TOWNSON ROAD PRECINCT COLEBEE, NSW

Flood Study and Detention Assessment for Rezoning Application

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TOWNSON ROAD PRECINCT, COLEBEE NSW

Civil Engineering

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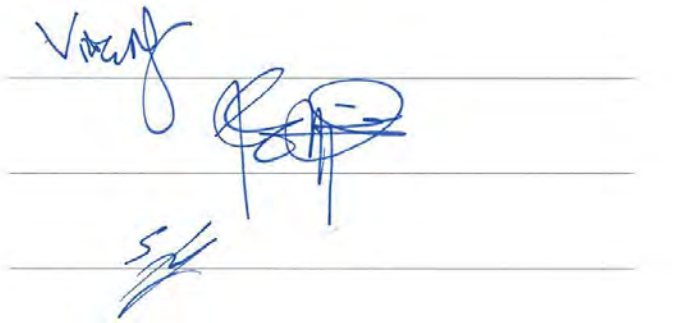

Report No DN00333 – Rev 1

Date 07/03/2014

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1 INTRODUCTION

Hyder Consulting Pty Ltd was engaged by Mecone Pty Ltd, on behalf of the Townson Road Precinct Land Owner Group, to undertake a flood study and stormwater detention basin assessment in support of a land rezoning application for the Townson Road Precinct (Lots 5-9 DP 27536 & Lot 48 DP 117513) in Colebee, NSW where a residential development is proposed.

The site is located to the south east of the Townson Road and Richmond Road intersection, as indicated in Figure 1. It currently has a 'General Rural' zoning classification within the Blacktown Local Government Area.

Figure 1 – Site Location (Source: Google)

In particular, this report presents the details of:

- A flood analysis of Bells Creek which runs along the western boundary of the site and
- A conceptual detention storage assessment for the attenuation of runoff from the proposed residential development.

2 SITE DESCRIPTION

2.1 EXISTING SITE

The existing site (see Figure 2) is a largely undeveloped rural land dominated by grasses and trees and generally slopes to the west towards Bells Creek at a grade of about 3 to 4%.

Figure 2 – Existing Site Conditions (Source: Google)

2.2 PROPOSED DEVELOPMENT

The proposed development covers an area of approximately 30 hectares. It is anticipated that the development could eventually cater for some 420 residential units with a typical lot size of about 450m^2. A preliminary development layout is shown in Figure 3.

Further details on the catchment, proposed site development, and detention storage concept are shown in the accompanying Appendices.

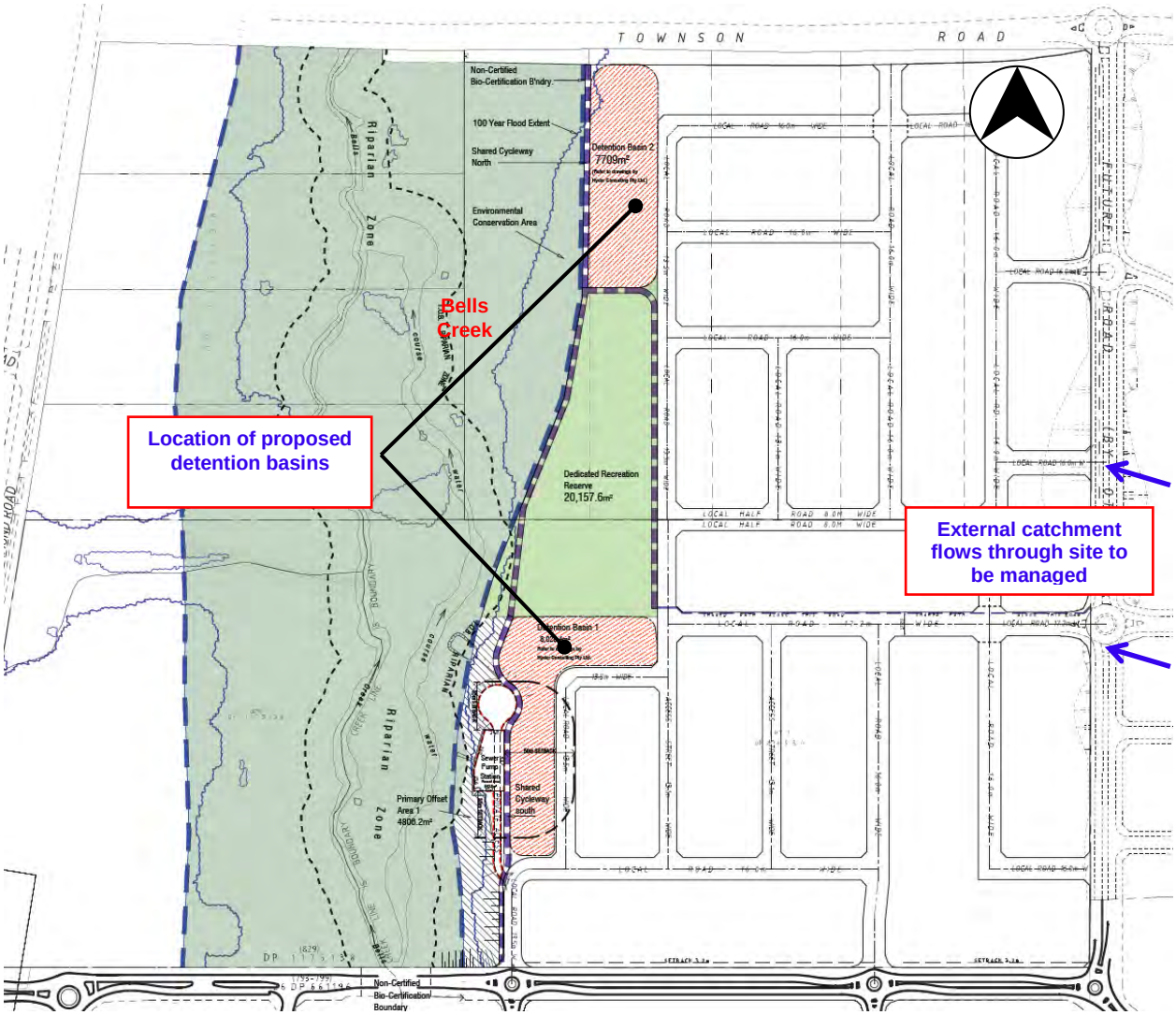


Figure 3 – Indicative Proposed Development Master Plan

3 FLOOD STUDY

A flood assessment of Bells Creek was carried out to determine the 100 year Average Recurrence Interval (ARI), Probable Maximum Flood (PMF), and 100 year ARI post Climate Change flood regimes along Bells Creek from Townson Road up to the southern boundary of the neighbouring upstream development known as No.799 Richmond Road (see Figure 2).

The flood assessment used the RAFTS model for Bells Creek catchment provided by Blacktown City Council. Hyder developed a TUFLOW model of Bells Creek to represent flow regimes across its floodplain. The modelling process and results are discussed below.

3.1 HYDROLOGIC MODELLING

A version of Bell Creek RAFTS model was provided by Blacktown City Council. The model covers the Bell Creek catchment up to Grange Avenue in Marsden Park (about 1.6 km downstream of Townson Road). The RAFTS schematic diagram is shown in Figure 4. The RAFTS model was modified to include a more detailed definition of the local catchments draining into the section of Bell Creek located next to the site. The modified RAFTS model and catchment plan are shown in Figures 5 and 6 respectively.

3.1.1 RAINFALL INTENSITY

The rainfall intensities adopted in the original RAFTS model were found to be slightly higher than the design rainfall Intensity-Frequency-Duration (IFD) data obtained from Blacktown City Council's Engineering Guide for Development 2005. As the discrepancies are minor (+0.4% to +3.5%) and occurring on the conservative side, the rainfall intensities used in the original RAFTS were adopted in this study. Table 1 shows the 100 year rainfall intensities used in the RAFTS model.

Table 1 – 100 year ARI design rainfall intensities adopted in the RAFTS model

Design Rainfall Event Duration (minutes)	Rainfall intensity in RAFTS model (mm/hr)	IFD Rainfall intensity in BCC's Engineering Guide (mm/hr)
25	111.8	108.0
30	101.1	98.0
60	67.0	66.0
90	52.5	52.0
120	43.7	43.4
180	34.2	33.8

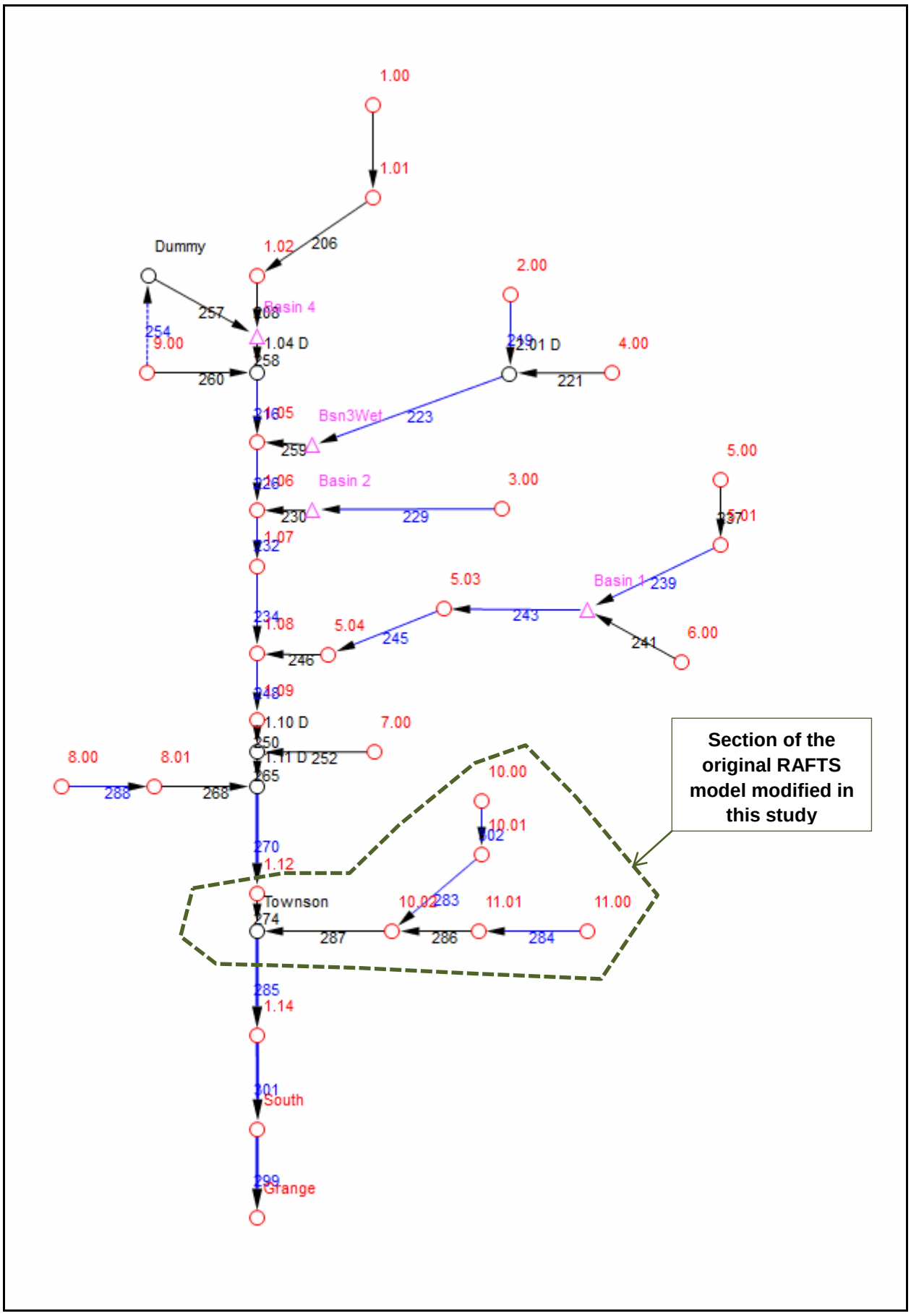


Figure 4 – Council RAFTS Model Schematic Diagram

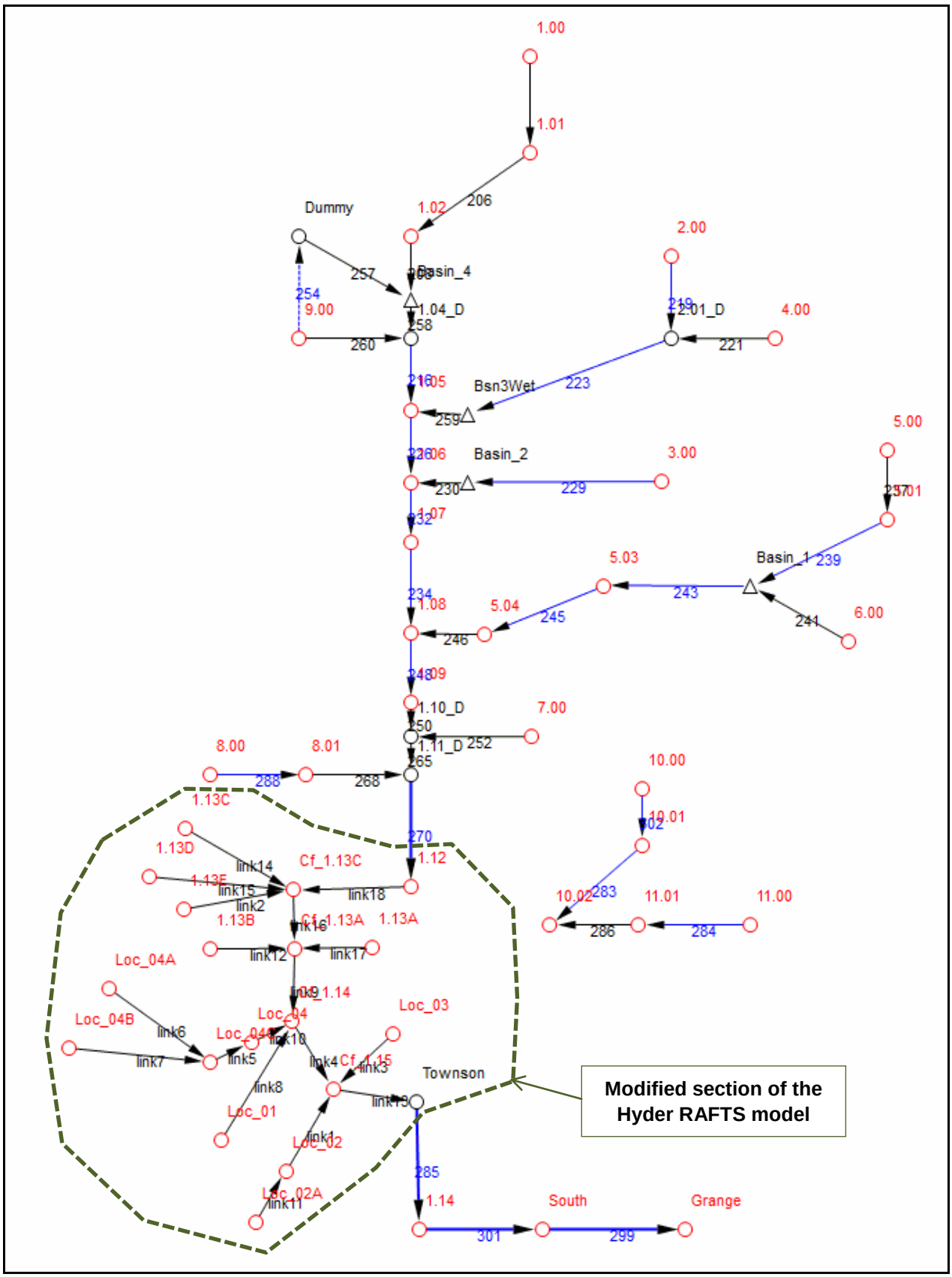


Figure 5 – Modified RAFTS Model Schematic Diagram

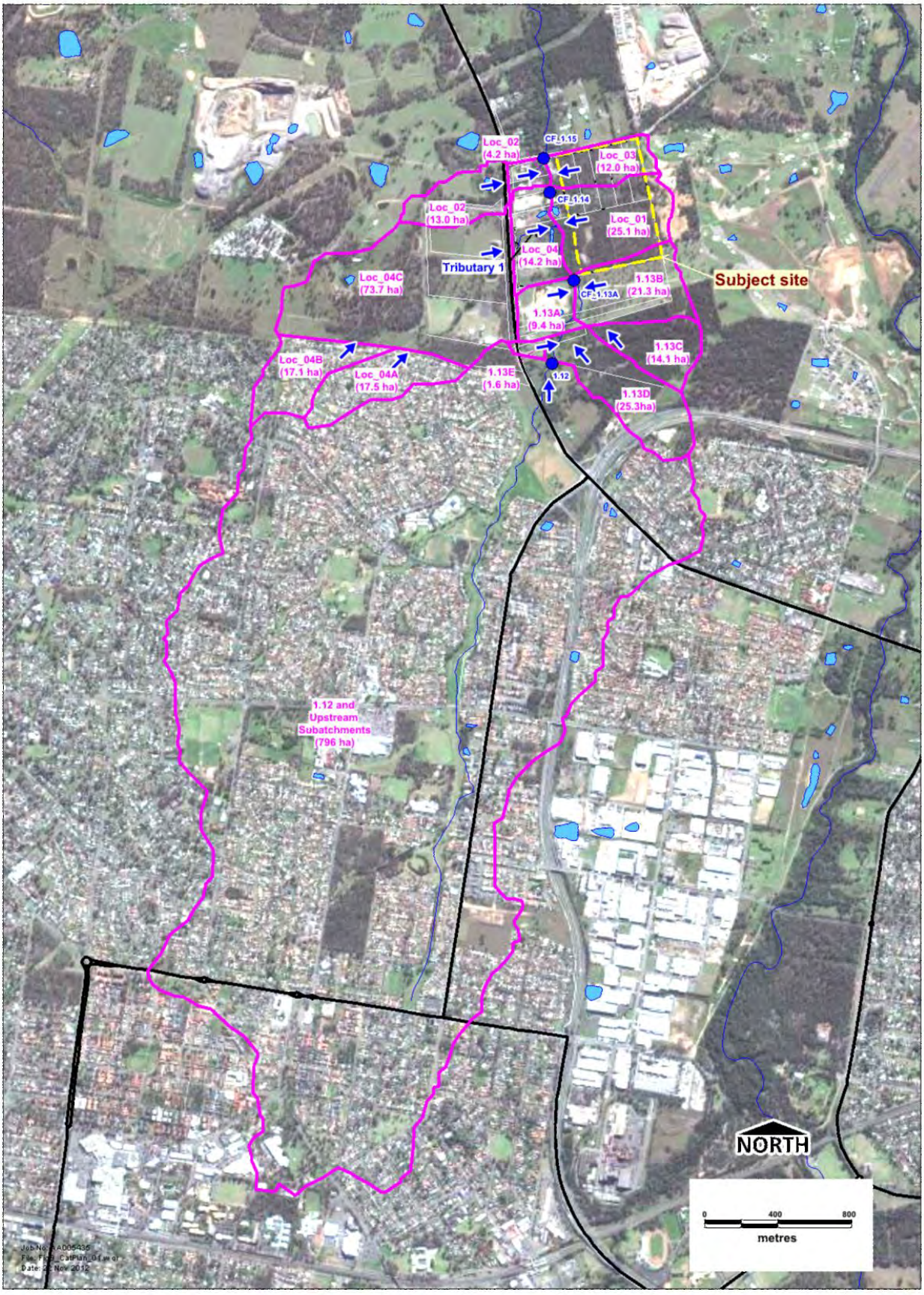


Figure 6 – Modified RAFTS Model Catchment Diagram

3.1.2 LOSSES MODEL

The original RAFTS model adopted the ARBM losses model for all subcatchments. The parameters used are consistent with "Table 10.2 – Parameters of Hydrological models" of Council's Engineering Guide. The same losses approach was adopted in the modified RAFTS model.

3.1.3 VERIFICATION OF THE MODIFIED RAFTS (100 YEAR FLOWS)

Council provided Hyder with the original RAFTS model but with no accompanying report or related documentation.

J Wyndham Prince (JWP) was commissioned by NSW Department of Planning to undertake the MPIP Bells Creek Corridor Water Cycle Management Strategy. As part of this undertaking, a more comprehensive RAFTS modelling was developed by JWP for the Bells Creek catchment. Hyder requested this model but the department was unable to provide it in time for the current study. However, the documentation of the JWP study is available from the NSW Planning and Infrastructure's Sydney's Growth Centres website.

Table 2 – Comparison of 100 year flows from the three RAFTS models

Catchment Location	Modified RAFTS Node ID	Modified Council RAFTS (Hyder) 100 yr Flows (m^3/s)	JWP RAFTS 100 yr Flows (m^3/s)	Original Council RAFTS Model 100 yr Flows (m^3/s)	Remarks
MPIP Site Boundary (South)	1.12	97 (74)	96 (66)	97	Approximate location only
799 Richmond Rd Boundary (Upstream)	CF_1.13C	101 (74)	NA	NA	
Subject Site / 799 Richmond Rd Boundary	CF_1.13A	103 (76)	NA	103	MPIP Site Boundary (North)
Confluence of Tributary 1	CF_1.14	124 (77)	121	NA	
Townson Road	CF_1.15	126 (78)	126 (101)	117	Confluence of Tributary 2

Notes: a) MPIP stands for Marsden Park Industrial Precinct.
b) Tributary 1 (Original name used in JWP's report. For location, refer to Figure A.3)
c) ( ) value below flow refers to time to peak in minutes in the flow hydrograph.

Table 2 shows a summary of the predicted 100 year pre-development flows predicted by both the original and modified Council models. JWP flows are also included in the table for comparison. The flows from the modified model generally agreed with JWP peak flows at the reported locations. However times to peak from the two models are considerably different. For instance, the peak flow at Townson Road predicted by the JWP model comes some 20 minutes later than that predicted by the modified model. This could be due to the fact that basin systems located to the east of Richmond Road were included in the JWP model. These basin systems were not modelled in the original and modified Council models. Since the peak flood level and flow velocity are largely controlled by flow rate, the modified Council model was adopted for the TUFLOW flood model used in this study.

3.1.4 PMP AND PMF ESTIMATES

No Probable Maximum Precipitation (PMP) data was embedded in the Council model files. PMP rainfall intensities for various storm durations were estimated using the GSDM method. This procedure is based on the BOM publication "The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method - 2003" (GSDM). The GSDM PMP rainfall intensities calculation sheet is included in Section A.6 below. Table 3 below summarises the PMP rainfall intensities for storm durations, from 15 minutes to 2 hours, estimated by both Hyder and JWP. It is evident that Hyder estimates are lower than JWP estimates for all storm events. We note that JWP's study followed the earlier BOM procedure of Bulletin 53. In the latest guideline, a revised method of spatial distribution has been introduced and the moisture factors updated. These changes likely explain the difference in PMP estimates between the two studies. Table 4 summarises the Probable Maximum Flood (PMF) peak flow estimates by Hyder and JWP at selected locations in Bells Creek. Details of PMP estimates are provided in Appendix A.

Table 3 – Comparison of Hyder and JWP PMP rainfall intensities

Storm Duration (minute)	Hyder Rainfall intensity (mm/hr)	JWP Rainfall intensity (mm/hr)
15	600	640
30	440	460
45	373	390
60	320	340
90	247	290
120	210	255

Note: Hyder PMP estimates considered ellipse 'A' only, similar to simplified approach adopted by JWP

Table 4 – Comparison of Modified RAFTS with JWP RAFTS PMF Flows

Catchment Location	Modified RAFTS ID	Hyder PMF peak flows (m^3/s)	JWP PMF peak flows (m^3/s)	Remarks
MPIP Site Boundary (South)	1.12	811	766	Approximate location only
799 Richmond Rd Boundary (Upstream)	CF_1.13C	829	-	
Subject Site / 799 Richmond Rd Boundary	CF_1.13A	840	-	MPIP Site Boundary (North)
Confluence of Tributary 1	CF_1.14	968	925	
Townson Road	CF_1.15	983	959	Confluence of Tributary 2

3.1.5 CLIMATE CHANGE

As discussed with Council, a 15% increase in rainfall intensities was adopted to consider the impact of Climate Change on the site's hydrology. The post Climate Change discharges generated from RAFTS are tabulated in Table 5. JWP modelled values are also included for comparison.

Table 5 – Comparison of 100 year ARI post Climate Change flows between Hyder RAFTS with JWP RAFTS models

Catchment Location	RAFTS Node ID	Hyder Post Climate Change 100 yr flows (m^3/s)	JWP Post Climate Change 100 yr flows (m^3/s)	Remarks
MPIP Site Boundary (South)	1.12	116	114	Approximate location only
799 Richmond Rd Boundary (Upstream)	CF_1.13C	121	-	
Subject Site / 799 Richmond Rd Boundary	CF_1.13A	124	-	MPIP Site Boundary (North)
Confluence of Tributary 1	CF_1.14	150	147	
Townson Road	CF_1.15	153	153	Confluence of Tributary 2

3.1.6 SUMMARY OF RAFTS MODELLING RESULTS

Tables 6 to 8 present the summary of RAFTS flow modelling results. It is noted that the critical storms for the 100 year ARI and PMP events are the 2 hour and 1 hour storms respectively. Hydrographs resulting from these storms were used in the TUFLOW model.

Table 6 - RAFTS Model Flow Summary Table - 100 year ARI

RAFTS_ID	Duration (min)						Max (m^3/s)
	25	30	60	90	120	180	
1.13B	3.8	3.9	4.3	4.3	**4.5**	3.3	**4.5**
1.13C	3.7	3.7	4.0	4.1	**4.3**	3.2	**4.3**
1.13D	4.0	4.2	4.8	4.7	**4.9**	3.6	**4.9**
1.12	74.3	80.4	**97.1**	96.2	97.0	84.4	**97.1**
1.13E	0.5	0.5	0.5	**0.5**	0.5	0.4	**0.5**
Cf_1.13C	76.1	82.2	99.9	99.9	**101.0**	87.7	**101.0**
1.13A	2.1	2.1	2.4	2.4	**2.5**	1.9	**2.5**
Cf_1.13A	77.0	83.1	101.4	102.0	**103.3**	89.9	103.3
Loc_04A	5.6	5.2	5.4	**6.0**	5.3	3.9	**6.0**
Loc_04B	5.6	5.2	5.4	**6.0**	5.3	3.9	**6.0**
Loc_04C	19.6	18.4	20.8	**23.2**	22.3	16.8	**23.2**
Loc_04	20.9	20.0	22.9	**25.1**	24.1	18.5	**25.1**
Cf_1.14	91.7	98.3	120.5	121.6	**123.7**	105.6	123.7
Cf_1.15	92.7	99.3	122.2	124.0	**126.3**	108.1	126.3
Townson	92.7	99.3	122.2	124.0	**126.3**	108.1	126.3

Table 7 - RAFTS Model Flow Summary Table – Probable Maximum Flood

RAFTS_ID	Duration (min)						Max (m^3/s)
	15	30	45	60	90	120	
1.13B	25.5	**26.2**	24.9	22.1	17.7	15.1	**26.2**
1.13C	**24.4**	23.8	22.1	19.6	15.4	13.1	**24.4**
1.13D	27.1	**32.1**	30.9	28.5	22.9	20.0	**32.1**
1.12	432.1	690.0	**810.9**	798.6	687.8	621.5	**810.9**
1.13E	**2.9**	2.6	2.3	2.0	1.6	1.3	**2.9**
Cf_1.13C	440.2	699.6	**829.2**	824.3	717.4	649.4	**829.2**
1.13A	14.3	**14.4**	13.6	12.1	9.6	8.2	**14.4**
Cf_1.13A	444.0	704.1	838.7	**839.9**	736.7	667.6	839.9
Loc_04A	**25.8**	25.3	24.4	21.1	16.5	14.1	**25.8**
Loc_04B	**25.6**	25.0	23.9	20.7	16.1	13.8	**25.6**
Loc_04C	114.7	**135.2**	131.8	119.9	97.8	85.4	**135.2**
Loc_04	117.6	139.8	**140.6**	131.9	108.2	95.1	**140.6**
Cf_1.14	559.1	825.6	**968.2**	967.6	852.7	773.0	968.2
Cf_1.15	563.1	830.2	979.1	**982.7**	871.2	791.0	982.7
Townson	563.1	830.2	979.1	**982.7**	871.2	791.0	982.7

Table 8 - RAFTS Model Flow Summary Table – 100 year ARI Post Climate Change

RAFTS_ID	Duration (min)						Max (m^3/s)
	25	30	60	90	120	180	
1.13B	4.8	4.8	5.3	5.4	**5.6**	4.2	**5.6**
1.13C	4.6	4.5	5.0	5.2	**5.3**	3.9	**5.3**
1.13D	5.1	5.3	5.7	5.8	**6.1**	4.5	**6.1**
1.12	90.5	96.9	111.9	114.7	**116.0**	98.0	**116.0**
1.13E	0.6	0.6	**0.7**	0.6	0.6	0.4	**0.7**
Cf_1.13C	92.7	99.2	115.7	119.4	**121.0**	102.2	**121.0**
1.13A	2.7	2.7	2.9	3.0	**3.1**	2.3	**3.1**
Cf_1.13A	93.8	100.3	117.8	122.1	**124.1**	105.0	**124.1**
Loc_04A	6.7	6.3	**8.0**	7.2	6.3	4.6	**8.0**
Loc_04B	6.7	6.2	**7.9**	7.1	6.3	4.6	**7.9**
Loc_04C	24.2	22.9	27.7	**28.6**	27.3	20.6	**28.6**
Loc_04	25.7	24.8	30.1	**30.8**	29.6	22.6	**30.8**
Cf_1.14	113.2	120.1	141.2	147.2	**149.8**	125.2	**149.8**
Cf_1.15	114.3	121.4	143.7	150.0	**152.9**	128.5	**152.9**
Townson	114.3	121.4	143.7	150.0	**152.9**	128.5	**152.9**

Outlined in Appendix A are the details of the RAFTS modelling input data and output summaries.

3.2 HYDRAULIC MODELLING

A site specific TUFLOW 2D dynamic model was developed to predict flood levels, depths, velocities and extents in Bells Creek under existing conditions within the subject site and No. 799 Richmond Road. The model includes the section of Bells Creek and adjoining areas from approximately 130 m upstream of No. 799 Richmond Road to about 300 m downstream of Townson Road. The locations of the inflow hydrographs (generated from XP-RAFTS) used as inputs to the TUFLOW model are indicated in Figure 7.

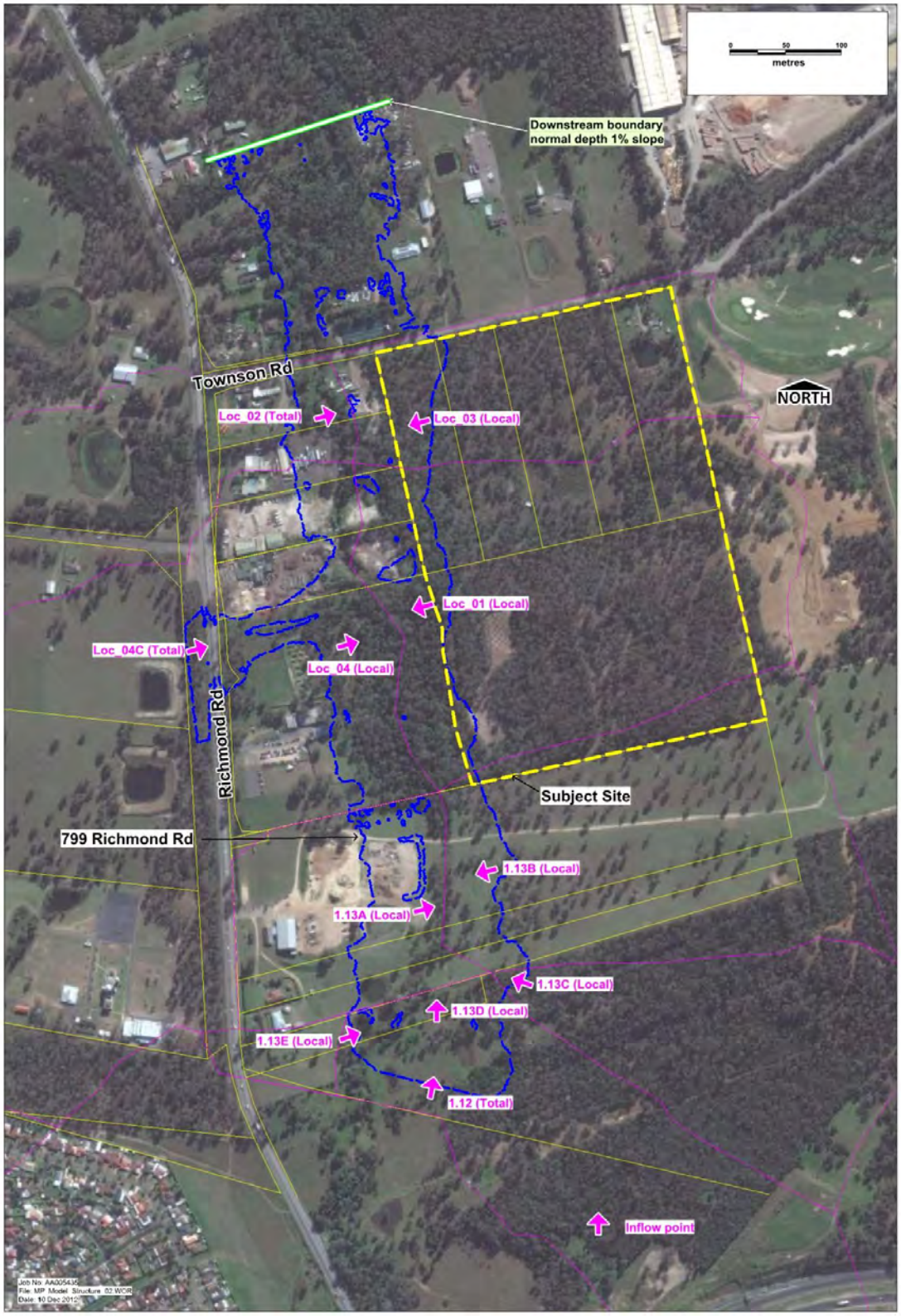


Figure 7 – TUFLOW model structure and flow boundary

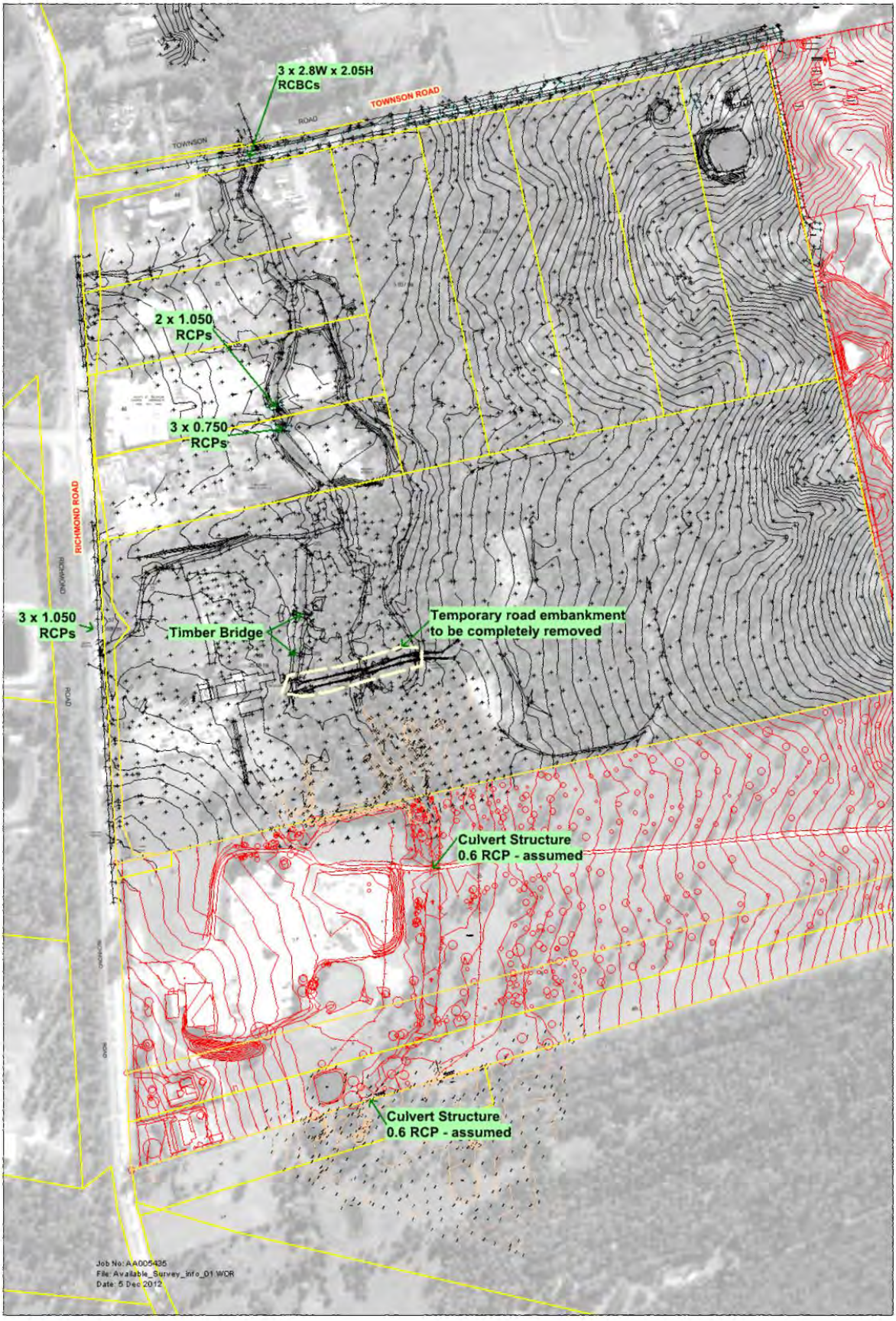


Figure 8 – Available ground survey information and hydraulic structures in the TUFLOW model area

3.2.1 SURVEY AND TOPOGRAPHIC INFORMATION

Topographic data was available from the following sources:

a) Land survey for No. 799 Richmond Rd (provided by the Client)

b) Land survey for the area immediately upstream of No. 799 Richmond Rd by Chadwick & Cheng Consulting Surveyors dated 21 June 2012

c) Land survey for the subject site and area between No. 799 Richmond Rd and Townson Rd by Chadwick & Cheng Consulting Surveyors dated 11 July 2012

d) Airborne Laser Survey (ALS) from Blacktown City Council (2010)

Plans for the three land surveys are included at the end of Appendix B for reference. Figure 8 shows the coverage of the land surveys undertaken in the areas included in the flood study. A Digital Elevation Model (DEM) was developed from the land survey data and ALS data (in areas where land survey was not undertaken). The composite DEM forms the background landform within the TUFLOW model.

3.2.2 TUFLOW MODEL SETUP

Hydraulic structures

There are number of man-made structures situated within the TUFLOW model area. Two major drainage structures were identified. These are the Townson Road culvert crossing at Bells Creek (3x2.8x2.05 RCBCs, Photo 1) and the Richmond Road culvert crossing at Tributary 1 (3x1.05 RCPs, Photo 2). A number of minor structures also exist along the Bells Creek waterway and were picked up by the survey. Two timber bridge crossings exist and are included in the TUFLOW model. A temporary earth embankment presumed as a road crossing is excluded in the TUFLOW model as it will be removed prior to any works on site being completed. These structures are shown in Figure 8.

Roughness

Roughness was assessed with the aid of aerial photo imagery (2009) and site inspection. Manning's roughness n assigned for various land uses are summarised in Table 9.

Table 9 – Manning's roughness coefficients used in TUFLOW

Land Use	Manning's n
Building footprint	0.5
Road and road reserve	0.02
Water body	0.02
Short grass / bare earth	0.035
Sparsely vegetated bush land	0.06
Densely vegetated bush land	0.08

Photo 1 – 3 x 2.8W x 2.05H RCBC under Townson Road looking upstream

Photo 2 – 3 x 1.05 RCPs under Richmond Road looking downstream

Downstream boundary

The model was extended to about 300 m downstream of Townson Road to ensure the assumption of a uniform depth as boundary condition is valid. Flows going past Townson Road either through the culverts or over the road (for extreme flood events) are expected to assume

normal flow conditions downstream once way clear of any hydraulic control by Townson Road. The model downstream boundary was assumed to be normal depth with 1% bed slope. Sensitivity tests undertaken using normal depth but varying the bed slope from 0.5 to 2% for show that the change in levels upstream of Townson Road is less than 5 mm. Townson Road and the underlying culvert structure combine to act as a hydraulic control for Bells Creek flood regime during the more frequent flood events up to the 100 year flood.

Blockage assumptions

For the design events (100 year ARI, PMF and Post Climate Change runs), a 50% blockage of the Townson Road culverts and road railings was considered. For the other culverts, a 100% blockage was assumed.

As a sensitivity check, an additional TUFLOW run was undertaken for the 100 year flood event which considers no blockage of the Townson Road culverts.

3.2.3 SUMMARY OF TUFLOW MODELLING RESULTS

a) Existing Conditions

RAFTS modelling results indicated the 2-hour storm as the critical 100 year event for Bells Creek (refer to Section A.7 of Appendix A). As for the PMF, the 1-hour event was the critical storm. Only 100 year 2-hour and PMF 1-hour events were simulated in TUFLOW.

Table 10 – Comparison of TUFLOW Model Levels with JWP Levels

Location	Hyder TUFLOW Flood Levels		JWP TUFLOW Flood Levels	
	100 year ARI	PMF	100 year ARI	PMF
Immediately U/S of Townson Road	27.41	29.14	27.56	29.03
Upstream lot boundary of Subject Site	30.07	31.73	31.04	32.47
Upstream lot boundary of 799 Richmond Rd	31.46	32.76	32.71	33.81

Figures B.1 and B.2 in Appenidix B show the flood levels and depths in Bells Creek under existing conditions predicted by TUFLOW for the 100 year ARI and PMF events. Table 10 summarises the average flood levels at key locations and includes the flood levels reported by JWP for comparison. At Townson Road, the Hyder flood level is lower than the JWP level by 0.15 m during the 100 year ARI event but higher than JWP's level by 0.11 m during the PMF event. Sensitivity analysis of the model's downstream boundary condition suggests the Townson Road as the hydraulic control. Hence, the flood levels in Bells Creek upstream of Townson Road will be governed by how the culverts and road crest levels along Townson Road are defined. The discrepancy in flood levels between the two models can be attributed to how Townson Road and the underlying culvert crossing were detailed.

Further upstream of Townson Road, the predicted flood levels from the current model are considerably lower than the JWP levels. JWP (2011) has indicated that the ground level

information in their model was derived from the ALS survey information provided by Blacktown City Council. The year the ALS survey was undertaken was not mentioned in their report. A significant portion of the modelled area is covered with sparse to dense vegetation especially areas within or close to the riparian corridor of Bells Creek. ALS data tends to suffer from some degree of inacurracy in these vegetated zones. The DEM generated from these dataset may misrepresent the actual creek definition. However, we note that the focus of the JWP study was the development of a Water Cycle Management Strategy for the regional Marsden Park Industrial Precinct (MPIP). Hence, the reported flood levels should only be viewed as indicative.

The current TUFLOW modelling, on the other hand, was based on land survey information and the resulting flood levels are deemed to be more reliable.

Sensitivity of Blockage Assumptions

Figure B.3 of Appendix B shows the change in 100 year flood levels in Bells Creek when the Townson Road culverts are unblocked. The resulting flood levels will lower slightly by at most 30 mm in areas immediately upstream of Townson Road. The effect gradually diminishes over a distance of 150 m. Based on this result, the effect of blockage in culverts has only a minor impact as majority of the flood flow is overtopping Townson Road.

b) Developed Conditions

The TUFLOW model for the existing condition was adjusted to produce the post-development model that includes the footprint of the proposed Townson Road Precinct development. All other aspects of the existing model remained unchanged. The development layout, shown in Appendix D, was configured to minimise encroachment into the existing 100 year flood extents.

Under developed conditions, the input hydrographs in the TUFLOW model are the same as those used for the pre-development runs. This is a conservative approach considering that the higher catchment flows resulting from the proposed development will be attenuated by detention. In other words, the post-development flood flows in Bells Creek will always be less than the flows under the pre-development conditions.

Table 11 – Summary of Average Flood Levels at key locations in Bells Creek

Location	Exsiting Flood Levels (m AHD)			Developed Flood Levels (m AHD)		
	100y ARI 50% Blockage	PMF 50% Blockage	100y ARI No Blockage	100y ARI 50% Blockage	PMF 50% Blockage	100y ARI Post CC 50% Block
Immediately U/S of Townson Road	27.41	29.14	27.38	27.41	29.14	27.49
Upstream lot boundary of Subject Site	30.07	31.73	30.07	30.07	31.78	30.17
Upstream lot boundary of No. 799 Richmond Rd	31.46	32.76	31.46	31.46	32.77	31.51

Figure B.4 presents the flood regime for the 100 year events under developed conditions. It shows that the proposed development has little impact on the 100 year flood extents. Table 11 shows no change in average flood level at three key locations. Figure B.5 shows the change in flood levels resulting from the proposed development. The changes are minimal (less than 5mm) and are considered to be “neutral” being within the limits of the model’s accuracy. With only minimal or negligible changes in the flood extents and levels in Bells Creek, the proposed development will then have no impact on the neighbouring properties,

In terms of the PMF levels, there was an average increase of 80 mm at the upstream boundary of the subject site. The increase diminishes to about 10 mm at the upstream boundary of No. 799 Richmond Road property. (Refer to Table 11)

Figures B.6 and B.7 show the flood extents and flood levels under the PMF and 100 year ARI Post Climate Change scenarios respectively.

Figure B.8 presents the hydraulic hazard map under the 100 year ARI developed conditions. The map shows Townson Road is subject to high hydraulic hazard under the definition of NSW Floodplain Management Manual (2005). This issue needs to be considered in the planning of the evacuation route for the area. We note that the proposed development only resulted in minimal or negligible changes in flood levels and is unlikely to cause significant change for Townson Road hazard category.

4 DETENTION STORAGE

To attenuate the increased stormwater runoff flows from the site detention basins are proposed. The conceptual detention storage assessment was carried out using DRAINS. Existing and post developed DRAINS models were developed to size the basins and compare existing and post developed flows from the site. The assessment process is described below.

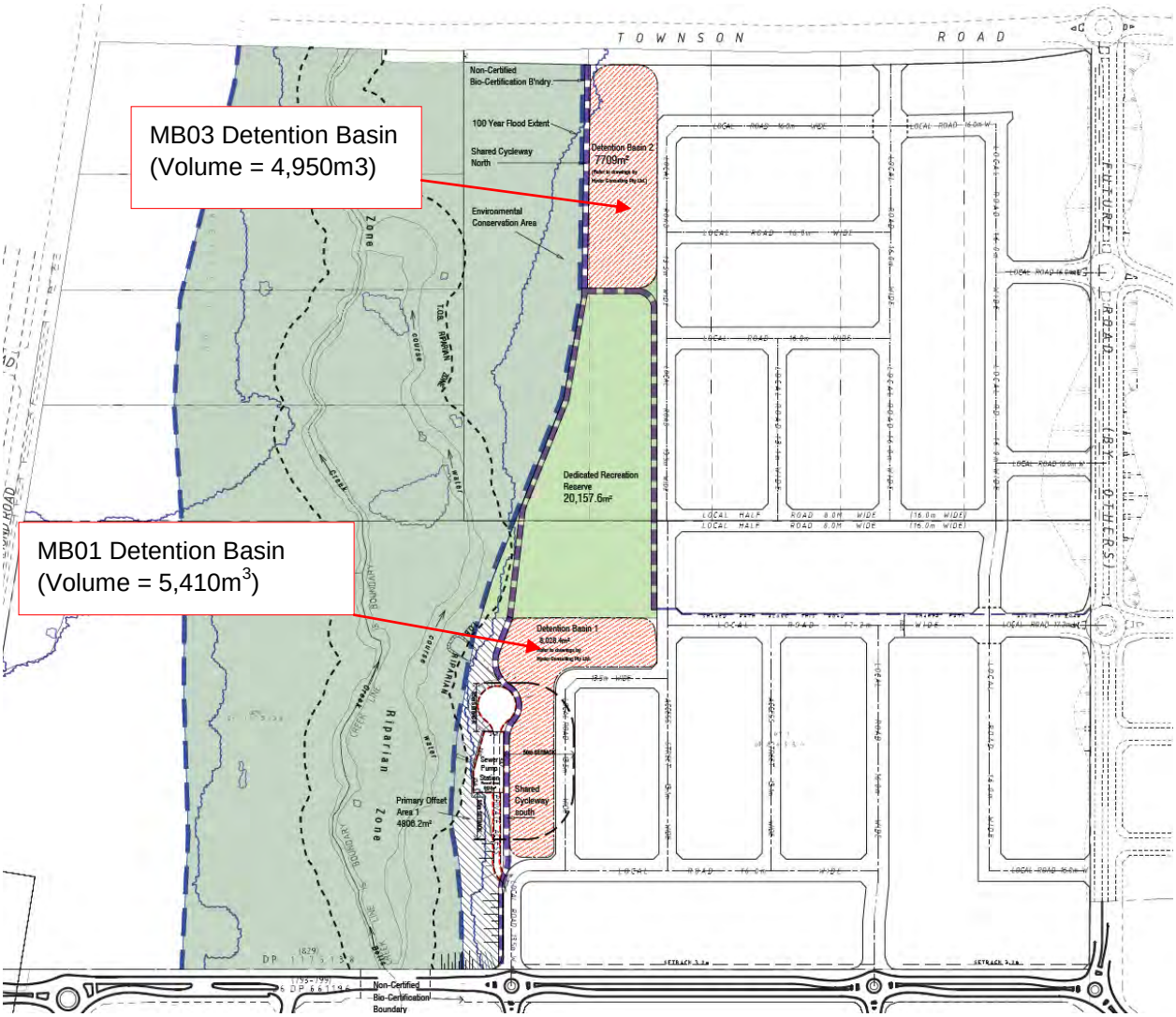


Figure 9 – Locations of the proposed OSD Storages (volumes shown are obtained from DRAINS modelling)

4.1 EXISTING CONDITIONS MODEL

The DRAINS model for the site under existing conditions was developed based on:

- Aerial photography
- Ground survey within the subject site and neighbouring property
- ALS survey data for areas external to the site and neighbouring property

The existing catchment is rural in nature consisting of grassland and sparse to dense bushlands. The RAFTS module within DRAINS was used to model the existing catchment conditions. A PERN value of 0.05 was adopted to represent the catchment roughness. An initial loss of 15 mm and a continuing loss of 2.5 mm/hr were adopted. The catchment delineation and DRAINS model for the existing site are shown in Figures 10 and 11 respectively.

The DRAINS model was run for various storm durations, from 10 minutes to 18 hours, for the 2 year, 20 year and 100 year ARIs. A summary of the model input data for existing conditions is included in Appendix C.

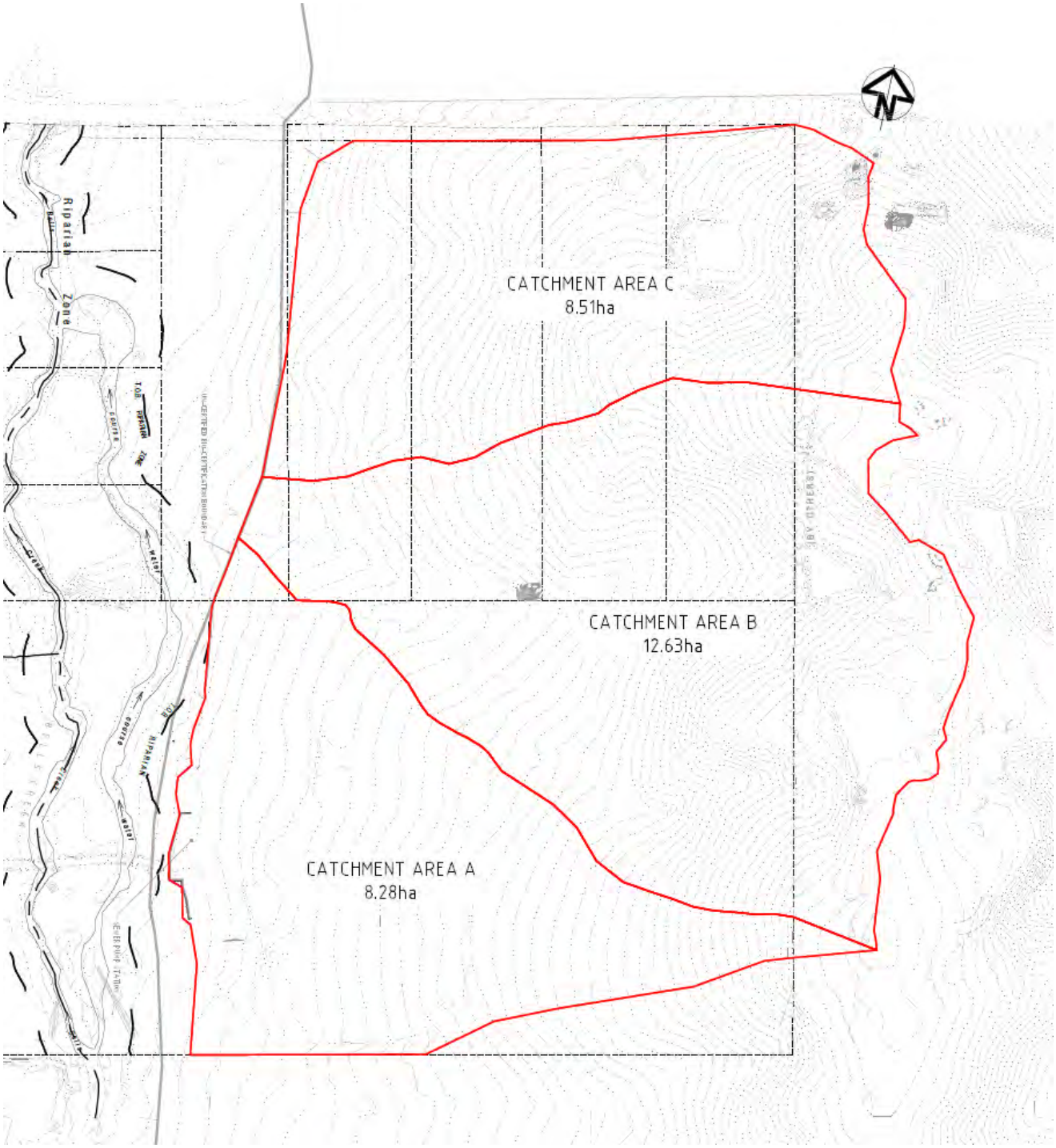


Figure 10 – Subcatchments under existing conditions

Figure 11 – Existing conditions DRAINS model

4.2 DEVELOPED CONDITIONS MODEL

The existing conditions DRAINS model was adjusted to include the proposed development site conditions. The ILSAX module was adopted to model the developed catchments. Figures 12 and 13 show the catchment breakup and the DRAINS model for the post developed scenario respectively. In developing the post-development DRAINS model, the following modelling considerations were taken:

a) ILSAX hydrology, which is considered to better represent urbanised catchments, was adopted instead of the RAFTS hydrology. Table 12 shows the ILSAX parameters adopted in the model.
b) Imperviousness adopted for the site was 85% which is consistent with Council's Engineering Development Guide (2005).
c) Flow travel times were reduced to reflect reduced times of the urbanised catchment.

Table 12 – Catchment parameters used in the DRAINS model

Model Parameter	Adopted Value
Soil Type – Normal	3
Paved (Impervious) Area Depression Storage	1
Supplementary Area Depression Storage	1
Grassed Area Depression Storage	5
Antecedent Moisture Condition (ARI = 1 to 5 years)	2.5
Antecedent Moisture Condition (ARI = 10 to 20 years)	3.0
Antecedent Moisture Condition (ARI = 50 to 100 years)	3.5

4.2.1 UPSTREAM CATCHMENTS

Initially for the post developed model the upstream catchments draining to the site from the east were assumed to be undeveloped as per the existing conditions. Council requested that coordination was required with the upstream property owner and that the preferred option was to attenuate flows from the post developed upstream property within the two basins in the subject site.

No agreement was reached between the two property owners and it was maintained that the post developed upstream flows are not to have an adverse impact on the basin and pipe sizes within the subject site. As a result the upstream property has regraded their site to significantly reduce the size of the upstream catchments draining to the subject site. The remaining existing upstream post developed catchments are proposed to drain to the east to proposed detention basins within their site.

The upstream property has submitted Development Application (DA) drawings to council reflecting the modified post developed catchments.

The post developed DRAINS model now reflects upstream property's reduced post developed catchments. The existing and post developed upstream catchments are shown on drawing C004 in Appendix D

4.3 ON-SITE DETENTION STORAGES

The locations of the detention basin are indicated in Figure 9 and in the Appendix D design drawings. Two detention basins MB01 and MB03 are proposed within the subject site.

Both basins drain directly into the Bells Creek corridor. The contributing catchments and the required detention storage volumes for the detention basins are summarised in Table 13.

Figure 12 – Post Developed Catchments

Figure 13 – Post Developed conditions DRAINS model

Table 13 – Proposed OSD storages and contributing catchments under existing and developed conditions.

OSD Name	Storage Type	Proposed Volume At Top Water Level (m^3)	Contributing subcatchments under developed conditions	Contributing subcatchments under existing conditions
MB01	Detention Basin	5,140	**C A1** **C A2** (13.46 ha)	**C A** **C B** (20.91 ha)
MB03	Detention Basin	4,950	**C B1** **C B2** (13.71 ha)	**C C** (8.51 ha)

4.4 DRAINS MODELLING RESULTS

The DRAINS models for both existing and developed scenarios were run for various storm durations from 10 minutes to 18 hours for the 2 year, 20 year and 100 year ARIs. Results are summarised in Figure 14 to 16 which include the following "developed versus existing" flow comparisons:

a) Figure 14: Outlet flows from MB01 compared against the existing conditions target flow from node F AB.
b) Figure 15: Outlet flow from MB03 compared against the existing conditions target flow from node F C
c) Figure 16: Compares the combined outlet flows of MB01 & MB03 (i.e. total outlet flow of the entire development) against the existing conditions target flow at Node F TOTAL EXISTING.

The results indicate that the proposed detention storages with the outlet configuration listed in Table 14 are adequate to attenuate the development flows to below pre-development levels. Exceptions to this are the short duration events 10 - 25-minutes duration 2 year ARI. The flow increases resulting from these storm events could likely be reduced to smaller values by fine tuning of the orifice configuration at the detailed design stage although may not be required as these flows are significantly less than the peak 2 year event.

The results show an increase in flows for the comparison of the existing and post developed flows at the basin MB03 outlet, this is due to a significant portion of the central existing catchment (C B) being diverted to basin MB03 in the post developed condition, therefore increasing the catchment at this outlet location. The opposite effect will be applied to the basin MB01 as there will be a reduction in post developed catchment at the outlet. The results show that there is a net reduction of total flows at the downstream location which indicates that the increased flows from basin MB03 are sufficiently offset by the reduction of flows from basin MB01. The result of this is there will be reduced flow in the creek between the basin MB01 outlet and the basin MB03 outlet.

Average storage volume per hectare of development for the individual detention storages and the combined storages are summarised in Table 15. The average storage provided by

detention basins is 406 m^3/ha, this is similar to the volume per hectare rate for the basins located in 799 Richmond road development which is currently being approved for construction.

DRAINS modelling input and output summaries for the 2, 20 and 100 year runs under both existing and developed conditions are included at the end of Appendix C. DRAINS input and output data are provided at the end of Appendix C for reference.

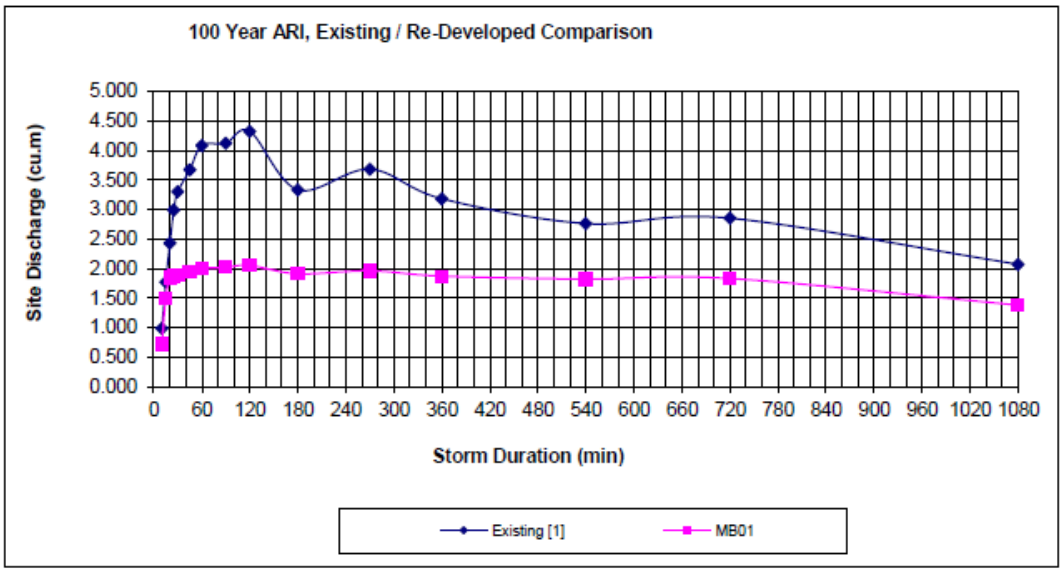
Table 13 – Detention storage parameters for detention basin MB01 and MB03

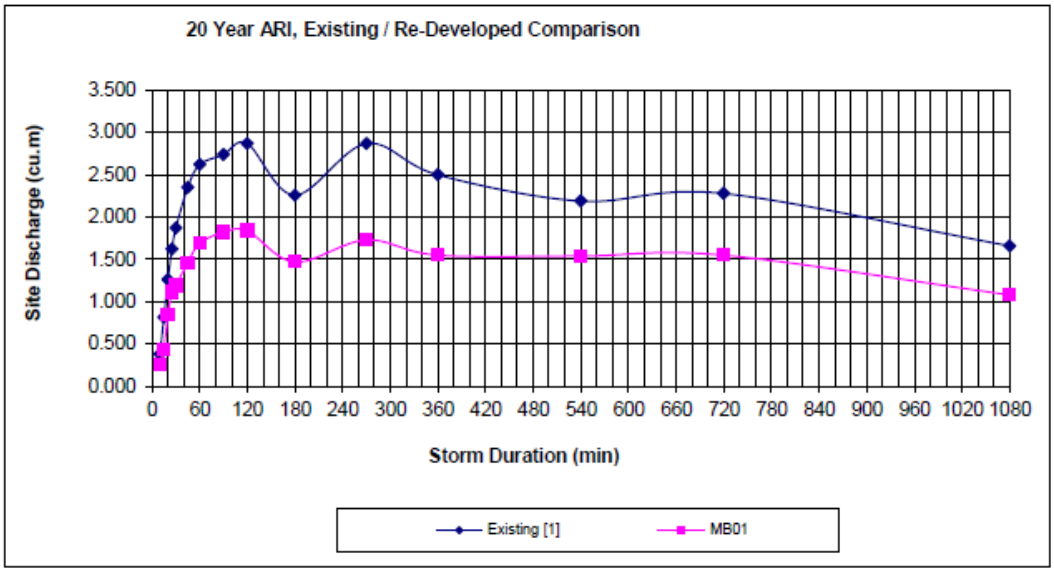
Parameter	MB01	MB03
Peak site discharge in 100 year ARI (m^3/s)	2.05	2.5
Low flow pit grate level	29.70m	28.75m
Orifice configuration in low flow chamber	4 x 200mm dia. CL @ 29.50m	4 x 200mm dia. CL @ 28.50m
High flow pit grate level	30.10m	29.50m
Orifice configuration in high flow chamber	3 x 540mm dia. CL @ 29.67m	3 x 540mm dia. CL @ 28.67m
Maximum OSD Storage Volume (m^3) reached in 100 year by DRAINS	5,140m3	4,950m3

Table 14 – Detention storage provided for flow attenuation for the proposed development

Basin ID	Storage At Top Water Level (m^3)	Contributing Site Catchment (ha) (1)	Average Storage (m^3/ha)
MB01	5,140	13.14	391
MB03	4,950	11.71	423
MB01 + MB03	10,090	24.85	406

Notes: (1) Catchment area excluding external catchments.





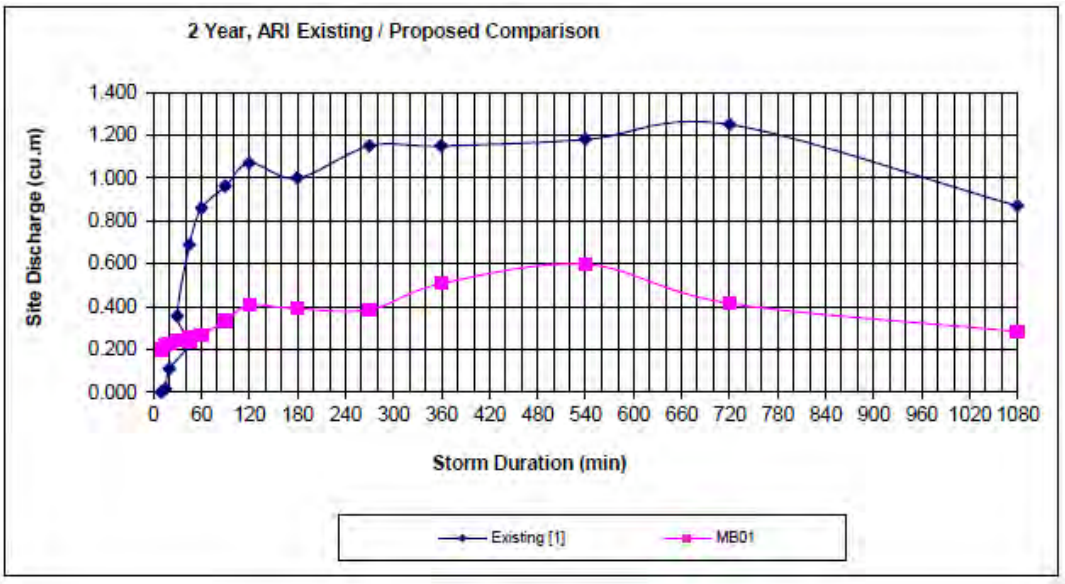
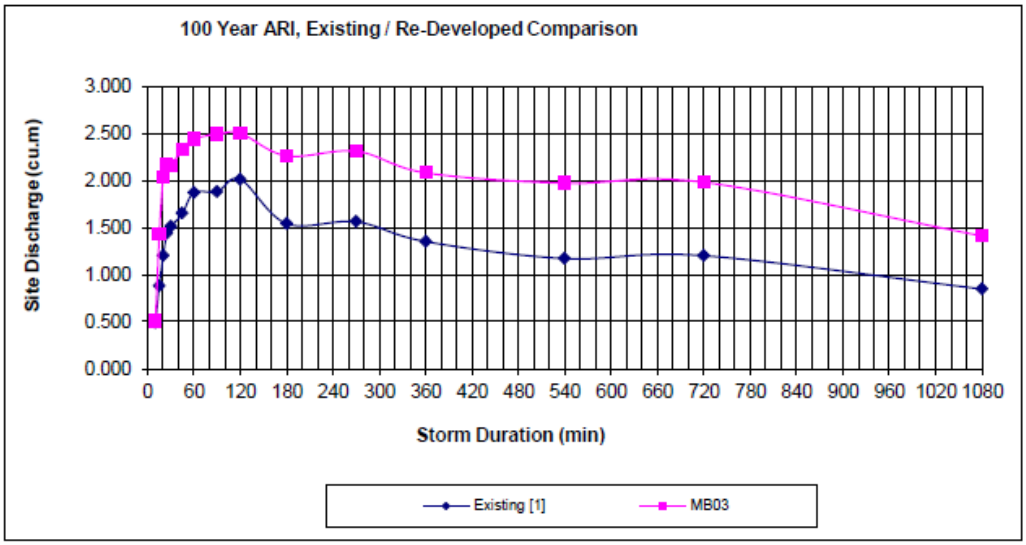
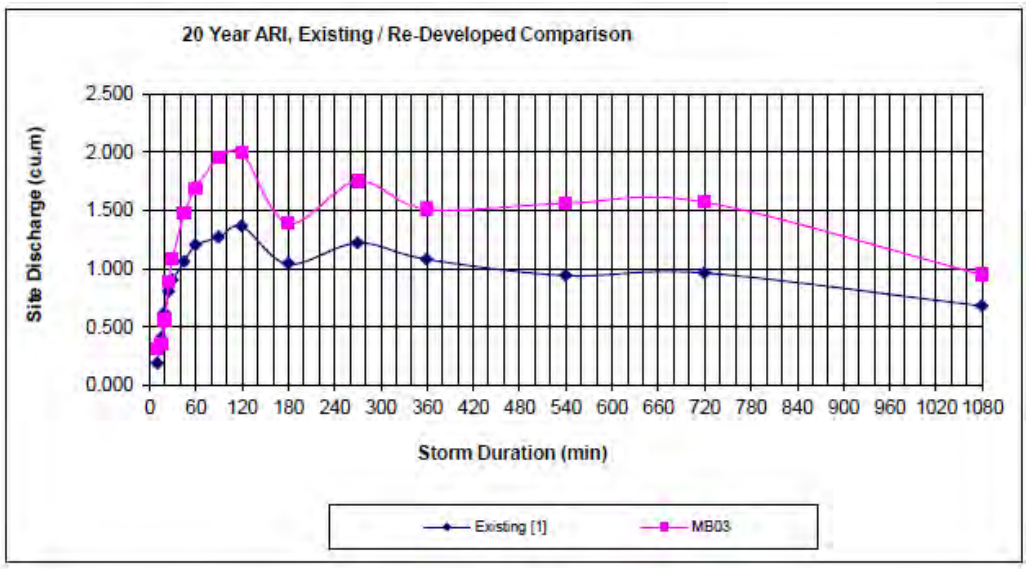


Figure 14 – Comparison between pre-development and post-development (MB01) outlet flows





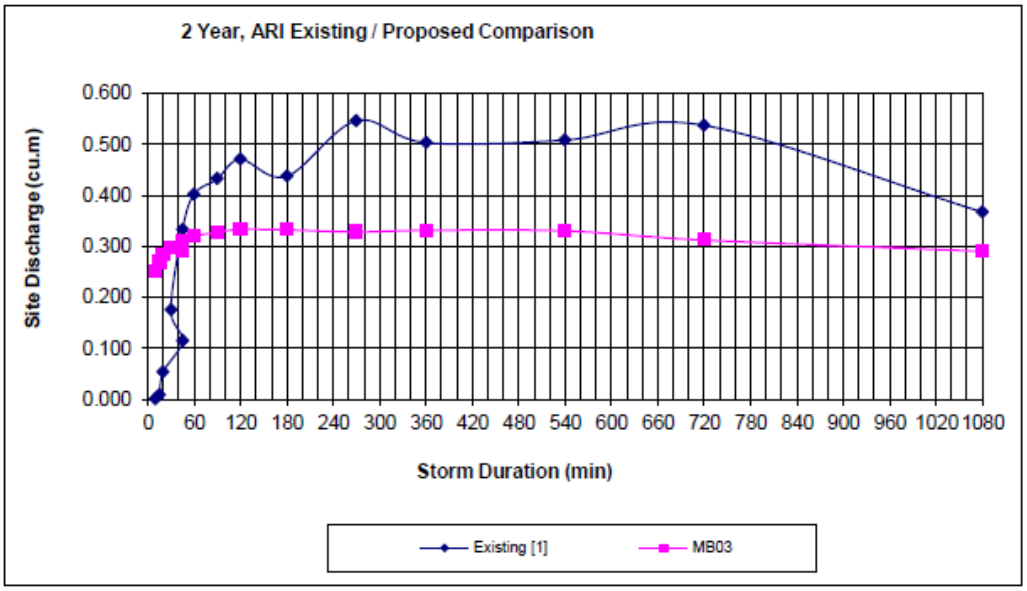
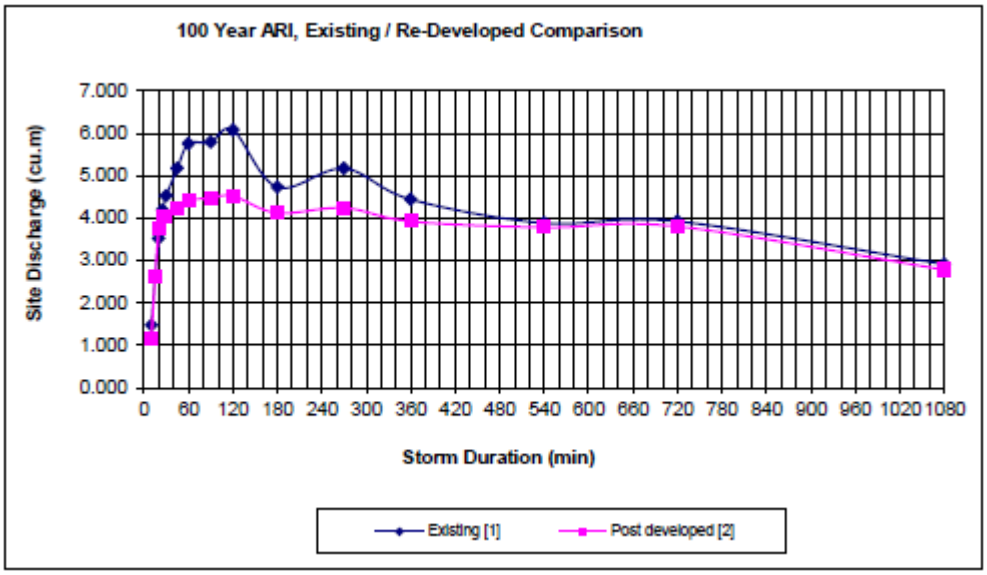
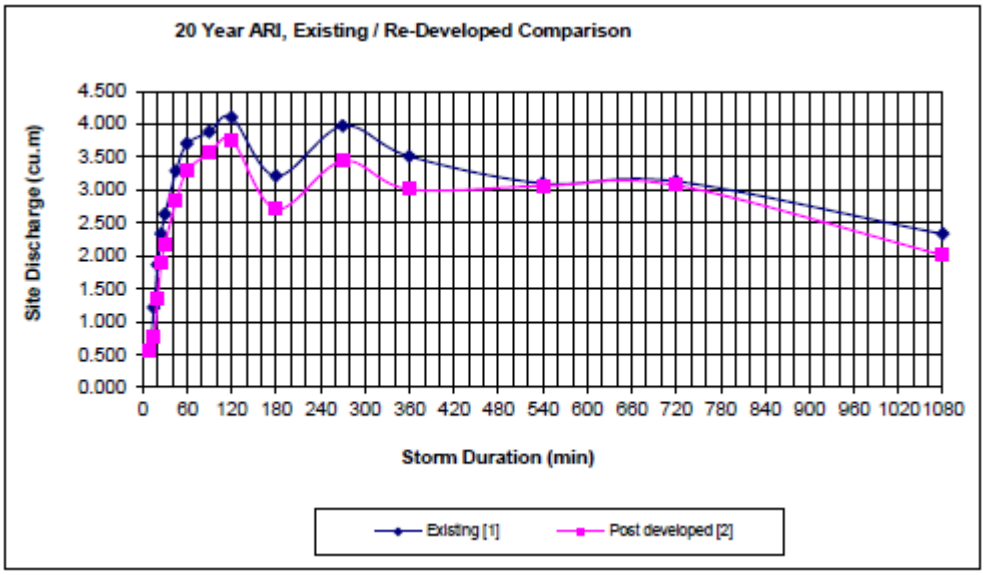


Figure 15 – Comparison between pre-development and post-development (MB03) outlet flows





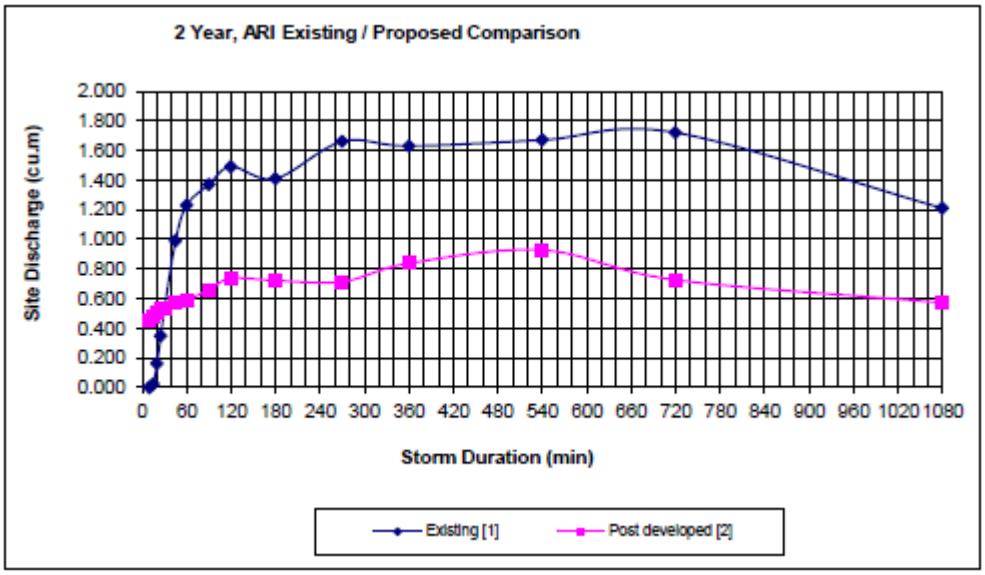


Figure 16 – Comparison between pre-development and post-development (MB01 +MB03) outlet flows

5 SUMMARY

A flood study was undertaken to assess the potential impact of the proposed residential development within the Townson Road Precinct in Colebee, NSW. The flood study aimed to determine the following:

a) The potential flooding impact of the development on neighbouring properties.

b) The sizing of the three regional on-site detention storages (two basins and one underground tank) to attenuate the higher flows resulting from the proposed development.

Input hydrographs used in the flood study were from the Blacktown Council RAFTS model that was modified to represent the developed conditions in the subject site. Output from this model was compared with the outputs from the original Council model and the RAFTS model developed by JWP for Bells Creek catchment.

In terms of the 100 year flows, peak flows from the Hyder model are generally similar or slightly higher than the flows from the Council and JWP models. PMP associated flows generated by the Hyder model are generally higher than those generated by the JWP model.

The impact of the development on the flood behaviour in Bells Creek was assessed using TUFLOW modelling. The development footprint was configured with minimal encroachment into Bells Creek. Flood modelling was undertaken for the 100 year ARI (pre and post Climate Change) and PMF scenarios with 50% blockage considered for the culverts under Townson Road. An additional assessment was carried out for the 100 year flood with no blockage in the Townson Road culvert. No change in the 100 year flood levels was predicted for areas external to the subject site as the result of the proposed development.

DRAINS was utilised to size the two proposed detention basins to attenuate the increased flows coming from the proposed development. The storage volumes required for MB01 and MB03 for peak flow attenuation are 5,140 and 4,950m^3 respectively.

APPENDIX A

RAFTS MODEL INPUTS & OUTPUTS

A.1 PROBABLE MAXIMUM PRECIPATION

GSDM CALCULATION

Location Information

Catchment:	Marsden Park		Area:	9.42	km2
State:	NSW		Duration limit	6	hour
Latitude	-33.737	Deg	Longitude:	150.837	Deg

Portion of area considered:

Smooth, S = 1 (0.0 to 1.0) Rough, R = 0 (0.0 to 1.0)

Elevation Adjustment Factor (EAF)

Mean elevation 36 m

Adjustment for elevation (-0.05 per 300m above 1500m) Nil

EAF = 1 (0.85 to 1.00)

Moisture Adjustment Factor (MAF)

MAF = 0.7 (0.40 to 1.00)

PMP values (mm)

Duration (hrs)	Initial Depth - smooth (Ds)	Initial Depth - rough (DR)	PMP Estimate (DsxS+DRxR) x MAF x EAF		Rounded PMF estimate (nearest to 10mm)	
0.25	212	212	149		150	
0.50	313	313	219		220	
0.75	398	398	278		280	
1.00	465	465	325		330	
1.50	530	595	371		370	
2.00	594	697	416		420	
2.50	632	768	442		440	
3.00	664	840	465		460	
4.00	730	962	511		510	
5.00	787	1057	551		550	
6.00	833	1124	583		580	

Prepared by VWN Date 17-Oct-12

Checked by ER Date 16-Dec-12

A.2 RAFTS OUTPUT FILES

100 year ARI 2-hour event

Probable Maximum Flood 1-hour event

100 year ARI 2-hour event Post Climate Change (15% increase in rainfall intensity)

```
################################################################################################
BELLS CK - FULLY DEVELOPED URBAN MODEL - ARBM RAINFALL LOSS MODULE

Results for period from  0: 0.0  1/ 1/1990
                     to 10: 0.0  1/ 1/1990
################################################################################################


                                ROUTING INCREMENT (MINS) =       1.00
                                STORM DURATION (MINS)    =       120.
                                RETURN PERIOD (YRS)      =       100.
                                BX                       =     1.0000
                                TOTAL OF FIRST SUB-AREAS  (ha) =    1017.32
                                TOTAL OF SECOND SUB-AREAS (ha) =     309.16
                                TOTAL OF ALL SUB-AREAS (ha)    =    1326.48


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B        Link
 Label      #1     #2     #1    #2      #1   #2     #1    #2    #1   #2     No.
            (ha)              (%)          (%)
Loc_03    12.020  0.000  2.800 0.000  5.000 0.000  .025 0.00  .0456 0.000  1.000
Loc_02A   12.990  0.000  2.900 0.000  5.000 0.000  .025 0.00  .0466 0.000  2.000
Loc_02     4.240  0.000  2.200 0.000  5.000 0.000  .025 0.00  .0299 0.000  2.001
Loc_01    26.990  0.000  2.700 0.000  5.000 0.000  .025 0.00  .0707 0.000  3.000
1.13B     18.970  0.000  2.400 0.000  5.000 0.000  .025 0.00  .0624 0.000  4.000
1.13C     16.460  0.000  2.900 0.000  5.000 0.000  .025 0.00  .0527 0.000  5.000
1.13D     25.330  0.000  1.700 0.000  5.000 0.000  .025 0.00  .0861 0.000  6.000
1.00      12.890  7.250  .9000 .9000  8.000 100.0  .025 .025  .0739 .0088  7.000
1.01      22.020 22.020  1.000 1.000  8.000 100.0  .025 .025  .0926 .0149  7.001
1.02      16.270 10.850  1.500 1.500  8.000 100.0  .025 .025  .0646 .0084  7.002
9.00       3.150  1.350  1.900 1.900  8.000 100.0  .025 .025  .0245 .0025  8.000
Dummy     .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  9.000
Basin_4   11.570  6.230  1.900 1.900  8.000 100.0  .025 .025  .0481 .0056  7.003
1.04_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.004
2.00      37.000 23.280  1.200 1.200  8.000 100.0  .025 .025  .1107 .0140  10.00
4.00       9.120  6.080  1.500 1.500  8.000 100.0  .025 .025  .0478 .0062  11.00
2.01_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  10.00
Bsn3Wet   19.400  0.000  1.700 0.000  10.00 0.000  .025 0.00  .0616 0.000  10.00
1.05      23.820 15.880  1.700 1.700  8.000 100.0  .025 .025  .0740 .0096  7.005
3.00      25.440 16.960  1.100 1.100  8.000 100.0  .025 .025  .0952 .0124  12.00
Basin_2   10.100  0.000  1.200 0.000  10.00 0.000  .025 0.00  .0522 0.000  12.00
1.06      28.020 18.680  1.500 1.500  8.000 100.0  .025 .025  .0857 .0111  7.006
1.07       5.450  5.450  1.400 1.400  8.000 100.0  .025 .025  .0379 .0061  7.007
5.00      14.830  7.990  1.300 1.300  8.000 100.0  .025 .025  .0661 .0077  13.00
5.01      15.930 10.620  .7000 .7000  8.000 100.0  .025 .025  .0935 .0122  13.00
6.00      24.820 16.540  1.400 1.400  8.000 100.0  .025 .025  .0833 .0108  14.00
Basin_1   37.800 21.250  1.100 1.100  8.000 100.0  .025 .025  .1169 .0139  13.00
5.03       9.070  2.270  1.400 1.400  8.000 100.0  .025 .025  .0494 .0039  13.00
5.04      13.600  5.820  1.100 1.100  8.000 100.0  .025 .025  .0687 .0071  13.00
1.08      54.300 36.200  1.400 1.400  8.000 100.0  .025 .025  .1252 .0163  7.008
1.09      39.300 26.200  1.500 1.500  8.000 100.0  .025 .025  .1022 .0133  7.009
7.00      29.940 16.120  1.300 1.300  8.000 100.0  .025 .025  .0953 .0111  15.00
1.10_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.010
8.00      18.300 18.300  2.500 2.500  8.000 100.0  .025 .025  .0532 .0085  16.00
8.01       9.300  0.000  1.200 0.000  2.000 0.000  .025 0.00  .0692 0.000  16.00
1.11_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.011
1.12      50.810  0.000  .9000 0.000  3.000 0.000  .025 0.00  .1849 0.000  7.012
1.13E      1.639  0.000  2.000 0.000  5.000 0.000  .025 0.00  .0191 0.000  17.00
Cf_1.13C  .00001  0.000  1.000 0.000  5.000 0.000  .025 0.00  0.000 0.000  5.001
1.13A     10.340  0.000  1.900 0.000  5.000 0.000  .025 0.00  .0511 0.000  18.00
Cf_1.13A  .00001  0.000  1.300 0.000  5.000 0.000  .025 0.00  0.000 0.000  4.001
Loc_04A   10.490  6.990  2.300 2.300  5.000 100.0  .025 .015  .0468 .0027  19.00
Loc_04B   10.240  6.830  2.400 2.400  5.000 100.0  .025 .015  .0453 .0026  20.00
Loc_04C   73.730  0.000  2.100 0.000  5.000 0.000  .025 0.00  .1351 0.000  19.00
Loc_04    14.210  0.000  1.300 0.000  5.000 0.000  .025 0.00  .0729 0.000  19.00
Cf_1.14   0.0100  0.000  .1000 0.000  5.000 0.000  .025 0.00  .0060 0.000  3.001
Cf_1.15   0.0100  0.000  .1000 0.000  5.000 0.000  .025 0.00  .0060 0.000  1.001
Townson   .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.002
```

1.14	105.20	0.000	1.400	0.000	0.000	0.000	.040	0.00	.3463	0.000	1.003
South	89.500	0.000	1.000	0.000	0.000	0.000	.040	0.00	.3766	0.000	1.004
Grange	42.700	0.000	1.800	0.000	0.000	0.000	.040	0.00	.1912	0.000	1.005

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess #1 (mm)	Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Loc_03	43.700	0.000	0.000	0.000	0.000	63.274	0.000	3.289	41.00	0.000
Loc_02A	43.700	0.000	0.000	0.000	0.000	63.274	0.000	3.551	41.00	12.00
Loc_02	43.700	0.000	0.000	0.000	0.000	63.274	0.000	4.204	53.00	0.000
Loc_01	43.700	0.000	0.000	0.000	0.000	63.274	0.000	6.329	43.00	0.000
1.13B	43.700	0.000	0.000	0.000	0.000	63.274	0.000	4.485	42.00	0.000
1.13C	43.700	0.000	0.000	0.000	0.000	63.274	0.000	4.335	41.00	0.000
1.13D	43.700	0.000	0.000	0.000	0.000	63.274	0.000	4.911	46.00	0.000
1.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	4.906	36.00	1.000
1.01	43.700	0.000	0.000	0.000	0.000	64.004	86.400	17.301	36.00	1.000
1.02	43.700	0.000	0.000	0.000	0.000	64.004	86.400	24.465	37.00	1.000
9.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	1.467	40.00	1.000
Dummy	43.700	0.000	0.000	0.000	0.000	87.400	0.000	0.1675	40.00	2.000
Basin_4	43.700	0.000	0.000	0.000	0.000	64.004	86.400	29.538	38.00	0.000
1.04_D	43.700	0.000	0.000	0.000	0.000	87.400	0.000	15.686	47.00	0.000
2.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	14.541	36.00	0.000
4.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	4.517	35.00	1.000
2.01_D	43.700	0.000	0.000	0.000	0.000	87.400	0.000	18.183	38.00	0.000
Bsn3Wet	43.700	0.000	0.000	0.000	0.000	64.491	0.000	22.750	41.00	0.000
1.05	43.700	0.000	0.000	0.000	0.000	64.004	86.400	26.447	58.00	0.000
3.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	10.588	36.00	0.000
Basin_2	43.700	0.000	0.000	0.000	0.000	64.491	0.000	12.539	40.00	0.000
1.06	43.700	0.000	0.000	0.000	0.000	64.004	86.400	35.535	59.00	0.000
1.07	43.700	0.000	0.000	0.000	0.000	64.004	86.400	37.140	46.00	0.000
5.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	5.907	35.00	0.000
5.01	43.700	0.000	0.000	0.000	0.000	64.004	86.400	12.211	36.00	0.000
6.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	10.857	36.00	0.000
Basin_1	43.700	0.000	0.000	0.000	0.000	64.004	86.400	34.192	40.00	0.000
5.03	43.700	0.000	0.000	0.000	0.000	64.004	86.400	17.140	72.00	0.000
5.04	43.700	0.000	0.000	0.000	0.000	64.004	86.400	19.406	65.00	0.000
1.08	43.700	0.000	0.000	0.000	0.000	64.004	86.400	68.803	61.00	0.000
1.09	43.700	0.000	0.000	0.000	0.000	64.004	86.400	77.492	63.00	0.000
7.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	10.913	36.00	0.000
1.10_D	43.700	0.000	0.000	0.000	0.000	87.400	0.000	83.927	61.00	0.000
8.00	43.700	0.000	0.000	0.000	0.000	64.004	86.400	12.419	35.00	0.000
8.01	43.700	0.000	0.000	0.000	0.000	62.543	0.000	12.999	44.00	0.000
1.11_D	43.700	0.000	0.000	0.000	0.000	87.400	0.000	91.375	49.00	0.000
1.12	43.700	0.000	0.000	0.000	0.000	62.787	0.000	96.975	74.00	1.500
1.13E	43.700	0.000	0.000	0.000	0.000	63.274	0.000	0.5262	40.00	0.000
Cf_1.13C	43.700	0.000	0.000	0.000	0.000	63.274	0.000	100.95	74.00	1.500
1.13A	43.700	0.000	0.000	0.000	0.000	63.274	0.000	2.522	43.00	0.000
Cf_1.13A	43.700	0.000	0.000	0.000	0.000	63.274	0.000	103.34	76.00	4.000
Loc_04A	43.700	0.000	0.000	0.000	0.000	63.274	86.400	5.314	35.00	7.000
Loc_04B	43.700	0.000	0.000	0.000	0.000	63.274	86.400	5.257	35.00	9.000
Loc_04C	43.700	0.000	0.000	0.000	0.000	63.274	0.000	22.259	47.00	19.00
Loc_04	43.700	0.000	0.000	0.000	0.000	63.274	0.000	24.126	66.00	0.000
Cf_1.14	43.700	0.000	0.000	0.000	0.000	63.274	0.000	123.69	77.00	2.000
Cf_1.15	43.700	0.000	0.000	0.000	0.000	63.274	0.000	126.25	78.00	0.000
Townson	43.700	0.000	0.000	0.000	0.000	87.400	0.000	126.25	78.00	0.000
1.14	43.700	0.000	0.000	0.000	0.000	62.057	0.000	133.66	91.00	0.000
South	43.700	0.000	0.000	0.000	0.000	62.057	0.000	139.13	102.0	0.000
Grange	43.700	0.000	0.000	0.000	0.000	62.057	0.000	141.88	107.0	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
Basin_4	38.00	29.54	56.00	15.07	80282.8	0.0000	17984.8	2.0119
Bsn3Wet	41.00	22.75	94.00	5.667	67412.7	0.0000	34775.2	2.0339
Basin_2	40.00	12.54	95.00	2.881	37416.4	0.0000	20312.0	1.7478

Basin_1 40.00 34.19 72.00 16.19 108466. 0.0000 34052.5 1.9259

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
Basin_4	2.0	1.000		0.000	30.500	0.7000
Bsn3Wet	2.0	1.000		0.000	18.300	2.000
Basin_2	2.0	1.000		0.000	14.000	1.500
Basin_1	1.0	1.000		0.000	46.000	20.000

SUMMARY OF CHANNEL/FLOODWAY DATA AND RESULT

Link Label	Ave. Vel. (m/s)	Ave. Rough. (n)	Flow Depth (m)	Max. Flow (m^3/s)	No. of Pipes	Pipe Dia. (m)	Pipe Slope (%)	Pipe Flow (m3^/s)
1.04_D	1.36	.0350	0.7375	15.652	1.0	0.000	0.000	0.000
2.00	0.872	.0350	0.5656	13.886	1.0	0.000	0.000	0.000
2.01_D	0.979	.0350	0.6438	17.997	1.0	0.000	0.000	0.000
1.05	1.39	.0350	0.7844	26.412	1.0	0.000	0.000	0.000
3.00	1.25	.0350	0.3688	10.183	1.0	0.000	0.000	0.000
1.06	1.51	.0350	0.9188	35.533	1.0	0.000	0.000	0.000
1.07	1.43	.0350	0.7750	36.899	1.0	0.000	0.000	0.000
5.01	1.35	.0350	0.5688	11.595	1.0	0.000	0.000	0.000
Basin_1	1.16	.0350	0.8438	16.172	1.0	0.000	0.000	0.000
5.03	1.56	.0350	1.159	17.131	1.0	0.000	0.000	0.000
1.08	1.73	.0350	1.806	68.683	1.0	0.000	0.000	0.000
8.00	0.839	.0520	1.013	11.381	1.0	0.000	0.000	0.000
1.11_D	0.859	.0660	2.687	91.229	1.0	0.000	0.000	0.000
Townson	0.733	.0668	3.419	125.38	1.0	0.000	0.000	0.000
1.14	0.741	.0669	3.469	133.04	1.0	0.000	0.000	0.000
South	0.903	.0669	2.994	138.80	1.0	0.000	0.000	0.000

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################################################################################################
BELLS CK - FULLY DEVELOPED URBAN MODEL - ARBM RAINFALL LOSS MODULE

Results for period from  0: 0.0  1/ 1/1990
                     to 10: 0.0  1/ 1/1990
################################################################################################


                                ROUTING INCREMENT (MINS) =       1.00
                                STORM DURATION (MINS)    =        60.
                                RETURN PERIOD (YRS)      =   1000000.
                                BX                       =     1.0000
                                TOTAL OF FIRST SUB-AREAS  (ha) =    1017.32
                                TOTAL OF SECOND SUB-AREAS (ha) =     309.16
                                TOTAL OF ALL SUB-AREAS (ha)    =    1326.48


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B        Link
 Label      #1     #2     #1    #2      #1   #2     #1    #2    #1   #2     No.
            (ha)              (%)          (%)
Loc_03    12.020  0.000  2.800 0.000  5.000 0.000  .025 0.00  .0456 0.000  1.000
Loc_02A   12.990  0.000  2.900 0.000  5.000 0.000  .025 0.00  .0466 0.000  2.000
Loc_02     4.240  0.000  2.200 0.000  5.000 0.000  .025 0.00  .0299 0.000  2.001
Loc_01    26.990  0.000  2.700 0.000  5.000 0.000  .025 0.00  .0707 0.000  3.000
1.13B     18.970  0.000  2.400 0.000  5.000 0.000  .025 0.00  .0624 0.000  4.000
1.13C     16.460  0.000  2.900 0.000  5.000 0.000  .025 0.00  .0527 0.000  5.000
1.13D     25.330  0.000  1.700 0.000  5.000 0.000  .025 0.00  .0861 0.000  6.000
1.00      12.890  7.250  .9000 .9000  8.000 100.0  .025 .025  .0739 .0088  7.000
1.01      22.020 22.020  1.000 1.000  8.000 100.0  .025 .025  .0926 .0149  7.001
1.02      16.270 10.850  1.500 1.500  8.000 100.0  .025 .025  .0646 .0084  7.002
9.00       3.150  1.350  1.900 1.900  8.000 100.0  .025 .025  .0245 .0025  8.000
Dummy     .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  9.000
Basin_4   11.570  6.230  1.900 1.900  8.000 100.0  .025 .025  .0481 .0056  7.003
1.04_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.004
2.00      37.000 23.280  1.200 1.200  8.000 100.0  .025 .025  .1107 .0140  10.00
4.00       9.120  6.080  1.500 1.500  8.000 100.0  .025 .025  .0478 .0062  11.00
2.01_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  10.00
Bsn3Wet   19.400  0.000  1.700 0.000  10.00 0.000  .025 0.00  .0616 0.000  10.00
1.05      23.820 15.880  1.700 1.700  8.000 100.0  .025 .025  .0740 .0096  7.005
3.00      25.440 16.960  1.100 1.100  8.000 100.0  .025 .025  .0952 .0124  12.00
Basin_2   10.100  0.000  1.200 0.000  10.00 0.000  .025 0.00  .0522 0.000  12.00
1.06      28.020 18.680  1.500 1.500  8.000 100.0  .025 .025  .0857 .0111  7.006
1.07       5.450  5.450  1.400 1.400  8.000 100.0  .025 .025  .0379 .0061  7.007
5.00      14.830  7.990  1.300 1.300  8.000 100.0  .025 .025  .0661 .0077  13.00
5.01      15.930 10.620  .7000 .7000  8.000 100.0  .025 .025  .0935 .0122  13.00
6.00      24.820 16.540  1.400 1.400  8.000 100.0  .025 .025  .0833 .0108  14.00
Basin_1   37.800 21.250  1.100 1.100  8.000 100.0  .025 .025  .1169 .0139  13.00
5.03       9.070  2.270  1.400 1.400  8.000 100.0  .025 .025  .0494 .0039  13.00
5.04      13.600  5.820  1.100 1.100  8.000 100.0  .025 .025  .0687 .0071  13.00
1.08      54.300 36.200  1.400 1.400  8.000 100.0  .025 .025  .1252 .0163  7.008
1.09      39.300 26.200  1.500 1.500  8.000 100.0  .025 .025  .1022 .0133  7.009
7.00      29.940 16.120  1.300 1.300  8.000 100.0  .025 .025  .0953 .0111  15.00
1.10_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.010
8.00      18.300 18.300  2.500 2.500  8.000 100.0  .025 .025  .0532 .0085  16.00
8.01       9.300  0.000  1.200 0.000  2.000 0.000  .025 0.00  .0692 0.000  16.00
1.11_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.011
1.12      50.810  0.000  .9000 0.000  3.000 0.000  .025 0.00  .1849 0.000  7.012
1.13E      1.639  0.000  2.000 0.000  5.000 0.000  .025 0.00  .0191 0.000  17.00
Cf_1.13C  .00001  0.000  1.000 0.000  5.000 0.000  .025 0.00  0.000 0.000  5.001
1.13A     10.340  0.000  1.900 0.000  5.000 0.000  .025 0.00  .0511 0.000  18.00
Cf_1.13A  .00001  0.000  1.300 0.000  5.000 0.000  .025 0.00  0.000 0.000  4.001
Loc_04A   10.490  6.990  2.300 2.300  5.000 100.0  .025 .015  .0468 .0027  19.00
Loc_04B   10.240  6.830  2.400 2.400  5.000 100.0  .025 .015  .0453 .0026  20.00
Loc_04C   73.730  0.000  2.100 0.000  5.000 0.000  .025 0.00  .1351 0.000  19.00
Loc_04    14.210  0.000  1.300 0.000  5.000 0.000  .025 0.00  .0729 0.000  19.00
Cf_1.14   0.0100  0.000  .1000 0.000  5.000 0.000  .025 0.00  .0060 0.000  3.001
Cf_1.15   0.0100  0.000  .1000 0.000  5.000 0.000  .025 0.00  .0060 0.000  1.001
Townson   .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.002
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1.14	105.20	0.000	1.400	0.000	0.000	0.000	.040	0.00	.3463	0.000	1.003
South	89.500	0.000	1.000	0.000	0.000	0.000	.040	0.00	.3766	0.000	1.004
Grange	42.700	0.000	1.800	0.000	0.000	0.000	.040	0.00	.1912	0.000	1.005

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess Rain #1 (mm)	Excess Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Loc_03	320.00	0.000	0.000	0.000	0.000	303.63	0.000	14.408	21.00	0.000
Loc_02A	320.00	0.000	0.000	0.000	0.000	303.63	0.000	15.576	21.00	12.00
Loc_02	320.00	0.000	0.000	0.000	0.000	303.63	0.000	19.993	33.00	0.000
Loc_01	320.00	0.000	0.000	0.000	0.000	303.63	0.000	31.456	27.00	0.000
1.13B	320.00	0.000	0.000	0.000	0.000	303.63	0.000	22.129	27.00	0.000
1.13C	320.00	0.000	0.000	0.000	0.000	303.63	0.000	19.610	21.00	0.000
1.13D	320.00	0.000	0.000	0.000	0.000	303.63	0.000	28.465	28.00	0.000
1.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	23.145	27.00	1.000
1.01	320.00	0.000	0.000	0.000	0.000	304.11	319.00	72.753	28.00	1.000
1.02	320.00	0.000	0.000	0.000	0.000	304.11	319.00	103.88	28.00	1.000
9.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	5.514	21.00	1.000
Dummy	320.00	0.000	0.000	0.000	0.000	320.00	0.000	4.214	21.00	2.000
Basin_4	320.00	0.000	0.000	0.000	0.000	304.11	319.00	127.00	28.00	0.000
1.04_D	320.00	0.000	0.000	0.000	0.000	320.00	0.000	123.33	30.00	0.000
2.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	67.459	27.00	0.000
4.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	18.211	27.00	1.000
2.01_D	320.00	0.000	0.000	0.000	0.000	320.00	0.000	84.557	28.00	0.000
Bsn3Wet	320.00	0.000	0.000	0.000	0.000	304.44	0.000	105.54	29.00	0.000
1.05	320.00	0.000	0.000	0.000	0.000	304.11	319.00	264.40	33.00	0.000
3.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	47.955	27.00	0.000
Basin_2	320.00	0.000	0.000	0.000	0.000	304.44	0.000	58.539	29.00	0.000
1.06	320.00	0.000	0.000	0.000	0.000	304.11	319.00	354.54	37.00	0.000
1.07	320.00	0.000	0.000	0.000	0.000	304.11	319.00	364.70	37.00	0.000
5.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	26.983	27.00	0.000
5.01	320.00	0.000	0.000	0.000	0.000	304.11	319.00	55.755	27.00	0.000
6.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	48.350	27.00	0.000
Basin_1	320.00	0.000	0.000	0.000	0.000	304.11	319.00	164.93	27.00	0.000
5.03	320.00	0.000	0.000	0.000	0.000	304.11	319.00	163.37	37.00	0.000
5.04	320.00	0.000	0.000	0.000	0.000	304.11	319.00	181.68	38.00	0.000
1.08	320.00	0.000	0.000	0.000	0.000	304.11	319.00	628.05	41.00	0.000
1.09	320.00	0.000	0.000	0.000	0.000	304.11	319.00	684.32	43.00	0.000
7.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	52.703	27.00	0.000
1.10_D	320.00	0.000	0.000	0.000	0.000	320.00	0.000	726.84	42.00	0.000
8.00	320.00	0.000	0.000	0.000	0.000	304.11	319.00	44.639	21.00	0.000
8.01	320.00	0.000	0.000	0.000	0.000	303.14	0.000	53.619	26.00	0.000
1.11_D	320.00	0.000	0.000	0.000	0.000	320.00	0.000	770.51	42.00	0.000
1.12	320.00	0.000	0.000	0.000	0.000	303.30	0.000	798.56	53.00	1.500
1.13E	320.00	0.000	0.000	0.000	0.000	303.63	0.000	1.996	19.00	0.000
Cf_1.13C	320.00	0.000	0.000	0.000	0.000	303.63	0.000	824.26	55.00	1.500
1.13A	320.00	0.000	0.000	0.000	0.000	303.63	0.000	12.077	27.00	0.000
Cf_1.13A	320.00	0.000	0.000	0.000	0.000	303.63	0.000	839.92	56.00	4.000
Loc_04A	320.00	0.000	0.000	0.000	0.000	303.63	319.00	21.124	21.00	7.000
Loc_04B	320.00	0.000	0.000	0.000	0.000	303.63	319.00	20.697	21.00	9.000
Loc_04C	320.00	0.000	0.000	0.000	0.000	303.63	0.000	119.91	28.00	19.00
Loc_04	320.00	0.000	0.000	0.000	0.000	303.63	0.000	131.86	47.00	0.000
Cf_1.14	320.00	0.000	0.000	0.000	0.000	303.63	0.000	967.64	59.00	2.000
Cf_1.15	320.00	0.000	0.000	0.000	0.000	303.63	0.000	982.67	61.00	0.000
Townson	320.00	0.000	0.000	0.000	0.000	320.00	0.000	982.67	61.00	0.000
1.14	320.00	0.000	0.000	0.000	0.000	302.82	0.000	1036.4	66.00	0.000
South	320.00	0.000	0.000	0.000	0.000	302.82	0.000	1078.3	71.00	0.000
Grange	320.00	0.000	0.000	0.000	0.000	302.82	0.000	1091.5	73.00	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
Basin_4	28.00	127.0	30.00	122.0	347240.	0.0000	54935.7	4.2145
Bsn3Wet	29.00	105.5	32.00	101.2	292911.	0.0000	68861.8	2.7560
Basin_2	29.00	58.54	42.00	49.60	162136.	0.0000	61081.8	3.0046

Basin_1 27.00 164.9 36.00 152.5 463759. 0.0000 95411.3 3.4319

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
Basin_4	2.0	1.000		0.000	30.500	0.7000
Bsn3Wet	2.0	1.000		0.000	18.300	2.000
Basin_2	2.0	1.000		0.000	14.000	1.500
Basin_1	1.0	1.000		0.000	46.000	20.000

SUMMARY OF CHANNEL/FLOODWAY DATA AND RESULT

Link Label	Ave. Vel. (m/s)	Ave. Rough. (n)	Flow Depth (m)	Max. Flow (m^3/s)	No. of Pipes	Pipe Dia. (m)	Pipe Slope (%)	Pipe Flow (m3^/s)
1.04_D	2.30	.0350	1.913	121.77	1.0	0.000	0.000	0.000
2.00	1.51	.0350	1.363	66.449	1.0	0.000	0.000	0.000
2.01_D	1.63	.0350	1.544	83.587	1.0	0.000	0.000	0.000
1.05	2.59	.0350	2.450	261.86	1.0	0.000	0.000	0.000
3.00	2.16	.0350	0.8813	47.131	1.0	0.000	0.000	0.000
1.06	2.83	.0350	2.800	354.54	1.0	0.000	0.000	0.000
1.07	2.79	.0350	2.537	362.38	1.0	0.000	0.000	0.000
5.01	2.19	.0350	1.306	53.911	1.0	0.000	0.000	0.000
Basin_1	2.21	.0350	2.675	152.35	1.0	0.000	0.000	0.000
5.03	2.75	.0350	3.075	162.96	1.0	0.000	0.000	0.000
1.08	3.00	.0350	4.350	625.27	1.0	0.000	0.000	0.000
8.00	1.33	.0512	1.406	43.785	1.0	0.000	0.000	0.000
1.11_D	1.46	.0686	4.312	757.88	1.0	0.000	0.000	0.000
Townson	1.38	.0686	5.950	975.03	1.0	0.000	0.000	0.000
1.14	1.40	.0686	6.062	1030.7	1.0	0.000	0.000	0.000
South	1.61	.0687	5.012	1075.1	1.0	0.000	0.000	0.000

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################################################################################################
BELLS CK - FULLY DEVELOPED URBAN MODEL - ARBM RAINFALL LOSS MODULE

Results for period from  0: 0.0  1/ 1/1990
                     to 10: 0.0  1/ 1/1990
################################################################################################


                                ROUTING INCREMENT (MINS) =       1.00
                                STORM DURATION (MINS)    =       120.
                                RETURN PERIOD (YRS)      =       100.
                                BX                       =     1.0000
                                TOTAL OF FIRST SUB-AREAS  (ha) =    1017.32
                                TOTAL OF SECOND SUB-AREAS (ha) =     309.16
                                TOTAL OF ALL SUB-AREAS (ha)    =    1326.48


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B        Link
 Label      #1     #2     #1    #2      #1   #2     #1    #2    #1   #2     No.
            (ha)              (%)          (%)
Loc_03    12.020  0.000  2.800 0.000  5.000 0.000  .025 0.00  .0456 0.000  1.000
Loc_02A   12.990  0.000  2.900 0.000  5.000 0.000  .025 0.00  .0466 0.000  2.000
Loc_02     4.240  0.000  2.200 0.000  5.000 0.000  .025 0.00  .0299 0.000  2.001
Loc_01    26.990  0.000  2.700 0.000  5.000 0.000  .025 0.00  .0707 0.000  3.000
1.13B     18.970  0.000  2.400 0.000  5.000 0.000  .025 0.00  .0624 0.000  4.000
1.13C     16.460  0.000  2.900 0.000  5.000 0.000  .025 0.00  .0527 0.000  5.000
1.13D     25.330  0.000  1.700 0.000  5.000 0.000  .025 0.00  .0861 0.000  6.000
1.00      12.890  7.250  .9000 .9000  8.000 100.0  .025 .025  .0739 .0088  7.000
1.01      22.020 22.020  1.000 1.000  8.000 100.0  .025 .025  .0926 .0149  7.001
1.02      16.270 10.850  1.500 1.500  8.000 100.0  .025 .025  .0646 .0084  7.002
9.00       3.150  1.350  1.900 1.900  8.000 100.0  .025 .025  .0245 .0025  8.000
Dummy     .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  9.000
Basin_4   11.570  6.230  1.900 1.900  8.000 100.0  .025 .025  .0481 .0056  7.003
1.04_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.004
2.00      37.000 23.280  1.200 1.200  8.000 100.0  .025 .025  .1107 .0140  10.00
4.00       9.120  6.080  1.500 1.500  8.000 100.0  .025 .025  .0478 .0062  11.00
2.01_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  10.00
Bsn3Wet   19.400  0.000  1.700 0.000  10.00 0.000  .025 0.00  .0616 0.000  10.00
1.05      23.820 15.880  1.700 1.700  8.000 100.0  .025 .025  .0740 .0096  7.005
3.00      25.440 16.960  1.100 1.100  8.000 100.0  .025 .025  .0952 .0124  12.00
Basin_2   10.100  0.000  1.200 0.000  10.00 0.000  .025 0.00  .0522 0.000  12.00
1.06      28.020 18.680  1.500 1.500  8.000 100.0  .025 .025  .0857 .0111  7.006
1.07       5.450  5.450  1.400 1.400  8.000 100.0  .025 .025  .0379 .0061  7.007
5.00      14.830  7.990  1.300 1.300  8.000 100.0  .025 .025  .0661 .0077  13.00
5.01      15.930 10.620  .7000 .7000  8.000 100.0  .025 .025  .0935 .0122  13.00
6.00      24.820 16.540  1.400 1.400  8.000 100.0  .025 .025  .0833 .0108  14.00
Basin_1   37.800 21.250  1.100 1.100  8.000 100.0  .025 .025  .1169 .0139  13.00
5.03       9.070  2.270  1.400 1.400  8.000 100.0  .025 .025  .0494 .0039  13.00
5.04      13.600  5.820  1.100 1.100  8.000 100.0  .025 .025  .0687 .0071  13.00
1.08      54.300 36.200  1.400 1.400  8.000 100.0  .025 .025  .1252 .0163  7.008
1.09      39.300 26.200  1.500 1.500  8.000 100.0  .025 .025  .1022 .0133  7.009
7.00      29.940 16.120  1.300 1.300  8.000 100.0  .025 .025  .0953 .0111  15.00
1.10_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.010
8.00      18.300 18.300  2.500 2.500  8.000 100.0  .025 .025  .0532 .0085  16.00
8.01       9.300  0.000  1.200 0.000  2.000 0.000  .025 0.00  .0692 0.000  16.00
1.11_D    .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  7.011
1.12      50.810  0.000  .9000 0.000  3.000 0.000  .025 0.00  .1849 0.000  7.012
1.13E      1.639  0.000  2.000 0.000  5.000 0.000  .025 0.00  .0191 0.000  17.00
Cf_1.13C  .00001  0.000  1.000 0.000  5.000 0.000  .025 0.00  0.000 0.000  5.001
1.13A     10.340  0.000  1.900 0.000  5.000 0.000  .025 0.00  .0511 0.000  18.00
Cf_1.13A  .00001  0.000  1.300 0.000  5.000 0.000  .025 0.00  0.000 0.000  4.001
Loc_04A   10.490  6.990  2.300 2.300  5.000 100.0  .025 .015  .0468 .0027  19.00
Loc_04B   10.240  6.830  2.400 2.400  5.000 100.0  .025 .015  .0453 .0026  20.00
Loc_04C   73.730  0.000  2.100 0.000  5.000 0.000  .025 0.00  .1351 0.000  19.00
Loc_04    14.210  0.000  1.300 0.000  5.000 0.000  .025 0.00  .0729 0.000  19.00
Cf_1.14   0.0100  0.000  .1000 0.000  5.000 0.000  .025 0.00  .0060 0.000  3.001
Cf_1.15   0.0100  0.000  .1000 0.000  5.000 0.000  .025 0.00  .0060 0.000  1.001
Townson   .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.002
```

1.14	105.20	0.000	1.400	0.000	0.000	0.000	.040	0.00	.3463	0.000	1.003
South	89.500	0.000	1.000	0.000	0.000	0.000	.040	0.00	.3766	0.000	1.004
Grange	42.700	0.000	1.800	0.000	0.000	0.000	.040	0.00	.1912	0.000	1.005

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess Rain #1 (mm)	Excess Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Loc_03	50.300	0.000	0.000	0.000	0.000	76.312	0.000	3.985	41.00	0.000
Loc_02A	50.300	0.000	0.000	0.000	0.000	76.312	0.000	4.314	41.00	12.00
Loc_02	50.300	0.000	0.000	0.000	0.000	76.312	0.000	5.061	52.00	0.000
Loc_01	50.300	0.000	0.000	0.000	0.000	76.312	0.000	7.848	41.00	0.000
1.13B	50.300	0.000	0.000	0.000	0.000	76.312	0.000	5.578	41.00	0.000
1.13C	50.300	0.000	0.000	0.000	0.000	76.312	0.000	5.332	41.00	0.000
1.13D	50.300	0.000	0.000	0.000	0.000	76.312	0.000	6.120	45.00	0.000
1.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	5.930	36.00	1.000
1.01	50.300	0.000	0.000	0.000	0.000	77.048	99.600	20.545	36.00	1.000
1.02	50.300	0.000	0.000	0.000	0.000	77.048	99.600	29.129	37.00	1.000
9.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	1.728	36.00	1.000
Dummy	50.300	0.000	0.000	0.000	0.000	100.60	0.000	0.4280	36.00	2.000
Basin_4	50.300	0.000	0.000	0.000	0.000	77.048	99.600	35.436	38.00	0.000
1.04_D	50.300	0.000	0.000	0.000	0.000	100.60	0.000	18.366	55.00	0.000
2.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	17.467	36.00	0.000
4.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	5.480	35.00	1.000
2.01_D	50.300	0.000	0.000	0.000	0.000	100.60	0.000	21.860	38.00	0.000
Bsn3Wet	50.300	0.000	0.000	0.000	0.000	77.538	0.000	27.438	41.00	0.000
1.05	50.300	0.000	0.000	0.000	0.000	77.048	99.600	30.145	60.00	0.000
3.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	12.626	36.00	0.000
Basin_2	50.300	0.000	0.000	0.000	0.000	77.538	0.000	15.032	40.00	0.000
1.06	50.300	0.000	0.000	0.000	0.000	77.048	99.600	40.788	46.00	0.000
1.07	50.300	0.000	0.000	0.000	0.000	77.048	99.600	43.937	41.00	0.000
5.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	7.040	35.00	0.000
5.01	50.300	0.000	0.000	0.000	0.000	77.048	99.600	14.618	36.00	0.000
6.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	13.019	36.00	0.000
Basin_1	50.300	0.000	0.000	0.000	0.000	77.048	99.600	41.221	40.00	0.000
5.03	50.300	0.000	0.000	0.000	0.000	77.048	99.600	21.786	71.00	0.000
5.04	50.300	0.000	0.000	0.000	0.000	77.048	99.600	23.745	73.00	0.000
1.08	50.300	0.000	0.000	0.000	0.000	77.048	99.600	79.915	52.00	0.000
1.09	50.300	0.000	0.000	0.000	0.000	77.048	99.600	90.406	57.00	0.000
7.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	13.200	36.00	0.000
1.10_D	50.300	0.000	0.000	0.000	0.000	100.60	0.000	98.218	57.00	0.000
8.00	50.300	0.000	0.000	0.000	0.000	77.048	99.600	14.705	35.00	0.000
8.01	50.300	0.000	0.000	0.000	0.000	75.577	0.000	15.605	44.00	0.000
1.11_D	50.300	0.000	0.000	0.000	0.000	100.60	0.000	109.88	47.00	0.000
1.12	50.300	0.000	0.000	0.000	0.000	75.822	0.000	115.96	70.00	1.500
1.13E	50.300	0.000	0.000	0.000	0.000	76.312	0.000	0.6245	40.00	0.000
Cf_1.13C	50.300	0.000	0.000	0.000	0.000	76.312	0.000	121.00	71.00	1.500
1.13A	50.300	0.000	0.000	0.000	0.000	76.312	0.000	3.069	41.00	0.000
Cf_1.13A	50.300	0.000	0.000	0.000	0.000	76.312	0.000	124.05	73.00	4.000
Loc_04A	50.300	0.000	0.000	0.000	0.000	76.312	99.600	6.327	35.00	7.000
Loc_04B	50.300	0.000	0.000	0.000	0.000	76.312	99.600	6.254	35.00	9.000
Loc_04C	50.300	0.000	0.000	0.000	0.000	76.312	0.000	27.349	47.00	19.00
Loc_04	50.300	0.000	0.000	0.000	0.000	76.312	0.000	29.562	66.00	0.000
Cf_1.14	50.300	0.000	0.000	0.000	0.000	76.312	0.000	149.78	73.00	2.000
Cf_1.15	50.300	0.000	0.000	0.000	0.000	76.312	0.000	152.92	75.00	0.000
Townson	50.300	0.000	0.000	0.000	0.000	100.60	0.000	152.92	75.00	0.000
1.14	50.300	0.000	0.000	0.000	0.000	75.086	0.000	162.20	86.00	0.000
South	50.300	0.000	0.000	0.000	0.000	75.086	0.000	168.82	95.00	0.000
Grange	50.300	0.000	0.000	0.000	0.000	75.086	0.000	172.40	101.0	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
Basin_4	38.00	35.44	56.00	17.78	94735.3	0.0000	23064.3	2.3147
Bsn3Wet	41.00	27.44	96.00	6.088	79834.2	0.0000	43607.0	2.2442
Basin_2	40.00	15.03	106.0	3.081	44298.2	0.0000	25381.4	1.9148

Basin_1 40.00 41.22 69.00 20.67 128111. 0.0000 41372.5 2.1056

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
Basin_4	2.0	1.000		0.000	30.500	0.7000
Bsn3Wet	2.0	1.000		0.000	18.300	2.000
Basin_2	2.0	1.000		0.000	14.000	1.500
Basin_1	1.0	1.000		0.000	46.000	20.000

SUMMARY OF CHANNEL/FLOODWAY DATA AND RESULT

Link Label	Ave. Vel. (m/s)	Ave. Rough. (n)	Flow Depth (m)	Max. Flow (m^3/s)	No. of Pipes	Pipe Dia. (m)	Pipe Slope (%)	Pipe Flow (m3^/s)
1.04_D	1.41	.0350	0.7969	18.314	1.0	0.000	0.000	0.000
2.00	0.934	.0350	0.6281	16.696	1.0	0.000	0.000	0.000
2.01_D	1.04	.0350	0.7156	21.580	1.0	0.000	0.000	0.000
1.05	1.44	.0350	0.8406	30.046	1.0	0.000	0.000	0.000
3.00	1.34	.0350	0.4078	12.207	1.0	0.000	0.000	0.000
1.06	1.57	.0350	0.9875	40.801	1.0	0.000	0.000	0.000
1.07	1.49	.0350	0.8500	42.984	1.0	0.000	0.000	0.000
5.01	1.44	.0350	0.6281	13.861	1.0	0.000	0.000	0.000
Basin_1	1.25	.0350	0.9625	20.595	1.0	0.000	0.000	0.000
5.03	1.65	.0350	1.294	21.709	1.0	0.000	0.000	0.000
1.08	1.79	.0350	1.919	79.634	1.0	0.000	0.000	0.000
8.00	0.887	.0519	1.053	13.517	1.0	0.000	0.000	0.000
1.11_D	0.885	.0664	2.787	108.67	1.0	0.000	0.000	0.000
Townson	0.772	.0670	3.569	151.59	1.0	0.000	0.000	0.000
1.14	0.786	.0671	3.619	161.14	1.0	0.000	0.000	0.000
South	0.944	.0672	3.125	168.45	1.0	0.000	0.000	0.000

APPENDIX B

TUFLOW INPUTS & RESULTS

B.1 TUFLOW MODEL RESULT FIGURES

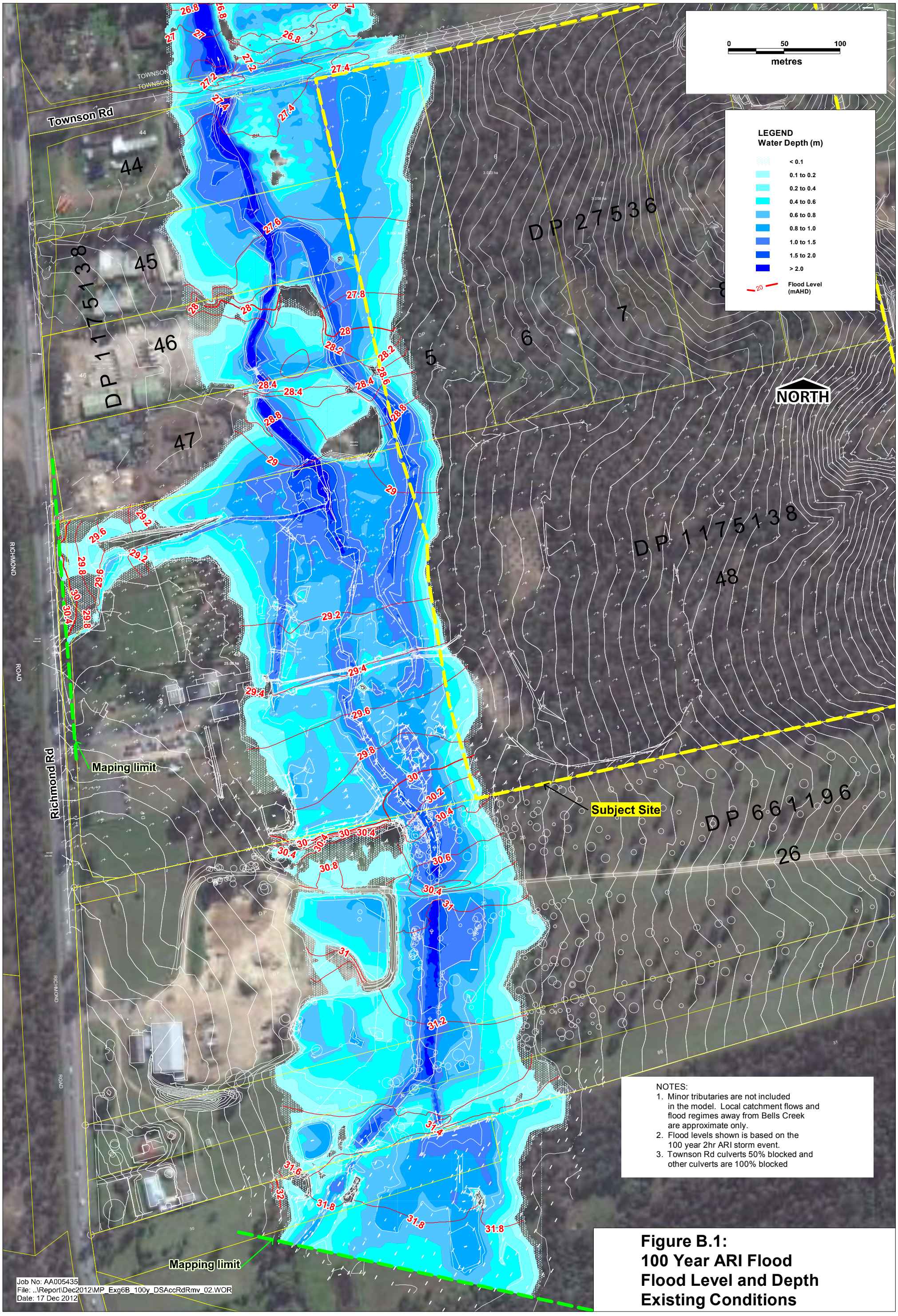


Figure B.1:
100 Year ARI Flood
Flood Level and Depth
Existing Conditions

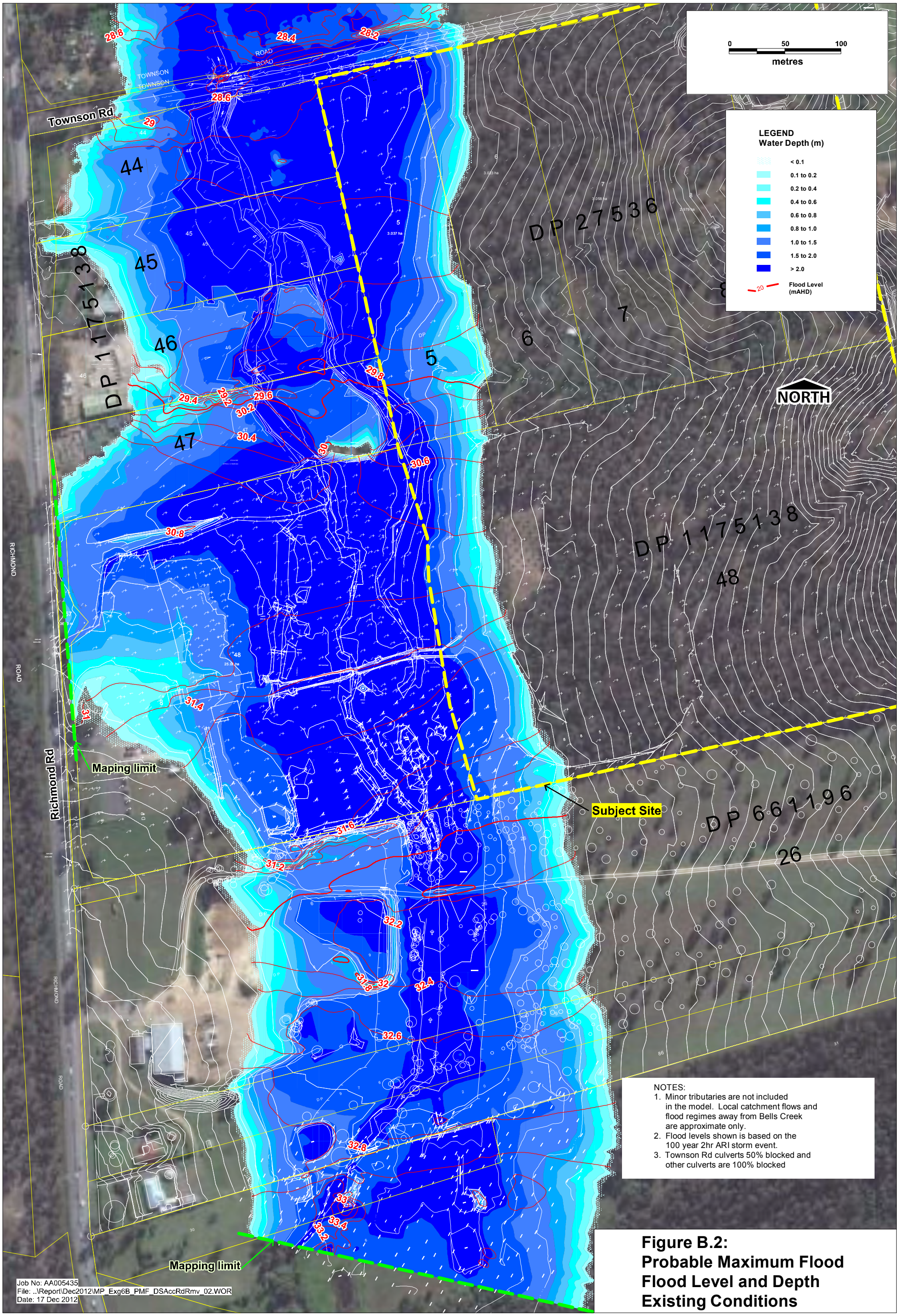


Figure B.2:
Probable Maximum Flood
Flood Level and Depth
Existing Conditions

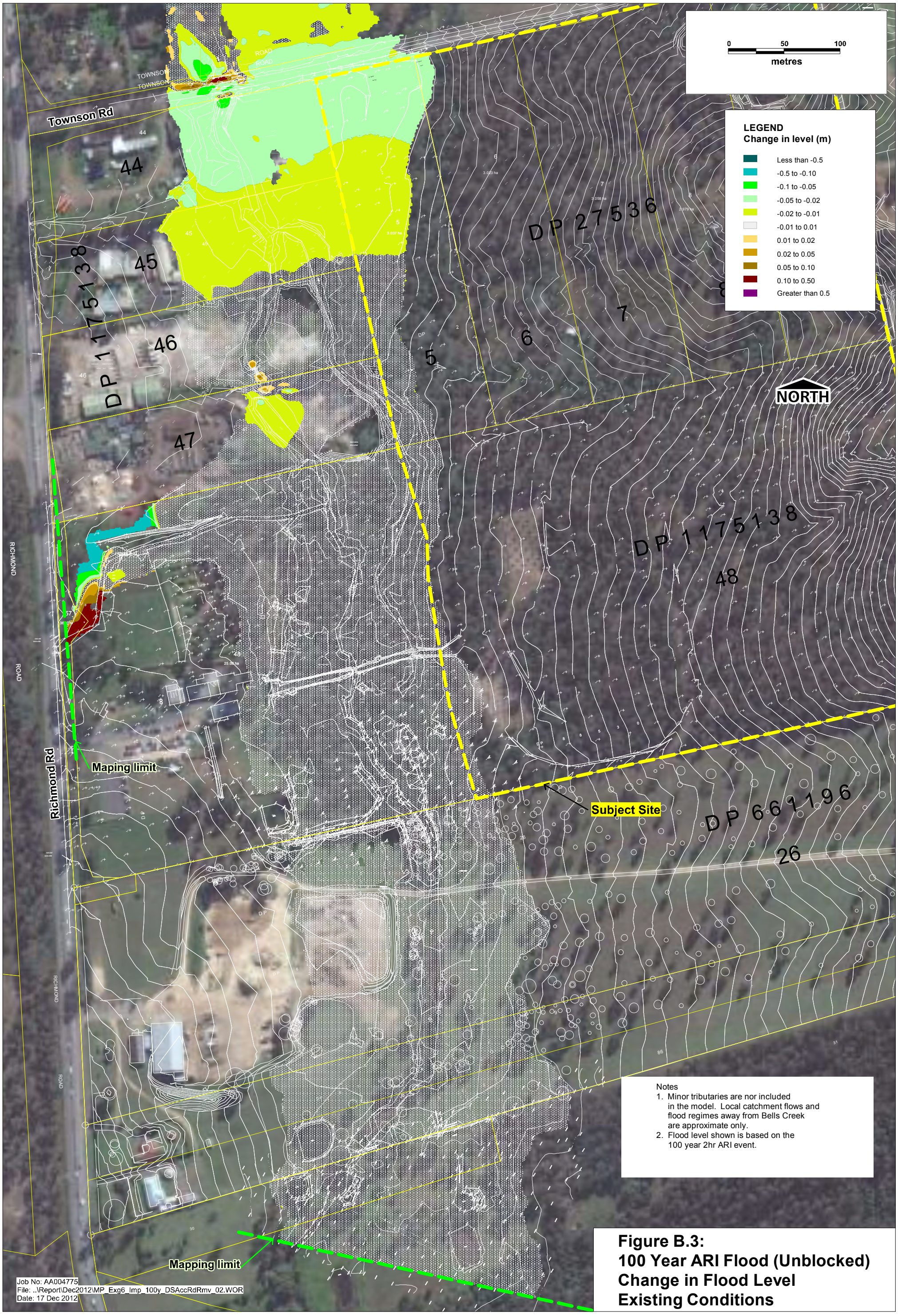


Figure B.3:
100 Year ARI Flood (Unblocked)
Change in Flood Level
Existing Conditions

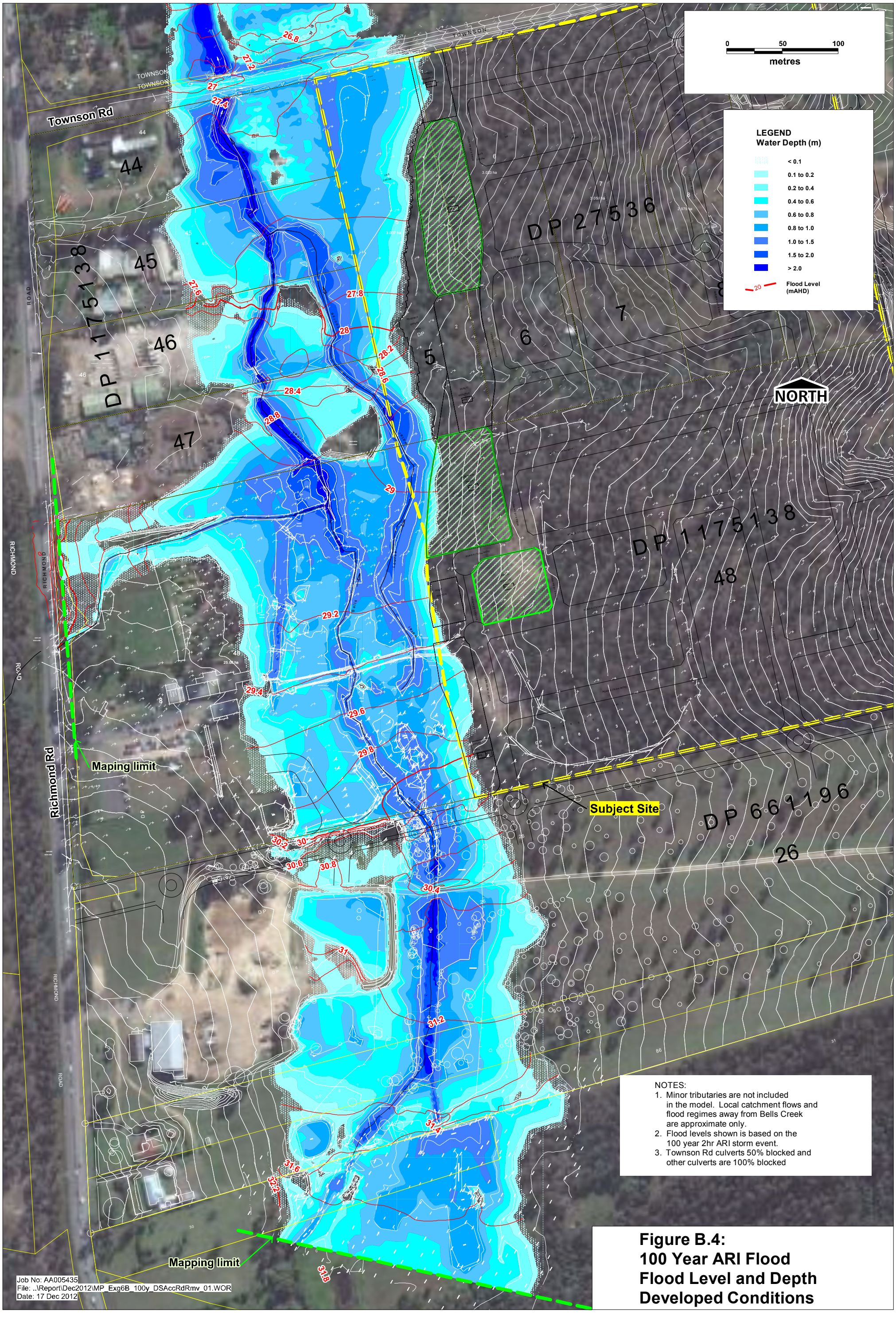


Figure B.4:
100 Year ARI Flood
Flood Level and Depth
Developed Conditions

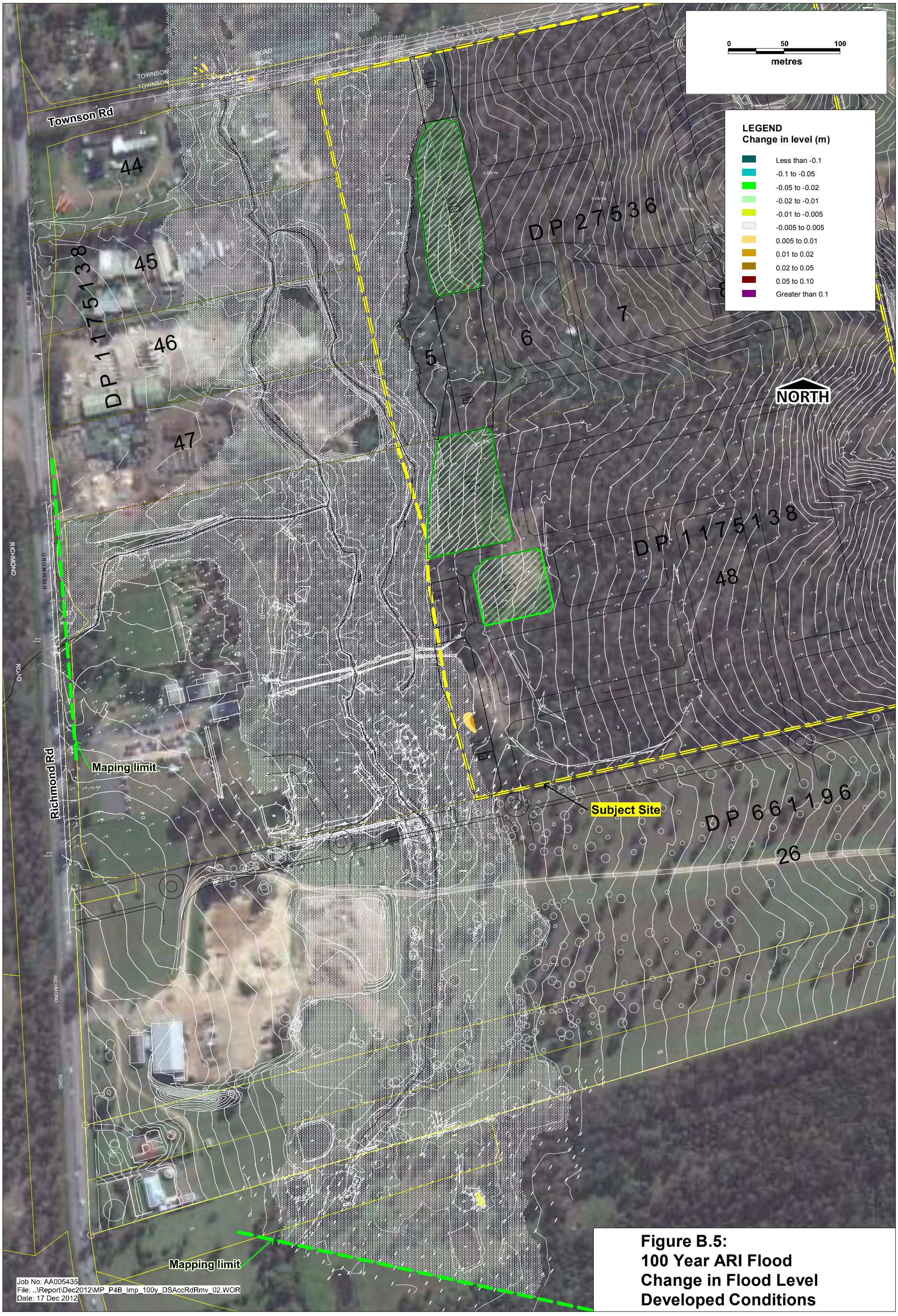


Figure B.5:
100 Year ARI Flood
Change in Flood Level
Developed Conditions

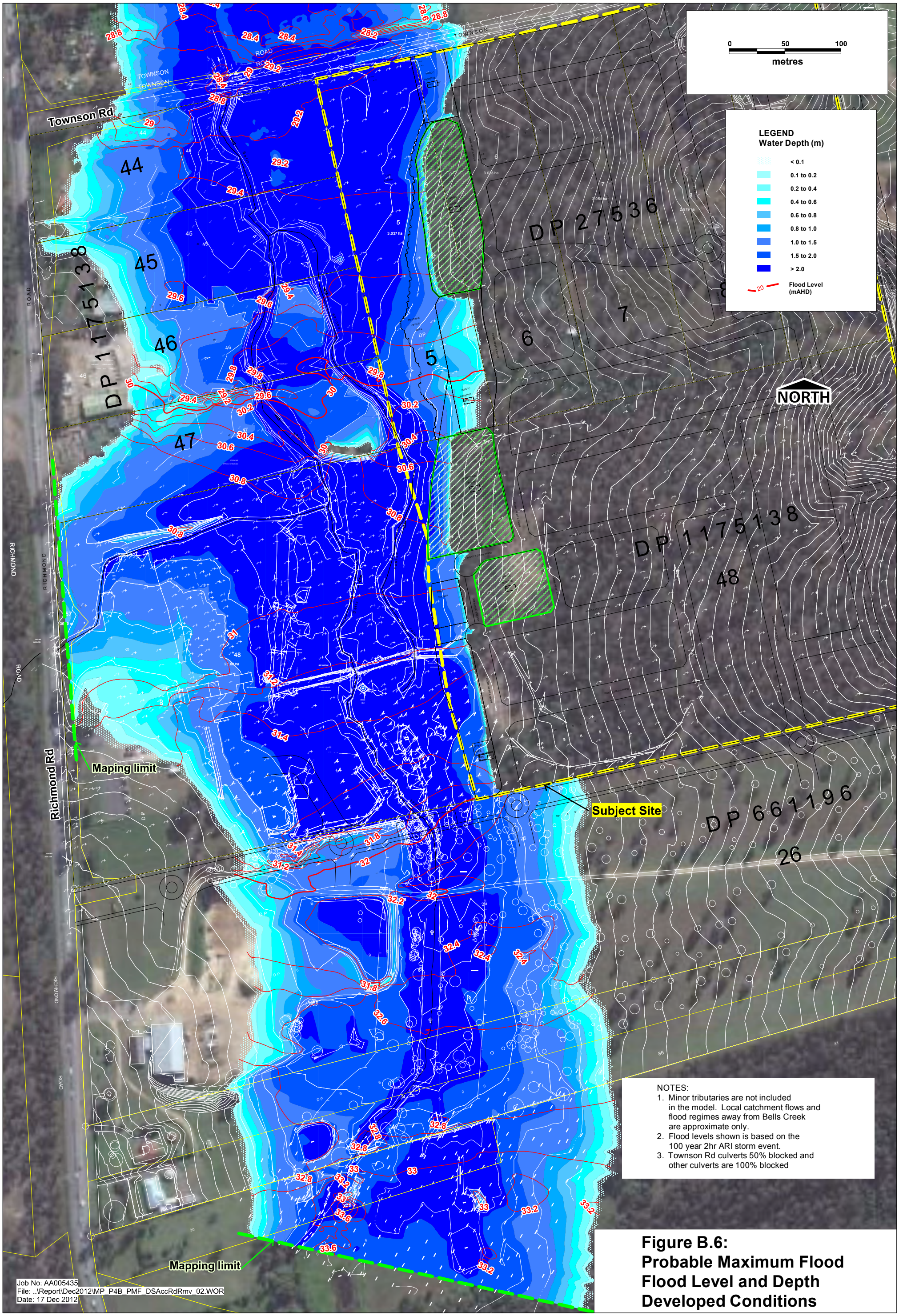


Figure B.6:
Probable Maximum Flood
Flood Level and Depth
Developed Conditions

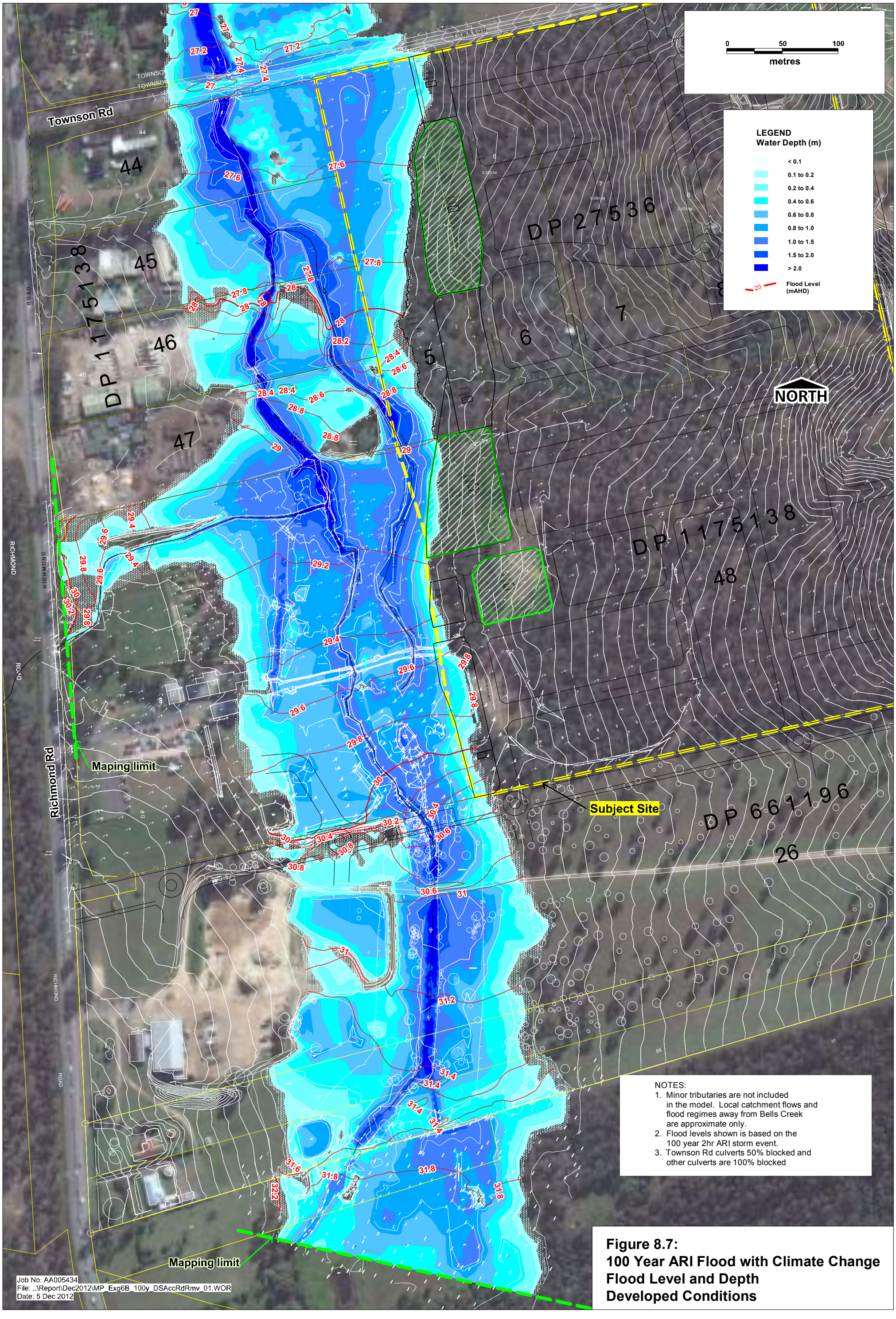


Figure 8.7:
100 Year ARI Flood with Climate Change
Flood Level and Depth
Developed Conditions

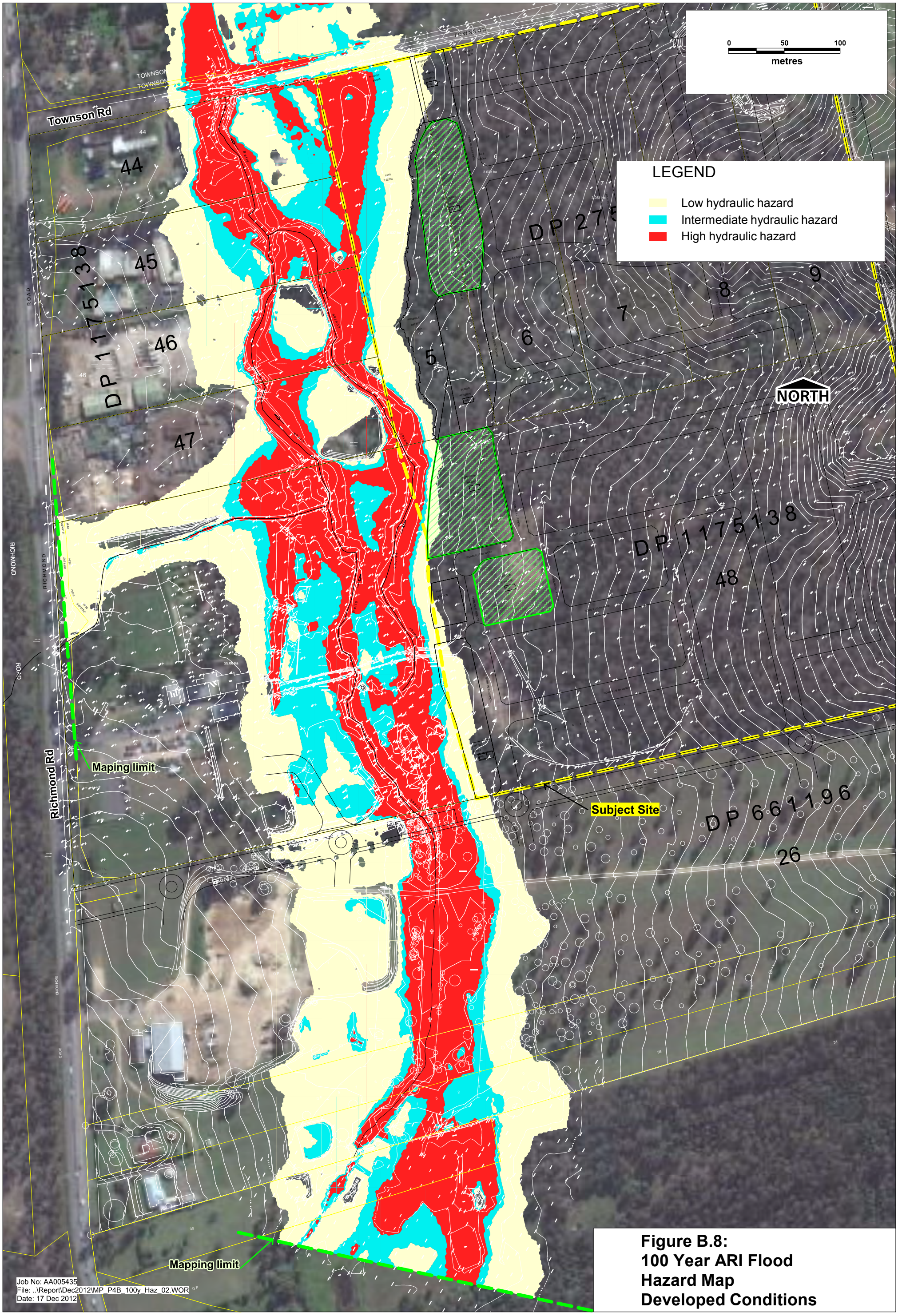


Figure B.8:
100 Year ARI Flood Hazard Map
Developed Conditions

B.2 GROUND SURVEY PLANS

799 Richmond Road Land Survey

Land Survey of Subject Site by Chadwick & Cheng Consulting Surveyors dated 21 June 2012.

Land Survey of Subject Site by Chadwick & Cheng Consulting Surveyors dated 11 July 2012.

RICHMOND ROAD

LEGEND

EXISTING BOUNDARY

CADASTRAL

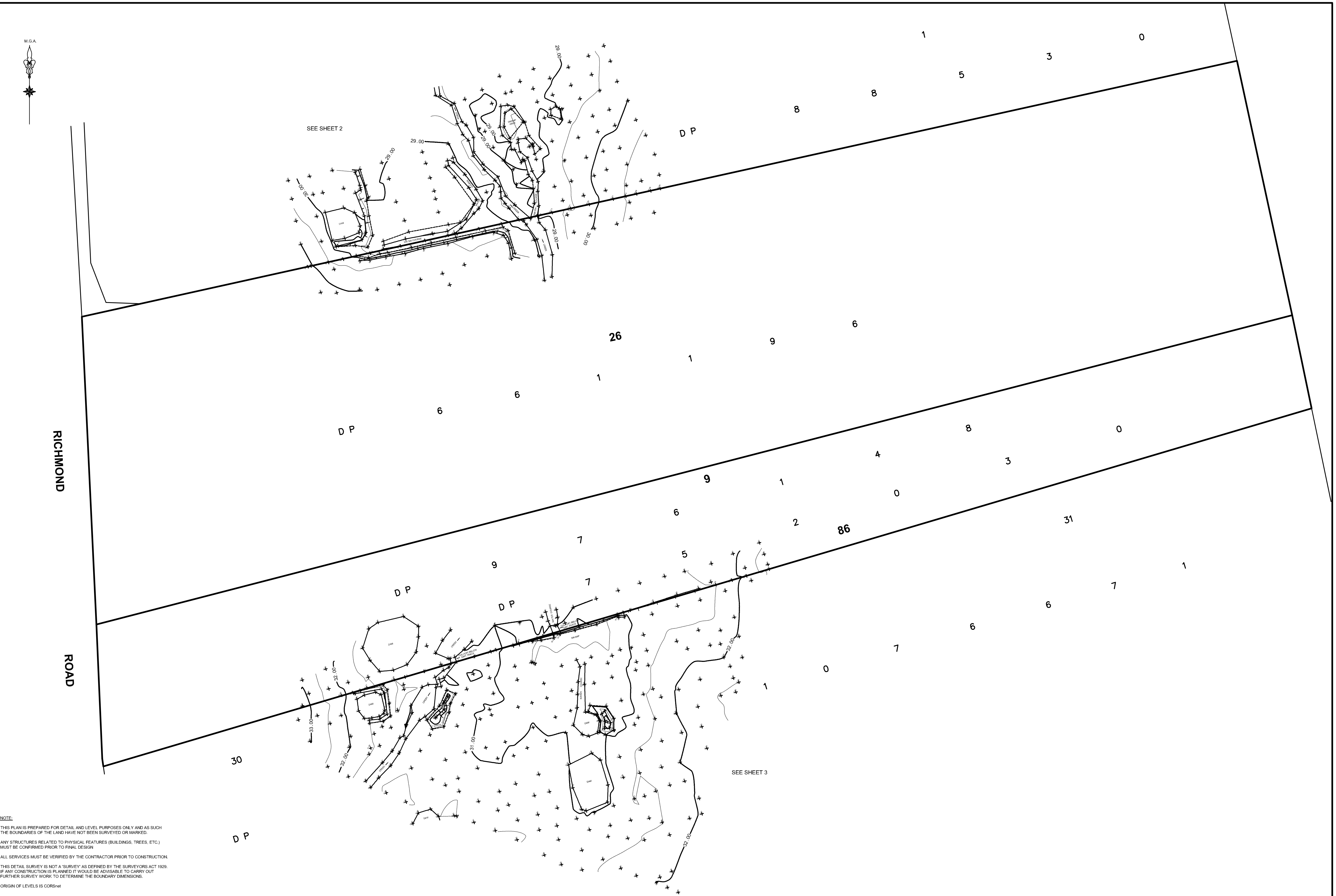
Hyder

799 RICHMOND ROAD
LAND SURVEY

N

0 100 200

1 : 4000



NOTE:

THIS PLAN IS PREPARED FOR DETAIL AND LEVEL PURPOSES ONLY AND AS SUCH THE BOUNDARIES OF THE LAND HAVE NOT BEEN SURVEYED OR MARKED.

ANY STRUCTURES RELATED TO PHYSICAL FEATURES (BUILDINGS, TREES, ETC.) MUST BE CONFIRMED PRIOR TO FINAL DESIGN

ALL SERVICES MUST BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

THIS DETAIL SURVEY IS NOT A 'SURVEY' AS DEFINED BY THE SURVEYORS ACT 1929. IF ANY CONSTRUCTION IS PLANNED IT WOULD BE ADVISABLE TO CARRY OUT FURTHER SURVEY WORK TO DETERMINE THE BOUNDARY DIMENSIONS.

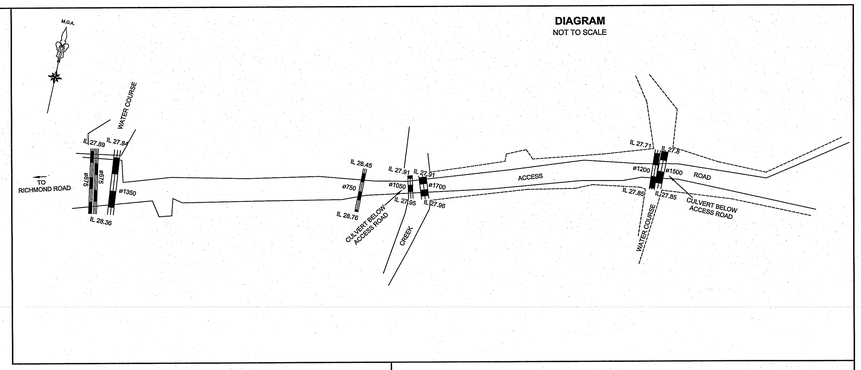
ORIGIN OF LEVELS IS CORSnet

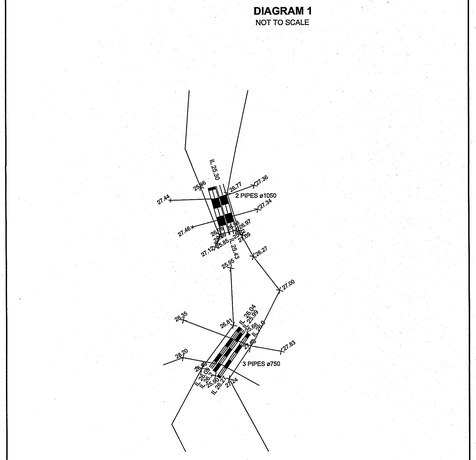
NO INVESTIGATION OF UNDERGROUND SERVICES HAS BEEN MADE. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE

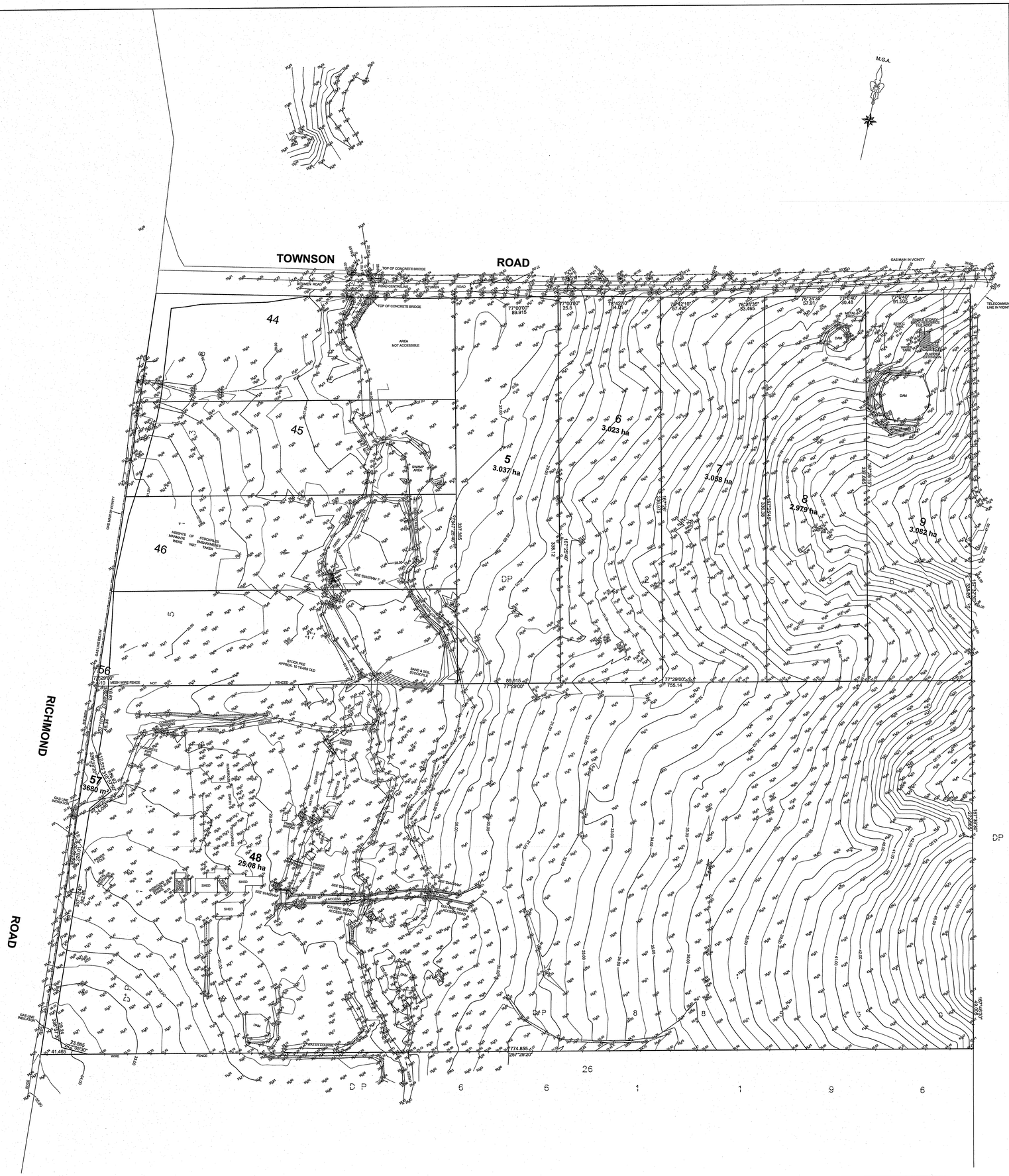
DEVELOPERS & EXCAVATORS MAY BE HELD FINANCIALLY RESPONSIBLE BY THE ASSET OWNER SHOULD THEY DAMAGE UNDERGROUND NETWORKS.

chadwickcheng consulting surveyors
suite 317 / 5 celebration drive norwest business park nsw 2153
po box 7979 baulkham hills business centre nsw 2153
dx 9951 norwest
p: 88832622 f: 88832633 e: admin@cca.net.au

PLAN SHOWING SELECTED DETAILS & LEVELS OVER LOT 26 IN DP 661196, LOT 9 IN DP 976148 & LOT 86 IN DP 752030 AT RICHMOND ROAD, MARSDEN PARK		SHEET 1 OF 3 SHEETS
DATUM: AHD	RATIO: 1 : 800 (A0)	REFERENCE 31326 / D
DATE: 21.06.2012	PRINCIPAL: GDS P/L	







NOTE:

THIS PLAN IS PREPARED FOR DETAIL AND LEVEL PURPOSES ONLY AND AS SUCH THE BOUNDARIES OF THE LAND HAVE NOT BEEN SURVEYED OR MARKED.

ANY STRUCTURES RELATED TO PHYSICAL FEATURES (BUILDINGS, TREES, ETC.) MUST BE CONFIRMED PRIOR TO FINAL DESIGN

ALL SERVICES MUST BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

THIS DETAIL SURVEY IS NOT A 'SURVEY' AS DEFINED BY THE SURVEYORS ACT 1929. IF ANY CONSTRUCTION IS PLANNED IT WOULD BE ADVISABLE TO CARRY OUT FURTHER SURVEY WORK TO DETERMINE THE BOUNDARY DIMENSIONS.

ORIGIN OF LEVELS IS CORSnet

DISCLAIMER OF LIABILITIES TO ANY THIRD PARTIES : THIS PLAN IS MADE SOLELY FOR THE USE AND BENEFIT OF THE CLIENT NAMED ABOVE AND NO LIABILITY OR RESPONSIBILITY WHATSOEVER IS ACCEPTED TO ANY THIRD PARTY WHO MAY RELY ON THIS PLAN WHOLLY OR IN PART. ANY THIRD PARTIES ACTING OR RELYING OF THIS PLAN WHETHER WHOLLY OR IN PART ARE IN BREACH OF OUR COPYRIGHT AND DO SO AT THEIR OWN RISK.

NO INVESTIGATION OF UNDERGROUND SERVICES HAS BEEN MADE. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE

DEVELOPERS & EXCAVATORS MAY BE HELD FINANCIALLY RESPONSIBLE BY THE ASSET OWNER SHOULD THEY DAMAGE UNDERGROUND NETWORKS.

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LEGEND:

———————	OVERHEAD WIRES
——— ——— ———	GAS LINE
PP	- POWER POLE
TP	- TELSTRA PIT

1) 18.07.2012 ADDITIONAL LEVELS IN TOWNSON ROAD
2) 8.10.2012 ADDITIONAL LEVELS LOT 48 IN DP 1175138
3) 1.11.2012 ADDITIONAL LEVELS

chadwickcheng
consulting surveyors
suite 317 / 5 celebration drive norwest business park nsw 2153
po box 7979 baulkham hills business centre nsw 2153
dx 9951 norwest
p: 88832622 f: 88832633 e: admin@cca.net.au

PLAN SHOWING SELECTED DETAILS & LEVELS OVER LOT 5 IN DP 27536 & LOT 48 IN DP 1175138 AT RICHMOND ROAD, MARSDEN PARK

DATUM: AHD	RATIO: 1 : 1250 (A0)	SHEET	1 OF 1 SHEETS
DATE: 11.07.2012	PRINCIPAL: GDS P/L	REFERENCE	31326 / D3

APPENDIX C

DRAINS MODEL INPUTS & OUTPUTS

Calculation Sheet

Job	Townson Road	Design	Vincent Ng	Office	Sydney
		Date	Mar-14	Job No	AA005435
		Checked			
		Date			

TOWNSON ROAD

PRECINCT

URBAN DRAINAGE

EXISTING SYSTEM

DRAINS OUTPUT

March 2014

PROJECT	TOWNSON ROAD PRECINCT					
		JOB No		AA005435		
TITLE	DRAINS DATA	PREPARED	VN	DATE	7/03/2014	DATA
		CHECKED	SK	DATE	7/03/2014	

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Existing
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Existing System

PIT / NODE DETAILS			Version 12												
Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down	id	Part Full
				Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		Shock Loss
				(cu.m)	Coeff. Ku			(cu.m/s)						
C	Node					27.6		0		300643	6267110.6		8344	
A	Node					29.2		0		300679.9	6266685.6		8345	
N2	Node					25		0		300437.2	6267089.5		8356	
Outlet existing	Node					25		0		300438.2	6267176		8400	
B	Node					29.33		0		300655	6266824.3		9774	
N1	Node							0		300578.2	6266831.3		13621	
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	Crest Length(m)
SUB-CATCHMENT DETAILS														
Name	Pit or	Total	Impervious	Avg	Mannings	Time lag	Rainfall	Hydrological						
	Node	Area	Area	Slope(%)	n	(mins)	Multiplier	Model						
C C	C	8.5126	5	4.2	0.05	0	1	Blacktown existing_RAFTS						
C A	A	8.284	5	4	0.05	0	1	Blacktown existing_RAFTS						
C B	B	12.63	5	3.2	0.05	0	1	Blacktown existing_RAFTS						
PIPE DETAILS														
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg
			(m)	(m)	(m)	(%)		(mm)	(mm)					
DETAILS of SERVICES CROSSING PIPES														
Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc				
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc				
CHANNEL DETAILS														
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Width	L.B. Slope	R.B. Slope	Manning	Depth	Roofed	
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)		
OVERFLOW ROUTE DETAILS														
Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area		id
			Time	Level	Length	Coeff. C	Section	Major Storn	Minor Storn	DxV	Slope	Contributing		
			(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%		
F C	C	N2	0.1				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		13623
F A	A	N1	1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		13618
F TOTAL EXISTIN	N2	Outlet existing	0.1				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		8402
F B	B	N1	0.1				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		13619
F AB	N1	N2	5				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		13622

PROJECT	TOWNSON ROAD PRECINCT		
TITLE	2 YEAR ARI RESULTS	JOB No	AA005435
		PREPARED VN	DATE 7/03/2014
		CHECKED SK	DATE 7/03/2014

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Existing
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Existing System

RESULTS 2 YEAR ARI

DRAINS results prepared 07 March, 2014 from Version 2014.02

PIT / NODE DETAILS

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
				Version 8			

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm								
C C	0.561	AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1								
C A	0.534	AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1								
C B	0.68	AR&R 2 year, 12 hours storm, average 10.1 mm/h, Zone 1								

Outflow Volumes for Total Catchment (1.47 impervious + 28.0 pervious = 29.4 total ha)

Storm	Total Rainfall (cu.m)	Total Runoff (cu.m (Runoff %))	Impervious Runoff (cu.m (Runoff %))	Pervious Runoff (cu.m (Runoff %))
AR&R 2 year, 10 minutes storm, average 74 mm/h, Zone 1	3629.28	102.05 (2.8%)	102.05 (56.2%)	0.00 (0.0%)
AR&R 2 year, 15 minutes storm, average 62 mm/h, Zone 1	4561.12	143.80 (3.2%)	143.80 (63.1%)	0.00 (0.0%)
AR&R 2 year, 20 minutes storm, average 54 mm/h, Zone 1	5296.79	693.20 (13.1%)	115.64 (43.7%)	577.56 (11.5%)
AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1	5922.1	1230.83 (20.8%)	117.56 (39.7%)	1113.27 (19.8%)
AR&R 2 year, 30 minutes storm, average 43.9 mm/h, Zone 1	6458.89	1678.63 (26.0%)	118.67 (36.7%)	1559.95 (25.4%)
AR&R 2 year, 45 minutes storm, average 35.1 mm/h, Zone 1	7746.31	2997.03 (38.7%)	216.45 (55.9%)	2780.57 (37.8%)
AR&R 2 year, 1 hour storm, average 29.8 mm/h, Zone 1	8769.13	3938.71 (44.9%)	308.95 (70.5%)	3629.76 (43.6%)
AR&R 2 year, 1.5 hours storm, average 23.4 mm/h, Zone 1	10328.98	5230.73 (50.6%)	431.41 (83.5%)	4799.31 (48.9%)
AR&R 2 year, 2 hours storm, average 19.7 mm/h, Zone 1	11594.57	6263.25 (54.0%)	515.18 (88.9%)	5748.07 (52.2%)
AR&R 2 year, 3 hours storm, average 15.4 mm/h, Zone 1	13594.35	7623.98 (56.1%)	637.21 (93.7%)	6986.77 (54.1%)
AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1	15891.1	9255.12 (58.2%)	789.79 (99.4%)	8465.32 (56.1%)
AR&R 2 year, 6 hours storm, average 10.1 mm/h, Zone 1	17832.52	10532.57 (59.1%)	831.88 (93.3%)	9700.69 (57.3%)
AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1	20817.84	12179.50 (58.5%)	894.43 (85.9%)	11285.07 (57.1%)
AR&R 2 year, 12 hours storm, average 6.6 mm/h, Zone 1	23307.34	13962.37 (59.9%)	1016.69 (87.2%)	12945.68 (58.5%)
AR&R 2 year, 18 hours storm, average 5.04 mm/h, Zone 1	26695.81	14473.68 (54.2%)	1230.05 (92.2%)	13243.63 (52.2%)

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)			Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
F C	0.561	0.561	0	0.069	0.06	17.74	0.82	AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1
F A	0.534	0.534	0	0.067	0.05	17.38	0.82	AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1
F TOTAL EXISTING	1.701	1.701	0	0.475	0.89	3.8	1.88	AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1
F B	0.68	0.68	0	0.074	0.06	18.82	0.87	AR&R 2 year, 12 hours storm, average 6.6 mm/h, Zone 1
F AB	1.187	1.187	0	0.094	0.09	22.77	0.99	AR&R 2 year, 12 hours storm, average 6.6 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
C	2683.76	2683.76	0	0
A	2600.07	2600.07	0	0
N2	9253.28	9252.95	0	0
Outlet existing	9252.61	9252.61	0	0
B	3971.33	3971.33	0	0
N1	6571.16	6570.9	0	0

Run Log for AA005435 Existing run at 13:41:41 on 7/3/2014

The maximum flow exceeded the safe value in the following overflow routes: F C, F AB, F B, F A, F TOTAL EXISTING

PROJECT	TOWNSON ROAD PRECINCT		
TITLE	20 YEAR ARI RESULTS	JOB No	AA005435
		PREPARED VN	DATE 7/03/2014
		CHECKED SK	DATE 7/03/2014

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Existing
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Existing System

RESULTS 20 YEAR ARI

DRAINS results prepared 07 March, 2014 from Version 2014.02

PIT / NODE DETAILS									
Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint		

SUB-CATCHMENT DETAILS									
Name	Max Flow (cu.m/s)	Due to Storm							
C C	1.372	AR&R 20 year, 2 hours storm, average 20.2 mm/h, Zone 1							
C A	1.309	AR&R 20 year, 2 hours storm, average 20.2 mm/h, Zone 2							
C B	1.692	AR&R 20 year, 4.5 hours storm, average 20.2 mm/h, Zone 1							

Outflow Volumes for Total Catchment (1.47 impervious + 28.0 pervious = 29.4 total ha)

Storm	Total Rainfall (cu.m)	Total Runoff (cu.m (Runoff	Impervious Ru (cu.m (Runoff	Pervious Runoff (cu.m (Runoff %)
AR&R 20 year, 5 minutes storm, average 166 mm/h, Zone 1	4070.68	105.00 (2.6%)	105.00 (51.6%	0.00 (0.0%)
AR&R 20 year, 10 minutes storm, average 127 mm/h, Zone 1	6228.63	1152.88 (18.5	138.47 (44.5%	1014.40 (17.1%)
AR&R 20 year, 15 minutes storm, average 106 mm/h, Zone 1	7798.05	2855.76 (36.6	196.56 (50.4%	2659.20 (35.9%)
AR&R 20 year, 20 minutes storm, average 92.0 mm/h, Zone 1	9024.16	4158.69 (46.1	244.58 (54.2%	3914.11 (45.7%)
AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1	10054.09	5137.85 (51.1	279.23 (55.5%	4858.63 (50.9%)
AR&R 20 year, 30 minutes storm, average 74.0 mm/h, Zone 1	10887.84	5886.83 (54.1	300.62 (55.2%	5586.21 (54.0%)
AR&R 20 year, 45 minutes storm, average 59.0 mm/h, Zone 1	13021.27	8148.76 (62.6	463.34 (71.2%	7685.42 (62.1%)
AR&R 20 year, 1 hour storm, average 50.0 mm/h, Zone 1	14713.3	9748.90 (66.3	586.10 (79.7%	9162.80 (65.6%)
AR&R 20 year, 1.5 hours storm, average 39.6 mm/h, Zone 1	17479.89	12212.79 (69.	768.42 (87.9%	11444.37 (68.9%)
AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1	19538.77	14055.00 (71.	897.98 (91.9%	13157.02 (70.9%)
AR&R 20 year, 3 hours storm, average 25.9 mm/h, Zone 1	22863.73	16774.12 (73.	1105.75 (96.7	15668.37 (72.1%)
AR&R 20 year, 4.5 hours storm, average 20.2 mm/h, Zone 1	26748.04	19889.88 (74.	1330.37 (99.5	18559.51 (73.0%)
AR&R 20 year, 6 hours storm, average 16.9 mm/h, Zone 1	29840.04	22204.04 (74.	1472.89 (98.7	20731.15 (73.1%)
AR&R 20 year, 9 hours storm, average 13.2 mm/h, Zone 1	34958.8	25540.72 (73.	1777.40 (101.	23763.32 (71.6%)
AR&R 20 year, 12 hours storm, average 11.0 mm/h, Zone 1	38841.64	28521.82 (73.	2007.88 (103.	26513.94 (71.9%)
AR&R 20 year, 18 hours storm, average 8.7 mm/h, Zone 1	46135.03	32222.64 (69.	2185.45 (94.7	30037.19 (68.5%)

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)			Due to Storm				

OVERFLOW ROUTE DETAILS									
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm	
F C	1.372	1.372	0	0.099	0.1	23.85	1.04	AR&R 20 year, 2 hours storm, average 20.2 mm/h, Zone 2	
F A	1.309	1.309	0	0.097	0.1	23.49	1.02	AR&R 20 year, 2 hours storm, average 20.2 mm/h, Zone 3	
F TOTAL EXISTING	4.13	4.13	0	0.6	1.55	8	2.58	AR&R 20 year, 2 hours storm, average 20.2 mm/h, Zone 4	
F B	1.692	1.692	0	0.108	0.12	25.64	1.1	AR&R 20 year, 4.5 hours storm, average 20.2 mm/h, Zone 1	
F AB	2.888	2.888	0	0.134	0.17	30.85	1.27	AR&R 20 year, 2 hours storm, average 20.2 mm/h, Zone 4	

DETENTION BASIN DETAILS					
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 20 year, 4.5 hours storm, average 20.2 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Chan (cu.m)	Difference %
C	5756.96	5756.96	0	0
A	5602.46	5602.46	0	0
N2	19887.63	19887.23	0	0
Outlet existing	19886.82	19886.82	0	0
B	8530.45	8530.45	0	0
N1	14132.61	14132.32	0	0

Run Log for AA005435 Existing run at 13:45:59 on 7/3/2014

The maximum flow exceeded the safe value in the following overflow routes: F C, F AB, F B, F A, F TOTAL EXISTING

PROJECT	TOWNSON ROAD PRECINCT		
TITLE	100 YEAR ARI RESULTS	JOB No	AA005435
		PREPARED VN	DATE 7/03/2014
		CHECKED SK	DATE 7/03/2014

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Existing
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Existing System

RESULTS 100 YEAR ARI

DRAINS results prepared 07 March, 2014 from Version 2014.02

PIT / NODE DETAILS				Version 8					
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint		
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)			
			(cu.m/s)	(cu.m)	(m)				

SUB-CATCHMENT DETAILS									
Name	Max	Due to Storm							
	Flow								
	(cu.m/s)								
C C	2.014	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1							
C A	1.933	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1							
C B	2.422	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1							

Outflow Volumes for Total Catchment (1.47 impervious + 28.0 pervious = 29.4 total ha)

Storm	Total Rainfall	Total Runoff	Impervious Ru	Pervious Runoff
	cu.m	cu.m (Runoff	cu.m (Runoff	cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 219 mm/h, Zone 1	5370.35	150.25 (2.8%)	150.25 (56.0%	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, average 167 mm/h, Zone 1	8190.4	2906.73 (35.5	206.06 (50.3%	2700.67 (34.7%)
AR&R 100 year, 15 minutes storm, average 139 mm/h, Zone 1	10225.74	5072.71 (49.6	297.53 (58.2%	4775.18 (49.2%)
AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1	11868.73	6853.03 (57.7	373.46 (62.9%	6479.56 (57.5%)
AR&R 100 year, 25 minutes storm, average 108 mm/h, Zone 1	13241.97	8157.01 (61.6	421.32 (63.6%	7735.69 (61.5%)
AR&R 100 year, 30 minutes storm, average 98.0 mm/h, Zone 1	14419.03	9267.97 (64.3	457.77 (63.5%	8810.20 (64.3%)
AR&R 100 year, 45 minutes storm, average 78.0 mm/h, Zone 1	17214.81	12251.09 (71.	659.72 (76.6%	11591.37 (70.9%)
AR&R 100 year, 1 hour storm, average 66.0 mm/h, Zone 1	19421.55	14360.89 (73.	809.85 (83.4%	13551.04 (73.4%)
AR&R 100 year, 1.5 hours storm, average 52.0 mm/h, Zone 1	22952.75	17595.50 (76.	1033.21 (90.0	16562.28 (76.0%)
AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1	25601.88	20056.40 (78.	1197.82 (93.6	18858.58 (77.5%)
AR&R 100 year, 3 hours storm, average 33.9 mm/h, Zone 1	29926.85	23748.35 (79.	1447.89 (96.8	22300.45 (78.4%)
AR&R 100 year, 4.5 hours storm, average 26.3 mm/h, Zone 1	34825.64	27871.30 (80.	1717.83 (98.7	26153.47 (79.1%)
AR&R 100 year, 6 hours storm, average 22.0 mm/h, Zone 1	38840.17	31042.63 (79.	1917.47 (98.7	29125.16 (78.9%)
AR&R 100 year, 9 hours storm, average 17.2 mm/h, Zone 1	45550.9	35815.37 (78.	2279.31 (100.	33536.05 (77.5%)
AR&R 100 year, 12 hours storm, average 14.4 mm/h, Zone 1	50849.16	39521.31 (77.	2577.23 (101.	36944.09 (76.5%)
AR&R 100 year, 18 hours storm, average 11.5 mm/h, Zone 1	60918.94	46100.16 (75.	2929.45 (96.2	43170.71 (74.6%)

PIPE DETAILS												
Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm							
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)								

CHANNEL DETAILS												
Name	Max Q	Max V			Due to Storm							
	(cu.m/s)	(m/s)										

OVERFLOW ROUTE DETAILS												
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm				
F C	2.014	2.014	0	0.116	0.13	27.26	1.15	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1				
F A	1.933	1.933	0	0.115	0.13	26.9	1.13	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1				
F TOTAL EXISTING	6.066	6.066	0	0.6	2.28	8	3.79	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1				
F B	2.422	2.422	0	0.125	0.15	29.06	1.2	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1				
F AB	4.337	4.337	0	0.159	0.22	35.7	1.41	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1				

DETENTION BASIN DETAILS												
Name	Max WL	MaxVol	Max Q	Max Q	Max Q							
			Total	Low Level	High Level							

CONTINUITY CHECK for AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1

Node	Inflow	Outflow	Storage Chan	Difference
	(cu.m)	(cu.m)	(cu.m)	%
C	5809.94	5809.94	0	0
A	5653.17	5653.17	0	0
N2	20047.98	20046.42	0	0
Outlet existing	20044.83	20044.83	0	0
B	8593.29	8593.29	0	0
N1	14245.37	14244.25	0	0

Run Log for AA005435 Existing run at 13:47:58 on 7/3/2014

The maximum flow exceeded the safe value in the following overflow routes: F TOTAL EXISTING

C_01	6623.46	6623.46	0	0

Run Log for AA005435_Exg2y_05 run at 10:06:28 on 12/12/2012

The maximum flow exceeded the safe value in the following overflow routes: OF_Cf_01, OF_F_01

Calculation Sheet

Job	Townson Road	Design	Vincent Ng	Office	Sydney
		Date	Mar-14	Job No	AA005435
		Checked			
		Date			

TOWNSON ROAD

PRECINCT

URBAN DRAINAGE

DEVELOPED SYSTEM

DRAINS OUTPUT

March 2014

PROJECT	TOWNSON ROAD PRECINCT					
		JOB No		AA005435		
TITLE	DRAINS DATA	PREPARED	VN	DATE	12/12/2012	DATA
		CHECKED	SK	DATE	7/07/2014	

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Design (lumped catchments)
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Developed System

PIT / NODE DETAILS			Version 12													
Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down	id	Part Full	Inflow
				Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		Shock Loss	Hydrograph
				(cu.m)	Coeff. Ku			(cu.m/s)							
B2	Sag	Infinite_Inlet	Infinite_Inlet	10	0	30.9	0.2	0	0	300694.2	6266997.9	No	8213	1 x Ku	No
B3	OnGrade	Gross Pollutant Tr	GPT		2.5	30.9		0	0	300667.2	6266989.5	No	8212	1 x Ku	No
A2	Sag	Infinite_Inlet	Infinite_Inlet	10	0	31.7	0.2	0	0	300779.7	6266719.5	No	2373631	1 x Ku	No
A3	OnGrade	Gross Pollutant Tr	GPT		2.5	31.7		0	0	300743	6266712.5	No	2373622	1 x Ku	No
B1	Node					12		0		301023	6266915.9		2373672		
A1	Node					50		0		301061.1	6266776.1		6814435		
Outlet	Node					25		0		300418.2	6267155.7		8183556		
F_01	Node					25		0		300486.3	6267096.6		8290112		
A4 Control Pit MB0	OnGrade	Infinite_Inlet	Infinite_Inlet		4	29.7		0	0	300642.1	6266723.7	No	8679710	1 x Ku	No
A5	OnGrade	Junction Pits	Junction Pit 1200x1200		2	30.5		0	0	300636	6266783.6	No	31944511	1 x Ku	No
A6	Node					29..5		0		300615.6	6266792.4		3446941		
B4 Control pit MB0	OnGrade	Infinite_Inlet	Infinite_Inlet		4	28.75		0	0	300580.2	6267081.6	No	8679728	1 x Ku	No
B5	Node					28		0		300533	6267102.1		8272		

DETENTION BASIN DETAILS															
Name	Elev	Volume	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
MB03	28.4	1	0	None						300628.2	6267055.9	No			31839322
	28.5	2													
	28.6	3													
	28.7	34.17													
	28.8	312.244													
	28.9	654.665													
	29	1031.66													
	29.1	1426.51													
	29.2	1830.66													
	29.3	2243.95													
	29.4	2666.56													
	29.5	3098.54													
	29.6	3540.11													
	29.7	3991.42													
	29.8	4452.6													
	29.9	4923.77													
	30	5405.07													
	30.1	5896.63													
	30.2	6398.59													
	30.3	6911.09													
	30.4	7434.27													
	30.5	7968.28													
MB01	29.3	0	0	None						300671.7	6266705.7	No			31839320
	29.4	1													
	29.5	2													
	29.6	259.046													
	29.7	622.703													
	29.8	1047.52													
	29.9	1532.31													
	30	2079.9													

	30.1	2664.93													
	30.2	3273.87													
	30.3	3899.59													
	30.4	4539.3													
	30.5	5192.89													
	30.6	5860.39													
	30.7	6541.83													
	30.8	7237.27													
	30.9	7946.75													
	31	8670.31													
SUB-CATCHMENT DETAILS															
Name	Pit or	Total	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved
	Node	Area	Area	Area	Area	Time	Time	Time	Length	Length	Length	Slope(%)	Slope	Slope	Rough
		(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%	%	%	
C B2	B2	13.1429	85	15	0	9	11	5							
C A2	A2	11.7071	85	15	0	9	11	0							
C B1	B1	0.5701	85	15	0	6	8	0							
C A1	A1	1.7539	85	15	0	7	9	0							
PIPE DETAILS															
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)
P B2	B2	B3	20	28.99	28.85	0.7	RCP Class 2	1200	1200	0.6	New	2	B2	0	
P B3	B3	MB03	10	28.85	28.8	0.5	RCP Class 2	1350	1370	0.6	NewFixed	2	B3	0	
P A2	A2	A3	10	30.02	29.95	0.7	RCP Class 2	1200	1200	0.6	New	2	A2	0	
P A3	A3	MB01	10	29.95	29.9	0.5	RCP Class 2	1350	1370	0.6	NewFixed	2	A3	0	
P A4	A4 Control Pit MB	A5	75	28.025	27.65	0.5	RCP Class 2	1200	1200	0.6	New	2	A4 Control F	0	
P A5	A5	A6	5	27.625	27.6	0.5	RCP Class 2	1200	1200	0.6	New	2	A5	0	
P B4	B4 Control pit MB	B5	40	27.2	27	0.5	RCP Class 2	1050	1070	0.6	NewFixed	2	B4 Control p	0	
DETAILS of SERVICES CROSSING PIPES															
Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc					
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc					
CHANNEL DETAILS															
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Width	L.B. Slope	R.B. Slope	Manning	Depth	Roofed		
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)			
OVERFLOW ROUTE DETAILS															
Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area		id	U/S IL
			Time	Level	Length	Coeff. C	Section	Major Storm	Minor Storm	DxV	Slope	Contributing			
			(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%			
F B2	B2	MB03	0.1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		421204	
F B3	B3	MB03	0.1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		1024603	
WEIR MB03	MB03	B5	0.1	30	50	1.7	Dummy used to model flow across ro	0.3	0.3	0.6	1	0		31839255	
F Control Pit MB03	MB03	B4 Control pit MB	0.1	28.75			Dummy used to model flow across ro	0.2	0.05	0.6	1	0		8274	
F A2	A2	MB01	0.1				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		31839209	
F A3	A3	MB01	0.1				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		31839210	
Weir MB01	MB01	A6	0.1	30.55	45	1.7	Dummy used to model flow across ro	0.3	0.3	0.6	1	0		31839205	
F Control Pit MB01	MB01	A4 Control Pit MB	0.1	29.7			Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		2373694	
F B1	B1	B2	4				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		5164208	
F A1	A1	A2	4				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		6814441	
F Total site	F_01	Outlet	0.1				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		8183559	
F A4	A4 Control Pit MB	A6	0.1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		2373696	
F MB01 outlet	A6	F_01	5				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	0		8077033	
F B4	B4 Control pit MB	B5	0.1				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		31924796	
F MB03 outlet	B5	F_01	0.1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		8290108	

PIPE DETAILS															
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)
P_P1_U	P1_U	P1_D	20	31.8	31.6	1	RCP Class 2	1500	1524	0.012	New	8	P1_U	0	
P_P1_D	P1_D	MB03	10	31.6	31.4	2	Box Culverts	1.2W x 1.2H		0.012	Existing	5	P1_D	0	
P_MB03	MB03	CF_01	100	29.25	25	4.25	RCP Class 2	750	750	0.012	NewFixed	2	MB03	0	
P_P2_U	P2_U	P2_D	20	31.45	31.25	1	RCP Class 2	1500	1524	0.012	New	5	P2_U	0	
P_P2_D	P2_D	MB01	10	30.01	30	0.1	Box Culverts	1.2W x 1.2H		0.012	Existing	5	P2_D	0	
DETAILS of SERVICES CROSSING PIPES															
Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of S	Chg	Bottom	Height of S	etc					
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc					
CHANNEL DETAILS															
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Width	L.B. Slope	R.B. Slope	Manning	Depth	Roofed		
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)			
OVERFLOW ROUTE DETAILS															
Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area		id	U/S IL
			Time	Level	Length	Coeff. C	Section	Major Storn	Minor Storn	DxV	Slope	Contributing			
			(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%			
OF_P1_U	P1_U	P1_D	1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		421204	
OF_P1_D	P1_D	MB03	1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		1024603	
OF_MB03	MB03	CF_01	1	29.25			Dummy used to model flow across ro	0.2	0.05	0.6	1	0		8274	
OF_Cf_01	CF_01	F_01	0.1				Dummy used to model flow across ro	0.3	0.3	0.6	1	0		8290108	
OF_A_01	A_01	P1_U	3.5				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		8233	
OF_P2_U	P2_U	P2_D	1				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		2373690	
OF_P2_D	P2_D	MB01	1				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		2373694	
OF_MB01	MB01	Cf_02	3	29.35			Dummy used to model flow across ro	0.2	0.05	0.6	1	0		2373696	
OF_A_02	A_02	P1_U	3.5				Dummy used to model flow across ro	0.2	0.05	0.6	1	0		5164208	
OF_D_01	D_01	P2_U	3				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		2373686	
OF_cf_02	Cf_02	F_01	2.5				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	0		8077033	
OF_E_01	E_01	P2_U	3.5				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		6814441	
OF_F_01	F_01	Outlet	0.1				Grassed swale with 1:4 sideslopes	0.5	0.4	1	1	50		8183559	

PROJECT	TOWNSON ROAD PRECINCT		
TITLE	100 YEAR ARI RESULTS	JOB No	AA005435
		PREPARED VN	DATE 12/12/2012
		CHECKED SK	DATE 7/07/2014

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Design (lumped catchments)
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Developed System

RESULTS 100 YEAR ARI

DRAINS results prepared 07 March, 2014 from Version 2014.02

PIT / NODE DETAILS

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
B2	30.62	31.01	6.364	3.2	0.28	0	Inlet Capacity
B3	30.44		0		0.46	0	None
A2	31.45	31.81	6.245	3.1	0.25	0	Inlet Capacity
A3	31.4		0		0.3	0	None
A4 Control Pit MB01	29.18		2.052		0.52	0	None
A5	28.97		0		1.53		None
A6	28.88		0				
B4 Control pit MB03	28.2		2.505		0.55	0	None
B5	27.46		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 Storm
C B2	6.109	5.34	0.821	9	11	5	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
C A2	5.442	4.757	0.732	9	11	0	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
C B1	0.287	0.251	0.037	6	8	0	AR&R 100 year, 15 minutes storm, average 139 mm/h, Zone 1
C A1	0.848	0.744	0.116	7	9	0	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1

Outflow Volumes for Total Catchment (23.1 impervious + 4.08 pervious = 27.2 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, 5 minutes storm, average 219 mm/h, Zone 1	4959.25	4429.99 (89.3%)	3984.39 (94.5%)	445.59 (59.9%)
AR&R 100 year, 10 minutes storm, average 167 mm/h, Zone 1	7563.43	6993.65 (92.5%)	6197.94 (96.4%)	795.72 (70.1%)
AR&R 100 year, 15 minutes storm, average 139 mm/h, Zone 1	9442.96	8837.23 (93.6%)	7795.54 (97.1%)	1041.69 (73.5%)
AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1	10960.18	10321.90 (94.2%)	9085.17 (97.5%)	1236.73 (75.2%)
AR&R 100 year, 25 minutes storm, average 108 mm/h, Zone 1	12228.3	11555.40 (94.5%)	10163.08 (97.8%)	1392.33 (75.9%)
AR&R 100 year, 30 minutes storm, average 98.0 mm/h, Zone 1	13315.26	12611.51 (94.7%)	11086.99 (98.0%)	1524.52 (76.3%)
AR&R 100 year, 45 minutes storm, average 78.0 mm/h, Zone 1	15897.02	15111.05 (95.1%)	13281.49 (98.3%)	1829.56 (76.7%)
AR&R 100 year, 1 hour storm, average 66.0 mm/h, Zone 1	17934.84	17075.80 (95.2%)	15013.65 (98.5%)	2062.15 (76.7%)
AR&R 100 year, 1.5 hours storm, average 52.0 mm/h, Zone 1	21195.72	20201.30 (95.3%)	17785.39 (98.7%)	2415.91 (76.0%)
AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1	23642.06	22519.08 (95.3%)	19864.78 (98.9%)	2654.30 (74.8%)
AR&R 100 year, 3 hours storm, average 33.9 mm/h, Zone 1	27635.96	26273.39 (95.1%)	23259.38 (99.0%)	3014.01 (72.7%)
AR&R 100 year, 4.5 hours storm, average 26.3 mm/h, Zone 1	32159.75	30458.23 (94.7%)	27104.15 (99.2%)	3354.08 (69.5%)
AR&R 100 year, 6 hours storm, average 22.0 mm/h, Zone 1	35866.96	33806.18 (94.3%)	30254.58 (99.2%)	3551.60 (66.0%)
AR&R 100 year, 9 hours storm, average 17.2 mm/h, Zone 1	42063.99	39367.97 (93.6%)	35522.61 (99.4%)	3845.36 (60.9%)
AR&R 100 year, 12 hours storm, average 14.4 mm/h, Zone 1	46956.67	43806.65 (93.3%)	39680.90 (99.4%)	4125.75 (58.6%)
AR&R 100 year, 18 hours storm, average 11.5 mm/h, Zone 1	56255.61	51914.65 (92.3%)	47589.54 (99.5%)	4325.12 (51.3%)

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
P B2	6.381	2.82	30.559	30.44	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
P B3	6.391	2.51	30.02	29.905	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
P A2	6.211	2.75	31.45	31.396	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
P A3	6.223	3.13	30.825	30.774	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
P A4	2.053	1.03	29.008	28.967	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1
P A5	2.053	0.91	28.883	28.88	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1
P B4	2.505	2.57	27.776	27.571	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1

CHANNEL DETAILS

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

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
F B2	0	0	0	0	0	0	0	
F B3	0	0	0	0	0	0	0	
WEIR MB03	0	0	0	0	0	0	0	
F Control Pit MB03	2.505	2.505	0	0.127	0.15	29.41	1.21	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1
F A2	0	0	0	0	0	0	0	
F A3	0	0	0	0	0	0	0	
Weir MB01	0	0	0	0	0	0	0	
F Control Pit MB01	2.052	2.052	0	0.533	0.95	5.34	1.78	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1
F B1	0.287	0.287	0	0.053	0.04	14.51	0.67	AR&R 100 year, 15 minutes storm, average 139 mm/h, Zone 1
F A1	0.848	3.49	0	0.6	1.31	8	2.18	AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1
F Total site	4.516	4.516	0	0.6	1.69	8	2.82	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1
F A4	0	0	0	0	0	0	0	
F MB01 outlet	2.053	2.053	0	0.533	0.95	5.34	1.78	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1
F B4	0	0	0	0	0	0	0	
F MB03 outlet	2.505	2.505	0	0.127	0.15	29.41	1.21	AR&R 100 year, 2 hours storm, average 43.5 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
MB03	29.9	4946.4	2.505	0	2.505
MB01	30.49	5136	2.052	0	2.052

CONTINUITY CHECK for AR&R 100 year, 20 minutes storm, average 121 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
B2	5208.72	5209.32	0	0
B3	5209.32	5191.86	0	0.3
MB03	5191.86	3380.62	1812.1	0
A2	5113.18	5115.86	0	-0.1
A3	5115.86	5114.28	0	0
MB01	5114.28	3253.79	1861.19	0
B1	216.71	216.71	0	0
A1	666.52	666.52	0	0
Outlet	6548.69	6548.69	0	0
F_01	6554.97	6551.84	0	0
A4 Control Pit MB01	3252.38	3252.15	0	0
A5	3252.15	3252.35	0	0
A6	3252.35	3250.97	0	0
B4 Control pit MB03	3378.9	3378.1	0	0
B5	3378.1	3376.37	0	0.1

Run Log for AA005435 Design (lumped catchments) (no existing) run at 14:06:41 on 7/3/2014

PROJECT	TOWNSON ROAD PRECINCT		
TITLE	2 YEAR ARI RESULTS	JOB No	AA005435
		PREPARED VN	DATE 12/12/2012
		CHECKED SK	DATE 7/07/2014

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Design (lumped catchments)
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Developed System

RESULTS
5 YEAR ARI

DRAINS results prepared 07 March, 2014 from Version 2014.02

PIT / NODE DETAILS

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
B2	29.7	30.96	2.72	1.5	1.2	0	Inlet Capacity
B3	29.66		0		1.24	0	None
A2	30.77	31.76	2.678	1.5	0.93	0	Inlet Capacity
A3	30.75		0		0.95	0	None
A4 Control Pit MB01	28.36		0.405		1.34	0	None
A5	27.92		0		2.58		None
A6	27.81		0				
B4 Control pit MB03	27.51		0.333		1.24	0	None
B5	27.2		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 Storm
C B2	2.597	2.556	0.04	9	11	5	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
C A2	2.313	2.277	0.036	9	11	0	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
C B1	0.123	0.121	0.002	6	8	0	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
C A1	0.365	0.359	0.007	7	9	0	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1

Outflow Volumes for Total Catchment (23.1 impervious + 4.08 pervious = 27.2 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 2 year, 5 minutes storm, average 97 mm/h, Zone 1	2196.56	1636.10 (74.5%)	1636.10 (87.6%)	0.00 (0.0%)
AR&R 2 year, 10 minutes storm, average 74 mm/h, Zone 1	3351.46	2617.76 (78.1%)	2617.76 (91.9%)	0.00 (0.0%)
AR&R 2 year, 15 minutes storm, average 62 mm/h, Zone 1	4211.97	3349.20 (79.5%)	3349.20 (93.5%)	0.00 (0.0%)
AR&R 2 year, 20 minutes storm, average 54 mm/h, Zone 1	4891.32	3937.21 (80.5%)	3926.64 (94.4%)	10.57 (1.4%)
AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1	5468.77	4436.75 (81.1%)	4417.47 (95.0%)	19.28 (2.4%)
AR&R 2 year, 30 minutes storm, average 43.9 mm/h, Zone 1	5964.47	4843.39 (81.2%)	4838.81 (95.4%)	4.58 (0.5%)
AR&R 2 year, 45 minutes storm, average 35.1 mm/h, Zone 1	7153.33	5852.63 (81.8%)	5849.35 (96.2%)	3.28 (0.3%)
AR&R 2 year, 1 hour storm, average 29.8 mm/h, Zone 1	8097.85	6699.22 (82.7%)	6652.19 (96.6%)	47.03 (3.9%)
AR&R 2 year, 1.5 hours storm, average 23.4 mm/h, Zone 1	9538.3	7934.91 (83.2%)	7876.57 (97.2%)	58.34 (4.1%)
AR&R 2 year, 2 hours storm, average 19.7 mm/h, Zone 1	10707.01	8967.67 (83.8%)	8869.97 (97.5%)	97.70 (6.1%)
AR&R 2 year, 3 hours storm, average 15.4 mm/h, Zone 1	12553.71	10526.30 (83.9%)	10439.65 (97.8%)	86.66 (4.6%)
AR&R 2 year, 4.5 hours storm, average 12 mm/h, Zone 1	14674.64	12416.04 (84.6%)	12242.47 (98.1%)	173.57 (7.9%)
AR&R 2 year, 6 hours storm, average 10.1 mm/h, Zone 1	16467.44	13992.97 (85.0%)	13766.04 (98.3%)	226.93 (9.2%)
AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1	19224.24	16651.99 (86.6%)	16109.44 (98.6%)	542.55 (18.8%)
AR&R 2 year, 12 hours storm, average 6.6 mm/h, Zone 1	21523.17	18780.47 (87.3%)	18063.26 (98.7%)	717.22 (22.2%)
AR&R 2 year, 18 hours storm, average 5.04 mm/h, Zone 1	24652.25	21191.20 (86.0%)	20723.45 (98.9%)	467.76 (12.6%)

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
P B2	2.692	1.92	29.704	29.664	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
P B3	2.697	2.19	29.447	29.433	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
P A2	2.587	1.75	30.766	30.748	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
P A3	2.602	2.51	30.473	30.427	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
P A4	0.406	1.5	28.237	27.916	AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1
P A5	0.406	1.49	27.844	27.814	AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1
P B4	0.333	1.45	27.398	27.198	AR&R 2 year, 2 hours storm, average 19.7 mm/h, Zone 1

CHANNEL DETAILS

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

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
F B2	0	0	0	0	0	0	0	
F B3	0	0	0	0	0	0	0	
WEIR MB03	0	0	0	0	0	0	0	
F Control Pit MB03	0.333	0.333	0	0.055	0.04	15.05	0.71	AR&R 2 year, 2 hours storm, average 19.7 mm/h, Zone 1
F A2	0	0	0	0	0	0	0	
F A3	0	0	0	0	0	0	0	
Weir MB01	0	0	0	0	0	0	0	
F Control Pit MB01	0.405	0.405	0	0.278	0.36	2.22	1.31	AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1
F B1	0.123	0.123	0	0.037	0.02	11.45	0.54	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
F A1	0.365	1.442	0	0.447	0.81	3.57	1.81	AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1
F Total site	0.737	0.737	0	0.348	0.53	2.78	1.52	AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1
F A4	0	0	0	0	0	0	0	
F MB01 outlet	0.406	0.406	0	0.278	0.36	2.22	1.31	AR&R 2 year, 9 hours storm, average 7.86 mm/h, Zone 1
F B4	0	0	0	0	0	0	0	
F MB03 outlet	0.333	0.333	0	0.055	0.04	15.05	0.71	AR&R 2 year, 2 hours storm, average 19.7 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
MB03	29.43	2807.7	0.333	0	0.333
MB01	30.14	2897	0.405	0	0.405

CONTINUITY CHECK for AR&R 2 year, 25 minutes storm, average 48.3 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
B2	2238.89	2241.27	0	-0.1
B3	2241.27	2239.12	0	0.1
MB03	2239.12	1580.78	659	0
A2	2197.87	2198.97	0	0
A3	2198.97	2200.51	0	-0.1
MB01	2200.51	1251.33	949.65	0
B1	93.22	93.22	0	0
A1	286.61	286.61	0	0
Outlet	2746.36	2746.36	0	0
F_01	2751.23	2748.8	0	0.1
A4 Control Pit MB01	1250.41	1242.67	0	0.6
A5	1242.67	1234.55	0	0.7
A6	1234.55	1233.56	0	0.1
B4 Control pit MB03	1579.47	1573.58	0	0.4
B5	1573.58	1572.27	0	0.1

Run Log for AA005435 Design (lumped catchments) (no existing) run at 13:59:12 on 7/3/2014

PROJECT	TOWNSON ROAD PRECINCT		
TITLE	20 YEAR ARI RESULTS	JOB No	AA005435
		PREPARED VN	DATE 12/12/2012
		CHECKED SK	DATE 7/07/2014

DRAINS File Path:	F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Design (lumped catchments)
DRAINS Version:	DRAINS Version 2014.02 - 24 Feb 2014
Modeller's Name:	Vincent Ng
Description:	Townson Road Precinct, Developed System

RESULTS 20 YEAR ARI

DRAINS results prepared 07 March, 2014 from Version 2014.02

PIT / NODE DETAILS

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
B2	30.11	31	5.073	2.6	0.79	0	Inlet Capacity
B3	30.05		0		0.85	0	None
A2	31.14	31.79	5.002	2.5	0.56	0	Inlet Capacity
A3	31.11		0		0.59	0	None
A4 Control Pit MB01	28.81		1.837		0.89	0	None
A5	28.28		0		2.22		None
A6	28.06		0				
B4 Control pit MB03	28.05		1.986		0.7	0	None
B5	27.5		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 Storm
C B2	4.84	4.34	0.516	9	11	5	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
C A2	4.311	3.866	0.46	9	11	0	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
C B1	0.233	0.205	0.028	6	8	0	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
C A1	0.69	0.609	0.082	7	9	0	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1

Outflow Volumes for Total Catchment (23.1 impervious + 4.08 pervious = 27.2 total ha)

Storm	Total Rainfall (cu.m)	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 20 year, 5 minutes storm, average 166 mm/h, Zone 1	3759.07	3133.69 (83.4%)	2964.23 (92.8%)	169.46 (30.1%)
AR&R 20 year, 10 minutes storm, average 127 mm/h, Zone 1	5751.83	5047.43 (87.8%)	4658.08 (95.3%)	389.35 (45.1%)
AR&R 20 year, 15 minutes storm, average 106 mm/h, Zone 1	7201.11	6434.42 (89.4%)	5889.96 (96.2%)	544.45 (50.4%)
AR&R 20 year, 20 minutes storm, average 92.0 mm/h, Zone 1	8333.36	7516.29 (90.2%)	6852.38 (96.7%)	663.91 (53.1%)
AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1	9284.45	8404.42 (90.5%)	7660.80 (97.1%)	743.62 (53.4%)
AR&R 20 year, 30 minutes storm, average 74.0 mm/h, Zone 1	10054.38	9116.86 (90.7%)	8315.24 (97.3%)	801.61 (53.2%)
AR&R 20 year, 45 minutes storm, average 59.0 mm/h, Zone 1	12024.5	10961.27 (91.2%)	9989.82 (97.7%)	971.45 (53.9%)
AR&R 20 year, 1 hour storm, average 50.0 mm/h, Zone 1	13587	12422.20 (91.4%)	11317.96 (98.0%)	1104.24 (54.2%)
AR&R 20 year, 1.5 hours storm, average 39.6 mm/h, Zone 1	16141.81	14804.78 (91.7%)	13489.60 (98.3%)	1315.18 (54.3%)
AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1	18043.08	16565.75 (91.8%)	15105.64 (98.5%)	1460.12 (53.9%)
AR&R 20 year, 3 hours storm, average 25.9 mm/h, Zone 1	21113.52	19421.30 (92.0%)	17715.20 (98.7%)	1706.10 (53.9%)
AR&R 20 year, 4.5 hours storm, average 20.2 mm/h, Zone 1	24700.49	22682.36 (91.8%)	20764.22 (98.9%)	1918.14 (51.8%)
AR&R 20 year, 6 hours storm, average 16.9 mm/h, Zone 1	27555.79	25282.32 (91.7%)	23190.89 (99.0%)	2091.43 (50.6%)
AR&R 20 year, 9 hours storm, average 13.2 mm/h, Zone 1	32282.71	29442.09 (91.2%)	27209.35 (99.2%)	2232.73 (46.1%)
AR&R 20 year, 12 hours storm, average 11.0 mm/h, Zone 1	35868.32	32773.69 (91.4%)	30256.43 (99.2%)	2517.26 (46.8%)
AR&R 20 year, 18 hours storm, average 8.7 mm/h, Zone 1	42603.4	38584.46 (90.6%)	35981.54 (99.4%)	2602.92 (40.7%)

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
P B2	5.01	2.28	30.112	30.048	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
P B3	5.029	2.57	29.713	29.71	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
P A2	4.819	2.19	31.145	31.115	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
P A3	4.833	2.96	30.694	30.643	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
P A4	1.838	2.17	28.506	28.281	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1
P A5	1.838	2.44	28.065	28.062	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1
P B4	1.987	2.39	27.703	27.502	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1

CHANNEL DETAILS

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

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
F B2	0	0	0	0	0	0	0	
F B3	0	0	0	0	0	0	0	
WEIR MB03	0	0	0	0	0	0	0	
F Control Pit MB03	1.986	1.986	0	0.115	0.13	27.08	1.15	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1
F A2	0	0	0	0	0	0	0	
F A3	0	0	0	0	0	0	0	
Weir MB01	0	0	0	0	0	0	0	
F Control Pit MB01	1.837	1.837	0	0.489	0.94	3.92	1.92	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1
F B1	0.233	0.233	0	0.048	0.03	13.61	0.64	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
F A1	0.69	2.685	0	0.598	1.01	7.94	1.69	AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1
F Total site	3.756	3.756	0	0.6	1.41	8	2.35	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1
F A4	0	0	0	0	0	0	0	
F MB01 outlet	1.838	1.838	0	0.489	0.94	3.92	1.92	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1
F B4	0	0	0	0	0	0	0	
F MB03 outlet	1.987	1.987	0	0.115	0.13	27.08	1.15	AR&R 20 year, 2 hours storm, average 33.2 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
MB03	29.71	4039.6	1.986	0	1.986
MB01	30.32	4053.6	1.837	0	1.837

CONTINUITY CHECK for AR&R 20 year, 25 minutes storm, average 82.0 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
B2	4241.1	4240.26	0	0
B3	4240.26	4223.49	0	0.4
MB03	4223.49	2439.4	1784.95	0
A2	4163.33	4164.7	0	0
A3	4164.7	4162.83	0	0
MB01	4162.83	2339.52	1824	0
B1	176.46	176.46	0	0
A1	542.72	542.72	0	0
Outlet	4670.57	4670.57	0	0
F_01	4676.85	4673.71	0	0.1
A4 Control Pit MB01	2338.13	2329.62	0	0.4
A5	2329.62	2320.96	0	0.4
A6	2320.96	2319.57	0	0.1
B4 Control pit MB03	2437.69	2431.07	0	0.3
B5	2431.07	2429.35	0	0.1

Run Log for AA005435 Design (lumped catchments) (no existing) run at 14:04:09 on 7/3/2014

PROJECT TOWNSON ROAD PRECINCT
PAGE No
JOB No AA005435
TITLE MB01
PREPARED GD DATE 07/07/143
CHECKED DATE

DRAINS Models (existing and proposed):
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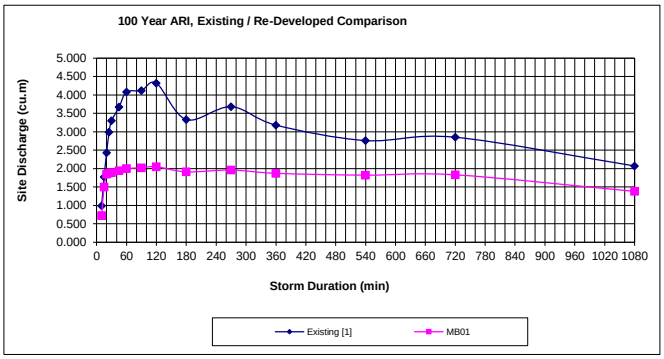
\\HC-AUS-NS-FS-01\jobs\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Design (lumped catchments).drn

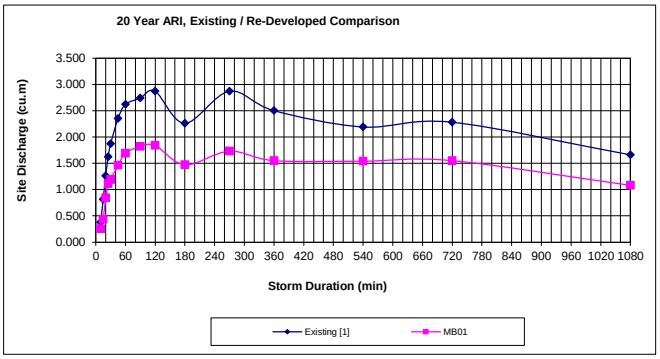
DRAINS Version: 2012.14 - 23 November 2012

Existing DRAINS Ref:
Re-Developed DRAINS Ref:

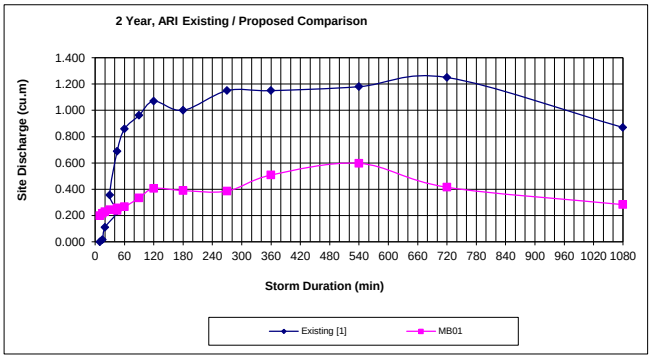
	100yr ARI Total		
Storm Dur. (min)	Existing [1]	MB01	[2] - [1]
10	0.987	0.725	-0.262
15	1.770	1.500	-0.270
20	2.430	1.850	-0.580
25	2.990	1.880	-1.110
30	3.300	1.890	-1.410
45	3.670	1.940	-1.730
60	4.080	2.000	-2.080
90	4.120	2.020	-2.100
120	4.320	2.050	-2.270
180	3.330	1.910	-1.420
270	3.680	1.960	-1.720
360	3.180	1.870	-1.310
540	2.760	1.820	-0.940
720	2.850	1.830	-1.020
1080	2.070	1.380	-0.690
Max	4.320	2.050	



	20yr ARI Total		
Storm Dur. (min)	Existing [1]	MB01	[2] - [1]
10	0.377	0.254	-0.123
15	0.814	0.436	-0.378
20	1.260	0.843	-0.417
25	1.620	1.110	-0.510
30	1.870	1.190	-0.680
45	2.350	1.460	-0.890
60	2.620	1.690	-0.930
90	2.740	1.820	-0.920
120	***2.870***	1.840	-1.030
180	2.260	1.470	-0.790
270	***2.870***	1.730	-1.140
360	2.500	1.550	-0.950
540	2.190	1.540	-0.650
720	2.280	1.550	-0.730
1080	1.660	1.080	-0.580
Max	2.870	1.840	



	2yr ARI Total		
Storm Dur. (min)	Existing [1]	MB01	[2] - [1]
10	0.000	0.199	**0.199**
15	0.016	0.217	**0.201**
20	0.110	0.229	**0.119**
45	0.234	0.238	**0.004**
30	0.356	0.244	-0.112
45	0.688	0.257	-0.431
60	0.858	0.267	-0.591
90	0.962	0.334	-0.628
120	1.070	0.406	-0.664
180	1.000	0.390	-0.610
270	1.150	0.386	-0.764
360	1.150	0.508	-0.642
540	1.180	0.597	-0.583
720	1.250	0.415	-0.835
1080	0.870	0.283	-0.587
Max	1.250	0.597	



PROJECT TOWNSON ROAD PRECINCT
PAGE No
JOB No AA005435
TITLE MB03
PREPARED GD DATE 07/07/143
CHECKED DATE

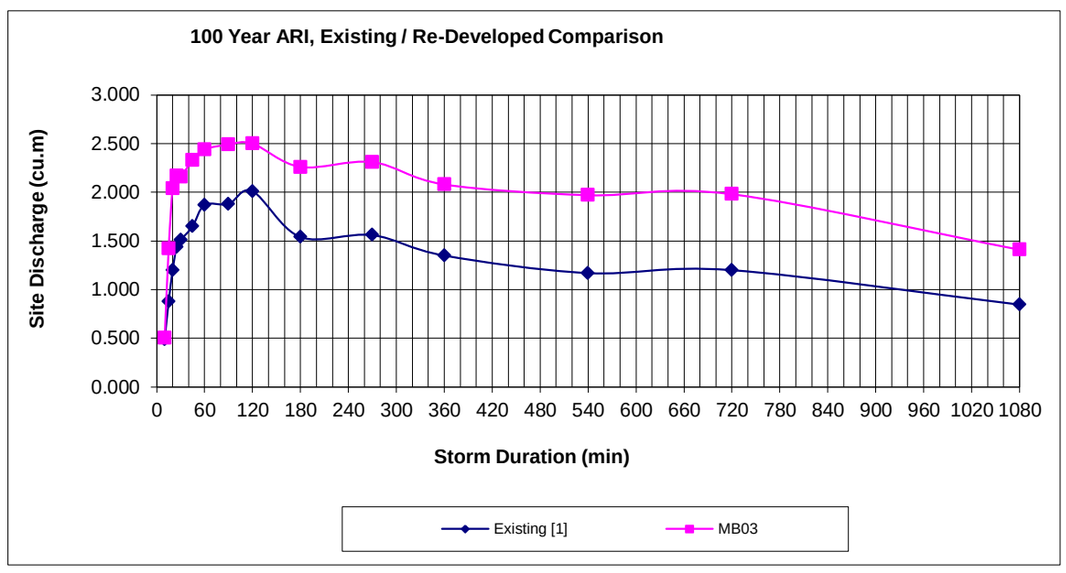
DRAINS Models (existing and proposed): \\HC-AUS-NS-FS-01\jobs\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Existing.drn

\\HC-AUS-NS-FS-01\jobs\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\AA005435 Design (lumped catchments).drn

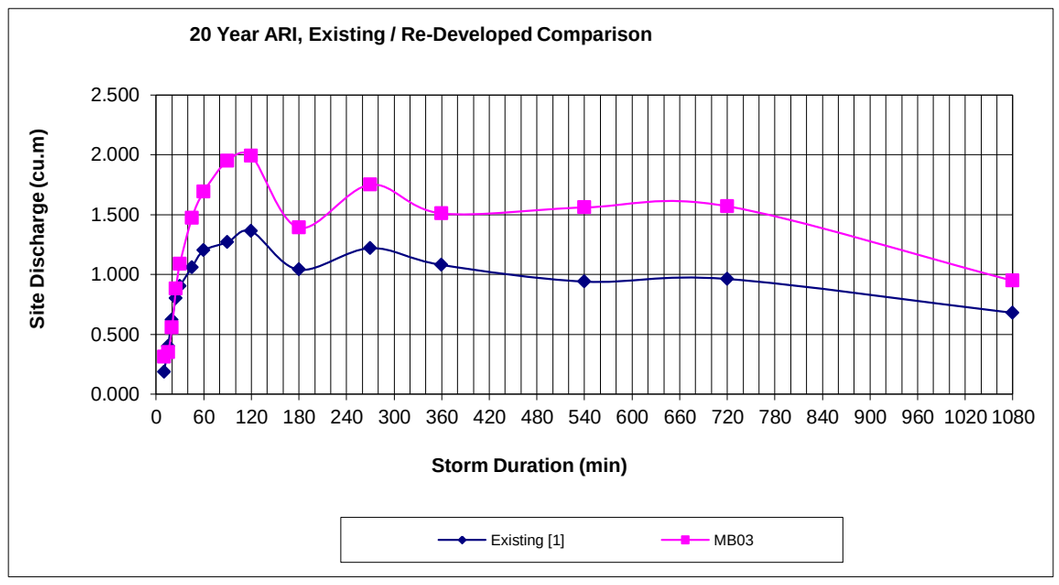
DRAINS Version: 2012.14 - 23 November 2012

Existing DRAINS Ref:
Re-Developed DRAINS Ref:

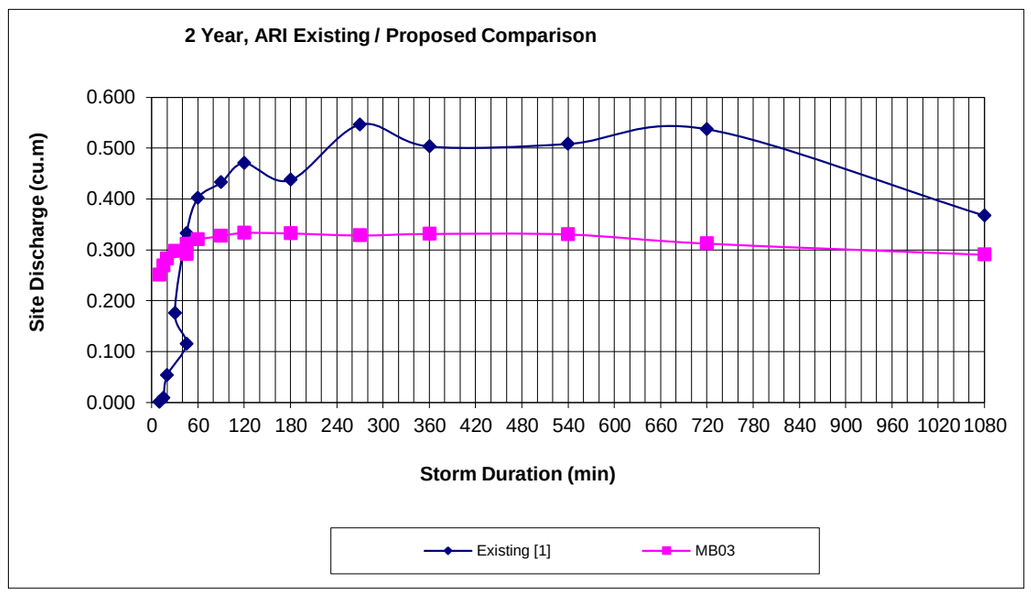
	100yr ARI Total		
Storm Dur. (min)	Existing [1]	MB03	[2] - [1]
10	0.487	0.502	**0.015**
15	0.875	1.420	**0.545**
20	1.200	2.040	**0.840**
25	1.440	2.170	**0.730**
30	1.510	2.160	**0.650**
45	1.650	2.330	**0.680**
60	1.870	2.440	**0.570**
90	1.880	2.490	**0.610**
120	2.010	2.500	**0.490**
180	1.540	2.260	**0.720**
270	1.560	2.310	**0.750**
360	1.350	2.080	**0.730**
540	1.170	1.970	**0.800**
720	1.200	1.980	**0.780**
1080	0.846	1.410	**0.564**
Max	2.010	2.500	



	20yr ARI Total		
Storm Dur. (min)	Existing [1]	MB03	[2] - [1]
10	0.186	0.311	**0.125**
15	0.402	0.350	-0.052
20	0.622	0.557	-0.065
25	0.803	0.882	**0.079**
30	0.901	1.090	**0.189**
45	1.060	1.470	**0.410**
60	1.200	1.690	**0.490**
90	1.270	1.950	**0.680**
120	***1.360***	1.990	**0.630**
180	1.040	1.390	**0.350**
270	***1.220***	1.750	**0.530**
360	1.080	1.510	**0.430**
540	0.941	1.560	**0.619**
720	0.963	1.570	**0.607**
1080	0.680	0.948	**0.268**
Max	1.220	1.750	



	2yr ARI Total		
Storm Dur. (min)	Existing [1]	MB03	[2] - [1]
10	0.000	0.251	**0.251**
15	0.008	0.269	**0.261**
20	0.053	0.282	**0.229**
45	0.115	0.291	**0.176**
30	0.175	0.297	**0.122**
45	0.332	0.311	-0.021
60	0.402	0.320	-0.082
90	0.432	0.327	-0.105
120	0.470	0.333	-0.137
180	0.437	0.332	-0.105
270	0.546	0.328	-0.218
360	0.503	0.331	-0.172
540	0.508	0.330	-0.178
720	0.537	0.312	-0.225
1080	0.367	0.290	-0.077
Max	0.546	0.333	



PROJECT TOWNSON ROAD PRECINCT
TITLE Combined Site Runoff

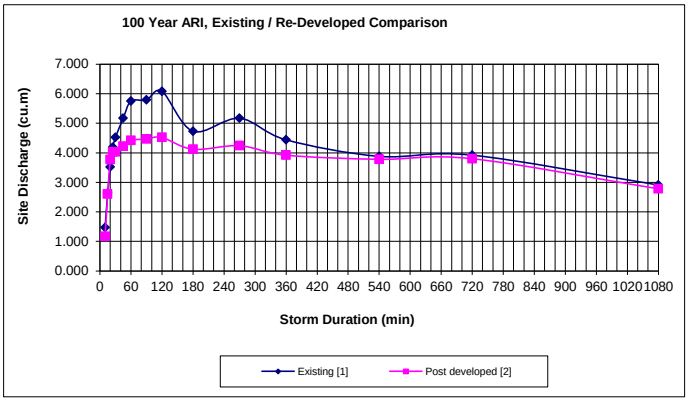
PAGE No
JOB No AA005435
PREPARED GD DATE 07/07/143
CHECKED DATE

DRAINS Models (existing and proposed):
F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\F - Exg_121211\AA005435_Exg_05
F:\AA005435\D-Calculations\A-Civil\A-Stormwater\A-DRAINS\G - Developed_121212\AA005435_P1_20y_06

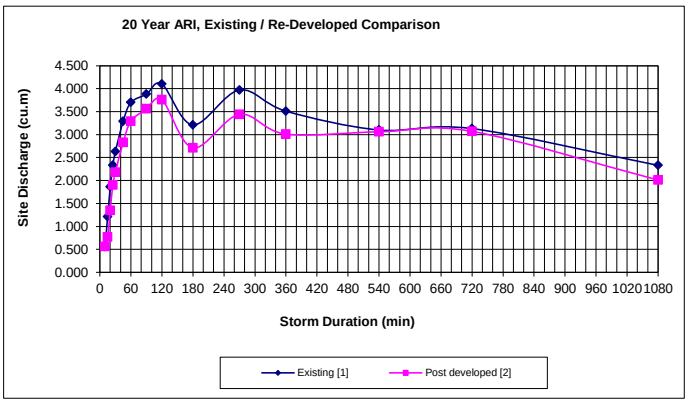
DRAINS Version: 2012.14 - 23 November 2012

Existing DRAINS Ref:
Re-Developed DRAINS Ref:

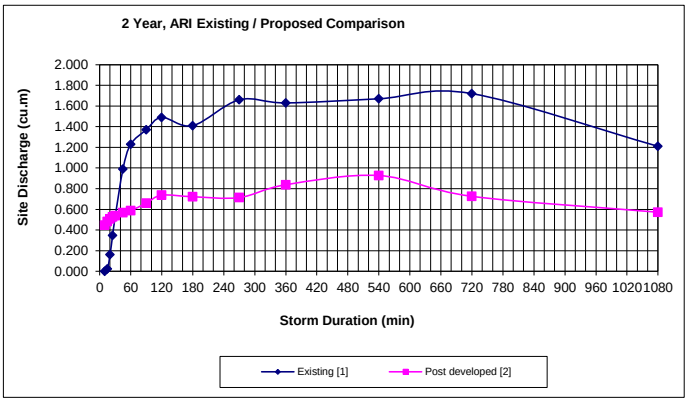
	100yr ARI Total		
Storm Dur. (min)	Existing [1]	Post developed [2]	[2] - [1]
10	1.470	1.170	-0.300
15	2.630	2.600	-0.030
20	3.520	3.770	**0.250**
25	4.190	4.030	-0.160
30	4.520	4.030	-0.490
45	5.170	4.220	-0.950
60	5.750	4.420	-1.330
90	5.790	4.470	-1.320
120	6.080	4.520	-1.560
180	4.730	4.120	-0.610
270	5.170	4.240	-0.930
360	4.440	3.920	-0.520
540	3.880	3.780	-0.100
720	3.920	3.800	-0.120
1080	2.910	2.780	-0.130
Max	6.080	4.520	



	20yr ARI Total		
Storm Dur. (min)	Existing [1]	Post developed [2]	[2] - [1]
10	0.561	0.561	0.000
15	1.210	0.769	-0.441
20	1.860	1.350	-0.510
25	2.330	1.900	-0.430
30	2.630	2.180	-0.450
45	3.290	2.830	-0.460
60	3.700	3.290	-0.410
90	3.880	3.560	-0.320
120	***4.100***	3.760	-0.340
180	3.210	2.710	-0.500
270	3.970	3.440	-0.530
360	3.510	3.010	-0.500
540	3.100	3.060	-0.040
720	3.130	3.070	-0.060
1080	2.330	2.010	-0.320
Max	4.100	3.760	



	2yr ARI Total		
Storm Dur. (min)	Existing [1]	Post developed [2]	[2] - [1]
10	0.000	0.446	**0.446**
15	0.023	0.482	**0.459**
20	0.162	0.508	**0.346**
25	0.348	0.526	**0.178**
30	0.530	0.538	**0.008**
45	0.990	0.567	-0.423
60	1.230	0.587	-0.643
90	1.370	0.660	-0.710
120	1.490	0.737	-0.753
180	1.410	0.722	-0.688
270	1.660	0.714	-0.946
360	1.630	0.838	-0.792
540	1.670	0.927	-0.743
720	1.720	0.726	-0.994
1080	1.210	0.572	-0.638
Max	1.720	0.927	-0.793



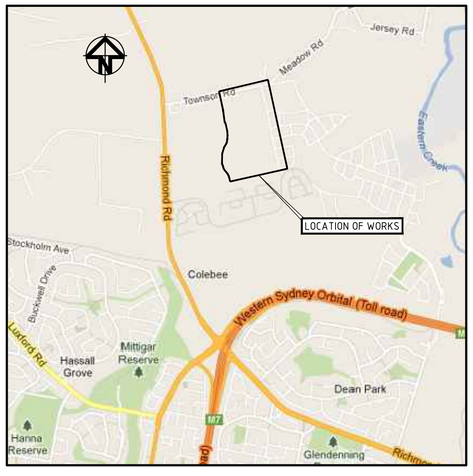
APPENDIX D

DESIGN DRAWINGS AND ARCHITECTURAL PLANS

TOWNSON ROAD PRECINCT
COLEBEE
REZONING APPLICATION

CIVIL DRAWING LIST

DRAWING NO.	DRAWING TITLE
C000	TITLE SHEET AND DRAWING LIST
C001	SITE PLAN
C002	CONCEPT STORMWATER DRAINAGE PLAN
C003	TYPICAL ROAD SECTION
C004	CATCHMENT PLAN
C005	POST DEVELOPED FLOOD MAP
C006	BASIN SECTIONS
C007	EARTHWORKS CUT AND FILL PLAN



LOCALITY PLAN
N.T.S

Issue	Description	Date
05	RE-ISSUE OF REZONING APPLICATION	07 MAR '14
04	RE-ISSUE OF REZONING APPLICATION	12 APR '13
03	RE-ISSUE OF REZONING APPLICATION	20 DEC '12
02	REZONING APPLICATION	14 DEC '12
01	FOR INFORMATION	12 DEC '12

100mm on Original

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY**
NOT TO BE USED FOR CONSTRUCTION

Scales	N.T.S.	Current Issue Signatures	
		Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	

Filename: C000-AA005435-NSD-00-TITLE SHEET AND DRAWING LIST.dwg

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: TITLE SHEET AND DRAWING LIST

HYDER CONSULTING PTY LTD
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Fax: +61 (0)2 8907 9001
www.hyderconsulting.com

Drawing No.	Project No.	Issue
C000	AA005435	05

Date Plotted: 7 Mar 2014 - 04:36PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C000-AA005435-NSD-00-TITLE SHEET AND DRAWING LIST.dwg V1

NOTES:

1. FLOOD EXTENTS AND DETENTION FEATURES DERIVED FROM HYDER MODELLING DATED DECEMBER 2012. REFER REPORT 'FLOOD STUDY AND MITIGATION BASINS FOR REZONING APPLICATION'

LEGEND:

- EXISTING PROPERTY BOUNDARY
- LIMIT OF WORKS
- EXISTING 100 YEAR FLOOD EXTENT
- EXISTING PROBABLE MAXIMUM FLOOD (PMF) EXTENT
- UN-CERTIFIED BIO-CERTIFICATION BOUNDARY
- PROPOSED CYCLEWAY

Issue	Description	Date
05	RE-ISSUE OF REZONING APPLICATION	07 MAR '14
04	RE-ISSUE OF REZONING APPLICATION	12 APR '13
03	RE-ISSUE OF REZONING APPLICATION	20 DEC '12
02	REZONING APPLICATION	14 DEC '12
01	FOR INFORMATION	12 DEC '12

0 50 100 150 200m

1 : 2000

100mm on Original

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY** NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 2000	Current Issue Signatures	
		Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	
Filename:	C001-AA005435-NSD-00-SITE PLAN.dwg		

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: SITE PLAN

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North Sydney NSW 2060
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Drawing No.	Project No.	Issue
C001	AA005435	05

Date Plotted: 7 Mar 2014 - 04:36PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C001-AA005435-NSD-00-SITE PLAN.dwg V1

TOWNSON ROAD

LIMIT OF WORKS

BASIN RAMP ACCESS

1:6 BATTER ALONG PARK EDGE

LOCAL 1:6 BATTER

DETENTION & WATER QUALITY BASIN MB03
100 YEAR WATER LEVEL VOLUME = 4,950m³

UN-CERTIFIED BIO-CERTIFICATION BOUNDARY

DETENTION & WATER QUALITY BASIN MB01
100 YEAR WATER LEVEL VOLUME = 5,140m³

T.O.B. RIPARIAN ZONE

water

SEWER PUMP STATION

LEGEND:

- EXISTING PROPERTY BOUNDARY
- LIMIT OF WORKS
- SW PROPOSED STORMWATER
- EXISTING 100 YEAR FLOOD EXTENT
- UN-CERTIFIED BIO-CERTIFICATION BOUNDARY
- PROPOSED CONTOURS
- RAINGARDEN

Issue	Description	Date
05	RE-ISSUE OF REZONING APPLICATION	07 MAR '14
04	RE-ISSUE OF REZONING APPLICATION	12 APR '13
03	RE-ISSUE OF REZONING APPLICATION	20 DEC '12
02	REZONING APPLICATION	14 DEC '12
01	FOR INFORMATION	12 DEC '12

100mm on Original

0 20 40 60 80 100m

1 : 1000

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	

File: C002-AA005435-NSD-00-CONCEPT STORMWATER DRAINAGE PLAN.dwg

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: CONCEPT STORMWATER DRAINAGE PLAN

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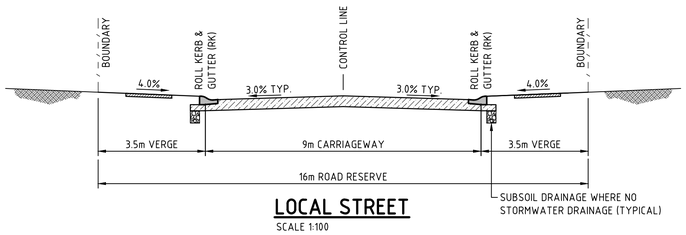
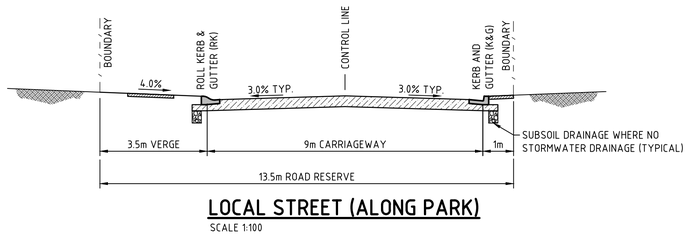
www.hyderconsulting.com

Drawing No.	Project No.	Issue
C002	AA005435	05

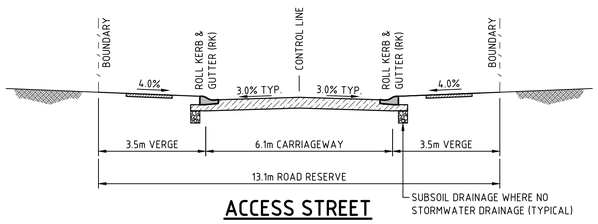
Date Plotted: 7 Mar 2014 - 04:37PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C002-AA005435-NSD-00-CONCEPT STORMWATER DRAINAGE PLAN.dwg V1



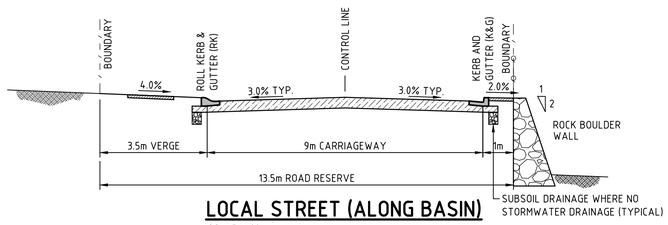
LOCAL STREET
SCALE 1:100



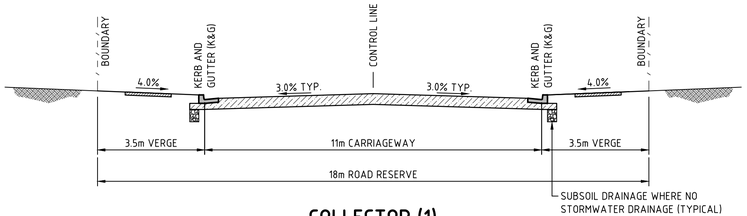
LOCAL STREET (ALONG PARK)
SCALE 1:100



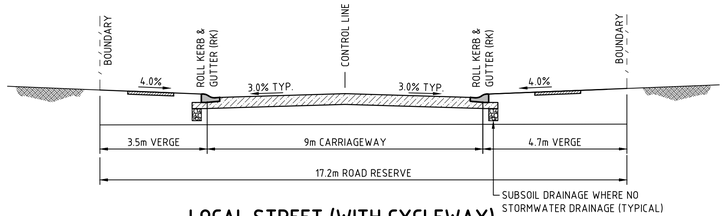
ACCESS STREET
SCALE 1:100



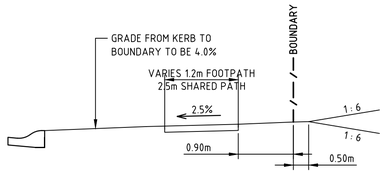
LOCAL STREET (ALONG BASIN)
SCALE 1:100



COLLECTOR (1)
SCALE 1:100



LOCAL STREET (WITH CYCLEWAY)
SCALE 1:100



TYPICAL VERGE DETAIL
1 : 50

Issue	Description	Date
05	RE-ISSUE OF REZONING APPLICATION	07 MAR '14
04	RE-ISSUE OF REZONING APPLICATION	12 APR '13
03	RE-ISSUE OF REZONING APPLICATION	20 DEC '12
02	REZONING APPLICATION	14 DEC '12
01	FOR INFORMATION	12 DEC '12

100mm on Original

0 2 4 6 8 10m

1 : 100

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 100	Current Issue Signatures	
		Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	

Filename: C003-AA005435-NSD-00-TYPICAL ROAD SECTIONS.dwg

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: TYPICAL ROAD SECTIONS

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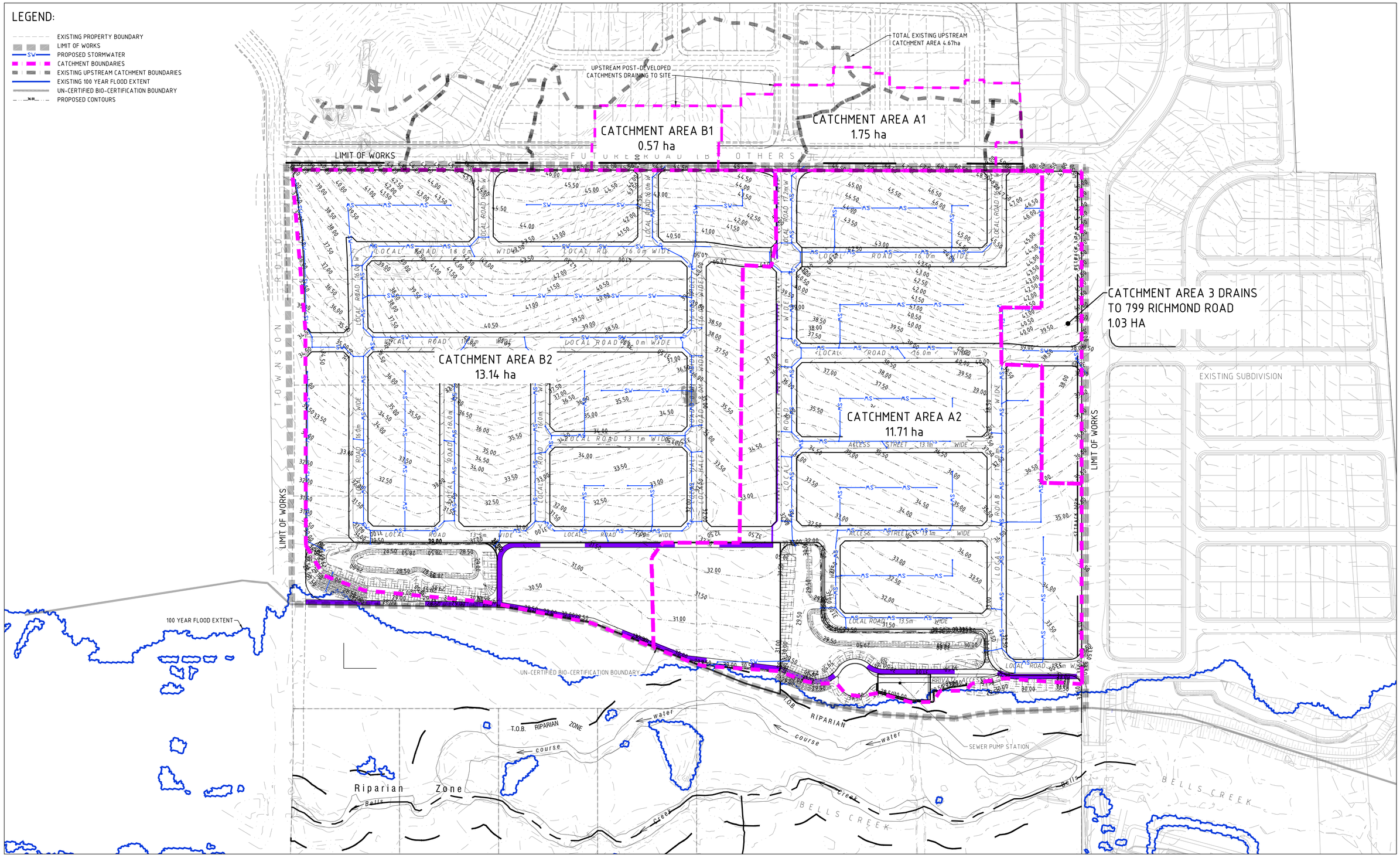
Drawing No. C003 | Project No. AA005435 | Issue 05

Date Plotted: 7 Mar 2014 - 04:37PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C003-AA005435-NSD-00-TYPICAL ROAD SECTIONS.dwg V1

LEGEND:

- EXISTING PROPERTY BOUNDARY
- LIMIT OF WORKS
- SW PROPOSED STORMWATER
- CATCHMENT BOUNDARIES
- EXISTING UPSTREAM CATCHMENT BOUNDARIES
- EXISTING 100 YEAR FLOOD EXTENT
- UN-CERTIFIED BIO-CERTIFICATION BOUNDARY
- PROPOSED CONTOURS



Issue	Description	Date
05	RE-ISSUE OF REZONING APPLICATION	07 MAR '14
04	RE-ISSUE OF REZONING APPLICATION	12 APR '13
03	RE-ISSUE OF REZONING APPLICATION	20 DEC '12
02	REZONING APPLICATION	14 DEC '12
01	FOR INFORMATION	12 DEC '12

0 30 60 90 120 150m

1 : 1500

100mm on Original

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY**
NOT TO BE USED FOR CONSTRUCTION

		Current Issue Signatures	
Scales	1 : 1500	Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	
Filename:	C004-AA005435-NSD-00-CATCHMENT PLAN.dwg		

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: CATCHMENT PLAN

HYDER CONSULTING PTY LTD
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Drawing No.	Project No.	Issue
C004	AA005435	05

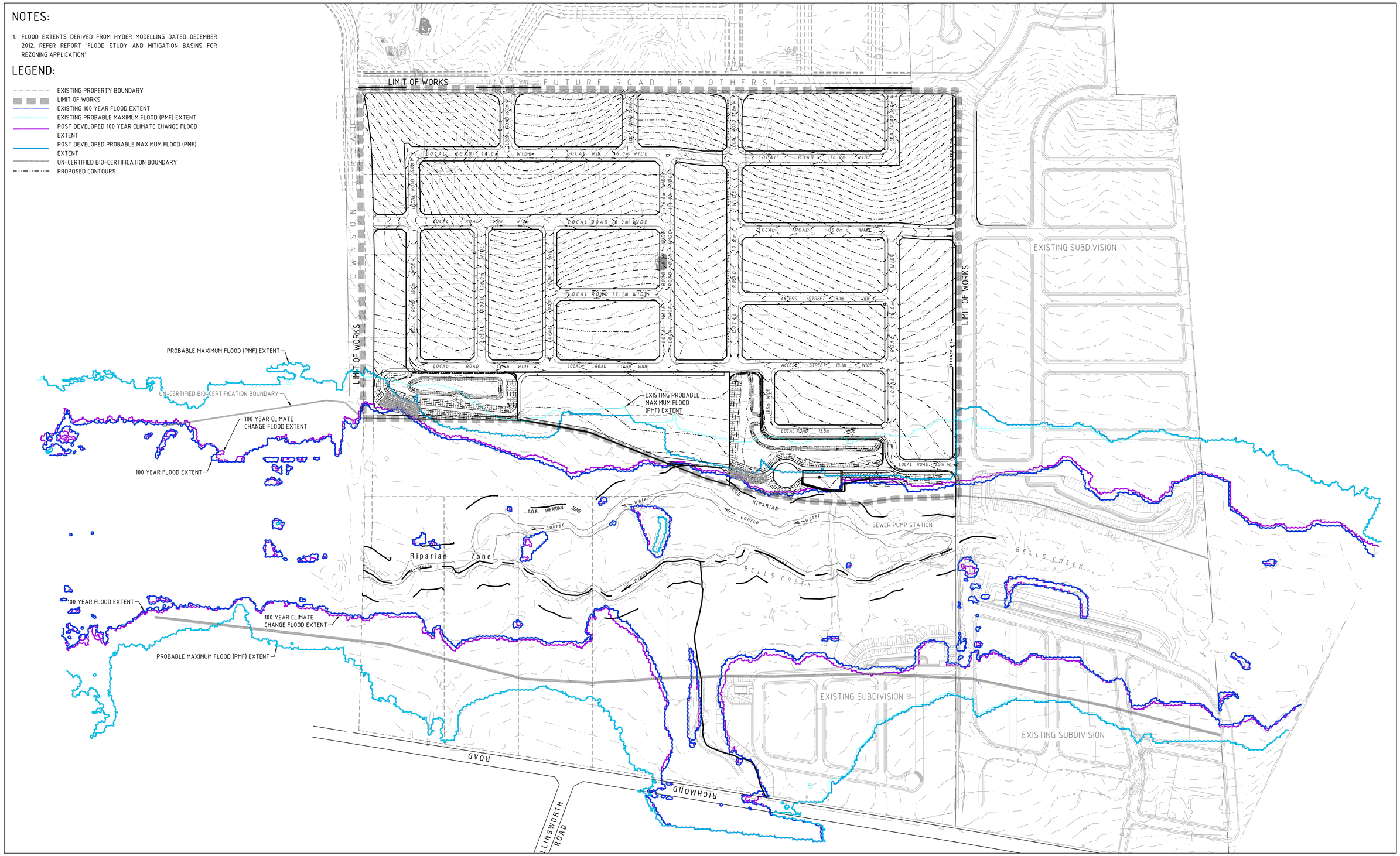
Date Plotted: 7 Mar 2014 - 04:37PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C004-AA005435-NSD-00-CATCHMENT PLAN.dwg V1

NOTES:

1. FLOOD EXTENTS DERIVED FROM HYDER MODELLING DATED DECEMBER 2012. REFER REPORT 'FLOOD STUDY AND MITIGATION BASINS FOR REZONING APPLICATION'

LEGEND:

- EXISTING PROPERTY BOUNDARY
- LIMIT OF WORKS
- EXISTING 100 YEAR FLOOD EXTENT
- EXISTING PROBABLE MAXIMUM FLOOD (PMF) EXTENT
- POST DEVELOPED 100 YEAR CLIMATE CHANGE FLOOD EXTENT
- POST DEVELOPED PROBABLE MAXIMUM FLOOD (PMF) EXTENT
- UN-CERTIFIED BIO-CERTIFICATION BOUNDARY
- PROPOSED CONTOURS



Issue	Description	Date
05	RE-ISSUE OF REZONING APPLICATION	07 MAR '14
04	RE-ISSUE OF REZONING APPLICATION	12 APR '13
03	RE-ISSUE OF REZONING APPLICATION	20 DEC '12
02	REZONING APPLICATION	14 DEC '12
01	FOR INFORMATION	12 DEC '12

100mm on Original

0 50 100 150 200m

1 : 2000

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY** NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 2000	Current Issue Signatures	
		Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	

Filename: C005-AA005435-NSD-00-POST DEVELOPED FLOOD MAP.dwg

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: POST DEVELOPED FLOOD MAP

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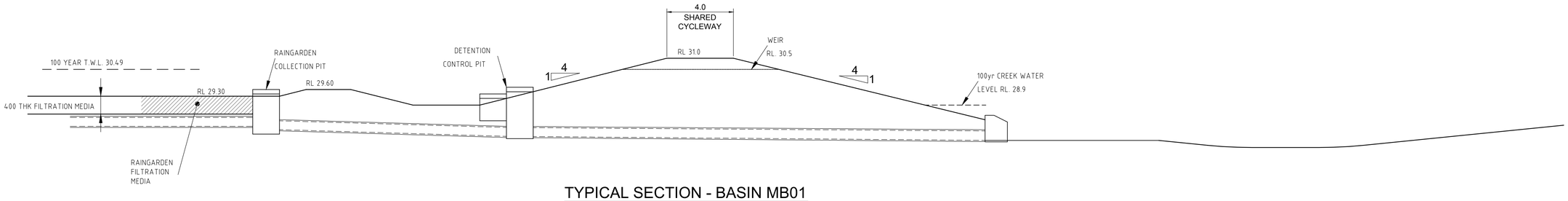
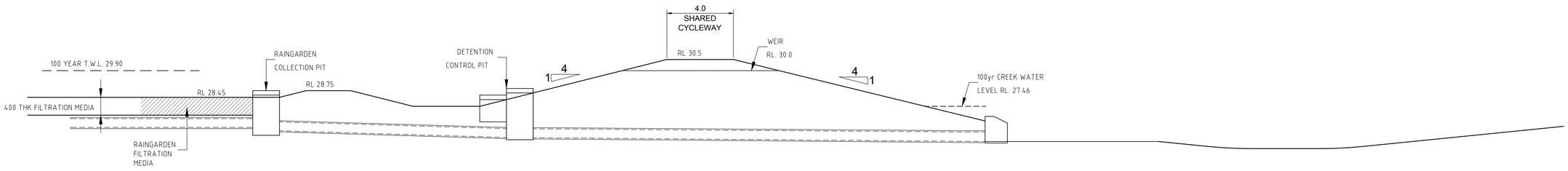
Drawing No.	Project No.	Issue
C005	AA005435	05

Date Plotted: 7 Mar 2014 - 05:55PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C005-AA005435-NSD-00-POST DEVELOPED FLOOD MAP.dwg V1



TYPICAL SECTION - BASIN MB01

SCALE 1 : 100



TYPICAL SECTION - BASIN MB03

SCALE 1 : 100

Issue	Description	Date
01	RE-ISSUE OF REZONING APPLICATION	07 MAR '14

0 2 4 6 8 10m

1 : 100

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY**
NOT TO BE USED FOR CONSTRUCTION

		Current Issue Signatures	
Scales	1 : 100	Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	

Filename: C006-AA005435-NSD-00-BASIN SECTIONS.dwg

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: BASIN SECTIONS

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North Sydney NSW 2060
Australia
Tel: +61 (0)2 8907 9000
Fax: +61 (0)2 8907 9001
www.hyderconsulting.com

Drawing No.	Project No.	Issue
C006	AA005435	01

100mm on Original

Date Plotted: 7 Mar 2014 - 04:38PM File Name: F:\AA005435\E-CAD\C-Civil\D-Final\C006-AA005435-NSD-00-BASIN SECTIONS.dwg V1

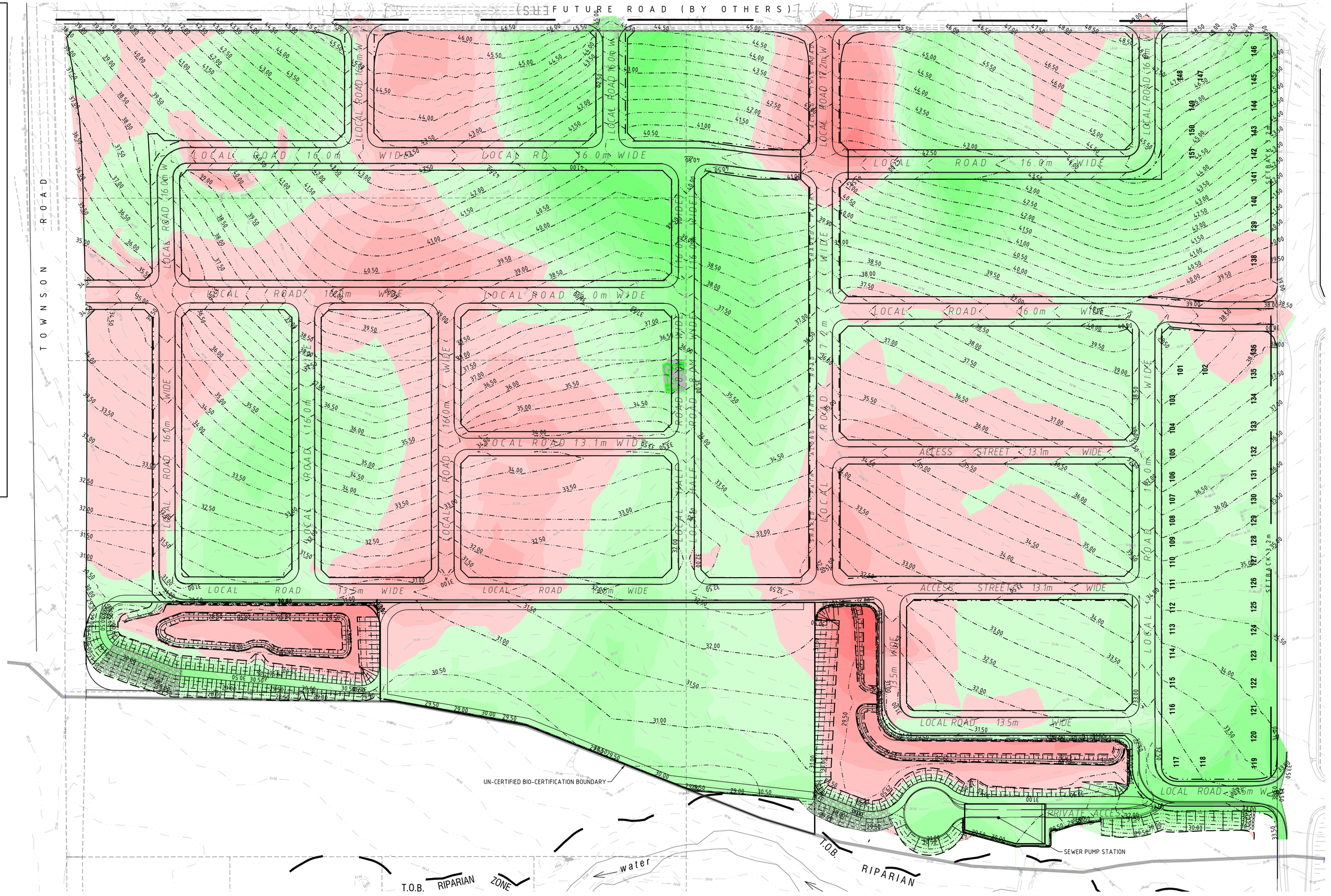
LEGEND:

EXISTING CONTOURS

PROPOSED CONTOURS

DEPTH OF FILL (m) / DEPTH OF CUT (m)

999 | 7.00 | 6.50 | 6.00 | 5.50 | 5.00 | 4.50 | 4.00 | 3.50 | 3.00 | 2.50 | 2.00 | 1.50 | 1.00 | 0.50 | 0.00 | 0.50 | 1.00 | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 999



Issue	Description	Date
01	RE-ISSUE OF REZONING APPLICATION	07 MAR '14

100mm on Original

Client: LAND OWNER GROUP

Status: **PRELIMINARY ONLY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn L. CORSCADDEN	
Original Size	A1	Designed S. KINSEY	
Height Datum	AHD	Checked M. KURTZ	
Grid	MGA	Approved S. KINSEY	

Filename: C007-AA005435-NSD-00-EARTHWORKS CUT AND FILL PLAN.dwg

Project: TOWNSON ROAD PRECINCT REZONING APPLICATION

Title: EARTHWORKS CUT AND FILL PLAN

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Drawing No.	Project No.	Issue
C007	AA005435	01

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