

Onsite Effluent Management Study

Appendix K



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Effluent management study

Small stock abattoir, Lot 17 DP753546 Mitchell Way, Bourke NSW



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Summary

Proposed development and situation

A small stock abattoir is proposed at Lot 17 DP753546 Mitchell way, Bourke NSW. The facility will produce approximately 174.7ML/year of effluent. Wastewater will be produced from the abattoir from the processing of sheep, lamb and goats for meat. The wastewater will be treated on-site using settlement, screening, air filtration and ponds. The wastewater will be stored in irrigation ponds and irrigated onto farmland.

The disposal of effluent by irrigation requires an assessment according to NSW Environment Protection Authority (EPA) guidelines to prevent environmental and public health risks.

Site and soil assessment

Site inspections and assessments were undertaken on 8 December 2015. The site is approximately 240ha in size. The central and eastern section of the site will contain the abattoir infrastructure including processing facility and wastewater treatment facility. The western section will be used for surface irrigation of treated wastewater. The existing primary land use of the site is sheep grazing.

The vegetation on the site consisted of sparse native shrubs, grasses and weeds. The terrain was level to very gently inclined with slopes of <1% to the south. There are no significant drainage lines on the site. No waterways are located near the site. The Darling River is located approximately 2.5kms to the east.

The soil was described from borehole profiles and analysis of representative soil samples for physical and chemical properties. Topsoil was grey, brown to red brown clayey sand to sandy clay. The subsoil typically was a grey, reddish brown, yellowish brown to brown clayey sand, sandy clay to silty clay. Subsoil depth is expected to be greater than 8m.

Chemical properties of the soil in the proposed irrigation application area were determined by analyses of representative soil samples. The level of pH in the soil across all boreholes was in the optimum range for soil stability and plant growth. The electrical conductivity of the soil in the root zone was non-saline. Most subsoils were moderately to extremely saline. Soil in the proposed application area is considered strongly sodic. The topsoil in the application area is moderately to slightly dispersive and the subsoil samples were slightly dispersive. Phosphorus sorption was determined to be 4,500kg/ha.

The effluent from the proposed small stock abattoir will be treated and classified as low to moderate strength effluent according to the DEC (2004) classification system. Phosphorus, nitrogen and biological oxygen demand concentrations were estimated based on data provided by the wastewater treatment system designer (BioChem Water).

Hydraulic and nutrient balance models were developed to calculate the required area for effluent irrigation. Nitrogen loading was calculated to be the limiting factor for irrigation. The required irrigation area is 38ha.

The assessed application area is suitable for the reuse of effluent by irrigation. Site limitations will require adoption of mitigation measures to reduce the impact of effluent irrigation. Mitigation measures include irrigation scheduling, maintenance of vegetation by crop rotations and regular application of gypsum or lime.

Ongoing monitoring will be undertaken to evaluate the effectiveness of control measures and impact on soil, surface water and groundwater.

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1. Introduction

1.1 Background

A small stock abattoir is proposed at Lot 17 DP753546 Mitchell way, Bourke NSW. Wastewater will be produced from the abattoir from the processing of sheep, lambs and goats for meat. The wastewater will be treated and disposed on-site using screening, dissolved air filtration (DAF), wastewater ponds and surface irrigation.

The disposal of effluent by irrigation requires an assessment according to NSW Environment Protection Authority (EPA) guidelines to prevent environmental and public health risks.

1.2 Scope of work

An assessment was undertaken of the liquid waste, effluent treatment and irrigation areas of the proposed abattoir. The assessment was undertaken in accordance with *Use of Effluent by Irrigation Environmental Guidelines* (DEC 2004) and *National Guidelines for Water Recycling: Managing Health and Environmental Risks* (NRMMC 2006). The assessment included:

- Site and soil assessment including limitations
- Description of the effluent, nutrient balances and irrigation sizing
- Management and mitigation measures

1.3 Statutory requirements

1.3.1 Environment protection licences

The irrigation requirements are controlled by the *Protection of the Environment Operations Act 1997* (POEO Act).

The small stock abattoir will require an environment protection licence under Schedule 1 of the *POEO Act*.

1.3.2 Other statutory requirements

Activities within national parks

The irrigation area is not located within national parks or other protected areas.

Threatened species

No threatened species were identified in the irrigation area.

Protection of drinking water supplies

The irrigation area is not located within drinking water catchments.

Animals to abattoirs

No animals will be grazed within the irrigation area.

Australian and New Zealand joint food standards code

Not applicable

2. Effluent treatment

2.1 Sources of effluent

The proposed abattoir will utilise reticulated water sourced from Bourke for the facility processes. The water will be used in several areas of the facility. The wastewater can be divided into three waste streams;

- The stockyard or holding yard will generate a wastewater flow containing contaminants such as manure and urine. The strength of the effluent water is expected to be high due to large concentrations of constituents in the water. This area is often called the “green” stream. The abattoir may utilise the dry manure for off-site purposes.
- The slaughter/evisceration area will generate low strength wastewater and contaminants will mostly be blood and fats. This area is generally called the “red” waste stream due to contamination with blood and fats in the effluent water.
- The inedible and edible offal processing area will have low to moderate strength wastewater due to the processing of internal organs.

2.2 Treatment system

The proposed abattoir will utilise a BioChem Water dissolved air floatation (DAF) system, anaerobic and aerobic ponds and a maturation pond to treat the effluent from the abattoir. This is considered a typical industry standard system in the treatment of effluent discharge from an abattoir prior to land irrigation (Figure 5). Details of the system are outlined below:

2.2.1 Screening

Raw influent will be captured in an equalisation tank to allow a constant flow to the treatment plant before being pumped through coarse screens to remove materials such as hair, paunch, manure and floating solids. This material captured will then be dewatered and the solids stored in a screenings bin for removal to a licenced landfill facility. This may be done by the use of a stationary screen, shaker screen or rotating screen.

2.2.2 Dissolved Air Floatation (DAF)

The effluent stream is then passed to a dissolved air floatation (DAF) plant for the removal of the bulk of the remaining fat and settleable solids. This process utilises bubbles of air to help in the floatation of fats which are then skimmed off the water surface. Material that settles on the bottom is also collected. Fat recovery in excess of 90% and solids recovery in excess of 70% can be achieved (Husband 1992).

2.2.3 Anaerobic treatment

The effluent will be processed in an anaerobic pond. The pond will be approximately 60 x 60m and depth of 1.2m. The anaerobic pond will be managed to produce a sealing crust cover to prevent excessive noxious odours.

2.2.4 Aerobic treatment

The effluent will be processed in an aerobic pond. The pond will be approximately 60 x 60m and depth of 4m to allow for optimum efficiency of nitrogen removal.

2.2.5 Maturation pond

The treated effluent is passed through a maturation pond where further disinfection by sunlight will occur.

2.2.6 Holding dam

A holding dam will be used to store treated effluent and provide wet weather storage. Land irrigation will occur from a large holding dam.

3. Effluent quality and irrigation considerations

3.1 Classification of effluent

Untreated effluent is classified into low, medium and high strengths (DEC 2004). The strength is determined by levels of nitrogen, phosphorus, biological oxygen demand (BOD₅), total dissolved solids (TDS) and other potential contaminants (Table 1). The different strengths have limitations for irrigation. Classification is undertaken according to the limiting constituent.

Table 1. Classification of effluent for environmental management (DEC 2004)

Constituent	Strength (average concentration mg/L)		
	Low	Medium	High
Total nitrogen	<50	50-100	>100
Total phosphorus	<10	10-20	>20
BOD ₅	<40	40-1,500	>1,500
TDS	<600	600-1,000	>1,000-2,500
Other pollutants	Effluent with more than 5 times the ANZECC and ARMCANZ (2000) long-term water quality trigger values for irrigation waters must be considered strength for the purpose of establishing a strength class for runoff and discharge controls and will require close examination to ensure soil is not contaminated.		
Grease and oil	Effluent with more than 1,500mg/L of grease and oil must be considered high strength and irrigation rates and practices must be managed to ensure soil and vegetation is not damaged.		

The quality of the wastewater anticipated to be generated by the small stock abattoir and subsequently processed through the wastewater treatment plant is summarised in Table 2.

A BioChem wastewater treatment system is proposed as described in Section 2.2. The designer has predicted the wastewater treatment system will reduce the level of constituents to the levels described in Table 2.

Table 2. Influent and effluent constituents in abattoir wastewater (BioChem Water)

Constituents	Influent (mg/L)	Treated effluent (mg/L)
BOD	2,000	<10
TSS	1,400	<10
TDS	3,500	1200
FOG	790-3,350	<2
TKN	230-260	45
NH ₃	<5	<5
TP	30-50	10
pH	6.5-8.0	7-8.0

3.2 Organic matter

Organic matter in irrigation water can contribute to soil fertility. Overloading with organic matter can clog soil pores, favour anaerobic soil microbes and lead to a coating on the soil, blocking pores and closing up cracks. DEC (2004) recommends an average loading rate of 1,500kg/ha/month as the maximum organic loading for most soils.

BOD levels in treated effluent has been estimated to be 10mg/L for the development (Table 2). Critical loading rate of BOD that will be used in the nutrient balance calculations is 930kg/ha/month (3,000mg/m²/day) (NSW Department of Urban Affairs 1998)

3.3 Solids

High concentrations of solids in irrigation water may coat leaf surfaces reducing plant vigour or obstruct some types of sprinkler nozzles resulting in operational problems. Suspended solids may provide a substrate for other pollutants such as heavy metals and pathogens and high turbidity can decrease the effectiveness of chlorine disinfection if used to treat the effluent.

The concentration of suspended solids in the treated effluent has been estimated to be 10mg/L (BioChem Water).

3.4 Nutrients

Nutrients in irrigation water are generally beneficial to plant growth and are not required to be removed when it can be demonstrated that the irrigation area effectively uses the nutrients both in the short and long term.

3.4.1 Nitrogen

The expected concentration of nitrogen in effluent prior to treatment is 250mg/L (Australian Meat Processor Corporation 2012). The proposed treatment system is expected to reduce nitrogen levels to 45mg/L (BioChem Water). Critical loading rate of nitrogen on summer crops and winter cereals that will be used in the nutrient balance calculations is 300kg/ha/month (82mg/m²/day) (Meyer *et.al* 1994).

3.4.2 Phosphorus

The typical concentration of phosphorus in untreated effluent in abattoirs is 30-50mg/L (Australian Meat Processor Corporation 2012). The proposed treatment system is expected to reduce the phosphorous concentration in the wastewater to 10mg/L (BioChem Water). Critical loading rate of phosphorus is based on removal by plants and soil sorption capacity. The loading rate of phosphorus used in the nutrient balance calculations is 15kg/ha/month (3mg/m²/day) (NSW Department of Urban Affairs 1998)

3.4.3 Potassium

Low levels of potassium are expected to be contained in the effluent.

3.5 pH

Effluent with a pH between 5 and 8.5 is generally acceptable for use in irrigation and will not impact on soil pH. Wastewater entering anaerobic ponds during the treatment process requires a pH range of 6.7-8 for the process to work effectively (Australian Meat Processor Corporation 2012). The average pH in untreated effluent from a livestock abattoir is 7.3 (Husband 2015). It is expected that the pH of the treated wastewater will be 7.0-8.0 and is within the range considered acceptable for irrigation.

3.6 Chemical contaminants

No persistent chemical contaminants will be utilised in the processing facility. Some detergents and disinfectants will be used in cleaning however these products will be biodegradable.

3.6.1 Metals

Some metals are essential for plant growth but become toxic when at elevated concentrations. DEC (2004) provides guideline values for levels of metals in irrigation water for long term use (Table 3).

The levels of metals in the effluent from the proposed small stock abattoir is expected to be low.

3.6.2 Synthetic organic compounds

Contamination of surface and groundwater by synthetic organic compounds may have a detrimental effect on wildlife. Aquatic organisms are sensitive to synthetic organic compounds and will exhibit effects from exposure at levels which have little or no effect on plants or mammals. Synthetic organic compounds include organochlorine pesticides (OCP), polychlorinated biphenyls (PCB) and organophosphorus pesticides (OPP). DEC (2004) recommends total concentration of synthetic organic compounds in effluent used for irrigation be less than 0.001mg/L (DEC 2004).

The proposed small stock abattoir will be utilising reticulated water sourced from the Bourke Shire Council for the facility and no contamination is expected from the water or during the livestock processing in the facility. The levels of synthetic organic compounds in the effluent are expected to be nil to very low.

Table 3. Trigger values for metals in long term irrigation water

Analyte	Long term irrigation trigger value (mg/L)
	DEC (2004)
Aluminium	5.0
Arsenic	0.1
Cadmium	0.01
Chromium	0.1
Copper	0.2
Lead	2.0
Nickel	0.2
Zinc	2.0

3.6.3 Herbicides

No herbicides will be contained in the wastewater.

3.7 Mineral salts

Effluent with a high electrical conductivity or TDS may result in soil salinity. Salinity levels in irrigation water may also impact on surface and groundwater quality. Sodicity degrades soil structure by breaking down clay aggregates, which makes the soil more erodible and less permeable to water and reduces plant growth. Gypsum or lime can reduce the impacts of salinity.

A typical analysis of total TDS from untreated abattoir wastewater is 3,500mg/L (Matheyarsu *et al.* 2015). Primary and secondary treatment of the effluent will reduce the amount of TDS in the wastewater to 1,200mg/L allowing disposal via land irrigation.

A general guide to water salinity ratings is outlined in Table 4 however other factors such as soil characteristics, climate, plant species and irrigation management must be considered before defining the suitability of irrigation water (DEC 2004).

Table 4. General irrigation water salinity ratings based on electrical conductivity (DEC 2004).

EC (dS/m)	Water salinity rating	Plant suitability
<0.65	Very low	Sensitive crops
0.65-1.3	Low	Moderately sensitive crops
1.3-2.9	Medium	Moderately tolerant crops
2.9-5.2	High	Tolerant crops
5.2-8.1	Very High	Very tolerant crops
>8.1	Extreme	Generally too saline

3.8 Specific ions

3.8.1 Sodium

Excessive sodium levels relative to calcium and magnesium can adversely affect plant growth, soil structure and permeability. Salt in effluent from abattoir wastewater comes from animals, water supply and chemicals used in the process.

A typical concentration of sodium found in abattoir wastewater is 250mg/L (Meat and Livestock Australia 2005).

The sodium adsorption ratio (SAR) is a ratio of the sodium to the combination of calcium and magnesium (beneficial elements) in relation to known effects on soil dispersibility. The SAR value for the proposed abattoir has been estimated using industry data. It is expected that the average SAR value of the abattoir wastewater at Bourke is 11 (Meat and Livestock Australia 2005).

3.8.2 Chloride and chlorine

Excess levels of chloride and chlorine can damage vegetation. Evidence of damage includes burning of leaf tips or margins and bronzing and premature yellowing of leaves.

Chloride may be present in abattoir wastewater in low concentrations with sodium as salt. Chlorine may be used in the disinfection of wastewater during the treatment process. Chlorine and chloride levels in the wastewater from the livestock facility is expected to be low.

3.8.3 Alkalinity

The alkalinity of wastewater from abattoirs has not been determined. The source of the wastewater is from reticulated water and alkalinity is expected to be low. No criteria level is recommended for alkalinity.

3.8.4 Bicarbonate

No criteria level for bicarbonate is recommended for effluent irrigation. The bicarbonate level is expected to be low as the water is from reticulated town water sources.

3.8.5 Boron

Boron levels in the effluent water have not been determined. Levels are not expected to be high in the source water or effluent.

3.8.6 Fluoride

The levels of fluoride are important for grazing stock. Fluoride may be present in the source water. The effluent water may be used to produce feed for stock. Regular animal health checks may be required to check for symptoms of excess fluoride intake. Plants have a high tolerance to fluoride. The level of fluoride in the wastewater has not been determined.

3.9 Oil and grease

Oil and grease in effluent at high rates can block irrigation systems and soil pores resulting in anaerobic conditions which will reduce plant growth and create odours.

The average concentration of oil and grease found in untreated wastewater from abattoirs is 790-3,550mg/L (McPhail 2015) (Table 2). The wastewater treatment process is expected to reduce oil and grease to less than 2mg/L.

3.10.2 Other effluent type

No other effluent types are included in this assessment.

4. Site considerations

4.1 Location

A site and soil assessment was undertaken at the proposed application area at Lot 17 DP753546 Mitchell Way, Bourke NSW (Figure 1).

4.2 Area and lot sizes

The total lot size is approximately 240 hectares. The western section comprising 89 hectares was assessed for the suitability of the application of treated effluent.

4.3 Current land use

The current land-use of the site is small scale sheep grazing.

4.4 Climate

The climate is typical of a semi-arid environment with a mean annual rainfall of 325mm and potential evaporation of over 2,000mm annually. The rainfall is slightly summer dominated with a mean maximum in February (42.2mm) and minimum in April (12.8mm). Temperature varies from mean maximum in January (36.6°C) to a minimum in July (4.6°C). Potential evaporation is greatest in January and lowest in July.

5. Detailed site and soil assessment

An assessment of the proposed irrigation site was made from a desktop study and field inspection. Information for the desktop study was obtained from topographic maps, aerial photographs and database searches.

Site inspections and assessments were undertaken on 8 December 2015. The landform was described and subsurface investigations undertaken. Boreholes were constructed with a truck mounted EVH Auger drill to a depth of 8.8 metres or drill refusal due to rock. Soil samples were collected for profile description and determination of characteristics by laboratory analysis.

5.1 Sampling plan and methodology

Fourteen boreholes were constructed on 8 December 2015 to provide information on the soil profiles and enable sampling. Seventeen discrete soil samples were collected on a systematic pattern from the assessment area on a grid pattern of approximately 200-300m. The sampling density was undertaken in accordance with McKenzie *et.al* 2008. Five boreholes were drilled to depths greater than the required depth of 1.5m to test for shallow groundwater and bedrock.

5.2 Land-use

The site is located approximately 14km to the north of Bourke in a rural area that is extensively used for livestock grazing. The lot is currently used for sheep grazing. Neighbouring land-use in all directions is rural sheep and cattle grazing.

There is no infrastructure located on the lot.

No irrigation of effluent has occurred on the site in the past 5 years.

No land-use conflicts have been identified from the current use of the site.

No previous investigations are known to have been undertaken on the site.

5.3 Topography

The terrain is level to very gently inclined lower-slope with a slope of 1%. The site has a slight southern aspect and a high exposure.

The site has an elevation of 111m in the northern section to 114m in the south. It is approximately 5-6m in elevation above the Darling River which lies 4.3km to the east. The site is not situated in the Darling River floodplain and has a low flood potential. Soil technical reports from NSW Environment and Heritage eSpade database state that subsoil erodibility is low and erosion hazard is low for soils that occur in and around the application area. Erosion hazard is further reduced by maintenance of adequate vegetation cover.

5.4 Vegetation

The site has been partially cleared of native tree species for grazing. The site consists of predominantly grasslands with some trees. Whitewood is the predominant tree species and are found scattered throughout the site. The site also contains native grasses, shrubs and flowers and weeds. The native grasses, shrubs and flowers include Warrego Grass, Mueller's Saltbush, Mallee Saltbush and Everlasting Daisy. Weeds include Goathead Burr.

No areas indicating salinity are located on the site from visual inspection of the soil or plant species or density. No areas contained highly water tolerant species.

No sensitive areas or protected ecosystems are located within 2km of the site.

5.5 Soils

Soil was assessed on the site on 8 December 2015 by drilling 14 boreholes to 8.8 metres or refusal due to rock with a truck mounted auger drill (Figure 3).

The soil profile was described and representative samples collected for the determination of physical and chemical properties.

Seventeen representative samples were analysed for a complete range of soil chemical properties including Emerson Aggregate Test, texture, colour, pH, electrical conductivity, hydraulic conductivity, available water capacity, cations, phosphorus, nitrogen and trace elements in the laboratories of Nutrient Advantage, ALS Environmental and NSW Soil Conservation Service (Table 6). The laboratory reports are presented in Appendix 3. A sampling log is presented in Appendix 2.

5.5.1 Soil landscape and geology

The site consists of plains with brown cracking and non-cracking clays, and grey cracking clays. Some surface cover of siliceous boulders to 20cm diameter with a surface mantle of fine quartz gravel.

No hardpans were identified in the soil profile.

Shallow crabhole Gilgais were identified in the investigation area.

No erosion was observed on the site.

The geology is predominantly quaternary alluvium consisting of black soil, silt, sand and minor claypans (Johnson and Menzies 1965).

5.5.2 Depth to bedrock

The depth to bedrock was determined to be greater than 8.8m. Drill refusal was encountered in Borehole 14 at a depth of 8.8 metres possibly due to an indurated layer or gravels.

5.5.3 Surface rocks, rock outcrops

No surface rocks or rock outcrops were located in the proposed irrigation area.

5.5.4 Coarse fragments

Sand and gravel were encountered in the profile; however is not a limitation to the application of effluent.

5.5.5 pH

The pH levels of the soil from the boreholes on the site were in the neutral to moderately alkaline range. The pH was within the optimum range for plant growth of 4.5 to 8.5.

5.5.6 Salinity

Salt tolerant vegetation was observed in the proposed application area. Saltbush species are scattered throughout the proposed application area. The electrical conductivity of the topsoil (0-100mm) samples tested was non-saline to moderately saline. The samples from the subsoil were moderately saline to extremely saline (Table 6) and expected to impact on salt sensitive plants. Soil salinity is a potential limitation to application of effluent.

Table 5. Soil salinity ratings based on ECe readings

Salinity rating	ECe (dS/m)*	Effects on Plants
Non saline (NS)	0-2	Salinity effects negligible
Slightly saline (SS)	2-4	Very salt sensitive plant growth restricted
Moderately saline (MS)	4-8	Salt sensitive plant growth restricted
Highly saline (HS)	8-16	Only salt tolerant plants unaffected
Extremely saline (ES)	>16	Only extremely tolerant plants unaffected

5.5.7 Cation Exchange Capacity (CEC), exchangeable cations

The CEC of the clay topsoil is high (Table 6). The levels of exchangeable potassium, calcium and magnesium in the topsoil samples expressed as a percentage of the total cations range from moderate to very high for calcium, moderate to very high for potassium, high to very high for magnesium and moderate to very high for sodium.

The calcium/magnesium ratio of the topsoil indicated that calcium and magnesium are low.

5.5.8 Soil sodicity

The topsoils were generally highly sodic with exchangeable sodium ranging between 1.6 and 14% (Table 6). Samples collected from the subsoils had very high sodicity. The sodicity has potential to result in crusting of the surface.

5.5.9 Dispersiveness

The Emerson aggregate tests (EAT) of the samples identified the topsoil samples as being slightly to moderately dispersive and the subsoil sample as slightly dispersive.

The moderately dispersive soil is a minor limitation to the application of effluent.

5.5.10 Phosphorus and phosphorus sorption

The phosphorous content in the topsoil of the samples tested ranged from very low to high.

The phosphorus sorption and the phosphorus buffer index relates to the soils capacity to immobilise phosphorous. The phosphorus sorption of the soil was estimated to be 4,500kg/ha (DEC 2004).

Phosphorus sorption is a moderate limitation to the application of effluent.

5.5.11 Soil structure

The soils were assessed to have a strong soil structure.

5.5.12 Bulk density

Bulk density was estimated to be moderate. Bulk density will not limit plant growth.

5.5.13 Permeability and water holding capacity

The soil profile is generally a strongly structured sandy clay topsoil to a depth of 300mm over a strongly structured sandy to silty clay subsoil to greater than 8,000mm. The major irrigation zone is expected to be the upper 300mm which is the rooting depth.

The permeability (K_{sat}) of the sandy clay topsoil is estimated to be in the range of 5mm/hour to 20mm/hour (Charman and Murphy 2001).

The available water holding capacity (AWHC) of the topsoil is estimated to range between 120 and 220mm of water per metre of soil. The 0.3m soil depth has capacity to hold 36mm of water. Irrigation will typically be applied when the soil is dry and before the crop becomes stressed. This is expected to be at around 80% of the AWHC of the soil. The level of water in the topsoil at 80% AWHC is 28.8mm which is a deficit of 7.2mm.

Table 6. Summary of laboratory results, Bourke Small Stock Abattoir

Analyte	E1 (100) (topsoil)	E1 (1000) (subsoil)	E3(300) (topsoil)	E3 (2000) (subsoil)	E5 (100) (topsoil)	E5 (900) (subsoil)	E6 (1000) (subsoil)	E6 (3000) (subsoil)
Colour	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
pH (1:5) (CaCl ₂)	7.8	8.1	7.9	7.9	7.9	7.9	7.9	7.4
Electrical conductivity (dS/m)	0.75	2.41	0.23	3.48	0.40	2.26	3.03	4.09
Elect conductivity, saturated extract (dS/m)	4.7	14.9	1.4	21.6	2.5	14.0	18.8	25.4
Emerson aggregate test	3	-	2	-	-	-	4	-
Organic carbon (%)	0.39	0.17	0.44	<0.15	0.35	0.26	0.22	<0.15
Nitrate (mg/kg)	21	4.7	29	4.3	2.3	1.5	1.4	1.8
Sulphate (mg/kg)	81	520	9.9	5300	43	1600	2400	3600
Phosphorus (mg/kg)	<5.0	9.4	17	9.2	8.0	<5.0	<5.0	<5.0
Phosphorus buffer index	94	71	89	55	56	69	130	62
Exchangeable potassium (%)	2.7	1.4	3.1	1.0	2.6	1.7	1.7	1.2
Exchangeable calcium (%)	63.6	55	85.2	78.6	64.2	65.7	69.6	68.9
Exchangeable magnesium (%)	21.3	20.3	8.8	10.6	23	17.8	14.5	12.3
Exchangeable sodium (%)	12.4	23.3	2.8	9.7	10.1	14.8	14.3	17.6
Cation exchange capacity (meq/100g)	36.6	47.3	34.9	65.2	29.6	42.6	56.0	62.5
Calcium /Magnesium ratio	3.0	2.7	9.7	7.4	2.8	3.7	4.8	5.6
Chloride (mg/kg)	610	2900	26	990	160	890	1000	2000
Copper (mg/kg)	1.4	1.1	1.1	0.77	1.2	1.0	1.2	0.82
Zinc (mg/kg)	0.21	0.13	0.13	0.084	0.16	0.56	0.13	0.23
Manganese (mg/kg)	7.6	2.3	3.8	1.9	11	5.0	6.3	5.9
Iron (mg/kg)	11	7.3	9.9	9.1	11	9.4	11	15
Boron (mg/kg)	2.1	10	1.5	16	2.8	9.9	8.9	5.8
Arsenic (mg/kg)	<5	-	<5	-	<5	-	-	-
Cadmium (mg/kg)	<1	-	<1	-	<1	-	-	-
Chromium (mg/kg)	19	-	17	-	20	-	-	-
Copper (mg/kg)	12	-	12	-	12	-	-	-
Lead (mg/kg)	8	-	7	-	8	-	-	-
Nickel (mg/kg)	11	-	8	-	10	-	-	-
Zinc (mg/kg)	24	-	22	-	22	-	-	-
Available water holding capacity (AWHC) mm/m	120	-	220	-	-	-	170	-
Hydraulic conductivity (Saturated hydraulic conductivity (mm/hr)	39	-	<1	-	-	-	7	-
Bulk Density (t/m ³)	1.22	-	1.35	-	-	-	1.21	-

Table 6 cont'd

Analyte	E7 (100) (topsoil)	E7(800) (subsoil)	E9(2000) (subsoil)	E10 (100) (topsoil)	E10 (1200) (subsoil)	E12 (100) (topsoil)	E12 (300) (topsoil)	E14 (600) (subsoil)	E14 (4500) (subsoil)
Colour	Brown	Brown	Brown	Grey	Grey	Brown	Brown	Grey	Brown
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
pH (1:5) (CaCl ₂)	7.5	8.0	7.9	6.9	7.9	7.6	8.1	7.8	4.2
Electrical conductivity (dS/m)	0.29	2.85	3.47	0.16	1.04	0.25	0.33	0.50	3.66
Elect conductivity, saturated extract (dS/m)	1.8	17.7	21.5	1.0	6.4	1.6	2.0	3.1	22.7
Emerson aggregate test	-	-	-	3	-	-	2	4	-
Organic carbon (%)	0.82	0.24	<0.15	0.77	0.30	0.54	0.33	0.40	<0.15
Nitrate (mg/kg)	34	16	5.9	17	3.3	5.4	7.8	4.2	<0.50
Sulphate (mg/kg)	29	2300	4100	14	260	15	7.8	32	2500
Phosphorus (mg/kg)	17	<5.0	<5.0	25	6.6	9.0	<5.0	8.7	11
Phosphorus buffer index	85	120	140	85	88	76	120	72	94
Exchangeable potassium (%)	6.7	1.7	1.0	11.1	2.9	5.1	2.3	3.3	1.2
Exchangeable calcium (%)	77.3	68.0	81.5	66.0	61.6	72.0	72.1	62.5	65.9
Exchangeable magnesium (%)	14.1	16.2	8.6	20.2	16.4	19.2	18.6	17.8	13.6
Exchangeable sodium (%)	1.8	14.1	8.9	38.4	19.1	3.8	7.0	16.4	19.3
Cation exchange capacity (meq/100g)	30.0	52.9	66.8	24.2	34.0	29.0	42.8	30.7	53.1
Calcium /Magnesium ratio	5.5	4.2	9.5	3.3	3.8	3.8	3.9	3.5	4.9
Chloride (mg/kg)	35	1400	1400	19	680	41	120	370	1600
Copper (mg/kg)	1.1	1.0	0.81	1.2	1.1	1.2	1.2	1	0.35
Zinc (mg/kg)	0.54	0.27	0.13	0.40	0.20	0.26	0.15	0.27	0.12
Manganese (mg/kg)	11	3.6	2.4	22	6.8	8.7	4.2	7.2	2.1
Iron (mg/kg)	11	7.4	7.2	23	16	13	9.6	19	72
Boron (mg/kg)	1.4	13	9.6	1.4	4.5	1.1	4.2	3.1	2.0
Arsenic (mg/kg)	<5	-	-	<5	-	<5	-	-	-
Cadmium (mg/kg)	<1	-	-	<1	-	<1	-	-	-
Chromium (mg/kg)	18	-	-	16	-	17	-	-	-
Copper (mg/kg)	13	-	-	11	-	11	-	-	-
Lead (mg/kg)	7	-	-	8	-	7	-	-	-
Nickel (mg/kg)	10	-	-	10	-	9	-	-	-
Zinc (mg/kg)	20	-	-	23	-	18	-	-	-
Available water holding capacity (AWHC) %	-	-	-	170	-	-	200	150	-
Hydraulic conductivity (Saturated hydraulic conductivity (mm/hr)	-	-	-	1	-	-	<1	6	-
Bulk Density t/m ³)	-	-	-	1.37	-	-	1.37	1.40	-

5.5.14 Heavy metals

Levels of heavy metals in the topsoil and subsoil were assessed against the *National Environmental Protection Measure, 1999* (NEPM) health investigation guidelines for land-use of residential with access to soil (HIL A). This is a conservative approach.

The levels of heavy metals in the topsoil and subsoil were below the adopted health investigation levels.

5.6 Hydrogeology

5.6.1 Surface water

No seasonal or permanent streams are located on the site. Minimal surface run-on and run-off occurs due to the level to very gently inclined topography and sandy clay soil on the site. Typically runoff drains to gilgis and drainage depressions on the site. The Darling River is located approximately 2.5kms to the east of the proposed small stock abattoir.

Crabhole Gilgais exist in the proposed irrigation area due to the presence of expanding grey clay soils.

5.6.2 Groundwater

No free groundwater was encountered during borehole construction. Mottled soil was observed in 9 boreholes from a depth of 0.7m indicating historical seasonal groundwater. No permanent groundwater occurs on the site above the sandstone.

One groundwater bore was identified in the locality (NSW Office of Water 2015). This bore is located at greater than 1km east of the site. The bore was constructed in 2000 for use as a monitoring bore by the NSW Department of Primary Industries. The bore was drilled to 14.7m. No further information is available.

Groundwater vulnerability is very low due to the absence of shallow aquifers. The site has a low rainfall and deep infiltration does not occur.

5.7 Available area for irrigation with treated effluent

The total lot size is 240ha (Figure 2). The site contains relatively uniform soils similarly impacted with limitations. Proximity of the irrigation ponds and distances to buffers are considerations for the location of the irrigation area. Approximately 89ha is suitable for irrigation with treated effluent after exclusion of buffer zones and separation distances. The area not used for irrigation can be utilised as a reserve area.

5.8 Limitations

A summary of the limitations identified on the site to the application of effluent is presented in Table 7.

Table 7. Site and soil limitations to the application of effluent

Property	Limitation (nil or slight/moderate/severe)
Slope (%)	Nil
Flooding	Nil
Landform	Nil
Surface rock outcrop	Nil
Exchangeable sodium percentage (0-400mm)	Slight to severe
Exchangeable sodium percentage (40-1000mm)	Severe
Electrical conductivity (ECe) (0-700mm)	Slight to moderate
Electrical conductivity (ECe) (700-1000mm)	Severe
Depth to seasonal high water table	Nil
Depth to bedrock or hardpan	Nil
Saturated hydraulic conductivity	Slight
Available waste holding capacity	Nil
Soil (pH)	Slight to moderate
Effective cation exchange capacity	Nil
Emerson aggregate test	Moderate
Phosphorus sorption	Moderate

6. Design considerations

6.1 Land area and storage requirements

Effluent generated from the small stock abattoir is to be treated on-site. Following primary and secondary treatment effluent will be stored in settling/evaporation ponds and an irrigation dam prior to land irrigation. Approximately 698kL of wastewater will be produced daily over 250 days of operation each year. This equates to 174.7ML of wastewater produced from the abattoir each year. The irrigation area has been designed assuming 698kL of wastewater will be produced 365 days a year. This provides a safety factor of 50%.

The irrigation demand is higher in the spring, summer and autumn months and lower in winter when storage may be required. The capacity of the holding dam will need to be sufficient to allow storage for up to 28 days where irrigation will not occur due to high soil moisture.

Irrigation will occur when soil moisture is in deficit and the crop can utilise the irrigation water. Irrigation will be undertaken year round and based on crop requirements. Irrigation will be applied at a sustainable rate to prevent accumulation of adverse soil impacts. The hydraulic and nutrient balances is a simulation of water and nutrient inputs and outputs (Appendix 6, 7, 8 and 9).

Irrigation rates will be based on crop requirements to prevent over watering and waterlogging of the soil.

6.2 Water balance

6.2.1 Precipitation

Precipitation data was sourced from the Bureau of Meteorology weather station at the Bourke Post Office. The average annual rainfall is 325mm and monthly rainfall varies between 12 and 41mm.

6.2.2 Evapotranspiration

Evaporation data was sourced from the Bureau of Meteorology weather station at the Bourke Post Office which is expected to be representative of evaporation at Bourke. The average annual evaporation is 2,190mm and monthly evaporation varies between 60 and 300mm. Evaporation exceeds rainfall.

The crop factor for summer crops and winter cereals will be 0.9 for summer and 0.7 for spring, autumn and winter.

6.2.3 Percolation

Percolation to prevent salt build up in the soil will be 1mm/day.

6.2.4 Run-off

No run-off will occur from the effluent irrigation area. The irrigation area will be bunded to prevent uncontaminated runoff entering the irrigation area and irrigated effluent moving away from the irrigation area. A cut off trench will be constructed around the irrigation block. The rate of effluent applied to the irrigation areas will not exceed permeability. Permeability of the sandy clay topsoil is estimated to be 20mm/hour. Quantity of effluent applied to irrigation areas will not exceed evaporation. Irrigation will occur when soil moisture is in deficit which is all months of the year.

6.2.5 Effluent storage

Effluent holding ponds will be required. Effluent in the pond will be maintained at 50% capacity to enable wet weather storage capacity

The ponds will be lined with a 1mm rubber liner to prevent leakages. The ponds will be bunded and not receive overland flows.

6.2.6 Supplementary irrigation

Supplementary irrigation may be required which will be sourced from the stormwater retention pond.

6.3 Nutrient loading rates

6.3.1 Nitrogen

Nitrogen utilised by the pasture or crops will be 50mg/L. Nitrogen concentration of the effluent has been estimated at 45mg/L based on data provided by the treatment system designer (BioChem Water).

Nitrogen is the limiting factor for irrigation and will require 38ha of irrigation area for removal (Appendix 8).

6.3.2 Phosphorus

The average phosphorus sorption of the sandy clay to silty clay subsoil has been estimated to be 4,500kg/ha (DEC 2004). Phosphorus sorption capacity is moderate and the system will be

designed to ensure phosphorus is retained on site (DEC 2004). Phosphorus concentration of the effluent is 10mg/L based on data provided by the treatment system designer (BioChem Water).

An irrigation area of 38 hectares is required to dispose of phosphorus over a period of 34 years (Appendix 9).

Supplementary phosphorus may be required to maintain adequate crop growth.

6.3.3 Other

Subsoil depth is greater than 8m in the boreholes across the application area.

6.4 Salinity control and salt balances

Soil electrical conductivity levels are a slight to moderate limitation to the application of effluent on the site. Leaching to prevent salt accumulation in the root zones will be utilised to control salinity. Selection of appropriate species may be required that are not saline sensitive.

Monitoring of soil salinity levels in the root zone will be undertaken on an annual basis.

6.5 Soil sodicity

Soil sodicity was determined to be a slight to severe limitation to the application of effluent on the site. Soil sodicity will be managed by application of gypsum and ripping of the soil to promote root growth. No till techniques will assist in increasing organic matter to reduce soil crusting and soil structural degradation. Vegetation cover will be maintained in un-irrigated areas.

6.6 Organic loading rates

Critical loading rate of BOD will be 930kg/ha/month (3,000mg/m²/day). BOD concentration of the effluent has been estimated to be 10mg/L based on data provided by the treatment system designer (BioChem Water).

Organic matter will require 0.2ha for removal (Appendix 7).

6.7 Heavy metals and persistent organic chemicals

The effluent is not expected to contain heavy metals or persistent organic chemicals.

6.8 Herbicides

The effluent is not expected to contain herbicides.

6.9 Model

The interactions between soil, climate, topography and the hydraulic and nutrient loadings were modelled based on the design in DUAP (1998). The irrigation area for hydraulic balance is detailed in Appendix 6, organic matter in Appendix 7, nitrogen in Appendix 8 and phosphorus in Appendix 9.

The irrigation area required per hectare for water, organic matter, nitrogen and phosphorus from simulation modelling are summarised in Table 8.

Table 8. Irrigation area from limiting factors in simulation model

Component	Irrigation area (ha)
Hydraulic	13
Organic matter	0.2
Nitrogen	38
Phosphorus	38

The limiting factor for irrigation was determined to be nitrogen. The minimum irrigation area required is 38ha. This can be undertaken within the area assessed as suitable for irrigation.

6.10 Plant selection

The proposed irrigation area should contain summer and winter crops to enable irrigation of effluent throughout the year. The selected crops may need to be salt sensitive. Suitable crops include sorghum and millet which are active in spring, summer and autumn and less active in winter in the Bourke climate. Winter cereal crops such as wheat, barley and oats are suited to the cooler months. The crops should be harvested and transported off-site. Pasture species may also be grown for hay or grazing.

Maintenance of vegetation cover will prevent occurrence of soil waterlogging.

6.11 Erosion control

The irrigation intensity will be monitored to ensure it does not result in erosion. An irrigation area of 38ha has been calculated based on nitrogen limitations to ensure rainfall and irrigation does not exceed evapotranspiration and percolation resulting in run-off but will need to irrigate bare area after sowing and germination.

Agronomic management will be undertaken to ensure the soil is not at risk of erosion.

6.12 Separation distances and management of buffer zones

DEC (2004) recommends the implementation of buffer areas to separate irrigation areas and irrigation infrastructure from neighbours and sensitive environments (Table 9). Buffer distances as recommended by DUAP (1998) and AS/NZS 1547:2012 have been included where buffer distances have not been provided by DEC (2004).

Table 9. Recommended buffer distances to neighbours and sensitive environments for low to moderate strength effluent (DEC 2004)

Sensitive area	Buffer distance (m)	Comment
Natural waterbodies	50	Protection of water quality and aquatic ecosystems. No recreational areas are located within 1km of the irrigation system.
Other water	Site specific	DUAP (1998)
Domestic wells	Site specific	No groundwater bores located within 500m of the site
Infrastructure (houses, roads, public open space)	50	Avoidance of spray drift.
Other sensitive areas	Site specific	None identified within 1km of irrigation areas.
Property boundary	12	Greater buffer distance required when boundary located downslope of application area. (AS/NZS 1547:2012) <i>On-site domestic wastewater management</i>

6.13 Irrigation

6.13.1 Method

Spray irrigation is the preferred method of application. The droplet size will be controlled to prevent drift by preventing excessively high pressure in the system design.

6.13.2 Suitable irrigation areas

Recommended irrigation area assessed as suitable for the application of effluent are described in Figures 2 to 3. The area suitable for irrigation is 38ha after exclusion of buffer zones and separation distances.

The irrigation area will be sown in rotation to ensure a crop is actively growing all year round. Areas not currently irrigated will be sown to native pastures.

6.13.3 Irrigation scheduling

Irrigation will typically be applied when the soil is dry and before the proposed crop becomes stressed. This is expected to be at around 80% of the AWHC of the soil. Soil moisture will be determined prior to irrigation events.

6.13.4 Storage management

The storage dam will need to be large enough to allow additional storage over the cooler months when irrigation is lower and used during the summer months when irrigation exceeds effluent flow rate. Storage will also be required for the irregular occasions when wet weather has prevented irrigation.

6.14 Solids management

Solids from pre-treatment will be disposed to landfill. Solids from the DAF treatment system and ponds will be dewatered, analysed for waste classification and disposed to a licensed landfill.

7. Operation and management plans

7.1 Control systems

Control systems are required to minimise risk to humans and the environment associated with the reuse of effluent by irrigation onto crops at Bourke. Table 10 identifies risks associated with the activity and control measures to be implemented to reduce the risk.

Table 10. Identified risks and control measures associated with the irrigation of effluent

Risk	Control
Human ingestion	Restrict public access Signage indicating treated effluent used to irrigate Irrigate at night Irrigate when low wind
Soil/water pollution	Monitor representative soil for nitrogen, phosphorus, exchangeable sodium percentage, pH, EC, heavy metals and pesticides (Section 6.2.2) Monitor treated effluent for irrigation volumes, biological oxygen demand (BOD), nitrogen (total), ammonia, oxidised nitrogen, oil and grease, phosphorus (total), phosphate, total suspended solids (TSS), total dissolved solids (TDS) and pH (Section 6.2.1) Monitor soil moisture No irrigation during storm events
Off-site movement - spray drift	Buffer zones Irrigate when low wind Irrigate at night
Water logging	Monitor soil moisture Monitor irrigation area Application of gypsum and deep ripping Maintenance of the vegetation Planting of crops with strong rooting systems
Sodicity	Application of gypsum and deep ripping Maintenance of vegetation cover No till agronomic management Selection of crops with vigorous establishment

7.2 Monitoring systems

Monitoring of the components of the system (treated effluent, irrigation system and irrigation area) is required to ensure satisfactory performance of the system. DEC (2004) recommends a rigorous monitoring program during the commissioning phase of the program. The sampling frequency can then be reduced based on satisfactory historical records.

7.2.1 Effluent

The treated effluent water will be required to be monitored on a monthly basis for BOD, nitrogen (total), ammonia, oxidised nitrogen, oil and grease, phosphorus (total), phosphate, TSS, TDS and pH.

Daily monitoring of irrigation volumes will also be required to allow refinement of the water and nutrient balances once the operation is established.

Samples for effluent monitoring should be collected out the irrigation storage pond outlet point.

Monitoring requirements for the effluent are described in Table 11.

Table 11. Monitoring requirements for low to moderate strength treated effluent

Analyte	Frequency
Volume irrigated	Daily
BOD	Monthly
Nitrogen (total)	Monthly
Ammonia	Monthly
Oxidised nitrogen	Monthly
Oil and grease	Monthly
Phosphorus (total)	Monthly
Phosphate	Monthly
TSS	Monthly
TDS	Monthly
pH	Monthly

7.2.2 Soil

Soil characteristics of the irrigation areas were determined during the site investigation process (Section 5).

DEC (2004) recommends monitoring of soil samples collected as follows:

- Surface soil – a composite soil sample of 40 cores per 1-2ha, taken at a depth of 0-10cm
- Soil profile – composite soil samples of 5 cores at four depth intervals to 1 metre, within a 5m diameter plot. The four depths should fall within 0-20, 20-40, 40-70 and 70-100cm depth increments.

Frequency of sampling and monitoring are described in Table 12.

Samples should be collected in close proximity to the sampling locations outlined in this report and include samples from within the effluent irrigation area and outside the effluent irrigation area.

Evaluation of the trends in the soil properties over time is recommended to be undertaken.

Inspection of the irrigation area is recommended to be undertaken prior each irrigation event. This will allow determination of soil moisture and therefore water requirements of the plants. Inspection during the irrigation event will allow an assessment to be made on efficiency of the sprinklers. Inspection following irrigation will allow assessment of potential water logging and ponding.

Table 12. Frequency of soil monitoring of irrigation areas

Analyte	Frequency of sampling	
	Surface soil	Soil profile
pH	Annually	Annually
Electrical conductivity (dS/m)	Annually	Annually
Nitrate – N (mg/kg)	Annually	Annually
Total N (mg/kg)	After 3 years	N/A
Available P (mg/kg)	Annually	N/A
Total P (mg/kg)	After 3 years	Every 3 years
Exchangeable sodium percentage	Annually	Every 3 years
Heavy metals and pesticides (mg/kg)	After 10 years	N/A
P sorption capacity (kg/ha)	3 years	3 years

Results for soil monitoring will be compared with previous results. A review of the results will determine corrective actions which may need to be adopted.

7.2.3 Surface water

Monitoring of surface water downstream of the irrigation areas is not required due to the minimal run-off from the flat topography.

7.2.4 Groundwater

Groundwater is located at a depth of greater than 8m and is not expected to be impacted by the operation. A groundwater monitoring network will be installed to monitor potential impacts from the holding ponds. The groundwater monitoring network will include:

- One monitoring bore located down hydraulic gradient from the holding ponds.
- One monitoring bore located up hydraulic gradient from the holding ponds.
- The monitoring bores will be constructed of 50mm casing with a slotted section. Gravel will be placed around the casing with a bentonite seal.

Groundwater will be monitored when water is detected in the monitoring wells.

7.2.5 Vegetation

Monitoring of vegetation will be undertaken on an annual basis. The monitoring will be a visual assessment of crop species and bare areas and will provide an indication of the presence of soil toxicities and soil degradation.

7.3 Tail water and stormwater runoff control

Run-off diversion and collection systems may be required as the effluent is classified as low to moderate strength.

The proposed irrigation area has low sensitivity with no endangered flora and fauna and no sensitive waterbodies located nearby. The effluent is low to moderate strength. Irrigation method will ensure droplet size is controlled to reduce spray drift and irrigation scheduling will ensure irrigation only occurs when the soil and crop require moisture. Water ponding in the irrigation area is expected to occur. A 15m wide vegetative buffer zone consisting of grasses, shrubs and trees will be required immediately downslope of the irrigation area to help slow down and capture any runoff that occurs from the irrigation area.

Uncontaminated stormwater will be directed around the irrigation area by use of earthen banks.

7.4 Site access

The proposed irrigation area will be irrigated with low to moderate strength treated effluent. The effluent water will be irrigated onto crops. Access should be restricted for the public, workers and animals.

7.5 Plant and animal health

Preservation of biodiversity should be considered in the management of effluent reuse schemes. Where effluents are irrigated onto fodder crops precautions to reduce the risk to animal health and productivity should be adopted.

7.6 Performance reporting

Performance reporting to the EPA and other agencies will be undertaken in accordance with the monitoring schedule.

7.7 Agronomic considerations

It is expected a pivot irrigation system will be utilised with an approximate diameter of 100m. The irrigation water will be applied to the irrigation area containing a rotation of summer and winter crops. Typical crops will be winter cereals (wheat and barley) and summer crops (sorghum and sunflower). Pastures may also be grown and cut for hay. Once off irrigation of the existing native vegetation is also considered suitable.

Grazing may occur on the pasture or crops after a 24 hour withholding period from irrigation.

7.8 Sustainability indicators

Criteria will be set where action will be taken based on monitoring results that indicate potential environmental impacts. The criteria area based on soil sampling results and visual indicator of vegetation growth.

Parameter	Criteria	Action
Effluent analytes	Greater than 2x design levels	Check treatment process
Soil analytes	Greater than 2x baseline levels	Check irrigation scheduling, application of lime or gypsum
Monitoring wells	Greater than 2x baseline levels	Investigation

8. Conclusions

Site inspections and assessments were undertaken on 8 December 2015. The site is approximately 240ha in size. The central and eastern section of the site will contain the abattoir infrastructure including processing facility and wastewater treatment facility. The western section will be used for surface irrigation of treated wastewater. The existing primary land use of the site is sheep grazing.

The vegetation on the site consisted of sparse native shrubs, grasses and weeds. The terrain was level to very gently inclined with slopes of <1% to the south. There are no significant drainage lines on the site. No waterways are located near the site. The Darling River is located approximately 2.5kms to the east.

The soil was described from borehole profiles and analysis of representative soil samples for physical and chemical properties. Topsoil was grey, brown to red brown clayey sand to sandy clay. The subsoil typically was a grey, reddish brown, yellowish brown to brown clayey sand, sandy clay to silty clay. Subsoil depth is expected to be greater than 8m.

Chemical properties of the soil in the proposed irrigation application area were determined by analyses of representative soil samples. The level of pH in the soil across all boreholes was in the optimum range for soil stability and plant growth. The electrical conductivity of the soil in the root zone was non-saline. Most subsoils were moderately to extremely saline. Soil in the proposed application area is considered strongly sodic. The topsoil in the application area is moderately to slightly dispersive and the subsoil samples were slightly dispersive. Phosphorus sorption was determined to be 4,500kg/ha.

The effluent from the proposed small stock abattoir will be treated and classified as low to moderate strength effluent according to the DEC (2004) classification system. Phosphorus,

nitrogen and biological oxygen demand concentrations were estimated based on data provided by the wastewater treatment system designer (BioChem Water).

Hydraulic and nutrient balance models were developed to calculate the required area for effluent irrigation. Nitrogen loading was calculated to be the limiting factor for irrigation. The required irrigation area is 38ha.

The assessed application area is suitable for the reuse of effluent by irrigation. Site limitations will require adoption of mitigation measures to reduce the impact of effluent irrigation. Mitigation measures include irrigation scheduling, maintenance of vegetation by crop rotations and regular application of gypsum or lime.

Ongoing monitoring will be undertaken to evaluate the effectiveness of control measures and impact on soil, surface water and groundwater.

9. References

- AS/NZS 1547:2012 *On-site domestic-wastewater management* (Standards Australia, Strathfield)
- Charman PEVH and Murphy BW (2001) *Soils: Their Properties and Management* (Oxford University Press)
- Colour: Munsell (2000) *Munsell Soil Color Charts* (Gretag Macbeth: NY)
- DEC (2004) *Use of Effluent by Irrigation Environmental Guidelines* (Department of Environment and Conservation [NSW])
- DEC (2006) *Contaminated Sites: Guidelines for the NSW Site Auditors Scheme* (NSW Environment Protection Authority, Chatswood)
- DUAP (1998) *On-site Sewage Management for Single Households* (Department of Urban Affairs and Planning: Sydney)
- Emerson: AS 1289.3.8.1-1997 Method of testing soil for engineering purposes- Soil classification tests- Dispersion- Determination of Emerson Class number of a soil analysis (Standards Australia: Homebush)
- EPA Victoria (2002) *Guidelines for Environmental Management – Disinfection of Treated Wastewater* (EPA Victoria, Southbank)
- Green J (1992) *Effluent treatment ponds* CSIRO Meat Research Laboratory and University of Queensland, 1992
- Husband P (1992) *Abattoir Waste Water & Odour Management: Workshop*, CSIRO Meat Research Laboratory and University of Queensland, 1992:27-38
- Johnson IR and Menzies IA (1965) *Enngonia 1:250 000 Geological Sheet SH/55-06, 1st edition* (Geological Survey of New South Wales, Sydney)
- McKenzie NJ, Grundy MJ, Webster R and Ringrose-Voase AJ (2008) *Guidelines for Surveying Soil and Land Resources Second Edition* (CSIRO Publishing, Melbourne)
- Meat & Livestock Australia Limited (2011) *Using covered anaerobic ponds to treat abattoir wastewater, reduce greenhouse gases and generate bio energy* (Meat & Livestock Australia Limited, North Sydney NSW)
- Myers RJK, Palm CA, Cuevas E, Gunatilleke IUN and Brossard M (1994) *The synchronization of nutrient mineralization and plant nutrient demand, The biological management of tropical soil fertility*
- NRMCC (2006) *National Guidelines for Water Recycling: Managing Health and Environmental Risks* (Natural Resource Management Ministerial Council Environment Protection and Heritage Council Australian Health Ministers' Conference)
- NSW Department of Urban Affairs (1998) *Environment and health guidelines, on-site sewage management for single households*

NSW Office of Water (accessed 2016) *Continuous water monitoring network* (<http://allwaterdata.water.nsw.gov.au/water.stm>)

Raghupathi Matheyarasu, Balaji Seshadri, Nanthi S. Bolan and Ravi Naidu (2015) *Impacts of Abattoir Waste-Water Irrigation on Soil Fertility and Productivity*, Centre for Environmental Risk Assessment and Remediation, South Australia.

Figures

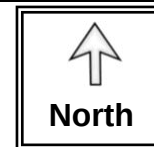
Figure 1. Locality plan

Figure 2. Plan of the proposed abattoir and investigation area

Figure 3. Site plan and borehole locations

Figure 4. Photographs of the proposed application area

Figure 5. A typical treatment process for wastewater generated from abattoirs



Location of proposed abattoir

Figure 1. Locality plan

Lot 17 DP753546 Mitchell way, Bourke NSW

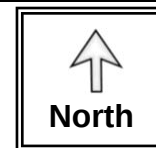
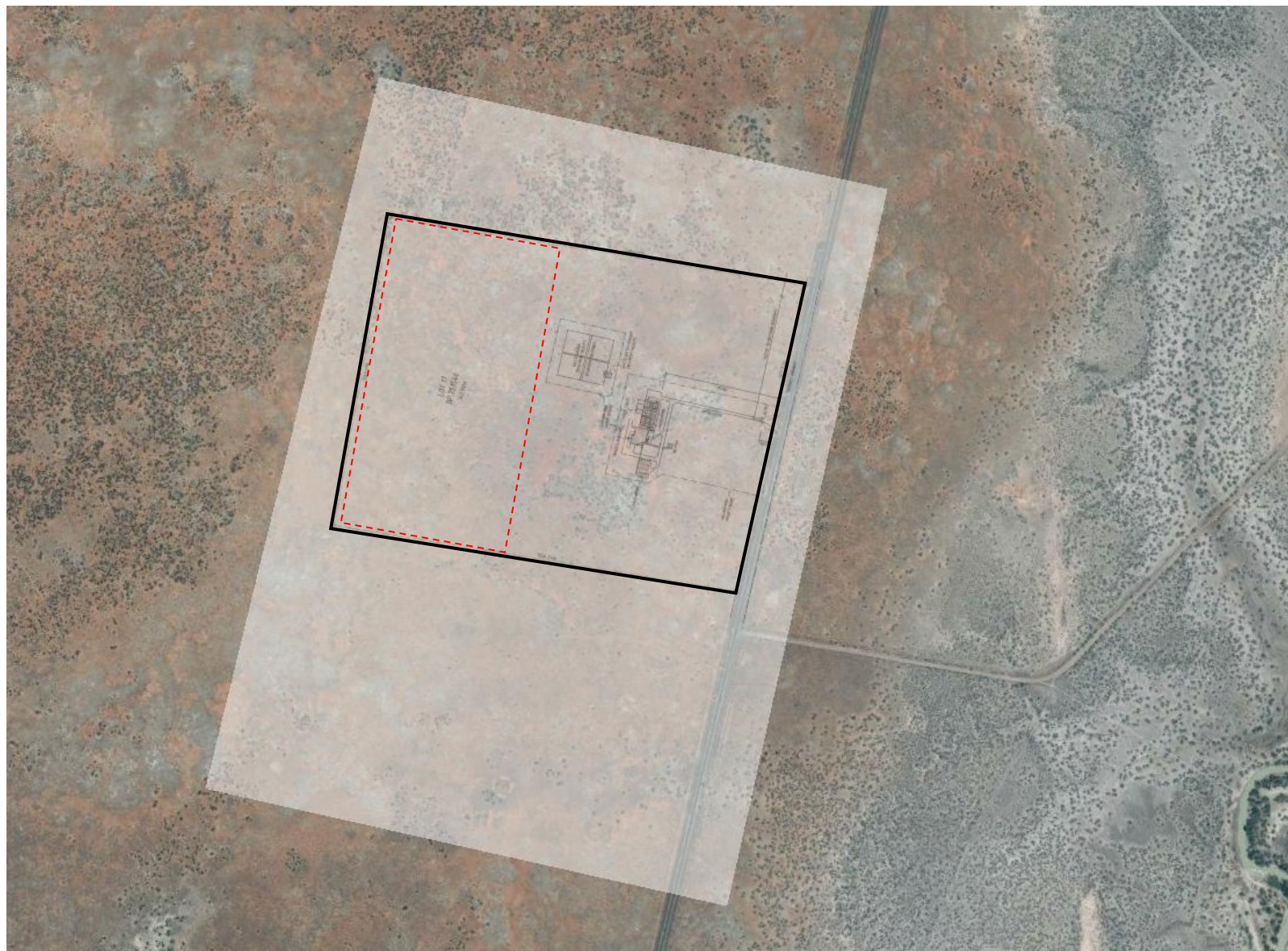


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Drawn by: PF

Date: 21/01/2016



Legend

- Investigation area
- Lot boundary

Approximate Scale 1: 25,000



Figure 2. Plan of proposed abattoir and investigation area

Lot 17 DP753546 Mitchell way, Bourke NSW

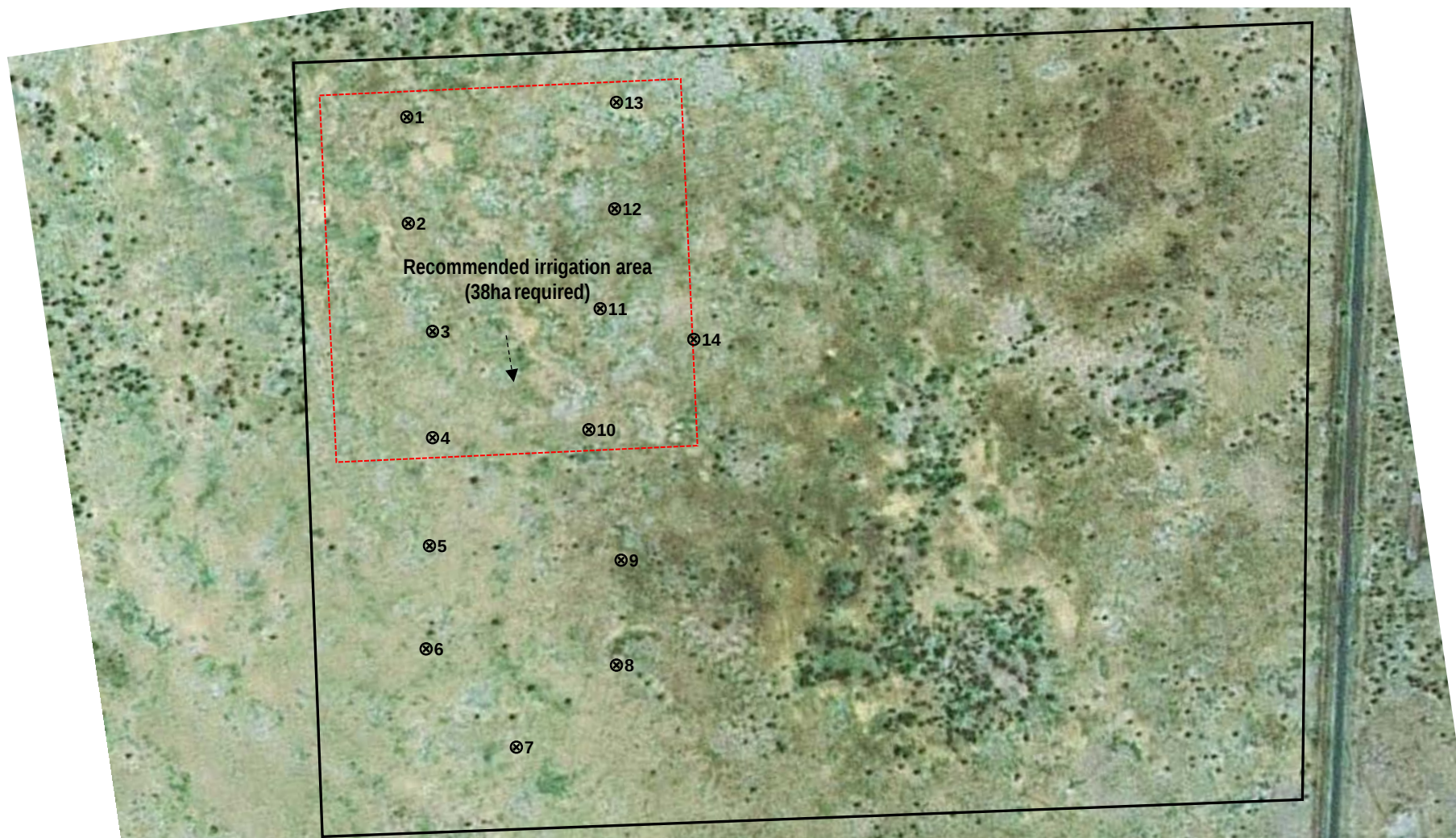


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Date: 21/01/2016



Legend

-  Recommended irrigation area
-  Borehole
-  Slope

Approximate Scale 1: 10,000

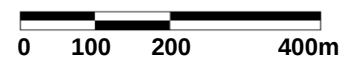


Figure 3. Site plan and borehole locations

Lot 17 DP753546 Mitchell way, Bourke NSW



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Job: R6612e1

Drawn by: LD

Date: 17/2/2016

Figure 4. Photographs of the proposed application area

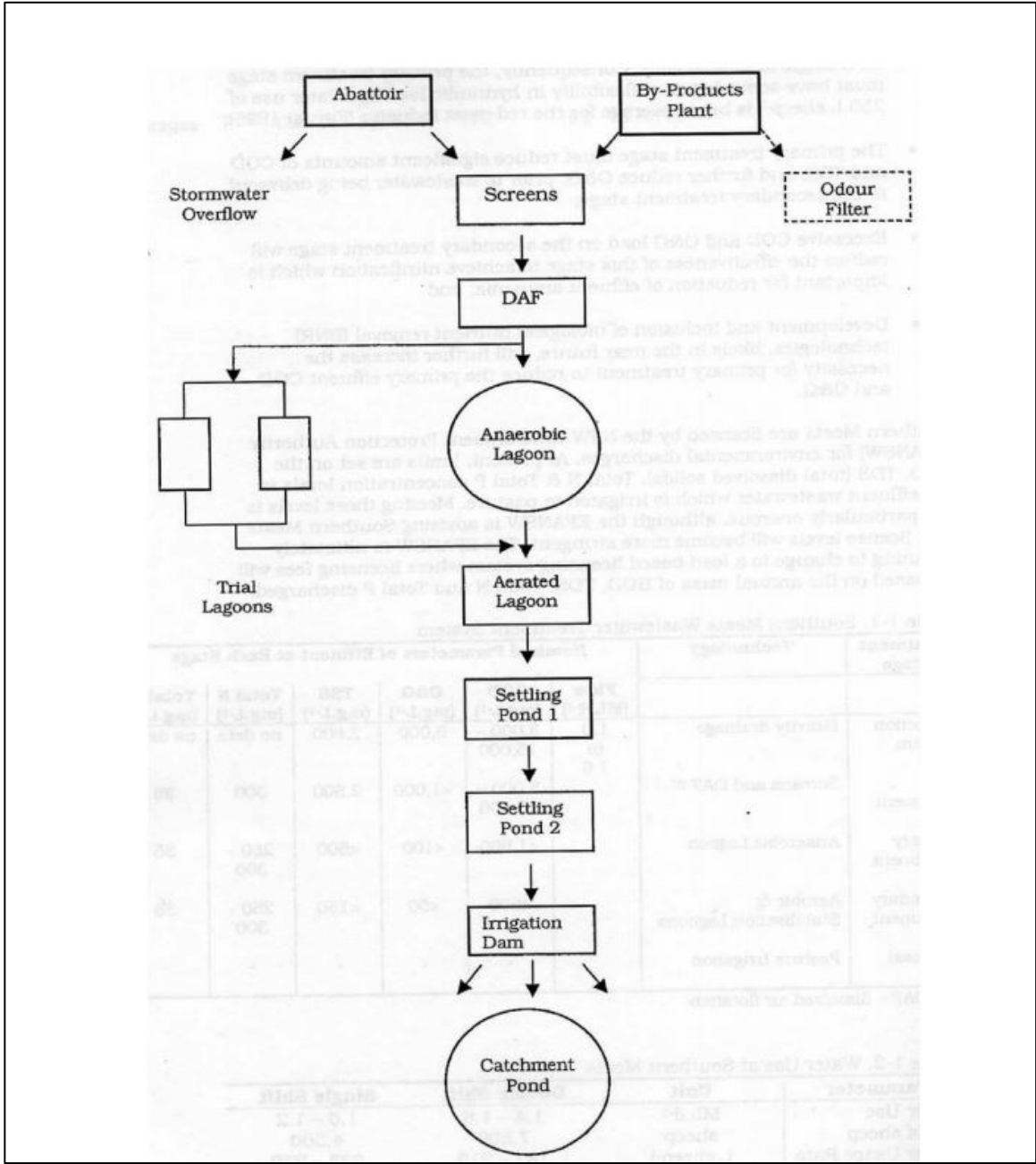


Looking north across proposed application area



Looking west across the proposed application area

Figure 5. A typical treatment process for wastewater generated from abattoirs (Meat and livestock Australia Limited, 2011)



Appendices

Appendix 1. Bore logs

Appendix 2. Sampling log

Appendix 3. Incitec Pivot Laboratory report

Appendix 4. ALS Environmental Laboratory report

Appendix 5. Scone Research Laboratory report

Appendix 6. Hydraulic balance

Appendix 7. Organic matter balance

Appendix 8. Nitrogen balance

Appendix 9. Phosphorus balance

Appendix 1. Bore logs

Depth (mm)	Description	Sampled (mm)	Texture group	Moisture
Borehole 1 (E1)	55H 402141mE, 6684808mN			
0-300	Brown to reddish brown sandy clay	X (100)	SC	D
300-1000	Yellowish brown clayey sand with gravel	X (600)	CS	D
1000-1500	Purple yellow sandy clay with silica grains	X (1200)	SC	D
Borehole 2 (E2)	55H 402130mE, 6684616mN			
0-300	Brown sandy clay	X (100)	SC	D
300-500	Reddish brown sandy clay	X (300)	SC	D
500-1200	Yellowish brown Sandy clay	X (900)	SC	D
1200-1500	Yellowish brown silty clay with calcite and grey mottles	-	ZC	D
Borehole 3 (E3)	55H 402106mE, 6684418mN			
0-200	Brown clayey sand	-	CS	D
200-700	Pale brown clayey sand	X (300)	CS	D
700-1400	Yellowish brown sandy clay	X (1000)	SC	
1400-2400	Pale brown silty clay with calcite/grey mottles	X (2000)	ZC	D
2400-3000	Yellowish grey silty clay with grey mottles	X (3000)	ZC	D
Borehole 4 (E4)	55H 402083mE, 6684251mN			
0-200	Brown clayey sand	X (100)	CS	D
200-800	Dull reddish brown sandy clay	X (600)	SC	D
800-900	Strong brown sandy clay	X (900)	SC	D
900-1500	Yellowish brown silty clay with calcite	X (1200)	ZC	D
Borehole 5 (E5)	55H 402044mE, 6684051mN			
0-300	Reddish brown sandy clay	X (300)	SC	
300-800	Brown sandy clay	X (600)	SC	D
800-1500	Yellowish brown silty clay	X (900)	ZC	D
Borehole 6 (E6)	55H 402008mE, 6683872mN			
0-400	Dark reddish brown sandy clay	-	SC	D
400-1200	Strong brown sandy clay	X (1000)	SC	D
1200-2200	Yellowish brown silty clay	X(2000)	ZC	D
2200-3000	Yellowish grey silty clay with quartz and grey mottles	X (3000)	ZC	D
Borehole 7 (E7)	55H 402059mE, 6683651mN			
0-200	Reddish brown clayey sand	X (100)	CS	D
200-900	Reddish brown sandy clay	X (600)	SC	D

Depth (mm)	Description	Sampled (mm)	Texture group	Moisture
900-1500	Yellowish red sandy clay with calcite and quartz	X (1200)	SC	D
Borehole 8 (E8)	55H 402351mE, 6683799mN			
0-200	Reddish brown clayey sand	X (100)	CS	D
200-900	Reddish brown sandy clay	X(600)	SC	D
900-1500	Yellowish red sandy clay with calcite/grey mottles	X(1000)	SC	D
Borehole 9 (E9)	55H 402360mE, 6683999mN			
0-200	Reddish brown clayey sand	-	CS	D
200-1000	Reddish brown sandy clay	-	SC	D
1000-2200	Yellowish red silty clay with grey mottles/calcite	X (2000)	ZC	D
2200-3000	Yellowish brown sandy clay with calcite/grey mottles	X(3000)	SC	D
Borehole 10 (E10)	55H 402383mE, 6684195mN			
0-200	Grey fine sandy clay	X (100)	SC	D
200-900	Greyish brown sandy clay	X (600)	SC	D
900-1300	Dark grey light clay	X(900)	LC	D
1300-1500	Grey sandy clay with calcite	X (1200)	SC	D
Borehole 11 (E11)	55H 402412mE, 6684414mN			
0-200	Reddish brown clayey sand	-	CS	D
200-700	Reddish brown sandy clay	X (600)	SC	D
700-1500	Reddish yellow sandy clay	X (1000)	SC	D
Borehole 12 (E12)	55H 402440mE, 6684589mN			
0-100	Reddish brown clayey sand	X (100)	CS	D
100-700	Reddish brown sandy clay	X(700)	SC	D
700-1100	Yellowish red sandy clay with grey mottles/calcite	X(800)	SC	D
1100-1500	Pale brown silty clay with grey mottles/calcite	X(1200)	ZC	D
Borehole 13 (E13)	55H 402440mE, 6684589mN			
0-700	Reddish brown clayey sand	X(100)	CS	D
700-1500	Reddish brown sandy clay	X(1000)	SC	D
1500-3000	Yellowish red sandy clay with grey mottles and calcite	-	SC	D
Borehole 14 (E14)	55H 402580mE, 6684336mN			
0-200	Grey brown clayey sand			M
200-1400	Grey brown sandy clay			M

Depth	Description	Sampled (mm)	Texture group	Moisture
1400-1600	Reddish brown sandy clay			M
1600-4500	Yellowish red sandy clay with grey mottles			D
4500-5000	Pale red light clay with grey and red mottles			M
5000-6000	Pale red sandy clay with grey mottles			M
6000-8800	Pale yellow sandy clay with weathered sandstone gravel			D

Appendix 2. Sampling log

Client	Saran Engineers and Managers
Contact	Jim Saran
Job number	6612
Location	Bourke
Date	7-10 th December
Investigator(s)	AR
Weather conditions	Hot

Sample id	Matrix	Time	Analysis required	Observations/comments
E1-100	Soil		Ammonium N, Nitrate N, Phosphorus (Colwell), Phosphorus Buffer Index (PBI), Exchangeable Cations (Ca, K, Mg, Na, CEC), Aluminium, Sulphur, pH & pH Electrical Conductivity, Chloride, Organic Carbon, Texture and Soil Colour, Boron, Copper, Iron, Manganese, Zinc, Moisture	Nutrient Advantage
E3-300	Soil		As for sample E1-100	Nutrient Advantage
E3-2000	Soil		As for sample E1-100	Nutrient Advantage
E5-100	Soil		As for sample E1-100	Nutrient Advantage
E5-900	Soil		As for sample E1-100	Nutrient Advantage
E6-1000	Soil		As for sample E1-100	Nutrient Advantage
E6-3000	Soil		As for sample E1-100	Nutrient Advantage
E7-100	Soil		As for sample E1-100	Nutrient Advantage
E7-800	Soil		As for sample E1-100	Nutrient Advantage
E9-2000	Soil		As for sample E1-100	Nutrient Advantage
E10-100	Soil		As for sample E1-100	Nutrient Advantage
E10-1200	Soil		As for sample E1-100	Nutrient Advantage
E12-100	Soil		As for sample E1-100	Nutrient Advantage
E12-300	Soil		As for sample E1-100	Nutrient Advantage
E14-600	Soil		As for sample E1-100	Nutrient Advantage
E14-4500	Soil		As for sample E1-100	Nutrient Advantage
E1-100	Soil		Hydraulic conductivity (Constant), Emerson aggregate test (EAT), Available Water Capacity (AWC)	Scone Research Centre
E3-300	Soil		Hydraulic conductivity, EAT, AWC	Scone Research Centre
E6-1000	Soil		Hydraulic conductivity, EAT, AWC	Scone Research Centre
E10-100	Soil		Hydraulic conductivity, EAT, AWC	Scone Research Centre
E14-600	Soil		Hydraulic conductivity, EAT, AWC	Scone Research Centre
E12-300	Soil		Hydraulic conductivity, EAT, AWC	Scone Research Centre
E1-100	Soil		Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn)	ALS Environmental
E3-300	Soil		As, Cd, Cr, Cu, Pb, Ni, Zn	ALS Environmental
E5-100	Soil		As, Cd, Cr, Cu, Pb, Ni, Zn	ALS Environmental
E7-100	Soil		As, Cd, Cr, Cu, Pb, Ni, Zn	ALS Environmental
E10-100	Soil		As, Cd, Cr, Cu, Pb, Ni, Zn	ALS Environmental
E12-100	Soil		As, Cd, Cr, Cu, Pb, Ni, Zn	ALS Environmental

Appendix 3. Incitec Pivot Laboratory report

SOIL ANALYSIS REPORT

Report Number: 477551

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544388	Paddock Name:	E1-100	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E1-100	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	380	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.8		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	4.7	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.39	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	21	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.4	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	81	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	94		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.97	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	23	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	7.7	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	4.5	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	36.6	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	12	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.0		04-026-ICP8	Calculation
pH (1:5 Water)	8.4		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.75	dS/m	04-031-PH	1:5 soil/water
Chloride	610	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.4	mg/kg	04-024-ICP6	DTPA
Zinc	0.21	mg/kg	04-024-ICP6	DTPA
Manganese	7.6	mg/kg	04-024-ICP6	DTPA
Iron	11	mg/kg	04-024-ICP6	DTPA
Boron	2.1	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

Nutrient Advantage Laboratory Services

Nutrient Advantage is a trademark of Incitec Pivot Limited
Incitec Pivot Limited - ABN 42 004 080 264
8 South Rd, Werribee Vic 3030
Toll-free: 1800 803 453 Fax: (61 3) 9974 0699
Enquiry: lab.feedback@incitecpivot.com.au

Disclaimer: This analysis report is prepared solely for the client listed above. To the extent permitted by law, Incitec Pivot Limited excludes all liability in connection with this report and, where liability cannot be excluded, limits its liability, at its election, to the re-supply of the analysis services or the cost of the re-supply of such services.

Report Number: 477551

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SOIL ANALYSIS REPORT

Report Number: 477552

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544387	Paddock Name:	E1-1000	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E1-1000	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	260	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	8.1		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	14.9	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.17	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	4.7	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	0.73	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	520	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	9.4	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	71		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.68	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	26	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	9.6	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	11	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	47.3	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	23	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	2.7		04-026-ICP8	Calculation
pH (1:5 Water)	8.3		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	2.41	dS/m	04-031-PH	1:5 soil/water
Chloride	2900	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.1	mg/kg	04-024-ICP6	DTPA
Zinc	0.13	mg/kg	04-024-ICP6	DTPA
Manganese	2.3	mg/kg	04-024-ICP6	DTPA
Iron	7.3	mg/kg	04-024-ICP6	DTPA
Boron	10	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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SOIL ANALYSIS REPORT

Report Number: 477553

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544386	Paddock Name:	E3-300	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E3-300	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	420	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	7.9		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	1.4	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.44	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	29	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.9	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	9.9	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	17	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	89		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	1.1	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	30	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	3.1	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	1.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	34.9	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	2.9	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	9.7		04-026-ICP8	Calculation
pH (1:5 Water)	8.6		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.23	dS/m	04-031-PH	1:5 soil/water
Chloride	26	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.1	mg/kg	04-024-ICP6	DTPA
Zinc	0.13	mg/kg	04-024-ICP6	DTPA
Manganese	3.8	mg/kg	04-024-ICP6	DTPA
Iron	9.9	mg/kg	04-024-ICP6	DTPA
Boron	1.5	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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Report Number: 477553

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SOIL ANALYSIS REPORT

Report Number: 477554

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544381	Paddock Name:	E3-2000	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E3-2000	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	260	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	7.9		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	21.6	dS/m	04-054-WCALC	Calculation
Organic Carbon	<0.15	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	4.3	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	5.2	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	5300	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	9.2	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	55		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.66	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	51	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	6.9	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	6.3	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	65.2	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	9.6	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	7.4		04-026-ICP8	Calculation
pH (1:5 Water)	8.0		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	3.48	dS/m	04-031-PH	1:5 soil/water
Chloride	990	mg/kg	04-063-FIA3	Soluble Chloride
Copper	0.77	mg/kg	04-024-ICP6	DTPA
Zinc	0.084	mg/kg	04-024-ICP6	DTPA
Manganese	1.9	mg/kg	04-024-ICP6	DTPA
Iron	9.1	mg/kg	04-024-ICP6	DTPA
Boron	16	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

Nutrient Advantage Laboratory Services

Nutrient Advantage is a trademark of Incitec Pivot Limited
Incitec Pivot Limited - ABN 42 004 080 264
8 South Rd, Werribee Vic 3030
Toll-free: 1800 803 453 Fax: (61 3) 9974 0699
Enquiry: lab.feedback@incitecpivot.com.au

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SOIL ANALYSIS REPORT

Report Number: 477554

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SOIL ANALYSIS REPORT

Report Number: 477555

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544379	Paddock Name:	E5-100	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E5-100	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	310	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.9		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	2.5	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.35	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	2.3	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	3.4	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	43	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	8.0	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	56		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.78	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	19	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	6.8	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	3.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	29.6	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	10	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	2.8		04-026-ICP8	Calculation
pH (1:5 Water)	8.8		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.40	dS/m	04-031-PH	1:5 soil/water
Chloride	160	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.2	mg/kg	04-024-ICP6	DTPA
Zinc	0.16	mg/kg	04-024-ICP6	DTPA
Manganese	11	mg/kg	04-024-ICP6	DTPA
Iron	11	mg/kg	04-024-ICP6	DTPA
Boron	2.8	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

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Enquiry: lab.feedback@incitecpivot.com.au

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Report Number: 477555

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SOIL ANALYSIS REPORT

Report Number: 477556

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544378	Paddock Name:	E5-900	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E5-900	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	280	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.9		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	14.0	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.26	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	1.5	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.8	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	1600	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	69		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.71	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	28	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	7.6	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	6.3	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	42.6	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	15	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.7		04-026-ICP8	Calculation
pH (1:5 Water)	8.1		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	2.26	dS/m	04-031-PH	1:5 soil/water
Chloride	890	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.0	mg/kg	04-024-ICP6	DTPA
Zinc	0.56	mg/kg	04-024-ICP6	DTPA
Manganese	5.0	mg/kg	04-024-ICP6	DTPA
Iron	9.4	mg/kg	04-024-ICP6	DTPA
Boron	9.9	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

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Enquiry: lab.feedback@incitecpivot.com.au

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Report Number: 477556

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SOIL ANALYSIS REPORT

Report Number: 477557

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544377	Paddock Name:	E6-1000	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E6-1000	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	370	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	7.9		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	18.8	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.22	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	1.4	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.3	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	2400	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	130		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.94	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	39	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	8.1	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	8.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	55.9	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	14	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	4.8		04-026-ICP8	Calculation
pH (1:5 Water)	8.0		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	3.03	dS/m	04-031-PH	1:5 soil/water
Chloride	1000	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.2	mg/kg	04-024-ICP6	DTPA
Zinc	0.13	mg/kg	04-024-ICP6	DTPA
Manganese	6.3	mg/kg	04-024-ICP6	DTPA
Iron	11	mg/kg	04-024-ICP6	DTPA
Boron	8.9	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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Enquiry: lab.feedback@incitecpivot.com.au

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Report Number: 477557

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Enquiry: lab.feedback@incitecpivot.com.au

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SOIL ANALYSIS REPORT

Report Number: 477558

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544376	Paddock Name:	E6-3000	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E6-3000	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	290	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.4		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	25.4	dS/m	04-054-WCALC	Calculation
Organic Carbon	<0.15	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	1.8	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	2.2	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	3600	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	62		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.75	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	43	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	7.7	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	11	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	62.5	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	17	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	5.6		04-026-ICP8	Calculation
pH (1:5 Water)	7.5		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	4.09	dS/m	04-031-PH	1:5 soil/water
Chloride	2000	mg/kg	04-063-FIA3	Soluble Chloride
Copper	0.82	mg/kg	04-024-ICP6	DTPA
Zinc	0.23	mg/kg	04-024-ICP6	DTPA
Manganese	5.9	mg/kg	04-024-ICP6	DTPA
Iron	15	mg/kg	04-024-ICP6	DTPA
Boron	5.8	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

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Report Number: 477558

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SOIL ANALYSIS REPORT

Report Number: 477559

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544380	Paddock Name:	E7-100	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E7-100	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	770	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.5		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	1.8	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.82	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	34	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.6	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	29	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	17	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	85		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	2.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	23	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	4.2	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	0.55	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	11	mg/kg	04-027-ICP9	
Aluminium	0.12	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	30.0	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	1.8	%	04-026-ICP8	Calculation
Aluminium % of Cations	0.40	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	5.5		04-026-ICP8	Calculation
pH (1:5 Water)	8.0		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.29	dS/m	04-031-PH	1:5 soil/water
Chloride	35	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.1	mg/kg	04-024-ICP6	DTPA
Zinc	0.54	mg/kg	04-024-ICP6	DTPA
Manganese	11	mg/kg	04-024-ICP6	DTPA
Iron	11	mg/kg	04-024-ICP6	DTPA
Boron	1.4	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

Nutrient Advantage Laboratory Services

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Report Number: 477559

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8 South Rd, Werribee Vic 3030

Toll-free: 1800 803 453 Fax: (61 3) 9974 0699

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SOIL ANALYSIS REPORT

Report Number: 477560

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 PO Box 9158
 ORANGE
 NSW 2800



Report Authorised
 Paul Kennelly
 Laboratory Manager
 NATA Accredited Laboratory
 Number: 11958

Sample Number:	021544372	Paddock Name:	E7-800	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E7-800	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	350	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	8.0		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	17.7	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.24	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	16	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.2	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	2300	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	120		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.89	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	36	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	8.6	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	7.5	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	52.9	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	14	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	4.2		04-026-ICP8	Calculation
pH (1:5 Water)	8.1		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	2.85	dS/m	04-031-PH	1:5 soil/water
Chloride	1400	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.0	mg/kg	04-024-ICP6	DTPA
Zinc	0.27	mg/kg	04-024-ICP6	DTPA
Manganese	3.6	mg/kg	04-024-ICP6	DTPA
Iron	7.4	mg/kg	04-024-ICP6	DTPA
Boron	13	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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 Incitec Pivot Limited - ABN 42 004 080 264
 8 South Rd, Werribee Vic 3030
 Toll-free: 1800 803 453 Fax: (61 3) 9974 0699
 Enquiry: lab.feedback@incitecpivot.com.au

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Report Number: 477560

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SOIL ANALYSIS REPORT

Report Number: 477561

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544373	Paddock Name:	E9-2000	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E9-2000	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	260	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	7.9		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	21.5	dS/m	04-054-WCALC	Calculation
Organic Carbon	<0.15	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	5.9	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	2.5	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	4100	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	140		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.66	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	54	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	5.7	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	5.9	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	66.8	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	8.8	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	9.5		04-026-ICP8	Calculation
pH (1:5 Water)	8.0		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	3.47	dS/m	04-031-PH	1:5 soil/water
Chloride	1400	mg/kg	04-063-FIA3	Soluble Chloride
Copper	0.81	mg/kg	04-024-ICP6	DTPA
Zinc	0.13	mg/kg	04-024-ICP6	DTPA
Manganese	2.4	mg/kg	04-024-ICP6	DTPA
Iron	7.2	mg/kg	04-024-ICP6	DTPA
Boron	9.6	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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SOIL ANALYSIS REPORT

Report Number: 477562

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544384	Paddock Name:	E10-100	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E10-100	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	1000	mg/kg	04-026-ICP8	Calculation
Colour	Grey		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	6.9		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	1.0	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.77	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	17	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	6.4	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	14	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	25	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	85		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	2.7	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	16	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	4.9	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	0.63	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	9.3	mg/kg	04-027-ICP9	
Aluminium	0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	24.2	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	2.6	%	04-026-ICP8	Calculation
Aluminium % of Cations	0.43	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.3		04-026-ICP8	Calculation
pH (1:5 Water)	7.6		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.16	dS/m	04-031-PH	1:5 soil/water
Chloride	19	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.2	mg/kg	04-024-ICP6	DTPA
Zinc	0.40	mg/kg	04-024-ICP6	DTPA
Manganese	22	mg/kg	04-024-ICP6	DTPA
Iron	23	mg/kg	04-024-ICP6	DTPA
Boron	1.4	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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SOIL ANALYSIS REPORT

Report Number: 477563

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544385	Paddock Name:	E10-1200	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E10-1200	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	410	mg/kg	04-026-ICP8	Calculation
Colour	Grey		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.9		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	6.4	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.30	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	3.3	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	3.7	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	260	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	6.6	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	88		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	1.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	21	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	5.6	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	6.5	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	34.0	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	19	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.8		04-026-ICP8	Calculation
pH (1:5 Water)	8.4		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	1.04	dS/m	04-031-PH	1:5 soil/water
Chloride	680	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.1	mg/kg	04-024-ICP6	DTPA
Zinc	0.20	mg/kg	04-024-ICP6	DTPA
Manganese	6.8	mg/kg	04-024-ICP6	DTPA
Iron	16	mg/kg	04-024-ICP6	DTPA
Boron	4.5	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

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SOIL ANALYSIS REPORT

Report Number: 477564

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544382	Paddock Name:	E12-100	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E12-100	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	570	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	7.6		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	1.6	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.54	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	5.4	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	1.5	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	15	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	9.0	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	76		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	1.5	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	21	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	5.6	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	1.1	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	29.0	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	3.9	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.8		04-026-ICP8	Calculation
pH (1:5 Water)	8.3		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.25	dS/m	04-031-PH	1:5 soil/water
Chloride	41	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.2	mg/kg	04-024-ICP6	DTPA
Zinc	0.26	mg/kg	04-024-ICP6	DTPA
Manganese	8.7	mg/kg	04-024-ICP6	DTPA
Iron	13	mg/kg	04-024-ICP6	DTPA
Boron	1.1	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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Report Number: 477564

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SOIL ANALYSIS REPORT

Report Number: 477565

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544383	Paddock Name:	E12-300	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E12-300	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	390	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	8.1		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	2.0	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.43	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	7.8	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	2.2	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	7.8	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	<5.0	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	120		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.99	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	31	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	8.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	3.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	42.8	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	7.1	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.9		04-026-ICP8	Calculation
pH (1:5 Water)	9.0		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.33	dS/m	04-031-PH	1:5 soil/water
Chloride	120	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.2	mg/kg	04-024-ICP6	DTPA
Zinc	0.15	mg/kg	04-024-ICP6	DTPA
Manganese	4.2	mg/kg	04-024-ICP6	DTPA
Iron	9.6	mg/kg	04-024-ICP6	DTPA
Boron	4.2	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

Nutrient Advantage Laboratory Services

Nutrient Advantage is a trademark of Incitec Pivot Limited
Incitec Pivot Limited - ABN 42 004 080 264
8 South Rd, Werribee Vic 3030
Toll-free: 1800 803 453 Fax: (61 3) 9974 0699
Enquiry: lab.feedback@incitecpivot.com.au

Disclaimer: This analysis report is prepared solely for the client listed above. To the extent permitted by law, Incitec Pivot Limited excludes all liability in connection with this report and, where liability cannot be excluded, limits its liability, at its election, to the re-supply of the analysis services or the cost of the re-supply of such services.

Report Number: 477565

The results pertain only to the sample submitted.

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Analyses performed on soil dried at 40 °C and ground to 2mm or less.

^ NATA accreditation does not cover the performance of this service.

Accredited for compliance with ISO/IEC 17025.

This results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

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SOIL ANALYSIS REPORT

Report Number: 477566

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544375	Paddock Name:	E14-600	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E14-600	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	390	mg/kg	04-026-ICP8	Calculation
Colour	Grey		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl2)	7.8		04-031-PH	1:5 soil/0.01M CaCl2
Electrical Conductivity (Sat. Ext.) ^	3.1	dS/m	04-054-WCALC	Calculation
Organic Carbon	0.40	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	4.2	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	3.1	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	32	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	8.7	mg/kg	04-013-COL_P	0.5M NaHCO3 (pH 8.5)
Phosphorus Buffer Index	72		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	1.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	19	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	5.4	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	5.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	<9.0	mg/kg	04-027-ICP9	
Aluminium	<0.10	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	30.7	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	16	%	04-026-ICP8	Calculation
Aluminium % of Cations	<1	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	3.5		04-026-ICP8	Calculation
pH (1:5 Water)	8.6		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	0.50	dS/m	04-031-PH	1:5 soil/water
Chloride	370	mg/kg	04-063-FIA3	Soluble Chloride
Copper	1.0	mg/kg	04-024-ICP6	DTPA
Zinc	0.27	mg/kg	04-024-ICP6	DTPA
Manganese	7.2	mg/kg	04-024-ICP6	DTPA
Iron	19	mg/kg	04-024-ICP6	DTPA
Boron	3.1	mg/kg	04-025-ICP7	Hot 0.01M CaCl2

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Report Number: 477566

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SOIL ANALYSIS REPORT

Report Number: 477567

ANDREW RUMING
Envirowest Consulting Pty Ltd
PO Box 9158
ORANGE
NSW 2800



Report Authorised
Paul Kennelly
Laboratory Manager
NATA Accredited Laboratory
Number: 11958

Sample Number:	021544374	Paddock Name:	E14-4500	Date Sampled:	10-Dec-2015
Test Code:	E13	Sample Name:	E14-4500	Date Received:	23-Dec-2015
Purchase Order No:	SITE 6612			Date of Report:	12-Jan-2016
Grower Name:	ENVIROWEST CONSULTING				

Analyte	Result	Units	Method Code	Comments
Available Potassium ^	250	mg/kg	04-026-ICP8	Calculation
Colour	Brown		04-042-PHYS	Munsell
Texture	Clay		04-042-PHYS	Field texture, Northcote (1984).
pH (1:5 CaCl ₂)	4.2		04-031-PH	1:5 soil/0.01M CaCl ₂
Electrical Conductivity (Sat. Ext.) ^	22.7	dS/m	04-054-WCALC	Calculation
Organic Carbon	<0.15	%	04-018-UV1	Walkley & Black (1947)
Nitrate Nitrogen	<0.50	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Ammonium Nitrogen	4.3	mg/kg	04-063-FIA3	Mineralisable Nitrogen
Sulphate Sulphur (KCl40)	2500	mg/kg	04-021-ICP2	0.25M KCl at 40°C
Phosphorus (Colwell)	11	mg/kg	04-013-COL_P	0.5M NaHCO ₃ (pH 8.5)
Phosphorus Buffer Index	94		04-020-ICP17	Calculation, using Colwell P (PBI)
Potassium	0.64	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Calcium	34	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Magnesium	7.0	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Sodium	10	cmol(+)/kg	04-026-ICP8	Ex. Cat. Ammonium Acetate (pH 7.0)
Aluminium	79	mg/kg	04-027-ICP9	
Aluminium	0.88	cmol(+)/kg	04-027-ICP9	Ex. Cat. 1M KCl
Cation Exch. Cap. (CEC)	53.1	cmol(+)/kg	04-026-ICP8	Calculation
Sodium % of Cations (ESP)	19	%	04-026-ICP8	Calculation
Aluminium % of Cations	1.7	%	04-026-ICP8	Calculation
Calcium/Magnesium Ratio	4.9		04-026-ICP8	Calculation
pH (1:5 Water)	4.3		04-031-PH	1:5 soil/water
Elect. Conductivity (EC)	3.66	dS/m	04-031-PH	1:5 soil/water
Chloride	1600	mg/kg	04-063-FIA3	Soluble Chloride
Copper	0.35	mg/kg	04-024-ICP6	DTPA
Zinc	0.12	mg/kg	04-024-ICP6	DTPA
Manganese	2.1	mg/kg	04-024-ICP6	DTPA
Iron	72	mg/kg	04-024-ICP6	DTPA
Boron	2.0	mg/kg	04-025-ICP7	Hot 0.01M CaCl ₂

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Report Number: 477567

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Appendix 4. ALS Environmental Laboratory report

CERTIFICATE OF ANALYSIS

Work Order	: ES1539403	Page	: 1 of 4
Client	: ENVIROWEST CONSULTING	Laboratory	: Environmental Division Sydney
Contact	: MR ANDREW RUMING	Contact	:
Address	: 9 CAMERON PLACE PO BOX 8158 ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: andrew@envirowest.net.au	E-mail	:
Telephone	: +61 63614954	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 63603960	Facsimile	: +61-2-8784 8500
Project	: 6612	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 6612	Date Samples Received	: 22-Dec-2015 08:20
C-O-C number	: 6612	Date Analysis Commenced	: 23-Dec-2015
Sampler	: ---	Issue Date	: 04-Jan-2016 17:33
Site	: 6612		
Quote number	: ---	No. of samples received	: 10
		No. of samples analysed	: 10

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 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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW



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	E1-100	E3-300	E5-100	E7-100	E10-100
Client sampling date / time					[10-Dec-2015]	[10-Dec-2015]	[10-Dec-2015]	[10-Dec-2015]	[10-Dec-2015]
Compound	CAS Number	LOR	Unit		ES1539403-001	ES1539403-002	ES1539403-003	ES1539403-004	ES1539403-005
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		----	----	----	----	----
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		----	----	----	----	----
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%		8.1	7.3	9.3	10.8	15.2
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		----	----	----	----	----
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		19	17	20	18	16
Copper	7440-50-8	5	mg/kg		13	12	12	13	11
Lead	7439-92-1	5	mg/kg		8	7	8	7	8
Nickel	7440-02-0	2	mg/kg		11	8	10	10	10
Zinc	7440-66-6	5	mg/kg		24	22	22	20	23



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	E12-100	R1-1000	R2-2000	R3-3000	R4-600
Client sampling date / time					[10-Dec-2015]	[10-Dec-2015]	[10-Dec-2015]	[10-Dec-2015]	[10-Dec-2015]
Compound	CAS Number	LOR	Unit		ES1539403-006	ES1539403-007	ES1539403-008	ES1539403-009	ES1539403-010
					Result	Result	Result	Result	Result
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		----	8.3	7.8	5.8	8.7
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		----	1580	4270	2310	815
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%		9.7	11.4	12.7	13.6	10.3
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		----	2290	25500	6580	750
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg		<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg		17	----	----	----	----
Copper	7440-50-8	5	mg/kg		11	----	----	----	----
Lead	7439-92-1	5	mg/kg		7	----	----	----	----
Nickel	7440-02-0	2	mg/kg		9	----	----	----	----
Zinc	7440-66-6	5	mg/kg		18	----	----	----	----

QUALITY CONTROL REPORT

Work Order	: ES1539403	Page	: 1 of 4
Client	: ENVIROWEST CONSULTING	Laboratory	: Environmental Division Sydney
Contact	: MR ANDREW RUMING	Contact	:
Address	: 9 CAMERON PLACE PO BOX 8158 ORANGE NSW, AUSTRALIA 2800	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: andrew@envirowest.net.au	E-mail	:
Telephone	: +61 63614954	Telephone	: +61-2-8784 8555
Facsimile	: +61 02 63603960	Facsimile	: +61-2-8784 8500
Project	: 6612	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 6612	Date Samples Received	: 22-Dec-2015
C-O-C number	: 6612	Date Analysis Commenced	: 23-Dec-2015
Sampler	: ----	Issue Date	: 04-Jan-2016
Site	: 6612	No. of samples received	: 10
Quote number	: ----	No. of samples analysed	: 10

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits



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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW



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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 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
 RPD = Relative Percentage Difference
 # = Indicates failed QC



Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA002 : pH (Soils) (QC Lot: 318700)									
ES1539373-010	Anonymous	EA002: pH Value	----	0.1	pH Unit	6.7	6.6	2.10	0% - 20%
ES1539366-001	Anonymous	EA002: pH Value	----	0.1	pH Unit	8.4	8.5	0.00	0% - 20%
EA010: Conductivity (QC Lot: 318702)									
ES1539373-010	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	366	422	14.2	0% - 20%
ES1539444-001	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	0.471	475	0.846	0% - 20%
EA055: Moisture Content (QC Lot: 319735)									
ES1539391-002	Anonymous	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	22.4	23.9	6.75	0% - 20%
ES1539403-005	E10-100	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	15.2	14.7	3.32	0% - 50%
ED040T : Total Sulfate by ICPAES (QC Lot: 320596)									
ES1539364-001	Anonymous	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	6470	6680	3.19	0% - 20%
ES1539364-011	Anonymous	ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	360	340	5.44	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 320378)									
ES1539391-006	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	372	378	1.68	0% - 20%
		EG005T: Nickel	7440-02-0	2	mg/kg	65	70	6.85	0% - 20%
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	30	32	5.25	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	15	14	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	35	28	20.3	No Limit
ES1539382-008	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	6	4	57.3	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	10	9	14.2	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	<5	<5	0.00	No Limit



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

Sub-Matrix: SOIL				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result		LCS	Low	High
EA010: Conductivity (QCLot: 318702)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	96.0	92	108
ED040T : Total Sulfate by ICPAES (QCLot: 320596)								
ED040T: Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	----	----	----	----
EG005T: Total Metals by ICP-AES (QCLot: 320378)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	104	86	126
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	101	83	113
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	91.2	76	128
EG005T: Copper	7440-50-8	5	mg/kg	<5	32 mg/kg	99.4	86	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	108	80	114
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55 mg/kg	102	87	123
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	107	80	122

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike Concentration	Spike Recovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number		MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 320378)							
ES1539374-003	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	104	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	106	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	104	70	130
		EG005T: Copper	7440-50-8	250 mg/kg	102	70	130
		EG005T: Lead	7439-92-1	250 mg/kg	105	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	104	70	130
		EG005T: Zinc	7440-66-6	250 mg/kg	107	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order : **ES1539403**

Page : 1 of 5

Client : **ENVIROWEST CONSULTING**
Contact : MR ANDREW RUMING
Project : 6612
Site : 6612
Sampler : ----
Order number : 6612

Laboratory : Environmental Division Sydney
Telephone : +61-2-8784 8555
Date Samples Received : 22-Dec-2015
Issue Date : 04-Jan-2016
No. of samples received : 10
No. of samples analysed : 10

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO** Method Blank value outliers occur.
- **NO** Duplicate outliers occur.
- **NO** Laboratory Control outliers occur.
- **NO** Matrix Spike outliers occur.
- For all regular sample matrices, **NO** surrogate recovery outliers occur.

Outliers : Analysis Holding Time Compliance

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- **NO** Quality Control Sample Frequency Outliers exist.



Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA002 : pH (Soils)						
Soil Glass Jar - Unpreserved R1-1000, R2-2000, R3-3000, R4-600	23-Dec-2015	17-Dec-2015	6	24-Dec-2015	23-Dec-2015	1
EA010: Conductivity						
Soil Glass Jar - Unpreserved R1-1000, R2-2000, R3-3000, R4-600	23-Dec-2015	17-Dec-2015	6	----	----	----
ED040: Sulfur as SO4 2-						
Soil Glass Jar - Unpreserved R1-1000, R2-2000, R3-3000, R4-600	24-Dec-2015	17-Dec-2015	7	----	----	----

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis			
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation	
EA002 : pH (Soils)								
Soil Glass Jar - Unpreserved (EA002) R1-1000, R2-2000, R3-3000, R4-600	10-Dec-2015	23-Dec-2015	17-Dec-2015	✖	24-Dec-2015	23-Dec-2015	✖	
EA010: Conductivity								
Soil Glass Jar - Unpreserved (EA010) R1-1000, R2-2000, R3-3000, R4-600	10-Dec-2015	23-Dec-2015	17-Dec-2015	✖	24-Dec-2015	20-Jan-2016	✔	
EA055: Moisture Content								
Soil Glass Jar - Unpreserved (EA055-103) E1-100, E3-300, E5-100, E7-100, E10-100, E12-100, R1-1000, R2-2000, R3-3000, R4-600	10-Dec-2015	----	----	----	23-Dec-2015	24-Dec-2015	✔	



Matrix: **SOIL**

Evaluation: ✖ = Holding time breach ; ✔ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED040: Sulfur as SO4 2-								
Soil Glass Jar - Unpreserved (ED040T)								
R1-1000, R3-3000,	R2-2000, R4-600	10-Dec-2015	24-Dec-2015	17-Dec-2015	✖	02-Jan-2016	21-Jan-2016	✔
EG005T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved (EG005T)								
E1-100, E5-100, E10-100,	E3-300, E7-100, E12-100	10-Dec-2015	24-Dec-2015	07-Jun-2016	✔	29-Dec-2015	07-Jun-2016	✔



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	Method	QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Electrical Conductivity (1:5)	EA010	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055-103	2	19	10.53	10.00	✓	NEPM 2013 B3 & ALS QC Standard
pH (1:5)	EA002	2	13	15.38	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	16	12.50	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Electrical Conductivity (1:5)	EA010	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Electrical Conductivity (1:5)	EA010	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate as SO4 2- Total	ED040T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Metals by ICP-AES	EG005T	1	16	6.25	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH (1:5)	EA002	SOIL	In house: Referenced to APHA 4500H+. pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3) (Method 103)
Electrical Conductivity (1:5)	EA010	SOIL	In house: Referenced to APHA 2510. Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (2013) Schedule B(3) (Method 104)
Moisture Content	EA055-103	SOIL	In-house. A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Sulfate as SO4 2- Total	ED040T	SOIL	In-house. Total Sulfate is determined off a HCl digestion by ICPAES as S , and reported as SO4
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)

Sheet 1 of 1

Environmental Division
Sydney
Work Order Reference
ES1539403



Appendix 5. Scone Research Laboratory report



SOIL TEST REPORT

Page 1 of 2

Scone Research Centre

REPORT NO: SCO15/254R1

REPORT TO: Andrew Ruming
Envirowest Consulting
PO Box 8158
Orange NSW 2800

REPORT ON: Six soil samples
Your ref: 6612

PRELIMINARY RESULTS
ISSUED: Not issued

REPORT STATUS: Final

DATE REPORTED: 27 January 2016

METHODS: Information on test procedures can be obtained from Scone
Research Centre

TESTING CARRIED OUT ON SAMPLE AS RECEIVED
THIS DOCUMENT MAY NOT BE REPRODUCED EXCEPT IN FULL

A handwritten signature in blue ink, appearing to read 'SR Young'.

SR Young
(Laboratory Manager)

SOIL CONSERVATION SERVICE
Scone Research Centre

Page 2 of 2

Report No: SCO15/254R1
Client Reference: Andrew Ruming
Envirowest Consulting
PO Box 8158
Orange NSW 2800

Lab No	Method	P9B/2	P17C/1 – Hydraulic conductivity		P18B/3 – Available water capacity (%)		
	Sample Id	EAT	Sat. HC (mm/hr)	BD (t/m ³)	FC (0.3 bar)	WP (15 bar)	AWC
1	E1-100	3(1)	39	1.22	25	13	12
2	E3-300	2(3)	<1	1.35	39	17	22
3	E6-1000	4	7	1.21	34	17	17
4	E10-100	3(2)	1	1.37	32	15	17
5	E14-600	4	6	1.40	30	15	15
6	E12-300	2(3)	<1	1.37	37	17	20

EAT-Emerson aggregate test

Field capacity (FC), wilting point (WP) and available water capacity (AWC) = moisture content (%) by weight

Sat. HC-saturated hydraulic conductivity

BD-bulk density of recompacted material at which hydraulic conductivity was determined



END OF TEST REPORT

Appendix 6. Monthly water balance determine the wastewater application area required (irrigation systems)

Design wastewater flow	Q	L/day	698000	
Design percolation rate	R	mm/wk	7	1 mm/day
Land area	L	m ²	125510	
Effective precipitation	EP		0.9	(10% runoff)

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	29	37	41	25	24	31	14	12	16	20	40	37	325
Evaporation	E		mm/month	300	250	200	150	100	60	80	100	150	200	300	300	2190
Crop factor	C		-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8
Inputs																
Effective Precipitation	EP		mm/month	26.46	32.94	36.72	22.68	21.51	28.08	12.33	10.71	13.95	17.82	35.91	33.48	293
Effluent irrigation	W	QXD/L	mm/month	172.4	155.7	172.4	166.8	172.4	166.8	172.4	172.4	166.8	172.4	166.8	172.4	2030
Inputs		P+W	mm/month	198.9	188.7	209.1	189.5	193.9	194.9	184.7	183.1	180.8	190.2	202.7	205.9	2322
Outputs																
Evapotranspiration	ET	ExC	mm/month	270	225.0	180.0	135.0	90.0	54.0	72.0	90.0	135.0	180.0	270.0	270.0	1971
Percolation	B	R/7xD	mm/month	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365
Outputs		ET+B	mm/month	301.0	253.0	211.0	165.0	121.0	84.0	103.0	121.0	165.0	211.0	300.0	301.0	2336
Storage	S	(EP+W)-(ET+B)	mm/month	-102.1	-64.3	-1.9	24.5	72.9	110.9	81.7	62.1	15.8	-20.8	-97.3	-95.1	
Cumulative storage	M		mm	0.0	0.0	0.0	24.5	97.4	208.3	290.1	352.2	368.0	347.2	249.9	154.8	
Storage																
	V	largest M	mm	368.0												
		Soil storage	mm	368.0												
		Storage required	mm	0.0												
		VxL/1000	m ³	-2.5												
Irrigation area																
			m ²	125510												
			ha	13												

	water holding capacity	depth (mm)	Totals(mm)
Topsoil	34%	300	102
Subsoil	38%	700	266
			368

Appendix 7. Organic matter balance

Estimated effluent flow	(Q)	698000	L/day
Soil depth		1	m
BOD (C)	10	mg/L	
treated wastewater flow rate (Q)	698000	L/day	
critical loading rate of BOD (Lx)	3000	mg/m ² /day	
land area required (A)	2326.7	m ²	

Appendix 8. Nitrogen balance

Estimated effluent flow	(Q)	698000	L/day
Soil depth		1	m
nutrient concentration	45	mg/L	
treated wastewater flow rate	698000	L/day	
critical loading rate of nutrient	82	mg/m ² /day	
land area required (A)	383049	m ²	

Determination of nitrogen critical loading rate

Nitrogen load (kg/year)	11464.7	kg/year		
Loss 20% denitrification	9171.7	kg/year		
Load to soil	239.4	kg/ha/year	assumed irr. area from table	383049 m
Vegetation usage	200.0	kg/ha/year		
Residual (potential leaching)	39.4	kg/ha/year		

Typical nitrogen uptake (Myers et al. 1984)		
Pastures	300 kg/ha/year	82 mg/m2/day
Pine	350 kg/ha/year	96 mg/m2/day
Eucalypts	180 kg/ha/year	49 mg/m2/day

Appendix 9. Phosphorus balance (DEC 2004)

Assumptions

Phosphorus sorption capacity: 4,510kg/ha (DEC 2004)

Phosphorus sorption capacity: 280mg/kg (DEC 2004)

Phosphorus sorption capacity (critical): 94mg/kg

Soil depth: 1m

Soil density: 1,370kg/m³ (average result for analysed samples)

Land area for irrigation: 38 hectares (based on area required for nitrogen balance)

Total P in effluent: 10mg/kg (from treatment system designer)

Volume of effluent: 255ML/year

Total P adsorbed before leaching

P sorption capacity (critical) x soil density x soil depth x 38 hectares
= 94mg/kg x 1,370kg/m³ x 1m x 38 hectares
= 48,940kg (A)

Total orthophosphate in applied effluent per year

= 10mg/kg x 255,000,000L
= 2,547kg (B)

Total P removed by crop per year

= 30kg

Total P removed by crop per 38 hectares per year

= 1,140kg (C)

Site irrigation period

= A/(B-C)
= 48,940/(2,547-1,140)
= 48,940/1,407
= 34 years