Land-Based Effluent Disposal Assessment Report and MEDLI 2.0 Modelling

Baralaba South Project EIS

September 22, 2023

Prepared for:

Baralaba Coal Company Pty Ltd

Prepared by:

Stantec Australia Pty Ltd

Revision	Description	Author		Approved by	
1	Issued for Client Review	AMW	10/07/2020	MF	MF
2	Update Draft	AMW	26/11/2020	MF	MF
3	Final	AMW	13/01/2021	MF	MF
4	Final Updated	AMW	03/03/2021	MF	MF
5	Final Rev 2	AMW	15/08/2023	MF	MF
6	Final Rev 3	AMW	22/09/2023	MF	MF

The conclusions in the Report titled Land-Based Effluent Disposal Assessment Report and MEDLI 2.0 Modelling are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from Baralaba Coal Company Pty Ltd (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided to applicable authorities having jurisdiction and others for whom the Client is responsible, Stantec does not warrant the services to any third party. The report may not be relied upon by any other party without the express written consent of Stantec, which may be withheld at Stantec's discretion.

Prepared by _____

Anita Webb
Environmental Scientist

Reviewed by _____

Mark Farrey
Principal Environmental Scientist

Approved by _____

Mark Farrey
Principal Environmental Scientist

Table of Contents

LIST OF TABLES

LIST OF FIGURES

List of Appendices

1.0 INTRODUCTION

Stantec (formerly Cardno) were commissioned by Baralaba South Pty Ltd (formerly Mount Ramsay Coal Company Pty Ltd and Wonbindi TLO Holdings Pty Limited) a 100% owned subsidiary of the Baralaba Coal Company, to undertake land-based irrigation modelling using the Model for Effluent Disposal Using Land Irrigation (MEDLI 2.0) version 2.0 for the Baralaba South Project (the Project).

The Project is a greenfield, open-cut metallurgical coal mine which would extract up to 2.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal to produce pulverised coal injection (PCI) coal for international export to the steel production industry over a life of 23 years. Mining activities are to be undertaken within the area of Mining Lease Application (MLA) 700057, whicOh covers a total of 2,214 ha.

The nearest sewage treatment facilities are located in Biloela. A primary sewage treatment process is proposed to be installed for the Project during construction. Septic tanks will collect liquid and sludge waste products, which will be routinely transported off-site to Biloela for further processing and disposal.

During operations, either the primary sewage treatment process will continue to be utilised (for transport off-site for processing and disposal) or a package Sewage Treatment Plant (STP) will be constructed within the administration area. The Project is currently in the Environmental Impact Statement (EIS) phase, and therefore detailed design/operation information is yet to be developed. During the construction phase up to 268 workers are estimated to be on site at a time, which will reduce to 155 workers on site at a time during the operation phase.

During both the construction and operation phases, workers will generate domestic wastewater from staff facilities. The wastewater will include that which is generated from the use of toilets (often classed as black water) as well as wastewater produced from showers, kitchen facilities and laundries (often classed as grey water). It is important to recognise that this domestic wastewater does not include mine affected water or sediment-laden water, which will be stored and handled in a separate manner. The wastewater from the staff facilities also does not include that from the accommodation camp which will be located off-site in Baralaba.

1.1.1 ENVIRONMENTAL AUTHORITY REQUIREMENTS

Given that the wastewater system for staff facilities at Baralaba South will cater for more than 21 Equivalent Persons (EPs) (1 EP = 200 L/day), the activity triggers Environmental Relevant Activity (ERA) 63 for sewage treatment to be added as an ancillary activity to the resource activity Environmental Authority (EA) being sought from the Department of Environment and Science (DES).

An application for ERA 63 must provide supporting technical information in accordance with the DES *Guideline Application requirements for activities with impacts to land*. This guideline encourages the applicant to:

- Design a sustainable system in accordance with Australian New Zealand Standard *AS/NZS 1547:2012 On-site domestic wastewater management*; and

- Undertake validation modelling of the system based on local land and rainfall factors. The recommended model being the Model for Effluent Disposal using Land Irrigation (MEDLI 2.0) Version 2.0.

This report therefore centres around AS/NZS 1547:2012 On-site Domestic Wastewater Management, and validation MEDLI 2.0 modelling of the irrigation site for the Baralaba South Project.

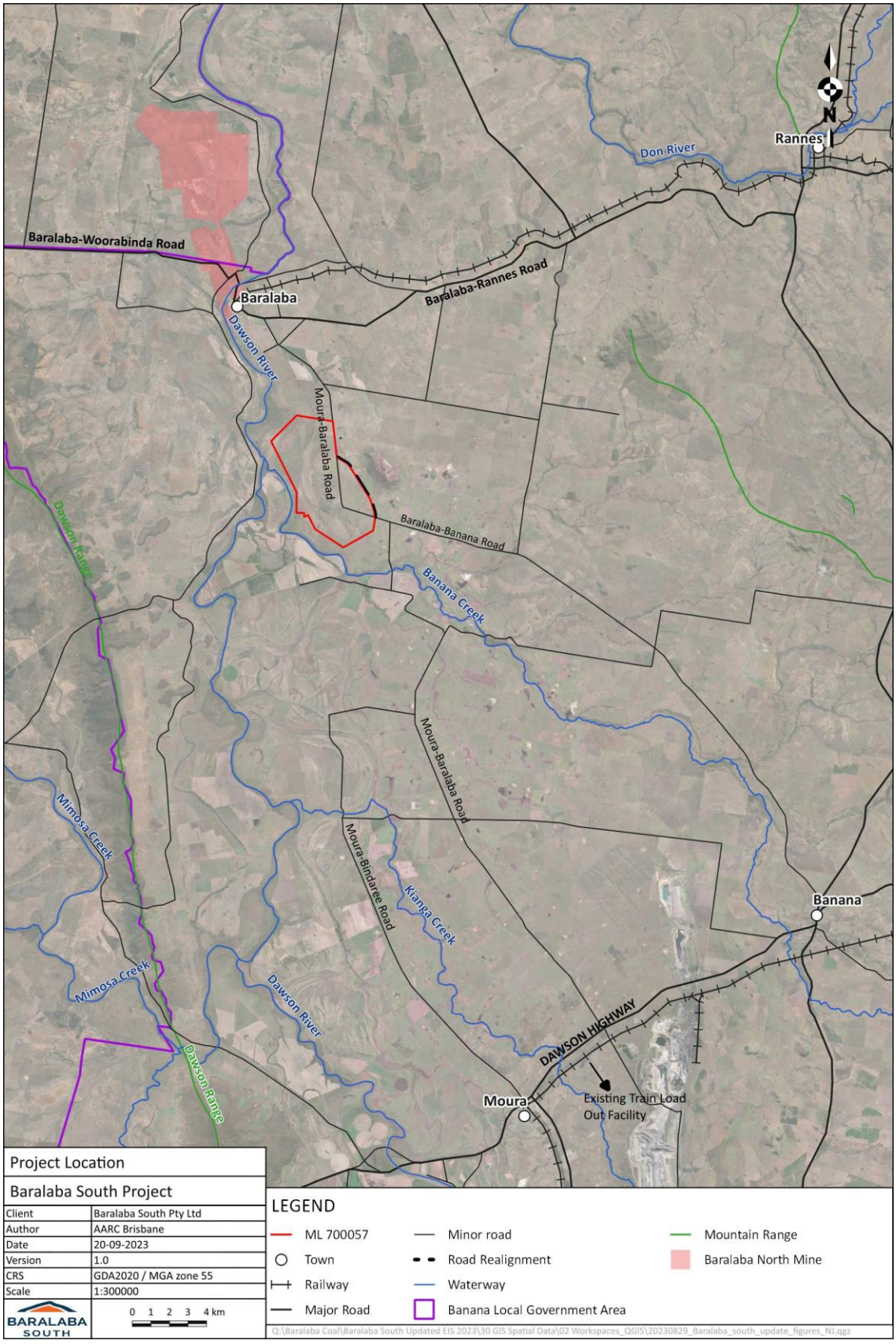


Figure 1-1 Baralaba South Project location (Data source: AARC Environmental)

2.0 AIM OF THE ASSESSMENT

2.1 OBJECTIVES

The principal objectives of this assessment are to:

- Characterise the estimated wastewater flow rates and treated wastewater quality in terms of Total Nitrogen, Total Phosphorus, Total Dissolved Salts, Electrical conductivity, pH, E coli concentrations, Total Suspended Solids, and Biochemical Organic Demand (5 day).
- Use a suitable water balance model, specifically the Model for Effluent Disposal via Land Irrigation (MEDLI 2.0) to arrive at the appropriate sustainable wet weather storage volume and area to be irrigated with treated sewage based on the quantity and quality of the treated sewage expected to be generated; and
- Account for and manage potential impacts of treated sewage irrigation on surface and groundwater and other environmental values and describe how these impacts will be mitigated so as not to cause environmental harm or adversely affect relevant environmental values and water quality objectives.

2.2 SCOPE OF WORK

The scope of this assessment is limited to assessing the suitability of land areas within the Baralaba South Project site for effluent disposal via irrigation. The assessment consisted of:

- A desktop review of site topography, hydrology and soil type to select the most suitable effluent disposal area.
- Using AS1547: 2012 to estimate the irrigation rate using soil condition assumptions obtained during the review.
- Sampling and analysis of the soil profile within the intended effluent disposal area to assess soil characteristics, including hydraulic permeability.
- Calculating expected wastewater quality and generation rates for the Project.
- Obtaining site-specific climate data for the Baralaba region (particularly rainfall and evaporation rates);
- Determining the feasibility of using an irrigation system in accordance with AS/NZ 1547:2012.
- Calculating wet weather storage requirements.
- Verifying the suitability of the subsurface irrigation system using MEDLI 2.0; and
- Providing recommendations to improve the performance of the irrigation system.

This report does not include provision for a Site Based Management Plan applicable to the ongoing operation of a wastewater disposal system. Prior to commissioning, a management document detailing the ongoing maintenance, emergency response and contingency plans will be required.

2.3 FUNDAMENTALS OF MEDLI 2.0

Irrigation modelling systems offer a way of validating and refining irrigation systems designed in accordance with AS 1547:2012. Daily time step simulation models such as MEDLI 2.0 are generally considered a requirement by DES in assessing ERA 63 applications. For this assessment, version 2.0 of MEDLI has been used.

2.3.1 MEDLI 2.0 BACKGROUND

MEDLI 2.0 is a modelling program that simulates the complex dynamics of the effluent cycle on a daily time step using historical daily climatic data. MEDLI 2.0 simulates the behaviour of water and nutrients in the soil column and the growth of irrigated pastures or crops in response to climatic conditions and nutrient and salt loadings. MEDLI 2.0 can be used to determine the required irrigation area, the likely stresses on irrigated vegetation and the concentration of nutrients below the root zone. The model incorporates historic climate information (temperature, rainfall, evaporation, and solar radiation), estimates of effluent quality and quantity, and soil properties. Modelling provides a means of identifying the potential environmental impacts of the proposed effluent treatment system. Actual outcomes may depend on aspects of geology, soils and groundwater not able to be ascertained by this level of assessment as well as proposed irrigation methods and actual management practices in the field.

Effluent modelling allows the identification of anticipated weaknesses in the wastewater disposal scheme, providing the opportunity to explore alternative solutions until a suitable and robust design is found.

2.3.2 MEDLI 2.0 Modelling Objectives

An optimal effluent management system will have the following outcomes:

- Wet weather storage tank overflow events will be negligible in frequency and volume;
- 95% reuse (irrigation) of effluent (99.5% re-use is ideal);
- No overflow events shall be greater than 1mm worth of the tank volume (i.e. in this case the tank surface area is 55m^2 and therefore 1 mm of the tank volume equates to 55 L);
- Overflow should be experienced less than 10 days per year;
- No surface runoff of irrigated effluent;
- Less than 5kg/ha/year of nitrate is to be lost in deep drainage;
- Limits phosphorus and salts in effluent irrigation such that soil adsorption capacity is not exceeded within the life of the Project;
- Build-up of salinity in the soil profile should not impede the growth of vegetation; and
- Any pasture die-off events resulting from water stress, waterlogging, temperature stress or nitrogen stress are minimised to as close as possible to zero.

3.0 DESKTOP ASSESSMENT

3.1 PREFERRED IRRIGATION LOCATION

The STP and associated wet weather storage for the Project will be constructed within the mine infrastructure area. Sewage which has been treated by the STP will be piped to the effluent disposal area.

The area being investigated for treated effluent disposal is located on Lot 11 Plan FN153, to the west of Moura Baralaba Road (**Figure 3-1**). This area has been proposed as an effluent treatment area because:

- It is located on high ground well away from Banana Creek.
- It is within close proximity and similar elevation to the primary source of wastewater, therefore minimising pumping requirements.
- It will be highly accessible from the Moura Baralaba Road.
- There is sufficient space to allow for placement of the disposal area, maintaining large buffers from sensitive receptors such as waterways, ecosystems and the public;
- The area has previously been cleared, and used for grazing purposes, and therefore contains limited ecological value.

The irrigation investigation area is shown in **Figure 3-1** below.

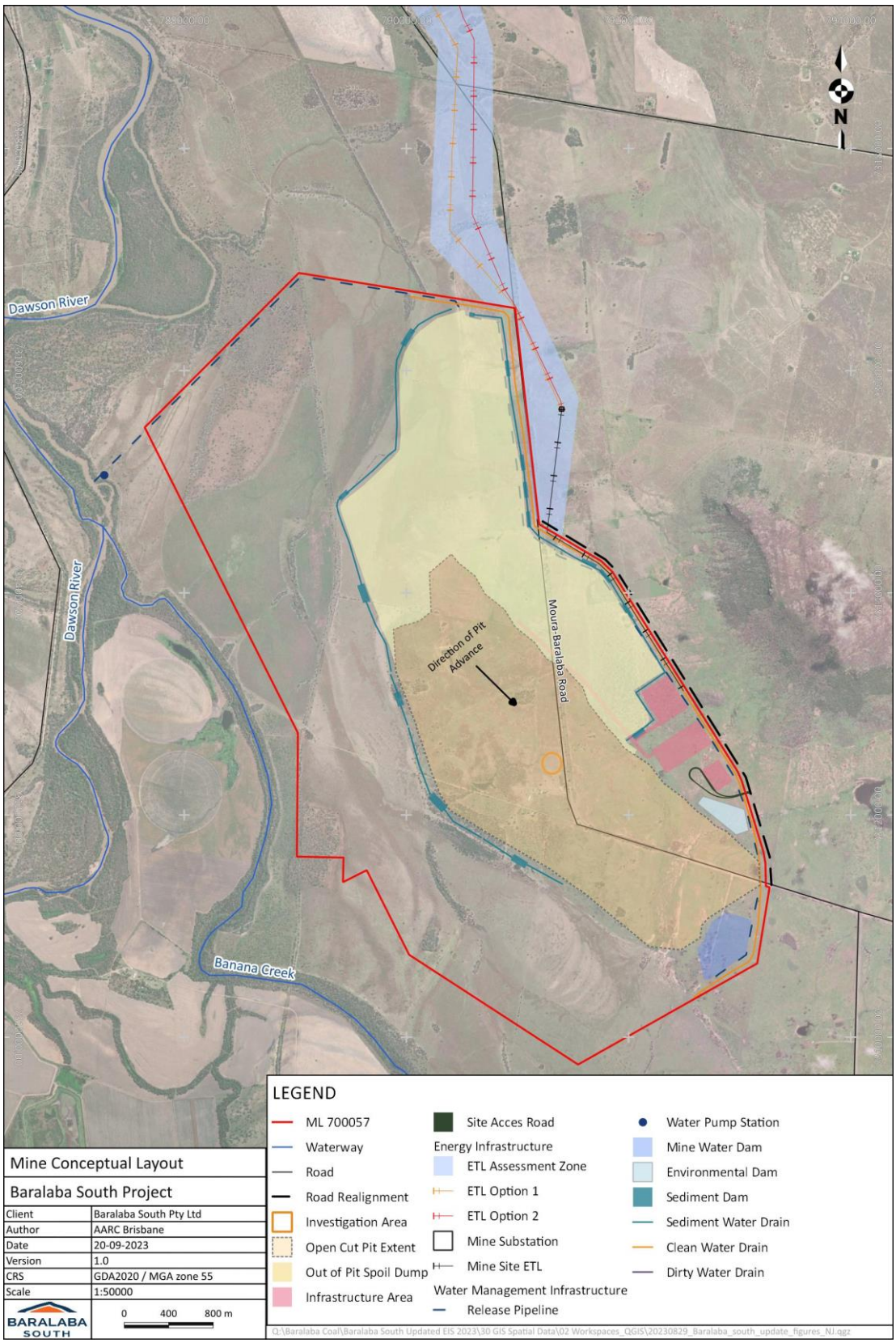


Figure 3-1 The irrigation area; shown by the orange circle (Data source: AARC Environmental)

3.1.1 Pit Advancement

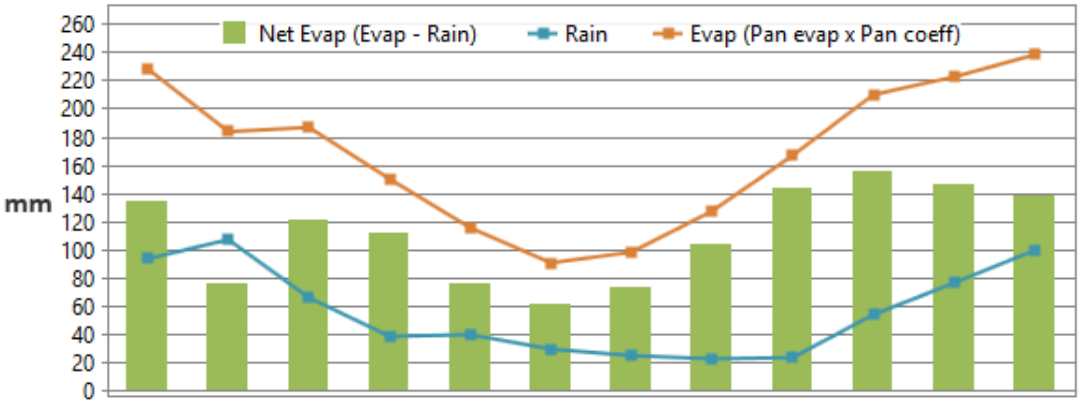
Figure 3-1 indicates the location of the investigation area in relation to mine pit advancement. Irrigation placement within the path of the mine pit advancement cannot be avoided given the limited room available within the mining lease.

After approximately 10 years, the mine pit is expected to have advanced to the location of the irrigation investigation area. At this point in time, the irrigation area will need to be relocated to an area which has been previously mined and backfilled.

3.2 CLIMATE

Climate data was obtained from the Queensland Government Scientific Information for Land Owners (SILO). The data represents the nearest SILO grid point (latitude -24.25, longitude 149.85) and interpolates data from the nearest climate stations. The data includes evaporation rates, rainfall and maximum and minimum temperatures for a period of 70 years (which was modelled in MEDLI 2.0) from 1950 to 2019.

Baralaba has a relatively dry climate, with evaporation rates exceeding rainfall throughout the year. A distinctive dry/wet season pattern is observed, whereby the winter period from May to August is traditionally dry, with monsoonal rainfall received over the summer months from September to January. During the wet season, the evaporation rates still exceed rainfall rates. Climate data has been summarised below in **Figure 3-2**.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	94.1	107.7	66.6	39.1	40.4	30.1	25.6	23.2	24.1	54.5	77.0	100.0	682.3
Evap	228.6	184.1	187.2	150.6	116.0	91.2	98.7	127.8	167.2	210.2	222.9	238.4	2023.1
Net Evap	134.5	76.5	120.6	111.5	75.7	61.1	73.2	104.6	143.1	155.7	146.0	138.4	1340.8
Net Evap/day	4.3	2.7	3.9	3.7	2.4	2.0	2.4	3.4	4.8	5.0	4.9	4.5	3.7

Figure 3-2 Climate Data interpolated for the site 1950 – 2019. Source: Queensland Government climate data (SILO)

3.3 TOPOGRAPHY, DRAINAGE AND GROUNDWATER

As per the Atlas of Australian Soils Queensland, geology of the irrigation investigation area has been classified as ‘Qr’ i.e. Quaternary colluvium, comprising clay, silt, sand, gravel and soil; colluvial and

residual deposits. The western areas of the site are classed as ‘Qa’ i.e. Quaternary alluvium, including clay, silt, sand and gravel; flood-plain alluvium.

Reference to the QLD Globe topography and drainage line layers indicates the investigation area is in a relatively flat location, with an elevation of approximately 110m Australian Height Datum (AHD). The investigation area does not contain any drainage lines of significance. The head of a drainage line, is noted to the west of the site (Figure 3-3). This drainage line is only expected to flow immediately following heavy rain. Any flow generated in such events eventually feeds into the Dawson River at a point approximately 5.5 km directly north east of the site just to the north of the confluence of Banana Creek and Dawson River. Small farm dams are located approximately 600 m to the south east and 1.3 km to the north east respectively.

The reasonably flat nature of the investigation area and distance from significant watercourses is ideal for effluent irrigation in accordance with ASNZS1547:2000.

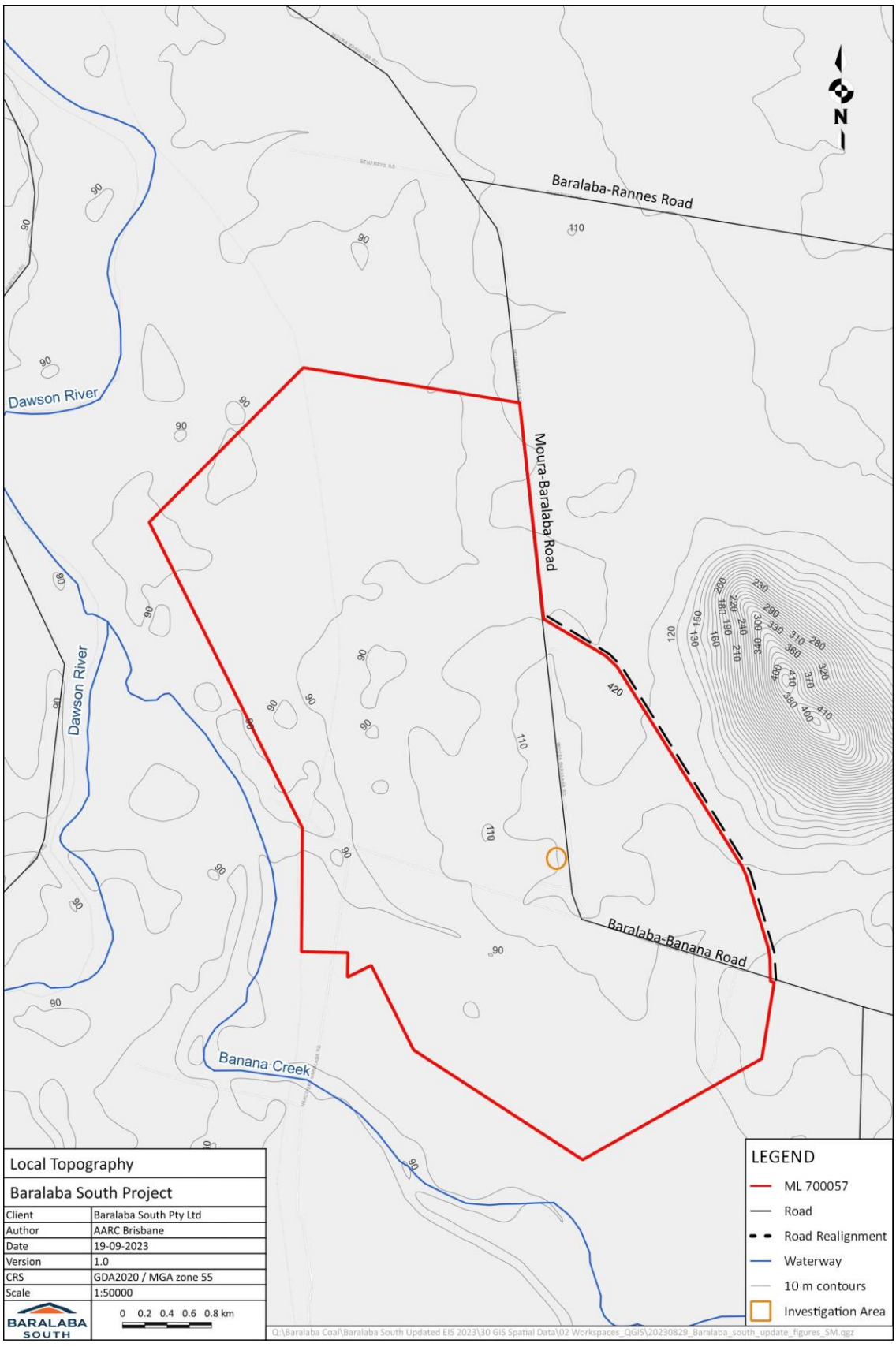


Figure 3-3 Topography and drainage of site and surrounds (Data source: AARC Environmental)

The site is situated approximately 2.5km east, south east of the confluence of Banana Creek and the Dawson River. There is potential for shallow groundwater to persist in alluvial soils which surround these watercourses (often referred to as alluvial groundwater). This alluvial groundwater can be drawn upon by plants and an ecosystem can develop around this. Where such ecosystems rely upon groundwater for their continued existence, they are referred to as groundwater dependent ecosystems (GDEs). The nearest terrestrial GDEs to the investigation area are associated with Banana Creek located 2.5 km to the west and are classed as having low potential for groundwater interaction (BOM 2020). The surface geology of the region, as described above, indicates the investigation area is likely to be outside areas of alluvial deposits.

A search of the closest groundwater bore register on QLD Globe Registered Bore Layer (bore RN128775), located approximately 1.4 km to the west of the investigation area, on 17/06/2012, recorded a standing water level of 16.94 m below ground, a yield of 1.1 L/second and water quality described as salty.

3.4 ONSITE VEGETATION

Based on Stantec's observations the area being investigated for irrigation has been previously cleared for grazing purposes and now consists predominantly of Buffel Grass. A terrestrial ecology assessment undertaken for the Project's impact assessment (EcoSM, 2019) field verified one regional ecosystem of least concern (11.5.9) located just over 1 km southwest of the irrigation investigation area.

3.5 SENSITIVE RECEPTORS

Aside from the sensitive natural environmental receptors outlined above, other sensitive receptors may include any nearby dwellings. The investigation area is located approximately 50m west of Moura Baralaba Road, approximately 200m northeast of a residential house and farm sheds, which are located within the proposed mining footprint. The nearest sensitive receptor outside of the MLA is located approximately 4.2 km to the southwest of the irrigation investigation area. As such, the risk of exposure to aerosols generated by the operation of the irrigation area is low.

The irrigation scheme will need to be managed as per Section 10 via an appropriate level of treatment, exposure reduction measures and controls (e.g. irrigation area restrictions, set back distances, personal protective equipment) to minimise any aerosol exposure risk to on-site residents, mining employees, operators or maintenance personnel.

4.0 WASTEWATER CHARACTERISTICS

Given that the mine and associated infrastructure facilities have yet to be established, wastewater quantities and quality have been estimated as follows:

4.1 WASTEWATER QUANTITY

4.1.1 Construction Period

The MEDLI modelling assumed a total of 275 construction workers are expected to be on site at any one time (although more recent estimates indicate 268 construction workers are more likely). The mine is not proposing to provide housing or messing facilities within the boundaries of the MLA. All employees and contractors will be accommodated at the Baralaba Mining Camp, located within the township of Baralaba. Therefore it is unlikely that all 275 workers will generate their entire volume of wastewater (e.g., showering, washing, toileting), for a day on site. However, for modelling purposes, it has been conservatively estimated that all 275 workers will be on site, and each worker will generate their entire wastewater volume - equating to one equivalent person (EP). The *Environmental Protection Regulation 2019* states that 1 EP = 200 L/day of effluent. For a total of 275 EPs the total daily wastewater volume is conservatively estimated at **55,000 L/day.**

4.1.2 Operational Period

The MEDLI modelling assumed a total of 200 operational workers are expected to be on site at any one time (although more recent estimates indicate 155 operational workers are more likely). Similarly to the Construction Period, it is unlikely that all 200 workers will generate their entire volume of wastewater (e.g., showering, washing, toileting), for a day on site, as many will utilise off site accommodation facilities. However again, for modelling purposes, it has been conservatively estimated that all 200 workers will be on site, and each worker will generate their entire wastewater volume - equating to one equivalent person (EP). The Environmental Protection Regulation 2019 states that 1 EP = 200 L/day of effluent. With a total of 200 EP's the total daily wastewater volume is conservatively estimated at **40,000 L/day**.

4.2 WASTEWATER QUALITY

4.2.1 Key Contaminants

At the time of undertaking this assessment, final STP selection had not been completed. In the absence of a finalised design, conservative estimates of wastewater characteristics have been provided in Table 4-1. Expected effluent quality has been estimated based on the long-term limits established in the Eligibility Criteria and Standard Conditions for Sewage Treatment Works (ERA 63) – Version 2. These limit values also align with the quality which would be expected from a basic sewage treatment plant as per Table A3.2 of the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1).

Table 4-1 Wastewater Quality Estimations: Source ERA 63 Eligibility Criteria Standard Conditions

Quality Characteristics	Release Limit	Limit Type
Total nitrogen	30 mg/L	Maximum
Total phosphorus	10 mg/L	Maximum
Electrical conductivity	1,600 µs/cm	Maximum
pH	5.0 – 8.5	Range
Total residual chlorine (if used for disinfection)	1 mg/L	Maximum
E. coli	<1000 cfu/100mL	Maximum

4.2.2 Other Contaminants

In addition to the above parameters, AS 1547:2012 recommends that a secondary treated effluent is achieved for irrigation systems as per Table 4-2. These limits are primarily for operational purposes (e.g. to avoid clogging up pipes/fittings and soil pore spaces with solids and biofilms).

Table 4-2 Wastewater Quality Estimates – Secondary Treated Effluent: Source AS/NZ 1547

Quality Characteristics	Release Limit	Limit Type
Total Suspended Solids	20 mg/L	Maximum
Biochemical Oxygen Demand	30 mg/L	Maximum

4.2.3 Toxins

There is potential for other contaminants to exist in domestic wastewater. These typically result from pharmaceuticals (present in human waste), cleaning products and pesticides which can be intentionally or unintentionally released. Concentrations of these toxins are hard to predict but will generally be very low in concentration in comparison to industrial trade waste. The only significant source of such toxins is typically from isolated pulse events, for example, should chemicals be poured down a drain.

5.0 IRRIGATION AREA INVISTIGATION

5.1 SAMPLING PROCEDURES

A field investigation was undertaken on the 19th May 2020 to conduct soil sampling and hydraulic permeability field testing. The results have been used to evaluate the irrigation suitability of soils at the site, provide inputs to the irrigation model and to confirm the irrigation application rates. The data collected also provides a pre-irrigation baseline record of soil parameters.

Three (3) boreholes were hand augered across the irrigation investigation area and soil samples collected for laboratory analysis. Soils were logged in accordance with AS1726: 2017 Geotechnical site investigations. Soil samples were collected for analysis at each different profile layer as per Table 5-1.

Approximate borehole locations are shown on the Site Map presented in Appendix A and a copy of the borelogs is provided in Appendix B.

Table 5-1 Sampling Depths

Borehole Number	Sampling Depths
BH 01	▪ 0.0 – 0.1 mbgl (surface - silt layer) ▪ 0.1 – 0.2 mbgl (upper subsoil - low plasticity clay layer) ▪ 0.2 – 1.2 mbgl (lower subsoil - intermediate plasticity clay layer)
BH02	▪ 0.1 – 0.3 mbgl (surface- silt layer) ▪ 0.3 – 1.2 mbgl (lower subsoil - intermediate plasticity clay layer)
BH 03	▪ 0.1 – 0.3 mbgl (surface - silt layer) ▪ 0.3 – 1.1 mbgl (lower subsoil - intermediate plasticity clay layer)

5.2 FIELD HYDRAULIC CONDUCTIVITY MEASUREMENTS

Three constant head permeability field tests were also undertaken in the upper 0.5 m of the soil profile. The hydraulic conductivity was calculated from these tests using the Talsma-Hallam constantly maintained head of water equation defined by AS1547:2012 as:

$$Ksat = \frac{4.4Q\left[0.5sinh^{-1}\left(\frac{H}{2r}\right) - \sqrt{\left\{\left(\frac{r}{H^2}\right) + 0.25\right\}} + \frac{r}{H}\right]}{2\pi H^2}$$

where:

Ksat = saturated hydraulic condutivity of the soil in cm/min;
4.4 = correction factor for a systematic under-estimate of soil permeability in the mathematical derivation of the equation;
Q = rate of loss of water from reservoir in cm^3/min;
H = depth of water in the test hole in cm; and
r = radius of the test hole in cm.

5.3 LABORATORY ANALYSIS

All chemical testing of the site soils was completed by ALS, a NATA certified environmental testing laboratory, and included:

- Soil pH, electrical conductivity and salinity.
- Calcium, magnesium and sodium adsorption rates.
- Total and exchangeable cation concentration (K+, Na+, Ca+, Mg+),
- Total nitrogen (TN), total kjeldahl nitrogen (TKN), nitrates, nitrites and ammonia.
- Sodium adsorption ratio (SAR).
- Bulk density (BD).
- Total phosphorus (TP) and orthophosphate.
- Saturated water content.
- Field capacity; and
- Wilting point.

5.3.1 Contamination Analysis

The site has historically catered for grazing purposes. Grazing land can sometimes contain former buried cattle tick dips, although the likelihood of this occurring on this site is low given that there was no on-site evidence. As a conservative measure, the soil was investigated for a broad suite of contaminants potentially associated with cattle dips. The contaminants investigated included metals/metalloids (arsenic, cadmium, chromium III and VI, copper, lead, nickel, mercury, and zinc) as well as organochlorine and organophosphate compounds which are commonly used in pesticides.

6.0 IRRIGATION AREA INVESTIGATION RESULTS

6.1 IRRIGATION AREA DESCRIPTION

The investigation area was observed to be covered with very dry grasses, with shrubs and juvenile trees scattered across the site. Site photographs are shown below, with additional photographs presented in **Appendix C**.

Figure 6-1 View from site looking southeast

Figure 6-2 View from site looking west

Site soils typically comprised very dry light brown sandy silts with fine to medium grained sand to 0.1 – 0.3 mbgl overlying brown very stiff low plasticity clays with fine to medium grained sand to the base of boreholes (1.1 – 1.2 mbgl). Groundwater was not encountered.

The borehole logs indicate the soil profile was consistent across the proposed irrigation area. The area is overlain by a layer of 0.1-0.3 m of light brown fine to medium grained sandy silt, underlain by brown low to intermediate plasticity, very stiff clays with fine to medium grained sand to the base of the boreholes (1.1-1.2 mbgl). Groundwater was not encountered. The three borehole logs are attached in **Appendix B**.

The hydraulic conductivity of the surface soils was measured at 0.5m depth in each bore at 0.07 m/day. This aligns with the hydraulic conductivity expected in a light clay (category 5 soil) as described by AS1547:2012. Field hydraulic conductivity test results are presented in **Appendix D**. Field data is summarised in **Table 6-1**.

Table 6-1 Summary of field data

BH	Dominant Soil Type	Depth of Investigation	Hydraulic Conductivity (upper 0.5m)
BH01	Surface: Sandy SILT Subsurface: CLAY with sand	0.05 – 1.2 m	0.07 m/day
BH02	Surface: Sandy SILT Subsurface: CLAY with sand	0.05 – 1.2 m	0.07 m/day
BH03	Surface: Sandy SILT Subsurface: CLAY with sand	0.05 – 1.1 m	0.07 m/day

6.2 CHEMICAL AND PHYSICAL ANALYSIS

6.2.1 Soil Moisture and Nutrient Results

The soil moisture results are an indicator of the soil's ability to hold water and are used in the MEDLI 2.0 validation model. The figures represent the soil's plant-available water. The greater the difference between the field capacity and wilting point, the more plant-available water the soil can provide.

Nutrients such as nitrate and extractable phosphorus are also used in the MEDLI 2.0 model. The levels serve as a baseline platform upon which the model predicts how nitrate and phosphorus will be transported or accumulate in the soil profile.

The values utilised in the MEDLI 2.0 model for soil moisture, field capacity, wilting point, nitrate, and extractable phosphorus are presented in **Table 6-2**.

Table 6-2 Physical analysis results

Analyte	Unit	Surface Average	Upper subsoil Average	Lower subsoil Average
Bulk density	Tonne/m^3	1.45	1.46	1.50
Field Capacity	%	25.47	24.9	24.60
Wilting Point	%	7.03	10.8	11.70
Dry Porosity	%	45.17	44.9	43.40
Extractable Phosphorus	mg/kg	13.67	7	5.00
Nitrate	mg/kg	0.4	0.3	0.27

6.2.2 pH, salinity and sodicity

The soil pH, salinity and sodicity readings are presented in **Table 6-3**.

Table 6-3 Chemical Analysis Results

Analyte	Unit	Surface Average	Upper subsoil Average	Lower subsoil Average	Range
pH	pH unit	6.47	7.00	8.13	6.3-8.6
Sodium Adsorption Ratio	-	0.85	2.73	4.67	0.77-5.62
Exchangeable Sodium Percent	%	2.73	1.70	2.77	2.4-3.3
Electrical Conductivity	µS/cm	24.67	15.00	60.00	15-104

Soil pH was close to neutral, with minor acidity in the surface samples and minor alkalinity in the subsurface. This tended to correlate with negligible levels of salt in the upper profile and slightly higher salt levels in the lower profile.

Overall, the level of salt within the soil was low. The former Department of Environment and Resource Management (DERM)'s Salinity Management Handbook Second Edition, 2011 provides a range of tolerance limits for soil salinity which has been adapted from Shaw et al. 1987. These limits have

been reproduced in **Table 6-4**. At the maximum 0.104 dS/m recorded, the salt content of the soil would be well be tolerated in all but the most sensitive crops.

Table 6-4 Soil salinity ECse, and EC1:5 for four ranges of soil clay content (adapted from Shaw et al. 1987).

Plant salt-tolerance grouping[1]	Corresponding ECse range[2] (dS/m)	Equivalent EC 1:5 reading, based on clay content of soil (dS/m)				Soil salinity rating
		10-20% clay	20-40% clay	40-60% clay	60-80% clay	
Sensitive crops	< 0.95	< 0.07	< 0.09	< 0.12	< 0.15	Very low
Moderately sensitive crops	0.95 – 1.9	0.07 – 0.15	0.09 – 0.19	0.12 – 0.24	0.15 – 0.3	Low
Moderately tolerant crops	1.9 – 4.5	0.15 – 0.34	0.19 – 0.45	0.24 – 0.56	0.3 – 0.7	Medium
Tolerant crops	4.5 – 7.7	0.34 – 0.63	0.45 – 0.76	0.56 – 0.96	0.7 – 1.18	High
Very tolerant crops	7.7 – 12.2	0.63 – 0.93	0.76 – 1.21	0.96 – 1.53	1.18 – 1.87	Very high
Generally too saline for crops	> 12.2	> 0.93	> 1.21	> 1.53	> 1.87	Extreme

Notes:

1. These groupings are statistically derived divisions based on families of linear curves representing the salt-tolerance ratings of the majority of crops reported by Maas and Hoffman (1977). The terminology of Maas and Hoffman has been modified and an additional group of sensitive crops incorporated.

2. ECse given here is the boundary ECse at which 10% yield reduction occurs for these plant salt tolerance groups. The EC1:5 ranges have been determined from these ECse ranges using the equations provided in Converting from EC1:5 to ECse (see page 30 of the Queensland Salinity Management Handbook).

Exchangeable Sodium Percentage (ESP) and the Sodium Absorption Ratio (SAR) measure the ratio of sodium in the soil with respect to other salts. A sodium ratio which is too high results in a sodic soil that readily dissolves and disperses in water (known as dispersive soils). Dispersive soils need to be managed carefully as the “dissolved” soil particles leach into the underlying soil profile and clog pore spaces, leading to reduced permeability of the soil profile.

Table 6-5 was sourced from *DERM’s Salinity Management Handbook Second Edition, 2011* and shows sodicity classifications for soil. The three subsurface samples tested showed ESP values ranging between 2.4% and 3.3% and are therefore considered non-sodic. The sodicity of a soil also needs to be considered with respect to the salt content to determine how prone the soil could be to dispersion. This is discussed further in Section 6.2.3.

Table 6-5 Criteria for classifying sodicity in soils (from Northcote and Skene 1972).

Criteria	Description
ESP < 6	Non-sodic
ESP 6 – 14	Sodic
ESP > 15	Strongly sodic

6.2.3 Sodium Adsorption Ratio

The influence of sodicity on soil behaviour varies with clay content and clay mineralogy. Where clay content is higher, lower ESP levels significantly affect soil structure.

The two red crosses on the following graph indicate the estimated SAR range for soils at the site based on EC results. Soils in the area to the left of soil type B are unstable. While at this point in time the soil is not strongly sodic, its salt content is so low that it is susceptible to becoming dispersive.

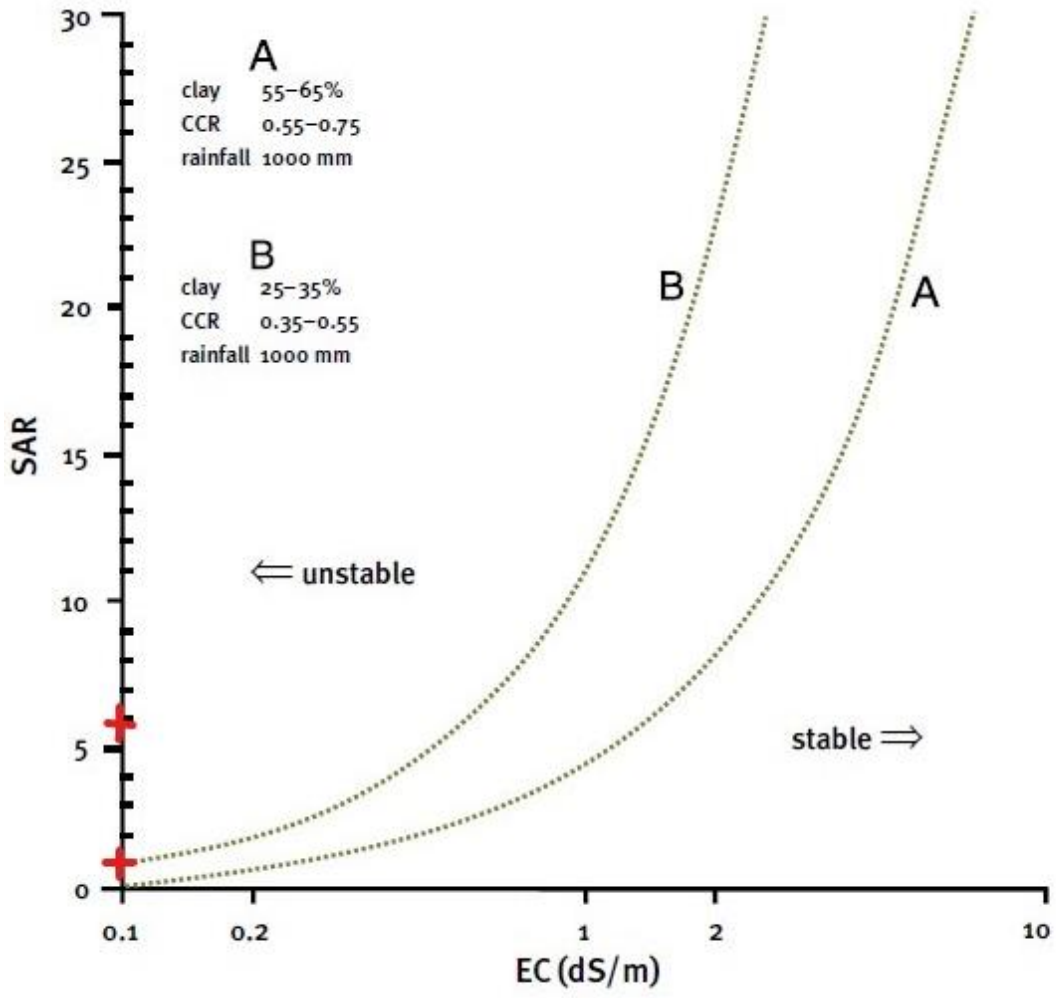


Figure 6-3 Reproduction of Figure 40 from the Salinity Management Handbook: The threshold lines for two soils of different clay content and mineralogy for an annual rainfall of 1000mm/yr.

The laboratory results are summarised in **Table 6-5**. Copies of the laboratory Chain of Custody, Sample Receipt Notification, Certificate of Analysis and quality control reports are provided in **Appendix E.**

6.2.4 Contaminant Analysis Results

Laboratory reports are shown in **Appendix F**, and a summary table is provided in **Appendix G**.

6.2.4.1 Metals/metalloids

Metals/metalloids were investigated because of the potential presence of toxins from unregistered cattle dips (notably arsenic).Although metals, including arsenic are present in all soils, at minute concentrations, they can pose environmental and health risks at higher concentrations. All soil samples were tested for the following eight metals/metalloids: arsenic, cadmium, chromium III and VI, copper, lead, nickel, mercury, and zinc. Results showed that very low levels of metals/metalloids are present on site, with the majority of samples testing at either below or just above the laboratory Limit of Reporting (LOR), placing the results well below the health and ecological investigation levels within the *National Environment Protection (Assessment of Site Contamination) Measure 2013*.

6.2.4.2 Organochlorine and Organophosphorus Pesticides

Organochlorine (OC) and organophosphorus (OP) pesticides were investigated because of their use in cattle dips (primarily DDT an OC). OC's and OP's are also widely used in agriculture, highly persistent in the environment and toxic, causing neurological damage, endocrine disorders and other health impacts if present at high concentrations. All soil samples were analysed for the presence of OCs and OPs, however, no OCs/OPs were detected at levels above the laboratory LOR, placing the results well below health investigation levels within the *National Environment Protection (Assessment of Site Contamination) Measure 2013.*

7.0 DESKTOP AS1547 ASSESSMENT

7.1 SELECTION CRITERIA

To determine the suitability of a site/system for spray irrigation, a comparison against Appendix K of AS 1547:2012 has been presented in **Table 7-1**. Overall, results indicate that the nature of the soil and of the site is generally supportive of spray irrigation.

Table 7-1 Selection Criteria for Irrigation Systems (Appendix K or AS/NZS 1547:2012)

	Slope Gradient	Soil Depth	Soil Category Number	Depth to seasonal water table	Duration of continuous seasonal soil saturation	Dispersive (sodic) soil	High content of stones, cobbles, or boulders	Climatic factors
Recommendation	Steep slopes can cause greater run-off during wet weather (< 10%).	A minimum of 0.6 m desirable.	Categories 1 and 2 may lead to nutrients reaching groundwater. Categories 4-6 may require large irrigation fields.	>1.2 m depth.	Prolonged saturation of upper soil impedes treatment and hinders adsorption.	Soil may lose permeability during life of system.	Unless extremely stony or covered in boulders, not relevant as delivery pipes need not be dug in soil in straight line.	Best in climates where intense rainfall events are uncommon and evapotranspiration exceeds rainfall in most months.
Conditions apparent on site	Gentle sloping site <10%.	Soil profile >1.2 m deep.	Soil profile category 5 (clay based)	Groundwater approx. 16 m below ground (based on QLD Globe Registered Bore layer).	Saturation generally not an issue given the dry climate and availability of the proposed wet weather storage capacity.	Sodicity not present, but soil has dispersive potential (needs to be managed to prevent reduction in permeability of the soil profile as per Section 13.5)	Gravel and stone not observed during investigation.	Climate suitable. Net evapotranspiration far exceeds rainfall for the whole of the year.

7.2 DESIGN CRITERIA

The following sections provide design criteria for standard surface spray irrigation systems in accordance with Appendix L and Appendix M of AS 1547:2012.

7.2.1 Irrigation Trigger

Irrigation schemes can be developed using either a soil moisture deficit standard or a set daily irrigation rate in the MEDLI 2.0 model.

A soil moisture trigger allows for large volumes to be irrigated in dry conditions (i.e. much of the winter dry season), but minimal or no irrigation can occur during wet conditions (i.e. frequent periods in the summer wet season). The use of a soil moisture trigger requires large wet weather storage volumes, but can lessen the irrigation area required.

A set daily irrigation rate will occur despite weather conditions. Given that irrigation will occur every day, minimal wet weather storage is required (it is generally reserved only for days when the irrigation field is waterlogged due to torrential rain). The disadvantage of a set daily irrigation rate is that the rate needs to be kept quite low, so as to not overload the soil profile in the wetter months. This typically results in the need for a larger irrigation area than would be required for a soil moisture trigger scheme.

The site has a moisture deficit throughout the year (average evaporation exceeds average rainfall), therefore there is unlikely to be a significant difference in irrigation area required for a moisture deficit or a set irrigation scheme. Given that a set irrigation rate scheme requires minimal wet weather storage requirements and is simpler to operate, a set irrigation scheme was considered to be warranted for this site.

7.2.2 Design Irrigation Rate

AS 1547:2012 assumes a secondary treated effluent will be irrigated (i.e., BOD of 20 mg/L and TSS of 30 mg/L). AS 1547:2012 uses this quality assumption to deem a suitable irrigation rate based on soil permeability.

The limiting soil profile is the subsoil which is consists of a slow-draining, light clay. In a light clay (category 5 soil) AS 1547:2012 recommends an irrigation rate no higher than 3 mm/day.

The 3 mm/day irrigation rate was set as a daily maximum within the MEDLI 2.0 model. The MEDLI 2.0 model was then used to predict the soil/plant response. In some cases, the daily maximum can be raised if the model responds well. In this case the maximum rate remained at 3 mm/day. This is discussed in further detail in Section 8.0.

8.0 MEDLI 2.0 MODELLING - MINE CONSTRUCTION PERIOD

The simulation was carried out using climate data for the period from 1950 to 2019. Given the wastewater will be sourced from a small new and confined network, the model assumed no wet weather infiltration into the network occurs.

The key model inputs used were as per **Table 8-1.**

Table 8-1 Mine Construction Period MEDLI 2.0 Input Parameters

Parameter	Proposed System
Effluent quantity	55 m^3/day
Wet Weather Storage Tank Volume/Capacity	165 m^3 (3 days)
Tank System Sludge Accumulation	0.0 kg dwt/year
Average Rainfall	674.3 mm/yr
Soil Evaporation	2031.2 mm/yr
Effluent Irrigation Area	2.1 ha
Irrigation Application	Daily maximum of 3 mm depth
Total Nitrogen entering the tank system	30 mg/L
Total Phosphorous entering the tank system	10 mg/L
Salinity	1,600 µs/cm
Pasture Type	Kikuyu Grass
Soil Type	Default MEDLI 2.0 Grey Clay based model. Soil Hydrologic, Soil Phosphorus, Initial Nitrogen in Soil amended to reflect site-based data.

8.1.1 Hydraulic Balance Results

The modelling outputs indicated that, by using the above irrigation scheme parameters, 100% of the treated effluent can be irrigated with no overflow events occurring.

8.1.2 Nutrient Balance Results

Nitrogen (N)

The nitrogen balance indicated that the average load of nitrogen added to the soil was 286.98 kg/ha/year. The average load of nitrogen removed by plant uptake was 337.23 kg/ha/year. This indicates there was a net average removal of nitrogen from the irrigation area. As is naturally expected, there are still a limited number of occasions when more nitrogen is added than removed (i.e. heavy rain periods), and during those occasions some nitrate is leached into the groundwater table. On average 0.04 kg/ha/year of nitrate would leach below the root zone via deep drainage. This is well within the accepted limit of 5 kg/ha/year (as per Section 2.3.2).

Phosphorous (P)

The phosphorus balance indicated that the average load of phosphorus added to the soil was 95.66 kg/ha/year. The average load of phosphorus removed by plant uptake was 61.58 kg/ha/year. This indicates a slight net average addition of phosphorus to the irrigation area. This is typically expected as most plants have a demand for nitrogen which far exceeds the demand for phosphorus.

Given that a net addition of phosphorus occurs in most land based effluent disposal systems, the soil phosphorus adsorption capacity is relied on. It is generally considered acceptable if the phosphorus adsorption capacity life reaches 30 years or more. The model confirmed that the above scenario can achieve 30.72 years life capacity.

Salinity

Modelling, assuming a Kikuyu Grass pasture (considered to be moderately salt-tolerant) indicated the resulting soil salinity would be too low to impact upon the health of the grass. Maintenance of grass health is important to maintain to ensure that nitrogen and phosphorus uptake is maximised.

8.1.3 Waterlogging

Clay based soils can be prone to waterlogging if they are irrigated too intensely. The model did not indicate any waterlogging issues occurring at the irrigation rate used for modelling but if irrigated much more intensely, such issues arise in model outputs.

8.1.4 Surface Runoff Water Quality

The model indicated no surface runoff of the irrigated effluent would occur. It is important to note that the model cannot account for site specific conditions such as rainwater ponding or run-on. However. given that the surface of the irrigation area consists of a gentle gradient neither run on, or ponding are expected to be significant factors on this site.

8.1.5 Pasture Health

Overall, the pasture maintains adequate health over the modelled period. No die off events were predicted and a high yield matter and coverage was maintained.

8.1.6 Model Summary

The MEDLI 2.0 model supports the irrigation of effluent at the proposed location over an area of 2.1 ha at an irrigation rate of no more than 3 mm/day. It is not recommended to irrigate any more intensively than this, as clay-based soils can be prone to waterlogging.

For further detail, the MEDLI 2.0 output report is provided in **Appendix H**.

9.0 MEDLI 2.0 MODELLING – MINE OPERATIONAL PERIOD

The simulation was carried out using climate data for the period from 1950 to 2019. Given the wastewater will be sourced from a small new and confined network, the model assumed no wet weather infiltration into the network occurs.

The key model inputs used were as per **Table 9-1.**

Table 9-1 Mine Construction Period Extreme Impermeable MEDLI 2.0 Input Parameters

Table 9-1 Parameter	Proposed System
Effluent quantity	40 m^3/day
Wet Weather Storage Tank Volume/Capacity	120 m^3 (3 days) was modelled (in practice it's expected 165m^3 will still be available from the construction period)
Tank System Sludge Accumulation	0.0 kg dwt/year
Average Rainfall	674.3 mm/yr
Soil Evaporation	2031.2 mm/yr
Effluent Irrigation Area	1.5 ha
Irrigation Application	Daily maximum of 3 mm depth
Total Nitrogen entering the tank system	30 mg/L
Total Phosphorous entering the tank system	10 mg/L
Salinity	1,600 µs/cm
Pasture Type	Kikuyu Grass
Soil Type	Default MEDLI 2.0 2.0 Grey Clay base Soil Hydrologic, Soil Phosphorus, Initial Nitrogen in Soil amended to reflect site-based data.

9.1.1 Hydraulic Balance Results

The modelling outputs indicated that, using the above irrigation scheme parameters, 100% of the treated effluent can be irrigated with no overflow events occurring.

9.1.2 Nutrient Balance Results

Nitrogen (N)

The nitrogen balance indicated that the average load of nitrogen added to the soil was 292.19 kg/ha/year. The average load of nitrogen removed by plant uptake was 342.44 kg/ha/year. This indicates there was a net average removal of nitrogen from the irrigation area. As is naturally expected, there are still a limited number of occasions when more nitrogen is added than removed (i.e. heavy rain periods), and during those occasions some nitrate is leached into the groundwater table. On average 0.04 kg/ha/year of nitrate is predicted to leach via deep drainage. This is within the accepted limit of 5 kg/ha/year.

Phosphorous (P)

The phosphorus balance indicated that the average load of phosphorus added to the soil was 97.40 kg/ha/year. The average load of phosphorus removed by plant uptake was 61.98 kg/ha/year. This indicates a slight net average addition of phosphorus to the irrigation area. This is typically expected as most plants have a demand for nitrogen which far exceeds the demand for phosphorus.

Given that a small net addition of phosphorus occurs in most land based effluent disposal systems, the soil phosphorus adsorption capacity is relied on. It is generally considered acceptable if the phosphorus adsorption capacity life reaches 30 years or more (as per Section 2.3.2). The model confirmed that the above scenario can achieve 30.3 years life capacity.

Salinity

Modelling assuming a Kikuyu Grass pasture (considered to be moderately salt-tolerant) indicated the resulting soil salinity would be too low to impact upon the health of the grass. Grass health is important to maintain to ensure that nitrogen and phosphorus uptake is maximised.

9.1.3 Waterlogging

Clay based soils can be prone to waterlogging if they are irrigated too intensely. The model did not indicate any waterlogging issues occurring at the irrigation rate used for modelling.

9.1.4 Surface Runoff Water Quality

The model indicated no surface runoff of the irrigated effluent would occur. It is important to note that the model cannot account for site specific conditions such as rainwater ponding or run-on. However. given that the surface of the irrigation area consists of a gentle gradient neither run on, or ponding are expected to be significant factors on this site.

9.1.5 Pasture Health

Overall, the pasture maintains adequate health over the modelled period. No die off events were predicted and a high yield matter and coverage was maintained.

9.1.6 Model Summary

The MEDLI 2.0 model supports the irrigation of effluent at the proposed location over an area of 1.5 ha at an irrigation rate of no more than 3 mm/day.

For further detail, the MEDLI 2.0 output report is provided in **Appendix I**.

10.0 AEROSOLS, PATHOGENS, ODOURS AND TOXINS

10.1 AEROSOLS AND PATHOGENS

A spray irrigation system will likely be the most simple and practical method of irrigation for this site. Spray irrigation systems disperse effluent through the air, which can result in fine mist, otherwise termed as aerosols. The aerosols can contain pathogens which can be carried for some distance on the wind.

The *National Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) 2006* provide examples of how log reductions using treatment and exposure control can be achieved, where a log reduction corresponds to a 10-fold, or 90% reduction of a given pathogen. Three examples which are relative to municipal irrigation are provided below in Table 10-1. The options are presented in order of highest level of treatment to lowest level of treatment. The lower the level of treatment, the higher the level of exposure reductions measures are required.

Given that the site and available buffer area are not significantly constrained and are relatively isolated, it will be feasible to readily implement exposure reduction measures such as buffers, restriction of public access or spray drift control, if this is deemed to be necessary.

10.2 ODOUR

Both the sewage treatment plant and the irrigation field can be odour sources. Odour is spread in a similar manner to that of aerosols and can also be dealt with in a similar manner.

Odour can be reduced through increased treatment, set back distances and aerosol reduction measures (e.g. using aerosol limiting spray methods). Consideration to irrigation timing can reduce odour drift, for example avoiding irrigation when prevalent wind direction is towards nearby sensitive receivers.

10.3 TOXINS

Aside from nutrients and pathogens, wastewater can contain other toxins as described in Section 4.2. These tend to only pose a direct risk to humans if the treated wastewater is intended for re-use to supplement a drinking water supply. In such cases the wastewater must be treated to an extremely high level to address these risks.

There is also some risk of exposure to toxins from dermal contact or inhalation, however, repeated continuous exposure would be required to result in any noticeable health effects. Health risks associated with aerosol exposure to toxins can be minimised by reducing the production of aerosols during irrigation, implementing access restrictions to the irrigation area, and ensuring buffer zones are implemented as per Section 12.2.

Table 10-1 Examples of how pathogen log reduction targets can be achieved for Municipal Irrigation systems (Source – National Guidelines for Water Recycling)

Table 10-1 Log reduction targets (Virus, Protozoa, Bacteria) [a]	Indicative treatment process	Log reductions achievable by treatment (V, P, B)	On-site preventative measures	Exposure reduction [b]	Water quality objectives [c]
Municipal use – open use, sports grounds, golf courses, dust suppression, etc *or* unrestricted access and application					
5.0 3.5 4.0	Advanced treatment required; for example: Secondary, coagulation, filtration and disinfection Secondary, membrane filtration, UV light	5.0 3.5 4.0	No specific measures		To be determined on case-by-case basis depending on technologies Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) *E. coli* < 1 per 100ml
Municipal use, with restricted access and application					
5.0 3.5 4.0	Secondary treatment with disinfection	2.0 - 3.0 1.0 >6.0	Restrict public access during irrigation **and one** of the following: No access after irrigation, until dry (1-4 hours) Minimum 25-30m buffer to nearest point of public access Spray drift control; for example, through low-throw sprinklers (180º inward throw), vegetation screening, or anemometer switching	2.0 1.0 1.0 1.0	▪ BOD < 20mg/L[d] ▪ SS < 30mg/L[d] ▪ Disinfectant residual (e.g. minimum chlorine residual) or UV dose[e] ▪ *E. coli* < 100cfu/100mL
Municipal use, with enhanced restrictions on access and application					
5.0 3.5 4.0	▪ Secondary treatment with > 25 days lagoon detention or primary treatment with > 50 days lagoon detention ▪ Secondary treatment	1.0 – 3.0 1.0 – 3.0 3.0 – 4.0 0.5 – 2.0 0.5 – 1.0 1.0 – 3.0	Restrict public access during irrigation **and combinations** of: ▪ No access after irrigation, until dry (1-4 hours) ▪ Minimum 25-30m buffer to nearest point of public access ▪ Spray drift control, e.g. through low throw sprinklers (180º inward throw), vegetation screening or anemometer switching	2.0 1.0 1.0 1.0	▪ BOD < 20mg/L[d] ▪ SS < 30mg/L[d] ▪ *E. coli* < 1000 cfu/100mL (disinfection may be required to achieve this concentration)

B = enteric bacteria; BOD = biochemical oxygen demand; cfu = colony forming unit; Ct = disinfectant concentration x time; P = enteric protozoa; SS = suspended solid; V = enteric virus; UV = ultraviolet. a Log reduction targets are minimum reductions required from raw sewage based on 95th percentiles from Table 3.7 of the guidelines.

b Exposure reductions are those achievable by on-site measures as listed in Table 3.3 of the guidelines.

c Water quality objectives represent medians for numbers of *E. coli* and means for other parameters.

d BOD and SS are an indication of secondary treatment effectiveness.

e Aim is to demonstrate reliability of disinfection and ability to consistently achieve microbial quality.

f Log reductions for public in the vicinity of commercial food crop irrigation areas should comply with total log reductions required for municipal use

11.0 STANDARD OF WASTEWATER TREATMENT

11.1 STANDARD OF WASTEWATER TREATMENT

The MEDLI 2.0 model confirms that a standard secondary treated effluent as per Table 4-1 and Table 4-2 can be irrigated within the investigation area without overloading the modelled Kikuyu Grass or soil with nutrients.

In terms of pathogen treatment capability the classes of recycled water quality, as per the *Queensland Public Health Regulation 2018,* are as per Table 11-1. By utilising, for example, enhanced access restrictions (as per the last row of Table 10-1) a Class C recycled water quality would be acceptable standard of wastewater treatment.

If irrigation area restrictions need to be eased slightly (as per the middle row of Table 10-1) a Class B water quality may be required. If no restrictions are in place (as per the top row of Table 11-1), and staff/public can readily access the irrigation area then a Class A + quality may be required.

Table 11-1 Classes of Recycled Water

E.coli count	Class of Recycled Water
<1 cfu/100mL*	Class A+
<10 cfu/100mL	Class A
<100 cfu/100mL	Class B
<1000 cfu/100mL	Class C
<10,000 cfu/100mL	Class D

*to achieve A+ compliance other pathogens such as Clostridium perfringens, F-specific RNA coliphages, and somatic coliphages must also be tested for.

11.2 PACKAGE TREATMENT PLANT OPTIONS

Many remote mining operation relys on package STPs which can be delivered in shipping containers and assembled on site. These are scaled down STPs having a small footprint and are generally highly efficient and of low maintenance requirements. Most come with standard Class C treatment capability and many come with upgrade options allowing them to readily achieve Class A treatment capability.

During detailed design the most applicable treatment plant type will be decided upon. At this stage, it is recommended that a low maintenance system with secondary treatment capability and ability to

produce, at least, Class C effluent should be adopted, pending irrigation area restrictions detailed in Table 10-1. If irrigation area restriction requirements for Class C effluent are not feasible, a low maintenance system with secondary treatment capacity should be selected with effluent quality capability in accordance with the management measures outlined in Table 10-1.

In addition to producing treated effluent, sewage treatment plants produce waste in the form of sludge. Waste sludge can be either be disposed of offsite, or where possible, recycled/reused.

12.0 IRRIGATION AREA MANAGEMENT

12.1 SPRAY IRRIGATION

The irrigation system will adopt recommendations from AS/NZS 1547:2012 as determined to be appropriate. Key considerations are outlined in the following sections.

12.1.1 Designated Disposal Area

The designated irrigation area:

- Is not be used for purposes that compromise the effectiveness of the system or access for future maintenance purposes;
- Is to be used only for effluent application until the pit progress to a point at which another irrigation area is required at which point a review of the wastewater management system will be undertaken;
- Will have boundaries clearly delineated and not accessible to livestock (to minimise damage);
- Will be constructed to capture run-off and seepage of effluent beyond the designated area; and
- Will have appropriate buffer areas maintained.

12.1.2 Irrigation System

The spray-irrigation system will be designed to:

- Distribute effluent evenly in the designated area;
- Control the droplet size, throw and plume height so that the risk of aerosol dispersion and the likelihood of wind draft distributing any effluent beyond the designated area is negligible;
- Have warnings complying with AS 1319 or AS/NZS 1319, at the boundaries of the designated area, clearly visible to property users, with wording such as “Recycled Water – Avoid Contact – DO NOT DRINK”; and
- Have a buffer area to ensure that any potential spray drift is adsorbed within appropriate setback distances.

12.2 BUFFER DISTANCES

The *QLD Government Technical Guideline for Disposal of Effluent via Irrigation, 2020* provides the following distances for reducing the risk associated with land disposal schemes using effluent irrigation:

- Natural waterways: >100 m
- Residential facility or public amenities: >50 m
- Domestic water bore: > 250 m
- Drinking water catchment and aquatic ecosystems with high ecological value: > 250 m
- Town water supply bore: > 1000m
- Groundwater bore used for potable water supply: >250 m; and
- Groundwater table at a depth: >3 m.

It is recognised that the public buffer of 50 m is greater than that suggested in Table 10-1. As a conservative measure, it is recommended to implement a 50 m buffer.

12.3 MAINTAINING PASTURE

The MEDLI 2.0 model assumes that when the grass is mowed, that the grass clippings are removed from the area so that the nutrients within the grass clippings are removed with them. There are a couple of ways to achieve this, by either using a mower with a catcher, or by removing the grass clippings after mowing has been completed (e.g. mower grass catcher, leaf blower or raking).

The MEDLI 2.0 model indicates that mowing would only be required approximately 3 times per year to maintain sufficient growth and subsequent nutrient uptake. The grass can be mowed more frequently to maintain aesthetics if required.

12.4 MONITORING PROGRAM

Once detailed design progresses a risk assessment of the irrigation scheme will be undertaken to determine site-specific monitoring requirements. The monitoring program will be designed in accordance with the *QLD Government Technical Guideline for Disposal of Effluent via Irrigation* and can be adopted into the Irrigation Management Plan. The monitoring program may include periodic monitoring of soil, groundwater and any available surface water in close proximity to the irrigation area. Often such monitoring programs include 6 monthly or annual monitoring for nutrients, salts, sodicity and contaminants such as metals/metalloids and pesticides.

13.0 CONCLUSIONS

The model results presented are based on conservatively estimated wastewater volumes and treated water quality. These conclusions are therefore conservative and can likely be refined further during detailed design.

13.1 MINE CONSTRUCTION PHASE

During construction a conservative volume of **55m^3** per day of secondary treated effluent with a quality as per Table 4-1 and Table 4-2 is expected to be. This effluent can be irrigated over **2.1 ha** at a rate of no more than **3 mm/day** without nutrient leaching, runoff or overflow issues arising. The *Queensland Government Technical Guideline for Disposal of Effluent via Irrigation, 2020* recommends that **165m^3** of wet weather storage (3 days) be provided.

13.2 MINE OPERATION PHASE

During operation a conservative volume of **40m^3** per day of secondary treated effluent with a quality as per Table 4-1 and Table 4-2 is expected to be generated. This effluent can be irrigated over **1.5 ha** at no more than 3 mm/day without nutrient leaching, runoff or overflow issues arising. The *Queensland Government Technical Guideline for Disposal of Effluent via Irrigation, 2020* recommends **120m^3** of wet weather storage (3 days) should be provided.

13.3 LOCATION OF DISPOSAL AREA

The irrigation disposal area can be located anywhere within the investigation area, using whichever shape is most practical. The investigation area is sufficiently large to accommodate the modelled irrigation area sizes. Any ongoing use of the existing structures located to the north will need to take into consideration the operation of the irrigation system.

13.4 MANAGING PATHOGEN EXPOSURE RISK

It will likely be reasonable and practical to restrict public/staff access to the irrigation area and restrict the irrigation application method to that shown in the last row in Table 10-1. As a result, the risk of pathogen exposure to the public/staff is low enough justify a secondary treated Class C recycled water quality requirement.

13.5 MANAGING SOIL SODICITY

While the soil is not currently sodic, it has potential to become so after irrigation with wastewater, although this is unlikely for the expected duration of operation of this area. Sodic soils need to be managed to prevent them becoming dispersive, which leads to reduction in pore spaces and potential waterlogging issues. If required, management options include balancing the Sodium Adsorption Ratio (SAR) in the soil via direct addition of gypsum to the soil profile, or via the irrigated effluent.

13.6 STANDARD OF ASSESSMENT AND LIMITATIONS

This Land-Based Effluent Disposal Assessment Report has been undertaken in accordance with the current industry standard for wastewater management as set out in AS/NZS 1547:2012 On-site Domestic Wastewater Management.

14.0 REFERENCES

> AS/NZS 1547: 2012 On-site domestic wastewater management.

> AS/NZS 1319: 1994 Safety signs for the occupational environment.

> AS 1726: 2017 Geotechnical site investigations.

> Ayers, R.S. and Westcot, D.W. (1976) *Water quality for agriculture.* Previously published as *FAO Irrigation and Drainage Paper 29.* Food and Agriculture Organization of the United Nations, Rome, 1985. Available: http://www.fao.org/3/t0234e/t0234e00.htm

> Bureau of Meteorology (BOM) 2020, *Groundwater Dependent Ecosystem Atlas*. Bureau of Meteorology and Department of Environment and Science, Queensland Government, Brisbane.

> The State of Queensland (Department of Environment and Resource Management) (2011) *Salinity management handbook: second edition*. Available: https://www.publications.qld.gov.au/dataset/5f866f8d-d47a-430e-aa9f-c97f7c4147d7/resource/b586d088-63e2-4ae5-9488-fbf864dcd638/fs_download/salinity-management-handbook-foreword.pdf

> Department of Environment and Heritage Protection (2015) *Eligibility criteria and standard conditions for sewage treatment works (ERA 63) – Version 2*. Available: https://environment.des.qld.gov.au/__data/assets/pdf_file/0035/88919/pr-es-irrigate-treated-sewage.pdf

> Ecological Survey & Management (EcoSM) 2019, *Baralaba South Project Terrestrial Ecology Impact Assessment Report*. Report prepared for Baralaba Coal Company Pty Ltd, Brendale, Queensland.

> *Environmental Protection (Water and Wetland Biodiversity) Policy 2019.* Available: https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2019-0156#

> State of Queensland (2019) *Environmental Protection Regulation 2019.* Available: https://www.legislation.qld.gov.au/view/pdf/inforce/2019-09-01/sl-2019-0155

> Department of Environment and Science (2015) *The Model for Effluent Disposal Using Land Irrigation Version 2.0 (MEDLI 2.0)*. https://science.des.qld.gov.au/government/science-division/MEDLI 2.0

> State of Queensland (2017) *Model Operating Conditions: ERA 63 – Sewage Treatment.* Available: https://environment.des.qld.gov.au/__data/assets/pdf_file/0030/88419/pr-co-sewage-treatment.pdf

> The State of Queensland (2019) *SILO: Australian climate data from 1889 to yesterday*. Available: https://www.longpaddock.qld.gov.au/silo/

> Central Highlands Regional Council Planning Scheme Flood Hazard Overlay Map.

> Department of Natural Resources, Mines and Energy (2020) *Queensland Globe.* Available: https://qldglobe.information.qld.gov.au/

> Maas, EV & Hoffman, GJ (1977) 'Crop salt tolerance—current assessment.' Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, **103**: 115-130.

> Northcote, KH & Skene, JKM (1972) *Australian soils with saline and sodic properties*, CSIRO Soil Publication No. 27, CSIRO Melbourne, Australia.

> Shaw, RJ, Hughes, KK, Thorburn, PJ & Dowling, AJ (1987) 'Principles of landscape, soil and water salinity—processes and management options', Part A in Landscape, soil and water salinity, Proceedings of the Brisbane Regional Salinity Workshop, Brisbane, May 1987, Conference and Workshop Series QC87003, Department of Primary Industries, Queensland.

REFERENCES

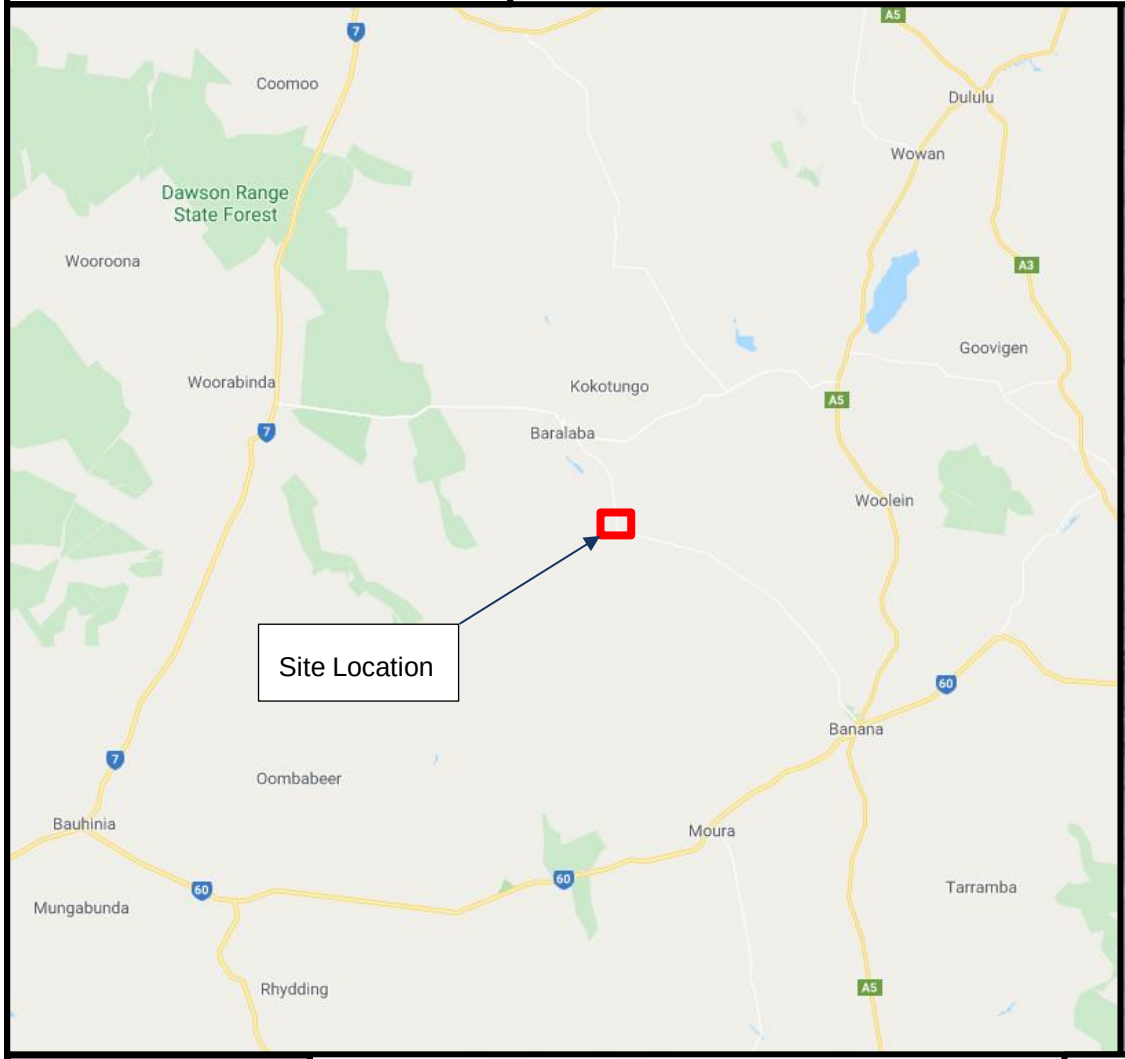
> National Resource Management Ministerial Council, Environment Protection and Heritage Council and Australian Health Ministers Conference (2006) Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1). Available: www.awa.asn.au/Documents/water-recycling-guidelines-health-environmental-21.pdf

> Tennakoon. S, and Ramsay. I, 2020*. Technical Guideline for disposal of effluent via irrigation.* Brisbane: Queensland Department of Environment and Science*.*

APPENDICES

APPENDIX A SITE SAMPLING

Site Map	Treated Sewage Effluent



Job No. M31218	Cardno®	**Mt Ramsay Coal Company Pty Ltd**	**Scale.** A4 NTS
Date. 19 May 2020			
Drawn By. L.Armstrong		Mount Ramsay, Baralaba QLD 4702	**Drawing No.** 001

Cardno (Qld) Pty Ltd
ABN 57 051 074 992

71 Maggiolo Drive
Paget QLD 4740
Australia

Phone +61 7 4952 5255

www.cardno.com

APPENDIX B BOREHOLE LOGS

BOREHOLE LOG SHEET

Client: Mount Ramsay Coal Company Pty Ltd
Project: Sewage Effluent
Location: Mount Ramsay, Baralaba QLD 4702

Hole No: BH01

Job No: M31030 **Sheet:** 1 of 1

Position: E791215.000 N7312531.000 55 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Hand Auger **Mounting:** Hand **Driller:** Cardno (QLD) Pty Ltd
Casing Diameter: **Contractor:** Cardno (QLD) Pty Ltd
Date Started: 19/5/20 **Date Completed:** 19/5/20 **Logged By:** LA **Checked By:** ML

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
HA			Groundwater Not Encountered	0.05 - 0.50 m Constant Head Permeameter	0.5		ML	Sandy SILT: low plasticity, light brown, fine to medium grained sand, very dry, cementation, rootlets, organics, MPS 3 LL 35 P75 70	D		ALLUVIAL
								0.10m			
							CL	CLAY: low plasticity, brown, with fine to medium grained sand, cementation, MPS 3 LL 40 P75 75			
								0.20m			
					1.0		Cl	CLAY: intermediate plasticity, brown, with fine to medium grained sand, MPS 3 LL 45 P75 80	D	VSt	
								1.20m			
					1.5			TERMINATED AT 1.20 m Terminated			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard
Fr - Friable

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

BOREHOLE LOG SHEET

Client: Mount Ramsay Coal Company Pty Ltd
Project: Sewage Effluent
Location: Mount Ramsay, Baralaba QLD 4702

Hole No: BH02

Job No: M31030 **Sheet:** 1 of 1

Position: E791290.000 N7312518.000 55 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Hand Auger **Mounting:** Hand **Driller:** Cardno (QLD) Pty Ltd
Casing Diameter: **Contractor:** Cardno (QLD) Pty Ltd
Date Started: 19/5/20 **Date Completed:** 19/5/20 **Logged By:** LA **Checked By:** ML

Drilling			Water	Sampling & Testing	Depth (m)	Material Description					
Method	Resistance	Casing		Sample or Field Test		Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
HA			Groundwater Not Encountered	0.05 - 0.50 m Constant Head Permeameter	0.5		ML	Sandy SILT: low plasticity, light brown, fine to medium grained sand, very dry, cementation, rootlets, organics, MPS 3 LL 35 P75 70	D	VSt	ALLUVIAL
					1.0		CI	0.30m CLAY: intermediate plasticity, brown, with fine to medium grained sand, MPS 3 LL 40 P75 80			
					1.5			1.20m TERMINATED AT 1.20 m Terminated			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard
Fr - Friable

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

CARDNO (QLD) PTY LTD

Cardno

BOREHOLE LOG SHEET

Client: Mount Ramsay Coal Company Pty Ltd
Project: Sewage Effluent
Location: Mount Ramsay, Baralaba QLD 4702

Hole No: BH03

Job No: M31030 **Sheet:** 1 of 1

Position: E791373.000 N7312510.000 55 MGA94 **Angle from Horizontal:** 90° **Surface Elevation:**
Rig Type: Hand Auger **Mounting:** Hand **Driller:** Cardno (QLD) Pty Ltd
Casing Diameter: **Contractor:** Cardno (QLD) Pty Ltd
Date Started: 19/5/20 **Date Completed:** 19/5/20 **Logged By:** LA **Checked By:** ML

Drilling: Method	Drilling: Resistance	Drilling: Casing	Water	Sampling & Testing: Sample or Field Test	Depth (m)	Material Description: Graphic Log	Classification	SOIL TYPE, plasticity or particle characteristic, colour, secondary and minor components ROCK TYPE, grain size and type, colour, fabric & texture, strength, weathering, defects and structure	Moisture Condition	Consistency Relative Density	STRUCTURE & Other Observations
HA			Groundwater Not Encountered	0.05 - 0.50 m Constant Head Permeameter	0.5		ML	Sandy SILT: low plasticity, light brown, fine to medium grained sand, very dry, cementation, rootlets, organics, MPS 3 LL 35 P75 70	D	VSt	ALLUVIAL
					1.0		CI	0.30m CLAY: intermediate plasticity, brown, with fine to medium grained sand, MPS 3 LL 40 P75 80			
					1.5			1.10m TERMINATED AT 1.10 m Terminated			

METHOD
EX Excavator bucket
R Ripper
HA Hand auger
PT Push tube
SON Sonic drilling
AH Air hammer
PS Percussion sampler
AS Short spiral auger
AD/V Solid flight auger: V-Bit
AD/T Solid flight auger: TC-Bit
HFA Hollow flight auger
WB Washbore drilling
RR Rock roller

PENETRATION
VE Very Easy (No Resistance)
E Easy
F Firm
H Hard
VH Very Hard (Refusal)

WATER
Water Level on Date shown
water inflow
water outflow

FIELD TESTS
SPT - Standard Penetration Test
HP - Hand/Pocket Penetrometer
DCP - Dynamic Cone Penetrometer
PSP - Perth Sand Penetrometer
MC - Moisture Content
PBT - Plate Bearing Test
IMP - Borehole Impression Test
PID - Photoionisation Detector
VS - Vane Shear; P=Peak, R=Resdual (uncorrected kPa)

SAMPLES
B - Bulk disturbed sample
D - Disturbed sample
ES - Environmental sample
U - Thin wall tube 'undisturbed'

MOISTURE
D - Dry
M - Moist
W - Wet
PL - Plastic limit
LL - Liquid limit
w - Moisture content

SOIL CONSISTENCY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard
Fr - Friable

RELATIVE DENSITY
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Refer to explanatory notes for details of abbreviations and basis of descriptions

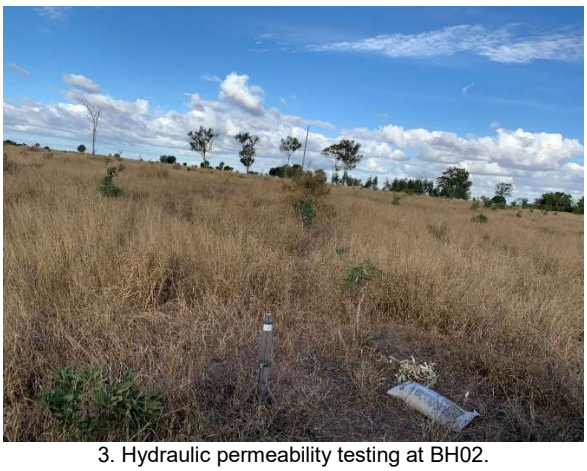
CARDNO (QLD) PTY LTD

APPENDIX C SITE PHOTOGRAPHS

Appendix C – Site Photographs

1. View from BH01 looking west.

2. View from BH01 looking east toward Mount Ramsay.



3. Hydraulic permeability testing at BH02.

4. BH02.

5. Hydraulic permeability testing at BH03.

6: View from BH03 looking southwest toward the house and sheds.

APPENDIX D CONSTANT HEAD PERMEABILITY TEST RESULTS

Ksat VALUES, Permeability Test Location

Job Location: Mt Ramsay, Baralaba

Permeability Test Location: PERM1 E0791215 N7312531

Soil Type: Sandy SILT / CLAY

Instrument Data

Reservoir internal Diameter (mm)	===>	60	6
Breather pipe Outer Diameter (mm)	===>	9	0.9
Test Hole radius (mm)	===>	37.5	3.75
Constant Water Depth in Test Hole (mm)	===>	450	45

Test Results

Water Fall (Constant rate)		Flow Rate	Ksat	**Ksat**
Rate (mm)/min		cm3/min	cm/min	**m/day**
6	0.6	16.58	0.0047	**0.07**

Ksat VALUES, Permeability Test Location

Job Location: Mt Ramsay, Baralaba

Permeability Test Location: PERM2 E0791290 N7312518

Soil Type: Silty Clay

Instrument Data

Reservoir internal Diameter (mm)	===>	60	6
Breather pipe Outer Diameter (mm)	===>	9	0.9
Test Hole radius (mm)	===>	37.5	3.75
Constant Water Depth in Test Hole (mm)	===>	450	45

Test Results

Water Fall (Constant rate)		Flow Rate	Ksat	**Ksat**
Rate (mm)/min		cm3/min	cm/min	**m/day**
5.8	0.58	16.03	0.0046	**0.07**

Ksat VALUES, Permeability Test Location

Job Location: Mt Ramsay, Baralaba

Permeability Test Location: PERM3 E0791373 N7312510

Soil Type: Silty Clay

Instrument Data

Reservoir internal Diameter (mm)	===>	60	6
Breather pipe Outer Diameter (mm)	===>	9	0.9
Test Hole radius (mm)	===>	37.5	3.75
Constant Water Depth in Test Hole (mm)	===>	450	45

Test Results

Water Fall (Constant rate)		Flow Rate	Ksat	**Ksat**
Rate (mm)/min		cm3/min	cm/min	**m/day**
6.1	0.61	16.86	0.0048	**0.07**

APPENDIX E LAB COC, SRN, QA CERTICATES

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8162 9700 E: adelaide@alsglobal.com

☐BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 4/6 Callemondah Drive Clinton QLD 4680 Ph: 07 4975 7444 E: ALSEnviro.Gladstone@alsglobal.com

☐MACKAY Unit 2/23 Caterpillar Drive Paget QLD 4740 Ph: 07 4952 5795 E: ALSEnviro.Mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 1/30 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgeemail@alsglobal.com

☐NEWCASTLE 5-665 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: ALSEnviro.Townsville@alsglobal.com

☐WOLLONGONG M19-21 Ralph Black Drive, Nth Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: CARDNO (QLD) PTY LTD	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☒ Standard TAT **(List due date):** [illegible]	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: FORTITUDE VALLEY		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes / No / N/A
PROJECT: Baralaba Mine **PROJECT NO. M31218**	**ALS QUOTE NO.: M431194**	**COC SEQUENCE NUMBER (Circle)**	Free Ice / frozen Ice bricks present upon receipt? Yes / No / N/A
ORDER NUMBER: **PURCHASE ORDER NO.: M31218**	**COUNTRY OF ORIGIN: AUSTRALIA**	COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Mark Farrey	**CONTACT PH: 07 3310 2309**	OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Luke Armstrong	**SAMPLER MOBILE: 07 4952 3477**	**RELINQUISHED BY:** LUKE ARMSTRONG	**RECEIVED BY:** N.SUTTON
COC Emailed to ALS? (YES / NO)	**EDD FORMAT (or default): Esdat**	DATE/TIME: 22/05/2020 1:30pm	DATE/TIME: 22.5.20 1:30
Email Reports to (will default to PM if no other addresses are listed): **mark.farrey@cardno.com.au**		**RELINQUISHED BY:** N.SUTTON	**RECEIVED BY:** [illegible]
Email Invoice to (will default to PM if no other addresses are listed): **mark.farrey@cardno.com.au**		DATE/TIME: 25.5.20 16:00	DATE/TIME: 26.5.2020 8:15

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: Testing as per ALS quote ref. BN/090/20

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	Tests as per ALS Quote No BN/090/20							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	BH01 0.00 - 0.10	19/05/2020 0:00	S	B		x							
2	BH01 0.10 - 0.20	19/05/2020 0:00	S	B		x							
3	BH01 0.20 - 1.20	19/05/2020 0:00	S	B		x							
4	BH02 0.00 - 0.30	19/05/2020 0:00	S	B		x							
5	BH02 0.30 - 1.20	19/05/2020 0:00	S	B		x							
6	BH03 0.00 - 0.30	19/05/2020 0:00	S	B		x							
7	BH03 0.30 - 1.10	19/05/2020 0:00	S	B		x							
				TOTAL									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

Environmental Division
Brisbane
Work Order Reference
EB2013980

Telephone : + 61-7-3243 7222

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB2013980**

Client	: **CARDNO (QLD) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MARK FARREY	Contact	: Carsten Emrich
Address	: LOCKED BAG 4006 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: mark.farrey@cardno.com.au	E-mail	: carsten.emrich@alsglobal.com
Telephone	: 33102309	Telephone	: +61 7 3552 8616
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: M31218 Baralaba Mine	Page	: 1 of 3
Order number	: M31218	Quote number	: EB2020CARDNO0001 (BN/090/20)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: LUKE ARMSTRONG		

Dates

Date Samples Received	: 26-May-2020 08:15	Issue Date	: 26-May-2020
Client Requested Due Date	: 10-Jun-2020	Scheduled Reporting Date	: **10-Jun-2020**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 5.3°C - Ice present
Receipt Detail	: MEDIUM ESKY	No. of samples received / analysed	: 7 / 7

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Wilting Point, Field Capacity and Porosity subcontracted to Bio-Track.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- **Bulk Density analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months ± 1 week) from receipt of samples.
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method / Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Pesticides by GCMS : EP068		
BH01 0.00-0.10	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH01 0.10-0.20	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH01 0.20-1.20	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH02 0.00-0.30	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH02 0.30-1.20	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH03 0.00-0.30	- Snap Lock Bag	- Soil Glass Jar - Unpreserved
BH03 0.30-1.10	- Snap Lock Bag	- Soil Glass Jar - Unpreserved

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - AG-2 EB Only Agricultural Soil Suite 2 EB Only	SOIL - EA006 (solids) Sodium Adsorption Ratio	SOIL - EA014 Total Soluble Salts	SOIL - EA055-103 Moisture Content	SOIL - NT-1T Total Major Cations (Ca, Mg, Na, K)	SOIL - S-02 8 Metals (incl. Digestion)	SOIL - S-12 OC/OP Pesticides
EB2013980-001	19-May-2020 00:00	BH01 0.00-0.10	✓	✓	✓	✓	✓	✓	✓
EB2013980-002	19-May-2020 00:00	BH01 0.10-0.20	✓	✓	✓	✓	✓	✓	✓
EB2013980-003	19-May-2020 00:00	BH01 0.20-1.20	✓	✓	✓	✓	✓	✓	✓
EB2013980-004	19-May-2020 00:00	BH02 0.00-0.30	✓	✓	✓	✓	✓	✓	✓
EB2013980-005	19-May-2020 00:00	BH02 0.30-1.20	✓	✓	✓	✓	✓	✓	✓
EB2013980-006	19-May-2020 00:00	BH03 0.00-0.30	✓	✓	✓	✓	✓	✓	✓
EB2013980-007	19-May-2020 00:00	BH03 0.30-1.10	✓	✓	✓	✓	✓	✓	✓

Matrix: **SOIL**

Laboratory sample ID	Client sampling date / time	Client sample ID	SOIL - EA051 Bulk Density	SOIL - EA055040 Moisture Content @ 40°C	SOIL - EA058 Emerson Aggregate Test	SOIL - EK080 Bicarbonate Extractable P (Colwell)	SOIL - EP003 Total Organic Carbon (TOC) in Soil	SOIL - MIS-SOL Miscellaneous Subcontracted Analysis (Solid)
EB2013980-001	19-May-2020 00:00	BH01 0.00-0.10	✓	✓	✓	✓	✓	✓
EB2013980-002	19-May-2020 00:00	BH01 0.10-0.20	✓	✓	✓	✓	✓	✓
EB2013980-003	19-May-2020 00:00	BH01 0.20-1.20	✓	✓	✓	✓	✓	✓
EB2013980-004	19-May-2020 00:00	BH02 0.00-0.30	✓	✓	✓	✓	✓	✓
EB2013980-005	19-May-2020 00:00	BH02 0.30-1.20	✓	✓	✓	✓	✓	✓
EB2013980-006	19-May-2020 00:00	BH03 0.00-0.30	✓	✓	✓	✓	✓	✓
EB2013980-007	19-May-2020 00:00	BH03 0.30-1.10	✓	✓	✓	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

MARK FARREY

- *AU Certificate of Analysis - NATA (COA)	Email	mark.farrey@cardno.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	mark.farrey@cardno.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	mark.farrey@cardno.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	mark.farrey@cardno.com.au
- A4 - AU Tax Invoice (INV)	Email	mark.farrey@cardno.com.au
- Attachment - Report (SUBCO)	Email	mark.farrey@cardno.com.au
- Chain of Custody (CoC) (COC)	Email	mark.farrey@cardno.com.au
- EDI Format - ENMRG (ENMRG)	Email	mark.farrey@cardno.com.au
- EDI Format - ESDAT (ESDAT)	Email	mark.farrey@cardno.com.au
- EDI Format - XTab (XTAB)	Email	mark.farrey@cardno.com.au

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB2013980**	Page	: 1 of 10
Client	: **CARDNO (QLD) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MARK FARREY	Contact	: Carsten Emrich
Address	: LOCKED BAG 4006 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 33102309	Telephone	: +61 7 3552 8616
Project	: M31218 Baralaba Mine	Date Samples Received	: 26-May-2020
Order number	: M31218	Date Analysis Commenced	: 27-May-2020
C-O-C number	: ----	Issue Date	: 10-Jun-2020
Sampler	: LUKE ARMSTRONG		
Site	: ----		
Quote number	: BN/090/20		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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 (%)*
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3043153)									
EB2013987-004	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	42	35	17.2	0% - 20%
		EG005T: Nickel	7440-02-0	2	mg/kg	10	16	41.7	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	6	6	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	57	# 167	98.3	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	211	# 144	37.8	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	133	# 210	44.5	0% - 20%
EB2013980-001	BH01 0.00-0.10	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	5	5	0.00	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	<5	<5	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	6	5	0.00	No Limit
EA002: pH 1:5 (Soils) (QC Lot: 3043166)									
EB2013739-001	Anonymous	EA002: pH Value	----	0.1	pH Unit	8.8	8.8	0.00	0% - 20%
EA010: Conductivity (1:5) (QC Lot: 3043165)									
EB2013739-001	Anonymous	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	1560	1570	0.320	0% - 20%
EA051: Bulk Density (QC Lot: 3046752)									
EB2013980-001	BH01 0.00-0.10	EA051: Bulk Density	BULK_DENSITY	1	kg/m3	1240	1230	0.594	0% - 20%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 3043177)									
EB2013939-001	Anonymous	EA055: Moisture Content	----	0.1	%	71.7	75.3	4.88	0% - 20%
EB2013980-005	BH02 0.30-1.20	EA055: Moisture Content	----	0.1	%	6.5	6.6	1.62	No Limit
ED006: Exchangeable Cations on Alkaline Soils (QC Lot: 3047977)									

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 (%)*
ED006: Exchangeable Cations on Alkaline Soils (QC Lot: 3047977) - continued									
EB2011143-001	Anonymous	ED006: Exchangeable Calcium	----	0.2	meq/100g	6.7	# 4.6	36.8	0% - 20%
		ED006: Exchangeable Magnesium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Exchangeable Sodium	----	0.2	meq/100g	<0.2	<0.2	0.00	No Limit
		ED006: Cation Exchange Capacity	----	0.2	meq/100g	6.7	# 4.6	36.8	0% - 20%
ED007: Exchangeable Cations (QC Lot: 3048607)									
EB2013777-002	Anonymous	ED007: Exchangeable Calcium	----	0.1	meq/100g	0.8	0.8	0.00	No Limit
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	0.8	0.8	0.00	No Limit
		ED007: Exchangeable Potassium	----	0.1	meq/100g	1.4	1.4	0.00	0% - 50%
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.4	0.3	0.00	No Limit
ED093T: Total Major Cations (QC Lot: 3043154)									
EB2013980-001	BH01 0.00-0.10	ED093T: Sodium	7440-23-5	50	mg/kg	<50	<50	0.00	No Limit
		ED093T: Potassium	7440-09-7	50	mg/kg	580	510	12.6	0% - 50%
		ED093T: Calcium	7440-70-2	50	mg/kg	1480	1340	10.0	0% - 20%
		ED093T: Magnesium	7439-95-4	50	mg/kg	500	460	6.56	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3043155)									
EB2013987-004	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	0.2	0.3	35.4	No Limit
EB2013980-001	BH01 0.00-0.10	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EK055: Ammonia as N (QC Lot: 3042343)									
EB2013980-002	BH01 0.10-0.20	EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	<20	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 3043172)									
EB2013980-001	BH01 0.00-0.10	EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	0.1	0.1	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 3043171)									
EB2013980-001	BH01 0.00-0.10	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.4	0.4	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 3043174)									
EB2013980-001	BH01 0.00-0.10	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	1030	1030	0.00	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 3043173)									
EB2013980-001	BH01 0.00-0.10	EK067G: Total Phosphorus as P	----	2	mg/kg	163	166	1.72	0% - 20%
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QC Lot: 3063212)									
EB2013980-001	BH01 0.00-0.10	EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	9	8	0.00	No Limit
EP003: Total Organic Carbon (TOC) in Soil (QC Lot: 3067276)									
EB2013980-001	BH01 0.00-0.10	EP003: Total Organic Carbon	----	0.02	%	0.73	0.75	2.73	0% - 20%
EB2014296-004	Anonymous	EP003: Total Organic Carbon	----	0.02	%	1.94	2.08	7.22	0% - 20%
EP068A: Organochlorine Pesticides (OC) (QC Lot: 3043158)									
EB2013980-005	BH02 0.30-1.20	EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit

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 (%)*
EP068A: Organochlorine Pesticides (OC) (QC Lot: 3043158) - continued									
EB2013980-005	BH02 0.30-1.20	EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Total Chlordane (sum)	----	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endosulfan (sum)	115-29-7	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: 4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
		EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
EB2013939-001	Anonymous	EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Total Chlordane (sum)	----	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: 4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit

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 (%)*
EP068A: Organochlorine Pesticides (OC) (QC Lot: 3043158) - continued									
EB2013939-001	Anonymous	EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
		EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 3043158)									
EB2013980-005	BH02 0.30-1.20	EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
		EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
EB2013939-001	Anonymous	EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit

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 (%)*
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 3043158) - continued									
EB2013939-001	Anonymous	EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	0.00	No Limit
		EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	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 Spike (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**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3043153)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	98 mg/kg	104	84.0	123
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
EG005T: Chromium	7440-47-3	2	mg/kg	<2	15.4 mg/kg	114	83.0	125
EG005T: Copper	7440-50-8	5	mg/kg	<5	48 mg/kg	106	86.0	122
EG005T: Lead	7439-92-1	5	mg/kg	<5	50 mg/kg	100	84.0	119
EG005T: Nickel	7440-02-0	2	mg/kg	<2	12.4 mg/kg	114	81.5	118
EG005T: Zinc	7440-66-6	5	mg/kg	<5	115 mg/kg	99.6	80.0	120
EA002: pH 1:5 (Soils) (QCLot: 3043166)								
EA002: pH Value	----	----	pH Unit	----	4 pH Unit	101	98.0	102
				----	7 pH Unit	100	98.0	102
EA006: Sodium Adsorption Ratio (SAR) (QCLot: 3062411)								
EA006: Sodium Adsorption Ratio	----	0.01	-	<0.01	----	----	----	----
EA010: Conductivity (1:5) (QCLot: 3043165)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	99.3	97.0	103
ED006: Exchangeable Cations on Alkaline Soils (QCLot: 3047977)								
ED006: Exchangeable Calcium	----	0.2	meq/100g	<0.2	8.19 meq/100g	118	70.0	130
ED006: Exchangeable Magnesium	----	0.2	meq/100g	<0.2	6.1 meq/100g	106	70.0	130
ED006: Exchangeable Potassium	----	0.2	meq/100g	<0.2	1.44 meq/100g	95.2	70.0	130
ED006: Exchangeable Sodium	----	0.2	meq/100g	<0.2	2.28 meq/100g	83.1	70.0	130
ED006: Cation Exchange Capacity	----	0.2	meq/100g	<0.2	18 meq/100g	107	70.0	130
ED007: Exchangeable Cations (QCLot: 3048607)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.1	8.1526 meq/100g	108	79.0	113
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.1	3.9743 meq/100g	105	85.0	115
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	1.1842 meq/100g	100	70.0	122
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.6015 meq/100g	102	76.0	112
ED007: Cation Exchange Capacity	----	0.1	meq/100g	<0.1	13.9127 meq/100g	106	82.0	112
ED093T: Total Major Cations (QCLot: 3043154)								
ED093T: Sodium	7440-23-5	50	mg/kg	<50	----	----	----	----
ED093T: Potassium	7440-09-7	50	mg/kg	<50	----	----	----	----
ED093T: Calcium	7440-70-2	50	mg/kg	<50	----	----	----	----
ED093T: Magnesium	7439-95-4	50	mg/kg	<50	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3043155)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.0847 mg/kg	92.8	70.0	125

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EK055: Ammonia as N (QCLot: 3042343)								
EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	25 mg/kg	94.8	80.0	110
EK057G: Nitrite as N by Discrete Analyser (QCLot: 3043172)								
EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	2.5 mg/kg	99.7	83.0	111
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3043171)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	88.0	83.2	111
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3043174)								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	848 mg/kg	104	73.0	121
				<20	2180 mg/kg	87.6	72.0	128
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3043173)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	939 mg/kg	86.6	80.0	115
				<2	1200 mg/kg	105	79.0	121
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 3063212)								
EK080: Bicarbonate Ext. P (Colwell)	----	5	mg/kg	<5	100 mg/kg	97.9	70.0	130
				<5	44.9 mg/kg	101	86.8	113
				<5	155 mg/kg	110	72.0	128
EP003: Total Organic Carbon (TOC) in Soil (QCLot: 3067276)								
EP003: Total Organic Carbon	----	0.02	%	<0.02	2.95 %	98.0	70.0	130
				<0.02	0.48 %	114	70.0	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 3043158)								
EP068: alpha-BHC	319-84-6	0.05	mg/kg	<0.05	0.5 mg/kg	98.4	54.0	121
EP068: Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	0.5 mg/kg	102	80.1	134
EP068: beta-BHC	319-85-7	0.05	mg/kg	<0.05	0.5 mg/kg	87.7	49.0	121
EP068: gamma-BHC	58-89-9	0.05	mg/kg	<0.05	0.5 mg/kg	102	75.5	136
EP068: delta-BHC	319-86-8	0.05	mg/kg	<0.05	0.5 mg/kg	100	61.0	122
EP068: Heptachlor	76-44-8	0.05	mg/kg	<0.05	0.5 mg/kg	96.0	65.0	130
EP068: Aldrin	309-00-2	0.05	mg/kg	<0.05	0.5 mg/kg	99.3	70.0	130
EP068: Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	0.5 mg/kg	101	58.0	118
EP068: Total Chlordane (sum)	----	0.05	mg/kg	<0.05	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	0.5 mg/kg	101	56.0	119
EP068: alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	0.5 mg/kg	101	51.0	125
EP068: cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	0.5 mg/kg	102	57.0	118
EP068: Dieldrin	60-57-1	0.05	mg/kg	<0.05	0.5 mg/kg	91.7	67.0	129
EP068: 4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	0.5 mg/kg	107	62.0	121
EP068: Endrin	72-20-8	0.05	mg/kg	<0.05	0.5 mg/kg	84.8	60.0	137
EP068: beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	0.5 mg/kg	96.2	61.0	122
EP068: Endosulfan (sum)	115-29-7	0.05	mg/kg	<0.05	----	----	----	----
EP068: 4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	0.5 mg/kg	91.8	60.0	123
EP068: Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	0.5 mg/kg	72.7	52.0	125

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP068A: Organochlorine Pesticides (OC) (QCLot: 3043158) - continued								
EP068: Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	0.5 mg/kg	78.0	55.0	125
EP068: 4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	0.5 mg/kg	72.0	70.0	130
EP068: Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	0.5 mg/kg	75.5	55.0	129
EP068: Methoxychlor	72-43-5	0.2	mg/kg	<0.2	0.5 mg/kg	82.8	53.0	136
EP068: Sum of DDD + DDE + DDT	72-54-8/72-5 5-9/50-2	0.05	mg/kg	<0.05	----	----	----	----
EP068: Sum of Aldrin + Dieldrin	309-00-2/60- 57-1	0.05	mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP) (QCLot: 3043158)								
EP068: Dichlorvos	62-73-7	0.05	mg/kg	<0.05	0.5 mg/kg	99.4	41.0	114
EP068: Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	0.5 mg/kg	82.6	25.0	120
EP068: Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	0.5 mg/kg	92.3	35.0	135
EP068: Dimethoate	60-51-5	0.05	mg/kg	<0.05	0.5 mg/kg	77.3	44.0	131
EP068: Diazinon	333-41-5	0.05	mg/kg	<0.05	0.5 mg/kg	99.9	70.0	131
EP068: Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	0.5 mg/kg	87.4	70.0	130
EP068: Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	0.5 mg/kg	73.9	60.0	122
EP068: Malathion	121-75-5	0.05	mg/kg	<0.05	0.5 mg/kg	83.1	64.0	125
EP068: Fenthion	55-38-9	0.05	mg/kg	<0.05	0.5 mg/kg	86.5	69.0	115
EP068: Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	0.5 mg/kg	103	66.0	120
EP068: Parathion	56-38-2	0.2	mg/kg	<0.2	0.5 mg/kg	75.8	57.0	118
EP068: Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	0.5 mg/kg	91.1	70.0	130
EP068: Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	0.5 mg/kg	70.7	62.0	127
EP068: Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	0.5 mg/kg	82.0	80.0	130
EP068: Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	0.5 mg/kg	64.0	55.0	106
EP068: Prothiofos	34643-46-4	0.05	mg/kg	<0.05	0.5 mg/kg	81.2	80.0	134
EP068: Ethion	563-12-2	0.05	mg/kg	<0.05	0.5 mg/kg	66.8	61.0	123
EP068: Carbophenothion	786-19-6	0.05	mg/kg	<0.05	0.5 mg/kg	63.9	57.0	124
EP068: Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	0.5 mg/kg	85.8	35.0	127

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**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3043153)							
EB2013980-002	BH01 0.10-0.20	EG005T: Arsenic	7440-38-2	100 mg/kg	86.2	70.0	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	94.3	70.0	130

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3043153) - continued							
EB2013980-002	BH01 0.10-0.20	EG005T: Chromium	7440-47-3	100 mg/kg	92.5	70.0	130
		EG005T: Copper	7440-50-8	100 mg/kg	95.2	70.0	130
		EG005T: Lead	7439-92-1	100 mg/kg	92.7	70.0	130
		EG005T: Nickel	7440-02-0	100 mg/kg	93.3	70.0	130
		EG005T: Zinc	7440-66-6	100 mg/kg	92.2	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3043155)							
EB2013980-002	BH01 0.10-0.20	EG035T: Mercury	7439-97-6	0.5 mg/kg	99.0	70.0	130
EK055: Ammonia as N (QCLot: 3042343)							
EB2013980-001	BH01 0.00-0.10	EK055: Ammonia as N	7664-41-7	100 mg/kg	98.5	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 3043172)							
EB2013980-002	BH01 0.10-0.20	EK057G: Nitrite as N (Sol.)	14797-65-0	2 mg/kg	80.3	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3043171)							
EB2013980-002	BH01 0.10-0.20	EK059G: Nitrite + Nitrate as N (Sol.)	----	2 mg/kg	95.6	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3043174)							
EB2013980-002	BH01 0.10-0.20	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	115	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3043173)							
EB2013980-002	BH01 0.10-0.20	EK067G: Total Phosphorus as P	----	100 mg/kg	# 166	70.0	130
EK080: Bicarbonate Extractable Phosphorus (Colwell) (QCLot: 3063212)							
EB2013980-002	BH01 0.10-0.20	EK080: Bicarbonate Ext. P (Colwell)	----	40 mg/kg	97.6	70.0	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 3043158)							
EB2013939-002	Anonymous	EP068: gamma-BHC	58-89-9	0.5 mg/kg	88.7	75.5	136
		EP068: Heptachlor	76-44-8	0.5 mg/kg	90.3	65.0	130
		EP068: Aldrin	309-00-2	0.5 mg/kg	# 34.6	70.0	130
		EP068: Dieldrin	60-57-1	0.5 mg/kg	83.9	67.0	129
		EP068: Endrin	72-20-8	0.5 mg/kg	101	60.0	137
		EP068: 4.4`-DDT	50-29-3	0.5 mg/kg	74.9	70.0	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 3043158)							
EB2013939-002	Anonymous	EP068: Diazinon	333-41-5	0.5 mg/kg	89.4	70.0	131
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5 mg/kg	93.5	70.0	130
		EP068: Pirimphos-ethyl	23505-41-1	0.5 mg/kg	80.1	70.0	130
		EP068: Bromophos-ethyl	4824-78-6	0.5 mg/kg	80.6	80.0	130
		EP068: Prothiofos	34643-46-4	0.5 mg/kg	# 69.4	80.0	134

APPENDIX F LABORATORY TEST RESULTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2013980**	Page	: 1 of 11
Client	: **CARDNO (QLD) PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MARK FARREY	Contact	: Carsten Emrich
Address	: LOCKED BAG 4006 FORTITUDE VALLEY QLD 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 33102309	Telephone	: +61 7 3552 8616
Project	: M31218 Baralaba Mine	Date Samples Received	: 26-May-2020 08:15
Order number	: M31218	Date Analysis Commenced	: 27-May-2020
C-O-C number	: ----	Issue Date	: 10-Jun-2020 17:27
Sampler	: LUKE ARMSTRONG		
Site	: ----		
Quote number	: BN/090/20		
No. of samples received	: 7		
No. of samples analysed	: 7		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.
~ = Indicates an estimated value.

- EP068 [Pesticides]: Sample EB2013939-002 shows poor matrix spike recovery due to matrix interference. Confirmed by re-extraction and re-analysis.
- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- **Bulk Density analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- EK067G (Total Phosphorus as P: Sample EB2013980_002 (BH01 0.10-0.20) shows poor matrix spike recovery due to sample heterogeneity. Confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): Sample EB2013987-004 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- ED006 (Exchangeable Cations on Alkaline Soils): Sample EB2011143-001 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EA058 Emerson: V. = Very, D. = Dark, L. = Light, VD. = Very Dark
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).
- ALS is not NATA accredited for the analysis of bulk density in a soil matrix.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH01 0.00-0.10	BH01 0.10-0.20	BH01 0.20-1.20	BH02 0.00-0.30	BH02 0.30-1.20
			Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2013980-001	EB2013980-002	EB2013980-003	EB2013980-004	EB2013980-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.6	7.0	8.6	6.5	8.1
EA006: Sodium Adsorption Ratio (SAR)								
Sodium Adsorption Ratio	----	0.01	-	0.85	2.73	4.25	0.77	5.62
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	20	15	104	32	47
EA014 Total Soluble Salts								
Total Soluble Salts	----	5	mg/kg	66	50	339	106	152
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	1240	1340	1050	1270	1090
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	2.4	4.7	7.1	2.9	6.5
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Very Dark Grayish Brown (2.5Y 3/2)	Very Dark Grayish Brown (2.5Y 3/2)	Dark Grayish Brown (10YR 4/2)	Very Dark Gray (10YR 3/1)	Dark Grayish Brown (10YR 4/2)
Texture	----	-	-	Medium Clay	Medium Clay	Medium Clay	Light Medium Clay	Medium Clay
Emerson Class Number	EC/TC	-	-	3	3	3	3	3
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	----	----	11.8	----	12.8
ø Exchangeable Magnesium	----	0.2	meq/100g	----	----	3.2	----	3.6
ø Exchangeable Potassium	----	0.2	meq/100g	----	----	0.3	----	0.4
ø Exchangeable Sodium	----	0.2	meq/100g	----	----	0.4	----	0.6
ø Cation Exchange Capacity	----	0.2	meq/100g	----	----	15.7	----	17.3
ø Exchangeable Sodium Percent	----	0.2	%	----	----	2.6	----	3.3
ø Calcium/Magnesium Ratio	----	0.2	-	----	----	3.7	----	3.6
ø Magnesium/Potassium Ratio	----	0.2	-	----	----	10.1	----	9.0
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	6.4	8.0	----	7.5	----
Exchangeable Magnesium	----	0.1	meq/100g	2.6	2.6	----	2.5	----
Exchangeable Potassium	----	0.1	meq/100g	0.4	0.3	----	0.5	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	----	<0.1	----
Cation Exchange Capacity	----	0.1	meq/100g	9.6	11.0	----	10.6	----
Exchangeable Sodium Percent	----	0.1	%	0.7	1.7	----	0.7	----
Calcium/Magnesium Ratio	----	0.1	-	2.5	3.1	----	3.0	----
Magnesium/Potassium Ratio	----	0.1	-	5.7	9.7	----	5.3	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01 0.00-0.10	BH01 0.10-0.20	BH01 0.20-1.20	BH02 0.00-0.30	BH02 0.30-1.20
				Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2013980-001	EB2013980-002	EB2013980-003	EB2013980-004	EB2013980-005
					Result	Result	Result	Result	Result
ED093T: Total Major Cations									
Sodium	7440-23-5	50	mg/kg		<50	70	140	<50	310
Potassium	7440-09-7	50	mg/kg		580	360	270	500	290
Calcium	7440-70-2	50	mg/kg		1480	2130	2520	2410	2460
Magnesium	7439-95-4	50	mg/kg		500	710	830	550	970
EG005(ED093)T: 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		5	7	7	6	7
Copper	7440-50-8	5	mg/kg		<5	<5	<5	6	<5
Lead	7439-92-1	5	mg/kg		<5	6	7	6	7
Nickel	7440-02-0	2	mg/kg		2	4	4	6	7
Zinc	7440-66-6	5	mg/kg		6	<5	<5	5	<5
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		0.1	<0.1	<0.1	0.1	0.3
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		0.3	0.3	0.6	0.4	<0.1
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		0.4	0.3	0.6	0.5	0.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		1030	660	350	1190	410
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		1030	660	350	1190	410
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		163	112	81	239	97
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		9	7	<5	21	<5
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		0.73	0.55	0.58	1.45	0.39
EP068A: Organochlorine Pesticides (OC)									

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH01 0.00-0.10	BH01 0.10-0.20	BH01 0.20-1.20	BH02 0.00-0.30	BH02 0.30-1.20
			Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00
Compound	CAS Number	LOR	Unit	EB2013980-001	EB2013980-002	EB2013980-003	EB2013980-004	EB2013980-005
				Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
^ Total Chlordane (sum)	----	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
^ Endosulfan (sum)	115-29-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4`-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH01 0.00-0.10	BH01 0.10-0.20	BH01 0.20-1.20	BH02 0.00-0.30	BH02 0.30-1.20
				Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00	19-May-2020 00:00
Compound	CAS Number	LOR	Unit		EB2013980-001	EB2013980-002	EB2013980-003	EB2013980-004	EB2013980-005
					Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued									
Fenthion	55-38-9	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Parathion	56-38-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Prothiofos	34643-46-4	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Ethion	563-12-2	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Carbophenothion	786-19-6	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
Azinphos Methyl	86-50-0	0.05	mg/kg		<0.05	<0.05	<0.05	<0.05	<0.05
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.05	%		**96.8**	**97.4**	**99.7**	**89.8**	**107**
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.05	%		**93.8**	**96.7**	**97.5**	**81.6**	**99.6**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH03 0.00-0.30	BH03 0.30-1.10	----	----	----
			Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2013980-006	EB2013980-007	--------	--------	--------
				Result	Result	----	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	6.3	7.7	----	----	----
EA006: Sodium Adsorption Ratio (SAR)								
Sodium Adsorption Ratio	----	0.01	-	0.94	4.14	----	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	22	29	----	----	----
EA014 Total Soluble Salts								
Total Soluble Salts	----	5	mg/kg	72	94	----	----	----
EA051 : Bulk Density								
ø Bulk Density	BULK_DENSITY	1	kg/m3	1330	1060	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	1.6	5.8	----	----	----
EA058: Emerson Aggregate Test								
Color (Munsell)	----	-	-	Very Dark Grayish Brown (10YR 3/2)	Dark Grayish Brown (10YR 4/2)	----	----	----
Texture	----	-	-	Sandy Clay Loam	Medium Heavy Clay	----	----	----
Emerson Class Number	EC/TC	-	-	3	3	----	----	----
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	----	13.4	----	----	----
ø Exchangeable Magnesium	----	0.2	meq/100g	----	3.6	----	----	----
ø Exchangeable Potassium	----	0.2	meq/100g	----	0.5	----	----	----
ø Exchangeable Sodium	----	0.2	meq/100g	----	0.4	----	----	----
ø Cation Exchange Capacity	----	0.2	meq/100g	----	18.0	----	----	----
ø Exchangeable Sodium Percent	----	0.2	%	----	2.4	----	----	----
ø Calcium/Magnesium Ratio	----	0.2	-	----	3.7	----	----	----
ø Magnesium/Potassium Ratio	----	0.2	-	----	7.0	----	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	4.4	----	----	----	----
Exchangeable Magnesium	----	0.1	meq/100g	1.9	----	----	----	----
Exchangeable Potassium	----	0.1	meq/100g	0.4	----	----	----	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	----	----	----	----
Cation Exchange Capacity	----	0.1	meq/100g	6.8	----	----	----	----
Exchangeable Sodium Percent	----	0.1	%	0.7	----	----	----	----
Calcium/Magnesium Ratio	----	0.1	-	2.3	----	----	----	----
Magnesium/Potassium Ratio	----	0.1	-	4.4	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH03 0.00-0.30	BH03 0.30-1.10	----	----	----
				Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2013980-006	EB2013980-007	--------	--------	--------
					Result	Result	----	----	----
ED093T: Total Major Cations									
Sodium	7440-23-5	50	mg/kg		<50	**160**	----	----	----
Potassium	7440-09-7	50	mg/kg		**420**	**280**	----	----	----
Calcium	7440-70-2	50	mg/kg		**1020**	**2600**	----	----	----
Magnesium	7439-95-4	50	mg/kg		**350**	**930**	----	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg		<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg		**6**	**7**	----	----	----
Copper	7440-50-8	5	mg/kg		<5	<5	----	----	----
Lead	7439-92-1	5	mg/kg		**5**	**7**	----	----	----
Nickel	7440-02-0	2	mg/kg		**4**	**6**	----	----	----
Zinc	7440-66-6	5	mg/kg		**5**	<5	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	----	----	----
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg		<20	<20	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg		**0.2**	<0.1	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg		**0.5**	**0.1**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg		**0.7**	**0.1**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg		**840**	**540**	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg		**840**	**540**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg		**173**	**93**	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)									
Bicarbonate Ext. P (Colwell)	----	5	mg/kg		**11**	<5	----	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.92**	**0.50**	----	----	----
EP068A: Organochlorine Pesticides (OC)									

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH03 0.00-0.30	BH03 0.30-1.10	----	----	----
				Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2013980-006	EB2013980-007	--------	--------	--------
					Result	Result	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
alpha-BHC	319-84-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg		<0.05	<0.05	----	----	----
beta-BHC	319-85-7	0.05	mg/kg		<0.05	<0.05	----	----	----
gamma-BHC	58-89-9	0.05	mg/kg		<0.05	<0.05	----	----	----
delta-BHC	319-86-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Heptachlor	76-44-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Aldrin	309-00-2	0.05	mg/kg		<0.05	<0.05	----	----	----
Heptachlor epoxide	1024-57-3	0.05	mg/kg		<0.05	<0.05	----	----	----
^ Total Chlordane (sum)	----	0.05	mg/kg		<0.05	<0.05	----	----	----
trans-Chlordane	5103-74-2	0.05	mg/kg		<0.05	<0.05	----	----	----
alpha-Endosulfan	959-98-8	0.05	mg/kg		<0.05	<0.05	----	----	----
cis-Chlordane	5103-71-9	0.05	mg/kg		<0.05	<0.05	----	----	----
Dieldrin	60-57-1	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDE	72-55-9	0.05	mg/kg		<0.05	<0.05	----	----	----
Endrin	72-20-8	0.05	mg/kg		<0.05	<0.05	----	----	----
beta-Endosulfan	33213-65-9	0.05	mg/kg		<0.05	<0.05	----	----	----
^ Endosulfan (sum)	115-29-7	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDD	72-54-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Endrin aldehyde	7421-93-4	0.05	mg/kg		<0.05	<0.05	----	----	----
Endosulfan sulfate	1031-07-8	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDT	50-29-3	0.2	mg/kg		<0.2	<0.2	----	----	----
Endrin ketone	53494-70-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Methoxychlor	72-43-5	0.2	mg/kg		<0.2	<0.2	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.05	mg/kg		<0.05	<0.05	----	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.05	mg/kg		<0.05	<0.05	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.05	mg/kg		<0.05	<0.05	----	----	----
Demeton-S-methyl	919-86-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Monocrotophos	6923-22-4	0.2	mg/kg		<0.2	<0.2	----	----	----
Dimethoate	60-51-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Diazinon	333-41-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg		<0.05	<0.05	----	----	----
Parathion-methyl	298-00-0	0.2	mg/kg		<0.2	<0.2	----	----	----
Malathion	121-75-5	0.05	mg/kg		<0.05	<0.05	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	BH03 0.00-0.30	BH03 0.30-1.10	----	----	----
				Client sampling date / time	19-May-2020 00:00	19-May-2020 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EB2013980-006	EB2013980-007	--------	--------	--------
					Result	Result	----	----	----
EP068B: Organophosphorus Pesticides (OP) - Continued									
Fenthion	55-38-9	0.05	mg/kg		<0.05	<0.05	----	----	----
Chlorpyrifos	2921-88-2	0.05	mg/kg		<0.05	<0.05	----	----	----
Parathion	56-38-2	0.2	mg/kg		<0.2	<0.2	----	----	----
Pirimphos-ethyl	23505-41-1	0.05	mg/kg		<0.05	<0.05	----	----	----
Chlorfenvinphos	470-90-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Bromophos-ethyl	4824-78-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Fenamiphos	22224-92-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Prothiofos	34643-46-4	0.05	mg/kg		<0.05	<0.05	----	----	----
Ethion	563-12-2	0.05	mg/kg		<0.05	<0.05	----	----	----
Carbophenothion	786-19-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Azinphos Methyl	86-50-0	0.05	mg/kg		<0.05	<0.05	----	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.05	%		**96.0**	**101**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.05	%		**97.0**	**102**	----	----	----

Surrogate Control Limits

Sub-Matrix: **SOIL**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	138
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	23	134

www.biotrack.com.au
781 Mt Glorious Rd Highvale 4520

Certificate of Analysis

Signatory:

Phone: +617 3289 7179 Bio-Track Pty Ltd ABN 91 056 237 275

Test Code/Name	**Moisture Content @ [51] Field Capacity(30 kPa) / [215] Wilting Point(1500 kPa) / Dry Density [293] % Air Filled Porosity**		
Lab Reference (LR)	**010620.490**	Client Name	ALS
SampleID	**All Samples**	Client Contact	Charles Tibbitts
		Project Name	Porosity/Wpoint/Fcapacity
Report Date	5/06/2020	Job Number	ALS Batch# EB2013980
Sample Received Date	1/06/2020	Order Number	505468
Sample Disposal Date	31/07/2020	Chain of Custody	
Sample Packaging	Plastic Bag	Client Email	charles.tibbitts@alsglobal.com
Temperature	Ambient	Client Address	2 Byth St Stafford Brisbane Queensland

Moisture Content at Field Capacity and Wilting Point calculated using Moisture Tension Plate.
Dry Density measured as dry mass/vol.
Porosity calculation assuming a particle density of 2.65 g/cc.

S#	SampleID	Dry Density Tonnes/M3	Air Filled Porosity %	MC% Grav. Field Capacity 30 kPa	MC% Grav. Wilting Point 1500 kPa
1	BH1 0-0.1	1.46	45.0	25.1	7.5
2	BH1 0.1-0.2	1.46	44.9	24.9	10.8
3	BH1 0.2-1.2	1.50	43.4	24.6	11.7
4	BH2 0-0.3	1.39	47.6	27.7	8.2
5	BH2 0.3-1.2	1.47	44.4	25.5	11.2
6	BH3 0-0.3	1.51	42.9	23.6	5.4
7	BH3 0.3-1.1	1.50	43.3	25.8	10.9

APPENDIX G SUMMARY OF CONTAMINATION TEST RESULTS

Cardno
Shaping the Future

	Bicarbonate Extractable P (Col	Emerson Aggregate Test			Exchangeable Cations on Alkali	Moisture Content	Total Soluble Salts	Metals													Inorganics								Organoch										
	Bicarbonate Ext. P (Colwell)	Emerson Class Number	Color (Munsell)	Texture	Magnesium/Potassium Ratio	Moisture Content	Total Soluble Salts	Arsenic	Cadmium	Calcium	Chromium (III+VI)	Copper	Lead	Magnesium	Mercury	Nickel	Phosphorus	Potassium	Zinc	Ammonia as N	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	pH (Lab)	Sodium	4,4-DDE	a-BHC	Aldrin	Aldrin + Dieldrin	b-BHC	chlordane	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	DDT+DDE+DDD
	mg/kg	-	-	-	-	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	pH_Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	5				0.1	1	5	5	1	50	2	5	5	50	0.1	2	2	50	5	20	20	0.1	0.1	0.1	20	0.1	50	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.05
NEPM 2013 Table 1A(1) HILs Res A Soil								100[#1]	20			6000	300[#2]		40[#3]	400			7400												6		50					240
Sample Date	Sample ID	Lab_Report_Number	SampleCode																																				
19/05/2020	BH01 0.00-0.10	EB2013980	EB2013980001	9	3	1[#1]	1[#8]	5.7	2.4	66	<5	<1	1480	5	<5	<5	500	<0.1	2	163	580	6	<20	1030	0.3	0.1	0.4	1030	6.6	<50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
19/05/2020	BH01 0.10-0.20	EB2013980	EB2013980002	7	3	1[#1]	1[#8]	9.7	4.7	50	<5	<1	2130	7	<5	6	710	<0.1	4	112	360	<5	<20	660	0.3	<0.1	0.3	660	7	70	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
19/05/2020	BH01 0.20-1.20	EB2013980	EB2013980003	<5	3	1[#3]	1[#8]	10.1	7.1	339	<5	<1	2520	7	<5	7	830	<0.1	4	81	270	<5	<20	350	0.6	<0.1	0.6	350	8.6	140	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
19/05/2020	BH02 0.00-0.30	EB2013980	EB2013980004	21	3	1[#4]	1[#6]	5.3	2.9	106	<5	<1	2410	6	6	6	550	<0.1	6	239	500	5	<20	1190	0.4	0.1	0.5	1190	6.5	<50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
19/05/2020	BH02 0.30-1.20	EB2013980	EB2013980005	<5	3	1[#3]	1[#8]	9	6.5	152	<5	<1	2460	7	<5	7	970	<0.1	7	97	290	<5	<20	410	<0.1	0.3	0.3	410	8.1	310	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
19/05/2020	BH03 0.00-0.30	EB2013980	EB2013980006	11	3	1[#2]	1[#7]	4.4	1.6	72	<5	<1	1020	6	<5	5	350	<0.1	4	173	420	5	<20	840	0.5	0.2	0.7	840	6.3	<50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
19/05/2020	BH03 0.30-1.10	EB2013980	EB2013980007	<5	3	1[#3]	1[#5]	7	5.8	94	<5	<1	2600	7	<5	7	930	<0.1	6	93	280	<5	<20	540	0.1	<0.1	0.1	540	7.7	160	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
Statistical Summary																																							
Number of Results		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Detects		4	7	7	7	7	7	0	0	7	7	1	6	7	0	7	7	7	3	0	7	6	4	7	7	7	4	0	0	0	0	0	0	0	0	0	0	0
Minimum Concentration		<5	3	1	1	4.4	1.6	50	<5	<1	1020	5	<5	<5	350	<0.1	2	81	270	<5	<20	350	<0.1	<0.1	0.1	350	6.3	<50	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
Minimum Detect		7	3	1	1	4.4	1.6	50	ND	ND	1020	5	6	5	350	ND	2	81	270	5	ND	350	0.1	0.1	0.1	350	6.3	70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration		21	3	1	1	10.1	7.1	339	<5	<1	2600	7	6	7	970	<0.1	7	239	580	6	<20	1190	0.6	0.3	0.7	1190	8.6	310	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05
Maximum Detect		21	3	1	1	10.1	7.1	339	ND	ND	2600	7	6	7	970	ND	7	239	580	6	ND	1190	0.6	0.3	0.7	1190	8.6	310	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Average Concentration		7.9	3	1	1	7.3	4.4	126	2.5	0.5	2089	6.4	3	5.8	691	0.05	4.7	137	386	3.7	10	717	0.32	0.12	0.41	717	7.3	108	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.025
Median Concentration		7	3	1	1	7	4.7	94	2.5	0.5	2410	7	2.5	6	710	0.05	4	112	360	2.5	10	660	0.3	0.1	0.4	660	7	70	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.025
Standard Deviation		6.7	0	0	0	2.3	2.2	100	0	0	606	0.79	1.3	1.6	234	0	1.7	57	120	1.6	0	316	0.2	0.095	0.2	316	0.88	105	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Env Stds Comments
#1:Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability maybe important and should be considered where appropriate (refer Shedule B7).
#2:Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered. Site-specific bioavailability should be considered where appropriate.
#3:Elemental mercury: HIL does not address elemental mercury. a site specific assessment should be considered if elemental mercury is present, or suspected to be present.

Data Comments
#1 Very Dark Grayish Brown (2.5Y 3/2)
#2 Very Dark Grayish Brown (10YR 3/2)
#3 Dark Grayish Brown (10YR 4/2)
#4 Very Dark Gray (10YR 3/1)

				Chlorine Pesticides														Organophosphorous Pesticides																												No group**
				Dieldrin	Endosulfan	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor	Azinophos methyl	Bromophos-ethyl	Carbophenothion	Chlorfenvinphos	Chlorpyrifos	Chlorpyrifos-methyl	Demeton-S-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenamiphos	Fenthion	Malathion	Methyl parathion	Monocrotophos	Parathion	Pirimphos-ethyl	Prothiofos	CEC
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g
EQL				0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.2	0.2	0.05	0.05	0.1
NEPM 2013 Table 1A(1) HILs Res A Soil					270				10				6		10	300					160																
Sample Date	Sample ID	Lab_Report_Number	SampleCode																																									
19/05/2020	BH01 0.00-0.10	EB2013980	EB2013980001	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	9.6
19/05/2020	BH01 0.10-0.20	EB2013980	EB2013980002	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	11
19/05/2020	BH01 0.20-1.20	EB2013980	EB2013980003	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	15.7
19/05/2020	BH02 0.00-0.30	EB2013980	EB2013980004	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	10.6
19/05/2020	BH02 0.30-1.20	EB2013980	EB2013980005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	17.3
19/05/2020	BH03 0.00-0.30	EB2013980	EB2013980006	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	6.8
19/05/2020	BH03 0.30-1.10	EB2013980	EB2013980007	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	18
Statistical Summary																																											
Number of Results				7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Detects				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Minimum Concentration				<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	6.8
Minimum Detect				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.8
Maximum Concentration				<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.2	<0.2	<0.05	<0.05	18
Maximum Detect				ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18
Average Concentration				0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.1	0.1	0.025	0.025	13
Median Concentration				0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.1	0.1	0.025	0.025	11
Standard Deviation				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.3
Number of Guideline Exceedances				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Env Stds Comments
#1:Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability maybe important and should be considered where appropriate (refer Shedule B7).
#2:Lead: HILs A,B,C based on blood lead models (IEUBK & HIL D on adult lead model for where 50% bioavailability considered. Site-specific bioavailability should be considered where appropriate.
#3:Elemental mercury: HIL does not address elemental mercury. a site specific assessment should be considered if elemental mercury is present, or suspected to be present.

Data Comments
#1 Very Dark Grayish Brown (2.5Y 3/2)
#2 Very Dark Grayish Brown (10YR 3/2)
#3 Dark Grayish Brown (10YR 4/2)
#4 Very Dark Gray (10YR 3/1)

APPENDIX H MEDLI 2.0 OUTPUT CONSTRUCTION SCENARIO

MEDLI REPORT - FULL RUN

Enterprise: **Baralaba Construction**

Description:
Clay Based Model

Client: **Baralaba Project**

MEDLI User: CARDNO\mark.farrey

Scenario Details:
Construction
-165KL Storage (3 days)
- 3mm/day max irrigation
- 2.1ha irrigation area
- Rhodes Grass

DESCRIPTION

Climate Data: Baralaba South_-24.25_149.85, -24.25°, 149.85°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days

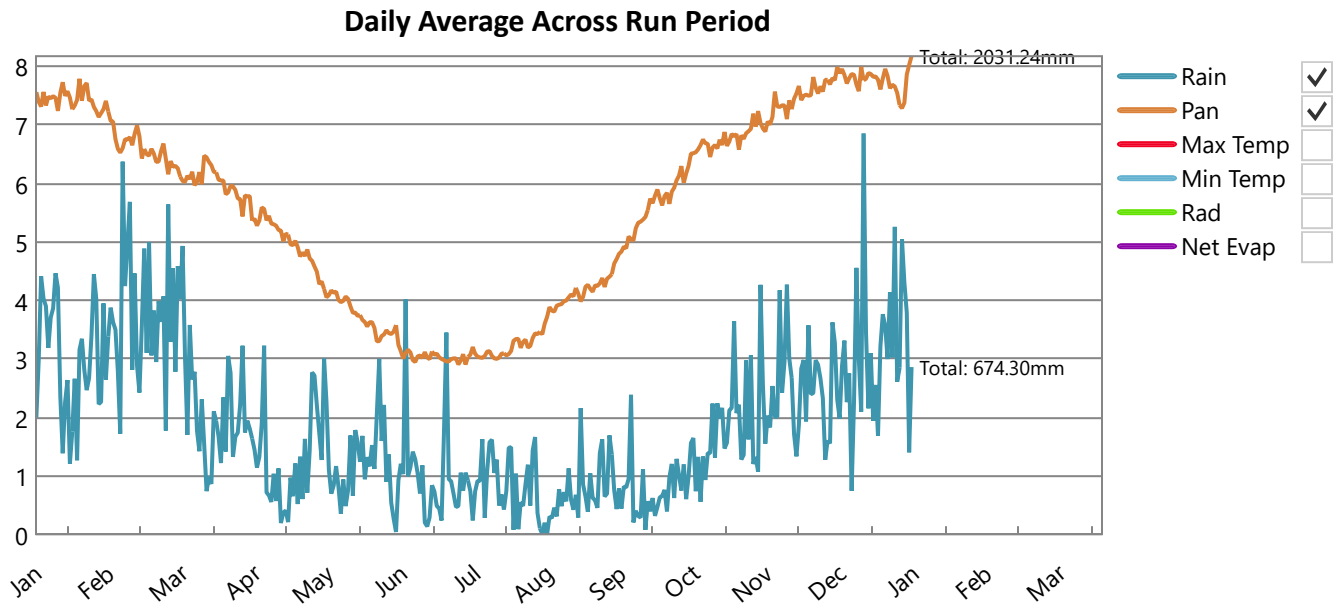
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	375	674	1059
Pan Evaporation (mm/year)	1795	2041	2232

Climate Data:

Chart Table

Monthly Daily

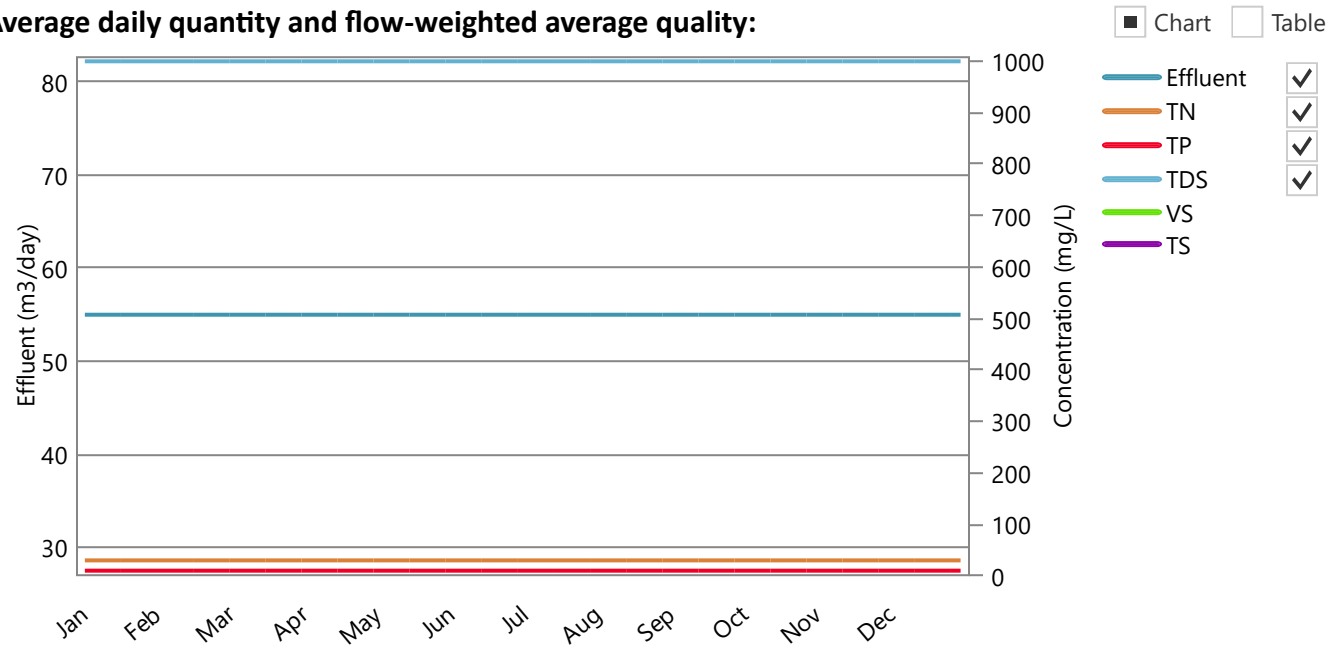


DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 20088.36 m3/year or 55.00 m3/day (Min-Max: 55.00 - 55.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

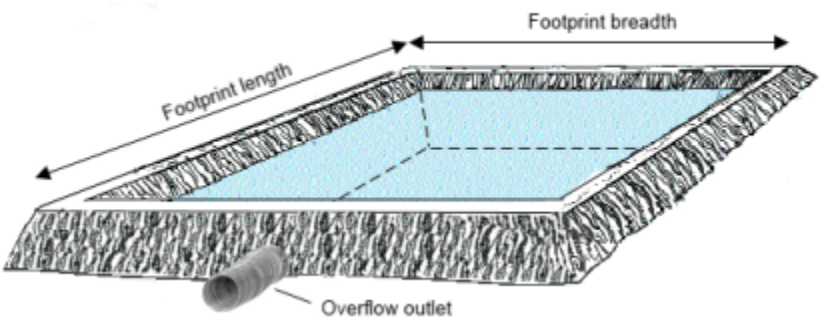
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	30.00 (30.00 - 30.00)	602.65 (602.25 - 603.90)
Total Phosphorus	10.00 (10.00 - 10.00)	200.88 (200.75 - 201.30)
Total Dissolved Salts	1000.00 (1000.00 - 1000.00)	20088.36 (20075.00 - 20130.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

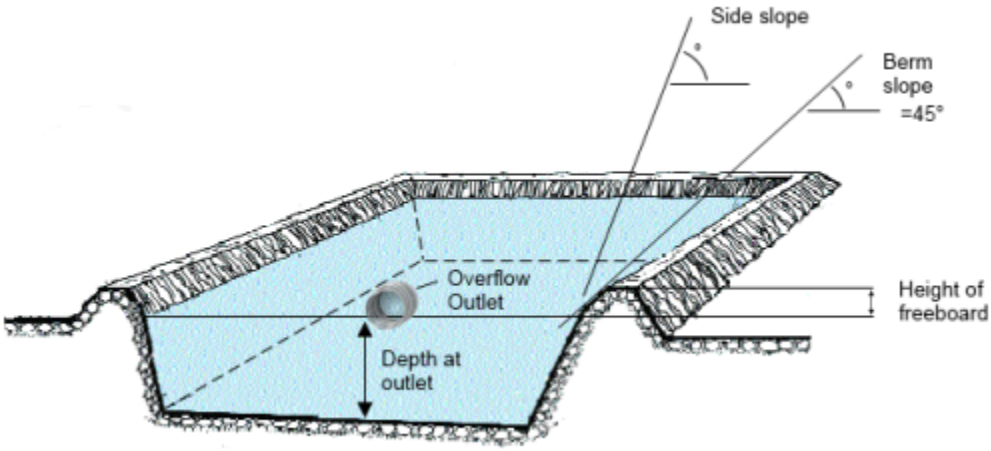
DESCRIPTION

Pond system: 1 closed storage tank

Pond system details:

	Pond 1
Maximum pond volume (m3)	165.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	55.00
Pond footprint length (m)	7.42
Pond footprint width (m)	7.42
Pond catchment area (m2)	55.00
Average active volume (m3)	0.00





Irrigation pump limits:

Minimum pump rate limit (ML/day)	0.00
Maximum pump rate limit (ML/day)	1000000.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

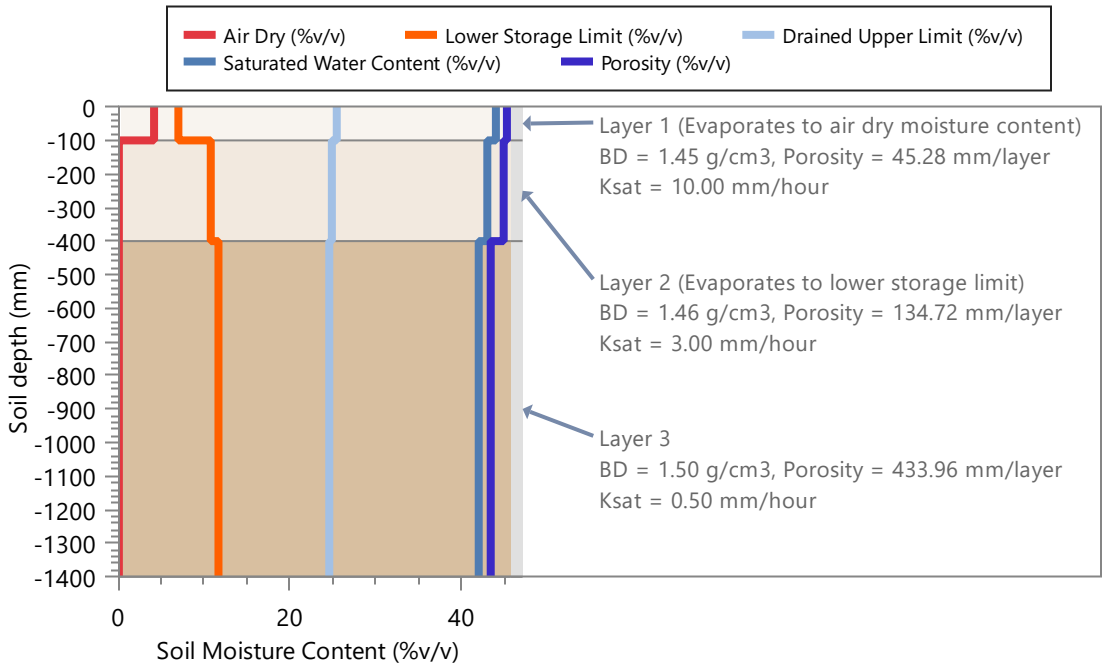
DESCRIPTION

Land: Baralaba Clay

Area (ha): 2.10

Soil Type: Baralaba Clay, 1400.00 mm defined profile depth

Profile Porosity (mm)	613.96
Profile saturation water content (mm)	593.00
Profile drained upper limit (or field capacity) (mm)	346.17
Profile lower storage limit (or permanent wilting point) (mm)	156.43
Profile available water capacity (mm)	189.74
Profile limiting saturated hydraulic conductivity (mm/hour)	0.50
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	75.00
Soil evaporation U (mm)	6.00
Soil evaporation Cona (mm/sqrt day)	3.50



Plant Data: Continuous Kikuyu 1 Pasture

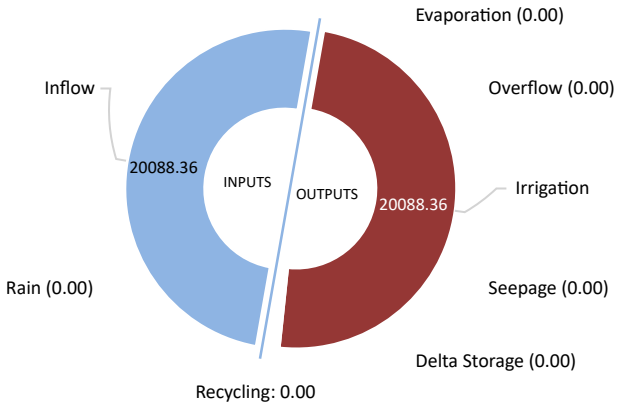
Average monthly cover (fraction) (minimum - maximum)	0.87 (0.83 - 0.90)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

PERFORMANCE

Pond System Water Performance - Overflow: 1 closed storage tank

Capacity of wet weather storage pond: **165 m3**

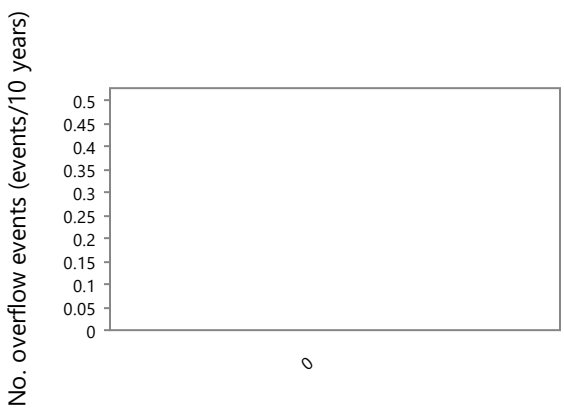
Pond System Water Balance (m3/year)



Name	Value
Rain	0.00
Inflow	20088.36
Recycling	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	20088.36
Seepage	0.00
Delta Storage	0.00

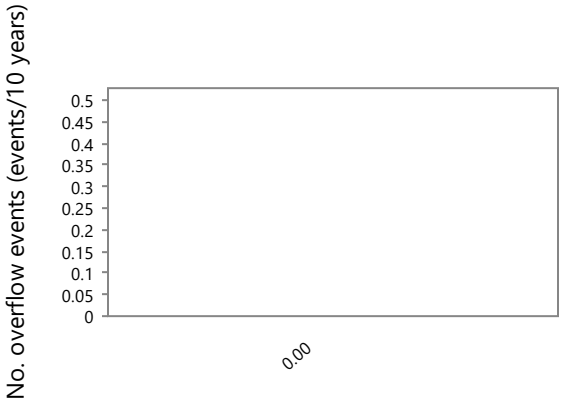
Overflow Diagnostics

Volume of overflow (m3/year)	0.00
No. days pond overflows (days/year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% reuse (fraction)	1.00



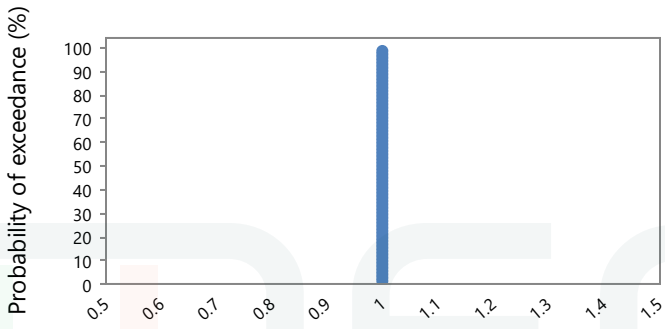
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

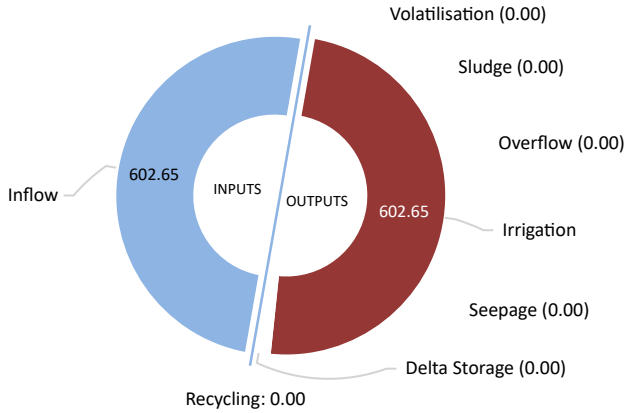
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

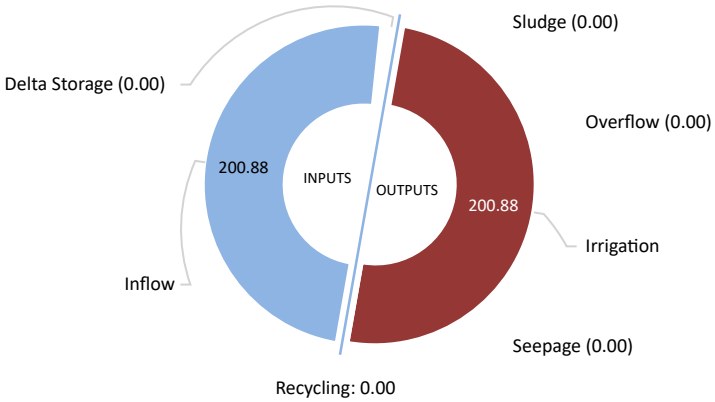
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



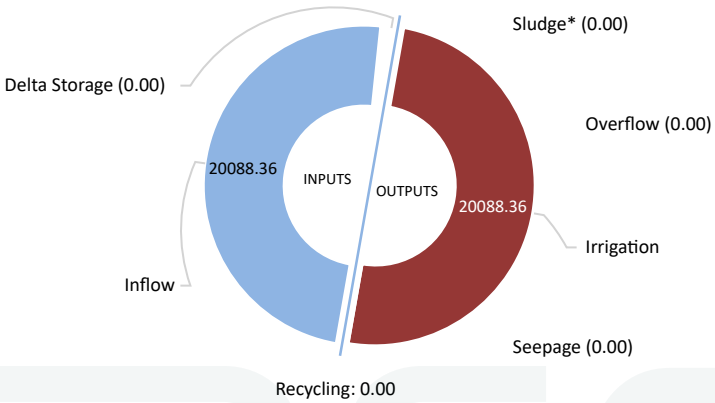
Name	Value
Inflow	602.65
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	602.65
Seepage	0.00
Delta Storage	0.00

Phosphorus Balance (kg/year)



Name	Value
Inflow	200.88
Recycling	0.00
Sludge	0.00
Overflow	0.00
Irrigation	200.88
Seepage	0.00
Delta Storage	0.00

Salt Balance (kg/year)



Name	Value
Inflow	20088.36
Recycling	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	20088.36
Seepage	0.00
Delta Storage	0.00

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	30.00
Average phosphorus concentration of pond liquid (mg/L)	10.00
Average salinity of pond liquid (dS/m)	1.56

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	N.D.*
Final phosphorus concentration of pond liquid (mg/L)	N.D.*
Final salinity of pond liquid (dS/m)	N.D.*

* Not determined. Pond is empty.

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	20088.36
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	20088.36
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	30.00
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	30.00
Average phosphorus concentration of irrigation water (mg/L)	10.00
Average salinity of irrigation water (dS/m)	1.56

Irrigation Diagnostics:

Proportion of Days irrigation occurs (fraction)	1.00

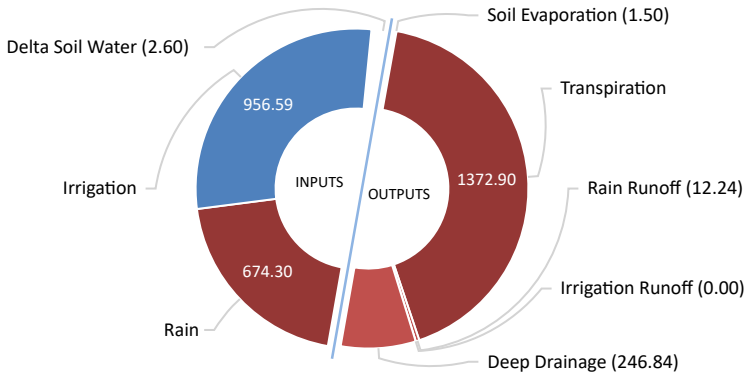
PERFORMANCE

Land Performance - Soil Water

Paddock: Baralaba Clay, 2.1 ha
Soil Type: Baralaba Clay, 163.94 mm PAWC at maximum root depth

Land Water Balance (mm/year):

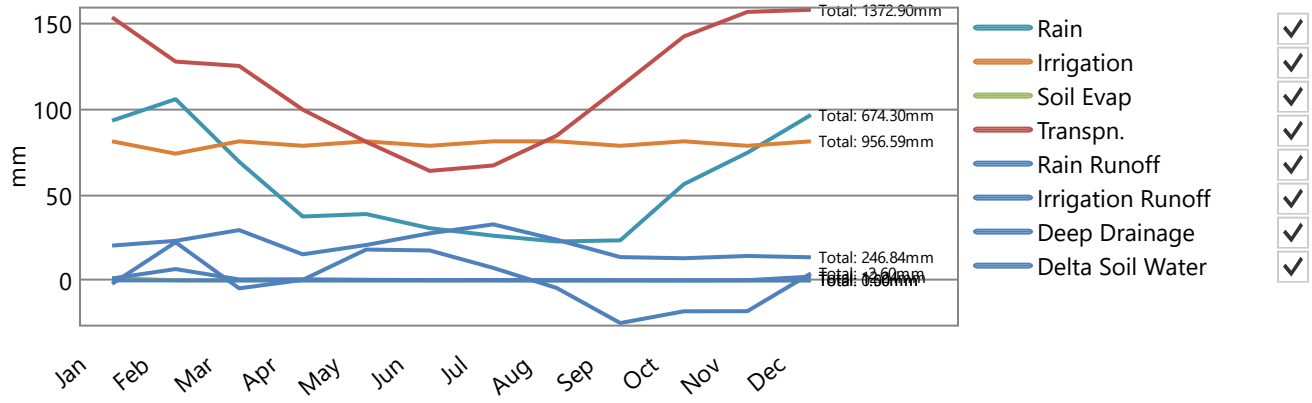
mm/year % Total inputs



Name	Value
Rain	674.30
Irrigation	956.59
Soil Evaporation	1.50
Transpiration	1372.90
Rain Runoff	12.24
Irrigation Runoff	0.00
Deep Drainage	246.84
Delta Soil Water	-2.60

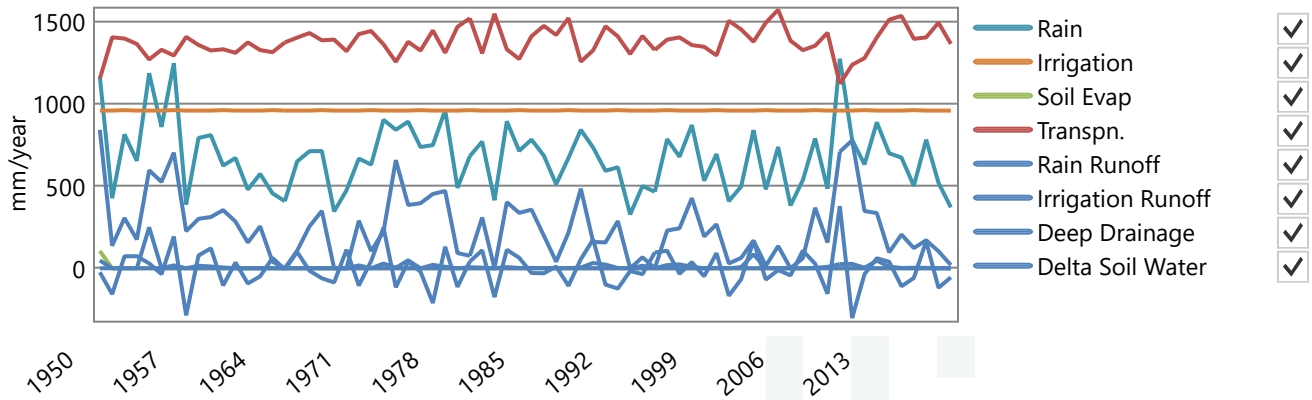
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



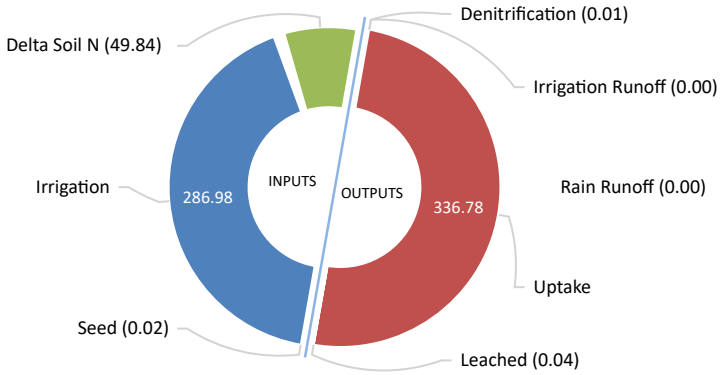
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Baralaba Clay, 2.1 ha **Soil Type**: Baralaba Clay

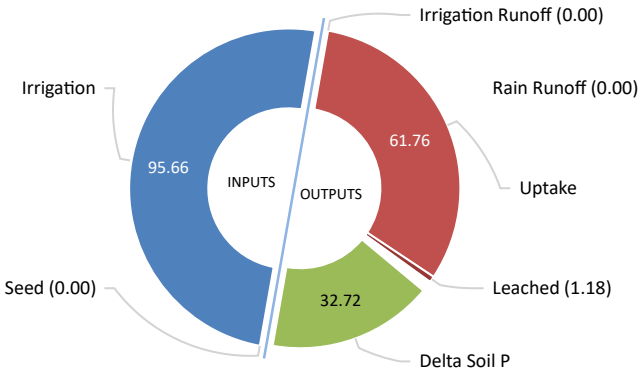
Irrigation ammonium volatilisation losses (kg/ha/year): 0.00
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.25

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	286.98
Denitrification	0.01
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	336.78
Leached	0.04
Delta Soil N	-49.84

Land Phosphorus Balance (kg/ha/year)



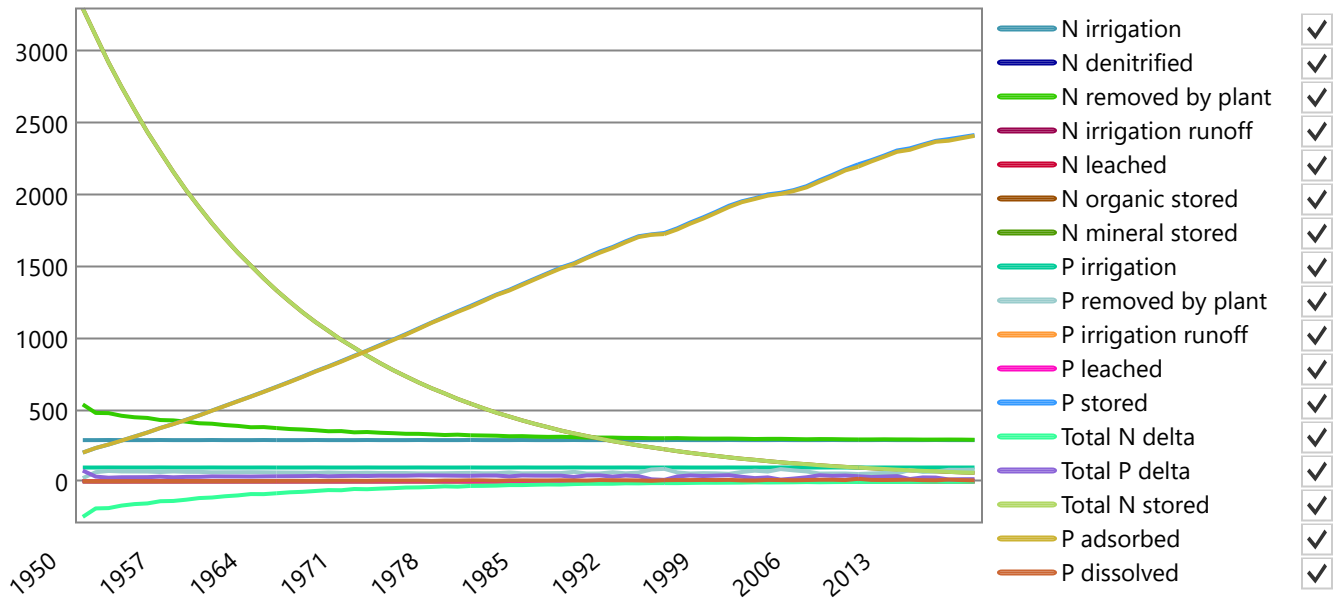
Name	Value
Seed	1.29E-03
Irrigation	95.66
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	61.76
Leached	1.18
Delta Soil P	32.72

PERFORMANCE

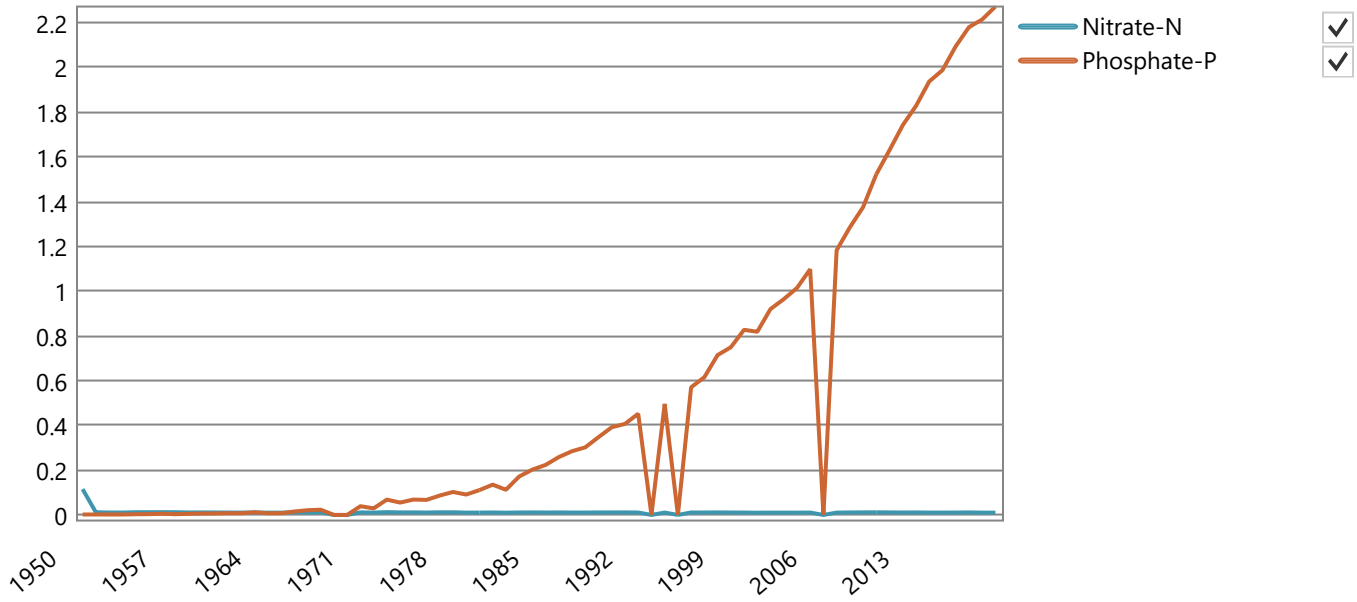
Land Performance - Soil Nutrient

Paddock: Baralaba Clay, 2.1 ha **Soil Type**: Baralaba Clay

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Baralaba Clay, 2.1 ha

Soil Type: Baralaba Clay

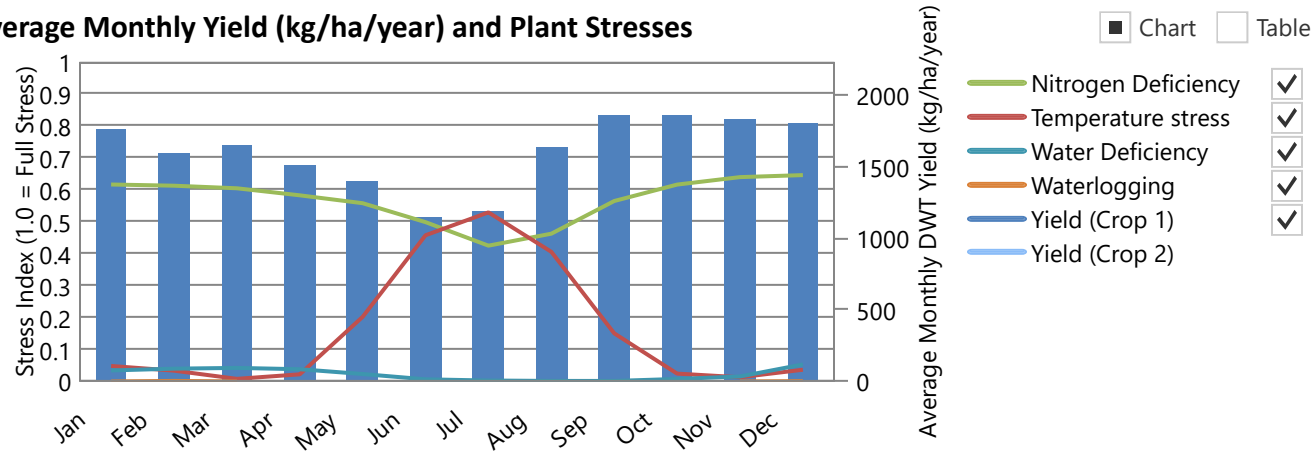
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	19248.21 (16744.24 - 24839.57)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.87 (0.83 - 0.90)
Average monthly root depth (mm) (minimum - maximum)	1199.16 (1190.19 - 1200.00)

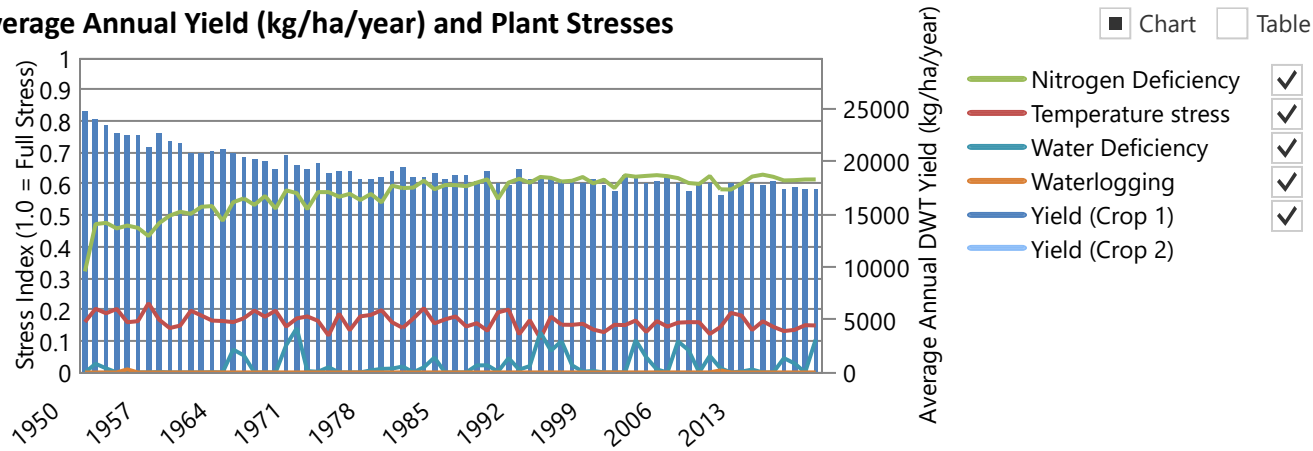
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	336.78 (289.21 - 535.72)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	61.76 (21.47 - 86.24)
Average annual shoot nitrogen concentration (fraction dwt)	0.02 (0.02 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.001 - 0.005)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 3.47 (normal)

No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Baralaba Clay, 2.1 ha **Soil Type**: Baralaba Clay

Plant: Continuous Kikuyu 1 Pasture

Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03
No. years assumed for leaching to reach steady-state (years)	10.00

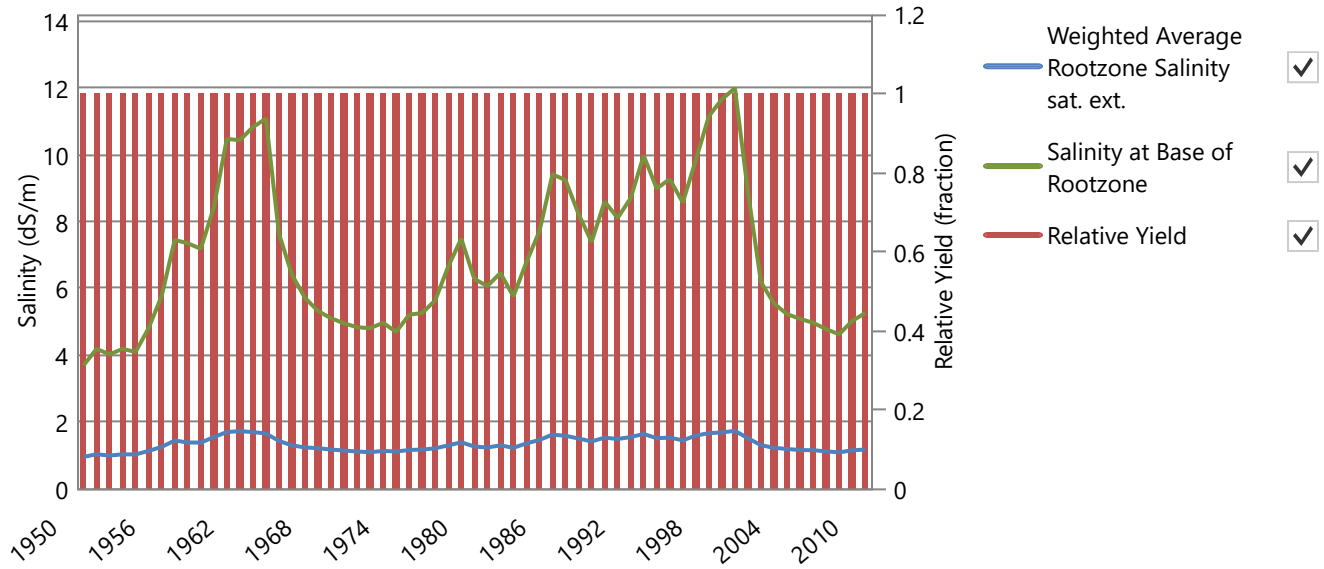
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.94
Salt added by rainfall (kg/ha/year)	127.12
Average annual effluent salt added & leached at steady state (kg/ha/year)	9693.00
Average leaching fraction based on 10 year running averages (fraction)	0.33
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.34
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	6.96
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



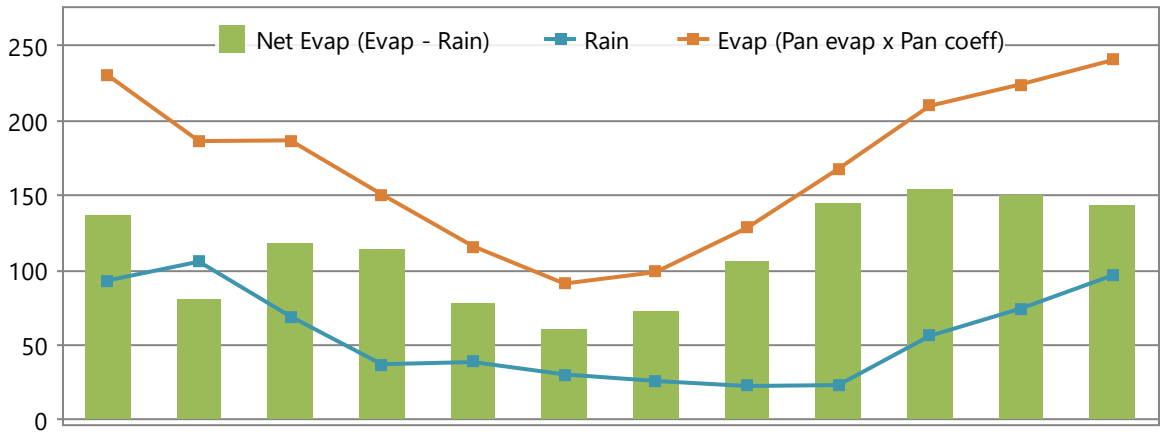
DIAGNOSTICS

Sustainability Diagnostics: Baralaba Construction

Averaged Historical Climate Data Used in Simulation (mm)

Location: Baralaba South_-24.25_149.85, -24.25°, 149.85°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	93.3	105.8	69.3	37.3	38.7	30.5	26.1	22.7	23.4	56.2	74.5	96.6	674.3
Evap	230.4	186.3	186.8	150.8	116.1	91.2	98.8	128.4	167.8	209.9	224.3	240.4	2031.2
Net Evap	137.1	80.5	117.6	113.5	77.4	60.7	72.7	105.7	144.4	153.7	149.8	143.8	1356.9
Net Evap/day	4.4	2.9	3.8	3.8	2.5	2.0	2.3	3.4	4.8	5.0	5.0	4.6	3.7

DIAGNOSTICS

Sustainability Diagnostics: Baralaba Construction

Pond System: 1 closed storage tank

New Sewage Treatment Plant - 20088.36 m3/year or 55.00 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	30.00 (30.00 - 30.00)	602.65 (602.25 - 603.90)
Total Phosphorus	10.00 (10.00 - 10.00)	200.88 (200.75 - 201.30)
Total Dissolved Salts	1000.00 (1000.00 - 1000.00)	20088.36 (20075.00 - 20130.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

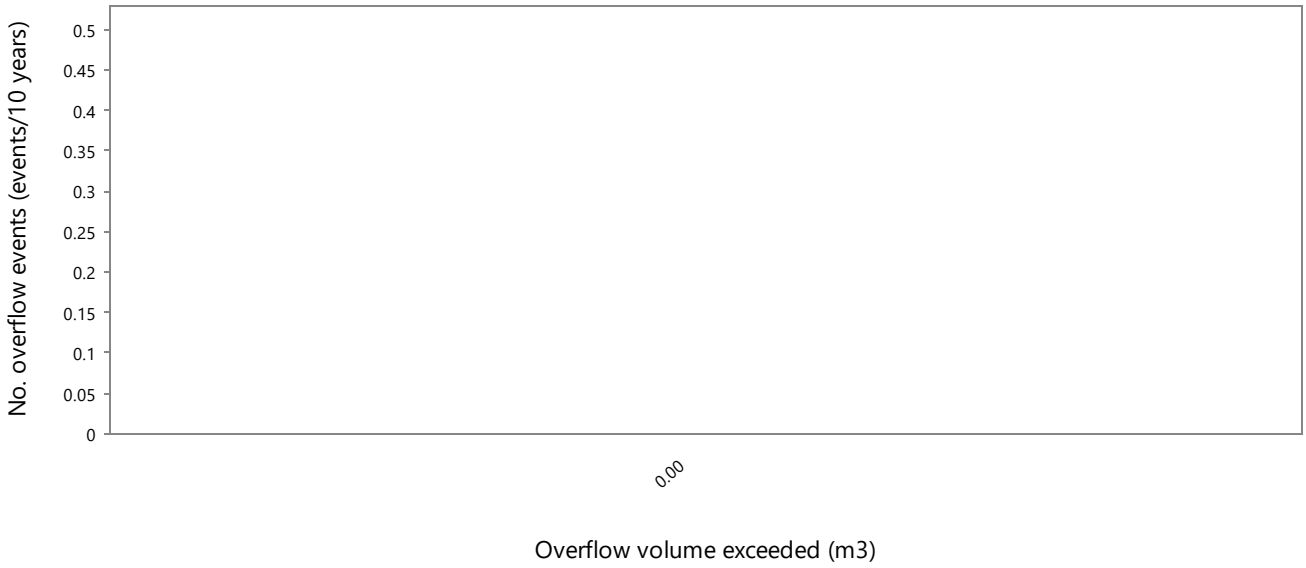
Last pond (Wet weather store): 165.00 m3

Theoretical hydraulic retention time (days)	3.00
Average volume of overflow (m3/year)	0.00
No. overflow events per year exceeding threshold* of 0.06 m3 (no./year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	1.56
Salinity of last pond on final day of simulation (dS/m)	1.56
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Baralaba Construction

Irrigation Information

Irrigation: 2.1 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	20088.36	9565.88
Total nitrogen applied (kg)	602.65	286.98
Total phosphorus applied (kg)	200.88	95.66
Total salts applied (kg)	20088.36	9565.88

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation occurs (fraction)	1.00

DIAGNOSTICS

Sustainability Diagnostics: Baralaba Construction

Paddock Land: Baralaba Clay: 2.1 ha

Irrigation: New Irrigation Method with 0% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 3.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Baralaba Clay, 163.94 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	93.3	105.8	69.3	37.3	38.7	30.5	26.1	22.7	23.4	56.2	74.5	96.6	674.3
Irrigation	81.2	74.0	81.2	78.6	81.2	78.6	81.2	81.2	78.6	81.2	78.6	81.2	956.6
Soil Evap	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Transpn.	153.5	127.7	125.2	99.7	80.9	63.9	67.1	84.5	113.2	142.4	156.7	158.0	1372.9
Rain Runoff	1.1	6.6	0.6	0.6	0.4	0.2	0.2	0.1	0.1	0.1	0.1	2.2	12.2
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	20.3	23.1	29.4	15.2	20.7	27.5	32.7	23.7	13.6	12.9	14.3	13.5	246.8
Delta	-2.0	22.3	-4.7	0.3	18.0	17.5	7.3	-4.5	-24.9	-18.0	-18.0	4.1	-2.6

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	286.98
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	336.78
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.01
Average annual soil nitrogen leached (kg/ha/year)	0.04
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.04
Soil organic-N kg/ha (Initial - Final)	3496.00 - 59.04
	52.08 - 0.02
Average nitrate-N concentration of deep drainage (mg/L)	0.02
Max. annual nitrate-N concentration of deep drainage (mg/L)	0.12

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	95.66
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	61.76
Average annual soil phosphorus leached (kg/ha/year)	1.18
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 5.54
Adsorbed phosphorus (kg/ha) (Initial - Final)	125.48 - 2410.42
Average phosphate-P concentration in rootzone (mg/L)	1.89
Average phosphate-P concentration of deep drainage (mg/L)	0.48
Max. annual phosphate-P concentration of deep drainage (mg/L)	2.27
Design soil profile storage life based on average infiltrated water phosphorus concn. of 5.91 mg/L (years)	30.55

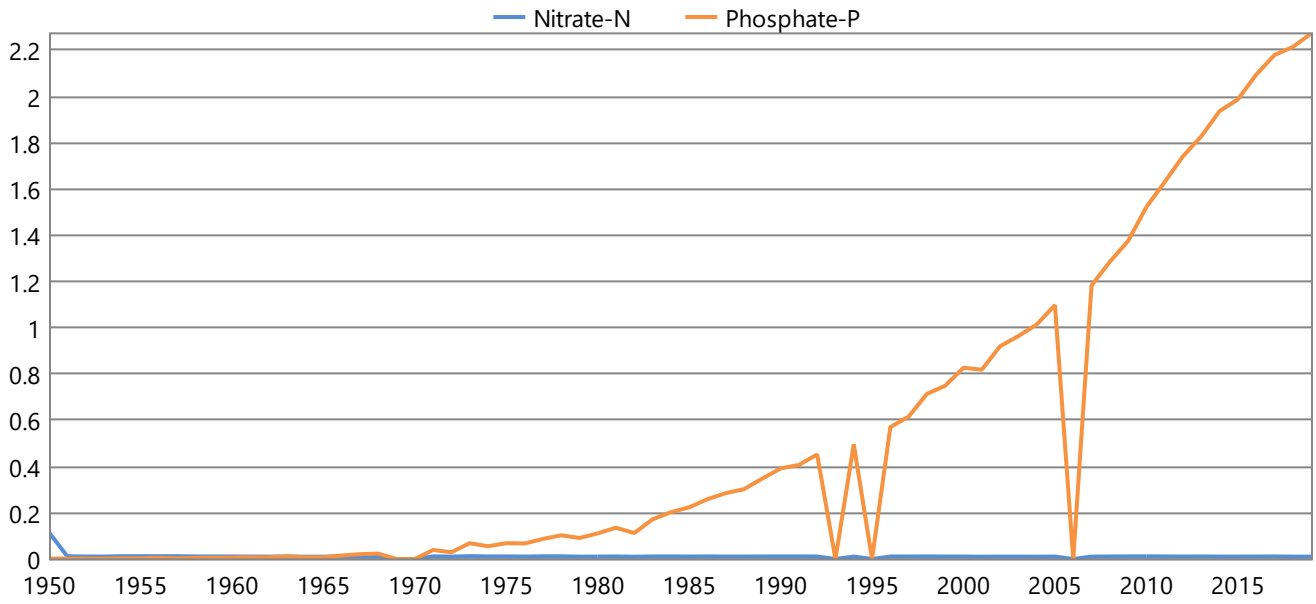
DIAGNOSTICS

Sustainability Diagnostics: Baralaba Construction

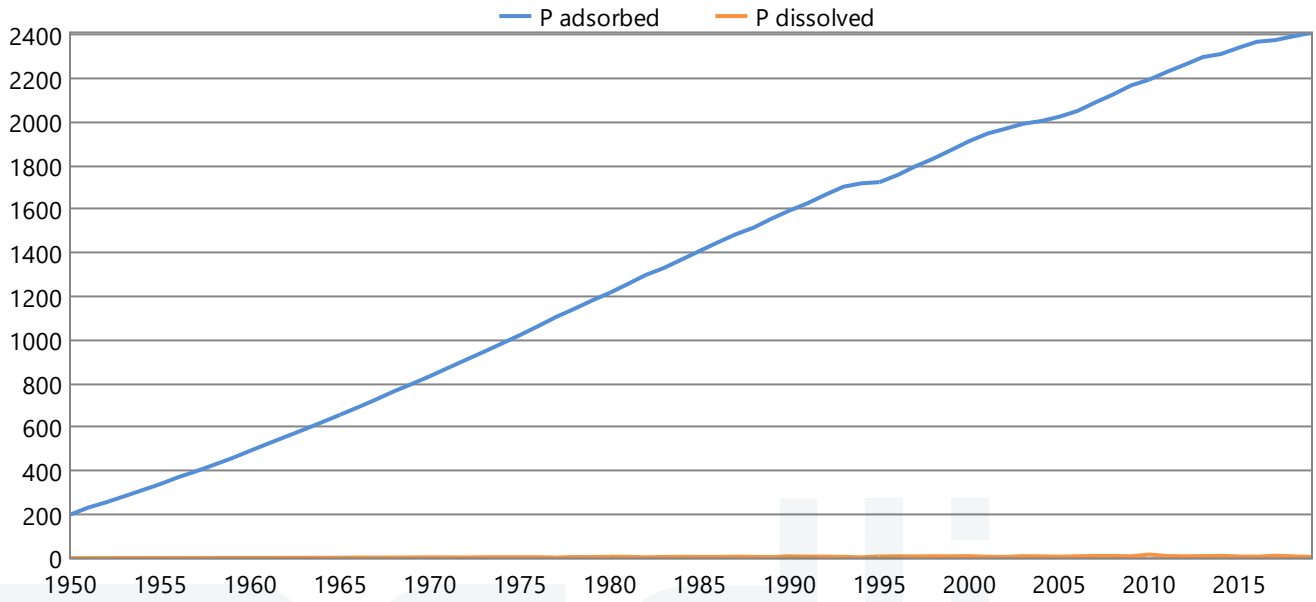
Paddock Land: Baralaba Clay: 2.1 ha

Irrigation: New Irrigation Method with 0% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: Baralaba Construction

Paddock Plant Performance: Baralaba Clay: 2.1 ha

Average Plant Performance (Minimum - Maximum): Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	19248.21 (16744.24 - 24839.57)
Average monthly plant (green) cover (fraction)	0.87 (0.83 - 0.90)
Average monthly crop factor (fraction)	0.70 (0.67 - 0.72)
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Average monthly root depth (mm)	1199.16 (1190.19 - 1200.00)
Average number of normal harvests per year (no./year)	3.47 (3.00 - 5.00)
Average number of normal harvests for last five years only (no./year)	3.20
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.57 (0.32 - 0.63)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.05 (0.00 - 0.18)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.53 (0.22 - 0.82)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.05)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Moderately tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.94
Salt added by rainfall (kg/ha/year)	127.12
Average annual effluent salt added & leached at steady state (kg/ha/year)	9693.00
Average leaching fraction based on 10 year running averages (fraction)	0.33
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.34
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	6.96
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

APPENDIX I MEDLI 2.0 OUTPUT OPERATION SCENARIO

MEDLI REPORT - FULL RUN

Enterprise: **Baralaba Operation**

Description:
Clay Based Model

Client: **Baralaba Project**

MEDLI User: CARDNO\mark.farrey

Scenario Details:
Operation
-120KL Storage (3 days)
- 3mm/day max irrigation
- 1.5ha irrigation area
- Rhodes Grass

DESCRIPTION

Climate Data: Baralaba South_-24.25_149.85, -24.25°, 149.85°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days

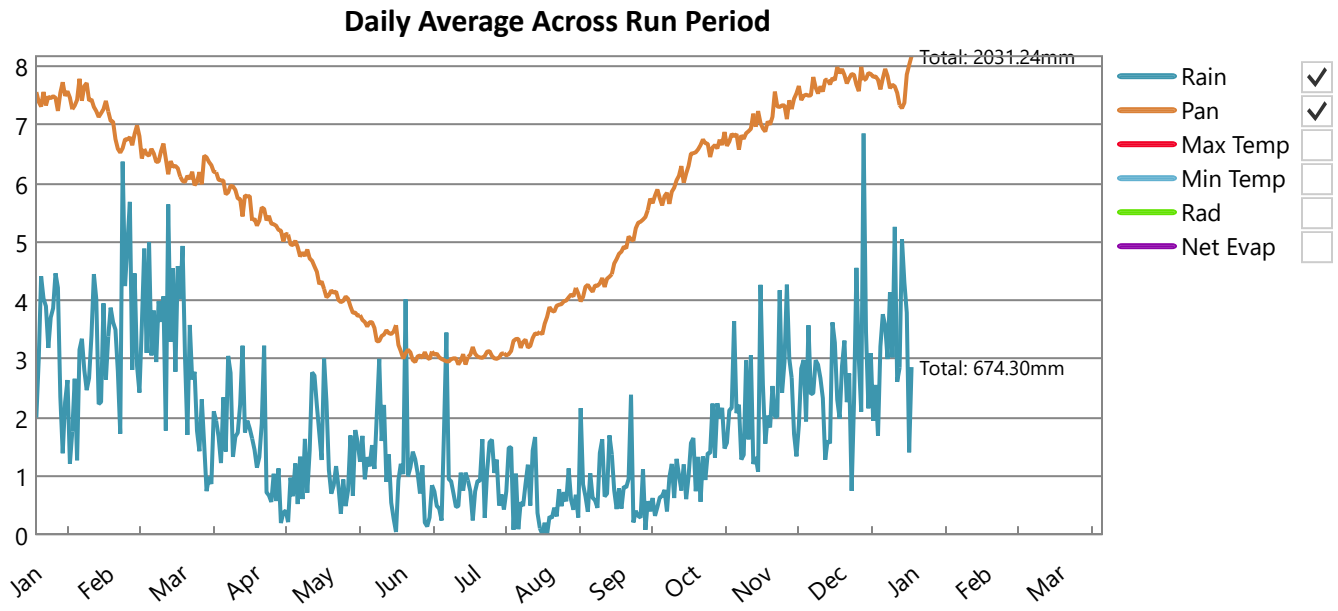
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	375	674	1059
Pan Evaporation (mm/year)	1795	2041	2232

Climate Data:

Chart Table

Monthly Daily

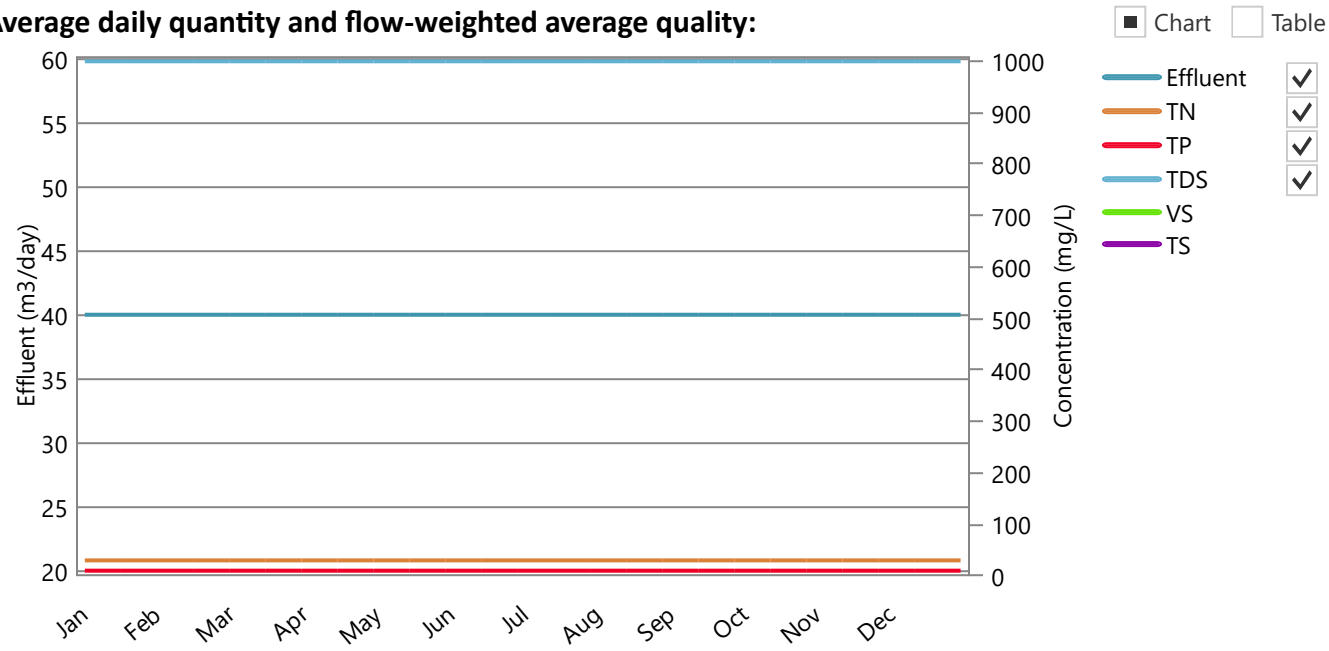


DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 14609.71 m3/year or 40.00 m3/day (Min-Max: 40.00 - 40.00)

Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:

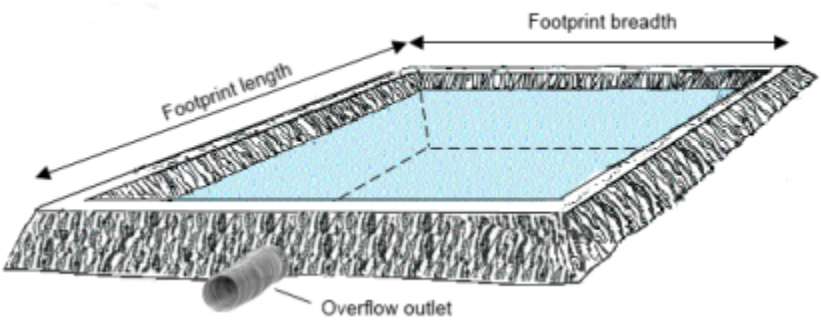
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	30.00 (30.00 - 30.00)	438.29 (438.00 - 439.20)
Total Phosphorus	10.00 (10.00 - 10.00)	146.10 (146.00 - 146.40)
Total Dissolved Salts	1000.00 (1000.00 - 1000.00)	14609.71 (14600.00 - 14640.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

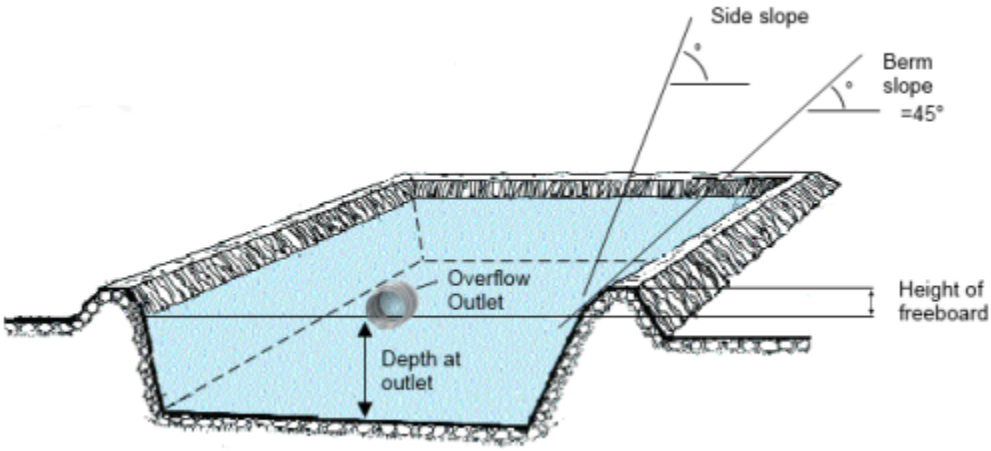
DESCRIPTION

Pond system: 1 closed storage tank

Pond system details:

	Pond 1
Maximum pond volume (m3)	120.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	3.00
Maximum water surface area (m2)	40.00
Pond footprint length (m)	6.32
Pond footprint width (m)	6.32
Pond catchment area (m2)	40.00
Average active volume (m3)	0.00





Irrigation pump limits:

Minimum pump rate limit (ML/day)	0.00
Maximum pump rate limit (ML/day)	1000000.00

Shandying water:

Annual allocation of fresh water available for shandying (m3/year)	0.00
Maximum rate of application of fresh water (ML/day)	0.00
Nitrogen concentration (mg/L)	0.00
Salinity (dS/m)	0.00
Minimum shandy water is used	False

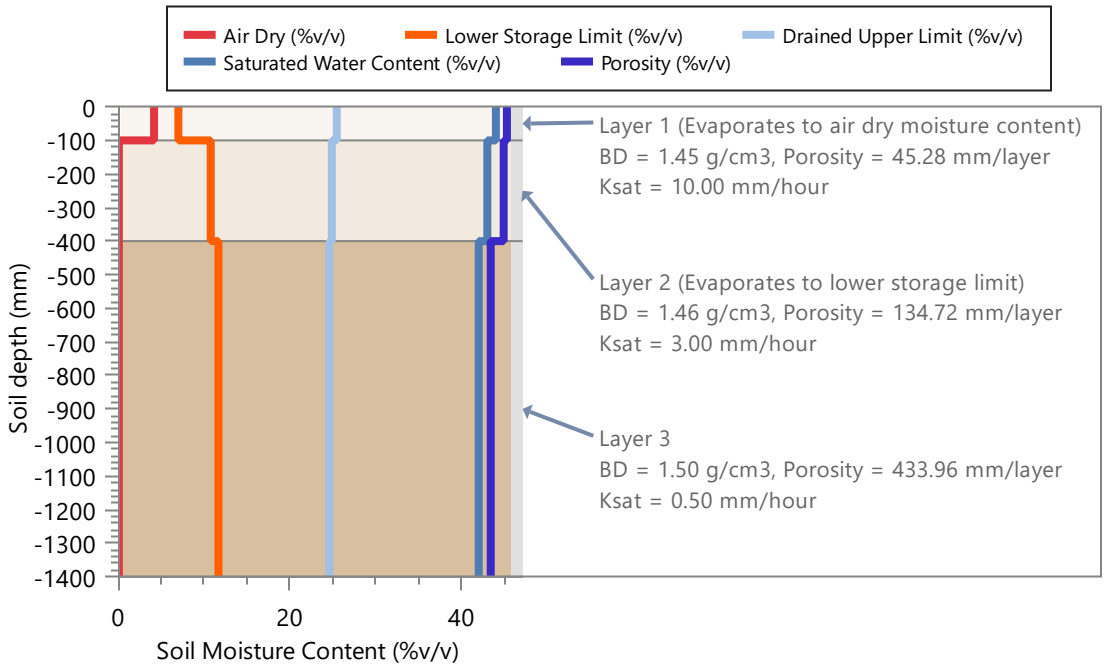
DESCRIPTION

Land: Baralaba Clay

Area (ha): 1.50

Soil Type: Baralaba Clay, 1400.00 mm defined profile depth

Profile Porosity (mm)	613.96
Profile saturation water content (mm)	593.00
Profile drained upper limit (or field capacity) (mm)	346.17
Profile lower storage limit (or permanent wilting point) (mm)	156.43
Profile available water capacity (mm)	189.74
Profile limiting saturated hydraulic conductivity (mm/hour)	0.50
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	75.00
Soil evaporation U (mm)	6.00
Soil evaporation Cona (mm/sqrt day)	3.50



Plant Data: Continuous Kikuyu 1 Pasture

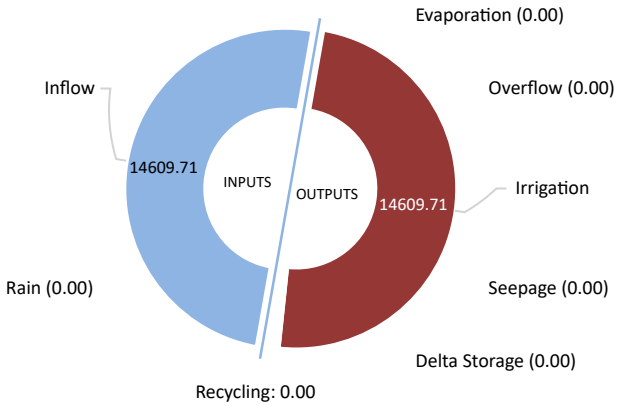
Average monthly cover (fraction) (minimum - maximum)	0.87 (0.83 - 0.90)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

PERFORMANCE

Pond System Water Performance - Overflow: 1 closed storage tank

Capacity of wet weather storage pond: **120 m3**

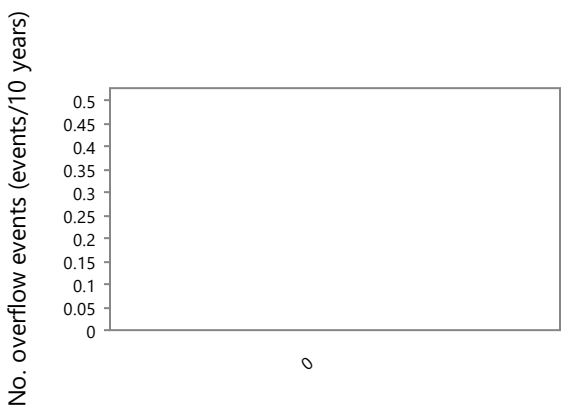
Pond System Water Balance (m3/year)



Name	Value
Rain	0.00
Inflow	14609.71
Recycling	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	14609.71
Seepage	0.00
Delta Storage	0.00

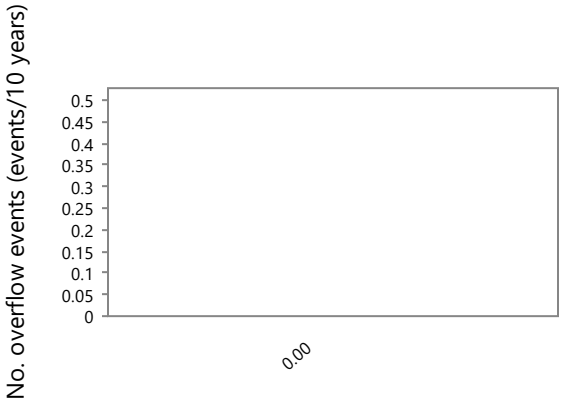
Overflow Diagnostics

Volume of overflow (m3/year)	0.00
No. days pond overflows (days/year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% reuse (fraction)	1.00



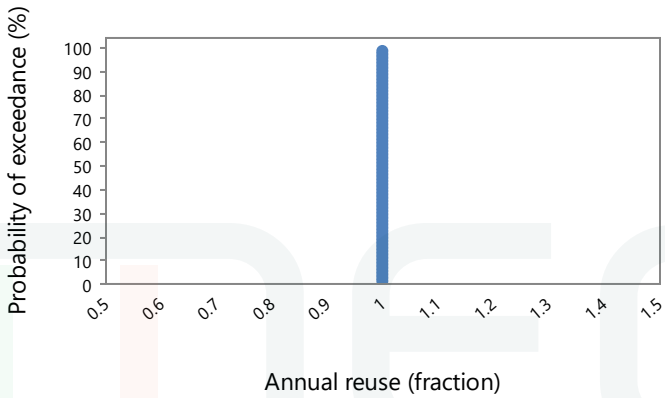
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

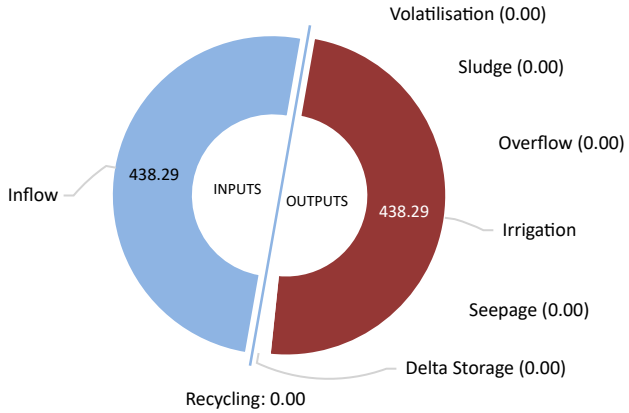
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

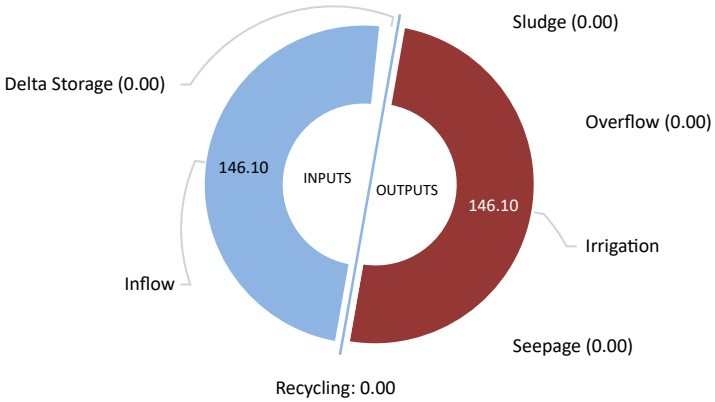
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



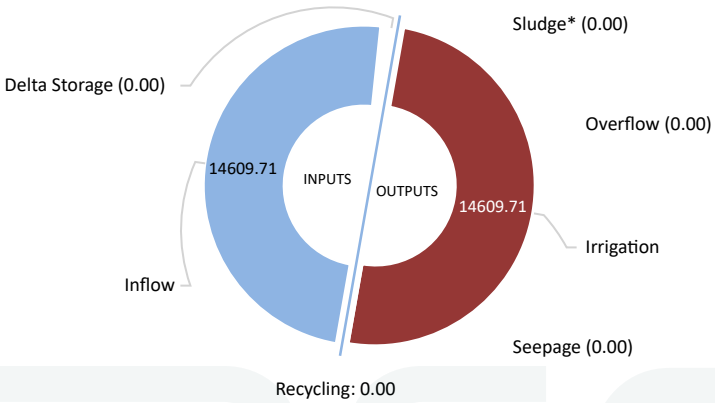
Name	Value
Inflow	438.29
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	438.29
Seepage	0.00
Delta Storage	0.00

Phosphorus Balance (kg/year)



Name	Value
Inflow	146.10
Recycling	0.00
Sludge	0.00
Overflow	0.00
Irrigation	146.10
Seepage	0.00
Delta Storage	0.00

Salt Balance (kg/year)



Name	Value
Inflow	14609.71
Recycling	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	14609.71
Seepage	0.00
Delta Storage	0.00

* Salt removal in sludge is not calculated from the pond salt balance. However if salt could be assumed to be present in the sludge at the same concentration as in the pond supernatant (up to a maximum of salt added in inflow) - then salt accumulation in the sludge could be 0.00 kg/year

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	30.00
Average phosphorus concentration of pond liquid (mg/L)	10.00
Average salinity of pond liquid (dS/m)	1.56

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	N.D.*
Final phosphorus concentration of pond liquid (mg/L)	N.D.*
Final salinity of pond liquid (dS/m)	N.D.*

* Not determined. Pond is empty.

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	14609.71
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	14609.71
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (fraction of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (fraction of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)

Irrigation Quality:

Average nitrogen concentration of irrigation water - before ammonia loss during irrigation (mg/L)	30.00
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	30.00
Average phosphorus concentration of irrigation water (mg/L)	10.00
Average salinity of irrigation water (dS/m)	1.56

Irrigation Diagnostics:

Proportion of Days irrigation occurs (fraction)	1.00

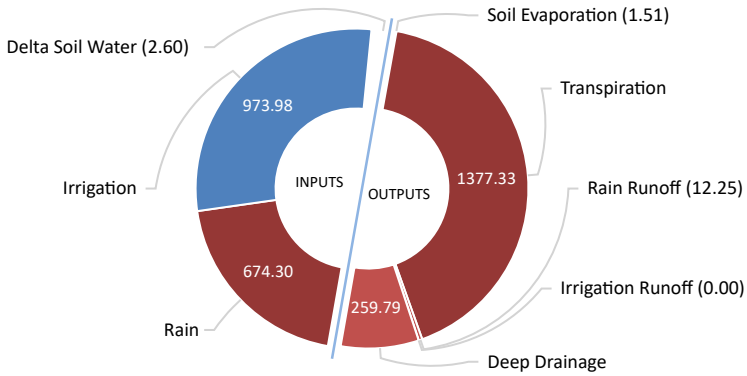
PERFORMANCE

Land Performance - Soil Water

Paddock: Baralaba Clay, 1.5 ha
Soil Type: Baralaba Clay, 163.94 mm PAWC at maximum root depth

Land Water Balance (mm/year):

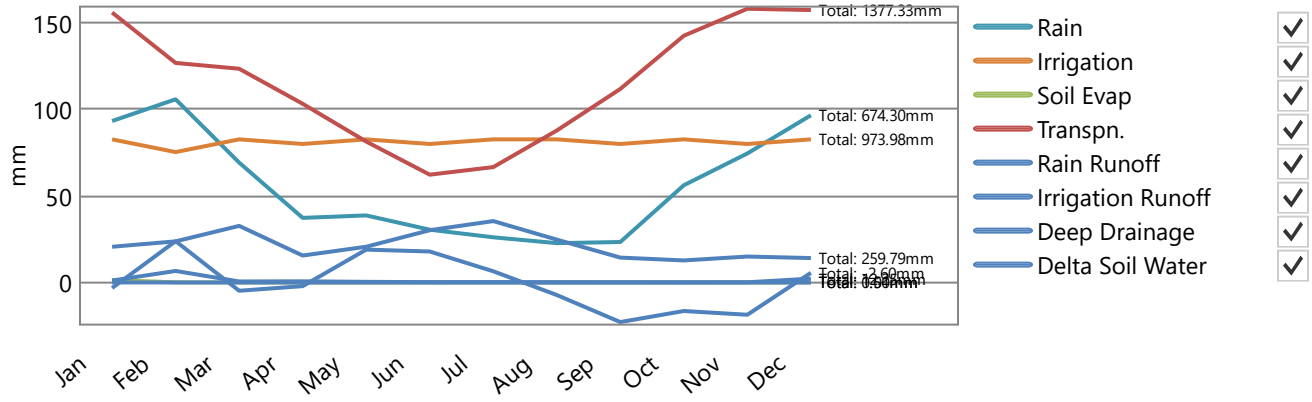
mm/year % Total inputs



Name	Value
Rain	674.30
Irrigation	973.98
Soil Evaporation	1.51
Transpiration	1377.33
Rain Runoff	12.25
Irrigation Runoff	0.00
Deep Drainage	259.79
Delta Soil Water	-2.60

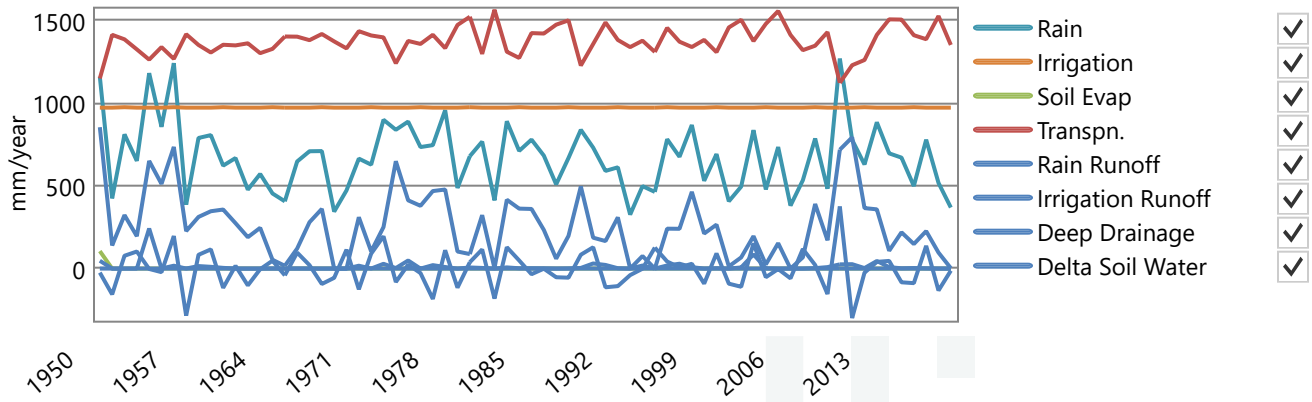
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



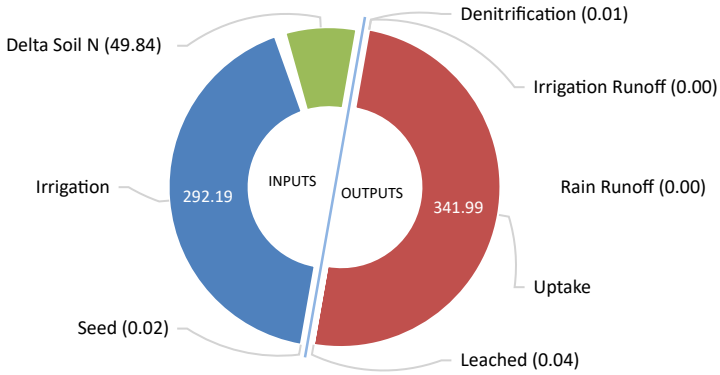
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Baralaba Clay, 1.5 ha **Soil Type**: Baralaba Clay

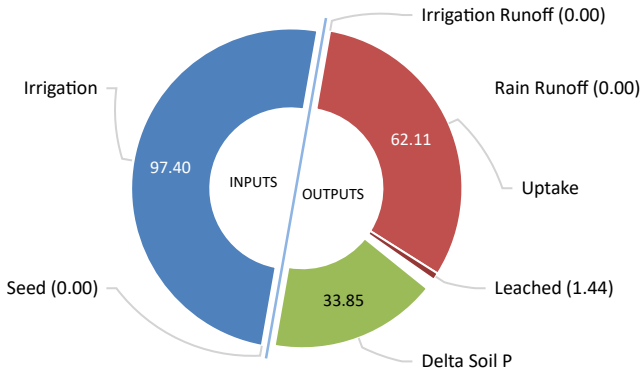
Irrigation ammonium volatilisation losses (kg/ha/year): 0.00
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.25

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	292.19
Denitrification	0.01
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	341.99
Leached	0.04
Delta Soil N	-49.84

Land Phosphorus Balance (kg/ha/year)



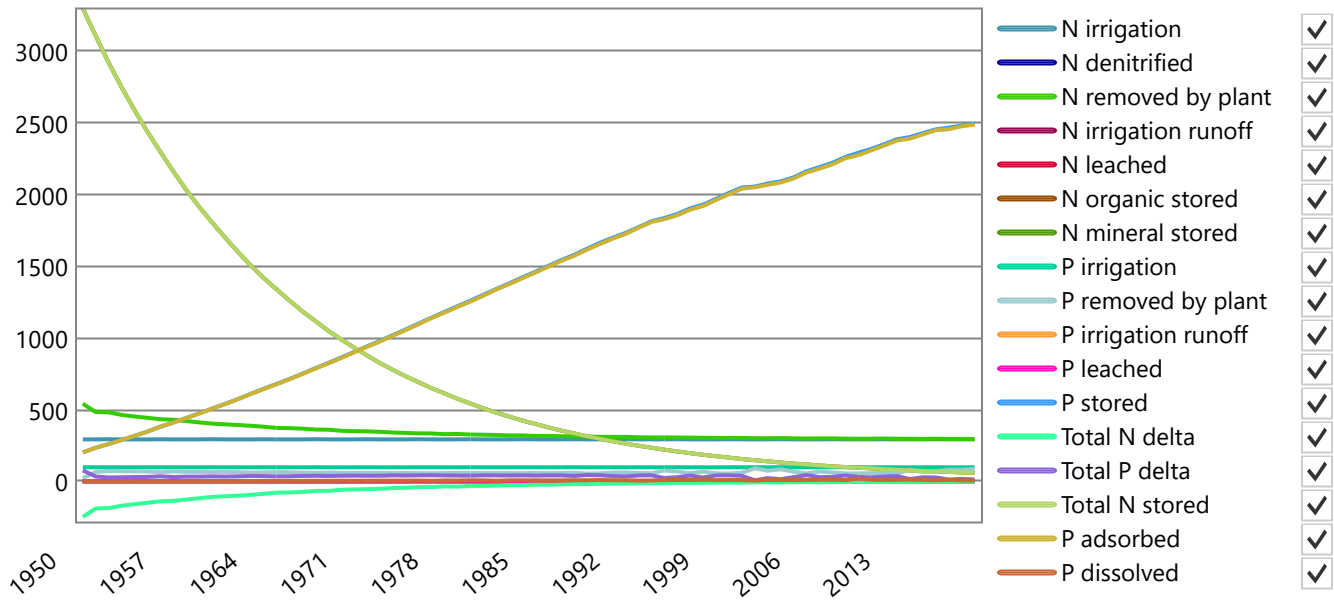
Name	Value
Seed	1.29E-03
Irrigation	97.40
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	62.11
Leached	1.44
Delta Soil P	33.85

PERFORMANCE

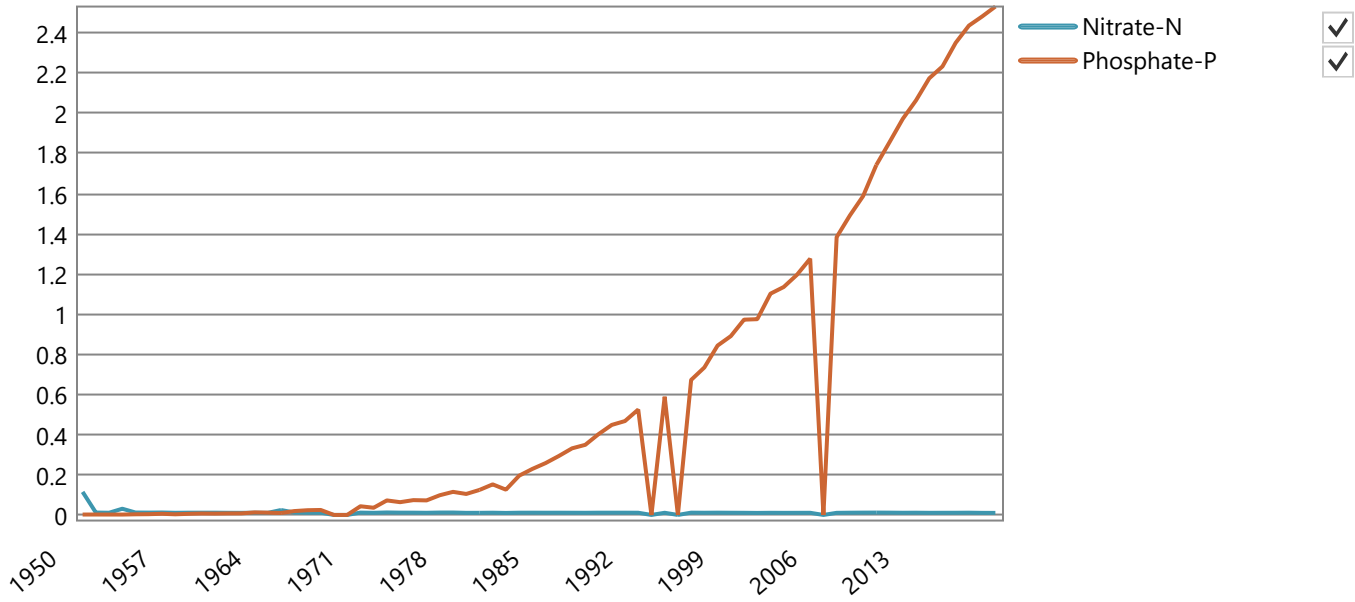
Land Performance - Soil Nutrient

Paddock: Baralaba Clay, 1.5 ha **Soil Type**: Baralaba Clay

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Baralaba Clay, 1.5 ha **Soil Type**: Baralaba Clay

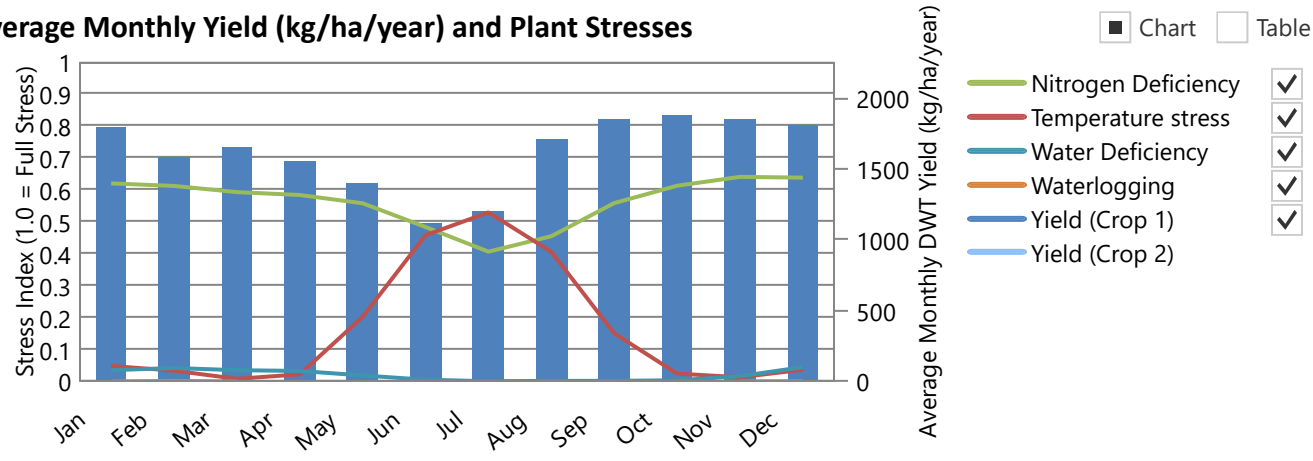
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	19443.77 (16871.63 - 24941.37)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.87 (0.83 - 0.90)
Average monthly root depth (mm) (minimum - maximum)	1199.16 (1190.19 - 1200.00)

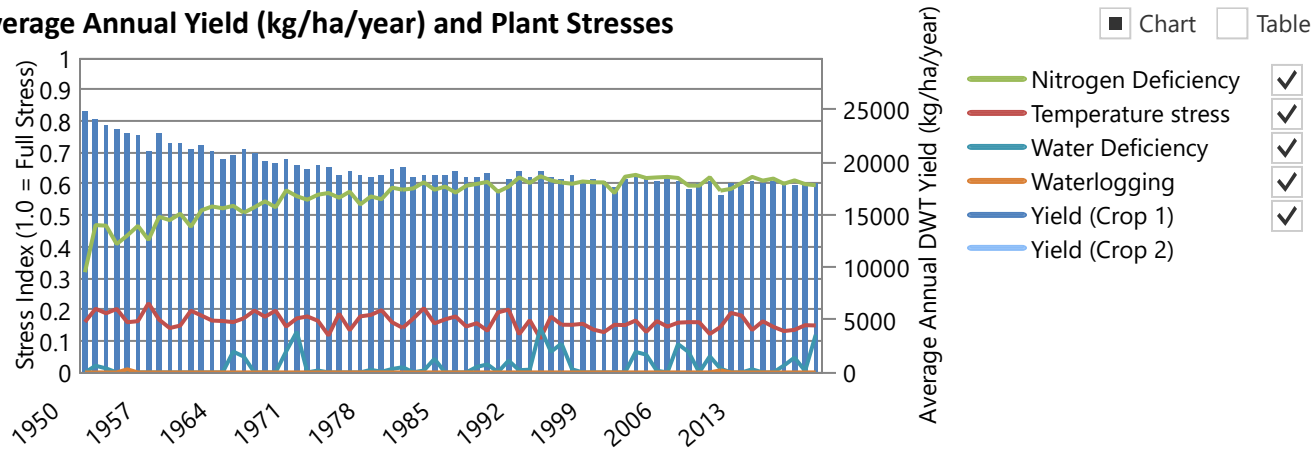
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	341.99 (293.94 - 540.91)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	62.11 (22.06 - 90.10)
Average annual shoot nitrogen concentration (fraction dwt)	0.02 (0.02 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.001 - 0.005)

Average Monthly Yield (kg/ha/year) and Plant Stresses



Average Annual Yield (kg/ha/year) and Plant Stresses



No. of harvests/year: 3.50 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Baralaba Clay, 1.5 ha **Soil Type**: Baralaba Clay

Plant: Continuous Kikuyu 1 Pasture

Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03
No. years assumed for leaching to reach steady-state (years)	10.00

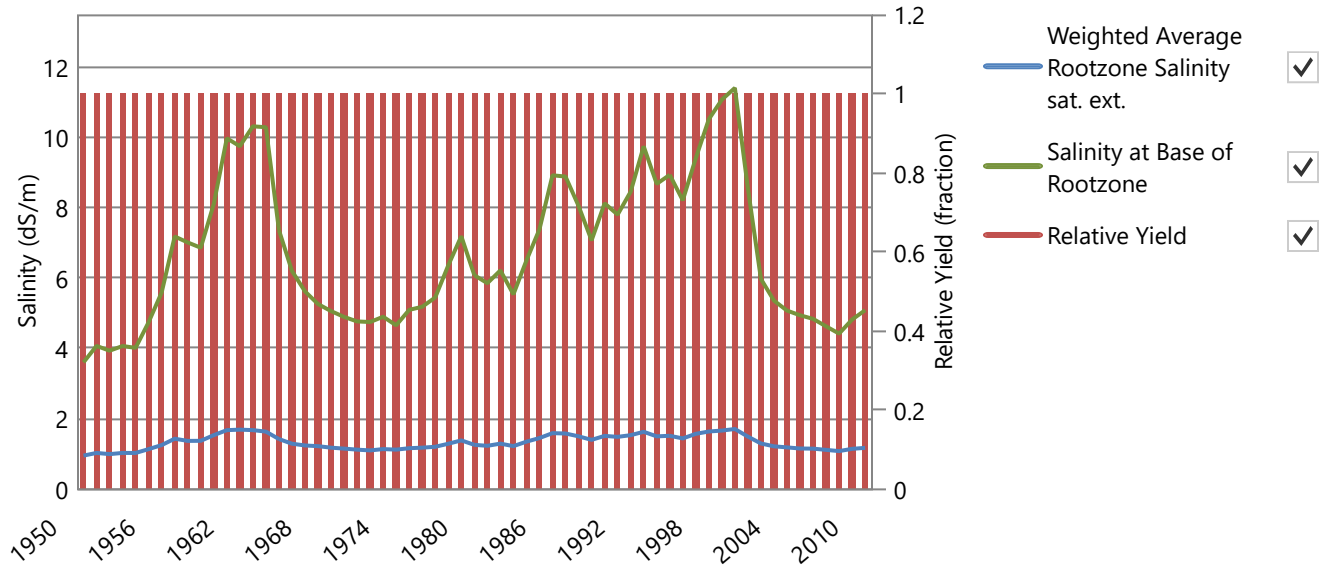
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.95
Salt added by rainfall (kg/ha/year)	127.11
Average annual effluent salt added & leached at steady state (kg/ha/year)	9866.92
Average leaching fraction based on 10 year running averages (fraction)	0.33
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.32
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	6.69
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



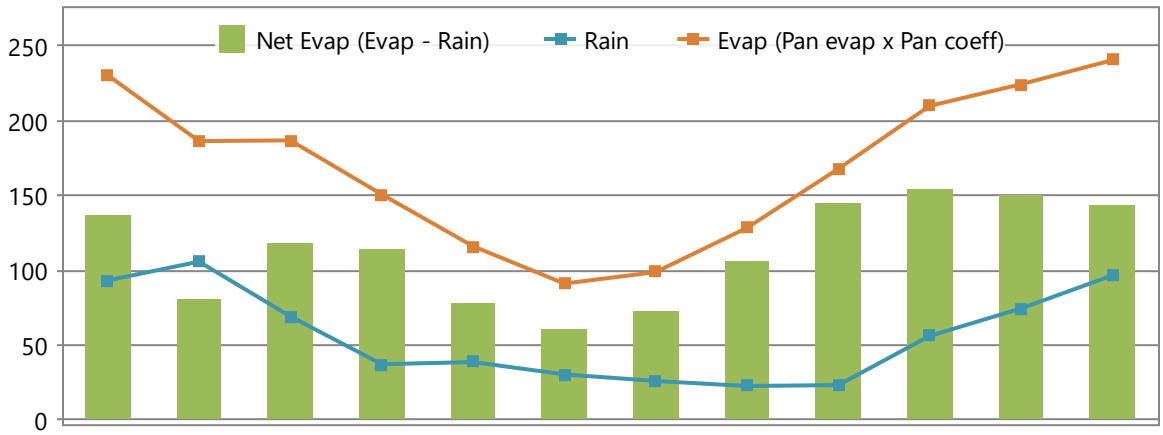
DIAGNOSTICS

Sustainability Diagnostics: Baralaba Operation

Averaged Historical Climate Data Used in Simulation (mm)

Location: Baralaba South_-24.25_149.85, -24.25°, 149.85°

Run Period: 01/01/1950 to 31/12/2019 70 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	93.3	105.8	69.3	37.3	38.7	30.5	26.1	22.7	23.4	56.2	74.5	96.6	674.3
Evap	230.4	186.3	186.8	150.8	116.1	91.2	98.8	128.4	167.8	209.9	224.3	240.4	2031.2
Net Evap	137.1	80.5	117.6	113.5	77.4	60.7	72.7	105.7	144.4	153.7	149.8	143.8	1356.9
Net Evap/day	4.4	2.9	3.8	3.8	2.5	2.0	2.3	3.4	4.8	5.0	5.0	4.6	3.7

DIAGNOSTICS

Sustainability Diagnostics: Baralaba Operation

Pond System: 1 closed storage tank

New Sewage Treatment Plant - 14609.71 m3/year or 40.00 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.24 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	30.00 (30.00 - 30.00)	438.29 (438.00 - 439.20)
Total Phosphorus	10.00 (10.00 - 10.00)	146.10 (146.00 - 146.40)
Total Dissolved Salts	1000.00 (1000.00 - 1000.00)	14609.71 (14600.00 - 14640.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

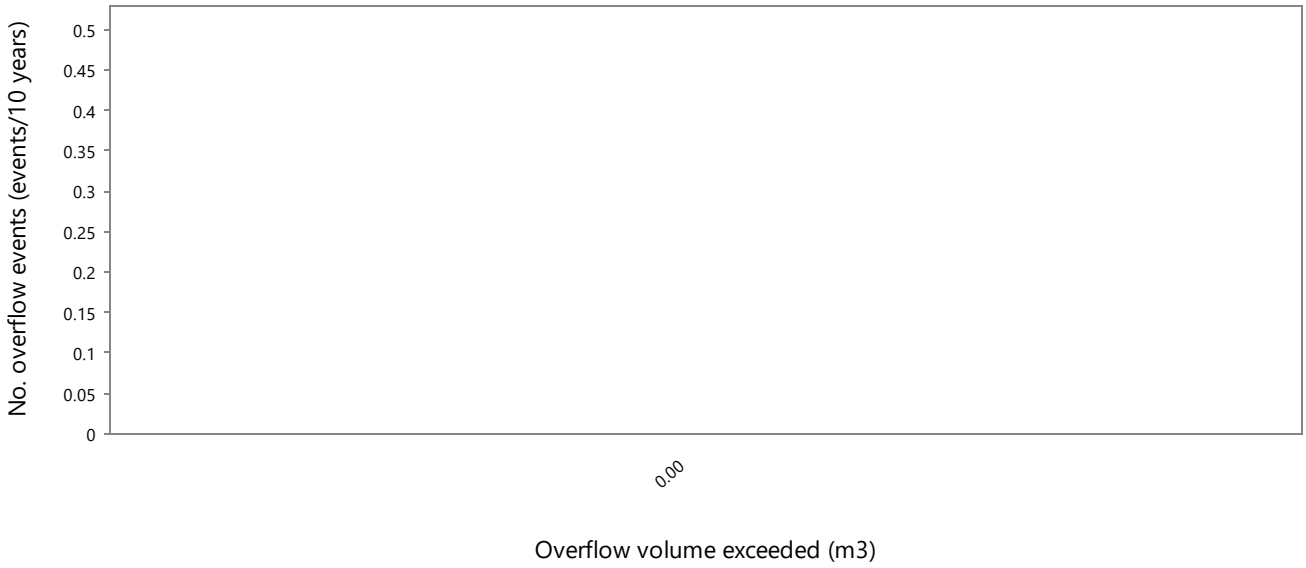
Last pond (Wet weather store): 120.00 m3

Theoretical hydraulic retention time (days)	3.00
Average volume of overflow (m3/year)	0.00
No. overflow events per year exceeding threshold* of 0.04 m3 (no./year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	1.56
Salinity of last pond on final day of simulation (dS/m)	1.56
Ammonia loss from pond system water area (kg/m2/year)	0.00

* The threshold is the volume equivalent to the top 1 mm depth of water of a full pond

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: Baralaba Operation

Irrigation Information

Irrigation: 1.5 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	14609.71	9739.81
Total nitrogen applied (kg)	438.29	292.19
Total phosphorus applied (kg)	146.10	97.40
Total salts applied (kg)	14609.71	9739.81

Shandying

Annual allocation of fresh water for shandying (m3/year)	0.00
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Average exceedance as a proportion of annual shandy water allocation (% of allocation) (minimum - maximum)	0.00 (0.00 - 0.00)
Proportion of irrigation events requiring shandying (fraction of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation occurs (fraction)	1.00

DIAGNOSTICS

Sustainability Diagnostics: Baralaba Operation

Paddock Land: Baralaba Clay: 1.5 ha

Irrigation: New Irrigation Method with 0% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 3.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): Baralaba Clay, 163.94 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	93.3	105.8	69.3	37.3	38.7	30.5	26.1	22.7	23.4	56.2	74.5	96.6	674.3
Irrigation	82.7	75.3	82.7	80.0	82.7	80.0	82.7	82.7	80.0	82.7	80.0	82.7	974.0
Soil Evap	1.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Transpn.	155.9	126.8	123.5	103.2	81.4	62.3	66.6	87.8	111.8	142.5	158.1	157.4	1377.3
Rain Runoff	1.1	6.6	0.6	0.6	0.4	0.2	0.2	0.1	0.1	0.1	0.1	2.2	12.3
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	20.6	23.7	32.7	15.5	20.7	30.2	35.5	24.7	14.4	12.7	15.0	14.1	259.8
Delta	-3.2	23.9	-4.8	-2.1	19.0	17.9	6.5	-7.2	-22.9	-16.5	-18.6	5.6	-2.6

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	292.19
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	341.99
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.01
Average annual soil nitrogen leached (kg/ha/year)	0.04
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.04
Soil organic-N kg/ha (Initial - Final)	3496.00 - 59.60
	52.08 - 0.02
Average nitrate-N concentration of deep drainage (mg/L)	0.02
Max. annual nitrate-N concentration of deep drainage (mg/L)	0.11

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	97.40
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	62.11
Average annual soil phosphorus leached (kg/ha/year)	1.44
Dissolved phosphorus (kg/ha) (Initial - Final)	0.01 - 5.88
Adsorbed phosphorus (kg/ha) (Initial - Final)	125.48 - 2489.40
Average phosphate-P concentration in rootzone (mg/L)	1.98
Average phosphate-P concentration of deep drainage (mg/L)	0.55
Max. annual phosphate-P concentration of deep drainage (mg/L)	2.53
Design soil profile storage life based on average infiltrated water phosphorus concn. of 5.95 mg/L (years)	30.15

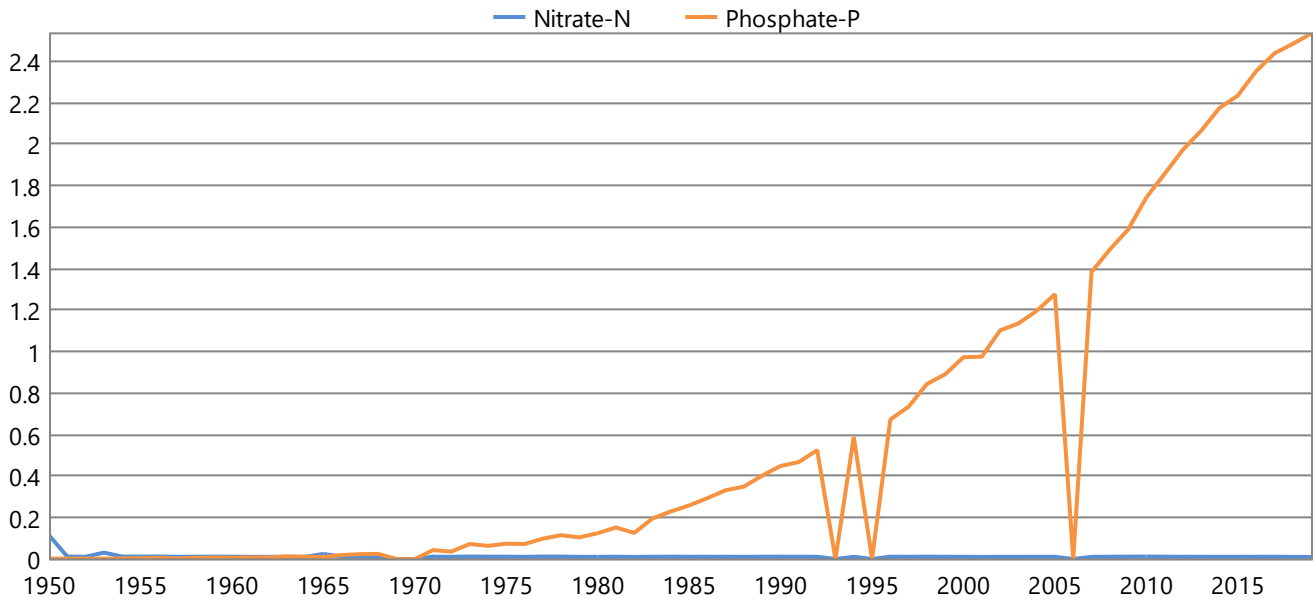
DIAGNOSTICS

Sustainability Diagnostics: Baralaba Operation

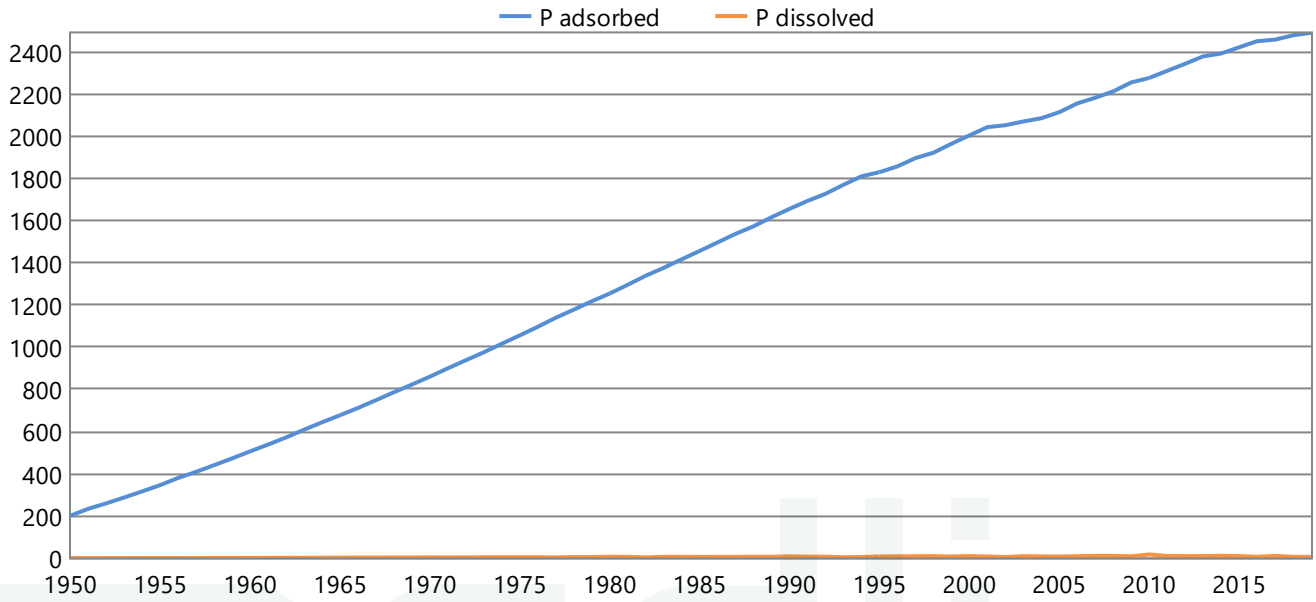
Paddock Land: Baralaba Clay: 1.5 ha

Irrigation: New Irrigation Method with 0% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: Baralaba Operation

Paddock Plant Performance: Baralaba Clay: 1.5 ha

Average Plant Performance (Minimum - Maximum): Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	19443.77 (16871.63 - 24941.37)
Average monthly plant (green) cover (fraction)	0.87 (0.83 - 0.90)
Average monthly crop factor (fraction)	0.70 (0.67 - 0.72)
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Average monthly root depth (mm)	1199.16 (1190.19 - 1200.00)
Average number of normal harvests per year (no./year)	3.50 (3.00 - 5.00)
Average number of normal harvests for last five years only (no./year)	3.20
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.56 (0.32 - 0.63)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.05 (0.00 - 0.18)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.53 (0.22 - 0.82)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.02 (0.00 - 0.04)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Moderately tolerant

Assumes 1.0 dS/m Electrical Conductivity = 640 mg/L Total Dissolved Salts

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.95
Salt added by rainfall (kg/ha/year)	127.11
Average annual effluent salt added & leached at steady state (kg/ha/year)	9866.92
Average leaching fraction based on 10 year running averages (fraction)	0.33
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.32
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	6.69
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

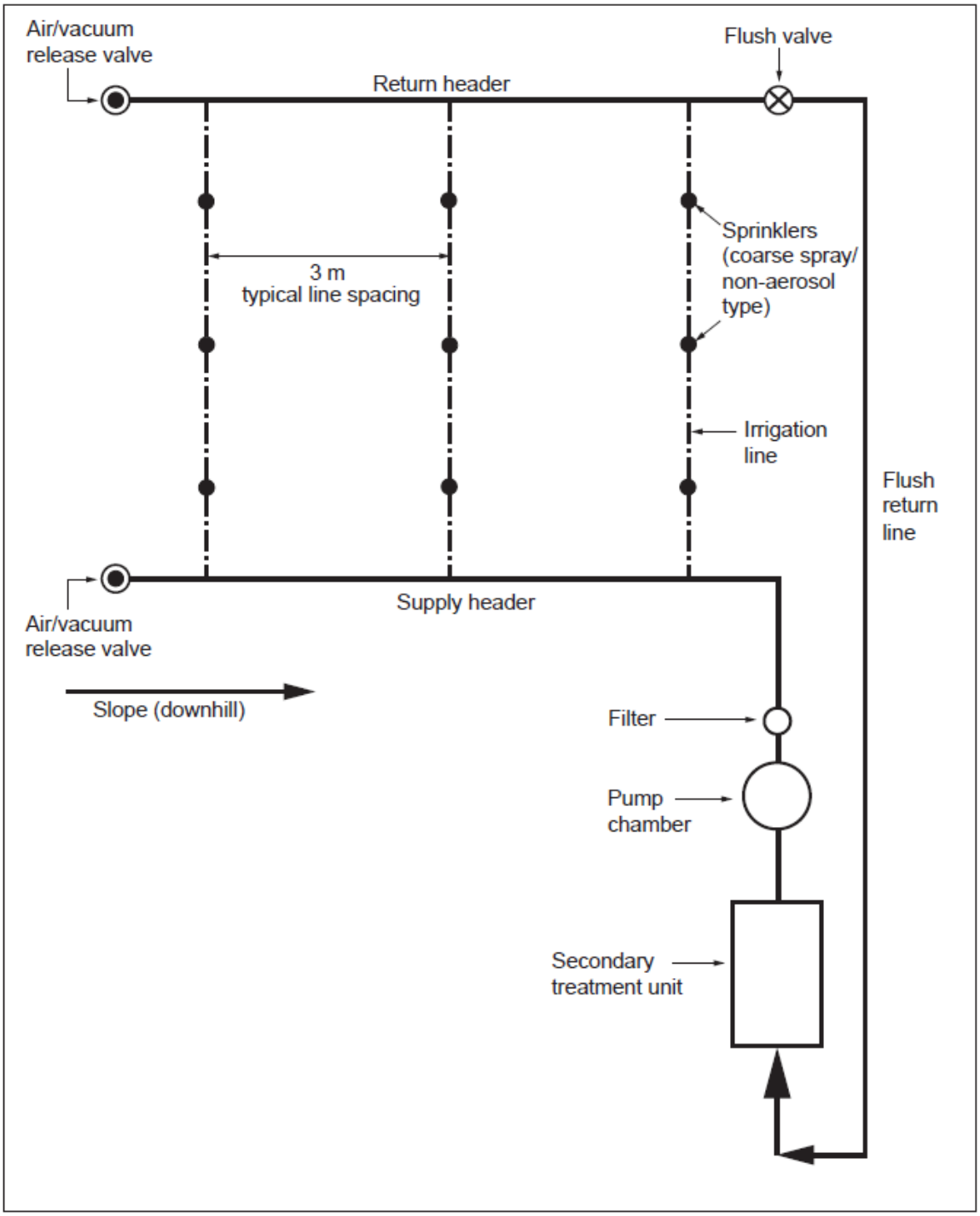
DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Full run chosen

APPENDIX J EXAMPLE OF SPRAY IRRIGATION SYSTEM



Source: AS/NZS 1547:2012