

OPERATIONAL ENVIRONMENTAL MANAGEMENT PLAN

Northern Australian Beef Limited
Livingstone Processing Facility



Australian Agricultural Company Ltd
North Australian Beef Limited

2019

Document Control Record

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Abbreviations and Acronyms

AACo	Australian Agricultural Company
ANZECC	Australian and New Zealand Environment and Conservation Council
AQIS	Australian Quarantine & Inspection Service
BNR	Biological Nutrient Removal
BOD ₅	Biochemical Oxygen Demand (measured in 5 days at 20°C) (mg/L)
BOM	Bureau of Meteorology
Ca	Calcium
CAL	Covered Anaerobic Lagoon
COD	Chemical Oxygen Demand
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAF	Dissolved Air Flotation
DUL	Drained Upper Limit
DO	Dissolved oxygen concentration (mg/L)
EC	Electrical Conductivity
EPA	Environment Protection Authority
HA	hectare
HDPE	High Density Polyethylene
HSCW	Hot Standard Carcass Weight*
J	Joule
KL	kilolitres
KG	kilogram
L	Litre
m	Metre
Mg	Magnesium
mg/L	milligrams per litre
ML	Megalitre
mm	millimetres
N	Nitrogen
Na	Sodium
NA	Not Applicable
NABL	Northern Australian Beef Limited
NH ₃	Ammonia
nm	nanometre

OEMP	Operational Environmental Management Plan
P	Phosphorus
SBR	Sequencing Batch Reactor
SS	Suspended Solids
t	tonne
TDS	Total Dissolved Solids (mg/L)
TKN	Total Kjeldahl nitrogen (mg/L)
TN	Total Nitrogen (mg/L)
TP	Total Phosphorus (mg/L)
TSS	Total Suspended Solids
$\mu\text{S/cm}$	microSiemens per centimetre
WWS	Wet Weather Storage
WWTP	Waste Water Treatment Plant

* **HSCW = weight of animal – (head + feet + blood + hide + viscera)**

Definition of Terms

Aerobic	Biological treatment processes that occur in the presence of oxygen.
Anaerobic	Biological treatment processes that occur in the absence of oxygen.
Best Practice	Practices adopted by an organisation which are effective at achieving the most stringent criteria.
Biochemical Oxygen Demand	The amount of oxygen utilised by micro-organisms in the process of decomposition of organic material in wastewater over a period of 5 days at 20°C.
Chemical Oxygen Demand	A measure of oxygen required to oxidise organic matter in wastewater.
Cleaner Production	Involves the management of environmental impacts of an organisation or process while improving the economic efficiency of the process. Cleaner Production overcomes the problems associated with the end of pipe approach.
Dissolved Solids	Salts dissolved in wastewater.
E-Coli	One of the coli form bacteria population and is entirely of faecal origin.
Effluent	Liquid outflow after one or more stages of treatment.
Electrical Conductivity	A measure of the ability of the water to conduct an electrical current. Conductivity is sensitive to dissolved solids and is a good indication of increased inputs of these compounds
End - Of - Pipe	The process of cleaning up wastes once they have been generated.
Environment	Surroundings in which an organisation operates including air, water, land, natural resources, flora, fauna, humans and their interrelation.

Facultative	Biological treatment processes in which the organisms can function in the presence or absence of oxygen.
Faecal Coli forms	General term for the bacteria produced from the gut of warm-blooded animals (used as an indicator of organic pollution).
Flocculation	Involves the physical aggregation of particles and subsequent floc formation.
Kjeldahl Nitrogen	The Kjeldahl test determines the quantity of organic nitrogen and ammonia present in the wastewater.
Non-potable	Water, which cannot be used for drinking, purposes.
Paunch	Animal stomach contents
pH	A measure of the acidity or alkalinity of the waste.
Pickling	The process whereby felled animal skins are agitated in a brine (salt) or acid mixture prior to tanning.
Potable	Water which can be used for drinking purposes.
Primary Treatment	Wastewater treatment which involves coarse solids removal, sedimentation and sludge disposal.
Receiving Water	The waters into which effluent flows or is discharged.
Rendering	The cooking of animal wastes followed by drying in order to produce a proteinaceous meal.
Secondary Treatment	Wastewater treatment by biological processes to remove organic matter.
Sewer/Sewerage system	The network of collection, conveyance, pumping, treatment and disposal facilities owned and/or operated by a sewerage authority.
Suspended Solids	The insoluble solid matter suspended in wastewater that can be separated by filtration.
Trade Waste	The liquid waste generated from any industry, business, trade or manufacturing process not including domestic wastewater.
Wastewater	Raw (untreated) liquid flow from an abattoir.
Wet weather storage	Storage facility required to contain irrigation water during periods of heavy rain etc when irrigation is not required.

SECTION 1: Environmental Policy

1 Environmental Policy



Northern Australian Beef Limited Environmental Policy

Australian Agricultural Company Limited and Northern Australian Beef Limited are committed to environmental practices which effectively manage any effects of our business activities on the environment in which we operate.

Australian Agricultural Company Limited and Northern Australian Beef Limited are committed to:

- Complying with all relevant environmental laws, regulations, standards and practices;
- Maintaining a policy of continuous improvement in our environmental management practices;
- Managing our diverse activities to prevent or minimise pollution and impacts on visual amenity, air, water, land, flora, fauna and cultural and heritage values;
- Striving to improve resource consumption efficiency and minimise waste generation in our operations;
- Investigating and implementing mutually beneficial programs of environmental management with governments, stakeholders and customers;
- Ensuring environmental requirements and implementation of standards are understood by our employees, suppliers and contractors;
- Responding to the environmental concerns of our customers and the communities in which we operate; and
- Continuing to improve our environmental management system and environmental performance.

Australian Agricultural Company Limited and Northern Australian Beef Limited will ensure diligent and regular monitoring of relevant environmental factors is undertaken and will report on environmental management practices and performance in accordance with all regulatory and legislative requirements.



Hugh Killen
CEO and Managing Director

Date:  2018

Review Date 1/12/2020

This policy is to be displayed in a prominent location. New employees and contractors will be informed of this policy. All employees and contractors are required to read and comply with relevant sections of the WHS Policy and Procedures Manual which support this statement

2 Overview of OEMP

2.1 Suspension of Operations

In early 2018, the AACO CEO announced a suspension of operations at the Northern Australian Beef Limited Livingstone Beef facility due to significant and ongoing financial losses of the business. The final day of processing operations was the 26th of July 2018. As a result of this suspension, AACo has negotiated an amendment to EPL219 to accommodate maintaining the license for the facility during this suspension of operations period. An amended license EPL219-01 is to be issued

This amendment includes the addition of a new section “Site Suspension of Operations” which outlines the requirements for management during this period and for the recommencement of operations should this take place during the license period.

During this suspension of operations period, environmental monitoring requirements specified in EPL219-01 Table 5, Condition 60 will be suspended. This includes all monitoring as outlined in this OEMP including:

- Surface water monitoring outlined in Section 9
- Groundwater monitoring outlined in Section 9
- Soil monitoring outlined in Section 8
- Wastewater quality monitoring outlined in Section 8
- Odour monitoring outlined in Section 11
- Other general monitoring including (daily, weekly and monthly checks) outline in Section 13

The last required monitoring event was for groundwater monitoring carried out in November 2018. This groundwater monitoring found no non-compliances against the groundwater monitoring trigger values at the compliance bores 8 and 9 and therefore no further monitoring actions are required.

During this suspension of operations period a maintenance team will be maintained on site to ensure all plant is kept in good operational order. During this time the WWTP may be operated in “maintenance mode” which does not require the discharge of irrigation water. Should the discharge of irrigation water be required during this period or the complete shutdown of the WWTP, conditions controlling this discharge are outlined in EPL219-01 Condition 22 and Condition 23.

2.2 Purpose of This Plan

This management plan is Northern Australian Beef Limited’s (NABL) Operational Environmental Management Plan (OEMP) for the sustainable management of its Livingstone facility (from here after referred to as “the facility”). NABL is a wholly owned (100%) subsidiary of Australian Agricultural Company Limited (AACo). This OEMP is intended to enable the implementation of operations at the facility in an environmentally sustainable manner and in compliance with Environment Protection License, EPL219 (Appendix A).

An OEMP is a structured and systematic means of planning for good environmental performance. It can be viewed as a quality assurance system for the environmental aspects of a company’s operations. An OEMP is a tool which assists management to:

- Know and appreciate its actual and potential environmental risks.

SECTION 2: Overview of OEMP

- Have in place management measures to minimise these risks.
- Continually monitor and review the environmental performance of the organisation.

This OEMP consolidates a suite of management plans that were developed to support the establishment and early operating phase of the NABL Livingstone facility into a single, operational document. These plans include:

- Operational Environmental Management Plan
- Stormwater Management Plan
- Irrigation Management Plan
- Water Quality Monitoring Plan
- Weed Management Plan

This initial suite of plans contains a significant body of data and environmental modelling that underpins the approaches and procedures of this current operational plan. While much of this data is not included in this plan, it is available for reference as required within the previous plans.

2.3 Responsibilities

This management plan will be implemented according to the core organisational responsibilities outlined in Table 1. While these roles hold specific and core responsibility for environmental compliance and sustainability, every person engaged at the facility is responsible for ensuring they carry out their tasks in an environmentally responsible manner and is required to comply with environmental policies and procedures.

Table 1: NABL organisational responsibilities for implementation of the OEMP

Position	Environmental Responsibilities
AACo CEO and General Manager	Responsible for overall corporate governance relating to NABL operations
Plant Manager	Responsible for all operations of the facility. Responsible for ensuring that all aspects of operations outlined in this plan are implemented.
AACo Environmental Manager	Responsible for holding the master copy of the document, ensuring that it is current and that controlled copies are distributed as appropriate. Responsible for overseeing AACo's environmental compliance including (but not limited to) compliance with EPL219.
Maintenance Manager	Responsible for the implementation of key operational components of the OEMP relating to facility infrastructure and maintenance.
Environmental Officer	Responsible for the day to day monitoring of environmental policies and procedures and ensuring that activities at the facility comply with EPL219 and relevant environmental legislation. Provide technical support to ensure the effective implementation of environmental policies and procedures by NABL staff.

2.4 Document Review

The OEMP is to be reviewed once a year as part of the Annual Internal Audit process (Section 13.6) by an internal audit team.

The aim of the review is to ensure that it is relevant to current needs, and to ensure that the information contained in all sections of the manual is accurate and up to date. The document may also be reviewed in response to Qualified Person Reviews, as a part of any amendment processes to EPL219 and biennial Environmental Audits as required under EPL219. If modifications are made to any part of the document, the issue number and revision date must be updated for that section.

SECTION 2: Overview of OEMP

2.5 Document Control and Distribution

A master copy of the OEMP shall be held by the Environmental Manager. Access to controlled copies are to be provided to the other site personnel according to the following schedule.

Environmental Manager Main Office	Master copy of OEMP - Main Office
Plant Manager	1 Controlled copy of OEMP - Main Office
Environment Officer	1 Controlled copy of OEMP - Main Office
Quality Assurance Manager	1 Controlled copy of OEMP - Main Office
Maintenance Manager	2 Controlled copy of OEMP - Workshop Office
Personnel in charge of irrigation	1 Controlled copy of OEMP – Farm Equipment Area
Personnel in charge of WWTP	1 Controlled copy of OEMP – WWTP Office

The Environmental Manager holds a master copy of the OEMP and is responsible for updating sections within the manual and for issuing updated copies to holders of controlled copies. The Plan will generally be updated following the Annual Internal Audit to reflect any identified changes.

Officers of the company may hold multiple positions listed above

When changes are made to sections within the Plan, the revision date and issue number in the footer of that section are to be updated. Copies of the updated sections are distributed to holders of controlled copies to replace the obsolete section.

2.6 Environmental Records

In addition to the OEMP, other Environmental Records will need to be maintained. Environmental Records include:

- Records of environmental complaints and incidents
- Register of Chemicals
- Results of environmental monitoring
- Results of environmental audits and inspections
- Sampling and analysis results
- Records of annual management reviews
- Any waste, energy or cleaner production audits or reviews
- Records of environmental training

Copies of these records are to be maintained within the designated filing system so that they can be readily accessible if necessary. They should be kept for 2 years.

3 Regulatory Requirements

3.1 Purpose of This Section

This section provides a summary of the regulatory requirements contained in the Environmental Protection Act, 1994 (EPA Act) that are of relevance to GMF operations.

3.2 Responsibilities

Environmental Officer	The designated site Environmental Officer is responsible for ensuring that the information contained in this section is accurate and up to date. A review of legislation and regulations is to be conducted as part of the Annual Return.
AACo Environmental Manager	The Environmental Manager is responsible for overseeing and advising on compliance with the legislative requirements described in this section.
Plant Manager	The Plant Manager is responsible for ensuring all aspects of operational implementation within the facility are compliant with the legislative requirements described in this section.

3.3 Requirements Under Relevant Legislation

3.3.1 Waste Management and Pollution Control Act NT (2016)

General Environmental Duty (Section 12)

A person who conducts an activity or performs an action that causes or is likely to cause pollution resulting in environmental harm or that generates or is likely to generate waste must take all measures that are reasonable and practicable to prevent or minimise the pollution or environmental harm and reduce the amount of the waste.

Duty to Notify Environmental Harm (Section 14)

Where an incident occurs in the conduct of an activity and the incident causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm the person conducting the activity must notify the NT EPA in accordance with subsection (3) as soon as practicable after (and in any case within 24 hours after) first becoming aware of the incident or the time he or she ought reasonably be expected to have become aware of the incident.

All employees must notify their supervisor if they become aware that environmental harm is caused or threatened as a result of activities on the site. Upon notification, supervisors in association with the site Environmental Officer will:

- verify the extent of the environmental occurrence
- if the occurrence breaches the EPA, the Environmental Officer will report the occurrence to the NT EPA

Failure to notify the administering authorities may attract penalties.

Requirement to hold a licence (Section 30)

A person must not, except under an environment protection license or a best practice license, conduct an activity specified in Part 2 of Schedule 2:

SECTION 3: Regulatory Requirements

Collecting, transporting, storing, re-cycling, treating or disposing of a listed waste on a commercial or fee for service basis, other than in or for the purpose of a sewage treatment plant.

Requirement to comply with conditions of a licence (Section 39)

The holder of an environment protection approval or a licence must not intentionally or otherwise contravene or fail to comply with the environment protection approval or licence.

Requirement to pay annual licence fee. (Section 42)

The holder of an environmental protection license that is granted for a period of 2 years or more must pay the annual fee according to the conditions of the environmental protection license.

3.3.2 Water Act (2016)

Prohibition of pollution (Section 16)

A person shall not, unless authorised to do so by or under this or any other law in force in the Territory and in accordance with that authorisation, wilfully cause, either directly or indirectly waste to come into contact with water or water to be polluted causing serious environmental harm.

Water Quality Standards (Section 73)

Section 73 includes a process for identifying and declaring “beneficial uses” for specific waterways, which describe the purpose of use for which water quality should be maintained and Section 73 includes a process for identifying and declaring “beneficial uses” for specific waterways, which describe the purpose of use for which water quality should be maintained.

3.3.3 Other Relevant Acts and Guidelines

- **Public and Environmental Health Act NT** - The human effluent treatment system (aeration tank system) and associated absorption trench array has been approved by the NT Department of Health (DoH) under Regulation 17 of the Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations.
- **Darwin Harbour Strategy** - The Darwin Harbour Strategy (DHAC 2010) sets out the goals and guidelines for policy and decision-makers managing the sustainable development of Darwin Harbour. Decisions made on developments within the Darwin Harbour catchment need to consider the cumulative impacts on the Harbour’s environment; a highly valued asset to the people of Darwin.
- **Darwin Harbour Water Quality Objectives** - *Water Quality Objectives* (listed in Table 8 of NRETAS 2010) were derived on the basis of the “Beneficial Uses” declared for waterways within the Darwin Harbour catchment under the *Water Act*. *Water Quality Objectives* for surface waters of the Blackmore River and Berry Creek catchments are to be taken into consideration in this OEMP when assessing surface water quality in streams receiving run-off from the facility. Site-specific triggers (i.e. derived from baseline/upstream reference data) are the primary assessment criteria applied for this site, as they will represent water quality expected directly downstream of a typical rural land use in the area.

In relation to groundwater quality, beneficial uses have been declared for all groundwater in the Blackmore River region. These are agriculture, environment and rural stock and domestic. The Water Quality Objectives for the Darwin Harbour Region also apply to this groundwater, since groundwater discharges into surface waterways, and during the mid-late dry season, provides the only source of stream flow (base flows).

- **Australian Drinking Water Guidelines 2011** - relate to the quality of water at the point of use (e.g. kitchen or bathroom tap). They apply to reticulated water at the consumer’s tap, rainwater for drinking, and source

SECTION 3: Regulatory Requirements

water if it is to be used without prior treatment, such as groundwater (NHMRC 2011). The ADWG specify that drinking water should contain zero levels of disease-causing organisms and provides guideline values for safe levels of specific chemicals. While these are considered, site-specific triggers are the primary assessment criteria applied for this site as they will represent groundwater quality expected downstream of a typical rural land use in the area (see Section 4 for details).

- **ANZECC Guidelines for Fresh and Marine Water Quality 2000** - provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters. These guidelines were used in the development of the Water Quality Objectives for Darwin Harbour.

It is a condition of EPL219 that the licensee must ensure that each Monitoring Report is prepared in the format described in the Australian Guidelines for Water Quality Monitoring and Reporting (Chapter 7), and include:

- Data analysis and interpretation using the National Water Quality Management Strategy, Australian Guidelines for Water Quality Monitoring and Reporting, Chapter 6
- Trend analysis and interpretation of monitoring data required as a condition of this licence
- Assessment of environmental impact from the activity.
- **NT Guidelines for Wastewater Works Design Approval of Recycled Water Systems 2013** - aligns the principles outlined in the Australian Guidelines for Water Recycling to the NT Department of Health approvals process for recycled water systems with a minimum capacity of 8 kL/day; equivalent to 40 Equivalent Persons (EP).
- **NT Guideline for Reporting on Environmental Monitoring** – outlines the NT EPA's requirements for environmental monitoring reports – to establish a minimum standard and consistent approach. The guideline outlines how to report the information collected through monitoring to the NT EPA. EPL219 Condition 76.1 requires that the Annual Monitoring Report to be submitted the the NTEPA is prepared in accordance with these guidelines.
- **Northern Territory Noise Management Framework** - The purpose of this framework guideline is to assist and provide guidance to the community and industry about the noise regulatory framework as it applies in the NT. It addresses the noise issues that the NT EPA and other NT noise regulators deal with on a day to day basis in a one stop shop basis so that the NT community is aware of its rights and responsibilities. All activities on site must comply with these guidelines. These guidelines inform Section 10 Noise Management.

3.4 Review of Regulatory Requirements

A review of regulatory requirements pertaining to environmental protection is to take place as part of the Annual Internal Audit by NABL's internal audit team. Refer to Section 13.6 for details.

4 Environmental Aspects

4.1 Purpose of This Section

The purpose of this section is to:

- Identify and record activities occurring at the site;
- Identify and record those aspects of site operations, products or services that are likely to impact on the environment;
- Determine the actual or potential impacts whether positive or negative; and
- Define objectives to ensure that activities occurring at the site are in line with the company's environmental policy.

4.2 Site Location

The NABL Livingstone facility is located at Lot 4, Hundred of Cavanagh and Section 5543, Hundred of Strangways (270 Blyth Road, and 2660 Stuart Highway, Livingstone), approximately 50km by road south of Darwin (see Site Location Map, Section 15.1).

The facility is located on 601ha within a rural area and was previously used for cattle grazing and haymaking prior to construction of the meat processing facility, which commenced operations in November 2014. The main operational area is zoned according to:

- Main processing area – 34ha
- Total irrigation zones – 253ha
- Active irrigation area – 97.4ha 2017-18 Wet season, 37.4ha dry season
- Riparian and environmental buffer areas, cattle grazing – remaining area

Surrounding land use includes 2 ha and 8 ha rural residential blocks, commercial cattle holding facilities, cattle grazing and horticulture. A linear "Conservation Zone" (according to NT Planning Scheme) incorporating the former rail corridor lies along the western boundary. To the east of the property runs the interstate rail line and the Stuart Highway.

The site is located within the upper Berry Creek catchment, a tributary of the Blackmore River, which in turn flows into Darwin Harbour. Most of the property is flat to gently sloping grassland with scattered trees and all wet season run-off from the site flows into a central seasonally-wet area. The three minor tributaries draining the site are fed by overland flows, and converge into a single channel near to the western boundary of the property, which is located approximately 5 km upstream of the main channel of Berry Creek. Flows in the drainage lines generally only occur for relatively short periods during the annual Wet Season (November-May), following prolonged periods of rainfall (e.g. monsoon events).

4.3 Description of Activities

NABL's Livingstone facility is a hot-boning operation with the approval to kill and process up to 1,000 head of cattle per day, although the plant does not currently operate at this capacity.

Typically production occurs 5-days/week with an annual shutdown of production planned for 2-4 weeks in late December and early January to allow comprehensive maintenance of all machinery and equipment. During the peak of the wet season, operations may be limited to 4 days a week as a result of slowing cattle supply.

SECTION 4: Environmental Aspects

The site incorporates the following features, the locations of which are shown on the detailed site plan in Section 15.2.

- Livestock unloading facility;
- Covered and uncovered livestock holding yards;
- Slaughter floor and associated areas;
- Carcass sorting and feed to boning operations;
- Boning and packing area and packaging material store;
- Freezing and chilling systems, cold storage, carton sorting, palletising and dispatch zone;
- Refrigeration engine room;
- Rendering plant with associated biofilter to treat odorous vapours;
- Hide processing with a brine evaporator to recycle salt to the process and eliminate the need for effluent discharges containing high salt levels;
- Three gas engines used to generate on-site electricity and hot water;
- Workshop and maintenance buildings;
- Staff amenities (including toilets/showers), offices, training rooms and canteen.
- Enclosed sewage treatment system and covered absorption trenches for sullage disposal
- Car parking for ~250 cars and access roads;
- A wastewater treatment plant and wet weather storage (WWS) for combined process effluent ;
- Irrigated areas for effluent reuse and haymaking.

The design and operation of the facility incorporates several best practice environmental elements including:

- the use of a waste heat evaporator for concentrating selected high strength render waste streams so that they can be recovered as meat meal product;
- The biofilter for treating odorous off-gas from the render process;
- A brine evaporator dedicated to recovering the surplus brine effluent from the hide salting process and recovering the salt for reuse in the process;
- The segregation and treatment of human amenities effluent to eliminate human pathogens from the process wastewater and hence the irrigation areas.
- The capture and flaring of biogas generated by the Covered Anaerobic Lagoon to reduce odour emissions from wastewater treatment

The site is self-sufficient with respect to, effluent treatment and disposal. Water used at the facility is obtained from PowerWater Corporation. Electricity is generated onsite through gas-powered generators. Effluent generated from the abattoir is treated through a biological treatment system incorporating anaerobic and aerobic treatment systems. The resulting treated effluent is applied to an irrigated area used for the growing of crops.

Approximately 220 staff is employed at the site with 200 employees being on site at any one time. Hours of operation are currently 4am to 12pm, 5 days per week, but depend on production demands.

Processes occurring in the abattoir are described in Figure 1 including an indication of wastes generated from the process.

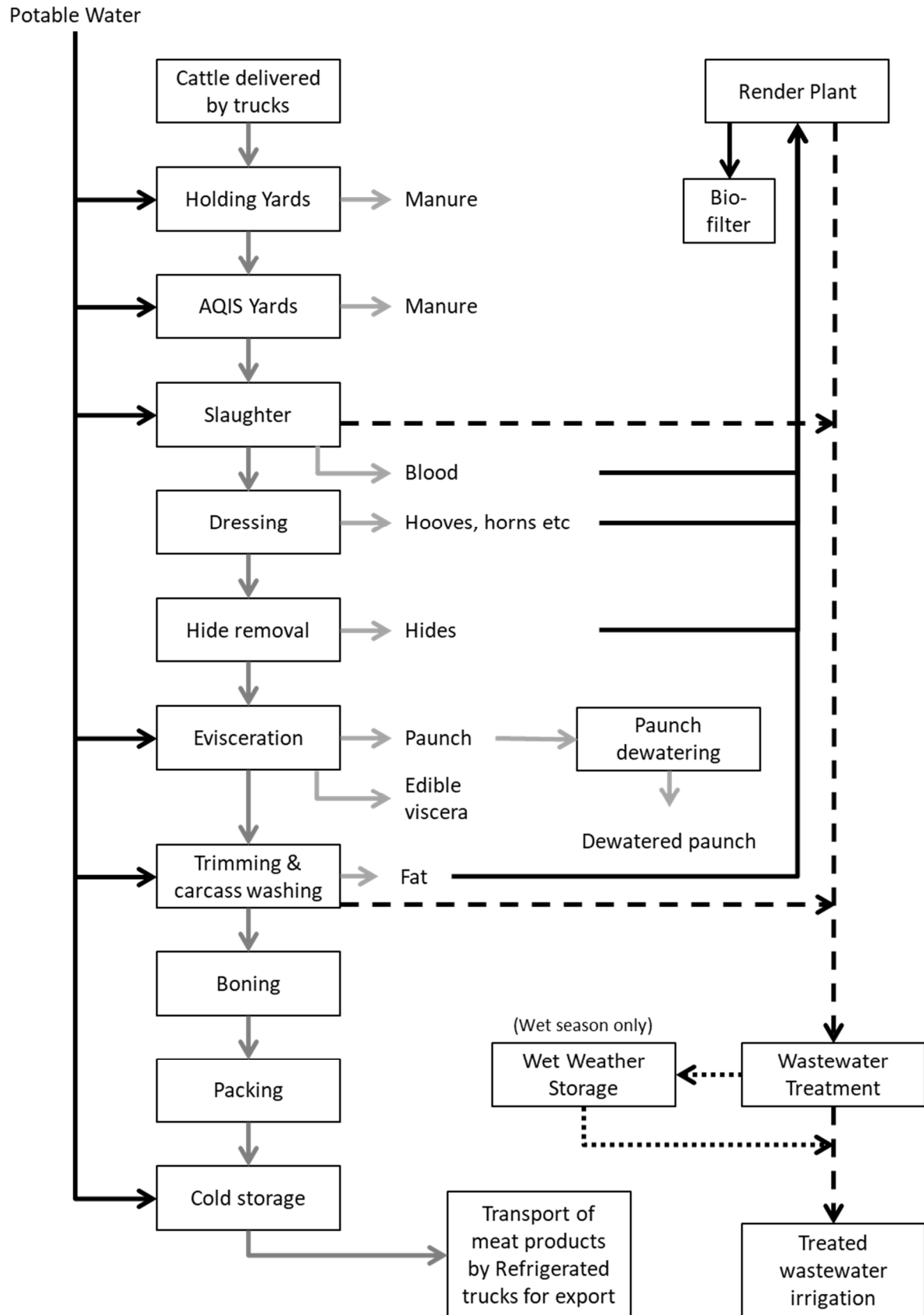


Figure 1: Operational process diagram

SECTION 4: Environmental Aspects

4.4 Environmental Aspects of the Operation

The following describes the various aspects of the operations of the facility with the potential for environmental impacts. A full risk assessment of all activities has been carried out and operational actions to manage these risks have been identified. Further details can be found in Appendix B.

4.4.1 Cattle Receiving and Holding

Cattle are received at the site by road transport vehicles and are held on site for short periods of time in the holding facilities; an uncovered holding yard and a set of covered AQIS yards.

The holding yard is a simple structure with no roofing, sealed surface or drainage. Cattle excrement collects on the floor (which is gravelled to reduce dust) and is removed daily.

The AQIS yards have concrete floors with bunding and drainage and are roofed. Cattle excrement from this area is washed to the manure dewatering facility, from which the de-watered manure is taken for disposal offsite and the wastewaters drains to the effluent treatment system.

Runoff from the uncovered holding yards drains to the first flush dam downstream from the yards where any contaminants are captured for processing in the WWTP. Subsequent flows are captured in Dam 1 and Dam 2 for natural processing prior to release to surrounding vegetation. Due to the large grassed buffer strip between the site and the riparian zone, it is expected that any solids in the runoff will be held up in the paddock and not flow to the creek. As a result this aspect is not considered to be significant; however care is to be taken to ensure that this area does not cause any environmental impacts on the riparian system.

The environmental aspects associated with cattle receiving and holding are:

- Potential for contamination of surface waters by runoff from the build-up of cattle excrement on exposed surfaces;
- Generation of manure;
- Potential for odour generation;
- Potential for noise generation;
- Potential for introduction of weeds;
- Potential for proliferation of pest insects.

4.4.2 Abattoir Operations

At the abattoir, cattle are slaughtered, dressed, and the carcasses boned and packaged for distribution off site. A central refrigeration system services process areas, cold rooms, chillers and freezers used for the chilling and storage of products. A large basement area below the processing floor is used to handle all solid and liquid wastes generated from the process.

Water is used in the process for the cleaning of plant and equipment and for carcass washing. Most intensive cleaning activities occur at the end of each production shift.

The environmental aspects associated with the abattoir process are:

- generation of solid waste streams which require careful handling, storage and disposal;
- potential for odour generation from the handling of waste materials;
- generation of wastewaters which require treatment prior to disposal;
- Potential contamination of exposed surfaces with process wastes which could contaminate surface water.

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4.4.3 Rendering Plant

The rendering plant takes the unused Material from the abattoir and via a cooking process the material is rendered into blood meal, tallow & meat meal. The product is stored in appropriate storage tanks, silos & bags before being distributed off site.

The wastewater generated from this system is contained in the building and drained to the wastewater stream. Water is used in the process for the cleaning of plant and equipment. Most intensive cleaning activities occur at the end of each production shift.

The environmental aspects associated with the Rendering process are:

- generation of putrescible solid waste streams which require careful handling, storage and disposal;
- potential for odour generation from the handling of putrescible waste materials;
- generation of wastewaters which require treatment prior to disposal;
- potential contamination of exposed surfaces with process wastes which could contaminate surface water.
- storage of tallow and the potential for spills

4.4.4 Biofilter

Air and vapour from the rendering plant building and the process are drawn into the bio filter via an extraction fan. The biofilter bed is a natural system to break down and eliminate the odour. The sprays on the bed are to keep the humidity to an accepted level and there should be minimal over spray.

The environmental aspect associated with the bio filter process is:

- Potential odour generation
- Potential contamination of exposed surfaces with over spray which could contaminate surface water.

4.4.5 Effluent Treatment

A pre-treatment system comprising rotary screening, paunch screw press and a Dissolved Air Floatation (DAF) system followed by biological treatment in a 16ML Covered Anaerobic Lagoon (CAL) and a 5.3 ML Sequencing Batch Reactor (SBR) treats the combined effluent from the abattoir (excluding human wastes). The treated effluent is discharged into a Decant Basin prior to irrigation or reuse for non-potable purposes. Biogas from the CAL is incinerated in a purpose-built enclosed flare. Excess biological sludge (WAS) from the SBR can be dewatered through a belt filter press and disposed to an approved receival location.

In order to perform effectively and to avoid environmental problems, biological treatment systems need suitable conditions, such as:

- correct sizing to ensure sufficient treatment capacity;
- a regular feed of effluent;
- the correct pH and temperature for a healthy microbial population;
- Avoiding slugs of chemical contaminants and high temperature effluent entering the ponds.

If not sized correctly, the organic and nutrient load of the effluent will not be reduced enough to allow for safe disposal. Excessive fluctuations in influent quality or slugs of chemicals or high temperature effluent can upset the biological balance in the ponds and result in odour generation.

The CAL, SBR and Decant Basin have been built using a 2mm thick HDPE liner to eliminate the infiltration of effluent into underlying soil profile and possibly groundwater. A sub-surface system with inspection outlets has been installed to ensure any leakage of effluent from the WWTP is detected rapidly.

SECTION 4: Environmental Aspects

During periods of heavy or sustained rainfall, irrigation of the treated effluent poses a risk to surface water and groundwater. A 70ML Wet Weather Storage (to be commissioned by 30th November 2018) stores treated effluent during periods of significant rainfall until soil conditions enable the safe irrigation.

In summary, the environmental aspects associated with effluent treatment are:

- odour generation if the biological system is overloaded or if conditions are upset;
- potential for contamination of surface water from spills;
- reduced water quality if the biological system is overloaded or if conditions are upset.

4.4.6 Irrigation of Treated Effluent

The irrigation area receives treated effluent. Irrigation of effluent is an accepted form of wastewater disposal for activities which have sufficient land available, as long as irrigation is well managed. The treated effluent contains organic matter, nutrients and salt.

The nutrients in the irrigated effluent, in particular nitrogen and phosphorus, will be taken up by the crops and pastures grown in the irrigation area. However there is a limit to how much nitrogen and phosphorus can be applied to the soil, as the soil has a limited nitrogen and phosphorus holding capacity. Nitrogen and phosphorus applied in excess of the holding capacity will seep down through the soil profile and may potentially contaminate groundwater. The amount of nitrogen and phosphorus added must be balanced by the amount of nitrogen and phosphorus taken up by the crops and pastures.

The Electrical Conductivity (EC) and concentration of salts and specific ions (sodium, chloride, alkalinity, bicarbonate etc) in the treated effluent are relatively low. The aim is to protect soil structure and downstream surface and groundwater, and to not exceed the salt tolerance of pasture grasses, in particular, the existing grasses of the site. A site specific comprehensive salinity and sodicity assessment is provided the previous Irrigation Management Plan 2017.

Irrigation of treated effluent during the wet season is determined by surface moisture, ensuring a 10mm deficit below the soil's drained upper limit, meaning irrigation will cease at greater than 30mm below the saturation point. Stormwater diversion channels have been installed upstream of the irrigation paddocks to reduce the risk of surface runoff during rainfall events, though if some runoff were to occur, a significant vegetative buffer is likely to protect downstream surface water and groundwater from contamination.

In summary the environmental aspects associated with irrigation of treated effluent areas are:

- excessive application of nutrients, particularly nitrogen and phosphorus, which may result in deep drainage loss of nitrogen and phosphorus to groundwater,
- excessive application of salt will result in soil salination and sodicity,
- surface runoff and potential contamination to groundwater of effluent if irrigation occurs during wet weather,
- potential odour generation if poor water quality irrigated
- potential introduction and establishment of weeds.

4.4.7 On-Site Domestic Sewage Treatment

Domestic sewage from staff amenities at the abattoir are treated in a separate enclosed sewage system. The unit operates effectively to treat sewage and currently have sufficient capacity to cope with employee numbers. Treated water is released to pasture through an absorption trench to the west of the DAF.

Under normal operating conditions, there are no significant environmental impacts associated with the treatment of domestic sewage. However environmental risks could occur in the event of a failure, such as

SECTION 4: Environmental Aspects

pump failures, overflows due to blockages or insufficient maintenance. In these instances however the risks would be localised to the site and would not generate any off site impacts.

The septic system is approved by the NT Department of Health and is de-sludge annually. The septic has been installed by a licensed plumber.

The environmental aspect associated with on-site domestic sewage treatment are:

- The risk of failure of the system, including pump failures, overflows or insufficient maintenance.
- Disposal of sewage by septic could degrade downstream and groundwater water quality should the system fail

4.4.8 Carcass Disposal

Animal mortalities occur in very small numbers in the cattle yards. Improper disposal of dead animals may cause problems such as odour, vermin and propagation of diseases. All carcasses that are not suitable for processing through render are removed from site for deep burial at Shoal Bay by a licensed waste transporter.

In summary, the environmental aspects associated with the disposal of mortalities are:

- potential for odour generation if carcasses are not disposed of correctly and in a timely manner,

4.5 Summary of Environmental Aspects

The matrix below (Table 2) summarises the potential environmental impacts of the various site activities.

Table 2: Summary of Potential Environmental Impacts associated with facility activities

Aspect	Area of Potential Environmental Impact					
	Soil	Community Amenity (odour/ noise)	Surface Water Contamination	Groundwater Contamination	Waste/ Wastewater Generation	Storage/ Handling of Hazardous Substances
Cattle receipt and holding		x	x	x	x	
Abattoir operations:		x	x		x	x
Rendering operations:		x	x		x	x
Bio Filter		x	x			x
Effluent treatment		x	x	x	x	x
Irrigation of treated effluent	x		x	x		
On-site domestic sewage treatment		x	x	x		
Carcass disposal		x				

5 Environmental Objectives and Targets

5.1 Purpose of this Section

The purpose of this section is to:

- Define the environmental objectives for each aspect identified in Section 4, and
- Set targets, where appropriate.

5.2 List of Environmental Objectives and Targets

The following table below (Table 3) lists the environmental objectives and targets that have been set for the site.

Table 3: Environmental Objectives and Targets

Environmental Aspect	Objective
Stormwater protection	To ensure that activities occurring at the site do not cause stormwater runoff from the site to be contaminated.
Wastewater generation	To minimise the volume of process wastewaters generated through efficient water use and recycling.
	To minimise the contaminant load in process wastewaters through source reductions, effective treatment and recovery of nutrients.
Wastewater treatment	To ensure that wastewaters are effectively treated to reduce Biological Oxygen Demand (BOD), Suspended Solids, nutrients and pathogens in the treated effluent.
	To put in place source reduction schemes to reduce the nutrient content of the treated effluent.
	To harvest as many valuable components (such as nutrients, biogas etc) from the wastewater stream as possible.
Disposal of treated wastewater	To pursue opportunities for reuse of water within the plant.
	To optimise the application of the treated wastewater in the growing of fodder crops for hay production.
	To ensure that wet season irrigation is effectively managed and that sufficient wet weather storage is available to avoid irrigation during extended periods of wet weather.
Groundwater protection	To ensure that groundwater quality is not adversely affected as a result of irrigation. To minimise deep drainage loss of nitrogen and phosphorus.
Protection of soils	To ensure that topsoil, root zone and underlying soils do not become saline or sodic as a result of irrigation practices and that soil nutrient loading does not exceed plant nutrient demands.
Storage & handling of hazardous substances	To ensure that the risks associated with the storage and handling of hazardous substances are minimised through careful management practices.
Noise	To ensure that noise levels generated from site operations does not adversely affect the amenity of the surrounding environment and that noise levels comply with the NT EPA restrictions.
Odour	To ensure that offensive odours generated at the plant do not cause nuisance for sensitive receptors and reduce amenity of the surrounding community.

SECTION 5: Environmental Objectives and Targets

5.3 Review of Objectives and Targets

Objectives and targets are to be reviewed as part of the Annual Internal Audit to ensure that they continue to reflect current regulatory requirements and industry standards. Target should also be reviewed in light of the company's performance with respect to these targets.

If the company is easily meeting targets, consideration should be given to making them tighter in order to promote continual performance improvement.

6 Stormwater Management

6.1 Stormwater Protection Objectives

NABL will endeavour to ensure that activities undertaken at the site do not adversely affect the quality of surface water runoff from the site. To achieve this, NABL will:

- provide adequate facilities for the containment and correct storage of chemicals, wastes, wastewaters and contaminated stormwaters;
- enforce procedures governing housekeeping and any other processes in exposed areas;
- promote awareness of stormwater protection amongst staff;
- implement the management practices outlined in this plan;
- check compliance with specified management practices and licence conditions through a monitoring, auditing and review programme;
- Identify responsibilities and provide budget allocations and procedures to enable the implementation of this management plan.

6.2 Purpose of the Plan

The purpose of this Stormwater Management Plan is to:

- identify and describe the stormwater catchments on the site;
- identify and describe those water bodies receiving stormwater runoff from the site;
- describe activities occurring within the stormwater catchments that could potentially contaminate stormwater runoff;
- define appropriate management practices to ensure the protection of stormwater runoff;
- determine the company's performance with respect to stormwater protection when judged against current environmental legislation and licence conditions.

6.3 Responsibilities

Environmental Officer	Responsible for ensuring that the information contained in this plan is accurate and up to date. The details of stormwater catchment areas and management practices described in this plan are to be reviewed and updated annually as part of the annual OEMP audit and as agreed in the licence conditions. Monitoring and reporting performance against the targets and management actions outlined in this plan.
Maintenance Manager	Responsible for ensuring that the stormwater management practices described in this plan are effectively actioned.
Plant Manager	Responsible for ensuring that the stormwater management practices described in this plan are effectively implemented and that corrections are carried out as required.
AACo Environmental Manager	Responsible for driving stormwater management improvement initiatives and ensuring compliance with EPL219.

SECTION 6: Stormwater Management

6.4 Description of Stormwater Discharge

The four principal stormwater catchment areas have been identified for the abattoir complex and surrounding lands. Details are provided below and these catchment areas are indicated in the plan in Section 15.5 and the first flush infrastructure in Section 15.6.

6.4.1 Stormwater Catchment Areas

Four stormwater catchments encompass the facility. Details of these catchment areas and their respective drains and discharge points are summarised in Table 4 below and in the figure in Section 15.5.

Catchment 1 is by far the largest catchment (29.2 ha). This catchment drains predominantly grassed paddocks located south of the facility. A small proportion of this catchment comprises landscaped and grassed areas, a section of the main car park, and a small area of the facility that includes sealed pathways and roofed areas.

Catchment 2 is 6 ha and comprises a proportion of the main car park, grassed and landscaped areas and the sealed access road.

Catchment 3 is 9.1 ha and encompasses most of the meat processing facility infrastructure where rainfall and run-off will flow from roofed areas and sealed pathways.

Catchment 4 is 0.68 ha and comprises the open cattle holding yards only. This catchment is relatively small and represents just 1.5% of the entire catchment area encompassing the meat processing facility.

Table 4: Stormwater Catchment details

Catch	Area (ha)	Catchment Features	Dam design specifications	Discharge point design specifications
1	29.2	Paddocks to the south of the facility, a proportion of the main car park, sealed pathways, grassed landscaped areas and a small proportion of roofed area of the facility operations buildings.	Main cut-off drain – sized for Q100 rainfall event. Rock-check dams along drain designed to slow flows. Reno mattress at drain intersections and outlet into Dam 2 to slow flows and prevent erosion.	Dam 1 – capacity 10,000 m ³ . If empty, dam will fill and overflow after receiving 35 mm of rainfall. If dam already contains some water, then less than 35 mm will fill the dam. Spillway designed to slow flows and discharge at rate of less than 9.25 m ³ /s for a Q100 rainfall event.
2	6.0	Sealed access road, grassed landscaped areas.	Open drain sized for Q5 rainfall event.	Drain flows discharged via spreader onto ground to north of facility. Spillway designed to slow flows and discharge at rate of less than 1.12 m ³ /s for Q5 rainfall event.
3	9.1	Roofed areas and sealed pathways of the facility operations building.	Open drains sized for Q5 rainfall event. Rock-check dams along drains to slow flows. Reno mattress at drain intersections and outlet into Dam 2 to slow flows and prevent erosion	Dam 2 –capacity 11,000 m ³ . If empty, dam will fill and overflow after receiving 121 mm of rainfall. If dam already contains some water, then less than 121 mm will fill the dam. Spillway designed to slow flows and discharge at rate of less than 1.97 m ³ /s for a Q5 rainfall event. First flush captured and diverted to WWTP for processing according to details below.
4	0.68	Cattle-holding yards only.	Open drains sized for Q5 rainfall event Reno mattress at drain	Drains to first flush dam whilst holding yards in use in dry season and at start of

SECTION 6: Stormwater Management

Catch	Area (ha)	Catchment Features	Dam design specifications	Discharge point design specifications
			intersections and outlet into Dam 2 to slow flows and prevent erosion	wet season until water quality meets the Assessment Criteria. For remainder of wet season, once Assessment Criteria is met, drains direct to Dam 1. First flush dam – capacity designed to capture 60% of a Q1 storm event i.e. 76 m ³ , Actual as-built capacity is actually larger than this = 112.5 m ³ .

There are minimal sources of contamination within catchments 1 and 2 and stormwater from these catchments is considered uncontaminated other than what would normally be present in urban stormwater draining roads, car parks, gardens and roofed areas. Additionally, all drains are completely grassed and there are no areas of bare, exposed soil within any of the catchments, therefore no sediment is entrained in stormwater. Monitoring and corrective actions of any erosion or sedimentation that may arise within the catchments is outlined in Section 5.

Catchment 3 and 4 contain potential sources of contamination from cattle yards, operational buildings and plant, and incoming cattle trucks. These sources could contribute organic materials, nutrients, salts and pathogens to stormwater. This contamination is addressed through regular clean-up processes and the use of a first flush system as explained below.

6.4.2 Open Drains and Culverts

Table 4 summarises the design specifications and erosion and sediment controls for the stormwater drains capturing and diverting stormwater from each of the four catchments.

All stormwater drains and erosion and sedimentation controls associated with these drains are designed in accordance with *Australian rainfall and runoff: a guide to flood estimation* (Engineers Australia 1997) and *Best Practice Erosion and Sediment Control* (IECA 2008). These controls were designed by a Chartered Professional Engineer recognised by Engineers Australia (Simon Byrne from Byrne Design Pty Ltd).

The open drains servicing Catchments 2 and 3 have been sized for a Q5 storm event. Whereas the main cut off drain (OUD 1), servicing Catchment 1 is sized for a Q100 storm event.

Rock-check dams are spaced along all drains to reduce stormwater velocities. Reno mattresses are also installed at all drain intersections and outlet structures. The plan in Section 15.6 shows the location of rock-check dams and reno mattresses.

All drains are completely grassed and any erosion or sedimentation that may arise within these drains or their respective catchments will be detected through regular monitoring and addressed as required.

6.4.3 Stormwater Control Dams

Table 4 summarises the design specifications and erosion and sediment controls for Dam 1, which receives stormwater from Catchment 1 and Catchment 4 (if not diverted to first flush dam), Dam 2, which receives stormwater from Catchment 3, and the outlet structure, which receives stormwater from Catchment 2 (if not diverted by the first flush system).

Both dams and the outlet structure, and associated erosion and sedimentation controls are designed in accordance with *Australian rainfall and runoff: a guide to flood estimation* (Engineers Australia 1997) and *Best Practice Erosion and Sediment Control* (IECA 2008). These controls were designed by a Chartered Professional Engineer recognised by Engineers Australia (Simon Byrne from Byrne Design Pty Ltd).

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Given the two dams and the outlet structure will only receive uncontaminated stormwater, as explained in Section 1.2 above, and Section 3 below), the purpose of the dams and outlet structure is not to retain large volumes of stormwater but to slow and spread flows to the natural surface. The capacity and amount of rainfall that would result in overflow from the dams is given below:

- Dam 1 has approx 10,000 m³ capacity; given Catchment 1 and Catchment 4 have a combined area of 30 ha, and assuming Dam 1 is empty and 100% of rainfall runs off the land (i.e. no infiltration), it would take a 34 mm rainfall event for the dam to overflow.
- Dam 2 has approximately 11,000 m³ capacity; given Catchment 3 has an area of 9.1 ha, and assuming Dam 2 is empty and 100% of rainfall runs off the land (i.e. no infiltration), it would take a 121 mm rainfall event for the dam to overflow.

The overflow structure for Catchment 2 has no storage capacity and will flow following any rainfall event where rainfall volume exceeds infiltration capacity of the catchment.

The spillways of Dams 1 and 2, and the outlet structure, have been designed to cater for the flood capacity of the drains, and are designed to spread the flows and reduce outlet velocities. The spillway of Dam 1 will reduce outlet velocities to less than 9.24 m³/s for a Q100 storm event. The spillway of Dam 2 will reduce the outlet velocities to less than 1.94 m³/s for a Q5 storm event, and the spillway for the outlet structure will reduce outlet velocities to less than 1.12 m³/s for a Q5 storm event.

6.4.4 First Flush System

The first flush system is broken into three areas. The first is the section of the sealed internal roadway that passes through the stock unloading area and the render products loading area – Internal Road Catchment (IRC). The second is the small concrete concourse that lies between the render building and the hide processing shed – Hide/Render Catchment (HRC). The IRC and HRC both fall within stormwater catchment 3. The last is the overland catchment from the uncovered stock holding yards – Cattle Yard Catchment (CYC) (catchment 4)) (refer to Section 15.6 First Flush Infrastructure Schematic).

As a first intervention to stormwater contamination, ground surfaces subject to regular contaminant contact (such as the cattle unloading ramp, tallow load out area etc identified with a black star in First Flush Schematic in Section 15.6) are subject to immediate dry clean and localised area wash down to eliminate progressive build-up of contaminants over time (refer to Appendix W for clean-up procedures). This significantly reduces the contaminants present in Catchment 3 and therefore the volume of first flush capture during a rainfall event.

The first flush system has been designed as a three stage installation to appropriately manage potentially contaminated surface runoff during a storm event that factors in frequency and the amount of rainfall generally experienced during the wet season (Figure 2):

- Stage 1: Water hits the first flush drainage system and starts to fill the first flush sump triggering a timed pump event that transfers an initial 2l/m² to the waste water treatment system.
- Stage 2: The automatic timing cycle finishes and the first flush sump fills and retains a specific volume on top of that collected in stage one. Stage one and two volumes together form the total first flush collection for the specified area in a 24hr period. The catchment area sumps are pumped down (contents transferred to the WWTP) and pump timers reset every 24hrs.
- Stage 3: Once the first flush sumps reach their over flow point, remaining flow bypasses the catchment tank and runs directly from tank inlet to overflow outlet sending the remaining storm water volumes to the internal storm water drainage system.

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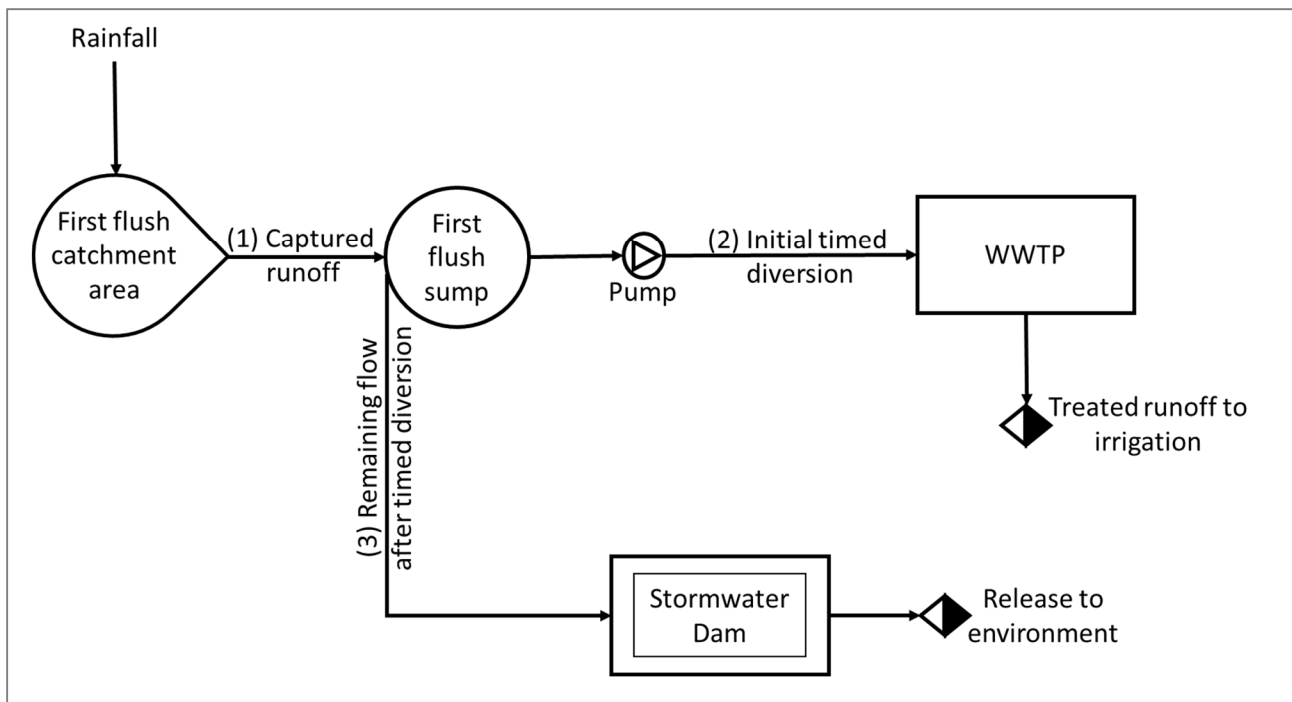


Figure 2: Basic functional process of first flush system

All pumps utilized in the first flush systems are of the submersible variety, this eliminates any potential priming issues when duty is required. The model, max flow rate, solids handling capacity and efficiency de-ratings (applied by NABL) of the pumps are shown in Table 5.

Internal Roadway Catchment

The contaminated run off capture system for the internal roadways handles overflow from a total area of approximately 8,000m². There are a series of five pits cut into the road side curbing (curbing is continuous and acts as a bund wall) at appropriate drainage points to catch and distribute water to a final sump area. The IRC FF sump then pumps back to the primary section of the WWTP on a timer (see timer calculation below) returning the potentially contaminated water volume to the front end of the WWTP. The timer sequence is activated via the high level float switch positioned in the IRC FF sump.

In the event of a spill or emergency not related to a stormwater event – the pump can be alternatively activated by a manual push button. Note this manual intervention does not bypass the auto functionality of the system – it merely simulates a high level float activation leaving the pump to stop at the end of the timer program or the sump low level switch activation, whichever comes first. A fault beacon light is positioned external to the control board at the IRC sump to indicate automatic operation availability. Manual operational checks of this light along with checking pump operation (manual push button) forms part of the system maintenance program.

Internal Roadway FF timer calculation

$$\frac{\{\text{Volume Required}\}}{\{\text{Pump Rate}\}} = \text{Min. Pump Timer Value} \Rightarrow \text{IRC System Allowance}$$

$$\frac{\{8000(\text{m}^2) \times 2(\text{L}/\text{m}^2)\}}{\{1050 (\text{L}/\text{min})\}} = 15.24 \text{ min} \Rightarrow 20\text{min}$$

Hide/Render Catchment

The concrete concourse between the Render Building and the Hide Shed receives any hosed or swept contaminants that leave either building. The concrete is shaped but passes close to an open storm water inlet. An interceptor pit has been installed that will capture and pump away the appropriate volume of suspect

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water in a storm event before allowing normal storm water drainage to occur. The concrete area between the two buildings has an area of 405m².

The pump in the interceptor pit is controlled as per the two previous pumping systems.

Hide/Render Shed FF timer calculation

{Volume required} / {pump rate} = Min. Pump Timer value => RHS System allowance

{405(m²) x 2(L/ m²)} / {210 (L/min)} = 3.86 min => 5min

Cattle Yard Catchment

The open cattle holding yards are used all year round. Therefore, stormwater and wash water from Catchment 4 (comprising the open cattle holding yards only) has the potential to contain contaminants from cattle manure. All water flowing from the yards is diverted via an open drainage system over a collection pit that diverts the initial flows to the first flush dam and on to the WWTP for treatment. The first flush dam will accept flows until the water level inside reaches a level that prevents further inflow. Stormwater then bypasses over the collection pit and down the open drain to Dam 1.

The first flush dam was designed by a Chartered Professional Engineer recognised by Engineers Australia (Simon Byrne from Byrne Design Pty Ltd).

The first flush dam is designed to take the initial runoff from the cattle holding yards based on receiving 60% of a Q1 storm event. Discharge from the holding yards for 60% of a Q1 storm is 0.054m³/s. Based on this, the design volume for the dam is calculated to be 76 m³. In actual fact, the first flush dam is 112.5 m³ and therefore has 1.5 times greater capacity than the design capacity.

Timed pumps have been installed in the First Flush Dam for additional capacity to divert stormwater flows for treatment if required.

Table 5: First Flush pump matrix

	Render/Hide Catchment	Internal Road Catchment	Cattle Yard Catchment
Type	Grunfos SEG.40.1.5E.EX.2.50B	Grunfos SEV.80.80.75.2.50.B	Grunfos SEV.80.80.75.2.50.B
Max Pump rate	4.75 l/s	25 l/s	25 l/s
Solids Handling	grinder	80mm	80mm
Efficiency De-rating	70%	70%	70%
Effective rate (l/min)	210.00	1050.00	1050.00
Duty Area (m2)	405	8000	7000
ltrs required/m2	2	2	2
Total Liquid Duty (litres)	810	16000	14000
Min Pump Duty (min)	3.86	15.24	13.33
Suggested pump timer settings	5 min	20 min	15 min
Max Pump rate	4.75 l/s	25 l/s	25 l/s

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6.5 Stormwater Risks

The environmental risk of stormwater leaving the operational area is assessed as moderate based on the following:

- Stormwater drains are designed to prevent run-on of stormwater onto the site from surrounding catchments.
- The stormwater system maintains complete separation of stormwater from the enclosed drainage systems within the meat processing facility used to capture and convey wastewater from cattle processing operations and wash-down activities.
- Stormwater that falls directly onto the site outside of the first flush system protecting catchments 3 and 4 will only come into contact with outdoor hardstand areas (i.e. car parks, roads, roofs) and grassed landscaped areas of the facility. Therefore, this stormwater is unlikely to transport contaminants other than what would normally be present in urban stormwater.
- Catchment 4 cattle holding yards and the various operating areas within Catchment 3 (cattle unloading area, DAF, listed waste area, rendering plant and brine shed surrounds) pose the highest risk of stormwater contamination. All first flush water flowing from these operational areas will be captured by a first flush system and treated through the WWTP. This diversion will be in place throughout the year and will capture the first flows in each rainfall event.
- All drains are completely grassed and there are no areas of bare, exposed soil within any of the catchments, therefore no sediment is entrained in stormwater. Monitoring and corrective actions of any erosion or sedimentation that may arise within the catchments is outlined below.
- Monitoring of water quality in Dams 1 and 2 and the outlet structure, and the first flush dam will be undertaken as per the WQMP and below.
- Visual monitoring of stormwater drains, dams, and the outlet structure will be undertaken weekly for any signs of erosion or sedimentation, or stagnating and deteriorating ponded water quality, or mosquito breeding.
- If ponded water is causing issue or erosion or sedimentation occurs, corrective measures will be implemented as per below.
- There is minimal potential for stormwater to be contaminated by spills/leaks of hazardous materials. All useable areas are either inside, covered (or trade waste is direct plumbed) so there is no stormwater/process water cross contamination. Therefore systems failures will be contained within the buildings and unable to escape. Grey and black water is low pressure and transferred to the septic system via underground pipes. The DAF has external components (pipework) and has critical shutdown systems for any compromised structures.

6.6 Maintenance Requirements

Regular maintenance of the stormwater control infrastructure will include the following:

- Clean-out of all dams (Dams 1 and 2 and first flush dam), including all sediments, sludge and/or ponded water will be conducted at the end of each wet season and also prior to the start of each wet season and also in response to any issues identified during the weekly inspections, such as stagnating water during dry periods over the wet season, mosquito breeding, or sediment build-up (although any sediment build-up will be addressed through the implementation of improved erosion and sediment controls).
- Sludge removed from the first flush dam will be taken to a disposal facility approved for this material. The need to remove sludge from the first flush dam will be identified during the weekly inspections.

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- The cattle holding yards will be completely cleaned out and washed down at the end of each dry season and prior to the first wet season rains.
- Inspection of all hard stand areas is carried out each day by the Environmental Officer and any spills identified are scheduled for cleaning by maintenance staff.

6.7 Monitoring, Reporting and Contingency Planning

6.7.1 Stormwater Monitoring and Assessment

Water quality samples will be taken from stormwater dams (Dams 1 and 2) as outlined in the Water Quality Management Plan. This will be undertaken during every rainfall event that results in stormwater flows in the drains and prior to overflow from the dams. The frequency of this sampling over the course of each wet season will depend on the frequency and intensity of rainfall events but is likely more frequent than that required for the surface water sites, given the catchment for the stormwater drains comprises areas of hardstand and roofs, rather than the extensive areas of well-grassed paddocks that comprise the majority of catchment of the surface water sites.

In regards to stormwater from the cattle-holding yards, all stormwater or wash water from the yards must be diverted to the first flush dam and the WWTP system for treatment during the dry season and for first flush flows of each wet season. All contaminated stormwater from the cattle holding yards will be diverted to the first flush dam for WWTP treatment to ensure the capture of the required volumes outlined in the First Flush section above to ensure contaminants are collected. Once this volume has been captured and diverted for treatment, stormwater from the yards may by-pass the first flush dam and flow into Dam 1.

Visual monitoring of stormwater drains, dams, and the outlet structure will be undertaken weekly for any signs of erosion or sedimentation, or stagnating and deteriorating ponded water quality, or mosquito breeding.

6.7.2 Reporting, Incident Response and Contingency Planning

All stormwater system monitoring data (along with all routine surface, groundwater, wastewater and soils monitoring data, and incident/investigative monitoring data) will be recorded in a central, one-stop database, and made available to the authorities on request.

This data will be presented in an *Annual Environmental Performance Report*. Review, assessment and interpretation of trends in monitoring results will highlight the need for any improvements to plant processes, equipment, and wastewater treatment or irrigation management. Regular review of monitoring results will also highlight any adjustments needed to this SWMP.

If water quality tested as part of the monitoring program breaches the Assessment Criteria, the source of any contamination will be identified and addressed immediately. Also, any breaches in the water quality of stormwater leaving the cattle holding yards and released to Dam 1 will be reported to the NT. EPA.

Additionally, all pollution incidents will be reported to the NT. EPA immediately as per NABL's responsibility under Section 14 of the *NT Waste Management and Pollution Control Act*. The pollution incident will be immediately cleaned up, an investigation carried out, and measures implemented to prevent the incident occurring again.

Ultimately, if surface and groundwater quality at the downstream NABL property boundary consistently breaches assessment criteria, NABL is committed to suspending meat processing operations to allow installation of additional stormwater or wastewater treatment infrastructure to increase the quality of treated wastewater.

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6.8 Performance Review

Review of stormwater management practices at the site is to be undertaken through:

- Annual internal audits
- Annual management reviews

Refer to Section 13 for details of monitoring, auditing and management review requirements.

7 Waste Management

7.1 Waste Management Aims

NABL will endeavour to adopt the principles of ecological sustainable development by making the most efficient use of resources and minimising wastes. NABL will also aim to provide facilities and procedures to ensure that wastes generated at the site do not result in actual or potential environmental harm or environmental nuisance being caused. To achieve this, NABL will:

- Adopt the principles of Cleaner Production by incorporating appropriate technologies and procedures for (i) waste minimisation, (ii) re-use and recycling, (iii) treatment and (iv.) disposal.
- adopt best practice techniques for waste storage, handling, treatment and disposal;
- promote awareness of waste management issues amongst staff;
- check compliance with specified management practices and licence conditions through a monitoring, auditing and review programme;
- Endeavour to identify opportunities to improve its waste management performance;
- Identify responsibilities, and provide budget allocations and procedures to enable the implementation of this management plan.

7.2 Purpose of This Plan

The purpose of this Waste Management Plan is to:

- identify and record all waste streams and by-products associated with the complex;
- record approximate quantities of wastes and by-products generated under current operating conditions;
- define the appropriate management practices for the handling, storage and disposal arrangements for all waste streams and by-products;
- determine the company's performance when judged against current environmental legislation and licence conditions;
- Determine areas in which waste minimisation is feasible.

7.3 References

In developing this management plan, reference has been made to the following

- Queensland Department of Environment, Draft Environmental Guidelines for Abattoirs, 1994
- NSW Environmental Protection Agency (EPA), Authorised Officers Manual - Abattoirs, 1995
- ANZECC, Draft Effluent Management Guidelines for Dairy Sheds, 1995.
- ANZECC, Draft Effluent Management Guidelines for Piggeries, 1995
- Department of Primary Industries, Environmental Guidelines for Queensland Dairy Farms, 1994
- Meat Research Corporation / Gutteridge Haskins & Davey Pty Ltd, Benchmarking of Environmental Performance, 1998

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7.4 Responsibilities

Environment Officer	Responsible for ensuring that the information contained in this plan is accurate and up to date. The details of waste management practices described in this plan are to be reviewed and updated annually as part of the annual OEMP audit and as agreed in the licence conditions. Responsible for ensuring the implementation waste handling processes are compliant with EPL219 and environmental legislation
Maintenance Manager	Responsible for ensuring that the waste management practices described in this plan are effectively actioned.
Plant Manager	Responsible for ensuring that the waste management practices described in this plan are effectively implemented.
AACo Environmental Manager	Responsible for ensuring NABL compliance with waste management and minimisation legislation and ensuring compliance with EPL219. Responsible for driving waste reduction and handling improvement initiatives.

7.5 By-Product Inventory

The following in Table 6 is an inventory of by-products generated at the facility. These materials have been termed by-products because they are rendered on site into tallow, meat meal, blood meal.

Table 6: By-products produced

By-products	Source	Storage / Treatment Requirements	Disposal Requirements
Rendering material (hoofs, heads, bone horn & fat)	Carcass dressing	Conveyed directly by enclosed chute and screw conveyor to truck positioned in basement area.	Transported to Rendering plant on site via belt for rendering into meat meal and tallow.
Wash down solids	Slaughter-floor and boning room wash-down	Separated from wastewater in contra-shear screen and then conveyed by belt to render	As above
Product not suitable for human consumption	Evisceration area	Conveyed directly by enclosed chute and screw conveyor to truck positioned in basement area.	Transported to Rendering plant on site via belt for rendering into meat meal and tallow
Hides	Hide removal area	Collected and transported by belt to hide shed	Processed in brine as preparation for export.
Blood	Slaughter floor	Conveyed by pipe to enclosed blood pit	Pumped To rendering plant via a pipe system to be rendered into blood meal

SECTION 7: Waste Management

7.6 Waste Inventory

The following Table 7 and Table 8 are an inventory of solid and liquid wastes generated at the facility. These materials are classified as wastes because they currently have no monetary value, cannot readily be converted into a useful by-product and are disposed. This inventory is to be updated as part of the annual environmental audit to reflect current conditions.

Table 7: Solid wastes produced

Solid Wastes	Source	Storage /Treatment Requirements	Disposal Requirements	Average quantity
Paunch Manure (wet)	Paunch room	De-watered through FAN screw press and collected in paunch bin.	Stored in listed waste area in bins for removal from site for deep burial. (NOTE: this waste stream has potential to be harvested and composted once the appropriate infrastructure and licensing is in place)	~140m ³ / month
Manure waste from washing of pens	Holding pens	As above	As above	Included in above
DAF Sludge	DAF	Dewatered through decanter and collected in listed waste bins	As above	~70m ³ / month
Stock yard manure	Stock yards	Scooped up with front end loader and stored adjacent to yards	Collected by local landscape operator and/or farmer as required. (NOTE: this waste stream has potential to be harvested and composted once the appropriate infrastructure and licensing is in place)	~100m ³ / month
Waste Activated Sludge	Sequencing Batch Reactor	De-watered through belt press at WWTP dewatering shed	Stored in listed waste area in bins for removal from site for deep burial. (NOTE: this waste stream has potential to be harvested and composted once the appropriate infrastructure and licensing is in place)	~80m ³ / month
Mortalities	Cattle receival area	NA	Stored in listed waste area in bins for removal from site for deep burial.	~1 / month

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Table 8: Liquid wastes produced

Liquid Wastes	Source	Minimisation Strategy	Storage/Treatment Requirements	Disposal Requirements	Average Quantity
Abattoir process wastewaters	Manure waters from cleaning of holding pens		Treated through contra-shear at the manure treatment plant and directed to WWTP for further treatment.	Treated effluent irrigated to land.	~4.5 ML/week
	Cleaning in slaughter, evisceration & boning areas	Dry clean-up prior to wet cleaning.	Passes through contra-shear in basement area and the directed to WWTP for further treatment.		
	Edible offal washing	“Water saver” spray nozzles and pressure control			
	Carcass washing	Modified washing system to be introduced in slaughter area which will reduce the volume of water needed for final carcass wash.			
	Defrost water from continuous freezer conveyor tunnels				
Cooling water bleed	Evaporative condensers in refrigeration system.	System for collection and reuse proposed.	Drains away to WWTP via in-ground drain	Land dispersal to paddock	Not Measured
Domestic sewage	Abattoir	N/A	Collected and treated septic units.	Sludge generated by the septic processing is disposed to PowerWater sewage treatment facility and treated wastewaters are discharges to covered absorption trenches.	Not Measured

7.7 Management Practices for Wastes and By-Products

This section describes the current practices for the management of wastes and by-products, including handling, storage, treatment and disposal.

SECTION 7: Waste Management

7.7.1 By-Products

By-products generated from slaughtering and carcass dressing is processed on site for further value adding into products for sale, as follows:

- Cattle heads, horns, hoofs, bone, body fat and blood are collected for rendering into meat meal and tallow.
- Hides are collected for brining and then exported.

The central collection and storage point for all by-products is the 'basement area' located directly below the slaughter floor. All materials are conveyed by belt to the render plant and hide shed.

By-products are putrescible and must not be stored on-site for long periods of time to avoid odour generation. Currently all putrescible materials are collected and removed off site at least daily, and in some cases twice per day. There are additional listed waste bins available if there are other delays.

7.7.2 Paunch

Paunch manure and manure from the AQIS holding pens is collected in a wet form and is de-watered by screw press before being removed off site for deep burial. The process for collection and dewatering is as follows. Wet paunch manure from the tripe room and manure which is washed from the AQIS holding pens feeds by gravity to a Contra Shear Screen which de-waters the manure. The manure cake falls into a bin and is taken to a drying area. The wastewater generated from the dewatering flows to the WWTP via the CAL feed tank.

7.7.3 Sludges

DAF Sludge

The wastewater stream is processed through the DAF prior to being piped to the WWTP. The DAF functions as a final save all, removing much of the suspended solids and oil and grease from the wastewater stream. This sludge is dewatered via a decanter. Depending on the quality of the sludge, it may be reprocessed through render. However if the quality is low and the material cannot be recovered through render, it is collected in listed waste bins and removed from site along with paunch three times a day.

WWTP - Waste Activated Sludge

Wastewater treated through the WWTP generates a waste activated sludge (WAS). Wastewater passed from the CAL into the SBR contains some fine solids and nutrients. The SBR continues the biological process of this material in an aerobic environment. The SBR is also dosed to cause solids and phosphorus to precipitate out. Excess biological sludge in the SBR also containing the precipitated phosphorus is removed via belt press in the dewatering shed generating the WAS as a fine, wet cardboard-like material that is collected in bins and removed from site for deep burial at a registered disposal facility. The water extracted from this process is returned to the SBR. The belt press is run manually as the system requires on most days of production.

The processing of wastewaters in the CAL also generates a sludge which settles to the bottom of the pond. The CAL should be de-sludged once the sludge takes up one third of the total volume (or half depth) of the pond, to maintain the hydraulic capacity of the pond. Sludge extraction piping exists in the CAL to make this possible.

7.7.4 Mortalities

About a dozen or so cattle mortalities occur every year, usually as a result of old age or stress and carcasses are collected in listed waste bins and removed from site for deep burial at a licensed facility within 12 hours of being collected in the bins.

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7.7.5 Wastewaters

Wastewaters are generated from the processing floor and render and flow via in-ground pipe work to the DAF for pre-treatment and then to the WWTP located south of the abattoir complex via the CAL feed tank. At current processing rates (4-500 head / day, five days a week) the total quantity of wastewater entering the treatment ponds from all site activities is approximately 4-5 ML per week. Water saving initiatives are in development to reduce the volume of water used in processing which will have a direct impact on volumes flowing to the WWTP.

Wastewaters from the abattoir are generated from cleaning activities in the slaughter, evisceration and boning rooms, washing of carcasses, and to a lesser extent truck wash down and wash out of the holding pens. Waste water generated by the rendering plant is made via evaporation of the cooking process and cleaning this water will be directed into the DAF prior to the WWTP.

Wastewaters from the slaughter, evisceration and boning rooms and from carcass and offal washing pass through a Contra-shear rotary screen in the basement area to remove solid material and then drains directly by gravity through an in-ground closed conduit to the DAF and then to the WWTP. The solid screenings are conveyed by belt to render for processing.

Blood is excluded from the wastewater stream as far as possible by allowing the carcasses to drain into the blood collection facility.

Wastewaters containing manure (from holding pen wash downs and from the paunch washing) are directed to a dedicated screw press screen located adjacent to the DAF. The screened wastewater drains to the CAL feed tank and then to the WWTP.

7.8 Effluent Treatment

This section describes the current practices for the management of effluent, including treatment, storage, and disposal.

7.8.1 Operation of Wastewater Treatment Plant

The WWTP is comprised of 3 lagoons in series; a covered anaerobic lagoon (CAL), a sequencing batch reactor (SBR), and finally the decant basin which acts as a holding pond prior to irrigation onsite. The CAL contains two key biological communities that break down the organic content within the wastewater and then convert this to Biogas which is captured under a cover and piped to a flare. The retention time in the CAL is approximately 14 days, after which time the wastewater is released to the SBR where a complex aerobic biological community process remaining organic material and nitrogen and a chemical dosing system removes phosphorus prior to water flowing to the decant basin. The SBR contains three aeration devices which operate automatically on a six hour batch cycle that includes, as a minimum, an aeration phase, a settling phase and a decant phase. At the end of each cycle, treated wastewater is released through an automated decanter arm into the adjacent Decant Basin where it is stored until pumped to either the Irrigation Tank or (when conditions are unsuitable for irrigation) to the Wet Weather Storage (WWS) Dam.

The 70ML WWS Dam is sized to hold up to the full volume of treated effluent and rainfall (into the dam) from a 90th percentile wet year while allowing irrigation during the wet season when conditions are suitable. The accumulated water in the WWS Dam can be held safely through the wet season by disrupting thermal stratification of water using suitable floating mixing/aeration devices. This also manages control of excessive algal growth. At the end of the wet season, any accumulated water is available for irrigation of pasture on the land allocated for irrigation. During the latter part of the dry season it is probable that the WWS Dam will be empty.

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A process flow diagram outlining the full wastewater treatment stream including the DAF is provided in Figure 3. In brief, full wastewater treatment stream is made up of the following:

- FAN screw press to remove gross solids from the “green” (manure and stomach contents) streams.
- Rotary screen to remove gross solids from the render wastewater streams.
- Large, mixed “common sump” which collects all flows discharged from the green FAN presses and the “red” (in contact with blood and fats during processing) stream off the processing floor and render streams.
- Twin 25 kL equalisation storage tanks prior to Dissolved Air Flotation (DAF) processing. These tanks are mixed.
- An undosed DAF unit to remove a large fraction of suspended solids and oils & greases from the wastewater stream.
- Decanter to dewater the DAF float solids.
- A 16ML nominal volume, 5m working depth Covered Anaerobic Lagoon (CAL) which is lined with an impermeable HDPE liner. A synthetic floating cover of 2 mm thick HDPE captures the methane-rich biogas produced by anaerobic digestion of the organic material (COD) in the wastewater. This also minimises odour emissions.
- Biogas flare to destroy methane-rich carbon emissions and odour produced within the CAL.
- Sequencing Batch Reactor activated sludge unit (SBR) with a 5.3ML working volume and depth of 5m. The primary role of the SBR is organic and nitrogen reduction using high rate biological action. The SBR is dosed with poly aluminium chloride (PAC) to precipitate phosphorus from the wastewater. The phosphorus precipitate is entrapped in the bacterial floc and removed from the SBR
- Combined gravity drainage deck/belt filter press dewatering device to remove waste activated sludge (WAS) generated by the SBR. The WAS is dosed with polymer to assist flocculation and is then dewatered.
- Decant Basin of a 2.4ML nominal volume.
- A 70ML wet weather storage dam to hold water during extended wet weather periods when soils are saturated (NOTE: WWS is not yet installed as operations on site are suspended – construction to be completed under the current approval EPA252 within 12 months of recommencement of site operations according to EPL219-01).
- 200kL storage tank to hold treated effluent prior to disposal by irrigation.

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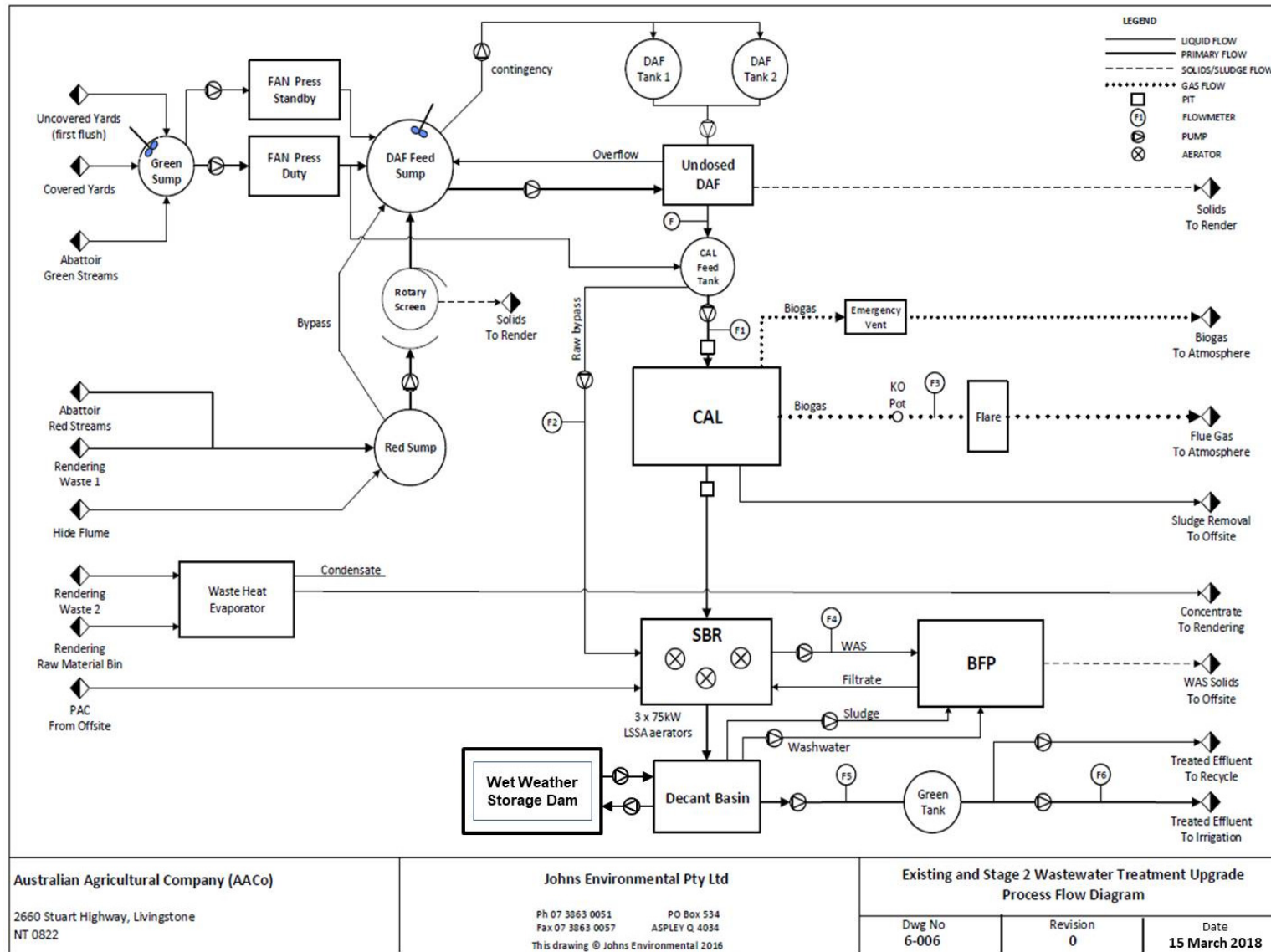


Figure 3: Schematic of the Wastewater Treatment System

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7.8.2 Treatment Efficiency

The WWTP has been designed to meet the water quality parameters and treatment efficiency outlined in Table 9.

Table 9: Water quality parameters the WWTP has been designed to meet

Parameter	Units	Final treated concentration	Design removal (%)
COD	mg/l	150	93
BOD5 (filtered)	mg/l	<10	98
Total Nitrogen	mg/l	40	78
NH3-N	mg/l	<2	99
Total Phosphorus	mg/l	10	67
Oil & Grease	mg/l	<10	-
Total Suspended Solids	mg/l	<50	90
pH	-	6.5-7.5	-
EC	µS/cm	~2,000	-
E. coli	#/100 ml	10,000	5-log

7.9 Waste Minimisation

Waste minimisation initiatives at the site have focused on the following areas, which represent the most significant sources of waste from the process.

- Maximising the utilisation of animal products either as saleable products or as by-products that receive further value adding in another process, to reduce the need to dispose of animal wastes to landfill.
- Minimising water use and wastewater generation.

7.9.1 Existing Waste Minimisation Practices

Currently the following measures are taken to minimise waste generation.

- Development of additional products and by-products. A processing facility has been established to process tripe and bibles into saleable products.
- Dry cleaning is undertaken prior to wet cleaning in all areas where practical.
- All process wastewaters are screened through Contra Shear screens to reduce the load of suspended solids discharged to the effluent treatment ponds.
- The DAF functions as a save all and materials that meet quality requirements can be reprocessed through render.
- ‘Water saver’ spray nozzles are used in all areas where water is used for cleaning.
- Backwash water from the water treatment plant is recycled as raw water.
- Treated effluent is utilised to irrigate crop pastures on site.

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7.9.2 Proposed Waste Minimisation Practices

The following have been identified as areas for further waste minimisation:

- Collection of organic solid wastes for sale as by-product. NABL is currently developing a proposal for the on-site processing of solid wastes including DAF and WWTP sludge, paunch and manure to generate a saleable soil amendment product suitable for the local horticulture industry. This proposal will require NT EPA approval and licensing.
- Additional water saving initiatives on the processing floor
- Productive use of biogas currently flared on site.

7.10 Performance Review

Review of stormwater management practices at the site is to be undertaken through:

- Daily, weekly and monthly routine checks by the Environmental Officer
- Quarterly monitoring to be performed by the site's Environment Officer
- Annual internal audits
- Annual management reviews

Refer to Section 13 for details of monitoring, auditing and management review requirements.

8 Irrigation Management

8.1 Irrigation Aims

The aim of the irrigation management plan is to efficiently utilise the treated effluent in the growing of fodder crops for hay production whilst ensuring that the irrigation area and adjacent environment is not degraded in the long term by salinity, waterlogging or nutrient build-up and that surface water and groundwater is protected from contamination.

8.2 Purpose of the Plan

The purpose of this Management Plan is to:

- Describe the suitability of land for irrigation with respect to erosion hazard, soil type and hydrology;
- Provide a simulation of the effects of the irrigation using a hydrology model;
- Provide an outline of the Irrigation Management Program based on a sustainable long term use of the irrigation area and
- Provide a monitoring program to verify and monitor the long-term sustainability of the Irrigation Management Program.

8.3 Responsibilities

Environmental Officer	Responsible for ensuring that the information contained in this plan is accurate and up-to-date. The details of irrigation strategy are to be reviewed and updated as part of ongoing monitoring of the irrigated area.
Farm Manager	Responsible for actioning irrigation procedures as defined in the Irrigation Management Procedures.
Maintenance Manager	Responsible for ensuring that the irrigation management practices described in this plan are effectively actioned.
Plant Manager	Responsible for ensuring that the irrigation management practices described in this plan are effectively implemented.
AACo Environmental Manager	Responsible for driving irrigation management improvement initiatives and ensuring compliance with EPL219..

8.4 Suitability for Irrigation

8.4.1 Topography and Drainage

Most of the property is flat to gently sloping grassland with scattered trees and all run-off flows into a centrally located seasonally wet area. Water from this area flows west into Berry Creek. Berry Creek then flows into the Blackmore River approximately 15 km downstream from the property, which then flows into Darwin Harbour a further 8 km downstream.

Three second order (Strahler's Order) streams, upper tributaries of Berry Creek, drain the property. The east branch runs on an east-west alignment through the centre of the site, while the southern branch runs from a point near the intersection of Scrutton and Cornock Roads outside the site, through Lot 4 and to the south-

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western corner of Section 5410. The north branch runs roughly parallel to the western boundary. The stream margins are well vegetated and as mentioned above; a greater than 50 m wide buffer zone has been established around the central wet area to protect it from erosion and to allow riparian vegetation to act as an extra filter for run-off from the irrigation area and stormwater run-off from around the processing facility infrastructure (See Section 15.4 for irrigation area map).

Streams on the property only flow immediately after heavy rainfall. Flows in the upper stream branches diminish rapidly after rainfall stops; whereas flows persist for longer downstream of where these stream branches meet and cross the property boundary.

8.4.2 Groundwater

A groundwater investigation has been undertaken at the site prior to operation. Full details of this groundwater report can be found in previous version of the Water Quality Monitoring Plan (2017). Pump testing and water quality sampling of the bores indicated two distinctive surficial groundwater systems:

- a shallow unconfined, and probably perched, aquitard system to between 2 m and 5 m deep; and
- a deeper semi-confined to confined aquifer between 30 m and 100 m deep.

Both these aquifers flow in a westerly direction with hydraulic conductivities ranging between:

- 7.6×10^{-3} m/s to 3.1×10^{-2} m/s with an average of 1.9×10^{-2} m/s for the overlying aquitard
- 8.7×10^{-5} m/s to 2.4×10^{-4} m/s with an average of 1.5×10^{-4} m/s for the deeper semi-confined to confined aquifer.

The relatively high conductivity of the shallow aquitard system is characteristic of systems in which primary porosity is controlled by coarse to finer grain sizes, particularly silts and finer sands.

Groundwater, including contaminants should they enter the surficial soils, may migrate at velocities of up to 50 m/day in a westerly downstream direction. In contrast, the permeability's for the underlying semi-confined to confined aquifer are much lower and typical for weathered rock aquifers, where the permeability is controlled by a combination of primary porosity from the pore space matrix and secondary porosity created by bedding planes. Flow velocities in the aquifer average 0.5 m/day.

Shallow water strikes were found between 3 m and 6 m below ground level and deep water strikes between 24 m and 44 m below surface but mostly between 26 m and 33 m below surface. Seasonal groundwater level fluctuations are expected to be about 6 m in shallow bores and little, if any, in the underlying confined to semi-confined aquifer. Recharge from rainfall is predominant to the shallow superficial soils. Groundwater leaves the aquitard and aquifer systems as:

- evapotranspiration and shallow discharge/seepage to streams and wetlands from the aquitard system
- regional groundwater flow from the semi-confined to confined aquifer system.

Discharge to streams and wetlands occurs where the groundwater potentiometric surface is higher than the stream/wetland i.e. across the central to western portion of the site. The amount of discharge would be controlled by the head differentials, the permeability of the stream/wetland bed sediments and seasonal precipitation amongst others. The wetlands, including that located to the west of Bore 5, seem to be hydraulically interacting with the shallow aquitard system and water balances, including water qualities.

Evapotranspiration constitutes a reduction of the net recharge from precipitation and primarily impacts the surficial aquitard system which dries out during late the dry season. In the absence of groundwater abstraction, groundwater through flow and outflow occurs from the deeper aquifer system.

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Groundwater flow directions in both the shallow surface soils and underlying aquifer are predominantly from east to west, controlled by the topographic and drainage features of the local landform. The shallow aquitard system appears to be in hydraulic interaction with streams and wetlands locally. Whilst the drilling, testing and sampling program suggested there is not a hydraulic connection between the shallow surficial soils and underlying aquifer, such connections and interactions cannot be ruled out exclusively. There is also the possibility the aquitard may not extend downstream of the site due to thickening of the underlying sandstones.

8.4.3 Soil Type

A site-specific soil investigation including laboratory analysis was undertaken prior to the construction of the facility. A summary of these results can be found in the previous Irrigation Management Plan (2017). The following is a description of the typical soil type across the relatively flat – low sloping landscape found by this investigation.

Yellow Podzolic Soil (Dy 5.11)

- The soils across the majority of the property are yellow duplex or texture contrast soils dominated by the mineral fraction.
- The surface soils of the area typically comprise dull yellowish loamy sands to approximately 20-30 cm depth with slightly higher clay content sandy loam soil to about 70-100 cm.
- The subsoils are typically yellowish brown sandy clays with approximately 19-28% clay content or light-medium clays with >30 % clay.
- The typical soil type is described as a relatively deep, light coarse sandy soil overlaying sandy clay subsoils. Note that generally, the subsoils of the lower elevation and flatter terrain were comprised of high plasticity clay.
- A prominent feature of most of the soil profiles inspected was the presence of a hard sesquioxidic layer ie. lateritic or iron-rich layer often including ironstone gravels.
- These leached sandy soils are strongly acidic throughout ie. pH 4.9 - 5.7, and are relatively infertile soils.
- The soil structure (pedality) is described as weak in the topsoil with generally moderate pedality in the clayey subsoils.
- Yellowish orange and reddish brown mottling was generally observed and beginning at ~ 60-80 cm.
- Significantly, fine plant roots (< ~1.0 mm) were generally observed to occur down through the lateritic layer to approximately 1.1 – 1.2 metres depth.

This soil type is suitable for grazing of native and improved pastures and will support irrigated hay production with the additional of soils amendment products to support soil health as required.

8.5 MEDLI Modelling

8.5.1 Introduction

The sustainability assessment was performed using the Model for Effluent Disposal using Land Irrigation (MEDLI). MEDLI is a specialist Windows™ based computer model for designing and analysing effluent disposal systems for intensive rural industries, agri-industrial processors (e.g. abattoirs) and sewage treatment plants using land irrigation.

MEDLI is a daily timestep model with scientific rigor. It was first developed in 1996, when it was released jointly by the then Queensland Department of Primary Industries, CRC for Waste Management and Pollution Control, and the Commonwealth Scientific Industrial Research Organisation (CSIRO). A new version (MEDLI

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Version 2) was released by the Department of Science, Information Technology and Innovation (DSITI) in June 2015. Version 2 represented a substantial upgrade designed with input by regulators.

MEDLI models the complex dynamics of an effluent irrigation system using site specific historical climate data to determine the wet weather storage and irrigation area requirements for a specific location. It is widely known and used in the abattoir/sewage/intensive livestock industries and results accepted in all Australian States and Territories.

Johns Environmental undertook the assessment and have performed MEDLI scenarios and sustainability/DA reports on over 100 occasions at many sites across Australia, all of which have been accepted by various EPA's and continue to operate.

Hydraulic and nutrient balance modelling using the MEDLI software has been undertaken to determine the sustainability of the effluent irrigation system including use of a wet weather storage dam to store treated effluent, allowing irrigation to occur only during favourable climatic and soil conditions. This would be considered best practice.

8.5.2 Climate

The climate is characterised by two distinct seasons, the wet and the dry. The wet season lasts for 4 to 6 months from November to April and receives over 90% of the annual rainfall. Sporadic thunderstorms start in September/October and continue through to December.

Rainfall is heaviest in January and February due to monsoonal activity and tapers off in March and April. May to October is the dry season and little or no rain is received in most years.

Seasonal rainfall variation is relatively low by Australian standards but weekly and fortnightly variations are high and may exceed 100%. The extreme variation within a season can result in intermittent periods of wet and very dry conditions occurring within the same month or even the same fortnight.

In order to undertake the necessary hydraulic and nutrient modelling, daily climate data for the Livingstone locality was required. Data was obtained from the SILO database operated by the Bureau of Meteorology (BOM). The mean annual rainfall is 1,551 mm/year, whilst the mean annual pan evaporation is 2,287 mm/year.

Wind data for the Noonamah AWS and Noonamah Airstrip, shows there is a marked difference in wind trends apparent between the two seasons, with the dry season showing slightly higher frequency of calm winds and a much stronger prevalence of winds from the southeast sector.

8.5.3 MEDLI Model Input Data

The annual effluent flow to irrigation at current production is estimated to be approximately 216.1 ML/yr based on the measurements of irrigated volumes from the WWTP (after allowance for recycled water use). This comprises 760 kL/d for the period 1 October to 30 April and 988 kL/d for the period 1 May to 30 September. There is an annual three week shutdown over the Christmas holidays.

The MEDLI modelling run for each scenario was then calibrated to have nitrogen, phosphorus and salinity concentrations based on the SBR treated effluent. For full details refer to the report titled "Supporting documentation for application to amend environment protection approval 20. Prepared by Johns Environmental, Brisbane, 8th June 2016". These concentrations are:

- Total nitrogen: 40 mg/L,
- Total phosphorus: 10 mg/L; and
- Electrical conductivity: 2.5 dS/m.

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A 128-year (1889-2016) climate file for the Livingstone area was obtained from the SILO database operated by the Bureau of Meteorology (BOM) that gives daily meteorological data. The mean annual rainfall is 1551 mm/year.

The soil parameters in the model were determined based on the soil and landscape sections of the effluent irrigation report prepared by Zinga & Associates (2011), as well as information by an experienced agronomist and data (physical and chemical) reviewed by a certified practicing soil scientist. Phosphorus sorption and current soil reserve data has been used in the modelling. Overall, this data shows that the soils have substantial capacity (355-583 mg/kg) to absorb and safely store excess phosphorus (Zinga and Associates 2011).

The irrigation input data includes the irrigator type, irrigation area size and irrigation scheduling rules. The irrigation method modelled was a spray system with scheduling based on maintaining a 10mm deficit below the soil's drained upper limit (DUL). By ceasing irrigation before the soil's DUL is reached means that irrigation will cease at greater than 30mm below the saturation point, which is the maximum water held in the soil before drainage takes place. This provides a safety margin to ensure the soil still has ability to infiltrate any unforeseen rainfall occurring after irrigation has ceased.

Irrigation of treated effluent is proposed to occur using an existing centre pivot purposely designed for controlled application rates of effluent plus supplementary areas irrigated using a small travelling irrigation.

The "pond" used in the modelling is a 70 ML wet weather storage dam. The size required was determined based on achieving an acceptable overtopping frequency using the irrigation scheduling above. The target overtopping was overflows only occurring in less than 10 percent of years.

The modelling was undertaken using the proposed hay production system, which involves growing improved pastures that are periodically cut, baled and removed from the site. The improved pastures grown are capable of good yields due to fertiliser application and supplemental water (through effluent). NABL have consulted extensively with the NT Department of Primary Industry and Mr Fergal O'Gara for expert local advice on suitable pasture species and their management. This is summarised in Section 8.7.4.

8.6 Nutrient and Water Balance

Table 10 shows the hydraulic and nutrient balances predicted by MEDLI for the effluent irrigation system discussed above. This includes provision of a 70 ML wet weather storage dam.

The results above show the predicted water and nutrient balances for the proposed effluent flows and quality supplied by NABL. The hydraulic loading is only 599 mm/yr (~6.0 ML/ha). The predicted deep drainage rate is 627 mm and predicted runoff is estimated to be only 34 mm/yr. The baseline (no irrigation) deep drainage and runoff are 1300 mm and 36 mm respectively. The substantial decrease in deep drainage is likely due to the growth of pastures which transpire significantly more water than the natural (unproductive) system.

The proposed 70 ML wet weather storage dam is sufficient to meet relevant guidelines. Only seven overflow events are predicted in the 128 year modelling period (~0.5 in 10 year frequency).

The nitrogen loading rate is estimated at 239 kg/ha/yr and leached nitrogen is predicted to be <0.5 kg/yr. The predicted phosphorus loading rate is 59 kg/ha/yr, with approximately 56 kg/ha/yr utilised by the growing and harvest of Rhodes grass pasture (or similar crops with good biomass production). Negligible phosphorus leaching is predicted to occur. These loading rates are fully compliant with Condition 39 (Table 4) of Environment Protection Licence 219.

The proposed effluent reuse system, comprising a 70 ML wet weather storage dam and irrigating onto suitable land (34 ha required) that is used for hay production is considered sustainable, because the nutrient

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applications through effluent closely match the predicted removal rates. There is no increase in runoff caused by effluent applications and the predicted deep drainage loss does not result in unacceptable leaching losses of nutrients.

Table 10: Effluent Irrigation Area Water and Nutrient Balance

Water Movement (ML/yr)	Sustainable Including Wet Weather Storage
Irrigation area required (ha)	34ha
Land management mode	Cut & cart
Water balance (mm/yr)	
Rainfall	1,551
Irrigation	599
Soil evaporation	3
Transpiration	1487
Runoff (effluent)	0
Runoff (rain)	34
Drainage	627
Nutrient Application and Losses (kg/ha/yr)	
N applied as effluent	239
N removed by hay production	241
N Leached	<0.5
P applied as effluent	59
P removed by hay production	56
P stored	3
P leached	<0.1
Nutrient Concentration in Deep Drainage (mg/L)	
Nitrogen	1
Phosphorus	<0.1
Crop Yield (t DM/ha/yr)	
Crop yield	18.8

NB: All data are means over 128-year simulation period.

8.7 Irrigation Plan and Implementation

The Irrigation Management Plan is being implemented in three stages. The first stage reflected irrigation regime prior to implementation of the WWTP in October 2017. Details on this irrigation program can be found in the previous Irrigation Management Plan (2017).

Stage 2 will outline irrigation management practices under the WWTP Stage 2 development prior to the development of the wet weather storage and included management of irrigation through the 2017-18 wet season and up until the implementation of the wet weather storage (due for completion on the 30th November 2018).

Stage 3 addresses irrigation management practice after the implementation of the wet weather storage and into the long term.

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8.7.1 Irrigation Management Overview

Buffers have been established from the closest neighbour (250m), property boundary (50m) and ephemeral watercourses (50m) from each irrigation area. The irrigation area closest to these buffers is the centre pivot irrigation area, which is placed approximately 115m from the bank of the watercourse, an additional 65m from the riparian buffer.

NABL has also installed a stormwater diversion drain (as shown in the map in Section 15.4) within the irrigation area to improve the ability to manage stormwater in the irrigation paddocks and protect surface water from potential contamination in runoff. This drain directs water from the incoming drain from the adjacent train line into natural drainage lines and do not alter the total flow leaving the site from its natural levels. This drain includes a settling pond that captures and slows the stormwater as it enters the site, allowing for contaminants that may enter the site from neighbouring facilities to be trapped and detected. This small pond also reduces the velocity of the water and therefore reduces erosion risk associated with diversion of stormwater. In addition to this, NABL has a significant vegetative buffer asset that further protects surface water and groundwater, including a significant vegetation zone which is maintained between the irrigation area and the watercourse.

The aim of the irrigation system at the facility is to ensure that treated effluent is managed so that practices do not impact negatively on the environment or community. Sustainable effluent management involves matching irrigation to the water and nutrient requirements of the crop whilst controlling runoff and maintaining or enhancing the soil resource on the property.

Northern Australian processing facility has a fulltime Irrigation Supervisor who is responsible for irrigation management at the site. All designated Irrigation paddocks onsite are inspected daily by the Irrigation Supervisor as well as the Environmental Officer, who conduct daily inspections of the areas being irrigated for any ponding, erosion, odour or mosquito breeding issues.

Regular groundwater and surface water monitoring is conducted downstream of the irrigation paddocks to identify any potential contaminants entering into downstream water sources. Further details of this monitoring can be found in the Water Quality Monitoring Section.

The procedures for managing the irrigation areas (refer to Appendix L) cover items including:

- Suitability of effluent for irrigation
- Selection of area to be irrigated
- Wet Season Irrigation Timing
- Application of irrigation; and
- Irrigation recording sheet

8.7.2 Stage 2 Irrigation Management

Stage 2 irrigation primarily focuses on irrigation under the 37.4ha Centre Pivot Irrigation System in the Northern Irrigation Zone (See Section 15.4 for a map of irrigation areas) as the primary mechanism for effluent irrigation. The Centre Pivot Irrigation System irrigates treated effluent at a low pressure over a large surface area. The irrigation rates of the Centre Pivot system ranges from 1mm/m² to 3.5mm/m². According to the current effluent production rates of ~1.05 ML/day the Centre Pivot requires approximately 2.5 days to complete an entire cycle.

During periods of soil saturation, EPL219 requires a maximum irrigation rate of 1mm/m².day to limit the risk of surface water and groundwater contamination. In order to effectively manage irrigation during the 2017-18 wet season, NABL has installed additional Travelling Irrigators in the Northern Irrigation Zone in what was previously the K-line irrigation area. This infrastructure will provide an additional 60ha of irrigation area during the wet season, to a total of approximately 97.4ha of irrigation area. This will enable NABL to effectively manage the application of effluent during periods of soil saturation at the required rate.

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8.7.3 Stage 3 Irrigation Management

(NOTE: WWS is not yet installed as operations on site are suspended – construction to be completed under the current approval EPA252 within 12 months of recommencement of site operations according to EPL219-01. It is likely that the WWS will be located to the immediately west of the current WWTP, however a site has not been finalised).

Stage 3 Irrigation Management incorporates a wet weather storage into the effluent treatment and irrigation management stream. The WWS enables the storage of irrigation water during periods throughout the wet season where soil conditions are saturated. This ensures that irrigation of treated effluent will not occur when there are active surface flows within the irrigation paddocks, significantly reducing the risk of contamination of surface and groundwater.

The Wet Season in the Top End is typically considered to extend from October to April each year. While there is potential to receive significant rainfall events at any point throughout this period, it is generally the case, that the peak of the rainfall is received in the January to March window. It is not uncommon to have long periods of little to no rainfall throughout the wet season, during which time the soil can become relatively dry and crops can fail.

The wet weather storage provides the flexibility to hold water during the high rainfall periods and enable a return to irrigation during drier periods to ensure healthy crop growth is sustained. Sustaining healthy crop growth is essential to ensuring a system through which nutrients from the treated effluent can be successfully capture and recycled in the form of fodder. The point at which irrigation is ceased and the storage of irrigation water in the WWS is commenced is determined by ensuring a 10mm deficit below the soil's drained upper limit. Applying this condition to irrigation scheduling means that irrigation will cease when soil moisture is at greater than 30mm below the saturation point. Soil moisture readings will be collected on a daily basis during the wet season to determine when irrigation will commence and cease. Procedures for managing this process are outlined in Appendix L - Irrigation Management Procedures

Under Stage 3 Irrigation Management, irrigation activities will focus primarily on the Centre Pivot area which covers 34ha with an additional 3.4ha extended area. Travelling irrigators will provide an additional 60ha of irrigation area if it is required. This area may be used at times when the Centre Pivot is unavailable for use including times when it is undergoing other management activities such as soil amendment or hay cutting. This area may also be available should it be necessary to rest the Centre Pivot paddock to support soil health.

The rate of application of irrigation water will be within the range of 1ml/m² to 3.5ml/m² and will be driven by plant demand for moisture and nutrients. More information on fodder crops and their requirements can be found in the crop Management section below.

8.7.4 Crop Management for Nutrient Capture

Currently, the irrigation areas are dominated by a thick cover of improved pasture grasses including mainly Tully Grass (*Urochloa humidicola*) and Jarra Grass (*Digitaria milaniana*) which are harvested for hay. The cutting and harvesting of hay occurs 2-3 times over the course of each dry season, depending on pasture growth, with the first cut occurring as soon as conditions allow following the end of wet season rains around April/May.

Under improved irrigation practices, this pasture will be further improved to produce a higher value hay product that can be used in other parts of the NABL business including weaner supplemental feeding. A full cropping plan is currently being developed in consultation with Fergal O'Gara and will be implemented with the commissioning of the WWS. This plan will focus on the development of an improved grass crop under the centre pivot with other crop rotations through the pivot to match seasonal conditions and to protect soil health. The plan will include:

- Recommendations for fodder species that will meet business and operational requirements;
- Input requirements for these species;
- The likely productivity of these crops;

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- Soil health requirements for crop management;
- Recommendations on crop rotation between wet and dry season and over multiple seasons;
- A basic schedule of crop management activities.

Tropical pastures and fodder crops take up appreciable amounts of nitrogen (N), phosphorus (P) and potassium (K) as well as other secondary elements sulphur (S), calcium (Ca), magnesium (Mg) as well as trace elements such as zinc (Zn), copper (Cu), boron (B) and iron (Fe). The high biomass accumulated by tropical species results in uptake and utilization of all essential plant nutrients in relatively high quantities. N and K are taken up in the greatest quantities followed by P, S, Mg and Ca.

When tropical species are used for fodder production, (i.e the harvest and removal of biomass as either hay or silage) almost all of the available nutrients are taken off in the product and removed from site. The only nutrients remaining are those locked up in the organic fraction and those bound chemically to clay colloids, which will in time become slowly available.

Leaching and erosion also plays a role in nutrient loss but under well managed pasture and fodder crop systems these losses can be kept to very low levels. For example, on flat well grassed areas, erosion is negligible even under tropical environments. Leaching occurs in situations where N loads are higher than the plants nutrient requirement or ability to take up N. Again, in well managed pasture and fodder cropping systems, N inputs are matched and timed to make maximum use of N application. The extensive and deep root systems of perennial tropical species, effectively intercept most applied N and use it for growth and production. In most cases in northern Australia pastures and fodder crops totally exhaust soil N levels through the course of their growth cycle, leaving little N to be leached from the system.

Research and development undertaken since 1995 by the NT Department of Primary Industry and Fisheries (DPI&F) has determined the complete nutrient profile of several tropical pasture and fodder crop species which are shown in Table 11.

Initial work undertaken by DPI&F in Douglas Daly into irrigated Rhodes grass production demonstrated the uptake of N under both high and low rates of N application. Under a high N (> 180 kg/N/ha) regime mature Rhodes grass is capable of taking up between 2.0 and 2.4% N per kg of biomass or 25 gm/kg. (O’Gara 2010, O’Gara 2014).

Table 11: Nitrogen and Phosphorus removal for a range of N and P concentrations and biomass accumulation

Nutrient Concentration		Yield in kg/ha					Total Removed of 5x4 t/ha harvests (20Mt)
		1,000	2,000	3,000	4,000	5,000	20
N	1.5%	15	30	45	60	75	
	2.0%	20	40	45	80	100	400
	2.5%	25	50	45	100	125	500
	3.0%	30	60	45	120	150	600
	3.5%	35	70	45	140	175	
P	0.10%	1.0	2	3	4	5	
	0.15%	1.5	3	4.5	6	7.5	30
	0.20%	2.0	4	6	8	10	40
	0.25%	2.5	5	7.5	10	12.5	50
	0.30%	3.0	6	9	12	15	

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Under commercial conditions, irrigated Rhodes grass is a highly productive and nutritious fodder. It is currently the fodder of choice for most intensive warm season and tropical environments. When well managed irrigated Rhodes will produce 20 to 30 tonnes of biomass per hectare annually. Taking the lower level of 20t/ha annually and a 2.0% N concentration, the N uptake and removal equates to around 400 kg N/ha annually. At the higher level of biomass yield and N concentration, could equate to over 600 kg N/ha removal per year.

Phosphorus (P) concentration in Rhodes grass varies from about 0.18 to 0.34% depending on the age and growth stage, available soil P and soil type. Phosphorus removal per tonne varies from 2 kg to about 3.5 kg. In a commercial crop this equates to removal rates of between 36 kg and up to 100 kg P/ha, depending on how intensively the crop is managed and how many harvests are taken over the season.

8.7.5 Irrigation Control Systems

Irrigation of treated effluent is managed through an online control system supplied by Valley called Base Station 3. This system provides reports of irrigation volumes that are downloaded daily and recorded in the Irrigation Register and can generate reports on irrigation times and volumes.

The Centre Pivot irrigator is a Valley Pivot Point Irrigator made by Valmont USA with six spans extending to a diameter of 330m with an additional spray head that can extend the reach of the Centre Pivot by an additional 9m. The Centre Pivot Irrigation System irrigates treated effluent at a low pressure over a large surface area. The irrigation rates of the Centre Pivot system ranges from 1ml/m² to 3.5ml/m². According to the current effluent production rates of ~1.05 ML/day the Centre Pivot requires approximately 2.5 days to complete an entire cycle.

There are two Vaugh VCI MK2 travelling irrigators onsite which service the Northern Irrigation areas. Each travelling irrigator has a capacity of up to 50,000L/hour and a spray diameter of 40 meters. Each irrigator is set to run on an irrigation line which is retracted as the irrigator travels. These irrigators can be moved to different locations around the irrigation paddock to provide flexibility in the application of wastewater irrigation.

Variation of the pumping speed of wastewater to both the Centre Pivot and the Travelling Irrigators is controlled manually through an interface on the pump itself. Flow speed from the Decant Basin can also be controlled through the Human Machine Interface (HMI) located in the WWTP control room.

The Centre Pivot and Travelling Irrigators are fed by a main line which is 200mm HDPE pipe. This pipe feeds three different sprinkler head types on the Centre Pivot irrigator being Velmont s3030Y, S3030YLP and S2030SNP. The configuration of these different heads is designed to ensure equal water pressure and flow of irrigation water across the full length of the Centre Pivot span. Without this combination of heads, ensuring even application of wastewater would not be possible.

Each pump (shown in Figure 3) is fitted with a valve that enables manual shut off of the pump in the event that an intervention is required or to ensure that no flow can pass through when a complete system shutdown is required. These valves are used in conjunction with the computerised HMI and pump control panels for system shut down.

Irrigation scheduling is controlled by computer using the HMI through which the operator can set the point for pumping from the Decant Basin to the Irrigation tank. This is based on the required water levels within the Decant Basin.

Irrigation timing is fully automatic and is driven by level sensors within the Irrigation tank. Once feed from the Decant Basin fills the irrigation tank to 80%, irrigation is automatically triggered until the irrigation tank volume is reduced to 20%. A buffer volume of 20% is always maintained within the irrigation tank. Irrigation can be stopped manually through the HMI by controlling pumping from the Decant Basin to the irrigation tanks and water can be held temporarily in the Decant Basin if a hold on irrigation is required. Pumps from the irrigation tank can also be manually overridden if required.

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A number of flow meters have been installed to measure water flow at various points throughout the wastewater management system:

- From the CAL feed tank to the CAL;
- From the CAL feed tank to the SBR (to measure “raw feed” pumped to the SBR during aerates parts of the SBR cycle to supply carbon for nitrogen removal);
- From the Decant Basin to the Irrigation tank (Green tank);
- From the Irrigation tank to irrigation (controlled by the Valley Base Station 3 software).

In addition there is a flow meter to the Biogas flare that measures biogas produced by the CAL and a flowmeter which measures the quantity of SBR contents sent to the Dewatering Shed for waste activated sludge removal. All of these flowmeters are linked to the PLC controlling the wastewater treatment plant.

8.7.6 Wastewater Irrigation Monitoring Program

Table 12, Table 13, Table 14 and Table 15 outline the locations, parameters to be measured, wastewater quality limits listed in Table 3 and Table 4 of EPL219 and frequency of wastewater for irrigation and soils sampling. Refer to Section 9 for details on Water Quality Monitoring for surface water and groundwater monitoring programs.

The compliance monitoring aims to measure the concentrations of the contaminants listed in Table 3 of EPL219 in the treated effluent released to the irrigation areas to ensure that the degree of compliance with the water quality limits can be assessed. Additional regular monitoring of the WWTP is undertaken at several points through the treatment process for operational control and is addressed in this section.

Table 15 also includes additional parameters not required for compliance monitoring. These provide helpful assessment of the ongoing beneficial nature of the treated effluent for application to land by irrigation.

Table 12: Compliance Wastewater for Irrigation Monitoring Program

Sampling Sites	
Sampling will be undertaken of the treated effluent discharged to the irrigation area (preferably from irrigation pump discharge or storage tank). This is Sampling Point site 4 (See Plan in Section 15.11).	
Sampling Frequency	
Physical parameters measured in-situ and laboratory parameters will be sampled and analysed weekly as required under EPL219.	
Parameters Measured	
<u>In-situ-measured physical parameters:</u> <i>pH, Electrical Conductivity (EC) and Dissolved Oxygen (DO)</i>	
<u>Laboratory measured parameters:</u>	
<u>On a weekly basis:</u> Total Suspended Solids (TSS) Pathogens (<i>E.coli</i> and <i>Faecal Coliforms</i>) Nutrients (ammonia, Total Nitrogen, Total Phosphorus) Cations (Ca, Mg, Na)5-day Biological Oxygen Demand (BOD ₅) Oil and Grease	<u>On a quarterly basis (outside of compliance parameters):</u> Chlorides Sulphate

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Table 13: Wastewater quality limits for wastewater applied to irrigation land according to EPL219

Parameter	Units	Wastewater quality limits	Type of limit	Required sampling frequency
Biochemical oxygen demand	mg/L (5-day)	20	median ⁺	Weekly (not more than 7 calendar days between sampling events)
		30	90 percentile [*]	
Dissolved oxygen	mg/L	2	minimum	
Total suspended solids	mg/L	50	90 percentile [*]	
pH	pH	6.5-8.5	range	
Electrical conductivity	µS/cm	2500	median ⁺	
		3000	maximum	
<i>E.coli</i>	MPN/100ml	10,000	90 percentile [*]	

+ To comply with a median limit the results from 5 out of any 10 consecutive sampling events must comply with the wastewater quality limit(s)

* To comply with a 90 percentile limit the results from 9 out of 10 consecutive sampling events must comply with wastewater quality limit(s)

Table 14: Limits for mass loads of total nitrogen and total phosphorus applied to irrigation areas during any calendar year according to EPL219

Parameter	Maximum application rate to any irrigation are (kg/Ha.year)
Total nitrogen	250
Total phosphorus	60

Table 15: Compliance Soil Monitoring Program

Sampling Sites
Soil analysis will be undertaken within all areas currently utilised for effluent reuse. Any additional effluent reuse areas (if and when required) will also be sampled prior to and during their use. Soils analysis will occur at an intensity of one sampling site per 20 ha area being irrigated (See map in Section 15.9). Once soil sampling sites are established, these same sampling site locations will be used for all future sampling to allow for comparison and detection of any trends overtime. At each site (10 m diameter plot), a composite soil sample of 10-20 soil cores will be taken at a depth of 0-20 cm. Also, a composite soil sample of 5 cores will be taken at 40-60 and 80-100 cm depth increments.
Sampling Frequency
Soil sampling and analysis will be undertaken annually, with sampling scheduled to be undertaken during the late dry season (around September).
Parameters Measured
<u>Laboratory measured parameters:</u> <i>Both surface and subsoil will be analysed for</i> <i>pH, electrical conductivity (EC), available P (Colwell), nitrate nitrogen, exchangeable cations, cation exchange capacity, exchangeable sodium percentage (ESP) and organic matter</i>

The most critical parameters that need to be reviewed for soils irrigated with treated effluent are salinity, sodicity, nitrogen and phosphorus levels and pH. These are best monitored as electrical conductivity (EC),

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exchangeable sodium percentage (ESP), nitrate-nitrogen and available phosphorus, respectively, as indicators of irrigation sustainability. Trigger values for each of these parameters are listed in Table 16 to provide a guide to NABL staff of the health of the irrigated soils. These values take into account the nature of the irrigated soils (sandy loam/clay mixtures). The values apply to samples taken in the top root zone of the soil (0 – 0.2 m depth). The EC (1:5 water) value is equivalent to an EC_{se} value of 2 dS/m. The trigger is expressed as the EC value for ease of assessment, since that is the parameter measured by the laboratory.

Note that exceedance of these values does not denote environmental damage or harm – merely that soil conditions are becoming affected to a degree where some suitable intervention is wise.

Table 16: Suggested soil quality trigger values for management decisions

Parameter	Units	Soil trigger values
pH (1:5 water)	-	4.5 – 6.5
EC (1:5 water)	dS/m	< 0.15
Available P (Colwell)	mg/kg	< 85
Nitrate-nitrogen	mg/kg	< 5
ESP	%	< 5

8.7.7 WWTP Subsurface Leak Detection Monitoring Program

A condition of the EPA approval for construction of the WWTP was to provide a method for the detection of any failure in the pond linings and resultant leaks to groundwater. A substantial subsurface drainage leak detection system was installed as shown in the schematic diagram in Section 15.12. Three inspection pits through which subsurface drainage from each of the three ponds flows allow for inspection and sampling to be carried out. The structure of these pits is shown in Figure 4 below. Samples are collected from the upper pit inlet which drains subsurface moisture from under each of the ponds. The frequency of sampling, parameters and trigger values are outlines in Table 17 and Table 18. An inspection and sampling procedure can be found in Appendix O.

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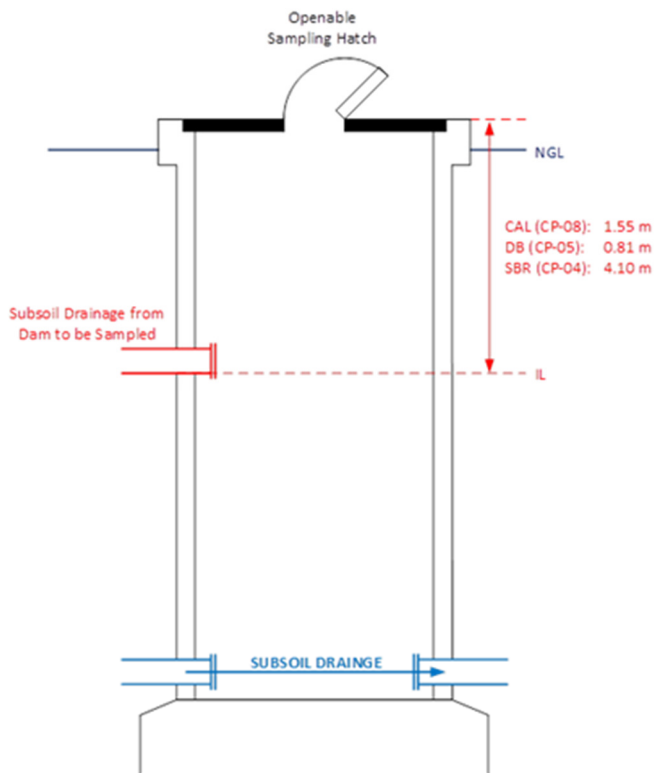


Figure 4: Operational process diagram

Table 17: WWTP subsurface leak detection Monitoring Program

Sampling Sites
Sampling of subsurface drainage for leak detection will be undertaken in the three inspection pits – Pit 1, Pit 2 and Pit 3.(See Plan in Section 15.12).
Sampling Frequency
Physical parameters measured in-situ and laboratory parameters will be sampled and analysed quarterly and will apply the same parameters and trigger values as the broader groundwater monitoring program.
Parameters Measured
<u>In-situ-measured physical parameters:</u> pH and Electrical Conductivity (EC)
<u>Laboratory measured parameters:</u> <u>On a weekly basis:</u> NO _x (mg/L) as N TKN (mg/L) as N Total Nitrogen (mg/L) Total Phosphorus (mg/L) Enterococci (cfu/100mL) E.Coli (cfu/100mL)

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Table 18: Trigger Values for WWTP subsurface leak detection

Parameter	80 th Percentile
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	186
pH	Range between 5.1 and 9.1
NO_x (mg/L) as N	0.09
TKN (mg/L) as N	0.35
Total Nitrogen (mg/L)	0.4
Total Phosphorus (mg/L)	0.10
Enterococci (cfu/100mL)	5.9
E.Coli (cfu/100mL)	2

8.7.8 Wet Weather Storage Water Quality Management

(NOTE: WWS is not yet installed as operations on site are suspended – construction to be completed under the current approval EPA252 within 12 months of recommencement of site operations according to EPL219-01).

The addition of a WWS to the wastewater treatment process and irrigation management system will significantly reduce the environmental risks associated with irrigation of wastewater during wet periods, primarily by eliminating the potential of contamination of surface water and groundwater during runoff events. The treated effluent transferred to the WWS Dam will experience dilution by rainfall during the wet season and concentration through evaporation during the dry season and consequently concentrations of the parameters listed in Table 13 and Table 14 can be expected to vary considerably during storage. Note however, that the mass load of nutrients (N, P) and salts (conductivity) transferred in and out of the WWS Dam will not change during storage and will not impact the sustainability of irrigation under the operating protocols used by NABL. Consequently there is little value in trigger values for these parameters.

It is likely that the treated wastewater stored in the WWS Dam will produce some algal biomass, which will fix carbon from the atmosphere and assist in oxygenating the stored effluent. The presence of algae will significantly increase Total Suspended Solids (TSS) levels in the stored water well in excess of the TSS water quality limit in Table 13

Table 13. TSS levels in water irrigated to land are of negligible deleterious impact and in fact are generally positive to irrigated pasture. The Queensland EPA has generally agreed to delete TSS quality limits on treated effluent irrigated to land.

Algal growth will also impact the Biological Oxygen Demand (BOD) concentration since algal biomass contributes towards BOD₅ concentration. This distorts interpretation of BOD values, since it is the soluble BOD which contributes to environmental hazard (typically odour) rather than slowly biodegradable forms such as algal biomass. Consequently we suggest a filtered BOD₅ value as a trigger water quality value from the WWS Dam as this excludes the algal contribution.

Other trigger values relate to dissolved oxygen, temperature and pH as being practically useful in identifying when water stored in the WWS Dam may cause hazards such as odour or vulnerability to severe algal blooms.

Updated wastewater quality limits for wastewater that is to be applied to land are to be developed through a negotiated amendment process for EPL219 as the WWS is commissioned. NABL anticipates that the majority of the parameters listed in EPL219, along with the compliance monitoring location at Site 4 will remain essentially unchanged. The two exceptions to this are TSS and BOD which are both anticipated to be amended (as discussed above) due to the effect of potential algal growth during storage of wastewater in the WWS. NABL suggests amended limits for these parameters as shown in **Table 19**.

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WWS Dam water quality monitoring trigger values are to be agreed with NT EPA. These trigger values will assist in both managing operation of the WWS Dam to minimise environmental impacts such excessive algal growth and odour and identifying potential exceedances in wastewater quality limits prior to the wastewater reaching compliance Site 4 at the irrigation tank, enabling time to take corrective action if required. NABL suggests that trigger values as outlined in Table 20 are appropriate for this purpose. The greater than/less than sign on the value indicates the direction of concern.

It is critical to understand that these are trigger values, not compliance values. As irrigation directly from the WWS will not be possible, all wastewater from the WWS will pass through the irrigation tank and the compliance monitoring point, Site 4. All existing monitoring and reporting requirements for Site 4 will remain unchanged and will accommodate that inclusion of the WWS into the system. There are miniscule data available on the values to expect in such a dam in the Northern Territory and the proposed values come from dams in tropical Queensland. The data shows significant variation in some parameters, especially chlorophyll-a and BOD₅. The pH range limit is increased compared to that in Table 12 to account for the impact of algal photosynthesis on WWS dam contents. It is infeasible to adjust the pH of dam contents and there is little evidence that increasing the upper limit of the range has significant impact on pasture growth or soil health.

The design of the WWS dam will include sophisticated monitoring and intervention systems to detect any changes in water quality that lead to an exceedance in the trigger values below and contribute to offensive odours. These systems will include automated sensors and aeration devices that prevent stratification, a key driver of in the growth of algal blooms that lead to odour generation. These trigger limits and core design features will sufficiently address these water quality concerns. The specific location of these sensors, monitoring points and aeration devices will be determined once the approval for the WWS has been received, and the development is progress to the design and construct phase. The specifics of these cannot be determined until the required volume of the WWS is approved.

Table 19: Suggested Wastewater quality limits for wastewater applied to irrigation land amendments

Parameter	Units	Wastewater quality limits	Type of limit
Biochemical oxygen demand (filtered)	mg/L (5-day)	10	median*
		20	90 percentile*
Total suspended solids	mg/L	no limit	

Table 20: Suggested WWS Dam water quality trigger values

Parameter	Units	Wastewater quality trigger value
Dissolved oxygen	mg/l	< 2.0
Total suspended solids	mg/l	> 100
BOD ₅ filtered	mg/l	> 10
pH	-	6.5 – 9.0
<i>E.coli</i>	MPN/100ml	< 10,000
Chlorophyll-a	mg/m ³	> 100

A number of strategies to manage water quality and reduce the potential for risks for environmental harm including odour through excessive algal growth, contamination of groundwater through seepage and surface water contamination as a result of overflow are outlined in Table 21.

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Table 21: WWS water quality management strategies

Aspect	Description of Impacts	Likelihood	Severity	Management Strategies
Odour	Nuisance	Low	High	- Only highly treated effluent is stored - Large surface area on dam to ensure uppermost layer is naturally aerated - Dam located >500m from nearest neighbour - Daily odour monitoring procedure in place and activated - Complaints recording & response procedure in place - Online dissolved oxygen monitoring with alarming - Provision of anti-stratification device considered in event of blue-green algae events - Active area of Dam minimised by deeper, first cell - WWS Dam likely to be completely empty more than 6 months of the year.
Visual	Amenity of dam	High	Low	- Dam located >500m from nearest neighbour - Earthworks consistent with surrounding environment – “natural appearance”
Groundwater	Contamination	Low	Medium	- Dam designed and constructed to meet required impermeability including HDPE lining - Subsurface leak detection system included as risk management strategy - Experienced contractor used - Routine groundwater monitoring
Surface water	Contamination	Low	Medium	- Prepare suitable erosion sediment control plan (ESCP) and follow the plan - Duty/standby pumps for irrigation water - Overflow contamination contained on property - Large buffer of grassed/native vegetation filter strips between WWS and riparian zones and waterway channel - Operational procedures

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Aspect	Description of Impacts	Likelihood	Severity	Management Strategies
				Large stormwater capacity if a high rainfall event occurs (designed to hold wet season rainfall)

8.7.9 Wastewater monitoring

Wastewater sampling will be in accordance with the following standards and guidelines:

- Australian/New Zealand Standard on Water Quality Sampling - Part 1: *Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998);
- Australian/New Zealand Standard on Water Quality Sampling – Part 10: *Guidance on sampling of waste waters* (AN/NZS 5667.10:1998)

All laboratory samples are analysed by a NATA accredited laboratory (ALS Environmental Laboratories).

8.7.10 Soil monitoring

Soil descriptions and sampling will be conducted in accordance with:

- McDonald R.C., 1990, *Australian Soil and Land Survey Field Handbook*, Third Edition, Australian Soil and Land Survey Handbooks Series 1, National Committee on Soil and Terrain, CSIRO Publishing, Melbourne, Victoria.

The intensity of surface soil and soil depth profile sampling is based on:

- Section 5.3 of the DEC 2004, *Use of Effluent by Irrigation; Environmental Guidelines*, Department of Environment and Conservation (DEC), New South Wales Government, Sydney.

8.8 On-going Reporting, Incident Response and Contingency Planning

All routine wastewater and soil monitoring data to meet licence conditions and incident/investigative monitoring data will be recorded in a central database, and made available to the NTEPA on request.

This data will be presented in the *Annual Return* required by EPL219. Review, assessment and interpretation of trends in wastewater quality and soil monitoring results will be undertaken annually, and will highlight the need for any improvements to plant processes, equipment, wastewater treatment or irrigation management. Regular review of monitoring results will also highlight any adjustments needed to this IMP, such as sample site locations, sampling frequency and parameters measured.

All pollution incidents will be reported to the NTEPA immediately as per NABL's responsibility under Section 14 of the NT *Waste Management and Pollution Control Act*. The pollution incident will be immediately cleaned up, an investigation carried out, and measures implemented to prevent the incident occurring again. In the case of a breakdown, a spill, or incident occurring within the upgraded WWTP, where incoming wastewater cannot be treated, the WWTP can be immediately shut-down and untreated wastewater held in balancing tanks and the CAL, which have sufficient capacity to allow time for maintenance.

Any breaches in the assessment criteria listed for wastewater in Section 8.7 above, will also be reported to the NTEPA; where, if a breach is detected, the site will immediately be re-sampled, and if the contaminant levels are still in breach, the NT EPA will be notified and the cause of the breach investigated and corrective actions implemented.

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Corrective actions may involve for example, adjusting parameters in the WWTP, changing work practices within the meat processing plant, adjusting irrigation areas and application rates, or installing additional treatment infrastructure. Ultimately, if surface and groundwater quality at the downstream NABL property boundary consistently breaches the assessment criteria, NABL is committed to suspending meat processing operations to allow installation of additional wastewater treatment infrastructure to increase the quality of treated wastewater.

8.9 Self-Assessment of Effluent Reuse Performance

The interpretation of analysis results from the monitoring programs are vital to ensure that any problems are identified quickly and measures implemented to rectify them. The following discusses important calculations and comparisons that should be performed to check the sustainability of the effluent irrigation regime.

8.9.1 Calculation of Irrigation Area Nutrient Balance

To ensure sustainability of the land utilised for effluent irrigation, a nutrient balance should be calculated regularly. Ideally, the mass of nutrients applied via effluent should match the mass of nutrients removed by the harvested crop. The two most important nutrients to consider are nitrogen and phosphorus. Using effluent analysis results, the mass of these nutrients applied and removed can be estimated.

If different areas receive significantly different effluent application rates, a nutrient balance should be calculated for each area. Only the mass of crop harvested and removed from the site should be included in the calculation (i.e. do not include grazing as this removes very few nutrients as almost all is recycled in manure and urine).

Nutrients applied

To calculate the mass of nitrogen applied to land through effluent irrigation, the following equation can be used:

$$\begin{aligned} \text{Mass of Nitrogen applied (kg/ha)} \\ = (\text{Total N (mg/L)} - 0.3 \times \text{Ammonia N}) \times \text{Volume applied (ML/ha)} \end{aligned}$$

where:

1. Total N and Ammonia N values are sourced from the average effluent results for that period;
2. A 30% volatisation loss assumption has been made based on the standard values within MEDLI modelling; and
3. The volume applied (irrigated) can be determined from irrigation records for that period. The volume should be measured using either a flow meter, or pumping hours if the pump flow rate is known.

Similarly, the mass of phosphorus applied can be calculated by:

$$\text{Mass of Phosphorus applied (kg/ha)} = \text{Total P} \times \text{Volume irrigated (ML/ha)}$$

Nutrients removed

To calculate the mass of nitrogen removed by the crop, the following equation can be used:

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$$\text{Mass of Nitrogen removed (kg/ha)} = \text{Plant N content (\%)} \times \text{Plant mass harvested (kg)}$$

where:

1. *Plant N content is determined through tissue analysis or, if past results are consistent, then the average results can be used for future calculations; and*
2. *Plant mass harvested can be calculated as follows: e.g. if 500 bales of hay are harvested from the irrigated area, and each bale weighs 25 kg, then the plant mass harvested is 12,500 kg (12.5 tonne). If the plant nutrient analysis is given on a dry matter basis, the plant mass harvested also needs to be converted to a dry matter basis.*

Nutrient Balance

After the mass of nutrients applied and removed have been calculated, the nutrient balance can be determined using:

$$\text{Nutrient surplus or deficit (kg/ha)} = \text{Nutrient applied (kg/ha)} - \text{Nutrient removed (kg/ha)}$$

If the calculation result is a positive number, then there has been a nutrient surplus for that period (this is not the preferred result for effluent irrigation). If the answer is a negative number, then there has been a nutrient deficit for that period.

The aim of calculating the nutrient balance is to ensure that the amount of nutrients applied matches the amount of nutrients removed. If results are consistently positive, this means excess nutrients are being applied, which will decrease the potential lifespan of the area and increase the risk of unacceptable losses to the environment.

8.9.2 Assessment of Performance Indicators

The nutrient balance results should be considered together with the soil monitoring results to assess the sustainability of the effluent reuse system. If managed so that a nutrient balance is maintained, the soil nutrient concentrations should remain fairly consistent.

Key parameters include:

- Soil nitrogen,
- Available phosphorus,
- Salinity and
- Sodidity.

These parameters should be graphed to compare results from year to year. For example, if the levels of nitrate in the subsoil increase with time, then leaching is likely to be occurring. This indicates that either the nutrient application rates are excessive or the irrigation scheduling practices are inappropriate.

9 Water Quality Monitoring

9.1 Water Quality Monitoring Aims

The purpose of water quality monitoring is to facilitate the early detection of any potential impacts of the facility on the beneficial uses of downstream waterways, including the Berry Creek catchment and/or groundwater aquifers in the area, and subsequent implementation of preventative actions.

9.2 Purpose of the Plan

The purpose of this Management Plan is to:

- Identify potential water contaminants and their sources;
- Provide details of the surface water and groundwater monitoring programs;
- Provide details of water quality trigger values against performance will be monitored
- Define sampling procedures and quality control and assurance
- Describe data management, analysis and reporting requirements
- Outline an incident response plan
- Outline auditing and review requirements

9.3 Responsibilities

Environmental Officer	Responsible for ensuring that the information contained in this plan is accurate and up-to-date. The details of water quality monitoring plan are to be reviewed and updated as part of ongoing monitoring of the irrigated area.
Plant Manager and Environmental Manager	Jointly responsible for ensuring appropriate corrective action is taken to prevent water contamination and environmental harm that may be identified as a result of this monitoring.
Plant Manager	Responsible for ensuring that the irrigation management practices described in this plan are effectively implemented.
AACo Environmental Manager	Responsible for reviewing, providing recommendations on compliance outcomes from water quality monitoring activities and ensuring compliance with EPL219.

9.4 Potential Contaminants and Contamination Sources

The primary potential sources of contamination as a result of the operation of the site are the disposal of treated wastewater by land irrigation and stormwater run-off from the processing operations area. If operated appropriately, land irrigation and stormwater would generally be considered as diffuse sources of potential contamination (as opposed to a point source) as there is no direct discharge of wastewater to surface water or groundwater. In addition, with the installation of the WWS, irrigation will not take place while surface water is present within the irrigation paddock, with controls in place to ensure irrigation does not take place until there is a sufficient soil moisture deficit.

A comprehensive wastewater monitoring program sampling over 100 water quality parameters was undertaken during the first year of operations at the site (November 2014 to June 2015), which included

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collection of field readings (pH, EC, turbidity, DO and temperature) on a 1-2 hourly basis and collection of laboratory samples on a daily basis. To inform revision of the WQMP a review of these data was undertaken, to ascertain which parameters were:

- Not detected on any occasions in the wastewater and are unlikely to be present in the wastewater based on risk assessment (e.g. pesticides/herbicides)
- Detected on very few occasions and not unique to the wastewater (i.e. likely to be already present in the environment and/or as a result of general rural land use)
- Repetitious (e.g. bacterial pathogens associated with faecal material).

A summary of analytes and data collected during the first year of operations can be found in the previous version of the Water Quality Management Plan (2017), including reasons for either including or removing the analyte from the ongoing downstream monitoring programs. From this review, the analytes presented Table 22 were identified as being the primary concern in relation to potential impacts on downstream water quality and beneficial uses.

Table 22: Characteristics of wastewater that may have downstream water quality effects

Parameter	Characteristics and potential effects
pH	Variable pH in wastewater, which may affect downstream water quality
Electrical conductivity (EC)	High EC in wastewater, which may affect downstream water quality
Biological oxygen demand (BOD)	High BOD in wastewater, which may affect downstream aquatic health by removing dissolved oxygen from the water column
Dissolved oxygen (DO)	High BOD in wastewater, which may affect downstream aquatic health by removing dissolved oxygen from the water column
Turbidity	High turbidity in wastewater, which may affect downstream aquatic health by affecting photosynthetic productivity
Suspended solids	High suspended solids in wastewater, which may affect downstream aquatic health by smothering benthic habitats and photosynthetic productivity
Nutrients - ammonia, nitrogen (primarily organic) and phosphorus	High nutrients in wastewater, which may be toxic to aquatic life (i.e. ammonia) and/or result in algal blooms downstream
<i>E. coli</i> and <i>Enterococci</i>	High counts in wastewater, which could impact on downstream beneficial uses (e.g. human health associated with contact with waters)
Coliphages	High counts in wastewater, which could impact on downstream beneficial uses (e.g. human health associated with contact with waters)
Salts – sodium, chloride and sulfate	High concentrations in wastewater may impact on downstream aquatic health
Oil and grease	High concentrations in wastewater may impact on downstream aquatic health

9.5 Proximity to receptors and transport pathways

Surface water

The processing area is located immediately adjacent to the top of the central drainage line that carries run-off in a westerly direction to the site boundary, which is approximately 2.5 km downstream. A considerable portion of the run-off from this location is diverted around the processing area and any run-off from the processing area reports to Dams 1 and 2 for sediment removal, prior to overflow into the central drainage line. First-flush run-off from the holding yards is diverted to the first-flush dam for treatment.

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The wastewater irrigation disposal areas, located to the north and south of the processing area, are also situated adjacent to the central drainage line described above. A buffer of at least 50 m is maintained between the edge of all irrigation areas and drainage lines, to ensure that no run-off from the irrigation areas reports directly as surface water flows.

Groundwater

Two aquifers are present within the site:

- A shallow unconfined (probably perched) aquitard system from 2 – 5 m below ground level, with hydraulic conductivities of up to 50 m/day.
- A deeper semi-confined to confined aquifer from 30 – 100 m below ground level, with average hydraulic conductivities of 0.5 m/day.

Both of these aquifers flow predominantly from east to west, controlled by the topographic and drainage features of the local landform, with the shallow aquifer presenting the greatest risk of contamination and transport of contaminants from the site into downstream waterways.

9.6 Surface Water Monitoring Program

9.6.1 Locations

Surface water monitoring (grab sampling) is undertaken at seven locations in and around the site, including at two reference sites upstream and in adjacent catchments (See map of locations in Section 15.7 and Table 23). These monitoring locations have been chosen to provide a comprehensive spatial representation of the site and adjacent areas that will facilitate the early detection of any potential impacts of operational activities on downstream surface water quality, and differentiation of impacts caused by NABL's operations and other land uses or natural occurrences.

Table 23: Details of surface water monitoring sites

Site Name	Reference/ Downstream	Purpose
Site 1	Reference	Represents typical rural land use. Relatively small catchment, so may not flow when sites further downstream are.
Site 2	Downstream	May receive run-off from southern irrigation area. Provides for early detection of contamination and potential pollution.
Site 3	Downstream	Receives run-off from both the processing area and irrigation areas. Provides for early detection of contamination and potential pollution.
Site 4	Downstream	Located at site boundary, represents all run-off from site. Compliance point for reporting to regulatory authorities.
Site 5	Downstream	Located about 1.5 km downstream of the site boundary, provides an indication of whether any potential contamination recorded within the site has been transported off-site (sample point on upstream side of the road only).
Site 6	Reference	Located on Malaplain Road in a parallel catchment.
Site 7	Reference/ Downstream	Located on the Western drainage channel to assess potential inputs from manure stockpiling activities on a neighbouring property.
Site 8	Reference	Represents typical rural land use.
Site 10	Reference	Located at an inflow point from neighbouring properties and is intended to detect any contaminants from neighbouring activities entering the site.
Dam 1	Downstream	Receives run-off from processing area and cattle yards.
Dam 2	Downstream	Receives run-off from processing area.

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9.6.2 Monitoring Frequency

Run-off from the site is highly dependent on the amount and timing of rainfall, as the location at the top of a catchment results in 'flashy' flows (particularly at sites 1, 2, 3 and 7 highest in the catchment). Sampling of the first-flush will be undertaken following the first stream flows, which typically occur in December or January, and further sampling will occur once wet season 'base flow' has commenced (i.e. usually following the first monsoon). Although it is unlikely to occur given the Northern Australian environment, monitoring for surface flows should out of season rainfall occur will be carried out immediately after an out of season (between May and September) rainfall event.

For the duration of the wet season, grab sampling will be undertaken immediately following the peak of each significant rainfall event, or at a minimum of monthly during periods of no significant rainfall (when there are visible flows). The peak of a rainfall event is defined as when the water level at Site 4 has reached its maximum height.

Sampling will also be undertaken during the dry season, should there be any unseasonal rainfall or accidental spills/releases of contaminated water that result in surface water flows at any of the downstream monitoring locations, noting that not all sites may flow in this instance.

Based on this sampling frequency, sampling will typically occur 4 - 6 times each wet season and possibly more during an above-average wet season. During each sampling event, sites will only be sampled if there is visible flow and sites not sampled will be noted on field sheets and recorded in the sites Surface Water Quality Database to assist in interpretation of data. The exception to this is for Dams 1 and 2, which are sampled on at least a monthly basis and regardless of whether they are overflowing.

Visual monitoring and inspection of stormwater drains, irrigation areas and drainage lines occurs throughout the year in accordance with the site OEMP and as follows:

- Visual monitoring of waterways downstream of the irrigation areas at Sites 2, 3 and 4 will be undertaken monthly during each dry season (or immediately following any observed run-off from irrigation areas) to detect any signs that irrigation is resulting in seepage or runoff to drainage lines.
- Visual monitoring of stormwater drains, dams, and outlet structure will be undertaken weekly for any signs of erosion or sedimentation, or stagnating and deteriorating ponded water quality (e.g. algal blooms), or mosquito breeding.
- Irrigation areas will be inspected daily by the irrigation manager for any ponding, erosion, odour or mosquito issues.

Surface water quality monitoring is currently undertaken by a contractor and visual monitoring of irrigation areas is undertaken by site personnel.

9.6.3 Parameters

Monitoring parameters are detailed in Table 24. The monitoring suite is based on the primary analytes of concern identified through review of the wastewater quality data collected over the period October 2014 to July 2015 (refer WQMP 2017).

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Table 24: Details of surface water monitoring parameters

Parameters
Field parameters: • pH (pH units) • Temperature (°C) • DO (% and mg/L) • EC (µS/cm) • Turbidity (NTU)
Laboratory parameters: • Total suspended solids – TSS (mg/L) • Ammonia (mg/L) • Nitrate, nitrite, NOx (mg/L) • Total Kjeldahl nitrogen –TKN (mg/L) • Total nitrogen – TN (mg/L) • Total phosphorus – TP (mg/L) • Biological oxygen demand – BOD (mg/L) • E. coli (CFU/100mL) • Enterococci (CFU/100mL) • Cations – Ca, Mg, Na, K (mg/L) • Anions – Cl, F SO₄ (mg/L) • Alkalinity (mg/L) • Oil and grease (mg/L) • Dissolved metals (As, Cd, Cr, Cu, Ni, Pb, Zn) (mg/L) • Chlorophyll a (mg/m³) • f-RNA Coliphages (pfu/100mL)

9.6.4 Dry Season Flows in Stormwater Drains

During the dry season, it is reasonable to expect that all stormwater drains are to remain dry. Stormwater drains are intended for stormwater only and should not be flowing during the dry season unless there has been an out of season rainfall. Any surface flow from on-site activities (such as hard surface hose down) is intended to be captured by the first flush system. An exception to this may be over spray from sprinklers or excess surface water from lawn irrigation and the like.

Inspections of the stormwater drains for out of season flows is a part of the daily check process (see the daily checklist in Appendix P). In the event that dry season flows are detected in the stormwater drains, an investigation to identify the source of the flow is required. If the source of the flow is determined to be from operational activities, appropriate corrective action is to be taken to ensure the flows are redirected through the first flush system.

9.7 Groundwater Monitoring Program

9.7.1 Locations

Groundwater monitoring is undertaken at 12 monitoring bores within the site, including sampling at three upstream reference sites (Table 25 and see map of locations in Section 15.8). These monitoring locations provide a comprehensive spatial representation of the site, with a focus of identifying any potential impacts of operational activities on downstream shallow aquifer water quality.

As the initial groundwater report demonstrated that there is no connection between the shallow and deep aquifer on site, deep aquifer bores are not sampled for contaminants. However, groundwater levels should be measured in all bores, including those bores screened within the deep aquifer but which are not currently

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sampled, to continue to demonstrate that there is no hydraulic connection between the shallow and deep bores.

9.7.2 Frequency

Groundwater monitoring will be undertaken quarterly to ensure that potential seasonal variation in aquifers is captured by the monitoring program.

9.7.3 Parameters

Monitoring parameters are detailed in Table 25. The parameters are based on the primary analytes of concern identified in the review the wastewater quality, as detailed in WQMP 2017.

Table 25: Details of groundwater monitoring sites

Site Name	Reference/ Downstream	Purpose
AACO1A	Reference/ Downstream	Shallow aquifer. Intended as reference but possibly located downstream of potential inputs from manure stockpiling activities on a neighbouring property.
AACO2	Reference	Deep aquifer upstream of site operations.
AACO2A	Reference	Shallow aquifer upstream of site operations.
AACO3A	Downstream	Shallow aquifer downstream of processing plant and irrigation areas.
AACO4A	Downstream	Shallow aquifer downstream of operational areas.
AACO5A	Downstream	Shallow aquifer downstream of operational areas.
AACO6A	Downstream	Shallow aquifer downstream of operational areas.
AACO7A	Reference	Shallow aquifer upstream of site operations.
AACO8	Downstream	Deep aquifer at site boundary, downstream of all site operations.
AACO8A	Downstream	Shallow aquifer at site boundary, downstream of all site operations.
AACO9A	Downstream	Shallow aquifer at site boundary, downstream of all site operations.

9.7.4 Groundwater Level Monitoring

Groundwater depth data is collected as a part of the standard monitoring procedure. This data will be used to generate groundwater contour maps for both the end of the wet season and the end of the dry season groundwater levels. These maps will be generated as a part of the Annual Internal Audit process and will be used to determine and demonstrate any impacts of site activities on groundwater flows.

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Table 26: Details of groundwater monitoring parameters

Parameters
Field parameters: • Standing water level (mbgl) • pH (pH units) • Oxidative-reductive potential - ORP • DO (% and mg/L) • EC (µS/cm) • Turbidity (NTU)
Laboratory parameters: • Ammonia (mg/L) • Nitrate + nitrite, NO_x (mg/L) • Total Kjeldahl nitrogen –TKN (mg/L) • Total nitrogen – TN (mg/L) • Total phosphorus – TP (mg/L) • E. coli (CFU/100mL) • Enterococci (CFU/100mL) • Cations – Ca, Mg, Na, K (mg/L) • Anions – Cl, F SO₄ (mg/L) • Alkalinity (mg/L)

9.8 Sampling Procedures and QAQC

9.8.1 Sampling Procedures

Surface water and groundwater sampling procedures are provided in Appendix M and Appendix N respectively. These sampling procedures were developed in accordance with the below listed accepted standards and guidelines for monitoring of water quality:

- Australian/New Zealand Standard on Water Quality Sampling - Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998)
- Australian/New Zealand Standard on Water Quality Sampling – Part 6: Guidance on sampling of rivers and streams (AS/NZS 5667.6:1998).
- Australian/New Zealand Standard on Water Quality Sampling – Part 10: Guidance on sampling of waste waters (AN/NZS 5667.10:1998).
- Australian/New Zealand Standard on Water Quality Sampling – Part 11: Guidance on sampling of groundwater (AS/NZS 5667.11:1998), Standards Australia, New South Wales.
- NT Department of Mines and Energy Methodology for the Sampling of Groundwaters, Advisory Note, 2009. Northern Territory Department of Mines and Energy (DME), NT Government, Darwin.
- ANZECC & AMRCANZ 2000, Australian Guidelines for Water Quality Monitoring and Reporting, National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- ANZECC & AMRCANZ 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

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9.8.2 Quality Control and Assurance

Quality control/quality assurance (QA/QC) samples comprising field duplicates and blanks are collected by the Environmental Officer for one in every ten water samples (applies to both groundwater and surface water sampling). Laboratory results for duplicates and blanks are reviewed when they are received and prior to entering data into the Surface and Groundwater Monitoring Databases. Any anomalous results are investigated in consultation with the laboratory, and rectified where possible.

Water quality meters used for field measurements of in-situ surface water and groundwater physical parameters are calibrated in accordance with Operating Manuals prior to each sampling day and calibration results are recorded in a log book.

All laboratory samples are analysed by a NATA-accredited laboratory, which incorporate laboratory duplicates, blanks and spikes to assess data accuracy. The Environmental Officer is responsible for reviewing the laboratory's QAQC data as it is received.

9.9 Site-Specific Water Quality Criteria

The rationale behind the setting of trigger values for surface water and groundwater monitoring can be found in the 2017 WQMP along with the supporting data and modelling behind the trigger values.

9.9.1 Surface Water Trigger Values

Trigger values for surface water are provided in Table 27. These criteria were calculated from baseline data collected at monitoring sites 1-5 prior to commencement of processing operations at the site and reference data post-operations from monitoring site 1.

From a regulatory compliance perspective (i.e. notification under EPL 219), these trigger values apply to the water quality results of Site 4, since it is located just upstream of the site boundary and represents the quality of all surface water draining from the processing area and all associated irrigation and infrastructure areas before leaving the site.

In addition to the water quality triggers, to prevent any potential impacts of wastewater irrigation (or other operational activities) on downstream surface water hydrology (e.g. unseasonal surface water flows), a trigger of no dry season run-off or flows in downstream drainage lines has been adopted.

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Table 27: Trigger Values for surface water

Parameter	Site 4	Stormwater Dams
	80 th Percentile Reference Data	QLD Water Quality Guidelines (Industrial Stormwater) ¹
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	82.1	
Turbidity (NTU)	57.4	
pH	Range between 3.94 and 6.79	
Dissolved Oxygen (%sat)	Range between 21 and 107	
Total Suspended Solids (mg/L)	21.5	140
BOD ₅ (mg/L)	2.6	
Chlorophyll-a (mg/m ³)	2.0	
NO _x (mg/L) as N	0.07	
TKN (mg/L) as N	0.95	
Total Nitrogen (mg/L)	1.05	2.0
Ammonia (mg/L)	0.03	
Total Phosphorus (mg/L)	0.07	0.25
Enterococci (cfu/100mL)	1548	
E.Coli (cfu/100mL)	2725	50,000
Arsenic (mg/L)	0.001	
Cadmium (mg/L)	0.0001	0.0045
Chromium	0.001	
Copper (mg/L)	0.002	0.08
Nickel (mg/L)	0.001	
Lead (mg/L)	0.001	0.15
Zinc (mg/L)	0.02	0.16
Mercury (mg/L)	0.0001	

9.9.2 Groundwater Trigger Values

Trigger values for groundwater are provided in Table 28. These criteria were calculated from baseline data collected at 16 monitoring bores prior to commencement of processing operations at the site and reference data post-operations from upstream reference sites AACO1, 1A, 2, 2A, 7 and 7A.

These assessment criteria apply to the water quality results of monitoring bores 8, 8A and 9A, since these sites are located at the site boundary and represent the quality of all groundwater draining from the site that is potentially affected by site operations.

Table 28: Trigger Values for groundwater

Parameter	80 th Percentile
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	186
pH	Range between 5.1 and 9.1
NO _x (mg/L) as N	0.09
TKN (mg/L) as N	0.35
Total Nitrogen (mg/L)	0.4
Total Phosphorus (mg/L)	0.10
Enterococci (cfu/100mL)	5.9
E.Coli (cfu/100mL)	2

¹ 'Typical Values' for 'Industrial' land use – Chapter 8 Qld Water Quality Guidelines (Department of Environment and Heritage Protection 2009) Queensland Water Quality Guidelines, Version 3

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9.10 Data Management, Analysis and Reporting

9.10.1 Data Management

All routine surface and groundwater monitoring data, and incident/investigative monitoring data, is recorded in a dedicated water quality database by the Environmental Officer and in accordance with the conditions of EPL219, will be made available at any time on request from the NT EPA. Where trigger values are exceeded, investigation and subsequent reporting will take place as detailed in Section 9.10 below. All monitoring data is analysed and presented in an Annual Monitoring Report to be submitted to the NT EPA within 60 business days of the license anniversary each year.

9.10.2 Data Analysis

As surface and groundwater field/laboratory data are entered into their respective databases, these are compared with relevant trigger values and any exceedances will be highlighted and compared with data from previous monitoring and from other sites on the same sampling occasion. Water quality monitoring data will also be assessed for any long term emerging trends.

Any trigger value exceedances will be reported to the NT EPA as detailed in Appendix U below.

Details of annual water quality data analysis are provided below.

For groundwater, contour maps of groundwater levels should be generated based on monitoring data twice per year using levels measured at the end of the wet season and those measured at the end of the dry season. These groundwater maps will be useful in demonstrating any impacts that site operations, particularly irrigation practices are having on the configuration of groundwater flow.

9.10.3 Reporting

Exceedance of trigger values

Any exceedances of trigger values will be recorded and reported in accordance with the following conditions of EPL219:

- 71 The licensee must keep records of all exceedances of trigger values specified in the most current Water Quality Monitoring Plan.
- 72 The licensee must as soon as practicable (and in any case within 24 hours) after becoming aware, notify the NT EPA of an exceedance of a trigger value in the most current Water Quality Monitoring Plan
- 73 The licensee must ensure that the notification of a trigger value exceedance includes the following information:
 - 73.1 when the exceedance was detected and by whom;
 - 73.2 the date and time of the exceedance;
 - 73.3 the actual and potential causes and contributing factors to the exceedance;
 - 73.4 the risk of environmental harm arising from the exceedance;
 - 73.5 the action(s) that have or will be undertaken to address the exceedance and/or environmental harm;
 - 73.6 if no action was taken, why no action was taken; and
 - 73.7 an incident investigation report must be submitted to the NT EPA not more than 20 Business days after the incident date.

For actions regarding trigger value exceedances and other incidents see Section 9.11.1 Trigger Action Response Plan (TARP).

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Annual Monitoring Report

All monitoring data is presented in an Annual Monitoring Report, to be submitted to the NT EPA with 10 business day of the anniversary date of EPL 219 as outlined in condition 74. Condition 66 states:

- 73 The licensee must ensure that each Monitoring Report:
 - 76.1 is prepared in accordance with the requirements of the NT EPA 'Guideline for Reporting on Environmental Monitoring';
 - 76.2 includes a tabulation of all monitoring data required as a condition of this licence;
 - 76.3 includes long term trend analysis of monitoring data to demonstrate any environmental impact associated with the activity over a minimum period of three years (where the data is available);
 - 76.4 includes a data analysis and interpretation using the National Water Quality Management Strategy, Australian Guidelines for Water Quality Monitoring and Report, Chapter 6;
 - 76.5 includes results of all regular nutrient balances assessed for the premises to ensure that the nutrient load applied to irrigated land matches the mass of nutrients removed by the harvested crops;
 - 76.6 includes an assessment of compliance against water quality limits as outlined in Tables 3 and 4 and water quality trigger values as outlined in the most recent version of the Water Quality Monitoring Plan; and
 - 76.7 includes an assessment of environmental impact from the activity.

9.11 Incident Response

NABL have developed an Environmental Emergency Response Plan. The plan details the processes to respond to and report environmental incidents and/or emergencies that may occur during NABL managed activities. Condition 698 of EPL219 requires that all non-compliance with licence conditions are reported to the NT EPA as soon as practicable after (and in any case within 24 hours after) first becoming aware.

Trigger value exceedances and non-compliances are recorded on the 'Non-compliance and trigger value exceedance form' (Refer to Appendix U).

Following any environmental incident that has the potential to impact on downstream waterways; incident response water quality sampling will be undertaken at relevant downstream locations (see TARP below). The parameters, location(s) and frequency of this monitoring will be determined at the time and based on the nature of the incident (e.g. the location, volume or type of a spill/leak), in consultation with a person with appropriate expertise in water quality monitoring.

9.11.1 Trigger, Action, Response Plan (TARP)

A Trigger, Action, Response Plan (TARP) (Table 29) has been developed outlining the responses required in the event of trigger value exceedances or other incidents such as spills or dry season surface water flows.

9.12 Auditing and Review

Regular review, assessment and interpretation of trends in surface and groundwater monitoring results will occur to highlight the need for any improvements to plant processes, equipment, wastewater treatment or irrigation management. Following each monitoring event, data will be reviewed in relation to the site specific water quality objectives and a summary report provided to the AACo Environment Manager. Where trigger value exceedances are identified, the TARP will be implemented.

SECTION 9: Water Quality Monitoring

The monitoring results may also highlight adjustments needed to this WQMP, such as sample site locations, sampling frequency and parameters measured. Accordingly, the need for revision of this WQMP will be considered as a part of the annual internal audit; however, revision may occur sooner if changes to site operations alter the surface and groundwater risk profile that the monitoring program is currently designed to capture.

In accordance with EPL219 Condition 43 every 2 years NABL will engage a 'qualified person' to undertake an environmental audit. The scope of the audit will include review of compliance with EPL219, the *WMPC Act* and *Water Act*. The WQMP and water quality analyses will be audited to ensure the monitoring program provides for compliance with all regulatory requirements.

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Table 29: Trigger, Action, Response Plan (TARP)

	Responsibility	Normal Situation	Level 1	Level 2	Level 3
1.		All water quality parameters of surface water sampled at Site 4 (i.e. compliance point) and groundwater sampled at Bores 8, 8A and 9A comply with the trigger values listed in Table 27 for surface water and Table 28 for groundwater.	One or more water quality parameters of surface water sampled at Site 4 (i.e. compliance point) and groundwater sampled at Bores 8, 8A and 9A <u>do not</u> comply with the trigger values listed in Table 27 for surface water and Table 28 for groundwater.	One or more water quality parameters of surface water sampled at Site 4 (i.e. compliance point) and groundwater sampled at Bores 8, 8A and 9A <u>do not</u> comply with the trigger values listed in Table 27 for surface water and Table 28 for groundwater for a second sampling round in a row.	One or more water quality parameters of surface water sampled at Site 4 (i.e. compliance point) and groundwater sampled at Bores 8, 8A and 9A continually <u>do not</u> comply (i.e. more than three times in a row) with the trigger values listed in Table 27 for surface water and Table 28 for groundwater
Trigger value exceedance/s in samples collected during routine monitoring	Environmental Contractor	Continue with surface water and groundwater quality monitoring as per WQMP.	Notify NABL Environmental Officer of exceedance/s immediately upon receiving results from laboratory (usually at least 5 business days since sampling). Note that NABL must notify the NT EPA within 10 business days of the exceedance/s. Discuss and determine in consultation with the NABL Environmental Officer any activities or incidents on site that may have caused the exceedance/s. Fill out <i>EPL219 Non-compliance and Trigger Value Exceedance Notification</i> form and send to NABL Environmental Officer for submission to NT EPA. If exceedance/s are found to be caused by natural or by non-NABL activities upstream of the site, no further action required. If exceedance/s are found to be caused by NABL operations discuss with NABL Environmental Officer how to change operations to prevent further exceedances. This may involve	All actions as per Level 1 (i.e. the NT EPA must be notified again within 10 business days of the exceedance and the <i>EPL 131 Non-compliance and Trigger Value Exceedance Notification</i> form submitted). If exceedance/s are found to be caused by natural or by non-NABL activities upstream of the site, no further action required. If exceedance/s are found to be caused by NABL operations discuss with NABL Environmental Officer as to why the implemented changes to operations have not prevented further exceedances. This may involve additional investigative sampling by the Environmental Contractor.	All actions as per Level 1 (i.e. the NT EPA must be notified again within 10 business days of the exceedance and the <i>EPL 131 Non-compliance and Trigger Value Exceedance Notification</i> form submitted). If exceedance/s are found to be caused by natural or by non-NABL activities upstream of the site, trigger values need to be reviewed and possibly recalculated so that only NABL=L-related causes result in trigger value exceedances. All proposed trigger value changes to be in consultation with and approved by the NT EPA. If exceedance/s are found to be caused by NABL operations and concentrations are not decreasing or improving with each successive monitoring round discuss with NABL Environmental Officer as to why the implemented changes to operations have not prevented further exceedances.

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	Responsibility	Normal Situation	Level 1	Level 2	Level 3
			additional investigative sampling by the Environmental Contractor.		Assess the risk of environmental harm of continually exceeding triggers and advise NABL Environmental Officer of this risk and potential consequences.
	NABL Environmental Officer	Continue operations as per OEMP.	Notify NT EPA within 10 business days of the exceedance/s by emailing waste@nt.gov.au. Provide contractor with all relevant information regarding any activities or incidents on site that may have caused exceedance/s. Review <i>EPL131 Non-compliance and Trigger Value Exceedance Notification</i> form completed by the contractor and submit to NT EPA (could be done at the same time as initially notifying the NT EPA). If exceedance/s are found to be caused by natural or by non-NABL activities upstream of the site, no further action required. If exceedance/s are found to be caused by NABL operations, discuss with Environmental Contractor and NABL operations staff and management the causes of trigger exceedances and how to change operations to prevent further exceedances. Immediately implement measures to prevent further exceedances. Respond to any requirements requested by NT EPA.	All actions as per Level 1 (i.e. the NT EPA must be notified again within 10 business days of the exceedance and the <i>EPL 131 Non-compliance and Trigger Value Exceedance Notification</i> form submitted). If exceedance/s are found to be caused by natural or by non-NABL activities upstream of the site, no further action required. If exceedance/s are found to be caused by NABL operations discuss with Environmental Contractor, NABL operations staff and management as to why the implemented changes to operations have not prevented further exceedances. Immediately implement measures to prevent further exceedances. Respond to any requirements requested by NT EPA.	All actions as per Level 1 (i.e. the NT EPA must be notified again within 10 business days of the exceedance and the <i>EPL 131 Non-compliance and Trigger Value Exceedance Notification</i> form submitted). If exceedance/s are found to be caused by natural or by non-NABL activities upstream of the site, trigger values need to be reviewed and possibly recalculated so that only NABL-related causes result in trigger value exceedances. Obtain proposed reviewed trigger values from Environmental Contractor. All proposed trigger value changes to be in consultation with and approved by the NT EPA. If exceedance/s are found to be caused by NABL operations and concentrations are not decreasing with each successive monitoring round discuss with Environmental Contractor, NABL operations staff and management as to why the implemented changes to operations have not prevented further exceedances. Based on risk assessment by Environmental Contractor of environmental harm and in consultation with the NT EPA, determine course of action.

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	Responsibility	Normal Situation	Level 1	Level 2	Level 3
					Respond to any requirements requested by NT EPA.
2.		All wastewater treatment and operations functioning as per OEMP.	Incident of chemical spill, spill of untreated or partially treated wastewater, or some other pollution spill into stormwater / surface waters / groundwater or onto land.		
Spill Incident	NABL Environmental Officer	Continue operations as per OEMP.	Immediately implement NABL <i>Emergency Response Procedure</i> to contain and clean-up the spill. Note this procedure is a requirement of EPL131 and must be maintained and kept up to date. Contact Environmental Contractor to immediately conduct sampling to determine if downstream environments affected. Notify NT EPA as soon as practicable after (and in any case within 24 hours) first becoming aware of the incident by emailing waste@nt.gov.au. Fill out <i>EPL131 Non-compliance and Trigger Value Exceedance Notification</i> form and submit to NT EPA as soon as possible following the incident. Include results of downstream sampling conducted by Environmental Contractor if possible. Immediately implement safeguards and operational improvements and measures to prevent the incident from reoccurring. Ask Environmental Contractor to conduct follow-up sampling to determine any residual concentrations of spill. Report results to NT EPA as required. Respond to any requirements requested by NT EPA.		
	Environmental Contractor	Continue with surface and groundwater quality monitoring as per WQMP.	Conduct sampling to determine if downstream environments affected. This may require surface water, groundwater and/or soil sampling depending on the nature and extent of the incident. Include sites immediately downstream and upstream (if possible), and also the routine sampling sites if flows present at these sites. Report results of sampling and assessment to NABL Environmental Officer and recommend any measures for preventing environmental harm. Recommend timing for follow-up sampling to determine any residual concentrations of spill. Conduct follow-up sampling. Report results to NABL Environmental Officer.		
3.		No surface water flows during dry season (usually between May and October)	Surface water flows resulting from unseasonal rainfall	Surface water flows resulting from over-irrigation and run-off from irrigation areas	Surface water flows resulting from wastewater spill
Dry Season Flows	NABL Environmental Officer	Continue operations as per OEMP.	Contact Environmental Contractor to immediately conduct sampling of surface water monitoring sites where flows are occurring. If any exceedances of trigger values – follow response as for item 1 above.	Immediately cease irrigation operations. Contact Environmental Contractor to immediately conduct sampling to determine if downstream environments affected.	As per item 2 above

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	Responsibility	Normal Situation	Level 1	Level 2	Level 3
				Notify NT EPA as soon as practicable after (and in any case within 24 hours) first becoming aware of the incident by emailing waste@nt.gov.au. Fill out <i>EPL131 Non-compliance and Trigger Value Exceedance Notification</i> form and submit to NT EPA as soon as possible following the incident. Include results of downstream sampling conducted by Environmental Contractor if possible. Immediately implement measures to prevent the incident from reoccurring. Ask Environmental Contractor to conduct follow-up sampling to determine any residual impacts from the run-off. Report results to NT EPA as required. Respond to any requirements requested by NT EPA.	
	Environmental Contractor	Continue with surface water and groundwater quality monitoring as per WQMP.	Immediately conduct sampling of surface water monitoring sites where flows are occurring. If any exceedances of trigger values – follow response as for item 1 above.	Conduct sampling to determine if downstream environments affected. Report results of sampling and assessment to NABL Environmental Officer and recommend any measures for preventing environmental harm. Recommend timing for follow-up sampling to determine any residual impacts from run-off (although flows are unlikely to continue for long). Conduct follow-up sampling. Report results to NABL Environmental Officer.	As per item 2 above.
4.		No complaints	Complaint received regarding downstream surface water quality or groundwater quality.		

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	Responsibility	Normal Situation	Level 1	Level 2	Level 3
Complaints	NABL Environmental Officer	Continue operations as per OEMP.	Enter details of complaint in the Complaint Log including all information required as per EPL131 Condition 14. Contact Environmental Contractor to immediately conduct sampling of all surface water and/or groundwater monitoring sites relevant to the complaint. If any exceedances of trigger values – follow response as for item 1 above.		
	Environmental Contractor	Continue with surface water and groundwater quality monitoring as per WQMP.	Immediately conduct sampling of surface water and/or groundwater monitoring sites relevant to the complaint. If any exceedances of trigger values – follow response as for item 1 above.		
5.		All water quality parameters sampled at Dam 1 and Dam 2 below Qld Water Quality Guidelines (Industrial Stormwater) listed in Table 27.	One or more water quality parameters sampled at Dam 1 and Dam 2 above Qld Water Quality Guidelines (Industrial Stormwater) listed in Table 27 .		
Stormwater Dams	Environmental Contractor	Continue with surface water and groundwater quality monitoring as per WQMP.	Notify NABL Environmental Officer of exceedance/s immediately upon receiving results from laboratory (usually at least 5 business days since sampling). Discuss and determine in consultation with the NABL Environmental Officer any activities or incidents on site that may have caused the exceedance/s. Discuss with NABL Environmental Officer how to change operations to prevent further exceedances. This may involve additional investigative sampling by the Environmental Contractor. Undertake follow-up sampling to determine if changes have resulted in water quality improvement.		
	NABL Environmental Officer	Continue operations as per OEMP.	Provide contractor with all relevant information regarding any activities or incidents on site that may have caused exceedance/s. Discuss with Environmental Contractor and NABL operations staff and management the causes of trigger exceedances and how to change operations to prevent further exceedances. This may involve investigative sampling by the Environmental Contractor. Immediately implement measures to prevent further exceedances. Contact Environmental Contractor to undertake follow-up sampling to determine if changes have resulted in water quality improvement.		

10 Noise Management

10.1 Noise Management Objectives

NABL will endeavour to ensure that noise generated from the site does not adversely affect the amenity of the surrounding environment and will:

- provide adequate processes for noise reduction where necessary;
- enforce procedures governing noise generation where necessary;
- Investigate noise complaints received from the community;
- promote awareness of noise issues amongst staff;
- implement the management practices outlined in this plan;
- check compliance with specified management practices and licence conditions through a monitoring, auditing and review programme;

10.2 Purpose of the Plan

The purpose of this Noise Management Plan is to:

- describe the acoustic characteristics of the surrounding environment;
- identify and describe noise sensitive receptors;
- identify and describe aspects of site operations that generate noise;
- define appropriate management practices to mitigate noise problems;
- define procedures for monitoring, recording and responding to noise complaints.

10.3 Responsibilities

Environmental Officer	Responsible for ensuring that the information contained in this plan is accurate and up-to-date.
Maintenance Manager	Responsible for ensuring that the noise management practices described in this plan are effectively actioned.
Plant Manager	Responsible for ensuring that the noise management practices described in this plan are effectively implemented.
AACo Environmental Manager	Responsible for driving noise management improvement initiatives and ensuring compliance with EPL219.

10.4 Description of Surrounding Acoustic Environment

The site is located in a rural environment; therefore background noise levels of the surrounding area are low.

The Stuart Highway and an interstate rail line with heavy traffic including road trains and freight trains runs along the eastern boundary of the site. The nearest noise receptors are a number of rural residential properties at the south eastern boundary, approximately 600m south of the WWTP.

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The risk of noise nuisance from the abattoir complex is low due to the large buffer distance between the plant and sensitive receptors.

10.5 Noise and General Methods of Control

The principal measure for controlling noise impacts from the abattoir operations is the large buffer distance between the plant and sensitive receptors. This greatly assists in avoiding noise complaints. Despite the favourable buffer conditions, measures are needed to control site noise within the limits specified in the Risk Assessment and these are described below.

10.5.1 Plant Noise

Plant equipment such as refrigeration units and Rendering Equipment, which can operate 24hrs a day in some instances, can cause a noise nuisance particularly in early morning and at night. In instances where a noise source is identified as causing noise which results in noise levels above those specified in Section 10.6, acoustic screening should be provided.

When purchasing new plant and equipment or when planning for site upgrades the noise ratings should be considered as purchasing criteria.

10.5.2 Stock Noise

The noise generated from the bellowing of stock can be minimised through quiet handling and provision of food and water while in the yards.

Cattle unloading has been identified in the risk plan at the commencement of operations in 2015 as a potential source of noise from operations. As a result of this, unloading of cattle is currently only undertaken during daylight hours. During the operational period of the plant, no complaints of noise associated with cattle unloading have been lodged.

A restriction on night unloading of cattle poses double handling and associated animal welfare impacts for cattle being transported long distances from across Northern Australia to the facility. To address this issue NABL will investigate options for facilitating night unloading and proposes to undertake the following:

- Carry out a noise audit to determine the potential noise impacts of this activity including a comparison of other noise sources in the area including the rail line and Stuart Hwy.
- Investigate as a part of the noise audit, potential interventions to mitigate any potential noise exceedances and implement these where required
- Consult with nearest neighbours prior to adopting the operational change to manage any impacts.
- Maintain consultation with nearest neighbours during the implementation of this operational change to ensure no impact occurs
- Monitoring of noise during night time cattle unloading activities at nearest sensitive receptors
- Consult with NT EPA before permanently implementing this management change

NABL will undertake these activities in early 2018 and provide a copy of the Noise Audit Report to the NT EPA.

10.6 Criteria for Assessing Noise Impact

The Northern Territory Noise Management Framework Guideline defines noise criteria for the operations of an industrial facility in a rural residential area. It identifies two key components for consideration: shorter-term intrusiveness due to changes in the noise environment and maintaining the noise amenity of an area.

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10.6.1 Intrusive Noise Impacts

The criteria for intrusive noise impacts, defined in the NTEPA Guideline, is aimed at controlling the impact of an intrusive noise from an industrial source on residential receptors over short term periods. The criteria is presented as maximum additional noise allowed above the Rating Background Noise Level (RBL), measured over a 15-minute period.

A noise study carried out at the facility in 2015 defined the Intrusive Noise Impact Criteria in Table 30 below.

Table 30: Intrusive Noise Impact Criteria

Measurement Location	Objective	Period	Calculated RBL	Criteria (L _{Aeq,15min})
Nearest Southern Neighbour	Rated Background noise level (RBL) + 5dB(A)	Day	34	39 (34+5)
		Evening	27 (set as 30)	35 (30+5)
		Night	24 (set as 30)	35 (30+5)
Nearest Northern Neighbour		Day	35	40 (35+5)
		Evening	32	37 (32+5)
		Night	35	40 (35+5)

10.6.2 Protection Noise Amenity

The NTEPA Guideline specifies the maximum acceptable noise levels within an area. These noise levels are aimed at limiting the continuing increases in the ambient noise levels as additional noise sources are introduced.

A noise study carried out at the facility in 2015 defined the Intrusive Noise Impact Criteria in Table 31 below

Table 31: Amenity Noise Criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Objective ($L_{Aeq,adj,T}$)
Residence	Rural	Day	50
		Evening	45
		Night	40

10.7 Performance Review

Review of noise management practices at the site is to be undertaken through:

- Annual internal audits
- Annual management reviews

Refer to Section 13 for details of monitoring, auditing and management review requirements

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10.8 Noise Surveys

When requested by the administering authority, noise monitoring must be undertaken to investigate any complaint of noise nuisance, and the results notified within the timeframes specified to the administering authority. Monitoring must include:

- Background noise level
- LA 10, adj, 10 mins
- LA 1, adj, 10 mins
- the level and frequency of occurrence of impulsive or tonal noise;
- atmospheric conditions including wind speed and direction;
- effects due to extraneous factors such as traffic noise; and
- location, date and time of recording.

11 Odour Management

11.1 Odour Management Objectives

NABL will endeavour to ensure that odour generated from the site does not adversely affect the amenity of the surrounding environment. To achieve this, NABL will:

- actively monitor, record and act on odour complaints received from the community;
- promote awareness of odour issues amongst staff;
- implement the management practices to mitigate odour risks;
- check compliance with specified management practices and licence conditions through a monitoring, auditing and review programme;
- Identify responsibilities and provide budget allocations and procedures to enable the implementation of this management plan.

11.2 Purpose of the Plan

The purpose of this Odour Management Plan is to:

- describe the air quality characteristics of the surrounding environment;
- identify and describe sensitive receptors;
- identify and describe aspects of site operations that generate odour;
- define appropriate management practices to mitigate odour problems;
- Define procedures for monitoring, recording and responding to noise complaints.

11.3 Responsibilities

Environment Officer	Responsible for ensuring that the information contained in this plan is accurate and up to date. He/she is also responsible for ensuring that the management practices described in this plan are reviewed and updated annually as part of the annual internal audit. Also responsible for carrying out odour monitoring and reporting.
Maintenance Manager	Responsible for ensuring that the odour management practices described in this plan are effectively actioned.
Plant Manager	Responsible for ensuring that the odour management practices described in this plan are effectively implemented.
AACo Environmental Manager	Responsible for reviewing, providing recommendations on compliance outcomes from odour monitoring activities and ensuring compliance with EPL219..

11.4 Description of Air Quality of Surrounding Environment

The site is located in a rural environment; therefore the air quality of the area is very good. The abattoir is the most obvious source of potential odours in the area; however other local odour sources from rural activities

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are likely to contribute to overall odour levels in the area including intensive cattle holding facilities for live export programs.

The site has sensitive neighbours on all boundaries, with the closest being approximately 600m from the production area to the south east. To the north east, there are sensitive receptors approximately 800m from irrigation areas.

11.5 Odour Generating Activities and Methods of Control

The following aspects of operations at the site can potentially generate odours:

11.5.1 Manure in holding yards and pens

The manure which collects on the floor of the cattle holding yards and pens can become anaerobic and very odorous when wet. One way of controlling the moisture level of the manure in the holding yards is by keeping the manure layer thin. Manure should be removed from the yards regularly; at least every three months, or more frequently if identified by regular inspections. The floors of the yard should be maintained to ensure that they have an even surface with no low spots where moisture can accumulate.

11.5.2 Solid wastes (manure, paunch contents)

To avoid odour generation from these materials go through a dewatering process before being removed from site for deep burial at a registered facility. Material is removed on the same day of production to minimise any odour risk.

11.5.3 Storage and handling of animal by-products

The animal by-products collected in the basement area are readily putrescible and will generate obnoxious odours if they are held for too long at outside temperatures. Any material in this area is to be processed promptly via the render or removed from site for deep burial at a registered facility.

11.5.4 Rendering of animal by-products

The animal by-products are to be rendered as soon as possible to reduce obnoxious odours.

The rendering plant is to be thoroughly cleaned at the end of each days operation to reduces obnoxious odours

The material will be stored in a raw material bin designed in such a way that the first product in the bin will be the first product to be rendered

The odour from the rendering process is ducted to a biofilter. To ensure this is effective, render plant is operated with all doors closed.

The biofilter ducting and bed must be maintained as to insure the maximum advantage of this technology

11.5.5 Overloaded effluent treatment ponds

The effluent treatment ponds can generate odour if they are overloaded with organic matter or if there is a sudden influx of organic matter.

Odour risks can be minimised by limiting the loading rate. A constant and consistent feed of effluent to the ponds and the avoidance of surges of flow or slugs of chemicals will also assist in maintain optimum performance of the ponds. Screening of solids from the effluent stream prior to entering the ponds assists in reducing the load. Should overloading occur, the treatment ponds are to be dosed with soda ash to balance pH and ensure biological communities are protected from any acidic shock.

11.5.6 Wet Weather Storage

A risk associated with the storage of treated effluent for extended periods is the growth of algal blooms which are a potential source of odour. The WWS has been designed to incorporate mechanisms to prevent

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stratification and reduce the growth of algae within the dam. Although it is unlikely under normal operating conditions that this dam will generate odour likely to cause environmental nuisance off site, regular monitoring will be carried out during periods where treated effluent is in storage to detect any algal blooms that may have occurred and any associated odour. If any algal bloom or offensive odour is detected an investigation as to the cause will be carried out and an action plan to redress any issues will be put in place immediately.

11.5.7 Effluent irrigation

It is unlikely that the treated effluent will generate odour when irrigated, however this has been a significant source of odour for the NABL plant in the past. To address this, NABL has installed an upgraded WWTP to process wastewater to a quality that it will not produce odour.

However should there be a problem, odour from effluent irrigation can be minimised by ensuring appropriate buffer zones are maintained between irrigation area and receptors, avoiding irrigation when the wind is blowing directly towards neighbours and avoiding irrigation prior to or on weekends or public holidays.

11.6 Odour Monitoring

11.6.1 Locations

Odour monitoring is carried out around the perimeter of the NABL site. Specific sites have been identified at key points around the site perimeter (see map of odour monitoring sites and route in Section 15.10) where odour assessments are carried out according to the procedure outlined in Appendix P. If odour is detected while travelling the route around the NABL site, additional odour assessments are carried out at the location where the odour has been detected and in the surrounding area to determine the source of the odour.

11.6.2 Frequency

Odour monitoring is carried out on a daily basis, generally in the morning when odours are most likely to become active. This frequency was set in response to a significant odour issues relating to NABL irrigation activities. In response to these odour issues, NABL installed a new WWTP to better process wastewater and eliminate the production of offensive odour from irrigation activities. Once it is determined that this odour source has been fully addressed, frequency and timing of monitoring is to be reviewed.

11.6.3 Data Recording

Odour monitoring assessments are recorded using a data collection App on a smart phone device. This app records the fields required as well as date and time stamp and a GPS coordinate for the assessment. Data is uploaded into a central online database and can then be transferred to the NABL daily observations register. The parameters for assessing odour during monitoring are outlined in Table 32

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Table 32: Key odour monitoring parameters

Parameter	Rating
Odour Description	0 – No odour Burnt/Smokey Earthy Sulphuric Fragrant Blood-like Musty/mouldy Putrid/rancid/decay Manure Other
Odour Source	Rendering – Raw Rendering – Cooking Rendering – Meal Paddocks Irrigation Wastewater Biofilter Other on-site source Other off-site source
Odour Intensity	0 – No odour 1 – Not distinguishable 2 – Distinguishable 3 – Clearly distinguishable 4 – Strongly distinguishable 5 – Stomach churning

11.7 Odour Incident Response

It is common to detect odours within the general area while undertaking odour monitoring. There are a number of naturally occurring and human activities that generate odour in the area including rank swamps and riparian areas, dead carcasses from incidents such as road kill, fires, horticultural operations (herbicides and insecticides generate odour), farming activities, livestock holding facilities, domestic septic tanks and the like. When an odour is detected and the source is potentially the facility operations, NABL will investigate and report appropriately according to the requirements outlined below.

Odours complaints may from time to time be received by NABL Environmental staff or facility management. In this case, the notification and investigation process outlined below is to be carried out.

11.7.1 Notification

When an odour is detected outside the NABL site boundary that is likely to have been generated by facility operations, the Environmental Officer is to immediately notify the Environmental Manager and the Plant Manager. The Environmental Manager (and if not available, the Environmental Officer) will immediately notify the NT EPA by email at pollution@nt.gov.au that there is a possible odour event that is being investigated.

Once the investigation has been completed as per below and if the odour has been confirmed as generated by facility operations, NABL will submit a Non-compliance Report as per Appendix U. The report should include the cause of the odour and corrective actions taken to address the odour source and prevent future odour occurrences from that source.

If the odour is determined **not** to have been generated by NABL site operations, the NT EPA is to be notified as to the results of the investigation and evidence (if available) as to the off-site source is to be provided to the NT EPA.

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11.7.2 Investigation and Response

When an odour is detected or a complaint has been received, the Environmental Officer in consultation with the facility management team where appropriate (primarily Plant Manager, Maintenance Manager and Environmental Manager) will carry out an investigation to identify the source of the odour. The investigation may include (but not limited to):

- On-site odour detection to identify the source (if odour still active)
- Interview of relevant operational staff (such as irrigation manager, WWTP and DAF operators, Render plant manager)
- Weather data
- Operational data (such as irrigation data, ender operational data etc)
- Standard Operational Procedure review

Where the source is confirmed to be an operational activity, procedures and equipment is to be reviewed to identify why the odour was generated and what actions are required to remedy this. Where appropriate, changes to standard operational procedures may be required to prevent future repeat odour events from this source. If plant repair or upgrade is required, the Environmental Officer is to produce a recommendations report for escalation via the Environmental Manager for action.

Results of the investigation are to be recorded in the Incidents Register and if the investigation is in relation to a complaint received, details are to be recorded in the Complaints Register.

11.8 Performance Review

Review of odour management practices at the site is to be undertaken through:

- Daily monitoring to be performed (until odour conditions at site are determined to be stable, when monitoring frequency can be reviewed) (See Appendix P for Odour Monitoring Procedure).
- Annual internal audits
- Annual management reviews

Refer to Section 13 for details of monitoring, auditing and management review requirements.

12 Weed Management

12.1 Weed Management Objectives

NABL also recognises the impact that managed weeds can have on production and land values and actively engages in weed management to prevent these losses. Through active weed management outlined in this plan NABL aims to:

1. Meet our obligations under legislation, to our shareholders and the broader community for responsible and sustainable land use.
2. Protect our land asset base from the threat of weeds and limit their impact on our production potential and the health of our environment.
3. Improve the return on our investment in weed management and ensure that the investments we make are protected through efficient and effective action.

Under the NT Weed Management Act, NABL must:

- (a) Take all reasonable measures to prevent the land being infested with a declared weed
- (b) Take all reasonable measures to prevent a declared weed or potential weed on the land spreading to other land
- (c) Within 14 days after first becoming aware of a declared weed that has not previously been, or known to have been, present on the land, notify an officer of the presence of the declared weed.

12.2 Current Weed Infestations

There are two main groups of weed species present at the facility – broadleaf weeds and grassy weeds. The key weed species present on site are listed in Table 33. Under the NT Weed Management Act, there are three classes of weed:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C – not to be introduced into the NT (all Class A and B weeds are also considered Class C).

Table 33: Weed species currently active on site

Group	Weed	Declaration Status	Threat Posed
Grassy Weeds	Gamba Grass	Class B (Zone B), Class C	Gamba grass is tolerant of drought, fire and low nutrient soils found in north Australian savannas. It produces up to 250,000 seeds per season that can establish in both disturbed and undisturbed areas. It grows rapidly to form tussocks which are bigger, taller and denser than native grasses. Gamba grass can have all of the following impacts: • creates high fuel loads which cause late and intense fires • fires dramatically alter the structure of native plant communities • severely decreases biodiversity • replaces woodlands with tall grasslands • alters water cycles.

SECTION 12: Weed Management

Group	Weed	Declaration Status	Threat Posed
	Mission Grass	Class B, Class C	By remaining green until the late dry season, this grass provides fuel for much hotter fires later in the year. It is also encouraged by repeated burning. The fuel load from this species can be three to five times that of native species. Mission grass can have all of the following impacts: - competes with native species - occupies disturbed areas - provides fuel for hotter late fires - fires are detrimental to native species as well as property and horticulture - is encouraged by repeated burns.
	Rats Tail	Not declared in the NT	Rat's tail grasses are invasive grasses that can reduce pasture productivity, out-compete desirable pasture grasses and cause significant degradation of natural areas.
Broadleaf weeds	Hyptis	Class B, Class C	- takes over improved and native pastures, especially when overgrazed - forms dense thickets - unpalatable to most livestock because of the aromatic oils.
	Lantana	Class B, Class C	- displace native species - alter fire regimes - leaves and seeds are toxic to many animals, causing gastrointestinal disturbance, photosensitivity and potentially death in cattle and sheep - loss of productivity due to toxicity to stock and pasture replacement.
	Sicklepod	Class B, Class C	- Invades pasture, roadsides, fence lines, creek banks, waste areas. - Potential to become major weed of many crops within 2-3 growing seasons.
	Spiny-head Sida	Class B, Class C	Weed of roadsides, pastures, cultivated fields, tropical crops and disturbed areas. It competes strongly with crops for light and nutrients. It is one of the most serious weeds of Northern Australia. Rapidly spreads in over-grazed areas near trees and troughs and as soil fertility builds up. Stock tend to ignore eating it even though it is nutritious.

12.3 Spread Prevention

Weed spread prevention alongside early detection and eradication of new weed infestations are without exception the most cost effective weed management strategies. To protect the facility from further weed incursions, NABL has implemented a weed hygiene policy with the following key actions:

1. **Livestock:** One of the main vectors of weed spread, particularly weeds with palatable seed pods, is the faeces of livestock. Other threats include seed transportation via hoofs and in the tail. NABL from time to time, grazes stock in paddocks on the site. To reduce the threat posed by cattle coming on to site:

SECTION 12: Weed Management

- (a) Where possible and in cases where the threat is determined to be high, quarantine cattle in holding yards prior to unloading into paddocks (transport times to the site may provide a degree of quarantining).
 - (b) Monitor paddocks where cattle have been introduced from high risk areas and treat any new weed infestations immediately.
2. **Holding Paddocks and Yards:** Holding paddocks/yards and their maintenance form the basis of a successful weed hygiene strategy. Key considerations are;
 - (a) Holding paddocks utilised for incoming cattle should be maintained free from declared weed species.
 - (b) Conduct twice yearly inspections for declared weed species, treating any identified weeds.
3. **Hay:** Hay is a key pathway of weed spread, particularly of broadleaf and grassy weed species. Key considerations are:
 - (a) Ensure hay or stockfeed is sourced from weed free areas or gain assurance from supplier as to weed free status of hay
 - (b) Conduct twice yearly inspections of the holding yards and treat any new weed infestations
 - (c) Ensure hay produced on site is free from weed seed prior to removal from hay paddocks.
4. **Machinery and Plant:** Farm machinery and earth moving plant are a significant weed introduction threat. Key considerations are:
 - (a) Ensure all machinery and plant coming onto site for use in paddocks is thoroughly washed down in the designated wash-down area prior to entering the paddock and after work is complete.
 - (b) Ensure farm machinery used to control weed infestations (ie slashing of weeds to prevent seed set) are washed down after works are complete and prior to moving machinery onto areas that are deemed free of the weed being controlled.

12.4 Management Actions

NABL will undertake an annual weed control program which will be conducted primarily through the wet season where active growth is taking place. Treatment programs will be timed according to the season and plant growth. A range of activities will be employed as outlined in Table 34.

Table 34: Weed management approaches to be employed

Weed	Aerial Spray	Ground spray	Slash	Fire
Gamba Grass	x	x	x	x
Mission Grass		x	x	x
Rats Tail			x	
Hyptis	x	x		
Lantana		x		
Sicklepod	x	x		
Spiny-head Sida	x	x		

SECTION 12: Weed Management

12.5 Recording, Monitoring and Evaluation

Access to reliable data is essential in planning weed management programs, successfully implementing on ground works, quantifying progress and return on investment and identifying areas for improvement. The NABL approach to weed data management will address all points throughout the process:

- **Recording weed infestations:** The existing NT Weed Management Branch weed data standard is an effective data structure for recording weed infestations as points, lines and polygons. NABL will apply this data standard for both on ground incidental mapping of weed infestations and for aerial survey. A number of tools are available for this including use of the Esri Survey123 and Collector apps and hard copy weed record books. All data will be compiled by NABL Rangelands Officers and stored in the central NABL geodatabase. Any new infestations that are identified are to be recorded using this standard and reported immediately to the Weed Management Branch.
- **Treatment records:** All weed treatments on NABL properties must be recorded as a part of compliance with cattle quality assurance programs as well as being best practice for weed management. All records of treatments of prickly acacia and mesquite will be stored both at Brunette Downs and in the Rangelands Central online database. Treatments will be recorded according to the datasheet in Figure 6-1. In addition to this, Spatial data depicting the area treated and the treatment method will be recorded and stored in the NABL geodatabase.
- **Monitoring:** a set of standard photo monitoring points are to be established at key prickly acacia and mesquite infestation sites to monitor changes in infestation dynamics. These monitoring sites will record numbers of adults, juveniles and seedlings and take a photo record. These sites will be assessed annually. Data will be stored centrally in the NABL geodatabase and on Rangeland's Central.
- **Reporting:** An annual report of prickly acacia and mesquite management actions and outcomes will be provided to the NT Weeds Branch at the end of each NABL financial year (end of March). The report will follow the format shown in Figure 6-2 and will also include spatial records of infestation locations and treatment areas.

12.6 Performance Review

Review of odour management practices at the site is to be undertaken through:

- Daily monitoring to be performed (until odour conditions at site are determined to be stable, when monitoring frequency can be reviewed) (See Appendix P for Odour Monitoring Procedure).
- Annual internal audits
- Annual management reviews

Refer to Section 13 for details of monitoring, auditing and management review requirements.

13 Monitoring, Auditing and Management Review

13.1 Purpose of this Section

The purpose of this section is to describe the mechanisms for reviewing the environmental performance of the NABL Livingstone operations. This includes the following three functions:

- Daily, Weekly, Monthly and Quarterly Monitoring;
- Annual internal audit; and
- Annual management review.

This section does not address the requirements of groundwater and surface water monitoring which are addressed in Section 9 (Water Quality Monitoring Plan) or soil monitoring of the irrigation areas which is addressed in Section 8 (Irrigation Management)

13.2 Responsibilities

Environment Officer	Responsible for scheduling and co-ordinating the monitoring tasks described in this section and for recording and reporting results to the appropriate personnel. He/she is also responsible for ensuring that the requirements detailed in this report are correct and up to date.
Plant Manager	Responsible for scheduling and co-ordinating the annual internal audit and management review and for recording and implementing any recommendation that arise from the audit or management review.
AACo Environmental Manager	Responsible for reviewing and providing recommendations on compliance outcomes from the audit or management review.

13.3 Scheduling of Monitoring, Audits and Management Reviews

Dates for weekly and quarterly monitoring, annual internal audits and annual management reviews are to be scheduled in advance. The schedule format contained in this plan can be used to record scheduled dates and also to record that these activities have taken place.

13.4 Daily, Weekly and Monthly Checks

Regular inspections of operations including the processing area, render, DAF, WWTP, irrigation paddocks and the site boundary are carried out daily, weekly and monthly according to the checklists that can be found in Appendix R. These checklists can be photocopied and used to record the monitoring results.

13.5 Quarterly Monitoring

The checklists contained in Appendix R of this plan list those aspects that are to be checked as part of the regular monitoring program. A checklist for sample collection and analysis is also supplied. These checklists can be photocopied and used to record the monitoring results. Any additional findings or recommendations should also be recorded on or attached to the checklist (This monitoring is in addition to items outlined in the WQMP and IMP).

SECTION 13: Monitoring, Auditing and Management Review

A copy of the completed checklist is to be forwarded to the Environmental Manager and a copy is to be retained on file.

13.6 Annual Internal Audit and Management Review

The purpose of the Annual Internal Audit and Management Review is to review the company's performance against the environmental requirements specified in the SBMP and to ensure that the SBMP remains applicable to activities occurring at the site and is up to date with respect to environmental obligations.

The Audit is to be performed by an internal audit team. Contractors may also be employed to undertake auditing activities if necessary.

The checklist contained in Appendix R of this plan lists those aspects that are to be audited as part of the Annual Internal Audit. The checklist can be photocopied and used to record the results of the audit. Any additional auditing reports or recommendations should also be attached to the checklist. In addition to the checklist, groundwater Contour maps are to be generated as required in Section 9.7.4.

A copy of the completed checklist and any auditing documents are to be forwarded to the Plant Manager and a copy is to be retained on file.

The purpose of the Annual Management Review is to review the audit results and to make recommendations for improvements if required and to revise if necessary the objectives, targets and management requirements specified in the OEMP.

Any improvements identified through the auditing and/or management review process are to be recorded in the Environmental Improvements Register (Appendix Q).

13.7 Review of Water Quality Limits and Trigger Values

The water quality limits for treated wastewater and trigger values for surface water and groundwater monitoring were determined by review of guidelines from a range of jurisdictions across Australia and through environmental modelling. These limits and trigger values are to be reviewed against actual performance data to determine their effectiveness and relevance to the specific operational conditions of the facility. An initial review of these limits and triggers should be carried out after 18 months of operations on site recommencing. This will allow for sufficient WWTP and WWS data to be collected and reviewed. The limits and triggers to be reviewed are:

- Wastewater quality limits (outlined in Section 8.7.6, Table 13 and Table 14)
- Soil quality trigger values (outlined in Section 8.7.6, Table 15)
- WWTP subsurface leak detection trigger values (outlined in Section 8.7.7, Table 18)
- WWS water quality trigger value (to be confirmed once WWS is installed, proposed trigger values outlined in Section 8.7.8, Table 20)
- Surface water monitoring trigger values (outlined in Section 9.6.3, Table 27)
- Groundwater monitoring trigger values (outlined in Section 9.7.3, Table 28)

The review should also assess the frequency of sampling and the location of sampling sites.

Once the initial review is complete, an ongoing review every three years should be carried out.

SECTION 13: Monitoring, Auditing and Management Review

13.8 Monitoring, Auditing and Management Review Schedule

Monitoring / Sampling			Annual Internal Audit			Annual Management Review		
<i>Scheduled date</i>	<i>Person responsible</i>	<i>Date performed</i>	<i>Scheduled date</i>	<i>Person responsible</i>	<i>Date performed</i>	<i>Scheduled date</i>	<i>Person responsible</i>	<i>Date performed</i>

14 Environmental Improvements

14.1 Purpose of this Section

The purpose of this section is to describe the process for recording and tracking environmental improvements that are identified from monitoring, auditing or management review activities.

14.2 Responsibilities

Environment Officer	The designated site Environmental Officer is responsible for maintaining the Environmental Improvements Register and ensuring that it is up to date
Plant Manager	Responsible for ensuring that the improvements documented in the Environmental Improvements Register are acted upon within the timeframes specified.
AACo Environmental Manager	Responsible for reviewing and providing recommendations on compliance requirements for operational improvement.

14.3 Identifying and Reporting Environmental Problems

If monitoring or auditing activities identify any environmental issues that are not within the guidelines established by the OEMP or causing or threatening environmental harm, then it is to be brought to the attention of the Environmental Manager for appropriate address or escalation.

Details of the problem are to be recorded on the Environmental Non-compliance Record, a copy of which is provided in this section. The original is to be submitted to the Site Manager and a copy is to be retained on file.

Other observations and ideas which will result in improved environmental performance, such as waste minimisation, energy efficiency or cleaner production should also be recorded and processed in the same fashion.

14.4 Recording Environmental Improvements

Any recommended improvements that result from an investigation of an Environmental Non-compliance Record are to be recorded in the Environmental Improvements Register contained within this document.

Other initiatives which will result in improved environmental performance, such as waste minimisation, energy efficiency or cleaner production should also be recorded in the Register.

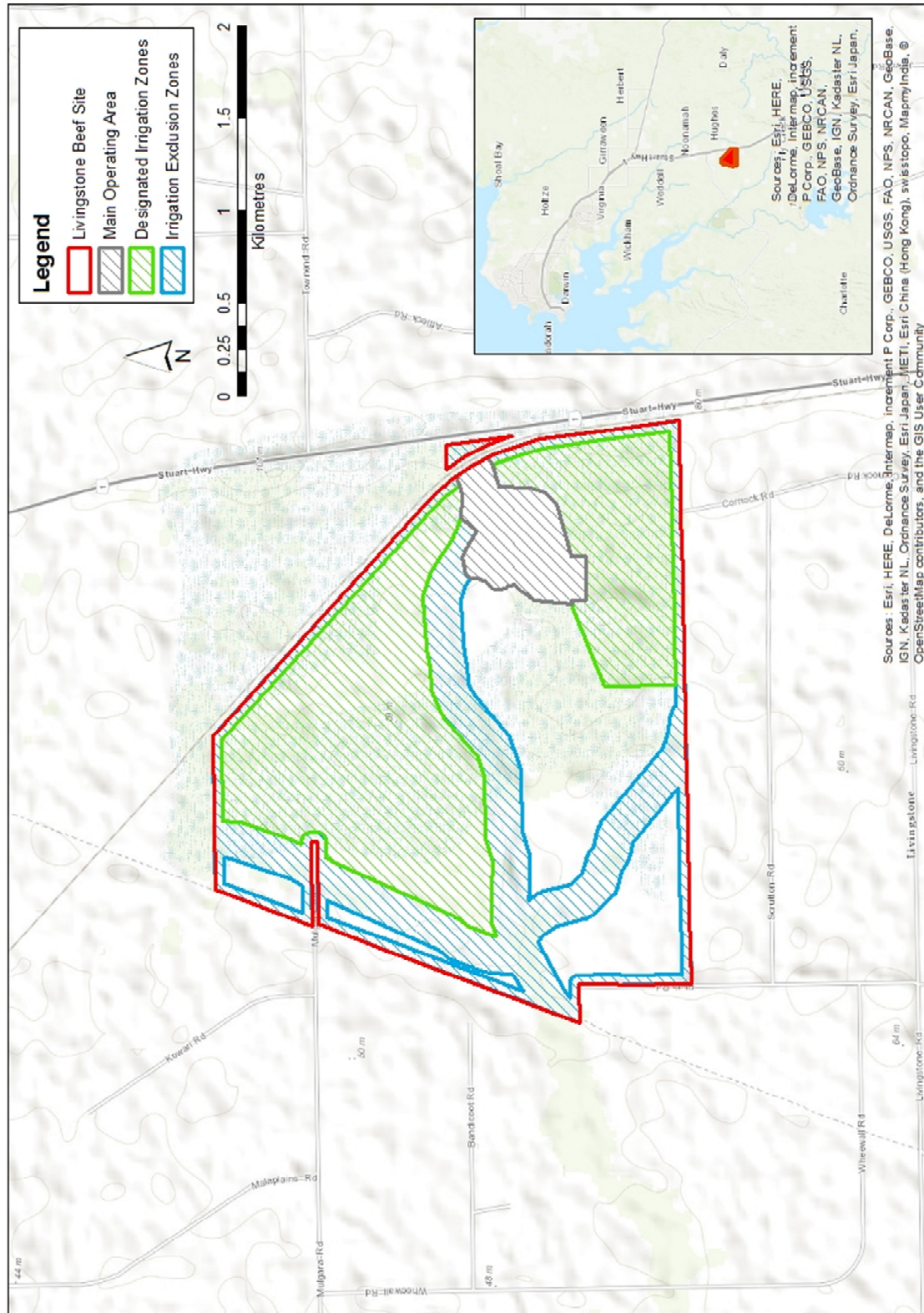
Details entered into the register should include the objective of the improvement, brief details of the improvement, the date the improvement was initiated and a proposed date for completion.

The Register is to be reviewed as part of the Annual Internal Audit to monitor progress on the improvements.

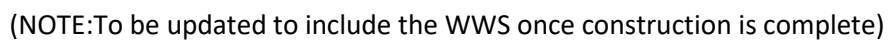
SECTION 15: Maps and Plans

15 Maps and Plans

15.1 Site Location Map

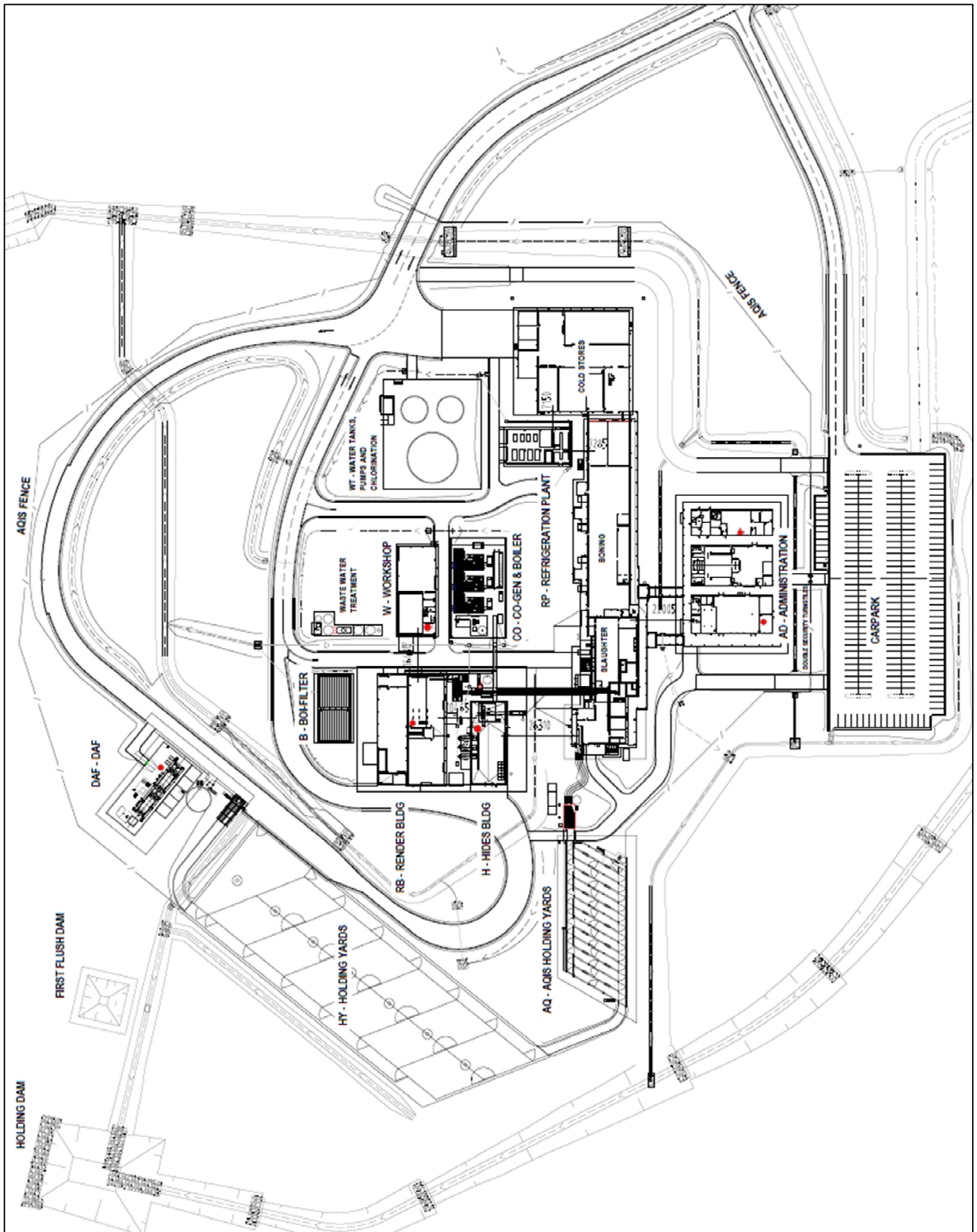


15.2 Site Plan



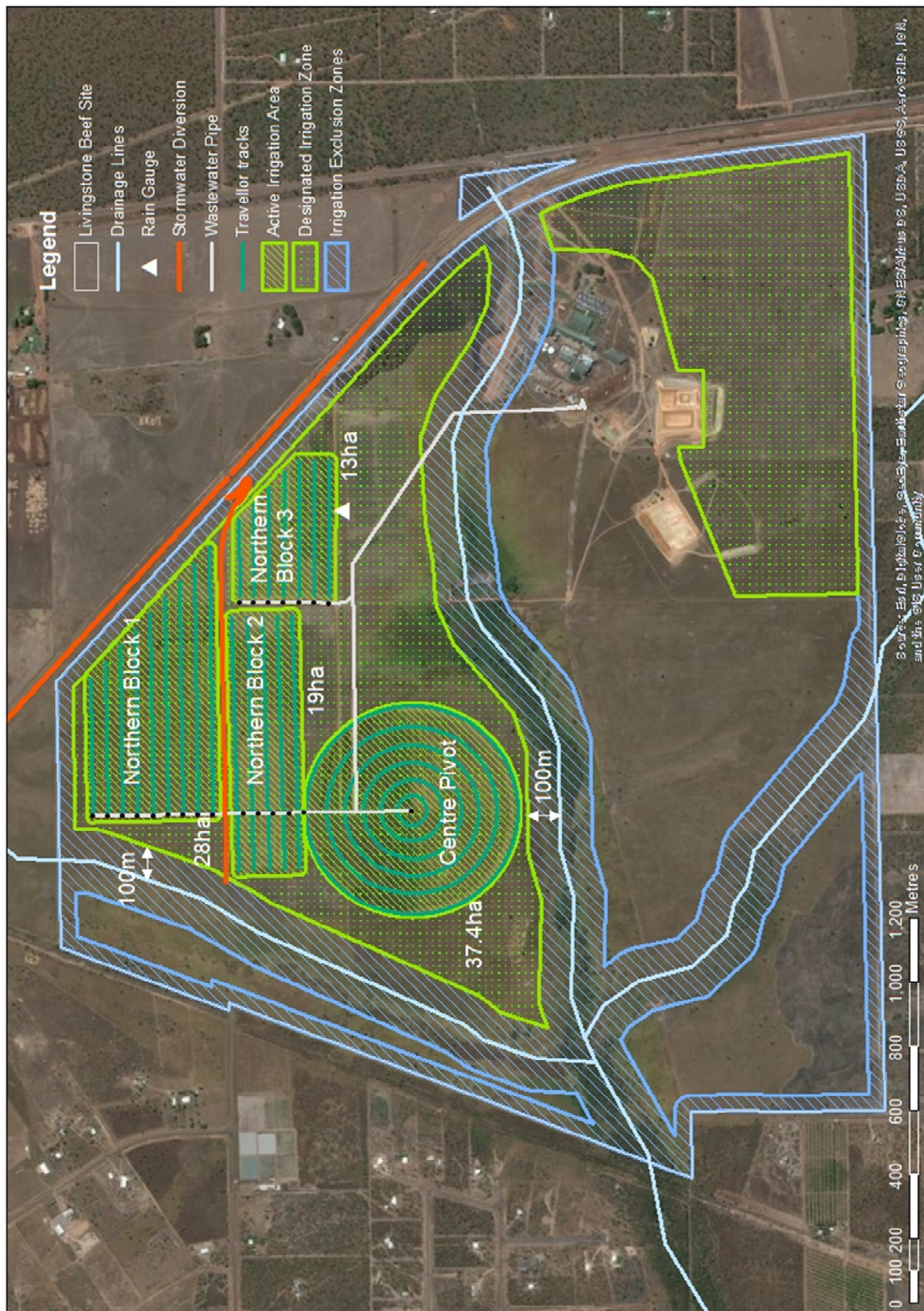
SECTION 15: Maps and Plans

15.3 MSDS locations



SECTION 15: Maps and Plans

15.4 Irrigation Areas and Infrastructure

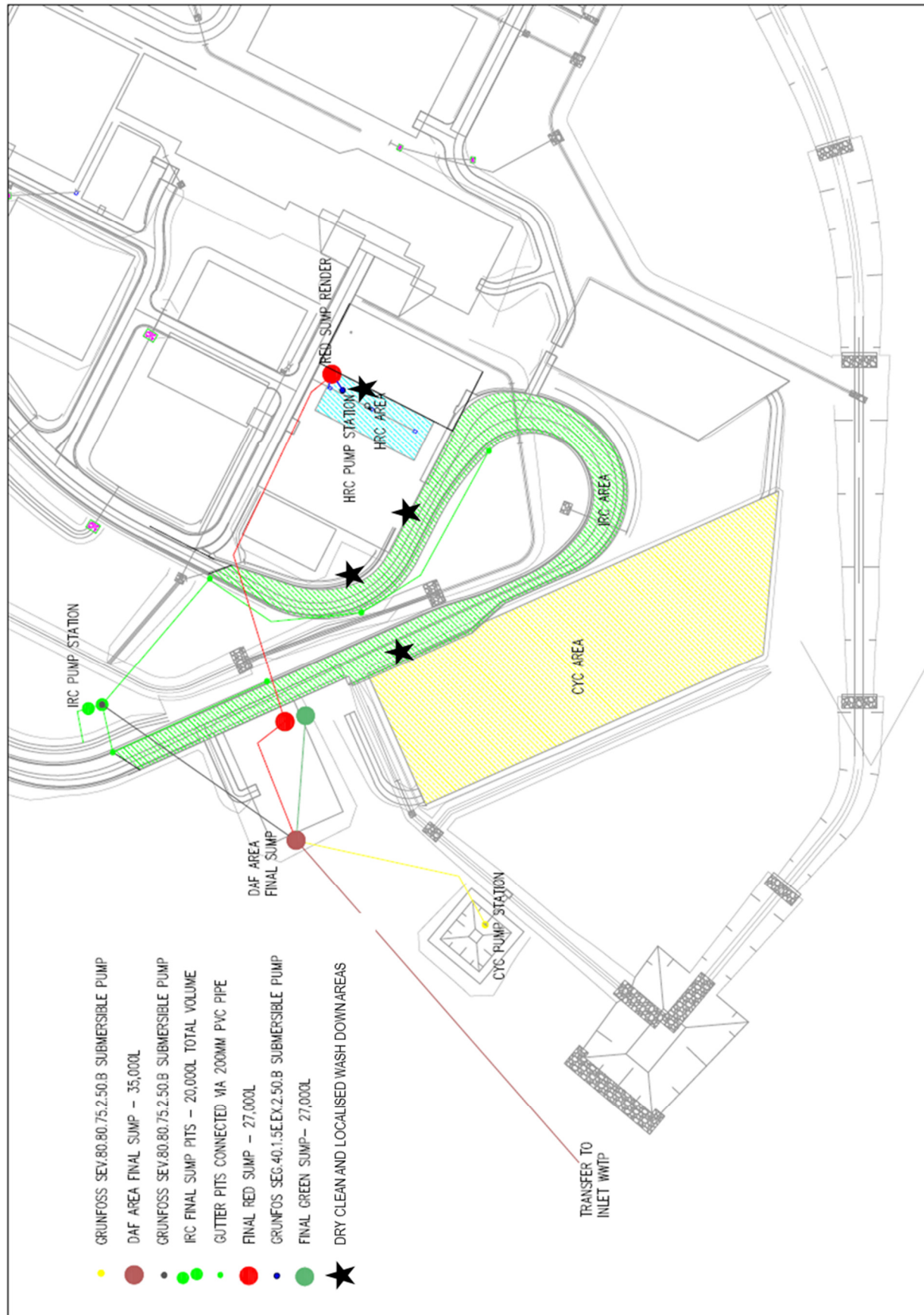


15.5 Stormwater Catchments

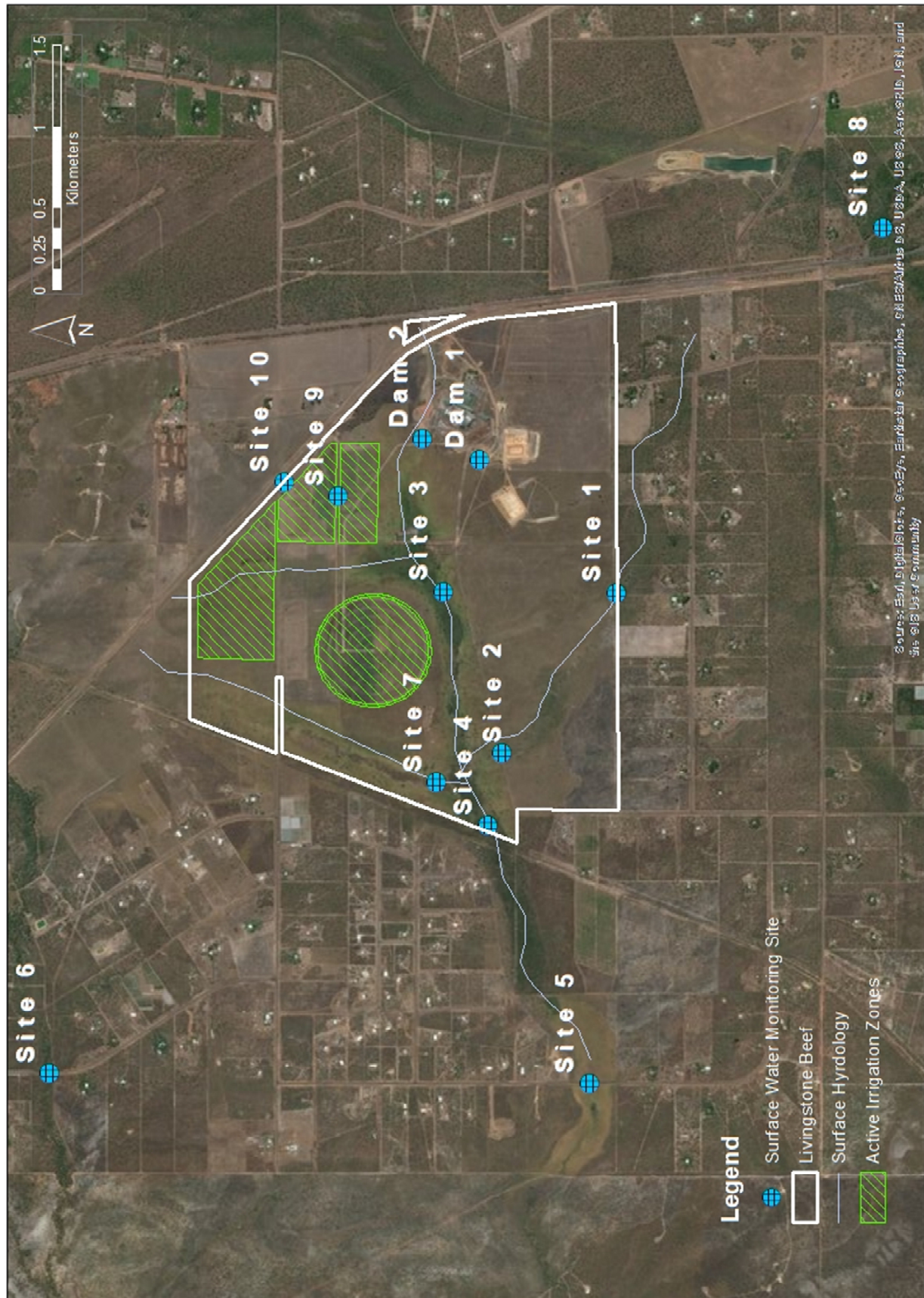


SECTION 15: Maps and Plans

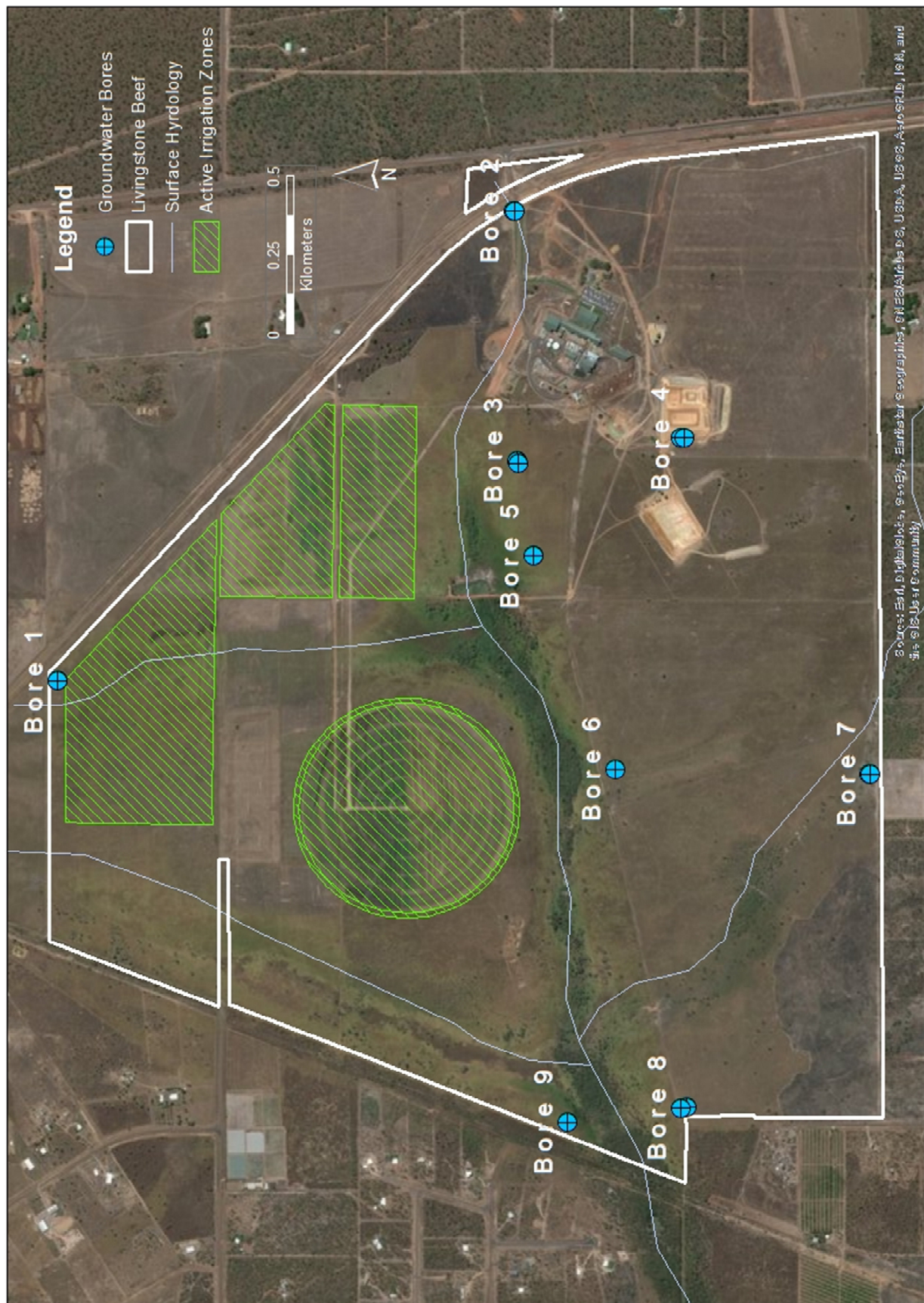
15.6 First Flush Infrastructure Schematic



15.7 Surface Water Monitoring Sites



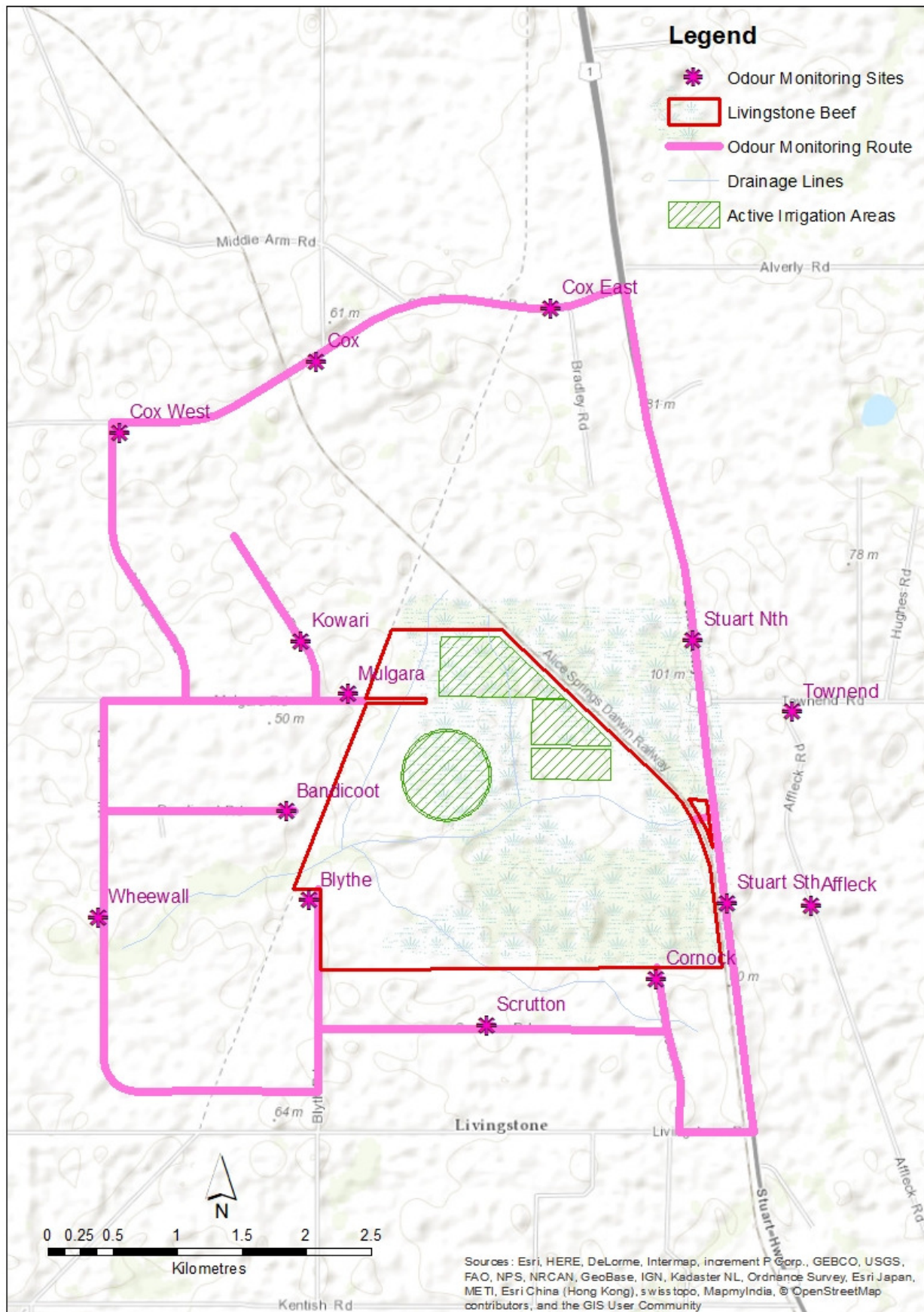
15.8 Groundwater Monitoring Sites



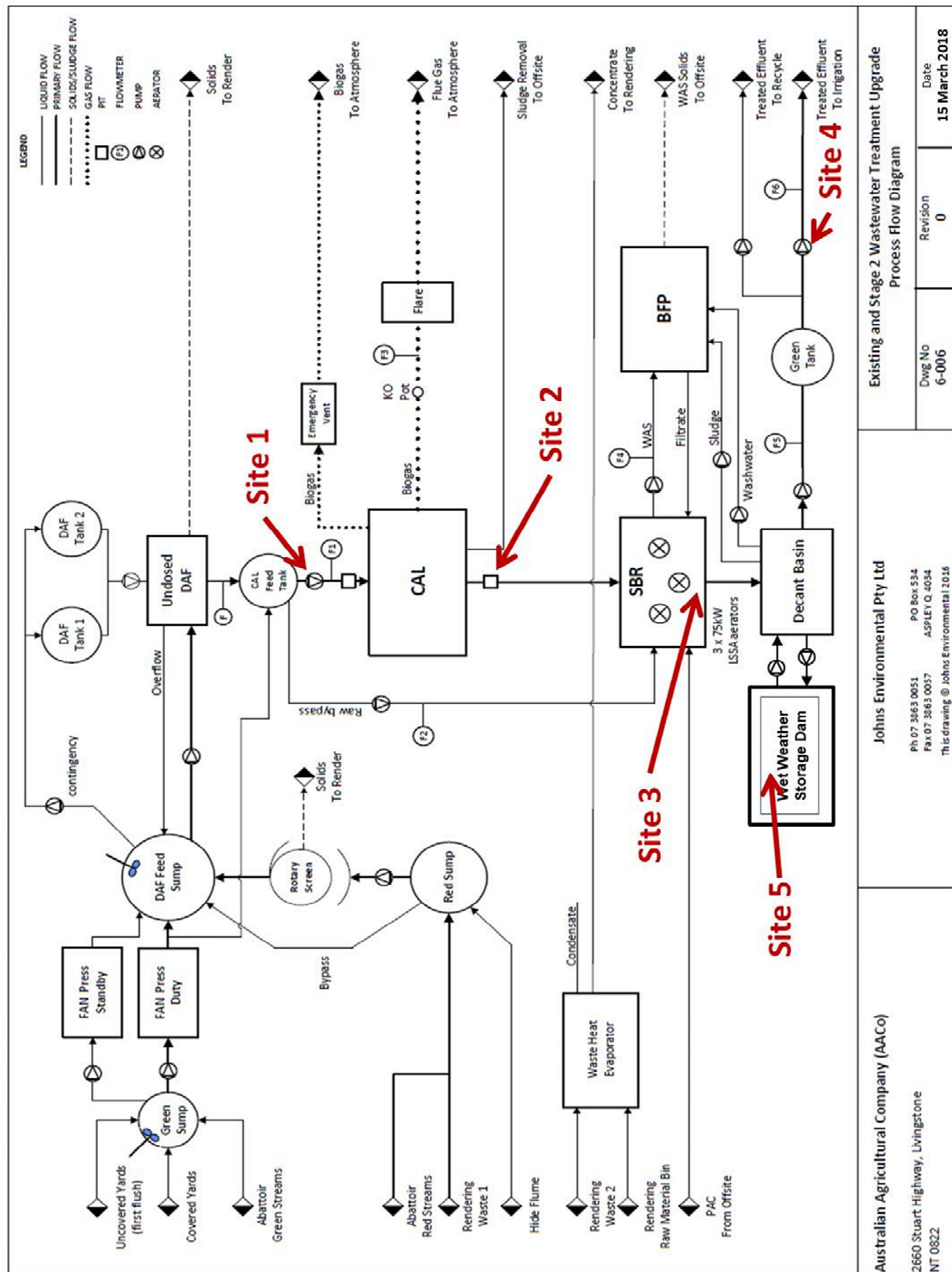
15.9 Soil Monitoring Sites



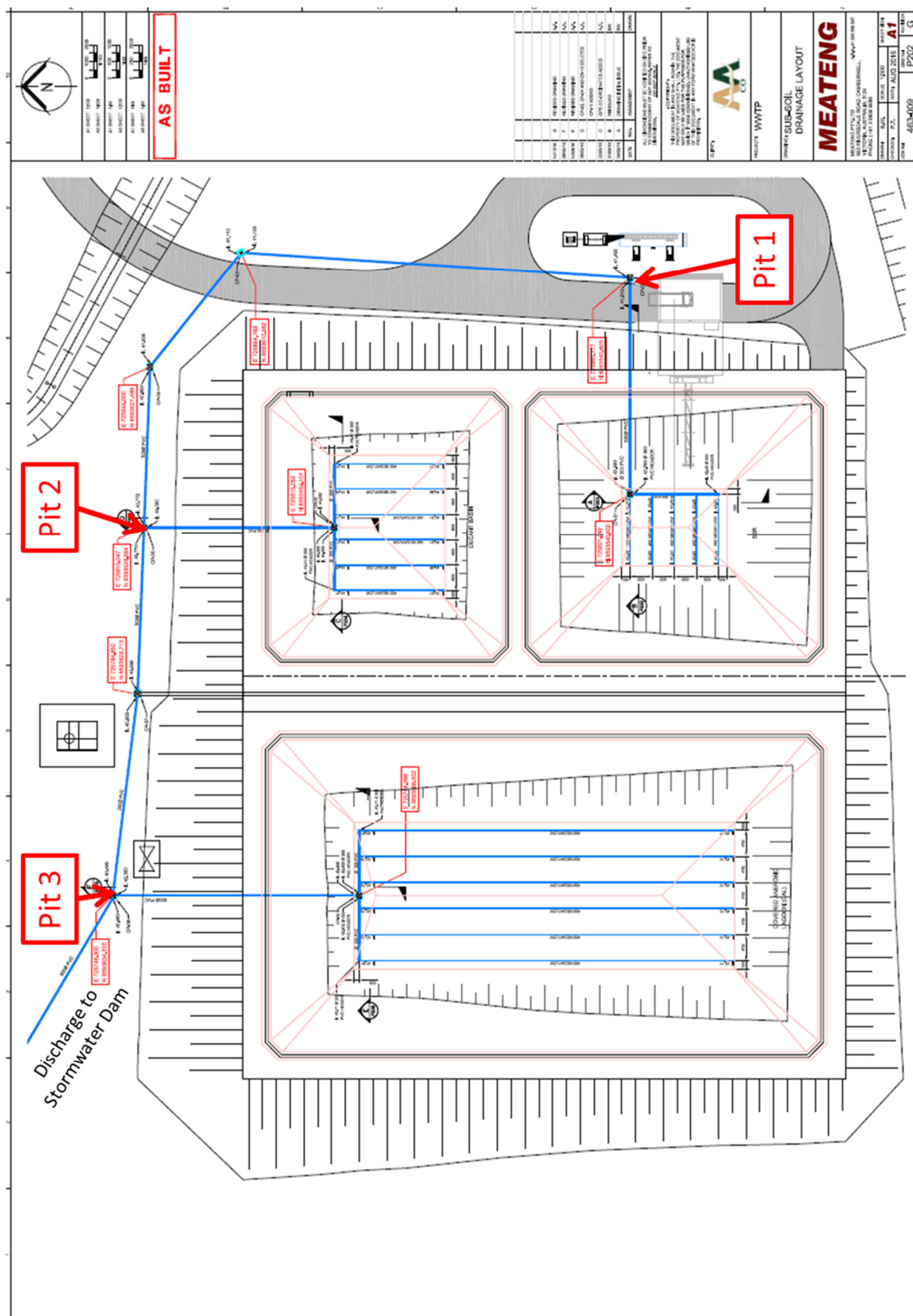
15.10 Odour Monitoring Sites



15.11 Wastewater Monitoring Sites



15.12 WWTP Subsurface Drainage Monitoring Sites



Appendix A Environment Protection License EPL219

Appendix B Risk Matrix and Risk Assessment

Appendix C Emergency Response Plan

Appendix D Control of Hazardous Substances Procedure

Appendix E Chemical Register

Appendix F MSDS File Locations

Appendix G Environmental Incident Register

Appendix H Process and Render Drawings

Appendix I WWTP Operating Manual

Appendix J Biogas Flare Operating Manual

Appendix K Biofilter Operations Manual

Appendix L Irrigation Management Procedures

Appendix M Surface Water Sampling Procedure

Appendix N Groundwater Sampling Procedure

Appendix O WWTP Subsurface Leak Detection Inspection and Monitoring Procedure

Appendix P Odour Monitoring Procedure

Appendix Q Environmental Improvements Register

Appendix R Monitoring and Audit Checklists

Appendix S Pest and Vermin Control Procedure

Appendix T Consultation and Communication Plan

Appendix U Non-compliance Notifications

Appendix V Weed Treatment Record

Appendix W First Flush Catchment Cleaning Procedures
