APPENDIX V

SURFACE WATER ASSESSMENT

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Rosebrook SAND & GRAVEL

DALSWINTON QUARRY EXPANSION

Surface Water Impact Assessment

FINAL

November 2020

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Surface Water Impact Assessment

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Rosebrook Sand and Gravel

Project Director:	Chris Bonomini
Project Manager:	Chris Bonomini
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Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au

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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Chris Bonomini	19/11/2020	Chris Bonomini	19/11/2020

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1.0 Introduction

1.1 Project Overview

Dalswinton Quarry (the Quarry) is situated on Lot 72 DP1199484 approximate 6.5 km to the south east of Denman, NSW (refer to **Figure 1.1**). The Quarry operates under DA 410/1995 which allows sand and gravel extraction and processing at a rate up to 150,000 tonnes per year on the site to beyond 2022. The owners, Rosebrook Sand and Gravel Pty Ltd (RSG), are seeking to expand the approved extraction area, extend extraction operations to beyond 2022 (the Project) and increase the allowable material stockpile inventory.

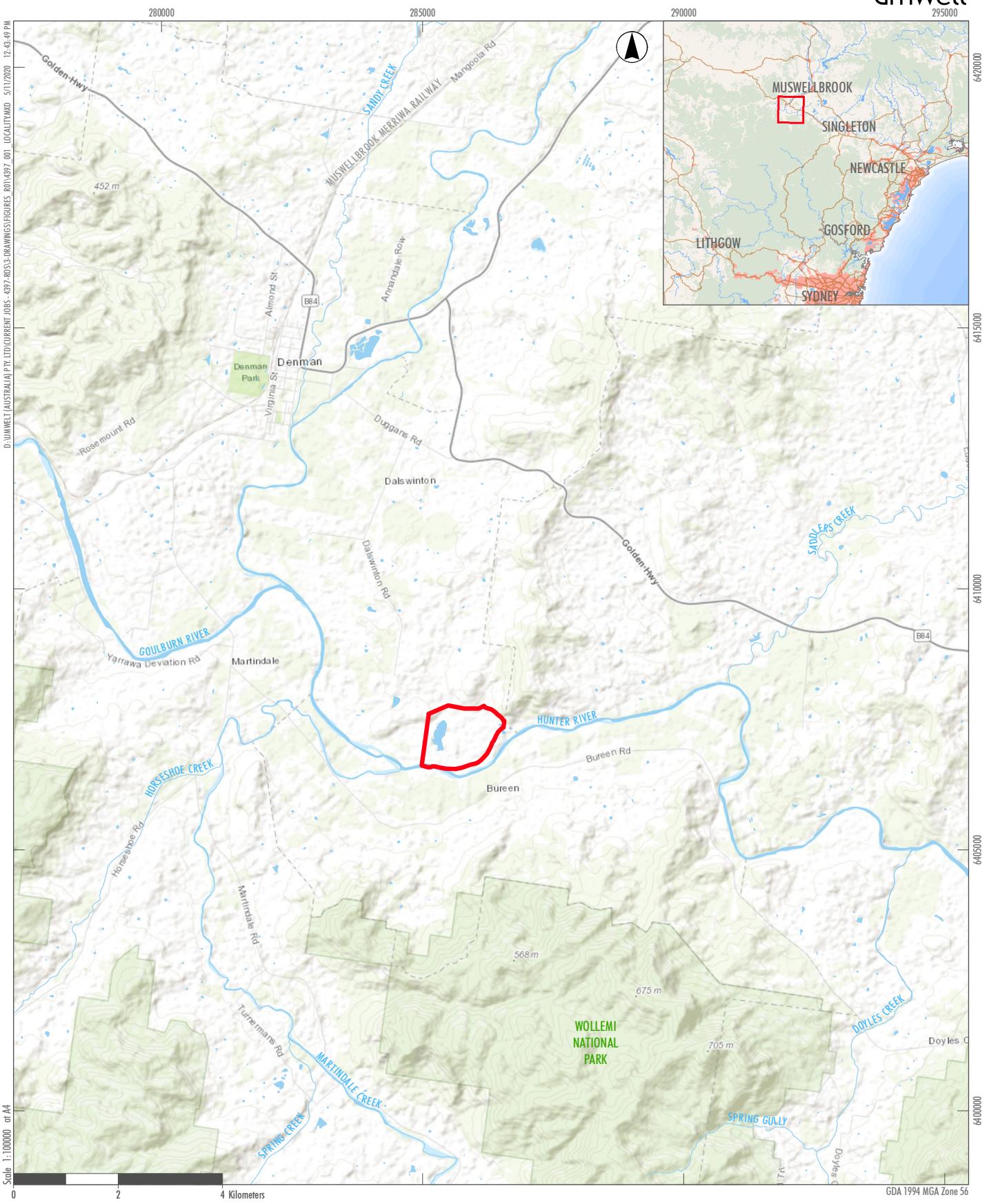
The Quarry operates on the broad terraces of a cut-off meander of the Hunter River. Quarrying on the site dates back to late 1980's when extraction and processing operations were undertaken in the south eastern part of the site. Operations were later relocated to the upper terrace in the western part of the site under the current consent, DA 410/1994. DA 410/1994 was issued on 13 November 1995, to extract approximately 1.87 million tonnes (Mt) over a 23 year period at an average rate of 80,000 tonnes per year. The consent conditions limit the excavation area to 2 ha at any given time and material stockpile inventory to 30,000 tonnes with a maximum height of 5 m. Through subsequent s96 modifications in 2001, 2006, 2009, 2014 and 2019 the extraction areas were realigned, and the life of the Quarry was extended to beyond 2022.

Quarrying activities are presently confined to the western part of the site and extraction occurs at an average extraction rate of 80,000 tonnes per year. The Project will expand across 89 ha of the site, with a maximum extraction rate of 500,000 tonnes per year. Approximately 12.5 Mt of sand and gravel material will be extracted over an expected Quarry life of 25 years. In addition to the expansion of extraction activities to the east of the present operation, the Project also includes reworking of the areas previously quarried to recover discarded fines and larger aggregates.

The Project will involve up to 5 ha of excavation area at any given time for improved workability and safety of the operations. Approximately 60,000 tonnes of materials consisting of varying grades/sizes will need to be stockpiled on site to maintain the higher production rate and meet market demand. The Project will adopt the existing method of operations, storage, processing and transfer of materials.

Areas of disturbance will be progressively rehabilitated to minimise the extent of disturbed area at any given time. Extraction pits will be backfilled, shaped, top soiled and sown with pasture species to prepare the site for grazing purposes at the end of the Quarry life.

The Quarry has had several owners prior to being acquired by Rosebrook Sand and Gravel Pty Ltd in 2010. As a consequence, production levels have varied and intermittent shut downs have occurred since the commencement of operations. As such, the forecast production rates have not been realised and significant reserves of materials still remain in the currently approved extraction area and the undisturbed area to the east. Further, given the presently high market demand for fines and aggregates larger than 10 mm, there is also the opportunity to economically recover materials previously discarded as reject.



Legend

- Project Area
- Drainage Line

FIGURE 1.1

Locality Plan

Image Source: ESRI (2020) Data Source: DSFI (2020)

1.2 Secretary's Environmental Assessment Requirements

Table 1.1 presents the key surface water issues identified in the Secretary's Environmental Assessment Requirements (SEARs) for the Project and the section where the key issue is addressed in this Surface Water Impact Assessment (SWIA).

Table 1.1 Surface Water Related SEARs

Key Issues	Section Addressed
Water – including:	
• 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;	**Section 4.0**
• identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*;	**Sections 0** and **6.1**
• 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);	**Sections 0**, **4.0** and **6.1**
• 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;	**Section 5.1**
• an assessment of any likely flooding impacts of the development;	Refer to *Dalswinton Quarry Flood Investigation and Impact Assessment* (Royal Haskoning DHV, 2020)
• a detailed assessment of any need to maintain an adequate buffer between excavations and the highest predicted or recorded regional groundwater table;	*Groundwater Impact Assessment Dalswinton Quarry* (hydrogeologist.com.au, 2020)
• 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;	**Section 5.0** and refer to *Groundwater Impact Assessment Dalswinton Quarry* (hydrogeologist.com.au, 2020)
• an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users; and	**Section 5.0** and refer to *Groundwater Impact Assessment Dalswinton Quarry* (hydrogeologist.com.au, 2020)
• a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.	**Section 0** and **0**

1.3 Potential Surface Water Impacts

Potential surface water impacts associated with the Project are:

- Increased capture of catchment runoff within the Quarry water management system (WMS)
- The higher proposed production rate and larger exposed areas will lead to higher operational water demands (processing plant and exposed area dust suppression). As such, there is the potential for an increased demand for groundwater imports.
- Release of sediment laden water from the Quarry WMS to the downstream environment.
- Local catchment flood regimes.

2.0 Surface Water Context

2.1 Catchment

The Quarry is located within the Hunter River catchment in the Hunter Regulated River Alluvial Water Source which is a water source covered by the Hunter Unregulated and Alluvial Water Sources 2009 WSP (refer to **Figure 2.1**). Therefore, water management at the Quarry is governed by the *Water Management Act 2000*.

2.1.1 Topography and Surface Hydrology

Flat farmland bounds the Quarry site to the west with hilly farmland to the north. The north eastern corner of the site is bounded by light to moderately forested hills while the south is bounded by the Hunter River. The Quarry site falls in south easterly direction from an elevation of approximately 96 mAHD in the north western corner down to an elevation of approximately 89 mAHD in the south east adjacent to the Hunter River.

The Quarry site can be described as flat to hummocky which generally drains in a south easterly direction to the Hunter River. Surface runoff to the existing disturbed areas on the Quarry site are contained within the Quarry WMS with undisturbed areas to the east of the extraction pit draining in a south easterly to the Hunter River.

Runoff from upslope catchments to the northwest (approximately 58 ha) and north (approximately 475 ha) of the Quarry presently drain around the northern edge of the Quarry disturbed areas to the undisturbed eastern side of to the site via a broad natural drainage depression. The north easterly catchment (approximately 128 ha) also drains to the undisturbed eastern side of the site.

A constructed channel has previously been constructed to accept overflows from northern pond. The overflow channel flows in a north easterly direction from the Northern Pond and converges with the natural drainage depression immediately to the north of the existing extraction pit. The overflow channel diverges from the broad natural drainage depression a further 200 m to the east where natural flows broaden into overland flow passing through low lying areas and areas of ponding.

Flows from the overflow channel and overland natural flows converge approximately 600 m further to the south east. These flows are conveyed along the northern side of the quarry access road for approximately 200 m from where they are directed to the southern side of the access road via a 900 mm pipe culvert. Flows then continue in an easterly direction for approximately 450 m prior to discharging into the Hunter River.

A 1.5 m levee to the south of the Quarry site protects the Quarry from inundation for Hunter River flooding events up to limited Hunter River flood flows.

Runoff from upslope catchment to the north flows into the same natural drainage line to the north of the quarry.

2.1.2 Soils

There are three soil landscapes mapped within the Quarry site (eSPADE v2.0, NSW Office of Environment and Heritage, https://www.environment.nsw.gov.au/eSpade2Webapp). The soil landscapes are presented in **Figure 2.2** and described below.

Singleton (sgw) alluvial

Singleton alluvial soil covers the majority of the Quarry site (refer to **Figure 2.2**) and are considered to have a widespread streambank erosion hazard. Soil distribution is variable across this landscape due to differing episodes of sedimentation. Singleton alluvial soils have five dominant soil types:

- generally deep (100 - <150 cm), moderately well-drained Brown and Black Dermosols (Prairie Soils and Chernozems) and deep (100 - <150 cm).
- well-drained Red and Brown Kandosols (Red Earths and Brown Earths) throughout the alluvial plain.
- deep (100 - <150 cm), imperfectly drained Haplic Epipedal Black Vertosols (Black Earths) occur on terraces and the alluvial plain.
- deep (100 - <150 cm), well-drained Bleached Red Chromosols (Red Podzolic Soils and Red Soloths) occur on prominent terrace surface between Scone and Muswellbrook.
- deep (100 - <150 cm), imperfectly to well-drained Stratic Rudosols (Alluvial Soils) occur on more recent sediment.

Brays Hill (RC-br)

Brays Hill soils are limited to strip along the northern end of the Quarry site ranging from approximately 100 to 200 m in width (refer **Figure 2.2**). Brays Hill soils are considered to have a moderate to very high erosion hazard and consist of eight dominant soil types:

- Red Clays (Ug5.3, Ug5.37) on mid to upper slopes that are dark or dull reddish brown light to light medium clay with strong structure to a depth of 30 cm.
- Black Earths (Ug5.15) on mid to lower slopes consisting of colluvial brownish black silty clay with moderate structure overlying black medium clay with strong structure.
- Grey Clays (Ug5.21) on mid to lower slopes that commonly have a linear Gilgai running parallel to the slopes. The Grey Clay consists of a dull yellowish brown light clay with strong structure to 7 cm which gradually changes to a dull yellow orange heavy clay with strong structure which has distinct brown mottles in the lower subsoil.
- Brown Clays (Uf5.1, Ug5.3) may also occur midslope that are black or dull brown light to light medium clay with strong structure to a depth of 10 cm with a clear change to bright brown or dark brown light medium to medium clay with strong structure.
- Yellow (Orange) Solodic Soils (Dy2.42) on the lower slopes and in drainage depressions that are hardsetting, dull reddish brown light sandy clay loam with weak structure overlying leached dull brown light sandy clay loam which is massive to a depth of 15 cm.
- Red-brown Earths (Dr3.13) occur on some crests and upper slopes that are Dark reddish brown loam with moderate structure; pH 9.0; depth to 8 cm. There is a sharp change to orange to bright brown light clay subsoil with strong structure.
- Rendzinas (Gc2.21, Gc2.22) occur on some crests and upper slopes with Red Clays and Black Earths. The Redzinas are Brown silty clay loam with moderate to strong structure to a depth of 10 cm with a clear to gradual change to dark reddish brown to brownish black light clay subsoil with strong structure.

- Alluvial soils that are Dark brown light medium to medium clay with strong structure overlying massive sandy clay, loam fine sandy and black light medium clay with weak structure.

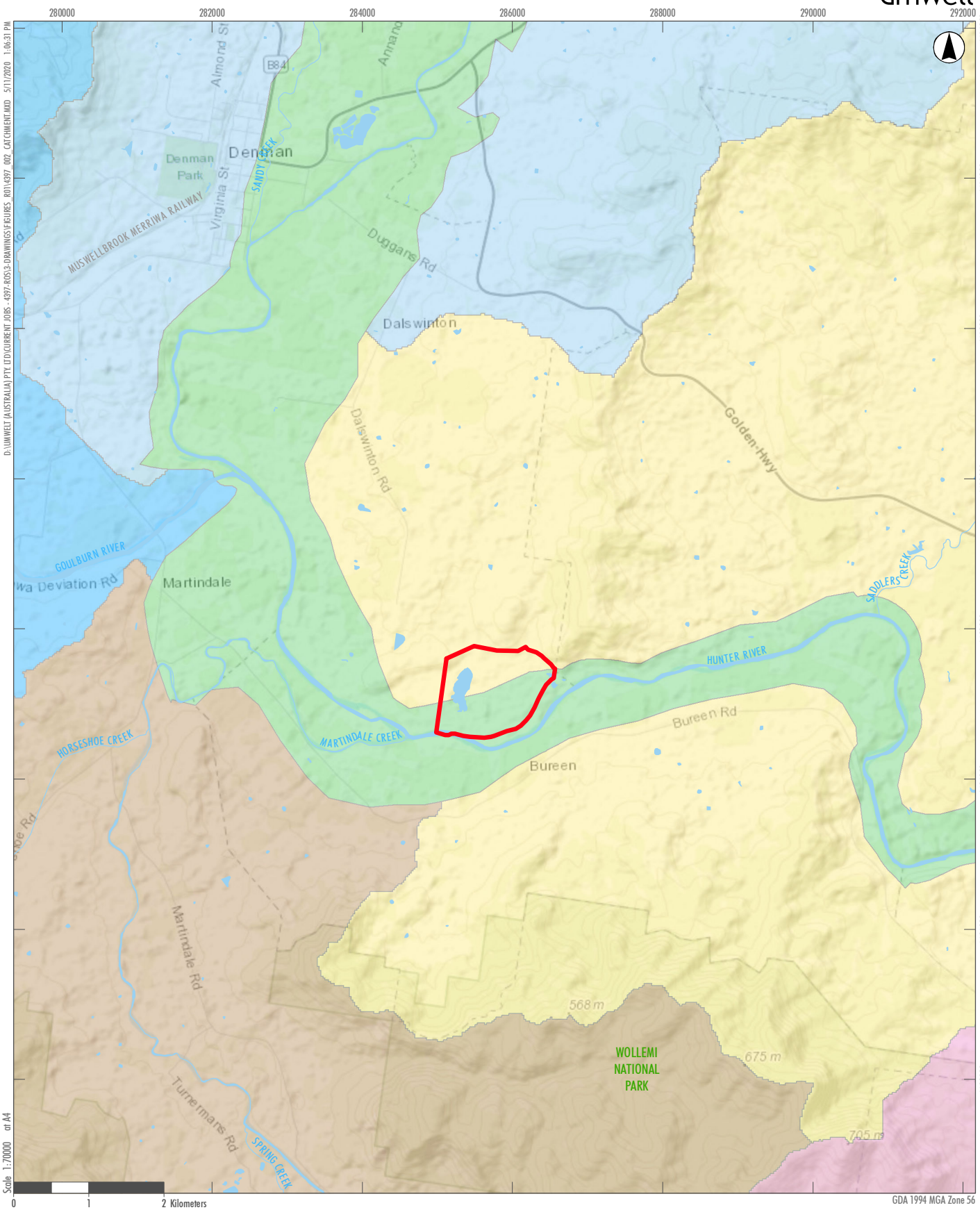
Benjang Variant A (bjua) erosional

The Benjang Variant A soils are only present on the very north western and north eastern fringes of the Quarry site (refer **Figure 2.2**). This soil landscape is distinguishable by its flat-topped sandstone/conglomerate crests and slopes that often contain highly erodible strongly weathered pale siltstones prone to gullying and movement. Benjang Variant A soils have five dominant soil types:

- Stony well-drained Leptic Rudosols (Lithosols) associated with rock outcrop occur on flat-topped crests and ridges to depths of 25 - <50cm and elsewhere, well-drained Red Chromosols (Red-brown Earths) to depths of 25 - <100 cm.

- Well-drained Brown Chromosols (Non-calcic Brown soils) occur on erodible slopes where white gullies or slips are common to depths of 50 - <100 cm over highly erodible, strongly weathered, pale siltstones.

- imperfectly drained Red Chromosols and Sodosols (Red-brown Earths) are common on lower slopes, fat depths to 100 - <150 cm).



Legend

Project Area

Drainage Line

Hunter Water Sharing Plan 2011

- Doyles Creek Water Source
- Hunter Regulated River Alluvial Water Source
- Jerrys Water Source
- Lower Goulburn River Water Source
- Martindale Creek Water Source
- Muswellbrook Water Source

FIGURE 2.1

Catchment Context

Image Source: ESRI (2020) Data Source: DSFI (2020)

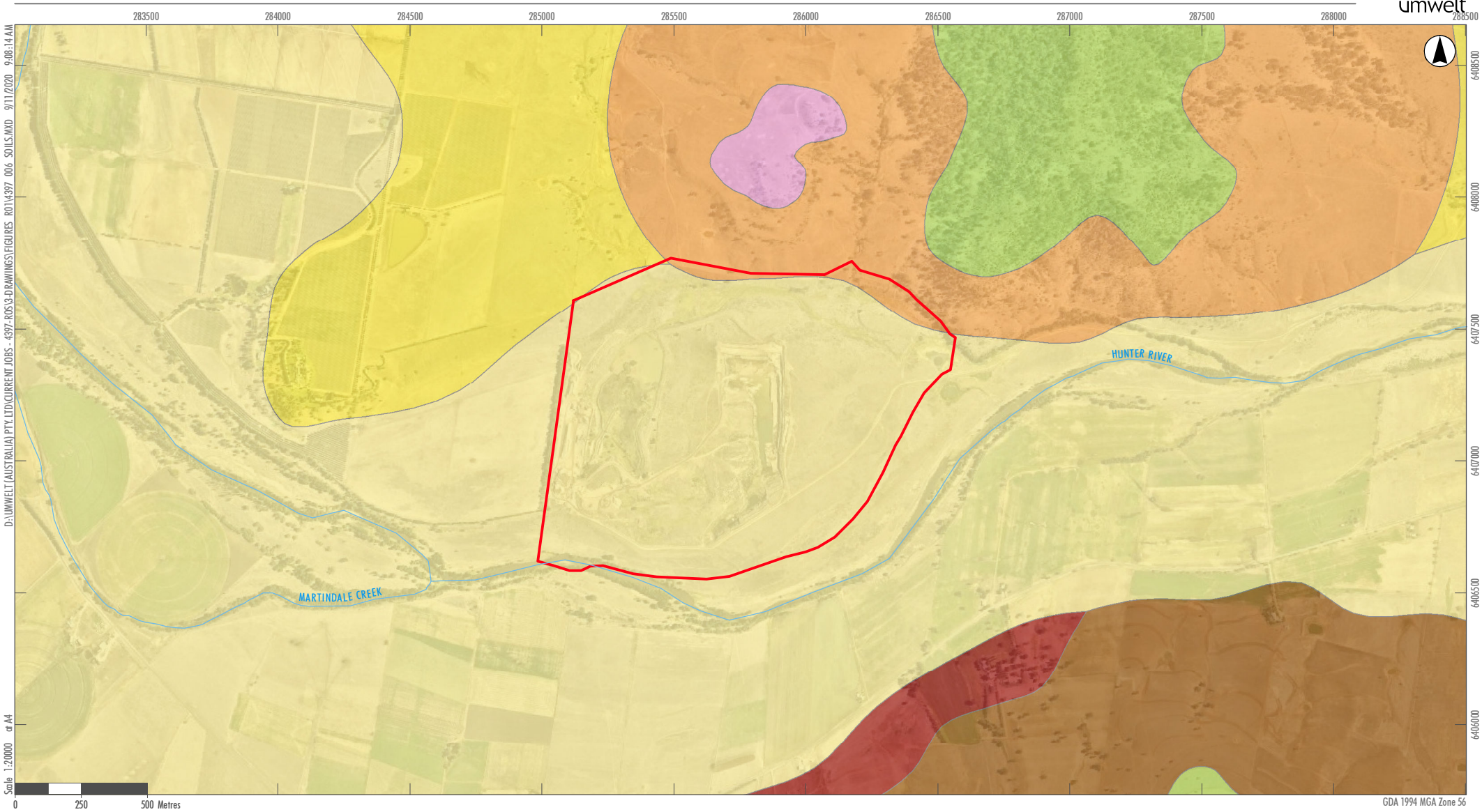


FIGURE 2.2

Soil Landscape

Image Source: Nearmap (Feb 2018) Data source: DFSI (2020), NSW Department of Planning, Industry and Environment (2020)

2.1.3 Climate

The Dalswinton climate is warm temperate with seasonal variation from hot wet summers to cool mild winters. Climate statistics recorded at the Jerrys Plains Post Office Bureau of Meteorology (BoM) Station (station #061086) between 1884 and 2014 are presented in **Table 2.1**. The Jerrys Plains BoM station is the BoM station nearest to the Quarry with long term climate statistics and is located approximately 18 km east south east of the Quarry. Long term daily rainfall data is also available from the Denman (Palace Street) BoM station (station #061016) which is located approximately 8 km to the north west of the Quarry. **Chart 2.1** presents the mean monthly rainfall recorded at the Denman BoM station (station #061016). The Denman BoM station operated between 1883 and 2014.

Table 2.1 Jerrys Plains Climate Statistics

Statistic	Value
Mean Minimum Temperature (1907 – 2014)	10.6°C
Lowest Recorded Temperature (1957 – 2014)	-4.5°C
Mean Maximum Temperature (1907 – 2014)	25.2°C
Highest Recorded Temperature (1957 – 2014)	45.6 °C
Mean 9am Wind Speed (1957 – 2010)	9.9 km/h
Mean 3pm Wind Speed (1957 – 2010)	13.1 km/h
Minimum Annual Rainfall (1884 – 2014)	1191.2 mm
Mean Annual Rainfall (1884 – 2014)	644.5 mm
Maximum Annual Rainfall (1884 – 2014)	234.2 mm

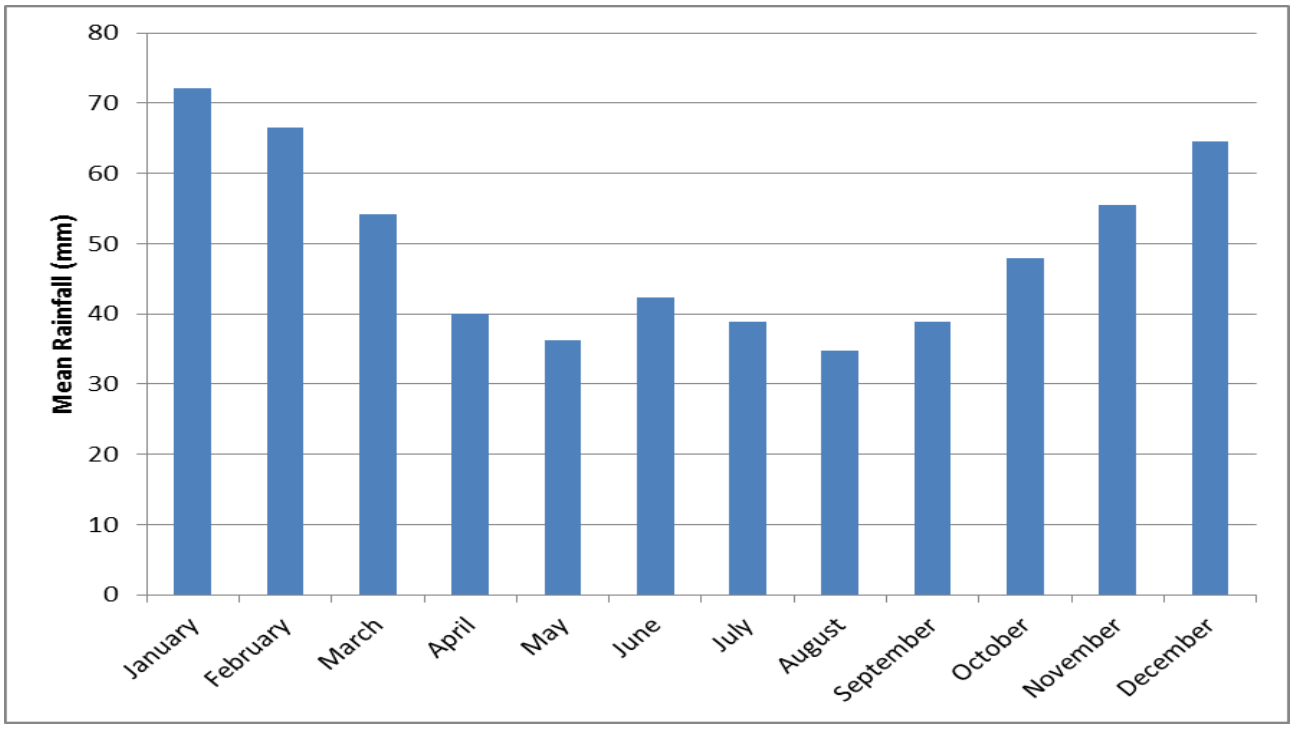


Chart 2.1 Denman (Palace Street) BoM Station Mean Monthly Rainfall

2.2 Water Quality

Surface water quality monitoring of site and receiving water sources has not previously been undertaken as part of the Quarry. However, it is proposed to implement a site and receiving surface water quality monitoring program as part of the Project. The proposed water quality monitoring program is detailed in **Section 6.2** and has been designed to ensure the Quarry is operated in a manner to assist in achieving NSW Water Quality Objectives for the Hunter River catchment (WQOs) (https://www.environment.nsw.gov.au/ieo/Hunter/report-02.htm#P236_26719) (refer to **Section 2.2.1**).

2.2.1 Receiving Water Quality Objectives

The NSW WQOs have been developed to guide plans and actions to achieve healthy waterways. Up to eleven WQOs apply and are based on providing the right water quality for the environment and the different uses people have for water. The WQOs are based on measurable environmental values for protecting aquatic ecosystems, recreation, visual amenity, drinking water and agricultural water. The WQOs for the Hunter River Catchment area where the Quarry is situated have been developed to achieve suitable water quality for the protection of:

- Aquatic ecosystems
- Visual amenity
- Recreation
- Livestock water supply
- Irrigation water supply
- Homestead water supply
- Drinking water at point of supply
- Aquatic foods

Based on a review of the relevant WQO trigger values (https://www.environment.nsw.gov.au/ieo/Hunter/maptext-03.htm#wq01) for the water uses listed above and the potential water quality impacts associated with the Quarry operation (refer to **Section 1.3**), the water quality parameters presented in **Table 2.2** have been included in the proposed surface water quality monitoring program (refer to **Section 6.2**). The default trigger values presented in **Table 2.2** are those presented in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council (ANZECC, 2000)) for the protection of aquatic ecosystems. While the ANZECC Guidelines have been superseded by the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia, 2018) (ANZG), the default trigger values presented in **Table 2.2** are yet to be updated in the ANZG and therefore remain valid.

Table 2.2 Relevant Hunter River Water Quality Objectives

Parameter	Units	Default Trigger Value Range
pH	-	6.5 – 8.5
Electrical Conductivity	µS/cm	125 – 2,200
Turbidity	NTU	6 - 50

Source: https://www.environment.nsw.gov.au/ieo/Hunter/maptext-03.htm#wq01)

2.3 Regulatory Framework

Extraction of water in NSW is managed under two legislative acts: *Water Act 1912* and *Water Management Act 2000*.

The objective of the *Water Management Act 2000* is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development by defining water access and water sharing strategies within NSW. The *Water Management Act 2000* supersedes the provisions of the *Water Act 1912* in regard to water take when a Water Sharing Plan (WSP) is in place and in regard to works adjacent to or within watercourses. Where WSPs have not commenced the provisions of the *Water Act 1912* continue to apply.

WSPs have been developed across NSW to protect the fundamental environmental health of water sources, whilst at the same time securing sustainable access to water for all users in the long-term. The WSPs specify maximum water extractions and allocations and provide water users with a clear picture of when and how water will be available for extraction.

The Project is located within the area covered by the WSP for the *Hunter Unregulated and Alluvial Water Sources* and as such, water management at the Project is governed by the *Water Management Act 2000*. RSG hold one water access licence (WAL 36474) and an associated works approval (20WA212819) for the Quarry to take of water from the Hunter Regulated River Alluvial water source. WAL 36474 has a continuing 20-unit share component in the alluvial water source (i.e 20 ML/year based on an available water determination (as determined by Water NSW) of 1 ML/share.

All water extraction in NSW, apart from some exemptions for basic landholder rights extractions and pollution control, must be authorised by a water licence. All surface water runoff captured by the existing Quarry WMS is for pollution control purposes and is considered to be exempt from licensing based on the following schedules in the *Water Management (General) Regulation 2018*:

Schedule 4

12 Excluded works

(1) Any landholder—in relation to the taking of water from or by means of an excluded work referred to in item 1, 2, 3, 4, 6, 7 or 9 in Schedule 1 that is situated on the land, for the purposes and in the circumstances specified in Schedule 1 in respect of the work.

Schedule 1

3 Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.

2.3.1 Water Users

Water uses downstream of the Quarry include:

- Agricultural: irrigation and livestock watering
- Domestic
- Drinking water supply
- Recreation: primary and secondary contact
- Industrial

There is only one property in the Jerrys water source downstream of the Project site that could be impacted by the Quarry operations. Other water users most likely to be impacted by the Project are within the Hunter Regulated River water source and the Hunter Regulated River Alluvial water source. Potential impacts on users in the Hunter Regulated River Alluvial water source have been assess in *Groundwater Impact Assessment, Dalswinton Quarry* (hydrogeologist.com.au, 2020)

A search of the online NSW Water Register indicates that there were 182 water access licences (WALs) with a total unit share allocation of 110,403.5 ML in Zone 1b (from the junction with the Goulburn River to Glennies Creek) of the Hunter Regulated River Water Source for the 2019/2020 financial year. 36,000 of these shares are licenced for Major Utility (Power Generation) usage and a further 36,000 are licensed as Supplementary Water for the same works approval as the Major Utility WAL. The remaining WALs are associated agricultural water usage (domestic and stock), industrial (e.g. mining) and potable water supply.

3.0 Water Management

3.1 Existing Water Management

Figure 3.1 presents a plan of the existing Quarry WMS and **Figure 3.2** presents a schematic of the existing Quarry WMS. The existing Quarry water management strategy is to direct runoff from upslope undisturbed catchments around the disturbed areas of the Quarry. Runoff from upslope catchments to the west and north of the Quarry are conveyed via a broad natural drainage depression from west to east around the northern boundary of the site. The Quarry Pit is protected from inundation from runoff events that exceed the hydraulic capacity of the natural drainage depression by a bund wall. The Quarry site is protected from limited Hunter River flood flows by a levee bank in the south west of the site.

Runoff within the Quarry site typically drains from north west to south east. The processing plant catchment either drains directly to the Northern Pond return channel or is collected in pits and drains via underground pipes to the Northern Pond return channel. The Western Drain running south to north along the western edge of the processing plant collects runoff from the western side of the processing plant catchment. The Western Drain presently flows to a low-lying area to the north of the processing plant where runoff ponds and seeps into the Northern Pond.

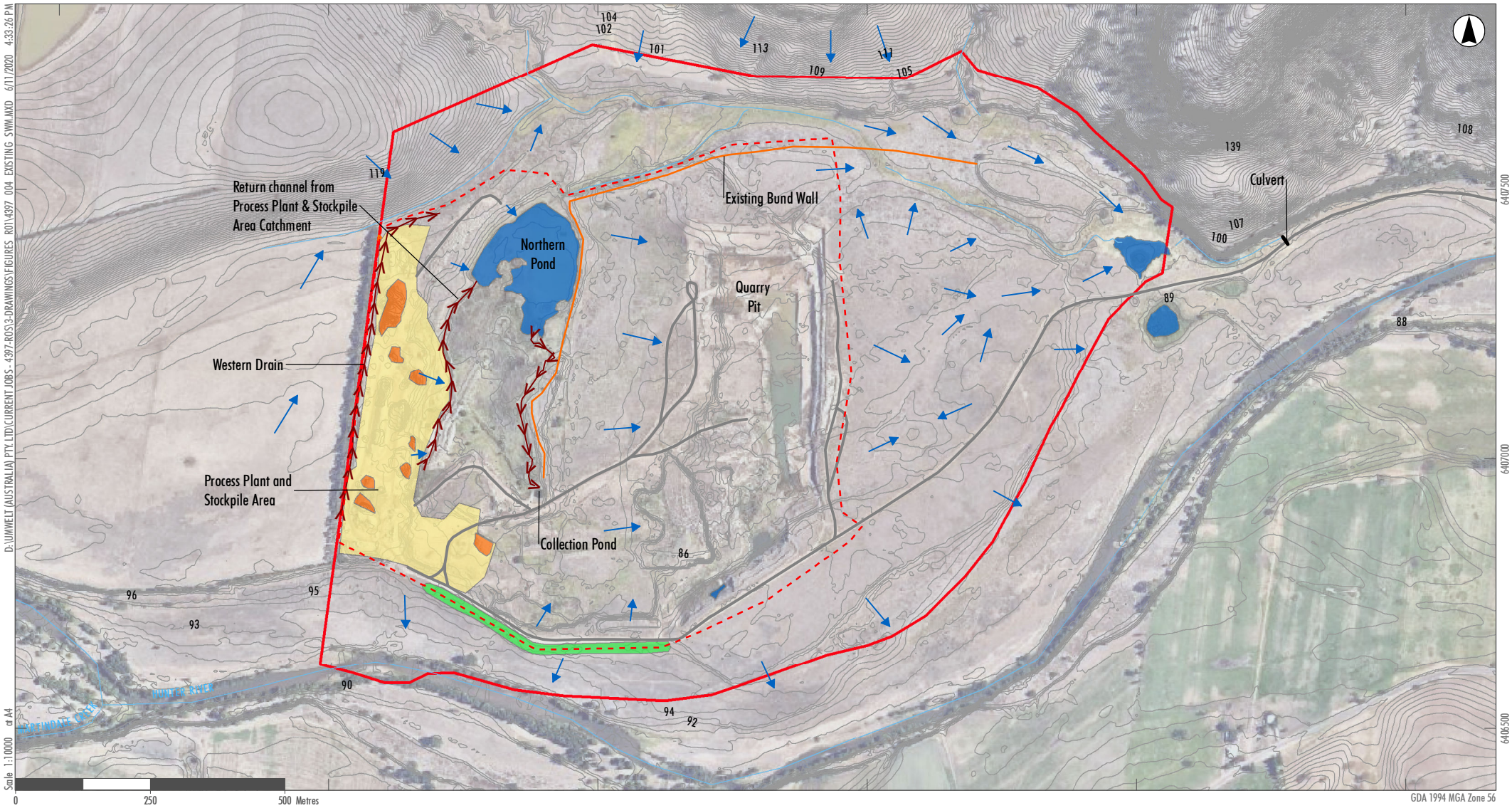
The Northern Pond is connected by a channel to the Collection Pond where water is pumped to the processing plant. The Collection Pond also receives water transfers from the Quarry Pit Pump. Most of the water pumped to the processing plant returns to the Northern Pond via the Processing Plant area drainage system with relatively small volumes of water lost to evaporation and product moisture. Water for haul road and exposed area dust suppression is also drawn from the Collection Pond. Due to the highly permeable nature of the alluvial soils underlying the Northern Pond, water rapidly seeps through the base of the pond to the Quarry Pit and the alluvial groundwater source. During high or prolonged rainfall events, the Northern Pond will overflow to the Quarry Pit. **Section 4.0** presents a site water balance for the existing Quarry operation.

Runoff from the previously quarried catchment to the east of the Northern Pond drains to the Quarry Pit. As mentioned above, Northern Pond seepage and alluvial groundwater seepage are also inflows to the Quarry Pit. Water is transferred from the Quarry Pit to the Collection Pond to allow uninhibited extraction in the Quarry Pit and maintain Northern Pond water levels for operational water demands. Outflows from the Quarry Pit to the alluvial groundwater source also occur with the seepage rate varying with water storage levels. Alluvial groundwater generally flows in the direction of surface water flow to the south east (hydrogeologist.com.au, 2020).

The area to the east of the Quarry Pit drains to a natural drainage depression at the eastern end of the Quarry site where flows meander through areas of ponding before converging into a more defined drainage line at a point approximately 1.5 km to the east of the processing plant. Flows in the drainage line are conveyed along the northern side of the Quarry access road for approximately 200 m to a 900 mm pipe culvert which directs water to the southern side of the access road. Water continues flowing in an easterly direction for approximately 450 m where it flows into the Hunter River.

The only chemicals stored at the Quarry in significant quantities are hydrocarbons (diesel fuel, engine oils and hydraulic oils). All hydrocarbons are stored in accordance with AS1970:2017 The storage and handling of flammable and combustible liquids, including the bulk diesel tank which is stored in an appropriately sized bund. No refuelling or maintenance of mobile plant or other vehicles is undertaken in the Quarry Pit. Mobile plant and other vehicles are regularly maintained to minimise the risk of oil/fluid leaks that that could potentially drain to the Quarry WMS.

Potable water for amenities is trucked to site and amenities wastewater is collected in an underground tank and periodically removed by a licensed waste contactor.



Legend

- Project Area
- Flood Levee
- Processing Area
- Stockpiles
- Water Surface
- Drainage Line
- Culvert
- Unsealed Road
- Existing Bund Wall
- Dirty Drain
- Flow Direction
- WMS Boundary

Image Source: Nearmap (Feb 2018) Data source: DFSI (2020)

FIGURE 3.1

Existing Water Management System Plan

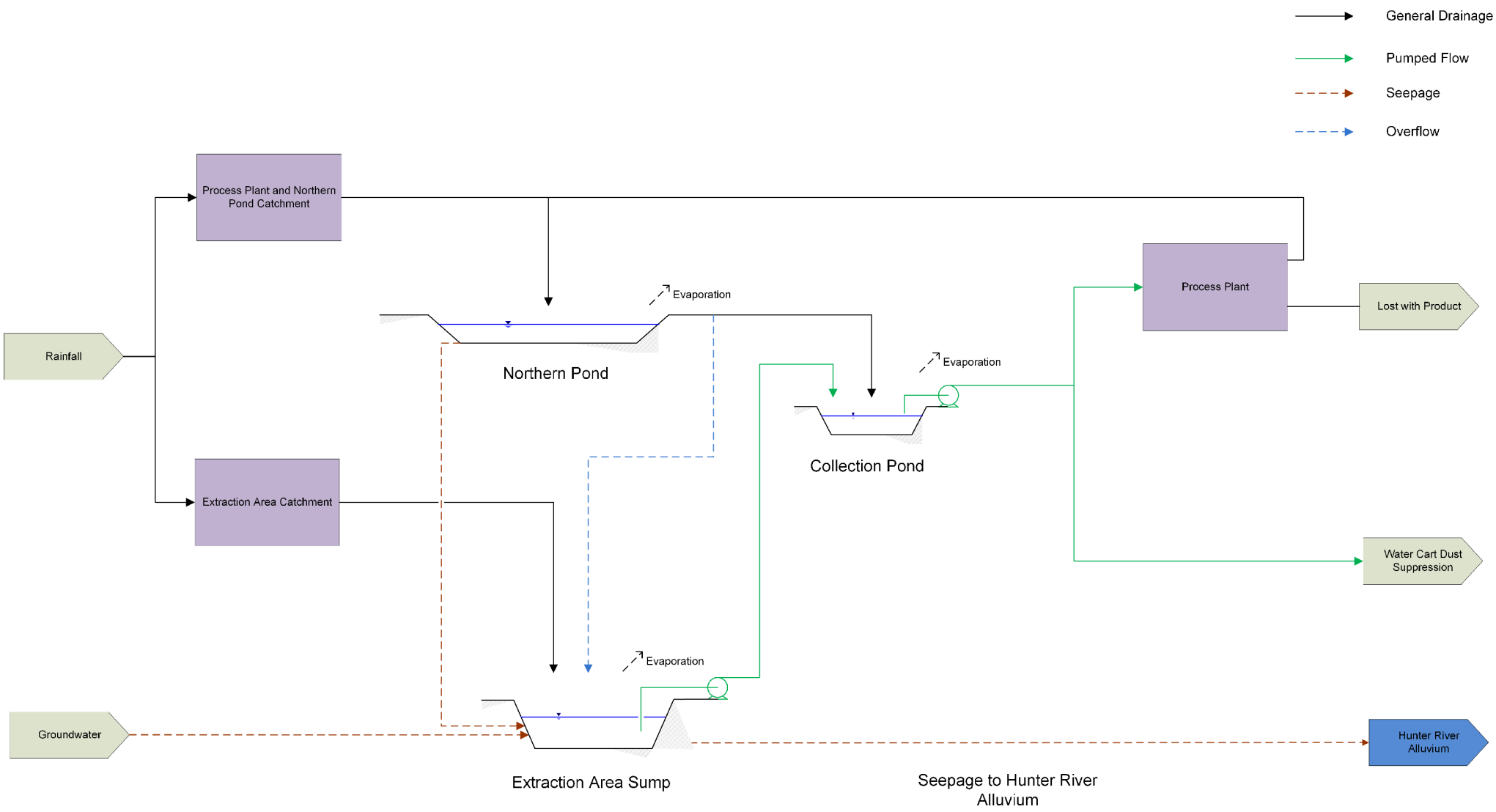


FIGURE 3.2

Existing Water Management System Schematic

3.2 Proposed Water Management

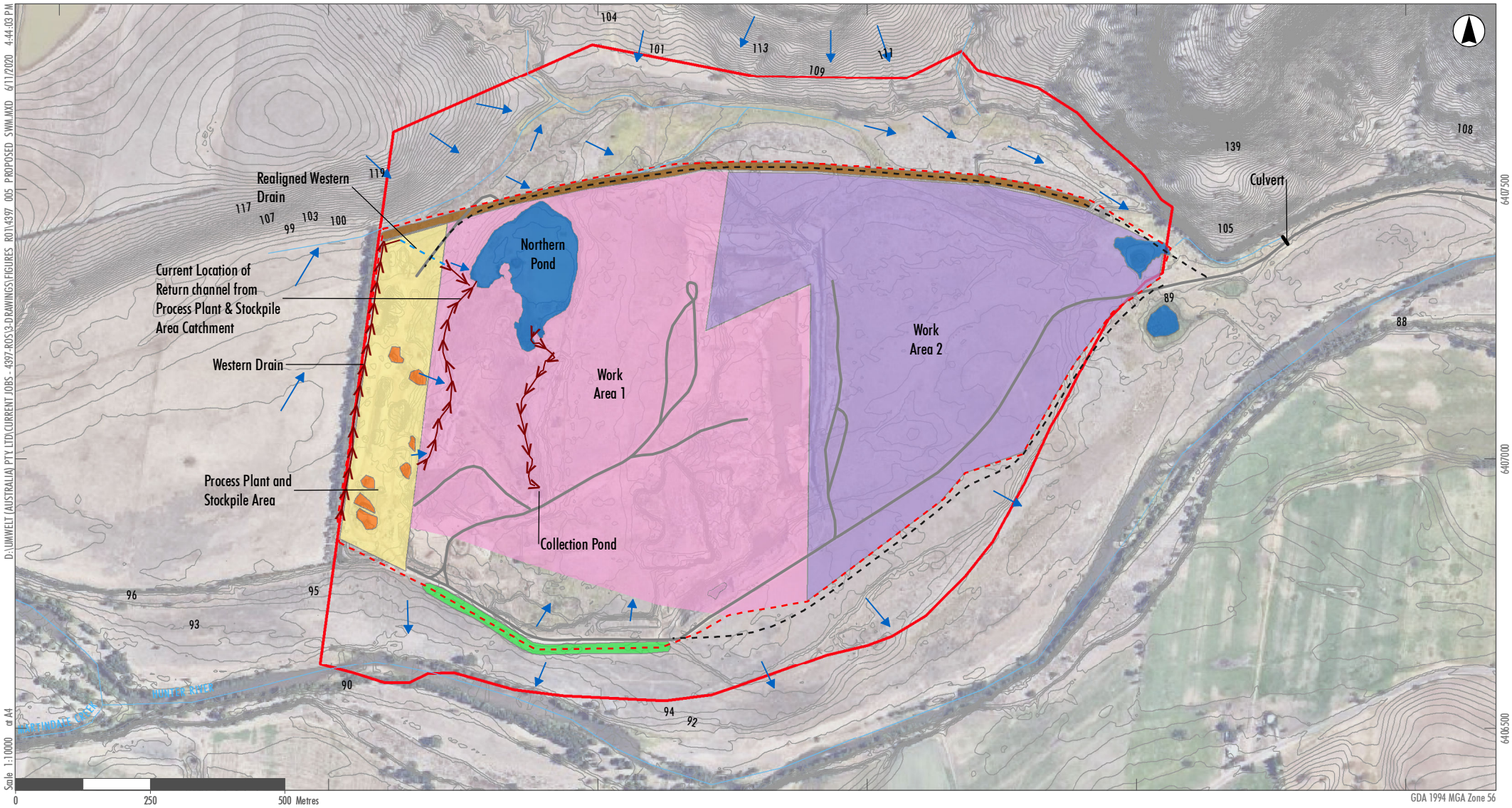
The present strategy of directing runoff from upslope undisturbed catchments around the disturbed areas of the Quarry will be maintained for the continued Quarry operation. **Figure 3.3** presents the proposed Quarry WMS plan. The proposed WMS will include, the realignment of the Western Drain to direct runoff to a collection pit that will be drained by an underground stormwater pipe to the Northern Pond and an extension of the bund wall along the northern side of the extraction area and Process Plant and Stockpile Area. Otherwise the WMS will remain generally unchanged with captured runoff from the Northern Pond being utilised for operational demands (i.e. material processing and dust suppression) and water extraction from the Quarry Pit supplementing the Northern Pond water supply. However, the progression of extraction in Area 1 will result in the requirement to modify the Collection Pond/channel system used to receive water discharged from the Quarry Pit and transfer water between the Northern Pond and the Process Plant.

The existing Quarry Pit has an estimated volume in excess of 200 ML. A volume of 200 ML is equivalent to over 200 mm of direct rainfall across the maximum proposed Quarry WMS catchment which is greater than a 48 hour 1% AEP storm event. Open pit volumes for the continued Quarry operation are expected to be comparable to the present pit volume.

The overall catchment reporting to the Quarry WMS will increase by up to approximately 100.6 ha (from 74.6 ha) as a result of the proposed extraction area extending to the eastern end of the site as will water demands associated with the proposed increase in production and haul road areas. **Section 4.0** presents site water balance for the proposed Quarry operation which accounts for the increased catchment areas and operation demands.

3.3 Final Landform

The proposed final landform has been designed to be a minimum of 2 m above mean Hunter River level adjacent to the Quarry and free drain in an easterly direction via overland flow to the Hunter River. **Figure 3.4** presents a plan of the proposed final landform.



Legend

- Project Area
- Earth Bund
- Flood Levee
- Pond
- Processing Area
- Stockpiles
- Work Area 1
- Work Area 2
- Drainage Line
- Piped Flow
- Haul Road Realignment
- Culvert
- Unsealed Road
- Dirty Drain
- Flow Direction
- WMS Boundary

FIGURE 3.3

Proposed Water Management System Plan

Image Source: Nearmap (Feb 2018) Data source: DFSI (2020)

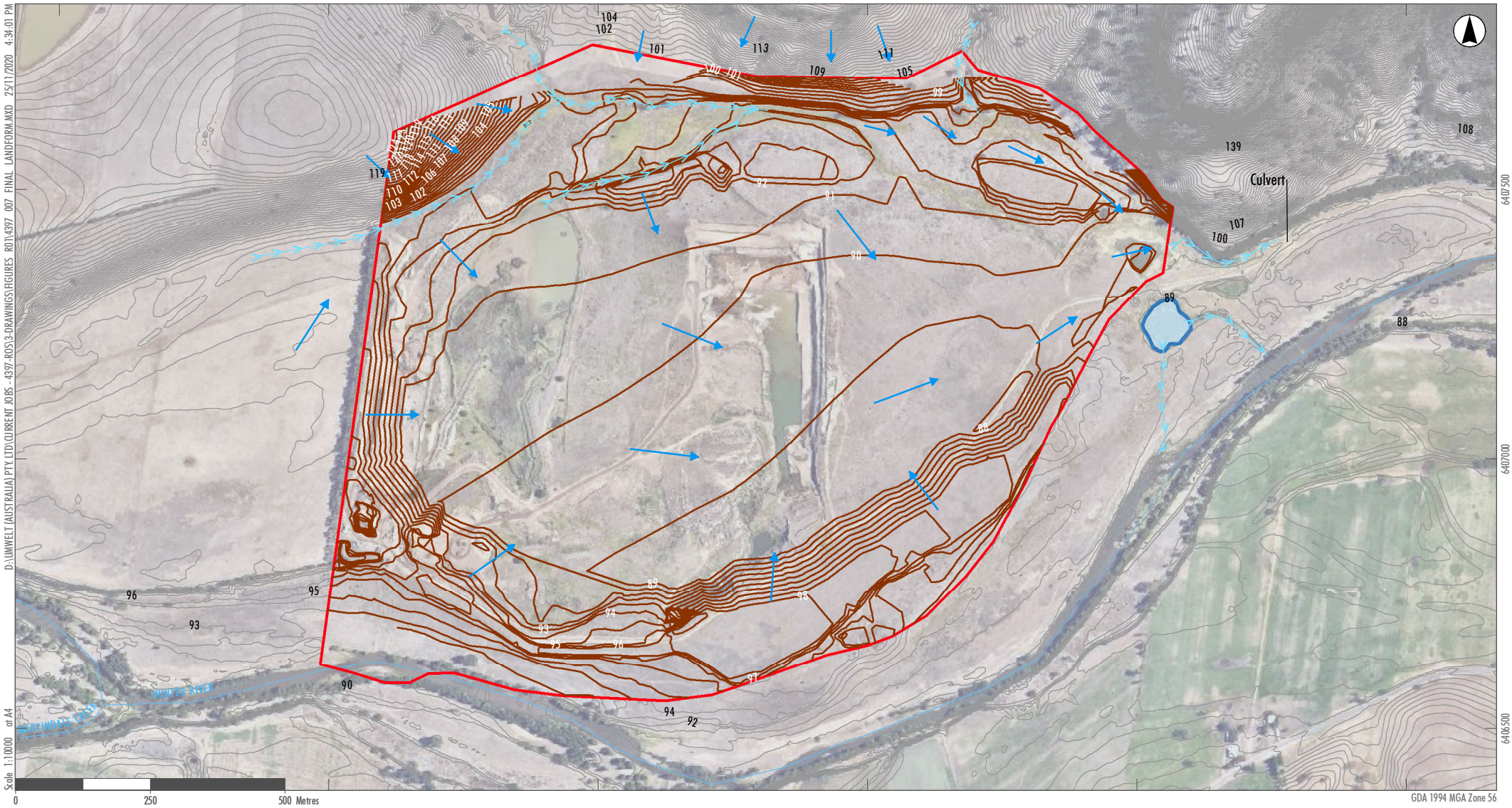


FIGURE 3.4

Final Landform

Image Source: Nearmap (Feb 2018) Data source: DFSI (2020)

4.0 Water Balance

A daily time step water balance model (the Model) of the existing and operational phases of Project was developed in the GoldSim modelling software platform to predict:

- the gross operational water balance (excludes water imports and controlled discharges)
- a detailed net water balance for the median gross water balance year
- the likely groundwater water import demand for the existing and proposed operation
- the volume and frequency of stormwater spills from the Quarry WMS.

4.1 Model Basis and Assumptions

4.1.1 Climate Data

The water balance model utilises 120 years (1900 to 2019) of rainfall and evaporation data sourced from the SILO climate database which provides site specific daily rainfall and evaporation records based on interpolated BoM monitoring records.

4.1.2 Runoff Model

Runoff was estimated using the Australian Water Balance Model (AWBM) (Boughton, 2003) and calibrated to the average annual regional runoff of 0.65 ML/ha/year (*NSW Farm Dams* Calculator, 2020) from undisturbed catchments in the quarry area. Baseflow Index (BFI) data from the *HUN Streamflow Baseflow Analysis* dataset (Bioregional Assessment Programme, 2016) was also utilised in the AWBM. It is noted, however, that no water inventory or transfer volume data for the Existing WMS was available to provide a site-specific basis for the AWBM calibration. Additional water quantity monitoring proposed for the Project (refer to **Section 6.2.2**) will allow better calibration of the AWBM and refinement of Model predictions.

4.1.3 Water Demands

Water demands considered in the water balance are:

- Process Plant water demands have been based on estimated losses associated with moisture in product dispatched from site as follows:
    - Gravel product does not have a net increase in moisture content as a result of processing (i.e. no additional water losses associated with gravel product processing)
    - Sand product has a net moisture increase as a result of processing of approximately 5% (raw material moisture 1%, product material moisture 6%
    - An existing production rate of 100,000 tonnes per year (approximately 70% gravel, 30% sand) and a future production rate of 500,000 tonnes per year (approximately 70% gravel, 30% sand).
- Water demands for dust suppression of the pre-cast product storage area has been estimated based on an evaporation - rainfall deficit, i.e.:
    - if rainfall exceeds pan evaporation then there is no dust suppression demand; or
    - if evaporation exceeds rainfall, the dust suppression demand is equal to pan evaporation minus rainfall

- A pan evaporation factor of 0.8 for water storage evaporative loss calculations+

- Outflow seepage from the Quarry Pit to the alluvium. The rate of seepage was estimated using an assumed function with seepage rates varied based on stored volume. Additional water quantity monitoring proposed for the Project (refer to **Section 6.2.2**) will allow calibration of pit seepage rates and refinement Model predictions.

4.1.4 Water Sources

Water sources used to supply operational water demands to the Project are stormwater captured in the Quarry WMS and groundwater from the Hunter Regulated River Alluvial water source for which RSG holds Water Access Licence (WAL) 36474 with a 20 unit share entitlement (20 ML per year when Water NSW Available Water Determinations offer a full allocation of 1ML/unit share).

4.2 Water Balance Results

4.2.1 Gross Water Balance

Table 4.1 presents the statistical 10th, 50th and 90th percentile gross water balance results (excludes controlled off-site discharges and water imports) for the Existing operation and the Proposed Operation

Table 4.1 Existing Operation Gross Water Balance Results

Statistic	Existing Operation (ML/year)	Proposed Operation (ML/year)
10th percentile	-15.9	-8.6
50th percentile	-4.3	-1.2
90th percentile	0.0	0.0

4.2.2 Median Year Water Balance

Table 4.2 presents the net water balance results for the modelled rainfall year closest to the gross water balance 50th percentile prediction for the Existing operation and Proposed operation.

Table 4.2 Median Year Net Water Balance

Parameter	Existing Operation (ML)	Proposed Operation (ML/year)
Inflows		
Rainfall Runoff	121.5	175.4
Groundwater Import	1.2	4.3
Total Inflows	***122.7***	***179.7***
Outflows		
Evaporation	-53.9	-46.4
Pit Seepage	-30.2	-131.4
Process Plant Demand (lost with product)	-1.2	-7.5
Haul Road Dust Suppression	-23.6	-38.7
Off-site Discharges	0.0	0.0
Total Outflows	***-108.9***	***-224.1***
Change in Storage	13.8	-44.3
Net Water Balance	**0.0**	**0**

The Model predicts an increase in surface water runoff capture of approximately 44% in the Quarry WMS for the Proposed operation due to the increase in the Quarry WMS catchment. An increase in operational demands associated with processing and haul road dust suppression is also predicted resulting in an increased groundwater import demand. The groundwater import demand is partly offset by the increase in surface water runoff captured in the Quarry WMS.

4.2.3 Imports

Table 4.3 presents the predicted groundwater water import volume statistics for the Existing operation and the Proposed operation.

Table 4.3 Existing Operation Groundwater Imports

Statistic	Existing Operation (ML/year)	Proposed Operation (ML/year)
Minimum	0.0	0.0
10th Percentile	0.0	0.0
50th Percentile	1.2	4.3
90th Percentile	8.6	15.9
Maximum	21.3	36.2
Average	3.2	6.7

As mentioned in **Section 4.2.1** the increase in production rate and haul road area results in a higher Process Plant water demand and therefore greater deficit. This is also reflected in the predicted increase in groundwater import volumes.

4.2.4 Discharges

Given the existing proposed WMS arrangement where all runoff, including excess water spilled from the Northern Pond, is drained to the Quarry Pit, no off-site discharges are predicted.

5.0 Surface Water Impacts and Mitigation Measures

5.1 Water Quantity

The water balance model predicts that the Project will result in an increased capture of surface water runoff (approximately 44% in for the median year water balance) and an increased requirement for groundwater import to supply increased operational demands associated with material processing and haul road dust suppression.

On average, groundwater import demands are predicted to increase by approximately 110% from 3.2 ML/year for the Existing operation to 6.7 ML/year for the Proposed operation. *Groundwater Impact Assessment Dalswinton Quarry* (hydrogeologist.com.au, 2020) estimates alluvial groundwater extraction of 14.6 ML/year based on the difference in evaporative losses between the undisturbed Quarry extraction area and the disturbed Proposed operation extraction area. As such, the Proposed Quarry operation may on average result in an exceedance (1.3 ML/year) of the existing Hunter Regulated River Alluvial WAL (WAL 36474) extraction limit of 20 ML/year. During dry years, the exceedance of the existing Hunter Regulated River Alluvial WAL (WAL 36474) may be greater. However, the proposed water quantity monitoring program (refer to **Section 6.2.2**) will further inform the site water balance and allow for groundwater extraction volume estimates to be determined with greater accuracy.

RSG will trade for additional Hunter Regulated River Alluvial water source shares should ongoing water quantity monitoring indicate that the Quarry water extraction of groundwater will exceed the WAL 36474 limit of 20 ML/year.

A significant amount of the additional surface water captured in the Quarry WMS will be returned to the environment via pit and disturbed area seepage to the alluvial water source which is highly connected with the Hunter River. This is due to the highly permeable alluvial soils and the rate of recharge to the alluvial water source for the disturbed catchment will be greater than that for undisturbed catchments. As such, the impact on base flows to the Hunter Regulated River is expected to be negligible. The loss of surface flows to the immediate downstream drainage lines and Hunter River is expected to be negligible given the relatively small increase in the Proposed Quarry WMS catchment. Further, the free draining final landform will result in all surface flows for the Quarry site being returned to the downstream environment.

During periods of drought and water shortages RSG will utilise surface water captured in the Quarry WMS, available water allocated under WAL 36474 and, if necessary, to ensure site environmental performance (i.e. dust suppression) is maintained. This may require curtailing Quarry production rates to reduce Process Plant water demands. Areas of the Quarry where resource extraction is complete will be progressively backfilled and rehabilitated (drought tolerant vegetation will be utilised wherever possible) reducing evapotranspiration rates and dust suppression demands.

5.2 Water Quality

Water balance modelling predicts that all dirty water runoff will be contained within the Quarry WMS and discharges to the environment will only be via seepage to the alluvial groundwater source. As no chemicals are used in material processing water seeping to alluvial groundwater source could only be contaminated by possible spills or leaks of fuels, oils or coolant. All fuels, oils and coolant stored at the Quarry is stored in accordance with relevant standards and guidelines including AS1940:2017 and mobile plant and vehicle maintenance and checks are undertaken to minimise the risk of leaks occurring. As such, the impacts associated with the Project on water quality are expected to be negligible.

5.3 Water Users

As noted in **Section 5.1,** a significant amount of the additional surface water captured in the Quarry WMS will be returned to the environment via pit and disturbed area seepage to the alluvial water source which is highly connected with the Hunter River. Further, the groundwater assessment for the Project (hydrogeologist.com.au, 2020) does not predict any impact on private bores in the area with drawdown confined to four monitoring bores at the northern boundary of the site.

There is only one potential surface water user downstream of the Quarry site within the Jerrys water source (property Lot 100 - DP39576), as there are no other downstream properties prior to surface flows entering the Hunter Regulated River water source. A search of the NSW Water register indicates that this property does not hold a WAL in the Jerrys Water source and there will still be significant upslope catchment draining to this property should the Project be implemented.

As noted in **Section 5.2** all dirty water is predicted to be retained within the Quarry WMS.

Based on the above, the impacts associated with the Project on water users downstream of the Quarry are expected to be negligible.

5.4 Stream Stability and Riparian Health

As there will be no increase in flows to downstream drainage lines as a result of the Project, no impacts on stream stability are expected. While there will be some loss in surface flows to the downstream drainage lines associated with an increase in Quarry WMS catchment, the loss is expected to the negligible given the significant upslope catchment area that will still flow to the downstream drainage lines around the northern extent of the Quarry. Further, as noted in **Section 5.2** all dirty water is predicted to be retained within the Quarry WMS. As such, impacts on riparian health are expected to be negligible.

6.0 Licensing, Monitoring and Reporting

6.1 Licensing

6.1.1 Environment Protection Licence

The Quarry operation is covered by EPL 12709 issued under the *Protection of the Environment Operations Act 1997* (NSW Government, 1997). Condition L1.1 in Section L1 of EPL 13351 states that:

Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

6.1.2 Water Extraction

6.1.2.1 Surface Water Extraction

The proposed Quarry WMS are designed to only capture water within disturbed and previously disturbed areas, with upslope undisturbed catchment surface runoff draining around the Project site to the downstream receiving environment. Surface flows from upslope undisturbed catchments outside of the proposed Quarry WMS are only expected during flood events when the Project site will be impacted tailwater flooding from the Hunter River.

Given surface water runoff captured within the Quarry WMS is to prevent the discharge of sediment laden water to the downstream environment, it is considered that there is no licencing requirement for surface water take (refer to **Section 0**).

Based on the Quarry landholding, RSG also has an approximate maximum harvestable right (capture of 10% of the average annual regional runoff for the landholding catchment) of 10.4 ML/year. This has been estimated based on a landholding of 160 ha (for Lot 72, DP1199484) and an average annual regional runoff of 0.65 ML/ha/year (refer to **Section 4.1.2**).

6.1.2.2 Alluvial Groundwater Extraction

RSG hold one water access licence (WAL 36474) and an associated works approval (20WA212819) for the Quarry for take of water from the Hunter Regulated River Alluvial water source. WAL 36474 has a continuing 20 unit share component in the alluvial water source (i.e 20 ML/year based on an available water determination (as determined by Water NSW) of 1 ML/share.

Water balance modelling indicates that the Quarry operation takes an average volume of 3.2 ML/year from the alluvial water source. With increased operational demands associated with the Project, the water balance model predicts that the Quarry will on average take approximately 6.7 ML/year from the alluvial water source.

The groundwater assessment for the Project (hydrogeologist.com.au, 2020) estimates alluvial groundwater extraction of 14.6 ML/year based on the difference in evaporative losses between the undisturbed Quarry extraction area and the disturbed Proposed operation extraction area. As such, the Proposed Quarry operation may on average result in an exceedance (1.3 ML/year) of the existing Hunter Regulated River Alluvial WAL (WAL 36474) extraction limit of 20 ML/year. During dry years, exceedance of the existing Hunter Regulated River Alluvial WAL (WAL 36474) may be greater. However, the proposed water quantity monitoring program (refer to **Section 6.2.2**) will further inform the site water balance and allow for groundwater extraction volume estimates to be determined with greater accuracy. RSG will trade for additional Hunter Regulated River Alluvial water source shares should groundwater import demands exceed the WAL 36474 limit of 20 ML/year.

6.1.2.3 Final Landform

The final landform has been designed to be a minimum of two metres above mean Hunter River level adjacent to the Quarry and free drain in an easterly direction via overland flow to the Hunter River. As such there will be no surface water licencing requirement for the final landform.

6.2 Monitoring

6.2.1 Environment Protection Licence

There are no specific surface water monitoring conditions listed in the current Quarry EPL (EPL 12709).

6.2.2 Water Quantity

WAL 36474 and the associated works approval requires RSG maintain a logbook and for each period of time that water is taken record:

A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and

B. the access licence number under which the water is taken, and

C. the approval number under which the water is taken, and

D. the volume of water taken for domestic and/or stock watering.

In practice, the Quarry cannot directly monitor groundwater take from the alluvial water source as runoff to the Quarry Pit cannot be segregated from the alluvial groundwater seepage inflows. As such the net groundwater take will be estimated using a water balance approach that accounts for direct rainfall runoff, evaporation and operational water demands. To inform the water balance, the RSG propose to implement the water quantity monitoring presented in **Table 6.1**.

Table 6.1 Water Quantity Monitoring Program

Parameter	Method/Measurement	Frequency
Haul Road and Exposed Area Dust Suppression	Number of water cart fills. Estimate demand by multiplying number of water cart fills by water cart capacity.	Monthly
Water storage inventories	Northern Pond inventory estimated based on water surface elevation and stage storage relationship for pond. Quarry Pit water inventory will vary with progression and backfilling of the extraction area. Quarry Pit inventory will be estimated based on the water surface elevation and the surveyed pit landform.	Monthly
Water lost with product	Dispatched product tonnage. Estimate demand based on incoming/outgoing material moisture to/from the Process Plant.	Annually
Rainfall and Evaporation	Source daily rainfall data from the nearest operating BoM station (currently Muswellbrook, station #61168). Source daily evaporation data from the Scone BoM station, station #61363. Daily rainfall and evaporation data are inputs to the water balance model which estimates runoff volumes to the WMS and evaporative losses from WMS water storages.	Annually

6.2.3 Surface Water Quality

RSG propose to implement a site and receiving water quality monitoring program as part of the continued Quarry operation (refer to **Section 2.2**). **Table 6.2** presents the proposed surface water quality monitoring program.

Table 6.2 Proposed Surface Water Quality Monitoring

Parameter	Units	Locations	Frequency
pH	-	Northern Pond Quarry Pit Hunter River Upstream Hunter River Downstream	Monthly[1]
Electrical Conductivity	µS/cm		
Turbidity	NTU		
Total Suspended Solids	mg/L		
Oil and Grease	mg/L		

1. Monthly monitoring of receiving waters is proposed for the first two years of the operation to establish a valid baseline data set. Monitoring results will be assessed after two years with a view to reducing monitoring frequency to quarterly

It is proposed to undertake water quality monitoring on a contiguous monthly basis for the first two years of operation under a new approval to develop a baseline data set in accordance with ANZG for receiving water quality. Provided the first two years of monitoring exhibit consistent and acceptable results, it is proposed to reduce the ongoing monitoring frequency to quarterly. This data will be used to set site specific trigger values for the downstream receiving water quality monitoring location and identify any potential risks to the receiving surface water and groundwater environments associated with Quarry WMS water quality. The NSW WQOs presented in **Table 2.2** will be adopted as in interim trigger values for the downstream monitoring location until site specific trigger values are established. It should be noted that if a trigger value is exceeded it does not necessarily indicate an impact on the receiving environment associated with the Quarry operation. Rather, a trigger value exceedance indicates that the receiving water quality has deviated outside of the expected range of results and further investigation should be undertaken to determine the likely cause of the deviation.

6.3 Reporting

6.3.1 Environment Protection Licence

Under EPL 12709 RSG is required to submit an Annual Return to the NSW EPA that includes:

- a Statement of Compliance,
- a Monitoring and Complaints Summary,
- a Statement of Compliance - Licence Conditions,

The Annual Return must be provided within 60 days of after the end of the reporting period. RSG is also required to provide a report to the NSW EPA in the following circumstances:

- Notification of environmental harm
    - Notifications must be made by telephoning the Environment Line service on 131 555.
    - The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.

- Where an authorised officer of the EPA suspects on reasonable grounds that:

  a) where this licence applies to premises, an event has occurred at the premises; or

  b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence, and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

  The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

6.3.2 Water Access Licence and Works Approval

RSG is required to produce the logbook (refer to **Section 6.2.2**) for inspection when requested by the licensor. RSG is also required to report:

- to the Minister when they become aware of a breach of any condition on WAL 36474;
- DoI when the water supply work authorised by the approval is no longer to be used permanently; and
- DoI within 60 days of the work being decommissioned.

7.0 Conclusions

Umwelt has completed a SWIA for the Project. The key conclusions from the surface water assessment are:

- The Project will result in an increase in surface water runoff captured within the Quarry WMS, however, a significant amount of the captured runoff will be returned to the environment via seepage to the Hunter River alluvial groundwater source.
- No off-site surface water discharges, other than seepage to the alluvial groundwater source, are expected from the Quarry WMS.
- No significant impacts on downstream water users, stream stability or riparian health are expected as a result of the Project.
- Additional Hunter River Alluvial water source share may be required to satisfy operation water demands. However, a water quantity monitoring program will be implemented to better inform potential licensing requirements.

8.0 References

Groundwater Impact Assessment, Dalswinton Quarry, hydrogeologist.com.au, 2020

Dalswinton Quarry Flood Investigation and Impact Assessment, Royal HaskoningDHV, 2020

umwelt
Environmental & Social Consultants

Newcastle | Perth | Canberra | Brisbane | Sydney | Orange

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au