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Our Reference: 13730-Soils final

Sunday, 30 August 2009

Primary Project Solutions Pty Ltd
Attn: Mr David English
75 Market Street
MUDGEE NSW 2850

Dear Sir,

Re: Soils and Salinity Investigation, Ulan

Barnson Pty Ltd was commissioned to undertake a soils and salinity investigation for the proposed spot rezoning of land in the vicinity of Ulan, NSW. The purpose of this assessment was to identify the main soil types across the site, together with potential site constraints in relation to future industrial development.

This investigation is based largely upon desktop review of available information together with interpretation of aerial photography and topographical maps, EMI survey, field survey and minor laboratory analysis.

This investigation was conducted throughout July 2009 by Barnson Environmental Scientists, together with advice from specialist sub-consultants and local Catchment Management Authority representatives.

If you have any further enquires regarding this matter, please do not hesitate to contact the undersigned.

Yours faithfully
BARNSON PTY LTD

Kristy Bennetts
B App Sci / Grad Dip Ed
Environmental Scientist

LIST OF CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Background

This report has been prepared by Barnson Pty Ltd for the Mid-Western Regional Council (MWRC), on behalf of Primary Project Solutions Pty Ltd. This investigation relates specifically to Lots 271 and 276 DP 755442, Ulan and Toole Roads, Ulan (referred thereafter as 'the study area'). The proposed development involves the rezoning of the land area from its current Agricultural zoning to Industrial, pursuant to the Mid-Western Regional Interim Local Environment Plan, 2008. It is understood this work was triggered by a request from the MWRC .

The Mudgee and Gulgong catchment areas were identified in the Mid Western Regional Council Comprehensive Land Use Strategy – Salinity Constraints Investigation for Mudgee and Gulgong, NSW 2008 (Environmental and Earth Sciences), as having a high salinity hazard due to factors such as change of slope, lithology, soil permeability and land use. These factors together with a change in landuse, could increase impediments to drainage and water loading, which may influence the likelihood of dryland salinity in certain areas.

This report aims to identify the main soil landscapes and soil types, together with the identification of potential limitations and salinity risks across the study area. Recommendations in relation to development contains, mitigation measures and salinity management strategies will also be made.

1.2 Objectives and Scope of Works

The broad objective of this investigation is to identify main soil and landscape types across the site, together with possible limitations for future industrial development. To do this, the following Scope of Works was undertaken:

- A desktop review of all available information for the area- including geological, hydrogical, hydrogeological, topographical, and landscape information;
- Local Site Investigation – which involved observation and inspection for signs of salinity, including waterlogging, dying and dead trees, salt tolerant species, and identification of salt crusting;
- Electromagnetic Induction Survey (EMI) - undertaken by the Lachlan Catchment Management Authority to identify possible areas of high conductivity across the site;
- Excavation of seven pits to expose the soil profile and collect samples for salinity testing;
- Completion of this report detailing the finding of the various tasks in order to make educated recommendations.

2.0 OVERVIEW OF SITE

2.1 Site Location

The subject land is located in the north-east sector of the Mid-Western LGA, alongside the Village of Ulan (Refer to **Figure 1** on the following page). The subject land is bordered by Ulan Road, Toole Road and Gulgong to Sandy-Hollow Railway. Ulan Village is located approximately 1km to the north of the site. The subject land is also located a short distance to the west of the major mining operations of Ulan Coal Mine (1km), Moolarben Mine (4kms) and Wilpinjong Mine (10kms).

2.2 Site Description

The property description is Lots 271 & 276 DP 755442, Parish of Moolarben. It is zoned agriculture pursuant to the Mid-Western Regional Interim Local Environmental Plan 2008. It has an area of approximately 38 ha and consists of two roughly triangular land portions - Lot 271 – 16.66 hectares and Lot 276 – 21.1 hectares.

2.3 Past and Current Land Uses

The subject land maintains a house and shed and is currently used for cattle and sheep grazing. The land is not suitable for cropping. In the past it is believed to have been part of a large farming establishment and there is evidence of old contour banks and tree removal, particularly in Lot 271.

The area subject to the rezoning application is bisected by the Sandy Hollow to Gulgong Railway line.

The recently installed Transgrid 330kV Power Line borders the subject land to the north.

The site has been extensively cleared, however patches of remnant vegetation do exist, particularly along the drainage lines.

Source: Department of Lands, 2003

Figure 1: Aerial of the Ulan proposed Rezone

2.4 Surrounding Development

The subject land is located in the north-east sector of the Mid-Western LGA, alongside the village of Ulan. The subject land is bordered by Ulan Road, Toole Road and Gulgong to Sandy-Hollow Railway. Ulan Village is located approximately 1km to the north of the site. The subject land is also located a short distance to the west of the major mining operations of Ulan Coal Mine (1km), Moolarben Mine (4kms) and Wilpinjong Mine (10kms).

2.5 Topography

The subject land is generally flat, with a gentle slope to the north north west in the direction of Sportsman's Hollow Creek. It is situated between RL 430m AHD and RL 440m AHD (refer to **Figure 2**). An unnamed drainage line, a tributary of Sportsman's Hollow Creek, runs though the site, passing under the rail line and Ulan road though a series of box culverts.

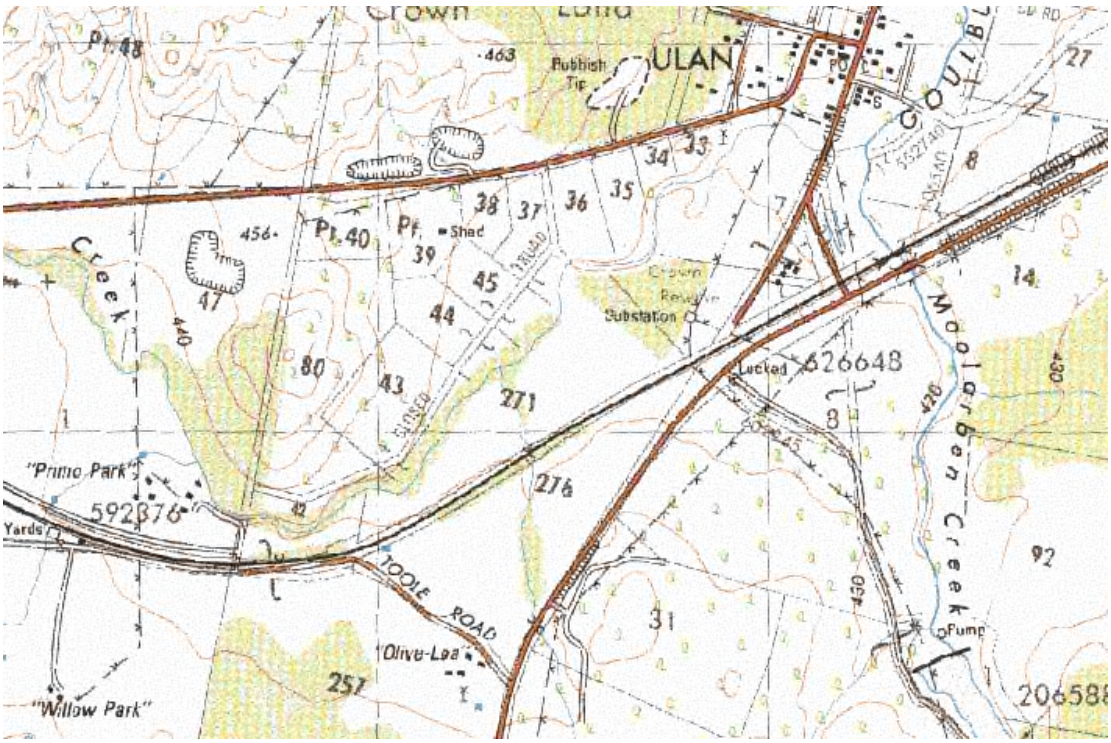

Figure 2: Topographic Map

3.0 INVESTIGATION METHODOLOGY

The following sub section outlines the methods used to undertake this investigation across the study area.

3.1 Desktop Review

All relevant, easily accessible database and literature information related to the site pertaining to soils and salinity were reviewed. Information reviewed included:

- Soil Landscape Mapping – using Murphy, B.W and Lawrie, J.W. 1998, *Soils Landscapes of the Dubbo 1:250 000 Sheet Map and report*;
- Department of Mineral Resources Geological Map, Dubbo 1:100 000;
- Local groundwater bore data – accessed via the NSW Department of Natural Resources (www.nratlas.com.au);
- Local Climatic data- accessed via the Commonwealth Bureau of Meteorology (www.bom.gov.au);
- *Mid Western Regional Council Comprehensive Land Use Strategy – Salinity Constraints Investigation for Mudgee and Gulgong, NSW 2008* (Environmental and Earth Sciences).
- Local Government Salinity Initiative program tools

3.2 Initial Site Investigation

An initial site investigation was undertaken in collaboration with the desktop review to allow the scientific team to assess site information – including topography, existing vegetation, potentially saline areas, erosional features and potential sampling localities.

3.3 EMI Survey

EMI survey provides a rapid assessment of potential salinity across a land area. It measures apparent electrical conductivity to a particular depth, depending on the electromagnetic band width being used. Care is required in interpreting the results as EMI readings are influenced by soil texture (amount of sand, clay and silt), soil moisture and salt content.

A representative of the Lachlan Catchment Management Authority (CMA) conducted a half day Electomagnetic Induction (EMI) survey of the site in July 2009. This was undertaken by way of a 4WD motorbike with an EM31conductivity sensor which measures Eca to a depth of 5m, and

GPS equipment. Transects of the paddock were undertaken at intervals of 15m and data was collected every 4-6m along each transect. Data was analysed and the ECa map produced. This map was used to identify potentially saline areas for ground truthing.

3.4 Detailed Site Investigation and Mapping

Ground truthing of EMI Survey results, together with initial site investigation and desktop review information, was undertaken in July 2009. This involved the excavation of seven sample pits to a depth of approximately 1.5m (or bedrock), review of the soil profile and collection of several test pit samples for salinity analysis. Assessment was undertaken in line with the Australian Soil and Land Survey Field Handbook, Volume 3 (2009). Sample locations are identified in **Figure 3.**

Site mapping was undertaken using research information, aerial photography, EMI survey results, and site investigation findings. Soil types together with potential saline areas were marked on the aerial photograph using GIS technology.

3.5 Study Limitations

3.5.1 Mapping Boundaries

The investigation aims to provide a broad overview of the major soil landscape units and types across the site. The boundaries identified are by no means exact. To create a definitively accurate map would require a large number of test pits to verify actual boundaries.

3.5.2 Other

The investigation was not intended to provide a detailed soils map of the site, rather it aims to identify the overall soil types and potential areas of salinity concern across the study area. It is important to note that the areas identified as having potential concern have been done so as a result of a combination of factors. More detailed laboratory analysis would provide data on the salinity levels found in surface and sub-soils for areas of concern across the site.

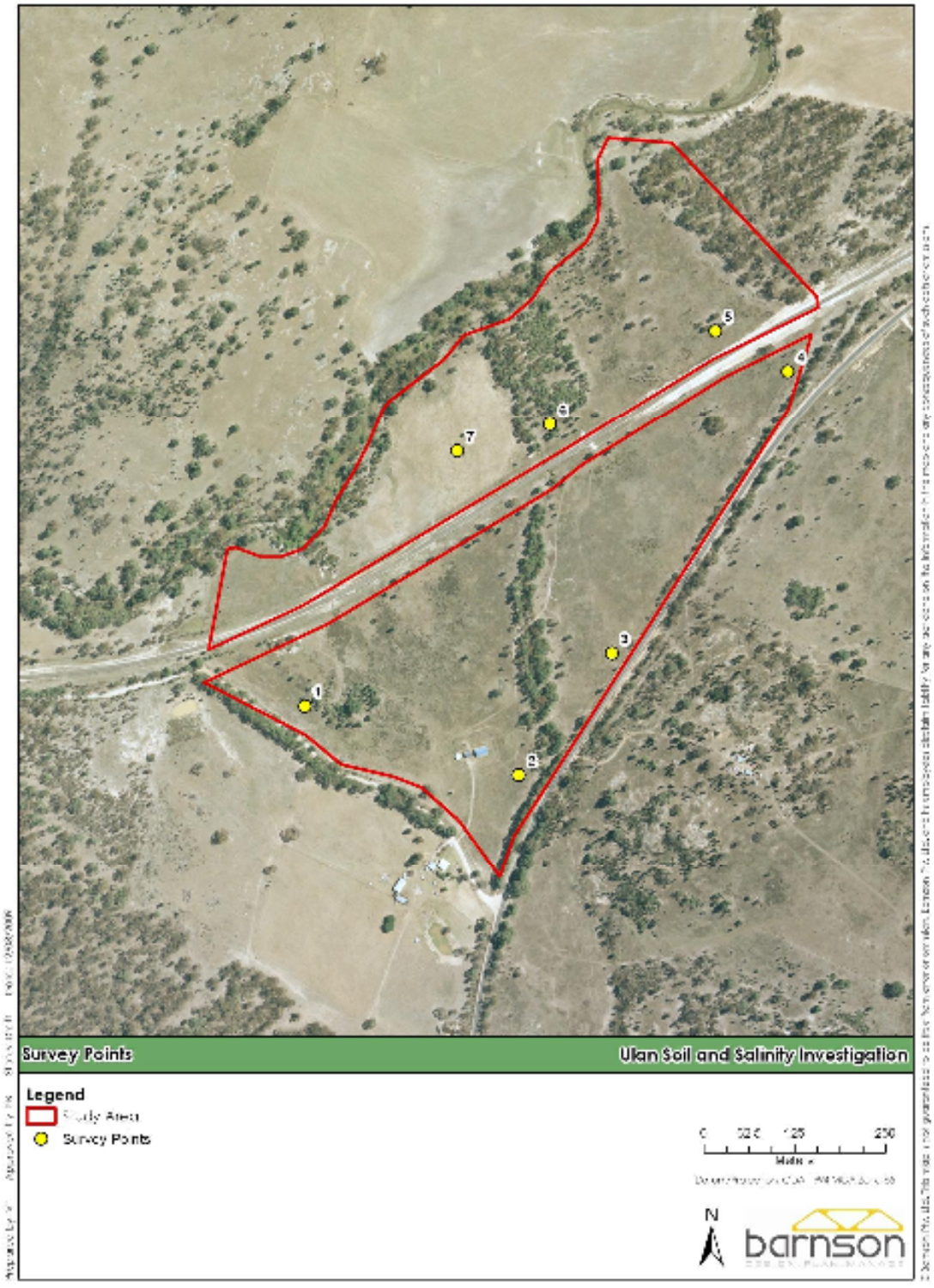

Figure 3 – Sample Sites

4.0 RESULTS & KEY FINDINGS

4.1 Desktop Review

4.1.1 Soil Types and Landscapes

The study area was identified on the Dubbo 1:250 000 Soil Landscape Map to comprise of one main soil landscape. It is summarised in the following table.

Table 1: Soil Landscapes of Lots 271 and 276

LANDSCAPE	LANDFORM	LITHOLOGY	TYPICAL SOILS	LIMITATIONS
Home Rule (hr)	Undulating, low rises ranging from 420-500m in elevation. Slopes are gently inclined 4-8%. Local relief varies from 30-60m.	Quaternary alluvium and the Gulgong and Rouse Granites.	Mainly Siliceous Sands and Earthy Sands on upper and mid slopes. Bleached sands, Yellow Podzolic Soils and yellow Solodic Soils on lower slopes and flats. Layered Siliceous Sands in drainage lines.	Very low fertility, low available water holding capacity, acidic surface soils, seasonal waterlogging, sodic subsoils in lower slopes, high permeability on mid to upper slopes, moderate to high erosional hazard under cultivation.

Salinisation for the landscape group is defined as – low levels of soil salinity are apparent and common across the landscape. Landform elements affected include the drainage lines, depressions, footslopes, lower slopes and more rarely mid to upper slopes.

The Soil Landscapes of the Dubbo 1:250 000 Sheet developed by Murphy and Lawrie (1998) describes the distribution of soils in each landscape in relation to topographic position and parent materials. Due to the age of the survey the soils have been classified using the Great Soil Group System (Stace et al 1968) rather than the more recent Australian Soil Classification System. The list below provides the equivalent terminology from the Australian Soil Classification.

- Orthic Tenosols (Siliceous Sands);
- Sodosols (Soloths);
- Yellow Chromosols and Yellow Kurosols (Yellow Podzolic Soils)

4.1.2 Underlying Geology

The Australian Geological Series Map – Dubbo 1:250 000 identifies the study area as existing within the Ulan Quartz Monozonite rock series. It is part of the Gulgong plutonic suite and is identified as a Carboniferous intrusion. The area is underlain by the Gulgong Granite Series of rock.

4.1.3 Hydrogeological Features

No hydrogeological maps for this area of Ulan were located. Therefore groundwater data was obtained via the NSW Department of Water and Energy groundwater works summary reports available online. As indicated in the following figure, there are 10 registered groundwater bores within a 2.5km radius of the site.

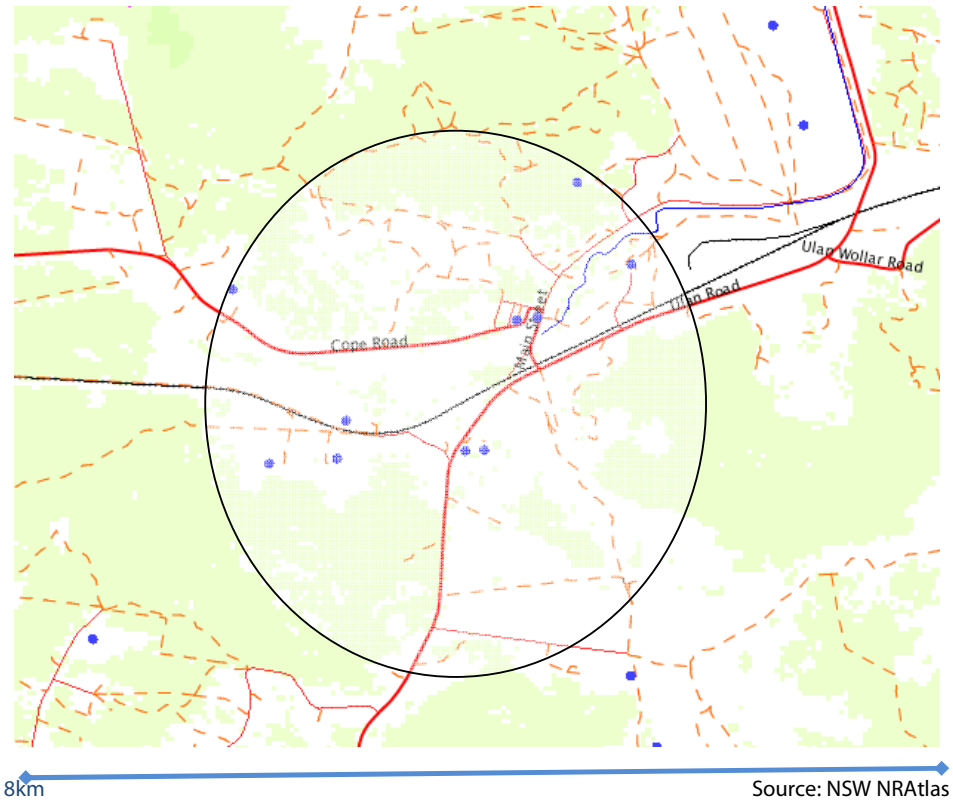

Figure 4 – Identifying Boreholes within 2.5km radius of the site

Two Bores, GW078174 and GW059683 are located directly east of the site across Ulan Road. Several others exist to the north of the site in Ulan village, as well south-west. Table 2 provides information on the depth, water bearing zone and basic soil descriptions of bores within this zone. Bore summaries are located in **Appendix A.** Other bores installed and monitored by Ulan Coal are not considered in this assessment.

Table 2 – Summary of Information from the Groundwater Work Summaries

BORE ID	DRILL DATE	FINAL DEPTH (m)	WATERBEARING ZONE YIELD	SALINITY INFO	APPROX DISTANCE TO SITE
GW078174	25-6-1993	83.80	54.90-55.50 - - 76.2 – 77.40 – 1.2L/s	Good Good	200m east Lot 276 (across Ulan Road)
GW059683	1-8-1984	61.50	24.00-24.30 – 0.19L/s	Fresh	400m east Lot 276 (across Ulan Road)
GW080350	28-11-2002	-	No details	No details	1km north of site
GW049542	1-6-1979	31.10	17.30 – 17.60 –- 25.00 – 25.30 --	Hard Hard	500m north Lot 271
GW065950	22-11-1988	81.00	53.5-55.5 -11L/s	No details	2km north east of site
GW200094	13-12-1999	-	No details	No details	2km north of site
GW080355	29-11-2002	-	No details	No details	2km north west of site
GW073549	24-11-1994	53.30	15.20-18.20 – 3.0L/s 35.00-35.40 – 0.4L/s	Potable	500m west of Lot 271
GW073550	24-11-1994	53.30	18.20-24.40 – 0.25L/s 38.10-38.40 -0.3L/s 42.60-42.90 – 0.3L/a	Good	1km south west of site
GW052802	1-7-1980	45.70	15.20-16.80 – 2.27L/s	Good	800m south west of site

Unfortunately there is little information provided in the summary reports regarding any pumping tests or permeability of hydrogeological materials. However, yield estimates provided in the water bearing zones for five of the bores indicate hydraulic conductivities of 0.3-3.0L/s. This indicates that yield from the fractured rocks in the vicinity of the site varies considerably from low to moderate, dependent with depth. The exception is GW065950 which demonstrated a yield of 11L/s, however this may be as a result of the external influence of Ulan Coal Mine, which is not within the scope of this report to consider. Information in these summaries do however indicate that permanent groundwater in the area is generally at a depth greater than 5m below the earths surface. Groundwater recharge across the area would be primarily via the infiltration of rainwater though open fractures, either at the surface or through unconsolidated material.

With the exception of GW049542, salinity readings taken from five of the bores reported a good, potable water rating, indicating a lack of salt. GW049542 reported a' Hard' rating, indicating a high mineral content, most probably of calcium and magnesium.

4.2 Climatic Data

Average rainfall for Gulgong is 649mm, as indicated on the Bureau of Meteorology website. The Ulan Coal Mine Met Station reported 774mm for the period November 2007-October 2008 (UCML AEMR, 2008), with December 2007 recording the highest rainfall. Historically, the summer months have higher rainfall.

The predominant wind direction record by UCML is South West (approximately 40%). North East and Easterly breezes are also common (UCML AEMR, 2008).

The hottest months of the year are January, February, March and December, with June, July and August recording the coldest average temperatures (as indicated by the Bureau of Meteorology website).

Mean annual evaporation for the Gulgong area is1475mm, with July in the vicinity of 41mm in July and 299mm in January (Murphy & Lawrie, 1998).

Murphy and Lawrie (1998) also describe the rainfall erosivity as being relatively uniform across the mapped area being 1000 to 1500 mm/hr/yr. These values are considered to be low compared to the north and east of the state where rainfall erosivity is in excess of 6000 mm/hr/yr.

4.3 EMI Survey

The following figure was developed by the Lachlan CMA.

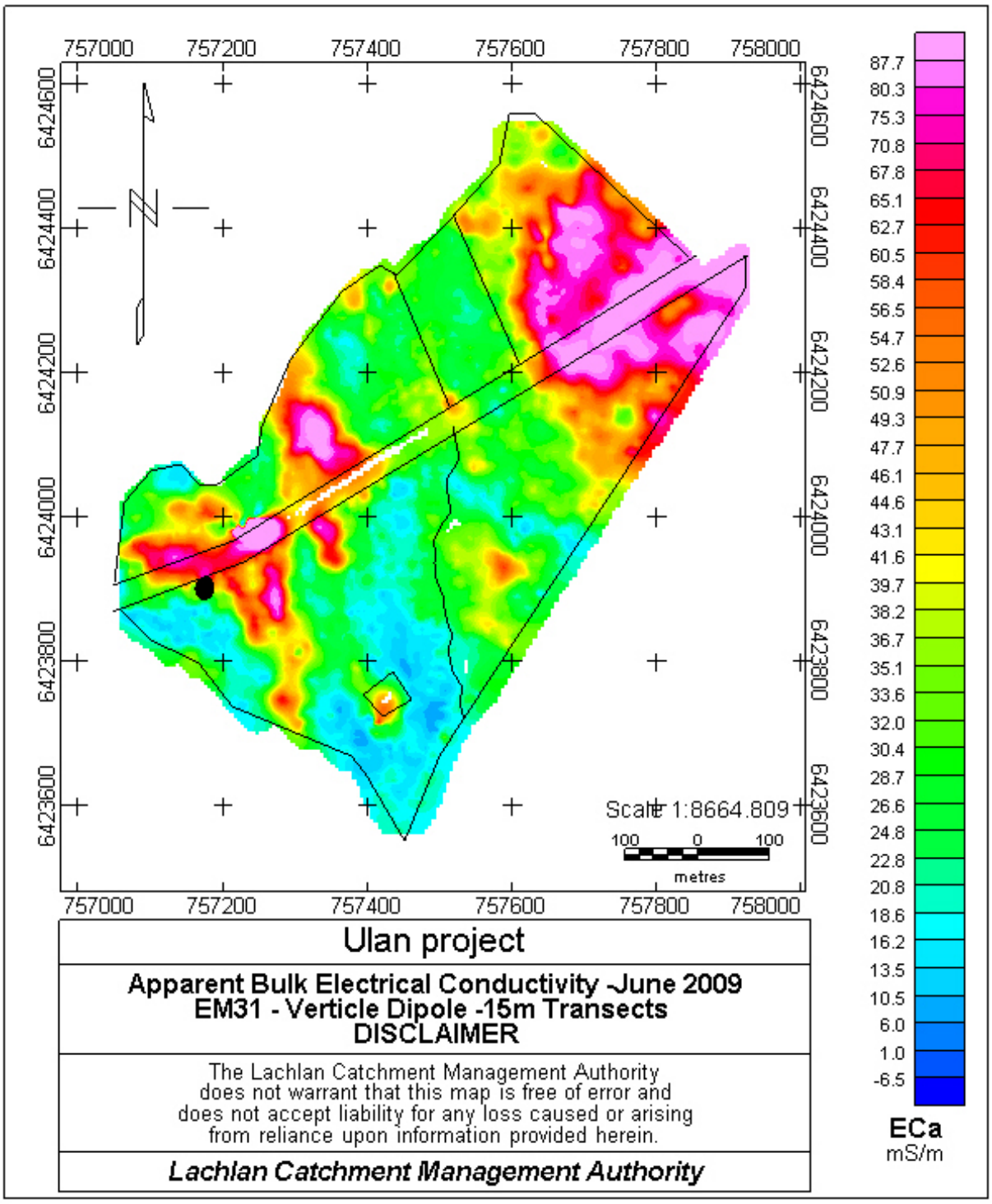

Figure 5: EMI Survey Results

The EMI Survey map was generated using GEOSOFT-Montaj data analysis, using minimum curvature to fill in gaps between transects. Readings vary between the two extremes:

- LOW apparent CONDUCTIVITY – these are the blue and green areas, inferring that they are recharge areas and generally comprise light textured soils which are free draining and have low levels of cyclic salts.

- HIGH apparent CONDUCTIVITY – these are the red and pink areas and they are considered to be mainly discharge sites and generally heavy textured soils, prone to periods of saturation, and contain high amounts of cyclic salts.

As identified in **Figure 5** there are three main 'hot spots' across the study site that recorded high conductivity ECa readings. This map provided a basis for the field assessment.

4.4 Soil Profiles and Laboratory Analysis

In July 2009, seven excavation pit locations were chosen for field ground truthing and basis salinity analysis. These locations were identified previously in **Figure 3.** Excavation of the pits to a depth of approximately 1.5 m was undertaken to expose the soil profiles. A summary is provided in **Tables 3- 9** below, together with plates of each of the exposed pits. Field soil profiling data sheets located at **Appendix B.**

It was necessary to collect samples from several representative pits for both surface soils and sub soils, for salinity analysis. Results of this testing is provided in **Table 10**. Laboratory analysis forms are provided at **Appendix C.**

Table 3 - Summary Survey Site 1

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A	0-0.1m	Clear	Loamy Sand	6	10YR 4/2	Non plastic	None
B1	0.1-1m	Gradational	Loamy Sand	6	10YR 5/4	Non plastic	Small pebbles <5%
B2/C	1-1.5m		Pebbly Sand	6-6.5	2.5 Y 7/4	Non plastic	Med – Large pebbles 60-80%

Table 4 - Summary Survey Site 2

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A	0-0.1m	Clear	Sandy loam	6	10 YR 3/3	Slightly plastic	Nil
B1	0.5m	Gradational	Sandy Loam	6	10YR 4/4	Slightly plastic	Nil
B2	0.5- 1m		Loamy Sand	6 to 6.5	10YR 6/4	Non plastic	Nil

Table 5- Summary Survey Site 3

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A	0-0.1m	Gradational	Loam	5.5 – 6	10 YR 3/3	Moderately Plastic	Nil
B1	01.-0.2m	Gradational	Clayey sand	6	7.5 YR 4/6	Slightly plastic	Pebbles small to large – 40%
B2	0.2-0.7m		Medium Silty Clay	6	10 YR 5/6	Very plastic	Small fragments 40-60%

Table 6 - Summary Survey Site 4

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A	0-0.2m	Gradational	Sandy Loam	6	10YR 3/2	Slightly plastic	Nil
B	0.2-1m		Heavy clay	7.5	2.5Y 5/2	Very plastic	Nil

Table 7 - Summary Survey Site 5

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A	0-0.1m	Gradational	Loamy sand	6	2.5 Y 4/2	Slightly plastic	Nil
B1	01.-0.3m	Gradational	Clayey sand	7	10YR 5/3	Slightly plastic	Nil
B2	0.3-0.8m		Medium heavy clay	7.5	2.5Y 6/3	Moderately plastic	Nil

Table 8 - Summary Survey Site 6

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A1	0-0.1m	Gradational	Loamy sand	6	10YR 3/3	Slightly plastic	Nil
A2	0.1-0.5m	Clear	Loamy sand	5.5	10YR 4/3	Non plastic	Nil
B	0.5-1m		sand	6.5	10YR 6/4	Non plastic	Small pebbles <10mm 30%

Table 9 - Summary Survey Site 7

HORIZON	DEPTH	BOUNDARY	FIELD TEXTURE	FIELD pH	FIELD COLOUR	PLASTICITY	ROCK FRAGMENTS
A	0-0.1m	Gradational	Sandy loam	5.5-6	10YR 4/3	Moderately plastic	Nil
A2	0.1-0.5m	Very gradational	Loamy sand	6.5	10YR 5/4	Slightly plastic	Nil
B	0.5-1m		Clayey sand – little cohesion	5.5-6	7.5 YR 5/4	Non plastic	Small to medium pebbles – 40%

Soil samples for surface (top 0.2m) and sub-surface (0.2-1m) areas were collected for survey sites 4, 5 and 6. Analysis was conducted by EnviroLab Services Pty Ltd for Electrical Conductivity (1:5 soil: water) and salinity as NaCl. Results were converted from microSiemen per cm (μS/cm) to the standard unit of electrical conductivity for soil suspensions, DeciSiemens (dS/m). Comparisons of values were undertaken using *Interpreting Soil Test Results Handbook* (Hazelton and Murphy, 2007).

Table 10 - Summary Laboratory Results and Calculations

	SURVEY SITE 4		**SURVEY SITE 5**		**SURVEY SITE 6**	
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Sample 6**
EC μS/cm	29	470	220	310	8	5
EC dS/m	0.029	0.47	0.22	0.31	0.008	0.005
EC 1:5 to ECe Factor	23	5.8	14	7.5	23	23
Conversion ECe	0.667	2.726	3.08	2.325	0.184	0.115
Rating	<2	2 to 4	2 to 4	2 to 4	<2	<2
Salinity Rating	Non-Saline	Slightly Saline	Slightly Saline	Slightly Saline	Non-Saline	Non-Saline
Salinity as NaCl mg/kg	99	1,600	750	1,100	27	17

The field inspection also resulted in the following observations:

- There was no salinity damage observed to the house existing on Lot 276;
- Some minor waterlogging was identified at the following locations-
    - Close to the dam in Lot 276;
    - In the southern portion of Lot 271, close to Sportsman's Hollow creek;
- Both lots at the time of inspection were well covered with vegetation. There were no patches of exposed topsoil and no evidence of salt crusting;
- No puffiness of dry soil were identified across either lot;
- No black staining on the soil surface was identified in either lot;
- Minor gully and bank erosion was evident along the drainage line running between both lots;
- Severe bank erosion exists in the bottom of Lot 271 along the Sportsman's Hollow Creek;
- No water was encountered in any of the excavation pits at the time of survey;
- Water in both Sportsman's Hollow Creek and the drainage line was turbid, indicating low salt concentration;
- Vegetation did not appear yellow, stunted, wilting or dead as a result of salinity;
- Minor sheet erosion exists over portions of both lots.

4.5 Vegetation

An ecological assessment by a specialist sub-consultant was conducted for the study area in line with this soils investigation. Refer to this assessment for detailed vegetation information. The following key information should however be noted:

- The site has been extensively cleared, apart from the drainage area there is little tree cover currently existing across the study area. Only one large Yellow-box exists in the northern portion of Lot 276. Riparian areas are dominated by Rough-barked Apple trees with some Blakely's Red Gum trees regenerating in the northern portion of Sportsman's Hollow Creek;
- There were five key vegetation communities identified and mapped across the study area. Vegetation is often related to the soil type existing in a particular area;
- Of the 65 identified flora species, 10 were exotic species. This species list was compared to the *Indicator Plant Species for Salinity list* (Department of Infrastructure, Planning and Natural Resources, 2005) specifically for the Central West. No Central West Salinity indicator species were found during the ecological survey. Although it should be noted that Rhodes Grass (*Chloris gayana)* and Wild Aster *(Aster subulatus)*, both salinity tolerant species were located;

4.6 Soils and Salinity Constraints Mapping

Figure 6 was derived using aerial photography, site inspection, soil profile results, topographical map, together with the EMI survey map and vegetation map devised for the study area. It should be noted that these boundaries may not reflect the true boundary that exists between each soil type, but provides a visual overview of what to expect across the site. For a more accurate soil map, at least 40 boreholes would be required in order to plot more accurate boundaries.

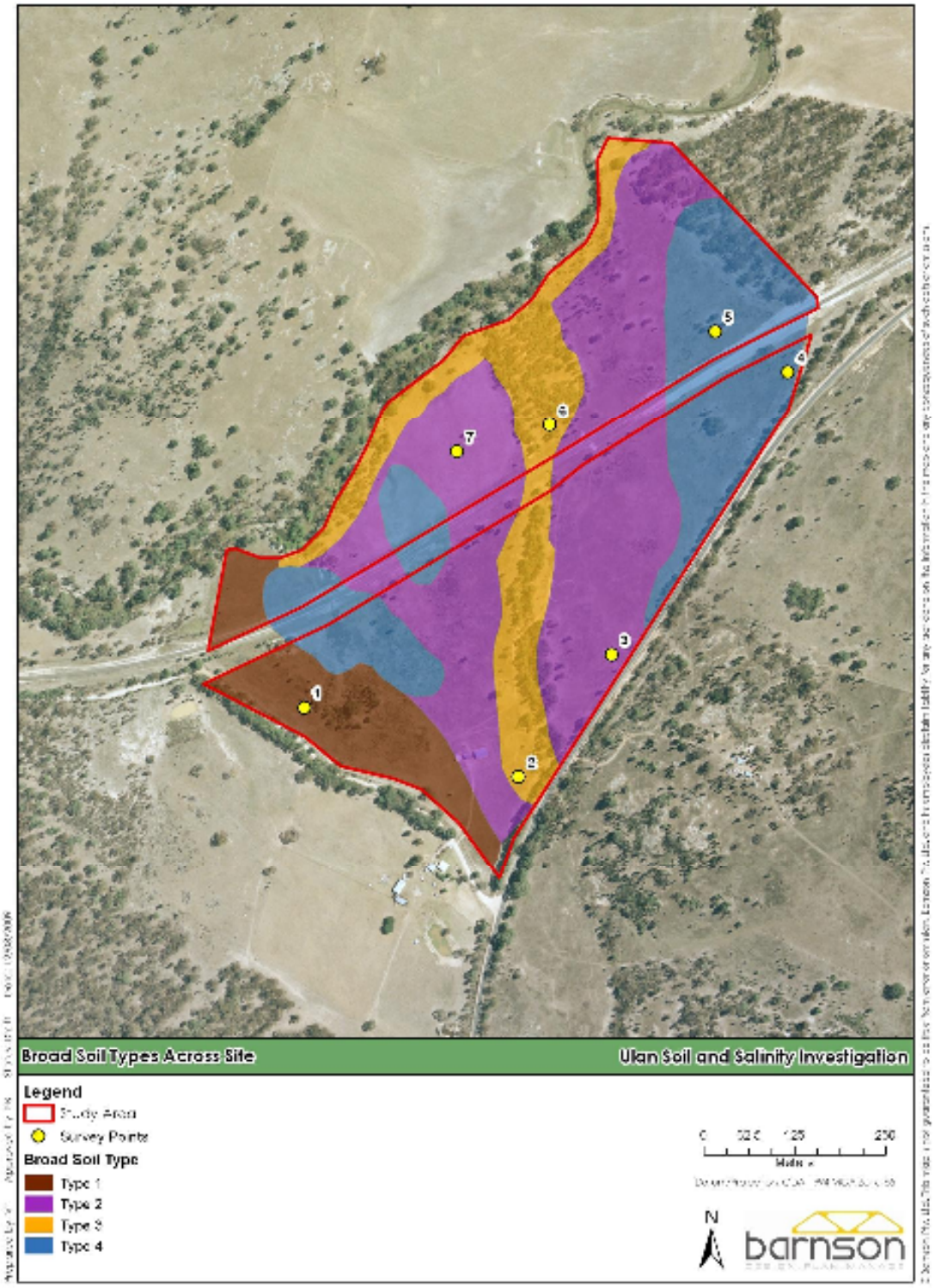

Figure 6: Broad Soil Types

In reference to the soils on **Figure 6,** the following types have been identified:

- Type 1 – Shallow Siliceous Sand overlaying quaternary alluvium derived from Gulgong granite, Land capability class of III -IV;

- Type 2 – Yellow Solodic Soils – hardsetting surface soils with slightly acidic topsoils, Land capability class of IV-V;

- Type 3 – Yellow Podzolic Soils – commonly located in the drainage lines around the Ulan area in association with Rough Barked Apple trees. Soil is subject to moderate gully erosion, Land capability class of III-IV;

- Type 4 – Siliceous Sand overlaying a thick clay pan – indicative of the higher EMI reading across the site, Land capability class of III-IV.

The Type 4 Siliceous Sand overlaying the clay pan identified in southern portions of the study area have not been ground truthed and were identified as such from surface inspection together with EMI Survey mapping.

The study area has undergone extensive land clearing and land disturbance in the past. Currently, only minor sheep and cattle grazing is being undertaken. This together with the fact the study site is generally well vegetated with native and exotic grasses has resulted in little surface/sheet erosion across both lots. In areas where vegetation is less vast (ie- in the Rough Barked Apple Community), there is less vegetation and more opportunity for surface erosion.

Gully erosion is evident along Sportsman's Hollow Creek as a result of the highly dispersive sandy soils existing in these drainage areas. At present the unnamed drainage line running though the study site only exhibits minor gullying.

The EMI Survey map identified three main areas of potential concern due to high ECa readings. However, at Sites 4 and 5, a thick layer of sub-surface clay was exposed during the excavation, which does influence the bulk conductivity readings. Laboratory analysis indicated that the Site 4 was non saline to slightly saline in the subsoil. Site 5 was slightly saline , with an increase in salinity from the surface soils to the sub-soils. As a result it was determined that the southern two areas identified in the EMI Survey mapping with high ECa readings are likely to be of similar soil characteristics because there was no clear evidence of highly saline soils in these area.

Figure 7 was constructed using all available information. It identifies three main areas of potential concern.

- Area 1 – this area was indicated on the EMI survey map as being potentially saline. Ground truthing was not undertaken in this area and therefore it can not be determined that this area is not potentially saline. This together with the fact that waterlogging occurs in this area and there is a high degree of erosion along the bank of Sportsman's Hollow Creek has resulted in the identification of this area as a potential concern.

- Area 2 – this area was identified on the EMI survey map as being potentially saline. Although there is a sub surface clay layer existing in this area, slightly saline analytical results were obtained. Therefore this area may be of potential concern in the future.

- Area 3 – soils along the drainage lines of the site are erodible. Management of these areas is essential to ensure that major gullying does not result.

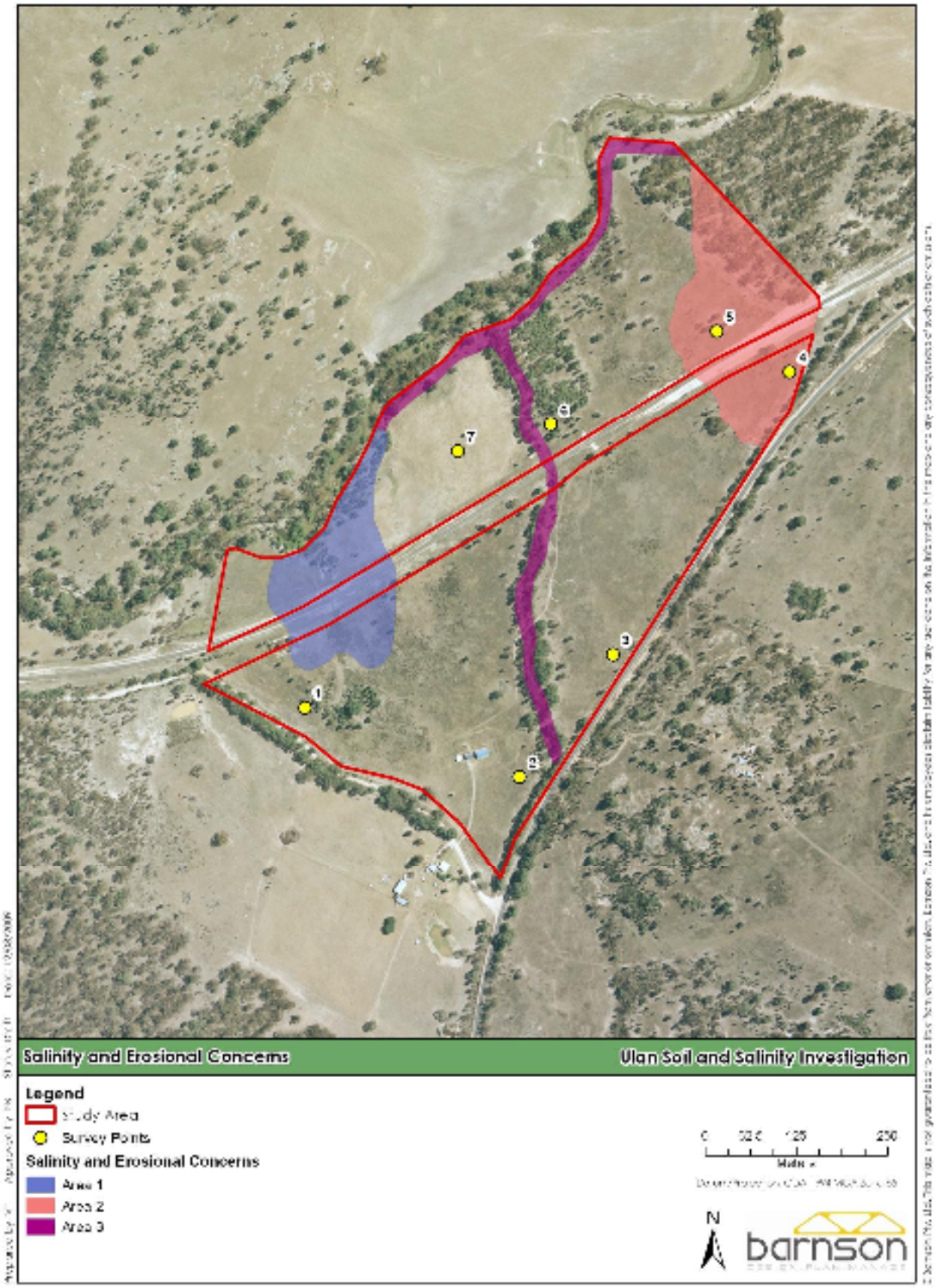

Figure 7: Salinity and Erosional Concerns

4.7 Future On-Site Drainage Considerations

It is expected that up to 60% of the site may be hardstand when the area is fully developed. This would greatly increase the run-off into the unnamed drainage line that runs through the site. It is therefore expected that any development application (DA) submitted at the site would be required to demonstrate that post development flows will not exceed pre-development flows for all storms up to and including the 1:100yr ARI. This will require the provision of on-site detention (OSD) units, thus reducing overland flow.

It is expected within the proposed industrial area, all roads would have a piped stormwater reticulation system. Therefore the impact of the soils on the drainage system is negligible. The outlet for any drainage system discharging to the unnamed drainage line should have a 'Downstream Defender' (or approved sim) to prevent pollution, reduces velocities and control sediment. There should also be a provision for an energy dissipation device to prevent scour at the discharge point.

5.0 RECOMMENDATIONS

The study area has undergone extensive land clearing in the past. In general terms the area can be classed as having an agricultural capability classification of IV – suitable for grazing only. The fertility of the soil is described by Murphy and Lawrie (1998) as generally low, with surface soils demonstrated as being slightly acidic in nature. In general terms, the site would be useful as an Industrial area, as long-term agricultural capability of the study site are limited due to the sites capability classification, small lot size and physical constraints (such as the railway and drainage lines).

It is recommended that the following be considered as part of the Development Approvals and Detail Design stages of the project:

1. Further soil profiling in the areas identified in the EMI map as being of high conductively – to ground truth current mapping and predicted areas of potential concern;

2. Further investigation into the structural integrity of the farm dam. The area adjacent to the dam was waterlogged and may indicate either a leaking dam or perched water table.

3. Establishment of a buffered area around drainage lines;

4. Development of an Environmental Management Plan to minimise and mitigate against erosion and potential saline soils during the construction phrase of the project. Particular attention should be given to:
    a. Cut and fill techniques used during construction;
    b. Compaction and disturbance to soils during road and building construction;
    c. Service trenches construction;
    d. Exposure of saline sub-soils;
    e. Stormwater detention area design;
    f. Retaining native flora where possible– such as retention of deep rooted vegetation,
    g. Developing good site drainage prior to construction;
    h. Implementation of sediment and erosion control plans that consider potentially saline soils;

5. Surface water quality monitoring could be undertaken to provide baseline data, prior to construction. Sites could include- the farm dam, unnamed drainage line and Sportsman's Hollow creek. A future monitoring program could be considered necessary;

6. Topsoil should be stockpiled and maintained appropriately during the construction phase for re-spreading where possible;

7. Landscaping should be considered and occur across the site with revegetation of both deep rooted native plants and shallow rooted native grasses and shrubs, to maximise groundcover where possible;

8. Plumbing and installation of pipes, watering systems and any other drainage needs to be leak free, durable and fitted correctly to minimise the risk of leaks, breaks and water spills;

9. Education and awareness of future landholders in relation to salinity and erosional risks, causes, and indicators, so that the issues can be addressed early;

10. If a water table is encountered during the construction phase of the project, all work should cease until expert advise is sort.

Other considerations such as – decreasing the permeability of concrete, installation of a damp proof membrane and course, increasing slab strength and resistance to salt attack, can be fully explored during the latter stages of the project. It is recommended that the principles of 'Building in a Saline Environment' DECC (2007), be considered in the design stage of the project.

6.0 CONCLUSION

This investigation has provided an overview of the landform, soil types, land capability classification and possible erosion and salinity constraints across Lot 276 and 271, Ulan. It is a reflection of the current state of the land area. Future mismanagement across the site could result in future soil and water issues. The study area has been deemed suitable for Industrial development, due to its land capability classing and prime service location.

The proposed development area is considered to be non –saline across most of the site. Slightly saline surface and sub-soils do exist in the northern portion of the land area and it is believed that there may be slightly saline soils in the southern portion of the land area. This is likely to be the result of naturally occurring salt in the soil rather than redistribution by a rising groundwater table.

The bores in the vicinity show the permanent water table is well below a depth of 5m. Apart from around the Farm Dam, there was no evidence to indicate that the watertable across most of the site was raised (or perched) during the inspection time. This area around the farm dam was waterlogged – which may indicate perching but more likely a leaking dam.

The soil types found during the field inspection are consistent with the landform grouping described as Home Rule by Murphy and Lawrie, 1998. These soils are identified as possessing a high to very high erosion hazard, low to moderate soil salinity potential, and slightly acidic in nature. Appropriate long term management of the site will ensure that potential land degradation as a result of erosion or salinity are minimised.

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