Wyvern Health P/L
C/- Bureau SRH

martens
consulting engineers

Stormwater Management and Water Balance Report: Lot 2, DP 1145029 4a Larool Road, Terrey Hills, NSW

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P1605687JR06V01
September 2021

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Background

1.1 Scope

This report summarises a stormwater and water balance assessment which has been undertaken by Martens and Associates Pty Ltd (MA) for the Wyvern Health private hospital development at 4A Larool Road, Terrey Hills, NSW ('the site'). This stormwater assessment has been prepared to address the following conditions of consent (DA2017/0385):

- Condition 11 - On-site Stormwater Detention Compliance Certification.
- Condition 14 - Stormwater Quality System.
- Condition 15 - Coastal Upland Swamp Recharge System.
- Condition 16 - Amendment to the On-Site Detention System Design.
- Condition 17 - Water Balance Model.

This report is to be read in conjunction with the Civil and Drainage Engineering Works planset by Martens and Associates (Ref: P1605687PS05).

1.2 Relevant Guidelines

This report has been prepared in accordance with the following standards / guidelines:

- Warringah Council On-site Stormwater Detention Technical Specification.
- Warringah Council Water Management Policy (2015).
- NSW MUSIC Modelling Guidelines (August 2015), compiled by BMT WBM.
- Northern Beaches Council WSUD & MUSIC Modelling Guidelines (2016).
- Adoption Guidelines for Stormwater Biofiltration Systems (2009), by the Facility for Advancing Water Biofiltration.

2 Stormwater Quality Assessment

2.1 Stormwater Quality Objectives

Consent Condition 14 requires the developer to:

> *'…ensure annual TSS, TN, TP and GP loads do not increase compared to a "natural conditions" pre development scenario. The treatment system must incorporate a rainwater capture/reuse system. MUSIC modelling must be completed to demonstrate compliance with the objectives of this condition.*
>
> *The Stormwater and Coastal Upland Swamp Recharge Systems must be designed to complement each other to ensure any changes to the natural hydrology and water quality of the Coastal Upland Swamp Endangered Ecological Community are avoided'.*

Further to the effective neutral or beneficial (NorBe) impact requirement as mentioned above, the following stormwater treatment targets as required by Northern Beaches Council WSUD & MUSIC Modelling Guidelines (2016) have been checked to ensure that the modelling treatment train is conservative:

- 85% reduction in total suspended solids (TSS).
- 65% reduction in total phosphorus (TP).
- 45% reduction in total nitrogen (TN).
- 90% reduction in gross pollutants (GP).

Maintenance of the site's hydrology *to the Coastal Upland Swamp Endangered Ecological Community* has been addressed by a detailed water balance assessment as documented in Section 3.

2.2 Modelling Methodology

2.2.1 Overview

MUSIC (version 6.3) developed by CRC for Catchment Hydrology was used to evaluate treatment train effectiveness (TTE) and pre-development and post-development pollutant loads from the site. The following modelling scenarios were considered:

1. Pre-development – the existing site was modelled to determine baseline pollutant generation rates for TSS, TP, TN and GP.

2. Post-development (untreated) – the developed site was modelled without any water quality treatment devices.

3. Post-development (treated) – the developed site was modelled with water quality treatment devices to achieve adopted objectives for nutrients and gross pollutants.

2.2.2 Approach

An iterative approach was used for post-development modelling to determine appropriate types, sizes and locations of stormwater treatment devices for modelling scenarios to achieve water quality objectives.

Individual treatment devices were assessed to determine the most effective treatment option.

2.2.3 Rainfall Data

MUSIC was run on a 6-minute time step from 01/01/1981 – 31/12/1985 using the Sydney Observatory pluviography. Average monthly evapotranspiration data for Sydney was obtained from Northern Beaches Council WSUD & MUSIC Modelling Guidelines (2016).

2.2.4 Input Parameters

Input parameters for source and treatment nodes are consistent with relevant guidelines or manufacture's specifications.

All MUSIC modelling inputs and treatment node parameters are provided in Attachment A.

2.2.5 Catchment Areas

Parts of the site that are not considered part of the development have been excluded from the model (such as the Duffys Forest EEC area). Any land that is proposed to be altered, have a change of land use or that drains towards a modelled water quality device is considered to be part of the development and has been included in the MUSIC model.

Pre-development and post-development pervious and impervious catchment areas are provided in MA planset PS05-E700.

2.3 Treatment Train Philosophy

The stormwater treatment strategy for the site uses roof water capture and reuse in combination with end of line controls to ensure objectives are satisfied. These are described below:

2.3.1 Rainwater Tank

A rainwater tank will be provided on Building 1 to capture roof water for reuse. Captured water shall be used for outdoor irrigation. The following was included in the modelling:

- 1 x 10 kL rainwater tank modelled at 80% of the volume capacity.
- An average external reuse rate of 200 kL/year was applied assuming a reuse rate of 0.4 kL/m^2/yr for areas available for irrigation.

2.3.2 Gross Pollutant Traps (GPTs)

SPEL Stormsacks (or similar) are pit inserts which are proposed to be implemented in nominated pits. This GPT device will be used to capture litter, debris and other pollutants. Pit inserts have been proposed to reduce the burden on and ease maintenance requirements of the bioretention basins.

2.3.3 Bio-infiltration Structures

Multiple biofiltration structures have been proposed to treat water before leaving the site. Basins provide treatment of water through filtration, biological uptake of nutrients, infiltration, evapotranspiration and detention. Basins have been sized to provide the necessary treatment to meet Council requirements.

Basins have been located to ensure surface and groundwater flows continue to discharge to the CUS, thus mimicking pre-development scenarios. This is discussed further in the water balance in Section 3. Some of the bioretention basins have also been proposed to act as onsite detention systems. Modelling to determine basin sizes for OSD has been completed and is provided in Section 4.

2.4 MUSIC Results

Modelling against the NorBE criteria for the developed site and the CUS has been undertaken with the results provided in and Table 2.

Table 1: MUSIC NorBe results: Pre development and post development for the developed site.

Parameter	Pre-development	Post-development	% Change	Complies (Y/N)
TSS (kg/year)	345.00	239.00	-30.72%	Y
TP (kg/year)	1.62	1.28	-20.99%	Y
TN (kg/year)	13.00	12.90	-0.77%	Y

Table 2: MUSIC NorBe results: Pre development and post development for the CUS.

Parameter	Pre-development	Post-development	% Change	Complies (Y/N)
TSS (kg/year)	206.00	59.80	-70.97%	Y
TP (kg/year)	1.06	0.496	-53.21%	Y
TN (kg/year)	9.09	5.35	-41.14%	Y

These results demonstrate that the NorBe criteria are achieved for both the developed site and the CUS. Water quality controls proposed reduce developed site pollutant loads below pre-development loads.

The results of the MUSIC model were also compared against Council's reduction targets to measure the systems treatment train effectiveness (TTE). These reduction targets are not a control for this development however the results of this check are available in Table 3. This configuration uses the proposed development with no treatment as the base case and compares it against the post development with treatment devices. MUSIC results demonstrate that the TTE criteria are achievable.

Table 3: MUSIC TTE results.

Parameter	Source	Residual Load	Achieved Reduction	Required Reduction	Complies (Y/N)
TSS (kg/year)	1710.00	239.00	86.0%	85%	Y
TP (kg/year)	3.89	1.28	67.1%	65%	Y
TN (kg/year)	32.60	12.90	60.4%	45%	Y
GP (kg/year)	353.00	11.00	96.9%	90%	Y

2.5 Conclusions

The MUSIC modelling results demonstrate that sediment, nitrogen phosphorus and gross pollutant loads do not increase post development (NorBe) for the overall developed site flows and flows tothe CUS. The proposed stormwater treatment system satisfies Consent Condition 14.

Furthermore, the effectiveness of the stormwater quality treatment system was found to comply with Council's reduction targets.

3 Water Balance Assessment

3.1 Water Balance Objectives

Condition 15 of the consent requires:

> *'… The Coastal Upland Swamp Recharge System shall be designed to ensure existing upstream groundwater and surface is intercepted and directed to the Coastal Upland Swamp. The recharge system must mimic the pre-development hydrological regime and be designed based on the outputs of the Water Balance Model…'*

Condition 17 of the consent requires:

> *'A detailed water balance model to be developed for the pre and post development catchments draining to the CUS. The model is to predict both surface and groundwater flows, frequency and volume. The modelling is to demonstrate maintenance of the pre development conditions (i.e. within +-10%)'.*

3.2 Modelling Methodology

3.2.1 Overview

A daily timestep water balance model has been developed using MUSIC to evaluate the volume and frequency of pre-development and post-development inflows to the CUS. The following scenarios were considered:

1. <u>Pre-development</u> – the existing site and upstream catchments draining to the CUS were modelled to determine baseline flow rates for both surface and groundwater flows.

2. <u>Post-development</u> – the developed site catchments draining to the CUS were modelled, including the water treatment devices. Refer to Section 3.3 for details of the Coastal Upland Swamp Recharge System.

3.2.2 Rainfall Data

MUSIC was run on a daily time step from 01/01/1925 – 31/12/1974 using the Sydney Observatory pluviography. This data period was chosen in accordance with Northern Beaches Council WSUD & MUSIC Modelling Guidelines (2016), and is considered acceptable because it is representative of the long-tern average annual rainfall of Northern

Beaches. Average monthly evapotranspiration data for Sydney was obtained from Northern Beaches Council WSUD & MUSIC Modelling Guidelines (2016).

3.2.3 Input Parameters

Input parameters are consistent with the parameters used for water quality modelling (see Section 2.2 for details) and are based on BMT WBM (2015) guidelines.

3.2.4 Catchment Areas

Any land (including upstream areas) that drains towards the CUS has been included in the water balance model.

Pre-development and post-development pervious and impervious catchment areas are provided in MA planset P1605687PS05.

3.3 Coastal Upland Swamp Recharge System

Details of the proposed stormwater management scheme elements relevant to the Coastal Upland Swamp Recharge System design are shown on MA planset P605687PS05 described below:

- Upstream Groundwater Interception Trench: A shallow groundwater interception trench is to be constructed on the western boundary of the proposed building to intercept sub-surface groundwater flows (above the soil rock interface) from the upstream catchment and redirect these around the building to an infiltration system just above the CUS. This will ensure that the magnitude and frequency of ephemeral groundwater flows to the CUS are maintained post-development.

- Unlined Bioretention Basins: the proposed bioretention basins are to be unlined and constructed without an underdrain. This design makes provision for water treated in the basins to infiltrate into the soil as it would under existing conditions. In the MUSIC model, the proposed basins have been sized to allow all excess runoff, created due to the development, to infiltrate into the soil. This will assist in groundwater recharge and maintenance of subsurface water levels.

- Basement drainage (i.e. below the soil / rock interface) will be isolated from bioretention basins using a clay bentonite seal to ensure infiltrated water flows to the CUS.

- Location of Bioretention Basins: Multiple bioretention basins have been proposed directly downslope of the proposed development footprints and upslope of the mapped CUS (rather than a single end of line basin in the lowest portion of the site). These basins will allow the infiltration of stormwater to occur downstream of the hospital facilities, thus mimicking subsurface flows into / through the CUS.

- Surface Water Discharge and Dispersion: The placement of basin outlet structures has been designed to ensure that discharge into the CUS will be well dispersed rather than concentrated, as it is currently. During larger storms, surface flows leaving the basins will be able to enter the CUS via level spreaders. The use of multiple basins and level spreaders will ensure that the flow into the CUS will mirror overland sheet flow, reflecting natural conditions.

Elements have been simulated in the post-development MUSIC model which shows that the existing flow regime is maintained in the post-developed condition.

3.4 Coastal Upland Swamp Hydrology Graphs and Results

The volumetric runoff coefficient and number of daily runoff events per year were calculated using the time series data for daily flow outputs. Water balance modelling results are summarised in with runoff event modelling summarised in Table 5. Detailed water balance modelling outcomes are provided in

Table 6 and

Table **7** for existing and developed conditions respectively. Results demonstrate that:

1. Surface and sub-surface flows to the CUS will be effectively unchanged, remaining within +/- 10% of existing conditions.

2. The number of daily runoff events to the CUS will remain unchanged, indicating that hydrology will effectively replicate existing conditions.

Table 4: Summary of surface and sub-surface flows to the CUS under existing and developed conditions.

Parameter	Pre-Development	Post-Development	Volumetric Runoff Coefficient[1]
Surface flow (ML/year)	0.513	0.462	0.900
Groundwater flow (ML/year)	7.830	8.430	1.077
Total flow (ML/year)	8.343	8.892	1.066

Notes:

1. Calculated by dividing post-development by pre-development value.

Table 5: Summary of average annual surface runoff events under existing and developed conditions.

Parameter	Pre-Development	Post-Development
No. daily runoff events / year	100	100

The daily runoff to the CUS for pre-development and post-development scenarios from 1925 - 1974 are graphed in Figure 1 and Figure 2 respectively.

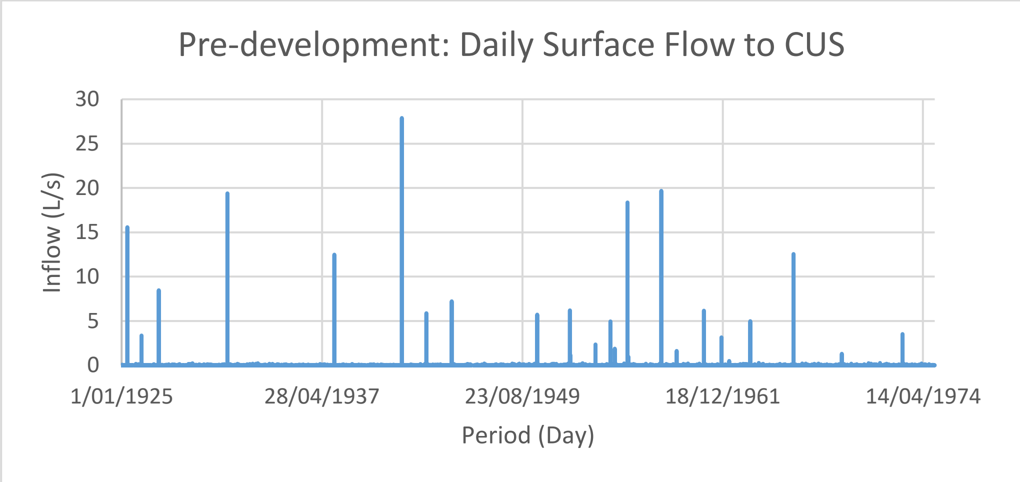

Figure 1: The daily runoff to CUS for pre-development scenario.

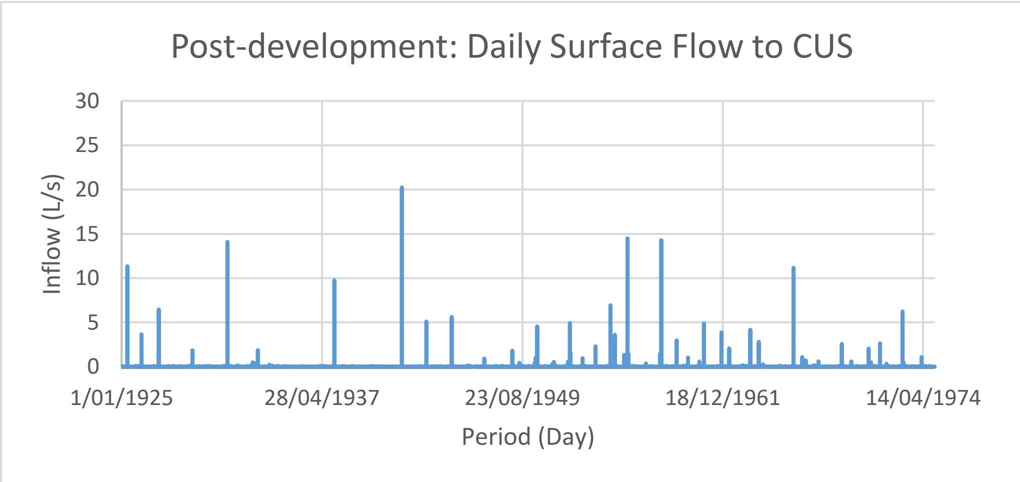

Figure 2: The daily runoff to CUS for post-development scenario.

Table 6: Detailed summary of pre-development surface and groundwater flows to CUS.

Description	MUSIC Node ID	Surface flow (ML/year)	Groundwater flow (ML/year)
Site to CUS	1E01	0.262	6.320
Upstream catchment to CUS	1E02	0.251	1.510
Total inflow to CUS	-	0.513	7.830

Table 7: Detailed summary of post-development surface and groundwater flows to CUS.

Description	MUSIC Node ID	Surface flow (ML/year)	Groundwater flow (ML/year)
Roof	1D01	2.070 [1]	0
Sealed road	1D02	1.340 [1]	0
Landscape	1D03	0.225 [1]	0.354
Landscape (above basement)	1D04	0.199 [2]	0 [6]
Landscape	1D05	0.211 [2]	0.088
Roof	1D06	2.110 [3]	0
Landscape (above basement)	1D07	0.237 [3]	0
Landscape	1D08	0.137 [3]	0.129
Development area to CUS	1D09	0.126	0.078
Undeveloped area to CUS	1D10	0.038	0.904
Upstream area to CUS	1D11	0.060 [4]	1.450
Bioretention Basin 1	BASIN 1	0.141	3.03
Bioretention Basin 2	BASIN 2	0.002	0.298
Bioretention Basin 3	BASIN 3	0.096	2.10
Total inflow to CUS	-	**0.462**	**8.430**

Notes:

1. Surface flow to be directed to Basin 1.
2. Surface flow to be directed to Basin 2.
3. Surface flow to be directed to Basin 3.
4. Surface flow to be captured by the proposed swale and directed to CUS.
5. Groundwater flow to be collected by pit and pipe system and directed to from Basin 1.
6. Groundwater flow to be collected by pit and pipe system and directed to from Basin 2.

3.5 Conclusions

The water balance assessment has demonstrated that the objectives as specified in Consent Conditions 15 and 17 will be achieved by the proposed stormwater system.

4 Stormwater Peak Flow Assessment

4.1 OSD Objectives

Consent Condition 11 requires:

> *'Drainage plans detailing the provision of On-site Stormwater Detention in accordance with Warringah Council's "On-site Stormwater Detention Technical Specification" and the concept drawing by Martens and Associates, project no. P1605687 drawing number PS02 - AOOO issue C, A050 issue B, E100 issue C, E200 issue B dated 26/6/2017.*
>
> *The On-site Stormwater Detention system is to be designed and constructed such that the post developed runoff does not exceed the 'state of nature' (0% fraction impervious) pre-developed runoff for all storms up to and including the 1 in 100 year ARI storm event.*
>
> *Stormwater runoff from the development is to be collected and piped to Council's stormwater drainage pipeline within the public roadway in accordance with Council's requirements'.*

Consent Condition 16 requires:

> *'The design of the On Site Detention (OSD) System shall be amended to comply with the following:*
>
> > *a) Post development flows are to be reduced back to predevelopment levels for all storm events (min. 1yr ARI to 100yr ARI) and durations (min. 5 minutes to 6hrs). The minimum rate of detention is to be 250m^3/ha of developable area.*
> >
> > *b) Detailed modelling of the proposed OSD system is to be completed using the outlet basin configuration that is proposed to be utilised (ie not a theoretical system or contrived equivalent). The modelling is to demonstrate compliance with a). The modelling is to compare pre and post development flows for the site itself as well as all upstream external catchments'.*

4.2 Modelling Methodology and Approach

4.2.1 Approach

Detailed DRAINS modelling of the proposed OSD system has completed based the proposed storage and outlet configuration of the OSD basins as documented on MA planset P1905687PS05.

Modelling has been completed for the 1yr ARI to 100yr ARI storm events with 5 minute to 6 hr durations.

4.2.2 Rainfall/IFD Data

IFD data that was used for the model was sourced from the Bureau of Meteorology (BoM), for the storm events and durations specified in Warringah Council On-site Stormwater Detention Technical Specification.

4.2.3 Catchment Areas

Extents of the pre development and post development sub catchments and pervious / impervious fractions, with the consideration of upstream catchment, are provided on MA planset P1905687PS05. 0% fraction impervious has been adopted on pre development catchments.

4.3 Results

Modelling results indicated that post development flow rates can be maintained to pre development levels for all storm events (min. 1 yr ARI to 100 yr ARI) and durations (min. 5 minutes to 6 hrs). Results have been provided on Sheet E600 of MA planset P1905687PS05.

In addition, proposed OSD basins with a total storage volume of approximately 520 m^3, for a developable area of 1.73 ha, has met the minimum rate of detention of 250m^3 / ha of developable area.

4.4 Conclusion

Proposed OSD system for the site as documented in MA planset P1905687PS05 has been designed in accordance with Warringah Council's "On-site Stormwater Detention Technical Specification" and the previous DA approved stormwater plans prepared by Martens.

Detailed modelling demonstrates that the proposed OSD system has met the stormwater quantity objectives as specified in Conditions 11 and 16.

5 References

BMT WBM (2015) *NSW MUSIC Modelling Guidelines,* August 2015.

FAWB (2009). *Adoption Guidelines for Stormwater Biofiltration Systems*, Facility for Advancing Water Biofiltration, Monash University, June 2009.

Martens & Associates (2017). Hydrogeological Assessment: 4a Larool Road, Terrey Hills, NSW.

Martens & Associates (2021). Civil & Drainage Engineering Works.

Northern Beaches Council (2016). WSUD & MUSIC Modelling Guidelines.

Warringah Council *On-site Stormwater Detention Technical Specification.*

Warringah Council (2015) *Water Management Policy,* December 2015.

6 Attachment A – Summary of MUSIC Input Parameters

Element	Factor	Input	Source
Setup	Climate File	Climate file, mlb file from Sydney Observatory pluviography (66062)	eWater
Source Nodes	Node Type	Site modelled as roof, sealed road, agricultural and commercial land uses	BMT WBM (2015)
	Rainfall Threshold	Based on surface type specified in Table 5-4 of NSW MUSIC Modelling Guidelines	BMT WBM (2015)
	Pervious Area Properties	Soil identified as sand, based on examined soils up to 0.5 m deep	Site Soil Tests
	Base & Storm flow Parameter	As per Table 5-6 & 5-7 of NSW MUSIC Modelling Guidelines	BMT WBM (2015)
	Estimation Method	Stochastically generated	BMT WBM (2015)
Gross Pollutant Traps	Low Flow Bypass	0 m³/s	SPEL Stormsack MUSIC node
	High Flow Bypass	0.022 m³/s	
	Treatment Efficiency	Per manufacturer's specifications	
Basin 1	Low Flow By-Pass	0 m³/s	BMT WBM (2015)
	High Flow By-Pass	100 m³/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.30 m	By design, within FAWB recommended range
	Surface Area	208 m², filter area without a battered slope	By design
	Filter Area	208 m²	By design
	Unlined filer media	67.15 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 2	Low Flow By-Pass	0 m³/s	BMT WBM (2015)
	High Flow By-Pass	100 m³/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.5 m	By design, within FAWB recommended range
	Surface Area	60 m², filter area without a battered slope	By design
	Filter Area	60 m²	By design
	Unlined filer media	33.47 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)

	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 3	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.3 m	By design, within FAWB recommended range
	Surface Area	122 m^2, filter area without a battered slope	By design
	Filter Area	122 m^2	By design
	Unlined filer media	65.30 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 4	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.3 m	By design, within FAWB recommended range
	Surface Area	312 m^2, filter area without a battered slope	By design
	Filter Area	312 m^2	By design
	Unlined filer media	136.2 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)

	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 5	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.2 m	By design, within FAWB recommended range
	Surface Area	20 m^2, filter area without a battered slope	By design
	Filter Area	20 m^2	By design
	Unlined filer media	90 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.3	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 6	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.2 m	By design, within FAWB recommended range
	Surface Area	34 m^2, filter area without a battered slope	By design
	Filter Area	34 m^2	By design
	Unlined filer media	26.75 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)

	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design
Basin 7	Low Flow By-Pass	0 m^3/s	BMT WBM (2015)
	High Flow By-Pass	100 m^3/s	Set to ensure all flows drain to bioretention
	Extended Detention Depth	0.2 m	By design, within FAWB recommended range
	Surface Area	12 m^2, filter area without a battered slope	By design
	Filter Area	12 m^2	By design
	Unlined filer media	14.49 m	Structure is unlined
	Saturated Hydraulic Conductivity	80 mm/hr	FAWB (2009)
	Filter Depth	0.5	By design, within FAWB (2009) standard range
	TN content of filter media	400 mg/kg	BMT WBM (2015) default
	Orthophosphate content of filter media	40 mg/kg	BMT WBM (2015) default
	Exfiltration rate	36 mm/hr	NBC (2016)
	Base lined	No	By design, to allow infiltration
	Vegetation properties	With effective nutrient removal plants	By design
	Overflow weir width	2 m	By design
	Underdrain present	No	By design
	Submerged zone	No	By design

7 Attachment B – Stormwater Management Plan