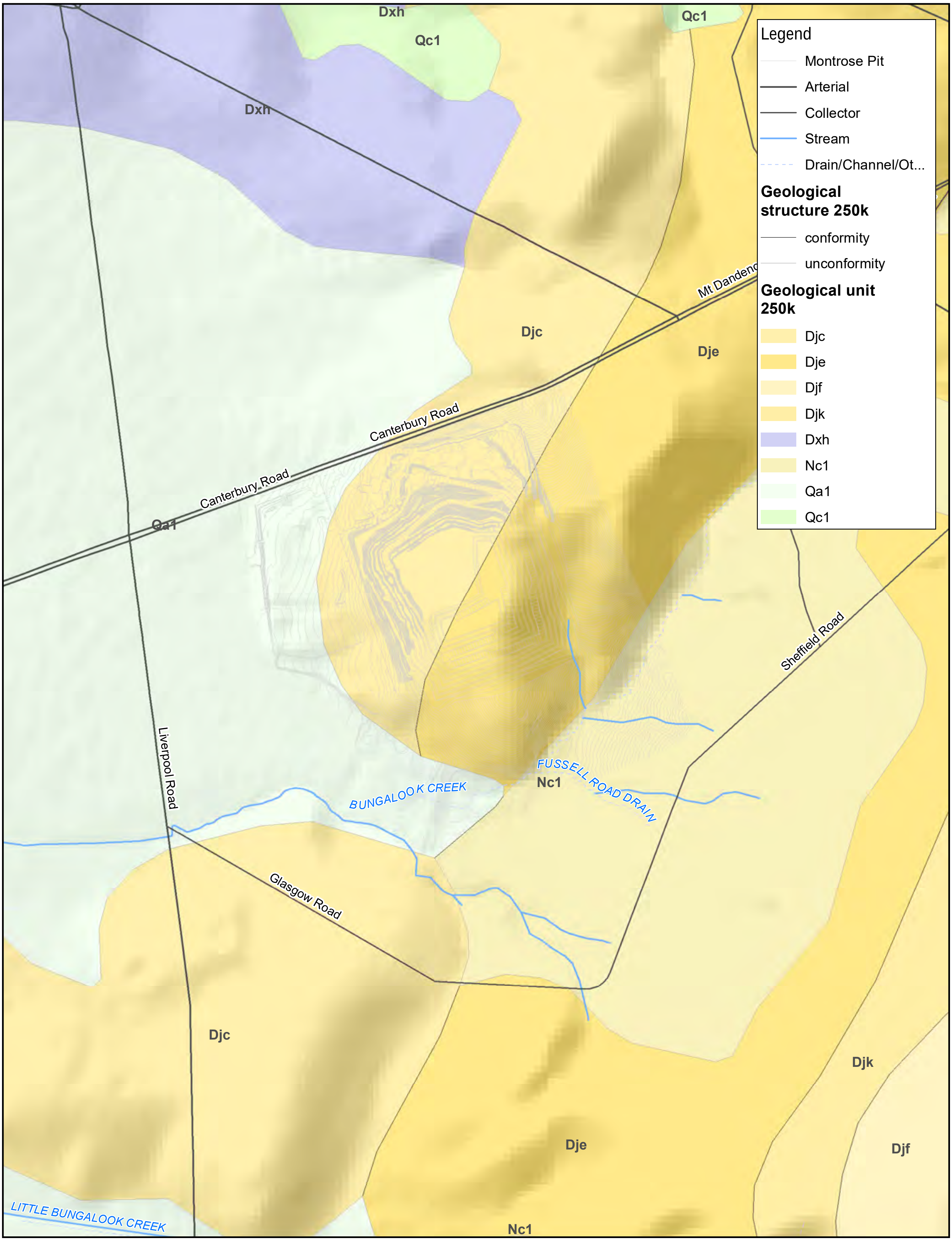
The Mount Dandenong Volcanics Complex has been differentiated into four formations, described from youngest to oldest:

- Ferny Creek Rhyodacite (Dfj)
- Kalorama Rhyodacite (Djk)
- Mount Evelyn Rhyodacite (Dje)
- Coldstream Rhyolite (Djc)

The complex forms a cauldron subsidence structure. These are inferred to be formed when the roof of the magma chamber collapses under the weight of the overlying extrusives. The Montrose Monocline, which is inferred to pass through the quarry (refer Figure 4) is a down-warp structure which defines the western margins of the subsidence cauldron.

The geological record following the Devonian age is not represented locally to the quarry. Between the Devonian and Triassic was a prolonged period of erosion. Further uplift and warping occurred during the Jurassic (VandenBerg 1970).

In the Quaternary age, alluvial sediments were deposited in the drainage lines within the ancestral basement topography. Although Cainozoic stratigraphy has been shown in Table 12, other than the alluvials, it is not well represented locally at the quarry.



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Geology Plan

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FIGURE 4

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Data source: VicMap Data, DELWP . Created by: lgomez

5.3.2 Quarry geology and structure

The surface geology has been shown in Figure 4 and a block diagram from the geological model developed to support the numerical groundwater model build (refer section 12) has been shown in Figure 5. Review of the Geological Survey of Victoria's 1:63,360 scale Ringwood map sheet indicates that the quarry is located on the southeast limb of an un-named anticline. Early-Mid Silurian Anderson Creek mudstones occupy the core of the fold with generally southeast-dipping, Devonian, Mount Dandenong Volcanics Complex felsic lavas and tuffs on limb of the fold. A geological contact within the Mt Dandenong Volcanics Complex passes through the quarry, aligned approximately southwest to northeast. The Coldstream Rhyolite lies to the west of the contact and the Mount Evelyn Rhyodacite is on the eastern side of the contact.

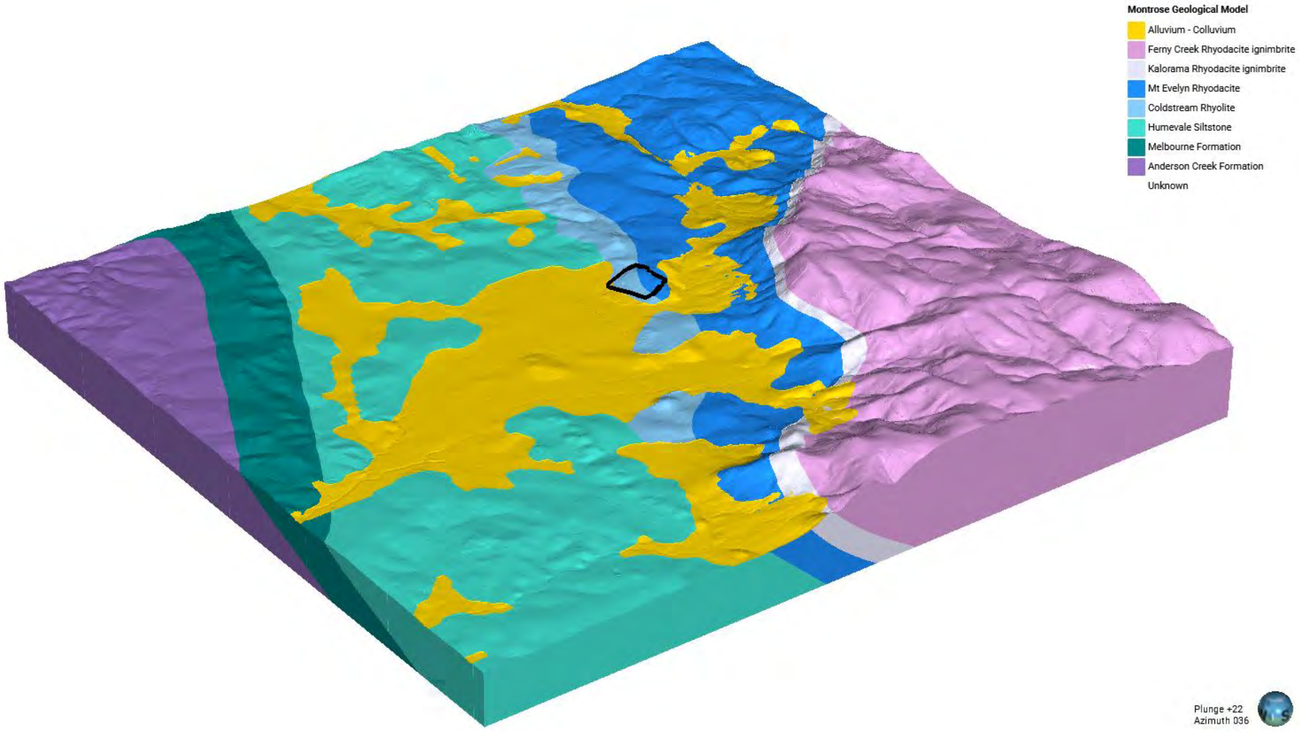

Figure 5 3D conceptualisation of the quarry geological setting

Some notable features were observed during a site visit on 11 January 2023 and these are described below. The locations visited during this site visit are indicated in Figure 6.

Parasitic folding and faulting in northeast corner of void

In the northeastern batter, the orientation of apparent stratification in the Mt Evelyn Rhyodacite appears to change, with strata dipping 50°to 60° to the northeast instead of moderately to the southeast as seen elsewhere (Figure 6). This gentle fold hosts a small fault in the north-east corner of the void, within the Mt Evelyn Rhyodacite. An oblique view of the fault is shown in Figure 7. The fault dips an average of 84° toward 176°. No slickensides were observed but the fault appears to be incipient only, with small normal displacement. It retains an immature configuration, with linking steep tensile failure surfaces and moderately dipping shear surfaces both obvious in outcrop.

Figure 6 ***Google Earth map view showing the location of observations and contacts as seen on 11 January 2023***

Note: The purple line is the contact between the Coldstream Rhyolite to the west and the Mt Evelyn Rhyodacite to the east. Red lines are faults and shears. Note the wide zone of faulting in the southwest corner of the quarry void.

Figure 7 ***Eastern fault in centre of image***

Note: The fault zone width is narrow but pinches and swells due to linkage of tensile and shear failure surfaces.

Slip along the shear surfaces has dilated sections of the fault, which contain a mixture of clay rich gouge and breccia. The feature currently acts as a preferential flow path for surface water down to the base of quarry. This has allowed for the erosion of the gouge within the feature and subsequent displacement of cobble sized blocks from within the disturbed zone.

Reference to this feature was not found in literature pertaining to the local geology, confirming outcrop indications that this fault is localised and unlikely to be of structural significance outside the quarry and immediate surrounds. This fault is probably a bending moment fault caused by stretching of the Rhyodacite around the outside of the fold's neutral surface. Overall, the fold is of local significance only (probably a small parasitic fold on the limb of the regional fold), as there is no regional change in the strike of the Mt Evelyn Rhyodacite or underlying units.

Southwest shear zone

A northeast dipping shear zone is developed in the southwest corner of the quarry (referred to as the southwest shear). It consists of a wide zone of anastomosing shears with individual orientations that dip 60° to 80° toward 8° to 30°. The zone is well exposed on the top bench in both the west and south walls, where it shows slickensides that plunge c.20° toward c.100° (ESE), suggesting that the fault has a strike slip sense of shear in its current orientation. It may have been folded or rotated since inception.

At lower RLs, the southwest shear is exposed in the southwest corner of the quarry haul road at RL70 m to RL 80 m, where it appears as a bench-scale triangular window, with similar shear orientations to the outcrops on the top bench (Figure 8). The full significance of the southwest shear is difficult to determine. However, the regional geology provides some clues. The outcrop width of the Coldstream Rhyolite increases dramatically to the south of the southwest shear and its dip increases, suggesting a significantly increased thickness. Geological maps suggest that the shear occurs at the point where hornfelsed Devonian siltstones are truncated, consistent with a fault that postdates intrusion of the volcanic source. The increased width of the Coldstream Rhyolite is created by an apparent dextral offset of its base and an apparent sinistral offset of its top surface. The fault may be part of a caldera margin, that changed sense from reverse in the early stages (presumably due to magmatic bulging), to normal in the later stages (deposition of the rhyodacite), presumably due to caldera subsidence. There are no thickness variations in the Kalorama (dacite) ignimbrite, suggesting that the shear was inactive by the time the ignimbrite draped the landscape.

Figure 8 *iPad photogrammetry of the southwest shear in the haul road*

Tuffaceous sediments

The tuffaceous layer presents as a small wedge near the surface between the Mt Evelyn Rhyodacite and the Coldstream Rhyolite. This tuffaceous layer is likely to be volcanigenic sediment deposited in thin bands from ash fall into a marine depositional environment (Geoscience Australia, ASU Database, 2021). This occurrence is observed intermittently upon the Mount Evelyn Rhyodacite. In general, the tuff is highly weathered, with weathering increasing to the surface with extensive rilling due to surficial erosion. Minor bedding was observed, and the absence of persistent defects was noted.

A very erosion prone unit with extensive veining is present on the south side of the southwest shear zone and has previously been described as a welded tuff. If this is the same tuff as seen between the Coldstream Rhyolite and Mt Evelyn Rhyodacite, it is either much thicker on the south of the fault or has been dragged there by dextral shear. It is not possible to differentiate these based on the poor-quality outcrop south of the southwest shear, but both dextral displacement and thickening to the south are consistent with the apparent offset of the base of the Coldstream Rhyolite based on regional geology, as described above.

5.4 Previous studies

The quarry was subject to a previous hydrogeological impact assessment (Golder 2006) which considered a similar southwards expansion. This works resulted in the first series of investigations that characterised the hydrogeological setting of the quarry and included:

- Field investigations
  - Establishment of a monitoring bore network
  - Limited groundwater sampling
  - Aquifer slug testing and infiltration testing
  - Inspection of Bungalook Creek
- Pit lake water balance modelling
- Saturated and unsaturated zone modelling

A numerical groundwater model was constructed and calibrated. The results from the modelling:

- Identified that the (2 m) drawdown extending from the expanded quarry would be generally within a 1 km radius of the quarry
- No privately owned groundwater users would be impacted by the quarry expansion
- Reductions in seepage of groundwater to Bungalook Creek
- Groundwater inflows into the pit would rise from 3.5 L/s (2006) to 5 L/s and to 12 L/s for the proposed expansion

The most sensitive impact arising from the expansion is the risk of reductions in baseflow, and available soil moisture for water loving plants. To mitigate the risk of adverse impact, it was recommended that groundwater recharge be undertaken.

Data and findings from this work has been used in this assessment and referenced where appropriate.

6. Surface water

6.1 Data sources

Information in this section has been derived from:

- Previous reports
- Bureau of Meteorology Water Data Online (**http://www.bom.gov.au/waterdata/**)
- SILO point climate data (**https://longpaddock.qld.gov.au/silo/point-data/**)

6.2 Waterways

There are three nearby named waterways that in the vicinity of the quarry (refer Figure 9). The nearest waterway to the quarry is Bungalook Creek, which flows in a westerly direction to its confluence with Dandenong Creek. Taralla Creek flows in a south-westerly direction to the north of Bungalook Creek and joins Bungalook Creek just upstream of its confluence with Dandenong Creek.

Bungalook Creek drains the northern slopes of Mount Dandenong and lies on the southern boundary of the Work Plan area. The creek commences further north east of the quarry near Aileen Avenue just south of Montrose Reserve and flows west and southwest towards the quarry. Small tributaries join Bungalook Creek, draining the northwestern facing slopes of Mount Dandenong. Its catchment includes urbanised and peri-urban areas. The dominant land use within the catchment is urban, but some areas are used for grazing and industrial land uses. The creek flows for around 13 km before ultimately confluences with Dandenong Creek approximately 7 km to the west – southwest of the quarry in Heathmont (Ecological Engineering 2007).

The Bungalook Creek flow record from gauge 228369A at Fussell Road Retarding Basin indicates typical daily flow rates ranging from around 0.1 ML/day to 30 ML/day, with a maximum recorded flow of around 250 ML/day (refer Figure 10 and Figure 11). During dry periods, the flow rate typically falls below the gauge threshold of around 0.1 ML/d, indicating generally limited groundwater baseflow contribution. This is supported by the field observations during dry periods, both in the past (limited to no flow in January 1998 and November 2002) and recently (December 2022 and February 2023).

Paper Size ISO A4

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Site Location and Waterways

Project No. **31-1270927**
Revision No. **A**
Date. **11/05/2023**

FIGURE **9**

Document Path:
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Print Date:

Data Source:

Created By: Eliza Karlson

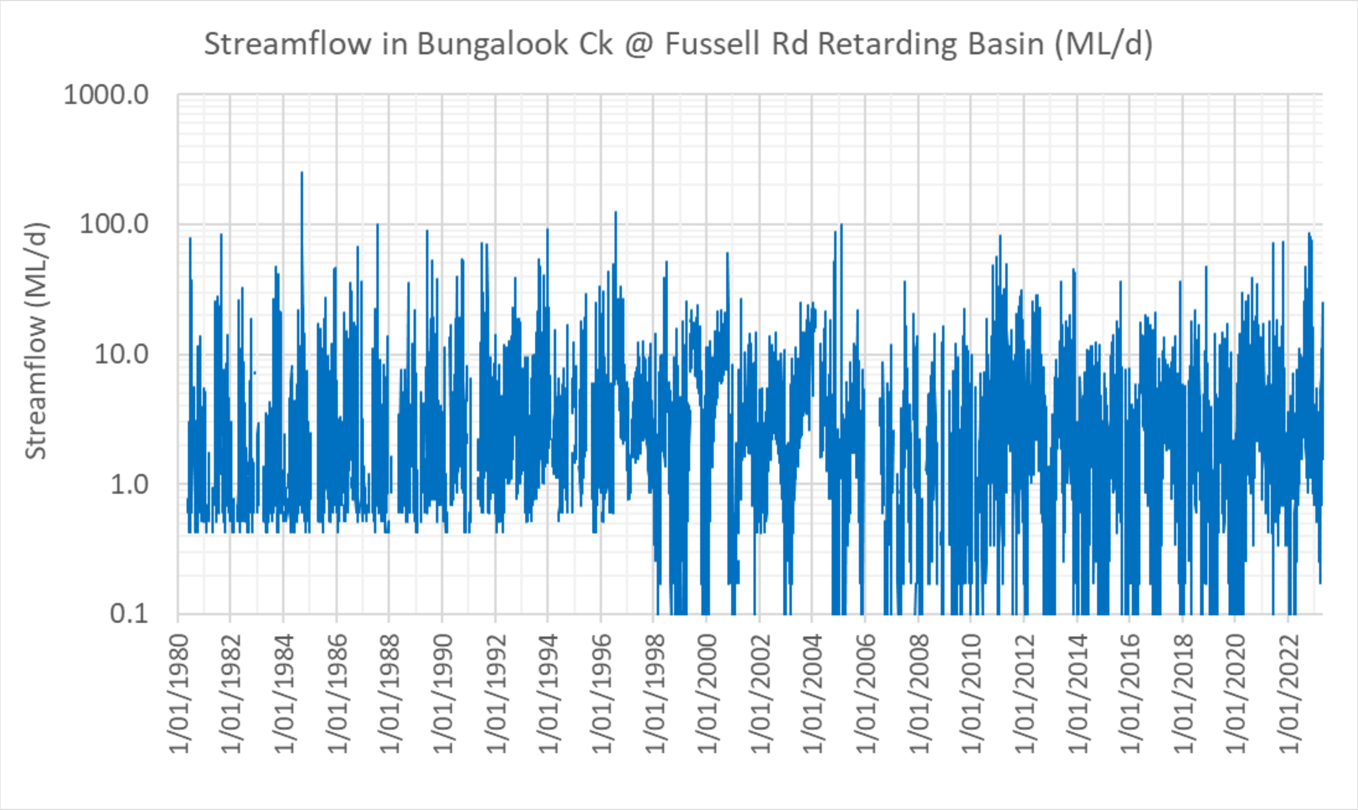


Figure 10 ***Bungalook Creek discharge (Gauge 228369A)***

Source: BOM **http://www.bom.gov.au/waterdata/**

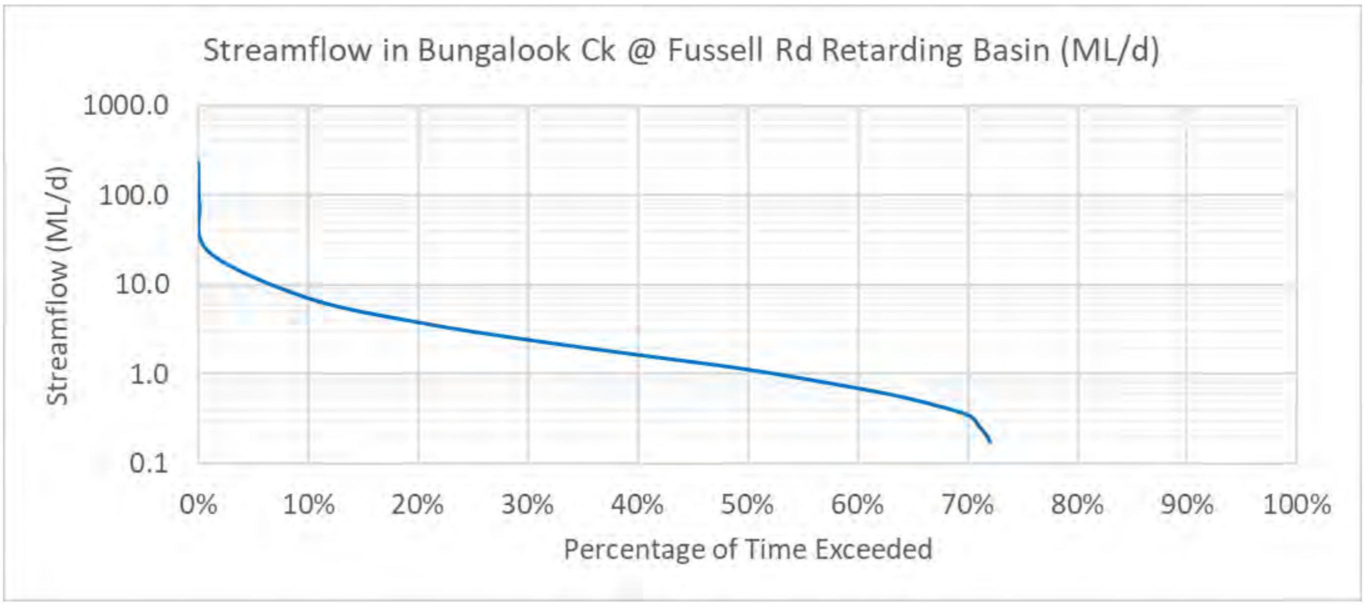


Figure 11 ***Bungalook Creek flow duration curve (Gauge 228369A)***

Source: BOM **http://www.bom.gov.au/waterdata/**

A comparison of annual Bungalook Creek flow against annual rainfall at Mt Dandenong is provided in Figure 12, based on a catchment area of 5.8 km^2. This shows that the annual factor between rainfall and runoff is typically between 0.05 and 0.2, with wet years such as 2011 and 2022 having a factor of 0.2 and dry years such as 1982 having a factor of 0.05. The year with the lowest flow was 2006, with a factor of 0.03. It is noted that there were a number of years in the late 1990s and early 2000s (e.g., 2000) where the streamflow appeared to be disproportionately high compared to the rainfall, and there is some uncertainty regarding the measured streamflow in these years.

A comparison of average monthly Bungalook Creek flow against rainfall at Mt Dandenong is provided in Figure 13. This shows that the month with the minimum streamflow is February, the month with the minimum rainfall is March, and the month with the lowest monthly runoff coefficient is March.

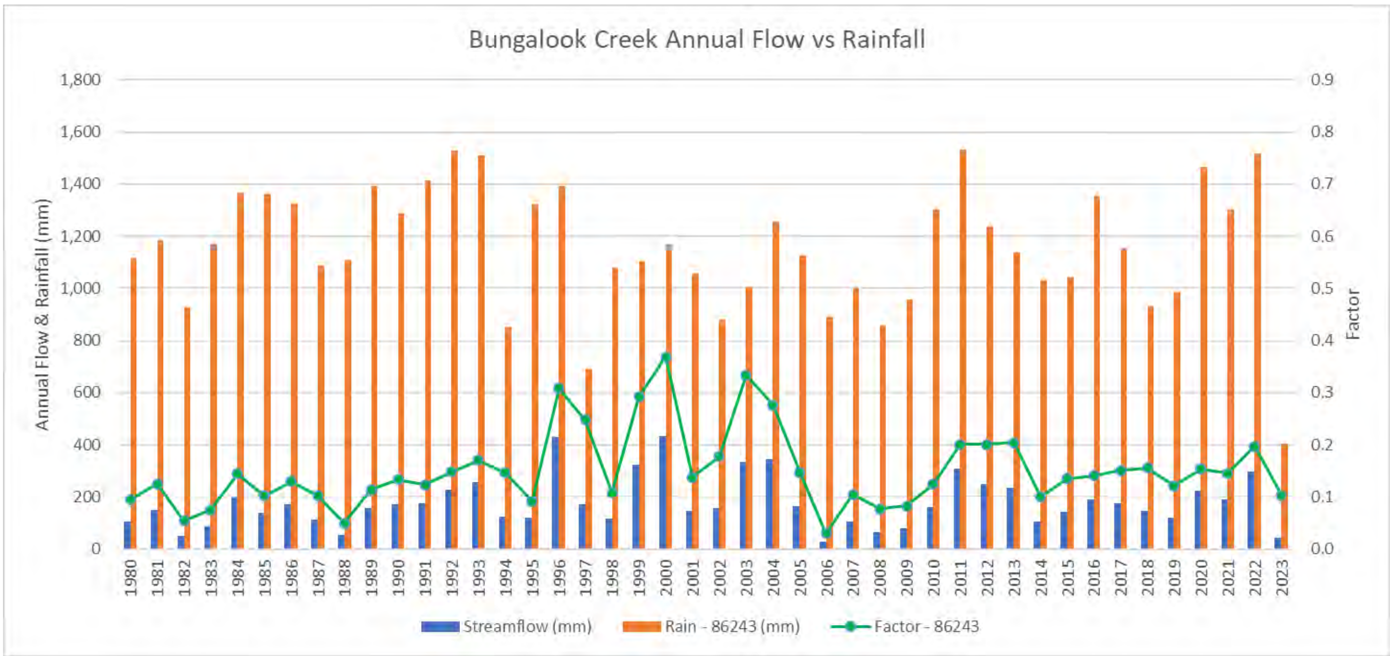


Figure 12 ***Comparison of Annual Flow (228369A) and Rainfall (86243)***

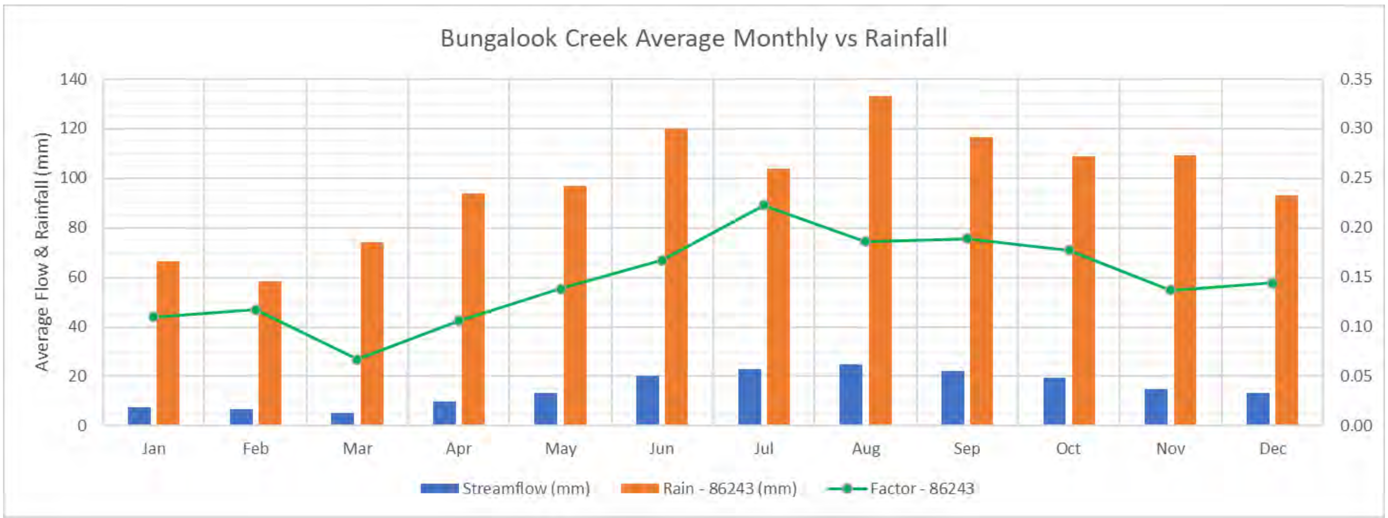


Figure 13 ***Comparison of Average Monthly Flow (228369A) and Rainfall (86243)***

Ecological Associates (2007) suggested that surface runoff can fully provide the observed streamflow and that groundwater influence is not significant (and potentially non-existent) during March. During the late summer and early autumn dry periods, flow in the creek can cease.

Ecological Associates (2007) noted that prior to urbanisation the creek is likely to have been ephemeral. However, with increased urbanisation, the creek appears to be moving towards a perennial system as a result of contributions from impervious connected areas within the catchment. The changing hydrological regime of Bungalook Creek is critical when considering potential impacts to the creek from the quarry, with development in the upper catchment leading to an effective increase in streamflow over time.

According to Golder (2006), a typical baseflow between 1980 and 1996 (a wet period prior to the Millennium Drought) was estimated to be in the range of 4 L/s to 5 L/s, although there is low confidence in this estimate due to the low baseflow contributions at or below the threshold of accuracy of the flow gauge. Ecological Engineering (2007) suggested that owing to the regional nature of the Golder (2006) model, actual flows are suspected as being less than that predicted by the modelling. Examination of baseflows was undertaken by GHD and discussed later in the report.

6.3 Catchments

A desktop assessment has been undertaken to consider surface water drainage and catchments within and around the Boral Montrose quarry area. The assessment has been carried out with a review of existing elevation, interpretation of flow paths and available flood mapping data within the existing and proposed quarry sites and surrounding area. The assessment included the use of various (publicly available) data sources:

- Previous reports
- Google maps satellite and road imagery
- VicPlan water course and water area overlays
- VicPlan contours
- Victoria Flood Database flood extents

The Bungalook Creek catchment above the Fussell Rd Retarding Basin has an area of around 5.8 km^2 (580 ha) (Ecological Engineering, 2007b) while the quarry pit area is around 38 ha and the process area around 8.5 ha (Ecological Engineering, 2007a). A map of the catchments and existing quarry is presented in Figure 14, while the same map with proposed quarry expansion is presented in Figure 15.

Ecological Engineering (2007a) reported that rainwater falling on the 38 ha quarry pit will collect at its base. Modelling was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC, with the quarry surface assumed to be fully impervious. Continuous three hour rainfall data from Croydon (station 86234) from 1985 to 1995 was used in the model. The model indicated that approximately 291 ML/year of rainfall will collect in the base of the quarry.

The process area is approximately 8.5 ha, and was assumed to be fully impervious (Ecological Engineering (2007a). MUSIC modelling using Fussell Road rainfall data indicates that the mean annual runoff from this area will be approximately 65 ML. This runoff is currently directed to a 385 m^3 sedimentation basin that removes coarse sediment. The runoff is then either pumped into the quarry pit to dilute the groundwater there, or when the pump rate is exceeded, discharged directly to the Fussell Road stormwater drain.

For the 10 year period 1985 to 1995 adopted for the MUSIC modelling, average annual streamflow in Bungalook Creek at the Fussell Road RB was 901 ML.

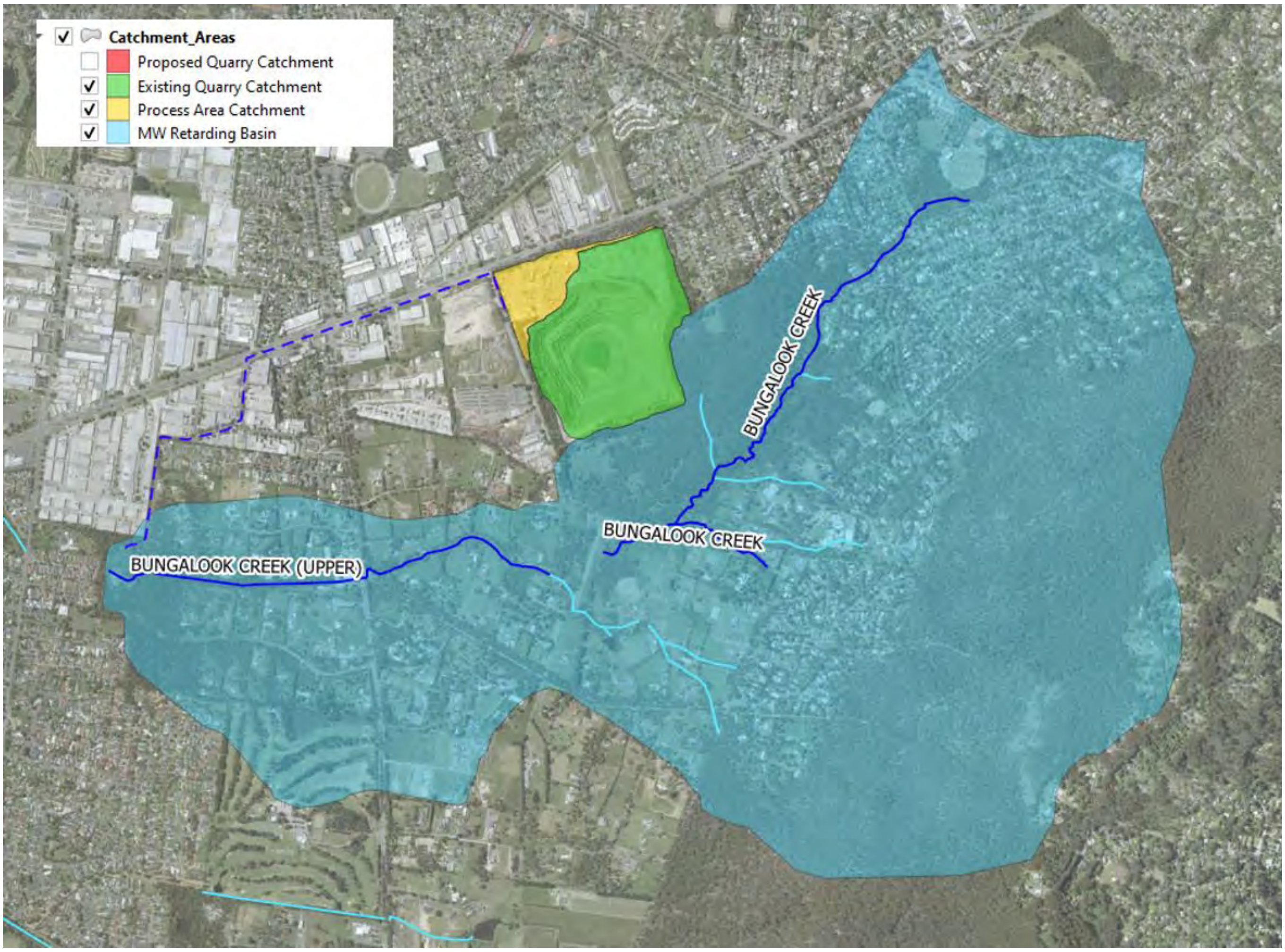


Figure 14 *Catchment plan and waterways (existing)*

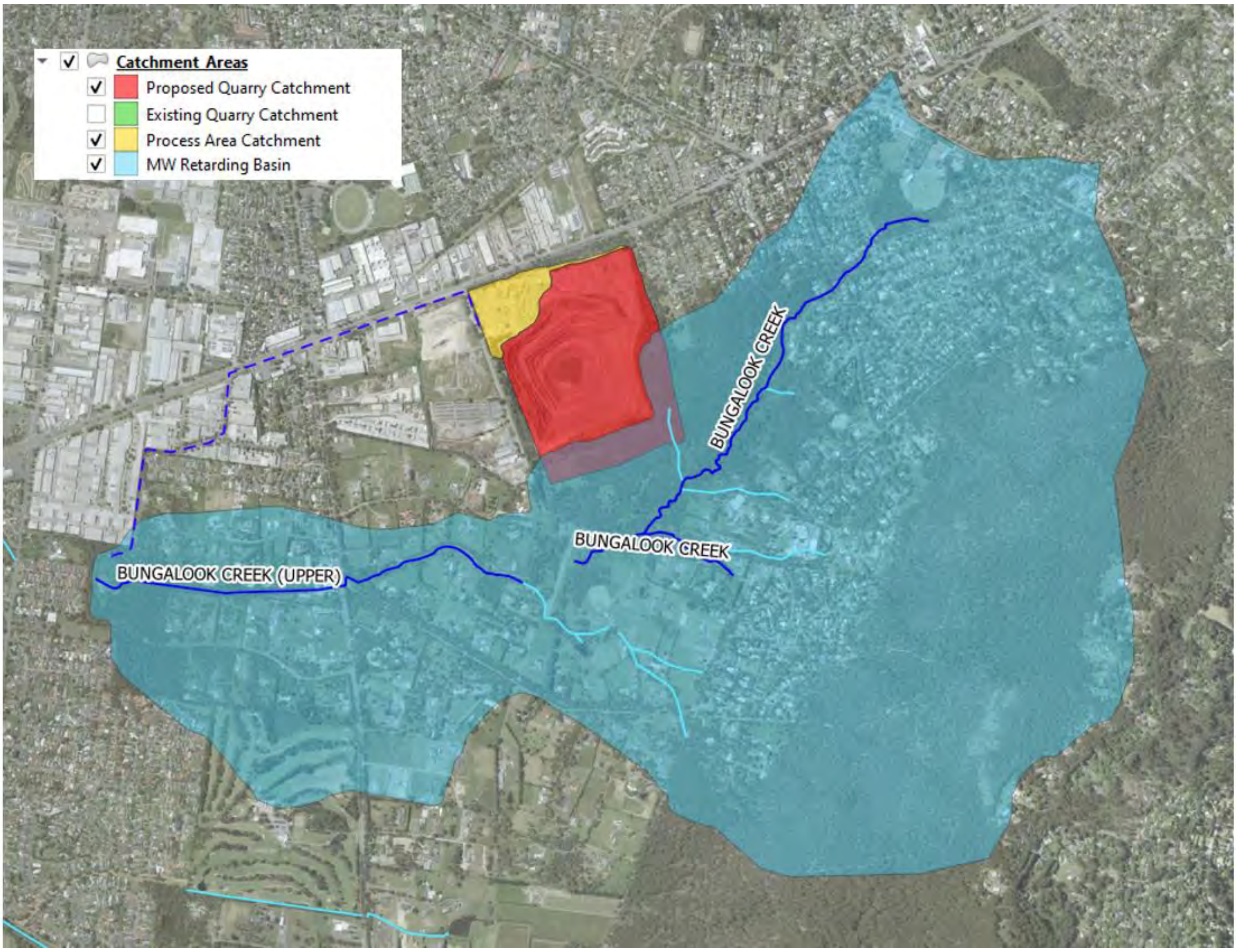


Figure 15 *Catchment plan and waterways (proposed)*

The existing catchment area of the quarry that discharges water to the sump in the middle of the quarry is approximately 0.34 km^2. The process area of the catchment which is located in the top left corner of the existing site boundary is approximately 0.07 km^2. The estimated catchment for the Melbourne Water Retarding Basin downstream of Bungalook Creek is 6.86 km^2.

The proposed quarry area catchment is estimated to be 0.4 4km^2 and will reduce the Bungalook Creek catchment by 0.1 km^2.

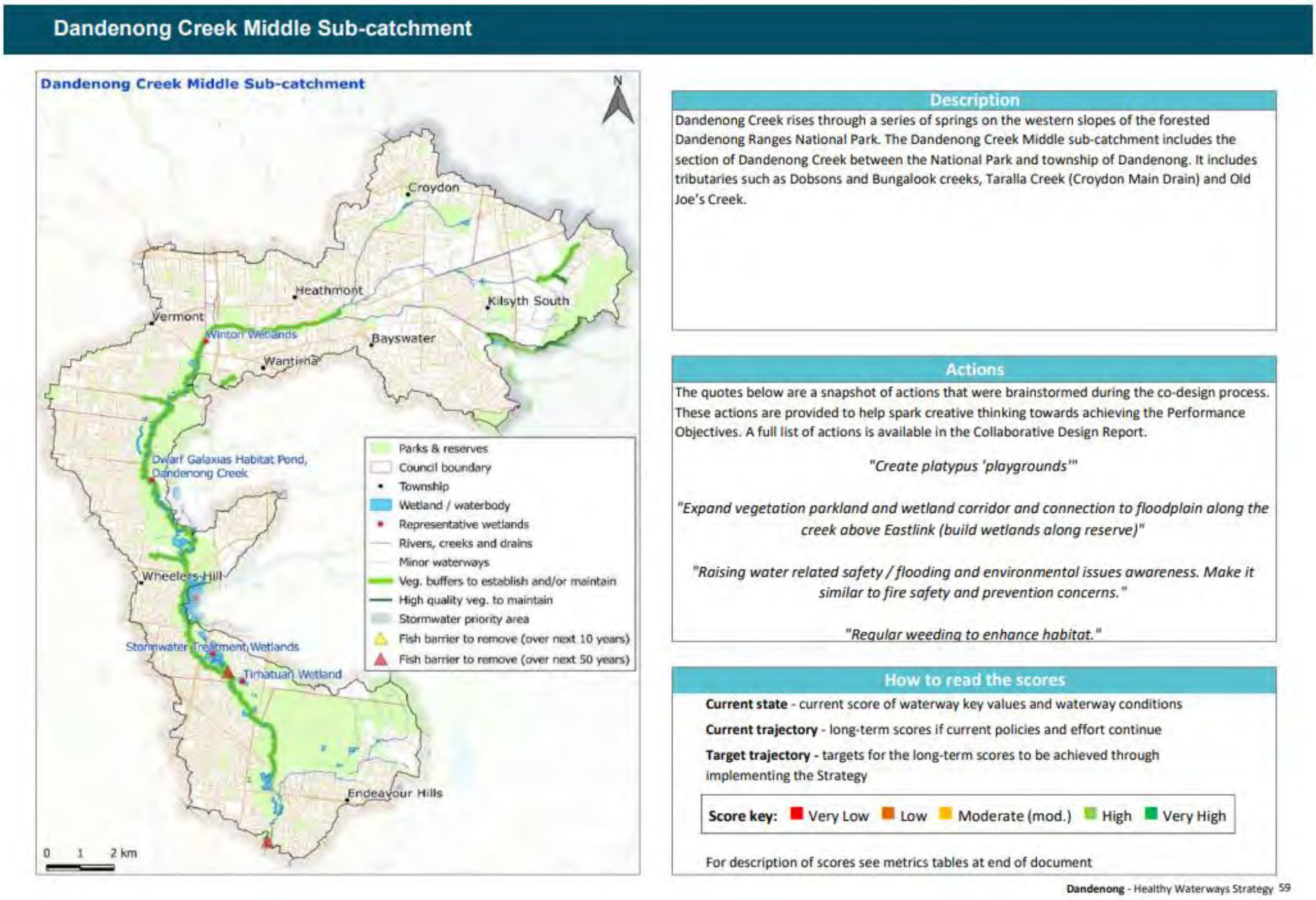
6.3.1 Index of stream condition

No waterways in the Dandenong Creek catchment have been included in the State-wide assessment of river condition undertaken in Victoria since 1999 using the Index of Stream Condition (ISC).

6.3.2 Healthy Waterway Strategy

The Healthy Waterways Strategy 2018-28 sets a long-term vision for managing the health of rivers, wetlands and estuaries in the Port Phillip and Westernport region, in order to protect and improve their value to the community. The Strategy was developed by Melbourne Water in partnership with State and local government, water corporations and the community and brings together scientific and stakeholder knowledge in a single, comprehensive framework for the region's five major catchments: Werribee, Maribyrnong, Yarra, Dandenong and Westernport. For each catchment, the strategy provides detailed, catchment-specific visions, goals, long-term targets (10 to 50 years), and 10-year performance objectives. Effort and investment at catchment and sub-catchment levels are prioritised and aligned to ensure they contribute to broader, regional goals and outcomes. (Melbourne Water, 2018a).

Bungalook Creek is located in the Dandenong Creek Middle Sub-Catchment, with performance objectives documented in the *Co-Designed Catchment Program for the Dandenong Catchment Region* (Melbourne Water, 2018b). A summary of the sub-catchment is presented in Figure 16.



Dandenong Creek Middle Sub-catchment

Description

Dandenong Creek rises through a series of springs on the western slopes of the forested Dandenong Ranges National Park. The Dandenong Creek Middle sub-catchment includes the section of Dandenong Creek between the National Park and township of Dandenong. It includes tributaries such as Dobsons and Bungalook creeks, Taralla Creek (Croydon Main Drain) and Old Joe's Creek.

Actions

The quotes below are a snapshot of actions that were brainstormed during the co-design process. These actions are provided to help spark creative thinking towards achieving the Performance Objectives. A full list of actions is available in the Collaborative Design Report.

"Create platypus 'playgrounds'"

"Expand vegetation parkland and wetland corridor and connection to floodplain along the creek above Eastlink (build wetlands along reserve)"

"Raising water related safety / flooding and environmental issues awareness. Make it similar to fire safety and prevention concerns."

"Regular weeding to enhance habitat."

How to read the scores

Current state - current score of waterway key values and waterway conditions

Current trajectory - long-term scores if current policies and effort continue

Target trajectory - targets for the long-term scores to be achieved through implementing the Strategy

Score key: 🟥 Very Low 🟧 Low 🟨 Moderate (mod.) 🟩 High 🟩 Very High

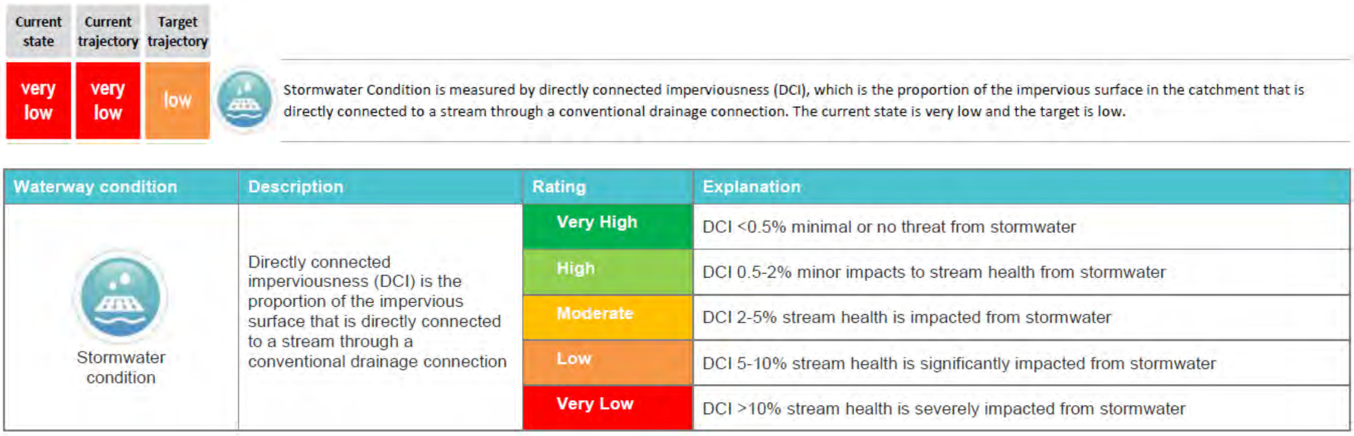
For description of scores see metrics tables at end of document

Dandenong - Healthy Waterways Strategy 59

Figure 16 Dandenong Middle Creek Sub-Catchment

Source: Melbourne Water (2018b)

The waterway conditions targets (10+ year) for the Healthy Waterway Strategy include a Stormwater Condition target, which is measured by directly connected imperviousness (DCI). The stormwater condition target for the Dandenong Creek Middle Sub-Catchment is presented in Figure 17 below, which shows that the current state is very low (DCI > 10%) and the target is low (DCI 5-10%). This highlights that the catchment is highly modified, with the waterways effectively acting as stormwater drains, and reinforces the changing hydrological regime of Bungalook Creek as development in the upper catchment leads to an effective increase in streamflow over time.



Current state	Current trajectory	Target trajectory
very low	very low	low

Stormwater Condition is measured by directly connected imperviousness (DCI), which is the proportion of the impervious surface in the catchment that is directly connected to a stream through a conventional drainage connection. The current state is very low and the target is low.

Waterway condition	Description	Rating	Explanation
Stormwater condition	Directly connected imperviousness (DCI) is the proportion of the impervious surface that is directly connected to a stream through a conventional drainage connection	Very High	DCI <0.5% minimal or no threat from stormwater
		High	DCI 0.5-2% minor impacts to stream health from stormwater
		Moderate	DCI 2-5% stream health is impacted from stormwater
		Low	DCI 5-10% stream health is significantly impacted from stormwater
		Very Low	DCI >10% stream health is severely impacted from stormwater

Figure 17 Stormwater condition target for Dandenong Creek Middle Sub-Catchment

6.3.3 Ramsar sites

No Ramsar sites were identified within the study area. The nearest Ramsar site is Edithvale-Seaford Wetlands which is located approximately 35 km southwest of the Boral Montrose quarry site.

6.4 Floodplain management

There are no local LSIOs (land subject to inundation overlay) or FOs (flood overlay) within the area. However, the Melbourne Water 1 in 100 year flood extent indicates that flooding from the small segment of Bungalook Creek in the southeast area of the site boundary does extend within the proposed quarry area.

6.5 Water quality monitoring

6.5.1 Quarry sump

Boral (2022) notes that visual checks are carried out on water to be discharged from the site, and if water is muddy and contains a high level of suspended solids, it will not be discharged. Boral (2022) also notes that an external supplier Scaada conducts regular water quality monitoring, with water quality reports provided to Boral.

6.5.2 Downstream waterway

Ecological Engineering (2007a) noted that the closest downstream water quality monitoring station was Dandenong Creek at Boronia Road Wantirna, shown in Figure 18 below. It can be seen that the monitoring station is located well downstream of the quarry and has a significantly greater catchment area of 6,900 ha, compared to the 900 ha for the catchment where the quarry discharges to Bungalook Creek. The mean annual runoff is also considerably higher (30,200 ML vs. 8,940 ML).

Water quality monitoring data from the station for the period July 1996 to September 2006 was presented in Ecological Engineering (2007a), refer Figure 19. Given the size of the monitoring catchment and other industrial land uses within the catchment, it would be preferable to have a water quality monitoring station closer to the quarry discharge point to measure the impact on water quality attributable to the quarry discharge.

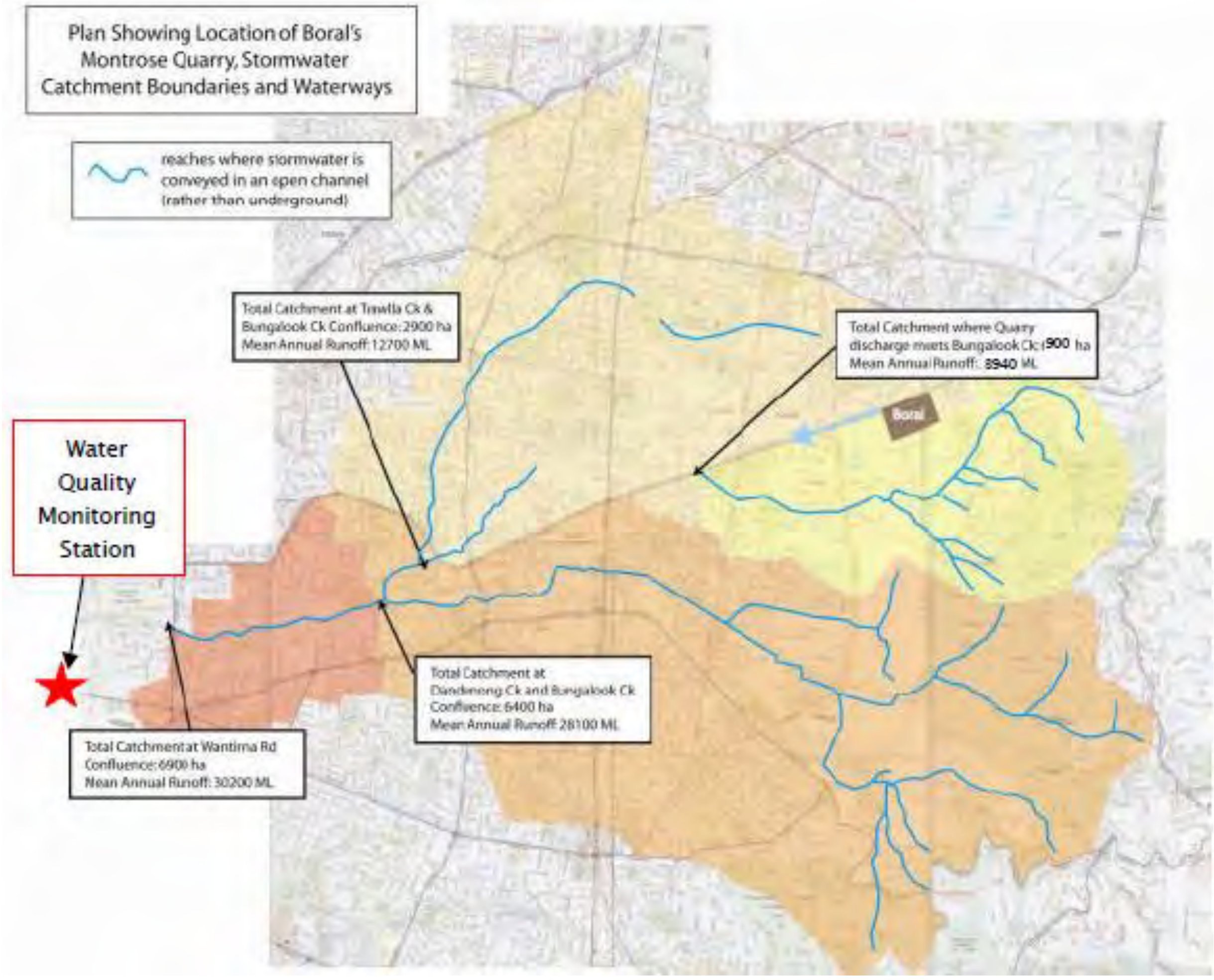


Figure 18 *Location of water quality monitoring station relative to quarry*

Source: Ecological Engineering (2007a)

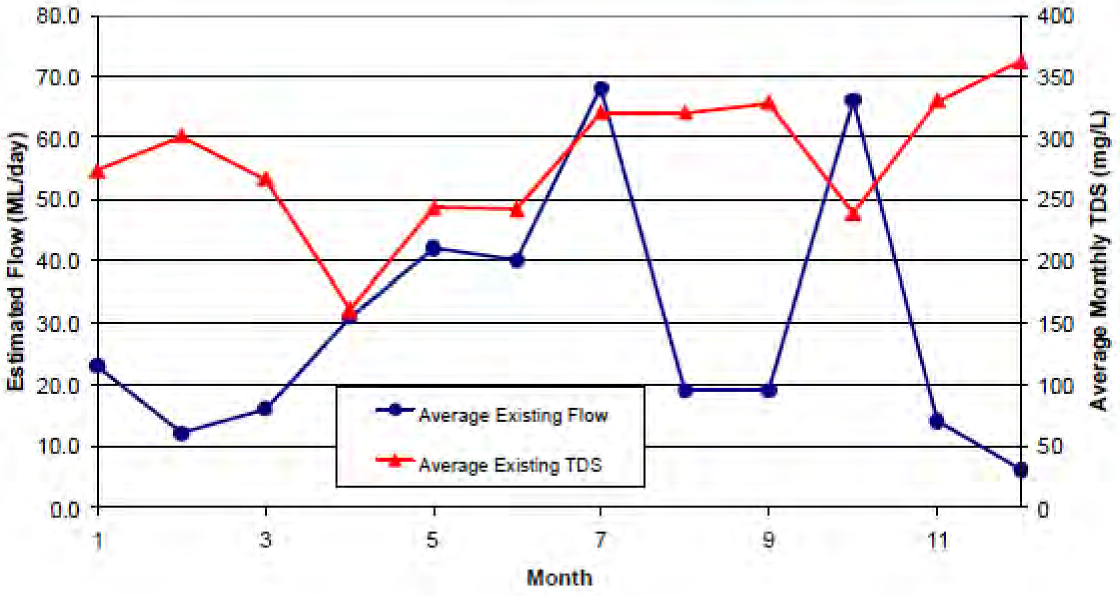


Figure 19 *Average salinity and flow for Dandenong Creek at Boronia Road, Wantirna*

Source: Ecological Engineering (2007a)

7. Hydrogeology

7.1 Aquifers

All of the geologies described previous constitute aquifers where they are saturated. The aquifers present at the quarry are described as follows:

- – Alluvial sediments, where saturated, laterally restricted to the present day drainage lines
- – Mount Dandenong Volcanics Complex (MDVC):
  - The MDCV have been differentiated locally into the Mount Evelyn Rhyodacite and the Coldstream Rhyolite. Hydrogeologically, these rocks are considered to have similar properties and have been grouped into a single fractured rock aquifer system, referred to as the MDVC aquifer

It is noted that the MDCV have intruded through the consolidated Silurian sediments (refer Table 12). These sediments, comprising siltstones, sandstones and mudstones, are a regional aquifer system, although they are not present locally at the quarry.

7.2 Neighbouring groundwater use

7.2.1 Data limitations

A search of DEECA's WMIS database was completed to identify groundwater bores in the area and characterise groundwater use near the proposed site.

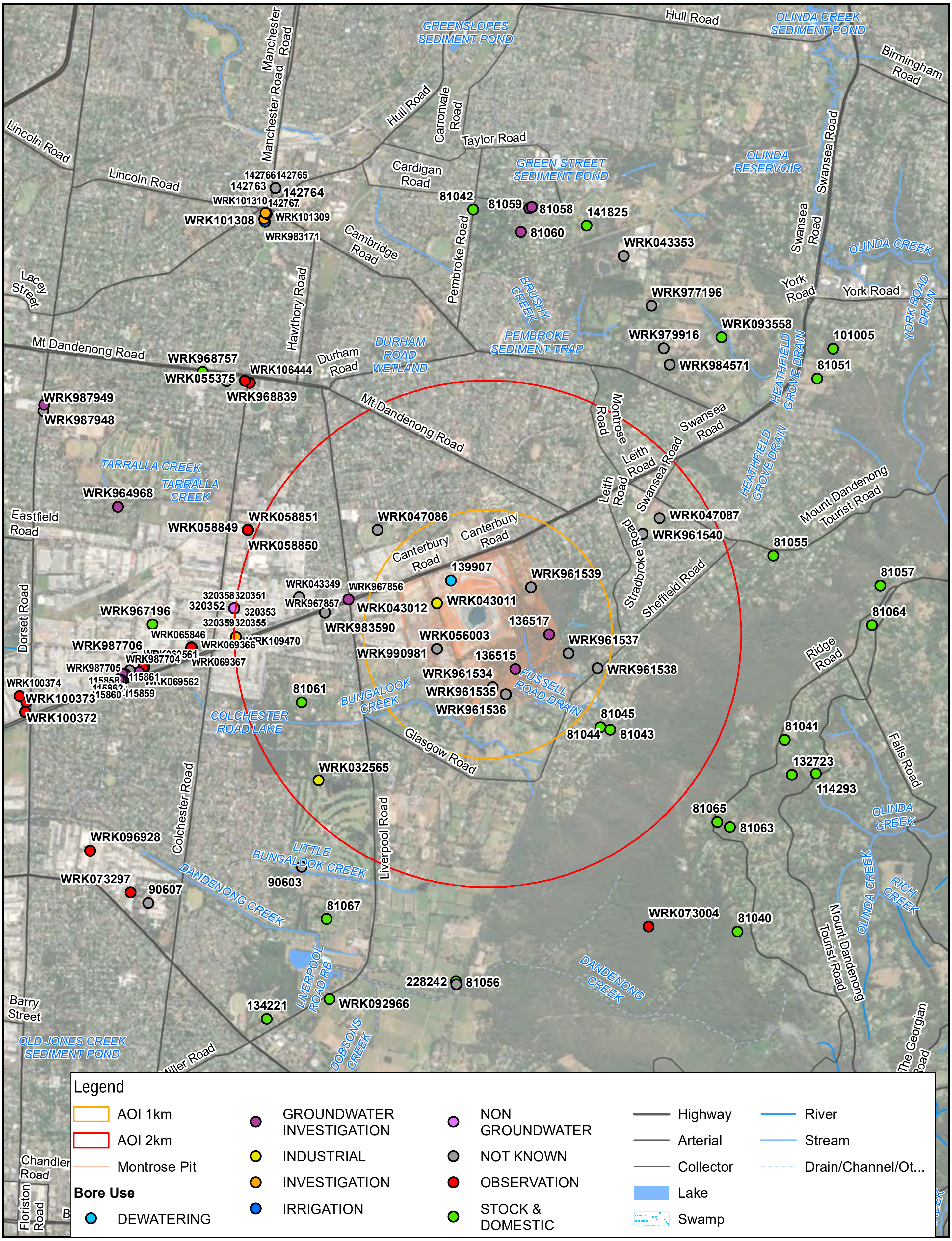
The following comments are made regarding the WMIS data:

- – 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
- – WMIS does not provide information regarding the operation status of the bores
- – Bores installed without a bore construction licence are unlikely to be registered on WMIS (unless detected by later audits)
- – Many bores have not been surveyed for location. Bore locations 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 the bore completion reports submitted by drilling contractors
- – Information registered on 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 WMIS, e.g., pump setting depth and bore ownership

7.2.2 Bore use

A total of 112 bores were identified on the WMIS based upon an approximate 5 km radial search from the centre of the quarry. A breakdown of bore use by radial distance from the quarry is provided in Table 13 and the bore locations are shown in Figure 20. The dewatering bore, bore 139907 falls within the quarry boundary.

A summary of the bore information has been presented in Appendix E.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

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MONTROSE QUARRY

Neighbouring bores

Project No.	31-1270927
Revision No.	B
Date	28/04/2023

FIGURE 5

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Print date: 28 Apr 2023 - 18:02

Data source: VicMap Data, DELWP Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: lgomez

Table 13 ***Neighbouring bore use***

Bore use	**Radial distance from centre of quarry**					**Total**
	1000 m	**1,001 – 2,000**	**2,001 – 3,000**	**3,001 – 4,000**	**4,001 – 5,000**	
Domestic/Stock (DM ST)	3	5	9	4	4	25
Dewatering (DW)		1				1
Industrial (IN)		4				4
Irrigation (IR)					1	1
Investigation (IV)	1	2	1	10	12	26
Non Groundwater (NG)			9			9
Not known (NKN)	5	3	6	7	3	24
Observation (OB)		1	11	7	3	22
Subtotal	9	16	36	28	23	112

The majority of bores have been installed for groundwater investigation purposes. These bores are likely associated with contaminated land investigations undertaken in the urbanised areas surrounding the quarry.

7.2.3 Bore depths

A histogram of bore depths has been provided in Figure 21 which indicates the majority of neighbouring bores are less than 30 m depth, and most less than 10 m depth. As noted above, this is likely a reflection of the investigation bores installed to intersect the water table.

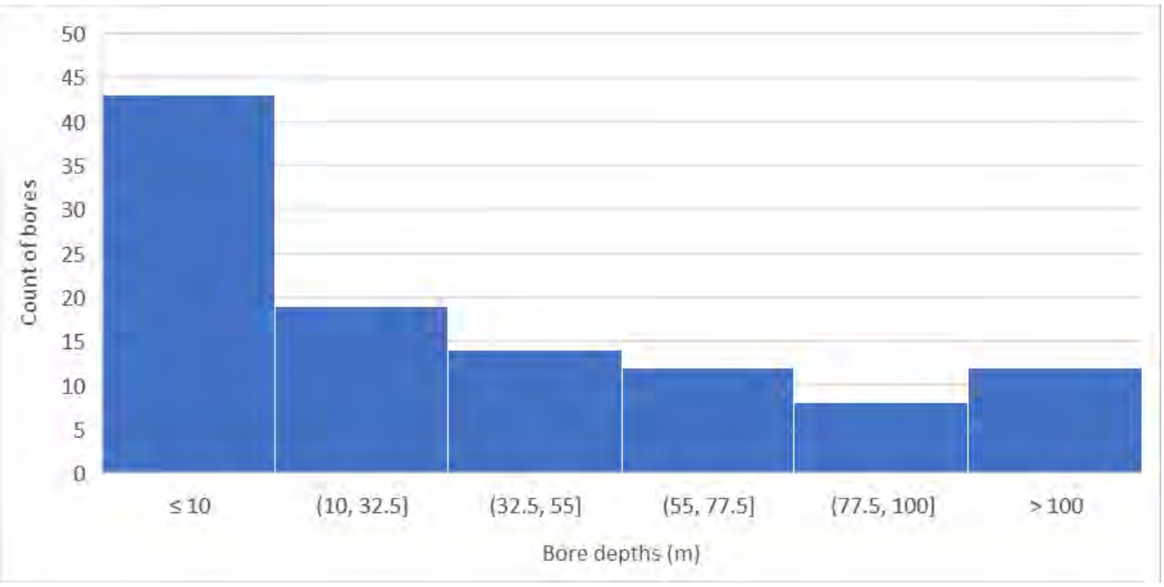


Figure 21 ***Neighbouring bore depths***

7.2.4 Yields

There is a paucity of groundwater bore information in the general region, but the MDVC is generally expected to be a relatively low yielding aquifer, with bores typically ranging between <0.2 L/s and 2 L/s.

Available data from the bores identified within the search radius has been summarised in Table 14.

Table 14 ***Neighbouring bore yield information***

Statistic	Value
Count	21
Minimum	0.17 L/s
Maximum	5 L/s
Average	1.56 L/s
Geometric Mean	1.08 L/s

7.3 Monitoring network

7.3.1 State Observation bores

A search was undertaken to identify State Observation Network (SON) bores near the quarry as these can have extensive time-series water level monitoring data. There are no SON bores within a 5 km radius of the quarry.

A number of investigation and observation bores were identified on the WMIS; however, time-series groundwater level information was not available for these private bores.

7.3.2 Boral monitoring

Golder (2006) document three phases of monitoring bore installations in 1998, 2003 and 2004. A summary of the monitoring bore construction is provided in Table 15 and the monitoring bore lithological logs and construction information has been attached as Appendix F. The monitoring bore locations are shown in Figure 22.

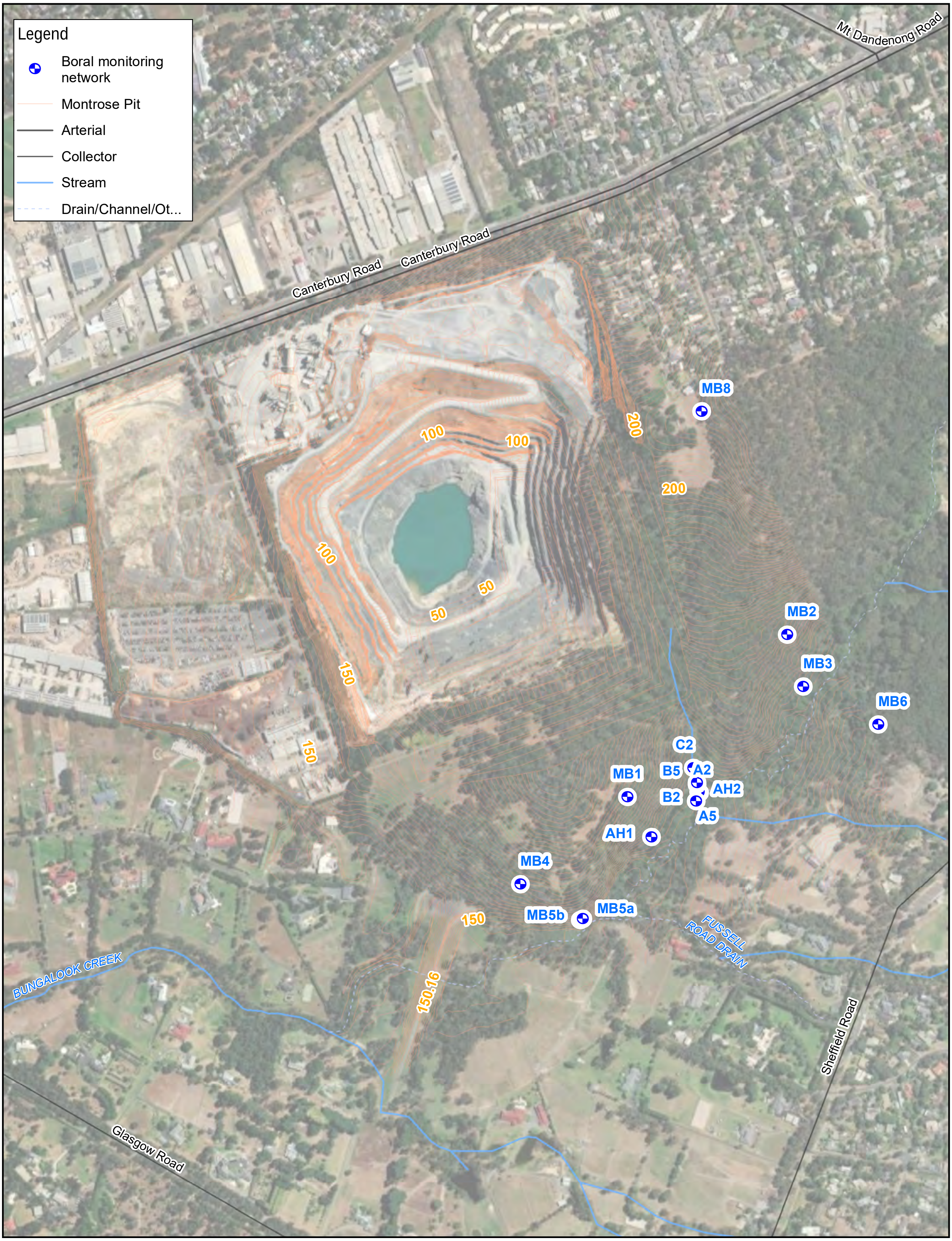
Monitoring bores have been sited principally around the southern and eastern parts of the quarry, and along Bungalook Creek. The bores nearest the quarry intersect the fractured rock aquifers, and in some cases have very deep water levels, which is not unexpected given the elevated topography in some parts of the study area. Monitoring bores were also installed near Bungalook Creek. Interpreted geological sections (from Golder (2006) have been attached as Appendix D.

The monitoring bores were briefly monitored in the mid-2000s, however, since this period there has been no active water level monitoring undertaken.

Table 15 Summary of existing monitoring bores

Bore ID	Date completed	AMG66		GDA94		RL TOC (m AHD)	Total depth (m)	Screen			Diameter (mm)	Screened lithology
		Easting	Northing	Easting	Northing			From	To	Length		
MB1	Feb 1998	353078	5812291	353190	5812474	169.08	65.5	5.3	6.5	1.2	35	Sand
								59.5	65.5	6	50	Rhyodacite
MB2	Feb 1998	353349	5812566	353461	5812749	171.69	70.5	3.1	4.1	1	35	Silty CLAY
								64.5	70	6	50	Rhyodacite
MB3	Feb 1998	353376	5812478	353488	5812661	158.51	8.3	5.0	8.3	3.3		Silty CLAY
MB4	Oct 2003	352896	5812143	353008	5812326	161.63	100.0	90	99	9	50	Rhyodacite
MB5a	Oct 2003	352998	5812082	353110	5812265	151.86	60.0	54	60	6	50	Rhyodacite
MB5b		353002	5812084	353114	5812267	152.16	5.0	3	5	2		Rhyodacite
MB6	Oct 2003	353503	5812414	353615	5812597	167.62	67.5	61.5	67.5	6	50	Rhyodacite
MB7	Oct 2003	353736	5812294	353848	5812477	190.66	50.0	44	50	6	50	Rhyodacite
MB8	Oct 2003	353204	5812945	353316	5813128	212.70	130.0	121	130	9	50	Rhyodacite
MB9	Oct 2003	354099	5813374	354211	5813557	181.34	49.0	46	49	3	50	Rhyodacite
AH1	1998	353118	5812223.2	353230	5812406	150.92	1.86	1.36	1.56	0.5	25	Sandy CLAY
AH2	1998	353194	5812228	353306	5812411	150.88	1.75	1.25	1.75	0.5	25	Sandy CLAY
A2	18/10/04	353200.48	5812298.05	353312.5	5812481	153.50	3.1	1.5	3	1.5	50	Clayey SAND
A5	18/10/04	353198.69	5182299.44	353310.7	5182482	153.51	8.0	6.0	8.0	2	50	SAND
B2	19/10/04	353195.84	5812312.30	353307.8	5812495	154.19	3.0	1.5	3.0	1.5	50	Clayey SAND
B5	19/10/04	353195.83	5812315.07	353307.8	5812498	154.30	8.0	6.0	8.0	2	50	Rhyodacite
C2	19/10/04	353189.07	5812339.88	353301.1	5812523	155.76	12.0	10.0	12.0	2	50	Rhyodacite

Note:
Bores MB1 to MB3 assumed relative to AMG66
Bores A2 – C2 Relative to AMG66. Add 112 m to easting and 183 m to northing to convert to GDA94
Golder (2006) initially indicates A1 was an installation (p9) but subsequently refer to A2



Paper Size ISO A4

0 0.06 0.12 0.18 0.24

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Boral Resources (Vic) Pty Limited
MONTROSE QUARRY

Boral monitoring network

Project No. 31-1270927
Revision No. A
Date 28/04/2023

FIGURE 8

\\ghdnet\ghd\AU\Traralgon\Projects\31\12570927\GIS\Maps\Working\31_12570927_08_Boral_Monitoring_Network.mxd
Print date: 01 May 2023 - 09:36

Data source: VicMap Data, DELWP Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: lgomez

7.3.3 Monitoring bore condition

Boral is in the process of implementing a groundwater monitoring program for the quarry. As part of the current investigations, GHD inspected the headworks of the existing bores, and completed a water level gauging event. The total bore was measured during site visitation, however, no internal survey of the bore condition were completed. Copies of monitoring bore headworks inspection records have been attached as Appendix H.

Table 16 Monitoring bore depths

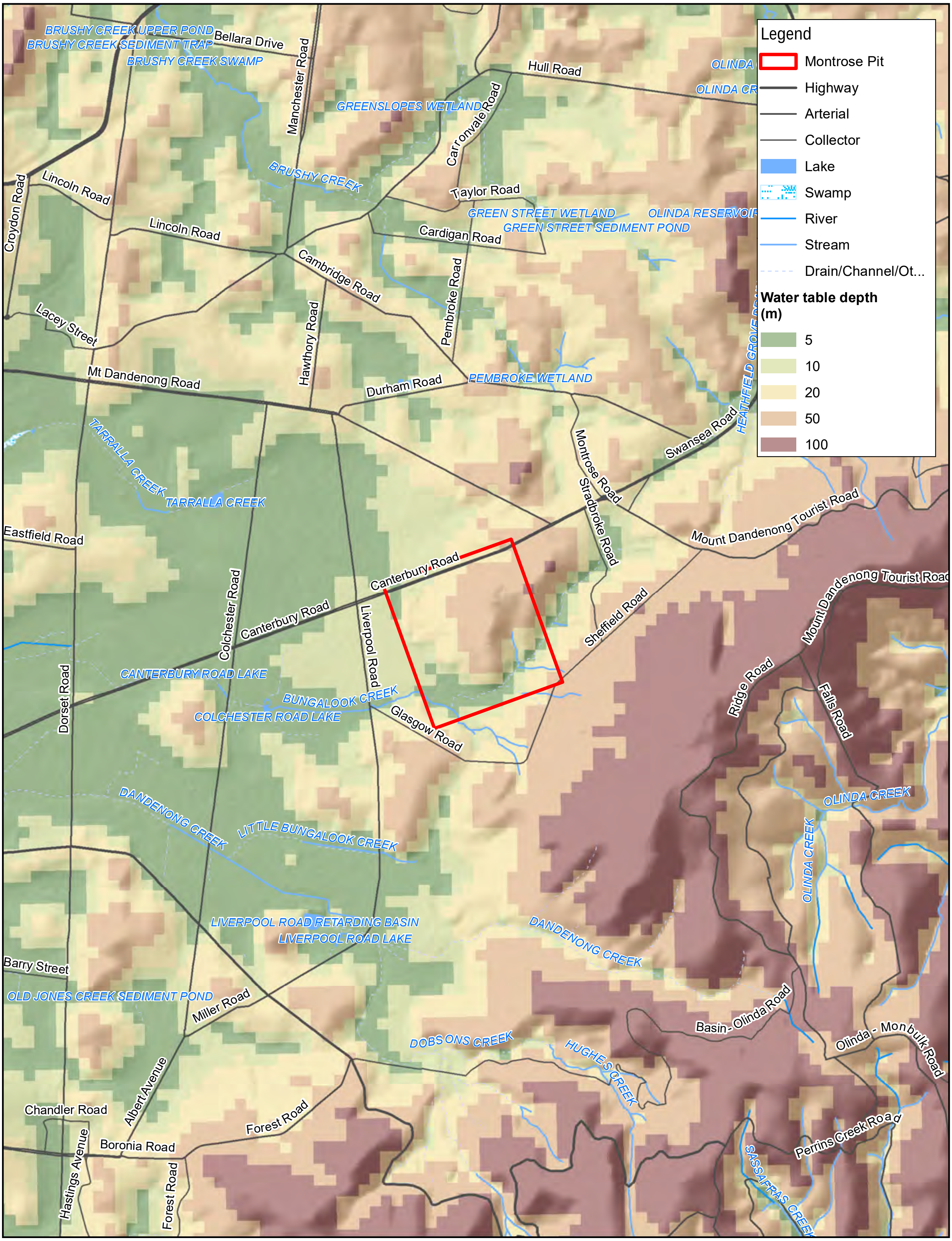
Bore ID	Bore depth (m)		Comment
	As constructed	Measured 2023	
MB01a	6.5	5.3	
MB01b	65.5	64	
MB02a	4.1	3.75	
MB02b	70.5	72.4	
MB03	8.3	8.54	
MB04	100	100	
MB05			Not found. Located close to the intersection of two tracks. Large fallen tree in this area, but no evidence of the monitoring bore.
MB06	67.5	68	Gatic
MB07	50		Not found In this area it is understood that significant improvements have been made to the road reserve. Suspected that the bore has been destroyed.
MB08	130	133	
MB09	181.3		Not found Located within recreation reserve, however, no obvious evidence of gatic cover identified.
A5	8	8.8	
A2	3.1	3.7	
B2	3.0	3.44	
B5	8.0	8.9	
AH1	1.86	1.8	
AH2	1.75		Not found
C2	12	12.8	

7.4 Groundwater potentiometry

7.4.1 Regional mapping

Regional depth to water table indicates groundwater levels less than 5 m depth along Bungalook Creek and in the suburbs to the west of Liverpool Road (approximately 0.5 km to the west of the western boundary of the landfill). Groundwater levels are interpreted to be greater than 10 m east and north of the quarry. The depth to water mapping is shown in Figure 23.

As topography rises towards the east and Mount Dandenong, groundwater level become considerably deeper and potentially greater than 50 m below the surface.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Boral Resources (Vic) Pty Limited
MONTROSE QUARRY

Depth to Water

Project No.	31-1270927
Revision No.	A
Date	21/04/2023

FIGURE 23

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Print date: 28 Apr 2023 - 18:08

Data source: VicMap Data, DELWP . Created by: lgomez

7.4.2 Site specific monitoring

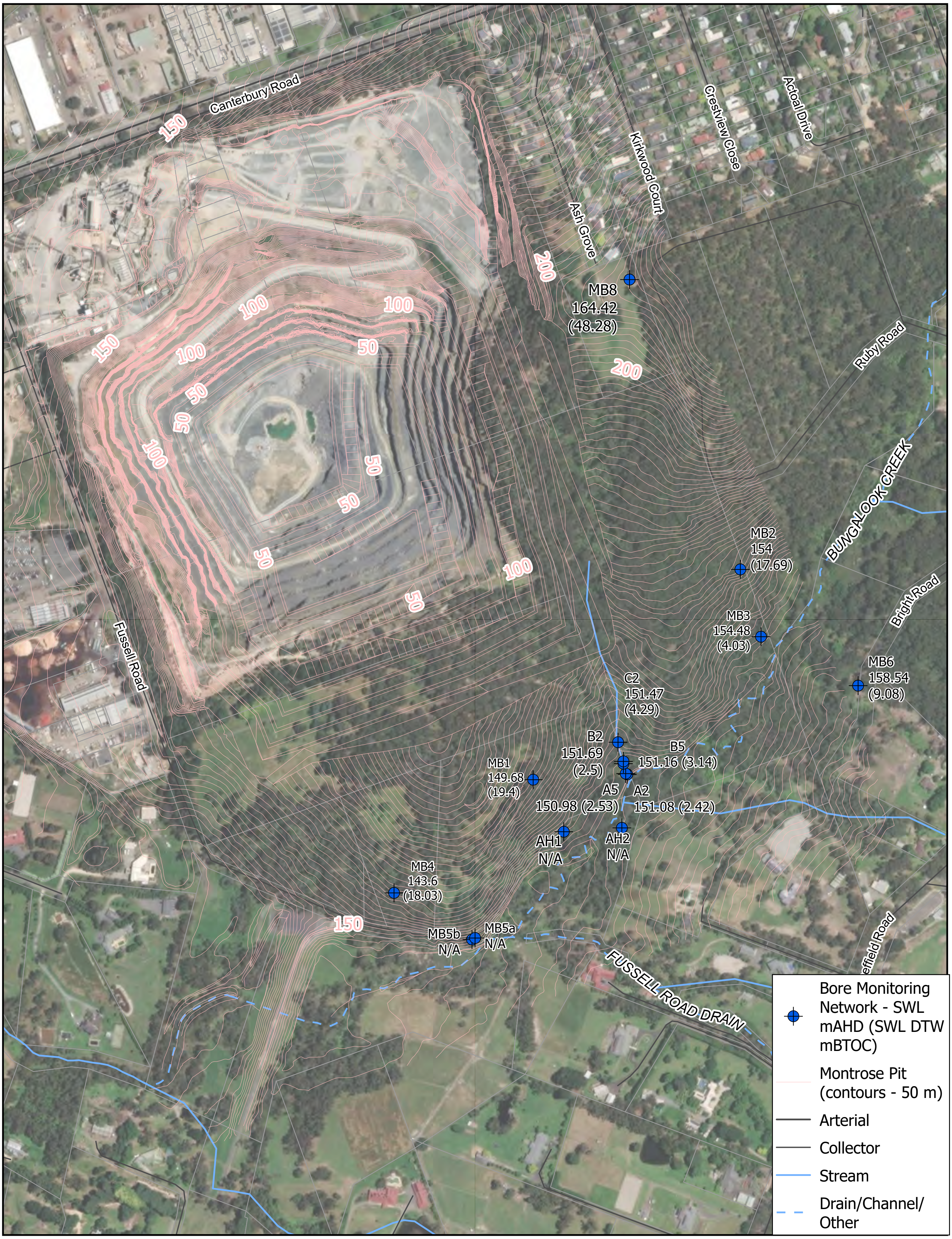
Available time-series water level information has been attached as Appendix G. A number of the bores have multiple water level readings; however, these were collected between 1998 and 2004. Many of the monitoring bores were exhibiting a recovering groundwater level response early in their monitoring records. The latest readings were collected in late 2022 and early 2023 by GHD, representing an approximate 19 year gap in the monitoring record. The available monitoring record for the network has been summarised in Appendix G, which includes the difference in reduced water levels from the reading last collected in 2004, and the most recent water level measurement (where available). A negative difference indicates that groundwater levels are deeper than they were in 2004, and a positive difference indicates reduced water levels are shallower. Noting that 2022 was had above average rainfall, there has not been a significant decrease in reduced groundwater levels over the 19 year period of continued quarry operation.

Groundwater level monitoring is proposed to be implemented moving forward to obtain a better understanding of the seasonal groundwater level behaviour.

Groundwater levels in site monitoring bores in early 2023 has been shown in Figure 24. Both relative groundwater levels and depth to water have been shown. Figure 25 presents interpreted groundwater contours for early 2023. The inferred groundwater flow direction is south west, i.e., downstream along Bungalook Creek.

Table 17 Boral Monitoring Network current condition

Bore ID	Number of readings	Difference in reduced water level between 2004 and 2023	Comment
MB01	15	1.23	
MB02a	17	0.66	
MB02b			
MB03	16	0.14	
MB04	11		
MB05	11		MB5a and MB5b had 11 readings. Nested bore site not identified in 2022.
MB06	14	0.57	
MB07	12	N/A	Bore not identified – possibly destroyed
MB08	12	1.62	
MB09	11	N/A	Bore not identified – possibly destroyed
A5	3	-0.05	
A2	3	-0.18	
B2	3	-0.12	
B5	3	0.67	
C2	3	-0.69	



Paper Size ISO A4

0 75 150 225 300

Meters

N

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

Boral

Montrose Quarry

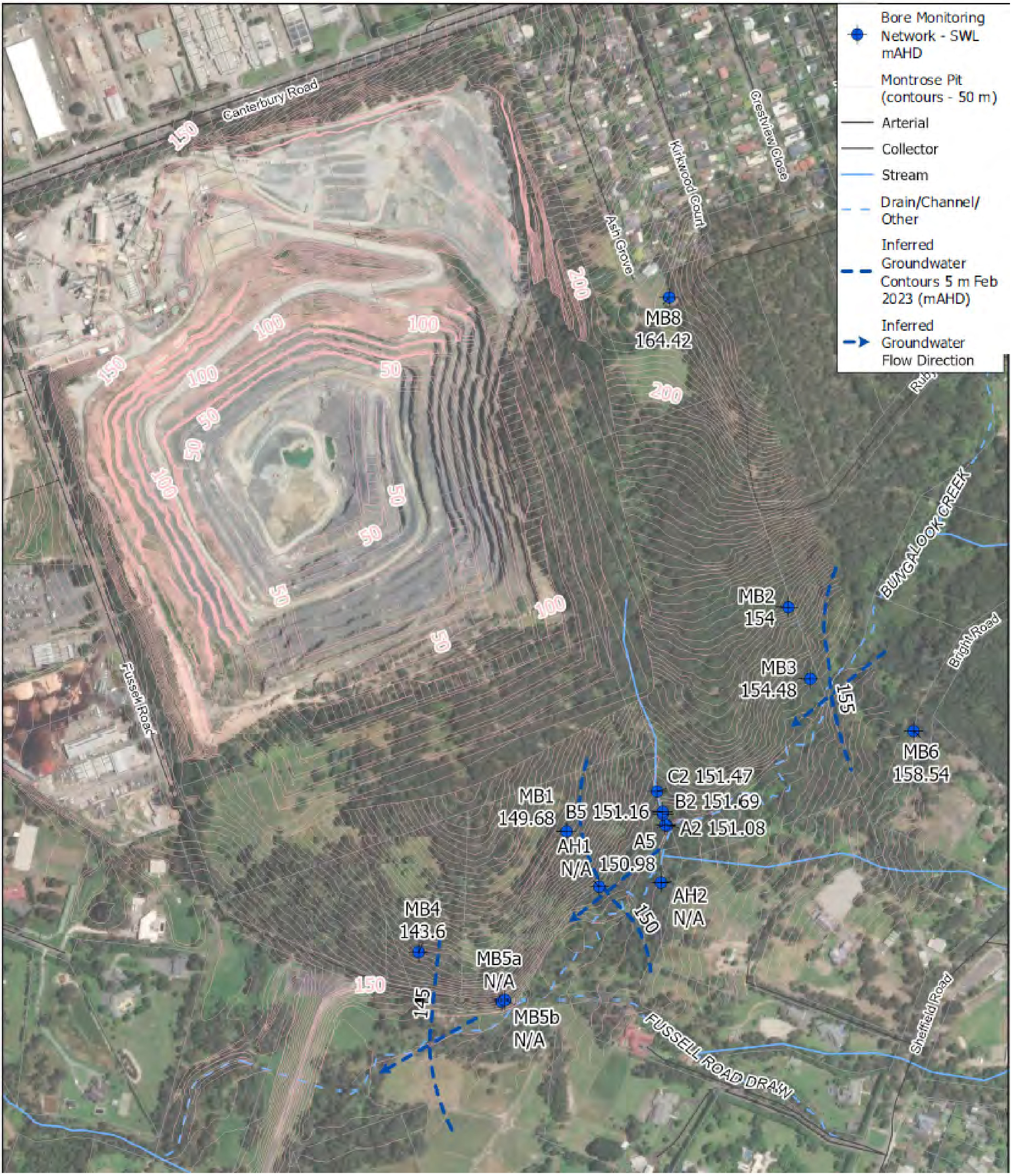
Boral Monitoring Network
Standing Water Levels - Feb 2023

Project No.	**12570927**
Revision No.	**A**
Date	**14/02/2025**

FIGURE 24

\\ghdnet\ghd\AU\Melbourne\Projects\31\12621218\GIS\Maps\Working\12621218_Montrose_GW_Monitoring\12621218_Montrose_GW_Monitoring.aprx - Map 1
Print date: 14 Feb 2025 - 10:16

Data source: World Imagery: Maxar. VicMap, 2024. GHD, 2023. Boral, 2023. Created by: lgreen



Paper Size ISO A4

75 150 225 300

Meters

N

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

Boral

Montrose Quarry

Inferred Groundwater Contour Map
Feb 2023

Project No.	12570927
Revision No.	A
Date	25/02/2025

FIGURE 25

\\ghdnet\ghd\AU\Melbourne\Projects\31\12621218\GIS\Maps\Working\12621218_Montrose_GW_Monitoring\12621218_Montrose_GW_Monitoring.aprx - Map 2
Print date: 25 Feb 2025 - 13:13

Data source: World Imagery: Maxar, VicMap, 2024; GHD, 2023; Boral, 2023. Created by: lgreen

7.5 Groundwater quality

7.5.1 Background groundwater quality

Neighbouring bores on DEECA WMIS

There was limited salinity information available for those bores identified on the DEECA WMIS. A summary of the available data has been provided in Table 18.

Table 18 WMIS bore salinity information

Bore	Conductivity (µS/cm)	Total Dissolved Solids (mg/L)
81040	130	
81043	943	
81044	830	
81045	845	
81056	1100	643.1
81057	650	409.1
81058	780	
81061	3600	1986.2
114293	110	
132723	18	150

DEECA mapping generally places the MDVC as having salinities less than 1,000 mg/L TDS in the higher topography areas of the Dandenong Ranges. The groundwater quality is interpreted as becoming brackish at the lower elevations and flatter topographies (refer Figure 26).

Boral Groundwater monitoring network

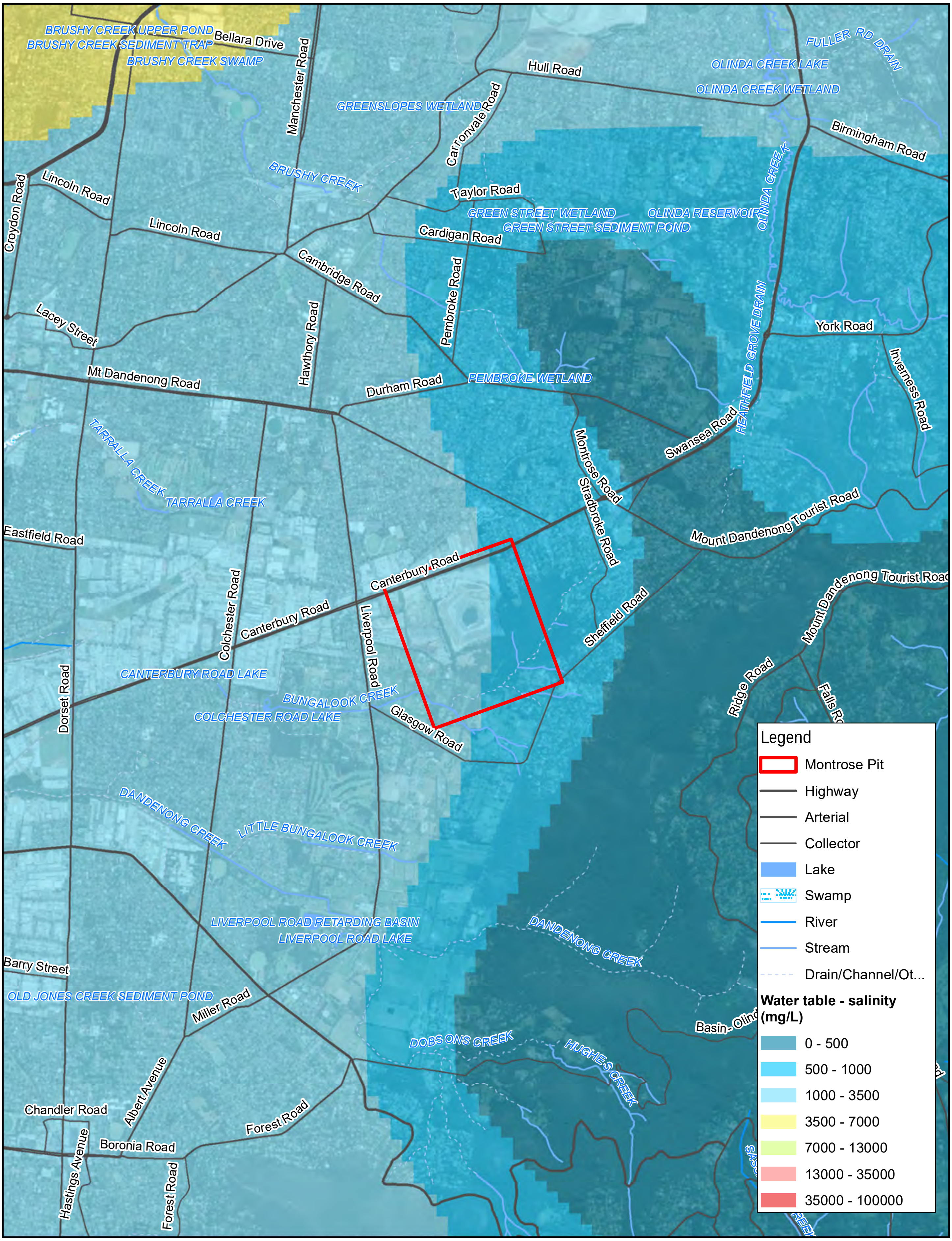
No groundwater quality monitoring was undertaken as part of the current (2023) scope of works; however, it is understood that Boral propose to implement a monitoring program for the quarry (refer Appendix M).

Golder (2006) document an average salinity from selected site monitoring bores, and groundwater seepage into the quarry as 1,630 mg/L TDS. Groundwater salinities reported from the monitoring bore network (Golder 2006) have been summarised in Table 19.

Table 19 Boral monitoring network salinity

Location	Salinity (mg/L TDS)
MB1	2,200
MB5a	2,000
MB6	1,300
Quarry sump	1,000

Note: Salinities obtained from sampling completed in 2003 (Golder 2006)



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Boral Resources (Vic) Pty Limited
MONTROSE QUARRY

Groundwater Salinity

Project No. 31-1270927
Revision No. A
Date 21/04/2023

FIGURE 26

\\ghdnet\ghd\AU\Traralgon\Projects\31\12570927\GIS\Maps\Working\31_12570927_09_Groundwater_Salinity.mxd
Print date: 28 Apr 2023 - 18:13

Data source: VicMap Data, DELWP Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: lgomez

7.6 Aquifer testing

7.6.1 Slug testing

Golder (2006) document the results of constant head permeability testing of 12 boreholes which has been reproduced in Table 20.

Table 20 *Summary of previous permeability testing*

Bore	Screen		Lithology	Saturated Hydraulic Conductivity (m/s)
MB1	6.5	65.5	Rock	3.3×10^{-7}, 2×10^{-6}
MB2	4.1	70.5	Rock	3.2×10^{-7} to 1×10^{-6}, 6×10^{-6}
MB3	1.5	8.3	Rock	0.15×10^{-7}, 5×10^{-7}
MB6	61.5	67.5	Rock	2×10^{-6}
MB7	44	50	Rock	1×10^{-8}
MB9	121	130	Rock	2×10^{-6}
A2	2.6	3.1	Clayey SAND	1.6×10^{-9}
A3	1.5	2.0	Mainly SILT	5.7×10^{-10}
A4	0.5	1.0	Sandy SILT and Silty SAND	1.0×10^{-7}
B2	2.5	3.0	Silty SAND/SAND	1.3×10^{-8}
B3	1.5	2.0	Clayey SAND	1.4×10^{-8}
B4	0.5	1.1	Clayey SAND and Clayey SILT	1.4×10^{-6}

Source: Golder (2006)

7.6.2 Pumping test

No traditional pumping test investigations have been undertaken at the quarry, i.e., using a test pumping bore and observation bores to derive estimates of aquifer transmissivity and storativity.

7.6.3 Sump testing

Previous works

According to Golder (2006), Boral estimated a groundwater seepage rate of around 3.5 L/s into the quarry based on the rate of rise of water level observed in the sump in May 2003. During a field inspection carried out around the same time, Golder (2006) estimated a slightly lower seepage rate in the range of 1 L/s to 2 L/s from several seepage points observed in the quarry.

Sump testing 2022/23

A sump test was undertaken to obtain a more recent estimate of inflow rates into the base of the quarry. This was used to aid calibration of the numerical groundwater model currently under being developed by GHD (2023). Boral are actively dewatering the sump to access deeper resources, and therefore GHD installed a datalogger in the sump and logged the water levels between mid-December 2022 and February 2023. Seepage rates have been estimated from the magnitude and duration of recovery following several pumping cycles occurring during this period.

Figure 27 shows the estimated seepage rates based on this method. The seepage rate estimated for each recovery accounts for contributions from rainfall and evaporation over the ponded area, calculated using the daily rainfall and evaporation from the nearest BoM station 86076. These seepage rates generally agree with the seepage rates derived from an alternative method based on the estimated pumping volume and the percentage recovery (fraction of drawdown recovered following pumping). The seepage rates are estimated to range from around 3.4 L/s to 9 L/s. Given the deepening of the quarry since 2003, a typical seepage rate would be expected to be higher than the 1 L/s to 3.5 L/s range estimated in 2003 and the 3.4 L/s to 9 L/s range estimated is therefore considered plausible.

For the purpose of model calibration, a seepage rate of 6 L/s (the middle of the estimate range) has been used as the flow observation target assigned at the end of model calibration.

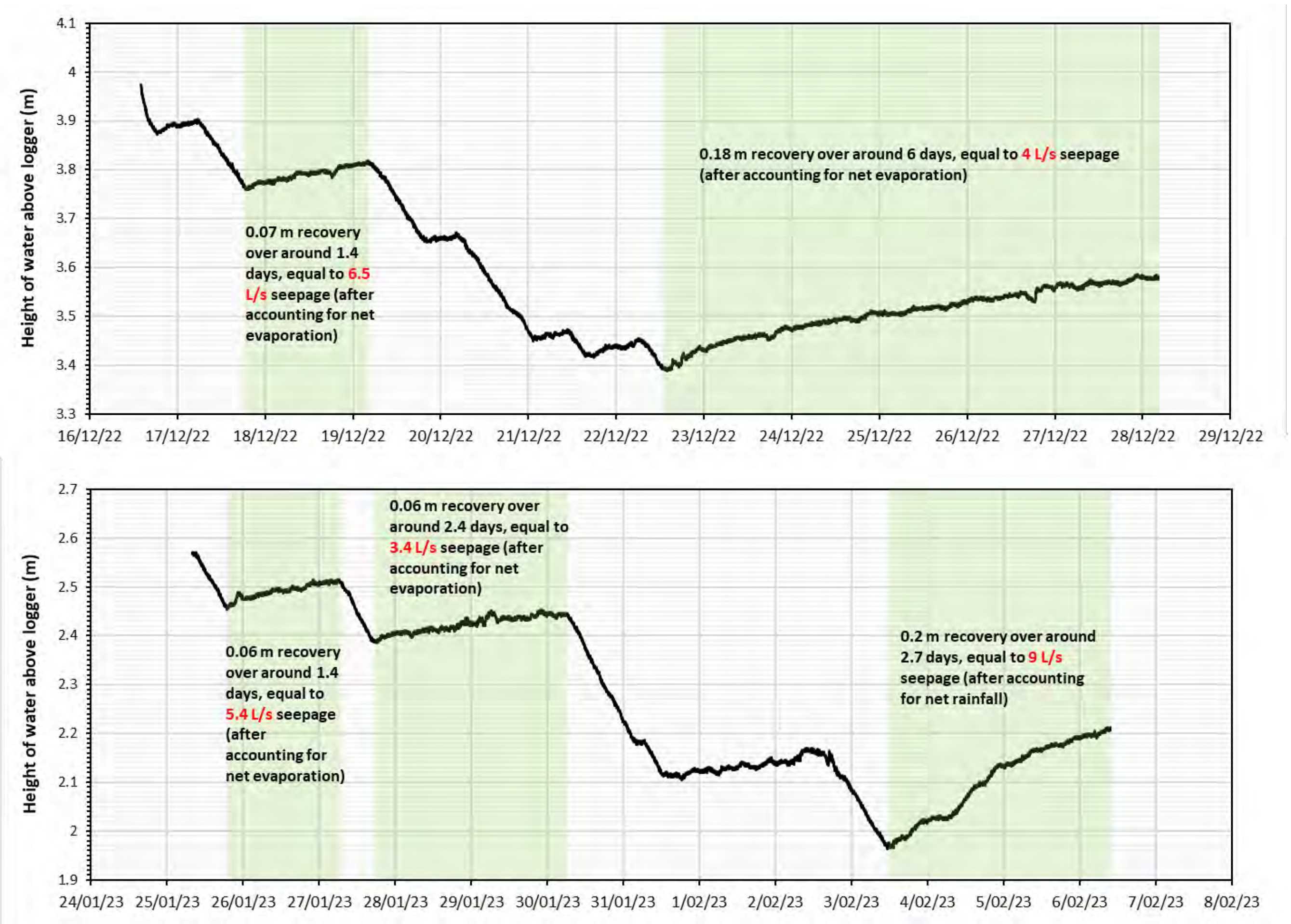


Figure 27 Estimated groundwater seepage rates

7.7 Groundwater dependent ecosystems

7.7.1 Definition

A groundwater dependent ecosystem (GDE) is an ecosystem which has its species composition and natural ecological processes determined by groundwater (ARMCANZ & ANZECC, 1996). 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 watertables. 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

7.7.2 GDEs near to the quarry

The results of the interrogation of the BOM GDE atlas identify the following GDEs.

7.7.2.1 Aquatic GDE

- Bungalook Creek (moderate potential GDE)

7.7.2.2 Floodplain riparian vegetation (moderate potential GDE)

Two ecological vegetation classes (EVC) are mapped in the adjacent bushland:

- EVC 23: Herb Rich Foothill Forest. Predominantly Messmate and Grey Gum upper storey or Red Stringybark in drier locations with an understorey of sparse shrubbery
- EVC 938: Shrubby Gully Forest. Small sections adjacent to Bungalook Creek where soil is seasonally waterlogged. Predominant upper storey of Grey Gum and Swamp Gum with Scented paperbark in the understorey

7.7.2.3 Subterranean systems

Stygofauna is a collective term for all groundwater animals, encompassing animals with varying levels of dependence on groundwater (Hancock *et al.* 2005). A number of specific terms are used to differentiate the types of stygofauna:

- Stygoxenes and Stygophiles are able to utilise groundwater during at least part of their lifecycle but are not reliant upon it
- Stygobites are obligate groundwater species (Hancock *et al.* 2005)
- Phreatobites are a type of Stygobite which are specially adapted to live in the interstitial spaces of alluvial aquifers
- Troglofauna are also subterranean animals but are distinct from Stygofauna as they are not associated with groundwater (Humphreys 2008)
- Edaphobites are terrestrial soil dwelling animals which can accidentally or opportunistically colonise subterranean environments

Because of the adaptation of stygofauna to the groundwater environment, and limited connectivity between favourable habitats, some obligate stygofauna species can have restricted distributions (short range endemism) making them especially vulnerable to anthropogenic impacts.

None were identified on the BOM Atlas, however, their absence on the atlas is not conclusive proof of the non-existence as the Atlas is based upon regional mapping. In Australia, stygofauna research has increased greatly over the last two decades, particularly in Western Australia and Queensland, but also in South Australia and New South Wales.

Overall, there is a poor understanding of stygofauna in Victorian geological settings, however, based upon other national studies, an understanding of the likelihood of their presence can be determined from the hydrogeological setting summarised in Table 21.

Table 21 Preferred conditions for stygofauna occurrence in Eastern Australia

Element	Parameter	Range	Comment
Aquifer type	Permeability and porosity	Cavities, fractures or coarse grained alluvial systems	Qld studies (coal mining in Bowen Basin) indicate a preference for alluvial aquifers. WA studies have included a broader range of geologies including Karstic and basalt terrain. Degree of connectivity to other habitats is important for allowing the transfer of food and pathways for dispersal. The Quarry intersects a fractured rock aquifer system. Measured hydraulic conductivities are very low, and low visible groundwater seepage at the quarry suggest that the rocks are relatively tight and may not be a conducive environment.
Hydrochemistry	Salinity	< 2,000 µS/cm	Values exceeding approximately 1,500 µS/cm result in an exponential decrease in taxonomic richness up to approximately 3,000 µS/cm, after which occurrence of any stygofauna is very unlikely. The bore data for the study area indicates low groundwater salinities.
	pH	6.5 to 8	Stygofauna taxa have been recorded at extremely low pH (i.e., 4.3). Qld studies occur between 6.5 and 7.5. There is no understanding of groundwater pH.
	Dissolved Oxygen		Presence of dissolved oxygen.
	Temperature	16 – 26ºC	Most species occur within this range, however taxonomic richness did increase towards the lower temperatures.
Potentiometry	Depth to Water	< 10 m	Taxonomic richness decrease in an exponential trend with depth below ground level with aquifer aquifers less than 10 m deep displaying significantly greater richness. Water levels are interpreted to be very deep and therefore not a conducive habitat for stygofauna.
		Seasonal and other influences on water levels	Seasonal influences on groundwater levels are not known. There may be a marked variation in groundwater levels given the inferred low aquifer storage. There is limited groundwater near the quarry to consider pumping impacts on groundwater levels.

Sources: Hancock & Boulton 2008 and Tomlinson & Boulton 2008

In summary, the knowledge base of stygofauna in Victoria is limited, however, the factors listed in Table 21 suggest that some key conditions, e.g., pore space, water levels, for their existence are present in the study area. The low permeability of the bedrock (regionally), however, suggests that pore space for their habitat may be problematic.

7.7.3 Summary

The preliminary GDE potential map identified high potential areas primarily along bungalook Creek, based on the assumption that groundwater is shallow (<5 mbgl) and therefore accessible to vegetation. It is recognised that that the BOM GDE atlas is based upon regional information and its accuracy at a local scale is uncertain.

Ecological studies of Bungalook Creek and the surrounds have been completed to assess the potential for dependence, and the significance of the ecosystem, should it have either an obligatory or facultative dependence upon groundwater.

To evaluate these risks, Boral commissioned GHD to conduct an ecological assessment surrounding the quarry.

Their findings confirmed the presence of GDEs and ecological values within the study area - many of which are dependent on groundwater or sustained surface water flows. These include burrowing crayfish, riparian vegetation, and fauna reliant on that habitat. Several threatened species protected under State or Commonwealth legislation were identified as potentially present, including native flora, vegetation communities, mammals, birds, reptiles, frogs, and crustaceans.

The assessment concluded that most GDEs and ecological values face low inherent risks from projected changes to groundwater levels. For example, it was determined that trees prefer soil moisture as a source of water rather than groundwater, while other threatened water dependent floral species such as Pteris epaleata (Netted Brake) and Senecio campylocarpus (Bulging Fireweed) were not detected in the study site during targeted surveys.

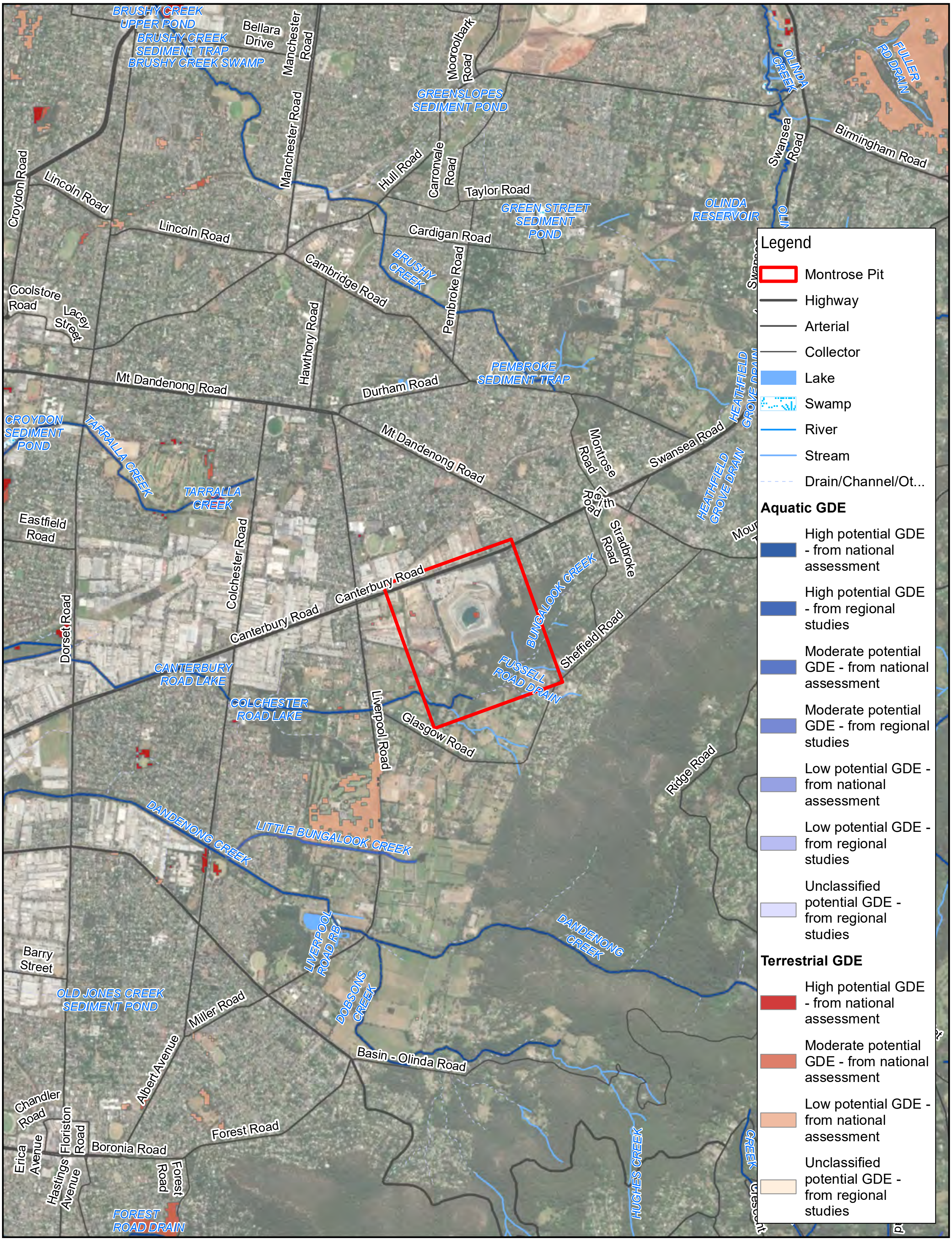
However, there were some medium inherent risks associated with Bungalook Creek and associated aquaticvalues due to the loss of surface water. These included risks to Burrowing Crayfish, the health of the creek itself, and trees along the creek that are partly reliant on creek water and seepage.

These inherent risks were further reduced by modifying the discharge system - specifically by relocating the existing discharge point upstream of the predicted drawdown areas (Ref to section 13.1.1.4) to allow quarry water to be returned to Bungalook Creek, thus compensating for lost surface flow.

To further examine the impacts to GDE's Boral engaged EMM Consulting undertake an independent Groundwater Dependent Ecosystem Assessment (EMM June 2025). The assessment prepared by EMM included additional field surveys and used a multiple lines of evidence approach, to characterise the nature, groundwater dependence and risk posed to the potential GDEs caused by the project's predicted groundwater drawdown.

The results of the field surveys do not suggest any GDEs exist within the project area. The *'risk of terrestrial ecosystems at the Montrose Quarry project area is low to negligible'.* The EMM assessment indicated that existing vegetation is accessing available moisture within at least the top 3 m of the soil profile, rather than relying on groundwater.

The GDE Impact assessment Report prepared by GHD (August 2025) and the Groundwater Dependent Ecosystem Assessment: Field Summary Report (June 2025) prepared by EMM consulting should be read an addendum to this GW impact assessment.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Boral Resources (Vic) Pty Limited
MONTROSE QUARRY

Groundwater Dependent Ecosystems

Project No. 31-1270927
Revision No. A
Date 26/04/2023

FIGURE 28

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Print date: 28 Apr 2023 - 18:16

Data source: VicMap Data, DELWP Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: lgomez

7.8 Hydrogeological conceptualisation

A hydrogeological conceptualisation has been prepared to aid the description and understanding of the groundwater related processes that could be occurring on the site. The conceptualisation is a tool that formalises an understanding of the major components of a hydrogeological system, their interaction and how external changes can modify the system. They can often be a highly simplified way of expressing what is known about a system and can assist in defining (and/or testing hypotheses regarding) the critical components that make up the structures, processes and interactions, the relationships of cause and effect, and more generally, how a system works.

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 29.

Identified aquifers

The schematic shows a two- aquifer system, representing the alluvial sediments associated with Bungalook Creek (and other waterways in the area), and the fractured Palaeozoic rocks (Silurian and MDVC). The aquifers within the MDVC (and indurated Silurian sediments) are fractured rock aquifers where groundwater is stored and transmitted by the secondary porosity of the massive rock. The permeabilities of the rock mass are likely to be very low, except in areas that have been subject to faulting and shearing, and such structures have been mapped within and adjacent to the quarry. These structures would have formed following emplacement of the rocks and through subsequent tectonic activity.

The sediments may have higher permeabilities than the underlying fractured rock systems where they are thicker, although this is not reflected in the site specific data (refer Table 20). In some areas, the fractured rocks may be weathered (saprolitic) which may locally enhance permeabilities and provide additional storage.

Groundwater flow systems

Pre-quarrying activities, the groundwater flow direction is interpreted to have been towards the west/northwest, based upon review of the interpreted topography (with Mount Dandenong and the Dandenong Ranges located further to the east of the quarry). The quarrying activities would not have significantly altered this regional groundwater flow, however, the dewatering would locally distort flows, creating a localised depression in the water table. There is a lack of groundwater development neighbouring the quarry and therefore water levels in the Palaeozoic rocks are interpreted to be influenced by prevailing climate, rather than abstractive groundwater development.

Recharge to the fractured rock aquifers is predominantly due to infiltrating rainfall. Additional recharge may occur due to:

- Irrigation of gardens and public open space (within the urbanised areas of the catchment)
- Leaking services such as sewer and reticulated water
- Flood events on the local waterways, or where water ways are losing systems

However, the proportional contribution of these other recharge sources is expected to be insignificant when compared to rainfall.

Groundwater discharge would occur in the lower lying topographies and emerge as springflow, or seepage contributions to waterways within the catchment. The quarry itself represents an artificial discharge feature of groundwater. Near waterways where groundwater levels may be nearer to the ground surface, groundwater losses may occur through evapotranspirative effects, i.e., riparian vegetation is reducing the water levels.

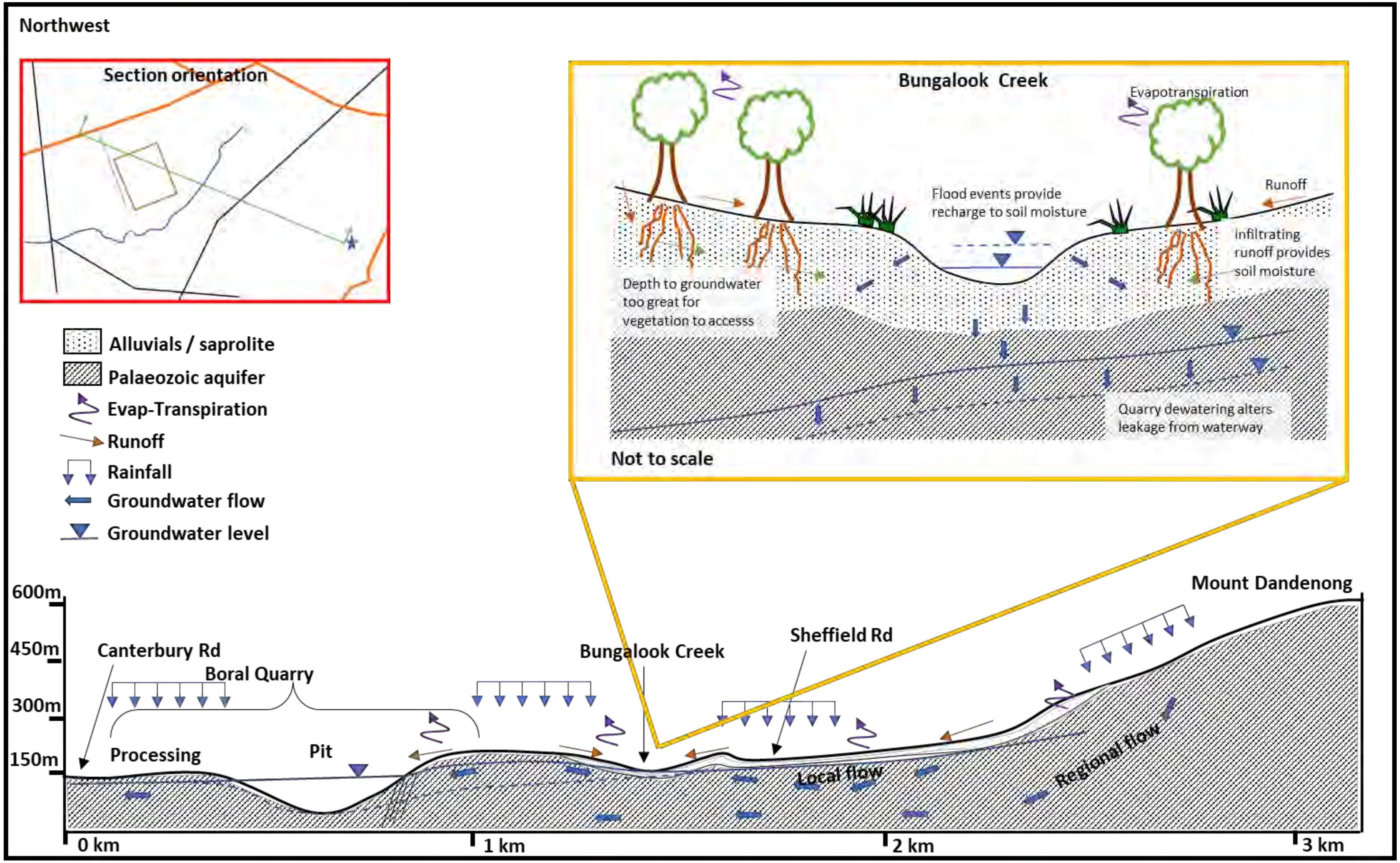


Figure 29 *Boral Montrose Hydrogeological Conceptualisation*

Interaction with waterways

Groundwater processes and interactions with Bungalook Creek are complex. The schematic in Figure 29 shows a thin deposit of alluvial and colluvial sediments associated with the waterway, which are generally laterally restricted from the present day course of the waterway. Interactions between groundwater and Bungalook Creek will vary along its reaches depending upon whether the waterway is either gaining (influent) or losing (effluent). Where groundwater elevations are above that of the creek, groundwater would discharge into the creek. Where the streambed is elevated above the regional water table, the creek may be losing (shown conceptually in Figure 30). Flow direction can also change over time, e.g., the action of flooding, of growth in the riparian vegetation (additional evapotranspiration effects).

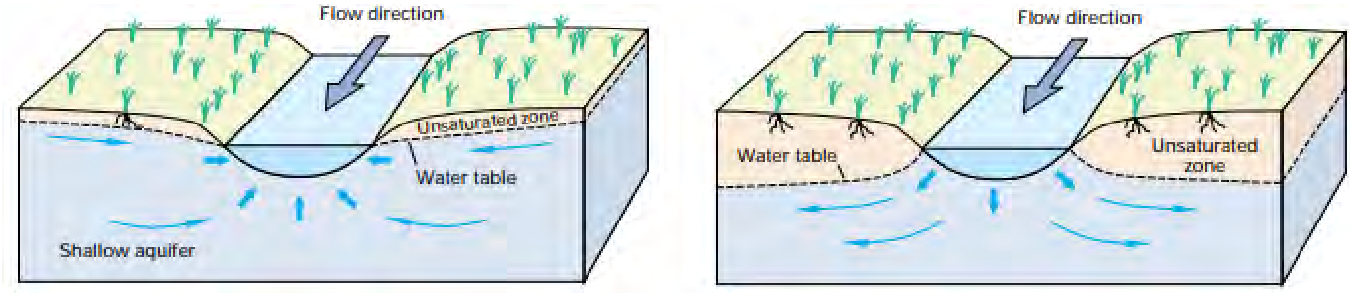


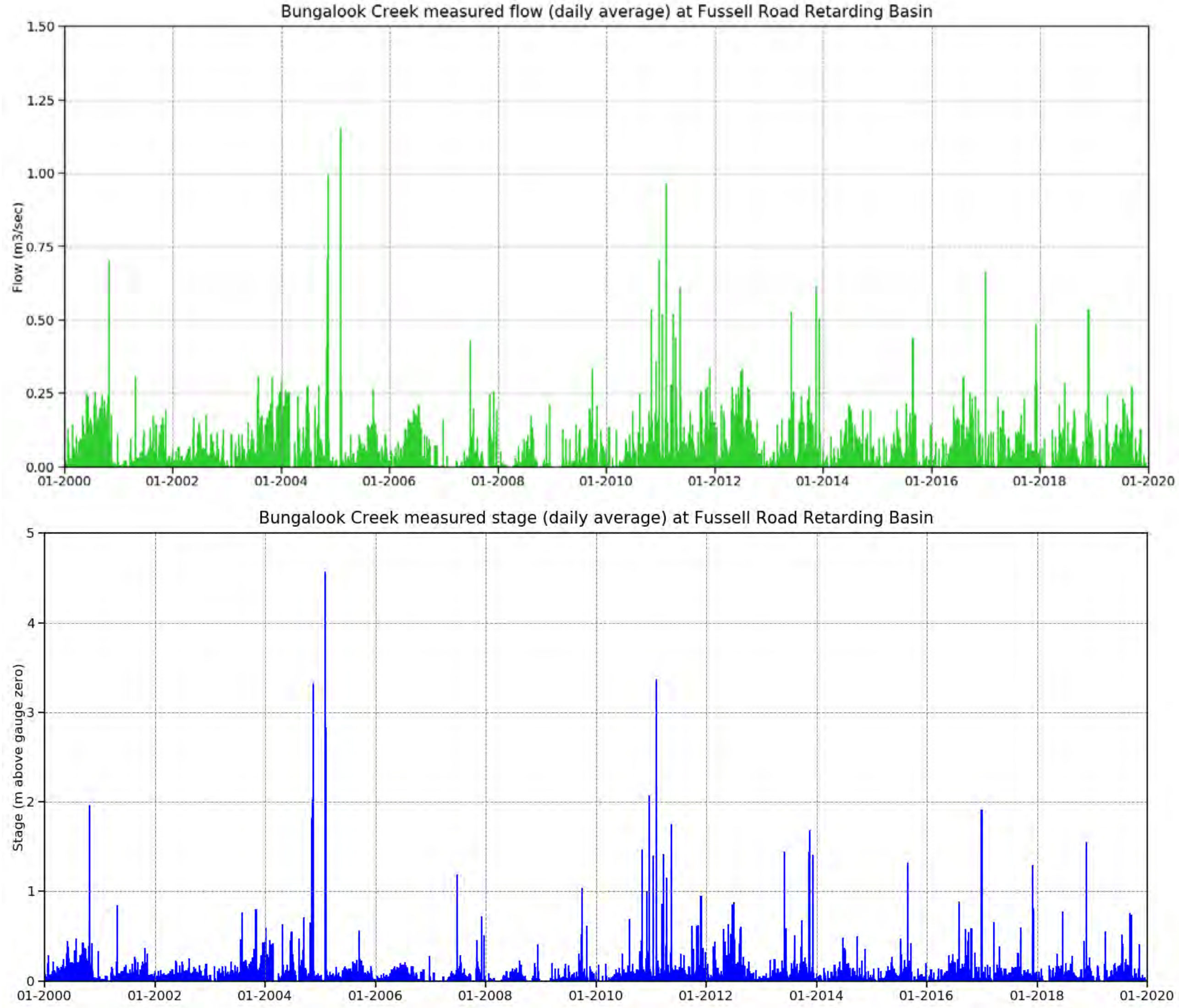
Figure 30 ***Gaining and losing streams***

Source: Winter et al (1999)

The flow and stage data from the Fussell Road gauge (228369A) provide important insights into the nature of surface water dynamics along Bungalook Creek. These are presented in Figure 31, using the data from 2000 onwards for the purpose of demonstrating the seasonal variability (data from this gauge is available since 1979). The gauge data indicate the following:

- For most of the time, the water level in the creek (stage) is low, with the duration curve indicating less than 0.2 m of water above gauge zero for 90% of the time, i.e., close to the creek bed elevation, consistent with the low water level observed during a site visit (see Figure 32). This suggests that the difference between the creek elevation and adjacent groundwater level could provide general indications of flow direction between the creek and groundwater under a typical condition
- During wet days, the water level in the creek can rise rapidly (by 2 to 4 m) but also drains quickly. High flow events, accompanied by a rapid rise in creek level, may initially supply recharge to the water table. As the creek level quickly recedes, groundwater may locally discharge to the creek as baseflow where the water table is above the creek level
- During dry periods, little to no flow and stage are recorded. This means any flow accumulated from upstream (either from runoff and/or baseflow) is lost to the groundwater system before flow reaches the gauge

In order to understand the likely flow direction along Bungalook Creek adjacent to the quarry, available creek elevation data has been compared against the groundwater levels measured in the nearby monitoring bores and summarised in Table 22 below. The creek elevation is sourced from Boral's propeller survey, which is considered more accurate than the Vicmap elevation data (also included in the table for comparison). For some locations, the propeller survey includes a feature labelled as "watercourse" whose elevation is typically smaller than that of the adjacent topographic contour (in this case, both values are provided, with the water course elevation considered more representative of the creek elevation). The comparison indicates that the creek is likely to be generally losing at the upstream end of the quarry (adjacent to bore MB3 and as shown conceptually in Figure 29) and likely to become gaining at the downstream end (adjacent to bore MB5b), with a transitional zone in the middle (adjacent to AS2, where the creek elevation and groundwater levels are similar, indicating a loosely gaining or baseflow neutral condition). This is consistent with the north to south schematic section presented in Golder (2006), indicating a gaining condition adjacent to bore AS2 (with the creek level placed at around 150.5 mAHD and the creek bed at around 149.5 mAHD, between the 147.29 to 152 mAHD range estimated in Table 22).


Bungalook Creek measured flow (daily average) at Fussell Road Retarding Basin

Bungalook Creek measured stage (daily average) at Fussell Road Retarding Basin

Figure 31 ***Bungalook Creek gauged flow and stage data from Fussell Road Retarding Basin***

Figure 32 ***Water in Bungalook Creek – site visit October 2022***

Table 22 Creek elevation and groundwater level comparison

Bore	Distance from creek (m)	Groundwater level (mAHD)	Creek elevation (mAHD)		Surface water-groundwater interaction
			Propeller	Vicmap	
MB3	~28	153.06-155.78	157	157	Losing
AS2	~5	151.08-151.96	147.29-152	153.5	Loosely gaining/baseflow neutral
MB5b	~19	147.29-147.71	146.15-147	148	Gaining

Given the generally small difference in the groundwater level and estimated creek level in the potentially gaining sections of the creek, large increases in the creek level during wet days (in the order of 2 to 4 m) are likely to result in the creek temporarily becoming a losing system. Similarly, the lowering of the water table during extended dry periods (such as the Millennium Drought) is likely to result in the water table becoming disconnected from sections of the creek bed, leading to little to no baseflow (with zero flow recorded at the Fussell Road gauge). The potential short term variability in the flow direction is schematically presented in Figure 33, using the cross-section from Golder (2006).

The information currently available suggests that flows in Bungalook Creek are derived from the following three sources:

- Groundwater contributions as baseflow, representing flow from within the saturated zone. According to Golder (2006), a typical baseflow between 1980 and 1996 (a wet period prior to the Millennium Drought) was estimated to be in the range of 4 L/s to 5 L/s at the flow gauge, although there is low confidence in this estimate due to the low baseflow contributions at, or below, the threshold of accuracy of the flow gauge
- Interflow, representing the proportion of rainfall that infiltrates below the subsurface and moves laterally through the soil profile before discharging to the waterway. These processes occur above the regional water table (i.e., unsaturated flow) and can include macropore flows that were observed by GHD ecologists during a site visit
- Stormwater run-off or overland flow, i.e., that component of rainfall that flows along the ground surface and into the waterway. Proportionally, this provides the greatest contribution to stream flow in Bungalook Creek

Historical dewatering would have lowered the piezometric heads in the bedrock aquifer system, potentially extended to, and beyond Bungalook Creek at depth (refer discussion in Section 13). Under these circumstances, there would be a change in piezometric head between the alluvial sediments and the bedrock aquifer, which could have modified the inter-aquifer fluxes (transfer of groundwater between different aquifer units) and potentially surface water-groundwater interactions (e.g., a slight reduction in baseflow). It is noted from the gauging information (refer Section 7.4) that there has been little change in the groundwater levels in Boral monitoring bores that are located adjacent to Bungalook Creek over the last 19 years.

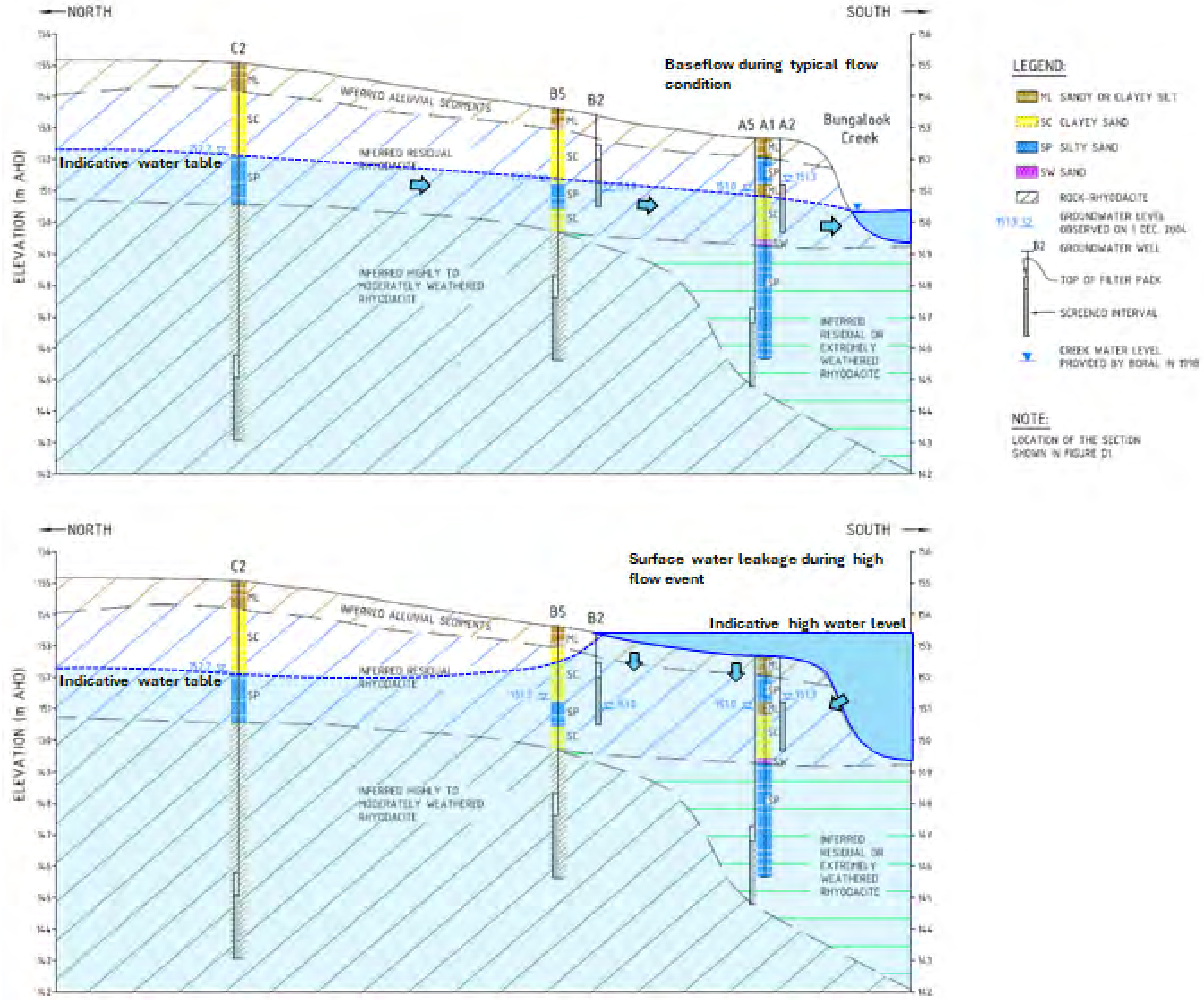


Figure 33 ***Schematic cross section of flow dynamics at Bungalook Creek***

Source: Modified from Golder (2006)

8. Acid generating geological materials

8.1 Acid sulfate soils

8.1.1 Definition

Acid sulphsulfate 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 sulphsulfide). 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 sulphsulfides oxidise to sulphsulfate, with resultant soils having low pH and potentially high concentrations of the heavy metals.

Groundwater levels may rise as a result of recovery from construction dewatering activities, or leaching of infiltrating rainfall through the sulphsulfate rich zones. 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.

The occurrence of acid sulfate soil can be present in the form of:

- Potential Acid Sulfate Soil (PASS) – Soil that contains unoxidised metal (iron) sulfides. This is usually in oxygen free or waterlogged conditions. When exposed to oxygen through drainage or disturbance, these soils produce sulfuric acid
- Actual Acid Sulfate Soil (AASS) – Potential acid sulfate soil that has been exposed to oxygen and water, and has generated acidity

There are two main pathways for the activation of acid sulfate soil to form groundwater impacts:

- Excavation of PASS soils above the water table and their management, such as acid run-off from stockpiles and treatment areas, filling, handing of spoil from excavations
- Dewatering required as part of the construction of features below the water table

8.1.2 Potential in study area

CSIRO's Atlas of Australian Acid SulphSulfate Soils was interrogated, and the mapping indicates that the site and surrounds have an extremely low probability and very low confidence of acid sulfate soils occurring.

8.2 Acid, Saline and Metalliferous (AMD) drainage

8.2.1 Definition

Acid, Saline and Metalliferous (AMD) drainage is generally caused by the oxidation of sulfide minerals. AMD sources can include mine and quarry pits, waste rock dumps, roadways and embankments constructed with sulfidic material, etc.

The dewatering of sulfide bearing geological materials can result in their oxidation, and generation of acidic groundwater, which can in turn can mobilise heavy metals within the groundwater. Exposing quarry faces, and any sulfide bearing geological materials to the air through dewatering and lowing of pit water levels, may result in seepage from quarry faces. Such seepage would enter the pit, and potentially the groundwater system, which may in turn affect the quality of water in pit sumps, any discharged water, i.e., drainage lines, and any nearby monitoring bores.

In addition, quarries that are backfilled with waste rock above the water table can also be a source of AMD to the groundwater environment.

Indicators of AMD, from DFAT (2016), can include:

- Visual indicators
  - Red coloured or unnaturally clear water – in pit sumps, drainage lines, etc.
  - Orange–brown iron oxide precipitates in drainage lines
  - Dense coatings of green algae filaments on the bed of a stream with unnaturally clear water
  - The death of fish or other aquatic organisms on mixing AMD with receiving water
  - Precipitate formation on mixing AMD with groundwater inputs into stream channels or on mixing AMD with receiving surface waters, such as at stream junctions
  - Vegetation dieback or soil scalds
- Groundwater changes
  - Ongoing increases in sulfate concentrations or the sulfate to chloride mass-ratio (SO_4/Cl) in groundwater
  - Ongoing reduction in the alkalinity of groundwater over time
  - Ongoing increases in the total titratable acidity of groundwater samples
  - Acidification of groundwater and elevated metals concentrations

8.2.2 Available results

Based on information provided by Boral as part of this assessment, the following is noted:

- The geology of the quarry consists of the Coldstream Rhyolite and Mount Evelyn Rhyodacite. GHD notes that the bedrock (indurated Siluro-Ordovician age turbiditic sediments) may contain disseminated sulfides, however, whilst such materials are found in the broader region, they have not been identified at the quarry
- Boral has not reported any visual indictors of AMD and have not reported any obvious water quality impacts through their monitoring at the quarry, i.e., monitoring of pit sump water
- Groundwater quality information is limited to that provided in Golder (2006) which includes a single monitoring event. Results from this single monitoring event are insufficient to determine any long term changes in groundwater quality. Summary results from this monitoring are provided in Table 23
  - Iron was included in the analytical suite however it is unknown if this represents total or dissolved iron. Analysis for other metals was not completed
  - Golder (2006) report a near-neutral pH
  - Chloride/Sulfatide ratios vary from 19.4 to 100 for groundwater and 1.8 for the quarry sump. The low (1.8) Cl/SO_4 ratio from the quarry sump, as well as the pH of 8, suggests there may have been oxidisation of sulfides in the past but the pH of 8 suggests they have been neutralised

Table 23 Boral SO4/CL ratios

Location	Salinity (mg/L TDS)	Alkalinity as CaCO3 (mg/L)	pH	Iron (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Cl/SO_4 ratio
MB1	2,200	220	7.2	3.3	1,000	< 10	100
MB5a	2,000	280	7	4.6	940	52	18.1
MB6	1,300	270	7	0.58	640	33	19.4
Quarry sump	1,000	130	8.0	0.47	400	220	1.8
Seawater	-	-	-		19,400	2700	7.2
Note: Results obtained from sampling completed in 2003 (Golder 2006)							

8.2.3 Potential in study area

There have been no visual indictors of AMD and obvious water quality impacts, e.g., low pH water, have not been identified.

This suggests that the risk for AMD occurrence at the quarry may be low. Ongoing monitoring for potential visual indicators of AMD, as well as monitoring groundwater quality, e.g., quarry sump water quality, is recommended to confirm the expected low risk level.

9. Proposed development

9.1 Operations

9.1.1 Historical

Golder (2006) document the gradual growth of the quarry over time based upon a review of aerial imagery and available mine plans. It is understood that there were two separate quarry operations in 1970 which merged into the single operation in the early 1980s. Progressive deepening of the pit is summarised in Table 24.

Table 24 Quarry floor levels

Year	Pit Floor Level	
	Northern	Southern
1970	152	160
1979	97	131
1987	97	
1992	87	
1997	87	
2005	73	

9.1.2 Current

GHD (2022) indicates that the typical slope geometry of the current quarry consists of an overall slope angle in the order of 35° to 40°, batter heights occurring variably between 10 m and 18 m and slope faces in the order of 75°. Bench widths along the North and South Wall were in the order of 10 m to 15 m, and 5 m to 10 m along the East and West walls.

A selection of recent aerial images has been provided in Appendix I which indicate that the bottom of quarry was reached circa 2017/2018. Circa 2020 (and Covid 19 lockdowns throughout Victoria) the sump was allowed to fill, restricting access to the lower benches of the quarry. In 2022 Boral commenced dewatering of the sump to access deeper resources, and at the time of reporting the dewatering of the sump was continuing (May 2023).

In November 2020 the bottom of pit was around RL 21 m (GHD 2022) and quarrying operations are currently deepening the existing pit and where geometry allows additional trimming of the batters is conducted to maximise the extractable resource.

Operations are conducted by pre-strip, drill and blast followed by truck and shovel. As required, an excavator will follow the truck and shovel operations to scale walls and remove loose debris. All material is transported to the surface level primary crusher for processing.

9.2 Proposed quarry expansion

The quarry expansion has been split into eight stages and assumes and approximate 800 kt/year extraction rate, and recovery of around 9.6 Mm^3 of resource, and 1.6 Mm^3 of overburden. The expansion would occur over an approximate 32 year period (GHD 2023). A concept design of the extent of the expansion is shown in Appendix J.

Overburden required to be removed in the quarry expansion is to be placed in an internal dump at the base of the (existing) quarry and progressively filled in layers up to a final level of nominally RL 88 m. The internal overburden dump will toe out against the final batters of the expansion at completion, but a sump can be maintained for water storage and storm water retention.

The concept design has access to the extension area occurring along haulage routes on both the eastern and western batters. Both routes would be tied into the existing ramps and haulage network.

9.3 Rehabilitation

The rehabilitation plan for the Montrose quarry is under preparation, however, the proposed final landform has been conceived that would see the quarry void filled with material from external sources. The landform would include:

- An internal overburden dump
- Filling of the void to RL 98 m AHD
- Placement of fill at a 3Filling of the void would commence as soon as practicable; however, this would be likely towards the end of the extraction process. Fill material would be sourced from external sources on the open market or other Boral sites as require or where available. Backfilling would initially fill the remainder of the internal dump, as well as dumping at the base of the pit in areas not impacted by the final extraction. It is estimated that approximately 14.3 Mm^3 is required, which would require around 56 years assuming a filling rate of 250,000 m^3 (500,000 t/year at an average density of 2 t/m^3).

Dewatering would be required at least to the end of the quarry resource extraction period to maintain access and safe and stable working conditions within the quarry. Subject to rate of groundwater level recovery, some form of dewatering may need to continue to maintain the stability of the internal overburden dump and initial stages of the void backfilling.

10. Water management

10.1 Existing site water balance

Key sources of water into the quarry have previously been detailed by Ecological Engineering (2007a) and are shown in Figure 34. Key sources of water to the quarry:

- Rainfall landing on pit (assumed to be impervious)
- Runoff from the process area (assumed to be impervious)
- Groundwater seeping into pit
- Potable supply from Yarra Valley Water to the site office and firefighting stations

Figure 34 Water inflows to the quarry

Source: Ecological Engineering (2007a)

The groundwater that seeps into the existing quarry is mostly into the sump at the base of the quarry. There are also a couple of fractures where seepage is emanating from the sides of the quarry, however, it is uncertain as to whether this represents groundwater seepage, or run-off derived for batters located at higher elevations.

The sump therefore contains a combination of surface water runoff and groundwater. This water is used widely throughout the quarry for a range of industrial applications such as dust suppression and processing of the quarry product, as detailed in Table 25.

Table 25 On-site water use at the Montrose quarry

Use	Type of water used	Requirements
Drinking	Bottled water	Up to 50 litres per day in hot weather
People washing and toilets	Mains water	2 shower stations at 20 litres per shower
		10 toilets at 10 litres per flush
		16 sinks and basins at 2 litres per use Potential total 1000 litres per day
Dust suppression	Stored ground and rain water	Site water truck at 30,000 litres per load, and up to 10 loads per day in hot weather.
		Plant water sprays using up to 2000 litres per day.
		Water sprays alongside high traffic areas at approx. 2000 litres per day in hot weather.
		Potential total 304,000 litres per day.
Trucks and plant washing	Stored ground and rain water	Truck body washing station at approx. 100 litres per use.
		4 Quarry plant washing station at up to 200 litres per use.
		Potential total 6000 litres on a busy day.
Firefighting	Mains water	Various firefighting stations around the site but rarely used.
Wet mix production	Stored ground and rain water	6% of a wet mix is water. Up to 1000 tons of wet mix can be produced on a busy day.
		Potential total 60000 litres on a busy day
Concrete production	Stored ground and rain water	Concrete use recycled water from the paddle pit in concrete production.
		Washing of agitator barrels and cleaning plant is up to 5000 litres per day when busy.
Garden and landscape maintenance	Stored ground and rain water	Several small garden bed and planted areas around the site could use approx. 1000 litres per day in hot weather.
	Total from tanks	377,050 litres

Source: Boral (2022)

Water is pumped from the sump at the base of the quarry to storage water tanks (Figure 35), before being reused throughout the site and discharged (Figure 36).

Figure 35 ***Dewatering from pit lake***

Source: Boral (2022)

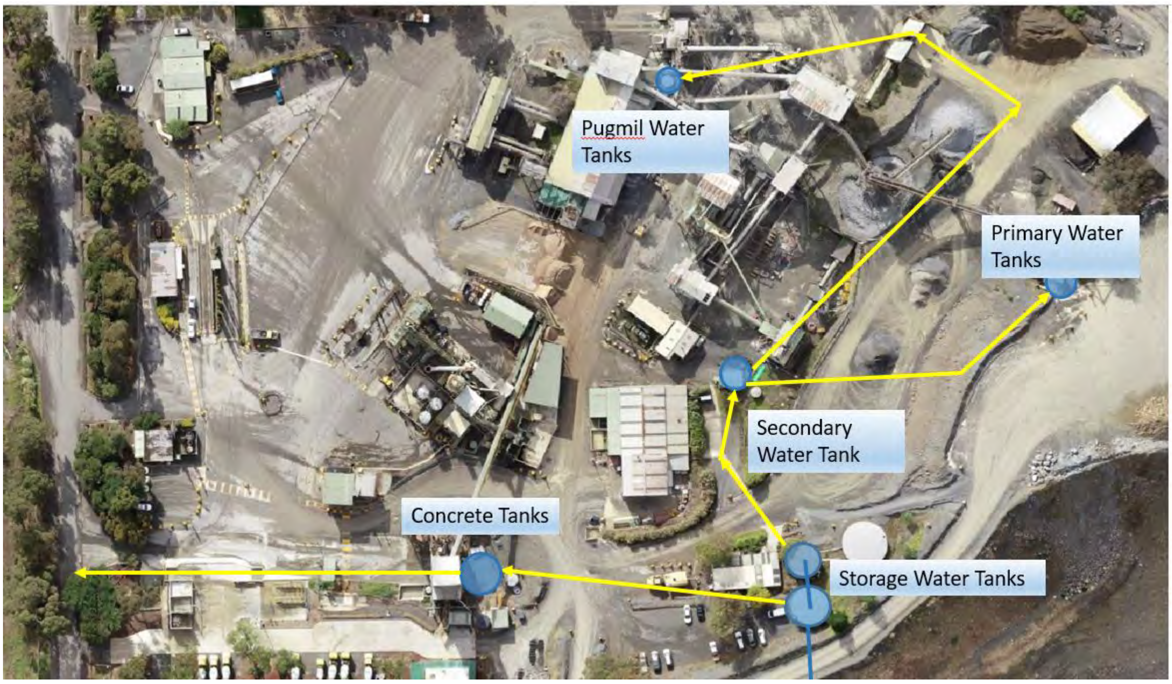


Figure 36 ***Water reuse and discharge routes***

Source: Boral (2022)

The industrial water runs through a treatment system (settling of suspended solids) before it is discharged indirectly to Bungalook Creek under an EPA Waste Discharge Licence (Figure 37). Water can also be returned following treatment to the pit lake (Figure 38).

Figure 37 *Water treatment and discharge point*

Source: Boral (2022)

Figure 38 ***Recycling of water to pit lake***

Source: Boral (2022)

Boral has provided metering data for volumes discharged offsite via Discharge Point B, with the daily volumes between 2017 and 2023 shown in Figure 36.

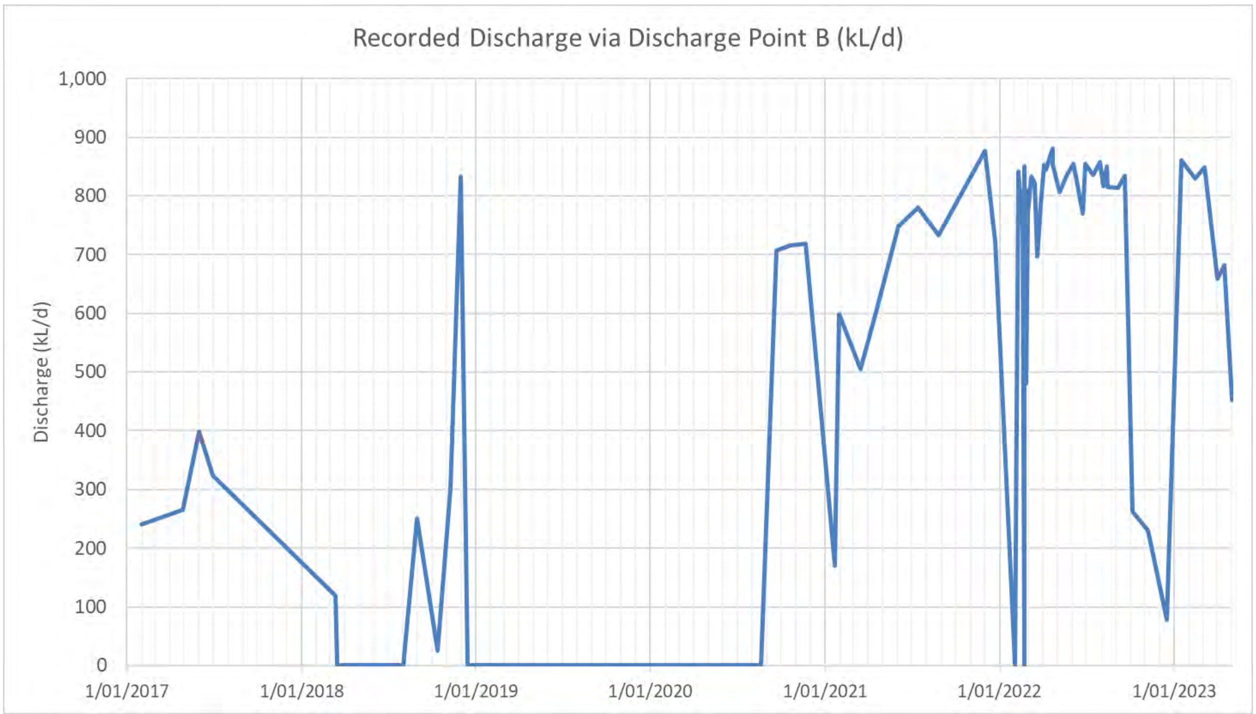


Figure 39 ***Boral discharge metering***

Between 2017 and early 2018, the average daily discharge of water from the quarry was around 270 kL/day (3.1 L/s) which is the net amount after surface water runoff, groundwater seepage, net evaporation and on-site reuse. This would suggest that groundwater inflow into the quarry was less than 3 L/s on the assumption that the quarry sump level was relatively stable. There were long periods in the first half of 2018 and throughout much of 2019 and 2020 where discharge was not recorded. During this period, the quarry sump and lower benches were filling with water from surface water runoff and groundwater seepage.

Throughout much of 2021 through to the present, Boral have been actively dewatering the quarry to enable access to the bottom of the pit. During this period, the average daily discharge from the site has been around 740 kL/day or 8.5 L/s, with the 860 kL EPA licence volume slightly exceeded on two occasions.

10.2 Future site water balance

The following describes impacts on the site water balance as the quarry expands:

- Pumped discharges via Discharge Point B are currently high (and approaching the discharge licence limit) as a result of the water level in the pit being drawn down to enable access to the bottom of the pit
- Once the pit lake has been drawn down to its final level, pumping discharges from the site will decrease and reach a state of equilibrium where:
    - *Discharge = surface water runoff + groundwater seepage + rainfall – evaporation – on-site reuse*
- As the mine advances, groundwater seepage will increase, as will surface water runoff from the expanded pit footprint:
    - Based on the assumption that the pit area is impervious, runoff from the pit will be increase proportionally to the increase in pit area (i.e., increasing the pit area from the current 34 ha to the ultimate 44 ha would lead to a 29% increase in surface water runoff)
- There will be a small sump which would store some seepage and rainfall runoff, with the balance to be pumped for on-site reuse or discharge via DPB

10.2.1 Groundwater licence

With the expansion of the quarry, it is important for Boral to have an understanding of what proportion of the total discharge is groundwater and what is surface water runoff/stormwater, as this will have a bearing on:

a. What Boral is charged for annual groundwater use, and

b. There will be a trigger in monitoring plan for Boral to update their GW licence – this will need to rely on the proportion of surface water and groundwater of the total discharge, to get an understanding of how much groundwater has been pumped relative to their licensed amount

Given that it will not be possible to measure groundwater inflow to the pit, it is important that surface water inflows to the pit are estimated as accurately as possible. As previously discussed, surface water inputs to the quarry pit include:

- Rainfall landing on pit (can be estimated from the pit area on the day and daily rainfall at the closest climate station 86234; assumes that the pit area is impervious)
- Runoff from the process area (depending on the drainage arrangement, this could be gauged or an estimate made similar to the pit runoff)

Water is removed from the pit via:

- Evaporation on the water surface area (can be estimated based on the pit lake area on the day and daily evaporation at the closest climate station 86234)
- Pumping for reuse and discharge (currently gauged)

Assuming that the sump at the base of the pit is kept at a relatively stable level, the groundwater seepage inflow can be calculated as the balance of estimated surface runoff into the pit and estimated evaporation and measured pumping from the pit.

10.2.2 Discharge licence

Once the pit lake has been drawn down to its final level, pumping discharges from the site will decrease from the current levels and reach a state of equilibrium.

In general, on-site reuse and evaporation from the pit lake should provide the ability to manage discharge from the site to within the current EPA licence volume of 0.86 ML/d.

There will, however, be periods where there is a requirement to increase the discharge beyond the current limit. These would typically be very wet periods where:

- Surface runoff to the quarry is high due to high rainfall
- Groundwater seepage is relatively high due to the expanded quarry
- Evaporation is low due to the wet conditions
- On-site reuse is low (i.e., no water use for dust suppression, which accounts for a large part of reuse)

Based on the 257 mm of rainfall in October 2022, an ultimate pit area of 44 ha, and assuming that there is no ability to reuse water on-site, an average discharge of 3.6 ML/d would be required to avoid an increase in the level of the pit lake sump. This assumes that no alternative storage is available on the quarry site.

10.3 Rehabilitation water balance

10.3.1 Overview

A daily water balance was also prepared for the quarry to inform rehabilitation planning. The daily water balance covered a 281 year period, including a 40 year expansion phase and the first 240 years of the rehabilitation phase (GHD, 2024).

Inputs and assumptions to the water balance model are documented in GHD, 2024 and are summarised below:

- Inputs
  - Pit geometry as stage-storage-area relationship, aligned to expansion and rehabilitation staging
  - Rainfall falling directly on the pit
  - Evaporation from water surface area
  - Groundwater seepage into pit
- Assumptions
  - During operation and the first years of rehabilitation, a sump has been nominated at the base of the quarry to collect and remove water from the quarry via pumping
  - Dewatering; as per GHD (2024):
  - The long-term water balance is sensitive to the rate of groundwater seepage, with average evaporation volumes slightly exceeding rainfall over the long-term
  - To prevent groundwater seepage rates from increasing unrealistically leading to excess water in the pit, a threshold water level was adopted above which groundwater seepage ceases

10.3.2 Results

Water quantity

- Under current climate baseline conditions, the pit starts to fill relatively quickly when dewatering ceases, with initial groundwater seepage and direct rainfall being significantly higher than the evaporation loss
- As the water level and surface area start to increase, the groundwater inflow reduces due to the reduction in hydraulic gradient (head difference between pit water level and groundwater level), while evaporation from the open water increases
- There is then a declining rate of increase in the water level, until a state of equilibrium is reached where the rainfall and evaporation components are similar and the groundwater seepage is negligible

- There is a stable long term water level of ~139 to 142 m AHD, below the top of pit level of around 150 m AHD, i.e., approximately 1,900 ML of airspace available between the 141 and 150 m AHD levels
- The quarry water balance is sensitive to climate change with the maximum water level significantly lower under a high climate change model

Water quality

- The risk of algal blooms in the pit lake was deemed to be low due to the lack of inflows from the catchment surrounding the quarry, i.e., reduced nutrient loads
- A contaminated site was previous identified in the modelled zone of groundwater drawdown adjacent Fussell Road (refer Section 5.1.4). The potential for groundwater contamination from this site is unknown. Contaminants from this site could be mobilised towards the quarry and potentially accumulate in pit water. Further monitoring of groundwater and pit water quality during quarry expansion would inform the risk of contaminant migration on the future pit water quality

11. Water risk assessment

11.1 General

Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. These three stages of the risk assessment process are outlined in further detail in the context of the surface water and groundwater risks associated with the quarry.

Risk analysis involves consideration of the source of risks, their consequences and the likelihood of those consequences occurring. Risks are usually analysed by combining their likelihoods and consequences. The risk evaluation process involves comparing the level of risk derived from the risk analysis with the risk criteria established when the context for the risk management process was considered. The purpose of the risk evaluation is to use the outcomes of risk analysis to decide which risks require treatment, and the treatment priorities.

A semi quantitative risk assessment process has been applied which is broadly consistent with AS/NZS 4360: 2004 (Standards Australia 2004). The methodology used to determine the groundwater impact pathways and define risk ratings was as follows:

1. Determine the 'impact pathway' – how the quarry impacts on a given surface water or groundwater value, or issue. These pathways are:
    - Changes to water quality
    - Changes to water availability or access, e.g., reduction in groundwater levels
2. Describe the 'consequences' of the impact pathway to define levels of consequence (Table 26). Note that these consequences are based upon guidelines prepared by the Earth Resources Regulator. Consequence criteria existing for three categories:
    - Protection of public health, safety and amenity, and aboriginal heritage
    - Protection of land, property and infrastructure *beyond the boundary of the licence area*
    - Protection of the environment (air, water, soil, vegetation, flora and fauna species)

    The criteria for the protection of surface water and groundwater have been summarised in Table 26, however, in some cases, e.g., the surface water, the impacts to the other two categories are also applicable
3. Determine the 'likelihood' of the consequence occurring to the level assigned in Step 2. Likelihood descriptors are provided in Table 27
4. Determine the maximum credible 'consequence level' associated with the impact as defined in Table 26
5. From the consequence and likelihood levels assigned to the impact pathway, use a risk matrix to determine the risk rating (Table 28)

Table 26 Consequence criteria

Severity	Consequences for “the water environment” other than for planned and approved disturbances within the licence area
Critical Hazard has critical impact, in terms of severity and/or duration. Treatment or remediation effort is required, although some effects may be irreversible. Remediation of environmental contamination would require significant private and public resources. Hazard event would be the subject of widespread community outrage.	**Environmental contamination event**: Environmental contamination event (of air, soil-land and/or water) of a magnitude that a State-level incident response is required. Incident response, clean-up and rehabilitation expected to run for years and/or cost ≥$10 million. **Surface water or groundwater**: Contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by ERS (2022) for more than year.
Major Hazard has major impact, in terms of severity, duration and/or frequency of occurrence. Treatment or remediation effort is required. Some effects may be irreversible. Remediation of environmental contamination would require significant private and public resources. Hazard event would be the subject of widespread community concern.	**Environmental contamination event:** Environmental contamination event (of air, soil-land and/or water) of a magnitude that would necessitate a regional emergency management incident response. Clean-up and rehabilitation expected to run for months and/or cost $1–10 million. **Surface water or groundwater:** Contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by ERS (2022) for up to one year
Moderate Hazard has moderate, noticeable impact, in terms of severity, duration and/or frequency of occurrence. Moderate treatment or remediation effort may be required. Hazard event would be the subject of limited community concern.	**Environmental contamination event:** Environmental contamination event (of air, soil-land and/or water) with clean-up and rehabilitation expected to run for weeks and cost $10k–$1 million. **Surface water or groundwater:** Localised contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by ERS (2022) for weeks to months.
Minor Hazard is perceived but has minor and typically temporary effects. Some remediation may be required.	**Environmental contamination event:** Minor environmental contamination event (of air, soil, land and/or water). Clean-up and rehabilitation may be required but can be completed within days. **Surface water or groundwater:** Minor contamination of natural waterway or wetland occurs, but water quality remains within applicable EPA or ANZECC guidelines for existing beneficial uses. Water extraction or diversion reduces surface water flows or groundwater available for environmental uses, but with no detectable effect on dependent species or ecosystems and carried out within terms of water licence.
Insignificant Impacts are barely recognised and/or quickly recovered from. No specific remediation required.	Hazard event with minimal environmental impact and no noticeable effect beyond the immediate occurrence or expression of the hazard.

Table 27 Likelihood categories

Descriptor	Explanation
Almost Certain	The event is expected to occur in most circumstances. 90% – 100% chance of occurring
Likely	The event will probably occur in most circumstances. 70% – 90% chance of occurring
Possible	The event might occur at some time. 30% – 70% chance of occurring
Unlikely	The event could occur at some time. 5% – 30% chance of occurring
Rare	Highly unlikely, but the risk event may occur in exceptional circumstances. Less than 5% chance of occurring
Eliminated	Risk has been eliminated

Table 28 Risk rating matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Critical
Almost Certain	Medium	High	Very High	Very High	Very High
Likely	Medium	Medium	High	Very High	Very High
Possible	Low	Medium	Medium	High	Very High
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Medium	Medium	High
Eliminated	Eliminated				

Once the risk rating has been established, some risks will need to have controls in place to reduce them to an acceptable level. Higher risk levels should take priority. Table 29 provides guidance on what steps need to be taken depending upon the risk rating.

Table 29 Risk rating acceptability

Risk level	Description
Very High	Totally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels.
High	Generally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels or seek specific guidance from ERR.
Medium	May be acceptable provided the risk has been minimised as far as reasonably practicable.
Low	Acceptable level of risk provided the risk cannot be eliminated.

11.2 Environmental aspects

The expansion of the quarry may have an effect on groundwater, but groundwater may have an effect on the project. Details of these potential impacts are discussed in the following sections and have been summarised in Table 30.

Table 30 Aspects and impacts

Environment	Aspect	Impact
Surface water	Effect of the project on surface water	– Dewatering required to maintain safe and stable working conditions may result in reductions in baseflow to waterways such as Bungalook Creek – Spills/Hazardous materials handling could contaminate waterways
	Effect of surface water on the quarry expansion	– There will be a minor increase in the quarry size and therefore an increase in the volumes of run-off generated into the quarry void
Groundwater	Effect of the project on groundwater	– Deep excavations intersecting groundwater will require ongoing dewatering throughout the quarry life span. This can affect existing groundwater users, GDEs, the generation and release of acidic leachates
	Effect of groundwater on quarry expansion	– A slight increase in quarry seepage volumes will occur. This would require Boral to have the necessary infrastructure to manage, handle, treat and dispose of these flows

11.3 Risk register

The intent of this risk assessment is to identify the key risks of the site operations upon the surface water and groundwater environment and inform the development of a surface water and groundwater monitoring program to address these risks. Specifically, this risk assessment demonstrates that these risk mitigation protocols reduce the residual risk to tolerable thresholds in line with industry norms and legislative requirements. The completed risk register has been attached as Appendix K.

12. Summary of numerical modelling

A numerical groundwater model was developed to quantitatively assess the impact of the proposed expansion on the groundwater environment. The modelling report has been attached as Appendix L and a summary of the work undertaken has been provided in this section. The findings of the numerical model have been incorporated into the impact assessment discussions in section 13.

12.1 Model design

For this project, an unstructured grid version of MODFLOW called USG-Transport version 2.01 (Panday, 2023) has been chosen as the most appropriate modelling platform. USG-Transport is based on the MODFLOW-USG code (Panday et al., 2013) developed by the United States Geological Survey.

The quarry is located approximately in the middle of the domain, with the down gradient edge of the domain extending around 6 km from the boundary of the quarry (large enough to simulate the depressurisation effect of the quarry without incurring boundary-induced effects). The edge of the model domain follows hydrologically sensible boundaries that have been delineated from the expected flowlines of the regional groundwater system (informed by the topography and other regional datasets such as the water table elevation layer from the Visualising Victoria's Groundwater website). These include no-flow boundaries parallel to regional flowlines and along topographic ridges that form groundwater flow divides and through-flow boundaries in the direction of groundwater flow. The model domain has a large total area of 86.5 km^2.

The model mesh uses mostly Voronoi-shaped (tessellated) cells. Within the quarry, 10 m by 10 m rectangular cells are used to ensure consistent (and high) grid resolution across the entire footprint of the quarry area. The mesh is locally refined along major water courses, including Bungalook Creek, Dandenong Creek and Tarralla Creek. Bungalook Creek is refined using 10 m wide cells adjacent to the quarry, to accurately define the alignment of the creek, and the cell size is gradually increased further away from the quarry where accuracy is less critical (increasing to cell lengths of 50 m to 100 m). The mesh is also refined over the extent of the Quaternary Alluvium and along geological contacts, with Voronoi cells of around 50 m to 100 m in lengths. Elsewhere, larger Voronoi cells of more than 250 m in length are used (outside of the expected area of influence of quarrying).

A geological model was developed using the Leapfrog™ modelling software. The surfaces (contacts) from the Leapfrog geological model have been used to define the layers of the groundwater model. Each geological unit within the model domain was initially incorporated as a layer in the groundwater model. Owing to the faulted contact between the Mt Evelyn Rhyodacite and Coldstream Rhyolite, and the need to improve vertical resolution, both of these units were further split into multiple layers. A total of 23 layers were used.

12.2 Boundary conditions

12.2.1 Recharge and evapotranspiration

Recharge and evapotranspiration are simulated using USG-Transport's Recharge (RCH) and Evapotranspiration (EVT) packages. The time-varying recharge and evapotranspiration rates have been derived using a simple water balance model called LUMPREM (Doherty, 2020) which uses daily climate data and soil zone parameters to derive deep drainage, runoff and evapotranspiration. The daily rainfall and pan evaporation data from Bureau of Meteorology (BoM) station 86234, are used as climate inputs to the LUMPREM model.

12.2.2 Stream boundaries

USG-Transport's Stream Flow Routing (SFR) package is used to simulate the major water courses (Bungalook Creek, Dandenong Creek and Tarralla Creek) and their interaction with the groundwater system. The main advantage of the SFR boundaries, compared to alternative head-dependent flux boundaries is that the volume of water available for interaction with the modelled groundwater system is limited to that which has accumulated from upstream within the defined stream channel network (from baseflow, and/or any runoff and artificial discharges, less any diversions). In dry times, there may be no or little water flowing down the stream network, thus avoiding unrealistic leakage of water into the model from these boundaries.

12.2.3 Drains

USG-Transport's Drain (DRN) package is used to simulate the progression of mining and associated dewatering of aquifers. For historical progression, the DRN elevations are sourced from historical mine surfaces at selected time periods (where this information is available). Between these time periods, the DRN elevations are assumed to change linearly (resulting in progressive dewatering as well as backfilling in some places).

12.2.4 General-head boundary condition

USG-Transport's General-Head Boundary (GHB) package is used to simulate throughflow of groundwater across small sections of the model boundary, where the available regional data suggests a component of flow perpendicular to the model boundary. The GHB elevations have been estimated from groundwater levels recorded in nearby registered bores and regional water table elevation map.

12.3 Calibration

Model calibration is a process by which model parameter values are altered within realistic bounds until the model outputs fit historical measurements, such that the model can be accepted as a reasonable representation of the physical system of interest (Barnett et al., 2012).

Given the long history of mining, the model calibration has been undertaken transiently with the calibration period commencing in January 1975 and ending in February 2023. It is understood that quarry commenced in the 1950s, however the limited historical information on quarry elevations suggests that direct interaction with the underlying groundwater may have been limited.

The primary hydraulic head targets are the measurements of groundwater level taken from 15 monitoring bores constructed by Boral (refer section 7.4.2). Modelling was also calibrated against the seepage inflows into the quarry which were estimated from:

- Historical site observations made by both Boral and Golder (2006)
- Sump recovery test completed by GHD (refer section 7.6.3)

PEST_HP, an automated calibration tool was used to assist with the model calibration. During automated calibration, many different parameter realisations are generated. Some are better calibrated to observed heads while others are more closely calibrated to estimated seepage rates and/or baseflow. Qualitative indicators, such as the magnitude of seasonal variations and recharge distribution, are also considered in assessing the reasonableness of model performance. For the purpose of model calibration, a set of model parameters that best satisfy both the heads and flow observations targets was selected and used as the basis for projecting future impacts associated with the proposed expansion. Uncertainty analysis was undertaken to assess the effect of model non-uniqueness arising from parameter uncertainty (refer section 12.6).

12.4 Predictive analysis

The purpose of the predictive modelling was to simulate the hydrogeological effects of the proposed expansion of the quarry and subsequent rehabilitation, and to quantify potential changes to groundwater levels and fluxes (water balance) arising from these effects.

The proposed expansion would involve widening of the quarry footprint and deepening of the quarry base over a period of around 40 years. This will be followed by backfilling of the quarry, which would occur in five stages (each typically lasting around 10 years). The total predictive modelling period is 94 years, which is simulated using 94 yearly stress periods.

In order to clearly separate out the effects of quarry expansion from background hydrogeological stresses, a suitable base case scenario was required. Due to the presence of the existing quarry, there would be antecedent effects on the hydrogeological system as it tends towards dynamic equilibrium if the existing quarry were to remain in place without expansion. For the purpose of predictive modelling, a base case scenario assumed ongoing presence of the existing quarry (the current condition remaining in perpetuity), while an expansion scenario assumed expansion and deepening of the quarry. The effect of the expansion is quantified as the difference between the two scenarios, with the maximum impact (drawdown) occurring at the end of expansion in year 40. This concept is shown in Figure 40.

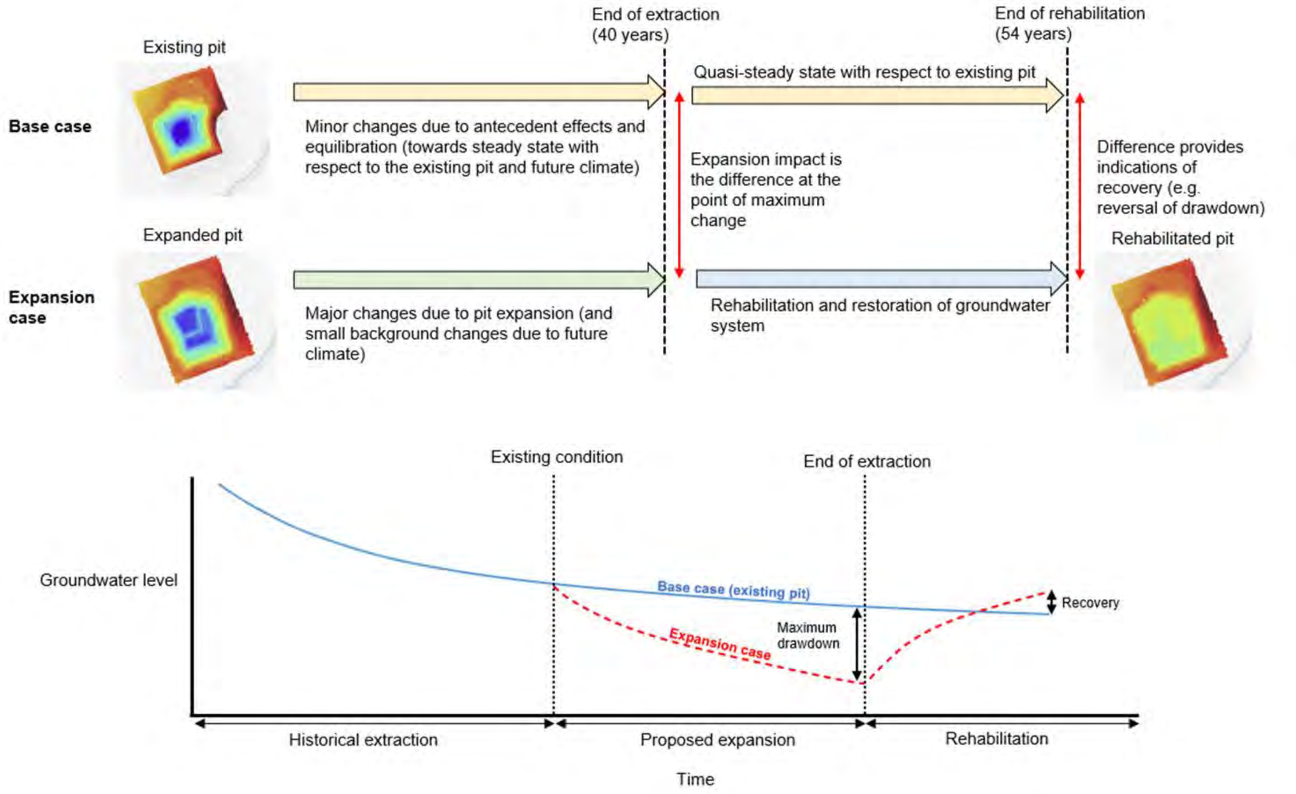


Figure 40 *Workflow for the predictive modelling*

12.5 Climate change

Changes to climate have the potential to affect the groundwater system, primarily by altering the dynamics of recharge and evapotranspiration. Predicting potential changes induced to these processes by future climate variations is challenging due to their dependence on multiple climate variables and complex interactions between vegetation, soil and climate (McCallum et al., 2010).

The potential impact of climate change on groundwater is assessed in this project with reference to the Victorian Government's Guidelines for Assessing the Impact of Climate Change on Water Availability in Victoria (DELWP, 2020). The guidelines provide projections of percentage changes in key climate parameters such as average annual rainfall, potential evapotranspiration and runoff under three climate change conditions (low, medium and high impact). The percentage changes (or scaling factors) for each of the three climate change conditions are provided for years 2040 and 2065, under two emission scenarios referred to as high Representative Concentration Pathway (RCP) 8.5 and low RCP 4.5. The RCP8.5 percentage changes are considered more conservative and have been adopted in this project.

12.6 Uncertainty analysis

Hydrogeological systems are complex natural systems whose properties cannot be measured at all spatial and temporal scales. Hydrogeological processes that have occurred in the past can only be inferred from a finite number of measurements. Simplifications are therefore necessary in groundwater modelling and uncertainty is inherent in all model predictions.

In groundwater modelling, uncertainty in model parameters can lead to the problem of model non-uniqueness or identifiability. This is when the behaviour of the groundwater system being modelled depends on a particular combination of parameters rather than a single parameter in isolation. Because model parameters are uncertain, with a plausible range of values, different combinations of parameter values could result in more than one plausible realisation of the same model.

For the purposes of assessing model uncertainty, a Monte Carlo analysis was undertaken using PEST. This involves running many realisations of the model with a range of parameter values, and using the outputs from these models to estimate the uncertainty range of the outputs produced by the calibrated model. Using this data, GHD has generated a statistical image of the spatial drawdown characteristics, based upon the multiple realisations of the model.

12.7 Model classification

Based on the quality of the calibration achieved and overall performance of the model, a confidence level classification of Class 2 (moderate confidence) is considered appropriate for the project.

Where there are gaps in the hydrogeological knowledge, a rigorous calibration-constrained uncertainty analysis has been undertaken to explore their influence on the predictions of interest. This approach is consistent with the recommendations of the recently revised IESC uncertainty guidelines (Peeters and Middlemis, 2023), which suggest that the confidence level classification of the Australian Groundwater Modelling Guidelines is no longer a useful measure of whether or not the model is fit for purpose, and more efficient and effective uncertainty analysis should be undertaken to address recognised data gaps and limitations of the model.

13. Impact assessment

13.1 Operation phase

13.1.1 Impacts to Bungalook Creek and GDEs (water availability)

13.1.1.1 Description of risk pathway

There are basically three forms of potential GDEs relevant to the Montrose quarry: the aquatic ecosystems with the nearby waterways (Bungalook Creek), their associated riparian habitats, and terrestrial vegetation further removed from the waterways, e.g., Scrubby Gulley and forests. This assessment focuses on the changes to streamflow (specifically Bungalook Creek as it is the nearest waterway to the quarry) and regional groundwater levels. The values of these ecosystems, their potential reliance upon groundwater, and the effect of reduced water levels or streamflow has been addressed in separate ecological studies.

The three potential GDEs can be at risk due to three pathways:

- Dewatering reducing groundwater levels around the quarry

  Groundwater levels underlying the terrestrial vegetation are lowered to depths that are beyond the reach of roots, i.e., access to the groundwater is reduced and/or removed
- Dewatering reducing baseflow contributions to Bungalook Creek

  As discussed in the hydrogeological conceptualisation, surface and groundwater systems can have varying degrees of interaction and hydraulic connection. Groundwater can discharge to waterways providing a baseflow contribution to the waterways. Groundwater drawdown occurring close to waterways can alter hydraulic gradients and reduce baseflow, thus impacting upon the streamflow in the waterway (this is quantified by the numerical groundwater model)
- Changes in the catchment size/surface conditions effecting the run-off and streamflows in Bungalook Creek

  The expansion of the quarry will remove approximately 15 ha of vegetated area to the south and east of the existing quarry (this is a minor volume in the overall catchment)

13.1.1.2 Assessment of the impact – changes in groundwater level

The extent of drawdowns is influenced in how the behaviour of Bungalook Creek is treated in the set up of the numerical groundwater model. Two approaches that were examined by the numerical model were:

- Treating Bungalook Creek as solely receiving baseflow, i.e., when groundwater levels fall below the elevation of the stream bed, there is no longer flow in creek. This was the approach adopted by Golder (2006) but ignores the much larger volumes of stormwater run-off that contributes streamflow to the waterway. It is realistic under an extreme condition with an extended period of little to no surface water flow contribution
- Routing flows in Bungalook Creek, i.e., this approach incorporates the baseflow component noted above, but it also includes modelling streamflows in the waterway such that depending upon head conditions, leakage can occur from the stream to the groundwater. If there is flow in the waterway but the groundwater level has been drawdown under the streambed, this will create a hydraulic gradient causing a proportion of this streamflow to leak downwards and recharge the groundwater system. This, in turn influences groundwater behaviour elsewhere, i.e., if some streamflow is lost through leakage, it results in less streamflow further downstream being available to leak and recharge groundwater in these downstream areas (where the influence of drawdown may have extended to)

The two approaches are documented in Appendix L, however, as the streamflow routing is considered to represent a more realistic approach, it has been adopted for the impact assessment. As part of the uncertainty analysis, 131 realisations of the calibrated model were generated and the upper bound estimate of drawdowns determined at the end of the expansion (Figure 41) and during the quarry rehabilitation phase (Figure 42). This means that 95% of 131 realisations of the model have drawdowns which are less than that shown in the two figures.

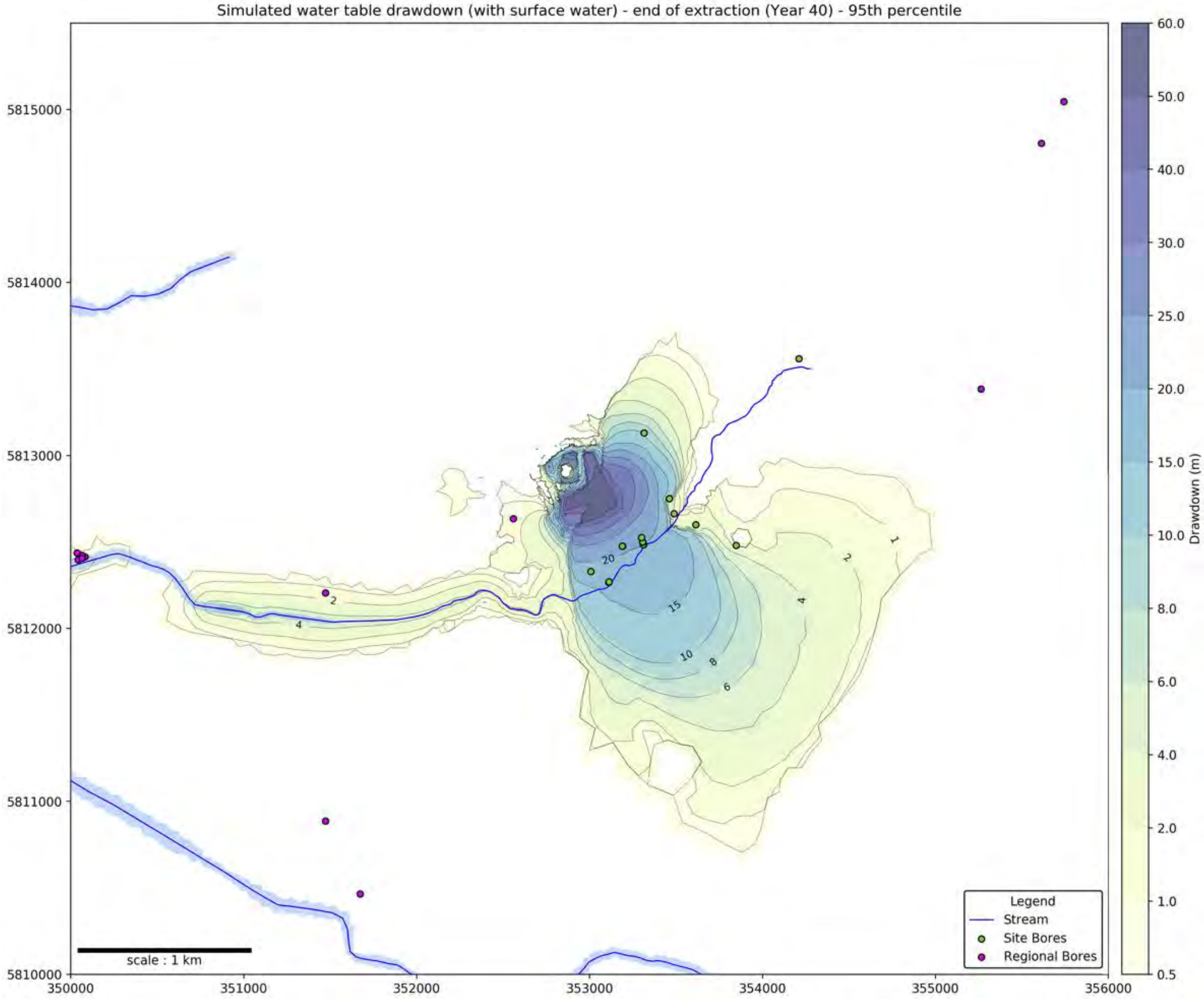
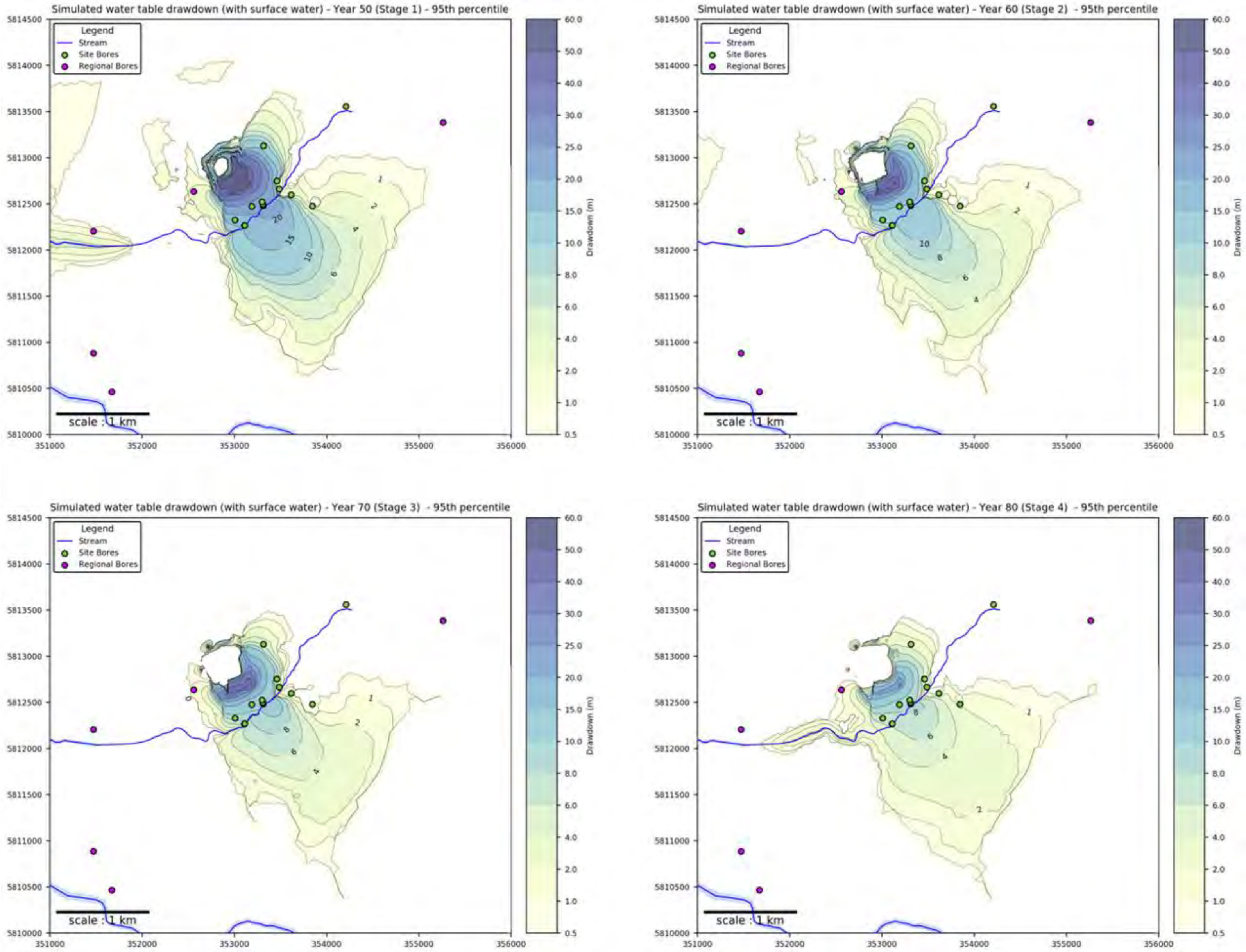


Figure 41 *Simulated water table drawdown at end of extraction period (95th percentile)*

It is noted that the groundwater drawdowns shown in Figure 41 is not instantaneous but occurs over a 40 year period, and represent the net change from a condition of the existing quarry remaining in place in perpetuity. The gradual decline in water levels predicted over the 40 years of expansion provides some opportunity for some dependent vegetation to adapt to the falling water levels, but also for Boral to monitor and implement appropriate mitigations. Some species may suffer a decline in condition or premature mortality depending upon their ability to access groundwater. The ability for species to access water would depend upon:

- Current groundwater depth
- Species and known rooting depths
- Modelled drawdowns

The depth to groundwater maps generated from numerical modelling suggest that areas of shallow water table are likely along Bungalook Creek. However, the GDE study completed by EMM (2025) indicates the "*risk of terrestrial GDE occurrence in the project area is low to negligible*" (with vegetation meeting their water requirements from soil moisture). While there is some uncertainty on groundwater reliance of vegetation within the broader area of modelled drawdown, the depth to groundwater in higher topography areas (away from the creek) is expected to be already be beyond the accessible threshold depths for mature trees. The ecology assessment outlines future monitoring requirements to verify this expected low level impacts from groundwater drawdown.


Simulated water table drawdown (with surface water) - Year 50 (Stage 1) - 95th percentile

Simulated water table drawdown (with surface water) - Year 60 (Stage 2) - 95th percentile

Simulated water table drawdown (with surface water) - Year 70 (Stage 3) - 95th percentile

Simulated water table drawdown (with surface water) - Year 80 (Stage 4) - 95th percentile

Figure 42 *Simulated water table during rehabilitation (95th percentile)*

The effects of climate change were quantified by comparing the drawdowns between the base case quarry (existing quarry continuing in perpetuity) to the expansion case model and repeating this process for each of the three DELWP climate change conditions (low, medium and high impact).

The climate change scenarios did not identify a significant change in the drawdowns simulated between the base climate and low climate change condition, which was not unexpected given the relatively small changes to recharge, evapotranspiration and streamflow. For the medium and high climate change conditions, greater drawdown is simulated along Bungalook Creek and beyond. The contours also show a larger area of downstream drawdown for the base climate and low climate change condition compared to the medium climate condition (refer Appendix L). This is because under these drier climate change conditions, a much greater overall reduction in streamflow and recharge means the drawdown impact of the quarry becomes more pronounced, i.e., greater drawdowns occurring beneath the waterway, inducing greater leakage from the waterway, however, there is less streamflow available to leak and recharge the underlying groundwater system. This results in a much broader area of impact downstream.

13.1.1.3 Assessment of the impact – changes in baseflow

The numerical modelling indicates that during dry periods, when the total streamflow is less than 10 L/s, all of the streamflow is lost as leakage due to the expansion of the quarry and associated drawdown of the water table. During these low flow periods, the loss of streamflow in the upstream section of Bungalook Creek results in localised drawdown along the downstream section of Bungalook Creek. The downstream losses and localised drawdown are shown in Figure 41.

Uncertainty in the modelled streamflow is demonstrated in Figure 43, which shows the modelled streamflow at gauge 228369A for all 131 realisations applied in the uncertainty analysis. During periods of normal flow, the uncertainty in streamflow arising from the uncertainty in model parameters is around 5 L/s. During periods of low flow and high drawdown (from year 35 to 58), the uncertainty range is wider (up to around 10 L/s) and this influences the frequency and duration of periods with limited to no streamflow.

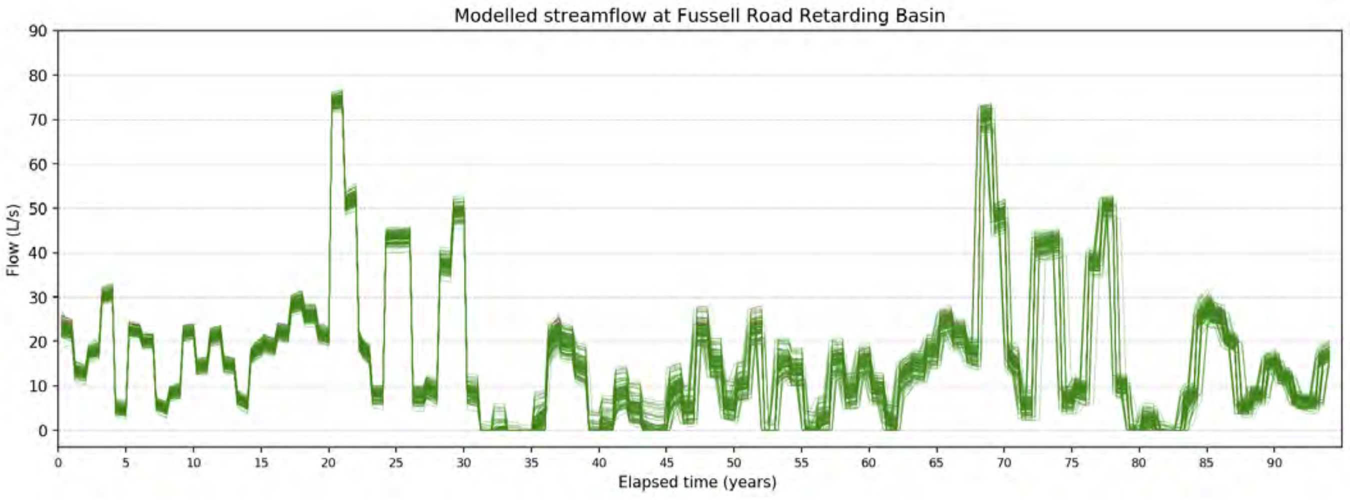


Figure 43 *Modelled streamflow – uncertainty analysis*

When compared with the outputs from the climate change assessment, the uncertainty in streamflow due to model parameter uncertainty is less than that arising from the uncertainty in future climate (with the latter indicating potential flow differences of 20 L/s or more).

13.1.1.4 Management controls

Boral recognises the importance of maintaining the condition of Bungalook Creek and its associated habitat, as well as the terrestrial vegetation of the Dr Ken Leversha Reserve, as these form buffers between the industrial operations of the site, and neighbouring residential areas.

Boral currently reuses groundwater seepage water for onsite industrial uses, before returning it to Bungalook Creek under their EPA discharge licence. This regime would continue throughout the quarry expansion, as there is no other practicable and cost effective means of disposing of the water. For example, waters could be disposed to sewer, however, this has an ongoing cost (trade waste agreement fees) and does not replenish flows in Bungalook Creek. It is noted:

- Discharge to Bungalook Creek occurs downstream of the retarding basin using the local council stormwater drainage network. In this regard, the water quality may be altered through the addition of urban stormwater pollutants that are harvested through this drainage network
- Current EPA discharge is limited to 0.86 ML/day. This may require amendment during the later phases of the expansions when groundwater seepage rates (and stormwater inflows into the quarry) increase (refer section 13.1.3)
- Returning groundwater seepage to Bungalook Creek (downstream of the quarry) is beneficial to maintaining stream flows (and associated aquatic ecosystems), however, it is recognised that only a proportion of this returned flows could become groundwater recharge (via leakage from the waterway)

It is noted that Boral monitoring bores adjacent the creek currently have groundwater levels similar to those recorded 19 years previously, despite a significant increase in the quarry depth over this period. This suggests that stream flow events are important to maintaining soil moisture in the alluvials and adjacent MDVC and therefore maintaining potential vegetation accessibility to water. Implementation of a monitoring program is required to verify the groundwater behaviour adjacent to sensitive receptors such as Bungalook Creek (and associated impacts of baseflow changes on streamflow dynamics and dependent ecosystems). This has been documented in Appendix M.

Further ecological studies have been completed by EMM (2025), which indicated there were *“not any GDEs in the project area and the risk of terrestrial GDE occurrence in the project area is deemed to be low to negligible”.* EMM (2025) indicated that existing vegetation is accessing available moisture within at least the top 3 m of the soil profile, rather than relying on groundwater. This further suggests that the replenishment of soil moisture by streamflow events is likely to be more important to the health of vegetation along Bungalook Creek than the changes to baseflow characteristics that may arise due to the project.

13.1.1.5 Groundwater recharge system

The focus of the mitigation works would be to increase soil moisture/water availability for GDEs and to target those ecosystems that are at risk. The above discussion identifies that groundwater drawdowns will occur as a result of the quarry expansion, however, ecological studies undertaken by EMM (2025) suggest low potential for terrestrial GDEs as vegetation along Bungalook Creek is more likely to depend on soil moisture that is replenished by surface water flow. Notwithstanding that, an assessment of a possible recharge system has been completed to understand the potential effectiveness such control measures where ecosystems may be perceived to be at a risk of impact from groundwater drawdown (or streamflow reduction).

The recharge scheme could involve one or more of the following processes:

- Source water would be derived from the groundwater seepage into the expanded quarry
  - Source water quality would need to have sufficient treatment to comply with:
    - The water quality objectives of the aquifer and maintain its environmental values (protection of freshwater ecosystems)
    - Minimise contaminants, e.g., microbiological, suspended solids, that could promote fouling of the injection system, i.e., continue to meet EPA discharge licence conditions
- Completing technical studies to understand the environmental watering requirements
  - Discharge currently occurs through the year; however, some ecosystems may require defined wetting and drying periods, i.e., is there a need to mimic natural recharge
  - Depending upon the quarry extraction plan, at certain stages, e.g., accessing the low point of the quarry, Boral may not have the capacity to ‘store’ large volumes of water (run-off and groundwater seepage)
  - Whether water application can occur to general areas of the site, targeted to specific sensitive habitats or maintain stream flow within Bungalook Creek
- Identify the preferred watering approach and when it should be implemented
  - As noted above, direct discharge to Bungalook Creek (the status quo) is the least complicated means to manage groundwater seepage. However, it does not necessarily maximise the mitigation of the

    groundwater drawdowns as only a proportion of the returned water would leak from the streambed and become a groundwater accession

  - Construction and maintenance of irrigation systems, e.g., sprinkers, drippers
  - Installation of water control structures on Bungalook Creek, or its tributaries, noting this would require work on waterway approvals from Melbourne Water and may not be a practical option
  - Relocating the discharge point further upstream of the retarding basin (subject to flood analysis and Melbourne Water approvals)

- Undertake monitoring of the system to assess its performance

The numerical groundwater model was applied to assess the efficacy of a recharge system. This modelling examined two options for the return of the groundwater seepage water to the environment, and the results are discussed below:

- Direct disposal to Bungalook Creek, i.e., maintaining the status quo

  The modelling suggests that the increased stream leakage from the higher flow may not be sufficient to prevent drawdown along the creek and in adjacent areas. The hydrograph of the maximum water table drawdown simulated along Bungalook Creek indicates that the additional flow could limit the maximum drawdown to no greater than 5 m but does not reduce it to zero (refer Appendix L)

  It is noted that the numerical modelling is potentially conservative, as the stream boundary condition is not configured to simulate wider stream extents and higher stream levels that may arise from the higher flow, i.e., as the waterway floods, it may break its banks and flood a wider area, providing a greater amount of recharge. More detailed modelling, supported by additional data on surface water-groundwater interactions, would be necessary to confirm the effectiveness of this mitigation option

- Establishment of an injection system, i.e., network of bores that can recharge the groundwater table

  The modelling has shown that groundwater recharge (refer Figure 44) can be very effective in mitigating groundwater drawdowns close to Bungalook Creek. However, it requires the groundwater recharge system to have the capacity to inject all of the flows as they gradually increase over the expansion period. If aquifer hydraulic conductivities are low, the size of the recharge system will have to increase, e.g., more closely spaced injection bores

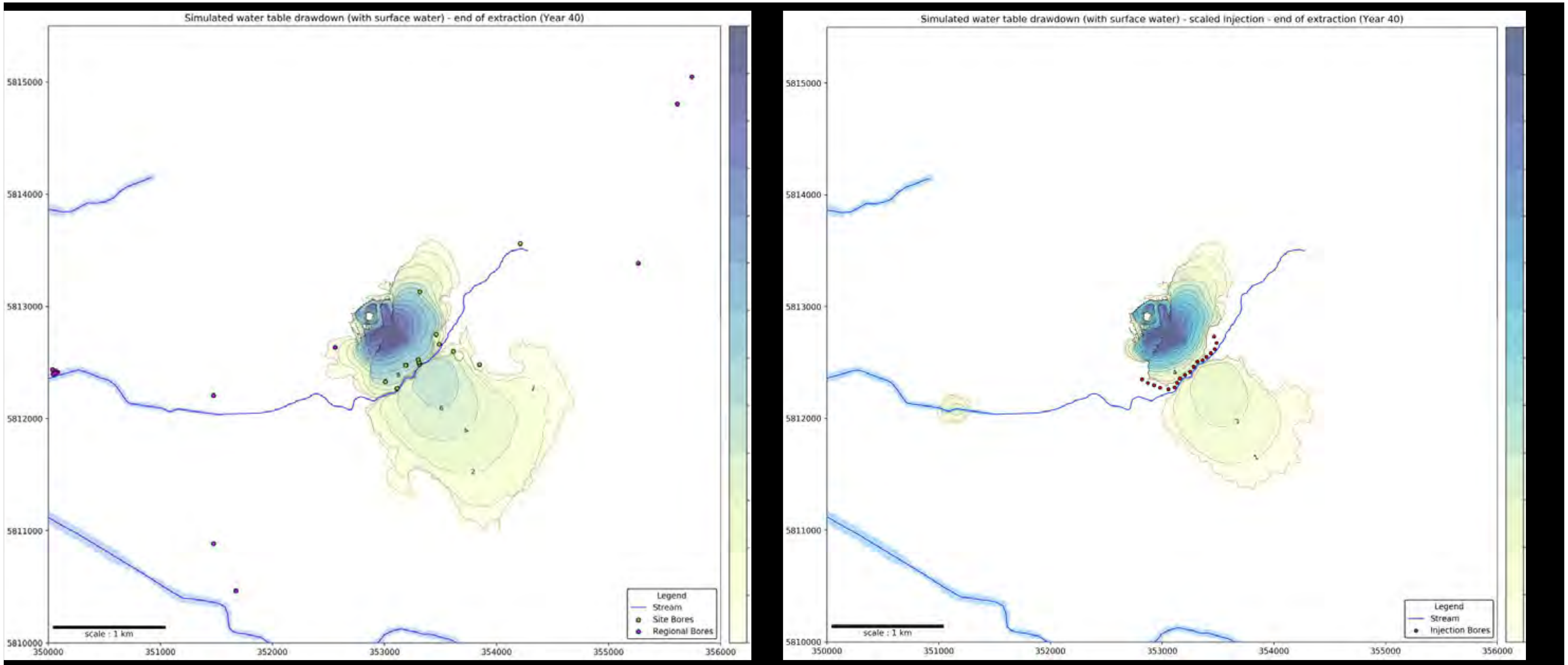
  As noted in Golder (2006) a combination of systems may be required, e.g., direct creek discharge, irrigation, soakage trenches and injection bores. This assessment has not considered the practicabilities of installing such as system and notes that its footprint may require disturbance to existing vegetation

Returning the quarry water back into the aquifer via induced stream leakage or an injection system (bores or trenches) has the potential to result in some recirculation of that water.

Site investigations would be required to assess the ability of the aquifer to take the water, and a monitoring program implemented to assess its effectiveness. The recharge to groundwater would also require approval from Southern Rural Water.

Regardless of the hydrogeological properties, a practical measure for directly offsetting drawdown would likely require a system capable of capturing and redirecting the majority of groundwater seeping into the quarry which could replenish the aquifer storage and reduce drawdown extents.

While the assessment finds the recharge system to be potentially effective, significant planning and investigation efforts will be necessary to ensure successful implementation. Based on the low potential for terrestrial GDEs identified by EMM (2025), this level of mitigation may not be warranted and the management efforts may be better targeted at redirecting flow to Bungalook Creek, similar to the current practice, which would top up the soil moisture and maintain the streamflow downstream of the project area.



Drawdown at end of quarrying (discharge of seepage to Bungalook Creek)

Drawdown at end of quarrying (with injection system)

Figure 44 *Simulated drawdown with continued discharge to Bungalook Creek, and with recharge system*

13.1.2 Impact on existing groundwater users

13.1.2.1 Description of risk pathway

Pumping from a groundwater bore results in a decline in groundwater levels surrounding the bore. The decline in water level is referred to as the “drawdown cone” or “cone of depression” around the pumping bore. The drawdown decreases with distance from the bore (refer Figure 45) and expands in size whilst pumping occurs until steady-state conditions are reached. In terms of the Montrose quarry, the quarry is analogous to a pumping bore in that it presents a point of take in the MDVC aquifer, with the pumping rate being the sump dewatering rate.

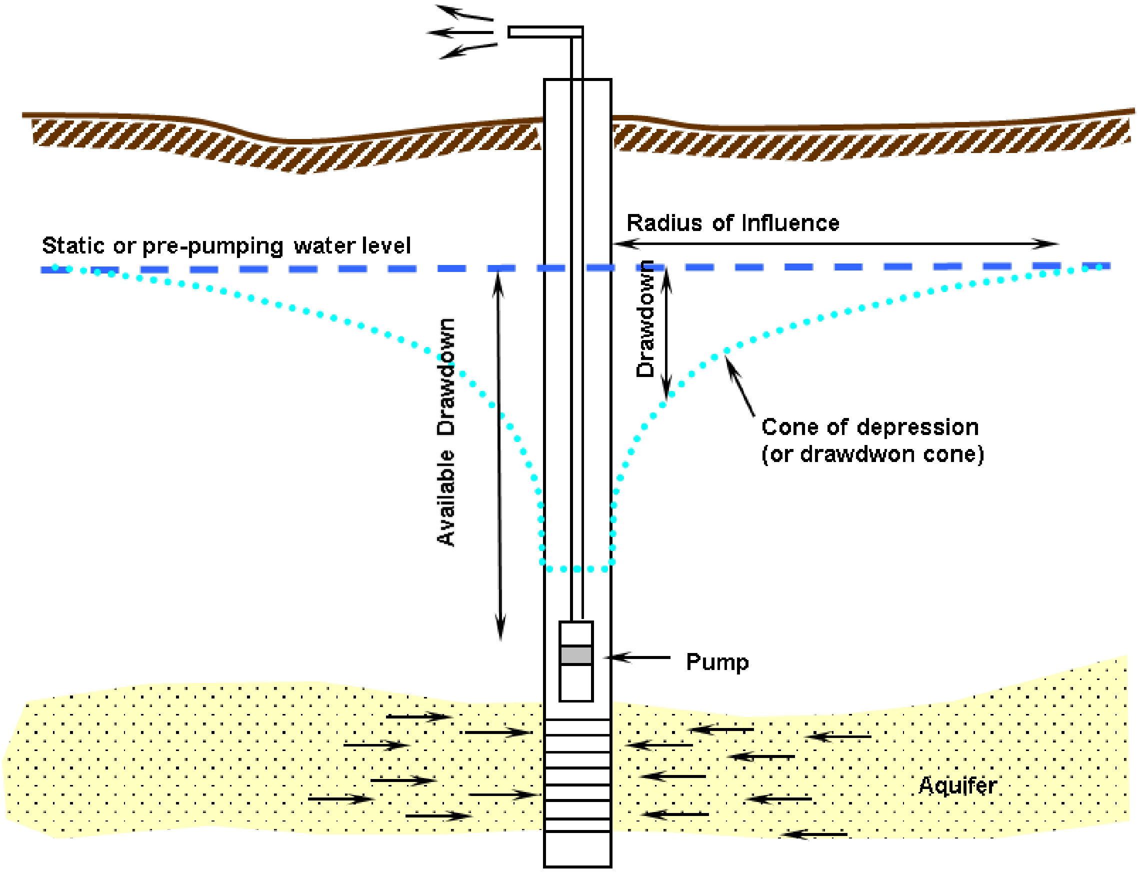


Figure 45 What happens when a bore is pumped

The distance the drawdown cone extends depends primarily on the nature of the aquifer, the pumping rate and pumping duration. If the aquifer system consists of fractured rock, or is of odd geometry, the shape and form of the cone may vary or extend further in certain preferential directions. If the drawdown cone extends such a distance from the pumping or production bore that it intersects other bores or in the case of unconfined aquifers, environmental features (e.g., creeks, rivers, coastline), it is said to have interfered with these features, i.e., interference has been manifested.

The effect of interference is shown in Figure 46, which schematically depicts a pumping bore, three neighbouring bores and a creek. Interference can become a significant issue because it can affect the amount of water pumped from a neighbouring bore and can reduce environmental water flows in unconfined aquifers. The significance of the bore interference will depend on many factors, the most important being the impact on the available drawdown in the neighbouring bore. The available drawdown in a bore is defined as the distance between the standing water level and the pump intake. Interference reduces the size of the available drawdown in the bore.

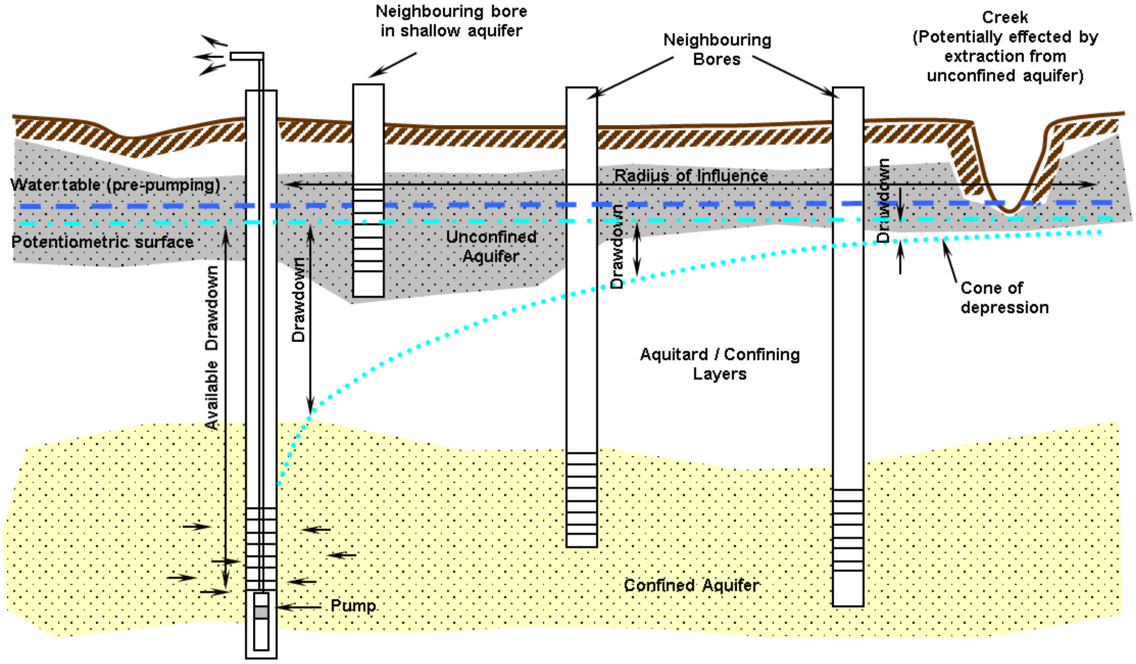


Figure 46 *Bore Interference*

Licensing authorities, in this case Southern Rural Water, need to be confident that the expansion of the quarry or increasing licensed allocations from the existing quarry will not cause significant interference on the existing surrounding groundwater users (including the environment) prior to issuing an extraction licence. Acceptable interference limits between bores have been generally adopted from the guidelines recommended by the Rural Water Corporation (1993). In terms of a basis for acceptable limits:

- Poorly defined Aquifer System: Upper limit of acceptable interference is 10% of the available drawdown in the neighbouring bore; and
- Well defined Aquifer System: Upper limit of acceptable interference is 20% of the available drawdown in the neighbouring bore

13.1.2.2 Assessment of impact

Registered groundwater bores were identified using the WMIS (refer Appendix E) and these were overlaid with the contours of drawdown derived from the uncertainty analysis completed by the numerical modelling. Table 31 summarises the use, depth, location and proximity of these registered bores to the boundary of the quarry, and provides comments on the magnitude of drawdown predicted by the modelling.

To assess whether this drawdown would result in an unacceptable impact, it has to be compared to the pump intake depth (available drawdown within the production bore). Pump depth information is not contained on the WMIS and not publicly available, however, inferences can be made based upon the bore depth. Based upon the regional geology, the majority of bores develop fractured Palaeozoic rock aquifers, i.e., Melbourne Formation equivalents or the MDVC. These geologies tend to be low yield aquifers and require a reasonable amount of aquifer penetration in order to intersect sufficient water bearing fractures.

A bore census has not been undertaken and therefore the operation status of these bores is not known.

Whilst specific assessment of interference impact has not been completed, it is noted that bores within 1,000 m of the quarry have an elevated risk of impact. Stock and domestic bores are typically low use bores, used intermittently, however, there is an industrial bore (WRK056003) located on Fussell Road and such is a licensable use. Small changes in the available drawdown in stock and domestic bores may not result in significant detriment to their operation. However, an industrial use bore may be used more regularly.

Table 31 ***Registered bores within predicted area of influence***

Bore ID	Registered use	Depth (m)	MGA95 AMG Coordinates		Date of construction	Approximate distance from quarry (m)	Comment
			Easting	Northing			
139907	Dewatering	90	352673.2	5813184.1	1956	80	This bore falls within the footprint of the Boral quarry and is thought to be an old dewatering bore? It has been ignored in the analysis.
WRK056003	Industrial	108	352560	5812634	2009	570	This bore plots on an industrial site on Fussell Road. It is estimated to get around 15 m of drawdown.
81043	Stock & domestic	51.8	353953.2	5811984.1	1974	950	Upwards of 15 m of drawdown are predicted, however, most of uncertainty realisations indicate less than 10 m of drawdown.
81044	Stock & domestic	73	353953.2	5811984.1	1975	950	
81045	Stock & domestic	64	353873.2	5812004.1	1975	880	Upwards of 18 m of drawdown are predicted, however, most of uncertainty realisations indicate less than 10 m of drawdown.
81061	Stock & domestic	121	351473.2	5812204.1	1991	1,340	Less than 5 m of drawdown predicted
81067	Stock & domestic	112	351673.2	5810464.1	1990	2,330	
WRK032565	Industrial	100	351611	5811577	1997	1,500	
134221	Stock & domestic	91.3	351193.2	5809664.1	1998	3,250	
WRK983590	Not specified	24	351660	5812926	Not known	940	Less than 1 m of additional drawdown
WRK967196	Stock & domestic	45	350277.2	5812832.1	2004	2,330	
WRK968757	Stock & domestic	19	350680	5814860	2005	2,620	
81055	Stock & domestic	64.57	355263.2	5813384.1	1983	2,000	

13.1.2.3 Management controls

The key control for Boral is monitor the groundwater levels in their bore network and verify that the drawdowns observed are consistent with the numerical groundwater model predictions. If there is a significant deviation from the model predictions, this would be a prompt for Boral actions, which could include:

- Increasing the monitoring frequency
- Re-calibration of the numerical groundwater model

If the monitoring indicates that the a nearby bore is going be impacted, it is potentially an impediment for Southern Rural Water to increase Boral's take and use licence volume. However, there are a number of options available to Boral to mitigate against the drawdown impacts it could be creating on nearby bores:

- Confirm whether the bores are still operational, and implement monitoring in the (potentially) impacted bore
- Negotiate with the bore owner regarding continued access to the water supply. This could include:
  - Compensating the bore owner to lower the production pump, or drill a deeper replacement bore
  - Providing alternate water, e.g., derived from mains supply

These above options are less desirable to Boral as there is a risk of ambit claims or possibly hostile bore owners that may be unwilling to negotiate. Aquifer recharge could be undertaken by Boral, e.g., injecting water between the bore owner and the quarry, however, this may not be a cost effective solution compared with other options.

Therefore, a monitoring plan that relies upon confirming the dewatering extent (and the magnitude of change in groundwater levels over time) is a preferred approach.

13.1.3 Impact on groundwater resource

13.1.3.1 Description of risk pathway

Groundwater development over the sustainable yield of the aquifer system can lead to a number of issues including:

- Reduction in groundwater levels which may reduce access to groundwater by abstractive groundwater users, e.g., stock and domestic, and licenced (irrigation)
- Damage to the aquifer, e.g., compaction
- Reduction in streamflows and access by GDEs

This risk may be realised when the take of groundwater from the aquifer is proportionally large to the sustainable limit of the aquifer, or in cases where there is an existing high level of groundwater use. As the quarry expands, it is predicted to have increased inflow, and therefore it may be required to increase the annual entitlement attached to its groundwater extraction licence.

13.1.3.2 Assessment of impact

The quarry is within an Unincorporated area, which means:

- There are currently no caps on the total volume of groundwater that can be taken, i.e., no Permissible Consumptive Volume (PCV) has been established
- There are no local groundwater management rules that limit the take of groundwater. The volumes that can be taken are determined by Southern Rural Water on an individual licence basis but subject to assessment of the impacts of the take. When assessing any amendment to an extraction licence, Southern Rural Water make a determination as per the requirements of the Water Act (1989)

Some stock and domestic bores have been identified within 1 km of the quarry, but in general, there is a very low level of existing groundwater development. This is due to:

- The existing land uses. Much of the land surrounding the quarry has been urbanised or is either forest reserve or part of the Dandenong Ranges National Park

- The low yielding nature of the underlying aquifers. The aquifer is not conducive to high volume groundwater extraction

The aquifer system is regionally extensive, and the existing entitlement held by Boral presents only a small proportion of the overall recharge to (and storage within) the aquifer. Numerical modelling has been applied to quantify the potential inflows into the quarry, but also the influences to seepage from climate change.

Inflows into the quarry were determined for each of the 131 realisations of the model as part of the uncertainty analysis which has been shown in Figure 47. Figure 47 also shows the 5th and 95th percentile inflows, where there is generally a 2.5 L/s to 5 L/s range of uncertainty across the modelling period. The highest inflows occur towards the end of the extraction period, i.e., upwards of 20 L/s, and during the initial 20 to 30 years into rehabilitation.

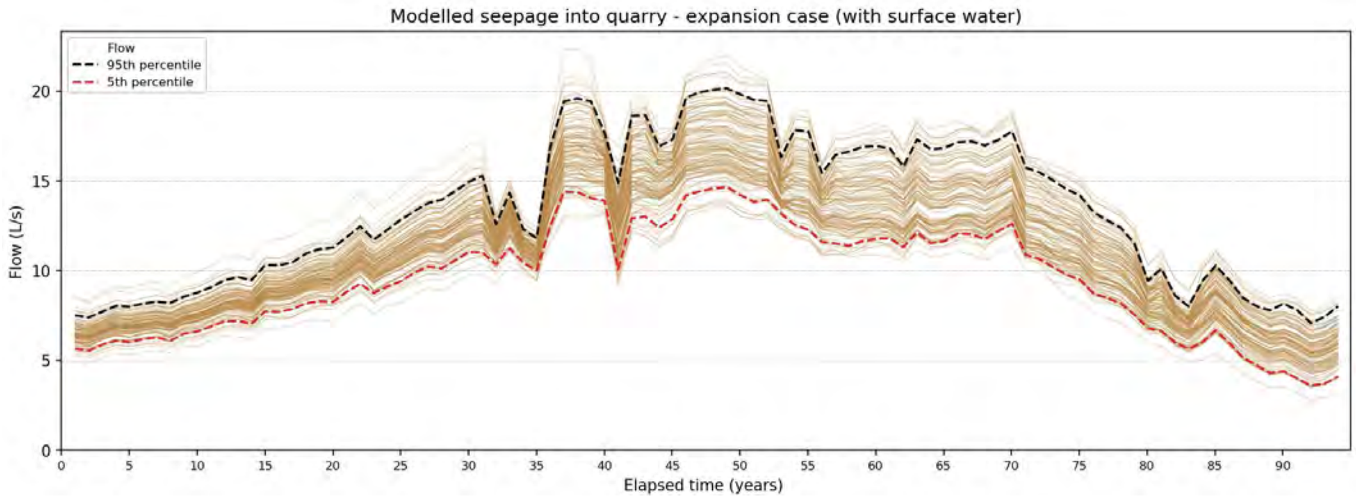


Figure 47 ***Modelled seepage into quarry – uncertainty analysis***

Currently Boral returns seepage (and stormwater run-off) to Bungalook Creek under its EPA discharge licence. Such return of flows is not expected to change in the future, however, it is noted that:

- If Boral has to implement aquifer recharge to protect terrestrial ecosystems, and riparian habitats of Bungalook Creek, a proportion of the recharge will be recycled through the aquifer, i.e., that component lost to evapotranspiration. Such recharge may stem the extent of drawdown and thus provide protection to neighbouring groundwater users.
- Risk of damage to the aquifer through processes such as subsidence from groundwater withdrawal are consider negligible in the fractured rocks at, and surrounding the quarry

13.1.3.3 Management controls

In terms of resource availability, Boral would need to implement a monitoring program of the volumes pumped to ensure compliance with their groundwater extraction licence. Should inflow rates approach their annual entitlement, an application would need to be made to increase their entitlement volume, which would trigger further hydrogeological assessment to support the licensing determination. This is considered a reasonable control to protect existing groundwater users and groundwater dependent environments, noting that these two potential impacts have been previously discussed above.

13.1.4 Impact on groundwater quality

13.1.4.1 Description of risk pathway

The groundwater quality could be impacted by several pathways including:

- Storage and handling of hazardous materials, e.g., refuelling and maintenance of plant
- Recharge of contaminated groundwater
- Seepage from sumps and onsite storages

13.1.4.2 Assessment of impact

In terms of quarry operations, there is little need to introduce hazardous materials or contaminating land uses. The quarry has existing environmental management plan and controls are in place regarding:

- Refuelling of plant
- Maintenance of plant
- Storage and handling hazardous materials on site
- Spill kits

The site operations are typical of quarrying practices throughout Victoria and the ongoing operation of the site is not expected to alter the risk profile in terms of having an impact on groundwater contamination. The site environmental controls and emergency response procedures are considered reasonable to mitigate this risk. Groundwater quality was initially characterised by Golder (2006). Since this period, there has been no further monitoring of groundwater quality and therefore characterisation prior to quarry expansion would be prudent.

Nitrogen compounds (commonly nitrate) can be introduced into the water environment through blasting practices undertaken at a quarry. This can be derived from the explosive emulsions, e.g., ammonium nitrate is commonly over 90% by weight in ANFO[1]. Excess nutrients can create algal nuisances in waterways that receive groundwater discharge. However, it is noted that during quarry, the dewatering would result in the quarry acting as a sink in the regional water table, drawing groundwater (and any contaminants) towards it. Therefore, the risk of offsite discharge (other than what occurs under licence) would be low.

As noted in section 13.1.1, groundwater recharge may be implemented to protect soil moisture and potential GDEs. This would involve the reinjection of the water intended to be discharged to Bungalook Creek, i.e., using groundwater seepage into the quarry collected within the sump. The injection of groundwater cannot have an adverse impact on the environmental values (beneficial uses) of the aquifer and therefore Boral needs to ensure that the recharge water is of the same or better standard than the receiving aquifer, i.e., compliant with the ERS (2022). In order to implement an aquifer recharge scheme, Boral would need to obtain approvals from Southern Rural Water (and its referral agencies such as the EPA), and therefore safeguards exist on this activity. Furthermore, aquifer recharge requires a high quality water (in terms of micro-organisms, and suspended solids) to minimise fouling and adverse impacts to the operation and maintenance of a recharge system. Therefore, it is prudent from a commercial and operational perspective that Boral maximises the water quality to reduce maintenance activities on a reinjection scheme should such be installed.

13.1.4.3 Management controls

As noted above, the existing site environmental controls are considered sufficient to reduce the risk of the impact from the spills and storage and handling of hazardous materials.

There are licensing approvals required with aquifer recharge as well as a need for the recharge water to comply with the environmental values of the receiving aquifer, and challenges associated with minimises clogging and impairment to the system operation. These are considered reasonable controls to protect groundwater quality.

The understanding of the current groundwater quality, and the potential influence of blasting and other site activities is not known and currently forms an objective of the proposed monitoring program.

Boral will need to continue to monitor the condition of the water discharged to Bungalook Creek to verify their compliance with their EPA discharge licence.

13.1.5 Impact on contaminated groundwater

13.1.5.1 Description of risk pathway

There are neighbouring contaminated sites to the quarry, and if contaminated groundwater exists at these sites, there is a risk that the plumes may be captured by the quarry dewatering. The quarry dewatering creates a localised depression in the water table, which is analogous to a ‘capture zone’ that develops around a pumping

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[1] ANFO – Ammonium Nitrate Fuel Oil

bore. The concept for a pumping bore is shown in Figure 48 which describes a zone of influence and a zone of contribution:

- ZOI
  - The Zone of Influence is the cone of depression, i.e., the areas surrounding a pumping bore (or quarry intersecting the water table) within which the water table or potentiometric surface has been lowered due to groundwater extraction
- ZOC
  - The Zone of Contribution is the area up-gradient and down-gradient from the ZOI that contributes groundwater to the extraction bore (or quarry intersecting the water table). The ZOC is the recharge area supplying water to the wellhead

If the contaminated groundwater plume lies within the zone of contribution, it may be dislocated, with contamination migrating towards the quarry. The capture zone does not equal the cone of depression created by an extraction bore, except in those cases where water tables are flat. At some point down gradient of an extraction bore, the pull of water from the bore is balanced by the natural groundwater flow away from the bore. This point is defined as the stagnation point.

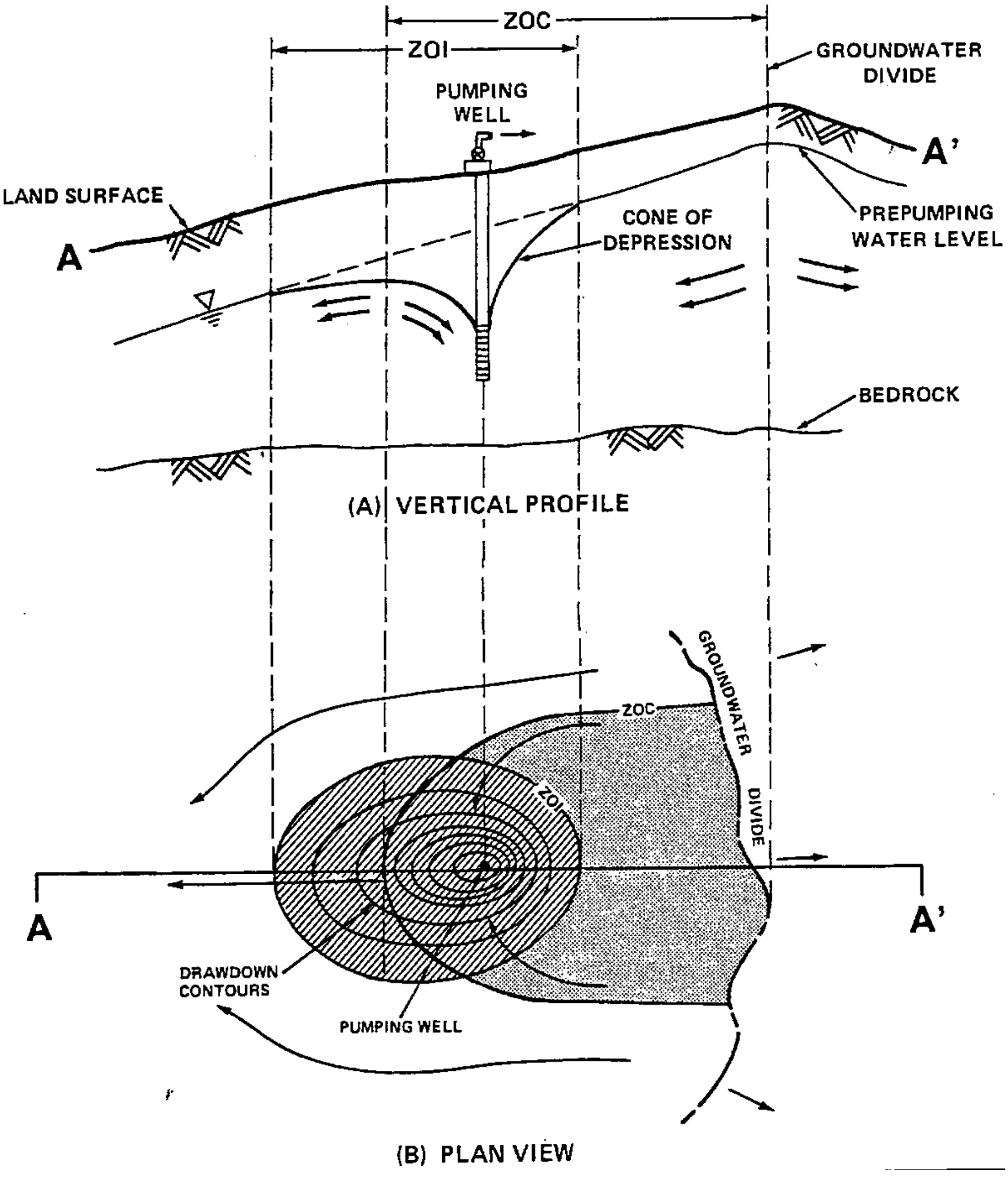


Figure 48 *Capture zone*

Source: US EPA (1987)

13.1.5.2 Assessment of impact

As noted in section 5.1.4, registered contaminated sites have been identified at 76 Fussell Road (Lots 1 and 2, with the former being subject to environmental audit). There may be other land uses contributing to groundwater contamination local to the quarry, e.g., the commercial/industrial land uses adjacent to Canterbury Road.

Part of the registered site at Fussell Road has been subject to contamination assessment. Source removal activities have been completed (e.g., removal of storage tanks and impacted soils), and there was evidence that natural attenuation of contamination was occurring.

Within the zone of contribution, if there is impacted groundwater at these sites, it would be drawn towards the quarry. Given the proximity of the Fussell Road site to the quarry, it is likely that this currently occurring. The expansion of the quarry may result in a steepening of hydraulic gradients, which may marginally increase groundwater migration rates. It is noted that the aquifer permeability tends to be very low and results in low migration rates.

There are a number of factors which suggest that risk arising from plume disturbance (if still present) is low, include:

- The Environmental Auditor (EES 2014) noted the that:
  - No Non-aqueous phase liquids (NAPL) were present
  - Contamination was within the boundary of the site
  - The extent of contamination is stable and unlikely to migrate beyond the boundary of the site boundary
- No residential properties between the site and the quarry, i.e., low risk of volatile contamination impacts
- Travel distance and residence time in the aquifer permit further attenuation of any remaining contamination
- Concentrations may disperse as the flows are combined with the other radial groundwater inputs into the quarry sump
- It is likely that quarry operations predate the site operations, i.e., expansion of the quarry and changes to the drawdown represent only an incremental change in the existing capture zone

13.1.5.3 Management controls

The risk of contaminated groundwater entering the sump is considered low and specific control measures are not required. Monitoring of the groundwater quality, as well as the discharge water quality is required to confirm compliance with the EPA discharge licence and may be required should an aquifer recharge scheme be implemented.

13.1.6 Impact on surface water quality

13.1.6.1 Description of risk pathway

Surface water runoff and waterways provide environmental value and should be protected from external impacts during expansion of the quarry. Existing surface water quality should be maintained so that impacts to receiving waterways and environments are avoided or minimised. Potential surface water quality changes may arise during quarry expansion from:

- Spillage, improper handling, storage and application of hazardous materials
- Erosion of ground surfaces and increased sediment load in runoff after a rainfall event

13.1.6.2 Assessment of impact

It is possible that quarry operations generate local surface water quality impacts from spillage or improper handling and application of hazardous materials, such as the refuelling and maintenance of construction plant and equipment. Similarly to groundwater, the likelihood of these environment incidents is low because of existing Boral environmental management procedures which would implement controls to manage chemicals, fuels and hazardous materials to manage these risks.

A hazardous material directly reaching a receiving water way and impacting the quality of water downstream is unlikely as part of the quarry operations would require bunding to be established to that run-off within the quarry is contained to the quarry. This would also include areas where overburden stripping is required in the proposed expansion areas to the south of the existing quarry.

It is also reasonable expectation that if a release of hazardous material occurred to the environment, incident response procedures would likely occur promptly, such as the use of spill kits/containment and reduce the severity of the consequence. It is recommended that all hazardous materials are used and stored at an appropriate distances (and have bunding) so that direct discharge to receiving waterways and waterbodies can be eliminated.

Erosion of ground surfaces and increased sediment load in runoff as a result of exposed soil has the potential to impact surface water and the quality of receiving waterways. Appropriate erosion and sediment controls and measures to reduce soil disturbance should be put in place before overburden stripping begins, and monitored and maintained throughout the development of the expansion area. Controls as per EPA Publication 1834, and re-established vegetation cover on the waterway side of the perimeter bunding would further assist in minimise offsite discharge of sediment laden run-off.

13.1.6.3 Management controls

Boral would need to undertake:

- Review and audit of environmental management procedures
- Perimeter bunding and stormwater controls
- Maintenance (and sizing) of treatment system
- Continued monitoring of discharge water quality and volumes as per licence conditions

13.2 Rehabilitation phase

13.2.1 Rate of groundwater recovery

Groundwater level recovery will occur when the quarry activities cease and backfilling of the void occur. Some on-going dewatering may be required to maintain safe and stable conditions for the placement of backfill. Regional water level recovery was shown previously in Figure 42 for the 95th percentile of the 131 model realisations adopted in the uncertainty analysis.

The post-excavation recovery of the water table within the quarry footprint is sensitive to the elevation of the rehabilitated surface (which varies over time), material properties of the fill and the rate of groundwater seepage that re-saturates the fill material. GHD adopted a recovery profile documented in a draft rehabilitation plan (GHD 2023).

To demonstrate the effect of model uncertainty on the recovery, hydrographs of the water table elevations within the footprint (floor) of the quarry are presented in Figure 49. These are generated by calculating the highest, average and lowest water table elevations anywhere within the quarry footprint for every simulation output time and plotting these for all 131 parameter realisations. During excavation, the water table elevation is constrained by the quarry elevation as the floor cuts into the water table.

The hydrographs indicate that there is around 10 m of uncertainty associated with recovery of the water table, on average. The hydrograph of the lowest water table shows a drop in year 41, when the filling commences. This is an artefact of the modelling (refer Appendix L).

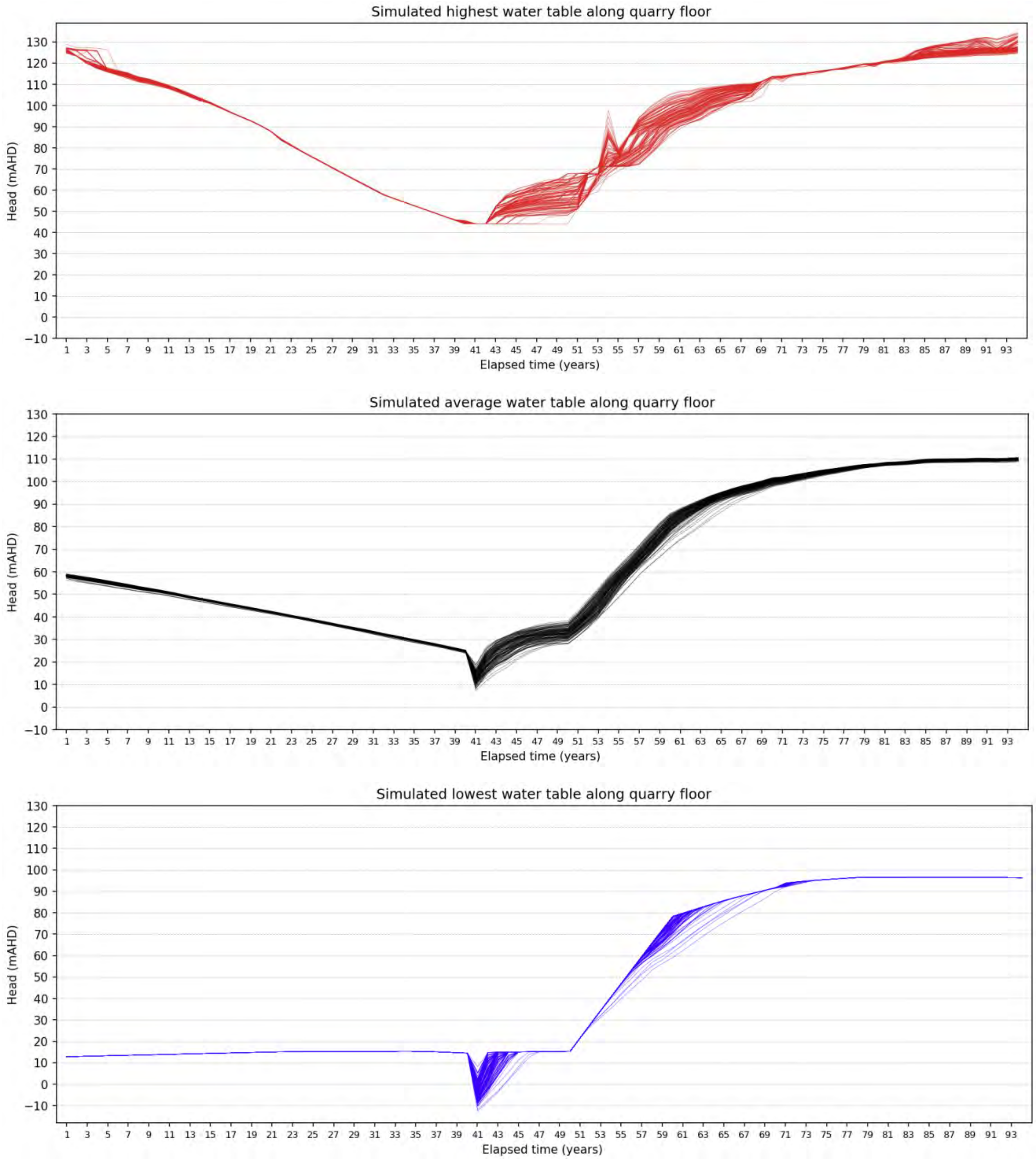


Figure 49 *Hydrographs of highest, average and lowest water table in quarry*

13.2.2 Impacts to Bungalook Creek and GDEs

The monitoring program implemented during the expansion phase of the quarry would identify the health and condition of the potential GDEs, and the need for the implementation of interventions such as irrigation or groundwater recharge schemes.

With a reduction and ultimately a cessation in groundwater extraction, groundwater recovery would occur, and the numerical modelling predicts that baseflow and groundwater level restoration would be upwards of 50 years (depending upon prevailing climate).

Return flows and/or irrigation/recharge systems (if implemented/ required) may need to continue to operate as they serve a dual purpose of wetting soil profiles but also as a means of disposing of site groundwater seepage. Monitoring would be required for a short period into the backfilling phase to verify the groundwater level recovery rates and numerical groundwater model predictions. Obviously, when dewatering ceases and the need for disposal of seepage water, the discharge licence would be surrendered, and water would not be available for recharge systems.

As indicated in section 13.1.1.5, an irrigation and recharge system is considered unlikely to be warranted/optimal based on the low potential for terrestrial GDEs assessed by EMM (2025).

13.2.3 Impacts to existing groundwater users

It is expected that any impact to neighbouring groundwater users would have been identified and manifested during the quarry expansion phase, and appropriate mitigations implemented. Under these circumstances, this risk would be eliminated during the rehabilitation phase of the project.

Monitoring would be required for a short period into the backfilling phase to verify the groundwater level recovery rates and numerical groundwater model predictions.

13.2.4 Impact on groundwater resource

The requirement for dewatering to continue post the end of construction would be dependent upon the rate of groundwater recovery, void backfill rates and the prevailing climate. Once pit backfill rates achieve a stable level above groundwater, the groundwater extraction licence can be terminated, and this risk would be eliminated.

Monitoring would be required for a short period into the backfilling phase to verify the groundwater level recovery rates and numerical groundwater model predictions.

13.2.5 Impact on groundwater quality

As noted in section 13.1.4, the risks of adverse impact to groundwater quality during the expansion phase are considered low and manageable through a range of management controls. Some of these risks remain relevant with the use of heavy plant to backfill the quarry and undertake land forming.

A risk exists that contamination could be introduced into the quarry through the backfill materials. Rainfall could leach these contaminants, or they could be mobilised when recovering groundwater levels saturate the materials. To minimise this risk, Boral would need to implement a Backfill management plan that would track the source of the backfill materials.

13.2.6 Impact on contaminated groundwater plumes

It is expected that any contaminated groundwater plumes would have been determined through groundwater monitoring undertaken during the quarry expansion phase. The quarry would remain a depression in the regional water table as the recovery is expected to take greater than 50 years. This time period provides significant opportunity for the natural attenuation of contaminants.

Subject to the end use of the rehabilitated quarry, which is assumed to be a public open space with a lake, there would a low risk of future onsite development of groundwater.

13.2.7 Impact on surface water quality

Erosion and sedimentation risks occurring external to the quarry would be identified and managed during the operation phase of the quarry expansion.

Backfilling and land forming of the quarry batters would expose geological materials and potential erosion and stormwater runoff risks that could lead to sediment loads into the rehabilitated quarry lake. Control measures that Boral would need to implement could include:

- Revegetation management plan
  - Rapidly establishing and maintaining a vegetative cover

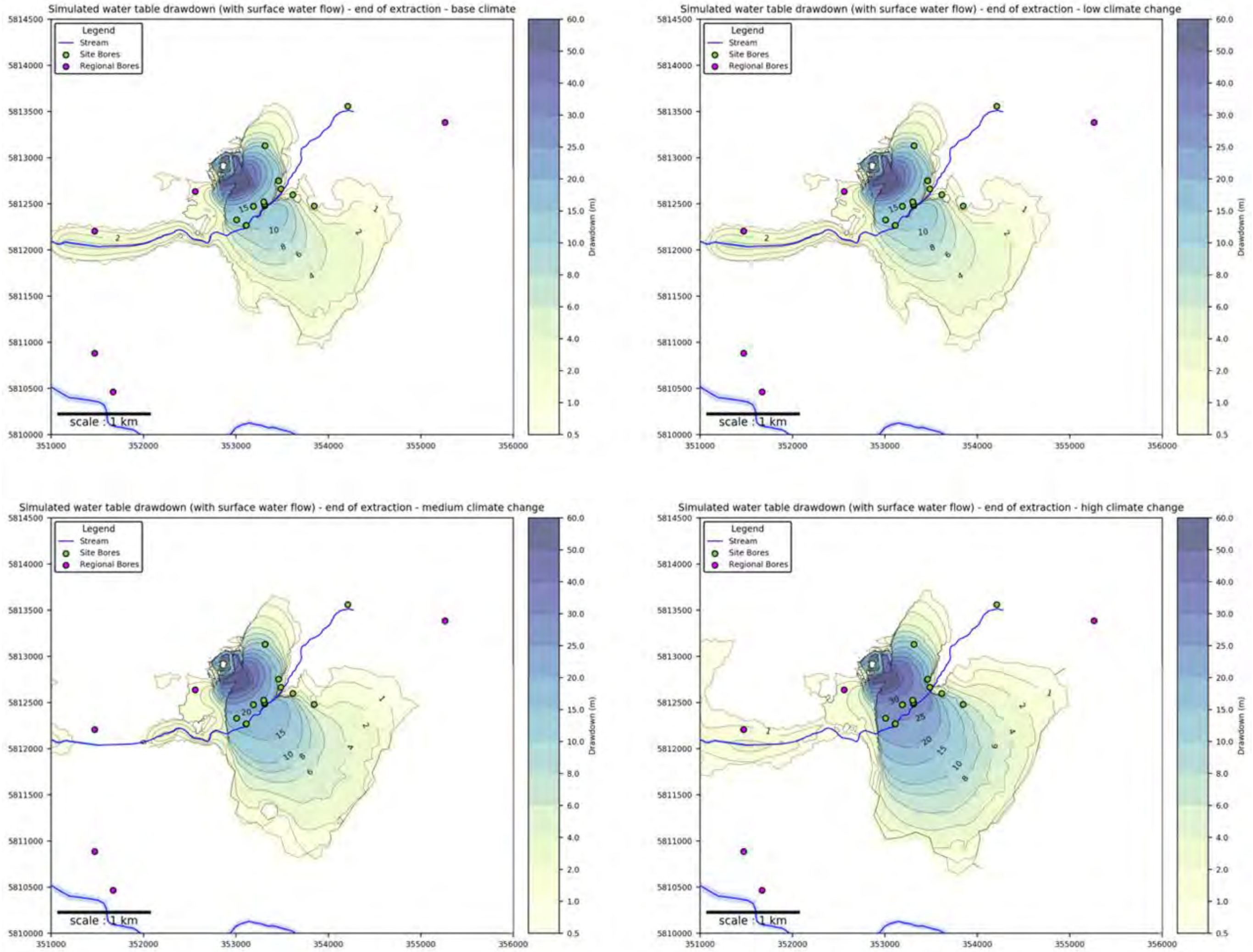
    - Selection of species
    - Weed control
    - Irrigation requirements
  - Design of pit lake
    - Objectives for use, e.g., aesthetics, primary contact recreation, stormwater treatment
    - Storage capacity and operating levels
    - Stormwater controls and landforms

13.3 Impact of climate change

13.3.1 Groundwater levels

The climate change predictions are calculated by subtracting the model outputs of the expansion case from the outputs of the base case (existing quarry) for each climate scenario (refer section 12.5). The results have been shown in Figure 50.

The contours of the base climate and low climate change condition are very similar due to the relatively small changes to recharge, evapotranspiration and streamflow. For the medium and high climate change conditions, greater drawdown is simulated along Bungalook Creek and beyond. The contours also show a larger area of downstream drawdown for the base climate and low climate change condition compared to the medium climate condition. This is because larger volumes of streamflow are maintained for the base case under the base climate and low climate change condition, resulting in greater drawdown when this flow is lost under the expansion case. In comparison, the base case streamflow is already reduced under the medium climate change such that the loss of this flow in the expansion case does not lead to material increase in drawdown. For the dry climate change condition, a much greater overall reduction in streamflow and recharge means the drawdown impact of the quarry becomes more pronounced, resulting in a broader area of impact downstream.



Simulated water table drawdown (with surface water flow) - end of extraction - base climate

Simulated water table drawdown (with surface water flow) - end of extraction - low climate change

Simulated water table drawdown (with surface water flow) - end of extraction - medium climate change

Simulated water table drawdown (with surface water flow) - end of extraction - high climate change

Figure 50 ***Simulated watertable drawdown at end of extraction phase***

Climate change will also influence the recovery of water levels during the rehabilitation phase of the quarry. The predicted contours are shown in Figure 51.

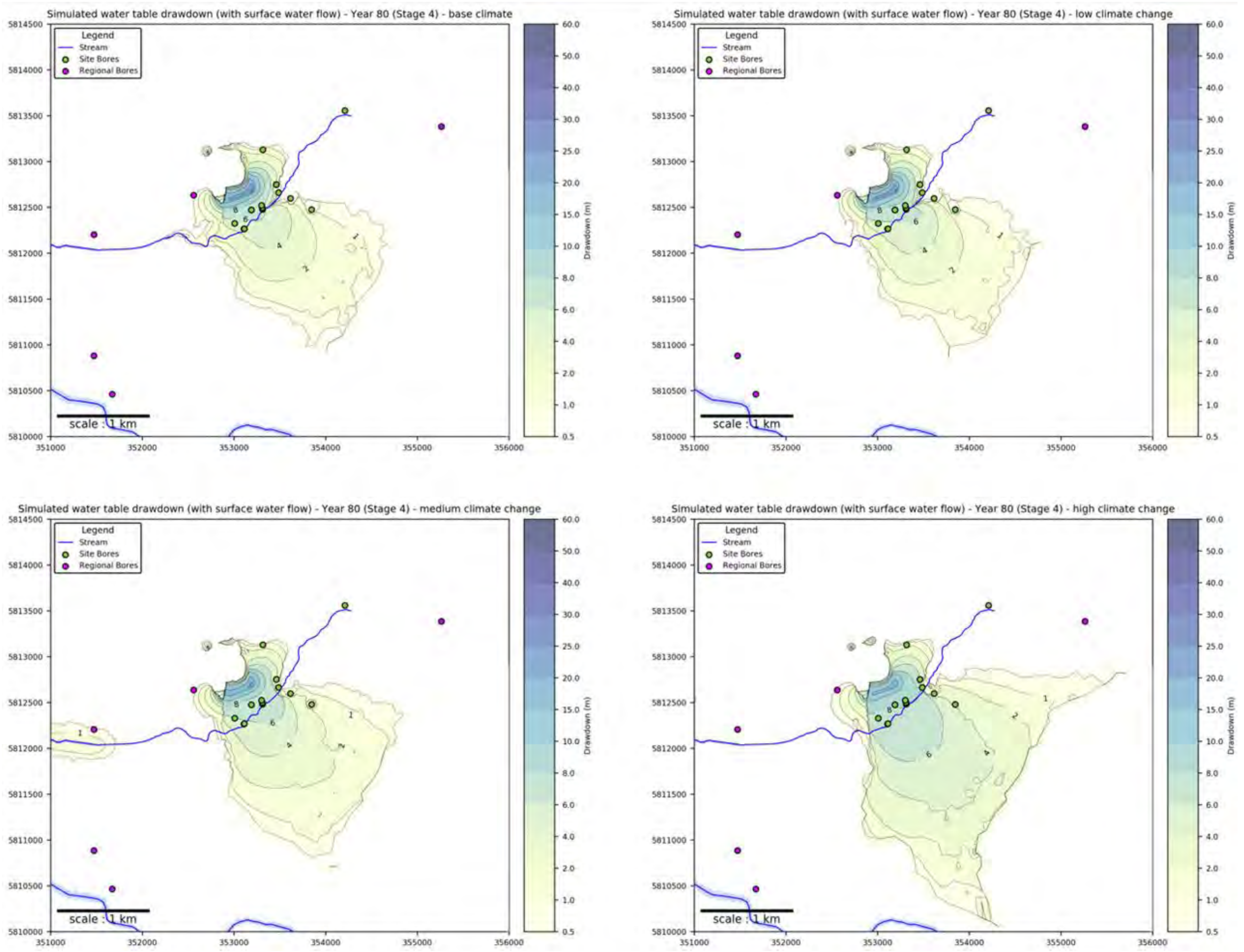


Figure 51 *Simulated watertable drawdown during rehabilitation*

Figure 52 compares the simulated hydrograph of maximum drawdown along Bungalook Creek under different climate change conditions. The maximum drawdown of up to around 37 m is predicted under the high climate change condition, compared to around 23 m for the base climate. The timing of maximum drawdown also occurs later for the high climate change condition, corresponding to an extended period of reduced streamflow (due to the synthetic rainfall dataset). With the exception of the high climate change condition, the water table is predicted to fully recover along Bungalook Creek at the end of Stage 5 rehabilitation.

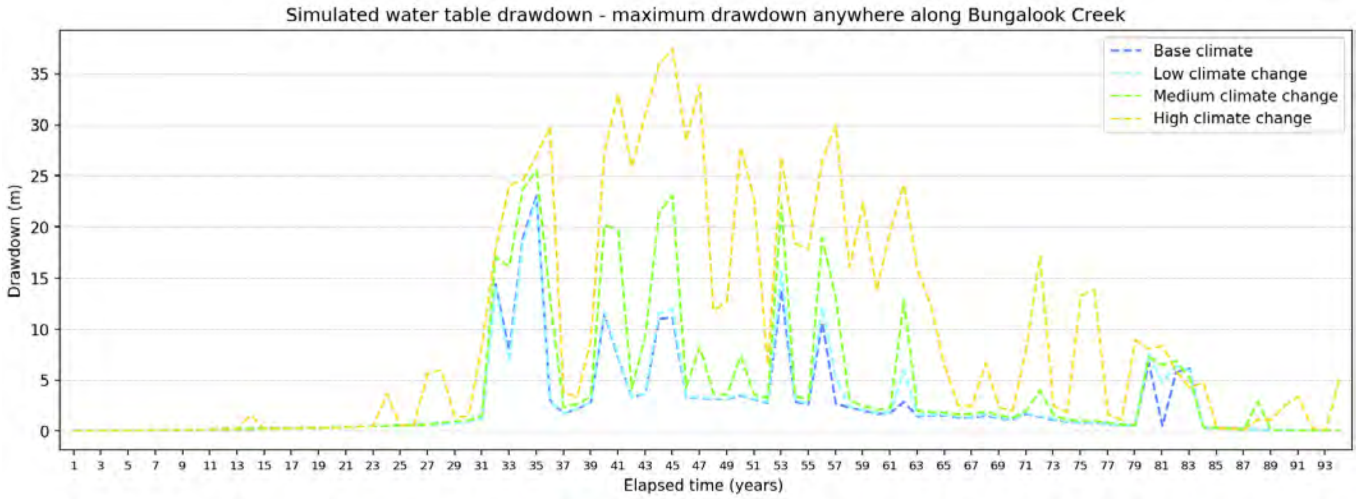


Figure 52 *Bungalook Creek maximum drawdown hydrograph – climate change*

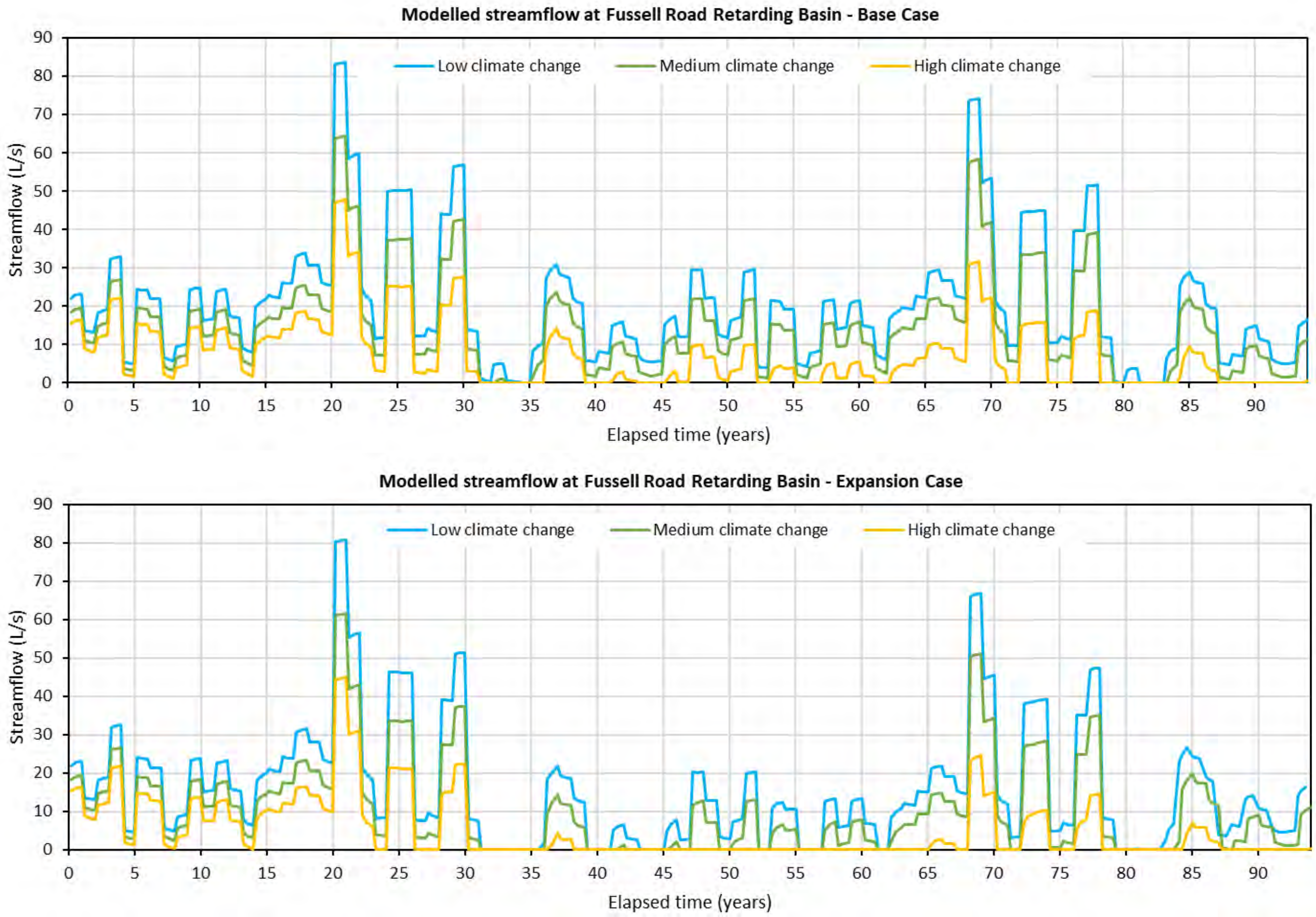
13.3.2 Baseflow

The impact of quarry expansion on total streamflow is demonstrated by comparing the modelled streamflow at gauge 228369A for the base case and expansion case under the three climate change conditions. Streamflow hydrographs have been shown in Figure 53.

Under the high impact climate change condition, there is a long period (from year 30 to around 68) where the streamflow in the base case is simulated to be less than 10 L/s. In the expansion case, most of this streamflow is lost as stream leakage, resulting in little to no flow reaching downstream of the flow gauge.

The model simulates limited to no streamflow in year 40 (end of extraction) for both the base case and expansion case under the medium and high climate change condition. In comparison, streamflow is slightly higher for the base case under the low climate change condition, resulting in a larger magnitude of stream loss when leakage is induced in the expansion case.

The climate change assessment indicates the potential for a downstream impact to arise due to the reduction in streamflow from the effects of climate change alone (even under the base case, with the existing quarry). The expansion of the quarry has the potential to exacerbate this effect, resulting more frequent and longer periods of little to no downstream flow due to induced leakage.


Modelled streamflow at Fussell Road Retarding Basin - Base Case

Modelled streamflow at Fussell Road Retarding Basin - Expansion Case

Figure 53 *Modelled streamflow – climate change*

13.3.3 Quarry seepage

The predicted the inflow to the expanded quarry under a low, medium and high climate change scenarios, have been reproduced as Figure 54 (single model realisation only).

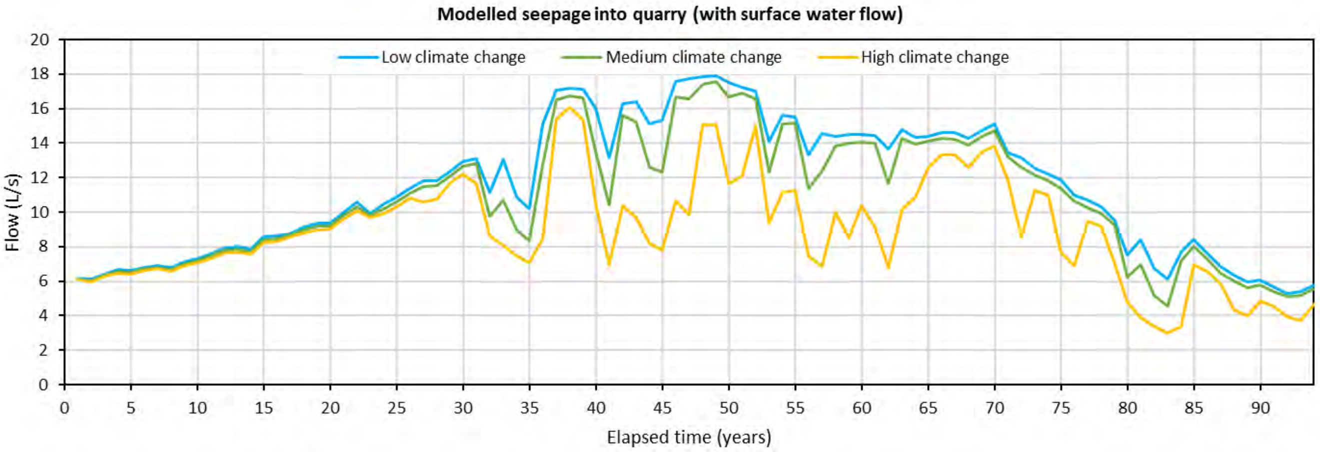


Figure 54 *Modelled seepage into quarry – climate change*

Climate change is generally considered to cause a reduction in recharge to groundwater, and therefore a resultant reduction in the regional water table. When the regional water level falls, there is less groundwater throughflow, which results in a reduction in seepage into the quarry. Towards the end of the quarry expansion, i.e., after 40 years, groundwater inflow could be upwards of 20 L/s, i.e., greater than 630 ML per annum, based upon the synthetic daily rainfall that has been applied in the numerical groundwater model.

14. Conclusions

Boral are proposing to expand their Montrose quarry and numerical groundwater modelling was commissioned to quantify the potential impacts of the expansion on groundwater and the flow regimes in nearby Bungalook Creek, and the water level recovery during rehabilitation. The quarry has been actively mining for over 50 years, holds a groundwater licence entitlement, and disposes of seepage inflows to Bungalook Creek under an EPA discharge licence.

The numerical groundwater modelling has shown:

- There is an existing level of disturbance to the groundwater environment caused by the historical and current quarry operations
- Streamflow in Bungalook Creek is likely to recharge the water table, via leakage from the stream bed. Historical extraction at the quarry is likely to have resulted in some drawdown towards Bungalook Creek, albeit temporary and limited to periods of low flow when there is insufficient leakage to top up the water table
- Further expansion has the potential to cause local disconnection between the streambed and underlying groundwater which can increase streamflow leakage. When streamflows are less than 10 L/s, potential exists for all streamflow to be lost via leakage
- Water table drawdown, notably along Bungalook Creek is sensitive to prevailing climate. Greater drawdowns occur during drier climate periods, as there is insufficient streamflow to supply recharge to the water table. For most periods, modelling predicts 5 m to 15 m of drawdown along Bungalook Creek, however, it could be 15 m to 27 m during dry periods
- Climate change modelling indicates that the uncertainty in future climate has a similar (if not, bigger) contribution to the uncertainty in modelled water table drawdown compared to that arising from the uncertainty in model parameters

In terms of impacts to groundwater and surface water resources:

- The quarry setting and low yield nature of the regional aquifers, would suggest limited likelihood for a significant increase in the local use of the groundwater resource. As the quarry expands, Boral will have to apply for an increased annual entitlement, which would be subject to Water Act (1989) approvals
- Drawdowns will extend from the expanded quarry and there are existing groundwater users within the estimated zone of dewatering. For the most part, most users are stock and domestic and estimated as having less than 5 m loss in available drawdown. A registered industrial bore (WRK056003) on Fussell Road is estimated to have upwards of 15 m loss in available drawdown. A range of mitigation measures are available if these potential interference impacts eventuate
- Groundwater seepage into the quarry is currently returned by Boral to Bungalook Creek under an EPA discharge licence, and this should continue into the future. Returning the volume of groundwater captured at the quarry to Bungalook Creek could maintain the streamflow and locally offset drawdown via leakage. A large portion of this flow may be lost downstream as the rate of leakage would be expected to be lower than the rate in which the flow is routed downstream. Direct recharge of this water via a series of injection bores is likely to be more effective in returning groundwater back into the aquifer (from where it is originally derived) and maintain the water table along the creek
- Drawdowns are predicted beneath Bungalook Creek and terrestrial vegetated land, i.e., Dr Ken Leversha Reserve. An ecological assessment completed by EMM (2025) indicates there were "*not any GDEs in the project area with the risk of terrestrial GDE occurrence deemed to be low to negligible*". Based on the results of EMM (2025) a groundwater recharge system may not be needed
- A stable long term pit water level of ~139 to 142 m AHD is predicted post closure, well below the top of pit level of around 150 m AHD

It is recommended that Boral implement a surface water and groundwater management plan (refer Appendix M) to establish baseline conditions prior to the quarry expansion. This adaptive management plan would also include monitoring triggers for Boral to implement additional actions depending upon the groundwater level response to the quarrying.

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16. Glossary of hydrogeological terms

Annulus	The space between the rising main and the casing, or between the casing and the wall of the well.
Anisotropic	Having some physical property that varies with direction.
Aquifer	A geologic formation, a group of formations or part of a formation that is water bearing. A geological formation or structure that stores and transmits water to wells, springs and seeps.
Aquifer, perched	Unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone.
Aquifer System	A body of permeable or relatively permeable materials that functions regionally as a water yielding unit. It comprises two or more permeable units separated by at least locally by confining units that impede groundwater movement.
Aquifer Test	A test undertaken to determine the hydraulic properties of an aquifer. It involves the withdrawal of measured quantities of water from or the addition of water to a well and the measurement of resulting changes in aquifer pressure.
Aquitard	A saturated by poorly permeable bed that impeded groundwater water movement and does not yield water freely to wells, but which may transmit appreciable water to or from adjacent aquifers.
Artesian Well	A well deriving uts water from a confined aquifer in which the water level stands above the ground surface.; synonymous with flowing artesian wells.
ASR	Aquifer Storage and Recovery is the re-injection of water (typically potable or semi-potable) back into an aquifer for later recovery and use
ASS	Acid Sulfate Soil (refer to PASS)
AASS	Actual Acid Sulfate Soil
Available Drawdown	The difference between the standing water level and the pump intake (i.e., the amount of water above a pump prior to pumping).
Baseflow	Also called drought flow, groundwater recession flow, low flow, and sustained or fair-weather runoff), is the portion of streamflow that comes from "the sum of deep subsurface flow and delayed shallow subsurface flow"
Beneficial Use	A use of the environment or any element of the environment which is conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits
Boundary	A lateral discontinuity or change in the aquifer resulting in a significant change in hydraulic conductivity, storativity, or recharge.
Capillary fringe	The zone at the bottom of a vadose zone where groundwater is drawn upward by capillary force.
Cavitation	A phenomena of cavity formation or formation and collapse, especially in regard to pumps, when the absolute pressure within the water reaches the vapour pressure causing the formation of vapour pockets.
Confined Aquifer	A formation in which the groundwater is isolated from the atmosphere at the point of discharge by impermeable geologic formations. Confined groundwater is generally subject to pressure greater than atmosphere.
Development	The act of repairing damage to the formation caused by drilling procedures and increasing the porosity and permeability of the materials surrounding the intake portion of a well.
Delayed Yield	Gravity drainage of water from interstices in the unsaturated zone, which may occur more slowly than the lowering of the watertable in an unconfined or semi-confined aquifer. The effect becomes negligible as the pumping period increases.
Discharge	The volume of water pumped or flowing from a well per unit of time, expressed in litres per second.

Drawdown	The distance between the static water level and the surface of the cone of depression
Effluent	A waste liquid discharged from a manufacturing or treatment process, in its natural state or partially or completely treated, that discharges into the environment.
Evaporation	In groundwater terms, evaporation is the loss of water from the water table to the atmosphere.
Evapotranspiration	Loss of water from a land area through transpiration of plants and evaporation from the soil
Flowing well, overflowing well, free-flowing well	A well from which groundwater is discharged at the ground surface without the aid of pumping.
Fouling	The process in which undesirable foreign matter accumulates in a bed, screen, bore, pump or rising main infrastructure clogging pores and coating surfaces and thus inhibiting or retarding proper operation of the bore.
Freshwater/Saline interface	The contact between two groundwaters of varying salinity, typically occurring near coastal regions, but can occur in terrestrial environments. The flow is governed by density flow processes, and the contact described as a mixing zone. Saline intrusion is when the movement of salt water occurs into a body of fresh water. It can occur in either surface water or groundwater basins.
GDE	Groundwater Dependent Ecosystem – Ecosystems that require a supply of groundwater (either directly or indirectly) to maintain their current structure (special composition) and function (for example, rates of carbon fixation).
Geothermal	Of or relating to the natural heat generated by the earth. In the context of groundwater: Groundwater that can be of naturally elevated temperature which can be used for heating and power generation purposes. Groundwater heat pumps that use a circulating fluid (often water) to pump heat to or from the ground for heating/cooling purposes.
GIS	Graphical Information System
GMA	Groundwater Management Area
Grouting	The operation by which grout is placed between the casing and sides of a well bore (annulus) to a predetermined height above the bottom of the well. This secures the casing in place and excludes water and other fluids from the well bore.
Groundwater Flow System	Groundwater flow is defined as the "…part of streamflow that has infiltrated the ground, has entered the phreatic zone, and has been discharged into a stream channel as spring or seepage water". Flow is driven by hydraulic gradients,
Head	Energy contained in a water mass, produced by elevation, pressure or velocity
Head Loss	That part of head energy which is lost because of friction as water flows
Heterogeneous	Non uniform in structure or composition throughout.
Homogeneous	Uniform in structure or composition throughout
Hydraulic Conductivity	The rate at which water at the prevailing kinematic viscosity will move under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow, expressed in metres per day. NOTE: This definition assumes medium in which the pores are completely filled with water.
Hydraulic Gradient	The rate of change in total head per unit of distance of flow in a given direction.
Hydrogeologic	Those factors that deal with subsurface waters and related geologic aspects of surface waters.
Interference	The condition occurring when the area of influence of a water well comes into contact with or overlaps that of a neighbouring well, as when two wells are pumping from the same aquifer or are located near each other.
Isotropic	Said of a medium whose properties are the same in all directions.
Leachate	The liquid that has percolated through solid waste and dissolved soluble components.
Lost Circulation	The result of drilling fluid escaping from a borehole into the formation by way of crevices or porous media.

MAR	Managed Aquifer Recharge
Monitoring Bore	Refer Observation bore
Numerical Model	A groundwater model is a (computer) program for the calculation of groundwater flow and level. Some groundwater models include (chemical) quality aspects of the groundwater. Groundwater models may be used to predict the effects of hydrological changes (like groundwater abstraction or irrigation developments) on the behaviour of the aquifer and are often named groundwater simulation models. As the computations in mathematical groundwater models are based on groundwater flow equations, which are differential equations that can often be solved only by approximate methods using a numerical analysis, these models are also called mathematical, numerical, or computational groundwater models.
Observation Bore	A well drilled in a selected location for the purpose of observing parameters such as water levels and pressure changes.
Partial Penetration	The condition of the intake portion of the wellbeing less than the full thickness of the aquifer.
PASS	Potential Acid Sulfate Soil (and ASS). Acid Sulfate soils are naturally occurring soils, sediments or organic substrates (e.g., peat) that are formed under waterlogged conditions. These soils contain iron Sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. When oxidised they can generate acidic (aggressive) groundwater
Permeability	The property of capacity of a porous rock, sediment or soil for transmitting a fluid, it is a measure of the relative ease of fluid flow under unequal pressure.
Piezometer	A pipe in which the elevation of the water level or potentiometric surface can be determined. The pipe is sealed along its length and open to water flow at the bottom.
Potentiometric surface	A surface that represents the standing or total hydraulic head. NOTES: 1. In an aquifer system, it represents the levels to which water will rise in tightly cased wells. 2. The watertable is the potentiometric surface of an unconfined aquifer.
Pump column	That part of the rising main from a pump within the well.
Recovery	The difference between the observed water level during the recovery period after cessation of pumping and the water level measured immediately before pumping stopped.
Recycled Water	Reclaimed water, sometimes called recycled water, is former wastewater (sewage) that has been treated to remove solids and certain impurities and then used for other purposes such as irrigation or to recharge groundwater aquifers. This is done for sustainability and water conservation, rather than discharging the treated wastewater to surface waters such as rivers and oceans.
Residual drawdown	The difference between the observed water level during the recovery period following pumping and the pre-pumping water level.
Rising main	The pipe carrying water from within a well to a point of discharge.
Semi-confined (or leaky) aquifer	An aquifer confined by a layer of moderate permeability (aquitard) that allows vertical leakage of water into or out of the aquifer.
Sieve Analysis	Determination of the particle size distribution of a soil, sediment or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.
Specific Capacity	The rate of discharge of a water well per unit of drawdown. IT varies with duration of discharge.
Specific Yield	The ration of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass.
Spring	A spring — also known as a rising or resurgence — is a component of the hydrosphere. Specifically, it is any natural situation where water flows to the surface of the earth from underground. Thus, a spring is a site where the aquifer surface meets the ground surface.
Static Water Level or Standing Water Level	The level of water in a well that is not being affected by withdrawal of groundwater.
Static head	The height, relative to an arbitrary reference level, of a column of water that can be supported by the static pressure of the aquifer at a given point.

Steady State conditions	A numerical (or analytical) model in which model stresses do not vary over time. A steady state model is run until the modelled region is in equilibrium and no more changes in potentiometric head are calculated. Steady state conditions can often be modelled under long term transient conditions.
Storage Coefficient/Storativity	The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. Note: 1. In an unconfined aquifer, it is normally referred to as specific yield. 2. In confined aquifers, it may be referred to as storage coefficient.
Stormwater	Stormwater is a term used to describe water that originates during precipitation events and that is collected by urban infrastructure (e.g., drains, some rivers).
Stream Depletion	A decrease in river gains or an increase in river losses resulting from a change in the water table. The depletion of streamflow caused by the operation of producing wells completed in the same aquifer intersected (or connected) with the stream or river.
Stratigraphy	The study of rock/soil strata, especially of their distribution, deposition and age.
Submersible Pump	A water pump with the motor and pump assembly located below ground at the bottom of the well column. A pump which is designed to operate under water. Usually these are electrical centrifugal pumps and have the electrical motor enclosed in a waterproof casing.
Sustained yield	The predicted long-term pumping yield of a well or well field under natural or established artificial conditions. NOTE: The values are normally calculated from pumping tests, allowance being made for hydrogeological and climatic conditions at the site.
Throughflow	Throughflow is the ‘horizontal’ flow of groundwater through a saturated aquifer.
Transmissivity	The rate at which water is transmitted through a unit width of aquifer under a unit hydraulic gradient.
Transient conditions	Typically applied in the context of a numerical model in which the model stresses (inflows and outflows) and aquifer head vary over time.
Transpiration	The process by which water is absorbed by plants, usually through the roots, is evaporated in to the atmosphere from the plant surface.
Unconfined Aquifer	An aquifer where the water table is exposed to the atmosphere through openings in the overlying materials.
Vadose Zone	The zone containing water under pressure less than that of the atmosphere including soil water, intermediate vadose water and capillary water. This zone is limited above by the land surface and below by the surface of the zone of saturation, that is the water table.
Water table	The water table is the level at which the groundwater pressure is equal to atmospheric pressure. It may be conveniently visualized as the 'surface' of the subsurface materials that are saturated with groundwater in a given vicinity. However, saturated conditions may extend above the water table as surface tension holds water in some pores below atmospheric pressure
Well Point or Spear Point	A screening device, generally less than 10 m that is meant to be driven into the ground to extract water.
Well Yield	The volume of water discharged from a well. Usually measured in litres per second or ML/day.

Appendix A

SRW Technical Hydrogeological Assessment Guidelines

SRW Hydrogeological Assessment Guidelines
for non-Urban Supply
Groundwater Licence Applications

These notes are only a guide, all consultants are advised to contact a SRW hydrogeologist to discuss their proposed hydrogeological assessment, prior to embarking on the assessment.

<table>
<tr><td></td><td>**Tier 1**</td><td>**Tier 2 & 3**</td></tr>
<tr><td rowspan="10">**Conceptual hydrogeology**</td><td colspan="2">Describe the conceptual hydrogeology from available site observations and/or desktop study including but not limited to main geological features/aquifers/aquitards, pumping/rest water levels, key bores, relevant surface water features, key groundwater components of the system (recharge, flow and discharge processes)</td></tr>
<tr><td></td><td>Map potentiometric surface from site & SOBN data</td></tr>
<tr><td>Identify and summarise the available data from all bores **within 2km** of the proposed extraction from GMS/WMIS search. It may also be necessary to undertake on the ground searches for bores and/or water features. Cross referenceing with SRW field inspection results must occur (where these are aavailable) to confirm all bores are included.</td><td>Identify and summarise the available data from all bores **within 5km** of the proposed extraction from GMS/WMIS search. It may also be necessary to undertake on the ground searches for bores and/or water features. Cross referencing with SRW field inspection results must occur (where these are available) to confirm all bores are included.</td></tr>
<tr><td>Identify and summarise the available data from the **nearest SOBN bore(s)**</td><td>Identify and summarise the available data from the **three nearest SOBN bores**</td></tr>
<tr><td>Identify all surface water features, wetlands etc **within 1 km**</td><td>Identify all surface water features, wetlands etc **within 5 km**</td></tr>
<tr><td colspan="2">Identify the nearest surface water feature, wetland etc</td></tr>
<tr><td colspan="2">Describe sw/gw interaction from available data</td></tr>
<tr><td colspan="2">Identify nearest likely recharge area(s) & mechanism(s)</td></tr>
<tr><td colspan="2">If estimating recharge from rainfall (optional), use 10 driest consecutive years from nearest weather station</td></tr>
<tr><td colspan="2">Specify target aquifer, bore depth, construction details</td></tr>
<tr><td></td><td colspan="2">All conceptual models must include at least one cross section showing relevant features, including but not limited to: main geological features/aquifers/aquitards, pumping/rest water levels, key bores, relevant surface water features, key groundwater components of the system (recharge, flow and discharge processes)</td></tr>
<tr><td rowspan="2">**Site Testing**
If multiple extraction wells are proposed, the testing guidelines should be applied to the well field as a whole, not to each individual bore (unless otherwise agreed by SRW)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Conduct site inspection - Confirm and provide details of all bores on site inc wl, construction, yield/specific capacity, total depth</td></tr>
<tr><td>Step testing may not be practical or necessary in all circumstances but must be conducted for extraction bores without existing pump/headworks infrastructure</td><td colspan="2">Step test - at least 3 steps 50-100 mins each + recovery to determine appropriate extraction rate</td></tr>
<tr><td rowspan="5"></td><td colspan="2">Constant rate pumping test - at rates equal to or greater than proposed pumping regime
Constant drawdown tests may be conducted in place of constant rate tests, if appropriate</td></tr>
<tr><td rowspan="2">**at least 48 hrs duration + recovery**</td><td>**at least 4 days duration + 4 days recovery**</td></tr>
<tr><td>**at least 7 days duration + 7 days recovery if application >400ML**</td></tr>
<tr><td colspan="2">The consultant may review and determine an alternative test pumping schedule if this can be justified. Changes to this schedule must be approved by SRW Hydrogeologist.</td></tr>
<tr><td>**Water levels - observations from pumping well at minimum, with at least 1 dedicated obs well (in same aquifer) preferred**. Recovery tests MUST be completed and analysed appropriately if there are NO appropriate observation bores in the same aquifer OR if no response is detected in the observation wells</td><td>**Water levels - observations from pumping well and at least 1 dedicated obs well in same aquifer + other aquifers as practical.** Recovery tests MUST be completed and analysed appropriately if there are NO appropriate observation bores in the same aquifer OR if no response is detected in the observation wells</td></tr>
<tr><td rowspan="2"></td><td></td><td>Groundwater chemistry - at least one sample to be collected in accordance with EPA VIC Pub#669 for lab analysis of major cations and anions, TDS, EC and pH.</td></tr>
<tr><td colspan="2">Monitoring of EC during pumping test (data logger preferred) IF within 1km of saline water body OR adjacent saline aquifer</td></tr>
</table>

SRW Hydrogeological Assessment Guidelines
for non-Urban Supply
Groundwater Licence Applications

<table>
<tr><td>Discharge approval may be required from the EPA, other Water Authorities or Catchment Management Authorities</td><td colspan="2">Fate of discharged water and discharge location relative to pumping and obs wells and water bodies</td></tr>
<tr><td rowspan="2">Test Data</td><td colspan="2">All raw data from aquifer testing and monitoring to be provided in graphical form</td></tr>
<tr><td colspan="2">All data analysis to be presented. Appropriate methods MUST be used which are consistent with the conceptual understanding of the groundwater system (dependent on the aquifer type, boundary conditions etc) and presented for review</td></tr>
<tr><td rowspan="3">Prediction of Drawdown Impacts
"Likely" and "Worst" case scenarios to be presented for all applications.</td><td rowspan="2">Drawdown assessment - simple Theis analysis to be completed using likely T, S values +/- 100% (based on lit & site data) over 1 year/extraction season, to estimate drawdown impacts/bore interference. Numerical modelling may be appropriate for complex cases.</td><td></td></tr>
<tr><td>Drawdown assessment - simple Theis analysis to be completed using site T, S values +/- 50% over 1 year/extraction season to estimate drawdown impacts/bore interference. Numerical modelling may be appropriate for complex cases.</td></tr>
<tr><td colspan="2">Use likely T&S values +/- 1 order of magnitude if in fractured rock</td></tr>
<tr><td>All assessments must include ALL water use on the subject property, including existing extraction licences, as well as any additional applications</td><td colspan="2">"Likely" case should assess the proposed pumping regime (proposed pumping rate for standard extraction period) eg 0.5L/s for 8 hours. "Worst" case should assume entire application volume is extracted in one pumping period at twice the proposed extraction rate</td></tr>
<tr><td>Bore interference Risk Assessment</td><td colspan="2">The bore intereference assessment must include a tabulated list of bores with estimate/actual values of bore depth, screened/open hole depths, pump depth, and rest water level (pumping water level if available). The assessment should also tabulate calculated drawdown and available drawdown for each bore.The assessment should clarify the impacts of the proposed licence in isolation, and also a combined drawdown assessment assuming all identified neighbouring bores pumping simultaneously over 1 year/extraction season (current licensing info to be obtained from SRW records via info statement). Use Principle of Superimposition to add individual drawdown impacts from multiple pumping bores.</td></tr>
<tr><td>Assessing impacts on groundwater dependant ecosystems</td><td colspan="2">The following guidelines must be used when assessing impacts on GDEs - <i>'The Ministerial Guidelines for Groundwater Licencing and Protection of High Value Groundwater Dependant Ecosystems, 2015. Minister for Environment, Climate Change and Water, Victoria.'</i> The consultant should use conceptual information, field measurements and/or modelling to assess the risk. Stream depletion assessments should consider direct impacts and indirect impacts.</td></tr>
<tr><td rowspan="3">Groundwater Quality risks</td><td colspan="2">Identify any risks to gw quality associated with proposed extraction</td></tr>
<tr><td colspan="2">Discuss any SOBN or site quality data</td></tr>
<tr><td colspan="2">Discuss likely salinity/groundwater chemistry and potential impacts on soil, surface water etc</td></tr>
<tr><td>Proposed pumping regime and monitoring</td><td colspan="2">The assessment must include a clear proposed pumping regime. If monitoring is proposed this must be focussed on monitoring specific triggers or answering specific technical questions.</td></tr>
</table>

NOTE TO CONSULTANTS:

1. All testing, assessment, data analysis and reporting is to be conducted by appropriately qualified hydrogeologists
2. All pumping tests to be conducted in accordance with AS2368-1990
3. The results of the site-specific assessment must be presented to SRW in a technical report

4. This document provides guidelines only. All assessments should be tailored to the needs and constraints of the specific project. However, the reasons for any deviations from the assessment methodology above must be documented in the hydrogeological assessment report
5. Submitted hydrogeological reports are in the public domain and may be reviewed by third party hydrogeologists, regulators and groundwater users.
6. All submitted reports should be accompanied by an Executive Summary (3 pages max) suitable for distribution to non-technical stakeholders

7. The role of the proponent's hydrogeologist is to assess the nature and magnitude of the impacts associated with the proposal. It is SRW's role to determine whether or not the predicted impacts are unacceptable.

Current tier determination

Base application - Maximum volume 20ML
Typically reserved for small, non-significant, irrigation or dairy applications where there would be minimal if any impact to existing water users and the environment

Tier 1 – Irrigation or dairy use 21 to 149ML.
And nearest neighbouring bore or waterway more than 1KM away. (If neighbouring bores or waterways closer than 1KM, tier 2 applies)

Tier 2 – Irrigation and dairy use between 150 and 399ML
Or purposes including: Aquaculture, Commercial Nursery or Carwash, Road Construction or Dewatering of construction sites

Tier 3 – Irrigation and dairy use 400ML and over
Or purposes including Feedlots, Pig or Poultry farming, Water Bottling, Town Supply, Quarrying / dewatering of site, Power Generation or other commercial uses

Differences between Tier 2 and 3

Step testing increases from 'at least 4 days duration + 4 days recovery' to 'at least 7 days duration + 7 days recovery if application >400ML'

Appendix B

EPA licence

ENVIRONMENT PROTECTION ACT 1970
SECTION 20

LICENCE

BORAL RESOURCES (VIC.) PTY. LIMITED

Holder of

Licence:	**17685**
Issued:	27/08/1992
Last Amended:	10/07/2018
ACN:	004 620 731
Registered Address:	LEVEL 3 40 MOUNT STREET NORTH SYDNEY NSW 2060
Premises Address:	CANTERBURY RD MONTROSE VIC 3765
Scheduled Categories:	C01 Extractive Industry and Mining
Description:	The licence-holder operates a rock quarry and manufactures products for the construction industry. This licence allows for discharges of treated wastewater to surface waters.

STEPHEN ADAMTHWAITE
Team Leader
Development Assessments
Delegate of the Environment Protection Authority

Issued under the *Environment Protection Act 1970*, Section 20

PREAMBLE

Licences

Who we are: The Environment Protection Authority ("EPA") is an independent statutory authority established under the *Environment Protection Act 1970* ("the Act"). Our purpose is to protect and improve our environment by preventing harm to the environment and human health.

Why we issue licences: EPA is responsible for preventing or controlling pollution (including noise) and improving the quality of the environment. This responsibility includes regulating activities that may present a danger to the environment. One of the tools available to EPA is the licensing of certain scheduled premises that may present a risk to the environment.

Section 20 of the Act requires the occupier of a "scheduled premises" to obtain an EPA licence to discharge, handle, treat or dispose of waste to the environment. These premises are defined in the *Environment Protection (Scheduled Premises and Exemptions) Regulations 2017* ("the Regulations").

When we issue licences: EPA will issue a licence when satisfied that an applicant has put in place measures to protect the environment. Licences allow activities to occur and set performance outcomes based on a site's environmental risk. EPA can amend, suspend or revoke a licence in response to changes in standards, site activities or licence holder performance. Licence holders must submit an annual performance statement and pay an annual fee to EPA. All licences and performance statements are publicly available.

Licence information and obligations

Interpretation: For the purposes of this licence "You" means the licence holder identified on the first page of this licence at the "premises" identified on the first page and represented in Schedule 1.
Unless the contrary intention appears, words or terms used in the conditions of your licence have the same meaning as in the Act, including any regulations or policies made pursuant to the Act."

Compliance:
You must comply at all times with the Act and all policies and regulations administered by EPA. Strict penalties apply for non-compliance with any part of your licence or making a false claim on your annual performance statement.

Your licence is subject to conditions. These conditions give rise to a number of duties and obligations on you as the licence holder. Some of these are general in nature, while others require you to do (or not to do) specific things. The duties and obligations imposed by these conditions do not derogate from each other in any way, nor do they affect any other duties or obligations which you are required by law to comply with. You must fulfil all of the duties and perform all of the obligations set out in this licence or otherwise required by law. Certain conditions on your licence may require you to seek a further approval from EPA. Such approvals can be sought via written application to approvals.applications@epa.vic.gov.au. Approvals are only given in writing from the lead assessing officer.

Landfill levy: Landfills must, in accordance with the method and frequency specified in section 50SB of the Act, calculate the amount of landfill levy payable, prepare a landfill levy statement, and submit to EPA both the statement and fee payable.

Review of decisions: If you object to any of the licence conditions, you may have the decision reviewed by applying in writing to the Registrar, Planning and Environment Division, Victorian Civil and Administrative Tribunal ("VCAT"), 7th Floor, 55 King Street, Melbourne within 21 days of the date of issue. An application fee may be applicable when lodging an appeal with VCAT. Contact VCAT on (03) 9628 9777 for further details on fees associated with an appeal. A copy of the appeal should also be forwarded to the Manager, Development Assessments Unit, Environment Protection Authority, GPO Box 4395, Melbourne, 3001, within 7 days of lodgement of the appeal.

Interested (third) parties may also appeal against the licence within 21 days of the date of issue. The Tribunal will notify you if such appeals are received. If an appeal is lodged, this licence will not come into effect.

Licence structure

Structure: Your licence has multiple parts:

- Environmental performance conditions - setting out the performance outcomes you must meet;
- Schedule 1A - locality plan of your premises, delineating the premises boundary;
- Schedule 1B - plan of premises (provided by you).

Some types of licences also contain Schedule 1C - final landfill contour plans and/or Schedule 2 - tables specifying wastes that may be accepted at the premises and the associated treatment applied to them.

CONDITIONS

General Conditions

LI_G1 You must ensure that waste is not discharged, emitted or deposited beyond the boundaries of the premises except in accordance with this licence or under the Act.

LI_G2 You must immediately notify EPA of non-compliance with any condition of this licence by calling 1300 EPA VIC (1300 372 842), sending an email to contact@epa.vic.gov.au, or using the EPA Interaction Portal.

LI_G3 By 30 September each year you must submit an annual performance statement to EPA for the previous financial year in accordance with the Annual Performance Statement Guidelines (EPA Publication 1320.3, released June 2011).

LI_G4 Documents and monitoring records used for preparation of the annual performance statement must be retained at the premises for five years from the date of each statement, and be able to be immediately produced upon request by an officer of the Authority.

LI_G5 You must establish and implement a risk based monitoring program that enables you and EPA to determine compliance with each condition of this licence. The monitoring program must comply with the requirements of the monitoring guidelines (EPA document 1321.2, released June 2011).

Amenity Conditions

Licence does not have any amenity conditions.

Waste Acceptance Conditions

Licence does not have any waste acceptance conditions.

Waste Management Conditions

Licence does not have any waste management conditions.

Landfill Conditions

Licence does not have any landfill conditions.

Air Conditions

Licence does not have any discharge to air conditions.

Water Conditions

LI_DW1 You must ensure that surface water discharged from the premises is not contaminated with waste.

LI_DW2 Discharge of waste to surface waters must be in accordance with the 'Discharge to Water' Table.

Discharge to Water Table - Discharge Limits

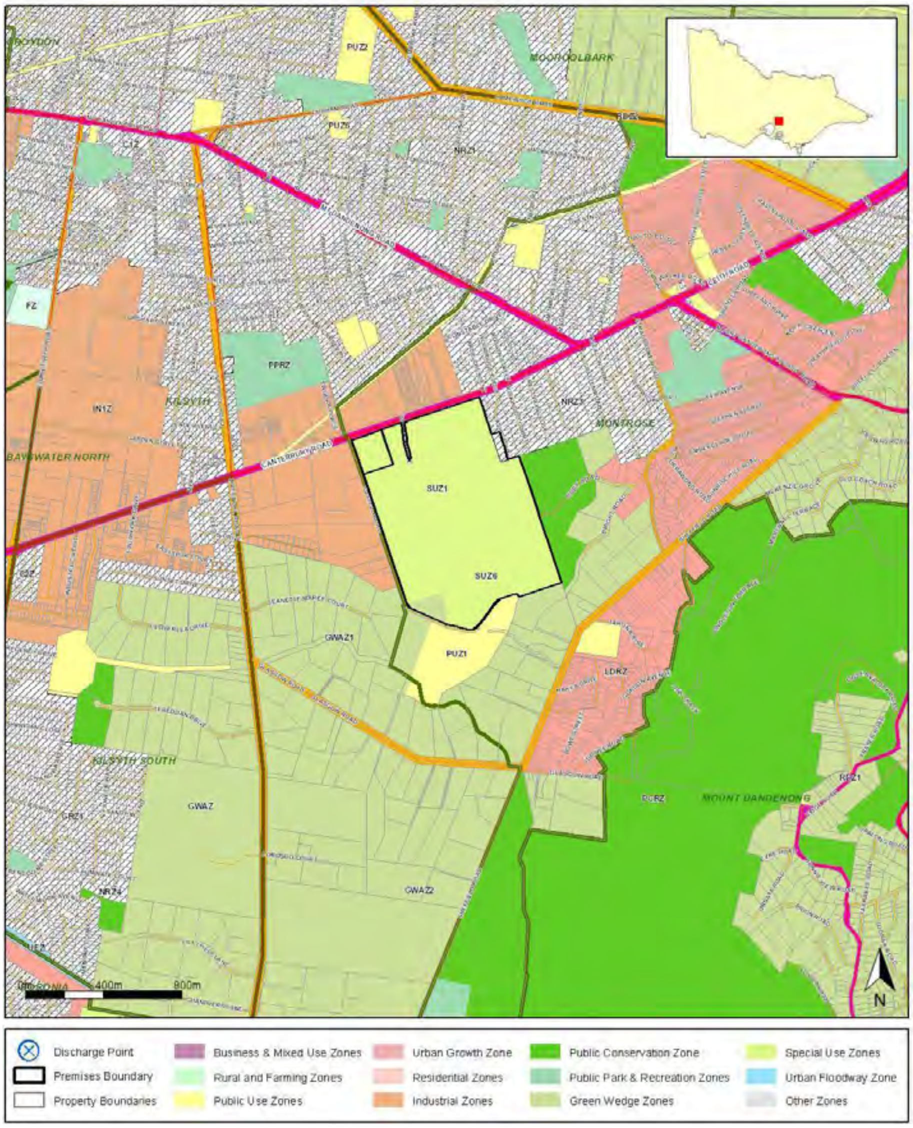
Discharge Point No	Description of Discharge Points	Indicator	Limit Type	Unit	Discharge Limit
DPB	DPB as shown in Schedule 1B	Flow Rate	Max Daily flow	ML/D	0.86
		Electrical conductivity	Annual Median	µS/cm	1,600
		Electrical conductivity	Maximum	µS/cm	2,000
		Turbidity	Annual Median	NTU	25
		Turbidity	Maximum	NTU	40
		pH	Maximum	pH	9
		pH	Minimum	pH	6

ML/D = Megalitre per day
NTU = Nephelometric Turbidity Units
pH = pH Units
µS/cm = Microsiemens per centimeter

Land Conditions

LI_DL1 You must not contaminate land or groundwater.

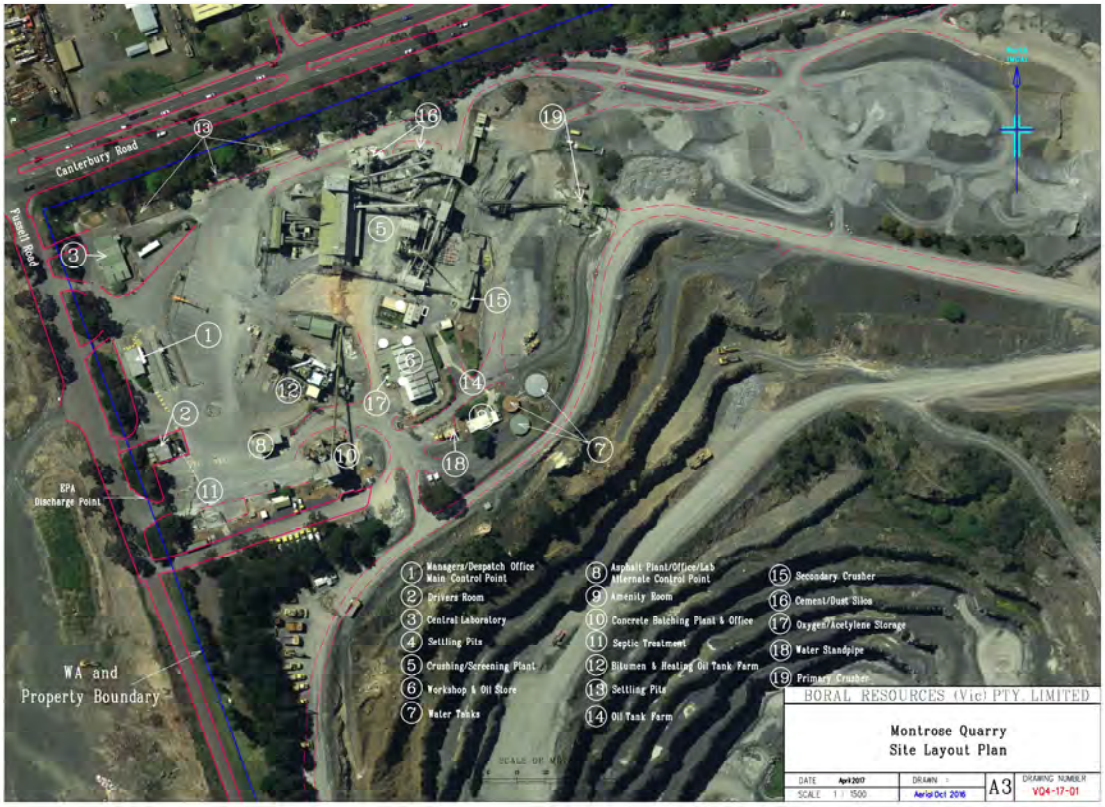
SCHEDULE 1A - LOCALITY PLAN



Licence:	17685
Company Name:	BORAL RESOURCES (VIC.) PTY. LIMITED
ACN:	004 620 731
Premises Address:	Canterbury RD, MONTROSE VIC 3765
Issued:	27/08/1992
Last Amended:	10/07/2018

Before relying on the information in this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances.

SCHEDULE 1B - PREMISES PLAN



Licence:	17685
Company Name:	BORAL RESOURCES (VIC.) PTY. LIMITED
ACN:	004 620 731
Premises Address:	Canterbury RD, MONTROSE VIC 3765
Issued:	27/08/1992
Last Amended:	10/07/2018

Before relying on the information in this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances.

Appendix C

Groundwater licence

Works Licence ID:

WLE034560

Printed on: 23 Feb 2016 4:07:51 pm

COPY OF RECORD IN THE VICTORIAN WATER REGISTER

LICENCE TO OPERATE WORKS

under Section 67 of the Water Act 1989

The information in this copy of record is as recorded at the time of printing. Current information should be obtained by a search of the register. The State of Victoria does not warrant the accuracy or completeness of this information and accepts no responsibility for any subsequent release, publication or reproduction of this information.

This licence does not remove the need to apply for any authorisation or permission necessary under any other Act of Parliament with respect to anything authorised by the works licence.

Water used under this licence is not fit for any use that may involve human consumption, directly or indirectly, without first being properly treated.

This licence is not to be interpreted as an endorsement of the design and/or construction of any works (including dams). The Authority does not accept any responsibility or liability for any suits or actions arising from injury, loss, damage or death to person or property which may arise from the maintenance, existence or use of the works.

Each person named as a licence holder is responsible for ensuring all the conditions of this licence are complied with.

This licence authorises its holders to operate the described works, subject to the conditions.

Licence Holder(s)

BORAL RESOURCES *(VIC) PTY LTD of C/- GREG CRAWFORD
P O BOX 604 BACCHUS MARSH VIC 3340

Licence Contact Details

BORAL RESOURCES *(VIC) PTY LTD	C/- GREG CRAWFORD P O BOX 604 BACCHUS MARSH VIC 3340 AU

Licence Details

Expiry date	30 Jun 2029
Status	Active
Authority	Southern Rural Water
Name of waterway or aquifer	UNC-Unincorporated
Water system	Unincorporated (GMU)

Summary of Licensed Works

The details in this section are a summary only. They are subject to the conditions specified in this licence.

Works ID	*Works type*	*Use of water*
WRK043011	Bore	Industrial or commercial
WRK043012	Bore	Industrial or commercial

Description of Licensed Works

WORKS ID WRK043011

Works type	Bore
Constructed depth	90.000 metres

Extraction Details

Service point/s	SP074751 NGMA.139907/1
Maximum extraction rate	0.600 megalitres per day (The physical capacity of the works)
Maximum daily volume	0.600 megalitres (The volume authorised to be extracted via the works)
Maximum annual volume	120.000 megalitres
Use of water	Industrial or commercial use - as well as domestic and stock use

Works location

Easting	*Northing*	*Zone MGA*
352560	5813000	Zone 55

Land description

Volume 5793 Folio 414
CA 38B Parish of Mooroolbark

Property address

MONTROSE QUARRY

Description of Licensed Works

WORKS ID WRK043012

Works type	Bore
Constructed depth	90.000 metres

Extraction Details

Service point/s	SP072243 NGMA.139907/2
Use of water	Industrial or commercial use - as well as domestic and stock use

Works location

Easting	*Northing*	*Zone MGA*
352560	5813000	Zone 55

Land description

Volume 5793 Folio 414
CA 38B Parish of Mooroolbark

Property address

MONTROSE QUARRY

Related Instruments

Related entitlements	BEE027293
Related water-use entities	Nil

Application History

Reference	*Type*	*Status*	*Lodged date*	*Approved date*	*Recorded date*
PTA017685	Address amendment	Recorded			07 Nov 2012
PTA007797	Address amendment	Recorded			09 May 2011
WLV007440	Modify	Approved	14 Oct 2014	14 Oct 2014	
WLI552969	Issue	Approved	29 Aug 2009	29 Aug 2009	

Conditions

Licence WLE034560 is subject to the following conditions:

Preventing pollution

1 Water must not be taken through the works if the Authority reasonably believes fuel, or lubricant, or any other matter used in connection with works and appliances associated with this licence, is at risk of contaminating a waterway, or aquifer, or the riparian or riverine environment.

2 The licence holder must construct and maintain bund walls around any hydrocarbon-fuel-driven engine, motor, fuel storage, or chemical storage used in connection with this licence, in accordance with the timeframe, specifications, guidelines and standards prescribed by the Authority.

Method of taking

3 The licence holder must at all times provide the Authority with safe access to inspect all works and appliances used to take water under this licence.

Rosters and restrictions

4 When directed by the Authority, water must be taken in accordance with the rosters and restrictions determined by the Authority, and advised to the licence holder.

Metering of water taken and used

5 Water may only be taken under this licence if it is taken through a meter approved by the Authority.

6 Meters must be installed, in accordance with the specifications set by the Authority, at the licence holder's expense.

7 Meters used for the purpose of this licence are deemed to be the property of the Authority.

8 The licence holder must at all times provide the Authority with safe access to meters for the purpose of reading, calibration or maintenance.

9 The licence holder must notify the Authority within one business day if the meter ceases to function or operate properly.

10 The licence holder must, if required by the Authority, keep an accurate record of the quantity of water taken under this licence and allow the Authority to inspect this record at all reasonable times, and provide a copy of the record when requested.

11 The licence holder must not, without the consent of the Authority, interfere with, disconnect or remove any meter used for the purposes of the licence.

12 The Authority may, if it deems necessary, make an estimate of the total volume of water taken under this licence.

Protecting other water users

13 The licence holder must, if required by the Authority, monitor and record water levels in the bore(s) before and after pumping; the licence holder must also provide this information in writing as directed by the Authority.

14 The licence holder must, at the licence-holder’s expense, if required by the Authority, conduct a pumping test and obtain a hydrogeological report, to the Authority's specification, on the potential for bore operation to interfere with any bore, aquifer, groundwater dependent ecosystem or waterway.

15 The licence holder must, if required by the Authority, provide the Authority with the results of water quality tests on samples of water pumped from the bore.

16 The licence holder must provide the Authority with safe access to the licensed bore and works for the purposes of obtaining water level measurements, water samples and any other information or data pertaining to the operation of the bore, the works and the aquifer.

17 The licence holder must, if required by the Authority, cease taking water entirely, or cease taking water for a given period, or reduce the quantity of water taken during any period if, the

Authority reasonably believes, or in accordance with the assessment in a Groundwater Management Plan, the use or disposal of water under this licence may injure or adversely affect any other person or an aquifer or the environment.

18 The licence holder must, if required by the Authority, enter into a formal agreement to supply water to any party affected by interference from bore operation.

19 The bore(s) must not be altered or decommissioned without a works licence that authorises alteration, or decommissioning.

Operation and maintenance

20 Water may only be taken through the works at the specified location.

21 The licence holder must keep all works, appliances and dams associated with this licence, including outlet pipes and valves, in a safe and operable condition, and free from obstacles and vegetation that might hinder access to works.

22 Water may only be taken through the works if the works are sited, constructed, operated and maintained to the satisfaction of the Authority.

Protecting biodiversity

23 Water must not be taken through the works if the Authority reasonably believes that the taking of water, through the works and appliances associated with this licence, is at risk of causing damage to the environment.

24 The licence holder must, if required by the Authority, remedy any damage to the environment that in the opinion of the Authority is a result of the installation, operation or maintenance of the works.

Particular conditions

25 Unless otherwise directed by the authority all discharge water off site must be in accordance with EPA direction

26 Unless otherwise directed by the authority meters must also be fitted to the works associated with water discharge offsite.

Fees and charges

27 The licence holder must, when requested by the Authority, pay all fees, costs and other charges under the Water Act 1989 in respect of this licence.

END OF COPY OF RECORD

Entitlement ID:

BEE027293

Printed on: 24 Apr 2017 2:43:38 pm

COPY OF RECORD IN THE VICTORIAN WATER REGISTER

TAKE AND USE LICENCE

under Section 51 of the Water Act 1989

The information in this copy of record is as recorded at the time of printing. Current information should be obtained by a search of the register. The State of Victoria does not warrant the accuracy or completeness of this information and accepts no responsibility for any subsequent release, publication or reproduction of this information.

This licence does not remove the need to apply for any authorisation or permission necessary under any other Act of Parliament with respect to anything authorised by the take and use licence.

Water used under this entitlement is not fit for any use that may involve human consumption, directly or indirectly, without first being properly treated.

The Authority does not guarantee, by the granting of the licence, that the licensee will obtain any specific quantity or quality of water. The Authority is not liable for any loss or damage suffered by the licensee as a result of the quantity of water being insufficient or the quality of the water being unsuitable for use by the licensee at any particular time or for any particular purpose.

This take and use licence entitles its holders to take and use water as set out under the licence description, subject to the conditions that are specified.

Licence Holder(s)

BORAL RESOURCES *(VIC) PTY LTD of C/- GREG CRAWFORD
P O BOX 604 BACCHUS MARSH VIC 3340

Licence Contact Details

BORAL RESOURCES *(VIC) PTY LTD
C/- GREG CRAWFORD
P O BOX 604
BACCHUS MARSH VIC 3340
AU

Licence Description

Expiry date	30 Jun 2029
Status	Active
Authority	Southern Rural Water
Name of waterway, aquifer or works	UNC-Unincorporated
Water system type	Groundwater (East Port Phillip Bay catchment)
River basin or groundwater unit	Unincorporated (GMU)
Licence volume	120.0 megalitres
Licence volume adjusted for temporary trade	120.0 megalitres
Method of taking	Direct extraction from Groundwater
Period during which water can be taken	01 Jul - 30 Jun inclusive
Use of water	Industrial or commercial use - as well as domestic and stock use
Trading Zone	Unincorporated

Licence Volume Details

Licence volume	120.0 megalitres
Licence volume adjusted for temporary trade	120.0 megalitres

Temporary volume transaction details

Approval date	*Volume traded (ML)*	*Expiry date*
Nil		

Extraction Point Details

Easting	*Northing*	*Zone MGA*	*Location description*
352560	5813000	Zone 55	Nil

Land on which the Water is to be Used

Land description

Volume 5793 Folio 414
CA 38B Parish of Mooroolbark

Property address

MONTROSE QUARRY

Related Instruments

Related entitlements	Nil
Related works licences	WLE034560
Other related entities	Nil

Application History

Reference	*Type*	*Status*	*Lodged date*	*Approved date*	*Recorded date*
PTA017685	Address amendment	Recorded			07 Nov 2012
PTA007797	Address amendment	Recorded			09 May 2011
BER021906	Modify	Approved	14 Oct 2014	14 Oct 2014	
BEI477316	Issue	Approved	29 Aug 2009	29 Aug 2009	

Conditions

This take and use licence is subject to the following conditions:

Method of taking

1 Water may only be taken under this licence if it is taken by the method specified in this licence.

2 The licence holder must at all times provide the Authority with safe access to inspect all works and appliances used to take water under this licence.

Take location

3 Water may only be taken under this licence if it is taken at the location specified in the licence under "extraction point details".

Take volume and rate

4 The volume of water taken under this licence in any twelve-month period from 1 July to 30 June must not exceed the licence volume, less any volume that has been temporarily transferred to another person or location.

5 The maximum volume that may be taken under this licence in any one day is 0.60 megalitres per day.

Temporary transfers to the licence holder

6 If there has been a temporary transfer of another licence to take water at the location, and use water on the land, specified in this licence:

a) the extra volume of water taken must not exceed the volume transferred, and

b) all the conditions of this licence apply to the taking and using of water consequential to the transfer.

Water allocations

7 The Authority may determine water allocations at 1 July or during the course of the subsequent twelve-month period that are less than 100% of the licence volume, in which case the licence volume is correspondingly reduced for that twelve-month period.

Take period

8 Unless otherwise directed by the Authority, water may be taken at any time between 1 July and 30 June.

Rosters and restrictions

9 When directed by the Authority, water must be taken in accordance with the rosters and restrictions determined by the Authority, and advised to the licence holder.

Metering of water taken and used

10 Water may only be taken under this licence if it is taken through a meter approved by the Authority.

11 Meters must be installed, in accordance with the specifications set by the Authority, at the licence holder's expense.

12 Meters used for the purpose of this licence are deemed to be the property of the Authority.

13 The licence holder must at all times provide the Authority with safe access to meters for the purpose of reading, calibration or maintenance.

14 The licence holder must notify the Authority within one business day if the meter ceases to function or operate properly.

15 The licence holder must, if required by the Authority, keep an accurate record of the quantity of water taken under this licence and allow the Authority to inspect this record at all reasonable times, and provide a copy of the record when requested.

16 The licence holder must not, without the consent of the Authority, interfere with, disconnect or remove any meter used for the purposes of the licence.

17 The Authority may, if it deems necessary, make an estimate of the total volume of water taken

under this licence.

Use of water

18 Water taken under this licence may only be used on the land, and for the purposes, specified in the licence.

19 The licence holder must at all times provide the Authority with safe access to inspect the land on which water is licensed to be used.

Managing drainage disposal

20 Where water use results in drainage from the land specified in the licence, that drainage water must be disposed in ways that meet with the standards, terms and conditions adopted from time to time by the Authority.

Particular conditions

21 Unless otherwise directed by the authority all discharge water off site must be in accordance with EPA direction.

22 Unless otherwise directed by the authority meters must also be fitted to the works associated with water discharge offsite.

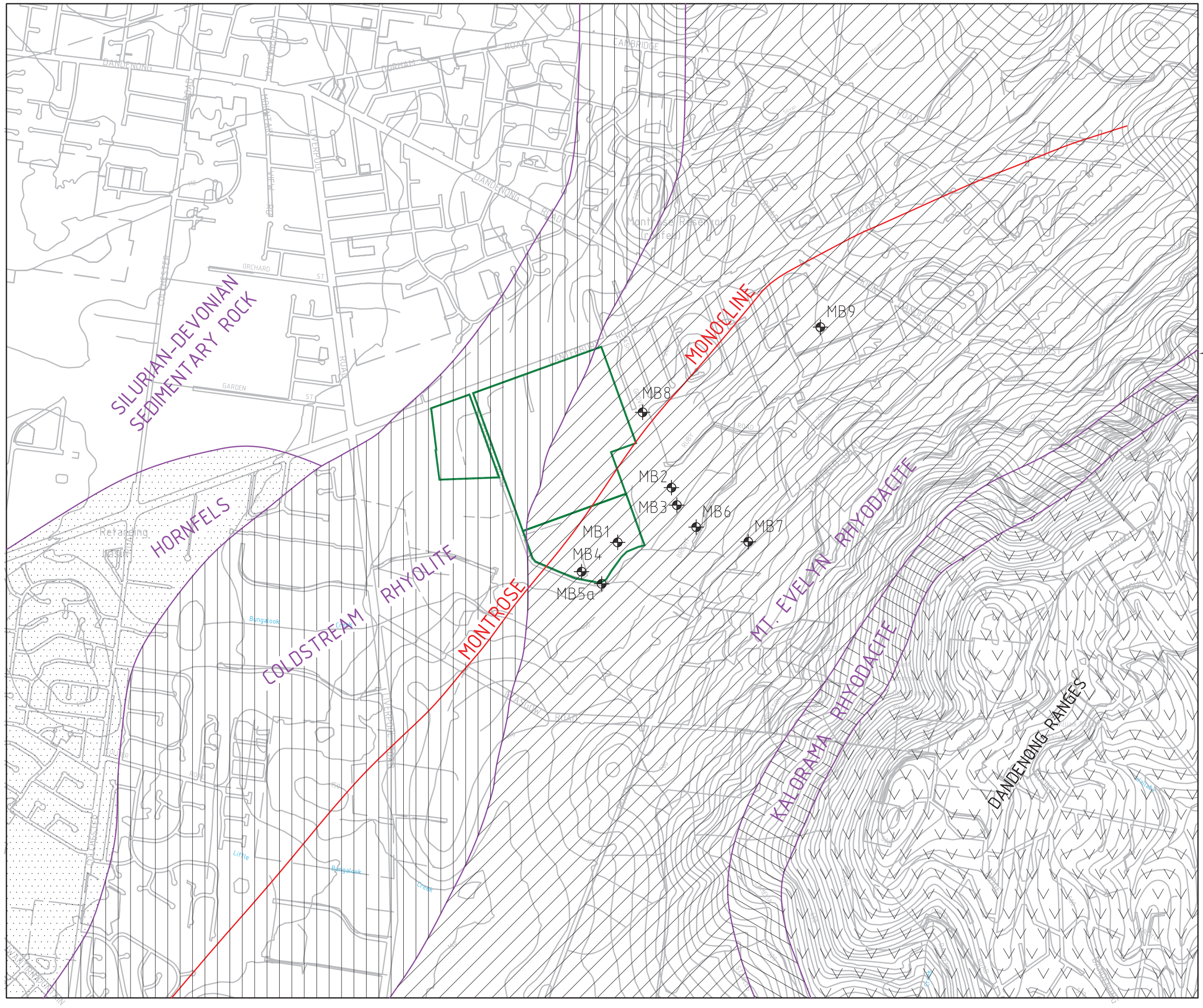
Fees and charges

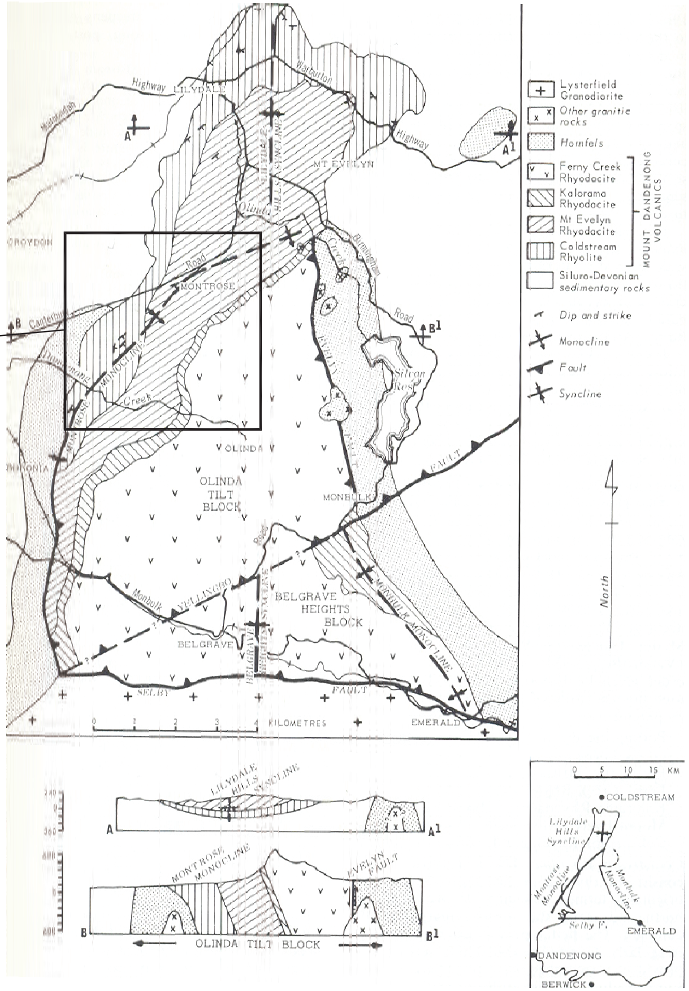
23 The licence holder must, when requested by the Authority, pay all fees, costs and other charges under the Water Act 1989 in respect of this licence.

END OF COPY OF RECORD

Appendix D

Geological mapping





NOTE:

Taken from Marsden (1988) Geology of Victoria pages 163-166

Golder Associates

50 BURWOOD ROAD
HAWTHORN Vic. 3122

Telephone (03) 8862 3500
Facsimile (03) 8862 3501

CLIENT: BOROAL LIMITED

DRAWN: JC 04.01.05

CHECKED: RGF 3.02.05

SCALE: 1:25000 A3

PROJECT: MONTROSE QUARRY

TITLE: GEOLOGY AND STRUCTURE

PROJECT No: 03612054/F92

FIGURE No: FIGURE C3

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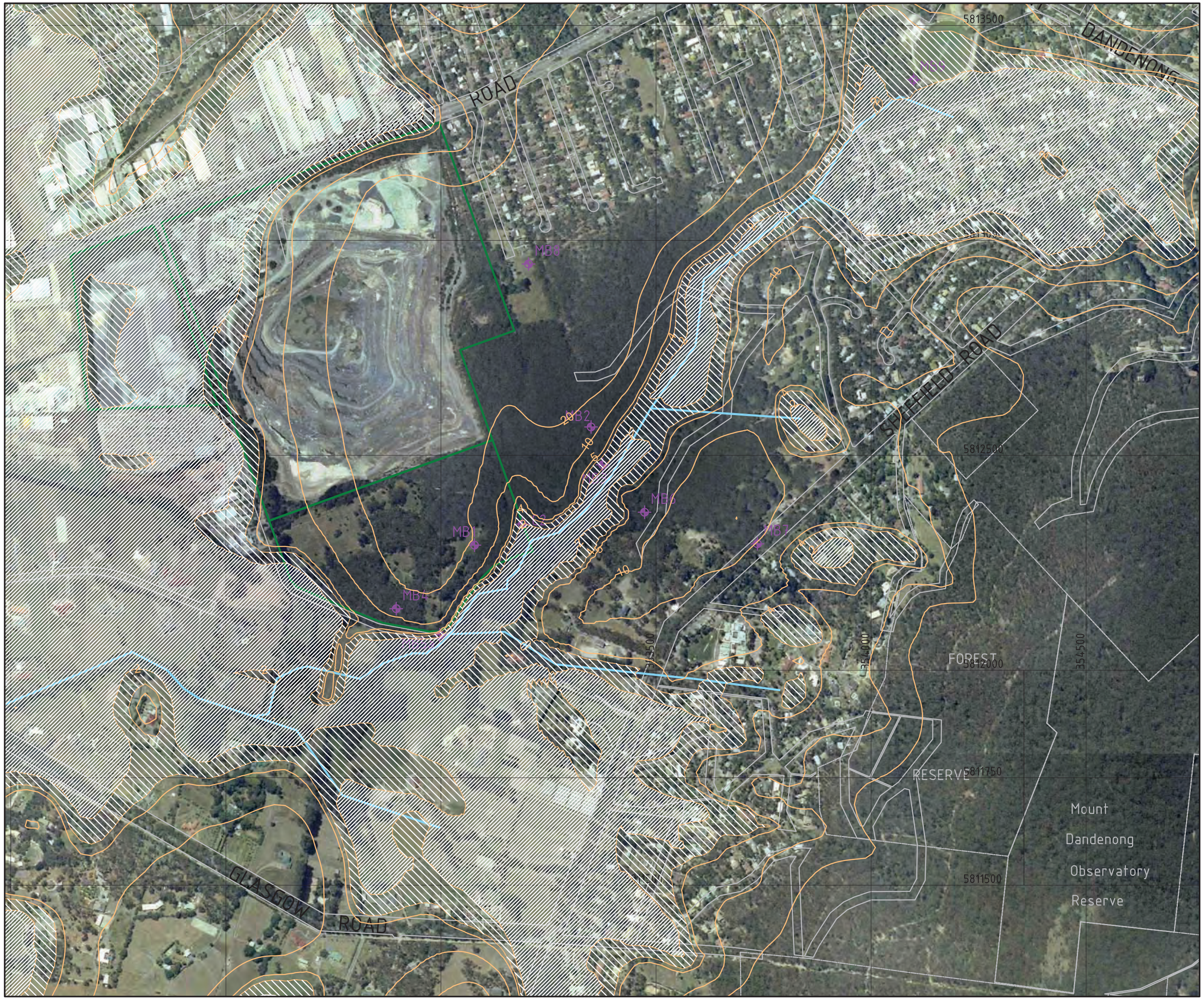
cadfile:- J:\GEO\DATA\03612054\054F92.dwg



LEGEND:

—	CONTOURS OF DEPTH TO GROUNDWATER (m)
▧	2-4m DEPTH TO GROUNDWATER (m)
▨	<2m DEPTH TO GROUNDWATER (m)

NOTE:

DEPTH TO GROUNDWATER IS TAKEN FROM NATURAL SURFACE

1:10000 0 100 200 300 400 500m

Golder Associates

50 BURWOOD ROAD
HAWTHORN Vic. 3122

Telephone (03) 8862 3500
Facsimile (03) 8862 3501

CLIENT	BORAL LIMITED		PROJECT	MONTROSE QUARRY
DRAWN	RLJ	10.05.05	TITLE	DEPTH TO GROUNDWATER PLAN - PRE-QUARRY
CHECKED	RGF	10.06.05		
SCALE	1:10000	A3	PROJECT No 03612054/F144	FIGURE No FIGURE C13a

xref:- J:\Geo\DATA\03data\03612054\dwg\Montrose04.jpg
cadfile:- J:\GEO\DATA\03612054\054F144.dwg

Appendix E

Neighbouring bore information

Table E.1 *Summary of neighbouring bore information*

Bore ID	Status	Easting	Northing	Distance to quarry (m)	Date completed	Use code	Total depth (m)	Elevation ground level (mAHD)	Top	Bottom	Lithology	Yield (L/s)
WRK961536	NU	353115.2	5812268	597		NKN - Blank	5	152.35	-	-	-	-
WRK961535	NU	353111.2	5812268	599		NKN - Blank	60	151.73	-	-	-	-
81045	U	353873.2	5812004	649	23/07/1975	DM ST	64	223.37	-	-	-	-
WRK961534	NU	353009.2	5812327	691		NKN - Blank	100	160.45	-	-	-	-
81043	U	353953.2	5811984	712	20/11/1974	DM ST	51.81	237.58	45.72	50.29	CLAY	0.38
81044	U	353953.2	5811984	712	11/03/1975	DM ST	73	237.58	-	-	-	-
136515	U	353191.2	5812474	782	20/12/1997	IV	65	168.78	59	65	-	-
WRK961537	NU	353616.2	5812598	952		NKN - Blank	67.5	167.87	-	-	-	-
WRK961538	NU	353849.2	5812478	952		NKN - Blank	50	190.88	-	-	-	-
136517	U	353462.2	5812749	1062	22/12/1997	IV	70	171.05	64	70	-	-
WRK056003	U	352560	5812634	1192	25/05/2009	IN	108	147.45	100	106		2
WRK990981	NU	352560	5812634	1192		NKN - Blank	80	147.45	-	-	-	-
WRK961539	NU	353317.2	5813129	1429		NKN - Blank	130	211.78	-	-	-	-
WRK043011	NU	352560	5813000	1496		IN		146.37	-	-	-	-
WRK043012	NU	352560	5813000	1496		IN		146.37	-	-	-	-
81065	U	354813.2	5811244	1580	1/01/1988	DM ST	12.1	584.46	-	-	-	-
139907	U	352673.2	5813184	1611	1/01/1956	DW	90	149.13	-	-	-	-
WRK073004	U	354260	5810404	1613	23/01/2013	OB	3.5		-	-	-	-
81063	U	354913.2	5811204	1688	1/01/1988	DM ST	18.2	576.51	-	-	-	-
WRK032565	U	351611	5811577	1693	15/11/1997	IN	100		40	100	-	2
81056	U	352713.2	5809964	1832	3/03/1988	DM ST	30	151.96	18	25	GRANITE	0.8
228242		352715.4	5809940	1855		NKN - Blank		-	-	-	-	-
81061	U	351473.2	5812204	1895	6/03/1991	DM ST	121	122.88	14	24	MUDSTONE	0.3
WRK967856	U	351850	5813030	1968	30/12/2004	DM ST	5	123.88	2	5	-	-
WRK967857	U	351850	5813030	1968	31/12/2004	IV	5	123.88	2	5	-	-
90603	NU	351473.2	5810884	2001	29/03/1983	NKN	43.8	126.57			SAND	1.26

Bore ID	Status	Easting	Northing	Distance to quarry (m)	Date completed	Use code	Total depth (m)	Elevation ground level (mAHD)	Top	Bottom	Lithology	Yield (L/s)
81067	U	351673.2	5810464	2043	24/12/1990	DM ST	112	131.69	30	112	BASALT	2.1
WRK983590	U	351660	5812926	2048		NKN - Blank	25	122.1	-	-	-	-
81041	NU	355353.2	5811904	2063	17/08/1972	DM ST	36.57	568.57	16.76	36.57	GRANITE	2.27
WRK961540	NU	354212.2	5813558	2070		NKN - Blank	50	180.89			-	-
132723	U	355413.2	5811624	2115	14/12/1997	DM ST	38	550.52	14	32	-	0.8
81040	U	354973.2	5810364	2141	17/12/1970	DM ST	34.74	501.47	30.48	34.74	RHYOLITE	0.63
WRK047086	NU	352085	5813589	2246		NKN - Blank	150	121.7			-	-
WRK047087	NU	354349	5813686	2246		NKN - Blank	150	185.83			-	-
WRK043349	NU	351454	5813050	2287		NKN - Blank	80	119.6			-	-
114293	U	355603.2	5811634	2304	15/09/1992	DM ST	28.5	515.76	22	27.5	GRANITE	1.2
WRK092966	U	351696	5809821	2471	17/03/2016	DM ST	35.1				-	-
WRK109470	U	350945	5812729	2570	23/10/2018	IV	8.7		5.7	8.7	-	-
81055	U	355263.2	5813384	2587	28/11/1983	DM ST	64.57	239.07	33.48	64.57	SILTSTONE	0.63
320351	U	350933.2	5812961	2682	31/12/1951	NG	89.61	114.14			-	-
320352	U	350933.2	5812961	2682	31/12/1951	NG	115.51	114.14			-	-
320353	U	350933.2	5812961	2682	31/12/1952	NG	110.94	114.14			-	-
320354	U	350933.2	5812961	2682	31/12/1952	NG	88.08	114.14			-	-
320355	U	350933.2	5812961	2682	31/12/1952	NG	66.59	114.14			-	-
320356	U	350933.2	5812961	2682	31/12/1952	NG	4.87	114.14			-	-
320357	U	350933.2	5812961	2682	31/12/1952	NG	41.14	114.14			-	-
320358	U	350933.2	5812961	2682	31/12/1952	NG	42.06	114.14			-	-
320359	U	350933.2	5812961	2682	31/12/1952	NG	71.32	114.14			-	-
WRK065844	U	350589	5812646	2871	14/05/2012	OB	9				-	-
WRK069366	U	350589	5812650	2873	14/05/2012	OB	9		6	9	-	-
WRK065841	U	350586	5812646	2874	14/05/2012	OB	12		9	12	-	-
WRK065842	U	350586	5812646	2874	14/05/2012	OB	12				-	-
WRK065843	U	350586	5812646	2874	14/05/2012	OB	9		6	9	-	-

Bore ID	Status	Easting	Northing	Distance to quarry (m)	Date completed	Use code	Total depth (m)	Elevation ground level (mAHD)	Top	Bottom	Lithology	Yield (L/s)
WRK065845	U	350586	5812646	2874	14/05/2012	OB	8		5	8	-	-
WRK065846	U	350586	5812646	2874	14/05/2012	OB	10		7	10	-	-
WRK069367	U	350586	5812646	2874	14/05/2012	OB	8		5	8	-	-
134221	U	351193.2	5809664	2930	14/05/1998	DM ST	91.3	150.31	37	91.3	-	5
WRK058851	U	351045	5813588	2941	5/10/2010	OB	9				-	-
WRK058849	U	351040	5813588	2945	5/10/2010	OB	9		3	9	-	-
WRK058850	U	351040	5813588	2945	5/10/2010	OB	9				-	-
81064	U	356053.2	5812824	2974	1/01/1988	DM ST	15.8	479.16			-	-
81057	U	356123.2	5813144	3171	27/05/1988	DM ST	37	462.06	31	37	GRANITE	0.17
WRK069562	U	350210	5812485	3188	23/05/2012	OB	11		8	11	-	-
WRK069560	U	350202	5812485	3196	23/05/2012	OB	10		7	10	-	-
WRK069561	U	350202	5812485	3196	23/05/2012	OB	10				-	-
WRK987704	Decom	350169	5812450	3220	23/08/2008	IV	9	109.63	3	9	-	-
WRK967196	U	350277.2	5812832	3228	22/11/2004	DM ST	45	109.21			MUDSTONE	-
90607	U	350242.2	5810593	3252	1/01/1988	NKN		118.83			-	-
WRK987706	NU	350132	5812561	3283		NKN - Blank	25	108.81			-	-
WRK987705	NU	350093	5812463	3297		NKN - Blank	25	108.64			-	-
115858	U	350081.2	5812412	3297	4/06/1993	IV	4	108.53	2.2	4	SILT	-
115856	U	350066.2	5812405	3310	4/06/1993	IV	3	108.35	1.3	3	CLAY	-
115857	U	350065.2	5812421	3314	4/06/1993	IV	4	108.42	2.2	4	SILT	-
115859	U	350043.2	5812396	3330	4/06/1993	IV	4.5	108.52	2.8	4.5	CLAY	-
115863	U	350051.2	5812434	3331	4/06/1993	IV	4.5	108.93	2.7	4.5	CLAY	-
115862	U	350036.2	5812435	3346	4/06/1993	IV	4.5	108.87	2.5	4.5	CLAY	-
115860	U	350021.2	5812386	3350	4/06/1993	IV	4.5	108.41	2.7	4.5	CLAY	-
WRK073297	U	350100	5810678	3359	15/02/2013	OB	8				-	-
115861	U	350003.2	5812388	3368	4/06/1993	IV	4.5	108.45	2.2	4	CLAY	-
WRK984571	NU	354431	5814916	3409		NKN - Blank	150	177.67			-	-

Bore ID	Status	Easting	Northing	Distance to quarry (m)	Date completed	Use code	Total depth (m)	Elevation ground level (mAHD)	Top	Bottom	Lithology	Yield (L/s)
WRK979916	NU	354381	5815048	3518		NKN - Blank	40	182.64			-	-
WRK096928	U	349776	5811015	3590	10/11/2016	OB	7		4	7	-	-
WRK093558	U	354846	5815136	3768	21/04/2016	DM ST	71					20
WRK106444	U	351058	5814772	3803	21/05/2018	OB	17.5		13	17.5	-	-
WRK977196	NU	354283	5815392	3821		NKN - Blank	150	184.27			-	-
WRK055375	U	351018	5814789	3841	2/03/2010	OB	21	118.47	14	21	-	-
81051	U	355613.2	5814804	3871	25/02/1985	DM ST	65	142.92	18	42	BASALT	0.75
WRK964968	U	349999	5813777	3900	7/04/2004	IV	12	106.68	5	8	-	-
WRK968839	NU	350873.2	5814784	3924		NKN - Blank	25	114.67			-	-
WRK100372	U	349263	5812204	4068	16/05/2017	OB	7.5		3	7.5	-	-
WRK100373	U	349253	5812128	4070	16/05/2017	OB	7.5		3	7.5	-	-
WRK968757	U	350680	5814860	4105	22/02/2005	DM ST	19	114.05			-	-
WRK100374	U	349210	5812256	4128	16/05/2017	OB	7.5		3	7.5	-	-
101005	U	355743.2	5815044	4142	21/05/1987	DM ST	149	168.8	134	149	MUDSTONE	1.26
WRK043353	NU	354061	5815791	4161		NKN - Blank	120	181.41			-	-
81060	U	353233.2	5815984	4285	15/08/1990	IV	9	124.91	3	9	-	-
141825	U	353763.2	5816034	4359	6/11/1998	DM ST	67	160.25			-	4.5
81058	U	353303.2	5816174	4474	15/08/1990	IV	9.5	137.71	2.25	9.5	CLAY	-
81059	U	353323.2	5816184	4484	15/08/1990	IV	9	139.97	7.5	9	CLAY	-
81042	U	352853.2	5816164	4486	17/01/1974	DM ST	23.77	107.01	18.29	23.77	-	-
WRK987949	U	349400	5814545	4827		NKN - Blank	25	104.2			-	-
WRK983171	U	351178	5816063	4852	2/06/2008	IR	44	89.14			CLAY	-
WRK987948	U	349404	5814595	4854	1/10/2008	IV	25	103.82	0.5	4	-	-
WRK101308	U	351172	5816087	4876	17/07/2017	IV	7		2.5	7	-	-
WRK101310	U	351194	5816129	4904	17/07/2017	IV	8.5		2.5	8.5	-	-
WRK101309	U	351182	5816134	4914	17/07/2017	IV	7		2.5	7	-	-
142762	NU	351263.2	5816334	5062	2/12/1998	IV	8	87.45			-	-

Bore ID	Status	Easting	Northing	Distance to quarry (m)	Date completed	Use code	Total depth (m)	Elevation ground level (mAHD)	Top	Bottom	Lithology	Yield (L/s)
142763	NU	351263.2	5816334	5062	2/12/1998	IV	8	87.45			-	-
142764	NU	351263.2	5816334	5062	2/12/1998	IV	8	87.45			-	-
142765	U	351263.2	5816334	5062	12/08/1998	IV	8	87.45	3.5	8	-	-
142766	U	351263.2	5816334	5062	12/08/1998	IV	8	87.45	3.5	8	-	-
142767	U	351263.2	5816334	5062	12/08/1998	NKN - Blank	8	87.45	3.5	8	-	-

Notes:

Decom – decommissioned, NU – Not used, U – Used, NKN – Not Known, IV – Investigation, DM – Domestic, IR – Irrigation, ST – Stock, NG – Non groundwater, IN – Industrial, OB – Observation

Radial distances based upon a site centroid (approximate) of 353300 mE, 5811700 mN

Appendix F

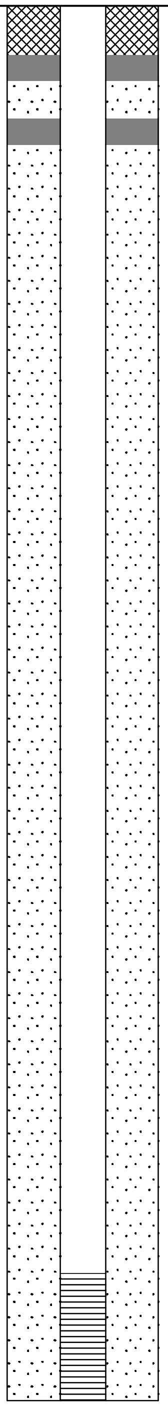
Boral monitoring bore logs

REPORT OF BOREHOLE: MB1 (Well)

SHEET: 1 OF 1

CLIENT:	Boral	COORDS: 353078 m E 5812290.6 m N AMG66		DRILL RIG: Gemco HT7	
PROJECT:	Quarry	SURFACE RL: 169.07 m DATUM: AHD		DRILLER:	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: GKW	DATE:
JOB NO:	97612266	HOLE DIA: mm HOLE DEPTH: 65.50 m		CHECKED:	DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
Rotary Blade			0					CL CL	TOPSOIL - Sandy CLAY, low plasticity, dark grey, fine to coarse sand	D	St VSt	0-2.3m, Backfill
				1.80 167.27				CL	CLAY, medium plasticity, pale brown, mottled red CLAY, low plasticity, yellow brown		H	Shallow well 2.3-3.5m, Bentonite Seal 3.5-5.3m, Gravel Pack 4.3-5.3m, Screen 1
			5	5.00 164.07				SW	SAND, fine to coarse grained, pale brown with low plasticity fines, with fine to medium gravel		MD-D	5.3-6.5m, Bentonite Seal
				7.50 161.57					trace coarse gravel			Shallow well Pipe 1 35mm
Percussion Drilling			10	11.00 158.07					RHYODACITE, grey	D D-M M M-W M-W W	H	6.5-65.5m, Gravel Pack Deep well Pipe 2 50mm 59.5-65.5, Screen 2
			65	65.50 103.57					END OF BOREHOLE @ 65.50 m GROUNDWATER ENCOUNTERED @ 31.0m			



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GAP gINT FN. F01d
RL2

Golder Associates

REPORT OF BOREHOLE: MB2 (Well)

SHEET: 1 OF 1

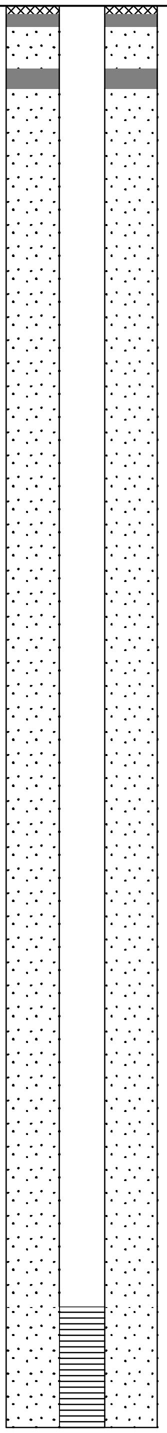
CLIENT: Boral
PROJECT: Quarry
LOCATION: Montrose
JOB NO: 97612266

COORDS: 353349.3 m E 5812565 m N AMG66
SURFACE RL: 171.29 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: mm HOLE DEPTH: 70.50 m

DRILL RIG: Gemco HT7
DRILLER:
LOGGED: GKW DATE:
CHECKED: DATE:

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
Rotary Blade			0	170.79			CL	TOPSOIL - Sandy CLAY, low plasticity, dark grey with fine to coarse sand		St
				3.20 168.09			CL	Silty CLAY, medium plasticity, red brown yellow mottled red	D	VSt
			10	9.00 161.99				red yellow-red		
				19.00				yellow red, mottled grey		
			20	20.00			CL	Silty CLAY, medium plasticity, yellow red, mottled grey		VSt-H
				21.00 150.29				trace fine to medium gravel	D-M	
				23.00				pale brown		
			25	24.00 147.29				inferred hard		
									M-W	
Percussion Drilling			30	30.00 141.29				RHYODACITE, grey	W	H
			45	44.00 127.29				brown, grey		
				48.00 123.29				grey		
				52.00 119.29				trace limonite staining		
			60	60.00 111.29				RHYODACITE, grey, trace limonite staining		
			70	70.50 100.79				END OF BOREHOLE @ 70.50 m GROUNDWATER ENCOUNTERED @ 21.0m		

PIEZOMETER DETAILS



0-0.4m, Backfill
Shallow well
0.4-1.0m, Bentonite Seal
1.0-3.1m, Gravel Pack
2.1-3.1m, Screen 1
3.1-4.1m, Bentonite Seal
Pipe 1 35mm
4.1-70.5m, Gravel Pack

Deep well
Pipe 2 50 mm

64.5-70.5m, Screen 2

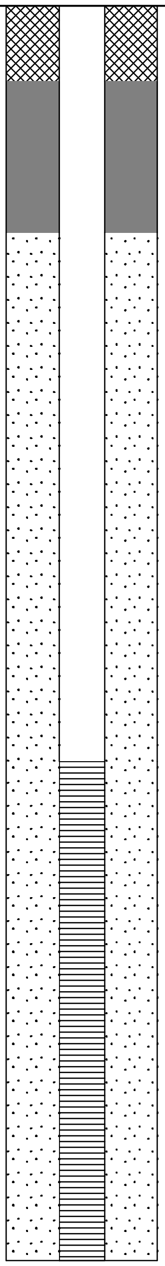
Golder Associates

REPORT OF BOREHOLE: MB3 (Well)

SHEET: 1 OF 1

CLIENT:	Boral	COORDS: 353376 m E 5712478 m N AMG66		DRILL RIG: Gemco HT7	
PROJECT:	Quarry	SURFACE RL: 158.09 m DATUM: AHD		DRILLER:	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: BJF	DATE:
JOB NO:	97612266	HOLE DIA: mm HOLE DEPTH: 8.30 m		CHECKED:	DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
Solid Auger			0	158.09	DS 0.50-0.60 m			OL	SILT, light grey brown, trace fine sand, trace organics, trace fine to medium gravel	D	S	0-0.5m, Backfill 0.5-1.5m, Bentonite Seal
			1.30	156.79	SPT 1.50-1.80 m 12,21,5/40mm			CH	Silty CLAY, medium to high plasticity, light grey brown and orange brown, trace fine sand		H	1.5-8.3m, Gravel Pack
			2.70	155.39	DS 2.80-2.90 m U63 3.00-3.40 m PP = 300-400 kPa				pale grey and orange brown	D-M	VSt	
			4.00	154.09	U63 4.50-4.90 m PP = >600 kPa				trace fine to medium quartz sand, trace fine angular gravel		H	5.0-8.3m, Slotted Screen
			5.70	152.39	U63 6.00-6.40 m PP = >600 kPa				pale grey and trace orange brown, with fine sand, trace fine gravel	M	VSt	
			7.50	150.59					hard			
			8.30	149.79					END OF BOREHOLE @ 8.30 m GROUNDWATER ENCOUNTERED @ 6.5m			



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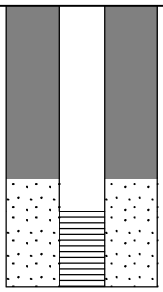
GAP gINT FN. F01d
RL2

Golder Associates

REPORT OF BOREHOLE: AH1

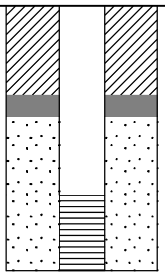
CLIENT:	Boral	COORDS: 353118 m E 5812223.2 m N AMG66		SHEET: 1 OF 1	
PROJECT:	Quarry	SURFACE RL: 150.92 m DATUM: AHD		DRILL RIG: Auger	
LOCATION:	Montrose	INCLINATION: -90°		DRILLER:	
JOB NO:	97612266	HOLE DIA: mm HOLE DEPTH: 1.86 m		LOGGED: SJT	DATE:
				CHECKED:	DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS –
Hand Auger			0	150.89				CL	Silty CLAY, dark brown, with organic root material, moist, friable, topsoil	M	VSt	 0-1.14m, Compacted clay
								CH	Silty CLAY, pale grey, trace orange brown mottles, trace fine sand	M (>PL)	H	
U63			1		DS 0.80-1.05 m	■						
Machine Auger				1.18 149.74	PP = 430-7600 kPa			CI	Sandy CLAY, medium plasticity, grey to yellow brown, fine to coarse sand, trace fine subrounded quartz gravel			1.14-1.86m, Gravel pack 1.36-1.86m, Slotted screen
			2	1.86 149.06					END OF BOREHOLE @ 1.86 m Standpipe installed Water at 1.83m below ground on 4/2/98			
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

REPORT OF BOREHOLE: AH2

				SHEET: 1 OF 1	
CLIENT:	Boral	COORDS: 353194.37 m E 5812228 m N AMG66		DRILL RIG: Auger	
PROJECT:	Quarry	SURFACE RL: 150.88 m DATUM: AHD		DRILLER:	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: SJT	DATE:
JOB NO:	97612266	HOLE DIA: mm HOLE DEPTH: 1.78 m		CHECKED:	DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
Machine Auger			0	150.88 *0.40*				CH	Silty CLAY, dark brown, trace fine to coarse sand, with root material	M (>PL)	F	0-0.59m, Backfitted with spoil
				150.48 *0.60*					trace root material, trace rotten wood chips			0.59-0.73m, Concrete cap
				150.28 *0.90*					grey with zones of yellow brown, with fine to coarse sand			0.73-1.75m, Gravel pack
U63			1	149.98 *1.20*	U63 0.80-1.05 m U63 attempted but not retained in tube	■		SC CI	Clayey SAND to Sandy CLAY, grey to yellow brown, fine to coarse sand	M	MD	
Machine Auger U63				149.68 *1.78*	Sa2 1.50-1.78 m	■		CI	Sandy CLAY, yellow brown, fine to coarse sand, trace fine subrounded quartz gravel	M (>PL)	F-St	1.25-1.75m, Slotted screen
			2	149.10					END OF BOREHOLE @ 1.78 m Standpipe installed Water at 0.77m below ground on 4/2/98			
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									



REPORT OF BOREHOLE: MB4 (Well)

SHEET: 1 OF 1

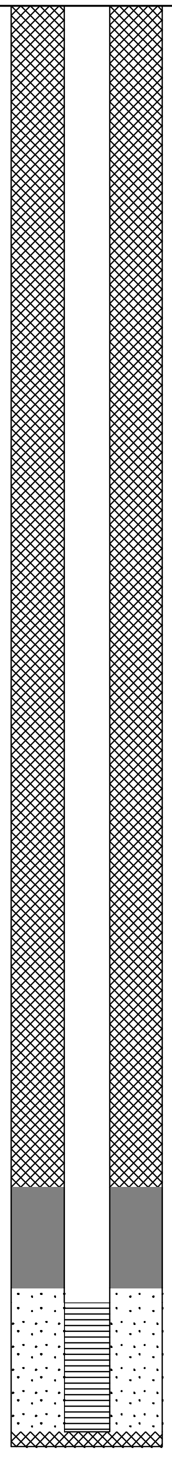
CLIENT: Boral
PROJECT: Groundwater Investigation
LOCATION: Montrose
JOB NO: 03612054

POSITION: Refer to Site Plan
SURFACE RL: 160.80 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 150 mm HOLE DEPTH: 100.00 m

DRILL RIG: UDR 650
DRILLER: AQUA
LOGGED: AR DATE: 1/5/03
CHECKED: DATE:

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	M		0	160.80			CL	Sandy CLAY, low plasticity, pale brown and brown, fine to coarse sand, subangular/subrounded		
Hammer				3.00 157.80				RHYODACITE, pale brown to brown, inferred very low strength, dry		
				6.00 154.80				brown and grey from 6.0m		
				10.00 150.80				dry to moist from 10.0m		
				16.00 144.80				pale brown and pale grey, moist from 16.0m		
				20.00 140.80				RHYODACITE, pale brown to brown, inferred very low strength		
				23.00 137.80				RHYODACITE, brown and grey, inferred low to medium strength, moist		
				29.00 131.80				RHYODACITE, grey, inferred high strength, moist		
		▷	50	50.00 110.80				wet from 50.0m		
				58.00 102.80				moist from 58.0m		
			100	100.00 60.80				END OF BOREHOLE @ 100.00m		

PIEZOMETER DETAILS



Concrete pad and gatic cover at surface
0.0-3.0m, 150mm casing installed
0.0-82.0m, Backfilled
0.0-90.m, 50mm PVC
82.0-89.0m, Bentonite Seal
89.0-99.0m, 8/16 Sand Pack
90.0-99.0m, 50mm machine slotted PVC Screen
99.0-100.0m, Fall in

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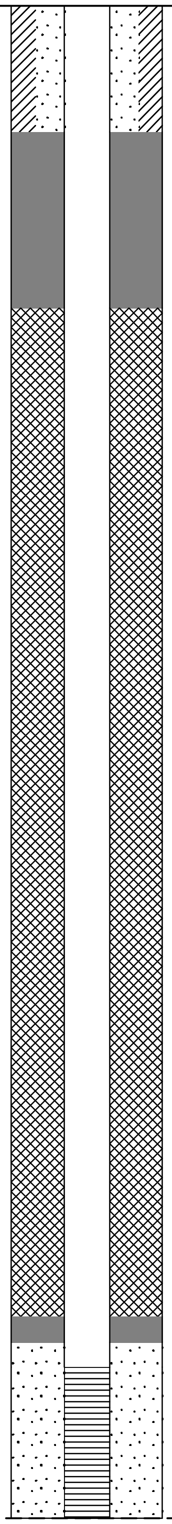
REPORT OF BOREHOLE: MB5a (Well)

SHEET: 1 OF 1

CLIENT: Boral	POSITION: Refer to Site Plan	DRILL RIG: UDR 650	
PROJECT: Groundwater Investigation	SURFACE RL: 151.94 m DATUM: AHD	DRILLER: AQUA	
LOCATION: Montrose	INCLINATION: -90°	LOGGED: AR	DATE: 30/4/03
JOB NO: 03612054	HOLE DIA: 150 mm HOLE DEPTH: 60.00 m	CHECKED:	DATE:

Drilling					Sampling	Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	M M-H		0	151.94 3.00				SP	Gravelly SAND, fine to coarse, brown, subangular to subrounded, gravel fine to coarse, subangular, inferred rhyodacite gravel, trace low plasticity fines	D	MD D
Hammer		⊻ 01/05/03	3.00	148.94 10.00					RHYODACITE, brown, inferred very low strength, dry to moist		
			10.00	141.94 15.00					RHYODACITE, grey and pale brown, inferred low strength, dry to moist		
			15.00	136.94 20.00					RHYODACITE, grey with some brown, wet, inferred medium to high strenth		
			20.00	131.94 23.00					RHYODACITE, grey and brown, wet, inferred low to medium strength		
			23.00	128.94 31.00					RHYODACITE, grey brown, wet, inferred medium to high strength		
			31.00	120.94 60.00					RHYODACITE, grey, wet, inferred high strength		
			60						END OF BOREHOLE @ 60.00m GROUNDWATER ENCOUNTERED @ 8.4m		

PIEZOMETER DETAILS



Gatic cover and concrete pad at surface
0.0-5.0m, Cement Grout
0.0-54.0m, 50mm PVC
5.0-12.0m, Bentonite Seal
12.0-52.0m, Backfilled with 7mm Rhyodocite Gravel
52.0-53.0m, Bentonite Seal
53.0-60.0m, 8/16 Sand Pack
54.0-60.0m, 50mm PVC Machine Slotted Screen

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GAP gINT FN. F01d
RL2

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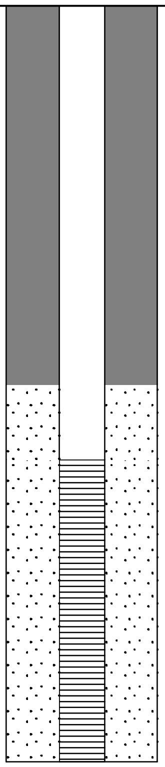
Golder Associates

REPORT OF BOREHOLE: MB5b (Well)

				SHEET: 1 OF 1	
CLIENT:	Boral	POSITION: Refer to Site Plan		DRILL RIG: UDR 650	
PROJECT:	Groundwater Investigation	SURFACE RL: 152.24 m	DATUM: AHD	DRILLER: AQUA	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: AR	DATE: 2/5/03
JOB NO:	03612054	HOLE DIA: 150 mm	HOLE DEPTH: 5.00 m	CHECKED:	DATE:

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADV	M		0	152.24				SP	Gravelly SAND, fine to coarse, brown, subrounded to subangular, gravel, fine to coarse subangular, inferred rhyodacite gravel, trace low plasticity fines			Gatic cover and concrete pad at surface 0.0-3.0m, 50mm PVC 0.0-2.5m, Bentonite Seal
			1									
	M-H		2									2.5.5-5.0m, 16/30 Sand Pack
Hammer			3	*3.00* 149.24					RHYODACITE, brown, inferred very low strength, dry to moist			3.0-5.0m, 50mm Machine Slotted PVC Screen
			4									
			5	*5.00* 147.24					END OF BOREHOLE @ 5.00 m GROUNDWATER NOT ENCOUNTERED			
			6									
			7									
			8									
			9									
			10									



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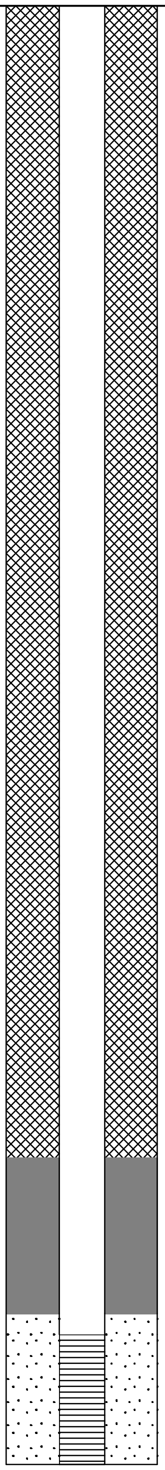
GAP gINT FN. F01d
RL2

REPORT OF BOREHOLE: MB6 (Well)

CLIENT: Boral	POSITION: Refer to Site Plan	SHEET: 1 OF 1	
PROJECT: Groundwater Investigation	SURFACE RL: 167.69 m DATUM: AHD	DRILL RIG: UDR 650	
LOCATION: Montrose	INCLINATION: -90°	DRILLER: AQUA	
JOB NO: 03612054	HOLE DIA: 150 mm HOLE DEPTH: 67.50 m	LOGGED: AR/NRC	DATE: 6/5/03
		CHECKED:	DATE:

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	M		0				CL	CLAY, low plasticity, yellow brown, trace fine to medium sand	M (<PL)	F
				1.00				grey and brown		
				2.00 165.69			CL	Sandy CLAY, low plasticity, yellow, brown and grey, fine to coarse sand, subangular to subrounded, with some fine to coarse subangular gravel, gravel inferred EW rhyodacite		F-St
				4.00 163.69			SP	Clayey SAND, brown and grey, fine to coarse subangular, low plasticity clay, with some fine to coarse subangular gravel, gravel inferred rhyodacite	D-M	MD
				10.00 157.69			CH	Sandy CLAY, high plasticity, brown, fine to coarse sand, subangular to subrounded, trace fine to medium subangular inferred EW rhyodacite gravel	M (cPL)	F
		▽	13.0							
WB			18						M (>PL)	
				25.00 142.69				with some fine to coarse subangular gravel, inferred EW rhyodacite gravel		F-St
Hammer				54.00 113.69				RHYODACITE, brown and grey, inferred very low to low strength		
				57.00 110.69				grey, inferred medium strength		
				67.50 100.19				END OF BOREHOLE @ 67.50 m GROUNDWTER ENCOUNTERED @ 13.0m		

PIEZOMETER DETAILS



Gatic cover and concrete pad at surface 0.0-61.50m, 50mm PVC 0.0-53.3m, Backfilled

53.3-60.6m, Bentonite Sand

60.5-67.5m, 8/16 Sand Pack 61.5-67.5m, 50mm Machine Slotted PVC Screen

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GAP gINT FN. F01d
RL2

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REPORT OF BOREHOLE: MB7 (Well)

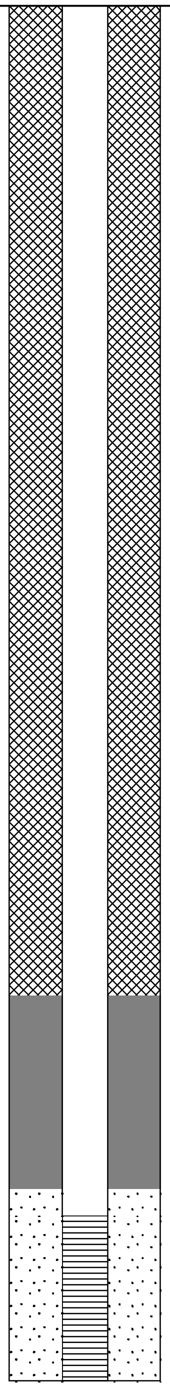
Golder Associates

SHEET: 1 OF 1

CLIENT:	Boral	POSITION: Refer to Site Plan		DRILL RIG: UDR 650	
PROJECT:	Groundwater Investigation	SURFACE RL: 190.73 m	DATUM: AHD	DRILLER: AQUA	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: AR	DATE: 5/5/03
JOB NO:	03612054	HOLE DIA: 150 mm	HOLE DEPTH: 50.00 m	CHECKED:	DATE:

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	M		0	190.73			SP	Gravelly SAND, fine to coarse, brown, subangular to subrounded, gravel fine to coarse, subangular, inferred EW rhyodacite gravel, with some low plasticity fines		
				6.00 184.73				Sandy CLAY, low plasticity, red brown, sand fine to coarse, subangular to subrounded, trace fine to medium gravel		
				20.00 170.73			CL	Sandy CLAY, low plasticity, brown and pale brown, sand fine to coarse, subangular, with some fine to coarse subangular gravel, inferred EW rhyodacite gravel		
Hammer				27.00 163.73				RHYODACITE, pale brown and brown, inferred very low strength, dry		
				30.00 160.73				RHYODACITE, brown and grey, inferred low strength, dry to moist		
				38.00 152.73				RHYODACITE, grey, inferred, medium to high strength, moist		
		▷		48.00 142.73				wet from 48.0m		
			50	50.00 140.73				END OF BOREHOLE @ 50.00 m GROUNDWATER ENCOUNTERED @ 48.0m		

PIEZOMETER DETAILS



Gatic cover and concrete pad at surface 0.0-44.0m, 50mm PVC 0.0-36.0m, Backfilled with 7mm Rhyodocite Gravel

36.0-43.m, Bentonite Seal

43.0-50.0m, 8/16 Sand Pack 44.0-50.0m, 50mm Machine Slotted PVC Screen

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GAP gINT FN. F01d RL2

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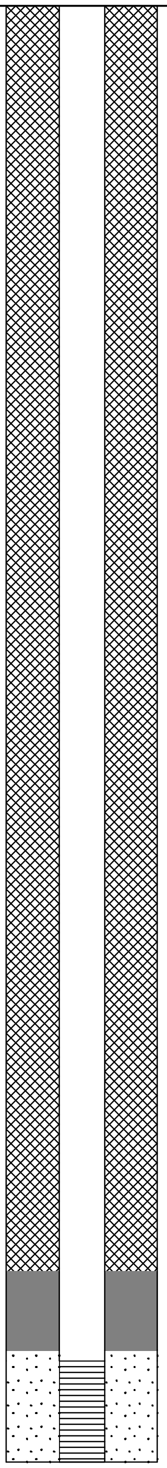
Golder Associates

REPORT OF BOREHOLE: MB8 (Well)

				SHEET: 1 OF 1	
CLIENT:	Boral	POSITION: Refer to Site Plan		DRILL RIG: UDR 650	
PROJECT:	Groundwater Investigation	SURFACE RL: 212.04 m	DATUM: AHD	DRILLER: AQUA	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: AR	DATE: 12/5/03
JOB NO:	03612054	HOLE DIA: 150 mm	HOLE DEPTH: 130.00 m	CHECKED:	DATE:



Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADV	M		0	212.04				CL	Sandy CLAY, low plasticity, brown, pale brown and pale red, fine to medium subangular to subrounded sand	D	St	Gatic cover and concrete pad at surface 0.0-121m, 50mm PVC 0.0-113.0m, Backfilled
Hammer			10	*11.00* 201.04				SP	Clayey SAND, brown and pale brown, fine to coarse, subangular to subrounded, low plasticity clay, with some fine to medium subangular gravel, inferred EW rhyodacite		MD-D	
			20	*22.00* 190.04					RHYODACITE, brown and grey, inferred very low strength, dry			
			35	*35.00* 177.04					grey from 35.0m, inferred low to medium strength			
			40	*40.00* 172.04					RHYODACITE, grey, inferred medium to high strength, dry			
		▷	50									
			90	*91.00* 121.04					RHYODACITE, grey, inferred high to very high strength, wet			113.0-120.0m, Bentonite Seal 120.0-130.0m, 8/16 Sand Pack 121-130m, Machine Slotted PVC, Screen
			130	*130.00* 82.04					END OF BOREHOLE @ 130.00 m GROUNDWATER ENCOUNTERED @ 50.0m			
			135									

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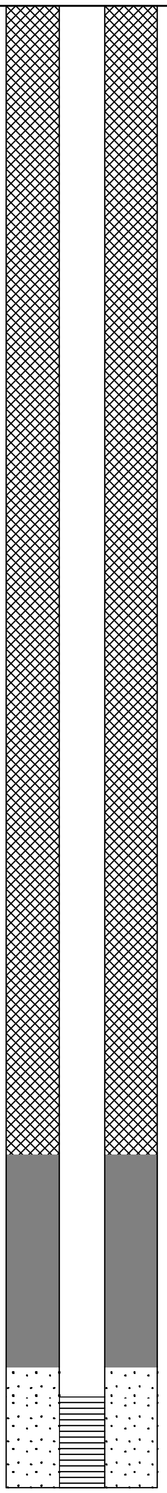
REPORT OF BOREHOLE: MB9 (Well)

CLIENT:	Boral	POSITION: Refer to Site Plan		SHEET: 1 OF 1	
PROJECT:	Groundwater Investigation	SURFACE RL: 181.39 m	DATUM: AHD	DRILL RIG: UDR 650	
LOCATION:	Montrose	INCLINATION: -90°		DRILLER: AQUA	
JOB NO:	03612054	HOLE DIA: 150 mm	HOLE DEPTH: 49.00 m	LOGGED: AR	DATE: 14/5/03
				CHECKED:	DATE:

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	M		0	181.39			CL	CLAY, low plasticity, brown, grey, trace pale brown, trace fine sand	M (<PL)	
		▽	6.00	175.39			CL	Sandy CLAY, low plasticity, brown and grey, fine to coarse sand, subangular to subrounded	M (<PL) M (>PL) M (>>PL)	F
WB	H		30.50	150.89				Sandy CLAY, low plasticity, brown and grey, fine to coarse subangular to subrounded sand, with some fine to medium subangular gravel, inferred EW rhyodacite gravel	M (>PL)	
Hammer			33.00	148.39				RHYODACITE, grey, inferred medium to high strength		
			49.00	132.39				END OF BOREHOLE @ 49.00m GROUNDWATER ENCOUNTERED @ 3.0m		

PIEZOMETER DETAILS



Gatic cover and concrete pad at surface
0.0-46.0m, 50mm PVC
0.0-38.0m, Backfilled

38.0-45.0m, Bentonite Seal

45.0-49.0m, 8/16 Sand Pack
46.0-49.0mm, Machine Slotted PVC, Screen

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REPORT OF BOREHOLE: A2

SHEET: 1 OF 1

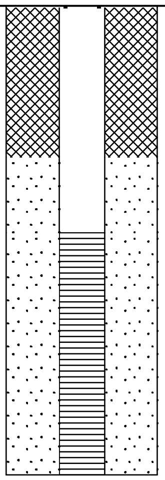
CLIENT: Boral Pty Ltd
PROJECT: Quarry
LOCATION: Montrose
JOB NO: 03612054

COORDS: 353200.38 m E 5812298.13 m N AMG66
SURFACE RL: 152.75 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 150 mm HOLE DEPTH: 3.10 m

DRILL RIG: Geoprobe 6620 DT
DRILLER: Aqua Drilling & Grouting P/L
LOGGED: DRP DATE: 18/10/04
CHECKED: DATE:

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	L		0	152.75					HUMUS, leaf litter, sticks, gum nuts, grasses	M	L
				0.20 152.55				ML	Sandy SILT, low liquid limit, brown, with ~30% fine sand and some organic material		VSt
				0.70 152.05				SP	Silty SAND, fine grained, poorly graded, subangular quartz with ~20-40% low liquid limit silt, grey with orange staining		D
			1	*1.20* 151.55					with some medium grained sand and some high plasticity clayey fines		
				1.40 151.35					fine to medium grained		VSt
				1.60 151.15				ML	SILT, medium liquid limit, grey with brown staining, some fine sand and some high plasticity clayey fines		D
			2	*1.90* 150.85				SC	Clayey SAND, poorly graded, fine to medium grained, brown and grey, subangular with ~30-40% high plasticity clayey fines		
HA		⊻ 22/10/04			U63 2.60-3.10 m PP = >600 kPa	■					
			3	*3.10* 149.65					END OF BOREHOLE @ 3.10 m GROUNDWATER NOT OBSERVED Standpipe installed to 3.0m.		
			4								
			5								
			6								
			7								
			8								
			9								
			10								

PIEZOMETER DETAILS



Protective Casing - 120mm Steel 0-0.3m Backfill

1.0-3.1m 18/40 Grade Sand

1.5-3.0m, 0.4mm Machine Cut Screen

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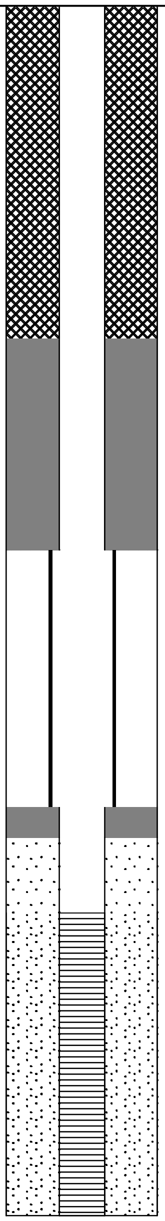
REPORT OF BOREHOLE: A5

SHEET: 1 OF 1

CLIENT: Boral Pty Ltd	COORDS: 353198.62 m E 5812299.5 m N AMG66	DRILL RIG: Geoprobe 6620 DT	
PROJECT: Quarry	SURFACE RL: 152.81 m DATUM: AHD	DRILLER: Aqua Drilling & Grouting P/L	
LOCATION: Montrose	INCLINATION: -90°	LOGGED: DRP	DATE: 18/10/04
JOB NO: 03612054	HOLE DIA: 150 mm HOLE DEPTH: 8.00 m	CHECKED:	DATE:

Drilling					Sampling	Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
AS	L		0	152.81					HUMUS, leaf litter, sticks, gum nuts, grasses	M	L
				0.20 152.61	U63 0.40-0.80 m PP = >600 kPa	■		ML	Sandy SILT, low liquid limit, brown with ~30% fine sand and some organic material		VSt
				0.70 152.11				SP	Silty SAND, fine grained, poorly graded, subangular quartz with 20-40% low liquid limit silt, grey with orange staining		D
			1	1.20 151.61	U63 1.20-1.60 m PP = >600 kPa	■			with some medium grained sand and some high plasticity fines		
				1.60 151.21				ML	SILT, medium liquid limit, grey with brown staining, some fine sand and some high plasticity clayey fines		VSt-H
			2	1.90 150.91	U63 2.40-2.80 m PP = >300-320 kPa	■		SC CI	Clayey SAND/Sandy CLAY, poorly graded, fine to medium grained, subangular with 30-40% medium to high plasticity fines		VSt
	H	▽ 22/10/04									
			3	3.20 149.61	U63 3.50-3.80 m PP = >600 kPa	■		SP	SAND, fine to coarse grained, angular, quartz, feldspar, mica fragments, grey with some hard gravel sized fragments of highly weathered rhyodacite		VD
			5	5.00 147.81					with highly weathered, high strength, rounded cobbles of rhyodacite		
			6		DS 6.00-6.10 m	■					
			8	8.00 144.81					END OF BOREHOLE @ 8.00 m GROUNDWATER ENCOUNTERED @ 2.6m. Standpipe installed at 8.0m.		
			9								
			10								

PIEZOMETER DETAILS



Protective Casing - 120mm Steel

0.0-2.2m, Backfill

2.2-3.6m, Bentonite Seal

3.6-5.3, Hole collapse

Pushed PVC through

5.3-5.5m, Bentonite Seal

5.5-8.0m, 16/30 Grade Sand

6.0-8.0m, 0.4mm Machine Cut Screen

Golder Associates

REPORT OF BOREHOLE: B2

SHEET: 1 OF 1

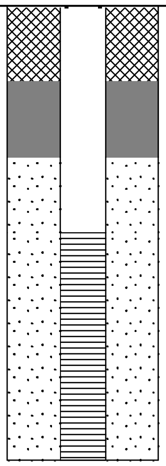
CLIENT: Boral Pty Ltd
PROJECT: Quarry
LOCATION: Montrose
JOB NO: 03612054

COORDS: 353195.82 m E 5812312.43 m N AMG66
SURFACE RL: 153.44 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 150 mm HOLE DEPTH: 3.00 m

DRILL RIG: Geoprobe 6620 DT
DRILLER: Aqua Drilling & Grouting P/L
LOGGED: DRP DATE: 19/10/04
CHECKED: DATE:

Drilling					Sampling	Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	L		0	153.44					HUMUS, leaf litter, sticks, grasses	M	L
				0.20 153.24				ML	Clayey SILT, brown, medium liquid limit, with ~30% high plasticity clays and some fine sand, with organic material, and tree roots		VSt
			1 2	0.70 152.74				SC	Clayey SAND, fine to medium grained, angular quartz, grey with brown iron staining. With ~30% high plasticity fines, trace organic material	W	D
HA	H	▽ 20/10/04		2.40 151.04	U63 2.50-2.90 m PP = >600 kPa	■		SP	Silty SAND/SAND, fine to medium grained quartz, feldspar and mica fragments, angular, grey with brown staining, with some pockets of clayey sand, silty sand and sand	D	VD
			3	3.00 150.44					END OF BOREHOLE @ 3.00 m GROUNDWATER NOT OBSERVED		
			4 5 6 7 8 9 10								

PIEZOMETER DETAILS



Protective Casing - 110mm Steel 0.0-0.5m,
Backfill Bentonite Seal 0.5-1.0m
8/40 Grade Sand 1.0-3.0m
0.4mm Machine Cut Screen 1.5-3.0m

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GAP gINT FN. F01d
RL2

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REPORT OF BOREHOLE: B5

SHEET: 1 OF 1

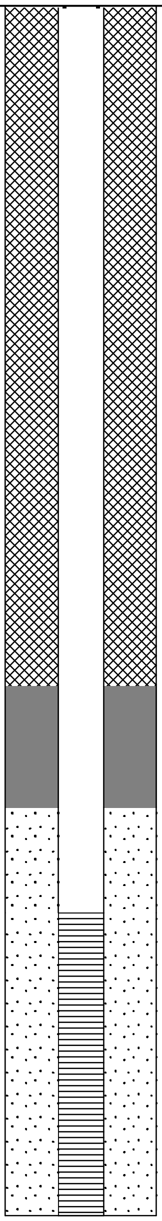
CLIENT: Boral Pty Ltd
PROJECT: Quarry
LOCATION: Montrose
JOB NO: 03612054

COORDS: 353195.74 m E 5812315.16 m N AMG66
SURFACE RL: 153.58 m DATUM: AHD
INCLINATION: -90°
HOLE DIA: 150 mm HOLE DEPTH: 8.00 m

DRILL RIG: Geoprobe 6620 DT
DRILLER: Aqua Drilling & Grouting P/L
LOGGED: DRP DATE: 19/10/04
CHECKED: DATE:

Drilling					Sampling	Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
ADV	L		0	153.58					Humus, sticks leaf litter, bracken	M	L
				0.20 153.38	U63 0.40-0.80 m PP = 280-300 kPa			MH	Clayey SILT, brown, medium liquid limit. With 30% high plasticity clays and some fine sand. With organic material including tree roots.		VSt
	M	▷	1	0.70 152.88	U63 1.00-1.30 m PP = 600 kPa			SC	Clayey SAND - fine to medium grained angular quartz, grey with brown iron staining . With approximately 30% high plasticity fines.	W	D
	H		2	2.40 151.18	U63 2.50-2.80 m PP = 760 kPa			SW SM	Silty SAND/SAND, fine to medium grained quartz, fieldspar and mica fragments. Angular, grey with brown staining. With some pockets of clayey SAND, silty SAND and SAND	D	
RAB	L		3	3.40 150.18				SC	Clayey SAND, fine to medium grained, quartz, feldspar and mica. With 30-40% grey high plasticity CLAY. With some high strength highly weathered rhyodacite, gravels and cobbles.	M	VD
		⊻ 22/10/04	4	3.90 149.68					RHYODACITE, extremely weathered, fine to medium angular grains with some clay minerals. High strength.	D	H
	H		5	5.30 148.28	DS @ 5.50 m				highly weathered Rhyodocite, grey with some staining. Very high strength.		
			6	6.20 147.38	DS @ 6.50 m DS @ 7.50 m				moderately weathered, dark grey, very high strength.		
			8	8.00 145.58					END OF BOREHOLE @ 8.00 m GROUNDWATER INFLOW @ 0.8m		
			9								
			10								

PIEZOMETER DETAILS



Protective Casing - 120mm Steel 0.0-4.5m, Backfill

4.5 - 5.3m Bentonite Seal

5.3 - 8.0m 16/30 Grade Sand

6.0 - 8.0m, 0.4mm Machine Cut Screen

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

Golder Associates

REPORT OF BOREHOLE: C2

SHEET: 1 OF 2

CLIENT:	Boral Pty Ltd	COORDS: 353189.11 m E 5812339.79 m N AMG66		DRILL RIG: Geoprobe 6620	
PROJECT:	Quarry	SURFACE RL: 155.01 m DATUM: AHD		DRILLER: Aqua Drilling & Grouting P/L	
LOCATION:	Montrose	INCLINATION: -90°		LOGGED: DRP	DATE: 19/10/04
JOB NO:	03612054	HOLE DIA: 100 mm	HOLE DEPTH: 12.00 m	CHECKED:	DATE:

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
ADV	L		0						Humus, leaf litter, sticks, bracken	M	L	Protective Casing - 120mm Steel 0.0-8.4m, Backfill
				0.10 154.91	U63 0.40-0.90 m PP = >600 kPa			ML	Clayey SILT, black, medium high liquid limit with approximately 40% high plasticity clay and some organic material with some fine SAND		VSt	
	M			0.80 154.21	U63 1.00-1.40 m PP = >600 kPa			SC	Clayey SAND, fine to medium grained black angular quartz, mica, feldspar with 20-30% black clay, silt and some organic material	M-W	D	
			2	2.10 152.91	U63 2.00-2.30 m PP = >600 kPa				grey			
			3	3.00 152.01	U63 3.50-3.90 m PP = >600 kPa			SP	SAND, fine grained, angular quartz, mica and feldspar. With some clayey fines. With highly weathered RHYODACITE gravels and cobbles, with some staining.	M	VD	
RAB	R	⊻ 22/10/04		4.50 150.51	DS @ 5.00 m				EW-HW RHYODACITE, inferred HW boulders and cobbles with EW sandy matrix.			
	H		6	6.00 149.01	DS @ 6.50 m DS @ 7.50 m				Moderately weathered RHYODACITE, grey quartz, feild span and mica grains.	D		
				8.50 146.51	DS @ 9.00 m				slightly weathered , very high strength, grey - black.	M W		8.4 - 9.3m Bentonite Seal 9.3 - 12.0m, 16/30 Grade Sand
			10									

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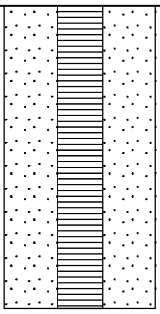
Golder Associates

REPORT OF BOREHOLE: C2

SHEET: 2 OF 2

CLIENT:	Boral Pty Ltd	COORDS: 353189.11 m E 5812339.79 m N AMG66	DRILL RIG: Geoprobe 6620
PROJECT:	Quarry	SURFACE RL: 155.01 m DATUM: AHD	DRILLER: Aqua Drilling & Grouting P/L
LOCATION:	Montrose	INCLINATION: -90°	LOGGED: DRP DATE: 19/10/04
JOB NO:	03612054	HOLE DIA: 100 mm HOLE DEPTH: 12.00 m	CHECKED: DATE:

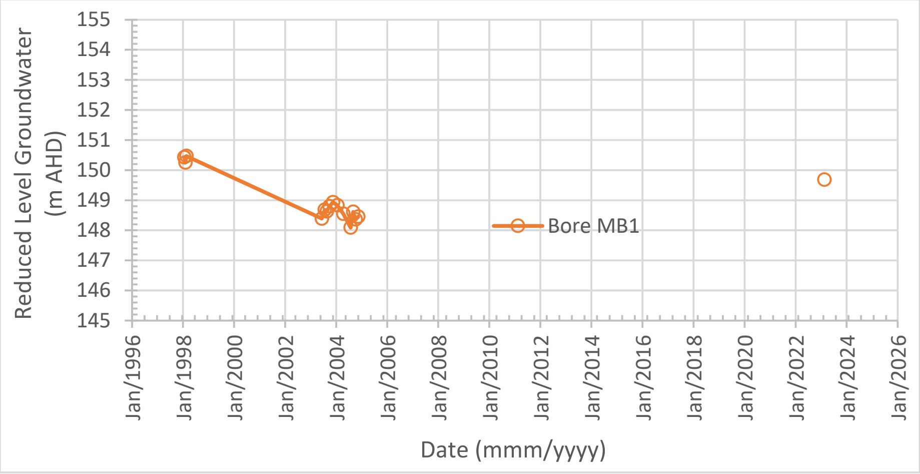
Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	PIEZOMETER DETAILS
RAB	H		10 11		DS @ 10.50 m				Moderately weathered RHYODACITE, grey quartz, feild span and mica grains.	W		 10.0 - 12.0m, 0.4mm Machine Cut Screen
			12 13 14 15 16 17 18 19 20	12.00 143.01					END OF BOREHOLE @ 12.00 m GROUNDWATER INFLOW OBSERVED @ 9.0m			

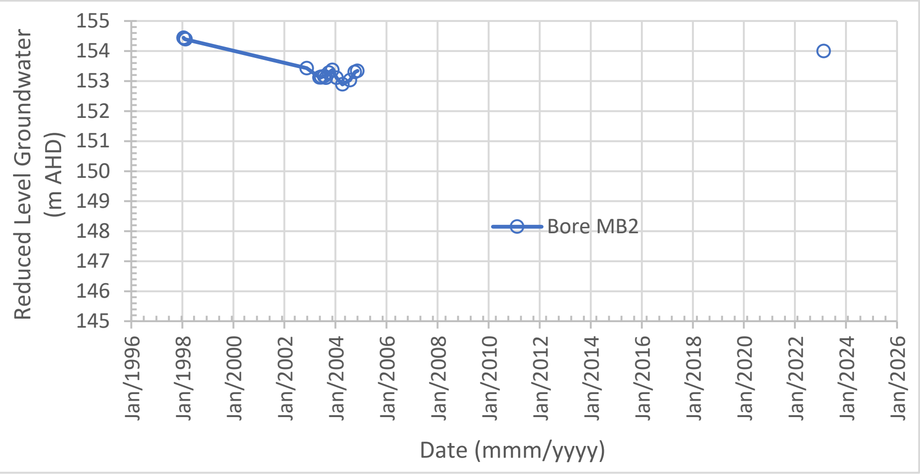
This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

Appendix G

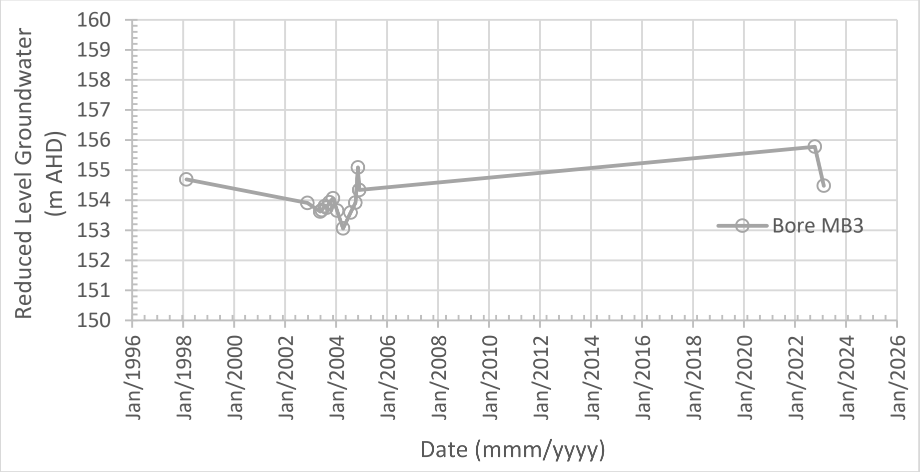
Time series water level information

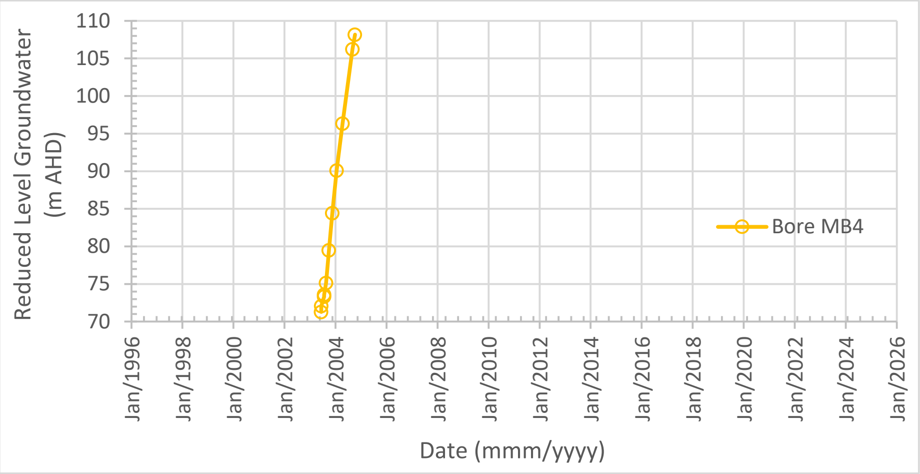
Well	Ground level	Stickup (m)	Level top PVC	Date	Depth to water (m below top of PVC)	Water level (m AHD)	Count of readings	SWL difference 2004 - 2023
MB1	169.07	0.01	169.08	19/01/1998	18.65	150.43		
				4/02/1998	18.83	150.25		
				17/02/1998	18.61	150.47		
				11/06/2003	20.69	148.39		
				24/07/2003	20.40	148.68		
				21/08/2003	20.45	148.63		
				30/09/2003	20.28	148.80		
				19/11/2003	20.15	148.93		
				19/01/2004	20.25	148.83		
				13/04/2004	20.53	148.55		
				29/07/2004	20.99	148.09		
				3/09/2004	20.47	148.61		
				7/10/2004	20.72	148.36		
				12/11/2004	20.63	148.45		
				18/10/2022				
				23/02/2023	19.40	149.68	15	1.23
MB2	171.29	0.40	171.69	19/01/1998	17.25	154.44		
				4/02/1998	17.29	154.40		
				17/02/1998	17.30	154.39		
				19/11/2002	18.26	153.43		
				20/05/2003	18.57	153.12		
				12/06/2003	18.57	153.12		
				13/06/2003	18.55	153.14		
				25/07/2003	18.53	153.16		
				21/08/2003	18.58	153.11		
				30/09/2003	18.41	153.28		
				19/11/2003	18.32	153.37		
				19/01/2004	18.58	153.11		
				13/04/2004	18.80	152.89		
				29/07/2004	18.66	153.03		
				7/10/2004	18.39	153.30		
				12/11/2004	18.35	153.34		
				18/10/2022				
				23/02/2023	17.69	154.00	17	0.66



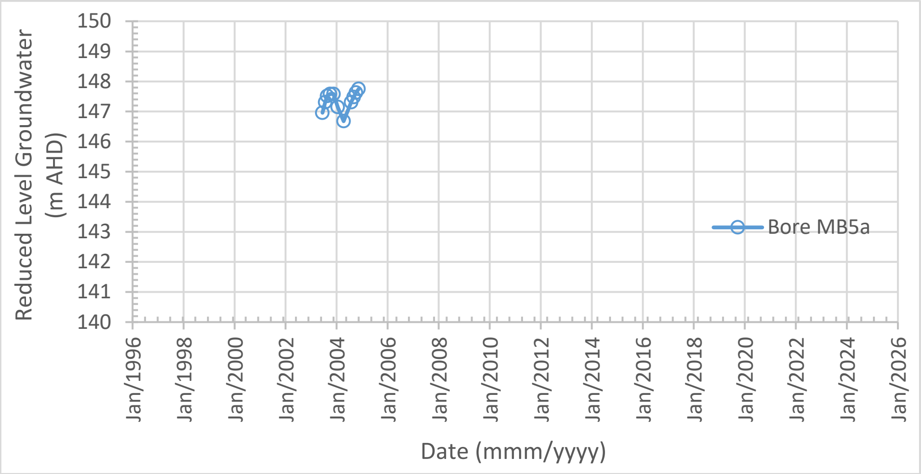


MB3	158.09	0.42	158.51	17/02/1998	3.82	154.69		
				19/11/2002	4.60	153.91		
				20/05/2003	4.89	153.62		
				12/06/2003	4.84	153.67		
				25/07/2003	4.71	153.80		
				21/08/2003	4.76	153.75		
				30/09/2003	4.59	153.93		
				19/11/2003	4.45	154.06		
				19/01/2004	4.86	153.65		
				13/04/2004	5.45	153.06		
				29/07/2004	4.92	153.59		
				7/10/2004	4.59	153.92		
				12/11/2004	3.42	155.09		
				1/12/2004	4.17	154.34		
				18/10/2022	2.73	155.78		
				23/02/2023	4.03	154.48	16	0.14
MB4	160.80	0.83	161.63	11/06/2003	90.35	71.28		
				13/06/2003	89.57	72.06		
				24/07/2003	88.32	73.31		
				25/07/2003	88.06	73.57		
				21/08/2003	86.50	75.13		
				30/09/2003	82.16	79.47		
				19/11/2003	77.21	84.42		
				19/01/2004	71.55	90.08		
				13/04/2004	65.31	96.32		
				3/09/2004	55.42	106.22		
				7/10/2004	53.48	108.15		
				18/10/2022				
				23/02/2023	18.03	18.03	12	-90.12

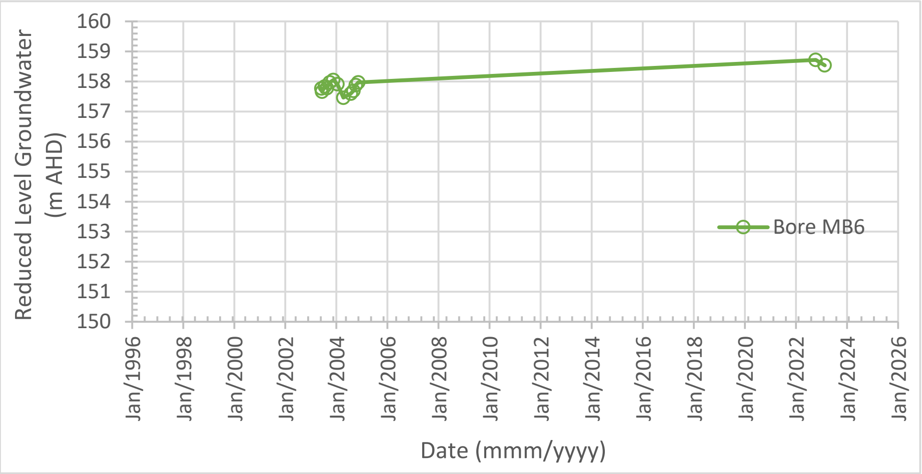


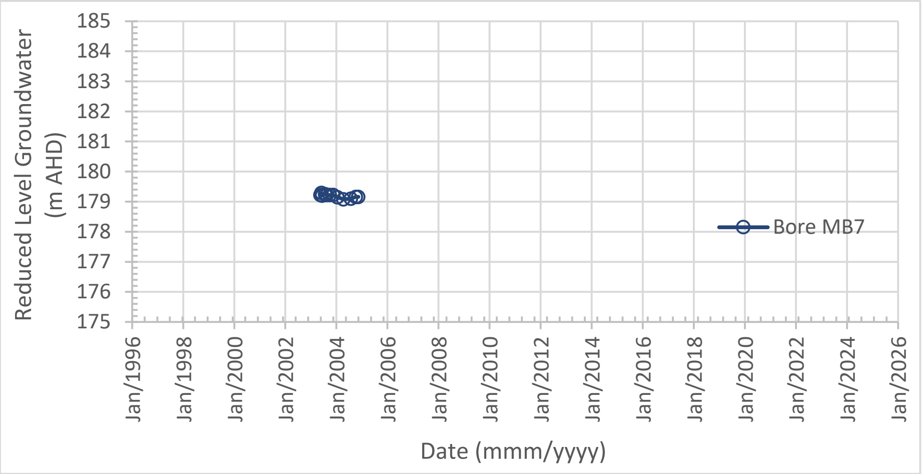


MB5a	151.94	-0.08	151.86	27/05/2003	(7.216)			
				11/06/2003	(6.682)			
				13/06/2003	4.90	146.96		
				24/07/2003	4.55	147.31		
				21/08/2003	4.34	147.52		
				30/09/2003	4.28	147.58		
				19/11/2003	4.28	147.58		
				19/01/2004	4.71	147.15		
				13/04/2004	5.18	146.68		
				29/07/2004	4.55	147.31		
				3/09/2004	4.38	147.48		
				7/10/2004	4.23	147.63		
				12/11/2004	4.11	147.75		
				18/10/2022				
				23/02/2023			11	-146.96
MB5b	152.24	-0.08	152.16	11/06/2003	DRY			
				13/06/2003	DRY			
				24/07/2003	DRY			
				21/08/2003	DRY			
				30/09/2003	DRY			
				19/11/2003	4.51	147.65		
				19/01/2004	4.87	147.29		
				13/04/2004	DRY			
				29/07/2004	4.81	147.36		
				3/09/2004	4.70	147.46		
				7/10/2004	4.45	147.71		
				12/11/2004	4.45	147.71		
				18/10/2022				
				23/02/2023			6	0.00

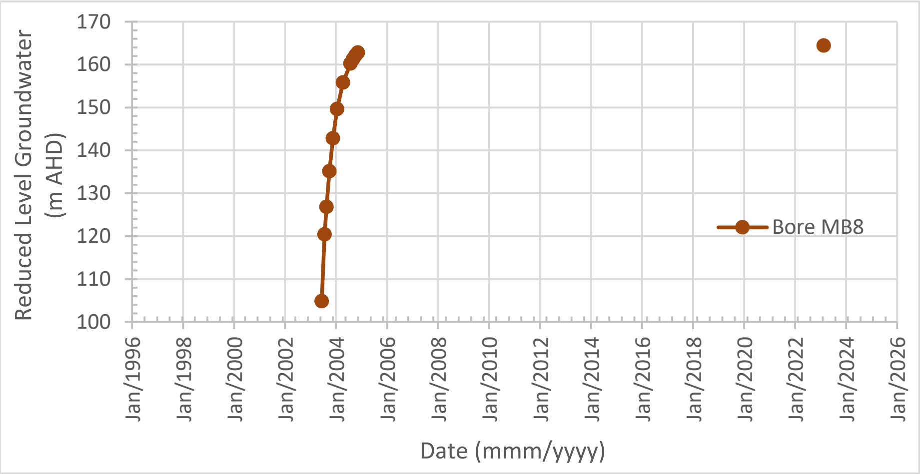


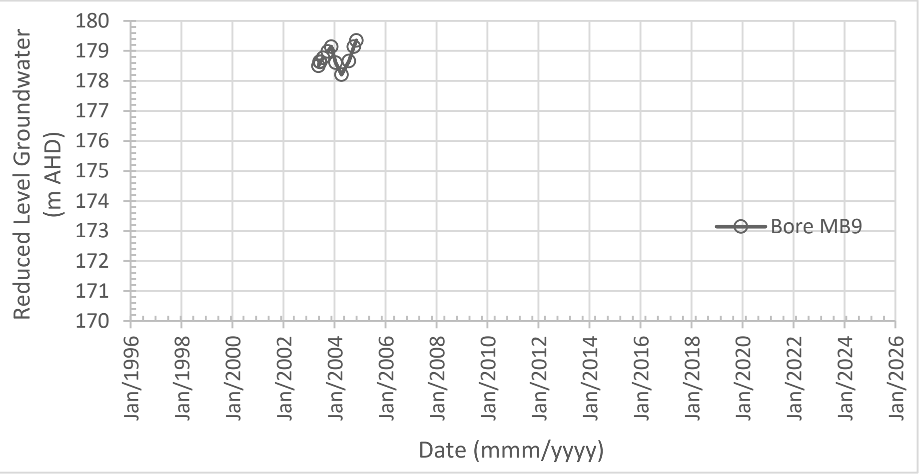
MB6	167.69	-0.07	167.62	4/06/2003	9.85	157.77		
				13/06/2003	9.96	157.66		
				24/07/2003	9.78	157.84		
				21/08/2003	9.84	157.78		
				30/09/2003	9.65	157.97		
				19/11/2003	9.57	158.05		
				19/01/2004	9.71	157.91		
				13/04/2004	10.16	157.46		
				29/07/2004	10.02	157.60		
				3/09/2004	9.93	157.69		
				7/10/2004	9.74	157.88		
				12/11/2004	9.65	157.97		
				18/10/2022	8.90	158.72		
				23/02/2023	9.08	158.54	14	0.57
MB7	190.73	-0.07	190.66	20/05/2003	11.44	179.22		
				4/06/2003	11.37	179.29		
				13/06/2003	11.46	179.20		
				25/07/2003	11.41	179.25		
				21/08/2003	11.44	179.22		
				30/09/2003	11.44	179.22		
				19/11/2003	11.44	179.22		
				19/01/2004	11.51	179.15		
				13/04/2004	11.58	179.08		
				29/07/2004	11.56	179.10		
				7/10/2004	11.51	179.16		
				12/11/2004	11.50	179.16		
				18/10/2022				
				23/02/2023			12	-179.16



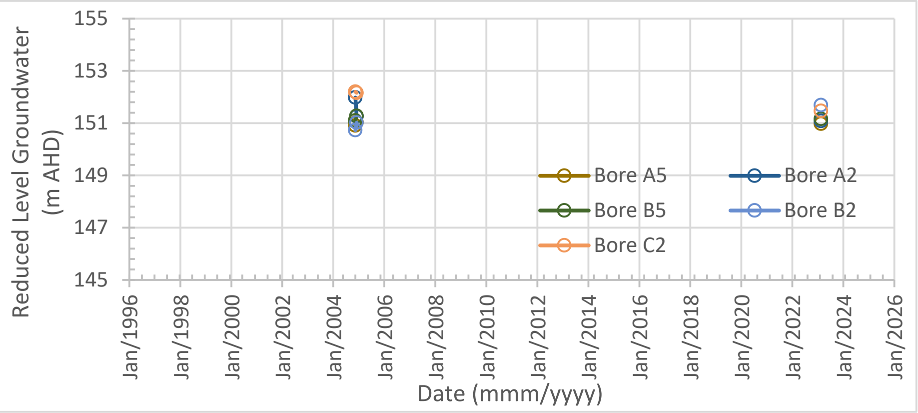


MB8	212.04	0.66	212.70	12/06/2003	107.85	104.85		
				24/07/2003	92.30	120.40		
				21/08/2003	85.88	126.82		
				30/09/2003	77.58	135.12		
				19/11/2003	69.89	142.81		
				19/01/2004	63.07	149.63		
				13/04/2004	56.88	155.82		
				29/07/2004	52.46	160.24		
				3/09/2004	51.42	161.28		
				7/10/2004	50.58	162.12		
				12/11/2004	49.91	162.80		
				18/10/2022				
				23/02/2023	48.28	164.42	12	1.62
MB9	181.39	-0.05	181.34	20/05/2003	2.84	178.50		
				4/06/2003	2.71	178.64		
				13/06/2003	2.71	178.63		
				25/07/2003	2.57	178.77		
				21/08/2003	(5.03)			
				30/09/2003	2.36	178.98		
				19/11/2003	2.20	179.14		
				19/01/2004	2.73	178.61		
				13/04/2004	3.13	178.21		
				29/07/2004	2.68	178.66		
				7/10/2004	2.20	179.14		
				12/11/2004	1.99	179.35		
				18/10/2022				
				23/02/2023			11	-179.35





BHA5 8m deep	152.81	0.7	153.51	12/11/2004	2.60	150.91		
				1/12/2004	2.48	151.03		
				18/10/2022				
				23/02/2023	2.53	150.98	3	-0.05
BHA2 3.1m deep	152.75	0.75	153.5	12/11/2004	1.52	151.98		
				1/12/2004	2.25	151.26		
				18/10/2022				
				23/02/2023	2.42	151.08	3	-0.18
BHB5 8m deep	153.58	0.72	154.3	12/11/2004	3.20	151.10		
				1/12/2004	3.02	151.28		
				18/10/2022				
				23/02/2023	3.14	151.16	3	-0.12
BHB2 3m deep	153.44	0.75	154.19	12/11/2004	3.46	150.73		
				1/12/2004	3.17	151.02		
				18/10/2022				
				23/02/2023	2.50	151.69	3	0.67
BHC2 12mdeep	155.01	0.75	155.76	12/11/2004	3.56	152.20		
				1/12/2004	3.60	152.16		
				18/10/2022				
				23/02/2023	4.29	151.47	3	-0.69



All levels are m AHD

Appendix H

Headworks inspections

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353190 mE
Northing:	5812474 mN
Approx. Elevation:	169.08 m AHD

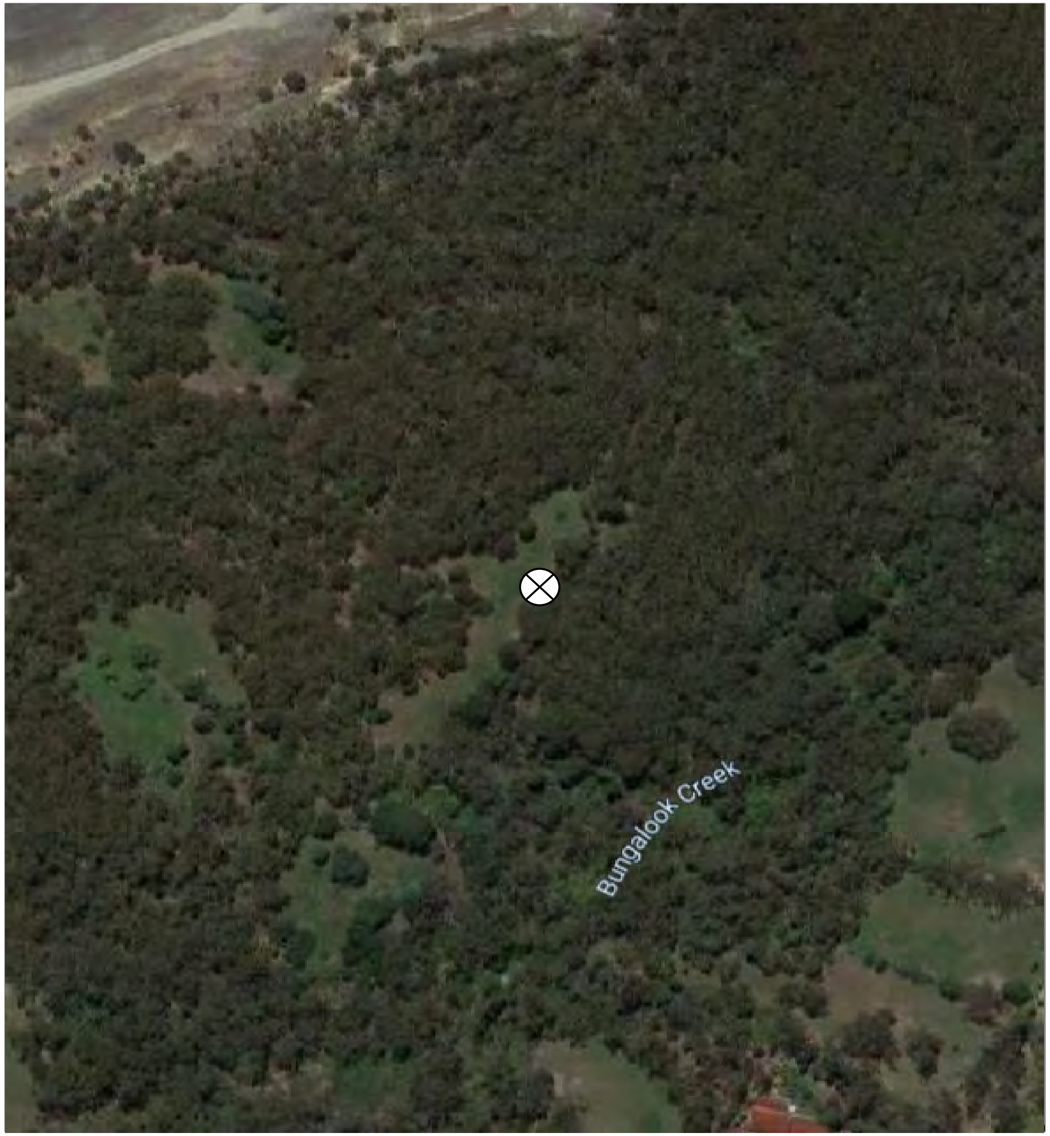
Location Description	
Road / intersecting Road	Entry via southern end of Fussell Road
Bore Owner / Authority:	Boral (Montrose)

SITE ID: MB1

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:



Comments / Other Notes: (use other side if insufficient room)

General Observations:		Comment
Any safety issues?	Y or [✓ N] or N/A	
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	[✓ Y] or N or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	[✓ Y] or N or N/A	
Is there an airline or access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:		**Location Description**		**SITE ID:**	MB2
Easting:	353461mE	**Road / intersecting Road**	Entry via southern end of Fussell Road Near boundary fenceline	**Inspected by / date:**	TRA / ADW 23/2/2023
Northing:	5812749 mN				
Approx. Elevation:	171.69 m AHD	**Bore Owner / Authority:**	Boral (Montrose)		

Reference:

Site Photo:

Comments / Other Notes: (use other side if insufficient room)

General Observations:		Comment
Any safety issues?	Y or [✓ N] or N/A	
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	[✓ Y] or N or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	Y or [✓ N] or N/A	
Is there an ~~airline~~ or access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:		**Location Description**	Entry via southern end of Fussell Road	**SITE ID:** MB3
Easting:	353488 mE	**Road / intersecting Road**	Near boundary fenceline	
Northing:	5812661 mN			**Inspected by / date:**
Approx. Elevation:	158.51 m AHD	**Bore Owner / Authority:**	Boral (Montrose)	TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: (use other side if insufficient room)

General Observations:		**Comment**
Any safety issues?	**Y or N or N/A**	
Is the bore located correctly on site plan?	**Y or N or N/A**	
Is the bore located in a dry area?	**Y or N or N/A**	
Is the bore accessible by vehicle?	**Y or N or N/A**	
Is the bore labelled legibly?	**Y or N or N/A**	
Is the bore protected with posts / fencing?	**Y or N or N/A**	
Is the casing protector firm and secure?	**Y or N or N/A**	
Is the cementing / seal in tact?	**Y or N or N/A**	
Is the casing protector locked / functioning?	**Y or N or N/A**	
Is there a protective cap?	**Y or N or N/A**	
Is there an airline or access for monitoring?	**Y or N or N/A**	
Is there sampling equipment inside casing?	**Y or N or N/A**	
Is the bore damaged?	**Y or N or N/A**	
Are there sharp edges on the casing?	**Y or N or N/A**	
Does the casing rock / move?	**Y or N or N/A**	
Is the casing dirty / soiled?	**Y or N or N/A**	
Is the protector weather proof / painted?	**Y or N or N/A**	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:

Easting:	353008 mE
Northing:	5812326 mN
Approx. Elevation:	161.63 m AHD

Location Description

Road / intersecting Road	Entry via southern end of Fussell Road
Bore Owner / Authority:	Boral (Montrose)

SITE ID: MB4

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: (use other side if insufficient room)

General Observations:		Comment
Any safety issues?	Y or [✓ N] or N/A	
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	[✓ Y] or N or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	Y or [✓ N] or N/A	
Is there an ~~airline~~ or access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353110 mE
Northing:	5812265 mN
Approx. Elevation:	151.86 m AHD

Location Description

Road / intersecting Road	Entry via southern end of Fussell Road
Bore Owner / Authority:	Boral (Montrose)

SITE ID: MB5

Inspected by / date:
TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: **(use other side if insufficient room)**

Nested bore site not found. Bore plots near arrow. Intersection of two tracks

General Observations:		**Comment**
Any safety issues?	**Y or N or N/A**	
Is the bore located correctly on site plan?	**Y or N or N/A**	
Is the bore located in a dry area?	**Y or N or N/A**	
Is the bore accessible by vehicle?	**Y or N or N/A**	
Is the bore labelled legibly?	**Y or N or N/A**	
Is the bore protected with posts / fencing?	**Y or N or N/A**	
Is the casing protector firm and secure?	**Y or N or N/A**	
Is the cementing / seal in tact?	**Y or N or N/A**	
Is the casing protector locked / functioning?	**Y or N or N/A**	
Is there a protective cap?	**Y or N or N/A**	
Is there an airline or access for monitoring?	**Y or N or N/A**	
Is there sampling equipment inside casing?	**Y or N or N/A**	
Is the bore damaged?	**Y or N or N/A**	
Are there sharp edges on the casing?	**Y or N or N/A**	
Does the casing rock / move?	**Y or N or N/A**	
Is the casing dirty / soiled?	**Y or N or N/A**	
Is the protector weather proof / painted?	**Y or N or N/A**	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353615mE
Northing:	5812597 mN
Approx. Elevation:	167.62 m AHD

Location Description Road / intersecting Road	Entry via western end of Bright Road
Bore Owner / Authority:	Boral (Montrose)

SITE ID: MB6

Inspected by / date:
TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: **(use other side if insufficient room)**

Enter off Bright Road. Locked gate into Reserve, but access on foot.

General Observations:		Comment
Any safety issues?	Y or [✓ N] or N/A	
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	[✓ Y] or N or N/A	LOCKED GATE
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	[✓ Y] or N or N/A	
Is there a protective cap?	[✓ Y] or N or N/A	
Is there an ~~airline or~~ access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	[✓ Y] or N or N/A	
Is the protector weather proof / painted?	Y or [✓ N] or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353848 mE
Northing:	5812477 mN
Approx. Elevation:	190.66 m AHD

Location Description
Road / intersecting Road Sheffield Road, approx 200 m east of Primary School

Bore Owner / Authority: Boral (Montrose)

SITE ID: MB7

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: (use other side if insufficient room)

Bore site not found. Bore plots near arrow.

General Observations:		Comment
Any safety issues?	Y or N or N/A	
Is the bore located correctly on site plan?	Y or N or N/A	
Is the bore located in a dry area?	Y or N or N/A	
Is the bore accessible by vehicle?	Y or N or N/A	
Is the bore labelled legibly?	Y or N or N/A	
Is the bore protected with posts / fencing?	Y or N or N/A	
Is the casing protector firm and secure?	Y or N or N/A	
Is the cementing / seal in tact?	Y or N or N/A	
Is the casing protector locked / functioning?	Y or N or N/A	
Is there a protective cap?	Y or N or N/A	
Is there an airline or access for monitoring?	Y or N or N/A	
Is there sampling equipment inside casing?	Y or N or N/A	
Is the bore damaged?	Y or N or N/A	
Are there sharp edges on the casing?	Y or N or N/A	
Does the casing rock / move?	Y or N or N/A	
Is the casing dirty / soiled?	Y or N or N/A	
Is the protector weather proof / painted?	Y or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353316 mE
Northing:	5813128 mN
Approx. Elevation:	212.7 m AHD

Location Description
Road / intersecting Road Entry via southern end of Ash Grove

Bore Owner / Authority: Boral (Montrose)

SITE ID: MB8

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: (use other side if insufficient room)

General Observations:		Comment
Any safety issues?	[✓ Y] or N or N/A	HORSES
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	Y or [✓ N] or N/A	LOCKED GATES
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	Y or [✓ N] or N/A	
Is there an ~~airline or~~ access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates: **Easting:** **Northing:** **Approx. Elevation:**	354211 mE 5813557 mN 181.348m AHD	**Location Description Road / intersecting Road** **Bore Owner / Authority:**	Entry via oval entrance, off Mount Dandenong Tourist Road Boral (Montrose)	**SITE ID:**	MB9
				Inspected by / date:	TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: **(use other side if insufficient room)**

Bore site not found. Bore plots near arrow.

General Observations:		**Comment**
Any safety issues?	**Y or N or N/A**	
Is the bore located correctly on site plan?	**Y or N or N/A**	
Is the bore located in a dry area?	**Y or N or N/A**	
Is the bore accessible by vehicle?	**Y or N or N/A**	
Is the bore labelled legibly?	**Y or N or N/A**	
Is the bore protected with posts / fencing?	**Y or N or N/A**	
Is the casing protector firm and secure?	**Y or N or N/A**	
Is the cementing / seal in tact?	**Y or N or N/A**	
Is the casing protector locked / functioning?	**Y or N or N/A**	
Is there a protective cap?	**Y or N or N/A**	
Is there an airline or access for monitoring?	**Y or N or N/A**	
Is there sampling equipment inside casing?	**Y or N or N/A**	
Is the bore damaged?	**Y or N or N/A**	
Are there sharp edges on the casing?	**Y or N or N/A**	
Does the casing rock / move?	**Y or N or N/A**	
Is the casing dirty / soiled?	**Y or N or N/A**	
Is the protector weather proof / painted?	**Y or N or N/A**	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	A2	A5
Easting:	353312 mE	353310 mE
Northing:	5812481 mN	5812482 mN
Approx. Elevation:	153.5m AHD	153.5m AHD

Location Description
Road / intersecting Road Entry via southern end of Fussell Road

Bore Owner / Authority: Boral (Montrose)

SITE ID: A2 and A5

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: **(use other side if insufficient room)**

General Observations:		Comment
Any safety issues?	[✓ Y] or N or N/A	VERY DIFFICULT ACCESS
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	Y or [✓ N] or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	[✓ Y] or N or N/A	
Is there an ~~airline~~ or access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	B2	B5
Easting:	353307 mE	353307 mE
Northing:	5812495 mN	5812498 mN
Approx. Elevation:	154.2m AHD	154.3m AHD

Location Description
Road / intersecting Road Entry via southern end of Fussell Road

Bore Owner / Authority: Boral (Montrose)

SITE ID: B2 and B5

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: (use other side if insufficient room)

General Observations:		**Comment**
Any safety issues?	[✓ Y] or N or N/A	VERY DIFFICULT ACCESS
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	Y or [✓ N] or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	Y or [✓ N] or N/A	
Is there an airline ~~or~~ access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353230 mE
Northing:	5812406 mN
Approx. Elevation:	150.92 m AHD

Location Description

Road / intersecting Road Entry via southern end of Fussell Road

Bore Owner / Authority: Boral (Montrose)

SITE ID: AH1

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

Comments / Other Notes: **(use other side if insufficient room)**

General Observations:

		Comment
Any safety issues?	[✓ Y] or N or N/A	DIFFICULTY ACCESS
Is the bore located correctly on site plan?	Y or [✓ N] or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	Y or [✓ N] or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	Y or N or [✓ N/A]	
Is the cementing / seal in tact?	Y or N or [✓ N/A]	
Is the casing protector locked / functioning?	Y or N or [✓ N/A]	
Is there a protective cap?	[✓ Y] or N or N/A	
Is there an air~~line or~~ access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	[✓ Y] or N or N/A	
Is the protector weath~~er proof~~ / painted?	[✓ Y] or N or N/A	

Additional Comments (casing type, size etc)

BORE HEADWORKS INSPECTION FORM

GPS Co-ordinates:	
Easting:	353301mE
Northing:	5812523 mN
Approx. Elevation:	155.76 m AHD

Location Description
Road / intersecting Road Entry via southern end of Fussell Road

Bore Owner / Authority: Boral (Montrose)

SITE ID: C2

Inspected by / date: TRA / ADW 23/2/2023

Reference:

Site Photo:

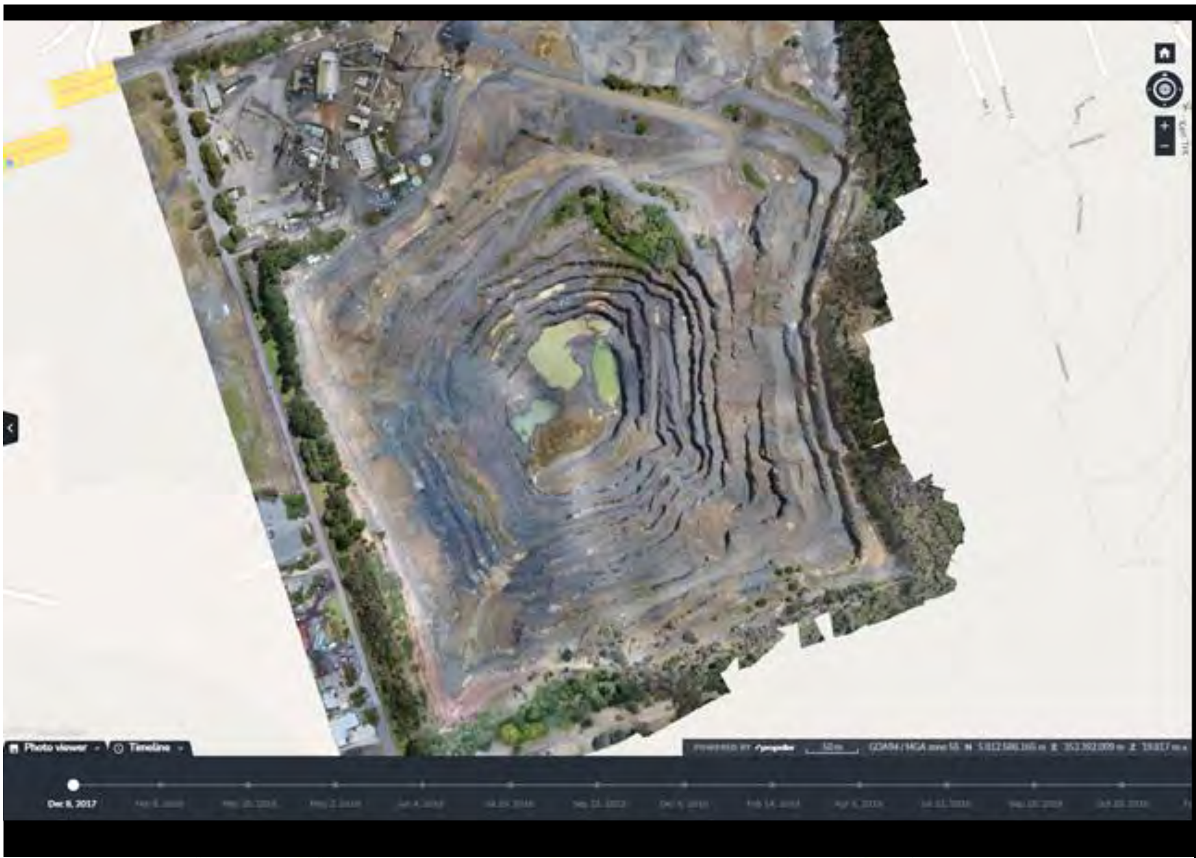
Comments / Other Notes: **(use other side if insufficient room)**

General Observations:		Comment
Any safety issues?	[✓ Y] or N or N/A	VERY DIFFICULT ACCESS
Is the bore located correctly on site plan?	[✓ Y] or N or N/A	
Is the bore located in a dry area?	[✓ Y] or N or N/A	
Is the bore accessible by vehicle?	Y or [✓ N] or N/A	
Is the bore labelled legibly?	Y or [✓ N] or N/A	
Is the bore protected with posts / fencing?	Y or [✓ N] or N/A	
Is the casing protector firm and secure?	[✓ Y] or N or N/A	
Is the cementing / seal in tact?	[✓ Y] or N or N/A	
Is the casing protector locked / functioning?	Y or [✓ N] or N/A	
Is there a protective cap?	[✓ Y] or N or N/A	
Is there an ~~airline~~ or access for monitoring?	[✓ Y] or N or N/A	
Is there sampling equipment inside casing?	Y or [✓ N] or N/A	
Is the bore damaged?	Y or [✓ N] or N/A	
Are there sharp edges on the casing?	Y or [✓ N] or N/A	
Does the casing rock / move?	Y or [✓ N] or N/A	
Is the casing dirty / soiled?	Y or [✓ N] or N/A	
Is the protector weather proof / painted?	[✓ Y] or N or N/A	

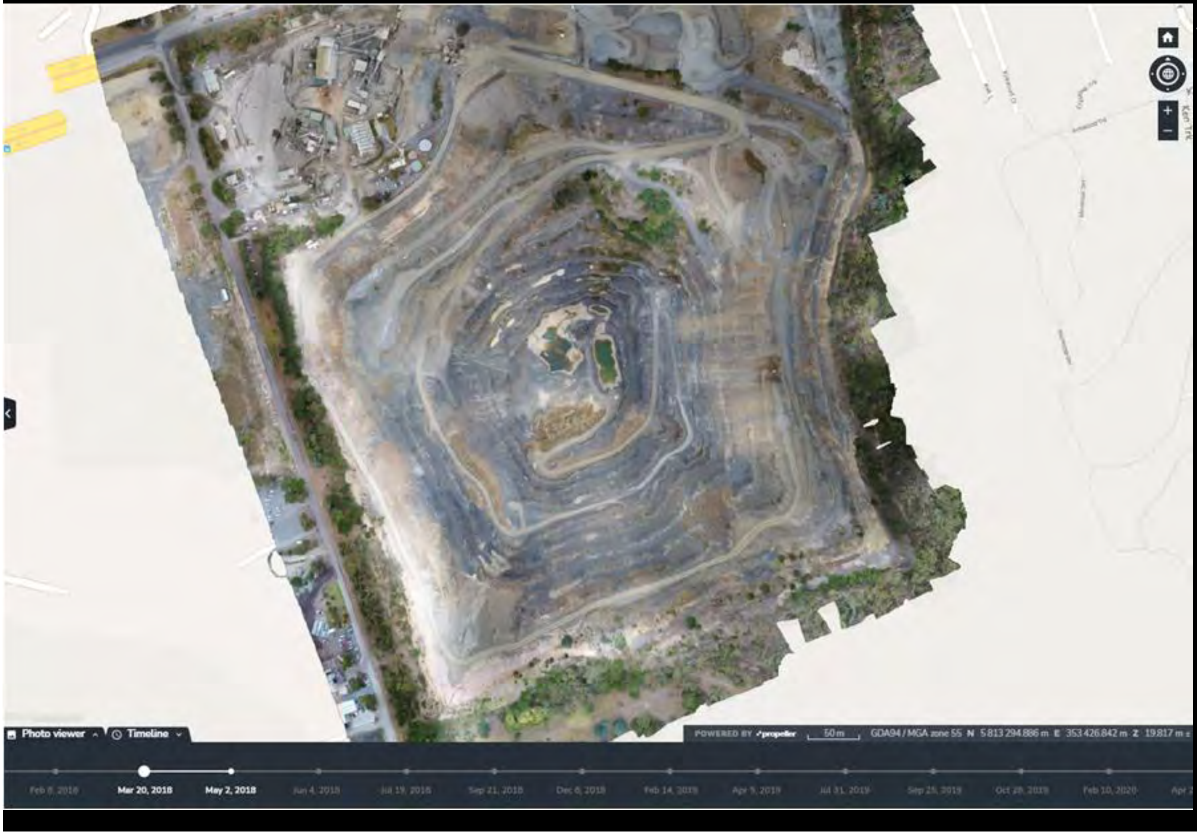
Additional Comments (casing type, size etc)

Appendix I

Aerial Imagery 2017-2023

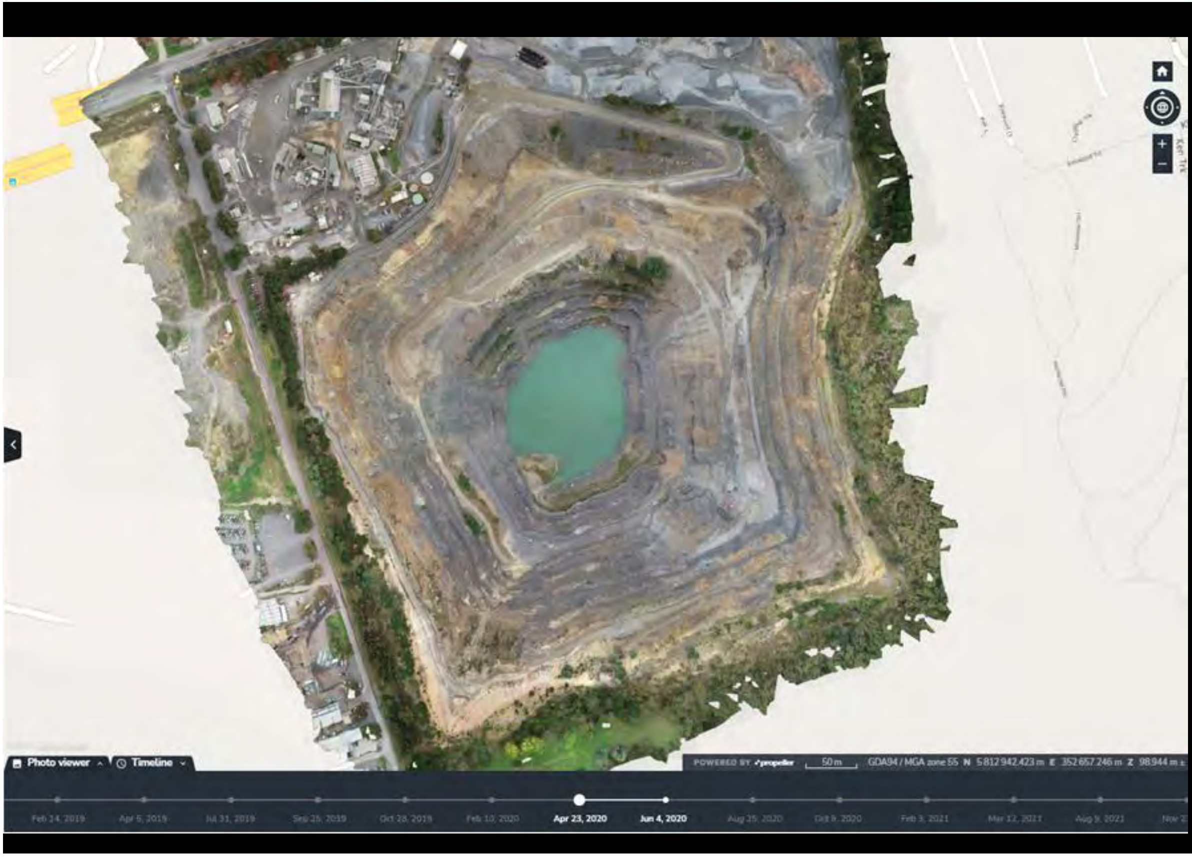


8/12/2017

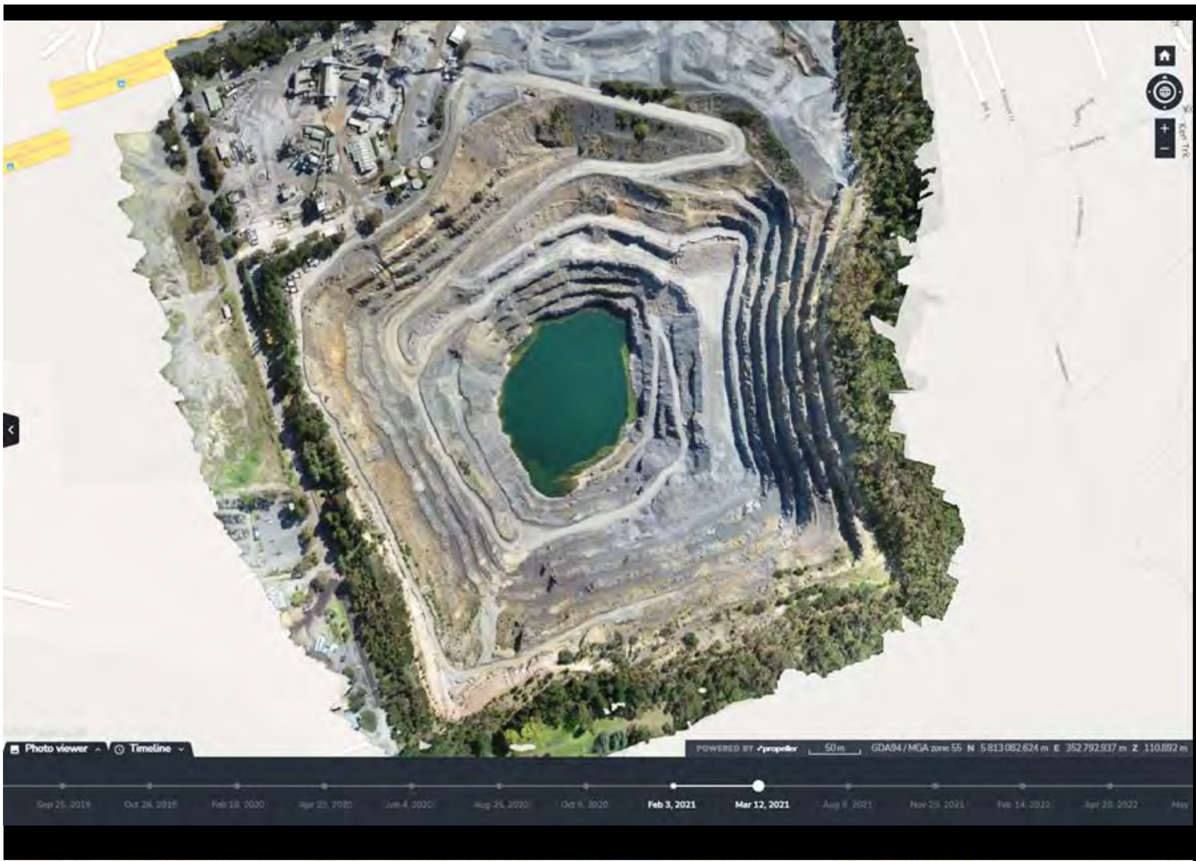


20/3/2018

5/4/2019

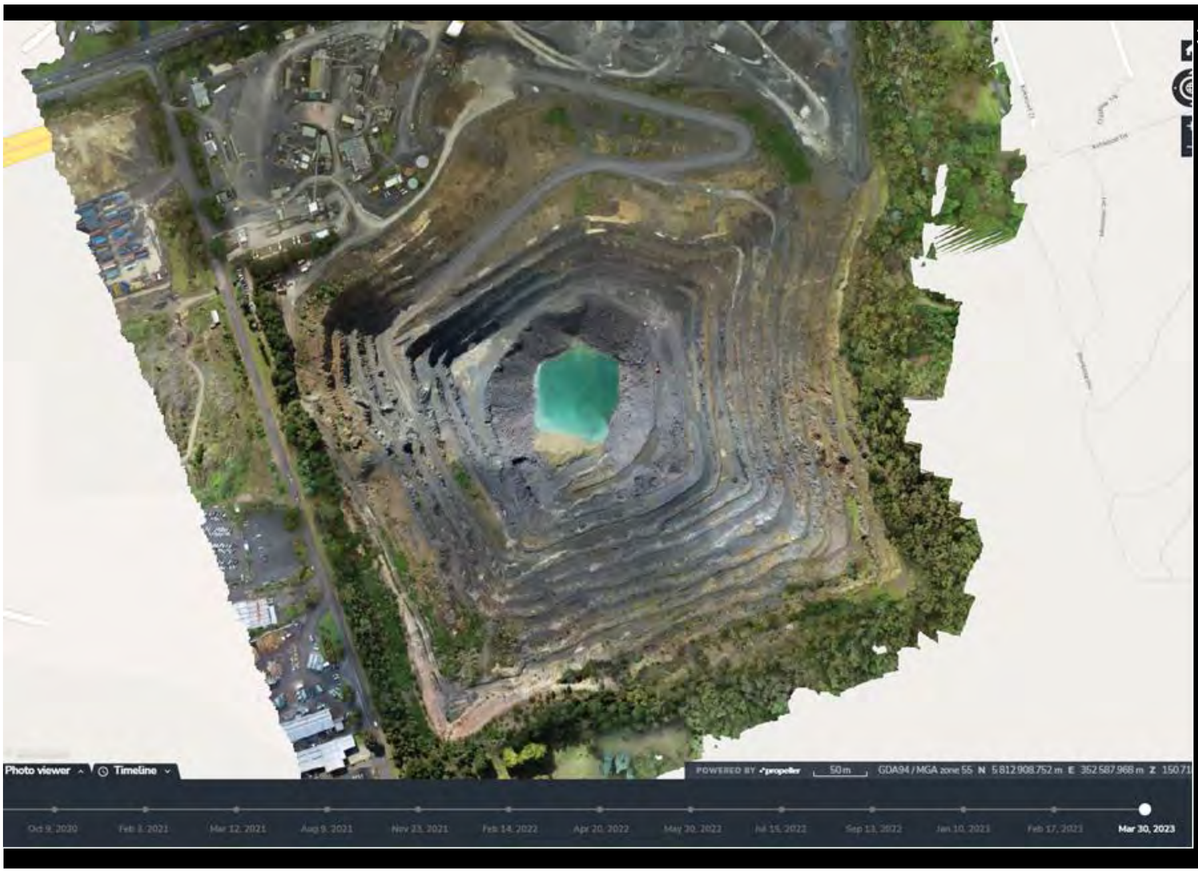


23/4/2020



12/3/2021

20/4/2022

Photo viewer
Timeline
POWERED BY propeller
50 m
GDA94 / MGA zone 55 N 5 812 908.752 m E 352 587.968 m Z 150.71
Oct 9, 2020
Feb 3, 2021
Mar 12, 2021
Aug 9, 2021
Nov 23, 2021
Feb 14, 2022
Apr 20, 2022
May 30, 2022
Jul 15, 2022
Sep 13, 2022
Jan 10, 2023
Feb 17, 2023
Mar 30, 2023

30/3/2023

Appendix J

Quarry expansion concept shell

Boral Montrose Staging Plan and Rehabilitation Concept

Boral Resources (Vic) Pty Limited

04 November 2022

→ **The Power of Commitment**

Project name	Boral Montrose Quarry Extension
Document title	Boral Montrose Staging Plan and Rehabilitation Concept | [Document subtitle]
Project number	12559266
File name	12559266_RPT_Boral Montrose Staging Plan and Rehabilitation Concept.docx

Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	A	M Armstrong	R Armstrong				21/10/2022
S4	**B**	M Armstrong					4/11/2022
[Status code]							
[Status code]							
[Status code]							

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→ **The Power of Commitment**

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Appendices

1. Introduction

GHD Pty Ltd (GHD) understand that Boral Resources (Vic) Pty Ltd (Boral) seeks to extend the existing extraction boundary of the Montrose Quarry, Work Authority 100 (WA 100) to extend its operational life by approximately 40 years. This requires a series of staged extraction and rehabilitation plans for the life of the quarry that are based on the current approved pit design and the proposed expanded pit footprint. As part of this intent, GHD has been requested to develop staging plans for the expansion of the quarry o at 5 yearly intervals and a rehabilitation concept plan.

In addition to this scope GHD has been requested to conduct a geotechnical assessment, including geotechnical risk assessment (GRA) and development of a risk register, ground control management plan (GCMP) and trigger action response plans (TARPs). These are being developed concurrently and summarised in two separate deliverables (Site Specific Geotechnical Assessment and the GCMP).

The proposed expansion to WA100 will extend the southern and eastern boundaries of the current approved extraction area.

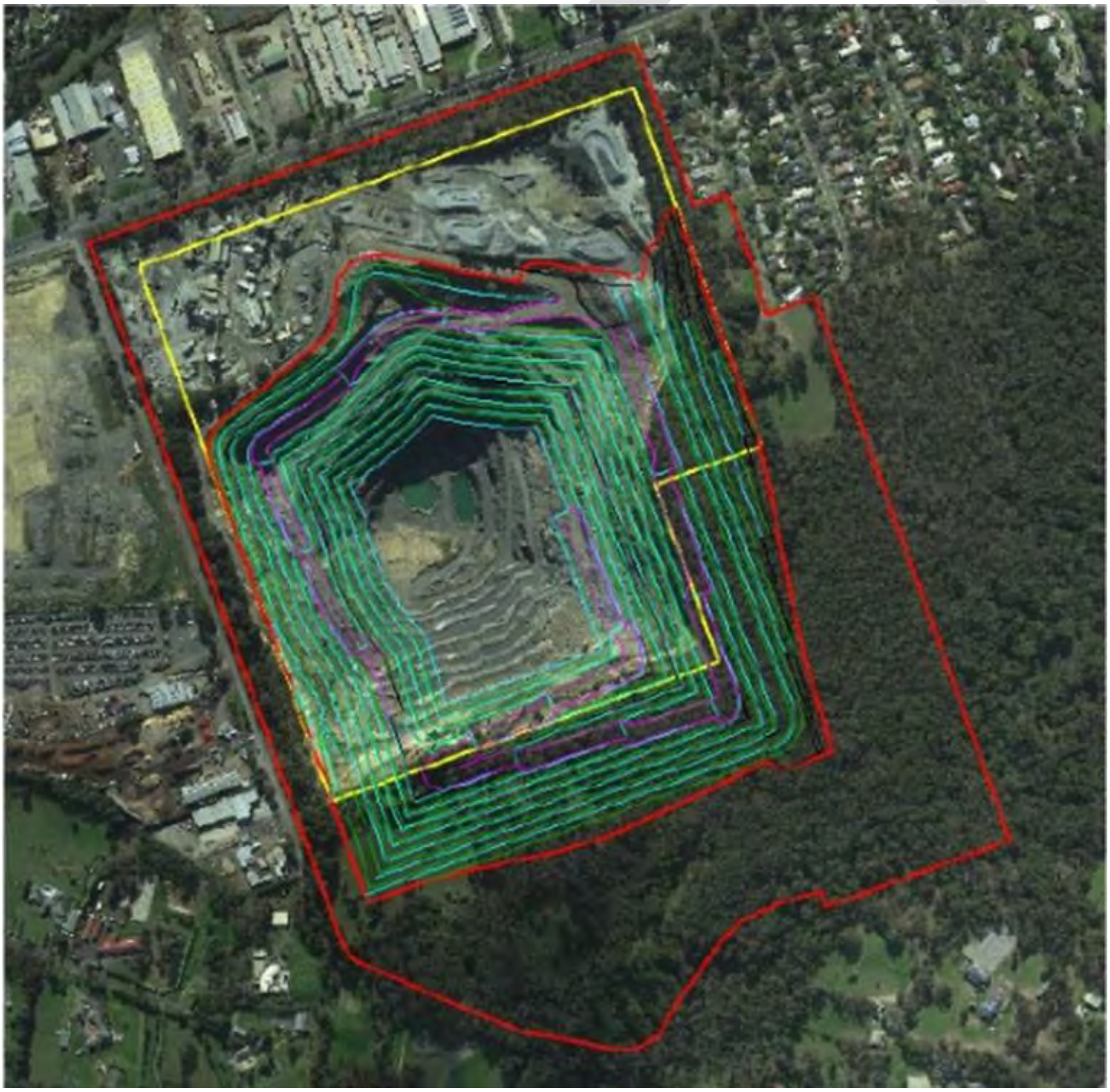


Figure 1 *The proposed footprint of the expanded Montrose Quarry (Source – Boral).*

1.1 Client Objectives

The primary objective is to expand the existing extraction boundary to extend the operational life of the quarry. Boral wish to understand and assess the progression of mining throughout the life cycle of the quarry extension from current operations to rehabilitation. The aim is to highlight potential impacts of the proposed quarry expansion on current and future operations, the environment and local sensitive receptors. This staging plan takes into consideration:

- Maximum resource extraction
- Internal storage of overburden and mine waste
- Site specific geotechnical assessment and allowable batter/slope profiles
- Access to expansion area internal overburden storage
- Staging progression plans on 5 yearly intervals
- Rehabilitation concept landform

The findings of the staging plans and rehabilitation concept will inform the proposed Site Rehabilitation Plan and subsequent work plan variation (WPV).

1.2 Scope of Work

As outlined in the GHD proposal document titled '*Montrose Quarry Extraction and Rehabilitation Modelling – Proposal*', dated 8 October 2021, (GHD Report Ref: 12559266/88273/16), GHD's scope of work is as follows:

- Project inception and development of Basis of Design (BoD) documentation to ensure all inputs to the design, and their status, are understood by Boral, GHD and other stakeholders.
- Site visit with site team and review available information with the aim of establishing appropriate site geological and/or material property distribution profiles, extraction and rehabilitation design criteria including batter profiles and cut/fill slopes, configuration, civil and geotechnical engineering considerations.
- Development of pit models including identification of key inter-dependencies and criteria that are to be used to test and refine the staging and sequencing of the current work plan and extended pit scenarios for the respective life cycle of the quarry. Noting this will require input from Boral operational staff and development team members.
- Preparation of extraction staging plans for the current work plan and extended pit scenarios that include illustration of calendar 5-year timelines over the life of the quarry.
- Preparation of rehabilitation staging plans for the current work plan and extended pit scenarios that include timeline illustration every five years over the life of the quarry, in accordance with the work authority requirements.
- Report preparation including documentation and diagrams for each scenario, that can be presented to the various stakeholders.

To assist designing rehabilitation outcomes, Boral proposes three potential scenarios to be assessed. These scenarios are intended to provide Boral with a range of hypothetical solutions for varying final landform usage.

- Fill to RL 28: It is assumed that an RL 28 fill level will seal the pit from the water table, this has not been verified by detailed assessment. Potential land use includes water storage options.
- Fill to RL 112: Filling to this level may be suitable for recreational and nature services, including a small lake. Ferntree Gully Quarry Reserve is an analogous local example of a public space in steep terrain that incorporates a pit lake.
- Fill to RL 154: Filling to this level is expected to average inclines of no more than 1:15 (estimated). With reprofiling, this could be suitable for a wide range of next uses such as recreational or urban development.

1.3 Limitations

This report has been prepared by GHD for Boral Resources (Vic) Pty Limited and may only be used and relied on by Boral Resources (Vic) Pty Limited for the purpose agreed between GHD and Boral Resources (Vic) Pty Limited as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Boral Resources (Vic) Pty Limited 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 bases of information provided by Boral Resources (Vic) Pty Ltd 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 (by the clients' other consultants) are likely to be 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.

Accessibility of documents

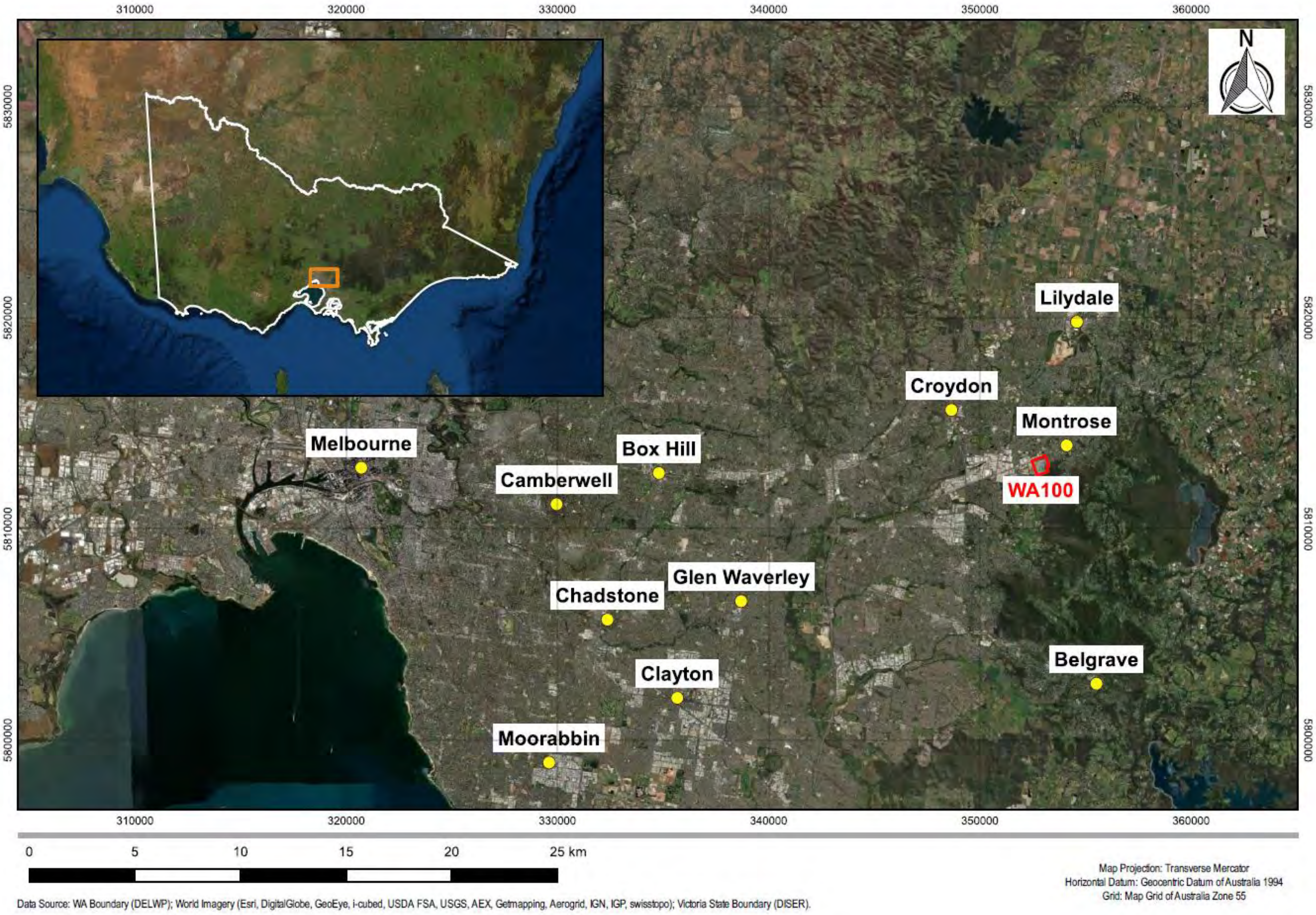
If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

2. Existing Quarry and Remaining Extraction

2.1 General

The WA100 site is situated in Montrose, Victoria, an area located at the foothills of the Dandenong Ranges approximately 32 km east of Melbourne (Figure 2). The site and the proposed expansion area is bound by Canterbury Road to the north, residential housing to the northeast, Dr Ken Leversha Reserve to the east and south, and Fussell Road to the west.

The current quarry operation occupies 57.5 ha out of Boral's 77.4 ha landholding and supplies concrete aggregates for projects across the greater metropolitan Melbourne area.



Data Source: WA Boundary (DELWP); World Imagery (Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo); Victoria State Boundary (DISER).

Figure 2 The location of Boral Montrose Quarry WA100

2.2 Site Observations

Matt Armstrong (Engineering Geologist), Nirav Patel (Senior Geotechnical Engineer) and Stefan Verhellen (Senior Mine Planner) of GHD carried out an inspection of the Montrose Quarry on 10 November 2021. The objective of the site visit was to inspect the stability performance of the existing quarry batters, undertake structural mapping, gain a visual appreciation of the efficacy of operational procedures and discuss operational constraints on extraction.

Visual inspections encompassed the entire extraction area, with structural field measurements taken from batters that were safely accessible by foot and where access was permitted. Summarised below are the relevant key observations pertaining to observed site conditions pertinent to the extractive operations and staging plan development. A more detailed description of the site conditions, specifically geotechnical and geological conditions is summarised in the corresponding Geotechnical Assessment titled '*Montrose Quarry (WA100) Geotechnical Assessment*', dated 25 November 2021, (GHD Report Ref: 12559266/59238/47).

2.2.1 Lithological Units

Four lithological units are currently exposed at Montrose Quarry, including a rhyolite, rhyodacite, welded tuff and soil fill unit. The site mostly comprises of the rhyolite and rhyodacite unit, with the contact between these two units exposed in the east and south wall of the current pit. The geology of Montrose quarry, as refined by PSM (2016), is presented in Figure 3.

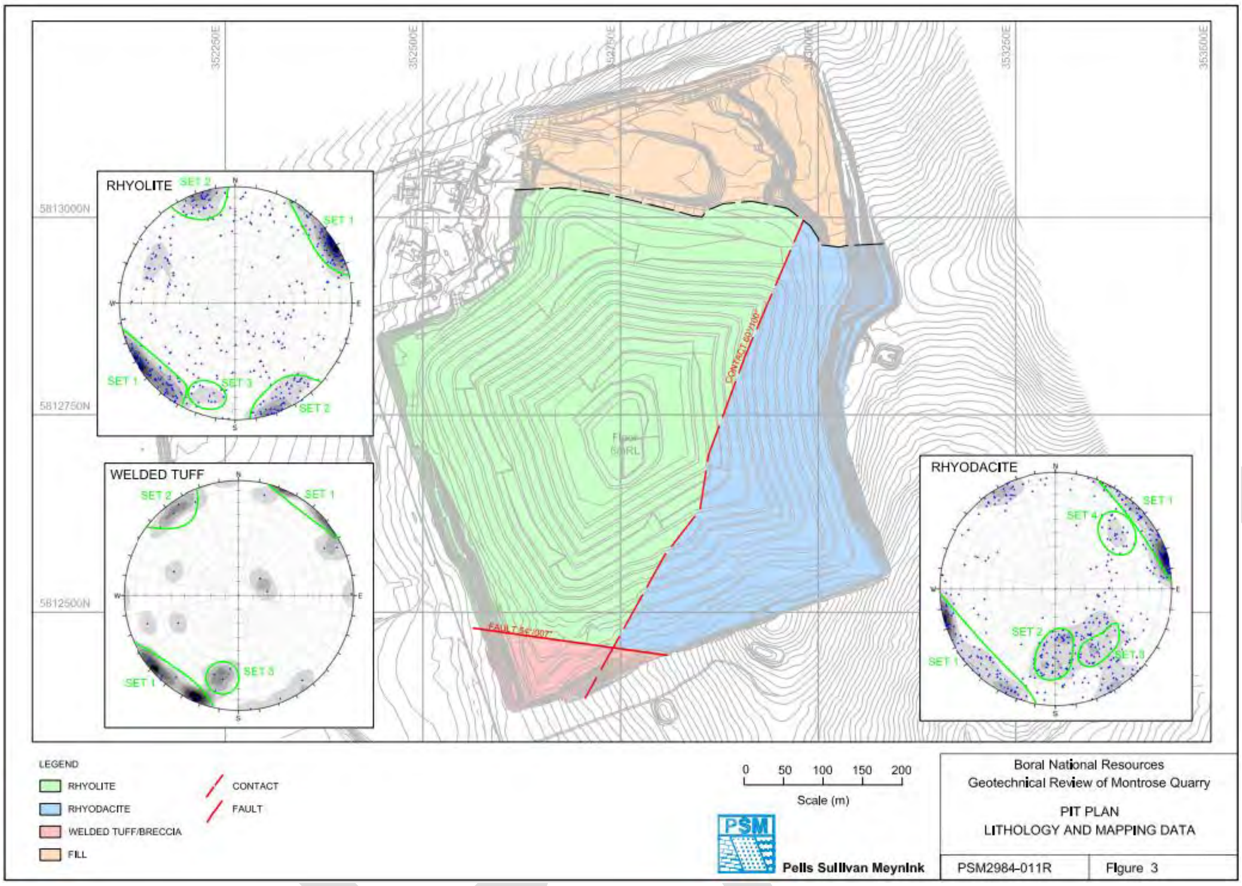


Figure 3 Lithological Units exposed at Montrose Quarry (PSM, 2016)

The depth of weathering was considered as part of the stability analyses and has been conservatively interpreted based on site observations. It should be noted that areas of intense weathering or reduced rock strength are likely to be encountered at contact and / or minor shear zones.

2.2.2 Stratigraphic Sequence

Four stratigraphic units have been observed on exposed quarry batters within the rhyolite and rhyodacite units. This includes a residual soil unit, a highly weathered unit, a moderately weathered to slightly weathered unit and a fresh unit. It should be noted that zones of intense weathering were also identified in the moderately weathered to slightly weathered and fresh units, this was typically observed along localised shear zones.

The stratigraphic sequencing, according to the observed weathering pattern, forms the basis for categorising materials with ‘similar’ geotechnical characteristics. It is noted that site observations and field estimates indicate that the rhyolite and rhyodacite unit exhibit similar rock strength properties and as such have been considered as a single unit. Montrose Quarry materials were categorised using weathering grades, in accordance with the ISRM (1981) criterion, as outlined in Table 1.

Table 1 *Summary of Material Type by Degree of Weathering*

Unit	Degree of Weathering	ISRM (1981) Weathering Grade
1	Residual Soil	RS
2	Highly Weathered	HW
3	Moderately Weathered to Slightly Weathered	MW
4	Fresh	FR

2.2.3 Hydrogeology

The groundwater table at the Montrose Quarry was interpreted using the Visualising Victoria's Groundwater (VVG, 2022) database, a web-based software that federates groundwater data from various sources. The modelled groundwater level ranges between 20 m on the western side of the quarry to a maximum of 50 m on the eastern side. The area surrounding the quarry has a shallower groundwater table, especially along Bungalook Creek to the south, where the depth to groundwater is typically shallower than 5 m.

2.2.4 Current Pit Design

The provided design files pertaining to the current surface topography as of November 2020 were imported into the Maptek Vulcan 11 software and digitised to produce 3D surface models. Figure 4 depicts a 3D surface model of the current quarry profile and area of disturbance.

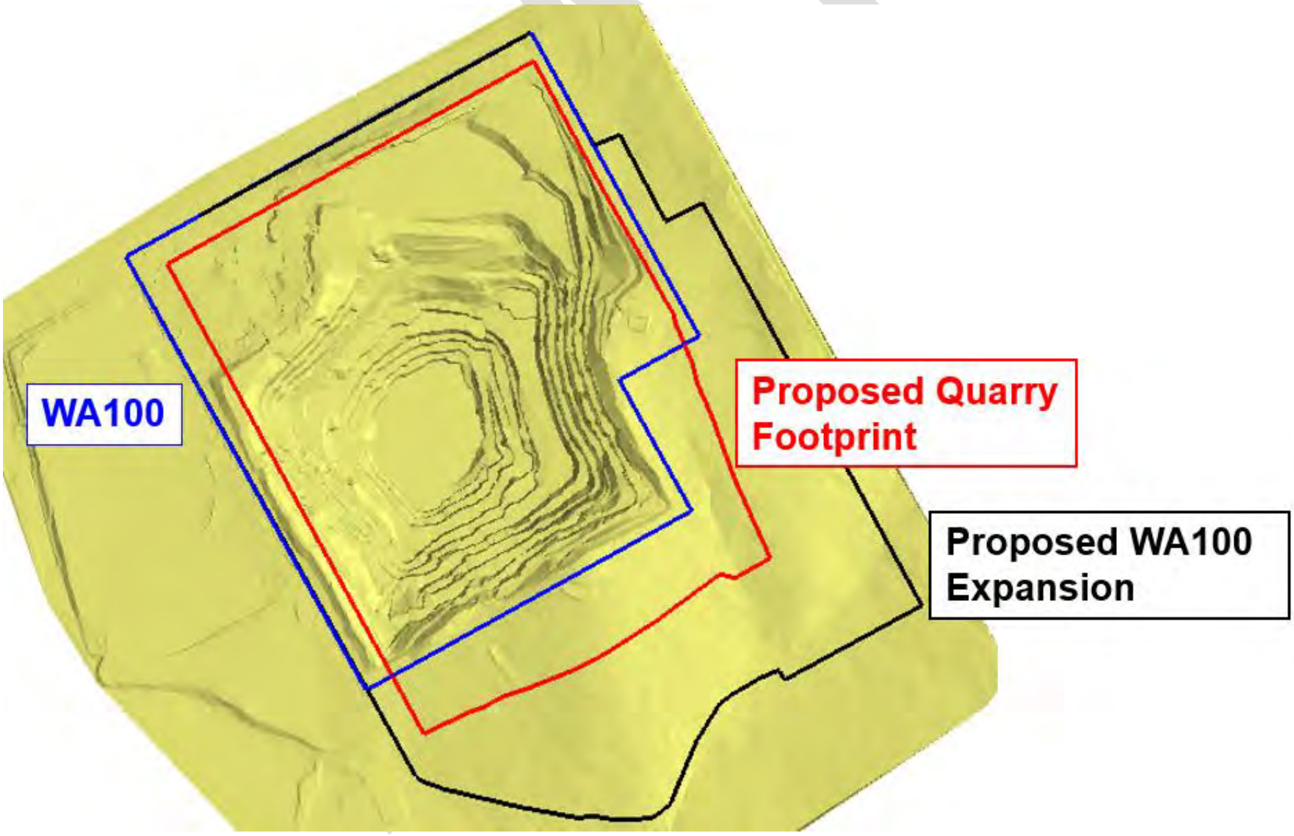


Figure 4 *3D Surface Model of Current Extraction Area*

Review of the November 2020 topography indicates that the current maximum depth of the quarry pit is in the order of 180 m below crest level, at approximately RL 21 m. Typical slope geometry consists of an overall slope angle in the order of 35° to 40°, batter heights occurring variably between 10 and 18 m and slope faces in the order of 75°. Bench widths along the North and South Wall were in the order of 10 to 15 m, and 5 to 10 m along the East and West walls. In some areas along the East Wall, bench widths were observed to be less than 5 m, with loss in berm width evident on some benches due to local batter scale instabilities.

2.2.5 Geotechnical Performance

Signs of previous single bench and multi-bench scale instabilities were evident during the site visit. However, this was not observed to affect the overall stability of the pit walls. Evidence of slumping in the soil fill material, sloughing / unravelling of the upper weathered units and batter-scale structurally controlled instabilities were readily observed on the exposed quarry batters. In general, no significant change in stability performance was observed compared to that described by PSM in previous site inspections.

However, instabilities extending over multiple benches were observed on the exposed pit walls (East and South), with undercutting of the batter face also evident in various areas. Significant berm loss has been observed at these locations. In areas where good blast and scaling practices have been observed (i.e., evidence of pre-split barrels or batter faces appear to have been scaled back), debris from structurally controlled instabilities are typically contained to a single bench.

2.2.6 Current Extraction

Quarrying operations are currently deepening the existing pit and where geometry allows additional trimming of the batters is conducted to maximise the extractable resource. Operations are conducted by pre-strip, drill & blast followed by truck & shovel. As required an excavator will follow the truck and shovel operations to scale walls and remove loose debris. All material is transported to the surface level primary crusher for processing.

All extracted material is processed onsite with additional feed from Boral’s Coldstream operations as required. Current projections indicate that the current pit has resource for an additional 18 months of extraction supplemented by feed from Coldstream.

3. Basis of Design

3.1 Guiding Design Principles

To formulate the staging plans and rehabilitation concept GHD has:

- Developed a pit model identifying key inter-dependencies used to test and refine the staging and sequencing extended pit design for the respective life cycle of the quarry with input from Boral operational staff and development team members.
- Prepared extraction staging plans for the current work plan and extended pit scenarios that illustrate calendar 5-year timelines over the life of the quarry.
- Prepared rehabilitation concept plan for extended pit in accordance with the work authority requirements.
- Considered the practical / operational requirements for the site including:
  - Continued quarrying of material
  - Dewatering of the quarry sump
  - Backfilling of the quarry floor
  - Staging backfilling to accommodate pre-strip of overburden
  - Providing achievable rehabilitation / dump infill rates, and any required individual material quality targets
  - Understanding available resources on site and imported resources available as an input into the development of the rehabilitation strategy
  - Understanding existing and intended rehabilitation equipment and build this into the proposed rehabilitation plan
  - Stand-offs from sensitive receptors and WA boundary

Three scenarios are intended to provide Boral with a range of hypothetical solutions for varying final landform usage.

- Fill to RL 28: It is assumed that an RL 28 fill level will seal the pit from the water table, this has not been verified by detailed assessment. Potential land use includes water storage options.
- Fill to RL 112: Filling to this level may be suitable for recreational and nature services, including a small lake. Ferntree Gully Quarry Reserve is an analogous local example of a public space in steep terrain that incorporates a pit lake.
- Fill to RL 154: Filling to this level is expected to average inclines of no more than 1:15 (estimated). With reprofiling, this could be suitable for a wide range of next uses such as recreational or urban development.

3.2 Updated Geotechnical Design Parameters

3.2.1 Design Acceptance Criteria

The nomination of suitable acceptance criteria is a key part of any design, this is particularly so for slopes that have experienced past instability and are now expected to remain stable for the foreseeable future.

Design acceptance criteria for the Montrose Quarry site have been nominated in line with accepted industry practice as outlined in DJPR's (2020) '*Geotechnical Guideline for Terminal and Rehabilitated Slopes*, and published precedents, as outlined in CSIRO's '*Guidelines for Open Pit Slope Design'*, (Stacey and Read, 2009). In nominating suitable design acceptance criteria, GHD has utilised the Factor of Safety (FoS) criteria outlined in Table 2 of DJPR (2020) and Table 9-3 of Stacey and Read (2009).

Table 2 FoS Guidelines (Table 2 after DJPR, 2020)

Consequence of Failure	**Examples**	**Minimum FoS**
Not Serious	Individual benches; small slopes (< 50 m), temporary slopes, not adjacent to haulage roads	1.3
Moderately Serious	Any slope of a permanent or semi-permanent nature	1.6
Very Serious	Medium sized (50-100 m) and high slopes (< 150 m) carrying major haulage roads or underlying permanent mine installations	2.0

Owing to the nature of the quarry deposit, two target FoS criteria have been nominated for this assessment, which are as follows:

- Working bench to Inter-ramp scale instabilities – FoS greater than 1.3
- Global scale instabilities – FoS greater than 1.6
- Rehabilitated batters – FoS greater than 2.0
- Seismic – FoS greater than 1.1

3.2.2 Initial Proposed Geometry

The results of the minimum catch bench width analysis determined a minimum bench width of 8 m is required for a 12 m high batter face. However, it should be noted that the following robust excavation methodology should be adopted to adequately arrest any potential material from batter instabilities.

- Drilling and blasting to be undertaken over a continuous 12 m face height, subsequent to which the walls will then be excavated in 3 x 4 m flitches and scaled to remove any loose/disturbed blocks. This assumption has been considered when assessing maximum berm scale instability that can occur at any time.

Based on the outcomes of the stability analysis, Table 3 presents the initial recommended slope geometry for the final pit wall. In general, although a steeper IRA has been proposed by GHD compared to those previously recommended by PSM, the overall slope angle is noted to be within a similar magnitude.

Table 3 Summary of the Montrose Quarry Batter and Inter-ramp Slope Geometries

Pit Wall	**Unit 1 (Residual Soil / Overburden Unit) Slope Angle (°)**	**Unit 2 – 4 (HW to FR Rock Unit)**			
		IRA (°)	**Overall Slope Angle (°)**	**Bench Height (m)**	**Bench Width (m)**
North	1V:1.5H	33	51	12	8
North East					
East		40	49		
South		43	51		
West		43	51		

In addition to the proposed pit design above, a minimum stand-off distance (i.e., buffer) distance is required between the crest of the pit and the WA boundary. The minimum buffer distance for each considered rehabilitation option is presented in Table 4 below. Conservatively, in the absence of a more detailed rehabilitation plan, it is recommended that the maximum buffer distance from the WA boundary is adopted (i.e., corresponding to the minimum fill level).

Table 4 Stability Analysis Results – Rehabilitated Batters

Pit Wall	Minimum stand-off distance for FoS = 2.0		
	RL 28 m	RL 112 m	RL 154 m
North	11.8	11.6	1.3
East	36.1	36.0	35.8
South	6.8	6.8	6.7
West	35.2	35.2	26.8

It should be noted that in addition to the pit design recommended above, a robust extraction methodology is also crucial to the stability of the pit walls and to maintain the integrity of the benches. As such, the use of controlled blasting followed by slope scaling and clean-up is considered favourable from a stability perspective. The recommended drill and blast techniques are further outlined in Geotechnical Assessment titled '*Montrose Quarry (WA100) Geotechnical Assessment*', dated 25 November 2021, (GHD Report Ref: 12559266/59238/47).

3.2.3 Revised Pit Geometry (Batter-berm configuration)

Revision of the pit geometry was undertaken after discussion between GHD and Boral technical staff. Boral site representatives requested the assessment of a batter bench configuration that complemented existing drill/blast and truck/shovel processes. Specifically, that the batter bench configuration would be designed at 8 m or 16 m face heights to allow for two 4 m flitches to be quarried from each production blast. The revised geometry is presented as Option B.

Based on the kinematic analysis, a batter-berm configuration of 16 m and 12 m is considered sufficient for catching and containing spillage to a single bench under managed conditions.

- NB: That this is an increase compared to the PSM report (in the order of 10 m)
- NB: Catching and containing spillage refers to single bench kinematic instabilities, not blasted material

Furthermore, a reduced batter height and associated berm width can be adopted for the final pit design, provided that an inter-berm angle equal to or less than 44° is maintained across the entire pit.

Based on the Option B design, the minimum stand-off distance is within the buffer from the crest of pit to the proposed WA boundary to maintain a FoS of greater than 2.0.

A summary of the accessed DAC for Option B compared to the initial design is shown in Table 5 below.

Table 5 DAC comparison of the initial design to Option B

Stability Section	Initial GHD Design (GHD,2022) 75 Batter Face 12 m Batter Height 10 Bench Width		GHD Option B Design 75 Batter Face 16 m Batter Height 12 m Bench Width	
	Inter-ramp DAC – FoS >1.3	Global DAC – FoS >1.6	Inter-ramp DAC – FoS >1.3	Global DAC – FoS >1.6
E1	2.58	4.00	2.17	>4.00
S1	2.99	4.00		
W1	3.68	4.77	3.56	>4.00
NE1	3.08	4.73		

3.3 Development of the Pit Model

The design of an initial pit model was developed by GHD in consultation with Boral site and technical representatives. This initial pit model, illustrates the final extraction of the resource within the current pit limits (Figure 5),GHD Proposed a realignment of the ramp to include a switchback on the eastern side to allow for the integration of internal dumping required as part of the expansion This initial model then served as the basis for the development of the extension pit model and staging plans. The following inputs, supplied by Boral, were used to design the initial pit model:

- Survey data as at November 2020 provided by Boral at project inception.
- Quarry face data, supplied by Boral via Propeller (web-based portal), from November 2020 to May 2022
- Updated extraction design of the remaining resource at the base of the pit incorporate an altered ramp design, supplied by Boral via Propeller (web-based portal), May 2022
- Aerial photography of the site
- Ecological off-set boundary
- Sensitive receptor locations and off-sets
- WA boundary

A 3D model of the pit was compiled to use as the basis for volumetric calculations of the proposed expansion design. The pit model, representing the maximum extraction limit, then served as the basis from which subsequent staging plans, the internal overburden dump and rehabilitation concept were developed. The plan view of the final pit model is attached as Appendix A.

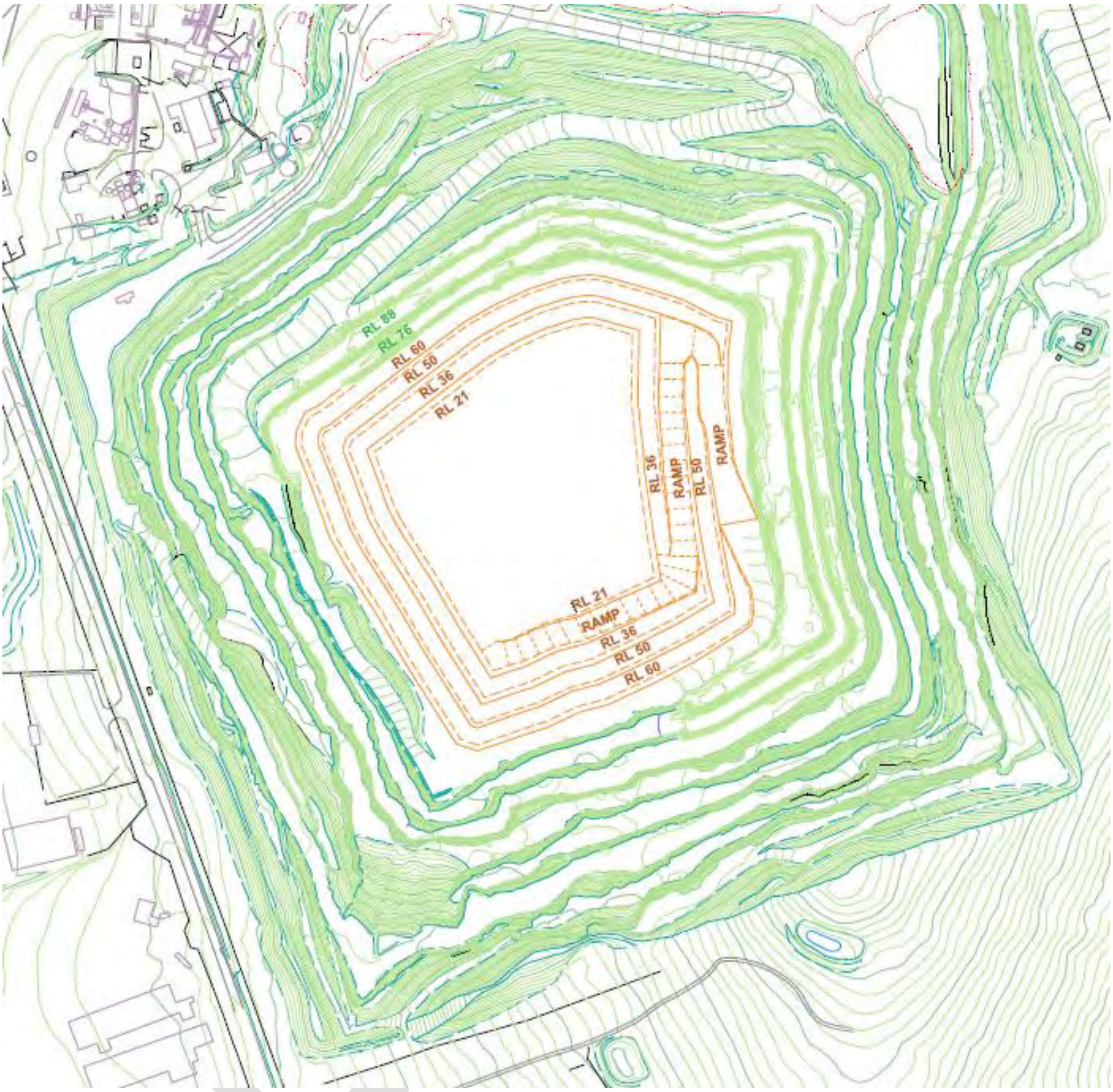


Figure 5 ***GHD Proposed ramp realignment at base of existing pit to include a switchback on the eastern side to allow integration of internal dumping during expansion***

The pit design for the quarry expansion is constrained by a series of buffer limits and associated buffer zones in relation to the WA boundary and sensitive receptors such as private dwellings. GHD has used the agreed limits / buffers, with the specific limiting geometry files detailed in Table 6.

Table 6 Boundary off-sets and buffers constraining pit limits

Boundary	Offset requirement
North	No off-set, Boral processing plant provides buffer from Canterbury Rd
East	Off-set 100 m from residential property, 33 Ash Grove and Dr Ken Leversha Reserve.
South	Dr Ken Leversha Reserve and Bungalook Creek
South-west	100 m from residential property 13 Jeanette Maree Court boundary
West	Fussell Rd / 20 m buffer from WA boundary
10 ha ecological off-set	Ecological offset provided by Boral Ecological offset includes buffer of 10m to define extraction limit Ecological offset affects eastern and southern extraction limit

In keeping with the principles detailed above in Guiding Design Principles (see Section 3.1 above), the impact of the pit expansion sensitive receptors has been incorporated into the design of the pit model. These are shown below Figure 6 and Figure 7 illustrating the adoption of batter geometries to navigate buffer zones and incorporate noise attenuation bunding as required.

3.3.1 Final Batter Profile

The final batter profile parameters were incorporated from the revised pit geometry (batter/berm configuration) of Option B, as assessed in Geotechnical Assessment titled '*Montrose Quarry (WA100) Geotechnical Assessment*', dated 25 November 2021, (GHD Report Ref: 12559266/59238/47). A summary of the adopted configuration is detailed below in Table 7.

Table 7 Adopted batter / berm configuration

Design parameter	Design parameter
Batter angle - resource	75º
Batter angle - rehab	33º
Inter-ramp angle (IRA)	49-51º
Batter height	16 m
Bench width	12 m
Ramp width	20 m
Ramp grade – permanent access ramp RL144 to base of pit	1:10

Figure 6 ***Extraction boundary off-set from residential property boundary above eastern batter***

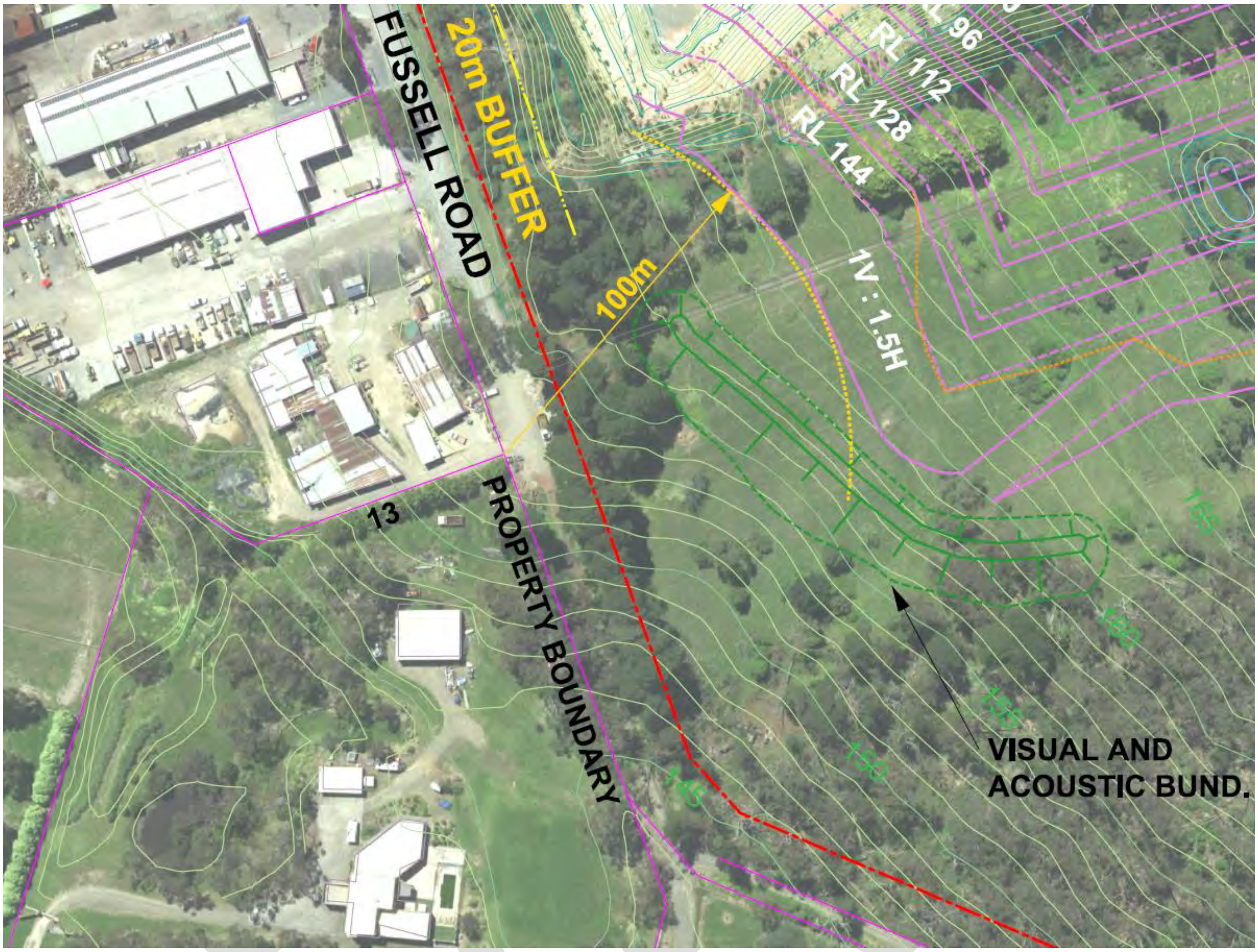


Figure 7 ***Extraction boundary off-set from residential property boundary above south-western batter and concept noise attenuation bund***

4. Staging and Sequencing

The development of the staging plans was developed based on extraction and backfill rates supplied by Boral and discussions with Boral site representatives. This has allowed GHD to develop staging plans with due consideration of access and dumping options and alignment with site practices. A summary of the rates used to develop the staging plans is detailed in Table 8.

GHD has not used these rates to develop staging plans for the development of the rehabilitation concept plan, as the availability of clean fill material, to be supplied externally to the quarry, is unknown at this time.

Table 8 Extraction and expected backfill rates

Extraction / Backfill Rate	Rate
Extraction	800 kt/yr
Stripping / Overburden Backfill	30,000 t/month

The development of the proposed pit expansion has been split into 8 stages. A methodology for sequencing the expansion has been developed and is illustrated in the accompanying staging plans 1 -8 in Appendix C. A summary of total extraction at each stage is detailed below in Table 9. A breakdown of extraction by bench at each stage is summarised in Appendix D.

Table 9 Summary of extraction volumes per stage

Stage	Volume (m^3)	Overburden (m^3)	Resource (m^3)	Resource (t) (2.7 t/m3)
1	55,400	55,400	-	-
2	682,400	408,000	274,400	740,880
3	1,609,000	638,800	970,200	2,619,540
4	938,100	349,500	588,600	1,589,220
5	1,354,300	124,500	1,235,500	3,335,850
6	1,336,700	-	1,337,000	3,609,900
7	2,132,900	-	2,132,900	5,758,830
8	2,246,900	-	2,246,900	6,066,630
Final	878,500	-	878,500	2,371,950
Total	11,234,200	1,576,000	9,658,000	26,076,600

Timeframes for extraction of each stage have been based on the above material movement rates provided by Boral and are summarised in Table 10. It is calculated that all overburden will be stripped within 8 years of commencing stage 1 and all available resource will be extracted within 32 years from commencement.

Table 10 Time to complete each stage based on provided extraction rates

Stage	Time from commencement (years)	Milestones
1	0.5	Initial eastern ramp access, OB excavation at RL 192. Upgrade of western haul road. Initial southern access ramp; at RL 192 and RL 160
2	2.3	Advance eastern batter face at Rl 192. Advance southern OB and resource faces from Rl 192 to RL 144. Complete first tier of dump at RL 36 and begin second tier at RL 50
3	5.5	Eastern batter, complete RL 192. Advance southern OB and resource faces, introduce bench level RL 128. Complete second tier of dump at RL 50 and commence third tier at R L70

Stage	Time from commencement (years)	Milestones
4	7.2	Eastern batter, excavate RL 176. Southern batter, Advance benches RL 126 to RL 160 eastwards. Complete third tier of OB dump at RL 70 and begin fourth tier at RL 88
5	10.2	OB excavation completed (to RL 128). Eastern batter, complete RL 176 and 160, establish RL 144.. Finish dumping to RL 88 (fourth / final tier).
6	14.7	Eastern batter, complete RL 144 and RL 128, establish RL 112. Southern batter, complete RL 128 and establish RL 112.
7	21.8	Eastern batter, continue RL 112 and establish RL 96. Southern batter, continue RL 96 and establish RL 80. No access from western haul road, access now from eastern haul road.
8	29.3	Completion of levels RL 96 & RL 80. Commencement of levels RL 64, RL 48 and RL 32 via extension of access ramp on southern and eastern sides. Potential to commence placement of imported fill material
Final	32.2	Completion of levels RL 48, RL 32 and RL 20. (Final Extraction Batters)

4.1 Overburden / Internal Dump

Contours for base of overburden were supplied by Boral. GHD has developed as isopach plan of overburden thickness and is attached in Appendix C. The overburden thickness varies from 4 m to 28 m in the south and from 4 m to 38 m on the eastern side. There would appear to be a possible anomaly as seen by the bullseye on the eastern side where the overburden shallows sharply to a 4 m thickness. This could potentially result in higher overburden volumes than those reported.

Weathered rhyolite/rhyodacite has been classified as a resource by Boral.

The overburden required to be removed in the quarry expansion is to be placed in an internal dump at the base of the pit and progressively filled in layers up to a final level, nominally RL 88. Figure 8 below illustrates a nominal overburden / waste dump design with a capacity of approximately 2.2 Mm$^{3.}$

The development of the internal waste dump has been assumed to following process:

- The first bottom two layers would be filled to match the existing bench levels at RL 36 (15 m thick) and RL 50 (14 m thick).
- A third 20 m thick layer is then placed starting from the western face to RL 70 with the toe limited at RL 50 to allow the future expansion batters to reach full depth.
- A fourth layer also starting from the western face to RL 88 would then be placed with leaving a 15 m berm at RL 70. A nominal 2H:1V fill slopes have been adopted.
- While the dump is designed to toe out against the final batters at completion, consideration has been given to maintain a sump at the base of the pit for water storage and storm water retention.
- The sump location changes as the dump advances as shown in the staging plans attached in Appendix C.

4.2 Access Options

Development of the proposed expansion was originally predicated on access along the eastern batter, eventually tying into the existing ramps and haulage network as quarrying progresses. This assumed that there was inadequate space on the western batters to accommodate a haul road due to the current extraction boundary, which in places, approaches the WA buffer zone.

Boral requested that GHD develop a concept haul road along the western batter and associated ramp to access the overburden from the south-west of the quarry. The south-western corner of the proposed extraction has reduced overburden thickness, allowing resource to be accessed earlier. The development of this additional ramp and haul route also provides Boral with an additional operational face providing operational flexibility.

4.2.1 Eastern Access Ramp

The eastern access ramp is designed as a 12 m wide cut / fill ramp at an 1 in 8 grade, from the RL 160 stockyard area up to RL 192 to allow excavation of the uppermost overburden benches. This ramp is progressively shortened as overburden levels are excavated as shown on Stage 1 – 5 drawings (see Appendix C). The eastern expansion will more likely need to be developed level by level until completion of the 160 Bench after which the permanent access ramp can commence, allowing multiple benches to be developed concurrently. It is at about this point that southern development would begin to retreat to the south western corner and ultimately reach their terminal faces.

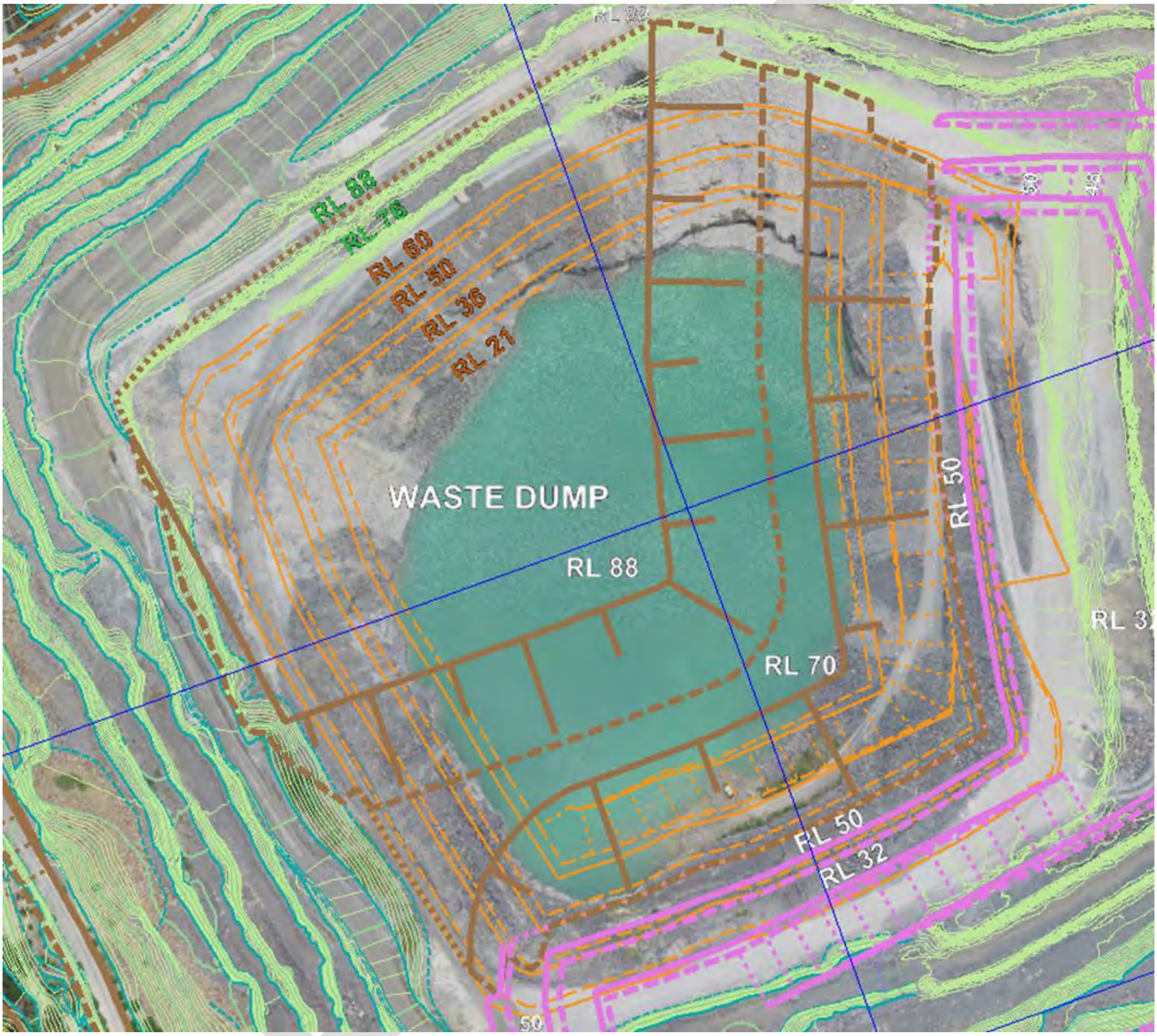


Figure 8 ***Nominal overburden / waste dump design***

4.2.2 Southern Development / Western Haul Route

The existing western perimeter track would be upgraded to create a haul route that will allow access to the southern region of the expansion much sooner than if the development was limited to only commencing from the northeast. The development of the western haul route and initial ramp are detailed in Appendix B in both plan and section view.

At the south west end of the upgraded western haul route an initial access ramp from RL144 to RL176 (20m wide, 1 in 10 grade) and RL176 to RL192 (12m wide, at 1 in 8 grade) is created. This will allow overburden initially, then rock to be transported from the southern expansion via the upgraded western haul route. Overburden excavation in the south commences from RL 192 & 160 progressively and rock extraction commences from the RL 144 Bench as shown on the Stage 1 & 2 drawings.

These ramps will eventually be removed in latter stages of development (stage 6 onwards).

5. Rehabilitation Concept

To develop an understanding of the volumes required to backfill the Montrose quarry, a rehabilitation concept has been developed. This concept is the culmination of multiple discussions between Boral and GHD to develop a safe, stable and sustainable landform, noting that no final land-use is yet proposed, and that this concept is not suitable for use in a Work Plan Variation. The intent of this design is to inform Boral's understanding of the fill required to achieve a similar landform and consideration of market conditions for fill and void space.

Backfill quantities have been modelled by volume and are described in this section accordingly. The nominated fill rate advised by Boral of 500,000 t/year has been converted to a volumetric rate of 250,000 m^3/year based on Boral's advised average density for the backfill of 2 t/m^3.

5.1 Options Analysis

Initially 3 concept landforms were to be assessed:

- Fill to RL 28: It is assumed that an RL 28 fill level will seal the pit from the water table, this has not been verified by detailed assessment. Potential land use includes water storage options.
- Fill to RL 112: Filling to this level may be suitable for recreational and nature services, including a small lake. Ferntree Gully Quarry Reserve is an analogous local example of a public space in steep terrain that incorporates a pit lake.
- Fill to RL 154: Filling to this level is expected to average inclines of no more than 1:15 (estimated). With reprofiling, this could be suitable for a wide range of next uses such as recreational or urban development.

GHD in consultation with Boral has agreed that the preferred option for the concept rehabilitation design is a 4th option of Fill to RL 98 with batter to crest fill at 3H:1V.

The factors considered in assessing the backfill options are summarised below:

Table 11 Rehabilitation Concept Options

Rehabilitation Concept	Backfill Volume (m^3) assumes internal O/B dump complete	Time to Backfill (years)	Considerations
Fill to RL 28	150,000	0.6	Slopes would be largely unbuttressed with exposed batters in perpetuity. Potential to create pit lake based on water level studies. Lost commercial potential as clean fill storage. No alternative final land use possible. Unlikely to meet minimum expectations of ERR or community. Ongoing liability for Boral.
Fill to RL 112	8,700,000	35	Unlikely to meet minimum expectations of ERR or community. Slopes would be buttressed and upper exposed batters in perpetuity. Limited future land-use potential. Access to useable surface area required through exposed batters. Backfill required over 35 years. Ongoing liability for Boral.

Rehabilitation Concept	Backfill Volume (m^3) assumes internal O/B dump complete	Time to Backfill (years)	Considerations
Fill to RL 154	19,700,000	79	Slopes fully buttressed although significant section of eastern batters left exposed in perpetuity. Multiple land-uses available. Backfill required over 79 years. Long life of rehabilitation phase. Uncertainty to availability of clean fill over lifetime of rehabilitation. Continued liability for Boral through to completion.
Fill to RL 98 and batter to crest at 3H:1V	14,000,000	56	1 in 3 Slopes fully cover remnant excavated batter thus more likely to meet minimum expectations of ERR and community Slopes fully buttressed. No batters exposed in perpetuity. Increased land use potential. Access maintained though rehabilitated area. Backfill completed in approximately 56 years. Potential to facilitate fastest release of liability for Boral.

5.2 Recommended Concept

A proposed final landform has been conceived which would see the pit void filled with material from external sources in addition to the development of an internal overburden dump to manage mining waste from operations.

This landform as illustrated in the rehabilitation concept drawing in Appendix E proposes to fill the final void to RL98. Above RL98 fill would be placed at a 3H:1V slope up to the pit crest. Intermediate berms at nominal 30 m vertical intervals would confine the slope lengths to no more than 100 m each. A 15 m wide ramp on the eastern side (retained from extraction operations) would provide access to the RL98 level. This is an additional 10m higher than the nominal internal dump design height of RL88 as shown in staging plans 7-8 (Appendix C).

There is 14,000,000 m^3 of void space at the completion of extraction, assuming that the internal dump (2,200,000 m^3 capacity) is completed, between the base of the quarry and the fill level of RL98, and 3H:1V slopes. The total surface area of the completed rehabilitation concept is 38 ha.

Filling of the void would commence as soon as practicable however this would likely be towards the completion of the extraction process. It is currently proposed that Boral will source the additional material required to complete the rehabilitation concept from external sources on the open market or from other Boral sites as required/available. Boral currently assumes to backfill the quarry void at a rate of 250,000 BCM per annum. At this rate, backfill of the remaining 14,000,000 m^3 of void space would take approximately 56 years to complete.

A series of sequencing plans has been developed outlining the steps involved in backfilling the pit void to achieve the rehabilitation concept (see Appendix E).(see Appendix C). Backfilling would begin towards the completion of the extraction process(as shown in Stage 8 extraction plan) and would commence with filling the remainder of the internal dump as well as dumping at the base of the pit in areas not impacted by the final extraction. A summary of the backfilling staging is shown in Table 12 below.

Table 12 *Rehabilitation Concept Backfill Volumes by Stage*

Stage	Fill Level	Remaining Internal Dump (m^3)	Imported Fill (m^3)	Volume – Cumulative (m^3)
1. 10 yrs	RL 70	300,000	2,300,000	2,600,000
2. 20 yrs	RL 88 (partial fill)	-	2,000,000	5,100,000
	RL 112 (partial fill)	-	500,000	
3. 30 yrs	RL 98 (complete)	-	8,000,000	7,300,000
	RL 112 (top of 1 in 3 batter)	-	1,400,000	
4. 40 yrs	RL 120 (top of 1 in 3 batter)	-	2,300,000	9,900,000
5. 54 yrs	RL 150 (top of 1 in 3 batter)	-	3,500,000	13,400,000
Backfill Complete	Final 1 in 3	-	900,000	14,300,000

The rehabilitation concept is further illustrated in Appendix F as a series of 3D rendered images of the site from eight (8) vantage points. These images are intended to show the rehabilitation concept in-situ with respect to the surrounding landscape. Examples of the 3D rendered images are shown below in Figure 9 and Figure 10

Figure 9 *Oblique view, orientated eastwards, towards Mount Evelyn.*

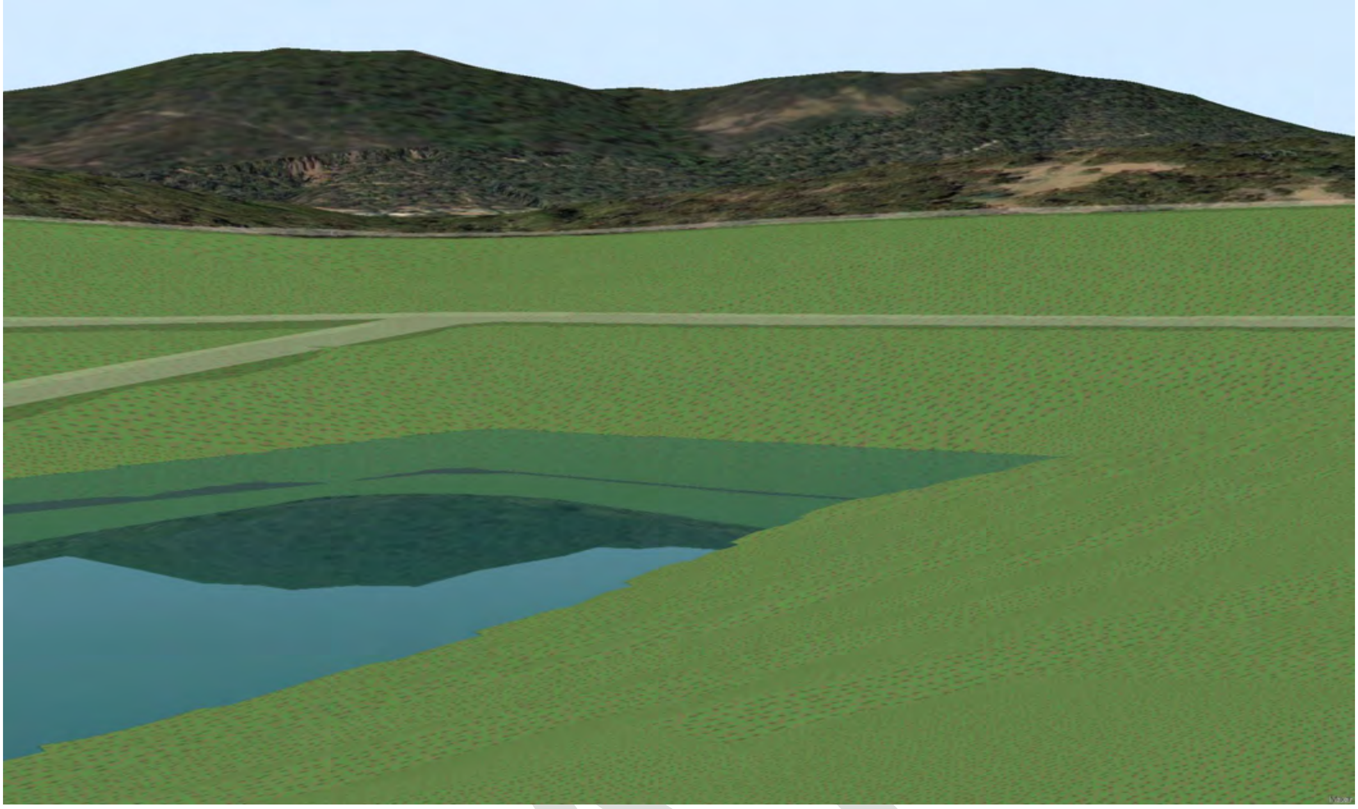


Figure 10 Internal view, orientated southeast, towards the Dandenong Ranges.

As part of the geotechnical assessment, completed in advance of this rehabilitation concept design, an erosion assessment was conducted using the Revised Universal Soil Loss Equation (RUSLE). RUSLE is a tool used to estimate the potential soil loss due to direct rainfall on an exposed slope and can provide an indication of the general erosion risk of the surface. It is useful for quantifying the impact of various factors that contribute to erosion when designing batters under long term (rehabilitated) conditions.

One of the factors considered in the RUSLE assessment the topographic factor (LS) which accounts for a slopes height (L) and gradient (S) and is used to represent the effect of topography on erosion rates. The topographic factors used in the assessment are detailed in Table 13.

Table 13 Summary of Topographic Factors

Geometry	Gradient (V:H)	Slope Length (m)	Topographic Factor, LS
North Wall	1V:1.5H (≈ 34°)	72	10.3
East, South and West Wall		54	10.8

Of note is the increased slope length of the batters from the assumed values in the earlier geotechnical assessment (72 m for the northern batter and 54 m for all other batters) compared to the current rehabilitation concept (approx. 100 m). As stated in the geotechnical assessment, GHD recommends that work is undertaken to verify the suitability of the erosion input parameters presented within the assessment, or in this case re-assess the model considering the increased slope length.

The Geotechnical Assessment titled '*Montrose Quarry (WA100) Geotechnical Assessment*', dated 25 November 2021, (GHD Report Ref: 12559266/59238/47) can be referenced to understand the erosion assessment in greater detail.

5.3 Legislative Considerations

While the outcome of this scope of works is not to develop a rehabilitation plan, it is intended to inform the development of a suitable final landform for rehabilitation. The rehabilitation concept is intended to directly feed into a subsequent rehabilitation plan and inform Boral's decision as to what the preferred final landform design and final land use will be. GHD has considered the requirements of a rehabilitation plan, within GHD's understanding of what is required by current legislation.

To this end, the following legislation is to be considered in the development of the concept design.

The relevant pieces of legislation that have been considered in the design of the rehabilitation concept are:

- *Mineral Resources (Sustainable Development) Act 1990*
- *Mineral Resources (Sustainable Development) (Extractive Industries) Regulations 2019*
- *Preparation of Work Plans and Work Plan Variations – Guideline for Extractive Industries Projects Revised October 2020 (Version 1.2)*
- *Preparation of Rehabilitation Plans - Guideline for Extractive Industry Projects March 2021 (Version 1.0*)
- *Geotechnical Guideline for terminal and rehabilitated slopes - Guideline for Extractive Industry Projects September 2020 (ERR)*

Both the MRSD Act and the Regulations include requirements for a rehabilitation plan. Section 79 of the *MRSD Act 1990* sets out what a rehabilitation plan must consider:

- Any special characteristics of the land.
- The surrounding environment.
- The need to stabilise the land.
- The desirability or otherwise of returning agricultural land to a state that is as close as is reasonably possible to its state before the mining licence, prospecting licence or extractive industry work authority was granted; and
- Any potential long-term degradation of the environment.

The Regulations further specify what information must be included in a rehabilitation plan lodged on or after 1 July 2021 at regulation 11(2) includes a description of proposed land uses for the affected land after it has been rehabilitated, that considers community views expressed during consultation; and a landform that will be achieved to complete rehabilitation, which must:

- Be safe, stable and sustainable; and
- Be capable of supporting a final land use.
- Objectives that set out distinct rehabilitation domains that collectively amount to the landform described.
- Criteria for measuring whether the objectives described have been met; and
- A description of, and schedule for, each measurable, significant event or step in the process of rehabilitation.
- An identification and assessment of relevant risks that the rehabilitated land may pose to the environment, to any member of the public or to land, property or infrastructure in the vicinity of the rehabilitated land, including:
  - The type, likelihood and consequence of the risks; and
  - The activities required to manage the risks; and
  - The projected costs to manage the risks; and
  - Any other matter that may be relevant to risks arising from the rehabilitated land.

6. References

DJPR (2021). *Preparation of Rehabilitation Plans - Guideline for Extractive Industry Projects March 2021 (Version 1.0)*

DJPR (2020). *Geotechnical Guideline for terminal and rehabilitated slopes - Guideline for Extractive Industry Projects September 2020 (ERR)*

DJPR (2020) *Preparation of Work Plans and Work Plan Variations – Guideline for Extractive Industries Projects Revised October 2020 (Version 1.2)*

GHD (2021). *Geotechnical Assessment 'Montrose Quarry (WA100) Geotechnical Assessment', dated 25 November 2021, (GHD Report Ref: 12559266/59238/47)*

Mineral Resources (Sustainable Development) Act 1990 (Vic)(Austrl.), Act Number 92/1990, Version 126, effective 01/07/2021

Mineral Resources (Sustainable Development) (Extractive Industries) Regulations 2019 (Vic)(Austrl.), Statutory Rule 137/2019, Version 002, effective 23/06/2020.

Read, J., & Stacey, P. (2009). *Guidelines for Open Pit Slope Design.* CSIRO Publishing.