Specialist Consultant Studies Compendium

Gunlake Quarries
Gunlake Quarry Project

ENVIRONMENTAL ASSESSMENT

VOLUME II

Part 2
SEEC Morse McVey
Managing Soil and Water. Proposed Gunlake Quarry and Haul Road, Brayton Road, Marulan

February 2008

Managing Soil and Water

Proposed Gunlake Quarry Project and Haul Road, Brayton Road, Marulan.

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Document Certification
This report has been developed based on agreed requirements as understood by SEEC Morse McVey at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects. Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

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Acknowledgement

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Executive Summary

Gunlake Quarries, a division of Rollers Australia Pty Ltd, proposes to establish a hard rock quarry and processing plant eight kilometres northwest of Marulan, NSW, off Brayton Road. The rock will be drilled, blasted and processed on site in a crushing and screening plant. Eventually, the product will be transported along a new Marulan bypass built to the north of the town. Together, the quarry, its access road and the bypass form “the site” (Figure 1).

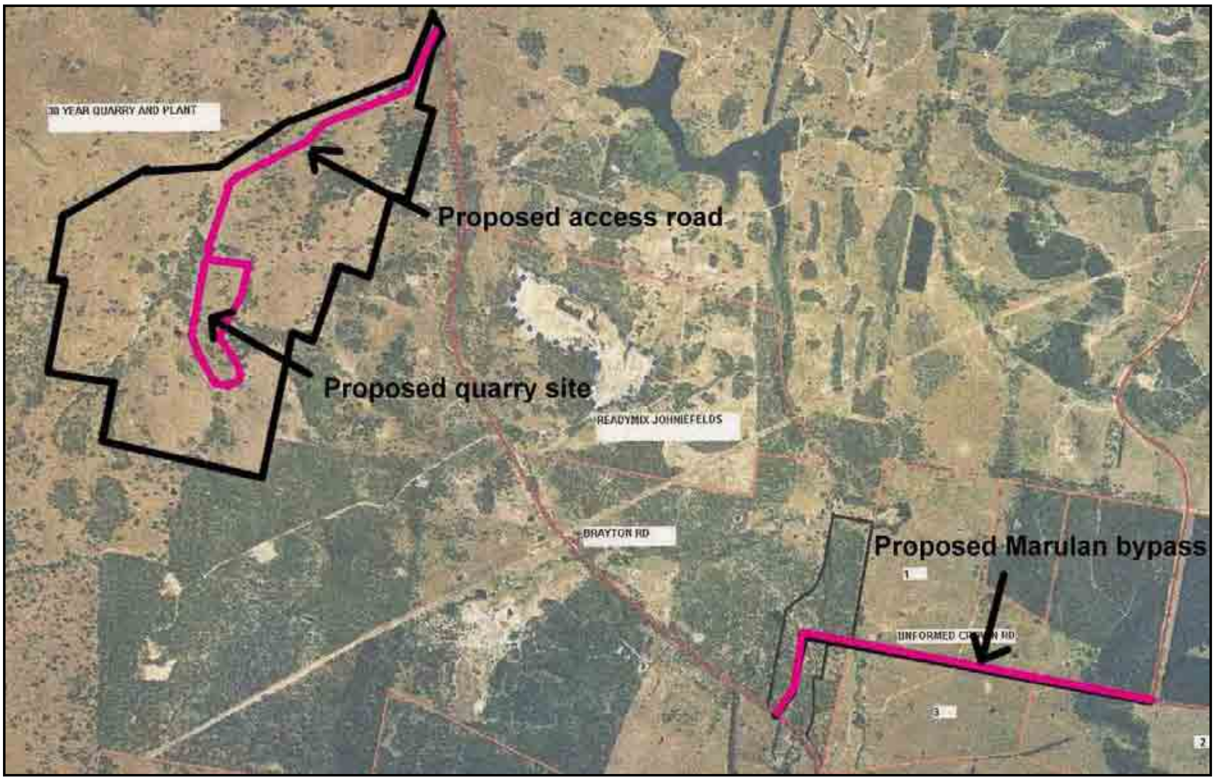

Figure 1 The site

This Soil and Water Management Study comprises of four parts:

Part 1. A description of the soils and an assessment of their agricultural value;

Part 2. A Conceptual Soil and Water Management Plan that shows how soil and water will be managed during the establishment stage to the requirements of Landcom (2004) (the Blue Book);

Part 3. A Conceptual Water Cycle Management Plan that shows how stormwater will be managed during the operational stage and how a neutral or beneficial effect (NorBE) on water quality will be obtained; and

Part 4. Appendices to support Parts 1 to 3.

It forms part of an Environmental Assessment (EA) prepared by David Olsen of Olsen Environmental Consulting P/L. Therefore, it addresses the Director General’s requirements, particularly *some* of those from:

- Department of Planning;
- Department of Environment and Climate Change (DECC) (particularly issues relating to water);
- Department of Primary Industries;
- NSW Department of Water and Energy; and
- The Sydney Catchment Authority.

Appendix II of the EA provides an itemised and tabulated summary of the Director General's requirements and indicates which of those are addressed by this study.

Part 1

Soil and Agricultural Impact Assessment

Part 1 Soil and Agricultural Impact Assessment

1.1 Introduction

This part of the study addresses various soil and agricultural impact-related issues at the site should the proposed development go ahead. It includes:

(i) An assessment of the soil landscapes, including soil sampling/testing to determine constraints and opportunities for the proposed development, and the potential for the soils to be used in site rehabilitation;

(ii) Identification of the agricultural value of the lands with respect to the inherent soil landscape characteristics;

(iii) Identification of potential impacts on significant agricultural lands and productive soils (if applicable);

(iv) Recommendations for impact mitigation on agriculturally valuable soil landscape areas (if applicable).

1.2 Topography and Drainage

The site is typified by undulating rises and valleys between low hills with slopes ranging from 2 to 10 percent and rising to 680 m AHD in the southwest corner. There are a few rock outcrops on crests and many surface cobbles in some areas. The aspect varies with ridge lines and contours.

Several drainage lines and few small farm dams are in the study area. Eventually, these drain into Lake Burragorang. Consequently, it forms part of the hydrological catchment for Sydney’s water supply.

1.3 Land Use and Vegetation

The present land use at the site is livestock grazing. Mostly, it is vegetated with native and improved pasture grasses including some broadleaved weeds. It has been cleared extensively of native vegetation, with some small patches of highly disturbed remnant woodland remaining. Figure 1 shows the current tree cover. No current active salinity or erosion is evident in the area of the proposed works.

At the time of inspection, the dominant pasture species were Ryegrass (*Lolium rigidum*), Phalaris (*Phalaris* spp.), Clover (*Trifolium repens, T. subterraneum*) and native grasses including Redgrass (*Bothriochloa macra*), Kangaroo grass (*Themeda triandra*), and *Poa* spp. Weed species present included Fescue (*Vulpia* spp.), Capeweed (*Arctotheca calendula*) and Dandelion (*Taraxacum officinale*).

On steeper slopes, crests and areas with many cobbles, vegetation consisted of highly disturbed native woodland. Dominant species present were Red Stringybark (*Eucalyptus macroryhnca*), Red Gum (*Eucalyptus blakelyi*) and White Box (*Eucalyptus albens*).

1.4 Soil Landscapes

The 1:100,000 scale soil landscape mapping prepared by DLWC & SCA (2002) identifies one soil landscape across the quarry and its access road, and six on the proposed Marulan bypass road (Figures 2 and 3). These are:

1.4.1 On the proposed quarry and access road:

- the Bindook Road Soil Landscape; and

1.4.2 On the Marulan bypass:

- the Bindook Road Soil Landscape;
- the Paddys River Soil Landscape (very small area);
- the Marulan Soil Landscape (very small area);
- the Jaqua Soil Landscape;
- the Gibraltar Rocks Soil Landscape; and
- the Larkin (Variant A) Soil Landscape (very small area).

A description of each of these soil units follows:

(a) Bindook Road Soil Landscape

The Bindook Road Soils Landscape comprises undulating low hills on Devonian Bindook Porphyry. The unit is identified by the sub-angular porphyry rock outcrop on upper slopes and crests. It includes poor to moderate quality grazing lands (Figure 4). Elsewhere on this unit are lands with high erosion problems, including some severe gullying, and localised high water tables that are often saline.

The proposed quarry and associated access road are on this soil landscape as well as the north-south oriented section of the Marulan bypass. The soils are highly variable. The results of our own laboratory testing on this unit are in Table 1 and data from Landcom (2004) are in Table 2. Figures 2 and 3 show the locations of soil sampling sites.

(b) Paddys River Soil Landscape

The alluvium that forms the banks and levees of the present day Paddys River comprises fine silts and clays derived from the surrounding geological units. Redoxic conditions occur in the sediments with sesquioxide movement (predominantly iron) common in profile descriptions. Being alluvial in nature, this unit can be expected to be highly variable. Nevertheless, data from Landcom (2004) are in Table 2.

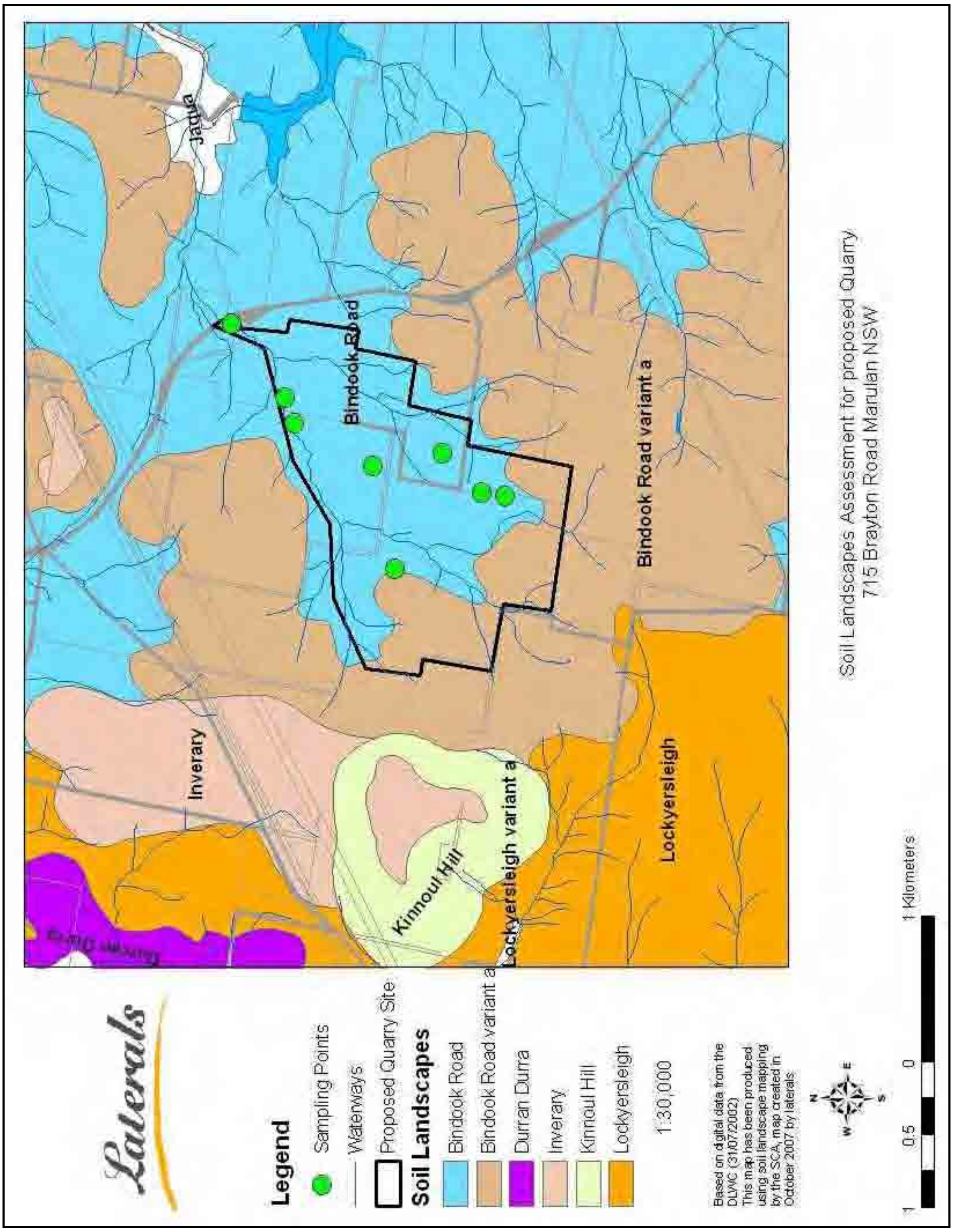

Figure 2 Soil Landscapes in the area of the proposed quarry and its access road

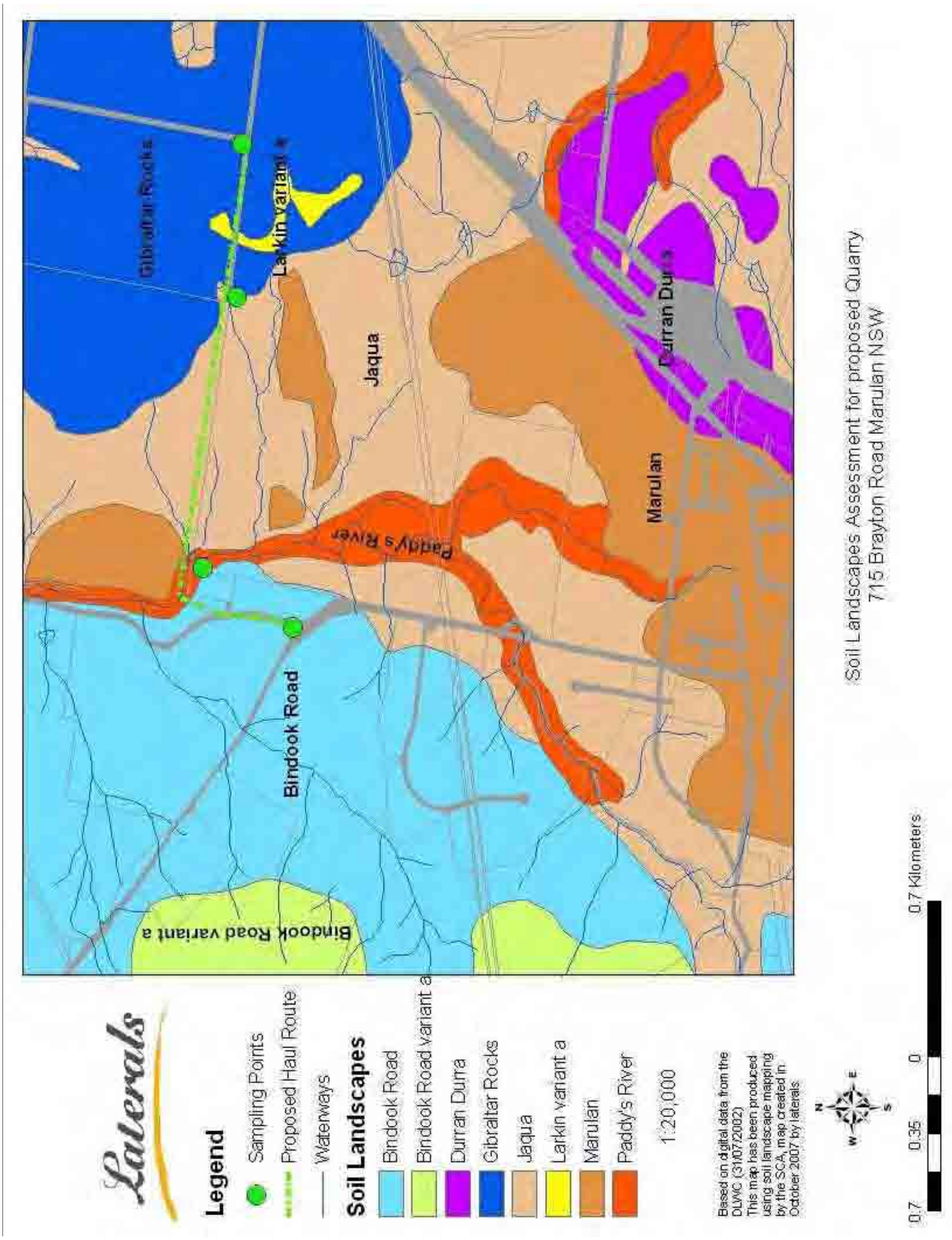

Figure 3 Soil Landscapes in the area of the proposed Marulan bypass

Figure 4 Typical view of the Bindook Road Soil Landscape where cleared for farming activities

While the Paddys River Soil Landscape is somewhat remote from the area from which it was originally described, the sediment that feeds the system is similar; hence, the name. The sediment is derived from confined Triassic and Permian sandstone units and the broader slopes of Ordovician metasediments and Devonian granites. The proposed Marulan bypass will cross this unit (Figures 3 and 5).

(c) Marulan Soil Landscape

Depending on the final location of the Marulan bypass, site works might not occur on the Marulan Soil Landscape. It occurs to the north of the Paddys River Soil Landscape where the road changes direction from a north-south orientation to east-west (Figure 3). The unit comprises gently undulating rises to undulating low hills formed on Devonian Granite. Distinct surface expression of outcropping of well rounded, spheroidal, weathered granite tors is common. Overgrazing and clearing can lead to significant erosion problems.

Soils range in depth from 0.5 to 2 metres. The topsoils are sandy and earthy in texture. Lower slope profiles are often sodic at depth and can contain high levels of sodium chloride. Data from Landcom (2004) are in Table 2.

(d) Jaqua Soil Landscape

The proposed Marulan bypass crosses the Jaqua Soils Landscape on the east-west oriented section (Figure 3). It comprises long footslopes and undulating low rises (Figure 6). Slopes are gentle, ranging from 1 to 5 percent.

The soils have developed from meta-sediments and granite. While sheet and gully erosion have occurred in the past, presently the lands here are stable due, largely, to soil conservation works and other good land management practices. The results of our own laboratory testing are in Table 1 and data from Landcom (2004) are in Table 2.

(e) Gibraltar Rocks Soil Landscape

The eastern quarter of the east-west oriented section of the Marulan bypass is on the Gibraltar Rocks Soil Landscape (Figures 3 and 7). It comprises rolling to steep hills on Megalong conglomerate, originally described in the Canyonleigh Hills Physiographic Region. Rock outcrop is common on the steeper slopes.

The soils are variable and can range from duplex on gentler slopes to gradational on steep colluvium. Localised outcrops of deeply weathered sandstone have been included in this unit. Data from Landcom (2004) are in Table 2.

(f) Larkin (Variant A) Soil Landscape

A very small section of the Larkin (Variant A) Soil Landscape occurs within the eastern half of the east-west oriented section of the Marulan bypass (Figures 3 and 8). It has formed, predominantly, *insitu* as a residual soil derived from lateritic (iron rich) substrate. Areas occur where shale, sandstone, metasediments and gravels have undergone alteration due to iron induration resulting in the typical lateritic profile, including mottled and pallid zones. The soils formed on these substrates contain high percentages of iron (>25%) in subsoils. They are easily distinguished by ironstone boulder outcrops and by the red colour. Data from Landcom (2004) are in Table 2.

Figure 5 Typical view of the Paddys River Soil Landscape – the greener alluvial unit across the centre of the view

Figure 6 Typical view of the Jaqua Soil Landscape – the alluvial materials in the centre of the view are the Paddys River Soil Landscape

Figure 7 Typical view of the Gibraltar Rocks Soil Landscape

Figure 8 Typical view of the Larkin (Variant A) Soil Landscape

Relevant laboratory data has been obtained from soil samples taken in the various test pits by us and DLWC & SCA (2002). These are presented in Table 1 (from our investigations) and Table 2 (from Landcom, 2004).

A location diagram for the test pits is in Figures 2 and 3. Our field investigations confirm the boundaries established by DLWC & SCA (2002) are accurate in the study area. The field work was undertaken on 12, 13 and 14 February 2007.

Tables 1 and 2 suggest that the soils have the following general features:

(i) dispersible (Sediment Type D) for the most part;

(ii) moderately to very highly erodible;

(iii) moderately acidic in the topsoils;

(iv) non saline to slightly saline;

(v) low to moderate cation exchange capacities;

(vi) calcium : magnesium ratios that infer low calcium to calcium deficient soils;

(vii) very low phosphorus levels;

(viii) very low to moderate potassium levels;

(ix) very high variability for use in the walls of sediment basins – site-specific testing recommended.

The phosphorus, potassium and calcium levels of the soils should be improved during rehabilitation to facilitate plant growth should it be desired to establish permanent pasture. Probably, areas to be used for native vegetation do not require the application of any fertilisers; however, advice from a suitably qualified Agronomist should be sought.

Other soil data relevant to Parts 2 and 3 are given in Table 3.

1.5 Agricultural Value

Based on the above data, we believe that the lands are in Agricultural Suitability Classes 4 and 5:

> ***Class 4*** include lands best suited to grazing. Cultivation of occasional crops is possible in some areas, especially during favourable seasons. However, this can increase the erosion hazard substantially. Production levels are likely to be low.
>
> ***Class 5*** lands are suited to occasional light grazing, best under natural bushland. Other agricultural pursuits are not recommended.

Consequently, the development of the quarry, its access road and the Marulan bypass will not affect any lands of significant agricultural value.

Potential impacts of the development can be mitigated by:

(i) Stripping and stockpiling topsoil from areas to be developed, including the quarry, its haul road and the Marulan bypass;

Table 1. Laboratory Test Results Relevant to Agricultural Suitability

Lab No	Sample Identification	EC (dS/m)	pH	CEC (me/100g)	Na (me/100g)	K (me/100g)	Ca (me/100g)	Mg (me/100g)	Al (me/100g)	P (mg/kg)	EAT	Texture
1	Waypoint 1, topsoil, depth 300 mm on the Jaqua Soils Landscape	0.01	5.7	4.3	0.1	0.3	0.9	0.4	0.6	1	3(1)	Sandy loam
2	Waypoint 1, subsoil, depth 1,000 mm on the Jaqua Soils Landscape	0.01	5.0	10.4	0.2	0.1	0.5	1.3	4.0	1	6	Sandy clay loam
3	Waypoint 3, subsoil, depth 1,000 mm on the Paddys River Soils Landscape	0.03	6.8	12.2	0.4	0.2	6.5	3.0	<0.1	1	3(3)	Sandy loam
4	Waypoint 8, subsoil, depth 1,000 mm on the Bindook Road Soils Landscape	0.14	6.3	19.8	3.2	0.7	1.8	11.7	<0.1	1	2(2)	Sandy clay loam
5	Waypoint 12, topsoil, depth 300 mm on the Bindook Road Soils Landscape	0.02	5.6	6.2	0.2	0.7	1.8	1.4	0.6	4	3(1)	Sandy loam
6	Waypoint 12, subsoil, depth 1,000 mm on the Bindook Road Soils Landscape	0.07	5.2	19.1	1.1	0.6	0.8	8.1	4.2	1	2(1)	Light clay
7	Waypoint 14, topsoil, depth 300 mm on the Bindook Road Soils Landscape	0.03	5.8	24.6	0.9	0.7	6.5	11.3	2.2	<1	3(1)	Sandy clay
8	Waypoint 14, subsoil, depth 1,000 mm on the Bindook Road Soils Landscape	0.03	6.0	24.5	1.3	0.3	4.7	12.9	<0.1	<1	3(2)	Sandy clay

Notes:

Sample 1 and Sample 2 were taken from the Jaqua Soils Landscape near the boundary of the Larkin (variant a) Soils Landscape. This point is located on figure 3.

Sample 3 was taken from the Paddys River Soils Landscape near the boundary of the Bindook Road Soils Landscape. This point is located on figure 3.

Sample 3 was taken from the Paddys River Soils Landscape near the boundary of the Bindook Road Soils Landscape. This point is located on figure 3.

Sample 4 was taken from the Bindook Road Soils Landscape in the middle of the proposed works area. This point is located on figure 2.

Samples 5, 6, 7 and 8 were taken from the Bindook Road Soils Landscape along the proposed access road to the quarry. These points are located on figure 2.

Table 2. Soils Data Relevant to Soil Conservation

Soil Landscape	Landscape code	Common constraints	Slope range	Soil Hydrologic Group	Acid sulfate risk	Soil Material	USCS class(es)	Recommended K-factor	Recommended Sediment Type	Sediment basin wall construction (earth)
Bindook Road	Erbo	localised poor drainage; localised high water tables; localised seasonal waterlogging; localised shallow soils; localised rock outcrop; localised foundation hazard; localised gully erosion hazard; widespread sheet erosion hazard; localised groundwater recharge zone; localised groundwater discharge zone; localised salinity; localised saline seepage scalds	3% to 12%	C	none	bo1	SM, SC	0.015	Type C	B, I
						bo2	ML	0.044	Type C	C
						bo3	SM, SC	0.039	Type F	B, J
						bo4	CL, CH	0.036	Type D	B
						bo5	SC	0.020	Type C	C
Gibraltar Rocks	Ergr	localised steep slopes; localised mass movement hazard; localised rockfall hazard; localised poor drainage; localised seasonal waterlogging; localised shallow soils; widespread non-cohesive soils; localised rock outcrop; localised foundation hazard; widespread sheet erosion hazard	10% to >70%	D	none	gr1	SM	0.015	Type C	I
						gr2	SM, ML	0.052	Type F	I
						gr4	CL	0.033	Type F	C
						gr5	SM	0.045	Type C	n/a
Jaqua	Trjq	localised flood hazard; localised poor drainage; localised high water tables; localised seasonal waterlogging; widespread high run-on; localised non-cohesive soils; localised foundation hazard; localised groundwater pollution hazard; localised gully erosion hazard; widespread sheet erosion hazard; localised groundwater recharge zone; localised groundwater discharge zone; localised salinity; localised saline seepage scalds	2% to 7%	C / D	none	jq1	SM	0.045	Type C	J
						jq2	ML, OL	0.058	Type F	A, J
						jq3	SM, ML, CL	0.058	Type D	I, J, K
						jq4	CL, CH	0.081	Type F	C
						jq5	SM, ML, CL	0.075	Type D	B, C, J, K
						jq6	CL	0.078	Type F	G
Larkin	Relr	localised non-cohesive soils; widespread groundwater pollution hazard; widespread sheet erosion hazard	2% to 6%	C	none	lr1	SM, ML, OL	0.041	Type F	B, C, I, K
						lr2	ML	0.033	Type D	C
						lr3	ML	0.082	Type F	C
						lr4	ML	0.062	Type F	C
Marulan	Erml	localised poor drainage; localised high water tables; localised seasonal waterlogging; localised high run-on; localised shallow soils; localised non-cohesive soils; localised rock outcrop; widespread groundwater pollution hazard; localised gully erosion hazard; widespread sheet erosion hazard; localised groundwater discharge zone	2% to 15%	C	none	ml1	SM, OL	0.051	Type F	B, I, J
						ml2	SP, SM	0.039	Type C	I
						ml3	GM, SM	0.065	Type D	J
						ml4	CL	0.024	Type D	A
						ml5	CH	0.025	Type D	G
						ml6	SM	0.029	Type D	K
Paddy's River	Alpr	widespread flood hazard; widespread poor drainage; permanently high water tables; widespread seasonal waterlogging; widespread high run-on; widespread non-cohesive soils; widespread foundation hazard; widespread groundwater pollution hazard	0% to 3%	D	none	pr1	SM	0.046	Type C	I
						pr1	ML	0.050	Type F	C
						pr3	ML	0.049	Type F	C

Table 3. Soil Loss Calculations

Item	Bindook Road and Marulan Soil Landscapes	Gibraltar Rocks	Jaqua and Larkin Soil Landscapes
Recommended K–factor	0.036	0.050	0.082
Site slope gradients	up to 5 % on site	up to 15%	up to 7%
Sediment type	Type D	Type D	Type D
Average annual soil loss [1]	71	550	320
Soil Loss Class	1	5	3
Soil Hydrologic Group	C	D	C/D

1 Likely annual soil loss figures are calculated using the Revised Universal Soil Loss Equation (Appendix 2) and are based on site conditions, where:

- The R–factor is 1,670 as derived from RAINER (Appendix 1)
- K–factors for each soil landscape were derived from Landcom (2004) and the maximum for each landscape or landscape group is used
- LS -factors for each landscape are:
  - Bindook Road and Marulan Soil Landscapes, 3.70
  - Gibraltar Rocks Soil Landscapes, 5.01
  - Jaqua and Larkin (variant a) Soil Landscapes, 1.76
- The P–factor (erosion control factor) is assumed to be 1.3
- The C–factor (cover factor) is assumed to be 1.0 for bare soil on construction areas.

(ii) Ensuring topsoils are stockpiled separately from the subsoils;

(iii) Ensuring newly revegetated lands are fertilised and, if possible, watered until established and the C-factors have dropped to less than 0.05 (Appendix 2);

(iv) Inspecting newly planted areas regularly and, where failures occur, replanting vegetation as necessary. Where areas of localised soil erosion are identified, implementing appropriate measures, such as:

- planting additional stabilising vegetation or wind breaks;
- stabilising soils with mulches or soil binders;
- taking steps to minimise any concentrated stormwater flows.

Should areas of localised poor drainage be identified, undertaking appropriate remedial action such as:

- installing formalised drainage channels or pipes;
- improving soil permeability by cultivating the soil surface;
- improving soil permeability by installing infiltration trenches;
- planting moisture tolerant vegetation in problem areas.

The above soil conservation matters are addressed in more detail in Part 2: *Conceptual Soil & Water Management Plan* .

Part 2

Conceptual Soil and Water Management Plan

(Managing Soil and Water During Establishment)

SEEC

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Part 2 Conceptual Soil and Water Management Plan

2 .1 Introduction

This part and accompanying drawings comprise a conceptual *Soil and Water Management Plan* (*SWMP*) for the site. It shows how soil erosion and sediment pollution can be managed following the guidelines and recommendations in Volume 1 of *Managing Urban Stormwater: Soils and Construction*(Landcom, 2004) (the "Blue Book") and a draft version of Volume 2 of the same text (unpublished). They include:

(i) concept plan drawings showing the locations for best management practices (BMP) measures for the quarry pits, processing plant, haul road and Marulan bypass; and

(ii) written text detailing:

- the installation, monitoring and maintenance requirements for each of the recommended BMPs for erosion and sediment control;
- recommendations for the ongoing adaptation and alteration of the erosion and sediment control plans as the quarry expands.

The *SWMP* assumes a detailed version will be prepared following project approval that is considerate of any conditions imposed and contains detailed drawings of any engineering structures. The detailed *SWMP* will form part of the final engineering design drawings and be documented in any Schedule of Rates or Bill of Quantities.

2 .2 Site Physical Attributes

Various physical attributes relating to the site are described in Part 1. In particular, the reader is referred to the following sections:

- Section 1.2, Topography and Drainage;
- Section 1.3, Land Use and Vegetation;
- Section 1.4, Soil Landscapes.

Special attention is drawn to Table 3 in Section 1.4, Soil Loss Calculations.

2 .3 Soil and Water Management Plan

2 .3.1 General Instructions

(i) Read this Plan together with:

- Drawings 06000725-01 and 06000725-02;
- Parts 1 and 3;
- the engineering plans;
- any other plans or written instructions issued in relation to development at the subject site; and
- Landcom, 2004 (The Blue Book).

(ii) Contractors will ensure that all soil and water management works are undertaken as instructed in this specification and constructed following the guidelines stated in the Blue Book; and

(iii) All subcontractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas.

2 .3.2 Staging

The development is to be constructed in stages in order to limit the amount of land disturbed at any one time. Stages are as follows:

(i) Stage 1 – Securing the quarry site;

(ii) Stage 2 – Construction of the quarry access road, the heavy haul roads, installation of services and construction of buildings, processing area and carparks;

(iii) Stage 3 – Preparation and operation of the quarry;

(iv) Stage 4 – Construction of the Bypass;

(v) Stage 5 – Final landscaping and rehabilitation of the quarry.

Note:

Apart from Stage 5, all stages are to be implemented in sequential order:

(i) Stage 5 should be implemented progressively as works are completed;

(ii) The Quarry Manager should make proactive changes to this plan as unforseen issues arise and in consultation with a suitably qualified consultant.

Refer to Drawings 06000725-01 and 06000725-02. Note that “SD” in the following clauses refers to a Standard Drawing found in Part 4, Appendix 3.

2 .3.3 Stage 1 – Securing the Site

(i) Establish the stabilised site access as marked on the drawing 06000725-01 and following SD 6-14;

Note that the SWMP assumes that access to the site will be confined to Brayton Road.

(ii) Install:

- all barrier fencing to prevent access to restricted areas, including around the drip lines of any significant trees that are to remain during and after construction;
- all sediment fencing following SD 6-8 to trap sediment and establish the stockpile sites. Stockpiles are to be constructed following SD 4-1;

Note that, for the most part, sediment and barrier fencing effectively delineates the inner boundaries of "no disturbance" areas. They should be placed no further than 5 metres (preferably 3 metres) from the edge of any essential construction activity.

(iii) Install earth banks EB4, EB5 and EB6 to deflect clean water away from the roadworks (SD 5-6 and Drawing 06000725-01);

(iv) Strip and stockpile topsoil from areas to be disturbed by the construction of WQCP's 1, 3, 4, and 5 and Sediment Basin 2. Stockpiles are to be established as marked or in other locations deemed suitable by the site supervisor providing they conform the general principles outlined in SD 4-1;

(v) Build WQCP's 1, 3, 4 and 5 and Sediment Basin 2 and their outlet structures following the engineering plans. Stabilise the areas once construction works are completed following Clause 2.4.3; and

(vi) Install Earth Banks (High Flow), EB1, EB2, and EB3 (SD 5-6 and Drawing 06000725-01). Note;

- the actual location of EB1 can vary from that shown on the drawing. It should be placed to allow for the first two years of quarry operation while minimising its footprint. It will move southwards progressively as the footprint enlarges – the subject of one of more subsequent SWMPs;
- ensure all earth banks outlet their concentrated flow in a non erodible manner;
- EB 2 drains to WQCP 5;
- EB 3 drains to WQCP 1.

2 .3.4 Stage 2 – Construction of Quarry Access Road, Heavy Haul Roads and Installation of Services

(i) Strip and stockpile topsoil from areas to be disturbed by roadworks, buildings, the crushing and screening plant and carpark construction. Stockpiles are to be established as marked or in other locations deemed suitable by the site supervisor providing they conform to the general principles outlined in SD 4-1;

(ii) Following the engineering plans, undertake earthworks for all roads, including their swales (Part 3) and installation of services (phone and electricity) and fuel tanks, and construct the buildings, carparks and the crushing and screening plant as required. Note that;

- the *Water Cycle Management Plan* requires the installation of a catch drain east of the access road that outlets to piped drainage under the road and discharge through level spreaders. While these pipes and level spreaders can be built now, they should be blocked until required later;
- the area surrounding the crushing and screening plant should be finished with a very low erosion hazard surface, such as crushed hard rock, excavated during the construction of the WQCP's.

(iii) During the works described in Clause 2.3.4 (ii), above, ensure that all stormwater from disturbed lands drains to a suitable sediment retention structure. Construct additional diversion drains as might become necessary under the direction of the Quarry Manager;

(iv) Once works are complete in each area, progressively stabilise the site following Clause 2.4.4 using stockpiled materials from S3, S4 and S5. Any surplus materials left in stockpiles S1 or S3 can be stored in S4 or S5 for later rehabilitation of the lands south of the office buildings;

(v) When all lands north and east of the office buildings are stabilised, remove all sediment and barrier fencing in that area;

(vi) When the likelihood of tracking sediment onto Brayton Road becomes very low, remove the stabilised accesses and complete the road surfaces in those areas.

2 .3.5 Stage 3 – Preparation and Operation of the Quarry

(i) Strip and stockpile topsoil and overburden from areas to be disturbed by the first 12 months operation of the quarry. Stockpiles are to be established as marked (S1 and S2) or in other locations deemed suitable by the Quarry Manager providing they conform the general principles outlined in SD 4-1. Ensure topsoil (S1) and overburden (S2) stockpiles are kept separate;

(ii) Note Clause 2.3.3 (vi) in relation to the construction and operation of EB1. Ensure EB 1 is fully operational and diverting "clean" upslope overland flows away from lands to be disturbed by the initial operation of the quarry;

(iii) Implement all the site works required by SEEC Morse McVey's *Water Cycle Management Plan* for the site; and

(iv) Begin quarry operation. Initially the works should ensure the effective construction and operation of WQCP 6, which is to remain fully operational through the life of the quarry.

2 .3.6 Stage 4 – Construction of the Bypass

(i) Establish the stabilised site access as marked on the drawing 06000725-02 and following SD 6-14;

(ii) Strip and stockpile topsoil from areas to be disturbed by roadworks. Stockpiles are to be constructed following SD 4-1;

(iii) Install:

- all barrier fencing to prevent access to restricted areas, including around the drip lines of any significant trees that are to remain during and after construction;
- all sediment fencing following SD 6-8 to trap sediment and establish the stockpile sites.

(iv) Following the engineering plans, undertake earthworks for all roads (including their swales (Part 3));

(v) Unless special measures are adopted, work on the Jaorimin Creek crossing can only occur during the period 1 April to 30 September, when the likelihood of heavy rain is least (refer to Table 4.3, Landcom, 2004);

(vi) Work on the Jaorimin Creek crossing will require a specific SWMP to show how erosion will be controlled. The SWMP will reflect the detailed engineering requirements;

(vii) Once works are complete in each area, progressively stabilise the site following Clause 2.4.4 using stockpiled materials.

2 .3.7 Stage 4 – Site Cleanup, Landscaping and Rehabilitation

(i) When works are complete, remove the buildings, the crushing and screening plant, car park and haul roads other than the Marulan Bypass; and

(ii) Progressively rehabilitate the site by revegetation following the *Landscape Plan*. Ensure all topsoil stored at the site is reused in this process (SD 4-2 and SD 7-1). A self sterile cover crop might be required for erosion control in certain areas before establishment of the final plant mix. Note especially the requirements of Clause 2.4.4.

2 .4 Erosion Control

2 .4.1 General Conditions

(i) Site disturbance will be limited in extent and nature to that described in this *SWMP*;

(ii) Development works will be undertaken in stages to facilitate the implementation of this *SWMP*;

(iii) Works will proceed according to the timing requirements detailed in Section 2.3.2;

(iv) Barrier and sediment fencing will be erected to minimise disturbance by preventing vehicular and pedestrian access to restricted areas;

(v) While cut and fill will generally be minimised throughout, any batters will not exceed gradients of:

- 2.5(H):1(V) on easterly and southerly-facing slopes;
- 3(H):1(V) on northerly and westerly facing slopes.

(vi) Vehicular access to disturbed lands will be confined to that essential for construction work.

2 .4.2 Land Disturbance

(i) The soil erosion hazard on the site will be kept as low as practicable by minimising land disturbance. Some ways of doing this are outlined in Table 4;

Table 4 General access limitations for site areas

Land use	Limitation	Comments
Construction areas	Limited to 5 (preferably 2) metres from the edge of any essential construction activity as shown on the engineering plans	All site workers should clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope) or similar materials.
Access areas	Limited to a maximum width of 5 metres	The Quarry Manager will determine and mark the location of these zones on site. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries
Remaining lands, including revegetation areas	Entry prohibited except for essential management works	Thinning of growth might be necessary, for example, for fire reduction or weed removal

(ii) Limit disturbance to that essential for works being undertaken at any given time. Limit access to other areas through the use of barrier or sediment fences;

(iii) Before construction activities begin, topsoil materials will be stripped to a depth of approximately 150 mm (if possible) and stockpiled; and

(iv) Stockpiles of topsoil (SD 4-1), and other building and landscaping materials, will be at least five metres from areas of likely concentrated or high velocity flows especially earth banks and roads. If necessary, low flow earth banks (SD 5-5) or drains will be constructed to divert localised run-on.

2 .4.3 Site Stabilisation

(i) Progressively stabilise any disturbed areas using appropriate erosion control measures;

(ii) While C-factors (Appendix 2) are likely to rise to 1.0 during the work's program, they must not exceed those given in Table 5;

Table 5 Maximum acceptable C-factors at nominated times during works

Lands	Maximum *C*-factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows will be limited to those shown in Table 5.1 of the Blue Book. Foot and vehicular traffic will be prohibited in these areas
Stockpiles, post construction	0.1	Applies after ten working days from completion of formation. Maximum *C*-factor of 0.10 equals 60% ground cover
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later. Maximum *C*-factor of 0.15 equals 50% ground cover

(iii) In the short term, the requirements of Table 5 can be achieved, for example:

- in areas exposed to sheet flow, with a temporary vegetative cover — a suggested listing of suitable plant species is shown in Table 6 (note, these plants only protect the ground surface for up to six months). Other temporary options include the use of a suitable soil binder, e.g. Terra-Control® or equivalent;

Table 6 Plant Species for Temporary Cover

Growing Season	Seed Mix
Autumn / Winter	oats @ 40 kg/ha Japanese millet @ 10 kg/ha
Spring / Summer	Japanese millet @ 20 kg/ha oats @ 20 kg/ha

- in areas exposed to concentrated flow (e.g. diversion banks and waterways) where stabilisation is to be undertaken by temporary means the requirements of Table 5 can be met by stabilising with hessian cloth tacked with a soil binder, such as anionic bitumen emulsion (0.5 L/m^2). Also, see Table 5.2 in the Blue Book. Apply soil binders following the manufacturer's instructions. Materials to be used will be specified in the detailed SWMP;

(iv) On completion of all major works and before revegetation, disturbed soils will be left with a loose surface to encourage water infiltration and help with keying topsoil later (SD 4-2); and

(v) Site landscaping will be undertaken as soon as possible and within 15 working days from completion of construction activities. This will include revegetation to provide a quick, temporary cover before a more permanent cover is established.

2 .4.4 Topsoil Replacement - General Conditions

(i) If possible, the blue book requires topsoil will be replaced to a minimum depth of 75 mm in all areas subjected to disturbance and requiring permanent vegetative stabilisation;

(ii) If the stockpiled topsoil volume is insufficient to permit this it may either:

- be extended by incorporating composted mulch or other organic material; or
- be reduced to 50 mm and supplemented with a thick biodegradable matting (300 gsm).

(iii) Ideally, handle topsoil only when it is moist (not wet or dry) to avoid decline of soil structure;

(iv) Disturbed areas that have been compacted by construction work should be deep ripped to greater than 200 mm along the contour to help keying of topsoil later and aid moisture infiltration and root penetration (see SD 4-2);

(v) Leave topsoil in a scarified or ploughed condition once replaced to help moisture infiltration and reduce soil erosion;

(vi) Avoid compaction of recently topsoiled areas by construction equipment.

2 .4.5 Revegetation - General Conditions

(i) Where practical, phase works so that:

- minimal lands are exposed to the forces of soil erosion at any one time;
- site stabilisation measures are progressively installed throughout the development phase, i.e. progressive revegetation; and
- Successful revegetation of lands, a principal stabilisation technique, requires:
  - availability of acceptable soil materials;
  - correct site preparation (see SD 4-2 and SD 7-1);
  - selection of the most suitable establishment technique
  - selection of appropriate plant species, fertiliser(s) and ameliorant(s);
  - application of sufficient water for germination and to sustain plant growth if rainfall is insufficient;
  - an adequate maintenance program.

Suitably qualified persons will be contracted for advice on the above issues.

2 .4.6 Earth Banks/Waterways

(i) All earth banks (high flow) will be constructed to be stable in at least the 10-year ARI, t_c event. Spillways in sediment basins and WQCP's will be designed to be stable in the 100-year ARI, t_c event. Erosion control materials used are to be specified on the detailed SWMP;

> Design to other events, such as the 100-year ARI, 24-hour event for spillways and the 20-year ARI, 24-hour event for earth banks are lower standards and do not meet the requirements Landcom (2004).

(ii) Unless they outlet to a sediment basin, a level spreader (SD 5-6) or other energy dissipater will be built with all earth banks to return concentrated flows to sheet flow. Lands downslope of the level spreaders must be stabilised with vegetation to prevent scouring; and

(iii) During road construction temporary earth diversions (SD 5-5) should be provided at a maximum spacing of 80 metres during rainfall to reduce the slope length that stormwater can travel over bare soil.

2 .4.7 Trenching

(i) Where practicable, the various service and drainage connections will be coordinated so that common trenching can be used;

(ii) Where practicable, the time trenches are open will be limited to less than five working days;

(iii) Where possible, place spoil on the uphill side of trenches to divert water flow away from the trench line (SD 9-1). Alternatively, use temporary bunds for similar effect; and

(iv) Trenches will be backfilled with subsoil and compacted to 95 per cent Standard Proctor. The final layer of topsoil will be slightly proud of the surface and will be seeded.

2 .4.8 Other Aspects

(i) Approved receptacles for concrete and mortar slurries, paints, acid washings and litter will be provided and arrangements made for collection and disposal; and

(ii) Roof stormwater will be connected to the rainwater tank system with their overflow directed to a stable outlet.

2 .5 Pollution Control

(i) Stabilised site accesses will be installed to all areas that are subject to disturbance and accessed from public, sealed roads;

(ii) Sediment fencing (SD 6-8) and other sediment traps will be installed as shown on the drawings or elsewhere at the discretion of the Quarry Manager to retain the coarser sediment fraction;

(iii) Sediment Basin 2 is designed for *Type D* soils to collect sediment laden runoff in the 80th percentile, 10-day rainfall depth (32 mm) [1] from the access road. It will have the following characteristics:

- Settling zone of 735 m^3
- sediment storage zone of 70 m^3
- total volume = 805 m^3

(iv) The other basins will become WQCP's and so will be built to the requirements of Part 3 of this report. This is because the volume requirements for a WQCP are greater than those calculated using the 80th percentile, 10-day rainfall depth. Their sediment storage volumes during the construction phase are (Appendix 4):

- WQCP1 = 100 m^3
- WQCPs 3 & 4 = 10 m^3
- WQCP 5 =45 m^3

(v) The trapped water will be tested for concentration of suspended solids. If that level is less than 50 mg/L it may be discharged straight to creek;

(vi) If the level of suspended solids is greater than 50 mg/L (more likely) then the basins will be flocculated (Appendix 5) before discharge occurs (unless the design storm event is exceeded);

(vii) Drain all basins following significant storm events and flocculation to regain design capacity. Do so within eight days of the storm event to the lower level of the sediment settling zone;

(viii) Place one or more pegs on the floor or side walls of WQCP's 3, 4 and 5 and Sediment Basin 2, to clearly indicate where the base of the settling zone and the upper limit of the sediment storage zone occurs. Ensure sediment is removed whenever sediment in the storage zone encroaches on the settling zone;

(ix) At this stage all basins will have two outlets:

- an emergency overflow (spillway) designed following SD 5-6 for

1 The 80th percentile is adopted due to the sensitivity of receiving waters and the 10-day period is adopted to allow time for flocculation of trapped water and its subsequent discharge.

earth banks (high flow). It will terminate at an energy dissipater to return flows to sheet flow. The energy dissipater will be sized in a detailed SWMP;

- an outlet for use during the construction stage only. This will be a floating outlet with pump, used to dewater the basin after flocculation that will deliver waters to the energy dissipater.

(x) Sediment removed from any trapping device will be disposed in locations where further erosion and consequent pollution to downslope lands and waterways will not occur;

(xi) Acceptable receptacles will be provided as required, for concrete and mortar slurries, paints, acid washings, lightweight waste materials and litter;

(xii) Safe storage areas will be provided for fuels, oils, paint, poisons, fertilisers, chemicals and other hazardous materials.

2 .6 Site Monitoring and Maintenance

Following the guidelines set out in the Blue Book, site monitoring will be undertaken during and after construction.

(i) Waste receptacles will be emptied as necessary. Disposal of waste will be in a manner approved by the Quarry Manager;

(ii) A self-auditing program will be initiated for the site. The Quarry Manager will inspect the site at least weekly and maintain a log of inspections, paying particular attention to:

- removal of spilled soil or other materials from near hazard areas;
- removal of trapped sediment from sediment fences;
- the stability of all sediment fences;
- ensuring barrier fencing is maintained and exclusion zones are being observed by all site workers and contractors;
- ensuring progressive and prompt rehabilitation of lands and that rehabilitation has effectively reduced the erosion hazard — initiate upgrading or repair as appropriate;
- constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved, i.e. make ongoing changes to the *SWMP*;
- maintaining erosion and sediment control measures in a functioning condition until all earthwork activities are completed and the site is rehabilitated;
- removal of trapped sediment and disposal to safe areas;
- removal of temporary soil conservation structures as the last activity in the rehabilitation program.

(iii) A rain gauge will be installed at the site and will be monitored by the Quarry Manager to determine the severity of any rain events (refer to Appendix 1);

(iv) Revegetation areas will be inspected regularly to investigate failures. Replant as necessary;

(v) An adequate watering and fertilising system will be maintained in revegetation areas;

(vi) Areas of localised soil erosion will be identified and appropriate preventive measures implemented. These might include:

- planting additional stabilising vegetation or wind breaks;
- stabilising soils with mulches or alternative soil binders;
- taking steps to minimise any concentrated stormwater flows.

(vii) Any areas of localised poor drainage will be identified and appropriate remedial action taken. This might include:

- installing formalised drainage channels or pipes;
- improving soil permeability by cultivating the soil surface;
- improving soil permeability by installing infiltration trenches;
- planting moisture tolerant vegetation in problem areas.

(viii) The first time waters are to be discharged, at least one sample will be sent to a NATA-registered laboratory for analysis first to ensure that the 50 mg/L level is being met. Further, a sample will be calibrated to the 50 mg/L level and returned to the site so a visual assessment can be made in future to ensure the criterion is being met. The sample should contain a small quantity of a chemical dispersing agent to prevent settling;

(ix) Check the basin outlets for stability and check the operation of all pumps.

2 .7 References

Landcom (2004). *Managing Urban Stormwater: Soil and Construction*. 4th Edition. NSW Government.

Part 3

Conceptual Water Cycle Management Plan

(Managing Soil and Water During Operation)

3 .1 Introduction

This conceptual Water Cycle Management Study (WCMS) includes:

- an investigation into the existing water cycles at both the quarry site and the new by-pass and an assessment on how the proposed developments will affect the management of those systems;
- a plan for managing the water cycles to achieve a neutral or beneficial effect on the quality of water leaving the site.

It is conceptual at this stage and assumes that the recommendations made will be included in the final engineering plans for the site.

The site is within the area administered by the Sydney Catchment Authority (SCA), which requires that all developments demonstrate a neutral or beneficial effect (NORBE) on receiving waters (*Drinking Waters Catchments Regional Environmental Plan No 1 (REP1)*). It is within the Wollondilly River catchment, which makes up part of the Warragamba Dam catchment.

The Warragamba Catchment Blueprint was published in 2003 and provides catchment and management targets for land and water management. These targets cover areas such as:

- soil and land condition (aim to use lands within their capability);
- river health (aim to improve river health);
- terrestrial biodiversity (aim to conserve biodiversity in priority areas);
- community involvement (aim to inform and involve the community in catchment management).

3 .2 Site Description

3 .2.1 Soils

Soils and Geology are discussed in Part 1.

3 .2.2 Climate and Erosion Potential

Marulan has a temperate climate, with warm summers and temperatures below 15°C in winter. According to the Australian Bureau of Meteorology, it receives a mean annual rainfall of about 650 mm and experiences approximately 1,277 mm mean annual evaporation (Goulburn data). Rainfall is fairly evenly distributed throughout the year, but with a peak in November and trough in July; evaporation is greater in late spring and summer. The estimated rainfall erosivity is low (R-factor of 1,680, see Appendix 1). C_{10} for the geographic area is 0.5 (undisturbed land).

3 .2.3 Topography

Both the quarry site and the alignment of the new bypass are typified by undulating rises and valleys between low hills with slopes ranging from 2 to 10 percent and rising to 680 m AHD in the southwest corner of the quarry site. There are rock outcrops on crests and many surface cobbles in some areas. The aspect varies with ridge lines and contours.

3 .2.4 Watercourse, Dams and Wetlands

3 .2.4.1 Watercourses

(a) The Quarry Area

There are two creek systems in the main quarry area, separated by the ridge that will become the quarry area (extraction and processing). Both flow in a southwest to northeast direction. The northernmost creek is Chapmans Creek, which is a third order stream from about directly north of the proposed Water Quality Control Pond 1 (WQCP 1). From this point it approximately forms the northern boundary of the site (Drawing number 06000725-02). The proposed access road does not cross Chapmans Creek but it does come to within 50 m of it near to the site entrance. No other works are proposed within 50 m of Chapmans Creek except for the outlet to WQCP 1.

The former DNR undertook a Riparian Corridor Objective Setting (RCOS) exercise in this general area and classified Chapmans Creek as a Category 2 stream – Terrestrial and Aquatic Habitat Classification. This has implications for any proposed Riparian re-vegetation (3.4.1.11).

An unnamed second order stream is approximately parallel to the eastern boundary. It joins Chapmans Creek near to the proposed quarry entrance. The proposed access road crosses this watercourse, about 450 m from the site entrance (3.3.2). This watercourse is not classified in DWE, 2007.

The Department of Water and Energy (DWE) have confirmed that neither of these watercourses are prescribed streams. Eventually, they drain into the Wollondilly River and, ultimately, into Warragamba Dam so they are part of Sydney's Drinking Water Catchment.

(b) The Bypass

The bypass crosses two watercourses (Section 3.3.2). One is a small depression/ watercourse but the other is Jaorimin Creek, which is a fourth order stream. Jaorimin Creek is also classified as a Category 2 stream by the RCOS. Jaorimin Creek eventually joins Chapmans Creek, the former keeping the name.

3 .2.5 Harvestable Rights

There are six small farm dams on the quarry site and the harvestable right multiplier for the property is 0.08 ML/ha. However, the harvestable right for this proposal does not apply because:

- (i) the quarry site is 231 ha and so the total harvestable right is 18.4 ML. The sum of the existing dams is less than this;
- (ii) all WQCPs are either offline or on minor watercourses only (first or second order streams); and
- (iii) all dams will be constructed for environmental purposes only.

There are no wetlands on the site.

3 .2.6 Recharge/Discharge Areas, Salinity

3 .2.6.1 The Quarry Area

The Bindook Road Soil Landscape is described as having localised saline recharge and saline discharge areas, depending on the landscape facet. Recharge would occur on the higher lands but, as soils are generally shallow and the bedrock generally impermeable, discharge will occur in the drainage lines on the same site. Localised occurrences of high groundwater, saturated soils and poor drainage all occur. Groundwater can be very saline in this soil landscape but, despite this, our site investigation did not show any surface signs of salinity (Table 1, Part 1).

3 .2.6.2 The By-Pass

Much the same comments apply to the Jaqua Soil Landscape that occurs under most of the proposed bypass alignment. There were no signs of salinity at the time of inspection.

3 .2.7 Current Land Use and Vegetation

The present land use for both the quarry site and the proposed by-pass is agricultural (livestock grazing). Mostly, the lands are vegetated with native and improved pasture grasses including some broadleaved weeds. They have been cleared extensively of native vegetation, with some small patches of highly disturbed remnant woodland remaining. Figure 1 shows the current tree cover.

3 .2.8 Current Water Quality

Investigations were undertaken between January and July 2007 at monthly intervals to establish baseline data for Chapmans Creek – six sample sets were taken from sites

Sample-I, Sample-D and Sample-O (figure 9). The data were analysed by VGT Pty Ltd, a NATA-Registered laboratory and the results are at Appendix 9. They show that the present water quality of Chapmans Creek is good and provide baseline data on existing water quality.

Figure 9 – Location of current water quality sampling

3 .3 Identifying Future Water Quality Issues

3 .3.1 Land Surface Changes

3 .3.1.1 The Quarry Site

Just now the entire quarry site is agricultural land, there is only a small amount of native woodland (1.5 ha). Post development some of these lands will become:

(i) 1,800 m of access road, 8 m wide sealed pavement, two one metre wide verges and drainage structures (swales). Contained within a 20 m wide corridor that will be 50 percent impervious.

(ii) 800 m of unpaved heavy haul roads, 15 m wide and with swales. Contained within a 20 m wide corridor that will be 75 percent impervious.

(iii) A heavily disturbed area of about 7 hectares around the crushing plant and the stockpiling areas. It is estimated to become 90 percent impervious.

(iv) A heavily disturbed area of about 1 ha that will have the offices/workshops/car park/hardstand etc. This area is estimated to become 80 percent impervious.

(v) The extraction area itself (ultimately 6 ha). This area will be internally draining, with stormwater collected within its confines. Rainwater that falls on it will evaporate or be used for irrigating pasture (3.4.1.5).

(vi) The out-of-pit overburden emplacement and a haul road to it. This will be actively used only at the beginning of the quarry works. Eventually the overburden is replaced into the quarry area itself.

3 .3.1.2 Proposed By-Pass

The majority of the new by-pass will cross land that is currently used for grazing. The exception is a 150 m stretch near to Brayton Road that is currently woodland. The road will be contained within a 20 m easement and will be 10 m wide with a 8 m wide sealed surface. Its total length is 1,800 m and so 3.6 ha of agricultural land will become road easement, 50 percent impervious (the small bit of woodland is ignored in the computer modelling).

3 .3.2 Connection to Receiving Waters

3 .3.2.1 Roads

(a) The Quarry Access Road

For the purpose of modelling, the access road is considered to be connected to receiving waters only where it is within 50 m of a watercourse. Elsewhere, we have assumed that a 50 m buffer of well vegetated lands is sufficient to treat pavement runoff before it reaches those waters. Effectively, this means the quarry access road is modelled "connected" to receiving waters for its first 250 m (i.e. where it is parallel to Chapmans

Creek) and then for lengths of 150 m and 50 m east and west of the tributary of Chapmans Creek respectively.

Where the access road crosses the tributary of Chapmans Creek about 400 m from the entrance, the estimated catchment is 151 ha giving a t_c of 53 min and an estimated 100-year ARI storm flow of 19.5 m^3/sec.

(b) The Bypass

The bypass crosses two watercourses:

- (i) Jaorimin Creek. A fourth order stream that has a catchment of about 870-900 hectares. Here, the estimated 100-year flow is about 110 m^3/sec and the road is considered connected to it for 50 m either side; and
- (ii) A small watercourse to the east of Jaorimin Creek that has a catchment of about 38 ha. Here, the estimated 100-year flow is about 6.7 m^3/sec and the road is considered connected to it for 100 m either side.

3 .3.2.2 The Quarry Area

(a) The Processing Area, offices etc.

All this area is considered connected to receiving waters as the runoff from it will be concentrated and directed to WQCP 1, which outlets to Chapmans Creek.

(b) The Extraction Area

The extraction area will be disconnected for receiving waters as it will be internally draining.

3 .3.3 Domestic Onsite Wastewater Management

The site is not connected to reticulated sewer and must treat and dispose domestic wastewater onsite. Domestic wastewater will be derived from the administration block and the maintenance sheds.

3 .3.4 Storage of Chemicals, Fuel, Machinery etc.

3 .3.4.1 Chemicals

Chemical use on the site will be low and will be restricted to detergents and possibly fertilizers. Chemicals are not required for the quarrying or processing works.

3 .3.4.2 Gypsum

Gypsum will be stored as a flocculent.

3 .3.4.3 Fuels/Oils

Fuel, machinery oil and hydraulic fluids will be stored on site.

3 .3.4.4 Machinery

Oils and fluids might leak from heavy machinery.

3 .3.5 Stockpiles

Crushed rock and overburden will be stockpiled.

3 .3.6 Dust

Dust is an obvious issue and Gunlake have commissioned Heggies P/L to address it.

3 .3.7 Water Demand

3 .3.7.1 At the Crushing Plant

Water will be required for the crushing plant as follows:

(i) Atomised water dust suppression at all discharge points (stockpiles);

(ii) Atomised dust sprays at tipping point into apron feeder; and

(iii) Atomised dust sprays at primary crusher input and discharge.

The operator estimates that 3.2 L will be used for every tonne of material produced. At peak production (500,000 tonne/year) this is 1.6 ML/year (equivalent to about 4,500 L/day). This water will be lost from the watercycle as it will evaporate or adhere to the gravel.

3 .3.7.2 Dust Suppression on the Major Haul Roads and Hardstands

The heavy haul roads and gravel hardstand areas around the offices/sheds will require dust suppression. There will be approximately 1.5 ha of haul roads and 1 ha of other gravel-paved hardstand areas around the offices/sheds etc.

Water required for dust suppression can be split into two components:

(i) An amount based on the difference between mean rainfall and mean potential evapotranspiration;

To estimate this we have done a water balance that uses mean monthly rainfall and mean potential evapotranspiration data (from nearby Goulburn) (see Section 3.3.7.3 below); and

(ii) An allowance of 2 mm per non-rainy day to allow for increased evaporative loss due to truck movements and to infiltration loss into the unpaved surface.

To estimate this demand we have assumed that Marulan (Goulburn) has 105 rainy days a year, i.e. 260 dry days a year. So, on average, if 2 mm is used per dry day over 25,000 m^2 this is an annual demand of 13 ML. The design spreadsheet uses daily data and so 35,000 L/day is adopted.

3 .3.7.3 Irrigating Pasture

Because of the increase in impervious surfaces there will be an increase in stormwater volume at this site. The increase is more the combined use at the crushing plant and for dust suppression as discussed above. Therefore, to use the extra water, it is proposed to irrigate some pasture on the site. At least 10 hectares of land will be set aside for this purpose.

Assuming that mean irrigation demand is equal to the difference between mean rainfall and mean evaporation, we undertook a balance to determine irrigation demand. Based on 10 hectares of pasture the total annual demand for irrigation is about 50 ML per year.

Total Requirement

Summarising the total quarry water demand:

The mean daily use for the quarry is taken at 4,500 L plus 35,000 L (39,500 L/day). To this is added the irrigation demand on the haul roads and the 10 ha of pasture. The result is given in Table 7. The total demand is 71.8 ML/year. This water will be drawn from WQCP 1 and so data from Table 7 is used in the MUSIC model at Section 3.5.4.3 .

Table 7 – Daily Water Balance for Crushing plant, Dust Suppression and Pasture Irrigation (mean data).

	Rainfall	PET	Days	Daily rain	Daily PET	Irrigation demand	Daily Demand (L)	weekly irrig demand	Monthly demand irrig only (L)	Irrig plus constant	Monthly (irrig and constant)	Daily multiplier to use in RATES	% of annual (for MUSIC)	% of irrig total
January	65	155	31	2.1	5.0	2.9	333500	2334500	10338500	373000	11563000	9.4	16	18
February	54	135	28	1.9	4.8	2.9	333500	2334500	9338000	373000	10444000	9.4	15	16
March	56	105	31	1.8	3.4	1.6	184000	1288000	5704000	223500	6928500	5.7	10	10
April	57	75	30	1.9	2.5	0.6	69000	483000	2070000	108500	3255000	2.7	5	4
May	53	50	31	1.7	1.6	-0.1	0	0	0	39500	1224500	1.0	2	0
June	49	40	30	1.6	1.3	-0.3	0	0	0	39500	1185000	1.0	2	0
July	45	40	31	1.5	1.3	-0.2	0	0	0	39500	1224500	1.0	2	0
August	59	55	31	1.9	1.8	-0.1	0	0	0	39500	1224500	1.0	2	0
September	52	85	30	1.7	2.8	1.1	126500	885500	3795000	166000	4980000	4.2	7	7
October	54	120	31	1.7	3.9	2.1	241500	1690500	7486500	281000	8711000	7.1	12	13
November	69	135	30	2.3	4.5	2.2	253000	1771000	7590000	292500	8775000	7.4	12	13
December	54	150	31	1.7	4.8	3.1	356500	2495500	11051500	396000	12276000	10.0	17	19
TOTALS	**667**	**1145**							**57373500**	**L/year**	**71791000**	**L/year**		
Area to be irrigated:		115000	sqm	IRRIGATION OF 10 HECTARE PASTURE AND DUST SUPRESSION ON ROADS AND HARDSTANDS										
Constant use:		39500	L/day	2 MM PER DAY FOR DUST SUPPRESSION ON NON-RAINY DAYS AND 4500 L IN PROCESSING PLANT.										
Figure for multiplier:		39500	L/day	For Rates										

3 .3.7.4 Domestic Water for the Offices etc.

There will be 20 staff at the site. They will have access to toilets, showers and a kitchen. Their daily use is estimated at 50 L/day/person (NSW Health, 2001). This is a daily use of 1,000 L, all of which will be sourced from rainwater tanks and all of which is assumed to become wastewater and leave the water cycle by evapotranspiration and percolation.

3 .3.7.5 Truck Washing

Semi trailers will be washed on site before they leave. This will be done by spray washing the vehicles as they leave the site. Water will be sourced from WQCP 1 and runoff will be collected and conveyed back to it. Therefore, the majority of this water will not leave the water cycle. Any loss is considered minor and has not been modelled.

3 .4 Proposed Water Cycle Management Plan

3 .4.1 The Quarry Site

3 .4.1.1 Soil and Water Management During Establishment

Refer to Part 2.

3 .4.1.2 Long-term Stormwater Control, The Quarry Access Road

(i) Ensure that EB's 4, 5 and 6 (Part 2) are functioning and stable. These divert clean water away from the proposed access road.

(ii) Build the quarry access road with in-fall drainage so the pavement drains back towards the cut face where there will be a grass-lined swale.

(iii) The upslope swale is conceptually sized as:

- base width = 0.3 m
- side slopes 3:1
- depth = 0.3 m
- top width = 2.1 m
- slope = 3 to 5 percent

(iv) Establishing a good cover of vegetation in the base of the swale is important and will require the use of a locally derived, drought resistant, native species. Establishing the vegetation will be helped by using a biodegradable mat (jute or coir).

(v) The swale will promote some infiltration into the soils (5 mm/day adopted) but this will be slight as its base will, most likely, be on low permeability clay subsoils. The vegetative cover will provide for nutrient uptake and sediment filtering.

(vi) For most of the road's length, flow will be collected in pits at every 50 m and piped back under the pavement, where it will discharge onto well-vegetated areas via an energy dissipater or level spreader. From here the runoff will flow onto a buffer of at least 50 m of well vegetated land between the road and Chapmans Creek.

(vii) The exceptions to (vi) are where the road is considered to be connected to receiving waters (Section 3.3.2) . This occurs at three locations:

- for the first 250 m of access road from the entrance;
- for 200 m east of the tributary to Chapmans Creek;
- and for 50 m to the west of the tributary to Chapmans Creek.

Stormwater from these three lengths of road will be collected upslope in the swale but then directed to a series of Water Quality Control Ponds before it is released (Drawing number 06000725-02).

(viii) Convert Sediment Basin 2 to WQCP 2

(ix) WQCP's 2, 3 and 4 are conceptually sized at:

- plan area = 10 m x 20 m
- Side slopes 2:1
- Extended detention depth = 0.5 m
- Total depth = 2.0 m
- Trickle outflow equivalent to a 20 mm pipe set at the base of the extended detention depth

3 .4.1.3 Long-term Stormwater Control, Heavy Haul Roads, Processing Area, Offices.

(i) Grass-lined swales will be used to divert run-on away from the disturbed areas (refer to Part 2).

(ii) Grass-lined swales SW4, SW5a and SW5b will also be used to convey dirty water from the heavily disturbed areas to Water Quality Control Pond 1 (WQCP 1). WQCP 1 will have a total catchment of 10.68 ha.

Excluding the sediment forebay, WQCP 1 will have the following conceptual characteristics:

- 75 m x 75 m (area 5,625 m^2)
- side slopes 3:1
- depth = 2 m
- extended detention depth = 0.5 m
- permanent storage = 9,250 m^3
- extended detention outlet equivalent to a 75 mm pipe set at the base of the extended detention depth.

The pond will have a stable outlet designed for the 100-year ARI storm event (estimated at 6 m^3/sec).

(iii) Water will be sourced from WQCP1 for:

- use in the processing plant (Section 3.3.7.1);
- dust suppression on the heavy haul roads and other unpaved hardstand areas (Section 3.3.7.2);
- Truck washing (section 3.3.7.5); and
- Pasture irrigation (Section 3.3.7.3).

(iv) To determine daily irrigation demand for the hardstand areas and the pasture it will be necessary to:

- monitor daily rainfall and to obtain evaporation data from the Bureau of Meteorology, Goulburn weather station; and
- Calculate daily demand calculations based on readily available irrigation demand methods (NSW Dept. Agriculture can help here).

For the purpose of this study, a balance has been done using an in-house daily rainfall spreadsheet known as RATES (Appendix 7), Table 8. Assuming:

- a catchment area of 10.68 ha;
- a rainfall runoff coefficient of 0.75;
- an average daily use of 39,500 L for dust suppression and crushing; and
- that mean irrigation demand is difference between mean potential evapotranspiration and mean rainfall.

RATES shows that the pond would fully meet the water demand of the quarry operation. However, when combined with irrigating 10 ha of pasture, it would meet the total demand only 72 percent of the time. This means it will not always be possible to irrigate the pasture but as this is not an operational requirement this is not an issue.

3 .4.1.4 Dust Control, Other Requirements

(i) A truck-washing bay will be provided so that all trucks are sprayed before they leave the site. Water will be sourced from WQCP 1 and drainage will be diverted back to it.

(ii) Trucks will be appropriately covered with tarps.

3 .4.1.5 Long-term Stormwater Control, The Extraction Area

(i) The extraction area and WQCP 6 will protected from run-on by earth diversion banks (Part 2). The extraction area will be internally draining, i.e. it will be disconnected from receiving waters. Therefore, the only water that it will trap will be from incidental rainfall and some groundwater seepage (although this is expected to be slight). The extraction area will be open to evaporation.

For the purpose of design, the extraction area can be divided up into a number of stages (e.g. four 1.5 ha stages). Each 1.5 ha stage will trap (mean) 10 ML per year (15,000 m^2x 0.650 m).

Table 8 – RATES Water Balance for WQCP 1

Morse McVey & Associates	
Site Location:	Gunlake
Input Statistics	
Rainfall Station:	0
Station Location:	Goulburn
Length of model run:	96.64 yrs (35,297 days)
Avg annual rainfall (mm):	665.72
Avg number of rain days/year:	105
Maximum 24 hr rainfall (mm):	136.1
Longest dry spell (days):	41
Runoff coefficient to rainwater tank:	0.75
Runoff coefficient to stormwater tank:	0
Rainwater Tank Statistics	
Rainwater tank volume (L):	10,000,000
Roof area to tank (sqm):	106,500
% full at model startup:	1
Mains top-up threshold (%):	0
Mains daily top-up amount (L/day):	0
Overflow to stormwater tank?	No
Total inflow to rainwater tank (excl top-up) (L):	5,138,782,088
Total supplied from rainwater tank (L):	1,008,642,230
Total overflow from rainwater tank (L):	788,179,213
No. of days rainwater tank overflowed:	1,490
Max overflow event from rainwater tank (L):	10,122,613
Total amount of mains top-up (L):	0
Longest period that tank ran dry (days):	83
% of time demand from rainwater tank met:	72.34
Avg annual supply from rainwater tank (L):	10,437,048
Avg annual overflow from rainwater tank (L):	8,155,780
Annual avg no. of days rainwater tank overflows:	15.42
Avg overflow event from rainwater tank (L):	528,979
Avg annual amount of mains top-up (L):	0
% of supply derived from mains top-up:	0.00

Daily Rainfall and Tank Modelling					
Daily Usage (L)					
	RainTank	SWTank		RainTank	SWTank
January	373,000	0	July	39,500	0
February	373,000	0	August	39,500	0
March	223,500	0	September	166,000	0
April	108,500	0	October	281,000	0
May	39,500	0	November	292,500	0
June	39,500	0	December	396,000	0
Stormwater Tank Statistics					
			Stormwater tank volume (L):	0	
			Impervious area to stormwater tank (sqm):	0	
			% full at model startup:	0	
			Daily trickle from stormwater tank (L):	0	
			Receives overflow from rainwater tank?	No	
			Total inflow to stormwater tank (L):	0	
			Total supplied from stormwater tank (L):	0	
			Total overflow from stormwater tank (L):	0	
			No. of days stormwater tank overflowed:	0	
			Max overflow event from stormwater tank (L):	0	
			% of time demand from stormwater tank met:	100.00	
			Avg annual supply from stormwater tank (L):	0	
			Avg annual overflow from stormwater tank (L):	0	
			Annual avg no. of days stormwater tank overflows:	0.00	
			Avg overflow event from stormwater tank (L):	0.00	

(ii) As part of Stage 1, WQCP6 will be built just north of the extraction area. Trapped stormwater and groundwater will be drained or pumped to it from the extraction area. It will not receive water from any other source (apart from its own area) and it will have the following conceptual dimensions:

- Area = 2,000 m^2
- Side slopes 1:1 (excavated into rock)
- Depth 2 m
- Storage volume = 3,600 m^3.

The basin will behave like a open-topped tank, that is it will allow evaporation to occur, estimated at (mean) 2.6 ML per year (2,000 m^2 x 1,300 mm). This leaves (mean) 7.4 ML/year for Stage 1.

(iii) It is proposed to re-use this trapped water to irrigate pasture around the site, calculated in the same way as in Section 3.3.7.3. For a mean year, about 1.5 ha of pasture will be required to use 7.4 ML, Table 9. Of course this will vary year to year depending on the weather and in wet years it will be necessary to commission more irrigation area.

(iv) It is possible that groundwater seepage into the extraction area will be saline. However, this seepage will be shandied with trapped rainwater. The groundwater consultant predicts groundwater inflow rates of less than 0.3 ML/yr in year 1 up to 3.5 ML/yr at full quarry extent (20-30 years). Therefore, adopting the same four stages described in Section 3.4.1.5, each 1.5 ha of quarry is estimated to trap 0.9 ML of potentially saline groundwater. On average, this will be shandied with 10 ML/year and so the shandy ratio will, on average, be about 1 part groundwater to 10 parts rainwater.

Most likely, at such a ratio, salinity levels will be low enough to permit direct irrigation from WQCP6, but that will be proved as part of the water quality monitoring program, and following advice from an agricultural consultant. However, if salinity levels prove too high then this water can also be shandied with water trapped in nearby WQCP1 before it is used for irrigation from there. WQCP will, on average, trap about 42 ML/year [2] and so the ultimate shandy ratio could be as high as about 1:50.

(v) Therefore, as the quarry expands more land, calculated at a rate equal to the area of quarry expansion, will need to be irrigated. There is ample land to do this to the southwest of the extraction area (Drawing number 06000752-02).

Table 9 - Irrigation Demand From Extraction Area (mean data)

	Rainfall	PET	Days	Daily rain	Daily PET	Irrigation demand	Daily Demand (L)	weekly irrig demand	Monthly demand irrig only (L)	Irrig plus constant	Monthly (irrig and constant)	Daily multiplier to use in RATES	% of annual (for MUSIC)	% of irrig total
January	65	155	31	2.1	5.0	2.9	43500	304500	1348500	43500	1348500	2.9	18.0	18.0
February	54	135	28	1.9	4.8	2.9	43500	304500	1218000	43500	1218000	2.9	16.3	16.3
March	56	105	31	1.8	3.4	1.6	24000	168000	744000	24000	744000	1.6	9.9	9.9
April	57	75	30	1.9	2.5	0.6	9000	63000	270000	9000	270000	0.6	3.6	3.6
May	53	50	31	1.7	1.6	-0.1	0	0	0	0	0	0	0.0	0.0
June	49	40	30	1.6	1.3	-0.3	0	0	0	0	0	0	0.0	0.0
July	45	40	31	1.5	1.3	-0.2	0	0	0	0	0	0	0.0	0.0
August	59	55	31	1.9	1.8	-0.1	0	0	0	0	0	0	0.0	0.0
Septembei	52	85	30	1.7	2.8	1.1	16500	115500	495000	16500	495000	1.1	6.6	6.6
October	54	120	31	1.7	3.9	2.1	31500	220500	976500	31500	976500	2.1	13.0	13.0
November	69	135	30	2.3	4.5	2.2	33000	231000	990000	33000	990000	2.2	13.2	13.2
December	54	150	31	1.7	4.8	3.1	46500	325500	1441500	46500	1441500	3.1	19.3	19.3
TOTALS	**667**	**1145**							**7483500**	**L/year**	**7483500**	**L/year**		
Area to be irrigated:		15000	sqm											
Constant use:		0	L/day											
Figure for multiplier:		15000	L/day											
REUSE FROM EXTRACTION AREA														

(vi) Trapped water will be allowed to settle for a minimum of five days before it is used for irrigation. The aim is to achieve a rate of suspended solids no more than 50 mg/L. To achieve this, flocculation with gypsum

2 From the MUSIC modelling

might also be required (Appendix 5), but this will be decided after experience is gained.

(vii) WQCP6 will be large enough to trap the 10 day, 80th percentile rainfall depth (32 mm) for the total extraction area (6 ha). It will also big enough to trap the 10-day 95th percentile rainfall depth. Therefore, it need not be enlarged as quarrying progresses.

Note that WQCP6 is not modelled with MUSIC (Section 3.5) as it is disconnected from receiving waters.

3 .4.1.6 Long Term Stormwater Control, The Overburden Area

(i) The overburden stockpile will be located to the northeast of the crushing area, in the catchment of an existing farm dam (Drawing number 06000725-02).

(ii) A haul road is required to access the area and this will extend from the haul road servicing the primary crusher.

(iii) The overburden area will drain to an existing farm dam that will become WQCP 5. The dam will be rebuilt and a new spillway installed to be stable in the 100-year ARI storm event (estimated at 1.7 m^3 /sec). Its conceptual dimensions are:

- 60 m x 30 m in plan
- 2 m deep
- 4:1 side slopes
- 0.5 m extended detention depth
- 1,500 m^2 permanent storage volume
- a trickle pipe equivalent to a 45 mm pipe set at the base of the extended detention depth.

3 .4.1.7 Rainwater Tanks

(i) The site is not connected to reticulated water and so the office and maintenance shed roofs (800 m^2 total) will drain to rainwater tanks. These tanks:

- will have a combined capacity of around 100,000 L;
- are to be plumbed to capture as much of the roof runoff as is feasibly possible;
- are to be plumbed to provide all internal water use;
- are to have any overflow directed onto a stable surface drainage pathway or an infiltration pit. Note that any overflow outlets must be stabilised to minimise the risk of scour or erosion;

- are to have any overflow directed to an area away from the effluent management system or irrigation field;
- are to have a first-flush device;
- are to be screened to prevent the entry of leaves, twigs and mosquitos;
- are to be installed and maintained according to the manufacturer's instructions

(ii) Based on 20 staff it is estimated that 1,000 L/day will be required for showers, toilets etc.

RATES shows that potable water demand will be met 97 percent of the time but, realistically, this would be 100 percent as people change their habits if levels get low), Table 10.

3 .4.1.8 Fuel/Oil Storage

(i) Fuel will be stored in dedicated tanks under roof cover and on a concrete surface at the end of the maintenance shed. They will be located away from areas of concentrated flow and have measures to contain spillage.

(ii) Fuel pumps will also be located away from areas of concentrated flow and on a concreted surface.

(iii) Spill-control kits will be made available and the staff inducted in their use.

(iv) Used oil will be temporarily stored before disposal at a licenced facility (e.g. the Council Waste Depot), or stored before collection and recycling by a licenced recycling contractor.

3 .4.1.9 Chemical Storage

Chemicals/oils etc. will be stored in dedicated containers and under cover in the maintenance shed. Spill-control kits will be made available and the staff inducted in their use.

3 .4.1.10 Onsite Wastewater Management

(i) All domestic wastewater will be collected and treated in a new wastewater management system. Due to the shallow, clay-rich, soils, the best wastewater management system is an aerated wastewater treatment system (AWTS) that will provide secondary treated effluent suitable for disposal by irrigation.

(ii) Section 3.3.7.4 estimated that 1,000 L/day of domestic wastewater will be generated by the offices and workshops. The required irrigation area is taken as the largest value given by hydraulic and nutrient balances as described in DLG, 1998. The balances are given in Appendix 8 and the largest is 690 m^2 (based on the phosphorous balance). A dedicated irrigation field will be provided and serviced by semi-fixed, surface spray, irrigation. The irrigation area must have a soil cover no less than 500 mm and must be no nearer than 100 m to a watercourse. A suggested location is shown on Drawing number 06000725-02.

(iii) The irrigation area will be fenced off from public access and signs installed informing the staff that treated wastewater is being reused for irrigation.

Table 10 – RATES Modelling of Potable Water Demand

SEEC Morse McVey	
Site Location:	0
Input Statistics	
Rainfall Station:	0
Station Location:	0
Length of model run:	96.64 yrs (35,297 days)
Avg annual rainfall (mm):	665.72
Avg number of rain days/year:	105
Maximum 24 hr rainfall (mm):	136.1
Longest dry spell (days):	41
Runoff coefficient to rainwater tank:	0.9
Runoff coefficient to stormwater tank:	0
Rainwater Tank Statistics	
Rainwater tank volume (L):	100,000
Roof area to tank (sqm):	800
% full at model startup:	0
Mains top-up threshold (%):	0
Mains daily top-up amount (L/day):	0
Overflow to stormwater tank?	No
Total inflow to rainwater tank (excl top-up) (L):	46,321,416
Total supplied from rainwater tank (L):	34,155,872
Total overflow from rainwater tank (L):	11,922,352
No. of days rainwater tank overflowed:	1,588
Max overflow event from rainwater tank (L):	83,456
Total amount of mains top-up (L):	0
Longest period that tank ran dry (days):	30
% of time demand from rainwater tank met:	96.77
Avg annual supply from rainwater tank (L):	353,432
Avg annual overflow from rainwater tank (L):	123,368
Annual avg no. of days rainwater tank overflows:	16.43
Avg overflow event from rainwater tank (L):	7,508
Avg annual amount of mains top-up (L):	0
% of supply derived from mains top-up:	0.00

Daily Rainfall and Tank Modelling					
Daily Usage (L)					
	RainTank	SWTank		RainTank	SWTank
January	1,000	0	July	1,000	0
February	1,000	0	August	1,000	0
March	1,000	0	September	1,000	0
April	1,000	0	October	1,000	0
May	1,000	0	November	1,000	0
June	1,000	0	December	1,000	0
Stormwater Tank Statistics					
Stormwater tank volume (L):	0				
Impervious area to stormwater tank (sqm):	0				
% full at model startup:	0				
Daily trickle from stormwater tank (L):	0				
Receives overflow from rainwater tank?	No				
Total inflow to stormwater tank (L):	0				
Total supplied from stormwater tank (L):	0				
Total overflow from stormwater tank (L):	0				
No. of days stormwater tank overflowed:	0				
Max overflow event from stormwater tank (L):	0				
% of time demand from stormwater tank met:	100.00				
Avg annual supply from stormwater tank (L):	0				
Avg annual overflow from stormwater tank (L):	0				
Annual avg no. of days stormwater tank overflows:	0.00				
Avg overflow event from stormwater tank (L):	0.00				

3 .4.1.11 Vegetation

(i) As far as possible native vegetation will be retained on the site but there is a requirement to clear about 1.5 ha, mostly from land on the Bindook Road Soil Landscape, upper slope facet.

(ii) Chapmans Creek and its tributary west of the main quarry area is classified as a category 2 stream (Section 3.2.4.1). Here, a Core Riparian Zone (CRZ) will be established that extends 20 m from the top of bank. It will be fully vegetated with local provenance vegetation selected from the list below or on advice from a flora expert. In all about 1,500 m of creek will be rehabilitated (9 ha).

(iii) The CRZ will be fenced off to prevent cattle access. The fences will be placed 30 m from the top of bank.

(iv) Tree planting will consist of a mixture of acacias and eucalypts chosen from the following list (taken from SCA/DLWC, 2002):

- *Eucalyptus macrorhyncha* (Red Stringybark),
- *E. amplifolia* (Cabbage Gum),
- *E. mannifera* (Brittle Gum),
- *E. melliodora* (Yellow Box),
- *E. blakelyi* (Blakelys Red Gum),
- *E. cinerea* (Argyle Apple),
- *Exocarpus cupressiformis* (Native Cherry),
- *Casuarina littoralis* (Black She Oak),
- *Acacia ulicifolia* (Prickly Moses),
- *Acacia mearnsii* (Black Wattle),
- *Kunzia parvifolia* (Violet Kunzia), and
- *Lissanthe stigosa* (Peach Heath).

3 .4.1.12 Creek Crossing

The anticipated creek crossing here is a box culvert or, possibly , a prefabricated concrete bridge. The aim of the culvert/bridge design will be to maintain the natural morphological features of the stream as much as possible. NSW Fisheries, 2003 gives the policy and guidelines that apply for providing a fish-friendly crossing but the design must also be considerate of the requirements of the DECC, DWE and SCA . Comprehensive guidelines for crossings such as this are contained in Witheridge, 2002 and Fairfull and Witheridge, 2003.

Special measures will be adopted in a detailed Soil and Water Management Plan for this creek crossing, following the guidelines of Chapter 5, Landcom, 2004.

3 .4.2 The New By-Pass

3 .4.2.1 Soil and Water Management During Construction

Refer to Part 2.

3 .4.2.2 Long-term Stormwater Control

The new by-pass will be in a 20 m wide corridor with an 8 m wide sealed pavement and 1 m wide shoulders (50 percent impervious).

(i) Swales (table drains) will be used for drainage along the full length of the road as follows:

- where it is aligned perpendicular to the contours (i.e for most of its length) table drains will be used along both edges and the pavement will be 'crowned' to drain water to both sides;
- Swales will have tail-outs (mitre drains) constructed at 50 m intervals or less. Although the swales will not infiltrate significant

amounts of water (as they will be largely cut into the subsoil) the tail out drains will (as they will be built at no more than 3% gradient and on more permeable surface soils);

- where cut and fill is required, in-fall drainage will be used and the entire surface will be graded to drain back towards a swale cut into the hillside;
- Where in-fall drainage is used, a pit and pipe will be installed at 50 m intervals to deliver water under the pavement, where it will discharge onto well-vegetated areas via an energy dissipater or level spreader;
- table drains and tail-out structures will be stabilised with a temporary liner (e.g. jute matting) immediately following construction;
- in the long term table drains will be stabilised using appropriate, deep-rooting, native grass species.

(ii) where cut and fill is required, fill batters will not exceed 2:1 and batter lengths will not exceed 7.5 m (note that we expect all batters to be well below this).

3 .4.2.3 Watercourse Crossings

The bypass crosses two very different watercourses:

(i) Jaorimin Creek, a fourth order stream; and

(ii) a drainage depression

Jaorimin Creek will require a bridge crossing. The aim of the culvert/bridge design will be to maintain the natural morphological features of the stream as much as possible. NSW Fisheries, 2003 gives the policy and guidelines that apply for providing a fish-friendly crossing but the design must also be considerate of the requirements of the DECC, DWE and SCA . Comprehensive guidelines for crossings such as this are contained in Witheridge, 2002 and Fairfull and Witheridge, 2003.

Special measures will be adopted in a detailed Soil and Water Management Plan for this creek crossing, following the guidelines of Chapter 5, Landcom, 2004.

The drainage depression will be crossed using a small box culvert structure. There is no riparian zone associated with this watercourse.

3 .4.3 Monitoring and Maintenance

An ongoing regime for maintenance of the various water quality control measures is required to ensure their continued performance level. This is to include:

3 .4.3.1 The Quarry Site

(i) All swales will require at least 75 percent ground cover to ensure they are protected from erosion. They will be inspected every six months to ensure that they are appropriately protected. If not, measures will be taken to replant and/or repair;

(ii) The access road will be monitored for damage and measures taken to ensure the pavement seal is intact and the pavement surface is draining properly to the swale;

(iii) The gravel hardstand areas will be inspected to ensure subsoils are not exposed, repair as necessary;

(iv) Sediment collected in the water quality ponds will be periodically (possibly yearly depending on prevalent rainfall) removed and placed away from concentrated flow paths;

(v) Onsite effluent management systems are to be maintained according to Council requirements and the recommendations of the manufacturer (normally at quarterly intervals);

(vi) Diversion drains will be inspected to ensure stormwater is being directed away from the extraction and processing areas. Check also they are not eroding and they have stable outlets;

(vii) Dirty water collection drains SW4, SW5a and SW5b will be inspected to ensure they are diverting stormwater to WQCP 1;

(viii) The sediment forebay of WQCP 1 will be periodically cleaned out (possibly yearly depending on prevalent rainfall) and the sediment placed away from concentrated flow, either on the overburden pile or in the extraction area;

(ix) The outlet to all WQCP's will be checked after major rainfall events to ensure stability. Repair if necessary.

(x) The truck-washing bay will be regularly checked to ensure it is operational and that drainage is directed to WQCP 1;

(xi) The rainwater tanks will be regularly checked to ensure inlets and outlets are not blocked and that the overflow path is stable;

(xii) All dust-control methods will be regularly inspected;

(xiii) Pasture irrigation is an important part of stormwater control at this site. Irrigation demand will be calculated daily using methods approved by NSW Dept. Agriculture. This will require accurate daily rainfall monitoring, with records kept on site;

(xiv) Irrigation, including from aerated wastewater treatment, must not produce runoff;

(xv) Water quality sampling will be undertaken to replicate the analyses outlined at Section 3.2.8 to show that NoRBE continues to be achieved. The methodology will accord with the Australian Guidelines for Water Quality Monitoring and Reporting (2000) and will be established together with a suitably qualified consultant and officers from the Department of Environment and Conservation (DEC). In the unlikely event that the monitoring indicates that NoRBE is unlikely to continue to be achieved, the soil and water management program will be adjusted to the satisfaction of DEC. After each sampling and analysis set, a report will be prepared and forwarded to DEC to show that the program continues and is on track.

3 .4.3.2 The By-Pass

(i) All swales and mitre drains will require at least 75 percent ground cover to ensure they are protected from erosion. They will be inspected every six months to ensure that they are appropriately armoured. If not, measures will be taken to replant and/or repair;

(ii) The access road will be monitored for damage and measures taken to ensure the pavement seal is intact and the pavement surface is draining properly to the swales.

3 .5 Comparison of Pre and Post Development Pollutant Loads

3 .5.1 MUSIC Modelling - Inputs

3 .5.1.1 Modelling Introduction

Pre and post development sediment and pollutant loads were modelled using MUSIC (Model for Urban Stormwater Improvement Conceptualisation), developed by the CRC for Catchment Hydrology. MUSIC contains algorithms based on the known performance characteristics of common stormwater quality improvement structures used in Australia. These data are derived from research undertaken by the CRC and others. The models are appropriately calibrated and all amendments to MUSIC defaults are noted in Appendix 6. The modelling quantifies:

(i) the levels of the principal pollutants before and after the development; and

(ii) changes in export levels because the development is there.

Statistics are produced in MUSIC for the following parameters:

(i) Flow (ML/yr)
(ii) TSS - Total Suspended Solids (kg/yr)
(iii) TP - Total Phosphorus (kg/yr)
(iv) TN - Total Nitrogen (kg/yr)
(v) Gross Pollutants (kg/yr)

MUSIC modelling concentrated on:

3 .5.1.2 The Quarry Site:

(i) the connected sectors of the access road (and their catchments)

(ii) the proposed catchment of WQCP 1 that includes:

- the processing area;
- offices;
- heavy haul roads;
- maintenance sheds;
- hardstands;
- truck washing area;
- stockpiles;
- the proposed riparian revegetation; and
- the overburden area (WQCP 5).

3 .5.1.3 Those lengths of the bypass considered to be connected to receiving waters (Section 3.3.2)

The quarry and the by-pass are modelled in one model. Four scenarios are modelled:

(i) existing conditions in a period of average rainfall (1966-1970);

(ii) existing conditions in a particularly wet year (1974);

(iii) proposed conditions for 1966-1970 and with the water quality measures described in 3.4; and

(iv) proposed conditions in 1974 and with the water quality measures described in Section 3.4.

3 .5.2 Climate Data

Creation of a MUSIC catchment file requires an associated meteorological data file. The data used here is that for Bungonia for 1966 to 1970 in 6 minute time steps. Data for this period were chosen because they have a similar rainfall pattern to Marulan as to annual load and pattern (Modelling annual average: 647 mm, Marulan long-term average: 650 mm). Potential evapotranspiration (PET) data are derived from the Climatic Atlas of Australia (Wang *et al.*, 2001). Basic rainfall and evapotranspiration statistics are in Table 11 and the time-series graph is in Figure 10. Note that the rainfall sequence includes a maximum value of 20.56 mm, which represents a storm event greater than the 100-year, 6-minute event (18 mm – See Appendix 1).

Wet year modelling was based on Bungonia 1974 (1,128 mm). During this year, Bungonia received approximately 75% more rainfall than in an average year.

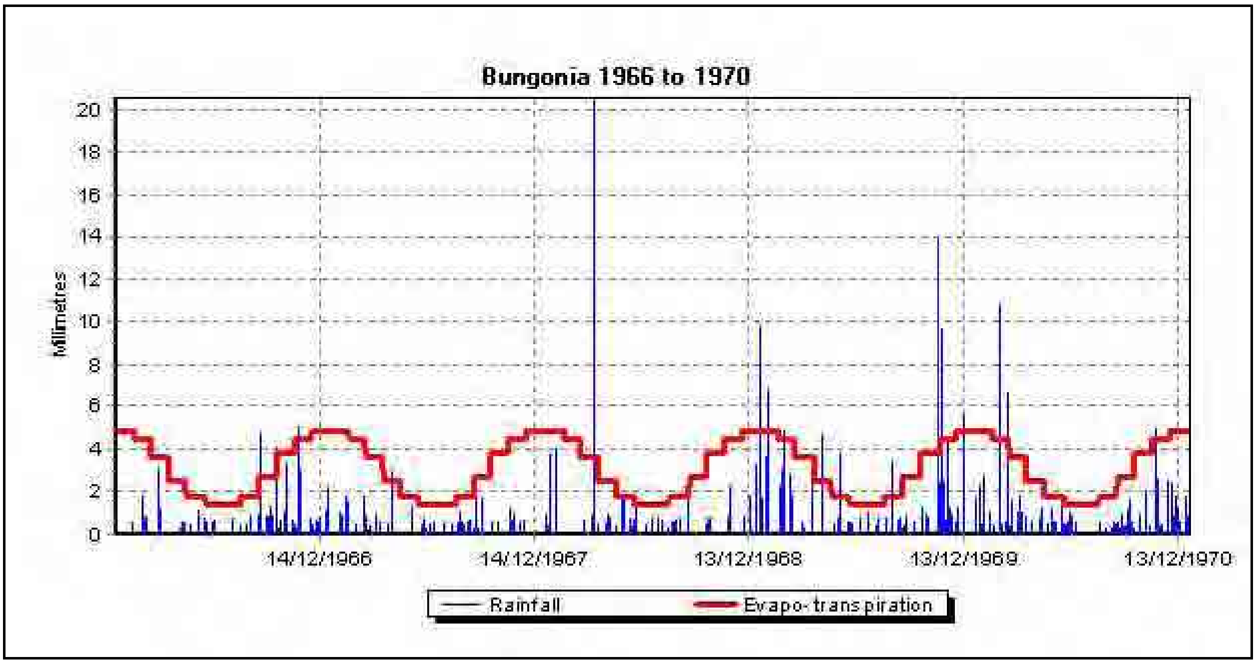

Figure 10 Time-series graph for Bungonia rainfall and potential evapo-transpiration, 1966 to 1970

Table 11 Rainfall and PET statistics for Bungonia 1966 to 1970.

Measure	Statistics						
	mean	median	maximum	minimum	10%ile	90%ile	mean annual (mm)
Rainfall (mm/6 minute steps)	0.007	0	20.56	0	0	0.001	647
Potential Evapotranspiration (mm/day)	3.118	2.67	4.84	1.35	1.37	4.84	1139

3 .5.3 Pre Development Modelling

The existing lands are modelled using five MUSIC-default "Agricultural" source nodes with 1 percent imperviousness (to model tramped soils) and one MUSIC-default Forest source node. All but one are on the Bindook Road Soil Landscape and they are as follows:

- 1.5 ha of forest that will be cleared, upper slope facet
- 9.18 ha of land that will become the quarry area (but not the extraction area), upper slope facet.
- 7.5 ha that will become the catchment of WQCP 5, upper slope facet.
- 0.9 ha that will become the connected sections of the access road.
- 9 ha that will become riparian re-vegetation, lower slope facet.
- 0.6 ha of land that will become the connected parts of the new by-pass, on the Jaqua soil Landscape.

3 .5.4 Post Development Modelling

3 .5.4.1 Roads

(i) The connected sections of both roads are modelled using a non-default, "Sealed Road" source node with event mean concentrations (EMC's) as given in Table 16, Appendix 6. The roads are assumed to be in a 20 m wide corridor with a 8 m wide sealed pavement and two 1 m shoulders (50 percent impervious). The EMC for suspended solids is assumed at 500 mg/L to represent the expected dusty surface.

(ii) The connected sections of the roads drain to their WQCP's via swales. Note that the length of the swales is halved in the model to account for lateral inflow.

3 .5.4.2 The Catchment of WQCP 1 will become:

(i) 1 ha of remnant agricultural land, modelled with a MUSIC-default "Agricultural" source node and assumed 5 percent impervious;

(ii) 1.6 ha of heavy haul roads modelled with a non-default gravel road node with EMCs calibrated as in Appendix 6, Table 16 and assumed 75 percent impervious;

(iii) 7.0 ha of disturbed land around the crushing plant that is modelled with a non-default “Gravel Road” source node calibrated as in Appendix 6, Table 16 and made 90 percent impervious;

(iv) 1 ha of land around the offices/sheds etc, modelled with a non-default “Gravel Road” source node calibrated as in Appendix 6, Table 16 and 80 percent impervious;

(v) 800 m^2 of roofs, modelled with a non-default “Roof” source node as calibrated in Appendix 6, Table 16 and draining to a 100,000 L rainwater tank from which 1,000 L/day is drawn;

(vi) the overflow from the tank.

3 .5.4.3 Water is drawn from WQCP 1 for reuse in the crushing plant, for dust suppression and for pasture irrigation, as described in section 3.3.7.

3 .5.4.4 The Catchment of WQCP 5 remains as before but now it has 0.5 hectare of disturbed land in it, modelled with a non-default “Gravel Road” source node calibrated as in Appendix 6, Table 16.

3 .5.4.5 9 hectares of riparian land that was agricultural is now modelled with MUSIC-default Forest source node, to account for the proposed watercourse rehabilitation works.

3 .6 MUSIC Modelling Results

3 .6.1 Mean Annual Nutrient loads

Table 12 gives the results of MUSIC modelling for a period of average rainfall (1966 to 1970). It shows that, when the recommendations of Section 3.4 are implemented, there will be a reduction in the mean annual nutrient export from this site. Note we have aimed for a 20 percent reduction as per SCA request. Table 13 gives the results of the same modelling but for a wet year (1974). Again, there is a predicted decrease in mean annual nutrient export.

Table 12 - Music Results for 1966-1970

1966-70		Pre	Pre	Post	Post		Change %
		Flow (ML/yr)	7.74	Flow (ML/yr)	9.25		20
		Total Suspended Solids (kg/yr)	1260.00	Total Suspended Solids (kg/yr)	389.00		-69
		Total Phosphorus (kg/yr)	3.45	Total Phosphorus (kg/yr)	0.93		-73
		Total Nitrogen (kg/yr)	24.30	Total Nitrogen (kg/yr)	13.00		-47

Table 13 - Music Results for 1974

1974		Pre	Pre	Post	Post		Change %
		Flow (ML/yr)	49.10	Flow (ML/yr)	64.80		32
		Total Suspended Solids (kg/yr)	8740.00	Total Suspended Solids (kg/yr)	3190.00		-64
		Total Phosphorus (kg/yr)	24.10	Total Phosphorus (kg/yr)	6.92		-71
		Total Nitrogen (kg/yr)	183.00	Total Nitrogen (kg/yr)	89.30		-51

3 .6.2 Pollutant Concentrations

NorBE also requires nutrient *concentrations* to be no greater post development than pre-development. MUSIC produces results for this in the form of cumulative frequency graphs. When plotted, the post development cumulative frequency graph must be less than (to the left of) the pre-development graph.

Figures 11 to 13 are the cumulative frequency graphs for suspended solids, phosphorous and nitrogen respectively. The plots show that predicted concentrations of nutrients will be lower post development.

3 .6.3 Gross Water Flow

Table 12 suggests that, despite water being used for the quarrying activities and pasture irrigation, there will be about a 1.5 ML/year increase in stormwater flow offsite in average years. However, this result does not account for:

(i) water lost to the extraction area (that is internally draining); or

(ii) the extra flow derived from the un-modelled parts of the access road and the bypass.

To estimate (i), a single 6 ha agricultural source node on the Bindook Soil Landscape (upper slope facet) was modelled for the same period. It showed that 1 ML/year of runoff would have been expected from this area in times of average rainfall.

To estimate (ii) a model was run with:

- 1.8 ha of land on the Bindook Road soil landscape, upper slope facet;
- 1.8 ha of land on the Bindook Road soil landscape, lower slope facet; and
- 3.6 ha on the Jaqua Soil Landscape, lower slope facet.

It showed that about 1 ML/year of runoff would have been expected from these areas in times of average rainfall. The model was then run with these areas being 50 percent impervious(i.e. the road pavements). It showed that post development there will be 20 ML/year of run off.

So, combining these losses and gains, the gross increase in stormwater flow during periods of average rainfall will be about 19.5 ML/year. This includes groundwater flow.

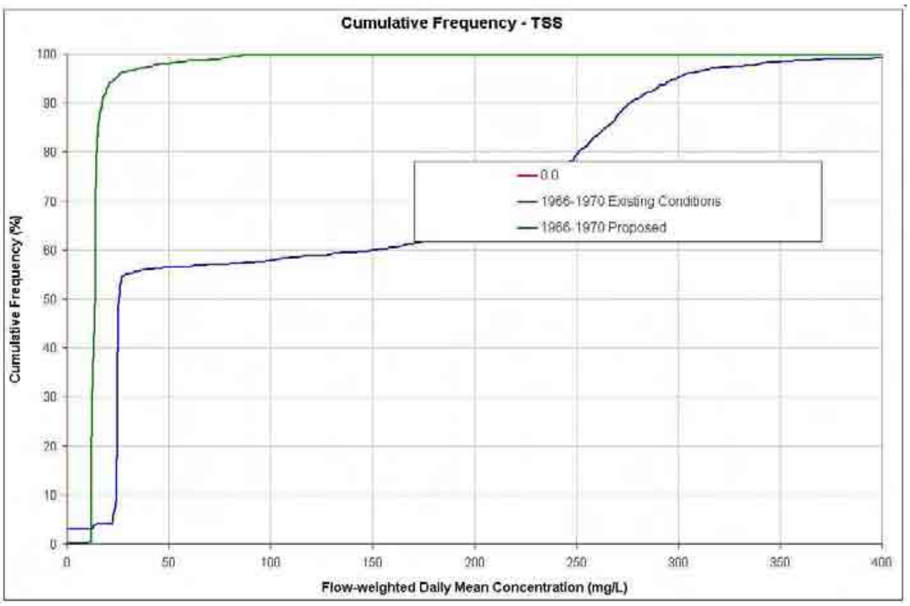

Figure 11 – Cumulative frequency graph for suspended solids

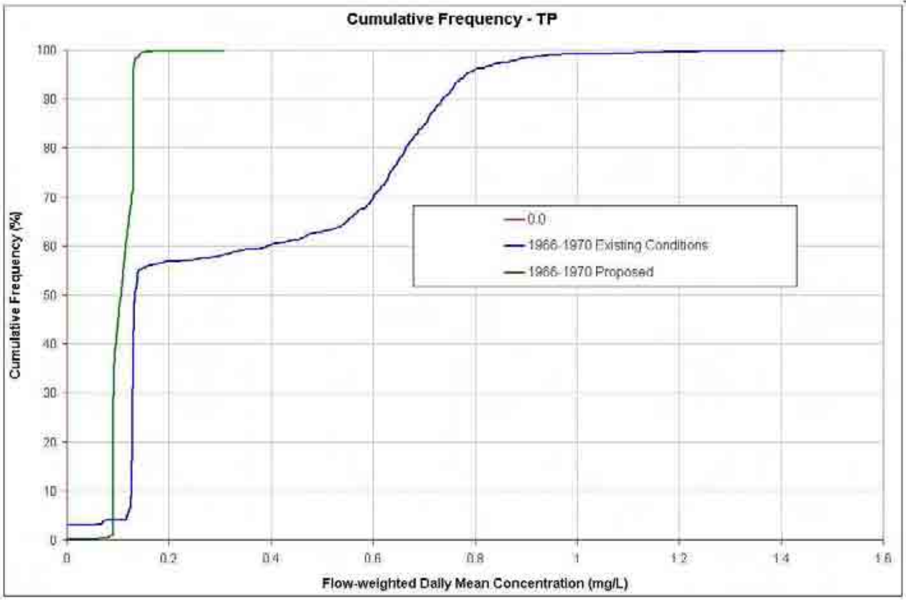

Figure 12 – Cumulative frequency graph for phosphorous

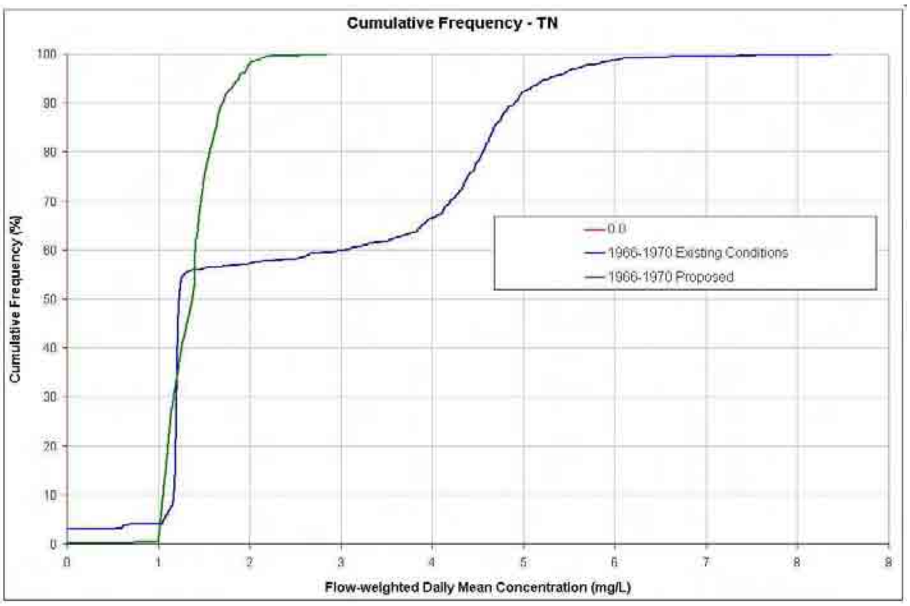

Figure 13 – Cumulative frequency graph for nitrogen

3 .6.4 Water Quality Objectives

A series of water quality objectives have been developed for the Hawkesbury-Nepean River catchment. These were first outlined in the Independent Inquiry into the Hawkesbury Nepean River System (HRC, 1998) and have been integrated into Catchment Blueprints. The Warragamba Catchment Blueprint, developed by the Coxs and Wollondilly River Catchment Management Committees incorporates targets for land and water management.

The Healthy Rivers Commission (HRC) proposed water quality objectives that are incorporated into the Catchment Blueprint. It recommends the following approximate targets for drinking catchment areas:

(i) 50 µg/L (0.050 mg/L) for TP (no percentile given, 50% assumed);

(ii) 700 µg (0.7 mg/L) for TN (no percentile given, 50% assumed).

Figures 14 and 15 show the TP and TN cumulative frequency graphs for the outflows from the site (zero flows excluded). The water quality concentration curves do not intersect the water quality objectives, demonstrating the effectiveness of the proposed treatment measures. The proposed measures significantly reduce annual flows and loads through extensive re-use and treatment. Major gains are made in managing runoff from smaller, more frequent storm events.

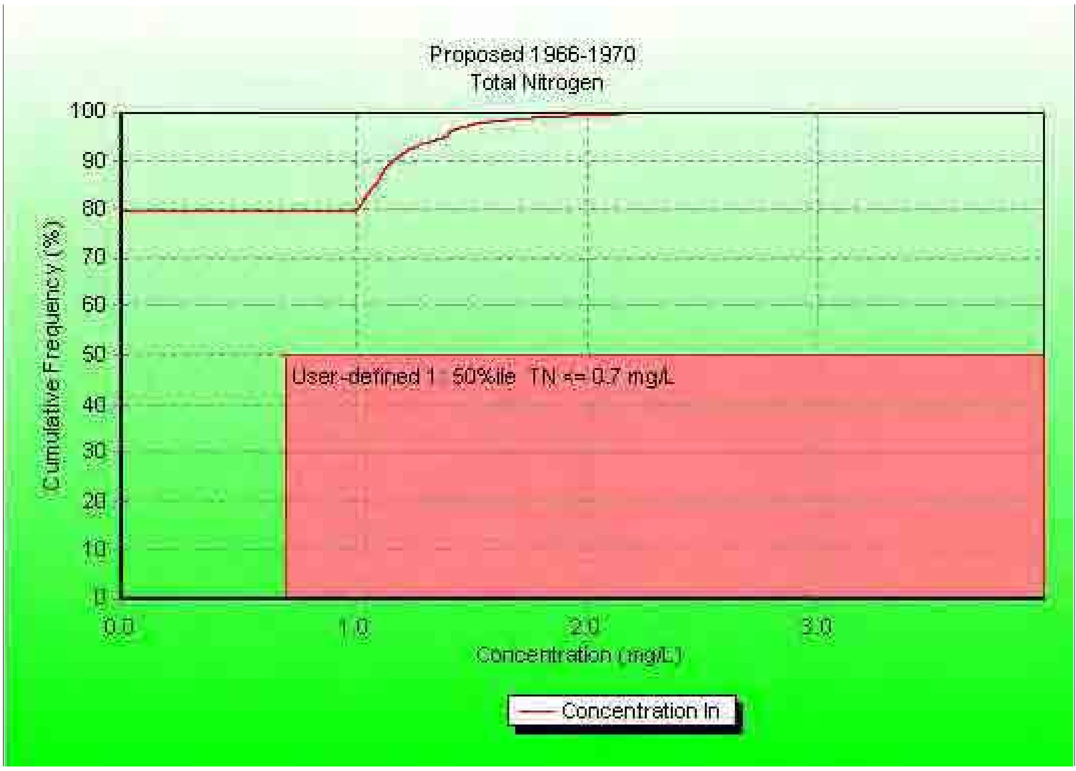

Figure 14

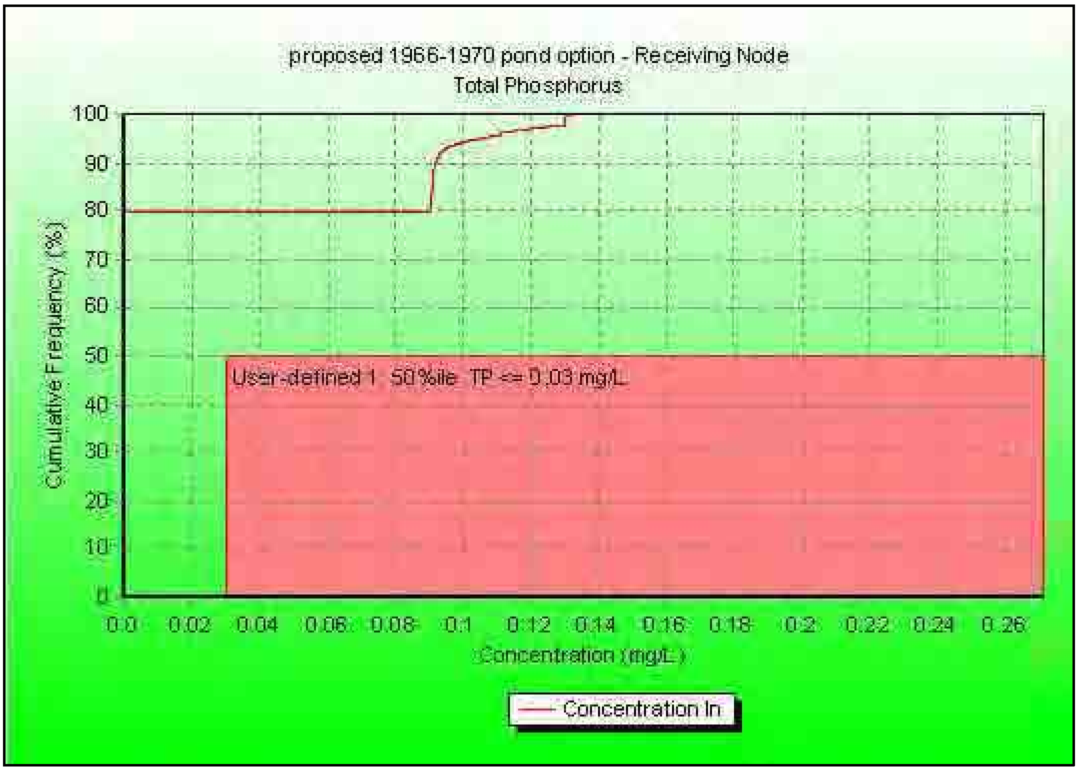
proposed 1966-1970 pond option - Receiving Node
Total Phosphorus
Cumulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
User-defined 1 50%ile TP <= 0.03 mg/L
0.0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
Concentration (mg/L)
Concentration In

Figure 15

3 .7 References

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Part 4

Appendices

4 .1 Appendix 1 – Intensity, Frequency and Duration Chart for Marulan

```
*********************** RAINER ****************************
      DEPARTMENT of CONSERVATION and LAND MANAGEMENT
Date: 12/06/2007


Rainfall Intensity (mm/h) for MARULAN
       1 hour, 2 years : 26.20
      12 hour, 2 years :  5.50
      72 hour, 2 years :  1.50
      1 hour, 50 years : 50.00
     12 hour, 50 years : 11.30
     72 hour, 50 years :  3.20
              Skewness :  0.13
Geographical factor F2 :  4.29
Geographical factor F50: 15.65
```

\DUR ARI	5m	6m	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h	User
1	66	62	50	36.6	29.7	20.2	13.1	10.1	6.49	4.18	2.59	1.57	1.13	0.00
2	86	80	66	47.4	38.4	26.0	16.9	13.1	8.44	5.45	3.39	2.05	1.49	0.00
5	113	105	85	61	49.6	33.3	21.9	17.0	11.0	7.20	4.50	2.74	1.99	0.00
10	129	121	98	70	56	37.6	24.9	19.4	12.6	8.28	5.20	3.18	2.31	0.00
20	151	141	114	81	65	43.5	28.8	22.5	14.8	9.70	6.10	3.74	2.73	0.00
50	180	168	136	97	77	51	34.2	26.8	17.6	11.6	7.34	4.51	3.30	0.00
100	203	190	153	109	87	57	38.3	30.1	19.9	13.1	8.31	5.12	3.75	0.00
User	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Estimated Rainfall Factor (R): 1670 Estimated 1:10 Storm (S10): 1160

	Years						
min	1	2	5	10	20	50	100
7	58	76	99	114	133	158	178
8	55	72	94	108	125	150	169
9	53	69	89	102	119	142	160
10	50	66	85	98	114	136	153
11	48.4	63	82	94	109	130	146
12	46.6	60	79	90	105	125	140
13	45.0	58	76	87	101	120	135
14	43.5	56	73	84	97	116	130
15	42.1	55	71	81	94	112	126
16	40.8	53	69	78	91	108	122
17	39.7	51	67	76	88	105	118
18	38.6	50.0	65	74	86	102	115
19	37.6	48.7	63	72	84	99	112
20	36.6	47.4	61	70	81	97	109
21	35.7	46.3	60	68	79	94	106
22	34.9	45.2	59	67	77	92	103
23	34.1	44.2	57	65	76	90	101
24	33.4	43.2	56	64	74	88	98
25	32.7	42.3	55	62	72	86	96
26	32.0	41.5	54	61	71	84	94
27	31.4	40.6	52	60	69	82	92
28	30.8	39.9	51	59	68	80	90
29	30.2	39.1	50	57	67	79	88
30	29.7	38.4	49.6	56	65	77	87
31	29.2	37.7	48.7	55	64	76	85
32	28.7	37.1	47.8	54	63	75	84
33	28.2	36.5	47.0	53	62	73	82
34	27.8	35.9	46.2	53	61	72	81
35	27.3	35.3	45.5	52	60	71	79
36	26.9	34.8	44.8	51	59	70	78
37	26.5	34.3	44.1	50	58	69	77
38	26.1	33.7	43.4	49.3	57	68	76
39	25.7	33.3	42.8	48.5	56	67	75
40	25.4	32.8	42.2	47.8	55	66	73
41	25.0	32.3	41.6	47.2	55	65	72
42	24.7	31.9	41.0	46.5	54	64	71
43	24.4	31.5	40.5	45.9	53	63	70
44	24.1	31.1	39.9	45.3	52	62	69
45	23.8	30.7	39.4	44.7	52	61	68
46	23.5	30.3	38.9	44.1	51	60	68
47	23.2	29.9	38.4	43.5	50	60	67
48	22.9	29.6	38.0	43.0	49.8	59	66
49	22.6	29.2	37.5	42.5	49.1	58	65
50	22.4	28.9	37.1	42.0	48.6	57	64
51	22.1	28.6	36.6	41.5	48.0	57	63
52	21.9	28.2	36.2	41.0	47.4	56	63
53	21.7	27.9	35.8	40.5	46.9	55	62
54	21.4	27.6	35.4	40.1	46.4	55	61
55	21.2	27.3	35.0	39.7	45.8	54	61
56	21.0	27.1	34.7	39.2	45.4	54	60
57	20.8	26.8	34.3	38.8	44.9	53	59
58	20.6	26.5	33.9	38.4	44.4	52	59
59	20.4	26.2	33.6	38.0	43.9	52	58

4 .2 Appendix 2 – Revised Universal Soil Loss Equation

While assessment of runoff is commonplace in the urban planning process, estimating possible soil loss is not. Nonetheless, estimates of soil loss have four important applications to soil and water management. These are to:

- assess the erosion risk at a site
- identify suitable measures to overcome the erosion risk
- estimate the required capacity of sediment retarding basins
- compare the effectiveness of various erosion control measures.

Therefore, by estimating likely soil loss levels, land planners can gear erosion and sediment control measures to each part of any development site. Consequently, they can mitigate possible soil erosion and consequent sediment pollution to downslope lands and waterways.

The Revised Universal Soil Loss Equation (RUSLE) is designed to predict the long term, average, annual soil loss from sheet and rill flow at nominated sites under specified management conditions. The predicted losses are empirically derived. The original application is described by Wishchmeier and Smith (1978) and revised by Renard, Foster, Weesies and Porter (1991) and Renard, Foster, Weesies, McCool and Yoder (1997). It has been adapted to urban sites and modified for Australian conditions in a computer program called SOILOSS (Rosewell, 1993). The equation is represented by:

$$A = RKLSPC$$

where, A = computed soil loss (tonne/ha/yr)
R = rainfall erosivity factor
K = soil erodibility factor
LS = slope length/gradient factor
P = erosion control practice factor
C = ground cover and management factors.

Typical values are given in Table 5.

Because the RUSLE takes into consideration all major components likely to affect sheet erosion, it is the most widely used (and abused) soil loss equation available. While it does have great practical value, its limitations should be recognised and understood.

The main limitations of the RUSLE are that it:

- only predicts sediment entrained in the erosion process and does not predict sediment yields into particular sediment basins; [3]
- predicts average annual soil loss and not that for a particular storm event;

3 In most situations, not all the sediment entrained on eroding lands is transported away from the site. However, at urban development sites where sediment trapping devices are very close to areas of erosion and most fine particles are flocculated, it can be assumed that most sediment entrained can be trapped.

- is effective for erosion through sheet and rill flow only on short slopes (<300 m) and not for concentrated flow or long slopes; and
- does not adequately take into account soil dispersibility in assessment of the *K*-factor.

Despite these matters, the RUSLE has its benefits and should be applied at all urban development sites, even at a cursory level, provided that any unmeasured factors are on the conservative side.

Table 14 Factors Used in the Interpretation of the RUSLE

Factors	Remarks
R - rainfall erosivity	Rainfall erosivity is a measure of the erosive force and intensity of rain in a normal year. In NSW, it varies from 500 to 9,500 while at the subject site it is 2,920 (Landcom, 2004)
K - soil erodibility	Soil erodibility is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. It can be normally expected to range from 0.005 to 0.02 on soils with low erodibility, from 0.021 to 0.04 to soils with moderate erodibility, and from 0.041 to 0.07 on soils with high erodibility
LS - slope length and gradient	Both slope length (metres) and gradient (per cent) have major effects on possible soil loss. They should be recorded as typical upper values for the site or unit in question. In the RUSLE, slope and length criteria are normally treated as a single entity, *LS*. On construction sites the *LS*-factor commonly ranges from 0.10 (flat, short slopes) to 5.0 (steep, long slopes)
P - erosion control practice	The erosion control practice is reflected in the roughening or smoothing of the soil surface by machinery, i.e. those practices that can reduce both the velocity of runoff and the tendency of runoff to flow directly downhill. *P*-factors normally range from 0.8 (low) to 1.3 (high). On construction sites assuming a worst case scenario of 1.3 is normal.
C - cover	The cover or *C*-factor, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from tilled, bare soil and taken as 1.0 — typical of urban construction sites. It normally ranges from about 0.005 on very well vegetated lands to 1.0 where the vegetation has been completely removed.

Table 15 and figure 16 provide indicative *C*-factors for some cover types.

Table 15 *C*-factors for Various Cover Types

Type of cover	***C*-factor**
No mulching or seeding, no plant roots	1.00
Little or no above-ground plant material but roots still intact and undisturbed (see figure A1)	0.45
Open-weave jute mesh (<40% coverage of soil surface)	0.40
Straw anchored * *to the soil at:*	
(i) 2.2 tonnes/ha and	
(a) 6-10% slope, up to 30 m long	0.20
(b) ≤5% slope, up to 60 m long	0.20
(ii) 4.5 tonnes/ha and	
(a) 34-50% slope, up to 10 m long	0.20
(b) 26-33% slope, up to 15 m long	0.17
(c) 21-25% slope, up to 22.5 m long	0.14
(d) 16-20% slope, up to 30 m long	0.11
(e) 11-15% slope, up to 45 m long	0.07
(f) 6-10% slope, up to 60 m long	0.06
(g) ≤5% slope up, to 120 m long	0.06
Woodchip applied at:	
(I) 16 tonnes/ha and	
(a) 16-20% slope, up to 15 m long	0.08
(b) ≤15% slope, up to 22.5 m long	0.08
(ii) 27 tonnes/ha and -	
(a) 21-33% slope, up to 22.5 m long	0.05
(b) 16-20% slope, up to 30 m long	0.05
(c) ≤15% slope, up to 45 m long	0.05
(iii) 56 tonnes/ha and -	
(a) 34-50% slope, up to 22.5 m long	0.02
(b) 21-33% slope, up to 30 m long	0.02
(c) 16-20% slope, up to 45 m long	0.02
(e) ≤15% slope, up to 60 m long	0.02
Woven straw blanket	0.08
Seeding grasses after 60 days (average conditions using perennial rye, small grains, millet or Sudan grass)	0.05
Bitumen emulsion (12,000 l/ha)	0.02
Jute fine mat (100% coverage of soil surface)	0.01
Sod (turf)	<0.01
Undisturbed native vegetation or well-established exotic grasses providing 100% cover	<0.01

* Rill erosion might occur beneath the mulch if it is not properly anchored. Accordingly, the soil loss factors could double those shown, especially on moderate or steep slopes and soils with moderate erodibilities.

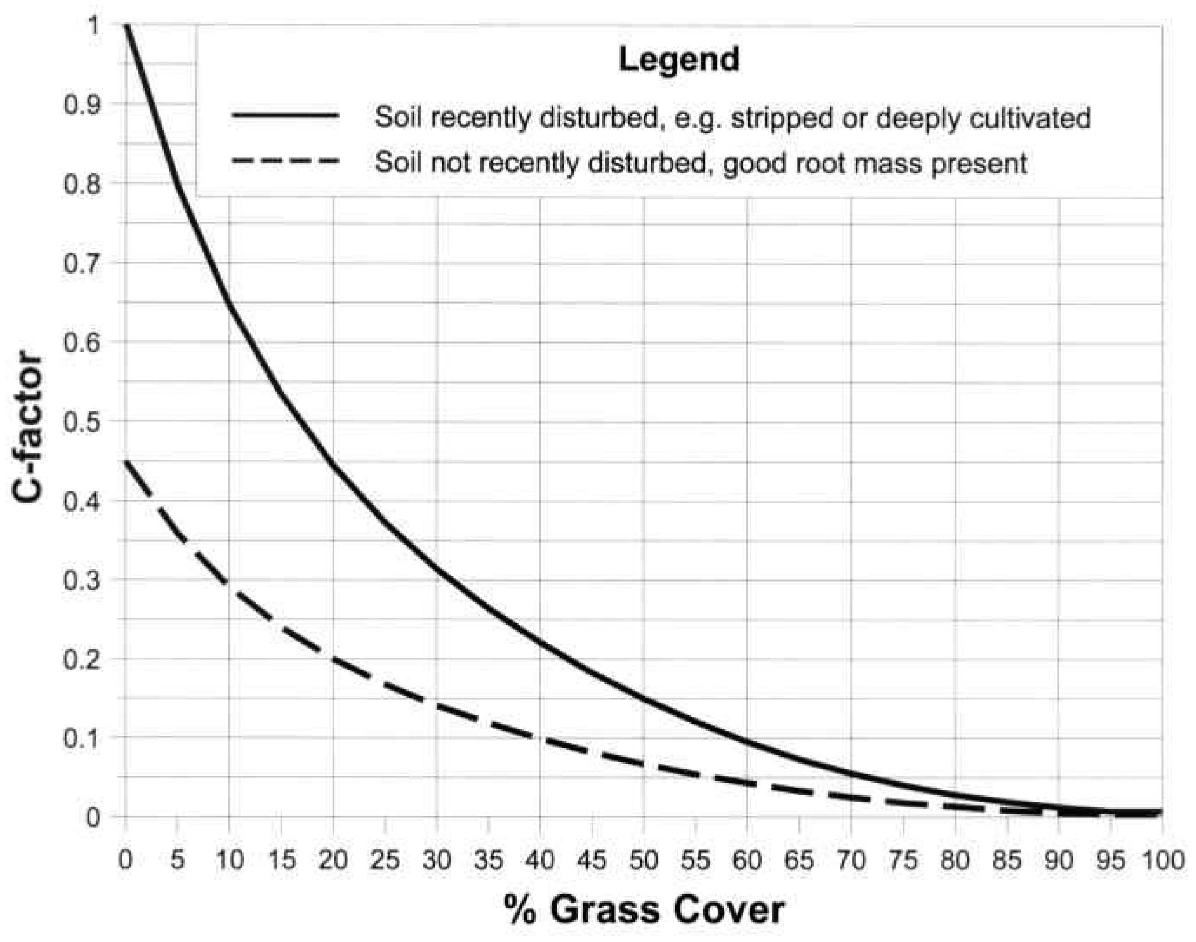
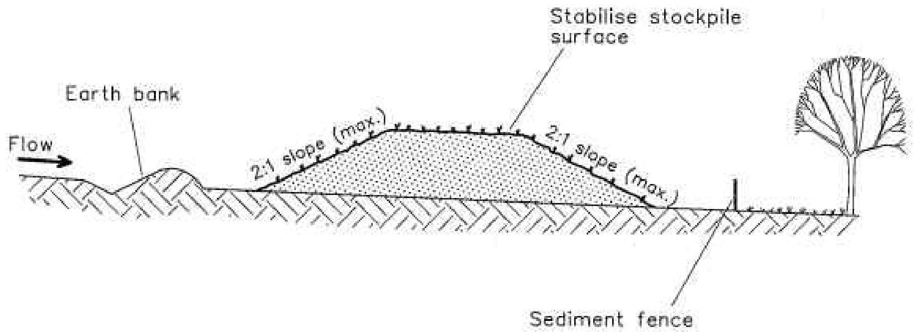


Figure 16 C-factors for established grass cover

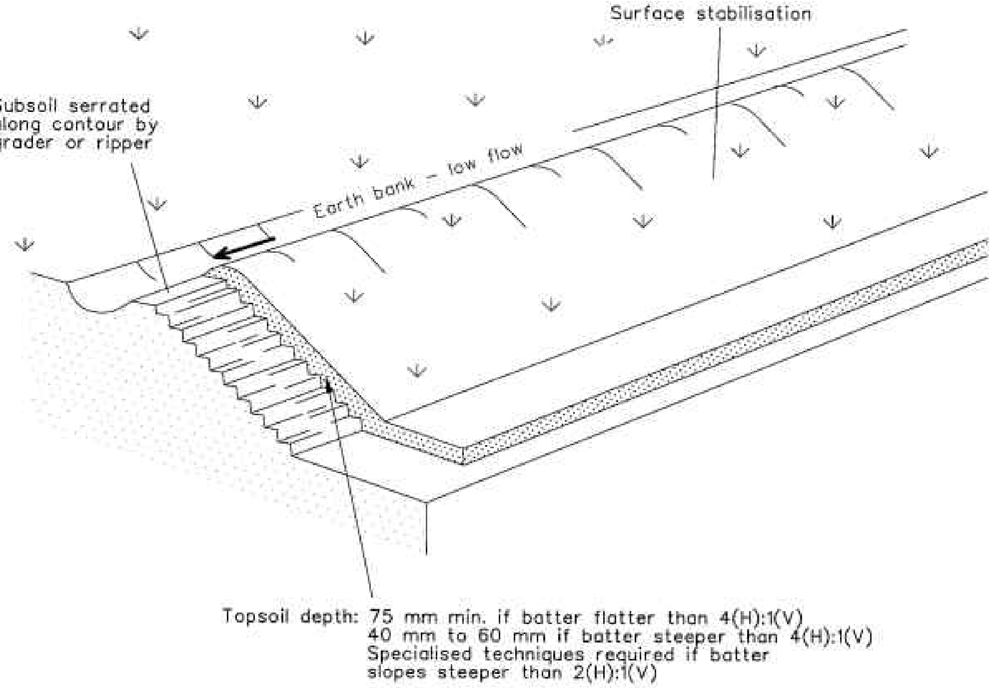
4 .3 Appendix 3 – Standard Drawings



Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES **SD 4-1**

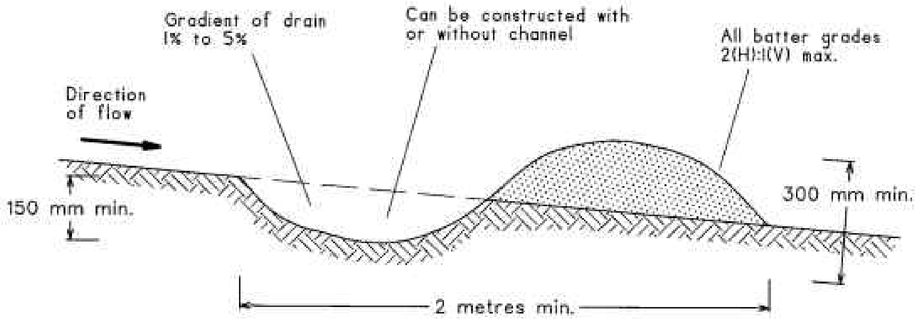


Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.
2. Add soil ameliorants as required by the ESCP or SWMP.
3. Rip to a depth of 300 mm if compacted layers occur.
4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

REPLACING TOPSOIL

SD 4-2

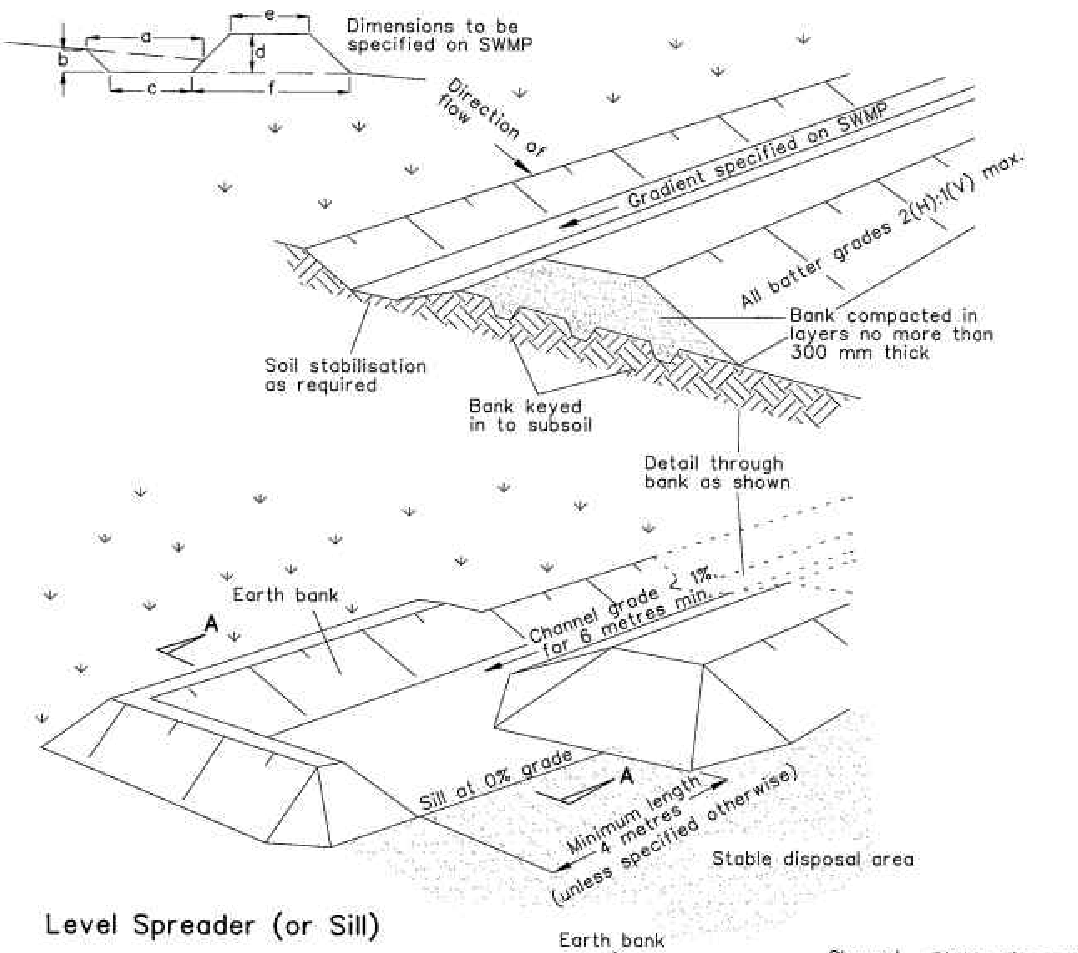


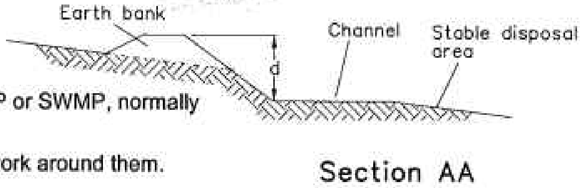
NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW) **SD 5-5**

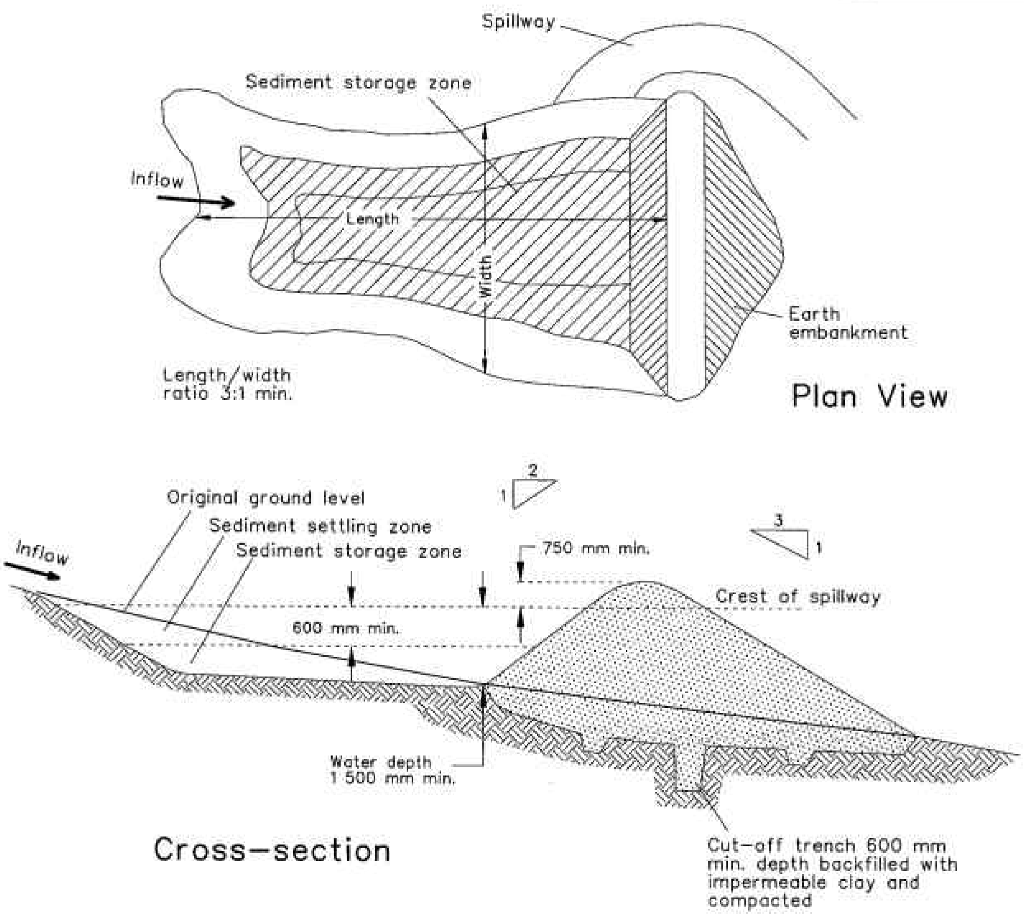




Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) **SD 5-6**



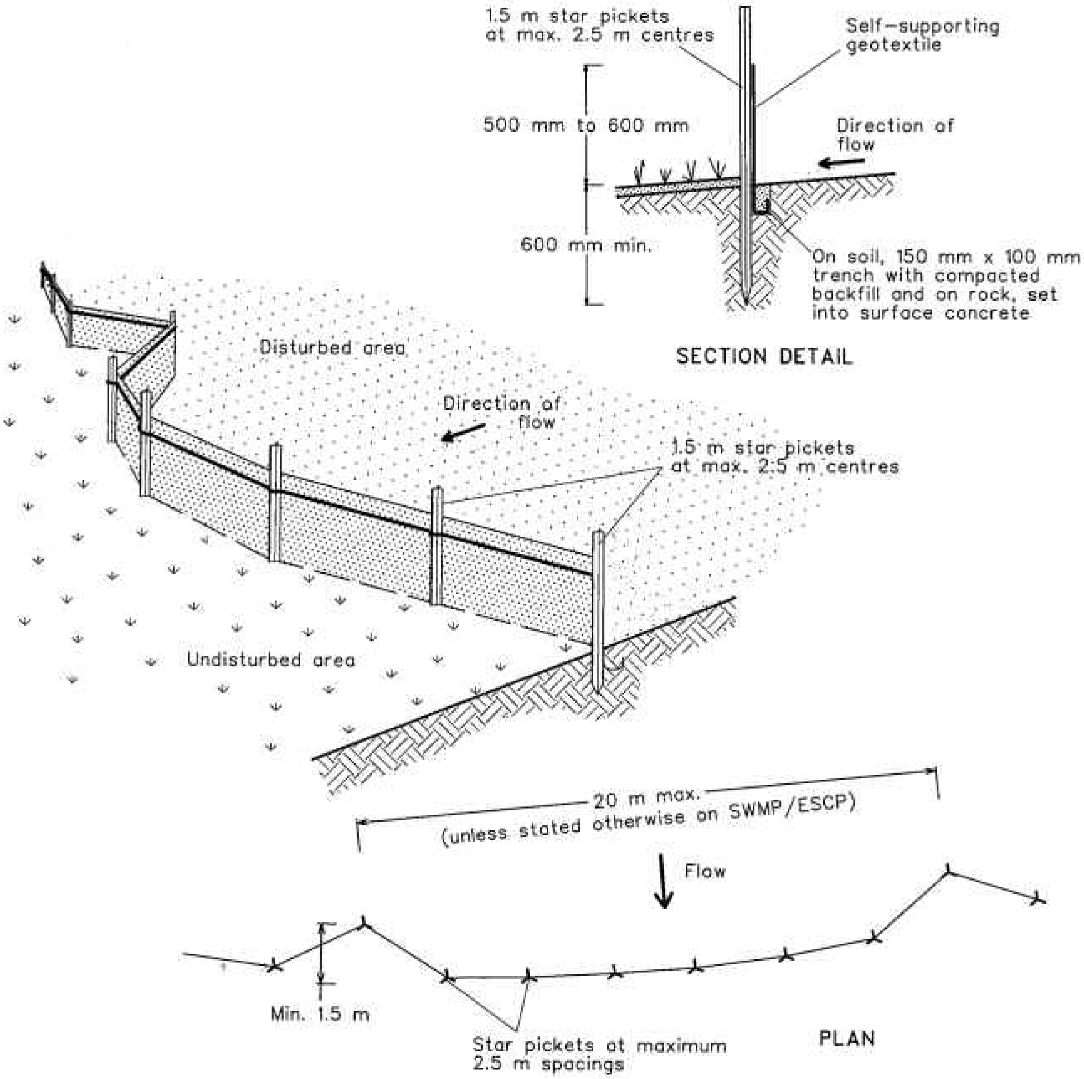
Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

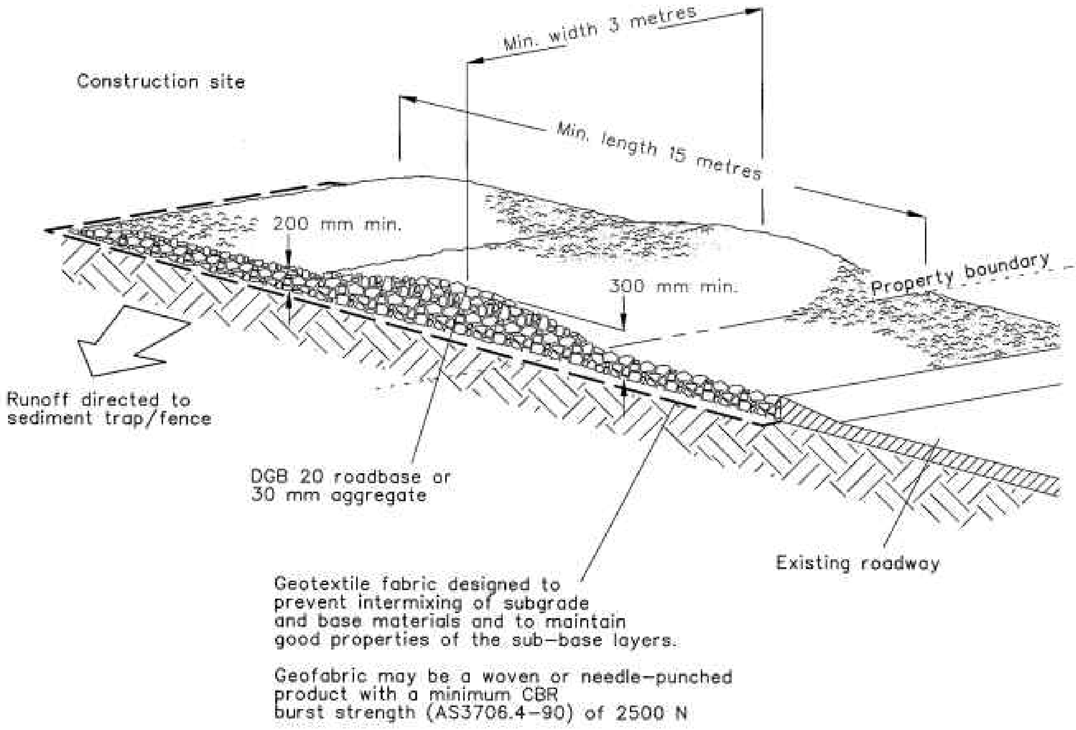
SD 6-4



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

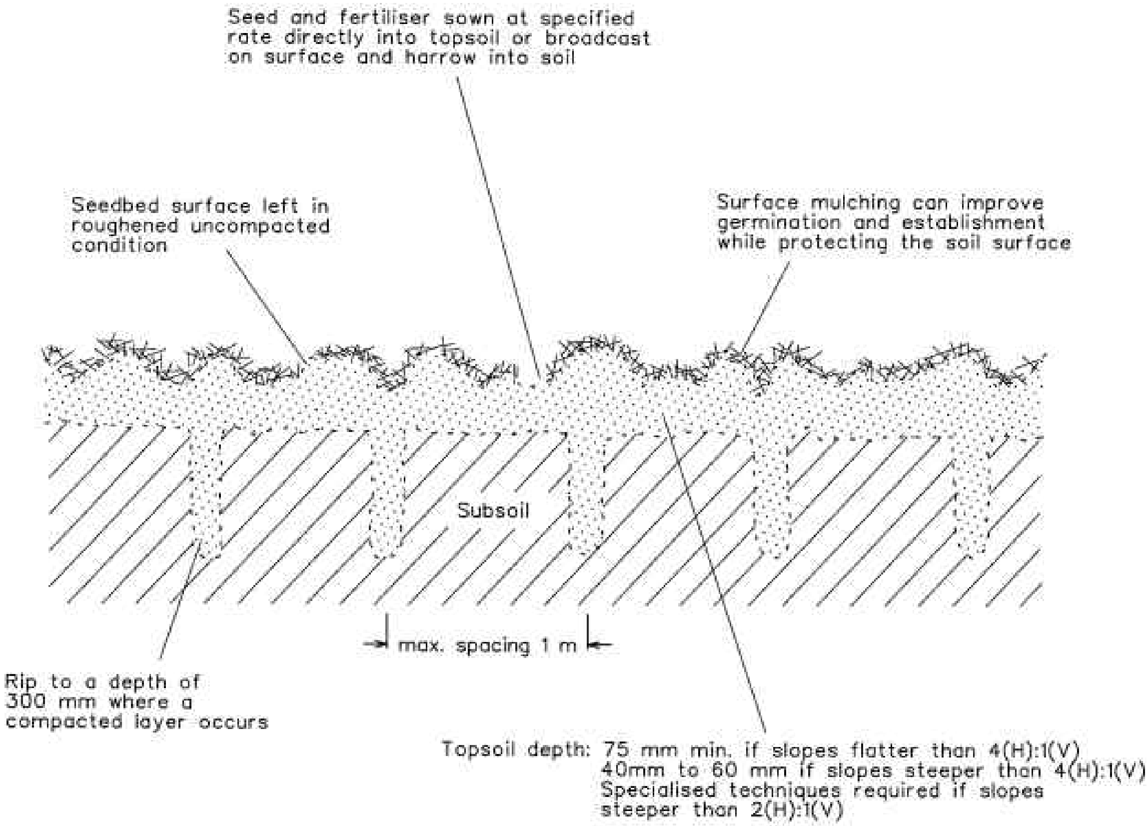
SEDIMENT FENCE **SD 6-8**



Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

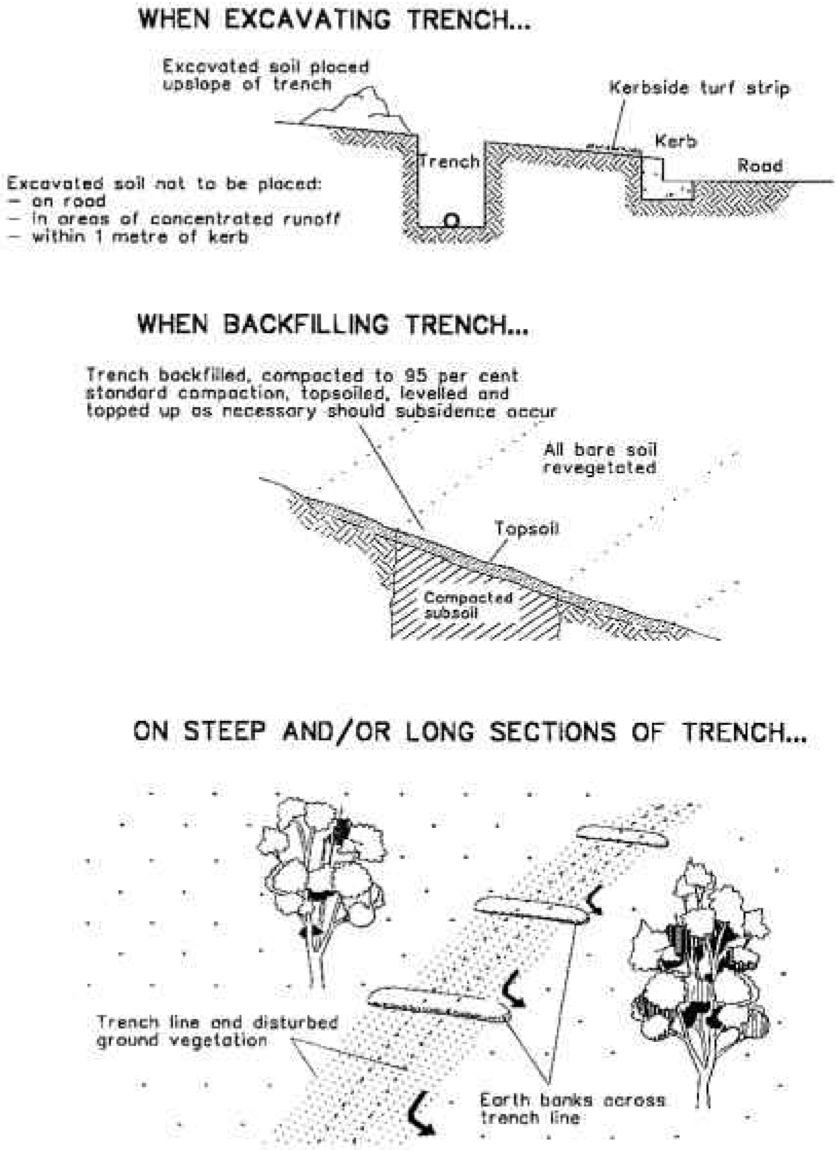
STABILISED SITE ACCESS **SD 6-14**



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION **SD 7-1**



Construction Notes

1. Do not open any trench unless it is likely to be closed in three days.
2. Place excavated material upslope of trench.
3. Stockpile topsoil separately from subsoil.
4. Divert runoff from the line of the cut with diversions as directed by Standard Drawing 5-2.
5. Rehabilitate in accordance with specification.

UTILITY CONSTRUCTION **SD 9-1**

4 .4 Appendix 4 – Sediment Basin, Earth Bank and Swale Calculations

1. Site Data Sheet

Site Name: Gunlake Quarry

Site Location: Brayton Road Marulan

Precinct:

Description of Site: Proposed Quarry

Site area	Sub-catchments						Remarks
	SB2	WQP3	WQP4	WQP1	WQP6	EB4	
Total catchment area (ha)	4.5	0.5	0.5	10.65	7	10	
Disturbed catchment area (ha)	3.6	0.5	0.5	9.2	0.5		
Soil analysis (enter sediment type if known, or laboratory particle size data)							
Sediment Type (C, F or D) if known:	D	D	D	D	D		From Appendix C
% sand (fraction 0.02 to 2.00 mm)							Soil texture should be assessed through
% silt (fraction 0.002 to 0.02 mm)							mechanical dispersion only. Dispersing
% clay (fraction finer than 0.002 mm)							agents (e.g. Calgon) should not be used
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D	D	D		Automatic calculation from above
Rainfall data							
Design rainfall depth (days)	10	10	10	10	10		See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	80	80	80	80	80		See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	32	32	32	32	32		See Section 6.3.4 (h)
Rainfall R-factor (if known)	1670	1670	1670	1670	1670	1670	See Appendix B
IFD: 2-year, 6-hour storm (if known)							See IFD chart for the site
RUSLE Factors							
Rainfall erosivity (*R*-factor)	1670	1670	1670	1670	1670	1670	Auto-filled from above
Soil erodibility (*K*-factor)	0.036	0.036	0.036	0.036	0.036		
Slope length (m)	80	80	80	80	30		
Slope gradient (%)	5	5	5	3	30		RUSLE LS factor calculated for a high rill/interrill ratio.
Length/gradient (*LS*-factor)	1.19	1.19	1.19	0.65	5.32		
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3		
Ground cover (*C*-factor)	1	1	1	1	1		
Calculations							
Soil loss (t/ha/yr)	93	93	93	51	416		
Soil Loss Class	1	1	1	1	4		See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	71	71	71	39	320		
Sediment basin storage volume, m^3	44	6	6	61	27		See Sections 6.3.4(i) and 6.3.5 (e)

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Q_y = 0.00278 \times C_{10} \times F_Y \times I_{y,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" year
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_Y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

To automatically halve the calculated time of concentration, place an "x" in this box:

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
SB2	4.5	14	62	105	121	141	168	190	0.88
WQP3	0.5	6	62	105	121	141	168	190	0.88
WQP4	0.5	6	62	105	121	141	168	190	0.88
WQP1	10.65	20	50	85	98	114	136	153	0.88
WQP5	7	17	40	67	76	88	105	118	0.5
EB4	10	19	37.6	63	72	84	99	112	0.5

Peak flow calculations, 2

ARI (yrs)	Frequency factor (F_y)	Peak flows						Comment
		SB2 (m^3/s)	WQP3 (m^3/s)	WQP4 (m^3/s)	WQP1 (m^3/s)	WQP5 (m^3/s)	EB4 (m3/s)	
1 yr,tc	0.57	0.389	0.043	0.043	0.743	0.222	0.298	
5 yr,tc	0.86	0.994	0.110	0.110	1.905	0.561	0.753	
10 yr,tc	1	1.332	0.148	0.148	2.553	0.739	1.001	
20 yr,tc	1.14	1.770	0.197	0.197	3.386	0.976	1.331	
50 yr,tc	1.33	2.460	0.273	0.273	4.713	1.359	1.830	
100 yr,tc	1.5	3.138	0.349	0.349	5.979	1.722	2.335	

Note: where catchments are significantly disturbed the rainfall intensities are based on a halved tc

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:

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

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

$R_{x\text{-day, }y\text{-\%ile}}$ = 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	$R_{x\text{-day, }y\text{-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
SB2	0.51	32	4.5	734.4	44	778.4
WQP3	0.51	32	0.5	81.6	6	87.6
WQP4	0.51	32	0.5	81.6	6	87.6
WQP1	0.51	32	10.65	1738.08	61	1799.08
WQP5	0.51	32	7	1142.4	27	1169.4
EB4			10			

1. Site Data Sheet

Site Name:	**Gunlake Quarry**
Site Location:	**Brayton Road Marulan**
Precinct:	
Description of Site:	**Proposed Quarry**

Site area	**Sub-catchments**						**Remarks**
	SW5b	EB2	EB5	SW5a	SW4	EB3	
Total catchment area (ha)	7.5	2.5	5	4	1.5	12.5	
Disturbed catchment area (ha)							
Soil analysis (enter sediment type if known, or laboratory particle size data)							
Sediment Type (C, F or D) if known:							From Appendix C
% sand (fraction 0.02 to 2.00 mm)							Soil texture should be assessed through
% silt (fraction 0.002 to 0.02 mm)							mechanical dispersion only. Dispersing
% clay (fraction finer than 0.002 mm)							agents (e.g. Calgon) should not be used
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group							Automatic calculation from above
Rainfall data							
Design rainfall depth (days)							See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)							See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event							See Section 6.3.4 (h)
Rainfall R-factor (if known)							See Appendix B
IFD: 2-year, 6-hour storm (if known)							See IFD chart for the site
RUSLE Factors							
Rainfall erosivity (*R*-factor)							Auto-filled from above
Soil erodibility (*K*-factor)							
Slope length (m)							
Slope gradient (%)							RUSLE LS factor calculated for a high
Length/gradient (*LS*-factor)							rill/interrill ratio.
Erosion control practice (*P*-factor)							
Ground cover (*C*-factor)							
Calculations							
Soil loss (t/ha/yr)							
Soil Loss Class							See Section 4.4.2(b)
Soil loss (m^3/ha/yr)							
Sediment basin storage volume, m^3							See Sections 6.3.4(i) and 6.3.5 (e)

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,tc} \times A$$

where: Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" year

C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F

F_Y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)

A is the catchment area in hectares (ha)

$I_{y,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

To automatically halve the calculated time of concentration, place an "x" in this box:

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
SW5b	7.5	17	55	94	108	125	150	169	0.88
EB2	2.5	11	50	82	94	109	1230	146	0.5
EB5	5	15	42.1	71	81	94	112	126	0.5
SW5a	4	13	58	99	114	133	158	178	0.88
SW4	1.5	9	66	113	129	151	180	203	0.88
EB3	12.5	21	50	85	98	114	136	153	0.88

Peak flow calculations, 2

ARI (yrs)	Frequency factor (F_y)	Peak flows						Comment
		SW5b (m^3/s)	EB2 (m^3/s)	EB5 (m^3/s)	SW5a (m^3/s)	SW4 (m^3/s)	EB3 (m3/s)	
1 yr,tc	0.57	0.575	0.099	0.167	0.324	0.138	0.872	
5 yr,tc	0.86	1.483	0.245	0.424	0.833	0.357	2.235	
10 yr,tc	1	1.982	0.327	0.563	1.116	0.473	2.997	
20 yr,tc	1.14	2.615	0.432	0.745	1.484	0.632	3.974	
50 yr,tc	1.33	3.660	5.685	1.035	2.056	0.879	5.531	
100 yr,tc	1.5	4.651	0.761	1.314	2.613	1.117	7.018	

Note: where catchments are significantly disturbed the rainfall intensities are based on a halved tc

4 .5 Appendix 5 – Flocculation Procedures for Sediment Basins

Gypsum (calcium sulfate) will be applied to all sediment basins after the conclusion of each rainfall event over 5 mm in sufficient time to allow settling of any dispersible fines (probably two days) and pumping out – all within 10 days. The gypsum will be mixed into a slurry with water (figure 16) and then sprayed over the basin surface. It is essential that the flocculating agent be spread evenly over the entire basin surface for proper treatment of water unless local experience or other criteria suggest differently. The gypsum will be applied at a rate of at least 32 kilograms per 100 cubic metres of stored water, with the actual rate being determined by the ability of the agent to reduce non filterable residues to 50 milligrams per litre of water or less. The supernatant waters can be discharged from each basin once these levels have been reached. If the gypsum is applied properly, 50 milligrams per litre of water or less should be achieved within 36 to 72 hours from application.

A discharge system will be established that:

- has a floating inlet to prevent flocculated sediments being removed as well — any materials from the sediment layer must not be discharged in the pumping process; and
- permits drainage of the pond in less than 24 hours.

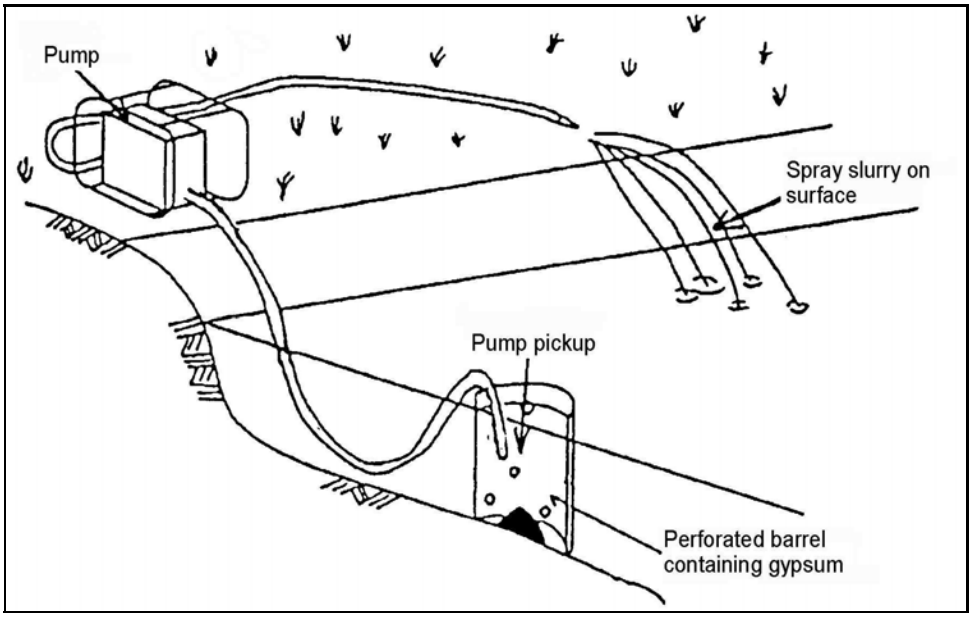


Figure 16 Application of gypsum. The drum will have about a 50-litre capacity with holes of about 25-mm diameter drilled on a 150-mm grid so water can enter

4 .6 Appendix 6: MUSIC Calibration

4 .6.1 Source Nodes

- Default MUSIC source nodes were used to model the existing agricultural lands
- Non-default source nodes were prepared for the other source nodes with stormflow pollutant concentrations calibrated as in Table 16. This data was derived from Fletcher *et al* (2004) Wong (2005) and verbal advice from Jim Caddey of SCA respectively.

Table 16 Stormflow concentration calibrations used in MUSIC at this site

	TSS mean (log mean)	TSS std dev (log std dev)	TP mean (log mean)	TP std dev (log std dev)	TN mean (log mean)	TN std dev (log std dev)
Roofs*	36 (1.556)	2.4 (0.380)	0.13 (-0.886)	1.941 (0.288)	2.0 (0.301)	1.778 (0.250)
Haul Roads/Gravel hardstands	800 (2.9)	4.6 (0.66)	0.29 (-0.538)	1.95 (0.29)	2.3 (0.362)	1.9 (0.28)
Sealed Access Road and by-pass	500 (2.7)	3.67 (0.565)	0.25 (-0.602)	2.75 (0.44)	2.1 (0.322)	1.97 (0.295)

* Note that roofs are assigned values as close to zero as MUSIC allows for the baseflow parameters, on the logical assumption that there is no flow from a roof unless it's raining.

- The pervious area storage characteristics for the various Soil Landscapes are as follows:

	Bindook Road (upper)	Bindook Road (mid and lower)	Jaqua
Soil storage capacity	137	514	256
Initial storage	2	30	20
Field capacity	74	242	134
Infiltration capacity coefficient “a”	250	90	250
Infiltration capacity coefficient “b”	1.5	4	3
Groundwater initial depth	20	20	20
Daily recharge rate:	50	10	25
Daily baseflow rate	5	12	4
Daily deep seepage rate:	10	5	10

4 .6.2 Treatment Nodes

Treatment nodes use default MUSIC parameters, as changing these criteria is not recommended in the absence of alternative measurements.

4 .7 Appendix 7 – RATES

RATES (Rainfall and Tank Excel Simulator) is a simple Excel spreadsheet that calculates runoff and tank supply, based on daily rainfall data provided by the Commonwealth Bureau of Meteorology. Users specify several parameters (listed below) and RATES then calculates various output statistics based on several simple algorithms.

4 .7.1 Input Criteria

Users can specify:

- the size of the rainwater tank,
- the roof area that drains to the rainwater tank,
- the runoff coefficient of the roof area draining to the rainwater tank,
- the size of the stormwater tank,
- the area that drains to the stormwater tank,
- the runoff coefficient of the area draining to the stormwater tank,
- the daily re-use from the rainwater tank (including a daily multiplier according to month),
- the daily re-use from the stormwater tank (including a daily multiplier according to month),
- the percent volume threshold of the rainwater tank at which mains top-up will occur,
- the daily inflow rate of the mains top-up into the rainwater tank if its volume falls below the top-up threshold,
- the daily outlet flow or infiltration rate out of the stormwater tank,
- the percent-full volume of each tank at startup,
- whether the rainwater tank overflows into the stormwater tank or not.

4 .7.2 Algorithms

RATES calculates a series of algorithms depending on the input data. If, for example there is no stormwater tank at a site, RATES simply calculates all values for stormwater re-use and supply as zero.

4 .7.3 Rainwater Tank

On any given day, RATES calculates the volume in the rainwater tank as:

Vol at end of previous day	+	(rainfall x roof area x runoff coefficient)	-	(daily use x monthly usage multiplier)	+	daily mains top-up rate (if tank is below threshold)

4 .7.4 Stormwater Tank

On any given day, RATES calculates the volume in the stormwater tank as:

Vol at end of previous day	+	(rainfall x catchment area x runoff coefficient)	+	overflow from rainwater tank (if specified)	-	(daily use x monthly usage multiplier)	-	daily trickle flow from storm tank

4 .7.5 Outputs

RATES produces outputs based on both totals for the entire modelling sequence and averages over the time length. Null values in the time sequence are treated as zero, and therefore they do not affect the model's accuracy. RATES calculates output statistics concerning:

- General Data
  - Model run length (days/years),
  - Average annual rainfall during the model run,
  - Maximum 24 hr rainfall during the model run,
  - Average daily rainfall during the model run,
  - Average daily rainfall on wet days only during the model run,
  - Total number of rain days during the model run.
- Rainwater Tank
  - Total inflow to rainwater tank (excluding top-up from mains),
  - Total and average annual overflow from rainwater tank,
  - Average overflow event size from rainwater tank,
  - Number of days rainwater tank overflowed,
  - Total and annual average amount supplied from rainwater tank,
  - Total and average annual amount of mains top-up,
  - Percentage of supply derived from the mains top-up,
  - Percentage of time that rainwater tank demand was met,
  - Maximum overflow amount from rainwater tank.
- Stormwater Tank
  - Total inflow to stormwater tank,
  - Total and average overflow from stormwater tank,
  - Average overflow event size from stormwater tank,
  - Number of days stormwater tank overflowed,
  - Total and annual average amount supplied from stormwater tank.

4 .7.6 Alternative Inputs

RATES inputs can be tailored to the site conditions, providing that they work within the bounds of reality set by the underlying algorithms. Based on the simple algorithms listed above, users can set the various tanks to represent a variety of potential structures. Likewise, the parameters that cause a reduction in tank volume (the daily use from each tank and the trickle flow from the stormwater tank) can be used to represent a variety of real-world events that would reduce tank volume.

4 .7.7 Limitations

RATES is based on daily rainfall data and cannot therefore be used as a definitive design tool in the design storm event. It is mainly for use in calculating annual runoff, supply versus demand and tank overflow, and is used for optimising tank sizes, mains top-up rates and top-up thresholds.

4 .8 Wastewater Balances

Table A4.8 -1 : Nominated Irrigation Area Method

Water Balance and Wet Weather Storage Calculations

Rainfall Station: Marulan
Expected Wastewater Quantity: 1,000 L/day

Design Wastewater Flow	(Q)	l/day	1000
Design Percolation Rate	(R)	mm/wk	25
Land Area	(L)	square metres	350

Parameter	Symbols	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	(D)		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	(P)		mm/month	61.5	51.6	49.1	39.3	33.8	45.9	32.2	33.8	38.5	47.7	49.8	53.0	698.7
Evaporation	(E)		mm/month	211.0	162.0	136.0	84.0	53.0	36.0	43.0	62.0	93.0	124.0	169.0	198.0	1371.0
Crop factor	(C)			0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	
Inputs																
Precipitation	(P)		mm/month	61.5	51.6	49.1	39.3	33.8	45.9	32.2	33.8	38.5	47.7	49.8	53.0	698.7
Effluent Irrigation	(W)	(Q x D) / L	mm/month	88.6	80.0	88.6	85.7	88.6	85.7	88.6	88.6	85.7	88.6	85.7	88.6	1042.9
Inputs		(P + W)	mm/month	150.1	131.6	137.7	125.0	122.4	131.6	120.8	122.4	124.2	136.3	135.5	141.6	1579.1
Outputs																
Evapotranspiration	(ET)	E x C	mm/month	168.8	129.6	108.8	58.8	37.1	25.2	30.1	43.4	65.1	99.2	135.2	158.4	1059.7
Percolation	(B)	(R / 7) x D	mm/month	110.7	100.0	110.7	107.1	110.7	107.1	110.7	110.7	107.1	110.7	107.1	110.7	1303.6
Outputs		(ET + B)	mm/month	279.5	229.6	219.5	165.9	147.8	132.3	140.8	154.1	172.2	209.9	242.3	269.1	2363.3
Storage	(S)	(P +W)-(ET +B)	mm/month	-129.4	-98.0	-81.8	-40.9	-25.4	-0.7	-20.0	-31.7	-48.0	-73.6	-106.8	-127.5	
Cumulative Storage	(M)		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Storage	**(V)**	**Largest M**	**mm**	**0.0**
		(V X L) / 1000	**m^3**	**0.0**

Table A4.8 - 2 : Nutrient Balances

Quantity: 800 l/day

Nitrogen Balance

The formula used to determine area requirements based on organic matter and nutrient loads is as follows:

$$A = \frac{C \times Q}{L_x}$$

Where:

A = Land area (m^2)

C = Concentration of nutrient or BOD (mg/l)
= 20 mg/l

Q = treated wastewater flow rate (l/d)
= 800 l/d

L_x = critical loading rate of nutrient or BOD ($mg/m^2/d$)
= 25 $mg/m^2/d$

Nitrogen Loading

A = 640 m^2 minimum area for total nitrogen

Phosphorus Loading

Determine the amount of phosphorus that can be absorbed without reaching over 50 years.

$P_{absorbed}$ = 6000 x 1/3
= 2000 kg/ha
= 0.2 kg/m^2

Determine the amount of vegetation uptake over 50 years.

P_{uptake} = 3 x 365 x 50
= 54 750 mg/m^2
= 0.055 kg/m^2

Determine the amount of phosphorus generated over that time.

C = Concentration of phosphorus (mg/l)
= 12 mg/l

$P_{generated}$ = total phosphorus concentration x volume of wastewater
= 175.2 kg

Irrigation area = $P_{generated}/(P_{absorbed} + P_{uptake})$
= 687 m^2

4 .9 Appendix 9 – Results of Water Quality Analyses (2007), Chapmans Creek

See over page.

Water Analysis Report Number: GQ070215

Date Issued: 1/03/2007

Client: Gunlake Quarries
Address PO Box 1665
Double Bay NSW 1360
Contact: Mr. E. O'Neill

Sampling:

Sampled by: Client
Samples Received: 15/02/07
Sampling Method: Unkown, not covered by endorsment

Laboratory:

VGT Pty Limited
Contact: Tara O'Brien
Date Analysed: 15/02/07
Location Analysed: 2/128 Melbourne St, East Maitland, NSW 2323.
Samples analysed as received

Sample ID	Client Identification	Date & Time	Comments
GQ070215/01	I	14/02/07	
GQ070215/02	D	14/02/07	
GQ070215/03	O	14/02/07	

NATA Accredited Laboratory - 15230. Scope of Accreditation covers: Sampling, pH, Electrical Conductivity, Total Suspended Solids, and Turbidity. All methods are EPA approved and based on APHA 20th Edition and Australian Standards. This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ICO/IEC 17025.

Water Analysis Report Number: GQ070215

Date Issued: 1/03/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Temperature (ºC)	pH	Conductivity (µS/cm k 25.00C)	TDS* (mg/L)	Salinity* (g/kg)
				Method Code	VGT-WI01	VGT-WI02	EA015	EA020
				Limit of Reading 0.1	0.1	1	1	0.01
GQ070215/01	I	14/02/07	15/02/07	24.7	6.8	111	110	0.06
GQ070215/02	D	14/02/07	15/02/07	24.8	6.4	69	111	0.04
GQ070215/03	O	14/02/07	15/02/07	24.7	6.5	279	207	0.12
GQ070215/03	O Duplicate	14/02/07	15/02/07	24.7	6.5	279	-	-
QC Samples	Standard Recovery (%)	-	15/02/07	-	101	101	100	-
QC Samples	Blank	-	15/02/07	-	-	<1	<1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	15/02/07	-	-	-	6	-

Comments:

This final report replaces any previous reports with the number GQ070215.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0702080.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070215

Date Issued: 1/03/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Chloride* (mg/L)	Sodium* (mg/L)	Arsenic* (mg/L)	Manganese* (mg/L)	Iron* (mg/L)
				ED045G	ED093F	EG020T	EG020T	EG020T
		Limit of Reading		1	1	0.001	0.001	0.05
GQ070215/01	I	14/02/07	15/02/07	17.5	11	<0.001	0.189	8.80
GQ070215/02	D	14/02/07	15/02/07	4.8	4	<0.001	0.111	1.54
GQ070215/03	O	14/02/07	15/02/07	51.2	22	<0.001	0.030	1.76
QC Samples	Standard Recovery (%)	-	15/02/07	104	101	91	89	92
QC Samples	Blank	-	15/02/07	<1	<1	<0.001	<0.001	<0.05
QC Samples	Relative Percentage Difference in Duplicates (%)	-	15/02/07	9.3	6.3	0.0	18	11

Comments:

This final report replaces any previous reports with the number GQ070215.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0702080.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070215

Date Issued: 1/03/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Nitrite as N* (mg/L)	Nitrate as N* (mg/L)	NO x as N* (mg/L)	TKN* (mg/L)	Total N* (mg/L)
				EK057G	EK058G	EK059G	EK061	EK062
		Limit of Reading		0.01	0.01	0.01	0.1	0.1
GQ070215/01	I	14/02/07	15/02/07	0.022	0.029	0.051	4.6	4.7
GQ070215/02	D	14/02/07	15/02/07	0.048	0.900	0.948	3.3	4.2
GQ070215/03	O	14/02/07	15/02/07	0.087	1.50	1.58	2.5	4.1
QC Samples	Standard Recovery (%)	-	15/02/07	106.00	-	89	98	99
QC Samples	Blank	-	15/02/07	<0.01	-	<0.01	<0.1	<0.1
QC Samples	Relative Percentage Difference in Duplicates (%)	-	15/02/07	0.0	-	14.2	20	-

Comments:

This final report replaces any previous reports with the number GQ070215.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0702080.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070215

Date Issued: 1/03/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Total Phosphorus as P* (mg/L)	Reactive Phosphorus as P* (mg/L)	TPH (C6-C9)* (µg/L)	TPH (C10-C14)* (µg/L)	TPH (C15-C28)* (µg/L)	TPH (C29-C36)* (µg/L)
				EK067G	EK071G	EP080/071	EP080/071	EP080/071	EP080/071
		Limit of Reading		0.01	0.01	20	50	100	50
GQ070215/01	I	14/02/07	15/02/07	5.55	0.019	<20	<50	400	90
GQ070215/02	D	14/02/07	15/02/07	3.15	0.182	<20	<50	<100	<50
GQ070215/03	O	14/02/07	15/02/07	0.26	0.079	<20	<50	300	80
QC Samples	Standard Recovery (%)	-	15/02/07	106	90	112	89	100	78
QC Samples	Blank	-	15/02/07	<0.01	<0.01	<20	<50	<100	<50
QC Samples	Relative Percentage Difference in Duplicates (%)	-	15/02/07	0.0	11	0	0	0	0

Comments:

This final report replaces any previous reports with the number GQ070215.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0702080.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070215

Date Issued: 1/03/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Benzene* (µg/L)	Toluene* (µg/L)	Ethlybenzene* (µg/L)	m- & p- Xylene* (µg/L)	o- Xylene* (µg/L)
				EP080	EP080	EP080	EP080	EP080
		Limit of Reading		1	2	2	2	2
GQ070215/01	I	14/02/07	15/02/07	<1	<2	<2	<2	<2
GQ070215/02	D	14/02/07	15/02/07	<1	<2	<2	<2	<2
GQ070215/03	O	14/02/07	15/02/07	<1	<2	<2	<2	<2
QC Samples	Standard Recovery (%)	-	15/02/07	103.00	100	94	100	99
QC Samples	Blank	-	15/02/07	<1	<2	<2	<2	<2
QC Samples	Relative Percentage Difference in Duplicates (%)	-	15/02/07	0.0	0.0	0.0	0	0

Comments:

This final report replaces any previous reports with the number GQ070215.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0702080.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070326

Date Issued: 5/04/2007

Client: Gunlake Quarries
Address: PO Box 1665
Double Bay NSW 1360
Contact: Mr. E. O'Neill

Sampling:
Sampled by: Client **Samples Received:** 26/03/07
Sampling Method: Unnown

Laboratory: VGT Pty Limited **Contact:** Tara O'Brien
Date Analysed: 26/03/07
Location Analysed: 2/128 Melbourne St, East Maitland, NSW 2323.
Samples analysed as received

Sample ID	Client Identification	Date & Time	Comments
GQ070326/01	D	22/03/2007	
GQ070326/02	O	22/03/2007	
GQ070326/03	I	22/03/2007	

NATA Accredited Laboratory - 15230. Scope of Accreditation covers: Sampling, pH, Electrical Conductivity, Total Suspended Solids, and Turbidity. All methods are EPA approved and based on APHA 20th Edition and Australian Standards. This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ICO/IEC 17025.

Water Analysis Report Number: GQ070326

Date Issued: 5/04/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Temperature (ºC)	pH	Conductivity (µS/cm k 25.00C)	TDS* (mg/L)	Salinity* (g/kg)
				Method Code	VGT-WI01	VGT-WI02	EA015	EA020
				Limit of Reading 0.1	0.1	1	1	0.01
GQ070326/01	D	22/03/07	26/03/07	23.9	6.6	84	77	0.05
GQ070326/02	O	22/03/07	26/03/07	23.9	7.5	400	252	0.19
GQ070326/03	I	22/03/07	26/03/07	23.8	6.6	142	213	0.07
QC Samples	Standard Recovery (%)	-	26/03/07	-	100	100	92	-
QC Samples	Blank	-	26/03/07	-	-	<1		-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	26/03/07	-	0.6	3.0	1	-

Comments:

This final report replaces any previous reports with the number GQ070326.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0703846.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070326

Date Issued: 5/04/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Chloride* (mg/L)	Sodium* (mg/L)	Arsenic* (mg/L)	Manganese* (mg/L)	Iron* (mg/L)
				ED045G	ED093F	EG020T	EG020T	EG020T
		Limit of Reading		1.0	1	0.001	0.001	0.05
GQ070326/01	D	22/03/07	26/03/07	3.9	4	<0.001	0.417	1.93
GQ070326/02	O	22/03/07	26/03/07	47.6	26	0.002	0.104	0.91
GQ070326/03	I	22/03/07	26/03/07	7.3	8	0.003	0.832	5.57
QC Samples	Standard Recovery (%)	-	26/03/07	105	89	94	94	93
QC Samples	Blank	-	26/03/07	<1.0	<1	<0.001	<0.001	<0.05
QC Samples	Relative Percentage Difference in Duplicates (%)	-	26/03/07	0.3	0.6	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070301.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0703846.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070326

Date Issued: 5/04/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Nitrite as N* (mg/L)	Nitrate as N* (mg/L)	NO x as N* (mg/L)	TKN* (mg/L)	Total N* (mg/L)
				EK057G	EK058G	EK059G	EK061	EK062
		Limit of Reading		0.010	0.010	0.010	0.1	0.1
GQ070326/01	D	22/03/07	26/03/07	<0.010	<0.010	<0.010	2.9	2.9
GQ070326/02	O	22/03/07	26/03/07	0.020	<0.010	<0.010	1.7	1.7
GQ070326/03	I	22/03/07	26/03/07	0.012	<0.010	<0.010	2.5	2.5
QC Samples	Standard Recovery (%)	-	26/03/07	119	-	104	106	-
QC Samples	Blank	-	26/03/07	<0.010	-	<0.010	<0.1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	26/03/07	0.0	-	0.1	0.0	-

Comments:

This final report replaces any previous reports with the number GQ070301.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0703846.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070326

Date Issued: 5/04/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Total Phosphorus as P* (mg/L)	Reactive Phosphorus as P* (mg/L)	TPH (C6-C9)* (µg/L)	TPH (C10-C14)* (µg/L)	TPH (C15-C28)* (µg/L)	TPH (C29-C36)* (µg/L)
				EK067G	EK071G	EP080/071	EP080/071	EP080/071	EP080/071
		Limit of Reading		0.01	0.010	20	50	100	50
GQ070326/01	D	22/03/07	26/03/07	0.22	0.012	<20	<50	200	370
GQ070326/02	O	22/03/07	26/03/07	0.07	<0.010	<20	<50	300	300
GQ070326/03	I	22/03/07	26/03/07	0.12	0.020	<20	<50	500	340
QC Samples	Standard Recovery (%)	-	26/03/07	96	102	80	87	87	95
QC Samples	Blank	-	26/03/07	<0.01	<0.01	<20	<50	<100	<50
QC Samples	Relative Percentage Difference in Duplicates (%)	-	26/03/07	4.7	0.2	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070301.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0703846.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070326

Date Issued: 5/04/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Benzene* (µg/L)	Toluene* (µg/L)	Ethlybenzene* (µg/L)	m- & p- Xylene* (µg/L)	o- Xylene* (µg/L)
				EP080	EP080	EP080	EP080	EP080
		Limit of Reading		1	2	2	2	2
GQ070326/01	D	22/03/07	26/03/07	<1	<2	<2	<2	<2
GQ070326/02	O	22/03/07	26/03/07	<1	<2	<2	<2	<2
GQ070326/03	I	22/03/07	26/03/07	<1	<2	<2	<2	<2
QC Samples	Standard Recovery (%)	-	26/03/07	88.70	89	85	85	86
QC Samples	Blank	-	26/03/07	<1	<2	<2	<2	<2
QC Samples	Relative Percentage Difference in Duplicates (%)	-	26/03/07	0.0	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070301.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0703846.

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070427

Date Issued: 7/05/2007

Client: Gunlake Quarries
Address PO Box 1665
Double Bay NSW 1360
Contact: Mr. E. O'Neill

Sampling:

Sampled by: Client **Samples Received:** 27/04/07
Sampling Method: Unnown, sampling not covered by endorsement

Laboratory: VGT Pty Limited **Contact:** Tara O'Brien
Date Analysed: 27/04/07
Location Analysed: 2/128 Melbourne St, East Maitland, NSW 2323.
Samples analysed as received

Sample ID	Client Identification	Date & Time	Comments
GQ070427/01	D	26/04/2007	
GQ070427/02	O	26/04/2007	
GQ070427/03	I	26/04/2007	

NATA Accredited Laboratory - 15230. Scope of Accreditation covers: Sampling, pH, Electrical Conductivity, Total Suspended Solids, and Turbidity. All methods are EPA approved and based on APHA 20th Edition and Australian Standards. This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ICO/IEC 17025.

Water Analysis Report Number: GQ070427

Date Issued: 7/05/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Temperature (ºC)	pH	Conductivity (µS/cm k 25.00C)	TDS* (mg/L)	Salinity* (g/kg)
				Method Code	VGT-WI01	VGT-WI02	EA015	EA020
				Limit of Reading 0.1	0.1	1	1	0.01
GQ070427/01	D	26/04/07	27/04/07	19.0	6.7	109	128	0.05
GQ070427/02	O	26/04/07	27/04/07	19.0	8.1	542	364	0.29
GQ070427/03	I	26/04/07	27/04/07	19.0	7.0	205	800	0.11
QC Samples	Standard Recovery (%)	-	27/04/07	-	100	101	106	-
QC Samples	Blank	-	27/04/07	-	-	<1	<1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	27/04/07	-	-	6.0	0.6	-

Comments:

This final report replaces any previous reports with the number GQ070427.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0705553

Analyst:

Lisa Thomson

Date: 7/05/2007

Water Analysis Report Number: GQ070427

Date Issued: 7/05/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Chloride* (mg/L)	Sodium* (mg/L)	Arsenic* (mg/L)	Manganese* (mg/L)	Iron* (mg/L)
				ED045G	ED093F	EG020T	EG020T	EG020T
		Limit of Reading		1.0	1	0.001	0.001	0.05
GQ070427/01	D	26/04/07	27/04/07	4.2	3	0.004	0.972	4.74
GQ070427/02	O	26/04/07	27/04/07	82.1	42	<0.001	0.080	0.44
GQ070427/03	I	26/04/07	27/04/07	20.4	14	0.007	1.70	28.6
QC Samples	Standard Recovery (%)	-	27/04/07	100	90	99	99	97
QC Samples	Blank	-	27/04/07	<1.0	<1	<0.001	<0.001	<0.05
QC Samples	Relative Percentage Difference in Duplicates (%)	-	27/04/07	3.6	0.4	0.0	3.9	1.4

Comments:

This final report replaces any previous reports with the number GQ070427.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0705553

Analyst:

Lisa Thomson

Date: 7/05/2007

Water Analysis Report Number: GQ070427

Date Issued: 7/05/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Nitrite as N* (mg/L)	Nitrate as N* (mg/L)	NO x as N* (mg/L)	TKN* (mg/L)	Total N* (mg/L)
				EK057G	EK058G	EK059G	EK061	EK062
		Limit of Reading		0.010	0.010	0.010	0.1	0.1
GQ070427/01	D	26/04/07	27/04/07	<0.010	0.014	0.014	3.7	3.7
GQ070427/02	O	26/04/07	27/04/07	<0.010	0.010	0.010	1.7	1.7
GQ070427/03	I	26/04/07	27/04/07	<0.010	0.036	0.036	8.7	8.8
QC Samples	Standard Recovery (%)	-	27/04/07	99	-	114	117	-
QC Samples	Blank	-	27/04/07	<0.010	-	<0.010	<0.1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	27/04/07	0.0	-	0.1	0.0	-

Comments:

This final report replaces any previous reports with the number GQ070427.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0705553

Analyst:

Lisa Thomson

Date: 7/05/2007

Water Analysis Report Number: GQ070427

Date Issued: 7/05/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Total Phosphorus as P* (mg/L)	Reactive Phosphorus as P* (mg/L)	TPH (C6-C9)* (µg/L)	TPH (C10-C14)* (µg/L)	TPH (C15-C28)* (µg/L)	TPH (C29-C36)* (µg/L)
				EK067G	EK071G	EP080/071	EP080/071	EP080/071	EP080/071
		Limit of Reading		0.01	0.010	20	50	100	50
GQ070427/01	D	26/04/07	27/04/07	0.26	0.035	<20	<50	300	230
GQ070427/02	O	26/04/07	27/04/07	0.05	<0.010	<20	<50	200	100
GQ070427/03	I	26/04/07	27/04/07	1.22	0.249	<20	<50	600	350
QC Samples	Standard Recovery (%)	-	27/04/07	101	104	106	82	80	85
QC Samples	Blank	-	27/04/07	<0.01	<0.01	<20	<50	<100	<50
QC Samples	Relative Percentage Difference in Duplicates (%)	-	27/04/07	0.0	0.0	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070427.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0705553

Analyst:

Lisa Thomson

Date: 7/05/2007

Water Analysis Report Number: GQ070427

Date Issued: 7/05/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Benzene* (µg/L)	Toluene* (µg/L)	Ethlybenzene* (µg/L)	m- & p- Xylene* (µg/L)	o- Xylene* (µg/L)
				EP080	EP080	EP080	EP080	EP080
		Limit of Reading		1	2	2	2	2
GQ070427/01	D	26/04/07	27/04/07	<1	<2	<2	<2	<2
GQ070427/02	O	26/04/07	27/04/07	<1	<2	<2	<2	<2
GQ070427/03	I	26/04/07	27/04/07	<1	<2	<2	<2	<2
QC Samples	Standard Recovery (%)	-	27/04/07	93	91	92	91	106
QC Samples	Blank	-	27/04/07	<1	<2	<2	<2	<2
QC Samples	Relative Percentage Difference in Duplicates (%)	-	27/04/07	0.0	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070427.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0705553

Analyst:

Lisa Thomson

Date: 7/05/2007

Water Analysis Report Number: GQ070529

Date Issued: 6/06/2007

Environmental
Compliance
Solutions

Client: Gunlake Quarries
Address PO Box 1665
Double Bay NSW 1360
Contact: Mr. E. O'Neill

Sampling:

Sampled by: Client **Samples Received:** 29/05/07
Sampling Method: Unnown, sampling not covered by endorsement

Laboratory:

VGT Pty Limited **Contact:** Tara O'Brien
Date Analysed: 29/05/07
Location Analysed: 2/128 Melbourne St, East Maitland, NSW 2323.
Samples analysed as received

Sample ID	Client Identification	Date & Time	Comments
GQ070529/01	D	28/05/2007	
GQ070529/02	I	28/05/2007	
GQ070529/03	O	28/05/2007	

NATA Accredited Laboratory - 15230. Scope of Accreditation covers: Sampling, pH, Electrical Conductivity, Total Suspended Solids, and Turbidity. All methods are EPA approved and based on APHA 20th Edition and Australian Standards. This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ICO/IEC 17025.

NATA
WORLD RECOGNISED
ACCREDITATION

Water Analysis Report Number: GQ070529

Date Issued: 6/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Temperature (ºC)	pH	Conductivity (µS/cm k 25.00C)	TDS* (mg/L)	Salinity* (g/kg)
				Method Code	VGT-WI01	VGT-WI02	EA015	EA020
				Limit of Reading 0.1	0.1	1	1	0.01
GQ070529/01	D	28/05/07	29/05/07	17.9	7.0	115	118	0.07
GQ070529/02	I	28/05/07	29/05/07	13.9	6.5	61	91	0.04
GQ070529/03	O	28/05/07	29/05/07	18.4	8.0	611	332	0.31
QC Samples	Standard Recovery (%)	-	29/05/07	-	100	101	92	-
QC Samples	Blank	-	29/05/07	-	-	<1	<1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	29/05/07	-	-	0.0	0.5	-

Comments:

This final report replaces any previous reports with the number GQ070529.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0707130

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070529

Date Issued: 6/06/2007

Environmental Compliance Solutions

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Chloride* (mg/L)	Sodium* (mg/L)	Arsenic* (mg/L)	Manganese* (mg/L)	Iron* (mg/L)
				ED045G	ED093F	EG020T	EG020T	EG020T
		Limit of Reading		1.0	1	0.001	0.001	0.05
GQ070529/01	D	28/05/07	29/05/07	4.4	4	0.002	0.940	7.82
GQ070529/02	I	28/05/07	29/05/07	6.2	9	<0.001	0.023	2.52
GQ070529/03	O	28/05/07	29/05/07	90.2	47	<0.001	0.164	0.36
QC Samples	Standard Recovery (%)	-	29/05/07	100	97	98	98	92
QC Samples	Blank	-	29/05/07	<1.0	<1	<0.001	<0.001	<0.05
QC Samples	Relative Percentage Difference in Duplicates (%)	-	29/05/07	0.0	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070529.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0707130

Analyst: Lisa Thomson

Date: 6/06/2007

NATA

WORLD RECOGNISED ACCREDITATION

Water Analysis Report Number: GQ070529

Date Issued: 6/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Nitrite as N* (mg/L)	Nitrate as N* (mg/L)	NO x as N* (mg/L)	TKN* (mg/L)	Total N* (mg/L)
				EK057G	EK058G	EK059G	EK061	EK062
		Limit of Reading		0.010	0.010	0.010	0.1	0.1
GQ070529/01	D	28/05/07	29/05/07	0.017	<0.010	0.017	6.3	6.3
GQ070529/02	I	28/05/07	29/05/07	0.034	0.114	0.148	1.5	1.6
GQ070529/03	O	28/05/07	29/05/07	<0.010	<0.010	<0.010	1.9	1.9
QC Samples	Standard Recovery (%)	-	29/05/07	97	-	95	89	-
QC Samples	Blank	-	29/05/07	<0.010	-	<0.010	<0.1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	29/05/07	34.5	-	26.7	0.0	-

Comments:

This final report replaces any previous reports with the number GQ070529.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0707130

Analyst: Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070529

Date Issued: 6/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Total Phosphorus as P* (mg/L)	Reactive Phosphorus as P* (mg/L)	TPH (C6-C9)* (µg/L)	TPH (C10-C14)* (µg/L)	TPH (C15-C28)* (µg/L)	TPH (C29-C36)* (µg/L)
				EK067G	EK071G	EP080/071	EP080/071	EP080/071	EP080/071
		Limit of Reading		0.01	0.010	20	50	100	50
GQ070529/01	D	28/05/07	29/05/07	0.46	0.184	<20	<50	300	180
GQ070529/02	I	28/05/07	29/05/07	0.04	0.024	<20	<50	400	110
GQ070529/03	O	28/05/07	29/05/07	0.12	<0.010	<20	<50	200	110
QC Samples	Standard Recovery (%)	-	29/05/07	96	98	82	86	88	88
QC Samples	Blank	-	29/05/07	<0.01	<0.01	<20	<50	<100	<50
QC Samples	Relative Percentage Difference in Duplicates (%)	-	29/05/07	4.9	1.6	1.9	-	-	-

Comments:

This final report replaces any previous reports with the number GQ070529.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0707130

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070529

Date Issued: 6/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Benzene* (µg/L)	Toluene* (µg/L)	Ethlybenzene* (µg/L)	m- & p- Xylene* (µg/L)	o- Xylene* (µg/L)
				EP080	EP080	EP080	EP080	EP080
		Limit of Reading		1	2	2	2	2
GQ070529/01	D	28/05/07	29/05/07	<1	<2	<2	<2	<2
GQ070529/02	I	28/05/07	29/05/07	<1	<2	<2	<2	<2
GQ070529/03	O	28/05/07	29/05/07	<1	<2	<2	<2	<2
QC Samples	Standard Recovery (%)	-	29/05/07	91	82	86	87	86
QC Samples	Blank	-	29/05/07	<1	<2	<2	<2	<2
QC Samples	Relative Percentage Difference in Duplicates (%)	-	29/05/07	1.6	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070529.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0707130

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070619

Date Issued: 28/06/2007

Client: Gunlake Quarries
Address PO Box 1665
Double Bay NSW 1360
Contact: Mr. E. O'Neill

Sampling:

Sampled by: Client
Samples Received: 19/06/07
Sampling Method: Unnown, sampling not covered by endorsement

Laboratory: VGT Pty Limited

Contact: Tara O'Brien
Date Analysed: 19/06/07
Location Analysed: 2/128 Melbourne St, East Maitland, NSW 2323.
Samples analysed as received

Sample ID	Client Identification	Date & Time	Comments
GQ070619/01	D	18/06/2007	
GQ070619/02	I	18/06/2007	
GQ070619/03	O	18/06/2007	

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Water Analysis Report Number: GQ070619

Date Issued: 28/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Temperature (ºC)	pH	Conductivity (µS/cm k 25.00C)	TDS* (mg/L)	Salinity* (g/kg)
				Method Code	VGT-WI01	VGT-WI02	EA015	EA020
				Limit of Reading 0.1	0.1	1	1	0.01
GQ070619/01	D	18/06/07	19/06/07	17.0	6.2	87	149	0.10
GQ070619/02	I	18/06/07	19/06/07	16.9	6.2	96	167	0.10
GQ070619/03	O	18/06/07	19/06/07	17.1	7.0	240	193	0.10
QC Samples	Standard Recovery (%)	-	19/06/07	-	100	101	101	-
QC Samples	Blank	-	19/06/07	-	-	<1	<1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	19/06/07	-	-	2	17.5	-

Comments:

This final report replaces any previous reports with the number GQ070619.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0708387

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070619

Date Issued: 28/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Chloride* (mg/L)	Sodium* (mg/L)	Arsenic* (mg/L)	Manganese* (mg/L)	Iron* (mg/L)
				ED045G	ED093F	EG020T	EG020T	EG020T
		Limit of Reading		1.0	1	0.001	0.001	0.05
GQ070619/01	D	18/06/07	19/06/07	19.2	9	<0.001	0.105	1.77
GQ070619/02	I	18/06/07	19/06/07	22.3	11	<0.001	0.032	1.69
GQ070619/03	O	18/06/07	19/06/07	42.5	20	<0.001	0.025	1.43
QC Samples	Standard Recovery (%)	-	19/06/07	102	101	90	92	100
QC Samples	Blank	-	19/06/07	<1.0	<1	<0.001	<0.001	<0.05
QC Samples	Relative Percentage Difference in Duplicates (%)	-	19/06/07	0.5	0.0	0.0	6.2	7.3

Comments:

This final report replaces any previous reports with the number GQ070619.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0708387

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070619

Date Issued: 28/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Nitrite as N* (mg/L)	Nitrate as N* (mg/L)	NO x as N* (mg/L)	TKN* (mg/L)	Total N* (mg/L)
				EK057G	EK058G	EK059G	EK061	EK062
		Limit of Reading		0.010	0.010	0.010	0.1	0.1
GQ070619/01	D	18/06/07	19/06/07	<0.010	0.243	0.243	1.3	1.5
GQ070619/02	I	18/06/07	19/06/07	0.012	0.198	0.210	1.0	1.2
GQ070619/03	O	18/06/07	19/06/07	<0.010	0.694	0.694	2.9	3.6
QC Samples	Standard Recovery (%)	-	19/06/07	84	-	93	84	-
QC Samples	Blank	-	19/06/07	<0.010	-	<0.010	<0.1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	19/06/07	26.1	-	18.2	13.6	-

Comments:

This final report replaces any previous reports with the number GQ070619.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0708387

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070619

Date Issued: 28/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Total Phosphorus as P* (mg/L)	Reactive Phosphorus as P* (mg/L)	TPH (C6-C9)* (µg/L)	TPH (C10-C14)* (µg/L)	TPH (C15-C28)* (µg/L)	TPH (C29-C36)* (µg/L)
				EK067G	EK071G	EP080/071	EP080/071	EP080/071	EP080/071
		Limit of Reading		0.01	0.010	20	50	100	50
GQ070619/01	D	18/06/07	19/06/07	0.04	0.011	<20	<50	<100	<50
GQ070619/02	I	18/06/07	19/06/07	0.03	<0.010	<20	<50	<100	<50
GQ070619/03	O	18/06/07	19/06/07	0.22	<0.010	<20	<50	<100	<50
QC Samples	Standard Recovery (%)	-	19/06/07	94	96	-	99	100	112
QC Samples	Blank	-	19/06/07	<0.01	<0.01	<20	<50	<100	<50
QC Samples	Relative Percentage Difference in Duplicates (%)	-	19/06/07	0.0	9.5	-	-	-	-

Comments:

This final report replaces any previous reports with the number GQ070619.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0708387

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070619

Date Issued: 28/06/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Benzene* (µg/L)	Toluene* (µg/L)	Ethlybenzene* (µg/L)	m- & p- Xylene* (µg/L)	o- Xylene* (µg/L)
				EP080	EP080	EP080	EP080	EP080
		Limit of Reading		1	2	2	2	2
GQ070619/01	D	18/06/07	19/06/07	<1	<2	<2	<2	<2
GQ070619/02	I	18/06/07	19/06/07	<1	<2	<2	<2	<2
GQ070619/03	O	18/06/07	19/06/07	<1	<2	<2	<2	<2
QC Samples	Standard Recovery (%)	-	19/06/07	101	97	94	95	93
QC Samples	Blank	-	19/06/07	<1	<2	<2	<2	<2
QC Samples	Relative Percentage Difference in Duplicates (%)	-	19/06/07	0.0	0.0	0.0	0.0	0.0

Comments:

This final report replaces any previous reports with the number GQ070619.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0708387

Analyst:

Lisa Thomson

Date: 6/06/2007

Water Analysis Report Number: GQ070718

Date Issued: 26/07/2007

vgt
Environmental
Compliance
Solutions

Client: Gunlake Quarries
Address: PO Box 1665
Double Bay NSW 1360
Contact: Mr. E. O'Neill

Sampling:

Sampled by: Client
Samples Received: 18/07/07
Sampling Method: Unnown, sampling not covered by endorsement

Laboratory: VGT Pty Limited
Contact: Tara O'Brien
Date Analysed: 18/07/07
Location Analysed: 2/128 Melbourne St, East Maitland, NSW 2323.
Samples analysed as received

Sample ID	Client Identification	Date & Time	Comments
GQ070718/01	D	16/7/07 3:00pm	
GQ070718/02	I	16/7/07 3:00pm	
GQ070718/03	O	16/7/07 3:00pm	

NATA Accredited Laboratory - 15230. Scope of Accreditation covers: Sampling, pH, Electrical Conductivity, Total Suspended Solids, and Turbidity. All methods are EPA approved and based on APHA 20th Edition and Australian Standards. This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ICO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

Water Analysis Report Number: GQ070718

Date Issued: 26/07/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Temperature (ºC)	pH	Conductivity (µS/cm k 25.00C)	TDS* (mg/L)	Salinity* (g/kg)
				Method Code	VGT-WI01	VGT-WI02	EA015	EA020
				Limit of Reading 0.1	0.1	1	1	0.01
GQ070718/01	D	16/7/07 3:00pm	18/07/07	15.2	6.1	138	129	0.07
GQ070718/02	I	16/7/07 3:00pm	18/07/07	15.5	5.9	143	142	0.07
GQ070718/03	O	16/7/07 3:00pm	18/07/07	16.1	7.2	855	480	0.42
QC Samples	Standard Recovery (%)	-	18/07/07	-	100	101	92	-
QC Samples	Blank	-	18/07/07	-	-	<1	<1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	18/07/07	-	-	2	3	-

Comments:

This final report replaces any previous reports with the number GQ070718.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0709737

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070718

Date Issued: 26/07/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Chloride* (mg/L)	Sodium* (mg/L)	Arsenic* (mg/L)	Manganese* (mg/L)	Iron* (mg/L)
				ED045G	ED093F	EG020T	EG020T	EG020T
		Limit of Reading		1.0	1	0.001	0.001	0.05
GQ070718/01	D	16/7/07 3:00pm	18/07/07	23.4	13	<0.001	0.257	1.57
GQ070718/02	I	16/7/07 3:00pm	18/07/07	25.7	14	<0.001	0.128	0.98
GQ070718/03	O	16/7/07 3:00pm	18/07/07	183	66	<0.001	0.028	0.34
QC Samples	Standard Recovery (%)	-	18/07/07	98	98	99	98	97
QC Samples	Blank	-	18/07/07	<1.0	<1	<0.001	<0.001	<0.05
QC Samples	Relative Percentage Difference in Duplicates (%)	-	18/07/07	4	0	0	0	15

Comments:

This final report replaces any previous reports with the number GQ070718.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0709737

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070718

Date Issued: 26/07/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Nitrite as N* (mg/L)	Nitrate as N* (mg/L)	NO x as N* (mg/L)	TKN* (mg/L)	Total N* (mg/L)
				EK057G	EK058G	EK059G	EK061	EK062
		Limit of Reading		0.010	0.010	0.010	0.1	0.1
GQ070718/01	D	16/7/07 3:00pm	18/07/07	0.010	0.054	0.064	2.3	2.4
GQ070718/02	I	16/7/07 3:00pm	18/07/07	0.020	<0.01	0.028	2.0	2.0
GQ070718/03	O	16/7/07 3:00pm	18/07/07	<0.010	0.196	0.196	1.0	1.2
QC Samples	Standard Recovery (%)	-	18/07/07	88	-	100	97	-
QC Samples	Blank	-	18/07/07	<0.010	-	<0.010	<0.1	-
QC Samples	Relative Percentage Difference in Duplicates (%)	-	18/07/07	0	-	0	7	-

Comments:

This final report replaces any previous reports with the number GQ070718.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0709737

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070718

Date Issued: 26/07/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Total Phosphorus as P* (mg/L)	Reactive Phosphorus as P* (mg/L)	TPH (C6-C9)* (µg/L)	TPH (C10-C14)* (µg/L)	TPH (C15-C28)* (µg/L)	TPH (C29-C36)* (µg/L)
				EK067G	EK071G	EP080/071	EP080/071	EP080/071	EP080/071
		Limit of Reading		0.01	0.010	20	50	100	50
GQ070718/01	D	16/7/07 3:00pm	18/07/07	0.20	0.042	<20	<50	<100	<50
GQ070718/02	I	16/7/07 3:00pm	18/07/07	0.13	<0.010	<20	<50	<100	<50
GQ070718/03	O	16/7/07 3:00pm	18/07/07	0.07	<0.010	<20	<50	<100	<50
QC Samples	Standard Recovery (%)	-	18/07/07	92	96	103	122	124	124
QC Samples	Blank	-	18/07/07	<0.01	<0.01	<20	<50	<100	<50
QC Samples	Relative Percentage Difference in Duplicates (%)	-	18/07/07	29	21	-	-	-	-

Comments:

This final report replaces any previous reports with the number GQ070718.

Unsigned reports are preliminary. Results apply to the sample as submitted.

*Analysis performed by ALS report no ES0709737

Analyst:

Tara O'Brien

Date:

Water Analysis Report Number: GQ070718

Date Issued: 26/07/2007

Results

Sample ID	Sample Description	Date Sampled	Date Analysed	Benzene* (µg/L)	Toluene* (µg/L)	Ethlybenzene* (µg/L)	m- & p- Xylene* (µg/L)	o- Xylene* (µg/L)
				EP080	EP080	EP080	EP080	EP080
		Limit of Reading		1	2	2	2	2
GQ070718/01	D	16/7/07 3:00pm	18/07/07	<1	<2	<2	<2	<2
GQ070718/02	I	16/7/07 3:00pm	18/07/07	<1	<2	<2	<2	<2
GQ070718/03	O	16/7/07 3:00pm	18/07/07	<1	<2	<2	<2	<2
QC Samples	Standard Recovery (%)	-	18/07/07	103	98	98	96	98
QC Samples	Blank	-	18/07/07	<1	<2	<2	<2	<2
QC Samples	Relative Percentage Difference in Duplicates (%)	-	18/07/07	0	0	0	0	0

Comments:

This final report replaces any previous reports with the number GQ070718.

Unsigned reports are preliminary. Results apply to the sample as submitted.

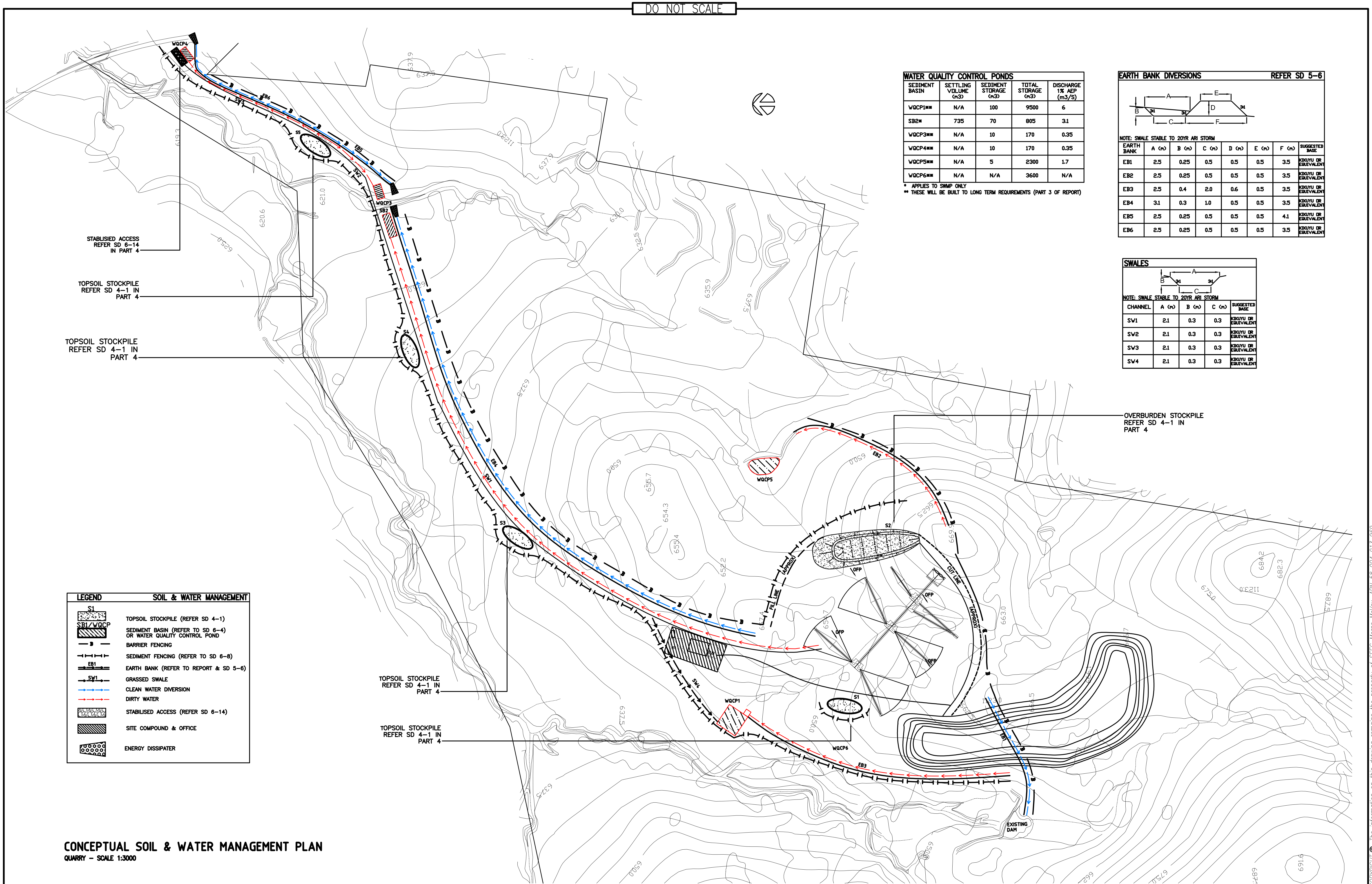
*Analysis performed by ALS report no ES0709737

Analyst:

Tara O'Brien

Date:

DO NOT SCALE



WATER QUALITY CONTROL PONDS

SEDIMENT BASIN	SETTLING VOLUME (m3)	SEDIMENT STORAGE (m3)	TOTAL STORAGE (m3)	DISCHARGE 1% AEP (m3/S)
WQCP1**	N/A	100	9500	6
SB2*	735	70	805	3.1
WQCP3**	N/A	10	170	0.35
WQCP4**	N/A	10	170	0.35
WQCP5**	N/A	5	2300	1.7
WQCP6**	N/A	N/A	3600	N/A

* APPLIES TO SWMP ONLY
** THESE WILL BE BUILT TO LONG TERM REQUIREMENTS (PART 3 OF REPORT)

EARTH BANK DIVERSIONS — REFER SD 5-6

NOTE: SWALE STABLE TO 20YR ARI STORM

EARTH BANK	A (m)	B (m)	C (m)	D (m)	E (m)	F (m)	SUGGESTED BASE
EB1	2.5	0.25	0.5	0.5	0.5	3.5	KIKUYU OR EQUIVALENT
EB2	2.5	0.25	0.5	0.5	0.5	3.5	KIKUYU OR EQUIVALENT
EB3	2.5	0.4	2.0	0.6	0.5	3.5	KIKUYU OR EQUIVALENT
EB4	3.1	0.3	1.0	0.5	0.5	3.5	KIKUYU OR EQUIVALENT
EB5	2.5	0.25	0.5	0.5	0.5	4.1	KIKUYU OR EQUIVALENT
EB6	2.5	0.25	0.5	0.5	0.5	3.5	KIKUYU OR EQUIVALENT

SWALES

NOTE: SWALE STABLE TO 20YR ARI STORM

CHANNEL	A (m)	B (m)	C (m)	SUGGESTED BASE
SW1	2.1	0.3	0.3	KIKUYU OR EQUIVALENT
SW2	2.1	0.3	0.3	KIKUYU OR EQUIVALENT
SW3	2.1	0.3	0.3	KIKUYU OR EQUIVALENT
SW4	2.1	0.3	0.3	KIKUYU OR EQUIVALENT

LEGEND — SOIL & WATER MANAGEMENT

S1	TOPSOIL STOCKPILE (REFER SD 4-1)
SB1/WQCP	SEDIMENT BASIN (REFER TO SD 6-4) OR WATER QUALITY CONTROL POND
	BARRIER FENCING
	SEDIMENT FENCING (REFER TO SD 6-8)
EB1	EARTH BANK (REFER TO REPORT & SD 5-6)
SW1	GRASSED SWALE
	CLEAN WATER DIVERSION
	DIRTY WATER
	STABILISED ACCESS (REFER SD 6-14)
	SITE COMPOUND & OFFICE
	ENERGY DISSIPATER

CONCEPTUAL SOIL & WATER MANAGEMENT PLAN

QUARRY – SCALE 1:3000

REV	DATE	BY	APP.	REVISION DETAILS
A	OCT 07	JMA	MP	MINOR REVISIONS
B	NOV 07	JMA	MP	MINOR REVISIONS
C	FEB 08	JMA	MP	ISSUE FOR APPROVAL

DRAWING STATUS		
DESIGN BY	RJM/MVP	08/06/2007
DRAWN BY	LAC	08/06/2007
FINAL APPROVAL	RJM/MVP	08/06/2007
CAD FILE	07000453-01 REV A.DWG	

FOR APPROVAL

Datum: AHD
Origin: Assumed
Scale: 1:3000 (on A1 Original)

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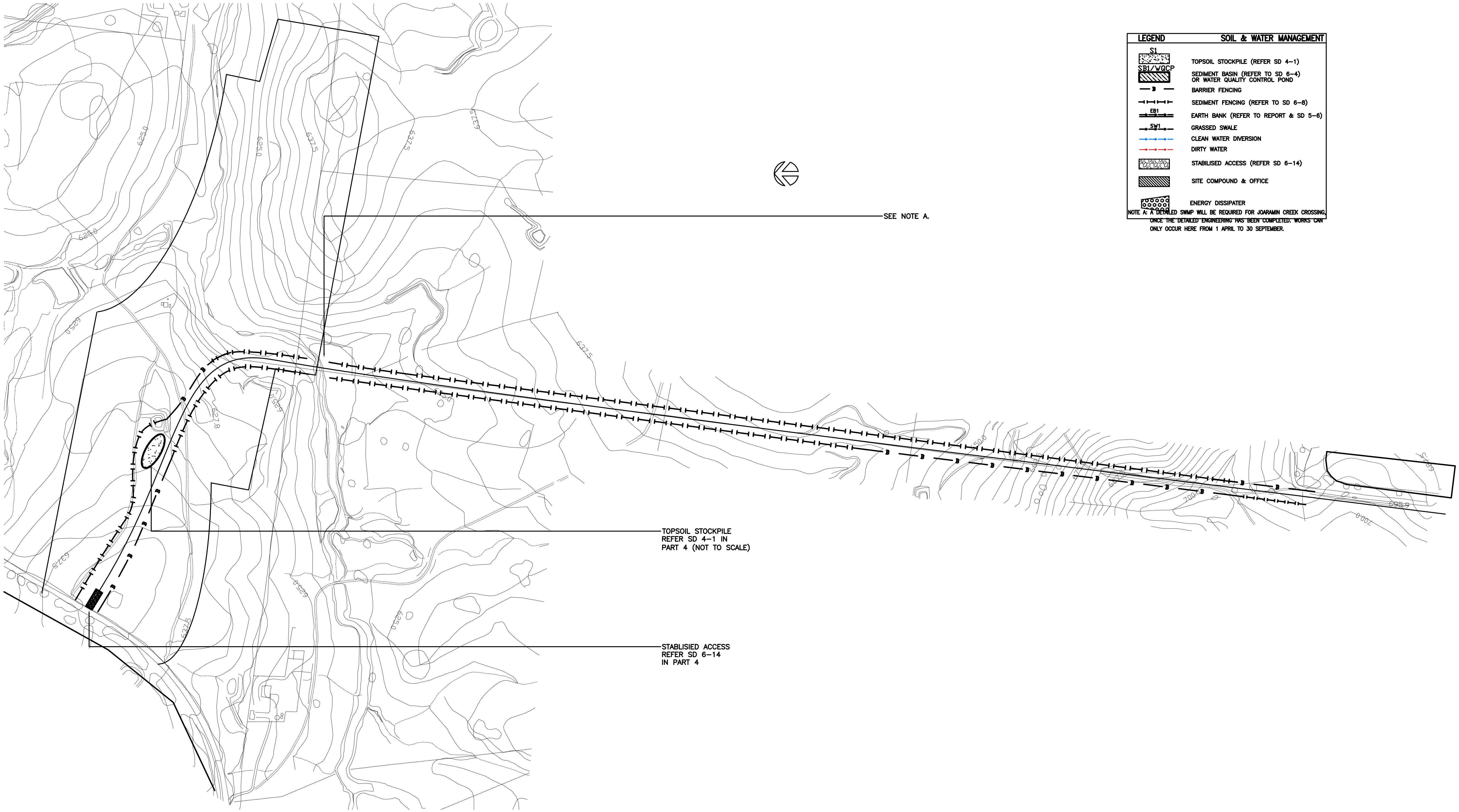
DRAWING TITLE: CONCEPTUAL SOIL & WATER MANAGEMENT PLAN

CLIENT: GUNLAKE QUARRIES

PROJECT TITLE: HARD ROCK QUARRY MARULAN

Plan No. 07000453 | Sheet No. 1 | REV C

DO NOT SCALE



CONCEPTUAL SOIL & WATER MANAGEMENT PLAN

SITE ACCESS – SCALE 1:3000

REV	DATE	BY	APP.	REVISION DETAILS
A	OCT 07	JMA	MP	MINOR REVISIONS
B	FEB 08	JMA	MP	ISSUE FOR APPROVAL

DRAWING STATUS		
DESIGN BY	RJM/MVP	08/06/2007
DRAWN BY	LAC	08/06/2007
FINAL APPROVAL	RJM/MVP	08/06/2007
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CLIENT: GUNLAKE QUARRIES

PROJECT TITLE: HARD ROCK QUARRY MARULAN

Plan No.	Sheet No.	REV
06000725–02	2	B

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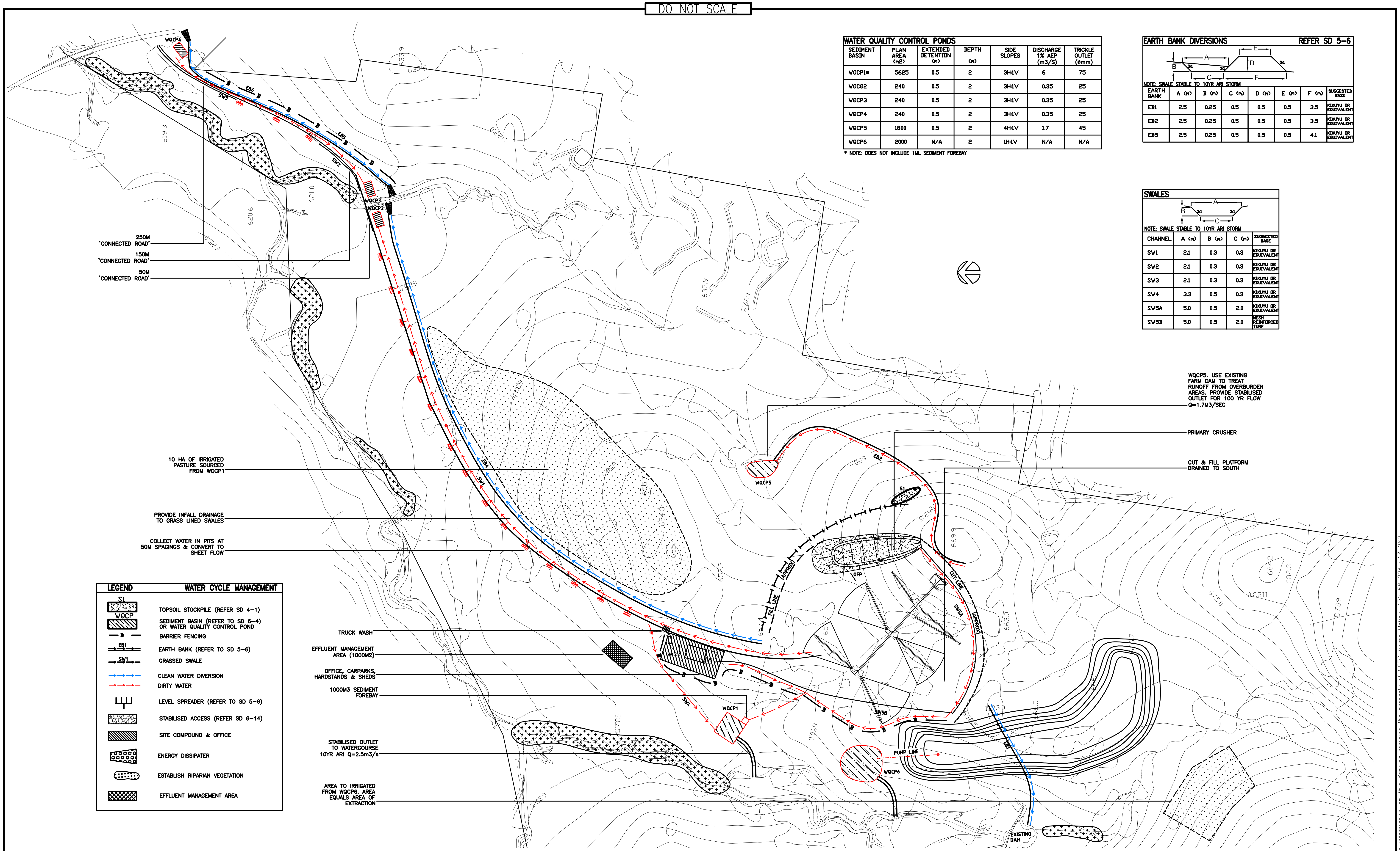

WATER QUALITY CONTROL PONDS

SEDIMENT BASIN	PLAN AREA (m2)	EXTENDED DETENTION (m)	DEPTH (m)	SIDE SLOPES	DISCHARGE 1% AEP (m3/S)	TRICKLE OUTLET (⌀mm)
WQCP1*	5625	0.5	2	3H:1V	6	75
WQCQ2	240	0.5	2	3H:1V	0.35	25
WQCP3	240	0.5	2	3H:1V	0.35	25
WQCP4	240	0.5	2	3H:1V	0.35	25
WQCP5	1800	0.5	2	4H:1V	1.7	45
WQCP6	2000	N/A	2	1H:1V	N/A	N/A

* NOTE: DOES NOT INCLUDE 1ML SEDIMENT FOREBAY

EARTH BANK DIVERSIONS — REFER SD 5–6

NOTE: SWALE STABLE TO 10YR ARI STORM

EARTH BANK	A (m)	B (m)	C (m)	D (m)	E (m)	F (m)	SUGGESTED BASE
EB1	2.5	0.25	0.5	0.5	0.5	3.5	KIKUYU OR EQUIVALENT
EB2	2.5	0.25	0.5	0.5	0.5	3.5	KIKUYU OR EQUIVALENT
EB5	2.5	0.25	0.5	0.5	0.5	4.1	KIKUYU OR EQUIVALENT

SWALES

NOTE: SWALE STABLE TO 10YR ARI STORM

CHANNEL	A (m)	B (m)	C (m)	SUGGESTED BASE
SW1	2.1	0.3	0.3	KIKUYU OR EQUIVALENT
SW2	2.1	0.3	0.3	KIKUYU OR EQUIVALENT
SW3	2.1	0.3	0.3	KIKUYU OR EQUIVALENT
SW4	3.3	0.5	0.3	KIKUYU OR EQUIVALENT
SW5A	5.0	0.5	2.0	KIKUYU OR EQUIVALENT
SW5B	5.0	0.5	2.0	MESH REINFORCED TURF

LEGEND — WATER CYCLE MANAGEMENT

- S1 — TOPSOIL STOCKPILE (REFER SD 4–1)
- WQCP — SEDIMENT BASIN (REFER TO SD 6–4) OR WATER QUALITY CONTROL POND
- BARRIER FENCING
- EB1 — EARTH BANK (REFER TO SD 5–6)
- SW1 — GRASSED SWALE
- CLEAN WATER DIVERSION
- DIRTY WATER
- LEVEL SPREADER (REFER TO SD 5–6)
- STABILISED ACCESS (REFER SD 6–14)
- SITE COMPOUND & OFFICE
- ENERGY DISSIPATER
- ESTABLISH RIPARIAN VEGETATION
- EFFLUENT MANAGEMENT AREA

CONCEPTUAL WATER CYCLE MANAGEMENT PLAN

QUARRY – SCALE 1:3000

REV	DATE	BY	APP.	REVISION DETAILS
A	OCT 07	JMA	MP	MINOR REVISIONS
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C	JAN 08	JMA	MP	MINOR REVISIONS
D	FEB 08	JMA	MP	ISSUED FOR APPROVAL

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Plan No. 07000453 | Sheet No. 1 | REV D