

JBS Townsville

## **Environmental Evaluation of Wastewater Irrigation**

Response to A Request

DES CA4544; 101/0008424

Ver 1.6



Prepared for

**JBS Australia**

By

**Bio-Track Pty Ltd**

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## 1 INTRODUCTION

Bio-Track Pty Ltd has been commissioned by JBS Australia Pty Ltd to prepare a response to a request from the Department of Environment and Science (Notice to conduct or commission an environmental evaluation, CA4544; 101/0008424, dated 19 April 2018). This assessment is based on field observation, measurements, laboratory analysis of soil and water samples, monitoring results, modelling predictions and uses information supplied by JBS. This study is an updated version of earlier reports. There have been numerous changes to assessment and further field work. The evaluation is on-going and groundwater assessment will be completed in 2019.

The abattoir has been in operation since 1966 and has used similar wastewater treatment and irrigation since at least, 2002.

## 2 EXECUTIVE SUMMARY

### Groundwater

Water samples have been collected from a total of 10 bores. Six are recently installed temporary monitoring bores and four are permanent piezometers. The analysis of the groundwater indicates the level of dissolved nutrient leaving the site is at the background level or very close to this. Monitoring of all these bores is scheduled for a further 10 months. One additional temporary monitoring bore will be installed in the north, west corner of the site.

The groundwater does not provide a base flow to local waterways. These appear to be wet season drainage lines that dry back to a series of water holes. There is no permanent, (dry season) stream flow.

The groundwater flow is to the north and north west. The gradient approximately follows the land surface. The depth to groundwater is approximately 3-4 metres below ground level (May-August 2018). It is expected to rise during the wet season.

There is no evidence of significant contamination of groundwater as a consequence of long-term wastewater irrigation.

### Surface Water

The JBS site has essentially no influent stormwater due to the elevated highway on the southern boundary. This provides a barrier to stormwater that would otherwise flow to irrigated land. All runoff from the irrigated land, first flush capture ponds, cattle yards and the facility flows to a northern recovery dam. This dam captures runoff events up to 12 mm from a 95 hectare catchment. Water from the recovery dam is re-irrigated. Release from this dam exits the property at one point on the north boundary. This flows through approximately 1400 m<sup>2</sup> of samphire vegetation on the edge of the salt flat. There is no visible evidence of disturbance to the samphire vegetation associated with overland flow of release water. Discharge is predicted, on average, 5.4 days/year. The release point flows across a salt flat, for 800-1000 m prior to entering Stuart Creek.

The release water has an average of 3.8 mg total nitrogen and 4.8 mg total phosphorus, and low suspended solids and BOD concentration. This release water is the major pathway for release of nutrient from the facility. This adds to the mass load of nutrient entering the ocean. It is not predicted to have a significant effect on local ecosystems. This is due to the low frequency of events, high mixing rates with the regional runoff water from a disturbed catchment, local sewer discharge and well mixed inshore waters. It is a recommendation of this report to investigate the source/s of nutrient in the JBS runoff and, where practical, take steps to reduce these.



To date recent improvements undertaken by JBS include the utilisation of old sludge drying dams as wet weather storage, an improved solids pre-screening system located at the plant and bunded to wastewater, improved boundary bunding, recent highway update diverting external surface water sources around the site and the internal bunding upgrades to the manure and paunch (organics) storage pad directing all runoff to the effluent treatment system.

#### Irrigation and Irrigation Modelling

The MEDLI model has been used to assess the performance of irrigated Rhodes grass. The plant does not operate during the wet season and this provides a self-limiting control for wet season conditions. The soils are silty clay overlying clay. The rate of deep drainage is low but sufficient for salinity control. Wastewater has been irrigated for more than 20 years. This is a sufficient time period to assess the medium to long term response. The soil nutrient is elevated in the surface soil (0-25 cm) and declines quickly below this. The soil phosphate sorption rates remain high. The ground water nutrient levels are low.

There is no evidence demonstrating the irrigation area is providing an adverse effect on the receiving environment.

Harvesting of hay is used as a nutrient removal mechanism. The measured removal represents 72% of the nitrogen applied and 55% of the applied phosphorus. This level of nutrient recovery is regarded as within the normal to high crop recovery range for an irrigated, fertilised cropping system. Loss pathways include denitrification, volatilisation and runoff. Significant errors can be expected when measuring hay harvesting and composition.

The MEDLI model has some limitations which limit the ability of this model to accurately represent the complexity of the JBS irrigation management and to provide an accurate mass balance for nutrient. Direct measurement, rather than predictive modelling, of the JBS conditions is the recommended technique to represent the on-going irrigation and nutrient management.

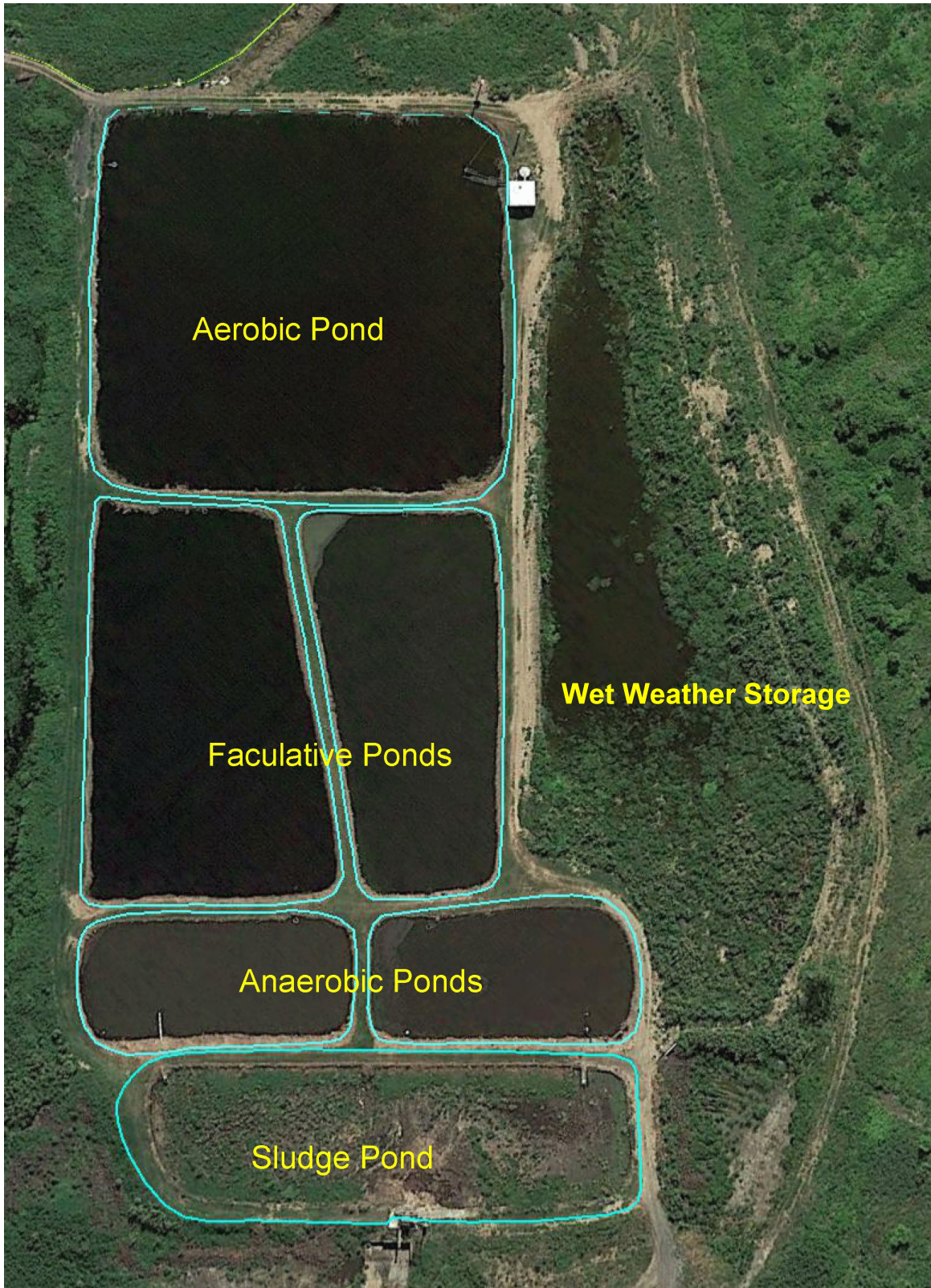
There is no evidence available to indicate the current irrigation strategy is causing an adverse effect on the local ecosystem. Nutrient loads to the ocean represent a small proportion of regional loads. However, it is necessary to demonstrate satisfactory performance through on-going monitoring and record keeping. This includes completion of the EE monitoring requirements and future JBS monitoring.

### 3 WASTEWATER IRRIGATION

#### 3.1 Description of Wastewater Irrigation - Current and Optimal Scenario

The Townsville abattoir operates for approximately 10 months of the year. Wastewater flows from the facility to anaerobic, facultative and aerobic ponds. The pond layout is shown in Figure 1. The dimensions of ponds and irrigation areas are provided in Attachment D.

Figure 1: Treatment Ponds





Effluent throughout the wastewater pond systems is sampled and tested. The long term average values of the effluent from the final pond have been used in this study. These are provided in Table 1.

| Analyte                          | Value | Units |
|----------------------------------|-------|-------|
| Total Nitrogen                   | 130   | mg/L  |
| Total Phosphorus                 | 30    | mg/L  |
| Dissolved Salt                   | 813   | mg/L  |
| Electrical Conductivity          | 1.95  | dS/m  |
| Biological Oxygen Demand (5 day) | 76    | mg/L  |

Table 1: Effluent Composition

The influent flow varies according year to year. A typical year has operation starting on year day 76 and finishing on year day 350. This schedule has 195 working days per year, with an influent wastewater flow of 0.864 ML/day during operational periods. This is the design flow and has an annual wastewater influent flow of 255 ML/year.

The facility has an area of 266 hectares with 95 hectares being available for irrigation. The irrigation methods are spray and flood irrigation. Most of the irrigation water is applied to the spray irrigation areas. The spray irrigation area is 65 ha and the flood irrigation area is 29 ha. The irrigation area runoff is to a tailwater recovery dam. This dam also serves as a runoff collection dam. Water from irrigated areas, cattle yards, storage areas and the plant drains to the runoff collection dam. Water held in the collection dam is harvested for irrigation.

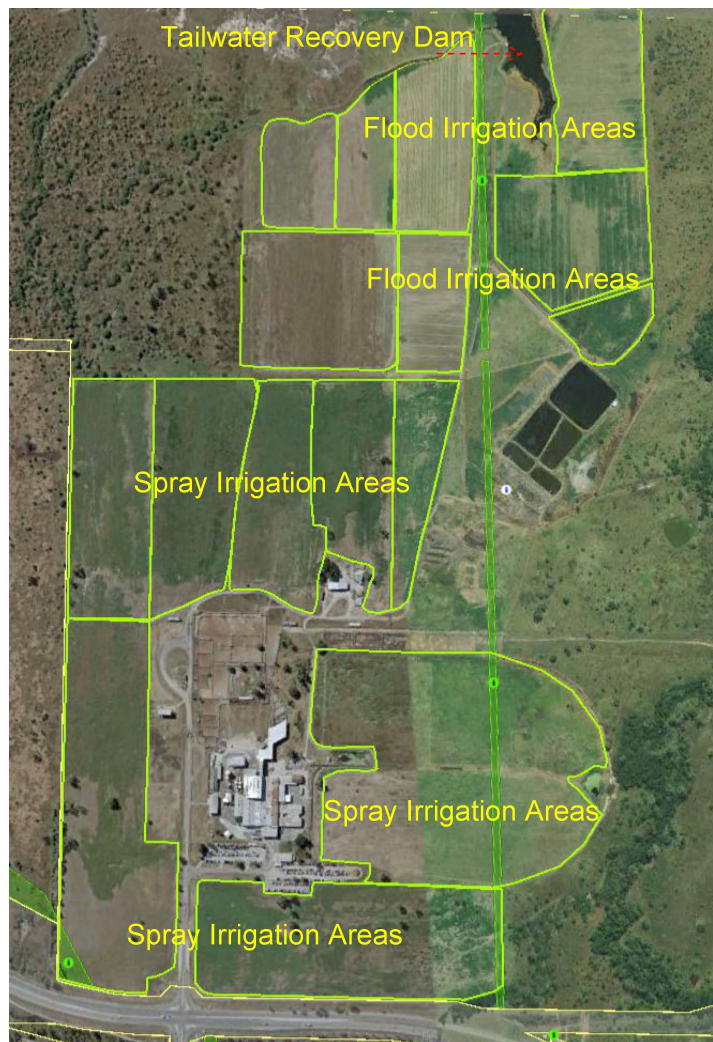


Figure 2: Irrigation Areas

The crop on the spray irrigation area is Rhodes grass. Flood irrigation areas have a mixture of Para grass and Rhodes grass. This is harvested for off-site re-use as fodder grass. Options for future management include upgrading the hydrant network to spray larger areas, including the flood irrigation fields. The required irrigated area is dependent on the supply of wastewater.

Irrigation is applied to spray irrigation land using traveling irrigators. The wetted width is 50 metres and the run length is 120 m. A network of hydrants is used. Two irrigators are used across the site, depending on the supply and demand. Water is applied across the spray irrigation areas in rotation. Application is made when the soil moisture has fallen and when irrigation water is available. There is typically insufficient water to meet the full plant water requirements. When runoff appears likely, irrigation is not applied and water is retained in the storage lagoons.

### 3.2 MEDLI Model - The Current Scenario

The current irrigation practice involves the following irrigation activities:

- \* use of two travelling irrigators, operating across a series of fields
- \* irrigation is applied when the following conditions apply:
  - a) water is available for irrigation. This includes water harvested from recovery dams.
  - b) no runoff is anticipated (from rainfall forecast)
  - c) the soil moisture deficit is sufficient to justify irrigation (as determined from field observation)
  - d) the crop growth stage permits (no irrigation prior to harvest but soon after harvest)

The above conditions are specifically intended to prevent runoff and excessive deep drainage. The site is typically short of water and economical use of water is an important consideration. The area irrigated, and the rate and depth of application are varied according to field conditions, as determined by field staff or contractors.

MEDLI can model some but not all of these processes. In particular, irrigation of a variable land area, weather forecasting, multi-field irrigation and opportunistic use of recovery water are not supported.

The current scenario is modelled as irrigation of 50 hectares of Rhodes grass, irrigated with up to 55 mm of water, every 21 days. This results in application of the available water, is applied at intervals of 21 days to 50 hectares. The irrigated application is approximately 35 mm.

This model approach ensures the full hydraulic and nutrient load is applied to 50 hectares of land. Assessment of the ability of the land to assimilate the hydraulic and nutrient load is then possible. This is a conservative approach. This includes tailwater nitrogen recovery. No fertiliser is applied. All of the irrigated wastewater nitrogen is modelled as being routed to the irrigation areas. Tailwater nitrogen represents a transfer of this nitrogen from irrigated land, to the dam and then back to irrigated land. The mass loading (in recovered tailwater) is equivalent to 9 kg N/ha/y. This rate will be lower, if more than 50 hectares are irrigated in the wet season.

In practice, 65 hectares of spray irrigation land is available and up to 95 hectares can be irrigated if flood irrigation is used. It is assumed, if 50 hectares of land performs adequately, then 65 and 95 hectares also will.

The concept of an optimal scenario assumes the current practices are less than suitable. One assumes an optimal irrigation practice would achieve the purpose of irrigating 100% of the irrigation water and still maintain acceptable environmental outcomes. Modelling of the current scenario, indicates there is 100% re-use of irrigation water. This is supported by long term records. (Exceptions to this occur in extreme wet season events where storage ponds fill with rainwater and release is unavoidable.) Ongoing monitoring of soil and ground water has not revealed evidence of environmental harm.

It is concluded that whilst the current scenario model does not exactly reproduce the sequence of irrigation, it does apply the full hydraulic and nutrient load to the irrigation areas and that this results in an acceptable outcome. It would be preferable to model the operation using a multi-paddock sequence, with irrigation applied by soil water deficit, combined with opportunistic runoff recovery, crop life cycle, and rainfall forecasting. Models with these features are currently not available for routine application.

The modelled scenario predicts runoff of irrigation water. This does not occur as irrigation is spray irrigated to dry soil, when it is not raining. Runoff, **of rainfall**, flows to catchment dams. The modelled scenario predicts some runoff of irrigation water but this is incorrect. If the 50 hectare irrigation area is modelled with irrigation controlled by soil water deficit, at irrigation intervals of 21 days, then storage dam overflow is predicted. This is incorrect. Long term experience with the irrigation area has demonstrated all the wastewater is irrigated without loss. Simulation of multi-paddock irrigation is required to correct this error.

For the above reasons, one MEDLI model scenario is presented. This represents the existing and optimal scenarios.

### 3.2.1 Hydraulic Control

There is more than 99.9% re-use of irrigation water, as modelled, and, as demonstrated by long term experience.

Modelled overflow events occur as a result of extreme wet weather and the plant is typically not-operational during these times.

Tailwater recovery of rainwater occurs on average 1.4 times/year when the plant is running and 6.7 times/year in total. The total recovered rainwater (tailwater) volume is 221 ML/y. Up to 95 hectares of land are available for rainwater runoff recovery. This is equivalent to 233 mm/ha/y.

In practical terms, the full hydraulic and nutrient load of treated wastewater is applied through irrigation to the land, without runoff.

There is a tailwater/runoff water retention dam on the northern boundary. All surface runoff from irrigated land and the abattoir and yards, ultimately flows to this point. Runoff occurs when the rainfall rate exceeds the soil infiltration rate. Rain, falling on dry soil, will not cause runoff. A 12 mm runoff event typically results from a much larger rainfall event. The tailwater dam has the capacity to retain a 12 mm runoff event from a 95 hectare catchment. Runoff from 48% of (up to 12 mm) runoff events is captured.

Release from the tail water recovery dam has been recorded and water quality testing has been undertaken of the release water. The test results are provided in Appendix 2. These events coincide with large wet season rainfall events.

Actual and reported overflows are as follows (data from JBS records):

- 31 Jan 2014 – Cyclone Dylan (plant closed)
- 17-18 Feb 2014 – 200mm in 24 hrs (plant closed)
- 14-16 Mar 2016 – 160mm
- 4-16 Jan 2017 – 245mm (plant closed)
- 23 March 2017 – 137mm
- 20 -28 Feb 2018 – 322mm (plant closed)
- 28 Mar 2018 – 155mm (plant closed)

The MEDLI runoff flow predictions (*events*) for the period 2014-2017 have been compared with recorded tailwater dam release events. There are 5 **recorded** events and 12 (**MEDLI predicted**) runoff events larger than 12 mm. The largest (MEDLI predicted) runoff event associated with a recorded release is 25.2 mm. MEDLI predicted runoff volumes below 25 mm did not cause a release event. Runoff associated with a MEDLI predicted runoff rate of less than this is not associated with a recorded release event. To be conservative, a 22 mm capture threshold has been applied to predicted MEDLI runoff to assess the long term behaviour.

Figure 3: Areas Required To Utilise Design Supply Of Water

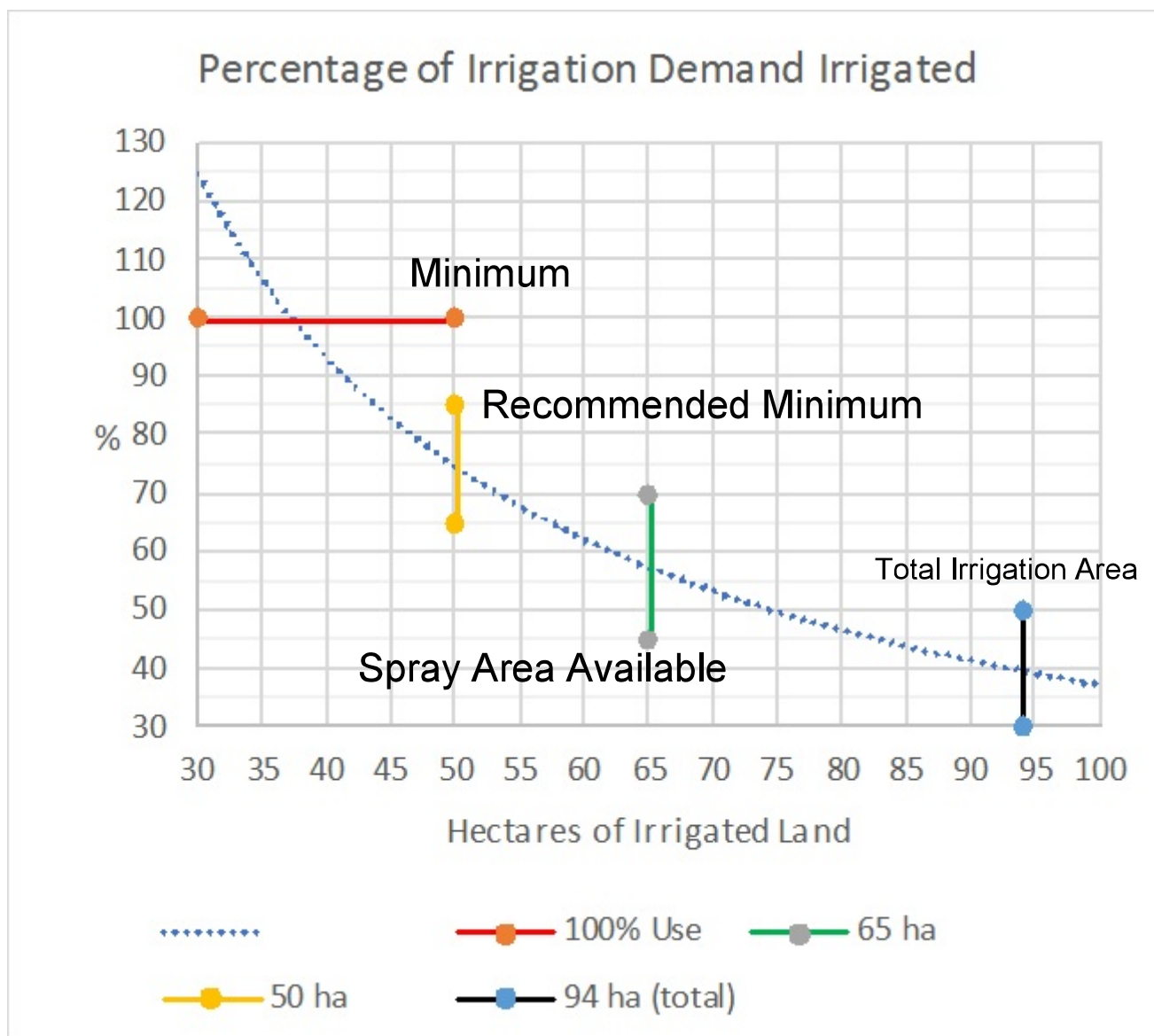


Figure 3 examines irrigation of irrigation areas between 30 and 100 hectares of irrigated Rhodes grass. The irrigation technique is simply irrigating every 21 days, at rates not exceeding 55 mm/d of water. This schedule forces all irrigation (99.9%) to be applied so there is no release of water. This examines the ability of the land to utilise the applied water (nutrient is not considered by this graph)

The irrigation strategy applied for the graphed performance is based upon irrigating up to 55 mm of water, every three weeks, except if the supply of water is insufficient. The strategy results in close to complete utilisation of the wastewater supply. About 37 hectares will utilise the supply as a long term average. As the area is increased above 37 hectares, there will be an increase in soil moisture stress for some of the time. An irrigated area of 50 hectares is recommended as a minimum. This reduces the opportunity for hydraulic overload and the risk of leaching of nutrient. Sixty-five hectares of land is available for spray irrigation.

The dry weather irrigation supply (864 m<sup>3</sup>/d) will irrigate approximately 25 hectares in warm dry weather at 3.5 mm/day of irrigation. In cool, winter weather, larger areas are required. In periods of extremely hot dry weather, it may only be possible to irrigate 10-12 hectares. The field staff assess the soil and weather conditions and irrigate accordingly. The area irrigated is varied seasonally.



The modelled approach assesses the crop water demand to ensure a zero discharge outcome can be achieved for the 90 percentile year.

The 90 percentile annual rainfall total for the 100 year data set 1916 to 2015 is 1722 mm. The year 1953 has a rainfall of 1733 mm and has been selected as representative of the 90 percentile year. This is presented in Table 2.

| Rank             | Year | Climate1 -<br>Rainfall Depth<br>(mm)<br><br>Annual Total | Pond33 - Overflow<br>Volume from Last Pond<br>(m3)<br><br>Annual Total | LandNutrient264 - Nitrate-N<br>Concentration Leached Below<br>Defined Soil Profile (mg/L)<br>Average For Year | Groundwater326 - Nitrate-N Mass Leached<br>Below Defined Soil Profile (kg/ha)<br><br>Annual Total |
|------------------|------|----------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Average          | 1979 | 1082                                                     | 0.000                                                                  | 0.011                                                                                                         | 0.016                                                                                             |
| 90<br>Percentile | 1953 | 1733                                                     | 0.000                                                                  | 0.067                                                                                                         | 0.126                                                                                             |

Table 2: 90 Percentile Performance Of Irrigation and Leachate

The 90 percentile rainfall year has no over-topping from the treatment ponds and low loss rates for nitrogen.

The 90 percentile runoff event from non-irrigated land is 66 mm. To capture the 90 percentile runoff event requires a storage of 63 ML. The local 10 year ARI, 24 hour rainfall is 260 mm. To capture a 260 mm rainfall event requires storage of 218 ML.

The lagoons have freeboard to retain rainfall. Provided all the lagoons are maintained with sufficient freeboard, then no overtopping of treated wastewater will occur. The high rainfall events typically occur when the plant is shut down and there is no wastewater flow to the treatment lagoons.

### 3.2.2 Maximum Crop Uptake

The Rhodes grass cropping system has the potential to utilise high rates of nutrient and water, if this is available. One hypothetical, “high rate” example has been modeled. This only irrigates 10 hectares of land. The crop is irrigated based on soil water deficit. Irrigation water is only applied to replace that used by transpiration. The irrigation rate 815 mm/year. The nutrient uptake rate is 813 kg N/ha/y and 161 kg P/ha/y. This demonstrates where there is an unlimited supply of water, the crop has the potential to utilise more water and nutrient than is currently being applied.

This high rate irrigation case is indicative of commercial farming practices where there is an ample supply of water. Plant yield per hectare is maximised. The limiting factors for intensive irrigation can be either hydraulic or nutrient based.

Table 3 presents the limits for Rhodes grass. This is based on MEDLI modelling of irrigation driven by a soil water deficit. This represents the theoretical minimum land areas required to utilise water and nutrient from the wastewater supply. No limitation due to storage is imposed. The supply refers to the volume of water irrigated, not the design daily wastewater effluent flow. The effluent flows to open lagoons and is subject to evaporation. The MEDLI model calculates evaporation losses and rainfall gains by the lagoon system.

In the absence of phosphate sorption and precipitation, the system is limited by phosphorus and 48 hectares are required. Thirty-two hectares are required to utilise the supply of water and 29 hectares are required for nitrogen uptake.

|                 | Concentration Irrigated |      | Supply   |      | Max Demand |         | 100% Utilisation |    |
|-----------------|-------------------------|------|----------|------|------------|---------|------------------|----|
| Hydraulic Loads |                         |      | 239.175  | ML/y | 7.46       | ML/ha/y | 32.1             | ha |
| Nitrogen Conc   | 100.71                  | mg/L | 24087.31 | kg/y | 823        | kg/ha/y | 29.3             | ha |
| Phosphorus Conc | 31.97                   | mg/L | 7646.425 | kg/y | 158        | kg/ha/y | 48.4             | ha |

Table 3: Minimum area requirement for complete crop uptake of wastewater components

The tabled limits are the minimum, theoretical limits, required for crop utilisation of irrigation water. In practice, larger areas are required. The larger areas are required to manage extended periods of high rainfall, to minimise the loss of nitrogen in deep drainage and to facilitate a practical agronomic irrigation schedule. The theoretical minimum requirements demonstrate the available area provides a large safety factor for these requirements.

A “design case” is discussed in the following section. This assumes the irrigated land area is 50 hectares and all of the wastewater is irrigated. The MEDLI model irrigation strategy assumes no more than 55 mm is applied per irrigation is applied with a rest interval of 21 days between irrigations.

The model uses measured soil properties for soil water retention, soil phosphate sorption and phosphorus and observed conditions for the soil layer and hydraulic conductivity.

The MEDLI model cannot be expected to reliably provide a nutrient balance that is reflected by field measurements. Numerous issues affect the ability to provide an accurate nutrient balance. These include:

- \* MEDLI has a small number of irrigation options that are supported. Multi-paddock modelling is required for systems where irrigation is rotated between fields. The current version simply irrigates the entire nominated area at each irrigation. This is a major limitation.
- \* The MEDLI irrigation process is a theoretical, exact water application. Real world systems have a gradient of water distribution and operators will modify their practices for many reasons.
- \* The MEDLI modelling of crop growth is necessarily a basic assessment of growth, limited by temperature, nutrient, salinity and soil moisture conditions. (More complex models require more complex data inputs and are equally limited by assumptions that may not be reflected by site conditions.)
- \* It is impossible to undertake accurate measurements of harvested nutrient at a farm scale, within the limitations imposed by conventional agricultural practice. For example, every bale of hay would need to be weighed, the moisture content measured and the nutrient content measured with a high level of accuracy.
- \* Nitrogen is lost through soil volatilisation of ammonia. This process is favoured by alkaline soil conditions and the sub-surface soils at the JBS site are strongly alkaline (pH 8.3 to 8.6). MEDLI currently does not address this pathway.
- \* A nitrogen loss rate of 1 ug N/g soil/day is a realistic rate of denitrification for soil above 75% of field capacity, at a temperature of 30°C and where there is sufficient organic carbon. If denitrification is active through 500 mm of freshly irrigated soil (bulk density 1.4 t/m<sup>3</sup>) then the loss of nitrogen through denitrification will be 7.5 kg/ha/day. This represents 10% of the applied nitrogen, when 500 mm of soil is irrigated with the JBS wastewater. If the crop uptake does not utilise all of the applied nitrogen immediately then a loss rate of 7.5 kg/ha/day will occur until either the water, nitrate or organic carbon levels become limiting.

T.W. Bruulsema, P.E. Fixen, C.S. Snyder (2004) provide an assessment of nitrogen recovery by corn in America. A copy of this paper is provided in Attachment F. The recovery averaged across 55 producers located in "north central U.S.) was 37%. Crop recovery rates for moist, warm, fine textured soils can be expected to be of a similar nature, and possibly lower.

The JBS nitrogen recovery is 72%. This is considered to be in the range of average to above average for crop nitrogen recovery. Recovery rates above 80% are not considered likely as a long term average for almost all cropping systems.

The prediction of crop nutrient recovery requires quantification of complex processes and not all of these are addressed by the MEDLI program and those that are, will be subject to errors and limitations. Limitations of this nature apply to all models. Whilst the program is extremely useful, direct measurement of field conditions remains the most appropriate technique for nutrient assessment.

A summary of the mass balance for irrigated nitrogen is provided in Appendix 1, Table 1. This applies to an irrigated land area of 50 hectares that accepts the full wastewater hydraulic and nutrient load.

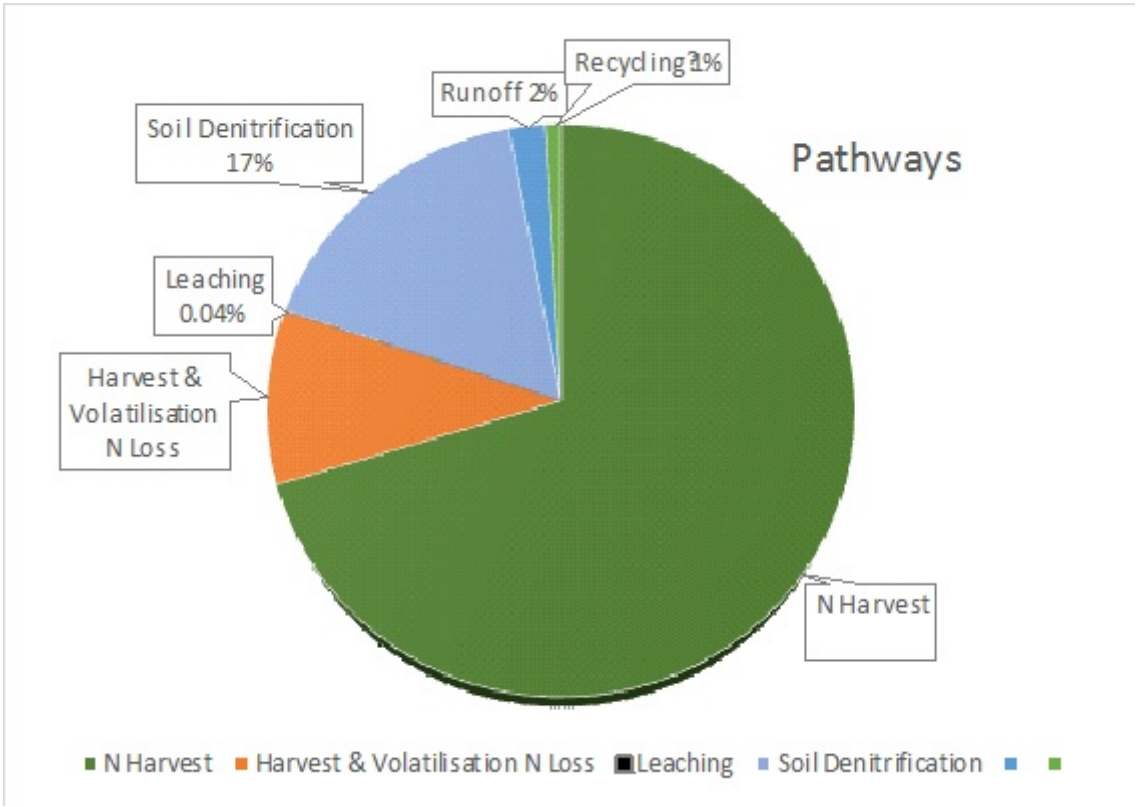


Figure 4: Pathways for Nitrogen

Figure 4 illustrates the distribution of the applied nitrogen load. Nitrogen that is not harvested, is lost through soil volatilisation , denitrification, harvest decay, runoff and leaching. Recycled nitrogen (from recovery of runoff) is subsequently re-applied.

The design case schedule forces all irrigation water to be applied and distributed across 50 hectares. In practice, all the water is distributed across 20-95 hectares, with approximately 21 days (minimum) of rest between irrigation of anyone area. The application rate is variable between 30 and 100 mm, depending on soil moisture.

Inputs

The input from irrigated wastewater is based upon the volume of water that is pumped from the treatment lagoons and the nutrient concentration. The volume allows for loss in evaporation as predicted by the MEDLI model. (The irrigated volume is less than the wastewater supply. The nutrient concentration of the irrigation is measured at the irrigation supply dam.)



## Crop Removal

The mass of harvested hay and nutrient composition of the hay is recorded. The hay harvest records are provided in Attachment C.

The crop removal is based upon the measured mass of hay and the measured nitrogen concentration in this hay. The average hay nitrogen concentration is 1.88% and the 2017 harvested mass is recorded at 1076 tons. The harvested nitrogen mass is calculated to be 20,229 kg in 2017. This is 72% of the irrigated nitrogen mass.

(The MEDLI program predicts 28 ton/ha/y biomass harvested for a 50 hectare irrigation. This is equivalent to 1,400 tons. The measured rate is 1076 tons.)

## Leaching

The groundwater nitrogen measured in 2016 from three monitoring bores is less than 0.1 mg/L

In 2017, the groundwater nitrate N levels were 0.03, 0.03 and 0.25 mg/L.

In 2018, shallow groundwater from five bores was measured. The total nitrogen levels ranged from 0.2 to 1.5 mg/L (nitrate N 0.2-0.7 mg/L). These measurements are on-going and this assessment will be updated as new data becomes available.

The groundwater is saline and this is characteristic of low rates of deep drainage. If the leaching rates were high (e.g. deep sandy soil) there is less change for concentration of salt by evapotranspiration. Deep drainage of rainfall is relatively high on sand. The groundwater is less saline due to the supply of rainwater. Clay soils, on coastal plains, which a shallow groundwater and low hydraulic gradient, typically have low rates of groundwater movement. This is associated with a slow movement (leaching) of mobile salts. This would include nitrate N.

The MEDLI model predicts the deep drainage rate is 85 mm/y for a 50 hectare irrigation rate using the design case. If 0.26 mg N/L is used to represent the site average groundwater concentration then the drainage loss is 11 kg/y.

The measured soil nitrate nitrogen levels show elevated nitrate at the surface with the concentration reducing to low levels with depth below the surface.

## Hay Nitrogen Loss

The measured hay nitrogen concentration is quite variable. This will be affected by the nitrogen loading rate of the hay that is sampled. Hay is harvested from across the site and this will be from land that is not irrigated, lightly irrigated, well irrigated, etc. When cut, dry matter and nitrogen is lost from hay. Dry matter losses of 10-30% can be expected. (Enoh M B, Kijora C, Peters K J, Tanya V N, Fonkem D and Mbanya J 2005: Investigation on change of forage quality at harvesting, during hay making and storage of hay harvested at different growth stages in the Adamawa plateau of Cameroon. Livestock Research for Rural Development. Vol. 17, Art. #49. Retrieved August 28, 2018, from <http://www.lrrd.org/lrrd17/5/enoh17049.htm>

Crude protein losses of 17% are reported by the same authors during the period between the pasture content and the hay at baling. Therefore monitoring of harvested mass and harvested nitrogen levels is prone to underestimate the nitrogen present in grass, when cut. For example if the measured mass is 90% of the mass when cut and the nitrogen level is 85% then the hay content is 76% of the cut grass nitrogen level.

For the purpose of this study a 14% nitrogen loss is applied between harvest and measurement of the hay. No separate volatilisation loss of soil ammonia has been included. This is included with the 14% allocated to hay loss.

The baling and soil ammonium loss is 10% of the supply.

## Runoff Loss

Runoff can carry nitrogen in particulate and dissolved forms. The irrigation areas flow to a tail water recovery dam and this water is subsequently re-irrigated.

There is runoff from the irrigation area. This is predicted to be 447 mm/y. This flows through a drainage network to a capture pond. The capture pond has a capacity of 15 ML. The recycled water provides an addition of 0.9% of the applied load. Released water represents 2.1% of the applied load (assuming 31% capture and re-use of runoff nitrogen).

## Soil Denitrification

Soil nitrogen is subject to a series of transformations. The classic sequence is:

|                              |                         |
|------------------------------|-------------------------|
| Organic -> Ammonia ->        | ->plant uptake          |
| Organic -> Ammonia ->Nitrate | ->plant uptake          |
|                              | ->Nox->atmospheric loss |
|                              | ->leaching loss         |

Both the ammonia and nitrate forms are available for plant uptake and the nitrate form is also subject to denitrification. Denitrification is fastest when the soil is depleted of oxygen (e.g., very moist), has an organic carbon supply (e.g., within the root zone) and is warm (e.g., a tropical climate). All three conditions are present within the plant root zone of any soil irrigated in Townsville. Much research has been undertaken on the subject as denitrification reduces the performance of expensive fertiliser and leads to run-down of nutrient levels in all soil systems, unless replaced at an equal rate. A universal feature of tropical soils is an extremely low organic matter and low organic nitrogen level. In almost all moist soils, approximately 98-99% of the soil nitrogen is present as organic nitrogen, except where the soil has been recently fertilised.

The MEDLI program assigns a 10% nitrate nitrogen loss rate per day, within the organic soil layer (layer with biodegradable organic carbon), but does not specify the moisture and temperature conditions when this rate applies. For the purposes of this study, a threshold value, equivalent to 80% of field capacity has been selected. This is the lowest soil moisture at which denitrification is calculated. At moisture contents of 80% and higher, a denitrification loss rate of 10% per day is assumed. In practice, denitrification will occur at lower rates, in small areas of soil which have little oxygen, at lower levels of soil moisture. The MEDLI program predicts quite low levels of denitrification. It appears crop uptake is modeled as the preferential pathway and residual nitrate nitrogen is then potentially subject to leaching or denitrification. This will bias the predicted outcome towards crop uptake.

When soil is irrigated, the moisture level at the surface rises and is normally above the threshold for denitrification. The soil will initially wet a depth of soil to field capacity. Then the soil dries down through evapotranspiration. The soil, wetter than the denitrification threshold is subject to denitrification for a period of time. The period of time is a function of the irrigated volume. The loss of nitrogen is also a function of the initial nitrate concentration.

Appendix 1 , Table 2, describes soil denitrification as a function of applied irrigation. If 35 mm of water is applied, the period of denitrification is predicted to be 1.75 days and a nitrogen loss of 17% occurs.

The more water is applied, the greater is the affected soil volume and the longer the wet soil will denitrify until it dries out. .

***The combined harvest, soil NH<sub>4</sub> volatilisation and denitrification loss rates presented in Appendix 1, Table 1 are sufficient to provide a nitrogen balance for the irrigation area.***

It is concluded little nitrogen is being lost to deep drainage. More significant pathways are harvest loss and soil denitrification. Errors in measurement of harvest biomass and harvested plant composition may also be significant.

The preceding (simplistic) assessment illustrates the difficulty of using a model to provide a nutrient mass balance.

The irrigation system is predicted to provide 97.9% control of the applied nitrogen load.

### 3.2.3.2 Phosphorus Control

Appendix 1, Table 3, provides a mass balance assessment of phosphorus applied in irrigation water. Harvesting removes 55% of the applied phosphorus. The remaining phosphorus is retained by the soil.

Phosphorus is expected to be conserved through hay production and there is no volatilisation of phosphorus from the soil. Surplus phosphorus is held in the soil as:

- \* soluble phosphorus
- \* organic phosphorus
- \* exchangeable phosphorus
- \* sorbed, nonexchangeable phosphorus
- \* insoluble phosphorus as calcium, magnesium, aluminium and iron phosphate

Soluble phosphorus will represent less than 1% and probably less than 0.1% of the soil total phosphorus. This is the pool that is at risk of leaching. Annual soil monitoring for water soluble phosphorus demonstrates this is present at a low level. Exchangeable phosphorus is elevated at the surface (30-50 mg/L Colwell P or 0.05 m H<sub>2</sub>SO<sub>4</sub> soluble P) and declines with depth. This is typically observed in a fertilised pasture. Sorbed-nonexchangeable and insoluble phosphorus comprise the majority of the phosphorus pool. Soil phosphate sorption is relatively rapid and measured using a 17-hour equilibrium period. Soil phosphate precipitation as insoluble phosphate is slow and approximately 100 days of groundwater residence would be required for 98% precipitation in solution. This assumes the soil does not dry out. The soil solute concentration rises as the soil dries and this will force precipitation at faster rates. Some of this will be sparingly soluble and will dissolve during another leaching event. The cycle repeats until essentially all of the soluble phosphorus is removed. The measured groundwater phosphorus levels do not reveal an elevated phosphorus concentration.

Phosphate sorption has been measured on soil taken at two depths from within the irrigation area. The soil test results are provided in Attachment B.

The surface soil has been irrigated for at least 20 years and still has a high phosphate sorption capacity. The MEDLI model (design case) predicts no significant export for another 100 years of irrigation, when the measured rate of phosphate sorption is applied.

Bicarbonate (Olsen) extraction tests for phosphorus show an elevation of phosphorus in the surface layer and a decline with depth. Acid (BASES) extraction on the same samples show a similar pattern.

The fine clay texture (high surface area), combined with calcareous subsoil and elevated salinity provide very favourable conditions for phosphate sorption and precipitation.

Soils most susceptible to release of phosphorus are sandy, have a high rainfall, low salt concentration, shallow groundwater and a short groundwater residence period before entering a stream or the ocean. These conditions do not apply to the study area.

Calcium can be applied to the soil as gypsum (calcium sulfate). This is typically used to supply calcium for sodicity control and plant nutrition. The soluble calcium will also combine with soluble phosphorus to form insoluble calcium phosphate. Routine application of gypsum is recommended for these reasons. A treatment rate of 5 tons/hectare, applied every two years is recommended.

The runoff concentration at the release point is elevated. The reason for this is unknown. A lower concentration of soluble phosphorus is expected. Further assessment is on-going. This includes analysis of drain flow across the site and tailwater dam influent/effluent measurement during runoff events. It is then possible to identify the cause and appropriate mitigation strategies.

The MEDLI program predicts an initial reduction in the soil nitrogen leachate (shown in Figure 5). This is assumed to be associated with a net reduction of soil organic matter as a consequence of biomass removal (reducing from the initial soil conditions). The model does not show a trend towards increasing concentration of nitrogen in leachate.

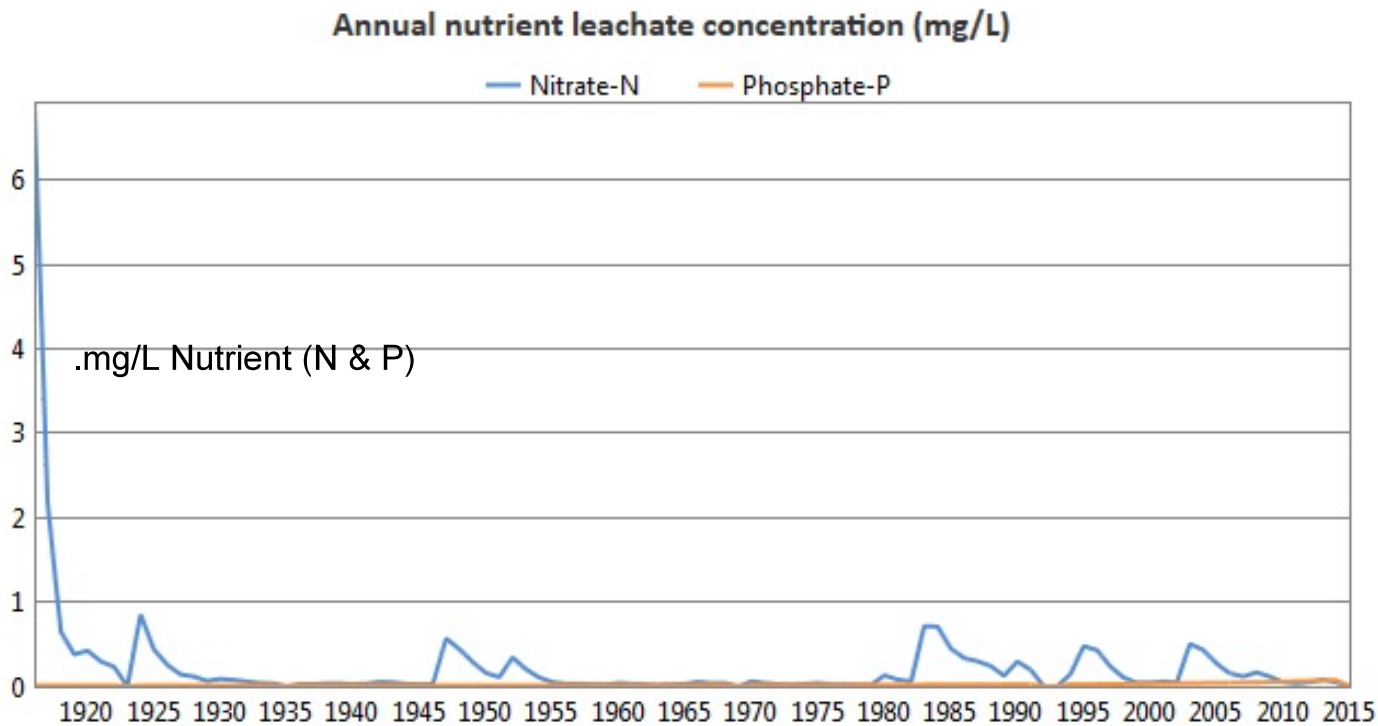


Figure 5: N & P leachate

Figure 5 shows the long term trend in the predicted concentration of nitrate N and phosphate P in deep drainage water that will enter the groundwater. There is a predicted reduction in nitrate N at the start of irrigation for approximately 8 years. The phosphorus concentration remains low for the 100 years of simulation. (Graph taken from MEDLI output.)



## 4 REQUIREMENT 2 - GROUNDWATER

### 4.1 Installation of Monitoring Bores

Temporary shallow groundwater monitoring bores have been installed at six locations on March 9, 2018. The locations were selected to sample water that may pass beyond the property boundary and potentially transport nutrient.

Three permanent monitoring bores are also located on the site. These are used for annual groundwater monitoring. A fourth bore has been located and will be included with on-going monitoring.

There are 10 monitoring and observation bores used for this assessment.

The location of the bores is shown in attachment E.

Bore log descriptions for the six temporary monitoring bores are provided in Attachment E.

### 4.2 Monitoring

Measurements of the ground water level and composition have been made. These are provided in Attachment E. This information will be used to address the final groundwater report required by Requirement 5 of the environmental evaluation.

### 4.3 Hydrogeology

No perched or confining features are known. The sediment in all the six shallow bores is relatively similar throughout the profile. The study area will have lenses of material with varying hydraulic conductivity.

### 4.4 Depth to groundwater

The depth to groundwater is between three and four metres below ground level.

### 4.5 Groundwater gradient and flow direction

The hydraulic gradient is approximately 0.0015 m/m on the southern and central sections and approximately 0.03 m/m on the northern section. This approximately follows the land surface contour.

Groundwater gradients are shown in Attachment E.

### 4.6 Soil Properties (Hydraulic and Lithology)

The hydraulic conductivity has been measured at three locations for the soil at the surface of the aquifer. The measured values are:

TMB3 0.003 m/d

TMB5 0.048 m/d

TMB6 0.006 m/d

The data has a wide spread but a representative range for the site is expected to be 0.01 to 0.001 m/d for the soil depth range of 1-3 metres below ground level.

A number of sediment layers are expected to exist within the upper 6 metres.

- 1 Depositional, flood plain deposits
- 2 A series of estuarine deposits (sand, silt, clay, sorted)
- 3 Relict stream beds (sand)

It is expected some of the underlying deposits will have a hydraulic conductivity range an order of magnitude, either side of the measured range.

The permanent monitoring bores appear to be slotted to a depth of 30 metres. The well depth is 30 metres for the permanent monitoring bores 1,2 and 3. A fourth bore was located in August. This has yet to be surveyed so the level has been determined approximately from land survey records. Samples were taken from this bore for the first time in August, 2108. The standing water level in this bore is similar to that of the other bores.

The standing water level in the deeper and shallow bores is similar. This suggests the aquifer is continuous to at least a depth of 30 metres and the hydrostatic pressure is approximately equal across this depth.

The soil observed to a depth of four metres at six locations across the study area are clay and sandy clay and are reasonably similar.

Piezo 4 (PMB 4) was discovered in August, 2018. This bore was located in long grass in August 2018, and there are no historical records of analysis or construction. Further study of this bore will be undertaken in 2018-19 to characterise this bore and understand the hydrology.

#### 4.7 Groundwater / Surface Water Interactions

No permanent surface fresh water exists and groundwater is expected to flow beneath the salt flats towards the ocean. The intertidal zone, or further oceanward, is the area where ground water will mix with the ocean. The distance to these areas is at least 1000 metres. Significant mixing with groundwater from other parts of the recharge area will occur before drainage from the JBS site enters the marine environment.

No surface waters are expected to be affected by ground water (no base flow has been observed).

#### 4.8 Groundwater Dependent Ecosystem

No terrestrial ecosystem is known to be dependent on the groundwater. The ground water has a high salinity (5 dS/m to 15 dS/m). The less saline water is located at the southern (higher) section of the site. There is some ponded water, on the salt flat, north of the north west corner of the JBS land. When full, this is approximately 100 m in diameter. This receives surface flow in wet season runoff but does not appear to be dependent upon flow from groundwater. It is expected seepage water flows into this pond from elevated land to the south-east in the wet season.

## 5 REQUIREMENT 6 - SURFACE WATER

### 5.1 Catchment Description

The catchment is essentially bounded on the south by the elevated highway. Water flows through culverts into drainage lines. The eastern drainage line is known as Sandfly or Vantasell Creek. The northern drainage line is unnamed. Internal drains divert water to a runoff/tailwater capture dam. Water from the dam is extracted and used for irrigation. Water is released from this dam during wet season events. The catchment is essentially, the irrigation area and the associated abattoir facilities.

### 5.2 Receiving Waters

There are no freshwater receiving waters. The tailwater dam releases to the salt flats. Water from the release point has approximately 1 km of overland flow across the salt flat to Sandfly/Vantasell Creek.

Cleveland Bay adjacent to the JBS site receives runoff from heavy industry. Sandfly/Vantasell Creek flows to a tidal waterway which discharges into Cleveland Bay. The outfall from the Townsville sewerage treatment plant is 100 metres from the mouth of this waterway. This treatment plant services a population of 126,000 people. This has a wet weather treatment capacity of 45 ML/day which is being upgraded to a capacity of 87 ML/day. The local water quality at this point, during runoff events, is unknown.

The key communities of the potentially affected receiving waters are:

- \* samphire on the salt flats
- \* mangrove community fringing the mouth of Stuart Creek
- \* suspended and benthic organisms at the mouth of Stuart Creek
- \* near inshore suspended and benthic organisms
- \* seagrass beds of Cleveland Bay and associated fauna/flora
- \* deeper marine ecosystems, including coral reef

5.3 Environmental Values

The environmental values identified for Sandfly Creek estuarine waters have been extracted from the document “Environmental Protection (Water) Policy 2009. Ross River Basin and Magnetic Island Environmental Values and Water Quality Objectives Basin No. 118 including all waters of the Ross River Basin, and adjacent coastal waters (including Magnetic Island)).

The environmental values for the receiving waters are:

- \* Aquatic ecosystems
- \* Human consumer
- \* Secondary recreation
- \* Visual recreation
- \* Cultural and spiritual values

The same document lists water quality objectives for this location:

|                                                                                            |                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bohle River and Sandfly Creek mid estuary waters outside Townsville State Development Area | Aquatic ecosystem—moderately disturbed (MD) | <ul style="list-style-type: none"><li>• ammonia N: &lt;30 µg/L<sup>d, t</sup></li><li>• oxidised N: &lt;40 µg/L<sup>d, t, t</sup></li><li>• dissolved inorganic N (DIN): &lt;20 µg/L<sup>d, g</sup></li><li>• organic N: &lt;260 µg/L<sup>e, d</sup></li><li>• total N: &lt;500 µg/L<sup>d, t</sup></li><li>• filterable reactive phosphorus (FRP): &lt;10 µg/L<sup>d, t</sup></li><li>• total P: &lt;50 µg/L<sup>d, t</sup></li><li>• chlorophyll a: &lt;8 µg/L<sup>t</sup></li><li>• dissolved oxygen: 85%–100% saturation<sup>h, t</sup></li><li>• turbidity: &lt;20 NTU<sup>t</sup></li><li>• Secchi depth: &gt;1.0 m<sup>e</sup></li><li>• suspended solids: &lt;20 mg/L<sup>e</sup></li><li>• pH: 7.0–8.4<sup>e</sup></li></ul> |
|--------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

A surface water quality monitoring plan is being implemented. Water samples will be collected during release events from the tailwater dam. Currently there is insufficient data to characterise the background water quality.

## Sediment Quality

Sediment and water samples were collected in August, 2018. These reflect the dry season conditions.

Sediment samples were collected at the receiving environment. This is the point at which water is released from the JBS site, onto the salt flats. The sediment analysis test reports are provided in Attachment B.

The samples from the salt flats, have very high levels of inorganic salt. The absolute nitrate nitrogen levels are elevated and phosphate levels more so, relative to those found in non-saline soils. The salt flats are a specialised zone of accumulation. Relative to the level of other salts, the nitrogen and phosphorus levels are not elevated. Phosphorus will accumulate as poorly soluble material, hence the high acid soluble concentration. Nitrogen remains in forms that are either soluble or will volatilise. This makes it less likely to accumulate.

The sediment at Sandfly/Vantasell Creek has an extremely high phosphorus level, with a low/normal nitrate nitrogen level. This may be partly due to accumulation of sparingly soluble phosphate during repeated wet/dry cycles of the stream bed. This is based on just one sample at one location and could be high for many other reasons. This includes a source of phosphorus in stream water, higher in the catchment. The sample taken from Stuart Creek has a moderately elevated phosphorus level, but not as much as the Sandfly/Vantasell Creek sample

### 5.4 Release Water Quality Objectives

The release water quality objectives need to be:

- \* as low as practically possible, for nutrient, suspended solids, coliform and BOD concentration
- \* as low as practically possible, for the release volume
- \* as short as practically possible, for the periods of release

The values are intended to protect the receiving environment, within the context of the location and operation of the facility. It is noted that neither regional storm water quality, nor release water quality from the tailwater catchment dam, meets all of the suite of environmental objectives listed in Environmental Protection (Water) Policy 2009, for this location. These objectives refer to a long term average water quality and make no account for temporal events, such as wet season runoff. Release from the JBS site occurs as a short term event, coincident with large regional runoff flows.



The release water quality is summarised in Table 4.

| Catchment Dam Release Water Analysis |         |         |      |      |
|--------------------------------------|---------|---------|------|------|
| Date                                 | Total N | Total P | TSS  | BOD  |
|                                      | mg/L    | mg/L    | mg/L | mg/L |
| 16/01/2017                           | 2.96    | 1.5     | 60   | 12   |
| 17/01/2017                           | 3.55    | 5.3     | 9.3  | 8    |
| 23/03/2017                           | 3.7     | 5.2     | ND   | 12   |
| 28/02/2018                           | 3.8     | 4       | 4.8  | 5    |
| 27/03/2018                           | 4.1     | 4.6     | 11   | 10   |
| average                              | 3.8     | 4.8     | 8.4  | 8.8  |

Table 4: Release water quality

The tailwater collection dam has a storage capacity of 15 ML, additional to other storage dams on the site. The runoff event that can be retained by this dam is 12 mm. Runoff volumes exceeding 12 mm from the site are expected to occur on 50% of runoff days. The tailwater dam captures 50% of all runoff events, including the first flush of all events.

Release from the dam is predicted 6.7 times per year as a long term average and 1.4 times/year during production periods from the irrigated land. The capture and re-use of runoff reduces the catchment export from land that would otherwise release runoff water. This represents a small environmental offset. The catchment Stuart Creek catchment area is 10,371 hectares and provides a mixing ratio of 311:1 for a 30 mm runoff event. This mixes with the release water from the JBS capture dam.

The short term nature of runoff events limits the period when nutrient is released. The water enters a well mixed estuary. The mixing point is close to the discharge point from the Townsville City Council STP.

The STP release point is subject the effluent release every day. Runoff from the JBS site, having a lower nutrient concentration, at this location, 6-7 times per year, is not expected to have a significant effect on the local aquatic ecosystem.

It is concluded the release water is highly unlikely to significantly effect the immediate estuarine ecosystem. The most significant effect is an addition to the mass load entering the marine environment that then interacts with the regional marine environment.

The estimated release volume is equivalent to 586 kg/y of nitrogen and 740 kg/y of phosphorus. This is based on daily runoff (MEDLI output) for 100 years. This period includes very large runoff events. It is anticipated, the runoff concentration will be lower, due to dilution with very large volumes of rainwater. The estimated release of nutrient is expected to be conservative for this reason.

The Bligh Tanner (2016) report "Townsville Regional Stormwater Strategy", estimates the existing stormwater loads to be 3236 t/y and 581 t/y for total nitrogen and total phosphorus. To this can be added nutrient from sewerage flows. The net effect on the Cleveland Bay nutrient load is small. However, this does not preclude all reasonable attempts to implement and maintain best management practice for stormwater quality management.

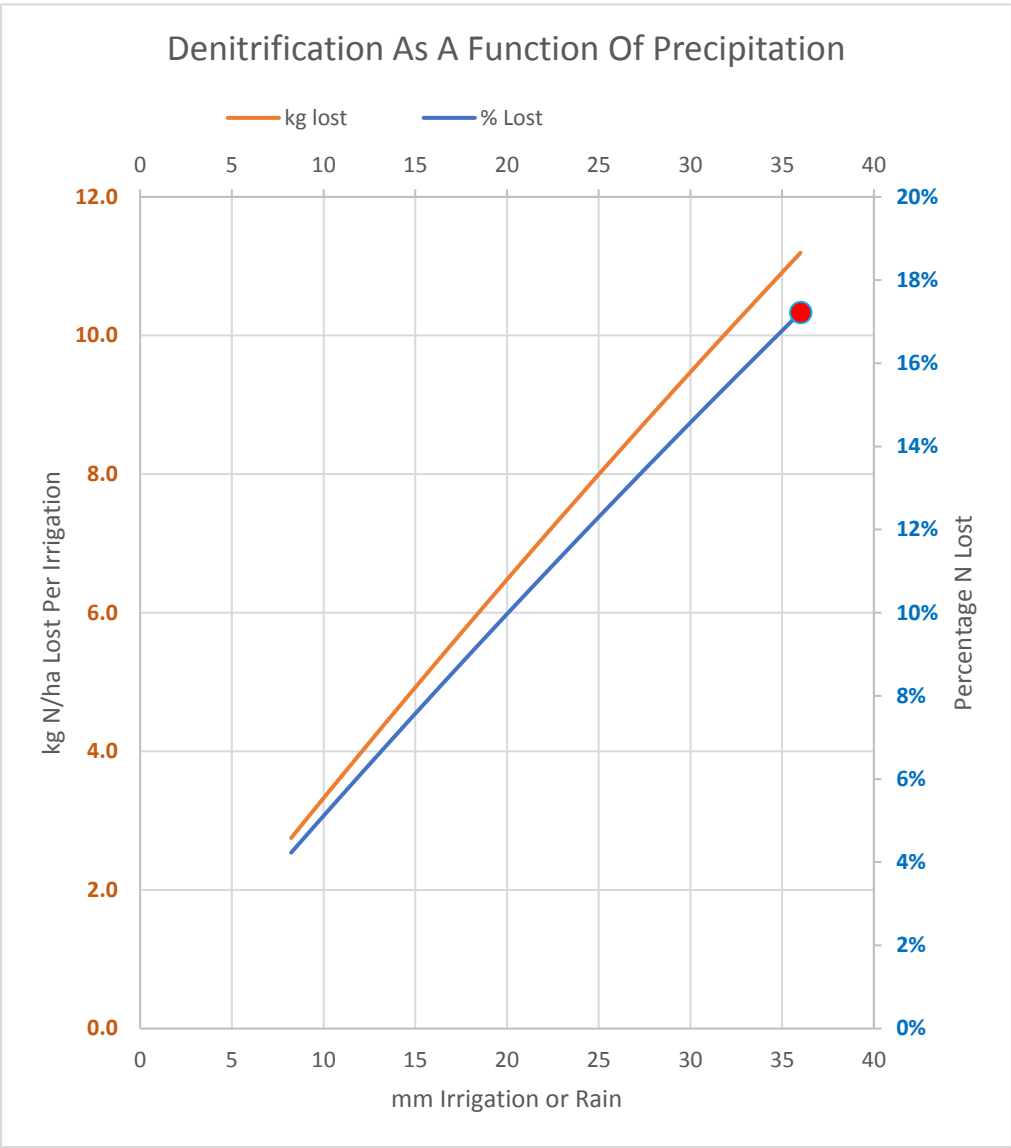
The JBS releases will occur when the water is turbid and are short term events. Released nutrient will be mixed, diluted and dispersed in a relatively short period of time. No long term residual change in nutrient concentration associated with the JBS release is predicted to be harmful for seagrass.



| Appendix 1 -Table 1: Nitrogen Mass Balance  |                                      |           |
|---------------------------------------------|--------------------------------------|-----------|
| COMPONENT                                   | Rate                                 | Units     |
| Wastewater Inflow To Pond                   | 255.0                                | ML/y      |
| Pond Evaporation                            | 38.1                                 | ML/y      |
| Wastewater Outflow From Pond                | 216.9                                | ML/y      |
| Irrigation Wastewater N Supply              | 130                                  | mg/L      |
|                                             | 28196                                | kg/y      |
| Irrigation Area                             | 50                                   | ha        |
| Hydraulic Loading                           | 4.34                                 | ML/ha/y   |
|                                             | 434                                  | mm/y      |
| Nitrogen Loading Rate To Land               | 564                                  | kg/ha/y   |
| Hay Harvested 2017                          | 1076                                 | ton       |
| Hay N Content                               | 1.88%                                |           |
| N Harvested                                 | 20                                   | ton       |
|                                             | 20229                                | kg        |
|                                             | 72%                                  | of supply |
| N Lost Post Harvest                         | 14%                                  |           |
|                                             | 2832                                 | kg/y      |
|                                             | 10%                                  | of supply |
| Biomass N                                   | 23061                                | kg/y      |
| # Irrigations Applied Annually              | 12.0                                 | times/y   |
| Irrigation Application/Event                | 36                                   | mm        |
| De-Nitrification                            | 17%                                  | applied N |
|                                             | 4856                                 | kg/y      |
| Deep Drainage                               | 85                                   | mm/y #    |
|                                             | 0.26                                 | mg N/L *  |
|                                             | 11.05                                | kg/y *    |
| INPUTS & OUTPUT - 50 hectare Irrigated Land |                                      |           |
| N Input                                     | 28196                                | kg/y      |
| N Harvest                                   | 20229                                | kg/y      |
| Harvest & Volatilisation N Loss             | 2832                                 | kg/y      |
| Leaching                                    | 11                                   | kg/y      |
| Soil Denitrification                        | 4856                                 | kg/y      |
| Runoff From Irrigation (partitioned below)  | 849                                  | kg/y      |
| Release Of Runoff From Site                 | 586                                  | kg/y      |
| Recycling of Runoff                         | 263                                  | kg/y      |
| Net Balance                                 | 5                                    | missing   |
|                                             | 0.0%                                 |           |
|                                             |                                      |           |
| #                                           | MEDLI prediction                     |           |
| *                                           | Measured 2018 in shallow groundwater |           |

Appendix 1 - Table 2: Soil Denitrification Losses

| Component                          | Rate   | Units        |
|------------------------------------|--------|--------------|
| Irrigation N Conc                  | 130    | mg N/L       |
| Irrigation Applied                 | 36     | mm           |
| Irrigated Volume                   | 36     | L/m2         |
|                                    | 500    | kL/ha        |
|                                    | 0.5    | ML/ha        |
| Irrigated Nitrogen                 | 4680   | mg/m2        |
|                                    | 65     | kg/ha        |
| M.C. @ Field Capacity              | 0.36   | vol. ratio   |
| P.A.W.                             | 0.12   | vol. ratio   |
| M.C. @ Wilting Point               | 0.24   | vol. ratio   |
| Soil Moisture Start (dry)          | 0.25   | vol. ratio   |
| Soil Moisture End (wetted)         | 0.36   | vol. ratio   |
| Added Water                        | 0.11   | vol. ratio   |
|                                    | 114    | L/m3         |
| Wetting Front                      | 0.316  | m            |
| Bulk Density                       | 1.55   | g/cc         |
| Air Filled Porosity oven dry       | 0.43   | vol. ratio   |
| Air Filled Porosity Start          | 0.67   | vol. ratio   |
| Air Filled Porosity End            | 0.79   | vol. ratio   |
|                                    |        |              |
| Dry Mass Soil Wetted               | 489    | kg           |
| Conc N Added To Soil               | 9.6    | mg N/kg soil |
|                                    |        |              |
| Evapotranspiration                 | 4      | mm/d         |
| Time To Dry                        | 9      | days         |
| Threshold M.C. For Denitrification | 0.8    | frac of F.C. |
| Period Of Denitrification          | 1.80   | days         |
| Denitrification Rate               | 0.1    | per day      |
|                                    | -0.105 | k            |
| Residual NO3                       | 7.9    | mg/kg        |
| N Noss                             | 1.6    | mg/kg        |
| % Denitrified                      | 17%    | of applied N |
|                                    | 11.2   | kg/ha        |



**Appendix 1- Table 3: Phosphorus Mass Balance**

| COMPONENT                       | Rate  | Units         |       |
|---------------------------------|-------|---------------|-------|
| Wastewater Inflow To Pond       | 255.0 | ML/y          |       |
| Pond Evaporation                | 38.1  | ML/y          |       |
| Wastewater Outflow From Pond    | 216.9 | ML/y          |       |
| Irrigation Wastewater N Supply  | 30    | mg/L          |       |
|                                 | 6507  | kg/y          |       |
| Irrigation Area                 | 50    | ha            |       |
| Hydraulic Loading               | 4.34  | ML/ha/y       |       |
|                                 | 434   | mm/y          |       |
| Phosphorus Loading Rate To Land | 130   | kg/ha/y       |       |
| Hay Harvested 2017              | 1076  | ton           |       |
| Hay N Content                   | 0.34% |               |       |
| P Harvested                     | 4     | ton           |       |
|                                 | 3605  | kg            |       |
|                                 | 55%   | of supply     |       |
| P Lost Post Harvest             | 0%    |               |       |
|                                 | 0     | kg/y          |       |
|                                 | 0%    | of supply     |       |
| Biomass N                       | 3605  | kg/y          |       |
| # Irrigations Applied Annually  | 13.1  | times/y       |       |
| Irrigation Application/Event    | 33    | mm            |       |
| Deep Drainage                   | 85    | mm/y #        |       |
|                                 | 0.01  | mg N/L *      |       |
|                                 | 0.425 | kg/y *        |       |
| <b>INPUTS &amp; OUTPUT</b>      |       |               |       |
| P Input                         | 6507  | kg/y          | 100%  |
| P Harvest                       | 3605  | kg/y          | 55%   |
| Harvest P Loss                  | 0     | kg/y          | 0.00% |
| Leaching                        | 0.4   | kg/y          | 0.01% |
| Runoff                          | 740   | kg/y          | 11%   |
|                                 |       |               |       |
| Net Balance                     | 2162  | soil fixation |       |
|                                 | 33.2% |               |       |

## ATTACHMENTS

### ATTACHMENT A - MEDLI OUTPUT

MEDLI program output is provided for a control case. This has no irrigation and no harvesting.

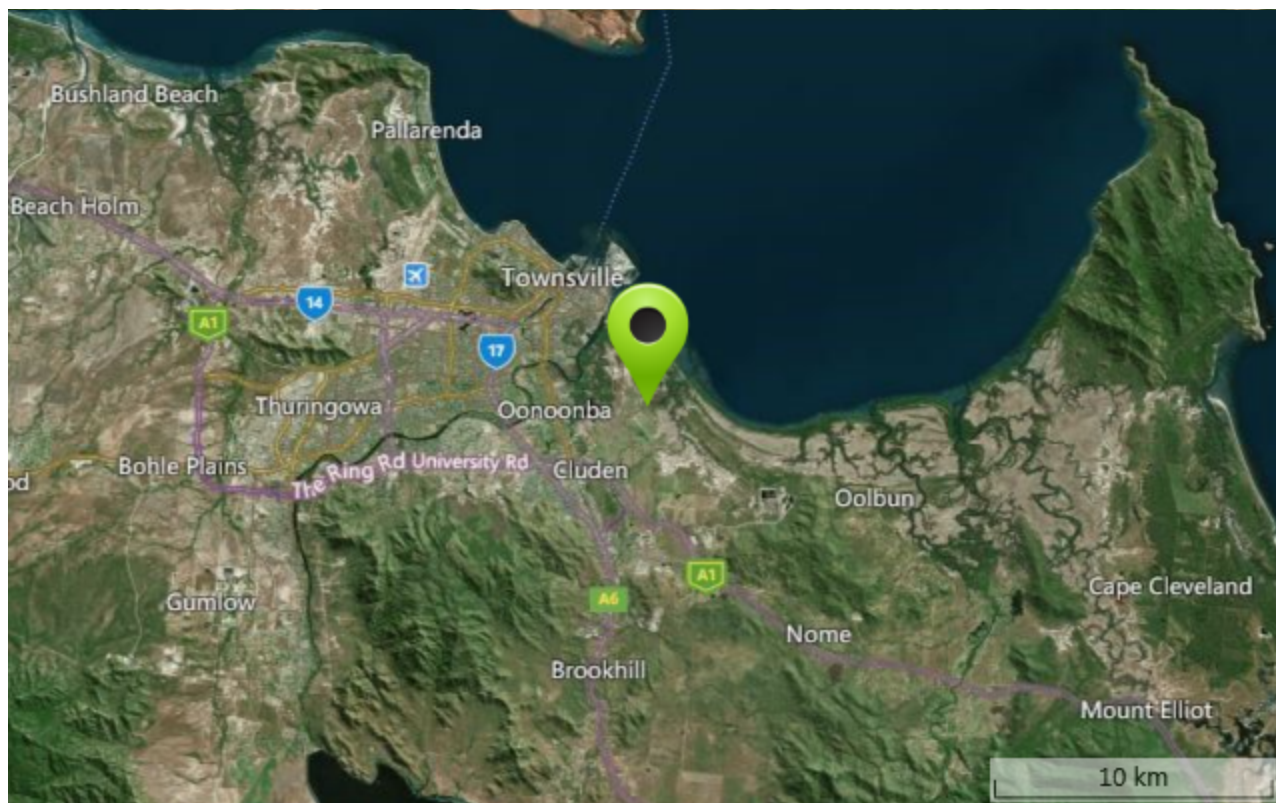
A second output covers the design case. This has irrigation and harvesting.

The climatic and MEDLI input definition files are provided as a separate ZIP file.



**Enterprise: JBS Townsville****Description:**

Nutrient Loading To Irrigated Land

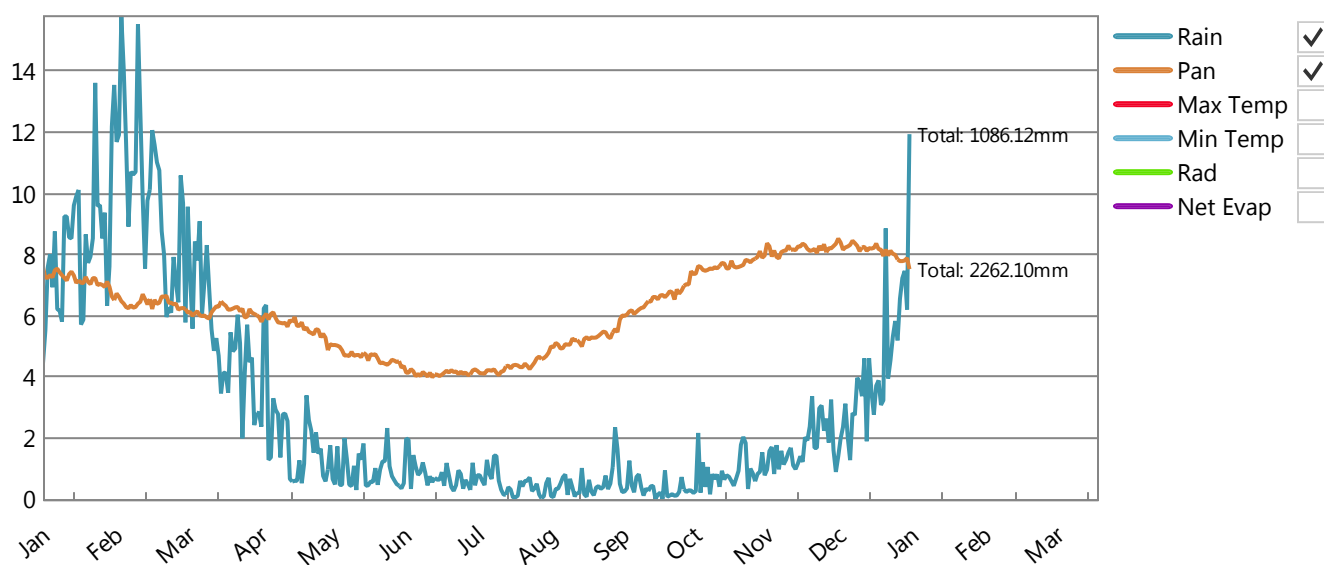
**Client: JBS****MEDLI User:** Bio-Track P/L**Scenario Details:**

MEDLI REPORT - FULL RUN

medli

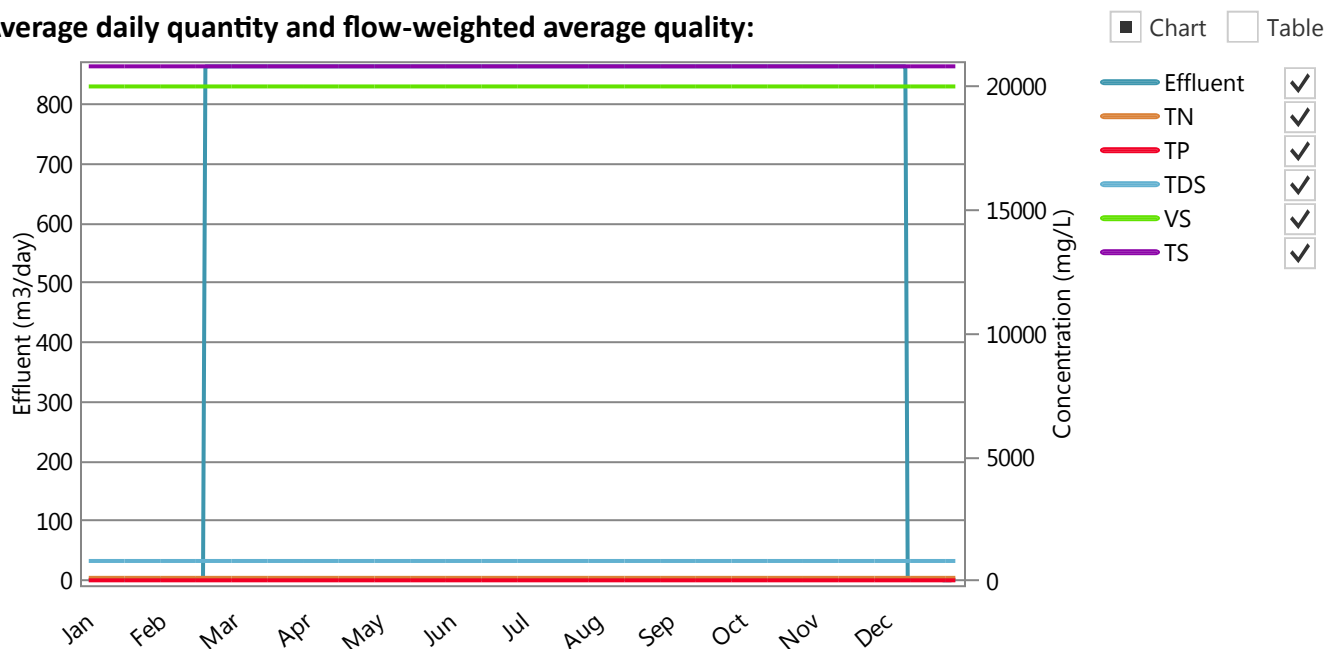
**Climate Data: Stuart, -19.3°, 146.85°****Run Period: 01/01/1916 to 31/12/2015** 100 years, 0 days**Climate Statistics:**

|                           | 5th ▾ | Percentile | 50th Percentile | 95th ▾ | Percentile |
|---------------------------|-------|------------|-----------------|--------|------------|
| Rainfall (mm/year)        |       | 459        | 1053            |        | 2062       |
| Pan Evaporation (mm/year) |       | 2019       | 2261            |        | 2456       |

**Climate Data:**☒ Chart ☐ Table☐ Monthly ☒ Daily**Daily Average Across Run Period**

DESCRIPTION

medli

**Effluent type: JBS Townsville****Wastestream before any recycling or pretreatment****Average daily quantity and flow-weighted average quality:****Wastestream after any recycling and pretreatment if applicable**

**Effluent quantity:** **254988.25 m³/year** or 698.12 m³/day (Min-Max: 0.00 - 864.00)

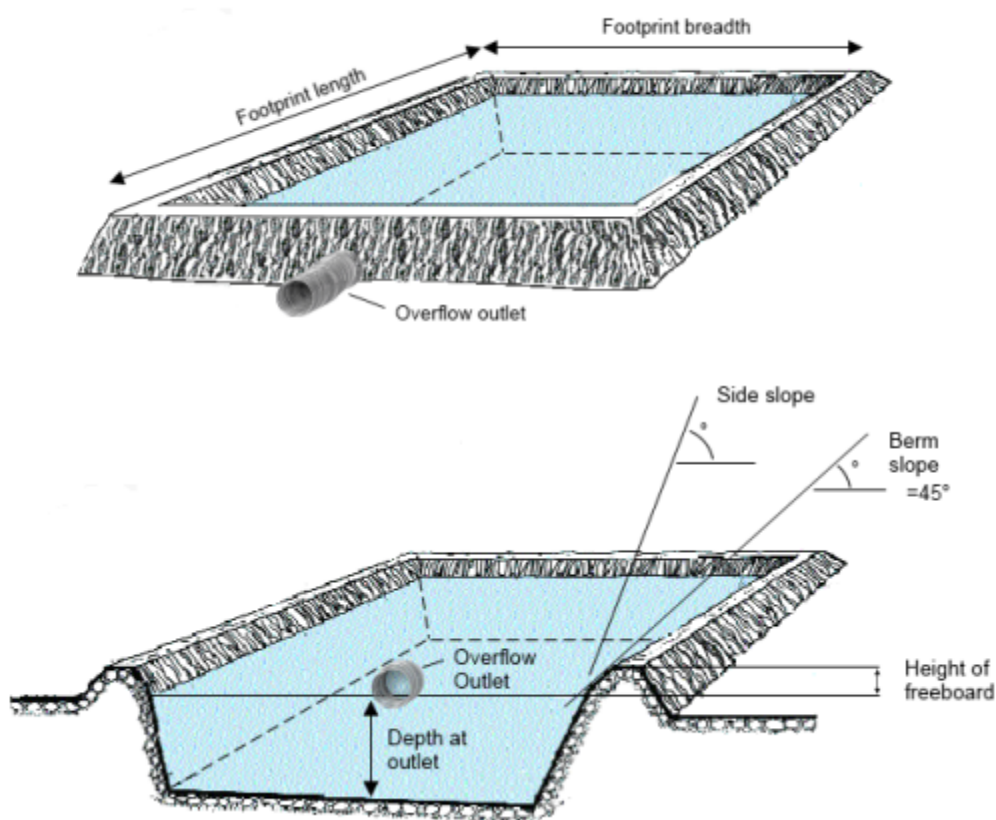
**Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:**

|                       | Concentration (mg/L)       | Load (kg/year)                       |
|-----------------------|----------------------------|--------------------------------------|
| Total Nitrogen        | 130.00 (0.00 - 130.00)     | 33148.47 (33148.44 - 33148.57)       |
| Total Phosphorus      | 30.00 (0.00 - 30.00)       | 7649.65 (7649.64 - 7649.67)          |
| Total Dissolved Salts | 813.00 (0.00 - 813.00)     | 207305.45 (207305.24 - 207306.06)    |
| Volatile Solids       | 20000.00 (0.00 - 20000.00) | 5099765.00 (5099760.00 - 5099780.00) |
| Total Solids          | 20813.00 (0.00 - 20813.00) | 5307070.45 (5307065.24 - 5307086.06) |

DESCRIPTION

**Pond system: 1 facultative, aerobic or storage pond****Pond system details:**

|                                    | Pond 1   |
|------------------------------------|----------|
| Maximum pond volume (m3)           | 25500.00 |
| Minimum allowable pond volume (m3) | 0.00     |
| Pond depth at overflow outlet (m)  | 1.20     |
| Maximum water surface area (m2)    | 21475.04 |
| Pond footprint length (m)          | 148.94   |
| Pond footprint width (m)           | 148.94   |
| Pond catchment area (m2)           | 22184.20 |
| Average active volume (m3)         | 6616.25  |

**Irrigation pump limits:**

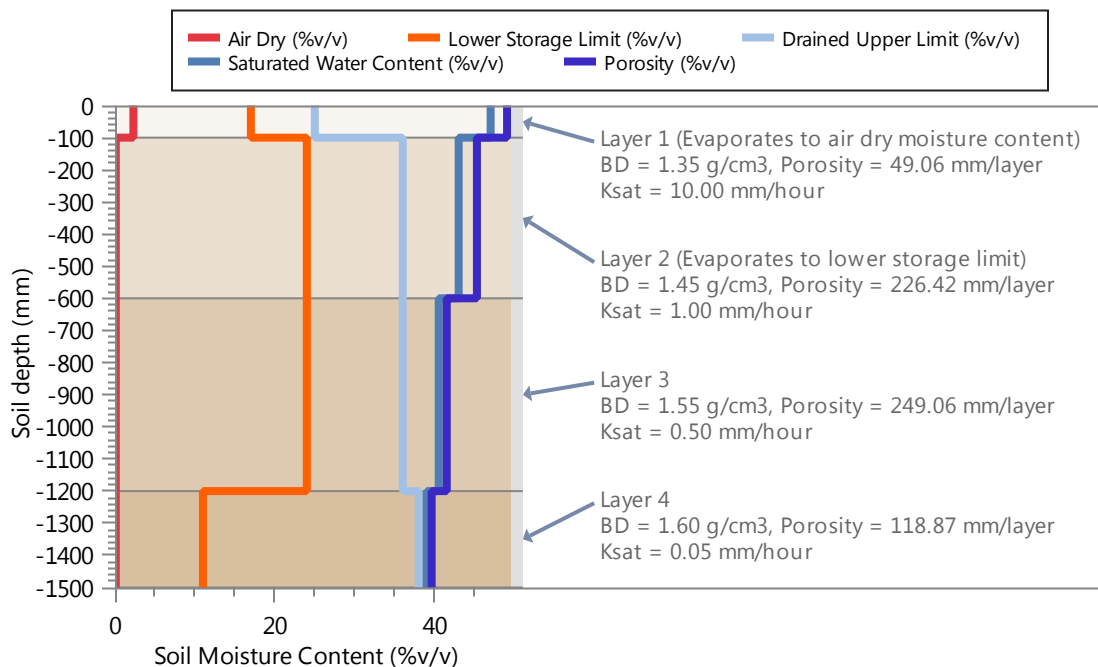
|                                  |       |
|----------------------------------|-------|
| Minimum pump rate limit (ML/day) | 0.00  |
| Maximum pump rate limit (ML/day) | 30.00 |

**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 |

**Land: Irrigated Pasture****Area (ha): 50.00****Soil Type: Grey Clay- low drainage**, 1500.00 mm defined profile depth

|                                                               |        |
|---------------------------------------------------------------|--------|
| Profile Porosity (mm)                                         | 643.40 |
| Profile saturation water content (mm)                         | 622.00 |
| Profile drained upper limit (or field capacity) (mm)          | 535.00 |
| Profile lower storage limit (or permanent wilting point) (mm) | 314.00 |
| Profile available water capacity (mm)                         | 221.00 |
| Profile limiting saturated hydraulic conductivity (mm/hour)   | 0.05   |
| 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 Rhodes Grass Pasture-tropical**

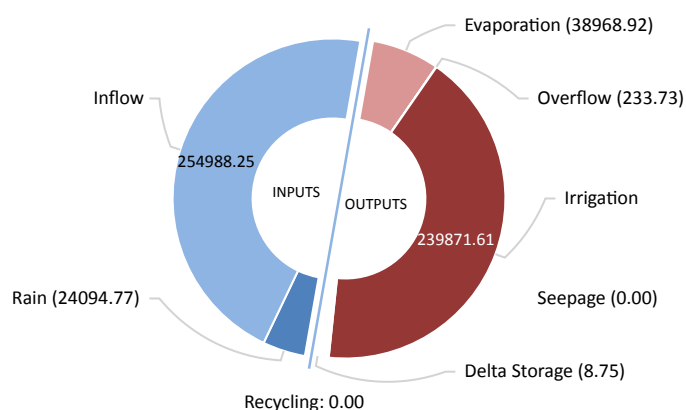
|                                                                                                |                    |
|------------------------------------------------------------------------------------------------|--------------------|
| Average monthly cover (fraction) (minimum - maximum)                                           | 0.64 (0.58 - 0.67) |
| Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.9 x Pan coefficient 0.9) | 0.81               |
| 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                                                                                 | Tolerant           |
| Salinity threshold EC sat. ext. (dS/m)                                                         | 7.00               |
| Proportion of yield decrease per dS/m increase (fraction/dS/m)                                 | 0.03               |

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## Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **25500 m3**

Pond System Water Balance (m3/year)

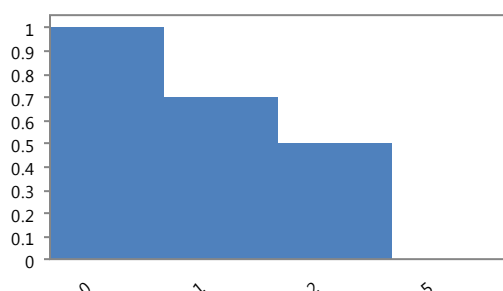


| Name          | Value     |
|---------------|-----------|
| Rain          | 24094.77  |
| Inflow        | 254988.25 |
| Recycling     | 0.00      |
| Evaporation   | 38968.92  |
| Overflow      | 233.73    |
| Irrigation    | 239871.61 |
| Seepage       | 0.00      |
| Delta Storage | 8.75      |

### Overflow Diagnostics

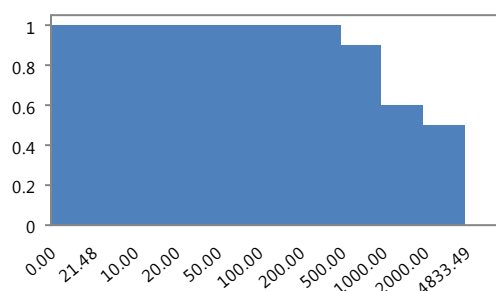
|                                                                                    |        |
|------------------------------------------------------------------------------------|--------|
| Volume of overflow (m3/year)                                                       | 233.73 |
| No. days pond overflows (days/year)                                                | 0.28   |
| Average duration of overflow (days)                                                | 2.80   |
| Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction) | 1.00   |
| Probability of at least 90% reuse (fraction)                                       | 1.00   |

No. overflow events (events/10 years)



Overflow event duration exceeded (days)

No. overflow events (events/10 years)

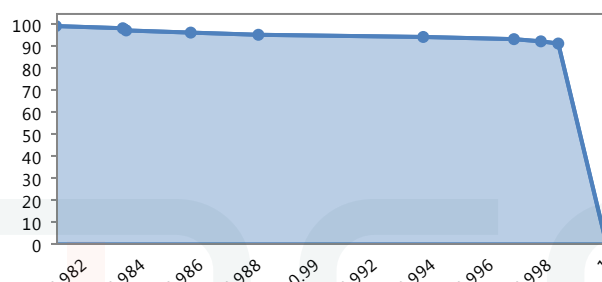


Overflow volume exceeded (m3)

[Export plot](#)

[Export plot](#)

Probability of exceedance (%)



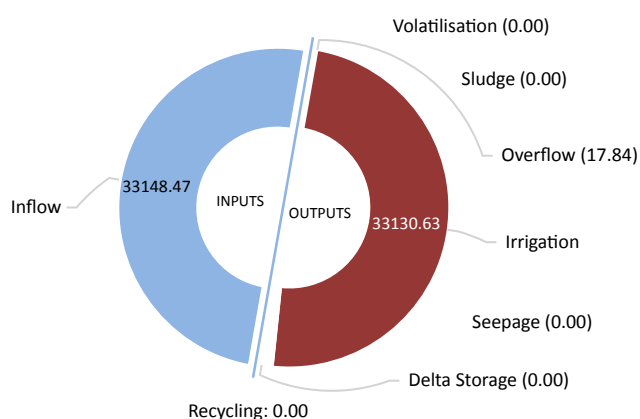
Annual reuse (fraction)

[Export plot](#)

## Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond

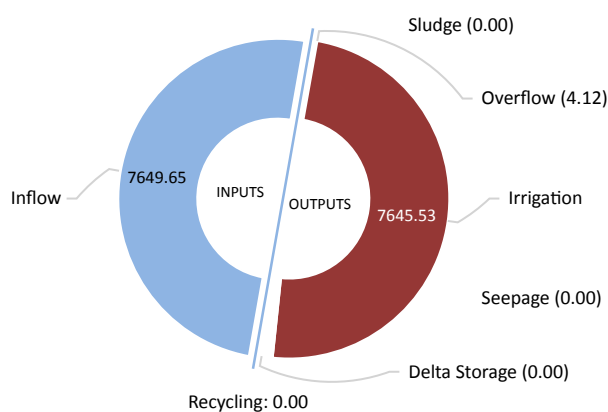
### Pond System Nutrients and Salt Balance:

#### Nitrogen Balance (kg/year)



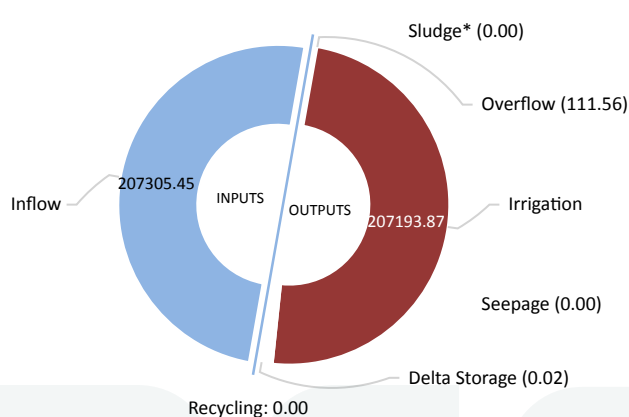
| Name           | Value    |
|----------------|----------|
| Inflow         | 33148.47 |
| Recycling      | 0.00     |
| Volatilisation | 0.00     |
| Sludge         | 0.00     |
| Overflow       | 17.84    |
| Irrigation     | 33130.63 |
| Seepage        | 0.00     |
| Delta Storage  | 0.00     |

#### Phosphorus Balance (kg/year)



| Name          | Value   |
|---------------|---------|
| Inflow        | 7649.65 |
| Recycling     | 0.00    |
| Sludge        | 0.00    |
| Overflow      | 4.12    |
| Irrigation    | 7645.53 |
| Seepage       | 0.00    |
| Delta Storage | 0.00    |

#### Salt Balance (kg/year)



| Name          | Value     |
|---------------|-----------|
| Inflow        | 207305.45 |
| Recycling     | 0.00      |
| Sludge*       | 0.00      |
| Overflow      | 111.56    |
| Irrigation    | 207193.87 |
| Seepage       | 0.00      |
| Delta Storage | 0.02      |

\* 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**



**Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond****Pond Nutrient Concentrations and Salinity:**

| Average across simulation period                       | Pond 1 |
|--------------------------------------------------------|--------|
| Average nitrogen concentration of pond liquid (mg/L)   | 137.23 |
| Average phosphorus concentration of pond liquid (mg/L) | 31.67  |
| Average salinity of pond liquid (dS/m)                 | 1.34   |

| Value on final day of simulation period              | Pond 1 |
|------------------------------------------------------|--------|
| Final nitrogen concentration of pond liquid (mg/L)   | 0.30   |
| Final phosphorus concentration of pond liquid (mg/L) | 0.07   |
| Final salinity of pond liquid (dS/m)                 | 0.00   |

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**Irrigation Performance:****Water Use: (assumes 100% Irrigation Efficiency)**

|                                                                                                                   |                    |
|-------------------------------------------------------------------------------------------------------------------|--------------------|
| Pond water irrigated (m3/year)                                                                                    | 239871.61          |
| Average Shandy water irrigation (m3/year) (minimum - maximum)                                                     | 0.00 (0.00 - 0.00) |
| Total water irrigated (m3/year)                                                                                   | 239871.61          |
| 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) | 138.12 |
| Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)  | 100.41 |
| Average phosphorus concentration of irrigation water (mg/L)                                       | 31.87  |
| Average salinity of irrigation water (dS/m)                                                       | 1.35   |

**Irrigation Diagnostics:**

|                                                  |      |
|--------------------------------------------------|------|
| Proportion Days Irrigation Turned Off (fraction) | 0.94 |
| Proportion of Days irrigation occurs (fraction)  | 0.06 |

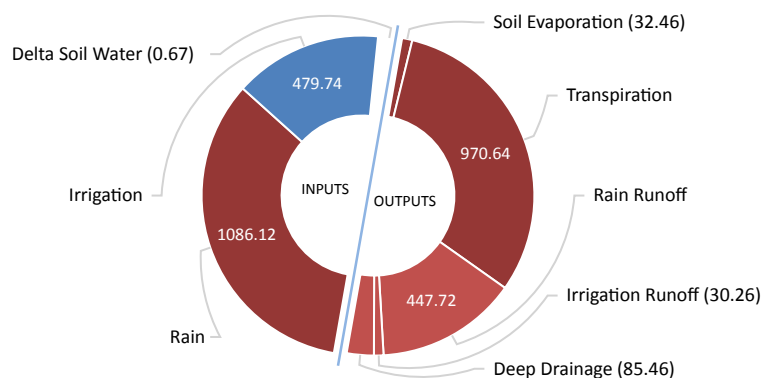
## Land Performance - Soil Water

Paddock: **Irrigated Pasture, 50 ha**

Soil Type: **Grey Clay- low drainage, 140.00 mm PAWC at maximum root depth**

Land Water Balance (mm/year):

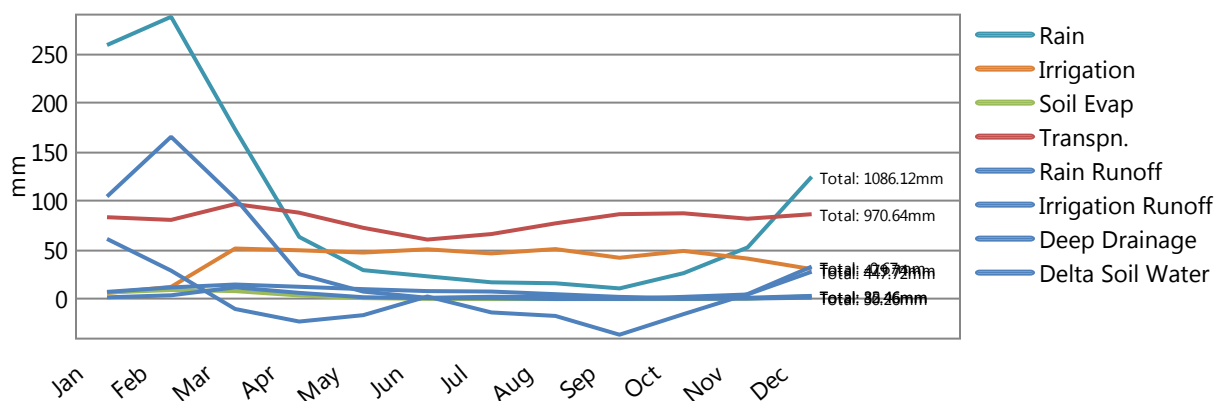
☒ mm/year ☐ % Total inputs



| Name              | Value   |
|-------------------|---------|
| Rain              | 1086.12 |
| Irrigation        | 479.74  |
| Soil Evaporation  | 32.46   |
| Transpiration     | 970.64  |
| Rain Runoff       | 447.72  |
| Irrigation Runoff | 30.26   |
| Deep Drainage     | 85.46   |
| Delta Soil Water  | -0.67   |

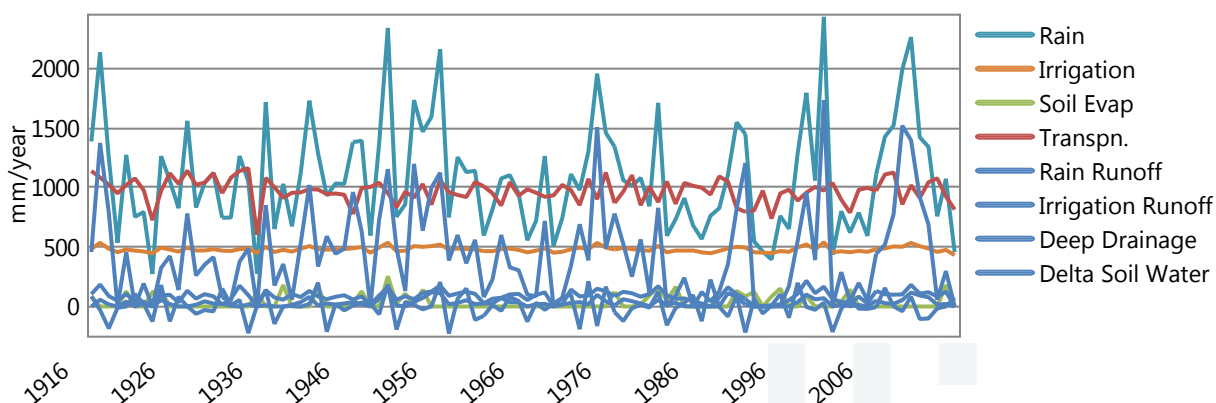
Average Monthly Totals (mm):

☒ Chart ☐ Table



Average Annual Totals (mm/year):

☒ Chart ☐ Table



Land Performance - Soil Nutrient

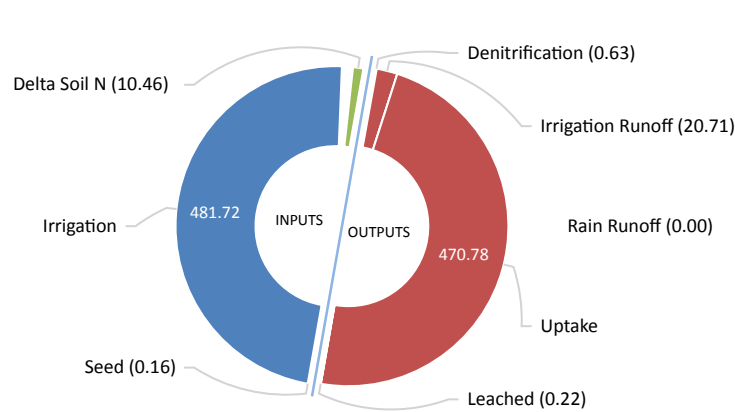
Paddock: Irrigated Pasture, 50 ha

Soil Type: Grey Clay- low drainage

Irrigation ammonium volatilisation losses (kg/ha/year): 180.89

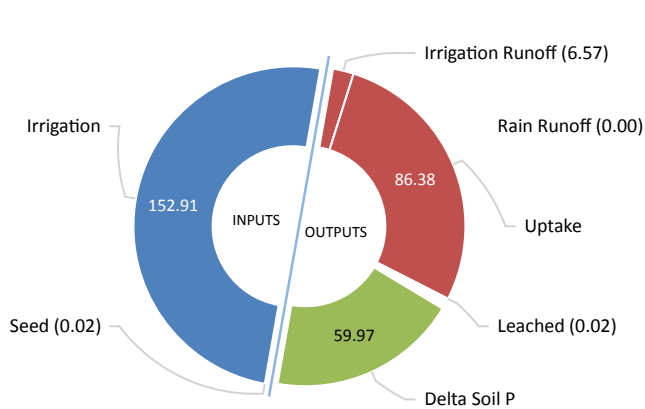
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.91

Land Nitrogen Balance (kg/ha/year)



| Name              | Value  |
|-------------------|--------|
| Seed              | 0.16   |
| Irrigation        | 481.72 |
| Denitrification   | 0.63   |
| Irrigation Runoff | 20.71  |
| Rain Runoff       | 0.00   |
| Uptake            | 470.78 |
| Leached           | 0.22   |
| Delta Soil N      | -10.46 |

Land Phosphorus Balance (kg/ha/year)



| Name              | Value  |
|-------------------|--------|
| Seed              | 0.02   |
| Irrigation        | 152.91 |
| Irrigation Runoff | 6.57   |
| Rain Runoff       | 0.00   |
| Uptake            | 86.38  |
| Leached           | 0.02   |
| Delta Soil P      | 59.97  |

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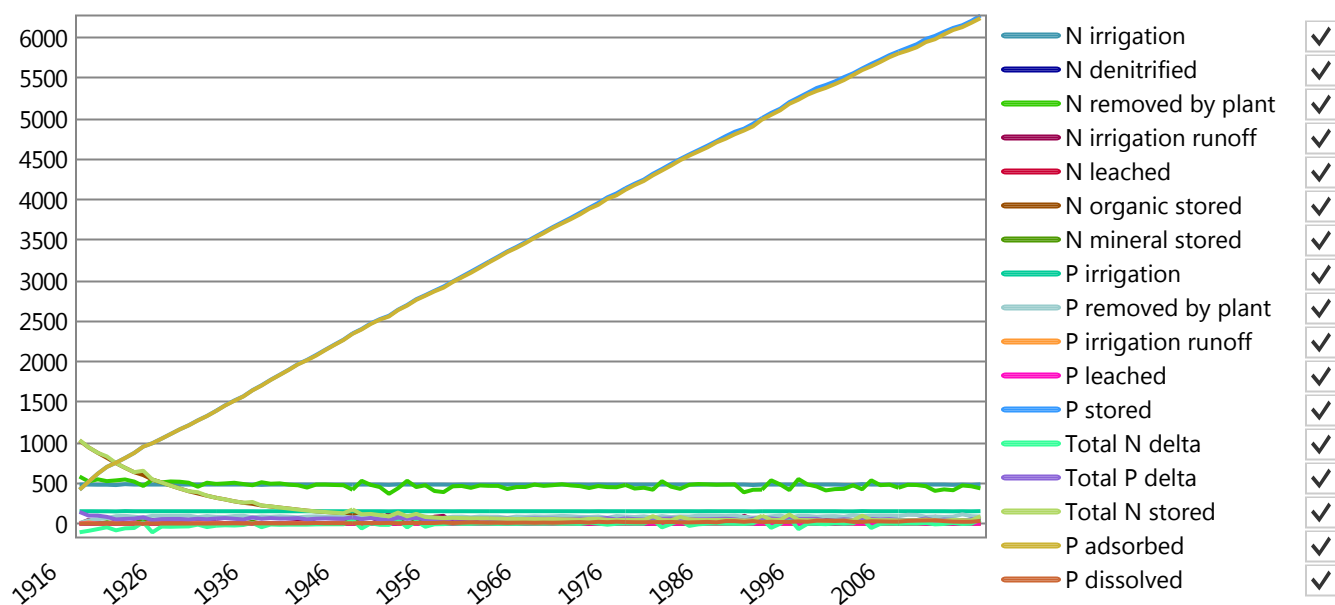


## Land Performance - Soil Nutrient

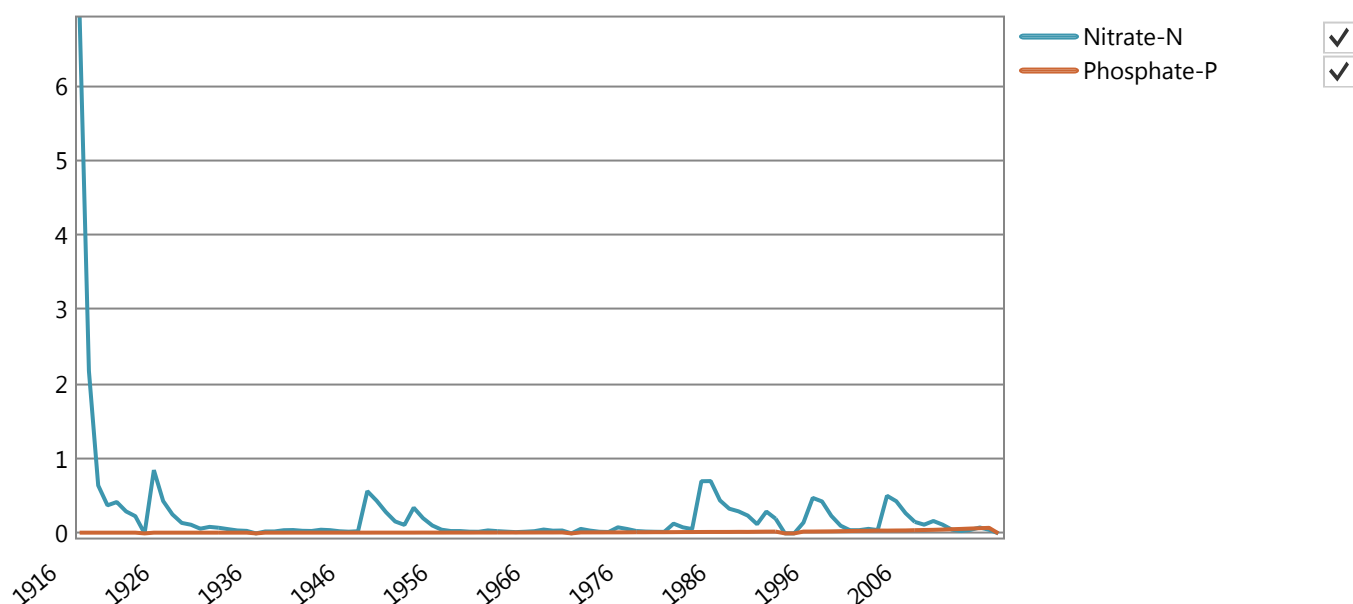
Paddock: Irrigated Pasture, 50 ha

Soil Type: Grey Clay- low drainage

## Annual Nutrient Totals (kg/ha):



## Annual Nutrient Leaching Concentration (mg/L):



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## Plant Performance and Nutrients

**Paddock:** Irrigated Pasture, 50 ha

**Soil Type:** Grey Clay- low drainage

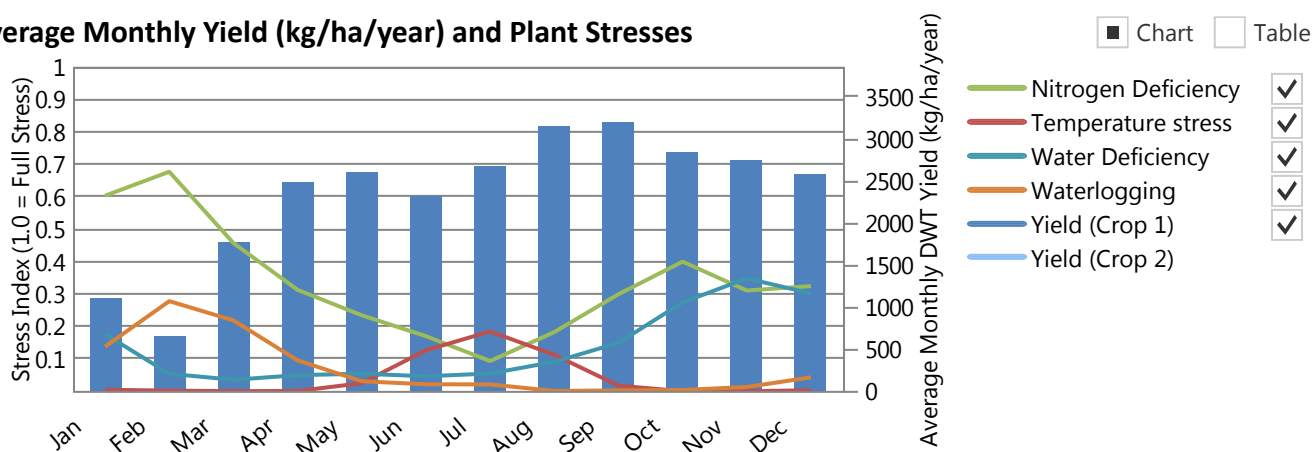
**Plant:** Continuous Rhodes Grass Pasture-tropical

|                                                                    |                                |
|--------------------------------------------------------------------|--------------------------------|
| Average annual shoot dry matter yield (kg/ha/year)                 | 28201.43 (22403.33 - 35313.29) |
| Average monthly plant (green) cover (fraction) (minimum - maximum) | 0.64 (0.58 - 0.67)             |
| Average monthly root depth (mm) (minimum - maximum)                | 1163.03 (1078.07 - 1200.00)    |

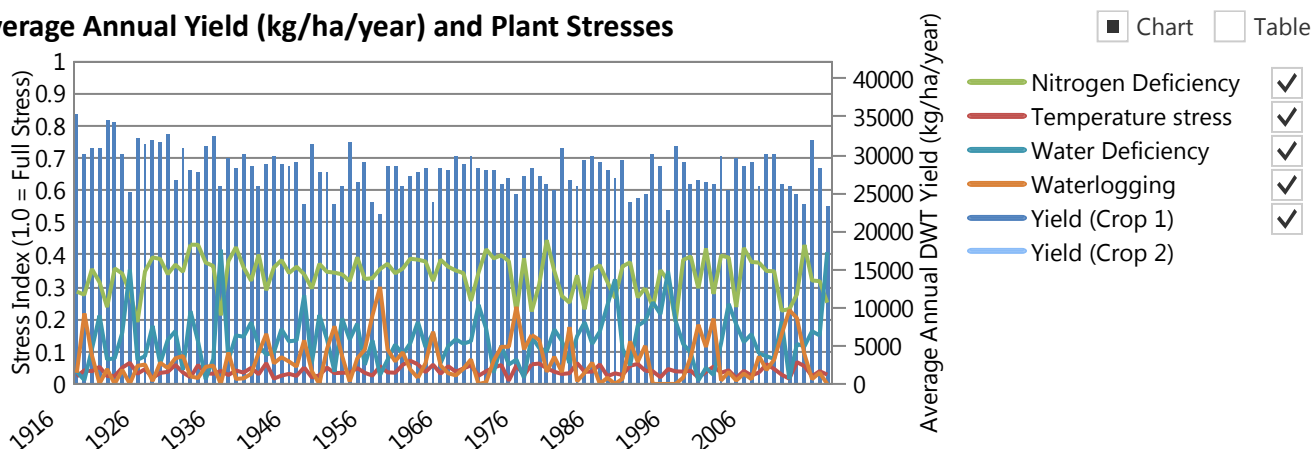
### Nutrient Uptake (minimum - maximum):

|                                                                    |                          |
|--------------------------------------------------------------------|--------------------------|
| Average annual net nitrogen removed by plant uptake (kg/ha/year)   | 470.78 (368.00 - 581.21) |
| Average annual net phosphorus removed by plant uptake (kg/ha/year) | 86.38 (8.52 - 115.00)    |
| Average annual shoot nitrogen concentration (fraction dwt)         | 0.02 (0.02 - 0.02)       |
| Average annual shoot phosphorus concentration (fraction dwt)       | 0.003 (0.000 - 0.004)    |

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



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



**No. of harvests/year:** 4.76 (normal), 0.26 (forced by crop death due to nitrogen stress (0.01), water stress (0.22), waterlogging (0.03))

**No. days without crop/year (days/year):** 2.39 due to water stress (2.11), waterlogging (0.28)

## Land Performance

**Paddock:** Irrigated Pasture, 50 ha

**Soil Type:** Grey Clay- low drainage

**Plant:** Continuous Rhodes Grass Pasture-tropical

|                                                                |          |
|----------------------------------------------------------------|----------|
| Salt tolerance                                                 | Tolerant |
| Salinity threshold EC sat. ext. (dS/m)                         | 7.00     |
| 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    |

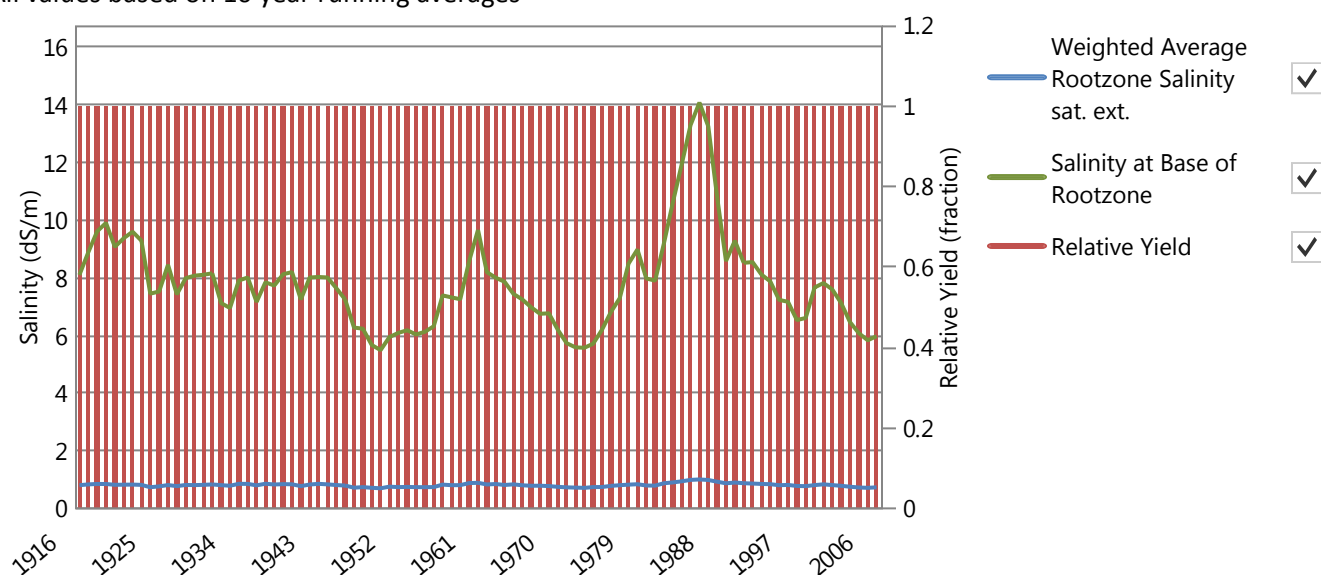
### Soil Salinity:

|                                                                                                                  |         |
|------------------------------------------------------------------------------------------------------------------|---------|
| Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)                                 | 0.59    |
| Salt added by rainfall (kg/ha/year)                                                                              | 122.57  |
| Average annual effluent salt added & leached at steady state (kg/ha/year)                                        | 4088.31 |
| Average leaching fraction based on 10 year running averages (fraction)                                           | 0.33    |
| Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)                                                 | 0.81    |
| Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)                                | 7.81    |
| 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



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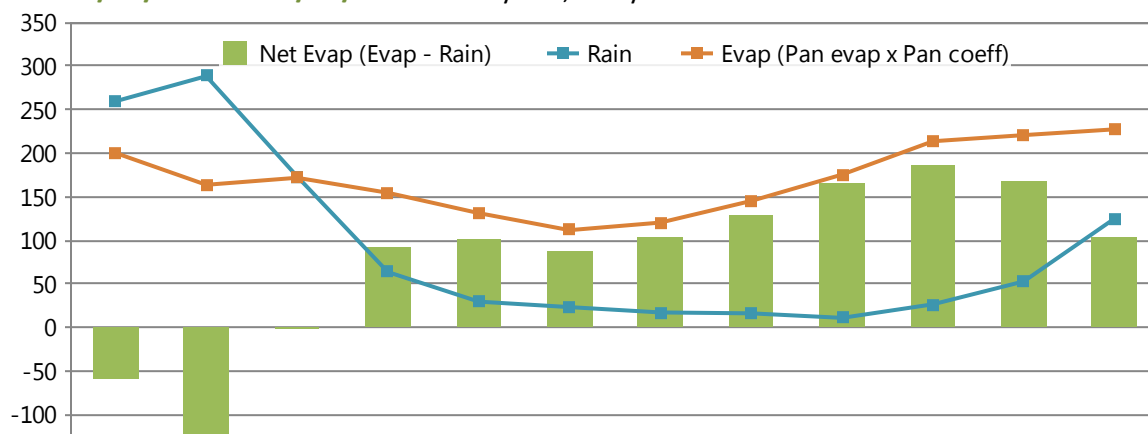


## Sustainability Diagnostics: JBS Townsville

### Averaged Historical Climate Data Used in Simulation (mm)

Location: **Stuart, -19.3°, 146.85°**

Run Period: **01/01/1916 to 31/12/2015** 100 years, 0 days



|              | Jan   | Feb    | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   | Year   |
|--------------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Rain         | 259.6 | 288.4  | 173.4 | 63.5  | 29.6  | 23.3  | 17.1  | 16.1  | 10.9  | 26.5  | 52.8  | 125.0 | 1086.1 |
| Evap         | 200.3 | 163.7  | 171.8 | 154.5 | 131.2 | 111.6 | 120.3 | 145.2 | 175.4 | 213.7 | 220.8 | 227.4 | 2035.9 |
| Net Evap     | -59.3 | -124.7 | -1.6  | 91.0  | 101.6 | 88.4  | 103.2 | 129.0 | 164.5 | 187.2 | 168.0 | 102.4 | 949.8  |
| Net Evap/day | -1.9  | -4.4   | -0.1  | 3.0   | 3.3   | 2.9   | 3.3   | 4.2   | 5.5   | 6.0   | 5.6   | 3.3   | 2.6    |

DIAGNOSTICS

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## Sustainability Diagnostics: JBS Townsville

**Pond System: 1 facultative, aerobic or storage pond**

**JBS Townsville - 254988.25 m3/year or 698.12 m3/day generated on average**

### Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 361.25 non-zero flow days, after any pretreatment and recycling.

| Constituent           | Concentration (mg/L)       | Load (kg/year)                       |
|-----------------------|----------------------------|--------------------------------------|
| Total Nitrogen        | 130.00 (0.00 - 130.00)     | 33148.47 (33148.44 - 33148.57)       |
| Total Phosphorus      | 30.00 (0.00 - 30.00)       | 7649.65 (7649.64 - 7649.67)          |
| Total Dissolved Salts | 813.00 (0.00 - 813.00)     | 207305.45 (207305.24 - 207306.06)    |
| Volatile Solids       | 20000.00 (0.00 - 20000.00) | 5099765.00 (5099760.00 - 5099780.00) |
| Total Solids          | 20813.00 (0.00 - 20813.00) | 5307070.45 (5307065.24 - 5307086.06) |

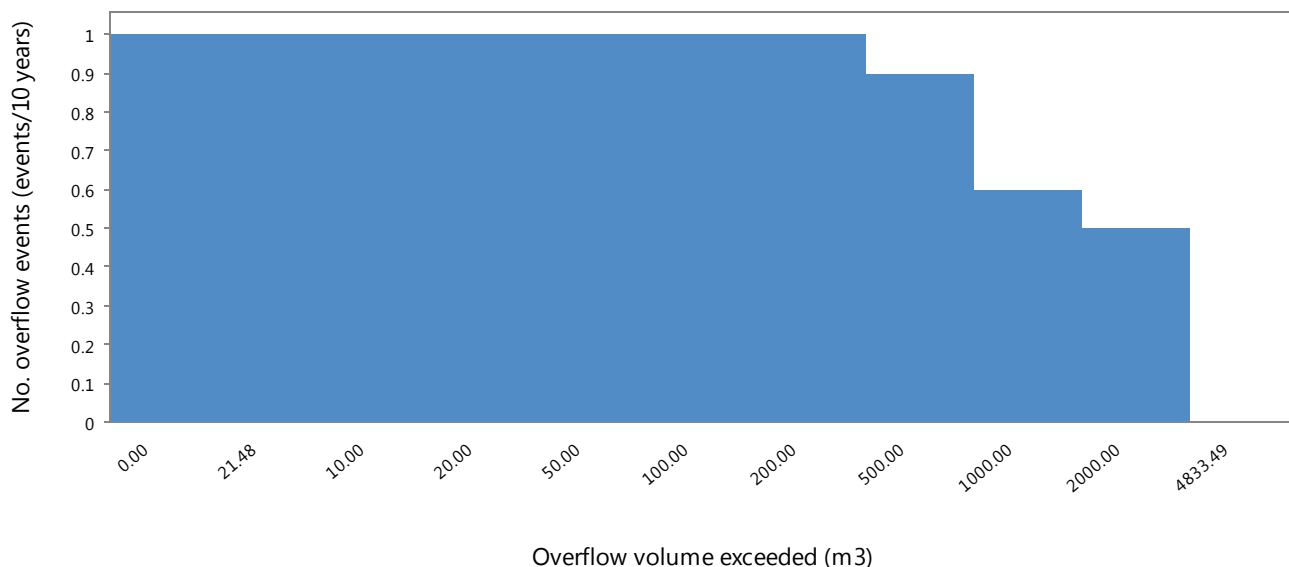
### Last pond (Wet weather store): 25500.00 m3

|                                                                                    |        |
|------------------------------------------------------------------------------------|--------|
| Theoretical hydraulic retention time (days)                                        | 36.53  |
| Average volume of overflow (m3/year)                                               | 233.73 |
| No. overflow events per year exceeding threshold* of 21.48 m3 (no./year)           | 0.10   |
| Average duration of overflow (days)                                                | 2.80   |
| 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)                                               | 1.34   |
| Salinity of last pond on final day of simulation (dS/m)                            | 0.00   |
| 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](#)



**Sustainability Diagnostics: JBS Townsville****Irrigation Information****Irrigation: 50 ha total area (assumed 100% irrigation efficiency)**

|                               | Quantity/year | Quantity/ha/year |
|-------------------------------|---------------|------------------|
| Total irrigation applied (m3) | 239871.61     | 4797.43          |
| Total nitrogen applied (kg)   | 24085.97      | 481.72           |
| Total phosphorus applied (kg) | 7645.53       | 152.91           |
| Total salts applied (kg)      | 207193.87     | 4143.88          |

**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 is turned off (fraction)               | 0.94 |
| Proportion of Days irrigation is prevented when triggered (fraction) | 0.01 |
| Proportion of Days irrigation occurs (fraction)                      | 0.06 |

## Sustainability Diagnostics: JBS Townsville

**Paddock Land: Irrigated Pasture: 50 ha**

**Irrigation: High Travelling Irrigator with 0.3% ammonium loss during irrigation**

|                                                                  |
|------------------------------------------------------------------|
| Irrigation triggered every 1 days                                |
| Irrigate a fixed amount of 55.00 mm each day                     |
| Irrigation window from 1/1 to 31/12 including the days specified |
| A minimum of 21 days must be skipped between irrigation events   |

**Soil Water Balance (mm): Grey Clay- low drainage, 140.00 mm PAWC at maximum root depth**

|             | Jan   | Feb   | Mar   | Apr   | May   | Jun  | Jul   | Aug   | Sep   | Oct   | Nov  | Dec   | Year   |
|-------------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|------|-------|--------|
| Rain        | 259.6 | 288.4 | 173.4 | 63.5  | 29.6  | 23.3 | 17.1  | 16.1  | 10.9  | 26.5  | 52.8 | 125.0 | 1086.1 |
| Irrigation  | 6.2   | 12.5  | 51.7  | 49.9  | 47.5  | 50.9 | 46.7  | 51.1  | 42.2  | 49.2  | 41.4 | 30.6  | 479.7  |
| Soil Evap   | 6.7   | 9.3   | 8.1   | 3.7   | 1.0   | 0.2  | 0.0   | 0.0   | 0.0   | 0.0   | 0.4  | 3.0   | 32.5   |
| Transpn.    | 83.6  | 80.9  | 97.1  | 88.3  | 72.8  | 60.8 | 66.4  | 77.4  | 86.8  | 87.7  | 82.1 | 86.7  | 970.6  |
| Rain Runoff | 104.8 | 165.8 | 103.1 | 25.4  | 7.6   | 1.3  | 2.4   | 2.0   | 0.3   | 2.3   | 4.7  | 28.0  | 447.7  |
| Irr. Runoff | 1.8   | 3.9   | 12.0  | 6.4   | 1.9   | 1.0  | 0.9   | 0.1   | 0.3   | 0.2   | 0.5  | 1.5   | 30.3   |
| Drainage    | 7.4   | 11.9  | 14.9  | 12.6  | 10.2  | 8.2  | 7.7   | 5.0   | 2.2   | 0.9   | 1.4  | 3.2   | 85.5   |
| Delta       | 61.5  | 29.1  | -10.1 | -23.0 | -16.4 | 2.7  | -13.6 | -17.2 | -36.4 | -15.4 | 5.1  | 33.2  | -0.7   |

### Soil Nitrogen Balance

|                                                                      |                 |
|----------------------------------------------------------------------|-----------------|
| Average annual effluent nitrogen added (kg/ha/year)                  | 481.72          |
| Average annual soil nitrogen removed by plant uptake (kg/ha/year)    | 470.78          |
| Average annual soil nitrogen removed by denitrification (kg/ha/year) | 0.63            |
| Average annual soil nitrogen leached (kg/ha/year)                    | 0.22            |
| Average annual nitrate-N loading to groundwater (kg/ha/year)         | 0.22            |
| Soil organic-N kg/ha (Initial - Final)                               | 1080.00 - 42.88 |
|                                                                      | 56.75 - 48.17   |
| Average nitrate-N concentration of deep drainage (mg/L)              | 0.26            |
| Max. annual nitrate-N concentration of deep drainage (mg/L)          | 6.92            |

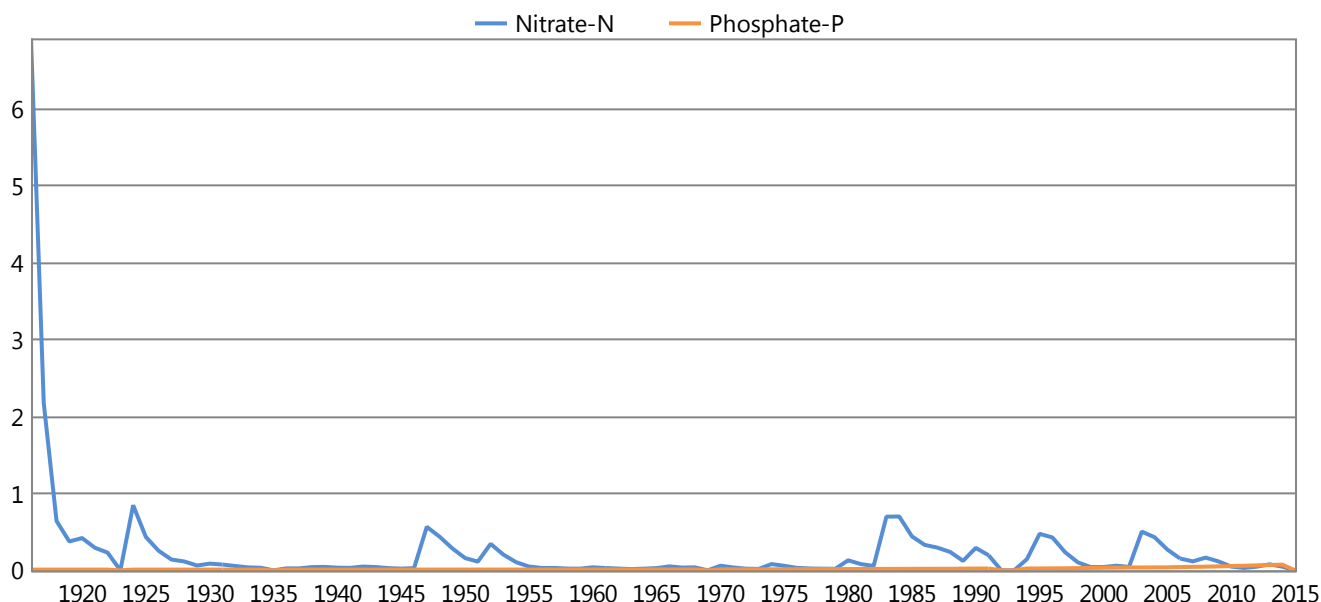
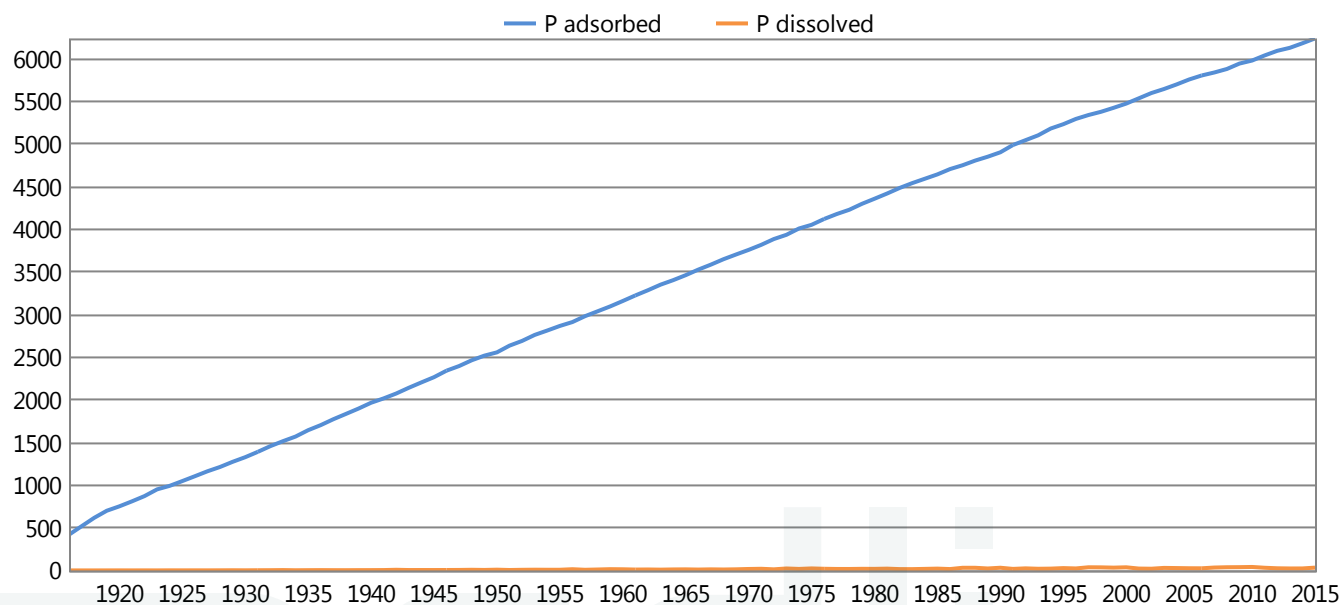
### Soil Phosphorus Balance

|                                                                                                             |                  |
|-------------------------------------------------------------------------------------------------------------|------------------|
| Average annual effluent phosphorus added (kg/ha/year)                                                       | 152.91           |
| Average annual soil phosphorus removed by plant uptake (kg/ha/year)                                         | 86.38            |
| Average annual soil phosphorus leached (kg/ha/year)                                                         | 0.02             |
| Dissolved phosphorus (kg/ha) (Initial - Final)                                                              | 0.05 - 32.93     |
| Adsorbed phosphorus (kg/ha) (Initial - Final)                                                               | 274.67 - 6238.34 |
| Average phosphate-P concentration in rootzone (mg/L)                                                        | 3.77             |
| Average phosphate-P concentration of deep drainage (mg/L)                                                   | 0.02             |
| Max. annual phosphate-P concentration of deep drainage (mg/L)                                               | 0.07             |
| Design soil profile storage life based on average infiltrated water phosphorus concn. of 13.45 mg/L (years) | 60.09            |



**Sustainability Diagnostics: JBS Townsville****Paddock Land: Irrigated Pasture: 50 ha****Irrigation: High Travelling Irrigator with 0.3% ammonium loss during irrigation**

## DIAGNOSTICS

**Annual nutrient leachate concentration (mg/L)****Annual Phosphate-P in soil (kg/ha)**

## Sustainability Diagnostics: JBS Townsville

### Paddock Plant Performance: Irrigated Pasture: 50 ha

#### Average Plant Performance (Minimum - Maximum): Continuous Rhodes Grass Pasture-tropical

|                                                                                         |                                |
|-----------------------------------------------------------------------------------------|--------------------------------|
| Average annual shoot dry matter yield (kg/ha/year)                                      | 28201.43 (22403.33 - 35313.29) |
| Average monthly plant (green) cover (fraction)                                          | 0.64 (0.58 - 0.67)             |
| Average monthly crop factor (fraction)                                                  | 0.52 (0.47 - 0.55)             |
| Total plant cover (both green and dead) left after harvest (fraction)                   | 1.00                           |
| Average monthly root depth (mm)                                                         | 1163.03 (1078.07 - 1200.00)    |
| Average number of normal harvests per year (no./year)                                   | 4.76 (3.00 - 6.00)             |
| Average number of normal harvests for last five years only (no./year)                   | 4.40                           |
| Average number of crop deaths per year (no./year)                                       | 0.26 (0.00 - 1.00)             |
| Average number of crop deaths for last five years only (no./year)                       | 0.20                           |
| Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient) | 0.34 (0.19 - 0.45)             |
| Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient) | 0.00 (0.00 - 0.04)             |
| Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)    | 0.18 (0.01 - 0.37)             |
| Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)       | 0.14 (0.04 - 0.35)             |
| Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)       | 0.07 (0.00 - 0.28)             |
| No. days without crop/year (days)                                                       | 2.39                           |

#### Soil Salinity - Plant salinity tolerance: 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)                                 | 0.59    |
| Salt added by rainfall (kg/ha/year)                                                                              | 122.57  |
| Average annual effluent salt added & leached at steady state (kg/ha/year)                                        | 4088.31 |
| Average leaching fraction based on 10 year running averages (fraction)                                           | 0.33    |
| Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)                                                 | 0.81    |
| Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)                                | 7.81    |
| 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    |



## Run Messages

### Messages generated when the scenario was run:

WARNING: Irrigation water salinity exceeds 10 dS/m. Leaf scorching and yield reduction likely. Careful irrigation management needed.

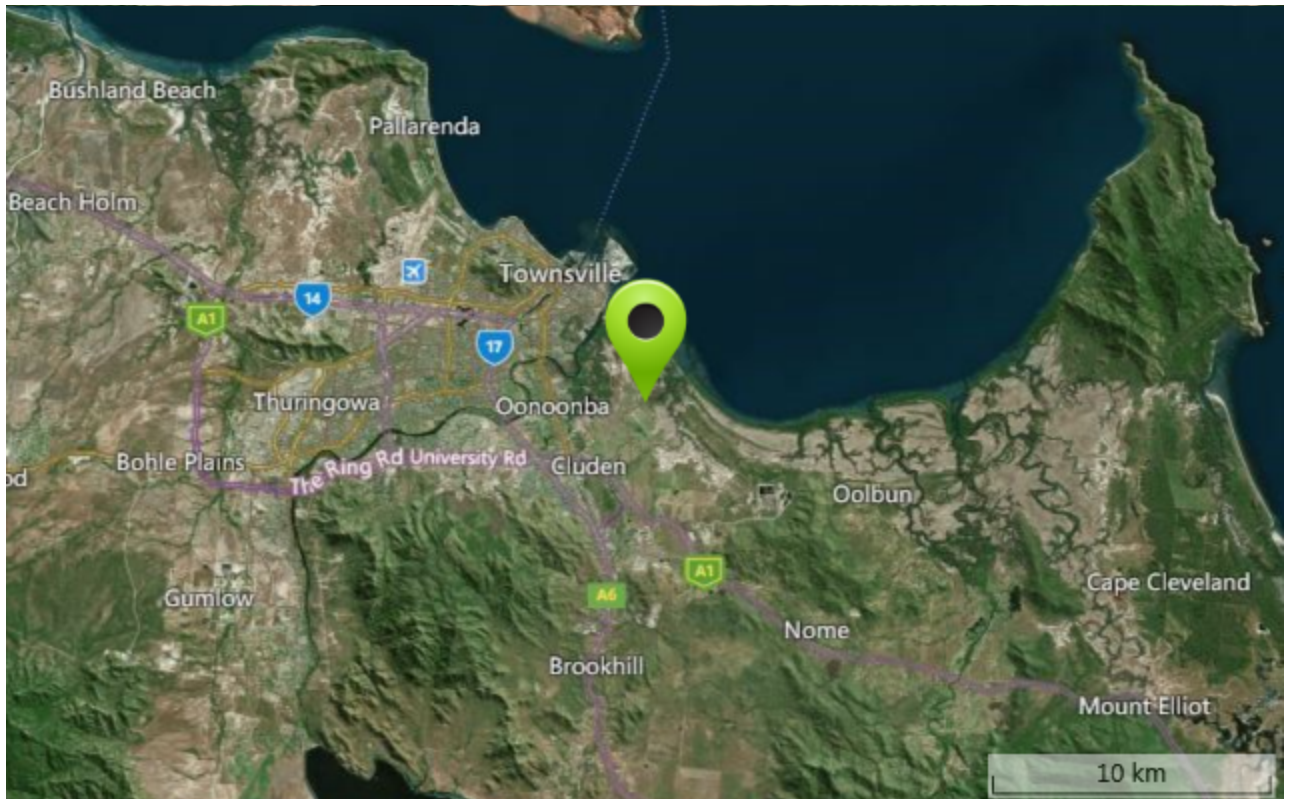
Full run chosen





**Enterprise: JBS Townsville****Description:**

Nutrient Loading To Irrigated Land

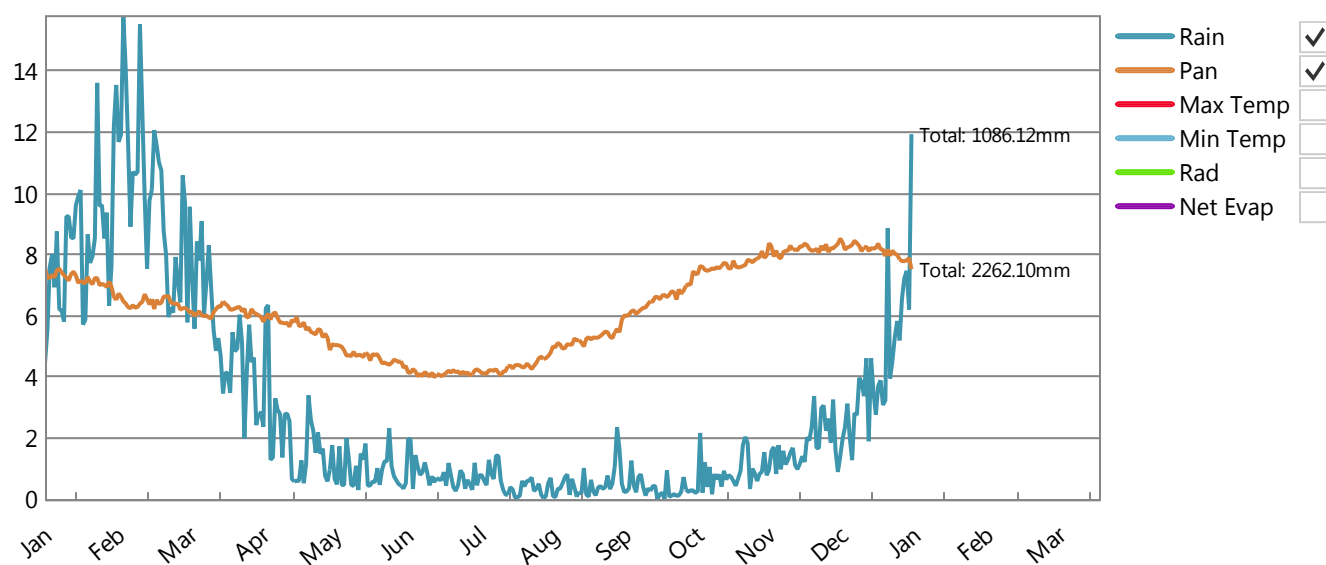
**Client: JBS****MEDLI User:** Bio-Track P/L**Scenario Details:**

MEDLI REPORT - FULL RUN

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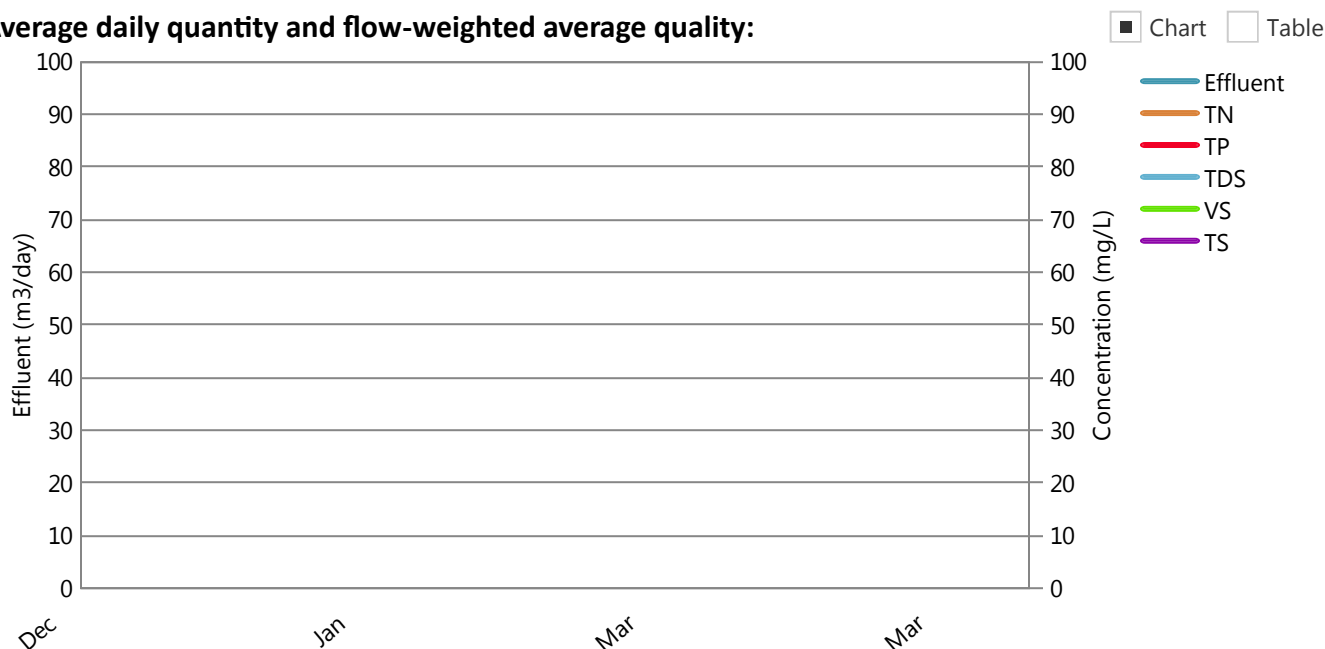
**Climate Data: Stuart, -19.3°, 146.85°****Run Period: 01/01/1916 to 31/12/2015** 100 years, 0 days**Climate Statistics:**

|                           | 5th ▾ | Percentile | 50th Percentile | 95th ▾ | Percentile |
|---------------------------|-------|------------|-----------------|--------|------------|
| Rainfall (mm/year)        |       | 459        | 1053            |        | 2062       |
| Pan Evaporation (mm/year) |       | 2019       | 2261            |        | 2456       |

**Climate Data:**☒ Chart ☐ Table☐ Monthly ☒ Daily**Daily Average Across Run Period**

DESCRIPTION

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**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:** 0.00 m3/year or 0.00 m3/day (Min-Max: 0.00 - 0.00)**Flow-weighted average (minimum - maximum) daily effluent quality entering pond system:**

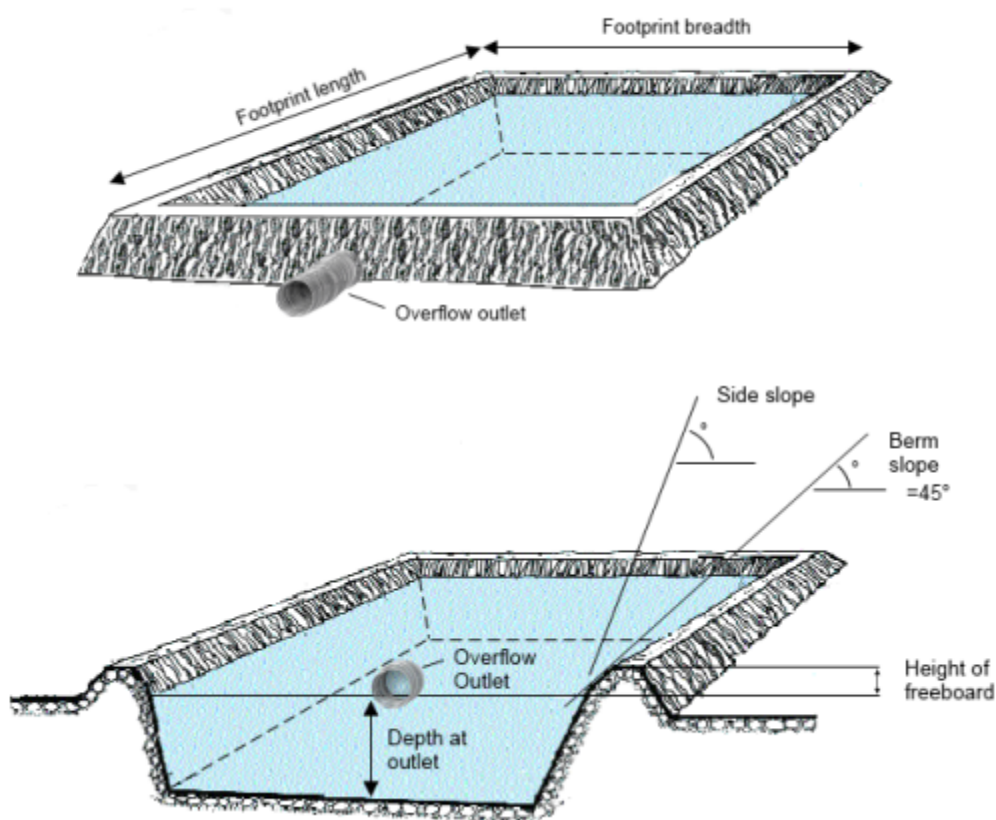
|                       | Concentration (mg/L) | Load (kg/year)     |
|-----------------------|----------------------|--------------------|
| Total Nitrogen        | 0.00 (0.00 - 0.00)   | 0.00 (0.00 - 0.00) |
| Total Phosphorus      | 0.00 (0.00 - 0.00)   | 0.00 (0.00 - 0.00) |
| Total Dissolved Salts | 0.00 (0.00 - 0.00)   | 0.00 (0.00 - 0.00) |
| 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

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**Pond system: 1 facultative, aerobic or storage pond****Pond system details:**

|                                    | Pond 1   |
|------------------------------------|----------|
| Maximum pond volume (m3)           | 25500.00 |
| Minimum allowable pond volume (m3) | 0.00     |
| Pond depth at overflow outlet (m)  | 1.20     |
| Maximum water surface area (m2)    | 21475.04 |
| Pond footprint length (m)          | 146.54   |
| Pond footprint width (m)           | 146.54   |
| Pond catchment area (m2)           | 21475.04 |
| Average active volume (m3)         | 3947.21  |

**Irrigation pump limits:**

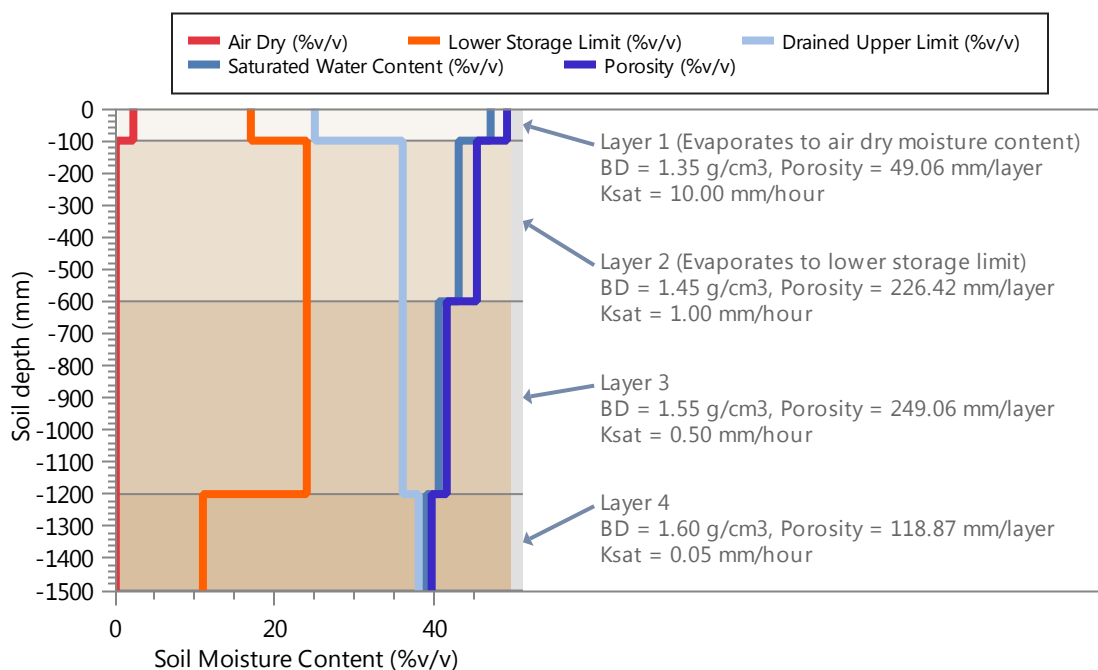
|                                  |       |
|----------------------------------|-------|
| Minimum pump rate limit (ML/day) | 0.00  |
| Maximum pump rate limit (ML/day) | 30.00 |

**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 |

**Land: Irrigated Pasture****Area (ha): 50.00****Soil Type: Grey Clay- low drainage, 1500.00 mm defined profile depth**

|                                                               |        |
|---------------------------------------------------------------|--------|
| Profile Porosity (mm)                                         | 643.40 |
| Profile saturation water content (mm)                         | 622.00 |
| Profile drained upper limit (or field capacity) (mm)          | 535.00 |
| Profile lower storage limit (or permanent wilting point) (mm) | 314.00 |
| Profile available water capacity (mm)                         | 221.00 |
| Profile limiting saturated hydraulic conductivity (mm/hour)   | 0.05   |
| 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 Rhodes Grass Pasture-tropical**

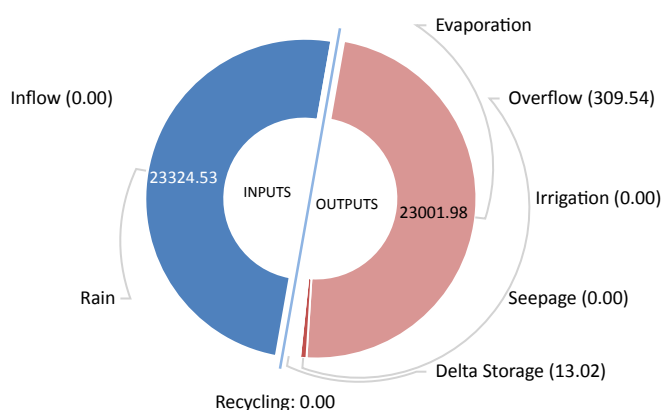
|                                                                                                |                    |
|------------------------------------------------------------------------------------------------|--------------------|
| Average monthly cover (fraction) (minimum - maximum)                                           | 0.03 (0.03 - 0.04) |
| Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.9 x Pan coefficient 0.9) | 0.81               |
| Total plant cover (both green and dead) left after harvest (fraction)                          | 1.00               |
| Maximum potential root depth in defined soil profile (mm)                                      | 400.67             |
| Salt tolerance                                                                                 | Tolerant           |
| Salinity threshold EC sat. ext. (dS/m)                                                         | 7.00               |
| Proportion of yield decrease per dS/m increase (fraction/dS/m)                                 | 0.03               |

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## Pond System Water Performance - Overflow: 1 facultative, aerobic or storage pond

Capacity of wet weather storage pond: **25500 m3**

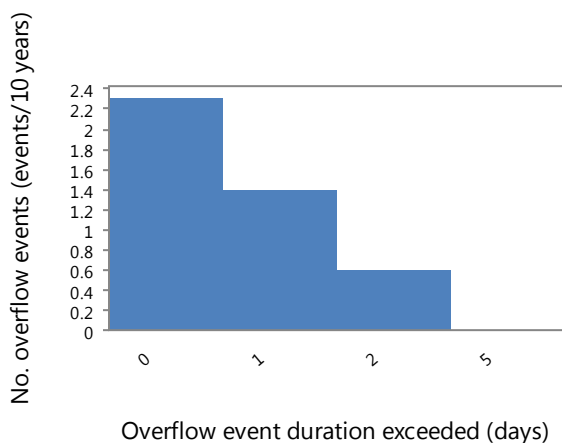
Pond System Water Balance (m3/year)



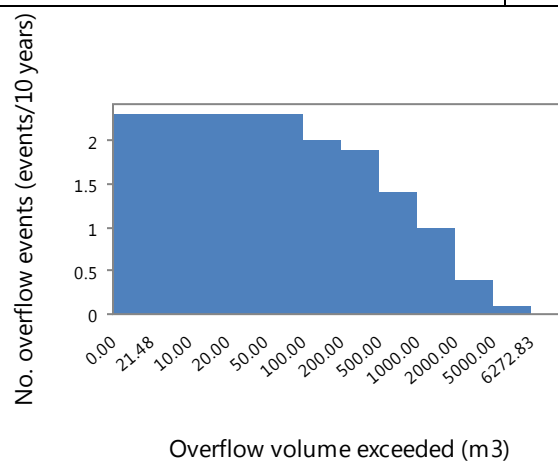
| Name          | Value    |
|---------------|----------|
| Rain          | 23324.53 |
| Inflow        | 0.00     |
| Recycling     | 0.00     |
| Evaporation   | 23001.98 |
| Overflow      | 309.54   |
| Irrigation    | 0.00     |
| Seepage       | 0.00     |
| Delta Storage | 13.02    |

### Overflow Diagnostics

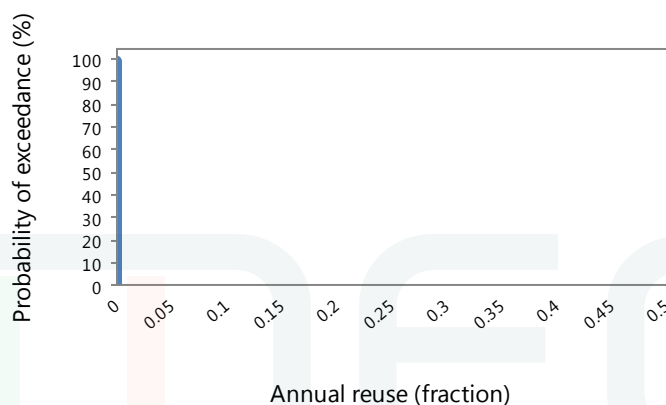
|                                                                                    |        |
|------------------------------------------------------------------------------------|--------|
| Volume of overflow (m3/year)                                                       | 309.54 |
| No. days pond overflows (days/year)                                                | 0.48   |
| Average duration of overflow (days)                                                | 2.09   |
| Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction) | 0.00   |
| Probability of at least 90% reuse (fraction)                                       | 0.00   |



[Export plot](#)



[Export plot](#)



[Export plot](#)

**Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond****Pond System Nutrients and Salt Balance:****Nitrogen Balance (kg/year)**

(no data available)

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

**Phosphorus Balance (kg/year)**

(no data available)

| Name          | Value |
|---------------|-------|
| Inflow        | 0.00  |
| Recycling     | 0.00  |
| Sludge        | 0.00  |
| Overflow      | 0.00  |
| Irrigation    | 0.00  |
| Seepage       | 0.00  |
| Delta Storage | 0.00  |

**Salt Balance (kg/year)**

(no data available)

| Name          | Value |
|---------------|-------|
| Inflow        | 0.00  |
| Recycling     | 0.00  |
| Sludge*       | 0.00  |
| Overflow      | 0.00  |
| Irrigation    | 0.00  |
| 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**

**Pond System Performance - Nutrient: 1 facultative, aerobic or storage pond****Pond Nutrient Concentrations and Salinity:**

| Average across simulation period                       | Pond 1 |
|--------------------------------------------------------|--------|
| Average nitrogen concentration of pond liquid (mg/L)   | 0.00   |
| Average phosphorus concentration of pond liquid (mg/L) | 0.00   |
| Average salinity of pond liquid (dS/m)                 | 0.00   |

| Value on final day of simulation period              | Pond 1 |
|------------------------------------------------------|--------|
| Final nitrogen concentration of pond liquid (mg/L)   | 0.00   |
| Final phosphorus concentration of pond liquid (mg/L) | 0.00   |
| Final salinity of pond liquid (dS/m)                 | 0.00   |

PERFORMANCE

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**Irrigation Performance:****Water Use: (assumes 100% Irrigation Efficiency)**

|                                                                                                                   |                    |
|-------------------------------------------------------------------------------------------------------------------|--------------------|
| Pond water irrigated (m3/year)                                                                                    | 0.00               |
| Average Shandy water irrigation (m3/year) (minimum - maximum)                                                     | 0.00 (0.00 - 0.00) |
| Total water irrigated (m3/year)                                                                                   | 0.00               |
| 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) | 0.00 |
| Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)  | 0.00 |
| Average phosphorus concentration of irrigation water (mg/L)                                       | 0.00 |
| Average salinity of irrigation water (dS/m)                                                       | 0.00 |

**Irrigation Diagnostics (No effluent irrigation occurred!):**

|                                                  |                             |
|--------------------------------------------------|-----------------------------|
| Proportion Days Irrigation Turned Off (fraction) | 1.00 (Hence no irrigation!) |
| Proportion of Days irrigation occurs (fraction)  | 0.00                        |

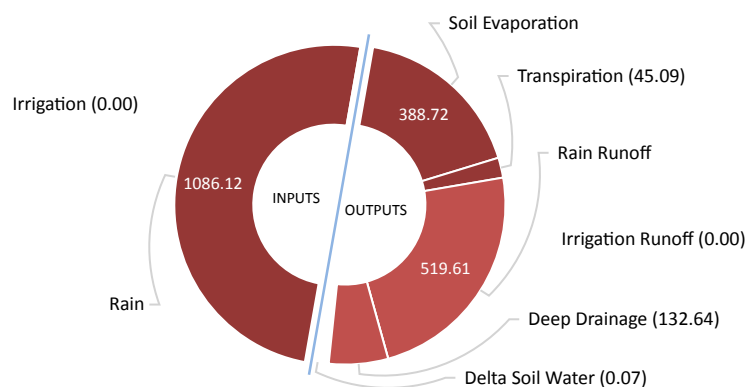
## Land Performance - Soil Water

**Paddock:** Irrigated Pasture, 50 ha

**Soil Type:** Grey Clay- low drainage, 44.08 mm PAWC at maximum root depth

**Land Water Balance (mm/year):**

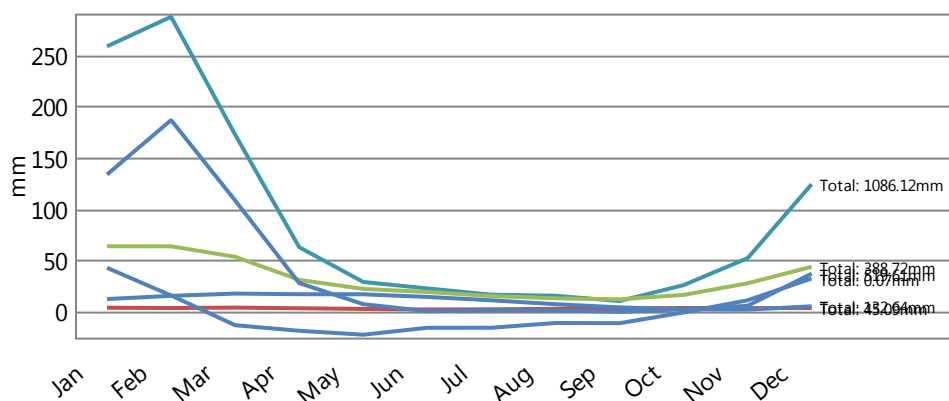
■ mm/year □ % Total inputs



| Name              | Value   |
|-------------------|---------|
| Rain              | 1086.12 |
| Irrigation        | 0.00    |
| Soil Evaporation  | 388.72  |
| Transpiration     | 45.09   |
| Rain Runoff       | 519.61  |
| Irrigation Runoff | 0.00    |
| Deep Drainage     | 132.64  |
| Delta Soil Water  | 0.07    |

**Average Monthly Totals (mm):**

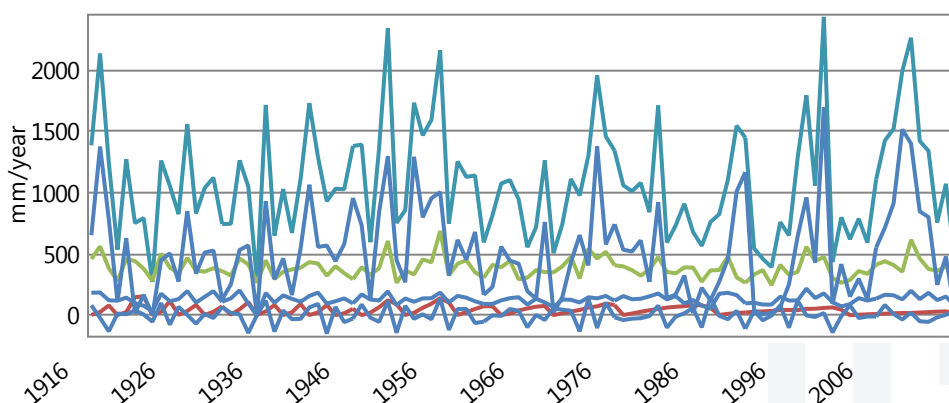
■ Chart □ Table



|                   |   |
|-------------------|---|
| Rain              | ✓ |
| Irrigation        |   |
| Soil Evap         | ✓ |
| Transpn.          | ✓ |
| Rain Runoff       | ✓ |
| Irrigation Runoff |   |
| Deep Drainage     | ✓ |
| Delta Soil Water  | ✓ |

**Average Annual Totals (mm/year):**

■ Chart □ Table



|                   |   |
|-------------------|---|
| Rain              | ✓ |
| Irrigation        |   |
| Soil Evap         | ✓ |
| Transpn.          | ✓ |
| Rain Runoff       | ✓ |
| Irrigation Runoff |   |
| Deep Drainage     | ✓ |
| Delta Soil Water  | ✓ |

## Land Performance - Soil Nutrient

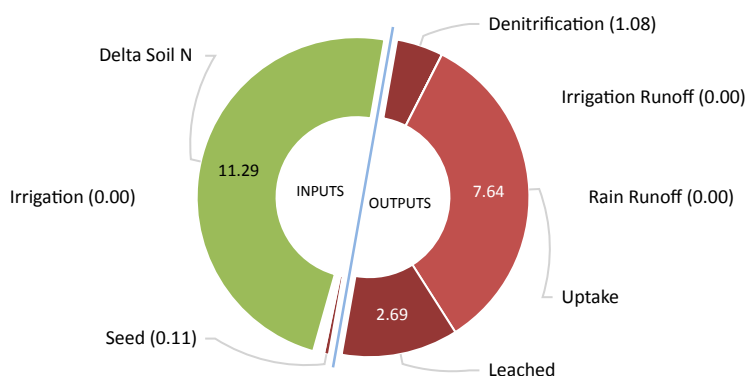
Paddock: **Irrigated Pasture, 50 ha**

Soil Type: **Grey Clay- low drainage**

Irrigation ammonium volatilisation losses (kg/ha/year): 0.00

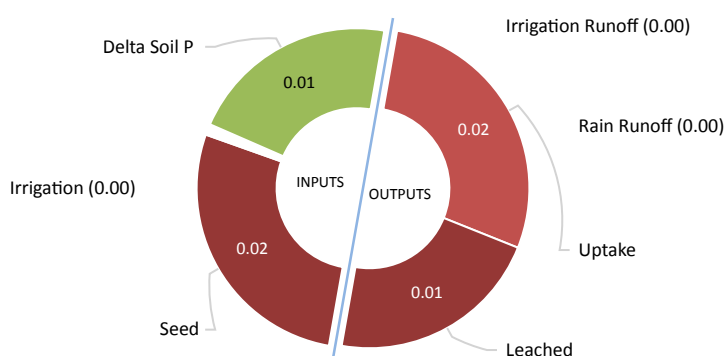
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.91

### Land Nitrogen Balance (kg/ha/year)



| Name              | Value  |
|-------------------|--------|
| Seed              | 0.11   |
| Irrigation        | 0.00   |
| Denitrification   | 1.08   |
| Irrigation Runoff | 0.00   |
| Rain Runoff       | 0.00   |
| Uptake            | 7.64   |
| Leached           | 2.69   |
| Delta Soil N      | -11.29 |

### Land Phosphorus Balance (kg/ha/year)



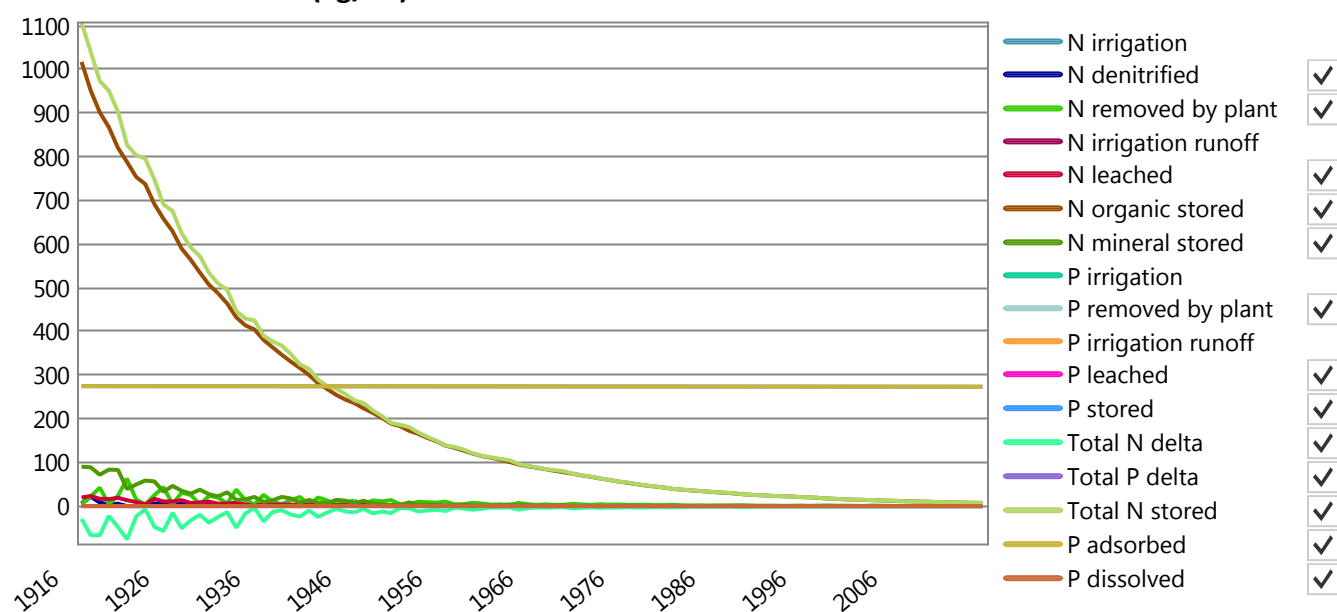
| Name              | Value |
|-------------------|-------|
| Seed              | 0.02  |
| Irrigation        | 0.00  |
| Irrigation Runoff | 0.00  |
| Rain Runoff       | 0.00  |
| Uptake            | 0.02  |
| Leached           | 0.01  |
| Delta Soil P      | -0.01 |

## Land Performance - Soil Nutrient

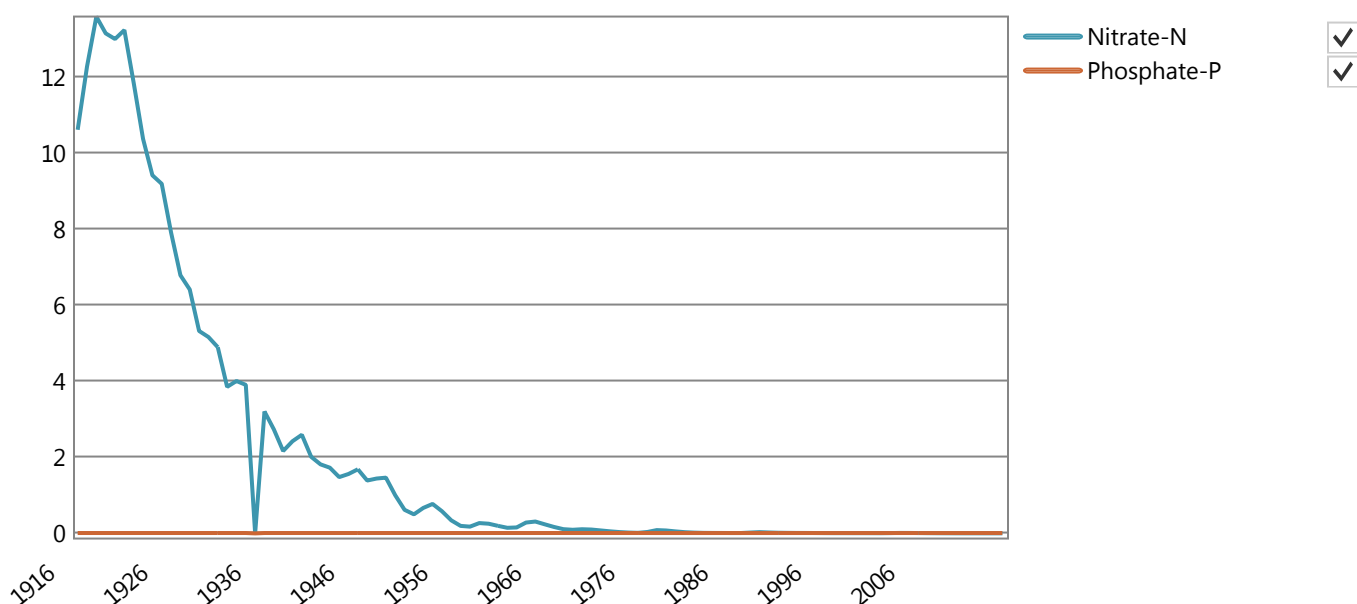
Paddock: Irrigated Pasture, 50 ha

Soil Type: Grey Clay- low drainage

## Annual Nutrient Totals (kg/ha):



## Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

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## Plant Performance and Nutrients

**Paddock:** Irrigated Pasture, 50 ha

**Soil Type:** Grey Clay- low drainage

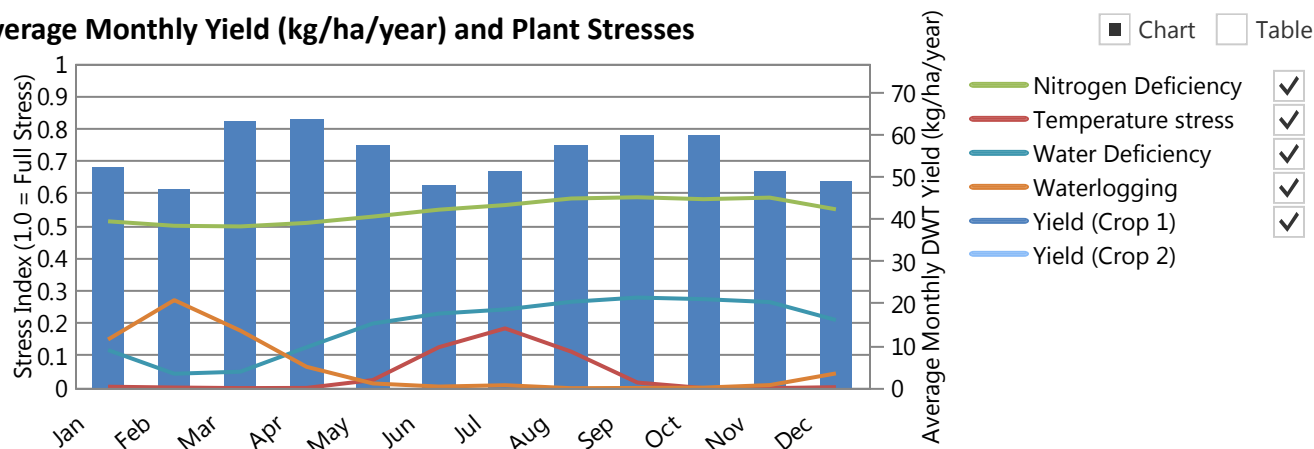
**Plant:** Continuous Rhodes Grass Pasture-tropical

|                                                                    |                          |
|--------------------------------------------------------------------|--------------------------|
| Average annual shoot dry matter yield (kg/ha/year)                 | 667.75 (39.09 - 5557.82) |
| Average monthly plant (green) cover (fraction) (minimum - maximum) | 0.03 (0.03 - 0.04)       |
| Average monthly root depth (mm) (minimum - maximum)                | 133.27 (122.28 - 139.59) |

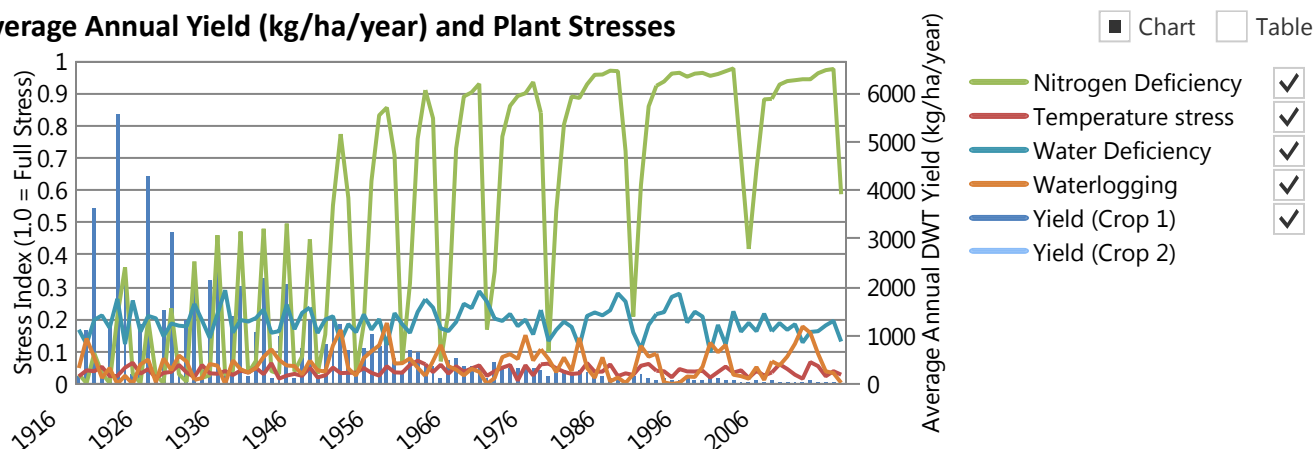
### Nutrient Uptake (minimum - maximum):

|                                                                    |                       |
|--------------------------------------------------------------------|-----------------------|
| Average annual net nitrogen removed by plant uptake (kg/ha/year)   | 7.64 (0.37 - 62.81)   |
| Average annual net phosphorus removed by plant uptake (kg/ha/year) | 0.02 (0.00 - 0.09)    |
| Average annual shoot nitrogen concentration (fraction dwt)         | 0.01 (0.01 - 0.02)    |
| Average annual shoot phosphorus concentration (fraction dwt)       | 0.000 (0.000 - 0.002) |

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



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



**No. of harvests/year:** 0.18 (forced by crop death due to nitrogen stress (0.02), water stress (0.16))

**No. days without crop/year (days/year):** 12.09 due to water stress (12.09)



## Land Performance

**Paddock:** Irrigated Pasture, 50 ha

**Soil Type:** Grey Clay- low drainage

**Plant:** Continuous Rhodes Grass Pasture-tropical

|                                                                |          |
|----------------------------------------------------------------|----------|
| Salt tolerance                                                 | Tolerant |
| Salinity threshold EC sat. ext. (dS/m)                         | 7.00     |
| 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:

|                                    |      |
|------------------------------------|------|
| Average Infiltrate Salinity (dS/m) | 0.03 |
|------------------------------------|------|

Insufficient deep drainage to run steady state salinity calculations.

PERFORMANCE

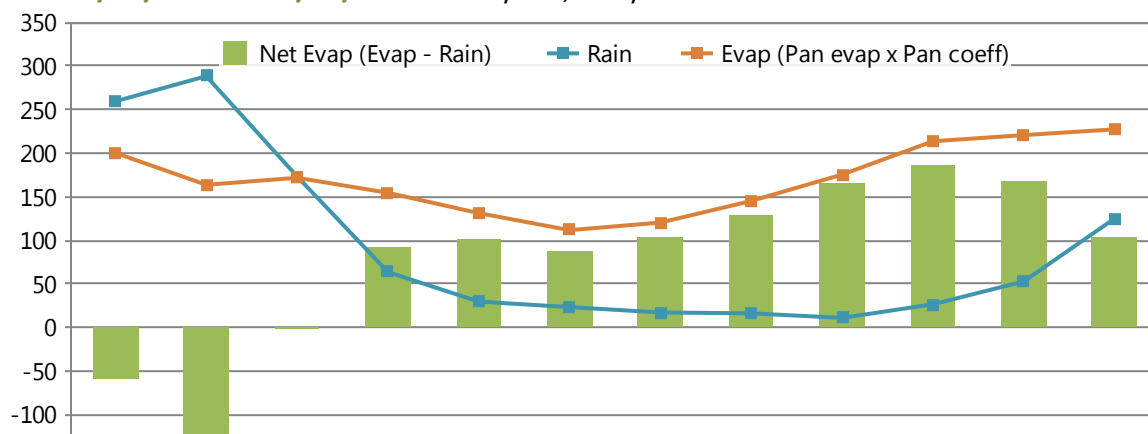
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## Sustainability Diagnostics: JBS Townsville

### Averaged Historical Climate Data Used in Simulation (mm)

Location: **Stuart, -19.3°, 146.85°**

Run Period: **01/01/1916 to 31/12/2015** 100 years, 0 days



|              | Jan   | Feb    | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   | Year   |
|--------------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Rain         | 259.6 | 288.4  | 173.4 | 63.5  | 29.6  | 23.3  | 17.1  | 16.1  | 10.9  | 26.5  | 52.8  | 125.0 | 1086.1 |
| Evap         | 200.3 | 163.7  | 171.8 | 154.5 | 131.2 | 111.6 | 120.3 | 145.2 | 175.4 | 213.7 | 220.8 | 227.4 | 2035.9 |
| Net Evap     | -59.3 | -124.7 | -1.6  | 91.0  | 101.6 | 88.4  | 103.2 | 129.0 | 164.5 | 187.2 | 168.0 | 102.4 | 949.8  |
| Net Evap/day | -1.9  | -4.4   | -0.1  | 3.0   | 3.3   | 2.9   | 3.3   | 4.2   | 5.5   | 6.0   | 5.6   | 3.3   | 2.6    |

DIAGNOSTICS

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## Sustainability Diagnostics: JBS Townsville

**Pond System: 1 facultative, aerobic or storage pond**

**New Sewage Treatment Plant - 0.00 m3/year or 0.00 m3/day generated on average**

**Effluent entering pond system after any pretreatment and recycling**

Average (Minimum-Maximum) influent quality calculated for 0.00 non-zero flow days, after any pretreatment and recycling.

| Constituent           | Concentration (mg/L) | Load (kg/year)     |
|-----------------------|----------------------|--------------------|
| Total Nitrogen        | 0.00 (0.00 - 0.00)   | 0.00 (0.00 - 0.00) |
| Total Phosphorus      | 0.00 (0.00 - 0.00)   | 0.00 (0.00 - 0.00) |
| Total Dissolved Salts | 0.00 (0.00 - 0.00)   | 0.00 (0.00 - 0.00) |
| 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) |

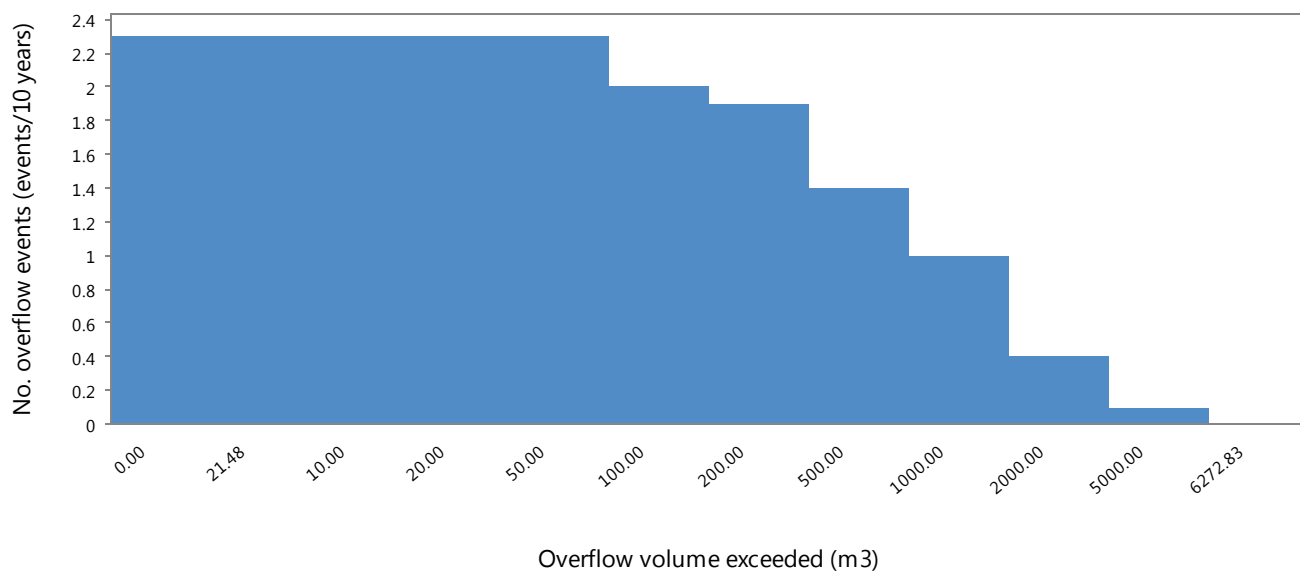
**Last pond (Wet weather store): 25500.00 m3**

|                                                                                    |        |
|------------------------------------------------------------------------------------|--------|
| Theoretical hydraulic retention time (days)                                        | 0.00   |
| Average volume of overflow (m3/year)                                               | 309.54 |
| No. overflow events per year exceeding threshold* of 21.48 m3 (no./year)           | 0.23   |
| Average duration of overflow (days)                                                | 2.09   |
| Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction) | 0.00   |
| Probability of at least 90% effluent reuse (fraction)                              | 0.00   |
| Average salinity of last pond (dS/m)                                               | 0.00   |
| Salinity of last pond on final day of simulation (dS/m)                            | 0.00   |
| 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](#)





**Sustainability Diagnostics: JBS Townsville****Irrigation Information****Irrigation: 50 ha total area (assumed 100% irrigation efficiency)**

|                               | Quantity/year | Quantity/ha/year |
|-------------------------------|---------------|------------------|
| Total irrigation applied (m3) | 0.00          | 0.00             |
| Total nitrogen applied (kg)   | 0.00          | 0.00             |
| Total phosphorus applied (kg) | 0.00          | 0.00             |
| Total salts applied (kg)      | 0.00          | 0.00             |

**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 is turned off (fraction) | 1.00 |
|--------------------------------------------------------|------|

## Sustainability Diagnostics: JBS Townsville

**Paddock Land: Irrigated Pasture: 50 ha**

**Irrigation: High Travelling Irrigator with 0.3% ammonium loss during irrigation**

|                                                                  |
|------------------------------------------------------------------|
| Irrigation triggered every 0 days                                |
| Irrigate a fixed amount of 100.00 mm each day                    |
| Irrigation window from 1/1 to 31/12 including the days specified |
| A minimum of 21 days must be skipped between irrigation events   |

**Soil Water Balance (mm): Grey Clay- low drainage, 44.08 mm PAWC at maximum root depth**

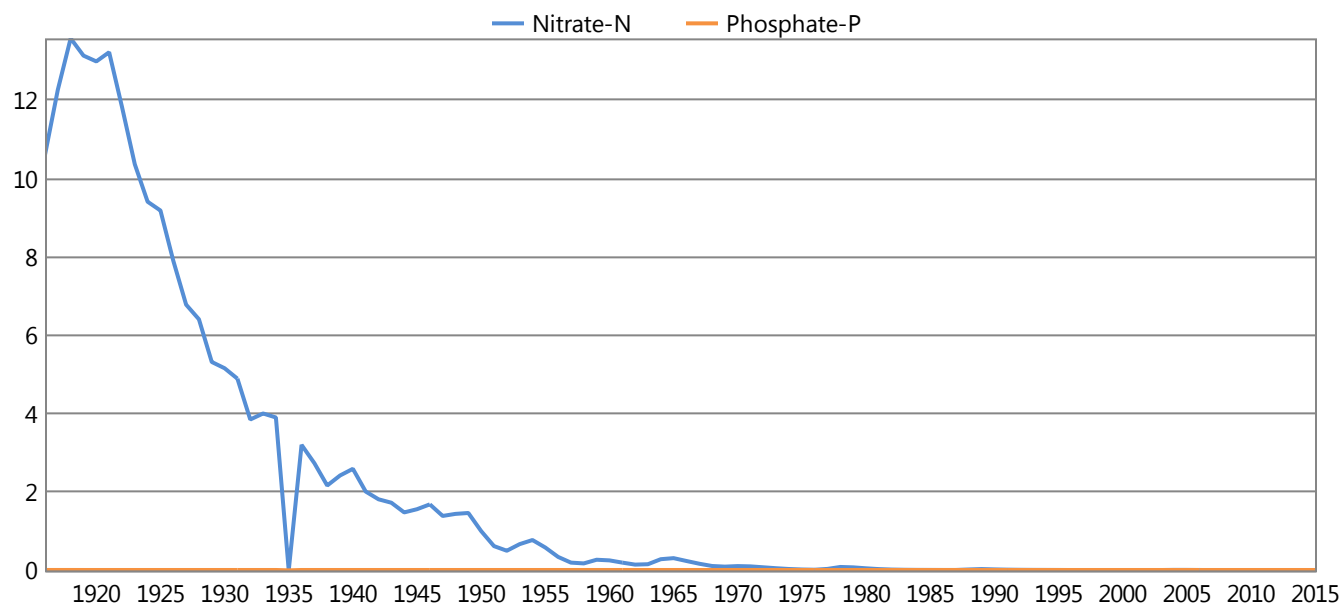
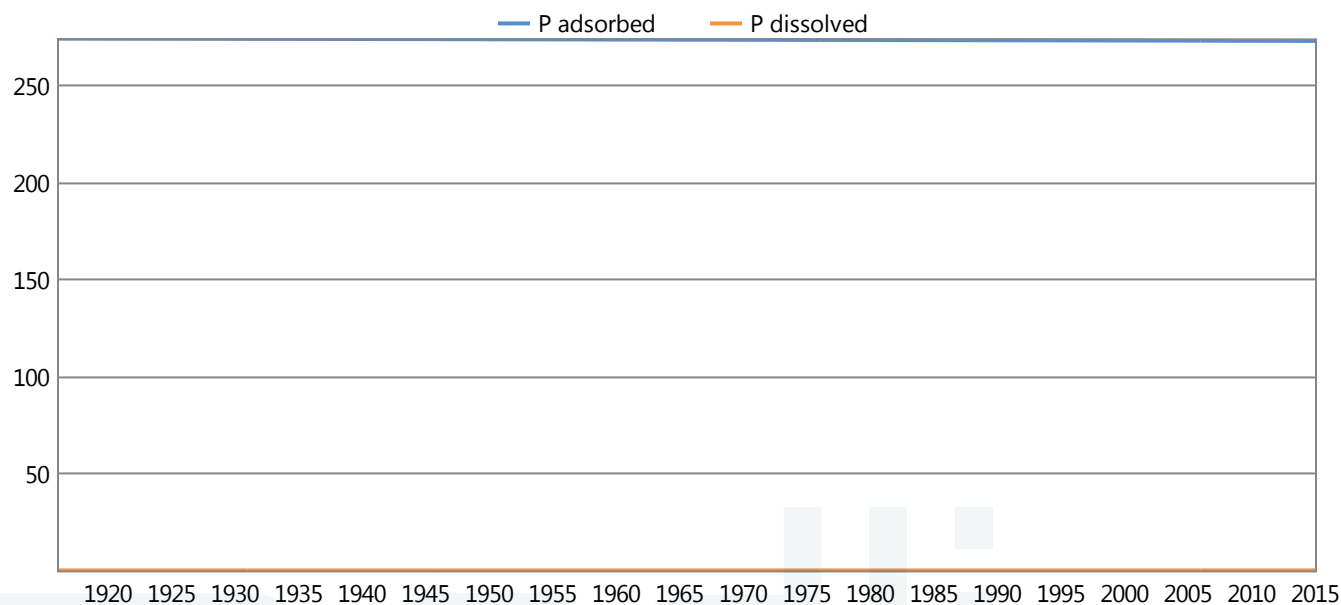
|            | Jan   | Feb   | Mar   | Apr   | May   | Jun   | Jul   | Aug   | Sep   | Oct  | Nov  | Dec   | Year   |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-------|--------|
| Rain       | 259.6 | 288.4 | 173.4 | 63.5  | 29.6  | 23.3  | 17.1  | 16.1  | 10.9  | 26.5 | 52.8 | 125.0 | 1086.1 |
| Irrigation | 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    |
| Soil Evap  | 64.4  | 64.3  | 54.1  | 31.6  | 22.8  | 19.7  | 15.9  | 13.6  | 12.6  | 16.9 | 28.3 | 44.4  | 388.7  |
| Transpn.   | 4.4   | 4.1   | 4.5   | 3.9   | 3.3   | 2.7   | 2.8   | 3.3   | 3.7   | 4.1  | 4.0  | 4.2   | 45.1   |
| Runoff     | 134.4 | 187.6 | 109.1 | 28.5  | 7.9   | 1.0   | 1.9   | 1.8   | 0.5   | 2.9  | 6.3  | 37.7  | 519.6  |
| Drainage   | 12.9  | 16.0  | 18.2  | 17.6  | 17.5  | 14.9  | 11.7  | 7.9   | 4.8   | 2.8  | 2.5  | 5.8   | 132.6  |
| Delta      | 43.4  | 16.4  | -12.6 | -18.1 | -21.9 | -15.2 | -15.1 | -10.5 | -10.7 | -0.2 | 11.7 | 32.9  | 0.1    |

### Soil Nitrogen Balance

|                                                                      |                |
|----------------------------------------------------------------------|----------------|
| Average annual effluent nitrogen added (kg/ha/year)                  | 0.00           |
| Average annual soil nitrogen removed by plant uptake (kg/ha/year)    | 7.64           |
| Average annual soil nitrogen removed by denitrification (kg/ha/year) | 1.08           |
| Average annual soil nitrogen leached (kg/ha/year)                    | 2.69           |
| Average annual nitrate-N loading to groundwater (kg/ha/year)         | 2.69           |
| Soil organic-N kg/ha (Initial - Final)                               | 1080.00 - 7.28 |
|                                                                      | 56.75 - 0.15   |
| Average nitrate-N concentration of deep drainage (mg/L)              | 2.03           |
| Max. annual nitrate-N concentration of deep drainage (mg/L)          | 13.58          |

### Soil Phosphorus Balance

|                                                                                                            |                 |
|------------------------------------------------------------------------------------------------------------|-----------------|
| Average annual effluent phosphorus added (kg/ha/year)                                                      | 0.00            |
| Average annual soil phosphorus removed by plant uptake (kg/ha/year)                                        | 0.02            |
| Average annual soil phosphorus leached (kg/ha/year)                                                        | 0.01            |
| Dissolved phosphorus (kg/ha) (Initial - Final)                                                             | 0.05 - 0.05     |
| Adsorbed phosphorus (kg/ha) (Initial - Final)                                                              | 274.67 - 273.36 |
| Average phosphate-P concentration in rootzone (mg/L)                                                       | 0.01            |
| Average phosphate-P concentration of deep drainage (mg/L)                                                  | 0.01            |
| Max. annual phosphate-P concentration of deep drainage (mg/L)                                              | 0.01            |
| Design soil profile storage life based on average infiltrated water phosphorus concn. of 0.00 mg/L (years) | 0.00            |

**Sustainability Diagnostics: JBS Townsville****Paddock Land: Irrigated Pasture: 50 ha****Irrigation: High Travelling Irrigator with 0.3% ammonium loss during irrigation****Annual nutrient leachate concentration (mg/L)****Annual Phosphate-P in soil (kg/ha)**

## Sustainability Diagnostics: JBS Townsville

### Paddock Plant Performance: Irrigated Pasture: 50 ha

#### Average Plant Performance (Minimum - Maximum): Continuous Rhodes Grass Pasture-tropical

|                                                                                         |                          |
|-----------------------------------------------------------------------------------------|--------------------------|
| Average annual shoot dry matter yield (kg/ha/year)                                      | 667.75 (39.09 - 5557.82) |
| Average monthly plant (green) cover (fraction)                                          | 0.03 (0.03 - 0.04)       |
| Average monthly crop factor (fraction)                                                  | 0.03 (0.02 - 0.03)       |
| Total plant cover (both green and dead) left after harvest (fraction)                   | 1.00                     |
| Average monthly root depth (mm)                                                         | 133.27 (122.28 - 139.59) |
| Average number of normal harvests per year (no./year)                                   | 0.00 (0.00 - 0.00)       |
| Average number of normal harvests for last five years only (no./year)                   | 0.00                     |
| Average number of crop deaths per year (no./year)                                       | 0.18 (0.00 - 1.00)       |
| Average number of crop deaths for last five years only (no./year)                       | 0.20                     |
| Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient) | 0.55 (0.00 - 0.98)       |
| Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient) | 0.00 (0.00 - 0.04)       |
| Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)    | 0.18 (0.01 - 0.37)       |
| Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)       | 0.19 (0.04 - 0.28)       |
| Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)       | 0.06 (0.00 - 0.27)       |
| No. days without crop/year (days)                                                       | 12.09                    |

#### Soil Salinity - Plant salinity tolerance: Tolerant

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

All values based on 10 year running averages

Insufficient deep drainage to run steady state salinity calculations.



## Run Messages

### Messages generated when the scenario was run:

|                                      |
|--------------------------------------|
| This is a Dryland scenario           |
| No effluent irrigation has occurred! |
| Full run chosen                      |



## ATTACHMENT B - SOIL, SEDIMENT & WATER TEST RESULTS

The soil has been disturbed by earthworks across much of the irrigation area. The soil is a cracking grey clay, mapped as a Gilgai Complex, by Murtha (1982) in the publication "Soils and Land Use on the Southern Section of the Townsville Coastal Plain, North Queensland , Soils and Land Use Series No. 59". Field observations indicate the adjacent soil group, the Gulliver-Purono Complex (OP) and the Northcote group Dy4.23 is applicable for some of this area.

The soil can be described as a sodic vertosol.

"Dark grey-brown, strong fine blocky structured light to medium clay A horizon; gradual change to olive brown heavy clay with coarse blocky structure grading to dark yellow-brown coarse lenticular structure. Some hard carbonate nodules below 0.5m", from Soil survey of the Townsville Coastal Plains, Poly #. 1073.

The soil is saline, sodic and has a strong alkaline trend with sub-soil having a pH of 8-9.

The geology is mapped as Qpa, Pleistocene, alluvium, Clay, silt, sand and gravel; flood-plain alluvium on high terraces .

The deeper rock is mapped as Odg? "Unassigned equigranular to porphyritic, locally foliated biotite-hornblende to biotite granite, granodiorite, microgranite, microgranodiorite and leucogranite "

# CERTIFICATE OF ANALYSIS



Analysis By: Bio-Track Pty Ltd  
ABN 91 056 237 275  
Mt. Glorious Road  
Highvale, Brisbane, Australia, 4520  
Ph. 07 3289 7179 Fx. 07 3289 7155

DATE OF REPORT 28 JULY 2018  
CLIENT NAME Peter Edmiston c/o BIO-TRACK PTY LTD  
CLIENT ADDRESS 781 Mount Glorious Road Highvale Brisbane  
PROJECT NAME Biotrack - JBS Townsville  
SAMPLING DATE NUMBER OF SAMPLES 11 SAMPLE TYPE: Soil/Solid  
PACKAGING Plastic Bag \*\* SAMPLES DISPOSED ON 15/09/2018  
DATE RECEIVED 17/07/2018 11:26:04 AM LAB REF. LR170718.483

Page 1 of 1 Report Pages.

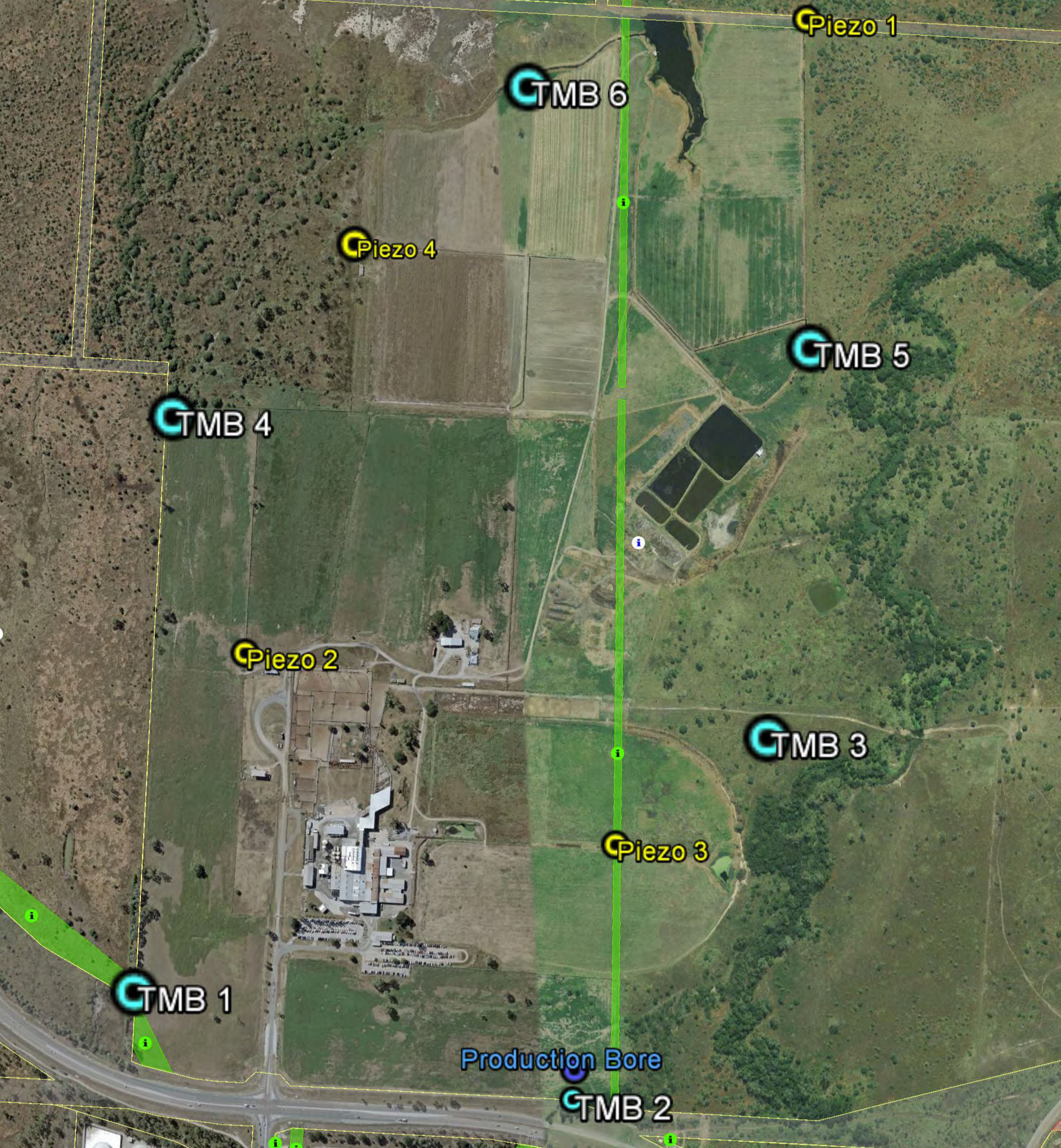
METHODOLOGY: EC pH Cl as 1:5 air dried soil in water, 30 minute rolling shake, Cl by ion selective electrode. Na K Mg Ca Fe Al S as 1:20 soil dried soil in 1 N NH<sub>4</sub>Cl, 60 minute rolling shake, Na K Mg Ca Fe Al S measured by ICP OES CEC (cation exchange capacity) as the sum of extracted cations (no pretreatment for soluble salts), SAR (sodium adsorption ratio) as  $\text{Na} / ((\text{Ca} + \text{Mg}) / 2)^{0.5}$ , %Na as Na% of CEC. (meq/100 = milli-equivalents/100 g soil)

| SAMPLE ID   | EC   | pH  | Na      | K       | Ca      | Mg      | Fe    | Al    | Cl    | S     | ECEC    | SAR   | %Na   | Ca:Mg |
|-------------|------|-----|---------|---------|---------|---------|-------|-------|-------|-------|---------|-------|-------|-------|
| m depth     | dS/m |     | meq/100 | meq/100 | meq/100 | meq/100 | mg/kg | mg/kg | mg/kg | mg/kg | meq/100 | ratio | ratio | ratio |
| SP1 0-150   | 0.09 | 5.2 | 0.7     | 0.2     | 3.8     | 2.8     | 2     | 4     | 42    | 13    | 7.5     | 0.38  | 9.2   | 1.4   |
| SP1 150-360 | 0.12 | 6.6 | 1.9     | 0.3     | 7.6     | 7.7     | <1    | <1    | 120   | 11    | 17.4    | 0.69  | 10.9  | 1.0   |
| SP1 360-570 | 0.49 | 8.1 | 4.4     | 0.3     | 23.1    | 12.6    | <1    | <1    | 650   | 4     | 40.3    | 1.04  | 10.9  | 1.8   |
| SP1 570-670 | 0.70 | 8.6 | 6.0     | 0.2     | 22.5    | 12.4    | <1    | <1    | 1149  | 7     | 41.2    | 1.44  | 14.6  | 1.8   |
| SP1 670-810 | 0.95 | 8.6 | 6.9     | 0.2     | 21.7    | 11.9    | <1    | <1    | 1949  | 14    | 40.8    | 1.68  | 16.9  | 1.8   |
| SP2 0-290   | 0.20 | 7.1 | 2.0     | 0.1     | 6.1     | 4.4     | <1    | 2     | 305   | 2     | 12.6    | 0.87  | 15.8  | 1.4   |
| SP2 290-440 | 0.38 | 7.8 | 6.2     | 0.2     | 7.4     | 11.2    | <1    | <1    | 950   | 5     | 25.0    | 2.03  | 24.7  | 0.7   |
| SP2 440-550 | 0.81 | 7.9 | 8.5     | 0.3     | 8.6     | 12.6    | <1    | <1    | 2101  | 5     | 29.9    | 2.60  | 28.3  | 0.7   |
| SP2 550-650 | 1.25 | 8.3 | 10.4    | 0.2     | 16.4    | 13.4    | <1    | 1     | 3303  | 15    | 40.4    | 2.69  | 25.7  | 1.2   |
| SP2 650-720 | 1.34 | 8.3 | 9.4     | 0.2     | 18.1    | 11.9    | <1    | <1    | 4194  | 22    | 39.7    | 2.43  | 23.8  | 1.5   |
| SP2 720-810 | 1.50 | 8.4 | 10.9    | 0.3     | 19.2    | 13.4    | <1    | 3     | 4046  | 36    | 43.9    | 2.71  | 24.9  | 1.4   |

Signatory

For and behalf of Bio-Track Pty Ltd





Piezo 1

TMB 6

Piezo 4

TMB 5

TMB 4

Piezo 2

TMB 3

Piezo 3

TMB 1

Production Bore

TMB 2



# CERTIFICATE OF ANALYSIS



Analysis By: Bio-Track Pty Ltd  
ABN 91 056 237 275  
Mt. Glorious Road  
Highvale, Brisbane, Australia, 4520  
Ph. 07 3289 7179 Fx. 07 3289 7155

DATE OF REPORT 15 MAY 2018  
CLIENT NAME Peter Edmiston c/o BIO-TRACK PTY LTD  
CLIENT ADDRESS 781 Mount Glorious Road Highvale Brisbane  
PROJECT NAME JB5 - Wastewater Irrigation  
SAMPLING DATE NUMBER OF SAMPLES 6 SAMPLE TYPE: Soil/Solid  
PACKAGING Plastic Bag \*\* SAMPLES DISPOSED ON 13/07/2018  
DATE RECEIVED 14/05/2018 11:43:55 AM LAB REF. LR140518.491

Page 1 of 1 Report Pages.

METHODOLOGY: EC pH Cl as 1:5 air dried soil in water, 30 minute rolling shake, Cl by ion selective electrode. Na K Mg Ca Fe Al S as 1:20 soil dried soil in 1 N NH<sub>4</sub>Cl, 60 minute rolling shake, Na K Mg Ca Fe Al S measured by ICP OES CEC (cation exchange capacity) as the sum of extracted cations (no pretreatment for soluble salts), SAR (sodium adsorption ratio) as  $\text{Na} / ((\text{Ca} + \text{Mg}) / 2)^{0.5}$ , %Na as Na% of CEC. (meq/100 = milli-equivalents/100 g soil)

| SAMPLE ID | EC   | pH  | Na      | K       | Ca      | Mg      | Fe    | Al    | Cl    | S     | ECEC    | SAR   | %Na   | Ca:Mg |
|-----------|------|-----|---------|---------|---------|---------|-------|-------|-------|-------|---------|-------|-------|-------|
| m depth   | dS/m |     | meq/100 | meq/100 | meq/100 | meq/100 | mg/kg | mg/kg | mg/kg | mg/kg | meq/100 | ratio | ratio | ratio |
| BH2 200-  | 0.30 | 5.8 | 2.1     | 0.4     | 6.9     | 6.5     | 4     | 2     | 220   | 46    | 16.0    | 0.80  | 13.0  | 1.1   |
| BH2 500-  | 1.29 | 7.6 | 11.3    | 0.3     | 18.4    | 17.9    | 2     | 2     | 1647  | 32    | 48.0    | 2.65  | 23.5  | 1.0   |
| BH2 600-  | 1.08 | 8.4 | 9.5     | 0.2     | 20.9    | 14.6    | 1     | 3     | 1351  | 24    | 45.2    | 2.24  | 20.9  | 1.4   |
| BH3 4000- | 0.75 | 8.5 | 7.6     | 0.2     | 12.7    | 13.2    | 1     | 1     | 901   | 28    | 33.6    | 2.11  | 22.5  | 1.0   |
| BH5 4000- | 0.92 | 8.2 | 6.8     | 0.3     | 16.0    | 12.4    | 2     | 3     | 1101  | 18    | 35.6    | 1.81  | 19.1  | 1.3   |
| BH5 4500- | 0.73 | 9.0 | 9.8     | 0.2     | 13.8    | 8.8     | 2     | 2     | 749   | 42    | 32.6    | 2.93  | 30.2  | 1.6   |

Signatory

For and behalf of Bio-Track Pty Ltd



| Test Code/Name       | [54] Nitrate+nitrite |                  |                                                      |
|----------------------|----------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 140518.490           | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples          | Client Contact   | Peter Edmiston                                       |
|                      |                      | Project Name     | JB5 - Wastewater Irrigation                          |
| Report Date          | 25/05/2018           | Job Number       |                                                      |
| Sample Received Date | 11/05/2018           | Order Number     |                                                      |
| Sample Disposal Date | 13/07/2018           | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag          | Client Email     |                                                      |
| Temperature          | Ambient              | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** 1:5 in 0.01M CaCl<sub>2</sub>. 2 hour rolling shake. Measurement by ICP.

| S# | SampleID | Nitrate<br>mg/kg |
|----|----------|------------------|
| 1  | BH2 200  | 3.2              |
| 2  | BH2 500  | 0.1              |
| 3  | BH2 600  | 0.2              |
| 4  | BH3 4000 | 0.1              |
| 5  | BH5 4000 | 0.3              |
| 6  | BH5 4500 | <0.1             |



# Certificate of Analysis

**Signatory:**

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

|                      |                             |                  |                                                      |
|----------------------|-----------------------------|------------------|------------------------------------------------------|
| Test Code/Name       | [179] Phosphorus Olsen 1:20 |                  |                                                      |
| Lab Reference (LR)   | 140518.489                  | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples                 | Client Contact   | Peter Edmiston                                       |
|                      |                             | Project Name     | JB5 - Wastewater Irrigation                          |
| Report Date          | 25/05/2018                  | Job Number       |                                                      |
| Sample Received Date | 11/05/2018                  | Order Number     |                                                      |
| Sample Disposal Date | 13/07/2018                  | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag                 | Client Email     |                                                      |
| Temperature          | Ambient                     | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** As per Olsen-P (9C), Colwell-P (9B), Soil Chemical Methods - Australasia, Raymont & Lyons, 2001.

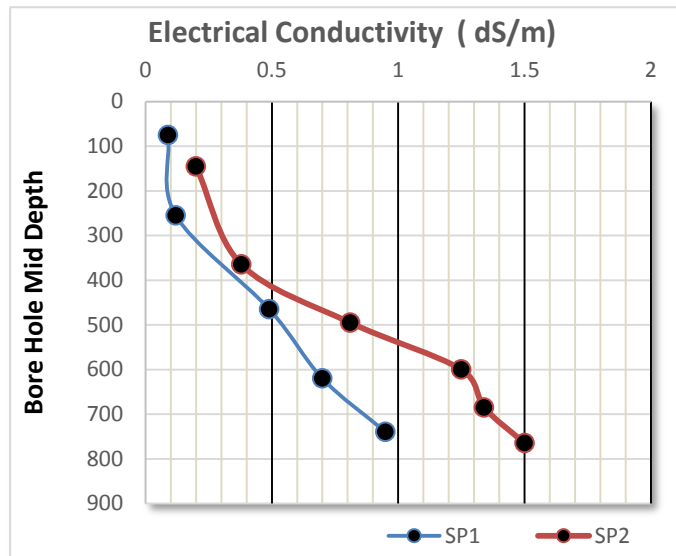
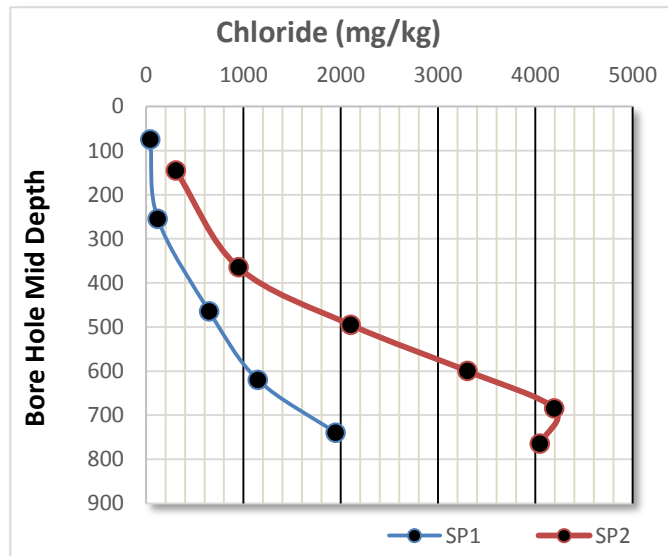
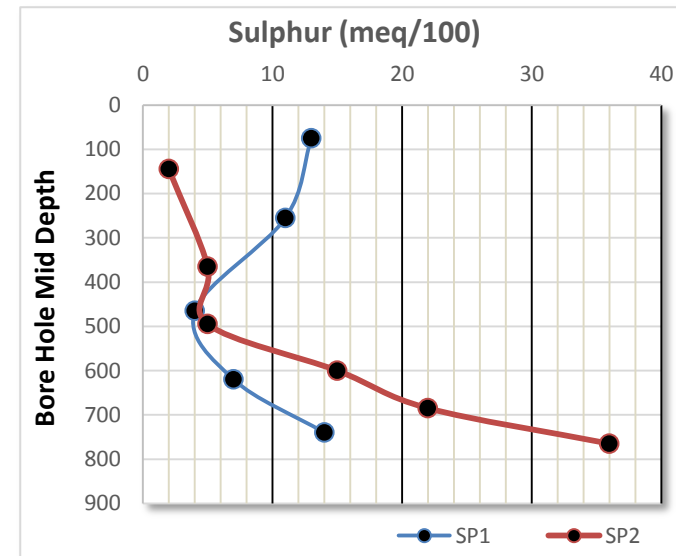
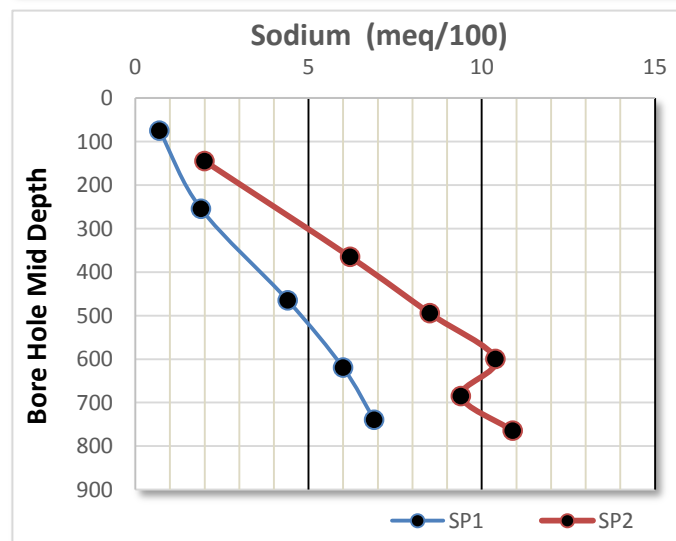
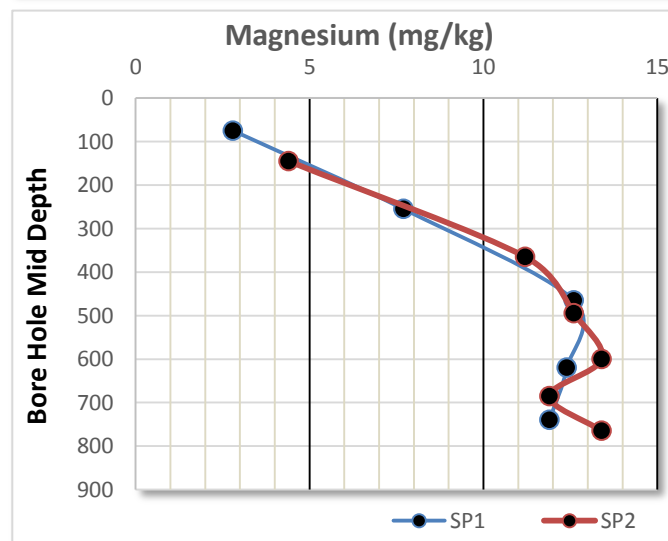
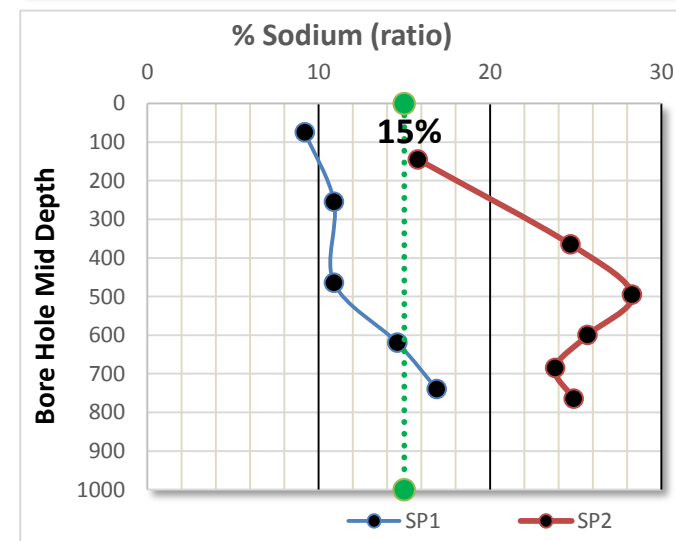
| S# | SampleID | Olsen P<br>mg P/kg |
|----|----------|--------------------|
| 1  | BH2 200  | 52                 |
| 2  | BH2 500  | 4                  |
| 3  | BH2 600  | 2                  |
| 4  | BH3 4000 | <1                 |
| 5  | BH5 4000 | 7                  |
| 6  | BH5 4500 | 6                  |

# Certificate of Analysis

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

**Signatory:** 

| Test Code/Name       | [65] Phosphate (H2SO4 available) |                  |                                                      |
|----------------------|----------------------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 170718.486                       | Client Name      | BIO-TRACK PTY LTD                                    |
| Report Date          | 31/07/2018                       | Client Contact   | Peter Edmiston                                       |
| Sample Received Date | 11/07/2018                       | Project Name     | Biotrack - JBS Townsville                            |
| Sample Disposal Date | 15/09/2018                       | Job Number       |                                                      |
| Sample Packaging     | Plastic Bag                      | Order Number     |                                                      |
| Temperature          | Ambient                          | Chain of Custody |                                                      |
|                      |                                  | Client Email     |                                                      |
|                      |                                  | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

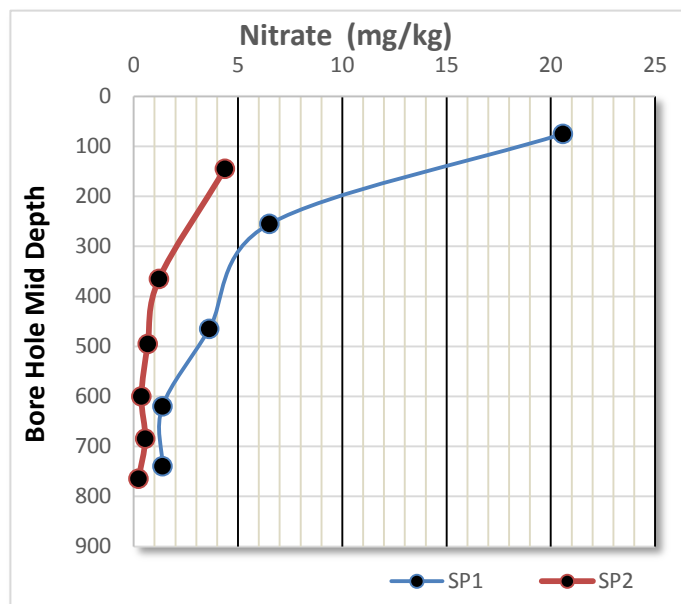
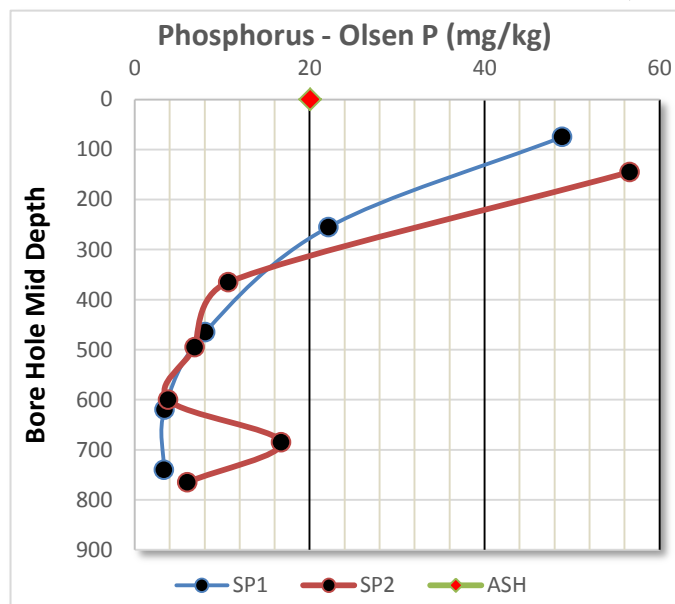
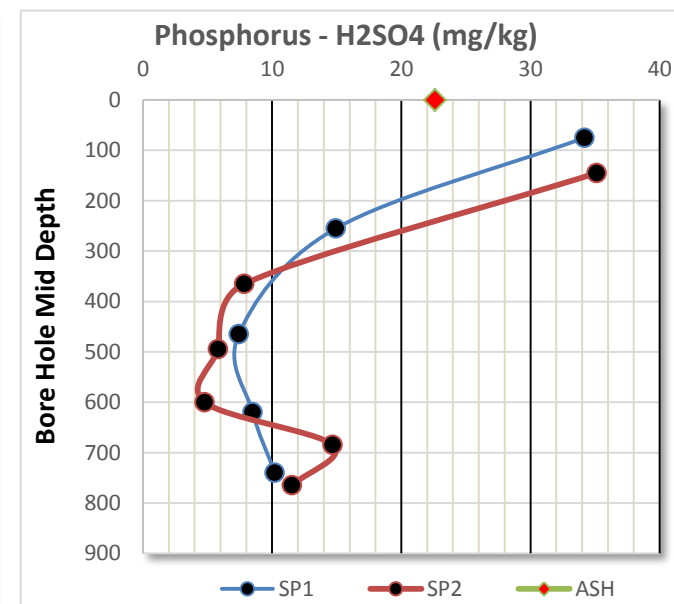


# Certificate of Analysis

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

Signatory: 

| Test Code/Name       |             | [65] Phosphate (H2SO4 available) |                                                      |
|----------------------|-------------|----------------------------------|------------------------------------------------------|
| Lab Reference (LR)   | 170718.486  | Client Name                      | BIO-TRACK PTY LTD                                    |
| Report Date          | 31/07/2018  | Client Contact                   | Peter Edmiston                                       |
| Sample Received Date | 11/07/2018  | Project Name                     | Biotrack - JBS Townsville                            |
| Sample Disposal Date | 15/09/2018  | Job Number                       |                                                      |
| Sample Packaging     | Plastic Bag | Order Number                     |                                                      |
| Temperature          | Ambient     | Chain of Custody                 |                                                      |
|                      |             | Client Email                     |                                                      |
|                      |             | Client Address                   | 781 Mount Glorious Road Highvale Brisbane Queensland |





# Certificate of Analysis

Signatory:

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

| Test Code/Name       | [54] Nitrate+nitrite |                  |                                                      |
|----------------------|----------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 170718.485           | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples          | Client Contact   | Peter Edmiston                                       |
|                      |                      | Project Name     | Biotrack - JBS Townsville                            |
| Report Date          | 24/07/2018           | Job Number       |                                                      |
| Sample Received Date | 11/07/2018           | Order Number     |                                                      |
| Sample Disposal Date | 15/09/2018           | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag          | Client Email     |                                                      |
| Temperature          | Ambient              | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** 1:5 in 0.01M CaCl<sub>2</sub>. 2 hour rolling shake. Measurement by ICP.

| S# | SampleID    | Nitrate<br>mg/kg |
|----|-------------|------------------|
| 1  | SP1 0-150   | 20.6             |
| 2  | SP1 150-360 | 6.5              |
| 3  | SP1 360-570 | 3.6              |
| 4  | SP1 570-670 | 1.4              |
| 5  | SP1 670-810 | 1.4              |
| 6  | SP2 0-290   | 4.4              |
| 7  | SP2 290-440 | 1.2              |
| 8  | SP2 440-550 | 0.7              |
| 9  | SP2 550-650 | 0.4              |
| 10 | SP2 650-720 | 0.6              |
| 11 | SP2 720-810 | 0.2              |





# Certificate of Analysis

**Signatory:**

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

| Test Code/Name       |             | [179] Phosphorus Olsen 1:20 |                                                      |
|----------------------|-------------|-----------------------------|------------------------------------------------------|
| Lab Reference (LR)   | 170718.484  | Client Name                 | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples | Client Contact              | Peter Edmiston                                       |
|                      |             | Project Name                | Biotrack - JBS Townsville                            |
| Report Date          | 26/07/2018  | Job Number                  |                                                      |
| Sample Received Date | 11/07/2018  | Order Number                |                                                      |
| Sample Disposal Date | 15/09/2018  | Chain of Custody            |                                                      |
| Sample Packaging     | Plastic Bag | Client Email                |                                                      |
| Temperature          | Ambient     | Client Address              | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** As per Olsen-P (9C) Soil Chemical Methods - Australasia, Raymont & Lyons, 2001.

| S# | SampleID    | Olsen P<br>mg P/kg |
|----|-------------|--------------------|
| 1  | SP1 0-150   | 49                 |
| 2  | SP1 150-360 | 22                 |
| 3  | SP1 360-570 | 8                  |
| 4  | SP1 570-670 | 3                  |
| 5  | SP1 670-810 | 3                  |
| 6  | SP2 0-290   | 57                 |
| 7  | SP2 290-440 | 11                 |
| 8  | SP2 440-550 | 7                  |
| 9  | SP2 550-650 | 4                  |
| 10 | SP2 650-720 | 17                 |
| 11 | SP2 720-810 | 6                  |
| 12 | ASH         | 20                 |

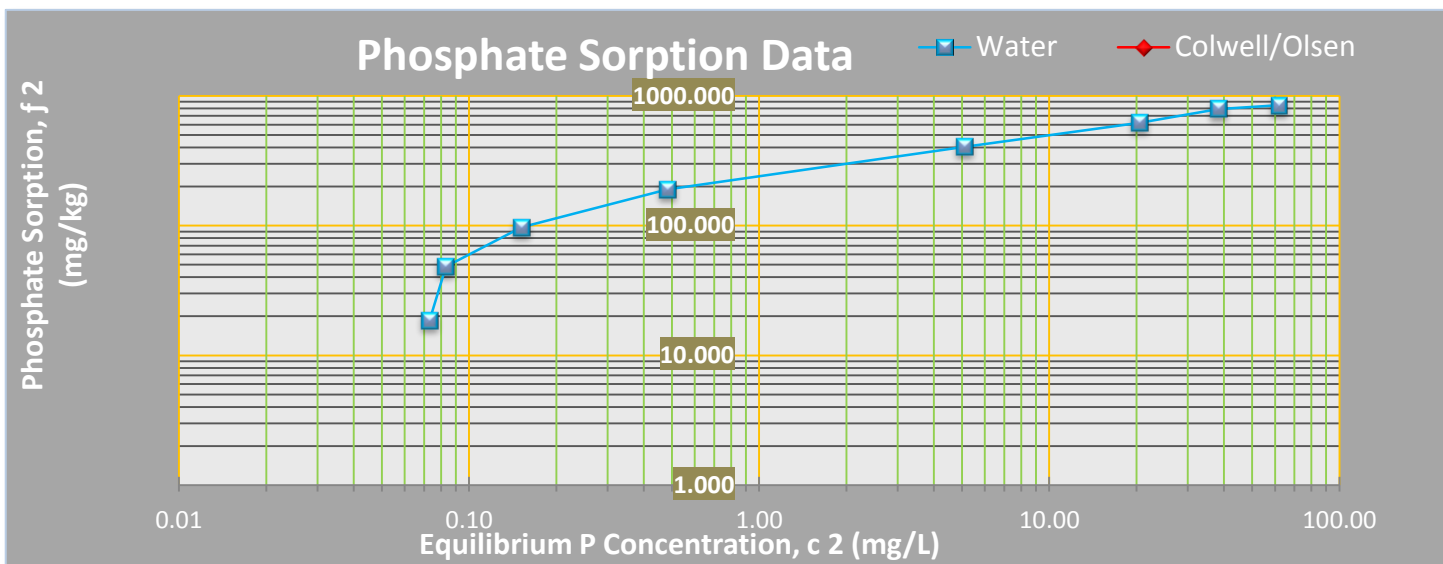
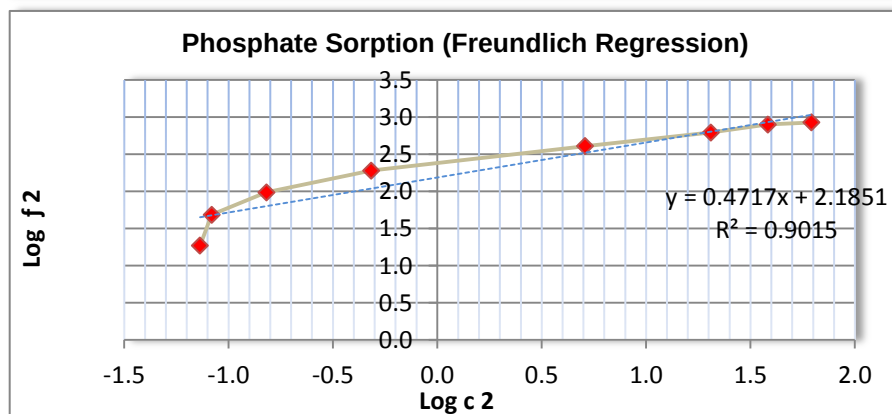
| Test Code/Name       | [62] Phosphate Sorption Isotherm |                  |                                                         |
|----------------------|----------------------------------|------------------|---------------------------------------------------------|
| Lab Reference (LR)   | 170718.487                       | Client Name      | BIO-TRACK PTY LTD                                       |
| SampleID             | SP1 150 - 360                    | Client Contact   | Peter Edmiston                                          |
|                      |                                  | Project Name     | Biotrack - JBS Townsville                               |
| Report Date          | 26/07/2018                       | Job Number       |                                                         |
| Sample Received Date | 11/07/2018                       | Order Number     |                                                         |
| Sample Disposal Date | 15/09/2018                       | Chain of Custody |                                                         |
| Sample Packaging     | Plastic Bag                      | Client Email     |                                                         |
| Temperature          | Ambient                          | Client Address   | 781 Mount Glorious Road Highvale Brisbane<br>Queensland |

|                           | c2                          | Colwell / Olsen (f2) | Water(f2) | log c2 | log f2 |
|---------------------------|-----------------------------|----------------------|-----------|--------|--------|
| Initial P Soil Conc. mg/L | Final P Solution Conc. mg/L | P sorption           |           |        |        |
|                           |                             | (mg/kg)              | (mg/kg)   |        |        |
| 0                         | 0.05                        |                      |           |        |        |
| 1                         | 0.07                        |                      | 19        | -1.14  | 1.27   |
| 2                         | 0.08                        |                      | 48        | -1.08  | 1.68   |
| 5                         | 0.15                        |                      | 97        | -0.82  | 1.99   |
| 10                        | 0.48                        |                      | 190       | -0.32  | 2.28   |
| 25                        | 5.11                        |                      | 405       | 0.71   | 2.61   |
| 50                        | 20.45                       |                      | 620       | 1.31   | 2.79   |
| 75                        | 38.34                       |                      | 791       | 1.58   | 2.90   |
| 100                       | 61.98                       |                      | 845       | 1.79   | 2.93   |

| Sample ID | SP1 150 - 360 |
|-----------|---------------|
|-----------|---------------|

| Desorption of Phosphorus |     |
|--------------------------|-----|
| Col/Olsen P              | N/A |
| Water Sol                | 0   |

\*Note: if Colwell/Olsen is being used, log f2 is based on Colwell/ Olsen, otherwise, Water Desorption



## Data Fit-Freundlich Regression \*

|                  |          |
|------------------|----------|
| Regression Slope | 0.4717   |
| Intercept        | 2.1851   |
| Freundlich "a"   | 153.1482 |
| Freundlich "b"   | 0.4717   |

\* if Colwell/Olsen is being used, Regression is based on Colwell/ Olsen, otherwise, Water)

|                  |        |
|------------------|--------|
| Regression Coef. | 0.9015 |
|------------------|--------|

**Analytical Method:** Air dry at 40°C for 48 hours, sieve (<850 um), add ammonium phosphate in .01 M KCl2 as a 1:20 soil/solution. Shake 17 hours at 25°C, test supernatant spectroscopically for residual phosphorus. Calculate P sorption as - **Water** {Water Soluble P+ (Initial P + Desorption - Final P) / soil mass} **Colwell** [ Colwell P+ (Initial P + Desorption - Final P) / soil mass]

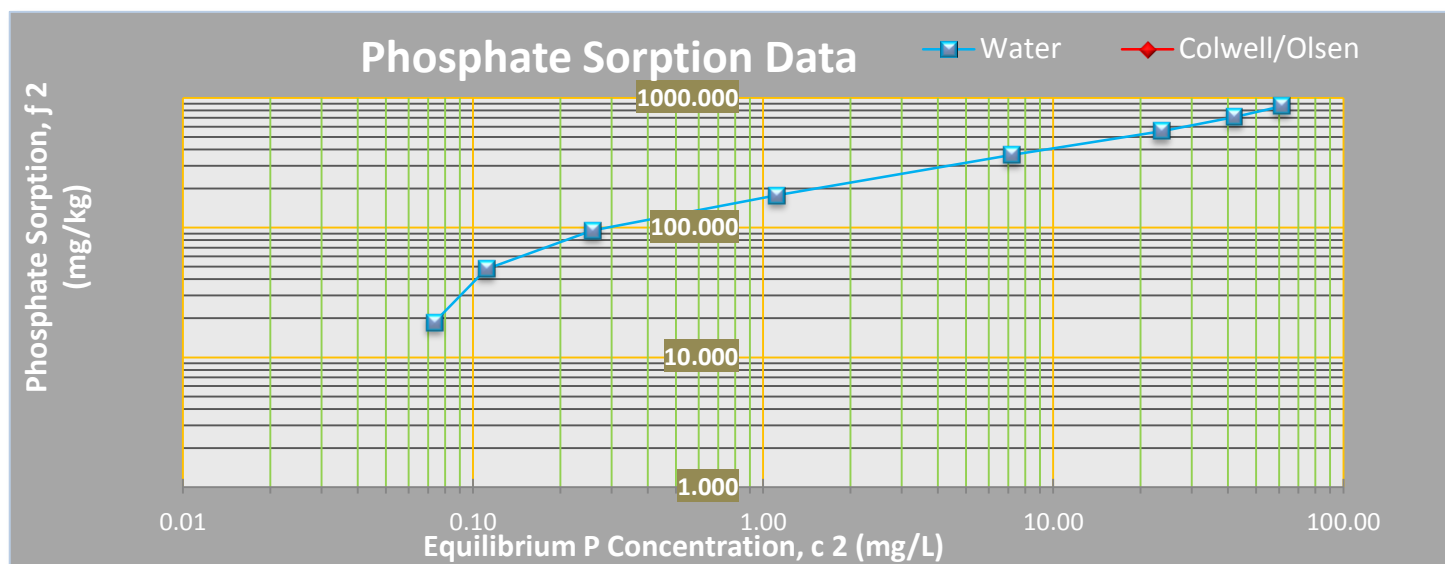
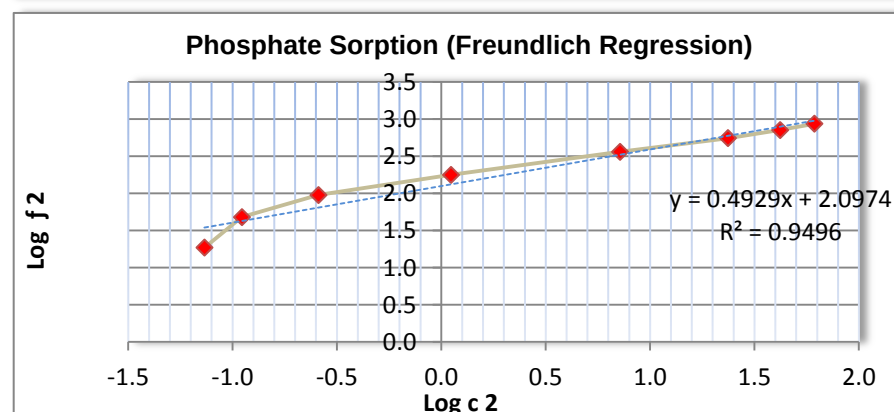
| Test Code/Name       | [62] Phosphate Sorption Isotherm |                  |                                                         |  |
|----------------------|----------------------------------|------------------|---------------------------------------------------------|--|
| Lab Reference (LR)   | 170718.487                       | Client Name      | BIO-TRACK PTY LTD                                       |  |
| SampleID             | SP1 670 - 810                    | Client Contact   | Peter Edmiston                                          |  |
|                      |                                  | Project Name     | Biotrack - JBS Townsville                               |  |
| Report Date          | 26/07/2018                       | Job Number       |                                                         |  |
| Sample Received Date | 11/07/2018                       | Order Number     |                                                         |  |
| Sample Disposal Date | 15/09/2018                       | Chain of Custody |                                                         |  |
| Sample Packaging     | Plastic Bag                      | Client Email     |                                                         |  |
| Temperature          | Ambient                          | Client Address   | 781 Mount Glorious Road Highvale Brisbane<br>Queensland |  |

|                           | c2                          | Colwell / Olsen (f2) | Water(f2) | log c2 | log f2 |
|---------------------------|-----------------------------|----------------------|-----------|--------|--------|
| Initial P Soil Conc. mg/L | Final P Solution Conc. mg/L | P sorption           |           |        |        |
|                           |                             | (mg/kg)              | (mg/kg)   |        |        |
| 0                         | 0.05                        |                      |           |        |        |
| 1                         | 0.07                        |                      | 19        | -1.13  | 1.27   |
| 2                         | 0.11                        |                      | 48        | -0.95  | 1.68   |
| 5                         | 0.26                        |                      | 95        | -0.59  | 1.98   |
| 10                        | 1.12                        |                      | 178       | 0.05   | 2.25   |
| 25                        | 7.20                        |                      | 362       | 0.86   | 2.56   |
| 50                        | 23.62                       |                      | 553       | 1.37   | 2.74   |
| 75                        | 42.03                       |                      | 711       | 1.62   | 2.85   |
| 100                       | 61.24                       |                      | 861       | 1.79   | 2.94   |

| Sample ID | SP1 670 - 810 |
|-----------|---------------|
|-----------|---------------|

| Desorption of Phosphorus |     |
|--------------------------|-----|
| Col/Olsen P              | N/A |
| Water Sol                | 0   |

\*Note: if Colwell/Olsen is being used, log f2 is based on Colwell/ Olsen, otherwise, Water Desorption



## Data Fit-Freundlich Regression \*

|                  |          |
|------------------|----------|
| Regression Slope | 0.4929   |
| Intercept        | 2.0974   |
| Freundlich "a"   | 125.1335 |
| Freundlich "b"   | 0.4929   |

\* if Colwell/Olsen is being used, Regression is based on Colwell/ Olsen, otherwise, Water)

|                  |        |
|------------------|--------|
| Regression Coef. | 0.9496 |
|------------------|--------|

**Analytical Method:** Air dry at 40°C for 48 hours, sieve (<850 um), add ammonium phosphate in .01 M KCl2 as a 1:20 soil/solution. Shake 17 hours at 25°C, test supernatant spectroscopically for residual phosphorus. Calculate P sorption as - **Water** {Water Soluble P+ (Initial P + Desorption - Final P) / soil mass} **Colwell** [ Colwell P+ (Initial P + Desorption - Final P) / soil mass]

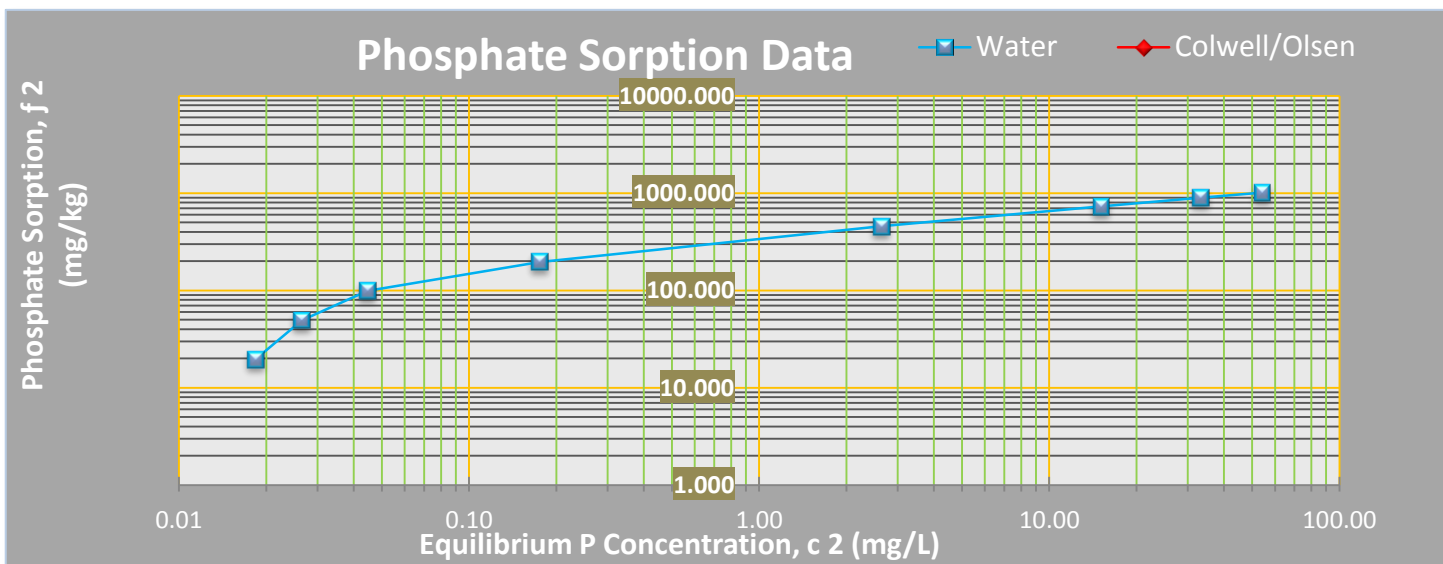
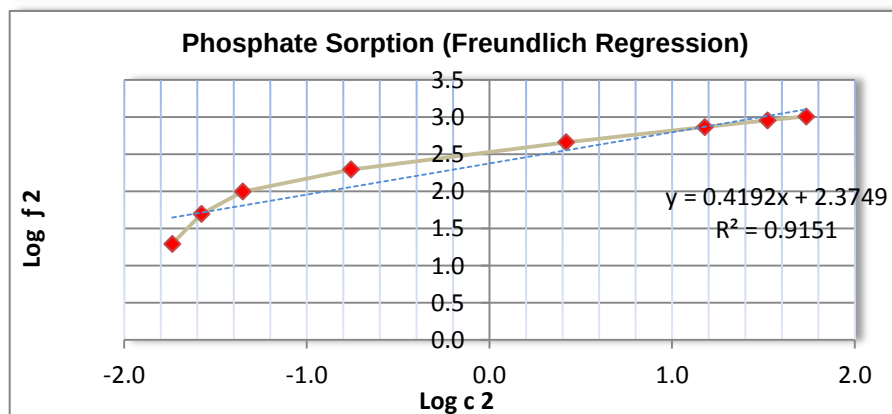
| Test Code/Name       | [62] Phosphate Sorption Isotherm |                  |                                                         |  |
|----------------------|----------------------------------|------------------|---------------------------------------------------------|--|
| Lab Reference (LR)   | 170718.487                       | Client Name      | BIO-TRACK PTY LTD                                       |  |
| SampleID             | SP2 290 - 440                    | Client Contact   | Peter Edmiston                                          |  |
|                      |                                  | Project Name     | Biotrack - JBS Townsville                               |  |
| Report Date          | 26/07/2018                       | Job Number       |                                                         |  |
| Sample Received Date | 11/07/2018                       | Order Number     |                                                         |  |
| Sample Disposal Date | 15/09/2018                       | Chain of Custody |                                                         |  |
| Sample Packaging     | Plastic Bag                      | Client Email     |                                                         |  |
| Temperature          | Ambient                          | Client Address   | 781 Mount Glorious Road Highvale Brisbane<br>Queensland |  |

|                           | c2                          | Colwell / Olsen (f2) | Water(f2) | log c2 | log f2 |
|---------------------------|-----------------------------|----------------------|-----------|--------|--------|
| Initial P Soil Conc. mg/L | Final P Solution Conc. mg/L | P sorption           |           |        |        |
|                           |                             | (mg/kg)              | (mg/kg)   |        |        |
| 0                         | 0.01                        |                      |           |        |        |
| 1                         | 0.02                        |                      | 20        | -1.74  | 1.29   |
| 2                         | 0.03                        |                      | 49        | -1.58  | 1.69   |
| 5                         | 0.04                        |                      | 99        | -1.35  | 2.00   |
| 10                        | 0.17                        |                      | 196       | -0.76  | 2.29   |
| 25                        | 2.64                        |                      | 456       | 0.42   | 2.66   |
| 50                        | 15.10                       |                      | 732       | 1.18   | 2.86   |
| 75                        | 33.27                       |                      | 901       | 1.52   | 2.95   |
| 100                       | 54.25                       |                      | 1017      | 1.73   | 3.01   |

| Sample ID | SP2 290 - 440 |
|-----------|---------------|
|-----------|---------------|

| Desorption of Phosphorus |     |
|--------------------------|-----|
| Col/Olsen P              | N/A |
| Water Sol                | 0   |

\*Note: if Colwell/Olsen is being used, log f2 is based on Colwell/ Olsen, otherwise, Water Desorption



## Data Fit-Freundlich Regression \*

|                  |          |
|------------------|----------|
| Regression Slope | 0.4192   |
| Intercept        | 2.3749   |
| Freundlich "a"   | 237.0670 |
| Freundlich "b"   | 0.4192   |

\* if Colwell/Olsen is being used, Regression is based on Colwell/ Olsen, otherwise, Water)

|                  |        |
|------------------|--------|
| Regression Coef. | 0.9151 |
|------------------|--------|

**Analytical Method:** Air dry at 40°C for 48 hours, sieve (<850 um), add ammonium phosphate in .01 M KCl2 as a 1:20 soil/solution. Shake 17 hours at 25°C, test supernatant spectroscopically for residual phosphorus. Calculate P sorption as - **Water** {Water Soluble P+ (Initial P + Desorption - Final P) / soil mass} **Colwell** [ Colwell P+ (Initial P + Desorption - Final P) / soil mass]

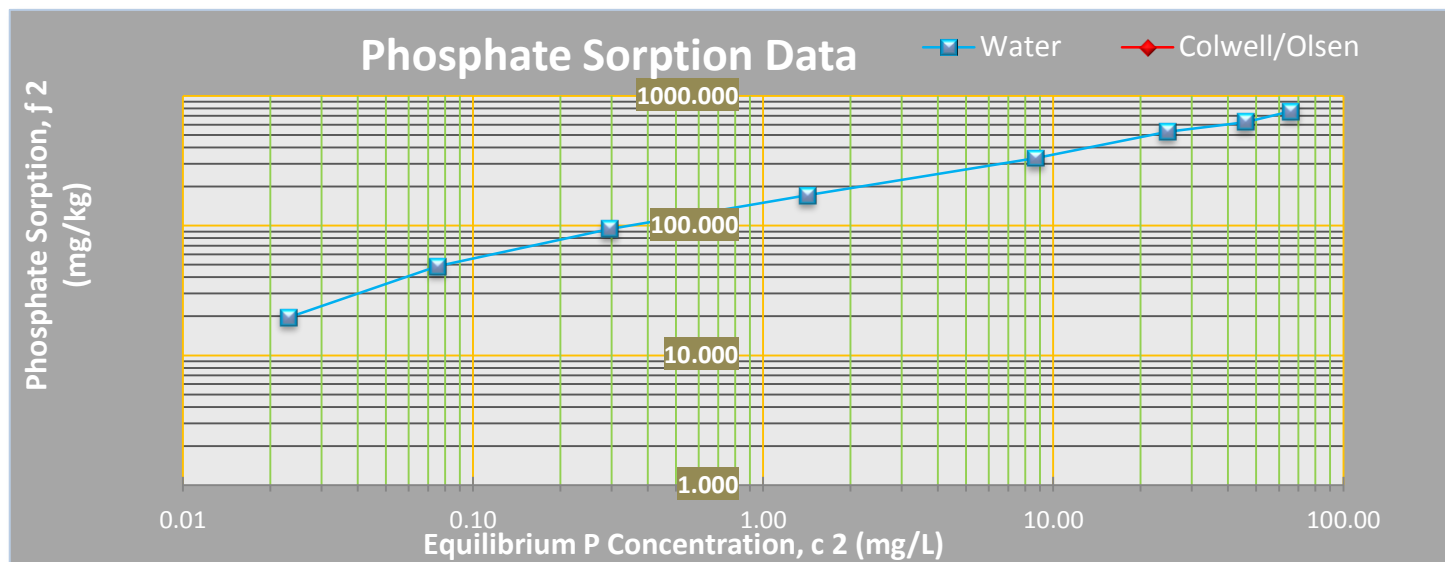
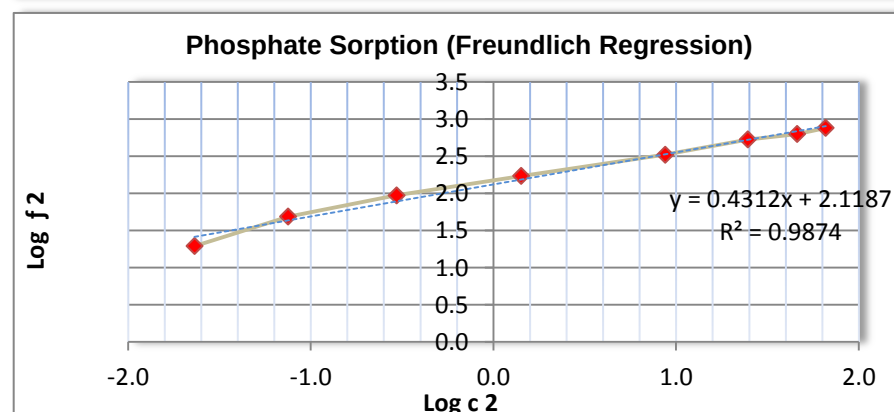
| Test Code/Name       |  |               |                  | [62] Phosphate Sorption Isotherm |                                                         |
|----------------------|--|---------------|------------------|----------------------------------|---------------------------------------------------------|
| Lab Reference (LR)   |  | 170718.487    | Client Name      |                                  | BIO-TRACK PTY LTD                                       |
| SampleID             |  | SP2 720 - 810 | Client Contact   |                                  | Peter Edmiston                                          |
|                      |  |               | Project Name     |                                  | Biotrack - JBS Townsville                               |
| Report Date          |  | 26/07/2018    | Job Number       |                                  |                                                         |
| Sample Received Date |  | 11/07/2018    | Order Number     |                                  |                                                         |
| Sample Disposal Date |  | 15/09/2018    | Chain of Custody |                                  |                                                         |
| Sample Packaging     |  | Plastic Bag   | Client Email     |                                  |                                                         |
| Temperature          |  | Ambient       | Client Address   |                                  | 781 Mount Glorious Road Highvale Brisbane<br>Queensland |

|                           | c2                          | Colwell / Olsen (f2) | Water(f2) | log c2 | log f2 |
|---------------------------|-----------------------------|----------------------|-----------|--------|--------|
| Initial P Soil Conc. mg/L | Final P Solution Conc. mg/L | P sorption           |           |        |        |
|                           |                             | (mg/kg)              | (mg/kg)   |        |        |
| 0                         | 0.01                        |                      |           |        |        |
| 1                         | 0.02                        |                      | 20        | -1.64  | 1.29   |
| 2                         | 0.08                        |                      | 49        | -1.12  | 1.69   |
| 5                         | 0.30                        |                      | 94        | -0.53  | 1.97   |
| 10                        | 1.42                        |                      | 171       | 0.15   | 2.23   |
| 25                        | 8.72                        |                      | 331       | 0.94   | 2.52   |
| 50                        | 24.74                       |                      | 529       | 1.39   | 2.72   |
| 75                        | 45.96                       |                      | 626       | 1.66   | 2.80   |
| 100                       | 65.88                       |                      | 758       | 1.82   | 2.88   |

| Sample ID | SP2 720 - 810 |
|-----------|---------------|
|-----------|---------------|

| Desorption of Phosphorus |     |
|--------------------------|-----|
| Col/Olsen P              | N/A |
| Water Sol                | 0   |

\*Note: if Colwell/Olsen is being used, log f2 is based on Colwell/ Olsen, otherwise, Water Desorption



## Data Fit-Freundlich Regression \*

|                  |          |
|------------------|----------|
| Regression Slope | 0.4312   |
| Intercept        | 2.1187   |
| Freundlich "a"   | 131.4293 |
| Freundlich "b"   | 0.4312   |

\* if Colwell/Olsen is being used, Regression is based on Colwell/ Olsen, otherwise, Water)

|                  |        |
|------------------|--------|
| Regression Coef. | 0.9874 |
|------------------|--------|

**Analytical Method:** Air dry at 40°C for 48 hours, sieve (<850 um), add ammonium phosphate in .01 M KCl2 as a 1:20 soil/solution. Shake 17 hours at 25°C, test supernatant spectroscopically for residual phosphorus. Calculate P sorption as - **Water** {Water Soluble P+ (Initial P + Desorption - Final P) / soil mass} **Colwell** [ Colwell P+ (Initial P + Desorption - Final P) / soil mass]

# Certificate of Analysis

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|                             |                                                                                                       |                         |                                                      |
|-----------------------------|-------------------------------------------------------------------------------------------------------|-------------------------|------------------------------------------------------|
| <b>Test Code/Name</b>       | <b>[59] Moisture Content @ Air Dry</b><br><b>[399] Moisture Content @ Field Moisture(as provided)</b> |                         |                                                      |
| <b>Lab Reference (LR)</b>   | <b>170718.481/536</b>                                                                                 | <b>Client Name</b>      | BIO-TRACK PTY LTD                                    |
| <b>SampleID</b>             | <b>All Samples</b>                                                                                    | <b>Client Contact</b>   | Peter Edmiston                                       |
|                             |                                                                                                       | <b>Project Name</b>     | Biotrack - JBS Townsville                            |
| <b>Report Date</b>          | 17/07/2018                                                                                            | <b>Job Number</b>       |                                                      |
| <b>Sample Received Date</b> | 11/07/2018                                                                                            | <b>Order Number</b>     |                                                      |
| <b>Sample Disposal Date</b> | 15/09/2018                                                                                            | <b>Chain of Custody</b> |                                                      |
| <b>Sample Packaging</b>     | Plastic Bag                                                                                           | <b>Client Email</b>     |                                                      |
| <b>Temperature</b>          | Ambient                                                                                               | <b>Client Address</b>   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Sample dried for 24 hours at 40'C and 12hrs at 105'C**

**\*NM = not measured**

| S# | SampleID    | MC% Grav.<br>@<br>Field Moisture | MC% Grav.<br>@<br>Air Dry |
|----|-------------|----------------------------------|---------------------------|
|    |             |                                  |                           |
| 1  | SP1 0-150   | 14.69                            | 1.27                      |
| 2  | SP1 150-360 | 20.74                            | 2.38                      |
| 3  | SP1 360-570 | 21.22                            | 2.02                      |
| 4  | SP1 570-670 | 20.30                            | 1.97                      |
| 5  | SP1 670-810 | 19.65                            | 2.40                      |
| 6  | SP2 0-290   | 23.42                            | 2.59                      |
| 7  | SP2 290-440 | 28.31                            | 2.76                      |
| 8  | SP2 440-550 | 27.85                            | 2.77                      |
| 9  | SP2 550-650 | 25.67                            | 2.49                      |
| 10 | SP2 650-720 | 22.74                            | 2.11                      |
| 11 | SP2 720-810 | 20.85                            | 1.94                      |



# Certificate of Analysis

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| Test Code/Name                                                                   |             |                  |                                                      |
|----------------------------------------------------------------------------------|-------------|------------------|------------------------------------------------------|
| <b>[359] Moisture Content @ Field Capacity(30 kPa) / Wilting Point(1500 kPa)</b> |             |                  |                                                      |
| Lab Reference (LR)                                                               | 170718.488  | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID                                                                         | All Samples | Client Contact   | Peter Edmiston                                       |
|                                                                                  |             | Project Name     | Biotrack - JBS Townsville                            |
| Report Date                                                                      | 3/08/2018   | Job Number       |                                                      |
| Sample Received Date                                                             | 11/07/2018  | Order Number     |                                                      |
| Sample Disposal Date                                                             | 15/09/2018  | Chain of Custody |                                                      |
| Sample Packaging                                                                 | Plastic Bag | Client Email     |                                                      |
| Temperature                                                                      | Ambient     | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Moisture Content at Field Capacity and Wilting Point calculated using Moisture Tension Plate.**

\*NM = not measured

| S# | SampleID          | MC% Grav.<br>@<br>Field Capacity<br>30 kPa | MC% Grav.<br>@<br>Wilting Point<br>1500 kPa |
|----|-------------------|--------------------------------------------|---------------------------------------------|
|    |                   |                                            |                                             |
| 1  | SP2(CORE) 0-100   | 24.97                                      | 17.12                                       |
| 2  | SP2(CORE) 180-200 | 40.95                                      | 31.74                                       |
| 3  | SP2(CORE) 230-270 | 41.74                                      | 28.21                                       |
| 4  | SP2(CORE) 320-350 | 35.71                                      | 24.51                                       |
| 5  | SP2(CORE) 350-370 | 35.16                                      | 23.72                                       |
| 6  | SP2(CORE) 400-420 | 32.20                                      | 21.99                                       |





PM4

S# N as NO3 mg/kg

|    |      |
|----|------|
| 1  | 27.5 |
| 2  | 49.1 |
| 3  | 13.4 |
| 4  | 18.7 |
| 5  | 56.8 |
| 6  | 5.3  |
| 7  | 19.5 |
| 8  | 26.5 |
| 9  | 14.5 |
| 10 | 17.6 |
| 11 | 22.8 |
| 12 | 15.0 |
| 13 | 28.7 |
| 14 | 73.3 |
| 15 | 13.4 |
| 16 | 12.5 |
| 17 | 5.4  |
| 18 | 17.3 |
| 19 | 0.3  |
| 20 | 0.5  |





A satellite map showing a wetland or marshy area. A road runs horizontally across the middle. A green highlighted path starts from the top right, goes down, and then turns left to follow the road. Two red location markers are placed on the map: one labeled 'CONTROL' on the left side of the road, and another labeled 'Runnel Junction' on the right side of the road, near the green path. The terrain is a mix of brown, grey, and green patches, indicating different types of vegetation or water levels.

CONTROL

Runnel Junction



# Certificate of Analysis

Bio-Track Pty Ltd ABN 91 056 237 275

Phone: +617 3289 7179

**Signatory:**

*P. Edmiston*

| Test Code/Name       |  |             |  | [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |  |                                                      |  |
|----------------------|--|-------------|--|----------------------------------------------------------|--|------------------------------------------------------|--|
| Lab Reference (LR)   |  | 100818.446  |  | Client Name                                              |  | BIO-TRACK PTY LTD                                    |  |
| SampleID             |  | Control     |  | Client Contact                                           |  | Peter Edmiston                                       |  |
|                      |  |             |  | Project Name                                             |  | Biotrack - JBS Townsville                            |  |
| Report Date          |  | 16/08/2018  |  | Job Number                                               |  |                                                      |  |
| Sample Received Date |  | 10/08/2018  |  | Order Number                                             |  |                                                      |  |
| Sample Disposal Date |  | 9/10/2018   |  | Chain of Custody                                         |  |                                                      |  |
| Sample Packaging     |  | Plastic Bag |  | Client Email                                             |  |                                                      |  |
| Temperature          |  | Ambient     |  | Client Address                                           |  | 781 Mount Glorious Road Highvale Brisbane Queensland |  |

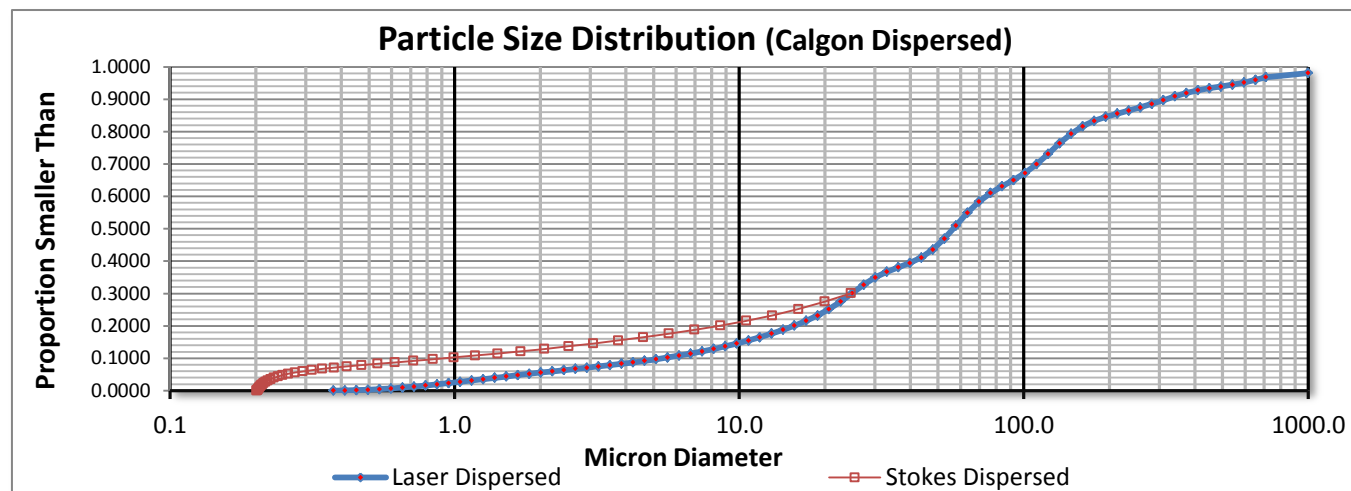
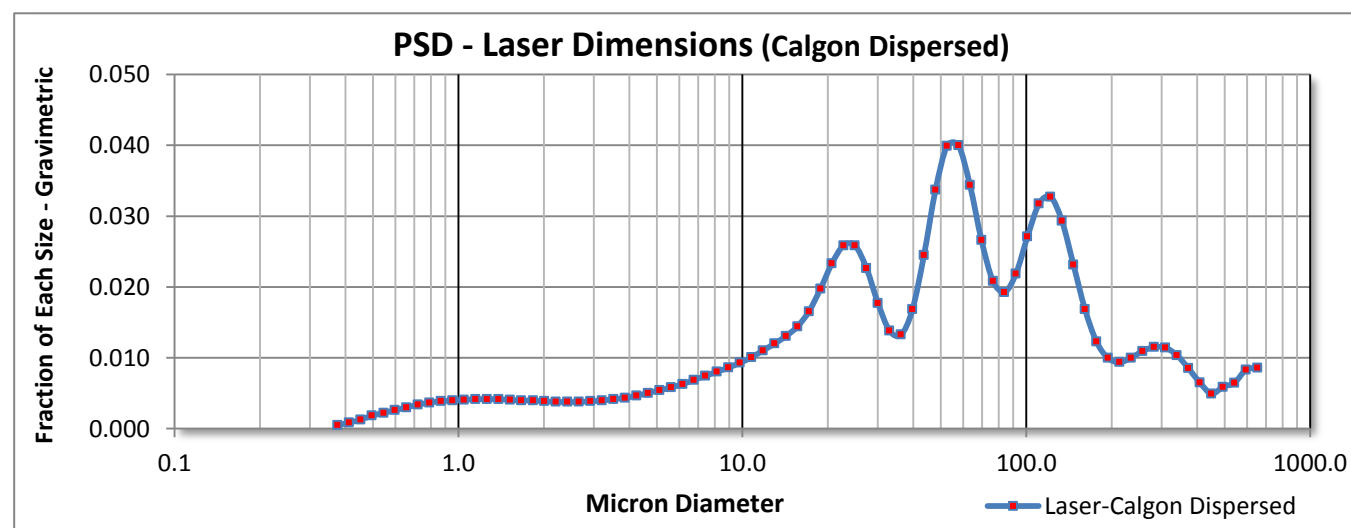
| CALGON DISPERSED SAMPLE TEST RESULTS<br>(gravimetric dry 105°C) |            |                  |
|-----------------------------------------------------------------|------------|------------------|
| Diameter mm                                                     | % In Range | Class            |
| > 2                                                             | 0.6%       | GRAVEL           |
| 1-2                                                             | 1.3%       | Very Coarse Sand |
| 1-0.5                                                           | 4.2%       | Coarse Sand      |
| 0.5-0.25                                                        | 6.4%       | Medium Sand      |
| 0.25-0.1                                                        | 20.3%      | Fine Sand        |
| 0.1-0.02                                                        | 39.7%      | Very Fine sand   |
| 2-0.02                                                          | 71.9%      | ALL SAND         |
| 0.02-0.002                                                      | 14.6%      | SILT *           |
| <0.002 mm                                                       | 12.9%      | CLAY *           |

## Analytical Method:

Soil dispersed using Hydrogen Peroxide & Calgon. Size Measurement: sieved >0.71mm, laser sized (Coulter LS 100Q) < 0.71 mm.

Water suspension, if measured: 10 minute slow rolling shake in rainwater.

\* Stokes Diameter estimated for sizes smaller than 25 microns. This estimates sizes measured by sedimentation methods (e.g. pipette & hydrometer). For sizes greater than 25 microns, the laser measurements are reported.



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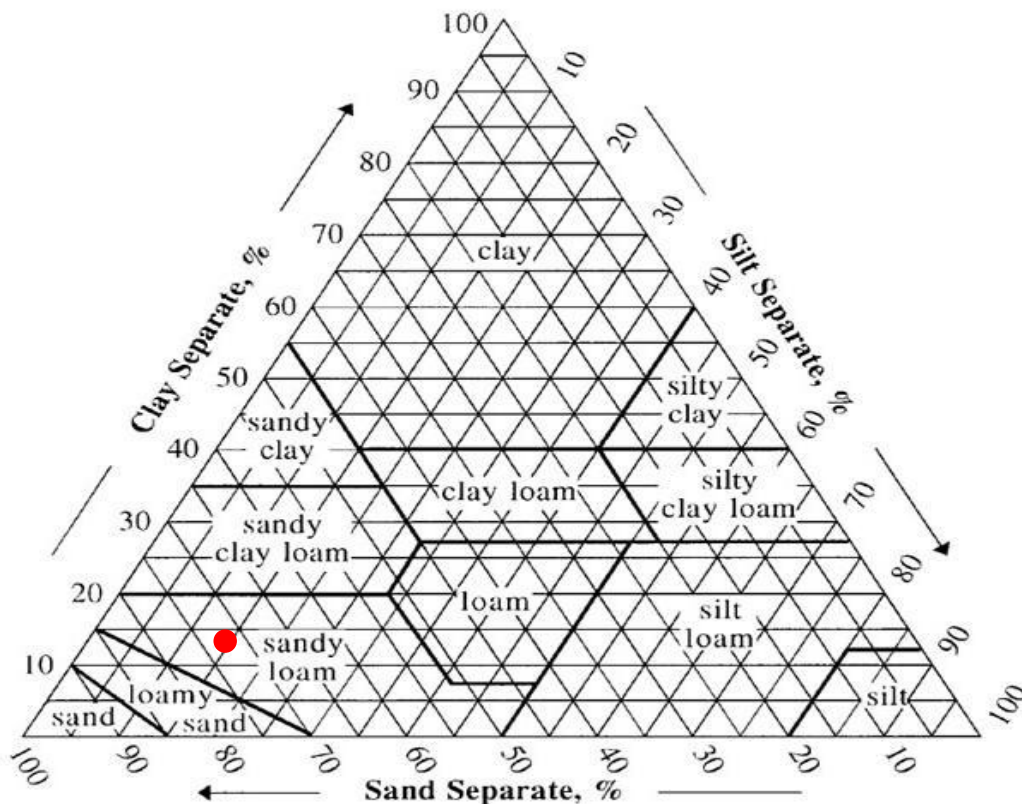
Phone: +617 3289 7179

|                    |                                                          |  |
|--------------------|----------------------------------------------------------|--|
| Test Code/Name     | [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |  |
| Lab Reference (LR) | 100818.446                                               |  |
| SampleID           | Control                                                  |  |

| Sand  | Clay  | Silt  | USDA Texture Class   |
|-------|-------|-------|----------------------|
| 72.3% | 13.0% | 14.7% | VERY FINE SANDY LOAM |

\* Texture Triangle proportions as a percentage of (Sand + Silt + Clay)

## Soil Texture Triangle



# Certificate of Analysis

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**Signatory:**



| Test Code/Name       | [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |                  |                                                      |
|----------------------|----------------------------------------------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 100818.446                                               | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | South Runnel-vacant                                      | Client Contact   | Peter Edmiston                                       |
|                      |                                                          | Project Name     | Biotrack - JBS Townsville                            |
| Report Date          | 16/08/2018                                               | Job Number       |                                                      |
| Sample Received Date | 10/08/2018                                               | Order Number     |                                                      |
| Sample Disposal Date | 9/10/2018                                                | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag                                              | Client Email     |                                                      |
| Temperature          | Ambient                                                  | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

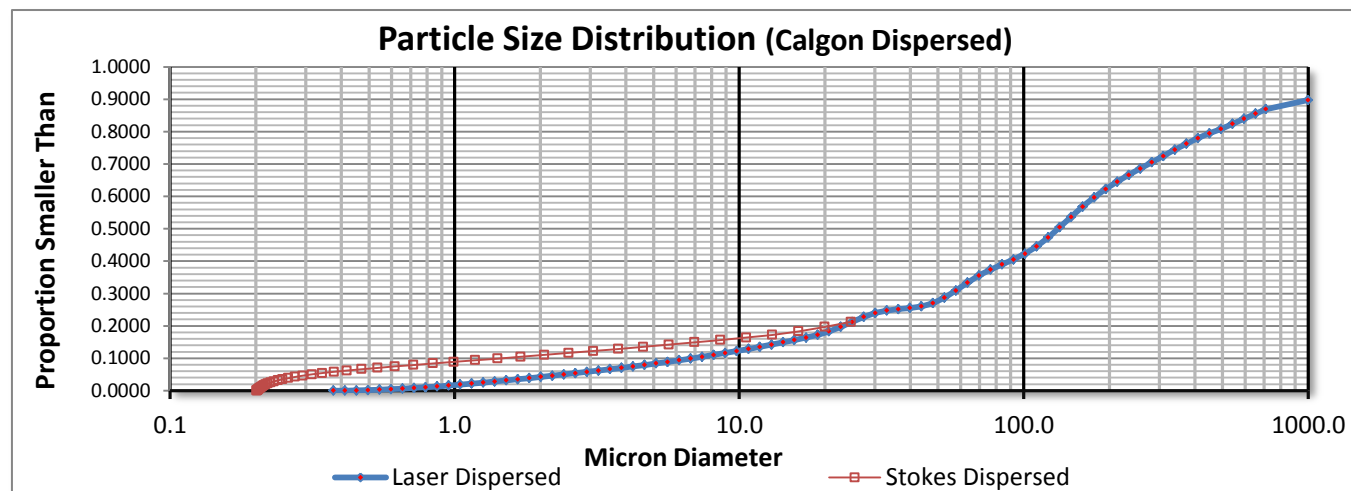
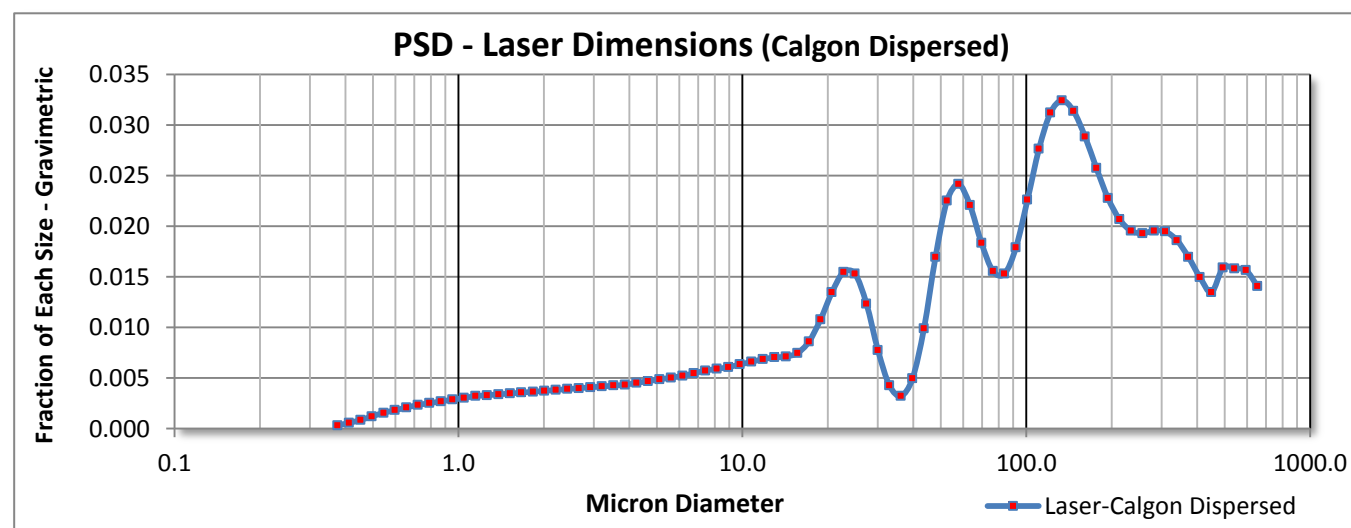
| CALGON DISPERSED SAMPLE TEST RESULTS<br>(gravimetric dry 105°C) |            |                  |
|-----------------------------------------------------------------|------------|------------------|
| Diameter mm                                                     | % In Range | Class            |
| > 2                                                             | 3.6%       | GRAVEL           |
| 1-2                                                             | 6.7%       | Very Coarse Sand |
| 1-0.5                                                           | 9.0%       | Coarse Sand      |
| 0.5-0.25                                                        | 12.2%      | Medium Sand      |
| 0.25-0.1                                                        | 26.3%      | Fine Sand        |
| 0.1-0.02                                                        | 22.6%      | Very Fine sand   |
| 2-0.02                                                          | 76.8%      | ALL SAND         |
| 0.02-0.002                                                      | 8.6%       | SILT *           |
| <0.002 mm                                                       | 11.0%      | CLAY *           |

## Analytical Method:

Soil dispersed using Hydrogen Peroxide & Calgon. Size Measurement: sieved >0.71mm, laser sized (Coulter LS 100Q) < 0.71 mm.

Water suspension, if measured: 10 minute slow rolling shake in rainwater.

\* Stokes Diameter estimated for sizes smaller than 25 microns. This estimates sizes measured by sedimentation methods (e.g. pipette & hydrometer). For sizes greater than 25 microns, the laser measurements are reported.





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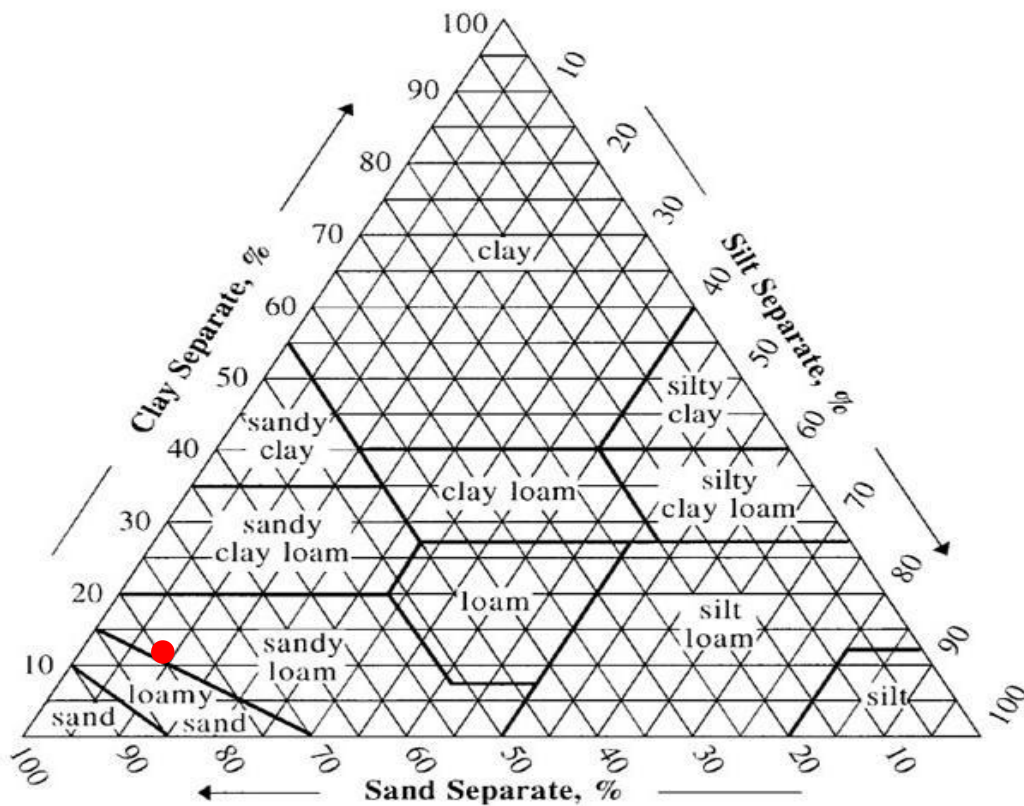
Phone: +617 3289 7179

|                    |                                                          |  |
|--------------------|----------------------------------------------------------|--|
| Test Code/Name     | [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |  |
| Lab Reference (LR) | 100818.446                                               |  |
| SampleID           | South Runnel-vacant                                      |  |

| Sand  | Clay  | Silt | USDA Texture Class |
|-------|-------|------|--------------------|
| 79.6% | 11.4% | 9.0% | FINE SANDY LOAM    |

\* Texture Triangle proportions as a percentage of (Sand + Silt + Clay)

## Soil Texture Triangle



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**Signatory:**



| Test Code/Name [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |                  |                  |                                                      |
|-------------------------------------------------------------------------|------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)                                                      | 100818.446       | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID                                                                | West Runnel -JBS | Client Contact   | Peter Edmiston                                       |
|                                                                         |                  | Project Name     | Biotrack - JBS Townsville                            |
| Report Date                                                             | 16/08/2018       | Job Number       |                                                      |
| Sample Received Date                                                    | 10/08/2018       | Order Number     |                                                      |
| Sample Disposal Date                                                    | 9/10/2018        | Chain of Custody |                                                      |
| Sample Packaging                                                        | Plastic Bag      | Client Email     |                                                      |
| Temperature                                                             | Ambient          | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

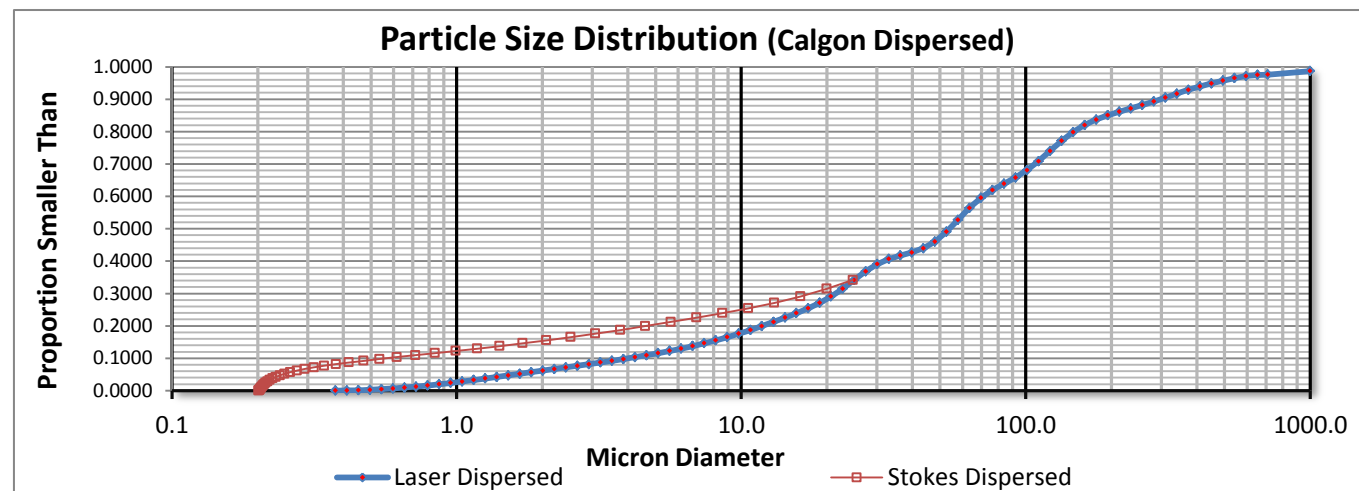
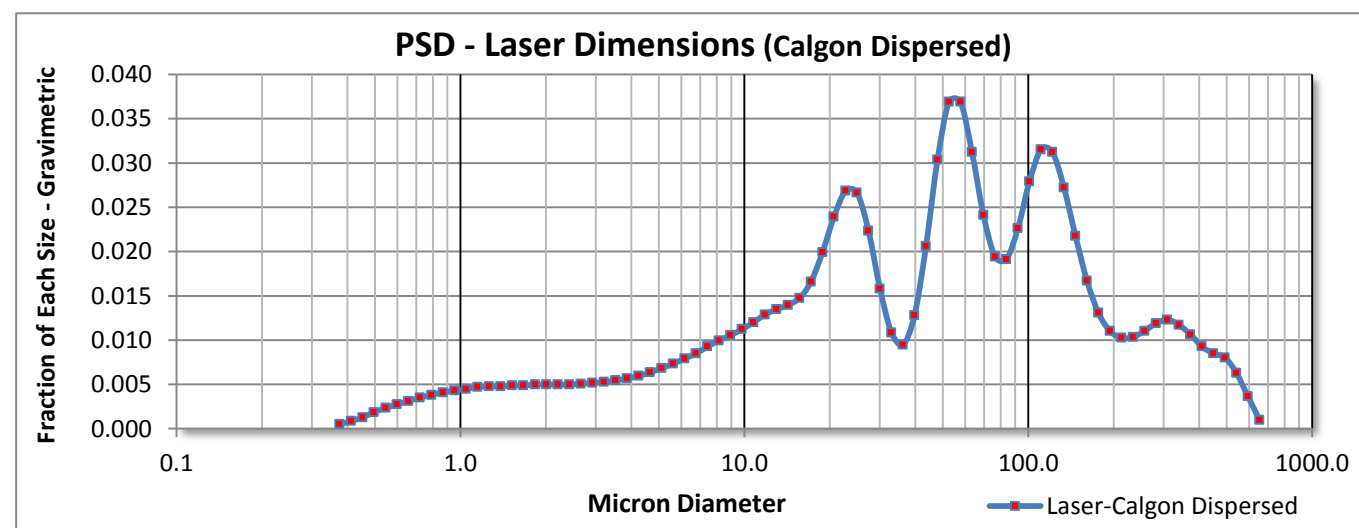
| CALGON DISPERSED SAMPLE TEST RESULTS<br>(gravimetric dry 105°C) |            |                  |
|-----------------------------------------------------------------|------------|------------------|
| Diameter mm                                                     | % In Range | Class            |
| > 2                                                             | 0.4%       | GRAVEL           |
| 1-2                                                             | 0.9%       | Very Coarse Sand |
| 1-0.5                                                           | 3.0%       | Coarse Sand      |
| 0.5-0.25                                                        | 7.5%       | Medium Sand      |
| 0.25-0.1                                                        | 20.1%      | Fine Sand        |
| 0.1-0.02                                                        | 36.6%      | Very Fine sand   |
| 2-0.02                                                          | 68.1%      | ALL SAND         |
| 0.02-0.002                                                      | 15.9%      | SILT *           |
| <0.002 mm                                                       | 15.6%      | CLAY *           |

## Analytical Method:

Soil dispersed using Hydrogen Peroxide & Calgon. Size Measurement: sieved >0.71mm, laser sized (Coulter LS 100Q) < 0.71 mm.

Water suspension, if measured: 10 minute slow rolling shake in rainwater.

\* Stokes Diameter estimated for sizes smaller than 25 microns. This estimates sizes measured by sedimentation methods (e.g. pipette & hydrometer). For sizes greater than 25 microns, the laser measurements are reported.



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|                    |                                                          |  |  |
|--------------------|----------------------------------------------------------|--|--|
| Test Code/Name     | [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |  |  |
| Lab Reference (LR) | 100818.446                                               |  |  |
| SampleID           | West Runnel -JBS                                         |  |  |

|                 |     |                  |     |                 |     |
|-----------------|-----|------------------|-----|-----------------|-----|
| pH              | NM* | EC (dS/m)        | NM* | Emerson Class   | NM* |
| Olsen P (mg/kg) | NM* | Total Nitrogen % | NM* | Organic Matter% | NM* |

pH & EC measured as 1:5 soil in water, 60 minute rolling shake

| Percentile | Measured Size |
|------------|---------------|
| Smaller    | micron        |
| 10         | 4             |
| 30         | 21            |
| 50         | 53            |
| 60         | 70            |
| 90         | 282           |

|                                           |     |
|-------------------------------------------|-----|
| D30 (microns)                             | 21  |
| Uniformity Coefficient (D60/D10)          | 18  |
| Coefficient of Gradation: D30^2/(D10*D60) | 1.6 |

| USGA Root Zone PSD Size Ranges : Dispersed Sample |                |      |                  |               |    |
|---------------------------------------------------|----------------|------|------------------|---------------|----|
|                                                   | Range          | %    | Conforming Sizes | Sample Rating |    |
|                                                   |                |      |                  | pass/fail     |    |
| Fine Gravel                                       | 3.4 - 2.0 mm   | 0.4  | 0                | High          |    |
| Very Coarse Sand                                  | 2.0 - 1.0 mm   | 0.9  | 0-5%             | Pass          |    |
| Coarse Sand                                       | 1.0 - 0.5 mm   | 3.0  | <20%             | Pass          |    |
| Medium Sand                                       | 0.5 - 0.25 mm  | 7.5  | 50-70%           | Low           |    |
| Fine Sand                                         | 0.25 - 0.15 mm | 8.3  | <= 5%            | High          |    |
| Very Fine Sand                                    | 0.15 - 0.05 mm | 30.8 | <= 5%            | High          |    |
| Silt                                              | 0.05 - 0.002mm | 33.5 | <= 5%            | High          |    |
| Clay                                              | < .002 mm      | 15.6 | <= 5%            | High          |    |
| Total Fines(Silt, Clay, VFSand)                   |                | 79.9 | <= 10%           | High          |    |
| Conforms to all specified size requirements?      |                |      |                  |               | No |

\*NM - Not Measured

|              | cm/hr | m/d | mm/hr |
|--------------|-------|-----|-------|
| Permeability | NM*   | NM* | NM*   |

| USCS Size Ranges: Dispersed Sample |                  |  | %    |
|------------------------------------|------------------|--|------|
| Gravel & Cobbles                   | >4.75 mm         |  | NM*  |
| Coarse Sand                        | 4.75 - 2.00 mm   |  | NM*  |
| Coarse Sand & Gravel               | >2 mm            |  | 0.4  |
| Medium Sand                        | 2.0 - 0.425 mm   |  | 5.6  |
| Fine Sand                          | 0.425 - 0.075 mm |  | 32.0 |
| Silt+Clay                          | <0.075 mm        |  | 62.0 |

| FAWB Soil Filter Media                                     |                |      |                  |               |
|------------------------------------------------------------|----------------|------|------------------|---------------|
| Bio-Retention Basin Specifications 2008 : Dispersed Sample |                |      |                  |               |
|                                                            | Range          | %    | Conforming Sizes | Sample Rating |
|                                                            |                |      |                  | pass/fail     |
| All Gravel                                                 | >2.0           | 0.4  | <3%              | Pass          |
| Fine Gravel                                                | 3.4 - 2.0 mm   | 0.4  | <3%              | Pass          |
| Coarse Sand                                                | 2.0 - 1.0 mm   | 0.9  | 7-10%            | Low           |
| Medium to Coarse Sand                                      | 1.0 - 0.25 mm  | 10.5 | 40-60%           | Low           |
| Fine Sand                                                  | 0.25 - 0.15 mm | 8.3  | 10-30%           | Low           |
| Very Fine Sand                                             | 0.15 - 0.05 mm | 30.8 | 5-30%            | High          |
| Clay & Silt(Stokes diameter <25micron)                     | <0.05 mm       | 49.0 | <3%              | High          |
| Conforms to all specified size requirements?               |                |      |                  | No            |

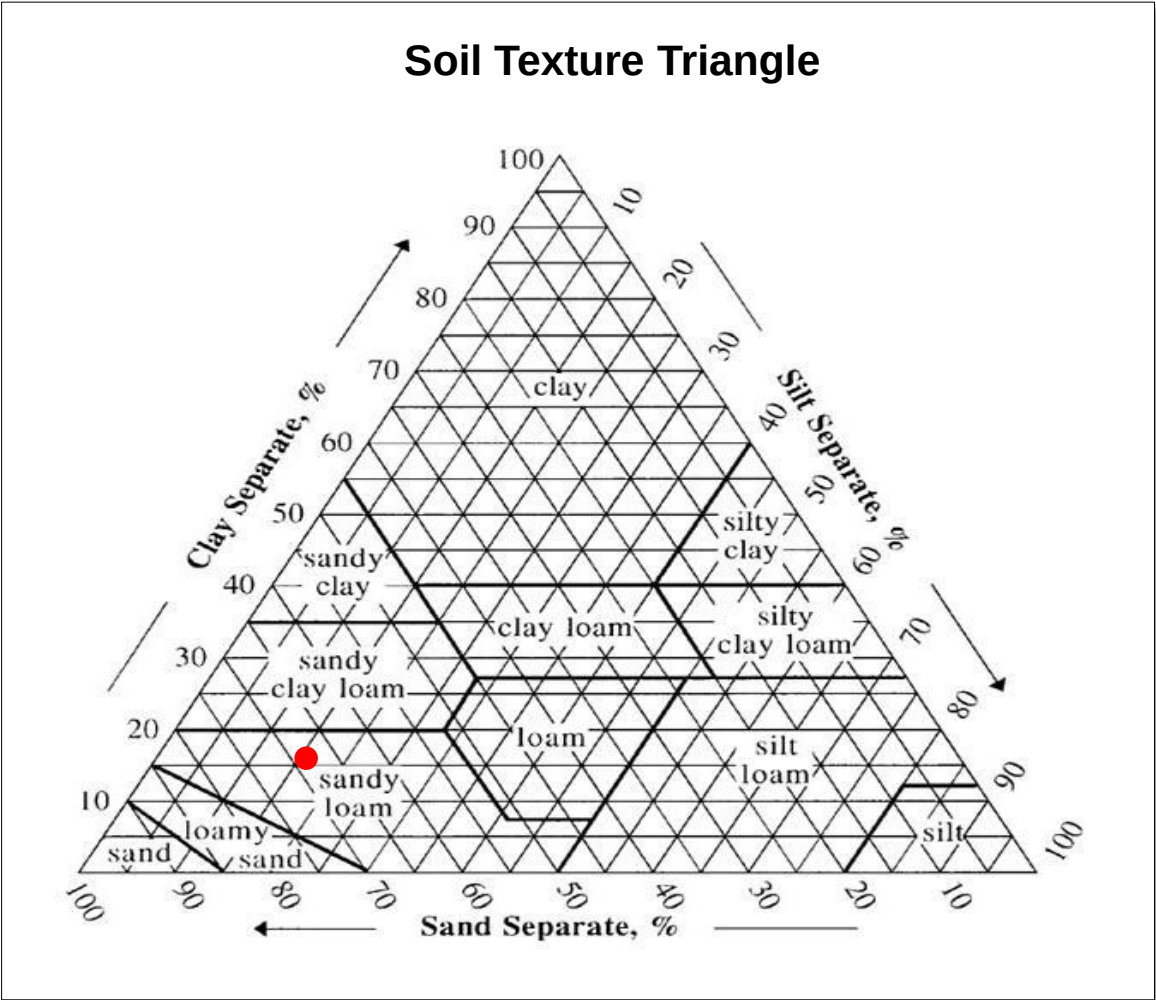
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|                    |                                                          |  |
|--------------------|----------------------------------------------------------|--|
| Test Code/Name     | [184] Particle Size Distribution (LASER <0.9 mm + Sieve) |  |
| Lab Reference (LR) | 100818.446                                               |  |
| SampleID           | West Runnel -JBS                                         |  |

| Sand  | Clay  | Silt  | USDA Texture Class   |
|-------|-------|-------|----------------------|
| 68.4% | 15.6% | 16.0% | VERY FINE SANDY LOAM |

\* Texture Triangle proportions as a percentage of (Sand + Silt + Clay)







# Certificate of Analysis

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| Test Code/Name       | [54] Nitrate+nitrite |                  |                                                      |
|----------------------|----------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 100818.444           | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples          | Client Contact   | Peter Edmiston                                       |
|                      |                      | Project Name     | Biotrack - JBS Townsville                            |
| Report Date          | 14/08/2018           | Job Number       |                                                      |
| Sample Received Date | 10/08/2018           | Order Number     |                                                      |
| Sample Disposal Date | 9/10/2018            | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag          | Client Email     |                                                      |
| Temperature          | Ambient              | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** 1:5 in 0.01M CaCl<sub>2</sub>. 2 hour rolling shake. Measurement by ICP.

| S# | SampleID            | Nitrate<br>mg/kg |
|----|---------------------|------------------|
| 1  | Control             | 38.6             |
| 2  | South Runnel-vacant | 3.2              |
| 3  | West Runnel -JBS    | 16.0             |



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| Test Code/Name       | [64] Phosphate (0.01 M KCl available) |                  |                                                      |
|----------------------|---------------------------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 100818.442                            | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples                           | Client Contact   | Peter Edmiston                                       |
|                      |                                       | Project Name     | Biotrack - JBS Townsville                            |
| Report Date          | 16/08/2018                            | Job Number       |                                                      |
| Sample Received Date | 10/08/2018                            | Order Number     |                                                      |
| Sample Disposal Date | 9/10/2018                             | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag                           | Client Email     |                                                      |
| Temperature          | Ambient                               | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** 1:5 in 0.01M KCL. 2 hour rolling shake. Measurement by ICP.

| S# | SampleID            | KCL P<br>mg P/kg |
|----|---------------------|------------------|
| 1  | Control             | 11               |
| 2  | South Runnel-vacant | 13               |
| 3  | West Runnel -JBS    | 20               |

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| Test Code/Name       | [65] Phosphate (H2SO4 available) |                  |                                                      |
|----------------------|----------------------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 100818.443                       | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples                      | Client Contact   | Peter Edmiston                                       |
|                      |                                  | Project Name     | Biotrack - JBS Townsville                            |
| Report Date          | 16/08/2018                       | Job Number       |                                                      |
| Sample Received Date | 10/08/2018                       | Order Number     |                                                      |
| Sample Disposal Date | 9/10/2018                        | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bag                      | Client Email     |                                                      |
| Temperature          | Ambient                          | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** As per Acid Extractable P (9G1), Soil Chemical Methods - Australasia, Raymont & Lyons, 2001.

| S# | SampleID            | H2SO4 P<br>mg P/kg |
|----|---------------------|--------------------|
| 1  | Control             | 120                |
| 2  | South Runnel-vacant | 132                |
| 3  | West Runnel -JBS    | 246                |

# Certificate of Analysis

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| Test Code/Name       | [56] Organic Carbon (LOI) |                  |                                                         |
|----------------------|---------------------------|------------------|---------------------------------------------------------|
| Lab Reference (LR)   | 100818.445                | Client Name      | BIO-TRACK PTY LTD                                       |
| SampleID             | All Samples               | Client Contact   | Peter Edmiston                                          |
|                      |                           | Project Name     | Biotrack - JBS Townsville                               |
| Report Date          | 13/08/2018                | Job Number       |                                                         |
| Sample Received Date | 10/08/2018                | Order Number     |                                                         |
| Sample Disposal Date | 9/10/2018                 | Chain of Custody |                                                         |
| Sample Packaging     | Plastic Bag               | Client Email     |                                                         |
| Temperature          | Ambient                   | Client Address   | 781 Mount Glorious Road Highvale Brisbane<br>Queensland |

**Analytical Method:** Based on modified version of D.F. Ball Loss-On-Ignition as an Estimate of Organic Matter and Organic Carbon in Non-Calcareous Soils *Journal of Soil Science*, Vol. 15, No. 1, 1964.

Initial dry for 2 hours at 110 degrees C, subsequent ignition for 17 hours at 375 degrees C

\* Regression:  $y = 0.46x - 0.6$

\*\*Organic Carbon to Organic Content Conversion Factor: 1.72

| S# | SampleID            | Percentage Lost on Ignition (LOI) % | *Organic Carbon % | **Organic Content % |
|----|---------------------|-------------------------------------|-------------------|---------------------|
| 1  | Control             | 3.67                                | 1.49              | 2.56                |
| 2  | South Runnel-vacant | 2.49                                | 0.95              | 1.63                |
| 3  | West Runnel -JBS    | 2.39                                | 0.90              | 1.55                |









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| Test Code/Name       | [54] Nitrate+nitrite |                  |                                                      |
|----------------------|----------------------|------------------|------------------------------------------------------|
| Lab Reference (LR)   | 100818.495           | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples          | Client Contact   | Peter Edmiston                                       |
|                      |                      | Project Name     | Biotrack - JBS Townsville                            |
| Report Date          | 14/08/2018           | Job Number       |                                                      |
| Sample Received Date | 10/08/2018           | Order Number     |                                                      |
| Sample Disposal Date | 9/10/2018            | Chain of Custody |                                                      |
| Sample Packaging     | Plastic Bottle       | Client Email     |                                                      |
| Temperature          | Chilled              | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** 1:5 in 0.01M CaCl<sub>2</sub>. 2 hour rolling shake. Measurement by ICP.

| S# | SampleID                    | Nitrate<br>mg/kg |
|----|-----------------------------|------------------|
| 1  | Stuart Creek-east of H.Way  | 0.3              |
| 2  | Vantassel Ck, east of track | 0.1              |



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| Test Code/Name       |                | [65] Phosphate (H2SO4 available) |                                                      |
|----------------------|----------------|----------------------------------|------------------------------------------------------|
| Lab Reference (LR)   | 100818.494     | Client Name                      | BIO-TRACK PTY LTD                                    |
| SampleID             | All Samples    | Client Contact                   | Peter Edmiston                                       |
|                      |                | Project Name                     | Biotrack - JBS Townsville                            |
| Report Date          | 16/08/2018     | Job Number                       |                                                      |
| Sample Received Date | 10/08/2018     | Order Number                     |                                                      |
| Sample Disposal Date | 9/10/2018      | Chain of Custody                 |                                                      |
| Sample Packaging     | Plastic Bottle | Client Email                     |                                                      |
| Temperature          | Chilled        | Client Address                   | 781 Mount Glorious Road Highvale Brisbane Queensland |

**Analytical Method:** As per Acid Extractable P (9G1), Soil Chemical Methods - Australasia, Raymont & Lyons, 2001.

| S# | SampleID                    | H2SO4 P<br>mg P/kg |
|----|-----------------------------|--------------------|
| 1  | Stuart Creek-east of H.Way  | 152                |
| 2  | Vantassel Ck, east of track | 950                |

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| Test Code/Name       | [56] Organic Carbon (LOI) |                  |                                                         |
|----------------------|---------------------------|------------------|---------------------------------------------------------|
| Lab Reference (LR)   | 100818.497                | Client Name      | BIO-TRACK PTY LTD                                       |
| SampleID             | All Samples               | Client Contact   | Peter Edmiston                                          |
|                      |                           | Project Name     | Biotrack - JBS Townsville                               |
| Report Date          | 13/08/2018                | Job Number       |                                                         |
| Sample Received Date | 10/08/2018                | Order Number     |                                                         |
| Sample Disposal Date | 9/10/2018                 | Chain of Custody |                                                         |
| Sample Packaging     | Plastic Bottle            | Client Email     |                                                         |
| Temperature          | Chilled                   | Client Address   | 781 Mount Glorious Road Highvale Brisbane<br>Queensland |

**Analytical Method:** Based on modified version of D.F. Ball Loss-On-Ignition as an Estimate of Organic Matter and Organic Carbon in Non-Calcareous Soils *Journal of Soil Science*, Vol. 15, No. 1, 1964.

Initial dry for 2 hours at 110 degrees C, subsequent ignition for 17 hours at 375 degrees C

\* Regression:  $y = 0.46x - 0.6$

\*\*Organic Carbon to Organic Content Conversion Factor: 1.72

| S# | SampleID                    | Percentage Lost on Ignition (LOI) % | *Organic Carbon % | **Organic Content % |
|----|-----------------------------|-------------------------------------|-------------------|---------------------|
| 1  | Stuart Creek-east of H.Way  | 16.94                               | 7.59              | 13.06               |
| 2  | Vantassel Ck, east of track | 5.71                                | 2.43              | 4.17                |





# Certificate of Analysis

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**Signatory:**

*P. Edmiston*

| Test Code/Name                                                                                                     |                             |                  |                                                      |
|--------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------|------------------------------------------------------|
| [184] Particle Size Distribution LASER <0.9mm fraction: Dispersion Only (Peroxide+Calgon) + Sieves(4/3.35/2/1/.71) |                             |                  |                                                      |
| Lab Reference (LR)                                                                                                 | 100818.492                  | Client Name      | BIO-TRACK PTY LTD                                    |
| SampleID                                                                                                           | Vantassel Ck, east of track | Client Contact   | Peter Edmiston                                       |
|                                                                                                                    |                             | Project Name     | Biotrack - JBS Townsville                            |
| Report Date                                                                                                        | 16/08/2018                  | Job Number       |                                                      |
| Sample Received Date                                                                                               | 10/08/2018                  | Order Number     |                                                      |
| Sample Disposal Date                                                                                               | 9/10/2018                   | Chain of Custody |                                                      |
| Sample Packaging                                                                                                   | Plastic Bottle              | Client Email     |                                                      |
| Temperature                                                                                                        | Chilled                     | Client Address   | 781 Mount Glorious Road Highvale Brisbane Queensland |

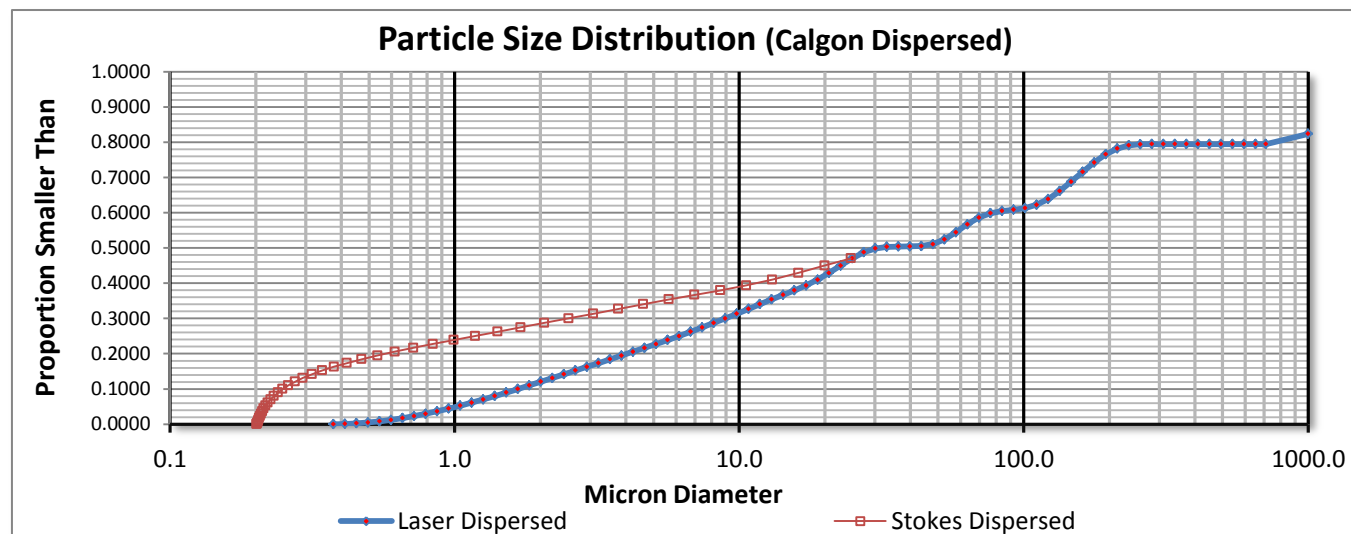
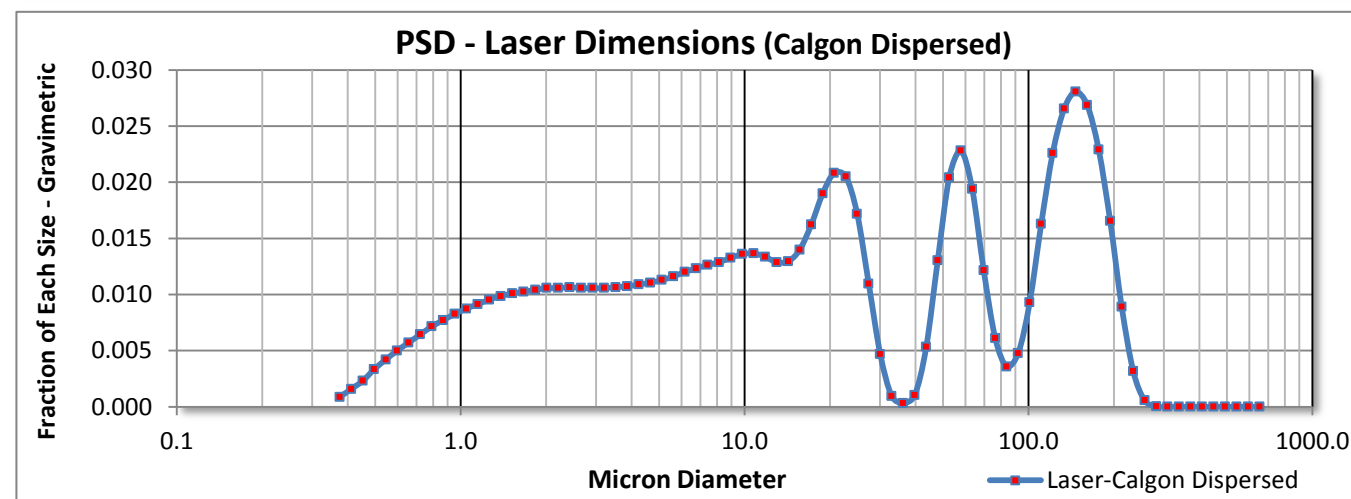
| CALGON DISPERSED SAMPLE TEST RESULTS<br>(gravimetric dry 105°C) |            |                  |
|-----------------------------------------------------------------|------------|------------------|
| Diameter mm                                                     | % In Range | Class            |
| > 2                                                             | 11.3%      | GRAVEL           |
| 1-2                                                             | 6.3%       | Very Coarse Sand |
| 1-0.5                                                           | 2.9%       | Coarse Sand      |
| 0.5-0.25                                                        | 0.1%       | Medium Sand      |
| 0.25-0.1                                                        | 18.1%      | Fine Sand        |
| 0.1-0.02                                                        | 16.3%      | Very Fine sand   |
| 2-0.02                                                          | 43.7%      | ALL SAND         |
| 0.02-0.002                                                      | 16.3%      | SILT *           |
| <0.002 mm                                                       | 28.7%      | CLAY *           |

## Analytical Method:

Soil dispersed using Hydrogen Peroxide & Calgon. Size Measurement: sieved >0.71mm, laser sized (Coulter LS 100Q) < 0.71 mm.

Water suspension, if measured: 10 minute slow rolling shake in rainwater.

\* Stokes Diameter estimated for sizes smaller than 25 microns. This estimates sizes measured by sedimentation methods (e.g. pipette & hydrometer). For sizes greater than 25 microns, the laser measurements are reported.



# Certificate of Analysis

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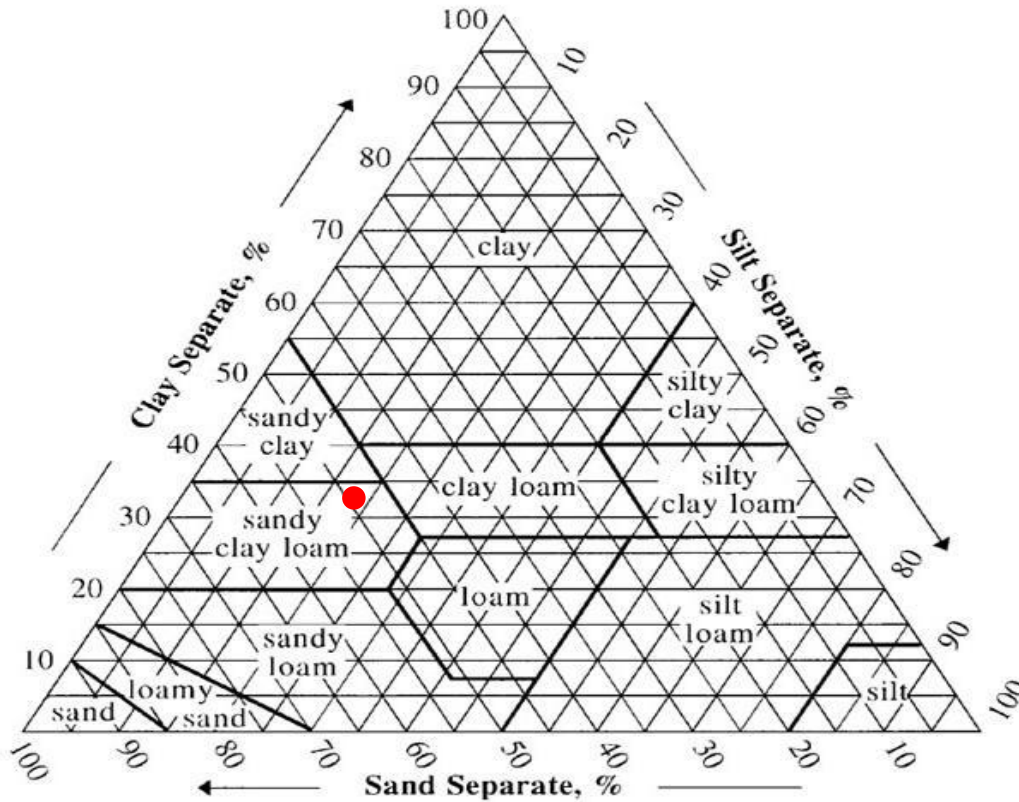
Phone: +617 3289 7179

|                    |                                                                         |  |
|--------------------|-------------------------------------------------------------------------|--|
| Test Code/Name     | [184] Particle Size Distribution LASER <0.9mm fraction: Dispersion Only |  |
| Lab Reference (LR) | 100818.492                                                              |  |
| SampleID           | Vantassel Ck, east of track                                             |  |

| Sand  | Clay  | Silt  | USDA Texture Class |
|-------|-------|-------|--------------------|
| 49.3% | 32.4% | 18.3% | SANDY CLAY LOAM    |

\* Texture Triangle proportions as a percentage of (Sand + Silt + Clay)

## Soil Texture Triangle







# TropWATER Analytical Services

James Cook University Townsville 4811 QLD Australia

Tel: 07 4781 4262 Fax: 07 4781 5589 Email: actfr.laboratory@jcu.edu.au

## Certificate of Analysis

### Client Details

**Client Name:** JBS Swift  
**Postal Address:** PO Box 1160  
AITKENVALE QLD 4810  
**Attention:** Trevor Govindsamy  
**Telephone:** 07 4720 8029  
**Email:** Trevor.Govindsamy@jbssa.com.au

### Laboratory Contact

**Michelle Tink**  
(MRACI C.Chem.)  
Laboratory Manager  
Phone: 07 4781 5214  
Fax: 07 4781 5589  
Email: michelle.tink@jcu.edu.au

### Analysis Results:

| Analysis   | Unit | Irrigation<br>Area 1<br>28/11/2017<br>J17-0346/1 | Irrigation<br>Area 2<br>28/11/2017<br>J17-0346/2 | Irrigation<br>Area 3<br>28/11/2017<br>J17-0346/3 | Irrigation<br>Area 4<br>28/11/2017<br>J17-0346/4 |
|------------|------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Phosphorus | %    | 0.33                                             | 0.47                                             | 0.41                                             | 0.33                                             |
| Nitrogen   | %    | 1.20                                             | 1.14                                             | 1.68                                             | 2.38                                             |
| Potassium  | %    | 1.40                                             | 1.74                                             | 1.49                                             | 1.68                                             |
| Sodium     | %    | 1.83                                             | 1.55                                             | 1.99                                             | 2.20                                             |

| Analysis   | Unit | Irrigation<br>Area 5<br>28/11/2017<br>J17-0346/5 | Irrigation<br>Area 6<br>28/11/2017<br>J17-0346/6 |
|------------|------|--------------------------------------------------|--------------------------------------------------|
| Phosphorus | %    | 0.32                                             | 0.27                                             |
| Nitrogen   | %    | 3.44                                             | 1.48                                             |
| Potassium  | %    | 2.13                                             | 1.94                                             |
| Sodium     | %    | 3.02                                             | 1.66                                             |

**Comment:**

Patrick Cunningham  
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**Monthly Bale Count - JBS Swift**

**Jan 2017**

| <b>Paddock Code</b>                | <b>Date Cut</b> | <b>Qty Silage</b> | <b>Qty 5x4ft</b> | <b>Qty 4x4ft</b> | <b>Qty 3x4ft</b> | <b>Qty Square</b> | <b>Paddock Totals (Bales)</b> | <b>Dry Matter Totals (t)</b> |
|------------------------------------|-----------------|-------------------|------------------|------------------|------------------|-------------------|-------------------------------|------------------------------|
| I1                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I2                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I3                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I4                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I5                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I6                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I7                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| I8                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F1                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F2                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F3                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F4                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F5                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F6                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| F7                                 |                 |                   |                  |                  |                  |                   | 0                             | 0                            |
| <b>Qty Sub Total</b>               |                 | 0                 | 0                | 0                | 0                | 0                 |                               |                              |
| <b>Avg Weight Dry Matter (kg)</b>  |                 | 240               | 426              | 230              | 131              | 340               |                               |                              |
| <b>Sub Weight Dry Matter (t)</b>   |                 | 0                 | 0                | 0                | 0                | 0                 |                               |                              |
| <b>Total Weight Dry Matter (t)</b> |                 | 0                 |                  |                  |                  |                   | 0                             | 0                            |

**Monthly Bale Count - JBS Swift**

**Feb 2017**

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          |          |            |           |           |           |            | 0                      | 0                     |
| I2                          | 10.02.17 | 52         |           | 132       | 140       |            | 324                    | 61                    |
| I3                          | 23.02.17 | 235        |           | 104       | 61        |            | 400                    | 88                    |
| I4                          | 20.02.17 | 192        |           |           |           |            | 192                    | 46                    |
| I5                          | 15.02.17 | 172        |           |           |           |            | 172                    | 41                    |
| I6                          | 28.02.17 | 91         |           |           |           |            | 91                     | 22                    |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 742        | 0         | 236       | 201       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 178        | 0         | 54        | 26        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 259        |           |           |           |            | 1179                   | 259                   |

**Monthly Bale Count - JBS Swift**

**March 2017**

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          |          |            |           |           |           |            | 0                      | 0                     |
| I2                          |          |            |           |           |           |            | 0                      | 0                     |
| I3                          |          |            |           |           |           |            | 0                      | 0                     |
| I4                          |          |            |           |           |           |            | 0                      | 0                     |
| I5                          |          |            |           |           |           |            | 0                      | 0                     |
| I6                          |          |            |           |           |           |            | 0                      | 0                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          | 06.03.17 | 78         |           |           |           |            | 78                     | 19                    |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          | 07.03.17 | 50         |           |           |           |            | 50                     | 12                    |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 128        | 0         | 0         | 0         | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 31         | 0         | 0         | 0         | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 31         |           |           |           |            | 128                    | 31                    |

**Monthly Bale Count - JBS Swift**

**April 2017**

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          |          |            |           |           |           |            | 0                      | 0                     |
| I2                          | 06.04.17 |            |           | 70        | 280       |            | 350                    | 53                    |
| I3                          | 24.04.17 |            |           |           | 126       |            | 126                    | 17                    |
| I4                          | 05.04.17 |            |           | 46        | 74        |            | 120                    | 20                    |
| I5                          | 06.04.17 |            |           |           | 40        |            | 40                     | 5                     |
| I6                          |          |            |           |           |           |            | 0                      | 0                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 0          | 0         | 116       | 520       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 27        | 68        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 95         |           |           |           |            | 636                    | 95                    |



Monthly Bale Count - JBS Swift

May 2017

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          | 28.05.17 |            |           | 44        | 186       |            | 230                    | 35                    |
| I2                          |          |            |           |           |           |            | 0                      | 0                     |
| I3                          |          |            |           |           |           |            | 0                      | 0                     |
| I4                          |          |            |           |           |           |            | 0                      | 0                     |
| I5                          |          |            |           |           |           |            | 0                      | 0                     |
| I6                          |          |            |           |           |           |            | 0                      | 0                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          | 02.05.17 | 20         |           |           |           | 70         | 90                     | 29                    |
| F3                          | 02.05.17 |            |           |           |           | 180        | 180                    | 61                    |
| F4                          | 08.05.17 |            |           |           | 205       |            | 205                    | 27                    |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          | 07.05.17 |            |           |           |           | 115        | 115                    | 39                    |
| Qty Sub Total               |          | 20         | 0         | 44        | 391       | 365        |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 5          | 0         | 10        | 51        | 124        |                        |                       |
| Total Weight Dry Matter (t) |          | 190        |           |           |           |            | 820                    | 190                   |

**Monthly Bale Count - JBS Swift**

**June 2017**

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          |          |            |           |           |           |            | 0                      | 0                     |
| I2                          | 19.06.17 |            |           |           | 175       |            | 175                    | 23                    |
| I3                          | 26.06.17 |            |           |           | 140       |            | 140                    | 18                    |
| I4                          | 07.06.17 |            |           | 44        |           |            | 44                     | 10                    |
| I5                          | 07.06.17 |            |           |           | 120       |            | 120                    | 16                    |
| I6                          | 05.06.17 |            |           |           | 58        |            | 58                     | 8                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 0          | 0         | 44        | 493       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 10        | 65        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 75         |           |           |           |            | 537                    | 75                    |

**Monthly Bale Count - JBS Swift**

**July 2017**

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          | 31.07.17 |            |           |           | 168       |            | 168                    | 22                    |
| I2                          |          |            |           |           |           |            | 0                      | 0                     |
| I3                          |          |            |           |           |           |            | 0                      | 0                     |
| I4                          |          |            |           |           |           |            | 0                      | 0                     |
| I5                          |          |            |           |           |           |            | 0                      | 0                     |
| I6                          | 25.07.17 |            |           |           | 46        |            | 46                     | 6                     |
| I7                          | 04.07.17 |            |           |           | 470       |            | 470                    | 62                    |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          | 26.07.17 |            |           | 54        | 35        |            | 89                     | 17                    |
| F3                          | 25.07.17 |            |           | 17        | 18        |            | 35                     | 6                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 0          | 0         | 71        | 737       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 16        | 97        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 113        |           |           |           |            | 808                    | 113                   |

Monthly Bale Count - JBS Swift

Aug 2017

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          |          |            |           |           |           |            | 0                      | 0                     |
| I2                          | 14.08.17 |            |           |           | 269       |            | 269                    | 35                    |
| I3                          |          |            |           |           |           |            | 0                      | 0                     |
| I4                          | 08.08.17 |            |           |           | 100       |            | 100                    | 13                    |
| I5                          | 08.08.17 |            |           |           | 100       |            | 100                    | 13                    |
| I6                          |          |            |           |           |           |            | 0                      | 0                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          | 14.08.17 |            |           |           | 72        |            | 72                     | 9                     |
| F7                          | 08.08.17 |            |           |           | 84        |            | 84                     | 11                    |
| Qty Sub Total               |          | 0          | 0         | 0         | 625       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 0         | 82        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 82         |           |           |           |            | 625                    | 82                    |



Monthly Bale Count - JBS Swift

Sept 2017

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          | 23.09.17 |            |           | 80        | 56        |            | 136                    | 26                    |
| I2                          |          |            |           |           |           |            | 0                      | 0                     |
| I3                          | 04.09.17 |            |           |           | 210       |            | 210                    | 28                    |
| I4                          |          |            |           |           |           |            | 0                      | 0                     |
| I5                          |          |            |           |           |           |            | 0                      | 0                     |
| I6                          | 20.09.17 |            |           |           | 68        |            | 68                     | 9                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 0          | 0         | 80        | 334       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 18        | 44        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 62         |           |           |           |            | 414                    | 62                    |

Monthly Bale Count - JBS Swift

Oct 2017

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          |          |            |           |           |           |            | 0                      | 0                     |
| I2                          | 09.10.17 |            |           |           | 171       |            | 171                    | 22                    |
| I3                          | 30.10.17 |            |           |           | 272       |            | 272                    | 36                    |
| I4                          |          |            |           |           |           |            | 0                      | 0                     |
| I5                          |          |            |           |           |           |            | 0                      | 0                     |
| I6                          |          |            |           |           |           |            | 0                      | 0                     |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 0          | 0         | 0         | 443       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 0         | 58        | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 58         |           |           |           |            | 443                    | 58                    |

Monthly Bale Count - JBS Swift

Nov 2017

| Paddock Code                | Date Cut | Qty Silage | Qty 5x4ft | Qty 4x4ft | Qty 3x4ft | Qty Square | Paddock Totals (Bales) | Dry Matter Totals (t) |
|-----------------------------|----------|------------|-----------|-----------|-----------|------------|------------------------|-----------------------|
| I1                          | 14.11.17 |            |           | 20        | 282       |            | 302                    | 42                    |
| I2                          |          |            |           |           |           |            | 0                      | 0                     |
| I3                          |          |            |           |           |           |            | 0                      | 0                     |
| I4                          | 04.11.17 |            |           |           | 215       |            | 215                    | 28                    |
| I5                          | 04.11.17 |            |           |           | 215       |            | 215                    | 28                    |
| I6                          | 04.11.17 |            |           |           | 100       |            | 100                    | 13                    |
| I7                          |          |            |           |           |           |            | 0                      | 0                     |
| I8                          |          |            |           |           |           |            | 0                      | 0                     |
| F1                          |          |            |           |           |           |            | 0                      | 0                     |
| F2                          |          |            |           |           |           |            | 0                      | 0                     |
| F3                          |          |            |           |           |           |            | 0                      | 0                     |
| F4                          |          |            |           |           |           |            | 0                      | 0                     |
| F5                          |          |            |           |           |           |            | 0                      | 0                     |
| F6                          |          |            |           |           |           |            | 0                      | 0                     |
| F7                          |          |            |           |           |           |            | 0                      | 0                     |
| Qty Sub Total               |          | 0          | 0         | 20        | 812       | 0          |                        |                       |
| Avg Weight Dry Matter (kg)  |          | 240        | 426       | 230       | 131       | 340        |                        |                       |
| Sub Weight Dry Matter (t)   |          | 0          | 0         | 5         | 107       | 0          |                        |                       |
| Total Weight Dry Matter (t) |          | 111        |           |           |           |            | 832                    | 111                   |









|                                     | Irrigated Area | Harvested      |
|-------------------------------------|----------------|----------------|
|                                     | m2             | m2             |
| Flood 1                             | 48,463         | 48,463         |
| Flood 2                             | 44,861         | 44,861         |
| Flood 3                             | 25,834         | 25,834         |
| Flood 4                             | 26,348         | 26,348         |
| Flood 5                             | 69,244         | 69,244         |
| Flood 6                             | 30,800         | 30,800         |
| Flood 7                             | 58,786         | 58,786         |
| Flood 8                             | 15,844         | 15,844         |
| <b>Total Flood</b>                  | <b>320,180</b> |                |
|                                     |                |                |
| Spray 1                             | 63,332         | 63,332         |
| Spray 2                             | 63,721         | 63,721         |
| Spray 3                             | 52,296         | 52,296         |
| Spray 4                             | 49,455         | 49,455         |
| Spray 5                             | 29,188         | 29,188         |
| Spray 6                             | 112,155        | 112,155        |
| Spray 7                             | 107,149        | 107,149        |
| <b>Mix Pasture *</b>                | <b>110,387</b> | <b>183,978</b> |
| <b>Total Spray</b>                  | <b>587,683</b> |                |
|                                     |                |                |
| <b>Total Irrigated</b>              |                | <b>907,863</b> |
| <b>Total Harvested</b>              |                | <b>981,454</b> |
| <b>* Proportion Spray Irrigated</b> |                | <b>0.6</b>     |

| Distribution of Irrigated Volume |     |
|----------------------------------|-----|
| Percentage Spray Irrigated       | 95% |
| Percentage Flood Irrigated       | 5%  |

| POND/STORAGE      |                           | Surface Area | Effective Max Depth | Effective Volume | Flows To   |
|-------------------|---------------------------|--------------|---------------------|------------------|------------|
|                   |                           | m2           | m                   | m3               |            |
| Treatment Ponds   | Sludge                    | 4187         | 2.41                | 10100            | Irrigation |
|                   | Pond 2 Anaerobic          | 1840         | 2.12                | 3900             |            |
|                   | Pond 3 Anaerobic          | 1887         | 2.07                | 3900             |            |
|                   | Pond 4 Faculative/aerobic | 4865         | 1.11                | 5400             |            |
|                   | Pond 5 Faculative/aerobic | 3586         | 1.78                | 6400             |            |
|                   | Final Aerobic             | 9111         | 1.15                | 10500            |            |
| Recovery Ponds    | First Flush Storage       | 2189         |                     |                  |            |
|                   | Tailwater                 | 12339        | 1.22                | 15000            |            |
| Stock Water Ponds | Stock 1                   | 4795         |                     |                  | Stormwater |
|                   | Stock 2                   | 2531         |                     |                  |            |
|                   | Stock 3                   | 2404         |                     |                  |            |

|                                   |            |    |
|-----------------------------------|------------|----|
| <b>Total Site Area</b>            | <b>266</b> | ha |
| <b>Abattoir</b>                   | 6          | ha |
| <b>Treatment Ponds</b>            | 2.5476     | ha |
| <b>First Flush Pond</b>           | 0.2189     | ha |
| <b>Tailwater Pond</b>             | 1.2339     | ha |
| <b>Stock Water Dam</b>            | 0.973      | ha |
| <b>Pond x ??</b>                  | 20996      | ha |
| Bunded Areas Flowing To Treatment |            | ha |
| <b>Abattoir Impervious</b>        |            | ha |
| <b>Abattoir Pervious</b>          |            | ha |
| <b>Flood Irrigation</b>           | 32.0       | ha |
| <b>Spray Irrigation</b>           | 58.8       | ha |
| <b>Grazed-not irrigated</b>       |            | ha |
| <b>Not Grazed-Not Irrigated</b>   |            | ha |
| <b>Balance</b>                    | calc       |    |
|                                   |            |    |

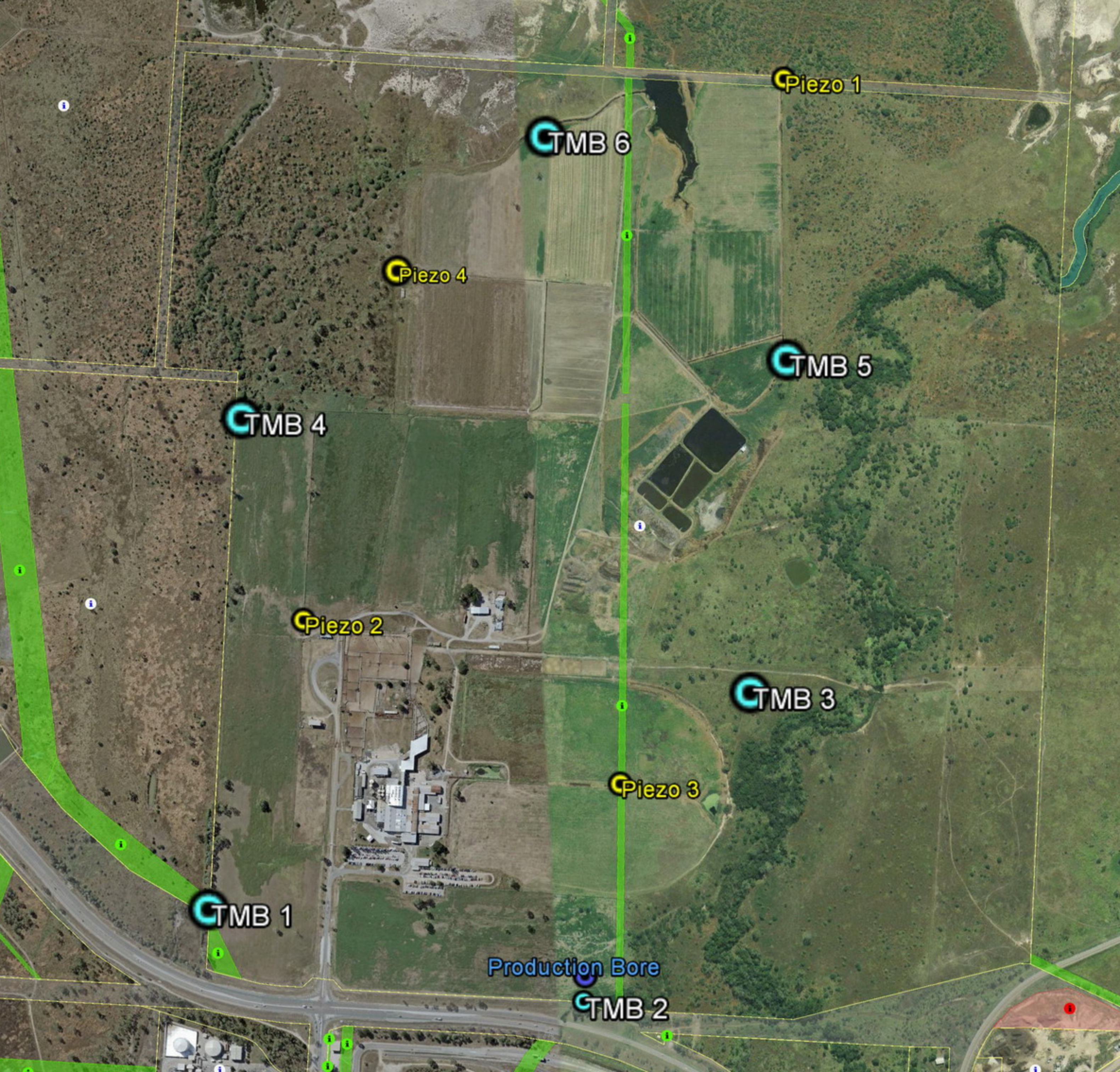
|                          |            |             |
|--------------------------|------------|-------------|
| <b>Wastewater Supply</b> | <b>260</b> | <b>ML/y</b> |
| Supply Period            | Day 49     | start       |
|                          | Day 344    | finish      |
| Supply Duration          | 43         | weeks/y     |
| Process Daily Supply     | 0.864      | ML/d        |

|                               |      |      |
|-------------------------------|------|------|
| <b>Wastewater Composition</b> |      |      |
| <b>Final Aerobic Pond</b>     |      |      |
| Total Nitrogen                | 130  | mg/L |
| Total Phosphorus              | 30   | mg/L |
| Dissolved Salt                | 813  | mg/L |
| Electrical Conductivity       | 1.95 | dS/m |
| Biological Oxygen Demand      | 76   | mg/L |
|                               |      |      |
| <b>Tail Water Pond</b>        |      |      |
| Total Nitrogen                | 3.9  | mg/L |
| Total Phosphorus              | 4.1  | mg/L |
| Dissolved Salt                | 190  | mg/L |
| Electrical Conductivity       | 0.22 | dS/m |
| Biological Oxygen Demand      | 12   | mg/L |









Piezo 1

TMB 6

Piezo 4

TMB 5

TMB 4

Piezo 2

TMB 3

Piezo 3

TMB 1

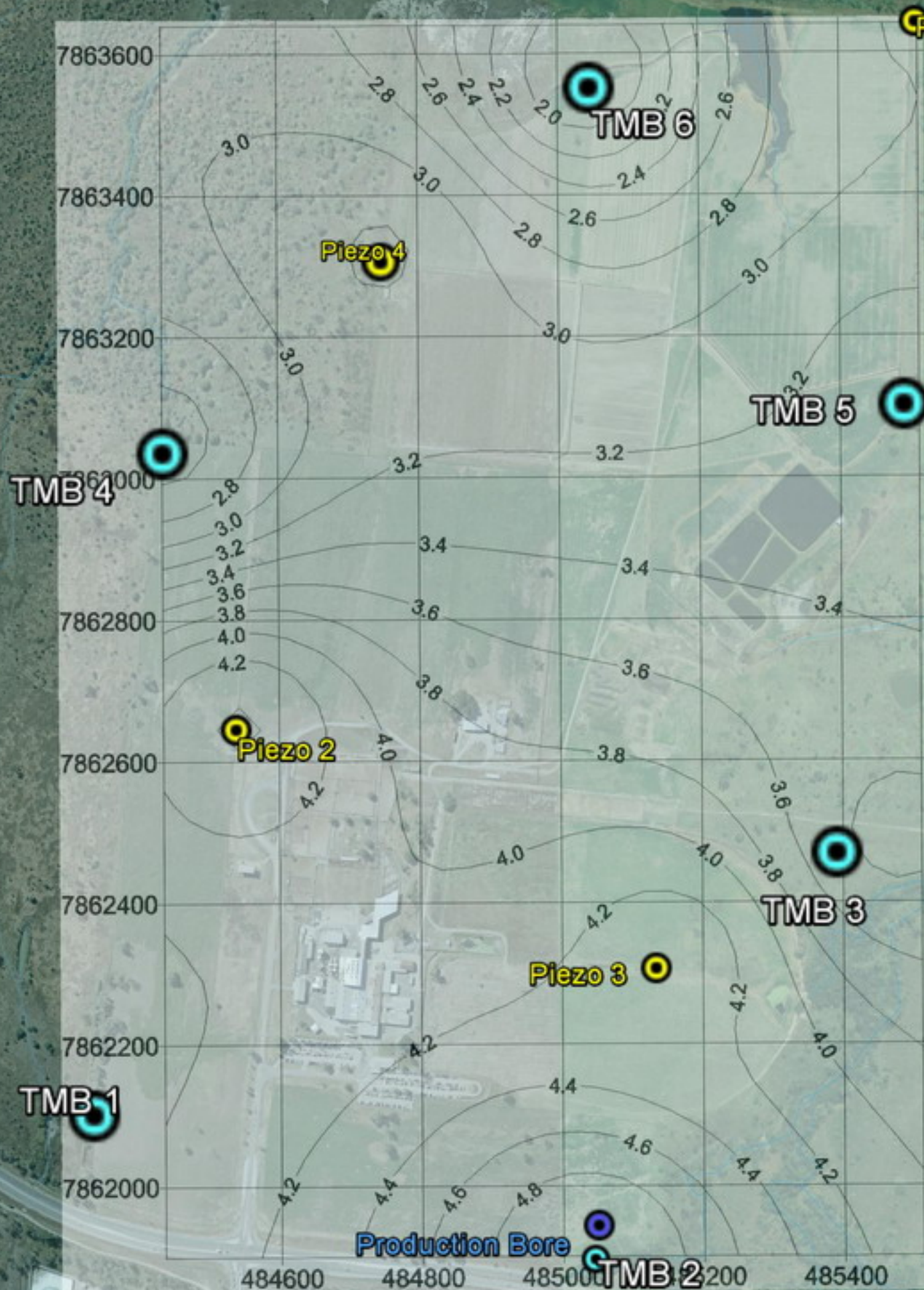
Production Bore

TMB 2



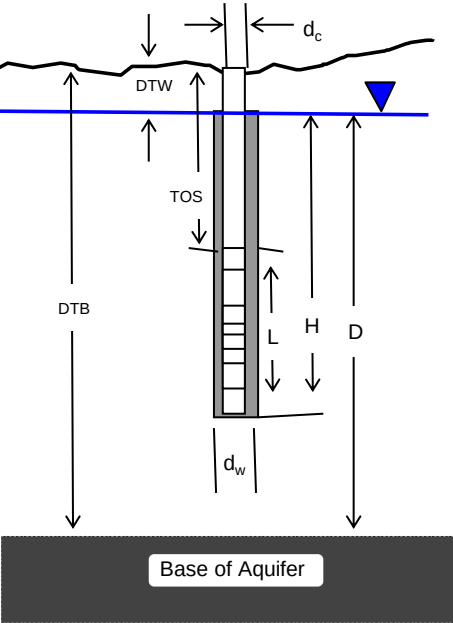
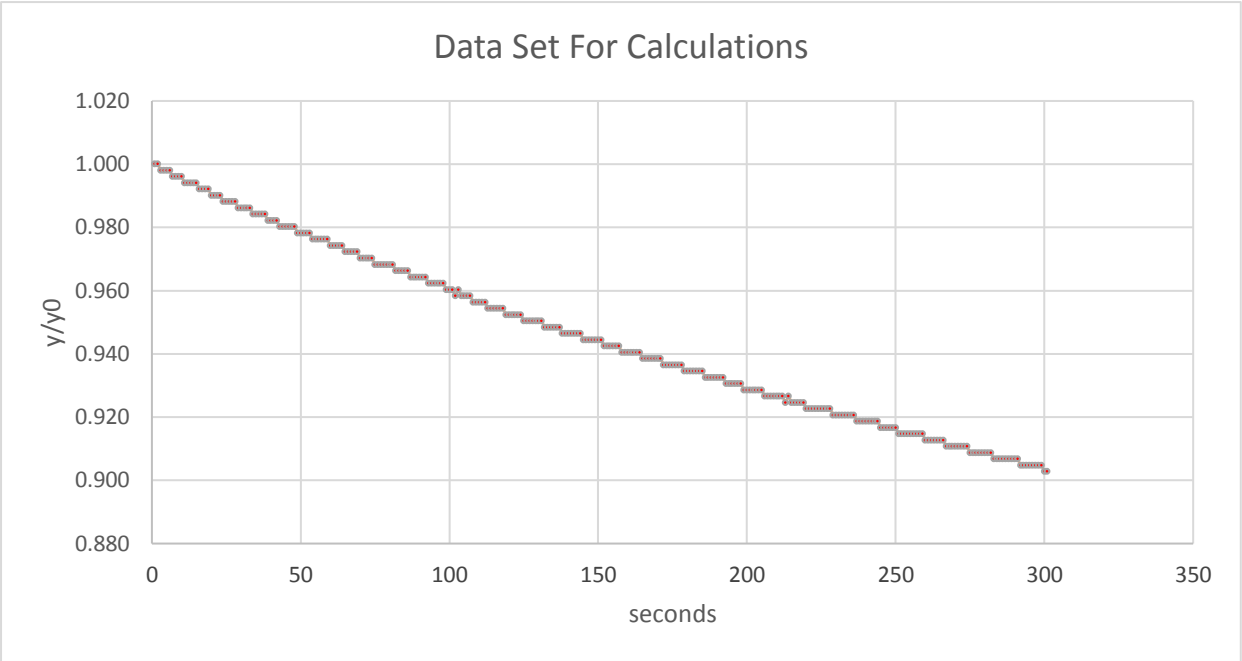
| TABLE 1: Soil Profile Description |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|-----------------------------------|-------------------------|----------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Date of Field Work                |                         | 9/5/2018                         |                        | Sampling Method        | 90 mm power auger      |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| Field Staff                       |                         | Peter Edmiston                   |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| Name                              | BH1                     | BH2                              | BH3                    | BH4                    | BH5                    | BH6                    |                        |                        |                        |                        |                        |                        |                        |                        |
| Relief/ Slope                     | Level plain             | Level plain                      | Level plain            | Level plain            | Level plain            | Level plain            |                        |                        |                        |                        |                        |                        |                        |                        |
| Landform Pattern                  | Alluvial fan            | Alluvial fan                     | Alluvial fan           | Alluvial fan           | Alluvial fan           | Alluvial fan           |                        |                        |                        |                        |                        |                        |                        |                        |
| Lf. Morphology                    | Simple-slope            | Simple-slope                     | Simple-slope           | Simple-slope           | Simple-slope           | Simple-slope           |                        |                        |                        |                        |                        |                        |                        |                        |
| Lf. Elements                      | Plain                   | Plain                            | Plain                  | Plain                  | Plain                  | Plain                  |                        |                        |                        |                        |                        |                        |                        |                        |
| Drainage Class                    | Imperfectly drained     | Imperfectly drained              | Imperfectly drained    | Imperfectly drained    | Imperfectly drained    | Imperfectly drained    |                        |                        |                        |                        |                        |                        |                        |                        |
| Microrelief                       | Normal gilgai           | Normal gilgai                    | Normal gilgai          | Normal gilgai          | Normal gilgai          | Normal gilgai          |                        |                        |                        |                        |                        |                        |                        |                        |
| Soil Order                        | Vertosol                | Vertosol                         | Vertosol               | Vertosol               | Vertosol               | Vertosol               |                        |                        |                        |                        |                        |                        |                        |                        |
| Sub Order                         | Sodic                   | Sodic                            | Sodic                  | Sodic                  | Sodic                  | Sodic                  |                        |                        |                        |                        |                        |                        |                        |                        |
| Profile Placement                 | depositional            | depositional                     | depositional           | depositional           | depositional           | depositional           |                        |                        |                        |                        |                        |                        |                        |                        |
| Lat (WGS84)                       | -19.335022°             | -19.336815°                      | -19.331401°            | -19.326486°            | -19.325505°            | -19.321642°            |                        |                        |                        |                        |                        |                        |                        |                        |
| Long.                             | 146.850899°             | 146.857647°                      | 146.861692°            | 146.851889°            | 146.861878°            | 146.857568°            |                        |                        |                        |                        |                        |                        |                        |                        |
| m                                 |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| Surface                           | firm                    | firm                             | firm                   | firm                   | firm                   | firm                   |                        |                        |                        |                        |                        |                        |                        |                        |
| 0.0                               | grey brown silty clay   | grey brown sandy clay, disturbed | dark grey silty clay   | dark grey silty clay   | dark grey silty clay   | brown sandy clay loam  |                        |                        |                        |                        |                        |                        |                        |                        |
| 0.2                               | yellow brown sandy clay |                                  |                        | dark grey silty clay   |                        | dark grey silty clay   | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |
| 0.4                               |                         | grey, medium clay                |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 0.6                               |                         |                                  |                        |                        |                        |                        |                        | dark grey silty clay   |                        |                        |                        |                        |                        |                        |
| 0.8                               |                         |                                  |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |
| 1.0                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        | brown clay, moist      |                        |                        |                        |                        |
| 1.2                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |
| 1.4                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |
| 1.6                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |
| 1.8                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        | dark brown clay, moist |
| 2.0                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 2.2                               |                         |                                  | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 2.4                               |                         | dark brown clay, moist           |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 2.6                               |                         |                                  |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 2.8                               |                         |                                  |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 3.0                               |                         |                                  |                        |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |
| 3.2                               | dark brown clay, moist  |                                  |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 3.4                               |                         |                                  |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |
| 3.6                               |                         |                                  |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |
| 3.8                               |                         |                                  |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |
| 4.0                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |                        |
| 4.2                               |                         |                                  |                        |                        |                        |                        |                        |                        |                        |                        | dark brown clay, moist |                        |                        |                        |
| 4.4                               |                         | dark brown clay, moist           |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 4.5                               |                         |                                  | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 4.8                               |                         |                                  |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
| 5.0                               |                         |                                  |                        |                        | dark brown clay, moist |                        |                        |                        |                        |                        |                        |                        |                        |                        |



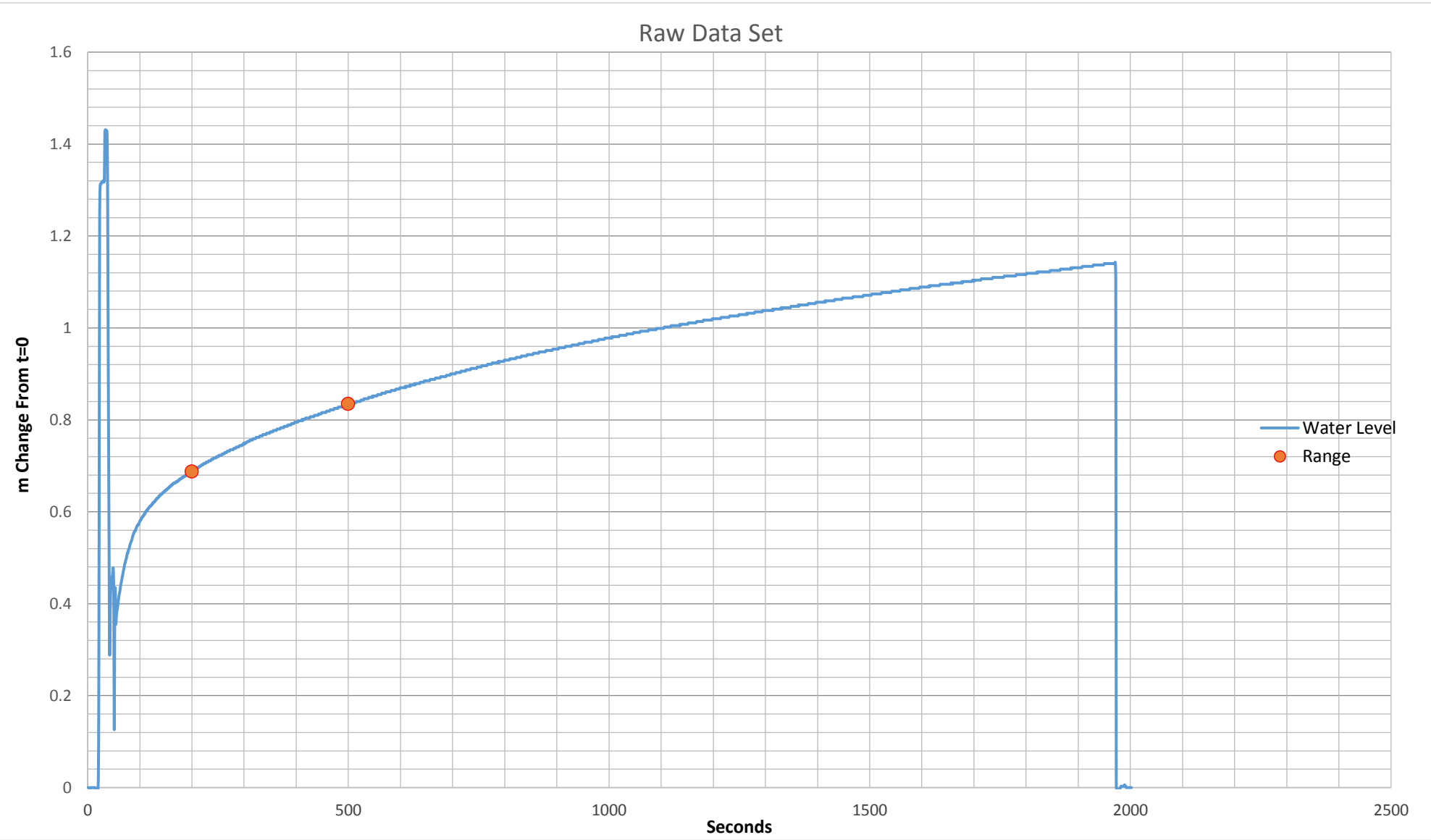




| INPUT                                    |            |
|------------------------------------------|------------|
| Construction:                            |            |
| Casing dia. (d <sub>c</sub> )            | 0.05 Meter |
| Annulus dia. (d <sub>w</sub> )           | 0.1 Meter  |
| Screen Length (L)                        | 3.4 Meter  |
| Depths to:                               |            |
| water level (DTW)                        | 3.22 Meter |
| top of screen (TOS)                      | 1.25 Meter |
| Base of Aquifer (DTB)                    | 30 Meter   |
| Annular Fill:                            |            |
| across screen -- Fine Sand               |            |
| above screen -- Cement                   |            |
| Aquifer Material -- Clay soils (surface) |            |

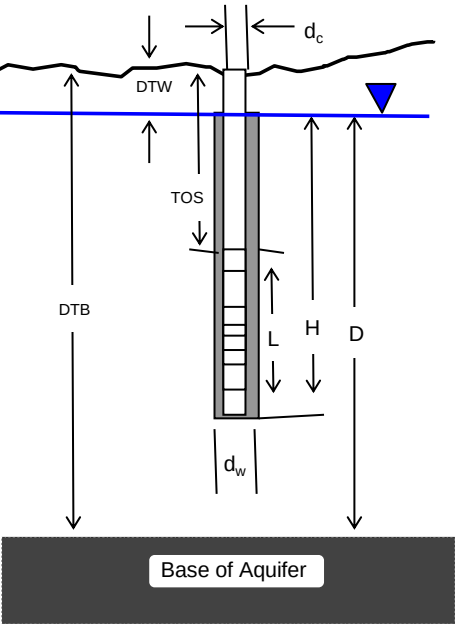
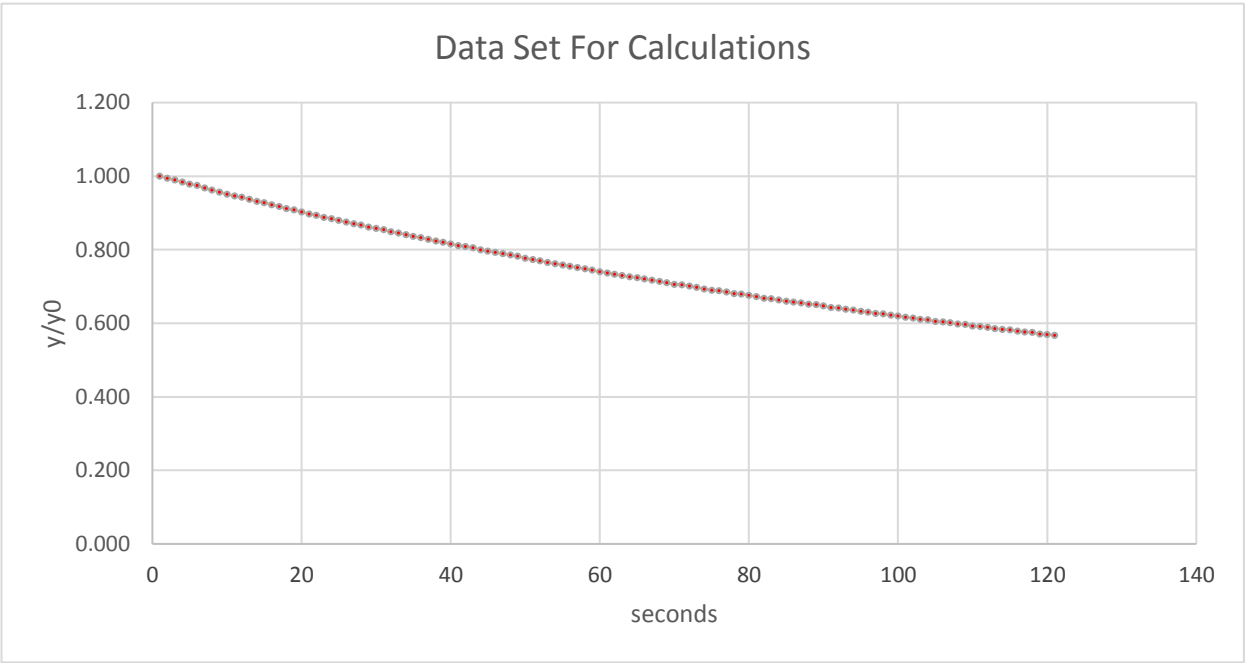
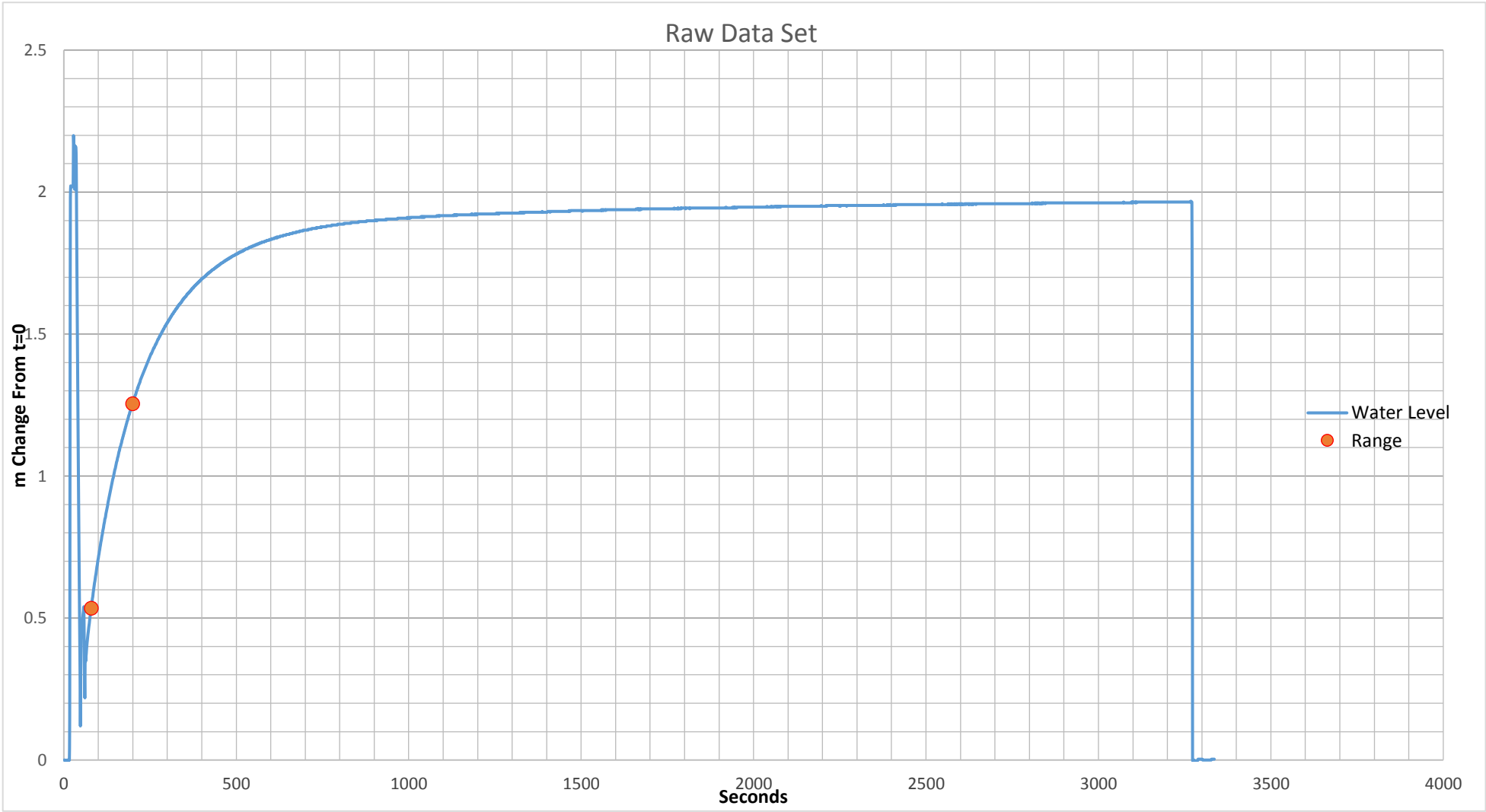


| COMPUTED                                                                 |                                 |
|--------------------------------------------------------------------------|---------------------------------|
| L <sub>wetted</sub>                                                      | 1.43 Meter                      |
| D =                                                                      | 26.78 Meter                     |
| H =                                                                      | 1.43 Meter                      |
| L/r <sub>w</sub> =                                                       | 28.60                           |
| y <sub>0</sub> -DISPLACEMENT =                                           | 1.51 Meter                      |
| y <sub>0</sub> -SLUG =                                                   | 2.00 Meter                      |
| From look-up table using L/r <sub>w</sub>                                |                                 |
| Partial penetrate A =                                                    | 2.462                           |
| B =                                                                      | 0.406                           |
| ln(Re/rw) =                                                              | 2.003                           |
| Re =                                                                     | 1.22 Meter                      |
| Slope =                                                                  | 2.96E-05 log <sub>10</sub> /sec |
| t <sub>90%</sub> recovery =                                              | 33769 sec                       |
| K= 0.0026 is less than extreme minimum of 0.003 for Clay soils (surface) |                                 |
| Calculated K                                                             | 0.0026 Meter/Day                |
| K Inconsistent with expected data for selected aquifer material          |                                 |
| METHOD: Bouwer and Rice analysis of slug test, WRR 1976                  |                                 |
| Distance to aquifer base is unknown but is expected to be >30 m.         |                                 |



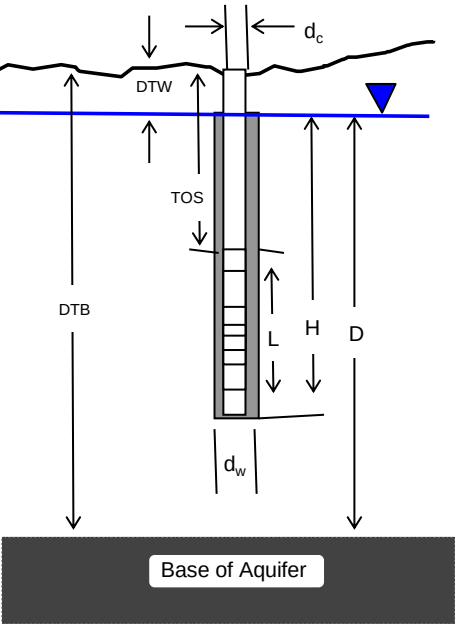
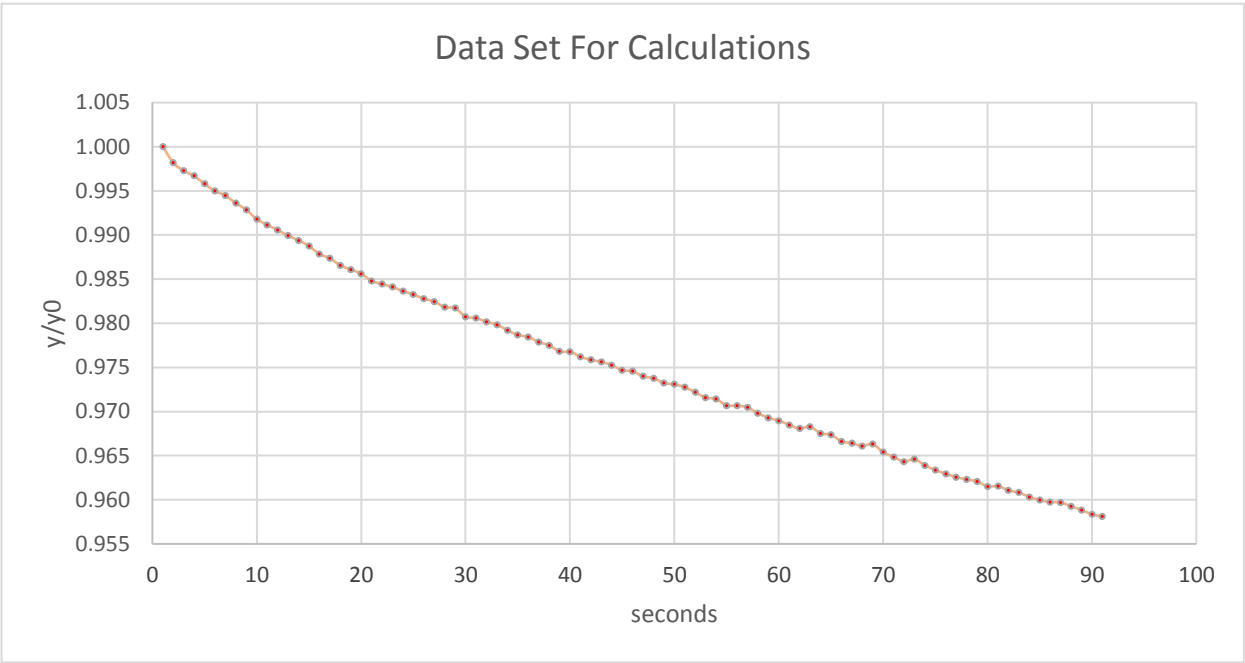
| INPUT                                    |            |
|------------------------------------------|------------|
| Construction:                            |            |
| Casing dia. ( $d_c$ )                    | 0.05 Meter |
| Annulus dia. ( $d_w$ )                   | 0.1 Meter  |
| Screen Length (L)                        | 3.4 Meter  |
| Depths to:                               |            |
| water level (DTW)                        | 2.57 Meter |
| top of screen (TOS)                      | 1.21 Meter |
| Base of Aquifer (DTB)                    | 30 Meter   |
| Annular Fill:                            |            |
| across screen -- Fine Sand               |            |
| above screen -- Cement                   |            |
| Aquifer Material -- Clay soils (surface) |            |

| COMPUTED                                                         |                                 |
|------------------------------------------------------------------|---------------------------------|
| $L_{wetted}$                                                     | 2.04 Meter                      |
| D =                                                              | 27.43 Meter                     |
| H =                                                              | 2.04 Meter                      |
| $L/r_w$ =                                                        | 40.80                           |
| $y_0$ -DISPLACEMENT =                                            | 1.67 Meter                      |
| $y_0$ -SLUG =                                                    | 2.00 Meter                      |
| From look-up table using $L/r_w$                                 |                                 |
| Partial penetrate A =                                            | 2.862                           |
| B =                                                              | 0.463                           |
| $\ln(Re/r_w)$ =                                                  | 2.300                           |
| Re =                                                             | 1.64 Meter                      |
| Slope =                                                          | 0.000683 $\log_{10}/\text{sec}$ |
| $t_{90\%}$ recovery =                                            | 1464 sec                        |
| Input is consistent.                                             |                                 |
| K =                                                              | 0.048 Meter/Day                 |
| METHOD: Bouwer and Rice analysis of slug test, WRR 1976          |                                 |
| Distance to aquifer base is unknown but is expected to be >30 m. |                                 |

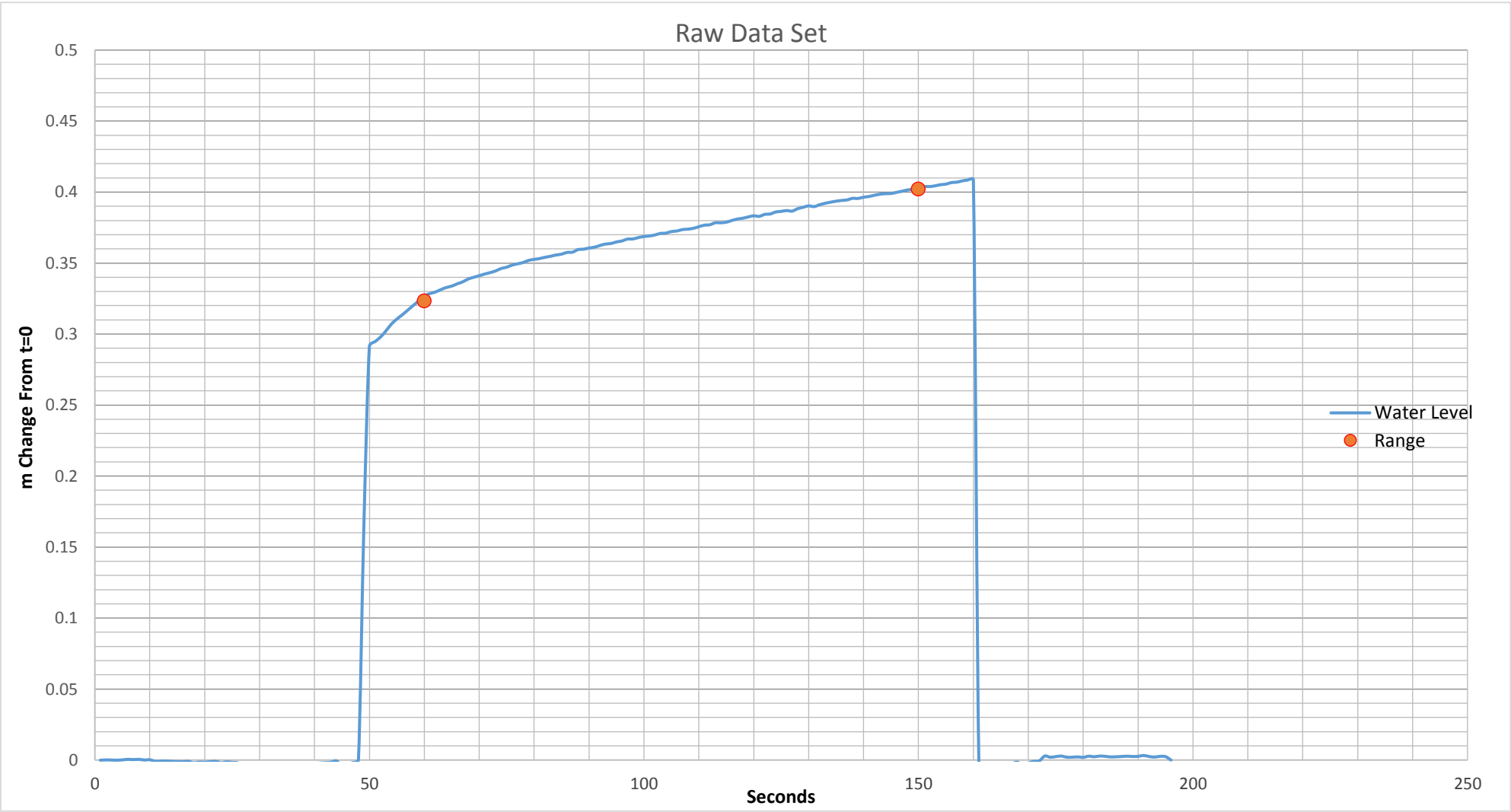




| INPUT                                    |            |
|------------------------------------------|------------|
| Construction:                            |            |
| Casing dia. ( $d_c$ )                    | 0.05 Meter |
| Annulus dia. ( $d_w$ )                   | 0.1 Meter  |
| Screen Length (L)                        | 3.4 Meter  |
| Depths to:                               |            |
| water level (DTW)                        | 2.77 Meter |
| top of screen (TOS)                      | 1 Meter    |
| Base of Aquifer (DTB)                    | 30 Meter   |
| Annular Fill:                            |            |
| across screen -- Fine Sand               |            |
| above screen -- Cement                   |            |
| Aquifer Material -- Clay soils (surface) |            |



| COMPUTED                                                         |                                 |
|------------------------------------------------------------------|---------------------------------|
| $L_{wetted}$                                                     | 1.63 Meter                      |
| $D =$                                                            | 27.23 Meter                     |
| $H =$                                                            | 1.63 Meter                      |
| $L/r_w =$                                                        | 32.60                           |
| $y_0$ -DISPLACEMENT =                                            | 1.88 Meter                      |
| $y_0$ -SLUG =                                                    | 2.00 Meter                      |
| From look-up table using $L/r_w$                                 |                                 |
| Partial penetrate A =                                            | 2.608                           |
| B =                                                              | 0.427                           |
| $\ln(Re/r_w) =$                                                  | 2.108                           |
| Re =                                                             | 1.35 Meter                      |
| Slope =                                                          | $6.89E-05 \log_{10}/\text{sec}$ |
| $t_{90\%}$ recovery =                                            | 14522 sec                       |
| Input is consistent.                                             |                                 |
| K =                                                              | 0.0055 Meter/Day                |
| METHOD: Bouwer and Rice analysis of slug test, WRR 1976          |                                 |
| Distance to aquifer base is unknown but is expected to be >30 m. |                                 |





All bores

• Bore

All bores

• All bores

Bore density per 25km<sup>2</sup>

• 1 - 5

• 6 - 10

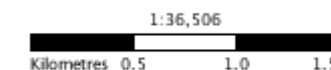
• 11 - 20

• 21 - 50

• 51 - 100

• 101 - 200

• More than 200



Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94

Date: 30 March, 2018

## BORE REPORT

REG NUMBER 96229

REGISTRATION DETAILS

|                                     |                                      |                     |              |
|-------------------------------------|--------------------------------------|---------------------|--------------|
| OFFICE Ayr                          | BASIN 1181                           | LATITUDE 19-20-15   | MAP-SCALE    |
| DATE LOG RECD                       | SUB-AREA                             | LONGITUDE 146-51-14 | MAP-SERIES   |
| D/O FILE NO. 110/000(0012)2         | SHIRE 7010-TOWNSVILLE CITY           | EASTING 484650      | MAP-NO       |
| R/O FILE NO.                        | LOT 100                              | NORTHING 7861809    | MAP NAME     |
| H/O FILE NO.                        | PLAN SP164769                        | ZONE 55             | PROG SECTION |
| ORIGINAL DESCRIPTION                | ACCURACY SKET                        | PRES EQUIPMENT      |              |
|                                     | GPS ACC                              |                     |              |
| GIS LAT -19.33761956                | PARISH NAME 434-BEOR                 | ORIGINAL BORE NO    |              |
| GIS LNG 146.8538636                 | COUNTY ELPHINSTONE                   | BORE LINE -         |              |
| CHECKED Y                           |                                      |                     |              |
|                                     |                                      | POLYGON             |              |
|                                     |                                      | RN OF BORE REPLACED |              |
| FACILITY TYPE Sub-Artesian Facility | DATE DRILLED 09/04/2004              | DATA OWNER          |              |
| STATUS Existing                     | DRILLERS NAME FULLER, GEOFFREY JAMES |                     |              |
| ROLES WS                            | DRILL COMPANY GJ & CRM FULLER        |                     |              |
|                                     | METHOD OF CONST. ROTARY AIR          |                     |              |

CASING DETAILS

| PIPE | DATE       | RECORD NUMBER | MATERIAL DESCRIPTION                         | MAT SIZE (mm) | SIZE DESC | OUTSIDE DIAM (mm) | TOP (m) | BOTTOM (m) |
|------|------------|---------------|----------------------------------------------|---------------|-----------|-------------------|---------|------------|
| A    | 09/04/2004 | 1             | Polyvinyl Chloride                           | 5.900         | WT        | 125               | 0.00    | 36.50      |
| A    | 09/04/2004 | 2             | Perforated or Slotted Casing                 | 3.000         | AP        |                   | 18.50   | 36.50      |
| A    | 09/04/2004 | 3             | Gravel Pack                                  | 10.000        | GR        |                   | 8.00    | 36.50      |
| A    | 09/04/2004 | 4             | Cuttings or other fill between casing and hc |               |           |                   | 0.00    | 8.00       |

STRATA LOG DETAILS

| RECORD NUMBER | STRATA TOP (m) | STRATA BOT (m) | STRATA DESCRIPTION             |
|---------------|----------------|----------------|--------------------------------|
| 1             | 0.00           | 0.10           | TOP SOIL                       |
| 2             | 0.10           | 1.00           | BROWN PUG CLAY                 |
| 3             | 1.00           | 4.00           | BROWN CLAY                     |
| 4             | 4.00           | 7.00           | BROWN S/CLAY WEATHERED GRANITE |
| 5             | 7.00           | 10.00          | L/BROWN CLAY WEATHERED GRANITE |



## BORE REPORT

REG NUMBER 96229

| RECORD<br>NUMBER | STRATA<br>TOP (m) | STRATA<br>BOT (m) | STRATA DESCRIPTION       |
|------------------|-------------------|-------------------|--------------------------|
| 6                | 10.00             | 13.00             | MOIST WEATHERED GRANITE. |
| 7                | 13.00             | 18.00             | SOFT JOINTED ROCK        |
| 8                | 18.00             | 19.50             | FIRM W.GRANITE *         |
| 9                | 19.50             | 21.00             | SOFT MOIST               |
| 10               | 21.00             | 27.00             | WET W. GRANITE *         |
| 11               | 27.00             | 36.50             | W.GRANITE BROWN *        |
| 12               |                   |                   | AND 36M SWL 7M           |

STRATIGRAPHY DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

AQUIFER DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

PUMP TEST DETAILS PART 1

\*\*\*\* NO RECORDS FOUND \*\*\*\*

PUMP TEST DETAILS PART 2

\*\*\*\* NO RECORDS FOUND \*\*\*\*

BORE CONDITION

\*\*\*\* NO RECORDS FOUND \*\*\*\*

ELEVATION DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER ANALYSIS PART1

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER ANALYSIS PART 2

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER LEVEL DETAILS

BORE REPORT

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REG NUMBER 96229

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WIRE LINE LOG DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

FIELD MEASUREMENTS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

SPECIAL WATER ANALYSIS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

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**BORE REPORT**

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**\*\* End of Report. Produced: 30/03/2018 03:12:14 PM \*\***

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## BORE REPORT

REG NUMBER 96230

REGISTRATION DETAILS

|                                     |                                      |                     |                     |
|-------------------------------------|--------------------------------------|---------------------|---------------------|
| OFFICE Ayr                          | BASIN 1181                           | LATITUDE 19-20-17   | MAP-SCALE           |
| DATE LOG RECD                       | SUB-AREA                             | LONGITUDE 146-51-24 | MAP-SERIES          |
| D/O FILE NO. 110/000(0012)2         | SHIRE 7010-TOWNSVILLE CITY           | EASTING 484945      | MAP-NO              |
| R/O FILE NO.                        | LOT 100                              | NORTHING 7861761    | MAP NAME            |
| H/O FILE NO.                        | PLAN SP164769                        | ZONE 55             | PROG SECTION        |
|                                     | ORIGINAL DESCRIPTION                 | ACCURACY SKET       | PRES EQUIPMENT      |
|                                     |                                      | GPS ACC             |                     |
| GIS LAT -19.33805556                | PARISH NAME 434-BEOR                 |                     | ORIGINAL BORE NO    |
| GIS LNG 146.8566667                 | COUNTY ELPHINSTONE                   |                     | BORE LINE -         |
| CHECKED Y                           |                                      |                     |                     |
|                                     |                                      |                     | POLYGON             |
|                                     |                                      |                     | RN OF BORE REPLACED |
| FACILITY TYPE Sub-Artesian Facility | DATE DRILLED 11/04/2004              |                     | DATA OWNER DNR      |
| STATUS Existing                     | DRILLERS NAME FULLER, GEOFFREY JAMES |                     |                     |
| ROLES WS                            | DRILL COMPANY GJ & CRM FULLER        |                     |                     |
|                                     | METHOD OF CONST. ROTARY AIR          |                     |                     |

CASING DETAILS

| PIPE | DATE       | RECORD NUMBER | MATERIAL DESCRIPTION         | MAT SIZE (mm) | SIZE DESC | OUTSIDE DIAM (mm) | TOP (m) | BOTTOM (m) |
|------|------------|---------------|------------------------------|---------------|-----------|-------------------|---------|------------|
| A    | 11/04/2004 | 1             | Plastic Casing               | 7.550         | WT        | 200               | 0.00    | 22.50      |
| A    | 11/04/2004 | 2             | Perforated or Slotted Casing | 2.000         | AP        | 200               | 18.50   | 22.50      |

STRATA LOG DETAILS

| RECORD NUMBER | STRATA TOP (m) | STRATA BOT (m) | STRATA DESCRIPTION                  |
|---------------|----------------|----------------|-------------------------------------|
| 1             | 0.00           | 2.00           | FILL CLAY AND STONES                |
| 2             | 2.00           | 3.00           | CLAY PUG                            |
| 3             | 3.00           | 10.00          | BROWN CLAY                          |
| 4             | 10.00          | 10.50          | SOFT WEATHERED GRANITE CLAYED MOIST |
| 5             | 10.50          | 12.00          | FIRM CLAYED W.G.                    |
| 6             | 12.00          | 13.50          | SOFT CLAYED W.G.                    |
| 7             | 13.50          | 16.00          | WATER INCREASING                    |

BORE REPORT

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REG NUMBER 96230

| RECORD<br>NUMBER | STRATA<br>TOP (m) | STRATA<br>BOT (m) | STRATA DESCRIPTION |
|------------------|-------------------|-------------------|--------------------|
| 8                | 16.00             | 18.00             | FIRM               |
| 9                | 18.00             | 22.00             | SOFT WET           |
| 10               | 22.00             | 23.00             | FIRM SWL 7.15M     |

STRATIGRAPHY DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

AQUIFER DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

PUMP TEST DETAILS PART 1

\*\*\*\* NO RECORDS FOUND \*\*\*\*

PUMP TEST DETAILS PART 2

\*\*\*\* NO RECORDS FOUND \*\*\*\*

BORE CONDITION

\*\*\*\* NO RECORDS FOUND \*\*\*\*

ELEVATION DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER ANALYSIS PART1

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER ANALYSIS PART 2

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER LEVEL DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WIRE LINE LOG DETAILS\*\*\*\* NO RECORDS FOUND \*\*\*\*

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BORE REPORT

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REG NUMBER 96230

FIELD MEASUREMENTS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

SPECIAL WATER ANALYSIS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

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**BORE REPORT**

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**\*\* End of Report. Produced: 30/03/2018 03:14:39 PM \*\***

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## BORE REPORT

REG NUMBER 140958

REGISTRATION DETAILS

|                                     |                                  |                     |                         |
|-------------------------------------|----------------------------------|---------------------|-------------------------|
| OFFICE Ayr                          | BASIN 1181                       | LATITUDE 19-20-06   | MAP-SCALE               |
| DATE LOG RECD 18-JAN-10             | SUB-AREA                         | LONGITUDE 146-52-58 | MAP-SERIES              |
| D/O FILE NO. 110/000/20P2           | SHIRE 7010-TOWNSVILLE CITY       | EASTING 487688      | MAP-NO                  |
| R/O FILE NO.                        | LOT 42                           | NORTHING 7862095    | MAP NAME                |
| H/O FILE NO.                        | PLAN CP905700                    | ZONE 55             | PROG SECTION            |
|                                     | ORIGINAL DESCRIPTION             | ACCURACY GPS        | PRES EQUIPMENT          |
|                                     |                                  | GPS ACC 20          |                         |
| GIS LAT -19.3350515                 | PARISH NAME 434-BEOR             |                     | ORIGINAL BORE NO M.B.33 |
| GIS LNG 146.8827847                 | COUNTY ELPHINSTONE               |                     | BORE LINE -             |
| CHECKED Y                           |                                  |                     |                         |
|                                     |                                  |                     | POLYGON                 |
|                                     |                                  |                     | RN OF BORE REPLACED     |
|                                     |                                  |                     | DATA OWNER              |
| FACILITY TYPE Sub-Artesian Facility | DATE DRILLED 16/12/2009          |                     |                         |
| STATUS Existing                     | DRILLERS NAME GRAFFUNDER, TREVOR |                     |                         |
| ROLES WS                            | DRILL COMPANY CORING DRILLING    |                     |                         |
|                                     | METHOD OF CONST. ROTARY AIR      |                     |                         |

CASING DETAILS

| PIPE | DATE       | RECORD NUMBER | MATERIAL DESCRIPTION         | MAT SIZE (mm) | SIZE DESC | OUTSIDE DIAM (mm) | TOP (m) | BOTTOM (m) |
|------|------------|---------------|------------------------------|---------------|-----------|-------------------|---------|------------|
| A    | 16/12/2009 | 1             | Polyvinyl Chloride           | 3.350         | WT        | 60                | 0.00    | 10.00      |
| A    | 16/12/2009 | 2             | Perforated or Slotted Casing | 1.000         | AP        | 60                | 7.00    | 10.00      |
| X    | 16/12/2009 | 3             | Gravel Pack                  | 10.000        | GR        | 125               | 6.00    | 10.00      |
| X    | 16/12/2009 | 4             | Bentonite Seal               |               |           | 125               | 5.00    | 6.00       |
| X    | 16/12/2009 | 5             | Grout                        |               |           | 125               | 0.00    | 5.00       |

STRATA LOG DETAILS

| RECORD NUMBER | STRATA TOP (m) | STRATA BOT (m) | STRATA DESCRIPTION |
|---------------|----------------|----------------|--------------------|
| 1             | 0.00           | 0.50           | DECO YELLOW        |
| 2             | 0.50           | 1.50           | CLAY               |
| 3             | 1.50           | 7.50           | DECO               |
| 4             | 7.50           | 8.00           | MOISTURE           |

## BORE REPORT

REG NUMBER 140958

| RECORD<br>NUMBER | STRATA<br>TOP (m) | STRATA<br>BOT (m) | STRATA DESCRIPTION |
|------------------|-------------------|-------------------|--------------------|
| 5                | 8.00              | 10.00             | DECO               |

STRATIGRAPHY DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

AQUIFER DETAILS

| REC | TOP<br>BED(M) | BOTTOM<br>BED(M) | BED<br>LITHOLOGY | DATE       | SWL<br>(m) | FLOW | QUALITY | YIELD<br>(l/s) | CTR | CONDIT | FORMATION NAME |
|-----|---------------|------------------|------------------|------------|------------|------|---------|----------------|-----|--------|----------------|
| 1   | 7.00          | 10.00            | GNTE             | 16/12/2009 | -7.50      | N    |         | 0.01           | Y   | WZ     |                |

PUMP TEST DETAILS PART 1

\*\*\*\* NO RECORDS FOUND \*\*\*\*

PUMP TEST DETAILS PART 2

\*\*\*\* NO RECORDS FOUND \*\*\*\*

BORE CONDITION

\*\*\*\* NO RECORDS FOUND \*\*\*\*

ELEVATION DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER ANALYSIS PART1

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER ANALYSIS PART 2

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WATER LEVEL DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

WIRE LINE LOG DETAILS

\*\*\*\* NO RECORDS FOUND \*\*\*\*



BORE REPORT

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REG NUMBER 140958

FIELD MEASUREMENTS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

SPECIAL WATER ANALYSIS

\*\*\*\* NO RECORDS FOUND \*\*\*\*

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**BORE REPORT**

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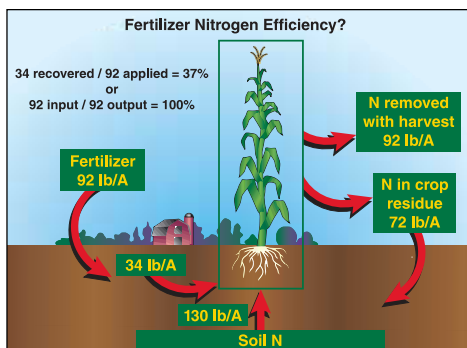
# Fertilizer Nutrient Recovery in Sustainable Cropping Systems

By T.W. Bruulsema, P.E. Fixen, and C.S. Snyder

While single-year crop responses often recover less than half the nutrients applied as fertilizers, cropping systems are more efficient. Nutrient additions support the maintenance of soil organic matter and fertility as well as crop yields.

Current estimates of recovery efficiencies for nitrogen (N), phosphorus (P), and potassium (K) fertilizers used in North American crop production vary considerably. They vary largely because of differences in definition. Recovery by the crop's response differs from recovery by the cropping system.

**Recovery efficiency is defined as the amount of nutrient in the crop as a ratio of the amount applied or available.** Its calculation varies widely depending on the system being considered: the soil-plant system, the whole plant, the above-ground portion of the plant, or the harvested portion of the plant may be considered the vessel of recovery. The inputs may or may not include: applied manures, mineralization of soil nutrients, atmospheric deposition, and contribution of soil micro-organisms, in addition to applied fertilizers. Recovery can be calculated for each single source or for the total of all sources.



Fertilizer N efficiency is influenced by long-term dynamics of a soil's organic matter.

Recovery from a single source is often estimated from the single-year response: the difference in nutrient uptake between fertilized and unfertilized plants. It can also be measured using tracers. Both methods are subject to error.

Error arises in the difference method because plants respond to nutrient deficiencies by altering root growth and the capacity of roots to acquire nutrients. These mechanisms may not be operative in—or compatible with—the type of plant growth associated with the higher yield levels of fertilized plants.

Recovery estimates using tracers are confounded by internal cycling of nutrients in the soil. For example, the rapid uptake and release of ammonium and nitrate forms of N (mineralization-immobilization turnover) generally reduces the concentration of the tracer in the N made available to plants.

A recent study measured the difference between N uptake in fertilized and unfertilized plots in 55 producer-managed corn fields in the north central U.S. (Cassman et al., 2002). Recovery of N in above-ground plant biomass averaged only 37% of fertilizer N applied. This is a disturbingly low figure. Assuming a typical N harvest index (portion of above-ground N in grain) of 56%, it implies that as little as 21% of the fertilizer N applied is removed in the grain. In actual practice, this level of efficiency would be difficult to match, since optimum rate was selected in hindsight from a rate study. Where is the

rest of the fertilizer going?

**Let's look more closely at the meaning of 37% recovery in this example.** What it means is that in these fields, when fertilizer was added at an optimum rate (which averaged 92 lb/A), it boosted the uptake of N into the above-ground portion of the plant by 34 lb/A (37% of 92).

The fertilized corn took up an average of 164 lb N/A: 130 from the soil and 34 from the fertilizer. The total amount of N in its grain would be 56% of 164 = 92 lb/A: equal to the amount of fertilizer applied. So is the recovery 21% (as estimated by single-year-response recovery in grain) or 100% (assuming the observed balance of input and output is sustainable long-term)?

The answer cannot be known unless the longer-term dynamics of the soil's organic matter are understood. If the cropping system is maintaining organic matter, and if the 130 lb/A of N from the soil came from mineralization of organic matter, an equivalent amount of N must be returned in the form of crop residues, and also stabilized to protect it from loss.

If the soil is gaining organic matter, even more N is required. The crop converted at least 164 lb/A of mineral N into organic forms; more if below-ground assimilation by roots and associated microflora is considered. How much will be held in that form depends on the dynamics of decomposition, controlled to some degree by tillage management.

**Mineralization of N from soil organic matter is a large but unsustainable source for the replacement of crop removal.** Depletion of organic matter eventually reduces the productivity of soils. In a sustainable cropping system, N contributed by mineralization needs to be returned to rebuild soil organic matter. Crop residues—exudates, roots, and stover—return this N.

In recent years, through a combination of reduced tillage and the return of increased residues from higher-yielding crops, many areas have reversed the trend of organic matter decline. Since 1970, soils of the central U.S. Corn Belt are

| Table 1. Soil organic carbon (SOC) accumulated from 1965 to 1995 in the top foot of a soil cropped to continuous corn. |                       |    |
|------------------------------------------------------------------------------------------------------------------------|-----------------------|----|
| Applied N, lb/A/yr                                                                                                     | SOC derived from corn |    |
|                                                                                                                        | tons/A                | %  |
| 150                                                                                                                    | 7.6                   | 21 |
| 75                                                                                                                     | 5.8                   | 17 |
| 0                                                                                                                      | 4.5                   | 12 |

Source: Wilts et al., 2004

sequestering N at the rate of 20 lb/A/year as their organic matter increases through reduced tillage (Lal et al., 1998). As conservation tillage expands, requirements for N can be expected to increase, and part of the reason is that a source of N is needed for soil organic matter accumulation.

**Nitrogen boosts the return of crop residue to the soil and enhances its conversion to stable soil organic matter.** Many experiments have shown that fertilizing crops with N results in higher levels of soil carbon over time. An example from Minnesota is shown in **Table 1**. Paustian et al. (1997) documented 20 sites worldwide that gained soil carbon (C) in response to application of N fertilizers over periods ranging from 7 to 120 years. As shown in **Figure 1**, N is integral to the chemical structure of soil organic matter, and is stabilized within it.

**The conversion of N into organic forms by plants and associated soil**

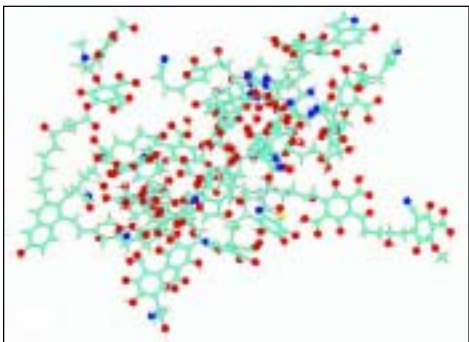


**Figure 1.** Chemical structure of soil organic matter (Schulten and Schnitzer, 1997). The element colors are: N-blue, C-cyan, hydrogen-white, oxygen-red, sulfur-yellow.

**microflora gives the mobile nutrient N properties similar to the relatively immobile nutrients P and K.** Recovery of all three nutrients is greater in the long term than in the short term. While single-year-response recovery of fertilizer P often ranges from 15 to 25%, longer-term recovery in cropping systems is more typically 50 to 60%, and for some systems as high as 70 to 90% (Smil, 2000).

Among the producer-managed fields described above, five had single-year-response recovery efficiencies in excess of 60% even when fertilized at rates of 160 lb N/A or more. This suggests that high rates of nutrient application can be compatible with high recovery efficiencies.

A study in France reported recovery of 71% of labeled fertilizer N in corn, with 26% of the remainder recovered as soil organic N and only 3% as inorganic forms subject to losses.

Recent data for U.S. corn suggest that the harvested grain removes amounts equivalent to 81, 122, and 77% of the N, P and K applied as fertilizers. Removals relative to applications have increased significantly in recent decades (**Figure 2**).

Removal by all North American crops relative to nutrients supplied in the form of fertilizers and manures amounts to 95% and 143% for P and K, respectively. The comparable figure for N is 77%, but considering non-legume crops only, it declines to 64%. The lower recovery for N could be taken as an indication of priority for

efforts at enhancement, or more thorough documentation of its role in contributing to increased soil organic matter. Appropriate management of P and K can contribute to improved N recovery.

## Conclusion

Low nutrient recovery in a single-year response does not imply that the remainder is permanently lost. We need to improve short-term response recovery, but not at the expense of long-term sustainability. Nutrient inputs to cropping systems have important roles in supporting the maintenance of soil organic matter and fertility, in addition to directly supporting crop yield. **Enhancement of use efficiency of nutrients must be integrated with that of all resources essential to sustainable crop production.** **BC**

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## References

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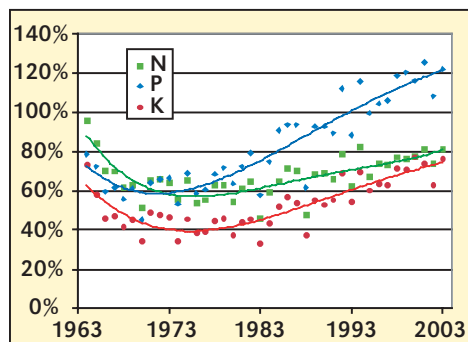


**Figure 2.** Grain nutrient removal as percentage of fertilizer use on corn in the U.S.



# Statutory Declaration

**Environmental Protection Act 1994**

**Environmental Evaluation**

## Suitably qualified person

*A Statutory Declaration is a written statement of facts that is sworn or declared under the Oaths Act 1867. This Statutory Declaration must be completed by the person who conducted the environmental evaluation and accompany the environmental report submitted to the Department of Environment and Heritage Protection (the department).*

### Oaths Act 1867

#### QUEENSLAND TO WIT

I

Peter James Edmiston

Insert the name of the person making this declaration

of

781 Mount Glorious Road, Highvale, Qld, 4520

Insert the street address of the person making this declaration

in the State of Queensland do solemnly and sincerely declare that:

- I am the suitably qualified person and author of an environmental report entitled

JBS Townsville Environmental Evaluation of Wastewater Irrigation

Response to A Request DES CA4544; 101/0008424 Ver 1.6 August 30,

Insert title of the environmental report

In accordance with the environmental evaluation issued by the department under the Act to:

JBS Australia Pty Ltd, ACN 011 062 339

19 April 2018

Insert name of recipient of the notice

Insert date of the notice

A copy of my report is attached to this statutory declaration and marked "A".

I possess the following qualifications and experience relevant to this environmental evaluation:

B.Sc. (Hons), M.Phil

I have not knowingly included any false, misleading or incomplete information in the report; and

I have not knowingly failed to reveal any relevant information or document to the department.

**Statutory Declaration**  
**Suitably qualified person**

---

I certify that:

- The report addresses the relevant matters for the evaluation and is factually correct; and
- The opinions expressed in it are honestly and reasonably held.

I make this solemn declaration conscientiously believing the same to be true, and by virtue of the *Oaths Act 1867*.

Taken and declared before me, at

Highvale

Insert location

this

30th

Insert day (e.g. 18th)

day of

August

Insert month

in the year

2018

Insert year

P. Edmund

Signed

(Person making this declaration)

L. Smith

Signed

<INSERT Justice of the Peace / Commissioner  
for Declarations / Lawyer>



**Linda Susan Smith JP (Qual)**

Printed name and registration number (if applicable)