EMU SWAMP DAM PROJECT

SOIL AND LAND SUITABILITY

Prepared for

SKM Pty Ltd

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GT ENVIRONMENTAL SERVICES
T. 0418 980 204 E. g.tuck@bigpond.com
10 Cressbrook Street
Eight Mile Plains
Brisbane QLD 4113

PROPOSED EMU SWAMP DAM AREA
SOIL AND LAND SUITABILITY

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Project Manager:	Graham Tuck
Author:	Graham Tuck
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GT ENVIRONMENTAL SERVICES
T. 0418 980 204 E. g.tuck@bigpond.com
10 Cressbrook Street
Eight Mile Plains
Brisbane QLD 4113

LIST OF FIGURES

LIST OF ATTACHMENTS

1 EXECUTIVE SUMMARY

The Emu Swamp Dam Project area is located approximately 10 kilometres south of Stanthorpe, Queensland and comprises 257 hectares. The area is contained within the upper catchment of the Severn River. Land types comprise uniform sands associated with granite rises and gently undulating plains. Land types along the proposed urban and irrigation pipeline routes are also within an undulating granite landscape and dominated by coarse sandy and texture contrast soils.

Survey Technique
A 1:10,000 scale soil survey and land suitability assessment was undertaken for areas of the proposed inundation area in a project area referred to as Emu Swamp. Soils and land suitability along the proposed pipeline route were assessed from field checking to refine the existing land type mapping of Maher (1996).

The survey procedure and land suitability assessments followed guidelines of Gunn *et al* (1988) and Land Resources Branch (1990). These guidelines are regarded as the established standard for soil survey in Queensland and form the basis of Local Government shire planning and agricultural assessments.

Soils and Land Suitability
Soil types are uniform across the area with gritty coarse uniform sands predominating. Granite rock outcropping is fairly common. Four soil types are described in the area with three of them (A, B and C) occurring in the dam inundation area.

The Emu Swamp Dam inundation area and pipeline routes are suited to sheep or cattle grazing at varying stocking rates. Some areas are suited to forage cropping, vineyards, fruits and vegetables. A significant portion of the proposed inundation area remains as uncleared bushland, particularly adjacent to the Severn River.

Observations were made at most sampling sites of the general state of the land in terms of erosion, vegetation condition and degradation. Overall, the survey area is in good condition and appears to have been used in accordance with land suitability.

A summary of the assessed land suitability for cropping and grazing follows.

Soil Unit	Description	Land suitability
A	Mostly uniform loamy coarse sands associated with active creek or river channels. Typified by variable soil depth and slope. Often extensive granite outcropping. Mostly uncleared scrub. Fertility is low to moderate. The soil is grey brown with a profile which is non-saline, non-dispersive, has an acid reaction trend with imperfect drainage and prominent red mottling common.	Unsuitable for cropping due to rockiness, physical factors, topography and flooding risk. Suitable grazing land with moderate limitations from erosion risk, low moisture availability and soil physical factors.
B	Undulating mostly uncleared scrub land with slope gradients generally greater than 2%. Soils are brownish grey with a uniform coarse to loamy sand profile overlying granite bedrock with a possible bleached A2 horizon. Granite outcropping rock may be significant and soil depth is generally within the range from 30 to 60 cm (average 40cm). A variant occurs with coarse sand overlying clayey subsoils which may be sodic and saline.	Unsuitable or marginal for cropping due to low plant availability of water, rockiness, physical factors, topography and workability problems. Suitable grazing land with moderate limitations from low moisture availability for pasture growth and erosion potential.

	Fertility is low to moderate, reaction trend is acidic, non-saline, non-dispersive, often imperfectly drained with prominent red mottling common.	
C	Very gently undulating uniform sandy soils often with red mottled subsoil extending past 50cm to weathered or fresh granite bedrock. Mostly cleared for cultivation (forage), pasture or grape vines and stone fruit. Soil depth is generally in a range from 40 to 100 cm (average 55cm) with occasional granite outcropping. Slope gradient is generally < 2% and fertility is low to moderate. The soil profile is non-saline, non-dispersive, has an acid reaction trend with areas of imperfect drainage and red mottling.	Suitable cropping land with moderate limitations from low moisture availability and low fertility. Highly suitable grazing land with minor limitations from low fertility and plant moisture availability.
D	Rocky uplands with variable (usually shallow) soils and extensive rocky areas. Marginal grazing land. No soils of this type were found in the Emu Swamp dam inundation area but they occur in limited areas along the pipeline route.	Not suitable for cropping but low intensity grazing.

Erosion Risk

In this survey, an assessment of erosion risk for each soil type was undertaken on the basis of soil morphology, slope gradients and soil chemistry. Various findings and recommendations from a survey conducted by Wills in 1980 to determine the extent of soil erosion in the Granite Belt region were sourced. Wills concluded that the sandy granitic soils which dominate the survey area have a low erosion potential and the current survey concurs with this view. Given appropriate management of earthworks activity, the likelihood of major potential impact to the downstream environment from erosion is considered low

Soils within the dam inundation area are rapidly draining uniform coarse sands which are non dispersive or saline. The soils are not considered highly erosive with the major risk being physical sedimentation which increases over exposed soil surfaces as slope gradient increases above 2%.

Monitoring of downstream water courses should focus on pH, electrical conductivity and sediment load. Values should be compared with natural background levels measured upstream from any construction activity.

Topsoil Management

All soil types may be utilised for construction activities or rehabilitation of disturbed areas and can be stripped until either bedrock, hard impervious layers or mottled clayey subsoils are encountered.

Good Quality Agricultural Land

The dam inundation area is assessed as good quality class B grazing land. This survey sought to refine GQAL classification following the higher scale mapping program and confirmed that much of the area is class B grazing lands but with important areas of class A crop land and limited class D non-agricultural land.

Construction Activities

Major environmental risks associated with soils during construction are seen as;

- Soils in the dam inundation area are uniform coarse sands overlying bedrock with low erosion potential in normal conditions. Following disturbance, the risk of sediment being removed downstream from exposed surfaces or topsoil stockpiles increases with slope gradient and proximity of disturbed areas to natural water flow paths.
- The uniform sandy soils have a low risk of soil dispersion or salinity.

- While the uniform sands are common along proposed pipeline routes, an increased environmental risk is noted from the likely presence of texture contrast soils with possible increased salinity in the clay subsoil. Chemical data indicate that some of these soils may be approaching levels considered dispersive and saline. Contaminated runoff may cause downstream impacts from sedimentation and salinity.

Suggested management controls for construction activities are included in Section 6.

2 BACKGROUND

2.1 LOCATION OF SURVEY AREA

The survey area is shown in Figure 1 and comprises ;

- The inundation footprint (to full supply level of 738m AHD) of 196 hectares in an area known as the Emu Swamp Dam Project.
- An approximate 120 kilometre strip of land proposed as a route for urban and irrigation pipelines.

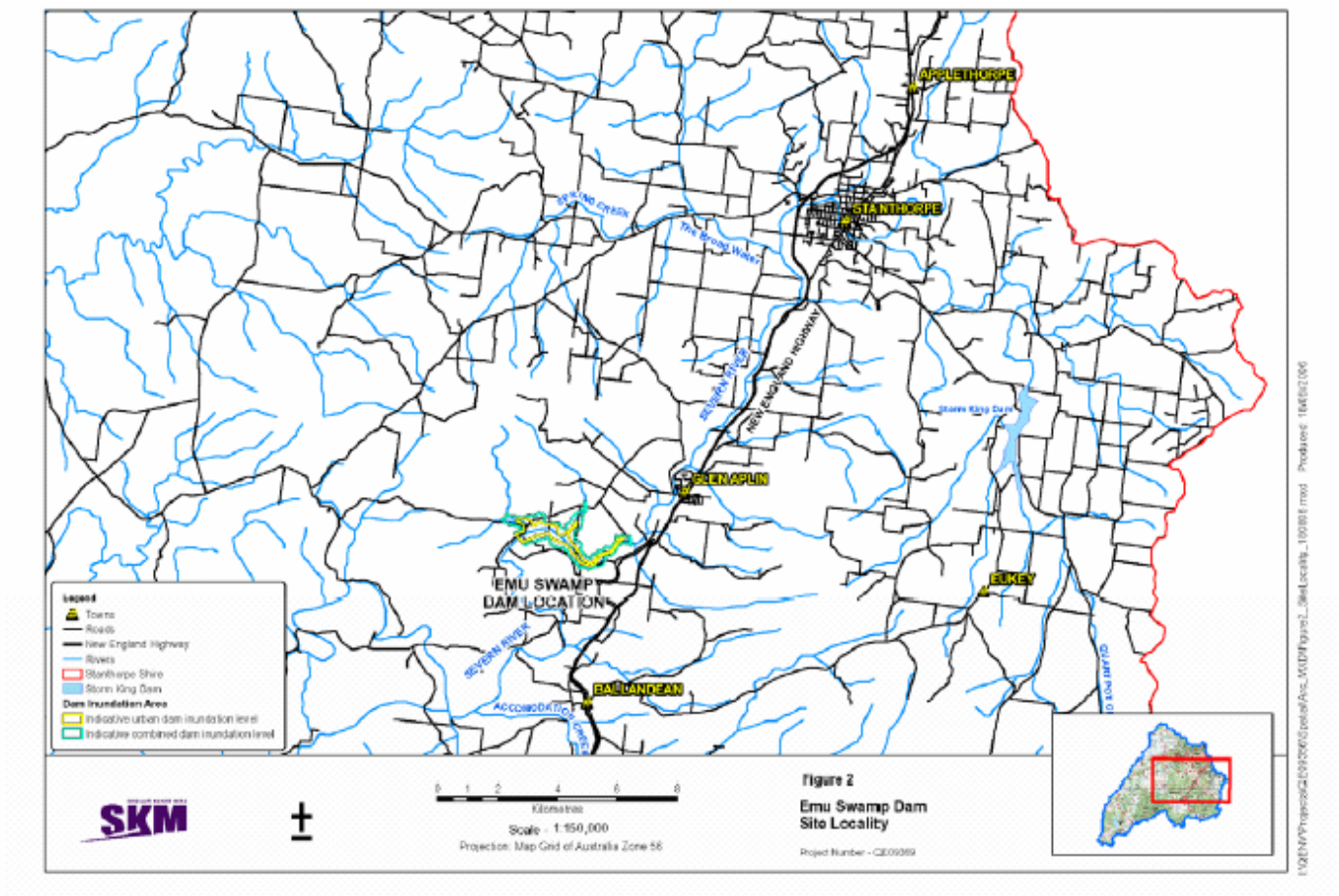


Figure 1 Location Map - Emu Swamp Project

2.2 EXISTING LAND USE

Predominant land use patterns in the survey area include high value horticultural crops, vineyards, commercial timber and grazing of improved and native pastures with opportunistic forage cropping undertaken in some areas. In the dam inundation area, vineyards and stone fruits occur on the southern side of the Severn River with about one third of the survey area cleared of original vegetation.

A full description of soils, land suitability and use is included in Section 5 of this report.

2.3 SCOPE OF WORK

SKM has been commissioned to undertake an EIS to review the Emu Creek urban supply / irrigation dam proposal. The EIS support work proposed by the consultant primarily involves;

- Collation and review of available background soils and land suitability data,
- description of regional geology,
- preparation of a soils and land inventory / map and assessments of land suitability,
- assessment of quality/ quantities of useable topsoil / subsoil,
- identification of problems from physical characteristics, sodicity, salinity and erosion potential,
- describe possible impacts, in particular erosion rates and effects,
- outline mitigation measures to control possible soil related impacts from salinity, acidity, sodium and sedimentation.
- A detailed assessment of soils in the dam area to confirm agricultural land suitability given that it is all assessed as Area B GQAL – potentially good agricultural land and,
- Describe landforms and soil types together with relevant information of land suitability and risks to the environment along proposed pipeline routes.

The land inventory study project was managed by GTES Pty Ltd and conducted by environmental scientist Mr Graham Tuck. This project does not include soils suitability information for engineering requirements such as construction of facilities.

2.4 SURVEY STANDARDS

Recommendations of *The Australian Soil and Land Survey Handbook – Guidelines for Conducting Soil Surveys, Gunn, Beattie, Reid and van de Graf*. *1988* (Gunn *et al* 1988) have been adopted in the selection of survey intensity. This standard of Land Resources Branch (1989) essentially follow those of Gunn *et al* (1988) which is the established standard for soil survey in Queensland. The mapping scale used in this survey follows recommendations of Gunn *et al* (1988) which is for a High Intensity Survey with a sampling program to meet a 1:20,000 scale map.

Gunn *et al* (1988) propose two levels of site descriptions in soil surveys; detailed and non-detailed. Detailed sites described the soil profile and landforms and non-detailed confirm soil type and boundaries. Gunn et al further recommend that the number of detailed site descriptions should be approximately 25% of total observations. Table 2.1 shows recommended survey scales for particular purposes.

Table 2.1 Class of Survey in relation to scale and recommended use.

Soil Survey Class	**Typical Scale**	**Area (ha) represented by 1cm2 of map**	**Recommended uses**
Very high intensity	1:5,000 to 1:10,000	0.25-1.0	Detailed intensive use eg Horticultural research and production
High intensity	**1:20,000 – 1:25,000**	**4 to 6.5**	**Ag production areas, mine site rehabilitation use**
Medium intensity	1: 50,000	25	As above, pasture production areas, small catchment management etc
Low intensity	1:100,000	100	Ag feasibility, large catchment management

Reconnaissance	1:250,000 to 1:500,000	625 to 2,500	Ag development potential, pasture production areas etc
Synthesis	1:2,500,000	40,000	National resource inventory

The guidelines suggest that 10 sites per 100 hectares is suitable for a 1:20,000 scale survey depending on pre existing resource information as well as the local knowledge and experience of the surveyor. Further, the guideline also recommends that between 1 and 5% of all sites are sampled and subject to laboratory analysis.

2.5 LAND SUITABILITY ASSESSMENT

Assessments were made for land suitability. Land suitability deals with the existing specific or potential uses for grazing and or cropping. The five-class system proposed by Land Resources Branch (1989) and used by Shields and Williams (QDPI, 1990) in the Kilcummin Soil Survey is considered appropriate for this survey. This system is based on physical and chemical limiting factors applied directly to specific uses. The system comprises:

Class 1	high quality land with few or very minor limitations,
Class 2	land with minor limitations,
Class 3	moderate limitations to sustaining the use,
Class 4	marginal land requiring major inputs to sustain the use
Class 5	unsuitable due to extreme limitations.

2.6 LAND RESOURCE INFORMATION REVIEW

A variety of background information relevant to the area was sourced in this survey. This information includes;

- Maher (1996). *Understanding and Managing Soils in the Stanthorpe Rosenthal Region*. *DNR*. This report collated available data from past surveys (below) and, combined with local knowledge and experience, developed a manual to assist in sound agricultural land management practices in the region. Mapping units are called 'Land Types' which may include different soil types. Mapping is at a scale of 1:250000 which is far too broad for direct application to the Emu Swamp survey but provides useful background data.

  The land type mapping from Maher (1996) was the basis for the soils assessment along the proposed pipeline route.

- Wills (1980). *Granite Belt Soil Erosion Survey*. QDPI. This report is based on a survey of landholders in the region and concluded that erosion problems on granitic soils are more a function of agricultural management practices than slope gradient. The major problem is soil degradation from physical siltation rather than dispersion related problems.

- Powell (1977). *Soils of the Granite Belt Vineyards. South-east Queensland. QDPI.* Powell characterized soil types from vineyards which existed in the mid 1970's in the area. As no vineyards existed in the proposed Emu Swamp dam area, no soils were described there. Nevertheless Powell described 'a shallow siliceous sand on weathered granite' which appears to predominate in the survey area. Data were reviewed for this soil and compared to data generated in the current survey.

- Wills (1976) *The Granite and Traprock area of South East Queensland*. *Part1 - Land Inventory and Part 2 Land Utilisation Study*. Wills included the Emu Swamp area within the Severn Land System which comprises siliceous sands from eroded granite of the upper Severn River Basin. Wills mapped the lands within the Emu Swamp area as 'shallow to moderately deep siliceous sands which were acidic reaction and possibly bleached with mottled subsoils'. Laboratory and morphological data for this soil are included in Attachment 2. Also included in Wills (1976) is an extensive geologic and geomorphologic background to the area which has also been sourced.

- Powell (1975) described and mapped soil types in the area for inclusion in Wills (1976). Figure 2 overlies the proposed inundation area and pipeline routes of the Emu Swamp Project with soil types described by Powell (1975).

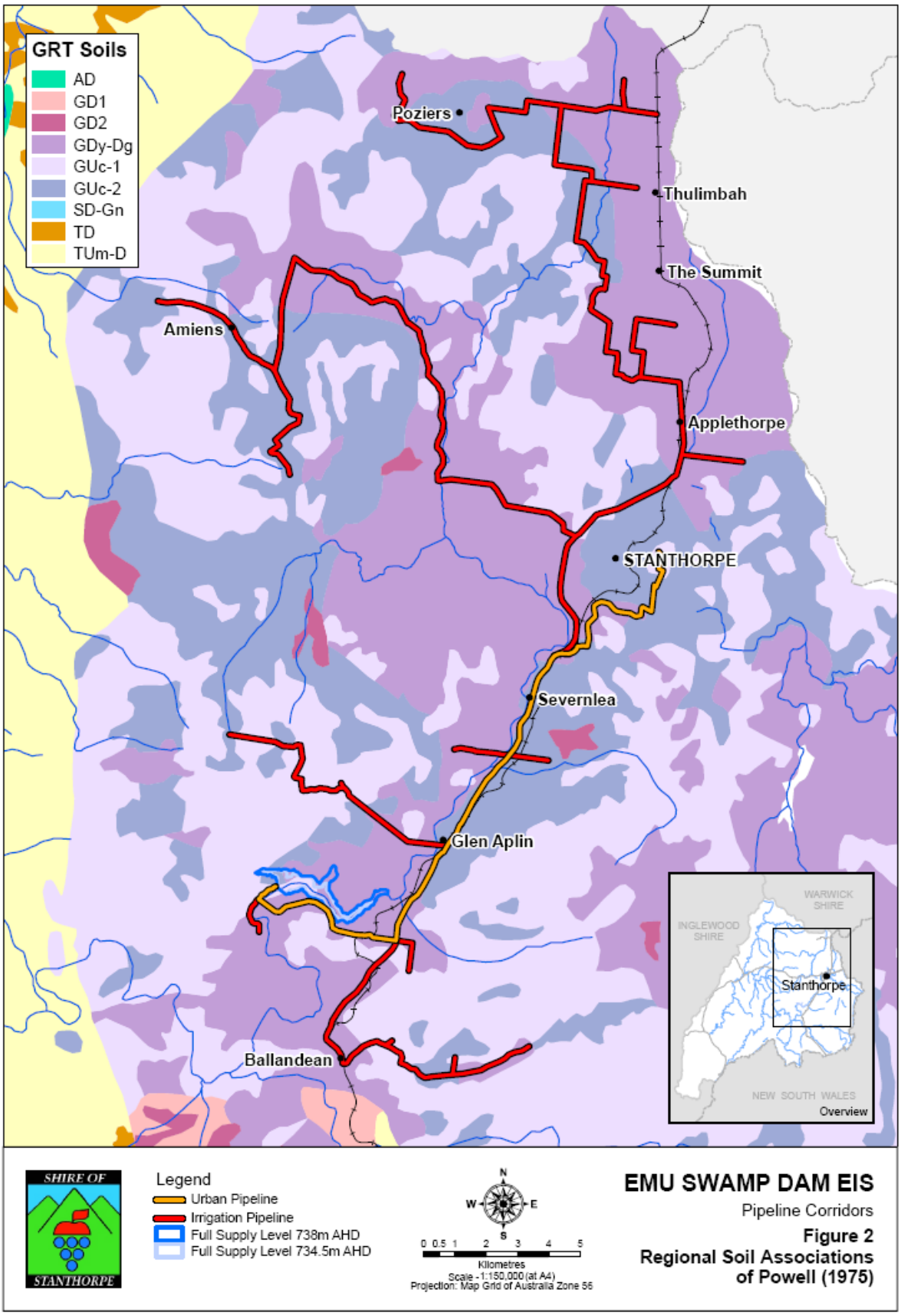
  Soils types and likely occurrence in the survey area from Powell (1975) are;

Soil Unit ID (Powell 1975)	Occurrence in survey area	Description
AD	Very minor	Yellowish brown, neutral to alkaline texture contrast soils (solodics)
GD1	Common	Acid to neutral texture contrast soils (soloths, solodics)
GD2	Isolated	Alkaline texture contrast soils (solodics)
GDy-Dg	Reasonably common along pipeline route	Acid, yellow and grey, mottled texture contrast soils (yellow podzolics)
GUc1	Major	Gritty siliceous sands among rocky outcrops
GUc2	Major	Gritty siliceous sands
SD-Gn	Very minor	Shallow, acid gravelly texture contrast soils

- Emma Bryant (in Maher 1996) described the types of soils which formed on granite landscapes in the region. The survey area is contained within the upper catchment of the Severn River which falls into Bryant's 'uniform sands associated with granite rises' as well as 'elevated granite plains'.

  Bryant described the granite rises as being lower in the landscape than the granite hills, more gently sloping (2-9 %) and less rocky. Granite rises generally occur along valleys and feature uniform sands overlying hard pans or hard rock. Soils are normally shallower than those of the associated lands of the elevated granite plains. A minor unit associated with this soil is texture contrast podzolic soils. (Only one such soil was found in the Emu Creek survey).

  Some evidence was found of Bryant's *Elevated Granite Plains* which have average slopes from 2-4% and are generally non-rocky with bleaching and mottling of subsoils as a result of poor drainage.


GRT Soils
AD
GD1
GD2
GDy-Dg
GUc-1
GUc-2
SD-Gn
TD
TUm-D
Poziers
Thulimbah
The Summit
Amiens
Applethorpe
STANTHORPE
Severnlea
Glen Aplin
Ballandean
WARWICK SHIRE
INGLEWOOD SHIRE
Stanthorpe
NEW SOUTH WALES
Overview
SHIRE OF STANTHORPE
Legend
Urban Pipeline
Irrigation Pipeline
Full Supply Level 738m AHD
Full Supply Level 734.5m AHD
N
W
E
S
0 0.5 1 2 3 4 5
Kilometres
Scale - 1:150,000 (at A4)
Projection: Map Grid of Australia Zone 56
EMU SWAMP DAM EIS
Pipeline Corridors
Figure 2
Regional Soil Associations of Powell (1975)

2.7 SURVEY METHODOLOGY

The soils were mapped at an approximate scale of 1:10,000 in line with recommendations of Gunn *et al* (1988). Following initial field checks, this scale was selected as most appropriate for the detailed evaluation of this particular area. Initially, available background information (refer above) was examined and air photo mosaics of the area were mapped to delineate proposed soil units on the basis of similar topographic and vegetative patterns.

As soils basically comprised uniform coarse sands with major variability being depth to weathered bedrock, mapping units were determined primarily on the basis of;

- similarity in morphological attributes, particularly soil depth,
- extent of granite surface outcropping and,
- slope gradient.

A brief reference-mapping phase was conducted to develop a draft soil type map legend and document the expected soil variation in the area. This was followed by detailed site sampling to verify soil types and define boundaries. Field sampling was quite straightforward as access was very good to all parts of the survey area.

Free survey techniques (Gunn *et al* 1988) were used to verify soil types and boundaries and involved 31 detailed site observations supported by other non-detailed sites to confirm soil type and map boundaries. Detailed sites involved the exposure of the soil profile with 75mm hand augers to depths up to 120 cm or to hard or otherwise impenetrable layers. Where possible, soil pits or cuttings were used to better describe subsoil structure. Background geological data confirm granite substrate as the only unit which is likely to influence soil attributes.

Non-detailed sites involved either a quick check of soil type and stripping depth with a hand auger or confirmation of changes in vegetation or topography. The soil scheme of Isbell (1998) is used to classify soil type. Almost all soils are silicious sands. Soil types have been confirmed following interpretation of laboratory data.

2.8 SOIL ANALYSIS

The selection of soils for chemical analysis was undertaken on the basis of that site being a good representation of the soil type as a whole. Analytical results were used to determine chemical limiting factors and utilised to assist in agricultural suitability assessments for cropping and grazing. In addition, these data helped determine soil potential in future construction activity. Representative sites were sampled for detailed analysis of major horizons at the *Phosyn Analytical Laboratory*, a NATA approved facility. Details of laboratory analyses undertaken, results and methods are included in Attachment 2. The following analyses were performed:

SAMPLES	ANALYSIS
All samples	pH, cations, CEC, Ca:Mg, % base saturation, electrical conductivity (1:5 soil water extract)
Detailed chemical characterisation of representative surface soils	pH (H2O), pH (CaCl2), Organic Matter (%), CEC (meq/100g), EC (dS/m), Nitrate – N (ppm), P (ppm), K (meq), Ca (meq), Mg (meq), S (ppm), B (ppm), Cu (ppm), Fe (ppm), Mn (ppm), Zn (ppm), Al (meq), Na (meq), Cl (ppm), Ca base saturation (%), K base saturation (%), Mg base saturation (%), Na base saturation (%), Ca:Mg, Nitrogen (%), particle size distribution and R1 dispersion.

3 EMU SWAMP DAM AREA SOILS

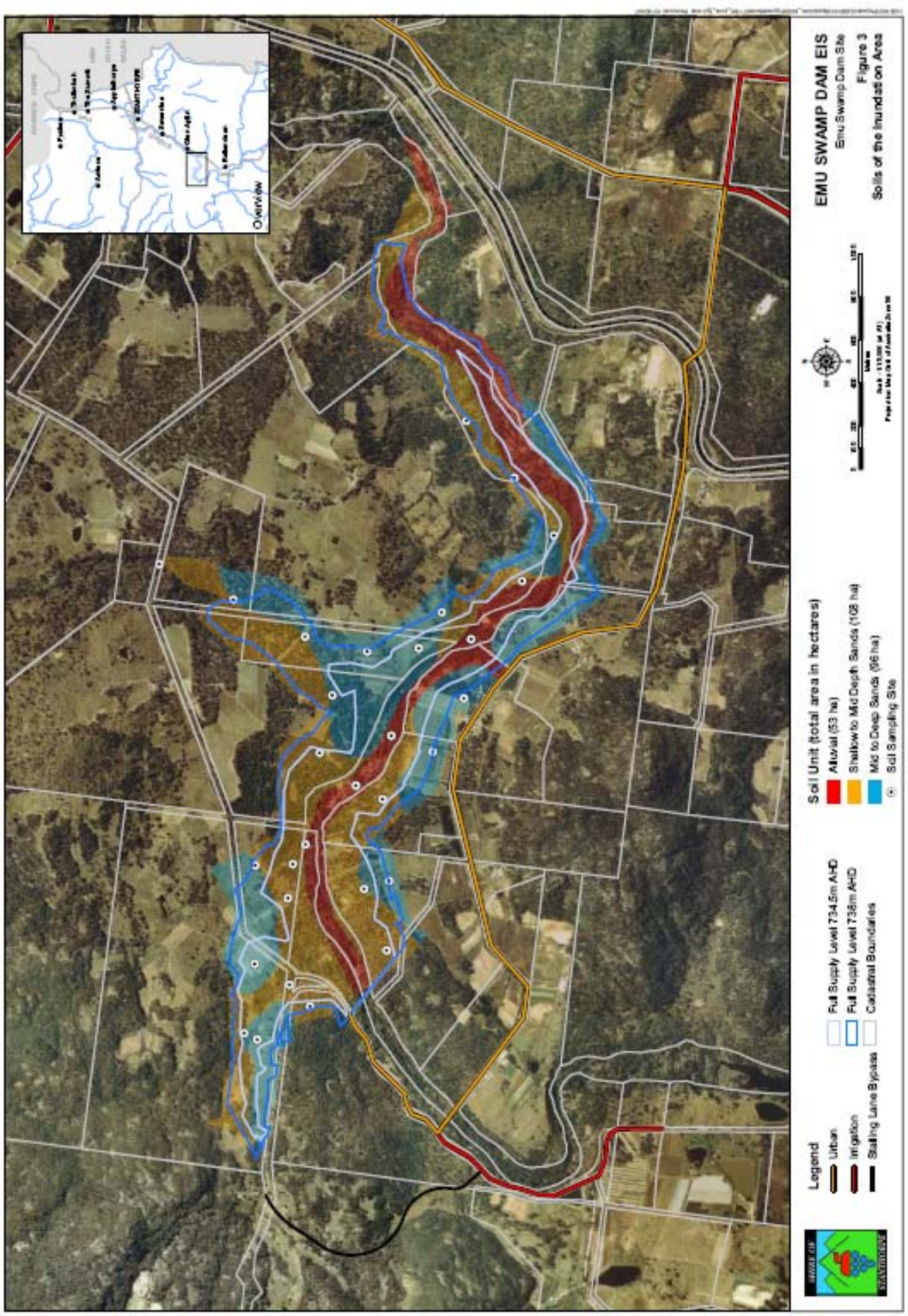
3.1 OVERVIEW

The survey area is contained in the upper catchment of the Severn River where underlying geology is exclusively granite from which all soils in the survey are derived. Soil mapping units have been developed primarily on the basis of similarity in morphology, laboratory data, soil depth, percentage of granite outcropping and topographic position. Table 3.1 shows the three soil types delineated in this survey and identifies comparable soils described in previous surveys. The soils distribution in the inundation area are shown on Figure 3.

The principal soil type is uniform coarse gritty sands of variable depth to weathered bedrock. Variations include mottled or bleached A2 horizons and very occasional clayey subsoil.

TABLE 3-1 RELATIONSHIP WITH GTES (2007) SOILS AND PREVIOUS SURVEYS

GTES Map Unit	Description	Comparable soils from other surveys		
		Powell (1977)	Powell (1975)	Land Type (Maher 1996)
A	Loamy coarse sands associated with active creek or river channels. Typified by variable soil depth and slope. Often extensive (>50%) granite outcropping. Mostly uncleared scrub.	Ucc	GUc1	Banca
B	Undulating with uniform coarse to loamy sands, possible bleach often with moderate granite outcropping. Soil depth is generally from 30 to 60 cm (average 40cm). Slopes generally 2- 4%. Mostly uncleared scrub.	Uca	GUc2	Pozieres and Banca
C	Very gently undulating uniform sandy soils often with red mottled subsoil extending past 50cm to weathered or fresh granite bedrock. Soil depth generally from 40 to 100 cm (average 55cm). Mostly cleared for cultivation (forage), pasture or grape vines and stone fruit. Granite outcropping < 20%. Slopes generally < 2%	Ucb	GUc2 and minor GD1 and G Dy-Dg	Pozieres


EMU SWAMP DAM EIS
Emu Swamp Dam Site
Figure 3
Soils of the Inundation Area
Soil Unit (total area in hectares)
Alluvial (53 ha)
Shallow to Mid Depth Sands (108 ha)
Mid to Deep Sands (96 ha)
Soil Sampling Site
Legend
Urban
Irrigation
Stalling Lane Bypass
Full Supply Level 734.5m AHD
Full Supply Level 736m AHD
Cadastral Boundaries
Overview

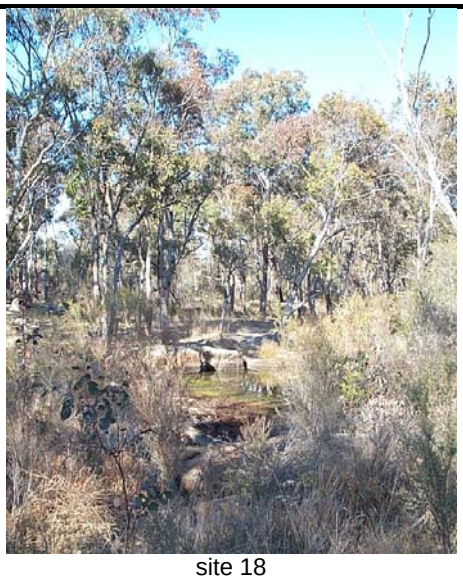
3.2 SOIL TYPES

A Uniform loamy sands associated with alluvial channels.

Major Distinguishing Features

- Variable topography including creek beds, rock outcrops, steep embankments and localised creek flats,
- Soil depth is highly variable in a range from 0 to over 120 cm,
- Subsoils with dispersive tendency may occur,
- Frequent granite outcropping, stones and boulders,
- Uncleared scrub with uniform loamy to coarse sands with possible hardpans,
- Major limitations to agriculture are flooding, access, variable topography, rock outcropping, variable soil depth and high erosion risk if cleared.
- The soils occupy 46 hectares (23.5%) of the survey area.

Land summary

Soil Mapping unit	**A**	 site 18
Concept Recent alluvial channels with variable surface topography in granite landscape.		
Substrate	Granite	
Sites described	1,4,15,18, 24,27,	
Laboratory sites	1	
Australian Soil Classification	Orthic Tenosol	
Landform Element	Creek channel and embankment	
Landform Pattern	Alluvial plain	
Slope %	1%	
Microrelief	nil	
Surface condition (when dry)	Highly variable. Granite common. Other areas firm silty loam and loose coarse sand.	
Land Condition	Stable. No erosion	
Current Land Use	Cattle grazing	
Major Vegetation Form and Type	Mostly remnant open forest with isolated areas of clearing.	
Erosion potential	In steeper creek embankments the silty loamy sand surface has high potential for erosion if adequate surface cover is not maintained.	

Land Suitability Summary.

Major land use limitations are;

- Flooding and access,
- highly variable surface topography with rock outcropping, steep embankments, creek flats.
- Highly variable soil depth and high erosion risk if cleared,
- Infertile, very low water holding capacity,
- Effective plant root depth highly variable.
- Sodic subsoil below 30cm in site 1.

Cropping Class 5 - Not suitable due to severity of risks above

This area was described as 'Banca' Land Type by Maher 1996. Land suitability and management requirements are derived from this report.

Grazing: Class 3/4 suitable for low density grazing of native pastures but managed to prevent erosion pathways developing as stock move down steep creek embankments. Likely management problems in control of stock & maintenance of fences and access.

Site 24 – Old weir on Severn River channel

TYPICAL SOIL PROFILE – Deep sand

0.0 m
0.2 m
0.6 m
0.9 m

site 18

Horizon	Depth cm	Field Description
A11	0 -60	Pale brown 10YR5/3, silty sandy loam, firm, field pH 5.5 clear change to;
A12	60 – 120+	dark brown 10YR 3/1, loamy coarse sand, massive, field pH 5,

Note that soil depth is often quite variable with exposed rock common.

Runoff: Quite good infiltration but rapid over exposed rock.
Permeability : High
Drainage: may be impeded by bedrock or hardpans.

MINOR VARIANT – Deep loamy

0.0m
0.2m
0.6m
0.9m
1.2m

site 1

Horizon	Depth cm	Field Description
A11	0 -10	Dark brown 10YR3/3, silty coarse sand, massive, field pH 5.0 clear change to;
A12	10 – 30	Pale brown 10YR 5/3, coarse sandy loam, massive, clear to;
A21	30-40cm	yellowish brown 10YR5/6(w), 10YR7/2(d), loamy coarse sand, conspicuous bleach, massive, no segregations, field pH 4.5, clear to;
A22	40-120+cm	Brown 7.5YR4/2, gritty coarse sand, massive but sets hard, field pH 4.5.

Runoff: Very rapid over exposed rock. Silty loam topsoil areas may be moderate but coarse loose sandy areas slow.
Permeability : High
Drainage: Impeded by bedrock or hardpans.

MAJOR ASPECTS OF CHEMICAL ANALYSES: SITE 1

Laboratory analyses indicate that fertility is very low. Specifically, nitrogen, phosphorus, sulphur and boron are very low while most trace elements are adequate. Cation exchange capacity is very low and pH trend is acid which continues to the bedrock. No tendency for dispersion is indicated above 30 cm depth. The subsoil below the bleached layer at 30cm is not saline. The soil bleach indicates a tendency to waterlog as rapidly infiltrating water is held up by the hard, impervious subsoil layer.

The surface is 80% sand with equal proportions of fine and coarse sand. This is the result of alluvial deposition of finer grained particles which suggests that the surface may tend to seal and set hard. The R1 is very low indicating little potential for dispersion.

ANALYTE	0 - 10CM	30 – 40 CM	100-110 CM	COMMENT
pH(H2O)	4.9	4.8	4.6	acidic
pH (CaCl2)	4.2			acidic
Organic matter (%)	1.9			low
CEC (meq/100g)	5.7	6.2	5.5	very low
EC (dS/m)	0.05	0.09	0.05	very low
NO3-N ppm	1.7			very low
Phosphorus (Olsen)ppm	6			very low
Potassium (meq/100g)	0.24	0.24	0.22	Medium - ok
Calcium meq/100g	3.30	2.88	2.72	moderate
Magnesium meq/100g	1.78	2.30	1.94	moderate
Sulphur ppm	5			low
Boron ppm	<0.1			Very low
Copper ppm	0.6			Medium - ok
Iron ppm	84			Medium - ok
Manganese ppm	21.1			Medium - ok
Zinc ppm	0.8			Medium - ok
Aluminium (meq/100g)	0.14	0.19	0.21	ok
Sodium (meq/100g)	0.3	0.6	0.4	low
Chloride (ppm)	12			Very low
Ca base sat %	57.5	46.3	49.6	ok
K base sat. %	4.2	3.9	4.0	ok
Mg base sat. %	31.0	37.0	35.4	ok
Na base sat % (ESP)	4.9	9.8	7.1	Sodic below 30cm however amounts of sodium are low as is EC. Not considered significant
Al base sat %	1.9	3.1	3.8	ok
Ca/Mg ratio	2.4	1.3		High - good

Site 1	Coarse Sand %	Fine Sand %	Silt %	Clay %	R1 Dispersion
0-20cm	42	40	7	12	0.40

B Uniform coarse loamy sands with moderate slope and granite outcropping.

Major Distinguishing Features

- Brownish grey uniform coarse sand,
- Moderate to frequent granite outcropping, stones or boulders,
- Undulating with slopes generally 2- 6%,
- Non dispersive or saline,
- Soil depth to hard bedrock generally in a range from 30 to 60 cm,
- Mostly uncleared scrub with uniform coarse to loamy sands, possible bleach,
- Major limitations to agriculture are low fertility, variable soil depth, increased erosion risk due to slopes > 2% and surface stone / rock and,
- Rapid drainage can be impeded by hardpans or bedrock.
- The soils occupy 83 hectares (42.3%) of the survey area.

Land Summary

Soil Mapping unit	**B**	 Site 17
Concept	Siliceous sand	
Substrate	Granite	
Sites described	2,3,5,8,9,10, 12,13,17,23,25,28 30,31,	
Laboratory sites	5	
Australian Soil Classification	Grey Kurosol	
Landform Element	midslope	
Landform Pattern	gently undulating plain	
Slope %	2 -6 %	
Microrelief	nil	
Surface condition (when dry)	sandy loose	
Land Condition	Stable. No erosion	
Current Land Use	Cattle grazing	
Major Vegetation Form and Type	Areas of remnant open forest with New England Blackbutt	
Erosion potential	Due to higher slope gradients and areas of concentrated water runoff due to rocky outcropping, erosion risk may be significant if sufficient surface cover is not maintained.	
Land Suitability Summary. .	**Cropping** Class 4/5. Unsuitable to marginal for cropping due to low plant available water, rockiness, physical factors, topography and workability problems. **Grazing**: Class 3 Suitable grazing land with moderate limitations from low moisture availability for pasture growth and erosion potential.	

TYPICAL SOIL PROFILE

0.0m

0.3m

0.5m

Site 5

0.6m

0.8m

Horizon	Depth cm	Field Description
A11	0 -20	Brown 10YR3/2, coarse sand, massive , field pH 5.5 clear change to;
A12	20 - 55	greyish brown 7.5YR 5/2, coarse sand, no segregations massive, field pH 4.5, red mottling below 30 cm depth increasing
C	55+	parent material

Runoff: Rapid over rock exposure areas otherwise slow
Permeability : High
Drainage: restricted by bedrock or hard pans

MAJOR ASPECTS OF CHEMICAL ANALYSES: SITE 5

Laboratory analyses indicate that fertility is very low – less than the alluvial site 1 for soil A. Specifically, nitrogen, phosphorus, copper, potassium, sulphur and boron are very low while most other trace elements are adequate. Cation exchange capacity is very low and pH trend is strongly acid which continues to the bedrock. Organic matter is high in the surface as is the calcium to magnesium ratio. Electrical conductivity is very low throughout as is cation exchange. The subsoil below the A horizon is non-sodic or saline. The site was freely drained with no sign of impeded drainage. Particle size distribution is dominated by sand with moderate fractions of fine sand included. Dispersive tendency is very low.

ANALYTE	0 - 10CM	30 - 40 CM	COMMENT
pH(H2O)	5.3	4.7	acidic
pH (CaCl2)	4.8		acidic
Organic matter (%)	3.3		high
CEC (meq/100g)	10.9	5.1	low
EC (dS/m)	0.05	0.02	very low
NO3-N ppm	3.5		Very low
Phosphorus (Olsen)ppm	8		Very low
Potassium (meq/100g)	0.24	0.10	low
Calcium meq/100g	8.76	3.05	adequate
Magnesium meq/100g	1.49	1.48	low
Sulphur ppm	8		low
Boron ppm	0.3		Very low
Copper ppm	0.2		Low / medium
Iron ppm	45		medium
Manganese ppm	52.2		high
Zinc ppm	0.6		medium
Aluminium (meq/100g)	0.12	0.18	ok
Sodium (meq/100g)	0.3	0.3	Very low
Chloride (ppm)	7		Very low
Ca base sat %	80.4	60.2	ok
K base sat. %	2.2	2.0	ok
Mg base sat. %	13.7	29.2	ok
Na base sat % (ESP)	2.6	5.1	Non sodic
Ca/Mg ratio	5.9	2.1	High - good
Al base sat %	1.1	3.6	ok

Site	Coarse sand	Fine sand	Silt	Clay	R1 Dispersion
	%	%	%	%	
5	40	34	14	12	0.63

C Uniform coarse loamy sands on low slopes

Major Distinguishing Features

- Very gently undulating uniform sandy soils often with yellow / red mottled subsoil extending 50 – 100 cm to weathered or fresh granite bedrock,
- Well suited to cultivation for vegetables, forage pasture, vineyards and fruit,
- Minor surface granite rock,
- Slopes generally < 2% gradient,
- Mostly cleared for cropping or grazing of native pastures,
- Major limitations to agriculture are low fertility, low plant available water holding capacity and erosion risk in furrow crops and,
- Rapid drainage can be impeded by hardpans or bedrock causing waterlogging in some areas.
- The soils occupy 67 hectares (34.2%) of the survey area.

TYPICAL SOIL PROFILE

0.0m

0.2m

0.5m

Site 11

0.6m

0.9m

Horizon	Depth cm	Field Description
A11	0 -20	Dark brown 10YR4/3, coarse gritty sand, massive , field pH 5.0 clear change to;
A12	20 - 50	greyish brown 10YR 5/3, coarse sandy loam, no segregations, massive, field pH 5.0,
A21	50 -100+	loamy coarse sand , greyish brown 10YR5/3 with yellowish red staining (mottles), no segregations field pH 4.5,

Parent rock may be encountered below 60 cm.

Runoff: Slow
Permeability : High
Drainage: possibly restricted by bedrock or hard pans

Land Summary

Soil Mapping unit	**C**
Concept	Deeper sandy agricultural soil
Substrate	Granite
Sites described	6,7,11, 14,16, 19,20,21,22, 26,29,
Analytical sites	11 and 21
Australian Soil Classification	Leptic Tenosol and Grey Kurosol
Landform Element	Lower slope
Landform Pattern	gently undulating plains
Slope %	1 – 2%
Microrelief	nil
Surface condition (when dry)	sandy loose

Site 11 – forage crop

Land Condition	Most areas quite stable with no erosion
Current Land Use	Cattle grazing, horticultural crops, vineyards and forage cropping
Major Vegetation Form and Type	Most sites cleared
Erosion potential	No dispersive soils indicated but sediment wash a risk. Graded rows should be constructed across

	contours when cultivation done on slopes > 2%.

Land Suitability Summary.

Major land use limitations are;

- Erosion risk increasing in cultivation on slopes >2%,
- Low plant available water holding capacity (PAWC),
- Moderate to low fertility,
- Excessively drained and waterlogging due to water trapped by bedrock or hardpans.
- Effective plant root depth in depth range of 50 – 90cm common.

Grazing: Class 2 suitable for grazing native or improved pastures and forage.

This area was described as 'Pozieres' Land Type by Maher (1996). Land suitability and management requirements are derived from this report.

site 21 – grazing land

Cropping Class 3 Most areas are well suited to improved pasture, forage cropping, vines, vegetables or fruit however irrigation may need to cover for low PAWC.

Site 18 – being prepared for crops

MAJOR ASPECTS OF CHEMICAL ANALYSES: SITES 11 and 21

Laboratory analyses on both sites indicates that fertility is quite reasonable. Site 21 may have had fertiliser applied however 11 probably has not. Phosphorus, magnesium. Sulphur and boron were low in both sites. However most other indicators of fertility were reasonable. Cation exchange capacity is very low and pH trend is mildly acid to strong acid at depth. Organic matter is high in the surface as is the calcium to magnesium ratio.

Electrical conductivity is very low throughout as is cation exchange capacity. The subsoil below the A horizon is non-sodic or saline. The sites had impeded drainage with red mottling evident below 50 cm depth.

Particle size distribution is dominated by coarse sand in both sites which differs from soils A and B which had considerably more fine sand fraction. Dispersive tendency in both soils is low.

Site 11

ANALYTE	0 - 10CM	40 – 50 CM	60 - 70 CM	COMMENT
pH(H2O)	5.5	5.9	5.4	acidic
pH (CaCl2)	4.9			acidic
Organic matter (%)	2.1			high
CEC (meq/100g)	7.3	4.2	3.6	very low
EC (dS/m)	0.04	0.03	0.02	very low
NO3-N ppm	1.9			Very low
Phosphorus (Olsen)ppm	21			Medium low
Potassium (meq/100g)	0.29	0.16	0.14	medium
Calcium meq/100g	4.93	2.17	1.85	medium
Magnesium meq/100g	1.68	1.55	1.27	low

Sulphur ppm	6			low
Boron ppm	0.2			Very low
Copper ppm	3.0			medium
Iron ppm	57			adequate
Manganese ppm	23.9			Very high
Zinc ppm	1.5			Low / medium
Aluminium (meq/100g)	0.15	0.15	0.12	ok
Sodium (meq/100g)	0.3	0.2	0.3	Very low
Chloride (ppm)	7			Very low
Ca base sat %	67.5	51.3	50.8	ok
K base sat. %	4.0	3.8	3.8	ok
Mg base sat. %	23.0	36.6	34.9	ok
Na base sat % (ESP)	3.4	4.7	7.1	Sodium % just into sodic category at depth however amount of sodium and EC are very low. Not significant.
Ca/Mg ratio	2.9	1.4	1.5	
Al base sat %	2.1	3.5	3.3	

Site	Coarse sand	Fine sand	Silt	Clay	R1 Dispersion
	%	%	%	%	
11 (0-20cm)	64	21	8	8	0.60

SITE 21

ANALYTE	0 - 10CM	50 - 60 CM	COMMENT
pH(H2O)	6.5	4.0	Slightly acid surface becoming strong acid at depth.
pH (CaCl2)	5.8		Slightly acid
Organic matter (%)	1.9		moderate
CEC (meq/100g)	9.4	8.7	low
EC (dS/m)	0.11	0.05	very low
NO3-N ppm	29.3		moderate
Phosphorus (Olsen)ppm	15		low
Potassium (meq/100g)	0.70	0.25	high
Calcium meq/100g	7.16	1.92	high
Magnesium meq/100g	1.11	3.60	Low / adequate
Sulphur ppm	9		Low / moderate
Boron ppm	0.4		low
Copper ppm	3.3		medium
Iron ppm	34		Low - adequate
Manganese ppm	31.5		medium
Zinc ppm	2.0		medium
Aluminium (meq/100g)	0.17		low
Sodium (meq/100g)	0.3	0.7	low
Chloride (ppm)	6		Very low
Ca base sat %	75.9	22.1	ok
K base sat. %	7.4	2.9	ok
Mg base sat. %	11.8	41.4	ok
Na base sat % (ESP)	3.1	8.0	Sodium % into sodic category at depth however amount of sodium and EC are very low. Not significant
Ca/Mg ratio	6.5	0.5	High at surface and low at depth
Al base sat %	1.8	25.6	High at depth

Site	Coarse sand	Fine sand	Silt	Clay	R1 Dispersion
	%	%	%	%	
21 (0-20cm)	62	26	7	6	0.49

3.3 TOPSOIL MANAGEMENT

This survey evaluated topsoil and subsoil with regard to potential for downstream environmental impact from erosion, dispersion, salinity and potential structural issues should they be exposed to the weather. Overall, the dam inundation area includes considerable reserves of topsoil that may be used in construction activities and any rehabilitation of disturbed areas which is required.

The following comments are included to assist management decisions for topsoil.

Soil Type	Stripping	Management of Topsoil	Major environmental risk
All	The entire soil profile to hard rock, hardpan or yellow / red mottled material may be stripped for construction or rehabilitation activities.	Preferably reuse topsoil as soon as possible to avoid time of exposure and erosion risk. If stockpiling is required than these coarse sandy soils may be stored indefinitely without significant deterioration. The major issue is the control of erosion. Long term stockpiles should be constructed with height <3 meters such that a plant cover can be quickly developed sustained. Any stockpiles should be located outside local drainage catchments or pathways as far as is possible. A replacement depth of at least 25cm is recommended if the material is used for regeneration of disturbed areas.	Most soils are non sodic or saline however minor occurrences of sodic clay subsoil were found in the inundation area. The soils have a neutral to slightly acidic reaction and do not pose any downstream risk from acidity. The major downstream risk is sedimentation from erosion.

4 SOILS OF THE PROPOSED PIPELINE ROUTE

4.1 BACKGROUND

Land and soil types which occur along proposed routes for a pipeline to distribute water from the Emu Creek Dam have been assessed and are shown on Figure 4. As with the actual dam area, the entire pipeline distribution system is contained within the granite landscape. For the most part, the pipeline route will follow established road corridors.

This section of the report seeks to identify soil types and relevant aspects for consideration in the construction of the pipeline.

4.2 ASSESSMENT METHODOLOGY

This assessment was basically a two part process involving;

- A review of available data and,
- field checking and refinement of the available data along the pipeline route.

Comprehensive data of the geology, geomorphology, land types, land use and soil types were sourced from the following reports;

- Maher (1996) Resource Information, in Understanding and Managing Soils in the Stanthorpe – Rosenthal Region, DNR. All areas along the pipeline route were included in a 1:250000 scale map of 'Land Types'. For each land type, major soil types have been described.
- Wills (1976) The Granite and Traprock Area of South-East Qld. QDPI., described land use, soils and geomorphology across the region, also at a 1:250000 scale. Soil data originated from Powell (1975),
- Powell (1977) Soils of Granite Belt Vineyards. Powell also mapped the soil types which were included in Wills (1976)
- Powell (1975) Soils of Granite Belt Region.
- Wills (1980) A Granite Belt Soil Erosion Survey identified issues and aspects in areas of existing and proposed cultivation.

The process of assessing land and soil types along the pipeline route was essentially an exercise in checking and refining soil boundaries described in Powell (1975). The aim was to refine map boundaries to a more useable 1:10,000 (approx) scale accuracy than the existing broad scale map. In addition, a selection of soil observations were made to confirm that soil types described for the area were accurate.

Following the completion of field traverses along the route, data was reviewed and compared to map boundaries and soil types described by Powell. It was decided that soil types described by Powell were appropriate for the area however boundaries of land types required refinement in some areas. For this reason, information of natural resources and management requirements included in Maher (1996) and Powell (1975) is considered directly applicable to the map of the pipeline route.

Attachment 1 shows site observations recorded along the pipeline route.

4.3 LAND TYPES ALONG PIPELINE ROUTE

Soil Mapping units

Three land types are described along the pipeline route and summarized below. The distributions of each type along the route are shown in Figure 4. Soil types are summarized below.

Map unit	Description	Land Type	Land Use
B	Soil profiles are uniform dark grey to brown, gritty siliceous sand over hardpans, bedrock or mottled subsoils. A fairly common variation occurs when the coarse sand is underlain by mottled clay subsoil which may be sodic.	Gently undulating plains and rises with colluvial lower hillslopes. May have stony surface and areas of rock outcrop. New England Blackbutt tall open forest. Average slopes 2 -5 %.	Many areas cleared for pasture production with some areas of irrigated crops or forage.
C	Deep soil with gritty dark grey sandy surface to 30-45cm over coarse sands or mottled, brown to grey acid clay subsoils. Often becoming more gritty with depth.	Flat and gently undulating plains with occasional rock outcrops. Average slopes <2%. Occurs in association with B/C.	Mostly cleared for intensive agricultural use
D	Dark grey to brown, gritty coarse sands to duplex soils often very shallow with acidic reaction trend and often underlain by bleached subsoils with hardpans. Soil depth varies between nil and 120cm+.	Low granite hills with areas of tors and rock outcrops common. Blue gum, stringybark grassy woodlands. Occurs in association with B. Also Includes alluvial channels.	Partially cleared grazing lands, commercial forestry or remain un-cleared

Soil type B

Mainly class 3 cropping and class 2 grazing land with major limitations being reduced plant available water, erosion susceptibility when slope exceeds 2%, granite rocks in some areas and low fertility. Cropping class can be improved with management of these 2 limitations.

Major aspects are;

- loose to firm surface usually with much less surface rock than A or D,
- more consistent and greater effective rooting depth than A or D but still with hardpans or rock (60-90cm),
- still quite low plant available water storage potential,
- low fertility with very low N, P, Cu with moderate K and high Zn,
- acidic reaction trend,
- generally non-sodic or saline,
- excessive drainage may cause waterlogging.

Representative site description (source Maher 1996)

Principal Profile Class : Uc223 Great Soil Group : Siliceous sand Location: Spring Ck Road, Amiens
Parent Material : Granite AMG Ref : Z56, 385200 E, 6834500 N
Topography: mid-lower slope of hillslope (3% slope) Vegetation : open forest

Profile Morphology :

A11	0 - 10 cm	Dark greyish brown (l0YR 4/2) ; coarse sandy loam; granular, weak consist., clear to;
A12	10 - 20 cm	Pale brown (10YR 6/3); coarse sandy-loam; massive; weak cons. Gradual to;
A21	20 - 60 cm	Light grey (l0YR 7/2) ; loamy coarse sand;, massive; very friable . weak cons., gradual to;
A22	60 - 80 cm	Light grey (l0YR 7/2) ; loamy coarse sand; massive ; few distinct yellow mottles gradual to;
A3	80- 90 cm	Light grey (l0YR 7/2); clayey coarse sand, with few yellow mottles. Very firm.

Laboratory data

				Particle size %				Exc cations (meq/100g)						Tot Elements %			Disp ratio
Depth (m)	pH	EC dS/cm	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	ESP %	P	K	S	
0-10	4.6	.06	.004	56	24	14	6	4	1.9	1.0	.21	.12	5	.03	4.0	.03	.63
20-30	5.6	.01	.002	62	25	7	7	1	0.2	.4	.01	.06	1	.02	4.0	.01	.89
50-60	5.7	.03	.008	59	26	12	3	1	0.2	.5	.01	.06	1	.01	4.4	.02	.96

80-90	5.6	.01	.002	53	28	16	4	1	0.3	.7	.02	.05	2	.01	4.1	.01	.79

Soil type C

This soil is similar to B with the essential differences being texture contrast clayey subsoils which may be sodic and saline. They are mainly class 3 or 4 cropping and class 2 grazing land with major limitations being low plant available water and reduced effective plant rooting depth. As with soil B, cropping class can be improved with management of limitations so that plant water availability is increased.

Major aspects are;

- surface may hard set or granular with little surface rock,
- lower effective rooting depth than soil B due to hard clay subsoil; (30-50 cm),
- still quite low plant available water storage potential,
- reasonable fertility but not high. Low N but better P, K, Cu and Zn.
- acidic reaction trend,
- strongly sodic subsoil which may also be saline (below 60cm),
- excessive drainage may cause waterlogging,

With the surface sandy soil, work areas should seek to restrict overland flow sufficiently to reduce sedimentation as far as possible, particularly as slope gradient increases.

Representative site description (source Maher 1996)

Principle Profile Class : Dy341 Great Soil Group : Yellow podzolic Location: Church Road, Summit
Parent Material : Granite AMG Ref : Z56, 396800 E, 6838100 N
Topography: upper slope (5% gradient) Vegetation : cleared

Profile Morphology :

A1	0 - 15 cm	Dark brown (7.5YR 3/2) ; coarse sandy clay loam; granular, gradual to;
A2e	15 - 40 cm	Light yellowish brown (2.5Y 6/3); con bleach; coarse sandy loam; granular. abrupt to;
B21	40 - 60 cm	Grey (7.5YR 6/1) ; angular blocky, gradual to;
B22	60 - 100 cm	Grey (7.5YR 6/1) ; coarse sandy light clay; massive ; many orange mottles.

Laboratory data

				Particle size %				Exc cations (meq/100g)						Tot Elements %			Disp ratio
Depth (m)	pH	EC dS/cm	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	ESP %	P	K	S	
0-10	5.8	.03	.003	50	23	14	19	4	1.7	1.8	.08	.30	2	.02	3.4	.02	.59
20-30	6.0	.03	.003	75	19	7	6	1	0.3	0.7	.18	.05	18	.01	3.7	.01	.10
50-60	4.7	**.52**	.076	36	12	12	47	7	0.2	4.3	2.2	.22	**31**	.01	2.2	.02	.10
80-90	4.6	.18	.025	43	19	16	30	4	0.1	2.6	0.9	.11	**22**	.01	2.9	.01	.10

Soil type D

Mainly class 5 cropping and class 3 or 4 grazing land with major limitations being low plant available water, erosion susceptibility when slope exceeds 2%, varied topography often with extensive granite rocks and low fertility. Major aspects are;

- loose to firm surface often with extensive rock,
- restricted effective rooting depth because of hardpans or rock (25-90cm),
- soil depth often quite variable over small areas,
- very low plant available water storage potential,
- very low N, P, Cu with moderate K and Zn,
- acidic reaction trend,
- non-sodic or saline,
- excessive drainage may cause waterlogging,

The following soil profile description and laboratory data was for a site which occurs in the area which was originally described by Powell (1975) and later by Maher (1996).

Representative site description (source Maher 1996)

Principal Profile Class : Uc221 Great Soil Group : Siliceous sand AMG Ref : Z56, 388750 E, 6870500 N
Parent Material : Granite Topography: mid slope of low hill (6% gradient) Vegetation : open forest

Profile Morphology :

A1	0 - 10 cm	Dark brown (l0YR 3/2) ; coarse sandy loam; massive anf friable.,
A2	10 - 20 cm	Brown (7.5YR 5/4); sandy loam clayey; massive; weak cons. Bleach;
B21	20 - 45 cm	reddish yellow (7.5YR 6/6) ; loamy coarse sand clayey, massive; very friable ;
B22	45 - 90 cm	Yellowish brown (l0YR 5/6) ; loamy coarse sand; massive ;

Laboratory data

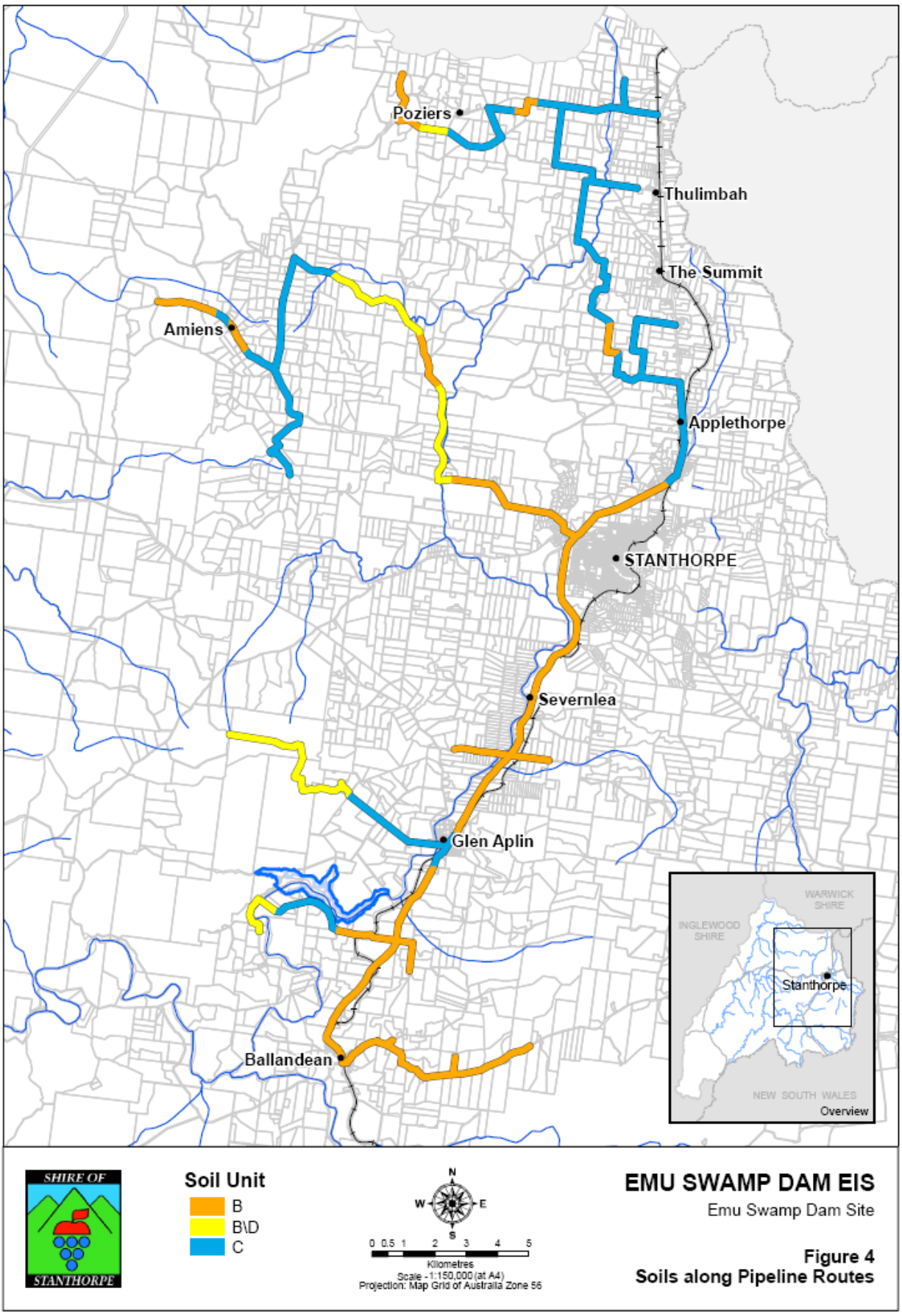
				Particle size %				Exc cations (meq/100g)						Tot Elements %			Disp ratio
Depth (m)	pH	EC dS/cm	Cl %	CS	FS	Si	C	CEC	Ca	Mg	Na	K	ESP %	P	K	S	
0-10	6.2	.03	.001	58	19	5	18	6	4.6	.6	.08	.33	1				
20-30	6.0	.02	.001	58	19	5	18	3	2.4	.4.3	.08	.11	3				
45-60	6.2	.01	.001	53	22	4	21	6	4.0	.51.0	.18	.13	3				
60-90	6.2	.02	.001	53	21	5	21	6	4.0	.71.3	.25	.13	4				

Erosion risk

Wills (1980) in his survey of erosion in the Granite Belt region, concluded that sandy granitic soils which dominate the survey area are considered to have a low erosion potential. This survey concurs with that view and the potential impact to the downstream environment should erosion of exposed soil occur is considered low.

All soil types along the pipeline routes are non saline and the uniform coarse sands are also non dispersive. A texture contrast soil with coarse sand overlying mottled clay subsoil is common in the area and if soil is exposed during construction activities, the risk of erosion increases as the clayey material is often sodic and dispersive.

Control measures should initially verify the soil types which occur in work locations. The higher risk texture contrast soil can be identified by the red and yellow mottling of the hard clayey subsoil. If so, care should be taken to minimise exposure of subsoils particularly where contaminated runoff may exit the area.
Monitoring of downstream water courses should focus on pH, electrical conductivity and sediment load. Values should be compared with natural background levels measured upstream from any construction activity.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Stanthorpe
NEW SOUTH WALES
Overview
SHIRE OF STANTHORPE
Soil Unit
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EMU SWAMP DAM EIS
Emu Swamp Dam Site
Figure 4
Soils along Pipeline Routes
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5 AGRICULTURAL LAND SUITABILITY

5.1 BACKGROUND

Figures 5 and 6 show the current agricultural suitability class for cropping and grazing land uses in the inundation area.

In the dam inundation area, the grazing of native and improved pastures by sheep and beef cattle has remained the dominant land use on the northern side of the Severn River while southern fringes have maintained forage cropping, fruit, vegetables and vines.

The methodology used to identify agricultural suitability was described in Section 2.5.

Limiting factors

The following limitations are considered relevant to the suitability for rainfed cropping and grazing in the area. These were (using the DPI nomenclature in brackets);

- plant available water capacity (m);
- nutrient deficiency (n);
- soil physical factors (p);
- soil workability (k);
- salinity (s);
- rockiness (r);
- microrelief (g-gilgai);
- wetness (w);
- water erosion (e);
- flooding (f); and
- topography (t).

Land suitability class is determined by the highest ranking limiting factor or a combination of a number of factors. Normally, only the most severe two or three limiting factors would determine suitability and the remainder become irrelevant. For this reason, only the major limiting factors determining suitability are presented. In this survey, the main limiting factors which determined crop and grazing suitability class were plant available moisture (m), nutrient deficiency (n), soil physical factors (p), erosion (e) workability (k) and susceptibility to flooding (f).

Land suitability classification is based on specific land uses assessed using the following classes:

Class 1	Suitable land with negligible limitations and is highly productive requiring only simple management practices;
Class 2	Suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use;
Class 3	Suitable land with moderate limitations – Land which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use;
Class 4	Marginal land with severe limitations which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long term; and
Class 5	Unsuitable land with extreme limitations that precludes its use.

5.2 LAND SUITABILITY FOR CROPPING

This classification evaluates the potential for growing non-irrigated cash crops which may include forage crops for stock feed, vegetables, vines and fruit. The suitability of each soil type for rainfed cropping is shown in Table 5.3. It is noted that irrigation practices used in the area can improve agricultural suitability potential considerably on soil types where the major limiting factor is low moisture storage potential. This aspect is noted where appropriate.

Plant Available Water Capacity (m)

Plant available water capacity (PAWC) is a significant soil property in this locality given the coarse sandy, highly pervious nature of the medium in an area of often erratic rainfall. PAWC is the moisture stored in the soil profile that is available to the plant and is classically defined as the moisture present between field capacity and permanent wilting point (15 bar).

Maher (1996) proposed PAWC for major land types in the granite landscapes of the survey area. In this survey, laboratory analysis and field morphology were used to verify which soil types can be compared to those described by Maher. Table 5.1 shows soil type for the Emu Swamp survey and the comparable Maher soil type together with calculated PAWC. Soil depth to parent rock is a major determinant of PAWC.

TABLE 5.1 PAWC CRITERIA FOR EMU SWAMP SOILS

GTES (2007) soil type	Maher (1996) comparable soil type	PAWC range (mm)	Effective root / soil depth range	Interpretation of Maher (1996)	Est. available plant moisture limitation for crops (m)
A and D	*Banca / Cottonvale*	0 - 50	0 – 60 cm	Highly variable - Very low	4
B	*Banca / Pozieres*	25 - 60	45 - 55cm	Very low	3*
C	*Pozieres*	40 - 60	55 – 80 cm	low	3*

* The severity of this limitation has been reduced in some portions of the area by irrigation.

In this survey, PAWC for soil groups was assessed from data presented by Maher (1996) applied to observed ranges of soil depth in this survey. Effective rooting depth estimations were deduced from observed field morphology and chemical data which included soil texture as well as barriers to root growth such as high sodium, hardpans, poor soil structure, waterlogging evidence and electrical conductivity.

From Table 5.1, no soil types hold significant water that can be effectively stored over extended periods for crop utilisation.

Susceptibility to Water erosion (e)

During this survey, little evidence of erosion was observed under cropping or grazing uses however the risk of soil loss from water erosion magnifies with increased slope gradient and water velocity when land is devoid of vegetation for cropping.

In the more undulating soil units of A, B and D, the risk has been assessed as moderate with limitation levels of 3 applied. Basic contour cultivation practices are recommended by Maher for slope gradients above 2%.

Severity of water erosion may also become a limiting factor in the agricultural C soils due to the gently undulating nature of the surface with slope gradients up to 2%. A limitation level of 2 is assigned to these soils.

Nutrient deficiency (n)

All sites indicated quite low fertility which is consistent with conclusions of Maher (1996) on similar soils in the area. Accordingly all soil types have a limitation level of 3 which would normally require fertiliser inputs for cropping.

Soil Physical Factors (p)
This limitation deals with conditions which determine sufficient seed contact with moist soil to prevent desiccation prior to germination and establishment. This condition applies to Emu Creek coarse sandy soils which may become waterlogged and have a narrow moisture storage potential for plant exploitation. Accordingly a limitation level of 3 applies to soil C (greater soil depth to reduce effects of waterlogging) and 4 to A, B and D.

Rockiness (r)
Rockiness refers to the amount of rock out crop and coarse fragments greater than 6 cm in diameter. Soil types A,B and D feature areas of granite outcropping which is considered a significant limitation for cultivation. Accordingly, limitation levels of 4 and 5 are assigned for this reason. Most soil type C is not significantly affected by surface rock and is assigned a level 2 limitation level.

Flooding (f)
Flooding may limit cropping opportunities due to the high risk of erosion of cultivated soil as well as loss of access in critical times. The alluvial channels of soil type A would flood regularly for short periods which attracts a limitation level 4.

Topography (t)
Topography is assessed in terms of slope. Slope may limit the effective and safe use of machinery and contribute to erosion hazard. Soils A, B and D are limitation level 4 and C is 2.

Salinity (s)
This refers to the reduction in dry matter yield as a result of soluble salt in the soil profile. No saline soils were evidenced from laboratory data or documented by Maher for these soil types. Accordingly a salinity limitation of 1 applies. Soil B may have increasing salt at depth but insufficient to affect the severity of this limitation.

5.3 SUITABILITY FOR GRAZING

The assessment process for grazing of native pastures adopted in his report follows that used by Shields and Williams (1991) and utilises the same limitations used to assess cropping. Basically, apart from the alluvial channels, all soils do not have significant limitations to a grazing use with the incorporation of sound management practices and have potential for pasture improvement.

Class 1 to 3 lands are considered suitable for significant pasture improvement, class 4 offers marginal potential for pasture improvement, and class 5 is not suitable for improvement and restricted to grazing of native pastures with low productivity. Major limiting factors are assigned a severity rating (1-5) with the most severe being the overall suitability class for that soil type.

The alluvial A soils present more stringent management requirements and are assigned as class 4. The other soils are considered classes 2 and 3 as a result of limitations from restricted soil water availability, erosion susceptibility and fertility.

Plant Available Water Capacity (m)

Using the logic described above for assessment of cropping lands, the assigned limitation levels for PAWC are described in Table 5.2 below;

TABLE 5.2 PAWC CRITERIA FOR EMU SWAMP SOILS - GRAZING

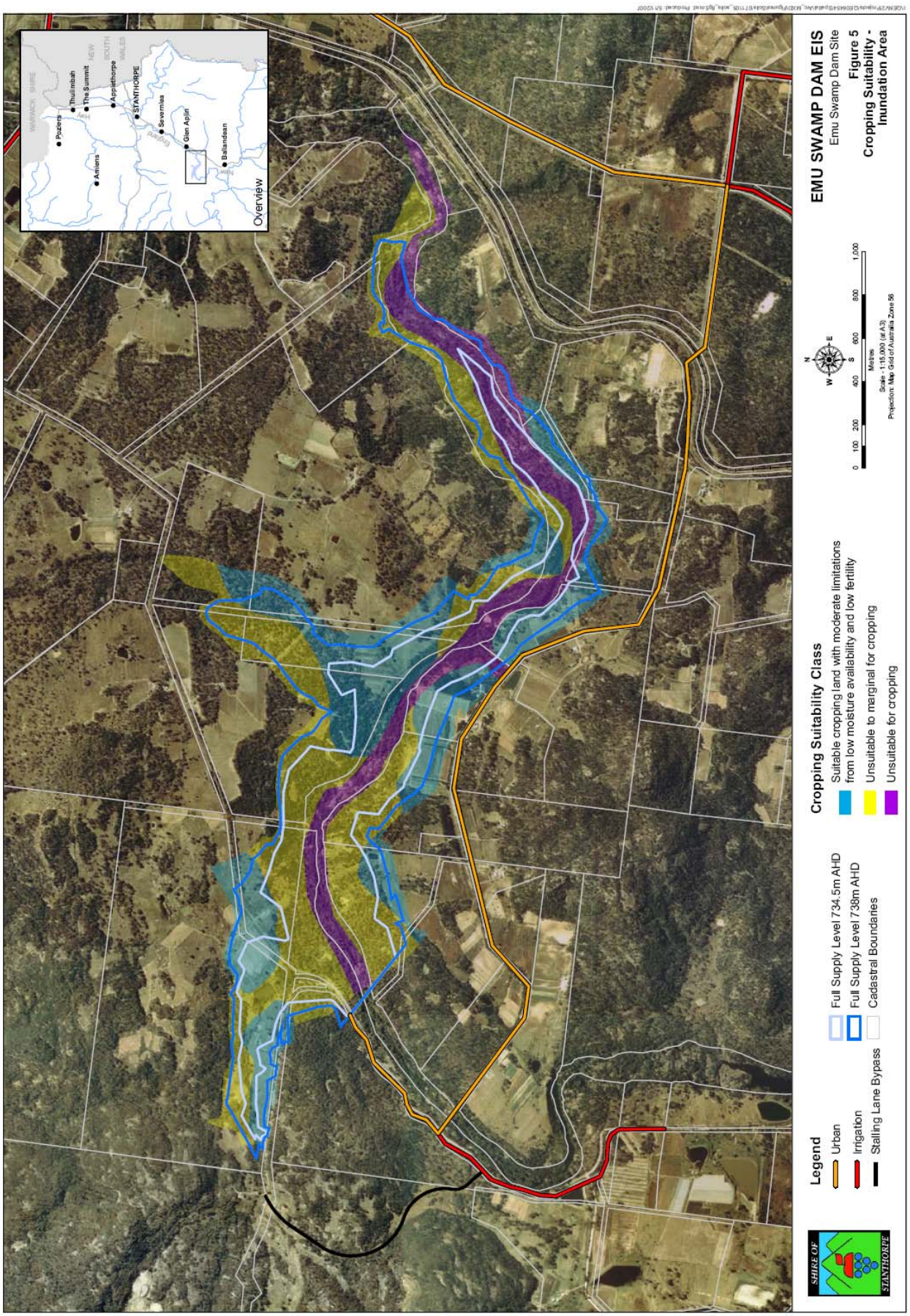
Soil type	Est. available plant moisture limitation for grazing (m)
A, B and D	3
C	2

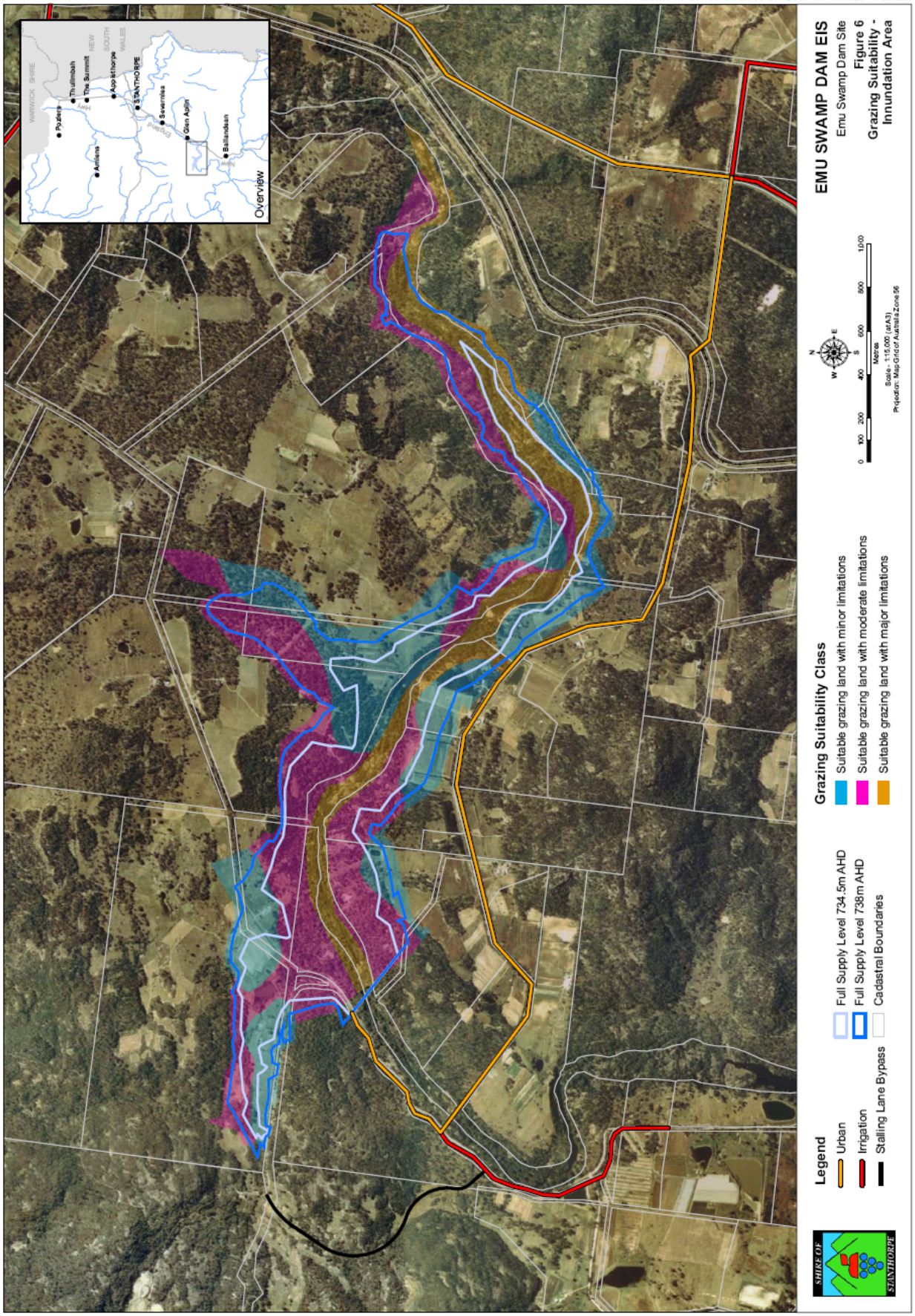
5.4 LAND SUITABILITY SUMMARY

TABLE 5-3 LAND SUITABILITY CLASSES

Soil Unit	Cropping		Grazing		SUMMARY
	Major Limitations and Severity	class	Major Limitations and Severity	class	
A	moisture – m4 workability – k5 topography – t4/5 rockiness – r5 soil physical factors – p4 erosion susceptibility e3 nutrients – n3 flooding – f4	5	erosion susceptibility e3/4 moisture – m3 nutrients – n2 soil physical factors – p3	4	Unsuitable for cropping due to rockiness, physical factors, topography and flooding risk. Suitable grazing land with moderate limitations from erosion risk, low moisture availability for pasture growth and soil physical factors.
B	moisture – m4 topography- t4/5 workability – k4/5 soil physical factors – p4 rockiness – r3-5 erosion susceptibility e3 nutrients – n3	4/5	erosion susceptibility e2 moisture – m3 nutrients – n2 soil physical factors – p2	3	Unsuitable to marginal for cropping due to low plant available water, rockiness, physical factors, topography and workability problems. Suitable grazing land with moderate limitations from low moisture availability for pasture growth and erosion potential.
C	moisture – m3 erosion susceptibility e2 rockiness – r2 topography – t2 workability – k2 soil physical factors – p2 nutrients – n3	3*	erosion susceptibility e1 moisture – m2 nutrients – n2 soil physical factors – p1	2	Suitable cropping land with moderate limitations from low moisture availability and low fertility. Suitable grazing land with minor limitations from low fertility and plant moisture availability. Note - Only one site was described in the Emu Swamp inundation area which approximated the texture contrast nature of soil type C.
D	Rocky upland areas with shallow sandy soil	5		4	None in the Emu Swamp dam area. Occur in some areas along the pipeline route.

* As the class 3 cropping suitability of soil C is a result of the low water storage potential of the sandy soil, with irrigation, the overall agricultural suitability can be improved considerably.


EMU SWAMP DAM EIS
Emu Swamp Dam Site
Figure 5
Cropping Suitability - Inundation Area
Overview
Pozieres
Thulimbah
The Summit
Amiens
Applethorpe
STANTHORPE
Severnlea
Glen Aplin
Ballandean
Legend
Urban
Irrigation
Stalling Lane Bypass
Full Supply Level 734.5m AHD
Full Supply Level 738m AHD
Cadastral Boundaries
Cropping Suitability Class
Suitable cropping land with moderate limitations from low moisture availability and low fertility
Unsuitable to marginal for cropping
Unsuitable for cropping
Metres
Scale - 1:15,000 (at A3)
Projection: Map Grid of Australia Zone 56
SHIRE OF STANTHORPE


EMU SWAMP DAM EIS
Emu Swamp Dam Site
Figure 6
Grazing Suitability - Innundation Area
Grazing Suitability Class
Suitable grazing land with minor limitations
Suitable grazing land with moderate limitations
Suitable grazing land with major limitations
Legend
Urban
Irrigation
Stalling Lane Bypass
Full Supply Level 734.5m AHD
Full Supply Level 738m AHD
Cadastral Boundaries
Overview
STANTHORPE
Pozieres
Thulimbah
The Summit
Applethorpe
Amiens
Severnlea
Glen Aplin
Ballandean
WARWICK SHIRE
NEW SOUTH WALES
Meters
Scale - 1:15,000 (at A3)
Projection: Map Grid of Australia Zone 56

Current land condition
Observations were made at most sampling sites of the general state of the land in terms of erosion, vegetation condition and degradation. Overall, the survey area is in good condition and appeared to have been used in accordance with land suitability. Comments follow for specific aspects.

Erosion and structural decline
Apart from very minor sedimentation which was evident in some areas of old cultivation to the south of the Severn River, the survey area was not degraded as a result of erosion. Active erosive gullies were not in evidence in any area.

Maher (1996) mapped the *Cottonvale* soil (described as a possible variant of soil type B in GTES 2007) as a possible soil type in the vicinity of the project area. These soils may have sodic dispersive subsoils with possible hard setting surface and present an increased risk from erosion. However in the survey area itself, no sites which match these erosive *Cottonvale* attributes were found. Apart from one site which had light clayey sand subsoil, all were uniform coarse sands with little indication of clayey, dispersive subsoils.

So erosion risk from dispersive soils is not considered a risk in the area with major concern being sedimentation from excessive overland flow on slope gradients over 2%.

No evidence of compaction as a result of overgrazing or cultivation practices was obvious.

Stocking rates
No specific data were obtained of historical rates however the condition of pastures (particularly in view of the dry season) did not indicate overgrazing was occurring.

Vegetation Vigor
Estimated pasture cover in grazing lands varies from 0% (rock outcrops) up to > 80% with most sites in the 60-70% range. This cover is quite good in view of seasonal experiences.
On the flatter lands where most of the original vegetation has been removed, regrowth is not an issue. Native woodland communities appear to be in a healthy condition in most areas where they remain.

There is no noticeable weed problem and no noxious species have been observed.

Fertility
Fertility levels for each soil type have been described previously. Overall, fertility levels recorded are quite low which is consistent with all background data inspected for the area. It is considered that low fertility is a natural aspect of these soils and not a result of land degradation from agricultural practices.

Property Management
Much of the area has been sub-divided with only 2 significant agricultural farms still operating. Farm infrastructure was well maintained and the properties appear to be very well managed.

5.5 GOOD QUALITY AGRICULTURAL LAND

The Planning Guidelines *The Identification of Good Quality Agricultural Land* (DLGP and DPI, 1993) have established four Classes of agricultural land for Queensland. Class A Land is considered to be good quality agricultural land. In some areas Class B land (where agricultural land is scarce) and better quality Class C land (where pastoral industries

predominate) may also be considered to be good quality agricultural land. The description of the classes is as follows:

CLASS DESCRIPTION
Class A Crop land – Land suitable for current and potential crops with limitations to production which range from non to moderate levels.
Class B Limited Crop Land – Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
Class C Pasture Land – Land suitable only for improved or native pastures due to limitations, which preclude continuous cultivation for crop production; but some areas, may tolerate a short period of ground disturbance for pasture establishment.
Class D Non-agricultural Land – Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

In the Stanthorpe Shire, QDPI have identified crop land (Class A), marginal crop land (Class B) and land suitable for improved pastures (Class C). All of the project area has been categorised as Class B - *Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures*.

This survey has followed the Guideline for the identification of good agricultural land and with the intensive sampling undertaken in this survey has refined the areas of good quality land.
A summary of areas considered to be present within the dam inundation area are shown in Table 5.4.

Table 5.4 GQAL Land in the Inundation Area

Soil map unit	Important Limitations	Land suitability		GQAL Land type	Area (ha)
		Fruit, vine, vegetable forage crops	Grazing native pastures		
A	Flooding and access, Highly variable surface topography with rock outcrop, steep embankments and creek flats, Highly variable soil depth, High erosion risk if cleared, Infertile, very low water holding capacity, Effective plant root depth Low & highly variable.	Not suitable class 5 Limitation ratings moisture – m4 workability – k5 topography – t4/5 rockiness – r5 soil physical factors – p4 erosion susceptibility e3 nutrients – n3 flooding – f4	Suitable class 3 Limitation ratings erosion susceptibility e3 moisture – m3 nutrients – n2 soil physical factors – p3	**Class D** - Non-agricultural Land	46
B	Erosion risk increasing on slopes >2%, Stone and rock, Very infertile, very low water holding capacity, excessively drained and waterlogging due to water trapped by bedrock or hardpans. Effective plant root depth can be quite variable.	Not suitable class 5 Limitation ratings moisture – m4 topography- t5 workability – k4 soil physical factors – p4 rockiness – r4 erosion susceptibility e3 nutrients – n3	Suitable class 3 Limitation ratings erosion susceptibility e2 moisture – m3 nutrients – n2 soil physical factors – p2	**Class B** – limited crop land suitable to pastures	83
C	Erosion risk increasing in cultivation on slopes >1%, Low plant available water holding capacity, Low fertility, excessively drained and possible waterlogging due to water trapped by hardpans. Effective plant root depth in depth range of 40 – 90cm (mainly 50-60cm).	Suitable class 3 Limitation ratings moisture – m3 erosion susceptibility e2 rockiness – r2 topography – t2 workability – k2 soil physical factors – p2 nutrients – n3	Suitable class 2 Limitation ratings erosion susceptibility e2 moisture – m2 nutrients – n2 soil physical factors – p1	**Class A** – crop land	67

5.6 GQAL CONCLUSION

From evidence available from previous surveys and that generated in this survey, (which has a refined mapping scale following 1:10000 sampling intensity), the area covers a range of good quality agricultural land categories which is made up of 67 hectares of class A crop land, 83 hectares of class B pasture grazing land and 46 ha of unsuitable class D land.

6 CONSTRUCTION MANAGEMENT

6.1 MAJOR ENVIRONMENTAL RISKS FROM SOIL DISTURBANCE

Dam Inundation Area

The major soil type in the area is uniform coarse sands overlying bedrock or gritty gravels. Major ground disturbance works will be required in this area which will include the removal of vegetation as well as the stripping and transport of topsoil for construction works. Consequently, the area will be exposed and vulnerable to erosive processes.

Major environmental risks from the effects of construction activities on soils are seen as;

- All soils have moderate risk of sediment being removed (siltation) downstream from exposed surfaces or topsoil stockpiles which increases with slope gradient and proximity of disturbed areas to natural water flow paths.
- A low risk of soil dispersion or salinity exists on the uniform sands and sandy A horizons of texture contrast soils which may be encountered.

Proposed Pipeline Routes

Assessments of major environmental risk have been carried out based on the data of Powell (1975), Wills (1976,1980) and Maher (1996) with risks developed essentially from field checking and refinement of soil boundaries of Maher.

Some variation in mapping boundaries of Maher (1996) and Powell (1975) were noted although the range of soils in the area as a whole were consistent. Accordingly, the soil types described in this report along the pipeline route may differ from Maher (1996) and Powell (1975) in some areas.

The major soil types along the proposed route are the uniform coarse sands referred to as soil types B, C and D. Major environmental risks to soils are seen as;

- A moderate environmental risk is noted from the existence of texture contrast soil variant which may occur in soil type B. It is only after excavation that the clayey subsoil becomes evident. Construction activity should therefore expect such soil variation. These soils have clayey subsoils below 50cm depth which may be approaching levels described by Baker and Eldershaw (1993) as dispersive and saline. Excavated or exposed subsoils which are clayey have increased risk of saline or sodium affected sediment in runoff to local streams.
- All soils have moderate risk of sediment being removed downstream from exposed surfaces or topsoil stockpiles which increases with slope gradient and proximity of disturbed areas to natural water flow paths.
- A low risk of soil dispersion or salinity exists on the uniform sands and sandy A horizons of texture contrast soils.

6.2 ENVIRONMENTAL CONTROLS DURING CONSTRUCTION (ALL AREAS)

Environmental Aspect	Major Risk	Controls
Clearing of vegetation	Soil erosion risk increases as surface laid bare.	Consider options to maximise vegetation preservation. Develop a clearing plan which clearly

		designates areas to be disturbed and removal of such vegetation. Requirements for environmental controls to be included in all works procedures involving disturbance of land. Responsible persons to be nominated to ensure that environmental controls are maintained.
Soil erosion	A moderate to high risk of sediment removal exists from exposed surfaces and topsoil stockpiles (see below). This risk increases with slope gradient and proximity of disturbed areas to natural water flow paths. Possible saline / sodic effected runoff.	Prior to commencement of clearing, topsoil removal and other construction activity, an operational plan be developed to stage operations to reduce environmental risk as far as possible. This may involve prior construction of temporary waterways, containment basins, contour diversion banks, reduction of overland flow velocity (hay bales, hession weirs etc), delaying vegetation removal along key natural waterways and considered locations of stockpiles. Specific controls to be implemented will vary with tasks to be performed. Monitoring of major downstream waterways during flow events should verify that impacts from sedimentation, salinity and pH are not occurring.
Topsoil stockpiles	Instigation of excessive erosion. Possible saline / sodic effected runoff. Loss of valuable resource.	Operations should seek to minimise the time of exposure of temporary and long term topsoil stockpiles as far as possible. All stockpiles should not exceed 3m in height and not be located near major drainage pathways. Longer term stockpiles should be shaped and fertilised and seeded immediately to pastures and annual cover crop. Most soil in the dam inundation area should be uniform sand to bedrock but persons involved in land disturbance works should be made aware of the need for extra care and controls as slope increases and if clayey subsoils are encountered. Such soils are common along the pipeline routes and are highly erodible and may be saline. (see following points)
Soil dispersion and salinity	<u>EMU SWAMP DAM AREA</u> All soils observed in this survey are considered a low risk of soil dispersion and all samples tested in the laboratory were non-sodic. A similarly low risk of saline discharge is apparent. All tests conducted for soils showed very low salinity. <u>PIPELINE ROUTES</u> In addition to the risks from the uniform sandy soils (as above), the route will include soils with mottled clayey subsoil below about 50 cm. This sub-soil material may be saline and sodic which significantly increases risks of erosion and saline runoff.	No additional controls required other than that above All operational personnel should be made aware of the possible existence of these soils. Should clayey subsoil be exposed then the following additional requirements are needed; • This material should not be stockpiled for reuse in revegetation, • Minimise exposure time, • Extra care in excluding surface wash where this material is exposed, • Replace this material back into excavation holes first with the sandy material above it.
Wind erosion and dust nuisance	As coarse sand particle size fractions dominate these soils, wind erosion risk may be considered low in the undisturbed state but increases to moderate depending on the type of disturbance and prevailing climatic conditions. For example, in windy dry	Operational procedures should include provision for visual monitoring of conditions to ensure required controls are implemented in a timely manner. Such controls may include watering for dust suppression and operations generally.

	conditions, topsoil removal using scrapers may initiate excessive wind erosion and nuisance.	

7 REFERENCES

Baker, D.E. and Eldershaw, V.J. (1993) Interpreting Soil Analysis for agricultural use in Queensland. QDPI QO93014

Bruce, R.C. and Rayment, G.F. (1982). Analytical Methods and interpretations used by the Agricultural chemical Branch, QDPI, for soil and land use surveys. QDPI Bulletin QB82004.

Bruce, R.C. and Rayment, G.F. (1984). Soil Testing and Some Test Interpretations used by the QDPI. QDPI Bulletin QI84029

DHLGP and DPI, (1993) Identification of Good Quality Agricultural Land and the State Planning Policy 1/92.

Gunn, R.H, Beattie, J.A., Reid, R.E. and van de Graff, R. (1988). Australian Soil and Land Survey Handbook. Inkata Press Melbourne.

Isbell, R.F (1998) The Australian Soil Classification. CSIRO Publishing

Land Resources Branch (1989) Guidelines for Land Suitability Evaluation in Queensland. QDPI.

Maher,J.M. (ed) 1996 Understanding and Managing Soils in the Stanthorpe-Rosenthal Region. Department of Natural Resources. DNRQ96001, Brisbane.

McDonald, R.C. and Isbell, R.F. (1984). Australian soil and land survey field handbook, Inkata Press.

Powell. B 1975. Soils of the Granite Belt Region. South-east Queensland. (soil map) QDPI.

Powell. B 1977. Soils of the Granite Belt Vineyards. South-east Queensland. QDPI.

Shields, P.G. and Williams, B.M. (1991) Land resource survey and evaluation of the Kilcummin area, Queensland. QDPI bulletin QV 91001.

Wills, A.K. 1980. Granite Belt Soil Erosion Survey. QDPI

Wills, A.K. 1976 The Granite and Traprock area of South East Queensland. Part1 Land Inventory and Part 2 Land Utilization Study

ATTACHMENTS

ATTACHMENT 1 A- SITE DESCRIPTIONS

Site	Soil	Northing	Easting	Landform / comments	Soil profile	Samples / photos / comment
1	B	6819944	387050	SURFACE: loose SLOPE : 1% ELEMENT : upper slope PATTERN: gently undulating plain VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand Angophera, Eucalyptus	A11 0–10cm. Dark brown 10YR3/3, coarse sand, massive , field pH 5.0 clear change to; A12 10-30cm. Pale brown 10YR 5/3, coarse sandy loam, massive, clear to; A21 30-40cm. yellowish brown 10YR5/6(w), 10YR7/2(d), loamy coarse sand, conspicuous bleach, massive, field pH 4.5, clear to; A22 40-120+cm. Brown 7.5YR4/2, gritty coarse sand, massive but sets hard, field pH 4.5.	Creek embankment. Samples 0-10, 30-40, 100-110. 3 photos.
2	B	6819348	385502	SURFACE: loose. 50% outcropping granite SLOPE : 2% ELEMENT : upper slope PATTERN: gently undulating hills VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–20cm. Brown 10YR4/2, gritty coarse sand, massive, field pH 5. C 20+ weathered / fresh rock	
3	B	6819325	385660	Same as 2 Angophera and Banksia.	Soil depth variable up to 20cm. massive coarse sand.	
4	A	6819267	385752	SURFACE: coarse sand and outcropping granite SLOPE : <1% ELEMENT : creek channel PATTERN: plain VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	Very shallow coarse sand in amongst fresh granite	
5	C	6819499	385653	SURFACE: 30% outcropping granite. loose SLOPE : 1-2% ELEMENT : upper slope PATTERN: gently undulating plain VEGETATION FORM: cleared with tall ironbarks SUBSTRATE: Granite GSG: Siliceous sand	A11 0–10cm. Dark brown 10YR4/3, gritty coarse sand, massive , field pH 5.0 clear change to; A12 10-50cm. grey 7.5YR 5/1, coarse sandy loam, massive, field pH 5.0, prominent yellowish red staining (mottles), field pH 4.5, clear to; C 50-60cm. Bedrock granite	Samples 0-10, 30-40. 2 photos.
6	C	6819502	385198	Same as 5	50cm soil to weathered PM	
7	C	6819490	384847	SURFACE: 20% outcropping granite. loose SLOPE : <2% ELEMENT : mid slope PATTERN: gently undulating plain VEGETATION FORM: cleared SUBSTRATE: Granite GSG: Siliceous sand	A11 0–20cm. Dark brown 10YR4/3, coarse sand, massive , field pH 5.0 clear change to; A12 20-60cm. greyish brown 10YR 5/3, coarse sandy loam, massive, field pH 5.0, yellowish red staining (mottles), field pH 4.5, C 60cm. Bedrock granite	
8	B	6819340	385101	SURFACE: loose. 50% outcropping granite SLOPE : 2% ELEMENT : lower slope PATTERN: gently undulating hills VEGETATION FORM:	A11 0–15cm. Brown 10YR4/2, gritty coarse sand, massive, field pH 5. C 15+ fresh rock	

				Open forest SUBSTRATE: Granite GSG: Siliceous sand		
9	A	6819245	385001	Creek line through much outcropping granite	Minor coarse sand between granite	
10	C	6819550	384876	SURFACE: loose. Below massive outcropping granite SLOPE : 4% ELEMENT : mid slope PATTERN: gently undulating hills VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–25cm. Brown 10YR4/2, gritty coarse sand, massive, field pH 5. C 25+ weathered / fresh rock	
11	C	6818880	385582	SURFACE: cultivation with forage crop, loose. Gritty sand SLOPE : 1-2% ELEMENT : mid slope PATTERN: gently undulating plain VEGETATION FORM: cleared SUBSTRATE: Granite GSG: Siliceous sand	AP 0–20cm. Dark brown 10YR4/3, coarse gritty sand, massive , field pH 5.0 clear change to; A12 20-50cm. greyish brown 10YR 5/3, coarse sandy loam, massive, field pH 5.0, A21 50-100cm+ loamy coarse sand , greyish brown 10YR5/3 with yellowish red staining (mottles), field pH 4.5,	Cultivation wet from 20 to 70cm. Samples 0-10, 40-50, 60-70. 2 photos.
12	B	6818995	385544	SURFACE: loose sand with outcropping granite SLOPE : 3-4% ELEMENT : mid slope PATTERN: gently undulating hills VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–25cm. pale brown 10YR5/2, silty loam, massive, field pH 5. C 25+ weathered / fresh rock	
13	B	6818891	385260	SURFACE: 20% outcropping granite. loose SLOPE : 3% ELEMENT : mid slope PATTERN: undulating plain VEGETATION FORM: tall Angophera mixed scrub SUBSTRATE: Granite GSG: Siliceous sand	AP 0–20cm. Brown 10YR4/2, gritty coarse sand, massive , field pH 5.0 clear change to; A12 20-70cm. greyish brown 7.5YR 5/3, coarse sandy loam, massive, field pH 5.0, field pH 5, clear to; C 70cm. Bedrock granite	Samples 0-20, 60-70. 4 photos.
14	C	6818678	386181	SURFACE: cultivated grapes - loose SLOPE : <1% ELEMENT : flat plain PATTERN: gently undulating plain VEGETATION FORM: grape vines SUBSTRATE: Granite GSG: Siliceous sand	A11 0–20cm. Brown 10YR4/2, gritty coarse sand, massive , field pH 5.0 clear change to; A12 20-50cm. greyish brown 7.5YR 5/3, coarse sandy loam, massive, field pH 5.0, field pH 5, clear to; A21 50-80cm+ loamy coarse sand , greyish brown 10YR5/3 with yellowish red staining (mottles), field pH 4.5,	
15	A	6818870	386255	SURFACE: coarse sand and outcropping granite SLOPE : <1% ELEMENT : creek channel PATTERN: plain VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	Very shallow coarse sand in amongst fresh granite	
16	C	6818533	386428	Irrigated fruit trees and grape vines	A12 0–20cm. Brown 10YR4/2, gritty coarse sand, massive , field pH 5.0 clear change to; A12 20-65cm. greyish brown 7.5YR 5/3, coarse sandy loam, massive, field pH 5.0,	

					field pH 5, clear to; C 65cm. Bedrock granite	
17	C	6819268	386714	SURFACE: sandy loose SLOPE : 2% ELEMENT : midslope PATTERN: gently undulating plain VEGETATION FORM: open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–30cm. Brown 10YR3/2, coarse sand, massive , field pH 5.5 clear change to; A12 30-50cm. greyish brown 7.5YR 5/2, coarse sand, massive, field pH 4.5, A21 50-80cm+ pale gritty coarse sand C 80+ weathered pm	2 photos
18	A	6812967	386681	SURFACE: sandy firm SLOPE : <1% ELEMENT : creek channel PATTERN: gently undulating plain VEGETATION FORM: open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–60cm. Brown 10YR5/3, silty sandy loam, firm, field pH 5.5 clear change to; A12 60-120cm+. dark brown 10YR 3/1, loamy coarse sand, massive, field pH 5,	Photos of creek & embankment
19	C	6819601	386885	SURFACE: sandy SLOPE : 2% ELEMENT : midslope PATTERN: gently undulating plain VEGETATION FORM: open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–20cm. Brown 10YR4/2, coarse sand, massive , field pH 5.0 clear change to; A12 20-80cm. brown 10YR 5/2, coarse sand, massive, field pH 4.5, C 80+ weathered pm	
20	C	6818981	386645	SURFACE: sandy loose SLOPE : 1-2% ELEMENT : midslope PATTERN: gently undulating plain VEGETATION FORM: cleared SUBSTRATE: Granite GSG: Siliceous sand	A11 0–30cm. Brown 10YR4/3, coarse sand, massive , wet, field pH 5.5 clear change to; A12 30-55cm. greyish brown 7.5YR 5/2, coarse sand with 40& fine gravel to 5mm. Prominent red yellow staining (mottles), massive, field pH 4.5, C 55 rock stopped auger	
21	C	6818742	386661	SURFACE: sandy loose recently cultivated SLOPE : 2-3% ELEMENT : midslope PATTERN: gently undulating plain VEGETATION FORM: cleared SUBSTRATE: Granite GSG: Gradational	AP 0–25m. Brown 10YR5/3, coarse sand, massive , field pH 5.0 clear change to; A12 25-70cm. brown 10YR5/2, coarse gritty clay loam . wet, field pH 5.0, C 70cm rock stopped auger	2 samples 0-10cm, 50-60cm. 1 photo cultivation
22	C	6819143	386442	Same as 17	Coarse sand to depth 65cm	
23	B	6819201	386176	SURFACE: lOAMY sand SLOPE : 3-4% ELEMENT : mid slope PATTERN: gently undulating hills VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–45cm. pale brown 10YR5/2, silty loam, massive, field pH 5. C 45+ weathered / fresh rock	
24	A	6819033	386024	Severn River channel. 50% granite outcropping.	Coarse sand at variable depths from 0 to 50cm	
25	B	6818910	385961	SURFACE: loose sand with outcropping granite SLOPE : 3-4% ELEMENT : mid slope PATTERN: undulating plain VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–25cm. dark brown 10YR3/3, coarse silty loam, massive, field pH 5. A12 25-60 cm brown 10YR5/2, coarse sand (loamy), massive, field pH 5.5. C 60+ weathered gravely rock	
26	C	6818636	386827	SURFACE: sandy	A11 0–25cm. Dark brown 7.5YR3/2, organic	

				SLOPE : 2% ELEMENT : mid slope PATTERN: gently undulating plain VEGETATION FORM: cleared - pasture SUBSTRATE: Granite GSG: Siliceous sand	staining, sandy loam, massive, field pH 5. A12 25-65cm Pale coarse sandy loam 7.5YR5/3, no bleach A21 65 – 120+cm. Red / yellow lateritic mottling with pebbles to 5 mm. wet all the way down. Edge of cultivation.	
27	A	6818500	386702	River edge. 50% outcropping granite.	Variable soil depth across the area. Much of the area < 10cm depth. A11 0–20cm. Dark brown 7.5YR3/2, sandy loam, massive, field pH 5. A12 20-80cm Pale coarse sandy loam 7.5YR5/3, field pH 4.5. C 80cm weathered rock	
28	A	6818264	386972	Same landform element characteristics as site 27. 3-4% slope.	Firm sandy surface with extensive granite outcropping. Soil depth variable up to 100 cm (this site) coarse sandy loam.	
29	C	6818116	387182	SURFACE: loose sand with outcropping granite SLOPE : 0% ELEMENT : flat depositional levee above main river channel PATTERN: alluvial plain VEGETATION FORM: Open forest SUBSTRATE: Granite GSG: Siliceous sand	A11 0–30cm. Brown 10YR4/3, coarse loamy sand, massive, field pH 5.5. A12 30-100+ cm brown 10YR5/2, coarse sand (loamy), massive, field pH 5.5.	1 sample 0-10cm. 1 photo flat area
30	B	6818299	387451	Significant outcropping granite	A11 0–30cm. Brown 10YR4/3, coarse loamy sand, massive, field pH 5.5. C 30cm rock stopped auger	
31	B	6818521	387714	2-3% slope. No outcropping rock here. Open forest. No erosion	A11 0–60cm. Brown 10YR4/3, coarse loamy sand, massive, C 60cm rock stopped auger	

ATTACHMENT 1 B- PIPELINE OBSERVATIONS

Site	Soil	Northing	Easting	Landform / comments
P1	B	6813613	387322	Vineyard. 2% slope. Coarse sandy 70cm +
P2	D	6814109	388102	Granite hills. <10cm soil. Sand. >8% slope
P3	B	6813953	388601	Near Watters Rd. lower slope. 3-4%, some soil here to 50cm. small area of better soil
P4	D	6813146	389474	Rocky undulating sands with some cleared flats pasture.
P5	B	6813068	390571	Perkins Lane turnoff. Small flat area 45-50cm soil depth. Coarse sandy.
P6	C	6813565	392198	Undulating coarse sand. Vineyard. Undulating 'better country in vicinity.
P7	C	6829006	394019	Flat area with cultivation soil sandy >50cm
P8	C	6834152	385467	Flat area with vineyards (Cowies land intersection)
P9	C	6834802	385295	Tree crops . deep coarse sandy. Flat <1%. Good soil
P10	B	6837746	381761	Fairly flat. 2% slope. Sandy. No rocks. Forest timber
P11	B	6837519	382728	Forestry Fairly flat. 2% slope. Sandy some outcropping granite (20% of surface)
P12	C	6837150	383450	Flat. Sandy uniform soil to 45cm +
P13	B	6836304	383951	Amiens town. Gently undulating. Mostly timbered.
P14	C	6935563	384946	Bapume road intersection. Sig agriculture to east. Good deep sandy soil.
P15	C	6837226	385160	Gently undulating sandy to 50cm +
P16	C	6839066	385688	Irrigated forage. Agric lands all along Bapume road.
P17	D	6838513	386942	Hilly with slopes >4%. Coarse sandy
P18	D	6837876	387900	Rocky O/C increasing. Shallow sands.
P19	D	6836952	389357	Same as 18
P20	B	6834900	390227	better agric land. Deep sandy. Only in 500m strip here
P21	D	6833082	390099	Undulating rocky
P22	D	6832100	390126	Amiens CC road intersection. Undul rocky
P23	C	6831994	391026	Good land since Amiens rd. irrigated forage. Soil >50cm coarse sandy. Mottled subsoil below 50cm.
P24	B	6831138	392800	Undulating with areas of rock.
P24a	B	6830770	394095	As 24
P25	C	6835161	397739	Pozierers area. Good land slope <2%. Cultivation. Deep dandy duplex.
P26	C	6835299	396600	As 25
P27	C	6835518	395840	As 25.
P28	B	6836193	395521	More undulating. Occasional rock. Coarse sandy loam to 50cm.

P29	C	6837266	395322	irrigated vegetables. flat. deep sandy. grey
P30	B	6838149	395490	Undulating with minor rock. Soil depth 50cm+
P31	C	6838491	396049	Good agric land south of road.
P32	C	6841317	396712	0-30cm grey coarse sand. pH 5.0, 30-80+cm mottled red clayey loam.
P33	C	6841468	395640	Tree crops in gently undulating lowlands. Deep sandy duplex.
P34				No site
P35	C	6842056	394200	Tree crops. Gently undulating. Gritty sand to 45cm over mottled sandy subsoil to 90+
P36	C	6842916	393988	As 35
P37	C	6844024	393735	As 35.
P38	B	6844124	393098	More slope here (3%) undulating land .
P39	C	6843821	392515	Good agric land. Deep coarse sandy. Slope <2%
P40	C	6843815	391843	As 39
P41	C	6842866	392000	As 39
P42	B	6842830	390997	Steeper with rocky areas. Soil depth 45cm to mottled gritty subsoil
P43	B	6843602	388868	As 42
P44	B	6843850	388868	Forestry timber.
P45	B	6844458	388965	Undulating sandy soil 50cm +
P46	C	6843930	394717	Good flat agric land
P47	C	6844538	396129	As 46
P48	C	6843765	396834	As 46

ATTACHMENT 2 - ANALYTICAL DATA AND METHODS

SOIL DISPERSION CLASS

CLIENT: GTES
PROJECT: Stanthorpe
SAMPLE ID: S1, S5, S11, S21
JOB NO: 07 248
LAB NUMBER: 1941 - 1950
SAMPLE DESCRIPTION: Gravelly Soils

PROPERTY	RESULTS
Emerson Class S1(3),S5(2)S11(3),S21(2) 7.1.1.1	7.1.1.2 $S1_{20cm}$ = 5, $S1_{40cm}$ = 5, $S1_{110cm}$ = 5, $S5_{10cm}$ = 5, $S5_{40cm}$ = 5, $S11_{10cm}$ = 5, $S11_{50cm}$ = 5, $S11_{70cm}$ = 5, $S21_{10cm}$ = 5, $S21_{60cm}$ = 2.

METHOD USED FOR ANALYSIS

ANALYTE	AS NUMBER	DESCRIPTION
Dispersion	AS-1289,3.8.1	INDEX

COMMENT:

- Soil all rated NON DISPERSIVE except S21 @ 50 – 60cm
- Note to major component tested some clay lumps may be different.

Dennis Baker
Authorised Signatory

PARTICLE SIZE

ESSA Pty Ltd

Soil Analysis Report
Batch Number: 07/57

Date Received: 20/8/2007
Date Completed: 29/8/2007
Printed: 29/8/2007

Client: GTES

Lab No	Client Ref No	Site	Date	PSA-CS	PSA-FS	PSA-Silt	PSA-Clay	R1
				%	%	%	%	
540		1		42	40	7	12	0.40
541		5		40	34	14	12	0.63
542		11		64	21	8	8	0.60
543		21		62	26	7	6	0.49

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QUALITY CONTROL DATA

Soil

Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)

Test Method	Units		Actual Value	Acceptance Criteria [Range]
Coarse sand	%	B	2.0	1.4 - 2.8
Fine Sand	%	B	18	13.1 - 19.1
Silt	%	B	20	19 - 26.1
Clay	%	B	61	55.4 - 62

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S1 0-20
Sample No : B032163G / SI1947
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	4.9
pH [CaCl2]	4.2
Organic Matter (%)	1.9
CEC (meq/100g)	5.7
EC (dS/m)	0.05
NO3-N (ppm)	1.7
Phosphorus [Olsen] (ppm)	6
Potassium (meq/100g)	0.24
Calcium (meq/100g)	3.30
Magnesium (meq/100g)	1.78
Sulphur (ppm)	5
Boron (ppm)	<0.1
Copper (ppm)	0.6
Iron (ppm)	84
Manganese (ppm)	21.1
Zinc (ppm)	0.8
Aluminium (meq/100g)	0.14
Sodium (meq/100g)	0.3
Chloride (ppm)	12
Ca base saturation (%)	57.5
K base saturation (%)	4.2
Mg base saturation (%)	31.0
Na base saturation (%)	4.9
Ca:Mg Ratio	1.9
Al base saturation (%)	2.4

Date Printed : 30 Aug 2007

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S1 30-40
Sample No : B032163A / SI1941
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	4.8
CEC (meq/100g)	6.2
EC (dS/m)	0.09
Potassium (meq/100g)	0.24
Calcium (meq/100g)	2.88
Magnesium (meq/100g)	2.30
Aluminium (meq/100g)	0.19
Sodium (meq/100g)	0.6
Ca base saturation (%)	46.3
K base saturation (%)	3.9
Mg base saturation (%)	37.0
Na base saturation (%)	9.8
Ca:Mg Ratio	1.3
Al base saturation (%)	3.1

Additional Comments

You should consult your local agronomist and/or Phosyn representative before deciding upon any course of action based on this report.
Calcium (Ca): 1 meq/100g equals 200ppm
Magnesium (Mg): 1 meq/100g equals 120ppm
Sodium (Na): 1 meq/100g equals 230 ppm
Potassium (K): 1 meq/100g equals 390 ppm
Aluminium (Al): 1 meq/100g equals 90 ppm

Date Printed : 30 Aug 2007

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S1 100-110
Sample No : B032163E / SI1945
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	4.6
CEC (meq/100g)	5.5
EC (dS/m)	0.05
Potassium (meq/100g)	0.22
Calcium (meq/100g)	2.72
Magnesium (meq/100g)	1.94
Aluminium (meq/100g)	0.21
Sodium (meq/100g)	0.4
Ca base saturation (%)	49.6
K base saturation (%)	4.0
Mg base saturation (%)	35.4
Na base saturation (%)	7.1
Ca:Mg Ratio	1.4
Al base saturation (%)	3.8

Additional Comments

You should consult your local agronomist and/or Phosyn representative before deciding upon any course of action based on this report.
Calcium (Ca): 1 meq/100g equals 200ppm
Magnesium (Mg): 1 meq/100g equals 120ppm
Sodium (Na): 1 meq/100g equals 230 ppm
Potassium (K): 1 meq/100g equals 390 ppm
Aluminium (Al): 1 meq/100g equals 90 ppm

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Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S5 0-10
Sample No : B032163H / SI1948
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	5.3
pH [CaCl2]	4.8
Organic Matter (%)	3.3
CEC (meq/100g)	10.9
EC (dS/m)	0.05
NO3-N (ppm)	3.5
Phosphorus [Olsen] (ppm)	8
Potassium (meq/100g)	0.24
Calcium (meq/100g)	8.76
Magnesium (meq/100g)	1.49
Sulphur (ppm)	8
Boron (ppm)	0.3
Copper (ppm)	0.2
Iron (ppm)	45
Manganese (ppm)	52.2
Zinc (ppm)	0.6
Aluminium (meq/100g)	0.12
Sodium (meq/100g)	0.3
Chloride (ppm)	7
Ca base saturation (%)	80.4
K base saturation (%)	2.2
Mg base saturation (%)	13.7
Na base saturation (%)	2.6
Ca:Mg Ratio	5.9
Al base saturation (%)	1.1

Date Printed : 30 Aug 2007

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Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S5 30-40
Sample No : B032163B / SI1942
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	4.7
CEC (meq/100g)	5.1
EC (dS/m)	0.02
Potassium (meq/100g)	0.10
Calcium (meq/100g)	3.05
Magnesium (meq/100g)	1.48
Aluminium (meq/100g)	0.18
Sodium (meq/100g)	0.3
Ca base saturation (%)	60.2
K base saturation (%)	2.0
Mg base saturation (%)	29.2
Na base saturation (%)	5.1
Ca:Mg Ratio	2.1
Al base saturation (%)	3.6

Additional Comments

You should consult your local agronomist and/or Phosyn representative before deciding upon any course of action based on this report.
Calcium (Ca): 1 meq/100g equals 200ppm
Magnesium (Mg): 1 meq/100g equals 120ppm
Sodium (Na): 1 meq/100g equals 230 ppm
Potassium (K): 1 meq/100g equals 390 ppm
Aluminium (Al): 1 meq/100g equals 90 ppm

Date Printed : 30 Aug 2007

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Andrews, Queensland 4220, Australia
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email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S11 LIGHT BRN 0-10
Sample No : B032163I / SI1949
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	5.5
pH [CaCl2]	4.9
Organic Matter (%)	2.1
CEC (meq/100g)	7.3
EC (dS/m)	0.04
NO3-N (ppm)	1.9
Phosphorus [Olsen] (ppm)	21
Potassium (meq/100g)	0.29
Calcium (meq/100g)	4.93
Magnesium (meq/100g)	1.68
Sulphur (ppm)	6
Boron (ppm)	0.2
Copper (ppm)	3.0
Iron (ppm)	57
Manganese (ppm)	23.9
Zinc (ppm)	1.5
Aluminium (meq/100g)	0.15
Sodium (meq/100g)	0.3
Chloride (ppm)	7
Ca base saturation (%)	67.5
K base saturation (%)	4.0
Mg base saturation (%)	23.0
Na base saturation (%)	3.4
Ca:Mg Ratio	2.9
Al base saturation (%)	2.1

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Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S11 40-50
Sample No : B032163C / SI1943
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	5.9
CEC (meq/100g)	4.2
EC (dS/m)	0.03
Potassium (meq/100g)	0.16
Calcium (meq/100g)	2.17
Magnesium (meq/100g)	1.55
Aluminium (meq/100g)	0.15
Sodium (meq/100g)	0.2
Ca base saturation (%)	51.3
K base saturation (%)	3.8
Mg base saturation (%)	36.6
Na base saturation (%)	4.7
Ca:Mg Ratio	1.4
Al base saturation (%)	3.5

Additional Comments

You should consult your local agronomist and/or Phosyn representative before deciding upon any course of action based on this report.
Calcium (Ca): 1 meq/100g equals 200ppm
Magnesium (Mg): 1 meq/100g equals 120ppm
Sodium (Na): 1 meq/100g equals 230 ppm
Potassium (K): 1 meq/100g equals 390 ppm
Aluminium (Al): 1 meq/100g equals 90 ppm

Date Printed : 30 Aug 2007

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S11 60-70
Sample No : B032163F / SI1946
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	5.4
CEC (meq/100g)	3.6
EC (dS/m)	0.02
Potassium (meq/100g)	0.14
Calcium (meq/100g)	1.85
Magnesium (meq/100g)	1.27
Aluminium (meq/100g)	0.12
Sodium (meq/100g)	0.3
Ca base saturation (%)	50.8
K base saturation (%)	3.8
Mg base saturation (%)	34.9
Na base saturation (%)	7.1
Ca:Mg Ratio	1.5
Al base saturation (%)	3.3

Additional Comments

You should consult your local agronomist and/or Phosyn representative before deciding upon any course of action based on this report.
Calcium (Ca): 1 meq/100g equals 200ppm
Magnesium (Mg): 1 meq/100g equals 120ppm
Sodium (Na): 1 meq/100g equals 230 ppm
Potassium (K): 1 meq/100g equals 390 ppm
Aluminium (Al): 1 meq/100g equals 90 ppm

Date Printed : 30 Aug 2007

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S21 DARK BRN 0-10
Sample No : B032163J / SI1950
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	6.5
pH [CaCl2]	5.8
Organic Matter (%)	1.9
CEC (meq/100g)	9.4
EC (dS/m)	0.11
NO3-N (ppm)	29.3
Phosphorus [Olsen] (ppm)	15
Potassium (meq/100g)	0.70
Calcium (meq/100g)	7.16
Magnesium (meq/100g)	1.11
Sulphur (ppm)	9
Boron (ppm)	0.4
Copper (ppm)	3.3
Iron (ppm)	34
Manganese (ppm)	31.5
Zinc (ppm)	2.0
Aluminium (meq/100g)	0.17
Sodium (meq/100g)	0.3
Chloride (ppm)	6
Ca base saturation (%)	75.9
K base saturation (%)	7.4
Mg base saturation (%)	11.8
Na base saturation (%)	3.1
Ca:Mg Ratio	6.5
Al base saturation (%)	1.8

Date Printed : 30 Aug 2007

Phosyn Analytical, 1/60 Junction Road,
Andrews, Queensland 4220, Australia
Tel: +61 7 5568 8700, Fax: +61 7 5522 0720
email: phosynanalytical@phosyn.com

Analysis Results (SOIL)

Customer : GTES
STANTHORPE

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : S21 50-60
Sample No : B032163D / SI1944
Crop : DATA ONLY

Date Received : 13/08/07

Analysis	Result
pH [H2O]	4.0
CEC (meq/100g)	8.7
EC (dS/m)	0.05
Potassium (meq/100g)	0.25
Calcium (meq/100g)	1.92
Magnesium (meq/100g)	3.60
Aluminium (meq/100g)	2.23
Sodium (meq/100g)	0.7
Ca base saturation (%)	22.1
K base saturation (%)	2.9
Mg base saturation (%)	41.4
Na base saturation (%)	8.0
Ca:Mg Ratio	0.5
Al base saturation (%)	25.6

Additional Comments

You should consult your local agronomist and/or Phosyn representative before deciding upon any course of action based on this report.
Calcium (Ca): 1 meq/100g equals 200ppm
Magnesium (Mg): 1 meq/100g equals 120ppm
Sodium (Na): 1 meq/100g equals 230 ppm
Potassium (K): 1 meq/100g equals 390 ppm
Aluminium (Al): 1 meq/100g equals 90 ppm

Date Printed : 30 Aug 2007

ESSA Pty Ltd

METHOD DESCRIPTIONS

Soil

Methods used to Analyse Samples

Analyte	ALHS*	Uncertainty %	LOQ	Unit	Name	Method Description
pH	4A1	1.1	0.1	pH	pH	1:5 water extr, pH meter
EC	3A1	5.4	0.01	dS/m	Electrical conductivity	1:5 water extr, EC meter
Cl	5A2	10.0	10.0	mg/kg	Chloride	1:5 water extr, (AA) colorimetric
NO3-N	7C1	6.7	1.0	mg/kg	Nitrate-nitrogen	1:5 water extr, (AA) colorimetric
Bicarb.P	9B2	16.8	1.0	mg/kg	Bicarb.ext.phosphorus	0.5M NaHCO3 @ pH 8.5, (AA) colorimetric
Ca (Alc)	15C1	7.2	0.18	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Mg (Alc)	15C1	4.7	0.31	meq/100g	Exchangeable magnesium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
Na (Alc)	15C1	9.6	0.09	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
K (Alc)	15C1	4.8	0.02	meq/100g	Exchangeable calcium	1M NH4Cl (alcoholic) @ pH 8.5 leach, AAS
CEC	15I3	5.7	1.0	meq/100g	Cation Exchange Capacity	KNO3 + Ca(NO3)2 extr, (AA) colorimetric
ESP	15N1	5.0	3	%	Exchangeable Na%	(Exchangeable Na/sum of exch.cations)%
Sand	no ref	22.1	1.0	%	Particle size, sand	Hydrometer, gravimetric
Silt	no ref	16.6	1.0	%	Particle size, silt	Hydrometer, gravimetric
Clay	no ref	12.7	1.0	%	Particle size, clay	Hydrometer, gravimetric
R1	NA	20.2	NA		Dispersion Ratio	Ratio [Aqueous dispersible (Silt + Clay):Total (Silt + Clay)]

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

For Manager
Analytical Services: _____

ESSA Pty Ltd

QUALITY CONTROL DATA

Soil

*** Australian Laboratory Handbook of Soil and Water Chemical Methods (1992)**

Test Method	Units		Actual Value	Acceptance Criteria [Range]
Coarse sand	%	B	2.0	1.4 - 2.8
Fine Sand	%	B	18	13.1 - 19.1
Silt	%	B	20	19 - 26.1
Clay	%	B	61	55.4 - 62