THE AUSTRAL BRICK COMPANY PTY LIMITED

ABN: 52 000 005 550

New Berrima Clay/Shale Quarry

Surface Water Assessment

Prepared by

SEEC

November 2010

Specialist Consultant Studies Compendium:
Part 2

ABN: 52 000 005 550

New Berrima Clay/Shale Quarry

Surface Water Assessment

Prepared for:

R.W. Corkery & Co. Pty Limited
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Tel: (02) 9985 8511
Fax: (02) 9985 8208
Email: brooklyn@rwcorkery.com

On behalf of:

The Austral Brick Company Pty Ltd
PO Box 6550
WETHERILL PARK NSW 1851

Tel: (02) 9830 7879
Fax: (02) 9831 2383

Prepared by:

SEEC
PO Box 1098
BOWRAL NSW 2576

Tel: 02 4862 1633
Fax: 02 4862 3088
Email: amacleod@seec.com.au

November 2010

CONTENTS

Page

CONTENTS

Page

APPENDICES

FIGURES

TABLES

EXECUTIVE SUMMARY

SEEC has assessed the potential surface water impacts associated with a proposed clay and shale quarry to be established by the Austral Brick Company Pty Limited near New Berrima in the NSW Southern Highlands. The proposed quarry includes an extraction pit, stockpile site, amenity bunds and associated infrastructure with a total potential area of disturbance of around 13.6ha.

The proposed quarry lies on a gently-inclined crest and, as such, facilitates relatively simple management of potential pollutants prior to discharge to the receiving environment. The only significant potential pollutant that might affect surface water as a result of the project is suspended sediment, eroded from areas of exposed soil.

A series of sedimentation basins is proposed to settle out suspended sediment prior to discharge. Sedimentation basins have been designed in accordance with best-practice guidelines for NSW and as dictated by the Sydney Catchment Authority. Clean water from upslope would be diverted away from sedimentation basins. Water pumped out of the extraction area would be treated in the sedimentation basins prior to discharge.

Water demand for the project is low and is limited to that required for dust suppression. Potable supply for workers and ablutions would be sourced from supplies of imported water, stored in a potable water tank. Modelling included in this assessment indicates that the water demand is easily met by the harvestable right for the project site area and could be sourced from sedimentation basins if desired.

The proposed project is unlikely to have an impact on the quantity of water discharged to the receiving waters because all water demand for the project can be achieved within the maximum harvestable right.

Although the project site is in relatively close proximity to the Wingecarribee River, it is unlikely to have a significant impact on water quality. All disturbed lands that might generate sediment pollution would ultimately drain to a series of sedimentation basins and a monitoring regime is proposed to dictate the quality of any discharge. Section 6 of this assessment includes a series of commitments designed to address and mitigate the identified risks to surface water.

This page has intentionally been left blank

1. INTRODUCTION

SEEC (Strategic Environmental and Engineering Consulting Pty Ltd) have been commissioned by The Austral Brick Company Pty. Limited to prepare a surface water assessment for a proposed clay/shale extraction project on lands near New Berrima, in the NSW Southern Highlands.

This report serves to identify specific surface water-related constraints and opportunities that might affect the proposed project's design, establishment, operation and post-operative rehabilitation. An integrated water management strategy is also included. In conducting this assessment we have:

- conducted a review of the existing surface water conditions on the site and within its local environs;
- conducted an extensive field survey of the landforms on the site and on the surrounding lands;
- investigated the existing site hydrology and runoff/infiltration characteristics;
- obtained water samples from local watercourses as a baseline for future water quality monitoring;
- assessed the potential impacts of the proposed development on the local surface water conditions, including downstream impacts;
- prepared a water balance for the site identifying supply/demand figures for the quarry's operational phase.

A field investigation was conducted by SEEC staff during August 2008 to investigate the site's existing hydrology and to collect soil samples. Water sample collection occurred on 22 August 2008.

2. PROJECT OVERVIEW

2.1 PROJECT SITE

The Project Site is approximately 51ha in area. It is wholly contained within the 100.2ha "Mandurama" property, namely Lot 1 DP 414246, 1 Berrima Road, New Berrima. The land is owned by The Austral Brick Company Pty Limited. The Project Site effectively incorporates the optimum clay/shale resource area on the "Mandurama" property and the access road between the property entrance and the extraction area.

The entrance to the "Mandurama" property is located on Berrima Road approximately 300m north of the intersection of Taylors Road and Berrima Road, New Berrima. **Figure 1** provides a topographic map presenting the local setting around the subject property.

2.2 PROJECT DESCRIPTION

The Proponent is proposing to extract and transport an average of approximately 120 000tpa shale, weathered shale, brick clay and some friable sandstone, with an upper limit of 150 000tpa, for a period of 30 years. The upper limit of 150 000tpa is being sought to allow for fluctuations in the demand for the product as determined by the production levels at the Bowral Brick Plant. The operation would employ approximately five part-time personnel for the duration of the project. The proposed project would involve a capital investment of approximately $1 million.

The extraction of the resource would be undertaken in six stages principally to reduce the area of disturbance at any one time and to facilitate progressive rehabilitation of disturbed areas. Austral's principal raw material requirement at its Bowral Brick Plant is for the shale material within the defined extraction area. Whilst the overlaying weathered shale, clay and sandstone has uses in the manufacture of bricks, Austral anticipates at this time, that only small quantities of the these materials would be extracted and transported to the Bowral Brick Plant, other Austral brick plants in the Sydney area or other sites requiring fill materials. For the purposes of this project, the materials transported from the extraction area are referred to as "product clay/shale".

The main features of the extraction operations would be:

- campaign stripping of topsoil and subsoil for use in the construction of amenity bunds and progressive site rehabilitation;
- progressive construction of amenity bunds;
- two or three extraction campaigns per year, each involving the excavation and stockpiling of the product clay/shale on the floor of the extraction area;
- a water management system to manage water collected in the pit and runoff from disturbed areas;
- full-time transportation of the product clay/shale to the Bowral Brick Plant.

3. STUDY AREA

The Surface Water Assessment Study Area is defined by the Project Site Boundary as shown in **Figure 1.** Included within this area are the quarry area and the site access road. The site access road comprises an 800m-long access between the extraction area and Berrima Road. The quarry site itself includes:

- the extraction area (approximately 7.7ha total),
- amenity bunds,
- stockpiles of extracted product and surplus overburden material,
- water storage and sediment retention structures,
- a storage area, workshop and lunchroom/amenities area.

The Study Area covers approximately 51ha within the 100.2ha property known as "Mandurama." Of this area, an estimated 13.6ha would be disturbed for the extraction area, stockpile and amenity bunds as shown in **Figure 2.** A significant area of suitable clay and shale has been identified north of the proposed extraction area and, although this might be subject to an application for extraction in future, is not intended for disturbance at this time.

The transportation route between the "Mandurama" boundary and the Austral Brick Plant in Bowral (as shown in **Figure 3**) is excluded from the Surface Water Management Study area. We anticipate that this aspect of the project would not involve significant land disturbance and is, therefore, unlikely to significantly affect surface water.

Although the majority of this assessment focuses on the areas to be disturbed by the quarry itself, comments are also included concerning the catchment conditions up- and down-stream of the quarry where water quality or flow might be affected. However, detailed assessments of external catchments are not included in this study. Catchment boundaries are discussed further in Section 4.4.

4. SITE CONDITIONS

4.1 TOPOGRAPHY

The Study Area comprises gently undulating rises and low hills with average slopes between 1:25 (V:H) and 1:10 (V:H). Elevation ranges from 651m AHD in the northwest corner of the Study Area to 681m AHD where the proposed extraction area resides.

Lands fall in a generally northerly direction towards the Wingecarribee River (**Figure 2**).

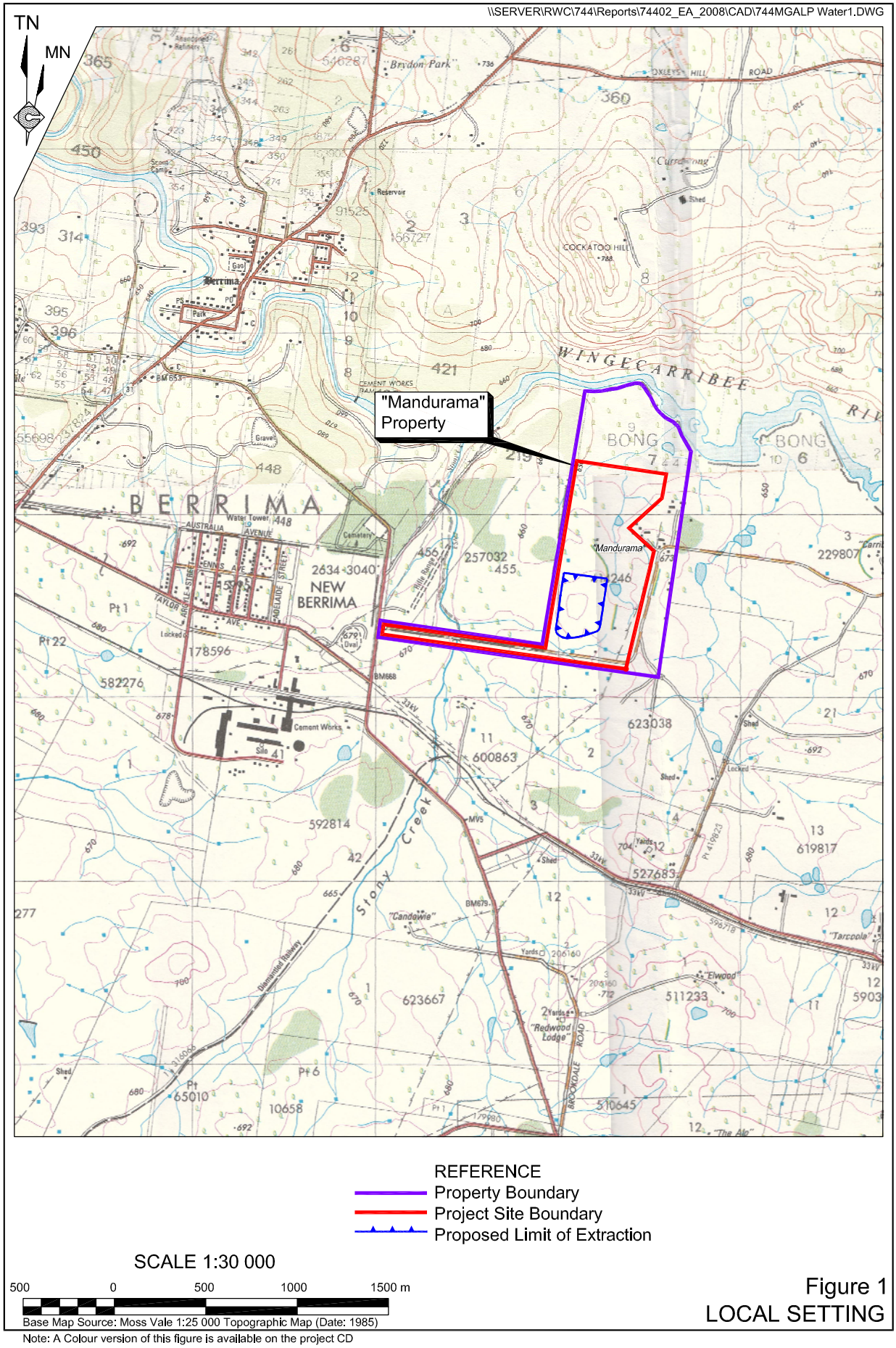
4.2 LAND USE

The entire Study Area has been disturbed previously and is presently used for grazing or fodder on improved pastures. The majority of the land is completely cleared with only a few scattered native trees and several rows of exotic species (*Pinus sp*). There are five farm dams within the Study Area which are presently used for watering livestock.

4.3 SOILS

4.3.1 Soil Landscapes

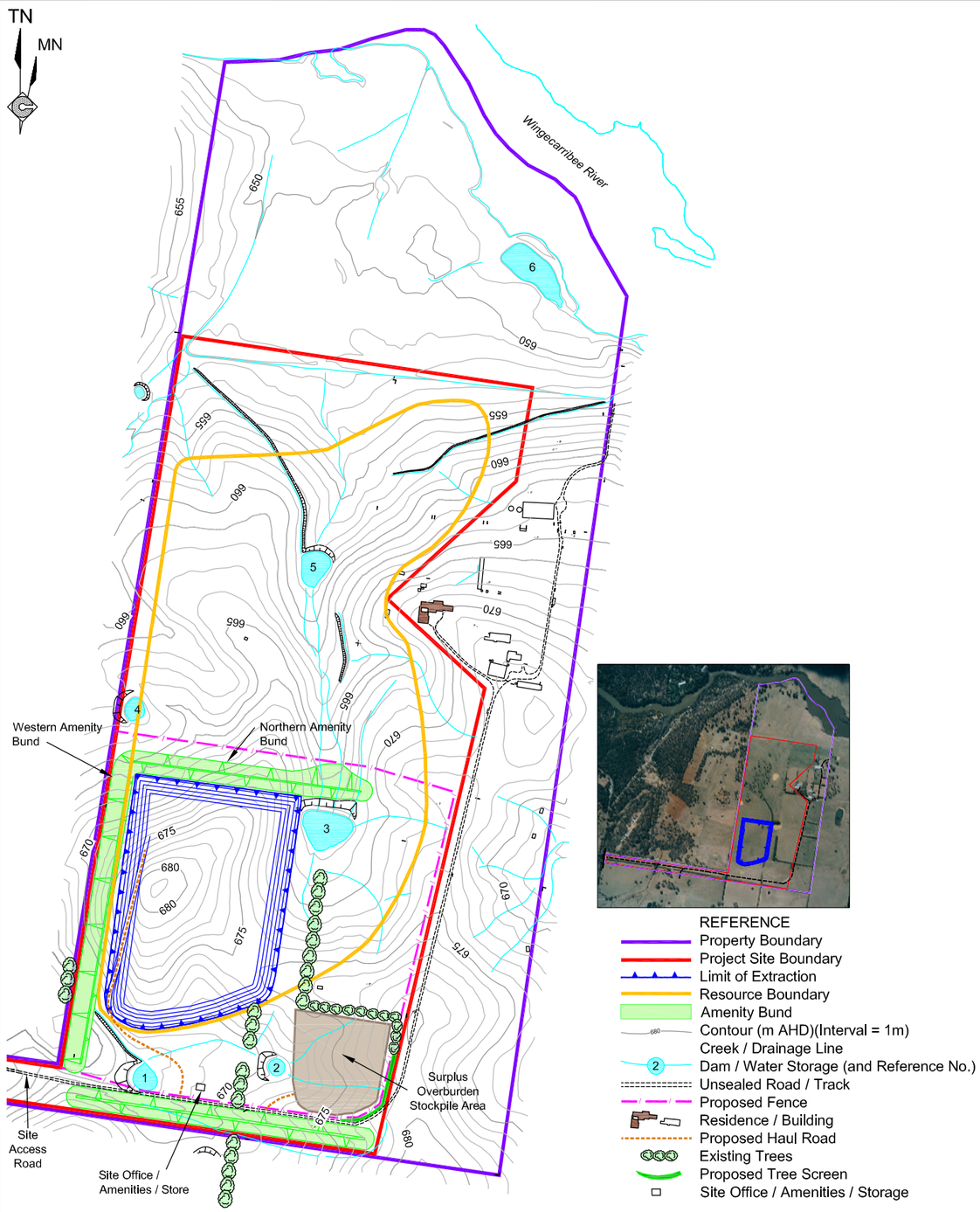
The project site is dominated by well-structured clay soils of the Moss Vale Soil Landscape (SCA/DLWC, 2002). The Moss Vale Soil Landscape comprises low hills and rises on shale and is generally moderately well drained. Further details are contained in the Soil and Land Capability Assessment by Geoff Cunningham Natural Resource Consultants Pty Ltd (**Appendix 9**).



Note: A Colour version of this figure is available on the project CD

Figure 1
LOCAL SETTING

\\SERVER\RWC\744\Reports\74402_EA_2008\CAD\744MGALP_Water 2.DWG

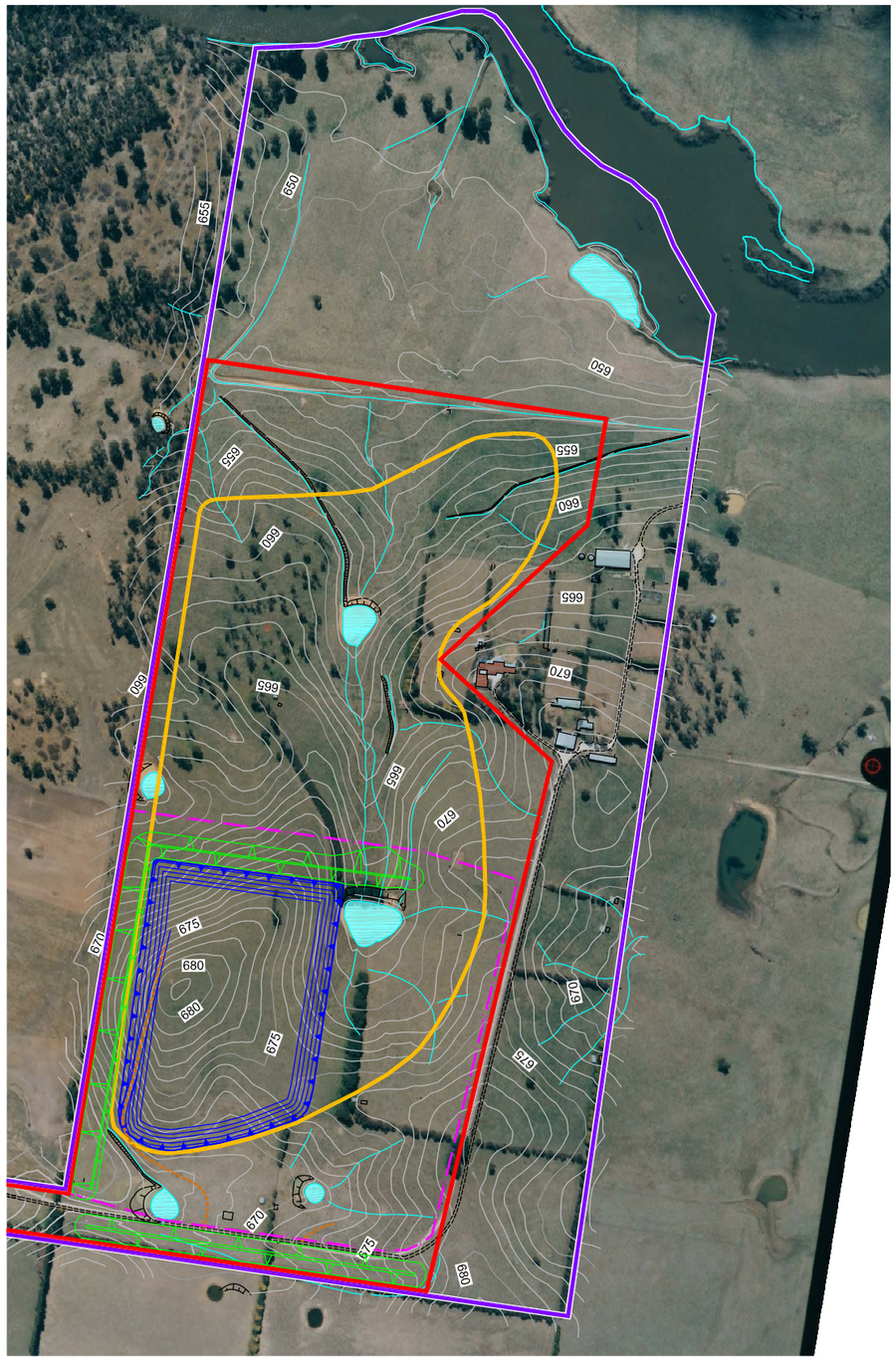


SCALE 1:7 500

100 0 100 200 300 400m

Base Map Source: Geo-Spectrum (Australia) Pty Ltd - Date of Photography: 26 August 2008

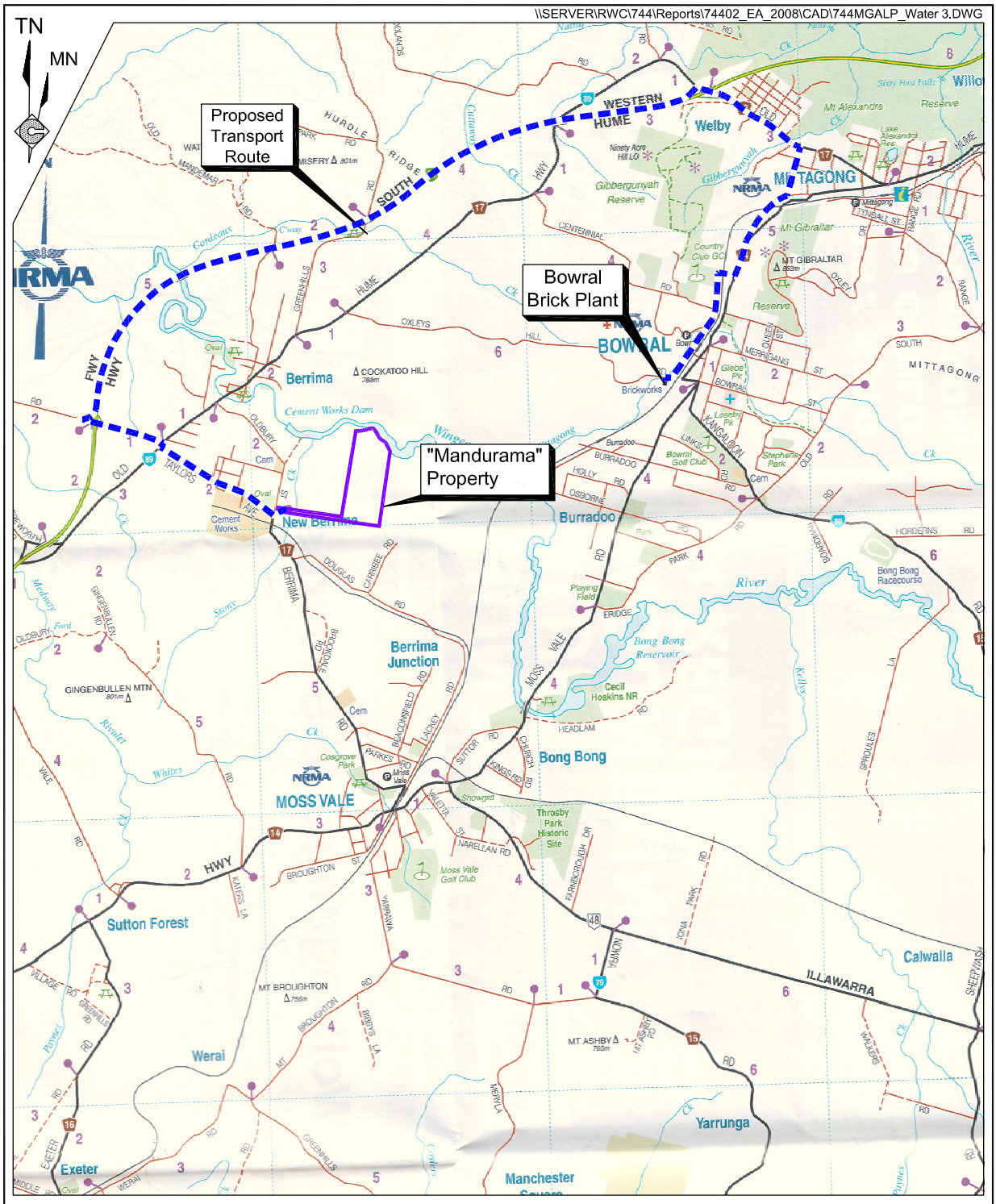
Note: A Colour version of this figure is available on the project CD



Base Photograph Source: Geo-Spectrum (Australia) Pty Ltd - Date of Photography: 26 August 2008

Figure 2
PROPOSED SITE LAYOUT

This page has intentionally been left blank



Note: A Colour version of this figure is available on the project CD

Figure 3
PROPOSED TRANSPORT ROUTE

4.3.2 Soil Testing

Soil tests were undertaken on a representative subsoil sample collected in the location of the proposed quarry pit to determine soil characteristics for erodibility, sediment basin sizing and dispersion. In addition to field observations regarding soil structure and profile drainage, the following laboratory tests were conducted:

- PSA = Particle size analysis (both chemically dispersed and non-chemically dispersed)
- DP = Dispersion percentage
- EAT = Emerson aggregate test
- OC = Organic carbon percentage

Table 4.1 contains the results of laboratory testing. These results show that soils contain a significant proportion of highly-aggregated clay that does not readily disperse under natural or atmospheric conditions. The chemically-dispersed sample contained 33% clay, which was not identified in the non-dispersed sample. In the non-dispersed sample, the clay particles remained strongly aggregated.

Table 4.1
Laboratory Test Results for a Representative Subsoil Sample

Sample	Particle Size Analysis						DP (%)	EAT	OC (%)
	Clay (%)	Silt (%)	Very fine sand (%)	Coarse-fine sand (%)	Coarse sand (%)	Gravel (%)			
Chemically-dispersed	33	18	21	12	6	10	0	6	0.37
Non-chemically dispersed	0	29	36	9	16	10			

Based on the results in **Table 4.1**, soils were found to have a K-factor (soil erodibility factor) of 0.064, which is high (Rosewell and Edwards, 1988). Soils were not identified as being *significantly dispersible* as determined by the methodology in Landcom (2004) – The "Blue Book". For the purposes of sediment basin design, soils are Type F (fine) – i.e. they require total storm capture structures for sediment retention prior to discharge (Landcom, 2004).

The strongly aggregating nature of the soils means that chemical dust suppressants are unlikely to be necessary, as the risk of discrete soil particles becoming airborne is low.

4.3.3 Soil Loss and Erosion Hazard

The annual soil loss was calculated using SOILOSS 5.3 (Rosewell, 2005), which is based on the Revised Universal Soil Loss Equation (RUSLE). For the purposes of this analysis, the following inputs were used (as recommended in Landcom, 2004).

- R-factor (rainfall factor): 2580 in Rainfall Zone 7.
- K-factor of 0.064.
- Average slope gradient of 6.5% (1:15 V:H) and a slope length of 80m.
- A rill:interill ratio of 3:1.
- P-factor (Conservation practice) of 1.3 (i.e. assuming no specific conservation practices).
- C-factor (Ground cover factor) of 1.0 (i.e. assuming bare soils).

This produces a calculated soil loss of 225t/ha/yr within the Study Area, which is low (Landcom, 2004).

4.4 DRAINAGE

4.4.1 Drainage Lines and Catchments

The proposed extraction area occupies a hillcrest position with radial drainage in all directions. Although all surface runoff from the site ultimately reaches the Wingecarribee River, three small catchments would be disturbed by the quarry site. These are shown in **Figure 4** and are labelled as Catchments A, B and C respectively.

Catchment A drains approximately 27ha within the Project Site Boundary. Only a small area within Catchment A drains onto the Project Site from upslope; for the most part, the watershed of Catchment A is wholly within the quarry site. There are no defined channels within Catchment A – all drainage is via open, grassy depressions.

Catchment A drains into a man-made lateral drain, the position of which is shown in **Figure 4**. We assume that this was constructed in the past to reduce waterlogging of the low-lying, flat areas adjacent to the river and permit grazing. This drain diverts flow into Catchment B.

Catchment B drains approximately 11.4ha of the Project Site via a series of open, grassy depressions. There is no run-on to the Project Site from external lands in Catchment B. Flows in Catchment A are diverted into Catchment B at the Project Site's northern boundary as shown in **Figure 4**.

Catchment C drains approximately 12.66ha of the Project Site via a series of open, grassy depressions. These join into Stony Creek before eventually entering the Wingecarribee River (**Figure 4**). Approximately 5.8ha upslope of the Project Site in Catchment C drains into it.

The proposed access road connecting the quarry site with Berrima Road traverses Stony Creek as shown in **Figure 4**.

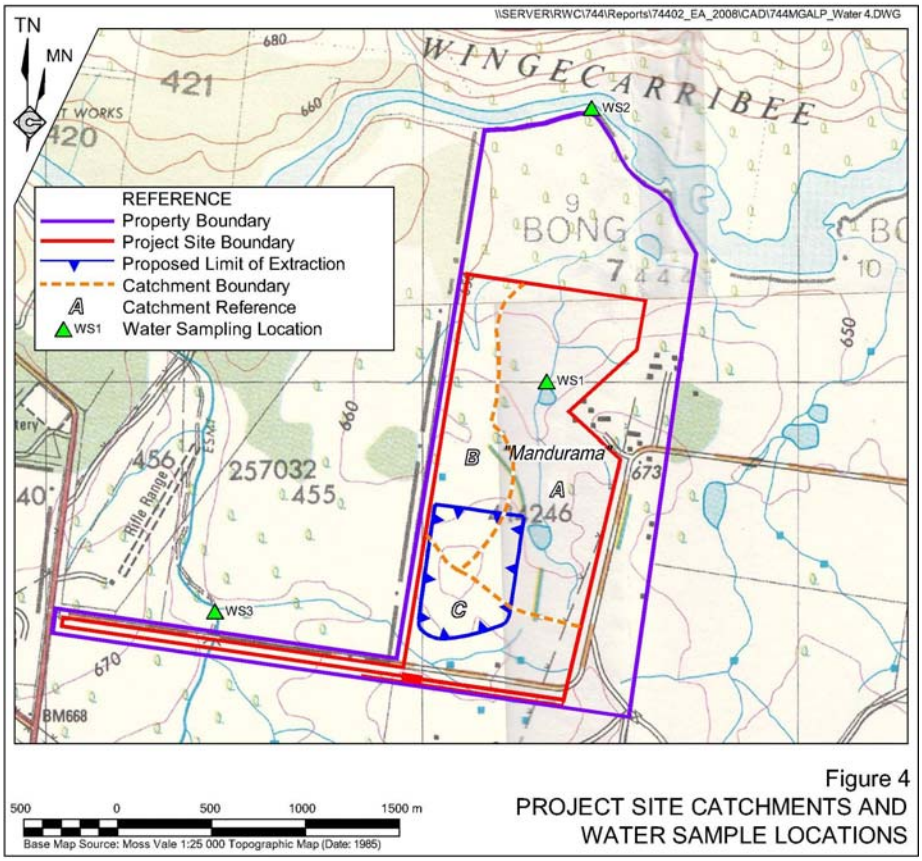


Figure 4
PROJECT SITE CATCHMENTS AND WATER SAMPLE LOCATIONS

4.4.2 Existing Dams

There are five farm dams within the Project Site. All appear to be structurally sound and capable of holding water. None exhibited obvious signs of leakage through their walls. Farm dams are numbered on **Figure 7** and their assumed capacities are shown in **Table 4.2**.

Table 4.2
Existing Dam Sizes

Structure Number	Approximate Surface Area	Assumed Capacity
1	950m^2	1.425ML
2	460m^2	0.69ML
3	2,960m^2	4.44ML
4	670m^2	1.005ML
5	1,570m^2	2.355ML

4.5 FLOODING

Although we have not conducted flood modelling for the Study Area, geomorphic site conditions suggest that overbank flows from the Wingecarribee River could inundate low-lying plains immediately north of the Project Site. The proposed extraction area and all associated infrastructure lie on gently undulating lands that appear to be well above the historic flood level. We do not expect flooding to be an issue for surface water management.

4.6 VEGETATION

The majority of the Study Area is completely cleared with only a few scattered native trees and several rows of pine trees. The remaining lands are under improved pasture and are used for grazing cattle.

4.7 CLIMATE

4.7.1 Rainfall

The Moss Vale (Hoskins Street) rainfall station (Bureau of Meteorology Station 68045) is the closest geographically to the project site with a reliable and relatively complete rainfall record exceeding 100 years. 138 years of data were available, from 1870 to 2008, giving an annual average rainfall of 965.6mm/yr.

Data from the Moss Vale (Hoskins Street) rainfall station were selected to represent the typical climate conditions expected at this site. An analysis of the monthly rainfall pattern is included in **Table 4.3** and **Figure 5**, showing that rainfall is fairly consistent throughout the year but with a slight trough in late winter and early spring. The period 1870 to 2008 includes significantly wet and dry periods, so can be considered a good representation of the long-term average for this site.

Table 4.3
Monthly Average Rainfall Values for Moss Vale (Station 68045)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Rainfall (mm)	89.3	95.3	90.3	81.3	84.9	100.4	76.1	63.6	60.4	74.8	72.9	76.3	89.3

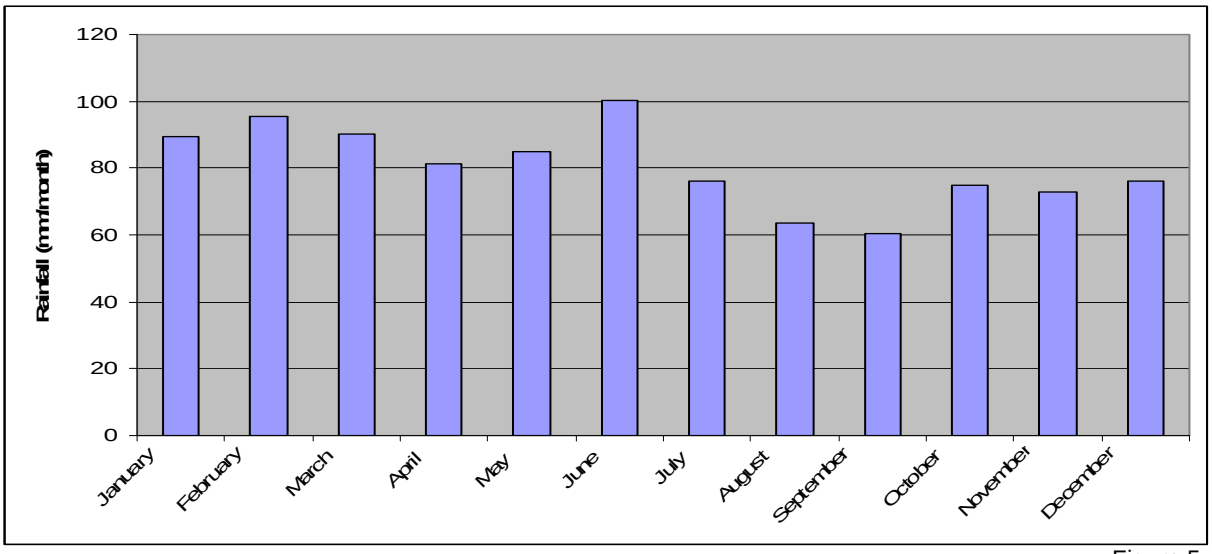


Figure 5
Monthly Average Rainfall Values for Moss Vale (Station 68045)

4.7.2 Evaporation

The closest meteorological station collecting evaporation data is at Goulburn (Bureau of Meteorology Station 70263), approximately 65km to the west-south-west. **Table 4.4** and **Figure 6** shows an analysis of the average daily evaporation occurring in each month.

Figure 6 shows that evaporation is significantly greater in the summer months. Although Goulburn has significantly different annual average rainfall to Moss Vale (640mm vs 968mm), potential evaporation is estimated to be fairly similar because they are at similar elevations (Goulburn 670m AHD, project site 653 to 681m AHD) and are only 65km apart.

Table 4.4
Mean Daily Evaporation (mm/day) by Month for Goulburn (Station 70263)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Evaporation (mm)	6.4	5.4	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.9	4.9	6.1	3.5

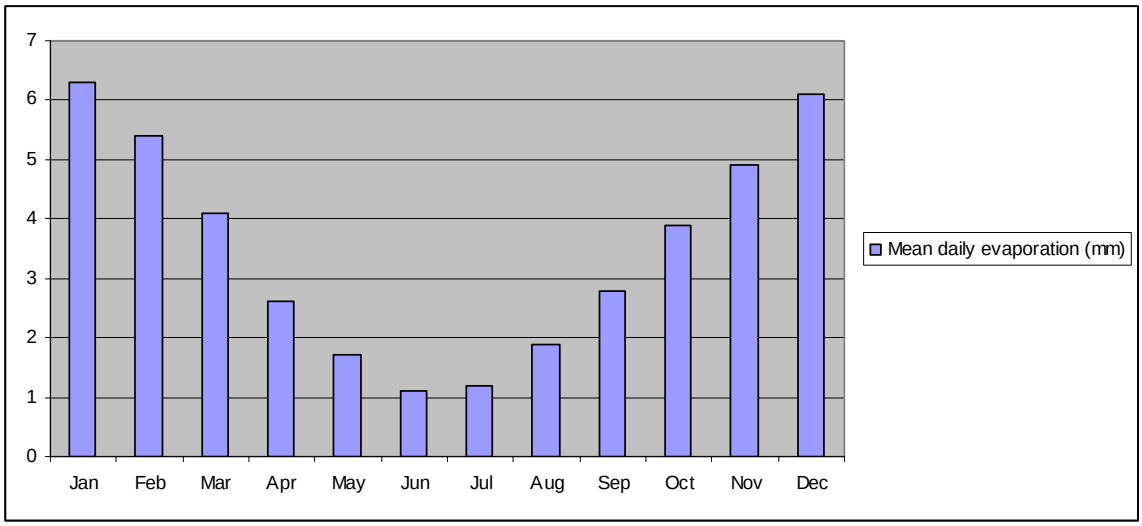


Figure 6
Mean Daily Evaporation (mm/day) by Month – Goulburn Station 70263.
(Bureau of Meteorology, 20 July 2008).

5. SURFACE WATER IMPACT ASSESSMENT

5.1 CATCHMENT AREA CHANGES

The proposed quarry would exclude a small area from each of Catchments A, B and C (as shown on **Figure 4**), as described in **Table 5.1**.

Table 5.1
Changes to Catchment Areas due to the Quarry Extraction Area

Catchment	Reduction of Catchment Area due to the Quarry Extraction Area
A	2.4ha
B	1.5ha
C	3.8ha

Actual changes in runoff volumes would be minimal, however, because water collecting in the extraction area would be pumped out to a series of dams. While some water in these dams would be reused onsite for dust suppression purposes, the majority would re-enter the surface water system and water reuse would be within the harvestable right for the Project Site. Section 5.6 contains details of anticipated water use and supply.

5.2 HARVESTABLE RIGHT

Present NSW legislation permits landholders to capture and use up to 10% of the total runoff from their land without requiring a licence. Two factors determine the harvestable right multiplier at a piece of land; namely:

- The property's geographical location; and
- The size of the property.

The entire 51ha of the Project Site was assessed using the harvestable right dam calculator at http://www.farmdamscalculator.dnr.nsw.gov.au/cgi-bin/ws_postcode.epl on 8 December 2009. This map shows that the site has a dam multiplier value of 0.09ML/ha, giving a total harvestable right of 4.59ML dam/basin capacity. Note that this is based on the assumption that any dams or basins are "off-line" from natural watercourses.

Dams or basins constructed for the purposes of maintaining water quality (e.g. sedimentation basins, effluent management structures or water quality control ponds) are exempt from the harvestable right calculation for a site, although this assumes that water detained in these structures is not re-used onsite and is eventually released to downstream waters.

Three sedimentation basins are proposed during the operational phase of the Project. If water from these basins is not reused onsite they are exempt from the harvestable right and 4.59ML of storage can be provided elsewhere. However if water from these basins is used to meet the demands of the Project then they need to be considered as part of the harvestable right.

5.3 WATER SAMPLING AND TESTING

Water samples were collected on 22 August 2008 at the locations shown on **Figure 4**. They were tested for the following parameters:

- pH
- Electric Conductivity
- Total alkalinity
- Chloride
- Sulphate
- Ion Balance
- Total Nitrogen
- Total Phosphorus
- Iron
- Major Cations
- Total suspended solids

The results of laboratory testing are included in **Appendix 1** and summarised in **Table 5.2.** These results would be used as part of the baseline water monitoring data during operation of the quarry.

Table 5.2
Results of Water Quality Testing

Parameter	Units	Sample Point 1	Sample Point 2	Sample Point 3
pH in water	pH units	7.7	7.5	7.8
Electric Conductivity (EC)	uS/cm	393	102	396
Total alkalinity	mg/L	76	27	89
Chloride	mg/L	60	15	55
Sulphate	mg/L	2	<2	26
Ion Balance				
Anions total	me/L	3.0	0.9	3.6
Cation total	me/L	3.2	0.9	3.8
Percent Difference	%	6.5	-	5.4
Total Nitrogen	mg/L	7.3	0.2	<0.1
Total Phosphorus	mg/L	0.2	0.02	0.03
Iron	mg/L	7.92	0.82	0.45
Major Cations				
Calcium	mg/L	13.6	4.0	34.6
Magnesium	mg/L	7.9	2.9	6.8
Sodium	mg/L	26.9	10	29.5
Potassium	mg/L	27.1	1.2	8.4
Total suspended solids	mg/L	32	11	4

5.4 WATER QUALITY

The proposed quarry involves disturbing approximately 13.6ha to establish the extraction pit, amenity bunds, quarry infrastructure and an overburden stockpile. Without appropriate mitigation and management measures, there is a significant risk that the proposed project could impact water quality in the Wingecarribee River.

The most significant potential pollutant that could be generated by the project is suspended sediment eroded from exposed areas, particularly during establishment. Stripping of topsoil from the extraction area and stockpiling it to create the amenity bunds would result in approximately 11.6ha of exposed soil. However, this would quickly reduce to just the extraction area (7.7ha) as the amenity bunds would be immediately vegetated for long-term stability.

After establishment we estimate that the only potential sources of sediment would be the extraction area, the overburden stockpile and any unsealed haul roads. Given the proposal to progressively rehabilitate disturbed areas, the maximum extent of sediment-generating land at any one time is estimated at 2.5ha.

The Project site includes ample room for construction of sediment-retention structures downslope of disturbed areas. The Sydney Catchment Authority (SCA) has requested that these structures be designed to capture the whole of the 24-hour, 100-year ARI rainfall volume. The soil analyses in Section 4.3 indicate that soils are not significantly dispersible and so any entrained sediment eroded from disturbed areas should settle out naturally in a detention structure. If, after commissioning of sediment retention basins, adequate suspended sediment loads could not be achieved in detained water, a flocculation regime would be implemented to aid settling prior to discharge. Further details regarding sediment basins are contained in Section 6.3.1.

5.5 ONSITE EFFLUENT MANAGEMENT

The quarry site is not serviced by reticulated sewer. As a result, porta-loos would be provided for staff and visitors. These would be serviced regularly as required by a third-party contractor.

5.6 WATER BALANCE

5.6.1 Sources of Water Demand Onsite

The proposed project includes three demand sources for water:

- dust suppression;
- machinery washdown; and
- staff requirements and ablutions.

5.6.2 Amenities and Ablutions Supply

The site office and ablutions would be supplied by potable water imported by tanker to the site.

5.6.3 Water Demand for Dust Suppression

Soils at the site are strongly aggregating and, as such, have a low potential for wind erosion. As such, dust suppression requirements would be minimal. For the purposes of dust suppression we have assumed:

- water application rates of 1L/m^2/day for dust suppression;
- dust suppression required only on non-rain days;
- significantly reduced requirements for dust suppression during those months when rainfall exceeds evaporation (i.e. April to August);
- dust suppression over an exposed area assumed at 25% of the total extraction area and internal roads, 100% of the access road (approximately 1ha) and 25% of the overburden stockpile (i.e. 3.5ha total area).

Based on these assumptions, we estimate that 33,400L per non-rainy day would be required during the months from September through to March, and 8,350L per non-rainy day would be required during the months from April through to August.

5.6.4 Water Supply

Water for dust suppression would be sourced primarily from harvested surface water runoff, either from Dams 1 and 3 (sedimentation basins) or from alternative storages.

Dams 1 and 3 would collect sediment-laden water pumped out of the extraction pit plus a minor amount of ‘clean’ runoff from their upslope catchments. They would be managed as sedimentation basins to settle out any suspended sediment prior to discharge. The sizing requirements of these sedimentation basins are detailed in Section 6.3.1.

As detailed in Section 5.2, the harvestable right for the Project Site permits a total of 4.59ML of water storage for reuse. Supply to meet the demand for dust suppression would be sourced from this volume, taken either from the sedimentation basins or from other storages within the Project Site. Regardless of where water is sourced from, no more than 4.59ML of water storage would be made available for onsite use.

5.6.5 Water Security

An assessment was made of the water supply confidence using an in-house water balance spreadsheet known as RATES. This spreadsheet was calibrated using 100 years of daily rainfall data from the Moss Vale rainfall station (as detailed in Section 4.7) and assuming no more than 4.59ML of water storage is available. The spreadsheet takes into account inherent system losses (e.g. infiltration, surface wetting) and runoff coefficients, calibrated for the site using data from Australian Rainfall and Runoff (IEA, 1998). The daily water demand was set according to the details in Sections 5.6.3 and 5.6.4.

For the purposes of modelling we assumed that water would be sourced from Dams 1 and 3 (**Figure 7**), with water collecting in the extraction area being pumped to these structures according to extraction staging (i.e. stages 1 to 3 dewatered to Dam 1 and stages 4 to 6 dewatered to Dam 3). Modelling assumes that the total combined catchment draining to Dams 1 and 3 is 1.95ha, with the runoff coefficient set at 60% and initial loss of 5mm per day.

RATES predicts that the anticipated total demand of 8.05ML/year would be met 100% of the time from the harvestable right of 4.59ML. Refer to **Appendix 3** for the RATES output details. Further modelling reveals that 2.9ML of storage (i.e. well below the maximum harvestable right) would give 99.9% supply confidence.

As such, the Project is unlikely to reduce flows to the receiving waters and there is no requirement for make-up water.

6. WATER MANAGEMENT STRATEGY

6.1 INTRODUCTION

The following water management strategy aims to address surface water-related issues identified in Section 5 of this report. This strategy includes a series of commitments in Section 6.3 to minimise the potential impacts of the proposed operation on surface water and a program for ongoing monitoring in Section 6.4.

The following plan includes three key components.

1. Construction and operation of various surface water management controls such as diversion structures and sediment retention basins.
2. Ongoing monitoring of water quality in both release water from the various structures and in downstream areas.
3. A maintenance and upgrade program to quickly repair any problems and to adapt the strategy as the operation progresses.

6.2 OBJECTIVES

This water management strategy aims to address the following objectives.

- Minimise changes to the hydrology of all catchments affected by the Project operations (**Figure 4**), so as to minimise potential impacts on surface water flows.
- Address the water quality requirements of key agencies such as DECCW and the SCA.
- Minimise the demand for water as much as possible and ensure demand is met from within the harvestable right for the Project Site.
- Maintain ecological conditions in downstream waters through adequate surface water management.
- Avoid artificial diversions of water between neighbouring catchments, (ie. maintain run-on and runoff within the original, natural catchments).

6.3 COMMITMENTS

6.3.1 Sedimentation Basins

Four sedimentation basins would be constructed in the locations shown in **Figure 7**. **Table 6.1** details the sizing of these structures during site establishment and then during the operational period. Basins required during establishment are short-term structures, so are sized according to the 5-day, 80th percentile rainfall depth criteria detailed in Landcom (2004).

Operational basins use a sediment retention and storage zone sized in accordance with Landcom (2004) and DECC (2008). The settling (water) zone of operational basins is sized to address the SCA requirement that water quality control structures such as these detain the whole runoff volume from the 100-year ARI 24-hour event.

As detailed in **Table 6.1**, Sedimentation Basin 4 is only required for a short time (estimated at no more than two months) during the construction of the Northern and Western Amenity Bunds. After these bunds have been revegetated to at least 60% grass cover (or equivalent), Sedimentation Basin 4 can be decommissioned or restored as a simple farm dam. After establishment and, particularly, revegetation of the amenity bunds, the sediment storage volumes of Sedimentation Basins 1 and 2 can be reduced in size if desired.

Calculations for the sizing of all sedimentation basins are included in **Appendix 3**.

As discussed in Section 5.6.5, part of the volume of water stored in Sedimentation Basins 1 and 3 could be reused onsite as part of the harvestable right for the Project Site. This equates to a total volume of 4.59ML and only that volume would be made available for onsite reuse. A log would be maintained showing reuse and pumping volumes to demonstrate to consent authorities that the harvestable right was not being exceeded.

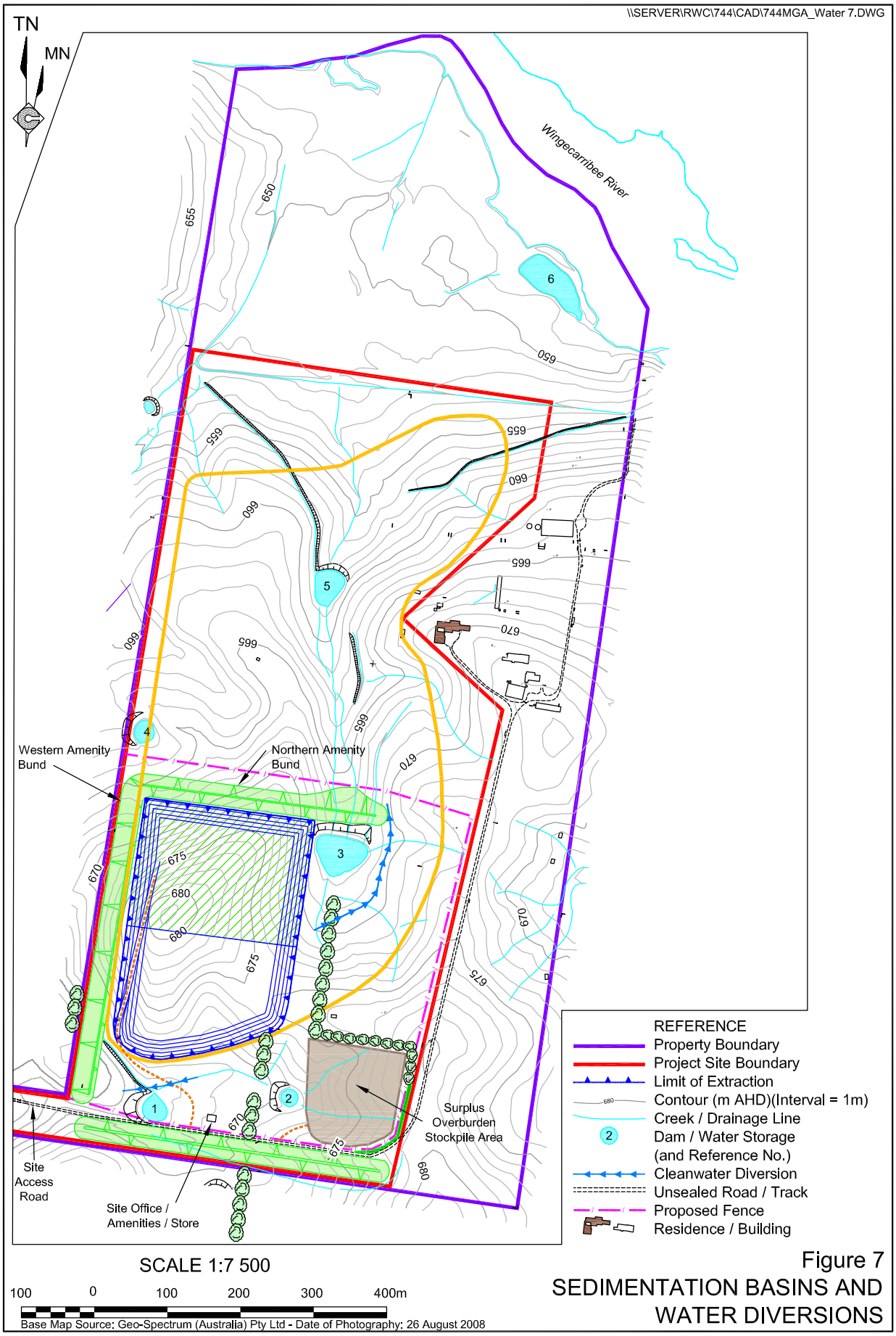


Figure 7
SEDIMENTATION BASINS AND WATER DIVERSIONS

Table 6.1
Sedimentation Basin Sizes Required During Site Establishment

Structure	Establishment Phase			Operational Phase			Notes
	Settling (water) Zone Volume (m^3)	Storage (sediment) Zone Volume (m^3)	Total Sedimentation Dam Capacity (m^3)	Settling (water) Zone Volume (m^3)	Storage (sediment) Zone Volume (m^3)	Total Sedimentation Dam Capacity (m^3)	
Sedimentation Basin 1	1,290	220	1,510	7,945	205	8,150	Ensure that natural drainage from upslope is diverted around basin.
Sedimentation Basin 2	613	119	732	5,720	26	5,746	Ensure that Sedimentation Basin 2 does not discharge into Sedimentation Basin 1 – must be diverted around it (see note above).
Sedimentation Basin 3	1,301	141	1,442	7,150	174	7,324	Ensure that natural drainage from undisturbed lands to the east and south-east is diverted around this basin.
Sedimentation Basin 4	583	284	867	Short-term basin for sediment-control during construction of the northern and western amenity bunds only. Can be decommissioned once bunds are constructed and they achieve 60% grass cover (or equivalent).			

All four sedimentation basins would be subject to the following design, monitoring and maintenance requirements.

- The design of operational sedimentation basins would include an emergency spillway designed to safely convey the 100-year ARI flow (DECC, 2008).
- Sedimentation basins would be inspected fortnightly and immediately following any rain event exceeding 5mm to check their capacity and integrity.
- Sedimentation basins would be discharged only when water has 50mg/L or less of suspended sediment. Note that soil investigations indicate that sediment will naturally settle out. If this does not occur in practice, flocculation to assist settling would be investigated.
- Waters would be discharged within five days after the conclusion of a rain event, at or below the required water quality limit of 50mg/L.
- A marker would be installed in each sedimentation basin showing the boundary between the Storage Zone (i.e. the lower zone) and the Settling Zone (i.e. the upper zone) in the basin.

- After discharging treated water from any sedimentation basin, the level of retained sediment would be inspected. If retained sediment exceeded the marked level of the Storage Zone, sediment would be removed and added to an active stockpile.
- Any damaged components of the sedimentation basins would be repaired as soon as practicable.
- The management procedures for the sedimentation basins would be regularly reviewed to ensure ongoing efficient operation and protection of downstream water quality.

Note that water sourced from the sedimentation basins for washdown or dust suppression does not need to meet any specific criteria for suspended sediment first. However, any such water must be used within the upslope catchment of a sedimentation basin, so that any accidental runoff simply drains back to a basin.

6.3.2 Surface Water Diversion

As indicated on **Figure 7**, the southern amenity bund would act as a diversion structure to direct natural flows around Sedimentation Basin 1, where they would then re-enter the natural depression invert. Similarly, a diversion bund or channel is required to ensure that outflows from Sedimentation Basin 2, and the natural flows downslope of it, do not enter Sedimentation Basin 1.

A diversion bund is required upslope of Sedimentation Basin 3 to divert runoff from the undisturbed portion of its catchment to the south-east and east

Diversion bunds or channels would adhere to the following requirements and commitments.

- All structures would be stabilised using appropriate ground cover to achieve a C-factor of 0.05 (achievable with 70% grass cover or equivalent) or less (Landcom, 2004) prior to conveying water.
- All structures would be designed to fully convey the 20-year ARI time-of-concentration event, and would be stabilised using materials capable of safely managing that flow volume and velocity.
- Potential scour points (e.g. channel inlets/outlets and bends) would be armoured with rock.
- All structures would be inspected monthly and immediately following any rain event that generates flow in the drains to identify areas of erosion, scour or damage. Any problem areas would be repaired and/or appropriate stabilising action taken.
- Inspection of diversion drains would also identify potential flow constrictions that might compromise channel capacity and, if required, remove them.

6.3.3 Erosion Control and Dust Suppression

6.3.3.1 Erosion Control

Rapid rehabilitation of disturbed areas is the most effective form of erosion control (Landcom, 2004). As such, the following would apply.

- Amenity bunds would be stabilised using vegetation (e.g. grass) to achieve at least 60% cover within 20 days of final shaping and 70% cover within a further two months.
- Stockpiles of waste material would be progressively stabilised using vegetation or similar. This would be conducted as new stockpile areas are opened and old ones are decommissioned.
- Clay and shale material awaiting transport would be stockpiled on the floor of the extraction area only. This ensures that any erosion of this material is confined within the extraction area and can be pumped to a Sedimentation Basin if required.

6.3.3.2 Dust Suppression

Dust suppression would be undertaken on exposed areas of the extraction pit walls, internal pit haul roads, unvegetated stockpiles and along the access road at the following rates:

- 1L/m^2/day on non-rainy days during the months September to March inclusive; and
- 0.25L/m^2/day on non-rainy days during the months April to August inclusive.

Records would be kept of water volumes removed from storages for the purposes of dust suppression and of the location, time and rate of each application of water.

6.3.4 Access Road

Any upgrade of the access road crossing over Stony Creek would include erosion and sediment controls in accordance with Landcom (2004). Dust suppression would be undertaken along the access road at the rates detailed in Section 6.3.3.2, above.

6.4 WATER QUALITY MONITORING

Water quality would be monitored at the three locations identified on **Figure 4** for the range of parameters listed in Section 5.3. Samples would be collected annually on or around the anniversary date of quarry establishment and tested at a registered and accredited laboratory. The results would be provided to Council, DECCW and any other relevant government agency. Results would be compared to existing baseline data and with previous years' data. Any decline in water quality would be investigated and, if required, appropriate remedial action would be taken.

6.5 WATER MANAGEMENT STRATEGY MONITORING AND AMENDMENT

The Water Management Strategy for the project would be independently audited every three years and upgrades or amendments made as required to ensure ongoing compliance with relevant environmental protection instruments.

7. REFERENCES

DECC (2008). *Managing Urban Stormwater: Soils and Construction.* Volume 2E; Mines and Quarries. NSW Department of Environment and Climate Change.

Institute of Engineers Australia (IEA) (1998). Australian Rainfall and Runoff, A Guide to Flood Estimation, Volume 1 and Volume 2.

Landcom (2004). *Managing Urban Stormwater: Soils and Construction.* Volume 1, 4th Edition. NSW Government.

Rosewell, C.J. (2005). Soiloss Version 5.3.

Rosewell, C.J. and Edwards, K. (1988). Soiloss; A program to assist in the selection of management practices to reduce soil erosion. Soil Conservation Service of NSW Technical Handbook No 11.

SCA/DLWC (2002). *Soil Landscapes of the Sydney Catchment Authority Hydrological Catchments.* Version 1. June 2002.

This page has intentionally been left blank

APPENDICES

(No. of pages including blank pages = 42)

Appendix 1 **Director-General's Requirements Relevant to this Assessment**

Appendix 2 **RATES Modelling Output**

Appendix 3 **Sedimentation Basin Sizing Spreadsheets**

Appendix 4 **Water Quality Test Results***

(*Please note: Appendix 4 is included on the Project CD Only)

This page has intentionally been left blank

Appendix 1

Director-General's Requirements Relevant to this Assessment

(No. of pages including blank pages = 9)

This page has intentionally been left blank

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement		Relevant Section
SOIL AND WATER		
A detailed description of the water management system for the site including water quality management, storm water management, erosion and sediment control and monitoring programs.		Section 6 of the Surface Water Management Assessment
BIODIVERSITY		
Include a detailed assessment of the potential impacts of the project on any terrestrial and aquatic threatened species, populations, ecological communities or their habitats and regional wildlife habitat corridors.		Not part of Surface Water Management Assessment
REHABILITATION		
Include a detailed description of the rehabilitation strategy for the site, taking into consideration any relevant strategic land use planning or resource management plans or polices.		Not part of Surface Water Management Assessment
REFERENCES		
The environmental assessment of the key issues listed above must take into account relevant guidelines, policies and plans. While not exhaustive, the following attachment contains a list of some of the guidelines, policies and plans that may be relevant to the environmental assessment of this project.		
CONSULTATION		
During the preparation of the *Environmental Assessment*, you should consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. In particular you should consult with: • Department of Environment and Climate Change; • Department of Primary Industries; • Department of Water and Energy; • Department of Lands; • Sydney Catchment Authority • Roads and Traffic Authority; and • Wingecarribee Shire Council. The consultation process and the issues raised must be described in the *Environmental Assessment*.		
GENERAL		
Department of Water and Energy (02/10/08)	The EA is required to take into account the following NSW Government policies, as applicable: • NSW Groundwater Policy Framework Document - General; • NSW Groundwater Quantity Management Policy; • NSW Groundwater Quality Protection Policy; • NSW Groundwater Dependant Ecosystem Policy; • NSW State Rivers and Estuaries Policy; • NSW Wetlands Management Policy • NSW Farm Dams Policy	Refer to the EA

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement		Relevant Section
GENERAL (Cont'd)		
Department of Environment and Climate Change (03/10/08)	Details are required on the location of the proposed development including the affected environment to place the proposal in its local and regional environmental context including surrounding land uses, planning zones, potential sensitive receptors, surface and sub-surface areas/features of conservation significance and environmental sensitivity. These should include areas containing natural and cultural heritage values.	Refer to the EA
	Describe mitigation and management options that will be used to prevent, control, abate or mitigate identified environmental impacts associated with the project and to reduce risks to human health and prevent the degradation of the environment.	Section 6 plus EA
SURFACE WATER		
Department of Water and Energy (02/10/08)	If a water supply is required, the source/availability of a sustainable water supply needs to be addressed in the EA.	Section 5.6
	The location and estimated capacity of every dam must be shown. Any capacity of the total of all dams on the property greater than the MHRDC may require a licence.	Section 6.3
	The EA should provide details on:	EA
	• any existing surface water and groundwater licences under the Water Act 1912 on the subject property;	
	• the purpose of the existing licences;	EA
	• the water supply source(s) for the proposal;	Section 5.6
	• volumes of water to be used;	Section 5.6
	• The function and location of all existing and proposed storages/ponds on the site; and	Section 6.3
	• The design layout, pumping and storage capacities, all associated earthworks and infrastructure works must be clearly shown and explained.	Section 6.3
Department of Water and Energy (02/10/08	If the proposal includes water management structures/dams, the EA needs to provide details on the following:	Section 6.3
	• any existing structure(s) (date of construction, location, purpose, size and capacity, the legal status/approval for existing structure/s);	
	• any proposal to change the purpose of existing structure/s;	Section 6.3
	• if any remedial work is required to maintain the integrity of the existing structure/s;	Not applicable
	• size and storage capacity of the structure/s;	Section 6.3
	• calculation of the Maximum Harvestable Right Dam Capacity (MHRDC);	Section 5.2
	• if the structure/s is affected by flood flows;	
	• any proposal for shared use, rights and entitlement of the structure/s; and	Not applicable
	• if the proposed development has the potential to bisect the structure/s.	Not applicable

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement		Relevant Section
SURFACE WATER (Cont'd)		
Department of Environment and Climate Change (03/10/08)	The goal of the project should ensure: • There is no pollution of waters (including surface and groundwater);	Section 6
	• Polluted water is captured on the site and directed to reticulated sewer where available or else collected, treated and beneficially reused, where this is safe and practicable to do so;	Section 6
	• There is consistency with any relevant Statement of Joint Intent established by the Healthy Rivers Commission; and	Not applicable
	• It contributes to the protection or achievement over time of River Flow Objectives and Water Quality Objectives.	Sections 5 and 6
	An assessment needs to be provided in the EA demonstrating how the above objectives will be achieved. The proponent should confirm in the EA the catchment that the development occurs in to determine the requirements that should apply. The EA should clearly identify any sensitive areas nearby and provide details on any potential impact this proposal may have on these areas including any associated mitigation measures.	Sections 5 and 6
GROUNDWATER		
Department of Water and Energy (02/10/08)	The Environmental Assessment (EA) needs to provide details on: • the source/availability of a sustainable water supply. The Environmental Assessment needs to address how a water supply will be sourced for the proposal due to the Hawkesbury-Nepean surface water licence embargo. Commercial groundwater extraction in the Parish of Bong Bong is also similarly embargoed;	Section 5.6
	• the protection of groundwater;	Refer to groundwater assessment
	• the protection of watercourses and riparian corridors.	
	The EA should identify groundwater issues and potential degradation to the groundwater source and provide the following details: • the predicted highest groundwater table at the site;	Refer to groundwater assessment
	• any works likely to intercept, connect with or infiltrate the groundwater sources;	Refer to groundwater assessment
	• a description of the flow directions and rates and physical and chemical characteristics of the groundwater source;	Refer to groundwater assessment
Department of Water and Energy (02/10/08)	• the predicted impacts of any final landform on the groundwater regime;	Refer to groundwater assessment

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement		Relevant Section
GROUNDWATER (Cont'd)		
Department of Water and Energy (02/10/08) (Cont'd)	• the existing groundwater users within the area (including the environment), any potential impacts on these users and safeguard measures to mitigate impacts;	Refer to groundwater assessment
	• an assessment of the quality of the groundwater for the local groundwater catchment;	Refer to groundwater assessment
	• how the proposed development will not potentially diminish the current quality of groundwater, both in the short and long term;	Refer to groundwater assessment
	• measures for preventing groundwater pollution so that remediation is not required;	Refer to groundwater assessment
	• protective measures for any groundwater dependent ecosystems (GDEs);	Refer to groundwater assessment
	• proposed methods of the disposal of waste water and approval from the relevant authority; and	Section 6.3.4
	• the results of any models or predictive tools used.	Refer to groundwater assessment
	Where potential impact/s are identified the assessment will need to identify limits to the level of impact and contingency measures that would remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on: • any proposed monitoring programs, including water levels and quality data;	Refer to groundwater assessment
	• reporting procedures for any monitoring program including mechanism for transfer of information;	
	• an assessment of any groundwater source/aquifer that may be sterilised from future use as a water supply as a consequence of the proposal;	
	• identification of any nominal thresholds as to the level of impact beyond which remedial measures or contingency plans would be initiated (this may entail water level triggers or a beneficial use category);	
Department of Water and Energy (02/10/08)	• description of the remedial measures or contingency plans proposed; and	Section 6
	• any funding assurances covering the anticipated post development maintenance cost, for example on-going groundwater monitoring for the nominated period.	EA

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement		Relevant Section
GROUNDWATER (Cont'd)		
Sydney Catchment Authority (23/09/08)	The SCA considers water quality issues should be comprehensively considered in the assessment process and that this planning instrument establishes appropriate assessment criteria. The SCA considers that the environmental assessment of the quarry proposal and the proposed transport route must include an assessment of whether the proposal will have a 'neutral or beneficial effect on water quality' as per the following: • Consider the Drinking Water Catchments Regional Environmental Plan No. 1 and have regards to the water quality objectives detailed in the plan;	Sections 5 and 6
Sydney Catchment Authority (23/09/08)	• Contain relevant studies and plans (eg Water Cycle Management Study, Stormwater Management Plan, Erosion and Sediment Control Plan and/or Soil and Water Management Plan) that address the following:	Sections 5 and 6
	• Identification of potential impacts on water quality and likely pollutants of concern (surface and groundwater) during construction, operation and decommissioning stages of the quarry;	Section 5.4
	• Identification of potential impacts on the development of water supply dams, groundwater and the relocation of watercourses and drainage lines. If there is no impact on groundwater a justification as to how this conclusion has been reached needs to be provided.	Refer to groundwater assessment
	• Details of water quality protection measures during construction, operation and decommissioning stages of the quarry along with the performance criteria for each measure and an assessment of whether the water quality measures are sustainable for the periods for which they are expected to be in place.	Section 6
	• With regards to soil and water management at the quarry site, critical structures such as Water Quality Control Ponds (WQCPs) and sedimentation basins should be designed, constructed and maintained to accommodate a 1 in 100 year ARI 24 hour event. Similarly other dams and water management structures should be designed, constructed and maintained to accommodate a 1 in 20 year ARI event. Justification for any deviation from this should be provided.	Section 6
	• Determine and state whether a neutral of beneficial effect on water quality of receiving waters (surface and groundwater) will occur during construction, operation and decommissioning stages of the quarry.	Sections 5 and 6

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement			Relevant Section
GROUNDWATER (Cont'd)			
	• In the event that water will be discharged from the site the SCA recommends that the proponent be required to meet the water quality guidelines identified below for the operation and decommissioning stages of the project which have been derived from the SCA (2006) Water Quality Monitoring Report 2005-2006 and the Healthy Rivers Commission Guidelines (1998). Any monitoring program for surface and groundwater quality would need to include these parameters.		Sections 5.3, 5.4 and 6.4
	Parameter	**Value**	
	Dissolved Oxygen (% saturation)	90 - 110	
	pH (pH unit)	6.5 – 8.0	
	Turbidity (NTU)	25	
	Total phosphorous (mg/L)	0.05	
	Total nitrogen (mg/L)	0.5	
Sydney Catchment Authority (23/09/08)	The Environmental Assessment needs to detail information regarding the following: • Provide details of the practices proposed to ensure materials transported from site do not spill (as solid, liquid or dust); • Provide details of an incident management plan that would be followed in the event of an incident (eg truck accident releasing fuel etc); • Provide details of any proposed offsets like Riparian Improvement adjacent to Wingecarribee River.		Refer to the EA Refer to the EA Not required
WATERCOURSES AND RIPARIAN LANDS			
Department of Water and Energy (02/10/08)	The EA should identify any watercourses at the site, or in the vicinity of the site and their associated riparian corridors which may potentially be impacted by the proposal and address how the watercourses and riparian corridors at the site will be protected and enhanced.		Section 4.4 and Section 5
	The riparian corridors should be protected and/or enhanced with native riparian vegetation.		Section 4.4
	The EA should provide on a scaled plan, details on the location of: a. the watercourses at the site b. top of bank c. the riparian corridors, including the Core Riparian Zone (CRZ) and vegetated buffers d. any Asset Protection Zones e. the footprint of the proposed development and any other areas of disturbance f. any proposed revegetation of the riparian corridors g. land uses associated with the proposal which are proposed to be located adjacent to the riparian corridor (eg roads, basins and any other works adjacent to the riparian corridor)		Section 4.4

Table A2.1 Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

Paraphrased Requirement		Relevant Section
WATERCOURSES AND RIPARIAN LANDS (Cont'd)		
	The EA needs to provide details on any watercourses and riparian corridors that may be affected by the proposal and the rehabilitation of these watercourses to mimic natural systems and the rehabilitation of vegetated riparian corridors.	Section 4.4
Department of Lands (25/11/08)	The proposed extraction should have no adverse affect on the bed or bank of the Wingecarribee River and or the associated riparian lands and water quality within, both upstream and downstream of the site.	Sections 5 and 6
ENVIRONMENTAL OFFSETTING		
Wingecarribee Shire Council (26/09/05)	Department of Natural Resources Riparian Corridor Management Study would be a significant offsetting opportunity. Furthermore, the augmentation of a vegetated corridor from this riparian area to the Crown land to the west of the proposed site would further enhance an offsetting opportunity and provide further community benefit.	Not part of Surface Water Management Assessment
WETLANDS		
Department of Water and Energy (02/10/08)	The EA should provide on a scaled plan, details on the location of: a. any wetlands on the subject property b. buffer setbacks around the wetlands c. any Asset Protection Zones d. the footprint of the proposed development and any other areas of disturbance	Not applicable at this site

This page has intentionally been left blank

Appendix 2

RATES Modelling Output

(No. of pages including blank pages = 4)

This page has intentionally been left blank

SEEC
MORSE McVEY

SEEC RATES IV Results
Site: New Berrima
Rain station: Moss Vale 68045

Total years:	99.33	Avg annual rainfall (mm):	954.57
Total days:	36278	Max daily rainfall (mm):	422
Total no of days when rain fell:	11614	Longest dry spell (days):	57
Avg days per year when rain fell:	116.9233867	Days when rain > S1 initial loss:	4380
Avg wet day rainfall (mm):	8.16	Avg days/yr rain > S1 initial loss:	44.09544

Input statistics:	**Model 1 (4.59ML storage)**		**Model 2 (2.9ML storage)**	
Capacity (L):	4590000		2900000	
Startup % full:	10		10	
Catchment area (sqm):	195000		195000	
Initial loss per day (mm):	5		5	
Runoff percentage:	60		60	
Apply use A on wet days (Y/N):	Y		Y	
Apply use B on wet days (Y/N):	N		N	
Revert to mains at threshold (Y/N):	N		N	
Mains reversion threshold (% full):	0		0	
Overflows into Storage 2 (Y/N):	N		N/A	
USAGE stats (L/day):	**Storage 1**		**Storage 2**	
Usage type:	**A**	**B**	**A**	**B**
January	2000	33400	2000	33400
February	2000	33400	2000	33400
March	2000	33400	2000	33400
April	2000	8350	2000	8350
May	2000	8350	2000	8350
June	2000	8350	2000	8350
July	2000	8350	2000	8350
August	2000	8350	2000	8350
September	2000	33400	2000	33400
October	2000	33400	2000	33400
November	2000	33400	2000	33400
December	2000	33400	2000	33400
Results:	**Storage 1**		**Storage 2**	
% of time demand met:	100		99.9	
% of demand supplied from mains:	0		0	
Longest time storage ran dry (days):	0		18	
Avg annual mains demand (L):	0		0	
Avg wet day overflow (L):	536466.24		536704.44	
Avg no of overflow events annually:	35.46763314		35.4978355	
Avg annual supply from rain in (L):	8048410		8032321	
Max daily overflow (L):	48755950		48755950	
Annual demand (L):	8048409.846		8048409.846	

This page has intentionally been left blank

Appendix 3

Sedimentation Basin Sizing Spreadsheets

(No. of pages including blank pages = 6)

This page has intentionally been left blank

1. Site Data Sheet

Site Name: New Berrima Clay/Shale Extraction

Site Location: Berrima

Precinct:

Description of Site: Clay/Shale Quarry - Establishment Phase

Site area	Sub-catchments						Remarks
	SB1	SB2	SB3	SB4			
Total catchment area (ha)	8.23	3.91	8.3	3.72			
Disturbed catchment area (ha)	4.98	2.29	2.46	2.69			

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	F	F	F	F			From Appendix C
% sand (fraction 0.02 to 2.00 mm)	33	33	33	33			Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)	18	18	18	18			
% clay (fraction finer than 0.002 mm)	33	33	33	33			
Dispersion percentage	1.0	1.0	1.0	1.0			E.g. enter 10 for dispersion of 10%
% of whole soil dispersible	0.42	0.42	0.42	0.42			See Section 6.3.3(e). Auto-calculated
Soil Texture Group	F	F	F	F			Automatic calculation from above

Rainfall data

Design rainfall depth (days)	5	5	5	5			See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	80	80	80	80			See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	28	28	28	28			See Section 6.3.4 (h)
Rainfall R-factor (if known)	2200	2200	2200	2200			See Appendix B
IFD: 2-year, 6-hour storm (if known)	9.96	9.96	9.96	9.96			See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R*-factor)	2200	2200	2200	2200			Auto-filled from above
Soil erodibility (*K*-factor)	0.064	0.064	0.064	0.064			RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	250	200	300	260			
Slope gradient (%)	4.3	5.3	4.8	8			
Length/gradient (*LS*-factor)	1.85	2.17	2.39	4.42			
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Calculations

Soil loss (t/ha/yr)	338	397	437	808			
Soil Loss Class	3	4	4	6			See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	260	305	336	622			
Sediment basin storage volume, m^3	220	119	141	284			See Sections 6.3.4(i) and 6.3.5 (e)

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day, y-\%ile}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day, y-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
SB1	0.56	28	8.23	1290.464	220	1510.464
SB2	0.56	28	3.91	613.088	119	732.088
SB3	0.56	28	8.3	1301.44	141	1442.44
SB4	0.56	28	3.72	583.296	284	867.296

Note that designers should achieve a minimum 3:1 length:width ratio in Type D or F basins

1. Site Data Sheet

Site Name: New Berrima Clay/Shale Extraction

Site Location: Berrima

Precinct:

Description of Site: Clay/Shale Quarry - Operational Phase

Site area	Sub-catchments						Remarks
	SB1	SB2	SB3				
Total catchment area (ha)	5	3.6	4.5				
Disturbed catchment area (ha)	4.64	0.5	3.05				

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	F	F	F				From Appendix C
% sand (fraction 0.02 to 2.00 mm)	33	33	33				Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)	18	18	18				
% clay (fraction finer than 0.002 mm)	33	33	33				
Dispersion percentage	1.0	1.0	1.0				E.g. enter 10 for dispersion of 10%
% of whole soil dispersible	0.42	0.42	0.42				See Section 6.3.3(e). Auto-calculated
Soil Texture Group	F	F	F				Automatic calculation from above

Rainfall data

Design rainfall depth (days)	24hrs	24hrs	24hrs				See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	100YR	100YR	100YR				See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	227	227	227				See Section 6.3.4 (h)
Rainfall R-factor (if known)	2200	2200	2200				See Appendix B
IFD: 2-year, 6-hour storm (if known)	9.96	9.96	9.96				See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R*-factor)	2200	2200	2200				Auto-filled from above
Soil erodibility (*K*-factor)	0.064	0.064	0.064				RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	250	200	300				
Slope gradient (%)	4.3	5.3	4.8				
Length/gradient (*LS*-factor)	1.85	2.17	2.39				
Erosion control practice (*P*-factor)	1.3	1.3	1.3				
Ground cover (*C*-factor)	1	1	1				

Calculations

Soil loss (t/ha/yr)	338	397	437				
Soil Loss Class	3	4	4				See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	260	305	336				
Sediment basin storage volume, m^3	205	26	174				See Sections 6.3.4(i) and 6.3.5 (e)

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day, y-\%ile}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day, y-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
SB1	0.70	227	5	7945	205	8150
SB2	0.70	227	3.6	5720.4	26	5746.4
SB3	0.70	227	4.5	7150.5	174	7324.5

Note that designers should achieve a minimum 3:1 length:width ratio in Type D or F basins

Appendix 4

Water Quality Test Results*

(No. of pages including blank pages = 18)

(Please Note: Appendix 4 is on the Project CD Only)

This page has intentionally been left blank