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Tyson Quig
Urban Land Development Authority
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PLANS AND DOCUMENTS referred to in the ULDA APPROVAL dated 21/3/12

Dear Tyson,

SUBJECT: CLINTON, GLADSTONE – DEVELOPMENT STAGES 2 AND 3, REVISED BIORETENTION AND DETENTION BASIN DESIGN

1 INTRODUCTION

In response to your request, we have revised the concept design for the proposed bioretention area and detention basin at the north-western corner of the above development. The locations of the bioretention and detention basins are shown in Figure 1. The revised design takes into account additional detail on the proposed stormwater drainage network for Stages 2 and 3 of the development and revised catchment areas as advised by the project civil engineers. The design parameters for the bioretention and detention basins provided in the following sections supersede the concept designs provided in our previous report (WRM, 2010). The revised concept designs have been developed using the methodology and models described in our previous report (WRM, 2010), with some modifications to assumptions and model parameters as described below.

2 CATCHMENT AREA

Figure 2 shows the estimated catchment area draining to the north-western discharge point from the site for pre and post-development conditions. Under pre-development conditions, the total catchment draining to the site boundary is 10.9 ha. Under post-development conditions, site earthworks and road construction slightly increase the total catchment area draining to this location to 11.0 ha.

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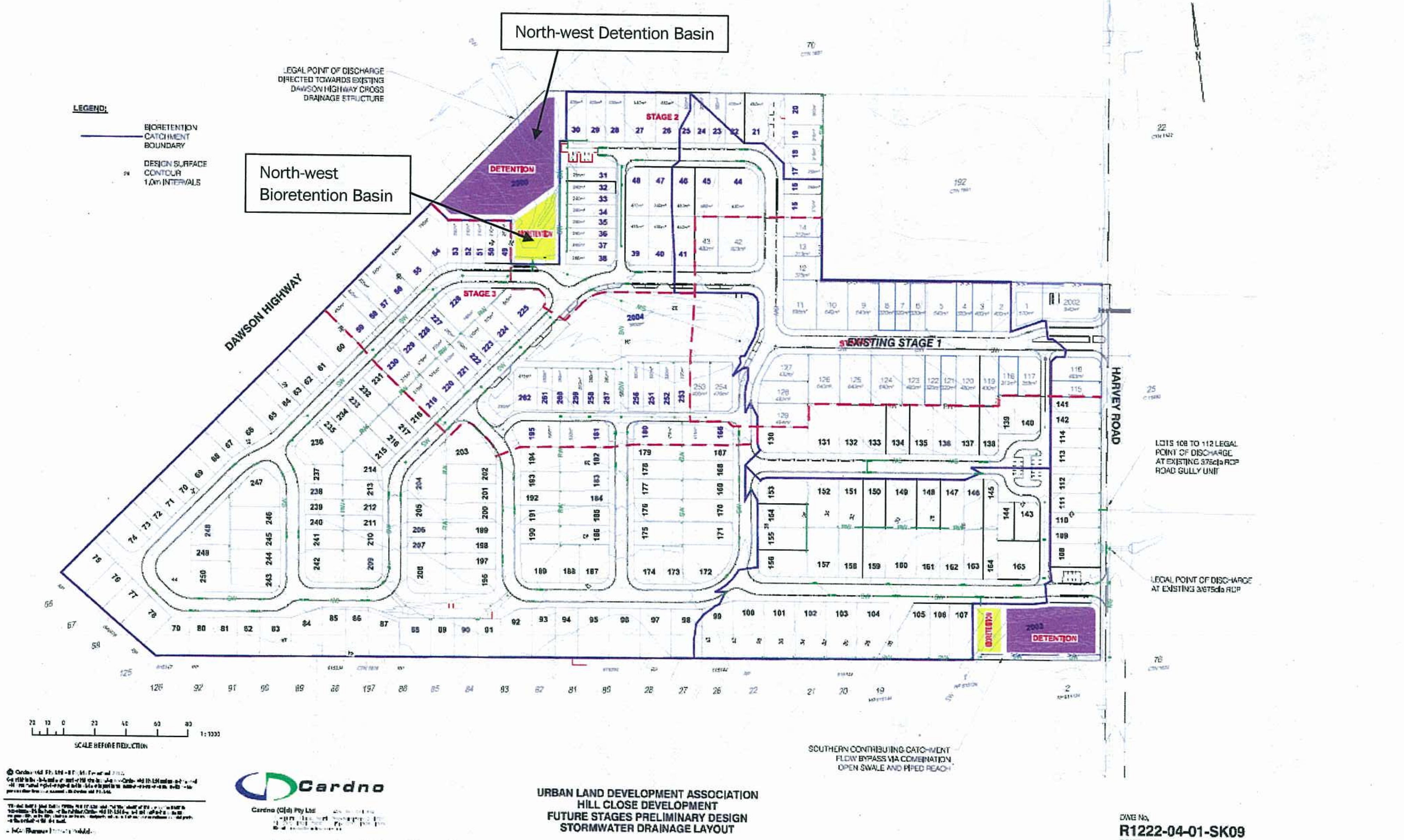

Figure 1 – Plan Showing Location of North-west Detention and Bioretention Basins

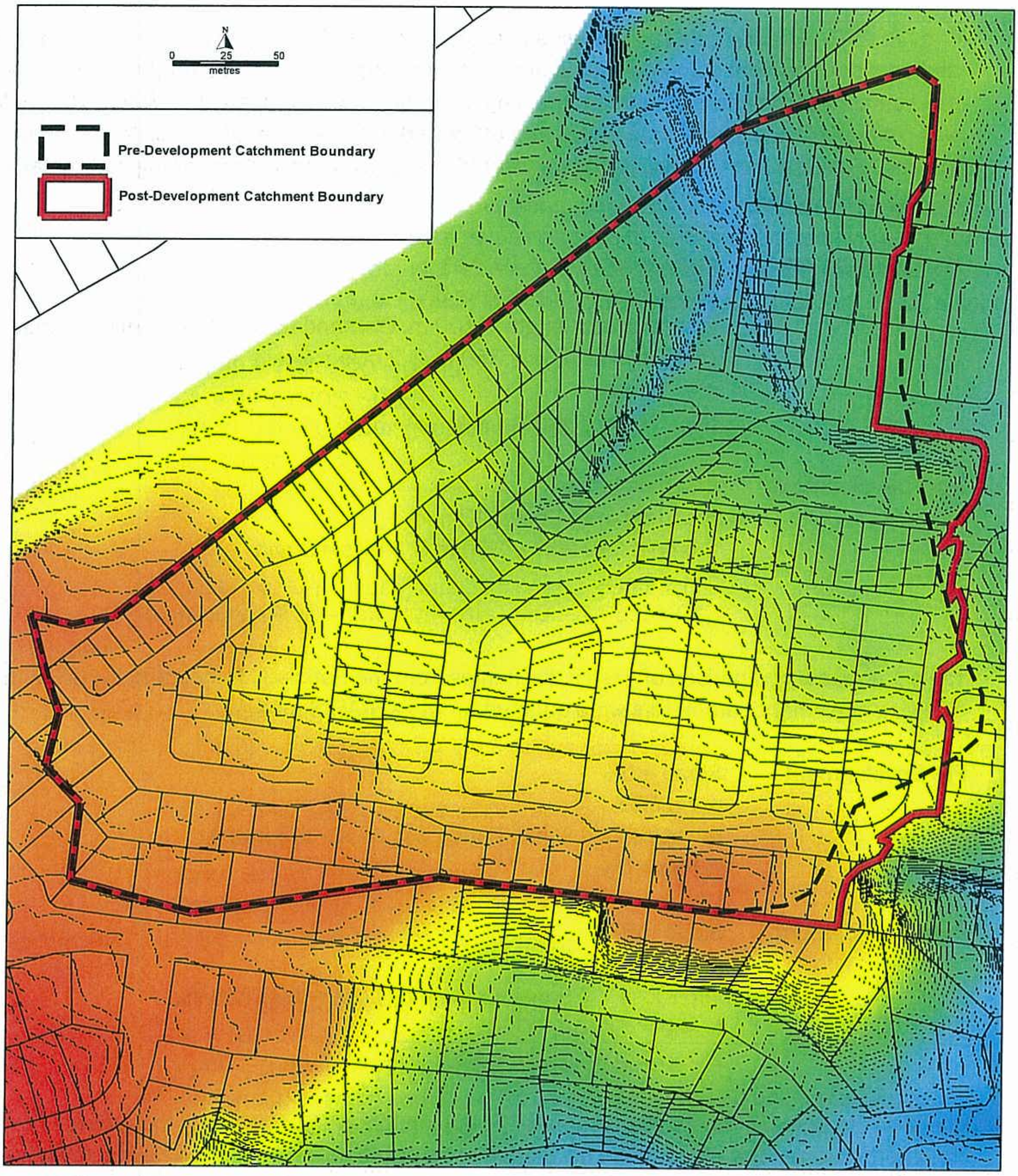

Figure 2 – Pre and Post-Development Catchment Boundaries Draining to North-west Site Boundary

3 DESIGN DISCHARGES

The XPRAFTS hydrologic model was used to estimate design flood discharges from the catchment for pre and post-development catchment conditions. The post-development catchment case is based on full development of the entire catchment draining to the north-west property boundary. The XPRAFTS model was configured as a single-node model and calibrated to achieve results consistent with the Rational Method. Rational Method calculations were undertaken based on the following parameter values taken from QUDM (2008):

Pre-Development:

Catchment area = 10.9 ha
Upper catchment slope = 5%
Overland flow length = 100 m, Overland flow time = 16 min (Friends Eqtn)
Channel flow time = 350 m @ 2 m/s = 3 min
tc = 19 min.
C10 = 0.66 (QUDM Table 4.05.3(b))

Post-Development:

Catchment area = 11.0 ha
Standard Inlet Time = 13 min
Channel flow time = 350 m @ 3 m/s = 2 min
tc = 15 min.
C10 = 0.80 (QUDM Table 4.05.3(a) - 60% impervious)

Table 1 shows a comparison of design discharges from the Rational Method and XPRAFTS model. The following catchment parameters were adopted for the XPRAFTS model:

Pre-Development:

Slope = 5%
n = 0.035
Initial loss = 15 mm, Continuing Loss = 2.5 mm/hr
% Imp = 0%

Post-Development:

Slope = 5%
n = 0.035
Initial loss = 7.5 mm, Continuing Loss = 1.25 mm/hr
% Imp = 5% (Q2 - Q20)
% Imp = 10% (Q50 - Q100)

Note that the percent impervious parameter (% Imp) in XPRAFTS affects only the timing of runoff and not the runoff volume. The effect of the development on runoff volume was modified by reducing initial and continuing rainfall losses by 50%. The % Imp parameter was used to calibrate the peak XPRAFTS discharge to the Rational Method. Different values of % Imp were used for smaller and larger design events to better match Rational Method peak discharges.

Table 1 Comparison of Rational Method and XPRAFTS Model Discharges

	Pre-Development				Post-Development			
Event ARI (Years)	Runoff Coeff. C	RF Intensity i (mm/hr)	Q Rational Method	Q XPRAFTS (m^3/s)	Runoff Coeff. C	RF Intensity i (mm/hr)	Q Rational Method	Q XPRAFTS (m^3/s)
2	0.56	85	1.44	1.41	0.68	96	2.00	2.10
5	0.63	108	2.05	2.19	0.76	123	2.86	2.94
10	0.66	122	2.44	2.63	0.80	140	3.43	3.39
20	0.69	142	2.98	3.25	0.84	163	4.20	4.09
50	0.76	168	3.86	3.85	0.92	193	5.44	5.42
100	0.79	189	4.53	4.49	0.96	217	6.38	6.37

4 REVISED DETENTION BASIN CONFIGURATION

The XPRAFTS model was used to re-design the detention basin based on the latest estimates of catchment area and available storage volume for the detention area. The revised detention basin configuration is summarised below:

- Lower level pipe outlet = 1 x 1050 mm dia RCP @ IL 27.4 mAHD.
- Higher level pipe outlet = 4 x 600mm dia RCP @ IL 28.5 mAHD.
- Stage-storage relationship shown in Table 2.

Peak inflows to and outflows from the basin are shown in Table 3.

The impacts of the proposed detention basin on downstream discharges at the north-western catchment boundary are shown in Table 4. The detention basin will ensure that peak discharges from the site are not increased by the development for events from 2 to 100 years average recurrence interval (ARI).

The peak water level in the detention basin for the 100 year ARI event is 29.27 mAHD. It is recommended that the detention basin embankment include a spillway weir section to pass flow events larger than 100 years ARI and allow for potential overflow due to blockage of the pipe outlets. The recommended weir and embankment configuration is summarised as follows:

- Spillway weir crest level = 29.3 mAHD.
- Minimum weir length = 6 m.
- Embankment crest level = 29.8 mAHD.

The adopted embankment crest level allows for a flow depth of 0.2 m over the spillway weir with a freeboard allowance of 0.3 m. At the embankment crest level (29.8 mAHD), the spillway could pass a discharge of approximately 3.6 m^3/s, which is similar to the 50 year ARI peak discharge from the detention basin. Appropriate erosion control measures should be implemented to ensure that discharges from the pipe outlets and spillway do not cause erosion damage to the outlet structure or embankment. The design of the detention basin outlet must also include adequate safety measures to prevent access to the outlet structure.

Table 2 Detention Basin Stage-Storage Relationship

Elevation (mAHD)	Stored Volume (m^3)
27.4	0
27.5	11
27.6	77
27.7	202
27.8	351
27.9	511
28.0	676
28.1	843
28.2	1011
28.3	1181
28.4	1351
28.5	1523
28.6	1697
28.7	1872
28.8	2051
28.9	2236
29.0	2426
29.1	2618
29.2	2811
29.3	3006

Table 3 Detention Basin Stage-Storage Relationship

Event ARI (Years)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Maximum Stored Volume (m^3)	Peak Water Level (mAHD)
2	2.10	1.33	1473	28.47
5	2.94	2.02	1892	28.71
10	3.39	2.45	2090	28.82
20	4.09	3.04	2347	28.96
50	5.42	3.83	2683	29.13
100	6.37	4.45	2943	29.27

Table 4 Impacts on Downstream Discharges, North-western Site Boundary

Event ARI (Years)	Pre-Development Discharge (m^3/s)	Post-Development Discharge (m^3/s)	Difference (m^3/s)
2	1.41	1.33	-0.08
5	2.19	2.03	-0.16
10	2.63	2.45	-0.18
20	3.25	3.04	-0.21
50	3.85	3.83	-0.02
100	4.49	4.45	-0.04

5 REVISED BIORETENTION SIZING

The MUSIC model developed for our previous study (WRM, 2010) was modified to reflect the proposed stormwater drainage system configuration, which includes discharge to a single bioretention basin located immediately upstream of the proposed detention basin (see Figure 1).

The results of the MUSIC model indicate that achieving the site water quality objectives will require bioretention with the following parameters:

- Bioretention filter surface area = 830 m^2.
- Extended detention basin depth = 0.3 m.
- Filter depth = 0.7 m.

The reductions in pollutant concentrations are shown in Table 5.

Table 5 Modelled Pollutant Export, Developed (Mitigated) Conditions

Pollutant	Percent Reduction (%)	WQO Percent Reduction (%)
Suspended Solids	83	80
Total Nitrogen	45	45
Total Phosphorus	66	60
Gross Pollutants	99	90

6 CONCLUSIONS

The proposed configuration of the bioretention and detention basins will ensure that the proposed development meets best practice water quality objectives for stormwater quality and does not increase peak stormwater discharges at the downstream development boundary.

I trust that the above information is sufficient for your present requirements. Please do not hesitate to contact me if you have any queries.

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For and on behalf of
WRM Water & Environment Pty Ltd

David Newton
Principal Engineer

References:

QUDM, 2008	*Queensland Urban Drainage Manual,* Second Edition, 2008, Department of Natural Resources and Water, June 2008.
WRM, 2010	*Clinton, Gladstone Stormwater Management Plan,* Report prepared by WRM Water & Environment Pty Ltd for the Urban Land Development Authority, 26 August 2010.