# Appendix E. Groundwater and Creek Water Quality Results

SGS

CTW.2602214

# *Certificate of Analysis*

This is to certify that the undermentioned sample(s) were analysed and this certificate was issued at SGS Agritech, 214 McDougall St., Toowoomba QLD 4350. Phone: 0011+61+7+46330599. NATA accredited laboratory 2120.

**APPLICANT:** NULLAMANNA FEEDLOT PTY LTD
NULLAMNNA STATION
INVERELL NSW 2360

**SAMPLE NUMBER:** 2006007049 — **SAMPLE(S) RECEIVED:** 28 April 2006

**COMMODITY:** Water — **CERTIFICATE ISSUED:** 10 May 2006

**MARKINGS:**

| TEST IDENTITY | RESULT | UNITS | METHOD |
|---|---|---|---|
| Total Dissolved Solids | 1506.0 | mg/L | TDS001 |
| Chloride | 358.73 | mg/L | ANL001 |
| Nitrate | 12.37 | mg/L | ANL001 |
| Fluoride | 0.34 | mg/L | ANL001 |
| Sulphate | 33.33 | mg/L | ANL001 |
| Nitrite | <0.010 | mg/L | ANL001 |
| Phosphate | <0.010 | mg/L | ANL001 |
| pH | 7.7 | pH | WAT001 |
| Electrical Conductivity | 2473 | µS/cm | WAT003 |
| Total Nitrogen | 4.4 | mg/L | TOT001 |
| Aluminium | <0.1 | mg/L | MIN001 |
| Boron | 0.030 | mg/L | MIN001 |
| Calcium | 87 | mg/L | MIN001 |
| Copper | <0.01 | mg/L | MIN001 |
| Iron | <0.01 | mg/L | MIN001 |
| Potassium | 2.7 | mg/L | MIN001 |
| Magnesium | 180 | mg/L | MIN001 |
| Manganese | <0.01 | mg/L | MIN001 |
| Molybdenum | <0.05 | mg/L | MIN001 |
| Sodium | 310 | mg/L | MIN001 |
| Phosphorus | <1 | mg/L | MIN001 |
| Sulphur | 14 | mg/L | MIN001 |
| Zinc | 0.030 | mg/L | MIN001 |
| E coli in Water | <1 | CFU/100mL | COL004 |
| Total Kjeldahl Nitrogen | 1.61 | mg/L | |

Note: < is Less Than.



Diana Abbott
Manager
For and on behalf of
**SGS Australia Pty Ltd**

The results apply only to the sample analysed. The sample on which the test was performed was not collected by or on behalf of SGS Agritech. This certificate is discrete and can only be reproduced in full. The analysis was performed between 28/04/2006 and 10/05/2006

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ABN 44 000 964 278 Member of SGS Group

SGS

CTW.2602214

# Certificate of Analysis

This is to certify that the undermentioned sample(s) were analysed and this certificate was issued at SGS Agritech, 214 McDougall St., Toowoomba QLD 4350. Phone: 0011+61+7+46330599. NATA accredited laboratory 2120.

**APPLICANT:** NULLAMANNA FEEDLOT PTY LTD
NULLAMNNA STATION
INVERELL NSW 2360

**SAMPLE NUMBER:** 2006007049

**SAMPLE(S) RECEIVED:** 28 April 2006

**COMMODITY:** Water

**CERTIFICATE ISSUED:** 04 May 2006

**MARKINGS:**

| TEST IDENTITY | RESULT | UNITS | METHOD |
|---|---|---|---|
| E coli in Water | <1 | CFU/100mL | COL004 |

Note: < is Less Than.
CFU - Colony Forming Units.



Robert Lascelles
Chief Chemist
For and on behalf of
**SGS Australia Pty Ltd**

The results apply only to the sample analysed. The sample on which the test was performed was not collected by or on behalf of SGS Agritech. This certificate is discrete and can only be reproduced in full. The analysis was performed between 28/04/2006 and 4/05/2006

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# ANALYTICAL REPORT

Accreditation No. 2562

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| Order Number | **Enviroag - Nullamanna Samples** |
| Samples | 2 |

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| Email | au.environmental.brisbane@sgs.com |
| SGS Reference | **BE015493 R0** |
| Date Received | 04 Jan 2016 |
| Date Reported | 07 Jan 2016 |

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(20707/1706).

SIGNATORIES

Caroline McDermid
Inorganics Supervisor

| Parameter | Units | LOR | Sample Number BE015493.001 | BE015493.002 |
|---|---|---|---|---|
| | | | Sample Matrix Water | Water |
| | | | Sample Date 31 Dec 2015 | 31 Dec 2015 |
| | | | Sample Name Bore | Creek |

**pH in water Method: AN101 Tested: 4/1/2016**

| | | | | |
|---|---|---|---|---|
| pH** | No unit | - | 7.9 | 7.8 |

**Conductivity and TDS by Calculation - Water Method: AN106 Tested: 4/1/2016**

| | | | | |
|---|---|---|---|---|
| Conductivity @ 25 C | µS/cm | 5 | 1800 | 350 |

**Low Level Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 5/1/2016**

| | | | | |
|---|---|---|---|---|
| Nitrate, $NO_3$ as $NO_3$ | mg/L | 0.05 | 7.7 | <0.05 |
| Nitrite, $NO_2$ as $NO_2$ | mg/L | 0.05 | <0.05 | <0.05 |
| Nitrite Nitrogen, $NO_2$ as N | mg/L | 0.005 | <0.005 | <0.005 |
| Nitrate Nitrogen, $NO_3$ as N | mg/L | 0.005 | 1.7 | <0.005 |

**Ammonia Nitrogen by Discrete Analyser Method: AN280/WC250.19 Tested: 6/1/2016**

| | | | | |
|---|---|---|---|---|
| Ammonia Nitrogen, $NH_3$ as N | mg/L | 0.05 | <0.05 | <0.05 |
| Ammonia, NH3 | mg/L | 0.05 | <0.05 | <0.05 |

**TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 6/1/2016**

| | | | | |
|---|---|---|---|---|
| Total Kjeldahl Nitrogen | mg/L | 0.05 | 0.11 | 0.93 |

**Calculated Nitrogen Forms - TN, organic N, inorganic N Method: AN281/292 Tested: -**

| | | | | |
|---|---|---|---|---|
| Total Nitrogen (calc) | mg/L | 0.05 | 1.9 | 0.94 |

**Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 7/1/2016**

| | | | | |
|---|---|---|---|---|
| Filterable Reactive Phosphorus | mg/L | 0.002 | 0.046 | 0.033 |
| Filterable Reactive Phosphorus as PO4 | mg/L | 0.02 | 0.14 | 0.10 |

**Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293 Tested: 6/1/2016**

| | | | | |
|---|---|---|---|---|
| Total Phosphorus (Kjeldahl Digestion) | mg/L | 0.02 | 0.09 | 0.11 |

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

**Ammonia Nitrogen by Discrete Analyser** **Method: ME-(AU)-[ENV]AN280/WC250.19**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery | MS %Recovery |
|---|---|---|---|---|---|---|---|
| Ammonia Nitrogen, $NH_3$ as N | LB023234 | mg/L | 0.05 | <0.05 | 0 - 1% | 85% | 74% |
| Ammonia, NH3 | LB023234 | mg/L | 0.05 | <0.05 | | | |

**Conductivity and TDS by Calculation - Water** **Method: ME-(AU)-[ENV]AN106**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery |
|---|---|---|---|---|---|---|
| Conductivity @ 25 C | LB023216 | µS/cm | 5 | <5 | 0% | 103% |

**Filterable Reactive Phosphorus (FRP)** **Method: ME-(AU)-[ENV]AN278**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery | MS %Recovery |
|---|---|---|---|---|---|---|---|
| Filterable Reactive Phosphorus | LB023272 | mg/L | 0.002 | <0.002 | 0% | 94% | 90% |
| Filterable Reactive Phosphorus as PO4 | LB023272 | mg/L | 0.02 | <0.02 | 5% | 94% | NA |

**Low Level Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA** **Method: ME-(AU)-[ENV]AN258**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery | MS %Recovery |
|---|---|---|---|---|---|---|---|
| Nitrate, $NO_3$ as $NO_3$ | LB023237 | mg/L | 0.05 | <0.05 | | | |
| Nitrite, $NO_2$ as $NO_2$ | LB023237 | mg/L | 0.05 | <0.05 | | | |
| Nitrite Nitrogen, $NO_2$ as N | LB023237 | mg/L | 0.005 | <0.005 | 0% | 105% | 117% |
| Nitrate Nitrogen, $NO_3$ as N | LB023237 | mg/L | 0.005 | <0.005 | | | |

**pH in water** **Method: ME-(AU)-[ENV]AN101**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery |
|---|---|---|---|---|---|---|
| pH** | LB023216 | No unit | - | 5.8 | 0% | 101% |

**TKN Kjeldahl Digestion by Discrete Analyser** **Method: ME-(AU)-[ENV]AN281**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery | MS %Recovery |
|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | LB023225 | mg/L | 0.05 | <0.05 | 2 - 3% | 99 - 100% | 97% |

SGS

# QC SUMMARY

BE015493 R0

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

**Total Phosphorus by Kjeldahl Digestion DA in Water    Method: ME-(AU)-[ENV]AN279/AN293**

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery | MS %Recovery |
|---|---|---|---|---|---|---|---|
| Total Phosphorus (Kjeldahl Digestion) | LB023225 | mg/L | 0.02 | <0.02 | 0 - 9% | 90 - 104% | 111% |

| METHOD | METHODOLOGY SUMMARY |
|---|---|
| AN101 | pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+. |
| AN106 | Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B. |
| AN258 | Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F. |
| AN278 | Reactive Phosphorus by DA: Orthophosphate reacts with ammonium molybdate (Mo VI) and potassium antimonyl tartrate (Sb III) in acid medium to form an antimony-phosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue colour and the absorbance is read at 880 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-P F |
| AN279/AN293 | The sample is digested with Sulphuric acid, K2SO4 and CuSO4. All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis. |
| AN280/WC250.19 | A filtered water sample containing ammonia (NH3) or ammonium cations (NH4+) is reacted with alkaline phenol and hypochlorite in a buffered solution to form the blue indophenol colour. The absorbance is measured at 630nm and compared with calibration standards to obtain the concentration of ammonia in the sample. |
| AN281 | An unfiltered water or soil sample is first digested in a block digestor with sulfuric acid, K2SO4 and CuSO4. The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample. |
| AN281/292 | Calculation of total nitrogen and organic nitrogen. |

FOOTNOTES

| | | | |
|---|---|---|---|
| IS | Insufficient sample for analysis. | LOR | Limit of Reporting |
| LNR | Sample listed, but not received. | ↑↓ | Raised or Lowered Limit of Reporting |
| * | NATA accreditation does not cover the performance of this service. | QFH | QC result is above the upper tolerance |
| ** | Indicative data, theoretical holding time exceeded. | QFL | QC result is below the lower tolerance |
| | | - | The sample was not analysed for this analyte |
| | | NVL | Not Validated |

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed ( Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

# Appendix F. Erosion and Sediment Control Plan

# Erosion and Sediment Control Plan

## Nullamanna Feedlot Expansion

**Report Number 23876.82361**

*Prepared for*

NULLAMANNA STATION

**Nullamanna Station**

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# Document Status Record

Report Type: Erosion and Sediment Control Plan

Project Title: Nullamanna Feedlot Expansion

Client: Nullamanna Station

Project Document Number: 23876.82361

File Name: 23876.82361_151210_Nullamanna ESCP_Rev0

| Revision | Date of Issue | Author | Reviewed | Quality Assurance | Approved |
|---|---|---|---|---|---|
| 0 | 01/02/2016 | Lindi Olivier | Simon Lott | Barb Calderwood | Simon Lott |
| **Signatures** | | | | | |

**Notes:**

**Rev** 0: Final Report

**Distribution:**

| Recipient | No. Copies |
|---|---|
| Nullamanna Station | 1 |
| EnviroAg Australia | 1 |

| | |
|---|---|
| Client | |
| Company | |

This document provides information to address the intent of Project Number 23876 as agreed to by Nullamanna Station.

# Executive Summary

EnviroAg Australia Pty Ltd has been engaged to provide an Erosion and Sediment Control Plan for the construction activities associated with the Nullamanna Station feedlot expansion.

Due to the steepness of the site, there is significant potential for erosion and sediment runoff. This Erosion and Sediment Control Plan (ESCP) outlines management conditions for best practice soils and water management. These include construction sequence, erosion and sediment control measures, waste management, stabilisation and rehabilitation as well as monitoring maintenance requirements.

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# 1. Introduction

Nullamanna Station is a feedlot located on Nullamanna Road, Nullamanna NSW 2360. The existing feedlot has a 1,000 SCU capacity, but this will be expanded to 3,000 SCU (where 1 SCU = one 600 kg animal).

To mitigate environmental impacts during the construction phase of the project, an Erosion and Sediment Control Plan will be enacted.

This ESCP has been prepared in accordance with the guidelines stated in “Managing Urban Stormwater: Soils and Construction Vol. 1” (Landcom 2004).

## 1.1 Objectives

The objectives of the ESCP area to;

- Implement best practice soil and water management;
- Provide management conditions for managers and construction personnel in relation to best practice erosion and sediment control;
- Reduce pollution and minimise impact from construction works on soils, landforms and receiving waters; and,
- Reduce land degradation and improve rehabilitation outcomes.

## 1.2 Scope

This ESCP is limited to the following construction items within the project site construction;

- Ten (10) additional feedlot pens;
- Sedimentation basin and holding pond for wastewater treatment;
- Cattle lanes;
- Feed truck driving and turning lanes;
- Expansion of 65ML gully dam for freshwater storage; and
- Catchment dams.

## 2. Site Description

Nullamanna Station is in an area of undulating hills. The current feedlot is on a relatively flat hilltop and the site of the expanded feedlot (approximately 676m AHD) is at a lower elevation to the current feedlot (eastern section 686m AHD, western section 681m).

Nullamanna Station is situated on the New England Fold Belt and the 1: 250,000 Geological Series Map for Inverell (Stroud and Brown 1998) indicates that it is situated on volcanic soils. Specifically, it is at the boundary of three different geological formations:

- Emmaville Volcanics – flat lying ignimbrite flows consisting of rhyolitic and rhyodacitic crystal, lithic and vitric tuffs; minor dacite and andesite compositions; also rhyodacitic lava, minor interbedded sediment;
- Texas beds (undifferentiated) – Low grade regionally metamorphosed, variably deformed lithic wacke, conglomerate, siltstone, mudstone, chert, basalt and rare tuff; and,
- Central Province – Basalt; undifferentiated basaltic flows.

Soil sampling and testing showed that the site typically has a topsoil of 0.3m, underlain by an impermeable layer of clay of variable depths, below which is basalt (Table 1). The field survey found that the soils in the feedlot expansion area are a Ferrosol on the upper slopes and Vertosols on the lower slope where gradients are flat.

**Table 1 Typical soil profile result from Nullamanna Station**

| Depth (m) | Horizon | Description |
|---|---|---|
| 0 – 0.1 | A1 | Dark brown silty sandy clay with gravels to cobbles. |
| 0.1-0.3 | A2 | Brown silty sandy clay with fine to course gravels. |
| 0.3-1.0 | B1 | Strong brown clay with fine sand. |
| 1.0-1.5 | B2 | Red brown clay with fine sand. |
| 1.5-3.0 | C1 | Clayey sandy gravel with boulders, as well as saprolite sandstone/mudstone. |

The site is located in the Border Rivers Catchment and has Frazers Creek running along the western boundary of the property at approximately 625 m AHD. Water on top of the hill where the expansion is to take place naturally drains towards the creek, i.e. to the west and south (Figure 2). Frazers Creek starts at the town of Sapphire, runs along the eastern boundary of the property and into the Severn River, which then leads into the Macintyre River.

Vegetation in the feedlot and expansion area is very sparse and clearance for development is likely to be restricted to less than 5 trees.

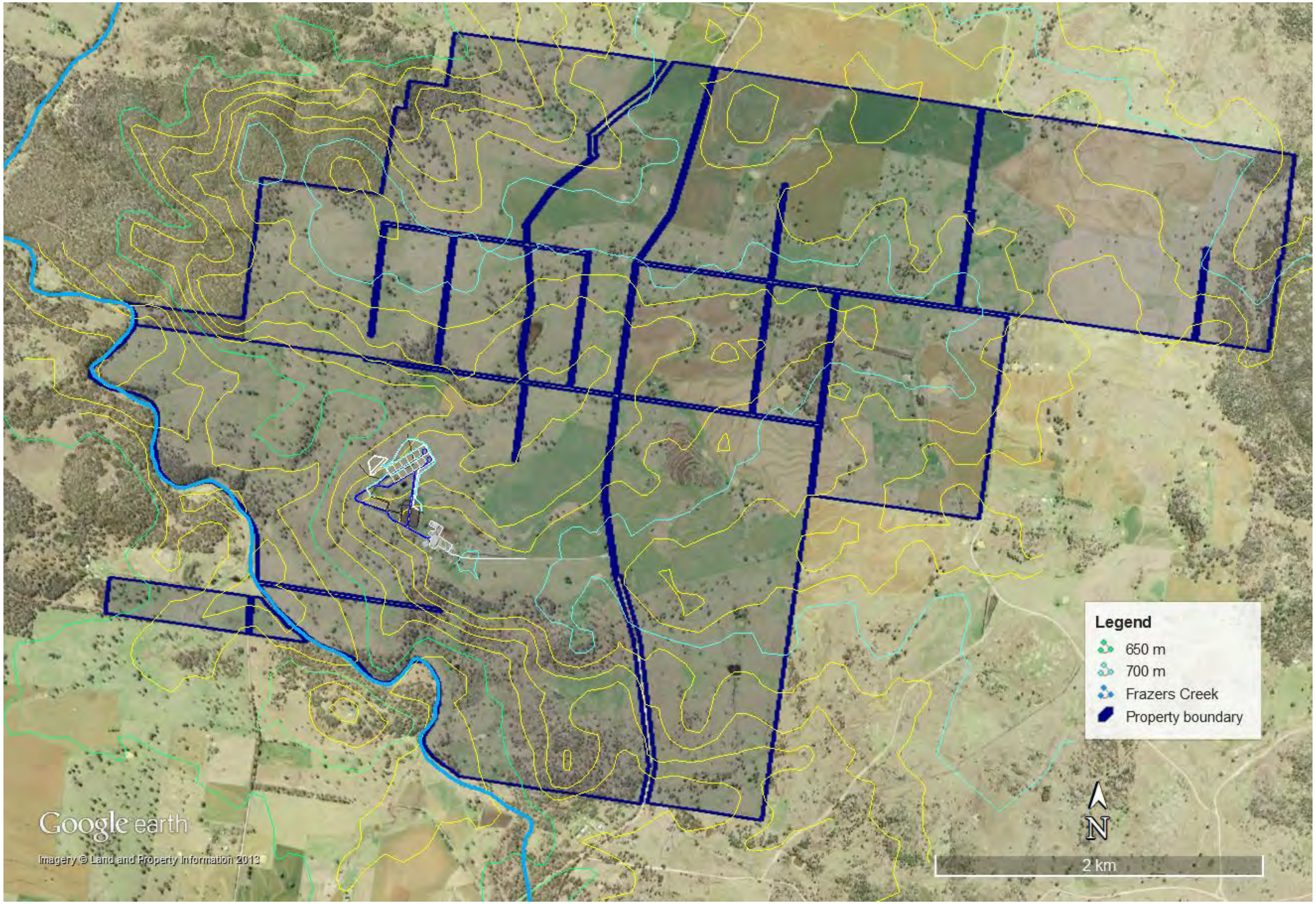


**Figure 1 Feedlot property boundary and adjoining roads**

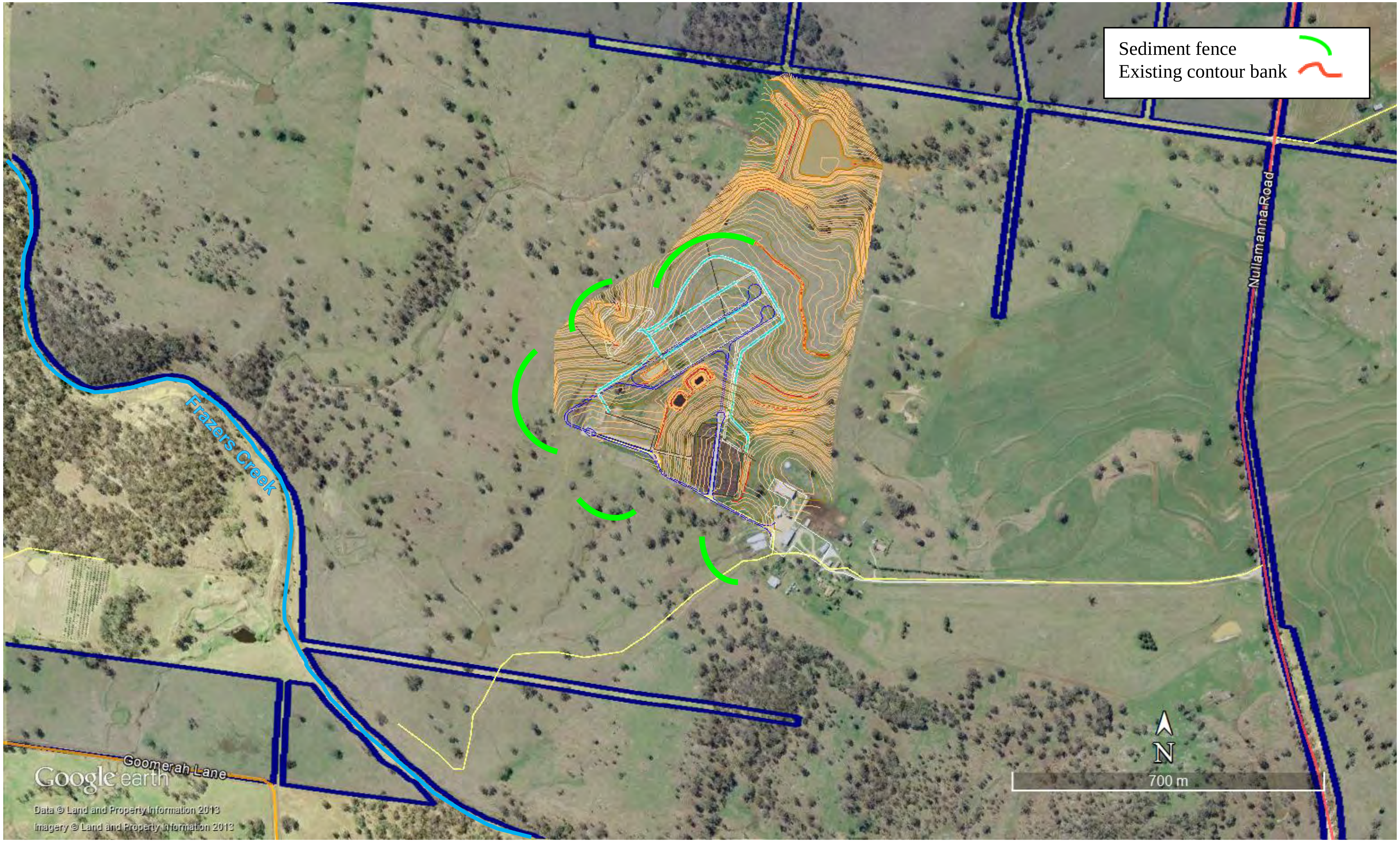


**Figure 2** **Conceptual design of the expanded feedlot, nearby waterways, vegetation and sediment runoff controls**

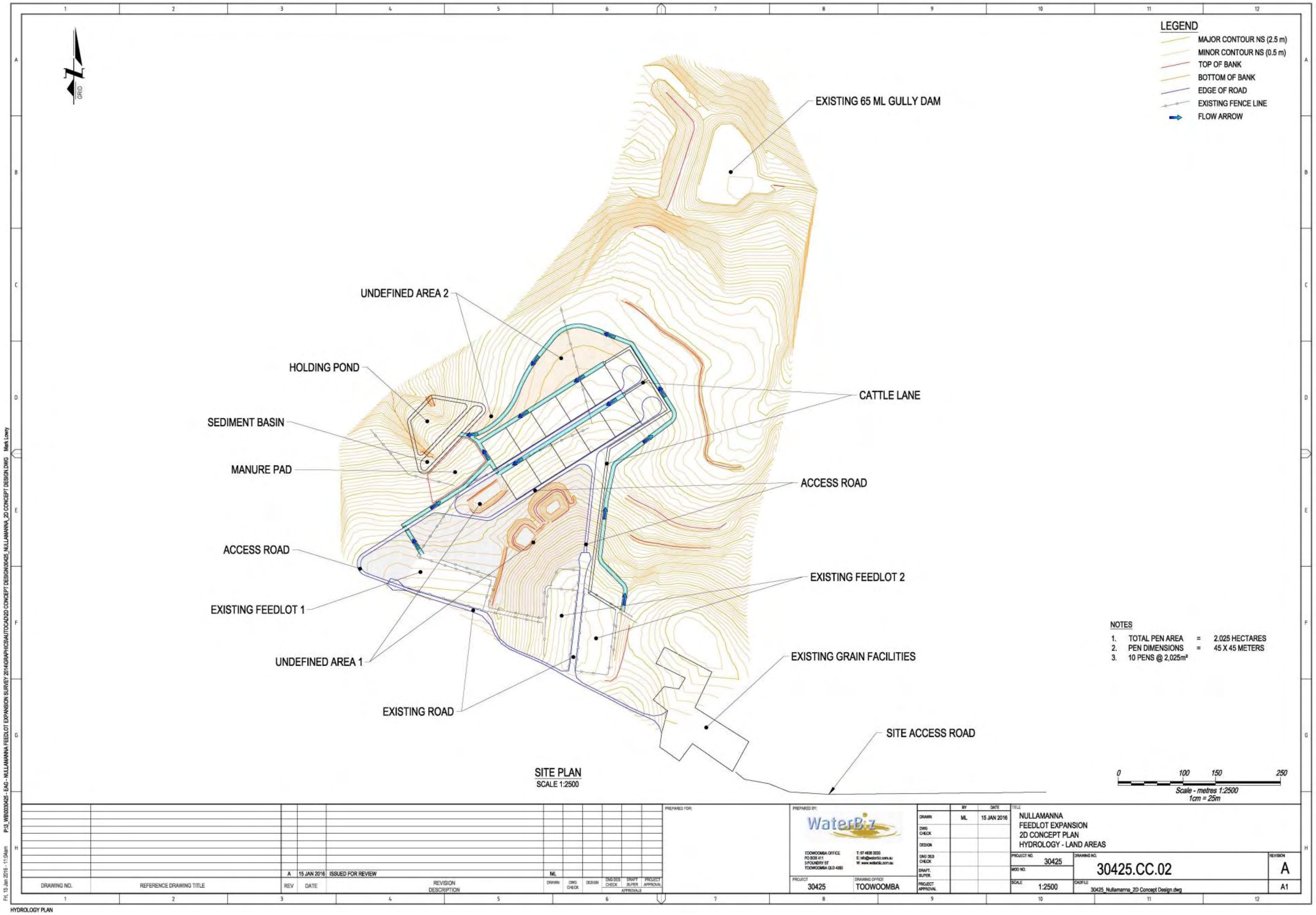


**Figure 3** **Conceptual design of the feedlot expansion**

## 3. Erosion and Sediment Runoff Susceptibility

An erosion risk assessment has been completed for Nullamanna Station in accordance with the principles outlined in Matthews (2008). The assessment, using the Revised Universal Soil Loss equation (RUSLE), concluded that during the land disturbance activities (3 months) across 17ha, the total soil loss would equal approximately 152.2 tonnes (Table 2) or 0.6mm of soil/ha across the 17ha. (see calculation presented in Appendix A)

Further to this, IECA (2008) states that developments disturbing more than 4 ha require 5 soil samples per every 2 ha of disturbance. As such it could be argued that the amount of soil samples supporting this erosion risk assessment is insufficient in order to be representative for the whole site. However, the samples taken are representative of the areas which will be disturbed and increase the erodibility of the site, hence; the erosion risk assessment has covered the worst case scenario.

**Table 2 Summary of site characteristics and constraints**

| Characteristic/Constraint | Value/Rating |
|---|---|
| Rainfall erosivity (R) | 1,399.2 |
| General slope gradient | 8 % |
| Potential erosion hazard | Medium to low (from figure 4.4 in Matthews (2008)) |
| Calculated soil loss | 35.8 tonnes/ha/year |
| Total soil loss | 152.2 tonnes |
| Soil loss class | Class 2 Low (from table 4.2 in Matthews (2008)) |
| Runoff coefficient for ARI of 10 years | 0.13 $m^3/s$ |
| Volumetric runoff coefficient | 0.8[1] |
| Total site area | 1872.71 ha |
| Disturbed site area | 17 ha |
| Annual mean rainfall | 798.7 mm (BOM, 2015) |
| 75$^{th}$ percentile, 5-day rainfall event | 22.5 mm (approximated using Landcom (2004)) |
| Duration of project (Construction) | 3 months |

[1] Western & Pilgrim, 2001

# 4. Erosion and Sediment Control Plan

The primary objective of erosion control measures is to control soil erosion and sediment generation from areas disturbed by construction activities.

## 4.1 General Instructions

- This ESCP shall be read in conjunction with engineering plans and any other plans or written instructions issued in relation to the development;
- All personnel, including contractors and subcontractors, must understand their responsibility to minimise the potential for soil and water pollution and undertake all measures described in this ESCP;
- Land disturbance is to be kept to a minimum at all times and where possible be limited to a maximum of 5 meters from the edge of any essential construction activity. Land clearing must be delayed as long as practicable and disturbed areas rehabilitated as soon as practical;
- Temporary end-of-day control measures must be put in place in the event that significant rainfall is expected. These may include the application of flow diversion banks, straw bales and geo-textile; and,
- Diversion banks shall be constructed along the top side of paddocks where required to intercept run-on from adjacent land away from the project site. All banks shall be seeded and/or lined with suitable material to prevent erosion. Run-on shall be directed to stable, well grassed waterways or drainage lines.

## 4.2 Construction Sequence

All work must be undertaken in the following sequence (Table 3). Each subsequent stage is not to commence until the previous one is completed.

**Table 3 Construction Sequence staging**

| Sequence Number | Construction Stage |
|---|---|
| 1 | Construct stabilised site access |
| 2 | Mark access tracks, sensitive areas and no-go zones as required. Temporary fencing may be used to mark access roads and no-go zones. Access areas should be limited to a maximum width of 10m |
| 3 | Install clean water diversion banks where required, directing overland flow away from disturbed areas and into stable areas. Stabilise drains with suitable material to prevent erosion. |
| 4 | Install sediment fences (per Figure 2) or other appropriate sediment controls downslope from disturbed areas. |
| 5 | Clear site, strip and stockpile topsoil/seedbed for later reinstatement or landscaping purposes. |
| 6 | Perform earth works as required and in accordance with engineering plans. |
| 7 | Apply erosion control measures to disturbed areas as required. |
| 8 | Monitor and improve controls as necessary. |
| 9 | Undertake final site stabilisation. |

## 4.3 Site Specific Conditions

### 4.3.1 *Clearing of Native Vegetation*

Clearing of native vegetation must be kept to a minimum at all times. Where clearing is required temporary sediment controls such as sediment fences must be installed prior to commencing clearing activities. Cleared vegetation should be mulched and used for soil stabilisation within the project site or relocated to adjacent vegetated areas within the project site to provide shelter and refugee habitat for fauna.

### 4.3.2 *Access Roads*

Control measures outlined in this section apply to the construction of all access roads within the Project Site. All work must be undertaken in the sequence listed in Table 4. Each subsequent stage is not to commence until the previous one is completed.

**Table 4 Road Construction Sequence staging**

| Sequence Number | Construction Stage |
|---|---|
| 1 | Construct stabilised site access |
| 2 | Install clean water diversion banks where required, directing overland flow away from disturbed areas and into stable, well grassed waterways or drainage lines. In sensitive areas, such as heritage listed sites, biosocks, sandbags or similar may be used in lieu of earth banks. Construct level spreaders at the end of diversion banks to disperse water over stabilised area and apply suitable erosion controls for diversion banks, such as a quick germinating annual and jute mat. |
| 3 | Construct dirty water diversion channels and install u-shaped sediment traps at suitable intervals along the bank so that catchment area does not exceed 1000 $m^2$. U-shaped sediment fences will be constructed for minor concentrated flows. Apply suitable erosion controls for diversion channels, such as a quick germinating annual and jute mat. |
| 4 | Strip and stockpile topsoil in designated stockpiling areas. |
| 5 | Construct access road in accordance with engineering plans. |
| 6 | Construct road drainage controls. |
| 7 | Apply additional erosion control measures to disturbed areas as required. |
| 8 | Monitor and improve controls as necessary. |
| 9 | Undertake final site stabilisation. |

### 4.3.3 *Construction of Contour Banks*

Construction of contour banks is an efficient measure to control run-off from cropping land. Contour banks are earthen banks constructed at intervals across a slope to intercept and divert run-off into waterways or natural depressions. If no natural waterways exist, contour banks can be constructed in a suitable location. By ensuring that contour banks are protected from erosion by either a crop or crop residues, there will be minimal movement of sediment into the contour bank channels.

Contour banks can be constructed as narrow- or broad-based contour banks. Narrow based contours are grassed batters that are too steep to cultivate and broad based are contour banks that can easily be cultivated. Recommended contour bank specifications are described in Table 5.

**Table 5 Contour bank specifications for lands with a slope of 1-5% (DERM 2004)**

| Land slope | Unit | 1 % | 1.5 % | 2 % | 3 % | 4 % | 5 % |
|---|---|---|---|---|---|---|---|
| Top section gradient | % | - | - | 0.15 | 0.2 | 0.2 | 0.2 |
| Middle section gradient | % | - | - | 0.15 | 0.25 | 0.25 | 0.25 |
| Outlet section gradient | % | - | - | 0.2 | 0.3 | 0.3 | 0.3 |
| Maximum bank length | m | 2500 | 2000 | 1750 | 1500 | 1000 | 750 |
| Single spacing V:H | m | 0.9:90 | - | 1.2:60 | 1.4:45 | 1.6:40 | 1.8:36 |
| Double spacing V:H | m | 1.8:180 | - | 2.4:120 | 2.8:90 | 3.2:80 | 3.6:72 |
| Batter on bank (bank height of 0.5 m) | - | - | - | 1:4 | 1:4 | 1:3 | 1:3 |
| Batter on inlet into channel (bank height of 0.5 m) | - | - | - | 1:50 | 1:20 | 1:10 | 1:5 |
| Bottom width (bank height of 0.5 m) | m | - | - | 4 | 4 | 2 | 2 |
| Cross sectional area (bank height of 0.5 m) | $m^2$ | - | - | 8.75 | 5 | 2.63 | 2 |

### 4.3.4 *Water Storage Areas*

Water storage areas (catchment dams, agricultural runoff dams) are subject to the following control measures (Table 6). Each subsequent stage is not to commence until the previous one is completed.

**Table 6 Water Storage Area Construction Sequence staging**

| Sequence Number | Construction Stage |
|---|---|
| 1 | Install clean water diversion banks where required. |
| 2 | Install sediment fences downslope of lands to be disturbed for construction of the CAR dam and storage ponds. |
| 3 | Stabilise land surfaces disturbed by construction of CAR basin and storage ponds as soon as final levels are established. |
| 4 | Construct dirty water diversion channels to direct run-off from disturbed areas |
| 5 | Strip and stockpile topsoil from areas to be disturbed from construction. |
| 6 | Perform earth works as required and in accordance with engineering plans. |
| 7 | Apply erosion control measures to disturbed areas as required. |
| 8 | Monitor and improve controls as necessary. |
| 9 | Undertake final site stabilisation |

### 4.3.5 *Hardstand Area*

The hardstand area is subject to the following control measures (Table 7). Each subsequent stage is not to commence until the previous one is completed.

**Table 7 Hardstand Area Construction Sequence staging**

| Sequence Number | Hardstand Construction Stage |
|---|---|
| 1 | Install clean water diversion banks where required. |
| 2 | Strip and stockpile topsoil from areas to be disturbed from construction |
| 3 | Perform earth works as required and in accordance with engineering plans |
| 4 | Construct rock lined chutes and outlet structures for cut and fill. |
| 5 | Apply erosion control measures to disturbed areas as required. |
| 6 | Monitor and improve controls as necessary. |
| 7 | Undertake final site stabilisation |

## 4.4 Erosion Control Conditions

The following erosion control measures are applicable to all construction works onsite.

- Clearly visible barrier fencing shall be installed at the discretion of the site superintendent to limit unnecessary disturbance.
- Soil materials must be replaced in the same order that they are removed from the ground.
- Topsoil/seedbed shall be stockpiled for later reinstatement or landscaping purposes.
- Disturbed areas must be seeded with a quick germinating annual as soon as practical after earth works have been completed. All disturbed areas are to have a maximum C-factor of 0.15 (minimum of 50 percent ground cover) after 20 days of inactivity, even though works might continue later.

- Stockpiles that are to be stored for more than 10 days also have to have a maximum C-factor of 0.15 within 20 days (50 percent ground cover). This can be achieved by using a quick germinating annual or geo-textile.
- Ensure the time from starting land disturbance activities to stabilisation is less than six months.
- Ideally, handle topsoil when moist (not wet or dry) to avoid deterioration of soil structure.
- Apply additional erosion control measures as required and in particular to areas of high erosion risk. Additional erosion control products include, but are not limited to geo-textile, jute-mesh, mulch, hydraulic seeding. Erosion blankets should be installed as per standard drawing ECM-01.
- Synthetic reinforced erosion control mats and blankets must not be placed within or adjacent to riparian zones and watercourses if such materials are likely to cause environmental harm to wildlife or wildlife habitats.
- Disturbed ground is not to exceed a slope length of 40 meters and 2 percent, unless additional erosion controls are applied. To reduce the slope length mid-slope flow control berms may be installed.
- All earthworks, including waterways, drains, spillways and their outlets, will be constructed to be stable in at least the 10-year ARI time of concentration storm event.
- Ensure effective weed control management is implemented.
- Construct earth batter with as low gradient as possible, but not steeper than 2(H):1(V) if the total slope length is 10 meters, 3(H):1(V) if the total slope length is 15 meters, 4(H):1(V) if the total slope length is 22 meters and 5(H):1(V) if the total slope length is 30 meters.
- Ensure discharged water does not cause an increased erosion hazard to downslope lands and waterways, which can be achieved by using geo-textile, installing energy dissipaters as per standard drawing OS-01 or constructing level spreaders as per standard drawing LS-01.

## 4.5 Pollution Control Conditions

- All stockpiled material must be located within designated stockpiling areas and be constructed as low, elongated mounds, no more than 2 m high. Stockpiles of erodible material must have sediment filters installed on the downslope side to trap sediment from run-off, as well as an earth bank constructed on the upslope side to divert run-on water around stockpile.
- Stockpiles must not be placed closer than 2 m from hazard areas such as concentrated water flows, gutters and existing vegetation and at least 40 m away from any riparian lands.
- All disturbed areas are to have sediment control measures installed on the down slope side of the disturbance and be designed to withstand at least a 10-year ARI storm event.
- Installed sediment controls are to be maintained and improved until site has been successfully stabilised.
- Minimise dust generation and wind erosion by applying water, gluon or erosion control blankets where necessary.
- Sediment fences will:
  - Be installed where shown on the Erosion & Sediment Control Plan Drawing and elsewhere at the discretion of the site superintendent.
  - Have no larger catchment than 1000 m2, or have returns of 1 metre upslope at intervals along the fence so that the catchment area does not exceed 1000 m2.
  - Be placed in a way that keeps the sediment as close to its source as possible.

# 5. Waste Management

The following waste management principles are to be implemented throughout the project:

- Separation of reusable and recyclable materials from waste.
- Storage of waste receptacles away from watercourses.
- Emptying of waste bins as required and disposal of waste appropriately.
- Wash down of materials and equipment to be undertaken away from watercourses and sediment filters to be used if required.
- Maintain and regularly check plant and equipment for leaks (e.g. fuels, oils, hydraulic fluids).
- Bund all fuel and oil storage areas to contain 120 percent of the maximum capacity of the largest storage container. These storage facilities and bunds must be regularly inspected for spills and drained of rainwater so there is sufficient storage volume in the event of a spill.
- Emergency spill response kits must be available on-site at all times. These kits must contain spill absorbent and containment materials to ensure materials do not migrate off-site, reach water bodies or create risk to employees.
- In the event of an emergency or spill, work must cease immediately and appropriate action undertaken. Actions may include, but are not limited to, containment of the spill, clean-up of contaminated soil and rectification of the problem that resulted in the spill.

# 6. Stabilisation and Rehabilitation

During all stages of the development, all disturbed areas, including stockpiles, are to have a maximum C-factor of 0.15 (50 percent ground cover or more) after 20 days. Additionally, upon reinstatement and site close-out the site is to achieve a C-factor of less than 0.05 (70 percent cover or more) within 60 days of completion.

Guiding principle to achieve successful stabilisation and rehabilitation of disturbed lands, include:

- Prepare a good seedbed and loosen compacted soil before sowing any seed;
- Avoid cultivation in very wet or very dry conditions;
- Apply appropriate ameliorants and/or fertilisers as required;
- Use plant species that are consistent within the existing soil conditions and climate;
- Undertake effective weed management; and
- Implement maintenance regimes.

Temporary erosion and sediment controls are not to be removed before the site has been adequately stabilised and rehabilitated.

# 7. Monitoring and Maintenance

During all stages of the development, site inspections are to be carried out at least weekly by the site manager, immediately before site closure and immediately following/during rain events that cause run-off. These site inspections may be implemented as part of a broader project specific Construction Environmental Management Plan (CEMP). Site inspections shall be done in a systematic manner and include recordings of:

- The condition and effectiveness of control measures; and
- Any maintenance requirements, including removal of sediment trapped in sediment fences, diversion drains, sediment basins and waterways etc. Ensure that:
  - Sediment filters are maintained so that no more than 30 percent of their design capability is lost to accumulated sediment.
  - Any sediment removed is placed in areas where further pollution to down slope lands and water will not occur.
  - Construction materials are replaced as required.
  - Installed sediment controls are maintained until site has been appropriately stabilised.
- Any improvements required, including additional sediment fences and maintenance of diversion banks;
- Maintenance requirements for grass cover in waterways;
- The condition of recently stabilised areas and any required repairs or measures to be initiated;
- Vehicle movements and signs of sediment being transported off-site through vehicle movements;
- Condition of waste bins; and
- Any modifications required to this plan.

Sediment basins must be kept in good working condition and attention will be given to:

- Recent works to ensure drains and basins have been constructed suitably to the local conditions and that sediment laden water is managed appropriately;
- Degradable products to ensure they are replaced as necessary;
- Sediment removal to ensure the design capacity or less remains in the settling zone; and
- Waters in sediment basins that occupy more than one quarter of the design capacity will be treated with a flocculating agent and discharged within five days from any storm event large enough to fill the basin to that level.

Furthermore, should significant erosion occur, demonstrated by visual loss of topsoil, subsoil or stockpiled material, all efforts must be made to address further loss from the site. This includes, but is not limited to:

- Diversion or slowing of water onto and away from the eroded area. Care should be taken not to unduly disturb other surfaces capable of becoming erosion sources.
- Improvements to earthworks to reduce or stabilise erodible slopes.
- The installation or improvement of sediment control structures.

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## 9. Appendices

# Appendix A. Erosion Risk Assessment

# Erosion Risk Assessment

According to Matthews (2008) the erosion risk for a particular area can be calculated with Equation 1.

**R = A x B x T (Equation 1)**

Where R = predicted total soil loss in tonnes, A = calculated soil loss in tonnes/hectare/year, B = surface area of disturbance (hectares), T = predicted duration of the disturbance (months disturbed/12).

The soil loss (tonnes/ha/year) is derived from the Universal Soil Loss Equation, Equation 2 below.

**A = R x K x LS x P x C (Equation 2)**

Where: A = computed soil loss (tonnes/ha/yr)

R = rainfall erosivity factor

K = soil erodibility factor

LS = slope length/gradient factor

P = erosion control practice factor

C = ground cover factor.

**Calculation of Equation 2**

The R-factor was calculated using:

$$\mathbf{R = 164.74(1.1177)^{S}S^{0.6444}}$$

Where S is the 2 year ARI, 6 hours ARI rainfall event (mm). Rainfall data from Inverell Raglan Street (BOM 2015) showed the 2 year, 6 hours rainfall event to be 45.2mm/6 h. Thus the S used was 7.53mm/h used. The **R-factor** was calculated to be **1,399.52**.

The K factor was derived using the soil erodibility nomograph in Landcom (2004). From the soil data acquired in the Soils Survey and Land Capability Assessment (Appendix G of the Statement of Environmental Effects) the following details where extracted and averaged across the 0-0.84m excavated depths for use in the nomograph:

| | |
|---|---|
| % silt and very fine sand = | 46% |
| % sand (0.1-2.0 mm) = | 54% |
| % organic matter = | 1.33% (from 0.7733% average organic) |
| Soil structure = | 1 (very fine granular) |
| Permeability = | 6 (less than 1 mm per hour) |

Based on these values the **K-factor** was calculated to be **0.053**.

The **LS factor** for the ILEF development site was 4.82, which corresponds to a slope length of 300 metres at an average gradient of **8%**.

The **P factor** was set to **1** (default)

The **C factor** to **0.1** (Grazing modified pastures).

The resulting soil loss (tonnes/ha/year) is then calculated as below:

**A** = 1399.52 x 0.053 x 4.82 x 1 x 0.1 = **35.8 tonnes/ha/year**

**Calculation of Equation 1**

The total soil loss is calculated by multiplying the estimated soil loss (35.8 tonnes/ha/year) with the total area of ground disturbance (17 ha) and the duration of the project (3 months/12):

**R** = 35.8 x 17 x (3/12) = **152.2 tonnes**

**Coefficient Calculation**

To determine the peak volumetric flow the formula for the Rational Method (Western & Pilgrim, 2001) is applied:

$$Q_y = 0.278\, C\ {}^{y}I_t\ A$$

Where Qy = peak volumetric flow ($m^3/s$) having an ARI of y years

C = runoff coefficient (typically 0.8)

yIt = rainfall intensity (mm/h) of design storm having duration tc,

A = catchment area ($km^2$).

For the runoff coefficient of a 10 year ARI rainfall event:

The runoff coefficient (C) is 0.08 in accordance with Western & Pilgrim (2001);

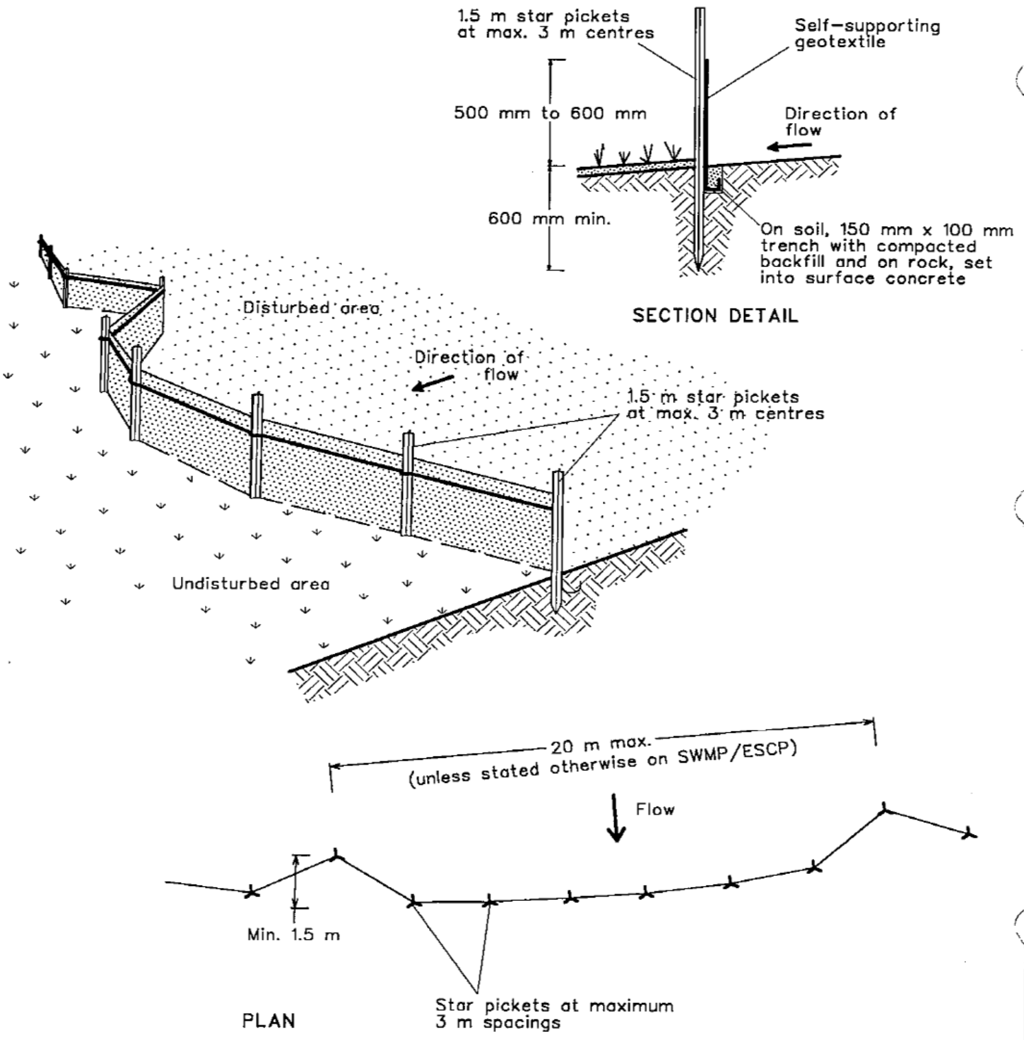
The rainfall intensity (${}^{y}I_t$) of a 10 year ARI rainfall event is 43.9 mm/h.

The catchment area of the Nullamanna site is 0.13449 $km^2$

The resulting peak volumetric flow having a 10 year ARI is below;

**Qy** = 0.278 x 0.08 x 43.9 x 0.13449 = **0.13 $m^3$/s.**

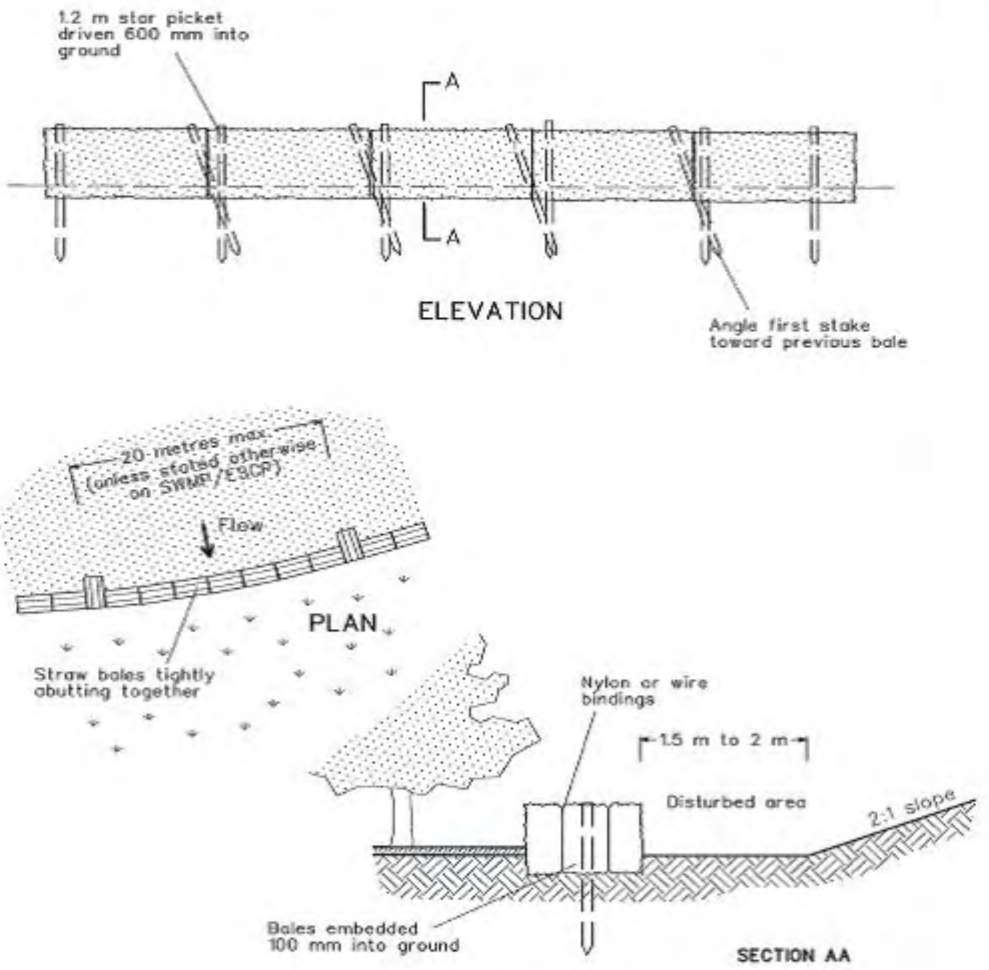
# Appendix B. Standard Drawings




## Construction Notes

1. Construct sediment fence as close as possible to parallel to the contours of the site.
2. Drive 1.5 metre long star pickets into ground, 3 metres apart.
3. Dig a 150 mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
4. Backfill trench over base of fabric.
5. Fix self-supporting geotextile to upslope side of posts with wire ties or as recommended by geotextile manufacturer.
6. Join sections of fabric at a support post with a 150 mm overlap.

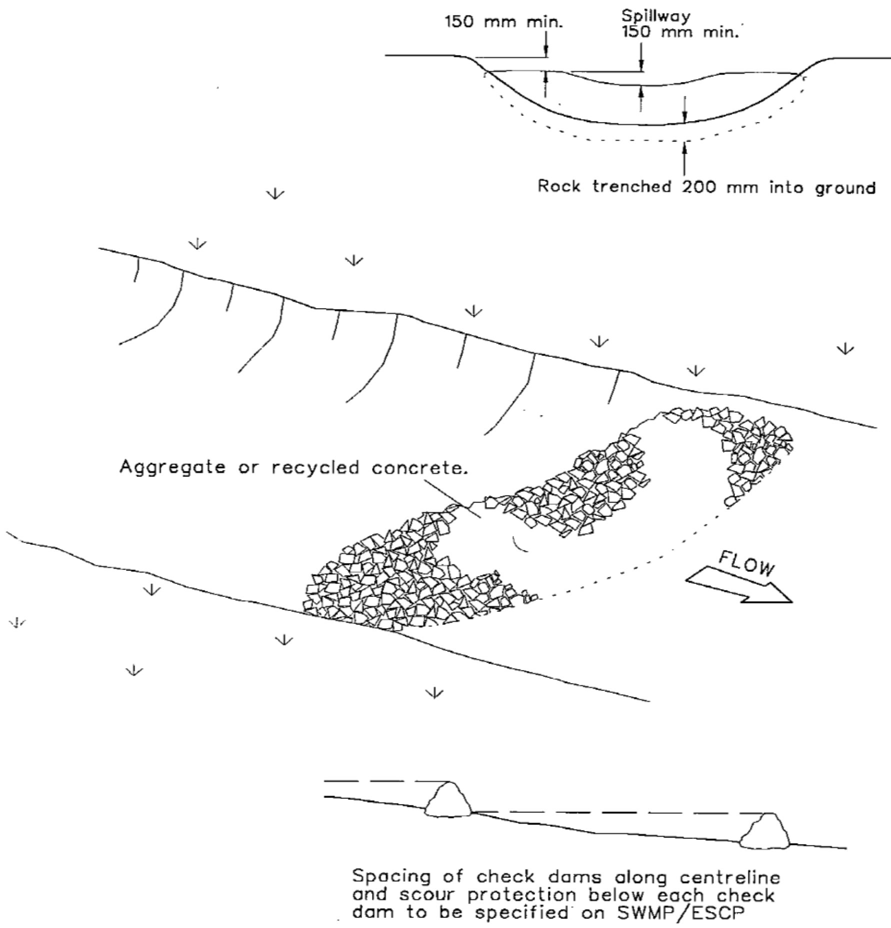
**SEDIMENT FENCE** **SD 6-7**




## Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

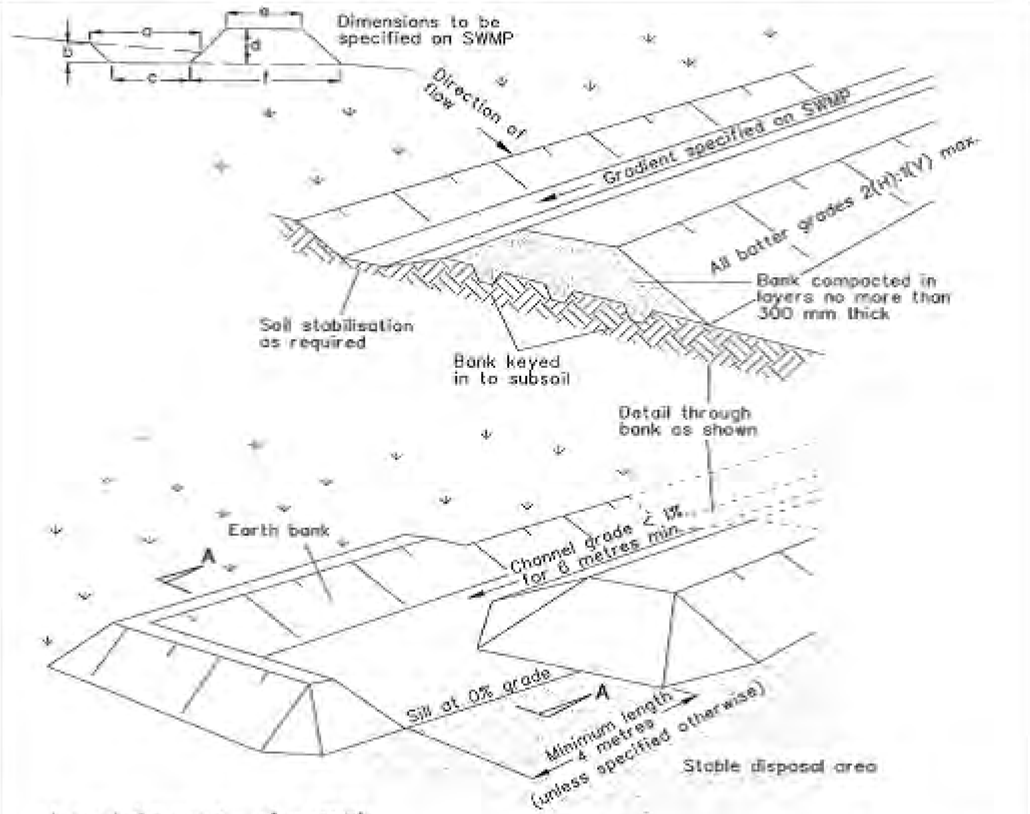
**STRAW BALE FILTER** **SD 6-7**



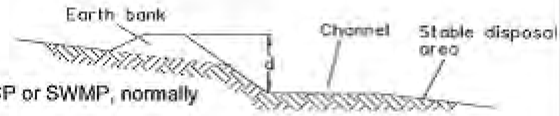

## Construction Notes

1. Trench structure 200 mm into ground surface wherever the structure contacts the gully base. Fill trenches to 100 mm above ground surface to reduce risk of undercutting.
2. Ensure height of spillway is less than 1 metre above the gully floor.
3. Space checks so the toe of the upstream dam is level with the spillway of the next downstream dam.

## ROCK CHECK DAM SD 5-1




Level Spreader (or Sill)

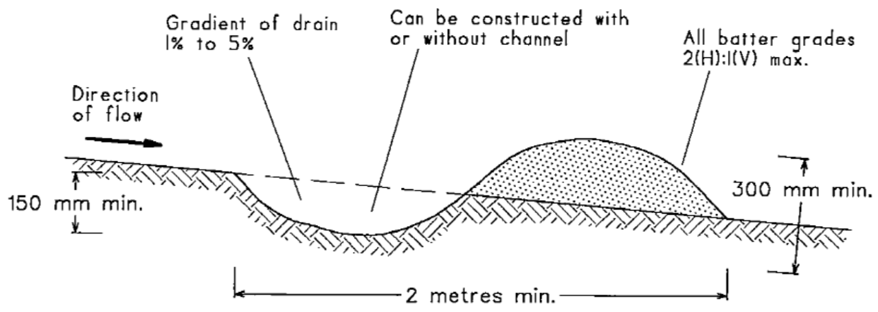



Section AA

## Construction Notes

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

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

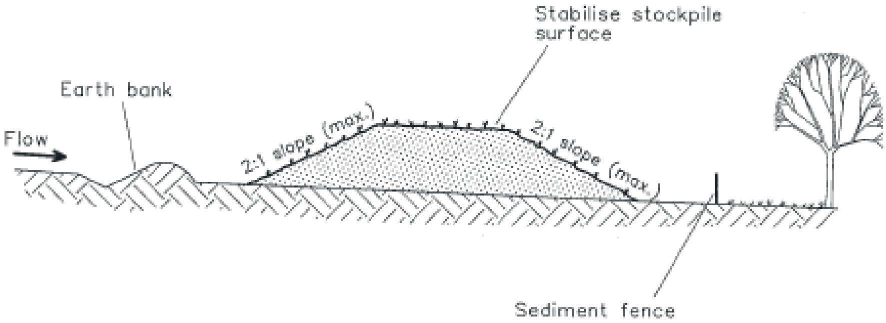



NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

## Construction Notes

1. Construct with gradient of 1 per cent to 5 per cent.
2. Avoid removing trees and shrubs if possible.
3. Drains to be of circular, parabolic or trapezoidal cross section not V-shaped.
4. Earth banks to be adequately compacted in order to prevent failure.
5. Permanent or temporary stabilisation of the earth bank to be completed within 10 days of construction.
6. All outlets from disturbed lands are to feed into a sediment basin or similar.
7. Discharge runoff collected from undisturbed lands onto either a stabilised or an undisturbed disposal site within the same subcatchment area from which the water originated.
8. Compact bank with a suitable implement in situations where they are required to function for more than five days.
9. Earth banks to be free of projections or other irregularities that will impede normal flow.

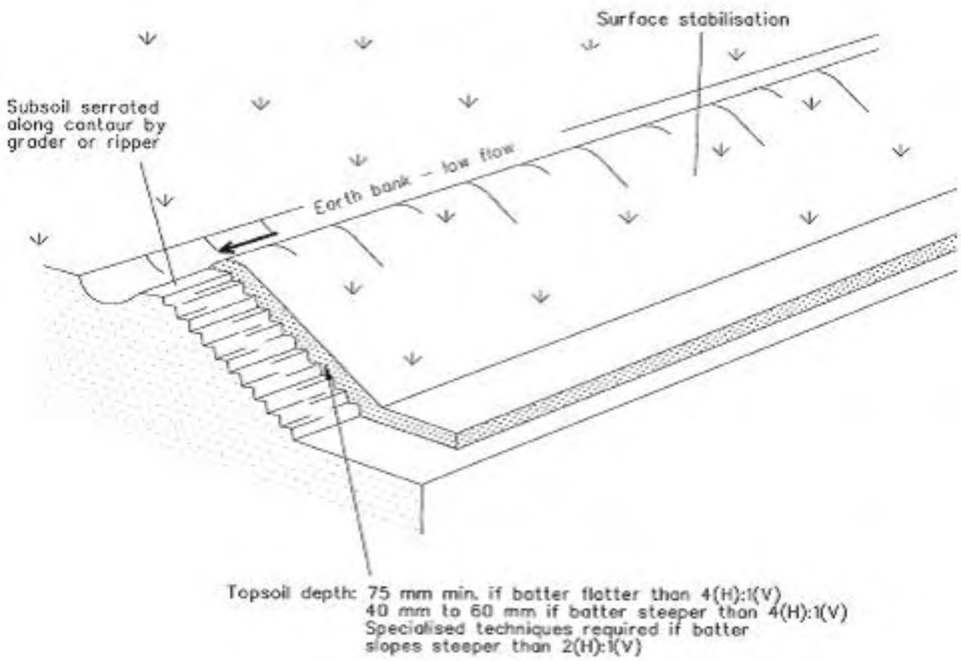
**EARTH BANK (LOW FLOW) SD 5-2**




## Construction Notes

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

**STOCKPILES** **SD 4-1**

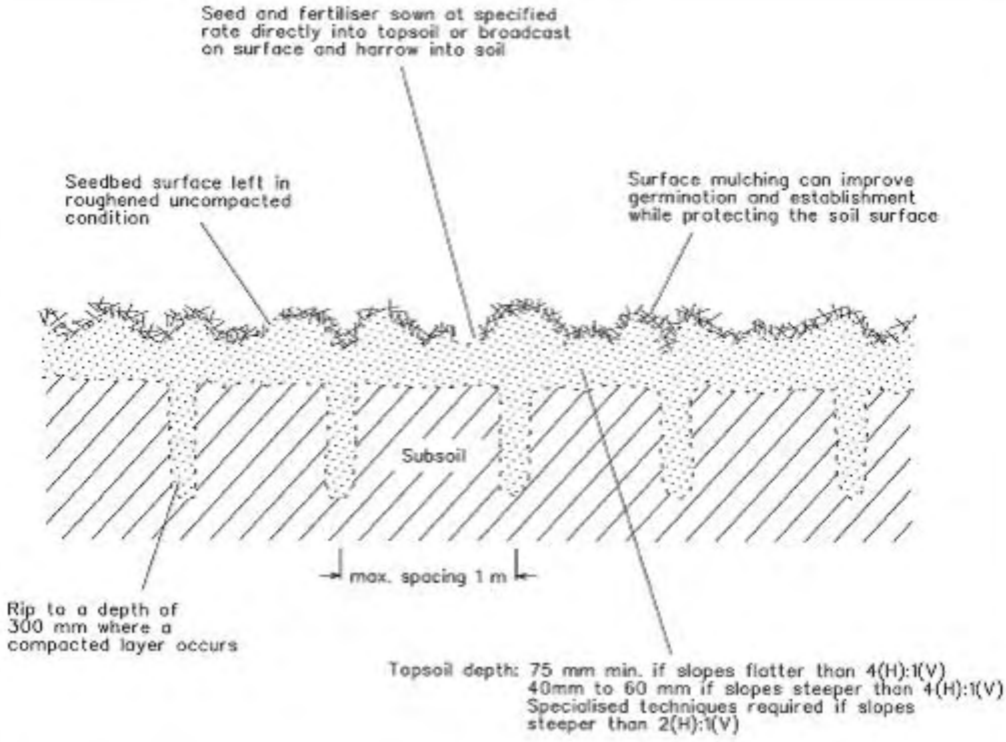



## Construction Notes

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

## REPLACING TOPSOIL

**SD 4-2**




## Construction Notes

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

## SEEDBED PREPARATION

**SD 7-1**

# Appendix G. Soils Survey and Land Capability Assessment

~ Commercial-in-Confidence ~

# Soils Survey and Land Capability Assessment

## Nullamanna Feedlot Expansion

**Report Number 23876.81961**

*Prepared for*


NULLAMANNA STATION

**Nullamanna Station**

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| **Signatures** | | | | | |

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**Rev** 0: Final Report

**Distribution:**

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| EnviroAg Australia | 1 |

Client

Company

This document provides information to address the intent of Project Number 23876 as agreed to by Nullamanna Station.

# Executive Summary

EnviroAg Australia Pty. Ltd. (EnviroAg) has been engaged by Messrs Peter and Mark Lane (the Client) to carry out a soils assessment for the property known as “Nullamanna Station” in Nullamanna NSW to determine its suitability for a feedlot expansion.

A total of eight test pits were excavated onsite. Soil samples collected during the survey were submitted for laboratory analysis. Analysis of bulk samples found that the soils in the feedlot expansion area are a Ferrosol on the upper slopes and Vertosol on the lower slope where gradients are flat.

The nutrient budget showed that the land in the irrigation area is deficient of nitrogen and phosphorus. However potassium and sodium will need to be managed.

Overall, this assessment found that sufficient land exists in the 6.6ha irrigation area to take up the wastewater. However, only a small volume of wastewater should be applied (0.87ML/ha across 6.6ha). The area of application should also be small, for example 2.2ha, and application areas should be rotated.

# Glossary

The following tables set out key works with a definition and abbreviations and their full meaning.

**Table 1 Definitions**

| | |
|---|---|
| Average recurrence interval | The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random. |
| Cation exchange capacity | The total capacity of a soil to hold exchangeable cations. CEC is an inherent soil characteristic and is difficult to alter significantly. It influences the soil's ability to hold onto essential nutrients and provides a buffer against soil acidification. |
| Land Capability | Assesses the limitations to land use imposed by the characteristics if the land and specifies management options. |
| Land classification | Land classification refers to land categories and assess quality classes, capability classes or grade, depending upon the characteristics of the land or its potential for agricultural use. |
| Land Cover | Represents the physical surface of the earth. It includes combinations of natural features such as vegetation, soil, exposed rocks, water bodies as well as anthropogenic (man-made) features such as agriculture and the built environment. Land cover classes can generally be identified by characteristic patterns using remote sensing. |
| Land Management Practice | Refers to the means by which the land management objective is achieved, that is the ‘how’ of land use (e.g. cultivation practices, cell grazing or broad acre grazing). |
| Land Suitability | Describes the fitness of a given area/type of land for a specified land use. |
| Land use | Refers to the purpose to which land is committed, that what the land manager wants to achieve (e.g. grazing on native or improved pastures). |
| Salinity | Soil salinity is the salt content in the soil. Salts occur naturally within the soils and water. |
| Sodicity | A term given to the amount of sodium held within the soil. |
| Sorption | The processes in which one substance takes up or holds another (via either absorption or adsorption) through a chemical process in which one substance permeates the other; a fluid permeates or is dissolved by a liquid or solid. |
| Standard Cattle Unit | One 600 kg animal |

**Table 2 Abbreviations**

| | |
|---|---|
| ARI | Average recurrence interval |
| CEC | Cation Exchange Capacity |
| COC | Chain of custody |
| EC | Electrical Conductivity |
| K | Potassium |
| N | Nitrogen |
| Na | Sodium |
| P | Phosphorus |
| pH | Potential Hydrogen |
| SCU | Standard Cattle Units |

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# 1. Introduction

EnviroAg Australia Pty. Ltd. (EnviroAg) has been engaged by Messrs Peter and Mark Lane (the Client) to carry out a soils assessment for the property known as “Nullamanna Station” in Nullamanna NSW to determine its suitability for a feedlot expansion.

As part of the Statement of Environmental Effects, EnviroAg conducted a soil survey on the property with soil sampling undertaken on the 9th of October 2015. The samples were analysed by Dr Simon Lott, a certified practicing soil scientist (Level 3), and registered professional engineer (agricultural, civil and environmental), and were then tested by a NATA accredited laboratory for their properties.

## 1.1 Project Description

Nullamanna Station is a feedlot situated north of Inverell NSW, which currently has the capacity to hold 1,000 Standard Cattle Units (SCU, where one SCU = one 600 kg animal). Nullamanna Station wishes to expand their feedlot capacity to 3,000 SCU.

## 1.2 Proposed Land Uses

It is proposed that the land be used for a feedlot and wastewater ponds. Importantly some land areas will be assigned to a controlled drainage area. These lands will be substantially modified with topsoils and subsoils being stripped from them and the areas made impervious.

## 1.3 Objectives of the Soil Survey

The objectives of this soil survey were to identify the soil types and profiles to assess constraints and benefits of the soil for the siting of the expanded feedlot, with consideration to site earthworks, borrow pits, crop irrigation and wastewater application. The soil survey covered both agronomic and geotechnical assessments.

The objective of the soil survey is to:

- Review existing mapping and land classifications for the site;
- Undertake a soil survey; and
- Test selected soil samples for their suitability for feedlot construction use; and,
- Methods

## 1.4 Introduction

The soil survey and its assessment included:

- Detailed assessment of available reference materials including ASRIS mapping and NSW Government soil reports in the area;
- Excavation of test pits;
- Lab testing (both agronomical and geotechnical tests); and,
- Data analysis and compilation.

## 1.5 Desktop Assessment

The desktop assessment undertook background research on the soils at the site and its surrounds.

## 1.6 Test Pits

The location of the pits for soils sampling was based upon mapping of the proposed land use areas. This was done so that the following could be determined:

- The structural integrity and quality of the soil for foundations and earthworks; and,
- The soil type and chemical characteristics for suitable qualities for irrigation and cropping.

On the 9th of October 2015 eight (8) test pits were dug using a backhoe (Figure 1). TP1, TP2, and TP3 were excavated to a depth of 3m, whilst TPA, TPB, TPC, TPD and TPE were excavated to a depth of 1.5m. Each location was logged with a handheld GPS (accurate to <±3 m). The test pit locations selected for sampling are shown in Figure 2.

Soil profile characteristics were carefully logged. Each pit and its profile was measured and photographed. Disturbed soil samples were collected from each test pit and from each horizon. Samples collected were tagged and sealed in individual plastic bags and forwarded to a NATA certified laboratory in Brisbane for analysis. Physical attributes were identified and logged on site.

## 1.7 Laboratory Testing

Bulk soil samples from TP2 and TP3 were submitted to NATA accredited laboratories for geotechnical testing.

## 1.8 Data Management

The soils' physical characteristics were described and entered onto EnviroAg field soil logs with photographs and GPS locations collected for each test pit (Appendix A). This information was tabulated into spreadsheets for interpretation and collation with laboratory analysis data.

Samples were freighted to the Toowoomba office where they were prepared and forwarded to the relevant laboratory for analysis. This was carried out under Chain of Custody (COC) documentation.

Soil samples were air dried and are currently stored at EnviroAg facilities in Toowoomba QLD.


**Figure 1 Excavation of test pits**


**Figure 2 Test pit locations**

# 2. Soil Survey Results

## 2.1 Existing Soil Mapping

Based on ASRIS (2011) and NSW Office of Environment and Heritage (OEH, 2015) Australian Soil Classification (Isbell, 2002) mapping (Figure 3 and Figure 4 respectively), soil in the proposed feedlot area may include:

- Ferrosols – Well-drained soils with red or yellow-brown colour and have clay-loam to clay textures. Their B2 horizons are high in free iron oxide, and they lack strong texture contrast between A and B horizons.
- Chromosols – Have a strong texture contrast between A horizons and B horizons. The B Horizon is not strongly acid or strongly sodic.
- Rudosols – Usually young, poorly developed soils with negligible pedologic organisation. The component soils can vary widely in terms of texture and depth; many are stratified and some are highly saline. They generally have low fertility and low water-holding capacity.
- Rudosols and tenosols – Rudosols as described above. Tenosols are soils that generally have only weak pedologic organisation apart from the A horizons. It encompasses a diverse range of soils.

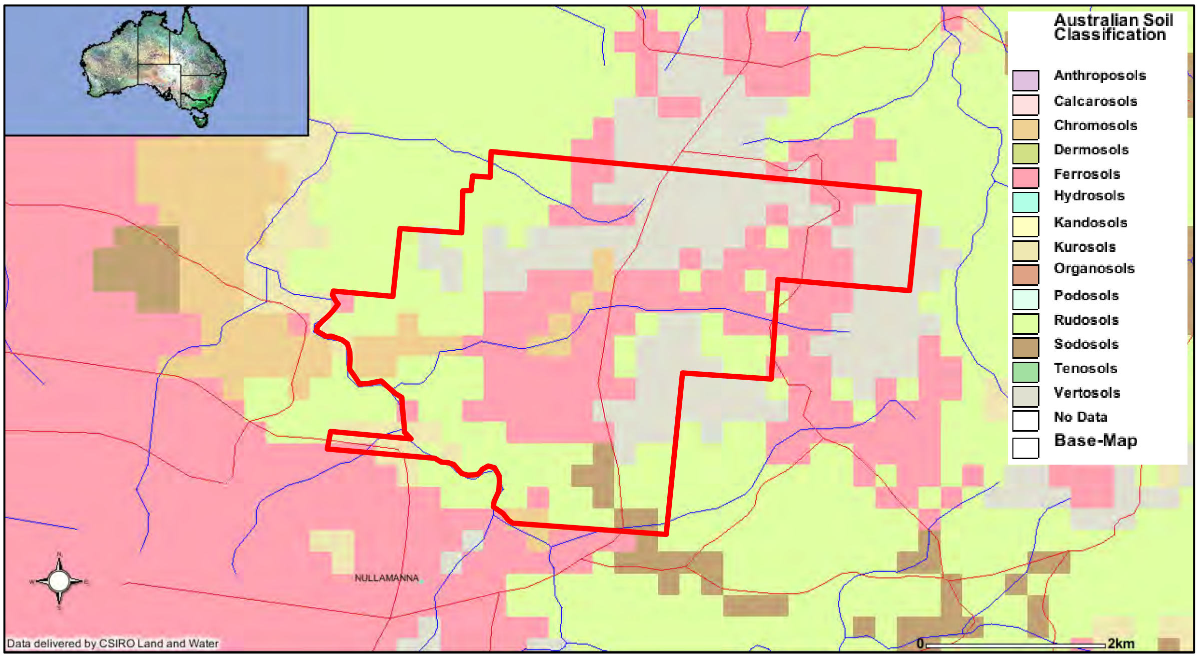


**Figure 3 ASRIS soil national grid mapping**

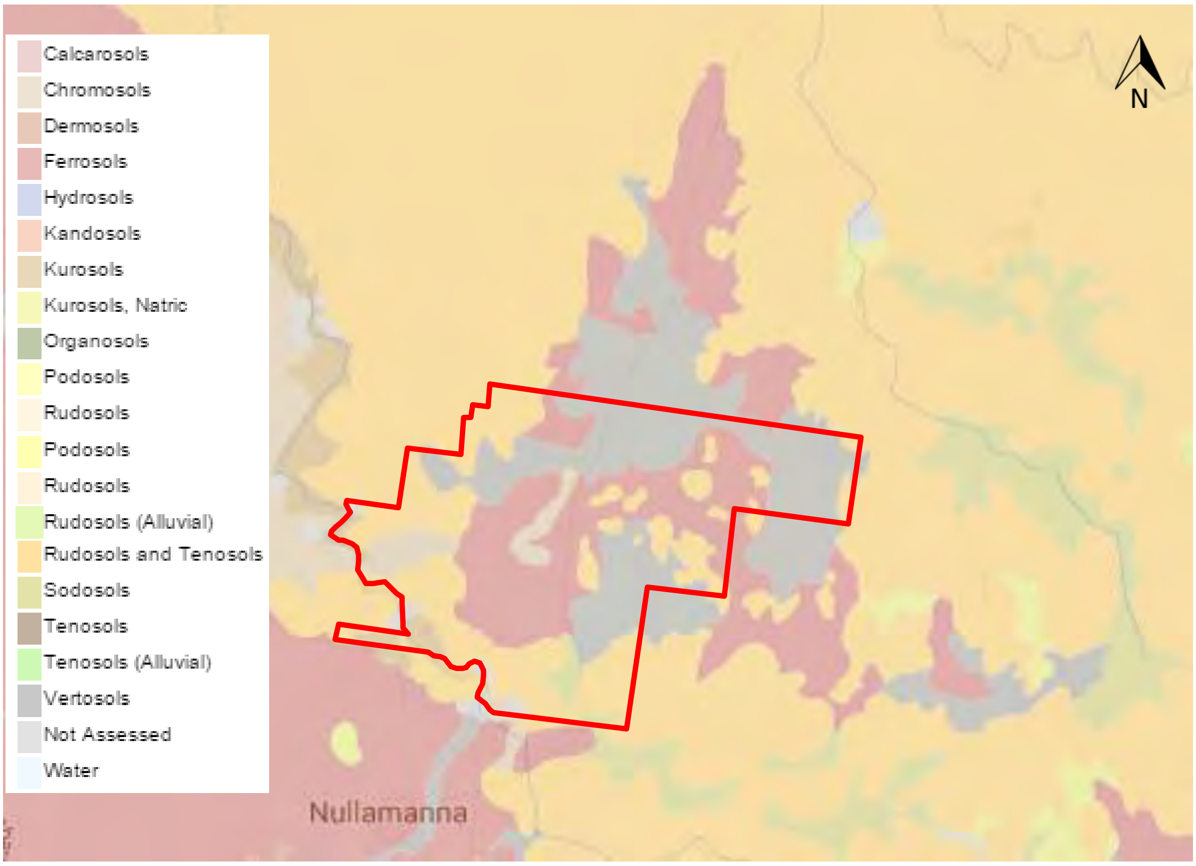


**Figure 4 NSW OEH soil and land information mapping**

## 2.2 Test Pits

As detailed in Section 1.6, a total of eight test pits were excavated. The location of the 8 test pits is shown in Figure 2. The soil profile logs are included in Appendix A. Soil samples were collected from the test pits for geotechnical analysis. Refer Appendix A and Appendix B.

The field survey found that the soils in the feedlot expansion area are a Ferrosol on the upper slopes and Vertosol on the lower slope where gradients are flat.

## 2.3 General Properties of the Soils

The general properties of the soils are described by the stratigraphic summary in Table 3 (the pond area) and in Table 4 (the pen area) below. Figure 5 to Figure 12 show the profiles to the soil.

Generally the soil profile was shallow with the A horizon averaging to a depth of 0.31 m and the B horizon depth average of 1.42 m throughout the test pits. All horizons had an aspect of clay with varying levels of silt and/or sand. The C horizon typically had some gravel and saprolite.

**Table 3 Typical soil profile from pond area (results noted from TP2)**

| Depth (m) | Horizon | Description |
|---|---|---|
| 0 – 0.1 | A1 | Dark brown silty sandy clay with gravels to cobbles. |
| 0.1-0.3 | A2 | Brown silty sandy clay with fine to course gravels. |
| 0.3-1.0 | B1 | Strong brown clay with fine sand. |
| 1.0-1.5 | B2 | Red brown clay with fine sand. |
| 1.5-3.0 | C1 | Clayey sandy gravel with boulders, as well as saprolite sandstone/mudstone. |

**Table 4 Typical soil profile from pen area (results noted from TPD)**

| Depth (m) | Horizon | Description |
|---|---|---|
| 0 – 0.1 | A1 | Very dark brown silty clay with traces of sand. |
| 0.1-0.25 | A2 | Reddish brown silty sandy clay. |
| 0.25-0.7 | B1 | Orange-red brown clay with traces of silt. |
| 0.7-1.2 | B2 | Light brown clay with traces of silt and sand, as well as some gravels (deco basalt). |
| 1.2-1.5 | C1 | Reddish orange brown clayey sandy gravel, with saprolite mafic basalt. |

**Figure 5 TP1 Profile**

**Figure 6 TP2 profile**


**Figure 7** **TP3 profile**


**Figure 8** **TPA profile**

**Figure 9** **TPB profile**

**Figure 10** **TPC profile**

**Figure 11** **TPD profile**

**Figure 12** **TPE profile**

## 2.4 Landscape Features

### 2.4.1 Irrigation Area

The irrigable area is located on the large lower slope areas to the NE of the feedlot development. Soils in this area are generally deeper vertosols suitable for wastewater reuse.

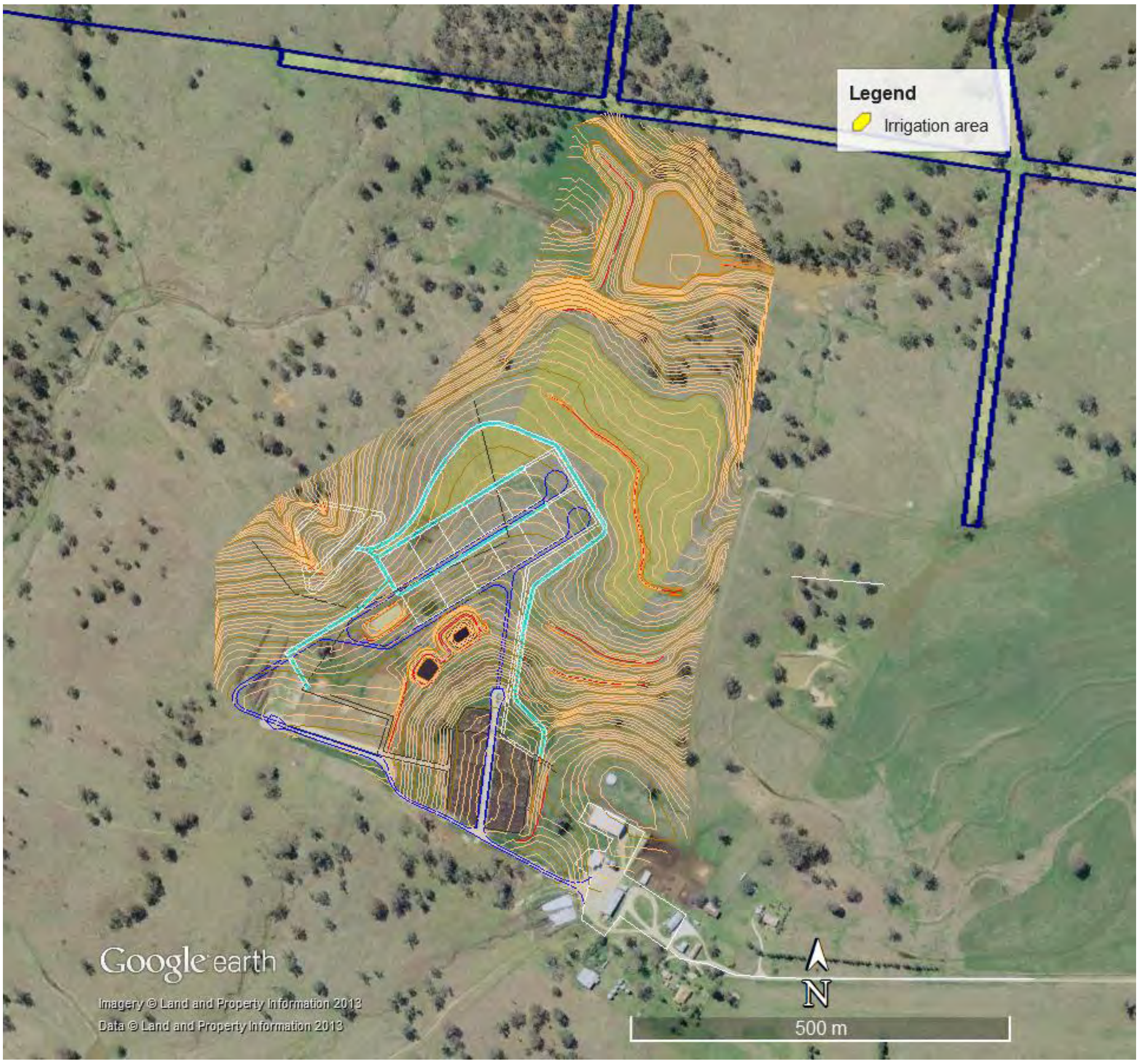


**Figure 13 Feedlot conceptual design showing the location of the irrigation area**

### 2.4.2 Controlled Drainage Area

The controlled drainage area of the development is well defined. It includes the existing and future pens, compost manure pad, drains and wastewater ponds. The storage capacity exceeds that required to hold rainfall runoff from a 1 in 10 year wet year.

The controlled drainage area is located upslope of the wastewater ponds. A topographic map from the Water storage facilities along the major drainage systems proposed to be developed is shown in Figure 13.

## 2.5 Soil Mapping

The NSW government mapping stated that for this area there was a low confidence in its mapping, whilst ASRIS had only mapped this area to a level 3, which means that each pixel on their map is a 3km mapping window. This also indicates that the mapping does not have a high level of precision.

The field survey found that the soils in the feedlot expansion area are a Ferrosol on the upper slopes and Vertosols on the lower slope where gradients are flat.

This is generally consistent with ASRIS and NSW OEH (2015) government mapping.

## 2.6 Soil Properties

Results from geotechnical analysis performed at the SoilTech Laboratory in Toowoomba QLD are noted in Table 5.

Permeability analysis was conducted on TP2 and TP3, which yielded a result of k(20) = $8.0 \times 10^{-11}$ m/sec and k(20) = $3.4 \times 10^{-10}$ m/sec respectively. A permeability of less than $1 \times 10^{-9}$ m/s is advised for pen surfaces and sedimentation/holding ponds by the *National Guidelines for Beef Cattle Feedlots in Australia* (MLA 2012), as well as the NSW EPA (recommendations for the Statement of Environmental Effects).

Soil pH is neutral and soil conductivity is relatively low.

**Table 5 Geotechnical analysis results**

| **Sample ID** | TP2 | TP3 |
|---|---|---|
| **Sampling Date** | 9/10/2015 | 9/10/2015 |
| **Soil description** | Red brown clay with fine sand | Strong brown clay with traces of sand |
| **Permeability (m/s)** | $8.0 \times 10^{-10}$ | $3.4 \times 10^{-10}$ |
| **Liquid Limit %** | 67 | 82 |
| **Plastic Limit %** | 26 | 31 |
| **Plasticity Index** | 41 | 51 |
| **Linear Shrinkage %** | 18.0 | 19.0 |
| 19.00 mm | | 100 |
| 13.2 mm | | 93 |
| 9.50 mm | 100 | 92 |
| 6.7 mm | 100 | 92 |
| 4.75 mm | 99 | 91 |
| 2.36 mm | 97 | 91 |
| 1.18 mm | 91 | 91 |
| 0.600 mm | 85 | 89 |
| 0.425 mm | 82 | 88 |
| 0.300 mm | 80 | 88 |
| 0.150 mm | 76 | 84 |
| 0.075 mm | 73 | 76 |
| **pH** | 6.5 | 7.5 |
| **EC (µS/cm)** | 57 | 80 |

Soil testing on Nullamanna Station has also been undertaken by the NSW OEH and the location of this sample is displayed in Figure 14. The sample has been analysed for chemical and agronomic properties, the results of which are shown in Table 6. This pin is located directly next to a cropping area on the north eastern side of the property.

As with the field sample results, these results show a pH that is slightly acidic to neutral and a low conductivity. They also show that clay content and cation exchange capacity increase with depth.

In summary of the field samples and NSW OEH samples it is noted that:

- Conductivity levels are low throughout the profile and indicate non-saline conditions.
- Soil pH is slightly acidic to neutral throughout the profile with pH ranging from 5.8 to 7.5. The soil will benefit from the application of lime and or gypsum.
- The cation exchange capacity of this soil is low in surface soils. This corroborates field soil texture assessments that identified silts and sands throughout the soil horizons.
- Organic carbon levels are low in surface and subsoils. The soil will benefit from the application of composted manures.
- The exchangeable sodium and calcium percentages of these soils are also low throughout the profile and provide no risk of soil dispersion.
- The capacity of the soil to absorb phosphorus is determined by the mineralogy, amount of clay, pH and the temperature of the soil. The topsoil has a relatively low P sorption capacity as a result of the silty, sandy clay horizons, which have low absorption ability. However, the p-sorption increases with depth.

The soils indicate low fertility with low cation exchange capacity in the surface soils. Nutrients, when applied, need to be applied frequently in low amounts. Organic matter contents need to be increased to assist in retention of soil moisture and nutrients.

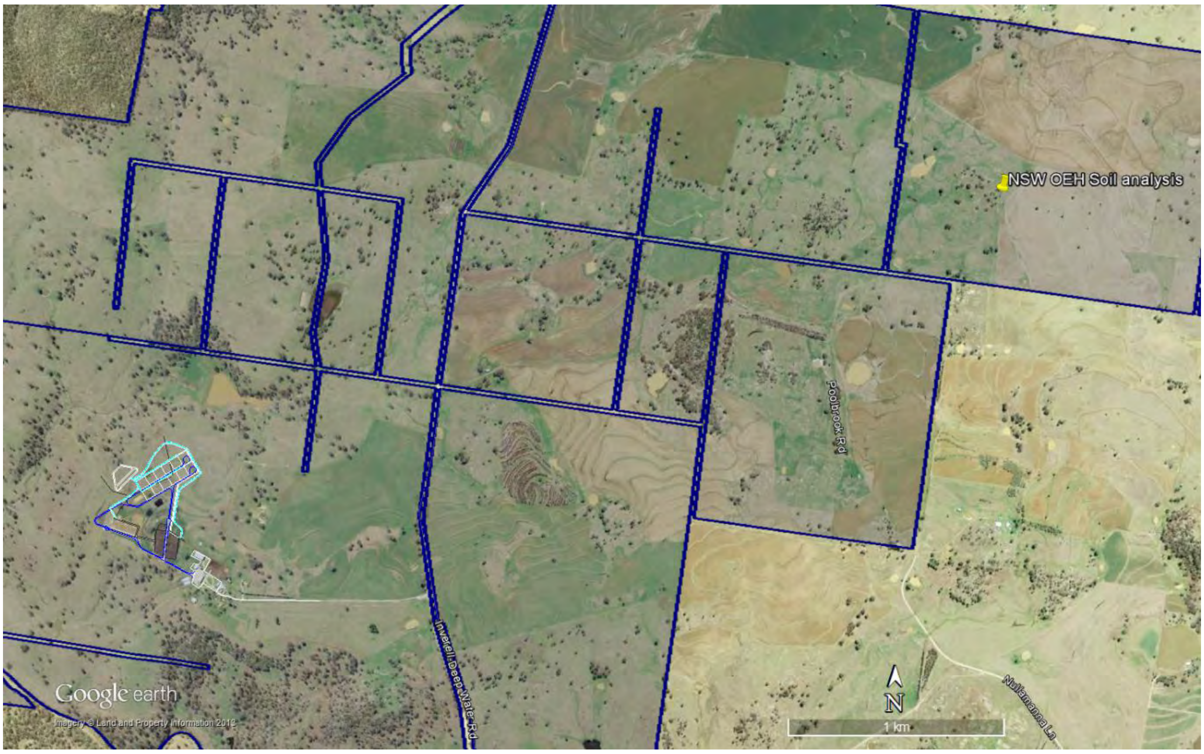


**Figure 14 Location of NSW OEH chemical/agronomic sampling point**

**Table 6 Chemical properties of NSW OEH soil sample starred in Figure 13**

| | Guidelines (AS 2159-2009) | Unit | 0 – 0.15m | 0.15 – 0.44m | 0.44 – 0.84m |
|---|---|---|---|---|---|
| **EC of 1:5 soil/water extract** | <3000 | µS/cm | 60 | 40 | 30 |
| **pH of 1:5 soil/water suspension** | 5.6-8.4 | | 6.2 | 6.5 | 5.8 |
| **pH of 1:5 soil/0.01M CaCl2 extract - direct, no stir** | | 1:5 0.01M | 5.6 | 5.8 | 4.6 |
| **CEC by 0.01M silver-thiourea (AgTU)+, no pret.** | >12 | meq/100g | 11 | 9.7 | 13.4 |
| **Exchangeable Ca - 0.01M (AgTU)+, no pretreatment** | >5 | meq/100g | 4.4 | 5 | 5.2 |
| **Exchangeable Mg - 0.01M (AgTU)+, no pretreatment** | >1 | meq/100g | 1.9 | 2.3 | 7 |
| **Exchangeable Na - 0.01M (AgTU)+, no pretreatment** | <6 | meq/100g | 0 | 0 | 0.2 |
| **Exchangeable K - 0.01M (AgTU)+, no pretreatment** | | meq/100g | 0.8 | 0.4 | 0.3 |
| **Organic carbon - Walkley & Black** | | % | 1.51 | 0.65 | 0.16 |
| **Fluoride-extractable P (Bray 1-P) - manual colour** | | mg/kg | 8 | 3 | 3 |
| **Phosphate sorption index** | | ppm | 118 | 108 | 245 |
| **Field Capacity, SWC pressure plate** | | % | 27.1 | 21.9 | 20.0 |
| **Permanent Wilt Point, SWC pressure plate** | | % | 6.8 | 7.2 | 8.5 |
| **Oven-dry moisture content** | | % | 0.0 | 0.0 | 0.0 |
| **Wind erodible aggregate percentage** | | % | 54 | 61 | 79 |
| **Water repellence field method** | | | 2 | 1 | 1 |
| **Volume expansion** | | % | - | 0 | - |
| **PSA clay – SDS** | | % | 12 | 15 | 24 |
| **PSA silt – SDS** | | % | 11 | 12 | 6 |
| **PSA fine sand – SDS** | | % | 24 | 20 | 14 |
| **PSA coarse sand – SDS** | | % | 53 | 53 | 56 |
| **PSA gravel – SDS** | | % | 0 | 0 | 0 |
| **Dispersion percentage** | | % | 38 | 58 | 50 |
| **Emerson aggregate test SCS method** | | | 8 | 5 | 2(1) |

# 3. Land Capability and Crop Use

## 3.1 Landscape Classification

The NSW OEH eSPADE NSW soil and land information mapping has mapped Nullamanna Station with the following land and soil capabilities:

2— Slight but significant limitations. Land capable of sustaining high impact land uses which can be managed by readily available, and easily implemented management practices.

3— Moderate limitations. Land capable of sustaining high impact land uses using more intensive, readily available and accepted management practices.

6— Very severe limitations. Land incapable of sustaining many land use practices (e.g. cultivation, moderate to high intensity grazing and horticulture). Highly specialised practices can overcome some limitations for some high value products. Land often used for low intensity land uses (low intensity grazing).

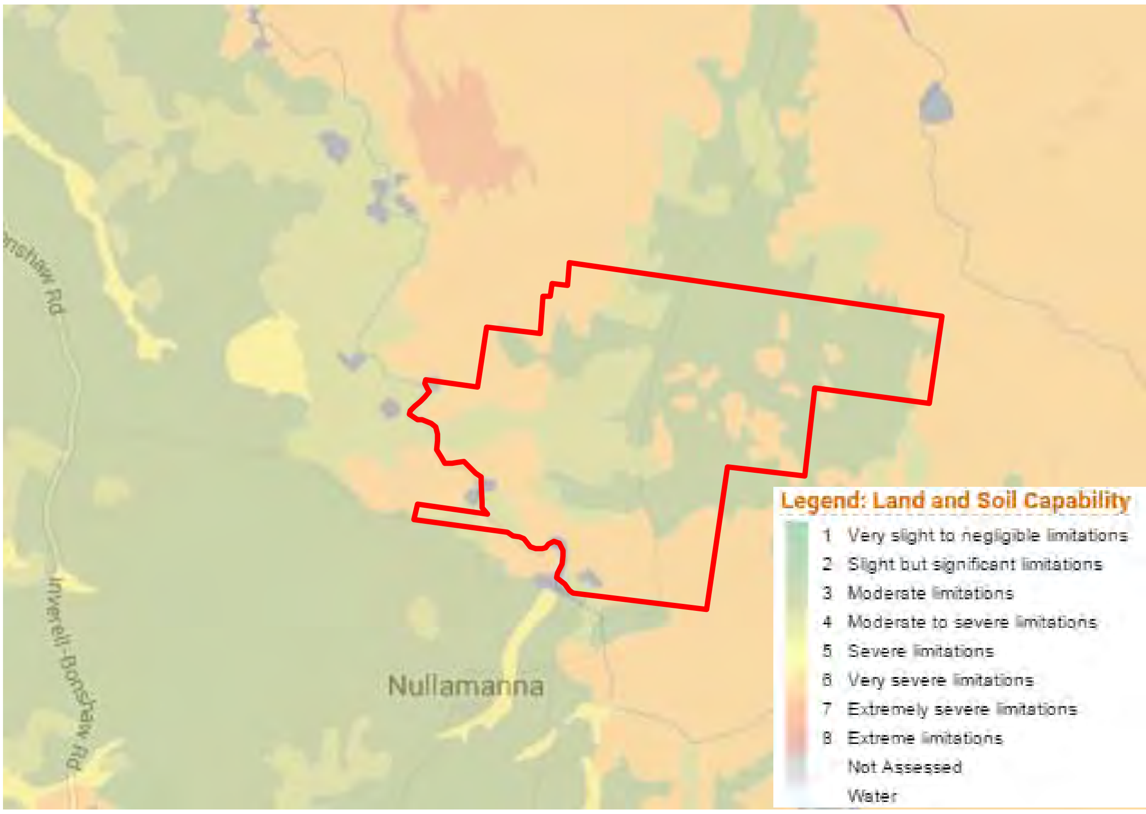


**Figure 15 Land and soil capability of the Nullamanna area**

## 3.2 Wastewater Application to Irrigable Area

Appendix D in the Statement of Environmental Effects presents the hydrological assessment of the proposed development. The modelling undertaken and described in the hydrological assessment shows that the annual average yield of wastewater from the facility is expected to be less than 20ML/year. The yield in the wettest year in 10 years is expected to be in the order of 30ML/year.

The total irrigable area proposed is 25ha. The expected average nutrient content of the treated wastewater is shown in Table 7 below.

**Table 7 Expected average nutrient content of treated wastewater**

| Attribute | pH | EC (dS/m) | TS (%) | TN (mg/L) | TP (mg/L) | K (mg/L) | Na (mg/L) |
|---|---|---|---|---|---|---|---|
| **Average (Watts *et al.* 1994; Skerman 2000, ICIAI 1997)** | 7.43 | 13.6 | 0.25 | 720.55 | 103.76 | 2370 | 260 |
| **Average Annual WW Generation (ML)** | | | | 5.782 | | | |
| **Mass (kg/ha)** | NA | NA | 2,190.15 | 631.25 | 90.9 | 2076.26 | 227.78 |
| **Losses in Wastewater (Wet Weather Storage) (kg/ha)** | NA | NA | 50%: | 40-70% (50%)^: | 10-40 (25%)#: | 10%: | - |
| | | | 1095.08 | 315.62 | 22.73 | 207.63 | |
| **Irrigation Application (kg/ha)** | NA | NA | **1095.08** | **315.62** | **68.18** | **1868.64** | **227.78** |

^ Volatilization (denitrification and evaporation)

# Chemical precipitation and deposition in algae detritus (sludges)

## 3.3 Capability of Soils for Irrigation

### 3.3.1 Expected Leaching Fraction (LF)

The soils are vertosols. They deliver a useful soil to sustain irrigated agriculture. The wet season delivers a moisture surplus. This significant episodic event provides a leaching fraction.

The SALF program was used to assess the leaching fraction of the soil profile in the proposed irrigation area.

Parameters consistent with the soil profile as it is were used. Based on the model, the leaching fraction is estimated to be about 3.8mm/year (average). Peak deep drainage under wet seasons can be 5-10 times this amount. The model shows that this will adequately remove deleterious salts (sodium) from the soil profile so that they do not accumulate. The expected soil water concentration of the salts is also very low and no salinity impacts are expected.

Given the leaching fraction; ongoing careful management of potential loss of nitrogen and phosphorus is important. This is best achieved by:

- Frequent moderate applications of irrigation;
- Maintaining an active plant growth;
- Maximising organic matter content to maximise nutrient holding capacity;
- Management of soil meta-metal balances by application of gypsum/lime, and,
- Maximising nutrient recovery by crop harvest.

### 3.3.2 Expected Crop Production Capacity

#### Crop Type

Improved pasture will be grown in the irrigable area. It will be cut for hay. Forage sorghum, Lucerne and medics maybe under / over sown into the pasture from time to time.

#### Dry Matter Production

The dry matter production from improved pastures in the irrigable area is anticipated to be 10T DM/ha/year as hay through multiple cuts.

With a total annual DM harvest of 10T/ha, hay production will use about;

- 250 kg/ha of Nitrogen (N),
- 35kg/ha of phosphorus (P) and

- Over 300 kg/ha of potassium (K) each year.

### 3.3.3 Crop Water Requirements

The annual average rainfall for Inverell is 798.7 mm, whilst the annual average evaporation is 1603.1 mm (Table 8). Thus the average moisture deficit is in excess of 800 mm/year. This is equivalent to an annual average water deficit of 8ML/ha/year.

**Table 8 Rainfall and evaporation data for Inverell Research Station (BOM 2015)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean rainfall (mm) | 100.0 | 96.8 | 68.0 | 40.7 | 48.5 | 44.5 | 48.4 | 43.6 | 47.6 | 75.0 | 86.6 | 99.2 | 798.7 |
| Mean monthly evaporation (mm) | 207.7 | 168 | 161.2 | 114 | 83.7 | 60 | 62 | 86.8 | 117 | 158.1 | 180 | 204.6 | 1603.1 |

Crop water use is proportionate to the evaporation and consequent transpiration of the environment. A Crop Factor is applied to the evaporation to determine a transpiration rate. The Crop Factor considers soil and climatic factors to accurately determine the transpiration rates in different conditions.

Given the soil type, selected cropping regime, and considering the climatic data, a crop factor of 0.5 has been applied for all months. Given crop factors for improved pasture, the expected irrigation demand is in the order of 4-8ML/ha/ year.

The 5.8 ML/yr of available treated wastewater when applied across 6.6 ha with an efficiency of 90 % will supply only 0.87 ML of water per ha per year. This is not sufficient to meet the irrigation demand for a fully irrigated improved pasture.

## 3.4 Nutrient Management

### 3.4.1 Nutrient budget

A nutrient budget is provided in Table 7 above. It shows the input and outputs for the proposed irrigation area, given the proposed wastewater application rate and the crop production from the area.

Expected wastewater constituents are expressed in Table 9 (per the Hydrological Assessment report provided in Appendix D of the Statement of Environmental Effects). It is from these data that application rates can be calculated.

With the P sorption, evapotranspiration rates and the removal of nutrients through harvesting of the improved pasture for silage and hay, removal rates can be determined.

**Table 9 Nutrient Budget (kg/ha/year)**

| | Total Solids kg/ha | N kg/ha | P kg/ha | K kg/ha | Na Kg/ha |
|---|---|---|---|---|---|
| **Inputs** | | | | | |
| Fertiliser | 0 | 0 | 0 | 0 | 0 |
| Wastewater | 1095 | 315 | 68 | 1868 | 228 |
| **Outputs** | | | | | |
| Runoff[(a)] | - | 40 | 4 | 400 | 100 |
| Loss from Field | 500 | 158 | 0 | 0 | 0 |
| LF[(b)] (allowable) | 0 | 5 | 0.1 | 10 | 100 |
| Harvest | 10,000 | 250 | 35 | 300 | 2 |
| Phosphorus Sorption | - | - | 48[(c)] | - | - |
| **Change** | -9405 | -138 | -19 | 1158 | 28 |

(a) Annual average runoff will be ~40mm/ha or 0.4ML/ha. Runoff will carry some organics containing some nutrient, and, will preferentially dissolve and carry dissolvable ions especially potassium and sodium (that dissolve readily);

(b) LF = Leaching Fraction. Quantities based on concentrations in ANZECC guideline values for waters.

(c) Life of irrigable area 50years

The following assumptions were made in the preparation of Table 9:

- Composted manure is applied based on agronomic advices and if only a nutrient deficit exists;
- Harvest of pasture crops removes 10,000kg of dry matter per ha per year; and,
- The design life is 50 years (for exhaustion of P sorption in soils).

From Table 9 above it is concluded that:

- The application of wastewater to the wastewater utilisation areas will not result in excess nutrient availability (N and P);
- Some accumulation of K occurs and this is expected to be compensated by plant luxuriant uptake and,
- The health of the soil will be directly related to management of organic matter (to prevent a decline) and use of lime and gypsum to manage the cation exchange balance (K and Na).

Annual soil monitoring will be undertaken to check nutrient levels in the soil. The crop type and application rates can be adjusted accordingly.

### 3.4.2 Nutrient Management

This nutrient demand is expected to exceed the nutrient application from wastewaters and as such the irrigable area will require supplementing with composted manure or inorganic fertilisers. Degradation of land and the soils within the irrigable areas is not expected.

## 3.5 Land Management

### 3.5.1 Land and Soil Management

The irrigable area must be managed to ensure that soil health is maintained. Equally it must be managed so that it is as productive as possible. To achieve these outcomes the land area and its soils will be managed to:

- Minimise weed infestations by spraying out dense infestations and careful use of residual chemicals for ongoing control to allow pastures to establish and outcompete weed species; and,

- Minimise soil compaction by limiting traffic across the irrigation area when the soil is wet; and if necessary alleviation of compaction by deep ripping with appropriate implements (tines that do not disrupt the surface soil appreciably).

### 3.5.2 Soil Amelioration

The soils are only slightly acidic to neutral which will be beneficial in nutrient solubility and availability. The addition of agricultural lime and gypsum will assist in improving soil structure.

These soils will benefit from the application of wastewater irrigation and should provide a suitable soil base for the intended cropping regime.

Over time and in regard to agronomics the soils often need "corrective calcium" additions (gypsum/lime) to rebalance the cation exchange percentages between CA:Mg:K and Na and typically some boron and potentially zinc to realise the soil potential for plant growth.

Application of amendments in the form of agricultural lime will be required to allow for utilisation of the wastewater application for fodder crops under irrigation.

The application of composted manure would also assist in increasing the structure of the soil and carbon content.

### 3.5.3 Cultural practices

The improved pasture will be maintained by separating out undesirable grass species and resowing or oversowing the land areas with improved pasture seed. Where appropriate, hybrid forage species will be added to the pasture mix to increase dry matter production (forage sorghum / millets).

Irrigation will be limited and managed so that sufficient water is applied to prevent fertiliser burn but low enough to prevent significant leaching that would carry any excess nutrient below the root zone. Generally in this circumstance irrigation would be limited to 25-50mm per irrigation event.

# 4. Conclusions and Recommendations

## 4.1 Conclusions

## 4.2 Recommendations

### 4.2.1 Design

- Some land areas will be assigned to a controlled drainage area for the feedlot. These lands will be substantially modified with topsoils and subsoils being stripped from them and the areas made impervious to water.
- Wastewater should be irrigated on elevated area selected for the proposed irrigable areas; and
- Grass embankments should be built to hold the structure firm and alleviate erosion issues.

### 4.2.2 Management Practices

- Careful management of potential loss of nitrogen and phosphorus is important. This is best achieved by:
  - Frequent moderate applications of irrigation;
  - Maintaining an active plant growth;
  - Maximising organic matter content to maximise nutrient holding capacity; and,
  - Maximising nutrient recovery by pasture crop harvest.
- Manage the irrigable areas using the following:
  - Minimise weed infestations by spraying out dense infestations and careful use of residual chemicals for ongoing control to allow pastures to establish and outcompete weed species;
  - Minimise soil compaction by limiting traffic across the irrigation area when the soil is wet; and if necessary alleviation of compaction by deep ripping with appropriate implements (tines that do not disrupt the surface soil appreciably); and,
- Maintain the improved pastures by separating out undesirable grass species and resowing or oversowing of land areas with improved pasture seed. Where appropriate hybrid forage species will be added to the pasture mix to increase dry matter production (forage sorghum / millets).
- Application of amendments in the form of agricultural lime will be required to allow for utilisation of the wastewater application for fodder crops under irrigation

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# 6. Appendices

# Appendix A. Agronomic Soil Logs Sheets

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328001.6 |
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721485.7 |
| Aspect: | West | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP 2 (3m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-10 cm | Dark Brown | Silty Sandy Clay | Dry/Soft/Medium Dense | w/gravels to cobbles | | | Y | N |
| | A2 | 10-30cm | Brown | Silty Sandy Clay | Dry/Soft/Medium Dense | w/ fine to course gravels | | | Y | N |
| | B1 | 30-100cm | Strong Brown | Clay w/fine Sand | Dry/Firm/Medium dense | | | Trace | Y | |
| * | B2 | 100-150cm | Red Brown | Clay w/fine sand | Dry/Firm/Medium dense | | | Trace | | |
| | B3 | | | | | | | | | |
| * | C1 | 150 – 300cm | Light Yellow | Clayey Sandy Gravel w/ boulders | S-F/MD-L | Saprolite “rotten rock” sandstone/mudstone (to depth) | | | | |

Photo

Other comments:

Bulk Samples at 100cm

EOH sample at 3m

| | |
|---|---|
| Parent material: | Mudstone/sandstone/meta morphosed |
| Surface drainage: | W – good |
| Surface slope: | 3-4% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 327983.8 |
|---|---|---|---|---|---|---|---|
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721517.4 |
| Aspect: | West | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP 1 (3m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-10 cm | Light Grey Brown | Silty Clay | Dry/Soft/ Medium Dense | w/course gravels | | | Y | N |
| | A2 | 10-50cm | Dark Grey Brown | Silty Clay | Dry/Soft/Loose to Medium Dense | w/ course gravels | | | | |
| * | B1 | 50-120cm | Strong Brown | Clay w/ Sand | Dry/Firm/Medium dense | t/fine to course “deco” gravel | | | | |
| | B2 | | | | | | | | | |
| | B3 | | | | | | | | | |
| | C1 | 120 – 300cm | Light Yellow | Clayey Sandy Gravel w/ boulders | S-F/MD-L | Saprolite “rotten rock” Sandstone/mudstone (to depth) | | | | |

Photo


Other comments:

Bulk Samples at 100cm

| | |
|---|---|
| Parent material: | Mudstone/ sandstone/ metamorphosed |
| Surface drainage: | W – good |
| Surface slope: | 3-4% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328057 |
|---|---|---|---|---|---|---|---|
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721545.3 |
| Aspect: | West | Current land use: | Grazing | Vegetation: | Introduced grasses | BH or TP No: | TP 3 (3m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-20 cm | Brown | Silty Clay | Dry/Soft/ Loose | t/gravels | | | Y | Trace |
| | A2 | 20-30cm | Dark Reddish Brown | Silty Clay | Dry/Soft/Loose | t/gravels | | | Y | Trace |
| * | B1 | 30-100cm | Dark Reddish Brown | Silty Clay | Moist/Soft/Loose | t/cobbles | | | | |
| * | B2 | 100-200cm | Strong Brown | Clay t/sand | Moist/Firm/Medium dense | t/cobbles, plastic clay | | | | |
| | B3 | | | | | | | | | |
| * | C1 | 200 – 300cm | Light orangey grey | Clay w/ sand and gravel | S-F/MD-L | t/cobbles | | | | |

Photo

Other comments:

Bulk Samples at 100-200cm

| | |
|---|---|
| Parent material: | Volcanics, basalt/andesite |
| Surface drainage: | W – good |
| Surface slope: | 2-3% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328135.7 |
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721602.8 |
| Aspect: | West | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP A (1.5m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-20 cm | Dark Reddish Brown | Silty Clay | Dry/Firm/Medium Dense | | | | Y | N |
| * | A2 | 20-30cm | Brown | Silty Clay | Dry/Firm/Medium Dense | Plastic | | | Y | N |
| * | B1 | 30-80cm | Red Brown | Clay t/silt and sand | Dry/Firm/Medium dense | Plastic | | | Y | |
| * | B2 | 80-120cm | Light Brown | Clay w/fine sand | Dry/Firm/Medium dense | w/course gravel to cobbles | | | | |
| | B3 | | | | | | | | | |
| | C1 | 120 – 150cm | Brown | Clayey Sandy Gravel w/ boulders | S-F/MD-L | Saprolite "rotten rock" mafic basalt (to depth) | | | | |

Photo


Other comments:

| | |
|---|---|
| Parent material: | Volcanics, basalt/andesite |
| Surface drainage: | W – good |
| Surface slope: | 2-3% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328135.7 |
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721602.8 |
| Aspect: | NW | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP C (1.5m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-20 cm | Brown | Silty Sandy Clay | Dry/Firm/Medium Dense | | | | Y | Trace |
| | A2 | 20-30cm | Strong Brown | Silty Sandy Clay | Dry/Firm/Medium Dense | | | | Y | Trace |
| * | B1 | 30-70cm | Light Brown | Silty Sandy Clay | Dry/hard/Dense | w/fine to course gravel | | | | |
| * | B2 – C1 | 70-150cm | Red Brown | Silty Sandy Clay Gravel | Dry/Hard/dense | w/ Saprolite, mafic basalt (to depth) | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Photo

Other comments:

Bulk Samples at B1

| | |
|---|---|
| Parent material: | Volcanics, basalt/andesite |
| Surface drainage: | NW – poor |
| Surface slope: | 1% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328231.3 |
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721663.7 |
| Aspect: | NW | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP D (1.5m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-10 cm | Very Dark Brown | Silty Clay t/ sand | Dry/Firm/Medium Dense | | | | Y | Trace |
| | A2 | 10-25cm | Reddish Brown | Silty Sandy Clay | Dry/Firm/Medium Dense | | | | Y | Trace |
| * | B1 | 25-70cm | Orange-Red Brown | Clay t/ silt | Moist/Hard/Dense | Plastic | | | Trace | |
| * | B2 | 70-120cm | Light Brown (some red) | Clay t/ silt and sand | Moist/Hard/Dense | w/ gravels (deco basalt) | | | | |
| | | | | | | | | | | |
| | C1 | 120-150cm | Reddish/orange brown | Clayey Sandy Gravel | Dry/Firm/Loose | w/ Saprolite, mafic basalt (to depth) | | | | |

Photo

Other comments:

Bulk Samples at B1

| | |
|---|---|
| Parent material: | Volcanics, basalt/andesite |
| Surface drainage: | NW – poor |
| Surface slope: | 1% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328288.8 |
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721600.5 |
| Aspect: | N | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP E (1.5m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-10 cm | Dark Brown | Silty Clay | Dry-Moist/Firm/Medium Dense | | | | Y | Trace |
| | A2 | 10-30cm | Dark Reddish Brown | Silty Clay | Dry-moist/Firm/Medium Dense | | | | Y | Trace |
| * | B1 | 30-80cm | Strong Brown | Clay t/ silt and sand | Dry/Hard/Dense | | | | | |
| | B2 | 80-140cm | Brown | Silty Sandy Clay | Dry/Hard/Dense | w/ gravels (deco basalt) | | | | |
| | | | | | | | | | | |
| | C1 | 140-150cm | Reddish brown | Clayey Sandy Gravel | Dry/Firm/MD-Loose | w/ Saprolite, mafic basalt (to depth) | | | | |

Photo

Other comments:

| | |
|---|---|
| Parent material: | Volcanics, basalt/andesite |
| Surface drainage: | N – good |
| Surface slope: | 2% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

| Form_06026_A | Agronomic Soil Sampling Report Sheet | EA Alliance |
|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Client:** | EAg | **Project No:** | 40850/23876 | GPS Zone | 56 | Easting: | 328113.9 |
| Property: | Nullamanna | Paddock: | | GPS Datum: | WGS84 | Northing: | 6721428.8 |
| Aspect: | N | Current land use: | Grazing | Vegetation: | Native grasses | BH or TP No: | TP B (1.5m) |

**Profile Description:**

| Sample No | Horizon | Horizon depth | Munsell Colour | Texture | Structure | Comments | pH | Mottles | Roots | Cracks |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | 0-10 cm | Light Brown | Silty Sandy Clay | Dry/Firm/Medium Dense | | | | Y | Trace |
| | A2 | 10-20cm | Brown | Silty Sandy Clay | Dry/Firm/Medium Dense | | | | Y | Trace |
| * | B1 | 20-50cm | Brown | Clay t/ silt and sand | Dry/Firm/Dense | | | | | |
| * | B2 – C1 | 50-150cm | Yellow/brown/orange | Clayey Sandy Gravel | Dry/Firm/Loose | w/ deco basalt | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Photo

Other comments:

10 from holding dams to south and west

Bulk samples at B2 – C1

| | |
|---|---|
| Parent material: | Volcanics, basalt/andesite |
| Surface drainage: | N – good |
| Surface slope: | 2-3% |
| Photos: | |
| Collector Name: | OW |
| Signature: | |
| Date: | 9/10/15 |

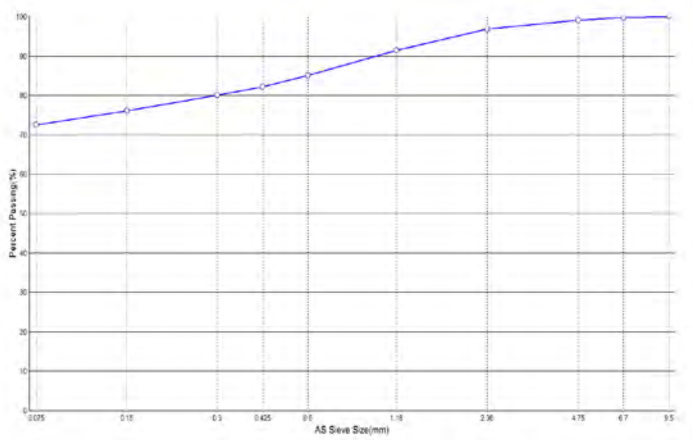
# Appendix B. Laboratory Soil Testing Certificates

SOILTECH Testing Services Pty Ltd
1300 736 724
www.soiltech.com.au

# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | **Enviro Ag Australia Pty Ltd** | Report Number: | **15196 - 2/1** |
| Client Address: | **Po Box 1775 Armidale QLD 2350** | | |
| Job Number: | **15196** | Report Date: | **15/12/2015** |
| Project: | **Nullamanna Feedlot** | Order Number: | **PEA0008880** |
| Location | **, Armidale** | **Page 1 of 2** | |
| Lab No: | **153863** | **Sample Location** | |
| Date Sampled: | **10/12/2015** | Sample ID 9729 | |
| Date Tested: | **14/12/2015** | Test Pit 2 | |
| Sampled By: | **Client** | Depth 0.3m-1m | |
| Sample Method: | **As Received** | | |
| Material Source: | **Natural** | Spec Description: | - |
| For Use As: | **-** | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: **AS1289.3.6.1**




| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | | |
| 53.00 mm | | | |
| 37.50 mm | | | |
| 26.50 mm | | | |
| 19.00 mm | | | |
| 13.2 mm | | | |
| 9.50 mm | | **100** | |
| 6.7 mm | | **100** | |
| 4.75 mm | | **99** | |
| 2.36 mm | | **97** | |
| 1.18 mm | | **91** | |
| 0.600 mm | | **85** | |
| 0.425 mm | | **82** | |
| 0.300 mm | | **80** | |
| 0.150 mm | | **76** | |
| 0.075 mm | | **73** | |

AS1726 Soil Classification: -

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | **AS1289.3.9.2** | | **67** | |
| Plastic Limit (%) | **AS1289.3.2.1** | | **26** | |
| Plasticity Index | **AS1289.3.3.1** | | **41** | |
| Linear Shrinkage (%) | **AS1289.3.4.1** | | **18.0** | |
| | | | | |
| | | | | |
| | | | | |



Approved Signatory

Drew Obst - Senior Laboratory Manager
NATA Accred No:2117

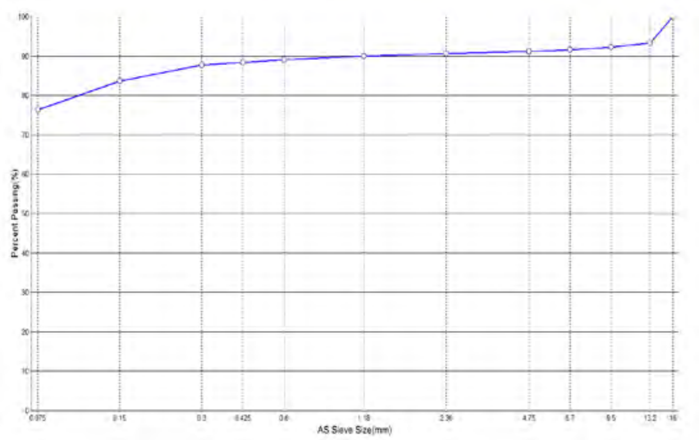
Form Number
**AQUAL-REP-3**

SOILTECH Testing Services Pty Ltd
1300 736 724
www.soiltech.com.au

# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | **Enviro Ag Australia Pty Ltd** | Report Number: | **15196 - 2/1** |
| Client Address: | **Po Box 1775 Armidale QLD 2350** | | |
| Job Number: | **15196** | Report Date: | **15/12/2015** |
| Project: | **Nullamanna Feedlot** | Order Number: | **PEA0008880** |
| Location | **, Armidale** | **Page 2 of 2** | |
| Lab No: | **153864** | **Sample Location** | |
| Date Sampled: | **10/12/2015** | Sample ID 9732 | |
| Date Tested: | **14/12/2015** | Test Pit 3 | |
| Sampled By: | **Client** | Depth 1m-2m | |
| Sample Method: | **As Received** | | |
| Material Source: | **Natural** | Spec Description: | - |
| For Use As: | **-** | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: **AS1289.3.6.1**



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | | |
| 53.00 mm | | | |
| 37.50 mm | | | |
| 26.50 mm | | | |
| 19.00 mm | | **100** | |
| 13.2 mm | | **93** | |
| 9.50 mm | | **92** | |
| 6.7 mm | | **92** | |
| 4.75 mm | | **91** | |
| 2.36 mm | | **91** | |
| 1.18 mm | | **90** | |
| 0.600 mm | | **89** | |
| 0.425 mm | | **88** | |
| 0.300 mm | | **88** | |
| 0.150 mm | | **84** | |
| 0.075 mm | | **76** | |

AS1726 Soil Classification: -

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | **AS1289.3.9.2** | | **82** | |
| Plastic Limit (%) | **AS1289.3.2.1** | | **31** | |
| Plasticity Index | **AS1289.3.3.1** | | **51** | |
| Linear Shrinkage (%) | **AS1289.3.4.1** | | **19.0** | |
| | | | | |
| | | | | |
| | | | | |

NATA WORLD RECOGNISED ACCREDITATION

**Accredited for compliance with ISO / IEC 17025**
**Laboratory Location:**
**194 Stephen Street,**
**Toowoomba, QLD, 4350**

Approved Signatory
Drew Obst - Senior Laboratory Manager
NATA Accred No:2117

Form Number
**AQUAL-REP-3**

ALS Environmental

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| **Work Order** | : **EB1537519** | Page | : 1 of 2 |
| Client | : **SOILTECH TESTING SERVICES PTY LTD** | Laboratory | : Environmental Division Brisbane |
| Contact | : DREW OBST | Contact | : Customer Services EB |
| Address | : 19 POUND ROAD<br>MILES QLD, AUSTRALIA 4415 | Address | : 2 Byth Street Stafford QLD Australia 4053 |
| E-mail | : drew@soiltech.com.au | E-mail | : ALSEnviro.Brisbane@alsglobal.com |
| Telephone | : +61 07 462 7288 | Telephone | : +61-7-3243 7222 |
| Facsimile | : ---- | Facsimile | : +61-7-3243 7218 |
| Project | : 15196 Nullamanna Feedlot | QC Level | : NEPM 2013 B3 & ALS QC Standard |
| Order number | : PEA 0008880 | Date Samples Received | : 11-Dec-2015 10:20 |
| C-O-C number | : ---- | Date Analysis Commenced | : 17-Dec-2015 |
| Sampler | : ---- | Issue Date | : 17-Dec-2015 12:57 |
| Site | : ---- | | |
| | | No. of samples received | : 2 |
| Quote number | : ---- | No. of samples analysed | : 2 |

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

## *Signatories*

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

| *Signatories* | *Position* | *Accreditation Category* |
|---|---|---|
| Kim McCabe | Senior Inorganic Chemist | Brisbane Acid Sulphate Soils, Stafford, QLD |

## General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

## Analytical Results

| Sub-Matrix: **SOIL** (Matrix: **SOIL**) | | | Client sample ID | **9729 - Test Pit 2, 0.3m to 1.0m depth** | **9732 - Test Pit 3, 1.0m to 2.0m depth** | **----** | **----** | **----** |
|---|---|---|---|---|---|---|---|---|
| | | | Client sampling date / time | [10-Dec-2015] | [10-Dec-2015] | ---- | ---- | ---- |
| Compound | CAS Number | LOR | Unit | **EB1537519-001** | **EB1537519-002** | **--------** | **--------** | **--------** |
| | | | | Result | Result | Result | Result | Result |
| **EA002 : pH (Soils)** | | | | | | | | |
| **pH Value** | ---- | 0.1 | pH Unit | **6.5** | **7.5** | **----** | **----** | **----** |
| **EA010: Conductivity** | | | | | | | | |
| **Electrical Conductivity @ 25°C** | ---- | 1 | µS/cm | **57** | **80** | **----** | **----** | **----** |

Trilab
Soil Rock Calibration

**Brisbane**
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

**Perth**
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

# PERMEABILITY BY FALLING HEAD TEST REPORT

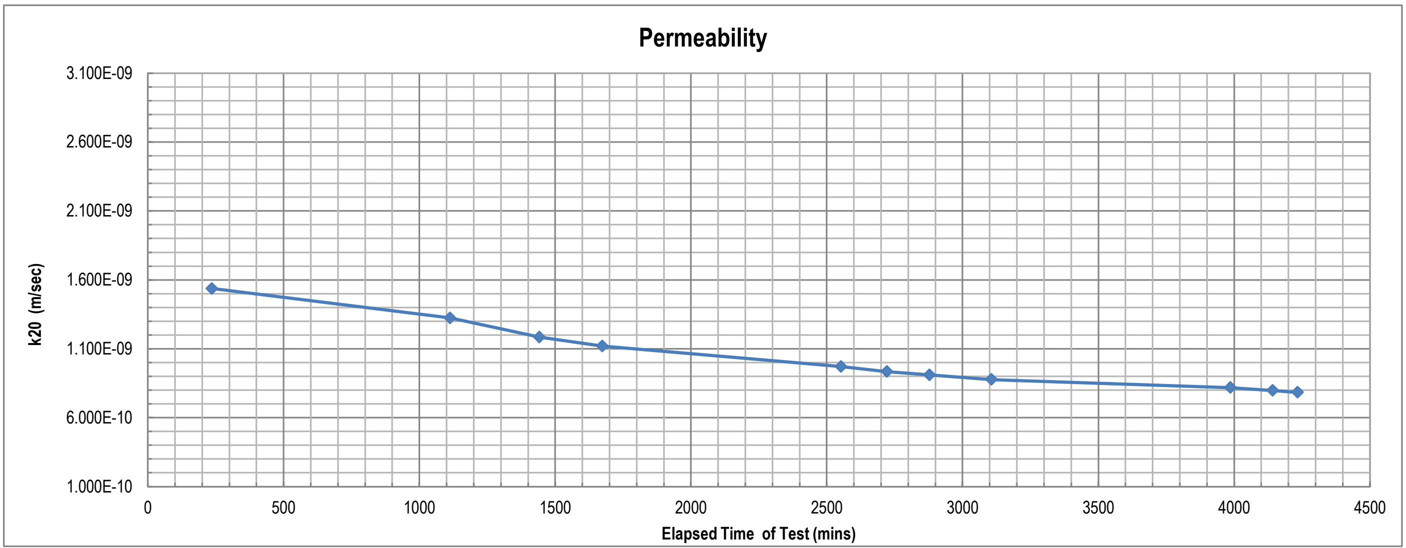
**Test Method AS 1289 6.7.2, 5.1.1 , KH2 (Based on K H Head (1988) Manual of Laboratory Testing,10.7)**

| | | | |
|---|---|---|---|
| **Client** | Soiltech Testing Services Pty Ltd | **Report No.** | 15120406-FHPT |
| **Project** | 15196 Nullamanna Feedlot | **Test Date** | 12/12/2015-18/12/2015 |
| | | **Report Date** | 18/12/2015 |
| **Client ID** | 9729 - Test Pit 2 | **Depth (m)** | 0.30-1.00 |
| **Description** | CLAY-red brown | **Sample Type** | Remoulded Soil Specimen |

**RESULTS OF TESTING**

| | | | |
|---|---|---|---|
| Compaction Method | **AS1289.5.1.1 - Standard Compaction** | | |
| Maximum Dry Density ($t/m^3$) | **1.49** | Hydraulic Gradient | **9.4** |
| Optimum Moisture Content (%) | **25.3** | Surcharge (kPa) | **2.9** |
| Placement Moisture Content (%) | **25.9** | Head Pressure Applied (kPa) | **10.79** |
| Moisture Ratio (%) | **102.3** | Water Type | **Deaerated** |
| Placement Wet Density ($t/m^3$) | **1.83** | Percentage Material Retained/Sieve Size (mm) | **0 % /9.5 mm** |
| Density Ratio (%) | **97.5** | | |

**PERMEABILITY** $k_{(20)} =$ **$8.0 \times 10^{-10}$ (m/sec)**




| | |
|---|---|
| Remarks: | The above specimen was remoulded to a target of 98% of Standard Dry Density and at 100% of Optimum Moisture Content. |

Sample/s supplied by client The compaction data was supplied by the client. **Page: 1 of 1** REP06301

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Park

NATA ACCREDITED FOR TECHNICAL COMPETENCE

**Laboratory No. 9926**

Trilab
Soil Rock Calibration

**Brisbane**
346A Bilsen Road,
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2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

# PERMEABILITY BY FALLING HEAD TEST REPORT

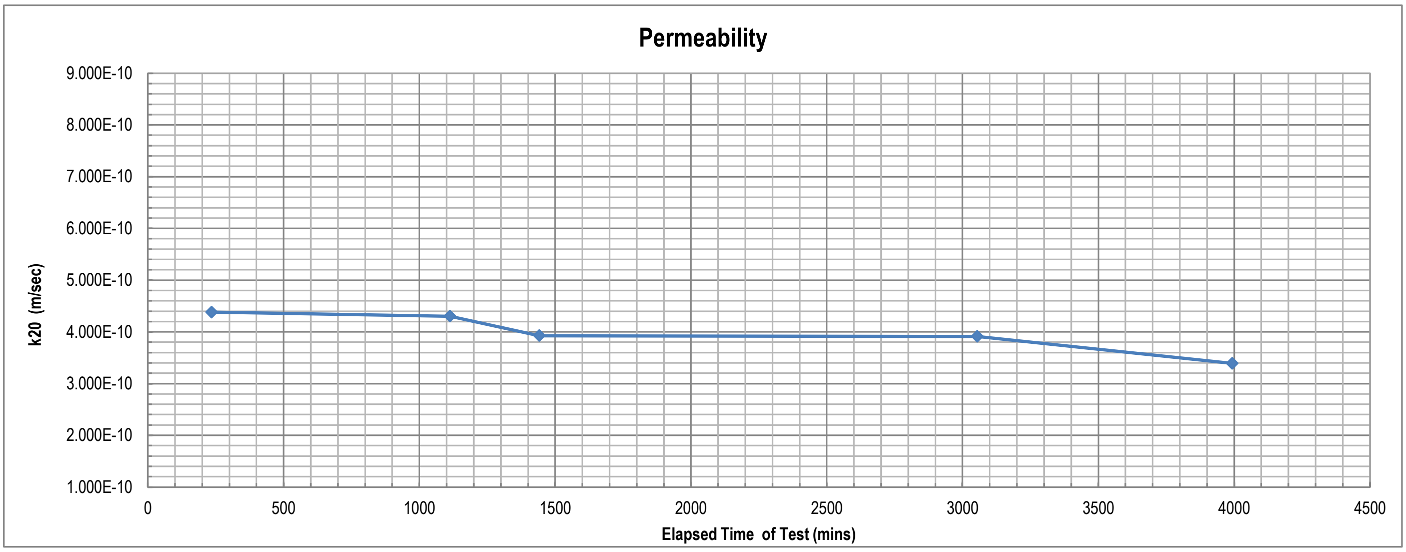
**Test Method AS 1289 6.7.2, 5.1.1 , KH2 (Based on K H Head (1988) Manual of Laboratory Testing,10.7)**

| | | | |
|---|---|---|---|
| **Client** | Soiltech Testing Services Pty Ltd | **Report No.** | 15120407-FHPT |
| **Project** | 15196 Nullamanna Feedlot | **Test Date** | 12/12/2015-17/12/2015 |
| | | **Report Date** | 17/12/2015 |
| **Client ID** | 9732 - Test Pit 3 | **Depth (m)** | 1.00-2.00 |
| **Description** | CLAY-brown | **Sample Type** | Remoulded Soil Specimen |

**RESULTS OF TESTING**

| | | | |
|---|---|---|---|
| Compaction Method | **AS1289.5.1.1 - Standard Compaction** | | |
| Maximum Dry Density ($t/m^3$) | **1.34** | Hydraulic Gradient | **9.5** |
| Optimum Moisture Content (%) | **35.4** | Surcharge (kPa) | **2.9** |
| Placement Moisture Content (%) | **35.0** | Head Pressure Applied (kPa) | **10.84** |
| Moisture Ratio (%) | **98.9** | Water Type | **Deaerated** |
| Placement Wet Density ($t/m^3$) | **1.77** | Percentage Material Retained/Sieve Size (mm) | **0 % /9.5 mm** |
| Density Ratio (%) | **98.2** | | |

**PERMEABILITY** $k_{(20)} = 3.4 \times 10^{-10}$ **(m/sec)**




Remarks: The above specimen was remoulded to a target of 98% of Standard Dry Density and at 100% of Optimum Moisture Content.

Sample/s supplied by client The compaction data was supplied by the client.



Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

**Authorised Signatory**

C. Channon

NATA ACCREDITED FOR TECHNICAL COMPETENCE

**Laboratory No. 9926**

SOILTECH Testing Services Pty Ltd
1300 736 724
www.soiltech.com.au

# Emerson Class Report

| | | | |
|---|---|---|---|
| Client : | **Enviro Ag Australia Pty Ltd** | Report Number: | **15196 - 1/1** |
| Address : | **Po Box 1775, Armidale, QLD, 2350** | Report Date : | **14/12/2015** |
| Project Name : | **Nullamanna Feedlot** | Order Number : | **PEA0008880** |
| Project Number : | **15196** | Test Method : | **AS 1289.3.8.1** |
| Location: | **Nullamanna Station** | **Page 1 of 1** | |

| | | | | |
|---|---|---|---|---|
| Sample Number : | 153863 | 153864 | | |
| Test Number : | TP2 | TP3 | | |
| Sampling Method : | As Received | As Received | | |
| Date Sampled : | 10/12/2015 | 10/12/2015 | | |
| Date Tested : | 11/12/2015 | 11/12/2015 | | |
| Material Type : | Soil | Soil | | |
| Material Source : | Natural | Natural | | |
| Lot Number : | - | - | | |
| Sample Location : | Sample ID 9729<br>Test Pit 2<br>Depth 0.3m-1m | Sample ID 9732<br>Test Pit 3<br>Depth 1m-2m | | |
| Primary Water Type : | Distilled Water | Distilled Water | | |
| Primary Soil Description : | Brown Orange Slightly Sandy Silty Clay | Brown Silty Clay with a trace of Gravel | | |
| Primary Temperature : | 23 | 23 | | |
| Primary Emerson Class Number : | **Class 5** | **Class 5** | | |
| Secondary Water Type : | - | - | | |
| Secondary Soil Description : | - | - | | |
| Secondary Temperature : | - | - | | |
| Secondary Emerson Class Number : | **-** | **-** | | |
| Remarks : | | | | |

NATA WORLD RECOGNISED ACCREDITATION

**Accredited for compliance with ISO / IEC 17025**
**Laboratory Location:**
**194 Stephen Street,**
**Toowoomba, QLD, 4350**

APPROVED SIGNATORY

Drew Obst

Drew Obst - Senior Laboratory Manager
NATA Accreditation Number
2117

SOILTECH Testing Services Pty Ltd

# Shrink Swell Index Report

| | | | |
|---|---|---|---|
| **Client:** | Enviro Ag Australia | **Report Number:** | 15196 - 3 |
| **Client Address:** | PO Box 1775, Armidale, NSW, 2350 | **Report Date:** | 15/12/2015 |
| **Job Number:** | 15196 | **Test Method:** | AS1289.7.1.1 |
| **Project:** | Geotechnical Testing | **Page:** | 1 of 2 |
| **Location:** | Nullamanna Feedlot | | |

| | | |
|---|---|---|
| **Lab No:** | 153863 | **Sample ID 9729** |
| **Date Sampled:** | 10/12/2015 | **Test Pit 2** |
| **Date Tested:** | 14/12/2015 | **Depth 0.3m - 1m** |
| **Sampled By:** | Client | |
| **Sample Method:** | U50 Tube | |
| **Material Source:** | Natural | |
| **For Use As:** | - | **Lot Number:** - |
| **Remarks:** | *Test specimen was remoulded using standard compaction at approximately the optimum moisture content* | **Item Number:** - |

| | | | |
|---|---|---|---|
| Shrinkage Moisture Content (%): | **25.1** | Swell MC Before (%): | **24.6** |
| Shrinkage (%): | **5.30** | Swell MC After (%): | **27.7** |
| Unit Weight (t/m3): | **1.937** | PP Before (kPa): | **-** |
| Swell (%): | **2.35** | PP After (kPa): | **-** |
| Shrink Swell Index (Iss%): | **3.6** | | |

| | |
|---|---|
| **Visual Classification:** | Brown Orange Slightly Sandy Silty Clay |
| **Inert Material Estimate (%):** | 2 |
| **Cracking:** | Nil |
| **Crumbling:** | Nil |

NATA WORLD RECOGNISED ACCREDITATION

**Accredited for compliance with ISO/IEC 17025.**

APPROVED SIGNATORY

Paul Sheppard

NATA Accred No: 2117

Form Number

**REP SS-1-1**

SOILTECH Testing Services Pty Ltd

15196
Enviro Ag Australia
Nullamanna Feedlot
QBCC License No: 1004554

# Shrink Swell Index Report

| | | | |
|---|---|---|---|
| **Client:** | Enviro Ag Australia | **Report Number:** | 15196 - 3 |
| **Client Address:** | PO Box 1775, Armidale, NSW, 2350 | **Report Date:** | 15/12/2015 |
| **Job Number:** | 15196 | **Test Method:** | AS1289.7.1.1 |
| **Project:** | Geotechnical Testing | **Page:** | 2 of 2 |
| **Location:** | Nullamanna Feedlot | | |

| | | |
|---|---|---|
| **Lab No:** | 153864 | **Sample ID 9732** |
| **Date Sampled:** | 10/12/2015 | **Test Pit 3** |
| **Date Tested:** | 14/12/2015 | **Depth 1m - 2m** |
| **Sampled By:** | Client | |
| **Sample Method:** | U50 Tube | |
| **Material Source:** | Natural | |
| **For Use As:** | - | **Lot Number:** - |
| **Remarks:** | *Test specimen was remoulded using standard compaction at approximately the optimum moisture content* | **Item Number:** - |

| | | | |
|---|---|---|---|
| Shrinkage Moisture Content (%): | **34.4** | Swell MC Before (%): | **36.3** |
| Shrinkage (%): | **7.88** | Swell MC After (%): | **40.5** |
| Unit Weight (t/m3): | **1.842** | PP Before (kPa): | **-** |
| Swell (%): | **3.61** | PP After (kPa): | **-** |
| Shrink Swell Index (Iss%): | **5.4** | | |

| | |
|---|---|
| **Visual Classification:** | Brown Silty Clay with a trace of Gravel |
| **Inert Material Estimate (%):** | 2 |
| **Cracking:** | Nil |
| **Crumbling:** | Nil |

| | | | |
|---|---|---|---|
| NATA WORLD RECOGNISED ACCREDITATION | **Accredited for compliance with ISO/IEC 17025.** | APPROVED SIGNATORY<br>Paul Sheppard<br>NATA Accred No: 2117 | Form Number<br>**REP SS-1-1** |