SEDGMAN

New Grafton Correctional Centre

Integrated Water Management Plan

NORTHERNpathways

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Terms and Abbreviations

DA	Development Application
DPI	NSW Department of Primary Industries
EIS	Environmental Impact Statement
FFE	Furniture, fittings & equipment
GFA	Gross Floor Area
GoldSim	A dynamic modelling environment used in the water balance modelling
INSW	Infrastructure New South Wales
MBR	Membrane Bioreactor (wastewater treatment process)
MEDLI	Model for Effluent Disposal by Land Irrigation
ML	MegaLitres (1,000,000 L)
NGCC	New Grafton Correctional Centre
PPP	Public-Private Partnership
RtS	Response to Submissions (on the Stage 1 EIS)
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SILO	Scientific Information for Land Owners - a database of historical climate records for Australia
WMCS	Water Management Control System

Executive Summary

A new correctional centre is being developed at Grafton to help meet the State's need for increased inmate capacity. The New Grafton Correctional Centre (NGCC) will be built and operated as a Public-Private Partnership (PPP) and will be retained in ownership by the NSW Government. The NGCC has been designated a State significant development and is expected to open in 2020 after the planning process and construction period.

The NSW Government is responsible for site acquisition and the provision of certain public utilities infrastructure to the site. Under the PPP arrangement, the private sector will be responsible for the initial design, construction and financing of the NGCC, as well as the provision of operational (custodial) services, designated health services and hard and soft facilities maintenance services over the contract term.

The NGCC will be the major multifunctional, regional correctional facility servicing the northern part of NSW and will be the primary correctional facility for all corrections operations from the Queensland border in the north to Kempsey in the south, and Tamworth in the southwest. The NGCC site is located 23 kilometres by road to the south east of Grafton, 5 kilometres north east of Grafton Airport and 7 kilometres east of the Pacific Highway at 313 Avenue Road Lavadia on the Mid North Coast of New South Wales.

This Integrated Water Management Plan has been prepared to support the Stage 2 Environmental Impact Statement and addresses the Secretary's Environmental Assessment Requirements (SEARs) relevant to water cycle management.

As part of the Stage 2 Assessment, this report builds on the scheme development described in the Stage 1 Environmental Impact Statement (EIS), and quantifies the overall water cycle for the NGCC to provide water demand and wastewater generation characteristics based on the facility design presented in the Stage 2 EIS.

The water balance modelling shows that, with the Water Management Control System (WMCS) to be implemented and high quality recycled water reuse, benchmarks provided in the Stage 1 DA concept assessment are similar to those in this report. Comparison of benchmark data from a range of other sites indicates the scheme is realistic and in the expected range.

The key outcomes from the model are as follows:

- Water supply requirements: supply requirement of 315kL/day;
- Wastewater Generation and Treatment Requirements: 469kL/day;
- Recycled Water Reuse: average 292kL/day, up to a maximum of 935kL/day; and
- Excess Recycled Water Requiring Disposal: average 115kL/day, up to a maximum of 242kL/day.

1 Introduction

1.1 Background

In 2016, the NSW Government called for Expressions of Interest from the private sector to design, build, operate and maintain the NGCC. Following a competitive tender process, NorthernPathways were announced as the preferred bidder. The project is being delivered a Public Private Partnership (PPP) which means NorthernPathways will design, construct, operate and maintain the new facility on behalf of the NSW Government for the next 20 years.

Infrastructure NSW (INSW) is the Proponent for the environmental impact statement and lodgement of an application for environmental and planning approval. INSW is working with NorthernPathways on the community consultation and public exhibition of this environmental impact statement.

NGCC will be the major multifunctional, regional correctional facility servicing the northern part of NSW and will be the primary correctional facility for all corrections operations from the Queensland border in the north to Kempsey in the south, and Tamworth in the southwest.

The vision for the project is to operate in accordance with innovative best practice, both in providing safety and security and providing dynamic, pro-social management of inmates.

1.2 Stage 1 Consent

On 14 March 2017 consent was granted to the concept proposal for the staged development of New Grafton Correctional Centre (NGCC) comprising:

- 1,700 maximum and minimum security beds, consisting of:
  - 1,000 maximum security beds for male inmates
  - 300 maximum security beds for female inmates, and
  - 400 minimum security beds for male inmates;
- core correctional facility buildings including: maximum and minimum accommodation units; special accommodation units; health facilities; education and programs areas; administration; workshops; staff amenities; and visitor facilities;
- a recreational oval within the perimeter of the facility;
- a six metre high fence or wall around the perimeter of the facility, with light and security camera poles up to 10 metres in height;
- store buildings, small ancillary facilities, a central energy plant, black - water treatment facilities and a drug dog detection unit and yard located outside the perimeter wall / fence;
- fire access roads on the inside and the outside of the perimeter wall/ fence of the facility;
- water, power, wastewater and communication utilities within the site;
- a maximum building height of 12 metres (approximately three storeys);
- total GFA of approximately 100,000 m2;
- vegetative buffer of 50 metres along the northern boundary, 15 metres along the eastern boundary and 30 metres along the southern boundary; and
- asset protection zone of 100 metres from every boundary or vegetation buffer;
- one vehicular entry/exit point from Avenue Road;
- 500 car parking spaces;
- 1.5 metre high boundary fence; and
- landscaping of ground cover and /or shrubbery.

All development under the concept proposal consent (Stage 1 consent) is the be the subject of a subsequent development application with the exception of the Stage 1 works.

The approved Stage 1 works include:

- vegetation clearance and biodiversity management activities;
- bulk excavation and site stabilisation works;
- demolition of the existing house and sheds;
- construction of access roads including fire access roads to the extent required to conduct Stage 1 works
- construction of auxiliary facilities such as construction compound, construction staff parking facilities and stockpiles sites;
- temporary provision of water, power and communication services within the site to the extent required to conduct Stage 1 works; and
- landscaping.

These Stage 1 works will be undertaken to facilitate the subsequent development as envisaged in the concept proposals.

At the same time, Infrastructure New South Wales (INSW) is arranging for the delivery of services to the site including a mains water supply, electricity, telecommunications and access.

The subsequent development application (Stage 2 DA) will be generally consistent with the concept proposal as outlined on the previous page.

NGCC will be constructed and maintained by John Holland and Serco will operate the correctional centre.

1.3 Approvals Framework

NGCC is a State significant development with planning approval being obtained in two stages:

- Stage 1 – for the concept proposal and Stage 1 works; and
- Stage 2 – for the design and construction of the facility.

The Stage 1 consent was obtained by the Infrastructure NSW (INSW) on behalf of Corrective Services NSW (CSNSW), a division of the Department of Justice, with approval perceived 14 March 2017.

INSW, on behalf of Corrective Services NSW (CSNSW), a division of the Department of Justice is the applicant for this Stage 2 development application.

The development to which the Stage 2 development application relates is also State significant development. Clause 8(1)(b) in Part 2 of State Environmental Planning Policy (State and Regional development) 2011 (“the SRD SEPP”), development is declared to be State significant development if the development is specified in Schedule 1 or 2 of the SRD SEPP. Schedule 1 includes paragraph 16:

> *16 Correctional centres*
>
> *Development for the purpose of correctional centres that has a capital investment value of more than $30 million.*

The proposed NGCC has a capital investment value of over $30 million and is State Significant Development.

The Minister for Planning is the consent authority for State Significant Development.

1.4 The site and its context

1.4.1 Regional context

The site is located 23 kilometres by road to the south east of Grafton, 5 kilometres north east of Grafton Airport and 7 kilometres east of the Pacific Highway at 313 Avenue Road Lavadia on the Mid North Coast of New South Wales.

The Pacific Highway provides connections north towards Queensland and south towards the Hunter and Sydney. The Gwydir Highway provides a connection between the North Coast and the New England and Summerland Way extends north connecting Grafton, Casino and Kyogle to the Mt Lindesay Highway.

Grafton is a focal point for regional road, river and other transport networks and a focus for higher order services to the Clarence Valley sub-region. It is the sub-region's major employment centre and a centre for government administration.

This is shown in Figure 1-1.

1.4.2 The site

The site comprises Lot 26 DP751376 and Lot 1 DP 1190399 each roughly rectangular with a total area of 195 hectares. It is known as 313 Avenue Road Lavadia although the site straddles the boundary between the localities of Lavadia and Glenugie.

It has a frontage to Avenue Road of approximately 2.2 km, a northern boundary to an unformed Crown road of 1.1 km, a western boundary to adjoining private property and unformed Crown roads of 2.3 km and a southern boundary of 627 metres to the Pacific Highway under construction including the relocated Old Six Mile Lane.

The site is shown in Figure 1-2.

1.5 The proposal

The proposed development comprises the construction of a new correctional centre designed to accommodate 1,700 male and female inmates comprising 14 different cohorts including but not limited to:

Classification	Number	Gender
Maximum Security Classification Inmates	1000	Male
Maximum Security Classification Inmates	300	Female
Minimum Security Classification Inmates	400	Male
Total	1,700	

Other associated facilities include but are not limited to:

- Recreational oval, special accommodation units, administration, industries and educational facilities, workshops, staff amenities, visitor facilities, prisoner reception and health facilities (including beds and some diagnostic facilities), access, parking and utilities:
- An overall Gross Floor Area (GFA) of approximately 90,700 m^2;
- Secure perimeter fences to the two correctional precincts comprising concrete and anti-climb mesh fences with a Sterile Zone;
- Additional beds for remand/reception management and management of unforeseen contingencies such as a requirement to separate inmates;
- Associated support and ancillary buildings for the delivery of services (other than functions);

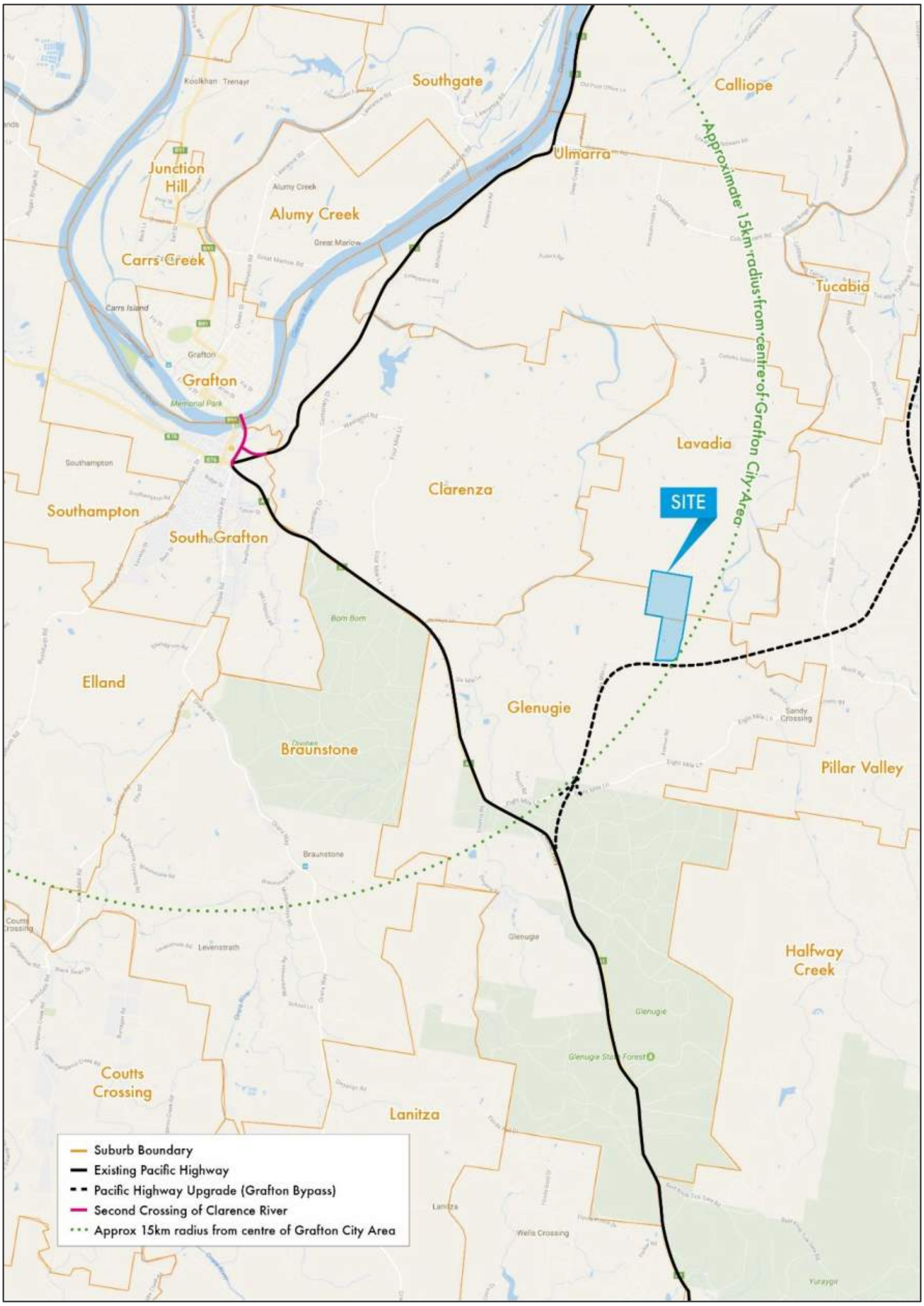

Figure 1-1. Site Location

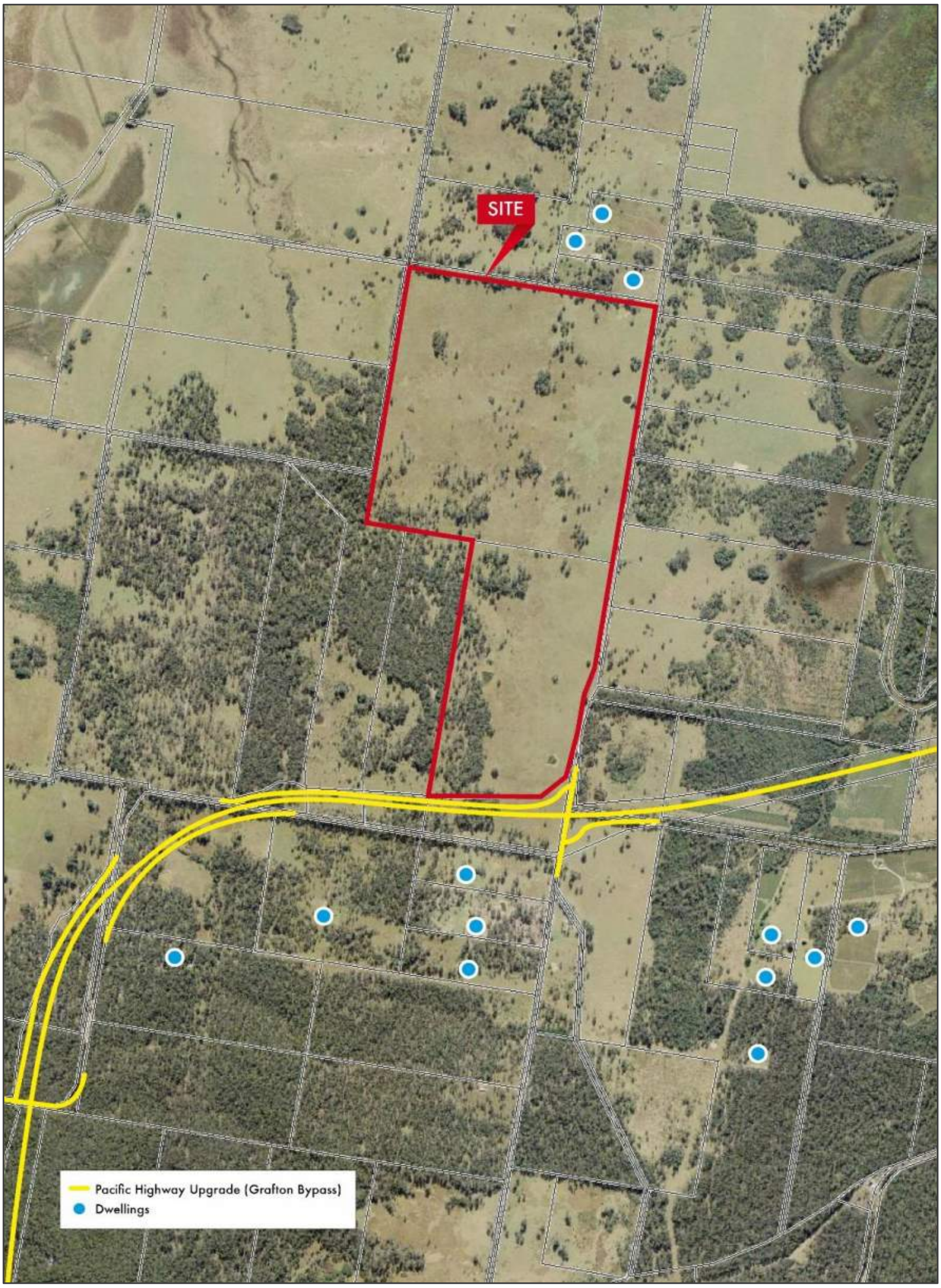

Figure 1-2. Project Site

- Provision of integrated power, fire, general infrastructure and security & communications backbone; and
- Provision of furniture, fittings & equipment (FF&E) to deliver the services and other functions.

Two distinct correctional precincts for the management of maximum and minimum security inmate cohorts are proposed with movement of staff, inmates and visitors managed through individual gatehouses.

These are located either side of central facilities such as parking areas, visitor arrivals areas and staff amenities.

The facility has been designed to be legible for all users, engendering a feeling of personal safety. In providing the physical spaces requisite for the execution of day-to-day operations and achievement of high-level goals, the design results in efficiencies and minimised impact on the environment through the location of buildings and design of movement systems.

The design provides a campus-style layout for the three correctional centres – male maximum, female maximum and male minimum and positions each centre on either side of the existing ridgeline running on a north–south axis through the Site. This ridgeline offers views to Glenugie Peak in the distance to the south, captured by the proposed cultural centre located between the male maximum and female maximum centres. Views to this significant feature are symbolic and meaningful to locals, and particularly for the Indigenous community.

Each centre is designed with a ‘spine’ or ‘street’ of support facilities, and a number of neighbourhoods of residential accommodation. These spines are set out along a gentle curve, generated from the existing topography and natural landforms.

The male maximum and female maximum centres are enclosed by one maximum-security perimeter and designed with physical, visual and acoustic separation between male and female inmates. This is achieved through the natural ridgeline layering the support facilities spines for each centre on either side of a green space. A secure line between each of the centres prevents inmates from accessing the other.

Each centre is accessed from the support facilities spine through a series of managed secure officer posts in lieu of a central movement control post, facilitating ease of movement into the campus facilities (e.g. recreation, industries, programs and education). The facilities are set out along a curved communication spine determined by functional requirements, acting as the ‘wayfinding’ across the facility. This pathway network provides a functional solution aligned with operational needs and accommodates natural ‘desire’ lines of pedestrians. Movement areas are observed by staff points, and movement within the centres’ shared spaces is controlled using buildings and landscape elements to define circulation routes.

The landscape design follows the campus style design approach being integrated into the existing local environmental context. Areas of existing vegetation are retained, wherever possible, and extensive screen planting of endemic trees, shrubs and grasses to the boundaries, the drainage lines, and the hill to the north. The entrance road planting of informal groves of local trees, retains the local rural character.

Secure perimeter fences would be provided to the two correctional precincts comprising 6.0m high concrete and anti-climb mesh fences with a secure sterile zone. Detection monitoring and CCTV coverage of perimeter security zones will be provided with security lighting.

A single point of entry and control would be provided from Avenue Road. Internal access roads and parking carparking for approximately 700 car spaces comprising:

- 350 staff car parking spaces and 10 motorcycles spaces; and
- 350 visitor car parking spaces and 10 motorcycles with a standover space with an overflow area accommodating a further 150 cars.

A bus stop close to the visitor reception area would be provided with provision for bus transport.

NorthernPathways propose to design, build and operate a Membrane Bioreactor (MBR) Waste Water Treatment Plant to accommodate inmates, staff and visitors and all peak load periods. The proposed MBR system is the combination of an activated sludge biological treatment plant with Ultra filtration membrane process utilising a suspended growth bioreactor producing Class A+ potable water. This water would be reticulated as recycle water through the facility, with excess directed to travelling surface irrigators. The plant would be fully automated and be remotely monitored for additional offsite technical support.

The facility would be constructed in one stage with occupancy managed by gradual ramp up to capacity over a period of 6 months. The facility will commence construction pursuant to the Stage 1 consent issued in March 2017 and, subject to works under a Stage 2 DA, is due for completion in early 2020 ready for occupation from July 2020.

The construction and delivery of the project will be undertaken in coordination with other major projects in the region, namely the Pacific Highway upgrade currently under construction by the Roads and Maritime Services and the additional bridge crossing of the Clarence River in Grafton.

Detailed consideration has been given to construction planning and management.

It is estimated that some 580 jobs would be provided at the facility with approximately 350 of these being custodial officers. During construction, some 1,100 jobs would be provided.

1.6 Purpose of this Report

This Integrated Water Management Plan is prepared to support the Stage 2 Environmental Impact Statement (EIS). The purpose of this report is to address the Secretary's Environmental Assessment Requirements (SEARs) relevant to water cycle management. The SEARs relevant to this report and where they have been addressed are provided in Table 1-1.

Table 1-1. Summary of SEARs relevant to this report

SEARs	Cross Reference
1. Statutory and Strategic Context – including: Address the statutory provisions contained in all relevant environmental planning instruments, including: • State Environmental Planning Policy (State & Regional Development) 2011; • State Environmental Planning Policy (Infrastructure) 2007; • State Environmental Planning Policy No 33 – Hazardous and Offensive Development; • State Environmental Planning Policy No.55 – Remediation of Land; and • Clarence Valley Local Environmental Plan 2011 …. *Development Standards* Identify compliance with the development standards applying to the site and provide justification for any contravention of the development standards. *Grafton Correctional Centre Concept Proposal* In accordance with section 83D(3) of the Environmental Planning and Assessment Act 1979, demonstrate that the proposal is not inconsistent with the development consent granted for the Grafton Correctional Centre concept proposal (SSD 7413).	Section 2 Assessment Requirements: • Statutory requirements • Development standards. Section 2 describes the requirements for compliance with the Stage 1 concept approval (SSD 7413).
14. Utilities … • Preparation of an Integrated Water Management Plan detailing any proposed alternative water supplies, proposed end uses of potable and non-potable water, water balance assessment and water sensitive urban design.	This report provides a water balance outlining water supply volumetric requirements and end uses. Further information is provided in the Infrastructure Management Plan (water infrastructure), and the Stormwater Management Plan (water sensitive urban design).

1.7 Report Structure

The structure of this report is summarised in Table 1-2.

Table 1-2. Report structure

Section Reference	Section Heading	Description
Executive summary	Executive summary	Summary of this report and key findings
1	Introduction • Background • Project description • Purpose of report • Report structure	Description of the project, an overview of the project purpose and structure of this report
2	Assessment requirements	The key drivers and requirements to be met for the work outlined in this report in terms of the Stage 2 EIS
3	Water cycle management strategy development	An overview of the approach, assumptions made, model and strategy development and results
4	References	

2 Assessment Requirements

As part of the Stage 2 Assessment, this Integrated Water Management Plan builds on the scheme development and the findings from the Stage 1 DA assessment, and quantifies the overall water cycle for the NGCC to provide water demand and wastewater generation characteristics to support the detailed design work.

2.1 Stage 1 Conditions of Consent

The Conditions of Development Consent SSD 7413 were issued on 14 March 2017 for the Stage 1 Concept Proposal and Stage 1 works. In relation to integrated water cycle management, the following Stage 1 conditions are relevant to this report:

- Schedule 2 Part A conditions A4 and A5 and Schedule 3 Part A conditions A2 and A4, requiring development in accordance with the conditions of consent (SSD 7413) and the EIS, as amended by the Response to Submissions (RtS); and
- Schedule 2 Part B, conditions B9 – B12 provide conditions related to wastewater and water infrastructure provision. Schedule 3 Part B condition B37 requires written advice from relevant utility authorities stating that satisfactory arrangements have been made to provide adequate services prior to the commencement of Stage 1 works.

  In support of this, this report provides an assessment of the volumes of water required and wastewater generated on the Project.

The Environmental Assessment Report (DPE, 2017) provides further information regarding the expectations in regards to the water cycle, in particular:

- Section 2.7 – minimising resource requirements through optimising efficiency of energy use, utilising renewable energy, water recycling, use of water efficient fixtures and waste recycling.
- Section 3.4 – recommendation from the NSW Department of Primary Industries (DPI) that a ‘sustainable and secure water supply be determined during the early stages of the project’’
- Section 4.2.2 – discussion of the wastewater management system, including reuse and irrigation requirements. States that water and wastewater assessments for the detailed design will require a detailed calculation of the water inputs and wastewater outputs, including justification of the figures used; and
- Section 4.3.3 – states that in relation to Water Supply and Water Cycle Management ‘the use of roof water or recycled wastewater to reduce the need for reticulated water is supported, though greater detail of the water cycle management would need to be provided in the development application for Stage 2.’

The supporting documentation, namely the EIS and RtS documentation relevant to this report in particular is:

- The Water Cycle Management Working Paper (Jacobs, 2016).

2.2 Legislative Requirements

The following State Environmental Planning Policies (SEPP) are specifically referenced in the Stage 2 SEARs:

- State Environmental Planning Policy (State & Regional Development) 2011;
- State Environmental Planning Policy (Infrastructure) 2007;
- State Environmental Planning Policy No 33 – Hazardous and Offensive Development; and
- State Environmental Planning Policy No.55 – Remediation of Land.

The SEPP (State & Regional Development) and SEPP (Infrastructure) are both related to planning requirements, designations and responsibilities. There are no elements directly relevant to this assessment.

The SEPP No 33 – Hazardous and Offensive Development relates to hazardous and offensive industries or storage establishments, providing guidance on approval, application requirements, and the provision of a preliminary hazard analysis. The development may be considered a potentially offensive industry, and perhaps also a potentially hazardous industry, although this does not relate to the integrated water cycle assessment presented in this report (refer to the Wastewater Servicing Report, Sedgman Consulting, 2017).

Likewise, the SEPP No. 55 – Remediation of Land does not relate to the purposes of this report.

2.3 Relevant Standards

The Clarence Valley Local Environmental Plan 2011 and the supporting Development Control Plans are the key relevant standard in relation to this report.

The Clarence Valley Local Environmental Plan 2011 (LEP) details the Development controls within the Clarence Regional Council area. The key requirement in relation to this assessment is the requirement to provide adequate water supply and sewerage services, to the satisfaction of the consent authority. This report provides an assessment of water supply requirements, and determines the quantity of wastewater to be treated and recycled water that can be reused, which is further assessed in the Wastewater Management Plan (Sedgman Consulting, 2017).

Council's Development Control Plans contain the following key requirements:

- Rural Zones DCP 2011:
  - C8.2 Supply of Water - subdivision and development must be connected to a reticulated town water supply system at a point acceptable to Council, where available
  - Part G - requires sustainable water controls for all new development (other than dwelling houses and dual occupancies). This includes:
    - installation of 3 Star rated fixtures, namely:

      - toilets to be dual flush (preferably 3 litre/6 litre)

      - 3 Star or better rated fixtures for taps, showerheads, toilet cisterns, clothes washers and dishwashers

      - 3 Star flow regulators fitted to hand basins, sinks and laundry tubs

      - 3 Star rated fixtures to achieve the requirements as specified in Australian Standard AS/NZS 6400:2003, AS/NZS 3662:1996, and subsequent updates.
    - compliance with 'sustainable water requirements' for stormwater
- Sustainable Water Requirements (Information for Applicants) - for larger developments (2.3.2):
  - a water cycle management plan including estimates of all water, wastewater and stormwater flows, including strategies to improve water efficiency and reduce wastewater volumes.

This Integrated Water Management Plan provides the above water balance model, including water efficient fixtures, water sources and end uses, recycled water use and the proposed strategy to improve water efficiency. Management of stormwater quality and quantity management is referenced herein, but is addressed in detail in the Stormwater Management Plan (Woolacotts, 2017).

3 Water Cycle Management Strategy Development

3.1 Options considered

3.1.1 Overview

The Water Cycle Management Working Paper by Jacobs (2016) considered a range of options. These options, along with the key findings from Jacobs (2016), are summarised in Table 3-1.

Table 3-1. List of Potential Water Cycle Management Options

Water Cycle Management Option	Target Issue	Other Benefits	Findings from Jacobs (2016)	Considered in this report?
Water efficient fixtures and appliances	Reducing water use	• Reduces water and energy (hot water and water pumping) usage • Reduces the need for water system amplification	Adopted – standard approach in modern building design	Y
Waterless Urinals	Reducing water use	• Reduces water and energy (water pumping) usage • Reduces the need for water system amplification	Not specifically considered – may be part of a package of more water efficient fixtures and appliances	N – not separately, considered as part of above water efficient fixtures and appliances
Recycled wastewater for non-potable uses: • Cooling towers • Toilet/urinal flushing • Irrigation	Reducing water use	• Reduces discharges to environment	Adopted as part of preferred option	Y
Roof water harvesting	Reducing water use	• Large roof areas available • Improves stormwater quality • Reduces stormwater runoff	Adopted as part of preferred option	Y
Stormwater harvesting	Reducing water use	• Large impervious areas available • Reduces stormwater runoff • Improves stormwater quality	As there is a need to minimise wastewater discharges from the site and considering the excess of wastewater anticipated, recycled wastewater was seen to be the preferred alternative water source for non-potable uses.	N – as per comments from Jacobs (2016), recycled water is the preferred source for non-potable uses, considering the excess of recycled water anticipated
Stormwater Management and Water Sensitive Urban Design (WSUD)	Improving stormwater quality	• Improves stormwater quality • Reduces stormwater runoff • Mitigates urban heat island effect • Improves public open space and amenity	Not covered – to be considered in Stormwater Management Strategy In Stage 2 Development Application	N - addressed as part of stormwater strategy. Refer to Section 3.2

3.2 Stormwater Management

The stormwater system is detailed in the Stormwater Management Plan prepared for the Stage 2 EIS (Woolacotts, 2017). In terms of the site water cycle, the report details the stormwater management and water sensitive urban design elements outlined in Table 3-1 in Section 3.1. In summary, the stormwater system involves:

- sediment and erosion controls including grassed swales, hay bales around pits, silt fences, and sediment / detention basins to treat fine particle contaminants
- design to ensure post development stormwater runoff volume and peak flow rates match the pre-development runoff within each of the existing drainage paths leaving the site for the 5, 10, 20 and 100 year ARI events, through the use of detention basins
- Stormwater quality improvement is satisfied through the use of water sensitive urban design features including sediment / detention basins and swales, as validated by the use of a MUSIC model developed for the site.

3.3 Water balance modelling approach

A dynamic simulation approach was adopted for the integrated water cycle modelling. This was developed within the GoldSim modelling environment (v12), a widely used modelling environment for water balance that incorporates and explicitly models both risk and probability.

The key element of the model is the ability to use variable inputs to provide risk based outputs, based on a whole of system approach – in short, the model allows the physical system to be simulated, using inputs that can be static or can vary over time, such as irrigation demand. However, given the nature of correctional facility demand, where maximum usage may occur at any time, user demand was instead adopted based on the maximum permissible water use under the Water Management Control System (WMCS) for inmates (refer Section 3.4.3). Similarly, a typical demand for staff and visitors was adopted, and other facility uses were calculated as outlined in Section 3.4.3.

Overall, the model incorporates 4 key elements:

- A demand model incorporating seasonal and non-seasonal components;
- A set of supply sources based on the selected water cycle components;
- An input set using the table in Appendix B; and
- Model verification algorithms, including mass balance check.

These are interlinked as shown in Figure 3-1.

Outputs from the model were determined for:

- Potable and non-potable demand;
- Sewage flow rates;
- Flow rates and demand per person;
- Flow rates and demand on a per inmate basis (for benchmarking purposes);
- Recycled water reuse within the facility; and
- Excess recycled water requiring disposal via irrigation on other parts of the site.

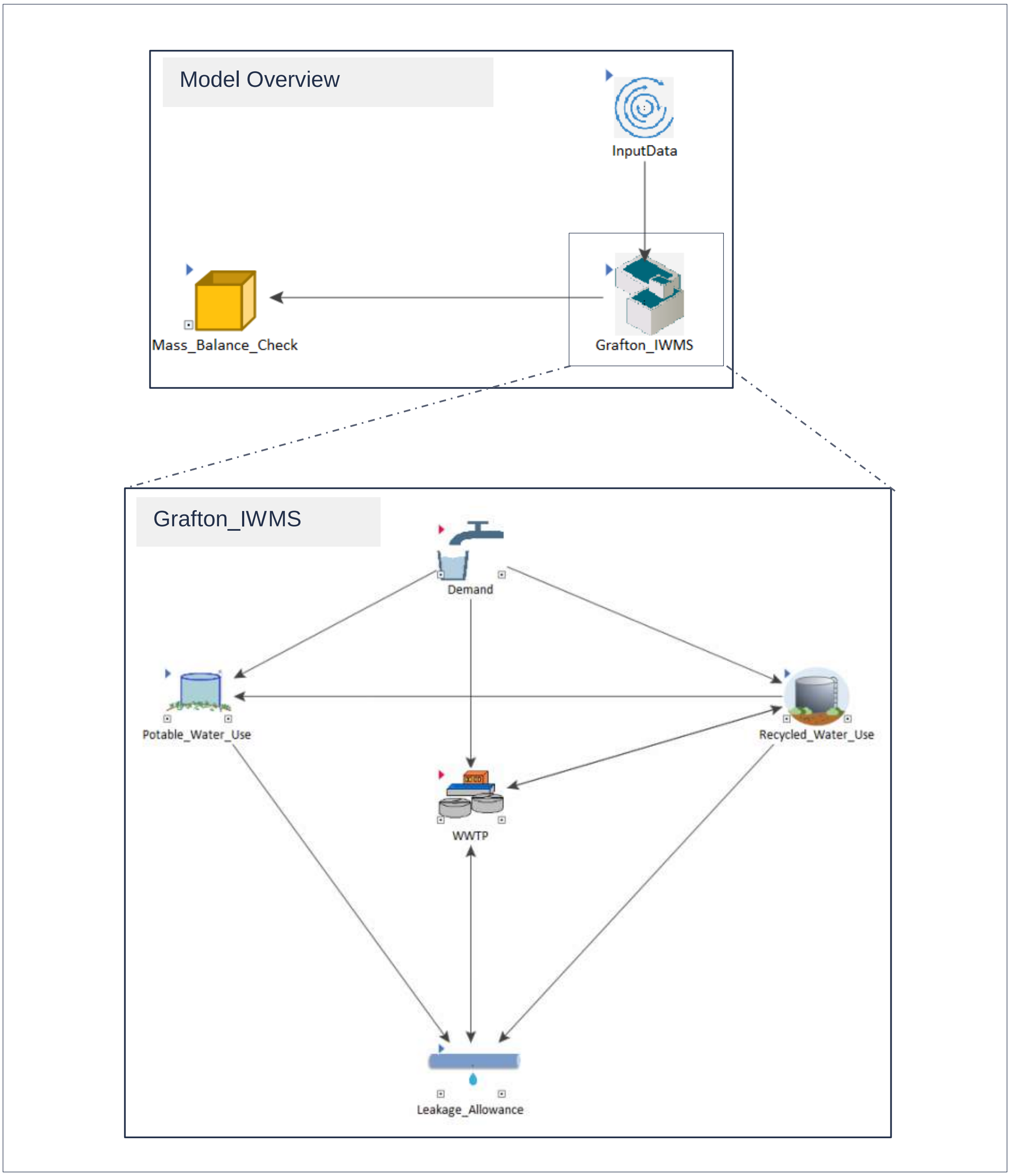

Figure 3-1. GoldSim model structure

3.4 Key assumptions and Input Data

3.4.1 Climate

Daily climate data, including rainfall, Class A pan evaporation, maximum and minimum temperature, and solar radiance, was obtained from SILO Drill Data for the site, with the 50 year period from January 1967 to December 2016 (inclusive) selected. The rainfall period was selected to account for potential changes in rainfall patterns over the past century, with the last 50 years allowing a suitably long time for modelling, while better reflecting current rainfall trends, as recommended in DSITIA (2016).

Average data statistics are shown in Figure 3-2 from this data.

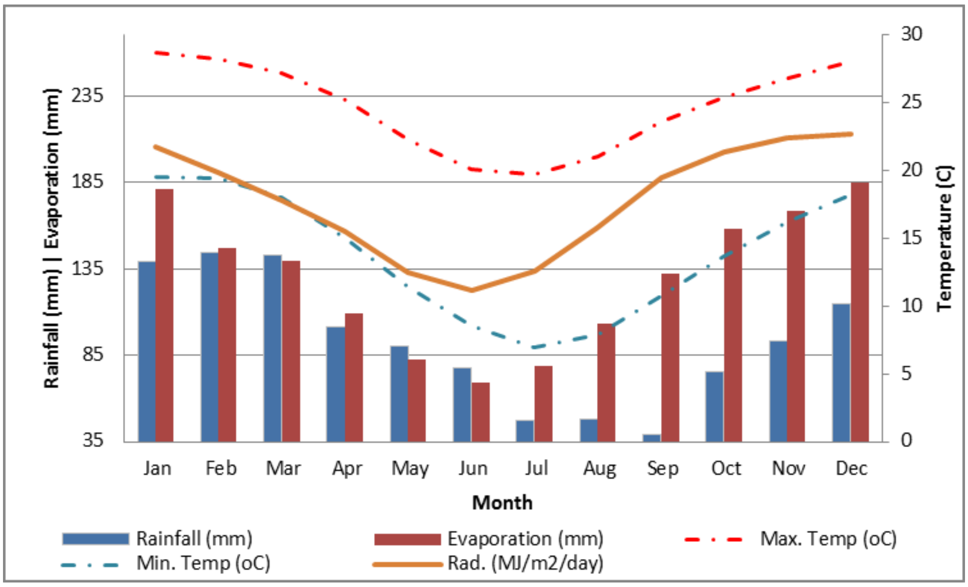

Figure 3-2. Climate statistics from SILO Drill Data for the site

The Conditions of Consent (number B9 a) note explicitly to consider evaporation data from both Coffs Harbour and Alstonville to ensure representative site data is utilised. This relates to comments made in the Stage 1 Assessment Report (DPE, 2017) regarding the evaporation data used in the concept assessment. They noted that evaporation from Coffs Harbour would be more 'reflective of the climatic conditions at Grafton compared to the Inverell data originally used, but is still likely to be quite different to evaporation data in Grafton considering the climatic differences between the two locations'. As such, the suggestion was to include 'consideration of Alstonville evaporation data to verify findings'.

As noted above, climate data used in the modelling has been obtained through the SILO *Data Drill* service – data obtained from grids of data interpolated from point observations by the Bureau of Meteorology (BOM). The data in the Data Drill are all synthetic, formed for any particular point in Australia based on nearby stations, and intended to best represent the selected point for the purposes of modelling.

Further information on the patched point and data drill datasets are available on the SILO website, https://www.longpaddock.qld.gov.au/silo/.

Daily pan evaporation from both Alstonville Tropical Fruit Research Station (BOM station 058131) and Coffs Harbour MO (BOM station 059040)[1] have been compared with the above Site data, as shown in Figure 3-3.

[1] *Patched Point* data (not data drill), which is observed data with missing or suspect values 'patched' with interpolated data by the BOM

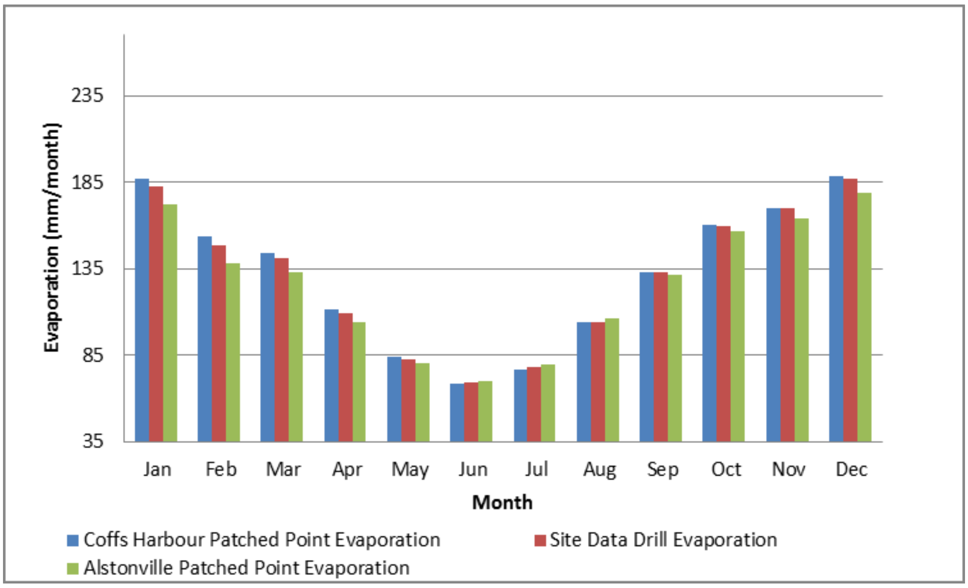

Figure 3-3. Comparison of evaporation data – model data, and both Coffs Harbour and Alstonville

As can be seen, the pattern of evaporation is broadly consistent, with annual evaporation of:

- Site drill data: 1563mm/year;
- Coffs Harbour: 1581mm/year; and
- Alstonville: 1514mm/year.

Alstonville shows a lower evaporation than both the Site data and Coffs Harbour, with the Site data generally midway between the two observational data sets. The Site data contains synthetic evaporation data used to supplement observed Class A pan evaporation data, estimated (through multiple regression) from a linear combination of solar radiation, vapour pressure and minimum and maximum temperature by the BOM[2]. This approach has provided good performance when comparing gridded surfaces of observed versus synthetic data[2].

A comparison of solar radiation and maximum temperature at the three sites with measurements from the nearby Grafton Airport AWS (BOM station 058161), located 3.5km to the southwest is shown in Figure 3-4 and Figure 3-5 respectively.

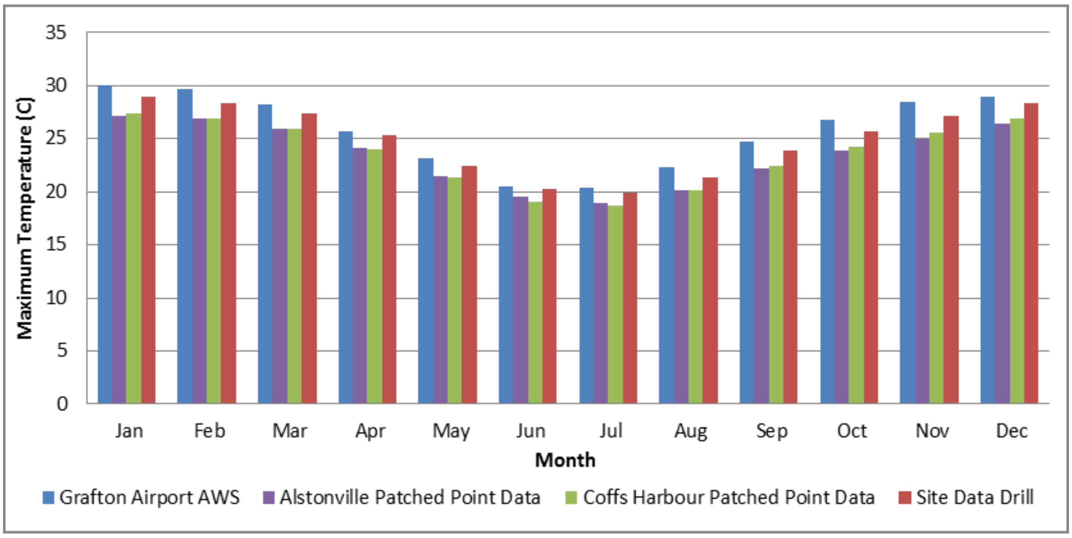

Figure 3-4. Comparison of maximum temperature statistics from the Bureau of Meteorology

[2] Refer to metadata at http://qldspatial.information.qld.gov.au/catalogueadmin/catalog/search/resource/details.page?uuid=%7B55DFAC89-1863-424D-AA84-1A664DDB0F05%7D

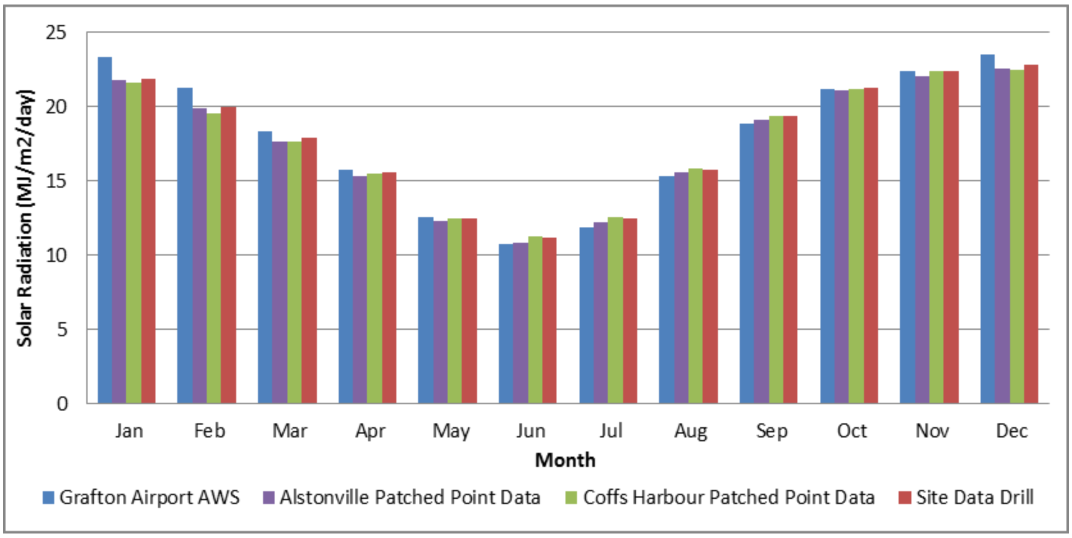

Figure 3-5. Comparison of solar irradiance statistics from the Bureau of Meteorology

These show that temperature and solar radiation are generally higher at Grafton than both the Coffs Harbour and Alstonville sites, although it is quite similar to the Site data, as would be expected.

As such, given the way the Data Drill has been compiled, and the differences in the key estimating parameters at the Project site compared to both Coffs Harbour and Alstonville, it is considered that the Data Drill would likely be the most representative data set to utilise in the modelling exercise for the project.

Considering rainfall (refer to Figure 3-6), it is also clear that using the complete data set from either Coffs Harbour or Alstonville would not be representative of the site, with the Site data being the most representative of the true site rainfall.

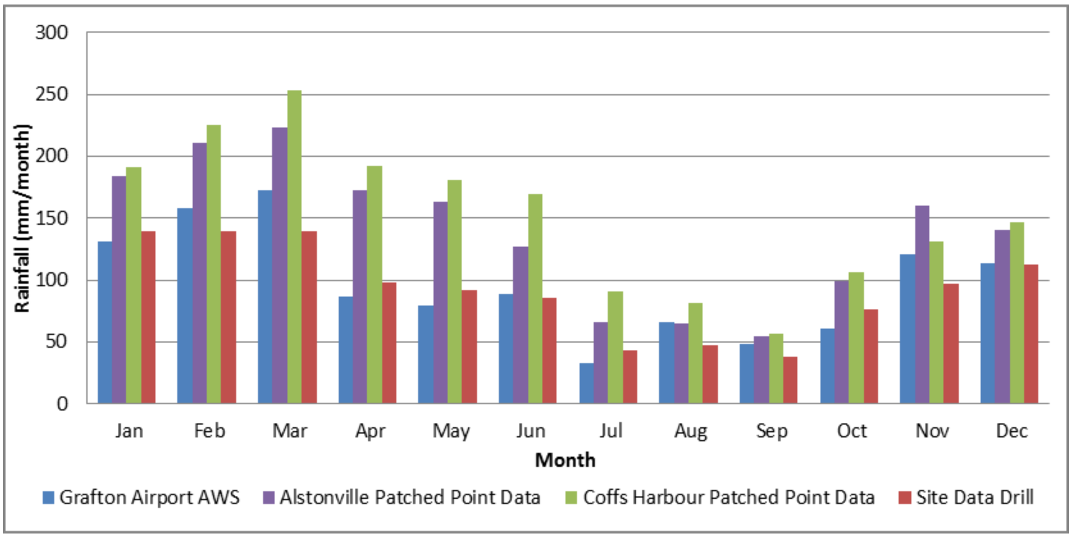

Figure 3-6. Comparison of rainfall statistics from the Bureau of Meteorology

3.4.2 Water Sources

The water sources considered in the modelling were as follows:

- Potable water supply from the Clarence Valley Council mains (to be delivered to site by INSW); and
- Recycled wastewater from the on-site sewage treatment plant, to be treated suitable for reuse in irrigation, toilet and urinal flushing, washdown and laundry use

3.4.3 Water Demand and Wastewater Generation

As part of detailed design, a Water Management Control System (WMCS) has been developed for inmates, providing for an absolute maximum amount of water for various uses. This WMCS represents the control system at the NGCC whereby staff can control the timing of different fixtures for inmate use – taps, showers, toilets, etc. This provides a strong level of control over water use (allowing for restrictions when necessary), but also provides for a maximum inmate water usage to be adopted for the water balance modelling.

This WMCS data has been incorporated in the demand model component of the GoldSim model, shown in Appendix B.

Further demand data has been adopted for other facility uses, as outlined below. All key inputs are included in Appendix B.

3.4.3.1 Staff and Visitors

Staff usage is based on a standard day office usage, which on a per person basis is:

- 1 full and 3 half toilet flushes;
- 8 x 0.15 minute handbasin usage;
- 25% of staff members have 1 x 5 minute shower per day; and
- 4 x 0.5 minute kitchen tap usage.

Only dual flush toilets are considered, with urinals taken as equivalent to the toilet half flush volume where installed.

Visitor usage is based on the following assumed usages on a per person basis:

- 1 full and 1 half toilet flushes;
- 2 x 0.15 minute handbasin usage;
- 2 x 0.5 minute kitchen tap usage; and
- No showers.

This is an assumption starting from staff usage and reducing down to account for lower usage expected for visitors to the site, who may be present for less than a FTE staff member.

3.4.3.2 Laundry

Laundry use is static, and calculated on a day to day basis from:

- Number of washes per day: 36;
- Litres per wash: 980L;
- Demand: 36 x 980 = 35,280L/day.

This is sourced from information provided by the design team and design plans for the laundry.

3.4.3.3 Kitchen

Kitchen usage is also static, and is calculated on a daily basis from:

- 5L/meal potable water use;
- 3 meals per day for inmates, and 2 meals per day for staff;
- Demand: 5 x 3 x 1700 + 5 x 2 x 570 = 31,200L/day.

3.4.3.4 Washdown

Washdown water demand was calculated as a maximum static daily demand, based on the number of washdown points, an assumed flow rate, and usage time at each point as follows:

- 100 spigot points x 0.3L/s x 10 minutes per point per day = 180 L/point/day = 18,000L/day.

3.4.3.5 Facility Irrigation

To determine the daily irrigation demand within the facility (item 1 above), a MEDLI (Model for Effluent Disposal by Land Irrigation) model was developed as follows:

- Soil model based on the existing soils on the site – silty clay loam over medium to heavy clays;
- Kikuyu turf grass;
- A daily irrigation schedule based on the following:
  - irrigating up to the drained upper limit (i.e. no ponding, limiting deep drainage)
  - a daily maximum pumping limit of 864kL/day, based on (from the Project irrigation design team):
    - a maximum of 5 outlets at a time, at 6L/s over 8 hours (night time irrigation window)
- Climate data as outlined in Section 3.4.1; and
- The priority irrigation area provided in the input table in Appendix B (other secondary areas may be irrigated, but are not always certain).

The input data and the MEDLI output are provided in Appendix B. This modelling provided a timeseries of daily irrigation amounts over the facility irrigation area, which was imported into the water balance model.

Further information on the MEDLI modelling for the Project is provided in the Wastewater Servicing Report (Sedgman Consulting, 2017).

3.4.4 Water Efficient Appliances

The following water efficiencies have been adopted for the site:

- Toilets (WC): 4.5/3 L/flush (full/half);
- Hand basin taps: 5 L/min;
- Kitchen/kitchenette taps: 6 L/min;
- Showers: 6 L/min;
- Accommodation unit washing machines (i.e. not the facility laundry): 60 L/wash.

3.4.5 Sewage Generation Rates

The above data was used along with standard sewage generation percentages (where appropriate) in determining sewage generation rates. These are shown in the data table in Appendix B.

3.4.6 Benchmarking

Benchmark data was obtained to compare with the modelled water use and effluent generation rates, with values compared on a total facility flow divided by total inmate number basis (L/inmate). Table 3-2 provides the available benchmark data, including that from the Stage 1 EIS report (Jacobs, 2016).

Table 3-2. Water demand and wastewater generation benchmark rates

Source	Description	Flow rate (L/inmate/day)
Water Demand		
Jacobs (2016)	Modelled Average Daily Water use[1]	376
Sevineratne (2007)	New South Wales Correctional Facilities	320 – 1,290
	USA Correctional Facilities	300 - 570
	UK Correctional Facilities	320 - 390
Wastewater Generation		
Jacobs (2016)	Modelled Average Daily Wastewater Flows	276
Lotus Glen Correctional	900 inmates, 250-300kL/day wastewater flows Pressure sewer, commercial laundry (external clients) – anticipate higher generation rates	280 - 340
Gatton Correctional	350 inmates, ~85kL/day wastewater flows Pressure sewer, water controls and recycling – anticipate similar generation rates	~240
Rockhampton Correctional	1000 inmates, 450-600kL/day wastewater flows Limited recycling and water controls – anticipate much higher generation rates	450-600
Woodford Correctional	1000 inmates, ~400kL/day wastewater flows Limited recycling and water controls – anticipate much higher generation rates	440

Table notes:

1 potable + non-potable use

3.5 The development of water cycle management scenarios

Jacobs (2016) recommended the following preferred options for the Project:

- Scenario 3 - the preferred option: recycled wastewater for cooling towers, irrigation and toilet and urinal flushing, and roof water for all other uses; followed by
- Scenario 4 - the second preferred option, should roofwater not be considered feasible: recycled wastewater for cooling towers, irrigation, toilet and urinal flushing and all other uses. No rainwater use.

Water efficient fixtures and appliances were considered a normal and necessary part of the Project regardless. However, cooling towers are no longer being considered for the site.

Harvesting of rainwater from roofs along with reuse of rainwater was considered as the preferred option by Jacobs (2016). On further investigation, and given the high quality of recycled water proposed and therefore the uses it could supply, roofwater would provide benefit only for potable supplies, namely:

- Taps, basins and sinks (kitchens, handbasins);
- Drinking water; and
- Showers.

Given that a reticulated water supply is provided to the site via Council's water supply network, and the additional costs (capital and operational costs of roof and tank network, plus pumps, filters and treatment systems energy and chemical usage), it has been deemed that rainwater collection for these uses is not cost effective. Given the additional energy and chemical usage to provide potable water, on top of the wastewater treatment requirements, the Council supply would provide a less intensive supply on a per kilolitre basis. This is particularly relevant given the quantity of recycled water available on the site (in excess of daily demands), and the low potable water demand able to be achieved for the facility without rainwater capture.

As such, rainwater harvesting is not further considered in this report, and only the following two scenarios were assessed:

- Scenario 1 – Base Case: Traditional development with no recycling; and
- Scenario 4 - recycled wastewater for facility irrigation, toilet and urinal flushing and all other uses.

Scenario 1 was included to provide a comparison for the preferred option, and calculate demand and wastewater reductions achieved.

3.6 Water cycle outcomes

The outcomes from the modelling for Scenario 4 compared to the base case with no on-site reuse are shown in Table 3-3.

The differences between the Jacobs (2016) results and the current results are mainly due to:

- Explicit modelling of the WMCS in this report, and based on the detailed facility design; and
- Additional facility irrigation increasing average recycled water use and reducing wastewater discharge.

The percent reduction in potable demand has decreased slightly, although the actual demand has decreased markedly, and the percent reduction in wastewater discharge has dropped marginally, though again the actual volume is much less.

Table 3-3. Summary of Water Balance Results

Water Type	Scenario 1 - Base Case: Traditional Development (no recycling or rainwater use)	Scenario 4 – Recycled Wastewater Harvesting only	Jacobs (2016) Scenario 4 Results
Potable Water Demands			
Average Day Potable Water Demand	0.607	0.315	0.410
Peak Day Potable Water Demand (ML/d)	1.248[3]	0.584	0.530
% Reduction in Potable Water Demand	-	48%	36%[2]
Wastewater Flows			
Average Day Wastewater Flows (ML/d)	0.469	0.469	0.470
Peak Day Wastewater Flow (ML/d)	0.469	0.469	0.610
Average Wastewater Discharge (ML/d)	0.422[1]	0.115	0.230
Peak Wastewater Discharge (ML/d)	0.422	0.242	0.400
% Reduction in Wastewater Discharge	-	73%	51%[2]
Recycled Water System Demand			
Average Day Recycled Water System Use (ML/d)	0	0.292	0.240
• Facility (toilets, washdown, etc.)	-	0.179	-
• Facility Irrigation	-	0.113	-
Peak Day Recycled Water System Use (ML/d)	0	0.935	0.580

Table notes:

1 water losses represents solids and bound water in biosolids, evaporation, etc. – i.e. losses in treating and producing recycled water

2 calculated from the Jacobs (2016) Scenario 1 & 4 data – i.e. $\frac{(Scenario\ 1\ average - Scenario\ 4\ average)}{Scenario\ 1\ average}$

3 Peak potable demand is high due to use in facility irrigation. Actual use might be limited more if required to save potable water

This is shown figuratively in

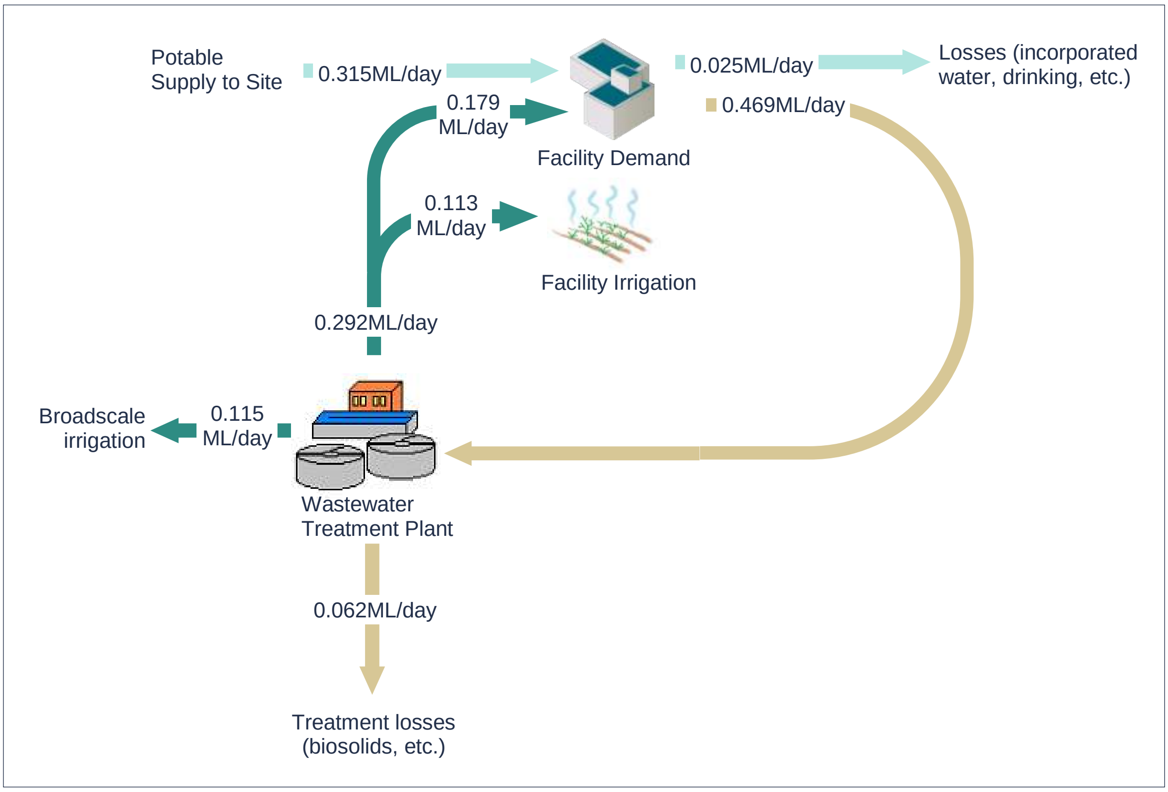

Figure 3-7. Water flow diagram (average model results)

3.7 Validation and Benchmarking

Table 3-4 shows the benchmarking data from Section 3.4.3 compared to the model outcomes for the preferred scenario. As noted in that section, this also includes the previous Jacobs (2016) results.

Based on the water balance and benchmark data, the water demand and sewage generation is in the expected range for the site, indicating the results are broadly achievable and realistic.

Table 3-4. Comparison of water demand and sewer flow benchmark rate with other Correctional Facilities

Facility / Source	Site particulars including typical flow rate	Flow On a per-inmate basis L/inmate/day
Water Demand		
Jacobs (2016)	Modelled Average Daily Water use, 410kL/day	241
Sevineratne (2007)	New South Wales Correctional Facilities range	320 – 1,290
	USA Correctional Facilities range	300 - 570
	UK Correctional Facilities range	320 - 390
New Grafton Correctional, Water Balance Results	1700 inmates, 315kL/day	185
Wastewater Generation		
Lotus Glen Correctional	900 inmates, 250-300kL/day, pressure sewer, commercial laundry (external clients)	280 - 340
Gatton Correctional	350 inmates, ~85kL/day, pressure sewer, water controls and recycling	~240
Rockhampton Correctional	1000 inmates, 450-600kL/day, limited recycling and water controls	450-600
Woodford Correctional	1000 inmates, ~400kL/day, limited recycling and water controls	440

Facility / Source	Site particulars including typical flow rate	Flow On a per-inmate basis L/inmate/day
Jacobs (2016) model results	Modelled Average Daily Wastewater Generation, 470kL/day	276
New Grafton Correctional, Water Balance Results	1700 inmates, 469kL/day	276

4 Summary and Conclusions

The previous modelling and water cycle assessment completed for the Stage 1 DA by Jacobs (2016) was based on the Project concept design, but recommended high levels of recycled water and harvested rainwater use on the site.

Given the large quantity of highly treated and high quality recycled water available, uses under which the rainwater would be supplied would include only 'potable-only' supplies such as sinks/basins, kitchens and showers. However, given that a Council water supply main will be connected to the site, this has been determined as not feasible.

As such, the detailed design has proceeded on the basis of maximising recycled water use on the site.

The water balance modelling shows that, with the WMCS to be implemented and high quality recycled water reuse, benchmarks provided in the Stage 1 DA concept assessment are similar to those in this report. Comparison of benchmark data from a range of other sites indicates the scheme is realistic and in the expected range.

The key outcomes from the model are as follows:

- Water supply requirements: supply requirement of 315kL/day;
- Wastewater Generation and Treatment Requirements: 469kL/day;
- Recycled Water Reuse: average 292kL/day, up to a maximum of 935kL/day; and
- Excess Recycled Water Requiring Disposal: average 115kL/day, up to a maximum of 242kL/day.

5 References

DPE (2017). State Significant Development Assessment Report: New Grafton Correctional Centre (SSD 7413). Environmental Assessment Report Section 89H of the Environmental Planning and Assessment Act 1979. NSW Department of Planning and Environment, March 2017

DSITIA (2016). Model for Effluent Disposal using Land Irrigation, Version 2: Technical Reference. Queensland Department of Science, Information Technology and Innovation, 13 September 2016.

Jacobs (2016). Water Cycle Management Working Paper. Prepared for Infrastructure New South Wales. Project No. IA101200, Version 7 (Final), Jacobs Australia Pty Limited, 10 November 2016.

Sedgman Consulting (2017). Wastewater Servicing Report. Report No. PRO-ENV-CD-RPT-00_506. Sedgman Consulting Pty Ltd, May 2017.

Sevineratne, M. (2007). A Practical Approach to Water Conservation for Commercial and Industrial Facilities. Queensland Water Commission

Woolacotts (2017). New Grafton Correctional Centre, Stage 2 – Stormwater Management Report. Report No. PRO_CIV_CD_RPT-02_001, Woolacotts Consulting Engineers, May 2017

Appendix A

Figures and Plans

AMMENDMENTS			
REV	BY	DATE	DESCRIPTION
A	MW	19.05.17	PRELIIMINARY
B	MW	22.05.17	MINOR UPDATES
C	MW	26.05.17	MINOR UPDATES
D	MW	26.05.17	MINOR UPDATES
E	MW	31.05.17	MINOR UPDATES

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(02) 9437 1000

HYDRAULIC
Sedgman
(07) 5578 8300

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WEB: www.ppa.com.au
Nominated Architect:
Vince Pedavoli NSW reg No.5045

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Webb Consulting
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LANDSCAPE
Lorna Harrison Pty Ltd
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QLD 4215 AUSTRALIA
T 07 5558 4200 consult@sedgman.com
www.sedgman.com/sedgman-consulting

NEW GRAFTON CORRECTIONAL CENTRE PPP
313 Avenue Rd, Lavadia NSW 2462

DRAWING NAME
BROADSCALE IRRIGATION AREAS

PROJECT NORTH
NORTH

0 150 300m

SCALE 1:3000 @ A1
22 MAY 2017

DRAWING NUMBER
SECTOR DISCIPLINE PHASE TYPE SERIES NUMBER
PRO-ENV-CD-DWG-00_500

REVISION
E

Appendix B

Input Data

B1 – Input Data Tables

Table B1. Input data for Water Balance Model

Aspect	Details				
Fixture Flow Rates[a]			Inmate, staff and visitor numbers[b]	Standard	Accessible / Disabled bathroom users	Total
WC	4.5/3	L full/half flush	Male maximum cells	875	19	894
Handbasin taps	5	L/min	Male Maximum Residential	136	8	144
Kitchen/kitchenette taps	6	L/min	Male Minimum Residential	380	20	400
Showers	6	L/min	Female Maximum Cells	125	5	130
Laundry	60	L/wash	Female Maximum Residential	104	8	112
			Female Maximum Cottage	63	7	70
			subTotal	***1683***	***67***	***1750****
			Staff	570	Full Time Equiv. per day	
			Visitors	350	per day[d]	

Water Management System for inmates (maximum uses/day and time/use. WC is full/half flushes)[e]

	WC				Hand basins				Showers				Kitchenette taps				Extra Flow Allowance	Washing Machines
Male maximum cells	7	full	7	half	16	x	0.5	min/use	4	min x	2	uses/day	8	x	1	min/use	0%	Each machine used
Male Maximum Residential + 20% allowance above base line	7	full	7	half	16	x	0.5	min/use	4	min x	2	uses/day	8	x	1	min/use +	20%	2 x per day[g]
Male Minimum Residential + 25% allowance above base line	7	full	7	half	16	x	0.5	min/use	4	min x	2	uses/day	8	x	1	min/use +	25%	Total machines[c] = 140
Female Maximum Cells	7	full	7	half	16	x	0.5	min/use	6	min x	2	uses/day	8	x	1	min/use +	0%	
Female Maximum Residential + 20% allowance above base line	7	full	7	half	16	x	0.5	min/use	6	min x	2	uses/day	8	x	1	min/use +	20%	
Female Maximum Cottage + 25% allowance above base line	7	full	7	half	16	x	0.5	min/use	6	min x	2	uses/day	8	x	1	min/use +	25%	
Accessible Cells/Bathrooms for Male and Female.	7	full	7	half	16	x	0.5	min/use	10	min x	2	uses/day	8	x	1	min/use		
Average Flow Rate (L/inmate/day)[f]	57.56				43.86				57.45				52.63					9.6
% to sewer	100%				100%				100%				80%					100%

Staff and Visitors[a]

	WC				Handbasins				Showers				Kitchenette taps				Washing Machine	
Staff	1	full	3	half	8	x	0.15	min/use	5	min x	0.25	uses/day	4	x	0.5	min/use	0	uses/day
Visitors	1	full	1	half	2	x	0.15	min/use	5	min x	0.00	uses/day	2	x	0.5	min/use	0	uses/day

Facility Laundry[i]					Common Kitchen		
	Washes/day		Total Washes	L/wash		Meals / day	L/meal
Common laundry	6	washes x	36	980	Inmates	3	5
	6	machines			Staff	2	5

Other

Washdown[k]	100 spigot points; 0.3L/s x 10 min per point = 180 L/point/day				18000	L/day			
Irrigation[l]	Priority area:	93500	m^2						
	Secondary Area:	31500	m^2						
Leakage[m]	Supply =	1%	of flow; sewer infiltration/inflow =	1%	of flow				
Recovery[n]	BWTP recovery =	90%							
Sludge Production[n]	10%	of flow,	1%	solids,	16%	solids after dewatering,	0.8	t/m3 dewatered solids	
Recycled Water End Uses	Personal Usage: WC:	100%	Taps:	0%	Showers:	0%	Residential/Cottage washing machines:	100%	
	Facility Usage: Laundry:	100%	Kitchen:	0%	Washdown:	100%	Facility Irrigation:	100%	

Sewer Rates[o]

Washing Machines	93%	to sewer
Common Kitchen	95%	to sewer
Facility Laundry	93%	to sewer
Washdown	100%	to sewer

Table notes:

* Count represents numbers for each type of room, used in calculating overall water demand per inmate. Actual flows calculated on 1700 inmates only

a Hydraulic design for fixtures

b Calculated based on design plans - single, double bedrooms/cells with access (i.e. disabled) rooms identified separately.

c Calculated based on design plans, allowing for 2 machines per laundry room

d Supplied by Serco based on existing operational experience e Developed by Hydraulics designers and Serco. Represents maximum water use rates to be allowed for inmates

f Calculated value based on WMS inputs - for comparison purposes

g Assumed rate

i Information from Food Services Design Australia (Laundry designers)

j Assumed numbers

k Assumed based on hydraulic design - worst case

l Data from irrigation designers (for internal facility areas only). Priority refers to areas that must be irrigated. Secondary areas that could or would be beneficial to irrigate

m Assumed rates

n Information from plant suppliers. Assumed rate

o Assumed - common to assume 95% conversion of water use to sewer. Kitchenette taps calculated to provide close to 95% overall for inmates.

Table B2. MEDLI Inputs

Parameter	Value
Climate data	NGCC Site 29.75^0 S, 153.05^0 E (SILO Data Drill data, https://www.longpaddock.qld.gov.au/silo/), with run period 1967 to 2016.
Crop	MEDLI default values for Kikuyu 1 Pasture.
Waste Stream	Unlimited (10ML/month) Nitrogen – 10 mg/L Phosphorous – 5 mg/L TDS – 1,024 mg/L Electrical Conductivity - 1.6 dS/m
Pond	Open Lagoon, 2:1 length: width ratio; 4 m deep; 45^0 side slopes. 100% withdrawal limit applied.
Irrigation	Fixed Sprinkler 9.35ha Trigger – Every 3 days Irrigate – to 0mm above drained upper limit (i.e. up to the DUL)
Pump Limit	864kL/day

Table B3. Adopted MEDLI Soil Model

Flagstone Duplex					
Item	Units	Data			
Profile		Layer 1	Layer 2	Layer 3	Layer 4
Layer Thickness	mm	17.7	19	23.7	26.2
Air Dry Moisture Content	%v/v	32.7	34	36	32.3
Lower Storage Limit	%v/v	15	37.5	86.1	27.45
Drained Upper Limit	%v/v	36	38	39.8	42.8
Saturated Water Content	mm	1.63	1.64	1.58	1.5
Available Water Capacity	%v/v	38.5	38.1	40.4	43.4
BD	g/cm3	10	5	2	0.5
Porosity	%v/v	17.7	19	23.7	26.2
Saturated Hydraulic Conductivity	mm/day	32.7	34	36	32.3
Rooting Depth	mm	1200			
Profile Available Water Capacity	mm	171.45			
Runoff					
Runoff curve No II		80			
Soil Evaporation					
Cona	mm/day0.5	4			
Uritch	mm	10			
Lag		0.73			
Wet day factor		0.49			
albedo		0.23			
Soil Starting Nitrogen					
Nitrate N	mg/kg	2.5			
Organic N	mg/kg	100			
Soil Phosphorous		Layer 1	Layer 2	Layer 3	Layer 4
Initial Soil Phosphorous	mg/kg	9	9	7	7
Freundlich Ads. Coeff., a		114	150	310	310

Flagstone Duplex					
Item	Units	Data			
Freundlich ads. Exponent, b		0.32	0.25	0.21	0.21
Freundlich Desorp. Exp., bn		0.13	0.10	0.060	0.060

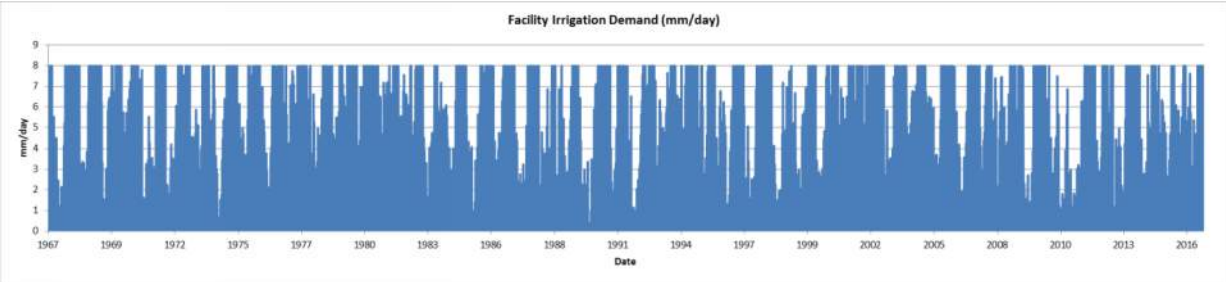


Figure B1. Facility Irrigation Rates (mm/day)

B2 – MEDLI Output for Facility Irrigation

(note: refer to the Wastewater Servicing Report (Sedgman Consulting, 2017) for more information regarding MEDLI

MEDLI REPORT - FULL RUN

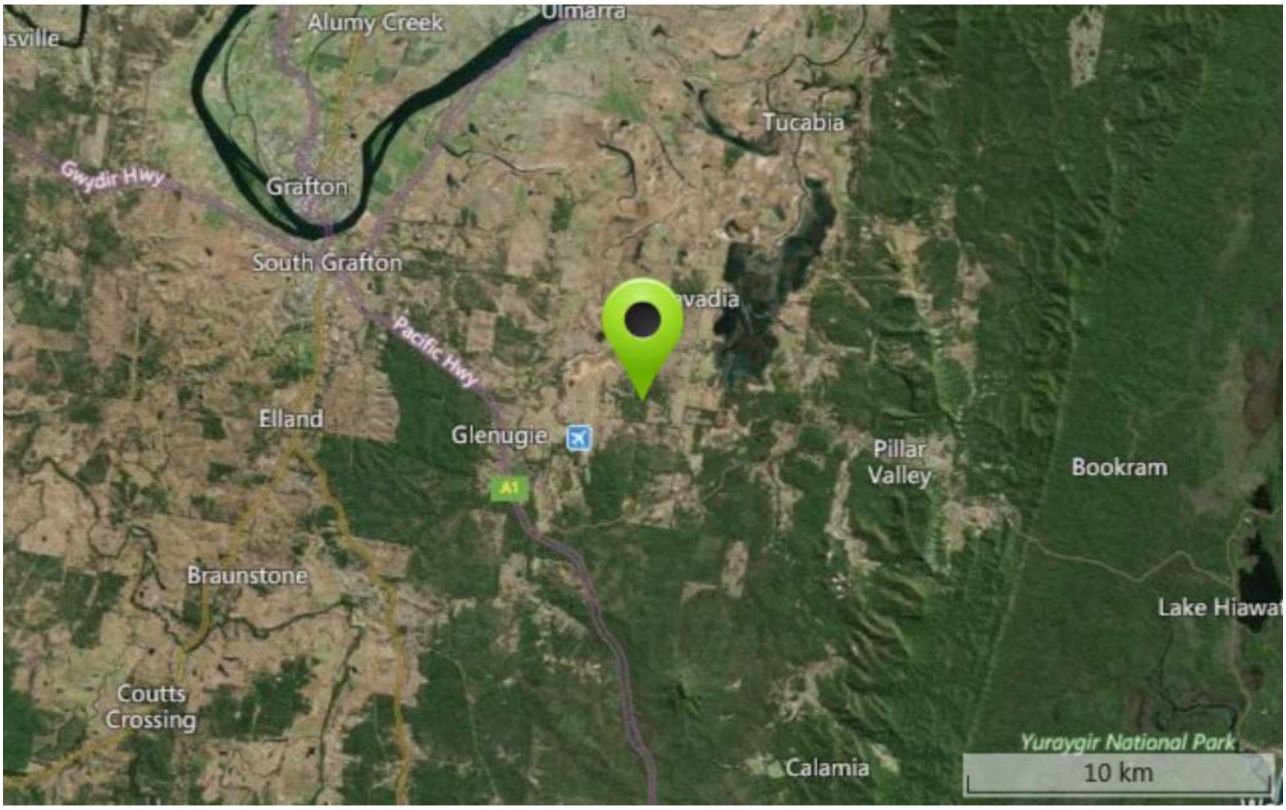
Enterprise: **Facility Irrigation - Priority Areas**

Description:
Priority irrigation areas

Client: **Internal**

MEDLI User: Marc Walker

Scenario Details:



DESCRIPTION

Climate Data: 29.75S 153.05E NGCC_Grafton_DataDrill, -29.75°, 153.05°

Run Period: 01/01/1967 to 31/12/2016 50 years, 0 days

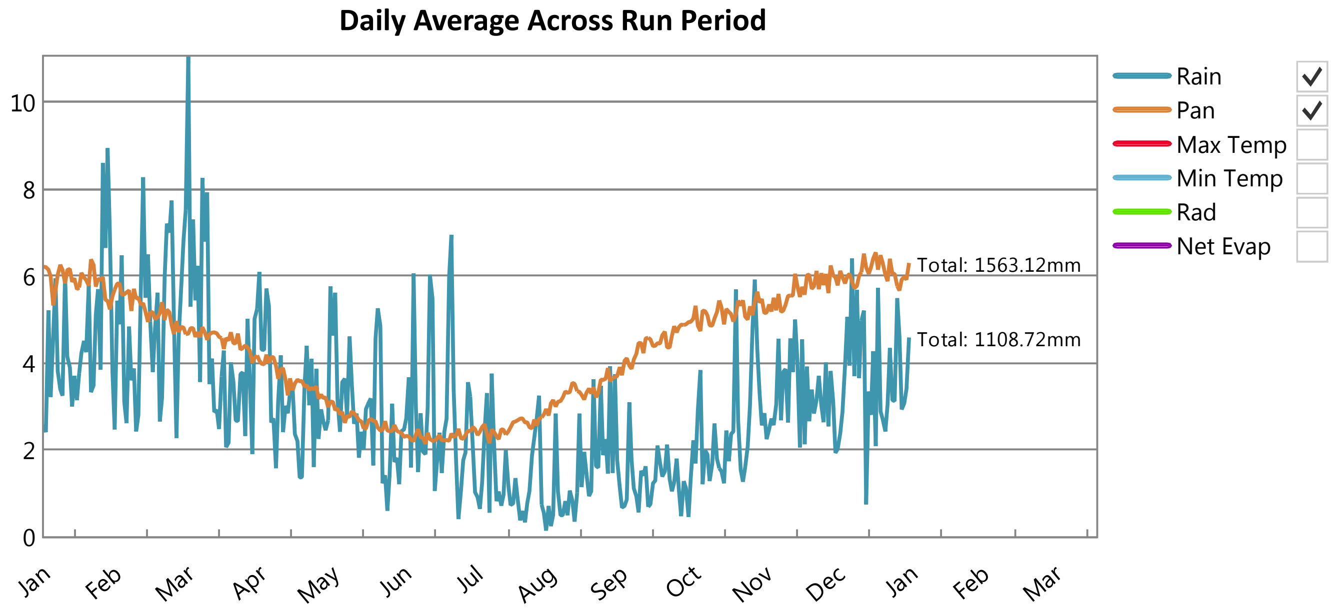
Climate Statistics:

	5th Percentile	50th Percentile	95th Percentile
Rainfall (mm/year)	654	1044	1545
Pan Evaporation (mm/year)	1413	1562	1690

Climate Data:

■ Chart ☐ Table

☐ Monthly ■ Daily



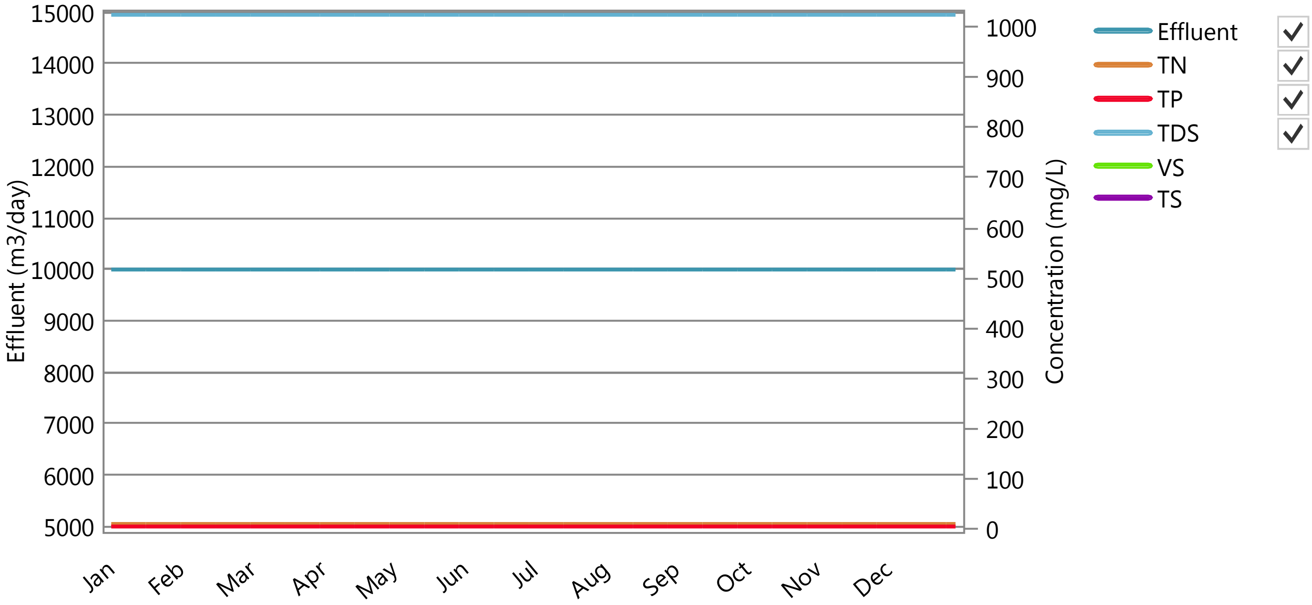
DESCRIPTION

Effluent type: New Sewage Treatment Plant

Wastestream before any recycling or pretreatment

Average daily quantity and flow-weighted average quality:

Chart Table



Wastestream after any recycling and pretreatment if applicable

Effluent quantity: 3652600.00 m3/year or 10000.00 m3/day (Min-Max: 10000.00 - 10000.00)

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

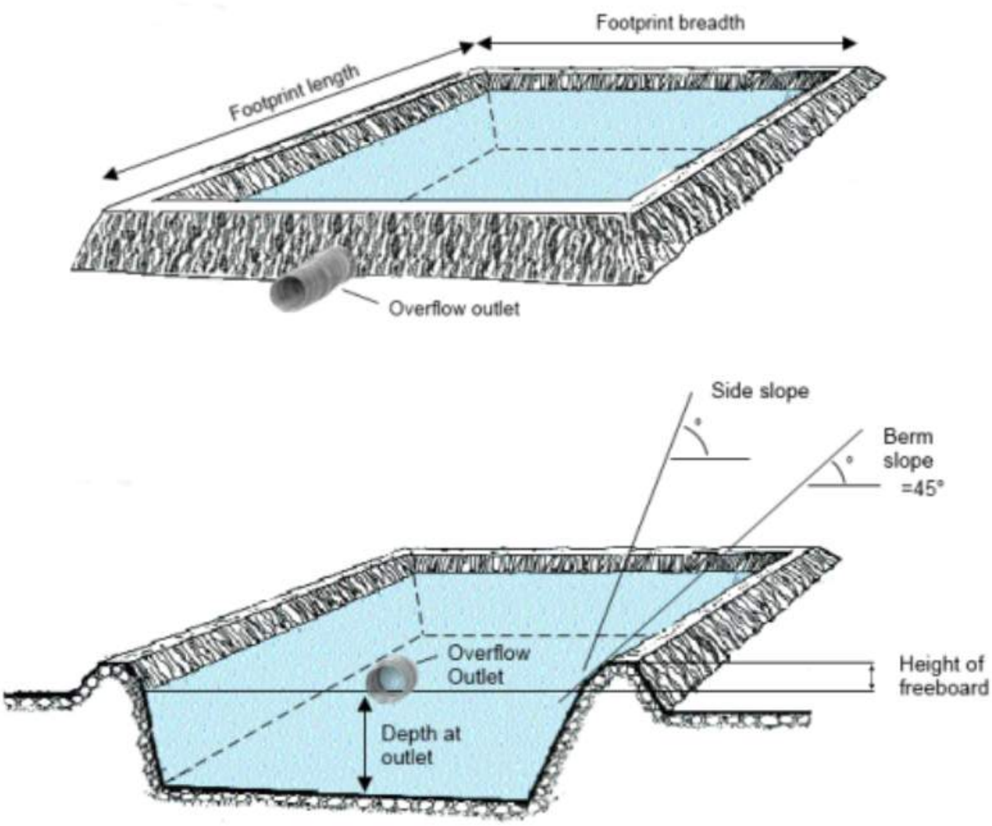
	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	10.00 (10.00 - 10.00)	36526.00 (36500.00 - 36600.00)
Total Phosphorus	5.00 (5.00 - 5.00)	18263.00 (18250.00 - 18300.00)
Total Dissolved Salts	1024.00 (1024.00 - 1024.00)	3740262.40 (3737600.00 - 3747840.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

DESCRIPTION

Pond system: 1 facultative, aerobic or storage pond

Pond system details:

	Pond 1
Maximum pond volume (m3)	50000.00
Minimum allowable pond volume (m3)	0.00
Pond depth at overflow outlet (m)	4.00
Maximum water surface area (m2)	13463.22
Pond footprint length (m)	166.09
Pond footprint width (m)	84.05
Pond catchment area (m2)	13959.50
Average active volume (m3)	49891.95



Irrigation pump limits:

Minimum pump rate limit (ML/day)	0.00
Maximum pump rate per area limit (ML/day/ha)	0.08

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

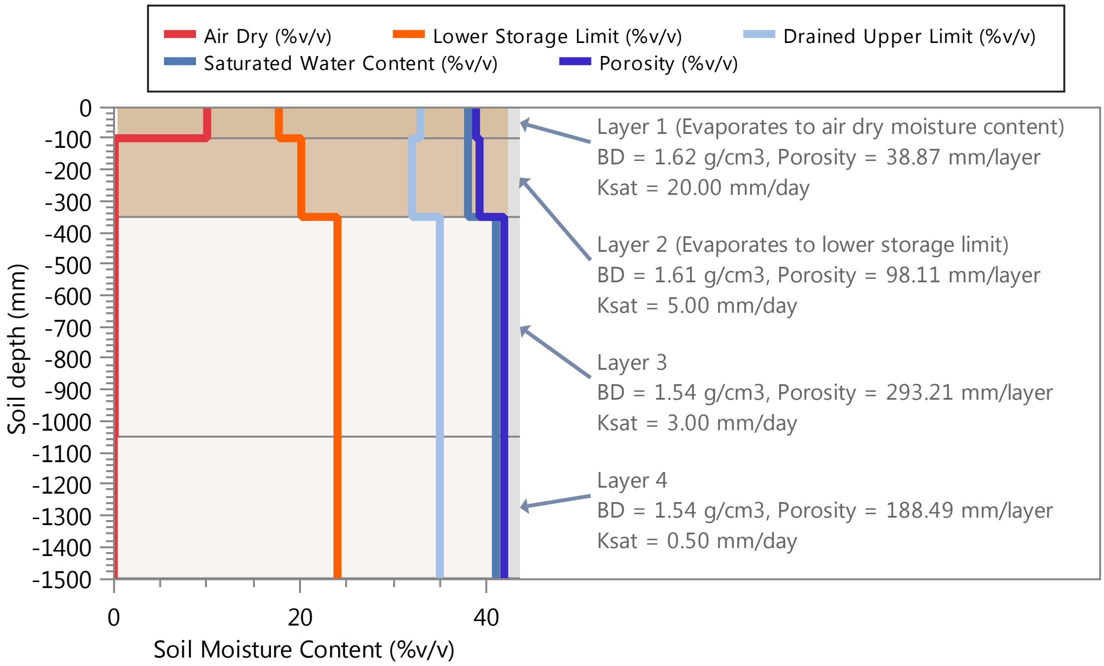
DESCRIPTION

Land: Priority Irrigation Area

Area (ha): 9.35

Soil Type: NGCC_Soil_1, 1500.00 mm defined profile depth

Profile Porosity (mm)	618.68
Profile saturation water content (mm)	604.50
Profile drained upper limit (or field capacity) (mm)	515.40
Profile lower storage limit (or permanent wilting point) (mm)	343.95
Profile available water capacity (mm)	171.45
Profile limiting saturated hydraulic conductivity (mm/day)	0.50
Surface saturated hydraulic conductivity (mm/day)	20.00
Runoff curve number II (coefficient)	80.00
Soil evaporation U (mm)	10.00
Soil evaporation Cona (mm/sqrt day)	4.00



Plant Data: Continuous Kikuyu 1 Pasture

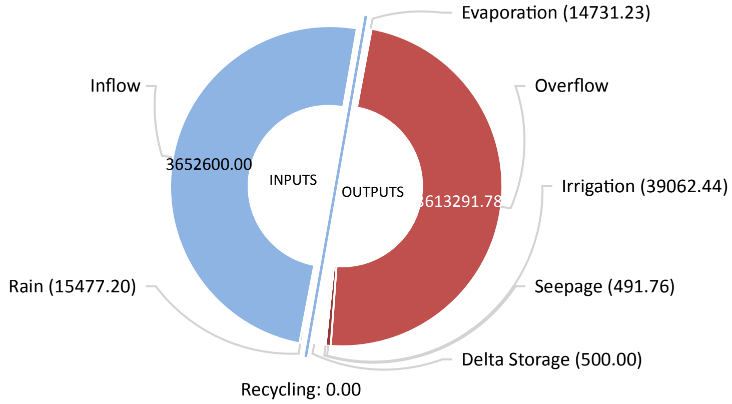
Average monthly cover (%) (minimum - maximum)	87.51 (84.11 - 89.54)
Maximum crop factor at 100% cover (mm/mm) (Maximum crop coefficient 0.8 x Pan coefficient 1)	0.80
Total plant cover (both green and dead) left after harvest (%)	100.00
Maximum potential root depth in defined soil profile (mm)	1200.00
Salt tolerance	Moderately tolerant
Salinity threshold EC sat. ext. (dS/m)	3.00
Proportion of yield decrease per dS/m increase (%/dS/m)	3.00

PERFORMANCE

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

Capacity of wet weather storage pond: **50000 m3**

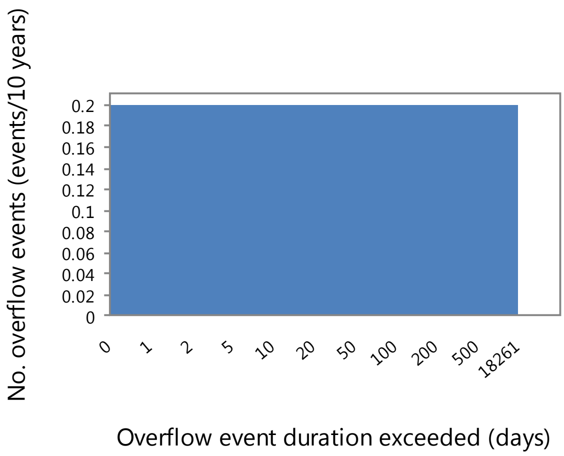
Pond System Water Balance (m3/year)

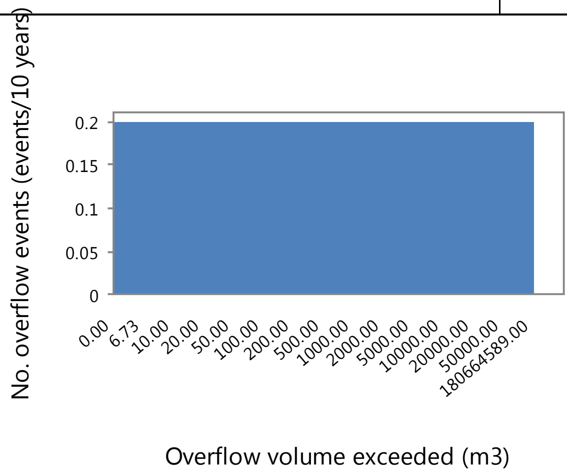


Name	Value
Rain	15477.20
Inflow	3652600.00
Recycling	0.00
Evaporation	14731.23
Overflow	3613291.78
Irrigation	39062.44
Seepage	491.76
Delta Storage	500.00

Overflow Diagnostics

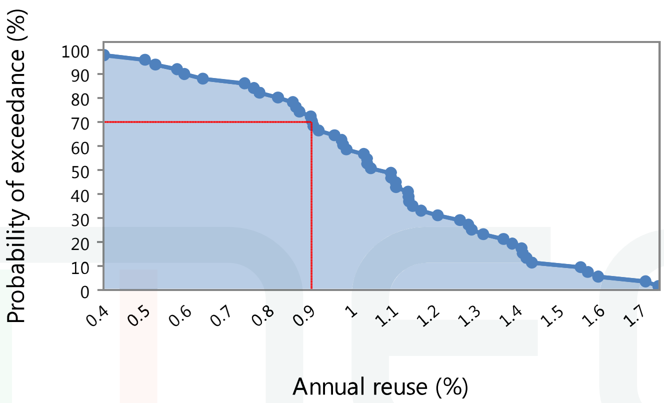
Volume of overflow (m3/year)	3613291.78
No. days pond overflows (days/year)	365.22
Average duration of overflow (days)	18261.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (%)	1.07
Probability of at least 90% reuse (%)	0.00





Export plot

Export plot



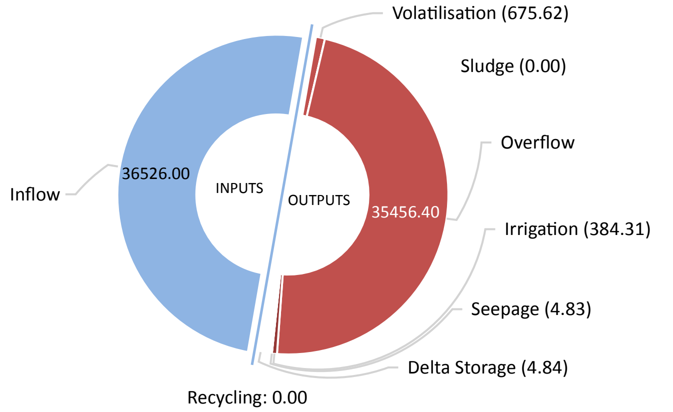
Export plot

PERFORMANCE

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

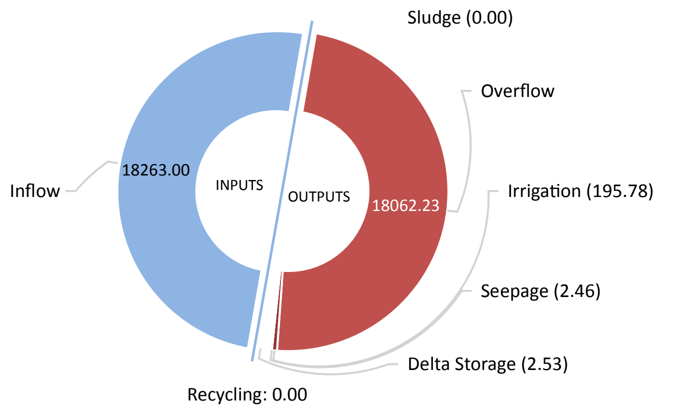
Pond System Nutrients and Salt Balance:

Nitrogen Balance (kg/year)



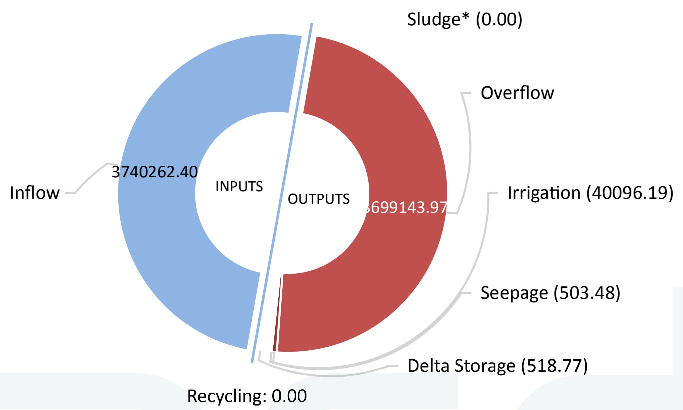
Name	Value
Inflow	36526.00
Recycling	0.00
Volatilisation	675.62
Sludge	0.00
Overflow	35456.40
Irrigation	384.31
Seepage	4.83
Delta Storage	4.84

Phosphorus Balance (kg/year)



Name	Value
Inflow	18263.00
Recycling	0.00
Sludge	0.00
Overflow	18062.23
Irrigation	195.78
Seepage	2.46
Delta Storage	2.53

Salt Balance (kg/year)



Name	Value
Inflow	3740262.40
Recycling	0.00
Sludge*	0.00
Overflow	3699143.97
Irrigation	40096.19
Seepage	503.48
Delta Storage	518.77

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

Pond System Sludge Accumulation: 0.00 kg dwt/year

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

Pond Nutrient Concentrations and Salinity:

Average across simulation period	Pond 1
Average nitrogen concentration of pond liquid (mg/L)	9.78
Average phosphorus concentration of pond liquid (mg/L)	5.00
Average salinity of pond liquid (dS/m)	1.60

Value on final day of simulation period	Pond 1
Final nitrogen concentration of pond liquid (mg/L)	9.84
Final phosphorus concentration of pond liquid (mg/L)	5.03
Final salinity of pond liquid (dS/m)	1.61

PERFORMANCE

PERFORMANCE

Irrigation Performance:

Water Use: (assumes 100% Irrigation Efficiency)

Pond water irrigated (m3/year)	39062.44
Average Shandy water irrigation (m3/year) (minimum - maximum)	0.00 (0.00 - 0.00)
Total water irrigated (m3/year)	39062.44
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)	9.84
Average nitrogen concentration of irrigation water - after ammonia loss during irrigation (mg/L)	8.26
Average phosphorus concentration of irrigation water (mg/L)	5.01
Average salinity of irrigation water (dS/m)	1.60

Irrigation Diagnostics:

Proportion Days Irrigation Turned Off (%)	66.67
Proportion of Days no irrigation occurs for some other reason (%)	7.70
Proportion of Days irrigation occurs (%)	25.63

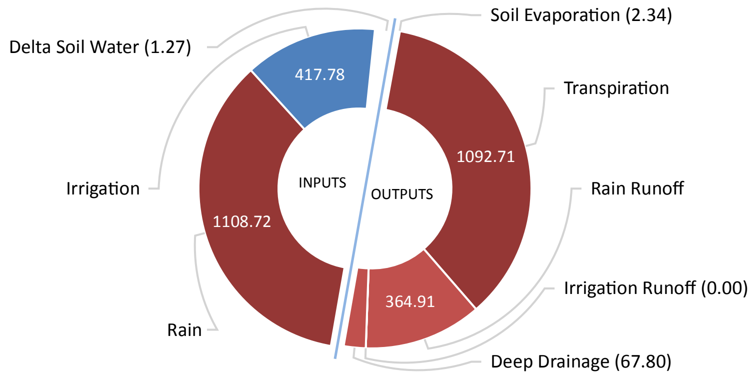
PERFORMANCE

Land Performance - Soil Water

Paddock: Priority Irrigation Area, 9.35 ha
Soil Type: NGCC_Soil_1, 138.45 mm PAWC at maximum root depth

Land Water Balance (mm/year):

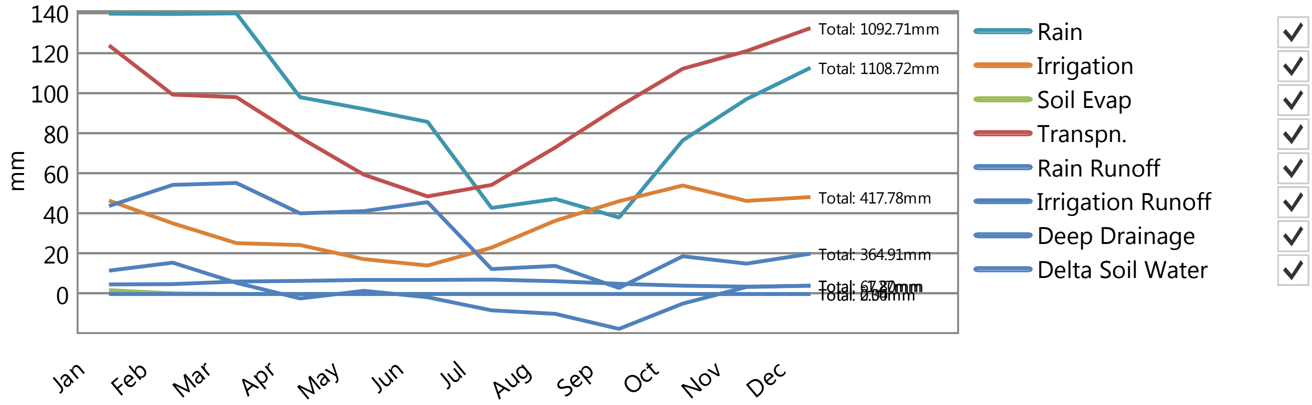
■ mm/year ☐ % Total inputs



Name	Value
Rain	1108.72
Irrigation	417.78
Soil Evaporation	2.34
Transpiration	1092.71
Rain Runoff	364.91
Irrigation Runoff	0.00
Deep Drainage	67.80
Delta Soil Water	-1.27

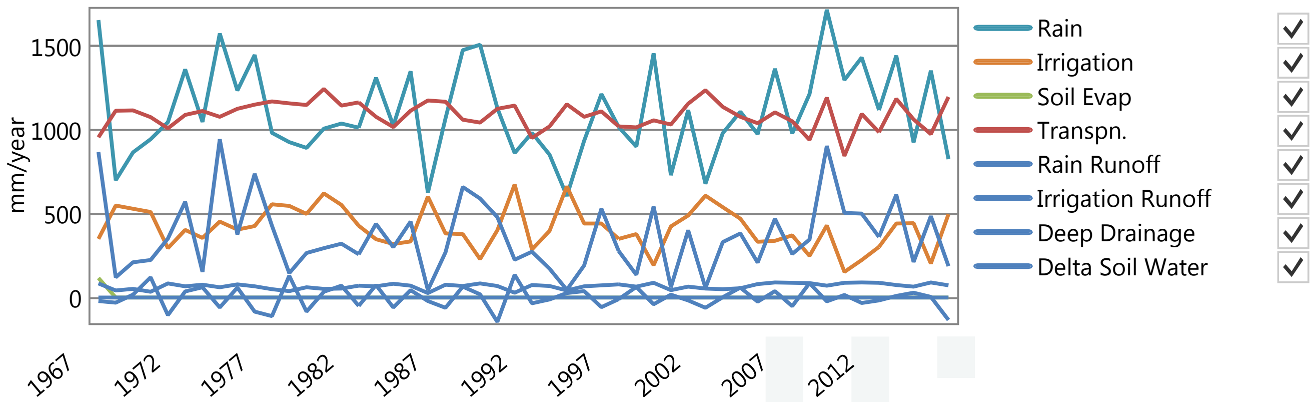
Average Monthly Totals (mm):

■ Chart ☐ Table



Average Annual Totals (mm/year):

■ Chart ☐ Table



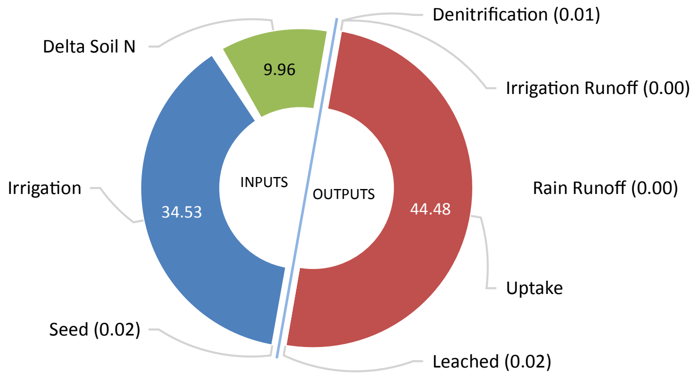
PERFORMANCE

Land Performance - Soil Nutrient

Paddock: Priority Irrigation Area, 9.35 ha **Soil Type**: NGCC_Soil_1

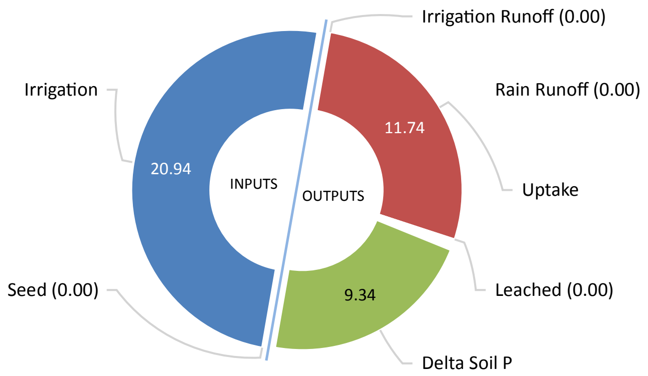
Irrigation ammonium volatilisation losses (kg/ha/year): 6.58
Proportion of total nitrogen in irrigated effluent as ammonium (%): 80.00

Land Nitrogen Balance (kg/ha/year)



Name	Value
Seed	0.02
Irrigation	34.53
Denitrification	0.01
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	44.48
Leached	0.02
Delta Soil N	-9.96

Land Phosphorus Balance (kg/ha/year)



Name	Value
Seed	1.80E-03
Irrigation	20.94
Irrigation Runoff	0.00
Rain Runoff	0.00
Uptake	11.74
Leached	7.75E-06
Delta Soil P	9.34

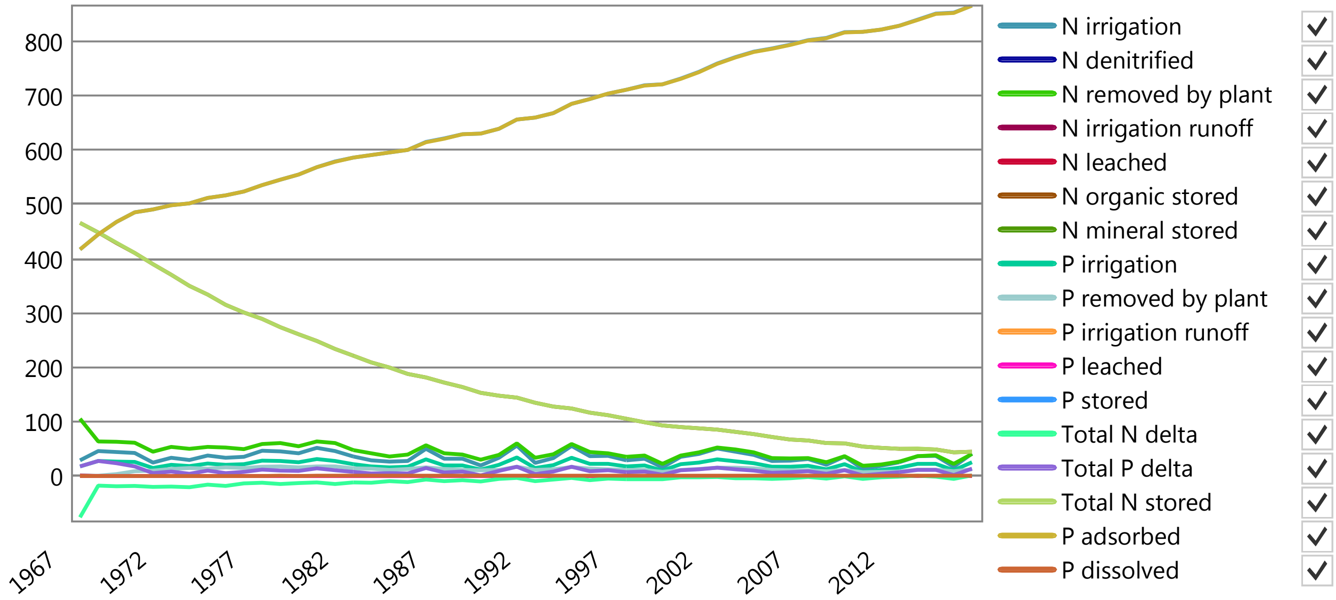
PERFORMANCE

Land Performance - Soil Nutrient

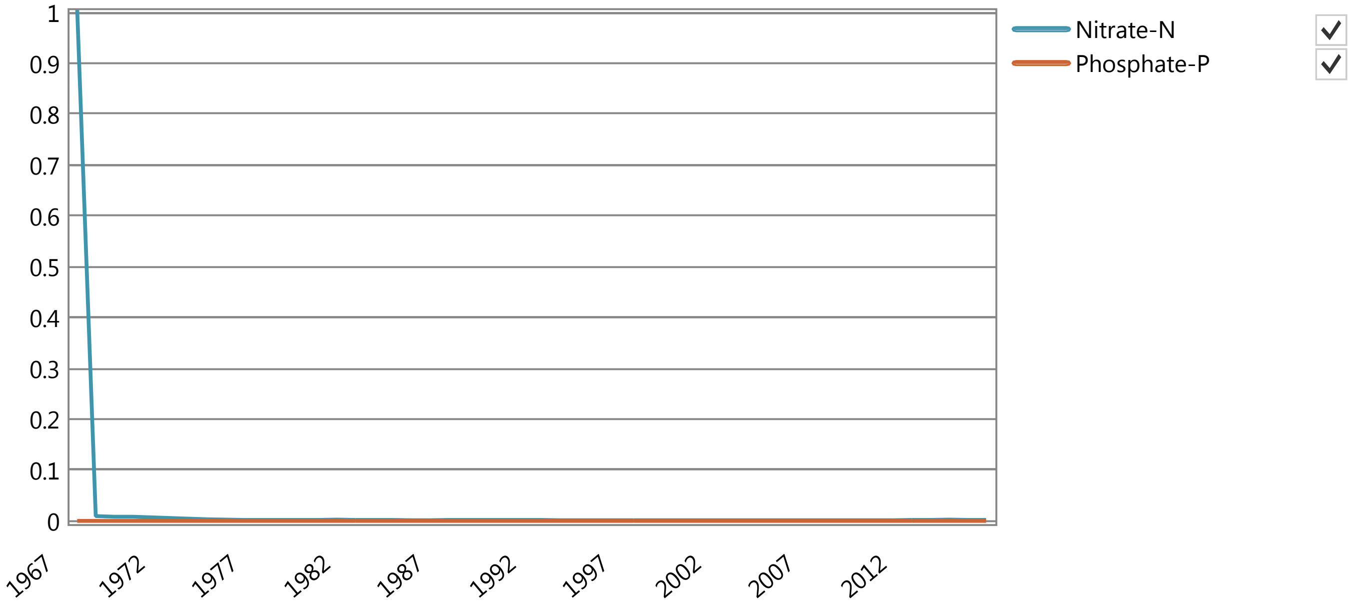
Paddock: Priority Irrigation Area, 9.35 ha

Soil Type: NGCC_Soil_1

Annual Nutrient Totals (kg/ha):



Annual Nutrient Leaching Concentration (mg/L):



PERFORMANCE

Plant Performance and Nutrients

Paddock: Priority Irrigation Area, 9.35 ha **Soil Type**: NGCC_Soil_1

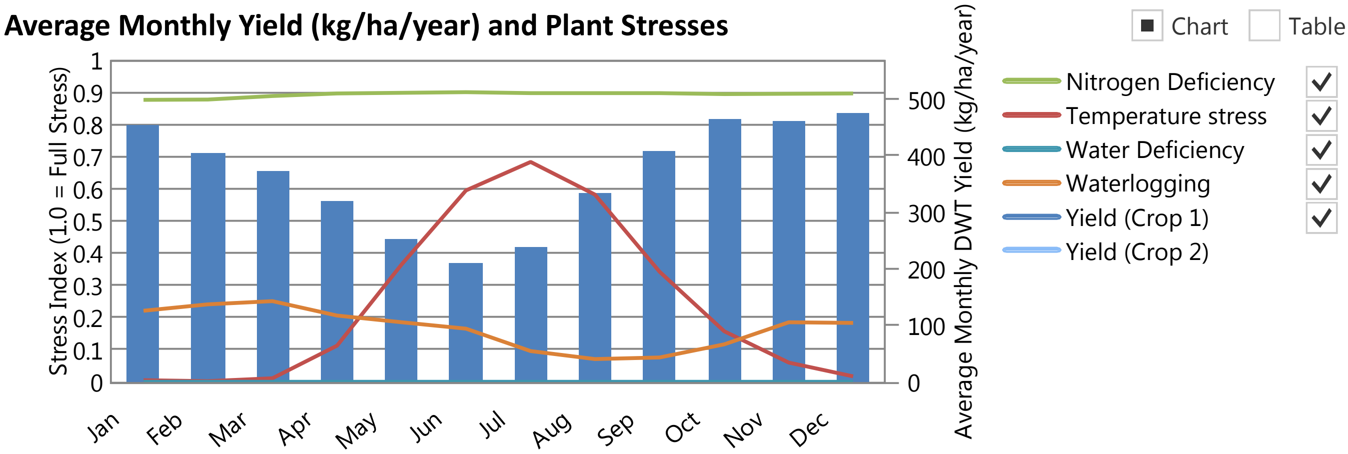
Plant: Continuous Kikuyu 1 Pasture

Average annual shoot dry matter yield (kg/ha/year)	4403.79 (2276.86 - 8892.48)
Average monthly plant (green) cover (%) (minimum - maximum)	87.51 (84.11 - 89.54)
Average monthly root depth (mm) (minimum - maximum)	1198.53 (1184.69 - 1200.00)

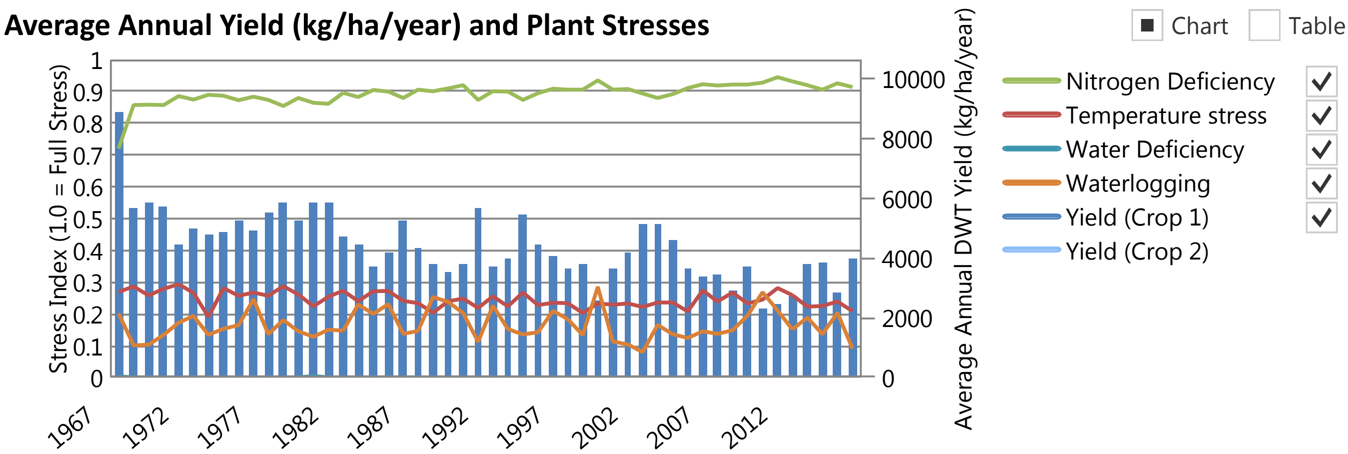
Nutrient Uptake (minimum - maximum):

Average annual net nitrogen removed by plant uptake (kg/ha/year)	44.48 (18.60 - 105.01)
Average annual net phosphorus removed by plant uptake (kg/ha/year)	11.74 (0.09 - 17.63)
Average annual shoot nitrogen concentration (fraction dwt)	0.01 (0.01 - 0.01)
Average annual shoot phosphorus concentration (fraction dwt)	0.003 (0.000 - 0.003)

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



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



No. of harvests/year: 0.78 (normal)
No. days without crop/year (days/year): 0.00

PERFORMANCE

Land Performance

Paddock: Priority Irrigation Area, 9.35 ha **Soil Type**: NGCC_Soil_1

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 (%/dS/m)	3.00
No. years assumed for leaching to reach steady-state (years)	10.00

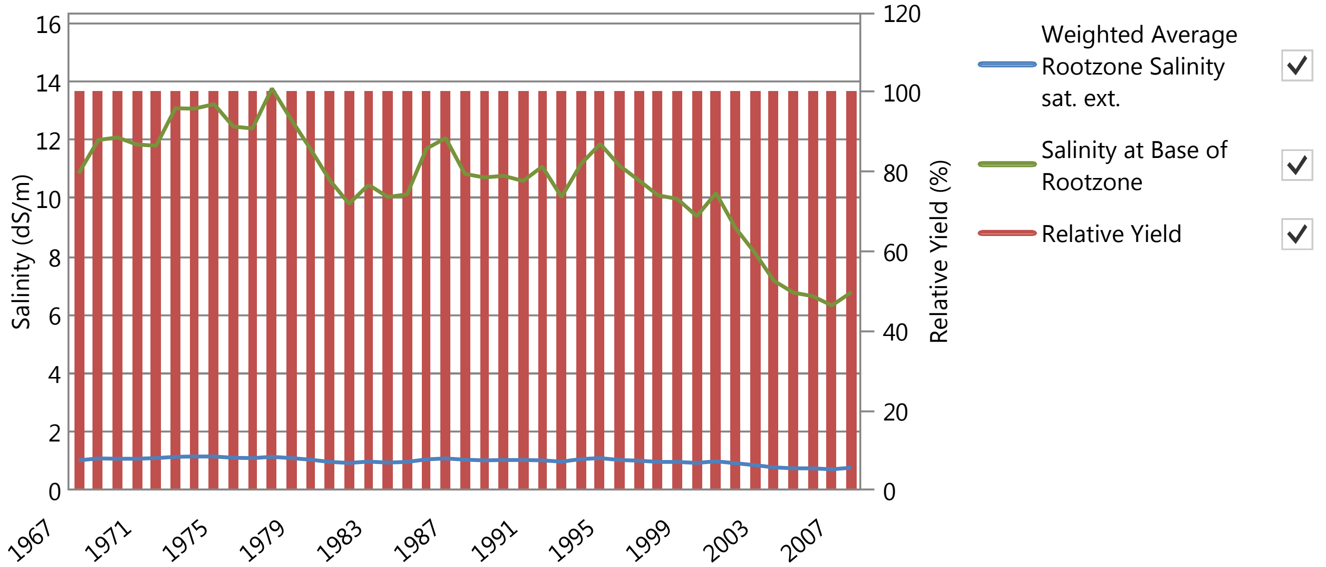
Soil Salinity:

Salinity of infiltrated water (Average salinity of rainwater = 0.03 dS/m) (dS/m)	0.60
Salt added by rainfall (kg/ha/year)	142.81
Average annual effluent salt added & leached at steady state (kg/ha/year)	4431.17
Average leaching fraction based on 10 year running averages (fraction)	0.27
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.01
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	10.61
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



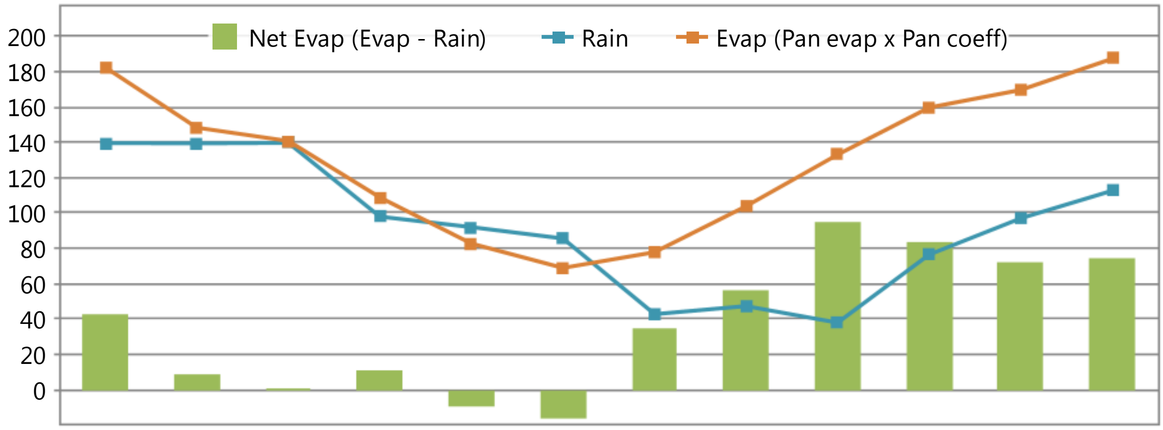
DIAGNOSTICS

Sustainability Diagnostics: Facility Irrigation - Priority Areas

Averaged Historical Climate Data Used in Simulation (mm)

Location: 29.75S 153.05E NGCC_Grafton_DataDrill, -29.75°, 153.05°

Run Period: 01/01/1967 to 31/12/2016 50 years, 0 days



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	139.5	139.4	139.6	98.0	92.1	85.6	42.9	47.4	38.0	76.5	97.0	112.7	1108.7
Evap	182.3	148.3	140.7	108.8	82.7	69.0	77.9	103.9	133.0	159.7	169.6	187.2	1563.1
Net Evap	42.8	8.9	1.1	10.9	-9.3	-16.6	35.0	56.5	95.0	83.1	72.5	74.6	454.4
Net Evap/day	1.4	0.3	0.0	0.4	-0.3	-0.6	1.1	1.8	3.2	2.7	2.4	2.4	1.2

DIAGNOSTICS

Sustainability Diagnostics: Facility Irrigation - Priority Areas

Pond System: 1 facultative, aerobic or storage pond

New Sewage Treatment Plant - 3652600.00 m3/year or 10000.00 m3/day generated on average

Effluent entering pond system after any pretreatment and recycling

Average (Minimum-Maximum) influent quality calculated for 365.26 non-zero flow days, after any pretreatment and recycling.

Constituent	Concentration (mg/L)	Load (kg/year)
Total Nitrogen	10.00 (10.00 - 10.00)	36526.00 (36500.00 - 36600.00)
Total Phosphorus	5.00 (5.00 - 5.00)	18263.00 (18250.00 - 18300.00)
Total Dissolved Salts	1024.00 (1024.00 - 1024.00)	3740262.40 (3737600.00 - 3747840.00)
Volatile Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)
Total Solids	0.00 (0.00 - 0.00)	0.00 (0.00 - 0.00)

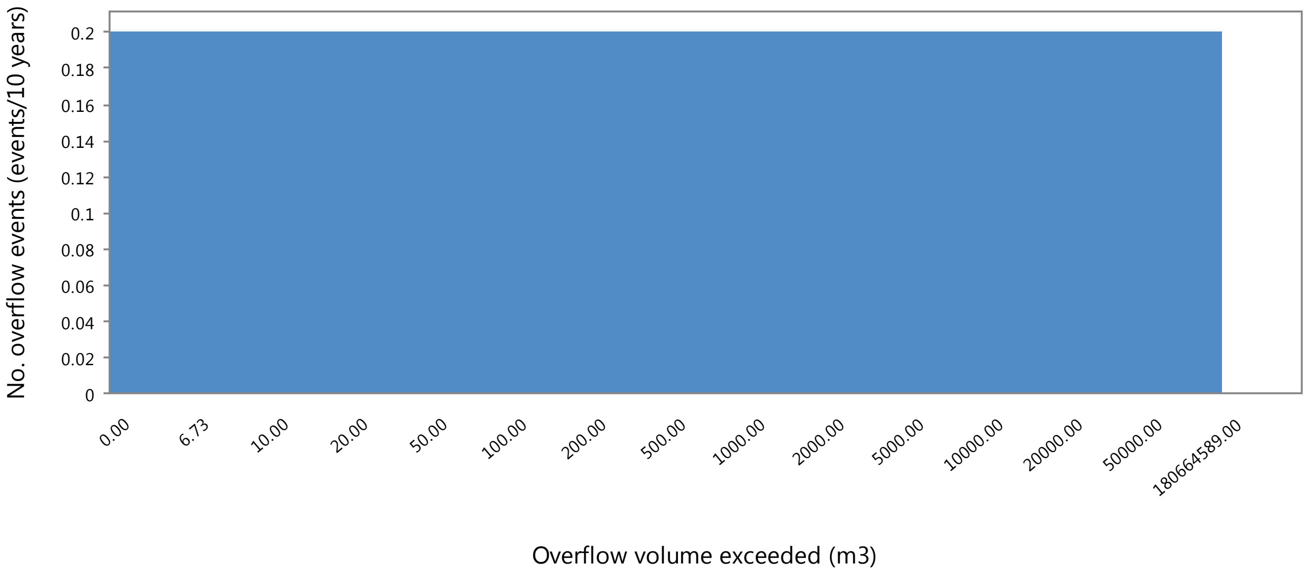
Last pond (Wet weather store): 50000.00 m3

Theoretical hydraulic retention time (days)	5.00
Average volume of overflow (m3/year)	3613291.78
No. overflow events per year exceeding threshold* of 6.73 m3 (no./year)	0.02
Average duration of overflow (days)	18261.00
Effluent Reuse (Proportion of Inflow + Net Rain Gain that is Irrigated) (%)	1.07
Probability of at least 90% effluent reuse (%)	0.00
Average salinity of last pond (dS/m)	1.60
Salinity of last pond on final day of simulation (dS/m)	1.61
Ammonia loss from pond system water area (kg/m2/year)	2.51

* 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: Facility Irrigation - Priority Areas

Irrigation Information

Irrigation: 9.35 ha total area (assumed 100% irrigation efficiency)

	Quantity/year	Quantity/ha/year
Total irrigation applied (m3)	39062.44	4177.80
Total nitrogen applied (kg)	322.82	34.53
Total phosphorus applied (kg)	195.78	20.94
Total salts applied (kg)	40096.19	4288.36

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 turned off (%)	66.67
Proportion of Days no irrigation occurs for some other reason (%)	7.70
Proportion of Days irrigation occurs (%)	25.63

DIAGNOSTICS

Sustainability Diagnostics: Facility Irrigation - Priority Areas

Paddock Land: Priority Irrigation Area: 9.35 ha

Irrigation: Fixed Sprinkler with 20% ammonium loss during irrigation

Irrigation triggered every 3 days
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): NGCC_Soil_1, 138.45 mm PAWC at maximum root depth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rain	139.5	139.4	139.6	98.0	92.1	85.6	42.9	47.4	38.0	76.5	97.0	112.7	1108.7
Irrigation	46.5	35.3	25.4	24.4	17.4	14.3	23.2	36.5	46.2	54.0	46.3	48.3	417.8
Soil Evap	2.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Transpn.	123.8	99.2	97.9	77.9	59.4	48.7	54.4	73.0	93.3	112.1	120.9	132.2	1092.7
Rain Runoff	43.8	54.4	55.4	40.2	41.3	45.7	12.6	14.2	3.1	18.9	15.2	20.2	364.9
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	4.8	5.0	6.2	6.6	7.1	7.1	7.2	6.5	5.2	4.2	3.7	4.3	67.8
Delta	11.7	15.7	5.6	-2.2	1.6	-1.6	-8.1	-9.7	-17.3	-4.8	3.6	4.3	-1.3

Soil Nitrogen Balance

Average annual effluent nitrogen added (kg/ha/year)	34.53
Average annual soil nitrogen removed by plant uptake (kg/ha/year)	44.48
Average annual soil nitrogen removed by denitrification (kg/ha/year)	0.01
Average annual soil nitrogen leached (kg/ha/year)	0.02
Average annual nitrate-N loading to groundwater (kg/ha/year)	0.02
Soil organic-N kg/ha (Initial - Final)	484.00 - 44.44
	58.39 - 0.01
Average nitrate-N concentration of deep drainage (mg/L)	0.03
Max. annual nitrate-N concentration of deep drainage (mg/L)	1.01

Soil Phosphorus Balance

Average annual effluent phosphorus added (kg/ha/year)	20.94
Average annual soil phosphorus removed by plant uptake (kg/ha/year)	11.74
Average annual soil phosphorus leached (kg/ha/year)	7.75E-06
Dissolved phosphorus (kg/ha) (Initial - Final)	9.67E-05 - 0.33
Adsorbed phosphorus (kg/ha) (Initial - Final)	399.36 - 865.93
Average phosphate-P concentration in rootzone (mg/L)	0.04
Average phosphate-P concentration of deep drainage (mg/L)	1.14E-05
Max. annual phosphate-P concentration of deep drainage (mg/L)	1.61E-05
Design soil profile storage life based on average infiltrated water phosphorus concn. of 1.80 mg/L (years)	326.71

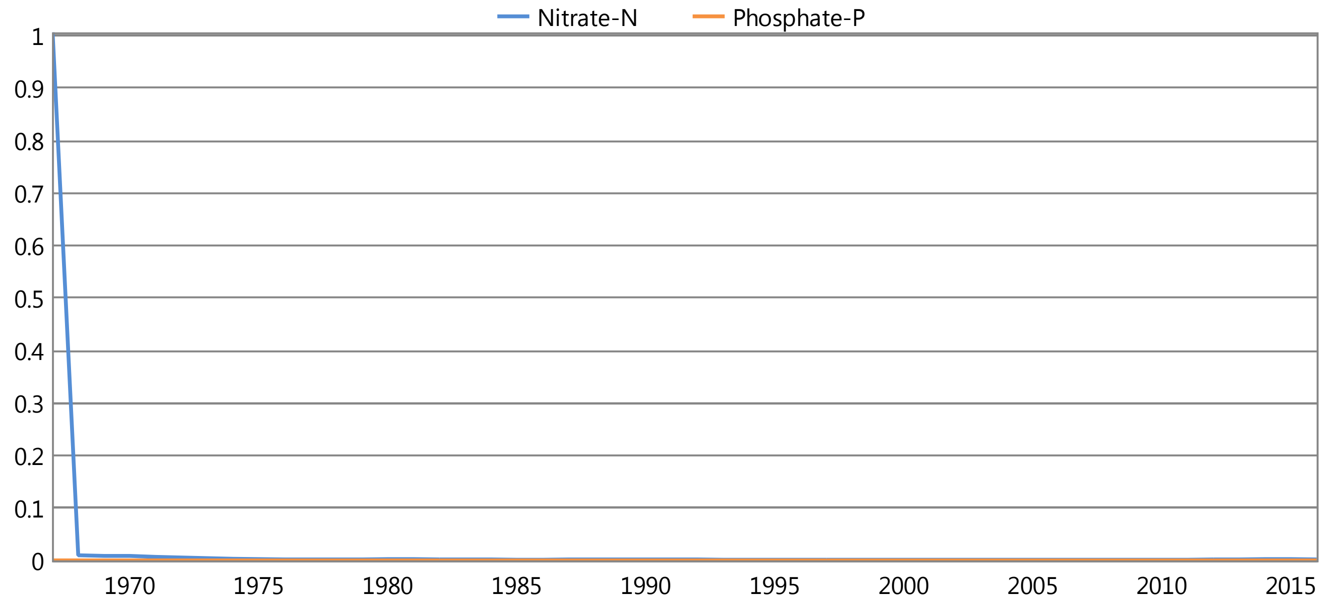
DIAGNOSTICS

Sustainability Diagnostics: Facility Irrigation - Priority Areas

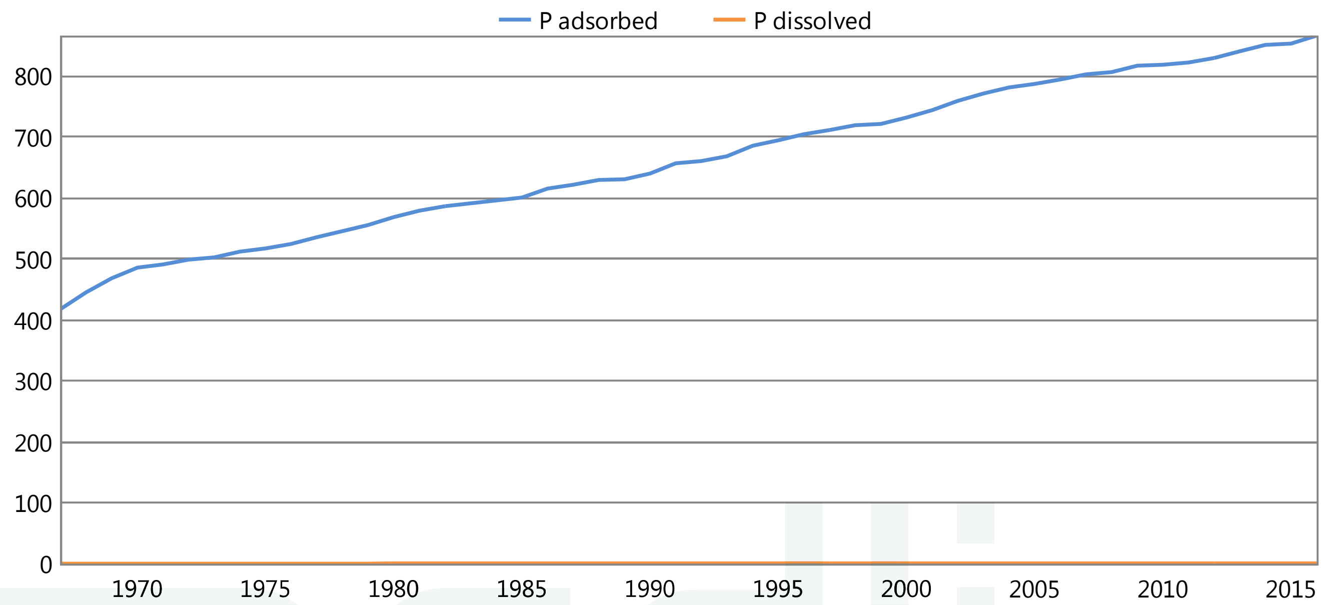
Paddock Land: Priority Irrigation Area: 9.35 ha

Irrigation: Fixed Sprinkler with 20% ammonium loss during irrigation

Annual nutrient leachate concentration (mg/L)



Annual Phosphate-P in soil (kg/ha)



DIAGNOSTICS

Sustainability Diagnostics: Facility Irrigation - Priority Areas

Paddock Plant Performance: Priority Irrigation Area: 9.35 ha

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

Average annual shoot dry matter yield (kg/ha/year)	4403.79 (2276.86 - 8892.48)
Average monthly plant (green) cover (%)	87.51 (84.11 - 89.54)
Average monthly crop factor (fraction)	0.70 (0.67 - 0.72)
Total plant cover (both green and dead) left after harvest (%)	100.00
Average monthly root depth (mm)	1198.53 (1184.69 - 1200.00)
Average number of normal harvests per year (no./year)	0.78 (0.00 - 2.00)
Average number of normal harvests for last five years only (no./year)	0.60
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)	0.89 (0.72 - 0.94)
Average January temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.03)
Average July temperature stress index (0 = no stress, 1 = full stress) (coefficient)	0.68 (0.46 - 0.82)
Average monthly water stress index (0 = no stress, 1 = full stress) (coefficient)	0.00 (0.00 - 0.00)
Average monthly waterlogging index (0 = no stress, 1 = full stress) (coefficient)	0.17 (0.07 - 0.25)
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)	0.60
Salt added by rainfall (kg/ha/year)	142.81
Average annual effluent salt added & leached at steady state (kg/ha/year)	4431.17
Average leaching fraction based on 10 year running averages (fraction)	0.27
Average water-uptake-weighted rootzone salinity sat. ext. (dS/m)	1.01
Salinity of the soil solution (at drained upper limit) at base of rootzone (dS/m)	10.61
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:

Failed Soil phos mass balance check by -6.70!
Full run chosen