To:	Cornelia Wiebels Warrumbungle Shire Council	From:	Clara Laydon Hunter H2O
		Date:	18/03/2019

Subject: Coolah STP Effluent Reuse MEDLI Modelling

1 Introduction

As part of the ongoing investigations into upgrade options for the existing Coolah STP, WSC has engaged Hunter H_2O to undertake reuse modelling using the MEDLI model to review feasibility of achieving a high percent reuse scheme (approximately 100%). The method for varying reuse percent, targeting 100%, was to run MEDLI using the inbuilt multi-run feature of the model to create a multi layered scenario, which changes *both* the land area and pond storage volume and determines varying reuse percent rates in an attempt to find the reuse target.

2 MEDLI Model

MEDLI is a computer model for designing and analysing effluent disposal enterprises for intensive rural industries, agri-businesses and sewage treatment plants using land irrigation. MEDLI was developed jointly by the CRC for Waste Management and Pollution Control, Queensland Department of Natural Resources and the Queensland Department of Primary Industries. MEDLI is a model recognised by the Department of Environmental Protection and Heritage and DERM.
MEDLI uses daily time series climate data (rainfall, temperature, Class A pan evaporation and solar radiation) and simulates crop growth and yield for estimating crop water and nutrient requirements. MEDLI uses incipient rainfall, free surface evaporation and seepage from storage ponds to predict pond water levels to predict periods of undersupply (no irrigation) and over supply (environmental discharge).

2.1.1 Model Inputs

To establish the model the following key inputs were used to asses reuse percent. The details on the MEDLI inputs can be found in the supporting MEDLI reports in Appendix A. However the following has been noted:

- Climate – Coolah (-31.8°; 149.7°) sourced from SILO/long paddock (https://legacy.longpaddock.qld.gov.au/silo/).
  The data is based on historical (59 years) of climate records and it should be noted that there is a level of uncertainty using historical weather data due to changing climate conditions.
- Soil type – two soil types were modelled to provide an additional level of sensitivity.
  - Medium Permeability Red Brown Earth as defined by the NSW Soil Condition Report for the Central West 2010; 2015
    https://archive.lls.nsw.gov.au/__data/assets/pdf_file/0009/495891/archive-soil-condition-central-west-region.pdf
    (Coolah Region defined as Ballimore-Curban Red Soil; Red Chromosols and Sodosols)
  - Krasnozem (Red Ferrosol)
- Crop – two crops were also modelled to provide sensitivity, both were pastures of:
  - Ryegrass
  - Kikuyu
- Wastewater with an annual dry weather volume of 73.79 ML and an average wet weather infiltration level.
- As this reuse assessment is to determine the reuse feasibility of a 'low technology' treatment option the effluent quality has been set in the model as
  - Total Nitrogen (mg/L): 40
  - Total Phosphorus (mg/L): 10
  - Total Dissolved Solids (mg/L): 400

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2.1.2 Model Runs

A full run was undertaken using the MEDLI software to provide a baseline of the existing lagoon volumes (approximately 20 ML and an irrigation area of 8.5 Ha). Following which a Multi run was undertaken which allows for an incremental increase in pond volume and land area. The Muti-run increments were:

- Land Area – 8.5 Ha to 50 Ha; increments of 5 Ha
- Volume – 20 ML to 70 ML; increments of 5ML

The multi run was undertaken for the two soil types and two crop types, total of four scenarios.

2.1.3 Model Outputs

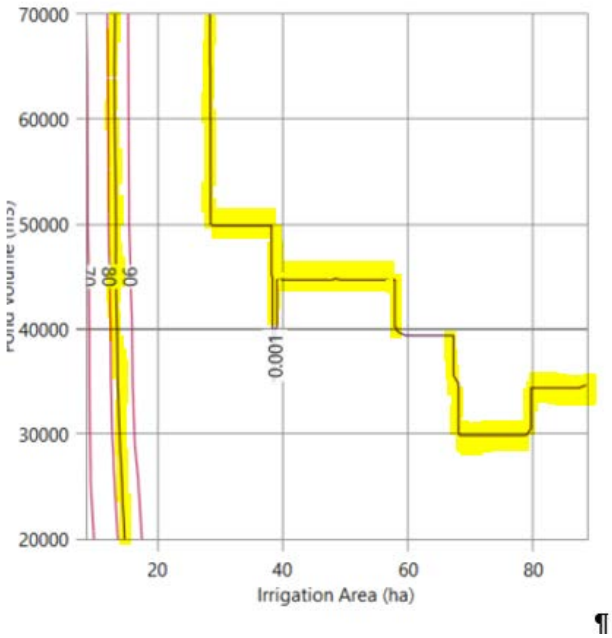
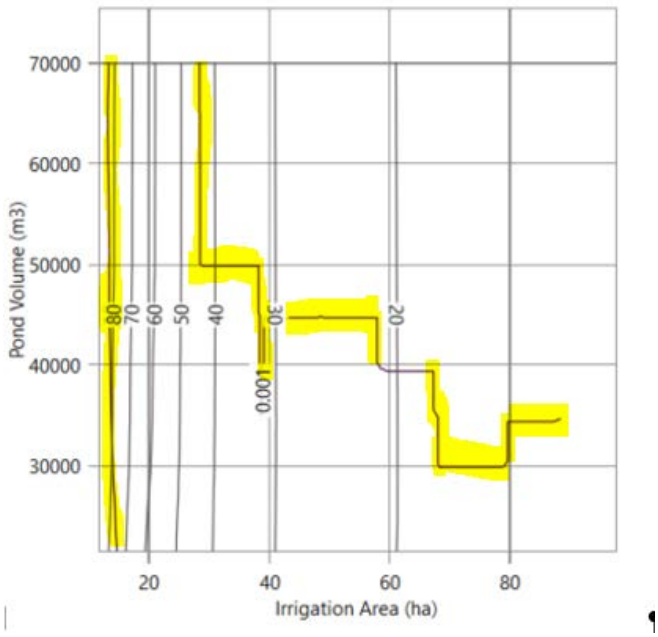
The key outputs from the MEDLI multi-run is a set of data and curves which show the impact of volume and land area have on reuse percent, overflows (>1mm) per year and irrigation demand supplied percent (as an indication of crop water stress).

The percent reuse and irrigation demand *both* need to be taken in as a balanced consideration. In most cases a high reuse percent can be achieved if land areas are substantial enough, however, in practice, this can become unfeasible due to crop water stress and in extreme plant death under summer conditions when there is insufficient reuse water to maintain crop growth over significant land areas.

3 MEDLI Model Results

Under the four scenarios the curves generated show the reuse percent, overflows per year (more than 1mm) and irrigation demand supplied as the storage and land area increase. This is summarised in Table 3-1 on the following page.

Table 3-1: MEDLI Multi-run Output Curves

High Permeability Red Brown Earth with Kikuyu	
	
Irrigation Reuse Percent (RED Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)	Irrigation Demand Percent (BLACK Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)

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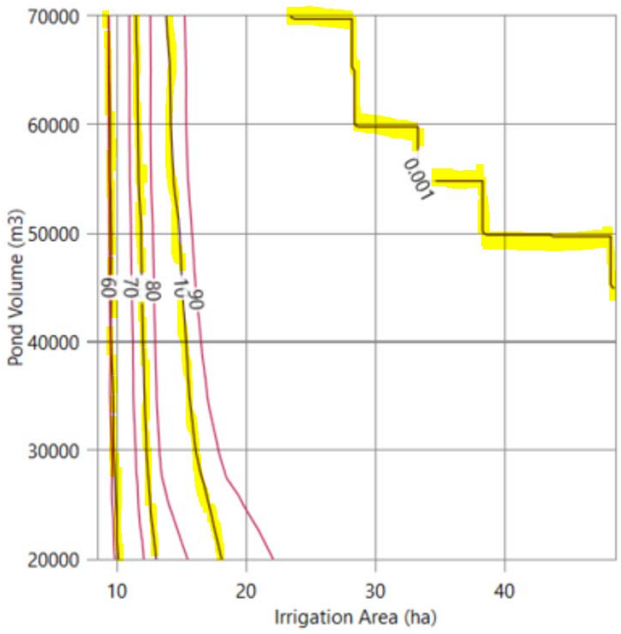
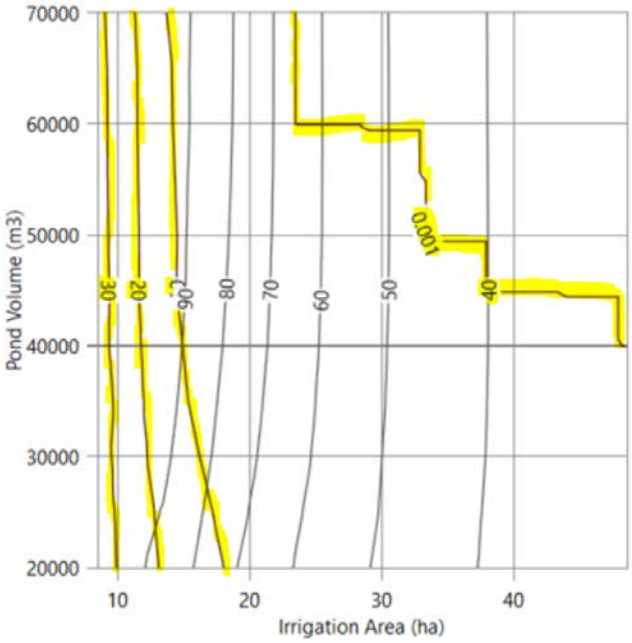
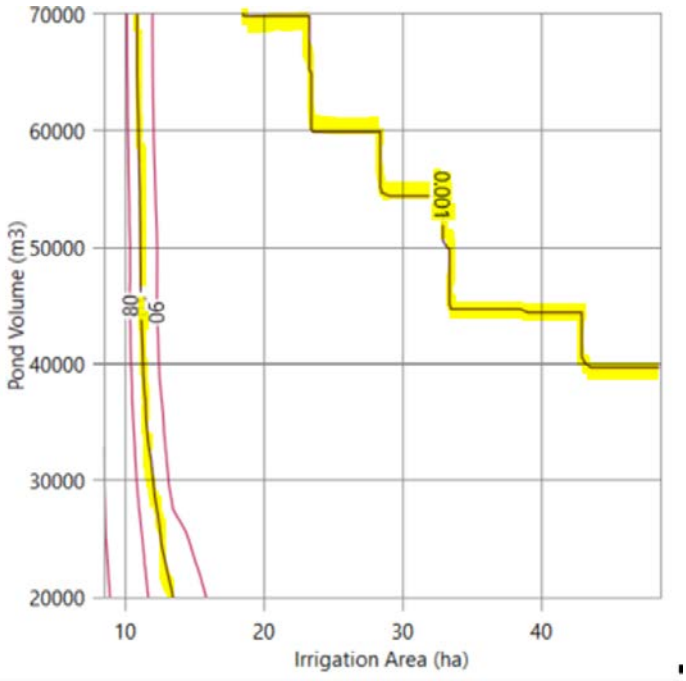
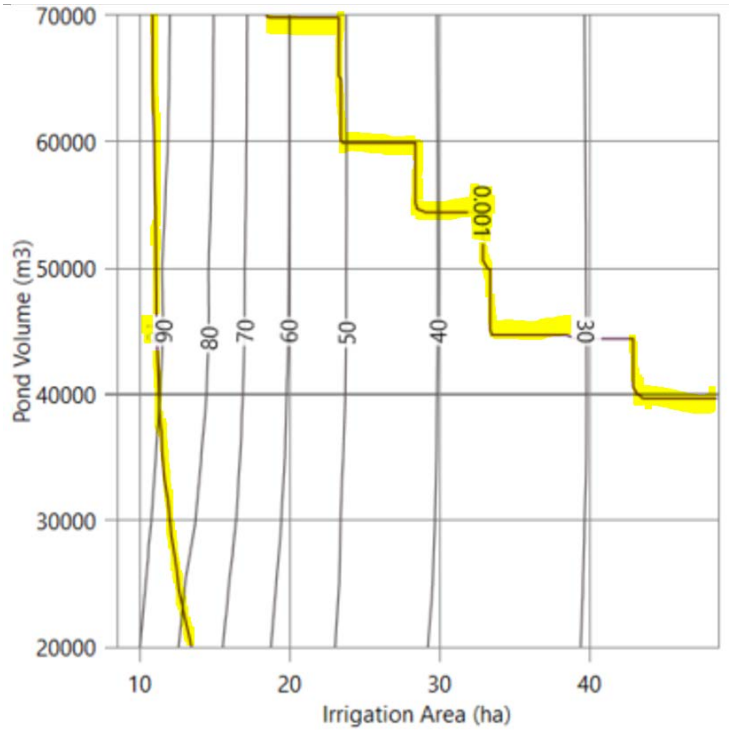
High Permeability Red Brown Earth with Ryegrass	
 Irrigation Reuse Percent (RED Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)	 Irrigation Demand Percent (BLACK Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)
Krasnozem Soil with Kikuyu	
 Irrigation Reuse Percent (RED Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines Lines)	 Irrigation Demand Percent (BLACK Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)

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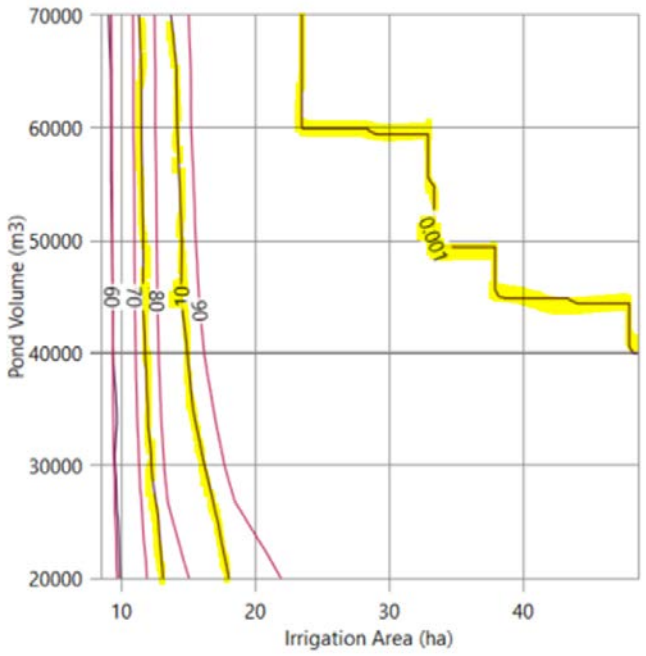
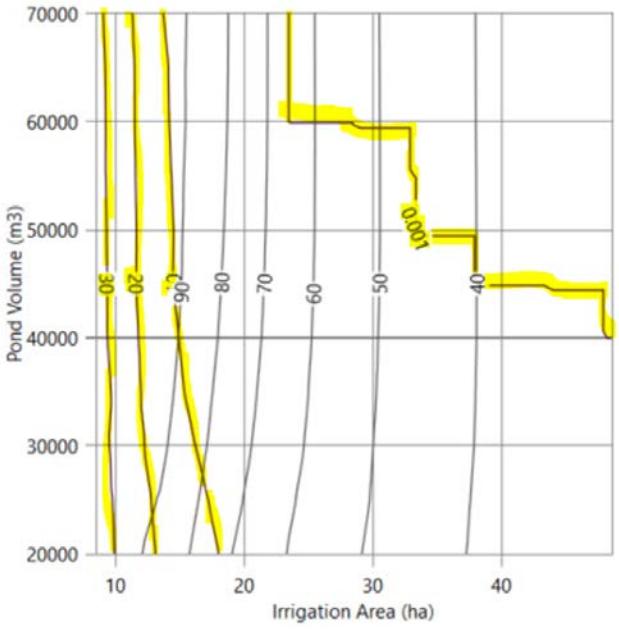
Krasnozem Soil with Ryegrass	
 Irrigation Reuse Percent (RED Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)	 Irrigation Demand Percent (BLACK Lines) and Number Overflows (>1mm) per year (Highlighted YELLOW Lines)

The output curves show a flat profile of reuse percent against the Pond Volume, with the flattening most apparent above a pond volume of 30 ML. This indicates that significant increases in pond volume make less of an impact on reuse percent against an increase in land area.

As a result the reuse curves for the starting pond volume of 20 ML and 30 ML at different land areas have been examined in more detail as shown in Table 3-2, on the following page.

As can be seen in Table 3-2 once the storage increases to 30ML the land area required to achieve an approximately 100% reuse is approximately 40 Ha. In reviewing the curves at the 30ML and 40Ha as shown in Table 3-1 the irrigation demand is meet between 30 and 40% of the time.

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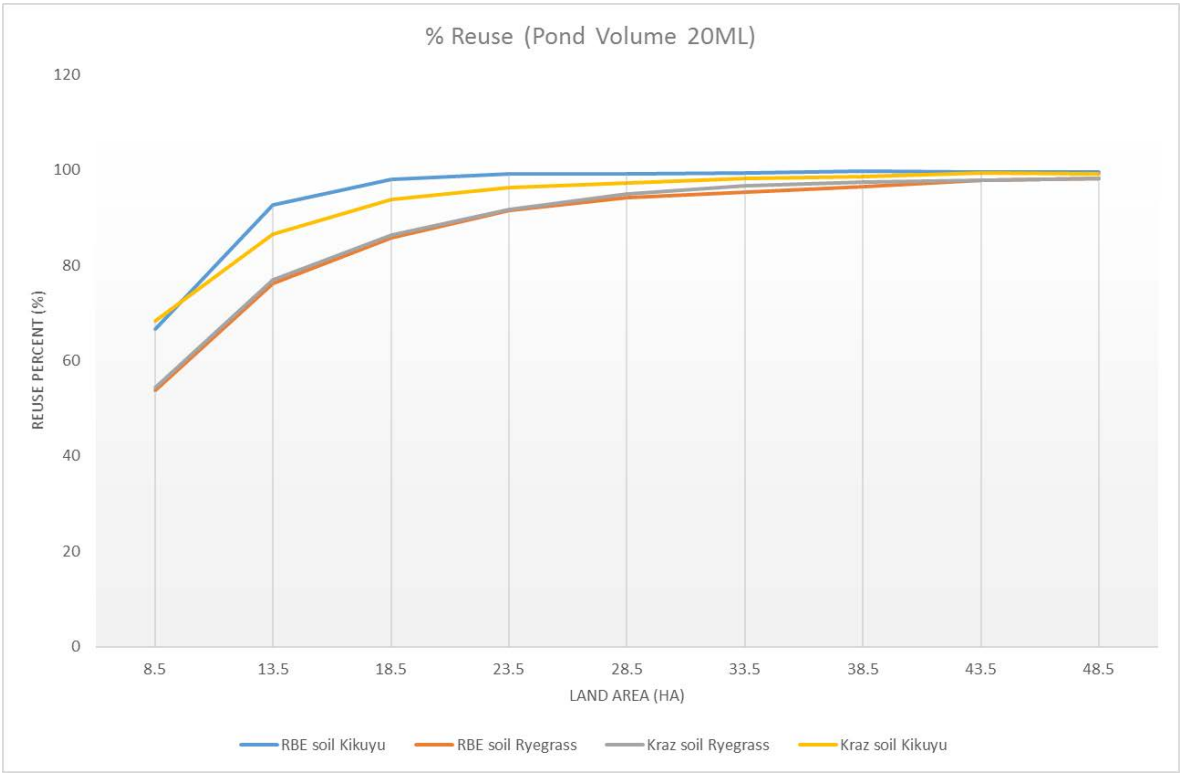
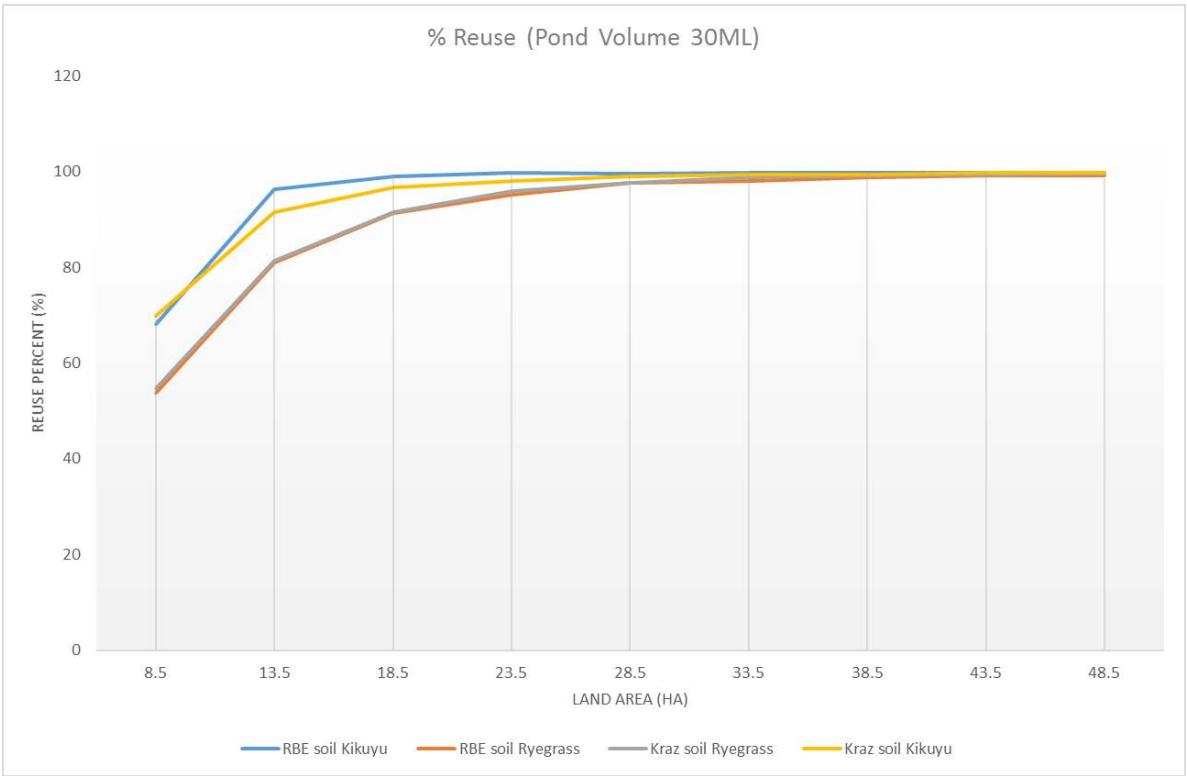
Table 3-2: Reuse Percent at 20ML and 30ML Storages

Pond Volume at 20 ML

Pond Volume at 30 ML


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Reviewing the key outputs from the multi-run a full run was then undertaken on Ryegrass with an irrigation area of 43.5 Ha and a storage volume of 30 ML with Medium Permeability Red Brown Earth.

The full run output report is provided in Appendix A.

As noted in the output run report:

- The reuse percent is 99.15%
- Volume of overflow 505 kL/year
- Number of days ponds overflow 2.44days/year
- Probability of at least 90% reuse 97.88%
- Irrigation runoff 0%
- Nitrogen Leached 0.55 kg/Ha/yr
- Phosphorus Leached 0.26 kg/Ha/yr
- Nitrogen stress levels would require additional ammonia based fertiliser to support crop growth

As a result a high level reuse percent is feasible if an irrigable land area of approximately 40 - 45 Ha can be sourced and a dedicated effluent reuse storage of 30ML or higher can be constructed. However overtopping events would still occur each year and establishing a reuse target of ~100% would become difficult, however based on the outputs of the MEDLI model achieving a reuse target of greater than 90%, would be probably 98% of years.

As it has been noted that while a high level of reuse has been determined using this model, there is a level of uncertainty regarding future climate conditions.

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Appendix A – MEDLI Full Run Sheet

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MEDLI REPORT - FULL RUN

Enterprise: **Coolah STP with Multirun with 30000.00 m3 storage pond volume and 43.50 ha irrigation area**

Description:
100% reuse target

Client: **WSC**

MEDLI User: C.Laydon

Scenario Details:
Trying different pond volumes and irrigation areas (using multirun)

DESCRIPTION

Climate Data: Coolah, -31.8°, 149.7°

Run Period: 01/01/1960 to 31/12/2018 59 years, 0 days

Climate Statistics:

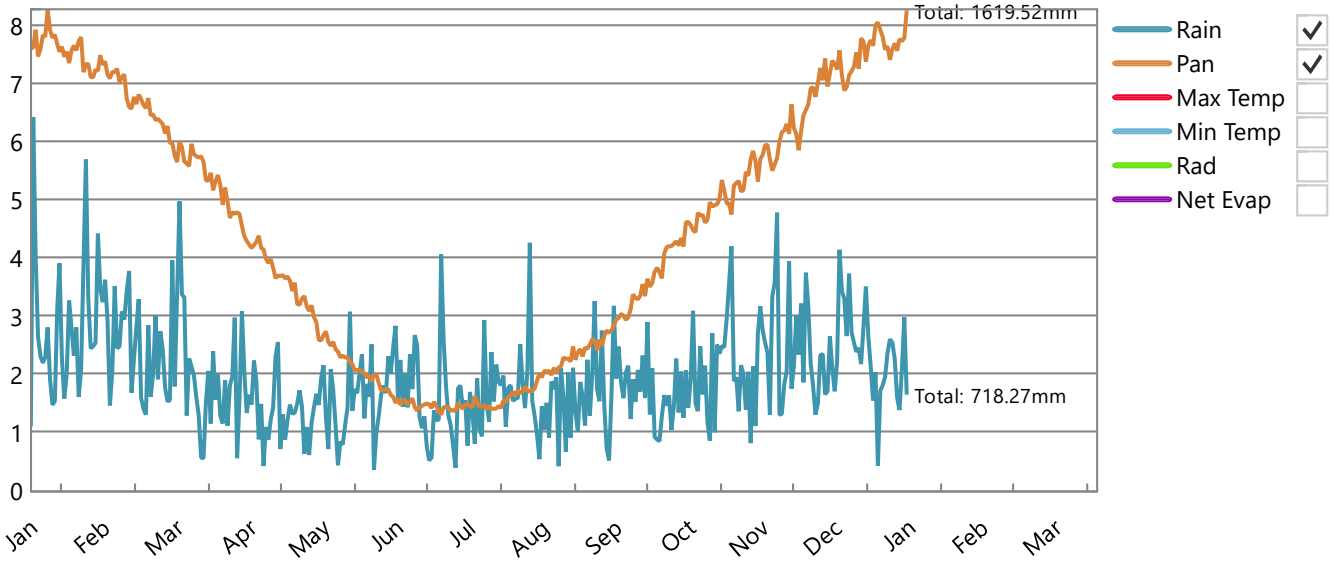
	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	438	696	987
Pan Evaporation (mm/year)	1402	1625	1860

Climate Data:

Chart Table

Monthly Daily

Daily Average Across Run Period

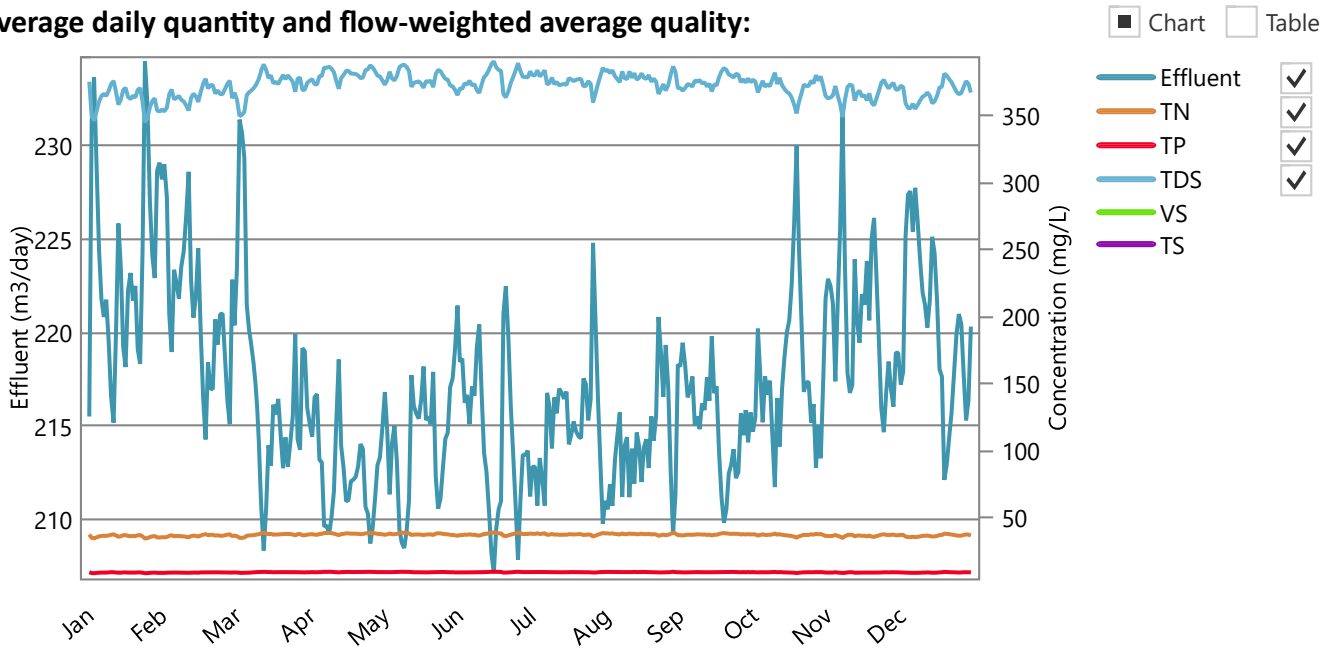


DESCRIPTION

Effluent type: Municipal STP Demo Waste Stream

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 79350.93 m3/year or 217.25 m3/day (Min-Max: 202.03 - 664.57)

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

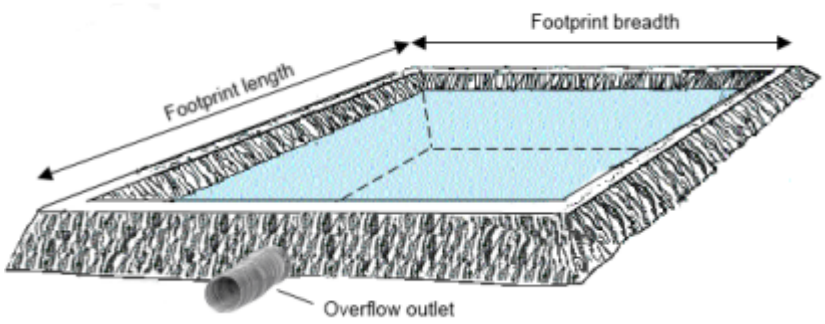
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	37.20 (12.16 - 40.00)	2951.72 (2949.67 - 2957.75)
Total Phosphorus	9.30 (3.04 - 10.00)	737.93 (737.42 - 739.44)
Total Dissolved Salts	371.98 (121.60 - 400.00)	29517.22 (29496.67 - 29577.48)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

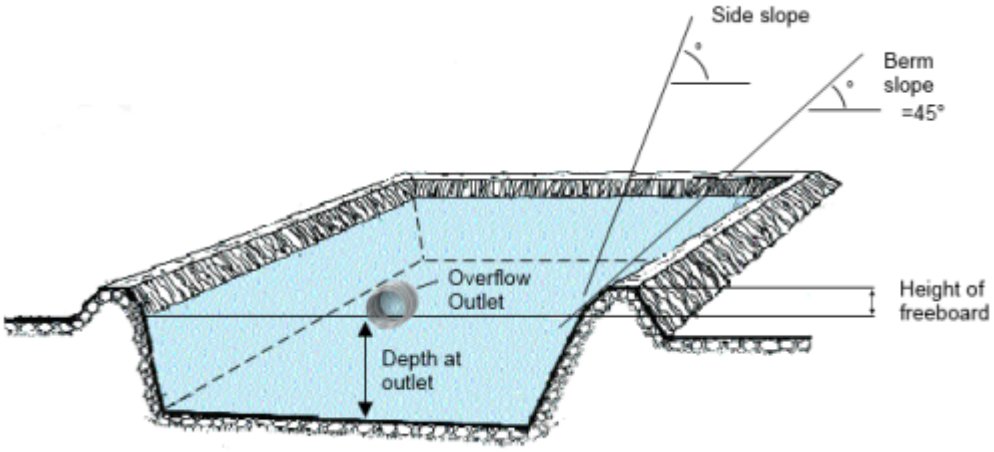
DESCRIPTION

Pond system: 3 facultative, aerobic or storage ponds

Pond system details:

	Pond 1	Pond 2	Pond 3
Maximum pond volume (m3)	7200.00	7200.00	30000.00
Minimum allowable pond volume (m3)	0.00	7200.00	14460.08
Pond depth at overflow outlet (m)	2.00	2.00	2.00
Maximum water surface area (m2)	4107.87	4107.87	16091.27
Pond footprint length (m)	66.09	64.09	179.39
Pond footprint width (m)	66.09	64.09	89.70
Pond catchment area (m2)	4368.24	4107.87	16091.27
Average active volume (m3)	7194.27	7183.09	16321.93





Irrigation pump limits:

Minimum pump rate limit (ML/day)	0.00
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

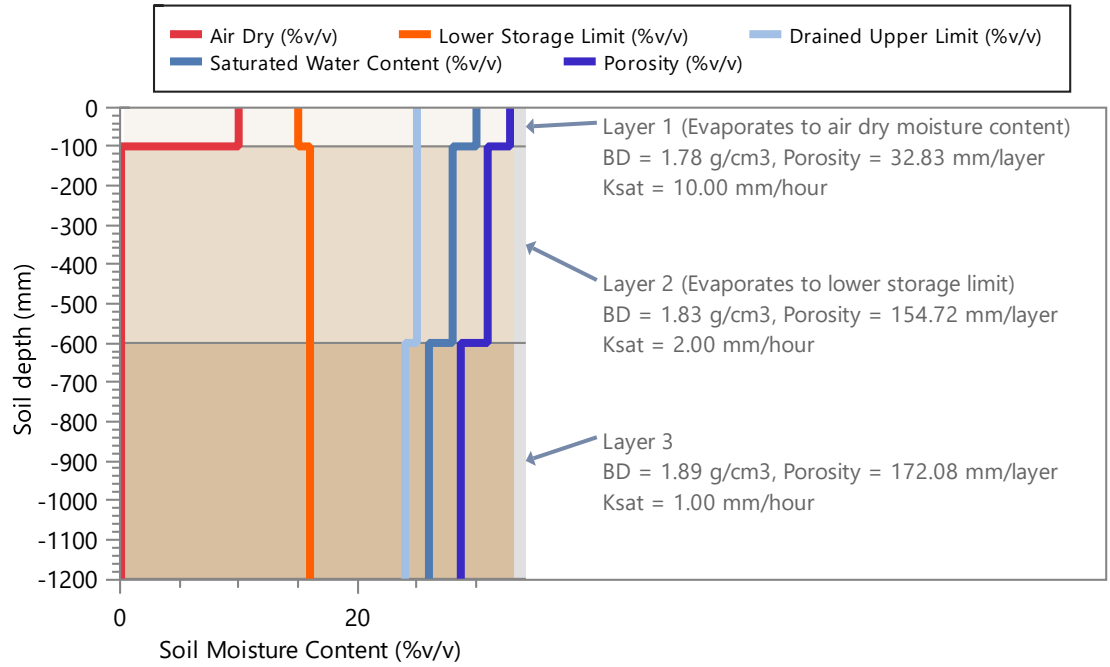
DESCRIPTION

Land: Default Paddock

Area (ha): 43.50

Soil Type: Medium Permeability Red Brown Ea, 1200.00 mm defined profile depth

Profile Porosity (mm)	359.62
Profile saturation water content (mm)	326.00
Profile drained upper limit (or field capacity) (mm)	294.00
Profile lower storage limit (or permanent wilting point) (mm)	191.00
Profile available water capacity (mm)	103.00
Profile limiting saturated hydraulic conductivity (mm/hour)	1.00
Surface saturated hydraulic conductivity (mm/hour)	10.00
Runoff curve number II (coefficient)	80.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Ryegrass 1 Pasture

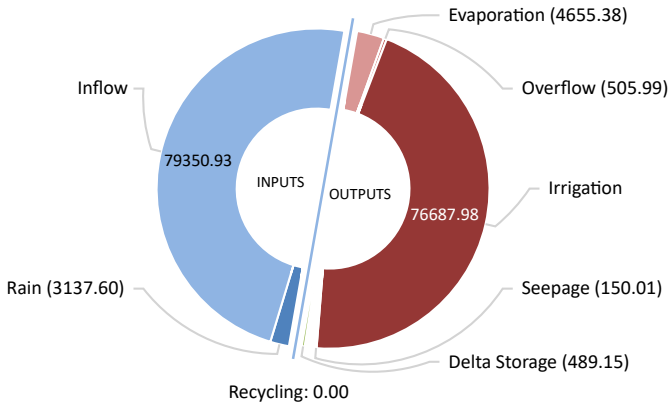
Average monthly cover (%) (minimum - maximum)	63.61 (61.01 - 65.20)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 0.8)	0.64
Total plant cover (both green and dead) left after harvest (%)	97.00
Maximum potential root depth in defined soil profile (mm)	600.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	5.60
Proportion of yield decrease per dS/m increase (%/dS/m)	7.60

PERFORMANCE

Pond System Water Performance - Overflow: 3 facultative, aerobic or storage ponds

Capacity of wet weather storage pond: **30000 m3**

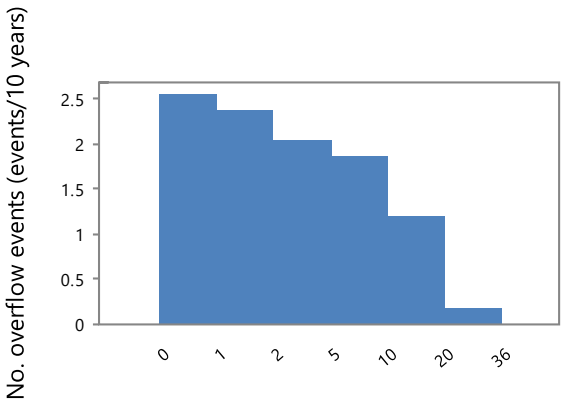
Pond System Water Balance (m3/year)



Name	Value
Rain	3137.60
Inflow	79350.93
Recycling	0.00
Evaporation	4655.38
Overflow	505.99
Irrigation	76687.98
Seepage	150.01
Delta Storage	489.15

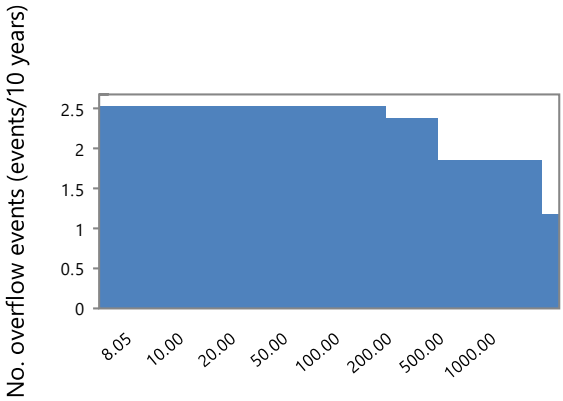
Overflow Diagnostics

Volume of overflow (m3/year)	505.99
No. days pond overflows (days/year)	2.44
Average duration of overflow (days)	9.60
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (%)	99.15
Probability of at least 90% reuse (%)	97.88



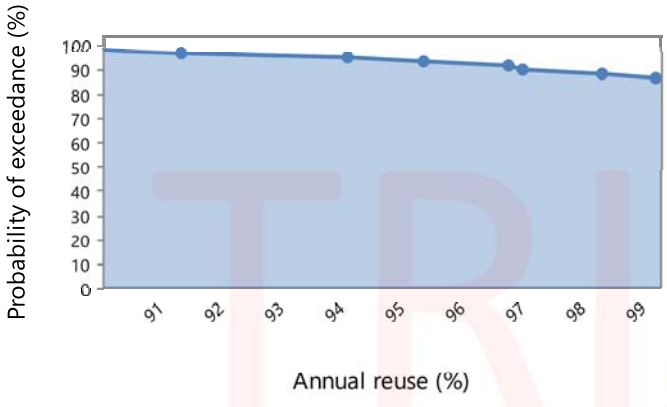
Overflow event duration exceeded (days)

Export plot



Overflow volume exceeded (m3)

Export plot



Annual reuse (%)

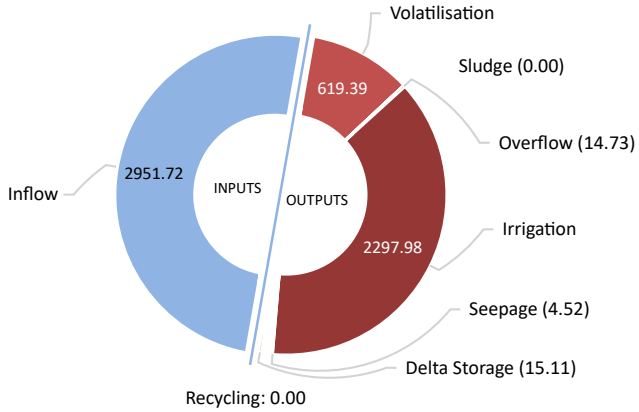
Export plot

PERFORMANCE

Pond System Performance - Nutrient: 3 facultative, aerobic or storage ponds

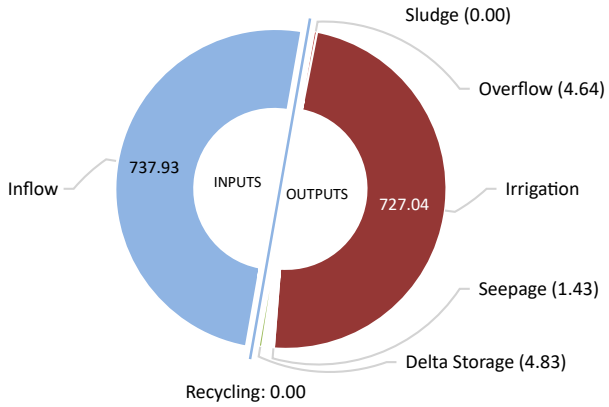
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



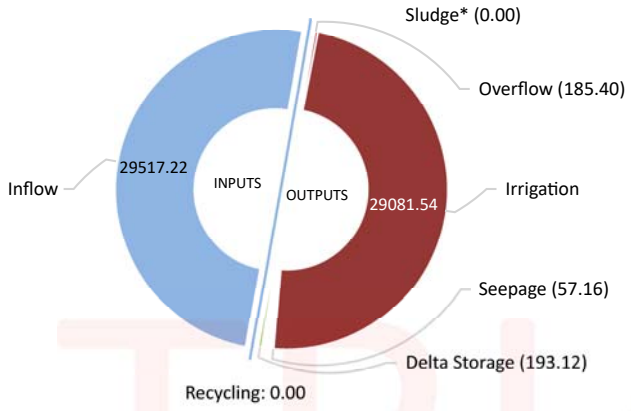
Name	Value
Inflow	2951.72
Recycling	0.00
Volatilisation	619.39
Sludge	0.00
Overflow	14.73
Irrigation	2297.98
Seepage	4.52
Delta Storage	15.11

Phosphorus Balance (kg/year)



Name	Value
Inflow	737.93
Recycling	0.00
Sludge	0.00
Overflow	4.64
Irrigation	727.04
Seepage	1.43
Delta Storage	4.83

Salt Balance (kg/year)



Name	Value
Inflow	29517.22
Recycling	0.00
Sludge*	0.00
Overflow	185.40
Irrigation	29081.54
Seepage	57.16
Delta Storage	193.12

* 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: 3 facultative, aerobic or storage ponds

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1	Pond 2	Pond 3
Average nitrogen concentration of pond liquid (mg/L)	29.87	29.98	29.98
Average phosphorus concentration of pond liquid (mg/L)	9.53	9.49	9.49
Average salinity of pond liquid (dS/m)	0.60	0.59	0.59

Value on final day of simulation period	Pond 1	Pond 2	Pond 3
Final nitrogen concentration of pond liquid (mg/L)	30.80	30.63	31.06
Final phosphorus concentration of pond liquid (mg/L)	9.87	9.77	9.92
Final salinity of pond liquid (dS/m)	0.62	0.61	0.62

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	76687.98
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	76687.98
Proportion of irrigation events requiring shandying (% of events)	0.00
Proportion of years shandying water allocation of 0 m3/year is exceeded (% of years)	0.00
Average exceedance as a proportion of annual shandy water allocation (% 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)	29.97
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	26.37
Average phosphorus concentration of irrigation water (mg/L)	9.48
Average salinity of irrigation water (dS/m)	0.59

Irrigation Diagnostics:

Proportion of Days rain prevents irrigation (%)	26.62
Proportion of Days water demand too small to trigger irrigation (%)	18.97
Proportion of Days pond volume below min. vol. for irrigation (%)	0.39
Proportion of Days irrigation occurs (%)	54.02

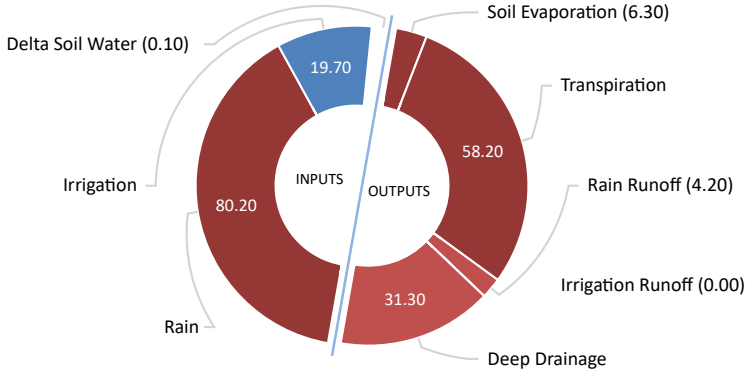
PERFORMANCE

Land Performance - Soil Water

Paddock: Default Paddock, 43.5 ha
Soil Type: Medium Permeability Red Brown Ea, 55.00 mm PAWC at maximum root depth

Land Water Balance (%):

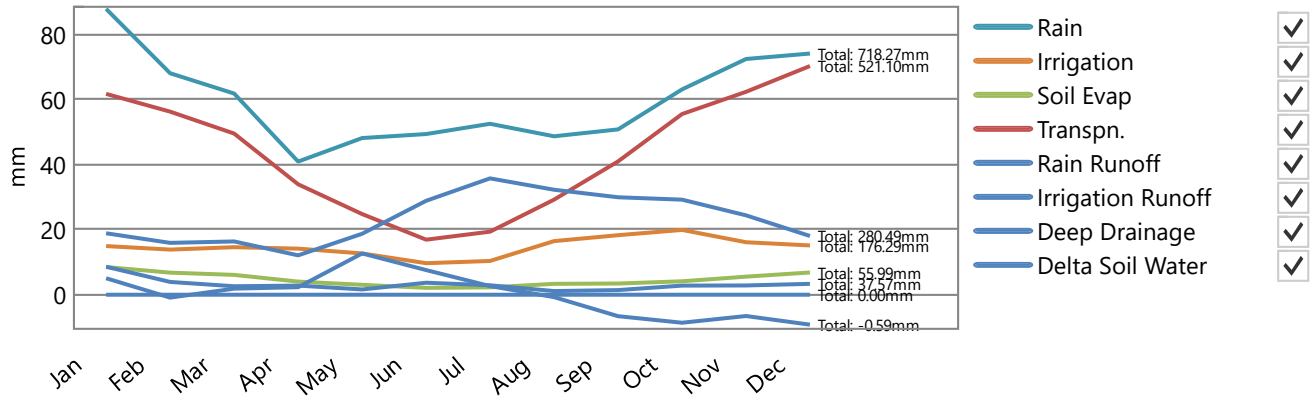
mm/year ■ % Total inputs



Name	Value
Rain	80.20
Irrigation	19.70
Soil Evaporation	6.30
Transpiration	58.20
Rain Runoff	4.20
Irrigation Runoff	0.00
Deep Drainage	31.30
Delta Soil Water	-0.10

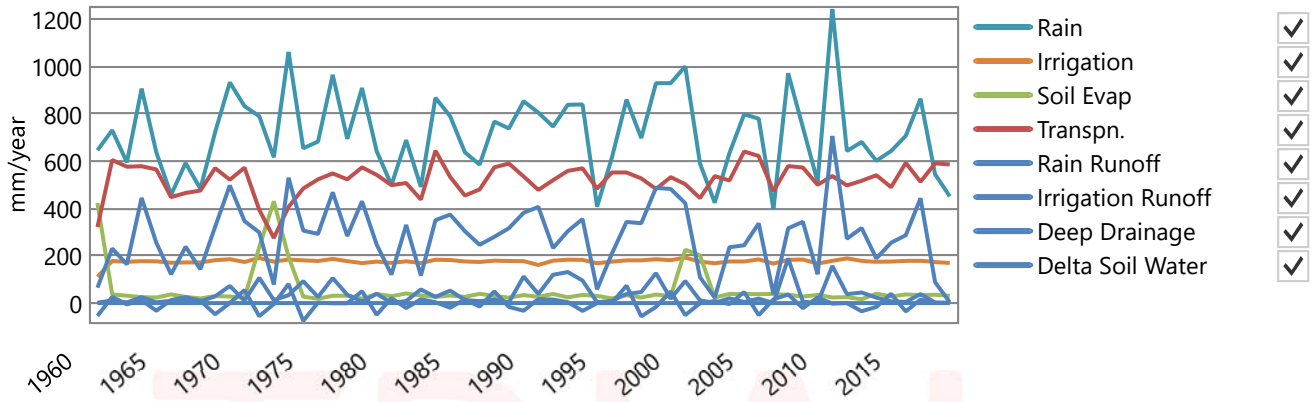
Average Monthly Totals (mm):

■ Chart ☐ Table



Average Annual Totals (mm/year):

■ Chart ☐ Table



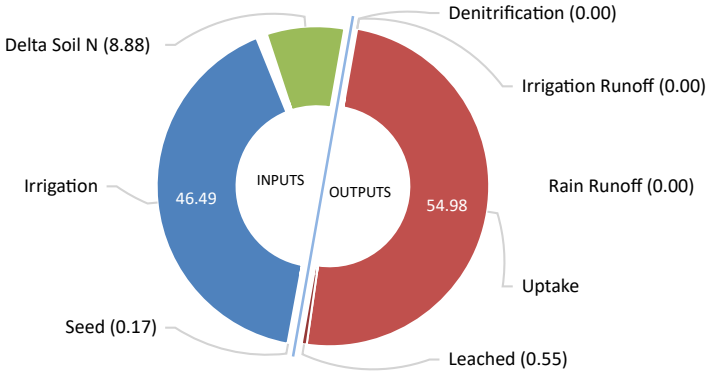
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Default Paddock, 43.5 ha **Soil Type**: Medium Permeability Red Brown Ea

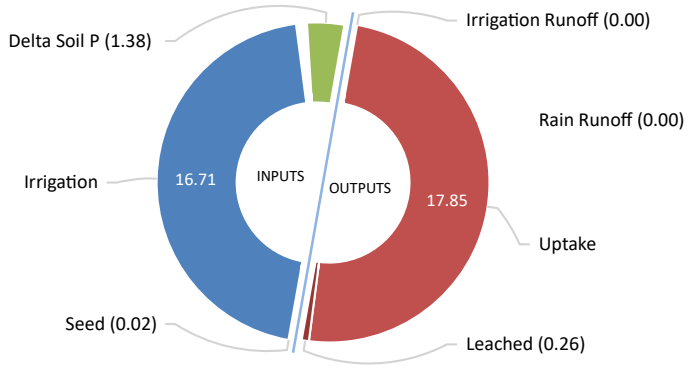
Irrigation ammonium volatilisation losses (kg/ha/year): 6.34
Proportion of total nitrogen in irrigated effluent as ammonium (%): 40.00

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.17
Irrigation	46.49
Denitrification	7.58E-04
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	54.98
Leached	0.55
Delta Soil N	-8.88

Land Phosphorus Balance (kg/ha/year)



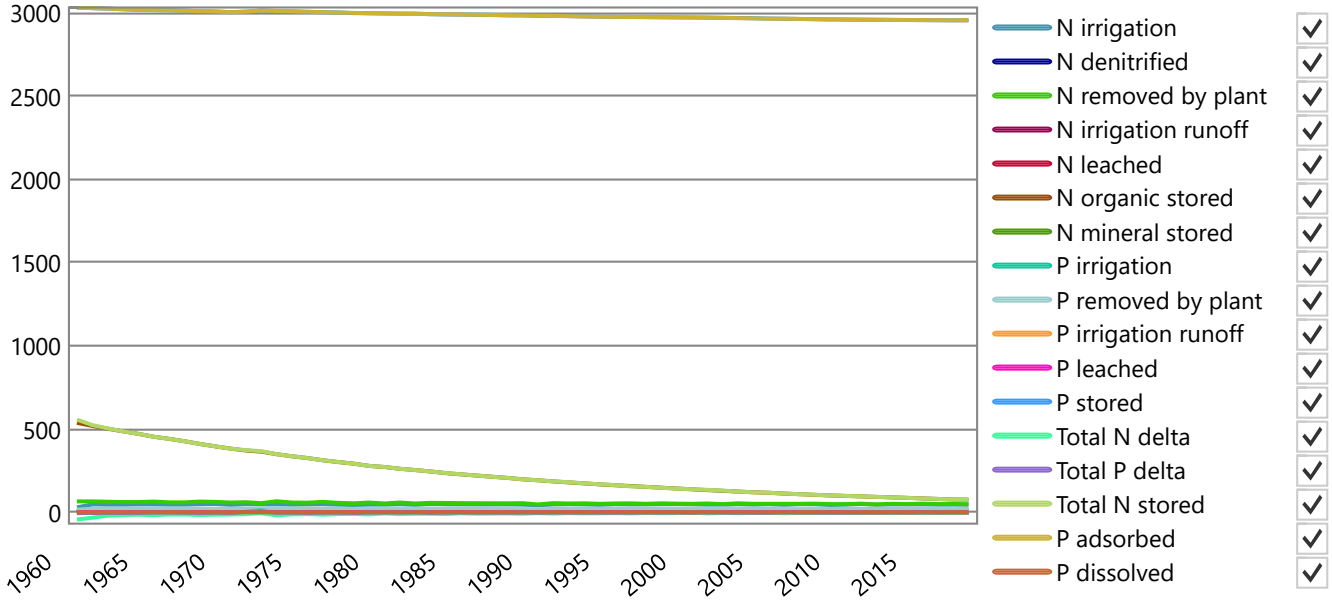
Name	Value
Seed	0.02
Irrigation	16.71
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	17.85
Leached	0.26
Delta Soil P	-1.38

PERFORMANCE

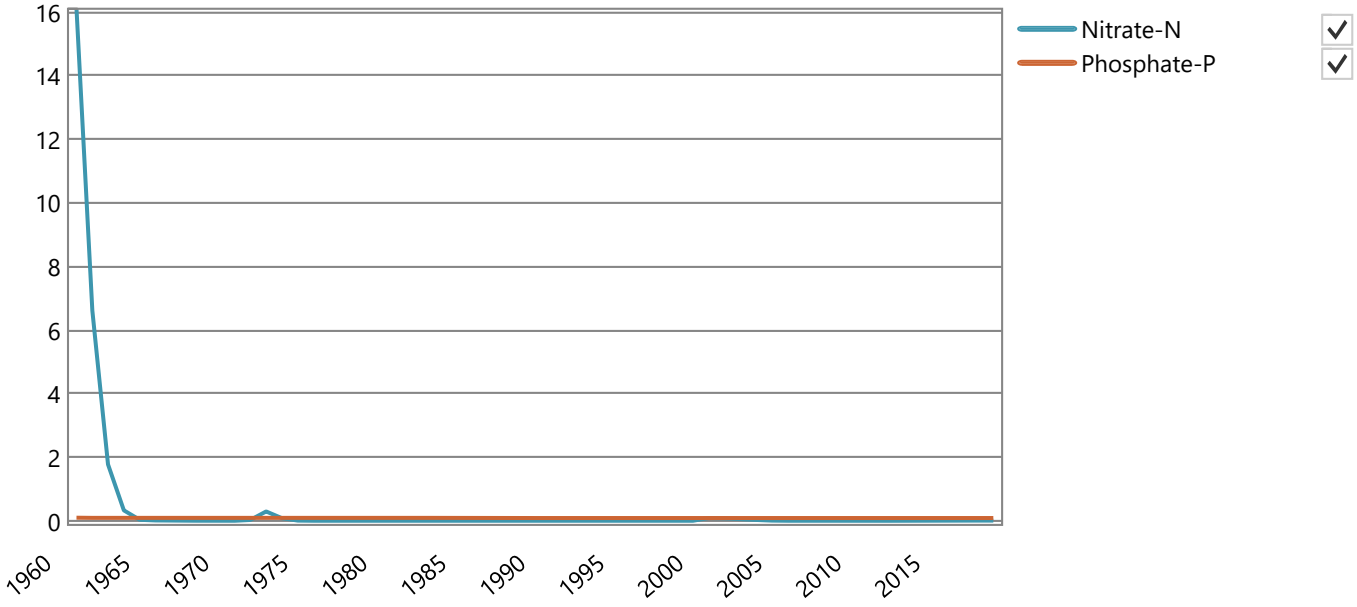
Land Performance - Soil Nutrient

Paddock: Default Paddock, 43.5 ha **Soil Type**: Medium Permeability Red Brown Ea

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Default Paddock, 43.5 ha **Soil Type**: Medium Permeability Red Brown Ea

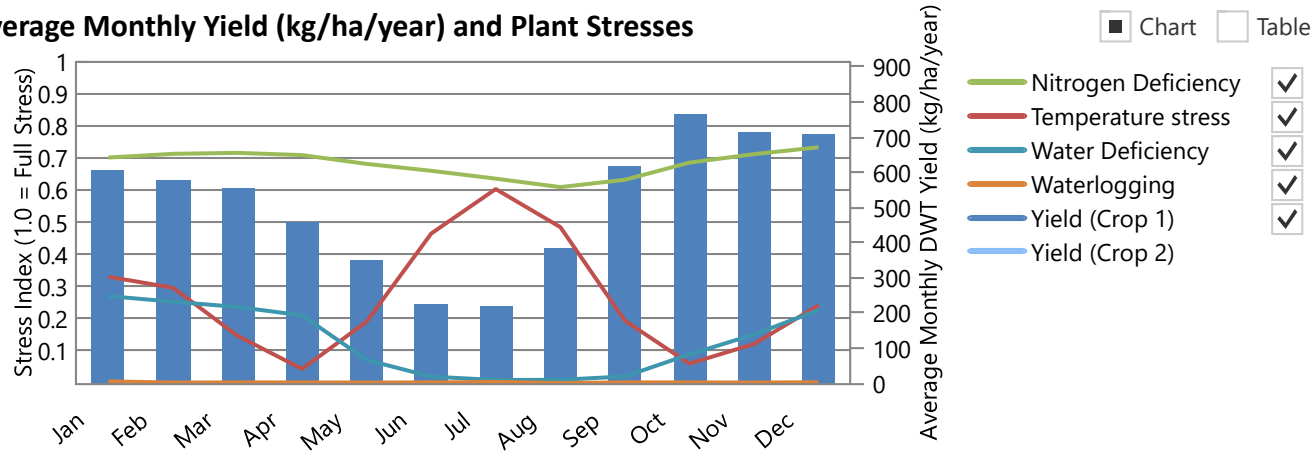
Plant: Continuous Ryegrass 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	6196.23 (5312.83 - 7073.52)
Average monthly plant (green) cover (%) (minimum - maximum)	63.61 (61.01 - 65.20)
Average monthly root depth (mm) (minimum - maximum)	577.56 (569.12 - 588.24)

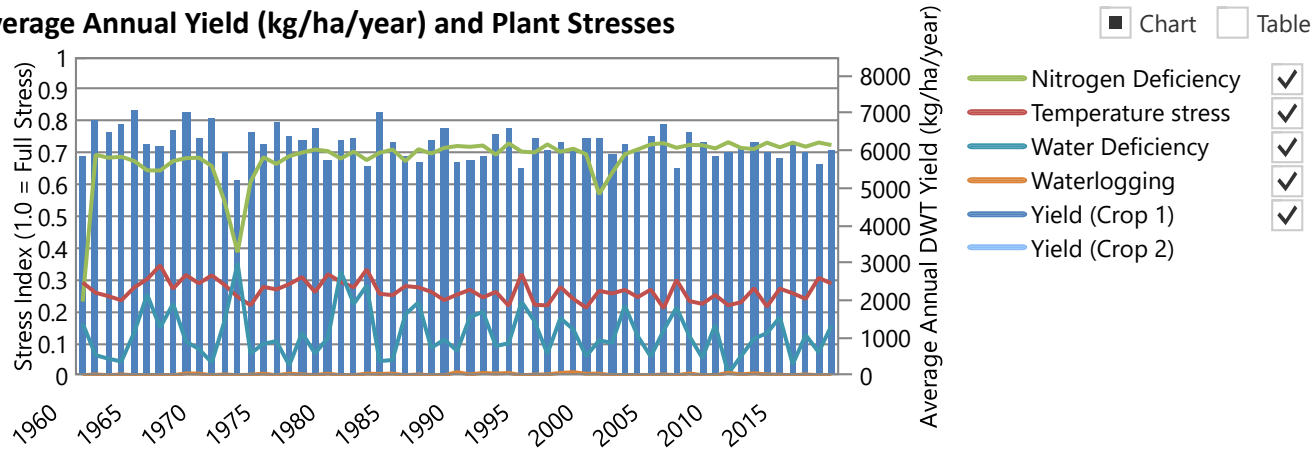
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	54.98 (47.01 - 66.24)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	17.85 (10.39 - 20.66)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.002 - 0.003)

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



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



No. of harvests/year: 1.54 (normal), 0.17 (forced by crop death due to frosting (0.03), water stress (0.14))
No. days without crop/year (days/year): 2.78 due to frosting (0.54), water stress (2.24)

PERFORMANCE

Land Performance

Paddock: Default Paddock, 43.5 ha **Soil Type**: Medium Permeability Red Brown Ea

Plant: Continuous Ryegrass 1 Pasture

Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	5.60
Proportion of yield decrease per dS/m increase (%/dS/m)	7.60
No. years assumed for leaching to reach steady-state (years)	10.00

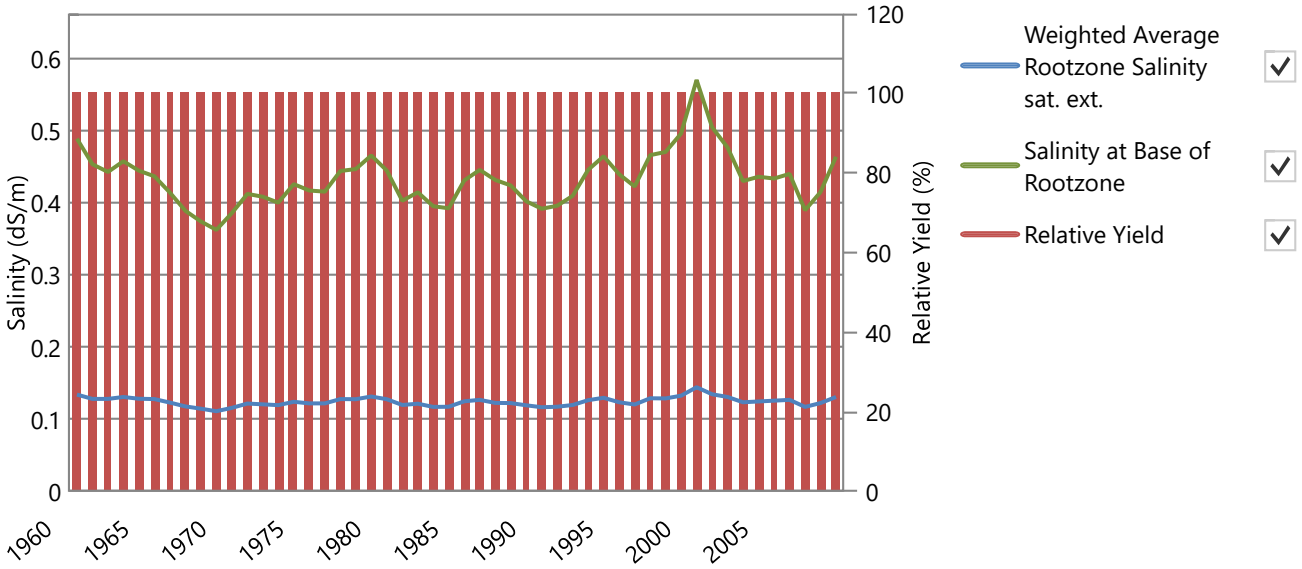
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.15
Salt added by rainfall (kg/ha/year)	130.70
Average annual effluent salt added & leached at steady state (kg/ha/year)	799.24
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.12
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.43
Relative crop yield expected due to salinity (%)	100.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (%)	0.00

Average Annual Rootzone Salinity and Relative Yield:

Chart Table

All values based on 10 year running averages



PERFORMANCE

Groundwater

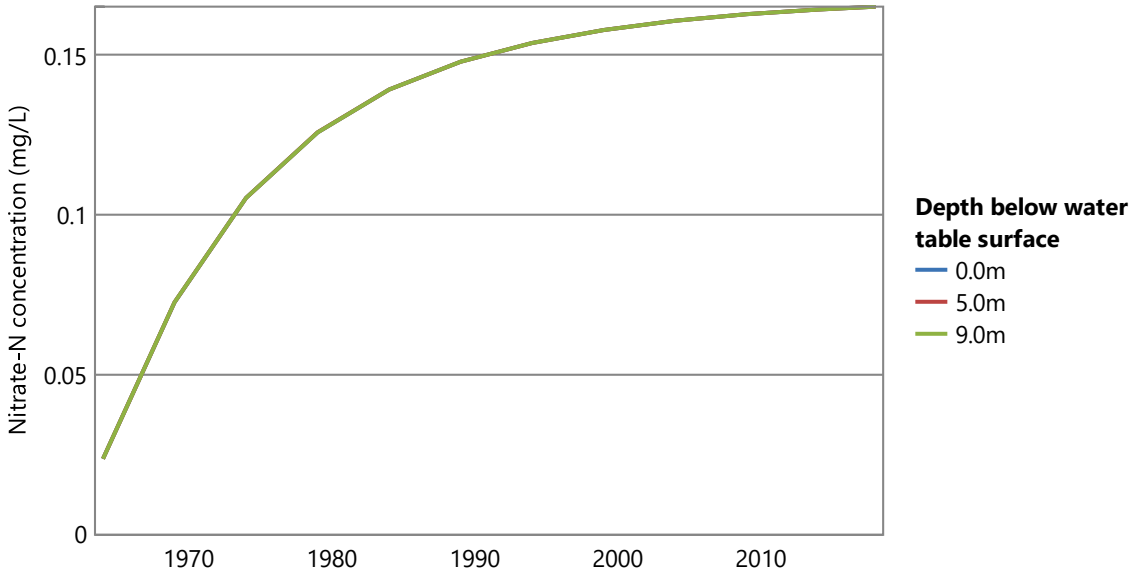
Recharge:
Average groundwater recharge (m3/day): 334.05
Average nitrate-N concentration of recharge (mg/L): 0.20

Aquifer characteristics:

Thickness (m)	10.0
Porosity (%)	10.0
Specific flux (mm/hour)	0.4
Vertical dispersion coefficient (m2/day)	0.1
Longitudinal dispersion coefficient (m2/day)	100.0
Retardation factor due to adsorption (multiplier)	1.0

Groundwater Nitrate-N concentration (mg/L) at property boundary, 1200 m from effluent irrigation area:

Chart Table



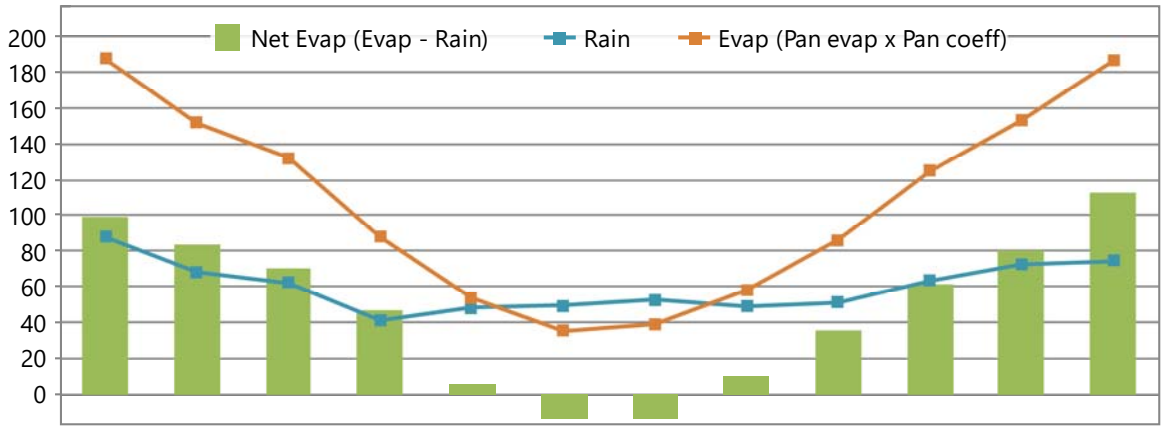
DIAGNOSTICS

Sustainability Diagnostics: Coolah STP with Multirun

Averaged Historical Climate Data Used in Simulation (mm)

Location: Coolah, -31.8°, 149.7°

Run Period: 01/01/1960 to 31/12/2018 59 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	87.9	68.1	61.8	41.0	48.2	49.4	52.5	48.7	50.8	63.1	72.5	74.2	718.3
Evap	187.5	151.6	132.4	87.9	53.5	35.0	38.9	57.9	86.5	124.7	153.1	186.6	1295.6
Net Evap	99.6	83.5	70.6	47.0	5.3	-14.4	-13.6	9.2	35.6	61.6	80.7	112.4	577.3
Net Evap/day	3.2	3.0	2.3	1.6	0.2	-0.5	-0.4	0.3	1.2	2.0	2.7	3.6	1.6

DIAGNOSTICS

Sustainability Diagnostics: Coolah STP with Multirun

Pond System: 3 facultative, aerobic or storage ponds

Municipal STP Demo Waste Stream - 79350.93 m3/year or 217.25 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	37.20 (12.16 - 40.00)	2951.72 (2949.67 - 2957.75)
Total Phosphorus	9.30 (3.04 - 10.00)	737.93 (737.42 - 739.44)
Total Dissolved Salts	371.98 (121.60 - 400.00)	29517.22 (29496.67 - 29577.48)
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)

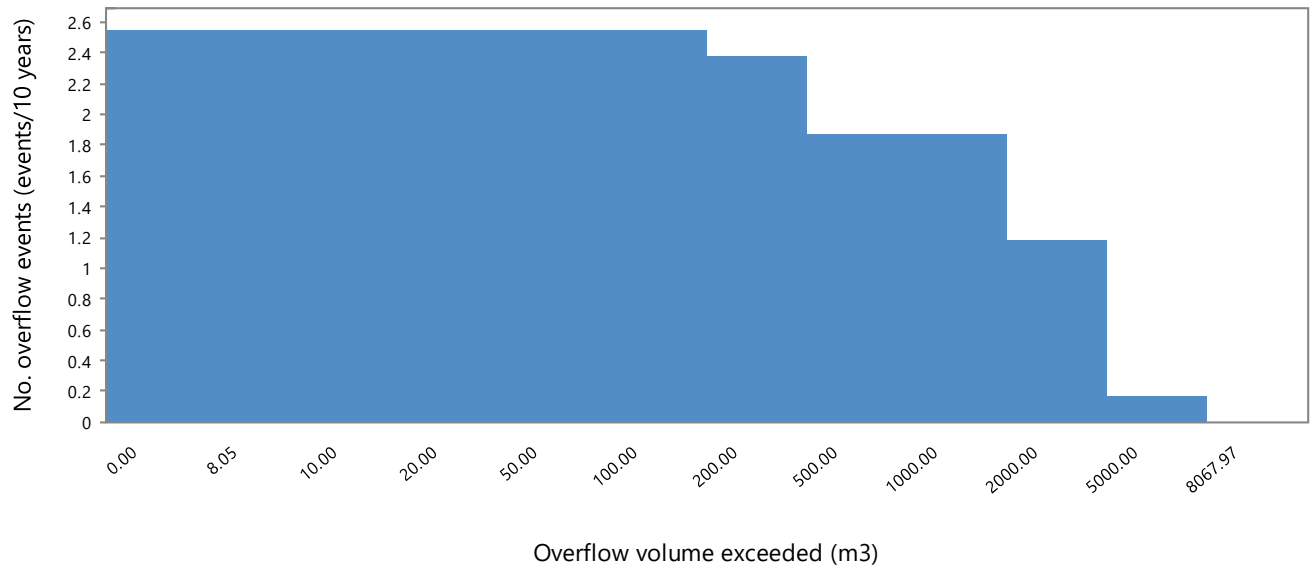
Last pond (Wet weather store): 30000.00 m3

Theoretical hydraulic retention time (days)	138.09
Average volume of overflow (m3/year)	505.99
No. overflow events per year exceeding threshold* of 8.05 m3 (no./year)	0.25
Average duration of overflow (days)	9.60
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (%)	99.15
Probability of at least 90% effluent reuse (%)	97.88
Average salinity of last pond (dS/m)	0.59
Salinity of last pond on final day of simulation (dS/m)	0.62
Ammonia loss from pond system water area (kg/m2/year)	1.56

* 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: Coolah STP with Multirun

Irrigation Information

Irrigation: 43.5 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	76687.98	1762.94
Total nitrogen applied (kg)	2022.22	46.49
Total phosphorus applied (kg)	727.04	16.71
Total salts applied (kg)	29081.54	668.54

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 (% of events)	0.00
Minimum shandy water is used	False

Irrigation Issues

Proportion of Days irrigation is prevented when triggered (%)	27.01
Proportion of Days water demand is too small to trigger irrigation (%)	18.97
Proportion of Days irrigation occurs (%)	54.02

DIAGNOSTICS

Sustainability Diagnostics: Coolah STP with Multirun

Paddock Land: Default Paddock: 43.5 ha

Irrigation: High Travelling Irrigator with 30% ammonium loss during irrigation

Irrigation triggered when soil water deficit reaches 2.00 mm and rainfall is less than or equal to 0.10 mm
Irrigate up to a soil water content of drained upper limit plus 0.00 mm
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): Medium Permeability Red Brown Ea, 55.00 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	87.9	68.1	61.8	41.0	48.2	49.4	52.5	48.7	50.8	63.1	72.5	74.2	718.3
Irrigation	15.0	13.9	14.6	14.2	12.7	9.7	10.4	16.5	18.3	19.9	16.1	15.1	176.3
Soil Evap	8.5	6.8	6.1	4.0	3.0	2.1	2.3	3.3	3.4	4.1	5.5	6.8	56.0
Transpn.	61.8	56.3	49.6	33.9	24.8	16.9	19.4	29.2	41.0	55.5	62.4	70.3	521.1
Rain Runoff	8.6	3.9	2.6	2.8	1.6	3.7	2.9	1.1	1.4	2.8	2.8	3.3	37.6
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	18.9	15.9	16.4	12.1	18.7	28.9	35.8	32.3	30.0	29.2	24.4	18.0	280.5
Delta	5.1	-0.9	1.9	2.3	12.7	7.5	2.7	-0.7	-6.6	-8.6	-6.6	-9.2	-0.6

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	46.49
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	54.98
Average annual soil nitrogen removed by denitrification (kg/ha/year)	7.58E-04
Average annual soil nitrogen leached (kg/ha/year)	0.55
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.55
Soil organic-N kg/ha (Initial - Final)	544.00 - 75.72
	55.68 - 0.02
Average nitrate-N concentration of deep drainage (mg/L)	0.20
Max. annual nitrate-N concentration of deep drainage (mg/L)	16.10

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	16.71
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	17.85
Average annual soil phosphorus leached (kg/ha/year)	0.26
Dissolved phosphorus (kg/ha) (Initial - Final)	0.29 - 0.14
Adsorbed phosphorus (kg/ha) (Initial - Final)	3036.52 - 2955.02
Average phosphate-P concentration in rootzone (mg/L)	0.04
Average phosphate-P concentration of deep drainage (mg/L)	0.09
Max. annual phosphate-P concentration of deep drainage (mg/L)	0.10
Design soil profile storage life based on average infiltrated water phosphorus concn. of 1.95 mg/L (years)	172.78

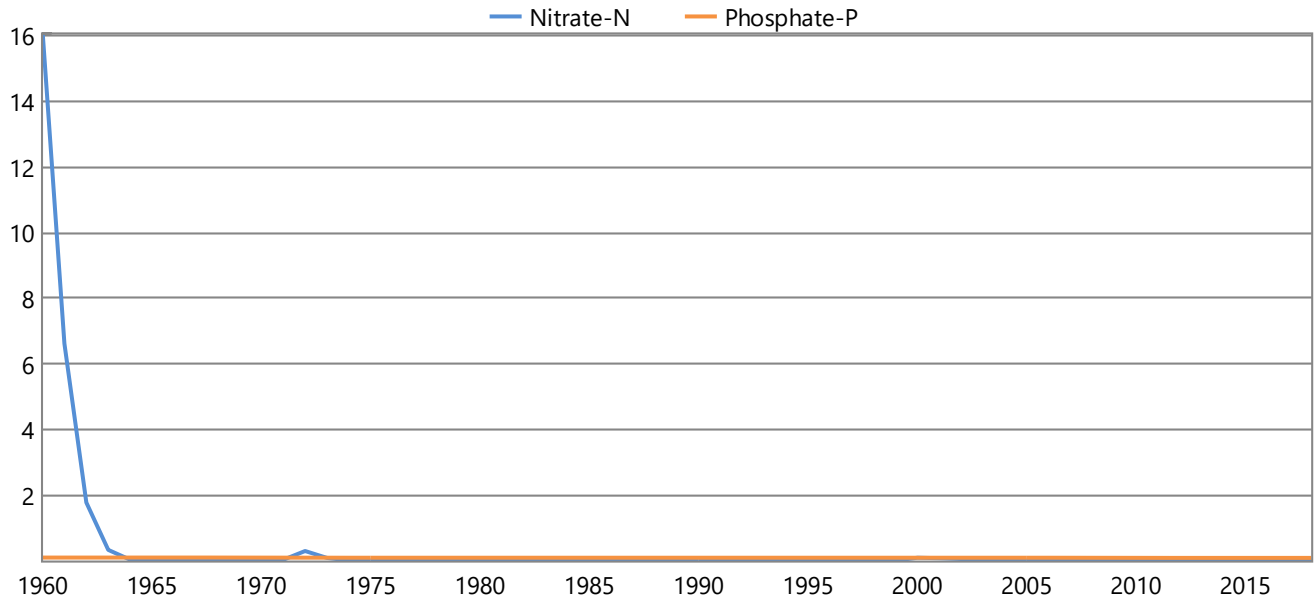
DIAGNOSTICS

Sustainability Diagnostics: Coolah STP with Multirun

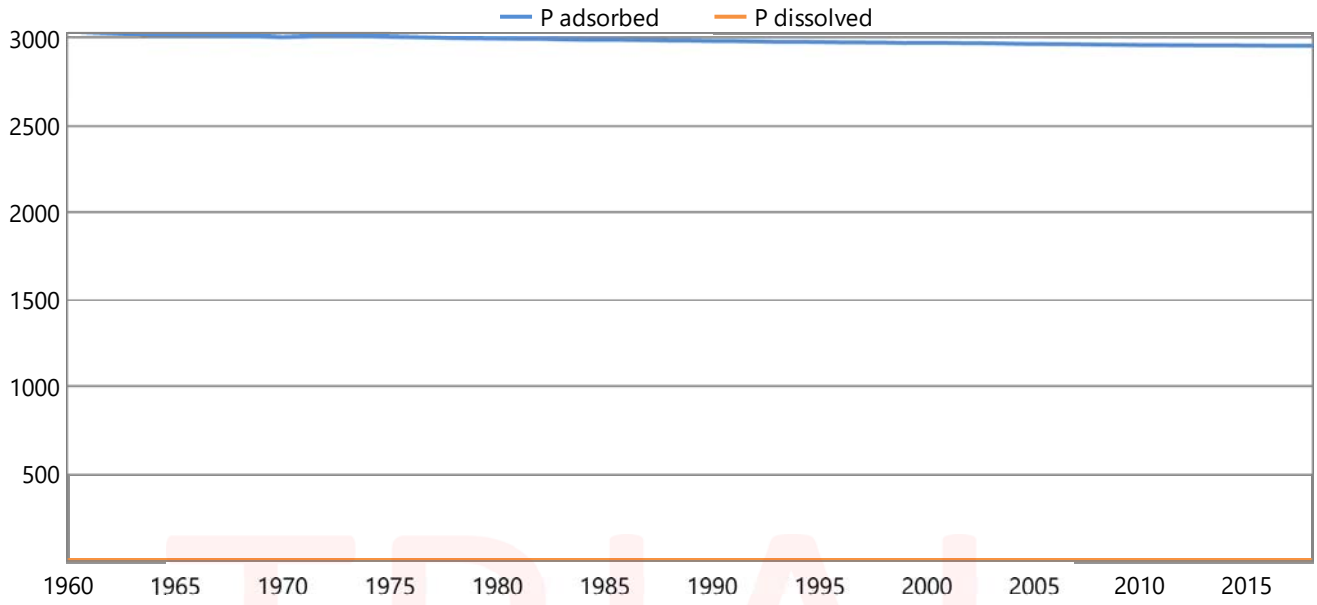
Paddock Land: Default Paddock: 43.5 ha

Irrigation: High Travelling Irrigator with 30% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: Coolah STP with Multirun

Paddock Plant Performance: Default Paddock: 43.5 ha

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

Average annual shoot dry matter yield (kg/ha/year)	6196.23 (5312.83 - 7073.52)
Average monthly plant (green) cover (%)	63.61 (61.01 - 65.20)
Average monthly crop factor (fraction)	0.41 (0.39 - 0.42)
Total plant cover (both green and dead) left after harvest (%)	97.00
Average monthly root depth (mm)	577.56 (569.12 - 588.24)
Average number of normal harvests per year (no./year)	1.54 (0.00 - 2.00)
Average number of normal harvests for last five years only (no./year)	1.60
Average number of crop deaths per year (no./year)	0.17 (0.00 - 4.00)
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)	0.68 (0.23 - 0.73)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.33 (0.14 - 0.55)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.60 (0.22 - 0.88)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.13 (0.01 - 0.27)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.01)
No. days without crop/year (days)	2.78

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)	0.15
Salt added by rainfall (kg/ha/year)	130.70
Average annual effluent salt added & leached at steady state (kg/ha/year)	799.24
Average leaching fraction based on 10 year running averages (fraction)	0.53
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	0.12
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	0.43
Relative crop yield expected due to salinity (%)	100.00
Proportion of years that crop yields would be expected to fall below 90% of potential due to salinity (%)	0.00

DIAGNOSTICS

Run Messages

Messages generated when the scenario was run:

No pathogen risk analysis were performed during multiruns
Full run chosen