

# Wetland Functional Design Report

North Sale – Area B South

Wellington Shire Council

January 2018





## Document Status

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## Project Details

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# 1 INTRODUCTION

The Area B South Bioretention Basin/Retarding Basin forms part of the North Sale Drainage Investigation located immediately west of the Princess Highway, approximately 350 metres south of Cantwell Drive.

Calculations used in the functional design are included in Appendix A.

## 1.1 Design Flow Rates

The design flow rates used in the design of the North Sale Area B South are shown in Table 1-1

Table 1-1 Design Flow Rates

Storm Event	Flow Rate (m <sup>3</sup> /s)
3 month ARI inflow	0.10
1 year ARI inflow	0.5
5 year ARI inflow	1.1
100 year ARI inflow	1.99
Target 100 year ARI outflow from retarding basin	0.2

## 1.2 Site Constraints

An existing minor pipeline (450 mm diameter) crossing of the Princess Highway in the vicinity of the retarding basin, is the outfall from the Area B South. The current capacity of this pipeline forms the limit to flows leaving the development area, with the limited flow rate of 0.2 m<sup>3</sup>/s adopted as the design discharge from the retarding basin during the 100 year ARI event. The limited outfall has resulted in an oversized retarding basing when compared to the future upstream developed catchment.



## 2 SEDIMENT BASIN

Sediment basins have been sized by the Fair and Geyer formula (Equation 10.3 in WSUD Engineering Procedures, 2004) to determine minimum surface area required to ensure the settling velocity criteria for sediments was satisfied. The 1 year AR flow rate of 0.5 m<sup>3</sup>/s was used to determine the required basin, which was sized to a cleanout frequency of 5 years or longer. It was found that the settling criteria was the critical factor in sizing of the sediment basins, not sediment storage volume.

An Extended Detention Depth of 350 mm has been incorporated into the sediment basin.[CD1][TC2]

A 500 mm wide weir has been sized to convey the 3 month ARI flow from the sediment basin to bioretention basin. A bypass weir from the sediment basin to the base of the retarding basin has been sized to convey the 5 year ARI flow rate.

The 100 year velocity in the sediment basin has been calculated as 0.11 m/s based on the cross sectional area between NWL and the 10 year level in the basin. This 100 year velocity is within the requirement of 0.5 m/s to prevent re-suspension of deposited sediment during a major storm event.

The cleanout frequency of the sediment basin was determined to equal once every 6.1 years, with the cleanout volume determined to be 204 m<sup>3</sup>, with ample sediment drying area available in the adjacent retarding basin the drainage reserve.



### 3 BIO-RETENTION BASIN

The bioretention basin has been design with 200 mm of Extended Detention Depth (EDD). The EDD is controlled by the pit sill level on the 600 mm by 600 mm outlet pit, located at the southern end of the basin.

During minor flow events, water will percolate through the basins filter media with stormwater treated by two mechanisms; nutrient uptake via plants within the basin and physical screening via the filter media.

Minor flows will be capture via the slotted 100 mm diameter PVC pipes at the base of the basin and directed to the outlet via, which then in turns outfalls to the base of the retarding basin. Larger flows will either be diverted around the basin via the sedimentation basin bypass weir, or spill into the outlet pit once the 200 mm EDD is exceeded.

A 450 mm deep submerged zone is located at the bottom of the filter media to aids in the denitrification process and also increases soil moisture to aid plants during dry periods.

The cross section or the bioretention basin showing the different filter media layers is shown in Figure 3-1

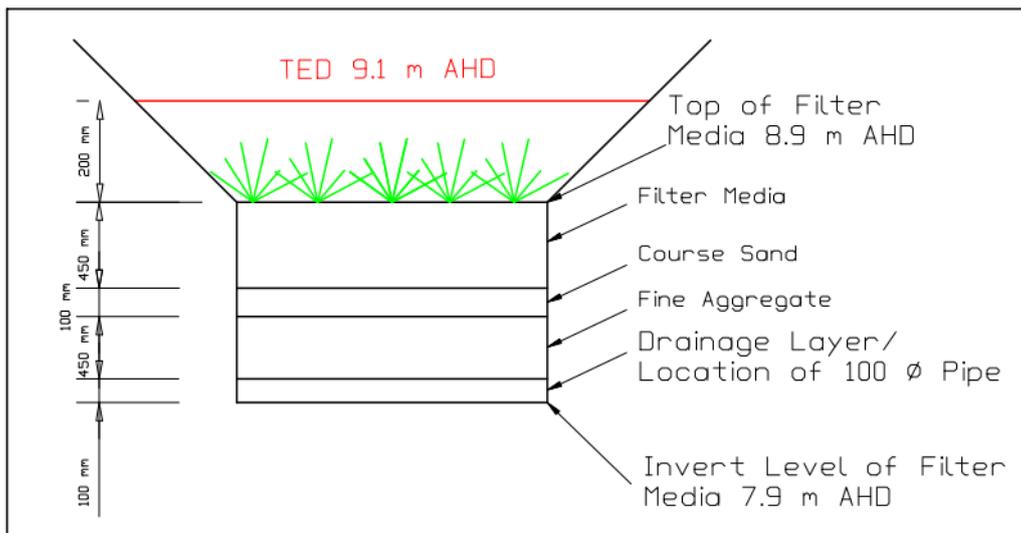


Figure 3-1 Bioretention Basin Filter Media Properties

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## 4 DRAINAGE RESERVE

### 4.1 Edge Treatments

A 1 in 8 safety bench has been incorporated into the bathymetry below NWL to a depth of 350 mm. Minimum batter slopes of 1 in 6 are incorporated above NWL with the typical edge treatment shown in Figure 4-1 which are applicable for the sediment basin.

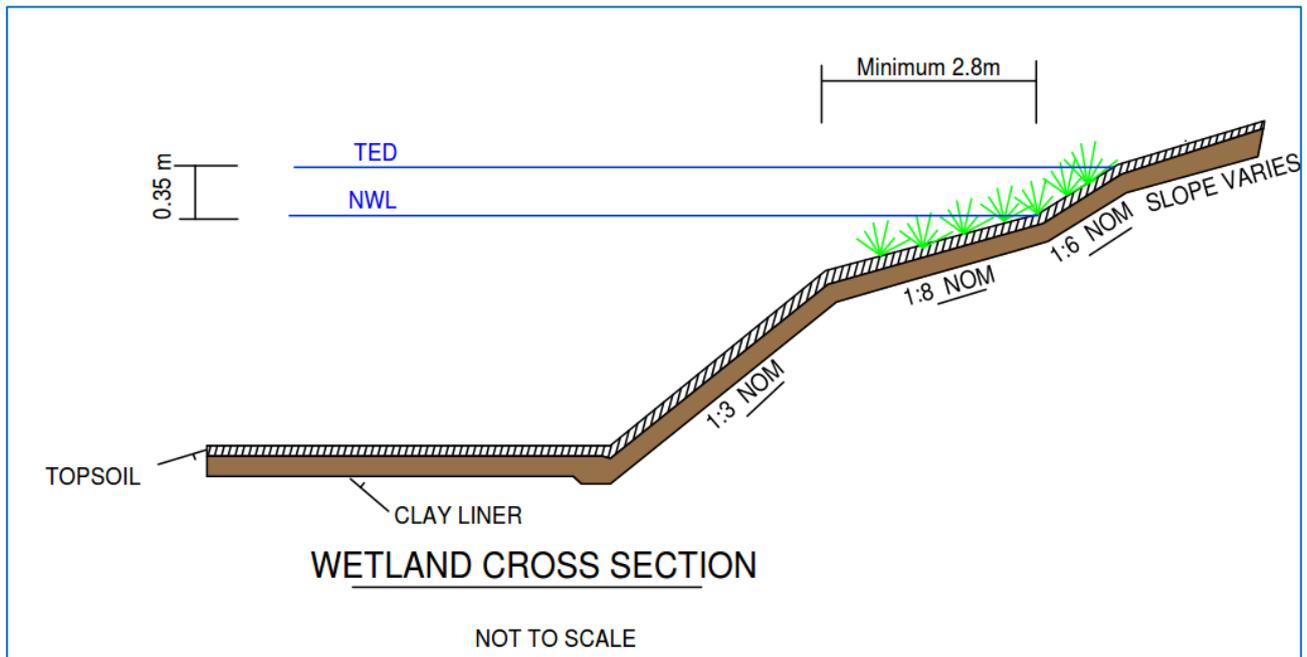


Figure 4-1 Typical Edge Treatment for Sediment Basin

#### 4.1.1 Low Flow Channel

A minor low flow channel has been designed to take small events through the retarding basin base in addition to acting as a bypass to the Bioretention Basin. This channel will also serve as a drain for the retarding basin base when flood levels in the basin recede after a storm event. The channel has been sized to match the outlet pipe capacity of 0.15 m<sup>3</sup>/s at the basin depth of 1.5 metres, and incorporates a 0.5 metre base width, 1 in 6 batter slopes and a depth of 0.2 metres.

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## 4.2 Retarding Basin

### 4.2.1 Outlet Details

A single 375 mm diameter pipelines have been sized to control flows leaving the retarding basin to desired flow rates.

### 4.2.2 Storage Volume

Table 4-1 shows the Height Storage relationship for the Area B South Retarding Basin.

**Table 4-1 Retarding Basin Height-Storage Details**

Height (m AHD)	Storage (m <sup>3</sup> )	Outflow (m <sup>3</sup> /s)
7.8	0	0.000
7.9	13	0.020
8	35	0.036
8.1	104	0.081
8.2	332	0.089
8.3	698	0.096
8.4	1,105	0.103
8.5	1,531	0.109
8.6	1,976	0.115
8.7	2,439	0.121
8.8	2,922	0.126
8.9	3,423	0.132
9	3,992	0.137
9.1	4,591	0.141
9.2	5,220	0.146
9.3	5,877	0.151
9.4	6,562	0.155
9.5	7,274	0.159
9.6	8,012	0.163
9.7	8,777	0.167
9.8	9,567	0.171
9.9	10,380	0.175
10	11,217	0.179
10.1	12,078	0.183
10.2	12,964	0.186
<b>10.3</b>	<b>13,874</b>	<b>0.190</b>
10.4	14,810	0.193
10.5	15,773	0.197
10.6	16,802	0.200

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## 5 COSTINGS

### 5.1 Cost Overview

Detailed cost estimates have been provided to Water Technology by Crossco Consulting. As per Council specification these estimates include a cut and fill rate of \$10.00 / m<sup>3</sup> and a contingency of 20%. An overview of these costs can be seen below in Table 5-1. A detailed breakdown of cost estimates is included in Appendix C.

Table 5-1 Cost Estimates Area B South

	Total (ex GST)	Incl 20% contingency (ex GST)	Incl GST	TOTAL (incl GST and contingency)
<b>Totals</b>	\$ 655,119	\$ 786,143	\$ 78,614	\$ 864,757
<b>Total Including 20% Contingency and GST</b>				\$ 864,757



# APPENDIX A DESIGN CALCULATIONS





## A-1 Sediment Basin Sizing

$V_s =$	0.011 m/s	Catchment Area =	20.4 ha
$d_e =$	0.35 m	Sediment load =	1.6 m <sup>3</sup> /ha/yr
$d_p =$	1.0 m	Gross Pollutant Load =	0.4 m <sup>3</sup> /ha/yr (Alison et al 1998)
$d^* =$	1.0 m	Actual basin depth =	1.0 m
$(d_e+d_p) =$	1.0	Actual Basin area =	500.0 m <sup>2</sup>
$(d_e+d^*)$		Basin sediment accumulation fraction	0.16 per year
$Q =$	0.5 m <sup>3</sup> /s	Clean out every	6.1 years
$A =$	500 m <sup>2</sup>		
$V_s =$	11.00		
$Q/A$			
$\lambda =$	0.26		
$n =$	1.35		
Fraction of Initial Solids Removed			
$R =$	95%		

## A-2 Sediment Basin Outlet

Broad Crested Weir		SED BASIN OUTLET WEIR	
Formula	$Q = CbH^{3/2}$		
Inputs	C	1.40	Weir Coefficient (1.4-2.1, typically 1.6)
	b	0.50 m	Breadth of Weir
	H	0.350 m	Head Of Water Above Crest
Output	Q	0.14	m <sup>3</sup> /s

Broad Crested Weir		SED BYPASS WEIR	
Formula	$Q = CbH^{3/2}$		
Inputs	C	1.40	Weir Coefficient (1.4-2.1, typically 1.6)
	b	8.80 m	Breadth of Weir
	H	0.200 m	Head Of Water Above Crest
Output	Q	1.10	m <sup>3</sup> /s

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## A-3 Bioretention Outlet Pit

Ignore the pit?? Yes/No					Are you Assuming INLET CONTROL???					No		
PIT					PIPE		INLET CONTROL		OUTLET CONTROL			
Pit Sill Level		9.1	m AHD		Invert Level	7.9	m AHD		Ke	0.5	Square edge	
Width		0.6	m		Dia	0.3	m		Kex	1.0		
Length		0.6	m		barrels	1			Length	25.0	m	
Area		0.36	m <sup>2</sup>		Area	0.070685835	m <sup>2</sup>		Tailwater Level	7.9	m AHD	
Grill blockage factor		0	%						wetted perim	0.94	m	
									Hyd Radius	0.08	m	
Height	Head	Orifice Flow	Weir Flow	total flow into pit	Head	Orifice Flow	head loss	flow	TOTAL FLOW RATE			
7.9	-1.2	0.000	0.000	0.000	-0.150	0.000	0.050	0.034	0.000	m <sup>3</sup> /s		
8	-1.1	0.000	0.000	0.000	-0.050	0.000	0.150	0.060	0.000	m <sup>3</sup> /s		
8.1	-1	0.000	0.000	0.000	0.050	0.046	0.250	0.077	0.000	m <sup>3</sup> /s		
8.2	-0.9	0.000	0.000	0.000	0.150	0.080	0.350	0.091	0.000	m <sup>3</sup> /s		
8.3	-0.8	0.000	0.000	0.000	0.250	0.103	0.450	0.103	0.000	m <sup>3</sup> /s		
8.4	-0.7	0.000	0.000	0.000	0.350	0.122	0.550	0.114	0.000	m <sup>3</sup> /s		
8.5	-0.6	0.000	0.000	0.000	0.450	0.139	0.650	0.124	0.000	m <sup>3</sup> /s		
8.6	-0.5	0.000	0.000	0.000	0.550	0.153	0.750	0.134	0.000	m <sup>3</sup> /s		
8.7	-0.4	0.000	0.000	0.000	0.650	0.167	0.850	0.142	0.000	m <sup>3</sup> /s		
8.8	-0.3	0.000	0.000	0.000	0.750	0.179	0.950	0.150	0.000	m <sup>3</sup> /s		
8.9	-0.2	0.000	0.000	0.000	0.850	0.191	1.050	0.158	0.000	m <sup>3</sup> /s		
9	-0.1	0.000	0.000	0.000	0.950	0.201	1.150	0.165	0.000	m <sup>3</sup> /s		
9.1	0	0.000	0.000	0.000	1.050	0.212	1.250	0.172	0.000	m <sup>3</sup> /s		
9.2	0.1	0.333	0.129	0.129	1.150	0.222	1.350	0.179	0.129	m <sup>3</sup> /s		
<b>9.3</b>	<b>0.2</b>	<b>0.471</b>	<b>0.365</b>	<b>0.365</b>	<b>1.250</b>	<b>0.231</b>	<b>1.450</b>	<b>0.186</b>	<b>0.186</b>	<b>m<sup>3</sup>/s</b>		
9.4	0.3	0.576	0.670	0.576	1.350	0.240	1.550	0.192	0.192	m <sup>3</sup> /s		
9.5	0.4	0.666	1.032	0.666	1.450	0.249	1.650	0.198	0.198	m <sup>3</sup> /s		

## A-4 RB Outlet

Ignore the pit?? Yes/No					Are you Assuming INLET CONTROL???					No		
PIT					PIPE		INLET CONTROL		OUTLET CONTROL			
Pit Sill Level		58	m AHD		Invert Level	7.8	m AHD		Ke	0.5	Square edge	
Width		1.2	m		Dia	0.375	m		Kex	1.0		
Length		1.2	m		barrels	1			Length	210.0	m	
Area		1.44	m <sup>2</sup>		Area	0.110446617	m <sup>2</sup>		Tailwater Level	7.6	m AHD	
Grill blockage factor		0	%						wetted perim	1.18	m	
									Hyd Radius	0.09	m	
Height	Head	Orifice Flow	Weir Flow	total flow into pit	Head	Orifice Flow	head loss	flow	TOTAL FLOW RATE			
7.8	-50.2	0.000	0.000	NA	-0.188	0.000	0.190	0.050	0.000	m <sup>3</sup> /s		
8.1	-49.9	0.000	0.000	NA	0.113	0.108	0.490	0.081	0.081	m <sup>3</sup> /s		
8.4	-49.6	0.000	0.000	NA	0.413	0.207	0.790	0.103	0.103	m <sup>3</sup> /s		
8.7	-49.3	0.000	0.000	NA	0.713	0.273	1.090	0.121	0.121	m <sup>3</sup> /s		
9	-49	0.000	0.000	NA	1.013	0.325	1.390	0.137	0.137	m <sup>3</sup> /s		
9.3	-48.7	0.000	0.000	NA	1.313	0.370	1.690	0.151	0.151	m <sup>3</sup> /s		
9.6	-48.4	0.000	0.000	NA	1.613	0.410	1.990	0.163	0.163	m <sup>3</sup> /s		
9.9	-48.1	0.000	0.000	NA	1.913	0.447	2.290	0.175	0.175	m <sup>3</sup> /s		
10.2	-47.8	0.000	0.000	NA	2.213	0.480	2.590	0.186	0.186	m <sup>3</sup> /s		
<b>10.5</b>	<b>-47.5</b>	<b>0.000</b>	<b>0.000</b>	<b>NA</b>	<b>2.513</b>	<b>0.512</b>	<b>2.890</b>	<b>0.197</b>	<b>0.197</b>	<b>m<sup>3</sup>/s</b>		
10.8	-47.2	0.000	0.000	NA	2.813	0.541	3.190	0.207	0.207	m <sup>3</sup> /s		
11.1	-46.9	0.000	0.000	NA	3.113	0.570	3.490	0.216	0.216	m <sup>3</sup> /s		
11.4	-46.6	0.000	0.000	NA	3.413	0.596	3.790	0.225	0.225	m <sup>3</sup> /s		

[CD3]

Broad Crested Weir		RB Weir	
Formula	$Q = CbH^{3/2}$		
Inputs	C	1.60	Weir Coefficient (1.4-2.1, typically 1.6)
	b	12.00 m	Breadth of Weir
	H	0.350 m	Head Of Water Above Crest
Output	Q	3.98	m <sup>3</sup> /s

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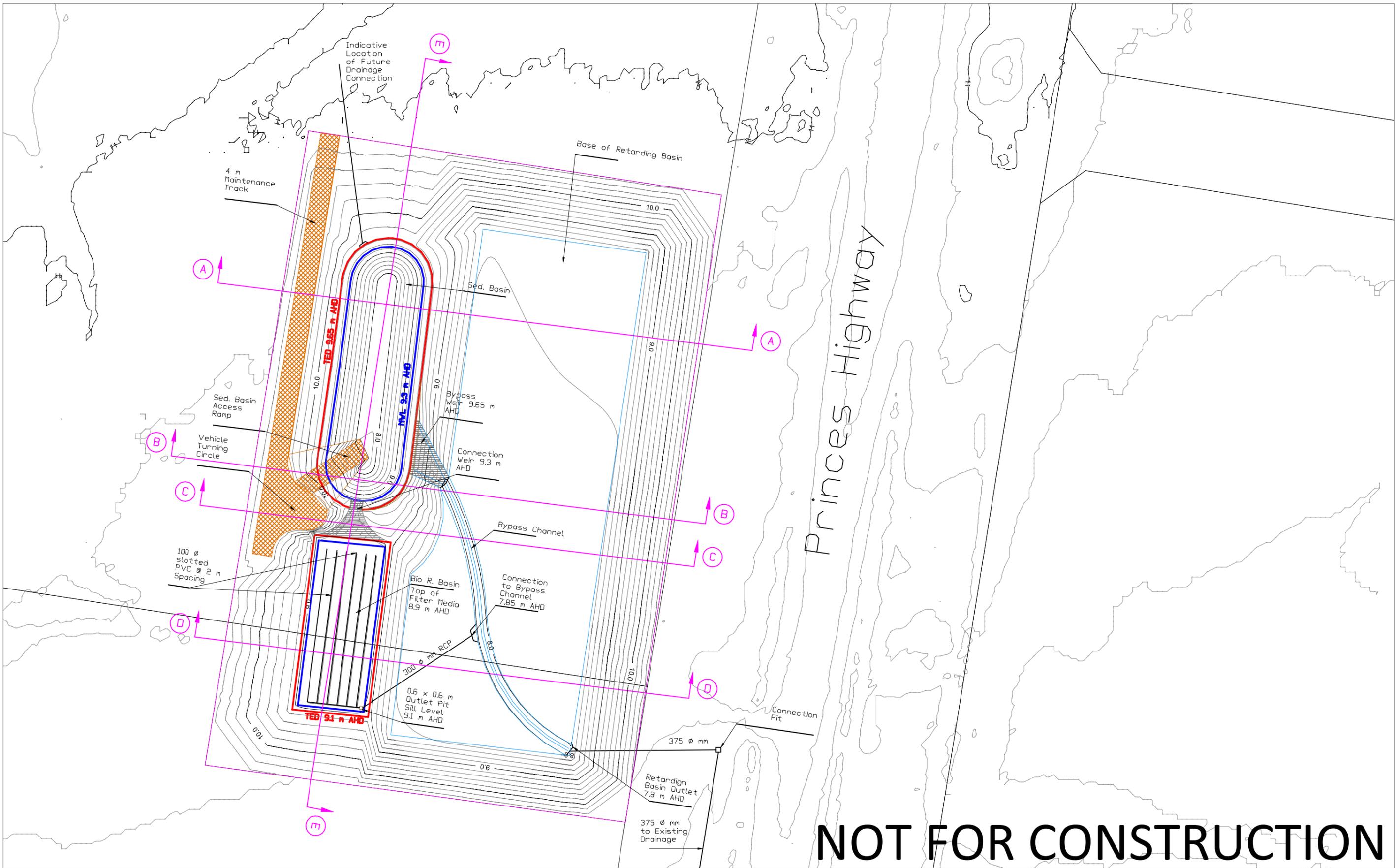
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# APPENDIX B

## AREA B SOUTH FUNCTIONAL DESIGN PLANS





REVISIONS			
REV.	DESCRIPTION	DATE	INIT.
V01	ISSUED FOR COMMENT	30/01/2017	TJC

CLIENT:  
WELLINGTON SHIRE COUNCIL



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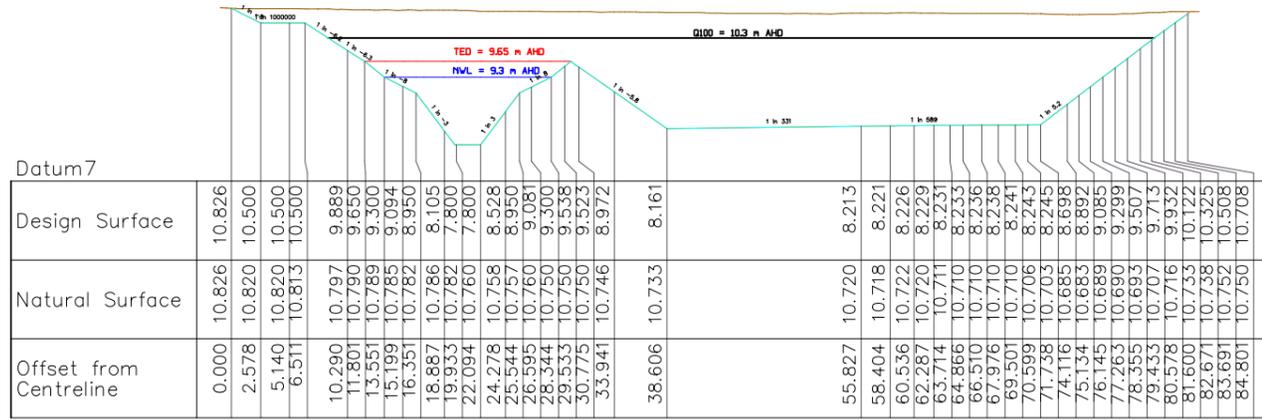
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FUNCTIONAL DESIGN  
PLAN VIEW

JOB NO. J4267-01  
SHEET 1 of 3

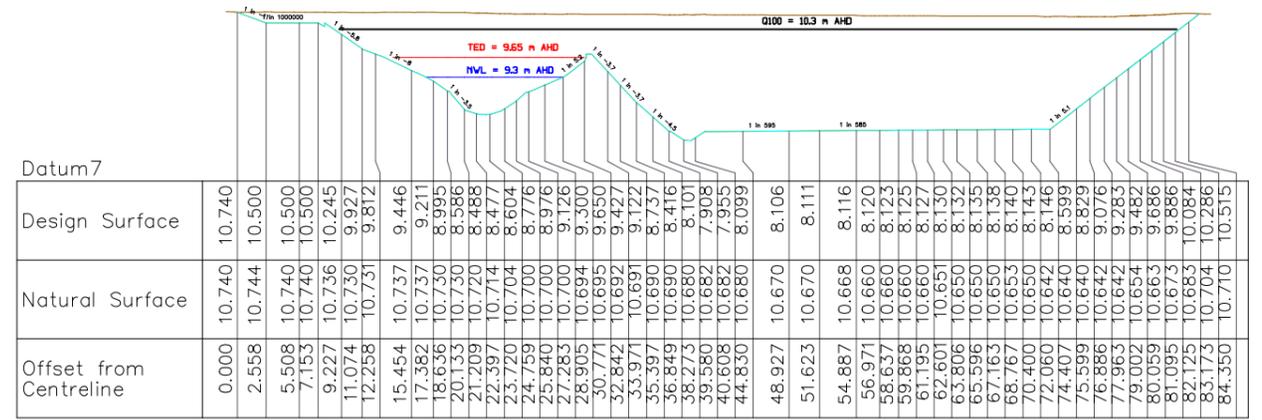
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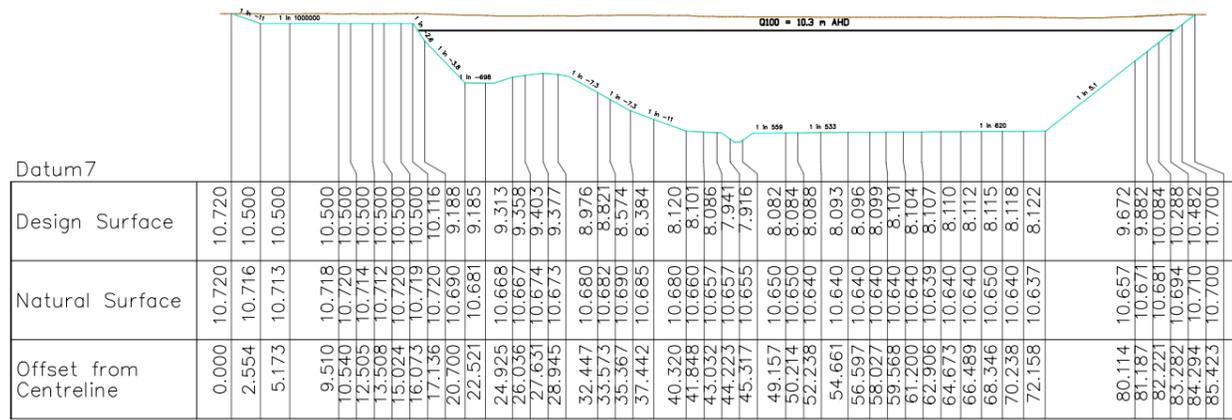
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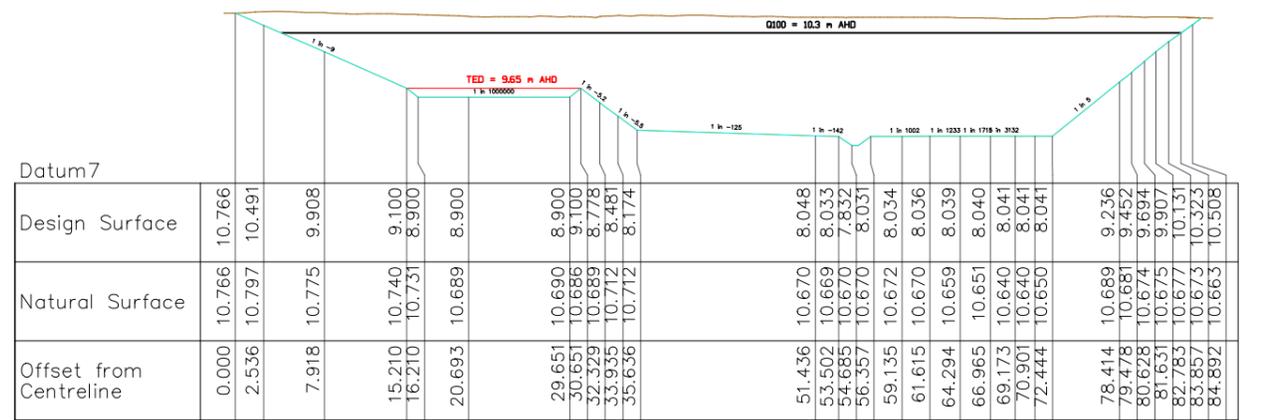
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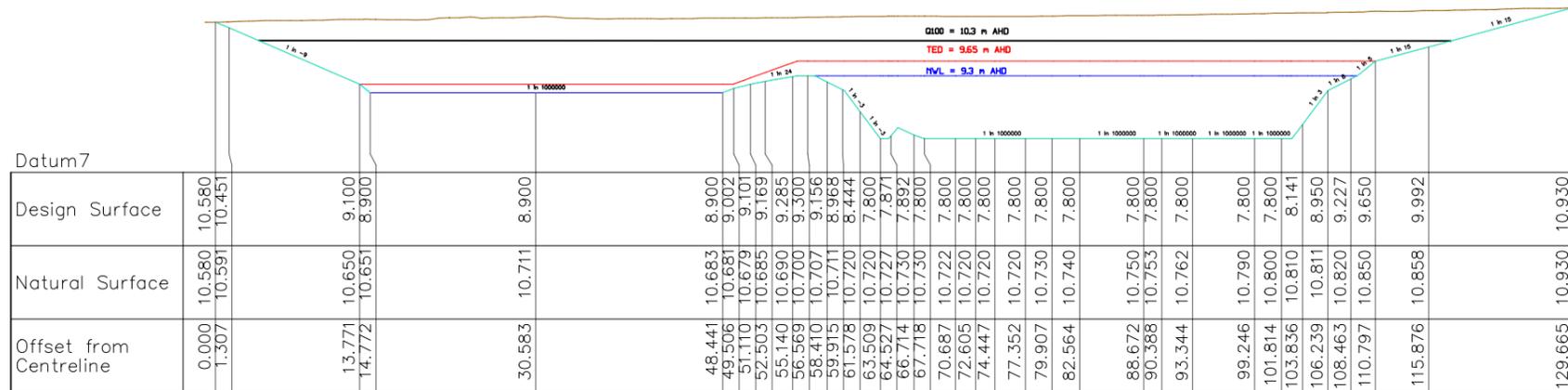
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Cross Section DD



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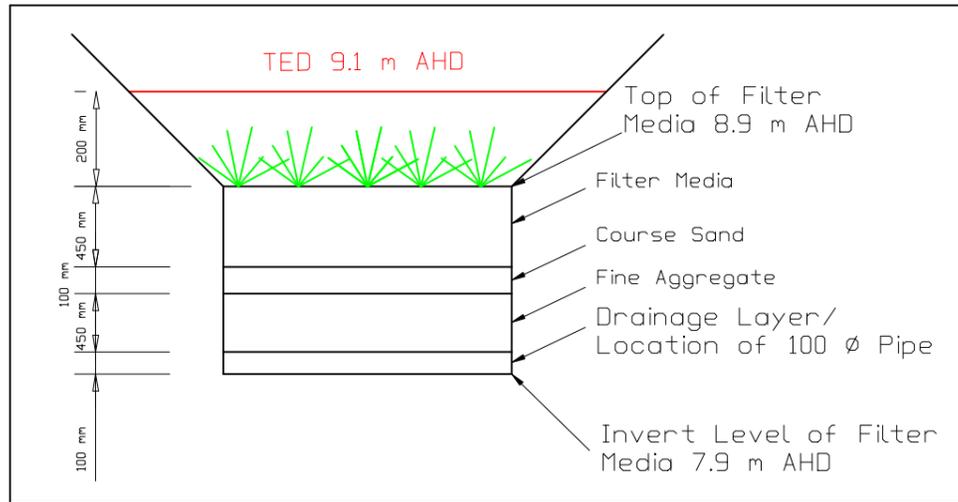
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FUNCTIONAL DESIGN  
CROSS SECTIONS

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SHEET 2 of 3

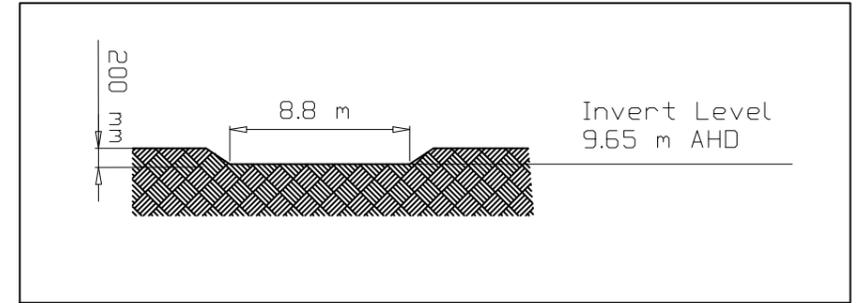
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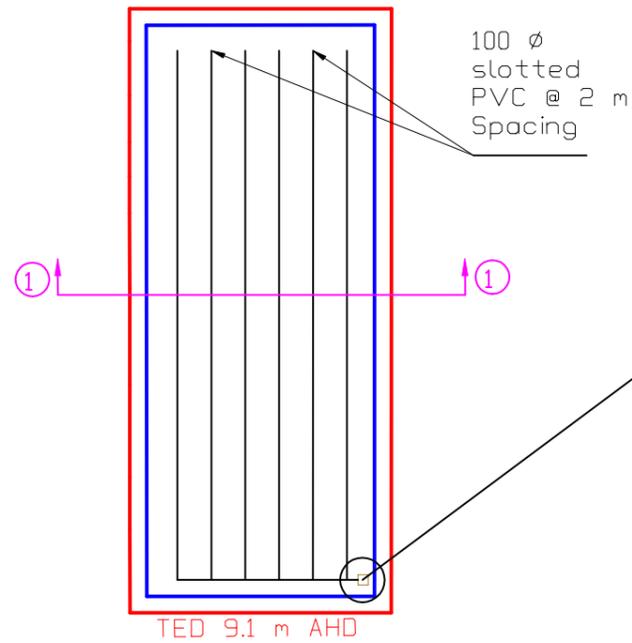
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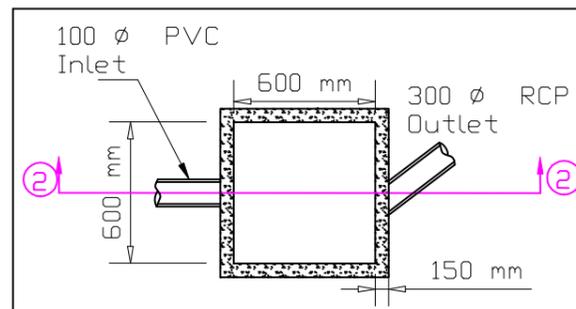
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NTS



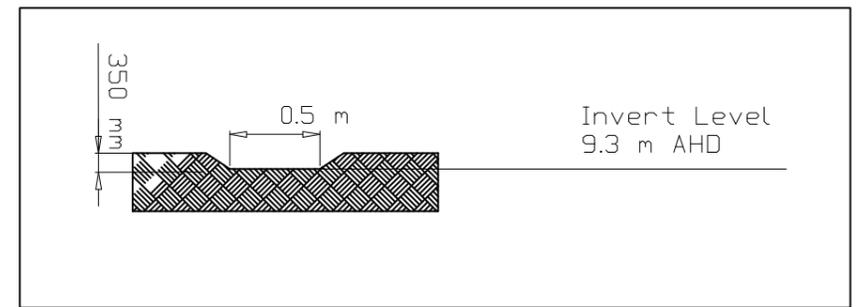
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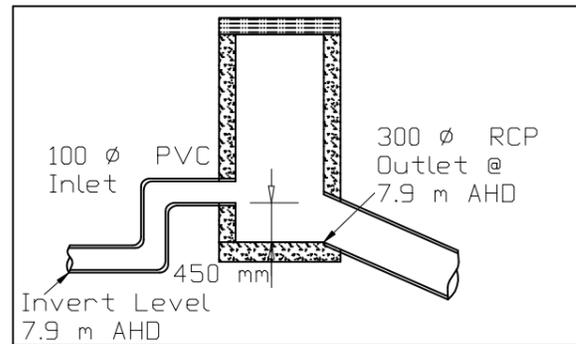
Bioretention Basin  
NTS



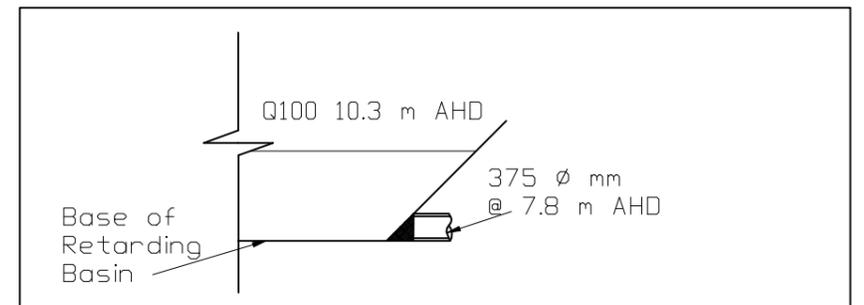
Bioretention Basin Outlet Pit  
NTS



Connection Weir  
NTS



Section 2  
NTS



Retarding Basin Outlet  
NTS

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REVISIONS			
REV.	DESCRIPTION	DATE	INIT.
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DRAWN	BE
CHECKED	TJC
DESIGN	BE
CHECKED	TJC
APPROVED	SMH

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FUNCTIONAL DESIGN  
CROSS SECTIONS  
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SHEET 3 of 3

Drawing No. 4267-01\_D02V01\_001 SCALE: AS NOTED  
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# APPENDIX C

## AREA B SOUTH COST ESTIMATES

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## C-1 Cost Estimates

<b>North Sale - Area B South Bioretention &amp; Retarding Basin</b>										
Item	Qty	Unit	Rate	Total (ex GST)	Incl 20% contingency (ex GST)	GST	TOTAL (incl GST and contingency)	Comments		
<b>Establishment, contractor management and supervision</b>										
Removal of vegetation		Item	10,000.00	10,000	12,000	1,200	13,200	Unknown		
<b>Earthworks</b>										
Strip site (say 200mm depth)	11,025	sq.m	1.50	16,538	19,845	1,985	21,830	assumed all topsoil is stockpiled for reuse		
Excavate to line and level	18,184	cu.m	10.00	181,840	218,208	21,821	240,029	excavate 300 below finished and below NTWL to allow for clay and topsoil and 200 below finished and above NTWL to allow for topsoil		
Fill and compact to design levels	0	cu.m	25.00	-	-	-	-			
Construct Clay liner (300mm depth to NTWL)	225	cu.m	25.00	5,625	6,750	675	7,425	See provisional item if treatment required		
Place topsoil won from s'pile (200mm depth)	10,300	sq.m	2.50	25,750	30,900	3,090	33,990	assumed material won from site; excludes area 500mm below NTWL in SB		
Dispose of excess material from site	18,329	cu.m	15.00	274,935	329,922	32,992	362,914	allowance for approx. 1hr of travel and dozer time to spread		
<b>Associated drainage infrastructure</b>										
100mm dia slotted PVC	200	lm	60.00	12,000	14,400	1,440	15,840			
300mm dia RCP	33	lm	155.00	5,115	6,138	614	6,752			
375mm dia RCP	172	lm	180.00	30,960	37,152	3,715	40,867			
Endwall to suit 300 Dia pipe incl rock beaching	1	#	2,200.00	2,200	2,640	264	2,904			
600x600 Outlet Pit	1	#	1,000.00	1,000	1,200	120	1,320			
<b>Bioretention Basin</b>										
450mm filter media	453	sq.m	40.00	18,120	21,744	2,174	23,918			
450mm transition layer/submerged zone	453	sq.m	30.00	13,590	16,308	1,631	17,939			
100mm drainage layer	453	sq.m	12.00	5,436	6,523	652	7,176			
Impervius geotextile liner	547	sq.m	15.00	8,205	9,846	985	10,831			
<b>Landscaping</b>										
Bioretention filter media (453m2) @8 plants/m2	3,624	#	2.20	7,973	9,567	957	10,524			
Ephemeral batters inc bioretention (195m2) @6 plants/m2	1,170	#	2.20	2,574	3,089	309	3,398	BRB = 100m2, SB = 95m2		
Shallow Marsh 45(m2) @2 plants/m2	90	#	2.20	198	238	24	261			
Deep Marsh (170m2) @2 plants/m2	340	#	2.20	748	898	90	987			
Submerged Marsh (115m2) @1 plant/m2	115	#	2.20	253	304	30	334			
<b>Miscellaneous</b>										
Construct Sed Basin hard base floor (400mm depth rock)	172	sq.m	15.00	2,580	3,096	310	3,406			
Construct drying areas with 100mm CL3 FCR	0	sq.m	12.00	-	-	-	-			
Construct Access Tracks / Ramps (200mm depth CR)	479	sq.m	20.00	9,580	11,496	1,150	12,646			
Construct Sed Basin connection weir (b=0.5m)	1	Item	2,700.00	2,700	3,240	324	3,564	\$150/m for 500 deep concrete weir (say 6m long) + \$40/m2 for apron rock (say 44m2)		
Construct Sed Basin bypass weir (b=8.8m)	1	Item	4,200.00	4,200	5,040	504	5,544	\$150/m for 500 deep concrete weir (say 12.8m long) + \$40/m2 for apron rock (say 56m2)		
As-constructed survey of basin/WLRB	1	Item	3,000.00	3,000	3,600	360	3,960	<b>\$774,143.16</b>		
<b>Maintenance of landscaping - 2yrs</b>										
Provisional Items										
Excavate and disposal of unsuitable material		cu.m	35.00	-	-	-	-			
Supply, place and compact clay fill from s'pile		cu.m	40.00	-	-	-	-			
Treat clay with (3% lime / 1% gysum) to 200mm depth		sq.m	9.00	-	-	-	-			
<b>Totals</b>				<b>655,119</b>	<b>786,143</b>	<b>78,614</b>	<b>864,757</b>			
<b>Professional fees</b>										
Detailed design & documentation (8% x const cost)	1	Item		-	-	-	-	\$61,931.45		
Geotechnical	1	Item		-	-	-	-			
Survey	1	Item		-	-	-	-			
<b>Totals</b>				<b>655,119</b>	<b>786,143</b>	<b>78,614</b>	<b>864,757</b>			
<b>Total including contingency and GST</b>							<b>\$</b>	<b>864,757.48</b>		
<b>Note:</b>										
1. Assumed 300mm depth for clay liner. TBC by Geotech investigation.										

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