WATER TECHNOLOGY
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Wetland Functional Design Report

North Sale – Area B North

Wellington Shire Council

January 2018

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1 INTRODUCTION

The Area B North Bioretention Basin/Retarding Basin forms part of the North Sale Drainage Investigation located North of existing rural-residential lots within Glen Campbell Court, approximately 650 metres west of the Princess Highway.

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 North are shown in Table 1-1

Table 1-1 Design Flow Rates

Storm Event	Flow Rate (m^3/s)
3 month ARI inflow	0.05
1 year ARI inflow	0.3
5 year ARI inflow	0.6
100 year ARI inflow	1.86
Target 100 year ARI outflow from retarding basin	0.2

1.2 Site Constraints

Significant regrading of land within Area B North is required to allow free draining outfall to the proposed retarding basin. The north-eastern most section of Area B North currently drains north to a low spot along the existing irrigation channel, particularly significant regarding will be required in this area to ensure that future lots drain southwards to the proposed retarding basin.

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 0.3 m^3/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.

A 750 mm wide weir has been sized to convey the 1 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 10 year ARI flow rate.

The 100 year velocity in the sediment basin has been calculated as 0.12 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 6.0 years, with the cleanout volume determined to be 100 m^3, 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 300 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

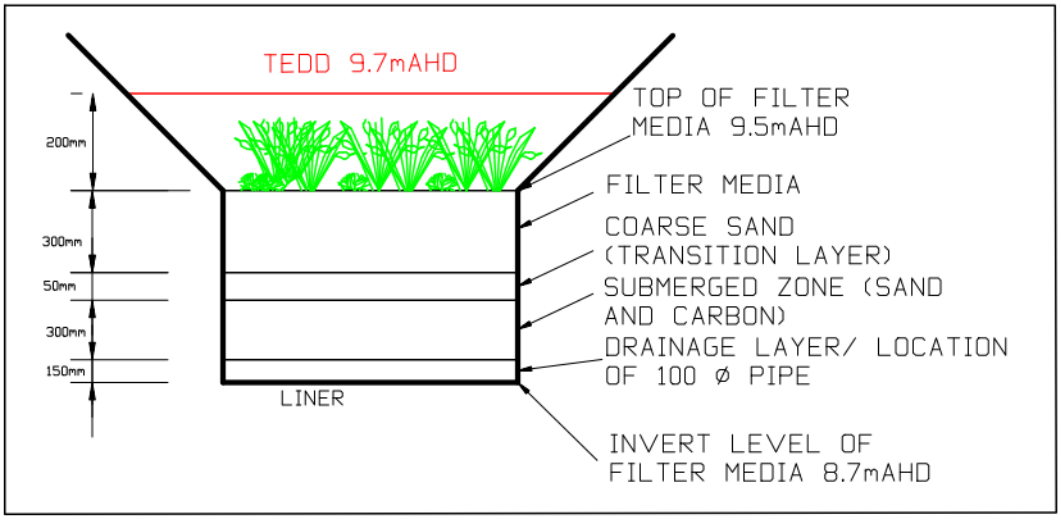

Figure 3-1 Bioretention Basin Filter Media Properties

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.

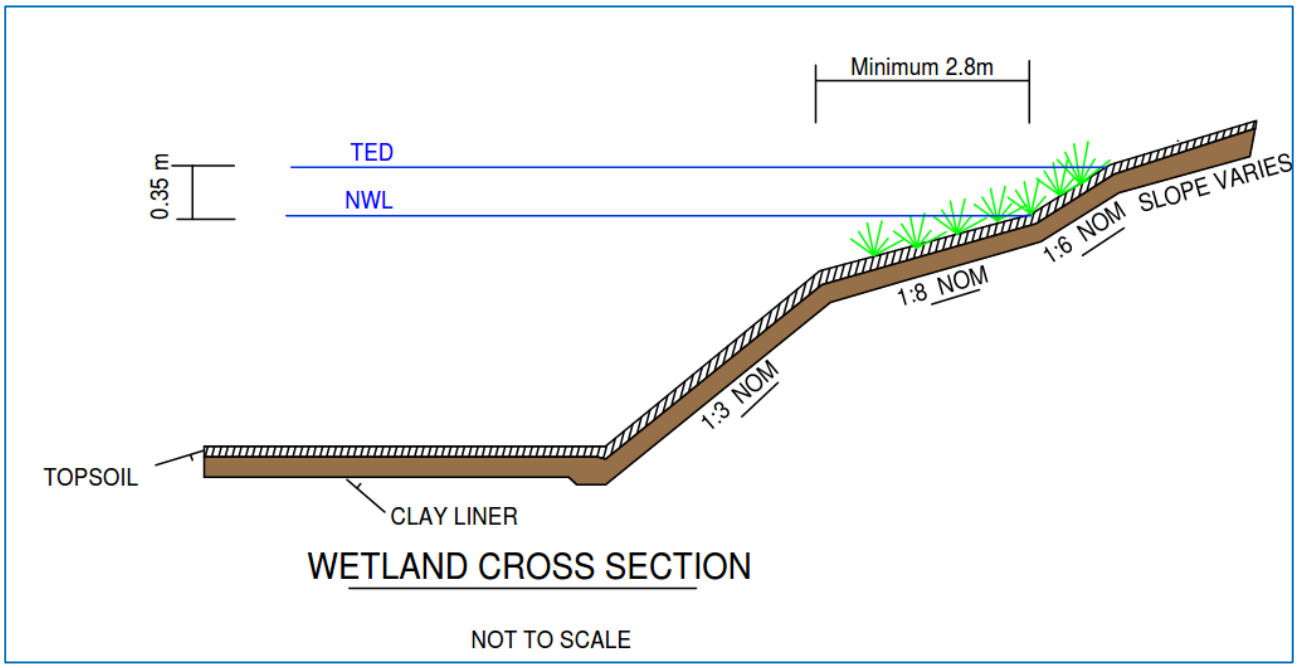

Figure 4-1 Typical Edge Treatment for Sediment Basin

4.2 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. The invert level has been determine by assuming a constant minimum grade from the retarding basin outlet to existing invert levels within sediment basin in the Glenhaven Estate.

4.2.2 Storage Volume

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

Table 4-1 Retarding Basin Height-Storage Details

Height (m AHD)	Storage (m^3)	Outflow (m^3/s)
9.1	0	0.000
9.2	5	0.000
9.3	62	0.036
9.4	212	0.108
9.5	419	0.149
9.6	677	0.163
9.7	970	0.167
9.8	1,285	0.171
9.9	1,623	0.175
10	1,987	0.179
10.1	2,367	0.183
10.2	2,763	0.186
10.3	3,176	0.190
10.4	3,606	0.193
10.5	4,054	0.197
10.6	4,519	0.200
10.7	5,003	0.204
10.8	5,506	0.207

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^3 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 North

	Total (ex GST)	Incl 20% contingency (ex GST)	Incl GST	TOTAL (incl GST and contingency)
Totals	**$ 192,270**	**$ 230,724**	**$ 23,072**	**$253,797**
Total Including 20% Contingency and GST				**$253,797**

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APPENDIX A
DESIGN CALCULATIONS

5.2 Sediment Basin Sizing

Vs =	0.011	m/s	Catchment Area =	10.0	ha
			Sediment load =	1.6	m^3/ha/yr
d_e =	0.35	m	Gross Pollutant Load =	0.4	m^3/ha/yr (Alison et al 1998)
d_p =	1.0	m	Actual basin depth =	1.0	m
d* =	1.0	m	Actual Basin area =	240.0	m^2
(d_e+d_p) =	1.0		Basin sediment accumilation fraction	0.17	per year
(d_e+d^*)					
Q =	0.25	m^3/s			
A =	240	m^2	Clean out every	6.0	years
V_s =	10.56				
Q/A					
λ =	0.26				
n =	1.35				
Fraction of Initial Solids Removed					
R =	95%				

5.3 Sediment Basin Outlet

Broad Crested Weir **SED OUTLET WEIR**

Formula $Q = CbH^{3/2}$

Inputs	C	1.60		Weir Coefficient (1.4-2.1, typically 1.6)
	b	0.75	m	Breadth of Weir
	H	0.350	m	Head Of Water Above Crest
Output	Q	0.25		m^3/s

Broad Crested Weir **SED BYPASS WEIR**

Formula $Q = CbH^{3/2}$

Inputs	C	1.60		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	1.26		m^3/s

5.4 Bioretention Outlet Pit

Ignore the pit?? Yes/No				No		Are you Assuming INLET CONTROL??? Yes/No				Yes		
PIT						PIPE	INLET CONTROL		OUTLET CONTROL			
	Pit Sill Level	9.7	m AHD			Invert Level	9.15	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^2			Area	0.070685835	m^2	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	
9.15	-0.55	0.000	0.000	0.000	-0.150	0.000		1.300	NA	0.000	m^3/s
9.2	-0.5	0.000	0.000	0.000	-0.100	0.000		1.350	NA	0.000	m^3/s
9.25	-0.45	0.000	0.000	0.000	-0.050	0.000		1.400	NA	0.000	m^3/s
9.3	-0.4	0.000	0.000	0.000	0.000	0.000		1.450	NA	0.000	m^3/s
9.35	-0.35	0.000	0.000	0.000	0.050	0.046		1.500	NA	0.000	m^3/s
9.4	-0.3	0.000	0.000	0.000	0.100	0.065		1.550	NA	0.000	m^3/s
9.45	-0.25	0.000	0.000	0.000	0.150	0.080		1.600	NA	0.000	m^3/s
9.5	-0.2	0.000	0.000	0.000	0.200	0.092		1.650	NA	0.000	m^3/s
9.55	-0.15	0.000	0.000	0.000	0.250	0.103		1.700	NA	0.000	m^3/s
9.6	-0.1	0.000	0.000	0.000	0.300	0.113		1.750	NA	0.000	m^3/s
9.65	-0.05	0.000	0.000	0.000	0.350	0.122		1.800	NA	0.000	m^3/s
9.7	0	0.000	0.000	0.000	0.400	0.131		1.850	NA	0.000	m^3/s
9.75	0.05	0.235	0.046	0.046	0.450	0.139		1.900	NA	0.046	m^3/s
9.8	0.1	0.333	0.129	0.129	0.500	0.146		1.950	NA	0.129	m^3/s
9.85	0.15	0.408	0.237	0.237	0.550	0.153		2.000	NA	0.153	m^3/s
9.9	**0.2**	**0.471**	**0.365**	**0.365**	**0.600**	**0.160**		**2.050**	**NA**	**0.160**	**m^3/s**
9.95	0.25	0.526	0.510	0.510	0.650	0.167		2.100	NA	0.167	m^3/s

5.5 RB Outlet

Ignore the pit?? Yes/No				Yes		Are you Assuming INLET CONTROL??? Yes/No				No		
PIT						PIPE	INLET CONTROL		OUTLET CONTROL			
	Pit Sill Level	58	m AHD			Invert Level	9.1	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^2			Area	0.110446617	m^2	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	
9	-49	0.000	0.000	NA	-0.288	0.000		1.390	0.137	0.000	m^3/s
9.2	-48.8	0.000	0.000	NA	-0.088	0.000		1.590	0.146	0.000	m^3/s
9.4	-48.6	0.000	0.000	NA	0.112	0.108		1.790	0.155	0.108	m^3/s
9.6	-48.4	0.000	0.000	NA	0.312	0.180		1.990	0.163	0.163	m^3/s
9.8	-48.2	0.000	0.000	NA	0.512	0.231		2.190	0.171	0.171	m^3/s
10	-48	0.000	0.000	NA	0.712	0.273		2.390	0.179	0.179	m^3/s
10.2	-47.8	0.000	0.000	NA	0.912	0.308		2.590	0.186	0.186	m^3/s
10.4	-47.6	0.000	0.000	NA	1.113	0.341		2.790	0.193	0.193	m^3/s
10.6	-47.4	0.000	0.000	NA	1.312	0.370		2.990	0.200	0.200	m^3/s
10.8	**-47.2**	**0.000**	**0.000**	**NA**	**1.512**	**0.397**		**3.190**	**0.207**	**0.207**	**m^3/s**
11	-47	0.000	0.000	NA	1.712	0.423		3.390	0.213	0.213	m^3/s
11.2	-46.8	0.000	0.000	NA	1.912	0.447		3.590	0.219	0.219	m^3/s
11.4	-46.6	0.000	0.000	NA	2.112	0.469		3.790	0.225	0.225	m^3/s

* Future road reserve to cater for spillway flows towards Glenhaven estate when flow exceed 100 year ARI.

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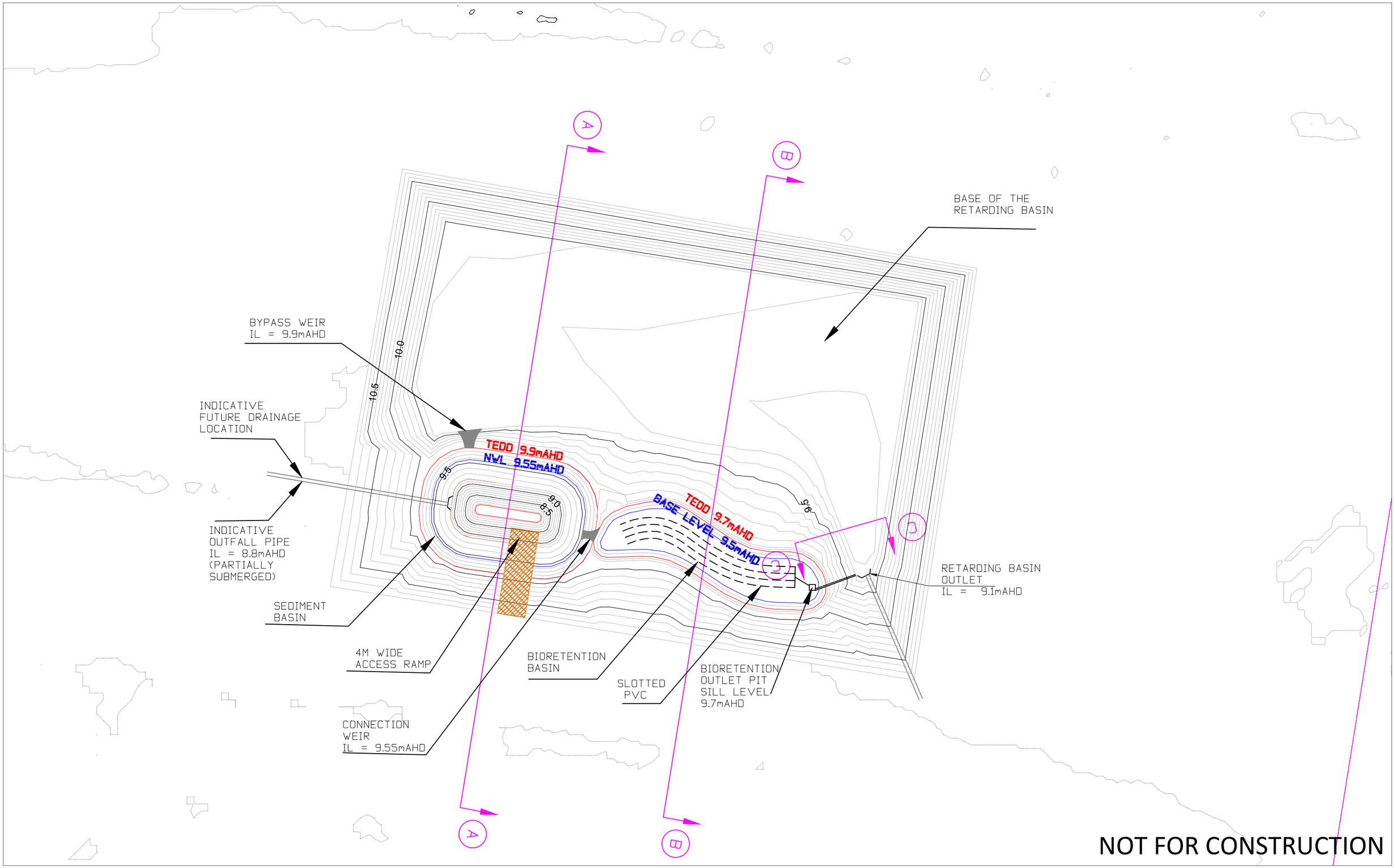
APPENDIX B
AREA B NORTH FUNCTIONAL DESIGN PLANS



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NORTH SALE AREA B NORTH BIORETENTION AND RETARDING BASIN

FUNTIONAL DESIGN
PLAN VIEW
JOB NO. J4267-01
SHEET 1 of 3

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Rev No. V01

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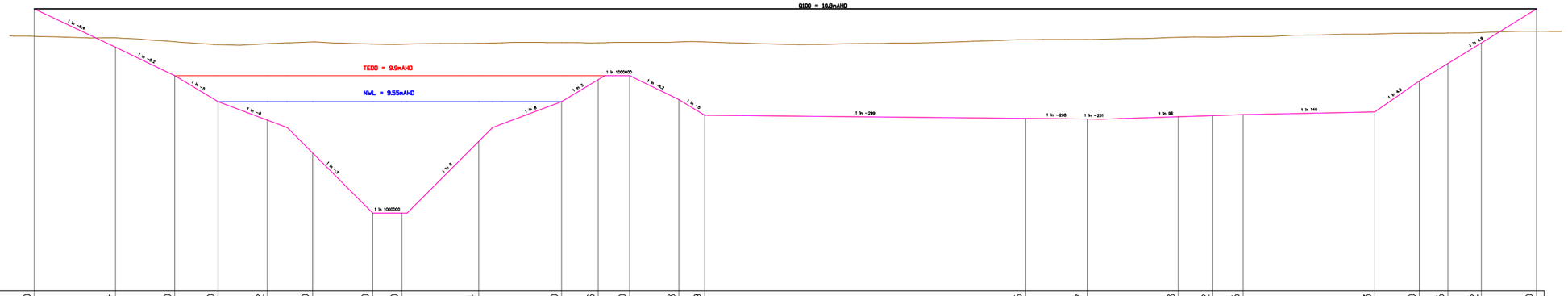

Datum7

Design Surface	10.800	10.284	9.900	9.550	9.302	8.860	8.050	8.050	9.014	9.550	9.846	9.900	9.578	9.369	9.325	9.317	9.348	9.362	9.375	9.413	9.830	10.065	10.342	10.800
Natural Surface	10.432	10.411	10.358	10.319	10.332	10.355	10.327	10.324	10.338	10.347	10.343	10.350	10.355	10.355	10.386	10.390	10.417	10.421	10.429	10.462	10.473	10.475	10.482	10.500
Offset from Centreline	0.000	3.283	5.682	7.433	9.420	11.256	13.687	14.863	17.971	21.330	22.810	24.080	26.067	27.121	40.097	42.586	46.273	47.668	48.902	54.224	56.027	57.178	58.530	60.771

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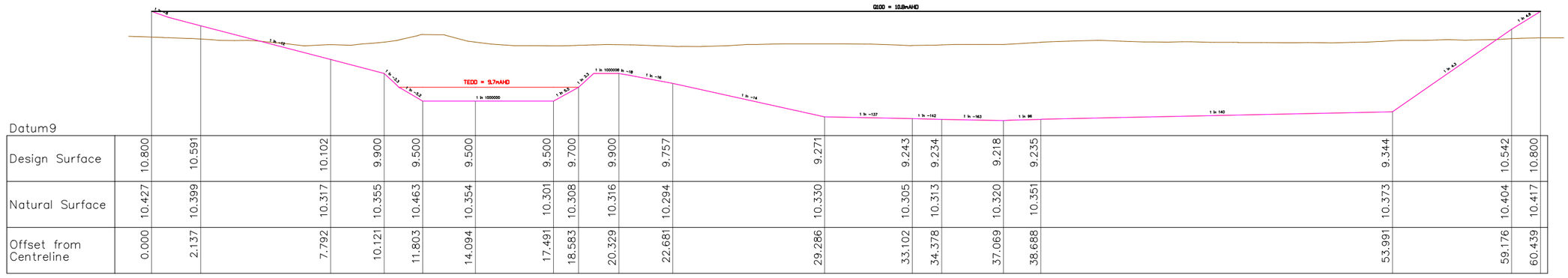

Datum9

Design Surface	10.800	10.591	10.102	9.900	9.500	9.500	9.500	9.500	9.700	9.900	9.757	9.271	9.243	9.234	9.218	9.235	9.344	10.542	10.800						
Natural Surface	10.427	10.399	10.317	10.355	10.463	10.354	10.301	10.308	10.316	10.294	10.330	10.305	10.313	10.320	10.351	10.373	10.404	10.417							
Offset from Centreline	0.000	2.137	7.792	10.121	11.803	14.094	17.491	18.583	20.329	22.681	29.286	33.102	34.378	37.069	38.688	53.991	59.176	60.439							

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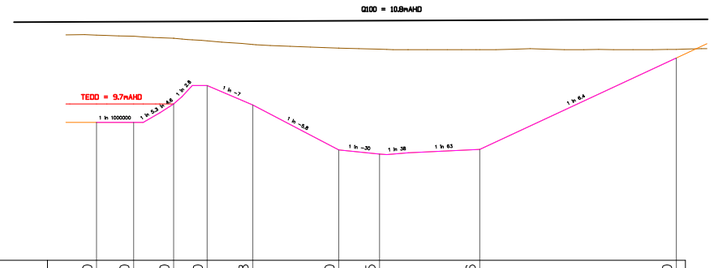

Datum8

Design Surface	9.500	9.500	9.700	9.900	9.688	9.200	9.155	9.206	10.200
Natural Surface	10.448	10.435	10.412	10.386	10.347	10.306	10.294	10.290	10.294
Offset from Centreline	0.000	1.212	2.515	3.605	5.097	7.901	9.232	12.502	18.906

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NORTH SALE AREA B NORTH BIORETENTION AND RETARDING BASIN

FUNTIONAL DESIGN
CROSS SECTIONS
JOB NO. J4267-01
SHEET 2 of 3

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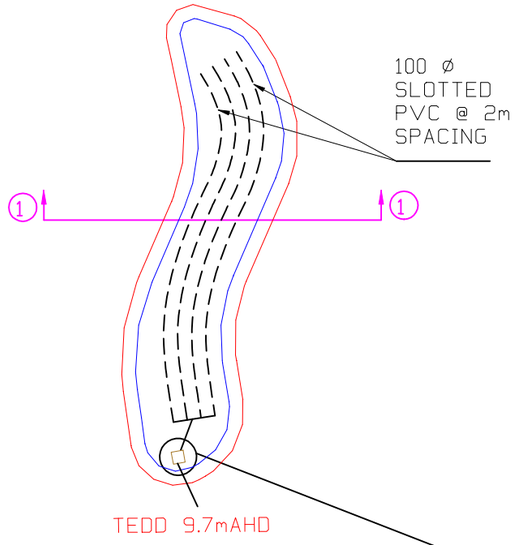
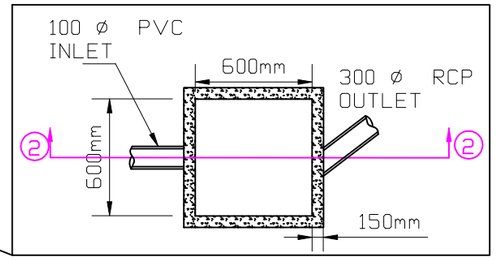


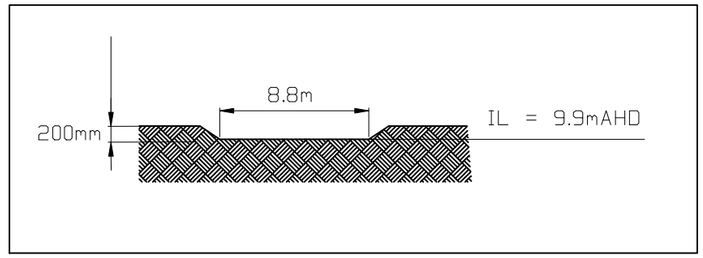
BIORETENTION BASIN

NTS



BIORETENTION BASIN OUTLET PIT

NTS



BYPASS WEIR

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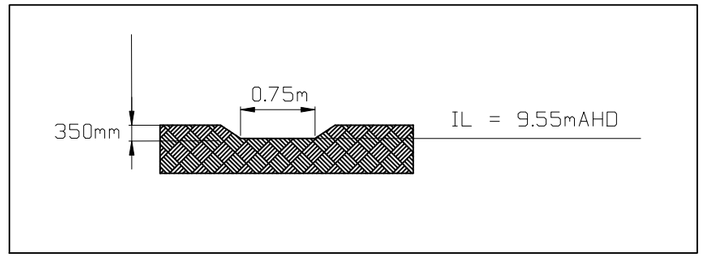

CONNECTION WEIR

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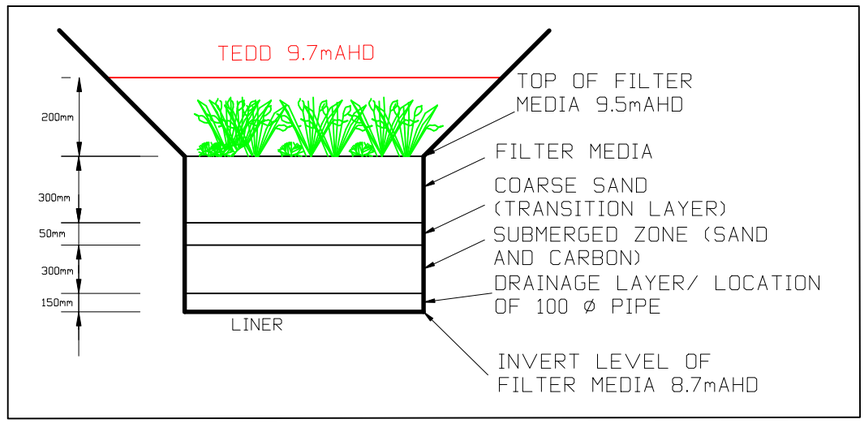

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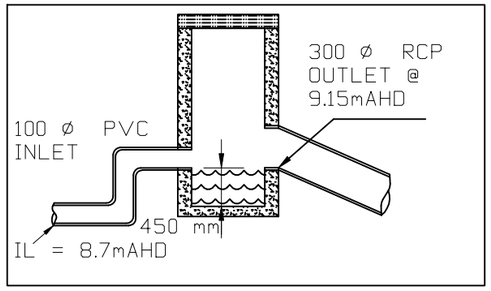

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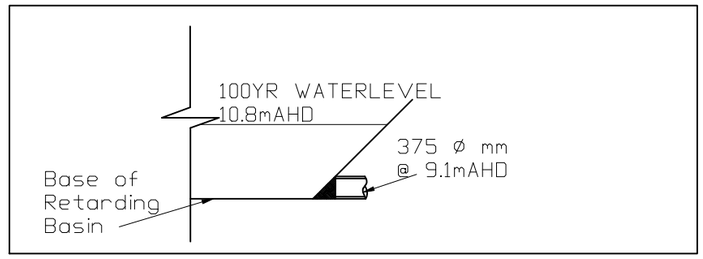

RETARDING BASIN OUTLET

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NORTH SALE AREA B NORTH BIORETENTION AND RETARDING BASIN

FUNTIONAL DESIGN
DETAIL AND TYPICAL SECTIONS
JOB NO. J4267-01
SHEET 3 of 3

Drawing No. 4267-01_D03V01_001 SCALE: AS NOTED
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APPENDIX C
AREA B NORTH COST ESTIMATES

North Sale - Area B North Bioretention & Retarding Basin

Item	Qty	Unit	Rate	Total (ex GST)	Incl 20% contingency (ex GST)	GST	TOTAL (incl GST and contingency)	Comments
Establishment, contractor management and supervision			10,000.00	10,000	12,000	1,200	13,200	
Removal of vegetation		Item		-	-	-	-	Unknown
Earthworks								
Strip site (say 200mm depth)	5,120	sq.m	1.50	7,680	9,216	922	10,138	assumed all topsoil is stockpiled for reuse
Excavate to line and level	3,663	cu.m	10.00	36,632	43,958	4,396	48,354	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	144	cu.m	25.00	3,600	4,320	432	4,752	
Construct Clay liner (300mm depth to NTWL)	85	cu.m	25.00	2,130	2,556	256	2,812	See provisional item if treatment required
Place topsoil won from s'pile (200mm depth)	4,867	sq.m	2.50	12,168	14,601	1,460	16,061	assumed material won from site; excludes area 500mm below NTWL in SB
Dispose of excess material from site	3,485	cu.m	15.00	52,269	62,723	6,272	68,995	allowance for approx. 1hr of travel and dozer time to spread
Associated drainage infrastructure					-			
100mm dia slotted PVC	106	lm	60.00	6,360	7,632	763	8,395	
300mm dia RCP	11	lm	155.00	1,705	2,046	205	2,251	
375mm dia RCP	81	lm	180.00	14,490	17,388	1,739	19,127	
Endwall to suit 375 Dia pipe incl rock beaching	1	#	2,500.00	2,500	3,000	300	3,300	
600x600 Outlet Pit	1	#	1,000.00	1,000	1,200	120	1,320	
Bioretention Basin					-			
300mm filter media	179	sq.m	45.00	8,055	9,666	967	10,633	
350mm transition layer/submerged zone	179	sq.m	25.00	4,475	5,370	537	5,907	
150mm drainage layer	179	sq.m	15.00	2,685	3,222	322	3,544	
Impervious geotextile liner	235	sq.m	15.00	3,531	4,237	424	4,661	
Landscaping					-			
Bioretention filter media (179m2) @8 plants/m2)	1,432	#	2.20	3,150	3,780	378	4,159	
Ephemeral batters inc bioretention (240m2) @6 plants/m2	1,440	#	2.20	3,168	3,802	380	4,182	
Shallow Marsh (22m2) @2 plants/m2	44	#	2.20	97	116	12	128	
Deep Marsh (80m2) @2 plants/m2	160	#	2.20	352	422	42	465	
Submerged Marsh (46m2) @1 plant/m2	46	#	2.20	101	121	12	134	
Miscellaneous					-			
Construct Sed Basin hard base floor (400mm depth rock)	32	sq.m	15.00	473	567	57	624	
Construct drying areas with 100mm CL3 FCR	0	sq.m	12.00	-	-	-	-	
Construct Access Tracks / Ramps (200mm depth CR)	50	sq.m	20.00	1,000	1,200	120	1,320	
Construct Sed Basin connection weir (b=0.5m)	1	Item	1,650.00	1,650	1,980	198	2,178	$150/m for 500 deep concrete weir (say 6m long) + $40/m2 for apron rock (say 18m2)
Construct Sed Basin bypass weir (b=8.5m)	1	Item	4,000.00	4,000	4,800	480	5,280	$150/m for 500 deep concrete weir (say 12.5m long) + $40/m2 for apron rock (say 53m2)
As-constructed survey of basin/WLRB	1	Item	3,000.00	3,000	3,600	360	3,960	**$223,524.48**
Maintenance of landscaping - 2yrs	1	Item	6,000.00	6,000	7,200	720	7,920	
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	-	-	-	-	
Totals				**192,270**	**230,724**	**23,072**	**253,797**	
Professional fees								
Detailed design & documentation (8% x const cost)	1	Item		-	-	-	-	$17,881.96
Geotechnical	1	Item		-	-	-	-	
Survey	1	Item		-	-	-	-	
Totals				**192,270**	**230,724**	**23,072**	**253,797**	
			Total including contingency and GST				**$ 253,796.93**	

Note:

1. Assumed 300mm depth for clay liner. TBC by Geotech investigation.

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