

Jet Zero™

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Jet Zero Water Management Study

Stormwater Management Plan

Jet Zero Australia Pty Ltd

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→ **The Power of Commitment**



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Abbreviations

Table 1 *List of abbreviations*

Abbreviation	Definition
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
ATJ	Alcohol-to-Jet
EY	Exceedances per Year
GPT	Gross Pollutant Trap
LPD	Lawful Point of Discharge
LTJ	LanzaJet Technology
MLPY	Million Litres per Year
OWS	Oily Water System
QUDM	Queensland Urban Drainage Manual
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
RD	Renewable Diesel
SAF	Sustainable Aviation Fuel
SSP	Shared Socioeconomic Pathway
T.EN	Technip Australia
TCC	Townsville City Council
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
DP	Development Permit
EA	Environmental Authority

1. Introduction

Jet Zero Australia (JZA) is proposing to construct Australia's first Alcohol to Jet (ATJ) fuel plant, known as Project Ulysses, in Queensland, Australia. This facility will convert ethanol feedstock into Sustainable Aviation Fuel (SAF) and Renewable Diesel (RD). The proposed plant will have the capacity to process 182 million litres per year (MLPY) of ethanol, achieving an output of approximately 102 MLPY of SAF (90 wt%) and 11 MLPY of RD (10 wt%). This project represents a strategic initiative aimed at reducing greenhouse gas emissions by developing a sustainable fuel alternative.

The facility's design is based on the proven technology and expertise of LanzaJet's Freedom Pines commercial demonstration plant in Georgia, USA, which is expected to commence operations in 2025. JZA has partnered with technology provider LanzaJet Technology (LJT) to deliver the inside battery limit (ISBL) scope of the ATJ facility, up to the basic engineering design phase.

Jet Zero Australian Pty Ltd have engaged GHD Pty Ltd (GHD) to undertake a water management study for the Ulysses Project, including the development of a conceptual Stormwater Management Plan (SMP) for the Ulysses Project site. GHD has previously prepared a Ulysses Water Management Study report (dated 9 April 2025) which identified and evaluated wastewater treatment options to support the facility's operations including consideration of stormwater management on the site considering the previous site boundary. This conceptual site-based stormwater management plan should be considered in the context of the Water Management Study report and presents an updated site boundary to the previous report.

1.1 Scope

The purpose of the Stormwater Management Plan is to:

1. Support a Development Permit (DP) application to Office of Coordinator General (OCG) and Townsville City Council (TCC)
2. Support an Environmental Authority (EA) application to Department of Environment, Tourism, Science, and Innovation (DETSI)
3. Provide a basis for how the stormwater will be managed on the ATJ facility site, that can be further assessed and refined during the FEED stage of the project.

The conceptual Stormwater Management Plan aligns with the requirements of the:

1. Department of Environment, Science and Innovation (State of QLD) (2014) Guideline, Stormwater and Environmentally Relevant Activities, ESR2015/1653, Version 1.06.
2. TCC City Plan (Planning Scheme) – Healthy waters code and Works code
3. State Planning Policy 04
4. Townsville State Development Area Development Scheme May 2019 (TSDA Development Scheme)
5. Queensland Government and TCC Climate Change policies and guidelines (guidelines followed listed in section 7)

GHD have developed this conceptual Stormwater Management Plan at the Pre-Front End Engineering Design (FEED) phase of the project for the ATJ facility site, based on the Conceptual Overall Plot Plan (dated 18/9/24) and Conceptual overall Plot Plan Preliminary Surface Finishes (dated 18/9/24) provided by T.EN. This plot plan was used as a basis to develop a conceptual stormwater layout for the site, nominate catchments and determine the size of the stormwater management system required. In addition, the proposed outlets were assessed to best match the natural points of discharge from the site.

1.2 Purpose of this report

The conceptual Stormwater Management Plan addresses the construction and operational phases of the proposed development covering the control of stormwater quantity and quality from the site to demonstrate that stormwater runoff from the site will not contain contaminants in excess of the water quality objectives specified in

the Environmental Protection (Water) Policy 2009 Ross River and Magnetic Island Environmental Values and Water Quality Objectives. This Plan would then inform the development of a FEED level SMP.

This report is intended to be used by Jet Zero for submission with the project approvals process.

1.3 Scope and limitations

This report: has been prepared by GHD for Jet Zero Australia Pty Ltd and may only be used and relied on by Jet Zero Australia Pty Ltd for the purpose agreed between GHD and Jet Zero Australia Pty Ltd as set out in this report.

GHD otherwise disclaims responsibility to any person other than Jet Zero Australia Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (in the relevant sections). GHD disclaims liability arising from any of the assumptions being incorrect.

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GHD has prepared the DRAINS and MUSIC Stormwater Models ("Model") for, and for the benefit and sole use of, Jet Zero Australia Pty Ltd to support an initial understanding of major flood event characteristic associated with the site and must not be used for any other purpose or by any other person.

The Model is a representation only and does not reflect reality in every aspect. The Model contains simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Model. Accordingly, the outputs of the Model cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data and assumptions ("Inputs") used as inputs into the Model are from publicly available sources or provided by or on behalf of the Jet Zero Australia Pty Ltd, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Model as further Inputs becomes available.

The Model is limited by the mathematical rules and assumptions that are set out in the Report or included in the Model and by the software environment in which the Model is developed.

The Model is a customised model and not intended to be amended in any form or extracted to other software for amending. Any change made to the Model, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Model including any outputs.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

2. Site description

2.1 Land use

The Project site is situated within the Townsville State Development Area (Townsville SDA) and is located approximately 8.4 kilometres (km) southeast of the Townsville CBD and 8 km south of Townsville Port and proposed to be located within lot 10 E124257 (see Figure 1). The Townsville SDA is a defined area of land dedicated for industrial development and occupies an area of 4,915 hectares (ha) – Figure 1.



Figure 1 Townsville State Development Area and Project site

The Townsville SDA supports the following existing facilities:

- Aurizon Stuart Intermodal Facility – 8 km north
- Aurizon locomotive and rolling stock maintenance facility – 8 km north
- Glencore Xstrata copper refinery – 2.2 km south
- JBS Australia abattoir – immediately south
- Origin Energy Mt Stuart peaking generator plant – 2.3 km south-west
- Pacific National rail freight terminal – 2.6 km south
- Sun Metals zinc refinery – 1.8 km south-east
- Sun Metals Zinc Refinery Solar Farm – 500m south-east

- Townsville City Council Stuart Landfill – 2 km south
- Townsville Correctional Facility – 3.6km south-west
- Stuart Industrial Area – 2.8 km south

The Project site has been previously cleared. The southern portion of the site is located within the High Impact Industrial Precinct whilst the northern portion of the site is located within the Environmental Management Precinct of the Townsville SDA as shown in Figure 2.

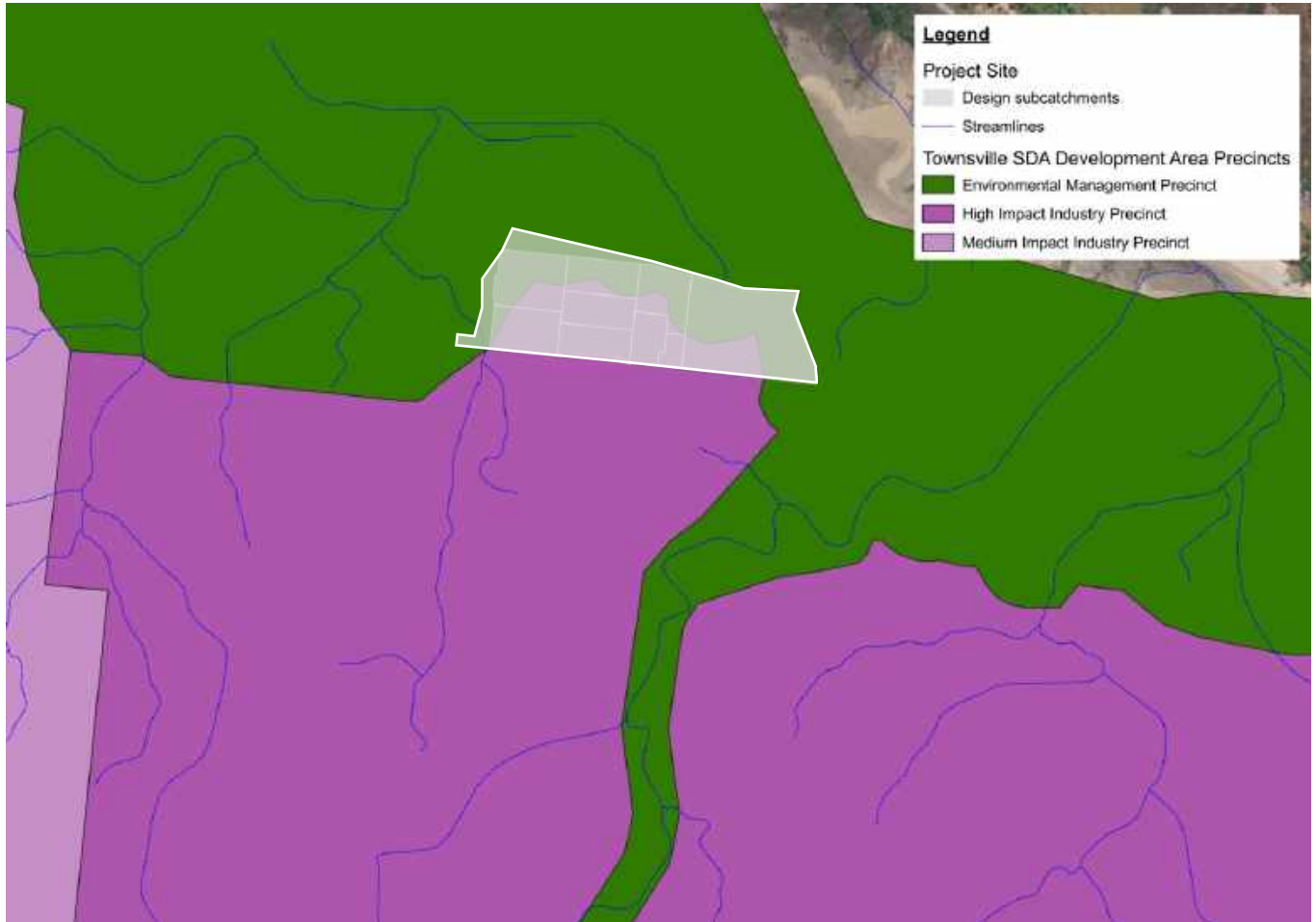


Figure 2 Project Site in the Context of Townsville SDA Precincts

The site is bounded by JBS Australia Abattoir to the south and the tidal flats associated with Sandfly Creek immediately to the north.

2.2 Topography

The Project site is located at an elevation of between 3 m and 4 m (AHD) and slopes gently to the north towards the tidal areas of Sandfly Creek.

2.3 Geology and soils

The surface geology of the site comprises recent Pleistocene alluvium and comprises coarse, medium to fine-textured (gravel-sand-clay) paleo-estuarine deposits.

The site is not listed on the Environmental Management Register or the Contaminated Land Register.

2.3.1 Acid Sulphate soils

The northern portion of the Project site is located within an area mapped as potential acid sulphate soils 0 – 5 m AHD whilst the southern section is located within an area mapped as potential acid sulphate soils 5 – 20 m AHD in Figure 9.2 of the TCC Planning Scheme – Healthy waters code – See Figure 3.

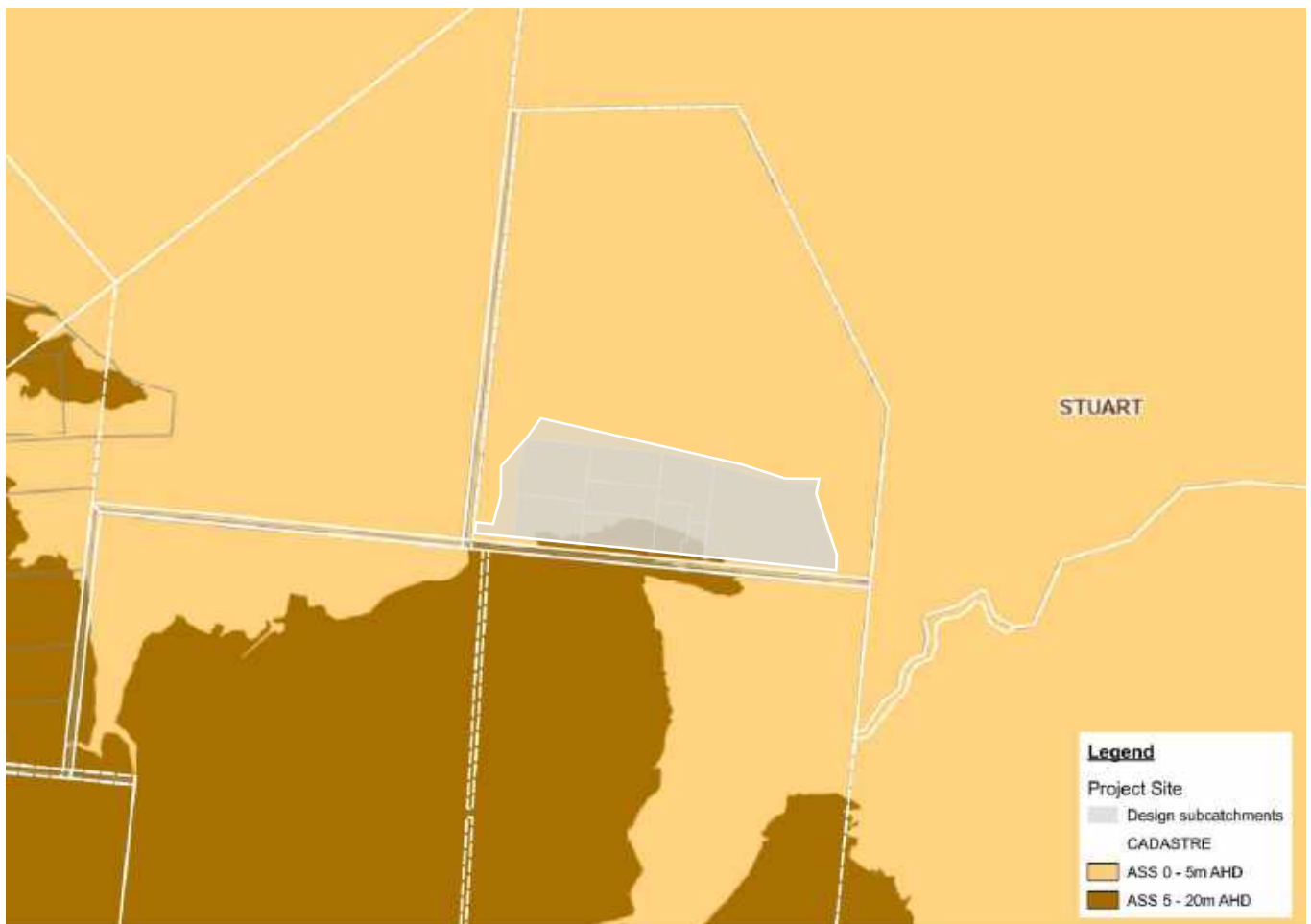


Figure 3 Project site acid sulphate soils mapping (Figure 9.2 TCC Planning Scheme – Healthy waters code)

2.4 Climate

The climate at the Project site has a tropical climate that is dominated by two distinct seasons; the wet season (November to April) and the dry season (May to October). Mean monthly rainfall and minimum and maximum temperatures are shown in Figure 4.

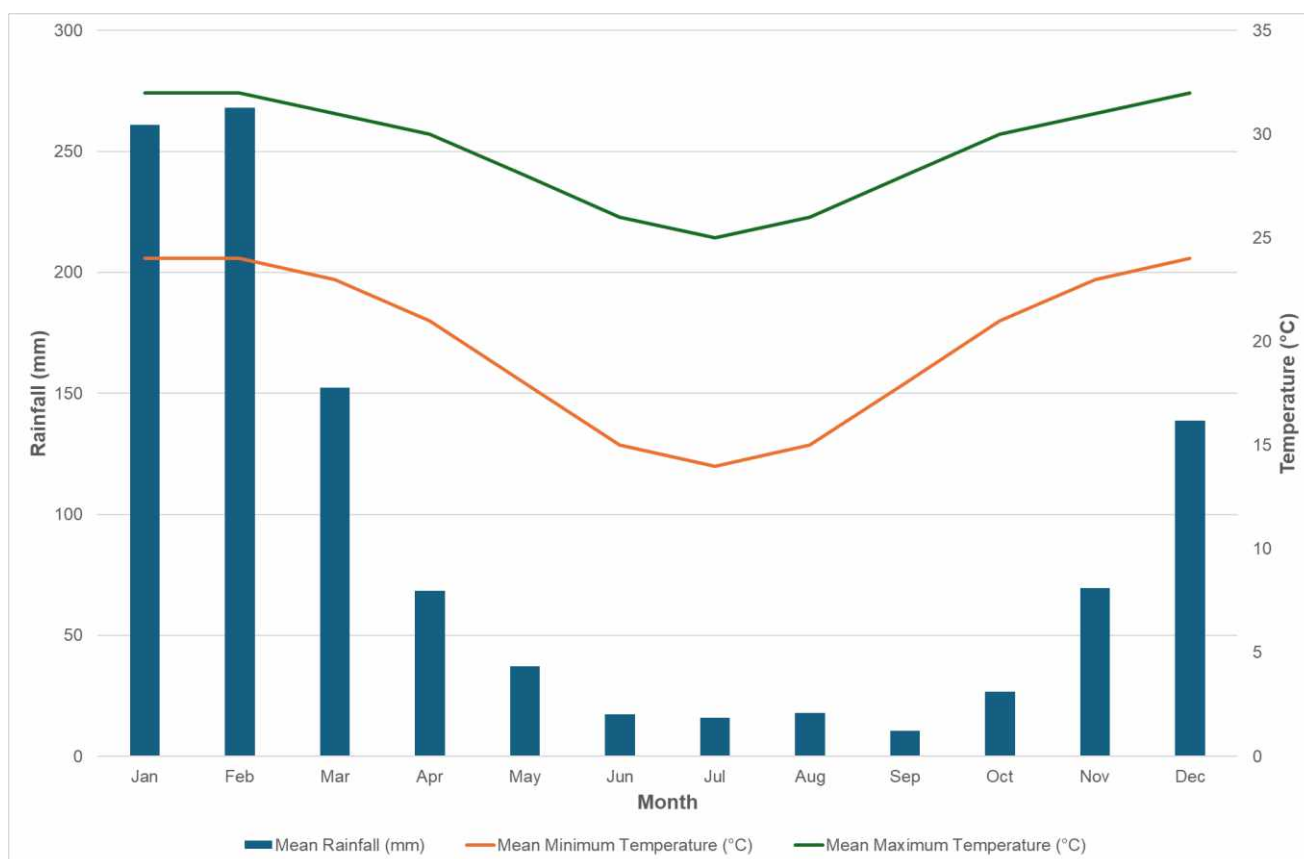


Figure 4 Mean monthly rainfall and temperature data

The summer months are hot and humid with “build-up” thunderstorms starting in late October or early November. Bursts of monsoon rain occur from late December until early April and this is also the season when Tropical Cyclones can threaten the region. Severe tropical cyclones are rare, effecting Townsville on average once in every twenty years.

The average annual rainfall is 1,143 millimetres (mm) on an average 91 rain days, most of which falls in the six-month wet season. Due to the “hit and miss” nature of tropical lows and thunderstorms there is considerable variation in rainfall totals from year to year.

2.5 Matters of National Environmental Significance

A search of the Department of Climate Change, Energy the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) identified Bowling Green Bay, which is a Ramsar Wetland is located within 10 km of the Project Site. Bowling Green Bay is approximately 7.8 km east of the Project site and 3.1 km south of the mouth of Sandfly Creek. Bowling Green Bay is located within the Great Barrier Reef World Heritage Area.

2.6 Wetlands

2.6.1 Directory of Important Wetlands

The Directory of Important Wetlands in Australia (DIWA) wetland Burdekin – Townsville Coastal Aggregation bounds the northern, eastern and western extent of the Project site with approximately 1.1 ha of the northern extent of the site mapped as being part of the wetland.

2.6.2 High Ecological Significance (HES) and High Ecological Value (HEV) Wetlands

HES mapping data shows that there are five Great Barrier Reef (GBR) HES wetlands within 2 km of the site. These wetlands are classified as ephemeral palustrine wetlands by DETSI Wetland Mapping (Version 6) and the dominant wetland habitat described as follows:

- Three coastal and sub-coastal non-floodplain tree (*Melaleuca* and *Eucalypt*) swamps
 - Regional ecosystem 11.2.5b (least concern), which consists of an open forest of *Melaleuca dealbata* (sometimes *M. leucadendra* or *M. viridiflora*), *Livistona drudei* or *L. decora* with shrubs of *Pandanus spiralis*.
- Two coastal and sub-coastal floodplain tree (*Melaleuca* and *Eucalypt*) swamps
 - Regional ecosystem 11.3.12a (least concern), which consists of *Melaleuca viridiflora*, *M. argentea* +/- *M. dealbata* woodland on alluvial plains
 - Regional ecosystem 11.3.27e (least concern) which consists of a freshwater wetland with vegetation ranges from open water +/- aquatics sometimes with fringing trees and shrubs

No GBR HES or HEV wetlands are located within the Project site. The nearest HEV wetland is located approximately 2 km north of the site

2.7 Hydrology

The Project site is located within the lower reaches of the Sandfly Creek subcatchment of the Ross River catchment. The upper reaches of Sandfly Creek are located approximately 5 km to the south of the Project Site. Sandfly Creek flows in a northerly direction before discharging into Cleveland Bay which is part of the Great Barrier Reef World Heritage Area and Marine Park and includes a Dugong Conservation Area.

The Project site is undeveloped and situated on a locally raised topographical feature in a tidally influenced floodplain.

The immediate receiving environment of the site includes the upper tidal limits of Sandfly Creek, which is classified as estuarine waters (WQ1181 – Ross River Basin). The natural drainage from the site enters the Sandfly Creek catchment via a stream order 2 waterway, which is located to the west of the site and stream order 1 waterway, which is located north of the site. Due to its proximity to the ocean and the very flat grades associated with the floodplain, draining and egress of floodwater is expected to be slower than a typical riverine environment.

2.8 Existing water quality

2.8.1 Environmental Values and water quality objectives

Environmental Values (EVs) and water quality objectives for the Project Site are specified in EPP (Water) 2009 Ross River and Magnetic Island Environmental Values and Water Quality Objectives. EVs for Sandfly Creek at the Project site and downstream are provided in Table 2.

Table 2 Environmental Values for Sandfly Creek

Environmental Value	TSDA Waters	Sandfly Creek Estuarine Waters (Outside TSDA)
Aquatic Ecosystems	✓	✓
Irrigation	✓	×
Farm Supply/Use	×	×
Stock Water	✓	×
Aquaculture	×	×
Human Consumer	×	✓

Environmental Value	TSDA Waters	Sandfly Creek Estuarine Waters (Outside TSDA)
Primary Recreation	x	x
Secondary Recreation	x	✓
Visual Recreation	✓	✓
Drinking Water	x	x
Industrial Use	✓	x
Cultural and Spiritual Values	✓	✓

Water Quality Objectives for the receiving environment are provided in Table 3.

Table 3 Water Quality Objectives (Short Term Tigger Values (SSTV))

Parameter	Unit	TSDA Waters SSTV (Lowland Freshwaters)	TSDA Waters SSTV (Estuarine)	Guideline Sandfly Creek Estuarine Waters (Outside TSDA) SSTV
Physio Chemical				
pH		6.5 – 8.0	7.0 – 8.4	7.0 – 8.4
Dissolved Oxygen	%	85 - 110	85 - 100	85 - 100
Electrical Conductivity	µS/cm	660 (75 th percentile)		
Temperature	°C	nd	nd	nd
Turbidity	NTU	< 22	< 20	< 20
Nutrients				
Ammonia N	µg/L	20 (DO >80% sat) 30 (DO 40 - 80% sat) 60 (DO < 40% sat)	10	30
Organic N	µg/L	420	260	260
Oxidised N	µg/L	60	10	40
Dissolved Inorganic N	µg/L	80	20	20
Total N	µg/L	630	300	500
Filterable Reactive Phosphorus	µg/L	20	8	10
Total P	µg/L	50	25	50
Suspended solids	mg/L	10 mg/L	20 mg/L	20 mg/L
pH	µg/L	6.5 – 8.0	7.0 – 8.4	7.0 – 8.4
Metals				
Aluminium (pH >6.5)	µg/L	55	-	-
Arsenic (AsIII)	µg/L	24	-	-
Boron	µg/L	370	-	-
Cadmium	µg/L	0.2	5.5	5.5
Chromium	µg/L	1.0	4.4	4.4
Cobalt	µg/L	-	1	1
Copper	µg/L	1.4	1.3	1.3
Lead	µg/L	3.4	4.4	4.4
Mercury (inorganic)	µg/L	0.6	0.4	0.4

Parameter	Unit	TSDA Waters SSTV (Lowland Freshwaters)	TSDA Waters SSTV (Estuarine)	Guideline Sandfly Creek Estuarine Waters (Outside TSDA) SSTV
Nickel	µg/L	11	70	70
Zinc	µg/L	8	8	8

2.8.2 Receiving Water Quality

A baseline water quality monitoring program was developed for the Project by Terra Solutions (Surface Water Quality Impact Assessment Jet Zero Refinery Facility Terra Solutions 12 February 2025) to characterise the baseline water quality conditions prior to commencement of construction and operational activities for the Project. As part of the baseline monitoring program 12 samples were collected from freshwater sites and 11 samples were collected from estuarine sites between October 2024 and January 2025. Summary water quality results are provided in Table 4.

Table 4 Existing water quality summary

Parameter	Freshwater	Estuarine
Physio-Chemical		
pH	pH was within the TSDA Lowland Freshwater SSTV Range in 55% of samples collected (range 6.79 – 7.82). The remaining samples were below the pH range	pH was within the TSDA and Sandfly Creek Estuarine SSTV range in 89% of samples collected (range 7.09 to 8.32). The remaining sample collected was below the objective range
DO	92% of samples collected were outside the TSDA Lowland Freshwater SSTV range (range 1.4 to – 53.1% and 124.6 to 135.8%).	All samples were outside the TSDA and Sandfly Creek SSTV Estuarine water quality objective range (59.4 – 83.85% and 132.9 – 182.40%).
Turbidity	80% of samples collected complied with the SSTV (range 3.3 – 16 NTU). Two samples exceeded the SSTV	67% of samples exceeded the estuarine SSTV (range 25 – 120 NTU)
Suspended Solids	50% of samples exceeded the SSTV (range 14 – 630 mg/L)	All samples exceeded the SSTV (range 47 – 170 mg/L)
Electrical Conductivity	All samples exceeded the lowland freshwater SSTV (range 830 – 32,000 µS/cm)	EC for all estuarine samples ranged from 28,000 – 93,000 µS/cm.
Nutrients		
Ammonia N	83% of samples exceeded the lowland freshwater SSTV (range 0.085 – 78 mg/L)	82% of samples exceeded the estuarine SSTV (range 0.018 – 0.27 mg/L)
Organic N	All samples exceeded the lowland freshwater SSTV (range 0.86 – 15 mg/L)	All samples exceeded the estuarine SSTV (range 0.33 – 1.6 mg/L)
Total Oxidised N	83% of samples complied with the lowland freshwater SSTV (range <0.005 – 0.026 mg/L). The remaining samples exceeded the SSTV (range (0.06 – 0.087 mg/L)	55% of samples complied with the estuarine SSTV (range <0.05 – 0.01 mg/L). The remaining samples exceeded the SSTV (range (0.06 – 0.067 mg/L)
Total N	All samples exceeded the SSTV (range 1.1 – 52 mg/L)	All samples exceeded the SSTV (range 0.45 – 2 mg/L)
Total P	All samples exceeded the SSTV (range 0.2 – 18 mg/L)	All samples exceeded the SSTV (range 0.08 – 0.67 mg/L)
Filterable Reactive Phosphorus	All samples exceeded the SSTV (range 0.026 – 20 mg/L)	All samples exceeded the SSTV (range 0.013 – 0.51 mg/L)
Metals		
Total Metals	Total arsenic concentrations exceeded the SSTV in 33% of samples (range 0.024 – 0.15 mg/L)	Total cadmium concentrations were below the SSTV in all samples Total chromium concentrations exceeded the SSTV in 45% of samples (0.009 – 0.019 mg/L)

Parameter	Freshwater	Estuarine
	Total cadmium concentrations exceeded the SSTV in 42% of samples (range 0.0003 – 0.0028 mg/L) Total copper concentrations exceeded the SSTV in all samples (0.003 – 0.64 mg/L) Total lead was not detected in the majority of samples Total mercury concentrations were below the SSTV in all samples Total nickel concentrations exceeded the SSTV in 58% of samples (range 0.012 – 0.93 mg/L) Total zinc concentrations were exceeded in 50% of samples (range 0.013 – 0.11 mg/L)	Total cobalt concentrations exceeded the SSTV in 89% of samples (0.002 – 0.005 mg/L) Total copper concentrations exceeded the SSTV in 91% of samples (0.003 – 0.021 mg/L) Total lead concentrations were below the SSTV in all samples Total mercury concentrations were below the SSTV in all samples Total nickel concentrations were below the SSTV in all samples Total zinc concentrations exceeded the SSTV in 88% of samples (range 0.011 – 0.074 mg/L)
Dissolved Metals	Dissolved arsenic concentrations were below the SSTV in 83% of samples. Two samples exceeded the SSTV (0.13 & 0.32 mg/L) Dissolved cadmium concentrations were below the SSTV in 83% of samples. Two samples exceeded the SSTV (0.0028 & 0.0003 mg/L) Dissolved copper concentrations exceeded the SSTV in 83% of samples (range 0.005 – 0.52 mg/L) Dissolved lead was detected in one sample and was below the SSTV Dissolved mercury concentrations were below the SSTV in all samples Dissolved nickel concentrations exceeded the SSTV in 42% of samples (range 0.016 – 0.67 mg/L) Dissolved zinc concentrations exceeded the SSTV in 75% of samples (range 0.011 – 0.063 mg/L)	Dissolved cadmium concentrations were below the SSTV in all samples Dissolved chromium concentrations exceeded the SSTV in 45% of samples (0.008 – 0.014 mg/L) Dissolved cobalt concentrations exceeded the SSTV in 44% of samples (0.002 – 0.003 mg/L) Dissolved copper concentrations exceeded the SSTV in all samples (0.003 – 0.019 mg/L) Dissolved lead concentrations were below the SSTV in all samples Dissolved mercury concentrations were below the SSTV in all samples Dissolved nickel concentrations were below the SSTV in all samples Dissolved zinc concentrations were below the SSTV in 90% of samples. One sample exceeded the SSTV (0.011 mg/L)
Alcohols		
Alcohols	Alcohol concentrations did not exceed the LOR at any site	
Volatile Organic Compounds (VOCs)		
VOC	VOC concentrations only exceeded the LOR on one occasion. A concentration of 17 µg/L was detected at the monitoring site immediately upstream of the Project site	VOC concentrations did not exceed the LOR in any estuarine samples
Polycyclic Aromatic Hydrocarbons (PAH)		
PAH	PAH concentrations only exceeded the LOR on one occasion. A concentration of 0.1 µg/L was detected for 1-Methylnapthalene and 2-Methylnapthalene was recorded at the monitoring site immediately upstream of the Project site	PAH concentrations did not exceed the LOR in any estuarine samples
BTEX		
BTEX	BTEX concentrations only exceeded the LOR on one occasion. A concentration of 17 µg/L was detected at the monitoring site immediately upstream of the Project site	BTEX concentrations did not exceed the LOR in any estuarine samples
Total Petroleum Hydrocarbons		
C6 – C10	C6- C10 fraction concentrations were below the LOR in all samples	

Parameter	Freshwater	Estuarine
C10 – C16	C6- C10 fraction concentrations exceeded the LOR in two samples (150 – 340 µg/L)	C10- C16 fraction concentrations were below the LOR in all samples
C16 – C34	C16- C34 fraction concentrations exceeded the LOR in two samples (220 – 1300 µg/L)	C16- C34 fraction concentrations were below the LOR in all samples
C34 – C40	C34-C40 fraction concentrations were below the LOR in all samples	
Perflouroalkyl substance (PFAS)		
PFAS	Perfluorobutanesulfonate was detected in all samples however concentrations were below National Environmental Management (HEPA 2000) guidelines All other PFAS substances were below the LOR	Perfluorobutanesulfonate was detected at one sampling site on three separate occasions. Detected concentrations were below the National Environmental Management (HEPA 2000) guidelines All other PFAS substances were below the LOR

3. Description of the project

The proposed Project involves the construction of a proposed ATJ biorefinery, which has a capacity of 102 ML/yr of Sustainable Aviation Fuel (SAF) and 11 ML/yr of Renewable Diesel (RD) based on 333 operating days per year. The proposed development layout is show in Figure 5.

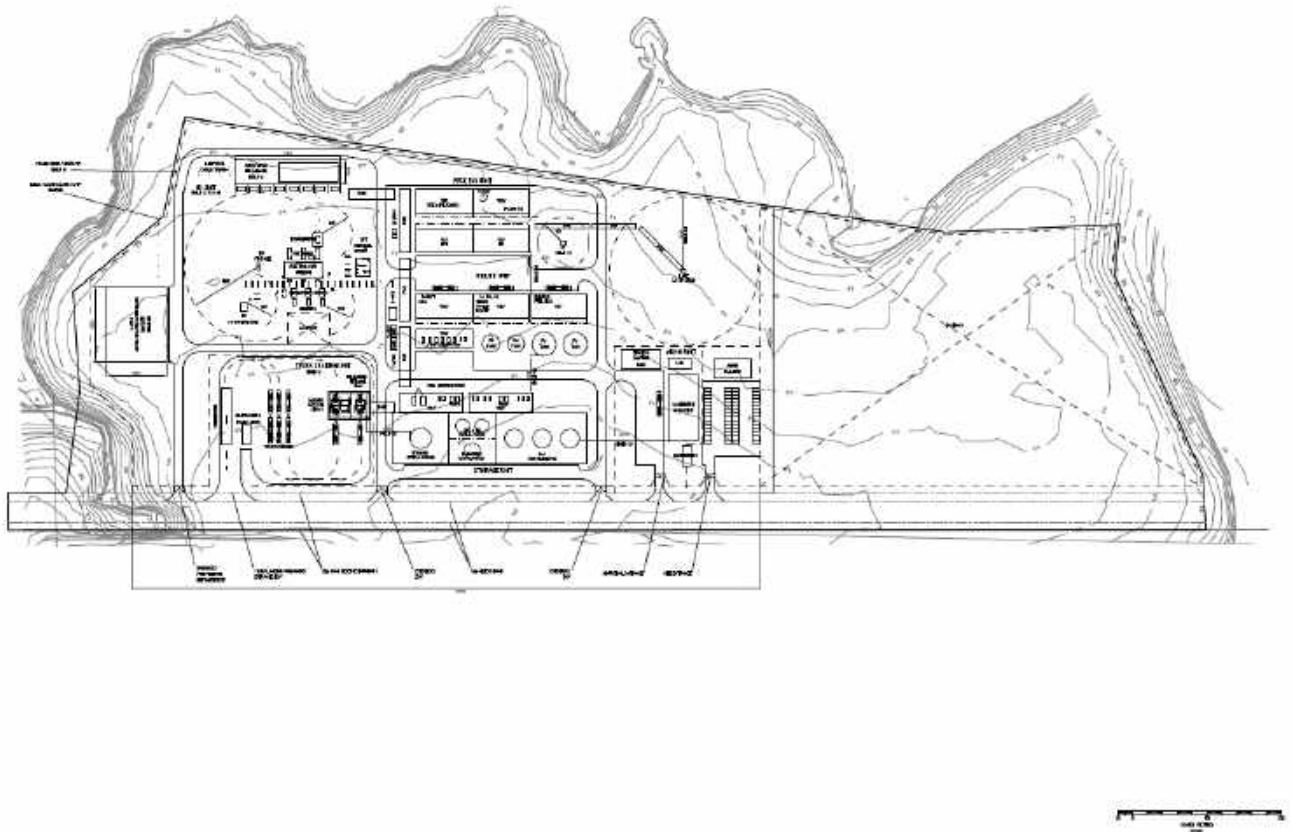


Figure 5 *Proposed development layout*

The biorefinery comprises the following plant areas:

- Tank farm & loading/unloading gantry
- Hydrogen generation
- ATJ plant (ISBL)
- Fire Protection
- Services/Utilities.

A snapshot of the total plant inputs and outputs is provided in Table 5.

Table 5 *Snapshot of plant*

Total Plant	Quantity	Units
Sustainable Aviation Fuel (SAF)	306	m ³ /day
Renewable Diesel (RD)	33	m ³ /day
Ethanol Consumption	550	m ³ /day
Hydrogen Consumption	3.2	T/day
Steam Consumption	784	T/day

Total Plant	Quantity	Units
ISBL Power Consumption	3	MW
OSBL Power Consumption	32	MW
Total Water Consumption	1,356	m ³ /day
Operating Hours	8,000	hr/annum
Operation	24	Hours/day
Operating Days	333	Days/year

3.1 ATJ Plant (ISBL)

LanzaJet has developed a proprietary Alcohol-to-Jet conversion process to enable the production of sustainable aviation fuel. The conversion consists of the following steps: dehydration, oligomerisation, hydrogenation, and fractionation. The plant main outputs are SAF and RD with two operating modes, “max jet”, which maximises the production of SAF at a ratio of 90% SAF/10% RD, or “max diesel” mode for 75% RD/25% SAF.

3.2 Balance of Plant (OSBL)

3.2.1 Tank farm and loading/unloading gantry

The tank farm is responsible for storing and distributing various products including RD, SAF and ethanol. The tank farm generally consists of storage tanks, containment bunds, pump bays, product piping, fire protection system, utilities piping and other ancillary items such as dewatering tanks.

The tank farm can be subdivided into the following sections and products:

- Flammables Bund
 - Ethanol
 - SAF
- Combustibles Bund
 - Renewable Diesel
- Intermediates Bund
 - Hydrogenation off spec
 - Oli1/Loi2 off spec
- Chemicals Bund
 - Dilute Caustic Solution
 - Neutralization Tank
 - Concentrated chemicals IBCs (Caustic & Sulphuric)
- Optional Flammables Bund
 - Ethanol
 - SAF

The total tank farm storage capacity is provided in Table 6.

Table 6 Tank farm storage quantities

Total Plant	Storage Capacity (m ³)
Flammables Bund	14,000
Combustible Bund	500
Intermediates Bund	2,100
Chemicals Bund	226

Total Plant	Storage Capacity (m³)
Optional Flammables Bund	28,350

Optional flammable bund tanks would be filled/discharged via optional import/export pipeline directly to the port.

3.2.2 Hydrogen generation

The hydrogen generation area is responsible for producing green hydrogen to supply the plant with a hydrogen stream (>99%). This is primarily utilised to saturate oligomerates derived from the ATJ oligomerization section. The hydrogen generation area includes alkaline electrolyzers, hydrogen compressors, and containerised hydrogen bulk storage.

The electrolyzers receive a steady stream of water from the biorefinery potable water supply. The electrolyser units are inclusive of a reverse osmosis treatment skid to ensure suitable water supply quality to the stacks. The modular package includes full balance of plant including cooling. The only external requirements are water, power and nitrogen to produce hydrogen and oxygen from the container unit.

3.2.3 Fire protection system

The fire protection system is designed to ensure the safety of personnel and assets, as well as to comply with applicable regulatory requirements and standards. The fire protection system primarily consists of fire water tanks, fire pump shed, and a foam deluge system providing fire protection via hydrants, monitors and fixed system. These components will be strategically located and reticulated throughout the site to provide adequate fire protection for the biorefinery.

3.2.4 Services/utilities

3.2.4.1 Utilities

The utilities block contains the following key utilities and their associated processes:

- Steam Generation
- Cooling Water System
- Compressed Air Systems
- Nitrogen Storage and distribution
- Thermal Oxidiser
- Wastewater Treatment Plant (WWTP)
- Demineralised water skid
- Miscellaneous water storage
- Fuel gas and LPG storage and distribution systems
- Slops Storage (light and heavy hydrocarbon waste streams produced during the processing of ethanol). The slops will be periodically trucked offsite for disposal

3.2.4.2 Flare system

The refinery requires a flare system to combust excess or waste gases that cannot be utilised in other processes. The flare system consists of three flare tips, low pressure, high pressure and cold flare tips. The flare system is intended to operate under normal plant conditions, as well as during pressure relief scenarios, PSV release, and depressurisation events.

3.2.4.3 Power supply, instrumentation and communication

The power supply section consists of the following key components:

- Transformers
- Switchyard

- Switch Rooms
- Switchboards
- Emergency power supply.

The communication and instrumentation system consists of the following key components:

- Communication network
- Instrumentation and Controls Systems
- Distributed Control System (DCS)
- Control Room.

3.2.4.4 Administration and services block

The administration block includes the site office, laboratory and warehouse/maintenance workshop facilities. The site office serves as the administrative hub and provides essential support for the site's operations. The laboratory serves as a critical facility for testing and analysis, supporting process control and quality assurance. The warehouse/maintenance workshop provides storage, inventory management and maintenance support for plant equipment and supplies.

The balance of plant items also includes paved road access to key areas of the plant, stormwater drainage, security fences, sanitary sewage reticulation and disposal.

4. Stormwater planning framework

4.1 State Planning Policy 2017

The *State Planning Policy 2017* (SPP) 7 ensures that the State's interests in planning are protected and delivered as part of local government planning across Queensland. In relation to stormwater management, the SPP aims to protect and enhance the environmental values and quality of Queensland waters. The SPP specifies stormwater management design objectives for construction and post-construction phase development. The SPP design objectives for construction phase are provided in Table 7, Table 8 and Table 9 and for the operational phase is provided in Table 10.

Table 7 Part 1 Construction phase stormwater management design objectives

Issue	Design Outcomes
Drainage Control	– Manage stormwater flows around and through areas or exposed soil to avoid contamination. – Manage sheet flows in order to avoid or minimise the generation of rill or gully erosion. – Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works. – Provide emergency spillways for sediment basins to achieve the construction phase design objectives for emergency spillways on temporary sediment basins.
Erosion Control	– Stage clearing and construction works to minimise the area of exposed soil at any one time. – Effectively cover or stabilise exposed soils to predicted rainfall. – Prior to completion of works for the development, and prior to removal of sediment controls, all site surfaces must be effectively stabilised using methods which will achieve effective short-term stabilisation.
Sediment Control	– Direct runoff from exposed site soils to sediment controls that are appropriate to the extent of disturbance and level of erosion risk. – All exposed areas greater than 2500 m² must be provided with sediment controls, which are designed, implemented and maintained to a standard that could achieve at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrological effectiveness) to 50 mg/L Total Suspended Solids (TSS) or less, and pH in the range (6.5 – 8.5).
Litter, hydrocarbons and other contaminants	– Remove gross pollutants and litter. – Avoid the release of oil or visible sheen to released waters. – Dispose of waste containing contaminants at authorised facilities.
Waterway stability and flood flow management	– Where measures are required to meet post-construction waterway stability objectives there are either installed prior to land disturbance and are integrated into with erosion and sediment controls, or equivalent alternative measures and implemented during construction. – Earthworks and the implementation of erosion and sediment controls are undertaken in ways which ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 1 in 100 years ARI (1% AEP).

Table 8 Part 2 Construction phase design objectives for temporary drainage works

Temporary Drainage Works	Anticipated operation design life and minimum design storm event		
	<12 months	12 – 24 months	> 24 months
Drainage Structure	1 in 2 year ARI / 39% AEP	1 in 5 year ARI / 18% AEP	1 in 10 year ARI / 10% AEP
Where located immediately up-slope of an occupied property that would be adversely affected by the failure or overtopping of the structure	1 in 10 year ARI / 10% AEP		
Culvert crossing	1 in 10 year ARI / 10% AEP		

Table 9 *Part 3 – Construction phase stormwater management design objectives for emergency spillways on temporary sediment basins*

Drainage Structure	Anticipated operation design life and minimum design storm event		
	<3 months	3 – 12 months	> 12 months
Emergency spillways on temporary sediment basins	1 in 10 year ARI / 10% AEP	1 in 20 year ARI / 5% AEP	1 in 50 year ARI / 2% AEP

Table 10 *Post-construction phase stormwater management design objectives*

Climatic Region	Design Objectives Reductions in mean annual load from unmitigated development (%)			
	Total suspended solids (TSS)	Total phosphorus (TP)	Total nitrogen (TN)	Gross Pollutants > 5mm
Wet tropics and dry tropics	80	60	40	90

4.2 State Development Assessment Provision (SDAP) State code 8 – Coastal development and tidal works

State code 8 is a Queensland SDAP that relates to coastal development and tidal works. The document specifies performance outcomes (PO) to protect erosion prone areas. Relevant POs to the Project site are listed below:

- PO2 – Development in the erosion prone area (1) does not adversely impact coastal processes; and (2) ensures that the protective function of landforms and vegetation is protected
 - The access handle and northern extent of the development site is located within mapped erosion prone areas (Figure 6)
- PO5 – Development in the erosion prone area does not directly or indirectly increase the severity of coastal erosion either on or off site
- PO13 – Development maintains or enhances environmental values of receiving waters; achieves the water quality objectives of Queensland waters
- PO17 – Development is designed and sited to avoid impacts on MSES.
 - The Project site has been previously cleared of vegetation

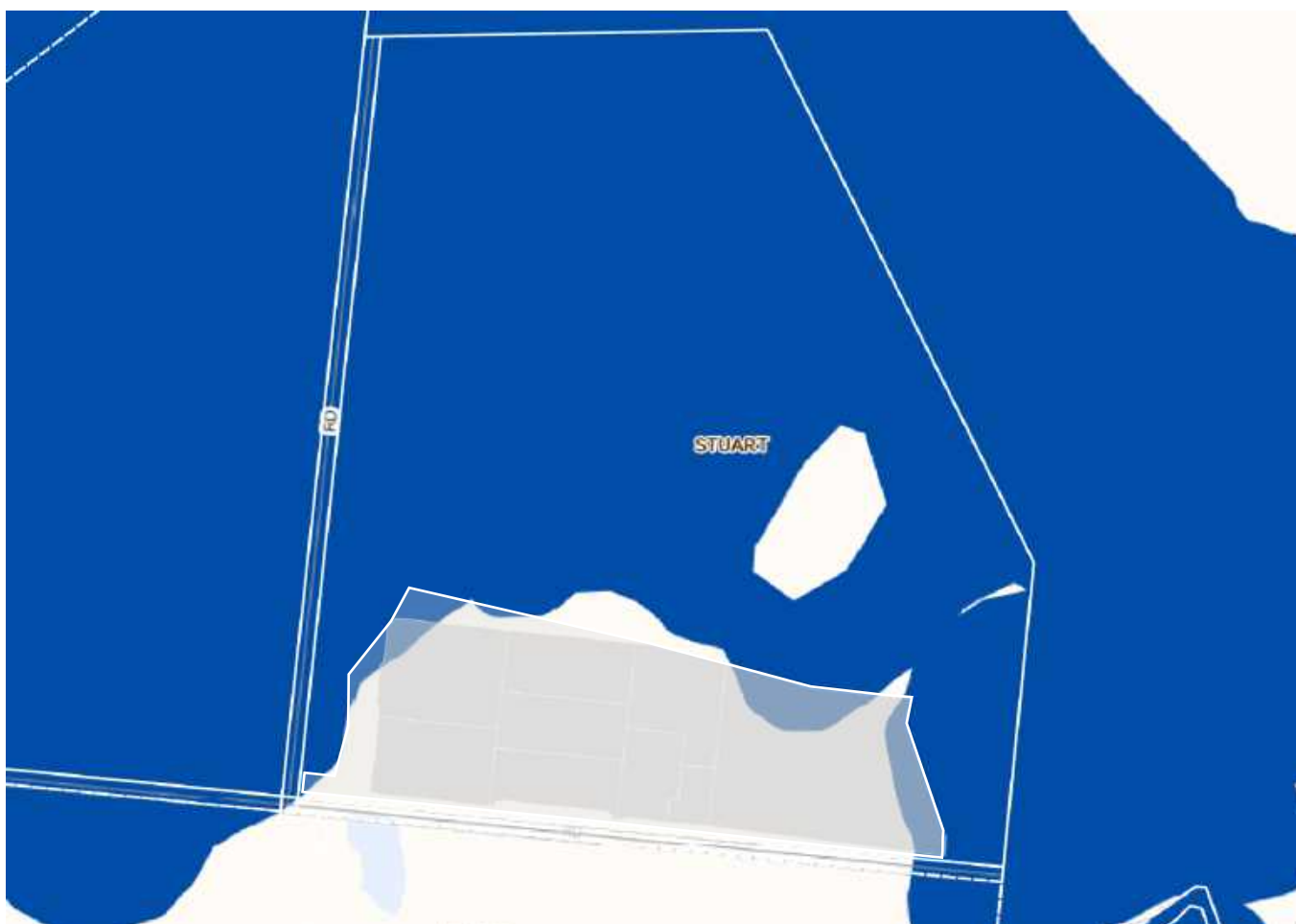


Figure 6 Erosion prone areas in proximity to the project site

4.3 Townsville Development Scheme 2019

The Townsville Development Scheme contains a development assessment framework and processes for making, assessing and deciding an SDA application. Engineering and design standards applicable to stormwater management are including in Table 8 of Section 2.5.8 Engineering and design standards and re-produced in Table 11 of this report.

Table 11 Relevant engineering and design standards for stormwater management

Issue	Engineering and Design Standard
Soil erosion	International Erosion Control Association (IECA) – Best Practice Erosion and Sediment Control
Stormwater Quality	Water sensitive urban design: Design objectives for urban stormwater management Construction and Establishment Guidelines, Swales, Bioretention Systems and Wetlands. Concept Design Guidelines for Water Sensitive Urban Design Standard Drawings for Water Sensitive Urban Design Table B (Appendix 2) of the State Planning Policy 2017 Environmental Protection (Water) Policy 2009 (Townsville Region) Water Quality Guidelines for the Great Barrier Reef Marine Park (2010)
Stormwater Quantity	Queensland Urban Drainage Manual Australian Rainfall and Runoff (ARR) – where referenced by QUDM

4.4 Townsville City Plan – Health waters code

The purpose of the Healthy waters code is to ensure development manages stormwater and wastewater as part of the integrated total water cycle and in ways that help protect the environmental values specified in the Environmental Protection (Water) Policy 2009. The purpose of the code is achieved through the following overall outcomes relating to stormwater:

- a. Environmental values of receiving water are protected from adverse development impacts arising from altered stormwater quality and altered stormwater flow.
- b. Stormwater is designed to maintain or recreate natural hydrological processes and minimise runoff.
- c. Well-designed developments are responsive to receiving water quality.

The Healthy waters code specifies assessment benchmarks for stormwater. These benchmarks are provided in Table 12.

4.5 Townsville City Plan – Works code

The purpose of the Works code is to ensure development is provided with a level of infrastructure, which maintains or enhances community health, safety and amenity and which avoids or minimises impacts to the natural environment.

Table 12 Healthy waters code assessment benchmarks for stormwater

Performance Outcomes	Acceptable Outcomes
Stormwater Management – protecting water quality	
PO1 Development contributes to the protection of environmental values and water quality objectives of receiving waters to the extent practicable	No acceptable outcome is nominated
PO2 High environmental value waters and slightly disturbed waters are protected from the impacts of development within their catchments. Existing water quality habitat and biota values, flow regimes and riparian areas are maintained and enhanced	No acceptable outcome is nominated
PO3 The entry of contaminants into, and transport of contaminants in, stormwater in avoided or minimised	No acceptable outcome is nominated
PO4 Within areas identified as potential acid sulphate soils, the generation or release of acid and metal contaminants into the environment from acid sulphate soils is avoided by: a. Not disturbing acid sulphate soils when excavating or otherwise removing soil or sediment, draining or extracting groundwater, excluding tidal water or filling land; or b. Where disturbance of acid sulphate soils cannot be avoided, development: i. Neutralises existing acidity and prevents generation of acid and metal contaminants; and ii. Prevents the release of surface or groundwater flows containing acid and metal contaminants to the environment	AO4.1 Development does not: a. Involve excavating or removing 100m³ or more of soil and sediment at or below 5m AHD b. Permanently or temporarily drain or extract groundwater or exclude tidal water resulting in the aeration of previously saturate acid sulphate soils; or c. Involve filling with 500m³ or more with an average depth of 0.5m or greater that results in: i. Actual acid sulphate soils being moved below the water table; or ii. Previously saturated acid sulphate soils being aerated OR AO4.2 Development manages waters so that: a. All disturbed acid sulphate soils are adequately treated and/or managed so that they can no longer release acid or heavy metals; b. The pH of all site water, including discharges and seepage to groundwater, is maintained between 6.5 and 8.5; c. Waters on the site, including discharges and seepage to groundwater, do not contain elevated levels of soluble metals; d. There are no visible iron stains, flocs or scums in discharge water;

Performance Outcomes	Acceptable Outcomes
	e. All reasonable preparations and actions are undertaken to ensure that aquatic health is safeguarded; and f. Infrastructure such as buried services, pipes, culverts and bridges are protected from acid attack
PO5 Construction activities for the development avoid or minimise adverse impacts on stormwater quality or hydrological processes	No acceptable outcome is nominated
Hydrological Processes	
PO6 The stormwater management system: a. Retains natural waterway corridors and drainage paths; and b. Maximises the use of natural channel design in constructed components	AO6.1 All existing waterways and overland flow paths are retained AO6.2 The stormwater management system is designed in accordance with the Development manual planning scheme policy no. SC6.4 – SC6.4.10.2 Water Sensitive Urban Design
PO7 The development is designed to minimise runoff and peak flows by: a. Minimising large areas of impervious material b. Maximising opportunities for capture and reuse	No acceptable outcome is nominated
PO8 Stormwater management is designed to: Protect in-stream ecosystems from the significant effects of increased runoff frequency by capturing the initial portion of runoff from impervious areas; and Create conditions such that the frequency of hydraulic disturbance to in-stream ecosystems in developed catchments is similar to pre-developed conditions	AO8 The stormwater management system is designed in accordance with the Development manual planning scheme policy no. SC6.4 – SC6.4.8 Stormwater Management, SC6.4.9 Stormwater Quantity and SC6.4.10 Stormwater Quality
PO9 Stormwater management is designed to prevent exacerbated in-stream erosion downstream of a development site by controlling the magnitude and duration of sediment-transporting, erosion-causing flows.	AO9 The stormwater management system is designed in accordance with the Development manual planning scheme policy no. SC6.4 – SC.4.10.2 Water Sensitive Urban Design and SC6.4.8.10 Stormwater Management Plans
Stormwater Drainage Generally	
PO10 The proposed stormwater management system or site works does not adversely affect flooding or drainage characteristics of properties that are upstream, downstream or adjacent to the development site	AO10.1 The development does not result in an increase in flood level or flood duration on upstream, downstream or adjacent properties AO10.2 The stormwater management system is designed in accordance with the Development manual planning scheme policy no. SC6.4 – SC6.4.8 Stormwater Management, SC6.4.9 Stormwater Quantity and SC6.4.10 Stormwater Quality

Performance Outcomes	Acceptable Outcomes
PO11 Development does not cause ponding, or changes in flows and velocities such that the safety, use and enjoyment of nearby properties are adversely affected	AO11 The stormwater management system is designed in accordance with the Development manual planning scheme policy no. SC6.4 – SC6.4.8 Stormwater Management, SC6.4.9 Stormwater Quantity and SC6.4.10 Stormwater Quality
PO12 The drainage network has sufficient capacity to convey stormwater runoff from site	AO12 Development is undertaken in accordance with the Development manual planning scheme policy no. SC6.4 – SC6.4.8 Stormwater Management, SC6.4.9 Stormwater Quantity and SC6.4.10 Stormwater Quality
PO13 The stormwater management system: a. Provides for safe access and maintenance; and b. Where relevant, provides for safe recreational use of stormwater management features	No acceptable outcome is nominated

5. Proposed stormwater management system

5.1 Existing site stormwater runoff

The existing site is undeveloped and situated on a locally raised topographical feature in a tidally influenced floodplain, with Sandfly Creek to the east and north and Stuart Creek to the west. The site has been cleared of native vegetation.

The proposed site footprint is shown in Figure 7 with existing natural points of discharge (**green** markers in the image) where stormwater naturally accumulates (noting that there will be laminar overland flow across multiple locations in the existing case).



Figure 7 Existing site conditions with the proposed site boundary superimposed

5.2 Regional flooding

This report was developed on the basis that the finished levels of the development are at a level that prevents the ingress of stormwater from overland flow into the site. A flood study to identify the appropriate development site

level is not part of this scope, however, is currently being completed by an external party as part of the regulatory approvals process.

The Townsville City Plan (2024/01) suggests that 1 % AEP flood immunity for the site is required. The Townsville City Plan also has a requirement that the proposed development does not impact surrounding properties or infrastructure by more than 0.01 m (10mm) when comparing pre-development and post-development simulated flood levels for the 1% AEP event.

Tailwater levels should be carefully considered given the location of this site. As such, the latest Coastal Hazard and Adaptation Strategy (CHAS) for Townsville City Council (GHD, 2012) should be assessed for use in determining potential future tidal and storm surge levels for a potential future climate. For current day tidal levels, the 2025 Queensland Tide Tables for Townsville (Bureau of Meteorology website) should be consulted.

It is understood that the TCC CHAS is being updated by TCC with an expected delivery date at the end of 2025. As such, a desktop study should be undertaken to confirm that the TCC CHAS has the latest sea level rise figures available.

5.3 Stormwater system design

5.3.1 Hydrologic and hydraulic modelling

5.3.1.1 Rainfall data

Rainfall, both in terms of typical design rainfall values using in stormwater management calculations and multi-day rainfall totals are important to consider for this site and would apply to the different stormwater management components (stormwater, potentially contaminated stormwater and OWS).

Design rainfall depths obtained from the Australian Rainfall and Runoff (ARR, 2019) Bureau of Meteorology (BoM) Datahub from the site (from the grid cell location 19.3125 (S), 146.8625 (E)). In addition, with the recent ARR (2019) updates released in August 2024, climate change has been considered, for the present day and progressing into the future.

There are a few potential rainfall types to consider in this design, namely:

- Design rainfall for select short-duration rainfall depths (ARR, 2019 datahub). Table 13 provides the typical minor (18.13 % AEP, or 1 in 5 ARI) and major stormwater design event, 1% AEP (or 1 in 100 ARI).
- Design rainfall for the tank storage bund has assumed to be a maximum of the 1% AEP 24 hour event, which would result in a storage volume to hold potentially contaminated water until tested and clear for release. Table 13 contains the rainfall depths for this event.
- Climate Change – the present day design rainfall has been scaled up based on the observed change in rainfall from the dataset used to develop the currently available design depths via the Bureau of Meteorology (BOM). This is in line with updates to the ARR (2019) guidelines that occurred in August 2024. The scaled-up data is representative of the 2030 SSP2-4.5 (Shared Socioeconomic Pathway) and this is what has been used to complete the design (i.e. based on a 1.2^o temperature increase from the historical rainfall data timeframes). An assessment using the 2050 SSP3-7.0 scenario has also been completed to identify any areas in the design that may be sensitive to increased rainfall levels. Noting the design life of the infrastructure is approximately 20 years (personal communication, Technip Enterprises; 2024), the client may well wish to consider 2050 as their preferred design horizon.

Table 13 Select duration design rainfall depths for the 18.13% AEP and 1% AEP events based on uplifted IFD data from BOM

Climate Condition	AEP event	Duration Depths (mm)					
		15 min	30 min	60 min	90 min	180 min	24 hour
Current and near future	18.13%	37.25	54.99	76.99	90.64	117.75	254.45
2050 SSP2-7.0	18.13%	40.51	59.8	83.72	97.9	125.9	260.73
Current and near future	1%	61.02	90.94	131.27	158.65	217.21	503.41
2050 SSP2-7.0	1%	66.36	98.9	142.75	171.36	232.5	527.20

5.3.1.2 Hydrological loss parameters

Several hydrological loss models were developed for the various scenarios adopted with the Project. The pre-developed (existing) scenario considered to be 100% pervious (see Table 14).

In the post-developed (design) scenario, the surface is to be mostly sealed with some gravel areas. As the gravel areas will have greater losses than the road or buildings, but not as significant as the existing scenario pervious losses, a reduced pervious loss rate was adopted for these gravel areas. As such, all gravel areas have been represented as pervious areas with an agreed initial and continuing loss of 5 and 1 respectively. The contaminated water tank is sized to contain the first 15mm of rainfall on the nominated areas, as such, to size the bio-retention basin, an additional loss model was created for these areas with a 15mm initial loss. This was to account for the volume of water that will be contained within the contaminated water tank. The hydrological loss models adopted are as outlined in Table 14.

The percentages assigned to the impervious (paved / roof) areas and pervious (gravel) areas have been determined by estimating the percentages within each sub-catchment. Figure 9 highlights the catchment areas adopted for the modelling activities and Table 20 summarises the impervious percentages for each sub-catchment.

Table 14 Hydrological loss parameters

Parameter	Existing Scenario	Design Scenario	OWS Locations
Impervious Area Initial Loss (mm)	N/A	1	15
Impervious Area Continuing Loss (mm/h)	N/A	0	0
Pervious Area Initial Loss (mm)	20	5	5*
Pervious Area Continuing Loss (mm/h)	2	1	0
BX	1	1	1

* No pervious area has been modelled in the OWS areas

5.3.1.3 Blockage

The blockage factors to be applied to theoretical inflow capacities of inlet pits are given in Table SC6.4.9.3 in the Townsville City Plan, as outlined in Table 15.

Table 15 Blockage factors (TCC Table SC6.4.9.3)

Condition	Inlet Type	Blockage Factor
Sag	Side entry	20%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	20%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%
Field Inlet	Flush	80%
Field Inlet	Raised grate	50%

5.3.1.4 Pressure change coefficient “K”

Hydraulic losses should be defined by the pressure change coefficient “K” and as per the appropriate charts given in QUDM (2017), Appendix 2. The software DRAINS has the ability to revise the “K” coefficient based on the results. The model has been run and the “K” coefficient revised repeatedly until the “K” coefficient stabilises.

5.3.2 Stormwater quality

5.3.2.1 Methodology

A stormwater quality treatment system is proposed to reduce the post-development pollutant loads required by the State Planning Policy (SPP) (Department of State Development, Infrastructure and Planning, 2017) as well as the Townsville City Plan (Townsville City Council, 2022). Stormwater quality analysis has been undertaken for this assessment using the MUSIC software to simulate the effectiveness of the proposed treatment train.

Further details of this assessment and the outcomes are provided in this section.

5.3.2.2 Stormwater management design objectives

The Stormwater Quality Objectives outlined in the Townsville City Plan (Townsville City Council, 2022) have been considered to assess the performance of the proposed operational phase of the development. These are outlined in Table 16.

The objectives are outlined in Schedule 6 of the Townsville City Plan Planning Scheme – SC6.4.10.2 Water Sensitive Urban Design (WSUD). This Schedule is also detailed in Section 9.3.2 Healthy Waters Code (PO1 – Table 9.3.2.3) – Assessable development (Townsville City Council, 2022).

Table 16 Reduction targets

Parameter	Reduction target (%)
Total suspended solids	80
Total Phosphorus	65
Total Nitrogen	40
Gross pollutants	90

5.3.3 Potential contaminants

5.3.3.1 Construction phase contaminant generation

The pollutants which have the potential to be generated during the construction phase and have the potential to contaminate stormwater runoff are listed in Table 17.

Table 17 Construction phase contaminants

Contaminant	Sources
Sediment	Unprotected exposed soils and stockpiles during earthworks and construction
Hydrocarbons	Fuel and oil spills, leaks from construction equipment
Toxic materials	Cement slurry from construction works
Gross pollutants	Paper, construction packaging, food packaging, off cuts, construction general waste
pH altering substances	Acid Sulphate Soils, cement slurry and wash waters

5.3.3.2 Operational phase contaminant generation

The pollutants that have the potential to be generated during the construction phase and have the potential to contaminate stormwater runoff are listed in Table 18.

Table 18 *Operational phase contaminants*

Contaminant	Sources
Sediment	Soil erosion
Hydrocarbons	Fuel and oil spills, leaks from vehicles
Sustainable Aviation Fuel	Process units, tank farm, truck loading facility
Renewable Diesel	Process units, tank farm, truck loading facility
Caustic	Tank farm
Sulfuric Acid	Tank farm
Ethanol	Tank farm
Gross pollutants	Paper, food packaging

5.3.4 Indicative development layout and catchment delineation

A summary of the system catchment is outlined in Table 19 and the sub-catchment breakdown is shown in Table 20. The catchment areas are shown in Figure 9. The catchments have been derived based on the surface mapping provided on the 'Conceptual Overall Plot Plan Preliminary Surface Finishes' shown below in Figure 8, however, it should be noted that there has been some changes to the arrangement. A portion of the truck loading area will now be part of the OWS and the tank storage area will be a separate component. Figure 9 shows the catchment areas that are part of each system.



Figure 8 Indicative development site layout

Table 19 *System catchment summary*

System	Total Catchment Area (ha)
General Site Drainage	8.7
Storage Bund	0.5
Laydown	5.5
OWS	1.5

Table 20 *Sub-catchment summary*

Catchment ID	System	Catchment Area (ha)	Impervious %
BASIN01	General Site Drainage	0.7	100%
BUND01	Storage Bund	0.5	100%
I01	General Site Drainage	0.1	100%
I01.2	General Site Drainage	0.1	100%
I01.3	General Site Drainage	0.04	100%
I01.4	General Site Drainage	0.02	100%
I03.2	General Site Drainage	0.1	50%
I04	General Site Drainage	0.1	50%
I04.2	General Site Drainage	0.1	100%
I05.2	General Site Drainage	0.03	50%
I06	General Site Drainage	0.03	50%
I08	General Site Drainage	0.3	10%
I09	General Site Drainage	0.1	10%
I10	General Site Drainage	0.2	10%
I11	General Site Drainage	0.3	10%
I12	General Site Drainage	0.2	100%
I13	General Site Drainage	0.1	100%
I14	General Site Drainage	0.2	100%
I14.2	General Site Drainage	0.5	100%
I15	General Site Drainage	0.1	100%
I15.2	General Site Drainage	0.1	100%
I15.3	General Site Drainage	0.1	100%
I16	General Site Drainage	0.1	100%
I17	General Site Drainage	0.3	100%
I18	General Site Drainage	0.2	100%
I19	General Site Drainage	0.2	100%
I20	General Site Drainage	0.1	100%
I21	General Site Drainage	0.1	50%
I22	General Site Drainage	0.2	100%
I22.2	General Site Drainage	0.3	100%

Catchment ID	System	Catchment Area (ha)	Impervious %
I22.3	General Site Drainage	0.5	100%
I23	General Site Drainage	0.3	10%
I24	General Site Drainage	0.3	10%
I25	General Site Drainage	0.2	10%
I26	General Site Drainage	0.2	10%
I27	General Site Drainage	0.2	100%
I28	General Site Drainage	0.2	100%
I28.2	General Site Drainage	0.1	100%
I29	General Site Drainage	0.2	100%
I30	General Site Drainage	0.3	10%
I30.2	General Site Drainage	0.3	10%
I30.3	General Site Drainage	0.1	10%
I31	General Site Drainage	0.1	100%
I32	General Site Drainage	0.1	100%
I33	General Site Drainage	0.1	20%
I34	General Site Drainage	0.2	50%
I35	General Site Drainage	0.2	100%
I36	General Site Drainage	0.4	100%
I37	General Site Drainage	0.1	100%
I38	General Site Drainage	0.1	20%
I39	General Site Drainage	0.5	30%
I39.2	General Site Drainage	0.3	10%
I39.3	General Site Drainage	0.2	10%
I40	Laydown	5.5	0%
OWS1	OWS	0.7	100%
OWS2	OWS	0.1	100%
OWS3	OWS	0.1	100%
OWS4	OWS	0.1	100%
OWS5	OWS	0.2	100%
OWS6	OWS	0.2	100%
OWS7	OWS	0.2	100%
OWS8	OWS	0.1	100%
OWS9	OWS	0.04	100%

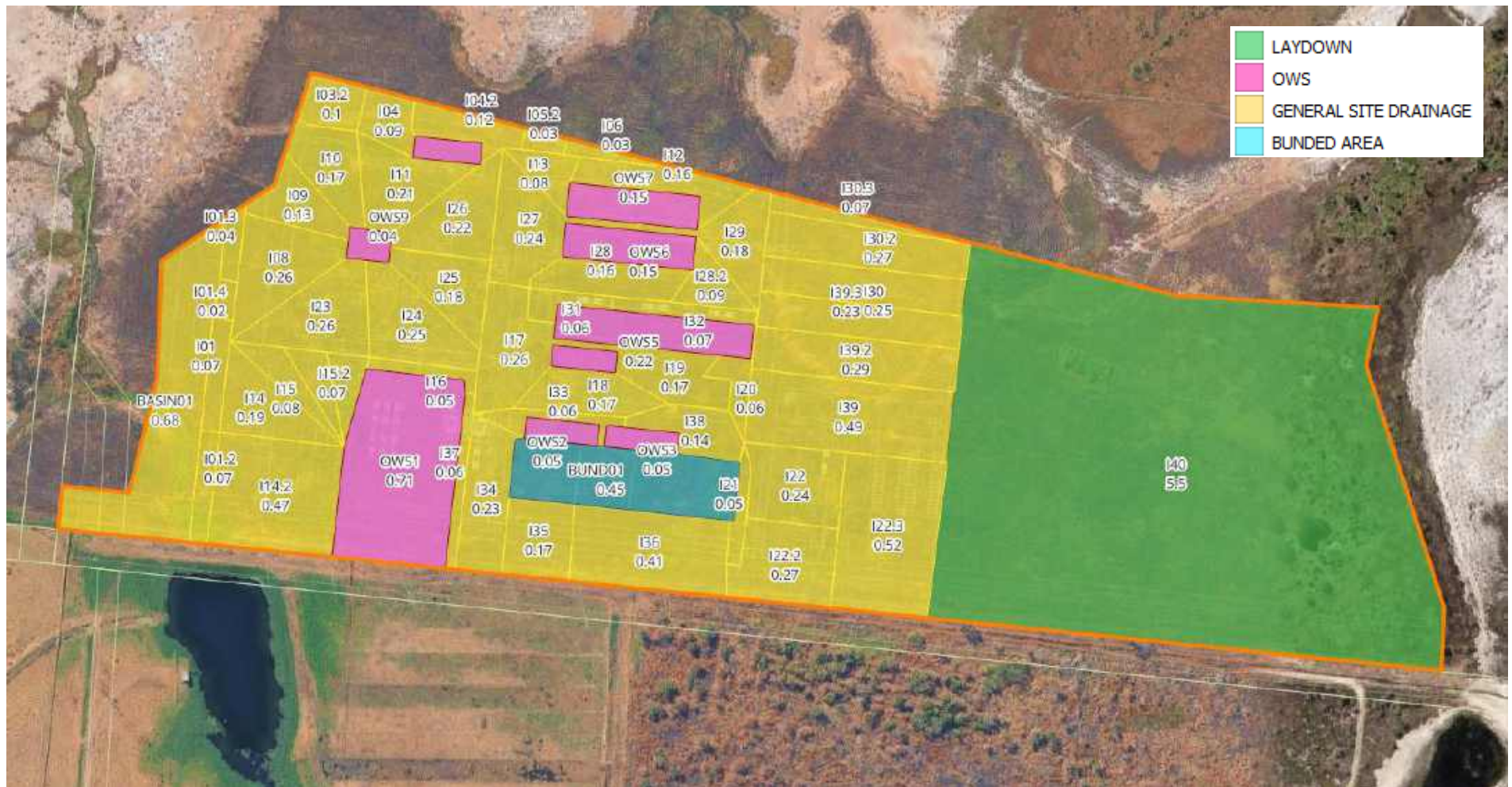


Figure 9 Catchment areas (ID and area in hectares)

5.4 Conceptual stormwater management system

This section describes the construction and operational phase stormwater management system for the Project. The performance of the stormwater management system in terms of stormwater quantity and quality is discussed in section 5.5.

5.4.1 Construction phase stormwater management

An erosion and sediment control plan (ESCP) will be prepared for the site to prevent contamination of receiving waters by ensuring compliance with the Environment Protection Act 1994 (EP Act) and the Environmental Protection (Water) Policy 2009. The key stormwater management measures which will be implemented during the construction phase include:

- Preparation of an ESCP for the site
 - Divert clean stormwater runoff around the construction site
 - Implementation of erosion and sediment controls including silt fences and sedimentation basins to help reduce contamination. Appropriate removal of sediment build up should also be undertaken.
 - Disturbance of topsoil should be minimised where possible
 - Vehicles should be washed down off-site to prevent introducing contaminated runoff
 - Minimise traffic and construction of additional roads
 - Dust suppression systems
 - Revegetation or rehabilitation of temporary construction areas to reduce exposure time of bare soil
 - Cease all work during major storm events
 - Regular inspection of erosion and sediment control measures following rainfall events.
- Strategic sequencing and timing of construction activities
 - Construction activities should not be carried out during high rainfall events.
- Management plans for storage and handling of contaminating substances including fuels, construction materials and supplies
 - Appropriate hazardous material measures (i.e. spill kits on site, staff training)
 - Install appropriate bunding
 - Vehicle maintenance
 - Designated laydown area.

5.4.2 Post-construction phase stormwater management

Stormwater from the developed area is proposed to be conveyed through four independent systems, namely:

- Clean water diversion swale – to divert clean runoff from entering the site from the south.
- General Site Drainage – The underground drainage network, which will convey runoff generated by the road network, roofs and area behind kerb not within the OWS system via a kerb and gutter and underground pit and pipe system. The general site drainage includes the temporary construction laydown area.
- OWS – The OWS which will convey flows generated by those pre-identified areas at risk of oily water contamination.
- Bunded Area – The bunded area containing the storage tanks.

Figure 10 shows the proposed system in its entirety, incorporating each of the itemised systems above and how they interact with each other. In the following sections, each system will be broken down to discuss details and provide a system specific plan to allow a clearer view of each proposed system. Pit and pipe sizes have been colour coded to provide a visual representation of the scale of the system required and separate line types have been used to denote the general site drainage system from the OWS. Inlet pit IDs have also been provided on the plans which align with those outlined in Figure 9 and Table 20 with the catchment areas colour coded to each system.

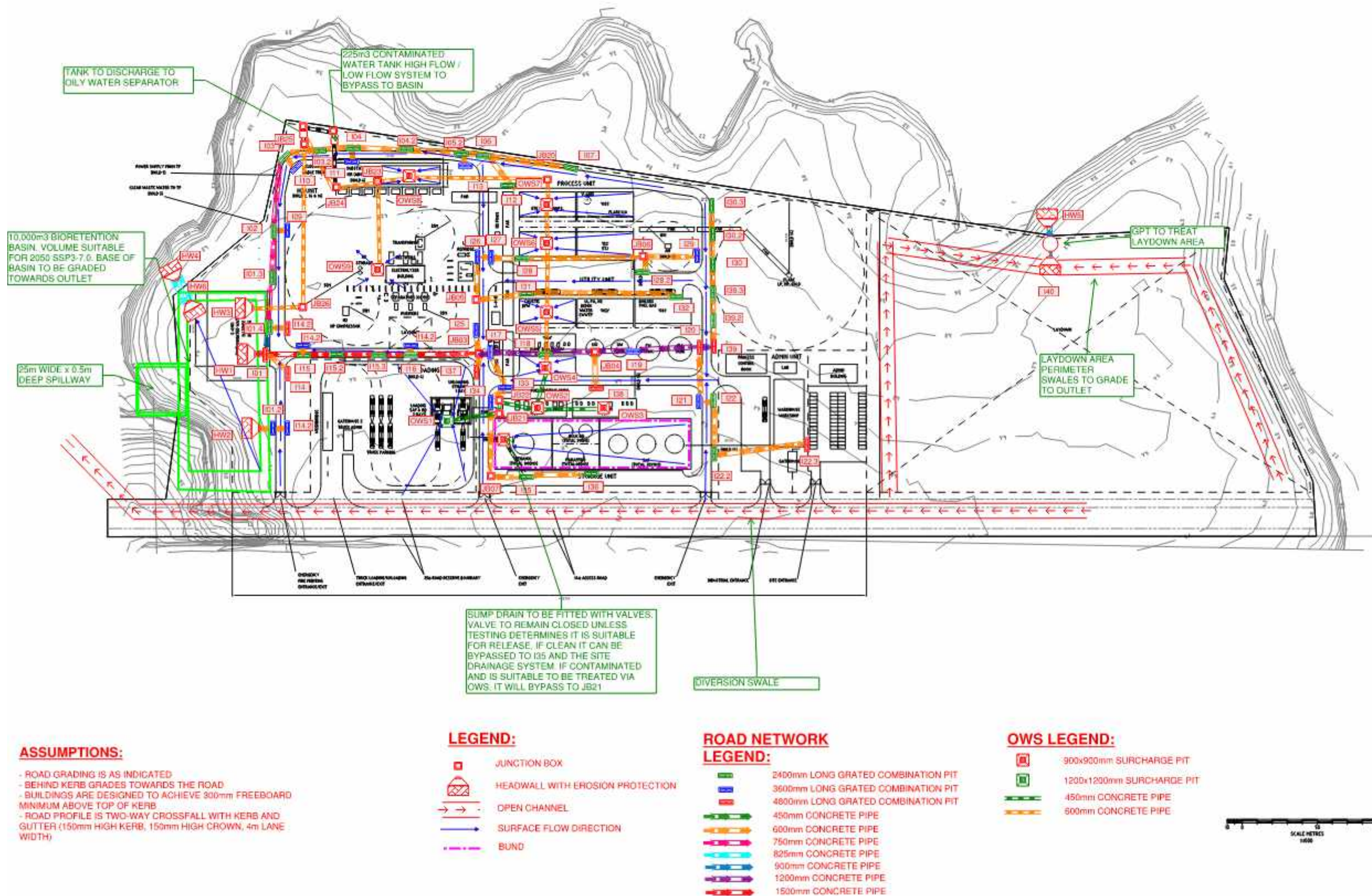


Figure 10 Proposed stormwater layout (including all elements of the system)

5.4.2.1 Clean water diversion channel

A clean water diversion swale will be constructed along the southern side of the site to divert external catchment flows around the site. Preliminary results indicates that there will be approximately 11.2 m³/s that is generated by the external catchments to be conveyed within this swale. Due to the flows associated, the position and dimensions of the channel will need to be a focus in the site grading works. A preliminary trapezoidal section may consist of a rock lined channel with 1:4 side slopes, 5 m base and 1.5 m deep. The catchment that will need to be diverted by this swale is shown in Figure 15 and entails a total area of 76.5 ha. These catchments approach the site on the western portion of the southern boundary, and this will be the primary area that will need diversion. The channel sized is to cater for this flow, however, additional roadside drainage may be required along the eastern portion for general road runoff.

5.4.2.2 General site drainage

Site drainage has been designed to convey the runoff to the bio-retention basin where it will be treated to achieve water quality targets (see section 5.6) and detained to pre-development peak discharge levels (per Figure 16 Existing case scenario DRAINS layout (simulated 1% AEP event peak flows provided in red text)).

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Due to the early stage of development of the Project and site layout, key details (such as road profile, platform height, etc.) are not yet developed. In order to assess the system, the following assumptions have been adopted:

- The platform grades from west to east, generally following the road gradings as indicated at 0.5%.
- The road profile has been adopted as the standard '7.5m roadway with 3% crossfall and barrier kerb' included in DRAINS.
- Allowable flow width in the minor event is 4.2 m (full width of crown, per QUDM (2017) Table 7.4.2)).
- Allowable flow width in the major event is 10 m (summation of both kerb lines, 5m if only single kerb)
- Buildings and structures will be placed to achieve 300 mm freeboard minimum above the top of kerb.
- Areas behind kerb drain towards the road (with the exception of those nominated for the OWS, or bunded area).
- Pipes have been graded at 0.5% to match the road gradings.
- Sag at locations where there are kerb protuberances and where flows will need to cross the road crown.
- Roofed areas will drain to the road.
- At nominated headwalls, rock rip rap erosion protection will be designed to dissipate the energy. The 1% AEP flow rates will be utilised in this.

As the basin will be the largest component of the system the rest of the network was designed around a suitable location for the basin. It was determined that the most suitable location would be the western side of the site as it is still mostly on land above the lower floodplain. The road network and underground pipe network was then graded towards this location.

Pits were first placed at assumed sag locations, upstream of intersections and prior to the end of kerb protuberances. Once these initial locations were determined, inlet pits were placed at the maximum 70m spacings and junction boxes to facilitate direction changes. Inlet spacings were then reduced to achieve the flow width requirements as outlined above. The alignment has also been developed to attempt to balance the length of pipe and number of road crossings.

At each of the nominated headwalls, rock rip rap erosion protection will be placed to help dissipate the velocity, energy and spread of the flows. This has been sized based on the 1% AEP.

Attenuation basin

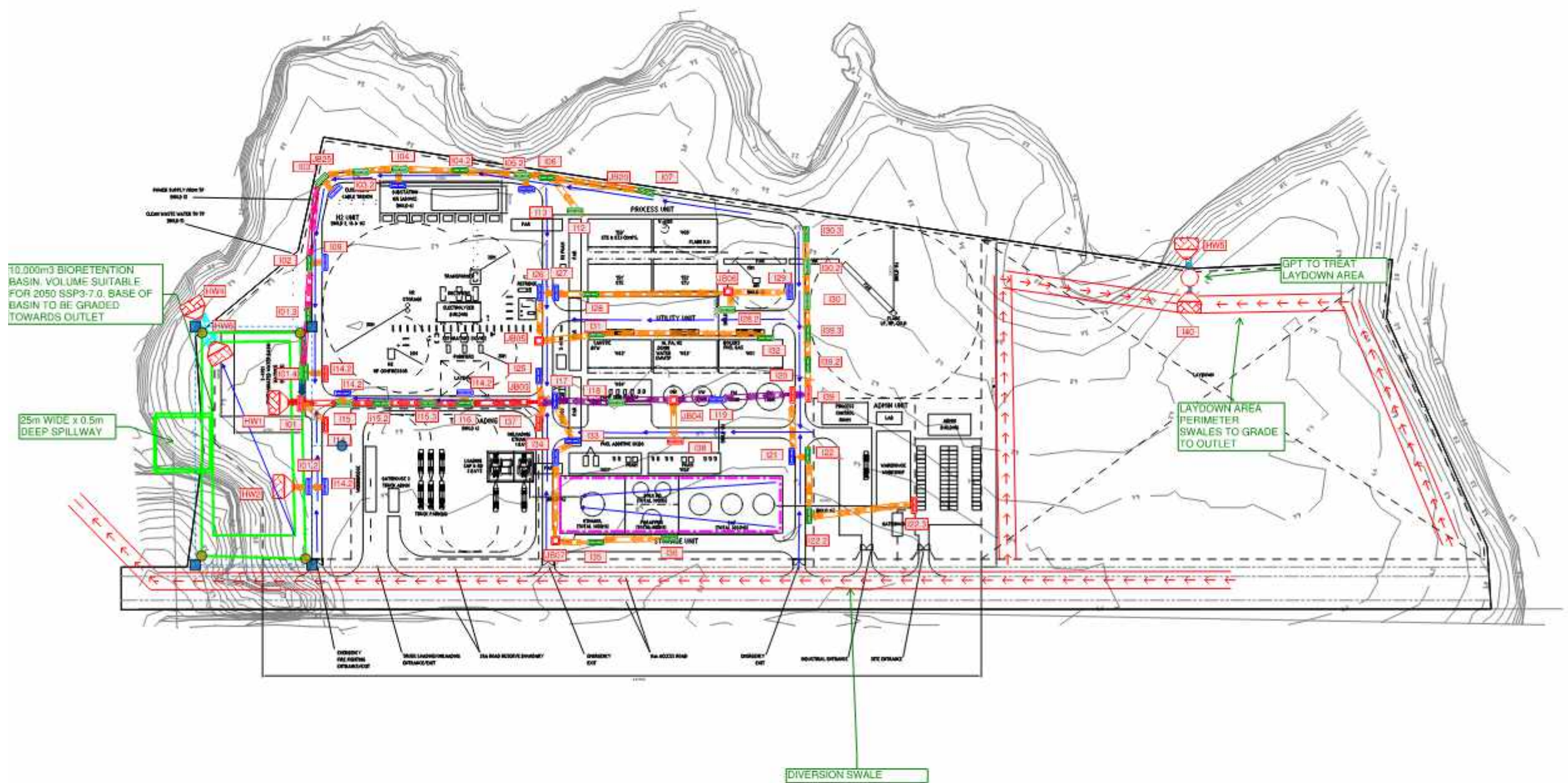
A requirement for the new development is for the runoff generated by the proposed site to not exceed the pre-development 1% AEP flows. To achieve this, it is proposed that the system will feed into an attenuation basin where runoff can be captured, stored and released at a controlled rate. The basin will be sized to be compliant with the requirements outlined with both TCC and QUDM.

While the basin has been sized to attenuate to the 1% AEP level, a spillway will be designed to cater for the 2% AEP event capacity while the basin is full. Details on the spillway will be discussed in section 5.5.2.

An additional feature of the basin is that it can act as a bio-retention basin, which will treat runoff for stormwater pollutants prior to being discharged to the receiving environment. Further discussion on the bio-retention features of the basin is discussed in section 5.6.2.

Laydown area

As the laydown area is only to be used temporarily, the stormwater system proposed for this area has been designed to be as simple as possible (Figure 10). It is proposed that the area will be bounded by perimeter swales and an outlet that restricts the discharging flows to the receiving environment to the pre-development flow rate of 1.24 m³/s. This has been achieved using a 900 mm concrete pipe. The perimeter swales have also been designed to allow storage for the 1% AEP event and achieving 300 mm freeboard. A Gross Pollutant Trap (GPT) will be required at the outlet to treat flows prior to discharging. Further discussion is provided in section 5.6.2.



ASSUMPTIONS:

- ROAD GRADING IS AS INDICATED
- BEHIND KERB GRADES TOWARDS THE ROAD
- BUILDINGS ARE DESIGNED TO ACHIEVE 300mm FREEBOARD MINIMUM ABOVE TOP OF KERB
- ROAD PROFILE IS TWO-WAY CROSSFALL WITH KERB AND GUTTER (150mm HIGH KERB, 150mm HIGH CROWN, 4m LANE WIDTH)

LEGEND:

- JUNCTION BOX
- HEADWALL WITH EROSION PROTECTION
- OPEN CHANNEL
- SURFACE FLOW DIRECTION
- BUND

ROAD NETWORK LEGEND:

- 2400mm LONG GRATED COMBINATION PIT
- 3600mm LONG GRATED COMBINATION PIT
- 4800mm LONG GRATED COMBINATION PIT
- 450mm CONCRETE PIPE
- 600mm CONCRETE PIPE
- 750mm CONCRETE PIPE
- 825mm CONCRETE PIPE
- 900mm CONCRETE PIPE
- 1200mm CONCRETE PIPE
- 1500mm CONCRETE PIPE

OWS LEGEND:

- 900x900mm SURCHARGE PIT
- 1200x1200mm SURCHARGE PIT
- 450mm CONCRETE PIPE
- 600mm CONCRETE PIPE



Figure 11 Site drainage layout

5.4.2.3 Oily water system

The OWS has been designed as a separate underground pit and pipe network that directs flows from specific areas of the site to a contaminated water tank. The contaminated water tank has been sized on the basis of collecting the first 15 mm of a rainfall event, which is the recommended rainfall depth from New South Wales guidelines for substances that are more difficult to mobilise, such as oil, grease and other non-volatile hydrocarbons. Based on the current understanding on the areas that could contribute to the first flush system (1.5 ha), a contaminated water tank sized to contain 225 m³ would be required. While the first flush system will only direct the first 15 mm of runoff into the contaminated water tank, the pit and pipe network conveying the flows has been designed to convey the 1% AEP event from each designated area into the site drainage system. Figure 13 highlights the areas that connected to the OWS.

At each of the locations connected to the OWS a sump pit has been placed inside of a trapezoidal open channel. The site grading of these areas will be directed towards the channel and sump pit. These channels have been designed to capture and direct runoff to the pit and store the water as it enters the system. Each channel has been sized to achieve 300 mm freeboard. The configuration of each channel is outlined below in Table 21. Grating to cover the drains should be considered in the next design phase.

Table 21 OWS Channel Configurations

OWS Area	Catchment Area (ha)	Side Slope (1 in x)	Base Width (m)	Depth (m)
1	0.7	3	5	1.1
2	0.1	3	0.5	0.5
3	0.1	3	0.5	0.5
4	0.1	3	2.5	0.6
5	0.2	3	0.5	0.5
6	0.2	3	1.5	0.6
7	0.2	3	1.5	0.6
8	0.1	3	2	0.6
9	0.04	3	0.5	0.5

At the inlet to the contaminated water tank a high flow / low flow bypass system is proposed, which will direct flows into the tank until it reaches the top operating water level in the tank where it will bypass the tank towards the bioretention basin.

The treatment procedure for the OWS involves treating the runoff captured in the contaminated water tank through a proprietary oily water separator (such as an Atlan Spillceptor) with oils directed to a waste oil tank and treated water tested (pH, 5-day BOD, Oil and Grease, Hydrocarbons and Ethanol) and either released to the bioretention basin or directed to the wastewater disposal system documented in the Water Management Report (GHD, 2024). The waste oil will be recycled via an oil recycling contractor.

5.4.2.4 Tank farm bund

The storage tank farm will be located within a self-contained bund with provision for pump out for disposal to a licenced facility by truck transport or release into the OWS where testing shows the water quality is appropriate. The bund has been sized to contain the volume of the 1% AEP 24-hour event (as JetZero have confirmed that daily testing is achievable within their operations) plus the volume of the largest storage tank. The required bund storage volume and required height of the bund has been estimated by using the following:

- Surface Area – 5000 m²
- 1% AEP – 2,300 m³
- Largest Tank – 2016 m³
- Freeboard – 300 mm

The above equates to a total volume of 5,816 m³ and an approximate required bund wall height of 1.16 m. The storage volume has been allowed for up to the 24-hour event as it is expected that personnel will be on site and be able to test the water on a daily basis. The tank farm bund release paths are shown in Figure 12.

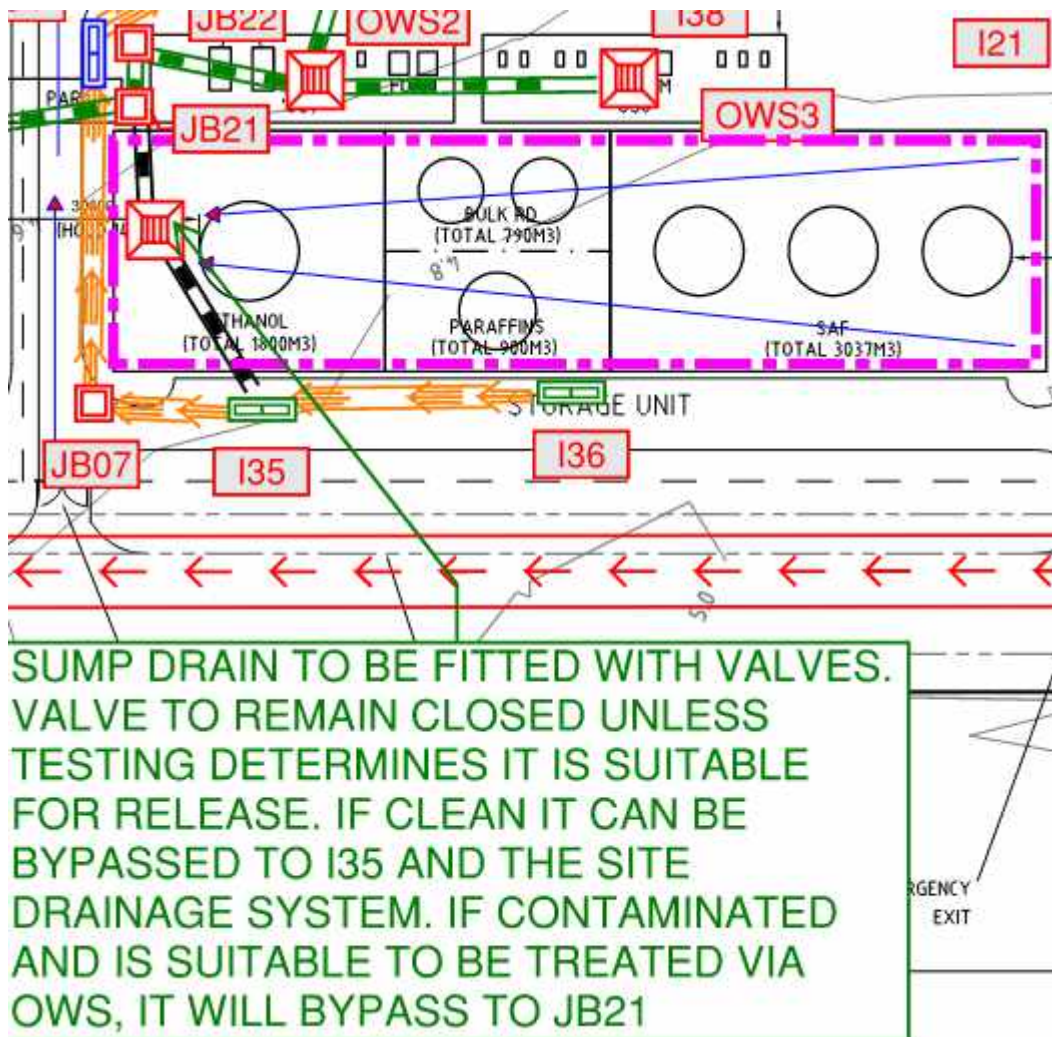
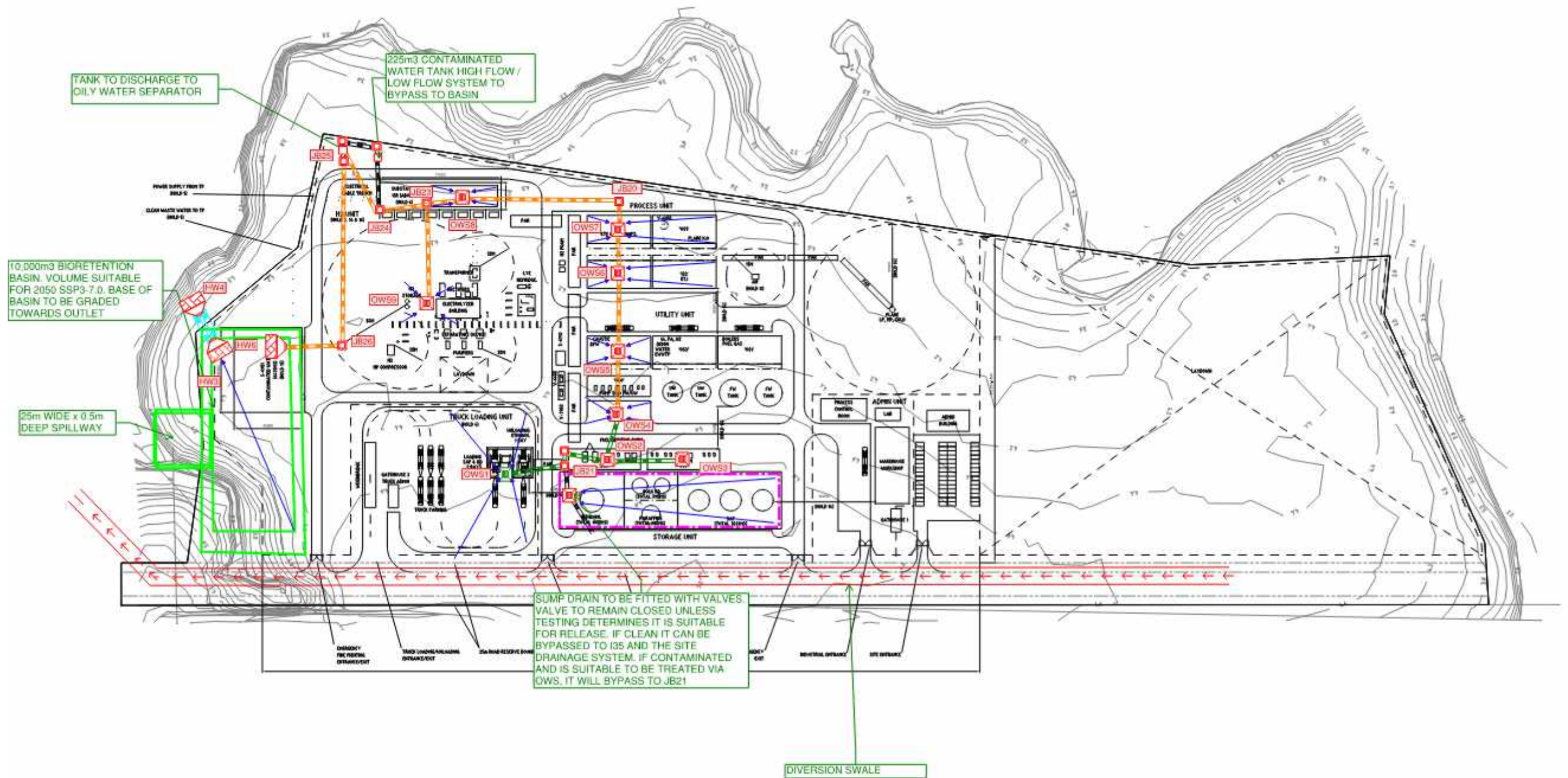


Figure 12 Tank farm bund release paths



ASSUMPTIONS:

- ROAD GRADING IS AS INDICATED
- BEHIND KERB GRADES TOWARDS THE ROAD
- BUILDINGS ARE DESIGNED TO ACHIEVE 300mm FREEBOARD MINIMUM ABOVE TOP OF KERB
- ROAD PROFILE IS TWO-WAY CROSSFALL WITH KERB AND GUTTER (150mm HIGH KERB, 150mm HIGH CROWN, 4m LANE WIDTH)

LEGEND:

- JUNCTION BOX
- HEADWALL WITH EROSION PROTECTION
- OPEN CHANNEL
- SURFACE FLOW DIRECTION
- BUND

ROAD NETWORK LEGEND:

- 2400mm LONG GRATED COMBINATION PIT
- 3600mm LONG GRATED COMBINATION PIT
- 4800mm LONG GRATED COMBINATION PIT
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- 600mm CONCRETE PIPE
- 750mm CONCRETE PIPE
- 825mm CONCRETE PIPE
- 900mm CONCRETE PIPE
- 1200mm CONCRETE PIPE
- 1500mm CONCRETE PIPE

OWS LEGEND:

- 900x900mm SURCHARGE PIT
- 1200x1200mm SURCHARGE PIT
- 450mm CONCRETE PIPE
- 600mm CONCRETE PIPE



Figure 13 OWS layout

5.5 Stormwater system performance – Water quantity

5.5.1 Existing conditions

A DRAINS model was developed to determine the pre-development flow rates that the stormwater management system needs to achieve. It is understood by GHD that the laydown area to the east will be levelled and compacted for use during construction, and then decommissioned post-construction. Due to this, two separate flow rates have been derived, one for the laydown area and one for the developed site. Figure 14 shows how the pre-development catchments (red) and post-development catchments (purple) align. Figure 15 shows the external catchment, which drain to the site.

It has been estimated that approximately 50% of the pre-development Cat9 area will be taken by the laydown area with the remainder to be utilised by the developed site. Based on this, two flow paths have been provided for Cat9 in the DRAINS model, allowing flows to be evenly split between the two locations. Figure 16 shows the structure of the pre-development DRAINS model with the corresponding 1% AEP results. As shown in Figure 16, the pre-development flows for each discharge location are:

- 2.45 m³/s for the site drainage
- 1.39 m³/s for the laydown area
- 11.2 m³/s for the external boundary catchments

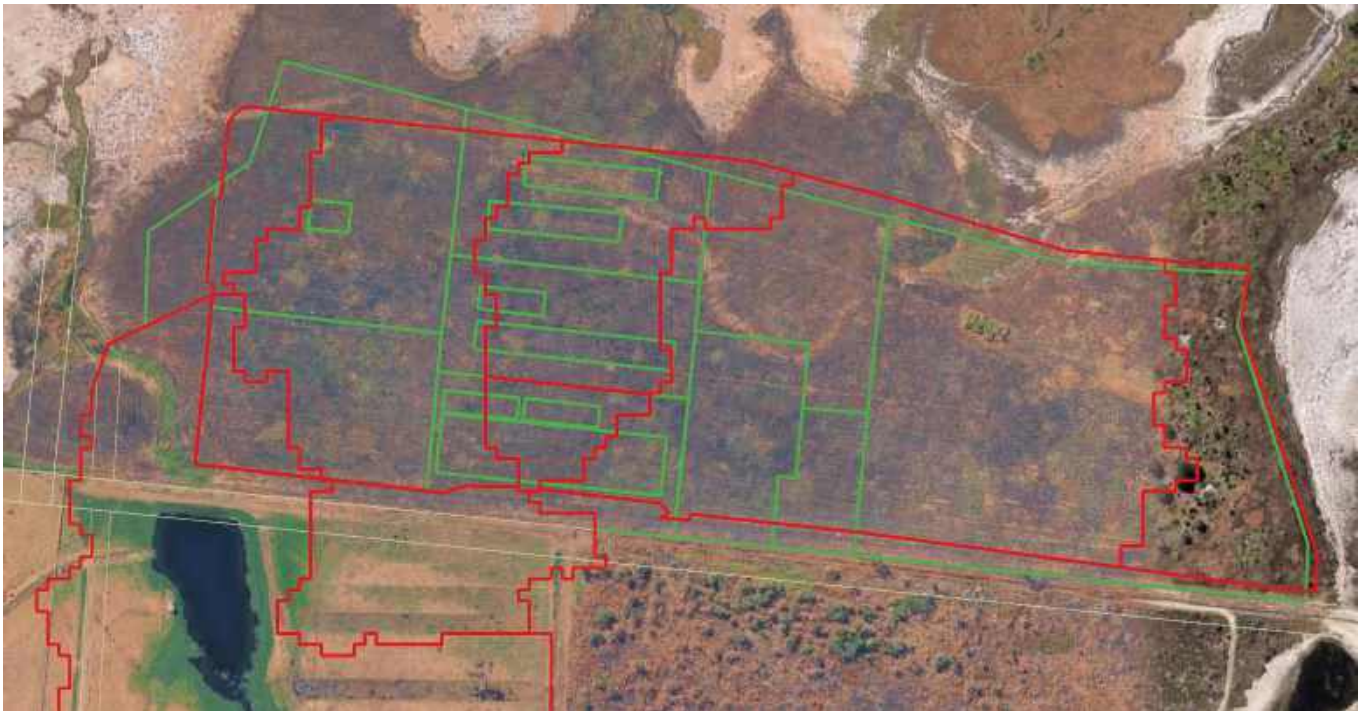


Figure 14 Pre-development catchments (red) and post-development catchments (green)

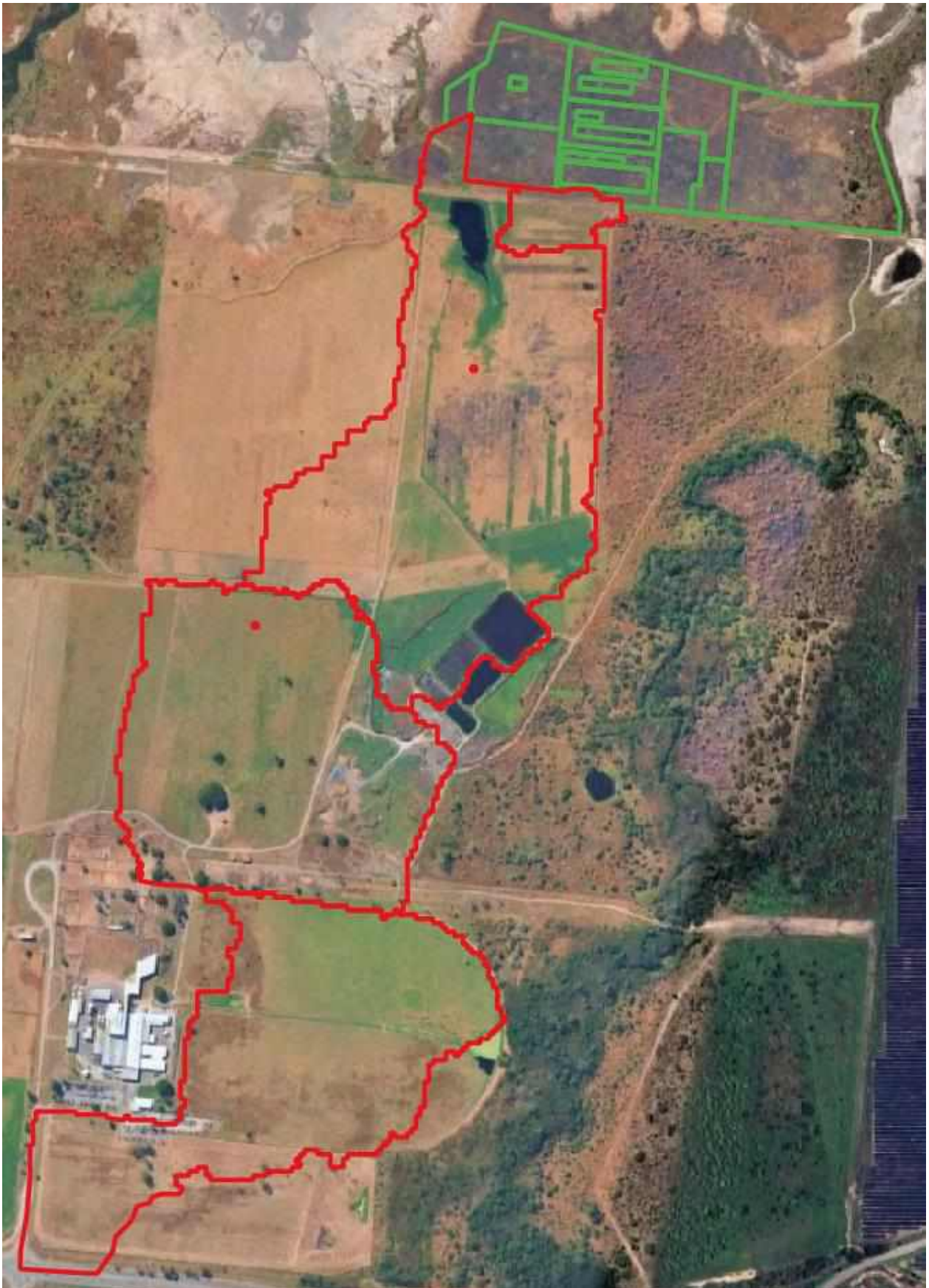


Figure 15 External catchments (red)

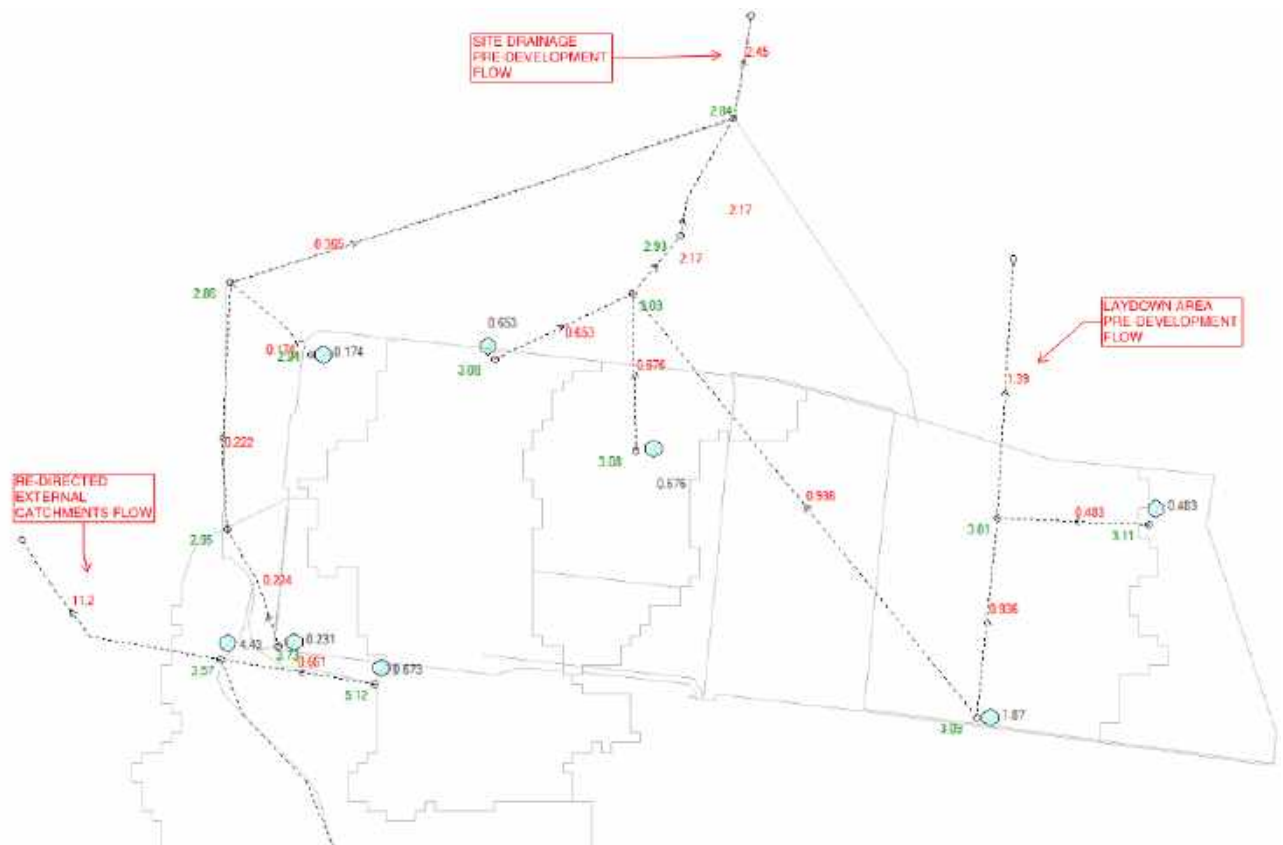


Figure 16 Existing case scenario DRAINS layout (simulated 1% AEP event peak flows provided in red text)

5.5.2 Hydrologic and hydraulic performance

18.13% AEP

The 18.13% AEP (1 in 5-year ARI) event was used to size the underground system, focusing on pit spacing to achieve compliant flow widths and pit freeboard. The proposed layout is able to achieve compliant freeboard and flow widths throughout the site. All pipes are compliant to SC 6.4.9.

The hydraulic grade line is generally contained within the pipe segment, providing some flexibility in the depth of pipe and size once the platform height has been set and surface grading completed.

Flow widths are also compliant with an average flow width of 2.5 m and all ponding depths at sags are less than 300 mm. Hazard safety checks (Depth x Velocity; $D \times V$) find that there are no locations where $D \times V$ is greater than 0.3 m²/s per Table 7.4.3 of QUDM (2017).

2% AEP

The 2% AEP event has been utilised to size the spillway from the attenuation basin in the event that an event occurs while the basin is full or the low-level outlet is blocked. To determine the design flow rate, all of the flow avenues entering basin have been concentrated and discharged in a single overflow route with no basin node in DRAINS. Figure 17 shows the DRAINS model outlet and required flow rate.

The following parameters have been assumed when developing the cross-section of the spillway:

- Maximum cross-sectional depth of 0.5m, inclusive of 0.3m freeboard, resulting in maximum flow depth of 0.2m
- Longitudinal slope of 1% (1 in 10)
- Grass-lined
- Side slopes of 1 in 6

The above assumptions and completing a Manning's equation to determine the cross section requires a 22.5m base to achieve 5.22 m³/s at 0.2m deep. Accounting for the 300 mm freeboard, this results in a total spillway width of 24.9m. The approach adopted is to limit the impact on the depth of the basin.

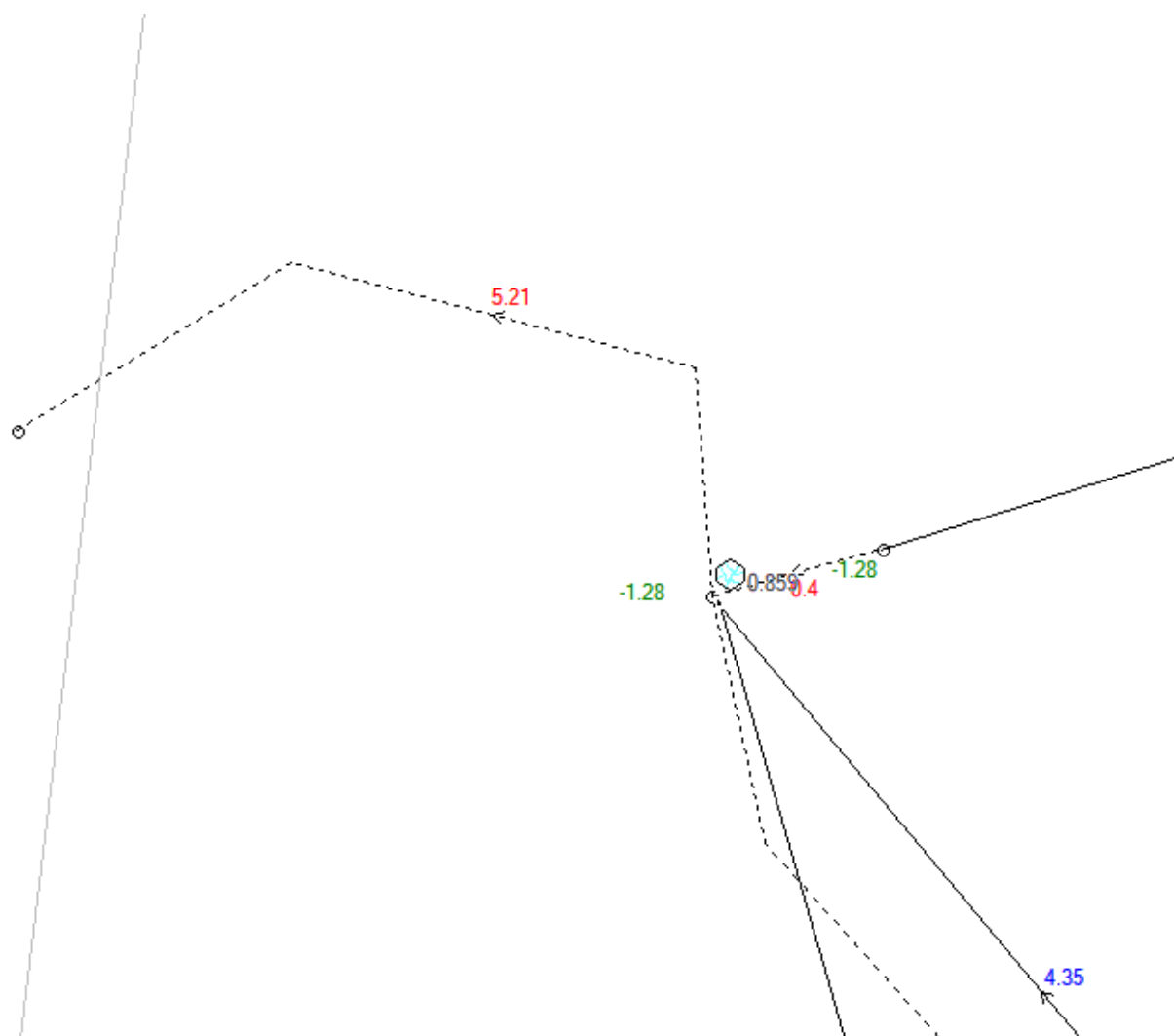


Figure 17 2% AEP Attenuation Basin Spillway Flow Rate

1% AEP

As with the 18.13% AEP event, the criteria for the 1% AEP event can be achieved. Flow widths are within the assumed range, depths do not exceed 300 mm and $D \times V$ is less than 0.4 m²/s (critical value for $D \times V$ per QUDM Tables 7.4.4 and 7.4.5).

The OWS system also does not spill out of the nominated areas and is contained within each of the channels with at least 300 mm freeboard.

Outflow requirements are also achieved with both the bio-retention basin and laydown area restricted to less than pre-development levels. The summary of flows are outlined below in Table 22 and a screenshot of the DRAINS model at each location are shown in Figure 18 and Figure 19. The maximum volume achieved in the basin is 7,100 m³.

Table 22 Summary of discharge flow rates (1% AEP)

Outflow Location	Pre-Development Flow Rate (m ³ /s)	Post-Development Flow Rate (m ³ /s)	Outlet Condition
Bio-Retention Basin	2.45	2.26	2x 825 mm concrete pipes
Laydown Area	1.39	1.34	1x 900 mm concrete pipe

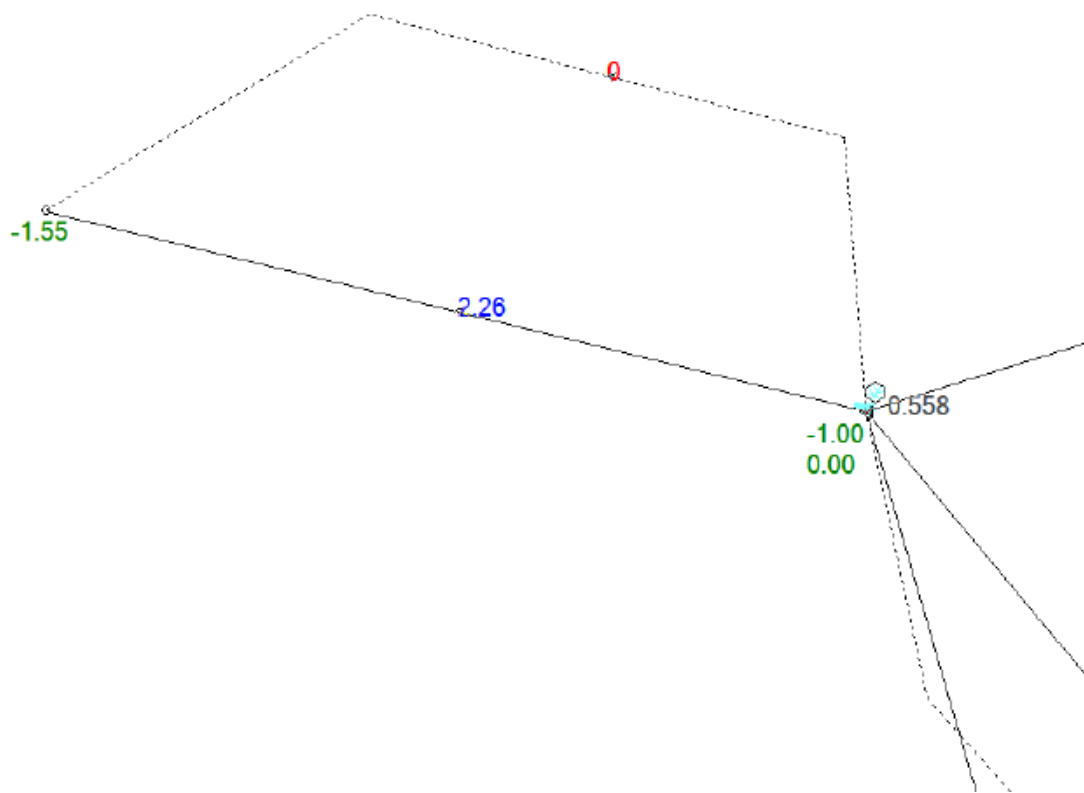


Figure 18 Bio-retention discharge flow rate (m^3/s)

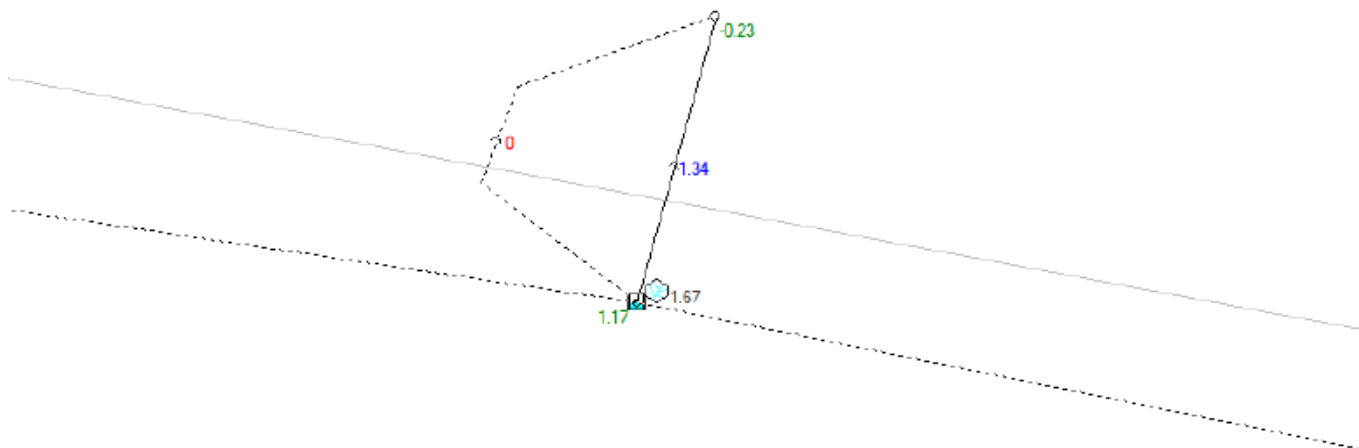


Figure 19 Laydown area discharge flow rate (m³/s)

Rock rip rap will also be placed at each headwall to reduce the velocity, energy and disperse the flows to minimise the risk of scour. This has been sized using the Catchments and Creeks (2011) publications which provide guidance on culvert outlet protection rock diameter and pad size. Table 23 summarises the required rock protection details for each headwall.

Table 23 Headwall erosion protection

Headwall ID*	Velocity (m/s)	Rock Size d_{50} (mm)	Pad Length (m)	Pad Width (m)
HW1	3.3	400	12	6.5
HW2	0.53	100	2.4	2
HW3 / HW4	3.0	300	3.3	2.5
I40 / HW5	2.6	200	5.4	3.5
HW6	1.4	100	2.4	2

* Refer to Figure 10 for location of each headwall.

Sensitivity checks

Climate change

To test how the system might perform in future conditions, a climate change factor of 1.1 has been applied to represent the 2050 SSP3-7.0 scenario.

In the 1% AEP event, the basin is at capacity requiring a maximum storage of approximately 8,400 m³ and with no overtopping and the discharge flow rate is increased from 2.34 m³/s to 2.47 m³/s. At the laydown area, the perimeter swales still have capacity, with a reduced freeboard of 250 mm.

The flow widths are also impacted by the increased rainfall with the average flow width increasing from 3.51 m to 3.57 m. All flow widths are typically within the 10m criteria.

The storage tank bund will have a decreased capacity with the volume from the 24-hour event now requiring 2,481 m³ instead of 2,300 m³. While the total bund capacity (5,816 m³) is sufficient to contain the increased rainfall and volume of the largest tank (2,016 m³), the remaining freeboard will be decreased to 264 mm.

All channel elements within the OWS system are able to retain the increased flows with no overtopping.

Tailwater levels

A sensitivity check has been completed where the outlet of the basin has been submerged to test the performance of the system if the outlet were to be restricted in the 1% AEP event. Since the platform level is yet to be determined and surface grading completed, it is assumed that the site will be built high enough that the flood water levels will not exceed the height of the basin. As such, the outlet has assumed to be submerged.

The main impacts to this were that the basin volume with approximately an additional 1,500 m³ required and the water level increasing by 200 mm. Due to the increased level, there is some reduced capacity within the system in terms of freeboard, with up to 257 mm decreased freeboard and an average of 11 mm. There were minimal impacts to the surface flow. Based on these results, the system will still function as intended, however, it will operate with reduced freeboard. It is not expected that this will have a substantial impact on the system.

5.6 Stormwater system performance – Water quality

5.6.1 MUSIC modelling

A MUSIC model (Version 6.3) was established to determine the post-development pollutant loads as referenced in the SPP (Department of State Development, Infrastructure and Planning, 2017) as well as the Townsville City Plan (Townsville City Council, 2022). The model has utilised split land use types based on the proposed development and the proposed stormwater management approach.

Meteorological data

The rainfall and evapotranspiration data adopted in the model is listed in Table 24.

Table 24 Meteorological data

Parameter	Value
Model time step	6 minute
Modelling period	1 January 1970 – 31 December 1983
Mean annual rainfall	1165 mm
Annual evapotranspiration	1201 mm

Six-minute rainfall data and daily evapotranspiration data for the Townsville Aero station (032040) was used for the simulation. All data from the modelling period was applied (i.e. there was no censoring of rainfall data), as the data quality was indicated to be high. The simulation period to as specified in the Water Sensitive Urban Design for the Coastal Dry Tropics (Townsville): Design Objectives for Stormwater Management (AECOM + McGarry and Eadie, 2011) and referenced in Section 9.3.2 Healthy waters code from the Townsville City Plan (and is considered representative of the site and including wet and dry years and mean annual rainfall.

Catchment delineation

A split catchment approach, as described in the MUSIC Modelling Guidelines (Water by Design, 2018) was adopted for the assessment. The stormwater catchments were derived based on the proposed site layout provided to GHD in February 2025. The catchment was divided into roof, road (sealed and unsealed) and pervious ground types based on the proposed site layout. Figure 20 indicates the MUSIC model layout.

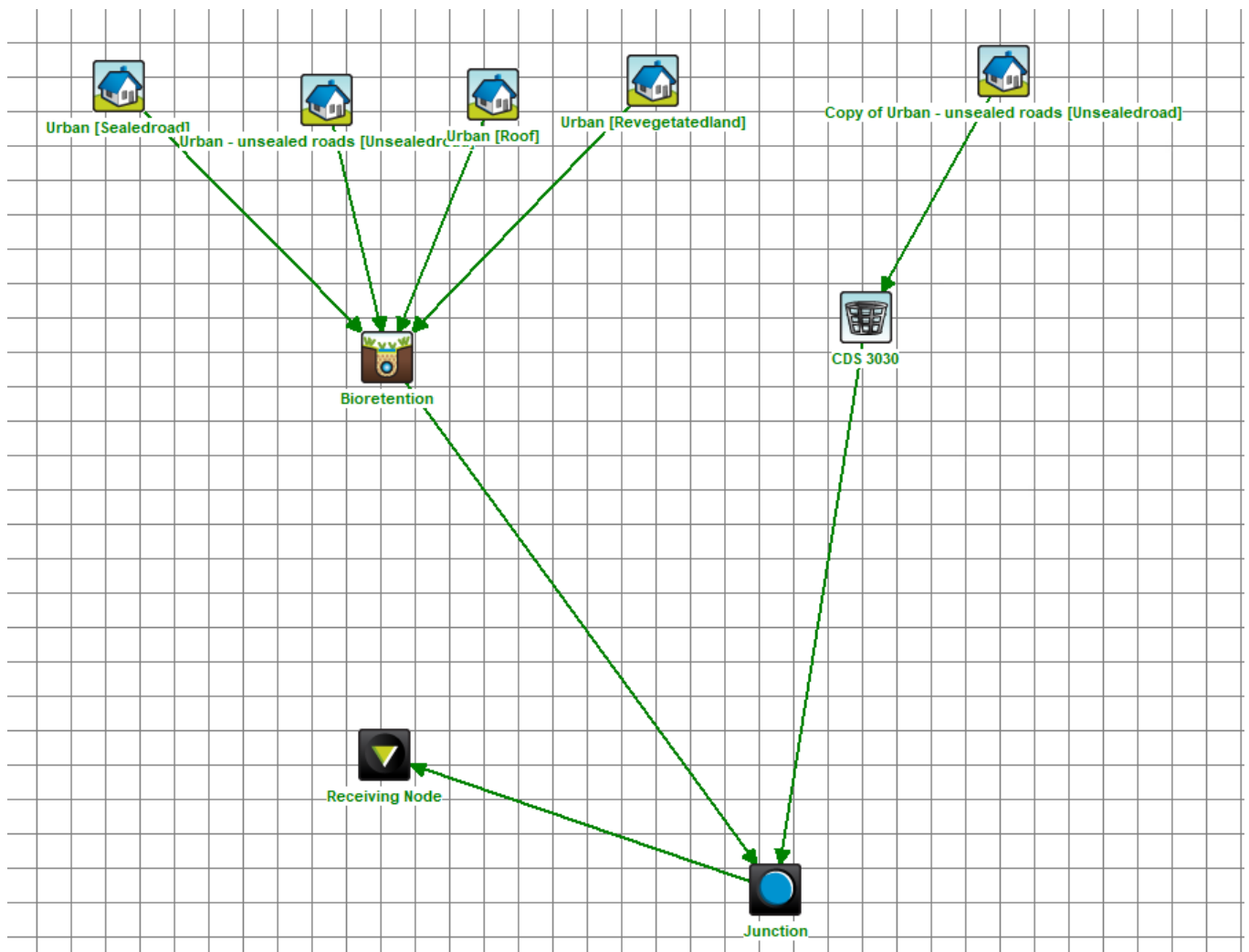


Figure 20 MUSIC model layout

The pollutant generation nodes were incorporated in the model to represent the land uses. In accordance with the Water Sensitive Urban Design for the Coastal Dry Tropics (Townsville): Design Objectives for Stormwater Management (AECOM + McGarry and Eadie, 2011) using the industrial type parameters.

Table 25 details the land use areas and impervious percentage used for the MUSIC model. The roughly 5.5 ha eastern area has been considered as an unsealed gravel surface type. The only roof areas considered in the assessment are the operational and administrative buildings in the southeast portion of the site. The areas draining to the oily water separator systems have not been considered as part of this assessment as these are proposed to drain into a separate dedicated system, and water quality testing undertaken prior to release either into the receiving environment or into the site stormwater system. The residual areas to the north and west (including the runoff directly on the proposed bioretention basin) have been classified as the pervious ground type.

Table 25 Catchment areas

Land use	Area (ha)	Impervious percentage (%)
Unsealed roads	8.1	75
Sealed roads	4.5	100
Roof	0.2	100
Pervious ground (incl. Bio-basin)	2.2	10
Total	15	

The recommended rainfall-runoff parameters for industrial land use types were applied as detailed in Water Sensitive Urban Design for the Coastal Dry Tropics (Townsville): Design Objectives for Stormwater Management (AECOM + McGarry and Eadie, 2011). These are shown in Table 26.

Table 26 *Rainfall-runoff parameters*

Parameter	Value
Impervious area – rainfall threshold (mm/day)	1
Pervious area – soil storage capacity (mm)	18
Pervious area – initial storage (% of capacity)	10
Pervious area – field capacity (mm)	80
Pervious area – infiltration capacity coefficient - a	243
Pervious area – infiltration capacity exponent - b	0.6
Groundwater properties – initial depth (mm)	50
Groundwater properties – daily recharge rate (%)	0
Groundwater properties – daily baseflow rate (%)	31
Groundwater properties – daily seepage rate (%)	0

5.6.2 Stormwater quality results

Bioretention basin

A bioretention basin is the proposed treatment train to be utilised within the site to treat stormwater pollutants. The basin uses a vegetated base where stormwater runoff is filtered through a filter media layer as it percolated downwards. The runoff is then collected through a series of under-drains towards an outlet pit and pipe before discharging into the receiving environment.

The adopted bioretention basin parameters have been applied as specified in Water Sensitive Urban Design for the Coastal Dry Tropics (Townsville): Design Objectives for Stormwater Management (AECOM + McGarry and Eadie, 2011). These are provided in Table 27.

The conceptual location and footprint of the proposed basin is indicated in Figure 11. This is to be refined further as the Project progresses to detailed design.

Table 27 *Bioretention details*

Parameter	Value
Surface area (m ²)	3300
Filter area (m ²)	3300
Extended detention depth (m)	0.3
Filter media depth (m)	0.5
Saturated hydraulic conductivity (mm/h)	200
TN content of filter media (mg/kg)	400
Orthophosphate content of filter media (mg/kg)	30
Overflow weir width (m)	5.5

The results from the MUSIC model are outlined in Table 28.

Table 28 *MUSIC model results*

Pollutant	Sources (kg/yr)	Residual load (kg/yr)	% reduction	% reduction target
Total suspended solids	33,000	5560	83	80
Total phosphorus	64.8	22.3	66	65
Total nitrogen	304	184	40	40
Gross pollutants	2500	71.2	97	90

This demonstrates that the proposed treatment train achieves the required reduction targets in line with the Townsville City Plan requirements.

6. Conclusions and recommendations

The system described here-in, at a concept design level, meets the relevant planning frameworks, i.e. SP TSDA Development Scheme and the TCC City Plan, as the post-construction Phase Stormwater Management Design Objectives were simulated to have been met, minor and major storms are managed within the required criteria and the proposed detention basin configuration reduce the post development peak discharge leaving the site to less than the pre-development peak flow rates. In addition, all outlets have energy dissipation elements to reduce flow velocities, reduce the risk of scour and to disperse stormwater leaving the site, which will mitigate significant potential impacts to the receiving environment.

The OWS system will collect potentially contaminated water and convey it to a first flush system, which will capture the first 15mm of a rainfall event, for testing and, if compliant, release. If not compliant, the water will be treated on site prior to release.

The tank farm area will be bunded, with controlled outlets. The bunding has been sized to accommodate the volume of a 24-hour rainfall event and the largest tank volume. Rainfall captured in this area will be tested and, if not contaminated, will be released to the environment through the regular stormwater system, after the peak of the event has passed. If the tested water in the bunded area is found to be contaminated, it will need to be dealt with by on site personal (depending on the pollutant) and potentially removed off site to a licensed treatment facility.

Based on the context provided here-in, the following provides the general recommendations that should be considered in the design stage of the development:

- Update the stormwater management plan design for any future proposed layout changes (if and when they originate).
- Determine whether climate change (beyond the current ARR 2019 requirements for present day uplift requirements) impacts are acceptable within the context of the stormwater management plan.
- Use the regional flood study to set the finished floor levels.
- Consult with TCC to understand their requirements for finished floor level immunity, especially for the potentially contaminated areas and the areas storing contaminants (such as hydrocarbons, ethanol, sulfuric acid and caustic).
- Consider Fire Water as a design case for the potentially contaminated system.
- Noting that the norther portion of the site is located within the Environmental Management Precinct of the Townsville SDA, resolve the relevant approvals needed to allow development to progress in this area.

7. References

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- Queensland Urban Drainage Manual. the Institute of Public Works Engineering Australasia, Queensland (IPWEAQ).



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