

PLANS AND DOCUMENTS
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The Reserve, Flagstone

Revised Stormwater Management Plan - Stormwater Quantity (Response to ULDA Information Request)

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EXECUTIVE SUMMARY

This revised Stormwater Management Plan (SWMP) has been prepared by Cardno (Water Resources and Coastal), specialist hydrologic and hydraulic consultants, for the proposed residential development of 'The Reserve' at Flagstone, New Beith in Logan City.

This report has been completed for MTAA Superannuation Fund Pty Ltd to provide a response to Urban Land Development Authority's (ULDA's) information request dated 14th December 2010 (ULDA Ref. No: DEV2010/085) for each of the items relating to the hydrologic processes within the local and regional drainage catchments.

The overall Flagstone development site has an approximate total area of 20 square kilometres, with 'The Reserve' (previously known as Stages 14A and 14B) covering approximately 12.8 hectares of this. 'The Reserve' is bound by Stage 12 of the Flagstone development to the south, by Stage 13 and Sandy Creek to the west and north, and by an unnamed tributary of Sandy Creek to the east.

Cardno has created a RAFTS model of Sandy Creek and its tributaries in order to assess the hydrologic regime in the vicinity of the site and to demonstrate that the development meets the non-worsening criterion with respect to discharge into Sandy Creek from the development. Both pre- and post-development scenarios have been considered, and preliminary detention basin designs are considered.

1 INTRODUCTION

This revised Stormwater Management Plan (SWMP) has been prepared by Cardno (Water Resources and Coastal), specialist hydrologic, hydraulic and water quality consultants, for the proposed residential development of 'The Reserve' at Flagstone, New Beith. The real property description of the site is Lot 900, SP216471, in the Logan City Council (LCC) Local Authority area. The site location and extents are shown on Figure 1.

The developer has previously facilitated the preparation of a SWMP for 'The Reserve' of the Flagstone development (Cardno report 7214/63-02 dated 30th April 2008). The original SWMP commented on the peak flow rates corresponding to different design storms events across the catchment and gave measures to be implemented to ensure that the runoff discharged from the site would not adversely impact on existing peak flow rates and flooding conditions of adjacent properties and receiving water bodies.

This revised SWMP follows on from the above mentioned previous SWMP and has been prepared in accordance with LCC's 'Logan Planning Scheme' (2006). The original SWMP has been reviewed to reflect the revised development layout and increased residential densities. The proposed site and drainage layout are shown on Cardno drawing number 7217/11/04-Figure No. 007. A copy of this plan is included in the reference drawing section of this report.

2 THE EXISTING SITE AND PROPOSED DEVELOPMENT

2.1 Existing Site Description

The subject site, as shown in Figure 1, is approximately 12.8ha in area and is located at 34 Creekside Crescent. The site is bound by Stage 12 of the Flagstone development to the south, by Stage 13 and Sandy Creek to the west and north, and by an unnamed tributary of Sandy Creek to the east.

The topography of the site is defined by a ridge running diagonally through the site in a north-easterly direction. This crest results in two main flow paths that affect flooding on the site. The northern catchment drains in a north-easterly direction and discharges directly to the Sandy Creek. The southern catchment drains in a south-easterly direction discharging further downstream into the Sandy Creek. Some parts of the site drain via sheet flow directly to the Sandy Creek. The site elevations range from approximately 45m AHD at the south-western corner to around 32m AHD where the site meets Sandy Creek. The site grades towards Sandy Creek and the tributary at an approximate average slope of 3-5%.

The current site is generally cleared, with scattered existing trees. The surface remains well grassed.

2.2 The Proposed Development

The proposed 'The Reserve' of the Flagstone development is approximately 12.8ha in size and comprises construction of 126 residential allotments ranging in size from approximately 230m² and also includes a central park space. Details of 'The Reserve' site layout are shown on Cardno drawing number 7217/11/04-Figure No. 007.

3 HYDROLOGY

3.1 Previous Studies

An analysis of the hydraulic and hydrologic conditions in the area was undertaken by Cardno for MTAA Superannuation Fund, and the results presented in the report "Flagstone Stages 14a, 14b, 15b, 15c & 15d Hydraulic Analysis (November 2009)". A hydrologic model describing Sandy Creek catchment was created using the runoff routing package RORB v6.0 (Laurenson, Mein and Nathan, 2008), for the purposes of reporting predicted peak flows in the pre and post development scenarios.

This modelling work is now required to be revisited to reflect the changes to hydrologic parameters arising from the redesigned lot layout.

3.2 Modelling Software

For the purposes of this study, an updated hydrologic model of Sandy Creek has been constructed using XP Software's RAFTS program. RAFTS is a non-linear runoff routing that uses the Laurenson non-linear runoff routing procedure to develop stormwater runoff hydrographs from either recorded rainfall data or design rainfall hyetographs (such as those proscribed in Australian Rainfall and Runoff (AR&R), 1987). It has been shown to successfully reproduce runoff characteristics for areas ranging in size from small urban catchments to large regional areas covering many hundreds of square kilometres.

Unlike RORB, RAFTS provides the user with the flexibility to specify both impervious fractions and abstraction models for individual sub-catchments, leading to an improved reproduction of the natural runoff process.

3.3 Catchment Description

The development site is located within the catchment of Sandy Creek, an ephemeral watercourse that rises in the foothills approximately 9 km west of the site, and flows in a generally eastwards direction to its confluence with the Logan River approximately 3.5 km downstream. The topography is characterised by its moderate relief, consisting of rolling hills around the vicinity of the site, and tending towards steeper slopes of up to 10% in upper catchment.

The total local catchment area was calculated to be 55.5 km². This area was then delineated into 31 sub-catchments for modelling purposes. A map showing sub-catchment definition is presented in Figure 2.

3.4 RAFTS Model Parameters

The initial-continuing rainfall abstraction model has been chosen for use in the RAFTS model, in accordance with the values shown in Table 1. Adopted Manning's n values are listed in Table 2.

Table 1 *Adopted Rainfall Loss Values*

Scenario	Initial Rainfall Loss	Continuing Rainfall Loss
Base Case – entire catchment undeveloped	0 mm	8.5 mm/h
Existing Case – pervious surface	0 mm	2.5 mm/h
Existing Case – impervious surface	0 mm	0 mm/h
Developed Case – pervious surface	0 mm	2.5 mm/h
Developed Case – impervious surface	0 mm	0 mm/h

In this report “Base Case” is taken to mean the catchment in its natural, undisturbed state; “Existing Case” is used to describe the catchment in its current condition; and “Developed Case” is used when describing the state of the catchment (including detention storages, unless otherwise noted) post the development of ‘The Reserve’ (formerly Stages 14a and 14b).

Table 2 *Manning’s ‘n’ Values*

Name	Value
Manning’s n	
Impervious surface	0.04
Pervious surface	0.12

3.5 Comparison to Previous RORB Model

In order to ensure the validity of the new RAFTS model, it was calibrated against outputs from the RORB model, using the RAFTS dimensionless ‘Bx’ factor as the main calibration tool. After several trial runs, a ‘Bx’ value of 0.72 was found to give a reasonable match to the RORB predicted peak flows, when measured at the catchment outlet (ie. the Logan River confluence). Results from this analysis, for the 100 year ARI design rainfall event, are shown in Table 3:

Table 3 *Comparison Between RORB and RAFTS Models*

Duration (min)	Predicted Peak Discharge (m ³ /s)		Difference (m ³ /s)
	RORB Model	RAFTS Model	
60	225	261	+ 36
120	289	299	+ 10
180	315	313	- 2
270	313	314	+ 1
360	303	309	+ 6
540	259	269	+10

The comparison shows that there is a reasonable level of agreement between the two models, particularly when considering the RAFTS critical duration storm event of 270 minutes. It is likely that the observed differences are a factor of the more complex catchment description utilised in the RAFTS program. Overall the analysis suggests that the RAFTS model is sound, and appropriate for the purposes of this study.

4 RESULTS

4.1 Local Catchment Runoff and Detention Basin Sizing

The area to be developed as "The Reserve" is defined by a ridge running through the site, splitting it into a northern and a southern drainage catchment. The effect of residential development in these two catchments was investigated by comparing the predicted peak discharges from the undeveloped site. Results are presented below.

Table 4 Northern Catchment – Predicted Peak Discharge

ARI (y)	Predicted Peak Discharge (m ³ /s)		Ratio (1)÷(2)
	Base Case ⁽¹⁾	Developed Case (without detention) ⁽²⁾	
1	0.19	1.01	5.48
2	0.28	1.31	4.68
5	0.43	1.68	3.92
10	0.52	1.90	3.64
20	0.65	2.19	3.39
50	0.81	2.43	3.02
100	0.95	2.72	2.85

Table 5 Southern Catchment – Predicted Peak Discharge

ARI (y)	Predicted Peak Discharge (m ³ /s)		Ratio (1)÷(2)
	Base Case ⁽¹⁾	Developed Case (without detention) ⁽²⁾	
1	0.20	1.62	8.04
2	0.31	2.10	6.69
5	0.49	2.71	5.54
10	0.60	3.05	5.07
20	0.75	3.51	4.69
50	0.96	3.87	4.06
100	1.12	4.34	3.87

Tables 4 and 5 clearly show the effect that the increased urbanisation has on peak discharge rates. Catchment runoff is predicted to increase by an order of magnitude, a result which is not unexpected considering the proposed lot density, and the change it represents from the catchment in its original, natural state.

To mitigate these effects a detention basin is proposed at the drainage outlet for both local catchments. An iterative design process was undertaken in RAFTS to determine appropriate basin geometries and outlet configurations. The adopted design is shown in Table 6, and the results from simulating catchment runoff with basins in place are shown in Table 7 and Table 8 respectively.

Table 6 *Proposed Preliminary Detention Basin Geometry*

Item	Northern Basin	Southern Basin
Shape	Inverted truncated pyramid	Inverted truncated pyramid
Base Length and Width	44.8 m x 44.8 m	54.5 m x 54.5 m
Batters	1v:4h on all sides	1v:4h on all sides
Top Length and Width	50.8 m x 50.8 m	61.9 m x 61.9 m
Top Footprint	2581 m ²	3832 m ²
Max. design water depth	1.2 m	1.55 m
Freeboard	0.3 m	0.3 m
Excavation Depth	1.5 m	1.85 m
Maximum Volume	3460 m ³	6310 m ³
Outlet Configuration	1/600 dia RCP	1/600 dia RCP

Table 7 *Northern Catchment – Detention Basin Results*

ARI (y)	Predicted Peak Discharge (m ³ /s)		Ratio (1)÷(2)
	Base Case ⁽¹⁾	Developed Case ⁽²⁾	
1	0.19	0.18	0.96
2	0.28	0.26	0.93
5	0.43	0.40	0.93
10	0.52	0.46	0.88
20	0.65	0.53	0.82
50	0.81	0.62	0.77
100	0.95	0.68	0.72

Table 8 *Southern Catchment – Detention Basin Results*

ARI (y)	Predicted Peak Discharge (m ³ /s)		Ratio (1)÷(2)
	Base Case ⁽¹⁾	Developed Case ⁽²⁾	
1	0.20	0.20	1.00
2	0.31	0.31	0.99
5	0.49	0.43	0.89
10	0.60	0.48	0.80
20	0.75	0.55	0.73
50	0.96	0.63	0.65
100	1.12	0.68	0.61

It can be seen from the results in Table 6 and Table 7 that the detention basins are effective in reducing the magnitude of post-development peak runoff, thus satisfying the no worsening criterion. The final layout and stage-storage configuration will be undertaken as part of the future submissions.

4.2 Regional Catchment Runoff

The interaction between the proposed detention system and coincident flows in Sandy Creek was investigated by simulating a range of 100 year ARI design event storms ranging in duration from 25 minutes to 6 hours, and comparing the peak flow rates. Two locations on Sandy Creek were chosen for the comparison – one immediately downstream of the site, and the other about 3.5 km downstream, just prior to the Logan River confluence. Results are presented in Table 8 and 9.

Table 9 *100 year ARI Flows – Sandy Creek Immediately Downstream of Site*

Duration (min)	Predicted Peak Discharge (m ³ /s)		Difference (m ³ /s)
	Existing Case	Developed Case	
25	94.7	94.6	0.0
30	103.9	103.9	0.0
45	125.9	125.9	0.0
60	141.2	141.2	0.0
90	149.4	149.4	0.0
120	154.0	154.0	0.0
180	156.5	156.4	-0.1
270	151.7	151.6	-0.2
360	148.0	148.0	0.0

Table 10 *100 year ARI Flows – Sandy Creek at Logan River Confluence*

Duration (min)	Predicted Peak Discharge (m ³ /s)		Difference (m ³ /s)
	Existing Case	Developed Case	
25	211.9	211.8	0.0
30	207.3	207.1	-0.2
45	219.7	219.7	0.0
60	251.8	251.8	0.0
90	275.7	275.6	0.0
120	288.1	288.1	0.0
180	299.8	299.7	-0.1
270	300.1	300.0	-0.2
360	305.2	305.2	0.0

The results from this analysis show that the implementation of the proposed detention system has almost no effect on peak discharge rates at the two downstream locations. Small decreases are noted for the 180 minute and 270 minute design storm events, however these changes are not considered to be significant given the magnitude of the flows.

5 CONCLUSION

This revised SWMP follows on from the initial SWMP dated 30th April 2008 prepared by Cardno and has been prepared to provide a response to ULDA's information request dated 14th December 2010 (ULDA Ref No: DEV2010/085) for each of the items relating to stormwater quantity.

The original SWMP has been reviewed to determine what impacts the change in allotment layout will have on the downstream environment. Revised hydrologic modelling was undertaken which showed that the implementation of detention basins as part of the development would reduce peak runoff rates to a level that resulted in no perceptible impact upon the receiving environment.

Figures

Figure 1 Locality Plan

Figure 2 Sandy Creek Catchment Map

Figure 3 Conceptual Stormwater Management Plan

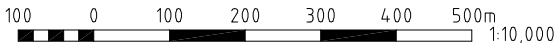


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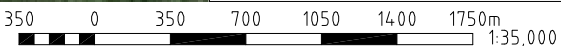
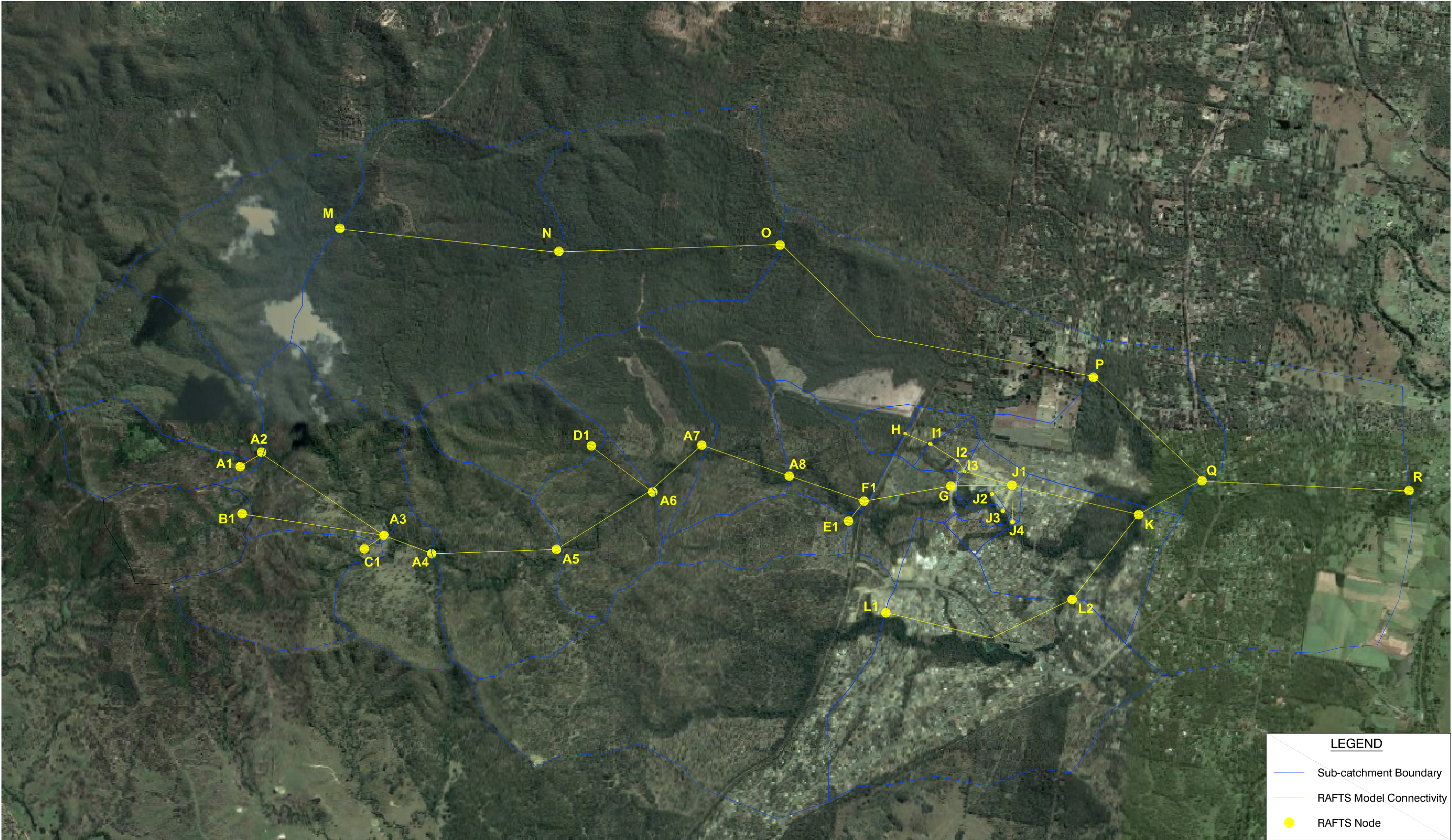


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FIGURE 1
SITE LOCATION

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LEGEND

Sub-catchment Boundary

RAFTS Model Connectivity

RAFTS Node

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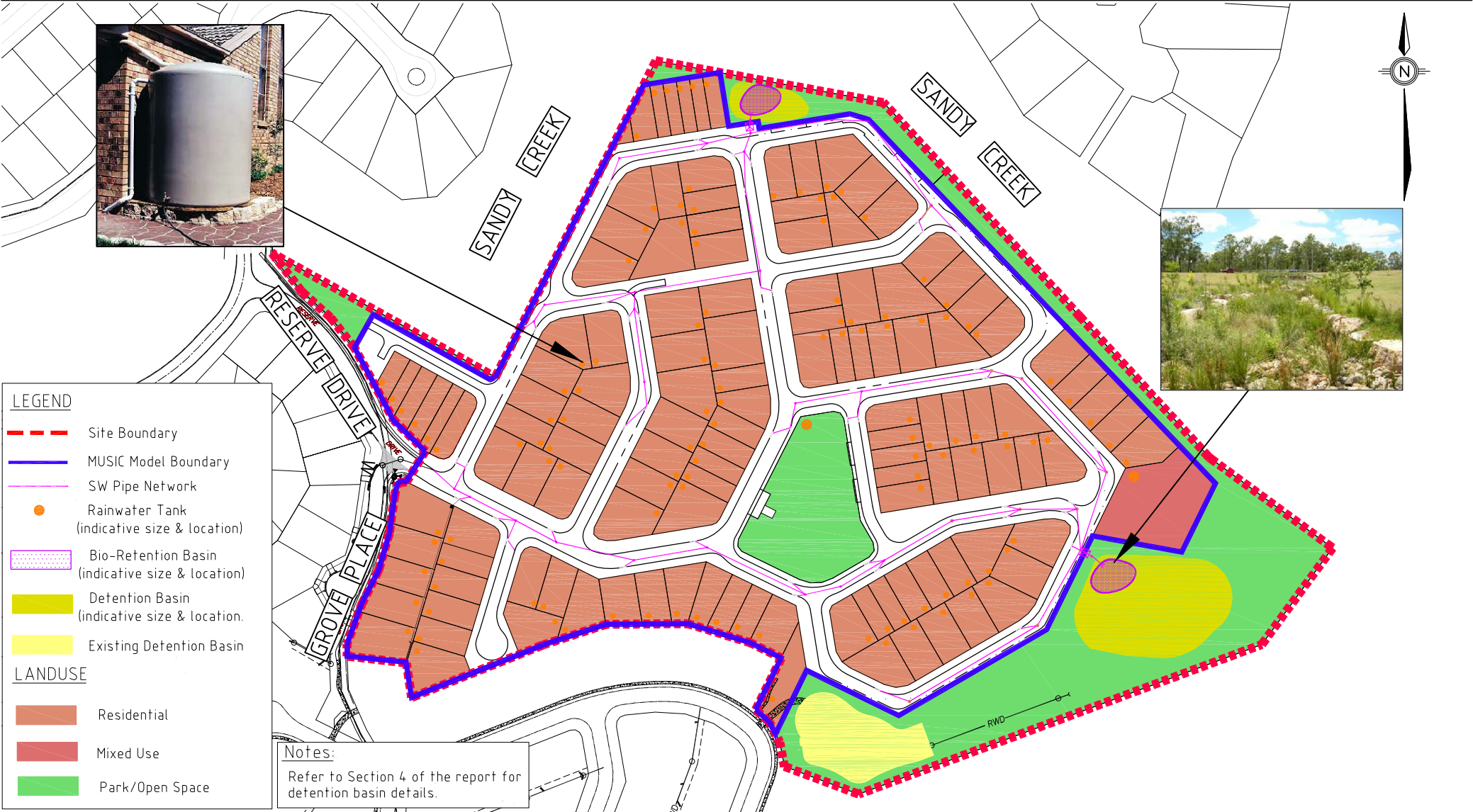
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FIGURE 2

SANDY CREEK CATCHMENT MAP AND RAFTS MODEL LAYOUT

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