Start Page

PEMBROKE

Olive Downs Coking Coal Project

Additional Information to the Environmental Impact Statement

Appendix C

MEDLI Modelling

DOCUMENT NO 18041-R2-181119

Sustainable Solutions International
Engineering. Ethics. Environment.

MEDLI Modelling

Final Report

Olive Downs Coking Coal Project

Wednesday, 28 November 2018

Prepared for:

Phronis Pty Ltd

ABN 96 158 390 400

135 Coronation Drive,

Milton, Brisbane, QLD 4064

ATTN: Shaun Nugent

For more information please contact:
Sustainable Solutions International Pty Ltd
ABN: 78 094 501 185
07 3255 0000 office@ssi-bne.com sustainablesolutionsinternational.com

Quality Assurance

Revision No.	Revision Date	Author	Checked	Document Status	Amendments
A	19/10/2018	G. Green	G. Green	D	Author QA
00	26/10/2018	G. Green	D. Xavier	F	RPEQ Review, changed from Supplemental Part 2 to FINAL
00A	22/11/2018	G. Green	D. Xavier	D	Revision of staff numbers to include expansion to full mining capacity of 20 Mtpa. Change of name to "Olive Downs Coking Coal Project"
01	22/11/2018	G. Green	D. Xavier	F	Peer review and RPEQ sign off
02	26/11/2018	G. Green	D. Xavier	F	Incorporate client comments

Document Status			
D – Draft	P – Preliminary	F – Final	A - Amended

Document Location
\\ssi-dc\Company Data\Projects\18000\18041ODCC Mine MEDLI Modelling\5_Reports\03 Final Report\18041 ODCC MEDLI FINAL Report Rev02 181126.docx

This document has been authored by Gary Green, peer reviewed by Dominic Xavier with a final sign off by

Dominic Xavier – RPEQ 7179
dxavier@ssi-bne.com
Managing Director
Sustainable Solutions International Pty Ltd

Executive Summary

This document covers the Model for Effluent Disposal by Land Irrigation (MEDLI) for the Olive Downs Coking Coal Project. The modelling conducted reflects the mine's stages of initial production of 6 Mtpa (2022 to 2027) and then full production of 20 Mtpa commencing around 2028. These stages have varying staffing rates which contribute to different wastewater hydraulic and nutrient rates. The below MEDLI model reflects these two stages of operation. It is crucial that the wastewater management processes for the treatment and disposal scheme reflect the staffing rates to effectively manage and mitigate environmental impacts of the wastewater treatment and disposal scheme via effluent irrigation. The MEDLI modelling conducted for the initial production stage of 6 Mtpa is accurate as it was based on soil characteristics specific to the proposed effluent irrigation area.

The full production stage of 20 Mtpa also incorporates the Willunga pit infrastructure area. This site is only conceptual and the MEDLI modelling conducted for the 1300 maximum work force is only for conceptual planning purposes only. Prior to the expansion of the Olive Downs Coking Project to Willunga, additional soil sampling and testing will need to be conducted for the designated effluent disposal area, and separate MEDLI modelling will need to be conducted based on soil data specific to the proposed effluent disposal area.

Initial Production Capacity of 6 Mtpa (2022 to 2027)

The final calculations of Equivalent Persons (EP) were brought in line with the QLD Government Environmental Protection Regulation 2008 (Reprint 2012).

After receiving soil test results for the site (12th Oct 2018), the Model for Effluent Disposal by Land Irrigation (MEDLI) program was further refined to ascertain the following outcomes of the proposed irrigation scheme at Olive Downs Coking Coal project for a staff population for the initial production capacity of 6 mega-tonne per annum (Mtpa):

1. The actual soil samples tested differed slightly to the initial generic selection of grey clay, but the overall performance has not been adversely affected. The only noticeable difference was the estimated decrease of design soil profile storage life of phosphorus from 47 years to 37 years, mainly due to the initial phosphorus measured in the soil samples.

2. The optimum size of wet weather storage and irrigation area was determined for the effluent volume of 25.5 kL/day and is summarised in the following table:

EP Loading Rate	Equivalent Persons (EP)	Wet Weather Storage capacity (kL)	Irrigation Area (ha)
200 L/EP/day (Hydraulic)	120	220	2.4
2.5gP/EP/day (Phosphorous Loading)	186	220	2.4

The treated effluent quality initially used in this set of modelling was as follows:

Treated Effluent Pollutant Loads used in the MEDLI Model	Maximum value
Total Nitrogen	30 mg/L
Total Nitrogen (Sensitivity Analyses)	50 mg/L
Total Phosphorus	16 mg/L
Total Dissolved Solids (Salts)	650 mg/L

3. An extra scenario was further run with an increased level of TN of 50 mg/L and no further detrimental effect was predicted to occur to the environment as the irrigation field would be capable of taking up the additional nutrient and increase in the biomass yield as a result. It should be noted that the overall crop yield increased and the amount of stress from nitrogen deficiency decreased slightly.

4. The nominated irrigation crop is kikuyu grass which is relatively drought resistant and moderately salt tolerant.

5. The final total nitrogen level in the treated effluent is to be negotiated with the Department of Environment and Science during the environmental licencing process, and this may impact on the final design of the wastewater treatment plant.

6. There were two calculations carried out for Equivalent Persons (EP) as stipulated by QLD Government Environmental Protection Regulation 2008 (Reprint 2012). The first was based on daily hydraulic load which stipulates an EP to equal 200L/day of wastewater requiring treatment. Based on the hydraulic loading of wastewater for initial production stage, the hydraulic loading EP was calculated to be 120. The second EP loading value is calculated based on phosphorous loading in the wastewater influent of 2.5g Phosphorous/ day = 1 EP. The EP base on influent phosphorous was calculated to be 186. The greater of the two EP values was what the EA licence should be based on. The MEDLI modelling process was conducted on the daily hydraulic loading rate.

7. The initial production EA licence is for an EP load of 186 as stipulated by the Environmental Protection Regulation 2008 which state the greater of the two values need to be what the EA licence is based on.

Full Production Capacity of 20 Mtpa (From 2028)

The full production MEDLI model reflected the predicted maximum staff numbers required for the estimated full production capacity of 20 Mtpa. These numbers are based on the Economic Assessment Information provided by Resource Strategies Pty Ltd and are planned to take effect from the year 2028.

This expanded model was based on the assumption that the treated effluent disposal was occurring in the same location on the same soil type that has been laboratory tested. In the event that this future expansion occurs with the effluent irrigation area sited at a different location, then it is a requirement that the new sites have soil testing carried out and a revised MEDLI model be run to ensure the accuracy of the future design.

The following outcomes were ascertained from the MEDLI model for full production:

8. The optimum size of wet weather storage and irrigation area was determined for the daily average effluent volume of 44.84 kL/day as summarised in the table below:

EP Loading Rate	Equivalent Persons (EP)	Wet Weather Storage capacity (kL)	Irrigation Area (ha)
200 L/EP/day (Hydraulic)	211	340	5.5
2.5gP/EP/day (Phosphorous Loading)	327	340	5.5

This model concluded the need for an irrigation area larger than 3.1 ha (designated originally) to cope with the increase in staff when production transitions from 6 Mtpa to 20 Mtpa.

The treated effluent quality initially used in this set of the MEDLI model was as follows:

Treated Effluent Pollutant Loads used in the MEDLI Model	Maximum value
Total Nitrogen	30 mg/L
Total Nitrogen (Sensitivity Analyses)	50 mg/L
Total Phosphorus	16 mg/L
Total Dissolved Solids (Salts)	650 mg/L

9. An additional scenario was also conducted with an increased level of TN of 50 mg/L in the treated effluent. The model indicated no further detrimental effect was predicted to occur to the environment as the irrigation field would be capable of taking up the additional nutrient and increase in the biomass yield as a result. It should be noted that the overall crop yield increased and the amount of stress from nitrogen deficiency decreased slightly

10. The nominated irrigation crop is kikuyu grass which is relatively drought resistant and moderately salt tolerant.

11. The final total nitrogen level in the treated effluent is to be negotiated with the Department of Environment and Science during the environmental licencing process, and this may impact on the final design of the wastewater treatment plant.

12. There were two calculations carried out for Equivalent Persons (EP). The first was for daily volume of wastewater with an **EP = 210**. This was used for the MEDLI modelling process. The second value was to do with pollutant load specifically phosphorous (prior to treatment) with **EP = 327**. Please note that the larger of the two is to be used for sizing and licensing the treatment plant in accordance with the Environmental Protection Regulation 2008.

13. The full production EA licence is for an EP load of 327 as stipulated by the Environmental Protection Regulation 2008 which state the greater of the two values need to be what the EA licence is based on.

Table of Contents

List of Figures

List of Tables

1 Introduction

Sustainable Solutions International Pty Ltd has been engaged by Phronis Pty Ltd to conduct modelling of effluent irrigation on the receiving environment using the QLD Government developed Model for Effluent Disposal by Land Irrigation (MEDLI) Software for the site location at the Olive Downs Mine.

The information provided for this modelling include the following:

- Soil and Land Suitability Assessment- Olive Downs Project, Section 4.1.2, GT Environmental. (7 pages)
- Soil and Land Suitability Assessment- Olive Downs Project, Figure 3.2: Soil Mapping Units, GT Environmental. (1 page)
- Drawing 84-6-3302-LAY-DWG-0004, Phronis Consulting
- Drawing 84-6-3302-LAY-DWG-0002, Phronis Consulting
- Google Maps layout of irrigation field coordinates
- Email dated 9 July 2018 from Richard Hill, Phronis Consulting
- Email dated 18 September 2018 from Richard Hill, Phronis Consulting – Anticipated Daily Workforce
- The following sample results from Environmental Analysis Laboratory (EAL), Southern Cross University, East Lismore:
  - CQS001-MEDLI-H4318
  - CQS001-SS-H4318
  - CQS001-Hydrometer-H4318
  - CQS001-SS-H4318(SS-PACK-003)
- *MEDLI Model for Effluent Disposal using Land Irrigation Version 2 Technical Reference*, Rev: 13 September 2016, Department of Information Technology and Innovation, State of QLD
- *Site Investigation Report,* CQ Soil Testing (21/09/2018)
- Excel spreadsheet*: Economic Assessment Information Request March 2018 (RES00902986-003),* Resource Strategies Pty Ltd, 15/11/2018.

2 Background and Model Input

2.1 Location of Irrigation field

The site for the Olive Downs Coking Coal project is located approximately 30km due south from Coppabella.

It is a green-field coal mine located south east of Moranbah. The Sewage Treatment Plant (STP) for initial production is to be located within the boundary of the Olive Downs South Mine Infrastructure Area (MIA) and the centre of the irrigation area is currently sited at Easting 639457, Northing 7543175 (Coordinate System: GDA94/MGA Zone 55).

Figure 2-1: Approximate location of Olive Downs Coking Coal project marked on satellite image from Google maps

This STP and the specific effluent disposal area MEDLI modelling will be applicable to the Olive Downs stage of the mine development until at least the initial production phase. There is a possibility during expansion to full production, a separate STP may be required which would be located within the Willunga pit infrastructure area (final location yet to be determined). The total wastewater produced from staff at full production level may therefore be treated between these two separate treatment plants and effluent disposal carried out on separate irrigation fields. For this stage of design, the Willunga

Plant will be based on the Olive Downs South STP, and the assumption made that the future irrigation area will consist of the same soil type as the initial irrigation area.

It should be noted that when the future expansion identifies a new location for an irrigation field, that the appropriate soil testing is carried out and the MEDLI model be revised to incorporate any actual soil type changes.

The location of the initial irrigation field is based on Drawing 84-6-3302-LAY-DWG-0004, (Phronis Consulting) by the eastings and northings as shown in Table 2-1 below.

Table 2-1: Coordinates supplied by Phronis Consulting

BORE HOLE LOCATIONS – SOIL SAMPLING FOR MEDLI		
PIT	**EASTING**	**NORTHING**
M1	639527.0	7543287.0
M2	639527.0	7543064.0
M3	639457.0	7543175.0
M4	639388.0	7543287.0
M5	639388.0	7543063.0

(Coordinate System: GDA94/MGA Zone 55).

A closer view of the irrigation field when measured on Google Maps, shows an approximate overall area of 31,200 m^2. Refer to Figure 2-2.

Figure 2-2: Irrigation field located by Eastings & Northings provided by Phronis Consulting and placed on Google Maps satellite image.

2.2 Climate Data

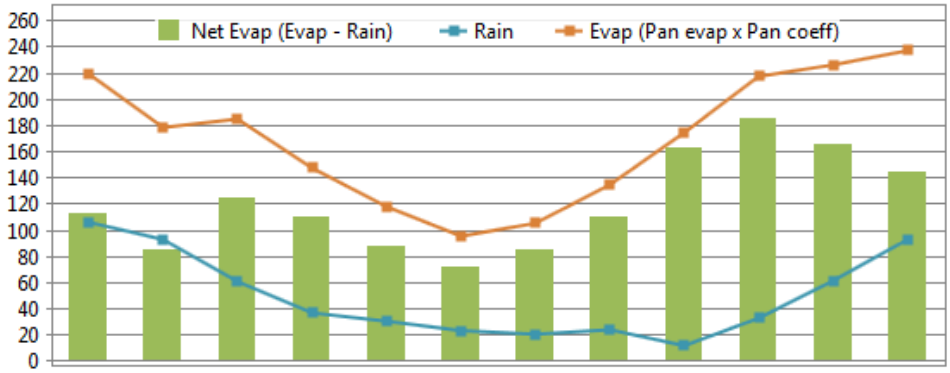
The climate data used was obtained from the SILO Climate Database provided by the QLD Government website: https://silo.longpaddock.qld.gov.au.

60 years of data, from 1957 to 2018, were applied to these MEDLI models (refer summary in Figure 2-3 below).

Averaged Historical Climate Data Used in Simulation (mm)

Location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Evap	219.5	178.6	185.0	147.6	118.1	95.6	105.4	134.8	174.7	217.6	226.3	237.2	2040.4
Net Evap	113.2	85.5	124.1	110.5	87.4	72.1	84.6	110.6	162.6	184.5	164.7	144.1	1443.9
Net Evap/day	3.7	3.0	4.0	3.7	2.8	2.4	2.7	3.6	5.4	6.0	5.5	4.6	4.0

Figure 2-3: Averaged Historical Climate Data for Olive Downs (obtained from the QLD Government's SILO website)

2.3 Estimate of effluent volume and nutrient loading

2.3.1 Original scope

The original scope provided was a conservative estimate for a **disposal area of 25,000m²** which was based on an **effective occupancy of 200 equivalent persons (EP)** producing **250L/EP/day of effluent**.

This scope has been revised to reflect the anticipated daily workforce as provided in Table 2-2 below.

It has been further adjusted to be more in line with the requirements of the *Environmental Protection Regulation 2008*, Schedule 2, Section 63 (4) whereby:

For daily peak design capacity, there are two calculations for Equivalent Persons (EP):

(a) EP = V/200, where V is the volume in litres of the average dry weather flow of sewage that can be treated at the works in a day; (Refer to Table 2-4)

(b) EP = M/2.5, where M is the mass, in grams, of phosphorus in the influent that the works are designed to treat as the inlet load in a day.

2.3.2 Calculation of EP and Average Dry weather flow

Table 2-2: Anticipated Daily Workforce (as at 15th November 2018)

OPERATION	Shift Description	Anticipated Daily Workforce - 6Mtpa Case Olive Downs Coking Coal Project only			Anticipated Daily Workforce – 20 Mtpa Case Olive Downs Coking Coal Project only		
		People per shift	People per Day	Total People	People per shift	People per Day	Total People
Pembroke Staff	8 hr, 6 day, 1 panel roster	15	15	15	25	25	25
Contractor/Admin/ Support/ Management	8 hr, 6 day, 1 panel roster	18	18	18	35	35	35
Equipment Operators	12 hr, 7 day, 4 panel roster	143	286	573	250	500	1000
Site Wide Maintenance	12 hr, 7 day, 4 panel roster	18	37	74	33	65	130
Coal Processing Plant & TLO Operations	12 hr, 7 day, 4 panel roster	15	30	59	28	55	110
Maximum Work force total personnel							**1300**

Each person working on a shift cannot be considered to generate the full amount of wastewater of an Equivalent Person (EP). The average 200 L of effluent/EP/day is based on an EP using the facility over a 24 hour period and would include toilet, hand-basin, shower, laundry and kitchen use.

Because this mine site is open-cut and most of the staff are working in an environment that could be considered equivalent to an air-conditioned office, each person would mainly contribute effluent from toilets and hand basins, with a small percentage also from showers. Even though there is a shower facility on site, it is not anticipated at this stage that it will be as highly used as it would if the site was an underground mine.

Using the following Table 2-3 (from *Planning Guidelines for Water Supply and Sewerage*, April 2010, Chapter 6 amended March 2014, Dept of Energy and Water Supply), toilet use comes out to being about 26% of the total, whilst baths/showers is about 34%.

Table 2-3: Typical household (2-4 persons) internal water use

Water use source	Range	Typical % of internal use	200L/EP/day
Toilets	110-180 L/d	26%	52L/day
Baths/showers	170-220 L/d	34%	68 L/day
Kitchen	45-90 L/d	13%	26 L/day

Water use source	Range	Typical % of internal use	200L/EP/day
Laundry	100-140 L/d	22%	44 L/day
Other	15-50 L/d	5%	10 L/day

For this exercise, we assume worst case that only half of the employees will use the showers reducing this to 17%. This then results in 26% +17% = 43% of an Equivalent Persons production could then be considered reasonable for a full 24 hour period.

Taking into account what proportion of an actual work day each employee is present on site, will then reduce this EP scaling factor further.

I.e. 1 x 8 hour shift is 33.3% of a 24-hour day, but can also be considered to be 50% of a daily 16-hour awake period (assuming 8 hours is average for sleeping).

Similarly, 1 x 12 hour shift is seen as 50% of a 24-hour day, but 75% of a 16-hour awake period.

For this exercise, the higher percentage value is chosen, as this site differs from a domestic situation, and is operated on a 24-hour basis, with 2 x 12 hour shifts.

Refer to Table 2-4 and Table 2-5 for the wastewater generation volume calculations for initial and full production rates. .

Table 2-4: Effluent Volume calculations - Initial 6Mtpa production (2022 to 2027)

Staffing Breakdown	Fraction of daily awake hours	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Average
Pembroke Staff	0.5	15	15	15	15	15	15	0	12.9
Contractor/Admin/ Support/Management	0.5	18	18	18	18	18	18	0	15.4
Equipment Operators	0.75	286	286	286	286	286	286	286	286.0
Site Wide Maintenance	0.75	37	37	37	37	37	37	37	37.0
Coal Processing Plant & TLO Operations	0.75	30	30	30	30	30	30	30	30.0
Total Employees per day		**386**	**386**	**386**	**386**	**386**	**386**	**353**	**381**
Estimated proportion of EP production (toilets and showers)		43%	43%	43%	43%	43%	43%	43%	
Overall Staff presence daily (%)		72.9%	72.9%	72.9%	72.9%	72.9%	72.9%	75.0%	73.2%
Effective EP scaling factor		0.31	0.31	0.31	0.31	0.31	0.31	0.32	**0.3**
Daily EP		**121**	**121**	**121**	**121**	**121**	**121**	**114**	**120**
volume/day/EP		200	200	200	200	200	200	200	**200**
Expected Daily Hydraulic Load (kL)		**24.2**	**24.2**	**24.2**	**24.2**	**24.2**	**24.2**	**22.8**	**24.0**

For the process of MEDLI modelling, the above value of EP = 120 is used for an expected daily load of 24.0 kL when the mine is producing 6Mtpa during initial operations.

Table 2-5: Effluent Volume calculations– Full 20 Mtpa production (From 2028)

Staffing Breakdown	Fraction of daily awake hours	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Average
Pembroke Staff	0.5	25	25	25	25	25	25	0	21.4
Contractor/Admin/ Support/Management	0.5	35	35	35	35	35	35	0	30.0
Equipment Operators	0.75	500	500	500	500	500	500	500	500.0
Site Wide Maintenance	0.75	65	65	65	65	65	65	65	65.0
Coal Processing Plant & TLO Operations	0.75	55	55	55	55	55	55	55	55.0
Total Employees per day		**680**	**680**	**680**	**680**	**680**	**680**	**620**	**671.4**
Estimated proportion of EP production (toilets and showers)		43%	43%	43%	43%	43%	43%	43%	
Overall Staff presence daily (%)		72.9%	72.9%	72.9%	72.9%	72.9%	72.9%	75.0%	73.2%
Effective EP scaling factor		0.31	0.31	0.31	0.31	0.31	0.31	0.32	**0.3**
Daily EP		**213**	**213**	**213**	**213**	**213**	**213**	**200**	**211**
volume/day/EP		200	200	200	200	200	200	200	200
Expected Daily Hydraulic Load (kL)		**42.6**	**42.6**	**42.6**	**42.6**	**42.6**	**42.6**	**40.0**	**42.2**

For the process of MEDLI modelling, the above value of EP = 211 is used for an expected daily load of 42.2 kL when the mine is producing 20 Mtpa.

2.3.3 Calculation of EP for pollutant load (Total Phosphorous)

The equivalent persons (EP) calculated for anticipated pollutant load of phosphorus differs from the EP calculations based on effluent volume calculations (shown above) due to the strength of the wastewater being higher in this application compared to a domestic situation. In this case, the fraction of the day that each staff is present on site is taken into account as the proportion of an EP contributing to the daily pollutant load.

Table 2-6: EP calculation for pollutant load – Initial 6Mtpa production (2022 to 2027)

Staffing Breakdown	No. Staff/day (averaged over a week)	Time Fraction of 24 hr day spent at the mine site	EP(nutrient load)
Pembroke Staff	**12.9**	0.33	4
Contractor/Admin/Support/Management	**15.4**	0.33	5

Staffing Breakdown	No. Staff/day (averaged over a week)	Time Fraction of 24 hr day spent at the mine site	$EP_{(nutrient\ load)}$
Equipment Operators	**286.0**	0.5	143
Site Wide Maintenance	**37.0**	0.5	19
Coal Processing Plant & TLO Operations	**30.0**	0.5	15
Total daily EP			**186**

Table 2-7: EP calculation for pollutant load – Full 20 Mtpa production (From 2028)

Staffing Breakdown	No. Staff/day (averaged over a week)	Fraction of 24 hr day	$EP_{(nutrient\ load)}$
Pembroke Staff	**21.4**	0.33	7.1
Contractor/Admin/Support/Management	**30.0**	0.33	10.0
Equipment Operators	**500.0**	0.5	250.0
Site Wide Maintenance	**65.0**	0.5	32.5
Coal Processing Plant & TLO Operations	**55.0**	0.5	27.5
Total daily EP			**327**

From the *QLD (2002) On-Site Sewerage Code*, pollution contributions per EP are as shown in Table 2-8 below.

Table 2-8: Pollution contributions per EP

Pollutant	Value	Unit
Nitrogen	15	g/EP
Phosphorus	2.5	g/EP
BOD	70	g/EP
SS	70	g/EP

Using these values with the EP calculated in Table 2-6 and Table 2-7 along with the estimated daily volumes in Table 2-4 and Table 2-5, the following estimated pollutant loads were calculated (Table 2-9 and Table 2-10).

Table 2-9: Estimated daily pollutant loads – Initial 6 Mtpa production (2022 to 2027)

Staff Location	Nitrogen (g/day)	Phosphorus (g/day)	BOD (g/day)	SS (g/day)
Pembroke Staff	64.3	10.7	300	300
Contractor/Admin/Support/Management	77.1	12.9	360	360
Equipment Operators	2145	357.5	10010	10010
Site Wide Maintenance	277.5	46.25	1295	1295
Coal Processing Plant & TLO Operations	225	37.5	1050	1050
Total Mass Load (g/day)	**2788.9**	**464.8**	**13015.0**	**13015.0**
Concentration in the influent (mg/L)	**116.3**	**19.4**	**542.6**	**542.6**

Note: The above pollutant mass and concentration values should only be used as a preliminary value just for the purposes of calculating the licence pollutant loads. It should not be used for the design of the wastewater treatment plant.

Table 2-10: Estimated daily pollutant loads – Full 20 Mtpa production (From 2028)

Staff Location	Nitrogen (g/day)	Phosphorus (g/day)	BOD (g/day)	SS (g/day)
Pembroke Staff	107.1	17.9	500	500
Contractor/Admin/Support/Management	150.0	25.0	700	700
Equipment Operators	3750	625	17500	17500
Site Wide Maintenance	487.5	81.25	2275	2275
Coal Processing Plant & TLO Operations	412.5	68.75	1925	1925
Total Mass Load g/day	**4907.1**	**817.9**	**22900.0**	**22900.0**
Concentration in the influent (mg/L)	**116.3**	**19.4**	**542.6**	**542.6**

Note: The above pollutant mass and concentration values should only be used as a preliminary value just for the purposes of calculating the licence pollutant loads. It should not be used for the design of the wastewater treatment plant.

2.3.4 MEDLI inputs for treated effluent used for irrigation

The treated effluent quality used for irrigation in the MEDLI model is listed below in

Table 2-11: MEDLI input of treated effluent quality used for irrigation

Treated Effluent Pollutant Loads used in the MEDLI Model	Maximum value
Total Nitrogen	30 mg/L
Total Nitrogen (Sensitivity Analyses)	50 mg/L
Total Phosphorus	16 mg/L
Total Dissolved Solids (Salts)	650 mg/L

The values of nitrogen and phosphorus are based on the usual levels of treated effluent required by the Department of Environment and Science (DES) for such an environmentally-relevant activity (ERA). The level of TDS is expected to be reasonably high due to the water supply being mainly based on bore water, which tends to have a higher level of dissolved solids (salts).

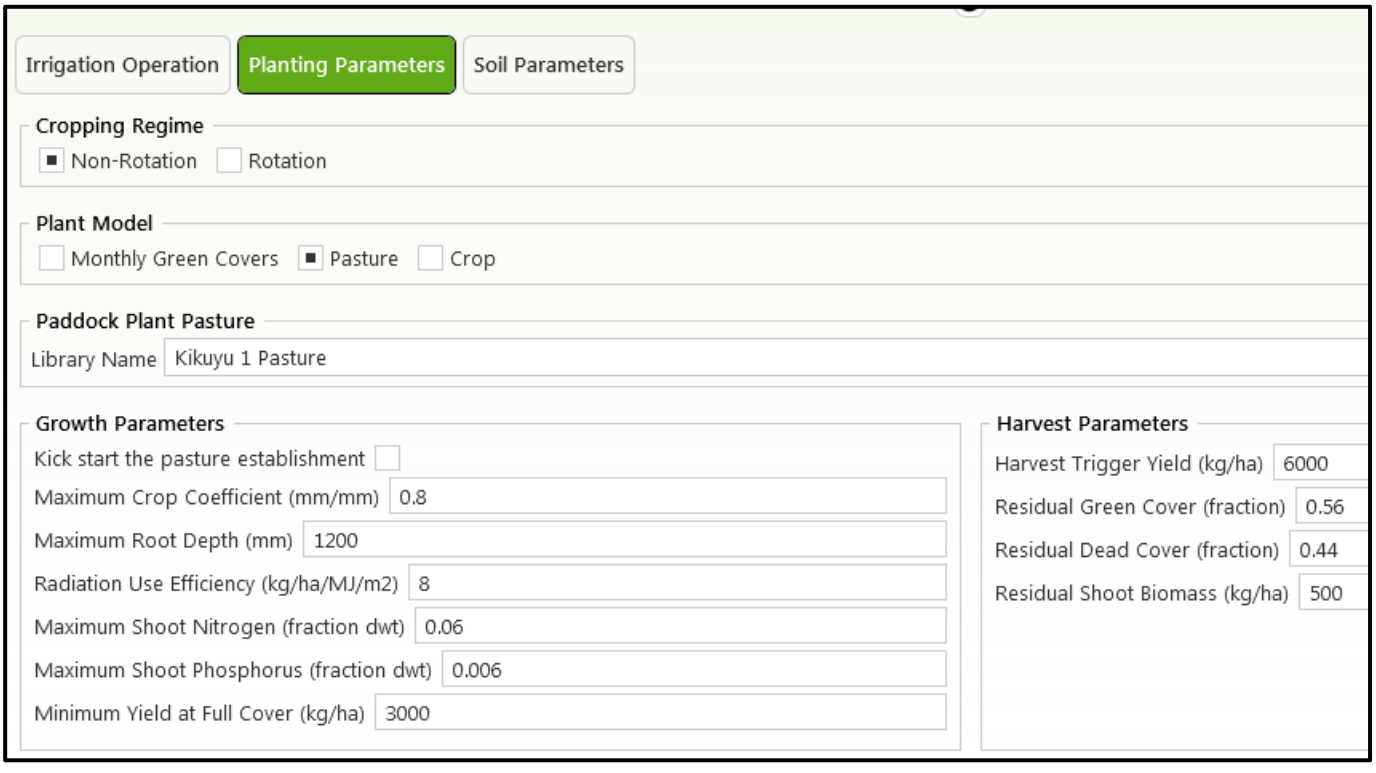
A sensitivity analyses between 30 mg/L and 50 mg/L of total nitrogen in the treated effluent was carried out in the MEDLI modelling to ascertain if there are likely to be any environmental consequences for a higher level of TN in the treated effluent.

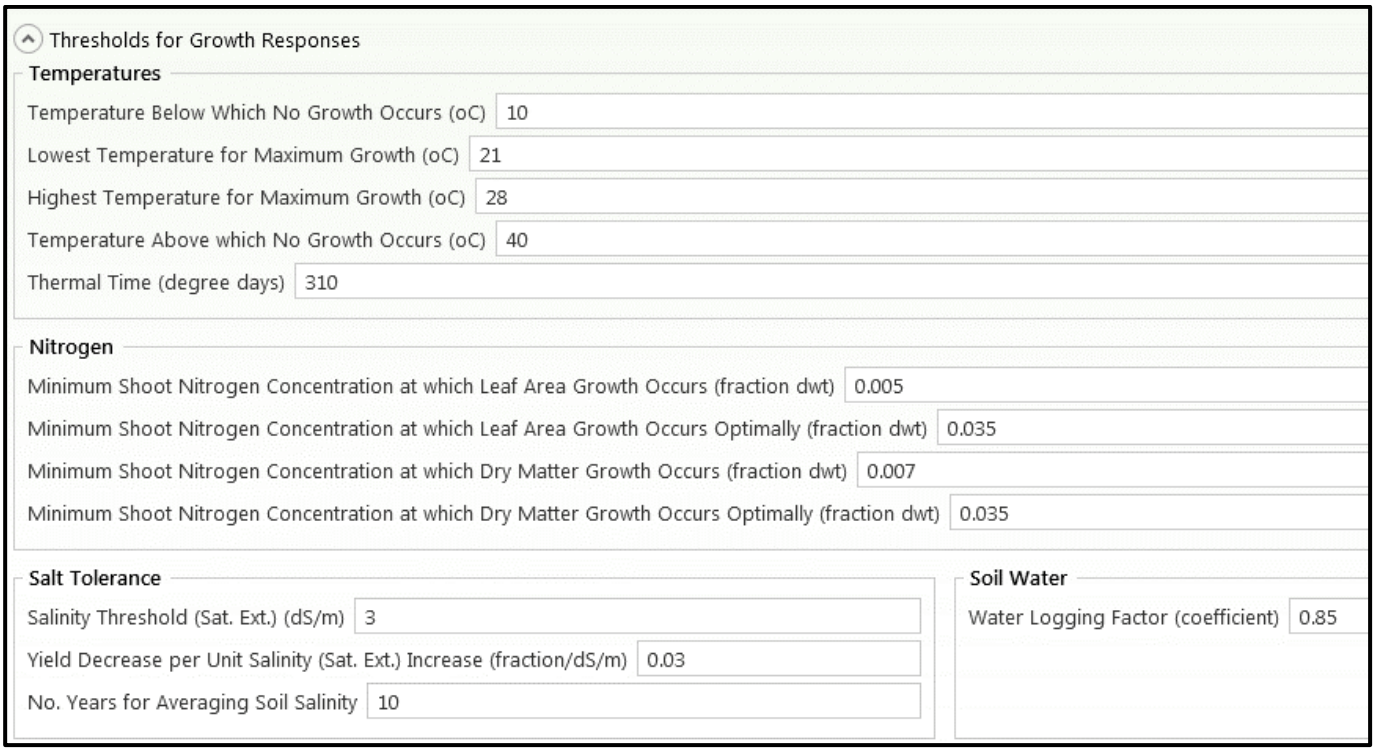
2.4 Irrigation field plant selection

The type of plant cover for the irrigation field has been selected as Kikuyu. The reason for this is that it is reasonably drought tolerant and moderately tolerant to salinity in soil.

The generic library for Kikuyu in MEDLI has the following parameters in Table 2-12.

Table 2-12: MEDLI Planting Parameters for Kikuyu





2.5 Soil Parameter Adjustments

The laboratory's wastewater disposal soil assessment classified the samples as listed in Table 2-13 below. The top layer of 200 mm depth was predominantly sandy clay loam with the remaining 1800 mm depth being medium clay.

Table 2-13: Soil Assessment descriptions

Sample ID	Sample description
Sample 1 ODS M1 0.0-0.2m	Sandy Clay Loam
Sample 2 ODS M1 0.2-2.0m	Medium Clay
Sample 3 ODS M2 0.0-0.2m	Fine Sandy Clay Loam
Sample 4 ODS M2 0.2-2.0m	Medium Clay
Sample 5 ODS M3 0.0-0.2m	Sandy Loam
Sample 6 ODS M3 0.2-2.0m	Medium Clay
Sample 7ODS M4 0.0-0.2m	Sandy Clay Loam
Sample 8 ODS M4 0.2-2.0m	Medium Clay
Sample 9 ODS M5 0.0-0.2m	Fine Sandy Clay Loam
Sample 10 ODS M5 0.2-2.0m	Medium Clay

Below in Table 2-14 a comparison of various soil parameters are shown in order to highlight what has been revised since the actual soil from the site was tested compared to the values used for the preliminary MEDLI modelling based on soil bore logs and MEDLI library values.

Not all parameters were provided by sample testing, with some parameters being determined from the *MEDLI Technical Reference* document once more detail of the soil had become available.

Table 2-14: Comparison of original Soil Hydrologic Layer parameters with soil samples from the proposed effluent irrigation area

Soil Parameter Description	Original Model Soil Parameters Grey Clay				Revised Model Soil Parameters ODS Soil Layers 1& 2: Sandy Clay Loam Layers 3 & 4: Medium clay			
	Layer 1	Layer 2	Layer 3	Layer 4	Layer 1	Layer 2	Layer 3	Layer 4
Soil Hydrologic Layers								
Soil layer thickness (mm)	100	500	600	300	100	100	900	900[1]
Air Dry (% v/v)	4.2	0.1	0.1	0.1	0.9 [2]	0.1	0.1	0.1
Lower Storage Limit (%v/v)	26.7	27.5	30.7	32.8	15[3]	15	25[4]	25
Drained Upper Limit (%v/v)	42	43.6	42.4	42.7	26[5]	26	42[6]	42
Available Water Capacity (mm)[7]	15.3	80.5	70.2	29.7	10	17	153	153
Saturated Water Content	47	48.6	47.4	48.2	40[8]	40	45	45
Bulk Density	1.35	1.33	1.37	1.35	1.54[9]	1.54	1.43[10]	1.43
Porosity[11]	49.06	49.81	48.3	49.06	41.89	41.89	46.04	46.04
Saturated Hydraulic Conductivity	10	1	0.5	0.1	10[12]	10	1.67[13]	1.67

[1] Samples taken from each of the 5 locations. First depth 0.0 – 0.2m, second depth 0.2 – 2.0m. MEDLI Model requires first layer to be no less than 100mm, therefore layer 2 is the remainder of the first sample depth, with Layers 3 and 4 being equal depths of the second sample depth
[2] Air Dry Average value calculated from laboratory test results for 5 samples at depth 0.0 – 0.2m.
[3] LSL Value based on soil texture being predominantly **sandy clay loam** at layers 1 & 2 and the typical limits used in *MEDLI Technical Reference* (Table 5-2)
[4] LSL Value based on soil texture being predominantly **medium clay** at layers 3 & 4 and the typical limits used in *MEDLI Technical Reference* (Table 5-2)
[5] DUL Value based on soil texture being predominantly **sandy clay loam** at layers 1 & 2 and the typical limits used in *MEDLI Technical Reference* (Table 5-2)
[6] DUL Value based on soil texture being predominantly **medium clay** at layers 3 & 4 and the typical limits used in *MEDLI Technical Reference* (Table 5-2)
[7] AWC Value calculated by program
[8] SWC value was set at less than the calculated porosity value
[9] Average bulk density value calculated from laboratory test results for 5 samples at depth 0.0 – 0.2m
[10] Average bulk density value calculated from laboratory test results for 5 samples at depth 0.2 – 2.0m
[11] Porosity value calculated by program using bulk density and absolute density of 2.65 g/cm^3
[12] Sat. Hyd, Cond. value used from *MEDLI Technical Reference Table 5-4* as middle of range for Weakly Pedal Clay Loam (5 - 20 mm/hr). Permeability testing was not carried out on site for layers 1 & 2 depths.
[13] Sat. Hyd. Cond. value averaged from 5 permeability tests carried out on site by CQ Soil Testing for depths 250 mm – 500 mm & 500 mm – 750 mm

The laboratory carried out testing of phosphorus to determine initial soil phosphorus as well as modelling the phosphorus sorption curve. These values were then averaged to provide the values in Table 2-15 below.

Table 2-15: Comparison of original Soil Phosphorus parameters with revised parameters for soil samples from the proposed effluent irrigation area

Soil Parameter Description	Original Model Soil Parameters Grey Clay				Revised Model Soil Parameters ODS Soil Layers 1& 2: Sandy Clay Loam Layers 3 & 4: Medium clay			
	Layer 1	Layer 2	Layer 3	Layer 4	Layer 1	Layer 2	Layer 3	Layer 4
Soil Phosphorus								
Initial Soil Phosphorus (mg/kg)	12.1	12.1	12.1	12.1	31.8[14]	31.8	31.8	31.8
Adsorption Coefficient	73	73	73	73	118.31[15]	118.31	21.67[16]	21.67
Adsorption Exponent	0.39	0.39	0.39	0.39	0.3[17]	0.3	0.82[18]	0.82
Desorption Exponent	0.25	0.25	0.25	0.25	0.28[19]	0.28	0.78[20]	0.78

Refer to Appendix A: Laboratory Phosphorus Sorption Curve Calculations for more details of the test results.

[14] Init. Soil Phosphorus average values calculated from laboratory test results for 5 samples at depth 0.0 – 0.2m and 5 samples at depth 0.2 - 2.0m.
[15] Adsorption Coefficient average values from laboratory test results for 5 samples at depth 0.0 – 0.2m calculated using P Adsorption Isotherm parameter calculator.
[16] Adsorption Coefficient average values from laboratory test results for 5 samples at depth 0.2 - 2.0m calculated using P Adsorption Isotherm parameter calculator.
[17] Adsorption exponent average values from laboratory test results for 5 samples at depth 0.0 – 0.2m calculated using P Adsorption Isotherm parameter calculator.
[18] Adsorption exponent average values from laboratory test results for 5 samples at depth 0.2 - 2.0m calculated using P Adsorption Isotherm parameter calculator.
[19] Desorption Exponent average values from laboratory test results for 5 samples at depth 0.0 – 0.2m calculated using P Adsorption Isotherm parameter calculator.
[20] Desorption Exponent average values from laboratory test results for 5 samples at depth 0.2 - 2.0m calculated using P Adsorption Isotherm parameter calculator.

The soil parameters for runoff and evaporation were adjusted to suit more for the top layer (sandy clay loam) and the percentage of clay determined by hydrometer analysis.

The MEDLI Technical Reference Tables 5-1 and 5-6 were used to determine the first 3 values shown in Table 2-16 below.

The value for initial Nitrate Nitrogen was adjusted to the value obtained from extractable Nitrate testing, whilst the remaining values were kept the same as the original grey clay parameters as these could not be tested and are considered generally typical.

Table 2-16: Comparison of original soil parameters with revised parameters used in the final MEDLI model.

Parameter Description	Original Model Soil Parameters grey clay	Revised Model Soil Parameters ODS Soil
Runoff & Evaporation Parameters		
Runoff Curve Number (coefficient)	75	85[21]
Evaporation Stage I Drying Maximum (U) (mm)	6	7.25[22]
Slope of Evaporation Stage II Drying (Cona) (mm/sqrt day)	3.5	3.5[23]
Initial Nitrogen in Soil		
Initial Nitrate Nitrogen (average in profile) (mg/kg)	2.5	2.34
Initial Organic Nitrogen (Average in Organic Layer) (mg/kg)	800	800
Thickness of Organic Layer (mm)	300	300
Thickness of Labile Carbon Layer (mm)	150	150
Soil Temperature Scalars		
Lag Coefficient	0.73	0.73
Wet Dry Scaling Factor	0.49	0.49
Albedo of Plant Cover (proportion reflectance)	0.23	0.23

[21] **Runoff curve number** for hydrologic soil group B from *MEDLI Technical Reference Table 5-1* used (worst case – highest value in range) to represent sandy clay loam topsoil (to 200mm depth)
[22] Clay % =12 is the average value from the laboratory Grain Size Analysis (hydrometer) testing. This value was then used with *MEDLI Technical Reference Table 5-6* to estimate value for **U**.
[23] Clay % =12 is the average value from the laboratory Grain Size Analysis (hydrometer) testing. This value was then used with *MEDLI Technical Reference Table 5-6* to estimate value for **Cona**.

Parameter Description	Original Model Soil Parameters grey clay	Revised Model Soil Parameters ODS Soil
Nitrogen Kinetic Rate Coefficients		
Ammonification of Soil Organic Nitrogen (fraction/day)	0.00035	0.00035
Denitrification (fraction/day)	0.1	0.1

3 MEDLI Model Scenarios

All scenarios were run with the following settings:

Table 3-1: Common Scenario Settings

Description	Set Value
Irrigation rate	2mm/day
Plant type	Kikuyu pasture
Treated Effluent – Total Phosphorus:	16 mg/L
Treated Effluent – Total Dissolved Salts	650 mg/L
L/EP/day	200
Equivalent Persons (EP)/day (Initial production)	Average of 120 every day;
Equivalent Persons (EP)/day (Full production)	Average of 211 every day;

Table 3-2: Varied Scenario Settings

Scenario No.	EP/day	Wet weather Storage volume (kL)	Irrigation Area (ha)	Total N (mg/L)
Scenario 5-1 Multi-run	120	200 – 250in 10 kL increments	2.0 – 3.0 ha in 0.1 ha increments	30
Scenario 5-1 Optimum	120	220 kL	2.4 ha	30
Scenario 5-2	120	220kL	2.4 ha	50
Scenario 6-1	211	280 – 360 in 10 kL increments	4.5 – 6.5 ha in 0.2 ha increments	30
Scenario 6-1 Optimum	211	340 kL	5.5 ha	30
Scenario 6-2	211	340 kL	5.5 ha	50

KEY

TN = 30 mg/L

TN = 50 mg/L

3.1 Optimised irrigation area and WWS volume for Initial 6 Mtpa Production (120 EP/day)

3.1.1 120EP/day – Scenario 5-1

A multi-run was carried out at the beginning of Scenario 5-1 to determine the optimum Wet Weather Storage (WWS) capacity and irrigation area for plant yield and minimum overflows. Refer to Figure 3-1.

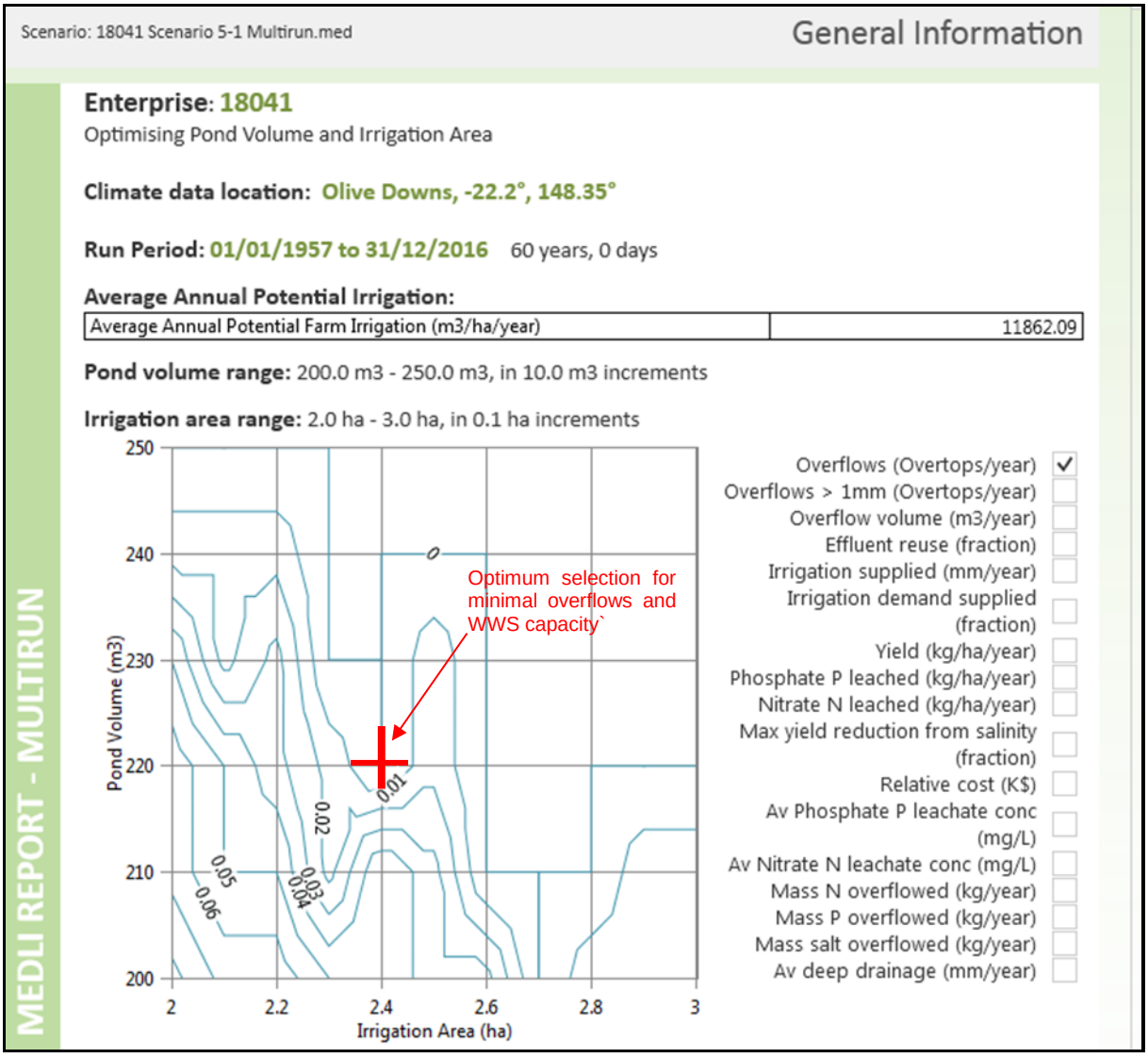


Figure 3-1: Scenario 5-1 Multi-Run – Overflow summary

The model was then run for optimal Wet Weather Storage capacity of 220 kL and an irrigation area of 2.4 ha with the following findings:

- 30% of the average annual irrigation demand was supplied over the 2.4 ha.
- Zero overflow predicted
- Negligible leaching of nitrogen and no leaching of phosphorus
- Low deep drainage and rain runoff predicted
- No signs of waterlogging of the irrigation field crop

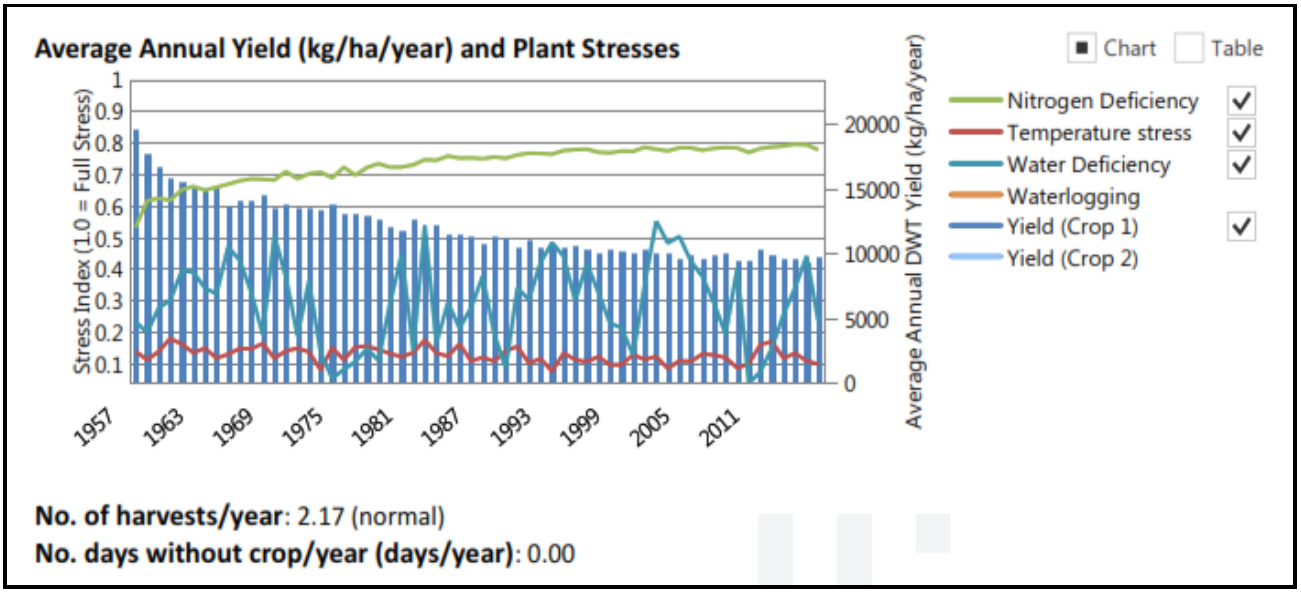


Figure 3-2: Scenario 5-1 Crop Yield and Plant Stresses chart

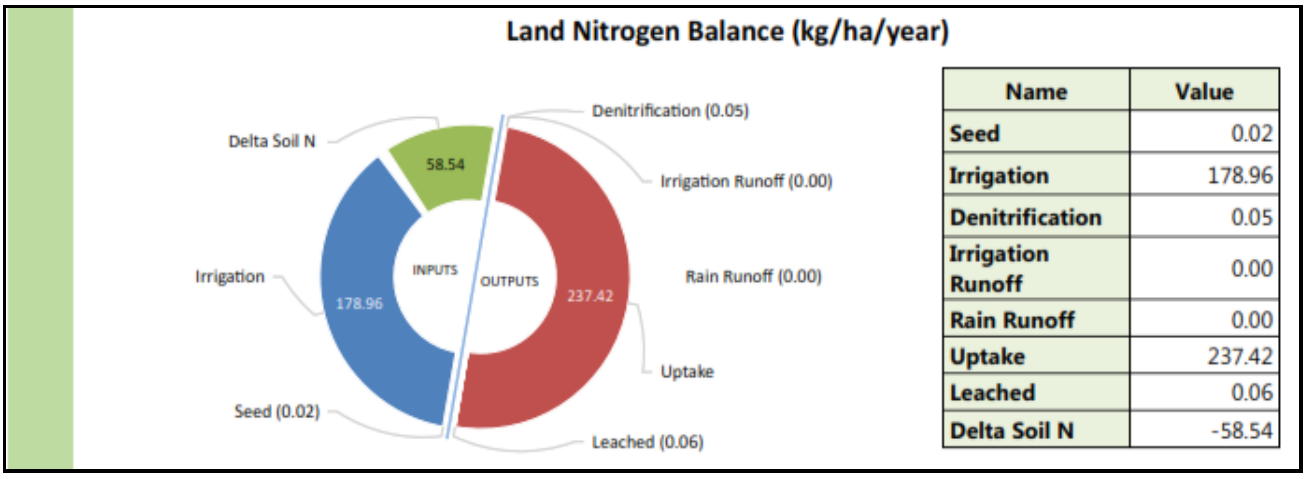
Refer to Appendix B: MEDLI Model Report – Scenario 5-1 for more detail.

3.2 Increased Nitrogen levels for Initial 6 Mtpa production (120 EP/day)

3.2.1 Scenario 5-2- TN of 50mg/L

The optimum Scenario 5-1 settings for irrigation field area and wet weather storage were used again in Scenario 5-2, with the only variable changed being the increase of total nitrogen from 30 mg/L to 50 mg/L.

Compared with Scenario 5-1, there was no noticeable increase in leached nitrogen as all of the nitrogen supplied from irrigation was taken up by the plants.



Name	Value
Seed	0.02
Irrigation	178.96
Denitrification	0.05
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	237.42
Leached	0.06
Delta Soil N	-58.54

Figure 3-3: Scenario 5-2 Land Nitrogen Balance

The overall yield increased and the amount of stress from nitrogen deficiency decreased slightly.

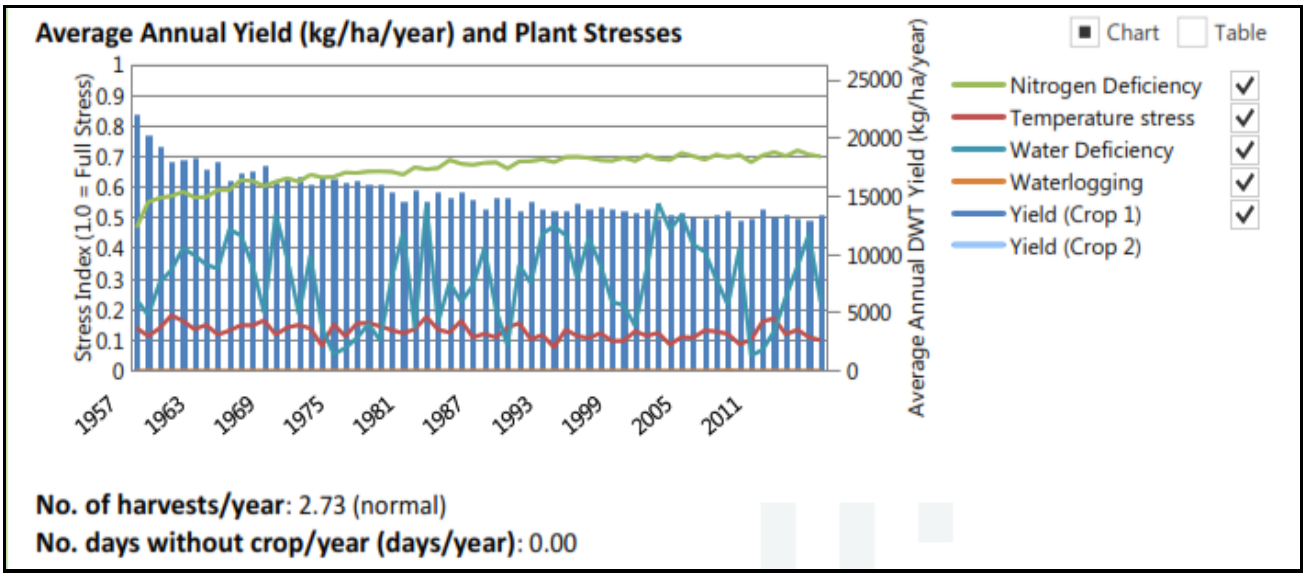


Figure 3-4: Scenario 5-2 Crop Yield and Plant Stresses chart

Refer to Appendix C: MEDLI Model Report – Scenario 5- below for more detail.

3.3 Optimised irrigation area and WWS volume for Full 20 Mtpa Production (211 EP/day)

3.3.1 211EP/day – Scenario 6-1

A multi-run was carried out at the beginning of Scenario 6-1 to determine the optimum WWS capacity and irrigation area for plant yield and minimum overflows. Refer to Figure 3-5.

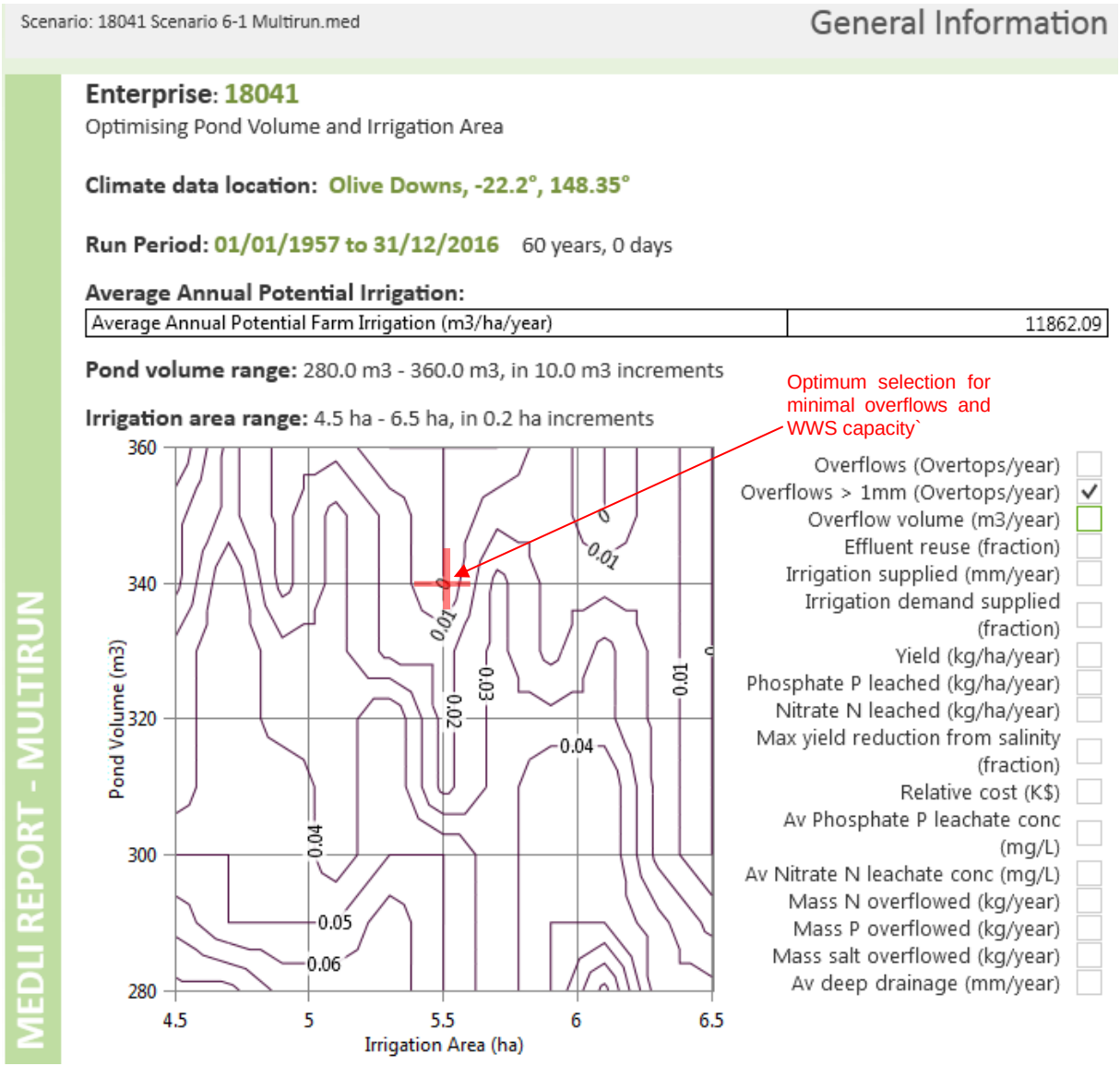


Figure 3-5: Scenario 6-1 Multi-Run – Overflow summary

The model was then run for optimal Wet Weather Storage capacity of 340 kL and an irrigation area of 5.5 ha with the following findings:

- 30% of the average annual irrigation demand was supplied over the 5.5 ha.
- Zero overflow predicted
- Negligible leaching of nitrogen and phosphorus
- Low deep drainage and rain runoff predicted
- No signs of waterlogging of the irrigation field crop

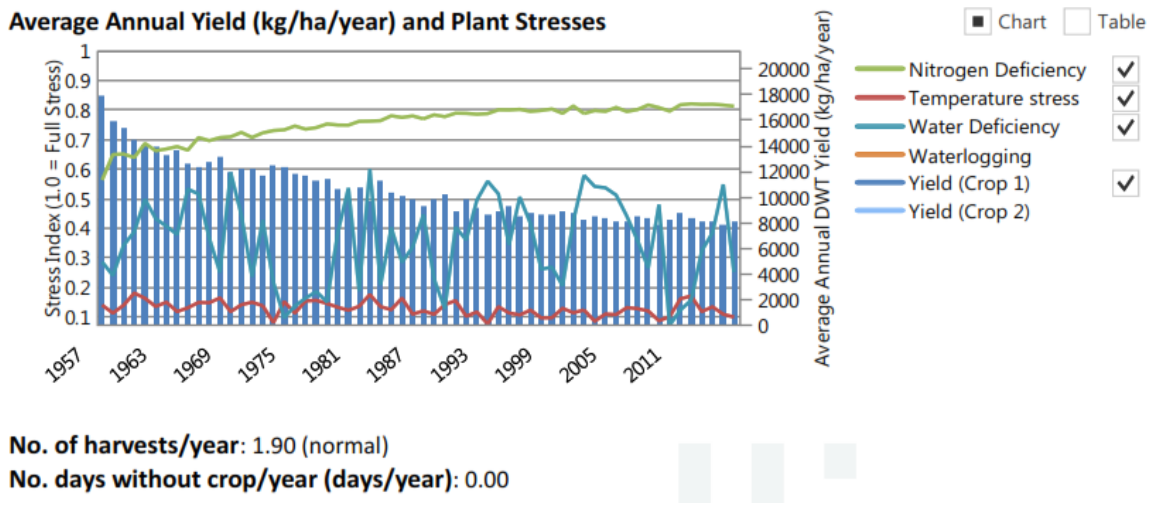


Figure 3-6: Scenario 6-1 Crop Yield and Plant Stresses chart

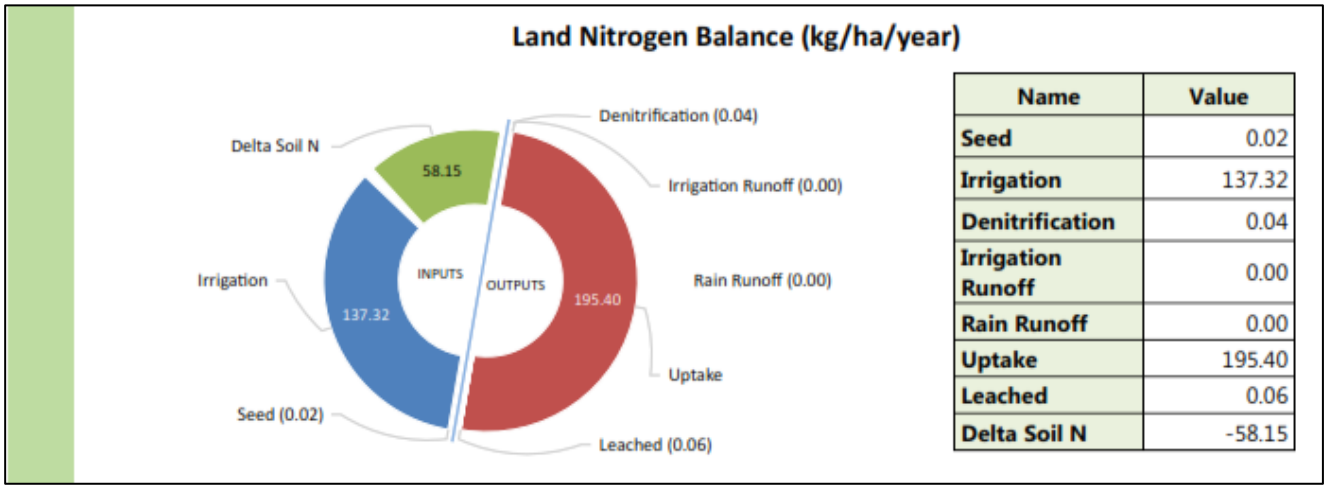
Refer to Appendix D:MEDLI Model Report – Scenario 6-1 for more detail.

3.4 Increased Nitrogen levels

3.4.1 Scenario 6-2- TN of 50mg/L

The optimum Scenario 6-1 settings for irrigation field area and wet weather storage were used again in Scenario 6-2, with the only variable changed being the increase of total nitrogen from 30 mg/L to 50 mg/L.

Compared with Scenario 6-1, there was no noticeable increase in leached nitrogen as all of the nitrogen supplied from irrigation was taken up by the plants.



Name	Value
Seed	0.02
Irrigation	137.32
Denitrification	0.04
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	195.40
Leached	0.06
Delta Soil N	-58.15

Figure 3-7: Scenario 6-2 Land Nitrogen Balance

The overall yield increased and the amount of stress from nitrogen deficiency decreased slightly.

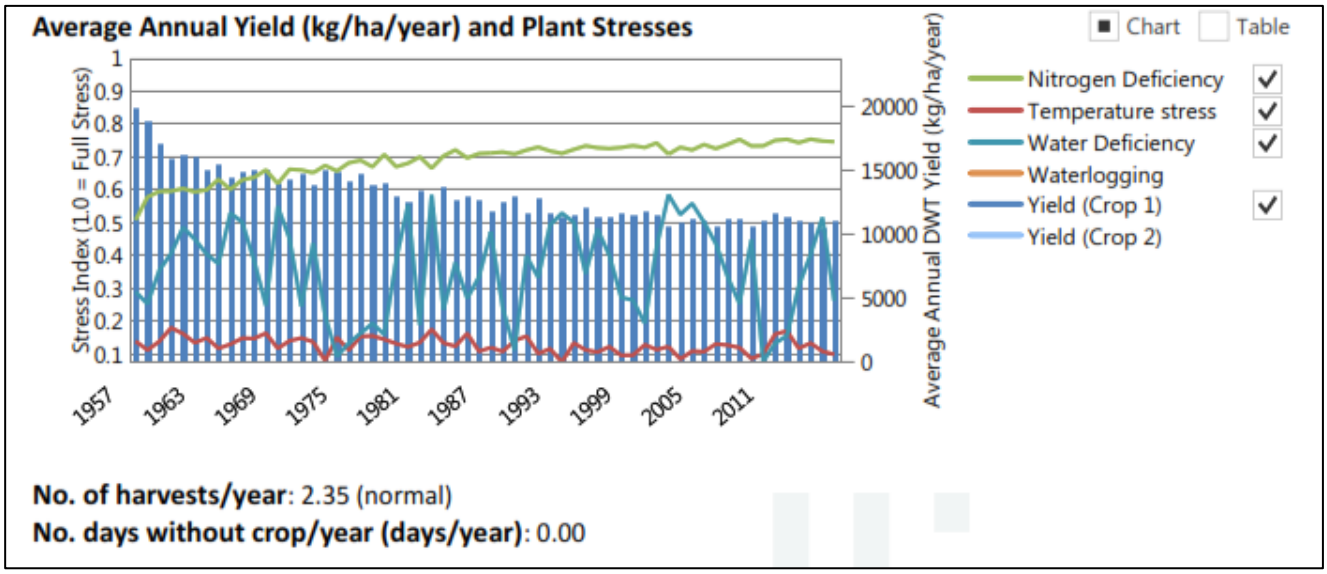


Figure 3-8: Scenario 6-2 Crop Yield and Plant Stresses chart

Refer to Appendix E:MEDLI Model Report – Scenario 6-2 for more detail.

4 Summary Of MEDLI Modelling Findings For Initial & Full Production Effluent Disposal

A comparison between the MEDLI model outcomes for Initial 6 Mtpa production and Full 20 Mtpa production are shown in Table 4-1 below.

Initial 6 Mtpa production - Scenario 5-1 is for a treated effluent total nitrogen content of 30 mg/L, whilst Scenario 5-2 is for a treated effluent total nitrogen content of 50 mg/L.

Full 20 Mtpa production - Scenario 6-1 is for a treated effluent total nitrogen content of 30 mg/L, whilst Scenario 6-2 is for a treated effluent total nitrogen content of 50 mg/L.

Points to note:

- All scenarios resulted in no overflows and very low deep drainage;
- Negligible leaching of nitrogen and phosphorus into the soil occurred;
- The design soil profile storage life for phosphorus is predicted to be about 37 years for Initial Production and 40 years for Full Production.
- The Full Production application actually results in slightly less yield than the Initial Production application, as the average effluent nitrogen and phosphorus added to the soil was calculated to be slightly lower.

There are no anticipated crop losses with the application of 2mm/day (when supply is available).

Table 4-1: Summary of Scenarios 5-1, 5-2, 6-1 & 6-2 Outcomes

MEDLI calculated parameter		SCENARIO 5-1	SCENARIO 5-2	SCENARIO 6-1	SCENARIO 6-2
	Wet Weather Storage Volume:	220 kL	220 kL	340 kL	340 kL
	Treated effluent volume:	25.50 m^3/day	25.50 m^3/day	44.84 m^3/day	44.84 m^3/day
	Irrigation Area:	2.4 ha	2.4 ha	5.5 ha	5.5 ha
	Total Nitrogen in irrigated effluent	30 mg/L	50 mg/L	30 mg/L	50 mg/L
Pond					
Rain	kL/year	0.00	0.00	0.00	0.00
Inflow	kL/year	9314.27	9314.27	16377.58	16377.17
Recycling	kL/year	0.00	0.00	0.00	0.00
Evaporation	kL/year	0.00	0.00	0.00	0.00
Overflow	kL/year	0.00	0.00	0.00	0.00
Irrigation	kL/year	9313.60	9313.60	16377.17	16377.17
Land					
Rain	mm/year	596.46	596.46	596.46	596.46
Irrigation	mm/year	388.07	388.07	297.77	297.77
Soil Evaporation	mm/year	1.52	1.51	1.41	1.40
Transpiration	mm/year	941.07	941.52	857.39	857.72
Rain Runoff	mm/year	29.33	29.34	28.24	27.99
Irrigation Runoff	mm/year	0.00	0.00	0.00	0.00
Deep Drainage	mm/year	17.41	17.15	12.12	12.02
Soil Nitrogen Balance					
Average annual effluent nitrogen added	(kg/ha/year)	107.38	178.96	82.39	137.32
Average annual soil nitrogen removed by plant uptake	(kg/ha/year)	165.83	237.42	140.43	195.40
Average annual soil nitrogen removed by denitrification	(kg/ha/year)	0.03	0.05	0.02	0.04
Average annual soil nitrogen leached	(kg/ha/year)	0.06	0.06	0.06	0.06

MEDLI calculated parameter		SCENARIO 5-1	SCENARIO 5-2	SCENARIO 6-1	SCENARIO 6-2
	Wet Weather Storage Volume:	220 kL	220 kL	340 kL	340 kL
	Treated effluent volume:	25.50 m^3/day	25.50 m^3/day	44.84 m^3/day	44.84 m^3/day
	Irrigation Area:	2.4 ha	2.4 ha	5.5 ha	5.5 ha
	Total Nitrogen in irrigated effluent	30 mg/L	50 mg/L	30 mg/L	50 mg/L
Average annual nitrate-N loading to groundwater	(kg/ha/year)	0.06	0.06	0.06	0.06
Soil organic-N (initial-Final)	(kg/ha)	3608.00 – 163.94	3608.00 – 162.70	3608.00 – 189.14	3608.00 – 185.15
Average nitrate-N concentration of deep drainage	mg/L	0.33	0.34	0.47	0.47
Max. annual nitrate-N concentration of deep drainage (mg/L)	mg/L	7.95	7.96	7.95	7.96
Soil Phosphorus Balance					
Average annual effluent phosphorus added (kg/ha/year)	(kg/ha/year)	58.44	58.44	44.84	44.84
Average annual soil phosphorus removed by plant uptake	(kg/ha/year)	47.70	49.78	37.74	40.57
Average annual soil phosphorus leached	(kg/ha/year)	0.23	0.21	0.15	0.13
Dissolved phosphorus (Initial – Final)	(kg/ha)	12.06 – 10.77	12.06 – 9.01	12.06 – 8.43	12.06 – 6.56
Adsorbed phosphorus (Initial – Final)	(kg/ha)	916.48 – 1547.97	916.48 – 1426.39	916.48 – 1337.31	916.48 – 1170.44
Average phosphate-P concentration in root zone	mg/L	1.81	1.48	1.36	1.04
Average phosphate-P concentration of deep drainage	mg/L	1.34	1.22	1.22	1.06
Max. annual phosphate-P concentration of deep drainage	mg/L	1.59	1.59	1.59	1.59
Design soil profile storage life	years	37.13 based on average infiltrated water phosphorus concn. of 6.12 mg/L	37.20 based on average infiltrated water phosphorus concn. of 6.12 mg/L	40.71 based on average infiltrated water phosphorus concn. of 5.18 mg/L	40.81 based on average infiltrated water phosphorus concn. of 5.18 mg/L
Average Plant Performance					

MEDLI calculated parameter		SCENARIO 5-1	SCENARIO 5-2	SCENARIO 6-1	SCENARIO 6-2
	Wet Weather Storage Volume:	220 kL	220 kL	340 kL	340 kL
	Treated effluent volume:	25.50 m^3/day	25.50 m^3/day	44.84 m^3/day	44.84 m^3/day
	Irrigation Area:	2.4 ha	2.4 ha	5.5 ha	5.5 ha
	Total Nitrogen in irrigated effluent	30 mg/L	50 mg/L	30 mg/L	50 mg/L
Average annual shoot dry matter yield	Kg/ha/year	11989.21	15166.28	10515.39	13063.17
Average number of crop deaths per year	no./year	0.00	0.00	0.00	0.00
No. of days without crop/year	days	0.00	0.00	0.00	0.00

5 References

Soil and Land Suitability Assessment- Olive Downs Project, Section 4.1.2, GT Environmental. (7 pages)

Soil and Land Suitability Assessment- Olive Downs Project, Figure 3.2: Soil Mapping Units, GT Environmental. (1 page)

Drawing 84-6-3302-LAY-DWG-0004, Phronis Consulting

Drawing 84-6-3302-LAY-DWG-0002, Phronis Consulting

Google Maps

Email dated 9 July 2018 from Richard Hill, Phronis Consulting

Email dated 18 September 2018 from Richard Hill, Phronis Consulting – Anticipated Daily Workforce

The following sample results from Environmental Analysis Laboratory (EAL), Southern Cross University, East Lismore:

- CQS001-MEDLI-H4318
- CQS001-SS-H4318
- CQS001-Hydropmeter-H4318
- CQS001-SS-H4318(SS-PACK-003)

MEDLI Model for Effluent Disposal using Land Irrigation Version 2 Technical Reference, Rev: 13 September 2016, Department of Information Technology and Innovation, State of QLD

Site Investigation Report, CQ Soil Testing (21/09/2018)

Excel spreadsheet*: Economic Assessment Information Request March 2018 (RES00902986-003),* Resource Strategies Pty Ltd, 15/11/2018.

Document No: 18041-R0-180903 - MEDLI Modelling Olive Downs South Mine Report, Tuesday, 4 September 2018, Sustainable Solutions International Pty Ltd

Document No: 18041R0-180921 – MEDLI Modelling Supplemental Report Part 1, Olive Downs South Mine, Wednesday, 26 September 2018, Sustainable Solutions International Pty Ltd

On-Site Sewerage Code, QLD (2002), Department of Natural Resources and Mines

Planning Guidelines for Water Supply and Sewerage, April 2010, Chapter 6 amended March 2014, Department of Energy and Water Supply (QLD Govt.)

Environmental Protection Regulation 2008, Reprinted as in force on 9 November 2012, Queensland Government

Appendix A: Laboratory Phosphorus Sorption Curve Calculations

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

Algorithms from HSPF (Johnson et al., 1984) and described fully in the MEDLI Version 2.0 Manual

Excel version by Alison Vieritz, NRS, NR&M [09/2002]

1 Colwell P

Analyse the sample for sodium bicarbonate extractable P (Colwell-P) in a solution to soil mixture. Enter the Colwell P in mg/kg solution and the solution to soil ratio used.

2 Isotherm Data

P sorption curve is performed on dried (40oC) soil samples ground to <2mm. The soil is then equilibrated with a solution containing 0.01 M CaCl2 and phosphorus (added as KH2PO4) ranging in concentration from 20 to 1600 mgP/kg (six data points on the curve). A soil to solution ratio of 1:10 is used and each sample is shaken end-over-end at 30 rpm for 18 hr at 25oC, before centrifuging at 2000 g for 30 minutes. The supernatant solution P concentration is then read by Auto Analyser using the procedure of Warrell and Moody (1984). This measure is then used to calculate the amount of extra phosphorus (mg/kg) that can be adsorbed by the soil at each equilibrium solution P concentration (Padded ads). For each equilibrium solution P concentration (mg/L):

Total sorbed P (mg/kg) = $P_{added\ ads}$ + Colwell-P

3 Linear regression of Ln(X) and Ln(Y)

The X (P Equilibrium concentration in mg/L) and Y (P sorbed in mg/kg) data is then fitted to the equation:

$Y = AX^B$ by linear regression of Ln(Y) = aLn(X) + b

where b = Ln(A) and a=B.

A = MEDLI adsorption coefficient

B = MEDLI adsorption exponent

Check the fit shown by the graph.

4 MEDLI Parameters

The MEDLI adsorption coefficient, adsorption exponent, desorption exponent are then estimated. In the absence of a desorption isotherm the desorption exponent is assumed to be 95% of the adsorption exponent to allow conservatively a very minor hysteresis effect.

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

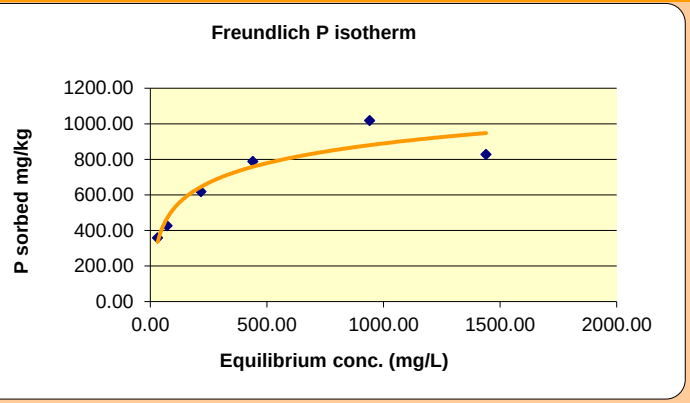
Input data in white cells only

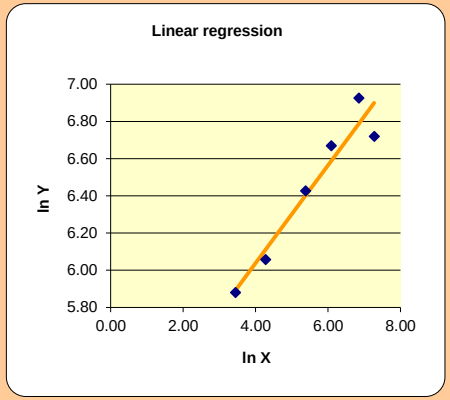
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
12.79	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	31.30	357.92
102.00	72.10	426.92
266.00	217.00	617.92
506.00	440.00	787.92
1030.00	941.00	1017.92
1510.00	1440.00	827.92





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.2633	4.9843	Equation is y = 0.2633x + 4.9843	0.9248

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**146.11**
Adsorption Exponent (B)	**0.2633**
Desorption Exponent	**0.2502**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

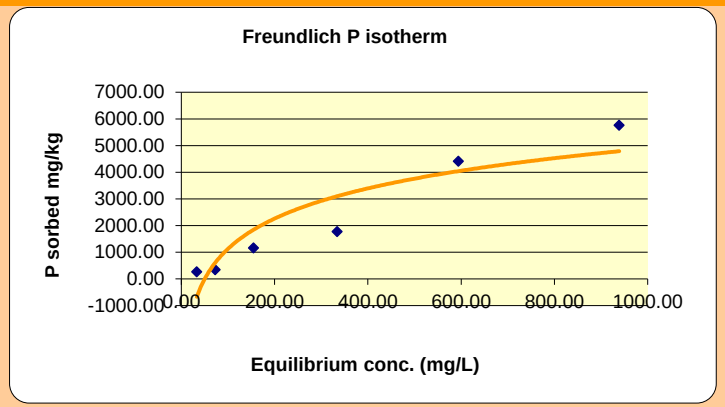
Input data in white cells only

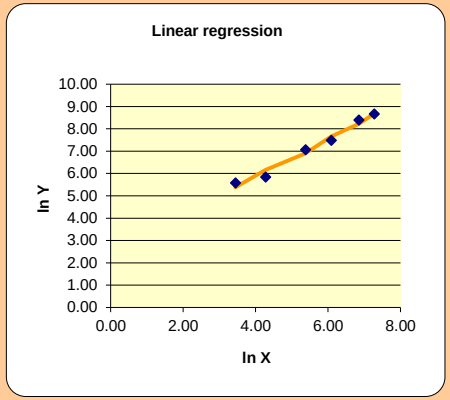
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
5.25	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	33.20	263.48
102.00	72.90	343.48
266.00	155.00	1162.48
506.00	334.00	1772.48
1030.00	594.00	4412.48
1510.00	939.00	5762.48





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.9857	1.9300	Equation is y = 0.9857x + 1.9300	0.9726

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**6.89**
Adsorption Exponent (B)	**0.9857**
Desorption Exponent	**0.9364**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

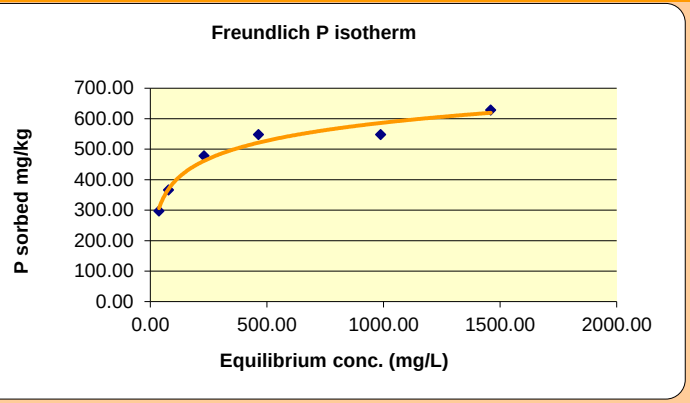
Input data in white cells only

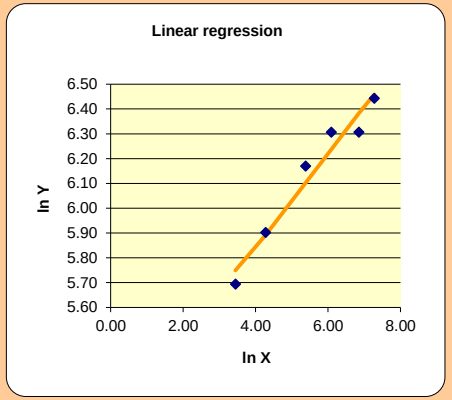
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
12.79	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	37.40	296.92
102.00	78.20	365.92
266.00	231.00	477.92
506.00	464.00	547.92
1030.00	988.00	547.92
1510.00	1460.00	627.92





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.1933	5.0494	Equation is y = 0.1933x + 5.0494	0.9534

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**155.93**
Adsorption Exponent (B)	**0.1933**
Desorption Exponent	**0.1837**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

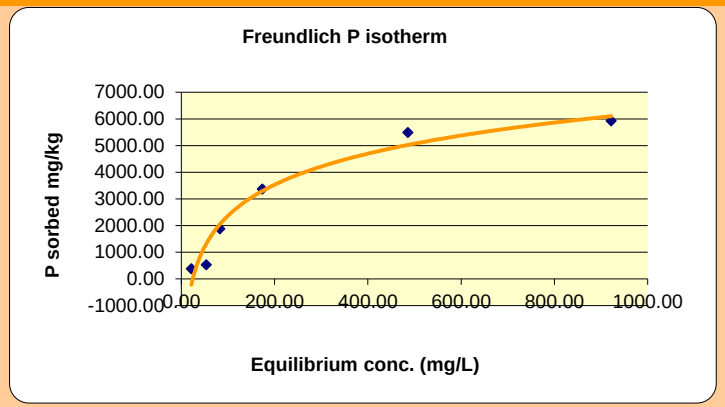
Input data in white cells only

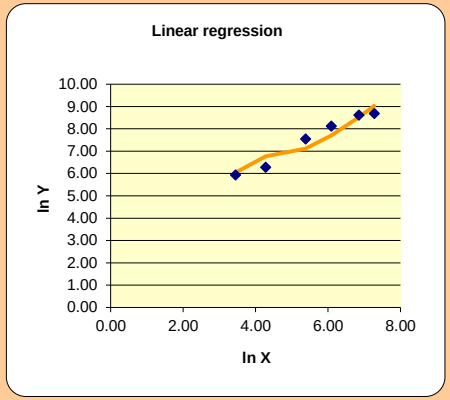
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
4.92	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	21.40	378.20
102.00	53.70	532.20
266.00	82.80	1881.20
506.00	174.00	3369.20
1030.00	486.00	5489.20
1510.00	922.00	5929.20





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.7949	3.6027	Equation is y = 0.7949x + 3.6027	0.8946

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**36.70**
Adsorption Exponent (B)	**0.7949**
Desorption Exponent	**0.7551**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

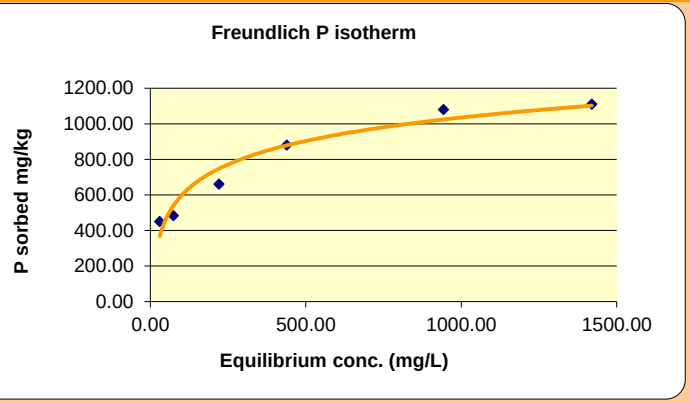
Input data in white cells only

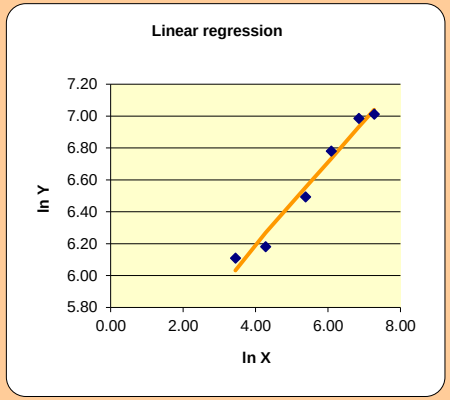
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
20.99	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	30.30	449.92
102.00	74.70	482.92
266.00	221.00	659.92
506.00	439.00	879.92
1030.00	943.00	1079.92
1510.00	1420.00	1109.92





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.2619	5.1387	Equation is y = 0.2619x + 5.1387	0.9703

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**170.50**
Adsorption Exponent (B)	**0.2619**
Desorption Exponent	**0.2488**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

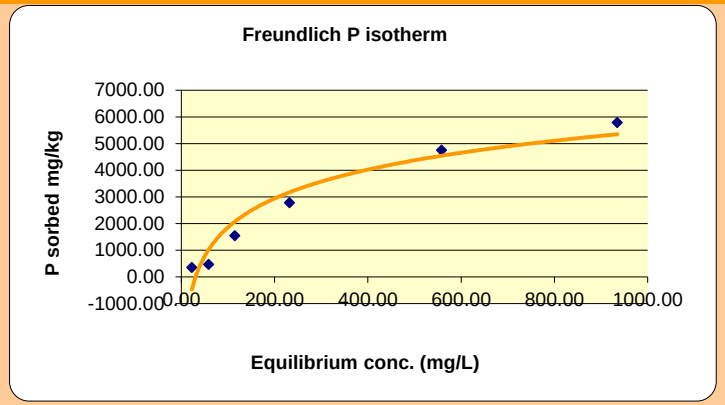
Input data in white cells only

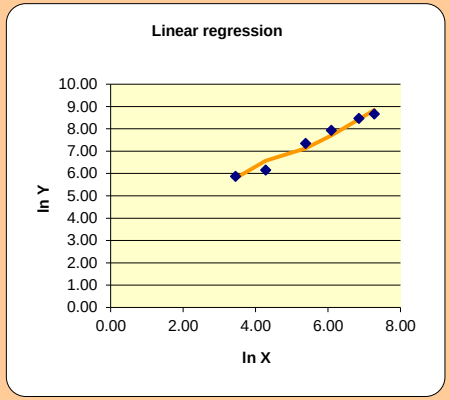
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
3.61	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	22.50	354.08
102.00	58.50	471.08
266.00	115.00	1546.08
506.00	232.00	2776.08
1030.00	558.00	4756.08
1510.00	935.00	5786.08





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.8211	3.2254	Equation is y = 0.8211x + 3.2254	0.9545

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**25.16**
Adsorption Exponent (B)	**0.8211**
Desorption Exponent	**0.7800**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

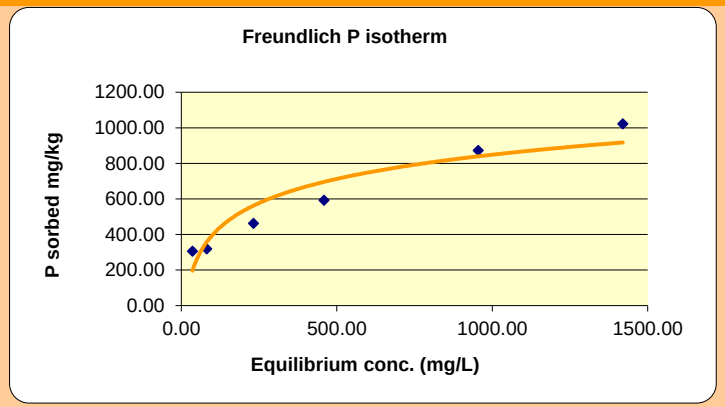
Input data in white cells only

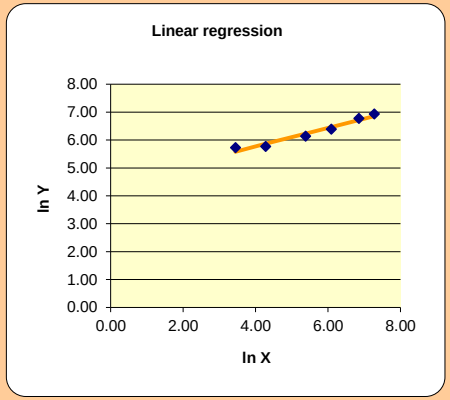
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
12.14	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	35.90	305.36
102.00	82.30	318.36
266.00	232.00	461.36
506.00	459.00	591.36
1030.00	955.00	871.36
1510.00	1420.00	1021.36





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.3466	4.3375	Equation is y = 0.3466x + 4.3375	0.9573

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**76.52**
Adsorption Exponent (B)	**0.3466**
Desorption Exponent	**0.3293**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

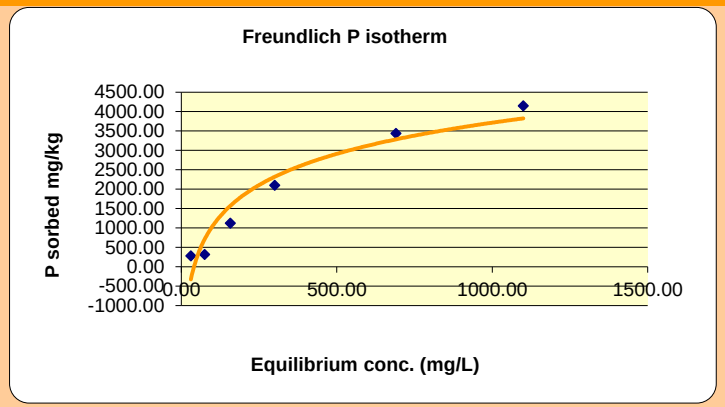
Input data in white cells only

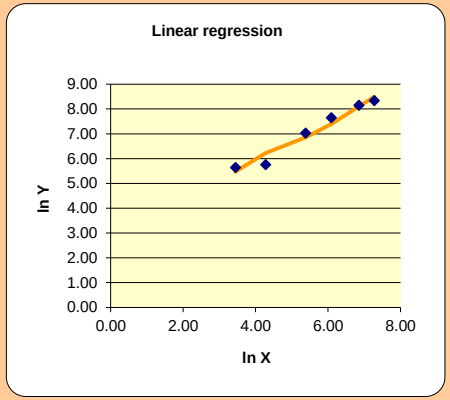
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
4.59	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	30.70	281.92
102.00	75.20	313.92
266.00	158.00	1125.92
506.00	301.00	2095.92
1030.00	691.00	3435.92
1510.00	1100.00	4145.92





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.8426	2.5879	Equation is y = 0.8426x + 2.5879	0.9449

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**13.30**
Adsorption Exponent (B)	**0.8426**
Desorption Exponent	**0.8005**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

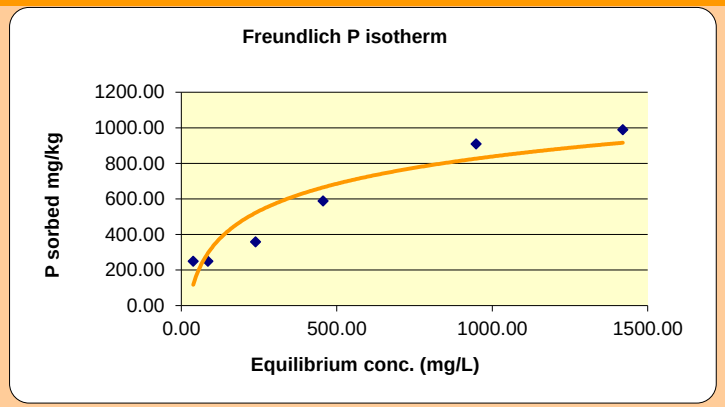
Input data in white cells only

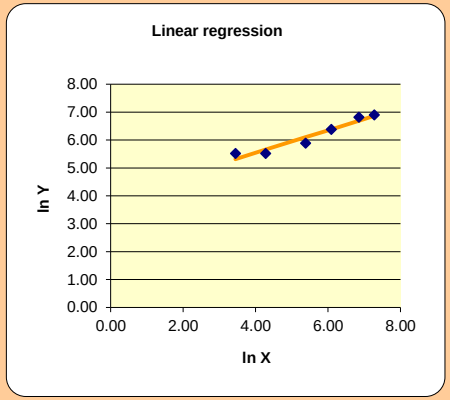
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
8.86	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	38.30	248.56
102.00	85.90	249.56
266.00	239.00	358.56
506.00	456.00	588.56
1030.00	948.00	908.56
1510.00	1420.00	988.56





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.4290	3.7495	Equation is y = 0.4290x + 3.7495	0.9355

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**42.50**
Adsorption Exponent (B)	**0.4290**
Desorption Exponent	**0.4076**

Example 1	Orig soln	Soln dilution	soln:soil ratio ?
	50	54.30	0.920810313
	100	102.00	0.980392157
	250	266.00	0.939849624
	500	506.00	0.988142292
	1000	1030.00	0.970873786
	1500	1510.00	0.993377483
		avg	0.965574276

Start Page

MEDLI P ADSORPTION ISOTHERM PARAMETER CALCULATOR

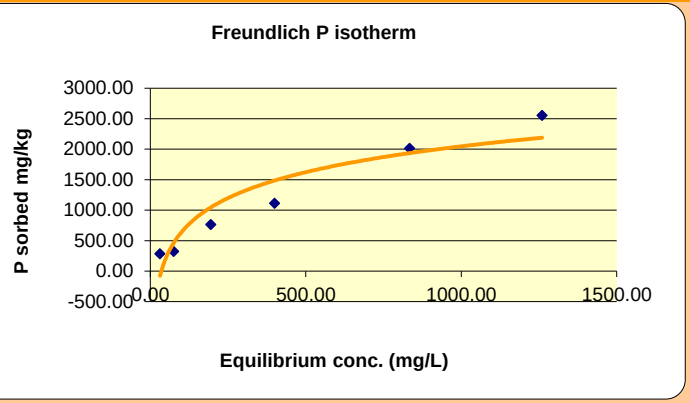
Input data in white cells only

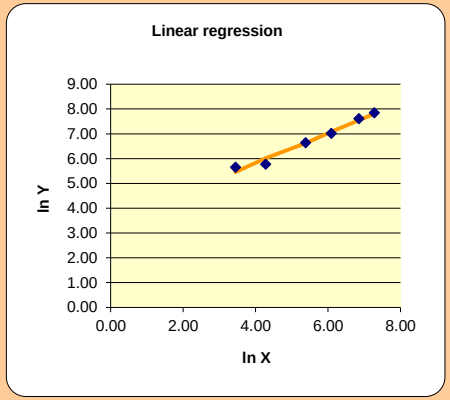
1 Colwell P

Colwell P mg/kg solution	Solution:soil ratio
5.25	10

2 Isotherm Data

Std Conc mg/L	Equil Conc mg/L X	P Sorbed mg/kg Y
54.30	31.20	283.48
102.00	75.20	320.48
266.00	195.00	762.48
506.00	400.00	1112.48
1030.00	834.00	2012.48
1510.00	1260.00	2552.48





3 Linear regression of Ln(X) and Ln(Y)

The linear regression equation uses the form y=ax+b

a	b		r^2
0.6356	3.2689	Equation is y = 0.6356x + 3.2689	0.9746

4 MEDLI Parameters

MEDLI's isotherm equation $Y=AX^B$ is shown on the graph above.

Adsorption Coefficient (A)	**26.28**
Adsorption Exponent (B)	**0.6356**
Desorption Exponent	**0.6039**

Example 1 Orig soln	Soln dilution	soln:soil ratio ?
50	54.30	0.920810313
100	102.00	0.980392157
250	266.00	0.939849624
500	506.00	0.988142292
1000	1030.00	0.970873786
1500	1510.00	0.993377483
	avg	0.965574276

REFERENCES

Johnson, R.C., J.C. Imhoff, J.L. Kittle and A.S. Donigan (1984). Hydrological Simulation Program - Fortran (HSPF): User

Warrell, LA, and Moody, PW (1984). Automated determination of micro amounts of phosphate in dilute calcium chloride extracts of soils. Commun. Soil Sci. Plant Anal. **v** 15, *pp* 779-85.

Appendix B: MEDLI Model Report – Scenario 5-1

MEDLI REPORT - RELIABILITY OF SUPPLY RUN

Title: 18041

Climate data location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

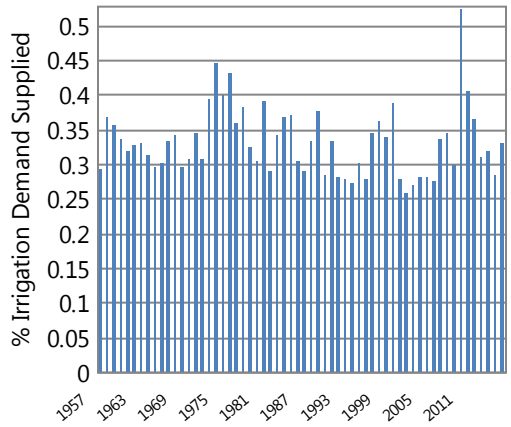
Average Annual %Irrigation Demand Supplied:

Potential annual irrigation when water supply is unlimited (m3/ha/year)	11862.1
Potential annual irrigation when water supply is unlimited (mm/year)	1186.2
Annual irrigation predicted for defined scenario (m3/ha/year)	3880.7
Annual irrigation predicted for defined scenario (mm/year)	388.1
Average annual irrigation demand supplied (fraction)	0.3

Or for 2.40 ha: 28469 m3/year

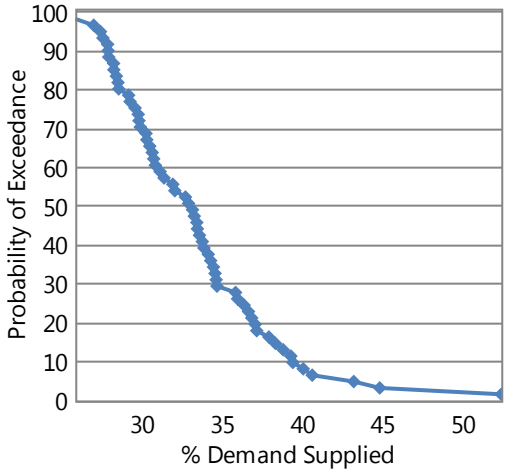
Annual % Irrigation Demand Supplied

Table Chart



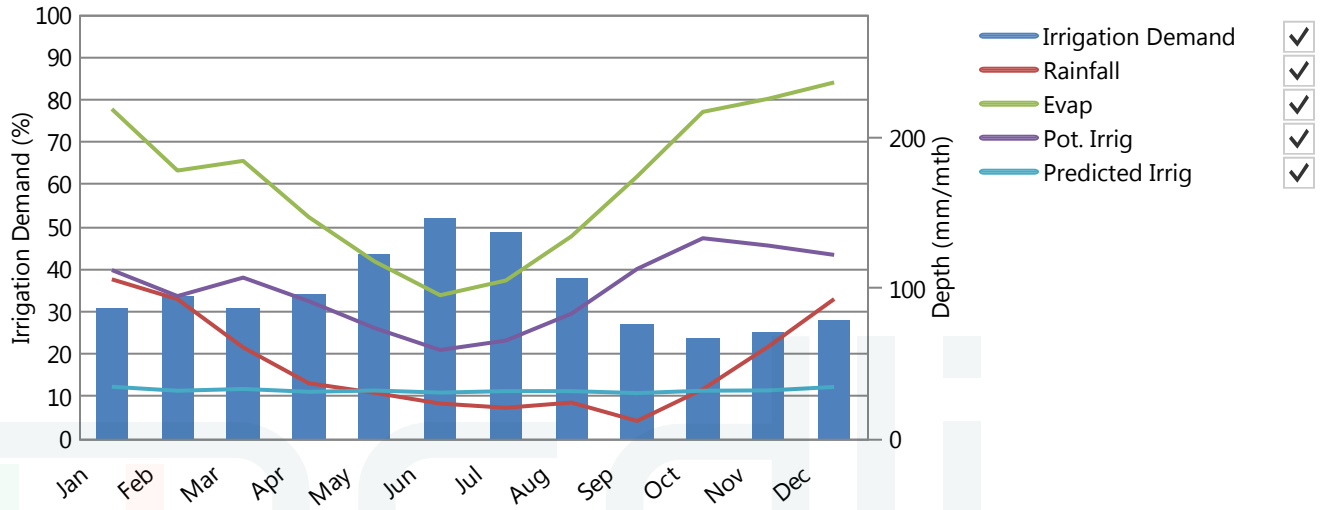
Probability of exceeding the % Irrigation Demand Supplied

Table Chart



Monthly % Irrigation Demand Supplied

Chart Table



DESCRIPTION

Climate Data: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

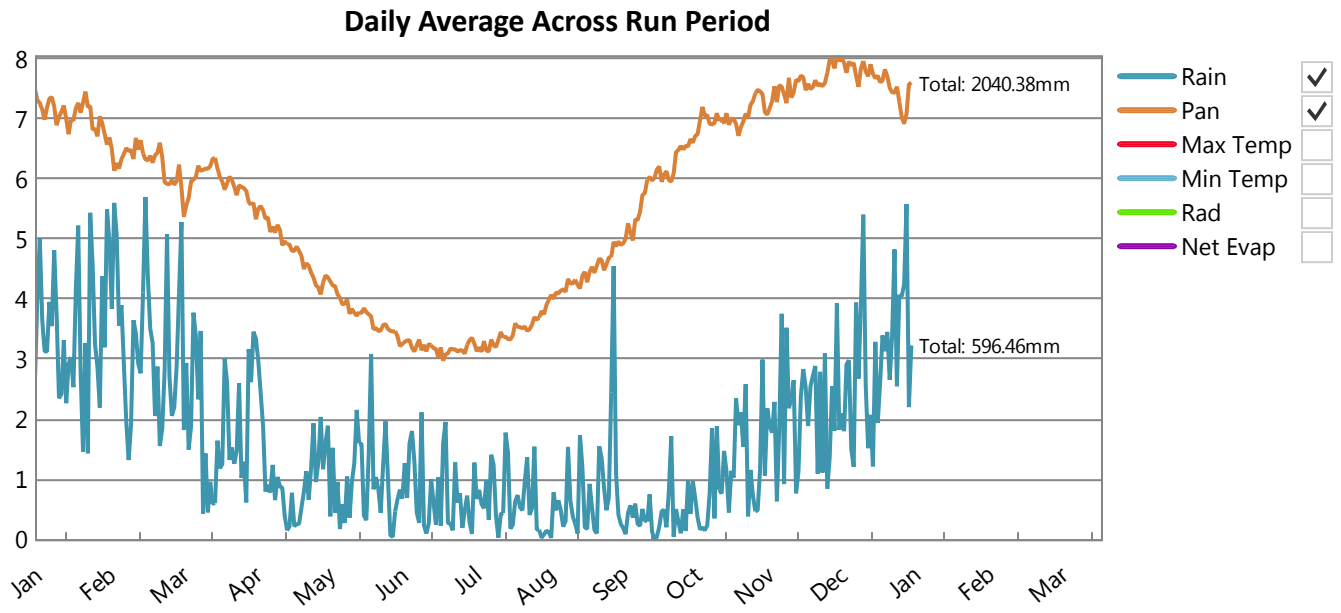
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	348	577	965
Pan Evaporation (mm/year)	1772	2083	2257

Climate Data:

Chart Table

Monthly Daily

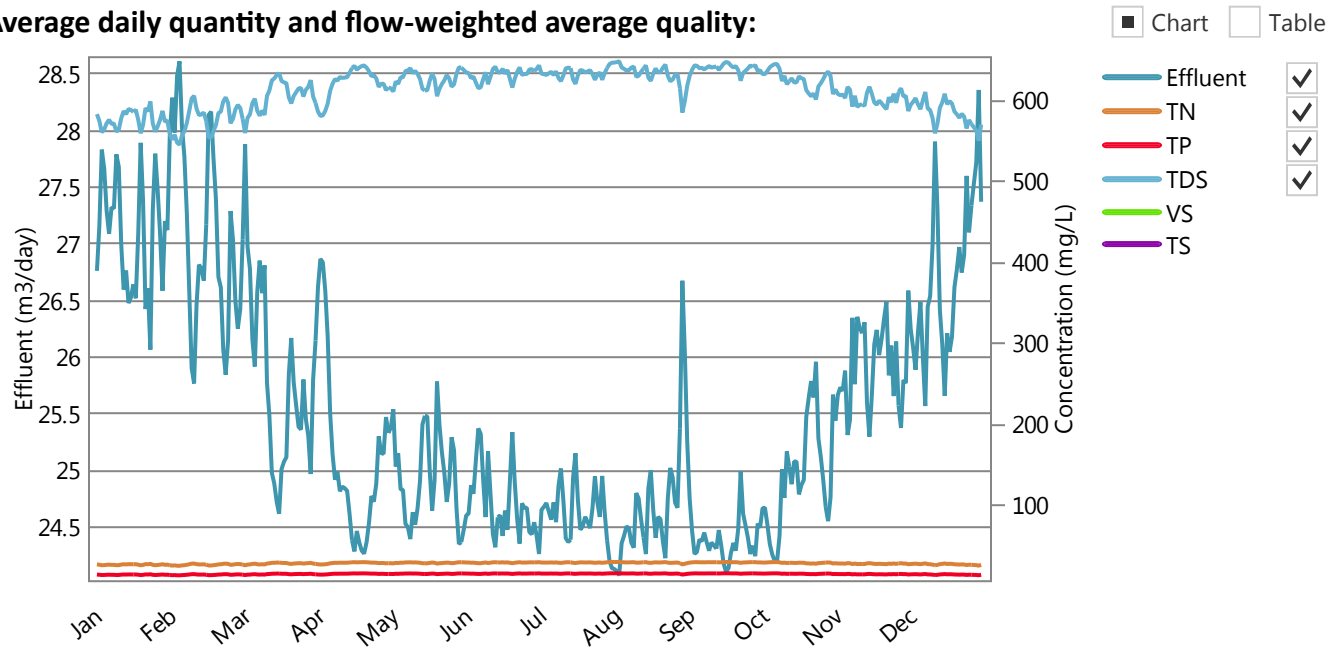


DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 9314.27 m3/year or 25.50 m3/day (Min-Max: 24.00 - 114.70)

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

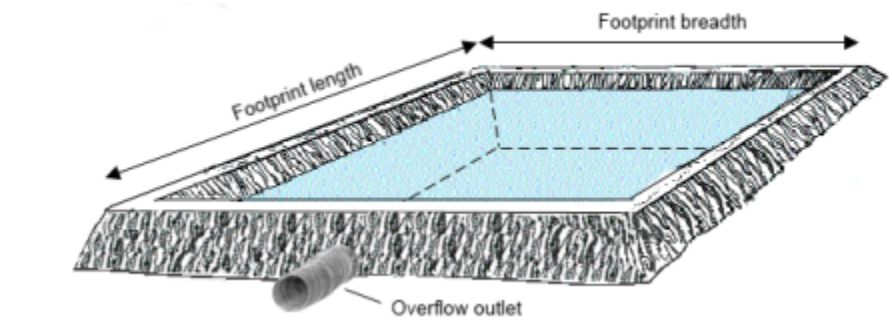
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	28.23 (6.28 - 30.00)	262.98 (262.80 - 263.52)
Total Phosphorus	15.06 (3.35 - 16.00)	140.26 (140.16 - 140.54)
Total Dissolved Salts	611.74 (136.01 - 650.00)	5697.90 (5694.00 - 5709.60)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

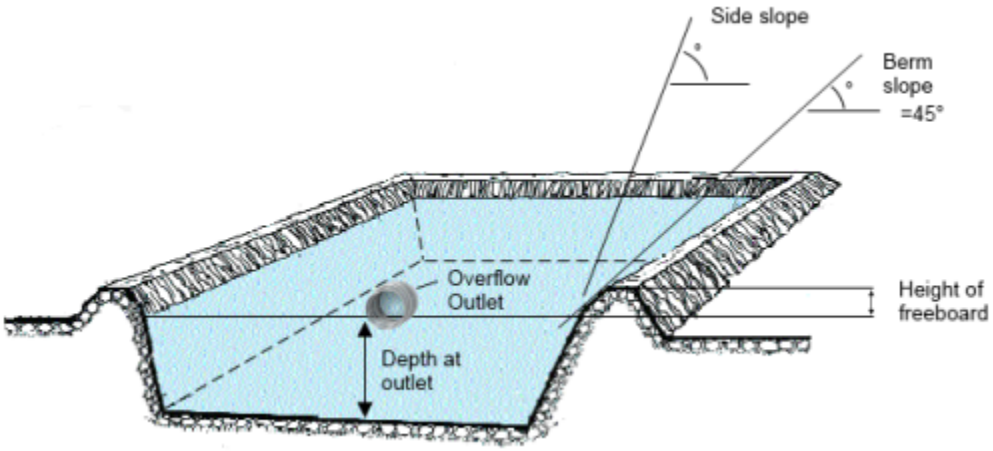
DESCRIPTION

Pond system: 1 closed storage tank

Pond system details:

	Pond 1
Maximum pond volume (m3)	220.00
Minimum allowable pond volume (m3)	14.22
Pond depth at overflow outlet (m)	2.00
Maximum water surface area (m2)	158.04
Pond footprint length (m)	17.78
Pond footprint width (m)	8.89
Pond catchment area (m2)	158.04
Average active volume (m3)	38.73





Irrigation pump limits:

Minimum pump limit	As scheduled
Maximum pump limit	As scheduled

Shandying water:

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

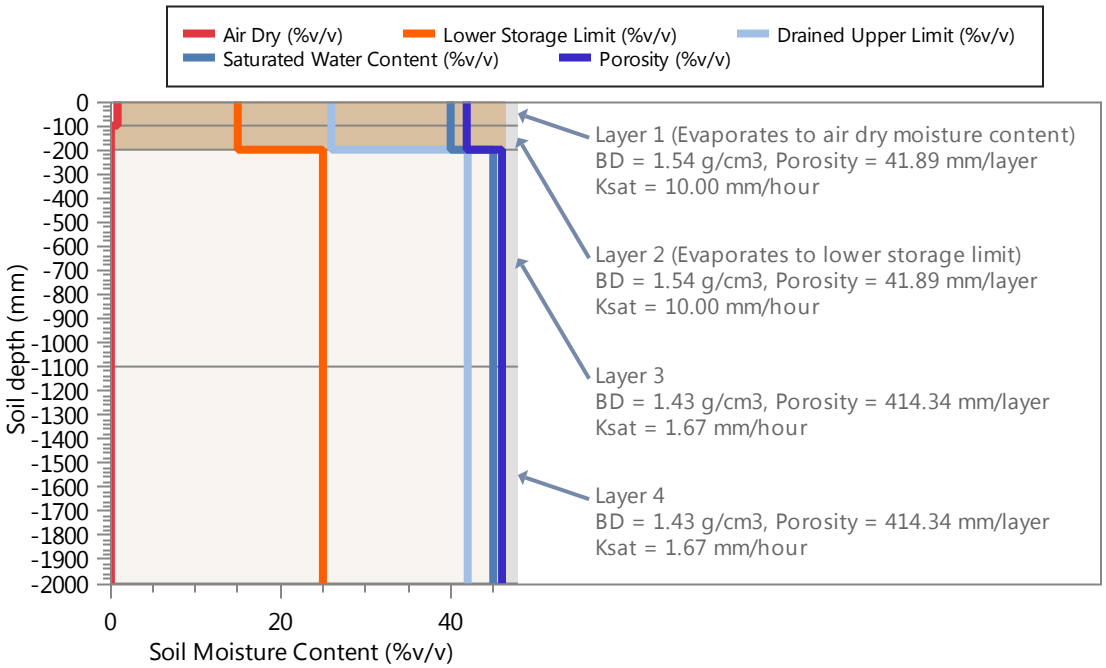
DESCRIPTION

Land: Kikuyu Paddock

Area (ha): 2.40

Soil Type: ODS Soil parameters, 2000.00 mm defined profile depth

Profile Porosity (mm)	912.45
Profile saturation water content (mm)	890.00
Profile drained upper limit (or field capacity) (mm)	808.00
Profile lower storage limit (or permanent wilting point) (mm)	480.00
Profile available water capacity (mm)	328.00
Profile limiting saturated hydraulic conductivity (mm/hour)	1.67
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	85.00
Soil evaporation U (mm)	7.25
Soil evaporation Cona (mm/sqrt day)	3.50



Plant Data: Continuous Kikuyu 1 Pasture

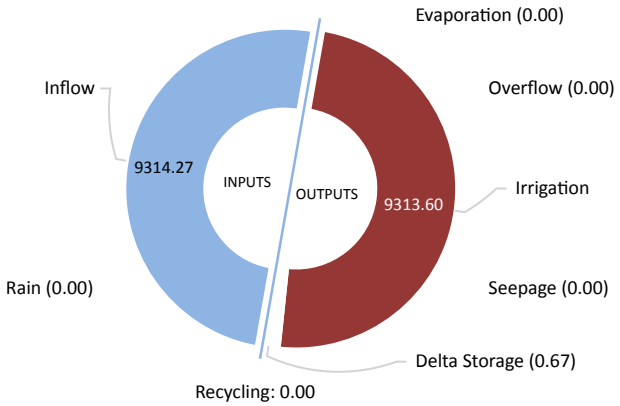
Average monthly cover (fraction) (minimum - maximum)	0.88 (0.83 - 0.91)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

PERFORMANCE

Pond System Water Performance - Overflow: 1 closed storage tank

Capacity of wet weather storage pond: **220 m3**

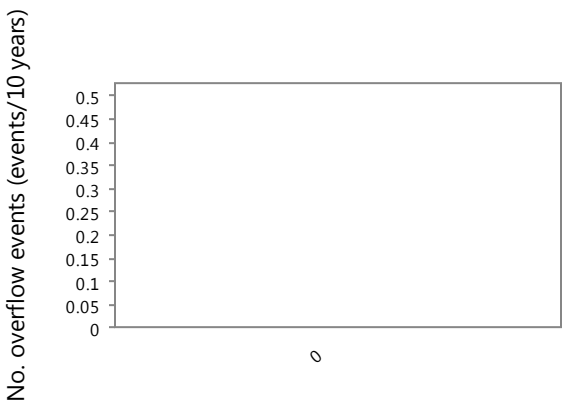
Pond System Water Balance (m3/year)



Name	Value
Rain	0.00
Inflow	9314.27
Recycling	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	9313.60
Seepage	0.00
Delta Storage	0.67

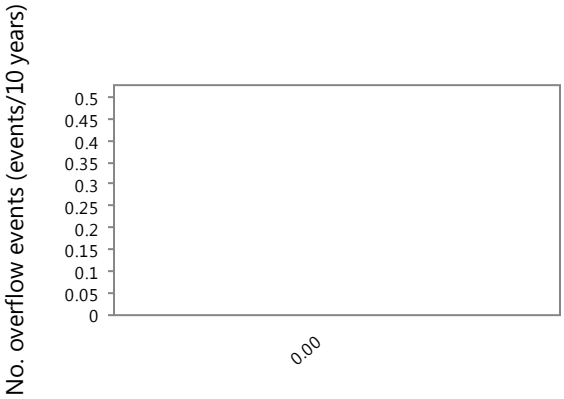
Overflow Diagnostics

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



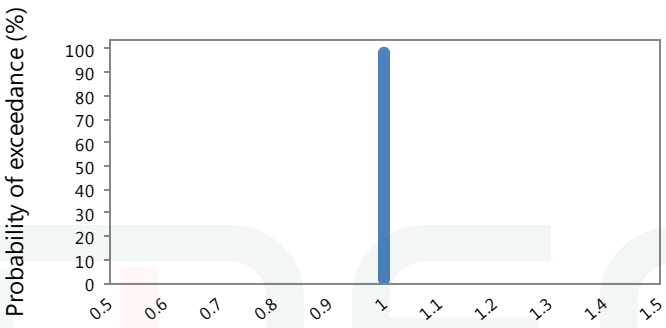
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

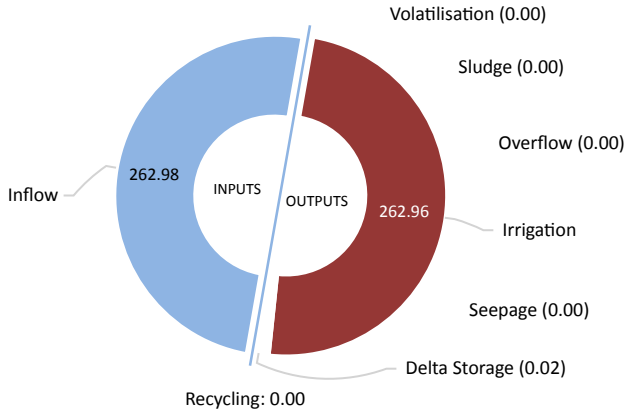
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

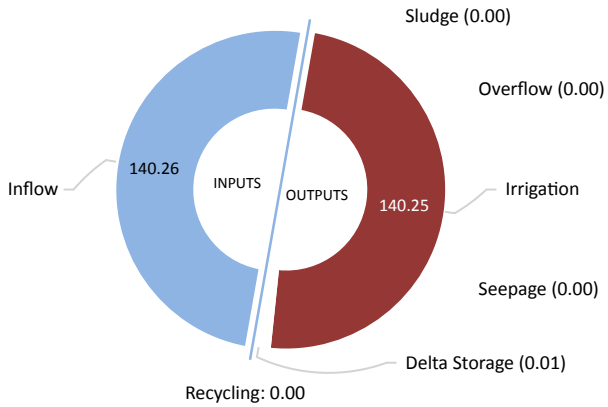
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



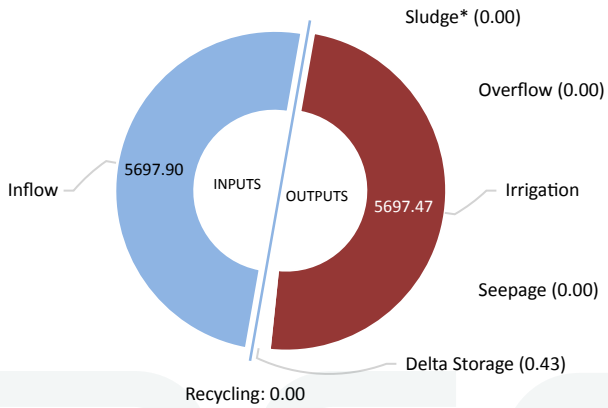
Name	Value
Inflow	262.98
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	262.96
Seepage	0.00
Delta Storage	0.02

Phosphorus Balance (kg/year)



Name	Value
Inflow	140.26
Recycling	0.00
Sludge	0.00
Overflow	0.00
Irrigation	140.25
Seepage	0.00
Delta Storage	0.01

Salt Balance (kg/year)



Name	Value
Inflow	5697.90
Recycling	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	5697.47
Seepage	0.00
Delta Storage	0.43

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	28.50
Average phosphorus concentration of pond liquid (mg/L)	15.20
Average salinity of pond liquid (dS/m)	0.96

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	30.00
Final phosphorus concentration of pond liquid (mg/L)	16.00
Final salinity of pond liquid (dS/m)	1.02

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	9313.60
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	9313.60
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)	28.23
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.67
Average phosphorus concentration of irrigation water (mg/L)	15.06
Average salinity of irrigation water (dS/m)	0.96

Irrigation Diagnostics:

Proportion Days Supply Insufficient For Pump (fraction)	0.47
Proportion of Days irrigation occurs (fraction)	0.53

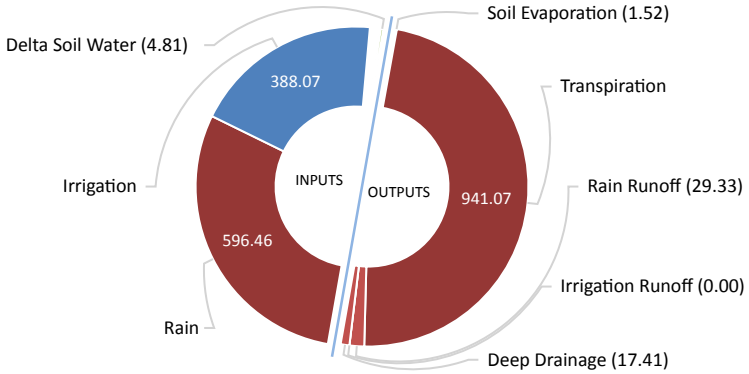
PERFORMANCE

Land Performance - Soil Water

Paddock: Kikuyu Paddock, 2.4 ha
Soil Type: ODS Soil parameters, 192.00 mm PAWC at maximum root depth

Land Water Balance (mm/year):

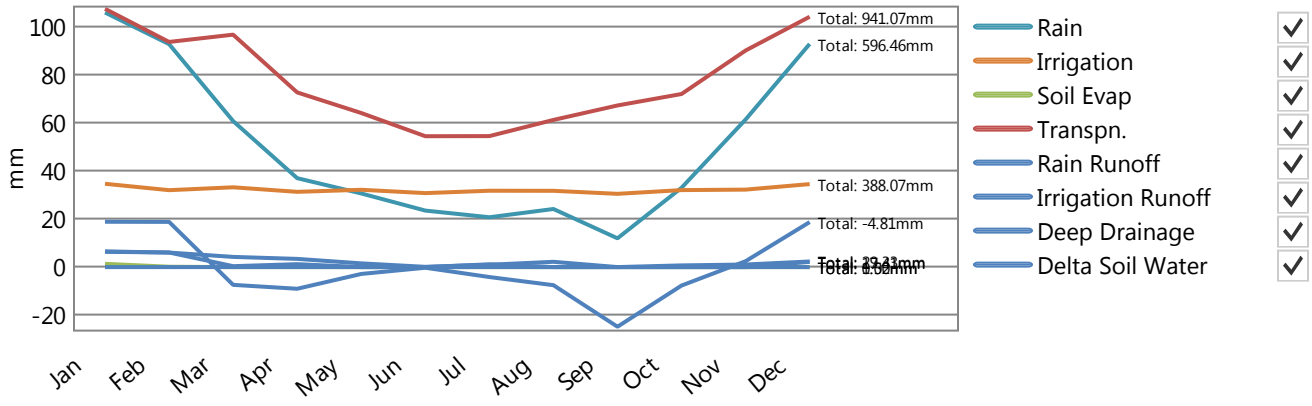
mm/year % Total inputs



Name	Value
Rain	596.46
Irrigation	388.07
Soil Evaporation	1.52
Transpiration	941.07
Rain Runoff	29.33
Irrigation Runoff	0.00
Deep Drainage	17.41
Delta Soil Water	-4.81

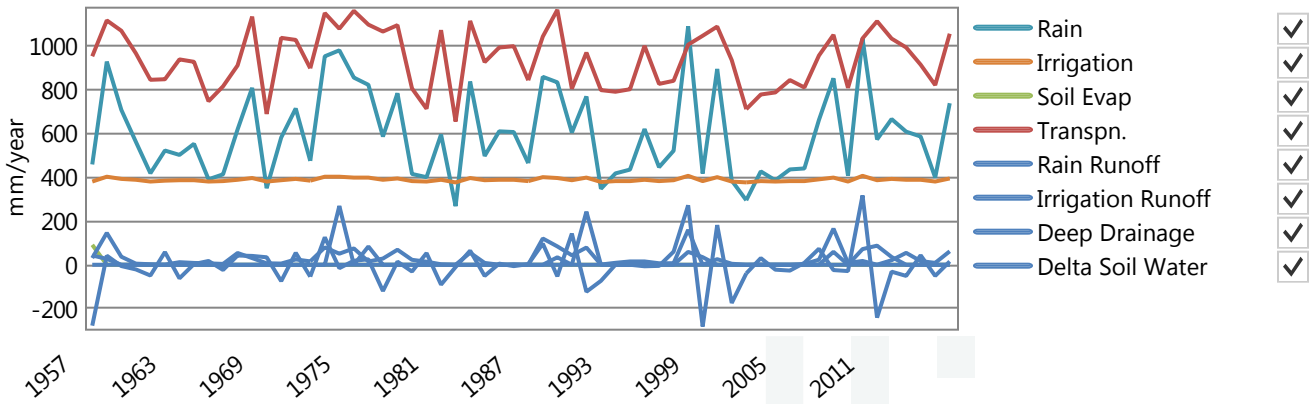
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



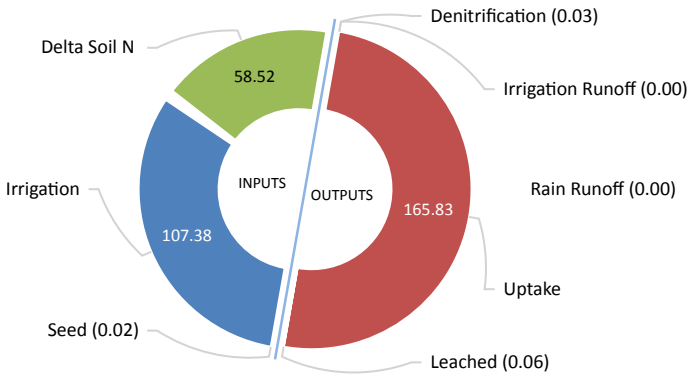
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

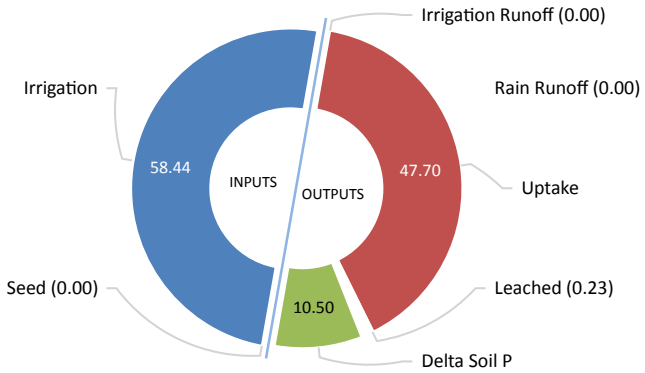
Irrigation ammonium volatilisation losses (kg/ha/year): 2.19
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	107.38
Denitrification	0.03
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	165.83
Leached	0.06
Delta Soil N	-58.52

Land Phosphorus Balance (kg/ha/year)



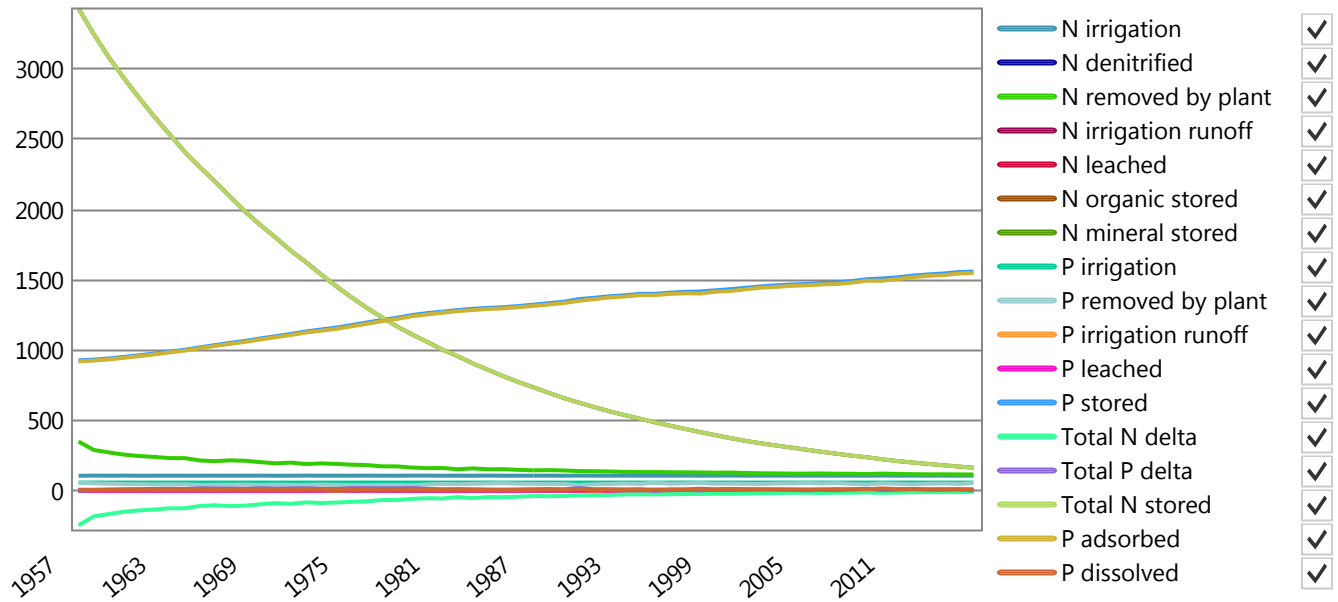
Name	Value
Seed	1.50E-03
Irrigation	58.44
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	47.70
Leached	0.23
Delta Soil P	10.50

PERFORMANCE

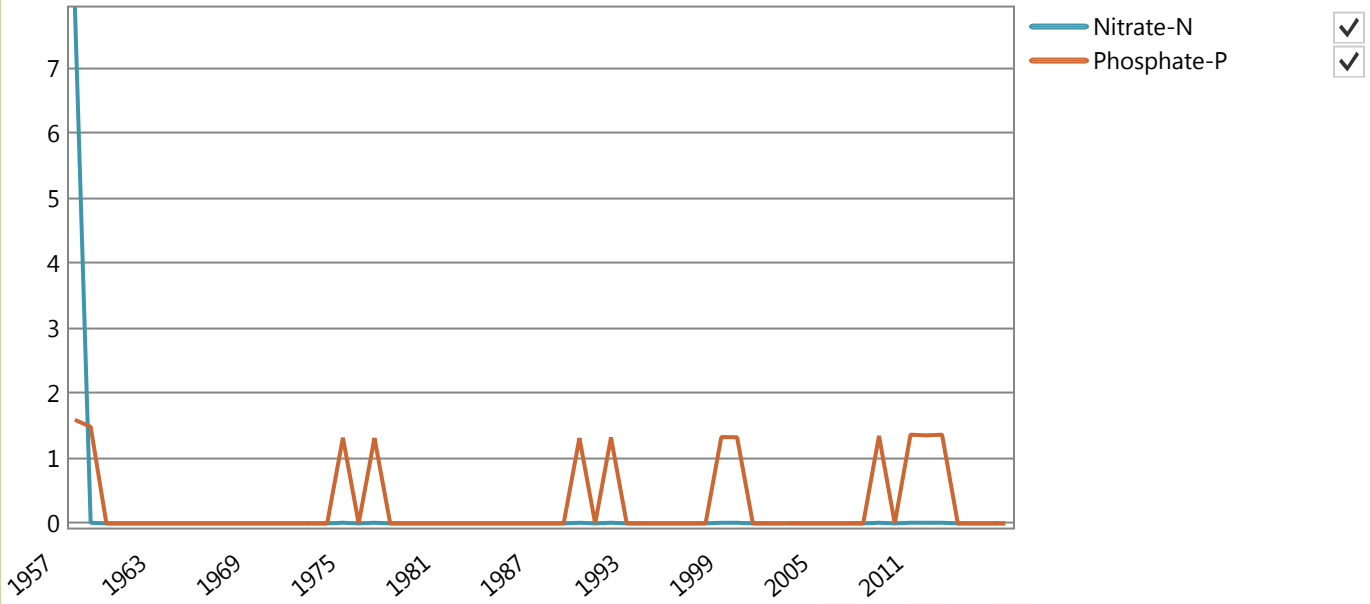
Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

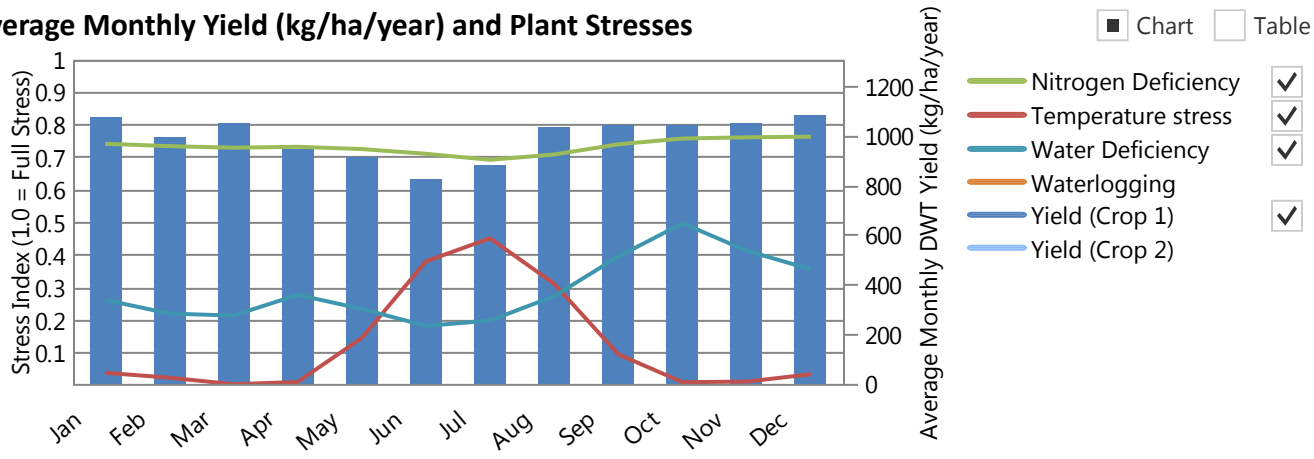
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	11989.21 (9298.82 - 19583.32)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.88 (0.83 - 0.91)
Average monthly root depth (mm) (minimum - maximum)	1198.91 (1187.85 - 1200.00)

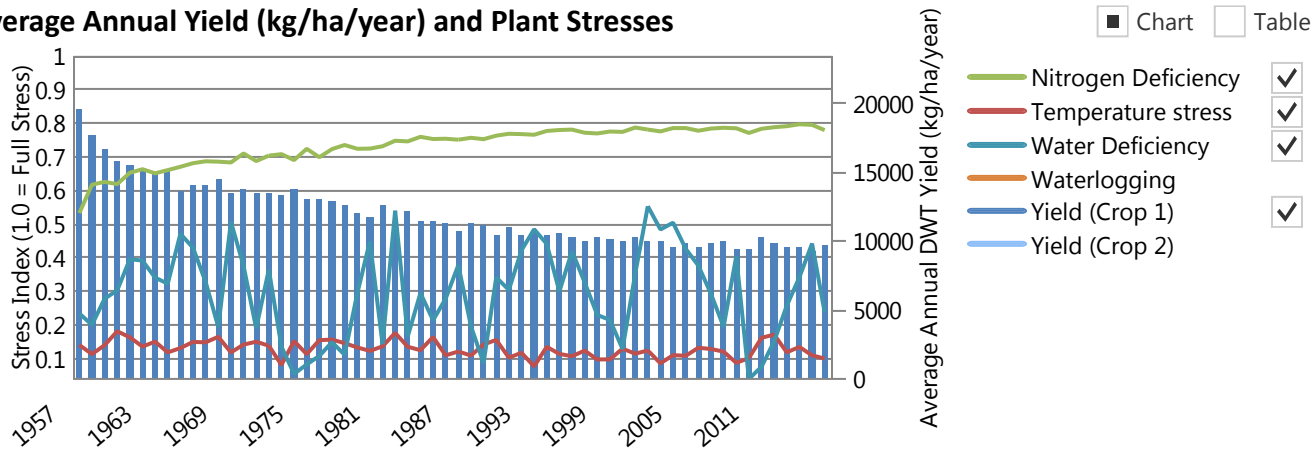
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	165.83 (115.94 - 349.99)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	47.70 (39.32 - 58.63)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.004 (0.003 - 0.006)

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



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



No. of harvests/year: 2.17 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

Plant: Continuous Kikuyu 1 Pasture

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

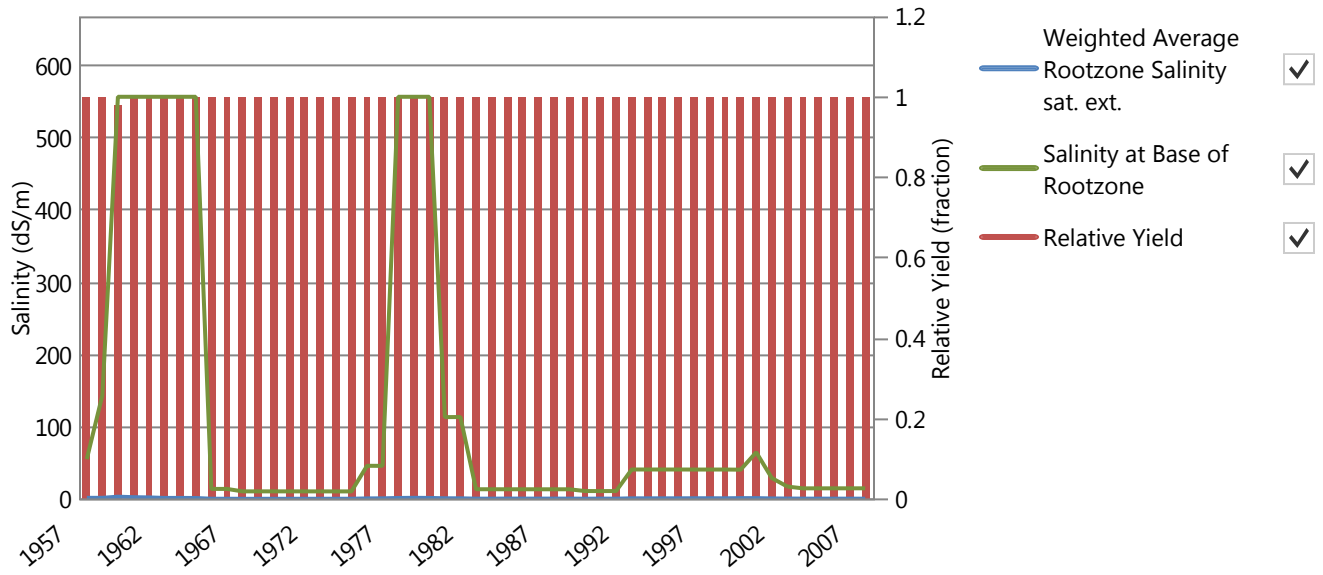
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.41
Salt added by rainfall (kg/ha/year)	108.89
Average annual effluent salt added & leached at steady state (kg/ha/year)	2482.83
Average leaching fraction based on 10 year running averages (fraction)	0.14
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.45
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



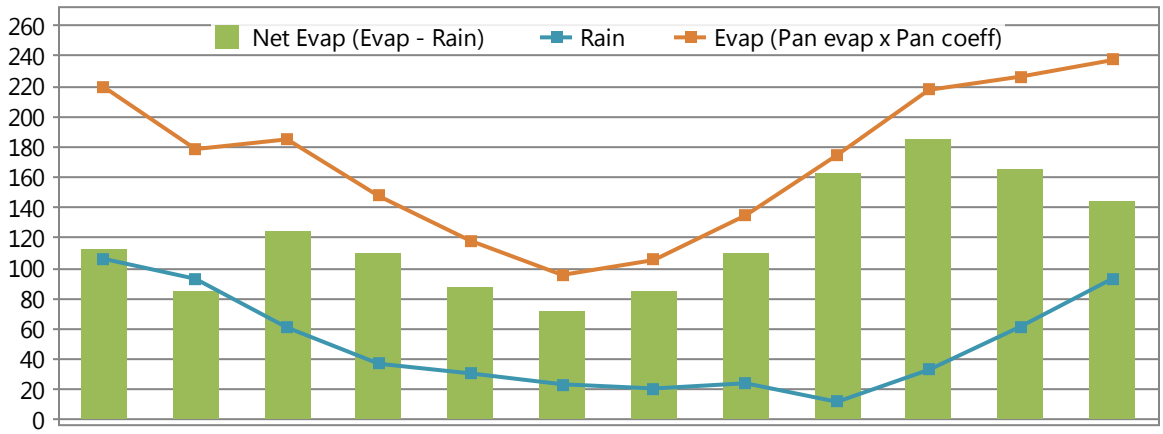
DIAGNOSTICS

Sustainability Diagnostics: 18041

Averaged Historical Climate Data Used in Simulation (mm)

Location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Evap	219.5	178.6	185.0	147.6	118.1	95.6	105.4	134.8	174.7	217.6	226.3	237.2	2040.4
Net Evap	113.2	85.5	124.1	110.5	87.4	72.1	84.6	110.6	162.6	184.5	164.7	144.1	1443.9
Net Evap/day	3.7	3.0	4.0	3.7	2.8	2.4	2.7	3.6	5.4	6.0	5.5	4.6	4.0

DIAGNOSTICS

Sustainability Diagnostics: 18041

Pond System: 1 closed storage tank

New Sewage Treatment Plant - 9314.27 m3/year or 25.50 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.25 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	28.23 (6.28 - 30.00)	262.98 (262.80 - 263.52)
Total Phosphorus	15.06 (3.35 - 16.00)	140.26 (140.16 - 140.54)
Total Dissolved Salts	611.74 (136.01 - 650.00)	5697.90 (5694.00 - 5709.60)
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)

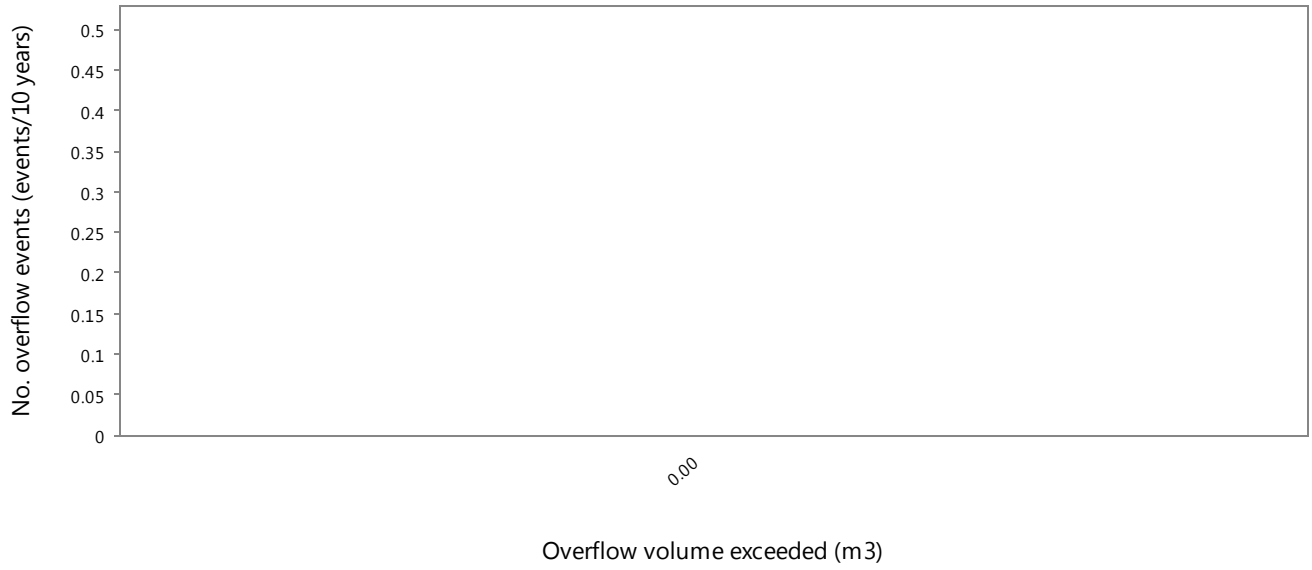
Last pond (Wet weather store): 220.00 m3

Theoretical hydraulic retention time (days)	8.63
Average volume of overflow (m3/year)	0.00
No. overflow events per year exceeding threshold* of 0.08 m3 (no./year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.96
Salinity of last pond on final day of simulation (dS/m)	1.02
Ammonia loss from pond system water area (kg/m2/year)	0.00

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

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: 18041

Irrigation Information

Irrigation: 2.4 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	9313.60	3880.67
Total nitrogen applied (kg)	257.70	107.38
Total phosphorus applied (kg)	140.25	58.44
Total salts applied (kg)	5697.47	2373.94

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 prevented when triggered (fraction)	0.47
Proportion of Days irrigation occurs (fraction)	0.53

DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Land: Kikuyu Paddock: 2.4 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 2.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): ODS Soil parameters, 192.00 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Irrigation	34.8	32.1	33.3	31.4	32.3	30.9	31.9	31.8	30.6	32.1	32.3	34.6	388.1
Soil Evap	1.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Transpn.	107.8	93.9	97.0	72.9	64.3	54.6	54.7	61.4	67.4	72.2	90.4	104.5	941.1
Rain Runoff	6.6	6.1	4.3	3.4	1.6	0.1	1.0	2.2	0.0	0.7	1.1	2.3	29.3
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	6.4	6.1	0.4	1.2	0.0	0.0	1.2	0.0	0.0	0.0	0.0	2.2	17.4
Delta	18.9	18.9	-7.4	-9.0	-2.9	-0.3	-4.1	-7.5	-24.9	-7.7	2.5	18.8	-4.8

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	107.38
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	165.83
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.03
Average annual soil nitrogen leached (kg/ha/year)	0.06
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.06
Soil organic-N kg/ha (Initial - Final)	3608.00 - 163.94
	67.44 - 0.05
Average nitrate-N concentration of deep drainage (mg/L)	0.33
Max. annual nitrate-N concentration of deep drainage (mg/L)	7.95

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	58.44
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	47.70
Average annual soil phosphorus leached (kg/ha/year)	0.23
Dissolved phosphorus (kg/ha) (Initial - Final)	12.06 - 10.77
Adsorbed phosphorus (kg/ha) (Initial - Final)	916.48 - 1547.97
Average phosphate-P concentration in rootzone (mg/L)	1.81
Average phosphate-P concentration of deep drainage (mg/L)	1.34
Max. annual phosphate-P concentration of deep drainage (mg/L)	1.59
Design soil profile storage life based on average infiltrated water phosphorus concn. of 6.12 mg/L (years)	37.13

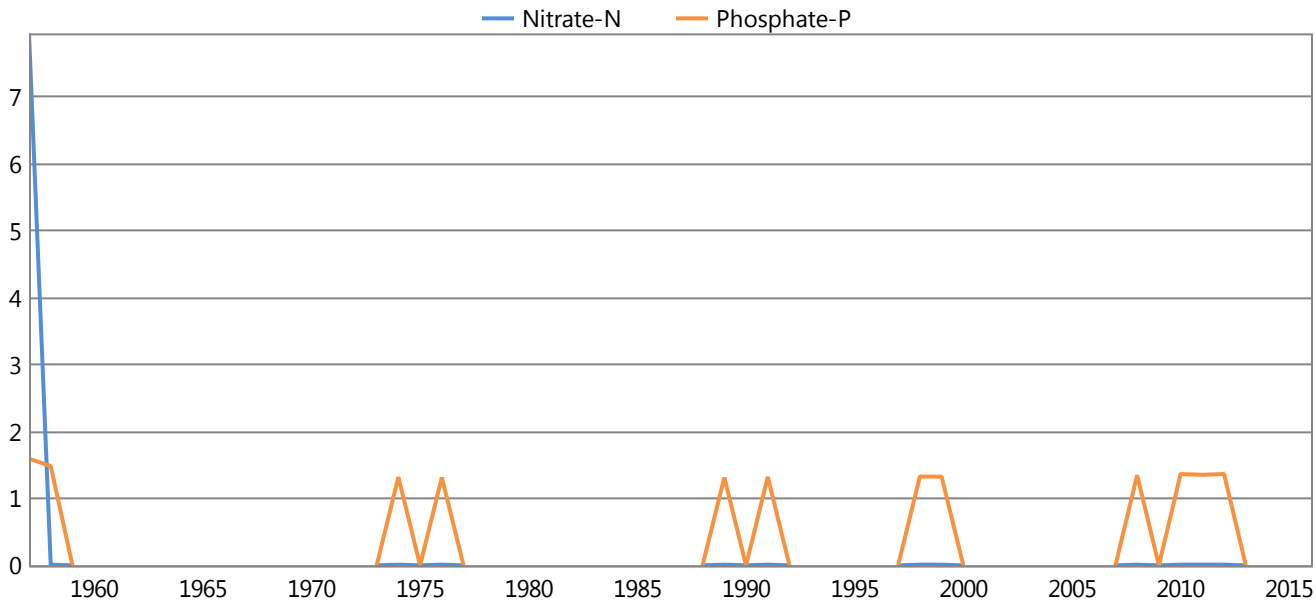
DIAGNOSTICS

Sustainability Diagnostics: 18041

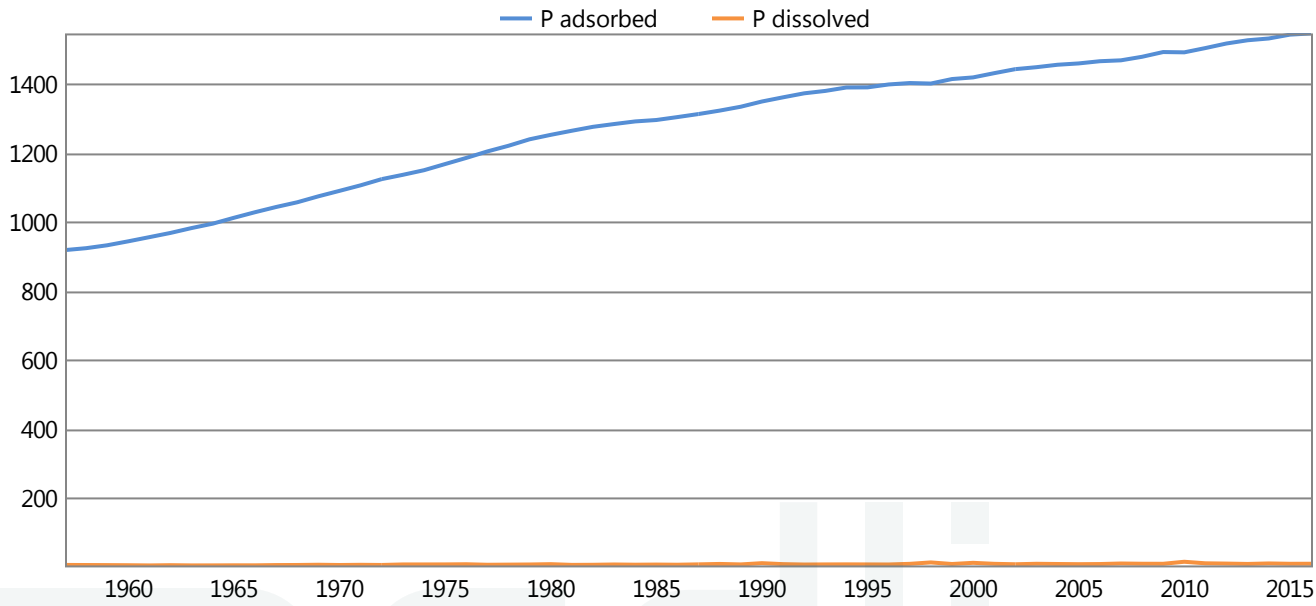
Paddock Land: Kikuyu Paddock: 2.4 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Plant Performance: Kikuyu Paddock: 2.4 ha

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

Average annual shoot dry matter yield (kg/ha/year)	11989.21 (9298.82 - 19583.32)
Average monthly plant (green) cover (fraction)	0.88 (0.83 - 0.91)
Average monthly crop factor (fraction)	0.70 (0.66 - 0.73)
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Average monthly root depth (mm)	1198.91 (1187.85 - 1200.00)
Average number of normal harvests per year (no./year)	2.17 (1.00 - 3.00)
Average number of normal harvests for last five years only (no./year)	1.80
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.73 (0.53 - 0.80)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.04 (0.00 - 0.17)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.45 (0.18 - 0.67)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.30 (0.18 - 0.50)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Moderately tolerant

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

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.41
Salt added by rainfall (kg/ha/year)	108.89
Average annual effluent salt added & leached at steady state (kg/ha/year)	2482.83
Average leaching fraction based on 10 year running averages (fraction)	0.14
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.45
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Supply reliability run chosen
Pathogen module switched off
Supply reliability run chosen
Pathogen module switched off

Appendix C: MEDLI Model Report – Scenario 5-2

MEDLI REPORT - RELIABILITY OF SUPPLY RUN

Title: 18041

Climate data location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

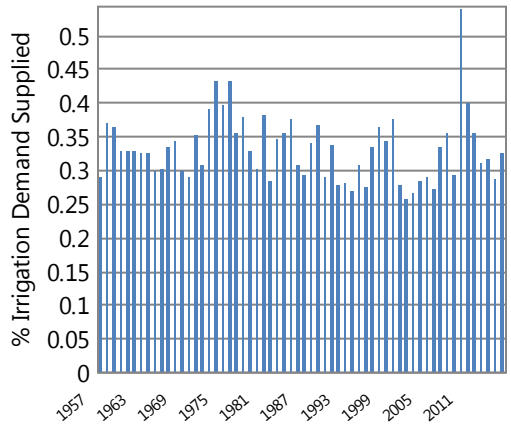
Average Annual %Irrigation Demand Supplied:

Potential annual irrigation when water supply is unlimited (m3/ha/year)	11878.1
Potential annual irrigation when water supply is unlimited (mm/year)	1187.8
Annual irrigation predicted for defined scenario (m3/ha/year)	3880.7
Annual irrigation predicted for defined scenario (mm/year)	388.1
Average annual irrigation demand supplied (fraction)	0.3

Or for 2.40 ha: 28507 m3/year

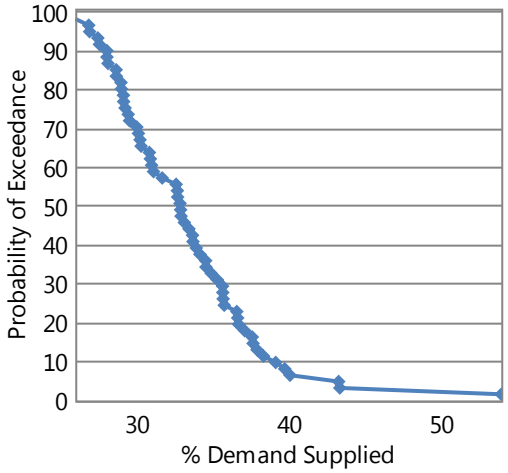
Annual % Irrigation Demand Supplied

Table Chart



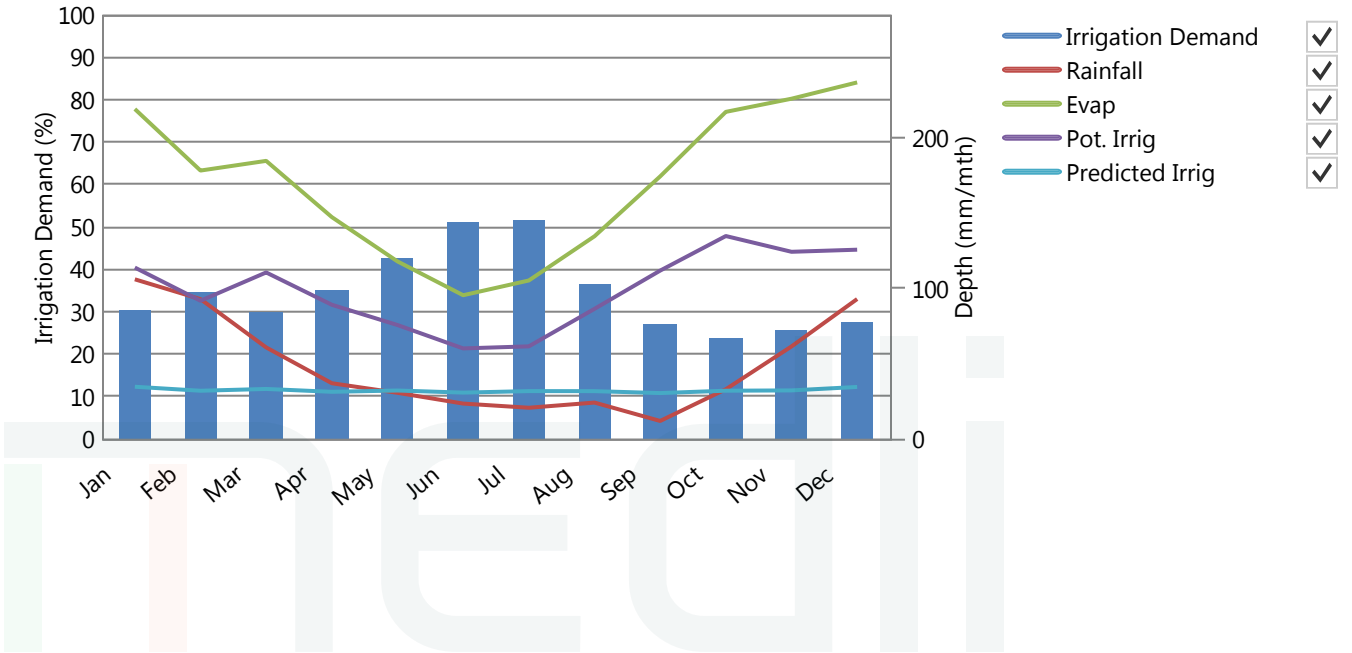
Probability of exceeding the % Irrigation Demand Supplied

Table Chart



Monthly % Irrigation Demand Supplied

Chart Table



DESCRIPTION

Climate Data: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

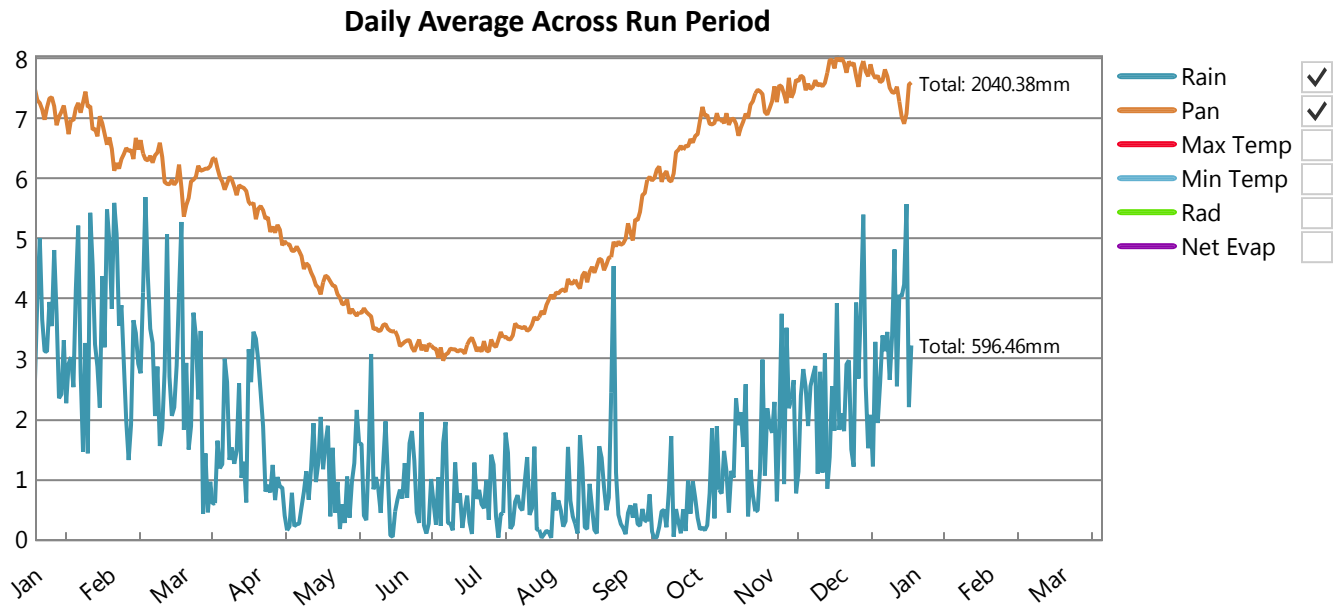
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	348	577	965
Pan Evaporation (mm/year)	1772	2083	2257

Climate Data:

Chart Table

Monthly Daily

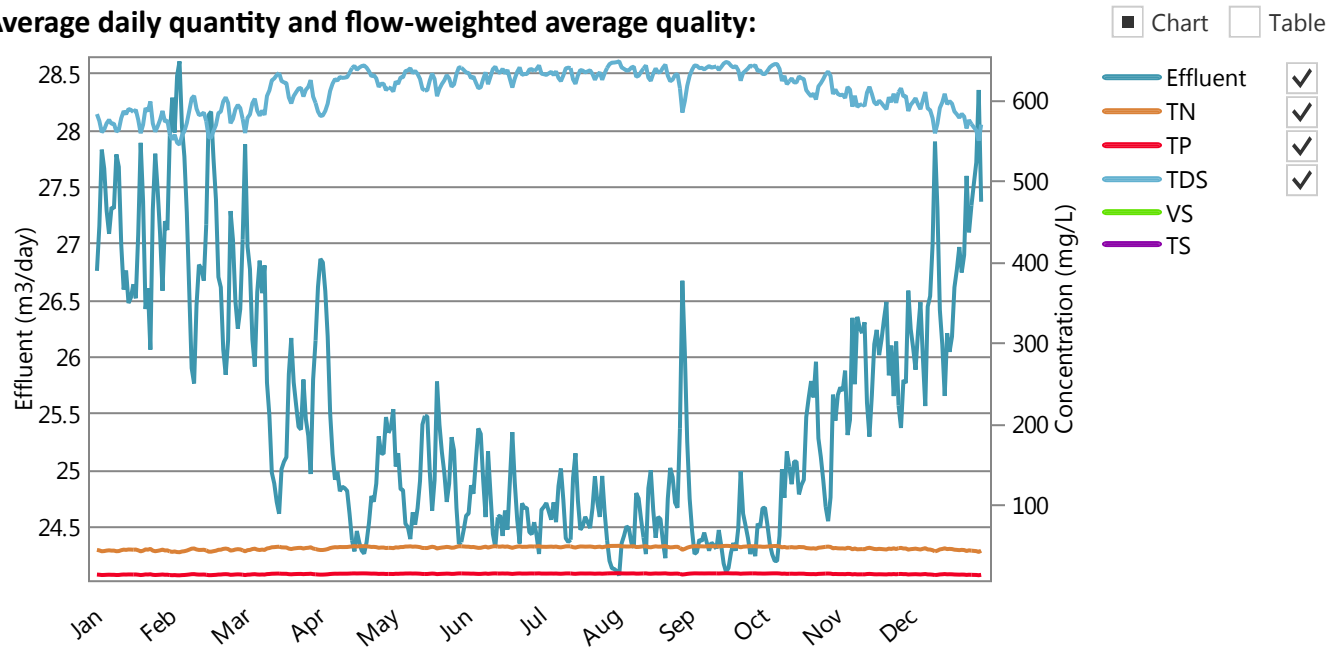


DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 9314.27 m3/year or 25.50 m3/day (Min-Max: 24.00 - 114.70)

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

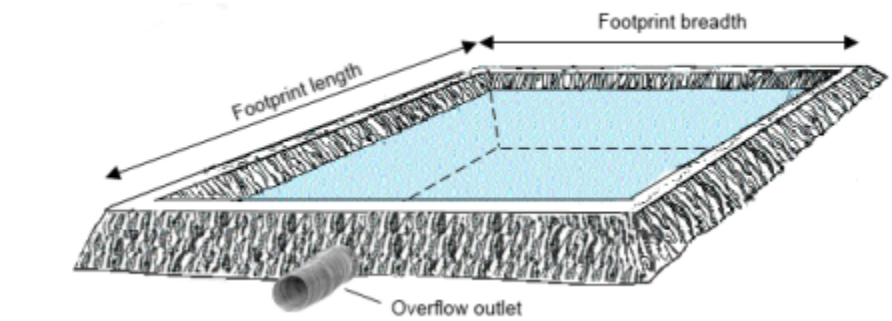
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	47.06 (10.46 - 50.00)	438.30 (438.00 - 439.20)
Total Phosphorus	15.06 (3.35 - 16.00)	140.26 (140.16 - 140.54)
Total Dissolved Salts	611.74 (136.01 - 650.00)	5697.90 (5694.00 - 5709.60)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

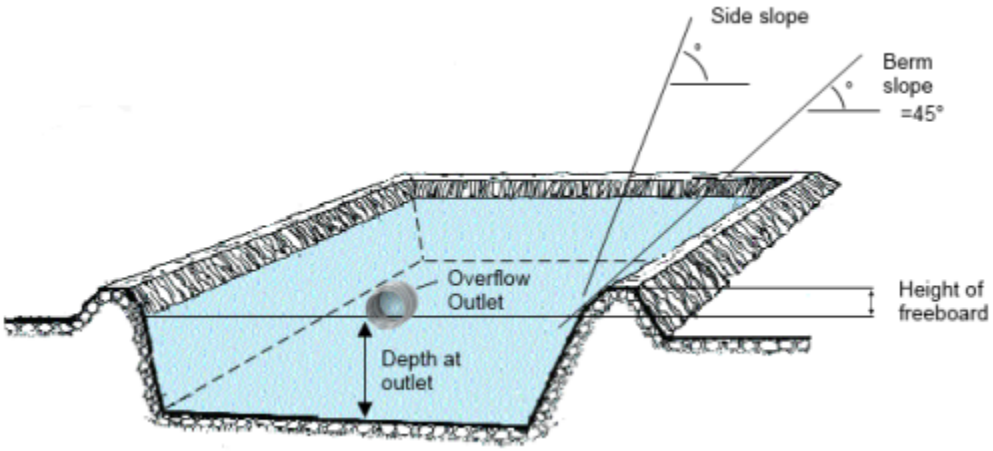
DESCRIPTION

Pond system: 1 closed storage tank

Pond system details:

	Pond 1
Maximum pond volume (m3)	220.00
Minimum allowable pond volume (m3)	14.22
Pond depth at overflow outlet (m)	2.00
Maximum water surface area (m2)	158.04
Pond footprint length (m)	17.78
Pond footprint width (m)	8.89
Pond catchment area (m2)	158.04
Average active volume (m3)	38.73





Irrigation pump limits:

Minimum pump limit	As scheduled
Maximum pump limit	As scheduled

Shandying water:

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

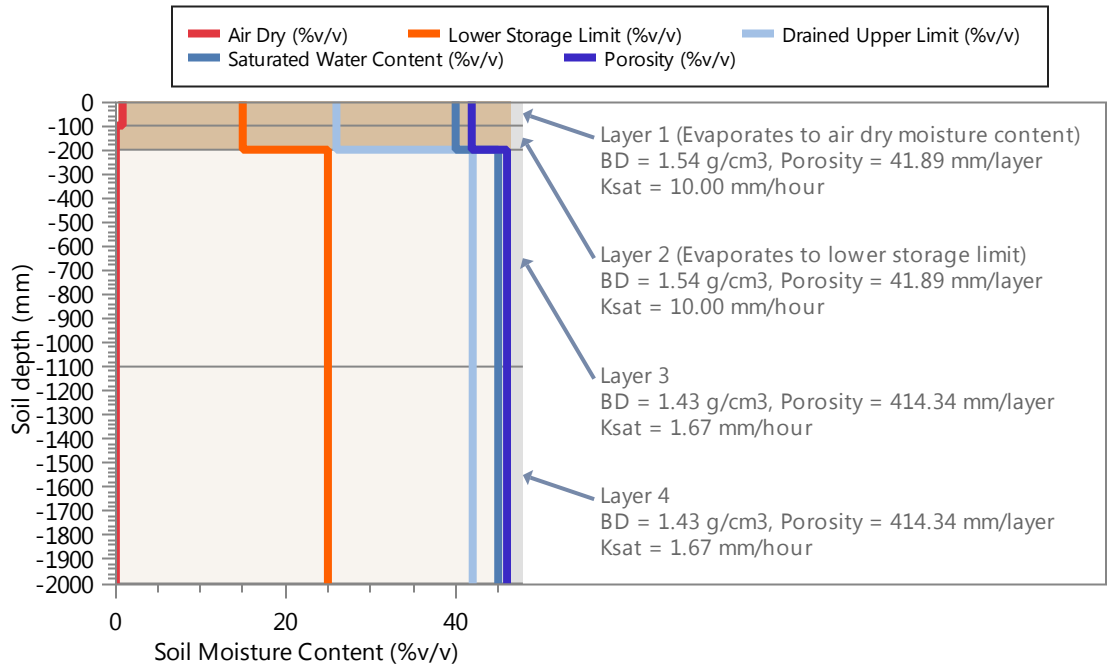
DESCRIPTION

Land: Kikuyu Paddock

Area (ha): 2.40

Soil Type: ODS Soil parameters, 2000.00 mm defined profile depth

Profile Porosity (mm)	912.45
Profile saturation water content (mm)	890.00
Profile drained upper limit (or field capacity) (mm)	808.00
Profile lower storage limit (or permanent wilting point) (mm)	480.00
Profile available water capacity (mm)	328.00
Profile limiting saturated hydraulic conductivity (mm/hour)	1.67
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	85.00
Soil evaporation U (mm)	7.25
Soil evaporation Cona (mm/sqrt day)	3.50



Plant Data: Continuous Kikuyu 1 Pasture

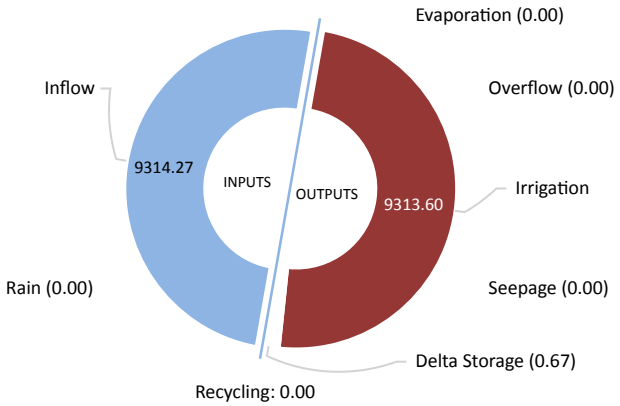
Average monthly cover (fraction) (minimum - maximum)	0.88 (0.82 - 0.91)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

PERFORMANCE

Pond System Water Performance - Overflow: 1 closed storage tank

Capacity of wet weather storage pond: **220 m3**

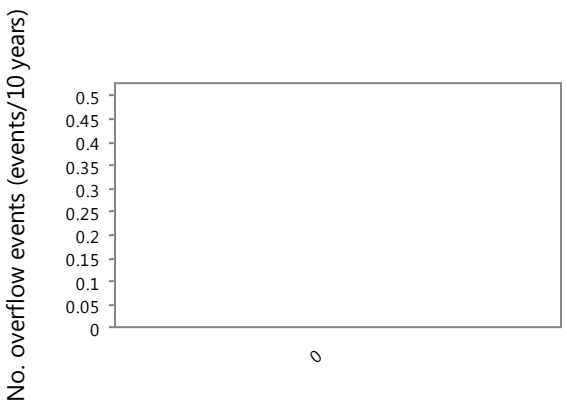
Pond System Water Balance (m3/year)



Name	Value
Rain	0.00
Inflow	9314.27
Recycling	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	9313.60
Seepage	0.00
Delta Storage	0.67

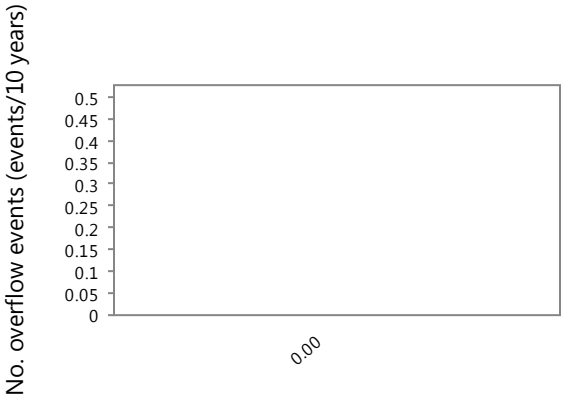
Overflow Diagnostics

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



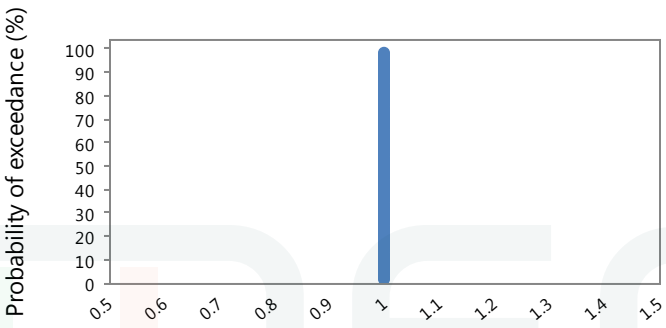
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

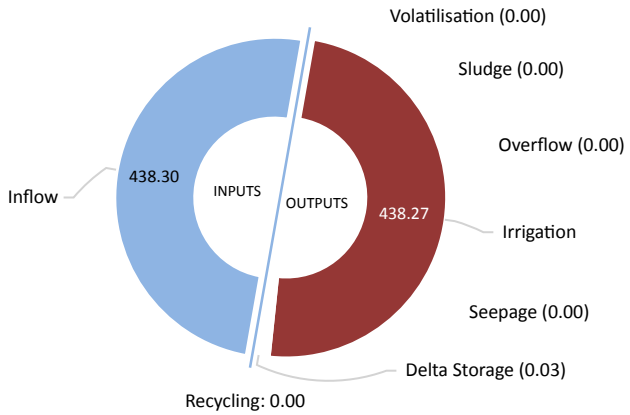
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

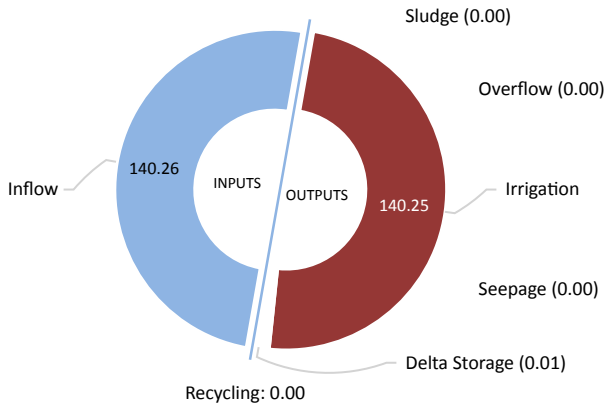
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



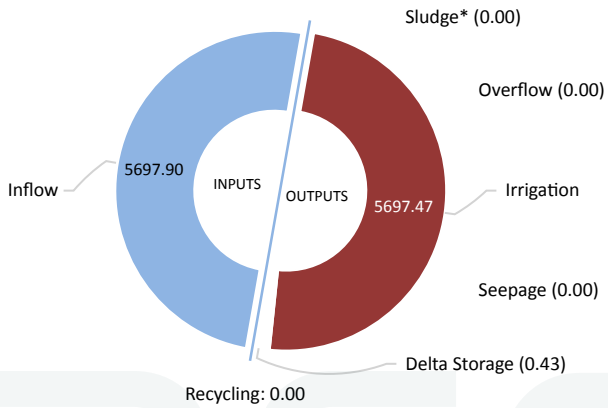
Name	Value
Inflow	438.30
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	438.27
Seepage	0.00
Delta Storage	0.03

Phosphorus Balance (kg/year)



Name	Value
Inflow	140.26
Recycling	0.00
Sludge	0.00
Overflow	0.00
Irrigation	140.25
Seepage	0.00
Delta Storage	0.01

Salt Balance (kg/year)



Name	Value
Inflow	5697.90
Recycling	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	5697.47
Seepage	0.00
Delta Storage	0.43

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	47.50
Average phosphorus concentration of pond liquid (mg/L)	15.20
Average salinity of pond liquid (dS/m)	0.96

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	49.99
Final phosphorus concentration of pond liquid (mg/L)	16.00
Final salinity of pond liquid (dS/m)	1.02

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	9313.60
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	9313.60
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)	47.06
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	46.12
Average phosphorus concentration of irrigation water (mg/L)	15.06
Average salinity of irrigation water (dS/m)	0.96

Irrigation Diagnostics:

Proportion Days Supply Insufficient For Pump (fraction)	0.47
Proportion of Days irrigation occurs (fraction)	0.53

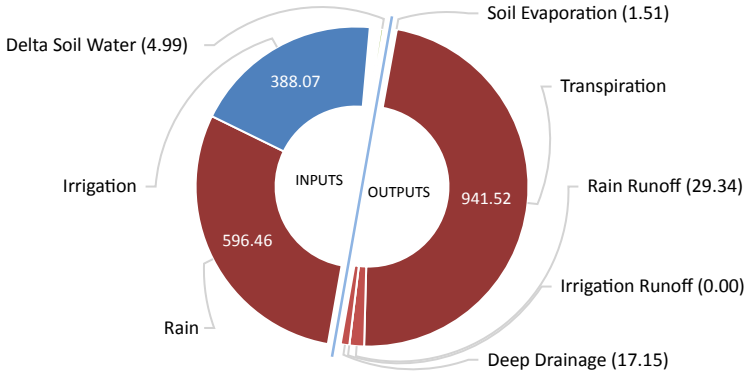
PERFORMANCE

Land Performance - Soil Water

Paddock: Kikuyu Paddock, 2.4 ha
Soil Type: ODS Soil parameters, 192.00 mm PAWC at maximum root depth

Land Water Balance (mm/year):

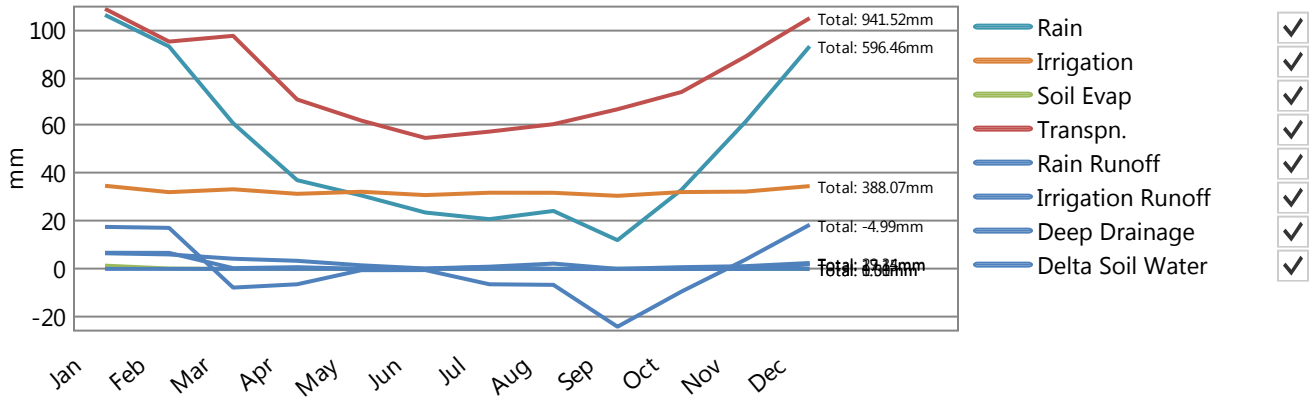
mm/year % Total inputs



Name	Value
Rain	596.46
Irrigation	388.07
Soil Evaporation	1.51
Transpiration	941.52
Rain Runoff	29.34
Irrigation Runoff	0.00
Deep Drainage	17.15
Delta Soil Water	-4.99

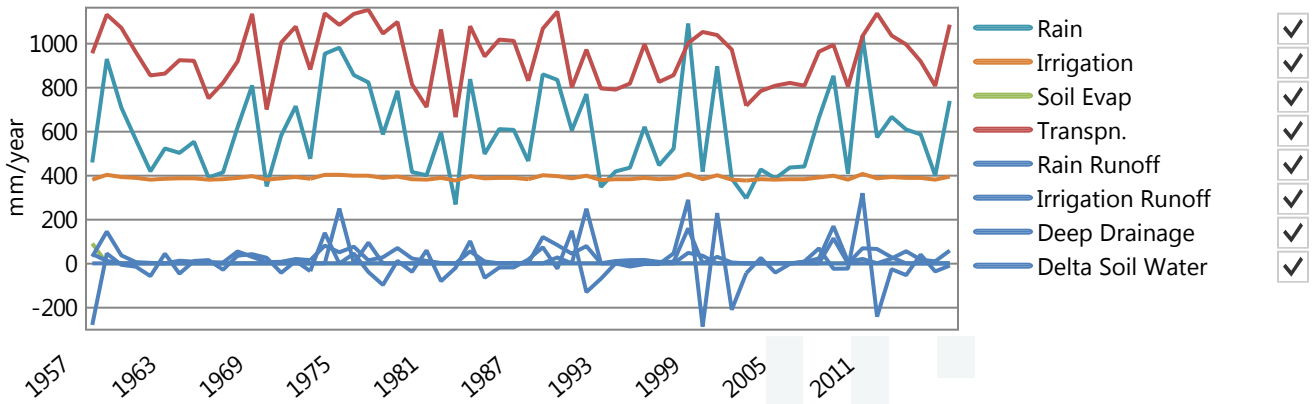
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



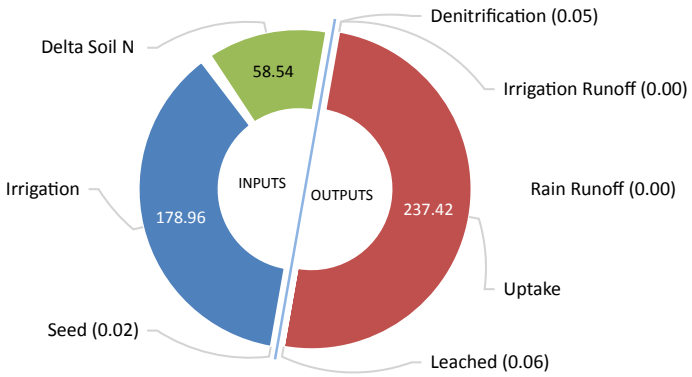
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

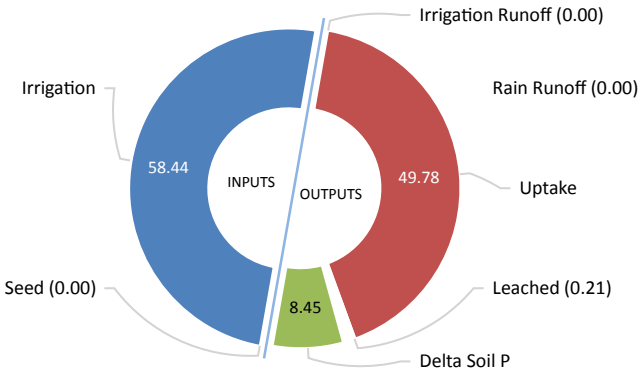
Irrigation ammonium volatilisation losses (kg/ha/year): 3.65
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	178.96
Denitrification	0.05
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	237.42
Leached	0.06
Delta Soil N	-58.54

Land Phosphorus Balance (kg/ha/year)



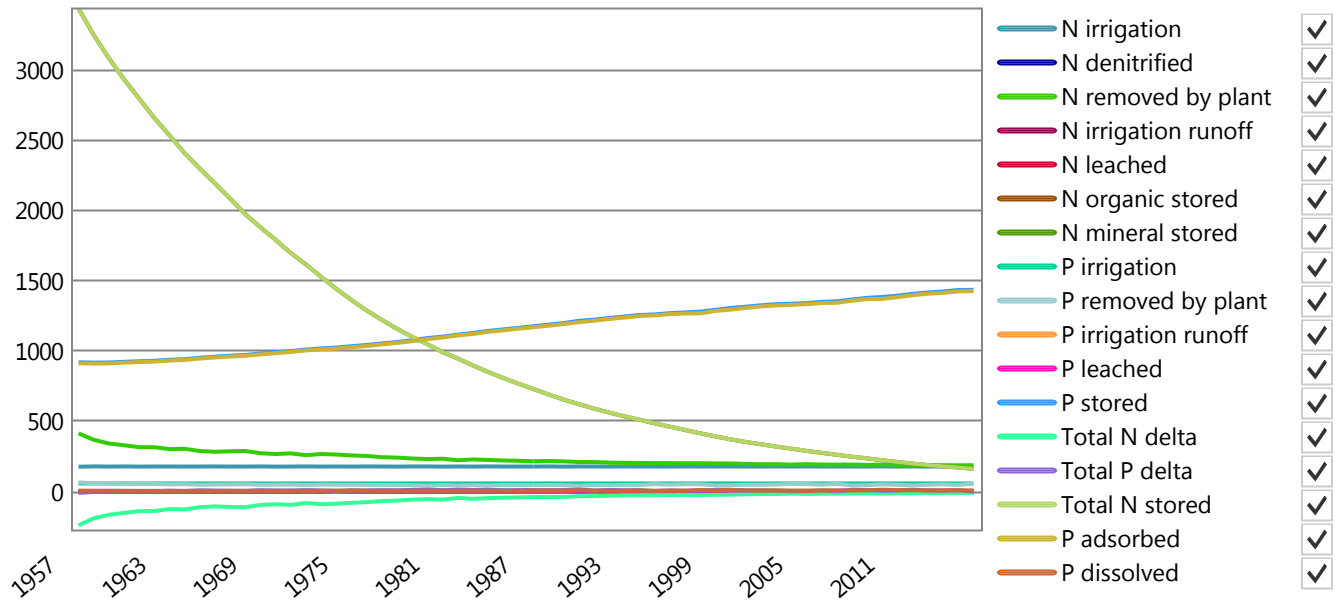
Name	Value
Seed	1.50E-03
Irrigation	58.44
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	49.78
Leached	0.21
Delta Soil P	8.45

PERFORMANCE

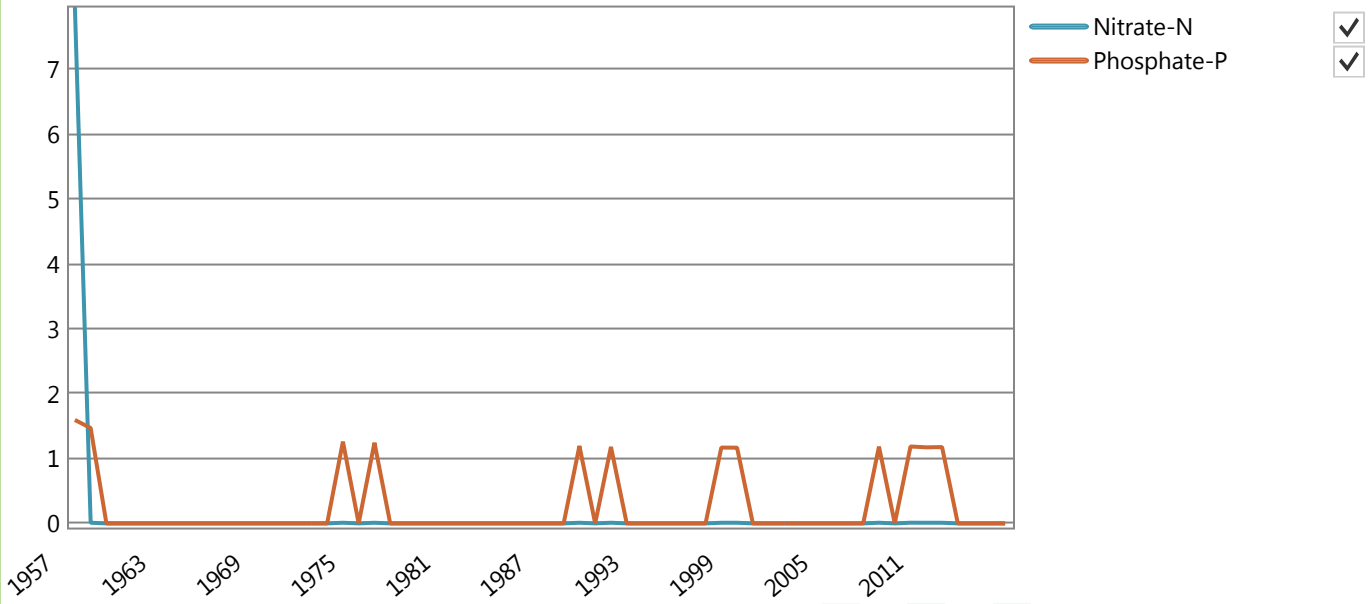
Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

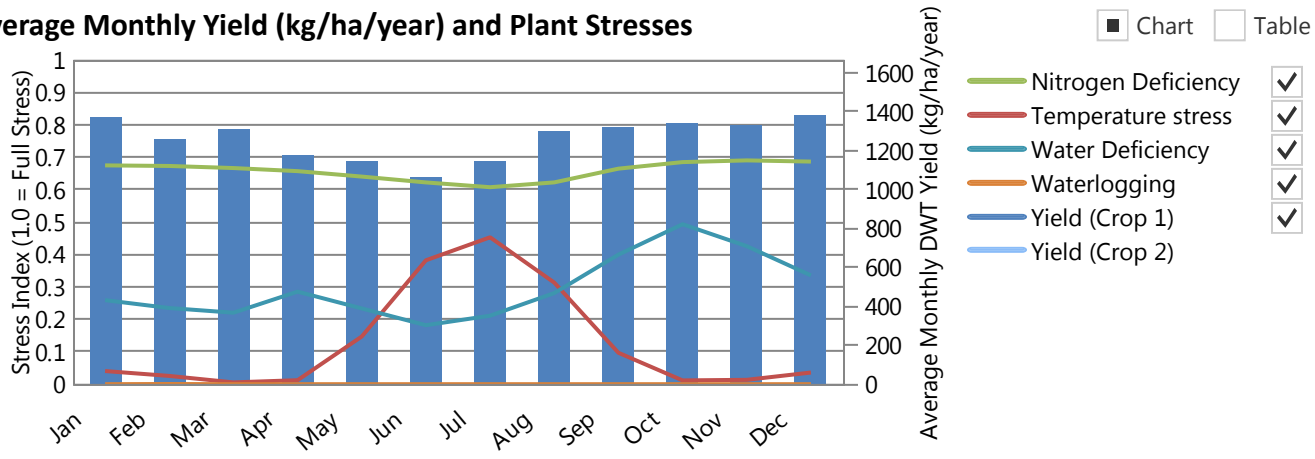
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	15166.28 (12822.22 - 21953.07)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.88 (0.82 - 0.91)
Average monthly root depth (mm) (minimum - maximum)	1198.92 (1187.85 - 1200.00)

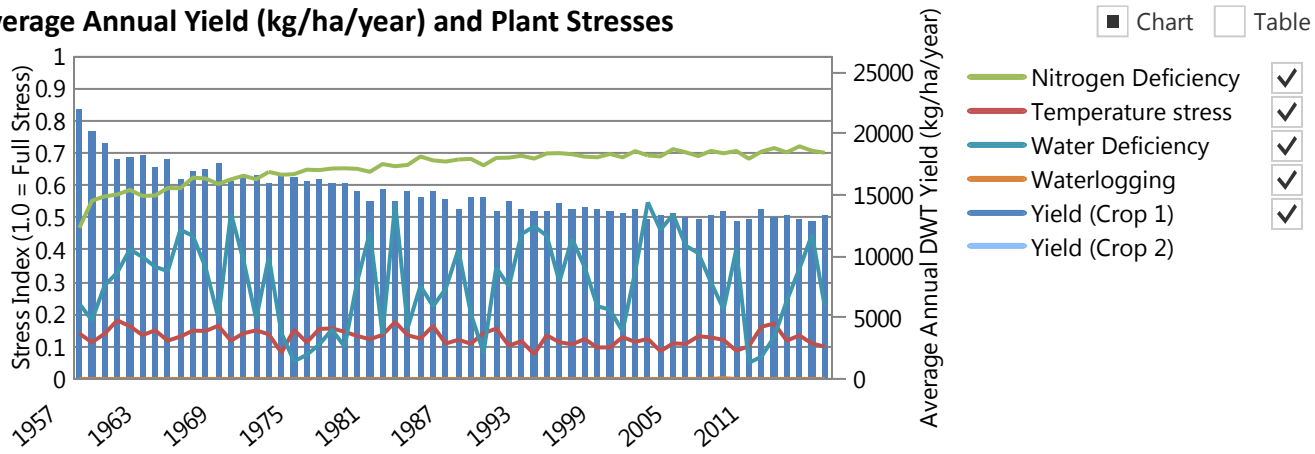
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	237.42 (187.45 - 414.42)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	49.78 (42.66 - 65.85)
Average annual shoot nitrogen concentration (fraction dwt)	0.02 (0.01 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.003 - 0.004)

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



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



No. of harvests/year: 2.73 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Kikuyu Paddock, 2.4 ha **Soil Type**: ODS Soil parameters

Plant: Continuous Kikuyu 1 Pasture

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

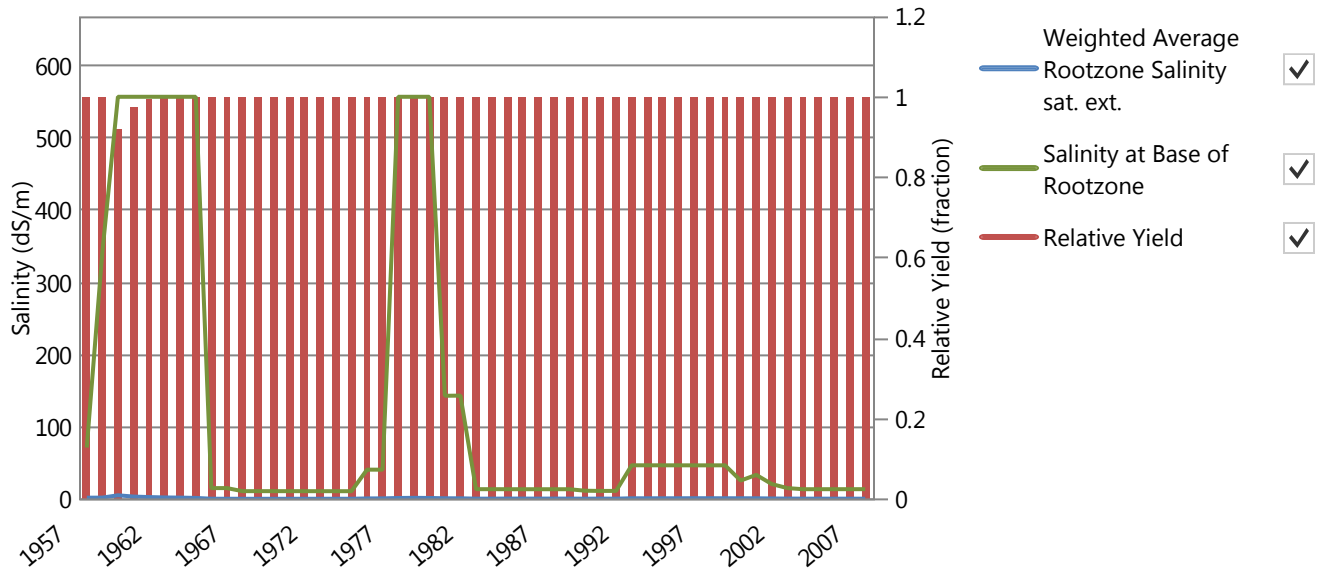
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.41
Salt added by rainfall (kg/ha/year)	108.89
Average annual effluent salt added & leached at steady state (kg/ha/year)	2482.83
Average leaching fraction based on 10 year running averages (fraction)	0.14
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.54
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



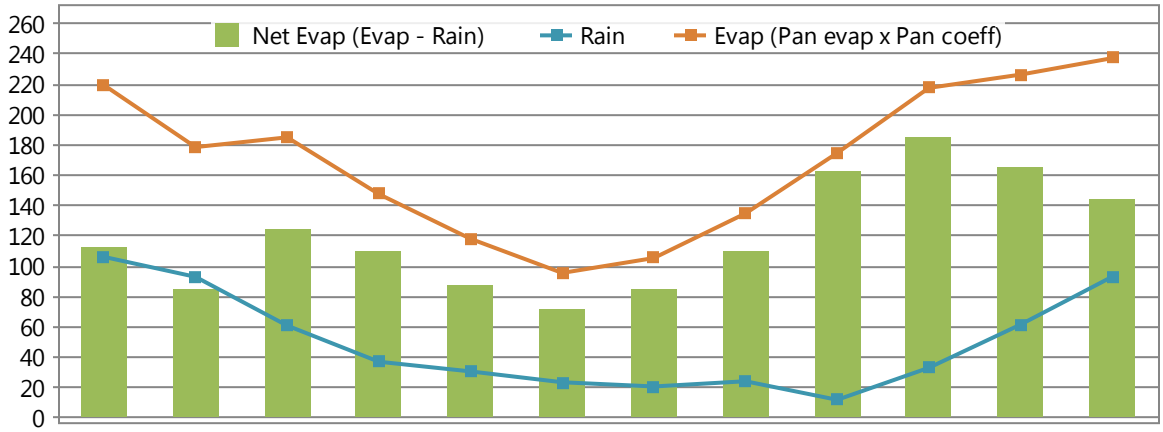
DIAGNOSTICS

Sustainability Diagnostics: 18041

Averaged Historical Climate Data Used in Simulation (mm)

Location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Evap	219.5	178.6	185.0	147.6	118.1	95.6	105.4	134.8	174.7	217.6	226.3	237.2	2040.4
Net Evap	113.2	85.5	124.1	110.5	87.4	72.1	84.6	110.6	162.6	184.5	164.7	144.1	1443.9
Net Evap/day	3.7	3.0	4.0	3.7	2.8	2.4	2.7	3.6	5.4	6.0	5.5	4.6	4.0

DIAGNOSTICS

Sustainability Diagnostics: 18041

Pond System: 1 closed storage tank

New Sewage Treatment Plant - 9314.27 m3/year or 25.50 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.25 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	47.06 (10.46 - 50.00)	438.30 (438.00 - 439.20)
Total Phosphorus	15.06 (3.35 - 16.00)	140.26 (140.16 - 140.54)
Total Dissolved Salts	611.74 (136.01 - 650.00)	5697.90 (5694.00 - 5709.60)
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)

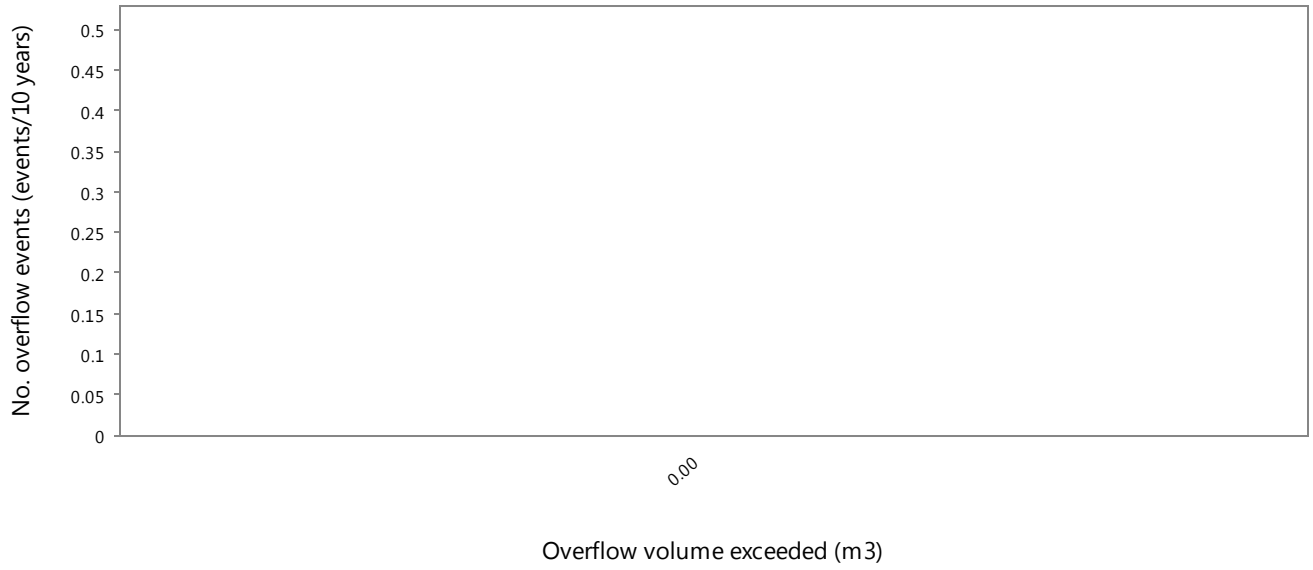
Last pond (Wet weather store): 220.00 m3

Theoretical hydraulic retention time (days)	8.63
Average volume of overflow (m3/year)	0.00
No. overflow events per year exceeding threshold* of 0.08 m3 (no./year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.96
Salinity of last pond on final day of simulation (dS/m)	1.02
Ammonia loss from pond system water area (kg/m2/year)	0.00

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

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: 18041

Irrigation Information

Irrigation: 2.4 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	9313.60	3880.67
Total nitrogen applied (kg)	429.50	178.96
Total phosphorus applied (kg)	140.25	58.44
Total salts applied (kg)	5697.47	2373.94

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 prevented when triggered (fraction)	0.47
Proportion of Days irrigation occurs (fraction)	0.53

DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Land: Kikuyu Paddock: 2.4 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 2.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): ODS Soil parameters, 192.00 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Irrigation	34.8	32.1	33.3	31.4	32.3	30.9	31.9	31.8	30.6	32.1	32.3	34.6	388.1
Soil Evap	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Transpn.	108.8	95.1	97.5	70.9	62.0	54.8	57.4	60.5	66.8	74.0	88.9	104.9	941.5
Rain Runoff	6.5	6.0	4.3	3.4	1.5	0.2	0.9	2.2	0.0	0.7	1.1	2.5	29.3
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	6.7	6.7	0.3	0.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0	1.9	17.1
Delta	17.6	17.2	-7.8	-6.4	-0.5	-0.5	-6.4	-6.7	-24.2	-9.5	3.9	18.5	-5.0

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	178.96
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	237.42
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.05
Average annual soil nitrogen leached (kg/ha/year)	0.06
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.06
Soil organic-N kg/ha (Initial - Final)	3608.00 - 162.70
	67.44 - 0.05
Average nitrate-N concentration of deep drainage (mg/L)	0.34
Max. annual nitrate-N concentration of deep drainage (mg/L)	7.96

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	58.44
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	49.78
Average annual soil phosphorus leached (kg/ha/year)	0.21
Dissolved phosphorus (kg/ha) (Initial - Final)	12.06 - 9.01
Adsorbed phosphorus (kg/ha) (Initial - Final)	916.48 - 1426.39
Average phosphate-P concentration in rootzone (mg/L)	1.48
Average phosphate-P concentration of deep drainage (mg/L)	1.22
Max. annual phosphate-P concentration of deep drainage (mg/L)	1.59
Design soil profile storage life based on average infiltrated water phosphorus concn. of 6.12 mg/L (years)	37.20

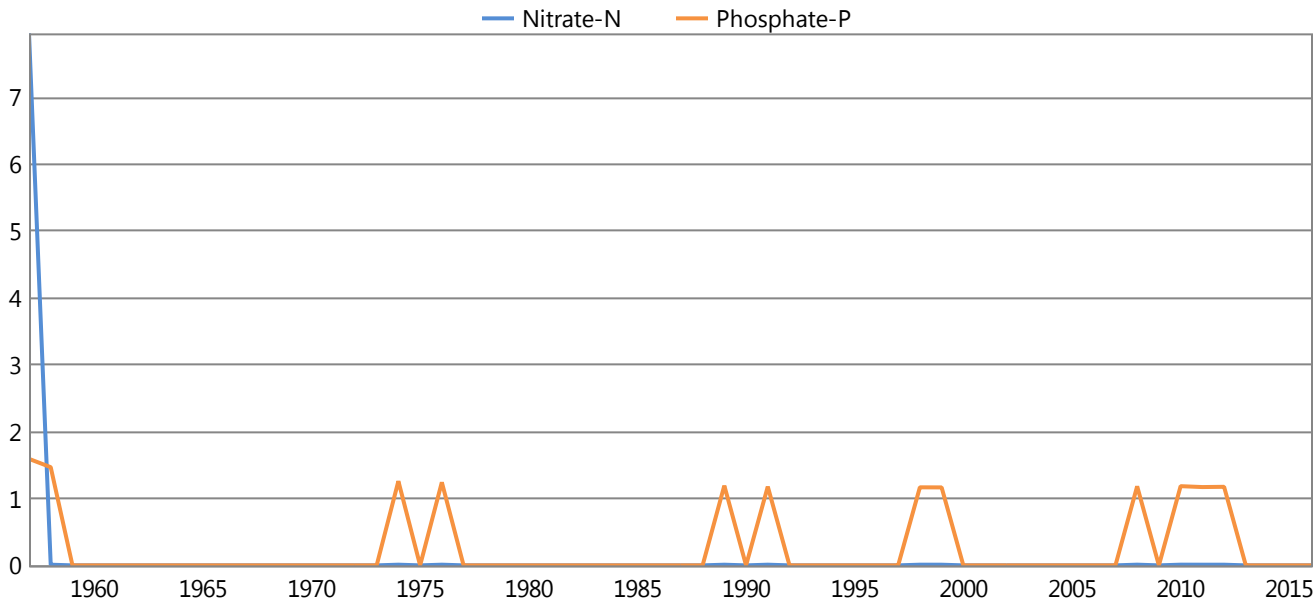
DIAGNOSTICS

Sustainability Diagnostics: 18041

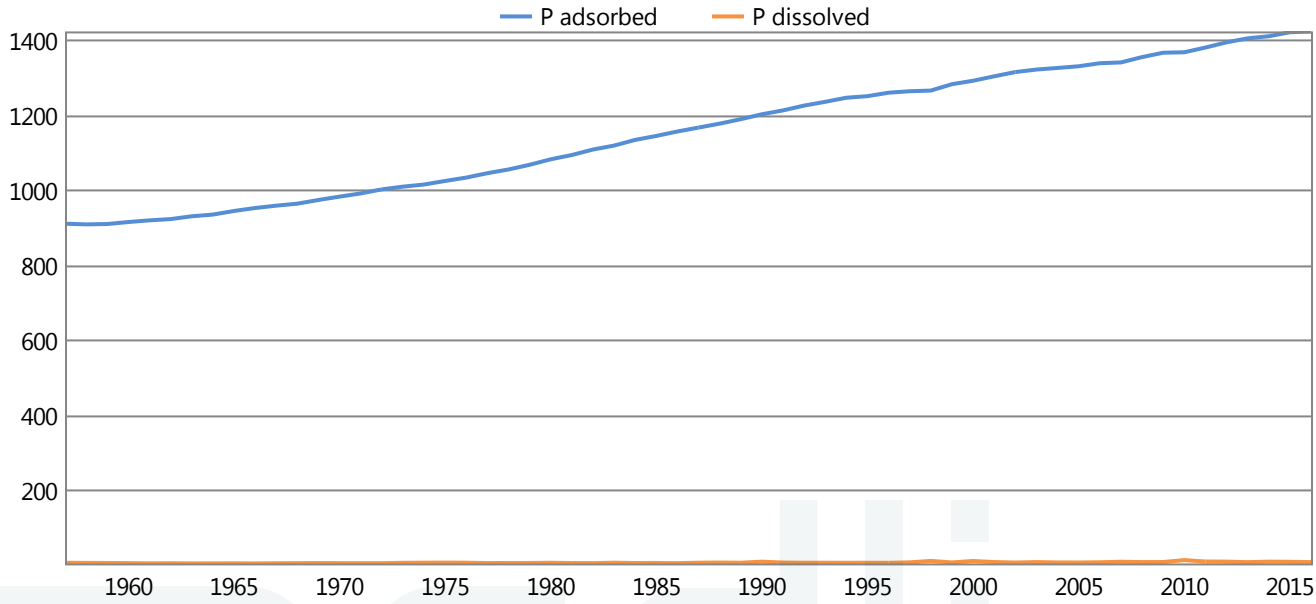
Paddock Land: Kikuyu Paddock: 2.4 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Plant Performance: Kikuyu Paddock: 2.4 ha

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

Average annual shoot dry matter yield (kg/ha/year)	15166.28 (12822.22 - 21953.07)
Average monthly plant (green) cover (fraction)	0.88 (0.82 - 0.91)
Average monthly crop factor (fraction)	0.70 (0.65 - 0.73)
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Average monthly root depth (mm)	1198.92 (1187.85 - 1200.00)
Average number of normal harvests per year (no./year)	2.73 (2.00 - 4.00)
Average number of normal harvests for last five years only (no./year)	2.40
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.66 (0.47 - 0.72)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.04 (0.00 - 0.17)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.45 (0.18 - 0.67)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.30 (0.18 - 0.49)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Moderately tolerant

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

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.41
Salt added by rainfall (kg/ha/year)	108.89
Average annual effluent salt added & leached at steady state (kg/ha/year)	2482.83
Average leaching fraction based on 10 year running averages (fraction)	0.14
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.54
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Supply reliability run chosen
Pathogen module switched off
Supply reliability run chosen
Pathogen module switched off

Appendix D: MEDLI Model Report – Scenario 6-1

MEDLI REPORT - RELIABILITY OF SUPPLY RUN

Title: 18041

Climate data location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

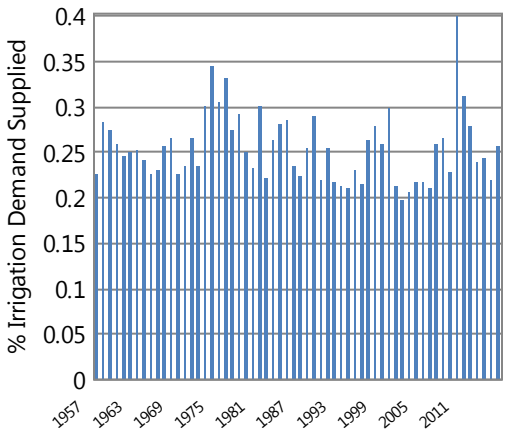
Average Annual %Irrigation Demand Supplied:

Potential annual irrigation when water supply is unlimited (m3/ha/year)	11862.1
Potential annual irrigation when water supply is unlimited (mm/year)	1186.2
Annual irrigation predicted for defined scenario (m3/ha/year)	2977.7
Annual irrigation predicted for defined scenario (mm/year)	297.8
Average annual irrigation demand supplied (fraction)	0.3

Or for 5.50 ha: 65241 m3/year

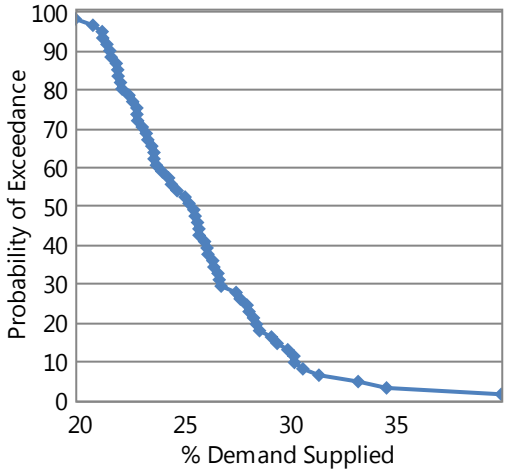
Annual % Irrigation Demand Supplied

Table ☐ Chart ■



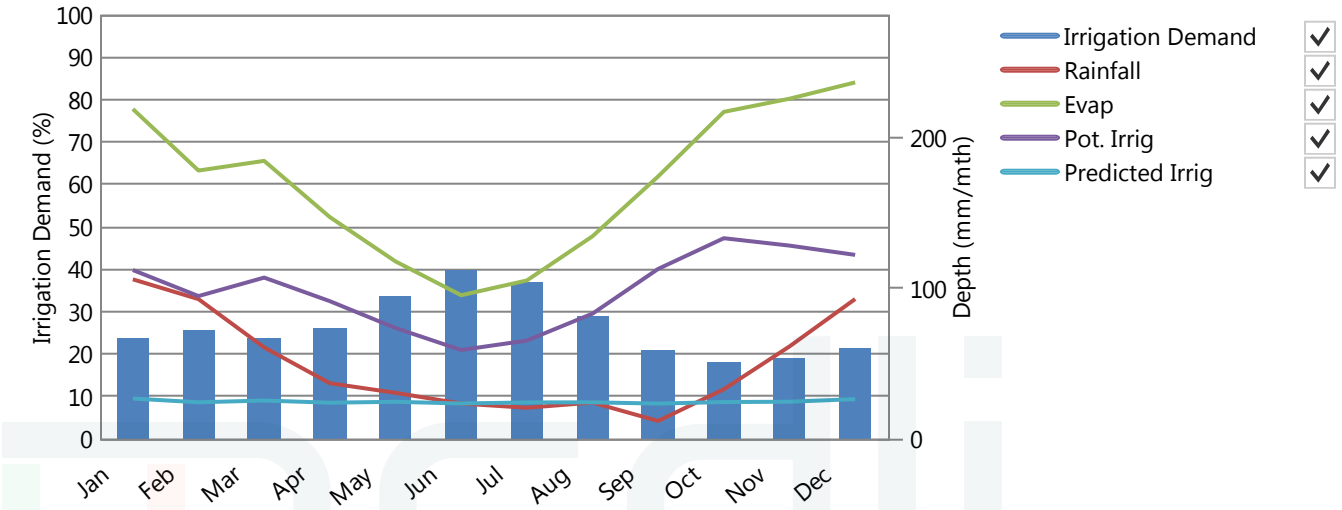
Probability of exceeding the % Irrigation Demand Supplied

Table ☐ Chart ■



Monthly % Irrigation Demand Supplied

Chart ■ Table ☐



DESCRIPTION

Climate Data: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

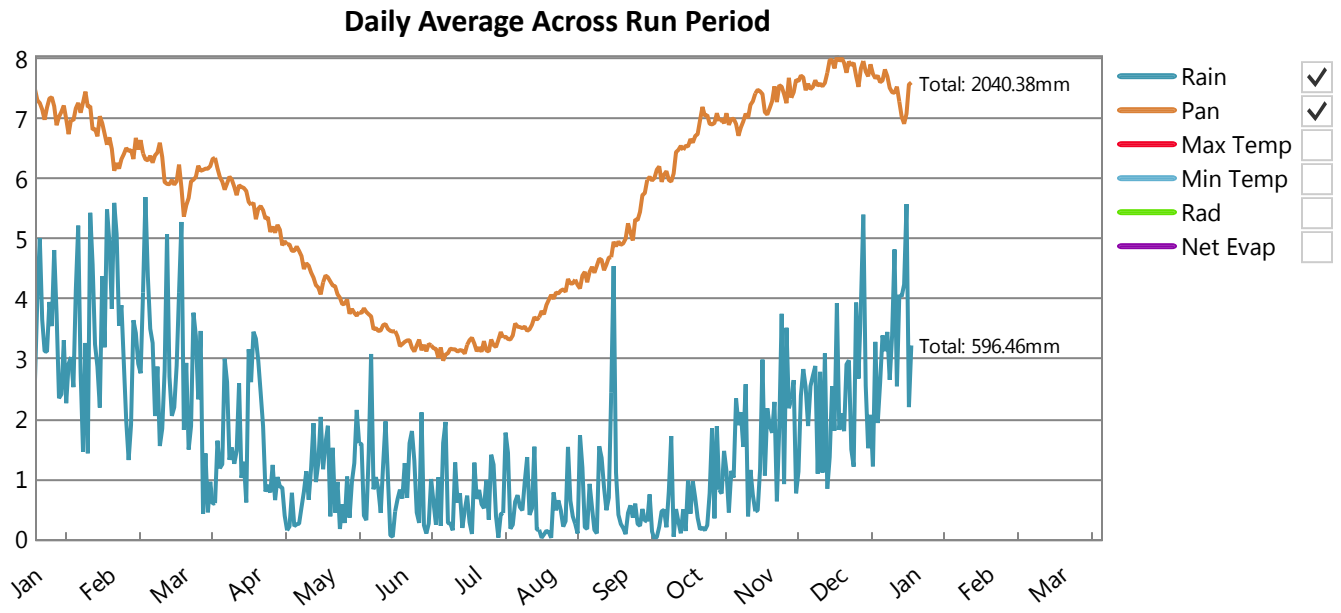
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	348	577	965
Pan Evaporation (mm/year)	1772	2083	2257

Climate Data:

Chart Table

Monthly Daily

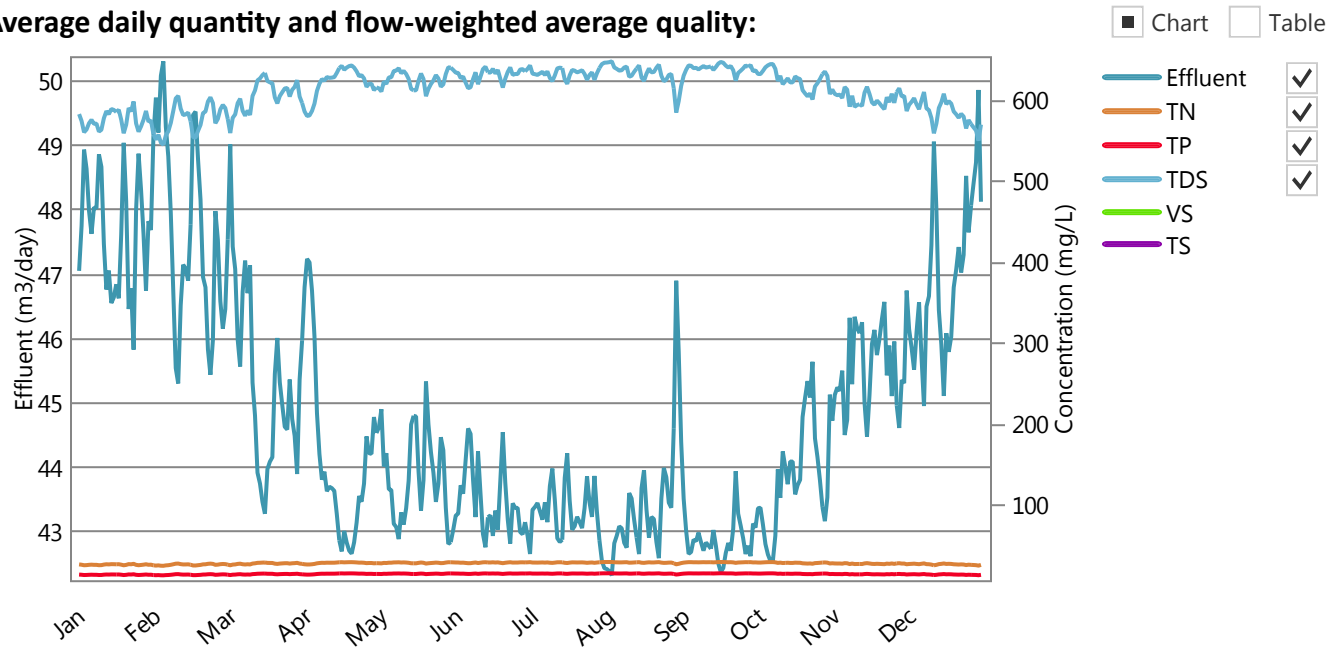


DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 16377.58 m3/year or 44.84 m3/day (Min-Max: 42.20 - 201.67)

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

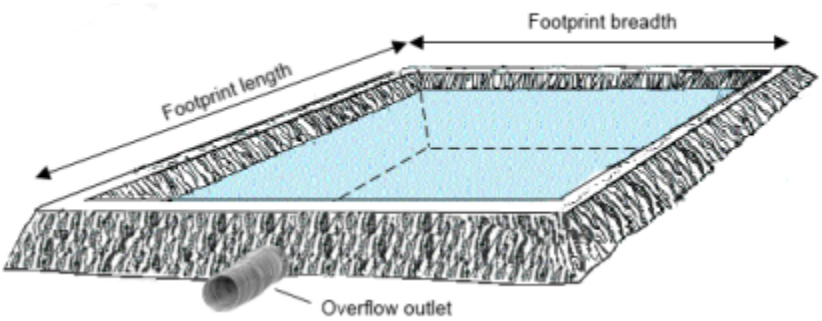
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	28.23 (6.28 - 30.00)	462.41 (462.09 - 463.36)
Total Phosphorus	15.06 (3.35 - 16.00)	246.62 (246.45 - 247.12)
Total Dissolved Salts	611.74 (136.01 - 650.00)	10018.81 (10011.95 - 10039.38)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

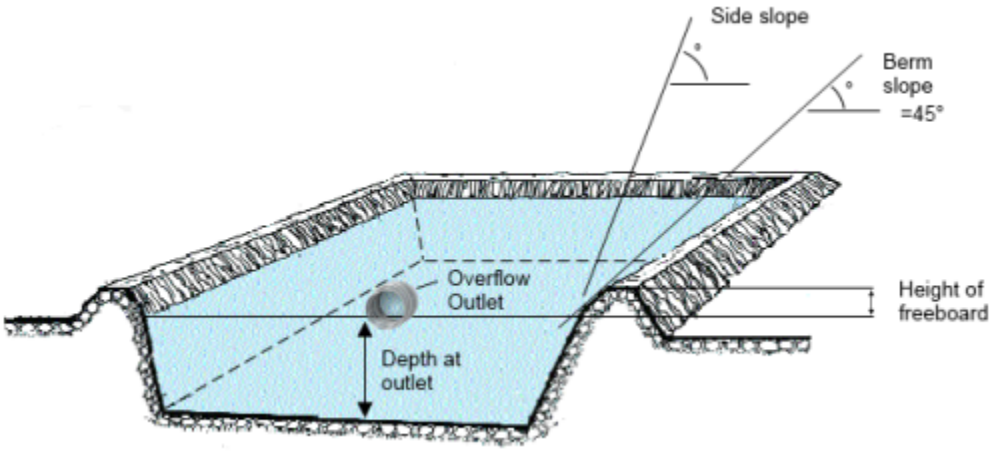
DESCRIPTION

Pond system: 1 closed storage tank

Pond system details:

	Pond 1
Maximum pond volume (m3)	340.00
Minimum allowable pond volume (m3)	24.26
Pond depth at overflow outlet (m)	2.00
Maximum water surface area (m2)	228.90
Pond footprint length (m)	21.40
Pond footprint width (m)	10.70
Pond catchment area (m2)	228.90
Average active volume (m3)	79.46





Irrigation pump limits:

Minimum pump limit	As scheduled
Maximum pump limit	As scheduled

Shandying water:

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

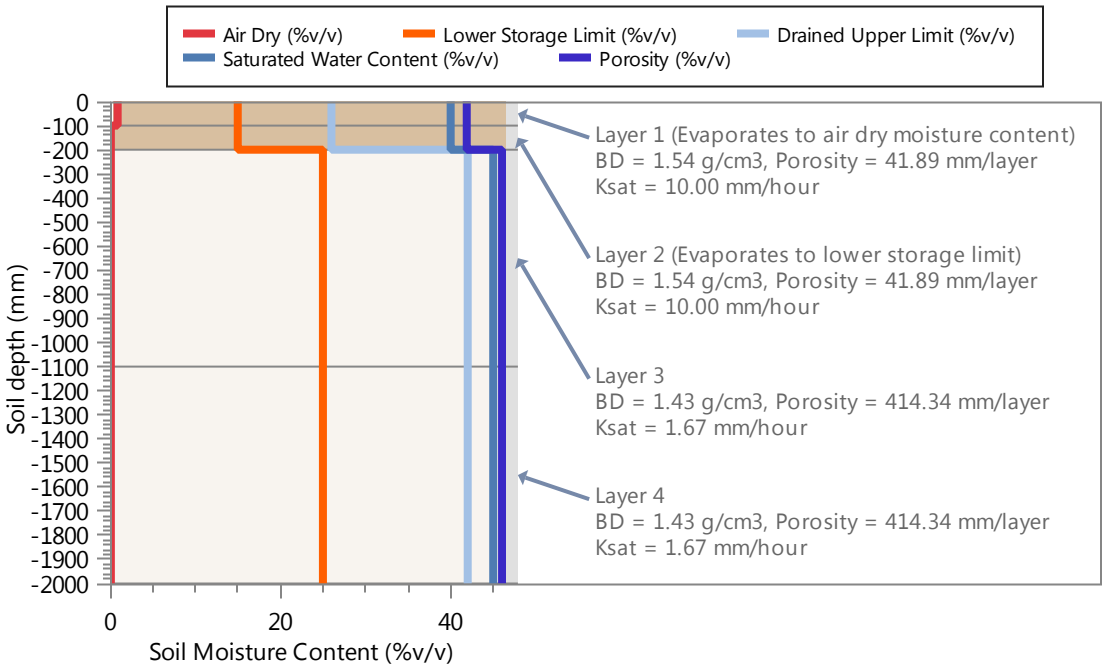
DESCRIPTION

Land: Kikuyu Paddock

Area (ha): 5.50

Soil Type: ODS Soil parameters, 2000.00 mm defined profile depth

Profile Porosity (mm)	912.45
Profile saturation water content (mm)	890.00
Profile drained upper limit (or field capacity) (mm)	808.00
Profile lower storage limit (or permanent wilting point) (mm)	480.00
Profile available water capacity (mm)	328.00
Profile limiting saturated hydraulic conductivity (mm/hour)	1.67
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	85.00
Soil evaporation U (mm)	7.25
Soil evaporation Cona (mm/sqrt day)	3.50



Plant Data: Continuous Kikuyu 1 Pasture

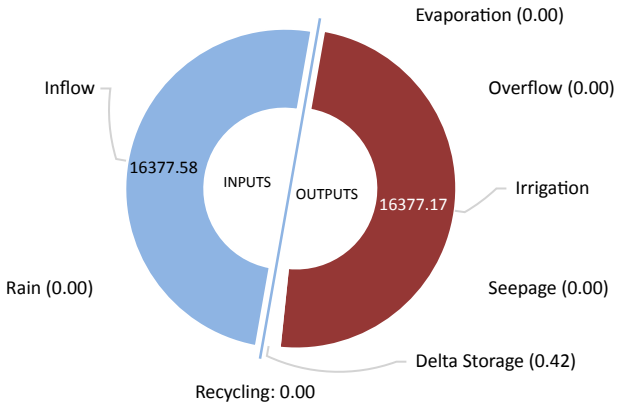
Average monthly cover (fraction) (minimum - maximum)	0.88 (0.86 - 0.90)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

PERFORMANCE

Pond System Water Performance - Overflow: 1 closed storage tank

Capacity of wet weather storage pond: **340 m3**

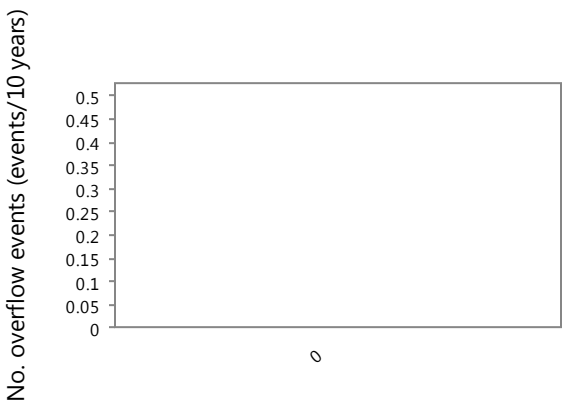
Pond System Water Balance (m3/year)



Name	Value
Rain	0.00
Inflow	16377.58
Recycling	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	16377.17
Seepage	0.00
Delta Storage	0.42

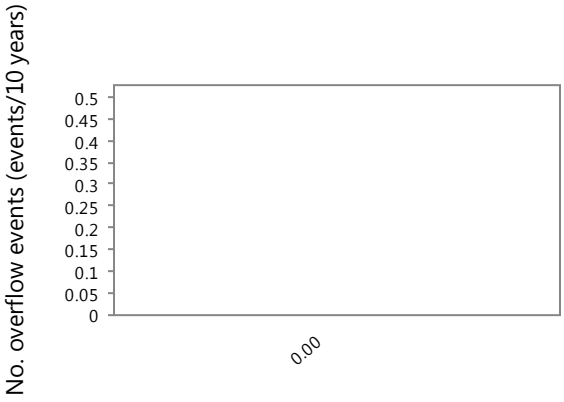
Overflow Diagnostics

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



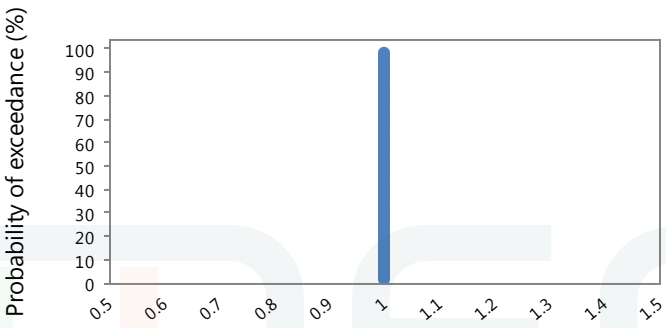
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

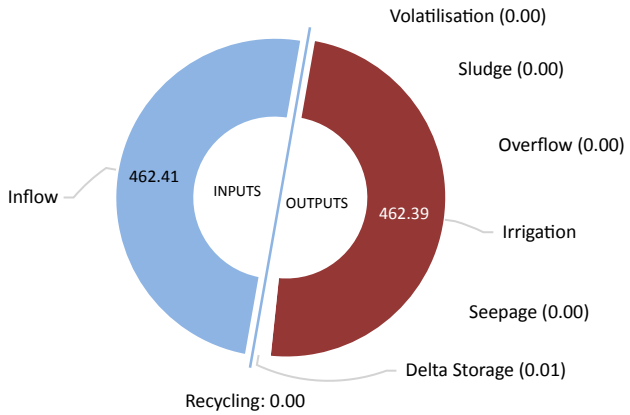
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

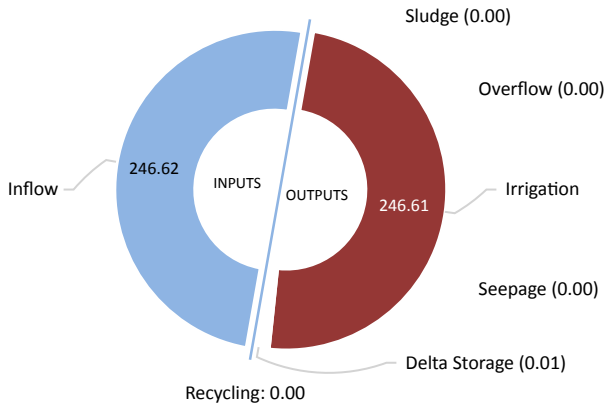
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



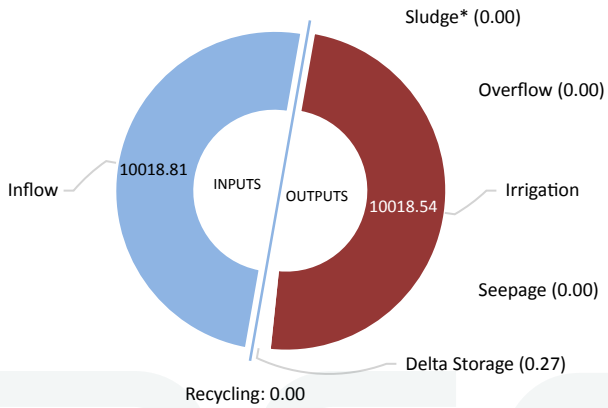
Name	Value
Inflow	462.41
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	462.39
Seepage	0.00
Delta Storage	0.01

Phosphorus Balance (kg/year)



Name	Value
Inflow	246.62
Recycling	0.00
Sludge	0.00
Overflow	0.00
Irrigation	246.61
Seepage	0.00
Delta Storage	0.01

Salt Balance (kg/year)



Name	Value
Inflow	10018.81
Recycling	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	10018.54
Seepage	0.00
Delta Storage	0.27

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	28.58
Average phosphorus concentration of pond liquid (mg/L)	15.24
Average salinity of pond liquid (dS/m)	0.97

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	29.97
Final phosphorus concentration of pond liquid (mg/L)	15.99
Final salinity of pond liquid (dS/m)	1.01

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	16377.17
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	16377.17
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)	28.23
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	27.67
Average phosphorus concentration of irrigation water (mg/L)	15.06
Average salinity of irrigation water (dS/m)	0.96

Irrigation Diagnostics:

Proportion Days Supply Insufficient For Pump (fraction)	0.59
Proportion of Days irrigation occurs (fraction)	0.41

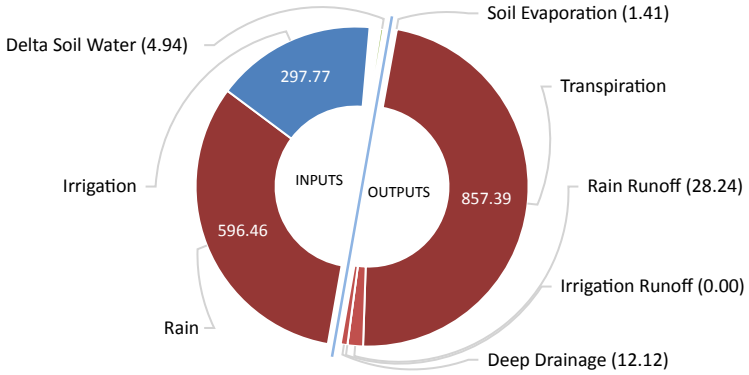
PERFORMANCE

Land Performance - Soil Water

Paddock: Kikuyu Paddock, 5.5 ha
Soil Type: ODS Soil parameters, 192.00 mm PAWC at maximum root depth

Land Water Balance (mm/year):

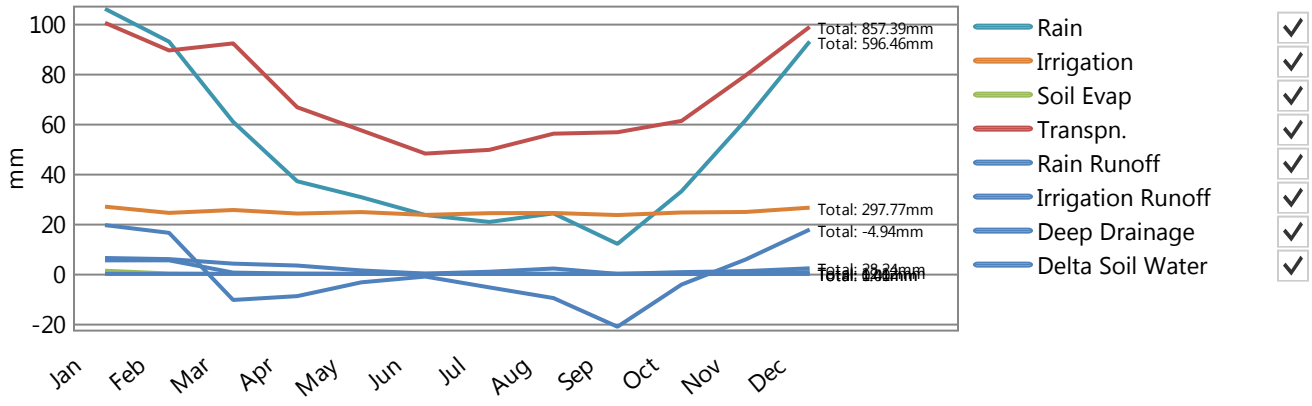
mm/year % Total inputs



Name	Value
Rain	596.46
Irrigation	297.77
Soil Evaporation	1.41
Transpiration	857.39
Rain Runoff	28.24
Irrigation Runoff	0.00
Deep Drainage	12.12
Delta Soil Water	-4.94

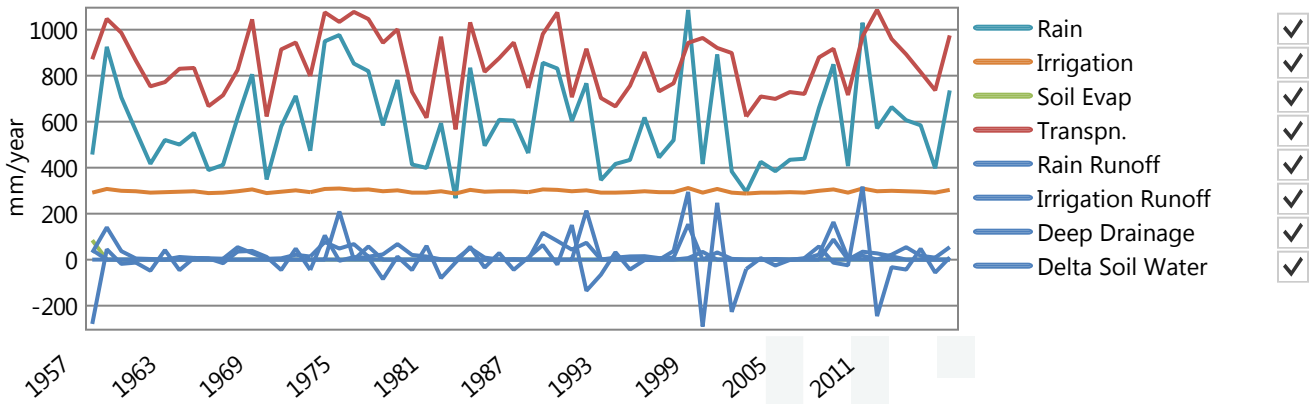
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



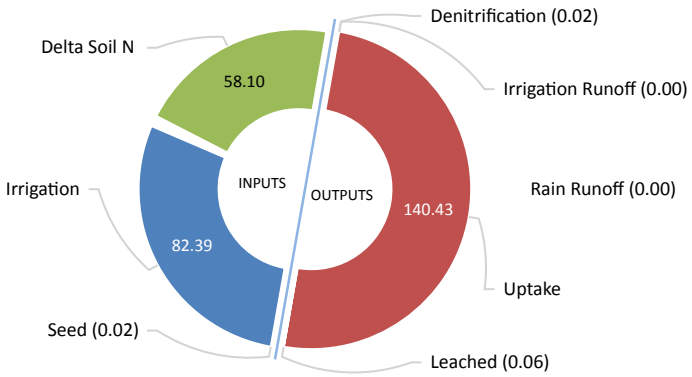
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

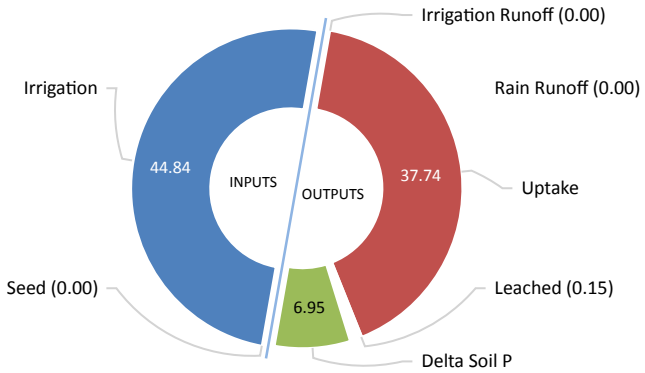
Irrigation ammonium volatilisation losses (kg/ha/year): 1.68
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	82.39
Denitrification	0.02
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	140.43
Leached	0.06
Delta Soil N	-58.10

Land Phosphorus Balance (kg/ha/year)



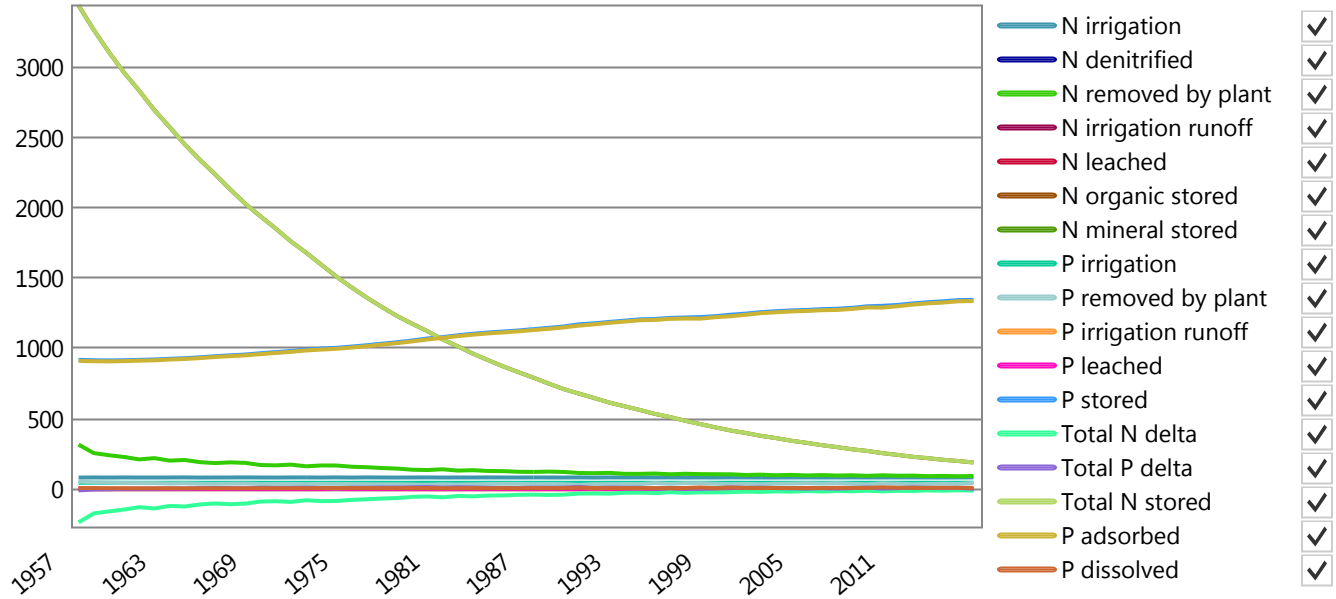
Name	Value
Seed	1.50E-03
Irrigation	44.84
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	37.74
Leached	0.15
Delta Soil P	6.95

PERFORMANCE

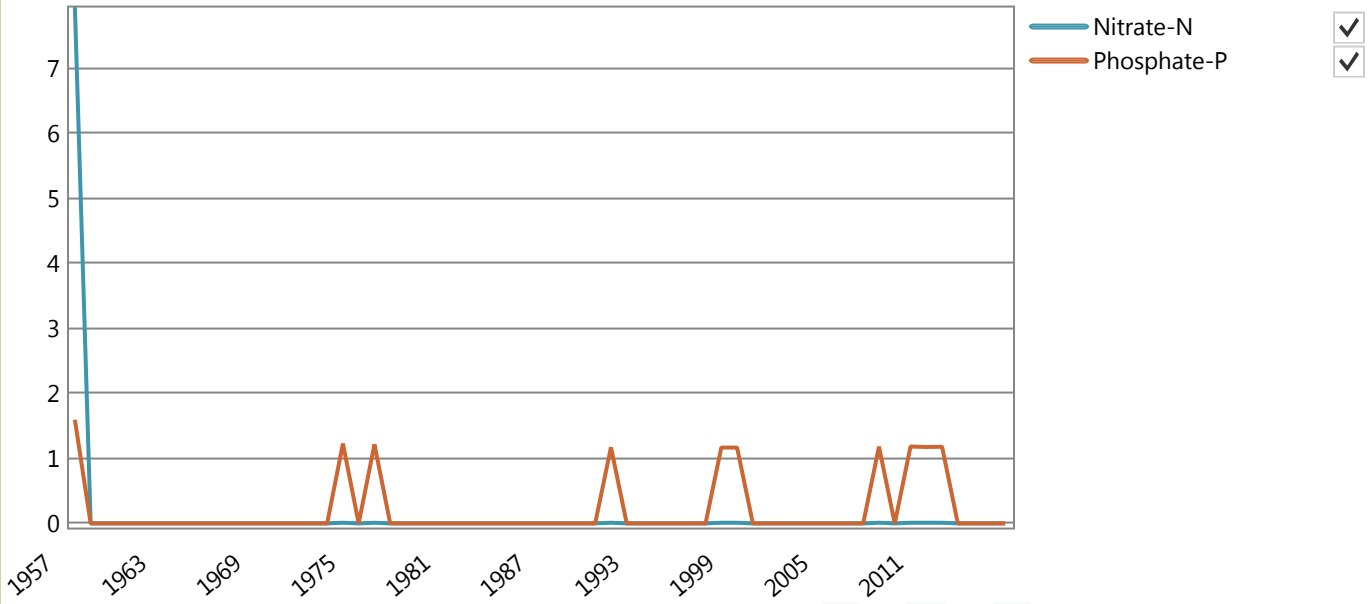
Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

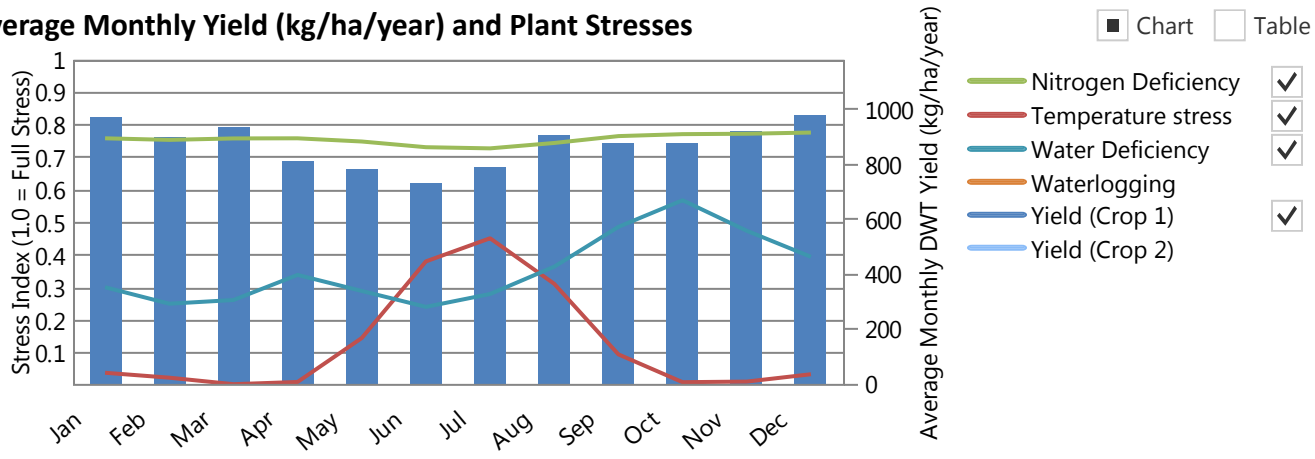
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	10515.39 (7777.33 - 17892.70)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.88 (0.86 - 0.90)
Average monthly root depth (mm) (minimum - maximum)	1198.92 (1187.96 - 1200.00)

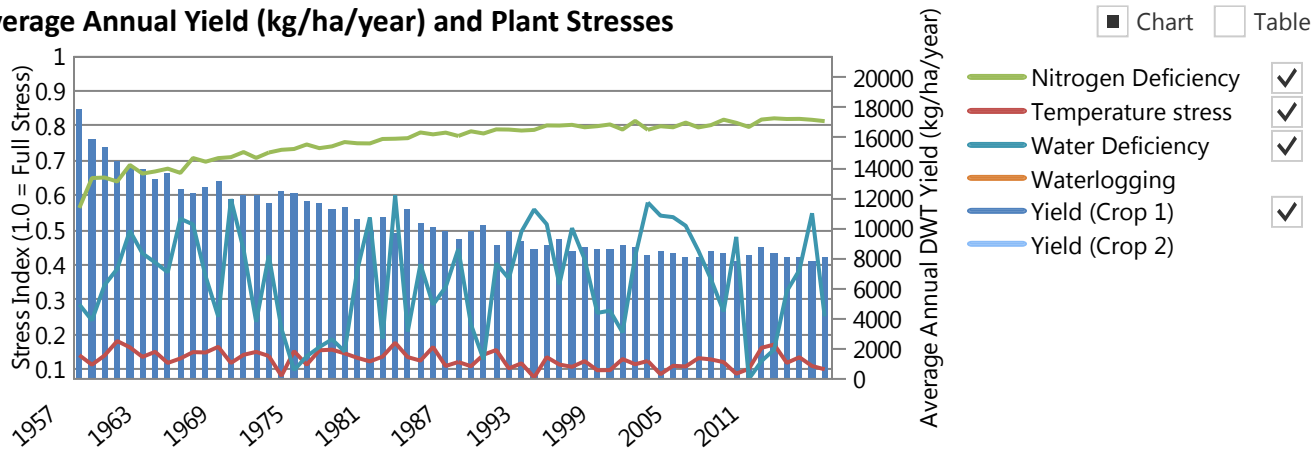
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	140.43 (91.11 - 316.09)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	37.74 (29.82 - 53.58)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.004 (0.003 - 0.005)

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



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



No. of harvests/year: 1.90 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

Plant: Continuous Kikuyu 1 Pasture

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

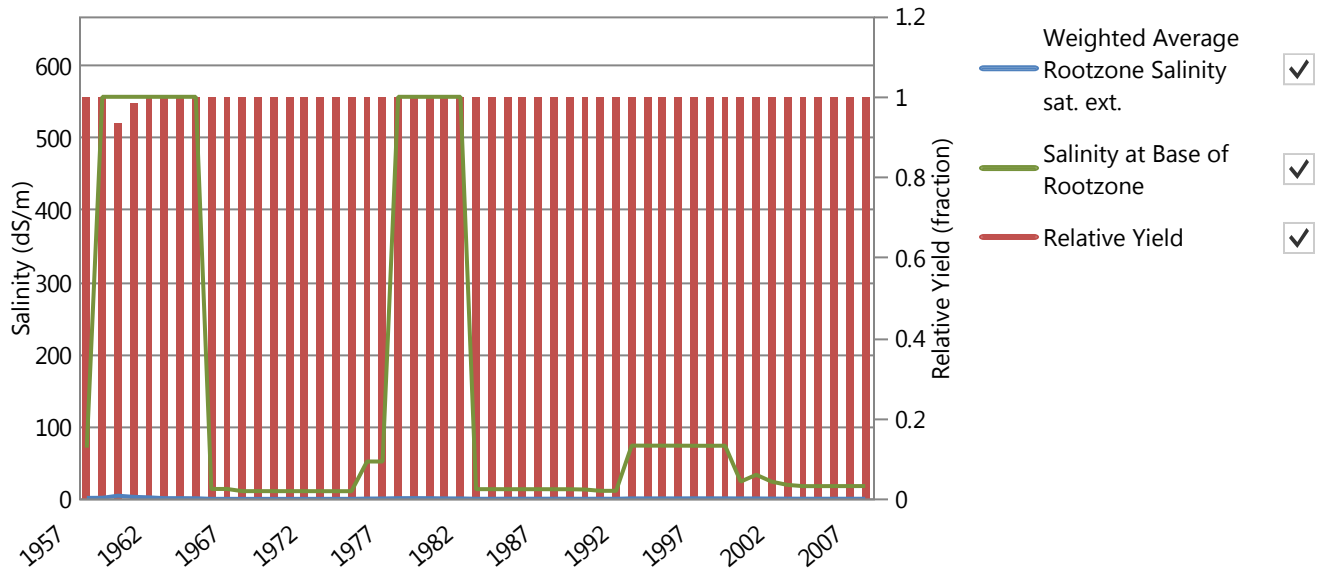
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.35
Salt added by rainfall (kg/ha/year)	109.10
Average annual effluent salt added & leached at steady state (kg/ha/year)	1930.65
Average leaching fraction based on 10 year running averages (fraction)	0.14
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.34
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



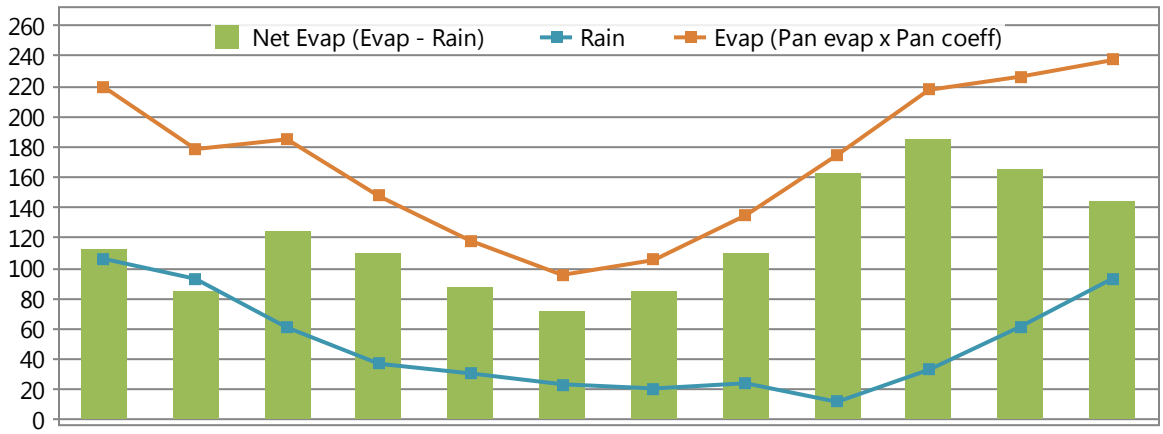
DIAGNOSTICS

Sustainability Diagnostics: 18041

Averaged Historical Climate Data Used in Simulation (mm)

Location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Evap	219.5	178.6	185.0	147.6	118.1	95.6	105.4	134.8	174.7	217.6	226.3	237.2	2040.4
Net Evap	113.2	85.5	124.1	110.5	87.4	72.1	84.6	110.6	162.6	184.5	164.7	144.1	1443.9
Net Evap/day	3.7	3.0	4.0	3.7	2.8	2.4	2.7	3.6	5.4	6.0	5.5	4.6	4.0

DIAGNOSTICS

Sustainability Diagnostics: 18041

Pond System: 1 closed storage tank

New Sewage Treatment Plant - 16377.58 m3/year or 44.84 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.25 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	28.23 (6.28 - 30.00)	462.41 (462.09 - 463.36)
Total Phosphorus	15.06 (3.35 - 16.00)	246.62 (246.45 - 247.12)
Total Dissolved Salts	611.74 (136.01 - 650.00)	10018.81 (10011.95 - 10039.38)
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)

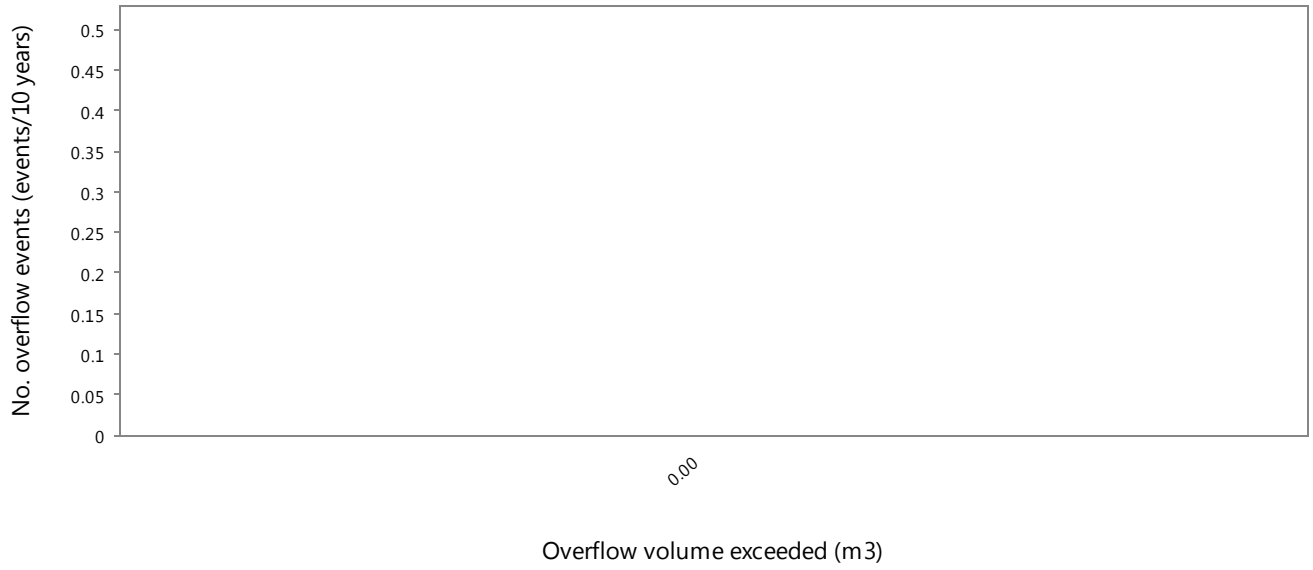
Last pond (Wet weather store): 340.00 m3

Theoretical hydraulic retention time (days)	7.58
Average volume of overflow (m3/year)	0.00
No. overflow events per year exceeding threshold* of 0.11 m3 (no./year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.97
Salinity of last pond on final day of simulation (dS/m)	1.01
Ammonia loss from pond system water area (kg/m2/year)	0.00

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

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: 18041

Irrigation Information

Irrigation: 5.5 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	16377.17	2977.67
Total nitrogen applied (kg)	453.15	82.39
Total phosphorus applied (kg)	246.61	44.84
Total salts applied (kg)	10018.54	1821.55

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 prevented when triggered (fraction)	0.59
Proportion of Days irrigation occurs (fraction)	0.41

DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Land: Kikuyu Paddock: 5.5 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 2.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): ODS Soil parameters, 192.00 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Irrigation	26.9	24.4	25.6	24.2	24.8	23.6	24.3	24.4	23.6	24.6	24.8	26.5	297.8
Soil Evap	1.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Transpn.	100.6	89.5	92.4	66.8	57.5	48.2	49.7	56.2	56.8	61.3	79.5	99.0	857.4
Rain Runoff	6.4	5.9	4.1	3.3	1.4	0.1	0.9	2.2	0.0	0.7	1.1	2.2	28.2
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	5.4	5.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	12.1
Delta	19.5	16.4	-10.5	-8.9	-3.4	-1.1	-5.4	-9.7	-21.2	-4.3	5.7	17.8	-4.9

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	82.39
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	140.43
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.02
Average annual soil nitrogen leached (kg/ha/year)	0.06
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.06
Soil organic-N kg/ha (Initial - Final)	3608.00 - 189.14
	67.44 - 0.05
Average nitrate-N concentration of deep drainage (mg/L)	0.47
Max. annual nitrate-N concentration of deep drainage (mg/L)	7.95

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	44.84
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	37.74
Average annual soil phosphorus leached (kg/ha/year)	0.15
Dissolved phosphorus (kg/ha) (Initial - Final)	12.06 - 8.43
Adsorbed phosphorus (kg/ha) (Initial - Final)	916.48 - 1337.31
Average phosphate-P concentration in rootzone (mg/L)	1.36
Average phosphate-P concentration of deep drainage (mg/L)	1.22
Max. annual phosphate-P concentration of deep drainage (mg/L)	1.59
Design soil profile storage life based on average infiltrated water phosphorus concn. of 5.18 mg/L (years)	40.71

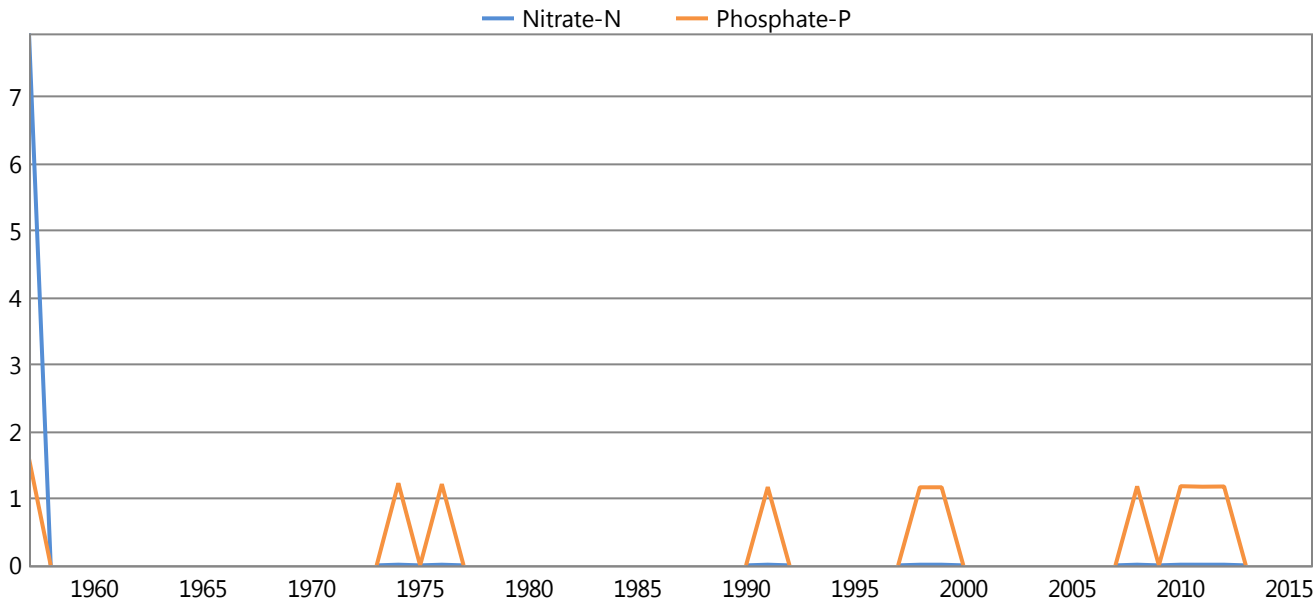
DIAGNOSTICS

Sustainability Diagnostics: 18041

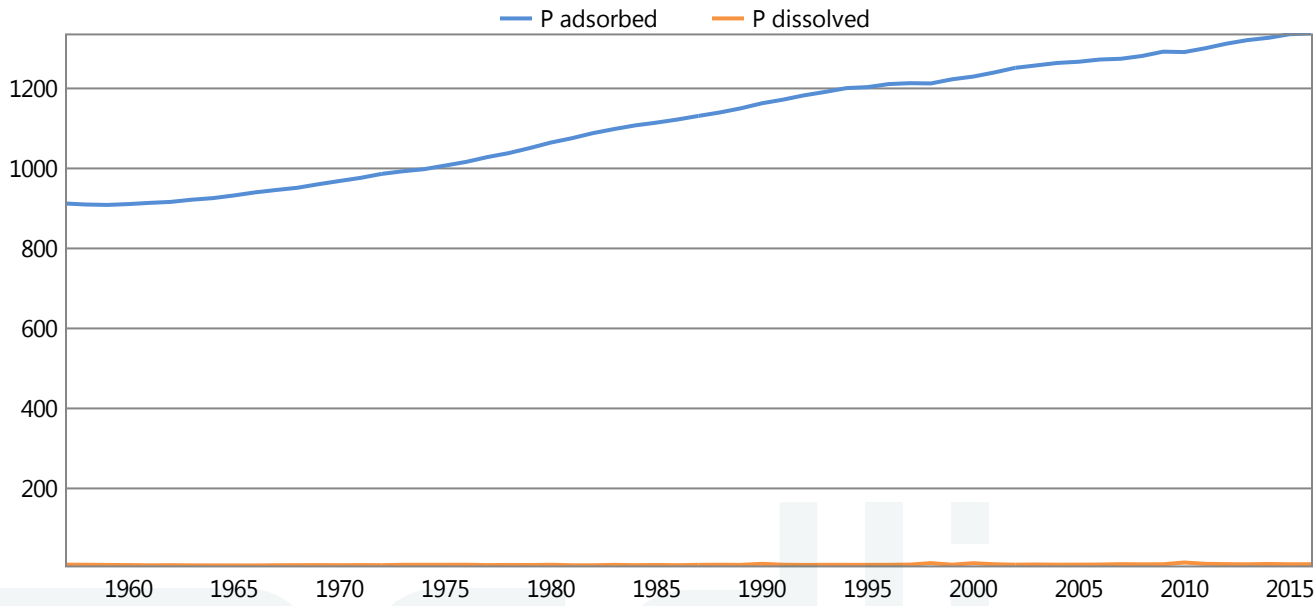
Paddock Land: Kikuyu Paddock: 5.5 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Plant Performance: Kikuyu Paddock: 5.5 ha

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

Average annual shoot dry matter yield (kg/ha/year)	10515.39 (7777.33 - 17892.70)
Average monthly plant (green) cover (fraction)	0.88 (0.86 - 0.90)
Average monthly crop factor (fraction)	0.70 (0.69 - 0.72)
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Average monthly root depth (mm)	1198.92 (1187.96 - 1200.00)
Average number of normal harvests per year (no./year)	1.90 (1.00 - 3.00)
Average number of normal harvests for last five years only (no./year)	1.60
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.76 (0.56 - 0.82)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.04 (0.00 - 0.17)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.45 (0.18 - 0.67)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.36 (0.24 - 0.57)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Moderately tolerant

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

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.35
Salt added by rainfall (kg/ha/year)	109.10
Average annual effluent salt added & leached at steady state (kg/ha/year)	1930.65
Average leaching fraction based on 10 year running averages (fraction)	0.14
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.34
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
Relative crop yield expected due to salinity (fraction)	1.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (fraction)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

Supply reliability run chosen
Pathogen module switched off
Supply reliability run chosen
Pathogen module switched off

Appendix E: MEDLI Model Report – Scenario 6-2

MEDLI REPORT - RELIABILITY OF SUPPLY RUN

Title: 18041

Climate data location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

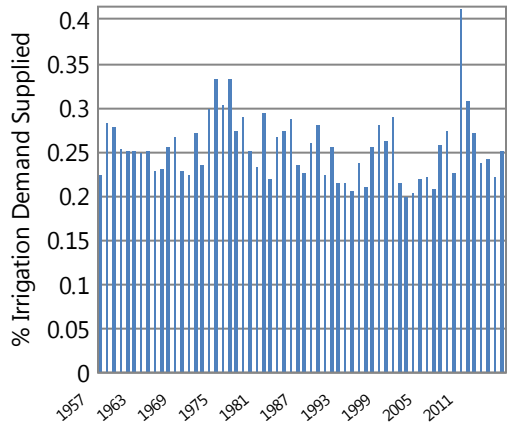
Average Annual %Irrigation Demand Supplied:

Potential annual irrigation when water supply is unlimited (m3/ha/year)	11878.1
Potential annual irrigation when water supply is unlimited (mm/year)	1187.8
Annual irrigation predicted for defined scenario (m3/ha/year)	2977.7
Annual irrigation predicted for defined scenario (mm/year)	297.8
Average annual irrigation demand supplied (fraction)	0.3

Or for 5.50 ha: 65329 m3/year

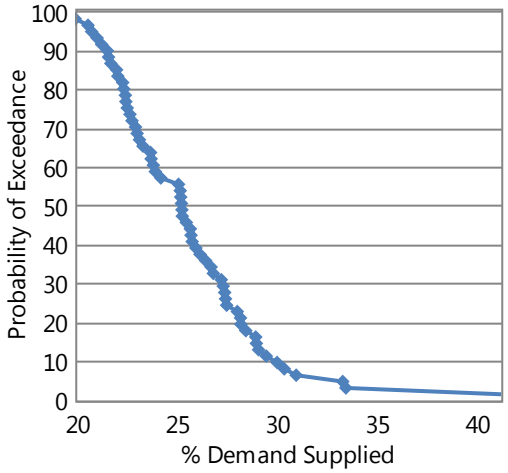
Annual % Irrigation Demand Supplied

Table Chart



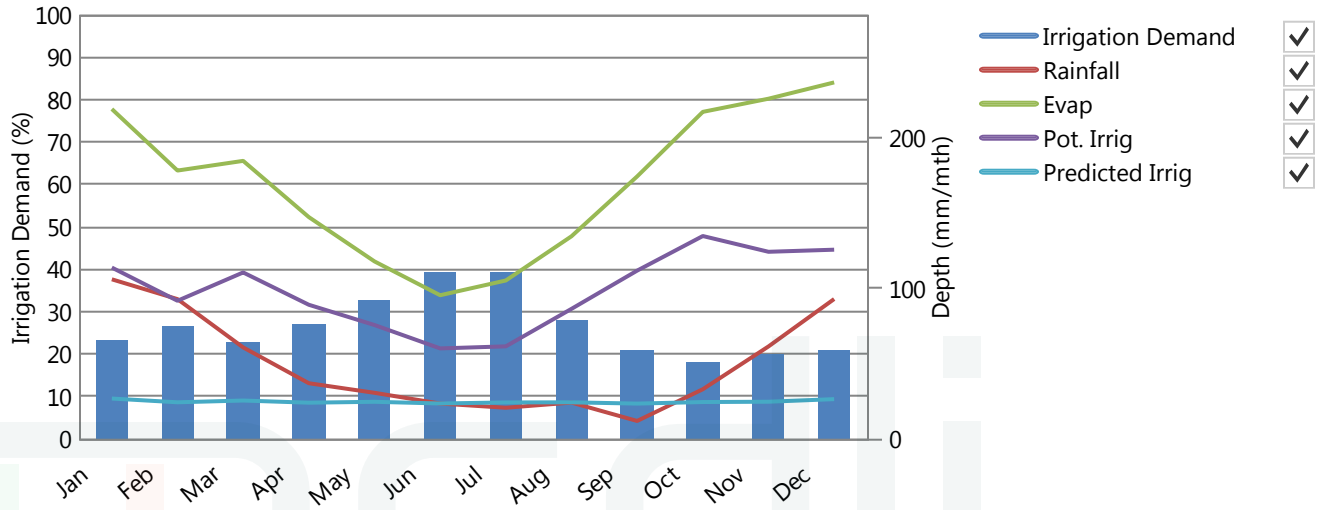
Probability of exceeding the % Irrigation Demand Supplied

Table Chart



Monthly % Irrigation Demand Supplied

Chart Table



DESCRIPTION

Climate Data: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days

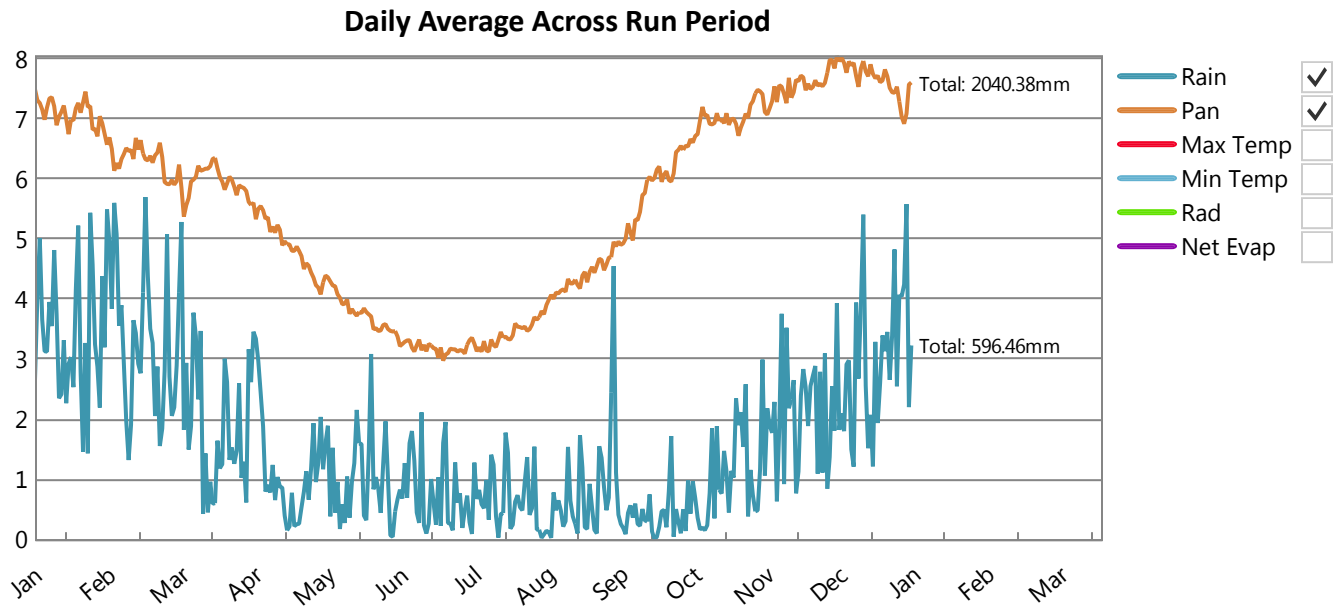
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	348	577	965
Pan Evaporation (mm/year)	1772	2083	2257

Climate Data:

Chart Table

Monthly Daily

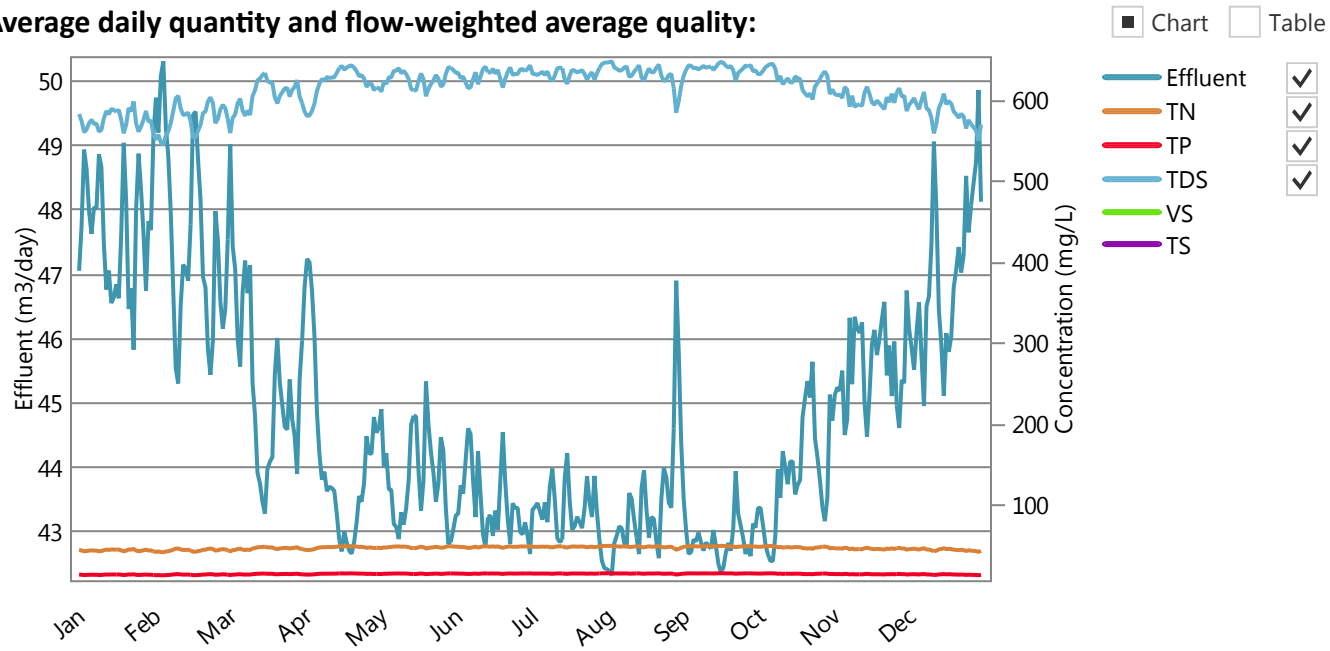


DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 16377.58 m3/year or 44.84 m3/day (Min-Max: 42.20 - 201.67)

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

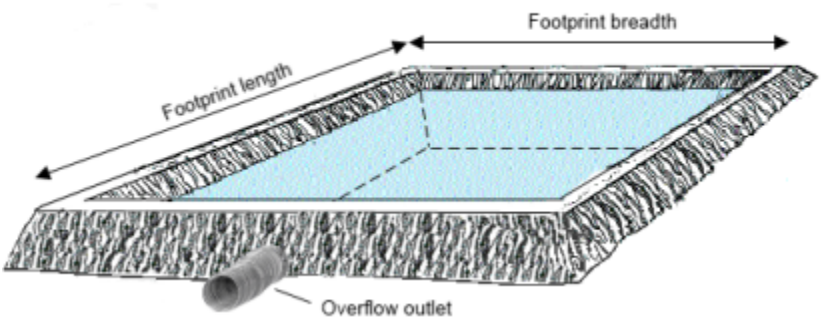
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	47.06 (10.46 - 50.00)	770.68 (770.15 - 772.26)
Total Phosphorus	15.06 (3.35 - 16.00)	246.62 (246.45 - 247.12)
Total Dissolved Salts	611.74 (136.01 - 650.00)	10018.81 (10011.95 - 10039.38)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

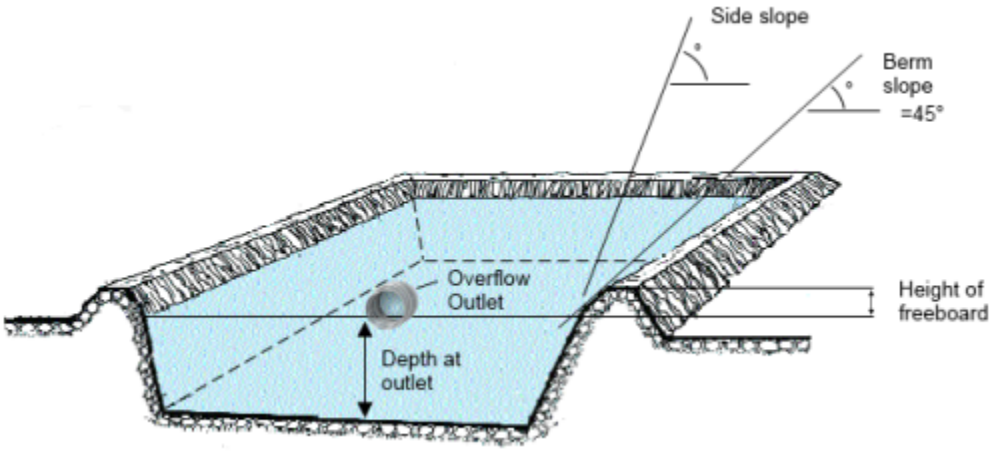
DESCRIPTION

Pond system: 1 closed storage tank

Pond system details:

	Pond 1
Maximum pond volume (m3)	340.00
Minimum allowable pond volume (m3)	24.26
Pond depth at overflow outlet (m)	2.00
Maximum water surface area (m2)	228.90
Pond footprint length (m)	21.40
Pond footprint width (m)	10.70
Pond catchment area (m2)	228.90
Average active volume (m3)	79.46





Irrigation pump limits:

Minimum pump limit	As scheduled
Maximum pump limit	As scheduled

Shandying water:

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

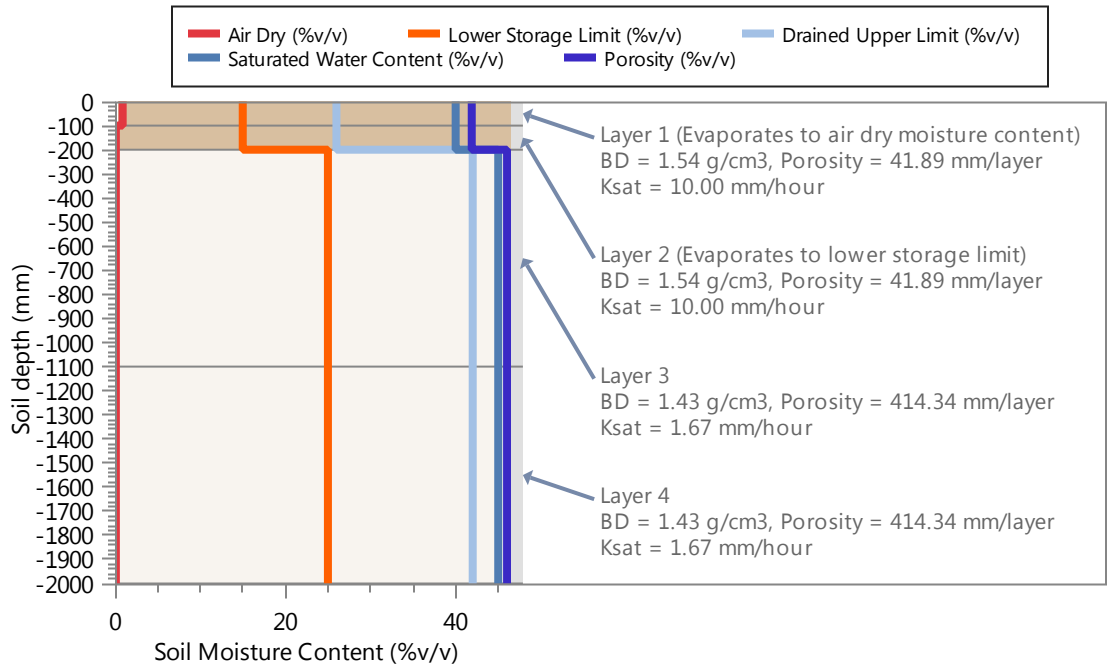
DESCRIPTION

Land: Kikuyu Paddock

Area (ha): 5.50

Soil Type: ODS Soil parameters, 2000.00 mm defined profile depth

Profile Porosity (mm)	912.45
Profile saturation water content (mm)	890.00
Profile drained upper limit (or field capacity) (mm)	808.00
Profile lower storage limit (or permanent wilting point) (mm)	480.00
Profile available water capacity (mm)	328.00
Profile limiting saturated hydraulic conductivity (mm/hour)	1.67
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	85.00
Soil evaporation U (mm)	7.25
Soil evaporation Cona (mm/sqrt day)	3.50



Plant Data: Continuous Kikuyu 1 Pasture

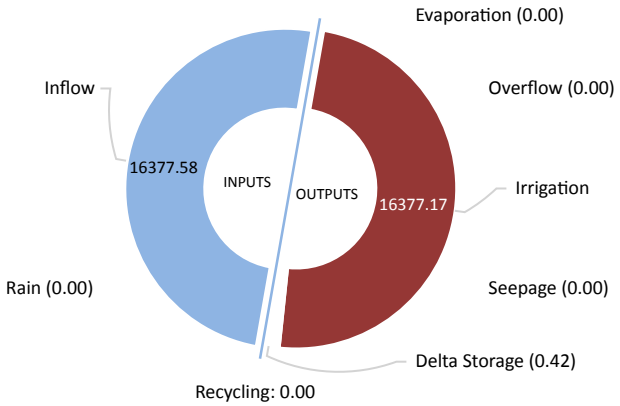
Average monthly cover (fraction) (minimum - maximum)	0.88 (0.81 - 0.93)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (fraction/dS/m)	0.03

PERFORMANCE

Pond System Water Performance - Overflow: 1 closed storage tank

Capacity of wet weather storage pond: **340 m3**

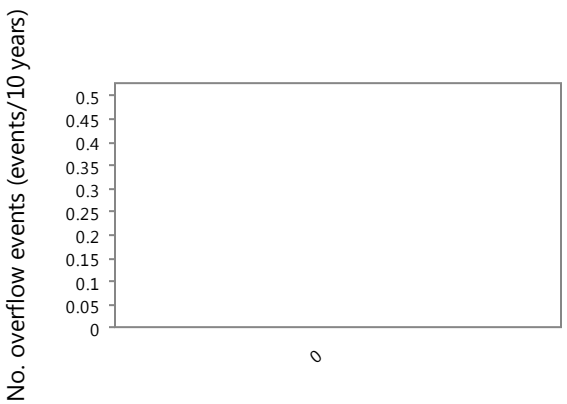
Pond System Water Balance (m3/year)



Name	Value
Rain	0.00
Inflow	16377.58
Recycling	0.00
Evaporation	0.00
Overflow	0.00
Irrigation	16377.17
Seepage	0.00
Delta Storage	0.42

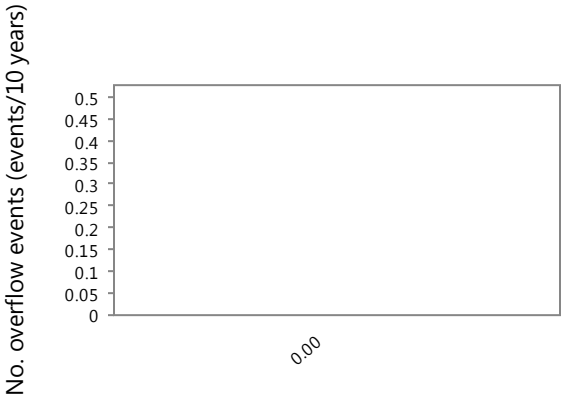
Overflow Diagnostics

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



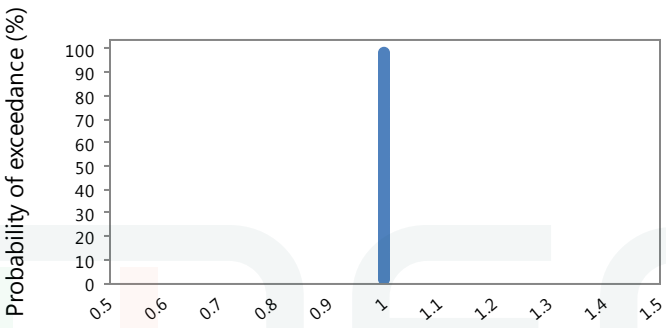
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (fraction)

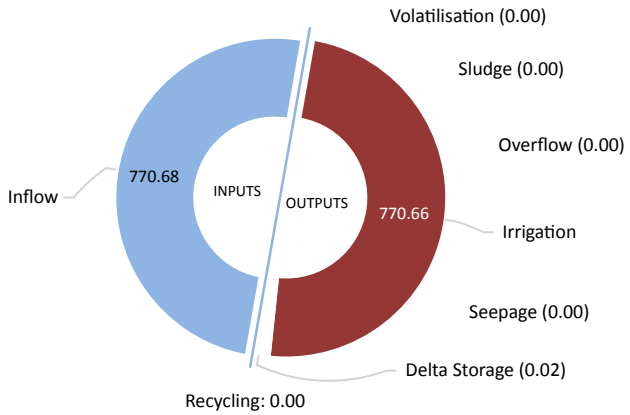
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

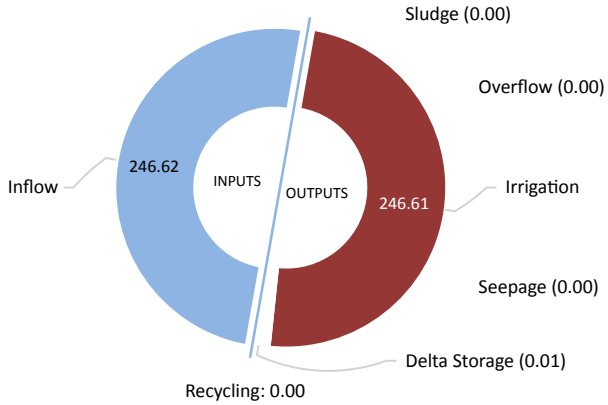
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



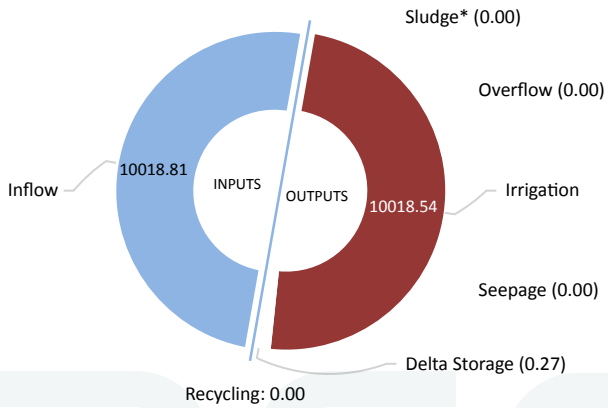
Name	Value
Inflow	770.68
Recycling	0.00
Volatilisation	0.00
Sludge	0.00
Overflow	0.00
Irrigation	770.66
Seepage	0.00
Delta Storage	0.02

Phosphorus Balance (kg/year)



Name	Value
Inflow	246.62
Recycling	0.00
Sludge	0.00
Overflow	0.00
Irrigation	246.61
Seepage	0.00
Delta Storage	0.01

Salt Balance (kg/year)



Name	Value
Inflow	10018.81
Recycling	0.00
Sludge*	0.00
Overflow	0.00
Irrigation	10018.54
Seepage	0.00
Delta Storage	0.27

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

PERFORMANCE

Pond System Performance - Nutrient: 1 closed storage tank

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	47.64
Average phosphorus concentration of pond liquid (mg/L)	15.24
Average salinity of pond liquid (dS/m)	0.97

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	49.96
Final phosphorus concentration of pond liquid (mg/L)	15.99
Final salinity of pond liquid (dS/m)	1.01

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	16377.17
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	16377.17
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)	47.06
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	46.12
Average phosphorus concentration of irrigation water (mg/L)	15.06
Average salinity of irrigation water (dS/m)	0.96

Irrigation Diagnostics:

Proportion Days Supply Insufficient For Pump (fraction)	0.59
Proportion of Days irrigation occurs (fraction)	0.41

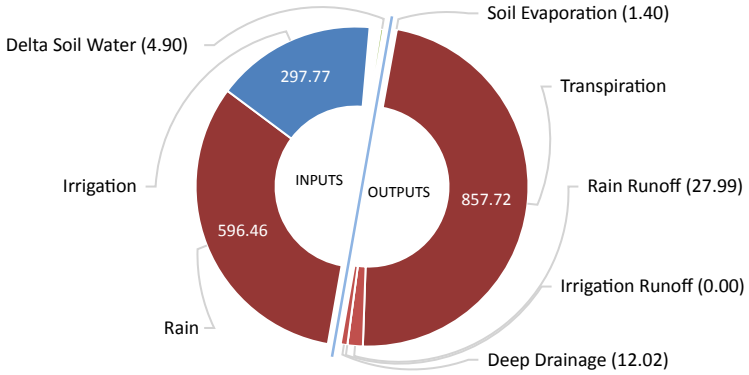
PERFORMANCE

Land Performance - Soil Water

Paddock: Kikuyu Paddock, 5.5 ha
Soil Type: ODS Soil parameters, 192.00 mm PAWC at maximum root depth

Land Water Balance (mm/year):

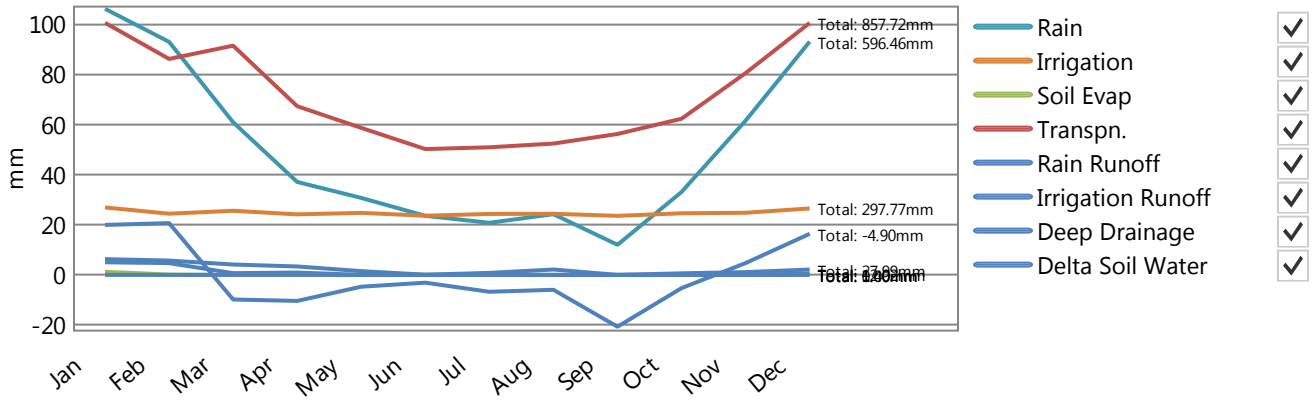
mm/year % Total inputs



Name	Value
Rain	596.46
Irrigation	297.77
Soil Evaporation	1.40
Transpiration	857.72
Rain Runoff	27.99
Irrigation Runoff	0.00
Deep Drainage	12.02
Delta Soil Water	-4.90

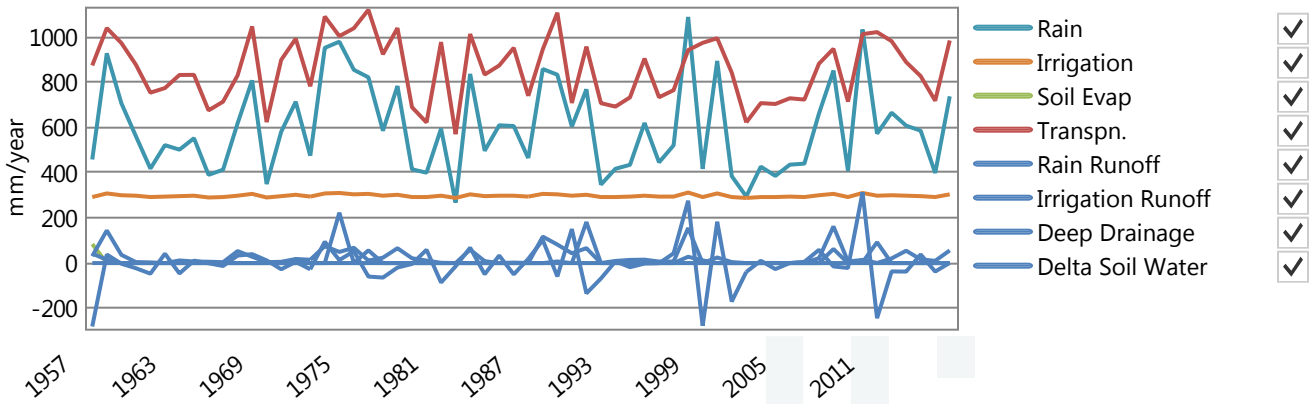
Average Monthly Totals (mm):

Chart Table



Average Annual Totals (mm/year):

Chart Table



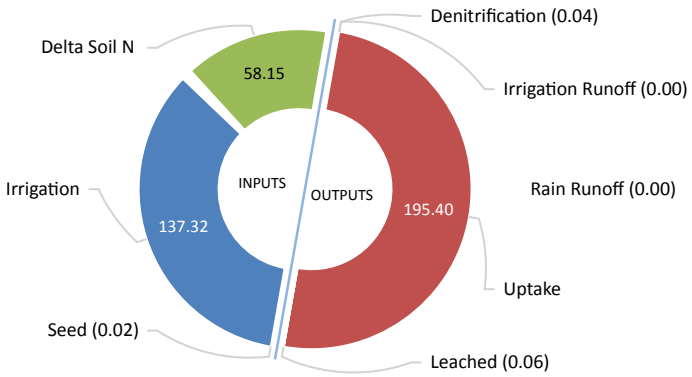
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

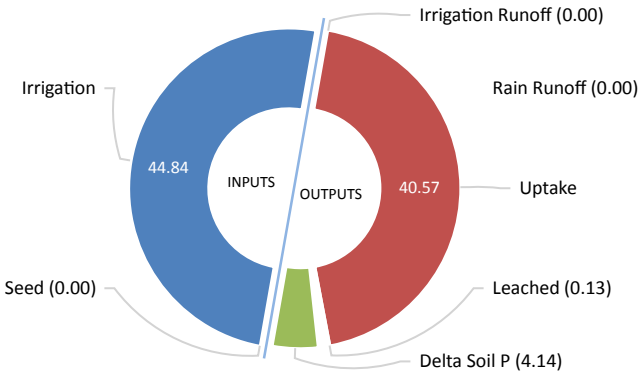
Irrigation ammonium volatilisation losses (kg/ha/year): 2.80
Proportion of total nitrogen in irrigated effluent as ammonium (fraction): 0.10

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	137.32
Denitrification	0.04
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	195.40
Leached	0.06
Delta Soil N	-58.15

Land Phosphorus Balance (kg/ha/year)



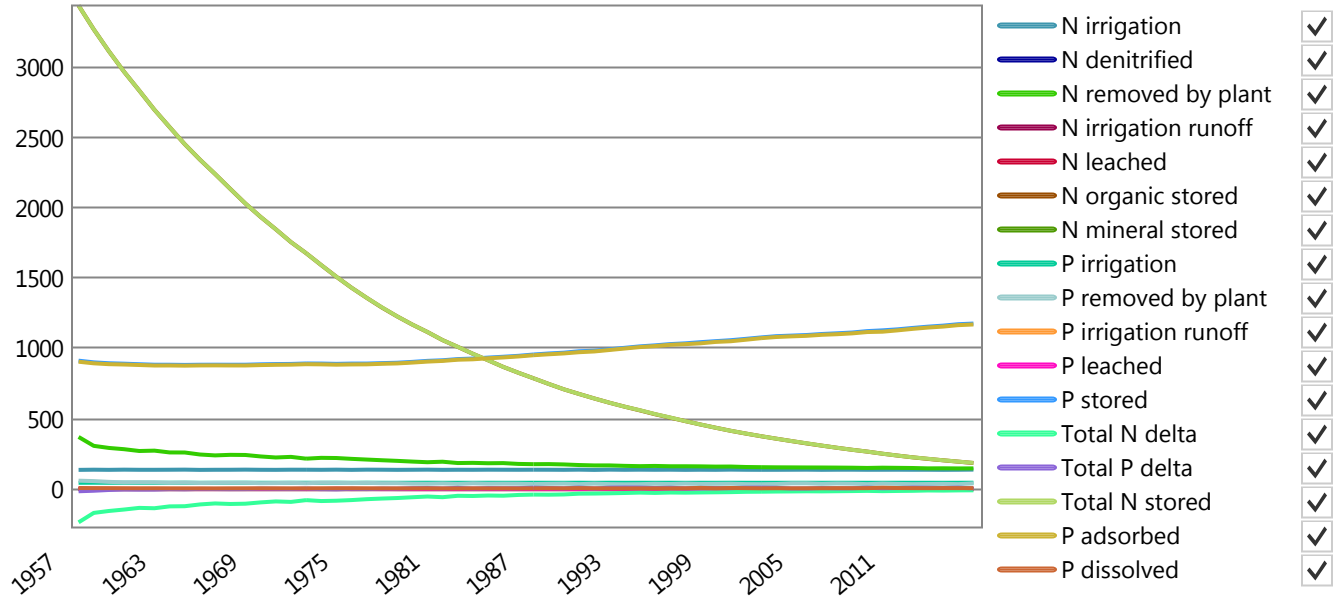
Name	Value
Seed	1.50E-03
Irrigation	44.84
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	40.57
Leached	0.13
Delta Soil P	4.14

PERFORMANCE

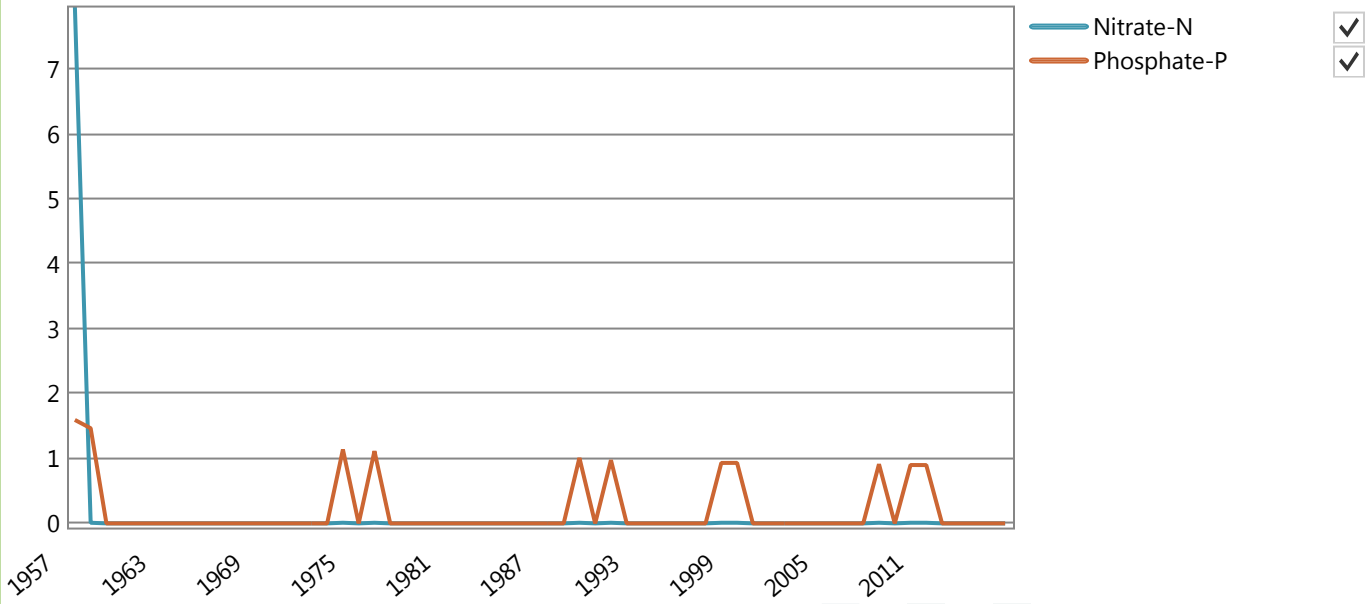
Land Performance - Soil Nutrient

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

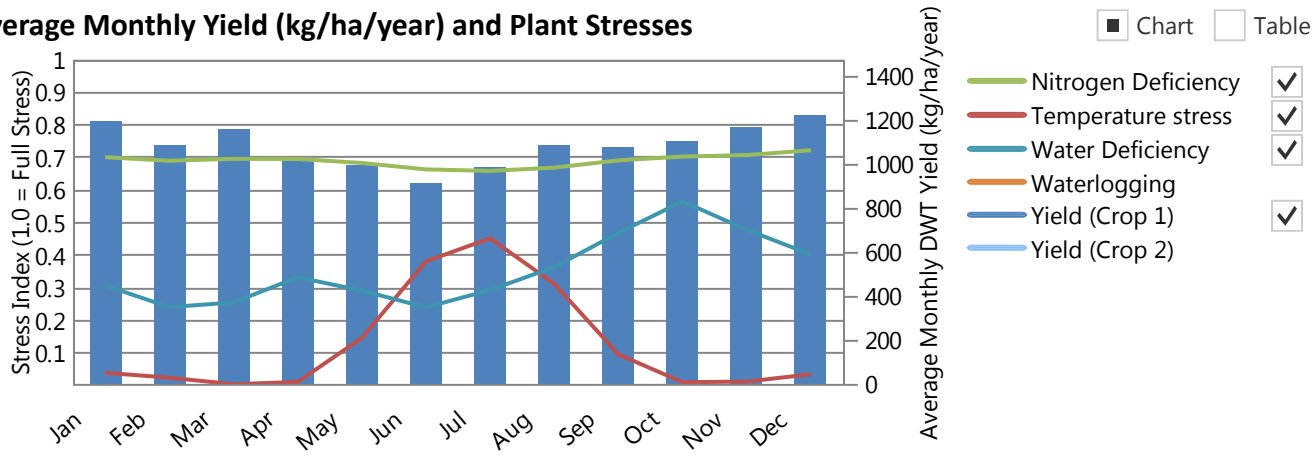
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	13063.17 (10522.61 - 19882.05)
Average monthly plant (green) cover (fraction) (minimum - maximum)	0.88 (0.81 - 0.93)
Average monthly root depth (mm) (minimum - maximum)	1198.92 (1187.96 - 1200.00)

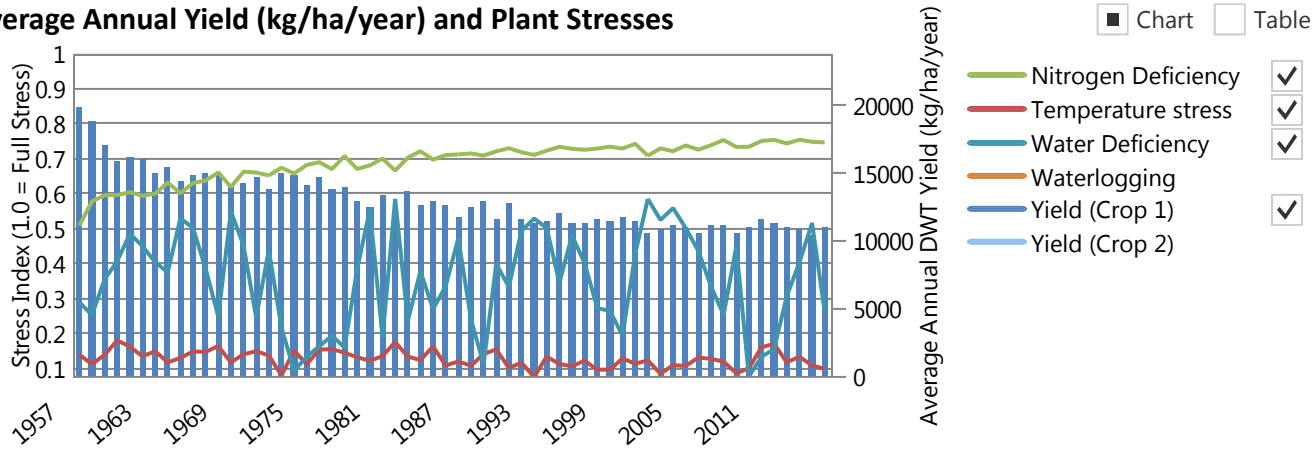
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	195.40 (146.83 - 370.68)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	40.57 (34.07 - 59.57)
Average annual shoot nitrogen concentration (fraction dwt)	0.02 (0.01 - 0.02)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.003 - 0.004)

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



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



No. of harvests/year: 2.35 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Kikuyu Paddock, 5.5 ha **Soil Type**: ODS Soil parameters

Plant: Continuous Kikuyu 1 Pasture

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

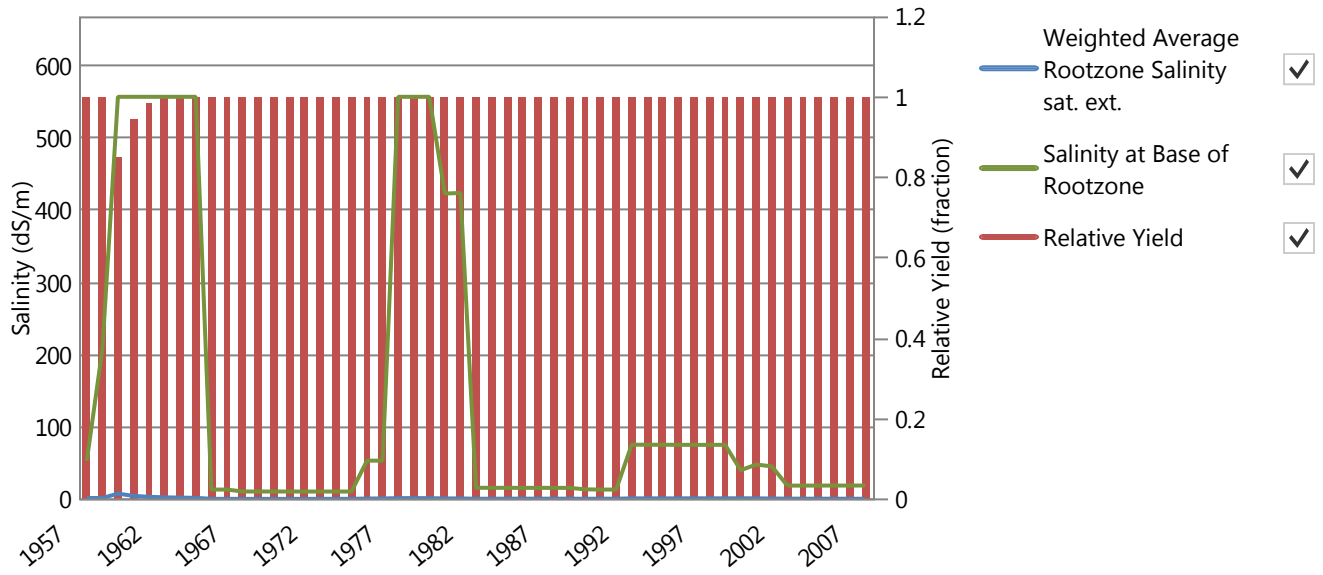
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.35
Salt added by rainfall (kg/ha/year)	109.15
Average annual effluent salt added & leached at steady state (kg/ha/year)	1930.70
Average leaching fraction based on 10 year running averages (fraction)	0.13
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.50
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
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)	0.02

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



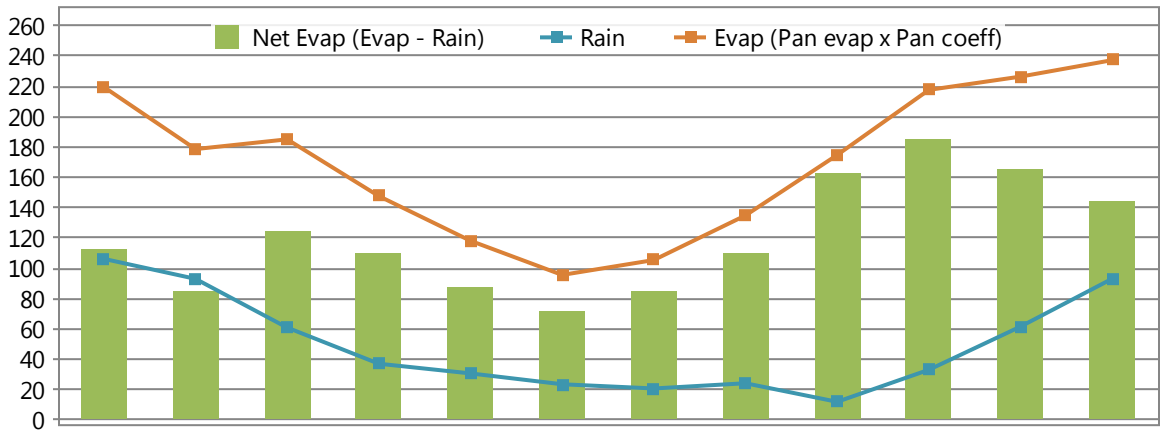
DIAGNOSTICS

Sustainability Diagnostics: 18041

Averaged Historical Climate Data Used in Simulation (mm)

Location: Olive Downs, -22.2°, 148.35°

Run Period: 01/01/1957 to 31/12/2016 60 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Evap	219.5	178.6	185.0	147.6	118.1	95.6	105.4	134.8	174.7	217.6	226.3	237.2	2040.4
Net Evap	113.2	85.5	124.1	110.5	87.4	72.1	84.6	110.6	162.6	184.5	164.7	144.1	1443.9
Net Evap/day	3.7	3.0	4.0	3.7	2.8	2.4	2.7	3.6	5.4	6.0	5.5	4.6	4.0

DIAGNOSTICS

Sustainability Diagnostics: 18041

Pond System: 1 closed storage tank

New Sewage Treatment Plant - 16377.58 m3/year or 44.84 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.25 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	47.06 (10.46 - 50.00)	770.68 (770.15 - 772.26)
Total Phosphorus	15.06 (3.35 - 16.00)	246.62 (246.45 - 247.12)
Total Dissolved Salts	611.74 (136.01 - 650.00)	10018.81 (10011.95 - 10039.38)
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)

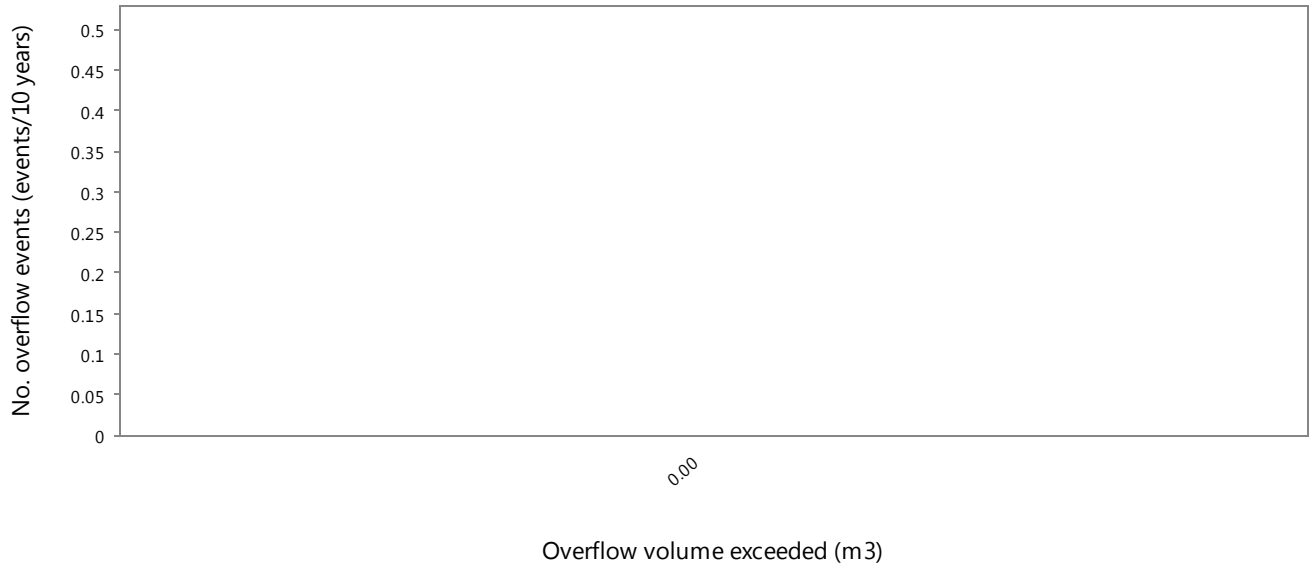
Last pond (Wet weather store): 340.00 m3

Theoretical hydraulic retention time (days)	7.58
Average volume of overflow (m3/year)	0.00
No. overflow events per year exceeding threshold* of 0.11 m3 (no./year)	0.00
Average duration of overflow (days)	0.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (fraction)	1.00
Probability of at least 90% effluent reuse (fraction)	1.00
Average salinity of last pond (dS/m)	0.97
Salinity of last pond on final day of simulation (dS/m)	1.01
Ammonia loss from pond system water area (kg/m2/year)	0.00

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

Overflow exceedance:

Chart Table



Export plot

DIAGNOSTICS

Sustainability Diagnostics: 18041

Irrigation Information

Irrigation: 5.5 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	16377.17	2977.67
Total nitrogen applied (kg)	755.24	137.32
Total phosphorus applied (kg)	246.61	44.84
Total salts applied (kg)	10018.54	1821.55

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 prevented when triggered (fraction)	0.59
Proportion of Days irrigation occurs (fraction)	0.41

DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Land: Kikuyu Paddock: 5.5 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Irrigation triggered every 1 days
Irrigate a fixed amount of 2.00 mm each day
Irrigation window from 1/1 to 31/12 including the days specified
A minimum of 0 days must be skipped between irrigation events

Soil Water Balance (mm): ODS Soil parameters, 192.00 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	106.2	93.0	60.9	37.1	30.7	23.6	20.8	24.2	12.0	33.1	61.6	93.1	596.5
Irrigation	26.9	24.4	25.6	24.2	24.8	23.6	24.3	24.4	23.6	24.6	24.8	26.5	297.8
Soil Evap	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Transpn.	100.6	86.2	91.5	67.3	58.7	50.2	50.9	52.4	56.3	62.3	80.6	100.6	857.7
Rain Runoff	6.3	5.7	4.2	3.4	1.5	0.1	0.8	2.2	0.0	0.6	1.1	2.1	28.0
Irr. Runoff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drainage	5.0	4.7	0.7	0.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5	12.0
Delta	19.9	20.7	-9.8	-10.4	-4.7	-3.1	-6.7	-5.9	-20.7	-5.3	4.7	16.4	-4.9

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	137.32
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	195.40
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.04
Average annual soil nitrogen leached (kg/ha/year)	0.06
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.06
Soil organic-N kg/ha (Initial - Final)	3608.00 - 185.15
	67.44 - 1.05
Average nitrate-N concentration of deep drainage (mg/L)	0.47
Max. annual nitrate-N concentration of deep drainage (mg/L)	7.96

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	44.84
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	40.57
Average annual soil phosphorus leached (kg/ha/year)	0.13
Dissolved phosphorus (kg/ha) (Initial - Final)	12.06 - 6.56
Adsorbed phosphorus (kg/ha) (Initial - Final)	916.48 - 1170.44
Average phosphate-P concentration in rootzone (mg/L)	1.04
Average phosphate-P concentration of deep drainage (mg/L)	1.06
Max. annual phosphate-P concentration of deep drainage (mg/L)	1.59
Design soil profile storage life based on average infiltrated water phosphorus concn. of 5.18 mg/L (years)	40.81

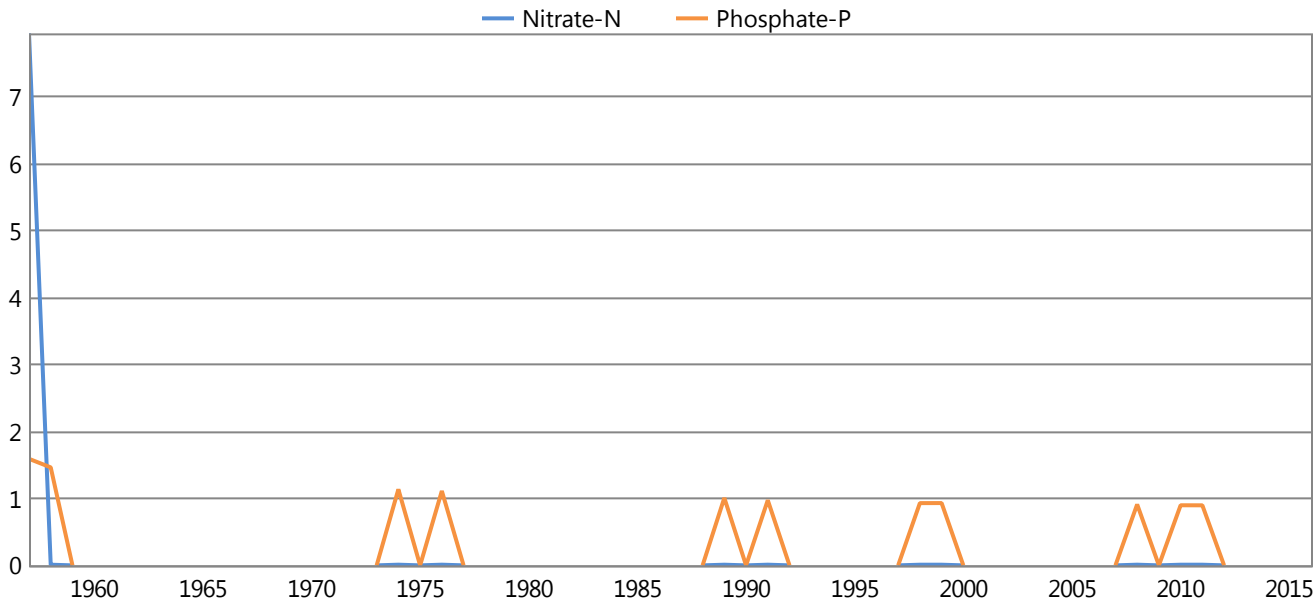
DIAGNOSTICS

Sustainability Diagnostics: 18041

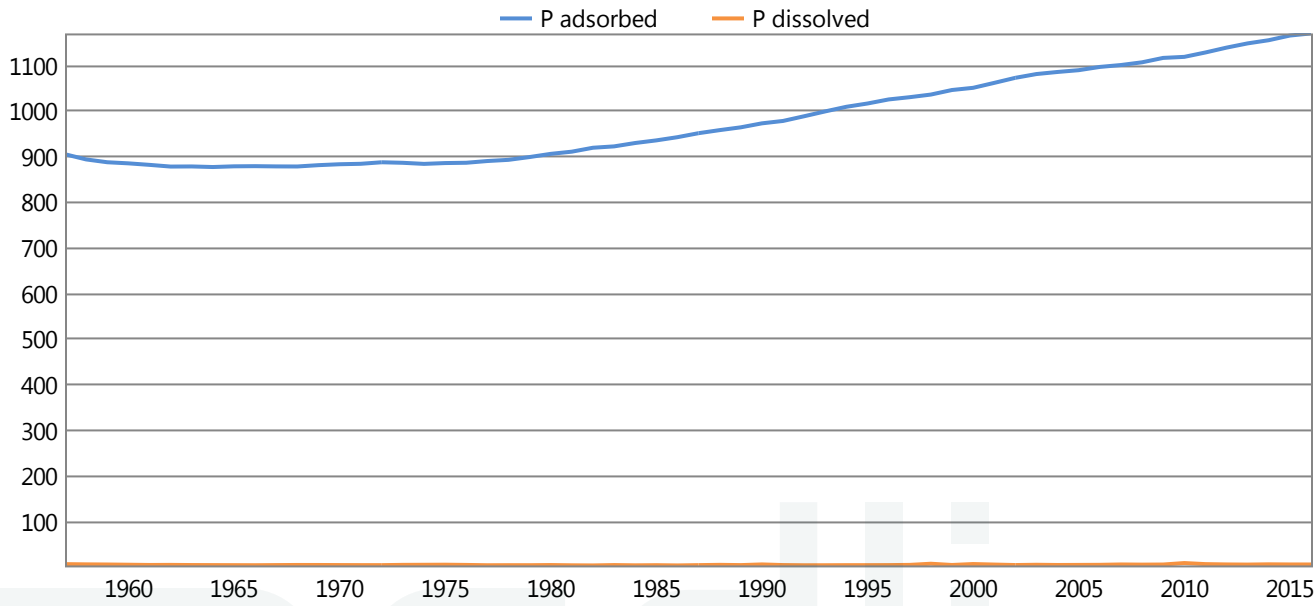
Paddock Land: Kikuyu Paddock: 5.5 ha

Irrigation: Fixed Sprinkler with 0.2% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: 18041

Paddock Plant Performance: Kikuyu Paddock: 5.5 ha

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

Average annual shoot dry matter yield (kg/ha/year)	13063.17 (10522.61 - 19882.05)
Average monthly plant (green) cover (fraction)	0.88 (0.81 - 0.93)
Average monthly crop factor (fraction)	0.70 (0.65 - 0.74)
Total plant cover (both green and dead) left after harvest (fraction)	1.00
Average monthly root depth (mm)	1198.92 (1187.96 - 1200.00)
Average number of normal harvests per year (no./year)	2.35 (2.00 - 4.00)
Average number of normal harvests for last five years only (no./year)	2.00
Average number of crop deaths per year (no./year)	0.00 (0.00 - 0.00)
Average number of crop deaths for last five years only (no./year)	0.00
Average annual nitrogen deficiency index (0 = no stress, 1 = full stress) (coefficient)	0.69 (0.51 - 0.75)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.04 (0.00 - 0.17)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.45 (0.18 - 0.67)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.35 (0.24 - 0.57)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
No. days without crop/year (days)	0.00

Soil Salinity - Plant salinity tolerance: Moderately tolerant

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

All values based on 10 year running averages

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.35
Salt added by rainfall (kg/ha/year)	109.15
Average annual effluent salt added & leached at steady state (kg/ha/year)	1930.70
Average leaching fraction based on 10 year running averages (fraction)	0.13
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.50
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	557.00
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)	0.02

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

WARNING: Yield has been substantially suppressed by soil salinity. Soil hydrology and nutrient balances are INVALID.
Supply reliability run chosen
Pathogen module switched off
Supply reliability run chosen
Pathogen module switched off

Appendix F: Laboratory Hydrometer Test Results

GRAIN SIZE ANALYSIS (hydrometer techniques)

10 soil samples supplied by CQ Soil Testing on 25th September, 2018 - Lab Job No. H4318
Analysis requested by Scott Walton
PO Box 9654 PARK AVENUE QLD 4701

SAMPLE ID	Lab Code	MOISTURE CONTENT (% Moisture)	GRAVEL > 2 mm (%)	SAND > 50 µm USDA (< 2 mm fraction)	SAND > 20 µm ISSS (< 2 mm fraction)	SILT 2–50 µm USDA (< 2 mm fraction)	SILT 2–20 µm ISSS (< 2 mm fraction)	CLAY < 2 µm (< 2 mm fraction)
ODS M1 0.0-0.2m	H4318/1	1.3%	1.4%	50.5%	66.5%	34.2%	18.2%	15.3%
ODS M1 0.2-2.0m	H4318/2	1.8%	0.1%	49.6%	61.6%	25.1%	13.1%	25.3%
ODS M2 0.0-0.2m	H4318/3	0.9%	4.5%	74.6%	84.4%	12.7%	2.9%	12.7%
ODS M2 0.2-2.0m	H4318/4	1.4%	4.1%	57.9%	67.3%	17.5%	8.1%	24.6%
ODS M3 0.0-0.2m	H4318/5	0.9%	0.0%	63.1%	87.9%	26.4%	1.5%	10.5%
ODS M3 0.2-2.0m	H4318/6	1.4%	1.1%	58.6%	64.6%	17.2%	11.2%	24.2%
ODS M4 0.0-0.2m	H4318/7	0.8%	0.1%	62.6%	79.7%	25.0%	7.8%	12.5%
ODS M4 0.2-2.0m	H4318/8	1.3%	0.5%	62.6%	68.5%	13.9%	8.0%	23.5%
ODS M5 0.0-0.2m	H4318/9	0.6%	0.1%	76.1%	86.5%	14.5%	4.1%	9.4%
ODS M5 0.2-2.0m	H4318/10	1.6%	0.0%	57.9%	63.6%	15.0%	9.4%	27.1%

Note:

1: The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,
modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986),
in *Methods of Soil Analysis. Part 1* Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

Appendix G: Laboratory Test Results – Wastewater Disposal Soil Assessment

WASTEWATER DISPOSAL SOIL ASSESSMENT

10 samples supplied by CQ Soil Testing on 25/9/18 - Lab Job No. H4318
Analysis requested by Scott Walton. - **Your Project: 18041 AKWQ1309 MEDLI Modelling**
(PO Box 9654 PARK AVENUE QLD 4701)

	SITE 1 ODS M1 0.0-0.2m	**SITE 2 ODS M1 0.2-2.0m**	**SITE 3 ODS M2 0.0-0.2m**	**SITE 4 ODS M2 0.2-2.0m**	**SITE 5 ODS M3 0.0-0.2m**	**SITE 6 ODS M3 0.2-2.0m**	**SITE 7 ODS M4 0.0-0.2m**	**SITE 8 ODS M4 0.2-2.0m**	**SITE 9 ODS M5 0.0-0.2m**	**SITE 10 ODS M5 0.2-2.0m**
Job No.	*H4318/1*	*H4318/2*	*H4318/3*	*H4318/4*	*H4318/5*	*H4318/6*	*H4318/7*	*H4318/8*	*H4318/9*	*H4318/10*
Description	Fine Sandy Clay Loam	Medium Clay	Sandy Clay Loam	Medium Clay	Sandy Clay Loam	Medium Clay	Fine Sandy Clay Loam	Medium Clay	Sandy Loam	Medium Clay
Moisture Content (% moisture)	1.3	1.7	0.9	1.4	0.9	1.4	0.8	1.3	0.6	1.6
Lab. Bulk Density (tonne/m3)	1.45	1.40	1.49	1.50	1.61	1.48	1.60	1.39	1.57	1.37
Modified Emerson Aggregate Test (SAR 5 Solution) [note 12]	MEAT Class 3/6, Slake 2[see note 12]	MEAT Class 3/6, Slake 3[see note 12]	MEAT Class 3/6, Slake 1[see note 12]	MEAT Class 3/6, Slake 2[see note 12]	MEAT Class 3/6, Slake 1[see note 12]	MEAT Class 3/6, Slake 3[see note 12]	MEAT Class 3/6, Slake 1[see note 12]	MEAT Class 3/6, Slake 3[see note 12]	MEAT Class 3/6, Slake 1[see note 12]	MEAT Class 3/6, Slake 3[see note 12]
Soil pH (1:5 $CaCl_2$)	4.89	6.68	8.59	5.88	8.50	5.28	8.84	5.65	8.67	5.01
Soil Conductivity (1:5 water dS/m)	0.078	0.856	0.042	0.394	0.043	0.594	0.043	0.636	0.037	0.637
Soil Conductivity (as EC_e dS/m)[note 10]	0.674	7.365	0.358	3.391	0.371	5.112	0.366	5.472	0.321	5.481
Native NaOH Phosphorus (mg/Kg P)	20	8	22	8	27	8	18	6	13	7
Residual phosphorus remaining in solution from the initial phosphate phosphorus										
Initial Phosphorus concentration (ppm P)	**31.8**	**31.8**	**31.8**	**31.8**	**31.8**	**31.8**	**31.8**	**31.8**	**31.8**	**31.8**
72 hour - 3 Day (ppm P)	27.65	30.89	30.58	30.07	28.35	28.04	28.92	27.46	30.61	29.43
120 hour - 5 Day (ppm P)	27.82	29.93	30.35	30.37	27.49	28.48	28.55	28.70	30.31	29.40
168 hour - 7 Day (ppm P)	27.99	30.37	31.38	30.66	26.65	28.91	27.95	29.94	29.26	29.27
Equilibrium Phosphorus (ppm P)	28.20	29.60	31.48	31.03	25.58	29.45	27.42	31.49	28.66	29.20
EXCHANGEABLE CATIONS										
Calcium ($cmol^+$/Kg)	8.42	14.91	3.47	12.34	2.43	9.91	2.60	7.61	1.72	6.86
Magnesium ($cmol^+$/Kg)	2.98	8.01	1.66	9.04	2.10	7.43	1.76	6.12	0.98	7.55
Potassium ($cmol^+$/Kg)	0.17	0.12	0.18	0.11	0.20	0.09	0.18	0.09	0.14	0.10
Sodium ($cmol^+$/Kg)	0.15	6.96	0.11	6.16	0.35	6.55	0.27	5.31	0.13	5.48
Aluminium ($cmol^+$/Kg)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00
Hydrogen ($cmol^+$/Kg)	0.00	0.00	0.00	0.00	0.07	0.00	0.05	0.00	0.04	0.00
ECEC (effective cation exchange capacity)(cmol+/Kg)	11.7	30.0	5.4	27.7	5.2	24.0	4.9	19.1	3.0	20.0
Exchangeable Calcium %	71.8	49.7	64.0	44.6	47.1	41.3	53.4	39.8	56.8	34.3
Exchangeable Magnesium %	25.4	26.7	30.6	32.7	40.8	31.0	36.1	32.0	32.5	37.7
Exchangeable Potassium %	1.5	0.4	3.4	0.4	3.9	0.4	3.8	0.5	4.7	0.5
Exchangeable Sodium % (ESP)	1.3	23.2	1.9	22.3	6.8	27.3	5.5	27.7	4.4	27.4
Exchangeable Aluminium %	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0
Exchangeable Hydrogen %	0.0	0.0	0.0	0.0	1.4	0.0	1.1	0.0	1.5	0.0
Calcium/ Magnesium Ratio	2.83	1.86	2.09	1.36	1.16	1.33	1.48	1.24	1.75	0.91

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Notes:

1: ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al
2: Exchangeable bases determined using standard Ammonium Acetate extract (Method 15D3) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).
3. ppm = mg/Kg dried soil
4. Insitu P determined using 0.1M NaOH and shaking for 24 hrs before determining phosphate
5. Soils were crushed using a ceramic grinding head and mill; five 1g subsamples of each soil were used to which 40ml of 0.1M NaCl with Xppm phosphorus was added to each. The samples were shaken on an orbital shaker
6. Exchangeable sodium percentage (ESP) is calculated as sodium ($cmol^+/Kg$) divided by ECEC
7. All results as dry weight DW - soils were dried at 6OC for 48hrs prior to crushing and analysis.
8. Phosphorus Capacity method from Ryden and Pratt, 1980.
9. Aluminium detection limit is 0.05 $cmol^+/Kg$; Hydrogen detection limit is 0.1 $cmol^+/Kg$. However for calculation purposes a value of 0 is used.
10. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm; EC_e conversions: sand loam 14, loam 9.5; clay loam 8.6; heavy clay 5.8
11. 1 $cmol^+/Kg$ = 1 meq/100g
12. Emerson Aggregate Stability Test (EAST) for Wastewater applications (see Sheet 3 - Patterson, 2015). MEAT Class 1: Slaking, complete dispersion;

Class 2: Slaking, some dispersion; Class 3-6: Slaking 1 slight to 3 complete, No dispersion; Class 7: No slaking, yes swelling; Class 8: No slaking, no swelling.

13. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions. These Terms and Conditions are available on the EAL website: scu.edu.au/eal, or on request.

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PHOSPHORUS SORPTION TRIAL

10 samples supplied by CQ Soil Testing on 25/9/18 - Lab Job No. H4318
Analysis requested by Scott Walton. - Your Project: 18041 AKWQ1309 MEDLI Modelling

Calculations for Equilibrium Absorption Maximum for Soil provided

I.D.	JOB NO.	Equilibrium P mg P/L (in solution)	Added P mg P/L	P Sorb at Equil. mg P/Kg	Native P mg P/Kg	Equilibrium P Sorption Level µg P/g soil	Divide Ø (from Table)	Equilibrium Absorption Maximum (B) µg P/g soil
ODS M1 0.0-0.2m	**H4318/1**	28.20	31.8	144	20.00	164	0.96	**171**
ODS M1 0.2-2.0m	**H4318/2**	29.60	31.8	88	8.40	96	0.97	**100**
ODS M2 0.0-0.2m	**H4318/3**	31.48	31.8	13	22.40	35	0.98	**36**
ODS M2 0.2-2.0m	**H4318/4**	31.03	31.8	31	8.40	39	0.98	**40**
ODS M3 0.0-0.2m	**H4318/5**	25.58	31.8	249	27.20	276	0.94	**294**
ODS M3 0.2-2.0m	**H4318/6**	29.45	31.8	94	8.00	102	0.97	**106**
ODS M4 0.0-0.2m	**H4318/7**	27.42	31.8	175	18.40	194	0.95	**204**
ODS M4 0.2-2.0m	**H4318/8**	31.49	31.8	13	6.40	19	0.98	**19**
ODS M5 0.0-0.2m	**H4318/9**	28.66	31.8	126	12.80	139	0.96	**144**
ODS M5 0.2-2.0m	**H4318/10**	29.20	31.8	104	6.80	111	0.96	**115**

Calculations for phosphorus sorption capacity

	JOB NO.	Equilibrium Absorption Maximum (B) µg P/g soil	multiply by theta of wastewater to be applied (=X)	minus the native P (=Y)	**Kg P sorption / hectare (to a depth of 15cm)** (1.95 is a correction factor for density, etc)	**Kg P sorption / hectare (to a depth of 100cm)** (1.95 is a correction factor for density, etc)
ODS M1 0.0-0.2m	*H4318/1*	171	(=B x theta)	(=X -native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M1 0.2-2.0m	*H4318/2*	100	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M2 0.0-0.2m	*H4318/3*	36	(=B x theta)	(=X -native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M2 0.2-2.0m	*H4318/4*	40	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M3 0.0-0.2m	*H4318/5*	294	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M3 0.2-2.0m	*H4318/6*	106	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M4 0.0-0.2m	*H4318/7*	204	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M4 0.2-2.0m	*H4318/8*	19	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M5 0.0-0.2m	*H4318/9*	144	(=B x theta)	(=X -native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
ODS M5 0.2-2.0m	*H4318/10*	115	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)

EXAMPLE 1 - Calculations for phosphorus sorption capacity using a wastewater phosphorus of 15mg/L P

	JOB NO.	Equilibrium Absorption Maximum (B) µg P/g soil	multiply by theta of wastewater to be applied (ie. 0.84)	minus the native P (=Y)	**Kg P sorption / hectare (to a depth of 15cm)** (1.95 is a correction factor for density, etc)	**Kg P sorption / hectare (to a depth of 100cm)** (1.95 is a correction factor for density, etc)
ODS M1 0.0-0.2m	*H4318/1*	171	144	124	**242**	**1,610**
ODS M1 0.2-2.0m	*H4318/2*	100	84	75	**147**	**978**
ODS M2 0.0-0.2m	*H4318/3*	36	30	8	**15**	**101**
ODS M2 0.2-2.0m	*H4318/4*	40	34	25	**50**	**330**
ODS M3 0.0-0.2m	*H4318/5*	294	247	220	**429**	**2,858**
ODS M3 0.2-2.0m	*H4318/6*	106	89	81	**157**	**1,048**
ODS M4 0.0-0.2m	*H4318/7*	204	171	153	**298**	**1,984**
ODS M4 0.2-2.0m	*H4318/8*	19	16	10	**19**	**128**
ODS M5 0.0-0.2m	*H4318/9*	144	121	108	**211**	**1,409**
ODS M5 0.2-2.0m	*H4318/10*	115	96	90	**175**	**1,166**

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

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Appendix H: Laboratory Test Results - Grain Size Analysis & Soil Analysis Report

GRAIN SIZE ANALYSIS (sieving technique) (Page 1 of 1)

10 soil samples supplied by CQ Soil Testing on 25/9/18. Lab Job No. H4318
Analysis requested by Scott Walton. **Your Reference:18041 AKWQ1309 MEDLI Modelling**
(PO Box 9654 PARK AVENUE QLD 4701)

SAMPLE ID	Lab Code	>2mm Gravel/ Organic Matter	1 - 2mm Very Coarse Sand	500µm - 1mm Coarse Sand	250 - 500µm Medium Sand	125 - 250µm Fine Sand	63 - 125µm Very Fine Sand	<63µm Mud (Silt/Clay)
ODS M1 0.0-0.2m	H4318/1	7%	6%	13%	17%	19%	19%	19%
ODS M1 0.2-2.0m	H4318/2	48%	13%	10%	10%	8%	6%	5%
ODS M2 0.0-0.2m	H4318/3	7%	5%	13%	19%	22%	18%	16%
ODS M2 0.2-2.0m	H4318/4	42%	14%	10%	11%	10%	8%	6%
ODS M3 0.0-0.2m	H4318/5	4%	4%	12%	20%	24%	20%	16%
ODS M3 0.2-2.0m	H4318/6	23%	19%	17%	17%	13%	7%	5%
ODS M4 0.0-0.2m	H4318/7	2%	3%	12%	21%	22%	31%	10%
ODS M4 0.2-2.0m	H4318/8	28%	18%	15%	15%	11%	7%	6%
ODS M5 0.0-0.2m	H4318/9	1%	2%	9%	24%	28%	22%	14%
ODS M5 0.2-2.0m	H4318/10	27%	15%	14%	18%	14%	8%	4%

Note:
1: The Dry and Wet Sieving Analysis method was used for this grain size determination (Method of: Lewis and McConchie, 1994. Analytical Sedimentology. Chapman and Hall, USA.)
2. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions. These Terms and Conditions are available on the EAL website: scu.edu.au/eal, or on request.

checked: .....
Graham Lancaster
Laboratory Manager

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

Environmental Analysis Laboratory

Southern Cross University
PO Box 157 Lismore NSW 2480
P: +61 2 6620 3678
E: eal@scu.edu.au
www.scu.edu.au/eal

ABN: 41 995 651 524

SOIL ANALYSIS REPORT

10 samples supplied by CQ Soil Testing on 25th September, 2018. Lab Job No.H4318

Analysis requested by Scott Walton. Your Job: 18041 AKWQ1309 MEDLI Modelling

PO BOX 9654 PARK AVENUE QLD 4701

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
	Sample ID:	ODS M1 0.0-0.2m	ODS M1 0.2-2.0m	ODS M2 0.0-0.2m	ODS M2 0.2-2.0m	ODS M3 0.0-0.2m	ODS M3 0.2-2.0m	ODS M4 0.0-0.2m	ODS M4 0.2-2.0m	ODS M5 0.0-0.2m	ODS M5 0.2-2.0m
	Crop:	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G	N/G
	Client:	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing	CQ Soil Testing
Parameter	**Method reference**	H4318/1	H4318/2	H4318/3	H4318/4	H4318/5	H4318/6	H4318/7	H4318/8	H4318/9	H4318/10
Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	4.3	0.8	2.5	0.9	2.2	1.2	1.7	0.9	1.0	0.9
Ammonium Nitrogen (mg/kg N)		2.5	0.6	7.7	4.6	9.1	4.6	5.9	4.9	5.7	3.0
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.11	9.39	6.55	9.80	6.27	9.78	6.43	9.65	5.90	9.60
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.078	0.856	0.042	0.394	0.043	0.594	0.043	0.636	0.037	0.637
Chloride (mg/kg)	**Rayment & Lyons 2011 - 5A3a	20	654	74	347	42	559	67	495	81	452
Organic Carbon (%)	**Rayment & Lyons 2011 - 6A1 (Walkley & Black)	1.20	0.16	1.35	0.13	0.80	0.09	0.86	0.09	0.56	0.08
Moisture Content (%)	**Inhouse S2 (105°C)	2.4	8.6	1.9	7.5	1.4	7.6	1.0	7.5	1.4	8.1
Bulk Density (t/m^3)	**AS4419-2003	1.45	1.40	1.49	1.50	1.61	1.48	1.60	1.39	1.57	1.37
Gravimetric Moisture (%)	**Inhouse S2 (105°C)	2.4	9.1	2.0	7.9	1.4	8.0	1.0	7.9	1.4	8.6
Air Dry Moisture Content (%)	**Inhouse S2 (105°C)	1.3	1.7	0.9	1.4	0.9	1.4	0.8	1.3	0.6	1.6

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. ** NATA accreditation does not cover the performance of this service.
4. Analysis conducted between sample arrival date and reporting date.
5. This report is not to be reproduced except in full.
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