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Erosion & Sediment Control Plan
Proposed RISE Development (MP08-0234)
Bilambil Heights, West Tweed
New South Wales

Prepared for:
Terranora Group Management
C/- Steve MacRae Development Services

April, 2009

Document control

Document:	**GJ0495-1_ESCP_RAG1.3D.doc**	Gilbert & Sutherland P/L ABN 56 077 310 840 Originating Office: Robina Eastside 5/232 Robina Town Centre Drive, Robina Q4226 PO Box 4115, Robina Q4230 Telephone 07 5578 9944 Facsimile 07 5578 9945 gsrobina@groupgs.com Also at Kawana and Brisbane
Title:	**Erosion & Sediment Control Plan Proposed RISE Development (MP08-0234) Bilambil Heights, West Tweed New South Wales**	
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Client Reference:		
Synopsis:	This report describes assessments of the erosion risk of the site and measures required to ensure that the stormwater runoff from the proposed development meets Tweed Shire Council's water quality objectives during the construction phase.	

Revision History

Revision #	Date	Edition By		Approved By	
1	01/04/09	AGG		LJV	AGG
2					
3					

Distribution

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Distribution	1	2	3	4	5	6	7	8	9	10
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Summary

Gilbert & Sutherland Pty Ltd was commissioned by Terranora Group Management Pty Ltd to prepare an Erosion and Sediment Control Plan in response to the Director General's Environmental Assessment Requirements (DGEAR's) regarding a Part 3A application for a Concept Plan approval for a State Significant Development (the proposed RISE development, reference no. MP08-0234).

This report summarises previous soils assessments and reports and provides a framework for the preparation of future Erosion and Sediment Control Plans and detailed construction drawings (showing the locations and details of temporary and permanent erosion and sediment management measures) to be prepared on a stage by stage basis and submitted to Tweed Shire Council for approval as part of each application for a Construction Certificate per Precinct or part precinct of the Rise project.

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Glossary

Australian Height Datum (AHD)	National reference for relative height measurement in Australia.
Average Recurrence Interval (ARI)	The average or expected length of time between exceedances of a given variable, such as rainfall.
Bund	An embankment constructed around an area to prevent the inflow or outflow of liquids. Also called Bunding.
Catchment	The area above a given point which contributes to the runoff.
Clay	Very fine-grained sediment or soil (often defined as having a particle size less than 0.002 mm, or 2 microns, in diameter).
Ephemeral	A stream that flows briefly only in direct response to precipitation in the immediate locality and the channel of which is at all times above the watertable.
Erosion	The process by which material (such as rock or soil) is worn away or removed (as by wind or water).
Groundwater	The water contained in interconnected pores located below the watertable in an unconfined aquifer or located in a confined aquifer.
Intermittent	A stream in which the flow is seasonal, usually in response to rainfall in the immediate area (see ephemeral).
Loam	Medium-textured soil composed of approximately 10% to 25% clay, 25% to 50% silt and less than 50% sand.
pH	The degree of acidity or alkalinity measured on a scale of 1 to 14 with 7 as neutral. From 0 to 7 is acidic; from 7 to 14 is alkaline.
Sand	Sediment composed of particles within the size range 63 microns to 2 millimetres.
Scouring	The action of removing sediment from stream banks, particle by particle. This is a more destructive process than collapse when viewed over time due to incremental effects.
Sediment	Unconsolidated, fine-grained material (typically derived from the weathering of rocks), that is transported by water and settles on the floor of seas, rivers streams and other bodies of water.
Silt	Sediment having particles finer than sand and coarser than clay (i.e. 2 to 63 microns).
Sub-catchment	A smaller area within a catchment drained by one or more tributaries of the main water body.
Suspended Solids (SS)	The concentration of filterable particles in water (retained on a 0.45mm filter) and reported by volume (mg/L).
Total Nitrogen (TN)	Total nitrogen is the sum of the nitrogen present in all nitrogen-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Total Phosphorus (TP)	Total phosphorus is the sum of the phosphorus present in all phosphorus-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Turbidity	A measure of the cloudiness of water which is determined by the amount of light scattered by suspended particles.

1) Introduction

Terranora Group Management Pty Ltd commissioned Gilbert & Sutherland Pty Ltd to prepare an Erosion and Sediment Control Plan (ESCP) in relation to the proposed RISE development at Bilambil Heights, New South Wales. The site location is shown on Drawing No GJ0495.3.1. This ESCP relates to the concept approval phase of the project.

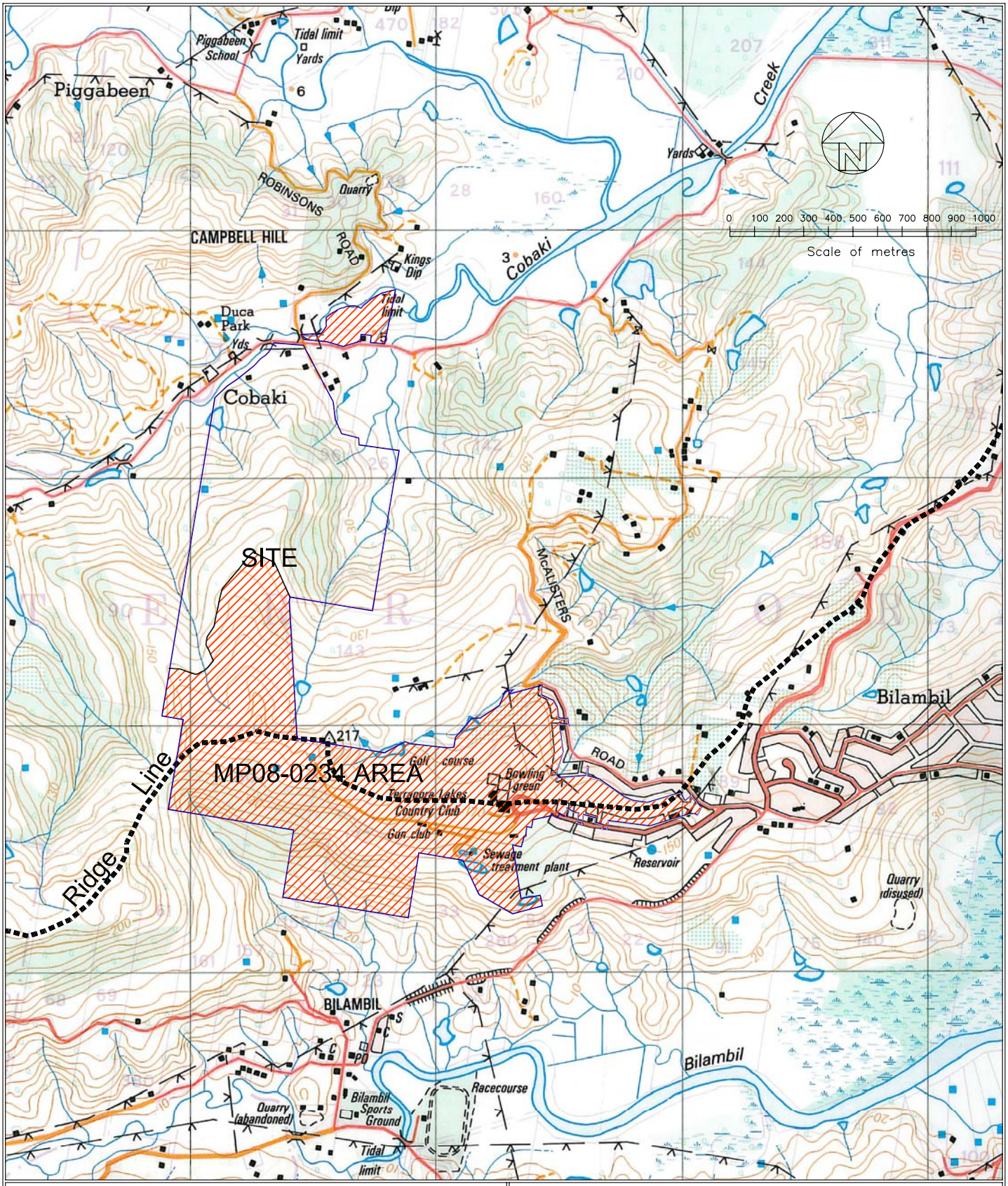
The RISE project is the subject of a Major Project application (reference: MP08-0234). This reference number, together with the term 'site', is used throughout this report to refer to the RISE Major Project application area (approximately 110ha).

The report is based on previous soil surveys carried out by qualified Gilbert & Sutherland staff, and has been based on information previously provided in '*Addendum Report & EMP - Onsite Sewage Treatment & Effluent Reuse*' by Gilbert & Sutherland, dated January 1998 and '*Amended Stormwater Management Plan, Pacific Highlands Estate, Stage 1*', by Gilbert & Sutherland, dated August 2006.

This report provides an overview of the site soils and their associated erosion potential. It adopts and is based on the Tweed Shire Council's 'Code of Practice for Soil and Water Management on Construction Works' contained in and as required by the 'Development Design Specification, D7, Stormwater Quality', Version 1.2, dated June 2004. Management of the potential impacts during the construction phase have been addressed in the management tables in Section 4 (which form the ESCP).

Specifically, this report addresses Item 12 (3) of the DGEAR's which requires:

> '*Provide a preliminary Erosion and Sediment Control Plan*'.



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PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

SITE LOCATION

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No.
		DATE 27/03/09	CHECKED	GJ0495.3.1

2) Site characteristics

2.1 Site description

The RISE site is located in New South Wales just south of the border between NSW and Queensland, approximately 10km south-west of Tweed Heads in the township of Bilambil Heights.

The site comprises; Lots 32 & 33 on DP1085109, Lot 31 on DP850230, Lot2 on DP867486 and Lot 4 on DP822786 under the ownership of Terranora Group Management Pty. Ltd.; Lot 1 on DP1033810, Lot 1 on DP1033811 and Lot 1 on DP595529 owned by Tweed Shire Council; and Crown Road separating Lot 2 on DP867486, Lot 33 on DP1085109 and Lot 2 on DP555026. The location of the site is shown on Drawing No. GJ0495.3.1.

With a total land area of approximately 184ha owned by the applicant, the subject site contains an area of some 110ha of development footprint (the area described by MP08-0234) and is characterised by undulating land ranging from 2m to 216m Australian Height Datum (AHD).

A number of small dams currently exist on the site and these will be preserved as wetlands and stormwater harvesting areas in the development.

2.2 Vegetation

The majority of the proposed development will occur in areas that have been cleared of native vegetation for past agricultural activities and a golf course (which currently occupies the south-eastern portion of the development footprint) as shown on the aerial photograph in Drawing No. GJ0495.3.2.

For a detailed description of the vegetation on site, refer to the report by James Warren & Associates which forms part of the MP08-0234 application.

2.3 Geology

A review of the Geological Survey of Queensland Geology, 1:100,000 series - Murwillumbah indicates that the site is underlain by soils of the Cainozoic period which largely comprise of Lamington Group, basalt flows.

2.4 Soil landscapes

Soils in the region have been mapped and described in 'Soil landscapes of the Murwillumbah – Tweed Heads 1:100,000 Sheet'[1] (Morand 1996). The relevant section is shown on Drawing No. GJ0495.3.3 attached. This mapping indicates that the proposed development will be within the Carool (ca) and Disturbed (xx) landscapes while the Sports Park to the north of Cobaki Creek Road is on the Crabbes Creek (cr) soils landscape. The bulk of the future Stage 2 will be on the Burringbar (bu) soil landscape with a small part on the Carool (ca) soils landscape.

The general soil profile over the site was described by Morand as friable clays overlying light medium to medium heavy clays or sandy clays. Emerson Aggregate Test results ranged from Class 6 to 8 and the proportion of clay ranged from 43% to 58%.

Morand indicates that the topsoils are likely to have low to moderate erodibility (K=0.006) while the subsoils may have a very high erodibility (K=0.065 to 0.067).

These results indicate that the soils should be classified as 'Type F' soils in accordance with Section 3.2.7 of 'Managing Urban Stormwater, Soils and Construction, Volume 1'.[2]

2.5 Soil classification

To characterise the site soils, Gilbert & Sutherland undertook a soil survey of the site in 1997 and again in 2005. These studies incorporated a total of 15 detailed boreholes and additional soil observations to an average depth of 0.6m.

Soil sampling and profile description was undertaken according to the Australian Soil and Land Survey Field Handbook (McDonald et al, 1990) with the soils classified according to the Australian Soil Classification (Revised) (Isbell, 1996;2002).

[1] *Soil landscapes of the Murwillumbah – Tweed Heads 1:100,000 Sheet*, NSW Department of Land & Water Conservation, Morand D.T. 1996.

[2] *Managing Urban Stormwater, Soils and Construction* 4th Edition, Landcon, 2004.

The updated soil borelogs are presented in Appendix 1 with the borehole locations shown on Drawing GJ0495.3.4.
The soils within the MP08-0234 area were identified predominantly as Ferrosols, with a smaller portion of Kurosols and Dermosols also present.

Ferrosols are described by Isbell (2002) as soils other than Vertosols, Hydrosols and Calcarosols that:

(i) Have B2 horizons in which the major part has a free iron oxide content greater than 5% Fe in the fine earth fraction (<2mm); and
(ii) Do not have clear or abrupt textural B horizons or a B2 horizon in which at least 0.3m has vertic properties.

These soils correspond with the Carool soil landscape described by Morand (1996) and are predominantly associated with dark reddish brown clay loams to light medium clays overlying reddish brown medium clays with moderate structure.

Kurosols and Dermosols were differentiated by either a clear and abrupt B horizon (as in the case of Kurosols) or less than 5% Fe in the fine earth fraction, as indicated by colour (in the case of Dermosols). These soils correspond with the disturbed and Burringbar soil landscapes described by Morand (1996).

2.6 Soil Dispersivity

Dispersion describes the tendency for the clay fraction of a soil to go into colloidal suspension where unlimited swelling and disintegration of some of the clay particles forms a colloidal cloud around the sample (Emerson & Seedsman, undated). These attributes provide an indication of the soil's erosion potential with a dispersive soil being (obviously) more susceptible to erosion.

The results of Modified Emerson Class testing of the samples collected from the site are detailed in Table 2.6.1.

The Emerson classes were assigned to each sample in accordance with the criteria specified in the technical paper by Emerson and Seedsman (attached as Appendix 2).

Fifteen (15) of the twenty (20) samples recovered exhibited class 4/7M characteristics of slight or no dispersion. Five (5) surface soils exhibited Class 8M characteristics indicating non dispersive material.
Class 1M, 2M and 3M soils (of which none were identified on the site) may cause problems during earthworks and should be managed to minimise the amount of reworking. Class 4/7M soils should pose no major problems during construction provided appropriate management measures are implemented. However, some class 4/7M materials may cause stability problems (Emerson and Seedsman, undated) and may be a concern given the slope encountered on the site.

Table 2.6.1 Emerson Class testing results

Borehole	Depth (m)	Emerson Class
BH1	0.00 - 0.05	4/7M
BH1	0.05 - 0.65	4/7M
BH2	0.00 - 0.05	4/7M
BH2	0.05 - 0.65	4/7M
BH3	0.00 - 0.05	4/7M
BH3	0.05 - 0.45	4/7M
BH4	0.00 - 0.05	4/7M
BH4	0.05 - 0.50	4/7M
BH5	0.00 - 0.10	4/7M
BH5	0.10 - 0.65	4/7M
BH6	0.00 - 0.10	4/7M
BH6	0.10 - 0.60	4/7M
BH7	0.00 - 0.05	8M
BH7	0.05 - 0.65	4/7M
BH8	0.00 - 0.05	8M
BH8	0.05 - 0.50	4/7M
BH9	0.00 - 0.05	8M
BH9	0.05 - 0.65	4/7M
BH10	0.00 - 0.05	8M
BH10	0.05 - 0.65	4/7M

These results confirm the findings of Morand that the soils should be classified as 'Type F' soils in accordance with Section 3.2.7 of 'Managing Urban Stormwater, Soils and Construction, Volume 1'.[3]

2.7 Soils erodibility and soil erosion hazard rating

2.7.1 Current erosion

The site shows little sign of any accelerated soil erosion, due primarily to the prevalent vegetative cover present across the site.

[3] *Managing Urban Stormwater, Soils and Construction* 4th Edition, Landcon, 2004.

2.7.2 Erosion risk

An assessment of the erosion risk over the complete site was undertaken to define whether erosion risk (and management) represents a significant issue.

2.7.3 SOILOSS modelling

To predict the rate of soil loss from the site during the construction phase, the National Landcare Program model SOILOSS was used. SOILOSS uses the principles of the Revised Universal Soil Loss Equation (RUSLE) to predict average annual soil losses due to sheet and rill erosion. SOILOSS also provides recommendations to reduce soil loss including adjustments to land and cover management practices and facilitates the testing of such alterations and changes.

In the RUSLE, soil erodibility is represented by the (K) factor and is defined as the annual average soil loss per unit of rainfall erosivity (Houghton and Charman, 1986, Loch and Rosewell, 1992).

For this site, a slope gradient of 6% was used to represent the site slopes on which development will occur. A slope length of 300m was used to represent the current conditions, as it was the maximum allowable length for a 6% slope in the SOILOSS model and is seen as a typical length for the site.

A slope length of 100m was selected to represent spacing of controls (for example, catch drains or diversion channels). These two slope lengths were used to provide a comparison between current management and the introduction of erosion measurement techniques.

An R value of 5,384 was used in the estimates. A support practice factor (P) of 1.2 was adopted as it represents soil that has been left bare by dozer or grader blade. The cover and crop management factor (C) was assumed to be bare earth with no cover (0.45).

The topsoils can generally be described as light to medium clay, with the subsurface soils described generally as medium clay. Subsurface soils have been included in the modelling as they may be exposed during development.

For SOILOSS modelling purposes, the most conservative texture class was adopted as the K factor, to ensure the worst case scenario is modelled. A K factor of 0.006 was used to represent light to medium clay and a K factor of 0.065 was used to represent a medium clay.

The results of the modelling are summarised in the following tables, with the SOILOSS output attached as Appendix 3.

Table 2.7.3.1 - Estimated soil loss t/ha for pre-development assuming 300m slope length, 0.013 cover factor and light to medium clay topsoil and a medium clay subsurface soil.

Soil type	Calculated potential soil loss from erosion (t/ha/yr)
Topsoil (light to medium clay)	1.1
Subsurface (medium clay)	11

Table 2.7.3.2 - Estimated soil loss t/ha for development assuming no erosion and sediment controls (300m slope length), 0.45 cover factor and light to medium clay topsoil and a medium clay subsurface soil.

Soil type	Calculated potential soil loss from erosion (t/ha/yr)
Topsoil (light to medium clay)	36
Subsurface (medium clay)	359

Table 2.7.3.3 - Estimated soil loss t/ha for development phase assuming 100m slope length, 0.45 cover factor and light to medium clay topsoil and a medium clay subsurface soil.

Soil type	Calculated potential soil loss from erosion (t/ha/yr)
Topsoil (light to medium clay)	23
Subsurface (medium clay)	246

The qualitative categories of erosion hazard used are low, moderate, high, very high and extreme (Houghton and Charman, 1986)5. The SOILOSS model (Rosewell, 1993) was originally used to derive soil loss quantities for these qualitative categories

mentioned above and these are presented in the following table; (Rosewell, (1993), NSW Department of Housing, (1998)).

Table 2.7.3.4 – Erosion Hazard for SOILOSS Modelling

Soil Loss Class	Calculated soil loss (t/ha/yr)	Erosion Hazard
1	<250	Very Low
2	251 – 300	Low
3	301 – 375	Low to Moderate
4	376 – 500	Moderate
5	501 – 750	High
6	751 – 1500	Very High
7	1501 – 3750	Extreme

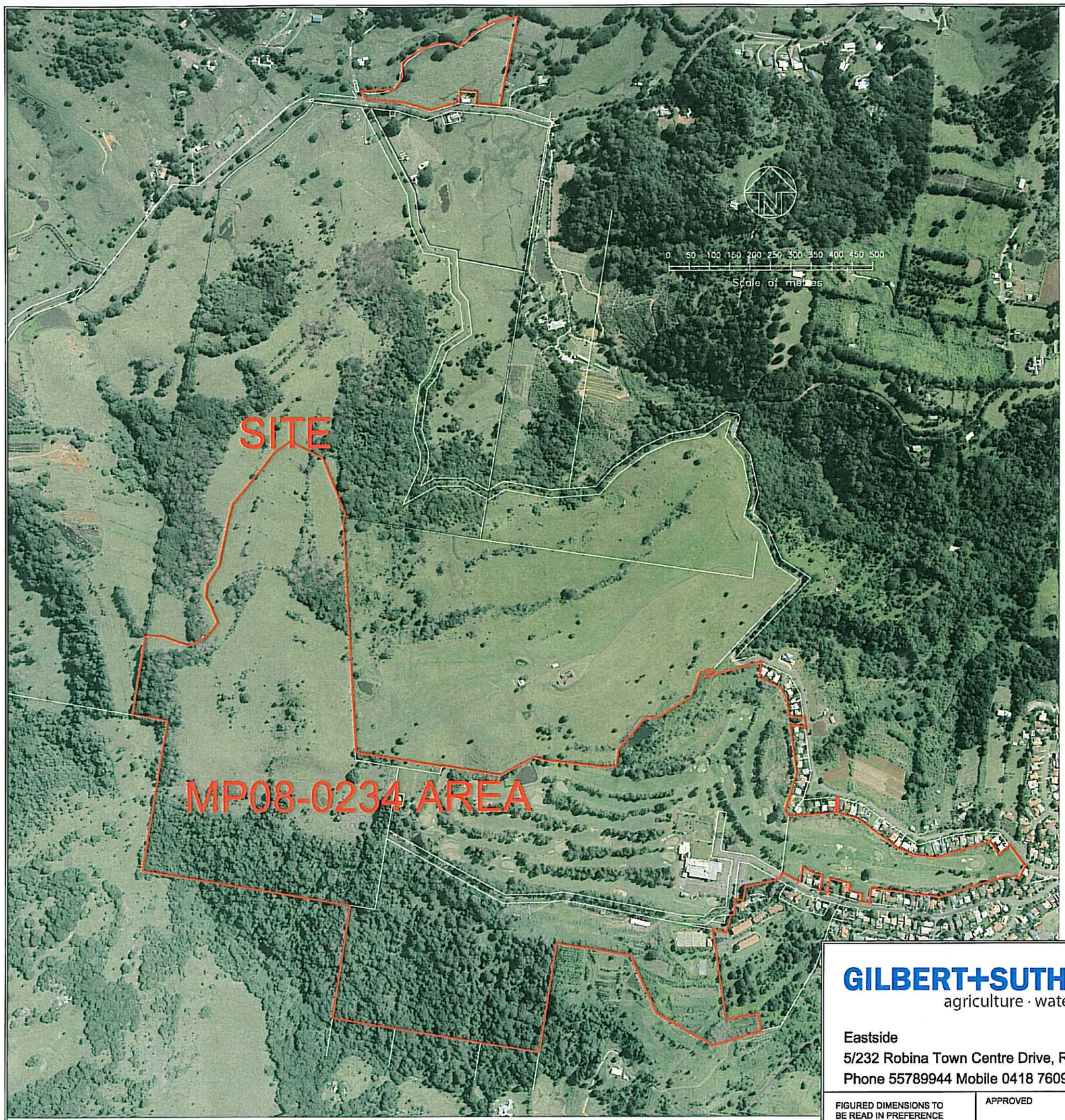
Based on the results of the soil survey, the SOILOSS modelling and erosion hazard categories presented, the overall soil erosion hazard (with the current vegetation cover and minimal disturbance) can be classed as 'Very Low' to 'Low'.

Although the modelling also shows 'very low' erosion hazard when no soil erosion management techniques are employed during construction, the calculated potential soil loss increases to 36t/ha/yr and 395t/ha/yr for topsoil and subsoil respectively.

The use of soil erosion and sediment controls at 100m intervals decreases the calculated potential erosion by up to 149t/ha/yr.

Based on the results of the soil survey, the modelling of the critical construction phase slopes and erosion hazard categories presented, the overall soil erosion risk can be classed as "Very Low" to "Low" considering the soil depth disturbed and assuming appropriate temporary control measures are installed.

Prior to commencement of construction of any earthworks, an Erosion and Sediment Control Plan and detailed drawings showing the locations and details of temporary and permanent erosion and sediment control measures shall be prepared in accordance with this ESCP, submitted to and approved by Council. Temporary erosion and sediment controls should then be installed in accordance with the approved Erosion and Sediment Control Plan.



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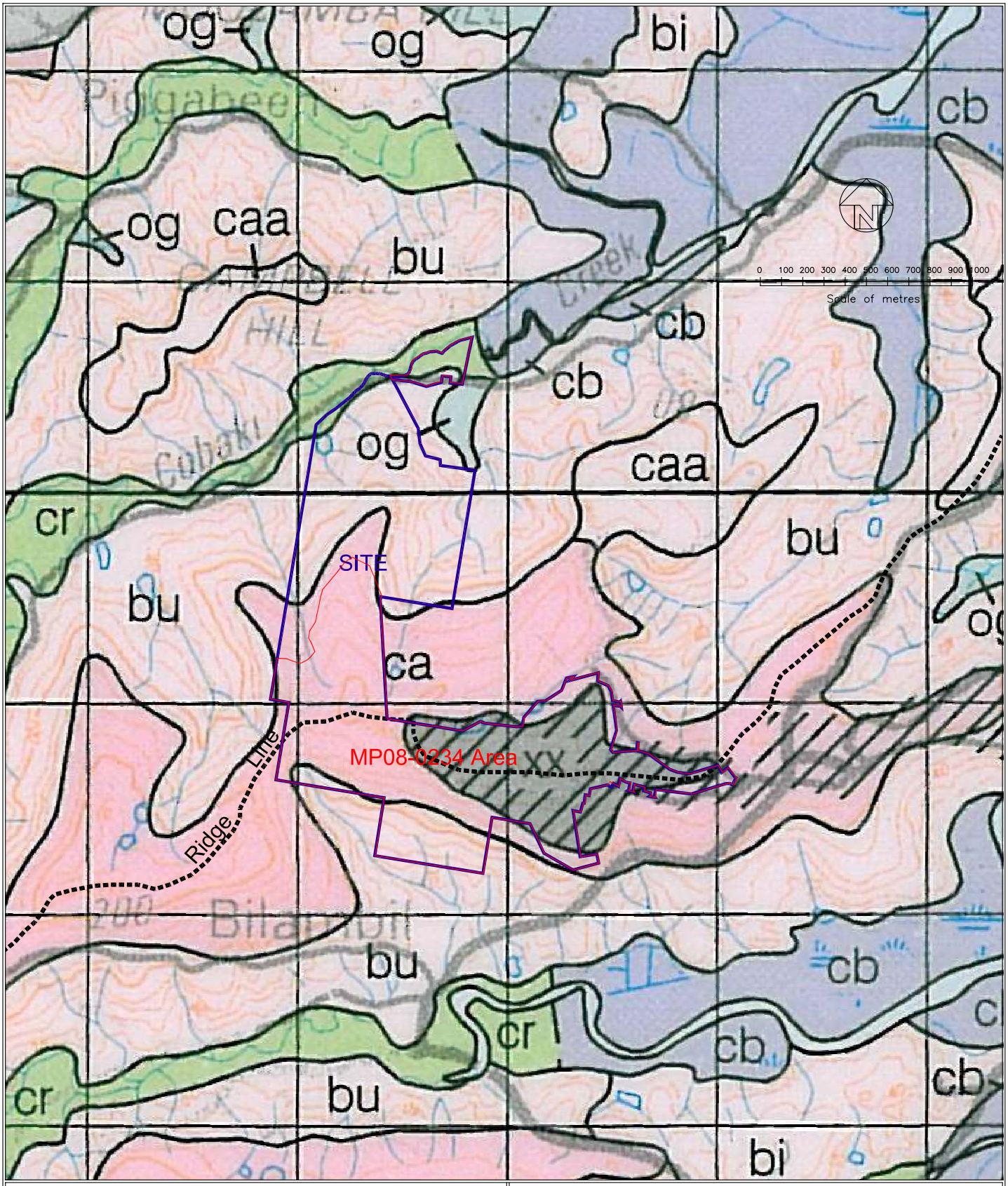
PROJECT
TERRANORA GROUP MANAGEMENT
RISE - MP08-0234
BILAMBIL HEIGHTS
EXISTING DEVELOPMENT

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.	DRAWING No. GJ0495.3.2
		DATE 27/03/09	CHECKED	



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PROJECT

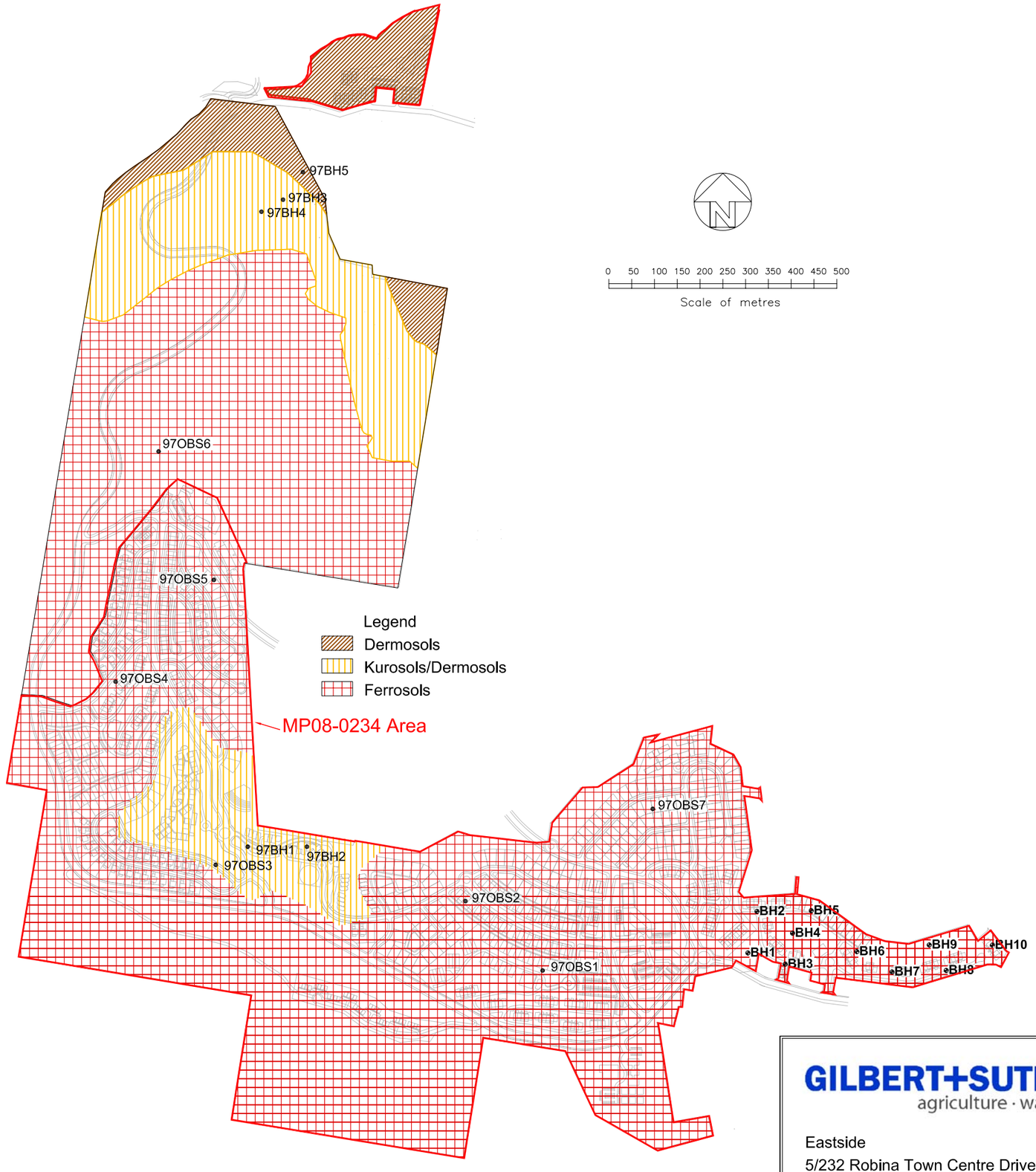
TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

SOIL LANDSCAPES

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.G.G.	DRAWING No.
		DATE 8/04/09	CHECKED	GJ0495.3.3



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PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

BOREHOLE LOCATIONS & SOILS MAP

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 27/03/09	CHECKED

DRAWING No. GJ0495.3.4

3) Erosion & sediment control plan

3.1 Objectives

The principle objective of this ESCP is to implement the requirements of the Tweed Shire Council's 'Code of Practice for Soil and Water Management on Construction Works' as required in Council's 'Development Design Specification, D7, Stormwater Quality'. Additionally, the ESCP provides information on site specific management issues to minimise potential environmental impacts from the development during the construction phase.

The control measures detailed in this ESCP have been developed to minimise impacts on the environment and achieve the following objectives:

- Minimise soil erosion and exposure
- Minimise transportation of eroded soil by air and water
- Limited suspended solids concentration in stormwater to not more than 50mg/L
- Limit/minimise the amount of site disturbance
- Isolate the site by diverting clean upstream 'run on' water around the development
- Control runoff and sediment at its point source rather than at one final point
- Stage ground disturbance/earthworks and progressively revegetate the site where possible to reduce the area contributing sediment
- Retain topsoil for revegetation works
- Locate sediment control structures where they are most effective and efficient.

3.2 Implementation

The ESCP requires the Proponent to mitigate the potential environmental impacts associated with the construction of the development works.

It is noted that the owner of the land being developed is responsible for the erosion and sediment control throughout the construction phase. In addition, the owner shall also be responsible for all persons, including employees, plant operators, contractors, subcontractors, delivery drivers, etc who may cause erosion and sediment generation. This responsibility also extends to adjacent land where construction activities may have encroached upon and caused sedimentation and erosion.

It is intended that the ESCP will provide a set of performance criteria and guiding principles with which the engineering designs for the development will comply. The plans and specifications forming part of the construction contract for each Precinct should also include these performance criteria.

The project should be developed in Precincts and stages of Precincts to minimise the potential for soil erosion and water pollution and this would enable the site to be progressively rehabilitated as the development proceeds. As soon as is practicable, after the completion of the earthworks in each section, the lots will be topsoiled and reseeded to establish a fast growing cover crop which will minimise erosion and movement of sediment across and off the site. On steeper slopes, hydromulching may be required.

Where ever possible the site will remain grassed and otherwise undisturbed until construction commences.

3.2.1 Self auditing system

According to Tweed Shire Council's 'Development Design Specification, D7, Stormwater Quality' Section D7.A11 Operation, Maintenance, Clause 11.2, where more than 2,500m^2 of land are disturbed, a self auditing program is to be developed for the site. A site inspection self audit and monitoring program shall be undertaken.

The self audit shall be undertaken systematically onsite including the recording of the following information:

- installation/removal of any erosion and sediment control device,
- the condition of each device employed (particularly outlet devices),
- circumstances contributing to damage to any devices, accidental or otherwise,
- storage capacity available in pollution control structures, including:
    - waste receptacles and portable toilets
    - trash racks
    - sediment barriers and traps

  - gross pollutant traps
  - wetlands/temporary sedimentation basin
- time, date, volume and type of any additional flocculants,
- the volumes of sediment removed from sediment retention systems, and where this sediment has been disposed (if required),
- maintenance or repair requirements (if any) for each device,
- circumstances contributing to the damage to device, and
- repairs affected on erosion and pollution control devices.

3.2.2 Construction phase control measures

Overview plans of the drainage scheme, including details of size and location of all major system elements will be prepared on a Precinct by Precinct (or part thereof) basis by VKL Consulting engineers and supplied to Council for approval on the detailed design drawings, as part of a Construction Certificate application.

Prior to commencement of bulk earthworks, temporary erosion and sediment controls should be installed. Where practicable, runoff from undisturbed areas should be diverted around disturbed areas and away from the temporary sedimentation basins. As work progresses, runoff from the disturbed areas should be diverted by means of surface slopes and V-drains to the temporary sedimentation basins described below.

A temporary sedimentation basin has been included in each catchment where the area to be developed exceeds one hectare. The locations of the basins are shown on the Gilbert & Sutherland ESCP Drawing No. GJ0495.3.5).

The catchment areas and associated temporary sedimentation basin sizes are shown in the table in Appendix 4.

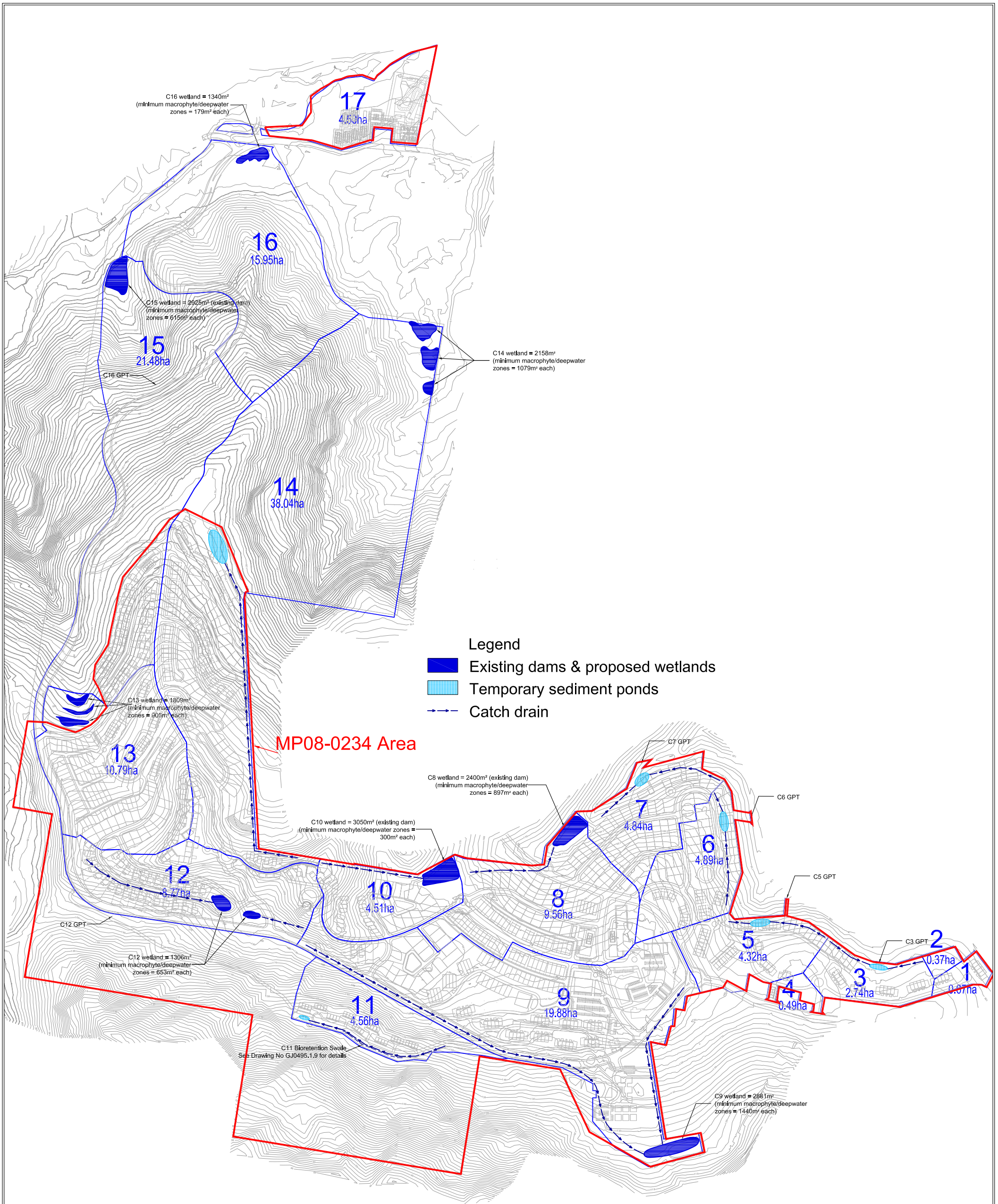
The sedimentation basins have been designed in accordance with requirements detailed within 'Managing Urban Stormwater, Soils and Construction' Landcom, March 2004 . Based on the definitions included within this document, and the necessity to release the stored waters in order to maintain adequate capacity, the basins have been classed as Type F. Type F sedimentation basins are designed for catchments where there are fine grained soils which contain a significant proportion of 'erodible' clay materials. These types of sedimentation basins may require the addition of a flocculant to assist in the settling process.

Gypsum is the most commonly used flocculant. Gypsum application rates are site specific and the appropriate rate for the 'RISE' site will need to be determined once construction commences. As a guide, Landcom provides a maximum rate of 70kg of gypsum per 100 cubic metres of water. Previous experience with soils similar to those found on this site indicates that an application rate of 30kg per 100 cubic metres should be adequate.

Other control measures such as (but not limited to) silt fences, contour drains, and straw bales should be installed and maintained in accordance with the recommendations contained in 'Managing Urban Stormwater, Soils and Construction' Landcom, March 2004.

The sedimentation basin may be removed when the site has been revegetated after completion of the bulk earthworks. However the other control measures mentioned above must be installed in disturbed areas during the building construction phase and maintained until landscaping has been completed and becomes established.

The exact number, location and size of the sedimentation basins will be determined at the detailed design stage concurrently with the development of the Precinct staging as it evolves over time.



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PROJECT

TERRANORA GROUP MANAGEMENT

RISE - MP08-0234

BILAMBIL HEIGHTS

SEDIMENT BASIN LOCATIONS

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN A.J.F.
		DATE 04/04/09	CHECKED

DRAWING No. GJ0495.3.5

4) Management of potential impacts – Construction phase

4.1 ESCP Structure

This ESCP acknowledges the environmental impacts associated with the development and details strategies to mitigate them.

Each control strategy is based upon proven environmental management methods and is presented as a commitment. The commitments made within this document will form the basis of future assessments, which will be made available to the Tweed Shire Council for review as part of the future Construction Certificate applications for each Precinct or part thereof.

The ESCP is based on a series of tables for the construction phase of the development. The person responsible for the implementation of the measures detailed is written on the table itself. The tables then detail the Issue, the performance criteria, the Implementation strategy, monitoring, auditing, reporting, failure identification and the corrective action. The detachable pages within each section detail the provisions of the ESCP. The format is presented below for reference purposes;

#.# Title

Person responsible	This is the person who has accepted the responsibility of implementing the ESCP provisions detailed on this page

Issue	The Issue that the table deals with
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies or tasks (to nominated operational design standards) that will be implemented to achieve the performance criteria
Monitoring	The monitoring requirements which will measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements, which will verify implementation of, agreed construction and operation phase environmental management strategies and compliance with agreed performance criteria.
Reporting	Content, timing and responsibility for reporting and auditing of monitoring results.
Identification of incident or failure	The circumstances under which the agreed performance criteria are unlikely to be met and environmental harm is likely to result.
Corrective action	The action to be implemented in case a performance requirement is not reached and the company(s) responsible for action.

Commitment #
A promise made by management.

An objective of the tabular format is to allow for change and allow the management plan to be a working document. If items need altering, changes may be made (after the appropriate consultation with the statutory authorities) to the individual tables.

4.2 General commitments

Commitment 1
The Proponents undertake to comply with the environmental implementation strategy as contained within the approved Erosion and Sediment Control Plan (ESCP) on a Precinct by Precinct (or part thereof) basis.

Commitment 2
The Proponents undertake to fulfil all commitments made in this ESCP and to carry on their activities on the project site in accordance with relevant current statutory requirements and approved amendments.

4.3 Definitions

In this ESCP the terms have the following meanings:

ESCP means the approved Erosion and Sediment Control Plan and includes any amendments that may be approved from time to time,
Development means the development of the MP08-0234 area in accordance with the approved Concept Plan;
TSC means Tweed Shire Council;
Proponent means the person undertaking the development of the land and includes the person nominated by the Proponent as having the responsibility for implementing the provisions of the SWMP;
DECC means New South Wales Department of Environment and Climate Change.

4.4 Contact details

The following persons are responsible for the implementation of the management measures described in the individual tables of the SWMP.

Contractor's Site Manager
The name and address of the Contractor and its representative will be notified to Council by the Consulting Engineer prior to the commencement of each contract/stage of the project.

Consulting Engineer
Unless advised otherwise the Consulting Engineer is:

Company:	VKL Consulting
Address:	PO Box 292
	Ashmore City Q 4214
Contact Details:	Mr Keith Vinnicombe
Phone:	55100200
Facsimile:	55100299

Environmental Consultant
Unless advised otherwise the Environmental Consultant is:

Company	Gilbert & Sutherland Pty Ltd
Address:	Eastside
	5/232 Robina Town Centre Drive
	PO Box 4115
	Robina Q 4230
Contact Details:	Mr Neil Sutherland
Phone:	55789944
Facsimile:	55789945

4.5 Vegetation clearing/Soil disturbance

Person responsible	Contractor's Site Manager

Issue	Minimisation of the removal or disturbance of trees, shrubs and ground covers
Operational policy	To maintain existing vegetation as long as possible during construction works.
Performance criteria	No vegetation is to be removed prior to Consent Approval being granted.
Implementation strategy	1. No vegetation removal prior to receipt of Consent Approval shall be undertaken. 2. Trees to be conserved are to be flagged with surveyors marking tape. 3. Compaction of ground in the dripline of trees to be retained shall be minimised. 4. The area of disturbance shall be clearly delineated to keep vehicles, building materials and refuse away from areas to be conserved. 5. The number of access points onto the site shall be minimised. 6. Vegetation buffer zones shall be maintained where possible. 7. Where practicable vegetative debris shall be salvaged as logs or woodchip. 8. Where possible, shakedown devices shall be utilised at each access point to minimise sediment transport onto public roads. 9. Newly completed hardstand areas shall be swept to prevent excess aggregate or gravel entering street drains.
Monitoring	Regular inspections shall be carried out to ensure that construction work areas are kept within stage boundaries.
Auditing	Management to examine the boundary of the works weekly.
Reporting	No reporting is necessary unless areas are inadvertently cleared outside approved stage boundaries.
Identification of incident or failure	Clearing outside of stage boundaries.
Corrective Action	Reinstate and revegetate overcleared areas where necessary, unless the area is to be used for future staging.

4.6 Dust Management

Person responsible	Contractor's Site Manager

Issue	Minimisation of movement of dust offsite
Operational policy	To achieve acceptable air quality standards through the control of the movement of dust offsite from site works.
Performance criteria	The target level for complaints by nearby residents is no more than one in any seven day period. Ambient air quality should not deteriorate by more than 30% over a period of seven consecutive days. Dust deposition at any nearby residence should not exceed 100mg/m^2/day.
Implementation strategy	The minimisation of the movement of dust offsite will be achieved through the following onsite practices (Landcom, 2004): 1. Construction works shall be staged where appropriate to limit the areas exposed at any one time. 2. All permanent bunds and reshaped areas will be revegetated within 10 days after completion of earthworks (including excavation and backfilling of services trenches). 3. Stockpiling onsite will be minimised where possible. 4. Ground surfaces will be kept damp (not wet). 5. Surfaces shall be left in a rough cloddy condition to increase roughness and slow surface wind speed. 6. An on-site water cart will be available at all times. 7. All dust creating work to cease if wind speed exceeds 10m/sec (36km/hour). 8. Contractors staff to be trained to implement dust minimisation measures. 9. Protective ground covers shall be provided, including mulches, vegetation, organic binders or dust retardants. 10. Traffic movements on any disturbed areas shall be minimised.
Monitoring	Daily inspections will be carried out to verify that dust mitigation measures are being implemented. Dust monitoring will be conducted upon receipt of complaints by residents. If dust monitoring is to take place, the following will occur: • Temporary dust deposition gauges will monitor the movement of dust offsite at the nearest residences adjacent to the proposed stages and within the predominant wind directions. • Monitoring will be undertaken in accordance with AS 3580.10.1 (1991).
Auditing	Management to examine the complaints register weekly and review corrective action taken.
Reporting	• The contractor to notify NSW DECC of a possible environmental nuisance on receipt of 3 or more dust complaints in any 24 hour period. • Reports will be provided to TSC upon request. • Complaints by residents are to be recorded in a Complaints Register and notified to TSC.

Identification of incident or failure	Any dust-related complaints by residents will indicate a failure of the dust control measures.
Corrective Action	Locate the source of the dust and implement the following measures: • apply water sprays to vegetation • cover or water exposed areas • if dust persists, cease the dust creating activities All dust complaints to be addressed in consultation with Council Officers.

Commitment 3

Dust generated during the construction of the development works will be managed to ensure that dust movement offsite is controlled.

4.7 Erosion Controls

Person responsible	Contractor's Site Manager, Consulting Engineer

Issue	Erosion Controls
Operational policy	To prevent the displacement of sediment and soil across and offsite during storm events.
Performance criteria	• Off-site discharges to comply with requirements for suspended sediments as detailed in Section 4.9 of the ESCP. • No visual indication of erosion on stages under construction, including evidence of rilling (an indicator of sheet erosion).
Implementation strategy	1. Erosion and sediment control devices shall be installed prior to commencement of work in each stage in accordance with the approved engineering plans and to the reasonable satisfaction of TSC. 2. No site disturbance shall commence until the appropriate approvals have been obtained. 3. Where possible, the construction programme shall be scheduled to minimise the potential for soil loss to occur. Where construction activities cannot be altered, additional controls shall be implemented in the areas of high erosion potential. 4. Runoff and erosion controls shall be installed prior to clearing and include: • Diversion of upslope runoff around cleared and/or disturbed areas in a way that minimises erosion, minimises the upslope catchment and diverts waters to a legal point of discharge. • Sediment control fences or other measures at the downslope perimeter of cleared and/or disturbed areas. • Maintenance of all erosion control measures at operational capacity until land is effectively rehabilitated. 5. Temporary erosion measures (e.g. hay bales, straw fences) are to be employed onsite during construction where reasonably deemed necessary by TSC from an assessment of slope and soil type. Such measures shall be maintained at, or above their design capacity. Such measures should be in accordance with the recommendations in Landcom 2004 Soils and Construction 'Managing Urban Stormwater'. 6. On sites where more than 1000m^2 are to be disturbed, runoff controls are also to include: • The use of barrier fencing, • The utilisation of exclusions zones, and • Minimising slope lengths of disturbed, uncontrolled areas. 7. Stripped topsoil shall be separated from subsoil materials and shall only be stripped from the areas designated on the appropriate plans. 8. Stockpiled soil should be stored taking into account the following considerations: • They are not to be located on public footpaths, nature strips, roads, road shoulders or any other public land. • Be located at least 2m away from any hazard areas. • Be protected from upslope surface flows, and • Be provided with sediment filters downslope.

	9. Fill batters shall be located to avoid established trees. 10. Unless otherwise specified, trenches must be backfilled and compacted to 95% standard compaction and capped with topsoil. 11. Excess spoil may be retained onsite provided the stockpile area is prepared by stripping topsoil from beneath the fill site for further use in revegetation. 12. Outside the construction area of each stage existing surface water conditions should be maintained wherever possible.

Monitoring	• Where more than 2,500m^2 of land are disturbed, a self auditing program shall be developed for the site. A site inspection and self audit and monitoring program shall include:
	  • weekly site inspections,
	  • inspections immediately following rainfall events that cause runoff, and
	  • inspections immediately before site closure.
	
	• Surface water quality to be monitored during rainfall events (refer to the section titled 'Surface Water Monitoring' which details monitoring of surface water and stormwater quality including during storm events).

Auditing	Regular self audits shall be carried out in accordance with the above monitoring requirements. Additional visual inspections to be carried out monthly and after rainfall events to verify that control measures are in place and properly maintained.
Reporting of Monitoring Results	Signed, completed self audits, original test results, weekly and other result sheets shall be kept on site and made available on request to Council officers and other relevant statutory authorities. Copies of test results, audits and other results to be submitted to TSC monthly.
Identification of incident or failure	1. Signs of erosion on site. 2. Damaged or failed erosion control devices. 3. Falling water quality as identified by Environmental Consultant.
Corrective action	Apply remedial measures to Improve sediment and erosion measures, for example; hay bales, silt fences and flocculation of the temporary sedimentation basin.

Commitment 4

Best management practices will be implemented into work practices throughout the construction of the subdivision works to minimise erosion.

4.8 Sediment Control

Person responsible	Contractor's Site Manager, Consulting Engineer

Issue	Sediment Control
Operational policy	To prevent the displacement of sediment and soil across and offsite during storm events.
Performance criteria	• Off-site discharges to comply with requirements for suspended sediments as detailed in Section 4.9 of the ESCP.
Implementation strategy	1. All sediment control measures and facilities must be installed and stabilised prior to the commencement of site construction activities. 2. No site disturbance shall commence until the appropriate approvals have been obtained. 3. Sedimentation basins shall be constructed where the area to be developed exceeds 1 hectare. 4. Temporary erosion measures (e.g. hay bales, silt fences) are to be employed onsite during construction where reasonably deemed necessary by TSC from an assessment of slope and soil type. Such measures should be in accordance with the recommendations in Landcom 2004 Soils and Construction 'Managing Urban Stormwater'. 5. Sediment is to be removed after each rainfall event and weirs are to be regularly maintained and cleaned. 6. Straw bales and silt fence geotextiles are to be replaced when damaged or permanently blocked. 7. Sediment basins shall be constructed upstream of wetlands, ponds or receiving waters and preferably offline. 8. Level markers shall be installed within all sediment basins. 9. Sediment basins shall be dosed with flocculating agents when required to ensure that discharge water quality meets required limits. 10. Sediment shall be cleaned out of sediment basins when accumulated sediment volume reaches 70%. Removed materials must be disposed of in a manner that does not cause pollution. 11. All weather access tracks shall be constructed to all wetlands, sediment basins, detention basin, trash racks, and GPT's. 12. Where practical, surface waters from undisturbed lands shall be diverted away from construction areas. 13. When sediment controls are required outside the construction site: • where increased stormwater runoff is likely to accelerate erosion of any downstream watercourse, the necessary remedial work shall be undertaken, • all immediate downstream drainage inlets shall have appropriate controls installed. • all disturbed areas on other property are to be reinstated to the original condition. • All external works are to be complete prior to the release of the linen plan of subdivision or building certificate. 14. Outside the construction area of each stage, existing surface water conditions should be maintained wherever possible.

Monitoring	• Where more than 2,500m^2 of land are disturbed, a self auditing program shall be developed for the site. A site inspection and self audit and monitoring program shall include:
	  • weekly site inspections,
	  • inspections immediately following rainfall events that cause runoff, and
	  • inspections immediately before site closure.
	
	• Surface water quality to be monitored during rainfall events (refer to the section titled 'Surface Water Monitoring' which details monitoring of surface water and stormwater quality including during storm events).

Auditing	Regular self audits shall be carried out in accordance with the above monitoring requirements. Additional visual inspections to be carried out monthly and after rainfall events to verify that control measures are in place and properly maintained.
Reporting of Monitoring Results	Signed, completed self audits, original test results, weekly and other result sheets shall be kept on site and made available on request to Council officers and other relevant statutory authorities. Copies of test results, audits and other results to be submitted to TSC monthly.
Identification of incident or failure	1. Falling water quality as identified by Environmental Consultant. 2. Build-up of sediment.
Corrective action	Apply remedial measures to Improve sediment and erosion measures, for example; hay bales, silt fences and flocculation of the temporary sedimentation basin.

Commitment 5

Best management practices will be implemented into work practices throughout the construction of the subdivision works to minimise sediment transport offsite.

4.9 Surface water monitoring

Person responsible	Contractor's Site Manager, Environmental Consultant

Issue	Surface water controls
Operational policy	To maintain runoff water quality during the construction phase.
Performance criteria	All water discharged from the site will comply with the following criteria:

Water Quality Parameter	Release Criteria	Criteria Type
pH	6.5 – 8.5	Range
Electrical Conductivity (EC)	<1.5 mS/cm	Maximum
Turbidity	<50 NTU	Maximum
Dissolved Oxygen (field measured)	>6.5 mg/L	Minimum
Oil and Grease	No visible film, No detectable odour	_
Aluminium	<10% change from background	Maximum
Iron	<10% change from background	Maximum

Implementation strategy	• Construction of temporary sedimentation basins prior to earthworks as shown on the approved plans • Stormwater control will be achieved by directing as much runoff as practicable to the temporary sedimentation basin as shown on the approved plans • Monthly and during the first rainfall event each month (defined as >25mm in any 24 hour period) samples are to be collected from the upstream sampling location, downstream sampling location and temporary sedimentation basin discharge point and analysed at a NATA registered laboratory for the above parameters. • Where sediment problems are identified, settling in the temporary sedimentation basin shall be aided by dosing with flocculation agents. • During disturbance of the site, surface water runoff from filled areas shall be directed to the temporary sedimentation basin. Runoff from unfilled disturbed areas shall be retained by perimeter bunds.
Monitoring	Surface water monitoring will be conducted at the monitoring points monthly and during rainfall events for pH, EC, Suspended Solids, Dissolved Oxygen, Oil & Grease, Aluminium and Iron. Flow rates are to be estimated and recorded at the time of sampling.

Auditing	Environmental Consultant to audit water quality results to ensure all discharges comply with the performance criteria.
Reporting	• Result sheets to be compiled for monitoring results relating to water quality of water bodies. These results to be kept on site for inspection by local and state government officers. • Monthly reports to TSC until completion of works.
Identification of incident or failure	Degradation of surface water quality at the monitoring points to below background level or below pH 6.5 or greater than pH 8.5 immediately prior to discharge.
Corrective action	If a pH is detected outside the criteria range, then such waters will be contained, and the pH adjusted to within the range of 6.5 to 8.5 prior to release. If total turbidity levels exceed the water quality criteria for this parameter, then water will be contained on site for a period sufficient to allow suspended solids to settle out prior to release, or treated with a flocculent. Erosion control devices will be immediately inspected and cleaned if necessary. Additional devices will be installed if a need is detected to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas will be reviewed with regard to sediment and silt control.

Commitment 6

Surface water quality at the discharge point will be maintained during the construction of the development works in accordance with the criteria agreed with TSC based on the background data.

4.10 Pollution control

Person responsible	Contractor's Site Manager, Environmental Consultant

Issue	Pollution control
Operational policy	To minimise polluting incidents through controlling risks and hazards onsite.
Performance criteria	No pollution incidents during construction phase.
Implementation strategy	1. Petroleum and other chemical products shall be prevented from contaminating surface water and soil. 2. Any onsite fuel storage areas shall comply with Australian Standards. 3. Adequate trade waste and litter bins shall be provided onsite and serviced regularly. 4. Concrete wastes and washouts shall not be deposited in any location where the wastes or washings can flow, or can be washed into any areas of retained vegetation or receiving waters.
Monitoring	Weekly inspections shall be carried out on containment structures and washout areas.
Reporting	Weekly checklists shall be completed detailing any containment structure failures.
Identification of incident or failure	Pollution incidents causing environmental harm.
Corrective action	Review procedures to ensure that the incident does not recur.
Contingency Plans	Maintain appropriate quantities of clean up substances onsite in case of spills.

Commitment 7

The Proponent will ensure construction works are managed in such a manner that minimises the risk of pollution or discharge of contaminants.

4.11 Rehabilitation and landscaping

Person responsible	Contractor's Site Manager, Environmental Consultant

Issue	Rehabilitation and landscaping
Operational policy	Progressively stabilise and rehabilitate working areas to minimise sediment transport.
Performance criteria	No sediment transport off completed areas.
Implementation strategy	1. Progressive stabilisation and revegetation of completed areas. 2. The landscaping and rehabilitation program shall be programmed to ensure that minimal time delay occurs between final land shaping and permanent rehabilitation (a period of 20 days is provided). 3. All landscaping and rehabilitation shall be completed before occupation or use of buildings or premises. 4. All temporary erosion and sediment control works are to be removed once works are complete and revegetation is successfully established in formerly disturbed areas.
Monitoring	Regular inspections shall be carried out on completed areas to assess success of revegetation works.
Reporting	No reporting is necessary unless problems are identified.
Identification of incident or failure	Failure to rehabilitate completed works areas progressively.
Corrective action	Revegetate as soon as possible.
Contingency Plans	Test topsoil if revegetation works have been unsuccessful to determine the possible problem.

Commitment 8

The proponent will undertale all necessary actions to ensure that disturbed areas are landscaped or otherwise rehabilitated expeditiously.

4.12 Contractor Management

Person Responsible	Consulting Engineer

Issue	Contractor management
Operational policy	To ensure the proponents Duty of Care is met by ensuring the Contractor is aware of his responsibilities under the terms of the ESCP and the EP & A Act.
Performance criteria	Contractor is fully aware of his responsibilities under the terms of the ESCP.
Implementation strategy	• Review of the ESCP and the construction phase contracts by the proponent. • Periodic checks to be made by an independent Environmental Consultant; • Training for construction staff in implementation of ESCP provisions.
Monitoring	Weekly site inspections to be carried out.
Auditing	Inspections will be carried out monthly during the construction phase by an Environmental Consultant for every stage of development.
Reporting	Full details to be available to the contractor together with suggested corrective actions if required.
Corrective action	To be detailed at the time.

Commitment 9

A proactive program of contractor management will be implemented.

5) Administration of the ESCP

5.1 Amendment of the ESCP

The Proponent may make an application to TSC to amend the provisions of this ESCP. The application shall:

1. be in writing; and
2. specify the provisions of the ESCP to which the application relates; and
3. state how the proposed amendments achieve the objectives of the provisions to which the amendments relate.

TSC shall approve the amendment where TSC is satisfied acting reasonably that the proposed amendments achieve the objective of the provisions to which the amendment relates.

5.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this ESCP have clearly defined responsibilities under the Environment Planning and Assessment Act 1979 to report any incidents likely to cause material or serious environmental harm.

6) Appendices

6.1 Appendix 1

6.1.1 Borelogs

Borehole: BH1

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878856

Easting: 546596

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					4/7M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional fine roots, moist.		2.5YR5/4					4/7M					.3
.4																.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH2

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878957

Easting: 546618

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					4/7M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional fine roots, moist.		2.5YR5/4					4/7M					.3
.4																.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH3

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878844

Easting: 546682

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					4/7M					
.1																.1
.2				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional fine roots, moist.		2.5YR5/4					4/7M					.2
.3																.3
.4																.4
.5				GRAVELY MEDIUM CLAY, Brown , moderate subangular blocky, trace of fine to medium grained sand, fine to medium sized angular gravel, moist.		7.5YR4/6										.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH4

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878904

Easting: 546699

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.5

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					4/7M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional fine roots, moist.		2.5YR5/4										.3
.4											4/7M					.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH5

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878933

Easting: 546766

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark brown , fine to medium grained sand, occasional fine sized angular gravel throughout, abundant fine to medium sized roots, moist.		7.5YR3/4					4/7M					
.1																.1
.2																.2
.3																.3
.4				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional fine to coarse angular gravel, occasional fine roots, moist.		2.5YR5/4					4/7M					.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH6

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878880

Easting: 546842

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.6

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LOAMY SAND, Brown , fine to medium grained sand, abundant fine to medium sized roots, occasional organics, moist.		7.5YR5/2					4/7M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional fine roots, moist.		2.5YR5/4					4/7M					.3
.4																.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH7

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878808

Easting: 546909

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					8M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, trace of fine sized angular gravel, occasional fine roots, moist.		2.5YR5/4					4/7M					.3
.4																.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH8

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878813

Easting: 547014

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.5

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					8M					
.1																.1
.2				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, trace of fine sized angular gravel, occasional fine roots, moist.		2.5YR5/4										.2
.3																.3
.4											4/7M					.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH9

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: _____

Easting: _____

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					8M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, occasional medium to coarse sized angular gravel, abundant fine to medium sized roots, moist.		2.5YR5/4					4/7M					.3
.4																.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: BH10

Project: GJ0425

Client: TERRANORA GROUP MGT

Northing: 6878871

Easting: 547134

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.65

Logged by: AJS

Drilled by: G&S

Start date: 23.06.05

Completion date: 23.06.05

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
				LIGHT MEDIUM CLAY, Dark reddish brown , moderate subangular blocky, trace of fine grained sand, abundant fine to medium sized roots, moist.		5YR3/4					8M					
.1																.1
.2																.2
.3				MEDIUM CLAY, Reddish Brown , moderate subangular blocky, trace of fine grained sand, trace of fine sized angular gravel, occasional fine roots, moist.		2.5YR5/4					4/7M					.3
.4																.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: 97BH1

Project: GJ9737-1

Client: Terranora Group Mgt

Northing: _____

Easting: _____

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.6

Logged by:

Drilled by:

Start date: 25/11/1997

Completion date: 25/11/1997

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
.1				CLAY LOAM, Brownish black , Weak to moderate (2-5mm) polyhedral		10YR3/2										.1
.2				MEDIUM CLAY, Greyish yellow brown , Weak to moderate (2-5mm) polyhedral		10YR4/2							4.49			.2
.3																.3
.4																.4
.5				MEDIUM TO HARD CLAY, Dark reddish brown, Dull yellowish brown, Mottling, weak to moderate (2-5mm) polyhedral		2.5YR3/6, 10YR4/3			10YR4/3							.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: 97BH2

Project: GJ9737-1

Client: Terranora Group Mgt

Northing: _____

Easting: _____

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.7

Logged by:

Drilled by:

Start date: 25/11/1997

Completion date: 25/11/1997

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description: Soil Description (as per McDonald et.al1990)	Soil Description: Ausl. Soil Class.	Soil Description: Revised Standard Colour	Soil Description: Depositional Environment	Soil Description: Accessories	Soil Description: Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
.1				CLAY LOAM, Brown , Fine sandy, strong angular blocky, weathered rock near surface (pieces)		7.5YR4/3										.1
.2																.2
.3																.3
.4				LIGHT CLAY, Dull yellowish brown , Strong polyhedral		10YR4/3							4.51			.4
.5																.5
.6				MEDIUM CLAY, Reddish brown , Strong polyhedral, basalt at depth visible		5YR4/4										.6
.7																.7
.8																.8
.9																.9

Borehole: 97BH3

Project: GJ9737-1

Client: Terranora Group Mgt

Northing: _____

Easting: _____

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.6

Logged by:

Drilled by:

Start date: 25/11/1997

Completion date: 25/11/1997

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Revised Standard Colour	Depositional Environment	Accessories	Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
.1				CLAY LOAM, Dull yellowish brown , Strong angular blocky		10YR4/3										.1
.2				LIGHT CLAY, Bright brown , Moderate (2-5mm) polyhedral		7.5YR5/6							4.67			.2
.3																.3
.4				MEDIUM CLAY, Reddish brown , Moderate (2-5mm) polyhedral		5YR4/6										.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: 97BH4

Project: GJ9737-1

Client: Terranora Group Mgt

Northing: _____

Easting: _____

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.6

Logged by:

Drilled by:

Start date: 25/11/1997

Completion date: 25/11/1997

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description: Soil Description (as per McDonald et.al1990)	Soil Description: Aust. Soil Class.	Soil Description: Revised Standard Colour	Soil Description: Depositional Environment	Soil Description: Accessories	Soil Description: Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
.1				CLAY LOAM, Dull yellowish brown , Strong angular blocky (2-10mm)		10YR4/3										.1
.2				LIGHT CLAY, Bright brown , Moderate (2-5mm) polyhedral		7.5YR5/6							4.85			.2
.3																.3
.4				LIGHT MEDIUM CLAY, Yellowish Red , Moderate (2-5mm) polyhedral		5YR5/8										.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

Borehole: 97BH5

Project: GJ9737-1

Client: Terranora Group Mgt

Northing: _____

Easting: _____

RL(m): ____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.6

Logged by:

Drilled by:

Start date: 25/11/1997

Completion date: 25/11/1997

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Method	Drilling: Graphic log	Soil Description: Soil Description (as per McDonald et.al1990)	Soil Description: Aust. Soil Class.	Soil Description: Revised Standard Colour	Soil Description: Depositional Environment	Soil Description: Accessories	Soil Description: Secondary Colour	Assays: Sample ID	Assays: Emerson class	Assays: pHfox	Assays: pH(Field)	Assays: Crs(%S)	Assays: TAA(molH/t)	Depth NSL(m)
.1				CLAY LOAM, Brown , Strong angular blocky (2-5mm)		10YR4/4										.1
.2																.2
.3																.3
.4				CLAY LOAM, Bright brown , Moderate to strong angular blocky (2-5mm)		7.5YR5/6							5.32			.4
.5																.5
.6																.6
.7																.7
.8																.8
.9																.9

6.2 Appendix 2

6.2.1 Emerson and Seedsman dispersion paper

Methods.

CSIRO
DIVISION OF APPLIED GEOMECHANICS

P.O. BOX 54,
MOUNT WAVERLEY, VIC. AUSTRALIA.

TECHNICAL MEMORANDUM 15

A FIELD TEST TO PREDICT THE BEHAVIOUR OF OVERBURDEN MATERIALS DURING MINING: MODIFIED EMERSON CRUMB TEST

BY W.W. EMERSON* & R.W. SEEDSMAN

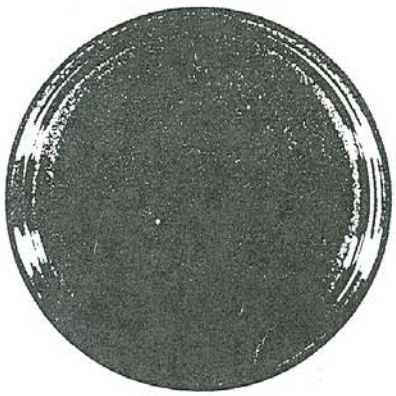
INTRODUCTION

Coal mining, especially strip mining, involves the break-up of interseam and overburden materials. This break-up results in an obvious loss of strength. However, if the materials are clay rich, there may be an additional loss of strength caused by the uptake of water by the clays present. It is this potential for water uptake by clays which should be tested in any survey of mine materials. The potential for water uptake is governed by the nature of the clays present, the type of exchangeable cations, and the way in which the clays are bound within the rock. A routine test for determining whether dangerous amounts of water are to be taker up is to look for the appearance of dispersed clay when wet sheared material is immersed in water.

When materials are placed in water three reactions may occur:

1. Slaking - the immediate macro break-up resulting from stresses induced both by the compression of the entrapped air and by swelling; followed by
2. Swelling - the slow increase in the size of the intact sample, or the slaked fragments, as the soluble salts diffuse out; followed by
3. Dispersion - the unlimited swelling of some of the clay particles so that a colloidal cloud is formed around the sample

SLAKING



DISPERSION

The Australian Standard for determining the Emerson class number of a soil (AS 1289.C8.1 - 1980) can be used as a routine test to identify materials that swell and/or disperse in their natural condition, or after they have been remoulded. In this procedure the initial break-up on wetting of air dry crumbs is an important criterion. However, in mining, this break-up is usually unimportant compared with that caused by the applied mechanical stress. Further, for a field test, it is convenient to use material with its in situ water content. Equally, the determination of the presence of carbonate/gypsum may be difficult under field conditions. Therefore the Australian Standard method has been simplified as follows.

APPARATUS

1. Beakers (100 ml) or plastic jars (squat form, about 35 mm in diameter).
2. Distilled or de-ionised water.

PROCEDURE

1. Obtain a few small chips (less than 3 mm in diameter) of the material at its field moisture content.
2. Put 50 ml of water in beaker. Place two chips in each beaker. Cover to prevent evaporation and let stand overnight on a stable surface. Do not stir or otherwise disturb.
3. Record the following: (i) time of placement in water (ii) whether or not slaking occurs (iii) degree of dispersion (iv) nature of water used.

If material does not disperse, add distilled water to more of the sample and work the material to approximately the plastic limit. Gentle pulverising may be needed to break up the material. Remould the material at this water content with a spatula for two minutes. Roll one or two balls of this material about 3 mm in diameter. Repeat steps (2) and (3). Do not allow the balls to dry before testing.

DETERMINATION OF MODIFIED EMERSON CLASS NUMBER

1. Class 1 M — Chips show a strong dispersion reaction, i.e. a colloidal cloud covers nearly the whole of the bottom of the beaker.
2. Class 2 M — Chips show a moderate to slight dispersion reaction and material remoulded at the plastic limit shows a strong dispersion reaction.
3. Class 3 M — Chips do not disperse but material remoulded at the plastic limit shows a moderate to strong dispersion reaction.
4. Class 4/7 M — Chips do not disperse and material remoulded at the plastic limit shows slight or no dispersion.
5. Class 8 M — Chips do not disperse and material cannot be remoulded.

SIGNIFICANCE OF TEST RESULTS

Materials of classes 1 M and 2 M will provide problems during strip mining if they occur in the base of spoil piles or in the immediate floor. Materials of class 3 M may cause problems during mining and care should be exercised to minimise the amount of reworking applied to them and to limit the ingress of water if they are placed at the base of spoil piles or occur in floors. Class 4/7 M and 8 M materials should perform satisfactorily during mining although there is a possibility that some class 4/7 M materials may cause stability problems. In this case complete testing as detailed in the Australian Standard would be necessary to identify the weakest materials in this class.

NOTES ON TEST

1. A black background may make observations of dispersion easier.
2. Use of air dry chips will accelerate the dispersion reaction. In this case, the classes of the Australian Standard could be used (except for the need for laboratory tests mentioned above).

ADDITIONAL REFERENCES

EMERSON, W.W. (1967).- A Classification of soil aggregates based on their coherence in water. Aust. J. Soil Res., 5 (1) : 47-58.

SEEDSMAN, R.W. and EMERSON, W.W. (1981).- Dispersion tests and their application to problems of mine stability. Geomechanics of Coal Mining CSIRO Aust., IEER, Div. Appl. Geomech. GCM Report No. 33.

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* CSIRO Division of Soils

6.3 Appendix 3

6.3.1 Soiloss output

****
********** User's Name **********
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SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal Soil Loss Equation (USLE) to predict the average annual soil loss due to sheet and rill erosion. It is based on extensive research in the United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

==========

Estimation prepared for : RISE BILAMBIL HEIGHTS
Date : 09-04-2009 Time : 11:57 Report Number : 1

A = R x K x L x S x P x C

Rainfall Erosivity: Rainfall Zone: 3 R = 5384
Soil Erodibility : User supplied K = 0.006
Topography :Slope: 6.0% Slope Length: 300 m LxS = 2.091
Support Practice : User supplied P = 1.200
Management :
Rotation :
Cultivations :
Stubble Mgmt : - User Supplied C = 0.0130

Long-term average annual soil loss: A = 1.1 t/ha

Soil Loss Targets :

There is very little information to indicate target levels of soil loss for Australian soils. The following are suggested as a guide:

Very deep and fertile soils	<10 t/ha.a
Moderately deep and fertile soils	<5 t/ha.a
Shallow or infertile soils	<1 t/ha.a

Management Options :

To reduce soil loss from 1.1 to 1 t/ha.a the options are :
* Reduce C to 0.0123

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****
********** User's Name **********
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SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal Soil Loss Equation (USLE) to predict the average annual soil loss due to sheet and rill erosion. It is based on extensive research in the United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

==========

Estimation prepared for : RISE BILAMBIL HEIGHTS
Date : 09-04-2009 Time : 11:59 Report Number : 2

A = R x K x L x S x P x C

Rainfall Erosivity: Rainfall Zone: 3 R = 5384
Soil Erodibility : User supplied K = 0.065
Topography :Slope: 6.0% Slope Length: 300 m LxS = 2.091
Support Practice : User supplied P = 1.200
Management :
Rotation :
Cultivations :
Stubble Mgmt : - User Supplied C = 0.0130

Long-term average annual soil loss: A = 11 t/ha

Soil Loss Targets :

There is very little information to indicate target levels of soil loss for Australian soils. The following are suggested as a guide:

Very deep and fertile soils	<10 t/ha.a
Moderately deep and fertile soils	<5 t/ha.a
Shallow or infertile soils	<1 t/ha.a

Management Options :

To reduce soil loss from 11 to 10 t/ha.a the options are :
* Reduce C to 0.0114

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********** User's Name **********
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SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal Soil Loss Equation (USLE) to predict the average annual soil loss due to sheet and rill erosion. It is based on extensive research in the United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

==========

Estimation prepared for : RISE BILAMBIL HEIGHTS
Date : 09-04-2009 Time : 11:59 Report Number : 3

A = R x K x L x S x P x C

Rainfall Erosivity: Rainfall Zone: 3 R = 5384
Soil Erodibility : User supplied K = 0.065
Topography :Slope: 6.0% Slope Length: 300 m LxS = 2.091
Support Practice : User supplied P = 1.200
Management :
Rotation :
Cultivations :
Stubble Mgmt : - User Supplied C = 0.4500

Long-term average annual soil loss: A = 395 t/ha

Soil Loss Targets :

There is very little information to indicate target levels of soil loss for Australian soils. The following are suggested as a guide:

Very deep and fertile soils	<10 t/ha.a
Moderately deep and fertile soils	<5 t/ha.a
Shallow or infertile soils	<1 t/ha.a

Management Options :

To reduce soil loss from 395 to 10 t/ha.a the options are :
* Reduce C to 0.0114

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********** User's Name **********
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SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal Soil Loss Equation (USLE) to predict the average annual soil loss due to sheet and rill erosion. It is based on extensive research in the United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

==========

Estimation prepared for : RISE BILAMBIL HEIGHTS
Date : 09-04-2009 Time : 12:00 Report Number : 4

A = R x K x L x S x P x C

Rainfall Erosivity: Rainfall Zone: 3 R = 5384
Soil Erodibility : User supplied K = 0.006
Topography :Slope: 6.0% Slope Length: 300 m LxS = 2.091
Support Practice : User supplied P = 1.200
Management :
Rotation :
Cultivations :
Stubble Mgmt : - User Supplied C = 0.4500

Long-term average annual soil loss: A = 36 t/ha

Soil Loss Targets :

There is very little information to indicate target levels of soil loss for Australian soils. The following are suggested as a guide:

Very deep and fertile soils	<10 t/ha.a
Moderately deep and fertile soils	<5 t/ha.a
Shallow or infertile soils	<1 t/ha.a

Management Options :

To reduce soil loss from 36 to 10 t/ha.a the options are :
* Reduce C to 0.1234

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********** User's Name **********
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SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal Soil Loss Equation (USLE) to predict the average annual soil loss due to sheet and rill erosion. It is based on extensive research in the United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

==========

Estimation prepared for : RISE BILAMBIL HEIGHTS
Date : 09-04-2009 Time : 12:00 Report Number : 5

A = R x K x L x S x P x C

Rainfall Erosivity: Rainfall Zone: 3 R = 5384
Soil Erodibility : User supplied K = 0.006
Topography :Slope: 6.0% Slope Length: 100 m LxS = 1.299
Support Practice : User supplied P = 1.200
Management :
Rotation :
Cultivations :
Stubble Mgmt : - User Supplied C = 0.4500

Long-term average annual soil loss: A = 23 t/ha

Soil Loss Targets :

There is very little information to indicate target levels of soil loss for Australian soils. The following are suggested as a guide:

Very deep and fertile soils	<10 t/ha.a
Moderately deep and fertile soils	<5 t/ha.a
Shallow or infertile soils	<1 t/ha.a

Management Options :

To reduce soil loss from 23 to 10 t/ha.a the options are :
* Reduce C to 0.1985

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********** User's Name **********
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SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal Soil Loss Equation (USLE) to predict the average annual soil loss due to sheet and rill erosion. It is based on extensive research in the United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

==========

Estimation prepared for : RISE BILAMBIL HEIGHTS
Date : 09-04-2009 Time : 12:01 Report Number : 6

A = R x K x L x S x P x C

Rainfall Erosivity: Rainfall Zone: 3 R = 5384
Soil Erodibility : User supplied K = 0.065
Topography :Slope: 6.0% Slope Length: 100 m LxS = 1.299
Support Practice : User supplied P = 1.200
Management :
Rotation :
Cultivations :
Stubble Mgmt : - User Supplied C = 0.4500

Long-term average annual soil loss: A = 246 t/ha

Soil Loss Targets :

There is very little information to indicate target levels of soil loss for Australian soils. The following are suggested as a guide:

Very deep and fertile soils	<10 t/ha.a
Moderately deep and fertile soils	<5 t/ha.a
Shallow or infertile soils	<1 t/ha.a

Management Options :

To reduce soil loss from 246 to 10 t/ha.a the options are :
* Reduce C to 0.0183

****

6.4 Appendix 4

6.4.1 Temporary sedimentation basin preliminary sizing

Catchment No.	Area (ha)	Disturbed area (ha)	Basin area (m^2)	Basin volume (m^3)	Depth (m)	Notes
1	0.67	0.67	NR	NR	NR	Catchment less than 1.0ha
2	0.37	0.37	NR	NR	NR	Catchment less than 1.0ha
3	2.74	2.74	375	560	1.5	
4	0.49	0.49	NR	NR	NR	Catchment less than 1.0ha
5	4.32	4.32	590	880	1.5	
6	4.89	4.89	665	1000	1.5	
7	4.84	4.84	660	990	1.5	
8	9.56	9.56	1300	1950	1.5	Use existing dam
9	19.88	6.00	2700	4060	1.5	Assumes staged construction Use existing dam
10	4.51	4.51	615	920	1.5	Use existing dam
11	1.17	1.17	160	240	1.5	Upstream areas diverted
12	8.77	8.77	1195	1790	1.5	Use propose wetland site
13	10.79	10.79	1470	2200	1.5	Use proposed wetland site
14	15.50	15.50	2110	3160	1.5	Assumes clean water diversion

NR=Not Required

Note: Basin sizes are preliminary only, subject to detailed design and staging of construction works.