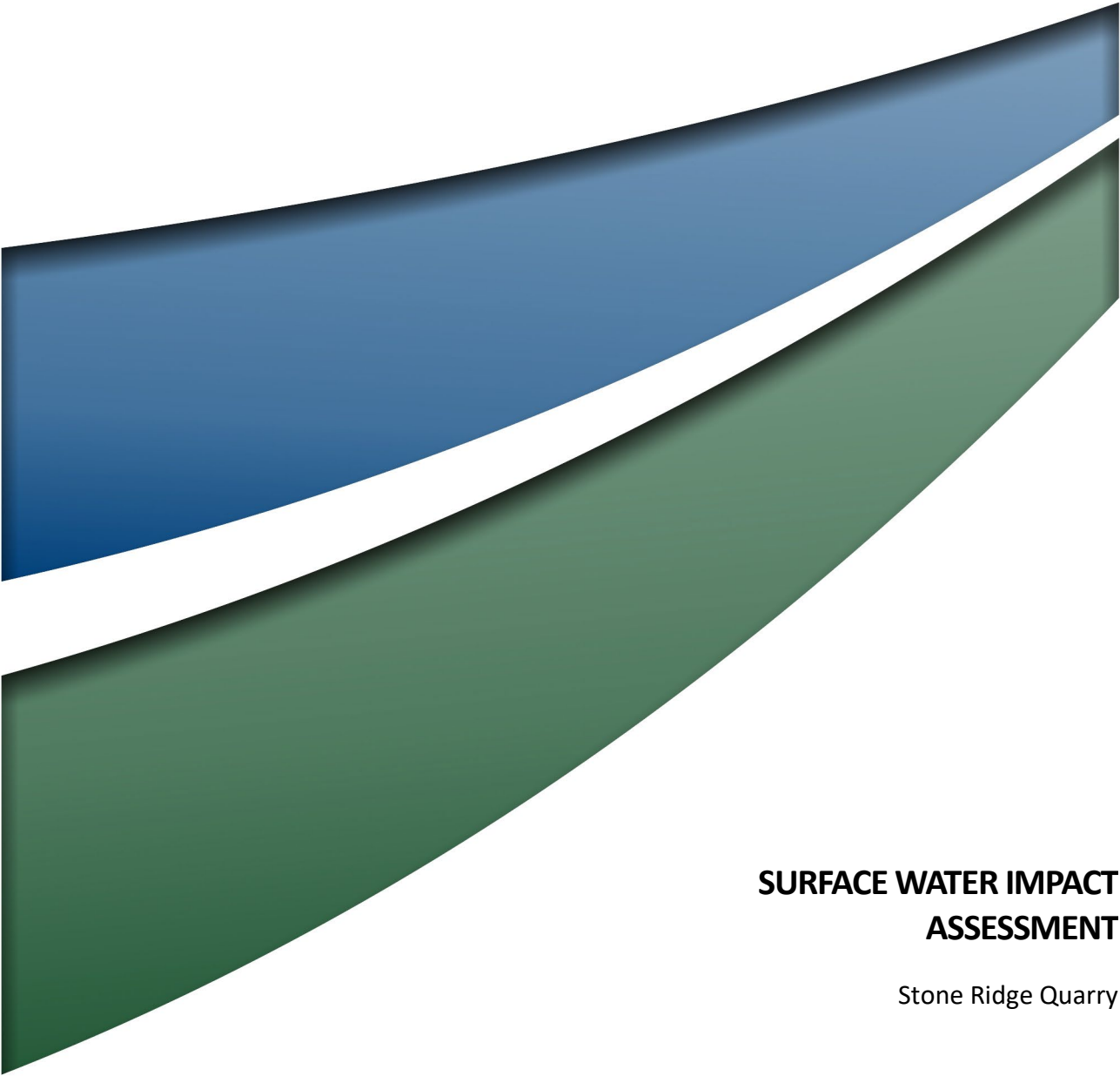


## APPENDIX 9

### Surface Water Impact Assessment



**SURFACE WATER IMPACT  
ASSESSMENT**

Stone Ridge Quarry

**FINAL**

May 2023

# **SURFACE WATER IMPACT ASSESSMENT**

Stone Ridge Quarry

## **FINAL**

Prepared by

**Umwelt (Australia) Pty Limited**

on behalf of

**Australian Resource Development Group Pty  
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Report No. **4158C/R12**

Date: **May 2023**



This report was prepared using  
Umwelt's ISO 9001 certified  
Quality Management System.

**Acknowledgement of Country**

*Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.*

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**Document Status**

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	Chris Bonomini	24 May 2023	Penelope Williams	24 May 2023

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# 1.0 Introduction

## 1.1 Project Overview

The Stone Ridge Quarry Project (the Project) is seeking to access a high quality, hard rock resource suitable for producing a wide range of quarry products for the Lower Hunter, Central Coast and northern Sydney construction material markets. The Project proposes to produce up to 1.5 million tonnes per annum (Mtpa) of saleable quarry product with approval sought for an initial 30-year quarrying period.

The construction phase of the Project consists of earthworks and clearing of vegetation for site preparation to enable access to target resources and development of the quarry extraction area. Construction of a weighbridge and associated administrative buildings combined with the installation of on-site processing plant and associated equipment are also required to facilitate the Project. A site access point off Italia Road would also need to be constructed. A summary of the of key Project aspects is provided in **Table 1.1**.

The Project is a State Significant Development (SSD) under the *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP) as proposed extraction will exceed 500,000 tonnes per year. A development application (DA) for the Project is required to be submitted under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

**Table 1.1 Summary of Key Project Aspects**

Aspect	Proposed for the Project
<b>Project life</b>	30 years
<b>Limits of production</b>	Up to 1.5 Mtpa of quarry product/sales per year
<b>Project Area</b>	Approximately 139 ha (including extraction, processing and stockpiling area and buffers), with a disturbance area of approximately 79 ha
<b>Extraction method</b>	Drill, blast, load and haul
<b>Material processing</b>	Processing on site with provision for both mobile crushing and screening plant, as well as modular/fixed processing plant
<b>Overburden management</b>	Overburden will be minimal and any topsoil and overburden will be stockpiled on site for use in rehabilitation
<b>Product</b>	Concrete, asphalt and sealing aggregates, gabion, armourstone, roadbase and other crushed rock products
<b>Product transport</b>	Road transport of up to 1.5 Mtpa of product via the Pacific Highway
<b>Site access</b>	1.5 Mtpa equates to average of 334 heavy vehicle movements (167 inbound and 167 outbound) each day (based on the transportation of materials using truck and dog combinations with a typical capacity of around 30 tonnes)
<b>Employment</b>	Construction: 10 to 15 full time employees Operation: Up to 10 full time employees, 3 to 5 part-time employees

Aspect	Proposed for the Project
<b>Hours of operation</b>	Construction: <ul style="list-style-type: none"> <li>• 7.00 am to 6.00 pm Monday to Friday</li> <li>• 8.00 am to 1.00 pm Saturday</li> <li>• No work on Sunday or Public Holidays</li> </ul> Operation: <ul style="list-style-type: none"> <li>• Quarrying and processing - 7.00 am to 6.00 pm Monday to Friday, and 7.00 am to 3.00 pm Saturdays</li> <li>• Truck loading, product transport and maintenance - 6.00 am to 10.00 pm Monday to Friday, and 7.00 am to 3.00 pm Saturdays</li> <li>• No operation on Sundays or Public Holidays apart from maintenance activities as required</li> </ul>
<b>Rehabilitation and final landform</b>	Rehabilitation will be undertaken progressively where appropriate in the context of further resources remaining available in the Project Area at the end of the planned 30-year approval life. A conceptual final landform will be prepared for the Project.

## 1.2 Project Location

The Project is located within Wallaroo State Forest at Balickera, NSW, approximately 30 km north of Newcastle. Wallaroo State Forest is located on the northern side of the Pacific Highway, and extends from Italia Road, in the west, to the Karuah River in the east. The Project Area covers 139 ha in the western part of Wallaroo State Forest (see **Figure 1.1**), immediately adjacent to Italia Road and to the immediate northeast of Boral’s Seaham Quarry, which has been in operation since 1991.

The Project Area is located fully within the boundary of the licence area and comprises the portion of the licence area within which quarry operations will occur. The current conceptual project design is shown in **Figure 1.2**.

The cadastre of the Project Area is described as follows:

- Lots 36 and 65 DP 753200
- Lot 1 DP 724372
- Part Lot 540 DP 1207159.

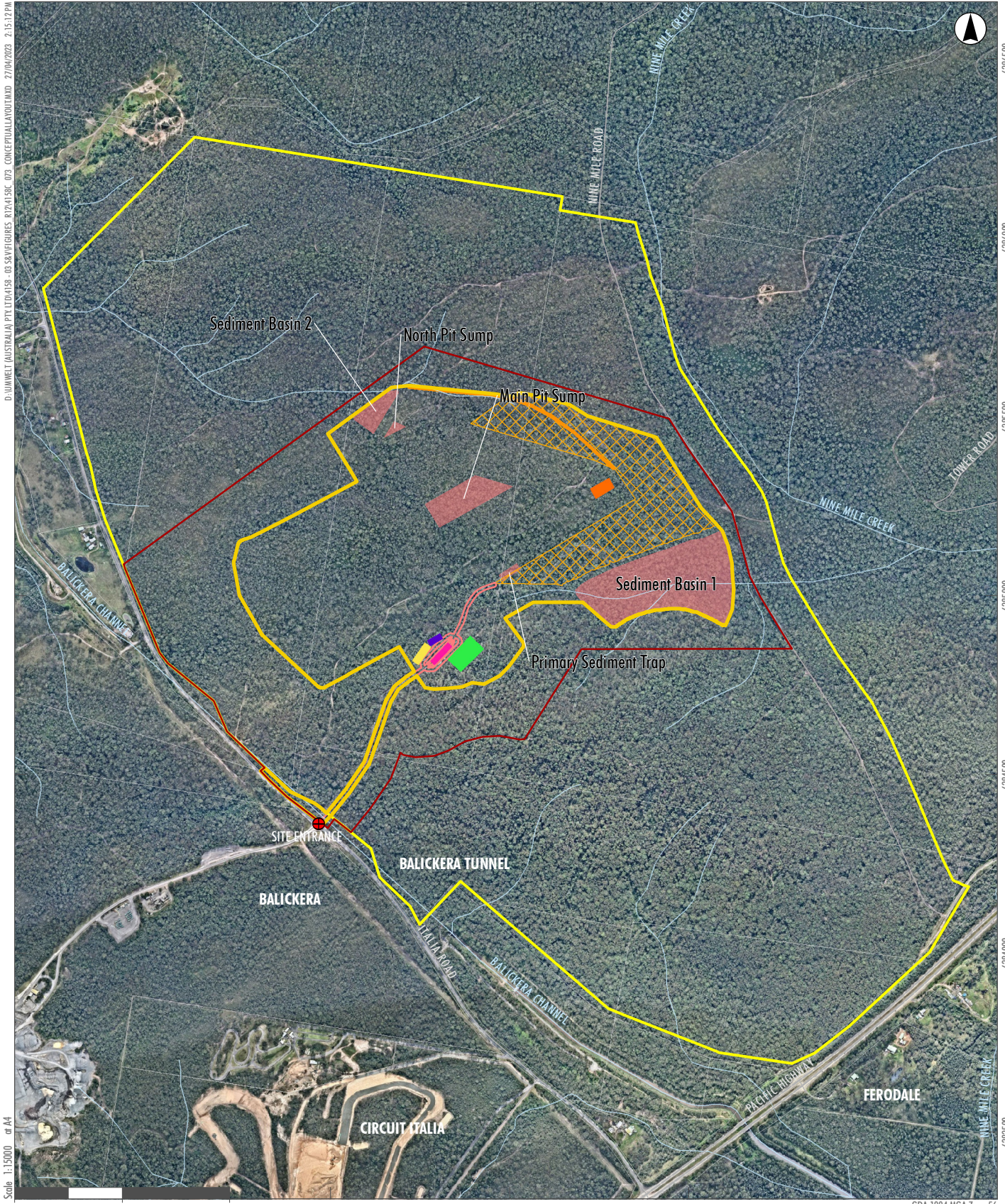
All lots are located on land managed by FCNSW.



- Legend**
- Project Area
  - LGA Boundary
  - National Parks (NPWS Estate)
  - State Forest
  - Pacific Highway
  - Road
  - Drainage Line
  - Waterbody
  - Lot Boundaries

Image source: Nearmap (2022) Data source: NSW FSDF (2022)

**FIGURE 1.1**  
**Project Locality**



Scale 1:15000 at A4  
0 300 600 Meters

GDA 1994 MGA Zone 56

- Legend**
- Project Area
  - Disturbance Area
  - Licence Area
  - Pacific Highway
  - Road
  - Drainage Line
  - Lot Boundaries
  - Office
  - Weighbridge
  - Access Road
  - Northern Haul Road
  - Workshop
  - Truck Parking
  - Light Vehicle Parking
  - Stockpile and Plant Area
  - Dams

**FIGURE 1.2**  
**Project Layout**

## 1.3 Secretary's Environmental Assessment Requirements

This SWIA has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (dated 1 June 2020).

**Table 1.2** presents the SEARs relating to the surface water and where each element is addressed in this SWIA report.

**Table 1.2 Secretary's Environmental Assessment Requirements**

Requirement	Section where addressed
The Environmental Impact Statement (EIS) for the development must comply with the requirements in Clauses 6 and 7 of Schedule 2 of the <i>Environmental Planning and Assessment Regulation 2000</i> . In particular, the EIS must include: <ul style="list-style-type: none"> <li>a full description of the development, including: <ul style="list-style-type: none"> <li>a water management strategy;</li> </ul> </li> </ul>	<b>Section 3.0</b>
The EIS must address the following key issues: <ul style="list-style-type: none"> <li><b>Water</b> – including: <ul style="list-style-type: none"> <li>a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;</li> </ul> </li> </ul>	<b>Sections 3.1 and 4.0</b>
<ul style="list-style-type: none"> <li>identification of any licensing requirements or other approvals under the <i>Water Act 1912</i> and/or <i>Water Management Act 2000</i>;</li> </ul>	<b>Section 7.1</b>
<ul style="list-style-type: none"> <li>demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);</li> </ul>	<b>Sections 4.0 and 7.1</b>
<ul style="list-style-type: none"> <li>a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;</li> </ul>	<b>Section 6.2.2 and 7.1.3</b>
<ul style="list-style-type: none"> <li>an assessment of any likely flooding impacts of the development;</li> </ul>	<b>Section 2.1.1 and 6.2.4</b>
<ul style="list-style-type: none"> <li>an assessment of the likely impacts on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives;</li> </ul>	<b>Section 6.0</b>
<ul style="list-style-type: none"> <li>an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, the Grahamstown Dam drinking water catchment, Balickera Channel, Balickera Tunnel and any other related infrastructure, and other water users; and</li> </ul>	<b>Section 6.0</b>
<ul style="list-style-type: none"> <li>a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts;</li> </ul>	<b>Sections 3.0 and 7.0</b>

## 1.4 Potential Surface Water Impacts

The Project has the potential to have the following impacts on surface water resources:

- a reduction in Grahamstown Dam catchment yield due to the capture of surface runoff within the Project Water Management System (WMS)
- degradation of downstream water quality as a result of ground disturbing activities leading to erosion and transport of sediment and nutrients to downstream water users and watercourses, including Grahamstown Dam, in water discharged from the Project WMS
- changes in catchment hydrology resulting in changes to receiving watercourse flow regimes.
- impacts on stream stability associated with quarry discharges.

The potential surface water impacts listed are assessed in **Section 6.0**.

## 2.0 Surface Water Context

### 2.1 Catchment

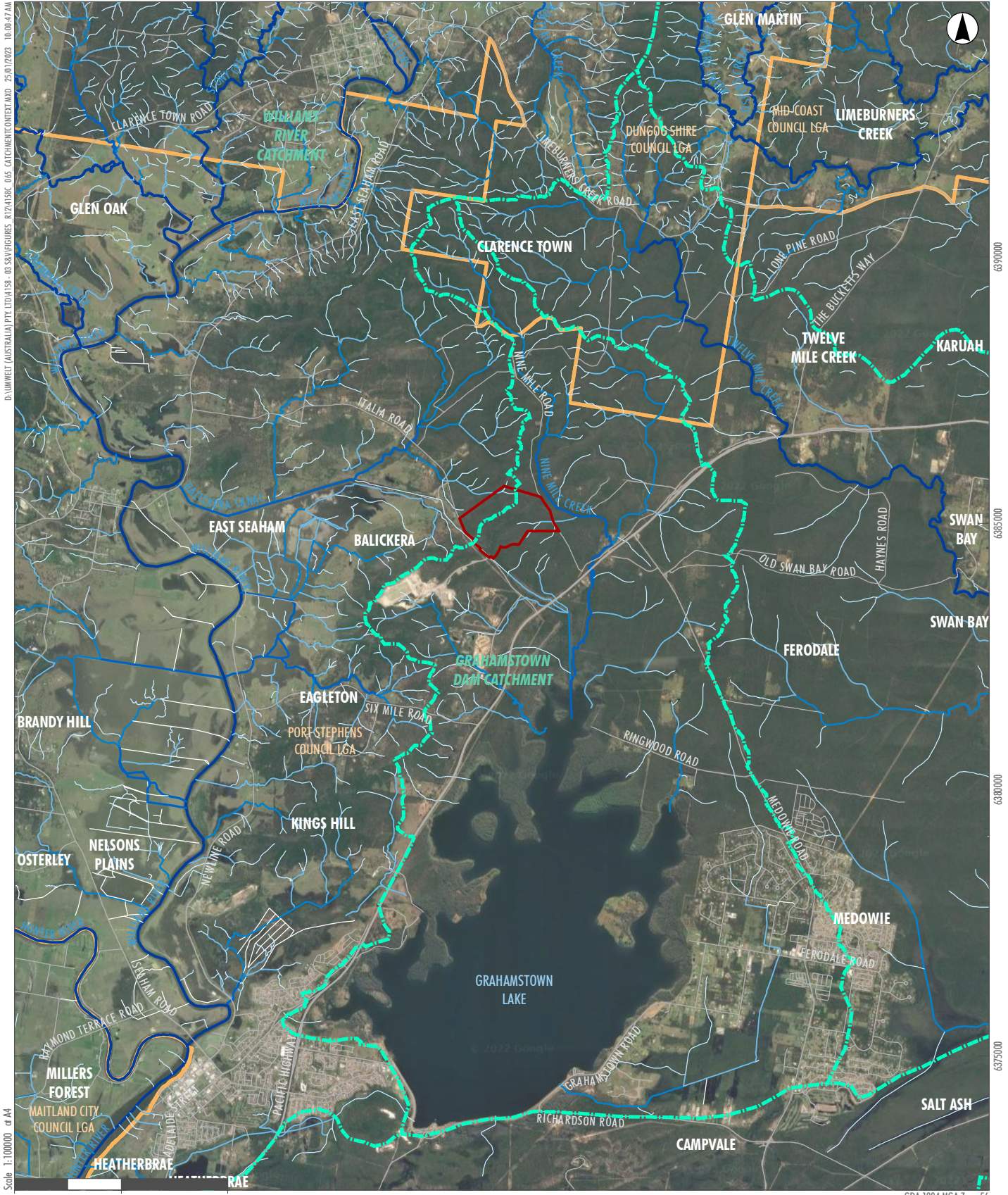
The Project is located within the Grahamstown Dam catchment and the Williams River catchment which are both part of Hunter Water's drinking water catchment. Grahamstown Dam has a total catchment area of approximately 115 km<sup>2</sup> (Hunter Water, 2022). Water is received by Grahamstown Dam via catchment rainfall runoff inflows as well as extraction from the Williams River via the Seaham Weir Pumps and the Balickera Pump Station which transfers water within Balickera Canal from the western side of Balickera Pump Station to the eastern side which drains to Grahamstown Dam (refer to **Figure 2.1**). Grahamstown Dam provides approximately 40% of the Hunter's potable water demand and meets up to 75% of daily supply requirements.

The Williams River catchment has its headwater in the forests of the Barrington Tops with the remainder of the catchment is primarily agricultural land and rural townships (Hunter Water, 2017). The Williams River has a catchment area of approximately 974 km<sup>2</sup>, is part of the broader Hunter River catchment (which has a total catchment area of approximately 21,500 km<sup>2</sup>) and flows into the Hunter River at Raymond Terrace. Water harvested from the Williams River at the Seaham Weir flows into Balickera Canal and provides approximately 50% of the inflows to Grahamstown Dam (Hunter Water, 2017). As such, impacts on the Williams River may also have an impact on water quality in the Grahamstown Dam

The Project Area catchment is typically steep, covered with woodland areas and was historically utilised for forestry. Vegetation density varies but is considerably less dense on the upper slopes where soils are skeletal and much of the surface is dominated by weathered rock (refer to **Photo 2.1**). Within the general area there is also some localised disturbance including fire trails that exhibit significant wear.



**Photo 2.1**      **Project Site Upper Slope Catchment**



D:\UMWELT (AUSTRALIA)\PTY.LTD\4159C\_045\_CATCHMENTCONTEXT.MXD 25/10/2023 10:00:47 AM

Scale 1:100000 or A4

- Legend**
- Project Area
  - LGA Boundary
  - Road
  - Catchment Boundaries
  - Strahler Stream Order**
  - 0th Order Stream
  - 1st Order Stream
  - 2nd Order Stream
  - 3rd Order Stream
  - 4th Order Stream
  - > 4th Order Stream

**FIGURE 2.1**  
Catchment Context

### 2.1.1 Surface Hydrology

Catchment inflows to Grahamstown Dam primarily drain from the northern and eastern shores of the dam. Approximately 75% of the total catchment runoff to Grahamstown Dam is received from the north, and inflow from the eastern catchment is received from the urban settlement of Medowie through the Campvale Swamps and into the dam via the Campvale Pump Station (Hunter Water, 2022). Water sourced from the Williams River is pumped into the Balickera Canal at Seaham Weir and then raised approximately 15 m at the Balickera Pump Station into the eastern end of Balickera Canal which drains into the northern end of Grahamstown Dam.

The north-western part of the Project Area drains either directly to Balickera Canal or to ephemeral tributaries of Caswells Creek which subsequently drains to Balickera Canal upstream of the Balickera Pump Station. Runoff from the eastern part of the Project Area drains to Nine Mile Creek, a fourth order stream that flows under Nine Mile Road and the Pacific Highway before discharging into Grahamstown Dam approximately two kilometres southeast of the Project site. Both Balickera Canal (on the eastern side of Balickera Pump Station) and Nine Mile Creek drain into the northern extent of Grahamstown Dam (refer to **Figure 2.2**).

Nine Mile Creek broadens as the terrain flattens downstream of the Project Area and has heavily vegetated banks where it passes under Nine Mile Road (refer to **Photos 2.2** and **2.3**). Upstream of the Project Area, Nine Mile Creek also appears to be well vegetated and have a light brown sandy clay and rock/pebble bed matrix (refer to **Photo 2.4**). A significant amount of woody debris from recent heavy rainfall was observed in Nine Mile Creek downstream of a fire trail creek crossing during a site inspection on 9 November 2022 (refer to **Photo 2.5**). Of the limited extent of Nine Mile Creek observed, there appeared to be moderate bank erosion with some undercut on the radius of outer bends and side bars formed from sediment deposition. In general, however, the significant bank vegetation would appear to be maintaining streambanks despite the recent high frequency of significant rainfall events in the catchment.

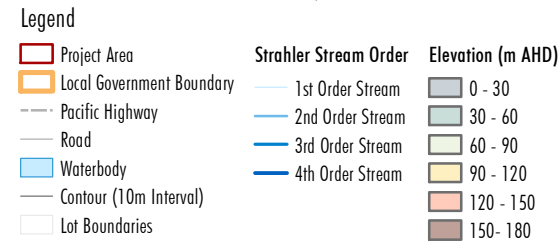
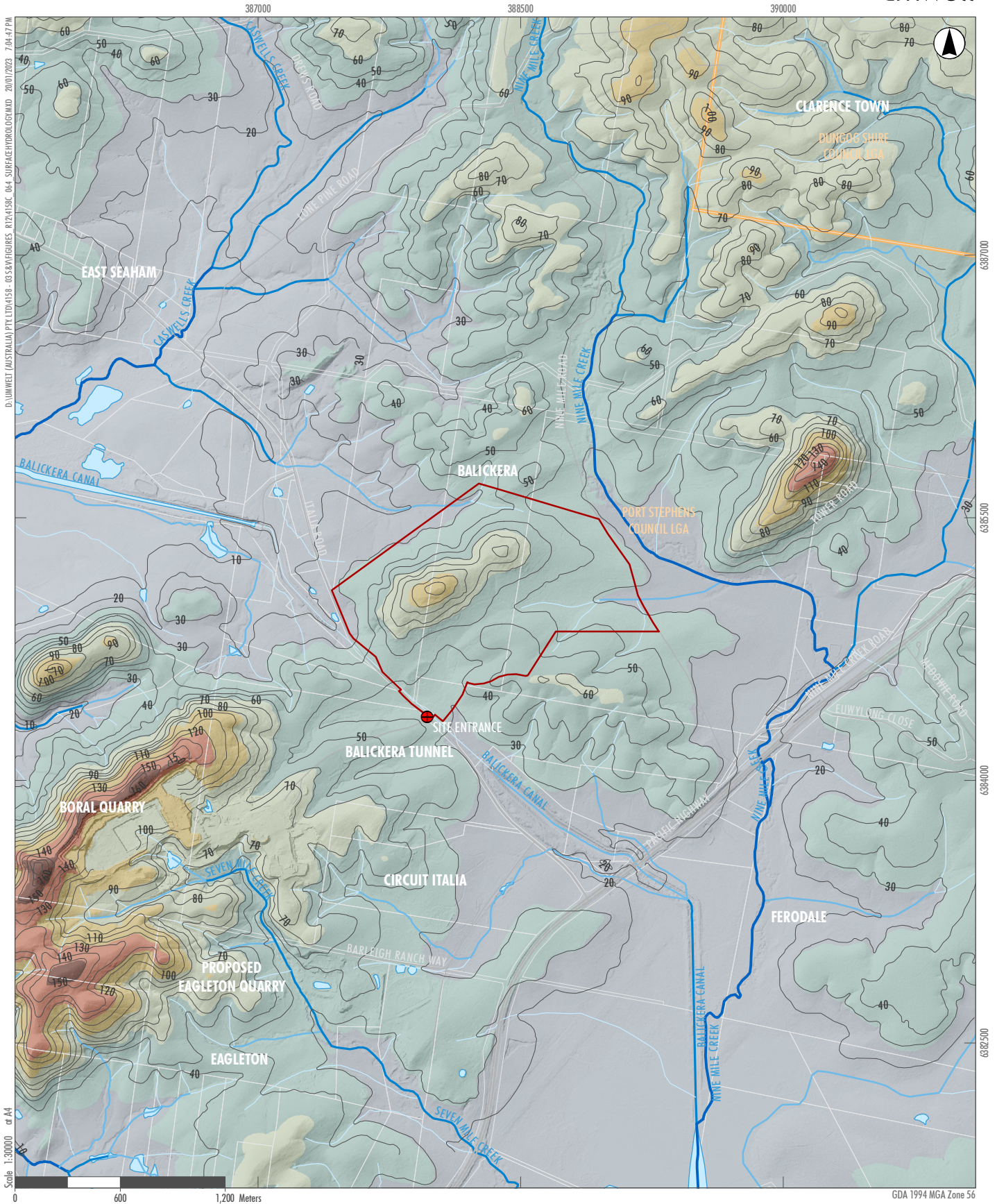


FIGURE 2.2  
Surface Hydrology



**Photo 2.2**      **Nine Mile Creek Upstream (north) of Nine Mile Creek Road**



**Photo 2.3**      **Nine Mile Creek Downstream (south) of Nine Mile Creek Road**



**Photo 2.4**      **Nine Mile Creek Upstream of Project Site (looking north of fire trail creek crossing)**



**Photo 2.5**      **Nine Mile Creek Upstream of Project Site (looking south of fire trail creek crossing)**

## 2.1.2 Topography and Soils

The Project is located on ridge line with an elevation of up to 107 mAH. The western part of the Project Area has the steepest terrain which grades to a minimum elevation of approximately 23 mAH at the western extent of the Project Area boundary. Surrounding the ridge line, slopes within the Project Area are milder and range from approximately 5% to 10%.

The Newcastle Soil Landscape Series Sheet 9232 (Matthei, 1995) indicates that the Project is located within the Ten Mile Road and the Nungra Soil Landscapes. **Figure 2.3** shows the soil landscapes within the Project Area. The Ten Mile Road Soil Landscape is described as undulating low hills on carboniferous sediments and acid volcanics in the Medowie Lowlands and Clarence Town Hills regions (Matthei, 1995). The Ten Mile Road Soil Landscape has a high-water erosion hazard, localised shallow soils, high run on and seasonal waterlogging and strongly to extremely acid soils of low fertility (Matthei, 1995).

The Nungra Soil Landscape is located within the eastern region of the Project Area and is described as long, smooth and gently inclined “Quaternary alluvium and deep silty footslope deposits eroded from surrounding hills and overlying Carboniferous rock strata” (Matthei, 1995). The soil types are relatively uniform; however the depth of topsoil is often shallow or absent on cleared footslopes. Total soil depth commonly exceeds 200 cm with the following qualities and limitations: water erosion hazard, salinity (localised), high run-on, seasonal waterlogging, flood hazard (localised) and foundation hazard (Matthei, 1995).

During a site inspection on 9 November 2022 the steeper Project Area slopes were observed to be dominated by weathered rock and shallow soils, while the lower slopes at the eastern end of the site exhibited deeper fine sandy soils with a light brown colour as well as bands of whiter clayey soils. Runoff ponded in access track wheel ruts was very turbid and indicative of soils containing non-settling dispersive sediments.

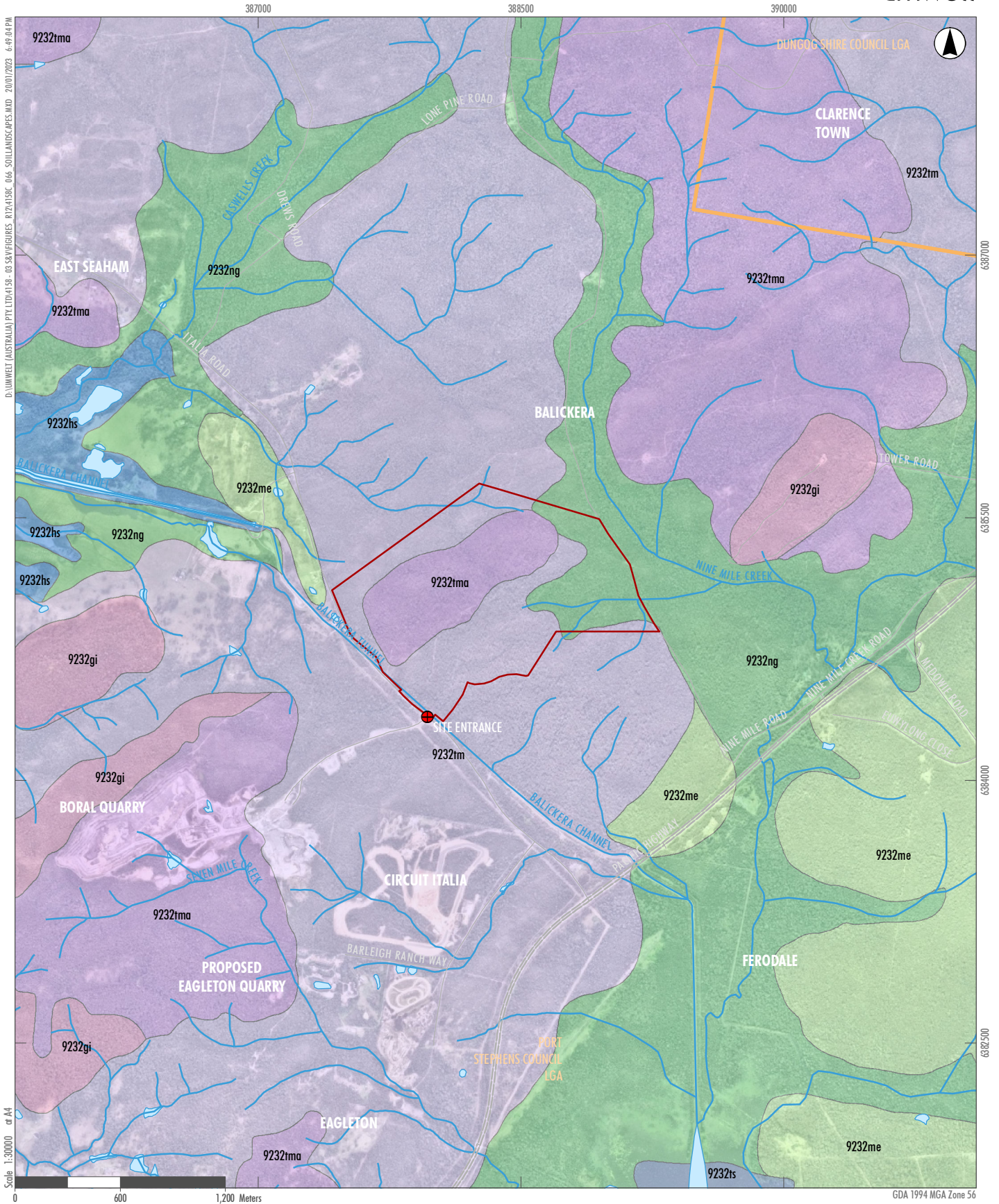
**Table 2.1** presents the modelled soil properties for the Project Area (Matthei, 1995).

**Table 2.1 Modelled Soil Properties**

Parameter	Value	
	0 – 30 cm Depth	30 – 100 cm Depth
Soil Erodibility, k factor (as used in the Revised Universal Soil Loss Equation (RUSLE))	0.04 – 0.07	
Clay Percentage	16 – 21%	22 – 37%
Silt Percentage	14 – 17%	14 – 16%
Sand Percentage	55 – 64%	39 – 51%
pH (CaCl <sub>2</sub> )	4.5 – 4.9	4.4 – 5.1
Electrical Conductivity (dS/m)	0.04 – 0.1	0.04 – 0.1
Cation Exchange Capacity (cmol <sub>c</sub> /kg)	6.0 – 8.0	7.0
Soil Organic Carbon	1.5 – 2.0%	0.4 – 0.6%
Exchangeable Sodium Percentage (ESP)	4.1 – 7.0%	4.7 – 8.8%

The modelled soil properties presented in **Table 2.1** indicate that the Project Area soils:

- are fine and highly erodible
- have a moderately low pH
- are non-saline
- are moderately sodic with an ESP > 6% and are likely to be dispersive
- have low fertility, indicated by a low CEC and low to moderate organic carbon.



Legend	
	Project Area
	Local Government Boundary
	Pacific Highway
	Road
	Drainage Line
	Waterbody
	Soil Landscapes
	9232me, Medowie
	9232gi, Gilmore Hill
	9232m, Ten Mile Road
	9232ma, Ten Mile Road variant a
	9232ng, Nungra
	9232hs, Hexham Swamp
	9232ts, Tacoma Swamp

FIGURE 2.3  
Soil Landscapes

## 2.2 Climate

The Project is located within the Port Stephens Local Government Area which has a temperate climate with warm to hot wet summers, lower winter rainfall and no dry season.

There are two Bureau of Meteorology (BoM) stations recording climate data within a 10 km radius of the Project, being:

- Station 061010 - Clarence Town (Prince Street) (approximately 9 km north north-west of the Project), with available records (rainfall) from 1895 to present.
- Station 061076 – Raymond Terrace (Wollaroo State Forest) (approximately 8.3 km north-east of the Project), with available records (rainfall) from 1889 to present.

**Table 2.2** and **Table 2.3** present the annual and monthly rainfall and evaporation data for the Project Area, which consists of interpolated data estimated based on the climate records of the nearest weather stations to the Project location sourced from the Queensland Government’s SILO climate database for grid coordinates -32.65° latitude, 151.80° longitude.

**Table 2.2 Annual Rainfall and Evaporation (mm), 1900 to 2021**

Statistic	Rainfall	Evaporation
10 <sup>th</sup> percentile	765	1335
50 <sup>th</sup> percentile	1071	1437
90 <sup>th</sup> percentile	1406	1529
Average	1085	1441

**Table 2.3 Monthly Average Rainfall and Evaporation (mm), 1900 to 2021**

Month	Rainfall	Evaporation
January	3.3	5.8
February	4.0	5.0
March	4.0	4.1
April	3.4	3.2
May	2.9	2.3
June	3.5	2.0
July	2.5	2.2
August	1.9	3.0
September	2.1	3.9
October	2.3	4.7
November	2.6	5.4
December	3.1	5.9

The average rainfall and evaporation for the Project Area are typically higher in the summer months and lower in the winter months with rainfall exceeding evaporation in the months April through to July.

## 2.3 Water Quality

### 2.3.1 NSW Water Quality Objectives

The NSW Water Quality Objectives (WQOs) have been developed to guide plans and actions to achieve healthy waterways. The WQOs are based on measurable environmental values (EVs) for protecting aquatic ecosystems, recreation, primary industries, drinking water and industrial water (ANZECC & ARMCANZ, 2000). There are no specific WQOs for the Grahamstown Dam catchment or the Williams River catchment from which water is transferred to Grahamstown Dam (refer to **Section 2.1**).

In the absence of catchment specific WQOs, the Hunter River WQOs are considered an appropriate surrogate to apply to the receiving waters in the Project Area catchment and are presented in **Table 2.4**.

**Table 2.4 Relevant Hunter River Water Quality Objectives**

Parameter	Units	Water Quality Objective
pH	-	6.5 to 8.5
Electrical Conductivity (EC)	µS/cm	125-2,200
Turbidity	NTU	6 to 50
NOx	mg/L	0.04
Total Phosphorus (TP)	mg/L	0.05
Total Nitrogen (TN)	mg/L	0.5

### 2.3.2 Baseline Receiving Water Quality

ARDG has undertaken baseline receiving water quality monitoring at three locations (RW1, RW2 and RW3) within the Project catchment area (refer to **Figure 2.4**):

- RW1 is located in Nine Mile Creek upstream of any potential future impacts associated with the Project
- RW2 is located in Nine Mile Creek downstream of any potential future impacts associated with the Project
- RW3 is located in Nine Mile Creek downstream of RW2, adjacent to and on the northern side of the Pacific Highway.

ARDG commenced baseline monitoring in January 2020 with regular sampling events occurring up to February 2021. The gap in monitoring between March 2021 and early 2022 were due to access restrictions resulting from both wet weather and COVID-19. Monitoring was re-commenced by ARDG in July 2022. Water samples have been analysed for:

- pH
- Electrical Conductivity (EC)
- Total Suspended Solids (TSS)
- Turbidity

- Nitrite
- Nitrate
- Total Kjeldahl Nitrogen (TKN)
- Total Nitrogen (TN)
- Total Phosphorus (TP)
- Oil and Grease.

**Table 2.5, Table 2.6** and **Table 2.7** present the water quality statistics for the monitoring results collected under the baseline receiving water quality monitoring program.



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 GDA 1994 MGA Zone 56

- Legend**
- Project Area
  - LGA Boundary
  - National Parks (NPWS Estate)
  - State Forest
  - Pacific Highway
  - Road
  - Drainage Line
  - Waterbody
  - Lot Boundaries

**FIGURE 2.4**

**Baseline Water Quality Monitoring Locations**

**Table 2.5 Baseline Nine Mile Creek Upstream Water Quality – RW1**

Statistic	pH	EC (µS/cm)	TSS (mg/L)	Turbidity (NTU)	Nitrite (mg/L)	Nitrate (mg/L)	NOx (mg/L) <sup>1</sup>	TKN (mg/L)	TN (mg/L)	TP (mg/L)	Oil & Grease (mg/L)
LOR <sup>2</sup>	0.01	1	5	0.1	0.01	0.01	0.01	0.1	0.1	0.01	5
# Results	8	8	8	8	8	8	8	6	6	6	3
# Results >LOR	8	8	1	8	0	5	5	6	6	5	0
Minimum	5.81	167	2.5 <sup>3</sup>	5.8	0.005 <sup>3</sup>	0.005 <sup>2</sup>	0.005 <sup>3</sup>	0.4	0.4	0.005 <sup>3</sup>	2.5 <sup>3</sup>
Average	6.26	241	4	18.4	0.005 <sup>3</sup>	0.05	0.05	0.6	0.7	0.02	2.5 <sup>3</sup>
Maximum	6.89	292	12	49.8	0.005 <sup>3</sup>	0.20	0.20	0.9	1.0	0.03	2.5 <sup>3</sup>

Notes

<sup>1</sup> Nitrite plus Nitrate

<sup>2</sup> Limit of Reporting

<sup>3</sup> Results below the LOR

**Table 2.6 Baseline Nine Mile Creek Downstream Water Quality – RW2**

Statistic	pH	EC (µS/cm)	TSS (mg/L)	Turbidity (NTU)	Nitrite (mg/L)	Nitrate (mg/L)	NOx (mg/L) <sup>1</sup>	TKN (mg/L)	TN (mg/L)	TP (mg/L)	Oil & Grease (mg/L)
LOR <sup>2</sup>	0.01	1	5	0.1	0.01	0.01	0.01	0.1	0.1	0.01	5
# Results	7	7	7	7	7	7	7	5	5	5	2
# Results >LOR	7	7	5	7	0	4	4	5	5	4	0
Minimum	5.89	174	2.5 <sup>3</sup>	6.8	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.6	0.6	0.005 <sup>3</sup>	2.5 <sup>3</sup>
Average	6.10	240	36	37.4	0.005 <sup>3</sup>	0.05	0.05	0.8	0.8	0.09	2.5 <sup>3</sup>
Maximum	6.35	297	191	89.1	0.005 <sup>3</sup>	0.19	0.19	1.0	1.1	0.4	2.5 <sup>3</sup>

Notes

<sup>1</sup> Nitrite plus Nitrate

<sup>2</sup> Limit of Reporting

<sup>3</sup> Results below the LOR

**Table 2.7 Baseline Nine Mile Creek Downstream Water Quality – RW3**

Statistic	pH	EC (µS/cm)	TSS (mg/L)	Turbidity (NTU)	Nitrite (mg/L)	Nitrate (mg/L)	NOx (mg/L) <sup>1</sup>	TKN (mg/L)	TN (mg/L)	TP (mg/L)	Oil & Grease (mg/L)
<b>LOR<sup>2</sup></b>	0.01	1	5	0.1	0.01	0.01	0.01	0.1	0.1	0.01	5
<b># Results</b>	9	9	9	9	9	9	9	6	6	6	3
<b># Results &gt;LOR</b>	9	9	7	9	0	5	5	6	6	6	0
<b>Minimum</b>	5.85	139	2.5 <sup>3</sup>	6.1	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.005 <sup>3</sup>	0.8	0.8	0.03	2.5 <sup>3</sup>
<b>Average</b>	6.29	222	10	33.1	0.005 <sup>3</sup>	0.04	0.04	1.0	1.0	0.04	2.5 <sup>3</sup>
<b>Maximum</b>	7.03	288	27	74.9	0.005 <sup>3</sup>	0.21	0.21	1.3	1.3	0.05	2.5 <sup>3</sup>

Notes

<sup>1</sup> Nitrite plus Nitrate

<sup>2</sup> Limit of Reporting

<sup>3</sup> Results below the LOR

The recorded water quality monitoring data was compared to the NSW WQOs.

- The majority of the pH results are outside the limit (6.5 – 8.5) for RW1 and RW3. All pH results recorded at RW2 were outside of the lower WQO limit. The lower pH results are consistent with the acidic Ten Mile Road soils mapped within the Project Area (refer to **Section 2.1.2**).
- All water monitoring results for EC were within the WQO limit (125 – 2,200  $\mu\text{S}/\text{cm}$ ) for RW1, RW2 and RW3.
- The majority of the turbidity results are within the WQO limit (6 – 50 NTU), with the exception of March 2020 for RW1 and RW2, as well as April 2020 for RW2 and July 2022 for RW3.
- The majority of the NO<sub>x</sub> results are below the WQO limit (0.04 mg/L), with the exception of February 2020 for RW1, RW2 and RW3, July 2020 for RW1 and RW2, and February and July 2022 for RW1.
- All TN results are above the WQO limit (0.5 mg/L), with the exception of June 2020 for RW1.
- All TP results are below the WQO limit (0.05 mg/L), with the exception of April 2020 for RW2. RW1 and RW2 results for June 2020 were below the limit of reporting.

### 2.3.3 Neutral or Beneficial Effect on Water Quality

As indicated in **Section 2.1** the Project is located within the Hunter Water’s drinking water catchment (i.e., Grahamstown Dam and the Williams River) and as such must have a Neutral or Beneficial Effect (NorBE) on water quality.

*Guidelines for Development in Drinking Water Catchments* (Hunter Water, 2017) indicates that a development is considered to have a NorBE on water quality if the development:

- a. has no identifiable potential impact on water quality, or
- b. will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or
- c. will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

An assessment of the potential impact on water quality in the Grahamstown Dam catchment is presented in **Section 6.1** and considers:

- the baseline receiving water quality data collected by ARDG (refer to **Section 2.3.2**) which has been utilised in conjunction with water balance modelling to inform the pre-development pollutant loads from the proposed Project catchment area
- estimated post-development pollutant loads based on likely Project discharge water quality and quantity (based on water balance modelling) when in operation.

## 2.4 Water Extraction

Water Sharing Plans (WSPs) have been developed under the *Water Management Act 2000* to protect the environmental health of water sources, whilst securing sustainable access to water for all users. The WSPs specify maximum water extractions and allocations and provide licensed and unlicensed water users with a clear picture of when and how water will be available for extraction.

The Project is located within the area regulated by the Hunter Unregulated and Alluvial Water Sources WSP which commenced in 2009. The WSP is divided in three Extraction Management Units (EMU); the Greater Hunter EMU, the Hunter Regulated River Alluvium EMU and the Lake Macquarie EMU. Further, the Alluvial Water Sources WSP is divided into 40 water sources corresponding to sub-catchment boundaries. The south-eastern portion of the Project is located within the Newcastle Water Source of the Greater Hunter EMU while the north western portion is located within the Seaham Weir Management Zone of the Williams River Water Source.

With respect to groundwater, the Project is located within the New England Fold Belt Coast Groundwater Source which is regulated under the North Coast Fractured and Porous Rock Groundwater WSP which commenced in 2016.

## 2.5 Surface Water Users

Licensed surface water users potentially impacted by the Project are located within the Newcastle Water Source and Williams River Water Source.

A search of the NSW Water Register indicates that for the 2021/2022 financial year there were 10 Water Access Licences (WALs) with a total of 100,571-unit shares allocated in the Newcastle Water Source area. Hunter Water holds 100,000 shares for the major utility while all but one of the other WALs are predominantly for irrigation and associated with land outside of Grahamstown Dam catchment. The one WAL associated with land within the Grahamstown Dam catchment is for horticulture and applies to land in Medowie approximately 2.5 km from the eastern bank of Grahamstown Dam.

A search of the NSW Water Register for the 2021/2022 financial year indicates that there are 162 WALs with a total of 57,131.2 units shares within the Williams River Management Zone of the Williams River Water Source. A search of the properties between the Project Area and Balickera Canal in the NSW Water Register did not identify any licensed water users in the Williams River Management Zone. The only water user immediately downstream of the quarry that could be impacted is Hunter Water which holds a WAL for major utility with a 50,000-unit share entitlement in the Williams River Management Zone and a 189,000-unit share entitlement in the Seaham Weir Management Zone of the Williams River Water Source.

Groundwater users that may potentially be impacted as a consequence of the Project are indicated in *Stone Ridge Quarry Groundwater Impact Assessment* (GHD, 2022).

## 3.0 Water Management

### 3.1 Operational Water Management

A conceptual operational Water Management System (WMS) has been developed for Stage 1 and Stage 9 of the proposed quarry operation. The conceptual WMS strategy is to:

- direct undisturbed catchment runoff around disturbed operational areas, where practicable, to minimise the quantity of dirty water runoff to be managed
- contain and reuse as much dirty water runoff from disturbed operational areas as possible to minimise import demands
- minimise the volume and frequency of controlled discharges from the WMS to the receiving environment
- minimise the risk of uncontrolled discharges from the WMS in storm events not exceeding the 24-hour duration, 0.2% Annual Exceedance Probability (AEP) storm event (i.e. the 24 hour duration, 500 year Average Recurrence Interval storm event)
- treat water prior controlled discharge to an appropriate standard to as far as practicable ensure the average total pollutant loads in controlled and uncontrolled discharges have a NorBE on water quality when compared to pre-development Project site runoff pollutant loads.

#### 3.1.1 Conceptual Stage 1 Water Management System

The conceptual Stage 1 WMS has an area of approximately 35 ha and incorporates the Main Pit, the North Pit (if constructed), relatively small areas of undisturbed catchment on steep slopes, materials processing plant, site office and amenities, weighbridge access roads and water management infrastructure. Key components of the conceptual Stage 1 WMS are presented in **Table 3.1**. Plan and schematic drawings of the conceptual Stage 1 WMS are presented in **Figure 3.1** and **Figure 3.2** respectively.

**Table 3.1 Stage 1 WMS Components**

Item	Functional Description	Preliminary Proposed Minimum Capacity
Main Pit Sump	<ul style="list-style-type: none"> <li>• Capture runoff from the Main Pit and receive overflows from the Primary Sediment Trap.</li> <li>• Serve as surge storage capacity during wet periods (i.e., will receive transfers of surplus water from sediment basins).</li> </ul>	100.0 ML
Primary Sediment Trap	<ul style="list-style-type: none"> <li>• Capture coarse sediment in runoff from the eastern portion of the Main Pit, processing plant area and upslope undisturbed catchment before it drains to Sediment Basin 1 (SB1).</li> <li>• Will operate as a flow through sediment trap.</li> <li>• Additional sediment traps may be constructed in the processing and stockpile areas to reduce SB1 sediment loads.</li> </ul>	0.2 ML

Item	Functional Description	Preliminary Proposed Minimum Capacity
Sediment Basin 1 (SB1)	<ul style="list-style-type: none"> <li>• Constructed on a second order tributary of Nine Mile Creek.</li> <li>• Capture runoff from the stockpile areas and carpark, office/amenities and weighbridge.</li> <li>• Primary site water storage and supply for operational demands.</li> <li>• Sized to minimise the risk of uncontrolled discharges in storm events not exceeding the 24-hour duration, 0.2% AEP storm event.</li> <li>• Exceeds the required capacity determined in accordance with <i>Managing Urban Stormwater – Soils and Construction Volume 1</i> and <i>Volume 2e – Mines and quarries</i> (hereafter collectively referred to as the Blue Book) of 18.3 ML (12.2 ML settling zone<sup>1</sup> and 6.1 ML sediment zone<sup>2</sup>).</li> <li>• Will be managed to maintain a storage inventory of at least 5 ML but with a target maximum operating capacity of approximately 10 ML to minimise the risk of uncontrolled discharges.</li> <li>• Should water inventories exceed the required freeboard to accommodate the Blue Book settling zone capacity (i.e., 12.2 ML), SB1 will be dewatered to ensure freeboard is restored within five days of runoff generating rainfall.</li> <li>• Water inventory to be managed through supply of operational demands (material processing and dust suppression), irrigation of undisturbed Project Area catchments and controlled discharges. Irrigation will be applied within the Project area at a rate that does not result in runoff to local drainage lines.</li> </ul>	100 ML
Sediment Basin 2 (SB2) Note: SB2 will only be required if the North Pit is constructed.	<ul style="list-style-type: none"> <li>• Capture runoff from the North Pit (if constructed) and haul road.</li> <li>• Sized to minimise the risk of uncontrolled discharges in storm events not exceeding the 24-hour duration, 0.2% AEP storm event.</li> <li>• Exceeds the required capacity determined in accordance with the Blue Book of 2.3 ML (1.5 ML settling zone<sup>1</sup> and 0.8 ML sediment zone<sup>2</sup>).</li> <li>• Will be managed to minimise inventory to reduce frequency of uncontrolled discharges by transferring to SB1.</li> <li>• Should water inventories exceed the required freeboard to accommodate the Blue Book settling zone capacity (i.e. 1.5 ML), SB2 will be dewatered to ensure freeboard is restored within five days of runoff generating rainfall.</li> </ul>	9.7 ML

Item	Functional Description	Preliminary Proposed Minimum Capacity
Clean Drains	<ul style="list-style-type: none"> <li>• Direct runoff from undisturbed catchment upslope of Main Pit around Main Pit.</li> <li>• Direct runoff from undisturbed catchment upslope of SB1 around SB1.</li> <li>• Direct runoff from undisturbed catchment upslope of SB2 around SB2.</li> <li>• Direct runoff from undisturbed catchment upslope of the North Pit and haul road around the North Pit and haul road.</li> </ul>	To be determined during detailed design phase
Licensed Groundwater Bore	<ul style="list-style-type: none"> <li>• To supply water to meet operational demands during dry periods.</li> </ul>	Up to 119 ML/year
Water Treatment Plant	<ul style="list-style-type: none"> <li>• Removal of suspended solids and nutrients prior to controlled discharge.</li> <li>• Water treatment plant technology to be confirmed during Project detailed design phase.</li> </ul>	Up to 220 ML/year

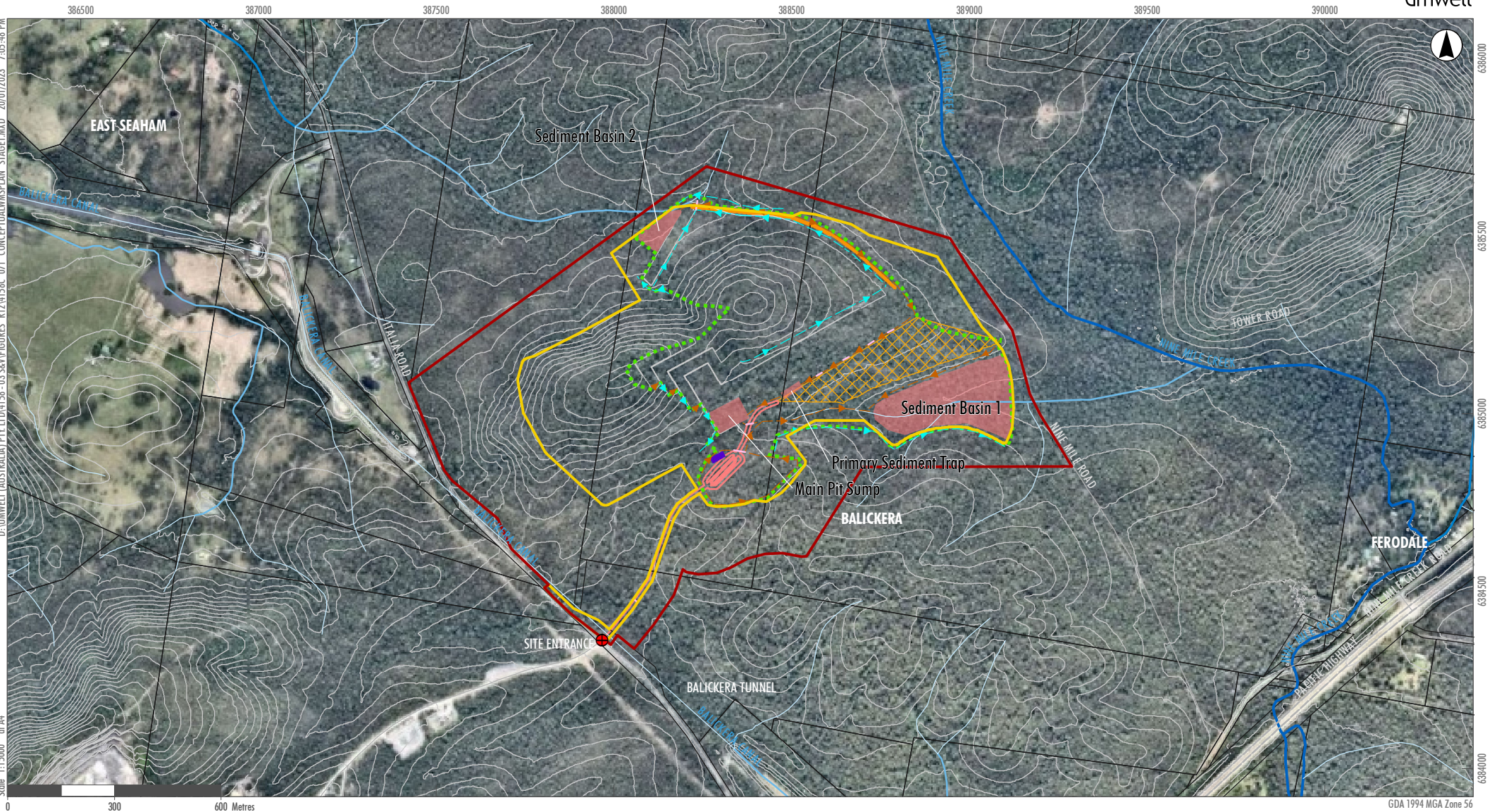
Notes

<sup>1</sup> Settling zone capacity based on runoff from the Newcastle 5 day 95<sup>th</sup> percentile rainfall depth of 76.7 mm sourced from the Blue Book

<sup>2</sup> Sediment zone equal to 50% of the settling zone capacity

Notwithstanding the preliminary proposed water storage capacities indicated in **Table 3.1**, different water storage capacities may be determined during detailed Project design. However, installed water storages will have adequate capacity to contain runoff from the 24-hour duration, 0.2% AEP storm event. Further, water storages will have adequate capacity such that they are not predicted to spill under the historical climatic conditions modelled in the operational water balance (refer to **Section 4.0**).

It is also important to note that if the North Pit is developed in Stage 1 and/or as it is developed in later stages, the capacity below spill level of the pit will be able to be utilised as surplus water storage. Prior to high or prolonged rainfall events, water from SB1, SB2 and the Main Pit Sump may be transferred to the North Pit to ensure adequate capacity is available to retain runoff from forecast rainfall and enable continued extraction in the Main Pit.

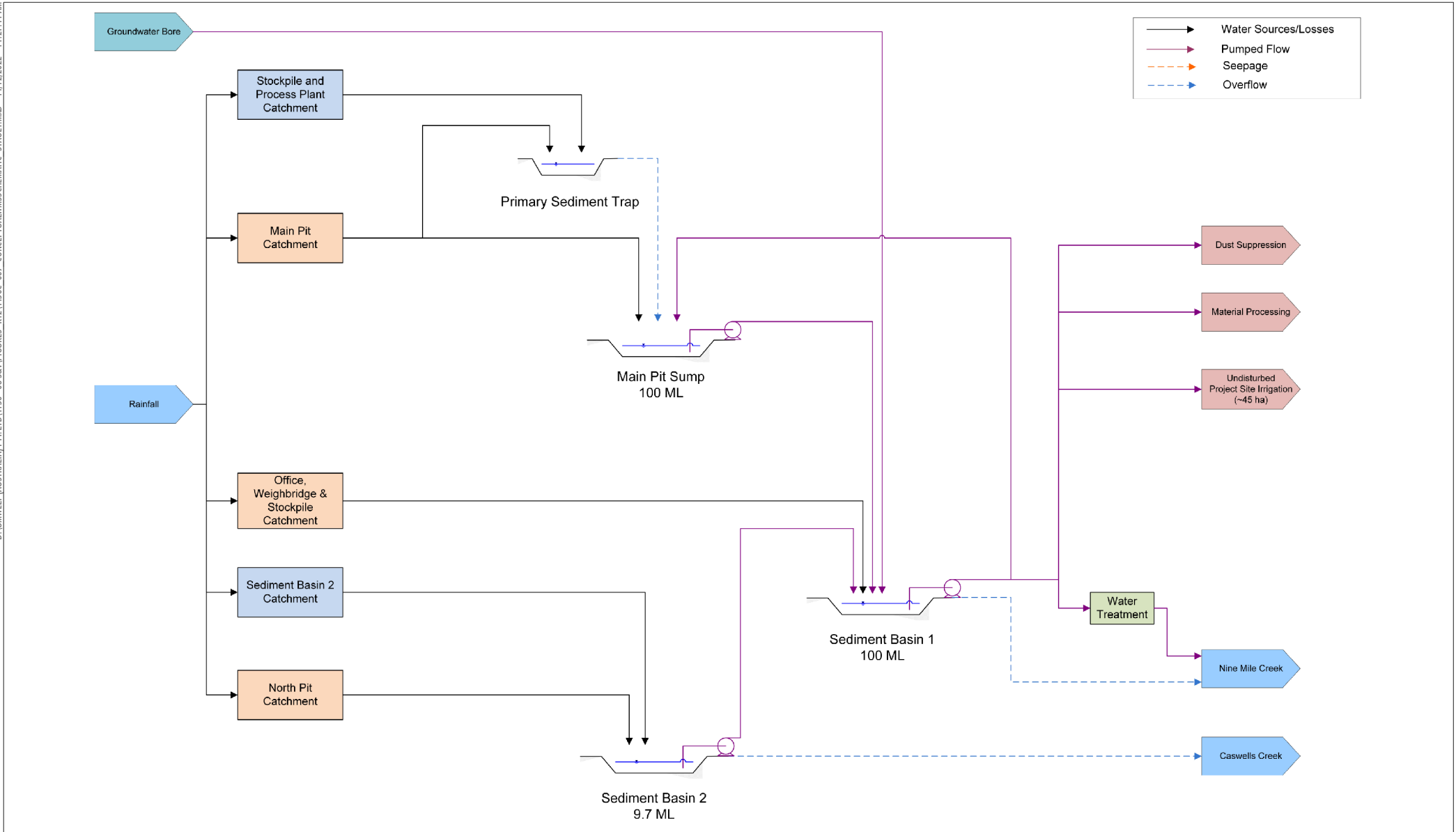


**Legend**

- |                  |                          |  |                              |
|------------------|--------------------------|--|------------------------------|
| Project Area     | Office                   | Culverts                                   | <b>Strahler Stream Order</b> |
| Disturbance Area | Northern Haul Road       | Clean Drain                                | 1st Order Stream             |
| Pacific Highway  | Access Road              | Dirty Drain                                | 2nd Order Stream             |
| Road             | Stockpile and Plant Area | Water Management System Catchment Boundary | 3rd Order Stream             |
| Contour Line     | Dams                     |  | 4th Order Stream             |
| Lot Boundaries   |                          |  |                              |

**FIGURE 3.1**  
**Stage 1 Conceptual Water Management System Plan**

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**FIGURE 3.2**  
**Stage 1 Conceptual Water Management System Schematic**

### 3.1.2 Conceptual Stage 9 Water Management System

The conceptual Stage 9 WMS has an area of approximately 74 ha and is generally the same as the conceptual Stage 1 WMS but includes increased storage within the Main Pit Sump and a North Pit Sump (if the North Pit is constructed) and some changes to the clean water drainage network as presented in **Table 3.2**. Plan and schematic drawings of the conceptual Stage 1 WMS are presented in **Figure 3.3** and **Figure 3.4** respectively.

**Table 3.2 Stage 9 WMS Components**

Item	Functional Description	Preliminary Proposed Minimum Capacity
Main Pit Sump	<ul style="list-style-type: none"> <li>• Capture runoff from the western portion of the Main Pit.</li> <li>• Serve as surge storage capacity during wet periods (i.e. will receive transfers of surplus water from sediment basins).</li> </ul>	100.0 ML <sup>3</sup>
North Pit Sump	<ul style="list-style-type: none"> <li>• Capture runoff from the North Pit.</li> <li>• Dewater to SB2.</li> <li>• The North Pit Sump will be constructed prior to Stage 9 as the pit progresses to an extraction depth below ground level (likely to be soon after Stage 1).</li> <li>• Note the capacity of the North Pit below spill level (estimated to be approximately 356 ML at Stage 9) will be utilised as surplus storage and receive water transfers from SB1, SB2 and the Main Pit Sump prior to high or prolonged rainfall events to ensure adequate capacity is available to retain runoff from forecast rainfall and enable continued extraction in the Main Pit.</li> </ul>	5.0 ML
Primary Sediment Trap	<ul style="list-style-type: none"> <li>• Capture coarse sediment in runoff from the processing plant area before it drains to SB1.</li> <li>• Will operate as a flow through sediment trap.</li> <li>• Additional sediment traps may be constructed in the processing and stockpile areas to reduce SB1 sediment loads.</li> </ul>	0.2 ML
Sediment Basin 1 (SB1)	<ul style="list-style-type: none"> <li>• Constructed on a second order tributary of Nine Mile Creek.</li> <li>• Capture runoff from the stockpile areas and carpark, office/amenities and weighbridge and overflow from the Primary Sediment Trap.</li> <li>• Primary site water storage and supply for operational demands.</li> <li>• Sized to minimise the risk of uncontrolled discharges in storm events not exceeding the 24-hour duration, 0.2% AEP storm event.</li> <li>• Exceeds the required capacity determined in accordance with the Blue Book of 20.1 ML (30.2 ML settling zone<sup>1</sup> and 10.1 ML sediment zone<sup>2</sup>).</li> <li>• Will be managed to maintain a storage inventory of at least 5 ML but with a target maximum operating capacity of approximately 10 ML to minimise the risk of uncontrolled discharges.</li> <li>• Should water inventories exceed the required freeboard to accommodate the Blue Book settling zone capacity (i.e., 20.1 ML), SB1 will be dewatered to ensure freeboard is restored within five days of runoff generating rainfall.</li> </ul>	130 ML

Item	Functional Description	Preliminary Proposed Minimum Capacity
	<ul style="list-style-type: none"> <li>Water inventory to be managed through supply of operational demands (material processing and dust suppression), irrigation of undisturbed Project Area catchments and controlled discharges. Irrigation will be applied within the Project area at a rate that does not result in runoff to local drainage lines.</li> </ul>	
Sediment Basin 2 (SB2) Note: SB2 will only be required if the North Pit is constructed.	<ul style="list-style-type: none"> <li>Capture runoff from the haul road and adjacent disturbed areas and receive pumped inflows from the North Pit.</li> <li>Sized to minimise the risk of uncontrolled discharges in storm events not exceeding the 24-hour duration, 0.2% AEP storm event.</li> <li>Exceeds the required capacity determined in accordance with the Blue Book of 1.1 ML (1.1 ML settling zone and 0.6 ML sediment zone<sup>2</sup>).</li> <li>Will be managed to be minimise inventory to reduce frequency of uncontrolled discharges by transferring to SB1.</li> <li>Should water inventories exceed the required freeboard to accommodate the Blue Book settling zone capacity (i.e., 1.1 ML), SB2 will be dewatered to ensure freeboard is restored within five days of runoff generating rainfall.</li> </ul>	9.7 ML
Clean Drains	<ul style="list-style-type: none"> <li>Direct runoff from undisturbed catchment upslope of SB1 around SB1.</li> <li>Direct runoff from undisturbed catchment upslope of SB2 around SB2.</li> </ul>	To be determined during detailed design phase
Licensed Groundwater Bore	<ul style="list-style-type: none"> <li>To supply water to meet operational demands during dry periods.</li> </ul>	Up to 34 ML/year
Water Treatment Plant	<ul style="list-style-type: none"> <li>Removal of suspended solids and nutrients prior to controlled discharge.</li> <li>Water treatment plant technology to be confirmed during Project detailed design phase.</li> </ul>	Up to 220 ML/year

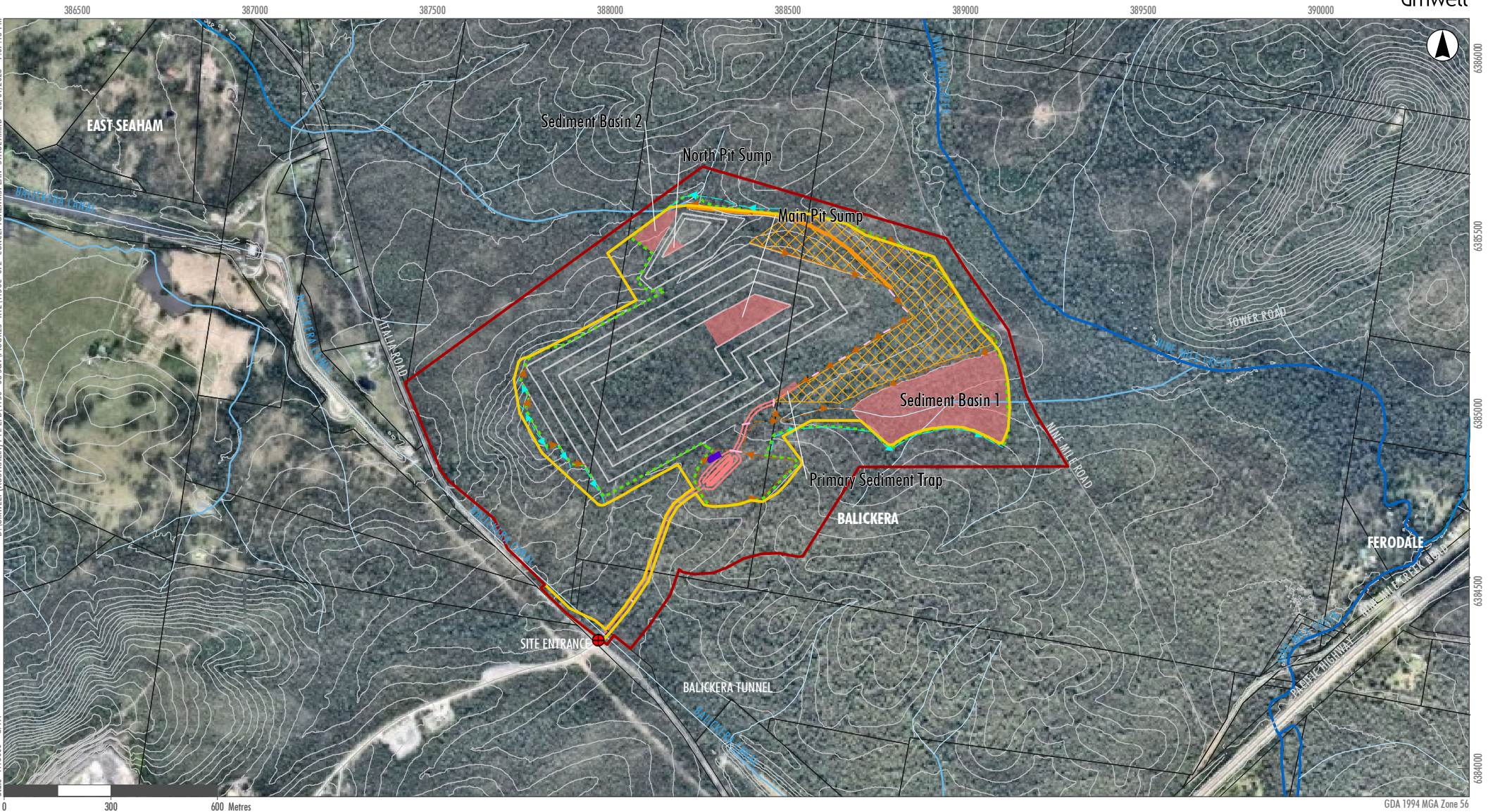
Notes

<sup>1</sup> Settling zone capacity based on runoff from the Newcastle 5 day 95<sup>th</sup> percentile rainfall depth of 76.7 mm sourced from the Blue Book

<sup>2</sup> Sediment zone equal to 50% of the settling zone capacity

<sup>3</sup> Note that exceedance of in-pit sump capacity will not result in spills to the WMS or environment as surplus water will be contained in the larger pit shell

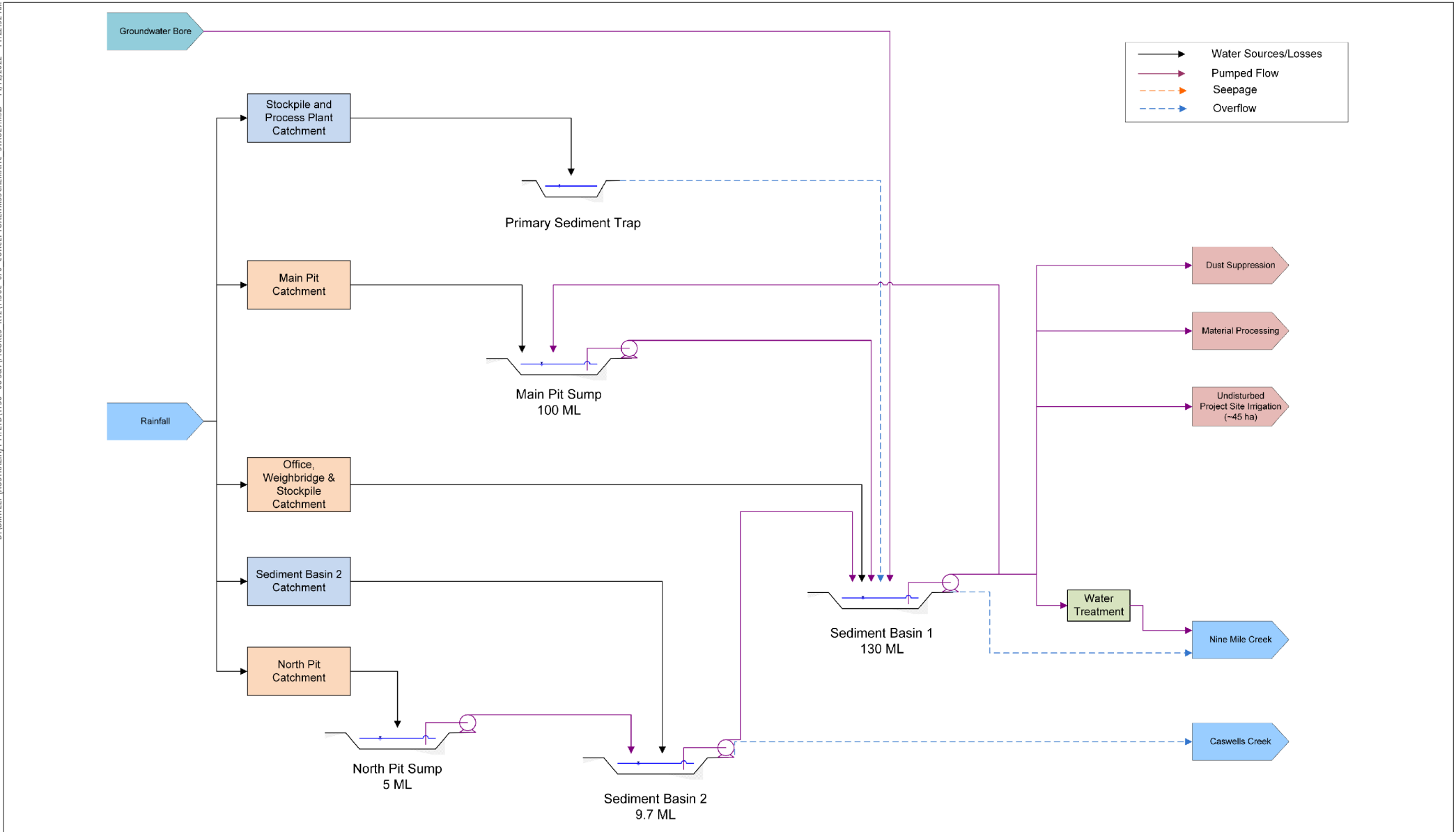
Notwithstanding the preliminary proposed water storage capacities indicated in **Table 3.2**, different water storage capacities may be determined during detailed Project design. However, installed water storages will have adequate capacity to contain runoff from the 24-hour duration, 0.2% AEP storm event. Further, water storages will have adequate capacity such that they are not predicted to spill under the historical climatic conditions modelled in the operational water balance (refer to **Section 4.0**).



**Legend**

- |                  |                          |  |                              |
|------------------|--------------------------|--|------------------------------|
| Project Area     | Office                   | Culverts                                   | <b>Strahler Stream Order</b> |
| Disturbance Area | Northern Haul Road       | Clean Drain                                | 1st Order Stream             |
| Pacific Highway  | Access Road              | Dirty Drain                                | 2nd Order Stream             |
| Road             | Stockpile and Plant Area | Water Management System Catchment Boundary | 3rd Order Stream             |
| Contour Line     | Dams                     |  | 4th Order Stream             |
| Lot Boundaries   |                          |  |                              |

**FIGURE 3.3**  
**Stage 9 Conceptual Water Management System Plan**



**FIGURE 3.4**  
**Stage 9 Conceptual Water Management System Schematic**

### 3.1.3 Water Storages

Table 3.3 presents a summary of the proposed water storages for Stages 1 and 9 of the Project.

**Table 3.3 Proposed Water Storages**

Water Storage	Stage 1			Stage 9		
	Catchment Area (ha)	Required Blue Book Capacity (ML) <sup>1,2</sup>	Preliminary Proposed Capacity (ML)	Catchment Area (ha)	Required Blue Book Capacity (ML) <sup>1,2</sup>	Preliminary Proposed Capacity (ML)
Main Pit Sump	12.5	NA	100	34.6	NA	100
North Pit Sump	-	NA	-	4.2	NA	5
Sediment Basin 1	20.1	18.3	100	33.2	30.2	130
Sediment Basin 2	2.6	2.3	9.7	1.8	1.7	9.7

Notes

<sup>1</sup> Settling zone capacity based on runoff from the Newcastle 5 day 95<sup>th</sup> percentile rainfall depth of 76.7 mm sourced from the Blue Book

<sup>2</sup> Sediment zone equal to 50% of the settling zone capacity

### 3.1.4 Amenities Water Management

Potable water for the amenities use will be supplied to the site by water tanker. A rainwater tank(s) will also collect roof runoff to be utilised for non-potable water demands (e.g. toilet flushing).

Wastewater from the amenities will be collected in a tank and removed from the site by a licensed waste contractor as required.

## 3.2 Erosion and Sediment Control

The conceptual WMS described in **Section 3.1** broadly outlines the operational phase erosion and sediment control plan for the Project. During all phases of the Project, including the construction phase and progression of the quarry disturbance footprint, erosion and sediment controls (ESCs) will be established in general accordance with *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2E: Mines and quarries* (Department of Environment and Climate Change, 2008) (i.e., the Blue Book). The following sections outline the Project ESC design standards and anticipated ESCs to be implemented at the Project. Should the Project be approved and constructed, a detailed soil and water management plan (SWMP) will be prepared by a suitably qualified person to facilitate implementation of best practise ESCs during all phases of the Project.

### 3.2.1 Design Standard

#### 3.2.1.1 Erosion Controls

An erosion hazard assessment has been undertaken in accordance with Chapter 4.4.1 of Volume 1 of the 'Blue Book'. The R-factor (rainfall erosivity) for the site was calculated using Equation (2) in Appendix A of Volume 1 of the 'Blue Book':

$$R = 164.74 \times 1.1177^S \times S^{0.6444}$$

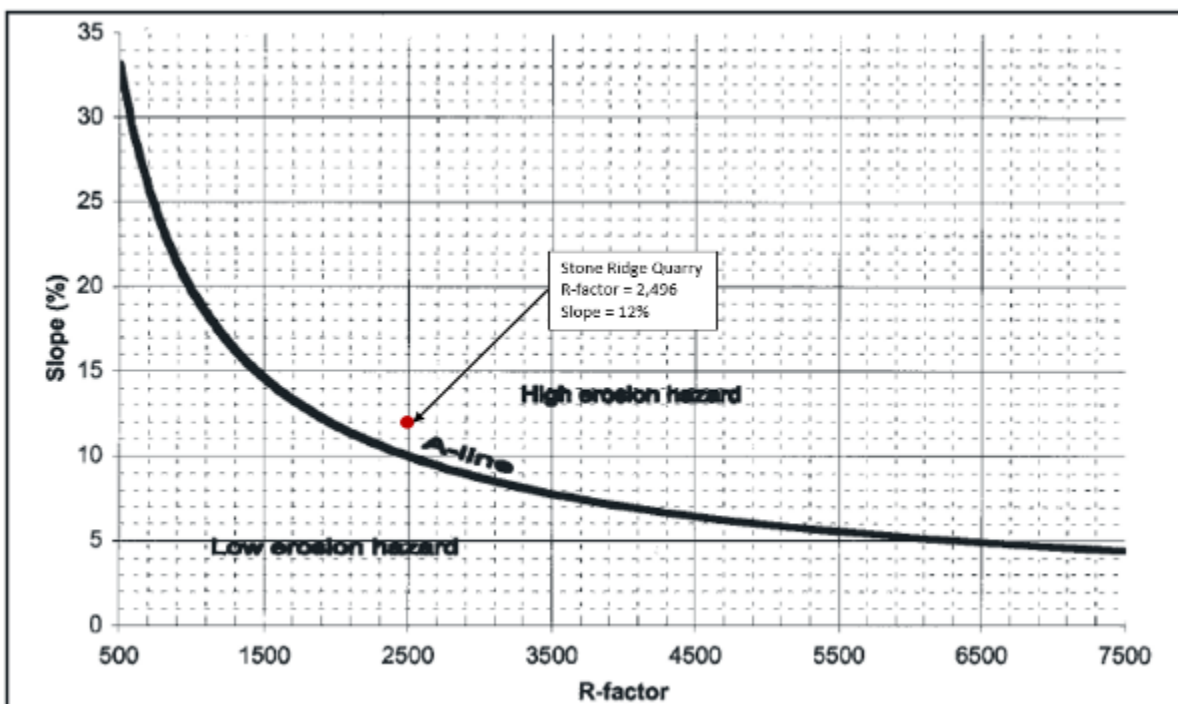
where

<b>S</b>	is the 2 year, 6 hour duration storm event intensity (based on <i>Australian Rainfall and Runoff 1987</i> Intensity Frequency Duration data)	10.7 mm/h
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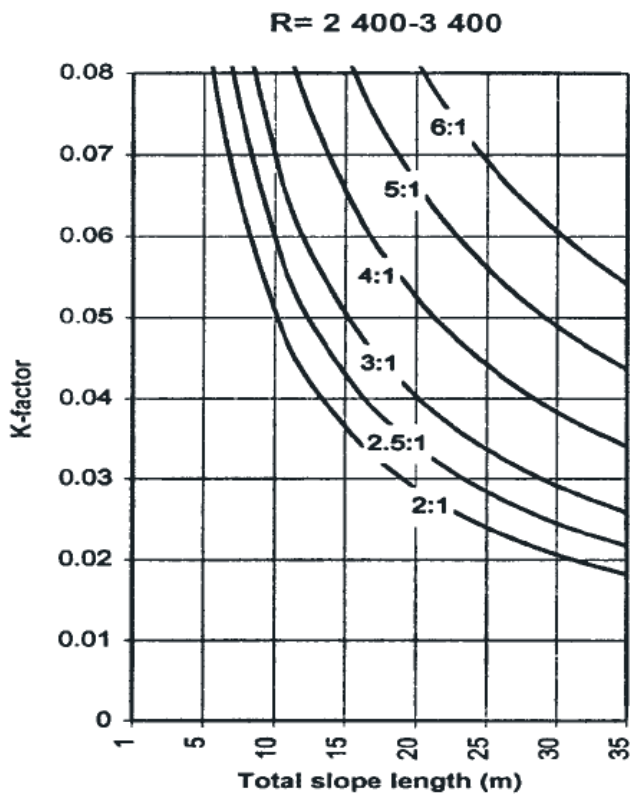
$$R = 164.74 \times 1.1177^{10.7} \times 10.7^{0.6444}$$

$$R = 2,496$$

Plotting the site slope, measured to be approximately 10% from Project Area contours, and R-factor on Figure 4.6 from Volume 1 of the 'Blue Book' determines whether the site has a high or low erosion hazard. The Project Area slope was estimated based on the geospatial analysis to determine the average site slope of the existing landform. **Figure 3.5** presents the erosion hazard assessment plot which demonstrates that the site has a high erosion hazard. As such, enhanced erosion control measures will be applied during construction, including limiting the slopes of constructed batters as indicated in **Figure 3.6** as well as the application of temporary ground cover to disturbed areas prior to significant rainfall where feasible and where the area of disturbance does not drain to a sediment basin.



**Figure 3.5 Erosion Hazard Assessment Plot**



**Figure 3.6 Batter Slope Limits**

Given the erosion hazard assessment indicates that the site has a high erosion hazard, an assessment of soil loss class based on the annual Project Area soil loss, as calculated using the Revised Universal Soil Loss Equation (RUSLE) and Table 4.2 of Volume 1 of the 'Blue Book', has been undertaken. The annual soil loss for the Project Area has been estimated using RUSLE as presented below.

RUSLE:

$$A = R \times k \times LS \times C \times P$$

where

		Value	Units
<b>A</b>	is the annual soil loss rate	to be calculated	tonnes/ha/year
<b>R</b>	is the annual average rainfall erosivity calculated based on the 2 year, 6 hour duration ARI storm event intensity (refer to <b>Section 3.2.1.1</b> )	2,496	-
<b>k</b>	is the soil erodibility (refer to <b>Table 2.1</b> )	0.07	-
<b>LS</b>	is the slope length gradient factor based on Table A1 of <i>Managing Urban Stormwater Volume 1</i> (Landcom, 2004) and is dependent on the slope length	3.70	-

		Value	Units
C	is the ground cover factor sourced from Figure A5 of <i>Managing Urban Stormwater Volume 1</i> (Landcom, 2004) (no ground cover in this case)	1.0	-
P	is the erosion control practise factor sourced from Table A2 of <i>Managing Urban Stormwater Volume 1</i> (Landcom, 2004) and is dependent on level of compaction and roughness of the disturbed surface (assume compacted and smooth)	1.3	-

$$A = 2,496 \times 0.07 \times 3.70 \times 1.0 \times 1.3$$

$$A = 842 \frac{\text{tonnes}}{\text{ha. year}}$$

According to Table 4.2 of Volume 1 of the 'Blue Book' the Project Area has a soil loss class of 6 and has a high erosion hazard. However, the potential for this high erosion rate is limited to short periods during initial stripping of soils with high erodibility during high rainfall events. Following stripping, these soils will be stockpiled and stabilised in general accordance with the 'Blue Book' and the exposed surfaces will consist of heavily trafficked and compacted surfaces and/or exposed rock with a much lower erodibility. Figure 4.9 of Volume 1 of the 'Blue Book' (Landcom, 2004) shows that the Project Area is located in rainfall distribution zone 1. Table 4.3 of Volume 1 of the 'Blue Book' indicates that timing restrictions apply for sites in rainfall distribution zone 1 with soil loss class 6. **Table 3.4** presents the recommended timing restrictions adapted from the 'Blue Book'.

**Table 3.4 Timing Restrictions for Soil Loss Class 6 Lands in Rainfall Distribution Zone 1<sup>1</sup>**

Half of Month	1 <sup>st</sup>	2 <sup>nd</sup>
January	YES	YES
February	YES	YES
March	YES	YES
April	YES	YES
May	YES	YES
June	NO	NO
July	NO	NO
August	NO	NO
September	NO	NO
October	NO	NO
November	NO	YES
December	YES	YES

Note: <sup>1</sup> Adapted from Table 4.3 of *Managing Urban Stormwater Volume 1* (Landcom, 2004) for rainfall zone 1

The practicality of restricting ground disturbing activities for the quarry operation to the time periods indicated in **Table 3.4** will be limited. However, following the early stages of construction, all disturbed areas will drain to sediment basins (refer to **Section 3.1**) which will be established in the early stages of

quarry development. For any ground disturbing activities that fall outside of sediment basin catchments, the timing restrictions indicated in **Table 3.4** will be applied as far as practicable. Where scheduling to avoid works in areas that fall outside of sediment basin catchments is not possible or is impractical, erosion control measures will be implemented to ensure disturbed lands only have C-factors of 0.1 or less (i.e., approximately 60% ground cover) when the forecast indicates a low likelihood of rainfall for at least three days.

### 3.2.1.2 Drainage Controls

All temporary drainage controls are to be designed to have non-erosive hydraulic capacity to convey runoff from a 20-year Average Recurrence Interval (ARI) critical duration storm event based on a duration of disturbance for each works area of greater than 3 years and a sensitive receiving environment (refer to Table 6.1 of *Volume 2E* (DECC, 2008) of the 'Blue Book'.

### 3.2.1.3 Sediment Controls

The 'Blue Book' recommends that sediment basins are used when the soil loss rate exceeds 150 m<sup>3</sup>/year (approximately 200 tonnes/year) for the total area to be disturbed. Given the estimated high soil loss rate (refer to **Section 3.2.1.1**) and the large area of disturbance associated with the quarry, the requirement for sediment basins is triggered. The typical design standard for sediment basins at the Project Area location (based on Blue Book design criteria) is presented in **Table 3.5**. Two sediment basins have been incorporated into the conceptual operational WMS design (refer to **Section 3.1**) that have preliminary proposed capacities exceeding the sediment basin design criteria presented in **Table 3.5**. As the Project site is within the Grahamstown Dam drinking water catchment, it is required to achieve a NorBE on water quality (refer to **Section 2.3.3**). The additional capacity proposed for the sediment basins is required to minimise the likelihood of uncontrolled discharges with elevated pollutant concentrations (primarily TSS) in high or prolonged rainfall events and achieve a NorBE on water quality. Consequently, the design of any additional sediment basins required for the Project will also need to consider the requirement to achieve a NorBE on water quality as well as the design criteria presented in **Table 3.5**.

**Table 3.5 Typical Sediment Basin Design Criteria**

Basin Type	Storm Event	Storm Event Rainfall Depth (mm)	Volumetric Runoff Coefficient (Cv)	Sediment Basin Embankment & Spillways	Sediment Zone Capacity
D	5 day 95 <sup>th</sup> percentile <sup>1</sup>	76.7 <sup>2</sup>	0.79 <sup>3</sup>	100 year ARI <sup>1</sup>	50% of Settling Zone capacity

<sup>1</sup> Based on a sensitive receiving environment and >3 years of disturbance

<sup>2</sup> 5 day 95<sup>th</sup> percentile rainfall depth derived from SILO climate database point data (-32.65° lat, 151.80° long) for the period 1900 - 2021

<sup>3</sup> Refer to Table F2 of Volume 1 of the 'Blue Book'

All temporary sediment controls will be designed and installed to be structurally sound during a 20-year ARI critical duration storm event based on a duration of disturbance for each works area of up to 6 months and a sensitive receiving environment (refer to Table 6.1 of Volume 2E of the 'Blue Book').

## 3.2.2 General Erosion and Sediment Control Strategy

All ESCs are to be installed, managed and maintained in general accordance with the 'Blue Book' (Landcom, 2004) to:

- divert clean water around site

- prevent sediment moving off-site and sediment laden water entering any watercourse, drainage line, or drain inlet
- reduce water velocity and capture sediment on site
- minimise the amount of material transported from site to surrounding pavement surfaces.

### **3.2.2.1 General Site Management**

The following ESC management strategies will be implemented at the Project.

1. To minimise ground disturbance, construction and operational activities including vehicle and machinery movements, stockpiling, temporary vehicle parking and material laydown will be restricted to designated work areas. The disturbance boundary is to be clearly delineated with construction fencing or barrier tape.
2. All fuels, chemicals and liquids will be stored in an impervious bunded area, a minimum of 50 m away from drainage lines or waterways.
3. Refuelling of plant and equipment is to be undertaken in an impervious bunded area located a minimum of 50 m from drainage lines or waterways.
4. Emergency spill kits are to be kept on site at all times. All workers are to be made aware of the location of the spill kits and trained in their use.
5. Any concrete washout undertaken on site (during construction phase) will be in a bunded area that is not on waterfront land and at least 10 m from drains.
6. Where possible, topsoil will be stripped and handled only when it is moist (not wet or dry) to avoid decline of soil structure.
7. Topsoil stockpiles will be stabilised with vegetation (seeded) if they are to be inactive for long periods.
8. Stockpiles of erodible material that have the potential to cause environmental harm if displaced will be located away from concentrated surface flow and excessive up-slope stormwater surface flows.
9. Wherever reasonable and practicable, “clean” surface waters must be diverted away from sediment control devices and any untreated, sediment-laden waters.
10. All runoff from the works is to be passed through sediment controls.
11. Sediment traps should be located as close to the source of the sediment as practicable.
12. Sediment control devices must be de-silted and made fully operational as soon as reasonable and practicable after a sediment-producing event. Sediment traps should be maintained to ensure that no more than 30% of their design capacity is lost to accumulated sediment.
13. Sediment removed from any trapping device is to be disposed of in locations where further erosion and consequent pollution to downslope lands and waterways will not occur.
14. Temporary soil and water management structures are to be removed only after the Project Area is stabilised appropriately.

## 4.0 Operational Water Balance

### 4.1 Model Overview

A daily time step water balance model (the Model) was developed in the GoldSim software modelling platform to simulate the performance of the conceptual Stage 1 WMS and conceptual Stage 9 WMS as described in **Section 3.1**. Quarry water sources and demands, model input data, assumptions and results are detailed in the following sections.

The Stage 1 and Stage 9 operating scenarios were modelled as follows:

- Stage 1 represents a period where there is no available in-pit storage other than the Main Pit Sump to accommodate surplus rainfall runoff during wet periods and while the WMS catchment area is smaller than in latter stages, the limited in-pit storage capacity results in an increased likelihood of uncontrolled discharges from the WMS.
- Stage 9 represents the maximum WMS catchment area and therefore the stage in which the largest volumes of rainfall runoff will require management through reuse and controlled discharges.

Water balance modelling results for Stage 1 and Stage 9 have been used to inform the NorBE on water quality assessment (refer to **Sections 2.3.3** and **6.1**) as well as WMS design (e.g., water storage capacity requirements, water treatment and disposal requirements).

### 4.2 Water Sources and Demands

#### 4.2.1 Water Sources

The modelled quarry water sources are:

- WMS catchment runoff and direct rainfall on water storages
- a groundwater bore as a supplementary supply.

#### 4.2.2 Water Demands

The modelled quarry water demands are:

- haul road, exposed area and stockpile dust suppression
- material processing
- evaporation from water storage surfaces
- undisturbed catchment irrigation (to contribute to disposal of surplus rainfall runoff captured in the WMS).

## 4.3 Underlying Data and Assumptions

### 4.3.1 Runoff Model

Catchment runoff has been calculated using the Australian Water Balance Model (AWBM) based on daily rainfall and evaporation records sourced from the SILO Climate Database for the Project Area location (grid point -32.65° latitude, 151.80° longitude) for the period 1 January 1900 to 31 December 2021. Catchment types and AWBM parameters used in the rainfall runoff model are presented in **Table 4.1**.

**Table 4.1 Catchment Types and AWBM Parameters**

Catchment	Surface Store Area Split			Surface Store Capacities			BFI <sup>1</sup>	Kb <sup>2</sup>	Ks <sup>2</sup>	Evap% <sup>4</sup>
	A1	A2	A3	C1	C2	C3				
Undisturbed	0.134	0.433	0.433	25.56	261.03	522.06	0.22	0.991	0.5	100
Disturbed	0.185	0.430	0.385	8.11	115.12	257.14	0.05	0.985	0.0	85
Pit	0.185	0.430	0.385	4.05	57.56	128.57	0.05	0.985	0.0	85

Notes: <sup>1</sup> Base flow index  
<sup>2</sup> Baseflow recession constant  
<sup>3</sup> Surface runoff recession constant  
<sup>4</sup> Pan factor to potential evapotranspiration

The rainfall runoff model was calibrated (i.e., AWBM parameters adjusted) to give an average annual runoff from undisturbed catchments equal to the average annual runoff of 1.0 ML/ha/year for the area estimated using the NSW Maximum Harvestable Rights Dam Capacity (MHRDC) calculator (WaterNSW, 2022). AWBM parameters applied to disturbed and pit catchment areas were based on parameters used in water balance models for other hard rock quarry operations with similar catchment characteristics and climatic conditions.

### 4.3.2 Groundwater Inflows

No groundwater inflow is predicted for Stage 1 of the Project. Groundwater inflows of 46.5 ML/year (0.13 ML/day) and 10.6 ML/year to the Main Pit and North Pit respectively have been applied for Stage 9 of the Project. These groundwater inflows correspond to those estimated as part of the Stone Ridge Quarry Groundwater Impact Assessment (GHD, 2022) assuming a 20% fractured rhyodacite resource. It has been assumed that only 50% of the groundwater inflow seepage reports as pumpable flow due to evaporative losses.

### 4.3.3 Site Demands

Site water demands were estimated as follows:

- Evaporation from water storage surfaces has been estimated based on daily evaporation sourced from the SILO Climate Database for the Project Area location (grid point -32.65° latitude, 151.80° longitude) and a pan factor of 0.75.
- Water demands for haul road dust suppression and irrigation have been estimated based on an evaporation – rainfall deficit, that is:
  - if rainfall exceeds pan evaporation, then there is no dust suppression/irrigation demand; or

- if evaporation exceeds rainfall, the dust suppression demand is equal to pan evaporation minus rainfall.
- Process plant water demands for Stage 1 of 1.73 ML/year and for Stage 9 of 2.70 ML/year as provided by ARDG.

## 4.4 Water Balance Results

### 4.4.1 Gross Water Balance and Catchment Runoff

**Table 4.2** presents the statistical 10th, 50th and 90th percentile gross water balance results (excludes controlled discharges, irrigation and groundwater imports) for the Stage 1 and Stage 9 operating scenarios.

**Table 4.2 Gross Water Balance Results (ML/year)**

Stage	10 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	90 <sup>th</sup> Percentile
Stage 1	-56.1	9.3	80.6
Stage 9	-16.7	53.6	293.2

Gross water balance results indicate that the quarry is likely to:

- have a water deficit and a requirement for imports to meet operational demands in dry years for both modelled stages
- have limited requirements for discharge in Stage 1 during median rainfall years
- have surplus water and a requirement for discharges for Stage 1 during wet rainfall years
- have surplus water and a requirement for discharges for Stage 9 during median and wet rainfall years.

**Table 4.3** presents the average annual volumes of surface runoff captured in the quarry WMS for the Stage 1 and Stage 9 operating scenarios as well as the volume of runoff from equivalent areas (i.e., the Stage 1 and Stage 9 WMS areas) of undisturbed catchment (i.e., the average pre-development runoff).

**Table 4.3 Average Annual Catchment Runoff Captured in WMS**

Stage	Captured Runoff Volume (ML/year)	Runoff from Equivalent Area Undisturbed Catchment (ML/year)
Stage 1	109	35.3
Stage 9	282	74.6

The results presented in **Table 4.3** demonstrate the increased runoff potential associated with the disturbed (approximately 2.6 ML/ha/year) and pit (approximately 3.5 ML/ha/year) areas compared to the undisturbed catchment (1.0 ML/ha/year as estimated using the NSW Farm Dams Calculator (WaterNSW, 2022)).

## 4.4.2 Median Year Net Water Balance

**Table 4.4** presents the net water balance results for the modelled rainfall year closest to the gross water balance 50<sup>th</sup> percentile prediction for the Stage 1 and Stage 9 operational scenarios.

**Table 4.4 Median Year Net Water Balance Results (ML/year)**

Parameter	Stage 1	Stage 9
<b>INFLOWS</b>		
Catchment Runoff	10.9	214.1
Pit Groundwater Seepage	0.0	28.5
Bore Import	118.8	14.0
<i>Total Inflows</i>	<i>129.7</i>	<i>256.6</i>
<b>OUTFLOWS</b>		
Evaporation	0.3	91.1
Operational Demands	129.3	127.6
Irrigation	0.0	33.6
Controlled Discharges	0.0	35.1
Uncontrolled Discharges	0.0	0.0
<i>Total Outflows</i>	<i>129.6</i>	<i>287.4</i>
Change in Storage	0.3	-30.8
Net Water Balance	0.0	0.0

## 4.4.3 Groundwater Bore Import

**Table 4.5** presents the minimum, average and maximum groundwater bore imports required for the Stage 1 and Stage 9 operating scenarios.

**Table 4.5 Groundwater Bore Imports (ML/year)**

Stage	Minimum	Average	Maximum
Stage 1	0.0	26.1	118.8
Stage 9	4.8	20.3	132.3

While the gross water balance results (refer to **Section 4.4.1**) indicate that there would likely be years with no requirement to import water from the groundwater bore, imports are predicted in all years for Stage 9. Given the quarry WMS will operate with a view to minimising water inventories to minimise the risk of uncontrolled discharges, there will be short term dry periods within an overall wet year where demands draw down the stored inventory. In practise, water storage inventories may be managed to maintain higher water inventories when short to medium term dry periods are forecast to minimise imports from the groundwater bore.

## 4.4.4 Discharges

### 4.4.4.1 Controlled Discharges

**Table 4.6** presents the predicted minimum, average and maximum annual controlled discharge volumes for the Stage 1 and Stage 9 operating scenarios. **Table 4.7** presents the predicted average annual number of days that controlled discharges will occur.

**Table 4.6** Controlled Discharges (ML/year)

Operating Scenario	Minimum	Average	Maximum
Stage 1	0.0	10.6	163.3
Stage 9	0.0	38.9	424.9

**Table 4.7** Average Annual Number of Controlled Discharge Days

Stage	Modelled Average Controlled Discharge Days
Stage 1	3
Stage 9	17

The results presented in **Table 4.6** and **Table 4.7** indicate that controlled discharges will be required in median and wet years to manage surplus rainfall runoff captured in the WMS.

### 4.4.4.2 Uncontrolled Discharges

The water storages within the conceptual WMS have been sized to minimise the risk of uncontrolled discharge and therefore, no uncontrolled discharges were predicted for either Stage 1 or Stage 9 for the modelled historical climate data set.

As indicated in **Section 3.1**, SB1 and SB2 were sized to minimise the risk of uncontrolled discharge during storm events not exceeding the 24 hour duration, 0.2% AEP storm event. The 24 hour duration, 0.2% AEP storm event rainfall depth for the Project site is 402 mm. **Table 4.8** presents the estimated runoff volume from the 24 hour duration, 0.2% AEP storm event for the SB1 and SB2 catchments with an assumed conservative runoff coefficient of 0.9 (i.e. 90% of rainfall reports as runoff).

**Table 4.8** 24-hour duration, 0.2% AEP Runoff Volumes

Sediment Basin	Stage	Catchment Area (ha)	Runoff Volume (ML)
SB1	1	20.13	72.8
	9	33.21	120.2
SB2	1	2.29	8.3
	9	1.76	6.4

## 5.0 Final Landform and Final Void Water Recovery

### 5.1 Final Landform

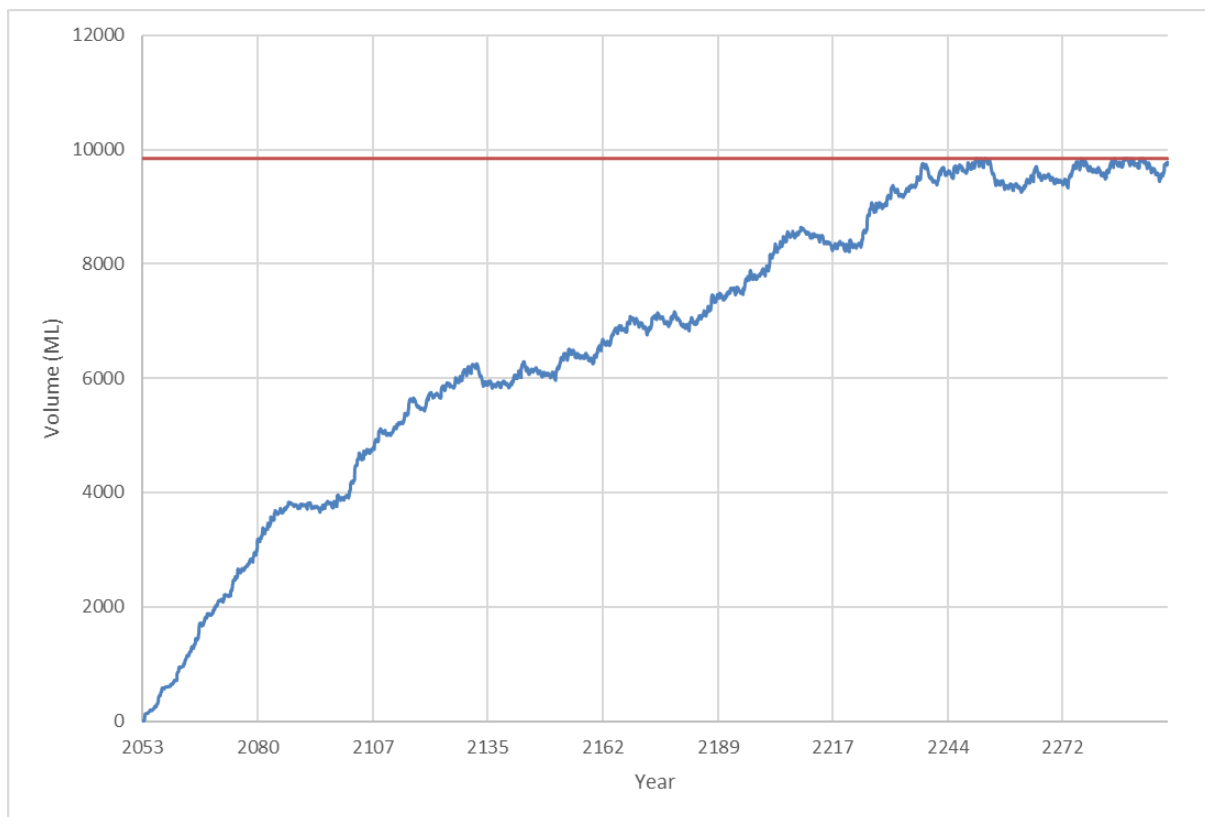
While a detailed final landform design has yet to be prepared, it is anticipated that the final landform will include two final voids, the Main Pit and the North Pit. It is also anticipated that all other water storages (SB1, SB2 and any other sediment traps/basins) will be decommissioned and the landform outside of the Main Pit and North Pit will be free draining.

### 5.2 Final Void Recovery

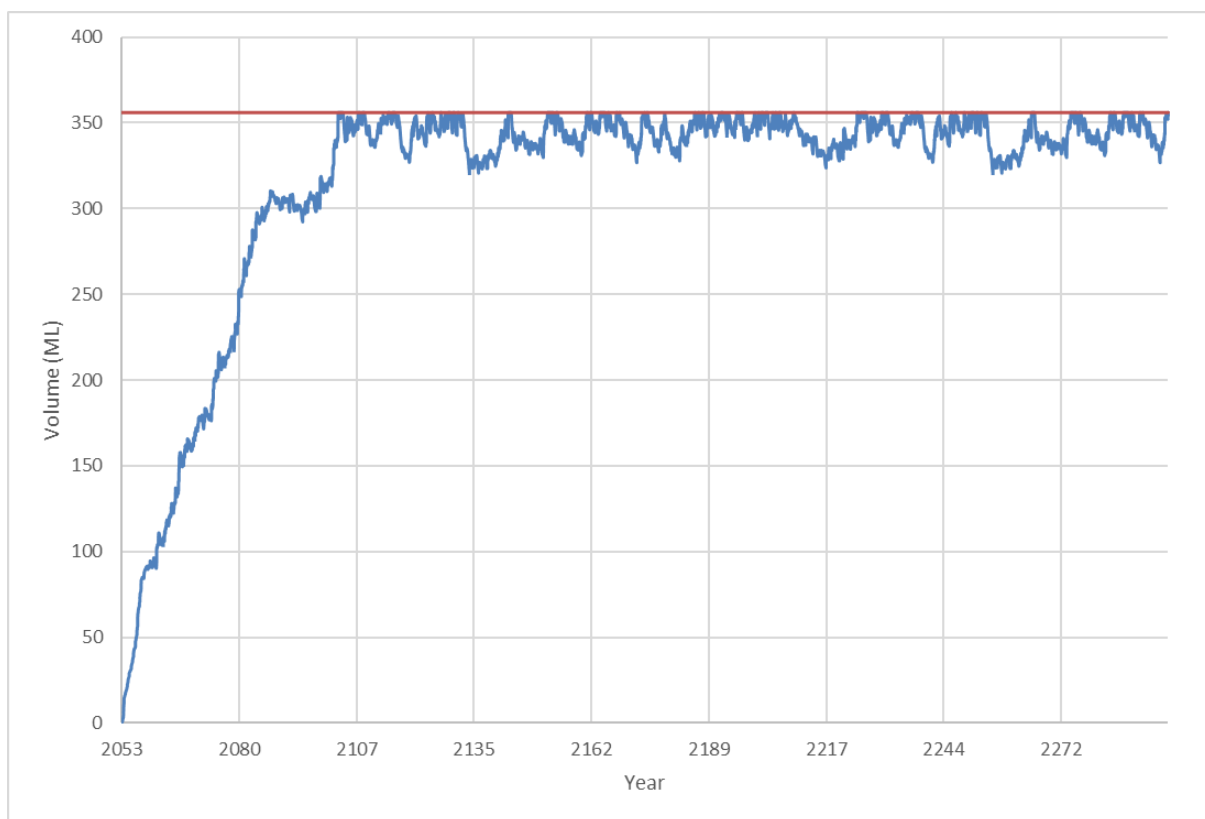
A final void water balance has been prepared in the GoldSim software modelling platform to estimate the equilibrium water levels in each void. The final void water balance model utilises the same rainfall and evaporation data set and AWBM runoff parameters used in the operational water balance model (refer to **Section 4.3.1**). Given the location of the final voids on a ridgeline, there will be negligible external runoff draining to the voids and inflows will predominantly be associated with direct rainfall on void surfaces as well as contributions from groundwater seepage. The groundwater inflow rates to the Main Pit of 46.5 ML/year and 10.6 ML/year to the North Pit applied in the operational water balance have also been used in the final void recovery water balance model. Each groundwater inflow rate has been varied linearly from the maximum inflow rates (i.e. 46.5 ML/year for the Main Pit and 10.6 ML/year for the North Pit) when the pits are empty down to 0 ML/year when the water surface elevation in the pits reach 13 mAHD which is the pit floor level at Stage 5 (North Pit) and Stage 6 (Main Pit) when groundwater is predicted to commence flowing into each pit (GHD, 2022). No outflows from the pit voids to the groundwater aquifer have been accounted for in the final void water balance model.

**Graph 5.1** and **Graph 5.2** present the final void recovery water levels for the Main Pit and North Pit respectively and indicate that the final voids will fill and spill off-site over time. The Main Pit is not predicted to spill until approximately 200 years after quarry closure due to its very large capacity, while the North Pit is predicted to spill approximately 50 years after closure. However, it is important to note that at this stage it is unknown whether there will be any outflow seepage from the pit voids to regional groundwater which may impact on the time in which the pit voids spill or whether they spill at all. The time at which the pit lake levels are expected to reach the pre-mining water table levels of approximately 28 mAHD is 50 years for North Pit (i.e. at spill level) and 90 years for the Main Pit.

Groundwater monitoring bore water quality results indicate that groundwater EC ranges from 198 mS/cm to 5,820 mS/cm (GHD, 2022). While the upper range of EC for groundwater significantly exceeds receiving surface water quality, groundwater inflows to the pit are expected to cease (GHD, 2022) with Main Pit void water quality characteristics being dominated by surface water inflows. As such, any spills that may occur from the Main Pit are expected to have ECs comparable to local catchment surface flows and any recharge to groundwater from the void would be expected to have a lower EC than the pre-mining conditions. No adverse changes to groundwater quality is anticipated as a result of groundwater recharge via the quarry voids.



**Graph 5.1 Main Pit Final Void Recovery**



**Graph 5.2 North Pit Final Void Recovery**

## 6.0 Impact Assessment

### 6.1 Water Quality

The proposed Project is located within the Hunter Water’s drinking water catchment (i.e., Grahamstown Dam and the Williams River) and therefore Hunter Water requires the proponent to undertake a Neutral or Beneficial Effects (NorBE) assessment. The NorBE analysis demonstrates whether the post-development pollutant loads discharged from the Project are equal to or less than the pollutant loads discharging from the pre-developed site. The pollutants of concern associated with the Project are considered to be total suspended solids and nutrients (Total Nitrogen and Total Phosphorus).

The average pre-development pollutant loads discharged from the Project Area have been determined using the average of the aggregated baseline water quality monitoring results (refer to **Section 2.3.2**) and the average annual catchment runoff from undisturbed catchment areas equivalent to the quarry WMS areas. **Table 6.1** presents the pre-development pollutant concentrations applied to the NorBE assessment.

**Table 6.1 Pre-Development Pollutant Concentrations Applied to NorBE Assessment**

Pollutant	Concentration (mg/L)
Total Suspended Solids	15.8
Total Nitrogen	0.8
Total Phosphorus	0.05

Water balance modelling demonstrated that the discharge volumes from the post-development Project Area would be significantly higher than discharges associated with catchment runoff from the undisturbed pre-development site (refer to **Section 4.4.1**). With an increase in discharge volumes, the only way to achieve a NorBE on water quality with respect to pollutant loads is to reduce the concentration of pollutants sufficiently below pre-development concentrations in the discharged water. Beca Hunter H2O has been engaged to undertake an options assessment of water treatment technologies to reduce pollutant concentrations in controlled discharges to levels where a NorBE on water quality could still be achieved despite the increase in Project site water discharge volumes relative to pre-development runoff volumes.

The Project WMS will be designed (refer to **Section 3.1**) to minimise the likelihood of uncontrolled discharges for storm events up to the 24 hour duration, 0.2% AEP (refer to **Sections 3.1** and **4.4.4.2**) and historical climatic conditions modelled in the water balance (refer to **Section 4.0**) and as such, uncontrolled discharges have not been considered on the NorBE assessment. The operational discharge pollutant concentrations applied to controlled discharges from the Stage 1 and Stage 9 quarry operating scenarios are presented in **Table 6.2**. A preliminary assessment indicates that available water treatment technologies should be able to treat water captured in the quarry WMS to the concentrations presented in **Table 6.2**.

**Table 6.2 Operational Discharge Pollutant Concentrations Applied to NorBE Assessment**

Pollutant	Controlled Discharge Concentrations (mg/L)
Total Suspended Solids	7.5
Total Nitrogen	0.70
Total Phosphorus	0.040

Table 6.3 presents a comparison of the pre-development and post-development pollutant loads for the Stage 1 and Stage 9 WMS catchment areas.

**Table 6.3 Comparison of Average Pre-Development and Post-Development Pollutant Loads**

Pollutant	Stage 1 WMS Catchment Area - 35 ha			Stage 9 WMS Catchment Area - 74 ha		
	Pre-development (kg/year)	Post-development (kg/year)	% Change Relative to Pre-development	Pre-development (kg/year)	Post-development (kg/year)	% Change Relative to Pre-development
Total Suspended Solids	557.3	142.8	-74%	1,178.4	1,098.1	-7%
Total Nitrogen	28.2	7.2	-74%	59.7	55.5	-7%
Total Phosphorus	1.8	0.4	-74%	3.7	3.5	-7%

The results presented in **Table 6.3** indicate that on average, a NorBE on water quality can be achieved for the Project for both the conceptual Stage 1 WMS and conceptual Stage 9 WMS. As indicated in **Section 4.0**:

- the Stage 1 operating scenario represents a period where there is no available in-pit storage other than the Main Pit Sump to accommodate surplus rainfall runoff during wet periods and, while the WMS catchment area is smaller than in latter stages, the limited in-pit storage capacity results in an increased likelihood of uncontrolled discharges from the WMS
- the Stage 9 operating scenario represents the maximum WMS catchment area and therefore the stage in which the largest volumes of rainfall runoff will require management through reuse and controlled discharges.

As such, it is considered that intermediate stages (i.e., Stages 2 to 8) will also on average achieve a NorBE on water quality by ensuring:

- adequate water storage capacity is constructed for each stage
- the water treatment system is operating to design specifications, and
- operational water management practises to minimise site water inventories prior to wet conditions are implemented to minimise likelihood of uncontrolled discharges for storm events up to the 24 hour duration, 0.2% AEP (refer to **Sections 3.1** and **4.4.4.2**) and historical climatic conditions modelled in the water balance (refer to **Section 4.0**).

## 6.2 Water Quantity

### 6.2.1 Catchment Yield

Water balance modelling predicts that for the Stage 1 operational scenario there will be a decrease in catchment yield during most years (an average decrease of approximately 25 ML/year) compared to the undisturbed catchment.

Water balance modelling predicts that for the Stage 9 operational scenario, compared to the undisturbed catchment, there will be:

- similar catchment yields during median rainfall years
- an increase in catchment yield primarily due to higher runoff from quarry surfaces compared to undisturbed catchment and limited quarry water demands resulting high controlled discharge volumes in wetter years (an average increase of approximately 4 ML/year)
- a decrease of catchment yield during drier years (a decrease of approximately 20 ML/year during a 10<sup>th</sup> percentile dry year).

The quarry WMS will occupy a maximum of approximately 75 ha, approximately 52 ha of which is in the Grahamstown Dam catchment and approximately 23 ha in the Williams River catchment. 52 ha is approximately 0.45% of the 11,500 ha Grahamstown Dam catchment while 23 ha is approximately 0.02% of the 97,400 ha Williams River catchment and it is considered that the loss in catchment yield during dry years will be negligible.

### 6.2.2 Water Security

Water balance modelling indicates that rainfall runoff and groundwater bore imports will provide an adequate and reliable supply of water to meet operational water demands for all stages of the Project (refer to **Section 4.0**). An assessment of the availability of groundwater source entitlements in the New England Fold Belt Coast Groundwater Source indicates that sufficient shares should be obtainable (refer **Section 7.1.3**). In the event of any temporary restrictions on access to the groundwater entitlements, the quarry will scale operations to an appropriate level to reduce operational water demands to meet the available supply while, as far as practicable, ensuring environmental controls are maintained (i.e., dust suppression).

### 6.2.3 Flow Regimes and Stream Stability

As a consequence of the Project capturing rainfall runoff and discharging water (controlled and uncontrolled discharges) as required, flow regimes will be altered and impacts to stream stability are possible in the watercourses downstream of the Project.

Prior to Project construction, ARDG will engage a suitably qualified and experienced specialist to undertake a baseline riparian corridor assessment of the streams (which will include an assessment of baseline stream stability) that will receive controlled and uncontrolled discharge. Further, a detailed hydrological and hydraulic assessment will be undertaken to assess the potential for scouring in downstream watercourses and inform maximum discharge flow rates (for controlled discharges) and the requirement for scour protection.

Notwithstanding, as the quarry will be located on a ridgeline and will only intercept first and second order ephemeral streams, significant impacts to the flow regimes of downstream higher order watercourses (i.e., Nine Mile Creek to the east and Caswells Creek to the northwest) associated with the capture of runoff and discharges as a result of the Project are considered unlikely.

#### **6.2.4 Flooding**

*Port Stephens Local Environmental Plan 2013* flood mapping indicates that the Project Area, including the quarry access off Italia Road, is not located in a flood planning area. The Project Area is located on a ridgeline with no upslope catchment and therefore no local flooding issues are expected on-site nor are any impacts on local flood regimes expected downstream of the Project.

## 7.0 Licensing, Monitoring and Reporting

### 7.1 Licensing

#### 7.1.1 Environment Protection Licence

The quarry will be required to hold an Environment Protection Licence (EPL) as it will be carrying out a premises-based activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act), i.e., Activity 19 Extractive activities, >30,000 tonnes/year. ARDG will include a request for at least one licensed discharge point in the EPL application to allow controlled discharges of surplus water from the quarry WMS.

The EPL application will also include proposed pollutant concentrations and controlled discharge volumes that have been informed by the NorBE assessment (refer to **Section 6.1**) and the hydrological and hydraulic assessment (refer to **Section 6.2.3**).

#### 7.1.2 Surface Water

##### 7.1.2.1 Licensing Exemptions

All surface water runoff capture within the quarry WMS dams will occur to prevent the contamination of a water source and therefore all Project dams/water storages are considered as excluded works under Schedule 1 of the Water Management (General) Regulation 2018 and therefore exempt from requiring a Water Access Licence under Schedule 4 Clause 12 of the Water Management (General) Regulation 2018.

##### 7.1.2.2 Harvestable Rights

The Maximum Harvestable Rights Dam Capacity (MHRDC) (for dams that are not exempt from licensing, refer to **Section 7.1.2.1**) for the licence area held by ARDG (391 ha) has been estimated using the NSW MHRDC calculator to be 117.3 ML (i.e. 30% of the average regional runoff for dams within coastal flowing catchments). However, as indicated in **Section 7.1.2.1**, all quarry dams/water storages during the operational phase of the Project are considered excluded works and exempt from water access licensing.

##### 7.1.2.3 Final Landform

As indicated in **Section 5.1**, it is anticipated that the final landform will include two final voids (the Main Pit and the North Pit) while all other water storages (SB1, SB2 and any other sediment traps/basins) will be decommissioned and the landform outside of the Main Pit and North Pit will be free draining.

While the Main Pit void and the North Pit void will have negligible external catchment areas draining into the voids, the direct rainfall runoff to the pit surfaces will require licensing. Water balance modelling indicates that the maximum surface water take based on runoff from an undisturbed catchment of equivalent size to the total final voids catchment area (approximately 37.5 ha) is 205.3 ML/year. Following completion of extractive activities and at the time that the final landform is established (i.e. after all rehabilitation activities are complete), ARDG will purchase and hold sufficient entitlement in the Newcastle Water Source and the Williams River Water Source to comply with contemporary surface water licensing legislation with consideration of harvestable rights provisions (and any applicable water returns policy at the time to account for spill volumes) associated with rainfall into the voids.

### 7.1.3 Groundwater

As indicated in **Section 3.0** and **4.0**, ARDG plans to source groundwater via a bore from the New England Fold Belt Coast Groundwater Source to supplement surface water runoff captured in the WMS as required (i.e., during dry conditions) to meet operational water demands. Water balance modelling indicates that the maximum groundwater import demand could be up to approximately 134 ML/year.

Elders Rural Services Australia was engaged to undertake an assessment of the availability of surface water entitlement in the New England Fold Belt Groundwater Source (refer to **Appendix A**). As of March 2023, there were 630 WALs with share entitlement ranging from 0 to 1,000 ML in the New England Fold Belt Groundwater Source. During the 2022/2023 water year there have been one permanent share assignment one temporary trade to date within the groundwater source and while no controlled allocations are presently available, there may be one similar in the future to that made available (1,739 ML) by the NSW Government in 2021.

Throughout the 2021/2022 water year the NSW Water Register indicates that 15,121 ML of water was made available in the New England Fold Belt Groundwater Source with only 133.1 ML of that water used.

Based on the above assessment of water trades, controlled allocations and usage within the New England Fold Belt Coast Groundwater Source it is expected that ARDG will be able to secure sufficient groundwater entitlement to supplement operational demands.

## 7.2 Monitoring

### 7.2.1 Surface Water

#### 7.2.1.1 Water Quality

**Table 7.1** presents the proposed surface water quality monitoring program and **Figure 7.1** shows the surface water monitoring locations.

**Table 7.1 Preliminary Surface Water Quality Monitoring Program**

Location ID	Description	Parameters	Units	Frequency
RW1	Upstream receiving water reference site – Nine Mile Creek	pH EC	- µS/cm	Monthly
RW2	Downstream receiving water impact site – Nine Mile Creek	TSS Turbidity	mg/L NTU	
RW3	Downstream receiving water impact site – Nine Mile Creek, adjacent to Pacific Highway	Nitrite Nitrate NOx (nitrite +nitrate)	mg/L mg/L mg/L	
RW4	Downstream receiving water impact site – tributary to Caswells Creek, adjacent to Italia Road	Ammonia TN TP Oil and Grease	mg/L mg/L mg/L mg/L	
SW1	Site water - Sediment Basin 1	pH	-	

Location ID	Description	Parameters	Units	Frequency
SW2	Site water - Sediment Basin 2	EC TSS Turbidity Nitrite Nitrate NOx (nitrite +nitrate) Ammonia TN TP Oil and Grease	μS/cm mg/L NTU mg/L mg/L mg/L mg/L mg/L mg/L mg/L	Monthly and during uncontrolled discharge (or following if uncontrolled discharge occurs when site unattended)
SW3	Site water - Main Pit Sump	pH EC TSS Turbidity Nitrite Nitrate NOx (nitrite +nitrate) Ammonia TN TP Oil and Grease	- μS/cm mg/L NTU mg/L mg/L mg/L mg/L mg/L mg/L mg/L	Monthly
LDP1	Quarry licensed discharge point	EC Nitrite Nitrate NOx (nitrite +nitrate) Ammonia TN TP Oil and Grease	μS/cm mg/L mg/L mg/L mg/L mg/L mg/L mg/L	Monthly during controlled discharge
		pH TSS TN TP	- mg/L mg/L mg/L	Daily during controlled discharge
		Turbidity	NTU	Continuous during controlled discharge

Impact assessment criteria for receiving water quality monitoring locations downstream of the quarry (i.e., RW2, RW3, RW4) will be developed in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) based on the pre-development baseline water quality data (refer to **Section 2.3.2**).

### 7.2.1.2 Water Quantity

**Table 7.2** presents the proposed surface water quantity monitoring program and **Figure 7.1** shows the surface water monitoring locations.

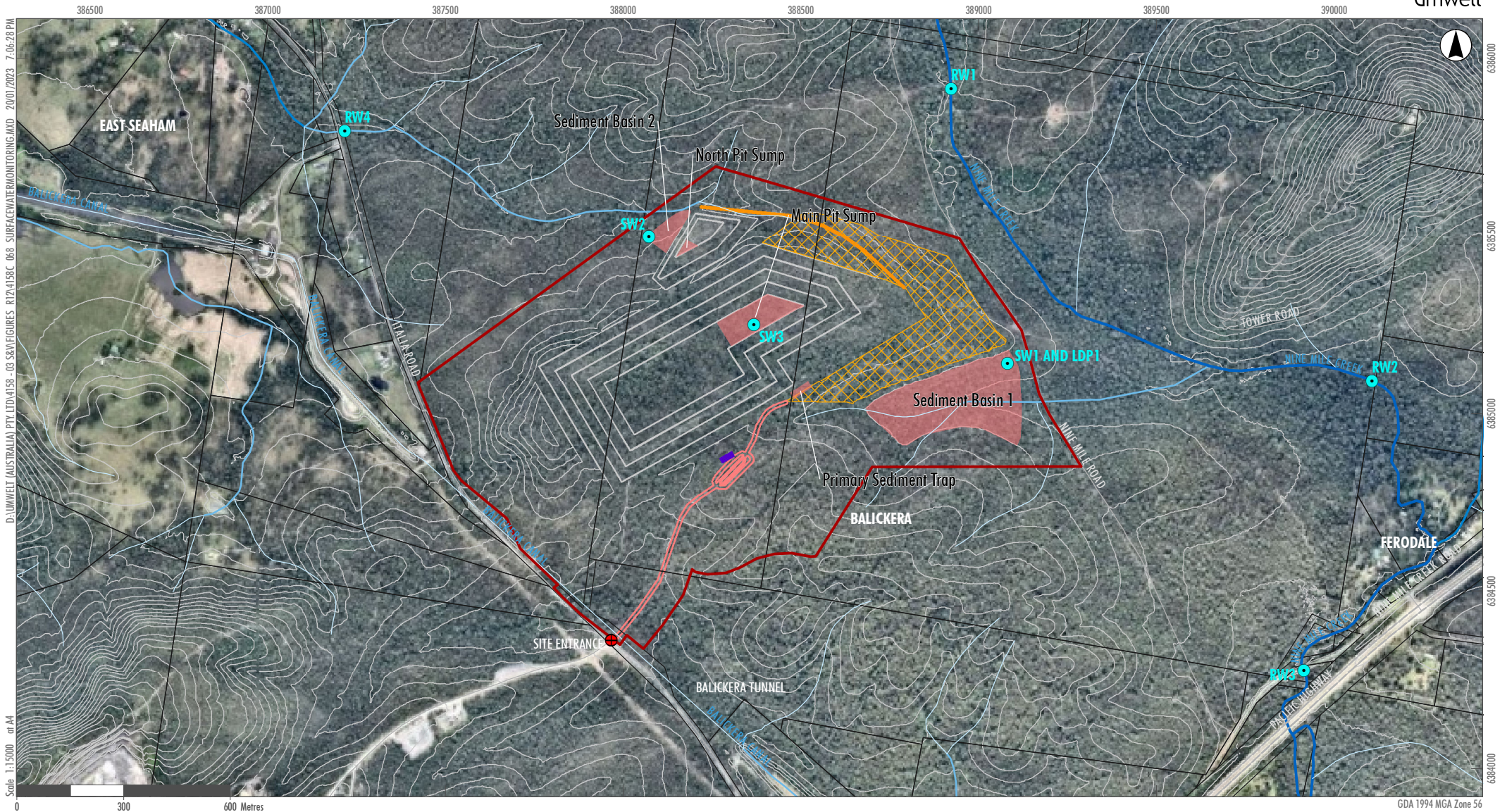
**Table 7.2 Preliminary Surface Water Quantity Monitoring Program**

Location ID	Description	Parameters	Units	Frequency	Methodology
SW1	Site water - Sediment Basin 1	Water surface elevation	mAHD	Continuous	Level sensor <sup>1</sup>
SW2	Site water - Sediment Basin 2	Uncontrolled discharge volume	ML		
SW1	Site water - Sediment Basin 1	Stored Water Volume	ML	Monthly	Staff gauge and/or survey <sup>2</sup>
SW2	Site water - Sediment Basin 2	Stored Sediment Volume	ML		
SW3	Site water - Main Pit Sump				
SW5	Site water - North Pit Sump				
-	Internal water transfers (i.e. pit dewatering and sediment basin transfers)	Transfer volume	ML	During transfers	Flow meter or pump duty and run time
LDP1	Quarry licensed discharge point	Instantaneous controlled flow rate	L/s	Continuous during discharge	Flow meter
		Total controlled discharged volume	ML		
AWS	Automatic weather station	Rainfall depth	mm	Continuous	-

Note

<sup>1</sup> Level sensor output may be used to determine flow height above sediment basin spillway weir allowing approximate calculation of discharge volumes. Level sensor also will be utilised to provide automated alerts for high basin levels and in the event the water level exceeds spillway elevation

<sup>2</sup> Monthly staff gauge and/or survey of stored water and sediment volumes may be used to verify level sensor outputs and inform the requirement for desilting of basins.



Legend

- |                                    |                          |                              |
|------------------------------------|--------------------------|------------------------------|
| Project Area                       | Office                   | <b>Strahler Stream Order</b> |
| Water Quality Monitoring Locations | Northern Haul Road       | 1st Order Stream             |
| Pacific Highway                    | Access Road              | 2nd Order Stream             |
| Road                               | Stockpile and Plant Area | 3rd Order Stream             |
| Contour Line                       | Dams                     | 4th Order Stream             |
| Lot Boundaries                     |                          |                              |

Image Source: Nearmap (2022) Data source: NSW FSDF (2022)

FIGURE 7.1  
Surface Water Monitoring Locations

## **7.2.2 Stream Stability**

Routine stream stability monitoring will be undertaken as recommended in the baseline stream stability assessment that will be completed prior to Project construction (refer to **Section 6.2.3**).

## **7.2.3 Amenities Potable Water**

ARDG will implement an inspection and water quality testing program for potable water stored in tanks on site (delivered by water tanker) to ensure amenities water quality meets the Australian Drinking Water Guidelines – Version 3.5 (ADWG) (National Health and Medical Research Council, 2011).

## **7.3 Reporting**

### **7.3.1 Environment Protection Licence**

ARDG will be required to complete and submit an Annual Return to the NSW Environment Protection Authority (EPA) that it is anticipated will include a summary of water discharges, monitoring, any complaints and a statement of compliance with EPL conditions. In the event that an incident occurs that threatens or causes environmental harm such as a discharge of water that does not meet EPL criteria, ARDG will notify the EPA immediately after becoming aware of the incident. ARDG will also provide a written report to the EPA within seven days of the date of becoming aware of the incident.

### **7.3.2 Annual Review and Incidents**

ARDG will submit an Annual Review to DPE that will include a summary of the quarry WMS performance. It is anticipated that the Annual Review will include the annual site water balance results, receiving water and discharge water quality monitoring results and details of any incidents or complaints. If an environmental incident involving surface water occurs the relevant authorities (including DPE, the EPA and Hunter Water) will be notified and reports provided as required.

## 8.0 Conclusions

An assessment of the potential impacts on surface water resources associated with the Project was undertaken and the following conclusions have been drawn from the assessment outcomes:

- The Project can on average achieve a NorBE on water quality (as required for developments within the Grahamstown Dam catchment) provided adequate site storage capacity is available for all stages of the quarry operation, an appropriate water treatment system is installed and maintained to ensure controlled discharge water quality targets are achieved and appropriate water inventory management is implemented to minimise the volume and frequency uncontrolled discharges.
- The Project will have an adequate and reliable water source (i.e., captured rainfall runoff and groundwater bore) for all stages of the Project.
- There is a predicted overall loss of catchment yield during Stage 1 of the Project and during dry years of Stage 9 of the Project, however, on average catchment yields are expected to increase as a result of the Project during the intermediate and latter operational stages due to the increased runoff potential of the developed quarry site and the requirement to manage surplus rainfall runoff through controlled discharges.
- Loss of catchment yield during dry years and early-stage operations will have a negligible impact on overall Grahamstown Dam catchment yields as the Project WMS will occupy less than 0.50% of the Grahamstown Dam catchment and less than 0.03% of the Williams River catchment.
- Potential stream stability issues associated with discharges are expected to be manageable and any required mitigation measures (e.g., scour protection, discharge flow rate limits) will be informed by the hydrologic and hydraulic assessment.
- The Project will have no impact on local or broader catchment flood regimes.

## 9.0 References

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – The Guidelines - Volume 1*.

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

Department of Environment and Climate Change (2008). *Managing Urban Stormwater: Soils and construction - Volume 2e: Mines and quarries*

GHD (2022). Stone Ridge Quarry Groundwater Impact Assessment. Unpublished report for ARDG.

Hunter Water (2017) Guidelines for Development in Drinking Water Catchments

Hunter Water (2022). *Grahamstown Dam*. <https://www.hunterwater.com.au/our-water/water-supply/dams-and-catchments/grahamstown-dam>

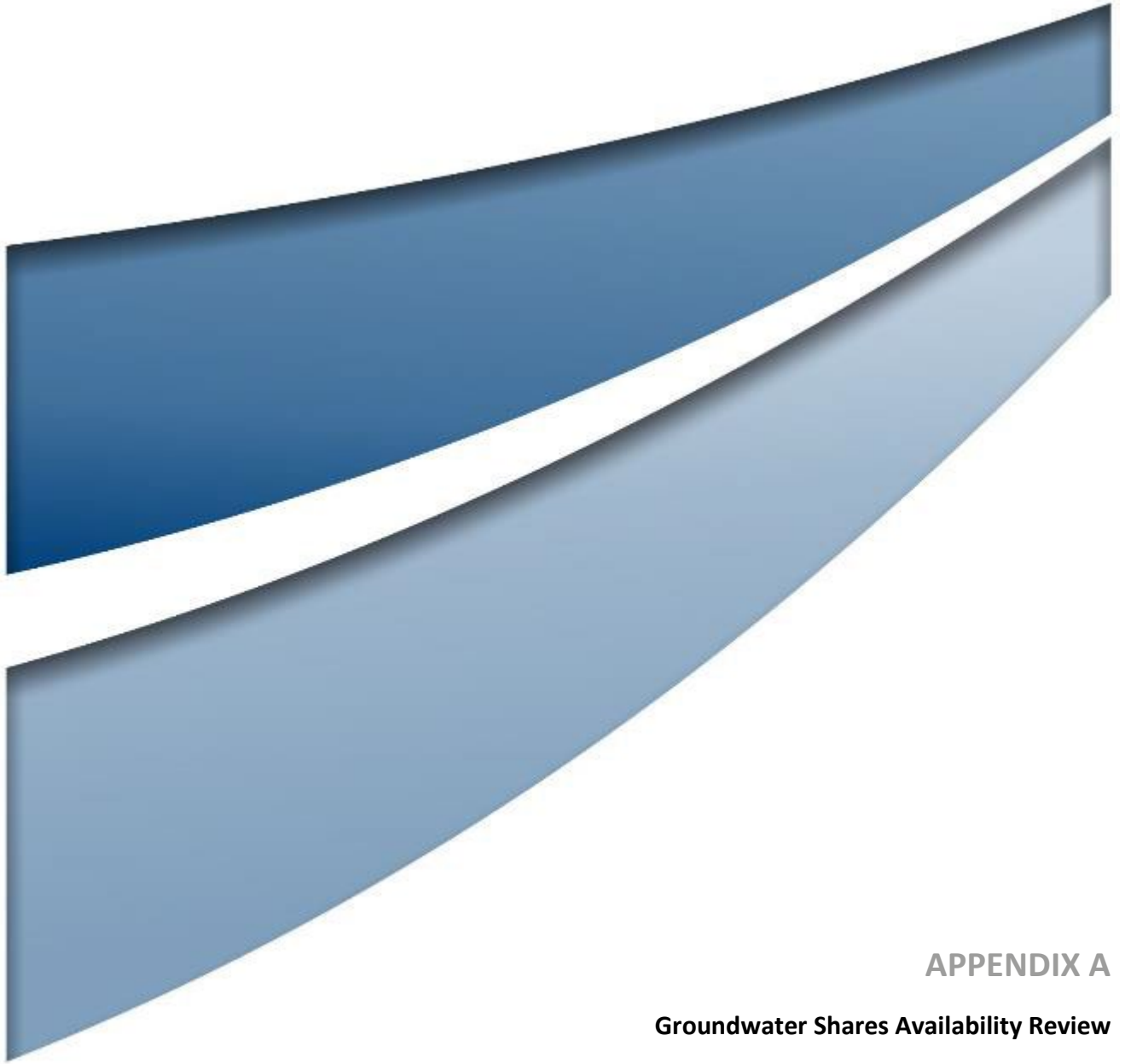
Landcom (2004). *Managing Urban Stormwater: Soils and construction - Volume 1*, 4<sup>th</sup> Edition.

Matthei, L.E. (1995). Soil Landscapes of the Newcastle 1:100 000 Sheet Report. Department of Land and Water Conservation, Sydney.

Umwelt (2021). Surface Water Impact Assessment, Martins Creek Quarry Extension State Significant Development Application

WaterNSW (2022). *Neutral or Beneficial Effect on Water Quality Assessment Guideline*.

NSW Government (2021). *Government Gazette of the State of New South Wales Number 522–Electricity and Water Friday, 15 October 2021*



**APPENDIX A**

**Groundwater Shares Availability Review**



23 March 2023  
Australian Resource Development Group Pty Ltd  
Mr Justin Meleo  
69 Ross St  
Belmont  
NSW 2280

Dear Mr Meleo

Re New England Fold Belt Coast Groundwater Source:

There are 629 registered licences in the New England Fold Belt Coast Ground water source with a range of 0-1000ML.

Number of licences by volume

287	0-10ML
271	10-50 ML
30	50-100 ML
35	100-400 ML
6	400-1000 ML
Total 629	15639 ML

- 2022 – 2023 1 Permanent Share assignment of 5ML @ \$650.00 / ML to current date.
- 2022-2023 18 Licence were transferred with no price recorded on 15 transfers indicating that these may have been part of a property sale. The remaining 3 transfers had a spread of \$740 to \$800 / ML.
- There has been 1 temporary trade in the current year 2022-2023 @ \$80/ ML and 3 trades in the previous year 2021 – 2022 to \$75 / ML indicating little activity in this area.
- There may be a similar Controlled allocation for the New England Fold Belt Coast in the future as was available in 2021 that could be considered as the project progresses.
- See following data from Water NSW.

Yours faithfully

  
Warwick Judge

Real Estate Sales Specialist & Water Broker

M:0428895425

Licence No 1285502

[Warwick.judge@elders.com.au](mailto:Warwick.judge@elders.com.au)

## Information about a water source

Use this tool to search for information about a particular water source in relation to [water access licences](#), [approvals](#) and water usage.

Search for:

Water access licences (including conditions) for a water source

Total number of water access licences and water usage for a water source

**Water Source** New England Fold Belt Coast Groundwater  
**Licence Category** All  
**Period (Financial Year)** 2022/2023

### Notes:

The calculation of all information in the search results - including the Water Access Licence (WAL) numbers, may be affected by the licences that were created and/or cancelled during the selected period (financial year).

Information on licences issued under the *Water Act 1912* is not available via this search.

Status of approvals (including conditions) for a water source or region

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Print >>>

## Search Results

Access Licence Category	No. of WAL(s)	Total Share Component	Total IDEC (Daily flow shares)	Cumulative AWD	Cumulative AWD Unit	Share Component Unit	Water made Available (ML)	Usage YTD (ML)
AQUIFER	629	16509	N/A	1	1	ML per share	15639	5.2
LOCAL WATER UTILITY	2	240	N/A	1	100	% of Share Component	240	0

**Disclaimer:** WaterNSW is making the information available on the understanding that it does not warrant that the information is suitable for any intended use. In using the information supplied, the user acknowledges that they are responsible for any deductions or conclusions arrived at from interpretation of the data.

**Privacy:** The information provided is limited to meet the requirements of section 57 of the *Privacy and Personal Information Act 1998*.

**Exporting and printing:** Search results show a maximum of 50 rows per page. Search results can only be printed page by page.

## Share assignment trading statistics

The whole or part of the share component of a [water access licence](#) can be sold or traded from one water access licence to another under section 71Q of the *Water Management Act 2000*. This water dealing is otherwise known as an 'assignment of share component' or 'share assignment'. See [assigning a share component](#).

Use the tool below to search for information on the trading of water access licence share components.

Search for the s71Q share assignment dealings for a particular water source. Alternatively, search for the s71Q share assignment dealings for a particular water access licence.

**Note:** The accuracy of pricing data is not guaranteed by WaterNSW; this search tool does not include transfers of water access licences pursuant to section 71 M of the *Water Management Act 2000*. For transfer dealings, go to Transfer trading statistics

Search by either:

### Water Source

Water Source  
Period (Water Year)

New England Fold Belt Coast Groundwater

This water year 01-Jul-2022 to 30-Jun-2023

### Water Access Licence (WAL)

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Print Export

## Search Results

<< < 1 to 1 of 1 rows > >>

### Intra Water Source

Assign From			Assign To			Application Number	Transferred	Share (units or ML)	Price Paid '\$ per Unit'
WAL No.	Water Source	Category	WAL No.	Water Source	Category				
40195	New England Fold Belt Coast Groundwater Source	Aquifer	43259	New England Fold Belt Coast Groundwater Source	Aquifer	1022558	23-SEP-2022	5	650

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**Privacy:** The information provided is limited to meet the requirements of section 57 of the *Privacy and Personal Information Act 1998*.

## Licence transfer statistics

A water access licence or a holding in a water access licence can be sold or transferred from one holder to another under section 71M of the *Water Management Act 2000*. See [transfer of water access licences](#).

If a [security interest](#) (mortgage or charge) is recorded on a water access licence and there is a default of mortgage payments, the security interest holder may take action to transfer the water access licence (or holding in the water access licence) by default under section 71X of the *Water Management Act 2000*. This is otherwise known as a dealing on default.

Use the tool below to search for information on water access licence transfers.

Search for information on types of transfers for a particular water source. In addition to s71M transfer dealings and s71X dealings on default, other forms of transfers such as transmissions and orders by the court are also available.

Alternatively, search for the transfer dealings for a particular water access licence.

**Note:** Some transfers may not involve the sale or purchase of the water access licence and therefore will not show a dollar (\$) value for the price per unit.

Search by either:

**Water Source**

**Water Source**

New England Fold Belt Coast Groundwater

**Transfer Type**

All

**Period (Water Year)**

This water year 01-Jul-2022 to 30-Jun-2023

**Water Access Licence (WAL)**

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## Search Results

1 to 18 of 18 rows

Transfers

WAL No.	Water Source	Category	Transferred	Share (units or ML)	Price Paid (\$ per Unit)
38376	New England Fold Belt Coast Groundwater Source	Aquifer	27-JUL-2022	5	0.00
38411	New England Fold Belt Coast Groundwater Source	Aquifer	01-SEP-2022	8	0.00
43607	New England Fold Belt Coast Groundwater Source	Aquifer	01-SEP-2022	12	0.00
40796	New England Fold Belt Coast Groundwater Source	Aquifer	12-SEP-2022	10	0.00
38358	New England Fold Belt Coast Groundwater Source	Aquifer	23-SEP-2022	27	0.00
38358	New England Fold Belt Coast Groundwater Source	Aquifer	23-SEP-2022	27	0.00
43785	New England Fold Belt Coast Groundwater Source	Aquifer	29-SEP-2022	7	0.00

①

43606	New England Fold Belt Coast Groundwater Source	Aquifer	29-SEP-2022	20	0.00
40235	New England Fold Belt Coast Groundwater Source	Aquifer	04-OCT-2022	10	0.00
40133	New England Fold Belt Coast Groundwater Source	Aquifer	24-NOV-2022	10	0.00
40089	New England Fold Belt Coast Groundwater Source	Aquifer	29-NOV-2022	5	0.00
44501	New England Fold Belt Coast Groundwater Source	Aquifer	10-JAN-2023	41	0.00
43349	New England Fold Belt Coast Groundwater Source	Aquifer	24-JAN-2023	30	800.00
38358	New England Fold Belt Coast Groundwater Source	Aquifer	31-JAN-2023	27	740.74
40060	New England Fold Belt Coast Groundwater Source	Aquifer	09-FEB-2023	6	0.00
44483	New England Fold Belt Coast Groundwater Source	Aquifer	01-MAR-2023	20	800.00
40078	New England Fold Belt Coast Groundwater Source	Aquifer	14-MAR-2023	25	0.00
40367	New England Fold Belt Coast Groundwater Source	Aquifer	16-MAR-2023	5	0.00

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**More information:** Should you require further information or technical assistance, please submit your request to [water.enquiries@waternsw.com.au](mailto:water.enquiries@waternsw.com.au) or contact 1300 662 077

## Water allocation assignment trading statistics

The water allocation available under a [water access licence](#) can be sold or traded to another water access licence.

This dealing is otherwise known as a '[water allocation assignment](#)', or an 'assignment of water allocations between water access licences' (and previously 'a temporary trade').

Use the tool below to search for information on the trading of water allocations.

Search for either:

**Water allocation assignments for a particular water source**

**Water Source** New England Fold Belt Coast Groundwater ▼  
**Licence Category** All ▼  
**Period**  **Water Year** 2022/2023 ▼  
 **Month of Allocation** ▼ **Year** ▼

- Water allocation assignments for a particular water access licence
- Total number of water allocation assignments and volume of water traded **within** a water source
- Total number of water allocation assignments and volume of water traded **between** water sources ('intervalley' and interstate)

<< Previous Search

Print Export

## Search Results

<< < 1 to 2 of 2 rows > >>

Water Access Licence	Assign From			Category	Water Access Licence	Assign To			Details			
	Water Source	Water Management Zone	Category			Water Source	Water Management Zone	Category	Application Number	Assigned	Trade Purpose	Volume (ML)
40195	New England Fold Belt Coast Groundwater Source		Aquifer	43259	New England Fold Belt Coast Groundwater Source		Aquifer	SWC828501	13-JUL-2022	Other	5	1
43713	New England Fold Belt Coast Groundwater Source		Aquifer	43896	New England Fold Belt Coast Groundwater Source		Aquifer	SWC828164	05-JUL-2022	Other	10	80

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Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Water Sharing Plan	Groundwater Source	Management zone in the water source (column 2)	Quantity of unit shares made available	Quantity of unit shares issued	Price paid per unit share \$	Total price paid \$
	Groundwater Source					
	Lorne Basin Groundwater Source		446	0	\$0.00	\$0.00
	New England Fold Belt Coast Groundwater Source		1739	15	\$1,200.00	\$18,000.00
20				\$950.00	\$19,000.00	
20				\$800.00	\$16,000.00	
20				\$800.00	\$16,000.00	
20				\$800.00	\$16,000.00	
20				\$700.00	\$14,000.00	
20				\$700.00	\$14,000.00	
20				\$700.00	\$14,000.00	
25				\$650.00	\$16,250.00	
25				\$621.00	\$15,525.00	
20				\$600.00	\$12,000.00	
4				\$600.00	\$2,400.00	
60				\$600.00	\$36,000.00	
25				\$570.00	\$14,250.00	
70				\$559.00	\$39,130.00	
20				\$555.00	\$11,100.00	
21				\$526.00	\$11,046.00	
30				\$525.00	\$15,750.00	
10				\$520.00	\$5,200.00	
100				\$520.00	\$52,000.00	
40	\$511.00	\$20,440.00				
20	\$501.00	\$10,020.00				
232	\$500.00	\$116,000.00				
20	\$500.00	\$10,000.00				
7	\$500.00	\$3,500.00				
	North Coast Volcanics Groundwater Source		299	40	\$550.00	\$22,000.00
30				\$550.00	\$16,500.00	
20				\$501.00	\$10,020.00	
35				\$501.00	\$17,535.00	

