Soil and Water Management Plan

Menangle Sand and Soil Quarry

Prepared for Menangle Sand and Soil Pty Ltd
February 2022

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Menangle Sand and Soil Quarry

Soil and Water Management Plan

Report Number

J190166 RP27

Client

Menangle Sand and Soil Pty Ltd

Date

25 February 2022

Version history

Version	Date	Prepared by	Approved by	Comments
v1	24 March 2021	M. Frankcombe J. O'Brien	P. Towler	Draft
v2	26 July 2021	M. Frankcombe J. O'Brien P. Towler	P. Towler	Updated to address comments from DPE and NRAR
V3	25 February 2022	K. Ward	P. Towler	Updated to incorporate Modification 2.

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1 Introduction

1.1 Background

Menangle Sand and Soil Pty Ltd (Menangle Sand and Soil) operates the Menangle Sand and Soil Quarry at 15 Menangle Road, Menangle (Figure 1.1). Quarrying has been undertaken in the location for over 40 years by a number of operators and at varying rates of production. Extraction, processing and rehabilitation activities have been undertaken by Menangle Sand and Soil since 1978.

The quarry, located in the Wollondilly and Campbelltown local government areas, extracts sand and soil along the Nepean River as approved by Development Consent 85/2865, granted by the Minister for Planning on 15 November 1989.

To date, sand and soil has been extracted from Stages 1 to 2 and 4 to 7 (Figure 1.2). While previously approved, sand and soil will not be extracted from Stage 3.

On 10 September 2020, the NSW Land and Environment Court (LEC) approved the Menangle Quarry Extension – Modification 1 (MOD1) to Development Consent 85/2865. Consent Conditions are provided in the Notice of Orders for LEC 2018/342158.

On 5 November 2021, the Minister for Planning and Public Spaces approved the Menangle Quarry Extension – Modification 2 (MOD2). Changes to the Consent conditions are provided in the Notice of Modification for Development Consent DA 85/2865.

The Consolidated Consent ('the Consent') allows the extraction of sand and soil in a new area, the Stage 8 area, that is about 13 ha, and extends about 2 kilometres (km) along the Nepean River south of the Stage 7 area. The quarry is approved to extract sand and soil from the Stage 8 area at a rate of up to 150,000 tpa.

The extracted material will be transported to the processing area where it will be stockpiled, processed and blended with materials imported to the site, prior to being dispatched from the quarry. Operations (but not extraction) will continue in the Stage 6 and Stage 7 areas.

Modification 2 removed the requirement for an overland conveyor and replaced it with the operation of an off-road haul truck for the transfer of extracted materials from the Stage 8 area to the processing area using existing roads.

This *Surface Water Management Plan* (SWMP) has been prepared to address the requirements of the Consent.

1.2 Project overview

The quarry has consent to extract the sand and soil resource in the Stage 8 area to 2035. Stage 8 has been split up into 15 sub-stages (Figure 1.3) which have been further categorised into seven extraction phases (Table 1.1).

Source: EMM (2022); DFSI (2017); GA (2011); ASGC (2006)

0 5 10 km

GDA 1994 MGA Zone 56

N

KEY

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

INSET KEY

- Main road
- State forest

Regional context

Menangle Sand and Soil Quarry
Figure 1.1

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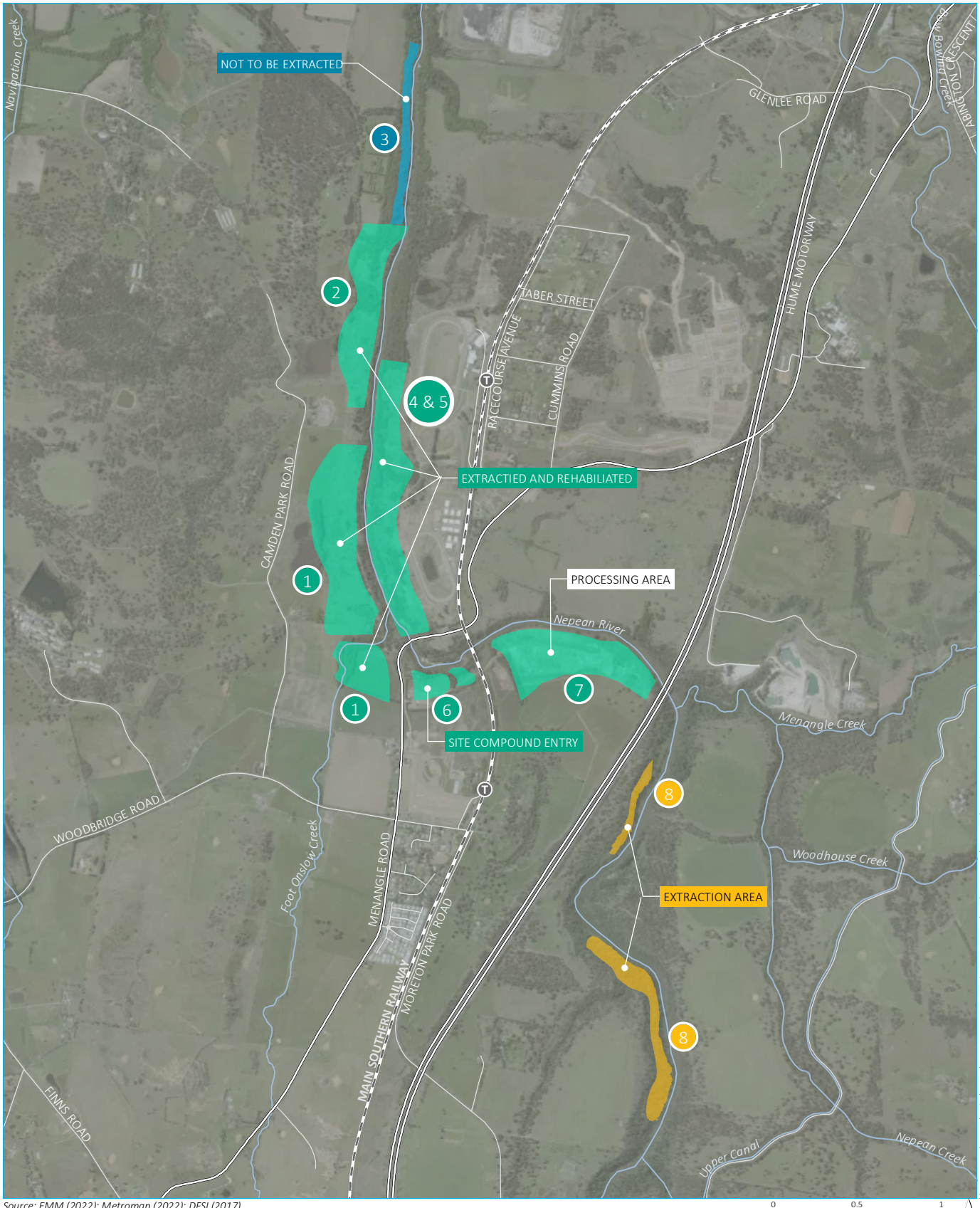

Source: EMM (2022); Metromap (2022); DFSI (2017)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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KEY

- Train station
- Rail line
- Main road
- Local road
- Named watercourse
- Extractive operations (approved)
- Extractive operations (approved but not extracted)
- Stage 8 - extraction/rehabilitation area

Menangle Quarry stages 1 to 8

Menangle Sand and Soil Quarry
Figure 1.2

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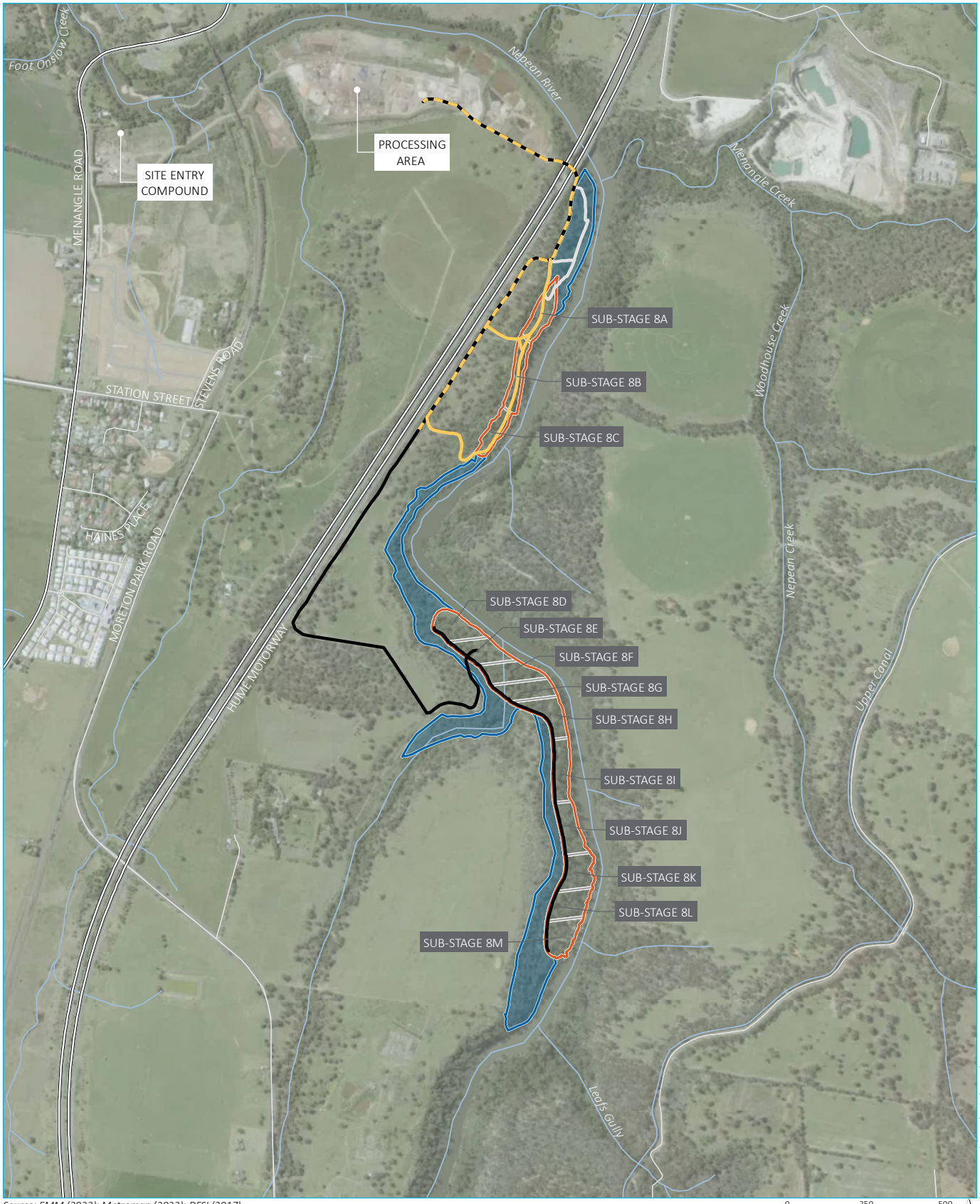

Source: EMM (2022); Metromap (2022); DFSI (2017)

0 250 500 m

GDA 1994 MGA Zone 56

N

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KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction)
- Main road
- Local road
- Watercourse/drainage line
- Access track

Haul roads

- Substage 8A-8M
- Substage 8A-8C
- Substage 8D-8M

- Substage boundary

Phase 1 Sub-stages 8A - 8B
Phase 2 Sub-stage 8C
Phase 3 Sub-stages 8D - 8E
Phase 4 Sub-stages 8F - 8G
Phase 5 Sub-stages 8H - 8I
Phase 6 Sub-stages 8J - 8K
Phase 7 Sub-stages 8L - 8M

Stage 8 area

Menangle Sand and Soil Quarry
Figure 1.3

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Table 1.1 Stage 8 phases

Phase	Substage
1	8A–8B
2	8C
3	8D–8E
4	8F–8G
5	8H–8I
6	8J–8K
7	8L–8M

Operations (but not extraction) will continue in the Stage 6 and Stage 7 areas.

As well as the extraction areas, key components of the quarry include:

- a wheel wash and weighbridge;
- a site office and amenity building;
- a workshop west of the site office;
- fuel supply tanks north of the storage shed;
- sand and soils storage and processing area; and
- other minor infrastructure.

These components will be used to support activities in the Stage 8 area which include:

- extraction in the Stage 8 extraction area followed by rehabilitation;
- restoration of areas adjacent to the extraction areas;

and

- internal haul roads utilising existing tracks.

1.3 Operations

1.3.1 Activities

Operations at the quarry comprises the following activities:

- vegetation management and clearance;
- sand and soil excavation;
- material transport by off-road haul truck;
- sorting and screening of excavated material;

- processing of excavated material;
- blending of excavated material with imported materials (permitted by the Consent and EPL 3991);
- stockpiling;
- loading of product into trucks; and
- product dispatch via trucks.

1.3.2 Plant and equipment

Consent Condition A33 states:

> All plant and equipment used on site, or to monitor the performance of the development must be:
>
> (a) maintained in a proper and efficient condition; and
>
> (b) operated in a proper and efficient manner.

Regular maintenance of all plant and equipment will be logged and records stored on site available for review at any time.

1.4 Quarry life

The Stage 8 Operations may be carried out on the site until 31 December 2035.

1.5 Operating hours

The quarry will operate during the approved hours in accordance with Consent Condition A26 Table 1 (see Table 1.2 below).

Table 1.2 Operating hours

Activity	Permissible hours
Construction work	• 7 am to 5 pm Monday to Friday • 7 am to 1 pm Saturday • At no time on Sundays or public holidays
Quarrying operations including loading and dispatch of laden trucks	• 6 am to 5 pm Monday to Friday • 6 am to 12 noon Saturday • At no time on Sundays or public holidays
Maintenance, security, office work, cleaning, etc	• May be conducted at any time, provided that these activities are not audible at any residence on privately-owned land

Consent Condition A27 states that where police or other public authorities request that deliveries or dispatching of materials are to be carried out outside operating hours and emergency work to avoid the loss of lives, property or to prevent environmental harm is required, then these activities are permitted outside the normal operating hours. In such circumstances, the Applicant must notify the Department and affected residents prior to undertaking the activities, or as soon as is practical thereafter.

1.6 Stage 8 area quarry design

The Stage 8 quarry design is presented in the *Applicant's Description of Amended Project* (EMM 2020a) and is summarised below, describing the design from the edge of the Nepean River to the landward side of the extraction area. A schematic of the quarry design is provided in Figure 1.4.

1.6.1 Lower riverbank

The lower riverbank will be retained below the 64 mAHD contour. No extraction will occur within this zone.

1.6.2 Nepean River Buffer Zone

The Nepean River Buffer Zone (NRBZ) will provide a minimum horizontal setback of 10 m extending landward from the 64 m AHD contour on the western side of the Nepean River. Where there are native trees within the 10-m wide horizontal setback area ('Protected Trees'), the width of the setback will be increased so that edge of the setback area/start of extraction area is at least 7.5 m (measured horizontally) from the trunk of these trees. Therefore, the NRBZ will be between 10-m and 17.5-m wide. As there will be no resource extraction within this zone, there will be no resource extraction within 7.5 m of Protected Trees.

The NRBZ for substages 8A–8C is presented in Appendix A of the *Biodiversity and Rehabilitation Management Plan* (BRMP).

1.6.3 Riverside batter

The riverside batter will be inland of the NRBZ and will be managed as follows:

- a temporary riverside batter with a maximum slope of 1:1 m (vertical: horizontal)[1], will be used during sand and soil extraction – this will allow the efficient extraction of the resource;
- following extraction of the resource above this batter, the batter will be then built up with suitable site material to give a permanent slope of 1:5 – this will provide additional assurance that the bank will be stable if the active extraction area is flooded during extraction;
- the maximum length of the riverside batter that has a slope between 1:1 and 1:5 will be restricted to 30-m long;
- regardless of the amount of material required, the maximum length of the riverside batter that has a slope between 1:1 and 1:5 will be restricted to 30 m, measured parallel along the river;
- in the final landform, the riverside batter will have a permanent slope of 1:5 – this will provide additional assurance that the bank will be stable in the long term; and
- if over the life of the quarry, activities temporarily cease in the extraction area such that the excavator is relocated from the Stage 8 area, the riverside batter will be always left as a 1:5 batter.

[1] All slopes in this report are expressed as vertical:horizontal.

Stage 8 quarrying schematic
Menangle Quarry
Figure 1.4

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1.6.4 Landward batter

The landward, or inland, batter is on the side of the extraction area furthest from the river. A maximum landward batter angle of 1:1 will be maintained, except where the batter is formed by the natural sandstone rock escarpment, which may be vertical in places.

1.6.5 Advancing quarry face

The quarry will progressively advance upstream at an average rate of about 150 m/year. The advancing quarry face will face downstream.

During large floods, river water may overtop the lower riverbank and horizontal setback area and flow into the active extraction area or may overtop the riverbank upstream of the active extraction area and flow along the bank to enter the active extraction area over the advancing face. A maximum batter angle of 1:2 will be applied to the advancing face so as to minimise any scour occurring as the water initially flows down the batter, until the water level in the extraction area is at the same level as the river.

1.6.6 Trailing quarry face

The trailing quarry face, between the active extraction area and backfilled extracted area, will face upstream.

This face will have a maximum landward batter angle of 1:5 as it will face upstream in a flood. As for the riverside batter, this will mitigate the scour risk.

1.6.7 Base of the extraction area

The resource will be extracted in a manner that ensures that the base of the extraction area is always at least 1 m above alluvial water table resulting from the normal low flow water level in the Nepean River.

Bores will be installed in the base of the active extraction area prior to the commencement of extraction in each successive substage and the water level will be recorded daily during active operations (see Section 6.4.1).

A casing (PVC pipe or similar) will be installed in each bore with the top of the casing extending above ground level. The depth to the water table from the top of the casing will be recorded. This depth will be written on a sign attached to the bore that is clearly visible to the excavator operator. The excavator operator will use this as a reference to determine the maximum extraction depth when within 2 m the water table.

1.7 Utilities

1.7.1 Potable water

Potable water from the mains supply is used for amenities in the site entry compound and is used to top up the wheel wash. The wheel wash recycles the wash water using an adjacent concrete sump so minimal top up with mains water is required.

No mains water is used for processing or dust suppression.

Menangle Sand and Soil will implement water saving measures such as water efficient toilets, flow reducers and ensuring that taps are not dripping.

1.7.2 Sewage

The site currently uses a septic system (as does the nearby Menangle Village) to manage sewage generated from the facilities in the site offices as there is currently no sewerage mains available. The site amenities are currently being relocated and the relocated facilities will be connected to Bio-Cycle treatment system.

1.8 Access

1.8.1 Site access

The main access to the site is from Menangle Road. Menangle Road is an arterial road which provides sub-regional access.

1.8.2 Access to the Stage 8 area

The existing access under the Hume Motorway was retained when the Road Transport Authority (now Transport for NSW, TfNSW) bisected the lands when acquiring the corridor for the original Hume Highway in 1969. The existing access road under the bridge will be sealed and will comply with TfNSW drainage and pavements standards.

Material will be transported beneath the Hume Motorway Menangle Bridge by off-road haul truck using existing tracks.

The earthmoving equipment, off-road haul truck and other plant to service the Stage 8 area may also access the area via Moreton Park Road. Major plant is expected to remain onsite through-out the duration of the quarrying operations except for major servicing or replacement.

1.8.3 Product dispatch

Truck movements at the site (ie combined inbound and outbound movements) will not exceed an average of:

- 147 per day on Monday to Friday; and
- 80 per day on Saturday.

1.9 Consultation

1.9.1 SWMP preparation

As required by Consent Condition B36(b), this SWMP has been prepared in consultation with:

- Environment Protection Authority (EPA); and
- Department of Planning, Industry and Environment (now Department of Planning and Environment, DPE) – Water (DPE-Water).

These regulators were contacted via email on 12 October 2020 (Appendix A) and invited to provide input to the SWMP preparation.

The EPA responded via a letter on 26 November 2020 that the EPA supports the development of Environmental Management Plans (EMPs) as part of good environmental management but does not generally approve specific EMPs for industry operations. The letter is provided in Appendix A.

A draft of this SWMP was provided to DPE-Water for their comment on 14 March 2021. The Natural Resources Access Regulator (NRAR) provided comments in the SWMP on 11 June 2021. The NRAR comments, with responses, are provided in Table 1.3.

Table 1.3 Natural Resources Access Regulator comments

NRAR comment	Response
The proponent must present a monitoring and operating strategy that includes on-going monitoring of permanent bores, as well as the proposed temporary method, that ensures extraction does not occur within one metre of the water table.	Permanent bores were installed at five locations (BH01_S, BH01_D, BH02, BH03 and BH04) and to date 12 months of groundwater level data has been collected. The dataloggers will continue to record the groundwater level every six-hours (see Sections 6.1 and 6.4.1). Temporary bores will be installed progressively in the active extraction area to determine the local water table level immediately prior to commencing extraction in each substage as required by Consent Condition B22 (a) (see Section 6.4.1). Additional text has been added to Section 1.6.7 regarding controlling the maximum depth of excavation.
The proponent must monitor, record and report all water take to demonstrate that take is less than 3 ML/year, thus qualifying for the licence exemptions afforded by the Water Management (General) Regulation 2018.	Further information has been provided in Section 2.3.2 on the annual process for determining that the water take remains less than 3 ML/year. This information has also been included in Table 6.6 and Table 6.7.
The Soil and Water Management Plan should include measures to address remediation or impacts that may be caused to the Nepean River or its banks and floodplain strips.	The measures that will be implemented to prevent impacts to the banks of the river by leaving the lower riverbank and Nepean River Buffer Zone in situ, preventing erosion and protecting bank stability are described in this SWMP. The *Biodiversity and Rehabilitation Management Plan* (BRMP) describes the measures that will be implemented to protect and improve vegetation on the bank of the Nepean River, to maintain the bank stability, and the rehabilitation of the impacted vegetation in the extracted areas.
The proponent must provide clarification over the contention minimal site runoff will enter the Nepean River. This clarification must include an explanation of the hydrology of the site and run-on locations and inputs from upslope catchment to the west of the site.	Section 1.6 has been added that details the Stage 8 area quarry design. Additional text and an indicative cross-section (Figure 5.6) have been added to Section 5.2.4 clarifying how the quarry design prevents runoff entering the Nepean River.
Management of woody debris for such an exposed site requires additional hydraulic analysis to determine if large woody debris should be imported to the site to aid in retention of soil material and resistance to scour during a moderate to high flood event on site.	Management of woody debris was considered during the assessment and approval of the Extension Project. This resulted in Consent Condition B78 which mandates the length of logs and woody debris that are to be placed within disturbance areas. Habitat trees and tree debris management is described in Section 5.2 of the BRMP.
The Department requests a copy of the Flood Management Plan is provided for consultation. This is needed to improve the Soil and Water Management Plan and for the proponent to be prepared for future flood events that scour bank faces and/or overtop the bank and drown out operational and rehabilitation areas.	The *Flood Management Plan*, prepared in accordance with Consent Condition B32 and approved by the Planning Secretary has been provided to DPE-Water.

The SWMP will be periodically reviewed in accordance with Consent Condition D5 and any material updates will be submitted to DPE, NSW EPA and DPE-Water.

Following the DPE review of the draft SWMP, the SWMP (version 2, 26 July 2021) was approved by the Planning Secretary on 24 September 2021 (Appendix B).

1.9.2 Plan update

Agencies, including NRAR, DPE-Water and Wollondilly Shire Council (WSC) were consulted during the MOD2 application process. Their comments were considered by Menangle Sand and Soil during the application process and by DPE on behalf of the Minister in approving the application and amending the Consent conditions.

A Controlled Activity Approval application for Substages 8A–8C was submitted to NRAR in May 2021. The Controlled Activity Approval was granted on 14 February 2022. As a result of consultation with NRAR, the following additional trigger action response plans (TARPs) were prepared and are referenced in the Controlled Activity Approval (CAA-2021-11223):

1. flood scour risk and remedial response; and

2. vegetation management and site stabilisation.

These TARPs are provided in Appendix E and Appendix F respectively.

1.10 Purpose and scope

This Soil and Water Management Plan (SWMP) presents the framework for the management of soil (primarily erosion and sediment control), surface water and groundwater at the quarry. It has been prepared to address the requirements of the Consent.

This SWMP provides a structured approach to soil and water across the quarry, including:

- a site water balance, including:
  - water sources and supply security;
  - water use;
  - reporting procedures, including annual site water balances;
  - outputs of the groundwater model; and
  - measures to minimise potable water use.
- a surface water management plan, including:
  - baseline flow and water quality data;
  - impact assessment criteria and trigger values;
  - a description of the quarry's surface water management system;
  - a surface water monitoring program; and
  - a protocol for identifying and reporting any exceedances of impact assessment criteria.

- a groundwater management plan, including:
    - baseline flow and water quality data;
    - impact assessment criteria and trigger values;
    - a protocol for ensuring that the quarry does not exceed the prescribed depth limits;
    - measures to protect the integrity of the groundwater monitoring network;
    - a groundwater monitoring program; and
    - a protocol for identifying and reporting any exceedances of impact assessment criteria.

The SWMP's appendices provide:

- consultation records;
- the Menangle Quarry Groundwater Model Report, including groundwater hydrographs;
- flood scour risk and remedial response TARP; and
- vegetation management and site stabilisation TARP.

This SWMP provides specific management measures for:

- the previously extracted Stage 6 and 7 areas including the infrastructure and processing areas;
- the Stage 8A–8C areas; and
- the tracks adjacent to the Stage 8 area that will be used by the haul truck.

An Ephemeral Creek Management Plan identifying measures to manage and control soil erosion and bank stabilisation for the ephemeral creek within substages 8E–8G has not been prepared at this stage but will be incorporated into the *Biodiversity and Rehabilitation Management Plan* (BRMP) prior to extraction within Substage 8E as required by Consent conditions B40 and B41.

Menangle Sand and Soil will not commence quarrying operations in the Stage 8 area until this SWMP is approved by the Planning Secretary.

Menangle Sand and Soil will implement this SWMP as approved by the Planning Secretary.

1.11 Report preparation

This SWMP has been prepared by Michael Frankcombe, Jason O'Brien, Nick Bartho and Dr Philip Towler.

Michael holds a Bachelor of Environmental Science and is a Certified Professional in Erosion and Sediment Control (CPESC No. 1341). Michael has over 30 years' practical experience in the civil construction, mining, and pipeline industries, specialising in erosion and sediment control, mining landform design, rehabilitation, revegetation, natural channel design and water treatment.

Nick holds a Bachelor of Engineering (Civil and Environmental) (Hons) and is EMM's Surface Water Team Leader. Nick has 19 years' experience as a water resources engineer, specialising in hydrologic and hydraulic modelling, flood impact assessment and flood risk management, including flood emergency and response planning.

Jason holds a Bachelor of Engineering (Environmental) (Hons). Jason has over five years' experience working as an environmental and water resources engineer, specialising in surface water assessments, water management plans, flood impact assessment, hydrologic and hydraulic modelling, water balance modelling, water quality investigation and data management, stormwater drainage, water and sewerage design, and GIS analysis.

Philip holds a Bachelor of Science and a PhD in environmental chemistry. Philip has extensive experience preparing environmental and social impact assessments and environmental management plans around Australia and internationally, and has led a wide range of geochemistry, water and sediment assessment projects.

2 Environmental requirements

Menangle Sand and Soil will comply with all legislation; project approvals; permits and licences; and standards and guidelines, as listed below.

2.1 Legislation

Legislation relevant to soil and water management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- Environmental Planning and Assessment Regulation 2000;
- *Protection of the Environment Operations Act 1997* (POEO Act);
- Protection of the Environment Operations (General) Regulation 2009;
- Protection of the Environment Operations (Waste) Regulation 2014;
- Protection of the Environment Operations (Waste) Regulation 2016;
- *Water Management Act 2000;*
- Water Management (General) Regulation 2018;
- *Work Health Safety Act 2011* (WHS Act);
- Work Health Safety Regulation 2017;
- *Contaminated Land Management Act 1997*;
- *Environmentally Hazardous Chemicals Act 1995;* and
- Environmentally Hazardous Chemicals Regulation 2008.

2.2 Consent conditions

The Consent conditions pertinent to this SWMP are listed in Table 2.1 below.

Table 2.1 Conditions relevant to the SWMP

Condition number	Condition	Relevant report section
Evidence of consultation		
A28	Where conditions of this consent require consultation with an identified party, the Applicant must:	
	(a) consult with the relevant party prior to submitting the subject document; and	Section 1.9
	(b) provide details of the consultation undertaken including:	Section 1.9 Appendix A

Table 2.1 Conditions relevant to the SWMP

Condition number	Condition	Relevant report section
	(i) the outcome of that consultation, matters resolved and unresolved; and	Section 1.9
	(ii) details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.	Section 1.9
Staging, Combining and Updating Strategies, Plans or Programs		
A29	The Applicant may prepare and submit the Soil and Water Management Plan and/or Biodiversity and Rehabilitation Management Plan required under conditions B36 and B73 of Schedule 2 on a staged basis, prior to the commencement of Quarrying Operations in each of Phases 1 to 7. Quarrying Operations must not commence in any phase until a management plan has been approved by the Planning Secretary for that phase.	Section 1.10
Part B Specific Environmental Conditions – Soil and Water		
B18	The Applicant must ensure that diesel spills and the like are cleaned up immediately so as not present a risk to water quality if the relevant Substage is inundated by floodwaters.	Section 5.2.5
Groundwater Monitoring and Management		
B19	The Applicant must monitor groundwater levels at Groundwater Bores BH01_S, BH01_D, BH02, BH03 and BH04 as shown in Figure 1 in Appendix 5, using continuous data loggers, for the duration of Quarrying Operations in the Stage 8 Area.	Section 6.1
B20	The Applicant must ensure that Quarrying Operations do not compromise the integrity of the monitoring bores identified in condition B19 of Schedule 2.	Section 6.1
B21	The Applicant must:	
	(a) collect groundwater quality samples at each of the monitoring locations identified in condition B19; and	Section 6.4.2
	(b) analyse collected groundwater quality samples for all major anions and cations and field parameters;	Section 6.4.2
	on an annual basis for the duration of Quarrying Operations in the Stage 8 Area.	Section 6.4.2
B22	The Applicant must ensure that:	
	(a) temporary bores are drilled or augered progressively in each Substage to determine the local water table position immediately prior to commencing extraction in each Substage; and	Section 6.4.1
	(b) the pit floor in each Substage remains at least 1 metre above the measured water table level averaged over a seven-day period following the date of drilling or augering.	Section 6.6
Water Supply and Licensing		
B23	The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of the development to match its available water supply.	Section 1
B24	The Applicant must develop a groundwater model using a variant of Modflow standard software, or equivalent software, to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 Area.	Section 6.2 Appendix C
B25	The Applicant must:	
	(a) initially construct the groundwater model required under condition B24 of Schedule 2 using the first three months of groundwater monitoring data collected from 17 June 2020 to 16 September 2020;	Section 6.2 Appendix C
	(b) update the groundwater model following collection of the first 12 months of data collected from 17 June 2020 to 16 June 2021; and	Section 6.2

Table 2.1 Conditions relevant to the SWMP

Condition number	Condition	Relevant report section
	(c) incorporate the outputs of the groundwater model into the Site Water Balance as required under condition B36(c)(i) of Schedule 2.	Section 5.3
B26	If a potential flood event (equivalent to a level of 64 m AHD at Menangle Weir, which represents the approximate height of overtopping of the Nepean River bank) does not occur between 17 June 2020 to 16 June 2021, then the Applicant must update the groundwater model required under condition B24 of Schedule 2 following the first flood event equivalent to or greater than this level when it occurs.	Section 6.2
B27	The Applicant must obtain any necessary Water Access Licences for the development under the *Water Act 1912* and/or the *Water Management Act 2000.*	Section 2.3.2
B28	When making an application for any necessary Water Access Licence, the Applicant must specify the annual take of water from each affected water source, as estimated by the groundwater model required under condition B24 of Schedule 2.	Section 2.3.2
B29	Should the maximum annual water take as calculated by the groundwater model increase due to subsequent revisions of the groundwater model, as required under conditions B25 and B26 of Schedule 2, the Applicant must acquire the necessary additional licence shares to account for the maximum predicted annual volume.	Section 2.3.2
B30	The Applicant must report on any water captured, intercepted or extracted from the site each year (directly and indirectly) in the Annual Review, including water taken under each Water Access Licence as applicable.	Section 5.8 Section 6.8
Soil Erosion		
B31	The Applicant must install and maintain suitable erosion and sediment control measures in the Stage 8 Area. These measures must be designed and implemented having regard to the guidance series *Managing Urban Stormwater: Soils and Construction*, and be detailed in the Soil and Water Management Plan required under condition B36 of Schedule 2.	Section 7
Soil and Water Management Plan		
B36	The Applicant must prepare a Soil and Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
	(a) be prepared by suitably qualified and experienced person/s;	Section 1.11
	(b) be prepared in consultation with EPA and DPE Water; and	Section 1.9
	(c) include a:	
	(i) **Site Water Balance** that:	Section 5.3
	• includes details of:	
	– sources and security of water supply;	Section 1
	– water use and management on the site;	Section 5.2
	– reporting procedures, including the annual preparation of a site water balance; and	Section 5.3.3 Section 5.8
	• minimises clean and potable water use on the site;	Section 1 Section 1.6
	• incorporates the outputs of the groundwater water model required under condition B24 of Schedule 2;	Section 5.3

Table 2.1 Conditions relevant to the SWMP

Condition number	Condition	Relevant report section
	(ii) **Surface Water Management Plan**, that includes:	
	• detailed baseline data on surface water flows and quality in watercourses and/or water bodies that could potentially be affected by the development;	Section 3.3 Section 5.1
	• surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts, and surface water management performance measures;	Section 5.5
	• a detailed description of the surface water management system on the site, including the:	
	– clean water diversion system;	Section 5.2.3
	– erosion and sediment controls (including the construction of bunds and swales within each Substage); and	Section 7.2
	– water storages (including a description of measures to maintain the storage capacity of sedimentation basins);	Section 7.2.5
	• a program to monitor and report on:	
	– any surface water discharges;	Section 5.4 Section 5.8
	– the effectiveness of the water management system;	Section 5.8
	– surface water quality in sedimentation basins; and	Section 5.4
	– water levels and quality in the Nepean River both upstream and downstream of the site; and	Section 5.4
	• a protocol for identifying and investigating any exceedances of the surface water impact assessment criteria and for notifying the Department and relevant stakeholders of these events;	Section 5.6
	(iii) **Groundwater Management Plan** that includes:	
	• all available baseline data for the site;	Section 6.3 Appendix C
	• groundwater performance criteria, including trigger levels for investigating any potentially adverse groundwater impacts, particularly with respect to aquatic habitat and regional groundwater systems;	Section 6.5
	• a protocol to ensure that Quarrying Operations do not exceed the extraction depth limit specified in condition B22(b) of Schedule 2;	Section 6.6
	• measures to ensure that the integrity of the groundwater monitoring network is not compromised by Quarrying Operations;	Section 6.1
	• a clear description of the reporting processes and procedures to be adopted for the routine collation, analysis and provision of monitoring data as required under conditions B21 and B22 of Schedule 2; and	Section 6.8
	• a protocol for identifying and investigating any exceedances of the groundwater performance criteria and for notifying the Department and relevant stakeholders of these events.	Section 6.6 Section 6.8
B37	Subject to condition A29, the Applicant must not commence Quarrying Operations in the Stage 8 Area until the Soil and Water Management Plan is approved by the Planning Secretary.	Section 1.10
B38	The Applicant must implement the Soil and Water Management Plan approved by the Planning Secretary.	Section 1.10
B39	The Applicant must ensure that all surface discharges from the site comply with the relevant provisions of the POEO Act.	Section 2.3.1

Table 2.1 Conditions relevant to the SWMP

Condition number	Condition	Relevant report section
Waste		
B91	The Applicant must:	
	(a) manage on-site sewage treatment and disposal in accordance with the requirements of an applicable EPL, and to the satisfaction of EPA and Council;	Section 1.7.2

2.3 Permits and licences

2.3.1 Environment Protection Licence

The quarry operates under Environment Protection Licence 3991 (EPL 3991) which has been varied to include the Stage 8 area. The EPL contains a number of conditions related to the prevention of pollution of, or to, water. These conditions are provided in Table 2.2, which also identifies the section of this SWMP or the *Environmental Management Strategy* (EMS) where each condition is addressed.

Table 2.2 Relevant conditions of EPL 3991 for prevention of pollution (water)

Condition	Requirement	Relevant report section
L1	**Pollution of waters**	
L1.1	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*.	Sections 5.5 and 6.5
M2	**Recording of pollution complaints**	
M2.1	The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.	EMS Sections 5 and 7
M2.2	The record must include details of the following: a) the date and time of the complaint; b) the method by which the complaint was made; c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect; d) the nature of the complaint; e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and f) if no action was taken by the licensee, the reasons why no action was taken	EMS Section 5
M2.3	The record of a complaint must be kept for at least 4 years after the complaint was made.	EMS Section 5
M2.4	The record must be produced to any authorised officer of the EPA who asks to see them.	EMS Section 5
R2	**Notification of environmental harm**	
R2.1	Notifications must be made by telephoning the Environment Line service on 131 555. Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.	EMS Section 8

Table 2.2 Relevant conditions of EPL 3991 for prevention of pollution (water)

Condition	Requirement	Relevant report section
R2.2	The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.	EMS Section 8

2.3.2 Water licensing

i Surface water

Menangle Sand and Soil hold existing water access licences (WAL) and approvals to extract surface water from the Hawksbury and Lower Nepean Rivers Water Source covered under the Water Sharing Plan (WSP) for the Greater Metropolitan Region Unregulated River Water Sources (see Section 5.3).

ii Groundwater

Consent Condition B27 requires that Menangle Sand and Soil obtain any necessary Water Access Licences for the development under the *Water Act 1912* and/or the *Water Management Act 2000*.

Part 1 of Schedule 4 of the Water Management (General) Regulation 2018 provides access licence exemptions, including:

> **7 Water taken in course of certain aquifer interference activities**
>
> (1) Any person lawfully engaged in an aquifer interference activity carried out in connection with an authorised project—in relation to the taking of up to 3 megalitres of groundwater from a groundwater source by one or more of those activities in a water year, if the taking of that groundwater is not for the purpose of its consumption or supply.
>
> (2) Without limiting subclause (1), the exemption conferred by that subclause (the exemption) applies to the taking of groundwater by the aquifer interference activity for the purpose of lawfully carrying out any of the following activities—
>
> (a) exploration for minerals (including coal) or petroleum,
>
> (b) quarrying, excavation, dredging or exploration for stone, aggregate, sand or gravel…

As described in Section 6.2, a peak inflow to the pit of 0.4 ML/year is predicted based on groundwater modelling. However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model, the inflow volumes may reach 0.7 ML/year. This is based on an annual average of 1.2 high flow events (with river levels above 62 mAHD but not greater than 64 mAHD) (see Section 5.1b of the *Groundwater Model Report,* Appendix C of this SWMP).

Therefore, as confirmed by NRAR (see Table 1.3), a groundwater access licence is not currently required by the quarry as peak inflow to the pit will be less than 3 ML/year.

As described in Section 6 of the *Groundwater Model Report* , the peak inflow is based on the highest modelled inflow volume during a high flow event for eight scenarios representative of the progression of the quarry. The predicted inflows per high flow event ranged from 0.003 to 0.34 ML, with the highest inflow predicted for Substage 8M. Given that there on average 1.2 high flow events annually, this was scaled to 0.4 ML/year. The predictive uncertainty analysis for the highest inflow scenario calculated a maximum inflow volume of 0.59 ML for

a high flow event. Based on the highest predicted inflow of 0.34 ML per high flow event, 8.8 high flow events in year would be required for the peak inflow to reach the exemption level of 3 ML/year. This is highly unlikely to occur. Based on the maximum inflow volume of 0.59 ML per high flow event, 5.1 high flow events in year would be required for the peak inflow to reach the exemption level.

Water levels at Menangle Weir will be reported annually (see Section 5.4). If there are more than 5 high flow events (with river levels above 62 mAHD but not greater than 64 mAHD) in a Water Year (July–June), the groundwater model will be used to predict the peak annual inflow over the year.

Should the modelled peak annual inflow exceed 3 ML/year, Menangle Sand and Soil will acquire the necessary water access licence shares for the Sydney Basin Nepean Groundwater Source (Management Zone 2) to account for the estimated maximum groundwater ingress to the excavations in a Water Year (July–June).

Should the modelled peak annual inflow exceed subsequently further increase due to revisions of the groundwater model, Menangle Sand and Soil will acquire the necessary additional licence shares to account for the estimated maximum groundwater ingress.

2.4 Controlled Activity Approval

Activities in the Stage 8 area will be undertaken in accordance with Controlled Activity Approval CAA-2021-1122 granted on 14 February 2022.

2.5 Guidelines

This SWMP has been developed consistent with the principles discussed in the following publications and documents:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000 and ANZG 2018);
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC 2008);
- *Best Practice Erosion and Sediment Control* (IECA 2008);
- *Managing Urban Stormwater: Soils and Construction (4th Edition) Volume 1* (Landcom 2004) (the "blue book"); and
- *Managing Urban Stormwater: Soils and Construction – Volume 2E – Mines and Quarries* (DECC 2008).

3 Existing environment

3.1 Climate

The nearest active rainfall gauge to the quarry is the Bureau of Meteorology (BoM) operated gauge Menangle Bridge (Nepean River) (station number 68216). The Menangle Bridge rainfall gauge is located adjacent to the existing processing area and has a data record from 2000 to present day. While the Menangle Bridge gauge provides the most representative rainfall conditions at the site, the relatively short available data record means that rainfall statistics for the gauge are skewed by the generally drier conditions observed post 2000.

To characterise the long-term climate of the site, daily rainfall and evaporation totals were obtained as SILO (Scientific Information for Land Owners) Point Data from the Queensland Climate Change Centre of Excellence. SILO Point Data consist of interpolated estimates based on historically observed data from the BoM weather stations. SILO data was obtained for the nearest grid point (34.10 °S, 150.75 °S) located approximately 2 km north of the site. The average annual rainfall total at the site is 722 mm/year based on the SILO Point Data between 1900 and 2020.

Monthly rainfall and evaporation statistics calculated from the SILO Point Data between 1900 and 2020 are shown in Figure 3.1. Monthly rainfall totals are shown to be variable across all months but are generally higher in summer and lower during winter and early spring. Monthly evaporation totals are shown to typically exceed monthly rainfall totals throughout the year.

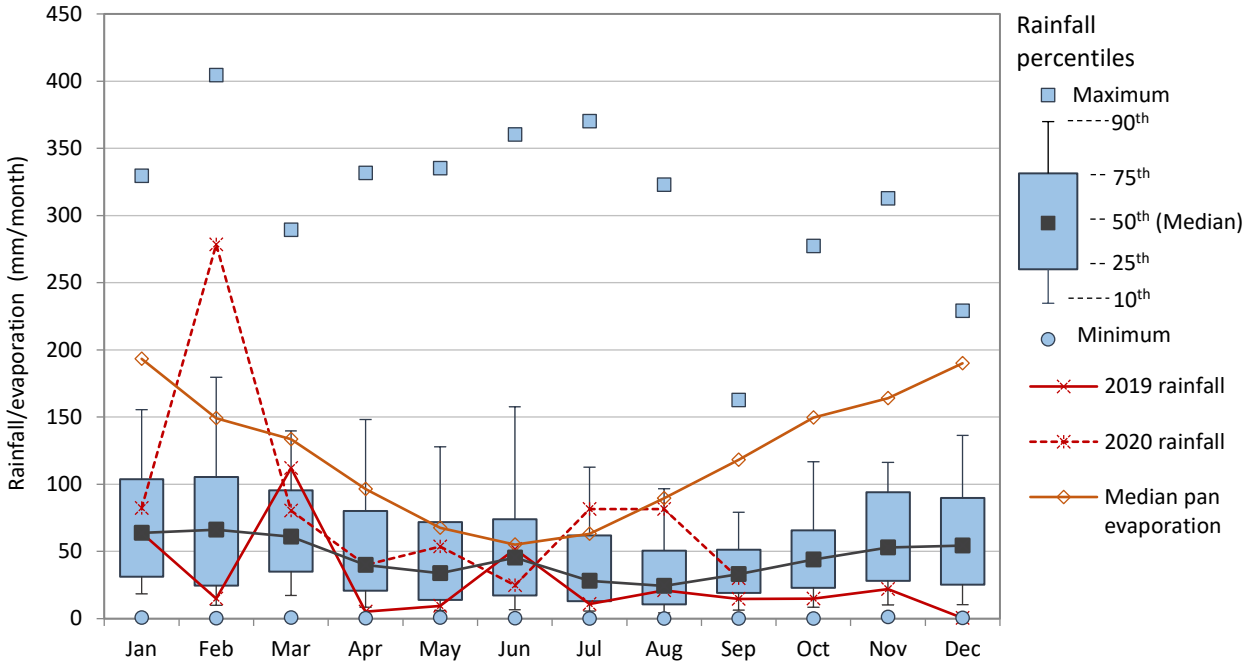


Figure 3.1 Monthly rainfall and evaporation statistics

The erosion potential of rainfall (rainfall erosivity (R-factor)) is a function of the rainfall amount and peak rainfall intensity measures in units of MJ.mm.ha^{-1}year^{-1}. It is a multi-annual average index that measures rainfall's kinetic energy and intensity to describe the effect of rainfall on sheet and rill erosion and is calculated using the formula (Rosewell and Turner 1992):

$$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$$

where, S is the 2-year annual recurrence interval (ARI), 6-hour rainfall event (0.5 exceedances per year, 6-hour event).

S equals 8.43 mm/h.

The calculated R-factor for the quarry site is 1,663 MJ.mm.ha^{-1}.year^{-1} The R-factor is used to determine erosion hazard for the quarry site in Section 7.1.

3.2 Land use and topography

The quarry is located in a semi-rural environment in the southwest of the Greater Sydney Metropolitan Region (see Figure 1.1). The surrounding land use includes scattered rural residential properties, agriculture and other extractive industry. The town of Menangle is located about 1 km to the south of the quarry's processing area. The area has a number of proposed housing developments currently in different stages of approval.

The quarry entry compound and processing area are located on the southern bank of the Nepean River, to the east and downstream of the Hume Motorway bridge. The ground surface elevation of these areas increases from approximately 61 m Australian Height Datum (AHD) at the Nepean River to approximately 70 m AHD at the southern boundary of the processing area. The terrain is terraced with lower elevations adjacent to the Nepean River and higher elevations forming the stockpiling and processing area.

Sand and soil will be quarried from the Stage 8 extraction area which is located along the western side of the Nepean River to the south of the processing area, upstream of the Hume Motorway bridge. The topography of the Stage 8 extraction area is steeper than the processing area, with a pronounced slope from the Nepean River to the agricultural land east of the Hume Motorway. The slope is generally gentler at the northern end of the Stage 8 area, increasing in steepness to the south. Terrain slopes within the Stage 8 area are described in Section 7.1.2.

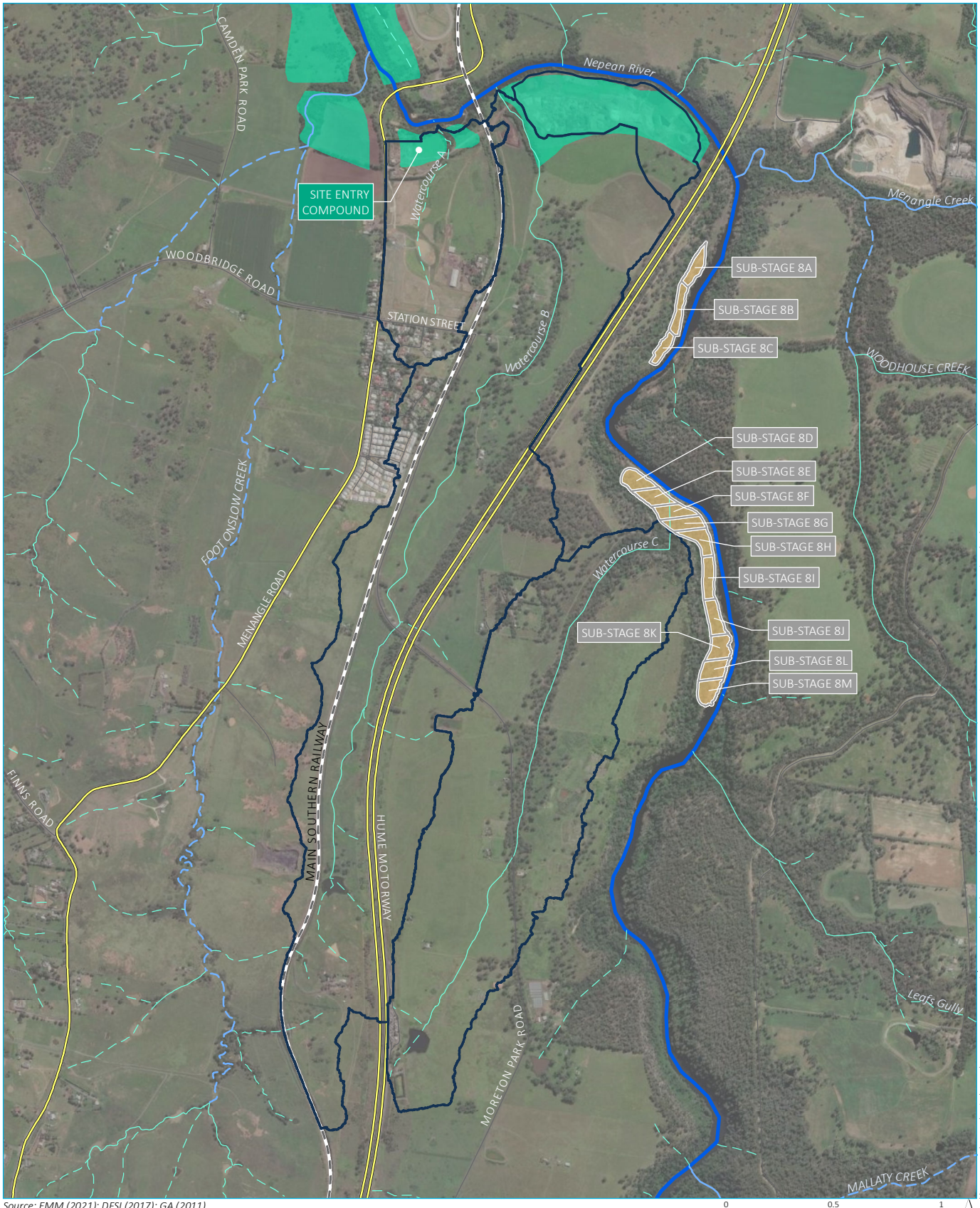
3.3 Surface water

The quarry is located on the floodplain of the Nepean River. The Nepean River is a major perennial watercourse and forms part of the greater Hawkesbury-Nepean system. Adjacent to the quarry, the Nepean River is classified as a seventh order watercourse ((Strahler 1952) and has a contributing catchment area of 1,280 km^2 (WorleyParsons 2015). A baseline characterisation of Nepean River flow regimes and water quality in the vicinity of the quarry is provided in Section 5.1.

There are several minor unnamed tributaries of the Nepean River close to, or within, the site entry compound, processing area and the Stage 8 extraction area (see Figure 3.2). All of these unnamed watercourses have an ephemeral flow regime and are identified as:

- Watercourse A – is a first order stream that flows north adjacent to the site entry compound and has a catchment of about 51 ha. The contributing catchment is comprised of rural grassland and a small area of residential development on the northern fringe of Menangle.

- Watercourse B – is a second order stream that flows north adjacent to the processing area. Watercourse B rises approximately 4 km south of the processing area and has a catchment of about 294 ha. The catchment is comprised of rural grassland with some scattered treed areas and includes parts of the Hume Motorway and Southern Rail Line corridors as well as a small area of existing residential development at Menangle.



Source: EMM (2021); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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KEY

- Substage boundary
- Stage 8 - extraction/rehabilitation area
- Extractive operations
- Rail line
- Main road
- Local road
- Catchment boundary

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

Local watercourses and catchment

Menangle Quarry Extension
Soil and water management plan
Figure 3.2

EMM
creating opportunities

- Watercourse C – is a second order stream that flows north and intersects the substage 8E, 8F and 8G extraction area. Watercourse C rises approximately 3 km south of the Stage 8 extraction area and has a catchment area of about 166 ha. The catchment is primarily comprised of rural grassland with some scattered treed areas.

An Ephemeral Creek Management Plan will be developed specifically for Watercourse C prior to commencement of quarrying in Stages 8E, 8F and 8G in accordance with Consent Condition B40.

3.4 Geology

The quarry is within the south-central portion of the Permo-Triassic Sydney Basin (Helby 1980). The Sydney Basin covers approximately 36,000 km^2 along the eastern coast of Australia, centred around Sydney, NSW (Geoscience Australia 2020). Geology within the Sydney Basin typically comprises sedimentary sandstones and mudstones, Permian coal measures and marine shales (Helby 1980).

The quarry is predominantly underlain by Triassic Hawkesbury Sandstone (Colquhoun 2019). The Hawkesbury Sandstone occurs across approximately 20,000 km^2 of the Sydney Basin and can be up to a 250 m thick, typically comprising flat-lying, quartzose sandstone with occasional interbeds/interlaminates of shale. Deposition of the Hawkesbury Sandstone varies from shallow marine, littoral, estuarine, fluvial lacustrine and aeolian environments (Helby 1980).

The quarry extracts the Quaternary alluvial deposits along the Nepean River. Although not mapped in the regional surface geology (Colquhoun 2019), the alluvial deposit extends further south, localised to the Nepean River valley. The alluvial deposits comprise a mixture of sand, silt, gravel and clay (Colquhoun 2019).

An outcrop of Triassic Ashfield Shale of the Wianamatta Group is inferred approximately 500 m west of the quarry (Colquhoun 2019) and conformably overlying the Hawkesbury Sandstone. In some areas adjacent to the Nepean River the unit has been completely eroded, resulting in the underlying Hawkesbury Sandstone being in direct contact with the overlying alluvium (Ross 2014).

3.5 Soils

The processing area is mapped as being located within the Blacktown soil landscape. The Blacktown soil landscape occurs on gently undulating rises on Wianamatta Group shales and generally features shallow to moderately deep soils (<0.1 m) (Hazelton 1990).

The Stage 8 area is mapped as the Hawkesbury soil landscape and borders on the Blacktown soil landscape. The Hawkesbury soil landscape is situated along major rivers, such as the Nepean River. It is characterised by sandstone escarpments with moderate to steep slopes (>25%) and deeply incised valleys. Rock outcrops are a significant feature. This soil landscape is comprised of sandstone-quartz, sandstone-lithic, sand and shale overlaid with shallow, sandy soil.

The soil and landscape characteristics of the Hawkesbury and Blacktown soil landscapes are summarised in Table 3.1.

Table 3.1 Summary of soil landscapes

Soil landscape	Description	Vegetation and land use	Landscape integrity
Blacktown	Gently undulating rises on Wianamatta Group shales. Shallow to moderately deep (<0.1 m) hard setting mottled texture contrast soils, red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines.	Near completely cleared open-forest and open-woodland (dry sclerophyll forest).	No appreciable erosion occurs. Minor sheet and gully erosion may be found where surface vegetation is not maintained.
Hawkesbury	Rugged, rolling to very steep hills on Hawkesbury Sandstone. Shallow (>0.5 m), discontinuous Lithosols/Siliceous Sands associated with rock outcrop; Earthy Sands, Yellow, Earths, and some Yellow Podzolic Soils on inside of benches and along joints and fractures; localised Yellow and Red Podzolic Soils associated with shale lenses; Siliceous Sands and secondary Yellow Earths along drainage lines.	Mostly uncleared open-woodland (dry sclerophyll) with pockets of tall open-forest (wet sclerophyll) and closed-forest (rainforest).	Severe sheet erosion often occurs during storms and after ground cover is destroyed by bushfire. Minor gully erosion occurs along unpaved tracks and fire trails.

Source: Hazelton and Tille (1990).

Importantly, field investigations have indicated that the Stage 8 area is not characteristic of the mapped soil landscapes but instead comprises alluvial deposits along a riparian corridor of the Nepean River. As such, the mapped soil landscapes are not indicative of the soils in the Stage 8 area. Drilling undertaking by Menangle Sand and Soil in 2014 indicates that the soils consist of deep fine to coarse sands ranging from 3 to 5.5 m deep with sandy loam soil with soil depth decreasing away from the river where bedrock is encountered.

3.6 Hydrogeology

The Hawkesbury Sandstone is a dual porosity aquifer unit, conducting groundwater flow primarily via interconnected fractures and partially via matrix pore spaces. Permeability of the unit is highly dependent on the degree, continuity and interconnectivity of fracturing. The unit is regionally semi-fully confined however, due to the inferred absence of the Wianamatta Group within the quarry the unit is assumed to be unconfined and hydraulically connected with overlying alluvial aquifers (where present) (Parsons Brinckerhoff 2009).

Groundwater within the upper section of the Hawkesbury Sandstone is typically slightly acidic-slightly alkaline (pH 5.3–7.3) (McLean 2009) and salinity of 1,000–3,000 milligrams per litre (mg/L) within the quarry (Russel 2009).

The localised alluvial aquifers within the quarry are likely highly permeable, unconfined aquifers. Water levels and quality are likely to be controlled by the Nepean River and rainfall with some potential influence from the underlying Hawkesbury Sandstone aquifer.

The Ashfield Shale typically has a very low permeability and contains saline groundwater. It is not considered an aquifer and, depending on the local underlying geological sequence, may be considered an aquitard or aquiclude. It may influence groundwater chemistry (particularly salinity) within the quarry (McLean 2009).

Further details of the baseline groundwater conditions are provided in Section 6.2 and in the *Menangle Quarry Groundwater Model Report* (provided in Appendix C).

4 Environmental aspects and impacts

4.1 Potential impacts

Key aspects of the quarry operation that could result in adverse impacts to soils and water include:

- vegetation clearing, including riparian vegetation, and topsoil stripping;
- earthworks, including resource extraction;
- transportation of extracted material;
- drainage works;
- material stockpiles;
- water use/extraction;
- landscaping and revegetation;
- operations including fuel and chemical storage, refuelling and chemical handling; and
- weed treatment, including herbicide spraying.

4.2 Impact summary

Potential impacts on soil and water depend on the nature, extent and magnitude of quarry activities and their interaction with the natural environment. The potential soil and water impacts associated with operations of the quarry are:

- erosion of land and soils within operational areas;
- mobilisation and transport of sediment into nearby surface water systems;
- contamination of surface water systems from activities associated with the quarry; and
- contamination of groundwater systems from activities associated with the quarry.

The potential soil and water impacts and associated risks are described in Table 4.1.

Table 4.1 Potential soil and water impacts and associated risk rating

Issue	Potential impact	Source	Risk ranking	Management response
Soil and water	Erosion of land and soils	Areas that have been disturbed by quarrying activities or areas that are unvegetated may be subject to erosion of topsoil in wet weather events.	High for soils Very low to very high from slope and rainfall	Refer to Section 7.2
	Mobilisation and transport of sediment	Runoff may transport sediment offsite and/or into surface water systems.	Moderate	Refer to Section 7.2

Table 4.1 Potential soil and water impacts and associated risk rating

Issue	Potential impact	Source	Risk ranking	Management response
	Contamination of surface water system from operational activities	If not properly managed, conducting quarrying operations in the vicinity of surface water systems could lead to contamination from waste, sediments, chemicals or other pollutants.	Moderate	Refer to Section 5.2
	Contamination of groundwater system from operational activities	If not properly managed, conducting quarrying operations could lead to contamination of groundwater from waste, sediments, chemicals or other pollutants.	Low	Refer to Section 6.6

5 Surface Water Management Plan

5.1 Baseline surface water data

5.1.1 Surface water flow

Nepean River water level and streamflow are measured at the WaterNSW operated Nepean River at Menangle Weir (212238) stream gauge. The Nepean River at Menangle Weir gauge is located approximately 250 m downstream of the processing area. The gauge provides a good representation of Nepean River flow characteristics adjacent to the site. Nepean River streamflow from 2015 to 2020 is shown in Figure 5.1

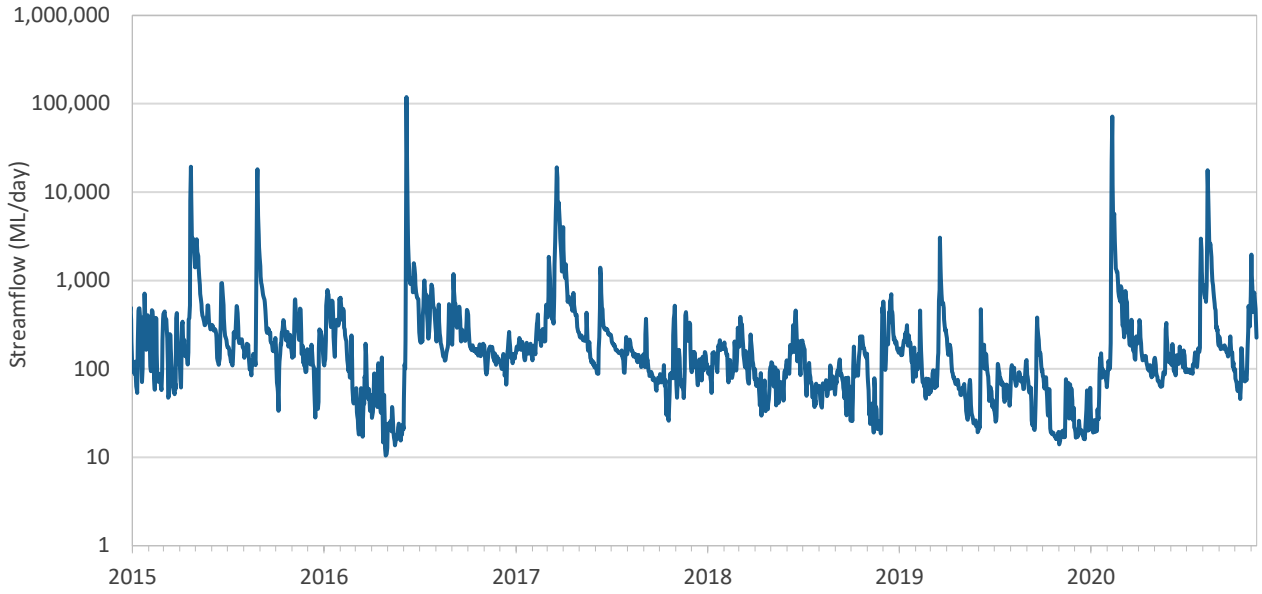


Figure 5.1 Nepean River at Menangle Weir streamflow from 2015 to 2020

The Nepean River experiences a broad range of daily streamflow totals with observed values ranging between about 10 ML/day and 100,000 ML/day (Figure 5.1). Streamflow at Menangle Weir typically ranges from 20 ML/day to 150 ML/day.

Water levels at Menangle Weir from 1990 to 2020 are shown in Figure 5.2. and from June 2020 to June 2021 in Figure 5.3. The Stage 8 horizontal setback contour (64 m AHD) and 20% and 50% annual exceedance probably (AEP) flood levels are shown for context. The Stage 8 extraction area is expected to be inundated by flooding. Flood conditions at the quarry are described in the *Flood Management Plan*.

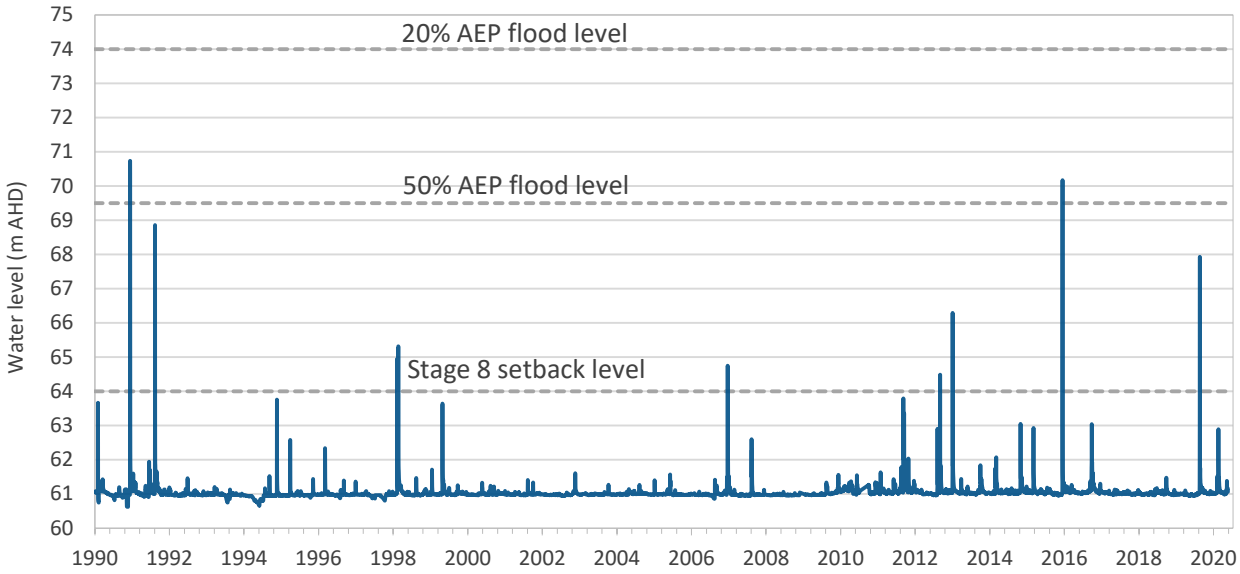


Figure 5.2 Menangle Weir water level from 1990 and 2020

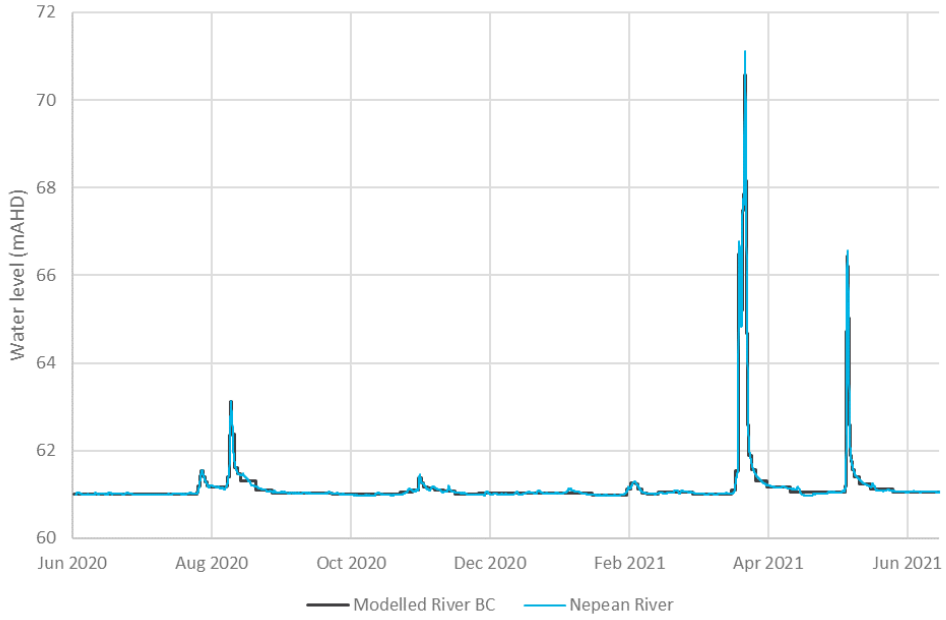


Figure 5.3 Menangle Weir water level from June 2020 to June 2021

5.1.2 Surface water quality

Water temperature and electrical conductivity are measured at the Nepean River at Menangle Weir (212238) stream gauge by WaterNSW. Temperature data are available from 1990 while electrical conductivity data are available from 2019.

Monthly average water temperatures range from 9 °C in July to 27 °C in January. Electrical conductivity is fresh and typically ranges between 100 and 250 µS/cm. Lower electrical conductivities are generally observed during high flow conditions when rainfall runoff contributes a greater portion of streamflow.

Water quality in the Nepean River is summarised in the *Aquatic Ecology Assessment, Menangle Weir Pool Nepean River* (Marine Pollution Research 2019) as follows:

- There were generally no major differences between surface and bottom readings at sampling sites (see Figure 5.4), or of readings between sites, indicating that waters were generally well mixed, even at depth.

- Water temperatures were similar between river, tributary (WQTrib) and downstream of weir (WQ4) sites, ranging between 15.3°C and 16.8°C. Site NepMB waters [the Maldon Bridge, about 23.5 km upstream of Menangle Weir] (measured a week later) were slightly cooler, around 14.4°C.

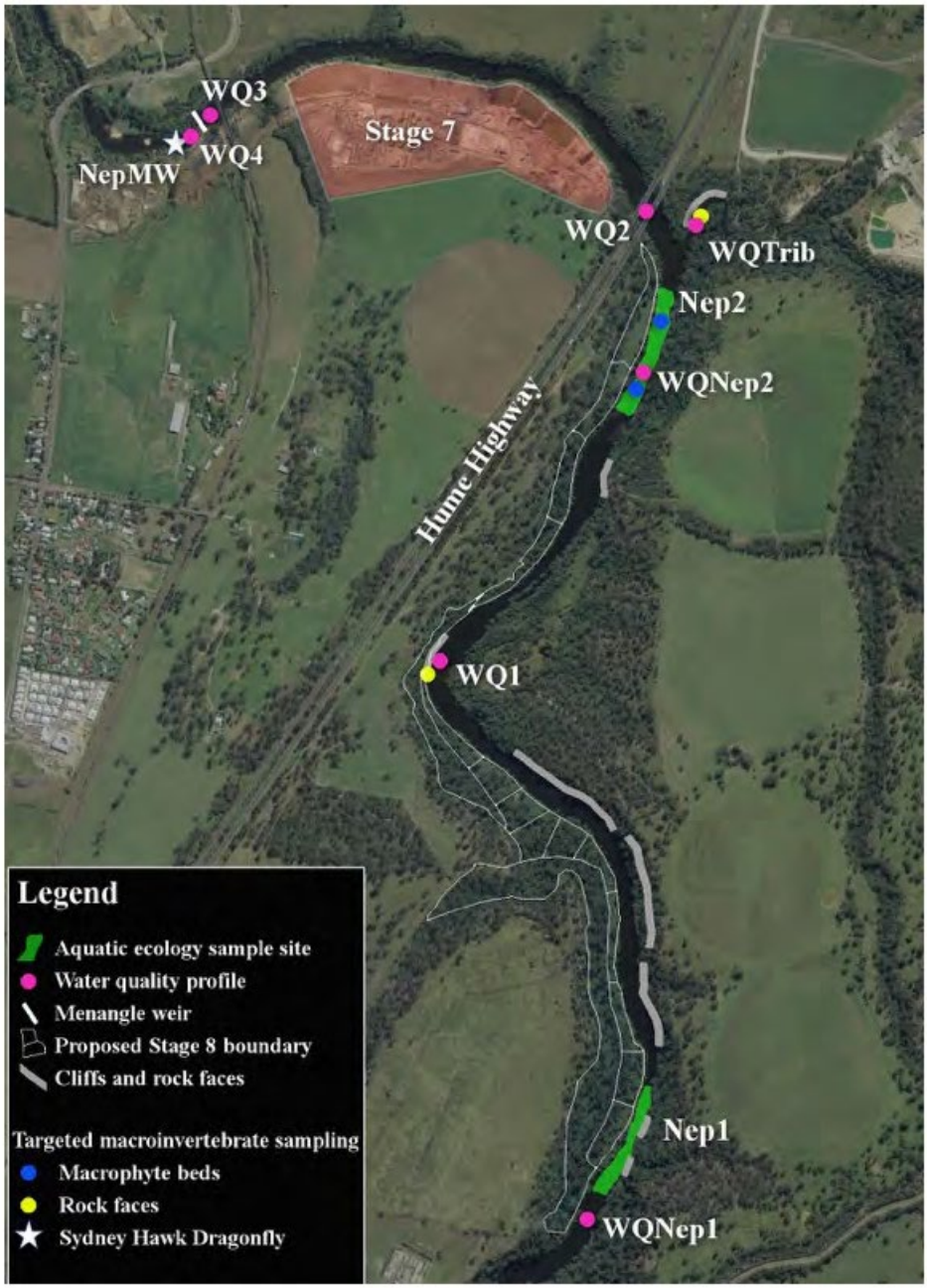
- Conductivity levels were low for all Nepean River sites and showed a general decrease from upstream site Nep1 (mean ± standard deviation 203.4 ± 2.4 µS/cm) through to WQ3 (159.4 ± 0.7 µS/cm). Site NepMB (measured a week later) had a conductivity of 330.7 ± 0.6 µS/cm).

- Dissolved oxygen values were much lower (ranging from 48.6% to 63.5% saturation) for the sites upstream of the weir when compared to the range of values recorded at downstream of weir sites NepMW and WQ4 (89% to 100.9% saturation), as would be expected from sites located below sources of broken water.

- Water pH levels were alkaline at NepMB (pH 7.7), compared to downstream sites which were slightly acidic (pH range of 6.2 to 6.8).

- Turbidity values were low throughout all the Nepean River sites, ranging between 1.3 NTU and 8.1 NTU. Two elevated readings at WQ2 (20.1 and 24.1 NTU) were likely due to the probe coming in contact with bottom sediments.

- Field alkalinity (expressed in mg/L $CaCO_3$) for sampling sites Nep 1 and Nep2 was 36 mg/L at both sites and field alkalinity for NepMB (measured a week later) was 95 mg/L.



Source: Marine Pollution Research (2019).

Figure 5.4 Nepean River water quality sampling locations

5.2 Surface water management

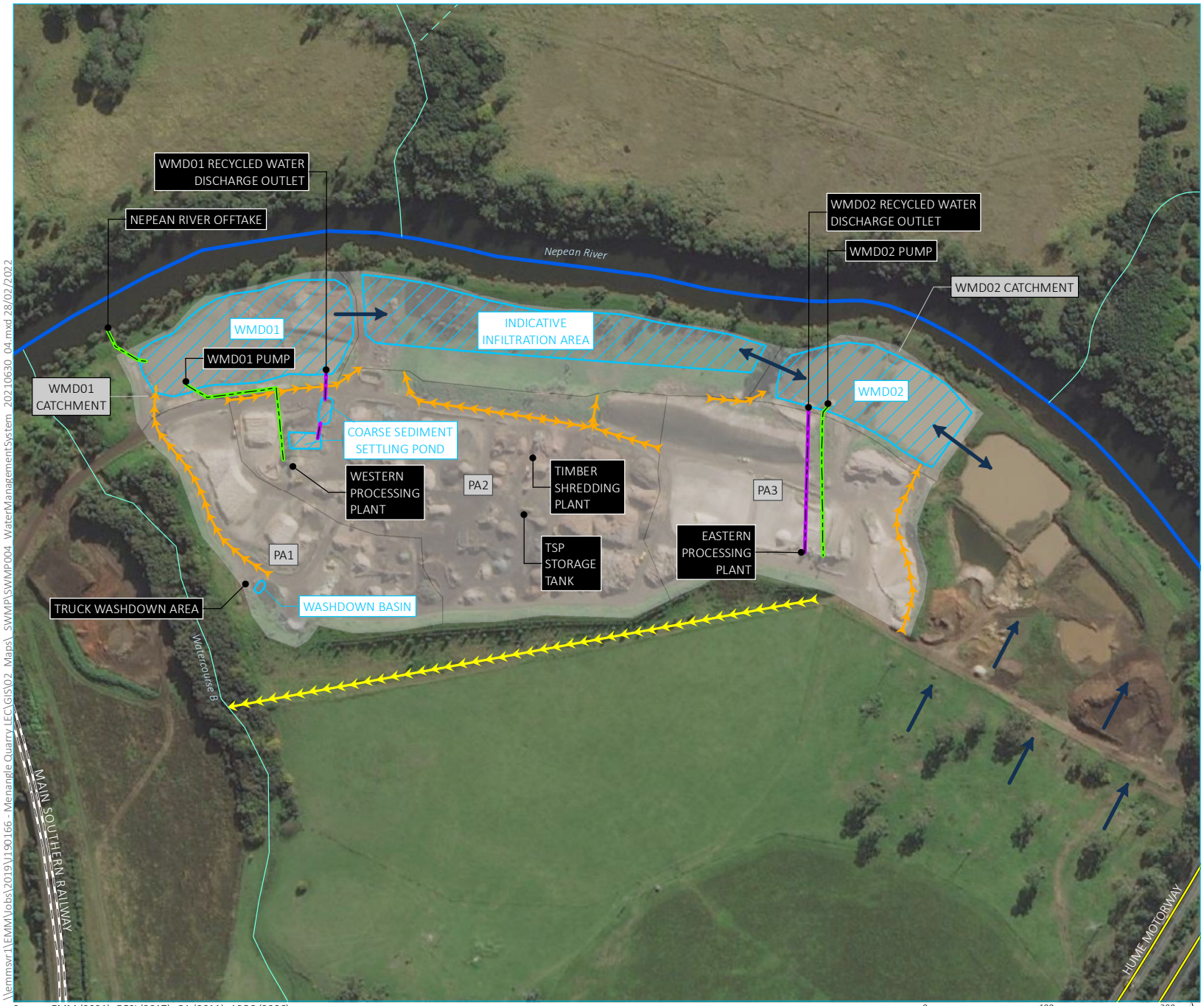
A surface water management system is in place for the existing processing area and Stage 7 extraction area. The existing processing area will be used to process, wash, blend and stockpile quarry material extracted from the Stage 8 area. Hence the existing surface water management system will be retained. Additional surface water

management measures will be implemented for the Stage 8 extraction area. The surface water management system aims to:

- maximise the separation of clean and quarry affected water runoff;
- minimise discharges from the site by maximising the re-use and recycling of water onsite;
- minimise discharges of quarry affected water by capturing runoff from the existing processing area and active extraction area in water management storages prior to re-use or infiltration and evaporation; and
- minimise the potential for erosion and scour by implementing erosion and sediment control measures in accordance with *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004).

The quarry activities and water management controls in each catchment are described in Table 5.1. Controls in Stage 8 will be progressively relocated as the quarry advances.

Catchment areas and the key water management infrastructure in the processing area are shown in Figure 5.5. The Stage 7 extraction area has not been included in the description of the water management system as operations have ceased and the area will be rehabilitated as described in the *Biodiversity and Rehabilitation Management Plan*.



KEY

- Rail line
- Main road

Strahler stream order

- 1st order
- 2nd order
- 7th order

Indicative pipeline alignment

- Gravity pipeline
- Rising pipeline

Water diversion/drainage

- Clean water diversion bund/drain
- Quarry affected water drainage direction
- Water management storage area
- Water management catchment area
- Direction of surface flow

\\emmsvr1\EMM\Jobs\2019\190166 - Menangle Quarry LEC\GIS\02 Maps\ SWMP\SWMP004 WaterManagementSystem 20210630 04.mxd 28/02/2022

Source: EMM (2021); DFSI (2017); GA (2011); ASGC (2006)

0 100 200 m

GDA 1994 MGA Zone 56

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Water management system overview

Menangle Quarry Extension
Soil and water management plan
Figure 5.5

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Table 5.1 Description of water management system

Catchment	Area (ha)	Catchment use	Surface water management
Site entry	0.8	• Parking • Site offices • Site access road • Truck wheel wash • Maintenance shed • Laydown area • Internal roads	• Runoff from the catchment drains onto the adjoining grassed area for infiltration. • Mains water is used to supply the site offices and truck wheel wash. • Water used in the truck wheel wash is recycled through a concrete sump pond resulting in a relatively small net water demand. • The internal roads are watered to minimise dust generation.
PA1	2.2	• Material stockpiling • Haul roads • Truck washdown	• Clean water diversion bund diverts runoff from upstream catchment into Watercourse B. • Runoff from the catchment drains to Watercourse B via culvert beneath haul road. • Water Management Dam (WMD) 01 is used to store water extracted from the Nepean River prior to use for dust suppression, truck washdown, and washing of material.
PA2	5.3	• Material processing and wash • Material stockpiling • Haul roads • Timber shredding plant (TSP) • Historical (Stage 7) extraction area	• Clean water diversion bund diverts runoff from upstream catchment into Watercourse B. • Runoff from the catchment drains to the historical Stage 7 extraction area for infiltration and evaporation. • Water used for material washing is recycled through two coarse-sediment settling ponds prior to discharging to WMD01 for re-use.
PA3	3.2	• Material processing and wash • Material stockpiling • Haul roads	• Clean water diversion bund diverts runoff from a portion of the upstream to Watercourse B. • Runoff from the catchment drains to WMD02 is used for material washing. • Water used for material washing is recycled through WMD02 for re-use.
Stage 8	0.33[1]	• Active extraction area • Haul roads	• Temporary sedimentation basin(s) will be constructed in extraction area to capture quarry affected water runoff prior to infiltration. No water will be extracted from the sedimentation basin.

1. Advancing progressively.

5.2.1 Water storages

The quarry has two existing water management dams (WMD01 and WMD02) that are used for water supply and to capture quarry affected runoff from the existing processing area. The historical Stage 7 extraction area (WMD03) is also used to capture quarry affected runoff from the existing processing area prior to infiltration and evaporation. While the historical Stage 7 extraction area is not a formal water storage, a detention function is provided as a result of the embankment associated with the Stage 7 Nepean River setback contour.

A sedimentation basin(s) will be constructed to capture quarry affected runoff from the active Stage 8 extraction area. The location of the sedimentation basin will move as quarrying progresses. The Stage 8 sedimentation basin is described further in Section5.2.4.

A description of each surface water storage including estimated storage volumes and overflow arrangement is provided in Table 5.2.

Table 5.2 Surface water storages

Storage ID	Description	Contributing catchment[1]	Estimated volume
WMD01	• Existing water management dam used to store water pumped from the Nepean River prior to use for dust suppression or in the western processing area. • Water used in the western processing area is recycled back into WMD01.	1.6 ha	6.1 ML[2]
WMD02	• Existing water management dam used to capture runoff from the PA3 catchment prior to use in the eastern processing area. • Water used in the eastern processing area is recycled back into WMD02. • Water exchange with the Nepean River may occur through the water management dam embankment but the exchange volume would be small compared to the pumped volume.	4.4 ha	27.5 ML[2]
Indicative infiltration area	• Historical extraction area that is used to capture and infiltrate runoff from PA2 catchment. • Receives overflows form WMD01 and WMD02.	7.7 ha	3.2 ML[2]
Stage 8 sedimentation basin	• Temporary sedimentation basin(s) to be constructed in the base of the Stage 8 extraction pit. • Captures runoff from the Stage 8 extraction area prior to infiltration into the underlying alluvium. • No water will be extracted from the sedimentation basin via a pump or other means.	1 ha[3]	0.3 ML

1. Contributing catchment includes adjoining processing area catchment, water management storage surface area and catchment immediately adject to water management.
2. Storage volumes have been estimated from 2019 Lidar data sourced from ELVIS Spatial Data (ICSM 2020).
3. The Stage 8 area contributing catchment and subsequently the required basin volume will vary as quarrying progresses.

5.2.2 Process water use

Typical process water requirements for the quarry have been provided by Menangle Sand and Soil (see Table 5.3). Operational water use is described further in the site water balance presented in Section 5.3.

Table 5.3 Water use description

Water use	Description	Water source	Annual water use
Dust suppression[1]	• The site operates a 12-kL water cart 5.5 days per week. Typical application rate is estimated at 5 loads per day (0.33 ML/week). • An automatic sprinkler system provides dust suppression along the haul road between the processing area and the site entry area. Typical application rate estimated at 0.48 ML/week. • The Stage 8 access/haul roads and extraction area is expected to require dust suppression for up to an additional 2 ha. Typical application rate is estimated at 0.46 ML/week.	WMD01	66 ML/year
Timber shredding plant (TSP)	• Water from WMD01 is transferred to a 23-kL water tank (TSP storage tank) to supply the TSP at an estimated rate of 0.18 ML/week.	WMD01	9 ML/year

Table 5.3 Water use description

Water use	Description	Water source	Annual water use
Truck washdown	• A sprinkler system extracts water from WMD01 and transfers it to the truck washdown area at an estimated average rate of 0.04 ML/week. • Truck washdown water drains into the adjacent washdown basin for settlement and re-use.	WMD01	2 ML/year
Washing	• Water for the washing of materials is sourced from, and recycled to, the water management dams. • Gross process water demand is estimated at 62.4 ML/week most of which is recycled back to the water management dams. The net process water use is substantially less and is estimated at 0.63 ML/week. • Water lost in the quarry product is estimated to be a maximum of 8% (by weight) of total production (400,000 tpa) which is equivalent to the net process water use of 0.63 ML/week.	WMD01/02	33 ML/year[2]
Truck wheel wash	• Truck wheel wash water is sourced from and recycled to an adjacent concrete sump pond. • The sump pond is topped up with mains water approximately once every week and is expected to have negligible process water demand compared to the other water use processes described above.	Mains water	Negligible

1. Median rainfall year.
2. Net annual water use.

5.2.3 Clean water management

Clean water diversions are used at the quarry to intercept runoff from upstream catchments prior to it entering disturbed areas. There is a large vegetated clean water diversion bund on the southern side of the processing area which diverts upstream runoff to west and into Watercourse B (see Figure 5.5). Clean water diversions are also used to direct runoff around the existing site entrance compound and into Watercourse A.

There is limited opportunity to divert clean water away from the Stage 8 extraction areas due to topography and extent of native vegetation required to establish diversion drains. Further, unnecessary concentration of flow increases the erosion potential of runoff and may encourage the dispersal of weed seeds from the upstream catchments into rehabilitation and biodiversity restoration areas. As such, the sedimentation basin will be sized for both the contributing exposed and clean run-on water catchments.

The extraction area will be separated from the Nepean River by the combined Nepean River Buffer Zone (10 m to 17 m wide horizontally) and the lower riverbank that will remain in situ.

Due to the permeable nature of the soils being extracted in Stage 8, runoff is expected to be minimal with the majority of rainfall infiltrating into the underlying soil. As has been found to be the case during quarry operations over the last 30 years.

5.2.4 Quarry-affected water management

Quarry-affected runoff from most of the processing area is managed within the water management dams and the historical Stage 7 extraction area. Quarry-affected runoff from catchment PA1 formerly drained to the Nepean River via Watercourse B. Water management system improvements now redirect quarry-affected runoff from PA1 to WMD01.

The water management dams, and historical Stage 7 extraction area provide the primary erosion and sediment control function for the processing area. Quarry-affected runoff that is captured in the water management dams is extracted for dust suppression and for use in the processing area. The runoff that drains to the historical Stage 7 extraction area is either evaporated or infiltrated into the underlying alluvium. The re-use and infiltration of quarry-affected water minimises the potential for this water to discharge into the Nepean River.

Quarry-affected runoff from the site entrance compound and access road drains to an adjacent vegetated buffer for infiltration. In higher runoff events, the vegetated buffer provides a treatment function prior to runoff entering the Nepean River.

Extraction and restoration activities within the Stage 8 area have been designed to prevent quarry-affected surface water entering the Nepean River. A schematic plan of the Stage 8 quarrying method is shown in Figure 1.4 and a cross-section is shown in Figure 5.6.

The following quarry design features will prevent quarry-affected water from entering the Nepean River (see Figure 5.6):

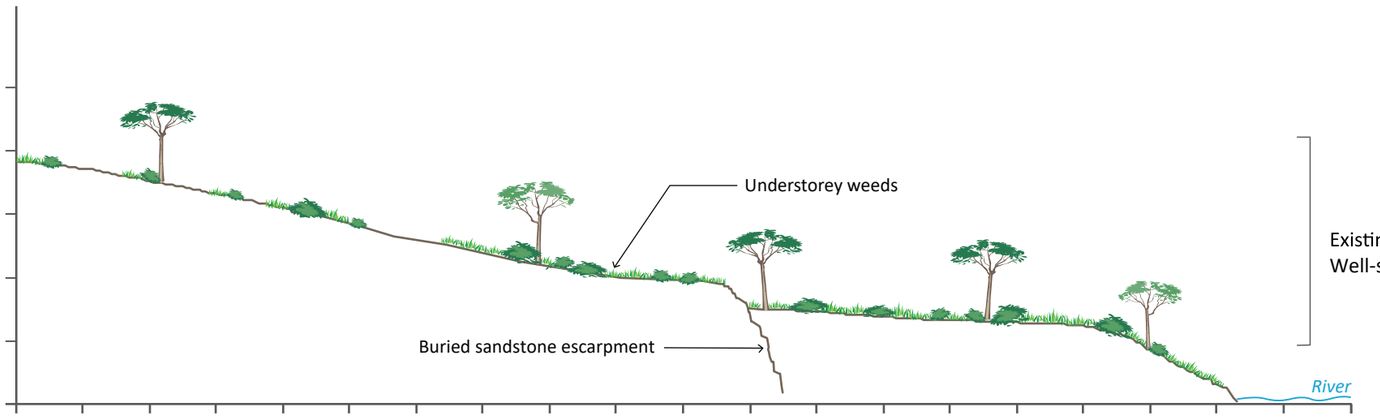
- the existing lower riverbank (which will be at least 3 m above the normal low flow level of the adjacent river) will be retained (see Section 1.6.1) – forming a bund between the extraction area and the river;

- native vegetation will be retained on the lower riverbank and within the Nepean River Buffer Zone (see Section 1.6.2) – any runoff to the river from rainfall falling on this area will be unaffected by quarrying activities;

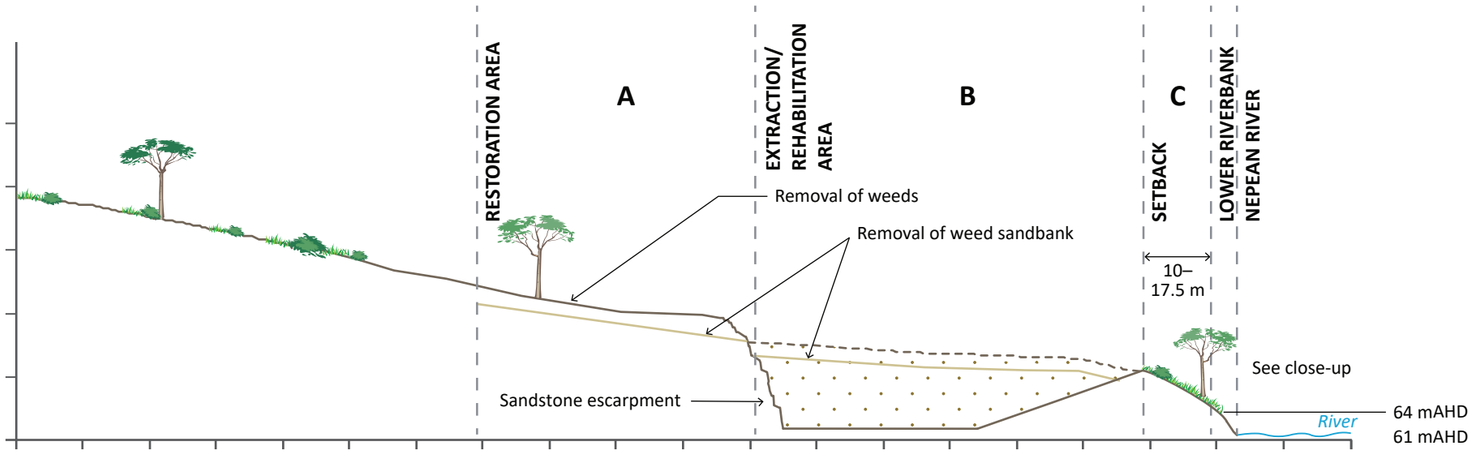
- any runoff entering the extraction area from upslope the extraction area or rainfall on the extraction area will infiltrate into the sandy soils within the extraction area or will be captured in a sedimentation basin within the extraction area (see below) – the quarry-affected water will not be able to runoff to the river as the riverbank will form a bund between the extraction area and the river; and

- material will be placed in the base of the extraction area as part of rehabilitation with a swale between the rehabilitated extraction area and the Nepean River Buffer Zone – any runoff from the rehabilitating/rehabilitated extraction area will be captured in this swale (see Figure 1.4) and infiltrate into the sandy soils.

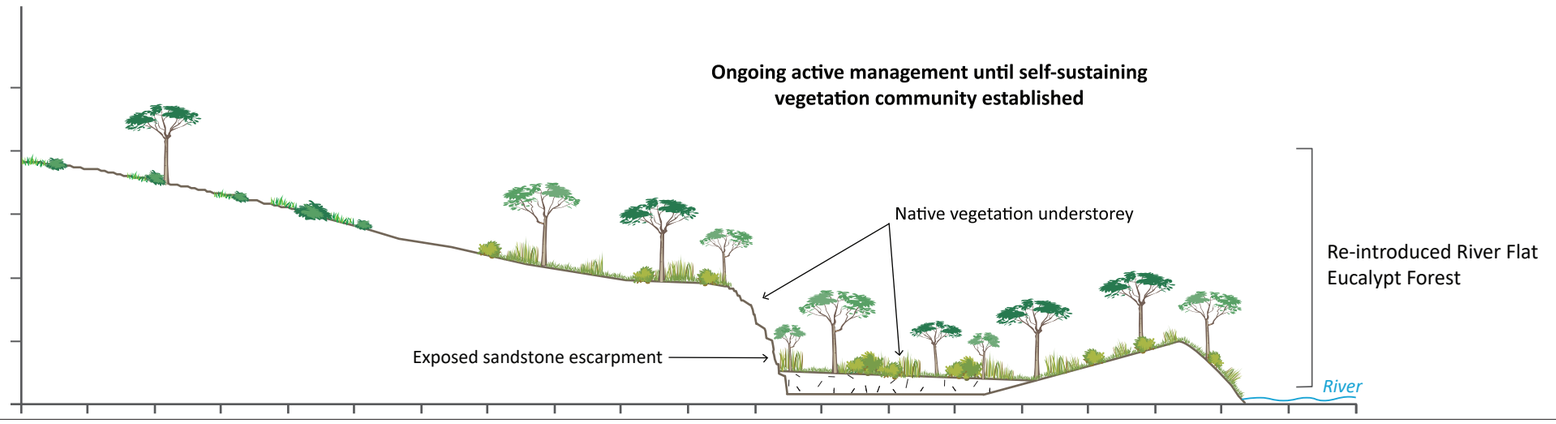
EXISITNG LANDFORM



EXTRACTION



FINAL LANDFORM



A. Restoration area

1. Understorey invasive weeds cleared
2. Large trees retained
3. Topsoil (containing weed seedbank) and weeds removed and buried in base of pit
4. Revegetation using species to form a high-quality vegetation community
5. Ongoing active management for years until self-sustaining vegetation community established

B. Extraction and rehabilitation

1. Clear vegetation
2. Topsoil (containing weed seedbank) removed and buried in base of pit
3. Extract sand and soil resource, remaining 1 m above water table
4. Place weed-infested soil in base of the pit followed by scalps to form final landform self-draining slope (≤1:50)
5. Revegetate final landform to form high-quality River Flat Eucalypt Forest
6. Ongoing active management until self-sustaining vegetation community established

C. Setback and lower river bank

1. Survey outer edge of buffer bank (64 m AHD contour)
2. Provide 10–17.5 m setback from 64 m AHD contour
3. Remove exotic trees and weeds from lower bank by hand
4. Ongoing active management for years until self-sustaining vegetation community established

KEY

Resource to be extracted including weed seed bed to be buried

Soil/scalps with weed infested soil placed at base of pit

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Indicative cross-section

Menangle Quarry Extension

Figure 5.6

Water management measures will be implemented within the Stage 8 extraction area to capture and treat quarry-affected runoff from the active extraction area. An adaptive approach to erosion and sediment control will be implemented to account for the constantly progressing quarry footprint. The following water runoff and erosion and sediment control measures (or design principals) will be implemented within the extraction area:

- clean water diversions will be constructed where practicable (see Section 5.2.3) prior to downslope disturbance to minimise the volume of water that requires management within the quarry affected water system;
- a sedimentation basin (or basins), sized to trap and treat runoff from the Stage 8 area will be excavated within the extraction pit;
- sedimentation basin(s) in the base of the pit will be relocated as the extraction area progresses;
- runoff that is generated within the pit will drain to the sedimentation basin and infiltrate into the underlying alluvium via gravity or evaporate; and
- sedimentation basins will be desilted as required to maintain adequate storage capacity.

Site sediments are generally coarse, and low in clay, and as such that sediment-laden water within the basin(s) are not expected to require treatment with coagulants or flocculants.

The optimal locations for sedimentation basins and diversion bunds/swales will be determined as the active extraction area progresses. The construction of these controls will be timed so that previously installed controls remain effective until the new controls are fully functional. Redundant controls will be removed/rehabilitated when they are no longer required to divert clean water or capture quarry-affected water. Erosion and sediment control measures will be regularly reviewed and maintained.

Quarrying methods aimed at reducing the risk of erosion and sedimentation during a Nepean River flood event are described in the *Flood Management Plan*.

5.2.5 Spill management

As described in the quarry's *Pollution Incident Response Management Plan*, all stored hydrocarbons (fuel) that could potentially contaminate the soil are stored in bunded facilities. Any spill would be contained within the bunded area preventing it from dispersing beyond immediate surrounds of the containment area.

Bunded areas are inspected regularly to ensure they are free of debris, spills or water to enable maximum capacity to capture any potential spills. Spill containment kits are maintained in place at each bunded area and at other locations where the potential for chemical spills exists (eg workshop area) as shown in Appendix B of the *Pollution Incident Response Management Plan*.

The potential for spills will be minimised by:

- inspecting incoming waste for liquids;
- re-fuelling operations of plant to be undertaken by suitably trained personnel; and
- provision of spill kits and training of personnel in their use.

However, in case a hydrocarbon spill (ie a burst hydraulic hose or spill during refuelling) occurs during refuelling, a spill kit will be stored on the refuelling vehicle and will be available during all refuelling. If a spill occurs it will be immediately cleaned up following the identification of the incident. Any soils contaminated by hydrocarbons will

be excavated and disposed off-site at a facility licenced to accept contaminated soils. The clean-up and treatment of spills will be managed under the *Pollution Incident Response Management Plan*.

5.3 Site water balance

A site water balance has been developed for the quarry to quantify water use and transfers under existing and future operational conditions. The water balance model applies a continuous simulation methodology that simulates the response of the water management system under a range of climatic conditions (ie rainfall and evaporation). The water balance model has been created by representing each process of the water management system with pre-determined responses that reflect how the water management system will operate. A schematic of the overall water management system is shown in Figure 5.7.

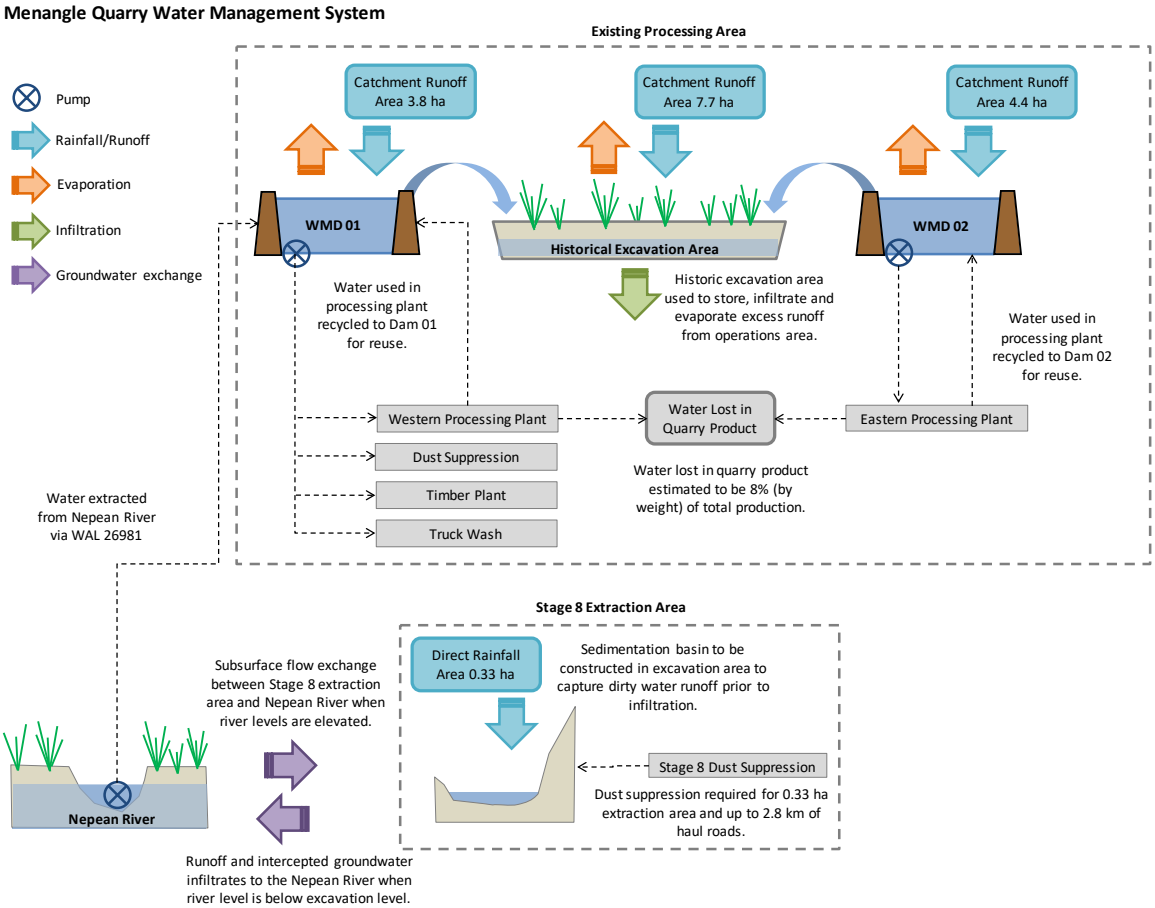


Figure 5.7 Water management system schematic

The model simulated the quarry water management system using 50 years of historical climate data and a daily time step. Daily rainfall and evaporation data for the period 1970 to 2020 was obtained as a SILO Point Data (see Section 3.1) and applied to the model. A summary of annual water management system inputs and outputs for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years is provided in Table 5.4.

Based on the groundwater modelling (see Section 6.2), a peak groundwater inflow volume of 0.4 ML/year is predicted. However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model, the inflow volumes may reach 0.7 ML/year. This higher value was used in the water balance, although it is noted that groundwater contribution is a small part (<0.5%) of

the total water inputs. The groundwater model update (see Section 6.2) did not change the predicted groundwater inflow volume or site water balance (see Appendix D).

Table 5.4 Summary of site water balance results

Water management component	Typical dry year (ML/year)	Median rainfall year (ML/year)	Typical wet year (ML/year)
Annual rainfall (mm/year)	443	730	916
Inputs			
Direct rainfall onto storages and catchment runoff	27	49	73
Nepean River water supply	116	90	82
Groundwater inflow to Stage 8 area	0.7	0.7	0.7
Total inputs	**144**	**140**	**156**
Outputs			
Evaporation	16	13	14
Infiltration (infiltration area, seepage from Stage 8 area)	10	19	28
Process water (dust suppression, timber plant, truck washdown)	86	76[1]	77
Water lost in product (wash water)	33	33[2]	33
Overflows from processing area	0	0	2
Total outputs	**145**	**141**	**154**
Change is storage	-1	-1	2
Balance (inputs – outputs – change in storage)	**0**	**0**	**0**

1. See Table 5.3: dust suppression + timber plant + truck washdown = 77 ML/year, with rounding difference.
2. See Table 5.3: washing = 33 ML/year.

5.3.1 Water supply security

Water for site operational demands is sourced from the Nepean River and from harvested quarry affected runoff.

To minimise the requirement to source water from the Nepean River, process water used for material washing is recycled to WMD01 and WMD02 for re-use. The water balance model results in Table 5.4 show in a typical dry year (10th percentile) the quarry requires 116 ML/year to be sourced from the Nepean River. Make-up water supply for quarry operations is primarily sourced from WAL 26981 (Water Supply Work Approval 10WA116673) for 640 units (ie 640 ML/year) from the Hawksbury and Lower Nepean Rivers Water Source.

Given the significant difference between the water supply requirements (up to 116 ML/year in a typical dry year) and existing WAL entitlements (640 ML/year), environmental and operational risks associated with water supply security are low. However, the rate of extraction will be reduced if water supplies are insufficient to meet operational requirements.

5.3.2 Overflow frequency

The water balance model results presented in Table 5.4 indicate overflows from the processing area water management system are predicted to occur during typical wet (90th percentile) conditions. The model results show overflows could theoretically occur due to high intensity rainfall events when runoff from the water management catchments exceed the storage and infiltration capacity of water management storages. However,

this has not occurred in practice. Because of the large catchment upstream of the site and the precautionary releases from an upstream dam, floodwaters from the Nepean River are observed to inundate the site (and the water management dams) before they fill from local catchment runoff from the processing area. Hence, impacts due to water management system overflows are mainly associated with the mixing of quarry materials with floodwaters. Control measures to reduce the risk of impacts during a Nepean River flood event are describe in the *Flood Management Plan*.

5.3.3 Preparation of annual site water balance

A site water balance will be prepared annually to document site water use and compliance with water licencing requirements. The water balance will include annual estimates of the following:

- runoff volume harvested by the water management dams using:
  - annual rainfall totals at BoM operated Menangle Bridge (Nepean River) rainfall gauge (or another appropriate gauge as necessary); and
  - appropriate hydrological assumptions for the contributing water management catchments.
- evaporation total based on nearest BoM operated evaporation gauge or Silo Patched Data for the site;
- net process water use including water lost in product; and
- water sourced from the Nepean River.

An estimate of annual groundwater inflows to the active Stage 8 extraction area will also be provided. The results of the annual site water balance will be reported in the Menangle Sand and Soil Quarry Annual Review.

5.4 Surface water monitoring program

The objective of the surface water monitoring program is to collect data to enable:

- the quality of surface water within the quarry's water management system and receiving waters to be progressively characterised;
- the site water balance to be progressively updated (as required); and
- assessment of compliance with the Consent and license conditions.

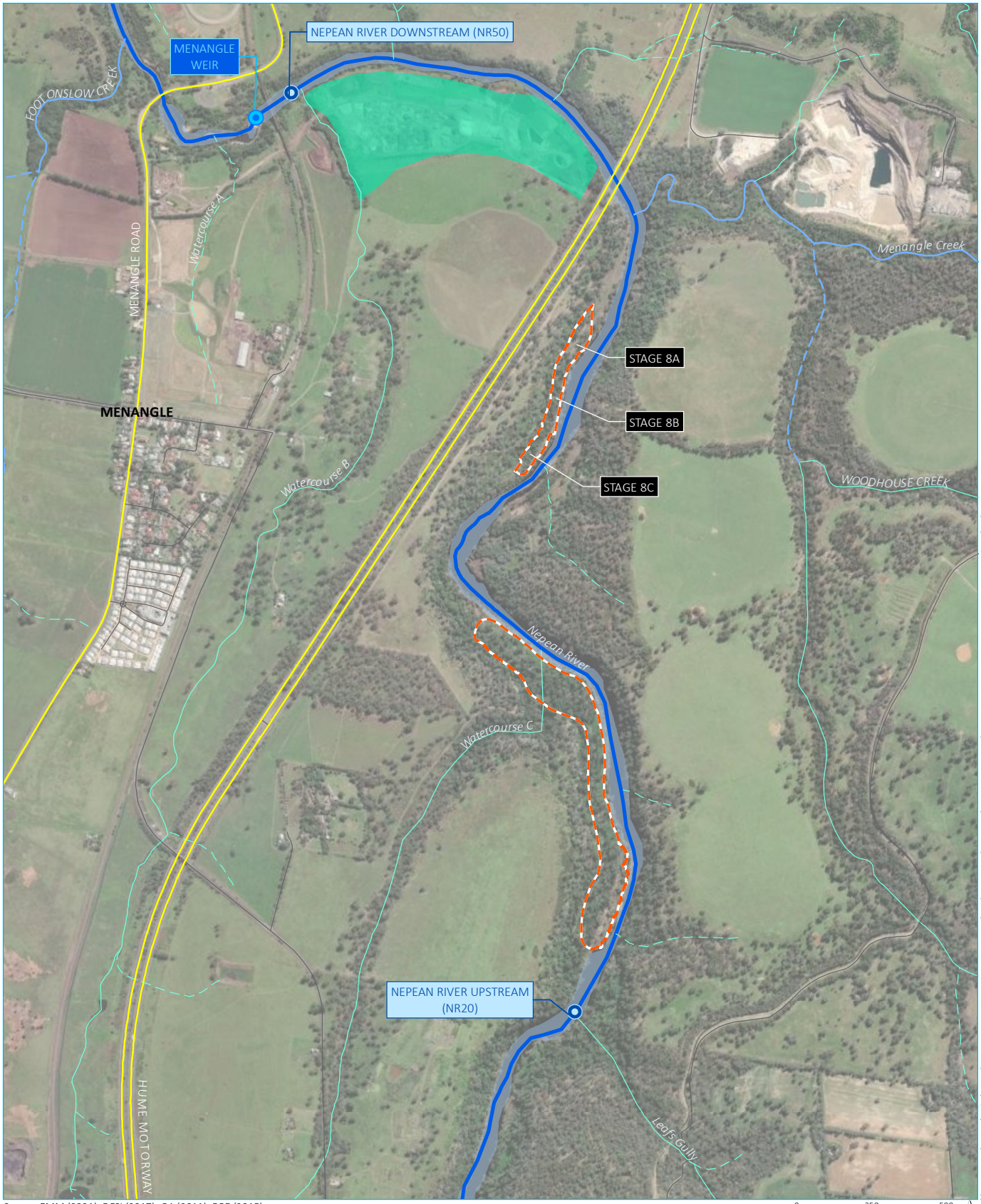
An overview of the surface water monitoring program is provided in Table 5.5. Monitoring locations are shown in Figure 5.8. Surface water quality monitoring will be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (DEC 2004). The suite of analytes and monitoring methods are presented in Table 5.6.

Table 5.5 Surface water monitoring program overview

Monitoring aspect	Objective	Monitoring locations	Monitoring description
River level	To monitor water levels in the Nepean River adjacent to the site.	• Nepean River at Menangle Weir (212238)	River levels obtained from the Water NSW gauging station (212238).
Process water	Record process water volumes to inform the site water balance.	• Water cart use • Nepean River to WMD01	Monthly process water volumes will be recorded either by a cumulative flow meter or daily tanker load count.
Discharges	To record the occurrence of site discharges.	• Processing area	The date and location of discharges (should they occur) will be recorded.
Water quality	To monitor the quality of water in the active extraction area sedimentation basins and in the Nepean River both upstream and downstream of the site.	• Active Stage 8 sedimentation basin • Nepean River (NR20 and NR50) • Processing pond in the Stage 7 area	Monitoring is to be undertaken via grab samples at each location. Samples are to be collected on a monthly basis for the first 12 months and quarterly thereafter.

Table 5.6 Surface water quality analytical suite and method

Category	Analyte to be tested	Analysis method
General	• Temperature • pH • Electrical conductivity	To be measured using a portable water quality meter in the field.
	• Turbidity • Total suspended solids • Major ions • Total hardness as $CaCO_3$ • Oil and grease	Analysis to be undertaken by a NATA certified laboratory.
Nutrients	• Ammonia, oxidised nitrogen, organic nitrogen and total nitrogen • Reactive and total phosphorus	Analysis to be undertaken by a NATA certified laboratory.
Dissolved metals	• Al, As, B, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag and Zn	Analysis to be undertaken by a NATA certified laboratory.



Source: EMM (2021); DFSI (2017); GA (2011), DPE (2015)

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KEY

- Menangle Quarry - stage 7
- Stage 8 - extraction/rehabilitation area
- River level monitoring location
- Water quality monitoring location
- Main road
- Local road
- Named waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

Surface water monitoring locations

Menangle Quarry Extension
Soil and water management plan
Figure 5.8

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5.5 Surface water assessment criteria and trigger values

There are no prescribed surface water monitoring criteria in DA 85/2865 or EPL3991. Notwithstanding, the quarry must comply with Section 120 of the *Protection of the Environment Operations Act 1997*. The quarry has been designed so that quarry-affected/polluted water is not discharged to the Nepean River or its tributaries. No discharge points are listed in the quarry's EPL. The quarry will be operated in accordance with this SWMP to prevent discharges from the quarry or the degradation of the water quality in the Nepean River or its tributaries.

Surface water monitoring will be undertaken to provide baseline Nepean River water quality and determine whether there are any contaminants in the sedimentation basins that could infiltrate to the underlying groundwater or Nepean River.

The baseline monitoring data (see Section 5.1.1) indicates the Nepean River is fresh with electrical conductivity and turbidity ranges which generally meet the ANZG (2018) default guideline values (DGVs) shown in Table 5.7. Water pH levels near the quarry were observed to be slightly acidic with some samples being lower than the DGV range.

Surface water assessment criteria have been developed using the default guideline values presented in ANZG (2018). The default trigger values provided in ANZECC & ARMCANZ (2000) are used where a parameter DGV is not yet defined in ANZG (2018). The surface water assessment trigger values are provided in Table 5.7.

Table 5.7 Surface water assessment trigger values

Parameter	Units	Trigger value
General[1]		
Temperature	°C	-
pH	-	6.5–8.5
Electrical conductivity[3]	µS/cm	200–300
Turbidity	NTU	6–50
Total suspended solids	mg/L	-
Total hardness as CaCO3	mg/L	-
Oil and grease	mg/L	-
Nutrients[1]		
Ammonia	µg N/L	20
Oxidised nitrogen	µg N/L	40
Organic nitrogen	µg/L	-
Total nitrogen	µg N/L	500
Reactive phosphorus	µg P/L	20
Total phosphorus	µg P/L	50
Dissolved metals[2]		
Aluminium (Al)	µg/L	55
Arsenic (As)[4]	µg/L	13
Boron (B)	µg/L	370
Cadmium (Cd)	µg/L	0.2

Table 5.7 Surface water assessment trigger values

Parameter	Units	Trigger value
Chromium (Cr)[5]	µg/L	1.0
Copper (Cu)	µg/L	1.4
Iron (Fe)	µg/L	-
Manganese (Mn)	µg/L	1,900
Mercury (Hg)	µg/L	0.06
Nickel (Ni)	µg/L	11
Lead (Pb)	µg/L	3.4
Selenium (Se)	µg/L	5
Silver (Ag)	µg/L	0.05
Zinc (Zn)	µg/L	8.0

1. The trigger values for general parameters and nutrients refer to the DGVs for physical and chemical stressors in south-east Australia (lowland river) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC & ARMCANZ (2000) as DGV is not yet defined in ANZG (2018).
2. Dissolved metal trigger values are for slightly to moderately disturbed ecosystems (ANZG 2018).
3. Table 3.3.3 of ANZECC & ARMCANZ (2000) specifies NSW coastal rivers typically have salinity values in the range of 200–300 µS/cm. The default trigger value for salinity in lowland rivers is 125–2,200 µS/cm as a DGV is not yet defined in ANZG (2018).
4. For AS (V).
5. For Cr (VI).

5.6 Surface water Trigger Action Response Plan

Surface water monitoring will be undertaken from within the water management system and the Nepean River (see Section 5.4). Exceedances will be identified and addressed as described in Table 5.8.

The Trigger Action Response Plan (TARP) provided in Table 5.8 establishes methods to identify the source of water quality exceedances and if necessary, establish actions to either improve water management or further investigate the exceedance.

Table 5.8 Surface Water Trigger Action Response Plan

Trigger	Action required	Timing	Follow up actions
Discharges			
Unanticipated overflows from the water management system to the Nepean River.	Implement immediate actions to stop, or if not immediately possible, control the discharge.	Immediate.	The notification and report will provide the information required by Consent conditions D7 and D8 as described in EMS Section 8.2.2. As well as the information required for all incidents (see EMS Section 8.2.2), the report will include the following information: 1. location of overflow event; 2. time at which overflow event commenced; 3. time at which overflow event ceased; 4. duration of the overflow event; and 5. estimated volume of overflow.
	Any unanticipated quarry-affected water overflows that is classified as an 'incident', ie causes or threatens to cause material harm, will be notified to DPE and EPA and an incident report will be sent to DPE and EPA.	Immediate notification (see EMS Section 8.3.2i). Written incident notification within 7 days (see EMS Section 8.3.2ii). Incident report within 30 days (see EMS Section 8.3.2iii).	
	All other unanticipated quarry-affected water overflows to the Nepean River will be reported to DPE and EPA within 7 days of the overflow occurring.	Written incident notification within 7 days (see EMS Section 8.3.2ii).	
Water quality			
Concentration of physical parameters within temporary sedimentation basin outside of trigger values provided in Table 5.7.	Investigate potential cause of exceedance and whether impacts to receiving environment are expected. Inspect the sedimentation basin catchment to identify contributing contaminant sources and remove these sources if possible.	Remove/control identified contaminant sources, if possible, as soon as practicable. Immediate notification of DPE and EPA if it is classified as an incident (see EMS Section 8.3.2i).	Document outcomes of investigation and any mitigation/management measures implemented in Annual Review.

Table 5.8 Surface Water Trigger Action Response Plan

Trigger	Action required	Timing	Follow up actions
Concentration of physical parameters at downstream Nepean River monitoring site (NR20) outside of trigger values provided in Table 5.7.	Identify if exceedance is naturally occurring or due to the quarrying operation by reviewing: 1. upstream sample location data to determine if exceedance naturally occurring; 2. baseline sampling data to determine if similar exceedances are known to occur; 3. sedimentation basin monitoring data to determine if similar exceedance occur. Inspect the quarry to identify contributing contaminant sources and remove these sources if possible.	Remove/control identified contaminant sources, if possible, as soon as practicable. Immediate notification of DPE and EPA if it is classified as an incident (see EMS Section 8.3.2i).	If the source of exceedance is determined not to be associated with quarry operations, no other further action is required. If the source of exceedance is undetermined or identified as potentially due to quarry activities, the exceedance is to be noted in database for consideration in future monitoring rounds. If ongoing (2 out of 3 consecutive monitoring rounds). water quality anomalies are detected at downstream Nepean River monitoring site, advise DPE and EPA.

The surface water TARP will be refined in future years as more site-specific surface water data are obtained.

5.7 Summary of surface water management actions

Specific surface water-related management measures and requirements to meet the objectives of this SWMP and to prevent impacts to surface water are outlined in Table 5.9. These will effectively manage potential surface water impacts that may arise due to the operation of the quarry. Erosion and sediment control management and mitigation measures are described in Section 7.

Table 5.9 Surface water management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
Hydrocarbons and other contaminant spills will be cleaned up immediately.	Throughout Stage 8A, 8B and 8C quarry operations	All quarry staff	Consent Condition B18
An annual water balance will be undertaken to describe water use and surface water licencing requirements.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Consent conditions B23 and B36(c)(i)

Table 5.9 Surface water management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
Surface water management measures such as clean water diversions, the capture of potentially quarry affected runoff and reuse of water onsite are to be implemented.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Consent Condition B36(c)(ii)
Surface water quality samples will be collected from within the Stage 8 sedimentation basin and upstream and downstream Nepean River locations.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Consent Condition B36(c)(ii)
Surface water assessment criteria will be used to identify potentially adverse impacts.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Consent Condition B36(c)(ii)
The TARP will be applied to investigate exceedances of surface water impact assessment criteria.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Consent Condition B36(c)(ii)

5.8 Data management and reporting

Menangle Sand and Soil will retain records of process water use, site discharges and surface water quality monitoring for a minimum period of the life of the quarry. Monitoring records will be made available to relevant government authorities upon request.

All data obtained as part of the surface water monitoring program (including any water captured, intercepted or extracted from the site each year (directly and indirectly), water taken under each Water Access Licence and any discharges) will be compiled and reported each year in the Annual Review. The data will be analysed against the established performance criteria triggers and for any trends that may be occurring. Triggers will be assessed for appropriateness against seasonal climatic variations and revised if necessary.

The Annual Review will report on the overall effectiveness of the quarry's water management system based on an analysis of the water monitoring data.

Any modifications to the surface water monitoring network will be reported in the Annual Review.

Details of regular reporting and incident reporting are provided in Section 7 and Section 8 of the EMS respectively.

6 Groundwater Management Plan

6.1 Groundwater monitoring network

The groundwater monitoring network comprises five bores (Table 6.1):

- two monitoring bores installed to assess groundwater within the alluvium; and
- three monitoring bores installed to assess groundwater within the Hawkesbury Sandstone.

One nested location (BH01_S/BH01_D) consists of adjacent bores installed within the alluvium and Hawkesbury Sandstone aquifers respectively. The location of the monitoring network is shown in Figure 6.1.

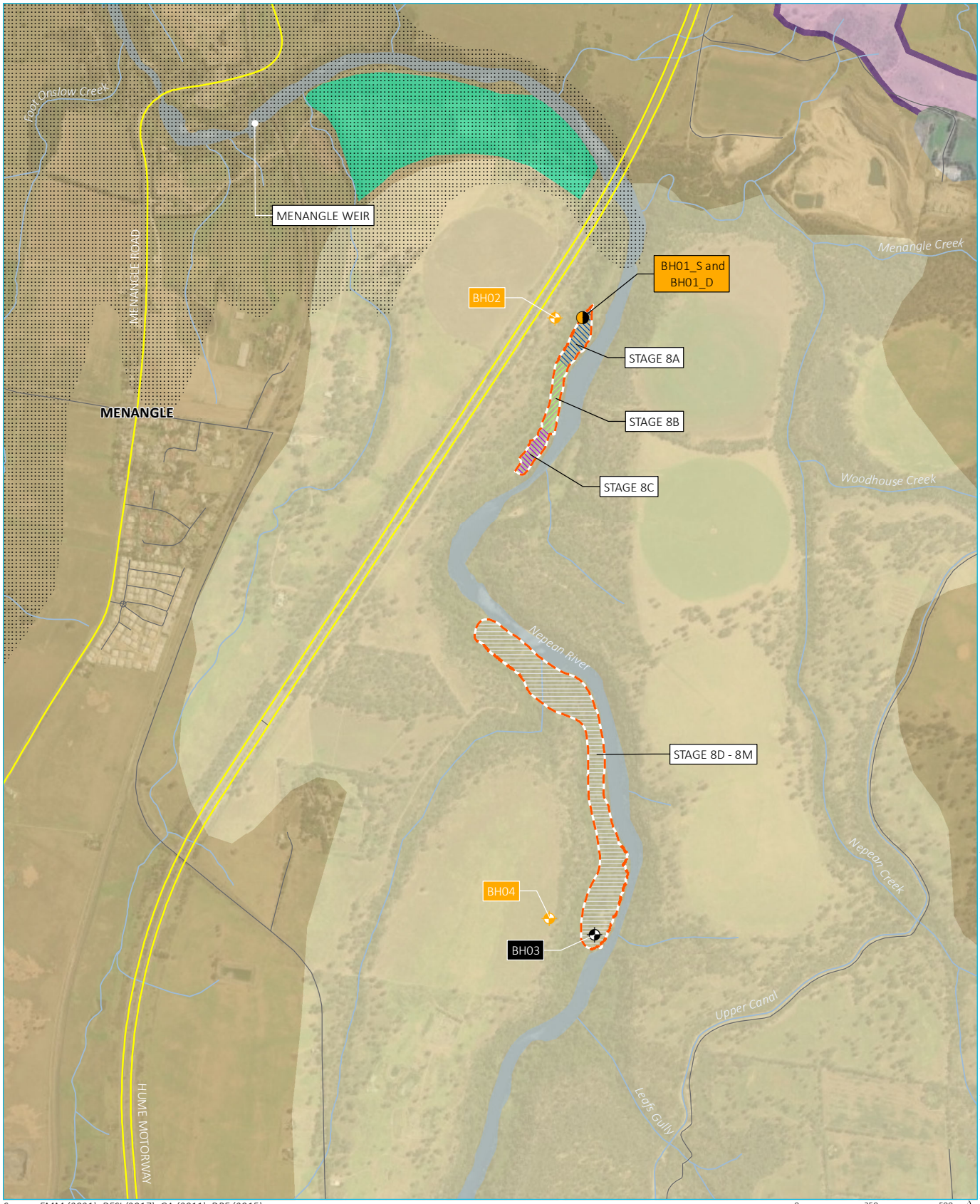
Table 6.1 Groundwater monitoring network summary

Location	Aquifer monitored	Coordinates[1]		Elevation	Screen depth	
		Easting	Northing	Ground level[2]	Top[3]	Bottom
		mEast	mNorth	m AHD	mbgl	mbgl
BH01_S	Alluvium	292937	6221762	66.73	4.4	7.4
BH01_D	Hawkesbury Sandstone	292934	6221758	67.04	8.5	11.5
BH02	Hawkesbury Sandstone	292844	6221762	87.62	33	39
BH03	Alluvium	292976	6219699	65.71	20	23
BH04	Hawkesbury Sandstone	292826	6219754	105.92	54	60

1. Coordinates are projected in Map Grid of Australia (MGA), Zone 56;
2. metres above Australian Height Datum, ±20 mm; and
3. metres below ground level.

Following drilling and screen installation, all five groundwater monitoring bores were installed with Solinst Levellogger™ pressure transducer dataloggers, set to record groundwater level fluctuations every six hours. A barometric logger installed at the site (within the protective cover of BH01_D) measures and logs changes in atmospheric pressure, which are used to compensate water level readings recorded by the dataloggers.

The groundwater monitoring network will be maintained over the life of the quarry ensuring that quarrying operations do not compromise the integrity of the monitoring bores. A visual assessment for damage or blockage of the bores will be undertaken during each monitoring round (see Section 6.4) and repairs or modifications actioned where necessary.



Source: EMM (2021); DFSI (2017); GA (2011), DPE (2015)

0 250 500 m

GDA 1994 MGA Zone 56

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KEY

- Menangle Quarry - stage 7
- Stage 8 - extraction/ rehabilitation area

Stage 8 - substages

- Stage 8A
- Stage 8B
- Stage 8C
- Stages 8D - 8M

- Main road
- Local road
- Watercourse/drainage line
- Waterbody

Monitoring location

- Borehole - alluvium
- Borehole - sandstone
- Borehole - alluvium & sandstone

Surface geology

- Alluvium
- Ashfield shale
- Bringelly shale
- Hawkesbury sandstone
- Minchinbury sandstone

Groundwater monitoring network

Menangle Quarry Extension
Soil and water management plan
Figure 6.1

EMM
creating opportunities

6.2 Groundwater modelling

Preliminary groundwater modelling was conducted, in accordance with Consent conditions B24, B25 and B28. The modelling quantified the temporary interception of groundwater by quarrying in the Stage 8 area. The preliminary modelling was informed by approximately three months of groundwater monitoring data, proposed quarrying operations and expected conditions at the site (water levels in the Nepean River and adjacent groundwater system are largely controlled by the Menangle Weir with only short-duration rises above this long-term average level).

Based on preliminary Stage 1 modelling, a peak inflow of 410 kL/year (0.4 ML/year) is predicted. However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model, the inflow volumes may reach 710 kL/year (0.7 ML/year).

As required by Consent conditions B25(b) and B25(c), the groundwater model has been updated based on the first 12 months of data collected from 17 June 2020 to 16 June 2021. The results are presented in the *Groundwater Monitoring and Modelling Update - July 2021* (Appendix D of this SWMP). There was a flood exceeding 64 m AHD at Menangle Weir during the 12-month monitoring period, satisfying the requirement of Consent Condition B26. The updated modelling confirmed the validity of modelling presented in the *Groundwater Model Report* Appendix C of this SWMP), including the maximum predicted groundwater interception of 0.4 ML/year for the base case and 0.7 ML/year from the uncertainty analysis.

The outputs of the groundwater model have been incorporated into the site water balance (see Section 5.3) which will be updated annually.

6.3 Baseline groundwater data

6.3.1 Groundwater levels and flow

Groundwater levels in all five monitoring bores have been recorded by continuous dataloggers every six hours since 3 June 2020 at 12:00. The loggers are downloaded and water levels verified by manual dips using an electronic dip meter. Baseline groundwater level data is provided as hydrographs in Section 2.2 of the *Groundwater Monitoring and Modelling Update - July 2021* (Appendix D). The hydrographs indicate that water levels in the Nepean River and the alluvial bores fluctuate in response to river flow and rainfall. A more muted response is observed in the bores targeting the Hawkesbury Sandstone aquifer.

Based on data collected from June 2020, groundwater within the Hawkesbury Sandstone typically flows east toward the Nepean River. However, during a flood event in August 2020 (see Appendix A of the *Groundwater Model Report*), data in bores BH01_S, BH01_D and BH02 indicates a reversal of the groundwater flow direction away from the Nepean River.

It is assumed that the alluvial aquifer is hydraulically connected to the Nepean River, based on the following:

- the alluvial aquifer comprises relatively high permeability sand deposits, directly adjacent to the Nepean River (*Menangle Sand and Soil Quarry Monitoring Bore Installation and Testing Program*, EMM (2020b)); and
- groundwater levels in the alluvial aquifer bores (BH01_S and BH03) are consistent with the surface water level measured in the adjacent Nepean River (Appendix A of the *Groundwater Model Report*).

6.3.2 Groundwater quality

One round of water quality samples was obtained from each bore within the groundwater monitoring network (Table 6.1) and at two locations within the Nepean River, adjacent to the alluvium bores BH01_S and BH03 (Figure

6.1) on 29 May 2020 and 2 June 2020. A summary of water quality baseline physico-chemical parameters (temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), oxidation-reduction potential (ORP) and dissolved oxygen (DO)), and major cations and anions are provided in Table 6.2 and Table 6.3, respectively.

The default trigger values provided in ANZECC & ARMCANZ (2000) are used where a parameter DGV is not yet defined in ANZG (2018).

The alluvial aquifer contains brackish and slightly acidic to basic water within the ANZECC (2000) protection levels (Table 6.2).

Table 6.2 Water quality baseline physico-chemical parameters

Water system	Monitoring bore	Temperature (°C)	pH		Electrical conductivity (µs/cm)		Total dissolved solids (mg/L)	Dissolved oxygen (% saturation)	Oxidation-reduction potential (mV)
		Field	Field	Laboratory[1]	Field	Laboratory	Laboratory	Field	Field
ANZECC (2000) guidelines[2]	N/A		6.5–8.0		125–2,200			85–110	
Alluvial aquifer	BH01_S	15.4	6.74	**6.45**	1,194	1,370	890	**128**	-5.4
	BH03	15.0	7.32	7.65	2,101	**2,640**	1,720	**127**	135.7
Hawkesbury Sandstone aquifer	BH01_D	13.5	7.53	6.85	**2,963**	**2,730**	1,770	**142**	99.7
	BH02	15.2	**8.38**	**8.04**	**8,732**	**9,840**	6,400	**157**	50.2
	BH04	14.3	**8.43**	**8.11**	**10,355**	**12,000**	7,800	**143**	94.5
Nepean River	Site 1	15.5	7.25	7.79	195	228	148	**112**	25.6
	Site 3	14.8	7.22	7.88	265	308	200	**128**	74.8

1. Laboratory pH was analysed outside of the typical holding time; EMM considers field pH more accurate
2. ANZECC (2000) Water Quality Guidelines: 95% protection levels (trigger values) for the protection of slightly disturbed freshwater ecosystems, South-East Australia, lowland river ecosystems. Values outside of the default trigger values are highlighted in bold.

'Field' indicates results have been obtained from in-situ measurements following well development.

'Laboratory' indicates results have been obtained from analysis at a NATA accredited laboratory.

Table 6.3 Water chemistry results - major cations/anions suite

Water system	Monitoring bore	Total Hardness as $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Alkalinity (as $CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (Fl)	Total anions	Total cations	Ionic balance
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
ANZECC (2000) guidelines[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alluvial aquifer	BH01_S	278	42	42	138	2	8	12	462	*ND*	13.4	11.6	7.33
	BH03	383	20	81	348	3	32	49	893	0.1	26.8	22.9	7.99
Hawkesbury Sandstone aquifer	BH01_D	260	43	37	450	5	228	215	732	*ND*	29.7	24.9	8.77
	BH02	1,180	142	201	1,650	15	318	770	2,880	0.8	104	95.8	3.93
	BH04	1,970	172	374	1,840	31	567	587	4,050	0.6	138	120	6.82
Nepean River	Site 1	26	4	4	34	3	52	6	35	*ND*	2.15	2.08	----
	Site 3	33	5	5	47	4	82	11	43	*ND*	3.08	2.81	----

1. ANZECC (2000) - Water Quality Guidelines: 95% protection levels (trigger values) for the protection of freshwater aquatic ecosystems. Values outside of the default trigger values are highlighted in bold.

Results have been obtained from analysis at a NATA accredited laboratory.

---- indicates limited cation/anion concentrations cannot be differentiated.

6.4 Groundwater monitoring program

6.4.1 Groundwater levels

The dataloggers in BH01_S, BH01_D, BH02, BH03 and BH04 will continue to record groundwater level fluctuations every six-hours. Dataloggers will be downloaded quarterly (every three months; nominally in March, June, September and December) and manual water level measurements will be taken using an electronic dip meter to verify the water level.

The monitoring bores will be inspected during the quarterly download. Defective dataloggers will be replaced to ensure a continuous record of groundwater level is maintained.

Temporary bores will be drilled or augered progressively in the active extraction area to determine the local water table position immediately prior to commencing extraction in each substage. Water levels in the temporary bores will be recorded twice a day via an electronic dip meter for a period of seven days following the date of installation. The water level will be recorded daily during active operations.

As described in Section 1.6.7, the resource will be extracted by an excavator in a manner that ensures that the base of the extraction area remains at least 1 metre above the measured water table level averaged over a seven-day period following the date of installation.

6.4.2 Groundwater quality

Groundwater quality monitoring will be undertaken once per year (nominally in June) at each of the monitoring bores (BH01_S, BH01_D, BH02, BH03 and BH04), in general accordance with the following:

- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC 2004); and
- AS/NZS 5667.11:1998 *Water Quality – Sampling – Part 11, Guidance on Sampling of Groundwaters*.

The groundwater quality sampling and analysis methodology will be as follows:

3. water quality physico-chemical field parameters (temperature, pH, EC, ORP and DO) will be measured using a calibrated water quality meter;
4. bores will be purged until three bore volumes have been removed or until physico-chemical field parameters have stabilised over three successive readings;
5. a representative groundwater sample will be collected in laboratory supplied bottles, appropriately preserved and submitted under chain-of-custody to a NATA accredited laboratory for analysis of the following analytical suites;
    a) physico-chemical parameters (pH, EC and TDS);
    b) major cation/anions (including hardness); and
6. all sampling equipment including but not limited to sampling pumps, the water quality meter and electronic dip meter will be decontaminated between sampling each bore.

6.5 Groundwater assessment criteria and trigger values

There are no prescribed groundwater monitoring criteria in DA 85/2865 or EPL3991. Rather, groundwater monitoring will be undertaken to prevent the unanticipated intersection of the local water table by extraction operations at the Quarry. Notwithstanding this, the Quarry must comply with Section 120 of the *Protection of the Environment Operations Act (*1997) (see Section 5.5).

6.5.1 Groundwater levels

In the absence of prescribed criteria, a deviation of two metres from the long-term median groundwater level in the quarry monitoring bores would be considered a trigger for further action. Two metres was chosen as the deviation value as it aligns to the minimal impact considerations for aquifer interference activities stated in the *NSW Aquifer Interference Policy* (DPI 2012).

Initial water level assessment criteria and trigger values have been derived at all five quarry monitoring bores within the alluvium and Hawkesbury Sandstone, as shown in Table 6.4. These values will be reviewed annually, and ongoing collation of site-specific groundwater level data will be assessed against seasonal variations. The trigger values will be revised (where necessary).

Table 6.4 Water level assessment criteria and trigger values

Monitoring bore	Aquifer	Median groundwater level[1] (m AHD)	Trigger level (m AHD)
BH01_S	Alluvium	61.27	59.27
BH01_D	Hawkesbury Sandstone	61.29	59.29
BH02	Hawkesbury Sandstone	62.29	60.29
BH03	Alluvium	61.20	59.20
BH04	Hawkesbury Sandstone	62.70	60.70

1. Based on groundwater levels recorded via continuous datalogger from 3 June 2020 to 23 September 2020.

The trigger levels in Table 6.4 provide an early indication of a change in groundwater level conditions. Should a change be observed a management response will be instigated in accordance with the Groundwater Trigger Action Response process detailed in Section 6.6.

6.5.2 Groundwater quality

The baseline monitoring data indicate that the alluvial aquifer contains brackish and slightly acidic to basic water, which generally meet the ANZECC (2000) default trigger ranges as shown in Table 6.2. However, the Hawkesbury Sandstone aquifer contains water of a more basic and saline nature, with recorded values outside of the ANZECC (2000) default trigger ranges.

Site-specific water quality assessment criteria have been assigned to the quarry monitoring bores. Assessment criteria have been adopted for field EC and pH. Assessment criteria has been developed using site-specific data or the ANZECC (2000) guidelines. Although ANZECC (2000) guidelines are generally not considered suitable for assessing groundwater quality, these guidelines were adopted as interim assessment criteria where appropriate for field pH and EC as baseline data were insufficient for the development of site-specific assessment criteria.

Initial field pH and EC assessment criteria and trigger values have been derived at the monitoring bores, as shown in Table 6.5. The ranges are suitable to identify a potentially adverse impact in the aquifers in the vicinity of the quarry.

Table 6.5 Field parameter assessment criteria and trigger values – alluvial bores

Monitoring bore	pH trigger levels		EC trigger levels (µS/cm)	
	Lower limit	Upper limit	Lower limit	Upper limit
BH01_S	6.5	8.0	125	2,500
BH01_D	6.5	8.0	125	3,000
BH02	6.5	8.5	125	10,000
BH03[1]	6.5	8.0	125	2,500
BH04	6.5	8.5	125	12,000

Assessment criteria are generally based on ANZECC (2000) guidelines – 95% protection levels (trigger values) for the protection of slightly disturbed freshwater ecosystems, South-East Australia, low lying river ecosystems, with the following exceptions to incorporate site-specific data:

- Alluvial aquifer bores (BH01_S and BH03) - slightly higher upper range for EC to accommodate naturally brackish water;
- Hawkesbury sandstone aquifer (BH02 and BH04) - slightly higher upper range for pH to accommodate naturally basic water; and
- Hawkesbury sandstone aquifer (BH01_D, BH02 and BH04) - higher upper range for EC to accommodate naturally saline water.

The assigned assessment criteria for EC and pH provide an early indication of a change in water quality conditions. Should a change be observed a management response will be instigated in accordance with the Groundwater Trigger Action Response process detailed in Section 6.6.

6.6 Groundwater Trigger Action Response Plan

As the Menangle Quarry will not intercept groundwater during its normal extraction operations it is considered highly unlikely that the quarry will alter groundwater levels or quality. Despite this, potential changes in groundwater conditions will be monitored during the undertaking of the groundwater monitoring program outlined in Section 6.4. If a change is detected that may be because of an unforeseen impact caused by the quarry operation, the Groundwater Trigger Action Response Plan (TARP) will be initiated. This TARP is detailed in Table 6.6.

Table 6.6 Groundwater Trigger Action Response Plan

Trigger value or level indicating potential impact	Action required	Timing	Any follow up actions
Water level			
Water levels in the groundwater monitoring bores decrease below the trigger levels provided in Table 6.4.	Continue to monitor and assess water level data, establish trends and correlate with quarrying activities and climatic data (rainfall). Apply statistical analysis to assess trends if required. Determine whether any decrease in water level may be due to impacts from the quarry. Calculate and assess any distance drawdown effects with respect to any neighbouring water users (bores). Notify relevant neighbouring water users owners if a drawdown of more than 2 m is predicted in a bore they own. Notify DPE and DPE-Water that relevant neighbouring water users owners have been notified.	Quarterly based on groundwater logger downloads	If some, or all of the water level declines in the monitoring bore network are assessed to be due to impacts from quarrying at Menangle and distance drawdown calculations by the hydrogeological consultant (in consultation with the DPE-Water) indicate a 'significant' impact on neighbouring water users (bores), access to the potentially affected bore/s should be requested in order to confirm and monitor any impact that may be solely or partly due to quarrying at Menangle. If a 'significant' impact on a neighbouring water user is scientifically demonstrated, make good arrangements may be implemented in consultation with the affected water user.
The water table measured in temporary bores installed within the extraction areas increases to within 1 m of the pit floor level.	Quarry manager to review pit floor/extraction levels to ensure a 1 m buffer is maintained.	Monitoring twice a day for seven days following installation Daily during extraction	Continue to monitor temporary bores to further assess fluctuations in the local water table.
Water quality			
Concentration of physical parameters increases outside the ranges of trigger levels as stated in Table 6.5.	Continue to monitor and assess groundwater quality data, establish trends and correlate with quarrying activities and climatic data to determine a causal link (if any) with Menangle quarrying operations.	Annual	If evolving geochemical anomalies are detected in groundwater sampled from the wider monitoring bore network and an impact from the quarrying on the 'regional' sandstone aquifer system is demonstrated, advise DPE-Water for further action.
Unanticipated groundwater inflow into the pit	All unanticipated groundwater inflow into the pit will be reported to DPE and DPE-Water within 7 days of the commencement of inflow.	Event based	A report to DPE-Water will be prepared that includes the following information: 1. time at which inflow event commenced; 2. time at which inflow event ceased; 3. duration of the inflow event; 4. volume of groundwater inflow; and extraction area floor elevation at which the inflow event occurred

Table 6.6 Groundwater Trigger Action Response Plan

Trigger value or level indicating potential impact	Action required	Timing	Any follow up actions
Groundwater inflow greater than the licence exemption volume (3 ML/year).	If there are more than 5 high flow events at Menangle Weir (with river levels above 62 mAHD but not greater than 64 mAHD) in a year, the groundwater model will be used to predict the peak annual inflow over the year (see Section 2.3.2). DPE and DPE-Water will be notified within 7 days of the determining that inflow into the pit will exceed 3 ML/year.	Annual	Obtain water access license share entitlements for the Sydney Basin Nepean Groundwater Source if inflow to the pit exceeds 3 ML/year.

The groundwater TARP will be refined in future years as more groundwater data is obtained.

6.7 Summary of groundwater management measures

Specific groundwater-related measures and requirements to meet the objectives of this SWMP and to address potential impacts on groundwater are outlined in Table 6.7. Based on the mitigation and management measures it is considered that potential groundwater impacts that may arise due to the operation of the quarry can be effectively managed.

Table 6.7 Groundwater management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
A spill kit will be available during refuelling. Diesel and other contaminant spills will be cleaned up immediately. Appropriate action will be taken to notify the appropriate regulatory authorities and report the incident in accordance with the requirements of the quarry's EMS.	Throughout Stage 8A, 8B and 8C quarry operation	All quarry staff	Consent Condition B18
Groundwater levels at BH01_S, BH01_D, BH02, BH03 and BH04 will be monitored using continuous data loggers.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Consent Condition B19
Exclusion fencing and signage will be installed around at BH01_S, BH01_D and BH02.	Prior to commencement of operation at Stage 8A, 8B and 8C extraction areas	Quarry manager	Consent conditions B20 and B36(c)(iii)
Groundwater quality samples will be collected annually from BH01_S, BH01_D, BH02, BH03 and BH04 and analysed for all major anions and cations and field parameters.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Consent Condition B21

Table 6.7 Groundwater management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
Temporary bores will be installed progressively in Stage 8A, 8B and 8C extraction areas to determine the local water table position. Groundwater level will be measured twice-daily in the temporary bores using an electronic dip meter over a period of seven days.	Immediately prior to commencement of operation at each of Stage 8A, 8B and 8C extraction areas	Quarry manager	Consent conditions B22 and B36(c)(iii)
The pit floor in Stage 8A, 8B and 8C will remain at least 1 metre above the measured water table level averaged over the seven-day monitoring period.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Consent conditions B22 and B36(c)(iii)
A Modflow groundwater model will be developed and updated to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 Area in accordance with Consent conditions B24, B25 and B26.	Model prepared (see Section 6.2 and Appendix C)	Quarry manager	Consent conditions B24, B25 and B26.
If there are more than 5 high flow events at Menangle Weir (with river levels above 62 mAHD but not greater than 64 mAHD) in a year, the groundwater model will be used to predict the peak annual inflow over the year.	Annual	Quarry manager	Consent conditions B27 and B29
All necessary Water Access Licences (WALs) and licence shares for the operation of the quarry under the *Water Act 1912* and/or the *Water Management Act 2000* will be obtained.	If the groundwater model indicates that net groundwater inflow into the pit exceeds 3 ML/year	Quarry manager	Consent conditions B27 and B29
Report on any water captured, intercepted or extracted from the site each year (directly and indirectly) in the Annual Review, including water taken under each WAL as applicable.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Consent Condition B30

6.8 Data management and reporting

Menangle Sand and Soil will retain records of water quality monitoring for a minimum period of the life of the quarry. Monitoring records will be made available to relevant government authorities upon request.

All data obtained as part of the groundwater monitoring program (including any water captured, intercepted or extracted from the site each year (directly and indirectly), including water taken under each Water Access Licence) will be compiled and reported each year in the Annual Review. The data will be analysed against the established performance criteria triggers and for any trends that may be occurring. Triggers will be assessed for appropriateness against seasonal climatic variations and revised if necessary.

Any modifications to the groundwater monitoring network will be reported in the Annual Review.

If groundwater trigger values are exceeded, DPE, DPE-Water and relevant stakeholders will be notified in accordance with Table 6.6.

Details of regular reporting and incident reporting are provided in Section 7 and Section 8 of the EMS respectively.

7 Erosion and sediment control

7.1 Erosion hazard assessment

The overall water erosion hazard has been determined using the process described in Section 4.4.1 of Landcom (2004). If a low erosion hazard is determined, no further delineation of erosion hazard is required. If a high erosion hazard is determined, further assessment is required to determine the Soil Loss Class (SLC).

SLCs are determined by calculating the annual average soil loss using the Revised Universal Soil Loss Equation (RUSLE) with a nominal 80 m slope length and soil surface cover factor (C-factor). The RUSLE calculates the annual average erosion in tonnes per hectare (t/ha) from rill and inter-rill (sheet) erosion. It does not consider gully or tunnel erosion and does not calculate peak erosion.

Section 4.4.2(c) of Landcom (2004) nominates additional requirements for land of SLC 4 and higher.

7.1.1 Soil erosion hazard

The erosion potential of a soil is determined by its physical and chemical properties and is expressed as its K-factor (t.ha.h)/(ha.MJ.mm). Table 7.1 provides soil erodibility rankings for a range of K-factors as per Rosewell (1993).

Table 7.1 Rosewell (1993) soil erosion ranking

K-factor (t ha h $ha^{-1}MJ^{-1}mm^{-1}$)	Erosion potential
<0.02	Low
>0.02 to <0.04	Moderate
>0.04	High

The modelled K-factors for the mapped quarry area were determined from the eSpade 2.1 database (OEH 2019) (Figure 7.1). The modelled K-factors range from 0.04–0.06 t ha h $ha^{-1}MJ^{-1}mm^{-1}$ which indicate that the quarry soils have a high erosion potential.

The default K-factors for well graded sands to silt sands range from 0.036 to 0.043 t ha h $ha^{-1}MJ^{-1}mm^{-1}$ (Table E5, IECA 2008). Therefore, the modelled K-factors reflect the mapped soil landscapes and not the alluvially deposited site soils. A K-factor of 0.043 t ha h $ha^{-1}MJ^{-1}mm^{-1}$ that is appropriate for the alluvially deposited soils has therefore been adopted.

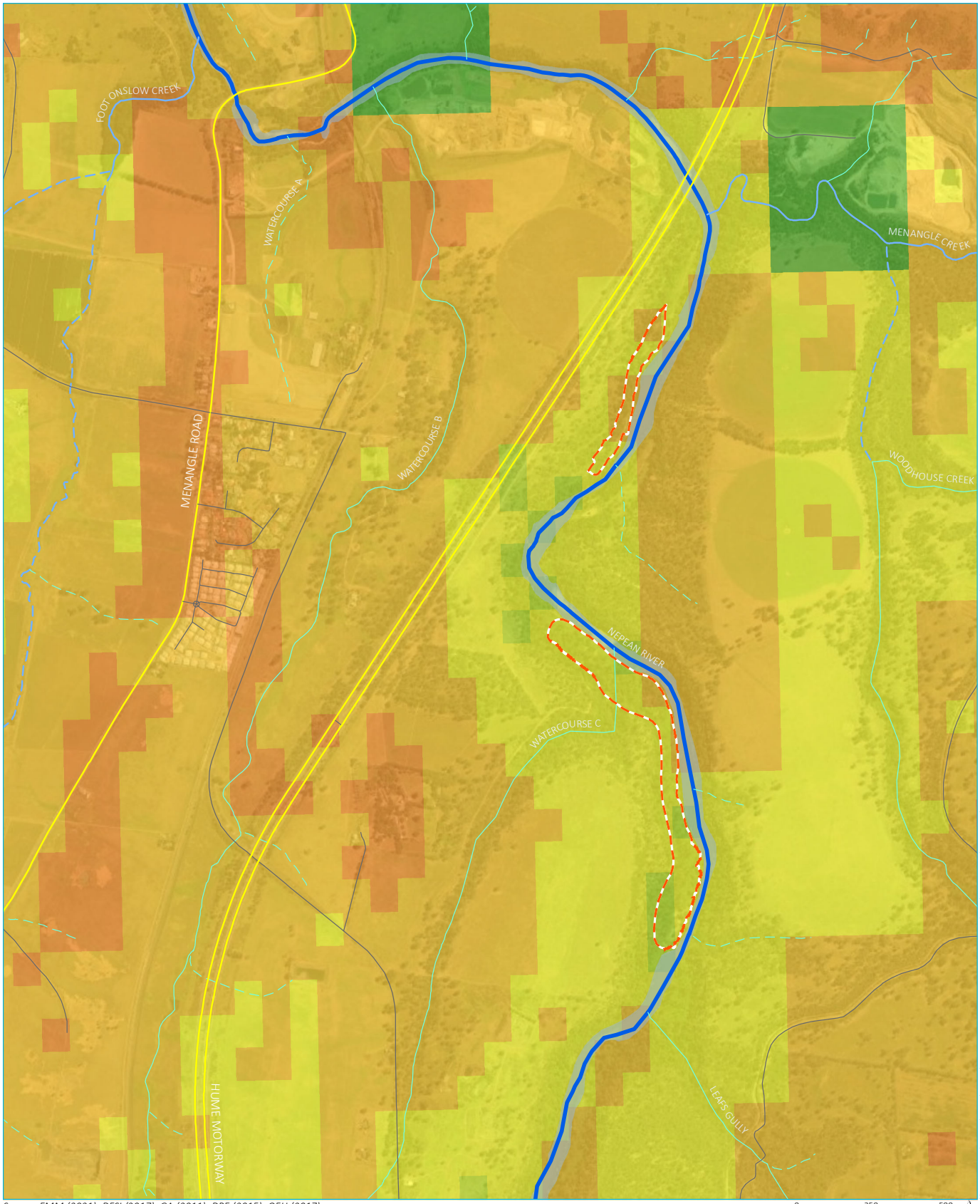
7.1.2 Slope and rainfall erosion hazard

The calculated R-factor for the quarry site is 1,663 MJ.mm.$ha^{-1}h^{-1}$ (see Section 3.1).

Slopes in the disturbance areas generally range from 0–180% (0 to 61°) (Figure 7.2).

Applying these parameters to the erosion hazard nomograph (Figure 7.3), indicates that there will be low to high erosion at the quarry due to slope and rainfall erosivity. On this basis, further analysis of SLCs is required.

A high erosion hazard requires further detailed assessment in accordance with Section 4.4.2 of Landcom (2004) to determine Soil Loss Classes (Table 7.2).



Source: EMM (2021); DFSI (2017); GA (2011); DPE (2015); OEH (2017)

0 250 500 m

GDA 1994 MGA Zone 56

N

\\emmsvr1\EMMJobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps_SWMP\SWMP005_SoilKFactors_20210630_03.mxd 30/06/2021

KEY

- Stage 8 - extraction/ rehabilitation area
- Main road
- Local road
- Named waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

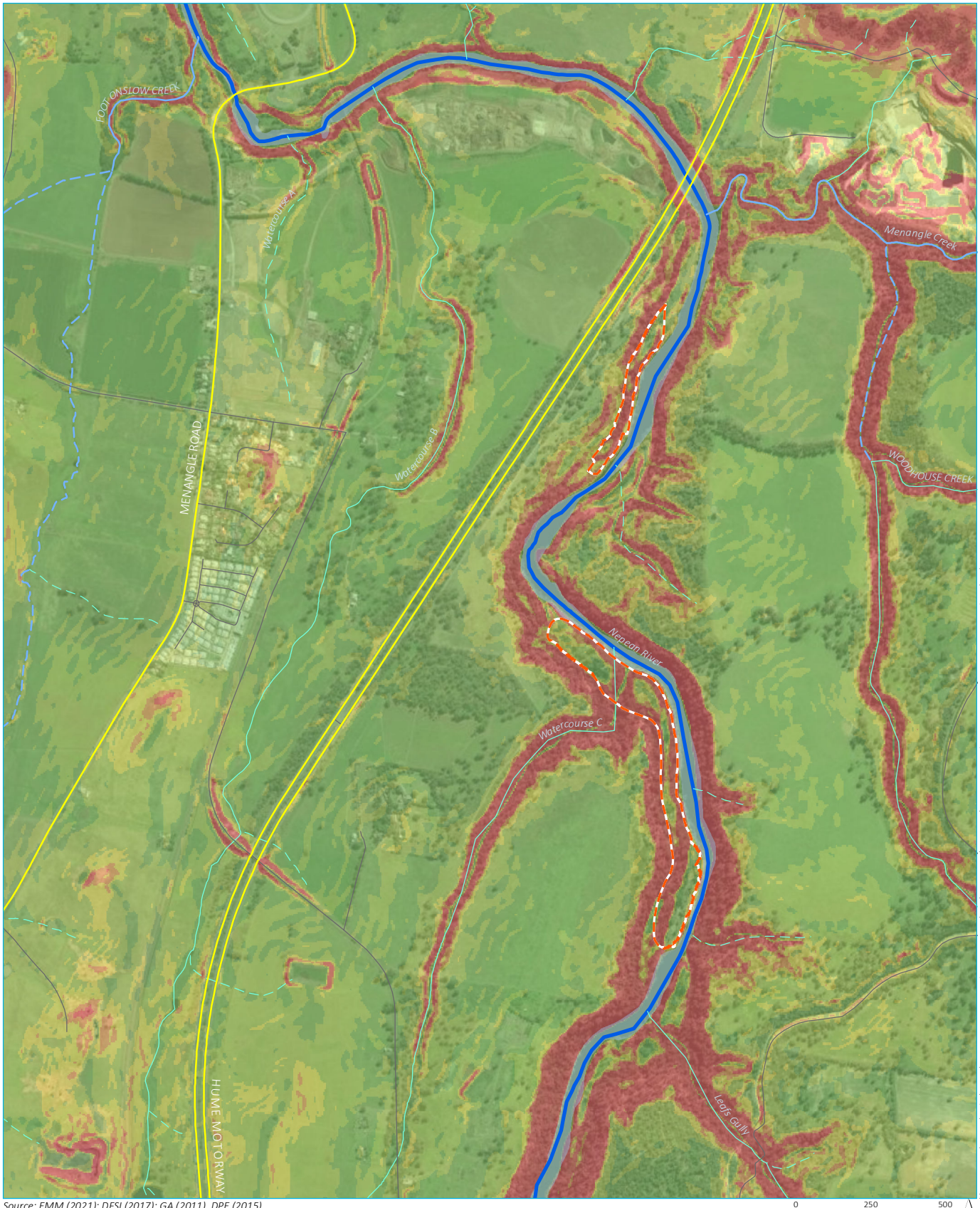
RUSLE K factor

- 0.01 - 0.01
- 0.03 - 0.04
- 0.04 - 0.05
- 0.05 - 0.06
- 0.06 - 0.07

Mapped soil K-factors

Menangle Quarry Extension
Soil and water management plan
Figure 7.1

EMM
creating opportunities



Source: EMM (2021); DFSI (2017); GA (2011), DPE (2015)

0 250 500 m

GDA 1994 MGA Zone 56

N

\\emmsvr1\EMMJobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps_SWMP\SWMP006_SlopePercent_20210630_02.mxd 28/02/2022

KEY

- Stage 8 - extraction/ rehabilitation area
- Main road
- Local road
- Named waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

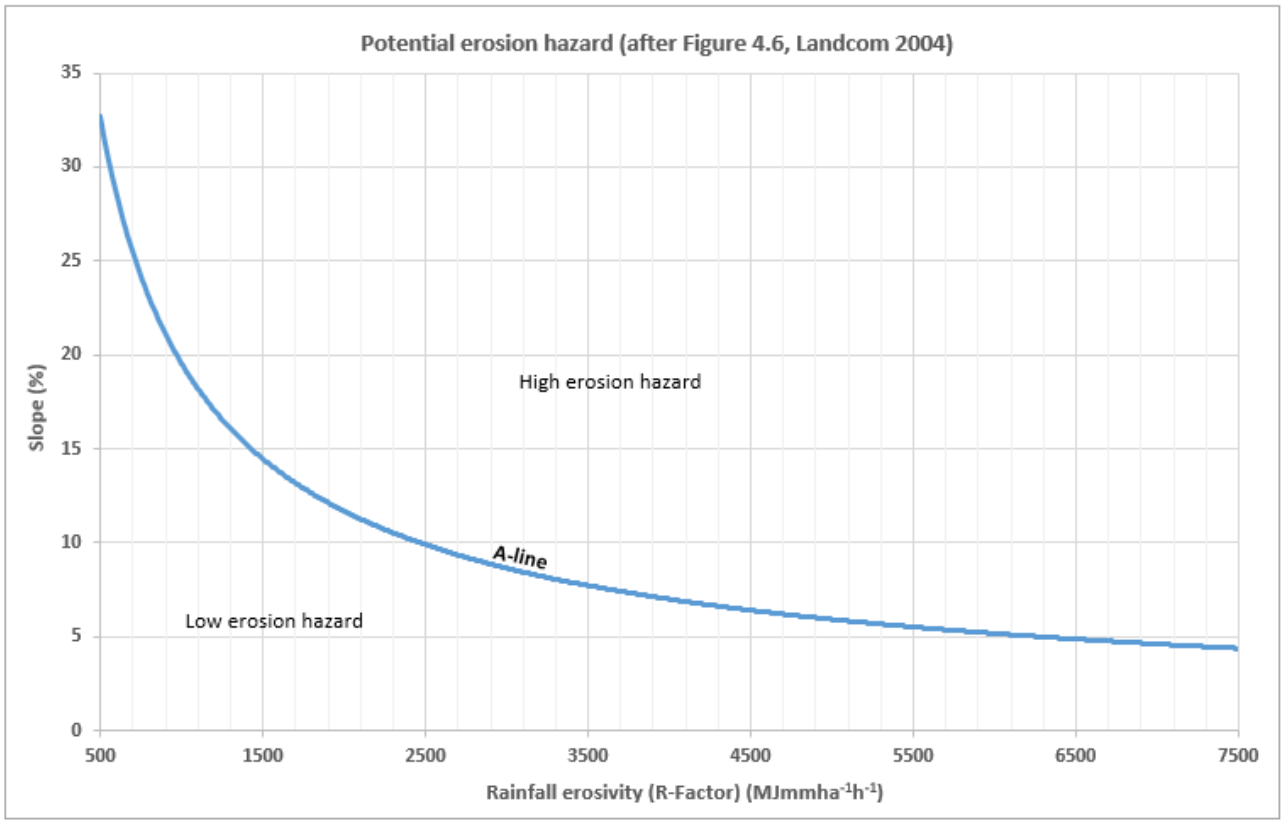
Slope percent

- < 5 %
- 5 - 10 %
- 10 - 15 %
- 15 - 20 %
- > 20 %

Quarry slope percentages

Menangle Quarry Extension
Soil and water management plan
Figure 7.2

EMM
creating opportunities



Source: Landcom (2004).

Figure 7.3 Assessment of potential erosion hazard

Table 7.2 Soil Loss Classes

Soil Loss Class (SLC)	Calculated soil loss (t/ha/year)	Erosion hazard
1	0 to 150	Very low
2	151 to 225	Low
3	226 to 350	Low-moderate
4	351 to 500	Moderate
5	501 to 750	High
6	751 to 1,500	Very high
7	>1,500	Extremely high

Source: Adapted from Table 4.2 of Landcom (2004).

Soil Loss Classes for the quarry have been determined by calculating the annual average soil loss using the RUSLE with a nominal 80 m slope length, C-factor of 1 (100% bare soil) and a soil conservation factor (P-factor) of 1.3 (compacted and smooth soil).

Calculated indicative soil loss for slopes ranging from 1–30% are provided in Table 7.3.

Table 7.3 Annual average soil loss

Slope	1%	10%	14%	20%	25%	30%	40%
R (calculated)	1,663	1,663	1,663	1,663	1,663	1,663	1,663
K (OEH 2019)	0.043	0.043	0.043	0.043	0.043	0.043	0.043
LS (Table A1 Landcom 2004 and USDA 1997)	0.19	2.81	4.61	7.32	9.51	11.6	15.67
P (Table A2 Landcom 2004)	1.3	1.3	1.3	1.3	1.3	1.3	1.3
C (Figure A5 Landcom 2004)	1	1	1	1	1	1	1
Soil loss t/ha/year	**18**	**261**	**429**	**680**	**884**	**1,078**	**1,457**

Applying the calculated annual average soil loss to Table 7.2 results in a SLC ranging from 1 (very low) to 6 (very high).

Lands with SLCs greater than 4 trigger increased erosion and sediment control management requirements as stipulated in Section 4.4.2 of Landcom (2004).

The quarry is in rainfall zone 4 (Figure 7.4).

Landcom (2004) defines highly sensitive lands as:

1. always on SLC 7 lands; and
2. at certain times of the year:
    a) on SLC 5 or 6 lands in all rainfall zones; and
    b) on SLC 4 lands in rainfall zones 5 and 11.

Waterfront land, ie between a river and its highest bank, is regarded as SLC 6 lands (Landcom 2004).

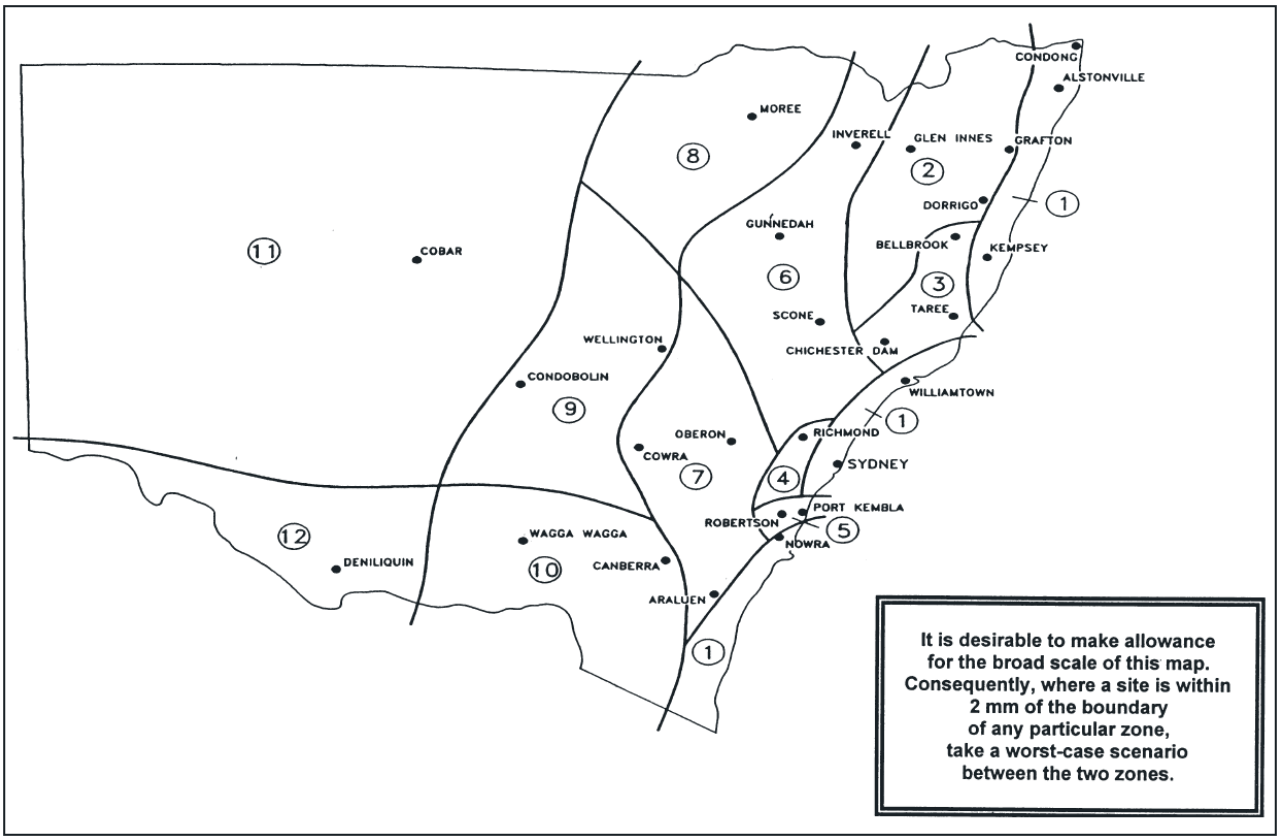


Figure 7.4 Rainfall zones (source: Landcom 2004)

Low and high rainfall erosivity periods for Zone 4 are provided in Table 7.4. Land disturbing works in highly sensitive areas should be scheduled for periods when rainfall erosivity is low.

Table 7.4 Zone 4 high and low rainfall erosivity periods

SLC	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
1-4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
5	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
6	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H
7	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

When it is not possible to schedule activities on highly sensitive land to periods when rainfall erosivity is low or is impractical, Menangle Sand and Soil will rapidly stabilise disturbed lands as far as practicable (see Section 7.2.5) to have a C-factor lower than 0.1 when the 3-day rainfall forecast suggests that rain is likely.

There is limited erosion associated with previous quarry extraction areas primarily due to the success in achieving soil surface cover via revegetation works.

However, in the absence of appropriate controls there would be a high to very high erosion risk for parts of the quarry. The erosion and sediment controls that will be implemented are described in Section 7.2.

7.1.3 Flood erosion hazard analysis

An assessment of flood erosion potential in the Stage 8 extraction area was undertaken by Fluvial Systems (2019) as part of the fluvial geomorphological assessment undertaken for the modification1 application. Fluvial Systems (2019) identified that during flood conditions, scattered patches of scour could occur within the Stage 8 area although these would be likely to infill, or partially infill with coarse sediment on the falling limbs of the flood hydrograph. Fluvial Systems (2019) stated that this is a natural and expected process that would occur regardless of extraction operations. They also stated that the risk of scour can be reduced by retaining as much vegetation as possible, revegetating disturbed land as quickly as possible and protecting with appropriate erosion resistant materials.

Table 5 in Fluvial Systems (2019) identifies there is a high risk of channel bench scour in exposed soils and well vegetated areas when shear stress exceeds 4 N/m^2 and 200 N/m^2 respectively. As described in Section 7.2.5, scouring during flooding will be minimised by rapidly stabilising disturbed areas (eg completed extraction areas) to cover and bind the soil, increasing the shear strength.

Management and mitigation of flood erosion risk is discussed further in the *Flood Management Plan*, including through the application of the Flood Scour Risk and Remedial Response TARP (Appendix E) and the Vegetation Management and Site Stabilisation TARP (Appendix F).

7.2 Application of the erosion risk assessment

The erosion risk assessment generally found that, without appropriate controls (as described in the SWMP) there will be a high to very high risk due to:

- the erodibility of soils;
- calculated soil loss;
- slope steepness; and
- rainfall erosivity in the wettest season (December to March).

Menangle Sand and Soil will adopt the following drainage, erosion and sediment control management measures to address this erosion risk.

Details of long-term quarry rehabilitation are provided in the *Biodiversity and Rehabilitation Management Plan*.

7.2.1 Full-time Rehabilitation Officer

The quarry will employ a full-time Rehabilitation Officer.

The Rehabilitation Officer will be onsite every working day that the quarry is operating, implementing the erosion control, soil stabilisation and rehabilitation measures described in this SWMP. They will ensure that disturbed areas are stabilised as soon as possible, initially applying temporary measures if required, such as sowing a cover crop, and then applying permanent measures such as establishment of native vegetation.

As the Rehabilitation Officer will be onsite every working day they will be able to implement the measures described in this SWMP progressively, targeting small area as soon as they are available rather than undertaking these works in larger areas on a less frequent ‘campaign’ basis.

The Rehabilitation Officer will regularly inspect the success, or otherwise, of the measures implemented and will adjust the application of these measures accordingly.

7.2.2 Appropriately integrating quarry design with site constraints

As noted above, there is limited erosion associated with previous quarry extraction areas primarily due to the success in achieving soil surface cover via revegetation works.

The quarry has been designed, constructed and rehabilitated so that the landform generally blends with the surrounding topography to generally avoid significant modification to landforms. The exception is the noise/visual bund surrounding the processing area. Previously extracted areas have been recontoured so that they resemble the pre-disturbance landform. This practice will continue in the Stage 8 area.

The Stage 8 extraction area will generally result in an overall lowering of the alluvial benches to 64 m AHD with final batters 1(v):5(h) on the river side and up to 1(v):1(h) on the landward side (although natural sandstone faces may be steeper, up to vertical or overhanging).

The extraction works will not result in the disturbance of electrochemically unstable soils.

7.2.3 Minimising the extent and duration of land disturbance

Menangle Sand and Soil will implement an internal Land Disturbance Permit process to ensure unnecessary land disturbance does not occur. Location-specific environmental, drainage and erosion and sediment controls will be planned and implemented as required.

Protected vegetation is identified in the quarry's BRMP. Clearing limits will be clearly demarcated using barrier mesh, bunting or some other appropriate high visibility material.

Initial clearing and stripping works will be scheduled to avoid high rainfall erosivity periods, where practical, to minimise erosion. Where major land disturbing works need to occur in a high rainfall erosivity period, there will be an appropriate increase in the levels of control measures to compensate for the increased erosion risk.

Progressive stabilisation and rehabilitation of disturbed areas is fundamental to successful erosion and sediment control to prevent turbid runoff and subsequent sedimentation. Only two substages will only be active at any time. The active extraction area will be no greater than 0.33 ha.

Progressive stabilisation and rehabilitation will continue to be undertaken with a goal of achieving the C-factors and timing nominated in Table 7.5.

Table 7.5 Maximum C-factors during and post land disturbance

Feature/area	C-factor	Requirement
During land disturbance		
Waterways and land below the 2-year ARI flood levels including stockpiles	0.10	When working in waterways and flood prone lands a C-factor of ≤0.1 is to be achieved (eg by the application of timber debris or soil stabilising polymer) if the 3-day forecast indicates rain causing runoff is likely.
Land above 2-year ARI flood levels flood levels (including stockpiles)	0.15	A C-factor of ≤0.15 is to be achieved within 20 working days of inactivity, even though works might continue later.
Post- land disturbance		
Waterways and other areas subjected to concentrated flows	0.05	Applies after 10 working days from completion of formation and before they are allowed to carry any concentrated flows.

Table 7.5 Maximum C-factors during and post land disturbance

Feature/area	C-factor	Requirement
Stockpiles	0.10	Applies after 10 working days from completion of formation. Maximum C-Factor of 0.10 equals 60% ground cover.
All other land	0.15	In periods of expected 'low' rainfall erosivity during the rehabilitation period, achieve a C-Factor of less than 0.15. Maximum C-factor of 0.15 equals 50% ground cover.
	0.10	In periods of 'moderate' to 'high' rainfall erosivity during the rehabilitation period, achieve a C-Factor of less than 0.1. Implement a program to ensure C-Factor would reduce permanently to less than 0.05 within 60 days of the preliminary stabilisation activities described above.

Source: Adapted from Section 7.1.2, Table 7.1 and Table 9.3 in Landcom (2004).

7.2.4 Controlling water movement through the site

As identified in Section 3.3, the passage of clean water running on to previously extracted areas and the infrastructure areas is generally via ephemeral waterways. As discussed in Section 5.2.3, clean water is diverted around the processing area via a diversion bund (noise/visual bund). A trafficable inclined diversion bank will be installed on the eastern side of Watercourse B to ensure all potentially turbid runoff from this area is diverted away from Watercourse B to WMD01.

Pipe culverts are installed on all waterway crossings.

There is limited opportunity to divert clean water around the Stage 8 extraction area due to topography and existing native vegetation that is to be retained. Further, the diversion of clean water could potentially lead to the dispersal of weed seeds to rehabilitation and biodiversity restoration areas. Erosion hazard for non-cohesive sandy and silty soils will be reduced by maintaining sheet-flow conditions instead of concentrating flows in diversion drains.

Rainfall falling onto the roofs of offices and workshop facilities is considered to be clean water. Roof runoff is captured using gutters and stored in tanks for re-use and overflows directed away from active exposed areas.

Fuel storages are bunded (see Section 5.2.5).

7.2.5 Minimise soil erosion

Sediment and turbid water are only generated when erosion occurs. Therefore, the most effective form of sediment control is erosion control. Effective erosion control will be a fundamental component of Menangle Sand and Soil's drainage, erosion and sediment control strategy.

The types of erosion that can potentially are:

- raindrop splash erosion;
- sheet erosion;
- rill erosion;
- gully erosion; and
- creek bed and bank erosion.

Raindrop splash erosion is most effectively controlled by providing soil surface cover. This is achieved within the quarry area by:

- minimising the extent and duration of soil disturbance;
- retaining vegetation and other soil surface cover (eg timber debris) and respreading as part of rehabilitation and restoration works;
- progressively rehabilitating disturbed areas; and
- covering and binding exposed soils (see Section 7.2.6).

Rill erosion is effectively controlled by minimising slope length and gradient. This is achieved within the quarry area by:

- minimising disturbance of steeply grading areas where possible;
- reducing slope gradient and length;
- minimising concentration of flow; and
- progressively revegetating disturbed areas.

Gully erosion is effectively controlled by minimising the concentration of flow and slowing flow velocity. This is achieved within the quarry area by:

- maintaining sheet-flow where possible; and
- lining drains and installing grade control measures in waterways where flow velocities exceed the maximum permissible velocity of the soil (temporary and permanent).

Energy dissipaters will be used at the outlets of drains and spillways to reduce flow velocities to less than the maximum permissible velocity for the soil type.

7.2.6 Promptly stabilising disturbed areas

Progressive stabilisation and rehabilitation of disturbed areas will be undertaken to minimise erosion and the generation of sediment and turbid runoff with the goal of achieving the C-factors and timing nominated in Table 7.5.

Stabilisation methods will be selected based on variables including the specific location, the slope gradient and length, proximity to the Nepean River, time of year, surrounding vegetation (weed-infested versus self-sustaining native vegetation) and the final rehabilitation objectives as described in the BRMP. Stabilisation methods are expected to include one or more of the following:

- sowing a cover crop along with seeding with the desired native tree and bush species;
- applying polymer soil stabiliser;
- slope reduction;
- spreading timber debris (in accordance with Consent Condition B78);
- permanent revegetation with native vegetation;

- applying straw based hydromulch/hydraulically applied growth medium (HGM); and/or
- rock mulching.

7.2.7 Maximise sediment retention

Irrespective of how well designed and implemented erosion control is on site, sediment and turbid water will always be generated during rainfall events.

As detailed in Section 5.2.4, sedimentation basins have been, and will continue to be constructed, to contain and treat sediment laden runoff from the disturbed areas, including the processing area and the Stage 8 area.

WMD01 and WMD02 are permanent water management dams that will remain until processing operations have been completed. These dams have been sized to contain the 95th percentile 5-day rainfall depth with the sediment storage zone 50% of the volume of the settlement zone in accordance with Table 6.1 of DECC (2008) for basins with a design life of greater than 3 years in a sensitive environment.

The first basin in the Stage 8 area will be constructed at the northern end of Stage 8A and will be progressively moved south as extraction progresses from the north to south.

Sedimentation basins in the Stage 8 area will be sized in accordance with Landcom (2004) for a Type D soil. The required sedimentation basin size will vary as quarrying progresses due to changes in the upstream clean water run-on catchment. The basins will be sized to contain the 85th percentile 5-day rainfall depth with the sediment storage zone 50% of the volume of the settlement zone in accordance with Table 6.1 of DECC (2008) for basins with a design life of 6 to 12 months in a sensitive environment. Indicative basin sizes for a typical Stage 8 area catchment as well as the maximum catchment expected to contribute to each substage area are provided in Table 7.6.

Table 7.6 Sedimentation basin sizing

Basin ID	Catchment area (ha)	Settling zone (m^3)	Sediment storage (m^3)	Total basin volume (m^3)	Total basin volume (m^3/ha)	Existing volume (m^3)
Stage 8 typical	0.8	164	82	246	307	-
Stage 8A max	1.3[1]	266	133	399	307	-
Stage 8B max	2.4[1]	492	246	738	307	-
Stage 8C max	2.1[1]	430	215	645	307	-
WMD01	3.8	1,990	995	2,985	786	6,100
WMD02	4.4	2,305	1,152	3,457	786	27,500

Notes: 1. Based on the estimated maximum catchment size including upstream run-on catchment and extraction area.

The sedimentations basins in the Stage 8 area will be in the base of the active extraction area. Should they fill with water, they will overflow into the base of the active extraction area. As the lower riverbank will be retained to a minimum height of 64 m AHD, there will be no overland flow-paths between the basins and the Nepean River, except when the river is flooding and the entire active extraction area is inundated.

The Quarry Manager will implement an onsite approval system to minimise the potential for accidental turbid water discharge during pumping and dewatering activities on site.

7.2.8 Maintain drainage, erosion and sediment control measures

Drainage, erosion and sediment control measures will be maintained at all times until their function is no longer required. Technical notes for drainage, erosion and sediment control measures are available from the International Erosion Control Association Australia's website: austieca.com.au/publications/book-4-design-fact-sheets and austieca.com.au/publications/book-6-standard-drawings. These technical notes include the construction and maintenance requirements for the control measures.

Controls will be inspected following rainfall that causes runoff or monthly during dry conditions.

Inspections will be undertaken by the Quarry Manager. The person undertaking the inspections will require the following knowledge:

- an understanding of site environmental values that could be impacted by the quarry's operations;
- an understanding of the requirements of the Consent and the EPL that are relevant to drainage, erosion and sediment control;
- a good working knowledge of drainage, erosion and sediment control fundamentals and their application; and
- the ability to provide advice and guidance on appropriate measures and procedures to maintain the site at all time in a condition representative of regionally specific best practice, and that is reasonably likely to achieve the required standards.

Menangle Sand and Soil will maintain control measures to maximum practicable extent so that they:

- will best achieve the required environmental protection including achieving the water quality criteria specified in the Consent and the EPL in the nominated design storm event (see Section 7.2.5);
- are in accordance with the specified operational standard for each drainage, erosion and sediment control measure; and
- prevent or minimise safety risks.

All natural debris and sediment removed from control measures will be transported to the processing area and incorporated into blended quarry products or will be placed into the base of a completed extraction area in a manner that will not create an erosion or pollution hazard. Any contaminated material will be removed from site for disposal at an appropriately-licenced facility.

7.2.9 Monitor and adjust drainage, erosion and sediment control practices to achieve the desired performance standard

As noted in Section 5.2.4, erosion and sediment controls will be progressively installed in the Stage 8 area as the active extraction area advances. The construction of these controls will be timed so that previously installed controls remain effective until the new controls are fully functional. Redundant controls will be removed/rehabilitated when they are no longer required to divert clean water or capture quarry-affected water.

If an inspection or environmental monitoring identifies a significant failure of the adopted drainage, erosion and sediment control measures, a critical evaluation of the failure will be undertaken to determine the cause and appropriate modifications made to the control measures on site and the SWMP amended if required.

7.2.10 Drainage, erosion and sediment control competence

Quarry personnel, including contractors, will have an appropriate level of drainage, erosion and sediment training. Two levels of competency training for personnel are recommended:

- Level 1 – basic awareness level training provided during the site induction.
- Level 2 – detailed training course where drainage, erosion and sediment control is a regular component of their daily activities and competence is required.

7.2.11 Erosion and sediment controls in each quarry area

A range of erosion and sediment control measures will be applied to each quarry area.

As described in Section 7.2.1, the quarry will employ a full-time Rehabilitation Officer. The Rehabilitation Officer will apply a combination (one or more) of the erosion and sediment controls provided in Tables 7.8 to 7.11 based on an assessment of the specific location within each quarry area:

- site entry compound: office, parking, workshop and laydown areas (Table 7.7);
- processing area (Table 7.8);
- Stage 8 extraction area (Table 7.9); and
- access track and haul road (Table 7.10).

Table 7.7 Drainage, erosion and sediment control options – site entry compound

Control measure	Purpose
Drainage control	
Lined drains	To convey run-off in a non-erosive manner.
Guttering and down pipes	To convey clean roof-run-off
Erosion control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Sediment control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Sediment fence	To capture coarse sediment in sheet flow environments.

Table 7.7 Drainage, erosion and sediment control options – site entry compound

Control measure	Purpose
Permanent	
Wheel wash	To remove sediment from light vehicles and trucks to prevent mud tracking to public roads

Table 7.8 Drainage, erosion and sediment control options – processing area

Control measure	Purpose
Drainage control	
Lined drains	To convey run-off in a non-erosive manner.
Erosion control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Revegetation	To protect exposed embankment and bunds from raindrop splash erosion and surface flows.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Check dams	Capture small quantities of coarse sediment in drains.
Sediment fence	To capture coarse sediment in sheet-flow environments.
Sediment sumps	To capture coarse sediments.
Type F, high efficiency sediment basin	To capture and treat sediment and turbid runoff.

Table 7.9 Drainage, erosion and sediment control options – Stage 8 extraction area

Control measure	Purpose
Drainage control	
Trafficable cross banks	To divert quarry runoff from the access track to sediment controls.
Lined drains	To convey run-off in a non-erosive manner.
Mitre drains	To divert run-off to reduce the volume and velocity of drainage.
Earth bunds	To contain sediment and turbid run-off to the active quarrying area.

Table 7.9 Drainage, erosion and sediment control options – Stage 8 extraction area

Control measure	Purpose
Erosion control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Timber debris	To provide soil surface cover, habitat, rill interruption and to discourage vehicle damage
Revegetation	To cover and stabilise exposed soil, including the completed extraction area and embankments from raindrop splash erosion and surface flows.
Straw based hydromulch/ Hydraulically applied growth medium (HGM)	To protect newly seeded areas from erosion and allow rapid vegetation establishment.
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Sediment Fence	To capture coarse sediment in sheet flow environments.
Mulch bunds	To capture medium and coarse sediment in sheet flow environments.
Type F sediment basin	To capture and treat sediment and turbid runoff.

Table 7.10 Drainage, erosion and sediment control options – access tracks and haul road

Control measure	Purpose
Drainage control	
Lined table drains	To convey track run-off in a non-erosive manner.
Mitre drains	To divert track run-off away from the track to reduce the volume and velocity of drainage.
Trafficable cross banks	To minimise track erosion, disperse water to reduce slope lengths and velocity.
Pipe culverts	To allow vehicle access over ephemeral creeks and to allow clean up-stream water to pass through the construction zone without contamination. Maintain natural drainage paths.
Erosion control	
Temporary	
Check dams	To reduce flow velocity in the access track table drains and mitre drains until permanent drain linings can be installed.

Table 7.10 Drainage, erosion and sediment control options – access tracks and haul road

Control measure	Purpose
Cover crops	Rapid vegetation establishment along track/haul road edges until permanent vegetation germinates and grows.
Trafficable polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Revegetation	To protect along track/haul road edges from raindrop splash erosion and surface flows.
Straw based hydromulch	To protect newly seeded areas from erosion.
Vegetation mulching	To protect exposed embankments from raindrop splash erosion and surface flows no steeper than 1(v):3(h).
Sediment control	
Check dams	Capture small quantities of coarse sediment in the table drains and mitre drains.
Sediment fence	To capture coarse sediment in sheet flow environments.

8 Inspection and maintenance

8.1 Incidents

All incidents will be reported and investigated, and corrective actions assigned to prevent future occurrences.

An incident may involve any action or activity deemed to be in non-compliance with this SWMP as well as actual or potential Material or Serious Environmental Harm.

All incident reporting will be undertaken in accordance with the procedures detailed in the EMS.

8.2 Inspections and monitoring

Inspections of drainage, erosion and sediment control measures will be undertaken:

- weekly during normal operations hours;
- daily during periods of rainfall; and
- within 12 hours of the cessation of a rainfall event (greater than 10 mm) causing runoff to occur on, or from, the quarry.

Inspections will be undertaken by the Quarry Manager.

8.3 Maintenance and remedial actions

As described in Section 7, a range of drainage, erosion and sediment control measures will be implemented within the quarry. A summary of the maintenance and remedial actions for these control measures is provided in Table 8.1.

Table 8.1 Maintenance and remedial actions

Control measure	Maintenance and remedial actions
Drainage control	
Lined clean water diversion drains and banks	Repair any damage to the liner (replace/re-anchor), repair any bunding or silt fence isolating the clean water catchment from the quarry affected water catchment.
Quarry affected water diversion drains and banks	Repair any erosion, re-line if necessary.
Temporary clean water culverts	Ensure water from disturbed areas cannot enter the pipe or channel. Monitor for erosion around the inlet and outlet headwalls and repair as necessary. Check the pipe outlet energy dissipater for erosion and repair and/or modify as necessary.
Culvert waterway crossing	Ensure the geofabric sediment retention is installed correctly and sediment cannot enter the waterway. Ensure the culvert pipe is not blocked. Ensure accumulated sediment is removed from the rock or rock is replaced as necessary. Inspect after flow events to ensure the crossing remains stable. Repair and/or modify as necessary.

Table 8.1 Maintenance and remedial actions

Control measure	Maintenance and remedial actions
Erosion control	
Temporary measures	
Polymer soil stabiliser	Re-apply following rainfall or heavy vehicle traffic as necessary.
Cover crops	Test the soil and apply ameliorants if necessary (see BRMP).
Permanent measures	
Lined channel, drains and batter chutes	Look for water flows under or beside the structure and repair and/or modify as necessary. Look for erosion around and downstream of the structure and repair and/or modify as necessary.
Revegetation	Inspect for evidence of rill, gully, and tunnel erosion, poor soil surface cover and nutrient deficiencies. Test the soil and apply ameliorants if necessary (see BRMP).
Sediment control	
Temporary measures	
Silt fences	Ensure silt fences pond water. If not, install additional panels. Check for blow-outs in the anchor trench. Re-anchor as necessary. Replace any ripped or damaged sediment fence.
Check dams	Check for erosion between check dams. Install additional check dams if necessary. Remove accumulated sediment.
Sedimentation basins	Remove accumulated sediment from WMD01 and WMD02 when it reaches the sediment storage zone marker. If required for sediment removal, dewater WMD01 and WMD02 when water quality is less than nominated water quality limits. Check basin inlets and outlets for erosion and repair as necessary. Check the basin wall for slumping or tunnel erosion. Repair as necessary. Sedimentation basins in the Stage 8 extraction area will be progressively built and then covered as the quarry advanced. Sediment will not need to be removed from these basins and therefore will not need to be dewatered.
Permanent measures	
Wheel wash	Clean out accumulated sediment, check sprays and repair as required.

8.4 Wet weather and site shutdown procedures

The Quarry Manager will monitor weather forecasts daily. Where the forecasts indicate that there is a greater than 60% chance of more than 10 mm of predicted rainfall, the Quarry Manager implement and the wet weather procedures.

The Quarry Manager will initiate erosion and sediment control wet weather preparedness at:

- the end of the working day; or
- in the event of imminent rainfall (greater than 60% chance of more than 10 mm of predicted rainfall).

Erosion and sediment control wet weather preparedness will include:

- ensuring clean water diversions are in place (where required);
- constructing temporary drains if required to ensure runoff from quarry affected catchments is diverted to sediment control measures;
- stabilise unprotected soil stockpiles and erosion prone embankments with soil stabilising polymers and ensure necessary sediment controls are in place;
- ensure sediment traps have been desilted, basins dewatered, and they are operating correctly; and
- implement any remaining controls.

Actions to be taken in the event of a flood warning are described in the *Flood Management Plan*.

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Appendix A

Agency consultation

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12 October 2020

Department of Planning, Industry & Environment: Water
Landuse.enquiries@dpi.nsw.gov.au

Re: Menangle Sand and Soil Quarry – Soil and Water Management Plan – Consultation with DPIE Water

To whom it may concern,

Menangle Sand and Soil Pty Ltd operates the Menangle Sand and Soil Quarry (the 'Quarry') at 15 Menangle Road Menangle. A modification to the Quarry's approval has recently been approved. The updated approval requires that the soil and Water Management Plan (SWMP) is prepared in consultation with the Environment Protection Authority (EPA) and DPIE Water.

This letter seeks the DPIE Water's input to these plans.

1 Quarry overview

Menangle Sand and Soil Pty Ltd operates the Menangle Sand and Soil Quarry at 15 Menangle Road Menangle. Quarrying has been undertaken in the location for over 40 years by a number of operators and at varying rates of production. Extraction, processing and rehabilitation activities have been undertaken by Menangle Sand and Soil since 1978.

Current extractive activities were approved in 1989 (DA 85/2865) and have involved the construction and operation of the quarry in seven stages. Sand and soil has been extracted from Stages 1 to 2 and 4 to 6 and is currently being extracted from Stage 7. While previously approved, sand and soil will not be extracted from Stage 3.

In September 2020, the NSW Land and Environment Court approved 'Menangle Quarry Extension – Modification 1' (MOD1). This allows the extraction of sand and soil in a new area, the Stage 8 area, that is about 13 ha, and extends about 2 kilometres along the Nepean River south of the Stage 7 area. The extension will increase the life of the quarry by 15 years. The extracted material will be transported to the existing processing area where it will be stockpiled, processed and blended with materials imported to the site, prior to being dispatched from the quarry.

A description of the quarry, including MOD1, is provided in Appendix A. The Notice of Orders Made by the Land and Environment Court (the 'consent') is provided in Appendix B.

2 Previous assessments

The preparation of the environmental assessment for the modification application included the preparation of a *Flooding, Geomorphology and Onsite Water Management* report as part of the *Environmental Assessment* (EMM 2017). The assessment found that the proposed sediment extraction works and the

mitigation measures would ensure that there would be no significant adverse impacts on flooding, river geomorphology and river water quality. The extraction works would have no significant adverse impacts on flood behaviour or flood levels because it would provide more flood conveyance area.

Following the preparation of this assessment, a number of additional reports were prepared in response to DOI/DPI-Water requests, including:

- *DA 85/2865 MOD1, Response to DOI-Water comments of 21 February 2018* (EMM 2018);
- *Menangle Quarry Modification to Development Consent 85/2865, Review of Fluvial Geomorphology* (Fluvial Systems 2018); and
- *Menangle Quarry Extension, Flood Impact Assessment* (Advisan 2018).

The modification application was initially rejected by DPIE. During the Land and Environment Court (Case number 2018/00342158) appeal, additional assessments were prepared during the appeal process, including:

- *Menangle Quarry, Amended Extraction Area and Setback*, letter dated 16 August 2019 (EMM);
- *Menangle Quarry, Groundwater Management*, letter dated 16 August 2019 (EMM);
- *Menangle Quarry, Riverside Batter,* letter dated 23 August 2019 (EMM);
- *Fluvial Geomorphology Assessment for Menangle Quarry Modification to Development Consent 85/2865* dated 5 September 2019 (Fluvial Systems);
- *Menangle Quarry, Flood Mitigation*, letter dated 9 September 2019 (EMM);
- *Menangle Quarry Extension – Flood Impact Sensitivity Assessment*, dated September 2019 (Advisian); and
- *Additional Flood Impact Sensitivity Assessment*, dated 17 December 2019 (Advisian).

These reports are available on the Major Projects website:

- http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=8531

3 Management Plan

EMM Consulting Pty Limited (EMM) is now preparing a Soil and Water Management Plan (SWMP) in consultation with the EPA and DPIE Water in accordance with Part B, Condition B36 (b) of the consent.

The SWMP will address the matters raised in the Condition B34 of the consent and Menangle Sand and Soil's Summary of Commitments provided in Table 3.1 of Appendix A, including:

- a site water balance;
- erosion and sediment controls;
- surface water and groundwater baseline characterisation, monitoring and performance criteria;
- protocols for identifying and investigating any exceedances of performance criteria; and
- reporting requirements.

This letter seeks your input into the contents and preparation of the SWMP. We will also provide the draft SWMP to you for your review and comment. We would welcome the opportunity to meet, via teleconference, to discuss the plan.

It is requested that any comments you may have on the content or preparation the SWMP are provided by 26 October 2020 to allow them to be considered during preparation of the plan.

Should you wish to discuss anything specific please call me on the below number.

Please do not hesitate to contact me if you have any questions.

Yours sincerely,

Jeremy Slattery
Associate, Environmental Management
Phone: 0421 827 231
jslattery@emmconsulting.com.au

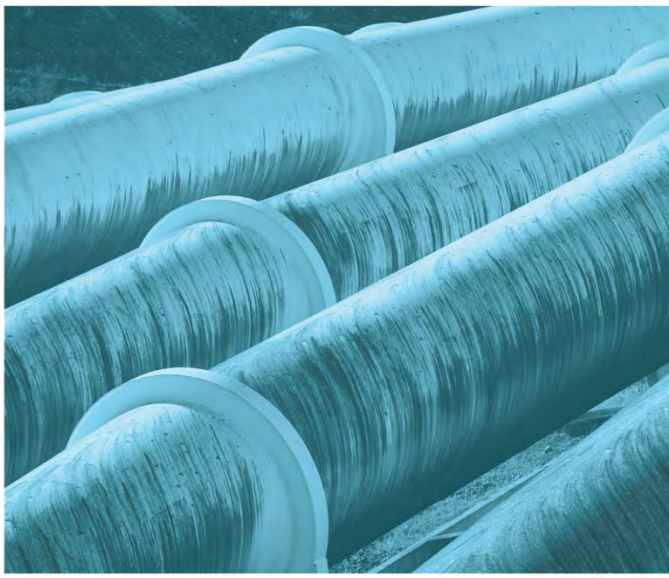
Appendix A

Project description


Land and Environment Court Proceedings 342158 of 2018

Applicant's Description of Amended Project

Menangle Sand & Soil Pty Limited v Minister for Planning
24 August 2020

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Land and Environment Court Proceedings 342158 of 2018

Applicant's Description of Amended Project

Prepared for Menangle Sand & Soil Pty Limited v Minister for Planning
24 August 2020

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Land and Environment Court Proceedings 342158 of 2018

Applicant's Description of Amended Project

Report Number

J190166 RP#4

Menangle Sand & Soil Pty Limited v Minister for Planning

Date

24 August 2020

Version

v7 Final

Approved by

Dr P. Towler
Associate Director
24 August 2020

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Appendices

Tables

Figures

1 Introduction

Menangle Sand and Soil Pty Ltd (Menangle Sand and Soil) seek a modification to Development Consent 85/2865 to extend the life of the quarry by 15 years while removing the need to re-establish quarrying activities, clear vegetation, and extract sand and soil from the approved Stage 3 area (the Menangle Sand and Soil Quarry Extension Project, the 'extension project'). It is proposed to forego approved land extraction (as well as dredging rights to another 200,000 tonnes) of 500,000 tonnes of sand and soil in the Stage 3 area and instead extend their current operations to extract sand and soil from an additional stage of the quarry (Stage 8). The Stage 8 area will extend approximately 2.8 km along the Nepean River on Company-controlled lands, within Lot 203//Deposited Plan 590247 on the eastern side of the Hume Highway. Approximately 760,000 tonnes of sand and soil will be extracted from the Stage 8 area land over about 15 years. Extraction will be in sequential substages so the active extraction area will be a small proportion of the total Stage 8 extraction area at any given time. No riverine extraction is proposed.

A modification application and accompanying environmental assessment (EA) report for the extension project was lodged in May 2017 and subsequently refused by the Department of Planning and Environment on 25 October 2018. The application is before the NSW Land and Environment Court (2018/342158).

An amended application was placed on public exhibition between 19 February 2020 and 4 March 2020. Amendments to the proposed modification are summarised in *NSW Land and Environment Court (2018/342158) Menangle Quarry - Project Amendments and Information Summary* (EMM [Towler] 2019a).

Given the application's history, the currently proposed modification is described in a range of documents.

This consolidated project description report provides a description of the currently approved quarry, based on Chapter 2 of the *Menangle Quarry Extension Environmental Assessment* (EA) (EMM 2017a), and the currently proposed modification (as amended) as described in Chapter 3 of the EA and subsequently amended in:

- *Supplementary Biodiversity Assessment* (EMM [Ward] 2019b);
- *Menangle Quarry - Amended Extraction Area and Setback* (EMM [Towler] 2019c);
- *Restoration Area Weed Strategy* (EMM [Grant] 2019d);
- *Groundwater Management* (EMM [Webb] 2019e); and
- *Flood Mitigation* (EMM [Towler] 2019f).

No modification amendments were proposed in the *Menangle Quarry Extension Response to Submissions* (RTS) (EMM 2017b).

The allotments subject to the development application modification, 'the site', are provided in Appendix A.

This consolidated project description report outlines the current proposal incorporating all of the changes to the project made since the Refusal and presents an updated statement of commitments.

2 Approved and proposed operations

2.1 Introduction

The extension project will increase the quarry life by 15 years (to 2035) by extracting the sand and soil resource in the Stage 8 area. The Stage 8 area extends approximately 2.8 km upstream of the currently active Stage 7 area. The project will require installation and operation of a conveyor between the existing processing area and the Stage 8 area. Menangle Sand and Soil will relinquish the approved extraction of resource (as well as its perpetual right to the resource located on the Elizabeth Macarthur Agricultural Institute land) from the approved Stage 3 area as part of the extension project.

The layout of the approved and proposed quarry is presented in Figure 2.1.

As well as the extraction areas, key components of the quarry include:

- an existing wheel wash and weighbridge;
- an existing site office and amenity building;
- an existing workshop west of the site office;
- existing fuel supply tanks north of the storage shed;
- existing sand and soils storage and processing area; and
- other existing minor infrastructure.

These components will be used to support activities in the Stage 8 area which will also include:

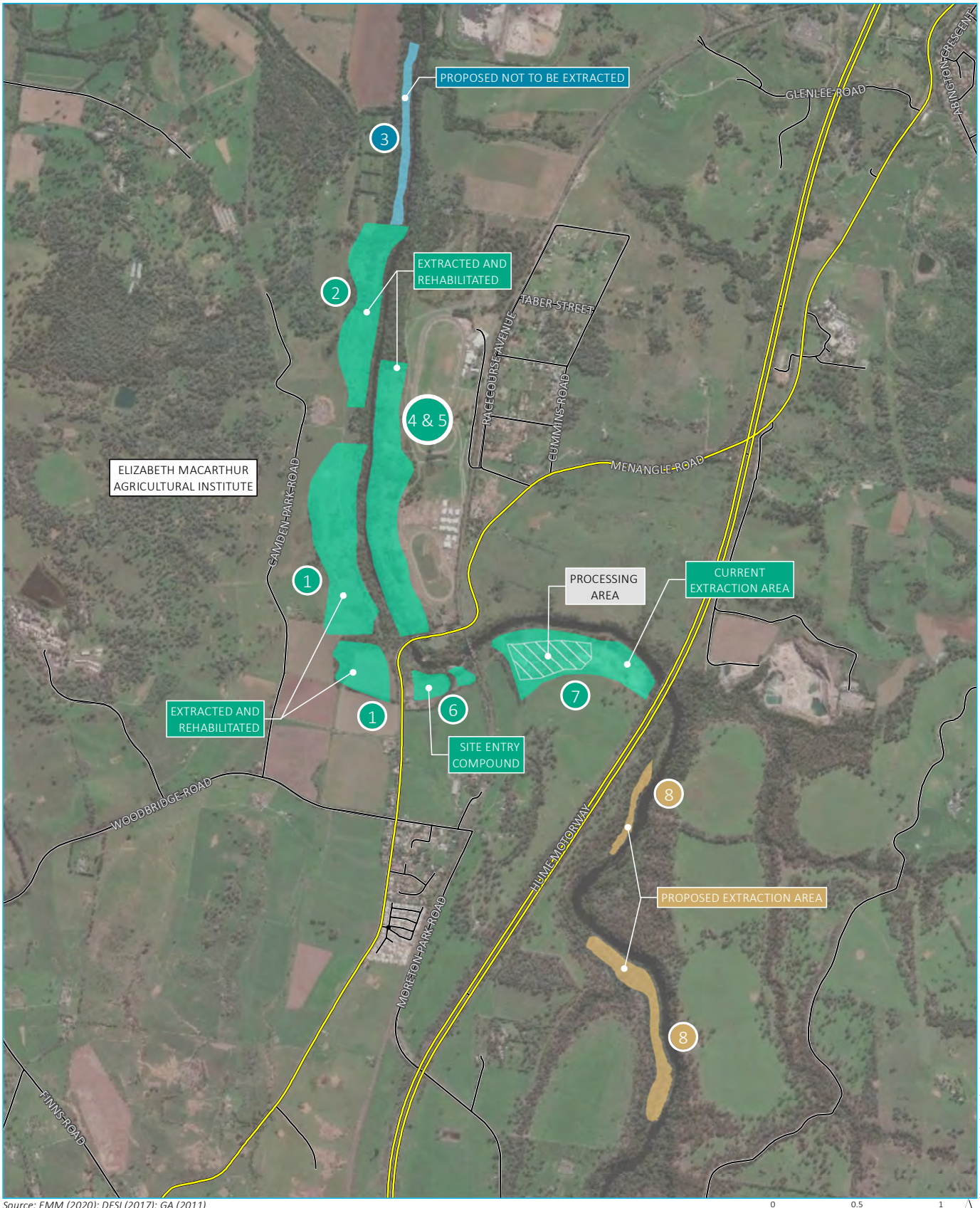
- extraction in the Stage 8 extraction area followed by rehabilitation;
- restoration of areas adjacent to the extraction areas;
- a conveyor; and
- a haul road.

These are described below.

2.2 Resource

The total resource in the 1989-approved quarry is approximately 7.7 million tonnes, made up of approximately 5.9 million tonnes of soil and 1.8 million tonnes of sand. The approved extraction area is approximately 123 ha. An extraction rate of up to 350,000–400,000 tonnes per annum (tpa) of soil and sand is approved. To date, the resource has been extracted in all but the Stage 3 (approximately 300,000 tonnes soil and 400,000 tonnes sand) and the remaining part of the of Stage 7 area.

It is proposed to extract 760,000 tonnes of sand and soil from the Stage 8 area at a rate of no more than 150,000 tpa.



Source: EMM (2020); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Main road
- Local road
- Existing processing area (to be retained)
- Extractive operations (approved)
- Extractive operations (approved but not extracted)
- Stage 8 - extraction/rehabilitation area

Menangle Quarry Stages 1 to 8

Menangle Quarry Extension
Figure 2.1

EMM creating opportunities

\\emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G022_OverallStagingExtractiveOperations_20200512_04.mxd 13/05/2020

It is proposed to extract sand and soil from the Stage 8 extraction area (Figure 2.2) which has a total area of 13.22 ha.

Given that the width of horizontal setback area (see Section 2.3.2i) is variable and to ensure that any biodiversity impacts are fully compensated for, the 'extraction area' is defined as including the horizontal setback area, although extraction will not occur within this setback. This also reflects the previous intent to grade parts of the horizontal setback area where there are no trees. However, it is now proposed to leave the entire horizontal setback area undisturbed, save for hand weeding of the extensive existing noxious weeds.

The 'active extraction area' is the area where the overlying vegetation will be cleared (removing extensive understory weeds and mature native trees) and the sand and soil resource extracted.

2.3 Quarrying

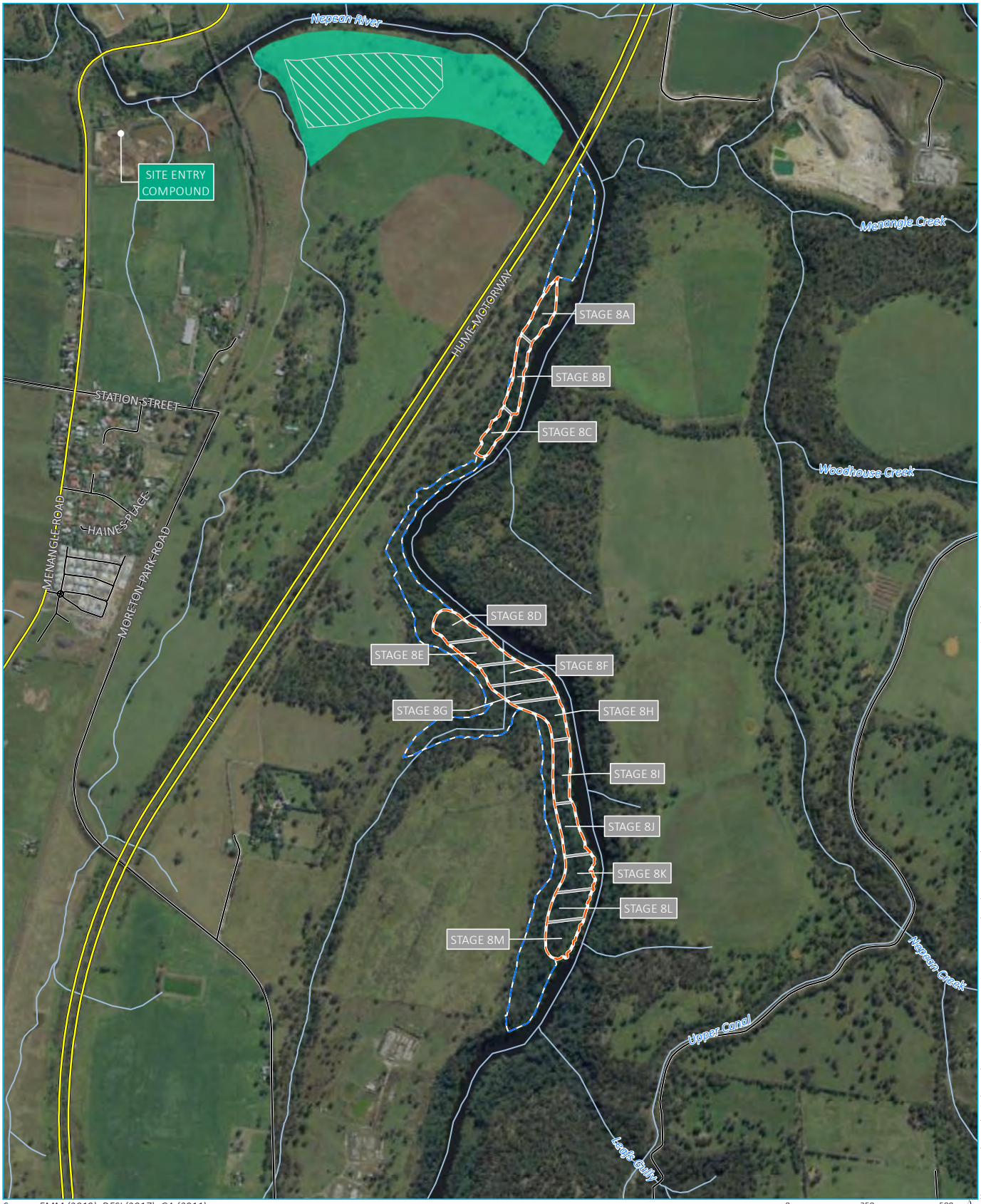
2.3.1 Quarry progression

Historically, quarrying has progressed from south to north (Stages 1–2) and from west to east (Stages 4–7). Quarrying activities in the Stage 7 area are progressing from west to east. Extraction in the Stage 8 area will occur in sub-stages such that only a small portion of the overall Stage 8 area will be the active excavation area at any one time. Extraction will progressively move upstream in thirteen sub-stages, with each sub-stage each covering about 1 ha (Figures 2.2 to 2.4). Each of these sub-stages will be a basic operating cell and will take approximately 1 year to complete, depending on demand for product. Each sub-stage will be progressively rehabilitated using similar methods to those as implemented in the Stage 1–2 and Stage 4–5 areas but with a more intensively managed native planting regime implemented.

The maximum area of each substage is provided in Table 2.1.

Table 2.1 Maximum area of each substage

Substage	Area (ha)
8a	0.93
8b	0.93
8c	0.69
8d	1.07
8e	1.07
8f	1.07
8g	1.07
8h	1.07
8i	1.07
8j	1.07
8k	1.07
8l	1.07
8m	1.07
Total	**13.25**



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Source: EMM (2019); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 56

N

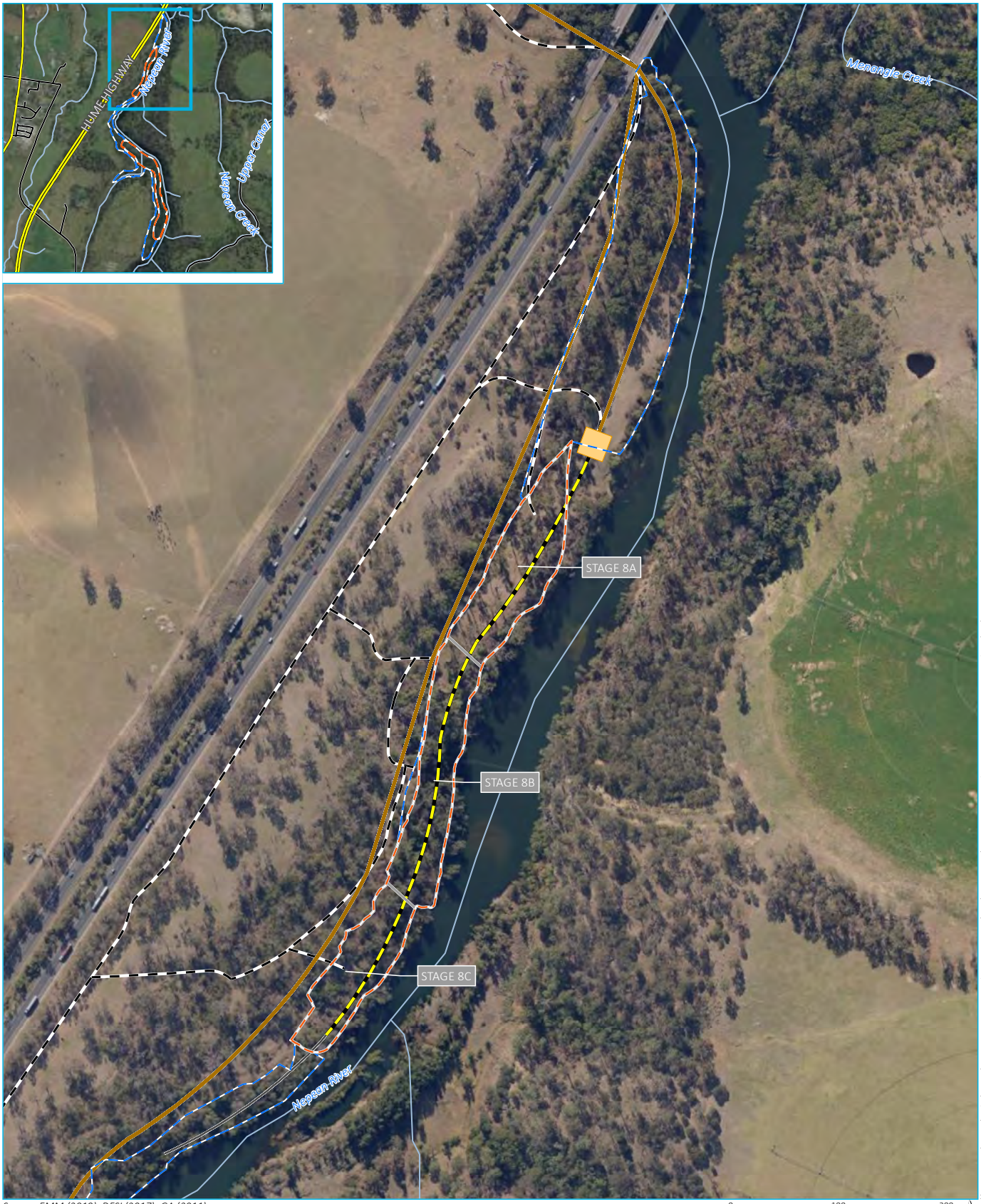
KEY

- Processing area (to be retained)
- Stage 7 - current extractive operations
- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction)
- Main road
- Local road
- Watercourse/drainage line

Overall staging plan

Menangle Quarry Extension
Figure 2.2

EMM creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

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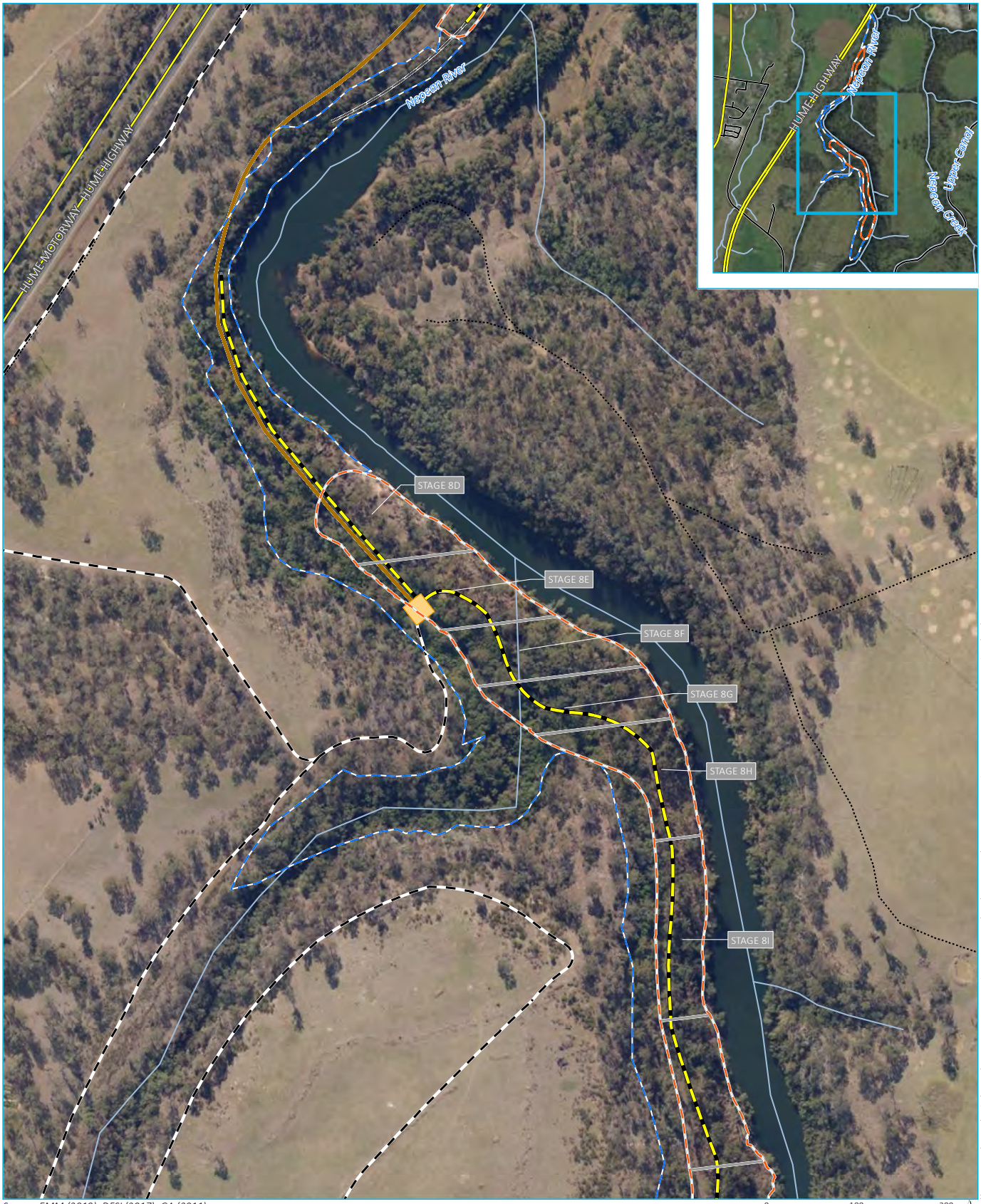
KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction) boundary
- Substage boundary
- Conveyor head
- Indicative conveyor location
- Haul road
- Access road
- Existing access track
- Watercourse/drainage line

Stage 8 Extraction and restoration areas Stage 8A to 8C

Menangle Quarry Extension
Figure 2.3

EMM creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

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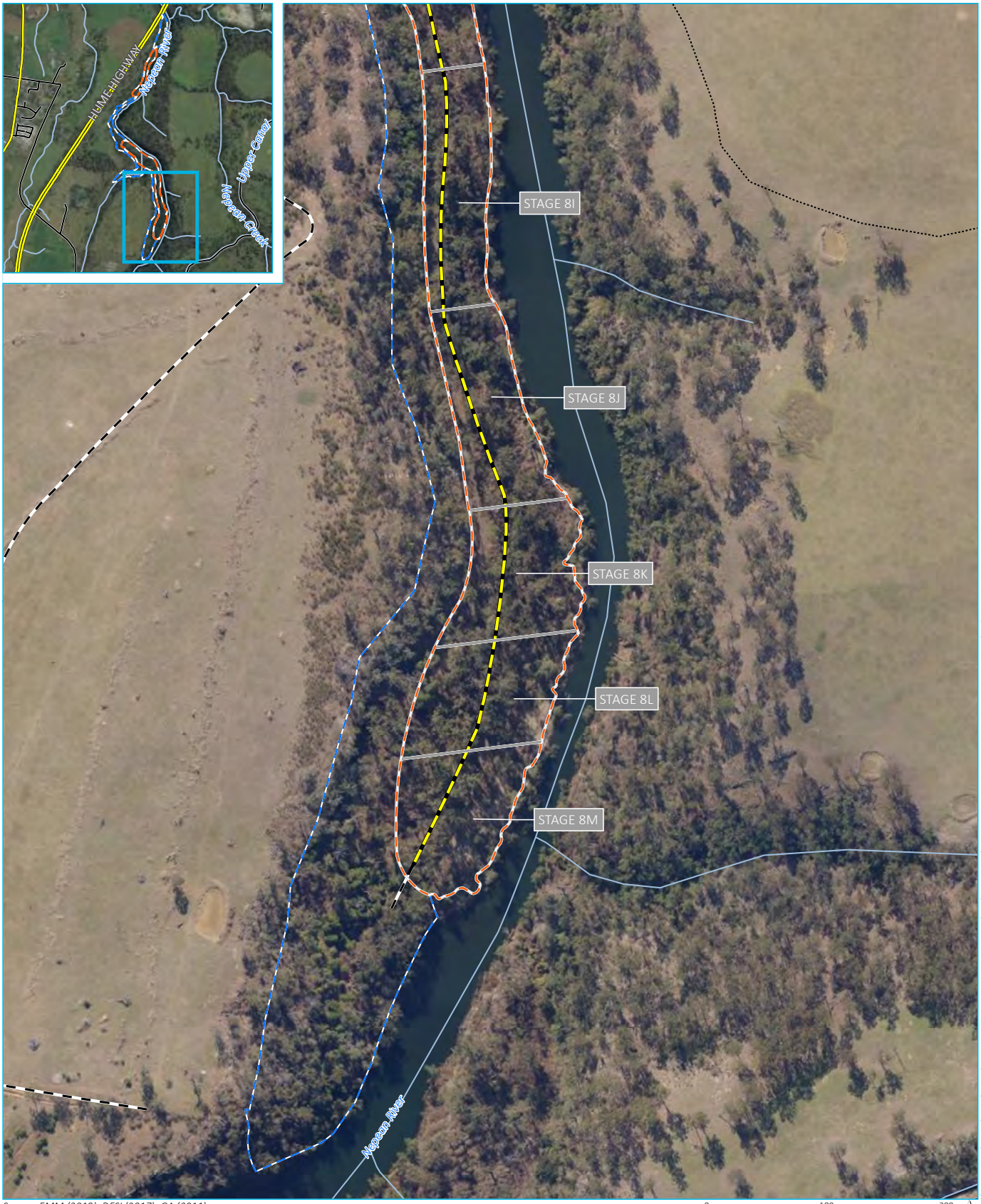
KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction) boundary
- Substage boundary
- Conveyor head
- Indicative conveyor location
- Haul road
- Access road
- Existing access track
- Main road
- Vehicular track
- Watercourse/drainage line

Stage 8 extraction and restoration areas – Stages 8D–8I

Menangle Quarry Extension
Figure 2.4

EMM
creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction) boundary
- Substage boundary
- Haul road
- Existing access track
- Local road
- Vehicular track
- Watercourse/drainage line

Stage 8 extraction and restoration areas – Stages 8I–8M

Menangle Quarry Extension
Figure 2.5

EMM creating opportunities

\\emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G014_StagingPlan1_M_20200512_04.mxd 12/05/2020

2.3.2 Stage 8 area quarry design

The Stage 8 quarry design is presented in Chapter 3 of the EA. Subsequently, the design has been amended to incorporate changes made since the Refusal. The amened proposed quarry design is summarised below.

Schematics showing the quarry progression in plan-view and in cross-section are is presented in Figure 2.6 and Figure 2.7 respectively. An indicative cross-section perpendicular to the bank is presented in Figure 2.8 and Figure 2.9.

i Lower riverbank and horizontal setback retention

The level of the Nepean River adjacent to the Stage 8 area is controlled by the downstream Menangle Weir so as to be about 61 mAHD during normal low flow.

During extraction of the resource from the previous quarry stages, the lower riverbank was retained and a horizontal setback from a contour approximately 3 m above the normal river level was provided. For example, in the Stage 7 area, the lower riverbank (below 64 mAHD) was retained and a horizontal setback of 10 m from the 64 mAHD contour on the natural riverbank (ie 3 m above the normal level of the Nepean River) was provided.

A similar setback was proposed for the Stage 8 area. However, the proposed setback method has since been amended to protect all native trees in the 10-m wide horizontal setback area as follows:

- The lower riverbank will be retained below the 64 mAHD contour and remain untouched (except for hand removal of weeds, felling of non-native trees leaving the roots in place, and very selective herbicide application).
- The riverbank will also be retained in a horizontal setback that extends at least 10 m (measured horizontally) inland from the 64 mAHD contour up the bank (referred to as the '10-m-wide horizontal setback area')[1].
- Where there are native trees[2] within the 10-m-wide horizontal setback area, the width of the setback will be increased so that edge of the setback area/start of extraction area is at least 7.5 m (measured horizontally) from the trunk of these trees.

Therefore, the active extraction area will be separated from the river by the lower riverbank (ie between 61 mAHD and 64 mAHD) and additionally by the horizontal setback that will be between 10 and 17.5 m wide. The undisturbed bank (ie the combined lower riverbank and horizontal setback) will vary in height but will be at least 3 m above the low-flow river level where the bank slope is shallow but will be higher where the bank slope is steeper.

[1] It was previously proposed to grade the horizontal setback to a slope of 1:50 where there are no native trees within the horizontal setback area. This is no longer proposed and the existing landform within the horizontal setback area will be retained, including where there are no trees.

[2] Native trees with a trunk diameter of >0.1 m diameter at breast height (DBH).