5 Concept Stormwater Management Requirements

5.1 Objectives

On the basis of investigations and findings presented in this study, the following drainage quantity and quality objectives are recommended. These should be in addition to any of Council's standard controls and are specific to the requirements for long-term management of the SEPP26 lands.

Water Quantity Management

The following water quantity design objectives are recommended for all development:

1. On-site stormwater detention (OSD) shall be provided for the site to ensure that pre-development flows are maintained up to the 1 in 100 year ARI storm event.

2. OSD volumes shall be determined on a individual sub-catchment basis and shall not be based on the aggregated total site discharge.

3. The following specific controls are required for each sub-catchment:

    a. A single OSD structure shall be provided at the lowest point possible in the catchment receiving urban drainage. This shall manage water from the entire sub-catchment.

    b. Each OSD shall be provided with an outlet structure(s) that allows flows to be spread such that they mimic current undeveloped surface flows arriving at the SEPP 26 rainforest.

    c. Each OSD shall where possible, be integrated with any end-of-line water quality management structure.

    d. Each OSD shall be provided with a temporary storage volume in addition to the OSD volume which can be directed to groundwater for recharge after treatment. Temporary storage volumes shall be sized on a sub-catchment basis to ensure that surplus water (ie. increased runoff received less increased evapotranspiration lost) within

the revegetation area is passed to the groundwater system.

e. Each OSD shall be provided with variable outlet control to enable maximum temporary ponded water storage levels and therefore recharge rates to groundwater to be controlled.

Water Quality

The following water quality design objectives are recommended met for all development:

1. All urban stormwater released to the SEPP 26 wetland should retain similar nutrient and suspended sediment concentrations to those being delivered under undeveloped conditions. These concentrations shall be based on representative surface and groundwater sampling prior to design of any water quality management system.

2. The following specific controls are recommended for each sub-catchment:

   a. All surface water used to recharge groundwater shall be treated prior to recharge occurring such that similar nutrient concentrations to existing groundwater conditions are maintained.

   b. Any stormwater treatment device shall be designed such that it will have the capacity to receive and treat up to an additional 30 % water volume annually in the event that groundwater recharge rates need to be increased in the future in response to climate change.

5.2 Quality Management

5.2.1 Overview

The MUSIC water quality model was used to determine preliminary water treatment requirements. Whilst this is not a precise engineering design tool, it does provide a means by which pre- and post-development stormwater quality can be assessed and determine preliminary sizes of any stormwater treatment structures.

5.2.2 Set-up and Assumptions

MUSIC model set-up and assumptions are summarised in Table 20. Model layout for pre- and post-development scenarios (with treatment) are provided in Attachment B. Given that at the time of

document preparation, urban design layouts were in concept stages only, analyses were detailed to the sub-catchment level.

Table 20: MUSIC model sub-catchment areas for existing conditions (ha).

Catchment	Area (ha)
C1 - Rural	1.213
C1 - Vegetation Regeneration Area	0.560
C2 - Rural	3.704
C3 - Rural	3.285
C3 - Vegetation Regeneration Area	0.969
C4 - Rural	0.106
C4 - Vegetation Regeneration Area	0.246

Table 21: MUSIC model sub-catchment areas for existing conditions (ha).

CATCHMENTS	AREA (ha)
C1 - Vegetation Regeneration Area	0.560
C1 - 40 m Vegetation Buffer	0.566
C1 - Urban Roads	0.184
C1 - All Urban	0.463
C2 - Vegetation Regeneration Area	0.000
C2 - 40 m Vegetation Buffer	1.107
C2 - Urban Roads	0.923
C2 - All Urban	1.674
C3 - Vegetation Regeneration Area	0.926
C3 -40 m Vegetation Buffer	0.374
C3 - Urban Roads	0.858
C3 - All Urban	2.096
C4 - Vegetation Regeneration Area	0.240
C4 - 40 m Vegetation Buffer	0.100
C4 - Urban Roads	0.000
C4 - All Urban	0.011

Table 22: Preliminary water quality modelling targets based on existing groundwater quality (mg/L).

Parameter	Target
Total Nitrogen (mg/L)	< 1.0
Total Phosphorus (mg/L)	< 0.6
Suspended Solids (mg/L)	< 50

Table 23: MUSIC model event mean concentrations (EMCs) and dry weather flow concentrations (DWC) (mg/L).

Type	Parameter	Concentration (mg/L)
Urban Roads	TN	2.100
	TP	0.260
	SS	260
All Urban	TN	2.700
	TP	0.340
	SS	150
Rural	TN	2.050
	TP	0.210
	SS	105
Forest	TN	0.850
	TP	0.075
	SS	80

5.2.3 *Preliminary Structure Specifications*

The following comments are made in relation:

1. Vegetation buffer plantings were included as part of the treatment train. Areas were based on existing aerial photography and the concept development layout (Attachment A).

2. Bio-filtration beds were used to treat urban runoff prior to release to the SEPP 26 lands. A single bed was used as an 'end-of-the-line' treatment system. Preliminary design parameters included:

Extended detention depth	0.5 m
Seepage loss	5.0 mm/hour
Filter depth	0.9 m
Filter median particle diameter	1.1 mm
Filter K_{sat}	40 mm/hour

We note that these parameters are preliminary and subject to modification and more detailed design at the development application stage of documentation. However, the preliminary specifications enabled preliminary estimates of bio-filtration unit areas to be estimated.

Preliminary bio-filtration surface areas are provided in Table 24.

Table 24: Preliminary estimates of bio-filtration unit surface areas (m²).

Catchment	Area (m²)
C1	210
C2	560
C3	750

5.2.4 *Results*

Results of MUSIC modelling are provided Table 25. These indicate that water quality targets (in terms of concentration, see Table 22) and discharge load targets (post-development ≤ pre-development load) to the SEPP26 land are achieved by the proposed treatment train. We note that gross pollutants have not been included in the modelling but we will need to be included as part of any future treatment train.

Table 25: MUSIC modelling results.

Existing Site Conditions						
	Concentration			**Load**		
Catchment	**TSS (mg/L)**	**TP (mg/L)**	**TN (mg/L)**	**TSS (kg/yr)**	**TP (kg/yr)**	**TN (kg/yr)**
C1	43.6	0.07	0.86	972.0	1.7	13.9
C2	51.5	0.10	0.91	2370.0	4.8	36.9
C3	46.3	0.08	0.88	2500.0	4.0	37.1
C4	33.0	0.05	0.80	133.0	0.2	1.92
Net / Total	47.3	0.08	0.88	5970.0	10.7	89.9
Post-development Site Conditions						
C1	23.5	0.04	0.83	332.0	0.7	10.4
C2	22.4	0.04	0.85	515.0	2.1	34.6
C3	23.0	0.04	0.86	593.0	2.3	37.2
C4	52.9	0.09	1.07	113.0	0.1	1.6
Net / Total	28.7	0.06	0.92	1550.0	5.3	83.9
Post-development Load Change (kg/year)				-4820.0	-5.4	-6.0

5.3 Quantity Management

5.3.1 *Recharge Requirements*

In accordance with the water quantity management objectives, there will be some requirement to enable excess surface water to adjacent to and within the revegetation area to be pass directly to groundwater after treatment in the bio-filtration units.

Preliminary estimates of annual recharge volumes are provided in Table 26. These will need to be refined through more detailed modelling (such as daily water balance modelling) as part of development application design and documentation. On the basis that vertical K_{sat} will be of the order of 4-5 m/d for recharge pits penetrating to the basal aquifer sands, our preliminary water balance modelling indicates that between 1 – 4 recharge pits will be required for catchments C1-C3.

Table 26: Preliminary design specifications for groundwater recharge pits.

Catchment	Estimate of Annual Surplus Runoff to go to Groundwater (ML/year)	Mean Design Recharge Rate for Infiltration Systems (m^3/d)	Total Recharge Well(s) Surface Area (m^2)	Number of 1.5x1.5 m Recharge Pits
C1	2.50	6.8	1.4	1
C2	15.12	41.4	8.3	4
C3	13.65	37.4	7.5	3
C4	0.00	0.0	0.0	0

5.3.2 *Stormwater Detention*

The DRAINS model was used to provide preliminary estimates of pre- and post-development sub-catchment flows to the SEPP26 lands. 70 % impervious area was assumed for the developed urban area. Preliminary on-site stormwater detention (OSD) specifications were determined on the following basis:

Available head and ground levels	Council survey data
Type	Dry surface depression
Minimum Surface Area	Based on bio-filtration

DRAINS model set-up, layout and detailed results are provided in Attachment B. A summary of OSD specifications is provided in Table 27.

Table 27: Preliminary design specifications for groundwater recharge pits.

Catchment	Storage Volume (m^3)	Surface Area (m^2)	Outlet Number & Size (mm)	Existing 100 Year ARI (m^3/s)	Developed 100 Year ARI (m^3/s)
C1	126	210	6 x 225	0.434	0.420
C2	476	560	5 x 450	1.610	1.610
C3	450	750	7 X 450	1.840	1.820
C4	na	na	na	0.259	0.259

5.4 Concept Designs

A concept design for the end-of-line stormwater management structures has been prepared and is provided in Attachment B. The following comments are made in respect of the concept design:

1. OSD and bio-filtration units are integrated into a single stormwater improvement device (SID).

2. SID unit locations are flexible.

3. Each catchment may contain one or more SIDs, although the preference is for a single unit in order to reduce maintenance requirements.

4. A single SID could be used to manage stormwater from 2 adjoining sub-catchments, providing that suitable fall can be achieved and the impacts on groundwater level have been fully determined.

5. SID outlet structures incorporate a water level control device which controls the bio-filtration unit invert and therefore the volume of water which is annually passed to groundwater.

6. The bio-filtration unit under-drain shall be directed to groundwater recharge. Recharge shall be undertaken by 1 or more pits in each sub-catchment. The recharge pits can be separated from the bio-filtration invert level control device. This will depend on final detailed design specifications and layout of the urban area.

7. SIDs will need to be provided with adequate access for on-going maintenance. The concept design provides for a wide bund to enable access to all areas of the SID. Where steeper side batters are required, a vehicular access ramp should be provided to enable bed maintenance.

5.5 Excavation Management

The recharge pits shall be excavated to penetrate into the medium – coarse sand beds beneath the upper clayey soil horizons. Pits should generally not be excavated below the water table. This will ensure that pit excavation can be shored by standard methods without significant risk of excavation collapse.

In the event that excavation into the permanent water table is required (to reach the more permeable underlying sand layers), permanent

shoring by way of contiguous or secant piles should be investigated prior to excavation commencing.

5.6 Maintenance

We expect the following will be required in terms of SID maintenance:

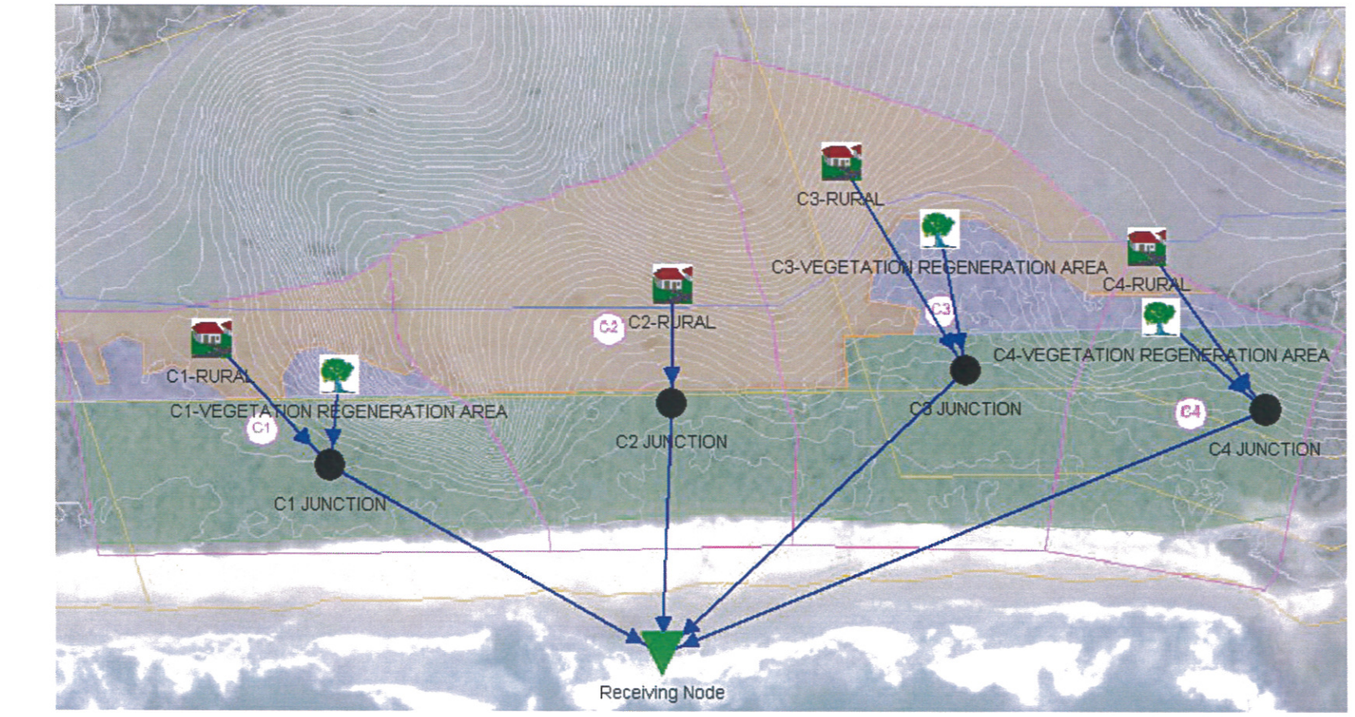
1. Gross pollutants should not be allowed to enter the SID units. Gross pollutant traps should be installed upstream of SID units to prevent ingress of these materials into the SID.

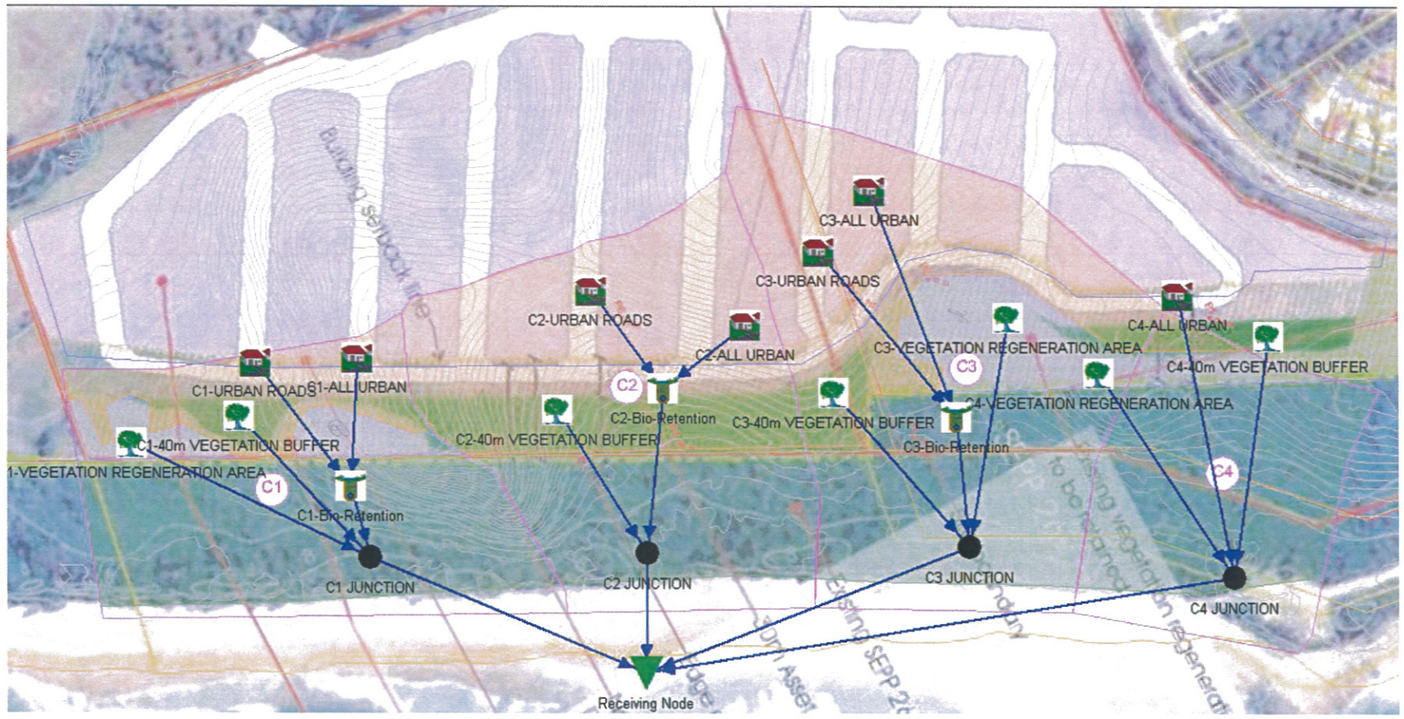
2. If the SID units are vegetated with grasses, these may need to be mown in accordance with normal maintenance regime. As an alternative, grass and other vegetative species could be selected which do not require regular mowing to reduce the need for this type of routine maintenance.

3. Geotextile covered litter baskets within the recharge pits should be routinely inspected to assess accumulation of fines. We do not expect any significant carry through of fines from the bio-filtration unit to the recharge pit on the basis that most fines should be removed within the upper bio-filter media layers.

4. The bio-filtration units should be relatively free draining with surface water ponding for no more than 1 day. Annual inspections following extended wet-weather should preferably be undertaken to confirm that the bio-filtration units continue to drain adequately.

   In the event that bio-filtration units do not adequately drain, then the top 100 mm of media may need to be removed and replaced. On the basis of our experience with similar bio-filtration units, careful design and construction should ensure that 're-dressing' the bio-filtration units should not be required for at least 15 years.





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DRAWN/REVIEWED: BR
PAPER SIZE: A1/A3
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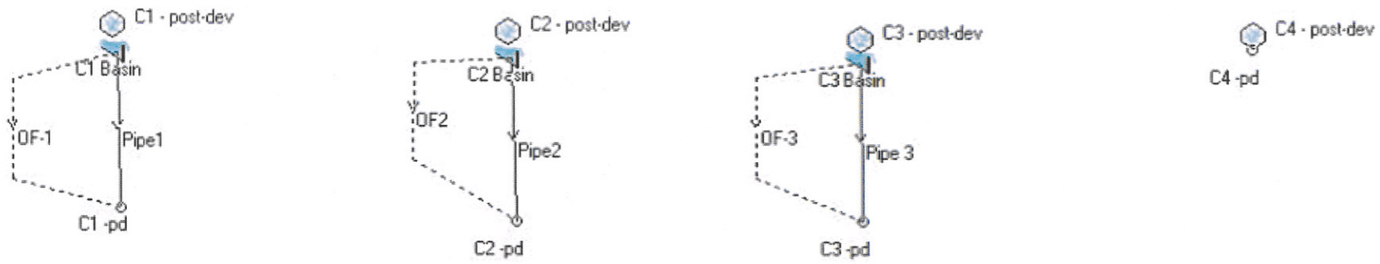
TITLE:
MUSIC MODEL SET-UP
TOP - PRE-DEVELOPMENT
BOTTOM - DEVELOPED WITH TREATMENT

PROJECT MANAGER: DR D. MARTENS
DRAWING NUMBER: P0601504JD04-V1.TCW

SHEET 7 OF 12 SHEETS

PRE-DEVELOPMENT

POST-DEVELOPMENT



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TITLE: DRAINS MODEL SET-UP

PROJECT MANAGER: DR D. MARTENS

DRAWING NUMBER: P0601504JD04-V1.TCW

SHEET 8 OF 12 SHEETS

DRAINS PRE-DEVELOPMENT MODEL INPUT DETAILS

PIT / NODE DETAILS			Version 9										
Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id
C1pre-node	Node					NA		0		60.671	93.454		53061608
C2pre-node	Node					NA		0		132.57	91.736		53061856
C3pre-node	Node					NA		0		198.089	91		53061857
C4pre-node	Node					NA		0		274.405	89.527		53061858
DETENTION BASIN DETAILS													
Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL
SUB-CATCHMENT DETAILS													
Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Slope(%)	Grass Slope %
C1 - pre-dev	C1pre-noc	0.647	0	100	0	0	10	0					
C2 - pre-dev	C2pre-noc	2.597	0	100	0	0	10	0					
C3 - pre-dev	C3pre-noc	2.954	0	100	0	0	10	0					
C4 - pre-dev	C4pre-noc	0.352	0	100	0	0	10	0					
PIPE DETAILS													
Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From
DETAILS of SERVICES CROSSING PIPES													
Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of	Chg	Bottom	Height of Service	etc			
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc			
CHANNEL DETAILS													
Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

DRAINS RESULTS FOR 1 IN 100 YR ARI STORM (PRE-DEVELOPMENT)

DRAINS results prepared 07 July, 2010 from Version 2010.04

PIT / NODE DETAILS				Version 8		
Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)
SUB-CATCHMENT DETAILS						
Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)
C1 - pre-dev	0.434	0	0.434	0	10	0
C2 - pre-dev	1.741	0	1.741	0	10	0
C3 - pre-dev	1.98	0	1.98	0	10	0
C4 - pre-dev	0.236	0	0.236	0	10	0
Outflow Volumes for Total Catchment (0.00 impervious + 6.55 pervious = 6.55 total ha)						
Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)		
AR&R 100 year, 15 minutes storm, average 200 mm/h, Zone 1	3275	2810.23 (85.8%)	0.00 (0.0%)	2810.23 (85.8%)		
AR&R 100 year, 20 minutes storm, average 177 mm/h, Zone 1	3864.5	3365.36 (87.1%)	0.00 (0.0%)	3365.36 (87.1%)		
AR&R 100 year, 25 minutes storm, average 161 mm/h, Zone 1	4393.96	3860.71 (87.9%)	0.00 (0.0%)	3860.71 (87.9%)		
AR&R 100 year, 30 minutes storm, average 148 mm/h, Zone 1	4847	4279.84 (88.3%)	0.00 (0.0%)	4279.84 (88.3%)		
PIPE DETAILS						
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm	
CHANNEL DETAILS						
Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm	
DETENTION BASIN DETAILS						
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level	
CONTINUITY CHECK for AR&R 100 year, 20 minutes storm, average 177 mm/h, Zone 1						
Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %		
C1pre-node	332.43	332.43	0	0		
C2pre-node	1334.33	1334.33	0	0		
C3pre-node	1517.75	1517.75	0	0		
C4pre-node	180.86	180.86	0	0		

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TITLE: DRAINS MODEL PRE-DEVELOPMENT INPUTS AND OUTPUT

PROJECT MANAGER: DR D. MARTENS | DRAWING NUMBER: P0601504JD04-V2.TCW

SHEET 9 OF 12 SHEETS

DRAINS POST-DEVELOPMENT MODEL INPUT DETAILS

PIT / NODE DETAILS — Version 9

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y
C1 -pd	Node					10			0	61.309	13.604
C3 -pd	Node					10			0	200.592	10.954
C2 -pd	Node					10			0	135.514	10.954

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Typ	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y
C1 Basin	10	210	0	Culvert	0.5					60.671	42.413
	10.6	210									
C3 Basin	10	750	0	Culvert	0.5					200.297	40.695
	10.6	750									
C2 Basin	10	560	0	Culvert	0.5					134.213	43.803
	10.85	560									

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)
C1 - post-dev	C1 Basin	0.647	79	21	0	5		10	0		
C3 - post-dev	C3 Basin	2.954	79	21	0	5		10	0		
C2-post-dev	C2 Basin	2.597	81	19	0	5		10	0		

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is
Pipe1	C1 Basin	C1 -pd	10	10	9.5	5	Concrete, not under roads	225	225	0.3	NewFixed
Pipe 3	C3 Basin	C3 -pd	10	10	9.5	5	Concrete, not under roads	450	450	0.3	NewFixed
Pipe 2	C2 Basin	C2 -pd	10	10	9.5	5	Concrete, not under roads	450	450	0.3	NewFixed

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of (m)	Chg (m)	Bottom Elev (m)	Height of (m)	etc	etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Sto (m)	Safe DxV (sq.m/sec	Bed Slope (%)
OF-1	C1 Basin	C1 -pd	1	10.6	5	1.7	Grassed swale with 1:4 sideslopes	0.5	0.4	1	5
OF-3	C3 Basin	C3 -pd	1	10.6	5	1.7	Grassed swale with 1:4 sideslopes	0.5	0.4	1	5
OF-2	C2 Basin	C2 -pd	1	10.85	5	1.7	Grassed swale with 1:4 sideslopes	0.5	0.4	1	5

DRAINS RESULTS FOR 1 IN 100 YR ARI STORM (POST-DEVELOPMENT)

DRAINS results prepared 07 July, 2010 from Version 2010.04

PIT / NODE DETAILS — Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
C1 -pd	9.61		0				
C3 -pd	9.68		0.013				
C2 -pd	9.7		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Sto
C1 - post-dev	0.487	0.4	0.087	5	10	0	AR&R 100
C3 - post-dev	2.224	1.826	0.398	5	10	0	AR&R 100
C2-post-dev	1.963	1.646	0.316	5	10	0	AR&R 100

Outflow Volumes for Total Catchment (4.95 impervious + 1.25 pervious = 6.20 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 15 minutes storm, average 200 mm/h, Zone 1	3099	2927.42 (94.5%)	2424.70 (98.0%)	502.72 (80.5%)
AR&R 100 year, 20 minutes storm, average 177 mm/h, Zone 1	3656.82	3472.67 (95.0%)	2870.05 (98.3%)	602.62 (81.7%)
AR&R 100 year, 25 minutes storm, average 161 mm/h, Zone 1	4157.83	3960.35 (95.3%)	3270.04 (98.5%)	690.30 (82.3%)
AR&R 100 year, 30 minutes storm, average 148 mm/h, Zone 1	4586.52	4376.73 (95.4%)	3612.30 (98.6%)	764.43 (82.7%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Pipe1	0.373	3.2	10.111	9.611	AR&R 100 year, 25 minutes stor
Pipe 3	1.872	4.4	10.182	9.682	AR&R 100 year, 25 minutes stor
Pipe 2	1.529	4.6	10.195	9.695	AR&R 100 year, 25 minutes stor

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Widtl	Max V
OF-1	0	0	1.262	0	0	0	0
OF-3	0.013	0.013	1.262	0.057	0.06	0.45	1.02
OF-2	0	0	1.262	0	0	0	0

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
C1 Basin	10.47	100.4	0.373	0.373	0
C3 Basin	10.61	465.4	1.885	1.872	0.013
C2 Basin	10.76	429.8	1.529	1.529	0

CONTINUITY CHECK for AR&R 100 year, 25 minutes storm, average 161 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
C1 Basin	412.83	410.52	2.31	0
C1 -pd	410.52	410.52	0	0
C3 Basin	1884.84	1867.21	17.63	0
C3 -pd	1867.21	1867.21	0	0
C2 Basin	1662.68	1648.77	13.91	0
C2 -pd	1648.77	1648.77	0	0

REV	DESCRIPTION	DATE	ISSUED
1.0	DRAFT	07.07.10	DMM

BAR SCALE

DESIGNED: DMM | DATUM: NA
DRAWN/REVIEWED: BR | HORIZONTAL RATIO: NA
PAPER SIZE: A1/A3 | VERTICAL RATIO: NA

CLIENT/ PROJECT: HASTINGS COUNCIL

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in mm unless otherwise specified

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TITLE: DRAINS MODEL
POST-DEVELOPMENT INPUTS AND 100YR OUTPUT

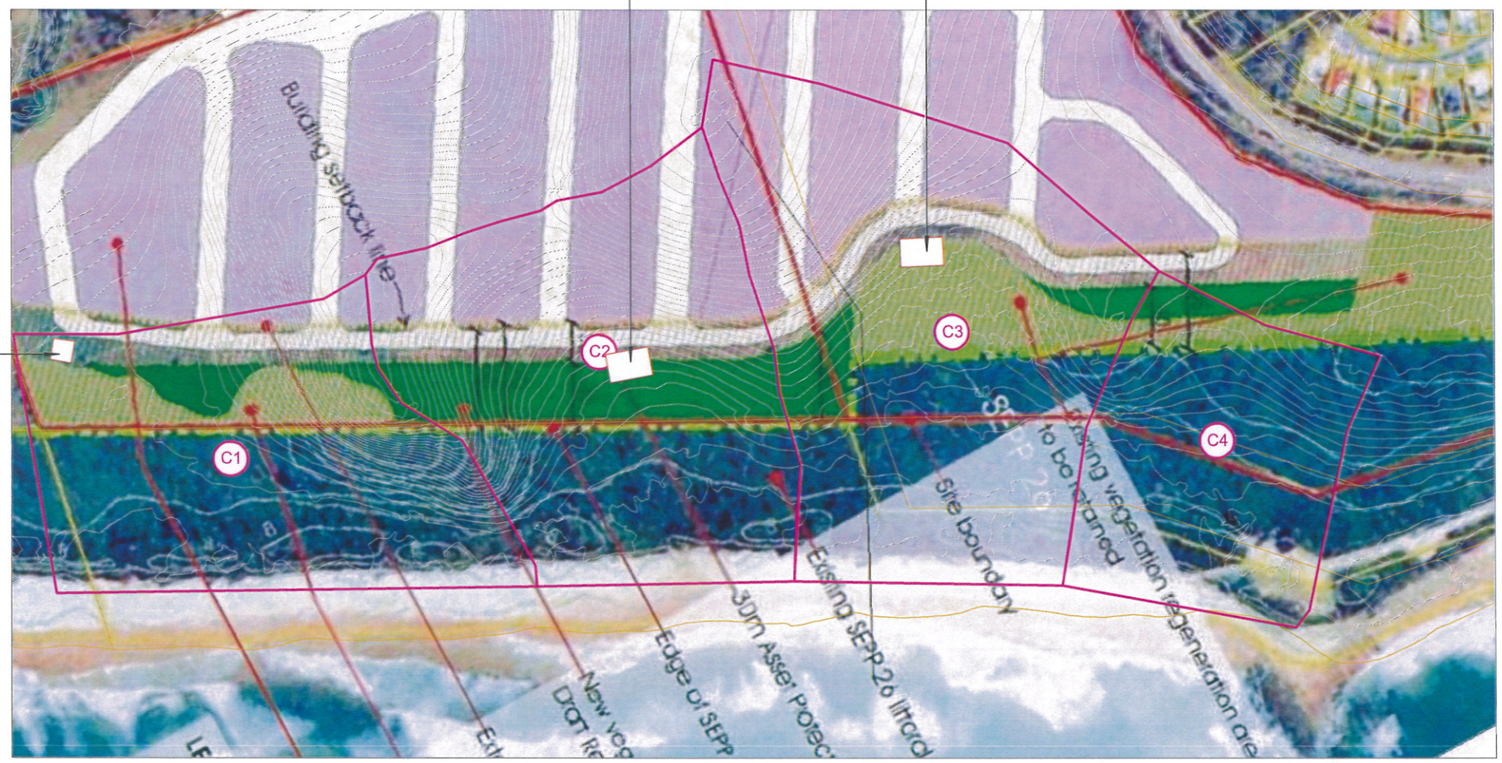
PROJECT MANAGER: DR D. MARTENS
DRAWING NUMBER: P0601504JD04-V2.TCW

SHEET 10 OF 12 SHEETS

BIOFILTRATION UNIT 2

BIOFILTRATION UNIT 3

BIOFILTRATION UNIT 1



- STRUCTURE PLAN DEVELOPMENT AREA
- EXISTING SEPP 26 FOREST
- EXISTING VEGETATION REGENERATION AREA
- EXISTING PASTURE
- SUB-CATCHMENT BOUNDARY

REV.	DESCRIPTION	DATE	ISSUED
1.0	DRAFT	26.06.09	DMM

BAR SCALE
0 40 80 120 160 200
UNITS - METRES
SCALE - 1:2000 @ A1 1:4000 @ A3

DESIGNED: DMM
DRAWN/REVIEWED: BR
PAPER SIZE: A1/A3
DATUM: NA
HORIZONTAL RATIO: 1:4000 @A3 1:2000 @ A1
VERTICAL RATIO: 1:4000 @A3 1:2000 @ A1

CLIENT/ PROJECT
HASTINGS COUNCIL

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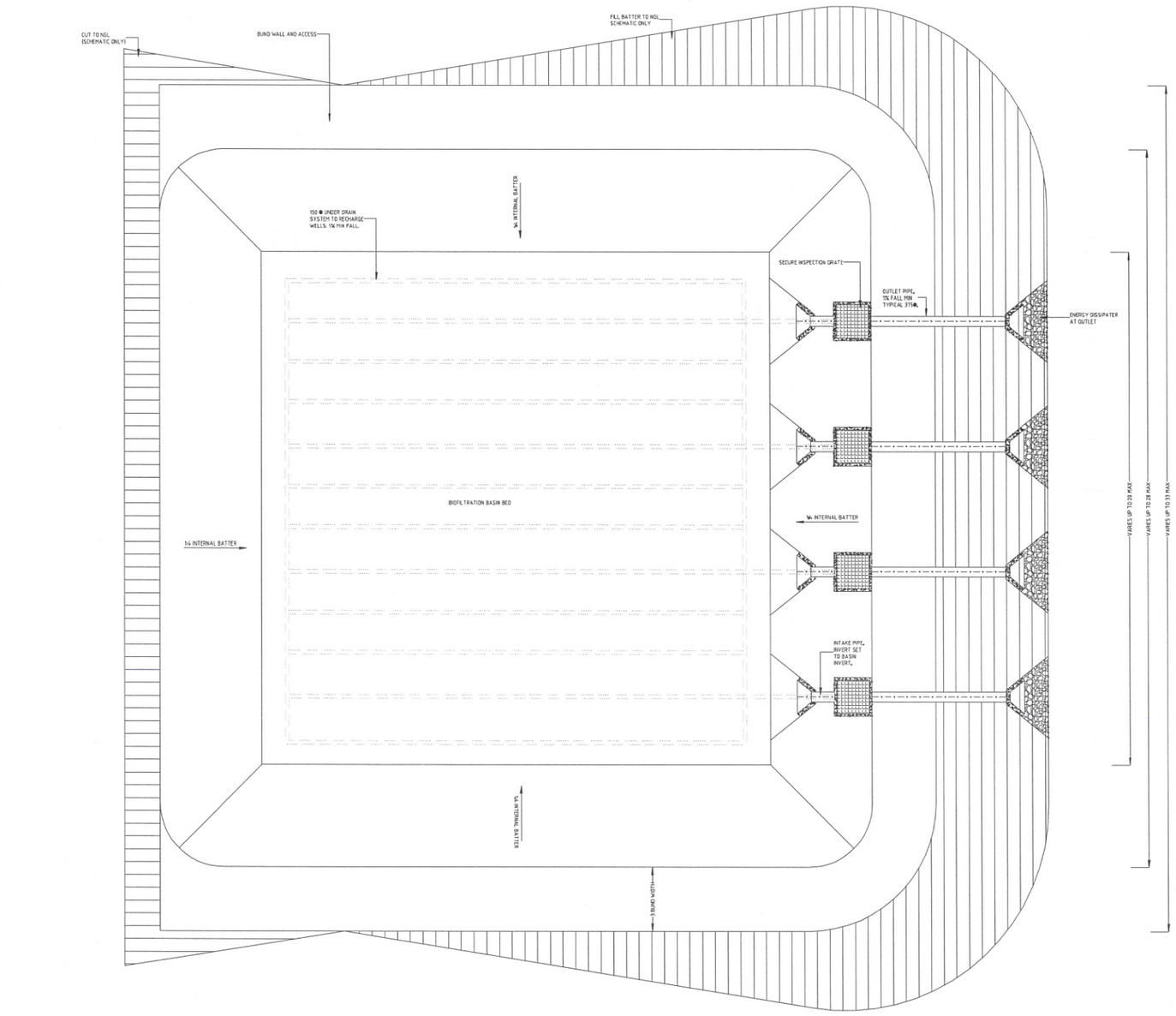
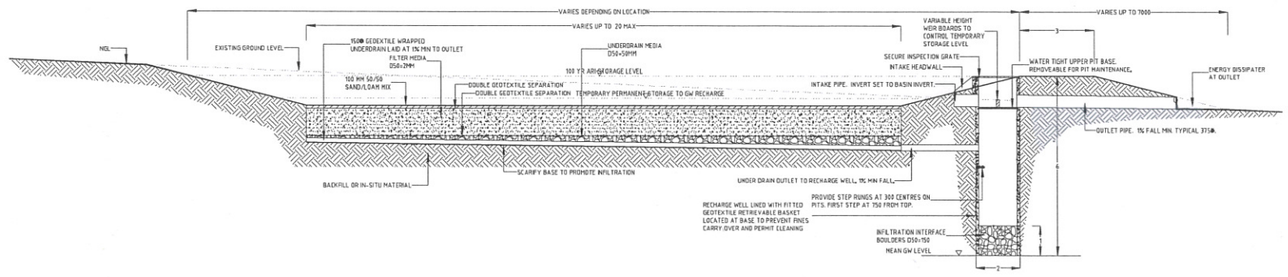
TITLE: PRELIMINARY BIO-FILTRATION UNIT LOCATIONS

PROJECT MANAGER: DR D. MARTENS
DRAWING NUMBER: P0601504JD04-V1.TCW

SHEET 11 OF 12 SHEETS





REV.	DESCRIPTION	DATE	ISSUED
1.0	DRAFT	04.06.09	DMM

BAR SCALE

0 2 4 6 8 10

UNITS - METRES

SCALE - 1:100 @ A1 1:200 @ A3

DESIGNED: DMM

DRAWN/REVIEWED: BR

PAPER SIZE: A1/A3

DATUM: NA

HORIZONTAL RATIO: 1:200 @A3 1:100 @ A1

VERTICAL RATIO: 1:200 @A3 1:100 @ A1

CLIENT/PROJECT: HASTINGS COUNCIL

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TITLE: CONCEPT STORMWATER MANAGEMENT STRUCTURE

PROJECT MANAGER: DR D. MARTENS

DRAWING NUMBER: P0601504JD04-V1.TCW

SHEET 12

OF 12 SHEETS