Little Mindil Beach

25 Gilruth Avenue, The Gardens, Northern Territory

Stormwater Management Plan

KTT Investments Pty Ltd

17 June 2021

Document Verification

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Document Control

Date	Document	Revision No.	Author	Reviewer
01.02.21	Stormwater Management Plan	01	H Davidson	B. Loughlin
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Approval for Issue

Name	Signature	Date
Harris Davidson		17.06.2021
Brian Loughlin		17.06.2021

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EXECUTIVE SUMMARY

ADG Engineers (Aust.) Pty Ltd was engaged by KTT Investments Pty Ltd to prepare a Stormwater Management Plan (SMP) as additional information in support of a Development Application for a proposed mixed-use development located at 25 Gilruth Avenue, The Gardens, Northern Territory.

This report comprises of a stormwater quantity assessment for the proposed development. This assessment is undertaken to confirm no actionable nuisance of peak flow discharges from the site.

The quantity assessment has identified an increase in the total impervious area across the site as a result of the proposed development. One of the implications of an increase in impervious area is that the total volume and peak flow rate of stormwater runoff from the catchment will increase. Although there has been an increase in peak runoff as a result of the proposed development, due to the sites immediate proximity to an open water body, being the Timor Sea, it is not recommended that detention measures will be required.

The quality assessment has identified that the development should include best practice measures for stormwater quality management in accordance with the Water by Design Deemed to Comply Solutions. Best-management practice for stormwater treatment measures will include:

- Option 1 –
  - 700m^2 of Bio-filtration basin;
  - Green roof; and
  - Litter baskets (200s EnviroPod of approved equivalent) placed within each inlet pit.
- Option 2 –
  - 190m^2 of Ocean Protect Filterra;
  - Green roof; and
  - Litter baskets (200s EnviroPod of approved equivalent) placed within each inlet pit.

All relevant standards and guidelines are addressed in the SMP including criteria from the City of Darwin Subdivision and Development Guidelines, QUDM and Water by Design Guidelines as well as the requirement of AS 3500.3.

1 INTRODUCTION

1.1 GENERAL

ADG Engineers (Aust.) Pty Ltd was engaged by KTT Investments Pty Ltd to prepare a Stormwater Management Plan (SMP) as additional information in support of a Development Application for a proposed mixed-use development located at 25 Gilruth Avenue, The Gardens, Northern Territory.

The purpose of this Stormwater Management Plan is to provide advice as to the development proposal as detailed in the Hachem architectural drawings in **Appendix A**. The works described herein are subject to further approvals and cover works required to service the proposed development with regard to stormwater management.

1.2 BACKGROUND INFORMATION

This report was compiled using information from the following sources:

- Dial Before You Dig' (DBYD) As-Constructed information;
- City of Darwin Council (CoD) As-Constructed information;
- City of Darwin Subdivision and Development Guidelines (2005);
- Architectural drawings by Hachem (**Appendix A**); and
- Survey Plan prepared by Land Surveys (**Appendix B**).

1.3 PROPERTY DETAILS

The total site area is approximately 5.13ha and the existing land titles are provided in **Table 1** below.

Table 1– Property Detail

Title	Lot 7651, Town of Darwin
Street Address	25 Gilruth Avenue, The Gardens, Northern Territory
Site Area	5.13ha

Figure 1 displays the locality of the subject site. The site is bound by Gilruth Avenue to the south-east, the Mindil Beach Casino to the north-east, the Timor Sea to the north-west and Burnett Place to the south.

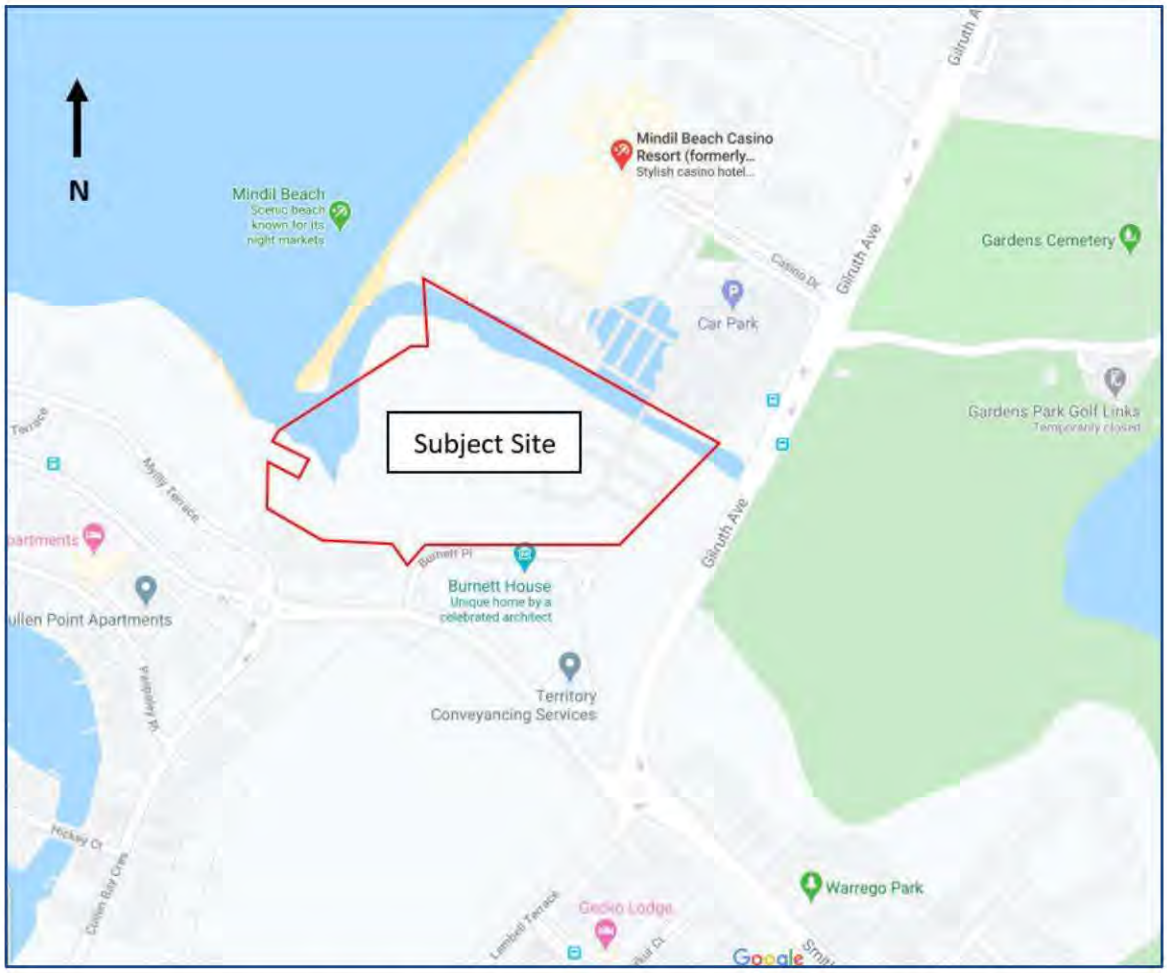


Figure 1 – Locality Map (As accessed from Google maps 30.04.2020)

1.4 Existing Site

The subject site is located at 25 Gilruth Avenue, The Gardens within the City of Darwin local government area and thus the stormwater drainage proposal will be assessed by City of Darwin Council officers. The subject site generally falls from south to north at a grade of approximately 1.00%. The site is bound by an existing 1 in 1 rock escarpment bordering the sites southern boundary.

As it currently stands, the subject site consists of one (1) freehold allotment which is predominantly pervious with an existing sealed carpark occupying the eastern half of the lot. These features account for approximately 30% of the site area. The remaining area may be described as good grass coverage with medium permeability. **Figure 2** illustrates these existing features.

Refer to **Appendix B** for the detailed survey plan prepared by Land Surveys.

Figure 2 – Existing Site Condition (As Accessed from Nearmap 30.04.2020)

2 PROPOSED DEVELOPMENT

2.1 Development Yield

The proposed development will seek approval for development to create a multi-story hotel, apartment and luxury villa precinct including commercial and function tenancies.

A breakdown of the areas for the proposed development is presented in **Table 2**.

Table 2 – Proposed Development Areas

Land Type	Area (m^2)	Percentage of Total Site Area
Roof Area (Impervious)	18,600	36%
Ground Area (Impervious)	4,520	9%
Ground Area (Pervious)	26,140	51%
Lagoon Area (Impervious)	2,040	4%
TOTAL	**51,300**	**100%**

Refer to the Architectural drawings prepared by Hachem in **Appendix A** for further information regarding the proposed development.

2.2 Existing Stormwater Infrastructure

Based on information gathered via survey, contour data, aerial imagery and site investigations, it has been determined that the majority of the subject site currently discharges via sheet flows towards the north-eastern boundary. Runoff generated within the site is conveyed toward an existing creek located within the site running parallel to the site's northern boundary. Runoff is then ultimately discharged to the adjacent Timor Sea.

A summary below identifies the existing stormwater infrastructure within the vicinity of the subject site:

- An open-channel natural creek located within the development running parallel to the northern boundary of the site. This drain conveys runoff west to the Timor Sea; and
- The Timor Sea located to the sites north-western boundary.

2.3 Point of Discharge

2.3.1 Existing PD

The existing Lawful Point of Discharge for the site has been identified as the existing creek running parallel to site's northern boundary. ADG note the existing Point of Discharge can be considered tidal as the existing creek within the allotment forms the mouth of the catchment to the Timor Sea.

2.3.2 Proposed PD

The existing Point of Discharge, being the creek running parallel to site's northern boundary, will be maintained for the proposed development. It is proposed to discharge flows to the creek via a

headwall outlet. The proposed outlet will need to consider tidal influence and the affected pipework will need to be saltwater cover class or a material not susceptible to saltwater corrosion (ie Poly Propylene). The proposed outlet should consider the installation of a non-return valve to regulate tidal influence to the internal hydraulic network.

Refer to **Appendix C** for a preliminary stormwater management layout plan which identifies the location of the Lawful Point of Discharge.

2.4 External Catchments

A large external catchment has been identified to discharge to the subject site through the existing creek located within the site parallel to northern boundary. Runoff from this catchment is captured and channelized prior to the subject site and is conveyed within the existing open-channel creek. As such this external catchment does not negatively burden the subject site.

2.5 Flooding Considerations

Refer to the Hydraulic Assessment Prepared by ADG Engineers (Aust.) Pty Ltd for further information on the flooding considerations for the proposed development (Ref: 23085 C R003 dated 28/01/2021).

3 STORMWATER QUANTITY ASSESSMENT

3.1 Proposed Development and Associated Issues

One of the implications of an increase in impervious area is that the total volume and flow rate of stormwater runoff from the catchment will increase. It is essential that these increases are mitigated such that post-developed peak flows and volumes do not exceed those for the pre-developed case. The aim of the stormwater quantity assessment is to:

- Address the need for stormwater quantity control measures.
- Ensure there is no increase in peak discharges from the subject site for events up to and including the 1 in 100 year ARI event.
- Ensure proposed quantity control measures detain and convey flows in accordance with QUDM (2017) minimum freeboard recommendations.

3.2 Flow Rate Methodology

3.2.1 Design Storm Events

Based on recommendations within QUDM 2017, AS/NZ 3500.3 and Council standards the major and initial storm events were selected as follows:

- Initial Event: 1 in 10 year ARI
  - Captured within pit and pipe drainage infrastructure through to Point of Discharge.
- Major Event: 1 in 100 year ARI
  - Surface drainage overflows in events up to and including the 1 in 100 year ARI are to be captured with overland flows paths and road corridors and will not present a hazard to people or cause significant damage to property.

Pipe sizing will be performed during detailed design and increased as required to ensure a safe depth vs velocity is maintained at all times during the major event.

3.2.2 Rational Method for Peak Flow Rate

The peak flow rate for the site has been obtained using the Rational Method in accordance with ARR and QUDM. Summaries of the hydrology calculations can be seen in **Sections 3.3** and **3.4** for the pre and post-development scenarios respectively.

$$Q = (2.78 \times 10^{-3})\ Cy\ Iy\ A \qquad \textbf{Equation 1}$$

Q = Peak flow rate (m3/s) for average recurrence interval

Cy = Co-efficient of runoff for ARI of y years (dimensionless)

A = Catchment area (ha)

Iy = Average rainfall intensity (mm/hr) for a design duration of t hours and an ARI of y years

3.3 Pre-Development Hydrology

ADG's pre-development stormwater catchment plan has been provided in **Appendix C** for further information on the location of the existing catchment and the corresponding point of discharge.

The hydrology of the pre-developed catchment has been assessed in accordance with QUDM Section 4.0 using the Rational Method. From QUDM Section 4.0, the theoretical calculated peak discharge for storm events ranging from the 1 in 1 year to 1 in 100 year ARIs has been calculated and a summary of the results is presented in **Appendix D**.

3.3.1 Existing Catchment 'A'

Catchment A has an area of 5.13ha and discharges naturally via overland sheet flow over the northern boundary. Since Catchment 'A' is 30% impervious corresponding to a fraction impervious of 0.30, QUDM 2013 (Table 4.5.3) recommends a C_{10} value of 0.76.

A time of concentration (t_c) of 18.8 minutes has been calculated for the pre-development scenario.

Refer to the Pre-Development Stormwater Catchment Plan in **Appendix C** for further information on the existing catchments.

3.3.2 Rational Method Pre-Development Summary

Table 3 provides a summary of the pre-development peak flow rates calculated using the Rational Method.

Table 3– Pre-development Peak Flow Rates

Catchment	Area (ha)	tc (min)	Coefficient of Discharge			Peak Flow Rate (m^3/s)		
			C_1	C_{10}	C_{100}	Q1	Q10	Q100
A	5.19	18.8	0.61	0.76	0.91	0.79	1.64	2.86

3.4 Post-Development Hydrology

The following sections will assess each catchment in terms of post-development hydrology. The key difference is the increase in impervious areas and shorter time of concentration resulting in an increase to the calculated peak flows.

The hydrology of the pre-development catchments has been assessed in accordance with QUDM Section 4.0 using the Rational Method. From QUDM Section 4.0, the theoretical calculated peak discharge for storm events ranging from the 1 in 1 year to 1 in 100 year ARIs has been calculated and a summary of the results is presented in **Appendix D**.

3.4.1 Proposed Catchment 'C1'

Proposed development Catchment C1 is approximately 49% impervious. A breakdown of the proposed development areas has been provided in Section 2 of this report. QUDM 2013 (Table 4.5.4) recommends a C_{10} value of 0.80 will be required for the corresponding fraction impervious of 0.49.

Due to the high impervious area and the relatively short length of flow for the post-development catchment, a standard inlet time of 10 minutes has been adopted.

Refer to the Post-Development Stormwater Catchment Plan in **Appendix C** for further information on the proposed catchments. Refer to **Appendix C** for a Preliminary Stormwater Management Layout Plan which identifies the location of the discharge point.

3.4.2 Rational Method Post-Development Summary (Unmitigated)

Table 4 provides a summary of the post-development unmitigated peak flow rates calculated using the Rational Method for the catchment.

Table 4– Post-development Peak Flow Rates (Unmitigated)

Catchment	Area (ha)	tc (min)	Coefficient of Discharge			Peak Flow Rate (m^3/s)		
			C_1	C_{10}	C_{100}	Q1	Q10	Q100
C1	5.19	10	0.64	0.80	0.96	1.05	2.21	3.88

3.5 Recommendation

As demonstrated in **Tables 3** and **4**, there has been an increase in peak flow from the pre to post development unmitigated stage. Although there has been an increase in peak runoff as a result of the proposed development, due to the sites immediate proximity to an open water body, the Timor Sea, it is not recommended that detention measures will be required.

Stormwater drainage infrastructure will be implemented throughout the site to convey stormwater to the proposed point of discharge. A pit and pipe system will be utilised to convey the minor storm flows to the point of discharge. Runoff from a major rainfall event (1 in 100 year) will be conveyed as overland flow through the centralised driveway (ensuring a depth velocity multiplier of less than 0.40) to the point of discharge.

The above proposal is subject to further approvals from City of Darwin, NTG Department of Infrastructure, Planning and Logistics (DIPL) and Department of Environment and Natural Resources (DENR).

Refer to the preliminary stormwater management layout plan in **Appendix C** for further information on the stormwater mitigation scheme.

4 STORMWATER QUALITY ASSESSMENT

This section considers stormwater runoff quality and assesses possible methods of treatment and the subsequent impacts on the drainage strategy. The section determines how to make sure that stormwater leaving the site complies with relevant stormwater quality improvement standards.

This section covers:

- Roof, pavement and hardstand runoff to relevant treatment devices;
- Landscaping runoff;
- Infiltration into the basement; and
- Ensuring treatment device selection criteria are in accordance with Industry Best Practice and, WSUD Engineering Guidelines.

4.1 Site Analysis and Design Strategy

The proposed development and total proposed pervious and impervious areas are summarised in **Table 2** in Section 2 of this report.

Currently no formal stormwater quality management measures are in place for the subject site. The proposed development offers the opportunity to provide stormwater quality treatment where none exists at present.

A MUSIC model analysis was undertaken to determine the extent of the treatment required for the site to achieve the pollutant reduction targets as identified in the NT Subdivision Guidelines. Stormwater treatment measures will include:

- Option 1 –
  - 700m^2 of Bio-filtration basin;
  - Green roof; and
  - Litter baskets (200s EnviroPod of approved equivalent) placed within each inlet pit.
- Option 2 –
  - 190m^2 of Ocean Protect Filterra;
  - Green roof; and
  - Litter baskets (200s EnviroPod of approved equivalent) placed within each inlet pit.

Stormwater within the proposed roof areas of the development will be initially treated through the provision of green, landscaped roofs. The internal hydraulic drainage network will direct then flows to *200s EnviroPod* litter baskets located within several of the proposed inlet pits prior to discharging to either the bio-filtration system (Option 1) or Filterra (Option 2) located within the landscaping areas of the development and ultimately from the site. Internal hydraulic stormwater drainage shall be designed and constructed in accordance with AS3500.3 and all other relevant standards and guidelines.

The above proposal is subject to further approvals from City of Darwin (CoD) and NTG Department of Environment and Natural Resources (DENR).

For further information on the conceptual layout of the proposed development refer to Architectural drawings in **Appendix A**.

4.2 MUSIC Modelling Results

The sites stormwater run-off was modelled using MUSIC version 6.3.0. The 6-minute rainfall data from 14015 Darwin monitoring site was utilised in the modelling (as recommended by Water by Design Music Modelling Guidelines 2010 and the NT Subdivision Guidelines).

The utilised data was over a 10-year timeframe from 1987 to 1996. Pollutant export parameters for the catchment's different land use types were applied in accordance with Table 3.8 of the above stated guidelines. The objective at each LPD was to achieve the desired target pollutant reduction levels as specified in the NT Subdivision Guidelines dated August 2020. The target pollutant reduction levels were as follows:

- 75% Reduction in Total Suspended Solids (TSS);
- 60% Reduction in Total Phosphorus (TP);
- 35% Reduction in Total Nitrogen (TN); and
- 90% Reduction in Gross Pollutants.

The following results meet the percent reduction water quality objectives identified by the NT Subdivision Guidelines. Refer to Error! Reference source not found. for further information on the M USIC Model compiled by ADG.

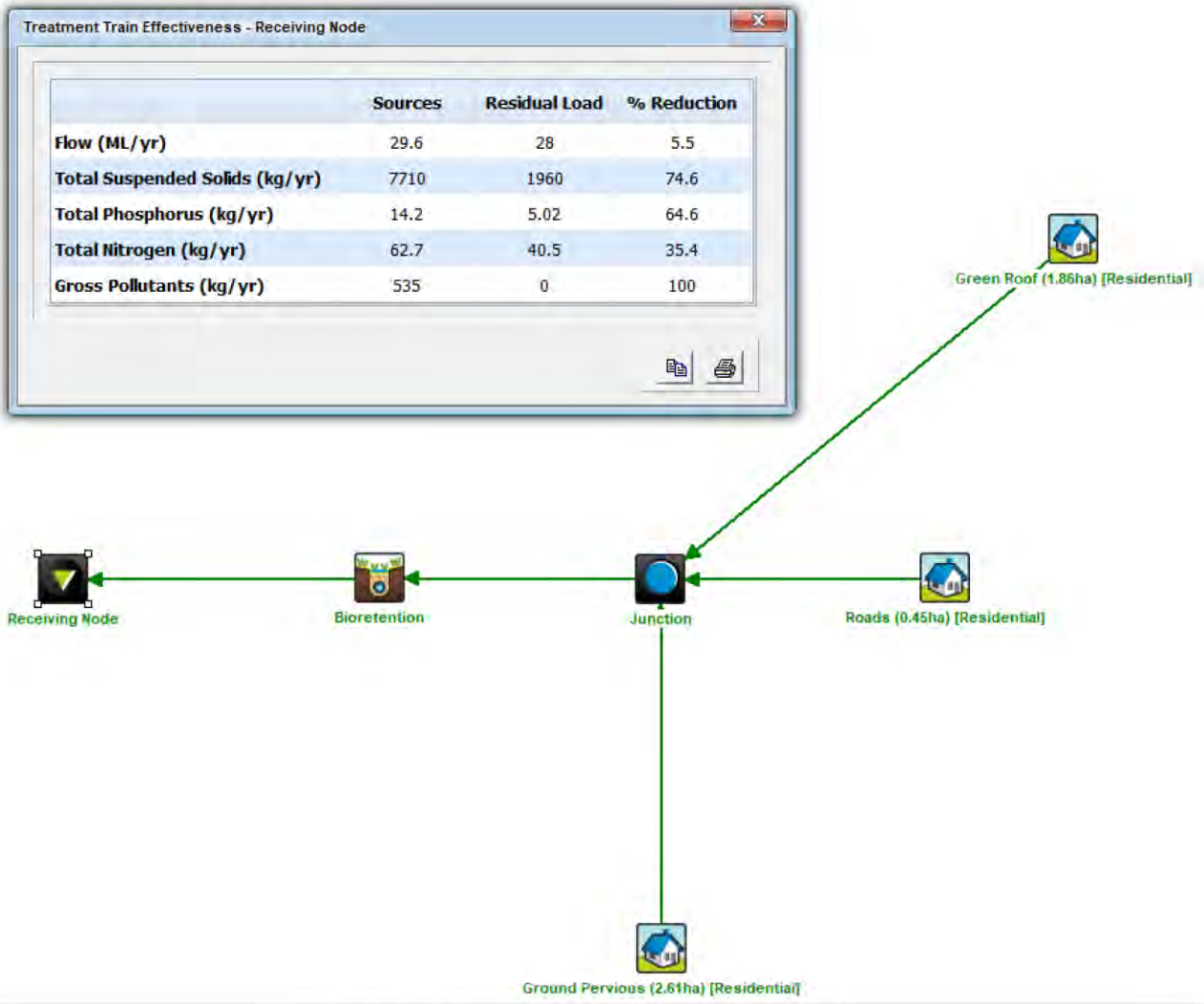
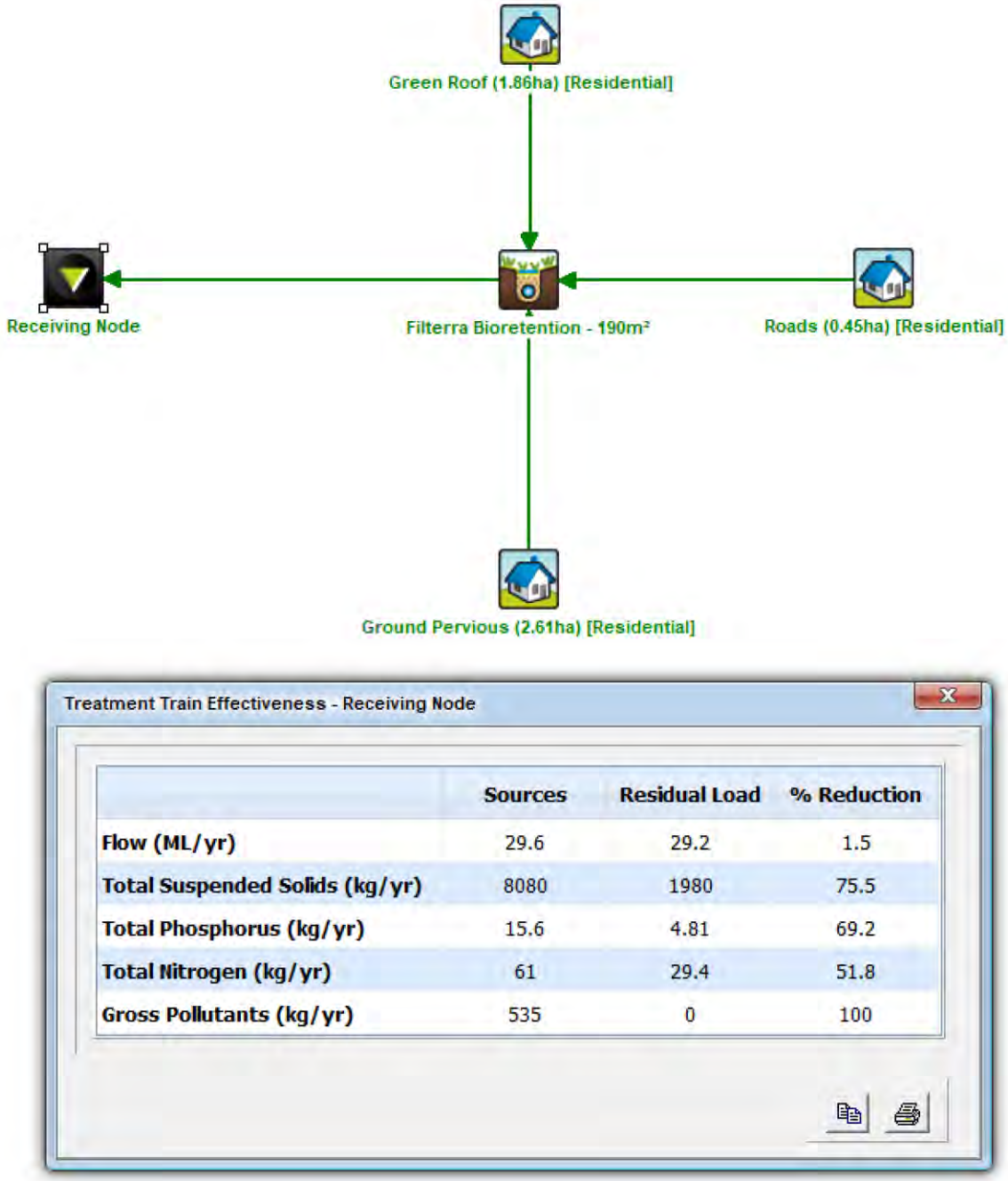


Figure 3 – Treatment Train – Option 1



	Sources	Residual Load	% Reduction
Flow (ML/yr)	29.6	29.2	1.5
Total Suspended Solids (kg/yr)	8080	1980	75.5
Total Phosphorus (kg/yr)	15.6	4.81	69.2
Total Nitrogen (kg/yr)	61	29.4	51.8
Gross Pollutants (kg/yr)	535	0	100

Figure 4– Treatment Train – Option 2

The above results for Options 1 and 2 respectively meet the percent reduction water quality objectives identified by the NT Subdivision Guidelines.

4.3 Operational phase

Once commissioned by the Superintendent and Project Engineers, the Stormwater Quality Improvement Devices (SQIDs) will provide the required level of stormwater quality treatment to runoff from the site prior to discharging into the stormwater drainage infrastructure. It is expected that sediment laden runoff and the erosion potential at the subject site during the operational phase will be minimal. This is due to the high amount of permanent impervious area in the form of roofs, paths,

courtyards, driveways and other impervious structures. The new landscaped areas will be maintained in a manner that will minimise erosion.

4.4 Stormwater Quality Improvement Devices (SQIDs)

Maintenance of the SQIDs will be the responsibility of the Site Manager or Owner, as determined. The maintenance should be carried out in accordance with the manufacturer's recommendations and in line with the maintenance schedule as specified in **Section 5.**

4.4.1 EnviroPod

EnviroPod litter baskets are small baskets consisting of a steel frame and a cage that can be fitted inside standard stormwater inlet pits. Within the cage a screening bag is attached to capture litter, debris, sediment and other pollutants from stormwater flows. The mesh size of the screening bag proposed for each *EnviroPod* within the site is to be 200 micro-meters. The mesh size is small enough to capture heavy metals and hydrocarbons associated with solids in the stormwater flows.

4.4.2 Green Roofs

As identified in the architectural layout plans prepared by Hachem in **Appendix A**, the development proposal intends to implement green roofs as an aesthetic feature to the net roof area of each building. The green roofs will allow rainwater infiltration which will provide increased water filtration and improve water quality in comparison to a traditional impervious roof. Refer to the Architectural drawings in **Appendix A** for the location and details of the propsoed green roofs.

4.4.3 Bio-Filtration Basin

Bioretention basins remove contaminants and sedimentation from stormwater runoff via infiltration through layers of soil media. The basin is made of a 400mm filter media layer, a 100mm transition layer, and a 300mm drainage layer, located above in-situ soil. The basin is to be vegetated, as per the landscape architect's recommendations. These plants provide additional treatment, and will prevent clogging of the basin. Runoff within the bioretention area gradually infiltrates the soil layers, before discharging through an underdrain to the point of discharge.

4.4.4 Filterra

The Ocean Protect Filterra System is a high-flow bio-filtration/retention technology which has been optimised for high volume/flow treatment and high pollutant removal. The Filterra's small footprint allows it to be used on highly developed sites such as landscaped areas, parking lots and streetscapes. Stormwater runoff enters the Filterra System through an inlet and flows through the specially designed filter media prior to discharging to the receiving waterway. The filter media captures and immobilises pollutants; those pollutants are then decomposed, volatilised and incorporated into the biomass of the Filterra system's micro/macro flora and fauna. Stormwater runoff flows through the media and into an underdrain manifold at the bottom of the system.

4.5 Lifecycle Costs

All the recommended water quality treatment infrastructure lies within the development site and it shall be maintained and serviced by the owners of the development at no cost to Council. A lifecycle cost analysis is not part of the scope of this report.

4.6 Water Quality Monitoring

Water quality monitoring is not proposed for this development at this stage due to the nature of the development and the fact that no monitoring currently takes place by another statutory authority.

5 MAINTENANCE

Maintenance of the stormwater network will need to be undertaken regularly by the end user to ensure the system performs as required. **Table 5** outlines a maintenance schedule and associated corrective measures to ensure the stormwater network performs adequately.

Table 5 –Maintenance Schedule

Structure	Maintenance	Maintenance Trigger	Timeframe for Completion of Maintenance
Grate	Removal of all debris and build-up	The capacity of grated field inlet pit falls below 70%	Prior to the next storm
Inlet Pit Structure	Removal of all silt and debris build-up in base of pit	The capacity of grated field inlet pit falls below 70%	Prior to the next storm
Litter Basket	Removal of all silt and debris build-up in litter basket	The capacity of grated field inlet pit falls below 70%	Prior to the next storm
Stormwater Pipe	Removal of any blockages	The capacity of the stormwater network falls below 70%	Prior to the next storm
Non-Return Valve	Removal of any blockages including silt and debris build-up	The capacity of the stormwater network falls below 70%	Prior to the next storm
Bio-filtration Basin	In accordance with the Healthy Waterways guidelines "Guide to the Cost of Maintaining Bioretention Systems" dated February 2015.		
Filterra	In accordance with manufacturers maintenance management plan		

6 Erosion and Sediment Control

6.1 Pre-Development Phase

Prior to construction commencing, the following erosion and sediment control measures will need to be installed around the subject site to minimise disturbance and ensure the quality of runoff discharging from the site is of an acceptable standard:

- Sediment barriers to be installed on all entrances to downstream stormwater infrastructure (i.e. gully pits);
- Designation of transport routes through the site to minimise vegetation disturbance;
- Maximise retention of existing vegetation to reduce soil disturbance and provide filter strip treatment for runoff;
- Install construction entry and exit shakedown areas;
- Sediment fences are to be installed on the downstream boundaries of the subject site; and
- Install dust control measures as required.

All erosion and sediment control measures are to be designed and installed in accordance with IECA Guidelines. Further details regarding the proposed erosion and sediment control measures will be provided during the detailed design phase of the development.

6.2 Bulk Earthworks Phase

During the bulk earthworks phase, the following erosion and sediment control measure will need to be installed in addition to the aforementioned measures (Pre-Development Phase) to ensure there is minimal disturbance to downstream receiving water bodies:

- Construction chutes to control runoff over earthworks batters;
- Construction of temporary bunds at the top of all earthworks batters to ensure runoff is directed away from exposed batters;
- Sediment basins to be constructed at low points within each stage of the proposed development;
- Construction of temporary diversion drains to divert water to sediment basins and around any stockpiles;
- Sediment fences to be installed on the downstream side of any stockpiles; and
- Stabilisation of all batters upon reaching the finished earthworks levels.

All erosion and sediment control measures are to be designed and installed in accordance with IECA Guidelines. Further details regarding the proposed erosion and sediment control measures will be provided during the detailed design phase of the development.

6.3 Construction Phase

During the construction phase of the development, there is a risk of sedimentation transport due to large areas of disturbed land. The following erosion and sediment control measure will need to be installed in addition to the aforementioned measures (Pre-Development and Bulk Earthworks

Phases) to ensure there is minimal disturbance and the quality of runoff is maintained to an acceptable standard:

- Construction of temporary diversion drains to divert water to sediment basins;
- Construction of temporary diversion drains to divert water to protect treatment devices as required;
- Sediment barriers to be installed on all entrances to newly constructed stormwater infrastructure (i.e. gully pits);
- Sediment fences to be installed on the downstream side of any stockpiles and batters; and
- Re-vegetation of all disturbed areas within two (2) weeks of completion.

All erosion and sediment control measures are to be designed and installed in accordance with IECA Guidelines. Further details regarding the proposed erosion and sediment control measures will be provided during the detailed design phase of the development.

6.4 Maintenance of ESC Measures

All erosion and sediment control devices are to be maintained through the entire phase of the development leading up to the operational phase. Erosion and sediment control devices will need to be monitored closely throughout the entire project to ensure they are operating correctly and efficiently. No erosion and sediment control devices are to be removed unless otherwise authorised by a suitably qualified engineer or the site superintendent.

7 CONCLUSIONS

Detailed design is to address the above water quantity recommendations. In preparing this report, we have achieved all requirements for Stormwater Management Plans as described in the City of Darwin Subdivision and Development Guidelines, Water by Design Guidelines and QUDM standards, as well as the requirement of AS 3500.3.

Detailed engineering diagrams and management requirements for the proposed development are to be submitted to Council for approval prior to any works commencing on site with design certification prepared by a qualified stormwater engineer or scientist.

Appendix A
Architectural Drawings

(Refer to Appendix 1B of the NT EPA Referral)

Appendix B
Site Survey

SERVICE LEGEND

DRAINAGE
- COMBO PIT
- GRATE
- SIDE ENTRY PIT
- STORM WATER MANHOLE

ELECTRICITY
- CABLE MANHOLE
- CABLE PIT / BOX — ECP / ECR
- CABLE DOME
- CONSUMER POLE — CP
- LIGHT POLE — LP
- POWER POLE — PP
- STAY POLE — SP
- STAY WIRE ANCHOR — SWA
- O/H POWER LINE

GAS
- GAS MANHOLE
- GAS MARKER — G
- GAS METER — GM
- GAS VALVE — GV

SEWERAGE
- SEWER MANHOLE
- PROPERTY CONNECTION — PC
- SEWER LINE

TELECOMMUNICATION
- TEL / COMMS MANHOLE — T / C
- TEL / COMMS MARKER
- TEL / COMMS PIT — TEL / COM

WATER
- FLUSH POINT — FP
- HYDRANT — HY
- STOP VALVE — SV
- TAP — TAP
- WATER MARKER — W
- WATER METER — M
- WATER LINE

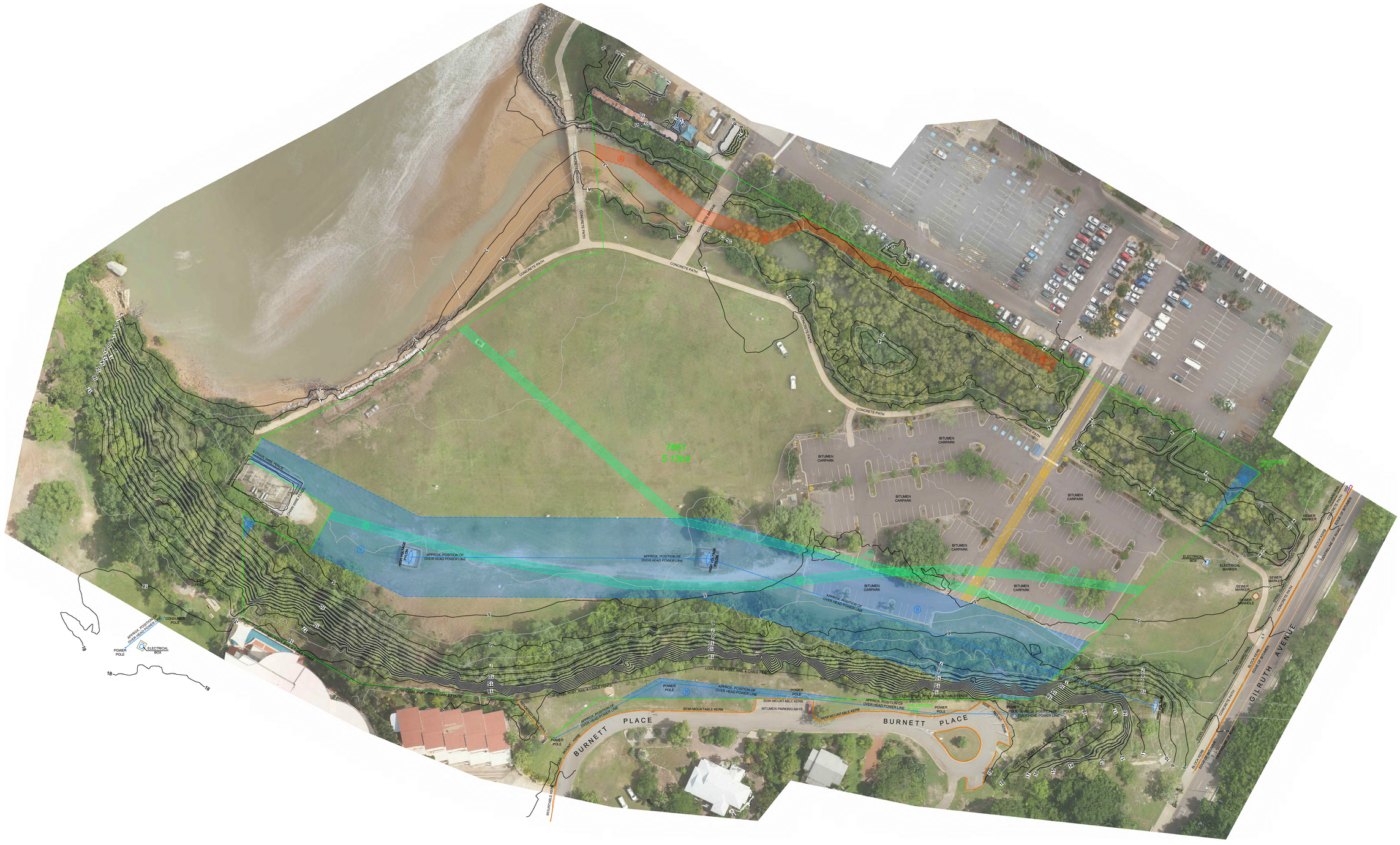
SURVEY
- DATUM
- PEG FOUND — PF

OTHER
- AWNING / EAVES
- ROOF RIDGE
- FLOOR RL
- WINDOW / DOOR — 1ST
- BANK - BOTTOM
- BANK - TOP

SERVICE RECORD

SERVICE \ STATUS	LOCATED	AVAILABLE	NOT AVAILABLE	CONFIRM
WATER	✓			
SEWERAGE	✓			
GAS				✓
TEL / COMM				✓
POWER U/G	✓			
POWER O/H	✓			

SERVICES MARKED CONFIRM REQUIRE BUILDER / CLIENT TO CONFIRM POSITION AND / OR AVAILABILITY ON SITE.



BOUNDARY INFORMATION SOURCED FROM THE NORTHERN TERRITORY ATLAS & SPATIAL DATA DIRECTORY. BOUNDARY LINE WORK HAS BEEN CONVERTED TO MGA BASED ON CRM S95220043, WITH A SCALE FACTOR OF 1.00038946 AND A GRID CONVERGENCE OF 0°23'40.83". BEARINGS & DISTANCES SHOWN ARE FROM SURVEY PLAN S2009/255A

Ⓐ = EASEMENT (SEWERAGE) BENEFIT TO THE POWER & WATER CORPORATION.

Ⓑ = EASEMENT (ELECTRICITY SUPPLY) BENEFIT TO THE POWER & WATER CORPORATION.

Ⓒ = EASEMENT (ELECTRONIC COMMUNICATIONS SUPPLY) BENEFIT TO TELSTRA CORPORATION LTD.

Ⓓ = EASEMENT (RIGHT OF WAY) BENEFIT TO THE POWER & WATER CORPORATION.

CONTOUR LEGEND - 0.5m INTERVALS
MAJOR CONTOURS 00
MINOR CONTOURS

NOTE:
THIS PLAN HAS BEEN PREPARED WITH 3D VALUES AND HAS MGA94 ZONE 52 COORDINATES.

NOTE:
AHD LEVEL DERIVED FROM COORDINATED REFERENCE MARK S95220043 - RL = 19.267

SURVEY CONTROL COORDINATE LISTING
MGA94 ZONE 52

NAME	EASTING	NORTHING	ELEVATION
CRM S95250001	699036.415	8622033.555	4.130
CRM S95220043	699506.915	8622841.908	19.267

REV	DESCRIPTION	DRN.	DATE	APP.

LOT : 7651 (# 25) GILRUTH AVENUE
SUBURB : THE GARDENS
SURVEY PLAN : S2009/255A
AUTHORITY : CITY OF DARWIN
C/T : 832 / 126

BUILDERS / CLIENTS: SITE SURVEY only. The information shown on this plan is current at the time of survey. Verify boundary information, easements etc. from the Certificate of Title. Plan / Diagram or a Boundary Regeg. Boundary position approximate only. Location of boundary pegs or fences in relation to the boundary at this time are not guaranteed. Swivel / meter may vary from schematic locations. Please have the site checked on-site to confirm service information with relevant Authorities. Refer to "Dial Before You Dig" for underground service confirmation. Consult Land Surveys on any anomaly before design and construction.

SCALE : 1:500 @ A0 Landscape

CLIENT : KTT INVESTMENTS PTY. LTD.
SURVEYED ON : 14/02/2020
SURVEYOR : LV / BZ
DRAFTER : MR

Land Surveys
29/113 Reichardt Road
WINNELLIE NT 0821
Telephone (08) 8948 1078
General@landsurveys.net.au

JOB No : 2000201 - PLAN: FS - DRG: 001 - REV. A - SHEET 1 OF 1

LS F 220

Appendix C
ADG Preliminary Plans

LEGEND

- EXISTING PROPERTY BOUNARY
- 12.00 EXISTING CONTOURS
- EXISTING OPEN DRAIN
- ESC CATCHMENT BOUNDARY
- A CATCHMENT LABEL
- DIRECTION OF FLOW

NOTE :
PRIMARY STORM SURGE (PSS) APPROXIMATE INUNDATION LEVEL IDENTIFIED AS 5.47m AHD BY NTG DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES.

CATCHMENT TABLE		
CATCHMENT ID	AREA	Fi
A	5.19ha	0.30

N

TIMOR SEA

EXISTING CREEK

A

7651
5.13ha

BURNETT PLACE

RUTH AVENUE

ISSUED FOR
INFORMATION ONLY

Rev	Date	Description	By	Chk
C	17.06.21	ISSUED FOR DISCUSSION	AM	HD
B	01.02.21	ISSUED FOR DISCUSSION	JMB	HD
A	01.06.20	ISSUED FOR INFORMATION	JMB	HD

0 10 20 30m
SCALE 1:500
AT ORIGINAL SIZE (A1)

Darwin Office
Suite G01, Manunda Place, 38 Cavenagh Street,
Darwin, Northern Territory 0800, Australia
GPO Box 2422, Darwin, Northern Territory 0801
T 1300 657 402 F +617 3871 2266
E info@adgce.com W www.adgce.com
BRISBANE / DARWIN / GOLD COAST / MELBOURNE / PERTH / SUNSHINE COAST / SYDNEY / TOOWOOMBA

Client: KTT Investments Pty Ltd	Discipline: CIVIL		Status: INFORMATION
Project Name: LITTLE MINDIL BEACH THE GARDENS, NORTHEN TERRITORY	Designed By: HD	Checked By: HD	Approved By: BL
	Project No.: 23085	Drawn By: JMB	Scale at A1: 1:1000

Title: STORMWATER CATCHMENT PRE-DEVELOPMENT PLAN

Drawing No.: DA_C010
Revision: C

PLOT DATE: 8/17/2021 4:48 PM FILENAME: J:\23000\23085\CVL\DWG\DA\23085_DA_C010_STORMWATER CATCHMENT PRE-DEVELOPMENT PLAN.DWG

FULL SIZE ON ORIGINAL 0 10 20 30 40 50 60 70 80 90 100mm

LEGEND

- EXISTING PROPERTY BOUNARY
- 12.00 EXISTING CONTOURS
- EXISTING OPEN DRAIN
- ESC CATCHMENT BOUNDARY
- C1 CATCHMENT LABEL
- DIRECTION OF FLOW

NOTE :
PRIMARY STORM SURGE (PSS) APPROXIMATE INUNDATION LEVEL IDENTIFIED AS 5.47m AHD BY NTG DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES.

CATCHMENT TABLE		
CATCHMENT ID	AREA	Fi
C1	5.19ha	0.49

N

TIMOR SEA

EXISTING CREEK

C1

BURNETT PLACE

RUTH AVENUE

ISSUED FOR
INFORMATION ONLY

Rev	Date	Description	By	Chk
C	17.06.21	ISSUED FOR DISCUSSION	AM	HD
B	01.02.21	ISSUED FOR DISCUSSION	JMB	HD
A	01.06.20	ISSUED FOR INFORMATION	JMB	HD

0 10 20 30m
SCALE 1:500
AT ORIGINAL SIZE (A1)

Darwin Office
Suite G01, Manunda Place, 38 Cavenagh Street,
Darwin, Northern Territory 0800, Australia
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E info@adgce.com W www.adgce.com
BRISBANE / DARWIN / GOLD COAST / MELBOURNE / PERTH / SUNSHINE COAST / SYDNEY / TOOWOOMBA

Client: KTT Investments Pty Ltd	Discipline: CIVIL		Status: INFORMATION
Project Name: LITTLE MINDIL BEACH THE GARDENS, NORTHEN TERRITORY	Designed By: HD	Checked By: HD	Approved By: BL
	Project No.: 23085	Drawn By: JMB	Scale at A1: 1:1000

Title: STORMWATER CATCHMENT POST-DEVELOPMENT PLAN

Drawing No.: DA_C011 Revision: C

PLOT DATE: 6/17/2021 4:48 PM FILENAME: J:\23000\23085\CIVIL\DWG\DA\23085_DA_C011_STORMWATER CATCHMENT POST-DEVELOPMENT PLAN.DWG

FULL SIZE ON ORIGINAL 0 10 20 30 40 50 60 70 80 90 100mm

LEGEND

- EXISTING SURFACE CONTOURS
- EXISTING ROAD
- SITE BOUNDARY
- PROPOSED STORMWATER DRAINAGE (INDICATIVE LOCATION ONLY)
- PROPOSED SWALE DISCHARGE
- PROPOSED FOOTPATH
- CLEAR ZONE
- PROPOSED ROAD PAVEMENT
- PROPOSED ROOFED AREA
- PROPOSED LAGOON AREA
- PROPOSED BIO-RETENTION BASIN OR FILTERRA
- PROPOSED STORMWATER PIT

STORMWATER QUALITY NOTES:

1. INLET PITS TO BE FITTED WITH ENVIROPOD 200S LITTER BASKET OR APPROVED EQUIVALENT.
2. ROOFWATER CATCHMENTS TO BE FITTED WITH FIRST FLUSH DEVICE.
3. GREEN ROOFS TO PROVIDE ADDITIONAL STORMWATER QUALITY FILTRATION.
4. BIO-RETENTION BASIN IN ACCORDANCE WITH DETAILS ON DRG DA_C013

TIMOR SEA

HEADWALL TO DISCHARGE TO CREEK. LOCATE HEADWALL IN SAME POSITION AS EXISTING.

EXISTING CREEK

MAINTAIN CLEAR ZONE FOR EMERGENCY OVERLAND FLOW POINT IN CASE OF MAJOR STORM EVENT.

MAINTAIN CLEAR ZONE FOR EMERGENCY OVERLAND FLOW POINT IN CASE OF MAJOR STORM EVENT.

BURNETT PLACE

GILRUTH AVENUE

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INFORMATION ONLY

Rev	Date	Description	By	Chk
C	17.06.21	ISSUED FOR DISCUSSION	AM	HD
B	01.02.21	ISSUED FOR DISCUSSION	JMB	HD
A	01.06.20	ISSUED FOR INFORMATION	JMB	HD

0 10 20 30m
SCALE 1:500
AT ORIGINAL SIZE (A1)

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Client	KTT Investments Pty Ltd
Project Name	LITTLE MINDIL BEACH THE GARDENS, NORTHEN TERRITORY
Discipline	CIVIL
Status	INFORMATION
Designed By	HD
Checked By	HD
Approved By	BL
Project No.	23085
Drawn By	JMB
Scale at A1	1:1000

Title	PRELIMINARY STORMWATER MANAGEMENT PLAN
Drawing No.	DA_C012
Revision	C

PLOT DATE: 6/17/2021 4:43 PM FILENAME: J:\23000\23085\CIVIL\DWG\DA\23085_DA_C012_PRELIMINARY STORMWATER MANAGEMENT PLAN.DWG

FULL SIZE ON ORIGINAL 0 10 20 30 40 50 60 70 80 90 100mm

BIO RETENTION NOTES:

INSPECTIONS:

1. CONTRACTOR TO CONTACT ADG ENGINEERS AT LEAST 48 HOURS PRIOR TO PLACEMENT OF EACH LAYER TO ORGANISE INSPECTION. EACH LAYER IS NOT TO BE PLACED UNTIL WRITTEN CONFIRMATION PROVIDED BY ADG ENGINEERS.

FILTRATION LAYER:

1. CONTRACTOR TO PROVIDE ADG ENGINEERS WITH TEST INFORMATION OF PROPOSED FILTER MEDIA TO CONFIRM THE BELOW PARAMETERS.
2. MATERIAL TO CONSIST OF SANDY LOAM OR EQUVALENT MATERIAL.
3. MATERIAL TO HAVE 5% - 10% ORGANIC CONTENT IN ACCORDANCE WITH AS1289.4.1.1
4. MATERIAL TO HAVE AN AVERAGE PARTICAL SIZE (D50) OF 0.45mm.
5. SATURATED HYDRAULIC CONDUCTIVITY TO BE BETWEEN 100-300mm/HR DETERMINED IN ACCORDANCE WITH AS 4419-1998 APPENDIX H SOIL PERMEABILITY.
6. pH BETWEEN 6 & 7.
7. TN CONTENT OF FILTER MEDIA TO BE <400mg/kg
8. ORTHOPHOSPHATE CONTENT TO BE <50mg/kg

DRAINAGE LAYER:

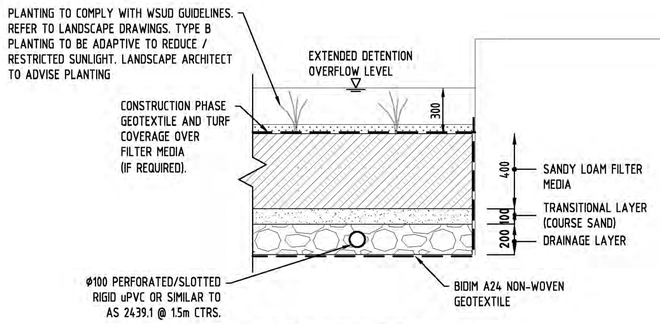
1. MATERIAL TO CONSIST OF 2-5mm GRAVEL.

PERFORATED PIPE:

1. 100Ø SLOTTED RIGID uPVC OR SIMILAR TO AS 2439.1 OR APPROVED EQUIVALENT MIN 0.5% GRADE @ 1.5m CTRS

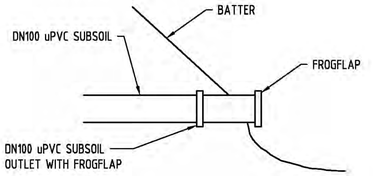
CONSTRUCTION PHASE:

1. COVER FILTRATION LAYER IN GEOTXTILE, 50mm TOPSOIL & TURF STRIPS PERPENDICULAR TO FLOW.
2. GEOTEXTILE TO BE REMOVED ONLY WHEN UPSTREAM SEDIMENT LOADS ARE CONTROLLED.
3. BASIN TO BE PLANTED AS PER THE APPROVED LANDSCAPE PLANS



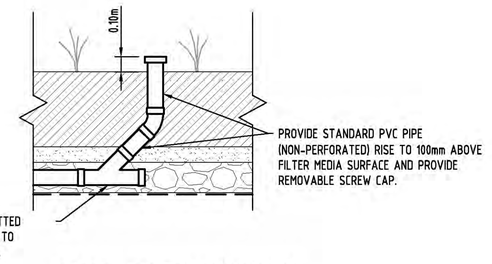
BIO-RETENTION SPECIFICATION

SCALE 1:20



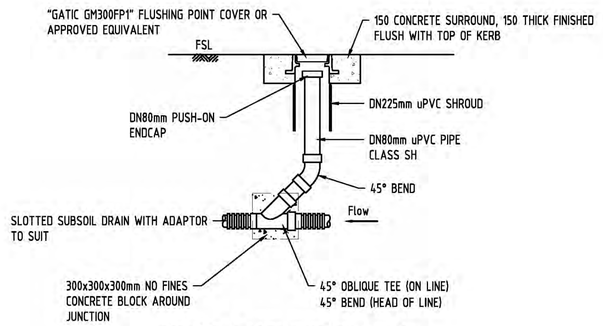
SUBSOIL DRAIN OUTLET TO BATTER/DRAIN

N.T.S.



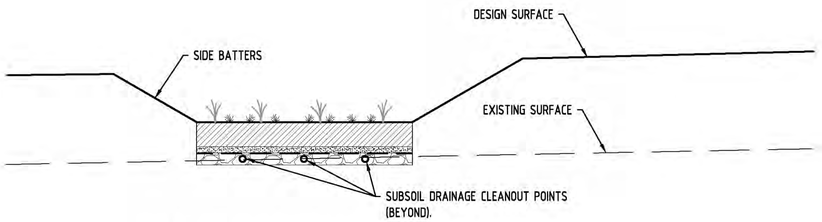
SUBSOIL DRAINAGE CLEANOUT TYPICAL DETAIL

(REFER STD IPWEAQ DETAIL ON DRG WSUD-003).
SCALE 1:20



SUBSOIL DRAIN FLUSHING POINT

N.T.S.



TYPICAL BIO-RETENTION (TYPE A) SECTION

SCALE 1:50

ISSUED FOR
INFORMATION ONLY

Rev	Date	Description	By	Chk
B	17.06.21	ISSUED FOR DISCUSSION	AM	HD
A	01.02.21	ISSUED FOR DISCUSSION	JMB	HD

0 1 2 3m
SCALE 1:50
AT ORIGINAL SIZE (A1)

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Client	KTT Investments Pty Ltd
Project Name	LITTLE MINDIL BEACH THE GARDENS, NORTHEN TERRITORY
Discipline	CIVIL
Designed By	HD
Checked By	
Drawn By	
Project No.	23085
Status	INFORMATION
Approved By	BL
Scale at A1	AS SHOWN
Title	BIO-RETENTION BASIN DETAILS
Drawing No.	DA_C013
Revision	B

PLOT DATE: 6/17/2021 4:43 PM FILENAME: J:\23000\23085\CIVIL\DWG\DA\23085_DA_C013_BIO-RETENTION BASIN DETAILS.DWG

FULL SIZE ON ORIGINAL 0 10 20 30 40 50 60 70 80 90 100mm

Appendix D
Rational Method Calculations

CIVIL DESIGN SPREADSHEETS

Project	Job #			Rev
Little Mindil Beach	23085			0
	Made by / date			
	HD		Apr-20	
Subject	Checked / date			
Pre-Development Catchment Runoff	SW		Apr-20	

RATIONAL METHOD CALCULATIONS (PRE-DEVELOPMENT)

PRE-DEV CATCH-MENT ID	AREA (ha)	Fi	Impervious Area (ha)	Pervious Area (ha)	C10	C1	C100	CA100	Sheet Flow Length (m)	Slope (%)	Mannings "n"	Sheet Flow Time (mins)	Channel Flow Time (mins)	Time of Conc. "tc" (mins)	Q1 Rainfall Intensity (mm/hr)	Q100 Rainfall Intensity (mm/hr)	Q1 Peak Flow (m3/s)	Q10 Peak Flow (m3/s)	Q100 Peak Flow (m3/s)
EX1	5.190	0.30	1.557	3.633	0.76	0.61	0.912	4.733	150	1.33	0.035	19	0	18.8	89.7	217.8	0.786	1.641	2.864

Notes:
1) Rational method calculations are in accordance with QUDM (2013) Volume 1 Chapter 4.0 where Q = CIA/360
2) Fraction Impervious and Mannings 'n' value estimated from site aerial imagery and topographical information
3) Intesity Frequency Duration Rainfall Data extracted from online Bureau of Meteorology 'Rainfall IFD Data System'
4) Time of concentration is sum of overland sheet flow time (Friend's eq.) plus channel time (Argue method)
5) C10 value for Fi values less than 0.10 assumes "medium" soil permeability and "poor" grass coverage

Project	Job #			Rev
Little Mindil Beach	23085			0
	Made by / date			
	HD		Apr-20	
Subject	Checked / date			
Post-Development Catchment Runoff	SW		Apr-20	

RATIONAL METHOD CALCULATIONS (POST-DEVELOPMENT)

POST-DEV CATCH-MENT ID	AREA (ha)	Fi	Impervious Area (ha)	Pervious Area (ha)	C10	C1	C100	CA100	Sheet Flow Length (m)	Slope (%)	Mannings "n"	Sheet Flow Time (mins)	Channel Flow Time (mins)	Time of Conc. "tc" (mins)	Q1 Rainfall Intensity (mm/hr)	Q100 Rainfall Intensity (mm/hr)	Q1 Peak Flow (m3/s)	Q10 Peak Flow (m3/s)	Q100 Peak Flow (m3/s)
C1	5.190	0.49	2.543	2.647	0.80	0.64	0.96	4.982	0	0.00	0	0	10	10.0	113.9	280.4	1.051	2.212	3.881

Notes:
1) Rational method calculations are in accordance with QUDM (2013) Volume 1 Chapter 4.0 where Q = CIA/360
2) Fraction Impervious and Mannings 'n' value estimated from site aerial imagery and topographical information
3) Intesity Frequency Duration Rainfall Data extracted from online Bureau of Meteorology 'Rainfall IFD Data System'
4) Time of concentration is sum of overland sheet flow time (Friend's eq.) plus channel time (Argue method)
5) C10 value for Fi values less than 0.10 assumes "medium" soil permeability and "poor" grass coverage

Appendix E
Storm Surge Flood Mapping and NTG Correspondence

Request from Harris Davidson about Storm Surge Level for the property Parcel – 7651, Town of Darwin, NT

The Surface Water group in DENR has carried out desktop study on storm surge level and flooding levels query for the property (**Parcel 7651, Town of Darwin, NT**) and have made the following comments based on available (published) relevant Mappings such as Storm Surge Flood Mappings and digital data as GIS layer:

SURFACE WATER COMMENTS:

- The lot of interest (**Parcel 7651** as shown in Figure 1 below**)** is affected by both Primary Storm Surge (PSS) and Secondary Storm Surge (SSS) inundation / flooding of 100 year and 1000 year ARI with approximate inundation levels as shown in Table 1 below *(Source: Darwin Area Storm Surge Inundation for 2100, November 2014 / prepared by GHD Pty Ltd for DLRM).*


5244
P1
S1
5772
5761
P6
S6
S5
7651
P2
S2
7656
P5
P4
S4
S3
P3


5244
P1
S1
5772
5761
P6
S6
S5
7651
P2
S2
7656
P5
P4
S4
S3
P3

Figure 1 Location of Primary and Secondary Storm Surge Levels (P – Primary; S – Secondary)

Table 1 Primary and Secondary Storm Surge Levels

Locations	Primary Storm Surge Level (PSS) (mAHD)	Secondary Storm Surge Level (SSS) (mAHD)
P1	5.46	-
P2	5.46	-
P3	5.47	-
P4	5.47	-
P5	5.47	-
P6	5.46	-
S1	-	5.75
S2	-	5.86
S3	-	5.85
S4	-	5.79
S5	-	5.75
S6	-	5.76

Appendix F
MUSIC Modelling Results

MUSIC Model Information

Introduction:

The quality of stormwater runoff and the impact of the proposed stormwater quality improvement measures were analyzed using MUSIC Version 6.3.0 according to the *MUSIC Modeling Guidelines Version 3.0, Water by Design 2018*. The source nodes in the model are split into various types and a summary of the area breakdown is presented below:

Meteorological Data:

The MUSIC model was carried out using the following parameters:

- Modeling period should be 10 years with a time step of 6 minutes
- The nearest available 6 minute time step rainfall series to the subject site is Darwin, with a mean annual rainfall of 1728 mm, and data from: 1987 to 1996.

Evaporation was applied as monthly mean. The mean annual evaporation was 1427 mm.

Source Nodes, Fractions Impervious:

The areas of the source nodes were estimated from the Functional Layout Plan as shown in **Appendix C**.

Source Nodes - Pollutant Exports:

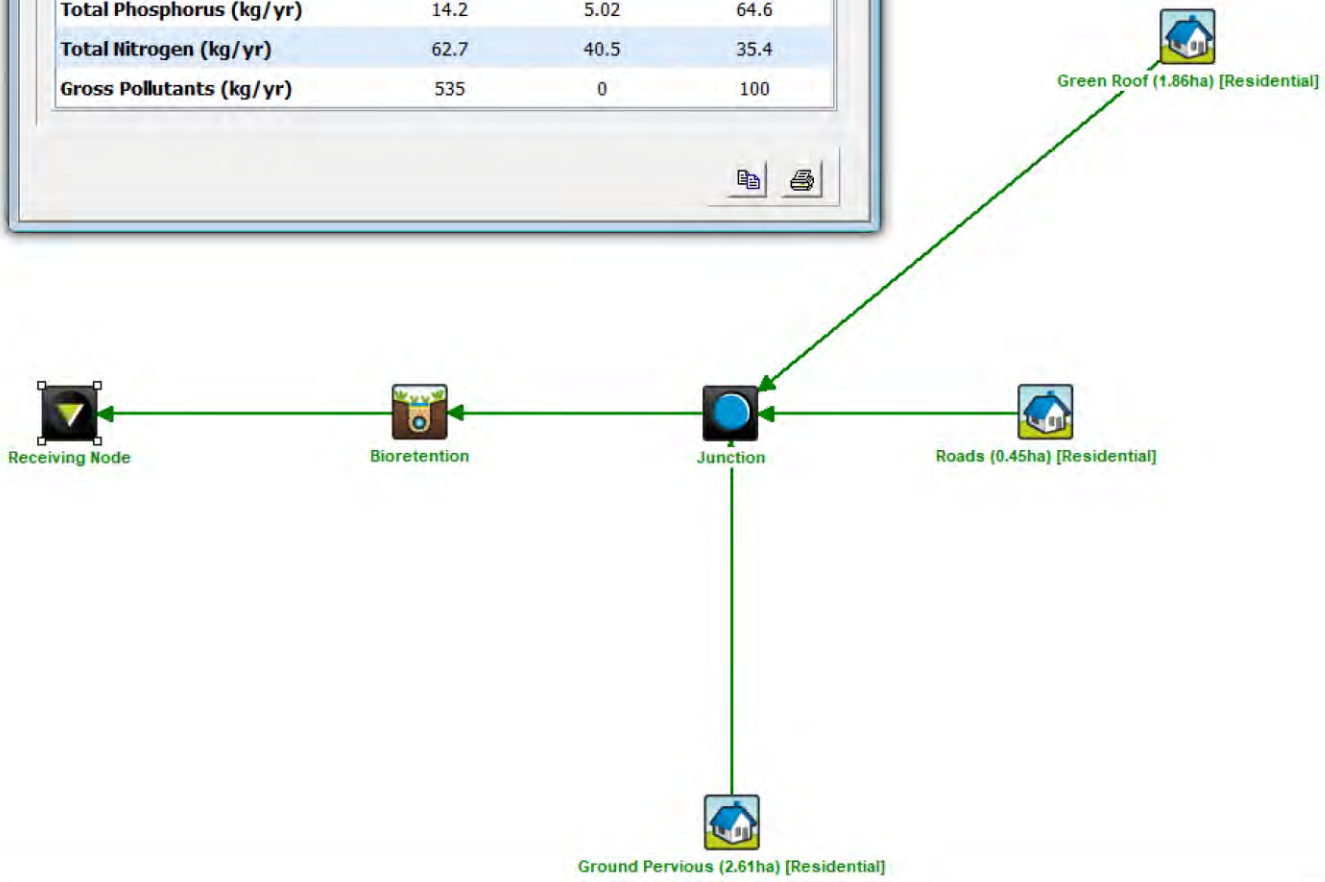
Rainfall runoff and pollutant export parameters were assigned per **Tables 3.7** and **3.8** of the Water by Design MUSIC Modeling Guidelines Version 1.0 (2010).

The rainfall runoff and pollutant export parameters for a residential development were adopted.

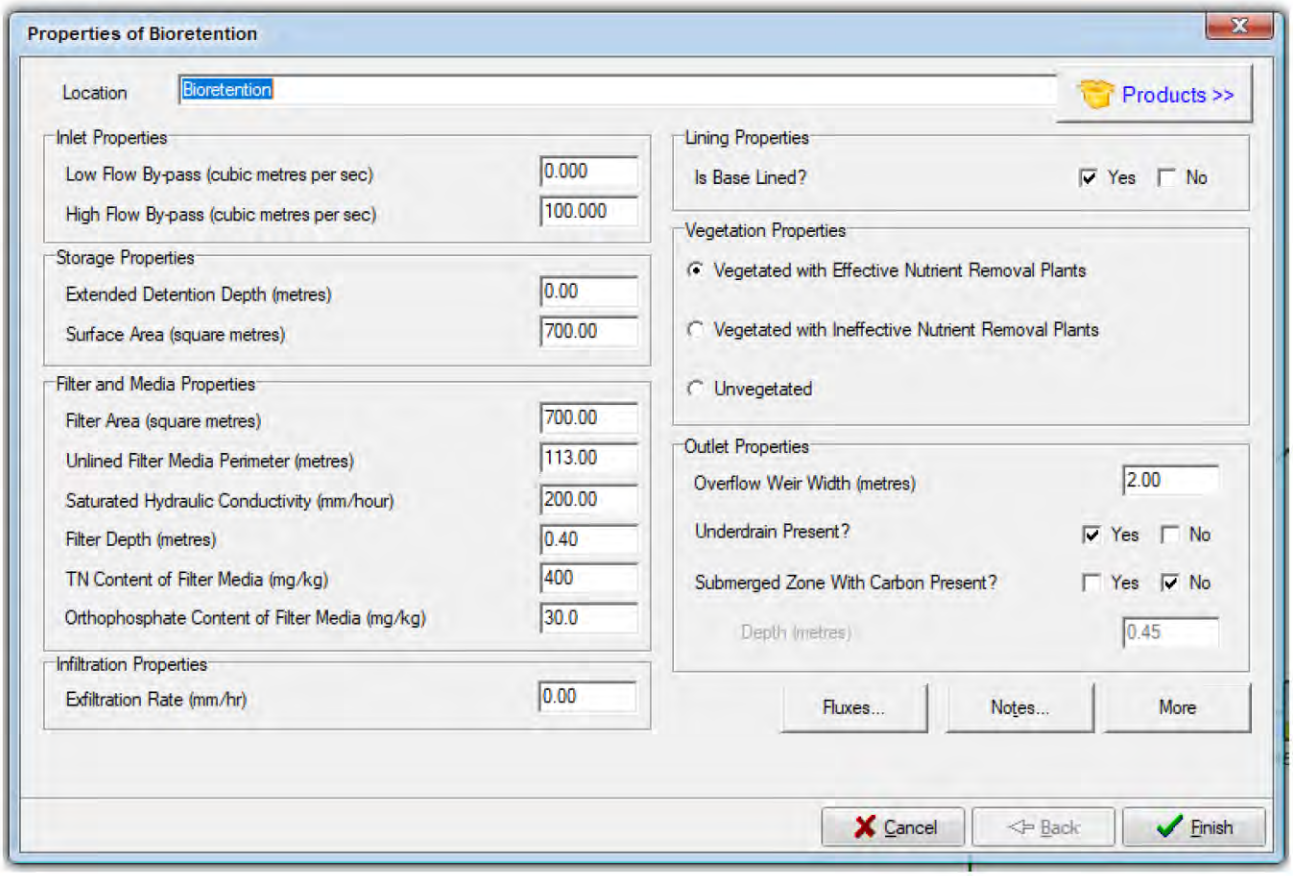
Option 1 Treatment Train Diagrams & Results

Treatment Train Effectiveness - Receiving Node

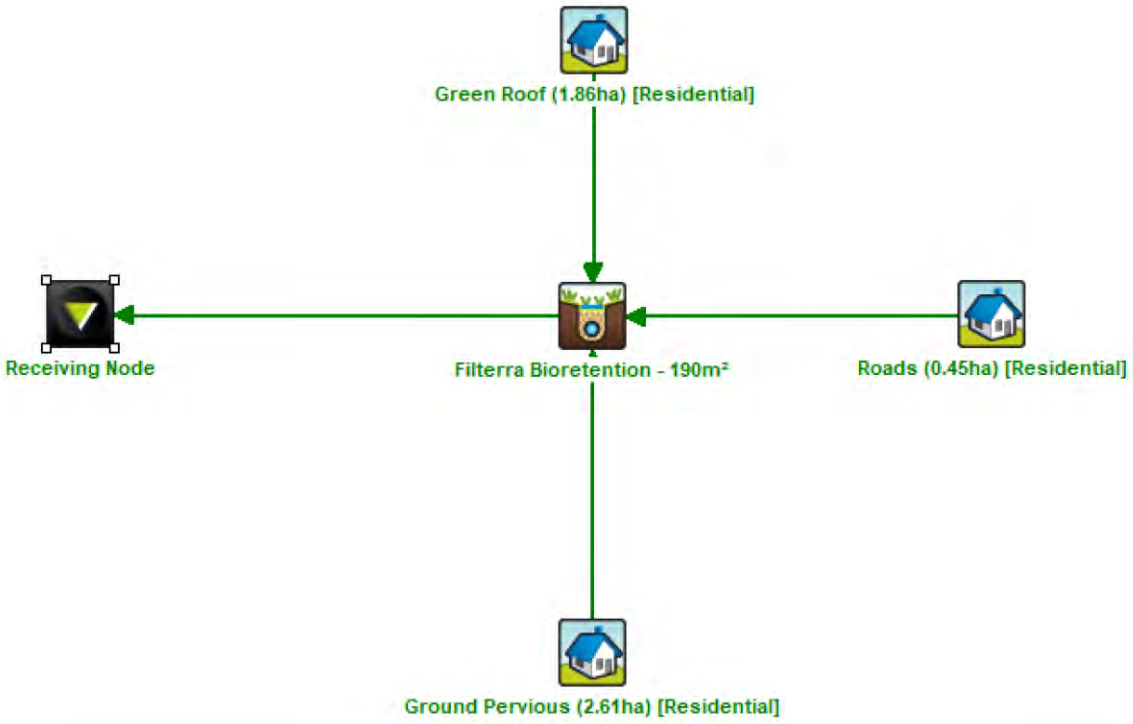
	Sources	Residual Load	% Reduction
Flow (ML/yr)	29.6	28	5.5
Total Suspended Solids (kg/yr)	7710	1960	74.6
Total Phosphorus (kg/yr)	14.2	5.02	64.6
Total Nitrogen (kg/yr)	62.7	40.5	35.4
Gross Pollutants (kg/yr)	535	0	100



Option 1 Bio-retention Basin:



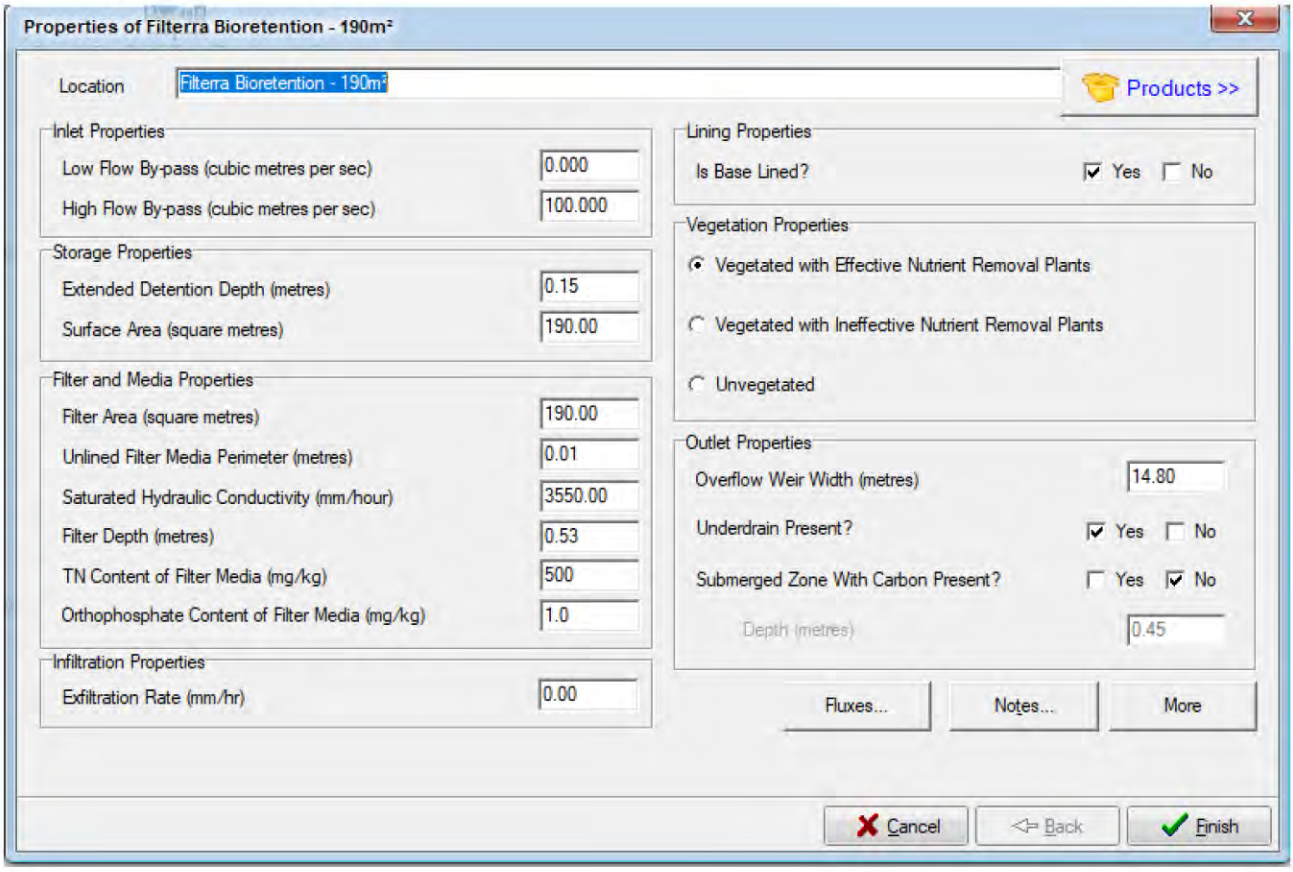
Option 2 Treatment Train Diagrams & Results



Treatment Train Effectiveness - Receiving Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	29.6	29.2	1.5
Total Suspended Solids (kg/yr)	8080	1980	75.5
Total Phosphorus (kg/yr)	15.6	4.81	69.2
Total Nitrogen (kg/yr)	61	29.4	51.8
Gross Pollutants (kg/yr)	535	0	100

Option 2 Filterra:



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Email: info@adgce.com

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PO Box 208
Southport, QLD 4215
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Perth
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Subiaco, WA 6904
PO Box 443
Subiaco, WA 6904
Phone: 1300 657 402
Email: info@adgce.com

ADG

ISO 9001
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