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Dyno Nobel Asia Pacific Limited

**Moranbah Ammonium Nitrate
Project**

Land Suitability Study

August 2006



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1. Introduction

1.1 Project Description

Dyno Nobel Asia Pacific Limited (DN) is seeking to construct and operate a proposed Ammonium Nitrate (AN) Plant and an Emulsion Manufacturing Plant (the project) at a site approximately 4.5 kms west-north-west of the township of Moranbah, Queensland. The current concept for the project is to construct an AN Plant making AN prill (solid) and AN emulsion (viscous liquid with a design capacity for immediate operation of 350,000 tonnes per annum (tpa). The total value of the project is approximately \$500 million.

GHD Pty. Ltd. has been contracted to conduct a Land Suitability Study on the Site in Moranbah proposed for this project. The objectives of the study are to describe the existing conditions of the soils, the geology and topography of the project site. In addition, relevant legislation is reviewed to assess the consistency of the project with existing land uses for the area. Whilst the area to be excised for this project is 270 ha an additional 25 hectares is required for the construction camp. It is also understood that approximately 75 ha is to be disturbed, with remainder to be reserved as a buffer zone. Hence, this study focuses on the areas to be disturbed which includes: the Ammonium Nitrate Plant, Accommodation Camp, and Effluent Irrigation Area. The study area for this investigation encompassed approximately 160 ha.

1.2 Methodology

The Land Suitability Study has been undertaken in accordance with that requested by the NRMW and based on the *Planning Guidelines: The Identification of Good Quality Agricultural Land* (Queensland Department of Local Government and Planning, 1993) (GQAL) and the *Guidelines for Agricultural Land Evaluation in Queensland* (QDPI Land Resources Branch, 1990). The methodology for this study is as follows.

- » Desktop review of the existing soils, geology, topography, and vegetation, and information for the area.
- » Ground observations were carried out at 10 locations being a density of 16 ha per observation.
- » Soil and landform descriptions will be described according to the *Australian Soil and Land Survey Field Handbook* (Mc Donald et al, 1990) as at each ground observation position.
- » Soil samples from three observation locations, encompassing the different soil types encountered, were collected and submitted for analysis. Bulk surface samples (0.0-0.1m) from nine (9) locations within 10m² of the observation site were collected, as well as discrete depth intervals (0.2-0.3m, 0.5-0.6m, 0.8-0.9, & 1.1-1.2m) throughout the profile.
- » All samples were submitted for laboratory analysis of parameters applicable to the Soil Survey and Agricultural Land Suitability Assessment.



- » Calculations of plant available water were based on the *Guidelines for Agricultural Land Evaluation in Queensland* (QDPI Land Resources Branch, 1990)
- » Soils were classified according to the Australian Soil Classification (Isbell, 1996), and mapped at a scale of 1:10 000.
- » The Agricultural Land Suitability of the study area was assessed.

2. Background

2.1 Location

The project is located approximately 4.5 kms northwest of the Moranbah township, adjacent to the Goonyella Road (see Figure 1). Moranbah is part of the Belyando Shire, and is predominantly a town supporting the local mining industry. The main agricultural land use in the district is grazing, which is also the current land use of the site.

2.2 Climate

The Australian Bureau of Meteorology operates a synoptic station at the Moranbah Waste Water Treatment Plant (WWTP), -27.9947S 148.0308E. The weather station has recorded temperature, humidity and wind speeds over a period of approximately 18 years, and rainfall data over a period of approximately 30 years. Meteorological observations are recorded on a 3-hourly basis at the WWTP. Data from this meteorological station is considered to be representative of the study area considering the proximity of the station to the study area, and given that the intervening terrain is flat.

The project area experiences a semi-arid climate characterised by higher minimum and maximum temperatures in summer and moderately high temperatures in winter (Figure 1). The mean daily maximum temperatures ranges from 35.3°C in January 2006 to 23.8°C in July 2006. The monthly averages (of daily minimum temperatures) range from 22.8°C in January to 11.2°C in July.

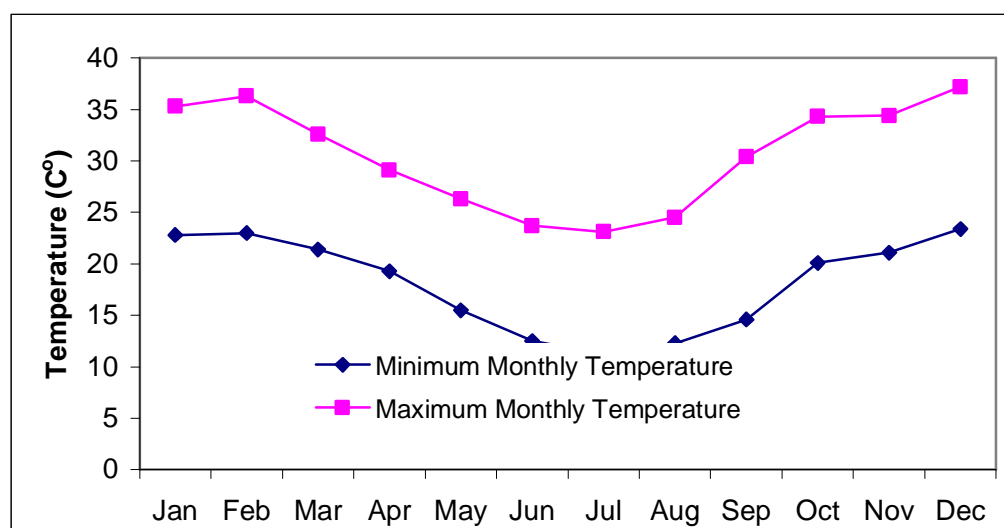


Figure 1: Temperature range of Moranbah monitoring station August 2005-July 2006

The relative humidity of the area is relatively consistent throughout the year, but does vary greatly throughout the day, with average annual humidity being 68% at 9 am and only 38% at 3 pm (Figure 2).

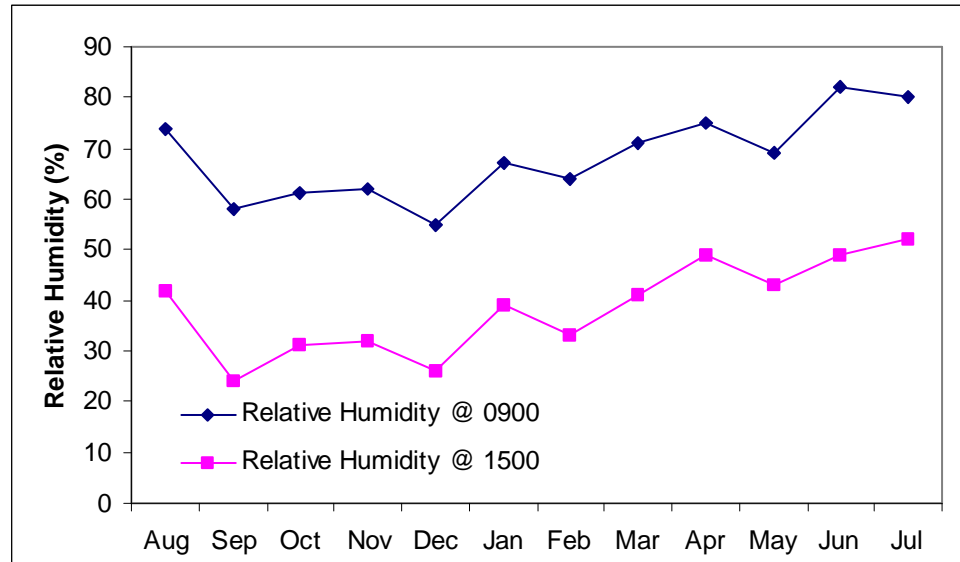


Figure 2: Relative humidity of Moranbah monitoring station August 2005-July 2006

December and January are the wettest months of the year on average in Moranbah, over a thirty-year history. December receives a mean monthly rainfall of 99.6 mm and January receives approximately 94.8 mm. The mean annual rainfall is 589.5 mm and occurs on average on 54.5 rain days throughout the year (Figure 3).

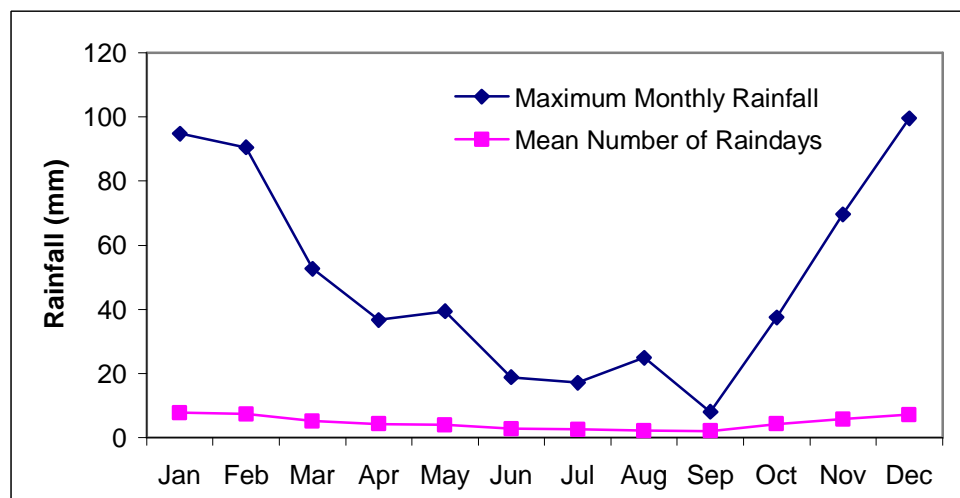


Figure 3: Mean rainfall and rain days for Moranbah monitoring station 1972-2004



2.3 Geology

The study area is underlain by Oligocene to Miocene (36.5 – 5.3 Ma¹) aged sediments. Late Cainozoic aged floodout and residual sands, soils and gravel extend regionally to the north, south and west of the study site. Tertiary aged (66.4 – 1.6 Ma) volcanics, consisting mainly of basalt outcrop, are located 500 m southeast and 1.5 km northeast of the site. Extensive exposures of sedimentary rocks of the Permian aged (286 – 245 Ma) Back Creek Group are located approximately 1.5 km southwest of the study site. Sedimentary facies of the Back Creek Group include quartz sandstone, siltstone, carbonaceous shale and minor coal deposits. Sedimentary facies of the Back Creek Group include quartz sandstone, siltstone, carbonaceous shale and minor coal deposits.

2.3.1 Coal Resources

The study area is located within the Bowen Basin of central Queensland, a coal resource area of international significance. The Bowen Basin is about 600 km long and up to 250 km wide, and contains vast resources of Permian black coals. Of these black coals, the late Permian coals of the Moranbah Coal Measures are favoured, as they provide uniformly high grade coking coals. The project is situated over a section of these Moranbah Coal Measures, which range in thickness from 250 m to 300 m, and variably consist of sandstone, shale, mudstone and coal. The aggregate thickness of coal in the Moranbah Coal Measures ranges from 12 m to 24 m, and is made up of up to 8 seams. The seams of economic significance within the Moranbah Area are Harrow Creek and Dysart Seams.

The project lies between and along strike of several major coal mines including BHP-Billiton Mitsubishi Alliance's (BMA's) Peak Downs and Goonyella open cut operations and Anglo Coal's Moranbah North underground longwall operation. The coal seams exploited by these operations are those of the Moranbah Coal Measures, and are known for producing low-ash hard coking coals.

2.4 Water Resources

Grosvenor Creek is the closest identified watercourse at approximately 2.1 km to the southwest of the site. There are no water reservoirs on the site. Fresh water is a limited resource in the area and in high demand by the surrounding coal operations. The majority of these coal operations have their own onsite rain fed water reservoirs, and surplus water demand is met by water from the Eungella-Moranbah pipeline.

The project area lies within the Fitzroy River catchment, 30 km east of the Burdekin River Catchment. The Fitzroy River is one of Queensland's largest river systems with a catchment area of 143,000 km² and a mean annual discharge of 5,370,000 mgL. The Fitzroy River system is interconnected upstream with several major rivers such as the Isaac, Connors and Mackenzie Rivers.

¹ Ma = million years ago



2.5 Vegetation

The vegetation and the structure of the vegetation communities on the project site were assessed by GHD ecologists. In summary, the investigations suggest that the site has little to differentiate itself from other open woodland sites dominated by *Eucalyptus populnea* and/or *Corymbia clarksoniana* found across large areas of the bioregion. Further details of the vegetation assessment, conclusions and recommendations are included in Appendix 7.5 of the Environmental Impact Statement.

2.6 Landform

The site is located 260 metres above sea level with the waterways of Grosvenor Creek and the Isaac River at approximately 225 meters elevation. The investigation area is relatively flat with gentle slopes <5%, with the majority drainage occurring to the southwest portion of the investigation area towards Grosvenor Creek.

2.7 Previous Assessments

2.7.1 Land Resource Assessments

The property concerned has been mapped at 1:250 000 in the report *Land Suitability Study of the Collinsville – Nebo – Moranbah Area* (QDPI 1984). This report classifies the whole of this study area as “Non Arable- suitable for grazing of native pastures”. According to the GQAL this land unit is classified as Class C- Pasture Land.

2.7.2 Soil Survey

The district has been included on the Australian Soil Resource Information System (ASRIS). According to ASRIS the soils in the investigation area are Kandosols, which are adjoined to the east with Sodosols (**Map 1, Appendix A**).

3. Soil Survey

The subject area has been mapped into two soil orders at a scale of 1:10 000 (**Map 2, Appendix B**). At ten ground observation sites, description of soil profiles, vegetation, and slopes were made. Details of these observation sites and soil descriptions included in **Appendix B**. Soil samples from three observation locations, encompassing the different soil types encountered, were collected and submitted for analysis. The laboratory report for these soil analyses is included in Appendix C. Field activities for the land resource survey were conducted between the 23-25 July 2006. A summary of the ground observation sites is included as Table 1.

Table 1 Summary of Observation Sites

Site	Soil	Morphology	Vegetation
1	Brown SODOSOL	Flat	Open woodland, mid-dense grass cover
2	Brown SODOSOL	Flat	Open woodland, mid-dense grass cover
3	Brown SODOSOL	Flat	Open woodland, mid-dense grass cover
4	Brown SODOSOL	Flat	Woodland, mid-dense grass cover
5	Red KANDOSOL	Flat	Open woodland, dense grass cover
6	Red KANDOSOL	Flat	Open woodland, dense grass cover
7	Brown SODOSOL	Flat	Open woodland, dense grass cover
8	Brown KANDOSOL	Flat	Open woodland, dense grass cover
9	Brown SODOSOL	Flat	Isolated trees, dense grass cover
10	Red KANDOSOL	Flat	Isolated trees, dense grass cover

There are two orders of soil encountered at the site being Sodosols and Kandosols. Details of the soils encountered at these observation sites are as follows.

3.1 Sodosols

Sodosols are characterised by a strong texture contrast between the A and B horizons with the major portion of the upper B horizon being sodic and not strongly acidic. The Sodosols were similar across the site with the main difference being in depth to B horizon which ranged between 0.34-0.69 m for most Sodosols except Observation site 7 where the B horizon was at 0.97 m. Samples of the Brown Sodosol from the observation site 9 were submitted for analysis. Analytical results of the bulked surface sample (0.0-0.1 m) are presented in Table 2, and from discrete depth intervals throughout the profile in Table 3.

Table 2 Chemical Analysis of bulked surface (0.0-0.1m) of observation site 9 -Brown Sodosol

PH	OM	Cl	NO ₃ -N	S	B	Cu	Fe	Mg	Zn	Total N	Extractable P
	CaCl ₂ 1:5 (%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(%)	(ppm)
5.3	0.9	10	3.7	3	0.2	0.3	25	10.3	0.3	<0.01	2

Table 3 Chemical Analysis of profile of observation site 9 -Brown Sodosol

Depth (m)	pH	EC _{1:5} (dS/m)	ESP (%)	Ca:Mg Ratio	Exchangeable Cations (meq/100g)					
					CEC	Al	Ca	Mg	K	Na
0.0-0.1	5.7	0.02	5.6	4.2	3.6	0.07	2.45	0.59	0.28	0.2
0.2-0.3	5.7	0.01	9.1	2.7	2.2	0.16	1.16	0.43	0.21	0.2
0.5-0.6	6.1	0.02	13.0	2.2	2.3	0.12	1.19	0.55	0.16	0.3
0.8-0.9	7.9	0.14	23.3	0.6	8.6	0.09	2.25	4.02	0.28	2
1.1-1.2	8.6	0.2	23.7	0.5	11.8	0.09	2.68	5.85	0.36	2.8

Profile descriptions of this Brown Sodosol are included in **Appendix B**. The bulked surface sample and sample from 0.0-0.1 m depth are from the A1 horizon; sample depths 0.2-0.3 m and 0.5-0.6 m are of the A2 horizon; and sample depths 0.8-0.9 m and 1.1-1.2 m are from the B2 horizon. Relevant details of analysis of the Brown Sodosol are as follows.

- » In the A horizon the soil pH (pH 5.7-6.1) and electrical conductivity (EC_{1:5}, <0.2 dS/m) are favourable to plant growth; however fertility of this soil is poor. Fertility analysis of the surface samples indicates that the concentrations of extractable phosphorus were low (2 ppm), and total nitrogen was below detection limit. In the B

horizon soil pH (pH 7.9-8.6) is approaching alkalinities that may cause nutritional deficiencies, and the EC_{1:5} (0.14-0.20 dS/m) ranges from low to moderate salinity.

- » Soil exchangeable sodium percentage (ESP) is commonly used as an analytical indicator of soil sodicity. ESPs of 6% to 15% are considered to be sodic to strongly sodic, respectively. All samples, except those from the surface, contained ESPs between 9.1%-23.7%, indicating that the A2 horizon is sodic to strongly sodic, and that the B horizon is strongly sodic.
- » Exchangeable magnesium has the potential to worsen the adverse effects of sodium, with calcium and magnesium ratios (Ca:Mg) of <1-2 indicating dispersive soils. The Ca:Mg ratios of the of the B horizon ranged between 0.6-0.5. As these Ca:Mg ratios were <1, this provides further indications that the B horizon has the potential to be dispersive.

Plant available water (PAW) are derived from calculations based on tabled values (DPI Land Resources Branch, 1990). The effective rooting depth of the Brown Sodosols is the boundary of the A and B horizons, as the B horizon is too sodic, massive, and hard for root growth. The A horizon is a structureless loamy sand and has a PAW of 12 mm/dm. Hence, in the A horizon of this profile the PAW is 83 mm. Brown Sodosols were reported at six observation sites across the study area. Based on the average depth of the A horizons being 0.54 m, the mean PAW for Sodosols is 65 mm.

3.2 Kandosols

3.2.1 Red Kandosol

Kandosols are characterised as lacking strong texture contrast between A and B horizons, have massive or weakly structured B horizons, and are not calcareous throughout. The soil profiles of the Kandosols were similar across the study area with the main difference being colour, such that two different suborders of Kandosols were identified being Red Kandosols and Brown Kandosols. The soil profiles of the Red Kandosol from observation site 5 were submitted for analysis. Analytical results of the bulked surface sample are presented in Table 4, and from discrete depth intervals throughout the profile in Table 5.

Table 4 Chemical Analysis of bulked surface (0.0-0.1m) of observation site 10-Red Kandosol

pH	OM	Cl	NO ₃ -N	S	B	Cu	Fe	Mg	Zn	Total N	Extractable P
CaCl ₂ 21:5 (%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(%)	(ppm)
5.6	1.1	13	3.4	4	0.3	0.5	17	16.6	1	<0.01	4

Table 5 Chemical Analysis of profile of observation site 10-Red Kandosol

Depth (m)	pH H ₂ O _{1:5}	EC _{1:5} (dS/m)	ESP (%)	Ca:Mg Ratio	CEC	Exchangeable Cations (meq/100g)				
						Al	Ca	Mg	K	Na
0.0-0.1	6.2	0.03	5.9	2.1	5.1	0.08	2.66	1.25	0.77	0.30
0.2-0.3	6.2	0.01	5.0	2.2	4	0.14	2.31	1.06	0.32	0.20
0.5-0.6	6.5	0.01	5.4	1.6	3.7	0.15	1.88	1.19	0.31	0.20
0.8-0.9	6.8	0.02	4.5	1.3	4.4	0.20	2.10	1.68	0.20	0.20
1.1-1.2	7.0	0.02	5.7	0.7	5.3	0.23	1.95	2.62	0.24	0.30

Profile descriptions of this Red Kandosol are included in Appendix B. The bulked surface sample and sample depth 0.0-0.1 are from the A1 horizon; sample depth 0.2-0.3 m is of the A2 horizon; and sample depths 0.5-0.6 m, 0.8-0.9 m, and 1.1-1.2 m are from the B2 horizon. Relevant details of analysis of the Red Kandosol are as follows.

- » The soil pH (pH 6.2-7.0) and electrical conductivity EC_{1:5} (<0.3 dS/m) throughout the profile are favourable to plant growth; however fertility of this soil is low. Fertility analysis of the surface samples indicates that the concentration of extractable phosphorus was low (4 ppm), and total nitrogen was below detection limit.
- » Throughout the profile ESPs were approaching 6% indicating that the soil is mildly sodic.
- » The Ca:Mg ratios through the profile tended to decrease with depth, ranging between 2.2-0.7. These low Ca:Mg ratios provide further indications that the Red Kandosol has the potential to be dispersive.

3.2.2 Brown Kandosol

The soil profiles of the Brown Kandosol from observation site 5 were submitted for analysis. Analytical results of the bulked surface sample are presented in Table 6, and from discrete depth intervals throughout the profile in Table 7.

Table 6 Chemical Analysis of bulked surface (0.0-0.1m) of observation site 5-Brown Kandosol

BROWN HANDBOOK											
pH	OM	Cl	NO ₃ -N	S	B	Cu	Fe	Mg	Zn	Total N	Extractable P
CaCl ₂ 21:5	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(%)	(ppm)
6.0	1.4	11	4.3	3	0.4	0.4	19	12	0.3	<0.01	2

Table 7 Chemical Analysis of profile of observation site 5-Brown Kandosol

Depth (m)	pH H ₂ O _{1:5}	EC _{1:5} (dS/m)	ESP (%)	Ca:Mg Ratio	Exchangeable Cations (meq/100g)					
					CEC	Al	Ca	Mg	K	Na
0.0-0.1	6.4	0.03	5.0	3.5	6.0	0.09	4.06	1.16	0.44	0.30
0.2-0.3	6.4	0.01	10.0	2.2	6.0	0.19	3.10	1.42	0.71	0.60
0.5-0.6	5.6	0.02	6.7	0.9	3.0	0.17	1.11	1.22	0.31	0.20
0.8-0.9	5.6	0.03	6.1	0.6	3.3	0.19	0.98	1.60	0.32	0.20
1.1-1.2	5.9	0.02	8.1	0.4	3.7	0.16	0.87	2.00	0.34	0.30

Profile descriptions of this Brown Kandosol are included in Appendix B. The bulked surface sample and sample from depth 0.0-0.1 are from the A1 horizon; sample depth 0.2-0.3m is of the A2 horizon; and sample depths 0.5-0.6m, 0.8-0.9m, and 1.1-1.2m are from the B2 horizon. Relevant details of analysis of the Brown Kandosol are as follows.

- » The soil pH (pH 5.6-6.4) and electrical conductivity EC_{1:5} (<0.3 dS/m) throughout the profile are favourable to plant growth; however fertility of this soil is low. Fertility analysis of the surface samples indicates that the concentrations of extractable phosphorus were low (2 ppm), and total nitrogen was below detection limit.
- » At all sample depths, except the surface, ESPs ranged between 6.7%-10%, indicating that the A2 horizon and the B horizon are dispersive.
- » The Ca:Mg ratios of the of the B horizon ranged between 0.4-0.9. As these Ca:Mg ratios were <1, this provides further indications that the B horizon has the potential to be dispersive.

As there are no physical or chemical limitations to root growth, the effective rooting depth of the Kandosols is taken as 1.0 m. In the Red Kandosol the PAW was calculated as 126 mm, in the Brown Kandosol the PAW was calculated as 120 mm. The mean PAW for all four Kandosols was 126 mm.

4. Land Resource Assessment

4.1 Land Unit Types

Land types were based on soil survey, vegetation, and topography of the investigation area. The investigation area contains two land types. A description of these land types is included in Table 8. See Appendix A for the map of the Land Units.

Table 8 Description of Land Types

Land Unit	Slope	Dominant Vegetation	Soils
1 (160 ha)	Flat to gentle incline (<5%)	<i>Eucalyptus populnea</i>	Sodosols: Poorly structured loamy sand A horizons (~0.4 m deep); over massive sandy clay to medium clays to > 1.2 m deep.
2 (50 ha)	Gentle incline (<5%)	<i>Eucalyptus populnea</i>	Kandosols: Clayey sand and sandy loam A horizons (0.3-0.7 m deep); over sandy loams to > 1.6 m deep.

Land Unit 1 includes 160 ha and the morphology is generally flat with gentle incline and slopes less than 5%. The soil type is Brown Sodosols and the vegetation is dominated with *Eucalyptus populnea* woodland, with dense to mid dense grass groundcover. In the northwestern portion of the study area chemical clearing of the woodland has occurred on approximately 11 ha, resulting in tree density being isolated and grass cover dense.

Land Unit 2 includes 50 ha and morphology is generally flat with gentle incline and slopes less than 5%. The soil type is Red and Brown Sodosols and the vegetation is similar to that of Land Unit 1 being dominated with *Eucalyptus populnea* woodland, with dense to mid dense grass groundcover. Chemical clearing of the woodland in the northwestern portion of the study area has occurred on approximately 10 ha, resulting in tree density being isolated and grass cover dense.

4.2 Land Suitability Assessment

The agricultural suitability of the study area was assessed in terms of suitability rain fed cropping, grazing on improved pastures native pastures. Irrigated cropping is not considered viable in the study area due to limitations on water available for irrigation in the area. The land suitability of the different mapping units is included in Table 9.

Table 9 Limitations and Agricultural Classes of Land Units

Land Unit	Limitations	Agricultural Land Class
1	Sodic to strongly sodic soils	C - Pasture Land
2	Mildly sodic to sodic soils	C - Pasture Land

Land Unit 1 is considered suitable for grazing of native pasture, but unsuitable for rain fed cropping. The Sodosols of this land unit have a poor fertility and are unsuitable for rain fed cropping due to the shallow A horizons, and sodic B horizons that are dispersible and highly erodable when exposed. The closer the sodic B horizon is to the surface the less soil that is available for water storage and root growth. Cultivation of these soils can bring the sodic soil to the surface can cause crusting and surface seal, which causes problems with seedling emergence.

Land Unit 2 is also considered suitable for grazing of native pasture, but unsuitable for rain fed cropping. The Kandosols of this land unit have poor fertility and are mildly sodic to sodic. These soils are also unsuitable for cultivation due to the potential for dispersion, slumping throughout the profile, and surface seal formation.

Pasture improvement on the land units of this study area is considered marginal. Nutritional deficiencies could be addressed with fertilizer application, but plant available water is likely to be limiting, particularly in the Brown Sodosols. Clearing of the *Eucalyptus populnea* woodland would be required for pasture improvement for which cost would be a major limitation. Re-growth of the *Eucalypt* could also be a problem.

Both Land Units of this study area are classified as *Pastoral Land*. This land is suitable for native pastures and marginal for improved pastures. Limitations preclude continuous cultivation for crop production, but some areas may tolerate a short period of ground disturbance for pasture establishment, although vegetation clearing would first be required. Considering the native pastures at this study area are poor, and that improved pasture is likely unviable and not an option in the current vegetated state, the study area is *not* considered to be *good agricultural land*.



5. Conclusions

This study area has been assessed to be suitable for *Pastoral Land*, and is *not* considered to be *good agricultural land*. This land is suitable for native and marginal for improved pastures. Limitations preclude continuous cultivation for crop production, but some areas may tolerate a short period of ground disturbance for pasture establishment, although vegetation clearing would first be required.

There were two different land units identified in the study area. Vegetation communities across both land units were similar being *Eucalyptus populnea* woodland and grasses. The distinguishing factor between these units is soil type being Sodosols (Land Unit 1) and Kandosols (Land Unit 2). Land unit 1 encompassed the largest area being 160 ha, whilst the size of Land Unit 2 is 50 ha.



6. References

Australian Soil Resource Information System (ASRIS). CSIRO.

Baker, D.E. (1991). *Interpreting Soil Analysis from Soil Surveys Conducted in Queensland*. Queensland Department of Primary Industries.

Gunn, R. *et al* (1988). *Australian Soil and Land Survey Handbook. Guidelines for Conducting Surveys*. Incarta Press, NSW.

Isbell, R. (1996). *The Australian Soil Classification System*. CSIRO, Vic.

Mc Donald, R. *et al* (1990). *Australian Soil and Land Survey Handbook*. Incarta Press, NSW.

QDPI Land Resources Branch (1984). *Land Suitability Study of the Collinsville – Nebo – Moranbah Area* (Queensland Department of Primary Industries, Shields P.G.), Department of Natural Resources, Mines, and Water.

QDPI (1993). *Planning Guidelines: The Identification of Good Quality Agricultural Land*. Queensland Department of Primary Industries and Queensland Department of Local Government and Planning.

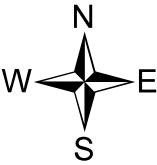
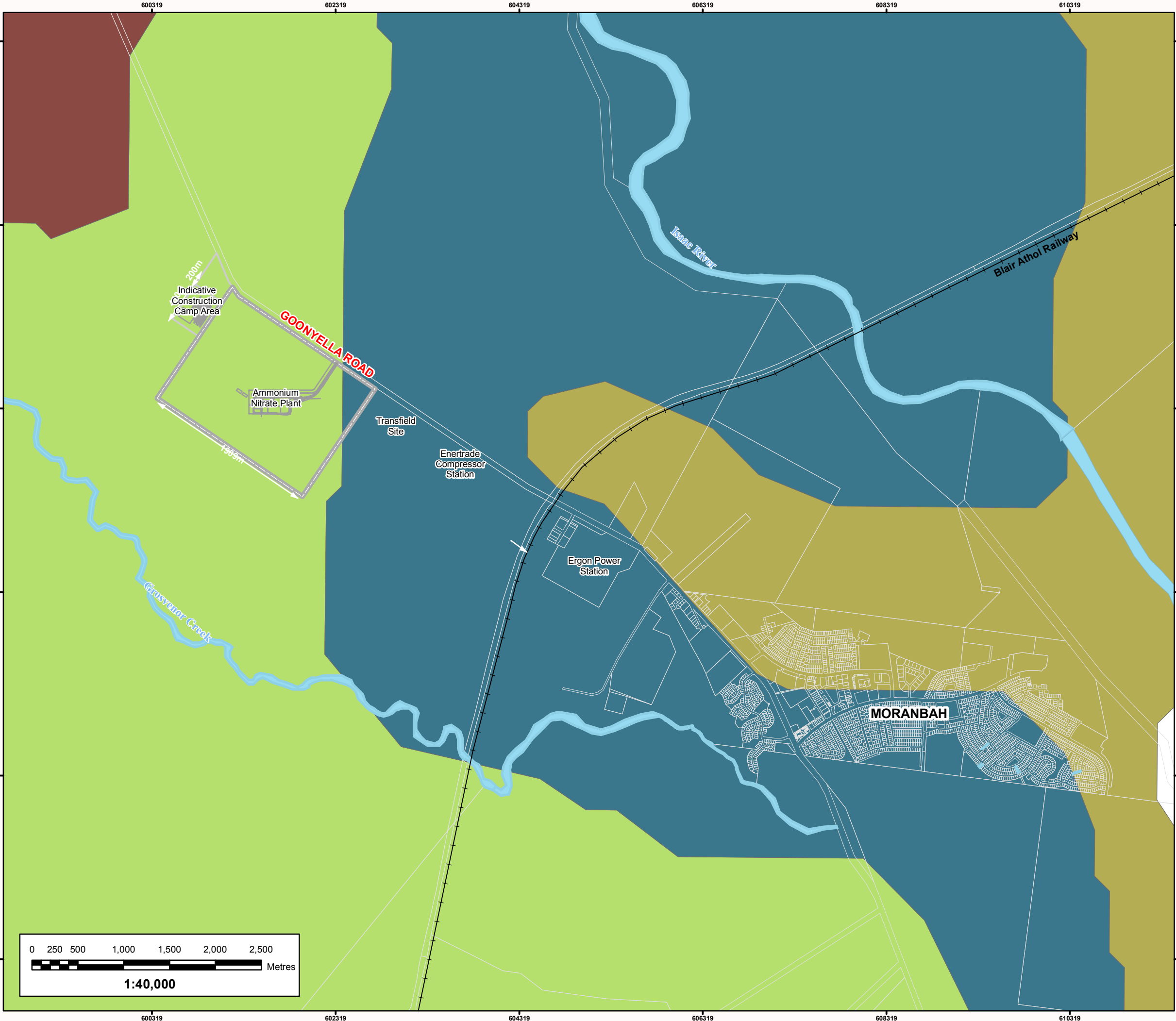
QDPI Land Resources Branch (1990). *Guidelines for Agricultural Land Evaluation in Queensland*. Queensland Department of Primary Industries.



Appendix A

Maps

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Date: 23-08-06
Datum: GDA94 (MGA) Zone 55
Source: Base data sourced from the State of Queensland, Department of Natural Resources, Mines. All other infrastructure supplied by Dyno Nobel Asia Pacific Ltd.
File: G:\4115824\GIS\Maps\Draft Fig4_ASRIS_Soil.mxd

Legend

- Ammonium Nitrate Plant Site
- Cadastre
- Railway
- SOIL ORDER**
- Vertisol
- Kandosol
- Sodosol
- Sodasol

*Generating Facility location is subject to detailed engineering.

Moranbah Ammonium Nitrate Plant

Environmental Impact Statement

MAP 1
ASRIS Broadscale Soil Mapping of Moranbah District



CLIENTS | PEOPLE | PERFORMANCE

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Date: 23-08-06
Datum: GDA94 (MGA) Zone 55
Source: Base data sourced from the State of Queensland, Department of Natural Resources, Mines. All other infrastructure supplied by Dyno Nobel Asia Pacific Ltd.
File: G:\41\15824\GIS\Maps\Draft Fig5_Land_Resource_Survey.mxd

Legend

- Ammonium Nitrate Plant Site
- Cadastre
- Ground Observation Points
- Soil Order**
- Land Unit 1 (Sodosol)
- Land Unit 2 (Kandosol)

*Generating Facility location is subject to detailed engineering.

Moranbah Ammonium Nitrate Plant

Environmental Impact Statement

MAP 2
Land Resource Survey



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Appendix B

Observation Site Descriptions

Site 1

Brown SODOSOL

A1: 0-0.22 m. Dark brown (7.5 YR 3/3), *loamy sand*, massive, dry, weak strength, pH 5. Gradual boundary change to A2.

A2: 0.22-0.34 m. Brown (7.5YR 5/4), *clayey sand*, massive, dry, firm strength, pH 6. Abrupt smooth boundary change to B2.

B2: 0.34m-0.93 m. Brown (7.5YR 5/3) with orange mottles, *fine sandy clay loam*, massive, moderately moist, firm strength, very plastic, pH 6. Gravel 7%, sub rounded, 12-25 mm. Diffuse smooth boundary change to B3.

B3: 0.93 m-depth. Pale brown (10YR 6/3) with yellow and grey (light) mottles, *sandy clay*, massive, moderately moist, firm strength, pH 9. Gravel 40%, sub rounded 10-25 mm.

Depth of Investigation: 1.53 m



MGA: 601911E/7569685N

Aspect: Northeast

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: Nil

Surface Condition: Loose, no coarse fragments.

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Mid-dense grass cover (grass 50%/bare 50%).

Land Unit: 1

Site 2
Brown SODOSOL

A1: 0-0.28 m. Brown (10YR 4/2), *loamy sand*, massive, dry, non sticky, weak strength, pH 6. Diffuse smooth boundary to A2.

A2: 0.29-0.38 m –Brown (10YR 5/3), *loamy sand*, massive, dry, non sticky, weak strength, pH 6. Abrupt smooth boundary change to B2.

B2: 0.38-0.97 m. Greyish brown (2.5Y 5/2) with orange mottles, *light medium clay*, massive, moderately moist, very plastic, slightly sticky, very firm strength, pH 9. Diffuse wavy boundary change to B3.

B3: 0.97 m depth. Greyish brown (2.5Y 5/2) with orange mottles, *sandy clay*, massive, moderately moist, strong plasticity, moderately plastic, slightly sticky, very firm strength, pH 9. Gravel 20% gravel, sub rounded, 10-15 mm (ironstone).

Depth of Investigation: 1.47 m



MGA: 601 923E/7570078N

Aspect: East

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: Active gully

Surface Condition: Loose, no coarse fragments.

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Mid-dense grass cover (Grass 40%/bare 60% including scalds 10%).

Land Unit: 1

Site 3

Brown SODOSOL

A1: 0-0.29m. Very dark greyish brown (10YR 3/2), *loamy sand*, massive, dry, non sticky, very weak strength, pH 5-5.5. Gradual smooth boundary change to A2.

A2: 0.29-0.40 m. Pale brown (10YR 6/3), *loamy sand*, massive, dry, non sticky, very weak strength, pH 6. Abrupt smooth boundary change to ironstone layer.

Ironstone gravel: 0.40-0.52m. Sub-rounded 5-20 mm. Abrupt smooth boundary change to B2.

B2: 0.52-0.76m. Dark brown (10YR 4/3) with orange mottle, *light medium clay*, massive, very firm, slightly sticky, very plastic, pH 8.5-9. Gravel 5%, sub-rounded, 10 mm. Gradual smooth change to B3.

B3: 0.76m – Yellowish brown (10YR 5/4), *sandy clay*, massive, weak strength, high plasticity, slightly sticky, pH 8.5-9. Gravel 20%, sub rounded, 5-15 mm.

Depth of Investigation: 1.54 m



MGA: 601915E/7570467N

Aspect: Northeast

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: Nil

Surface Condition: Loose, sandy, no coarse fragments.

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Mid-dense grass cover (grass 50%/bare 50%).

Land Unit: 1

Site 4
Brown SODOSOL

A1: 0-0.11 m – Dark yellowish brown (10YR 3/4), *sandy clay*, weak subangular blocky peds, dry, weak strength, moderately sticky, high plasticity, pH 5. Abrupt boundary change to A2.

A2: 0.11-0.43 m – Yellowish brown (10YR 5/6), *sandy clay*, massive, dry, very weak strength, moderately sticky, high plasticity, pH 5. Clear smooth boundary change to B2.

B2: 0.43-0.84 m. Yellowish brown (10YR 5/4), *medium clay*, massive, moderately moist, very firm, slightly sticky, high plasticity, pH 5.5. Gradual smooth boundary change to B3.

B3: 0.84 m depth. Dark yellowish brown (10YR 4/4), *medium clay*, massive, moderately moist, very firm, slightly sticky, high plasticity, pH 6.

Depth of Investigation: 1.23 m



MGA: 601512E/7569867N

Aspect: East

Morphology: Flat

Slope: Very gentle incline < 3%

Erosion: nil

Surface Condition: Loose, no coarse fragments.

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Mid-dense grass cover (grass 50%/bare 50%).

Land Unit: 1

Site 5

**Sodic, Mellic,
Red KANDOSOL,
Medium, Non-gravelly,
clayey sand, loamy,
deep-giant**

A1: 0-0.14 m. Dark brown (7.5YR 3/4), *clayey sand*, weak subangular blocky peds, dry, very weak strength, slightly sticky, pH 5.5-6. Diffuse smooth boundary change to A2.

A2: 0.14-0.29 m. Reddish brown (5YR 4/3), *clayey sand*, loose grained, dry, slightly sticky, pH 5.5-6. Diffuse smooth boundary change to B2.

B2: 0.29 m depth. Yellowish red (5YR 4/6), *sandy loam*, weak subangular blocky peds, dry, weak strength, slightly sticky, pH 6. Gravel 5%, sub rounded, 5-20 mm.

Depth of Investigation: 1.35 m



MGA: 601491E/7570303N

Aspect: Southeast

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: nil

Surface Condition: Loose, no coarse fragments.

Groundcover: Grass 75% cover

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Dense grass cover (grass 75%/bare 25%).

Land Unit: 2

Site 6
Red KANDOSOL

A1: 0-0.11 m. Dark brown/brown (7.5YR 4/3), *clayey sand*, weak subangular blocky peds, dry, weak strength, slightly sticky, pH 5.5. Gradual smooth boundary change to A2.

A2: 0.11-0.57 m. Dark brown/brown (7.5YR 4/4), *loamy sand*, loose grained, slightly dry, non sticky, pH 6. Diffuse smooth boundary change to B2.

B2: 0.59 m depth. Yellowish red (YR 4/8), *sandy loam*, weak subangular blocky peds, slightly moist, weak strength, slightly sticky, pH 5.5.

Depth of Investigation: 1.30 m



MGA: 601505E/7570715N

Aspect: South

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: Nil

Surface Condition: Loose, no coarse fragments.

Groundcover: Grass 80% cover

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Dense grass cover (grass 80%/bare 20%).

Land Unit: 2

Site 7
Brown SODOSOL

A1: 0-0.34 m. Brown (10YR 5/3), *clayey sand*, weak subangular blocky peds, dry, weak strength, slightly sticky, pH 7. Gradual smooth boundary change to A2.

A2: 0.34-0.97 m. Pale brown (10YR 6/4), *loamy sand*, loose grained, moderately moist, non sticky, pH7. Clear smooth boundary change to B2.

B2: 0.97 m depth. Yellowish brown (10YR 5/6) with orange mottles, *sandy clay loam*, sub angular blocky peds, moist, weak strength, slightly plastic, slightly sticky, pH 7.

Depth of Investigation: 1.34 m



MGA: 601 171E/7570114N

Aspect: Nil

Morphology: Flat

Slope: Flat

Erosion: Nil

Surface Condition: Loose to slightly crusty, no coarse fragments.

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Dense grass cover (grass 95%/bare 5%).

Land Unit: 1

Site 8
Brown KANDOSOL

A1: 0-0.16 m – Dark yellowish brown (10YR 3/4), *sandy clay loam*, loose grained, weak pedology, subangular blocky peds, dry, non sticky, non plastic, pH 5.5-6. Abrupt smooth boundary change to A2.

A2: 0.16-0.42 m – Brown/dark brown (7.5YR 4/3), *loamy sand*, apedal loose grained, dry, loose strength, non sticky, non plastic, pH 5.5-6. Gradual smooth boundary change to B2.

B2: 0.42-0.72 m. Strong brown (7.5YR 4/6), *fine sandy loam*, massive, dry, weak strength, slightly sticky, non plastic, pH 5.5-6. Gradual smooth boundary change to B3.

B3: 0.72 m depth. Yellowish brown (10YR 5/8), *fine sandy loam*, massive, dry, weak strength, slightly sticky, non plastic, pH 5.5-6.

Depth of Investigation: 1.48 m



MGA: 601099E/7570496N

Aspect: South East

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: Nil

Surface Condition: Loose, sandy, no coarse fragments.

Dominant vegetation: Open woodland (*Eucalyptus populnea*)

Groundcover: Dense grass cover (grass 75%/bare 25%).

Land Unit: 2

Site 9

**Mesotrophic, Mesonatric,
Brown SODOSOL,
medium, non-gravelly,
sandy, clayey, deep to
giant**

A1: 0-0.14 m – Dark yellowish brown (10YR 3/4), *loamy sand*, weak pedology, dry, weak strength, non sticky, pH 6-6.5. Abrupt smooth boundary change.

A2: 0.14-0.69 m. Yellowish brown (10YR 5/8), *loamy sand*, loose apedal, moderately moist, loose strength, non sticky, pH 6-6.5. Sharp smooth boundary change to B2.

B2: 0.69 m-depth. Yellowish brown (10YR 5/6), with grey/orange mottles, *light medium clay*, massive, very firm, moderately sticky, very high plasticity, pH 7.5.

Depth of Investigation: 1.26 m



MGA: 601108E/7570904N

Aspect: South-southwest

Morphology: Flat

Slope: Very gentle incline < 5%

Erosion: Nil

Surface Condition: Loose, slightly crusty, no coarse fragments.

Dominant vegetation: Grassland

Groundcover: Dense grass cover (grass 80%/bare 20%).

Land Unit: 1

Site 10

Halpic, Mellic, Red KANDOSOL, thin, non-gravelly, loamy, clay loam, deep to giant

A1: 0-0.09m – Dark reddish brown (5YR 3/3), *sandy loam*, weak-moderate, subangular blocky peds, dry, weak strength, non sticky, pH 5.5-6. Diffuse smooth boundary change to A2.

A2: 0.09-0.43m – Dark reddish brown (5YR 3/4), *sandy loam*, weak sub angular blocky peds, dry, firm strength, non sticky, pH 6. Diffuse smooth boundary change to B2.

B2: 0.43m-depth. Reddish brown (2.5YR 4/4), *sandy clay loam*, moderate sub angular blocky peds, dry, firm, slightly sticky, pH 6.

Depth of Investigation: 1.60m



MGA: 600701E/7570701N

Aspect: South-south western

Morphology: Flat

Slope: Very gentle incline < 3%

Erosion: Nil

Surface Condition: Loose, no coarse fragments.

Dominant vegetation: Grassland

Groundcover: Dense grass cover (grass 95%/bare 5%).

Land Unit: 2



Appendix C

Laboratory Report

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P5/0.0-0.1
Sample No : B022776-01 / SG1088
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

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Analysis	Result
pH [H2O]	6.4
pH [CaCl2]	6.0
Organic Matter (%)	1.4
CEC (meq/100g)	6.0
EC (dS/m)	0.03
NO3-N (ppm)	4.3
Phosphorus [Olsen] (ppm)	2
Potassium (meq/100g)	0.44
Calcium (meq/100g)	4.06
Magnesium (meq/100g)	1.16
Sulphur (ppm)	3
Boron (ppm)	0.4
Copper (ppm)	0.4
Iron (ppm)	19
Manganese (ppm)	12.0
Zinc (ppm)	0.3
Aluminium (meq/100g)	0.09
Sodium (meq/100g)	0.3
Chloride (ppm)	11
Ca base saturation (%)	67.6
K base saturation (%)	7.3
Mg base saturation (%)	19.3
Na base saturation (%)	4.3
Ca:Mg Ratio	3.5
Aluminium (%)	1.5
Nitrogen (%)	<0.01

Analysis Results (SOIL)

Sample Ref : P5/0.0-0.1
Sample No : B022776-01

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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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P5/0.2-0.3
Sample No : B022776-02 / SG1089
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	6.4
CEC (meq/100g)	6.0
EC (dS/m)	0.01
Potassium (meq/100g)	0.71
Calcium (meq/100g)	3.10
Magnesium (meq/100g)	1.42
Aluminium (meq/100g)	0.19
Sodium (meq/100g)	0.6
Ca base saturation (%)	51.5
K base saturation (%)	11.8
Mg base saturation (%)	23.6
Na base saturation (%)	10.0
Ca:Mg Ratio	2.2
Aluminium (%)	3.2

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P5/0.5-0.6
Sample No : B022776-03 / SG1090
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	5.6
CEC (meq/100g)	3.0
EC (dS/m)	0.02
Potassium (meq/100g)	0.31
Calcium (meq/100g)	1.11
Magnesium (meq/100g)	1.22
Aluminium (meq/100g)	0.17
Sodium (meq/100g)	0.2
Ca base saturation (%)	36.9
K base saturation (%)	10.3
Mg base saturation (%)	40.5
Na base saturation (%)	6.6
Ca:Mg Ratio	0.9
Aluminium (%)	5.6

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P5/0.8-0.9
Sample No : B022776-04 / SG1091
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	5.6
CEC (meq/100g)	3.3
EC (dS/m)	0.03
Potassium (meq/100g)	0.32
Calcium (meq/100g)	0.98
Magnesium (meq/100g)	1.60
Aluminium (meq/100g)	0.19
Sodium (meq/100g)	0.2
Ca base saturation (%)	29.8
K base saturation (%)	9.7
Mg base saturation (%)	48.6
Na base saturation (%)	6.1
Ca:Mg Ratio	0.6
Aluminium (%)	5.8

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P5/1.1-1.2
Sample No : B022776-05 / SG1092
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H ₂ O]	5.9
CEC (meq/100g)	3.7
EC (dS/m)	0.02
Potassium (meq/100g)	0.34
Calcium (meq/100g)	0.87
Magnesium (meq/100g)	2.00
Aluminium (meq/100g)	0.16
Sodium (meq/100g)	0.3
Ca base saturation (%)	23.8
K base saturation (%)	9.3
Mg base saturation (%)	54.8
Na base saturation (%)	7.7
Ca:Mg Ratio	0.4
Aluminium (%)	4.4

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P9/0.0-0.1
Sample No : B022776-06 / SG1093
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

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Analysis	Result
pH [H ₂ O]	5.7
pH [CaCl ₂]	5.3
Organic Matter (%)	0.9
CEC (meq/100g)	3.6
EC (dS/m)	0.02
NO ₃ -N (ppm)	3.7
Phosphorus [Olsen] (ppm)	2
Potassium (meq/100g)	0.28
Calcium (meq/100g)	2.45
Magnesium (meq/100g)	0.59
Sulphur (ppm)	3
Boron (ppm)	0.2
Copper (ppm)	0.3
Iron (ppm)	25
Manganese (ppm)	10.3
Zinc (ppm)	0.3
Aluminium (meq/100g)	0.07
Sodium (meq/100g)	0.2
Chloride (ppm)	10
Ca base saturation (%)	68.1
K base saturation (%)	7.8
Mg base saturation (%)	16.4
Na base saturation (%)	5.8
Ca:Mg Ratio	4.2
Aluminium (%)	1.9
Nitrogen (%)	<0.01

Analysis Results (SOIL)

Sample Ref : P9/0.0-0.1
Sample No : B022776-06

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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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P9/0.2-0.3
Sample No : B022776-07 / SG1094
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	5.7
CEC (meq/100g)	2.2
EC (dS/m)	0.01
Potassium (meq/100g)	0.21
Calcium (meq/100g)	1.16
Magnesium (meq/100g)	0.43
Aluminium (meq/100g)	0.16
Sodium (meq/100g)	0.2
Ca base saturation (%)	54.0
K base saturation (%)	9.8
Mg base saturation (%)	20.0
Na base saturation (%)	8.8
Ca:Mg Ratio	2.7
Aluminium (%)	7.4

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P9/0.5-0.6
Sample No : B022776-08 / SG1095
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	6.1
CEC (meq/100g)	2.3
EC (dS/m)	0.02
Potassium (meq/100g)	0.16
Calcium (meq/100g)	1.19
Magnesium (meq/100g)	0.55
Aluminium (meq/100g)	0.12
Sodium (meq/100g)	0.3
Ca base saturation (%)	52.2
K base saturation (%)	7.0
Mg base saturation (%)	24.1
Na base saturation (%)	11.4
Ca:Mg Ratio	2.2
Aluminium (%)	5.3

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P9/0.8-0.9
Sample No : B022776-09 / SG1096
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	7.9
CEC (meq/100g)	8.6
EC (dS/m)	0.14
Potassium (meq/100g)	0.28
Calcium (meq/100g)	2.25
Magnesium (meq/100g)	4.02
Aluminium (meq/100g)	0.09
Sodium (meq/100g)	2.0
Ca base saturation (%)	26.2
K base saturation (%)	3.3
Mg base saturation (%)	46.8
Na base saturation (%)	22.7
Ca:Mg Ratio	0.6
Aluminium (%)	1.0

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P9/1.1-1.2
Sample No : B022776-10 / SG1097
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	8.6
CEC (meq/100g)	11.8
EC (dS/m)	0.20
Potassium (meq/100g)	0.36
Calcium (meq/100g)	2.68
Magnesium (meq/100g)	5.85
Aluminium (meq/100g)	0.09
Sodium (meq/100g)	2.8
Ca base saturation (%)	22.8
K base saturation (%)	3.1
Mg base saturation (%)	49.7
Na base saturation (%)	23.6
Ca:Mg Ratio	0.5
Aluminium (%)	0.8

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P10/0.0-0.1
Sample No : B022776-11 / SG1098
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

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Analysis	Result
pH [H2O]	6.2
pH [CaCl2]	5.6
Organic Matter (%)	1.1
CEC (meq/100g)	5.1
EC (dS/m)	0.03
NO3-N (ppm)	3.4
Phosphorus [Olsen] (ppm)	4
Potassium (meq/100g)	0.77
Calcium (meq/100g)	2.66
Magnesium (meq/100g)	1.25
Sulphur (ppm)	4
Boron (ppm)	0.3
Copper (ppm)	0.5
Iron (ppm)	17
Manganese (ppm)	16.6
Zinc (ppm)	1.0
Aluminium (meq/100g)	0.08
Sodium (meq/100g)	0.3
Chloride (ppm)	13
Ca base saturation (%)	52.3
K base saturation (%)	15.1
Mg base saturation (%)	24.6
Na base saturation (%)	6.5
Ca:Mg Ratio	2.1
Aluminium (%)	1.6
Nitrogen (%)	<0.01

Analysis Results (SOIL)

Sample Ref : P10/0.0-0.1

Page Number

Sample No : B022776-11

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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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P10/0.2-0.3
Sample No : B022776-12 / SG1099
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	6.2
CEC (meq/100g)	4.0
EC (dS/m)	0.01
Potassium (meq/100g)	0.32
Calcium (meq/100g)	2.31
Magnesium (meq/100g)	1.06
Aluminium (meq/100g)	0.14
Sodium (meq/100g)	0.2
Ca base saturation (%)	58.0
K base saturation (%)	8.0
Mg base saturation (%)	26.6
Na base saturation (%)	3.8
Ca:Mg Ratio	2.2
Aluminium (%)	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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P10/0.5-0.6
Sample No : B022776-13 / SG1100
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H ₂ O]	6.5
CEC (meq/100g)	3.7
EC (dS/m)	0.01
Potassium (meq/100g)	0.31
Calcium (meq/100g)	1.88
Magnesium (meq/100g)	1.19
Aluminium (meq/100g)	0.15
Sodium (meq/100g)	0.2
Ca base saturation (%)	50.3
K base saturation (%)	8.3
Mg base saturation (%)	31.8
Na base saturation (%)	5.6
Ca:Mg Ratio	1.6
Aluminium (%)	4.0

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P10/0.8-0.9
Sample No : B022776-14 / SG1101
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H2O]	6.8
CEC (meq/100g)	4.4
EC (dS/m)	0.02
Potassium (meq/100g)	0.20
Calcium (meq/100g)	2.10
Magnesium (meq/100g)	1.68
Aluminium (meq/100g)	0.20
Sodium (meq/100g)	0.2
Ca base saturation (%)	47.7
K base saturation (%)	4.5
Mg base saturation (%)	38.2
Na base saturation (%)	5.0
Ca:Mg Ratio	1.3
Aluminium (%)	4.5

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : P10/1.1-1.2
Sample No : B022776-15 / SG1102
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

Analysis	Result
pH [H ₂ O]	7.0
CEC (meq/100g)	5.3
EC (dS/m)	0.02
Potassium (meq/100g)	0.24
Calcium (meq/100g)	1.95
Magnesium (meq/100g)	2.62
Aluminium (meq/100g)	0.23
Sodium (meq/100g)	0.3
Ca base saturation (%)	36.8
K base saturation (%)	4.5
Mg base saturation (%)	49.4
Na base saturation (%)	4.9
Ca:Mg Ratio	0.7
Aluminium (%)	4.3

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

Analysis Results (SOIL)

Customer : GHD MORANBAH
C/- ESSA

Distributor : ENVIRONMENTAL SOIL SOLUTIONS
5 DUNPHY ST
SUNNYBANK HILLS
QLD

Sample Ref : QC1
Sample No : B022776-16 / SG1103
Crop : DATA ONLY

Date Received : 08/08/06 (Date Sampled : 04/08/06)

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Analysis	Result
pH [H2O]	5.9
pH [CaCl2]	5.3
Organic Matter (%)	1.7
CEC (meq/100g)	5.9
EC (dS/m)	0.03
NO3-N (ppm)	3.5
Phosphorus [Olsen] (ppm)	3
Potassium (meq/100g)	0.46
Calcium (meq/100g)	3.70
Magnesium (meq/100g)	1.37
Sulphur (ppm)	4
Boron (ppm)	0.3
Copper (ppm)	0.3
Iron (ppm)	21
Manganese (ppm)	10.9
Zinc (ppm)	0.3
Aluminium (meq/100g)	0.10
Sodium (meq/100g)	0.2
Chloride (ppm)	13
Ca base saturation (%)	63.2
K base saturation (%)	7.9
Mg base saturation (%)	23.4
Na base saturation (%)	3.8
Ca:Mg Ratio	2.7
Aluminium (%)	1.7
Nitrogen (%)	<0.01

Analysis Results (SOIL)

Sample Ref : QC1
Sample No : B022776-16

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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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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S. Buchanan	David McLean		David McLean		24/8/06